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Basis of Design Report for the Long Pond Habitat Enhancement Design Project

PREPARED FOR

National Fish and Wildlife Foundation
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Cover photo: Aerial view of the Long Pond Project area within the Callahan Yuba Dredge Tailings reach of Scott River.

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1 INTRODUCTION

The Scott River Watershed Council (SRWC), in furthering its mission to support science-based restoration in Scott Valley, is working to restore natural processes and functions in the Callahan Yuba Dredge Tailings Reach of the Scott River (hereafter referred to as the Tailings Reach), located from River Kilometer (RKM) 83.8 to 91.9 in Siskiyou County, California. The work involves constructing and enhancing habitat features intended to invigorate positive ecological responses towards the recovery of listed anadromous salmonid species. Project implementation will be phased based on funding availability, as well as the willingness and availability of private landowners to implement actions in the channel and in existing and former floodplain portions of their property.

The Scott River Watershed Council, in collaboration with other key stakeholders, implemented the Westside Planning Project in 2018 (SRWC 2018). The project identified and prioritized high value, cost-effective opportunities to restore and enhance off-channel summer rearing and overwintering habitat for juvenile coho salmon (*Oncorhynchus kisutch*) in the Scott River and the west side tributaries to Scott Valley. The project identified lower Sugar Creek and the Scott River floodplain in the vicinity of the Sugar Creek confluence as high-priority areas for habitat restoration and enhancement. SRWC has implemented several habitat restoration projects in this area over the past six years, including construction and adaptive management of Beaver Dam Analogues (BDAs) in Sugar Creek from 2014 to 2017 and floodplain restoration in both lower Sugar Creek and the adjacent mainstem Scott River in 2020. SRWC has established and maintains a network of groundwater and surface water monitoring sites in the area and has been monitoring salmonid use of habitat features in this area since 2014.

The Long Pond Habitat Enhancement Design Project (hereafter Long Pond Project or Project) described in this Basis of Design report is located within the existing and former mainstem Scott River floodplain where SRWC has recently focused their habitat restoration efforts along lower Sugar Creek. The Long Pond project will establish connection to Sugar Creek and further enhance the complex mosaic of existing and restored aquatic and riparian habitat in the area. Stillwater Sciences is supporting SRWC with science-based engineering analysis and design development as part of the Project. The recent project implementation and monitoring by SRWC provides a wealth of information to inform the Long Pond project design elements. This draft basis of design (BOD) report describes preliminary feasibility analyses developed from field and office-based analyses, two conceptual design alternatives (i.e., 30% design level; see Appendix A for design drawings), and a preferred alternative.

During development of the project, stakeholders who form a Technical Advisory Committee (TAC) and who provide a cross section of habitat restoration knowledge and experience are helping integrate the best available science by reviewing technical analyses and conceptual designs and assisting in selecting and further developing a preferred alternative. TAC members for this project include representatives from the California Department of Fish and Wildlife (CDFW), the National Marine Fisheries Service (NMFS), the North Coast Regional Water Quality Control Board (Regional Water Board), University of California Davis, SRWC, and Stillwater Sciences (Table 1-1).

Table 1-1. Technical Advisory Committee members and other project stakeholders.

Technical Advisory Committee	
Member	**Affiliation**
Shari Witmore	NOAA
Bob Pagliuco	NOAA Restoration Center
Mark Elfgen	CDFW
Jacob Shannon	Regional Water Board
Eli Scott	Regional Water Board
Ann Willis	UC Davis
Erich Yokel	SRWC
Charnna Gilmore	SRWC
Betsy Stapleton	SRWC
Jay Stallman	Stillwater Sciences
Ryan Kilgren	Stillwater Sciences

1.1 Project Location

The Long Pond project site is located within the existing and former floodplains of the Scott River and Sugar Creek, near the Sugar Creek confluence approximately 2.5 miles north (downstream) of the town of Callahan in Siskiyou County, California (Figure 1-1). The project area encompasses dredged mine tailings and associated ponds, as well as an approximately 800-foot (ft)-long reach of the Sugar Creek channel immediately downstream of State Route 3.

The Scott River drains 813 square miles from its headwaters at approximately elevations of 7,000 to 8,000 ft (2,134 to 2,438 meters) to an alluvial valley floor at 2,700 ft (820 meters) and onward to the Klamath River at 1,580 feet (482 meters). Sugar Creek is a major west side tributary to the Scott River that originates at Russian Peak in the Salmon Mountains and drains 13.3 square miles as it flows east to the Long Pond project area and Scott River at approximately RKM 87.6. The drainage area of the Scott River upstream of the Sugar Creek confluence is approximately 170 square miles (USGS 2021). Average annual precipitation in the project vicinity is 42 inches, ranging from 20 inches in the valley bottom to 60 inches at higher elevations.

1.2 Need for the Project

The Scott River supports a core, functionally independent population of Southern Oregon/Northern California Coast (SONCC) Coho salmon, one of the most productive natural stocks in the Klamath River basin (NMFS 2014). Although little information is available to estimate coho abundance prior to the mid-20th century, legacy impacts from placer mining and other land uses have contributed significantly to a reduced population size relative to the historical size. CDFW currently estimates the adult coho population size in the Scott River watershed based on cooperative annual spawning ground surveys in the mainstem and tributaries (initiated in 2001) and adult migration past a video counting facility located in the mainstem Scott River at RKM 29 (initiated in 2007). Monitoring of the yearling juvenile emigration has also taken place since 2000. Since video operations began in 2007, the estimated escapement of coho Salmon in the Scott River has ranged from a low of 63 to a high of 2,752 and averaged 645 (Knechtle and Giudice 2020). The total number of Chinook Salmon that entered the Scott River during the 2019 season was estimated to be 2,090 fish (Knechtle and Giudice 2020).

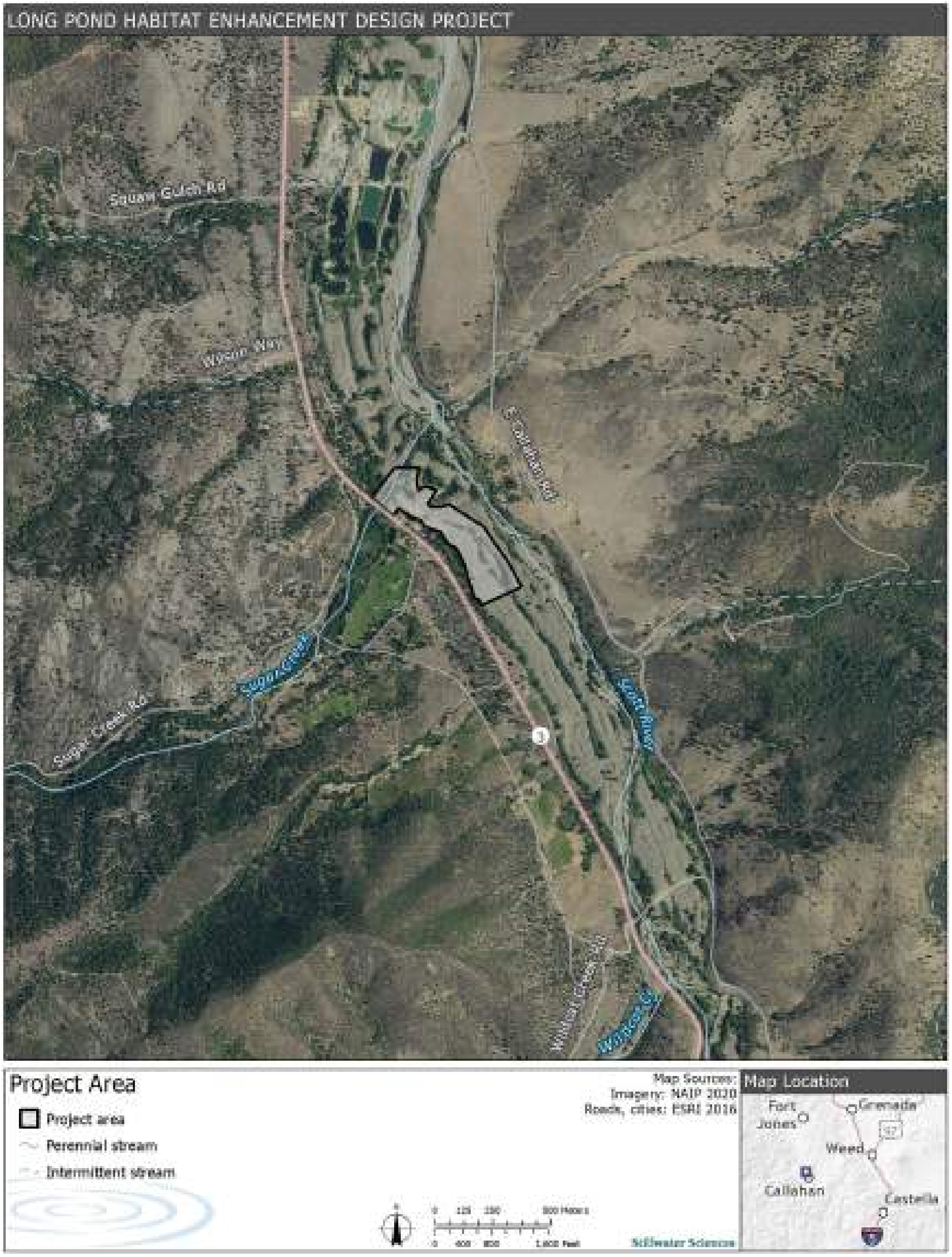

Figure 1-1. Location of the Long Pond Habitat Enhancement Design Project.

NMFS determined that 6,500 spawners are required to maintain a viable coho salmon population in Scott River. The discrepancy between the current estimated coho population size and the size required to sustain a viable population underscores the need for immediate intervention to help achieve recovery targets by eliminating migration barriers, improving water quality and availability, and restoring critical habitat.

An analysis of factors limiting coho salmon in the Scott River identified a lack of suitable rearing habitat during the summer and winter months as the most probable limitation for smolt production and the factor most limiting the population (SRWC 2006, NMFS 2014). Off-channel habitats are particularly important for survival, growth, high flow refuge, and overall life history diversity of juvenile coho in the Project area. These include habitats with slow-moving water, complex cover, and abundant food availability that are typically associated with floodplain wetlands and backwaters, secondary channels, alcoves, beaver ponds, and low-gradient tributaries. As water temperatures increase, individuals redistribute to thermal refugia with suitable low velocities and water temperatures.

Juvenile coho salmon redistribute from their natal habitats during the spring and fall in search of suitable summer or winter rearing locations. Gorman (2016) found that individual juvenile coho salmon in the Shasta River and Scott River that out-migrated as young-of-the-year (YOY), possibly due to poor natal conditions, experienced higher juvenile mortality than those rearing in natal streams. High juvenile mortality while transitioning to a non-natal stream can contribute to lower future adult returns. This mortality could have large effects on returns when, as in 2014 (a drought year), the abundance of YOY outmigrants is much larger than the number of smolt outmigrants within a cohort. Gorman (2016) interpreted from otolith analysis and PIT tag detections in the Shasta River that natal rearing contributes more to population persistence than non-natal rearing.

The mainstem Scott River within the Tailings Reach is confined to a narrow channel by 20 to 30 ft-high tailings piles comprised of small boulders, cobbles, and gravel. Confinement by tailings through the reach has disconnected the floodplain, simplified channel morphology, coarsened the bed, increased sediment transport, and resulted in increased deposition in downstream reaches. Floodplain disconnection has reduced groundwater recharge and storage capacity, as well as access to former floodplain habitat that provided high-value foraging, rearing, and slow water refugia for salmonids during winter high flows and helped fuel food-web productivity. In addition to causing floodplain disconnection, historical dredge mining realigned the mainstem Scott River channel to the eastern margin of the valley, establishing a gradient in the shallow aquifer from east to west away from the present river channel and toward the west side of the valley. As a result, the Scott River channel now goes dry and disconnects through the Tailings Reach during the spring baseflow recession through the fall, preventing anadromous salmonids from moving to and from mainstem and tributary habitats in the upper 20% of the watershed, including Sugar Creek. As drought and climate change progress, dewatering of this reach of the Scott River will likely become more frequent, more extensive, and longer in duration. The exposed cobble and lack of vegetation throughout the Tailing Reach have also increased incident solar radiation and added to the river’s thermal loading, contributing to the Scott TMDL temperature listing.

Remediation of the Tailings Reach has been identified in both the State and Federal coho recovery plans as a high priority restoration action for the recovery of coho salmon (CDFG, 2004). The SONCC Coho Salmon Recovery Plan (NMFS 2014) prioritizes recovery actions that (1) enhance and extend surface flow connectivity in the Scott River and tributaries so that sufficient instream flows are available for coho salmon migration, and (2) increase summer and winter rearing habitat through increased floodplain connectivity. NMFS recommends improving summer and winter rearing habitat by restoring natural channel form and function and by restoring or creating ponds, alcoves, backwater habitats and other off-channel features.

1.3 Project Goals

The central goal of the Long Pond Project is to develop and enhance habitat features in the Scott River floodplain in the vicinity of the Sugar Creek confluence that remediate limiting factors for ESA and CESA listed Southern Oregon Northern California Coast Coho. The design elements in the Project area are intended to provide the following attributes that support high quality summer and winter rearing habitat for juvenile coho:

- Access to cold water refugia for over-summering habitat with good water quality, high primary productivity, and sufficient depth and cover for protection from predation;
- Access to winter habitat with slow water during high flow events; and
- Connectivity between over-summering and winter rearing habitats in Long Pond, Sugar Creek, and the Scott River.

In addition to improved rearing habitat conditions for juvenile coho salmon, implementing actions that restore and enhance floodplain habitat and connectivity between Long Pond, Sugar Creek, and Scott River offers the potential for significant groundwater recharge, increases in dry season baseflow, and associated fish passage through reaches currently vulnerable to seasonal dewatering. The existing disconnected pond referred to as Long Pond and the other adjacent perennial ponded water features located in the Project area intercept an abundant supply of cool shallow groundwater, and connecting these ponds to the mainstem Scott River and/or Sugar Creek offers the potential to create and maintain connectivity between critical summer thermal refugia and winter velocity refugia for both adult and juvenile salmonids and other aquatic species.

The project objectives will be achieved by compiling existing data and acquiring additional relevant data, conducting analyses to evaluate opportunities and constraints, developing design alternatives, and producing a 100% design for a preferred alternative. The TAC met on 15 December 2020 to discuss opportunities and constraints and design alternatives.

1.4 Limitations and Constraints

Both the legacy of historical land uses and the current uses of private properties within the Project area result in potential limitations or constraints to habitat restoration and enhancement.

1.4.1 Historical land use

Prior to western expansion of settlers into Scott Valley during the early 1800s, the river occupied expansive floodplain aquatic and riparian habitat where a dynamic river channel contained complex morphology, multiple flow paths connecting to the floodplain, abundant large woody debris, and frequent beaver ponds. The river through the current Tailings Reach likely had year-round flows and supported large salmon and steelhead runs (Wells 1881; Stuart 1925, as cited in Klamath Basin Fisheries Task Force 1991; USDA 1944; Jackson 1966). Since then, the Scott River basin has been altered by many human activities that have affected aquatic and riparian habitats, including removal of beaver, hydraulic and dredge placer mining, construction of dams and diversions, river channelization, agricultural conversion, road construction, timber harvest, and rural residential development. These anthropogenic impacts, combined with the effects of large floods (e.g., 1955, 1964, and 1997) and fires, have simplified, degraded, and fragmented salmonid habitat within the basin (NMFS 2014).

Trappers removed large numbers of beaver from Scott Valley during the 1820s and 1830s (Wells 1881, as cited in Sommarstrom 1990). Many beaver ponds, which historically provided important off-channel rearing habitat and diverse channel margin habitat attractive to coho salmon, were lost with the removal of beaver (Mack 1958, SRWC 2005). This habitat loss likely significantly decreased the fitness and survivability of coho salmon in the Scott River basin (NMFS 2014).

Pervasive and lasting changes to the landscape began in about 1850 when alluvial reaches of the Scott River and major tributaries were extensively mined for placer gold deposits (Wells 1881). From 1936 to 1951, a floating dredge owned by the Yuba Consolidated Gold Fields Company mined the Scott River for placer deposits within a 4.7-mile reach downstream of Callahan between approximately RKM 83.8 and RKM 91.9 (Averill 1946, as cited in Klamath Basin Fisheries Task Force 1991; Jackson 1966; Sommarstrom 1990). The floating dredge reconfigured the entire Scott River valley within this reach, excavating up to 50 feet deep throughout the channel, floodplain, and nearby terraces. Dredging broke up naturally occurring cementation in the subsurface and inverted the alluvial stratigraphy in the valley, placing coarser material (i.e., cobble and boulder) at the surface in 20 to 30 foot-high piles and finer material (e.g., sand and finer) formerly at the floodplain surface at depth. The process typically removed all fine sediment and organic material from the ground surface that is necessary for supporting plant growth. The floating dredge advanced its position by continually excavating a pond in the forward direction while filling the ponded space behind. Where the dredge stopped, isolated ponds were left within the surrounding tailings. These ponds persist today and are fed by perennial, relatively cool shallow groundwater.

The legacy of dredging operations is pervasive and enduring: the realignment of the Scott River channel to the east side of its historical floodplain, confinement of the existing channel to a narrow floodplain within tailings piles that are immobile during all but the largest flood events, simplification of the channel to plane bed morphology with little in-channel or off-channel complexity, and increased transport capacity that coarsens the bed and exacerbates sedimentation in downstream reaches. The effects of these changes also contribute substantially to loss of annual shallow aquifer recharge, subsurface flow and disconnection of the Scott River channel through the Tailings Reach during the dry season, lower base flows during other times of the year, and increased incident solar radiation that contributes to thermal loading and increased water temperatures.

1.4.2 Contemporary land use

Agriculture, livestock ranching, mineral extraction (i.e., sand and gravel), and rural residential development have been and continue to be the major land uses in the Scott Valley. There are six private parcels that encompass portions of the Long Pond Project area (Table 1-2).

Table 1-2. Parcel information for properties within the Long Pond Project area.

Assessor's Parcel Number (APN)	Owner
031-490-440	Kalpin Michael R.
031-490-150	Kalpin Michael R.
031-490-460	Kalpin Marlin & Mary
031-220-420	Callahan Caleb & Nicole
031-220-430	Bundy Lee & Lorrie
031-220-310	Bowen Elizabeth

A residential structure and detached shop owned by Kalpin are located along the western portion of the site near the main access off State Route 3. Areas surrounding the structures are used for equipment and material storage and disposal. A network of secondary and tertiary roads, all with native surfacing, emanate from this location north to Sugar Creek, south down the Long Pond alignment, and east across the former Scott River floodplain to the Scott River channel and Sugar Creek confluence. The roads to the east are used primarily by Kalpin to provide guest access to private ponds for recreational fishing, Farmers Ditch Company to maintain their diversion facility located on the right bank of the Scott River about 700 feet upstream of the Sugar Creek confluence, and by SRWC to access habitat restoration projects and monitoring sites. Telecommunication lines suspended by wooden poles traverse the site from southwest to northeast over Long Pond.

2 GEOLOGY AND GEOMORPHOLOGY

2.1 Geology and Tectonics

The Scott Valley is a Quaternary tectonic basin located within the Klamath Mountains geomorphic province, which is underlain by a series of geologic terranes comprised of accreted oceanic lithosphere, volcanic arcs, and mélange (Irwin, 1994). The Project area is located in the Eastern Klamath terrane. The modern alluvial Scott Valley formed by Basin and Range extensional tectonics and was controlled by activity along two principal faults that form a graben, the northern Greenhorn fault and the western Scott Valley fault (Foglia et al. 2013). Activity along the Greenhorn and Scott Valley faults caused a dip in the alluvial Scott Valley during the Quaternary period, which resulted in stream captures, realignment of tributaries, dissection of older alluvial deposits, and tilting of the bedrock across the valley floor from east to west (Foglia et al. 2013).

Bedrock geologic units surrounding the Scott Valley range from late Precambrian to Early Cretaceous age and predominantly consist of the following strata in order of upward succession: Abrams and Salmon schists of early Paleozoic or late Precambrian age (older than 541 Ma), sedimentary rocks of Silurian-Ordovician age (419-485 Ma), the Copley greenstone of Devonian age (359-419 Ma), and ultramafic and igneous intrusive rocks of late Mesozoic age (Late Jurassic to Early Cretaceous, 100-163 Ma)(Figure 2-1)(Strand 1963, Holtz 1977). The oldest rocks are the Salmon and Abrams schists, recrystallized sedimentary and volcanic rocks of early Paleozoic or late Precambrian age. Unconformably overlying these rocks are more than 5,000 ft of slightly metamorphosed, strongly folded sedimentary rocks (e.g., sandstone, chert, slate, and limestone) of Silurian-Ordovician age correlated with the Duzel, Moffett Creek, and Gazelle formations (Holtz 1977). These relatively resistant rocks largely compose the bedrock in the mountains throughout the southern part of Scott Valley near the Project area. During the Mesozoic, these

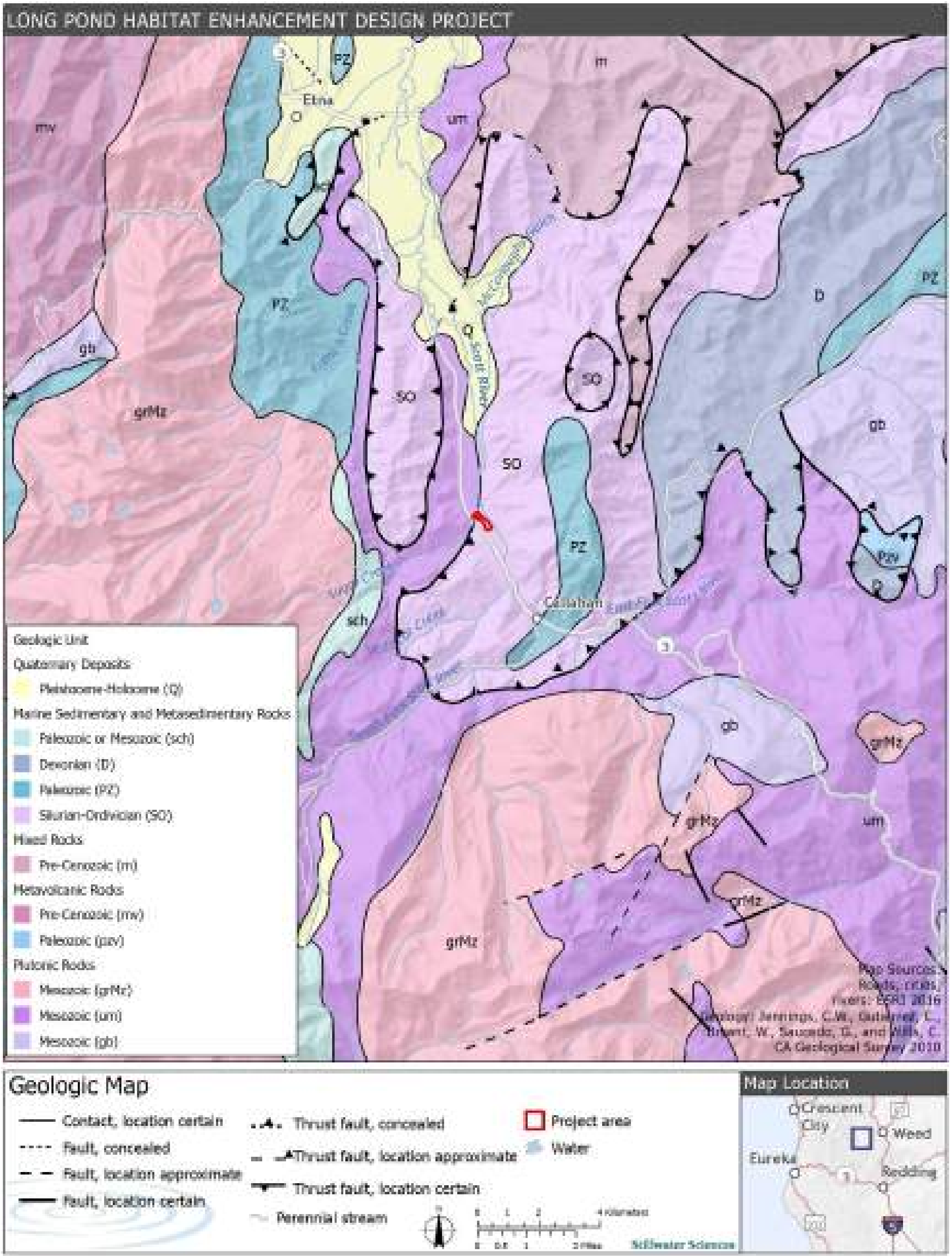

Figure 2-1. Geologic map of the Long Pond Project area and surrounding portions of the Scott River watershed.

bedrock units were intruded and deformed, leading to the formation of granitic and ultramafic rocks ranging in composition from peridotite to granodiorite (Mack 1958). The peridotites are typically highly sheared and serpentinized. The granodiorites are also commonly highly weathered and erosive where jointed and sheared, often producing a large supply of sand to the Scott River, especially from the west side tributaries such as Sugar Creek (Sommarstrom e al. 1990).

At the south end of Scott Valley, about 1 mile north of Callahan an ancient thrust or high angle reverse fault strikes northeastward through the Project area (Gutierrez et al. 2010). The lower reach of Sugar Creek, including the lowest reach that occurs within the Scott Valley, aligns with the fault trace where it is overlain by Quaternary sediments. The fault is a westward extension of the sinuous Mallethead fault, a major structural feature of the Eastern Klamath terrane (Hotz 1977). In the bedrock slopes west of the Sugar Creek confluence with Scott River, the fault juxtaposes competent sedimentary rocks of Silurian-Ordovician age to the south against less competent ultramafic rocks (i.e., serpentinized peridotite) to the north. This relationship of rock units and their respective properties may explain, in part, the hinge point in the groundwater hydraulic gradient indicated by water level monitoring in the Project area (refer to Section 3-4 for a discussion of water level monitoring), where groundwater that occurs at shallow depth over the more resistant and less permeable sedimentary units south of the fault precipitously deepens as it moves through the highly sheared and more permeable ultramafic units north of the fault.

The alluvial fill in the southern Scott Valley consists of isolated remnants of older alluvium (Late Pleistocene) that includes dissected fan and terrace deposits; and younger alluvium (Holocene) that includes stream channel, floodplain, and alluvial fan deposits related to the present course of the Scott River and its tributaries. The older alluvial deposits are prevalent at the south end of Scott Valley near Callahan, where they form terraces along the valley margins. The maximum exposed thickness of older alluvial deposits in this area is probably less than 50 ft (Mack 1958). These older alluvial deposits are poorly sorted and consist of well-rounded granodiorite, serpentine, chert, and quartzite clasts within a matrix of sand and silty clay. The younger alluvium reaches a thickness of as much as 400 feet in the widest part of Scott Valley, with thickness decreasing to the north and south (Foglia et al. 2013). Based on records derived from historical dredging operations, Mack (1958) reports thicknesses of younger alluvium of about 100 ft near McConaughy Gulch, 36 to 52 ft in the area between McConaughy Gulch and the southern end of the valley, and 12 ft in an unspecified area located approximately two miles north of Callahan.

2.2 Geomorphology

The project team conducted a geomorphic assessment to characterize existing geomorphology and geomorphic processes within and near the project area, assess risks associated with potential hazards, support assessment of opportunities and constraints, and inform project designs. The geomorphic assessment included review of existing information, analysis of historical aerial photographs from 1944 to 2020, and a field assessment.

As discussed above, the modern Scott Valley is a tectonic graben that evolved into its present form during the Late Quaternary in response to fault displacement, uplift, and tilting. The dissected alluvial fan and terrace remnants in the southern portion of the valley indicate that the Scott River incised during the late Pleistocene in response to regional uplift and base level lowering. Throughout the Holocene, however, the Scott valley has largely been aggradational, with the thickest valley fill located in the widest part of valley between Etna and Greenview and thinner alluvial fill in the southern portion of the valley within the Tailings Reach (Mack 1958).

The Tailing Reach is the transition zone between steeper headwater reaches of the drainage network and the wider, lower gradient valley bottom to the north. The major headwater tributaries draining to the Long Pond Project area upstream of Sugar Creek include Wildcat Creek (drainage area 0.9 mi^2), which meets the Scott River 1.8 miles upstream of the Sugar Creek confluence, and the South Fork Scott River (drainage area 44 mi^2) and East Fork Scott River (90 mi^2), which meet approximately 2.7 miles upstream of the Sugar Creek confluence near Callahan. The average valley slope through the tailings reach is about 0.87%.

Valley and channel widths are typically confined upstream of Callahan by bedrock toe slopes and remnants of Pleistocene alluvial fans and river terraces. Between Callahan and about the Wildcat Creek confluence, the valley widens to about 400–600 ft, with active channel and floodplain widths of about 130–160 ft. The channel in this reach becomes more sinuous but is still relatively narrowly confined by fan and terrace remnants. Mine tailings occur on floodplains and terraces but have less overall effect on confinement and associated fluvial processes than in downstream reaches. A prominent bedrock pinch point in the mainstem valley width located just upstream of the Wildcat Creek confluence signifies the upstream end of the Tailings Reach, downstream of which the valley quickly widens to 800–1,000 ft and is ubiquitously occupied by 20 to 30 ft-high tailings piles from valley toe to valley toe, except within the active channel and floodplain, which is confined to 100–150 ft by the tailings. The tailings are typically composed of small boulder, cobble, and gravel. Bedrock outcrops occur intermittently in the mainstem Scott River channel bed and right bank in the most upstream portions of the Tailings Reach; however, bedrock outcrops have not been observed in the Long Pond Project area.

The Scott River channel through the Tailings Reach has predominantly plane bed and shallow pool-riffle morphology with a predominantly cobble and gravel bed. Localized deposits of finer gravel, sand, and silt occur in the channel in association with planform curvature, pool tails, and large roughness elements (bedrock outcrops, boulders, large wood, and patches of riparian vegetation) and on floodplains. Planform is relatively straight to gently meandering with a low amplitude and long wavelength. The active channel is highly simplified, with typically shallow runs and riffles, little large wood or other structure, and a scarcity of woody riparian vegetation. Most woody riparian vegetation is young and highly transient in response to flood events and drought. High flow channels occur throughout the Tailings Reach, but typically in a dynamic state with little cover, velocity refuge, or overall habitat complexity. Historical dredger mining operations realigned the active Scott River channel to the east side of the valley throughout the Tailings Reach, where it remains confined on the right bank by bedrock. Isolated perennial ponds created by historical dredging operations occur throughout the tailings within the central and western (left bank) floodplain areas. These ponds are fed by relatively cool shallow groundwater flow. Wetland and woody riparian vegetation typically occur in narrow zones along the pond margins and in the troughs between tailings piles where vegetation can access surface water and shallow groundwater. The valley maintains these characteristics to the downstream extent of historical dredge mining operations located about 2.3 miles downstream of Sugar Creek near RKM 83.8.

Long Pond, the focus of this design project, is a prominent linear pond or series of ponded water features that occur in the axis of a narrowly confined trough between tailings piles. The overall length of the trough is approximately 1.0 miles, and the average slope is 0.9 percent (Figure 2-2). The upstream end of the trough is separated from the active mainstem Scott River channel by a large plug or berm that is approximately 140 ft long, 60 ft wide, and 10 ft high. Historical aerial photography indicates that the berm was built sometime between 1980 and 1992, likely in response to the large flood that occurred on 20 December 1981 (peak flow of 25,500 cfs with a

16-year recurrence interval at the USGS Scott River gage No. 11519500 near Fort Jones)(Appendix B). The event, scaled by drainage area, would be roughly 6,600 cfs in the Tailings Reach near the Project site. The berm prohibits surface water in the Scott River from entering Long Pond at all flow levels, including high flow events. Bottom width of the trough varies from 30 to 110 feet. The downstream half of the trough is occupied by three larger ponds and several smaller ponded water features. The upstream most pond, commonly referred to as Bowen Pond and which is outside the Project area, is approximately 0.5 acres; the middle pond, commonly referred to as Long Pond, is approximately 1.1 acres; and the smallest and most downstream pond is 0.6 acres.

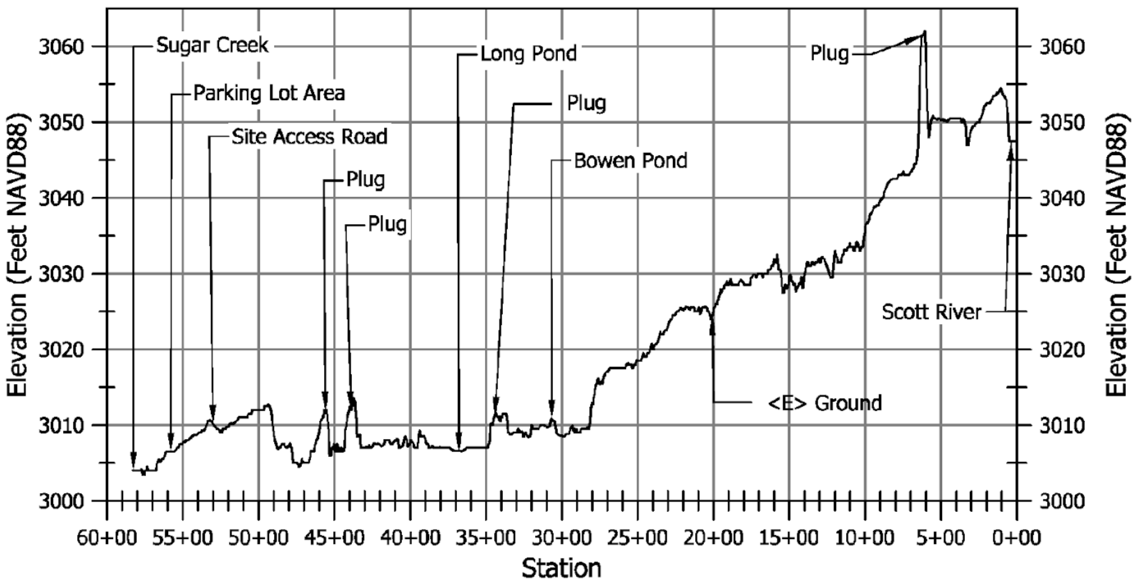

Figure 2-2. Longitudinal profile through Long Pond and adjacent ponds.

Although the ponds are hydrologically connected by a relatively large volume of rapid shallow groundwater flow through the highly permeable tailings deposits, surface water connection is blocked by small cobble-gravel plugs located between each pond. Monitoring of pond water surface elevations and surrounding shallow groundwater levels indicates that pond hydrology is highly responsive to changes in mainstem Scott River flow, with the ponds experiencing rapid stage changes over the course of a mainstem high flow event. However, the lack of surface water connection to the Scott River combined with the low gradient, lack of stream power to mobilize the existing coarse substrate, and lack of sediment supply leads to relatively static conditions with little to no fluvial geomorphic changes (e.g., scour and fill or vegetation removal) occurring over the historical or anecdotal period of record.

The downstream end of the trough transitions to a broad and relatively flat surface where the western side of the trough (left bank) becomes unconfined. The private residence and shop structures and the primary access to the project from State Route 3 are in this area. This relatively flat surface extends to and connects with the right bank floodplain of Sugar Creek. This area was an equipment yard and disposal site through 1980. Sometime between 1980 and 1992, the equipment and other materials stored at the site were removed, some of which may have been buried on site. The adjacent pond to the east was reduced in size by fill during this time.

The Sugar Creek channel within the Project area has an average slope of 0.2 percent. The gravel and sand-bedded channel has predominantly plane bed and pool riffle morphology. Pool water surface elevations though the reach are largely controlled by BDA's installed and adaptively managed by SRWC and by naturally occurring beaver dams. The channel and floodplain of Sugar Creek are narrowly confined by tailings piles on both banks over most of its course as it cuts across the former Scott River floodplain. The Scott River Watershed Council implemented a floodplain enhancement project on the left bank of Sugar Creek across and about 200 feet downstream from the Long Pond alignment in 2020. The project involved lowering floodplain elevations to increase the frequency and duration of inundation, thereby creating a surface for finer sediment and wood accumulation during high flow events in Sugar Creek, suitable conditions for riparian vegetation establishment and growth, and winter rearing habitat for juvenile coho salmon. In early 2021, SRWC began adaptively managing the newly constructed left bank floodplain by injecting sand into the surface to reduce rapid infiltration and minimize loss of surface flow in Sugar Creek. Anecdotal accounts indicate that lower Sugar Creek near the Scott River confluence is incising in response to base level lowering in the Scott River, which has the potential to increase the frequency and duration over which Sugar Creek becomes disconnected from the mainstem Scott River in the dry season and during dry years.

Two additional large, deep floodplain ponds occur within the tailings to the northeast of Long Pond. The first, which is part of the Long Pond Project, is located immediately adjacent to the parking area near State Route 3 and Sugar Creek. The Siskiyou Resource Conservation District (SRCD) implemented a project in 2015 that involved constructing two short channels connecting the existing pond to Sugar Creek to provide off channel rearing habitat and velocity refuge for juvenile coho salmon and other aquatic species. The Scott River Watershed Council maintains the off-channel project and monitors juvenile coho salmon use of this pond and other habitats in lower Sugar Creek via PIT Tags. The larger pond to the east that is privately used for recreational fishing is outside the project area and is not part of the current habitat enhancement design.

2.2.1 Aerial photograph interpretation

Historical aerial photographs and LiDAR were reviewed to characterize long-term changes in geomorphology, vegetation, and land use within the Project area. The historical aerial photo time series used in the analysis includes the following years: 1944, 1955, 1965, 1980, 1992, 2002, 2010, 2016, and 2020 (Table 2-1, Figure 2-3). Appendix B includes orthorectified historical aerial photographs cropped to the project vicinity. Table 2-2 includes a summary of changes interpreted from the historical aerial photographic time series. These interpretations can be expanded, as necessary, to address questions that may arise during future steps in the Project design process.

Table 2-1. Aerial photo acquisition dates and associated peak flows.

Representative photo year	Acquisition date	Date of largest annual peak discharge since previous photo	Approximate annual exceedance	Approximate recurrence interval	Preceding annual peak discharge (cfs) at USGS Fort Jones station	Preceding annual peak discharge (cfs) scaled to the Project site
1944	8/6/1944	1/22/1943	30.0	3.3	8,870	2,545
1955	8/12/1955	1/19/1953	12.5	8.0	16,000	4,591
1965	7/10/1965	12/22/1964	1.3	125	54,600	15,667
1980	6/17/1980	1/16/1974	3.7	26.7	36,700	10,531
1992	7/1/1992[1]	12/20/1981	6.2	16.0	25,500	7,317
2002	7/1/2002[1]	1/1/1997	5.0	20.0	34,300	9,842
2010	8/2/2010	12/31/2005	7.5	13.3	23,600	6,772
2016	6/19/2016	2/10/2015	17.5	5.7	14,600	4,189
2020	7/9/2020	2/10/2017	11.2	8.9	16,100	4,620

[1] Aerial photo acquisition date estimated.

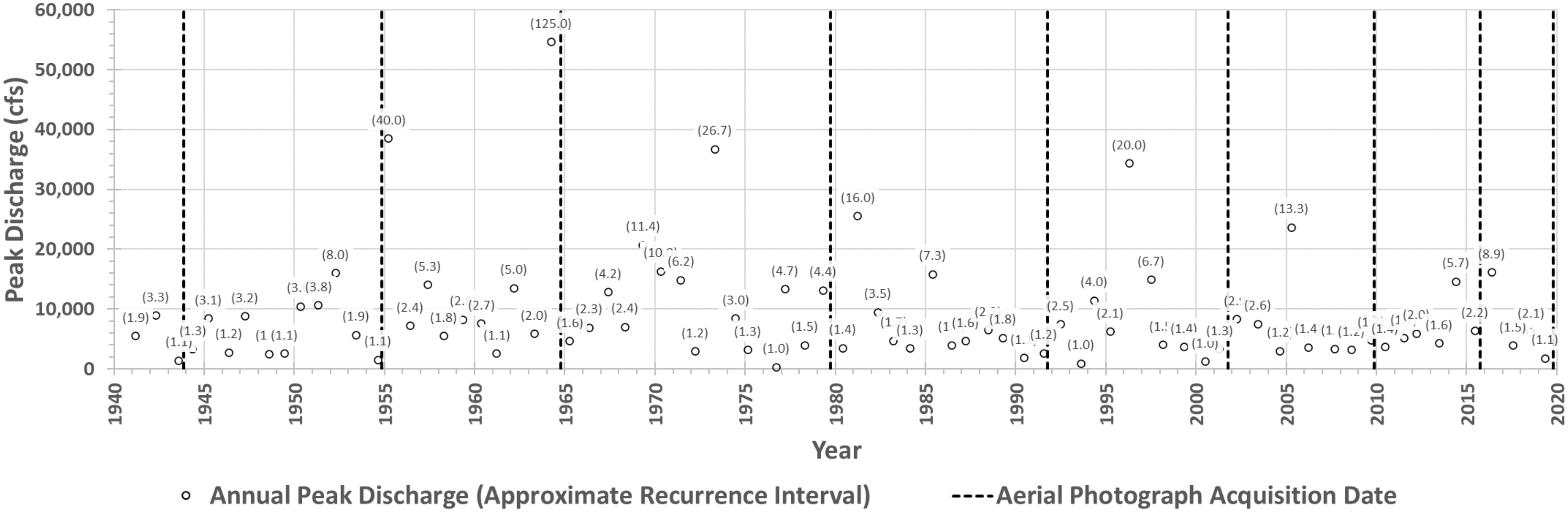

Figure 2-3. Annual peak discharge record for the Scott River (USGS gage No.11519500 near Fort Jones) associated with representative aerial photographs.

Table 2-2. Interpretation of changes observed within the Project vicinity based on representative historical aerial photography, 1944–2020.

Photo years	Observed changes by area: Sugar Creek downstream of State Route 3	Observed changes by area: Scott River near Sugar Creek confluence	Observed changes by area: Long Pond alignment	Observed changes by area: Infrastructure
1944–1955	Lower Sugar Creek appears to have aggraded. 1955 channels cut across prominent midchannel bar that is mostly undissected in 1944. 1944 pool located ~100 ft upstream of the confluence missing in 1955.	Secondary flow paths near confluence are less defined and more vegetated in 1955 than in 1944.	Open water in Long Podn is less apparent in 1955 (could be due to photo quality). Plugs separating ponds within the Long Pong alignment are already in place by 1944. Vegetation in vicinity of fin and elsewhere already established.	
1955–1965	Dramatic flood affects upstream and downstream of St Rte 4. Downstream of St Rte 4, Sugar Creek flood flows went out of bank and were routed down the west side of the mainstem valley, scouring the surface. The flood cut into the left bank tailings, creating new floodplain area over entire length. Sugar Creek straightened and simplified. Mainstem migration into Sugar Creek created new confluence and shortened Sugar Creek. Two flow paths at the confluence: one short, broad, and shallow; the other (mainstem side channel) is longer, narrower, more sinuous, and more complex channel. Riparian forest in the lee of the St Rte 4 appears less affected by flood and begins to thicken.	Dramatic shifts in planform to more single thread upstream of confluence. Vast areas scoured and filled, left unvegetated. Mainstem meander migrated downstream into Sugar Creek confluence and the adjacent pond to the south (upstream). Left bank side channel formed downstream of confluence, probably carrying most of Sugar Creek flow. Flow split downstream of this side channel outlet.	The 1955 and 1964 floods did not result in any apparent changes to the Long Pond alignment. Plugs and vegetation appear unaffected.	St Rte 3 constructed. New bridge over Sugar Creek. Levee may have been constructed along left bank of Sugar Creek immediately downstream of new highway alignment at the same time the highway and bridge were built.
1965–1980	Sugar Creek has midchannel bar with split flow just downstream of St Rte 4 but is otherwise wide, shallow, and plane bed. Midchannel bar formed at 1965 confluence. Extensive riparian vegetation has established (1) on the right bank in the lee of St Rte 4, (2) on the back side of the left bank levee and in the path of scour along the west side of the valley, (3) at the outer extent of the left bank floodplain near the confluence, and (4) in the mainstem floodplain upstream of the confluence where the pond was scoured. Short flow path at the 1965 confluence has incised and lengthened into mainstem floodplain but lacks good connection to Scott River. Longer, more sinuous channel now has pool riffle morphology with riparian vegetation, appears to convey much of Sugar Creek flow, connects to Scott River via wide shallow riffle.	Main channel shifted to right bank and straightened. Former channels established in 1964 flood now secondary features with riparian vegetation established along margins and intervening bars. Little vegetation along main channel.	Very little change to ponds and plugs in the Long Pong alignment. More riparian vegetation has established.	Equipment storage and disposal expanded around the Kalpin residence and shop and northward toward Sugar Creek and along the adjacent pond. Small portion at the southern edge of this pond was filled. Levee along left bank of Sugar Creek clearly in place by 1980 (if not earlier).
1980–1992	Midchannel bar at 1965 confluence apparent in 1980 transitions to transverse bar with pools at upstream and downstream ends. Dominant Sugar Creek connection to mainstem unclear in this photo. Flow appears to go subsurface at bar/fan feature at 1965 confluence (migration barrier?). Sinuous channel along left bank downstream of 1965 confluence now heavily vegetated. Other areas of riparian vegetation have expanded.	Main channel flow path still along right bank upstream of confluence with similar high flow features between channel and confluence. Riparian vegetation has expanded. Downstream of confluence, the main channel shifted to right bank, apparently with much less inundation of the former left bank features (high flow channel and sinuous side channel conveying Sugar Creek flow).	Very little change to ponds and plugs or riparian vegetation in the Long Pong alignment.	Equipment storage and disposal areas north of Kalpin residence/shop near pond and Sugar Creek are removed. Large area of adjacent pond has been filled. Road maintained from residence/shop north through riparian forest to Sugar Creek channel.
1992–2002	1997 flood scoured riparian vegetation from channel throughout the reach and deposited new bars in upper half of the reach. Areas in the lee of St Rte 4 and downstream right bank tailings were largely unaffected. Bar/fan feature at 1965 confluence still apparent and likely active depositional feature. Straight channel through this feature connects Sugar Creek to Scott River.	The 1997 flood scoured large alternate gravel-cobble bars and forced channel migration toward 1965 Sugar Creek confluence. This roughly established the confluence form that persists today. Large area between main channel and 1965 confluence now a dissected, infrequently inundated terrace that was not scoured by 1997 event. Flood did not significantly affect the sinuous side channel downstream of the Sugar Creek confluence.	Very little change to ponds and plugs or riparian vegetation in the Long Pong alignment.	Road network eastward across tailing and Scott River floodplain and around ponds was significantly developed. Equipment storage and disposal developed southeast of shop. Large area of riparian vegetation north of residence removed and converted to parking/storage.
2002–2010	Bar forms established in upper half of reach after 1997 flood are now less apparent (shadows obscure the channel, so unclear if they're gone or vegetated). Otherwise, little change.	Pond constructed at the eastern (right bank) edge of the channel directly opposite Sugar Creek confluence. Some small channel adjustments and riparian vegetation establishment along main channel, particularly at transverse bar opposite Sugar Creek confluence.	Some expansion of riparian vegetation, but otherwise little change.	Little change.
2010–2016	BDA and pond connection projects completed in Sugar Creek.	Main channel upstream of confluence avulsed, resulting in two dominant flow paths; one along east side of the valley that reoccupied the 1965 channel and filled the newly constructed pond; the other along the west side of the floodplain following the 2010 channel alignment. The bifurcation point, located at the grade control structure installed near Farmers Ditch Co. diversion, shifted flow toward left bank and Sugar Creek confluence. Intervening area extensively scoured and largely devoid of riparian vegetation except for the largest trees.	Some expansion of riparian vegetation, but otherwise little change.	Some expansion of equipment storage and disposal in yard near shop, but otherwise little change.
2016–2020	Continued development of riparian vegetation, but otherwise little change apparent in photographs.	Very dry conditions. Channel disconnected in places. Scour pools formed downstream of grade control structures. Some loss of riparian vegetation.	Continued expansion of riparian vegetation.	Little change.

2.2.2 Project datum

Project mapping and analyses are referenced to the California State Plane Zone 1, North American Datum of 1983 (NAD83) in units of U.S. survey feet and the North American Vertical Datum of 1988 (NAVD88) in units of feet. All elevations referenced in this report are with respect to NAVD88 unless otherwise noted.

2.2.3 Topography

Project site topography has been surveyed previously and during the current study. These efforts include (1) LiDAR flights in 2010 and 2018 that were each used to produce bare earth elevation digital terrain models (DTM), and (2) site specific topographic surveys conducted by SRWC during various field efforts. Topographic surveys conducted by SRWC include as-built surveys of the 2015 Sugar Creek off-channel habitat enhancement project area that is now permanently ponded and their Sugar Creek floodplain habitat enhancement project area completed in 2020, as well as site specific RTK GPS traverses of specific areas lacking adequate coverage in the LiDAR data.

Inaccuracies in LiDAR derived bare earth elevations are commonplace in areas of dense riparian and wetland vegetative cover and areas inundated during the time of LiDAR acquisition. Conversely, LiDAR elevations can be quite accurate in sparsely vegetated landscapes that are similar to a “bare earth” condition. The most recent 2018 LiDAR dataset was selected as an initial DTM for the project area. This DTM was visually inspected to assess the representation of major terrain features and quantitatively evaluated for elevation accuracy by comparing extracted point elevations with selected survey points. The initial DTM generally represented the major terrain features well, including the parking lot area and tailings pile ridges and valleys. Error statistics were computed for the initial DTM using selected survey points (Table 2-3). A histogram and cumulative distribution of the errors for each comparison survey point is shown in Figure 2-4.

Table 2-3. Error statistics for the initial DTM compared to selected surveyed site elevations.

Statistical descriptor	Error (feet)
Minimum	-3.15
Average	0.26
Median	0.15
Maximum	5.24
Root Mean Square	0.76
Standard Deviation	0.72

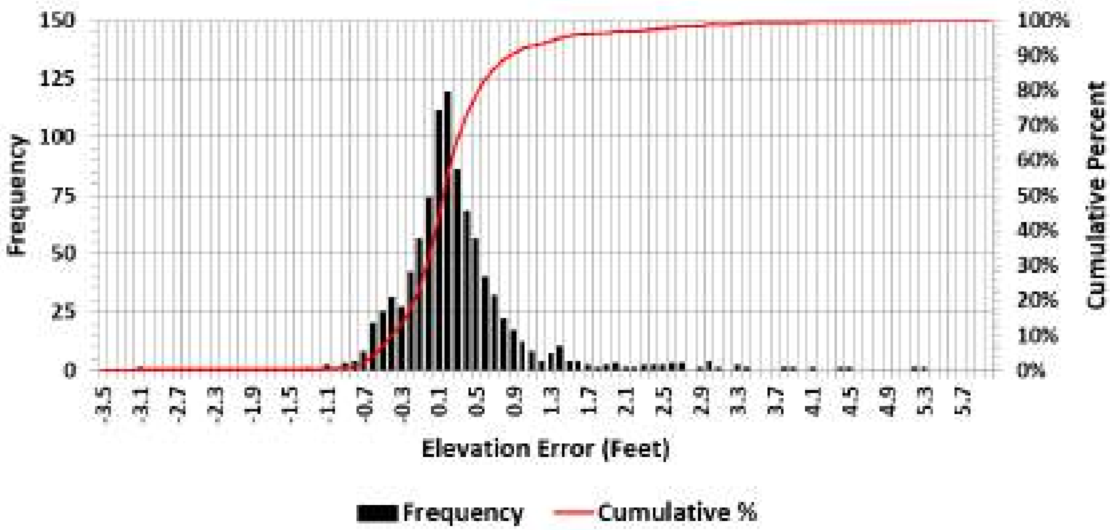

Figure 2-4. Histogram and cumulative distribution of elevation error between the initial DTM and selected survey points.

To better represent the actual elevations at the site, the initial DTM was adjusted in two steps to create an adjusted DTM that can be used for site specific analyses including design surface and earth work quantity estimates. The first step was to subtract the median elevation error of 0.15 ft from the initial DTM to vertically shift the entire initial DTM and remove this typical error. The second step was to create a representative DTM surface using the survey points for portions of the site not represented in the LiDAR derived DTM, such as the 2015 SRCD Sugar Off-Channel Habitat area that was inundated during the 2018 LiDAR and the recent 2020 Sugar Floodplain restoration project that occurred after the 2018 LiDAR acquisition. These representative DTM surfaces were then merged into the vertically shifted DTM to create the adjusted DTM.

3 HYDROLOGY AND WATER QUALITY

This section describes the general Scott River watershed characteristics, how the surface and groundwater portions of the watershed influence site conditions, and quantitative assessment of variable hydrologic conditions. These aspects of hydrology are used to develop design conditions that have seasonal importance, which are also described in this section.

3.1 Watershed Characteristics

The Scott River watershed area is approximately 800 square miles, of which 137 square miles are located upstream of the tailings reach (CH2M Hill 1985). The average annual precipitation ranges from 20 inches in the lower elevations of the valley up to 60 inches at the higher ridgeline elevations. Substantial precipitation occurs as snow during the cooler winter months. Snow melt infiltrates to shallow groundwater aquifers and is concentrated as runoff to Scott River tributaries and its mainstem. Rain-on-snow events occur often and result in high flows. Between 1911 and 1921 (the time period when a gauging station was present near the project site), mean annual discharge was about 100,000 acre-feet, with a recorded maximum of 206,000 acre-feet and a minimum of 36,000 acre-feet (DWR 1963).

3.2 Surface Water

The locations of long-term surface water monitoring within the Scott River watershed are limited (Foglia et al. 2013). The longest continuously operated monitoring station on the Scott River is the United States Geological Survey (USGS) station at Fort Jones (Station 11519500). This site is located approximately 49 RKM downstream from the Tailings Reach and has an associated watershed drainage area of 653 square miles, which represents about 80-percent of the total watershed area. The watershed area upstream of the site, in comparison, represents about 21 percent of the watershed area. Similarly, surface water monitoring in Sugar Creek is also limited, with the USGS operating a stream gage (Station 11518300) a short distance upstream of State Route 3 for three water years (1958-1960). The California Department of Water Resources has more recently operated a gage in Sugar Creek (Station F25890) from October 2009 to present. The gage is rated for low and moderate flows only. The Scott River Watershed Council also collected periodic discharge measurements in Long Pong between 22 May 2020 and 3 September 2020 to help develop an understanding of surface and groundwater processes and help inform habitat restoration and adaptive management within the Project area (Appendix C).

Analyses of peak flows described in the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS; FEMA 2011) acknowledges contributions to peak flows from tributaries downstream of the site, with Moffett Creek providing between 18% and 16% additional flow to the Scott River during 10-percent annual chance exceedance events (commonly referred to as the 10-year flood) and 1-percent annual chance exceedance events (commonly referred to as the 100-year flood), respectively. The peak discharge values from the FEMA FIS upstream of Moffett Creek can be used to roughly estimate peak flows for the Scott River at the upstream end of the Tailings Reach using the drainage area ratio method, which is a commonly used technique for estimating streamflow for ungaged stream locations, such as at the Project site. The drainage area ratio method is described by the following equation:

$$Q_{ungaged} = \frac{A_{ungaged}}{A_{gaged}} \times Q_{gaged}$$

where:

$Q_{ungaged}$ =: Flow at the ungaged location (e.g., Scott River at the upstream end of the Tailings Reach),

Q_{gaged} =: Flow at the gaged or known location (e.g., FEMA estimates for Scott River upstream of Moffett Creek),

$A_{ungaged}$ =: Drainage area at the ungaged location (e.g., Scott River at upstream end of the Tailings Reach at 137 square miles), and

A_{gaged} =: Drainage area at the gaged or known location (e.g., FEMA provided drainage area of the Scott River upstream of Moffett Creek at 416 square miles).

When using the drainage area ratio method, it is preferable to use gaged sites with drainage area equal to, or as close as possible to the drainage area of the ungaged location. Additionally, it is preferable to use a gaged site within the same drainage basin. However, if that is not possible, selecting a nearby gage with similar drainage area, precipitation, stream slope, land cover, and expected runoff is common. Given the lack of information on peak flow locations along the Scott River upstream of Moffett Creek, this method is suitable as an initial rough estimate of peak flows at the site. The estimated peaks flows are shown in Table 3-1.

Table 3-1. Estimated peak flows from FEMA FIS (2011) and at the Project site by drainage area ratio method.

Peak flow estimate location	Drainage area (square miles)	Peak discharge (cfs)			
		10-percent annual chance	2-percent annual chance	1-percent annual chance	0.2-percent annual chance
Scott River Downstream of Moffett Creek	538	19,400[1]	39,000[1]	49,000[1]	81,000[1]
Scott River Upstream of Moffett Creek	416	16,000[1]	32,000[1]	41,000[1]	69,000[1]
Moffett Creek	121	3,400[1]	7,000[1]	8,000[1]	12,000[1]
Scott River Upstream of Tailings Reach	137	5,269[2]	10,538[2]	13,502[2]	22,724[2]

Notes
[1] From FEMA FIS (2011).
[2] Estimated from FEMA FIS (2011) using drainage area ratio method.

Low flow estimates within the Scott River and Sugar Creek are less certain due to limited available information related to water use, the presence of volcanic soils, and dredger mine impacts to streambed and floodplain subsurface conditions (Tolley et al. 2019, FEMA 2011). Modeling efforts (e.g., Tolley et al. 2019) illustrate the relative importance of irrigation water application to water balance analysis, and emphasize the uncertainty associated with this data gap. Additionally, recent drought and associated extreme low flow conditions indicate that surface water discontinuities within the Tailings Reach of the Scott River can occur that result in isolated pools separated by dry reaches of channel in the mainstem and tributaries.

3.3 Groundwater Dependency

Investigation of the relationship between groundwater and surface flow has been undertaken via a community groundwater study plan (Harter and Hines 2008), an integrated hydrologic model (Foglia et al. 2013), a groundwater conditions study (Papadopulos & Associates 2012), and a groundwater management and enhancement plan (Scott Valley Groundwater Advisory Committee 2012). These studies help document interactions between groundwater use and water availability in groundwater dependent ecosystems, including aquatic and riparian habitats within the Project area. Additionally, more recent modeling efforts of Foglia et al. (2013) and Tolley et al. (2019) illustrate difficulties in resolving low streamflows and floodplain shallow groundwater levels in mainstem Scott River. These difficulties stem, in part, from limited surface water monitoring records but are further influenced by water withdrawals and porous subsurface conditions due to historical dredger mining impacts.

The Scott River mainstem channel is often flow deficient, most recently exhibited during fall 2020 during which discontinuities in surface inundation were prevalent throughout the upper portion of the tailings reach, as observed by SRWC field staff and captured by the 2020 United States Department of Agriculture's National Agriculture Imagery Program (NAIP) imagery. During these flow deficient periods, shallow water flows often persist within Sugar Creek. The 2015 Sugar Creek off-channel habitat enhancement project area, for example, remained inundated during this dry time period. These persistent inundation areas become very important in sustaining aquatic organisms until higher flows and water levels return.

3.4 Water Level Monitoring Network

The SRWC has worked towards furthering the understanding of site-specific water movement through the installation and maintenance of a network of water level monitoring stations (Figure 3-1). The monitoring network within the upper portion of the Tailings Reach includes loggers installed in surface water areas, such as Long Pond and the 2015 Sugar Off-Channel Habitat area, and in shallow groundwater monitoring wells. Given the lack of certainty with the surface water and groundwater relationships and the groundwater dependency of the site's ecological conditions (Section 3.2 and Section 3.3), the information from this monitoring network is leveraged in the Project design for approximating ecologically important seasonal water levels and using those as grading and excavation targets. A selected number of monitoring locations evaluated by SRWC staff as having relevant location and time series duration were provided for Project design analysis. These monitoring stations, including their type and period of record, are summarized in Table 3-2. Their locations are denoted on Figure 3-1, with an asterisk after the monitoring station ID.

Table 3-2. Period of record for water level monitoring stations used for project analyses.

Monitoring station ID	Type	Start date and time (PST)	End date and time (PST)
SUMW2S	surface water	July 22, 2014 13:15	December 19, 2019 9:00
SUMW5S	surface water	March 23, 2016 11:30	July 27, 2020 12:30[1]
SUMW9S	surface water	August 2, 2016 12:00	July 27, 2020 11:45[1]
SUMW11S	surface water	July 22, 2016 13:30	July 27, 2020 10:45[1]
SUMW12S	surface water	July 22, 2016 14:15	September 3, 2020 11:45[1]
SUMW13S	surface water	July 22, 2016 15:15	July 27, 2020 8:45[1]
SUMW14	groundwater	May 18, 2017 16:30	July 27, 2020 11:30[1]
SUMW15	groundwater	May 18, 2017 16:15	July 27, 2020 11:30[1]

Notes
[1] Gaps are present in the time series for the monitoring station.

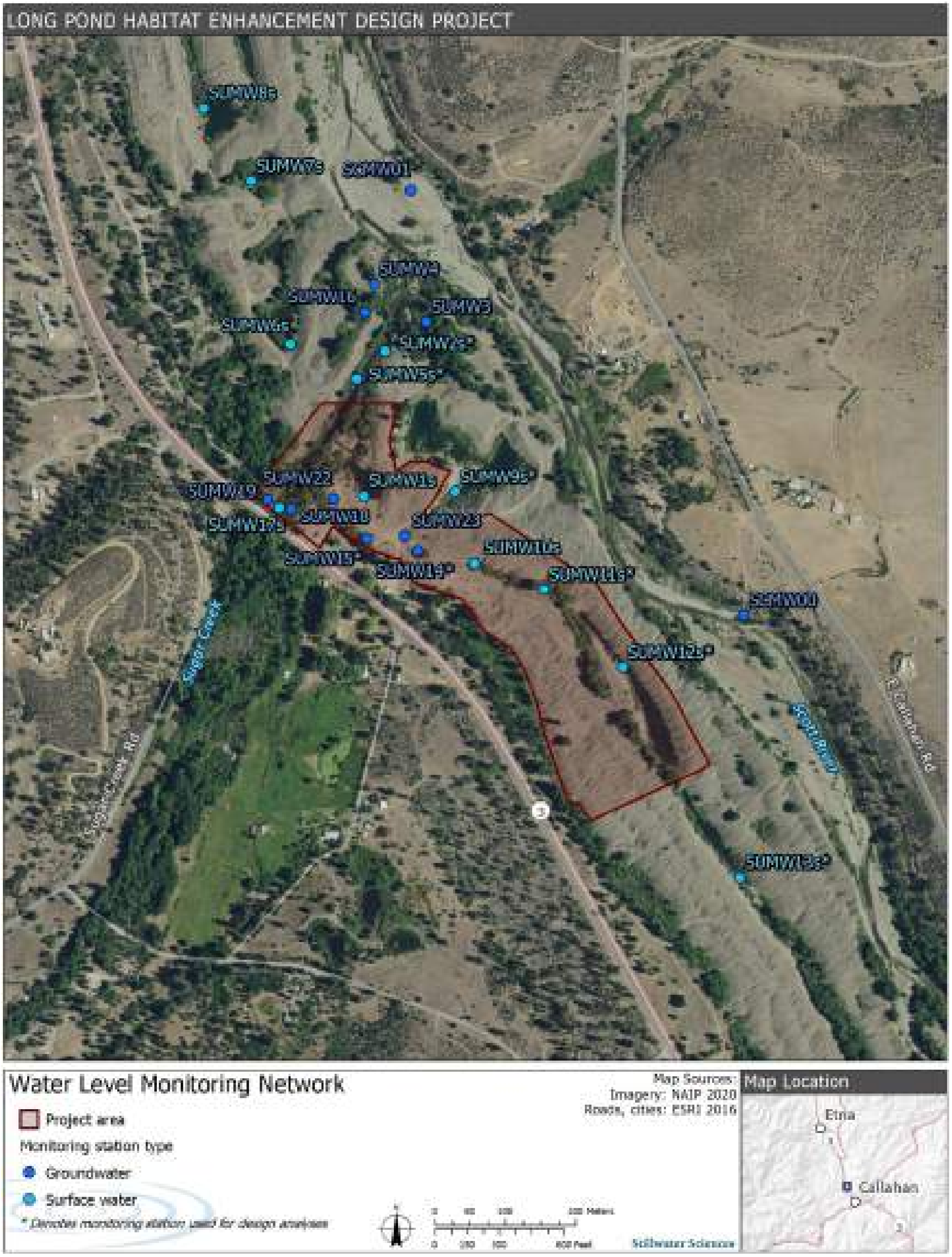

Figure 3-1. Surface water and shallow groundwater monitoring locations in the Project vicinity.

3.5 Dissolved Oxygen and Temperature Conditions

Water temperature and dissolved oxygen are important water quality parameters that influence aquatic habitat suitability, particularly for juvenile summer rearing of salmonids in Mediterranean climates like the Scott River that experience warm, dry conditions during the late spring through early fall period. The Scott River Watershed Council collects water quality data within their existing network of water level monitoring stations and elsewhere within the Long Pond Project area.

The Scott River Watershed Council analyzed surface water and groundwater temperatures (°C) at select stations within the Long Pond Project area to characterize summer and winter temperature regimes (Appendix D). The analysis included Water Years 2016-2020. Results of the analysis indicated that (1) maximum Moving Weekly Average Temperatures (MWATs) at the groundwater stations were significantly cooler than those observed at the surface water stations during summer, and (2) the minimum MWATs observed at the surface water stations were significantly cooler than those observed at the groundwater stations during winter. Warmer winter temperatures and cooler summer temperatures were also observed at stations located within the isolated ponds along the Long Pond alignment, indicating the strong effects of groundwater on the temperature regimes in these habitats. The temperature regimes observed at these sites are preferable (compared to Sugar Creek) for rearing coho salmon during the critical summer and winter life stages.

The Scott River Watershed Council also analyzed dissolved oxygen at select stations within the Long Pond Project area during the base flow period of the critically dry WY2020 (Appendix D). During the base flow period of WY2020, BDA Ponds 1 and 2 in Sugar Creek were dewatered from late August through early October. Surface water persisted in the impoundment behind the natural beaver dam located in Sugar Creek just Downstream of Highway 3. The Sugar off-channel pond was disconnected during this period but received groundwater inputs, and dissolved oxygen levels were not significantly impaired during the period of disconnection. A more significant reduction in dissolved oxygen was observed in the Long Pond during the base flow period of WY2020.

3.6 Seasonal Water Level Design Conditions

The time series for the selected water level monitoring stations was processed to develop a seasonal water level duration analysis derived from calculation of exceedance probabilities. Representative summer and winter periods were selected based on the life history timing of juvenile coho salmon and the seasonal hydrologic signatures that control juvenile rearing habitat availability and quality (e.g., interconnected habitat functions of emergent marsh and shallow water areas that foster development of macrodetrital and invertebrates vital to food web cycling). The representative summer period was selected as June through September, a period of 153 days; and the representative winter period was selected as December through February, a period of 91 days. Daily mean water levels were computed for the period of record for each of the selected monitoring stations, and those computed daily values were then grouped by the two analysis seasons for calculation of exceedance probability. Inundation duration during the selected season is then related as the product of the number of days during the seasonal period and the calculated exceedance probability. Three primary exceedance probabilities were queried for their habitat importance and use in the development of primary design elements described in Section 4. These three exceedance probabilities that informed the design process are described below.

- The 80-percent exceedance during the summer period, representing a probable water level that will be equaled or exceeded about 122 days between the start of June and the end of

September. During the summer period, lower water levels are common due to seasonally drier conditions and open water habitats within the mainstem Scott River may be limited, as previously noted. This seasonal design condition is used to target sufficient design inundation depth during this dry period to ensure habitat availability and access.

- The 50-percent, or median, exceedance during the winter period, representing a probable water level that will be equaled or exceeded about 46 days between the start of December and the end of February. During the wintertime, higher flows within the mainstem Scott River and Sugar Creek typically occur. During these peak flow events, juvenile salmonids may seek out slower moving habitats. This seasonal design condition is used to increase the amount and diversity of shallow and slow water habitat availability during these periods when mainstem conditions have higher velocities.
- The 10-percent exceedance during the winter period, representing a probable water level that will be equaled or exceeded about 9 days between the start of December and the end of February. Less frequent inundation of riparian habitats supports localized geomorphic processes that mimic floodplain activation in pre-disturbance settings, such as sediment deposition and erosion, that in turn contribute to food web cycling, terrestrial and aquatic ecosystem nutrient exchange, and plant dispersal. This seasonal design condition is used to activate higher elevation flow pathways to mimic historical floodplain engagement processes.

The associated exceedance values for each of the seasonal design conditions is provided in Table 3-3 for each of the selected monitoring stations used in the analysis. These values were utilized in developing alternatives by creating representative water level surfaces from triangulated station location exceedance values and then extending the edges of that triangulated surface to the project area extent. These surfaces were then used as excavation and grading targets for the alternative design elements described in Section 4.

Table 3-3. Summary of seasonal design condition water elevations for monitoring station locations and the intended design outcome targeted by each condition.

Monitoring Station ID	Design condition water elevation (feet NAVD88)/Intended design outcome		
	80-percent summer exceedance/habitat access and availability	**50-percent (median) winter exceedance/habitat diversity and amount**	**10-percent winter exceedance/geomorphic floodplain process mimicry**
SUMW2S	3001.4	3002.7	3002.8
SUMW5S	3001.9	3003.2	3003.4
SUMW9S	3002.2	3003.4	3003.7
SUMW11S	3005.8	3006.0	3006.4
SUMW12S	3006.4	3006.8	3007.4
SUMW13S	3008.8	3009.1	3010.1
SUMW14	3002.7	3003.4	3003.9
SUMW15	3004.1	3004.2	3004.5

The seasonal design condition water level exceedance values were used to inspect the period of record for the selected monitoring stations for the actual frequency measured water levels were at or above the targeted values. In particular, the frequencies associated with the lowest elevation target (i.e., the 80-percent exceedance during the summer period) were of most interest during this inspection to provide an approximation of project performance during these lower water periods. The frequencies of occurrence were organized by water year to help further relate potential project performance to interannual variability caused by wetter and drier water year types. The interannual variability was assessed by ranking water years by dryness, and the rank values and accumulated annual precipitation from the precipitation station at the USFS Ranger Station in Fort Jones, CA are presented alongside the results in Table 3-4. The dryness rank and accumulated annual precipitation values were provided by SRWC staff (Yokel, pers. comm. 2021), which are further described in Appendix E. The timeseries for each monitoring station shown in Table 3-4 are provided in Appendix F with the seasonal design condition elevations plotted for reference.

After evaluation of the seasonal design condition water elevations, the values for each of the three criteria were triangulated to develop respective groundwater surfaces. The boundaries of those surfaces were each extended laterally to the limits of the project area to provide a complete surface coverage estimate for the area considered for the alternative designs and the preferred alternative. Contours of groundwater elevation for each of the three design condition surfaces are provided in Appendix F.

Table 3-4. Percent of time that water levels exceeded the 80-percent summer exceedance design condition at each monitoring station (number in parenthesis indicates days exceeded).

Water year	Annual accumulated precipitation (inches)[1]	Dry rank[1]	Monitoring Station ID							
			SUMW2S	SUMW5S	SUMW9S	SUMW11S	SUMW12S	SUMW13S	SUMW14	SUMW15
2015	19.6	36	60% (157)	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]
2016	23.6	53	92% (337)	91% (173)	64% (38)	90% (64)	100% (70)	80% (57)	-[2]	-[2]
2017[3]	33.5	79	100% (365)	100% (355)	100% (365)	100% (350)	100% (345)	98% (357)	100% (124)	86% (116)
2018[4]	12.2	6	84% (298)	83% (295)	82% (231)	66% (228)	64% (216)	50% (138)	86% (291)	67% (215)
2019[5]	20.8	41	99% (362)	98% (248)	93% (340)	68% (249)	83% (289)	56% (205)	91% (334)	98% (356)
2020	10.1	3	100% (79)	96% (275)	92% (263)	49% (139)	46% (155)	44% (127)	93% (265)	61% (173)

Notes

1 Information prepared by SRWC Staff (Yokel, pers. Comm. 2021; see Appendix E).
2 Station period of record does not include water year.
3 Water Year 17 is considered to be a representative wet water year by SRWC Staff (Yokel, pers. Comm. 2021).
4 Water Year 18 is considered to be a representative dry water year by SRWC Staff (Yokel, pers. Comm. 2021).
5 Water Year 19 is considered to be a representative average water year by SRWC Staff (Yokel, pers. Comm. 2021).

4 PROJECT DESIGN

The conceptual design approach incorporates site specific characteristics as described in Section 2 and Section 3, along with lessons learned by SRWC from the implementation of recent and nearby restoration projects. Several of the designs target hydrologic conditions that are understood from a data driven perspective (Section 3), which also provides a method of assessing potential project performance, for example by comparison of the proposed design conditions to recent past site responses to relevant water year types and station recorded water levels (Section 3 and Appendix F). Each proposed design element is intended to work in concert to achieve project benefits over varying timeframes, such as from the immediate uplift realized by the form driven response of connectivity through grading to the longer-term uplift by process driven responses associated with mature native vegetation.

4.1 Overview of Primary Design Elements

Conceptual design alternatives for the Long Pond Project are shown in Appendix A. The conceptual design plans focus on several key enhancement components including (1) rearing habitat for juvenile coho salmon during the winter and spring, (2) hydrologic connectivity, (3) riparian function, and (4) healthy soil development. During the course of the project the conceptual design alternatives evolved and advanced in complexity into a preferred alternative based on input from SRWC, the TAC, landowners, and through further site analyses and understanding. The stepwise evolution for the project is delineated by milestone phases related to percent level of design completion (i.e., 30%, 65%, 90%, and final).

Several primary design elements are identified for application to the Long Pond project site. These primary design elements are intended to target the enhancement objectives, provide near-term immediate ecological uplift, and establish a longer-term process driven trajectory that achieves a self-sustaining and more robust functional state within the site. The primary design elements work best in concert through landscape linkages between climatic, topographic, geologic, and biotic response. The following subsections describe the proposed primary design elements and the method by which they seek to target the project objectives.

At the 30% design level the project team's primary goal was to determine the general form and intended function for the design elements having the highest implementation cost. This was predominately focused on earthwork quantity and excavation layout, or elements that rely on specific locations to achieve their intended function such as the proposed waterway crossing structure. Detailed design element rigor associated with less costly items and those that may not depend on specific locations to achieve their functional and process intent are represented on the alternative design drawings in a more general plan layout view and have been incorporated into planning level costs with higher uncertainty related to their quantities. Subsequent design of a preferred alternative at and beyond the 65% level (refer to Section 4.4) identifies the specific locations and quantities associated with these less costly elements.

4.1.1 Primary connection channel

The dredger placed tailings piles at the site have variable heights that form a coarse-grained undulating surface with ridges and valleys (or troughs). Between the tailings pile ridges, the valleys extend to lower elevations that periodically intersect with adjacent groundwater and create shallow ponded areas of cool oxygenated water. The largest feature within the site is Long Pond itself, which is comprised of several open water ponded areas oriented in a somewhat linear down valley alignment. Connection of Long Pond to the adjacent stream network can provide direct salmonid access to key habitat elements (e.g., cold water refugia) that are limited within the Scott River watershed. The treatment method proposed for direct connection is to construct a primary channel that connects the three downstream-most ponded portions of Long Pond to Sugar Creek. Direct connections of Long Pond to the Scott River were considered during early phases of the project, but discounted due to uncertainty in long-term function and perceived risks related to capture of the mainstem Scott River through the connected Long Pond flow alignment.

The previously implemented primary connection channels to the 2015 Sugar Creek off-channel habitat enhancement project provide a validated reference point for salmonid utilization of off-channel rearing habitats at the site through connection to Sugar Creek. These off-channel connections and fish rearing use is further enhanced through SRWC's previous beaver dam analogue restoration actions along Sugar Creek. These two previous restoration actions on Sugar Creek have created year-round habitat conditions that are unique within the Scott River watershed with respect to providing significant ecological opportunity and uplift. The additional primary connection channel proposed in the current project stands to further increase the amount of habitat access and opportunity for juvenile salmonids.

The primary connection channels proposed in the restoration design have variable benched widths and side slopes. An example of a typical primary connection channel cross section geometry is shown in Figure 4-1, and further details are included in the design drawings provided in Appendix A. The bottom width of the channel upstream of the proposed waterway crossing is 12 ft and downstream of the proposed waterway crossing is 16 ft. The channel bottom elevation targets an inundation depth of at least 0.5 ft when water levels are at or above typical summer lower water level conditions associated with the 80-percent exceedance probability. This is a frequently occurring summer condition, which ensures a minimum level of connectivity to achieve summer rearing habitat access and functional goals. A lower target elevation is used for the primary connection channel bottom within the downstream 400–500 ft of channel. This lower targeted elevation is intended to enhance rearing habitat access and opportunity with this lower portion of the primary connection channel, as well as hedge against uncertainty in the statistically derived target water level surface, ensure positive drainage for improved water quality, and help minimize the potential or fish entrapment during periods when water levels may fall below the targeted design condition. The lower targeted elevation ranges from 1.0 to 1.5 ft below the 80-percent exceedance probability water level.

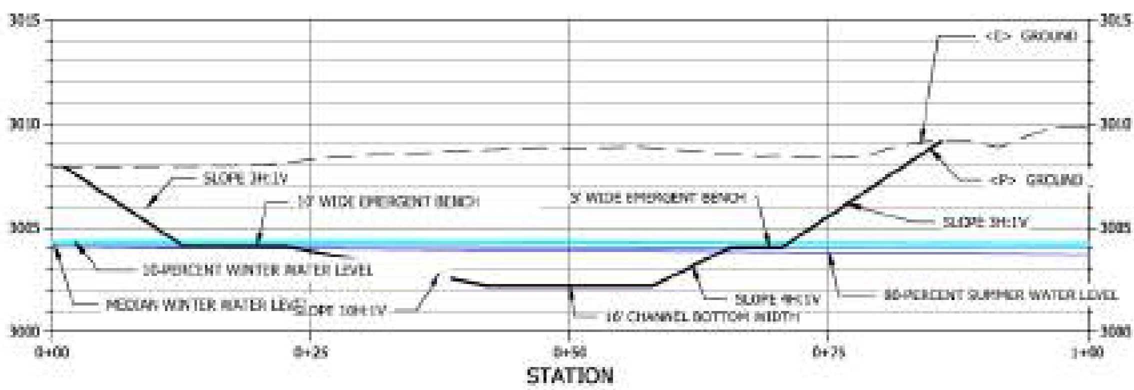

Figure 4-1. Example of typical primary connection channel cross section geometry.

4.1.2 High-flow connection channels

High-flow connection channels offer less frequently inundated and accessible flow pathways than primary connection channels. Less frequent flow pathways support both geomorphic processes and ecological functions. These processes and functions may include facilitation of floodplain deposition and scour and introduction of macro detrital and other food web components to open water refugia areas. Additionally, when the high flow connection channels provide connectivity with off-channel rearing areas, access is provided for fish to move into these slower off-channel refugia and out of the primary connection channel or stream channel higher velocity areas.

High flow connection channels proposed in the restoration alternatives target an activation frequency above the wintertime 10 percent exceedance probability water surface elevation.

4.1.3 Roughened channel grade control

Roughened channel grade controls, or constructed riffle segments, are a method of stabilizing the channel profile by mimicking natural coarse grained riffle type features. An example of a typical roughened channel grade control is shown in Figure 4-2. The proposed design includes several locations for roughened channel grade controls, including at the two plug grading locations between existing open water segments of Long Pond and the waterway crossing structure channel.

The proposed roughened channel grade controls include oversized boulders embedded within a coarse streambed rock matrix that is intended to provide hydraulic diversity through increased bed friction and water depths that then slow water velocities, dissipate energy through a range of flows, and provide a mechanism that retains higher upstream water depths for use as refugia habitat for juvenile salmonids and that supports emergent vegetation communities, and a method of bed armoring that hinders the potential for incision or erosion that could impact these upstream benefits.

The mimicked riffle forms are proposed to be created from sorted on-site materials obtained from channel excavation. Coarser sized materials would be selectively sorted, mixed, and then backfilled in over excavated trenches within the channel bottom and side slopes of the proposed locations.

Figure 4-2. Example of a typical constructed roughened channel grade control using oversized coarse materials.

4.1.4 Variable slopes and aspect

Diverse and rich ecological processes are fostered by varied physical watershed components. Variations in topographic relief, slope, and aspect, for example, can facilitate different solar exposure regimes that create microclimatic gradients in heating, cooling, and evaporation. Terrestrial wildlife utilize these differences for ease in motility and selection of suitable nesting and aestivation areas. Furthermore, these types of variations can create shading that helps maintain cool water refugia and assist seed and plant establishment. Given the general lack of taller mature vegetation at much of the site, topographic variability can help fulfill this near-term shade condition until the restored vegetation achieves sufficient height and canopy to contribute shade. In many parts of the site the tailings piles are relatively tall and relatively stable at steeper slope angles. These areas benefit from localized topographic shading on northern and eastern aspects.

The restoration alternatives include variable slopes to help achieve these objectives. For example, the primary connection channel downstream of the proposed waterway crossing has a lower slope of 10 feet horizontal to 1 foot vertical (10H:1V) on the south side below the emergent bench and a steeper slope of 3H:1V above the emergent bench. The lower slope is intended to provide a larger shallow water area that is accessible over a range of water level conditions and the steeper slope is intended to provide topographic shading of the bench and allow for future SRWC staff access for post-construction restoration monitoring.

4.1.5 Bench grading

Benched grading allows for the creation of surfaces targeting physically and biologically important water level frequency events. For example, these targets can include consideration for the depth from the bench surface elevation to seasonal water levels with respect to plant root depths or variable shallow water habitat areas. Bench grading is proposed in five locations in the alternative designs that target inundation at approximately the winter median water level condition to facilitate emergent wetland habitat conditions that support food web cycling, woody material source development, and habitat complexity during seasonally higher water level periods that extend shallow water inundation onto the bench surfaces. These benefits relate back to the varied uplift timelines expected for the site due to form and process driven responses. These proposed bench locations and approximate widths are listed in Table 4-1.

Table 4-1. Proposed emergent bench grading locations and widths (feet).

Location	Approximate bench width (feet)
Fin Alcove 1	24
Fin Alcove 2	24
South side of primary connection channel upstream of proposed waterway crossing	10
South side of primary connection channel downstream of proposed waterway crossing	10
North side of primary connection channel downstream of proposed waterway crossing	5

Two of the bench locations, referred to as Fin Alcove 1 and Fin Alcove 2 (Table 4-1 and Appendix A), included in the proposed alternative designs are located adjacent to and along the south side of the existing Long Pond open water area. This location was noted by the project design team as having a unique microclimate due to aspect and mature tree related shading, and potentially higher deposition and retention of finer topsoil due to the combination of terrain and vegetative disruption of wind fetch and the contribution of carbon rich material due to seasonal vegetative decay cycles. The proposed considerably larger width associated with these two bench locations is intended to enhance the response of these functions and processes. Additionally, since these alcove locations are positioned upstream of the majority of the proposed rearing habitat closer to Sugar Creek, it is anticipated that over time these two benches will become vital food source areas for the restored area. However, these two locations result in a higher incremental earthwork effort than the other bench forms, which translates to an assumed higher implementation cost. And, it is acknowledged that the timescale associated with the functional development of robust food and macrodetrital source areas is longer than that of more simplified shallow water habitat developed in large part by graded form.

4.1.6 Large wood habitat features

Large wood is an important habitat component that provides structure, shade and cover, moderates stream velocities, entrains sediment, and contributes to the development of macro detrital and benthic food source materials. Large wood sources have historically been removed from the watershed through land development and use actions, and these removal actions have concurrently reduced large wood recruitment from upstream sources to streams like Sugar Creek and the Scott River. This reduction in wood load and structure within the stream system contributes to the decline in insect prey for aquatic organisms and food web macro detrital inputs. Installation of large wood is a bioengineering technique that enhances habitats for aquatic organisms by providing shade, cover, and contributions to food source development.

Large wood habitat features are proposed along the constructed benches and channel segments to bolster the habitat enhancement value immediately following construction, and with the assumption that upstream logs from existing trees and those included with the proposed restoration planting will support natural recruitment processes that replace or supplement the installed logs in the coming years. The proposed large wood habitat features will be further developed during later phases of design but are likely to include crisscrossed 20–30 ft long 12- to 24-inch diameter logs with root balls. A horizontally placed footer log will likely get added beneath the stems of the root ball logs to provide vertical stability and minimize downward deformation of the habitat feature in the event of local scour. Specific embedment criteria will be further evaluated during later design phases based on the force balance requirements to maintain the position of the feature for habitat utilization. Given the low velocities assumed for the created refugia habitat areas, the feature stability factors are likely to be dominated by buoyant uplift during higher stage events. During later design phases, we proposed evaluating the uplift force and necessary embedment criteria for the log features using the 1-percent annual exceedance probability flood water surface elevation and a design safety factor of 1.5 in accordance with standardized restoration risk assessment and design methods (Rafferty 2013, USBR and USACE 2015).

4.1.7 Healthy soil development

Two test pits investigated during installation of shallow groundwater monitoring stations indicated that a relatively thin (e.g., approximately 1-3 inch) horizon of finer material occurs above the coarse tailings, but that this fine layer is compacted and comprised primarily of inorganic material. Historical dredger mining within the Tailings Reach dramatically altered near surface soil conditions. One of the most impactful alterations of soil conditions was the inversion of the alluvial stratigraphy from its pre-disturbance state to one where coarse material is now generally located in the upper soil layers and finer materials are present in the deeper layers. These disturbances severely limit biological processes in the near surface layers and the ability to retain moisture and nutrients necessary to support native woody vegetation. Additionally, the lighter colored coarse surficial materials likely contribute to an increased albedo effect that creates harsher diurnal temperature variations (i.e., warmer daytime temperatures and cooler nighttime temperatures) than the surrounding landscape. These combined impacts create inhospitable terrestrial habitat conditions that will likely persist for a very long time (i.e., on the order of thousands of years) without direct restoration actions.

The primary design elements for early establishment of a restored soil state involves the following:

1. Minimizing limits of disturbance and heavy equipment movement for construction activities to reduce compaction of site surface soils.
2. Salvaging and stockpiling the existing thin finer topsoil layer and all cleared vegetative material.
3. Restoring construction finished grade top soils to enhance early soil functions by:
    a. Re-use of salvaged and stockpiled topsoil and vegetative material by re-distribution onto finished grades;
    b. Deep ripping to at least 12 inches below finished grade to loosen compacted subsurface layers;
    c. Deep tilling of coarse mulch materials, such as chipped vegetative materials cleared prior to construction excavation activities and imported straw or bark mulch, into deeper subsurface to fill void space within the coarser layer materials to reduce migration of finer surface soils down through the more porous soil column and exposure of deeper roots to air pockets;
    d. Blending finer grained organic compost amended topsoil with the stockpiled site-salvaged topsoil and redistributing onto the finished surface; and,
    e. Top dressing the finished grade with 6-8 inches of imported compost amended topsoil.
4. Mulching around native restoration plantings.

5. Protecting restored soil areas from erosion or re-compaction by vehicular traffic.

Although the existing finer topsoil layer is relatively thin and vegetation is sparse, re-use of these materials is important in helping establish soil biologic process through inoculation with locally recruited microbial communities that are present within these salvaged materials while reducing the cost of importing soil amendments.

4.1.8 Fine substrate supplementation

Lack of fine materials within the existing Sugar Creek left bank can potentially cause a loss of stream flow to shallow groundwater. The more porous coarse substrate present at the site has an associated higher hydraulic conductivity than that of sites with well-mixed soils having a gradation that includes finer through coarser material sizes. For example, hydraulic conductivities between layers comprised solely of gravel can have hydraulic conductivity values two to four orders of magnitude higher than layers comprised solely of finer sands. Supplementation of fine materials into the soil subsurface can help reduce the hydraulic conductivity within the augmented soil layer and thereby reduce the potential loss of stream flow. Fine substrate supplementation may also help facilitate moisture retention and root zone establishment for restoration plantings.

The Scott River Watershed Council has implemented fine substrate supplementation on past projects to help reduce stream bank porosity and the associated subsurface hydraulic conductivities that may potentially contribute to localized loss of stream flows to shallow groundwater flows. The method utilized previously was performed in three steps:

1. Place native and imported fine materials on top of the coarser surface materials,
2. Wash the fines down into the coarse layer to fill void spacing using low- or high-pressure temporary pump supplied water, and
3. Repeat steps 1 and 2 until wash-water and fines cease to infiltrate into the subsurface and instead wash water flows on the surface.

When the wash-water ponds and flows on the surface, the void space is assumed to be sufficiently filled with finer materials and the subsurface hydraulic conductivity is assumed to effectively be reduced, thereby reducing the potential for loss of stream flow to shallow groundwater. A typical application of this technique for fine substrate supplementation is shown in Figure 4-3.

Figure 4-3. Typical application of fine substrate supplementation to treat coarse substrate void space and reduce the potential for stream flow loss.

Fine substrate supplementation is proposed in the alternative designs for application of an area of the left bank of Sugar Creek located about 50 ft downstream of the State Route 3 bridge. The application would extend for approximately 325 linear feet along this left bank location and span the height of the bank between ordinary high water and the top of the bank.

4.1.9 Protection of existing functional vegetation and disturbed area revegetation

Native emergent wetland and riparian plant communities serve as vital sources for detrital inputs for food web cycling, provide habitat for insect prey for juvenile salmonids, trap fine sediment and provide roughness that can enable natural habitat forming processes, as well as reduce heating of waterways through development of foliated shade. The timeline for vegetative growth at the site is relatively long in duration based on climatic and soil conditions. Therefore, protection of intact and functional vegetation is of high importance to ensure continued near-term ecosystem services offered by the existing vegetation. However, due to Primary Connection Channel and Bench Grading design elements, some intact vegetation will be disturbed during project implementation. The design alternatives propose revegetation of these disturbed areas. A native planting zone palette will be developed during future design phases, and the quantity, spacing, and size for the plants included in the palette will also be informed by past nearby and successful implemented revegetation projects.

Beaver are active within Sugar Creek and have constructed at least one beaver dam located between State Route 3 and the existing upstream connection channel to the 2015 Off-Channel Sugar Habitat area. Beaver can show preferences towards more supple young woody vegetation, and in the case of restoration plantings can negatively impact plant establishment through their browse and chew of woody materials. Additionally, SRWC staff (Yokel , pers. Comm. 2021) indicated that mulch placed around previous restoration project plantings attracted rodents that subsequently girdled woody plantings. Browse protection or other deterrents are recommended for incorporation into the restoration planting plan developed during later design phases to provide near-term herbivory protection of plantings and to ensure vigorous establishment.

4.1.10 Removal of existing roadways and waterway crossing structure

The proposed project elements include excavation extents that encompass some existing unpaved roadways. Most of the existing roadways and driving routes that are within the limits of the proposed restoration elements are proposed to be removed and alternate driving routes are proposed to use other existing unpaved roadways that already provide redundancy in the road network. The largest vehicle access area that is proposed to be altered by the restoration actions is referred to as the parking area in the southwest portion of the site. An alternative parking area is not proposed as part of the project.

The primary connection channel proposed bisects an existing unpaved roadway at the site that is used to access portions of properties closer to the Scott River. A waterway crossing structure is proposed at this location to provide vehicle access across the primary connection channel and prevent vehicles from directly crossing through the channel and potentially introducing sediment, turbidity, and other constituents into the restored aquatic habitat areas. The proposed waterway crossing structure is recommended to have a clear span width of the channel width without the need for mid-span support piers or multiple opening structure like a multi-barrel culverted crossing.

The proposed primary connection channel cross section geometry combined with the excavation depth to achieve the targeted connectivity at the 80-percent summer exceedance frequency water level results in a span width of approximately 60 ft at the existing road centerline elevation. This represents the maximum span width considered currently for a waterway crossing structure. The excavation at this location is estimated at 7.5 feet from the existing ground surface to the finished grade of the roughened channel grade control placed in the bottom of the primary connection channel. Narrower span width waterway crossing structures can be considered for this location as well but would result in decreased hydraulic performance during higher flow and stage conditions.

Bridge options allow for flexibility in span width and two options for consideration based on lower structural material cost and time efficient installation include:

- A repurposed railroad flat car bridge with wood decking (Figure 4-4), and
- A precast concrete slab decked bridge on steel girders (Figure 4-5).

Installation of these bridge options requires lifting bridge elements into place, which can be accomplished with multiple excavators working in sync or more easily with a truck crane. The bridges are recommended as a single 12-ft-wide travel lane to accommodate typical passenger vehicles as well as heavy equipment and emergency vehicles.

Large spanning pre-cast concrete culvert options are available such as Contech Conspan B-Series (three-sided box structures with a maximum span width up to 48 feet), O-Series (arch geometry with a maximum span width up to 65 ft), and BEBO-Series (arch geometries with a maximum span width up to 102 ft). However, these options are considerably more costly than the two bridge options previously listed and not recommended for further consideration on the project.

If the span width is reduced, aluminum plated culvert options may be considered. Aluminum culverts are lighter weight and have thinner material thicknesses than comparably sized concrete culverts. Additionally, aluminum culverts are cheaper than concrete culverts. The plated culvert option can be easily shipped and assembled without the need for a truck crane. An example of an installed aluminum culvert is illustrated in Figure 4-6.

A relatively small amount of approach grading is recommended for the selected option to elevate the selected waterway crossing to the top of the proposed primary connection channel bank slope. This approach grading would have a maximum height increase of approximately 3 ft.

The two bridge options and the aluminum plate culvert option can each be designed to meet the live load recommendations such as the American Association of State Highway and Transportation Officials (AASHTO) recommended HS-20 design loading. The HS-20 design loading is for a hypothetical vehicle with one 8,000-pound axle and two 32,000-pound axles. This design loading is consistent for some tractor trailer trucks and fire trucks, and the combined weight of this design loading exceeds the California Fire Code required access load requirement.

Comparison of the approximate structure material costs without consideration for design and installation for the three options considered here are provided in Table 4-2.

Table 4-2. Comparison of approximate waterway crossing structure material costs (In order from lowest to highest cost).

Waterway crossing type	Approximate structure cost
Railroad flat car bridge	$60,000
Aluminum plated culvert	$75,000
Precast concrete slab bridge	$120,000

Given the flexibility afforded span width and the lowest approximate structure cost, the railroad flat car bridge is the recommended type of waterway crossing for use at the project site. Further design on the waterway crossing structure is not included in the current project scope and can be effectively transferred to the construction phase of the project.

Figure 4-4. Example wood decked repurposed railroad flat car bridge.

Figure 4-5. Example pre-cast concrete slab on steel girder bridge.

Figure 4-6. Example aluminum culvert.

4.2 Project Design Alternatives

The primary design elements were assembled to provide two comparative options at the 30% design phase (Table 4-3), referred to as Alternative 1 and Alternative 2. Design drawings are included in Appendix A for the primary design element layout that illustrate the differences between the two alternatives.

4.2.1 Alternative 1

Each of the primary design elements described in Section 4.1 are incorporated in Alternative 1. The intended benefits for Alternative 1 include:

- Improved connectivity and habitat complexity along the existing Long Pond alignment, including: (1) roughened channels at the existing plugs to create hydraulic control that maintains the existing gradient and low velocity when the Long Pond open water areas are connected by surface water, (2) submersed benches and large wood to improve rearing habitat conditions, (3) riparian planting benches that create shade and cover and take advantage of topographic shading, (4) small alcoves and other site-specific habitat features that provide variable timeline functional and process gains.
- Extension of the Long Pond alignment through the existing parking area, with an outlet to Sugar Creek located across from the left bank berm and upstream of the recently lowered left bank floodplain (i.e., the outlet location that we have been discussing).
- Creation/enhancement of off-channel rearing habitat at the Long Pond outlet in the form of variable amounts of shallow water habitat based on seasonal water level fluctuations and multiple high flow connection channels between the primary connection channel and the 2015 Off-Channel Habitat area to mimic morphological floodplain connectivity.
- No change in the Sugar Creek mainstem channel.
- Fine substrate supplementation to seal all or portions of the left bank of Sugar Creek and/or dike to reduce flow losses through infiltration and high transmissivity.

A key difference between Alternative 1 and Alternative 2, is that Alternative 1 has a primary connection channel outlet that is tied to Sugar Creek as opposed to the 2015 Off-Channel Habitat area. This direct connection pathway allows direct juvenile salmonid movement between the Alternative 1 restoration area and the existing Sugar Creek channel.
Design drawing Sheets 6A, 8A, and 9A (Appendix A) illustrate the elements that are unique to Alternative 1.

4.2.2 Alternative 2

Alternative 2 includes the same primary design elements included as Alternative 1 for the purpose of achieving the same benefits. However, Alternative 2 incorporates two flow pathways that are different than Alternative 1 and intended to direct higher flows away from the existing Sugar Creek left bank, which could improve refugia access during higher flows and enhance the material exchange between Sugar Creek and off-channel areas. The flow pathway differences include:

- the primary connection channel alignment towards the 2015 Sugar Creek Off-Channel Habitat ponded area and downstream-most outlet channel, and
- a high flow connection channel that provides by-pass of higher Sugar Creek flows also through the 2015 Sugar Creek Off-Channel Habitat ponded area.

The function of the high flow connection for Sugar Creek is facilitated by construction of a mimicked low elevation gravel bar along the left bank of Sugar Creek. This mimicked bar form is intended help steer high flows into the by-pass channel alignment.

Design drawing Sheets 6B, 8B, and 9B (Appendix A) illustrate the elements that are unique to Alternative 1.

Table 4-3. Comparison of the two alternatives.

Alternative	Includes primary design elements (yes/no)	Redirects primary connection channel high flows away from Sugar Creek left bank (yes/no)	Includes Sugar Creek high flow connection channel by-pass (yes/no)	Planning-level construction cost
1	Yes	No	No	$821,000
2	Yes	Yes	Yes	$853,200

4.3 Planning-Level Construction Cost Estimates for Alternatives 1 and 2

Tables 4-4 and 4-5 provide planning-level cost estimates for Alternatives 1 and 2, respectively. These costs assume that the Project will be permitted through a streamlined permitting pathway (e.g., The Habitat Enhancement and Restoration Act) or a grant organization's programmatic permitting pathway (e.g., CDFW's FRGP programmatic permitting process). The permitting efforts associated with an individual CEQA permit and other individual permits are therefore not incorporated in the cost estimate provided, except for the necessary CDFW 1602 Stream Alteration permit process, for which a rough order of magnitude cost has been added. The unit costs were developed based on reference cost information from recent and nearby similar projects, CALTRANS and vendor specific standard unit cost guidance, and engineering experience. Quantity and material estimates are based on the 30% design plans (Appendix A). Optional additional work item costs are included as a contingency allowance to accommodate additional restoration feature opportunities that may not arise until during construction and provides a budgetary line item for achieving additional habitat enhancement without necessitating a construction contract change order. Payment of additional work items is contingent upon additional work being requested by SRWC, and subsequently directed by SRWC and completed by the restoration contractor. Construction management, engineering during construction, and construction contingency are estimated as 20% of the sum of the construction item subtotal. Additional considerations of the cost estimate include:

- Unit costs include equipment, labor, materials, and construction contractor overhead and profit;
- Costs do not account for phased construction (i.e., multiple mobilizations and demobilizations);
- Costs do not include permit preparation costs or application fees; and,
- Costs are in 2021 dollars. Escalation costs for anticipated period of construction are not included and would be needed if the time of construction is delayed into the future.

Table 4-4. Cost estimate for Alternative 1 based on 30% design.

Item no.	Description	Quantity	Units[1]	Unit cost	Total cost
Division II General Construction					
1	Mobilization	1	EA	10%	$56,364
2	Temporary Construction Entrance	1	EA	$500.00	$500
3	Temporary Sediment Control	1	LS	$14,000.00	$14,000
4	Temporary Construction Fence	300	LF	$5.00	$1,500
Division III Earthwork and Landscape					
5	Clearing and Stockpile of Salvaged Vegetation and Top Soil	1,500	CY	$20.00	$30,000
6	Channel and Bench Excavation, Including Haul (Assume cut/fill balanced on site)	28,500	CY	$12.00	$342,000
7	Roughened Channel Grade Control	131	CY	$24.00	$3,144
8	Large Wood Habitat Features	33	CY	$1,500.00	$49,500
9	Healthy Soil Development	1	LS	$40,000.00	$40,000
10	Fine Substrate Supplementation	100	CY	$95.00	$9,500
11	Seeding/mulch/planting	1	LS	$12,500.00	$12,500
12	Restoration Planting Browse Protection	1	LS	$1,000.00	$1,000
Division VI Structures					
13	Waterway Crossing Structure: Railroad Flat Car Bridge and Unpaved Road Approach Grading	1	LS	$60,000.00	$60,000
Construction Item Subtotal					$620,008
Construction Contingency (Percentage of Construction Item Subtotal)				20%	$124,001
Permits (CDFW 1602)					$5,000.00
Engineering - bid support, construction oversight, as-builts					$40,000.00
Base Construction Cost:					**$789,010**
Optional Additional Work					
14	Additional Excavation	1000	CY	12	$12,000
15	Additional Hourly Work: General Laborer	40	HR	$80.00	$3,200
16	Additional Hourly Work: Dozer	40	HR	$140.00	$5,600
17	Additional Hourly Work: Excavator	40	HR	$140.00	$5,600
18	Additional Hourly Work: Dump Truck	40	HR	$140.00	$5,600
Optional Additional Work Cost					**$32,000**
Construction Total (Base Construction Cost + Optional Additional Work Cost; rounded)					**$821,000**

Note
[1] Unit abbreviations include: CY – Cubic Yard, EA – Each, HR - Hour, LF – Linear Foot, LS – Lump Sum

Table 4-5. Cost estimate for Alternative 2 based on 30% design.

Item no.	Description	Quantity	Units[1]	Unit cost	Total cost
Division II General Construction					
1	Mobilization	1	EA	10%	$58,8030
2	Temporary Construction Entrance	1	EA	$500.00	$500
3	Temporary Sediment Control	1	LS	$14,000.00	$14,000
4	Temporary Construction Fence	300	LF	$5.00	$1,500
Division III Earthwork and Landscape					
5	Clearing and Stockpile of Salvaged Vegetation and Top Soil	1,500	CY	$20.00	$30,000
6	Channel and Bench Excavation, Including Haul (Assume cut/fill balanced on site)	28,650	CY	$12.00	$343,800
7	Roughened Channel Grade Control	368	CY	$24.00	$8,832
8	Large Wood Habitat Features	44	CY	$1,500.00	$66,000
9	Healthy Soil Development	1	LS	$40,000.00	$40,000
10	Fine Substrate Supplementation	100	CY	$95.00	$9,500
11	Seeding/mulch/planting	1	LS	$12,500.00	$12,500
12	Restoration Planting Browse Protection	1	LS	$1,000.00	$1,000
Division VI Structures					
13	Waterway Crossing Structure: Railroad Flat Car Bridge and Unpaved Road Approach Grading	1	LS	$60,000.00	$60,000
Construction Item Subtotal					$646,835
Construction Contingency (Percentage of Construction Item Subtotal)				20%	$129,367
Permits (CDFW 1602)					$5,000.00
Engineering - bid support, construction oversight, as-builts					$40,000.00
Base Construction Cost:					**$821,202**
Optional Additional Work					
14	Additional Excavation	1000	CY	12	$12,000
15	Additional Hourly Work: General Laborer	40	HR	$80.00	$3,200
16	Additional Hourly Work: Dozer	40	HR	$140.00	$5,600
17	Additional Hourly Work: Excavator	40	HR	$140.00	$5,600
18	Additional Hourly Work: Dump Truck	40	HR	$140.00	$5,600
Optional Additional Work Cost					**$32,000**
Construction Total (Base Construction Cost + Optional Additional Work Cost)					**$853,202**

Note
[1] Unit abbreviations include: CY – Cubic Yard, EA – Each, HR - Hour, LF – Linear Foot, LS – Lump Sum

4.4 Selection of a Preferred Alternative

Following review of conceptual design alternatives during the first TAC meeting on May 10, 2021, TAC members indicated a preference for a design planform that provides multiple connections for fish passage between rearing habitats in Long Pond, Sugar Creek, and the 2015 Sugar Off-Channel Habitat area. Support was expressed by the TAC for utilizing the 80-percent exceedance water surface elevation as a proposed design water surface elevation, and for lowering lateral connections between the proposed downstream rearing area and the 2015 Sugar Off-Channel Habitat area shown in the Alternatives to be activated by the 80-percent exceedance elevation. Based on the water quality conditions discussed in Section 3.5, the TAC members did not have concerns about fish stranding, seasonal water temperature fluctuations, or dissolved oxygen availability within the constructed rearing habitats or connected Long Pond open water area. The TAC recommended increasing topographic heterogeneity within the bench and alcove features and providing habitat areas with depths greater than 4 feet for optimal coho habitat. The TAC also recommended approaches for improving soil health (e.g., increasing soil moisture retention, carbon content, and nutrient content available) to improve successful establishment and growth of restoration plantings; specifically, re-use of salvaged whole trees and smaller woody materials (i.e., slash) through burial to emulate nurse log ecological processes. Larger whole tree and rootwad applications were suggested for placement on benches, alcoves, and within open water areas to provide habitat complexity.

The TAC also requested more information about sediment conditions in the Sugar Creek channel within the project reach to help inform any potential effects of channel erosion and sedimentation on the functionality and longevity of the proposed connection channels. In response, the project team analyzed changes in historical channel cross sections surveyed by the California Department of Transportation (CalTrans) at the State Route 3 bridge crossing of Sugar Creek, evaluated changes in longitudinal profiles in Sugar Creek downstream of the State Route 3 bridge crossing, and conducted a field reconnaissance of channel sediment conditions in the Project reach (Appendix H). The results indicated a relatively abundant supply of sand and fine gravel to lower Sugar Creek and a modest amount of bed elevation change related to sand deposition in the upstream portion of the project reach associated with local hydraulics at the State Route 3 bridge crossing, backwatering behind the natural beaver dam, and floodplain inundation on the downstream left bank. Little change in bed elevation due to sand deposition, however, was apparent in the main Sugar Creek channel downstream of the natural beaver dam and in the vicinity of the outlet from the 2015 Sugar Off-Channel Habitat area. These results suggest much of the sand and fine gravel flux into the reach is trapped by the first natural beaver dam obstruction, deposited on floodplains, and/or transported downstream of the proposed Long Pond connection points.

During the site reconnaissance of Sugar Creek performed by SRWC and Stillwater staff (Appendix H), the left bank of Sugar Creek between the State Route 3 bridge and SRWC's 2020 floodplain restoration project was observed to be primarily composed of sand and was occupied by dense riparian vegetation. The design alternatives previously considered an action to supplement left bank areas with a fine substrate (e.g., sand) to reduce void space, infiltration rate, and overall flow loss from Sugar Creek. Given the existing prevalence of sand across the floodplain surface, it is unlikely that further supplementation would be effective at reducing conductivity and could negatively impact existing riparian vegetation. This design element was therefore removed from the Preferred Alternative.

Following the TAC meeting, the Preferred Alternative was developed based on TAC input and with additional direction from SRWC. The Preferred Alternative was then advanced to the 65%

design level with supporting planset drawings, quantity estimates, and associated construction costs. Additional direction from SRWC included specifying removal and offsite disposal for debris accumulated at the site (predominately scrap metal and other building materials) and supplementing soil amendments with biochar to increase carbon, nutrient cycling, and soil moisture capacity. An additional TAC review meeting was conducted on August 3, 2021 to discuss the project design advancement to the 65% design level, which incorporated the recommendations and changes. TAC and SRWC recommendations and requested changes from review of the 65% and 90% designs have thus been incorporated into the grading and habitat design features of the 100% design. The following describes the key features and the associated design parameters.

4.4.1 Multiple and variable connections

The proposed design plans incorporate multiple and variably activated connection points between Sugar Creek, the 2015 Sugar Off-Channel Habitat area, and the proposed rearing channel area. The previously proposed high flow connection channels were lowered to provide a minimum inundation depth of 0.5 feet at the 80-percent exceedance water surface elevation to facilitate volitional movement of juvenile salmonids between these diverse habitat areas. An additional connection between Sugar Creek and the proposed rearing channel area is included to further increase salmonid ingress and egress opportunities. The primary connection between the rearing area and Sugar Creek was lowered to an approximate elevation of 2,998 feet NAVD88 to match the existing pool depth within Sugar Creek, and thus provide deeper rearing area depths (e.g. approximately 6 feet at the 80-pecent exceedance water surface elevation). The increased number of connections provides for a higher level of resiliency in the design to possible change in Sugar Creek channel form from episodic erosion and deposition events.

4.4.2 Large wood habitat features

Two large wood feature types are included in the designs to provide immediate habitat benefits. These are referred to as the Large Wood Habitat Feature, Type I (LWHF1) and the Large Wood Habitat Feature, Type II (LWHF2). The LWHF1 is constructed using a single log with intact rootwad, and the LWHF2 is constructed using two criss-crossed logs with intact rootwads. Based on SRWC's past experiences acquiring material for building large wood habitat features in the regions, these features are assumed to be constructed using Ponderosa Pine, Douglas Fir, or Western Juniper rootwad logs that are approximately 20 feet long with 1.5 foot diameter at breast height. Each log member will be embedded into the constructed bench or channel to at least 2/3 of total log length and ballast for vertical, horizontal, and rotational stability will be achieved by placement of native material backfill to the finished grades. Each log is assumed to be keyed with the stem angled vertically downward into the finished grade banks at a minimum of 10° from horizontal to increase the amount of native backfill ballast on the log stem.

The vertical and horizontal stability of the large wood habitat features was evaluated using an assumed flood stage and flow conditions. For the flood stage assumption, the 1-percent AEP flood water surface elevation (3,023 feet NAVD88) was derived by inspecting the point of intersection between the effective Special Flood Hazard Area (FEMA 2011) and State Route 3 near the project site and extracting the elevation for the intersections from the 2018 LiDAR. A normal depth calculation was used to estimate a high biased velocity associated with the future proposed water depth, calculated as the difference between the 1-percent AEP flood water surface and the lowest rearing channel bottom elevation. The slope used for the normal depth calculation was assumed as the proposed channel bed near the proposed crossing. These assumptions provide a high biased velocity estimate, since the FEMA (2011) mapping indicates that significant flooding would occur throughout the valley at the 1% AEP flood water surface elevation. This backwatering, combined with vegetative and topographic complexity in the tailings and restoration area, would likely reduce down valley velocities during such a flood event. The predicted factor of safety for each force (vertical, horizontal, and rotational) exceeds the design criteria factor a safety of 1.5, indicating that the proposed large wood habitat features are stable for the conditions considered.

Whole trees and associated smaller coarse woody materials (e.g., branches and shrubs) removed as part of clearing for project grading plan implementation can be salvaged and stockpiled for reuse in the project. Two habitat features, referred to in the design plans (Appendix G) as nurse logs and brush trenches, are proposed that incorporate these materials salvaged on site. The purpose for incorporating these materials into the proposed design features is primarily to increase soil organic and nutrient content and increase soil moisture capacity, as recommended by the TAC. Inspection of aerial photography overlain with grading contours indicates that approximately 38 whole trees may be available through salvage. The nurse log and brush trench features utilize salvaged woody material as either fully or partially embedded. The near surface soil associated with these two features is specified for amendment using a blend of 25-percent imported wood chips, 25-percent top soil, and 10-percent imported biochar materials mixed with the remaining 40% of salvaged native topsoil. Plantings and seeding are assumed to occur within these features to emulate naturally occurring nurse logs. Up to 25-percent of the protruded surficial area of the nurse logs is proposed to be enhanced for wood cavity nesting pollinator habitat by drilling nesting pilot holes with varying diameters and lengths. A blanket rolled erosion control product (i.e. coir matting) is proposed for installation along the subgrade bottom and sides of the nurse log installations to further enhance the soil moisture retention within the nurse log trench to improve the likely success of native plantings and accelerate macrodetrital processes.

4.4.3 Roughened channel grade control

Roughened channel grade control material is specified for each of the two proposed plug grading locations and at the proposed water crossing location. The intent of the roughened grade control material is to provide vertical bed stability and also increase hydraulic turbulence in an effort to aerate the water entering the proposed downstream rearing area adjacent to Sugar Creek. A 1.5 foot thick layer of engineered streambed material (ESM) is specified for construction of the roughened channel segments following the guidance of the *California Salmonid Stream Habitat Restoration Manual Part XII* (2009). A normal depth calculation was used to estimate the unit discharge associated with each of the three roughened channel locations. The highest unit discharge between the three locations was then used to compute the ESM gradation. It is assumed that the ESM gradation can be efficiently achieved by sorting materials excavated as part of the project grading plan and supplemented with imported rock materials on an as-needed basis. The ESM layer is assumed to be placed in a minimum of three lifts, with each lift having a maximum height of 0.5 feet. Construction of the ESM in smaller lifts is intended to improve the stability and compacted unified form of the overall ESM layer, that will then provide reduced infiltration and flow loss to potential ESM void space when the roughened channel segments are activated.

4.4.4 Healthy soil development

In addition to the soil amendments proposed for the aforementioned nurse log and brush trench habitat features, additional healthy soil development is proposed. Specifically, the designs include soil amendments for two habitat planting zones classified as future state riparian forest areas along portions of the grading plan slopes and emergent wetland bench areas along the grading plan benches. These locations are each assumed to be treated by 10-percent imported wood chips and 10-percent imported topsoil mixed with the salvaged native topsoil. For the riparian forest areas, an additional 10-percent of the amended soil is proposed to be made of imported biochar, however no biochar is assumed for addition to the emergent wetland bench amended soils. A netted rolled erosion control product (i.e., jute netting) is proposed for placement over top of these two amended soil locations to minimize the potential for fluvial or aeolian erosion of the lower density amended soil compared with the higher density native substrate. The depth of treatment application is assumed to be 18 inches for each of these locations.

4.4.5 Debris removal

Surficial debris, including discarded tires and scrap metal, is located near the grading areas and within a location that likely needs some minor grading to accommodate continued and future private property unpaved access routes. Potential mobilization of this material into the proposed aquatic habitat areas would be deleterious to the uplift processes that the project intends to provide. Therefore, offsite haul and disposal at appropriate landfill sites is proposed for this material. An estimate of the number of dump truck loads was prepared by inspection of aerial photography of the debris areas and using an assumed compacted thickness for haul transport. Using this methodology, the estimated number of 10 cubic yard dump truck loads is 16.

4.4.6 Native planting and seeding

A preliminary native planting zone palette was developed for the revegetation following completion of the grading work. The palette zonation is based on the habitat conditions that are likely to occur and that provides for the long-term physical and biological habitat attributes necessary to sustain robust salmonid rearing conditions. The plants and seeds proposed for the two zones, classified as riparian forest and emergent wetland bench habitats, include species commonly found in healthy similarly classified habitat areas near the project area. The native seed mix proposed as Seed Mix A is provided in Table 4-6.

Table 4-6. Native Seed Mix A for application to emergent wetland bench and riparian forest planting zone areas.

Common name	Scientific name	Pounds per acre of pure live seed (PLS)
Western Yarrow	*Achillea millefolium*	1
California Brome	*Bromus carinatus*	25
Clustered Field Sedge	*Carex praegracilis*	5
Blue Wildrye	*Elymus glaucus*	25
Barley	*Hordeum brachyantherum*	25
Beardless Wildrye	*Elymus triticoides*	15
Spanish Lotus	*Acmispon americanus*	10
Small Fescue	*Festuca microstachys*	5
Total Pounds PLS per acre =		**111**

4.5 Opinion of Probable Cost for the Preferred Alternative

Table 4-7 provides an opinion of probable cost for the preferred alternative that is commensurate with the 100% level design element considerations. The estimated direct construction item combined cost is $1,360,000, and with added contingency, permitting, and associated engineering support for implementation is $1,647,000. An additional $38,800 is included for budgetary purposes to allow for opportunistic construction actions that are within the permit constraints and in line with the project objectives, but that may not be readily apparent until active construction is underway. Accounting for this additional optional work budgetary cost, the project total cost is estimated at $1,685,800. The details provided in the design drawings (Appendix G) and Table 4-7, allows for a variety of methods to achieve project implementation with altered estimated costs, such as alternative unit cost assumptions, phased implementation of project elements, and reduction in item quantities.

SRWC requested cost details delineated for potential phased implementation. Potential project phases were delineated by work elements along the project length, and assumed to sequence from Sugar Creek towards the open water Long Pond feature. Three phases are delineated and correspond to the project elements shown on the design drawing plan views (Appendix G) as follows:

- Phase 1: Project elements shown on design drawing sheet 7, downstream of and not including the proposed waterway crossing,
- Phase 2: Project elements shown on design drawing sheet 10 and 14 that are upstream of and including the proposed waterway crossing to connect the Phase 1 area to Long Pond,
- Phase 3: Project elements shown on design drawing 12 that are along Long Pond, including the alcoves and associated habitat elements.

Quantity and cost estimates for the potential phased implementation are provided in Table 4-8, Table 4-9, and Table 4-10. The combined phased implementation cost is estimated at $37,500 more than the single phase of implementation provided in Table 4-7, due to uncertainty in phased implementation timing and therefore the need to assume duplication of temporary efforts and higher support costs.

Table 4-7. Cost estimate for the 100% Preferred Alternative design with assumed single phase.

Item no.	Description	Quantity	Units[1]	Unit cost	Total cost
Division II General Construction					
1	Mobilization	1	EA	5%	$64,700
2	Temporary Construction Entrance	1	EA	$4,300	$4,300
3	Temporary Erosion and Sediment Control Plan	1	LS	$2,000	$2,000
4	Temporary Erosion and Sediment Control Materials	1	LS	$21,150	$21,150
5	Temporary Construction Fence	300	LF	$5	$1,500
Division III Earthwork and Landscape					
6	Clearing and Stockpile of Salvaged Vegetation and Top Soil	2,675	CY	$20	$53,500
7	Removal and Disposal of Debris	160	CY	$141	$22,560

Item no.	Description	Quantity	Units[1]	Unit cost	Total cost
8	Channel and Bench Excavation, Including Haul (Assume cut/fill balanced on site)	37,950	CY	$14.00	$531,300
9	Roughened Channel Grade Control	575	CY	$73.00	$42,000
10	Large Wood Habitat Feature, Type 1 (LWHF1)	22	EA	$1,800	$39,600
11	Large Wood Habitat Feature, Type 2 (LWHF2)	11	EA	$3,000	$33,000
12	Brush Trench	900	LF	$64	$57,600
13	Nurse Logs, using onsite salvaged trees (including live stakes)	38	EA	$3,800	$144,400
14	Riparian Forest Soil Amendment	4,200	SY	$40	$168,000
15	Emergent Wetland Bench Soil Amendment	1,760	SY	$38.50	$67,760
16	Boulder Bollards, placed to deter larger vehicle access to plug and alcove grading areas	8	EA	$1,130	$9,040
17	Native Plant Seeding, Seed Mix A: Emergent Wetland Bench	0.5	AC	$6,000	$3,000
18	Native Plant Seeding, Seed Mix A: Riparian Forest	1	AC	$6,000	$6,000
19	Native Plant Seeding, Seed Mix A: Brush Trench	0.06	AC	$6,000	$360
20	Native Plant Revegetation: Emergent Wetland Bench Live Stakes Installed	6,287	EA	$3	$18,860
21	Native Plant Revegetation: Riparian Forest Live Stakes Installed	952	AC	$3	$2,860
22	Restoration Planting Browse Protection	1	LS	$6,000	$6,000
Division VI Structures					
23	Waterway Crossing Structure: Railroad Flat Car Bridge and Unpaved Road Approach Grading	1	LS	$60,000	$60,000
Construction Item Subtotal (rounded)					$1,360,000
Construction Contingency (Percentage of Construction Item Subtotal; rounded)				15%	$204,000
Permits (CDFW 1602)					$5,000
Engineering - bid support, construction oversight, as-builts					$78,000
Base Construction Cost (rounded):					**$1,647,000**
Optional Additional Work					
25	Additional Excavation	1000	CY	14	$14,000
26	Additional Hourly Work: General Laborer	40	HR	$100	$4,000
27	Additional Hourly Work: Dozer	40	HR	$140	$5,600
28	Additional Hourly Work: Excavator	40	HR	$240	$9,600
29	Additional Hourly Work: Dump Truck	40	HR	$140	$5,600

Item no.	Description	Quantity	Units[1]	Unit cost	Total cost
Optional Additional Work Cost					**$38,800**
Construction Total (Base Construction Cost + Optional Additional Work Cost; rounded)					**$1,685,800**

Note
[1] Unit abbreviations include: AC - Acre, CY – Cubic Yard, EA – Each, HR - Hour, LF – Linear Foot, LS – Lump Sum, SY – Square Yard

Table 4-8. Cost estimate for the Phase 1 of the 100% Preferred Alternative design.

Item no.	Description	Quantity	Units[1]	Unit cost	Total cost
Division II General Construction					
1	Mobilization	1	EA	5%	$19,100
2	Temporary Construction Entrance	1	EA	$4,300	$4,300
3	Temporary Erosion and Sediment Control Plan	1	LS	$2,000	$2,000
4	Temporary Erosion and Sediment Control Materials	1	LS	$9,600	$9,600
5	Temporary Construction Fence	300	LF	$5	$1,500
Division III Earthwork and Landscape					
6	Clearing and Stockpile of Salvaged Vegetation and Top Soil	974	CY	$20	$19,500
7	Channel and Bench Excavation, Including Haul (Assume cut/fill balanced on site)	7,950	CY	$14.00	$111,300
8	Roughened Channel Grade Control	275	CY	$73.00	$20,100
9	Large Wood Habitat Feature, Type 1 (LWHF1)	18	EA	$1,800	$32,400
10	Large Wood Habitat Feature, Type 2 (LWHF2)	5	EA	$3,000	$15,000
11	Brush Trench	540	LF	$64	$34,600
12	Nurse Logs, using onsite salvaged trees (including live stakes)	9	EA	$3,800	$34,200
13	Riparian Forest Soil Amendment	1,040	SY	$40	$41,500
14	Emergent Wetland Bench Soil Amendment	1,090	SY	$38.00	$41,400
15	Native Plant Seeding, Seed Mix A: Emergent Wetland Bench	0.22	AC	$6,000	$1,350
16	Native Plant Seeding, Seed Mix A: Riparian Forest	0.21	AC	$6,000	$1,290
17	Native Plant Seeding, Seed Mix A: Brush Trench	0.04	AC	$6,000	$220
18	Native Plant Revegetation: Emergent Wetland Bench Live Stakes Installed	2,830	EA	$3	$8,490
19	Native Plant Revegetation: Riparian Forest Live Stakes Installed	204	AC	$3	$612
20	Restoration Planting Browse Protection	1	LS	$2,000	$2,000
Construction Item Subtotal (rounded)					$400,000
Construction Contingency (Percentage of Construction Item Subtotal; rounded)				15%	$60,000
Permits (CDFW 1602)					$5,000
Engineering - bid support, construction oversight, as-builts					$35,000
Base Construction Cost (rounded):					**$500,000**

Item no.	Description	Quantity	Units[1]	Unit cost	Total cost
Optional Additional Work					
21	Additional Excavation	400	CY	14	$5,600
22	Additional Hourly Work: General Laborer	20	HR	$100	$2,000
23	Additional Hourly Work: Dozer	20	HR	$140	$2,800
24	Additional Hourly Work: Excavator	20	HR	$240	$4,800
25	Additional Hourly Work: Dump Truck	20	HR	$140	$2,800
Optional Additional Work Cost					**$18,000**
Construction Total (Base Construction Cost + Optional Additional Work Cost; rounded)					**$518,000**

Note
[1] Unit abbreviations include: AC - Acre, CY – Cubic Yard, EA – Each, HR - Hour, LF – Linear Foot, LS – Lump Sum, SY – Square Yard

Table 4-9. Cost estimate for the Phase 2 of the 100% Preferred Alternative design.

Item no.	Description	Quantity	Units[1]	Unit cost	Total cost
Division II General Construction					
1	Mobilization	1	EA	5%	$27,600
2	Temporary Construction Entrance	1	EA	$4,300	$4,300
3	Temporary Erosion and Sediment Control Plan	1	LS	$2,000	$2,000
4	Temporary Erosion and Sediment Control Materials	1	LS	$7,300	$7,300
5	Temporary Construction Fence	300	LF	$5	$1,500
Division III Earthwork and Landscape					
6	Clearing and Stockpile of Salvaged Vegetation and Top Soil	1,240	CY	$20	$24,800
7	Removal and Disposal of Debris	160	CY	$141	$22,560
8	Channel and Bench Excavation, Including Haul (Assume cut/fill balanced on site)	18,350	CY	$14.00	$257,000
9	Roughened Channel Grade Control	300	CY	$73.00	$21,700
10	Brush Trench	80	LF	$64	$5,200
11	Nurse Logs, using onsite salvaged trees (including live stakes)	21	EA	$3,800	$80,000
12	Riparian Forest Soil Amendment	650	SY	$40	$26,000
13	Emergent Wetland Bench Soil Amendment	670	SY	$38.50	$25,500
14	Boulder Bollards, placed to deter larger vehicle access to plug and alcove grading areas	4	EA	$1,130	$4,500
15	Native Plant Seeding, Seed Mix A: Emergent Wetland Bench	0.14	AC	$6,000	$830

Item no.	Description	Quantity	Units[1]	Unit cost	Total cost
16	Native Plant Seeding, Seed Mix A: Riparian Forest	0.13	AC	$6,000	$800
17	Native Plant Seeding, Seed Mix A: Brush Trench	0.01	AC	$6,000	$30
18	Native Plant Revegetation: Emergent Wetland Bench Live Stakes Installed	1,750	EA	$3	$5,240
19	Native Plant Revegetation: Riparian Forest Live Stakes Installed	128	AC	$3	$380
20	Restoration Planting Browse Protection	1	LS	$2,000	$2,000
Division VI Structures					
21	Waterway Crossing Structure: Railroad Flat Car Bridge and Unpaved Road Approach Grading	1	LS	$60,000	$60,000
Construction Item Subtotal (rounded)					$579,000
Construction Contingency (Percentage of Construction Item Subtotal; rounded)				15%	$87,000
Permits (CDFW 1602)					$5,000
Engineering - bid support, construction oversight, as-builts					$40,000
Base Construction Cost (rounded):					**$711,000**
Optional Additional Work					
22	Additional Excavation	300	CY	14	$4,200
23	Additional Hourly Work: General Laborer	10	HR	$100	$1,000
24	Additional Hourly Work: Dozer	10	HR	$140	$1,400
25	Additional Hourly Work: Excavator	10	HR	$240	$2,400
26	Additional Hourly Work: Dump Truck	10	HR	$140	$1,400
Optional Additional Work Cost					**$10,400**
Construction Total (Base Construction Cost + Optional Additional Work Cost; rounded)					**$721,400**

Note
[1] Unit abbreviations include: AC - Acre, CY – Cubic Yard, EA – Each, HR - Hour, LF – Linear Foot, LS – Lump Sum, SY – Square Yard

Table 4-10. Cost estimate for the Phase 3 of the 100% Preferred Alternative design.

Item no.	Description	Quantity	Units[1]	Unit cost	Total cost
Division II General Construction					
1	Mobilization	1	EA	5%	$18,800
2	Temporary Construction Entrance	1	EA	$4,300	$4,300
3	Temporary Erosion and Sediment Control Plan	1	LS	$2,000	$2,000
4	Temporary Erosion and Sediment Control Materials	1	LS	$21,150	$7,400
5	Temporary Construction Fence	300	LF	$5	$1,500
Division III Earthwork and Landscape					
6	Clearing and Stockpile of Salvaged Vegetation and Top Soil	640	CY	$20	$12,800
8	Channel and Bench Excavation, Including Haul (Assume cut/fill balanced on site)	11,650	CY	$14.00	$163,100
10	Large Wood Habitat Feature, Type 1 (LWHF1)	4	EA	$1,800	$7,200
11	Large Wood Habitat Feature, Type 2 (LWHF2)	6	EA	$3,000	$18,000
12	Brush Trench	270	LF	$64	$17,300
13	Nurse Logs, using onsite salvaged trees (including live stakes)	8	EA	$3,800	$30,400
14	Riparian Forest Soil Amendment	2,510	SY	$40	$100,400
16	Boulder Bollards, placed to deter larger vehicle access to plug and alcove grading areas	4	EA	$1,130	$4,500
18	Native Plant Seeding, Seed Mix A: Riparian Forest	0.52	AC	$6,000	$3,100
19	Native Plant Seeding, Seed Mix A: Brush Trench	0.02	AC	$6,000	$110
21	Native Plant Revegetation: Riparian Forest Live Stakes Installed	500	AC	$3	$1,500
22	Restoration Planting Browse Protection	1	LS	$2,000	$2,000
Construction Item Subtotal (rounded)					$394,400
Construction Contingency (Percentage of Construction Item Subtotal; rounded)				15%	$59,000
Permits (CDFW 1602)					$5,000
Engineering - bid support, construction oversight, as-builts					$15,000
Base Construction Cost (rounded):					**$473,500**

Item no.	Description	Quantity	Units[1]	Unit cost	Total cost
Optional Additional Work					
25	Additional Excavation	300	CY	14	$4,200
26	Additional Hourly Work: General Laborer	10	HR	$100	$1,000
27	Additional Hourly Work: Dozer	10	HR	$140	$1,400
28	Additional Hourly Work: Excavator	10	HR	$240	$2,400
29	Additional Hourly Work: Dump Truck	10	HR	$140	$1,400
Optional Additional Work Cost					**$10,400**
Construction Total (Base Construction Cost + Optional Additional Work Cost; rounded)					**$483,900**

Note
[1] Unit abbreviations include: AC - Acre, CY – Cubic Yard, EA – Each, HR - Hour, LF – Linear Foot, LS – Lump Sum, SY – Square Yard

5 CONSTRUCTION CONSIDERATIONS

5.1 Project Phasing

Like many of the habitat restoration projects implemented to address coho salmon recovery in the Scott River Watershed, the Long Pond Project occurs solely on private property and successful implementation of individual project elements depends on the voluntary participation of private property owners. The Scott River Watershed Council is working to engage landowners within and near the Project area through education and outreach, including by meeting with individual landowners on their properties to learn about their history and discuss their perspective on opportunities and constraints, inviting landowners to participate in technical and stakeholder work group meetings related to the project, and providing preliminary planning and design products for their review. The ability and willingness of private property owners to participate in the Project varies by individual and may change over time in response to unforeseen circumstances. Since the Long Pond Project concept was introduced in 2016 and awarded funding for planning and design in 2018, for example, certain parcels within the Project area have sold and/or have transferred title due to family circumstances. Although these changes do not alter the scope of the design phase of the Long Pond Project, SRWC acknowledges in this design process that some proposed project elements are more likely to be implemented in the near term based on the current willingness and ability of individual landowners to participate, while implementation of other proposed project elements located on properties where landowners have not yet committed their voluntary participation or where ownership is in flux are less certain and will occur at a later date, if at all.

The Long Pond design alternatives and individual design elements within those alternatives are therefore being developed with a phased approach in mind. Development of this phased approach is guided by the following principles:

- Prioritize creating and maintaining habitat connectivity to Sugar Creek, beginning with off-channel habitats located in the Sugar Creek floodplain and working from downstream to upstream through the Long Pond alignment during consecutive phases;

- Create flexibility to incorporate additional project design elements as landowners voluntarily agree to participate and based on the specific level and type of desired participation;
- Create opportunities to seek funding through a variety of sources with different focused objectives, timelines, and funding amounts; and
- Ability to adaptively manage site conditions and implementation of future design elements based on the results of post-implementation monitoring following the initial phase(s) of project implementation.

More details of the phased approach will be provided at subsequent steps in the design process.

5.2 Property Owner Access During Construction

Several private properties are located between the proposed primary connection channel alignment and the Scott River. The main access route for these properties is assumed to be by legal easement from State Route 3 and using the existing unpaved site roads. Construction sequencing should allow for this access route to be maintained for most of the construction work period, with the exception of the primary connection channel excavation needed at the proposed waterway crossing structure. This final portion of excavation can be sequenced immediately before the installation of the proposed railroad flat car bridge. The exact timing of these two actions during the construction period is not important for maintaining access through the site, so long as the two actions occur in sequence without delay between them. Private property owner access will be temporarily disrupted during this work, and the duration of disruption is estimated at three days.

5.3 Construction Access and Staging

Construction equipment and materials will likely be mobilized to and demobilized from the site by common tractor-trailer/low-boy methods. A single staging area at the site is proposed (shown on sheet 5 of Appendix A) for equipment and material day-to-day storage, fueling, and maintenance. The staging area is located in an upland area. Construction equipment access to the staging and work areas will predominately utilize existing site roads, but some ramped access grading is anticipated for the plug and alcove work areas near Long Pond.

5.4 Construction Equipment

Construction of the project is not expected to require specialized construction equipment. The equipment anticipated includes medium to large excavators, off-road haul trucks, loaders, and bull dozers.

5.5 Fill Disposal and Placement

Excavated material in excess of that needed as fill to create proposed bank slopes, road approach grading, and roughened grade controls will be mostly hauled and placed in an upland fill site identified on the design plans (Appendix G) with a stable side slope. Some minor quantities of excavated material may be side cast in a thin spread manner, such as for the realignment and grading of the unpaved site roads to tie in the proposed waterway crossing. Consideration for upland seeding and planting of the fill area is not proposed at this time since the fill materials will be primarily coarse alluvial gravel, cobble, and boulder materials that lack sufficient fines, organic content, and soil nutrients for plant establishment and growth. Additionally, the lack of fines and organic content of the fill materials and higher topographic position of the fill area inhibits the retention of soil moisture needed for plant vigor. The fill area location has been selected to blend with existing unvegetated areas overlain by coarse tailings materials. Field adjustment of the fill area extents may be needed to prevent impacts to existing and established native vegetation. Successful establishment of vegetative cover for the greater floodplain tailings extent is outside of the scope of this project and if undertaken would be costly and have a low likelihood of success without frequent and on-going interventions, such as application of fertilizers, repeated planting and seeding to replace unsuccessful plantings, and long-term irrigation. Therefore, vegetation of the fill area is omitted from the design plans to limit construction costs associated with healthy soil development and revegetation to those locations that have a higher likelihood of success, and that are near the restored and connected aquatic habitats so as to support ecological synergies. Cut and fill volumes will be balanced at the site, and no soil material is to be exported from the site. The limits of disturbance shall be minimized and confined to the construction and grading limits shown on the plans. The ultimate fill area height and extent can be varied during construction based on single or multi-phase implementations, landowner input, and to best blend the fill area into the existing landscape to minimize perceived visual impacts of newly created spoil piles in a legacy tailings pile area.

6 NEXT STEPS

The project development has taken into consideration input from three rounds of TAC and SRWC review to advance the designs to the 100% level. The next step is to seek implementation funding to implement the project.

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Appendices

Appendix A

Conceptual Alternative Design Plans

LONG POND HABITAT ENHANCEMENT DESIGN PROJECT
30 % DESIGN
SISKIYOU COUNTY, CA

PROJECT GOAL: DEVELOP AND ENHANCE HABITAT FEATURES IN THE SCOTT RIVER FLOODPLAIN IN THE VICINITY OF THE SUGAR CREEK CONFLUENCE THE REMEDIATES LIMITING FACTORS FOR C/ESA LISTED SOUTHERN OREGON/NORTHERN CALIFORNIA COAST COHO SALMON.

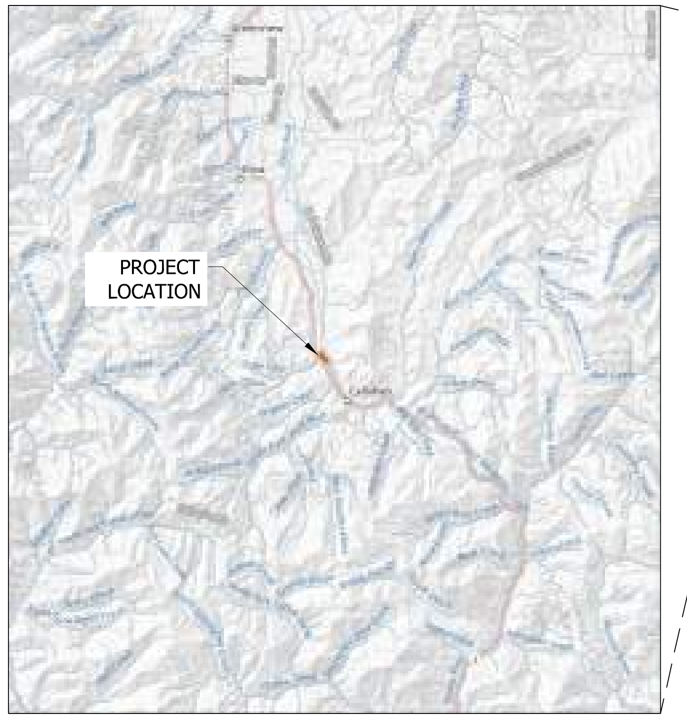
PRIMARY RESTORATION DESIGN ELEMENT INTENT:

- ACCESS TO COLD WATER REFUGIA SITES FOR OVER-SUMMERING HABITAT WITH GOOD WATER QUALITY, HIGH PRIMARY PRODUCTIVITY AND SUFFICIENT DEPTH/COVER FOR PROTECTION FROM PREDATION;
- ACCESS TO WINTER SLOW WATER HABITAT TO OFFER REFUGIA FROM HIGH FLOW EVENTS; AND
- SUFFICIENT FLOW AND CHANGES IN GEOMORPHOLOGY TO IMPROVE BOTH THE LONG POND CONNECTION TO SUGAR CREEK AND THE SUGAR CREEK CONNECTION TO SCOTT RIVER.

PRIMARY RESTORATION DESIGN ELEMENTS:

- PRIMARY CONNECTION CHANNEL BETWEEN SUGAR CREEK AND OFF-CHANNEL REFUGIA
- HIGH FLOW CONNECTION CHANNELS
- ROUGHENED CHANNEL GRADE CONTROL
- BENCHED GRADING
- VARIABLE GRADING SLOPES AND ASPECTS
- LARGE WOOD HABITAT FEATURES
- HEALTHY SOIL DEVELOPMENT
- FINE SUBSTRATE SUPPLEMENTATION
- EXISTING VEGETATION PROTECTION AND NATIVE PLANT REVEGETATION
- WATERWAY CROSSING STRUCTURE

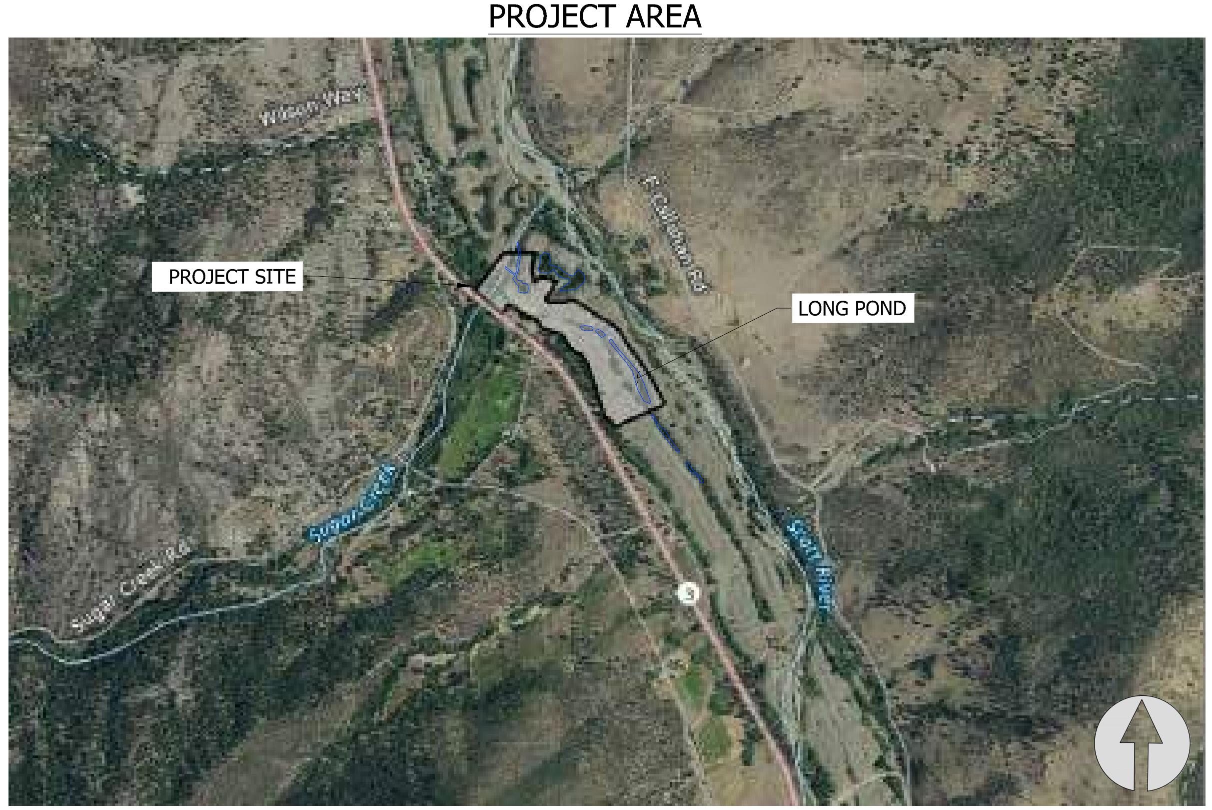
PROJECT VICINITY AND LOCATION



	Sheet List Table	
	Sheet Number	Sheet Title
X	1	TITLE SHEET
X	2	GENERAL NOTES
	3	EROSION AND SEDIMENT CONTROL PLAN
X	4	EXISTING CONDITIONS AND SURVEY CONTROL PLAN
X	5	CONSTRUCTION ACCESS AND STAGING
X	6A	SITE AND KEY PLAN
X	6B	GRADING PLAN
X	8A	LONG POND RESTORATION STA 51+00 TO 58+00 PLAN
X	8B	LONG POND RESTORATION STA 51+00 TO 58+00 PLAN
X	9A	LONG POND REST. STA 51+00 TO 58+00 PROFILES AND SECTIONS
X	9B	LONG POND REST. STA 51+00 TO 58+00 PROFILES AND SECTIONS
X	10	LONG POND RESTORATION STA 41+50 TO 53+00 PLAN
X	11	LONG POND REST. STA 41+50 TO 53+00 PROFILES AND SECTIONS
X	12	LONG POND REST. STA 33+00 TO 44+50 PLAN
X	13	LONG POND REST. STA 33+00 TO 44+50 PROFILES AND SECTIONS
X	14	WATERWAY CROSSING PLAN
X	15	WATERWAY CROSSING PROFILE AND SECTION
	16	RESTORATION TREATMENT SCHEDULE
	17	LARGE WOOD HABITAT FEATURE DETAILS
	18	SUBSURFACE SOIL TREATMENT - DETAILS
	19	ROUGHENED CHANNEL - DETAILS
	20	PLANTING PLAN
	21	PLANTING PALETTE
	22	PLANTING DETAILS

X DENOTES SHEET INCLUDED IN THIS PACKAGE

PROJECT AREA



LONG POND HABITAT ENHANCEMENT DESIGN PROJECT

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30% DESIGN REVIEW DRAWINGS

April 15, 2021

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DESIGN: JS/RWK
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CHECKED: JS
APPROVED: JS

TITLE SHEET

GENERAL NOTES, TERMS, & CONDITIONS:

1. **DESIGN INTENT.** THESE DRAWINGS REPRESENT THE GENERAL DESIGN INTENT TO BE IMPLEMENTED AND CONTRACTOR IS RESPONSIBLE FOR ALL ITEMS SHOWN ON THESE PLANS. CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING THE PROJECT MANAGER FOR ANY CLARIFICATIONS OR FURTHER DETAILS NECESSARY TO ACCOMMODATE ACTUAL SITE CONDITIONS. ANY DEVIATION FROM THESE PLANS WITHOUT THE CAR'S PRIOR WRITTEN APPROVAL ARE AT THE CONTRACTOR'S OWN RISK AND EXPENSE. NOTIFY PROJECT MANAGER IMMEDIATELY OF ANY UNEXPECTED AND CHANGED CONDITIONS, UNSAFE WORKING CONDITIONS, AND ENVIRONMENTAL CONCERNS ENCOUNTERED.

2. **JOB SITE CONDITIONS AND CONTRACTOR RESPONSIBILITY.** CONTRACTOR SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR SITE CONDITIONS DURING THE COURSE OF THE CONSTRUCTION OF THIS PROJECT, INCLUDING THE SAFETY OF ALL PERSONS AND PROPERTY, AND ALL ENVIRONMENTAL PROTECTION ELEMENTS, WHETHER SHOWN ON THESE DRAWINGS OR NOT. CONTRACTOR SHALL FOLLOW ALL APPLICABLE CONSTRUCTION AND SAFETY REGULATIONS. THESE REQUIREMENTS SHALL APPLY CONTINUOUSLY AND WILL NOT BE LIMITED TO NORMAL WORKING HOURS. THE CONTRACTOR SHALL DEFEND, INDEMNIFY, AND HOLD CAR HARMLESS FROM ANY AND ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT, EXCEPT FROM LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF THE CAR.

3. **DAMAGE.** CONTRACTOR SHALL EXERCISE CARE TO AVOID DAMAGE TO EXISTING PUBLIC AND PRIVATE PROPERTY, INCLUDING NATIVE TREES AND SHRUBS, AND OTHER PROPERTY IMPROVEMENTS. IF CONTRACTOR CAUSES DAMAGES TO SUCH ITEMS, CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIR OR REPLACEMENT IN LIKE NUMBER, KIND, CONDITION, AND SIZE. ANY SUCH COST MAY BE DEDUCTED BY OWNER FROM MONIES DUE TO CONTRACTOR UNDER THIS CONTRACT.

4. **LIMITS OF WORK, ACCESS, STAGING AND MOBILIZATION AREAS.** THE APPROXIMATE LIMITS OF WORK ARE SHOWN ON THE DRAWINGS. EXACT LIMITS OF WORK, POINTS OF INGRESS-EGRESS, STREAM CHANNEL ACCESS, MOBILIZATION, STAGING, AND WORK AREAS WILL SHALL BE IDENTIFIED AND DETAILED IN CONTRACTOR SAFETY PLAN PROVIDED FOR CAR REVIEW PER SPECIFICATIONS. EQUIPMENT MAINTENANCE AND FUELING MUST OCCUR OUTSIDE OF THE CHANNEL AREA AS DESCRIBED IN THE ENVIRONMENTAL PERMITS FOR THE PROJECT. CONTRACTOR PREPARED STAGING AREA AND SAFETY PLAN TO PROVIDE DETAILS OF EQUIPMENT MAINTENANCE AND FUELING ANTICIPATED DURING THE PERFORMANCE OF THE PROJECT WORK.

5. **WORK IN STREAM CHANNELS AND STREAM DIVERSIONS.** ALL WORK SHALL BE COMPLETED WITHIN THE IN-WATER WORK PERIOD, UNLESS OTHERWISE APPROVED.

   5.1. ALL HEAVY EQUIPMENT, MUST HAVE A SUPPLY OF SORBENT PADS AVAILABLE TO CLEAN-UP GREASE, OIL, OR FUEL THAT DRIPS OR SPILLS. SORBENT BOOMS MUST BE PLACED DOWNSTREAM FROM LOCATIONS WHERE MACHINERY IS EXPECTED TO CROSS CHANNELS. USED PADS AND BOOMS ARE TO BE DISPOSED OF PROPERLY AT CONTRACTOR'S EXPENSE.

6. **ESTIMATED QUANTITIES.** CONTRACTOR IS RESPONSIBLE FOR TRANSPORT AND PLACEMENT OF SPAWNING GRAVEL AND LARGE WOOD, AS SHOWN ON DRAWINGS AND PROVIDED IN CAR STAGING AREA STOCKPILES.

7. **THE** FOLLOWING PERMITS ARE REQUIRED FOR THIS PROJECT, THE CONTRACTOR SHALL BE GIVEN COPIES OF ALL THE PERMITS, SHALL BECOME FAMILIAR WITH THE PERMIT REQUIREMENTS, AND SHALL BE RESPONSIBLE FOR ADHERENCE TO AND CONFORMANCE WITH ALL PERMIT CONDITIONS.

   TBD

ABBREVIATIONS AND NOTATIONS:

ALT	ALTERNATIVE
APN	ASSESSOR'S PARCEL NUMBER
APPROX.	APPROXIMATE
BDA	BEAVER DAM ANALOGUE
BMP	BEST MANAGEMENT PRACTICE
CAR	CONTRACTING AGENCY REPRESENTATIVE, SCOTT RIVER WATERSHED COUNCIL (SRWC)
CHL, CHNL	CHANNEL
CL	CENTERLINE
CU YD	CUBIC YARD
DBH	DIAMETER BREAST HEIGHT
DIA	DIAMETER
DWG	DRAWING
DS	DOWNSTREAM
E	EASTING
<E>	EXISTING
EL, ELEV	ELEVATION
H, HORZ	HORIZONTAL
IE	INVERT ELEVATION
MAX	MAXIMUM
MIN	MINIMUM
N	NORTHING
NIC	NOT IN CONTRACT
NOM	NOMINAL
NTS	NOT TO SCALE
<P>	PROPOSED
PP	POWER POLE
QTY	QUANTITY
REST.	RESTORATION
SHT	SHEET
SPC	STATE PLACE COORDINATE
SPEC	SPECIFICATION(S)
SRWC	SCOTT RIVER WATERSHED COUNCIL
STA	STATION
STD	STANDARD
TBD	TO BE DETERMINED
TEMP	TEMPORARY
TOB	TOP OF BANK
TOS	TOE OF SLOPE
TYP	TYPICAL
US	UPSTREAM
V, VERT	VERTICAL
W/	WITH
W/O	WITHOUT
°	DEGREE
#	NUMBER

LEGEND

PLANVIEW	ELEMENT
	MAJOR 5 FOOT CONTOUR
	MINOR 1 FOOT CONTOUR
	<E> ROAD
	<P> ROAD TO BE DECOMMISSIONED
W	<E> SRWC WATER LEVEL MONITORING LOCATION
	<E> SURVEY CONTROL POINT
	EXISTING OVERHEAD ELECTRIC
	TAX PARCELS (APN & OWNER)
	<P> ROAD
	<P> GRAVEL BAR
	<P> SOIL AMENDMENT AND NATIVE PLANTINGS
	<P> FINE SUBSTRATE SUPPLEMENTATION
	<P> WATERWAY CROSSING

1 — SECTION # OF DETAIL

4 — SHEET # WHERE SECTION/DETAIL SHOWN

EARTHWORK ESTIMATES:

XXXXXXX:
TBD
TBD

LONG POND HABITAT ENHANCEMENT DESIGN PROJECT

SISKIYOU COUNTY, CA

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GENERAL NOTES AND LEGEND

CONTROL POINT TABLE				
POINT #	NORTHING	EASTING	ELEV	DESCRIPTION
101	2372539.53	6334902.73	3011.550	$\frac{3}{8}$" IRON ROD WITHOUT CAP AND MARKING
502	2372548.83	6334906.46	3010.972	PK NAIL WITHOUT WASHER AND MARKING

SURVEY CONTROL NOTES

1. EXISTING GROUND ELEVATION DATA IS FROM XXX 2018 LIDAR BARE EARTH DIGITAL TERRAIN MODEL ADJUSTED BASED ON COMPARISON TO RTK GPS SURVEY FROM RTK GPS SURVEY PERFORMED BY SRWC.
2. SURVEY CONTROL POINTS ARE PROVIDED BY SRWC SURVEY.
3. HORIZONTAL DATUM OF NAD83, CALIFORNIA STATE PLANE, ZONE VI, UNITS OF US SURVEY FEET. ALL ELEVATIONS ARE RELATIVE TO NAVD88 IN UNITS OF FEET.
4. ALL STATIONING REFERS TO CENTERLINE OF CONSTRUCTION, OR AS SHOWN, AND IS THE MEASURED HORIZONTAL DISTANCE.
5. CONSTRUCTION LIMITS, CENTERLINE AND OFFSET STAKING TO BE PERFORMED BY THE CONTRACTOR, UNLESS OTHERWISE DIRECTED BY CAR.
6. UTILITY LOCATIONS SHOWN ARE APPROXIMATE AND IN SOME CASES HAVE NOT BEEN SURVEYED. CONTRACTOR RESPONSIBLE FOR CONTACTING USA NORTH 811 FOR CALIFORNIA UTILITY NOTIFICATION AT 800.642.2444 72 HOURS PRIOR TO COMMENCEMENT OF CONSTRUCTION WORK. CONTRACTOR IS RESPONSIBLE FOR MAINTAINING MARKINGS.

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EXISTING CONDITIONS AND SURVEY CONTROL PLAN

GENERAL NOTES

1. SITE ACCESS IS FROM STATE ROUTE 3 USING PRIVATE DRIVEWAYS. CONTRACTOR TO NOTIFY SRWC 24-HOURS IN PRIOR TO EQUIPMENT AND MATERIAL DELIVERIES TO ALLOW SRWC SUFFICIENT TIME TO NOTIFY PRIVATE PROPERTY OWNERS OF POTENTIAL DRIVEWAY ACCESS DISRUPTIONS.
2. CONTRACTOR SHALL PROTECT EXISTING MONITORING WELLS AND SHALL NOTIFY SRWC FOR PRIOR APPROVAL TO REMOVE MONITORING WELLS THAT ARE WITHIN THE LIMITS. CONTRACTOR RESPONSIBLE FOR REPLACEMENT IN-KIND FOR MONITORING WELLS REMOVED WITHOUT PRIOR APPROVAL.
3. STAGING AREA LIMITS AND TEMPORARY CONSTRUCTION ACCESS AND HAUL ROUTES TO BE STAKED BY CONTRACTOR AND APPROVED BY SRWC PRIOR TO USE.
4. UNLESS SHOWN OTHERWISE ON THESE PLANS, AREAS DISTURBED FOR STAGING AND CONSTRUCTION ACCESS SHALL BE RESTORED TO PRE-CONSTRUCTION STATE AND PER DIRECTION OF SRWC.

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CONSTRUCTION ACCESS AND STAGING PLAN

SHEET 5 OF 22

1 PROPOSED GRADING AND SITE KEY PLAN - ALTERNATIVE 1

Scale: 1:40

0 50 100 200 FEET

SCALE: 1" = 200'

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PROPOSED GRADING AND SITE KEY PLAN

SHEET 6A OF 22

1 PROPOSED GRADING AND SITE KEY PLAN - ALTERNATIVE 2
Scale: 1:40

0 50 100 200 FEET
SCALE: 1" = 200'

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PROPOSED GRADING AND SITE KEY PLAN

SHEET 6B OF 22

1 LONG POND STA 51+00 TO 58+00 PLAN - ALTERNATIVE 1
Scale: 1:40

0 20 40 80 FEET
SCALE: 1" = 40'

CUT AND FILL SUMMARY			
SITE	CUT (CU YD)	FILL (CU YD)	BALANCE (CU YD)
LONG POND DS CONNECTION	3,400	150	3,250
HIGH FLOW CONNECTION 1	250	0	250
HIGH FLOW CONNECTION 2	50	0	50
FILL AREA 1*	0	27,650	-27,650
TOTAL	3,700	27,800	-24,100
* SITE LOCATED ON SHEET 12			

GENERAL NOTES

1. CONTRACTOR SHALL LIMIT EARTHWORK TO PERMANENT AND TEMPORARY FEATURES SHOWN ON THE PLANS AND PER DIRECTION OF CAR.
2. DISTURBANCE OUTSIDE THE WORK SHOWN SHALL BE MINIMIZED.
3. NEGATIVE VALUES SHOWN IN CUT AND FILL SUMMARY TABLE DENOTE SITE FILL VOLUME DEFICIT. NEGATIVE BALANCE VOLUMES INDICATE SITES REQUIRING MORE FILL VOLUME THAN CUT VOLUME PER PLAN VIEW SHOWN ON SHEET.
4. IF BEDROCK IS ENCOUNTERED ABOVE PROPOSED GRADE SHOWN, CONTRACT TO ADJUST PROPOSED GRADE ELEVATION TO MATCH EXISTING BEDROCK ELEVATION AND PER DIRECTION OF CAR.
5. ESTABLISH PLANTING ZONES FOLLOWING APPROVAL BY CAR AND ENGINEER OF PROPOSED GRADE. SEE SHEETS XX AND XX, AND SPECIAL PROVISIONS FOR PLANTING ZONE LAYOUT AND DETAILS. SEE DETAIL X/Y AND SPECIAL PROVISIONS FOR DETAILS ON SOIL AMENDMENT PRIOR TO PLANTING.

LONG POND HABITAT ENHANCEMENT DESIGN PROJECT

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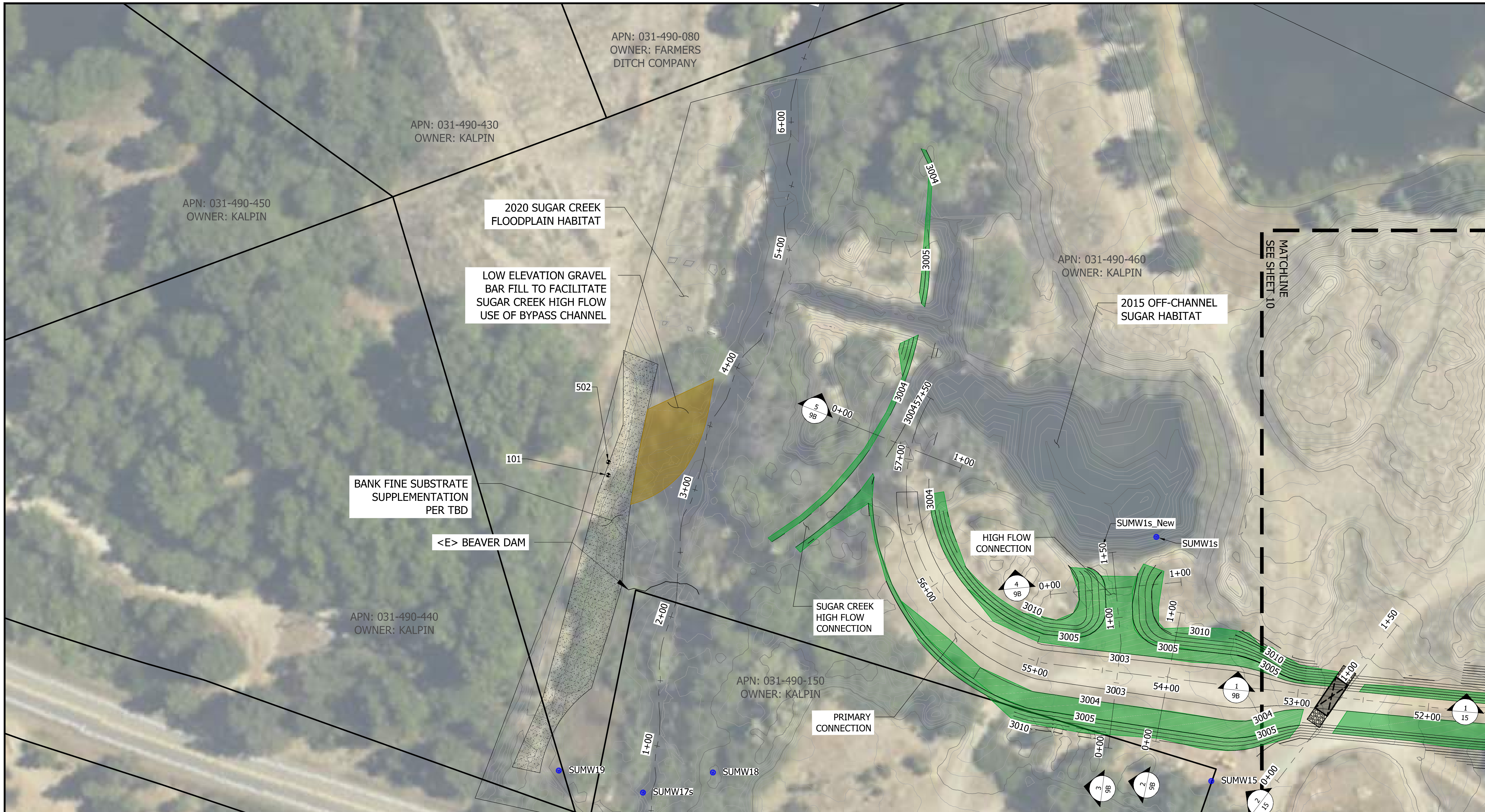
LONG POND REST. STA 51+00 TO 58+00 PLAN

SHEET 8A OF 22



1 LONG POND STA 51+00 TO 58+00 PLAN - ALTERNATIVE 2
Scale: 1:40

0 20 40 80 FEET
SCALE: 1" = 40'

CUT AND FILL SUMMARY			
SITE	CUT (CU YD)	FILL (CU YD)	BALANCE (CU YD)
LONG POND DS CONNECTION	3,100	0	3,100
HIGH FLOW CONNECTION	300	0	300
SUGAR CREEK HIGH FLOW CONNECION	150	0	150
FILL AREA 1*	0	27,950	-27,950
TOTAL	3,550	27,950	-24,400
* SITE LOCATED ON SHEET 12			

GENERAL NOTES

1. CONTRACTOR SHALL LIMIT EARTHWORK TO PERMANENT AND TEMPORARY FEATURES SHOWN ON THE PLANS AND PER DIRECTION OF CAR.
2. DISTURBANCE OUTSIDE THE WORK SHOWN SHALL BE MINIMIZED.
3. NEGATIVE VALUES SHOWN IN CUT AND FILL SUMMARY TABLE DENOTE SITE FILL VOLUME DEFICIT. NEGATIVE BALANCE VOLUMES INDICATE SITES REQUIRING MORE FILL VOLUME THAN CUT VOLUME PER PLAN VIEW SHOWN ON SHEET.
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LONG POND HABITAT ENHANCEMENT DESIGN PROJECT

SISKIYOU COUNTY, CA

Stillwater Sciences
850 G STREET SUITE K
ARCATA, CA 95521
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SCOTT RIVER WATERSHED COUNCIL
SCOTT RIVER WATERSHED COUNCIL
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530-598-2733

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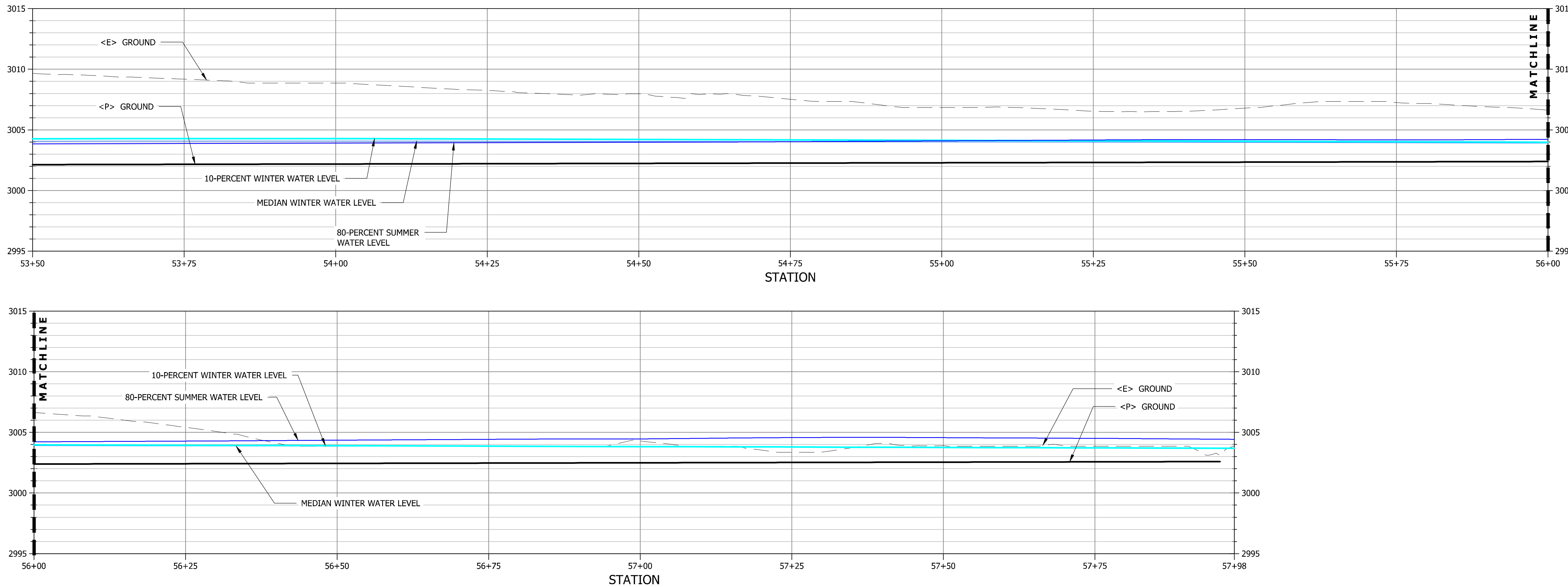
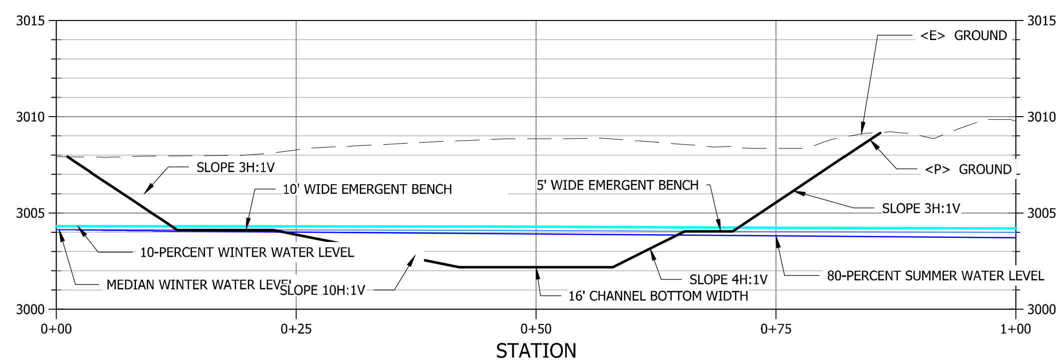
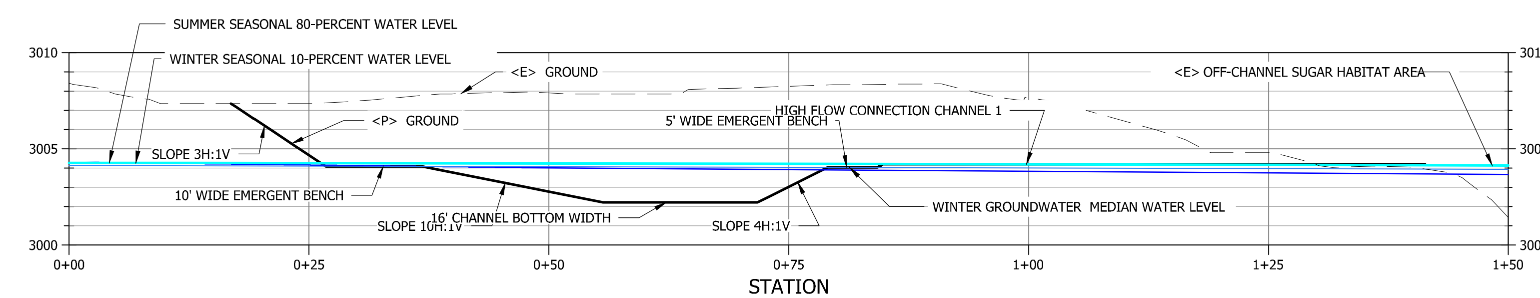
LONG POND REST. STA 51+00 TO 58+00 PLAN



1 8A LONG POND CL - LONGITUDINAL PROFILE
Scale: HOZ: 1" = 10' VERT: 1" = 5'



2 8A PRIMARY CONNECTION - SECTION
Scale: HOZ: 1" = 10' VERT: 1" = 5'



3 8A HIGH FLOW CONNECTION 1 - LONGITUDINAL PROFILE
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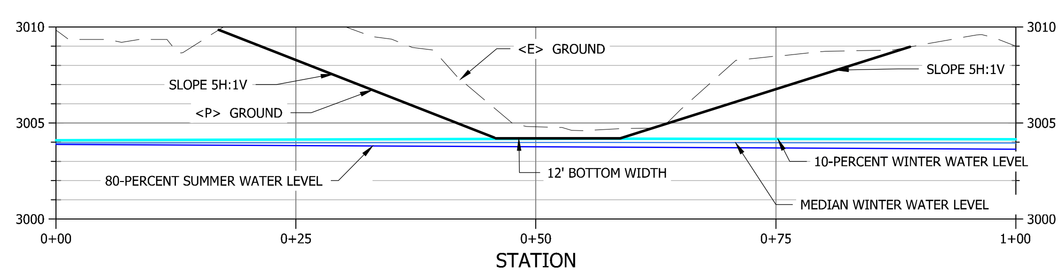

4 8A HIGH FLOW CONNECTION 1 - SECTION
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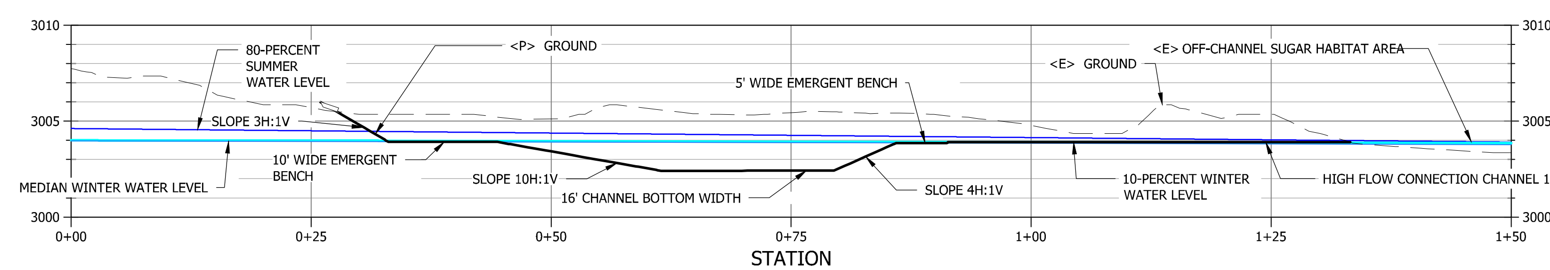

5 8A HIGH FLOW CONNECTION 2 - LONGITUDINAL PROFILE
Scale: HOZ: 1" = 10' VERT: 1" = 5'

GENERAL NOTES

1. CROSS SECTIONS CUT LOOKING DOWNSTREAM.
2. SECTIONS SHOW APPROX. AND TYPICAL PROPOSED GRADE. SEE PLAN AND DETAIL SHEETS FOR SPECIFIC FEATURES TO BE INCORPORATED.

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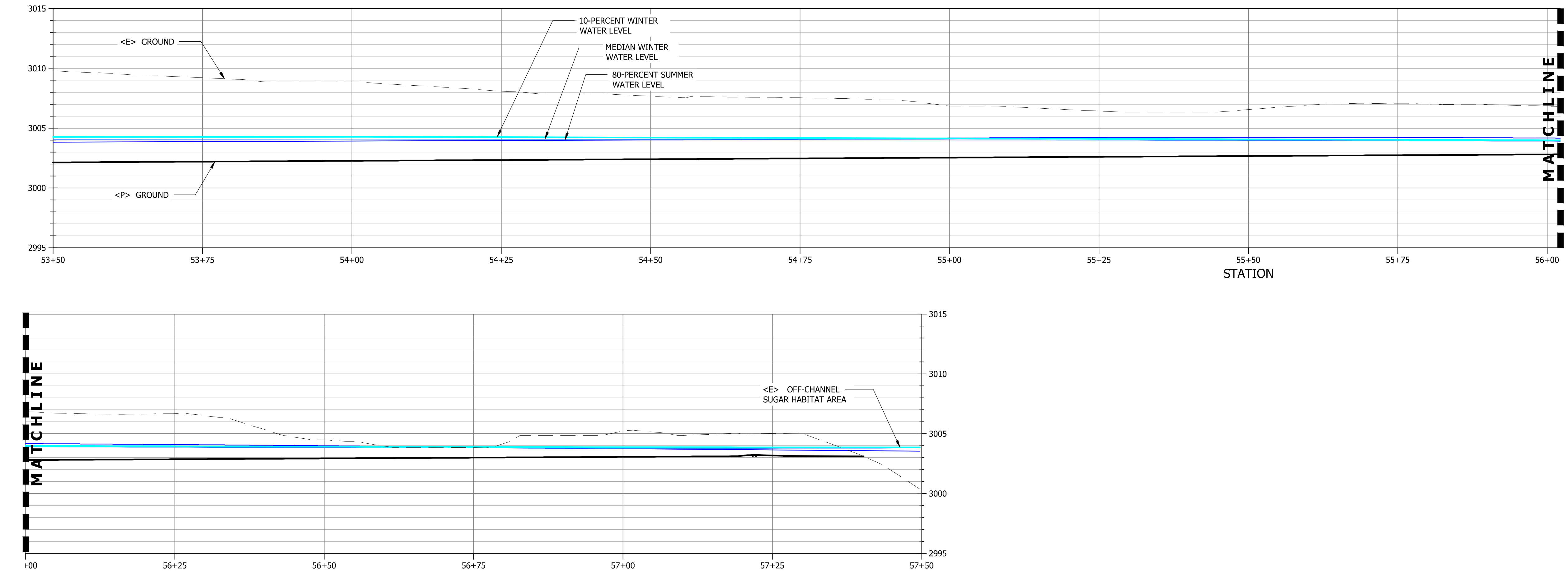
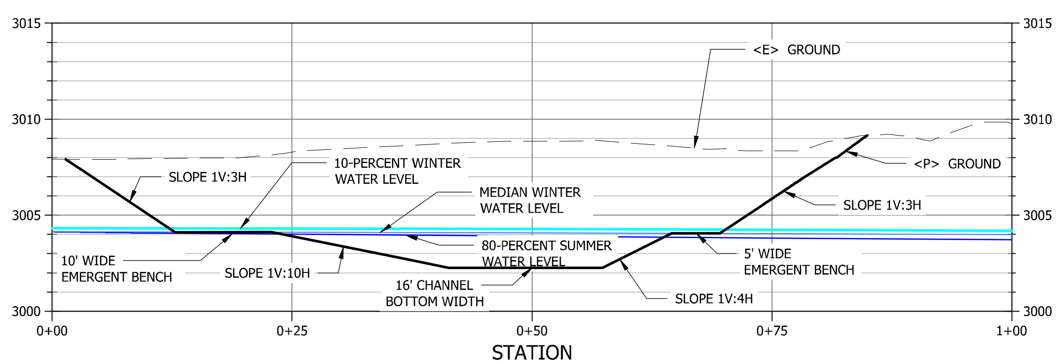
LONG POND REST. STA 51+00 TO 58+00 PROFILES AND SECTIONS

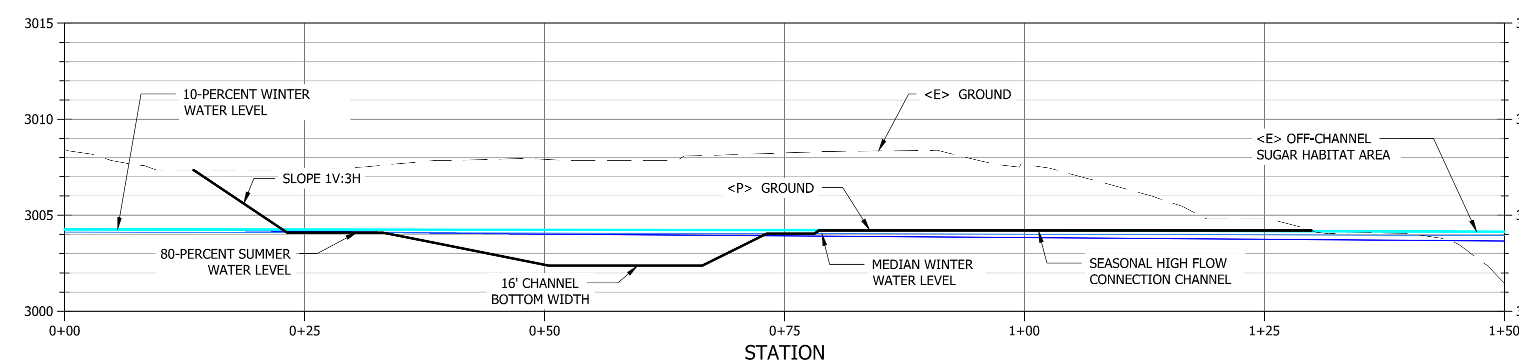
SHEET 9A OF 22



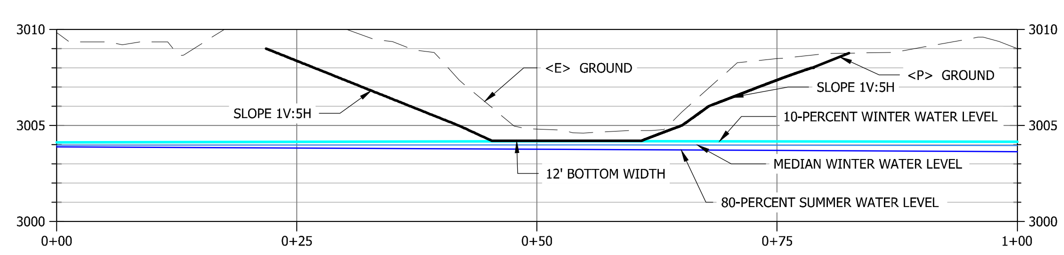
1 LONG POND CL - LONGITUDINAL PROFILE
8B Scale: HOZ: 1" = 10' VERT: 1" = 5'



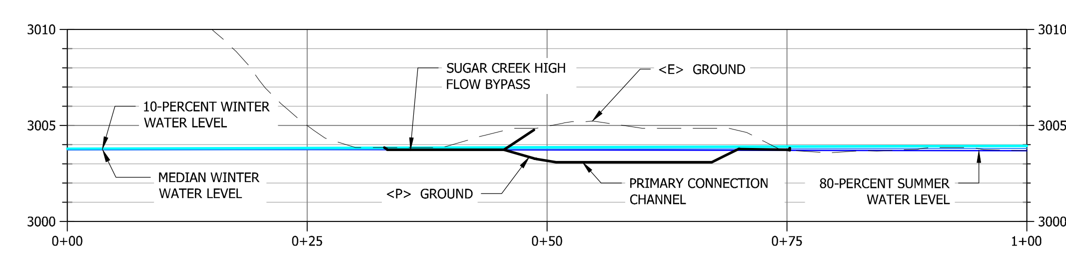
2 PRIMARY CONNECTION - SECTION
8B Scale: HOZ: 1" = 10' VERT: 1" = 5'



3 HIGH FLOW CONNECTION - LONGITUDINAL PROFILE
8B Scale: HOZ: 1" = 10' VERT: 1" = 5'



4 HIGH FLOW CONNECTION - SECTION
8B Scale: HOZ: 1" = 10' VERT: 1" = 5'



5 PRIMARY CONNECTION & SUGAR CREEK HIGH FLOW - SECTION
8B Scale: HOZ: 1" = 10' VERT: 1" = 5'

GENERAL NOTES

1. CROSS SECTIONS CUT LOOKING DOWNSTREAM.
2. SECTIONS SHOW APPROX. AND TYPICAL PROPOSED GRADE. SEE PLAN AND DETAIL SHEETS FOR SPECIFIC FEATURES TO BE INCORPORATED.

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LONG POND REST. STA 51+00 TO 58+00 PROFILES AND SECTIONS

SHEET 9B OF 22

1 LONG POND STA 41+50 TO 53+00 PLAN
Scale: 1:40

0 20 40 80 FEET
SCALE: 1" = 40'

CUT AND FILL SUMMARY			
SITE	CUT (CU YD)	FILL (CU YD)	BALANCE (CU YD)
PLUG 1	1,300	100	1,200
PLUG 2	1,000	0	1,000
LONG POND US CONNECTION	9,950	300	9,650
FILL AREA 1*	0	27,650	-27,650
TOTAL	12,250	28,050	-15,800
* SITE LOCATED ON SHEET 12			

GENERAL NOTES

1. CONTRACTOR SHALL LIMIT EARTHWORK TO PERMANENT AND TEMPORARY FEATURES SHOWN ON THE PLANS AND PER DIRECTION OF CAR.
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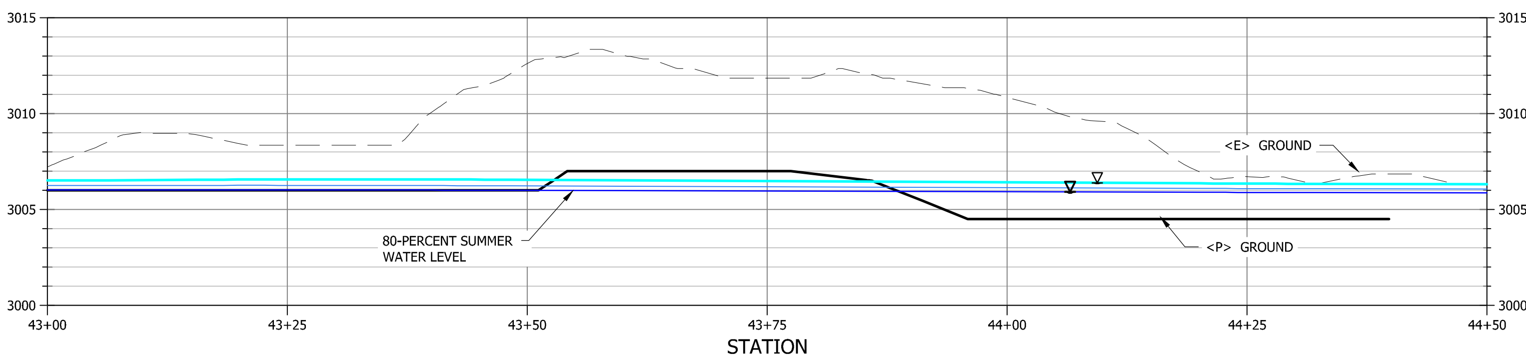
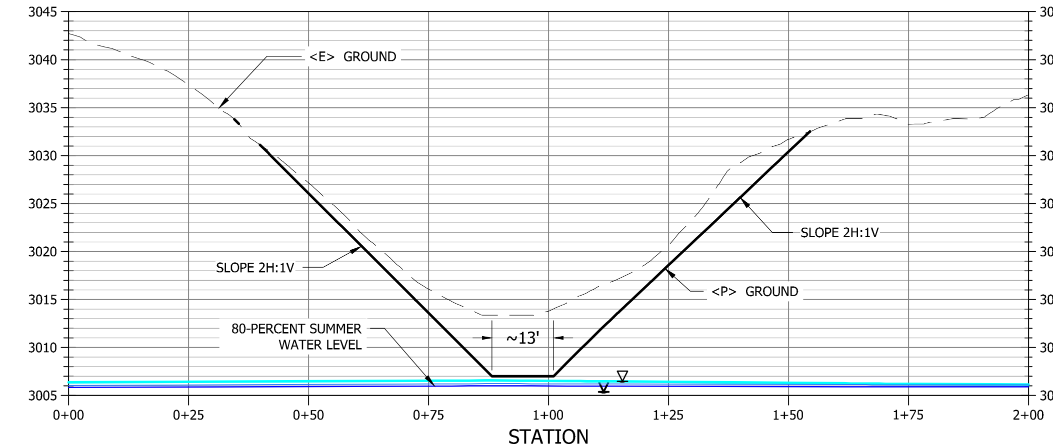
APPROVED: JS

LONG POND REST. STA 41+50 TO 53+00 PLAN

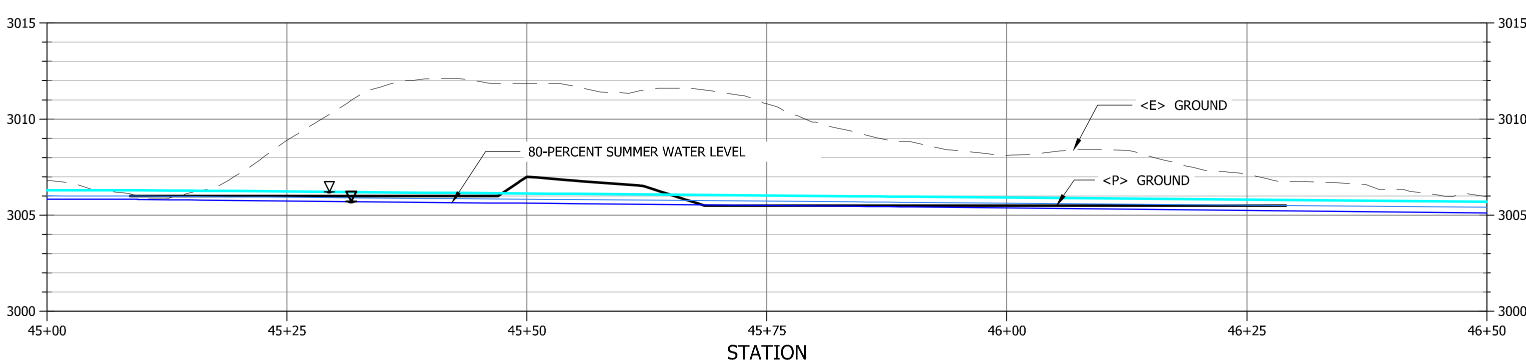
SHEET 10 OF 22



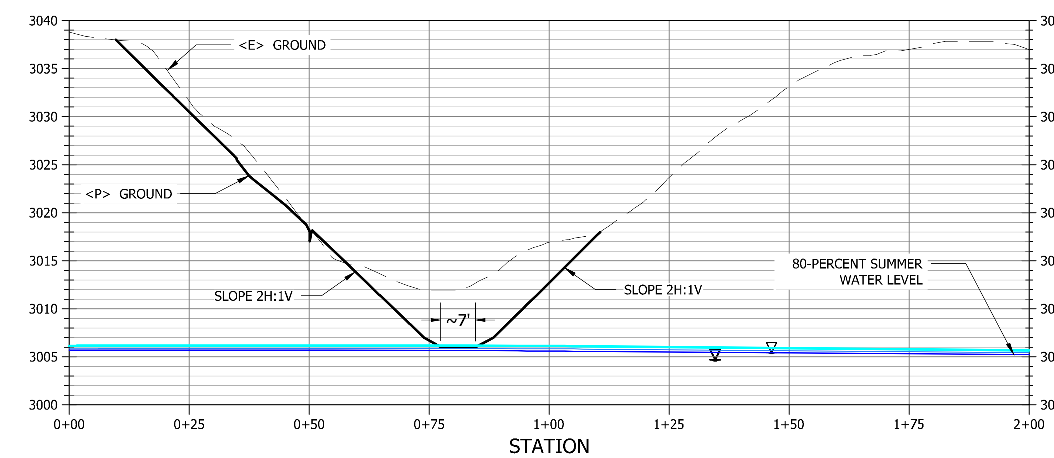
1/10 PLUG 1 - LONG POND CL LONGITUDINAL PROFILE
Scale: HOZ: 1" = 10' VERT: 1" = 5'



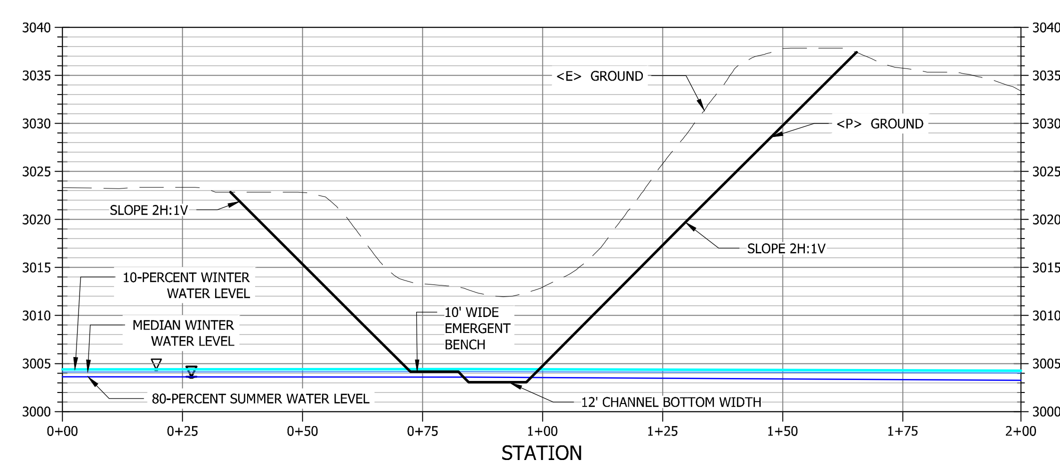
2/10 PLUG 1 - SECTION
Scale: HORZ: 1" = 20' VERT: 1" = 10'



3/10 PLUG 2 - LONG POND CL LONGITUDINAL PROFILE
Scale: HOZ: 1" = 10' VERT: 1" = 5'



4/10 PLUG 2 - SECTION
Scale: HORZ: 1" = 20' VERT: 1" = 10'



5/10 PRIMARY CONNECTION - SECTION
Scale: HOZ: 1" = 20' VERT: 1" = 10'

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LONG POND REST. STA 41+50 TO 53+00 PROFILES AND SECTIONS

1 LONG POND STA 33+00 TO 44+50 PLAN
Scale: 1:40

0 20 40 80 FEET
SCALE: 1" = 40'

CUT AND FILL SUMMARY			
SITE	CUT (CU YD)	FILL (CU YD)	BALANCE (CU YD)
FIN ALCOVE 1	4,600	0	4,600
FIN ALCOVE 2	6,850	0	6,850
PLUG 1	1,300	100	1,200
FILL AREA 1	0	27,650	-27,650
TOTAL	12,750	27,750	-15,000

GENERAL NOTES

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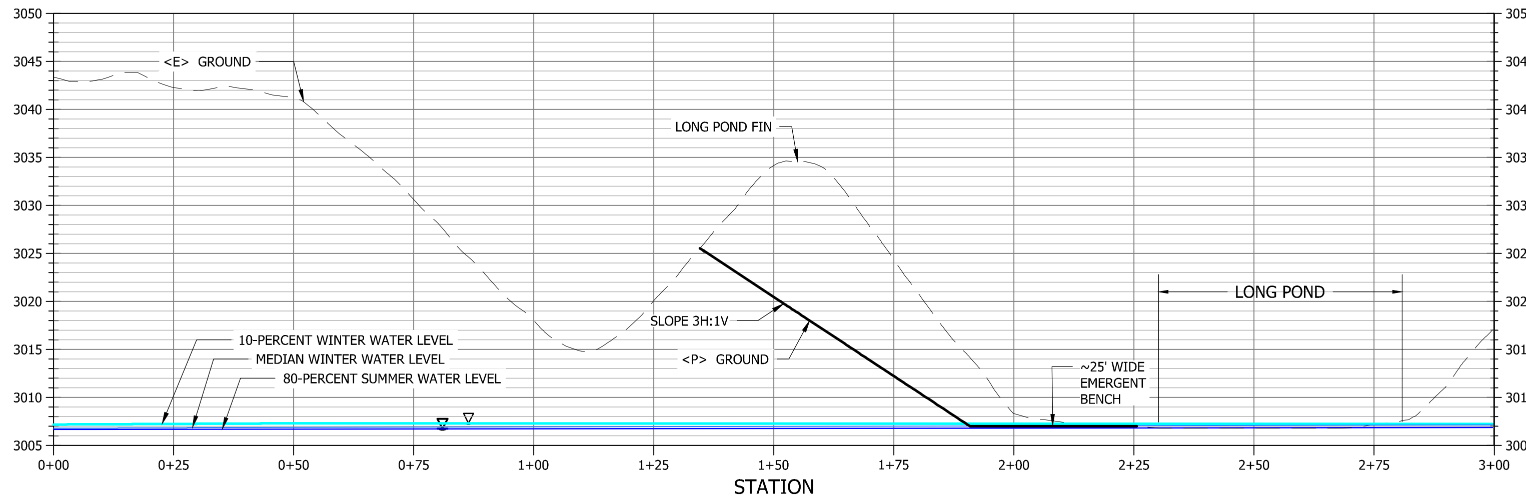
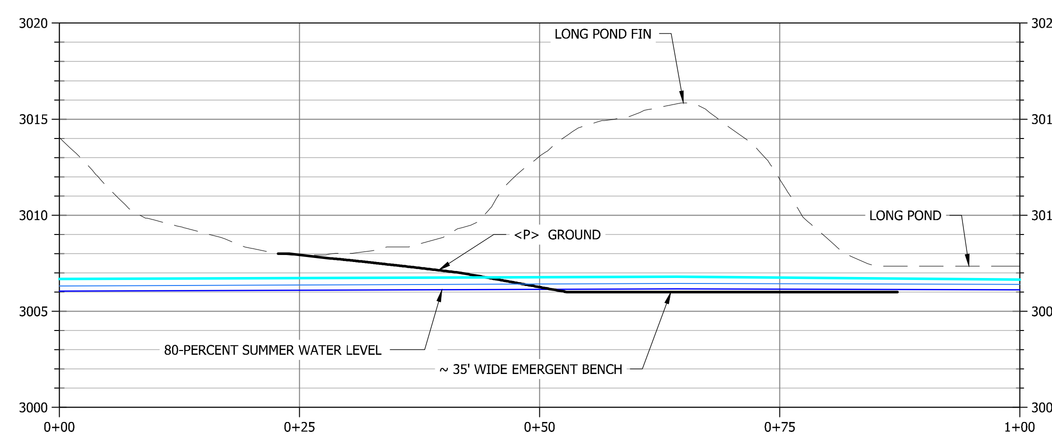
APPROVED: JS

LONG POND RESTORATION STA 33+00 TO 44+50 PLAN



1
12
FIN ALCOVE 1 - SECTION
Scale: HOZ: 1" = 20 VERT: 1" = 10'



2
12
FIN ALCOVE 2 - SECTION
Scale: HOZ: 1" = 10 VERT: 1" = 5'

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APPROVED: JS

LONG POND REST. STA 33+00 TO 44+50 PROFILES AND SECTIONS

SHEET 13 OF 22

1 WATERWAY CROSSING PLAN
Scale: 1:20

0 10 20 40 FEET
SCALE: 1" = 20'

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CUT AND FILL SUMMARY

SITE	CUT (CU YD)	FILL (CU YD)	BALANCE (CU YD)
BRIDGE CHANNEL	1,100	0	1,100
FILL AREA 1*	0	27,650	-27,650
TOTAL	1,100	27,650	-26,500
* SITE LOCATED ON SHEET 12			

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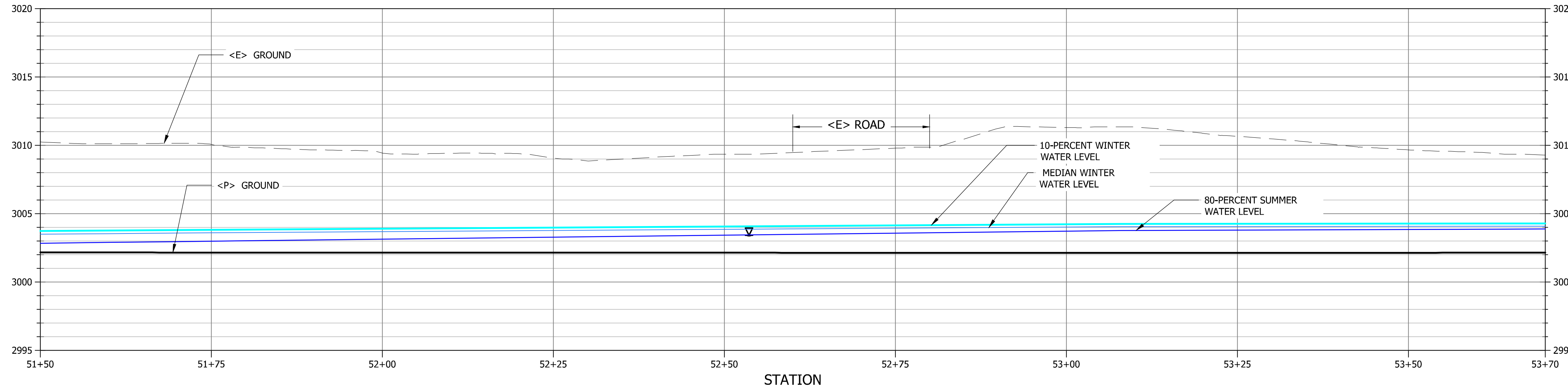
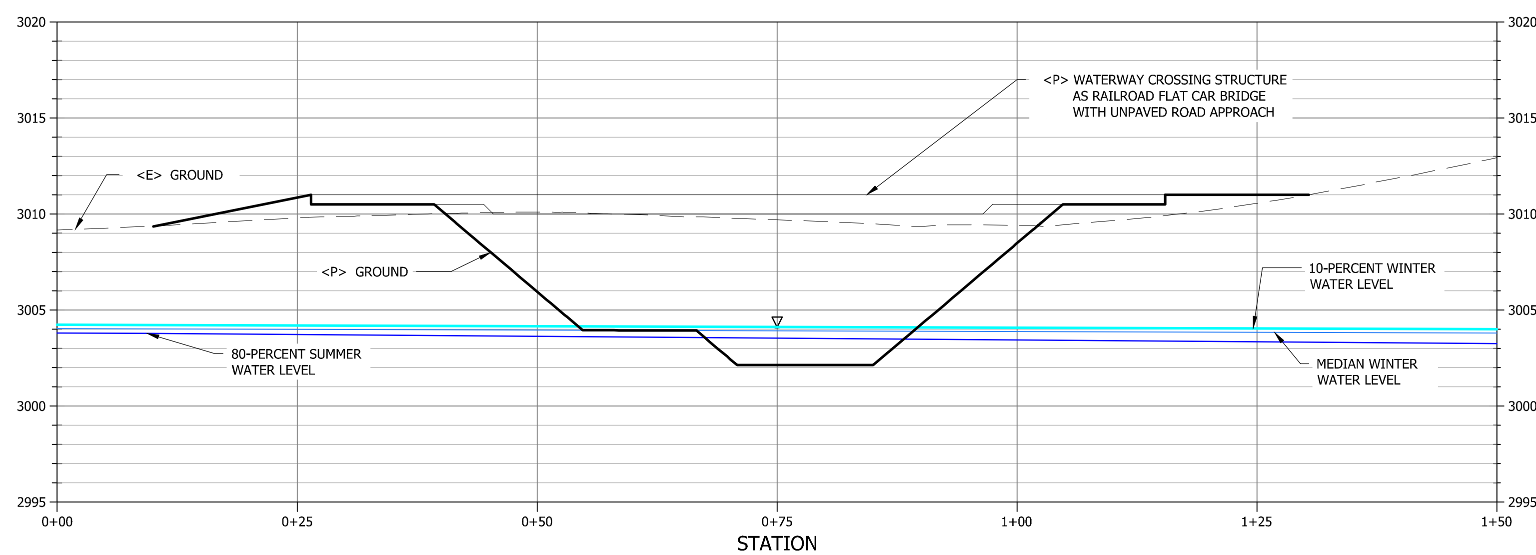
APPROVED: JS

WATERWAY CROSSING PLAN



1/14 LONG POND CL - LONGITUDINAL PROFILE

Scale: HOZ: 1" = 10' VERT: 1" = 5'



2/14 WATERWAY CROSSING - SECTION

Scale: HOZ: 1" = 10' VERT: 1" = 5'

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WATERWAY CROSSING PROFILE AND SECTION

SHEET 15 OF 22

Appendix B

Historical Aerial Photography

Table of Contents

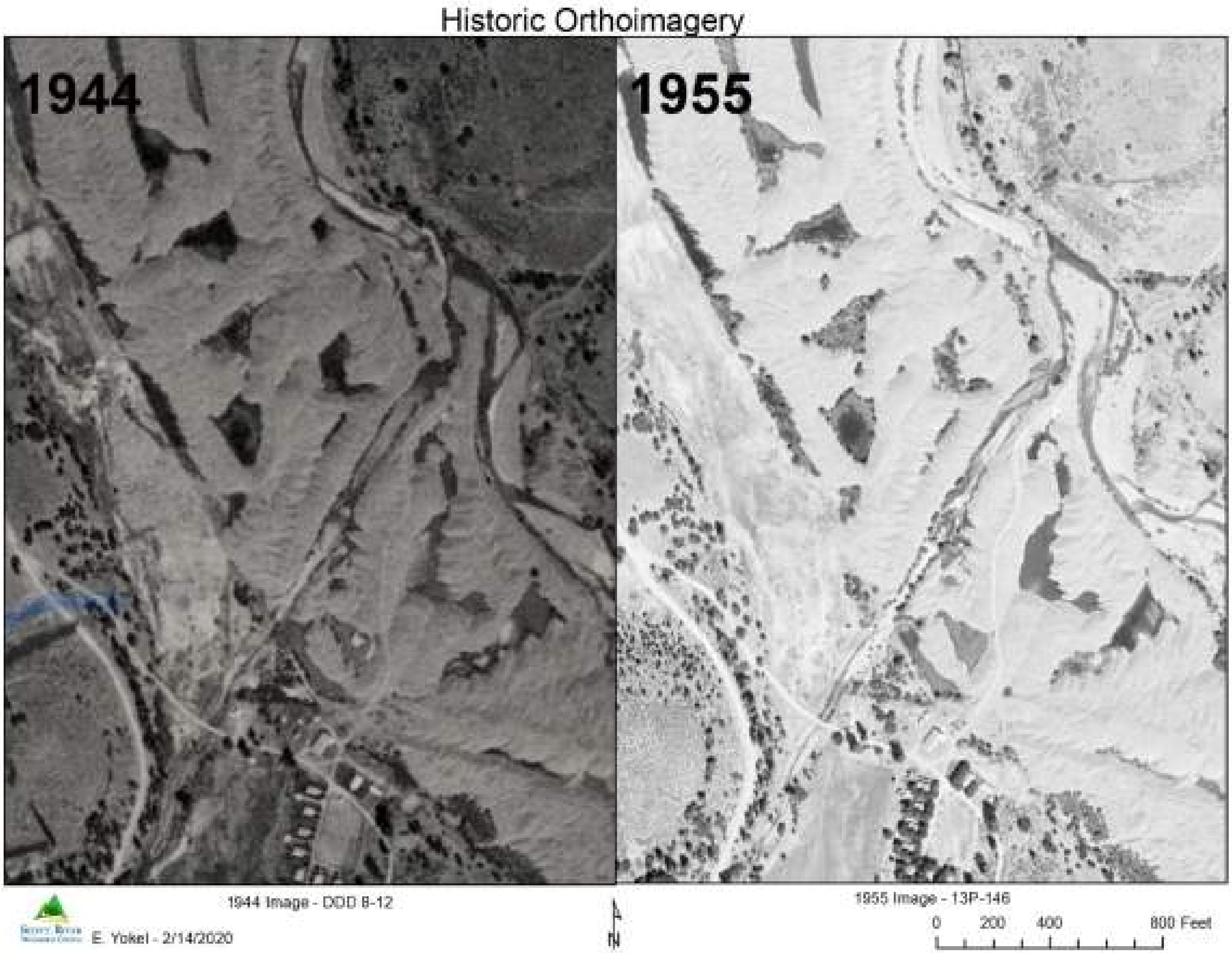


Figure B-1. Lower Sugar Creek – Scott River Confluence, 1944–1955.

Figure B-2. Lower Sugar Creek – Scott River Confluence, 1955–1965.

Figure B-3. Lower Sugar Creek – Scott River Confluence, 1965–1980.

Figure B-4. Lower Sugar Creek – Scott River Confluence, 1980–1992.

Figure B-5. Lower Sugar Creek – Scott River Confluence,1992–2002.

Figure B-6. Lower Sugar Creek – Scott River Confluence, 2002–2010.

Figure B-7. Lower Sugar Creek – Scott River Confluence, 2010–2016.

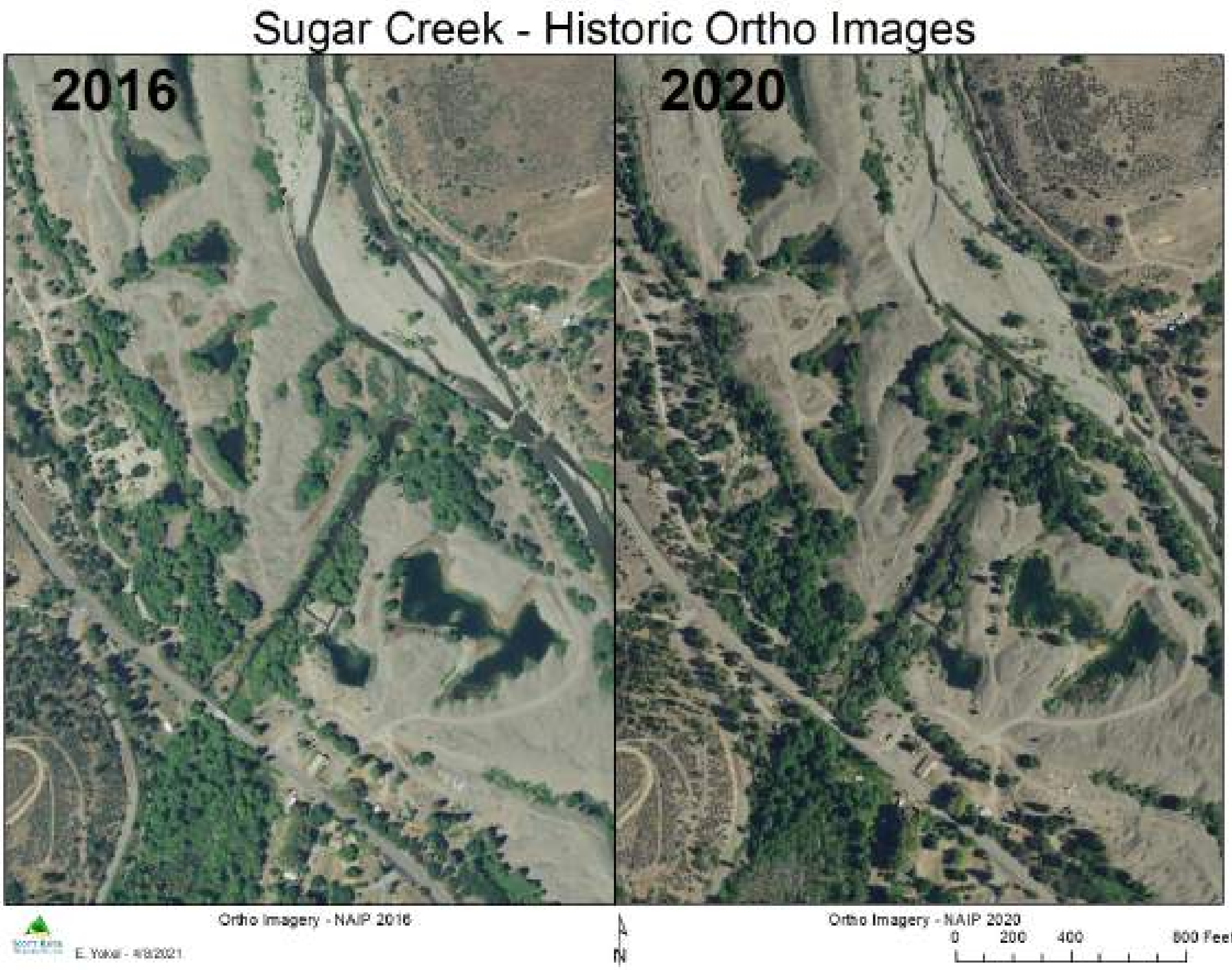


Figure B-8. Lower Sugar Creek – Scott River Confluence, 2016–2020.

Figure B-9. Lower Sugar Creek – Scott River Confluence, 1944–2020.

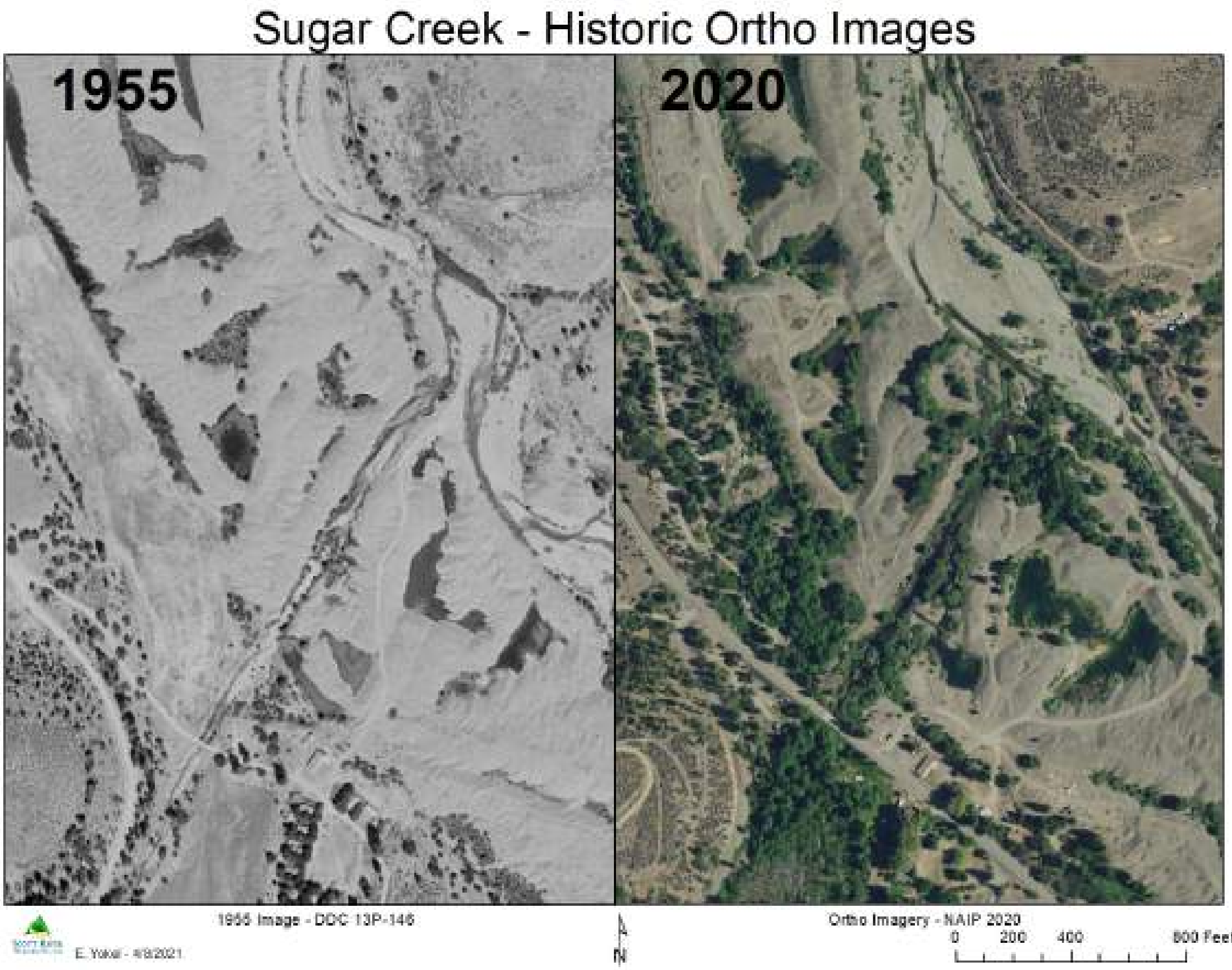


Figure B-10. Lower Sugar Creek – Scott River Confluence,1955–2020.

Figure B-11. Lower Sugar Creek – Scott River Confluence, 1965–2020.

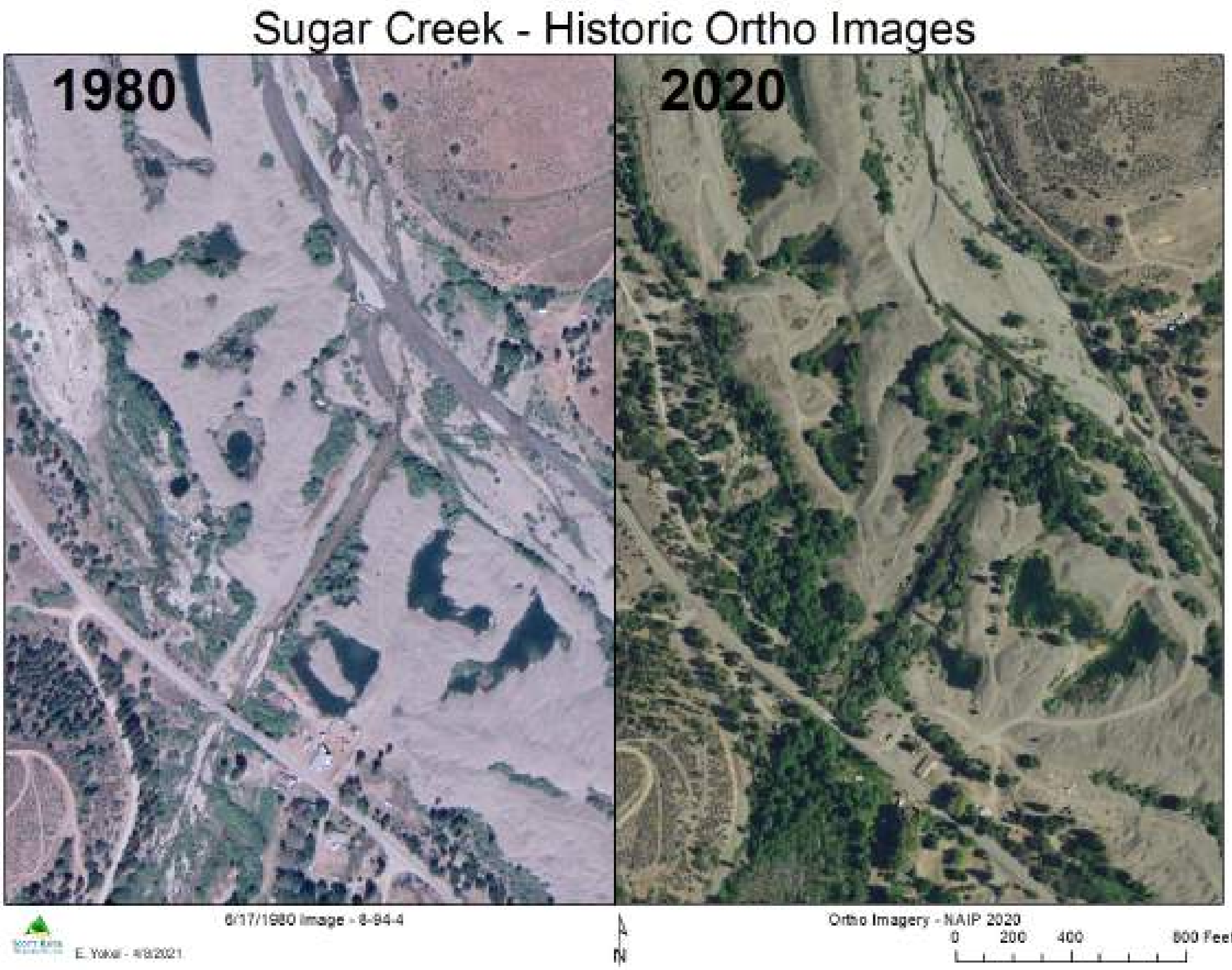


Figure B-12. Lower Sugar Creek – Scott River Confluence, 1980–2020.

Figure B-13. Lower Sugar Creek – Scott River Confluence, 1992–2020.

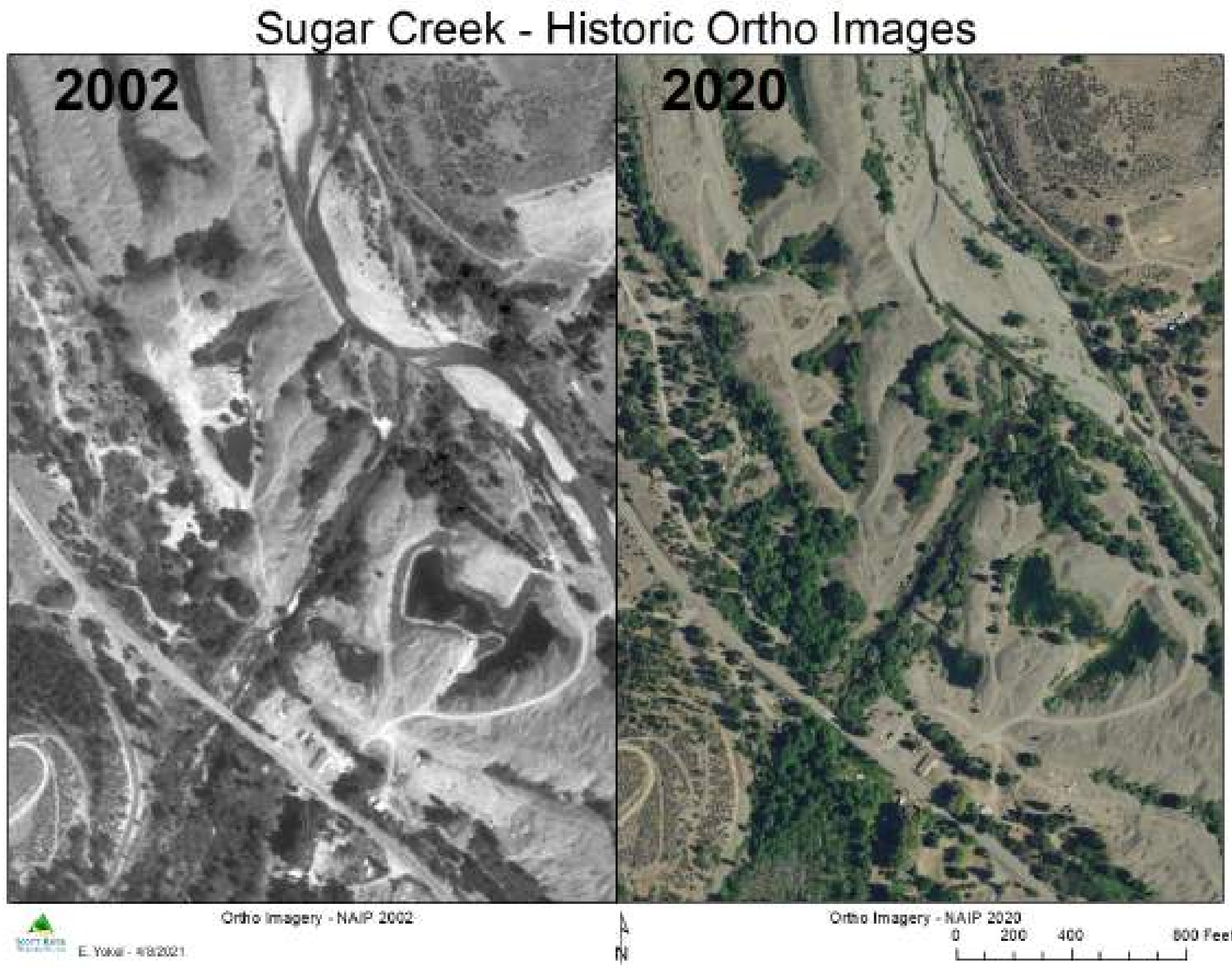


Figure B-14. Lower Sugar Creek – Scott River Confluence, 2002–2020.

Figure B-15. Lower Sugar Creek – Scott River Confluence, 2010–2020.

Figure B-16. Lower Sugar Creek – Scott River – Long Pond, 1944–1955.

Figure B-17. Lower Sugar Creek – Scott River – Long Pond, 1955–1965.

Figure B-18. Lower Sugar Creek – Scott River – Long Pond, 1965–1980.

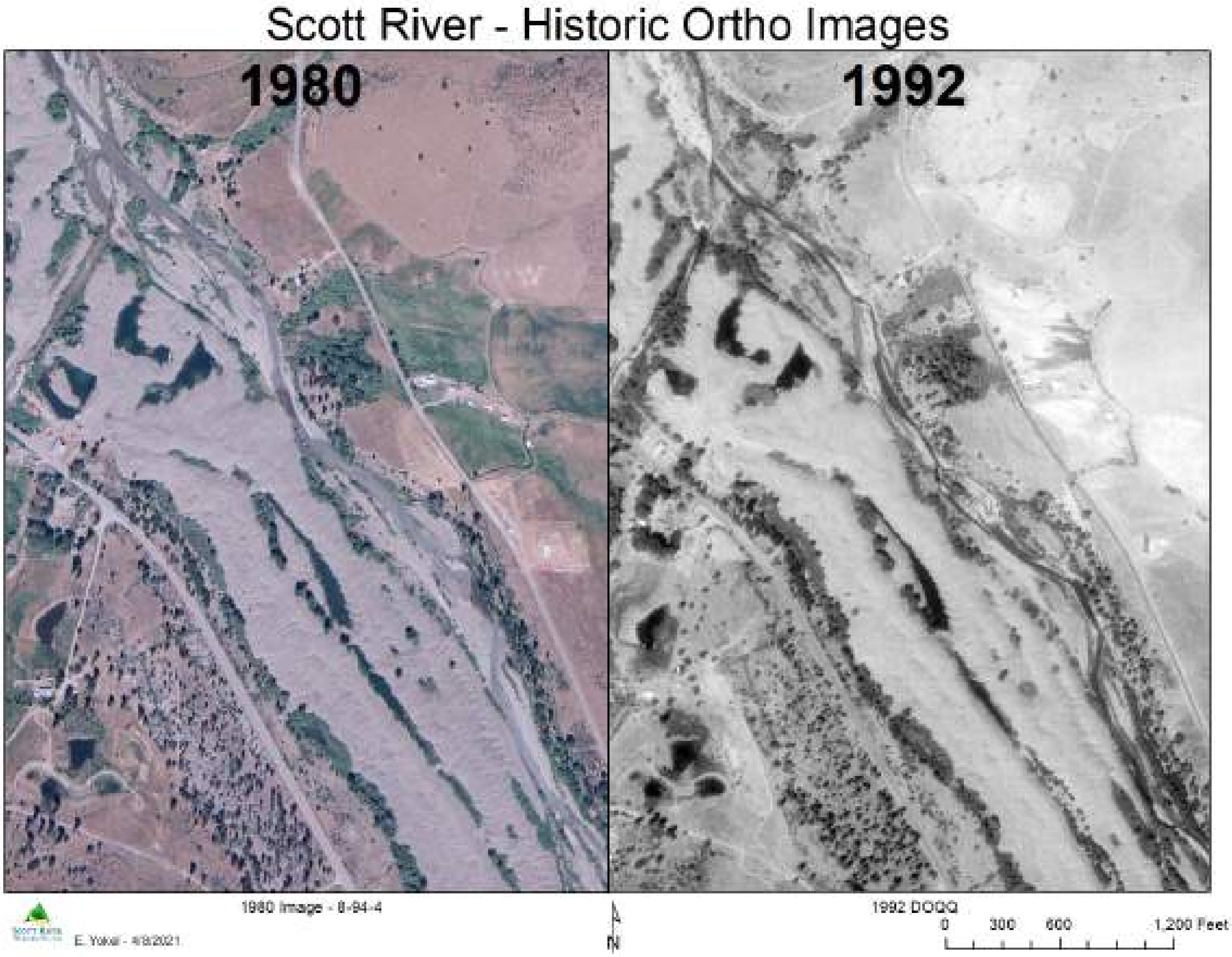


Figure B-19. Lower Sugar Creek – Scott River – Long Pond, 1980–1992.

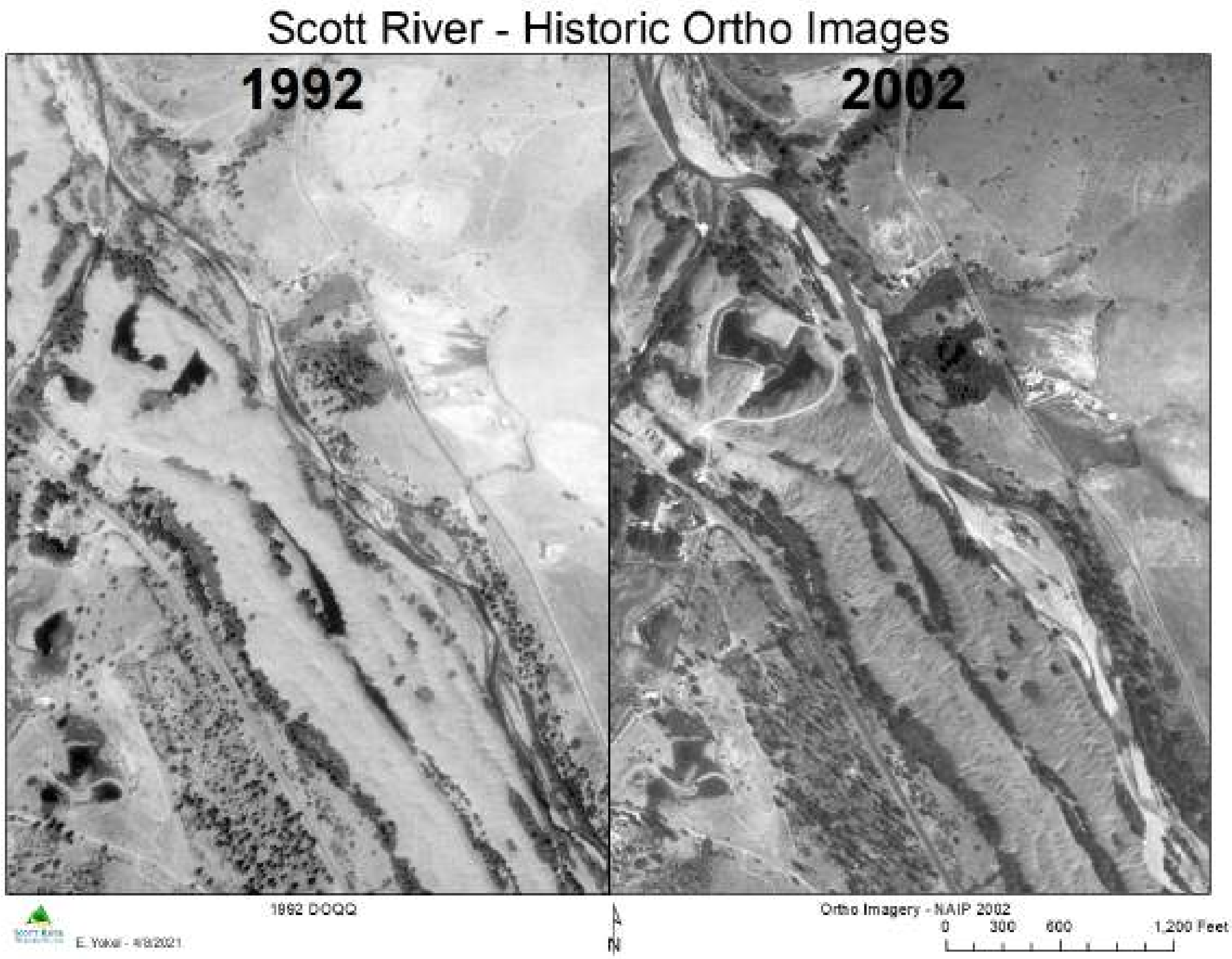


Figure B-20. Lower Sugar Creek – Scott River – Long Pond, 1992–2002.

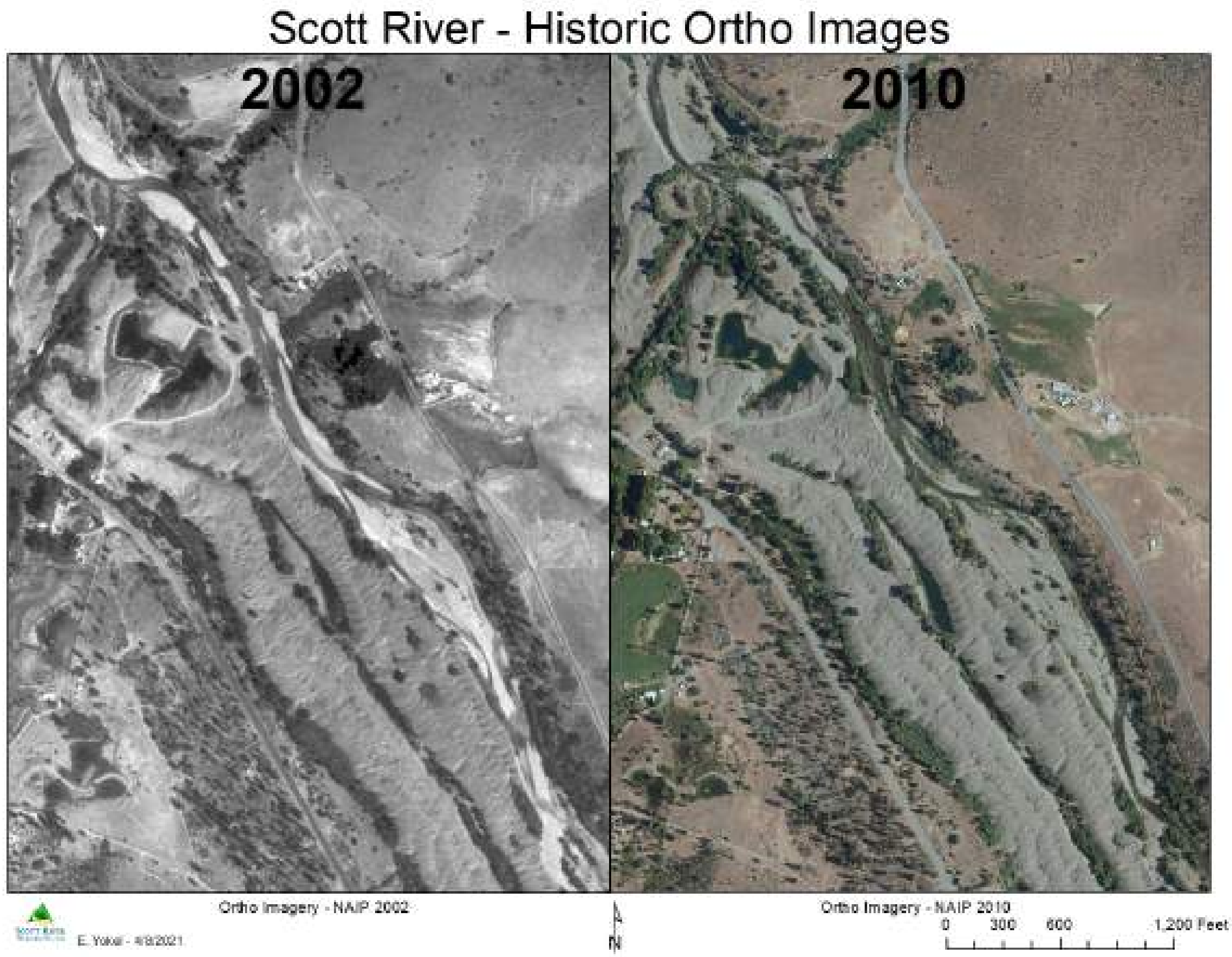


Figure B-21. Lower Sugar Creek – Scott River – Long Pond, 2002–2010.

Figure B-22. Lower Sugar Creek – Scott River – Long Pond, 2010–2016.

Figure B-23. Lower Sugar Creek – Scott River – Long Pond, 2016–2020.

Figure B-24. Lower Sugar Creek – Scott River – Long Pond, 1944–2020.

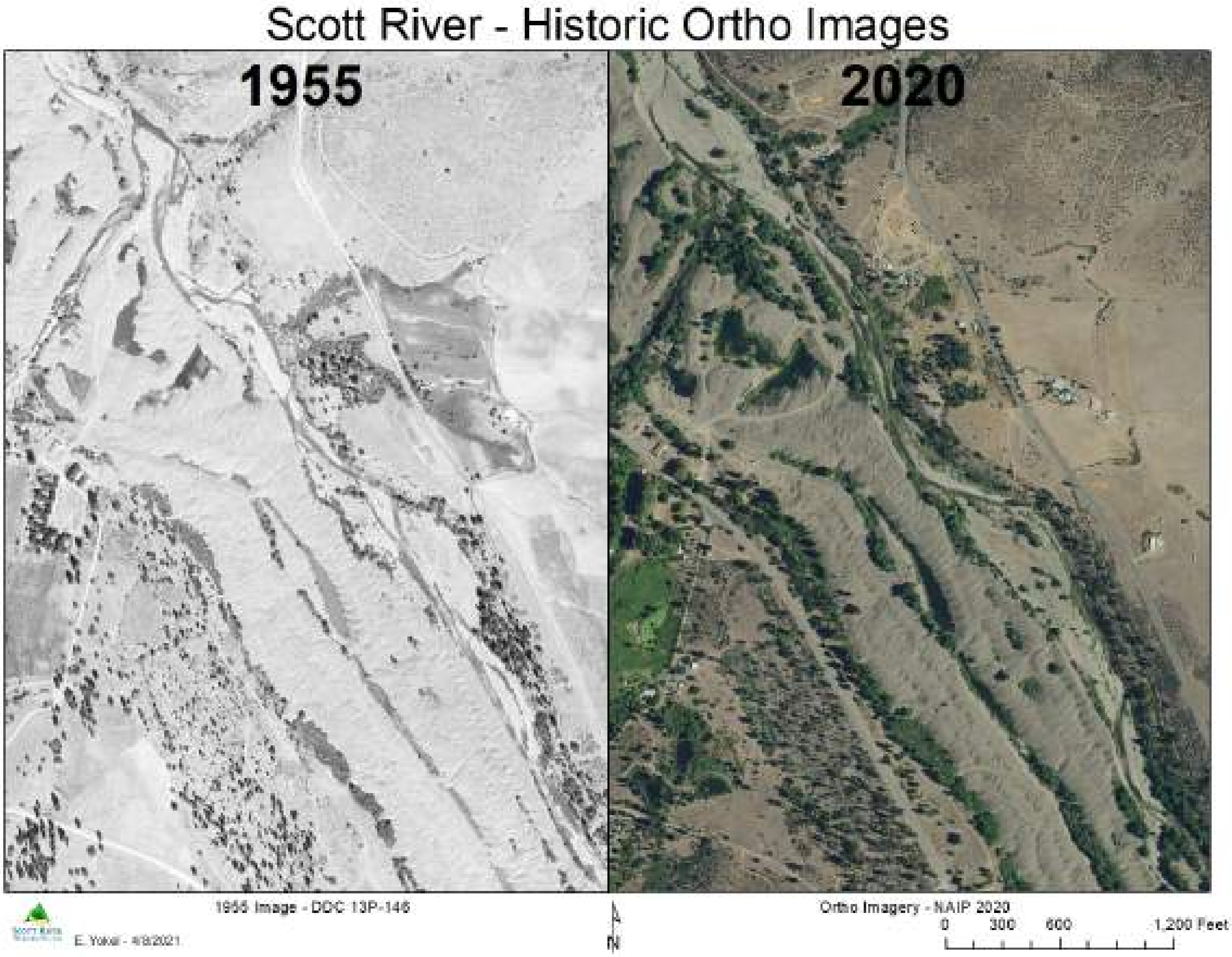


Figure B-25. Lower Sugar Creek – Scott River – Long Pond, 1955–2020.

Figure B-26. Lower Sugar Creek – Scott River – Long Pond,1965–2020.

Figure B-27. Lower Sugar Creek – Scott River – Long Pond, 1980–2020.

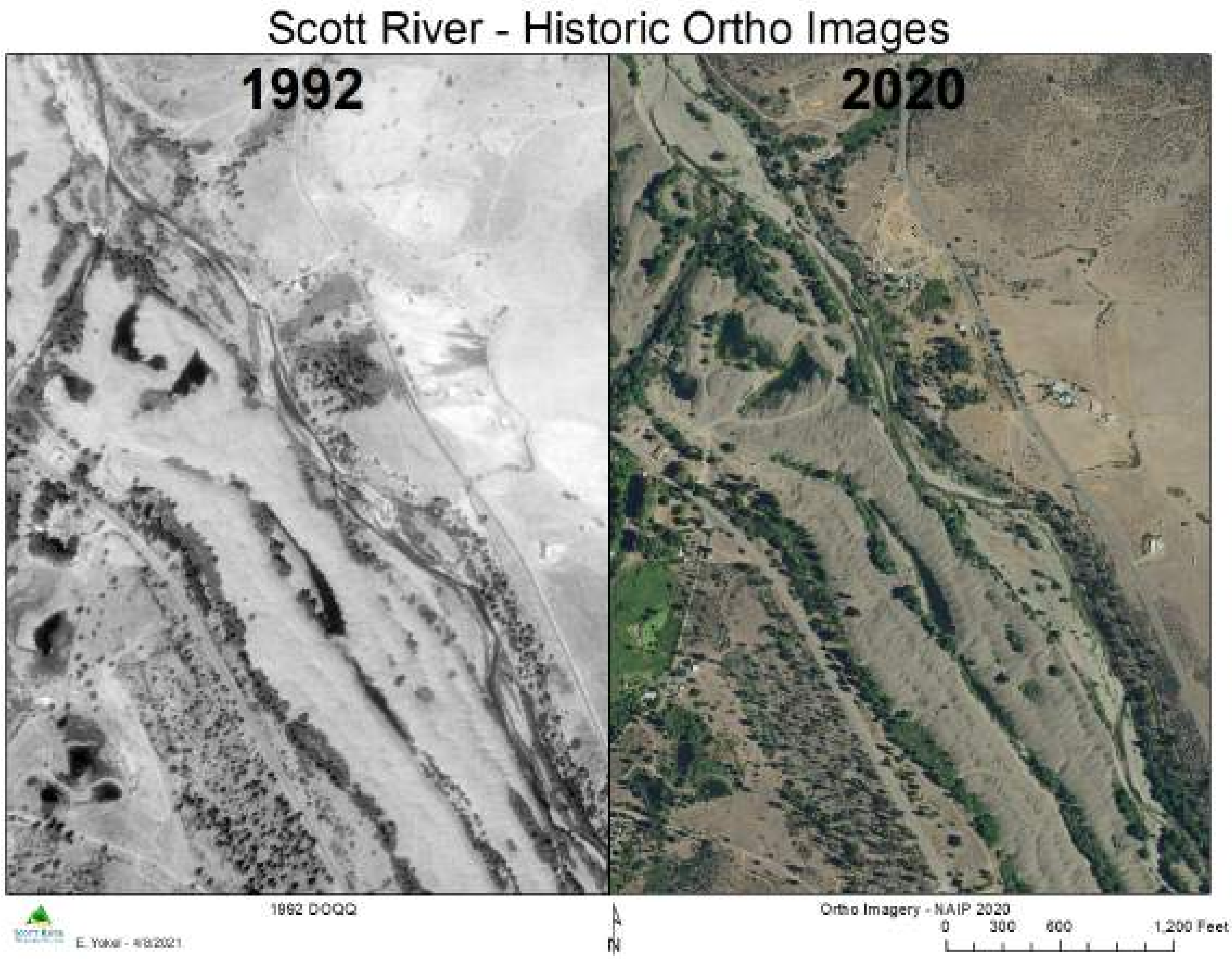


Figure B-28. Lower Sugar Creek – Scott River – Long Pond, 1992–2020.

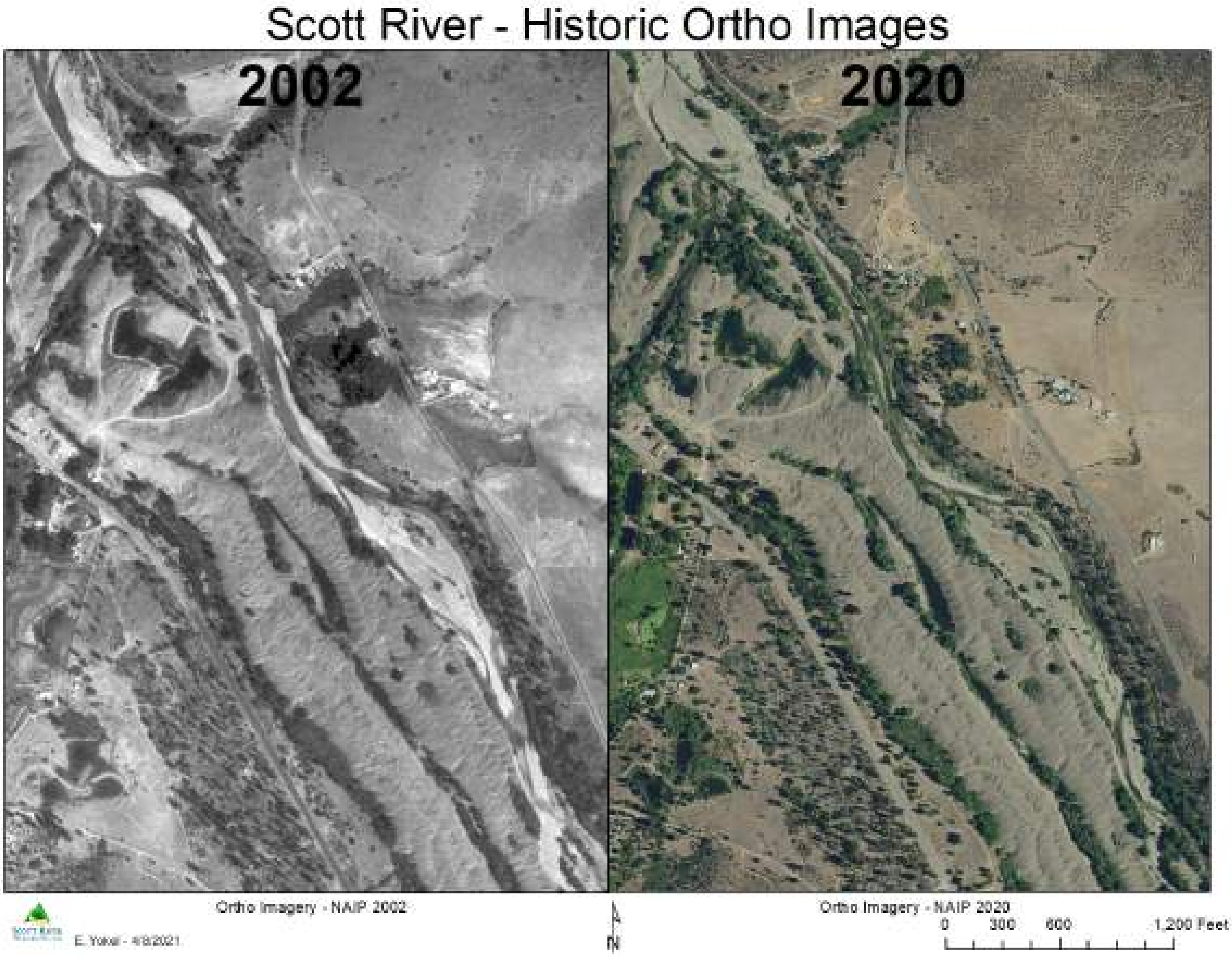


Figure B-29. Lower Sugar Creek – Scott River – Long Pond, 2002–2020.

Figure B-30. Lower Sugar Creek – Scott River – Long Pond, 2010–2020.

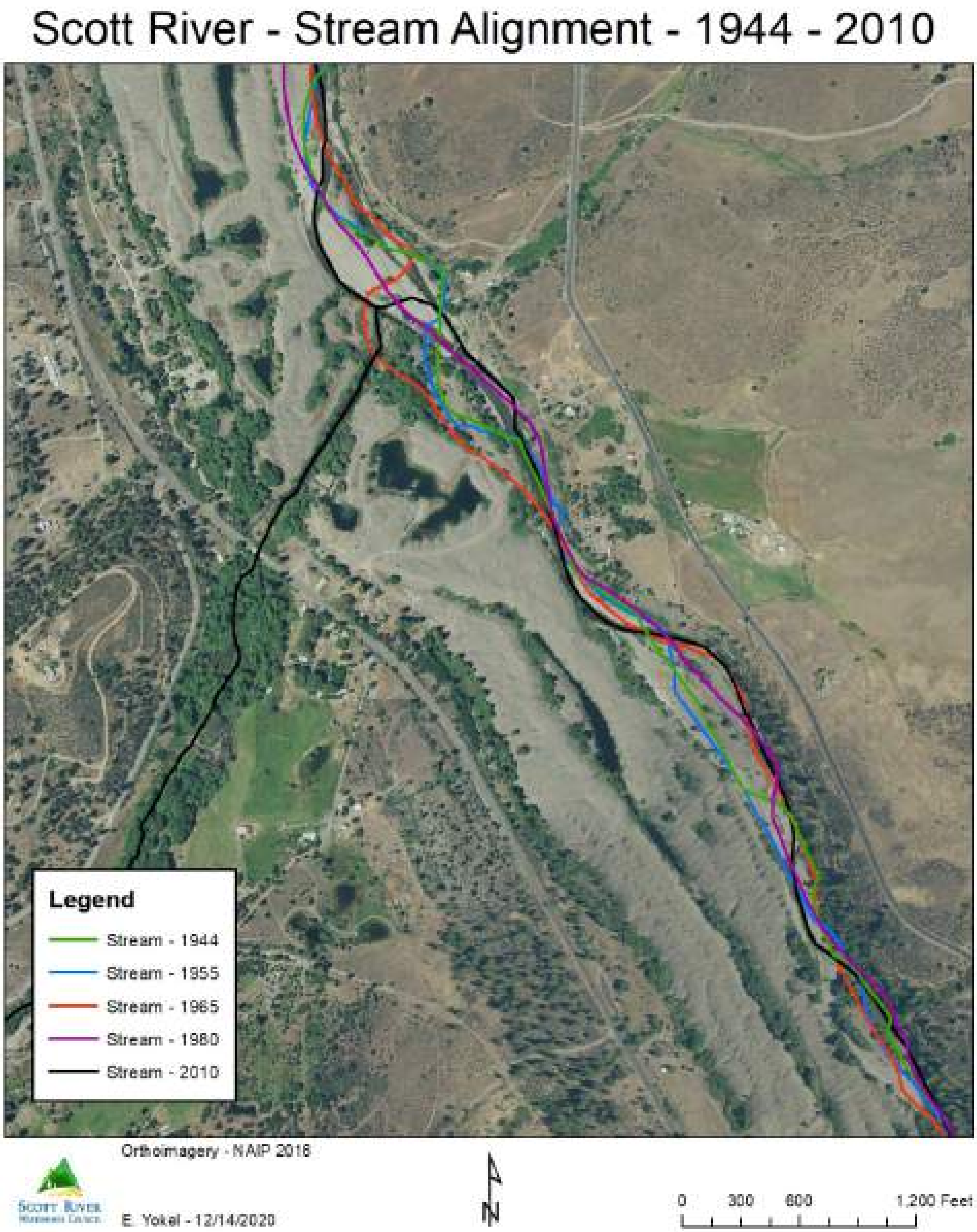


Figure B-31. Scott River Stream Alignment, 1944–2010.

Figure B-32. Sugar Creek, 1980–2020.

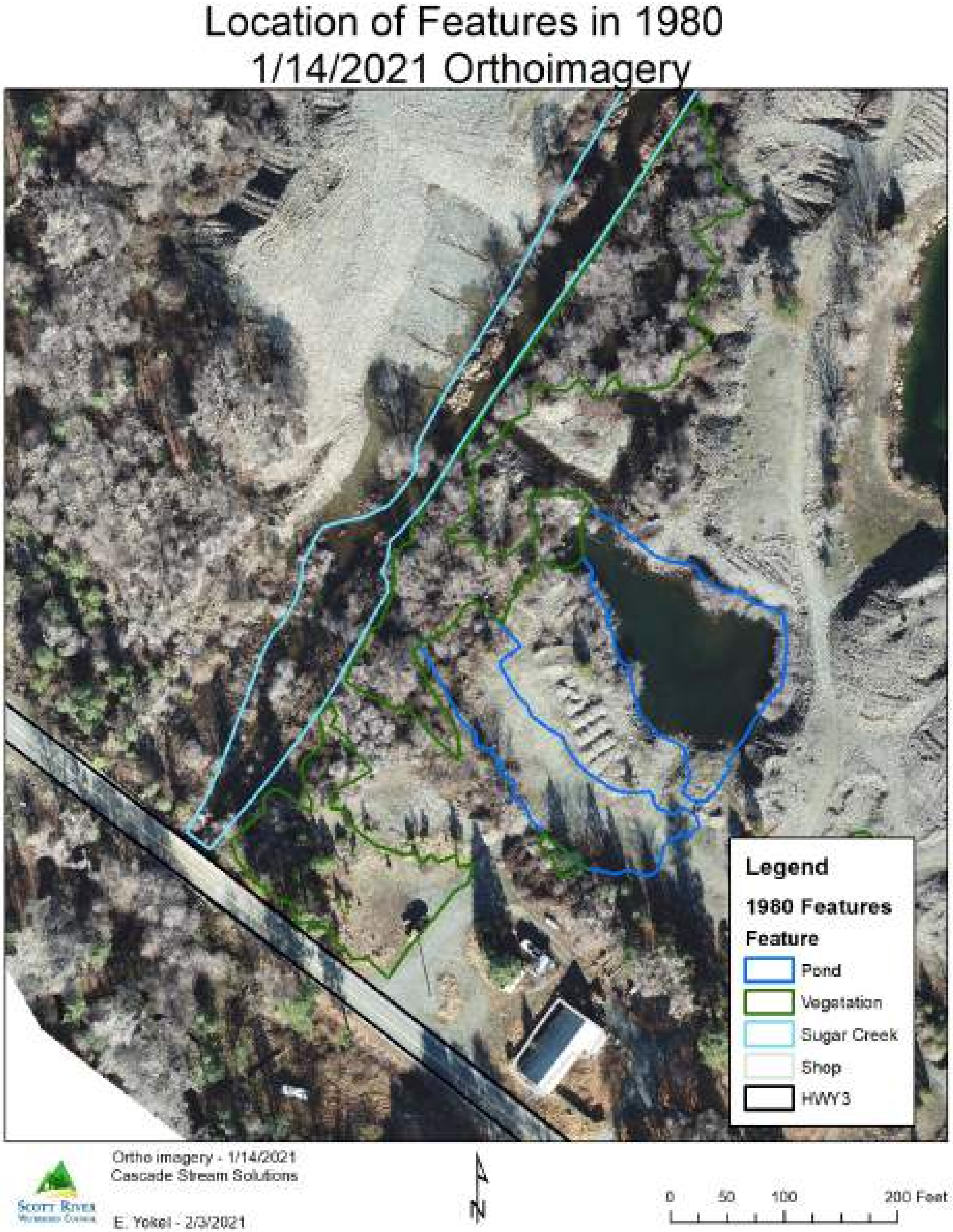


Figure B-33. 1980 features, January 14, 2021 orthoimagery..

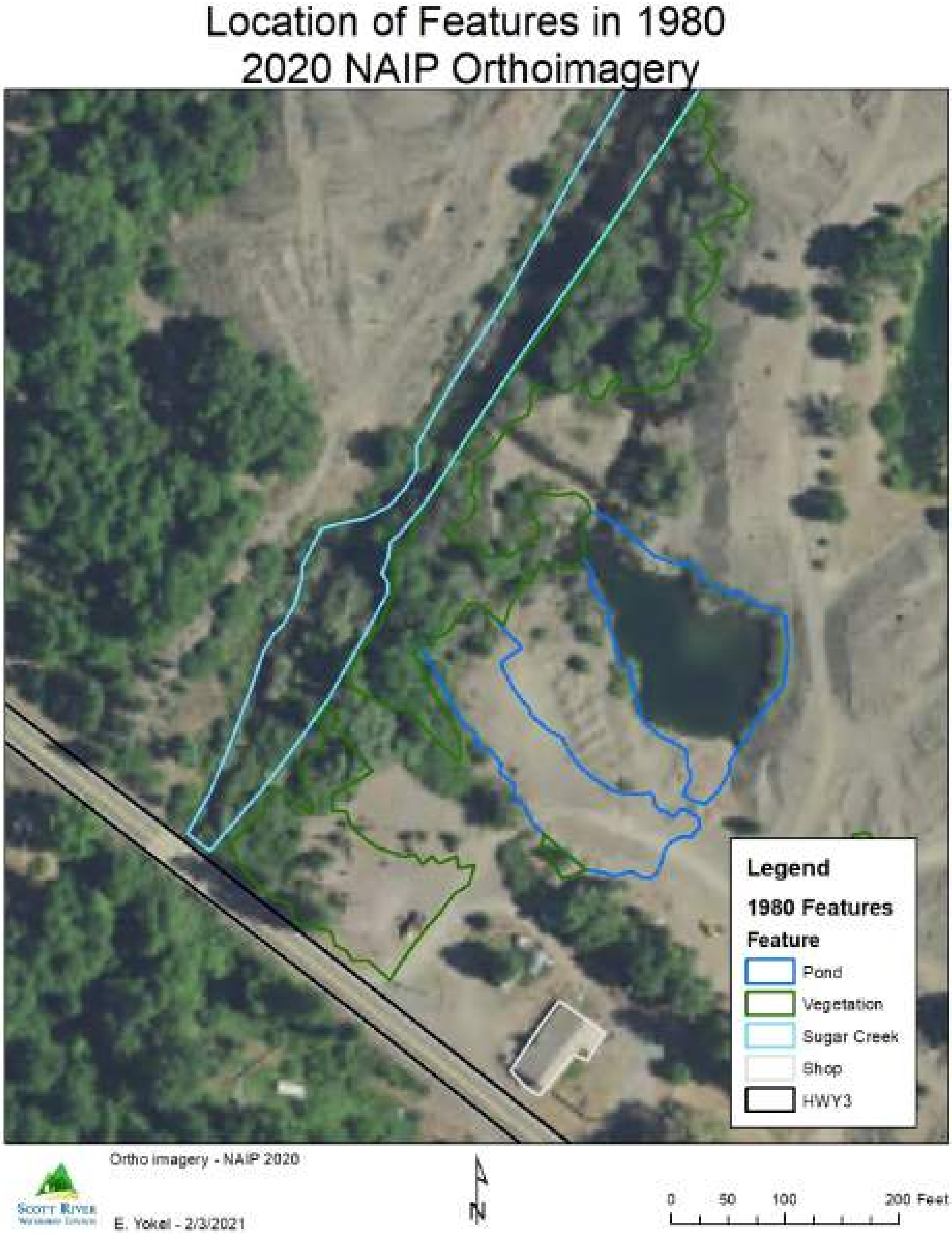


Figure B-34. 1980 features, 2020 NAIP orthoimagery.

Appendix C

Discharge Measurements in Long Pond

Appendix C. Discharge Measurements in Long Pond

Prepared by Erich Yokel – Scott River Watershed Council

Three surface water flow transects were identified in the Long Pond alignment for the performance of periodic discharge measurements to increase the understanding of the hydrology during the spring recession and base flow period of WY2020 (Map 1). The upstream station (Flow 1) is located at the Long Pond Inlet (STA 34+50 ft) where visible flow is percolating from the tailing “plug” separating the Long Pond from the upstream pond. The middle station (Flow 2 – STA 45+00) is in the body of surface water between Plug 1 and Plug 2 monitored by water surface elevation (WSE) station SUMW11s . The downstream station (Flow 3 – STA 46+50) is located in the body of surface water downstream of Plug 2.

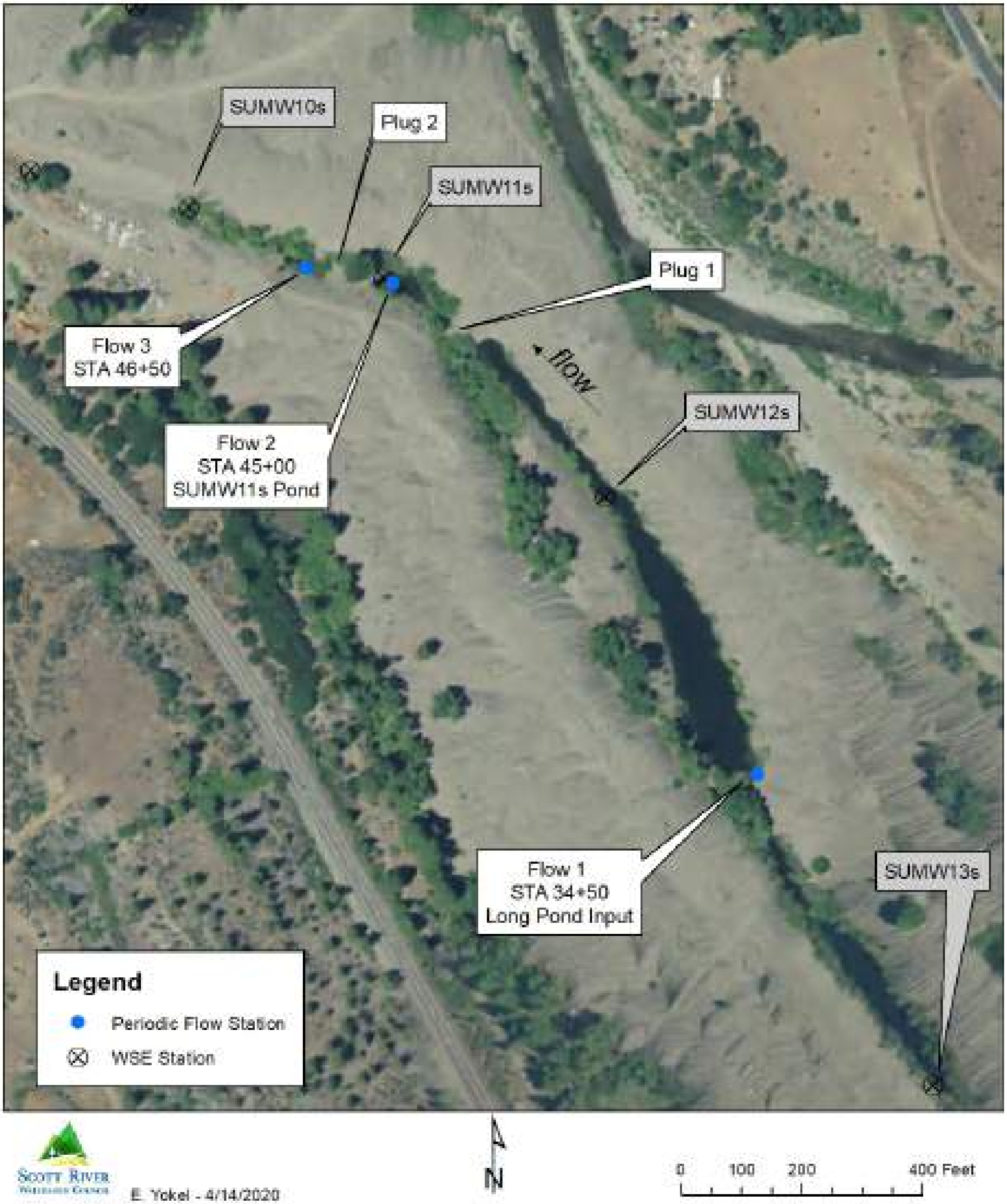
Discharge measurements were performed using a Flowtracker ADV meter from May 22 – September 3, 2020 (Figure 1 and Table 1). The upstream and downstream stations were measured during the initial effort on May 22, 2020 in which an 85% decrease in discharge from the upstream station (Q = 7.3 cfs) to the downstream statin (Q = 1.1 cfs) was observed.

All three stations were measured during the subsequent effort on June 11, 2020 during the period of recession to base flow. In early June, the discharge decreased 40% from the upstream station (Q = 5.2 cfs) to the middle station (Q = 3.1 cfs) with an additional 60% decrease in discharge between the middle and downstream stations (Q = 1.3 cfs) for a total decrease in discharge from the upstream to downstream station of 75%.

Two efforts to measure discharge at the three stations were made during the period of base flow on July 7 and September 3, 2020. The July 7, 2020 discharge measurements performed during the early period of base flow documented a decrease in discharge from the upstream to downstream stations with a 15% decrease from the upstream station (Q = 2.9 cfs) to the middle station (Q = 2.5 cfs) and a 60% decrease from the upstream station to the downstream station (Q = 1.1. cfs).

The final effort on September 3, 2020 documented significantly less discharge at the upstream station (Q = 0.2 cfs) than the middle (Q = 1.2 cfs) and downstream (Q = 0.7 cfs) stations. It is hypothesized that due to decreases in WSE the flow into the Long Pond at Flow Station 1 occurred at a different (lower elevation) location than the measured transect.

Long Pond Design Project - Periodic Flow Stations



Map 1 – Locations of Periodic Flow Stations

	Flow 1 STA 34+50	Flow 2 STA 45+00	Flow 3 STA 46+50
5/22/2020	7.3	--	1.1
6/11/2020	5.2	3.1	1.3
7/9/2020	2.9	2.5	1.1
9/3/2020	0.2	1.2	0.7

Table 1 – Periodic Discharge (cfs) measurements – Long Pond Alignment

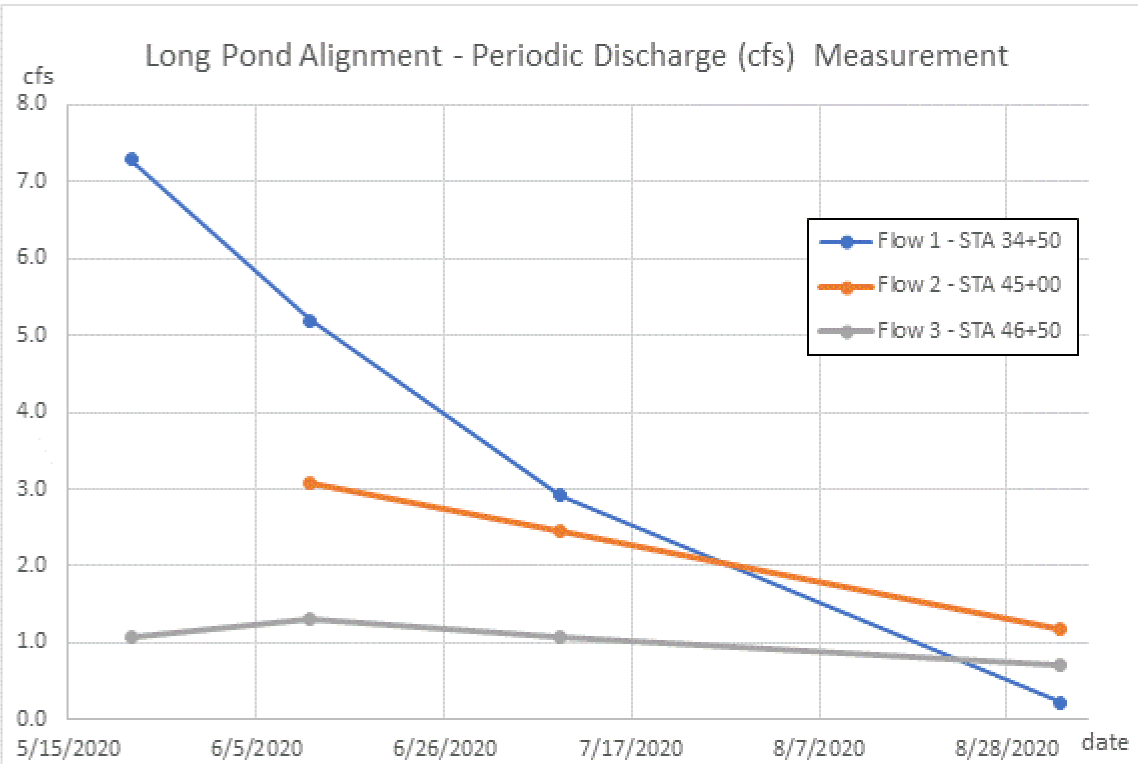


Figure 1 – Periodic discharge (cfs) measurements – Long Pond Alignment

Analysis of the mean daily discharge (cfs) in Sugar Creek RKM 2.6 at the CDWR Discharge Station (F25890) illustrates the hydrologic regime during the Long Pond Alignment discharge effort (Figure 2) - station data retrieved from wdlbeta.water.ca.gov.

The discharge at the Sugar Creek RKM 2.6 discharge station and the USGS discharge station in the Scott River below Fort Jones further illustrates the hydrologic regime during the effort (Table 2).

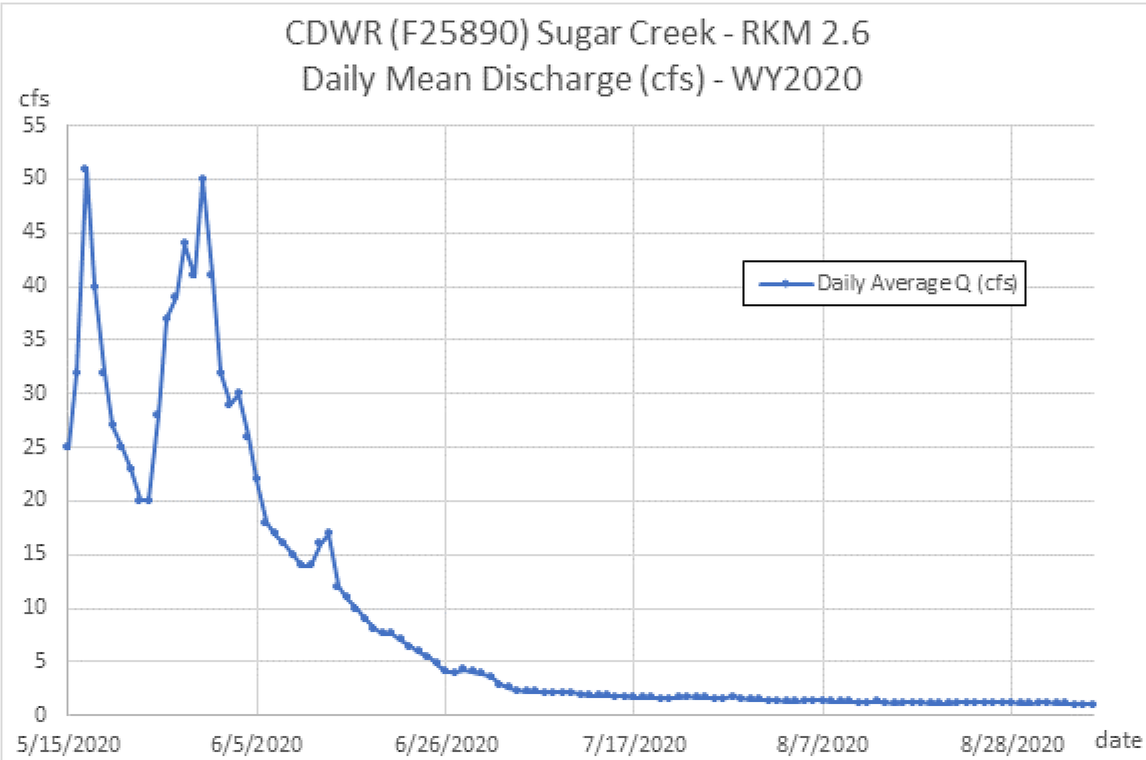


Figure 2 – Daily Mean Discharge (cfs) CDWR (F25890) – Sugar Creek – RKM 2.6 – WY2020

	Sugar Creek RKM 2.6	Scott River USGS
5/22/2020	23	421
6/11/2020	14	210
7/9/2020	2.1	18
9/3/2020	1.1	5

Table 2 – Discharge (cfs) – Sugar Creek RKM 2.6 and Scott River below Fort Jones

Analysis of the calculated continuous WSE (ft) at three WSE stations (SUMW12s, SUMW11s and SUMW10s) in the vicinity of the discharge measurements along the Long Pond alignment illustrates a reduction in WSE that correlates with the reduction of discharge documented at the CDWR gage in Sugar Creek RKM 2.6 (Figure 3).

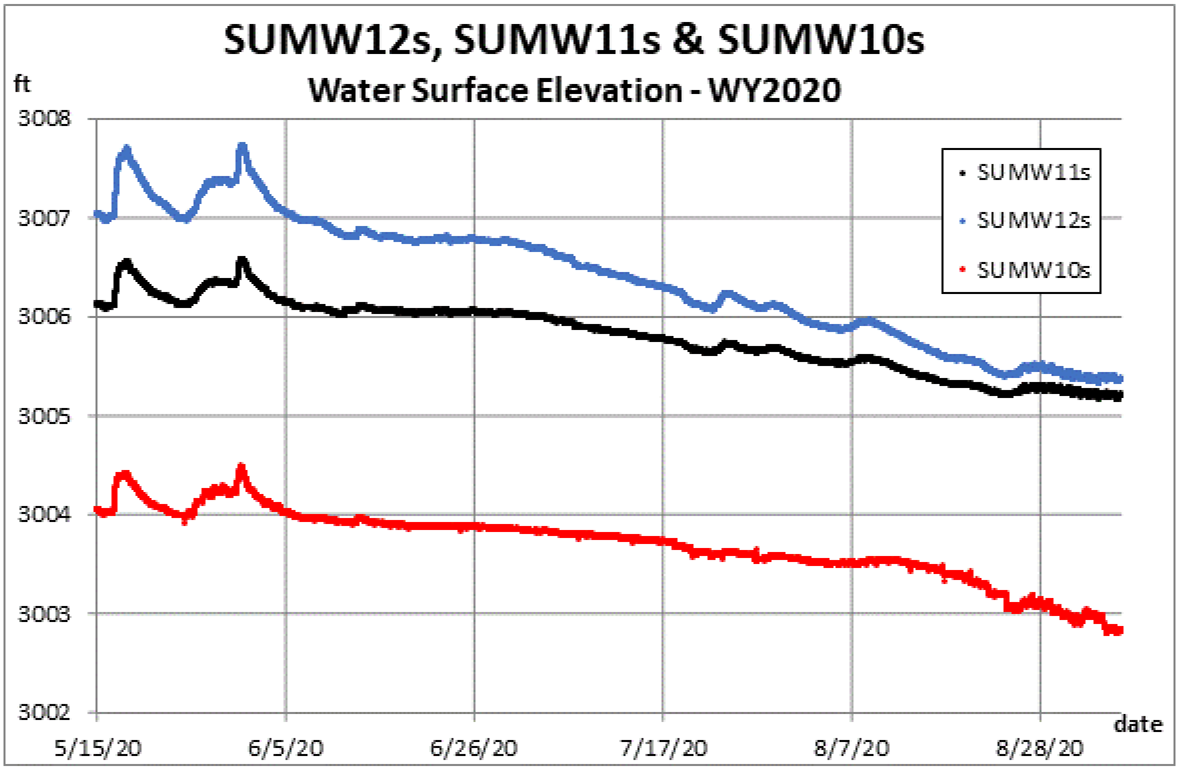


Figure 3 – Calculated continuous WSE (ft) at surface water stations – SUMW12s, SUMW11s and SUMW10s

Appendix D

Temperature and Dissolved Oxygen in Long Pond

Appendix D. Water Temperature and Dissolved Oxygen in Long Pond

Prepared by Erich Yokel – Scott River Watershed Council

The water temperature (°C) documented at select WSE stations was analyzed to characterize the temperature regimes in surface water and groundwater locations along the proposed Long Pond Restoration Design Channel alignment (Map 1).

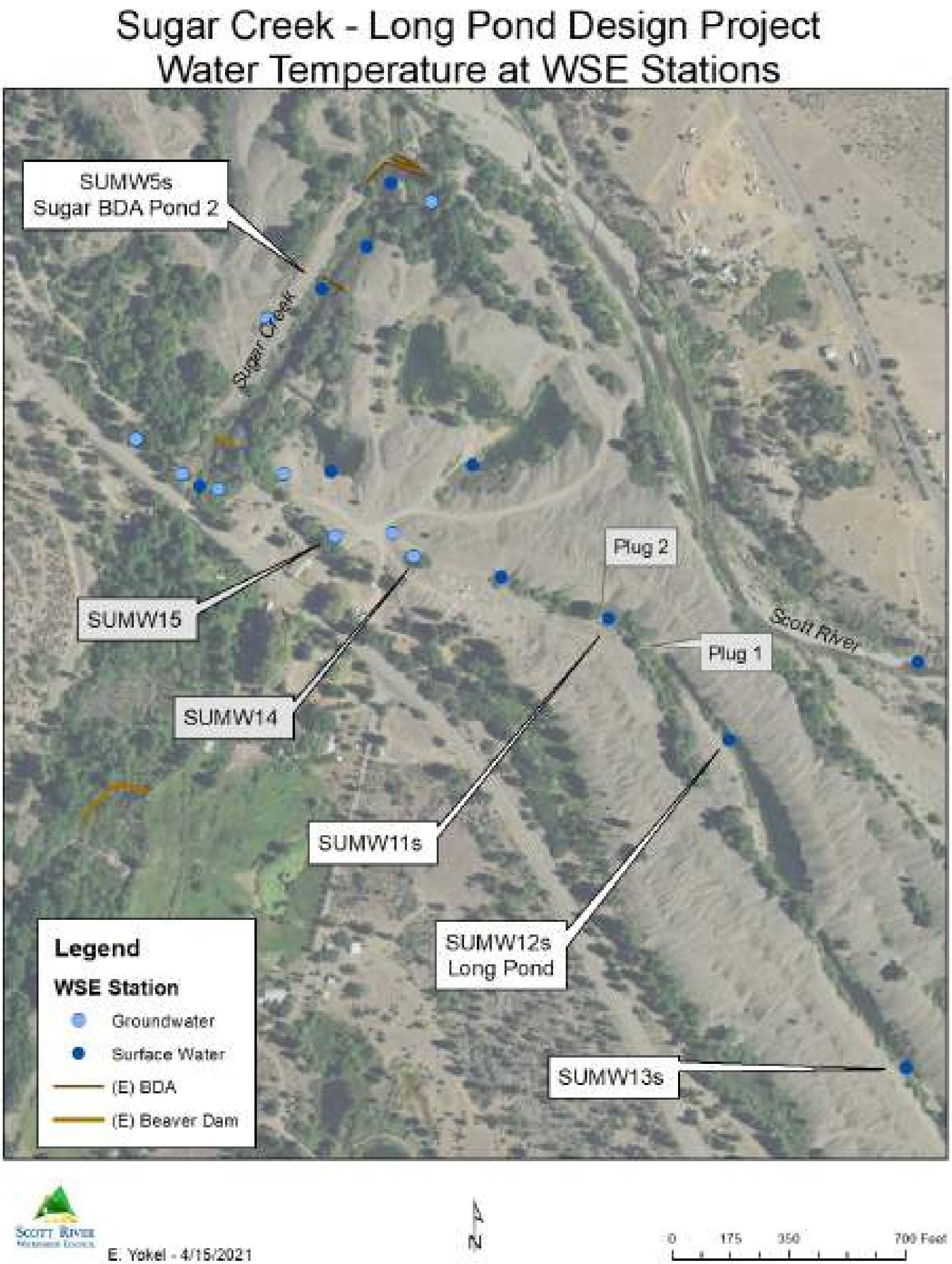
Water temperatures at surface water stations in the Long Pond (SUMW12s), the pond downstream of Plug 1 (SUMW11s) and Sugar BDA Pond 2 (SUMW5s) along with groundwater stations (SUMW14 and SUMW15) were analyzed to characterize summer and winter temperature regimes. The maximum and minimum Moving Weekly Average Temperature (MWAT) for each Water Year over the period of record was calculated for each station.

WY2019 is representative of an average Water Year Type per accumulated precipitation at Fort Jones and snowpack on April 1st. The maximum MWAT during the summer baseflow period of WY19 is warmest at the Sugar BDA Pond 2 station (17.1° C) with the maximum MWAT in Long Pond (16.3° C) and SUMW11s (16.1° C) stations being cooler. As expected, the maximum MWAT during summer baseflow at the two groundwater stations is significantly cooler than that observed at the surface water stations (SUMW14 = 13.8° C and SUMW15 = 14.6° C).

Conversely, the minimum MWATs observed at the surface water stations are significantly colder than those observed in the groundwater stations during winter. The minimum MWAT during WY2019 at the Sugar BDA Pond 2 (1.9°C) is colder than that documented at the Long Pond (4.5°C) and SUMW11s (4.6°C) with the groundwater stations having significantly warmer winter temperatures (SUMW14 = 6.8° C and SUMW15 = 10.4° C).

It is hypothesized that the warmer winter temperatures and cooler summer temperatures observed in the Long Pond and SUMW11s stations compared to the Sugar BDA Pond 2 station is indicative of greater groundwater effect on the temperature regimes of the isolated pond habitats. The temperature regimes observed in the Long Pond and SUMW11s sites compared to Sugar Creek are preferable for rearing Coho Salmon during the critical summer and winter life stages.

Analysis of the daily average water temperatures (°C) for the stations during WY2019 illustrates the different temperature regimes (Figure 6). The daily average water temperatures during the critically dry WY2020 have the same trend observed in WY2019 (Figure 7). The Sugar BDA Pond 2 station was dry during the base flow period of the Summer of 2020.



Map 1 – Location of WSE Stations in Long Pond Design Temperature Analysis

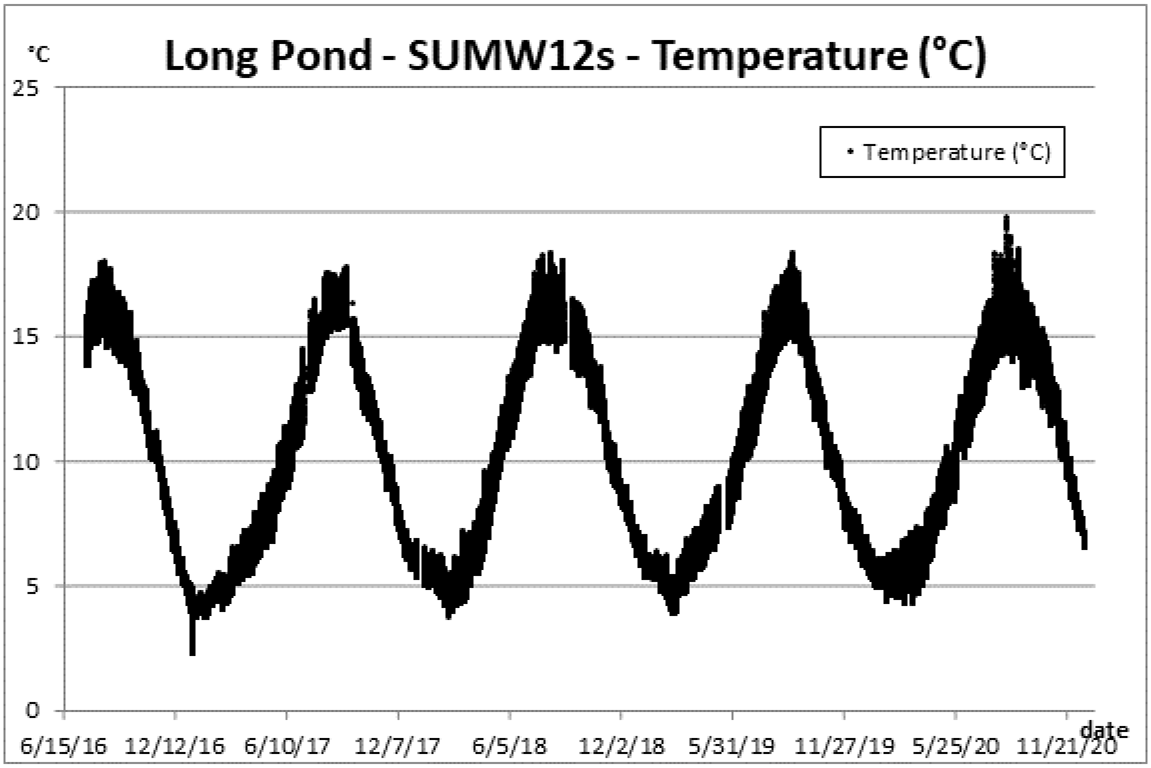


Figure 1 – Water temperature (°C) – Surface Water - Long Pond – SUMW12s

Long Pond - SUMW12s

Maximum MWAT (°C)			Minimum MWAT (°C)		
WY	°C	Date	WY	°C	Date
WY2016	16.4	8/20/2016	WY2016	ND	ND
WY2017	16.4	9/13/2017	WY2017	3.9	1/14/2017
WY2018	16.3	7/29/2018	WY2018	4.7	3/3/2018
WY2019	16.3	9/6/2019	WY2019	4.5	3/1/2019
WY2020	16.0	8/15/2020	WY2020	5.3	1/29/2020

Table 1 – Maximum and Minimum MWAT (°C) by Water Year – SUMW12s

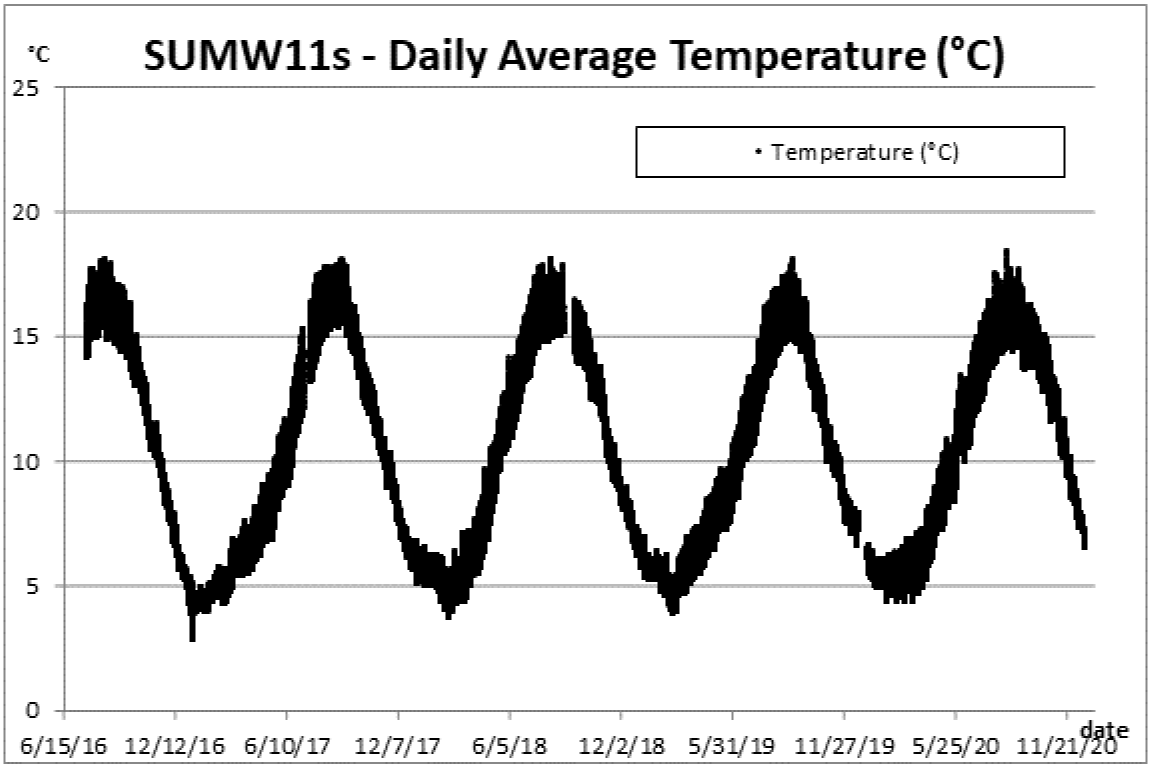


Figure 2 – Water temperature (°C) – Surface Water – SUMW11s

SUMW11s

Maximum MWAT (°C)

WY	°C	Date
WY2016	16.7	8/21/2016
WY2017	16.6	9/12/2017
WY2018	16.3	8/13/2018
WY2019	16.2	9/5/2019
WY2020	15.9	9/5/2020

Minimum MWAT (°C)

WY	°C	Date
WY2016	ND	ND
WY2017	4.1	1/15/2017
WY2018	4.7	3/4/2018
WY2019	4.6	2/28/2019
WY2020	5.3	2/9/2020

Table 2 – Maximum and Minimum MWAT (°C) by Water Year – SUMW11s

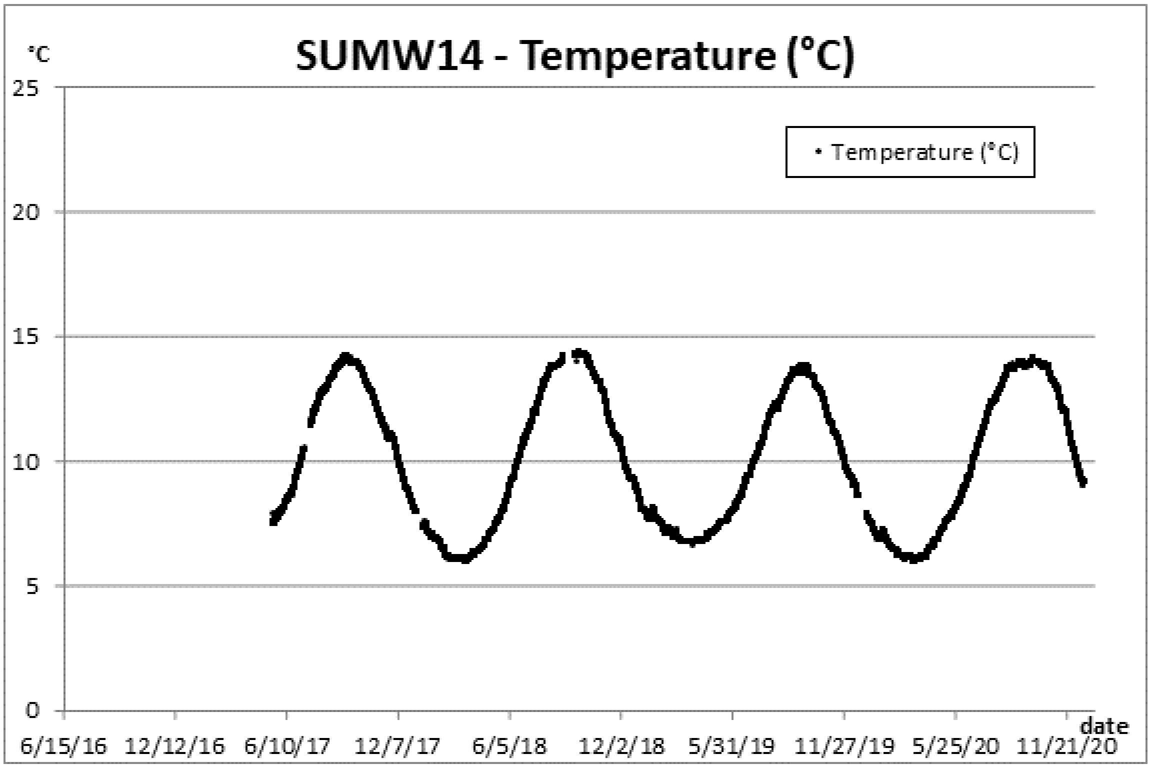


Figure 3 – Water temperature (°C) – Shallow Groundwater – SUMW14

SUMW14

Maximum MWAT (°C)

WY	°C	Date
WY2016	ND	ND
WY2017	14.2	9/19/2017
WY2018	14.3	10/5/2018
WY2019	13.8	9/29/2019
WY2020	14.0	10/1/2020

Minimum MWAT (°C)

WY	°C	Date
WY2016	ND	ND
WY2017	ND	ND
WY2018	6.1	3/27/2018
WY2019	6.8	3/27/2019
WY2020	6.0	3/21/2020

Table 3 – Maximum and Minimum MWAT (°C) by Water Year – SUMW14

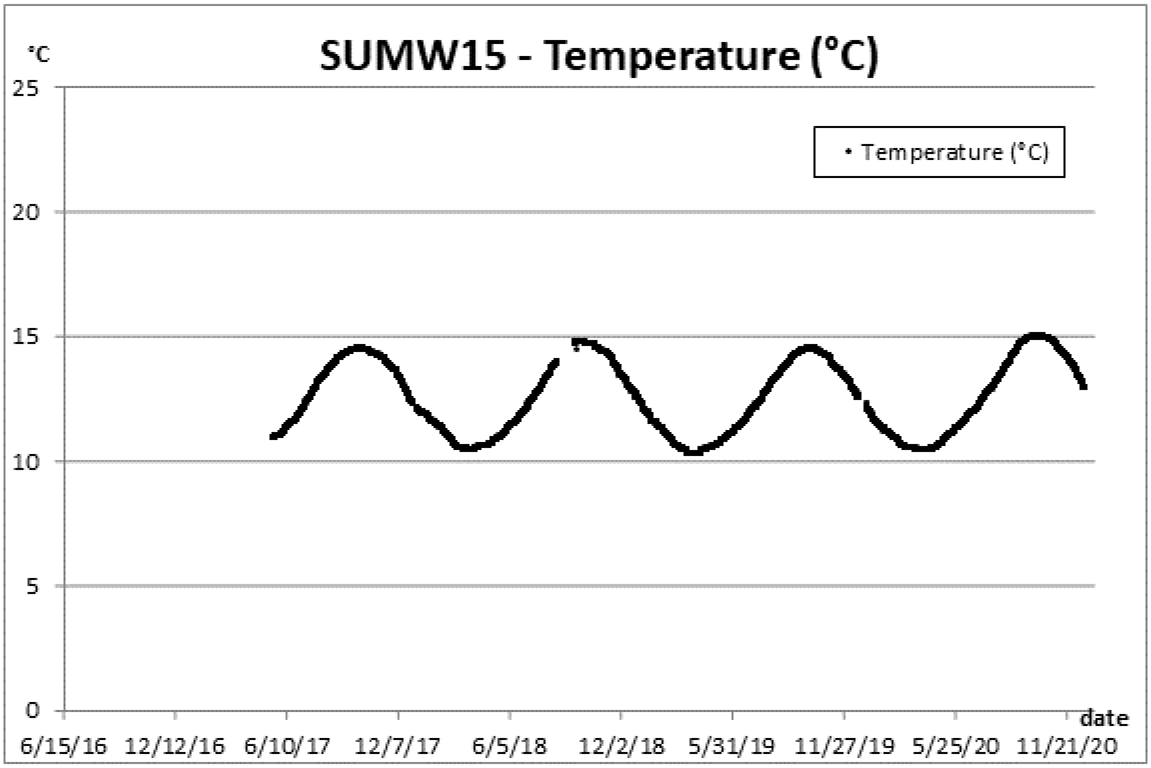


Figure 4 – Water temperature (°C) – Shallow Groundwater – SUMW15

SUMW15

Maximum MWAT (°C)

WY	°C	Date
WY2016	ND	ND
WY2017	14.6	10/10/2017
WY2018	14.8	9/26/2018
WY2019	14.6	10/6/2019
WY2020	15.1	10/3/2020

Minimum MWAT (°C)

WY	°C	Date
WY2016	ND	ND
WY2017	ND	ND
WY2018	10.5	4/5/2018
WY2019	10.4	3/23/2019
WY2020	10.5	3/28/2020

Table 4 – Maximum and Minimum MWAT (°C) by Water Year – SUMW15

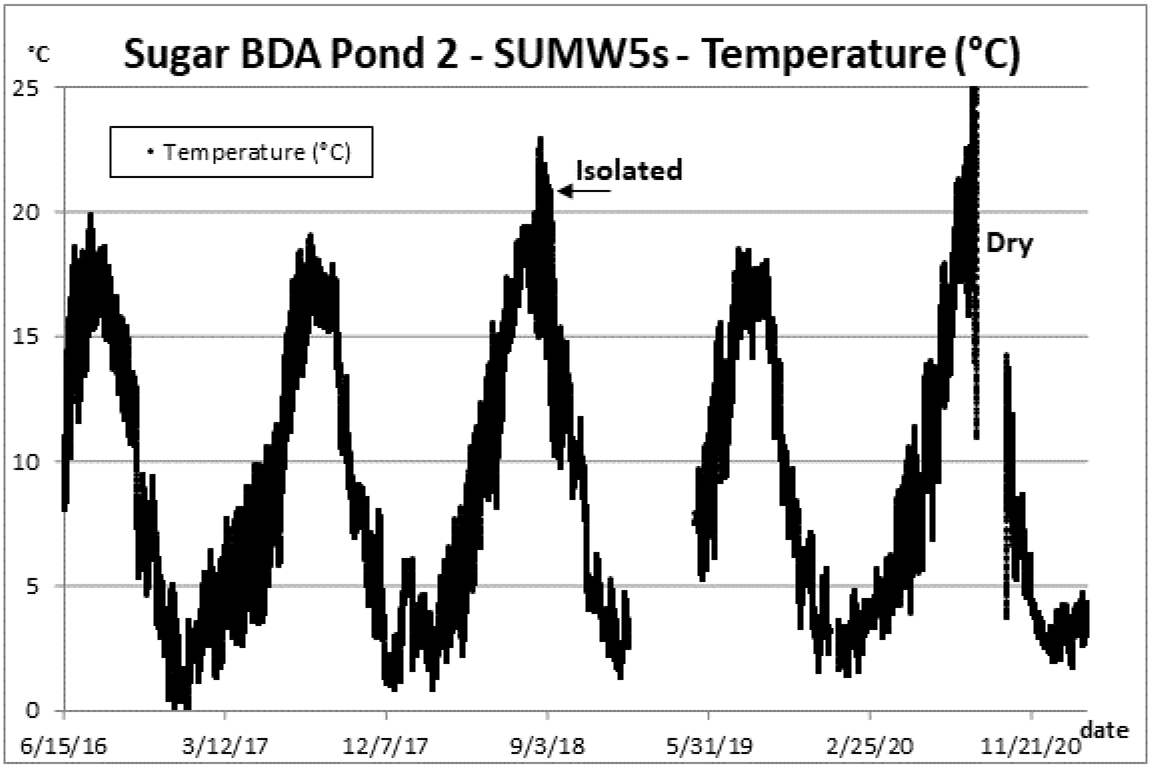


Figure 5 – Water temperature (°C) – Surface Water – Sugar BDA Pond 2 – SUMW5s

Sugar BDA Pond 2 - SUMW5s

Maximum MWAT (°C)

WY	°C	Date
WY2016	17.8	8/2/2016
WY2017	17.7	8/6/2017
WY2018	19.2	8/25/2018
WY2019	17.1	8/31/2019
WY2020	Dry	--

Minimum MWAT (°C)

WY	°C	Date
WY2016	ND	ND
WY2017	0.7	1/8/2017
WY2018	1.9	2/26/2018
WY2019	1.9	1/4/2019
WY2020	2.0	1/20/2020

Table 5 – Maximum and Minimum MWAT (°C) by Water Year – Sugar BDA Pond 2 - SUMW5s

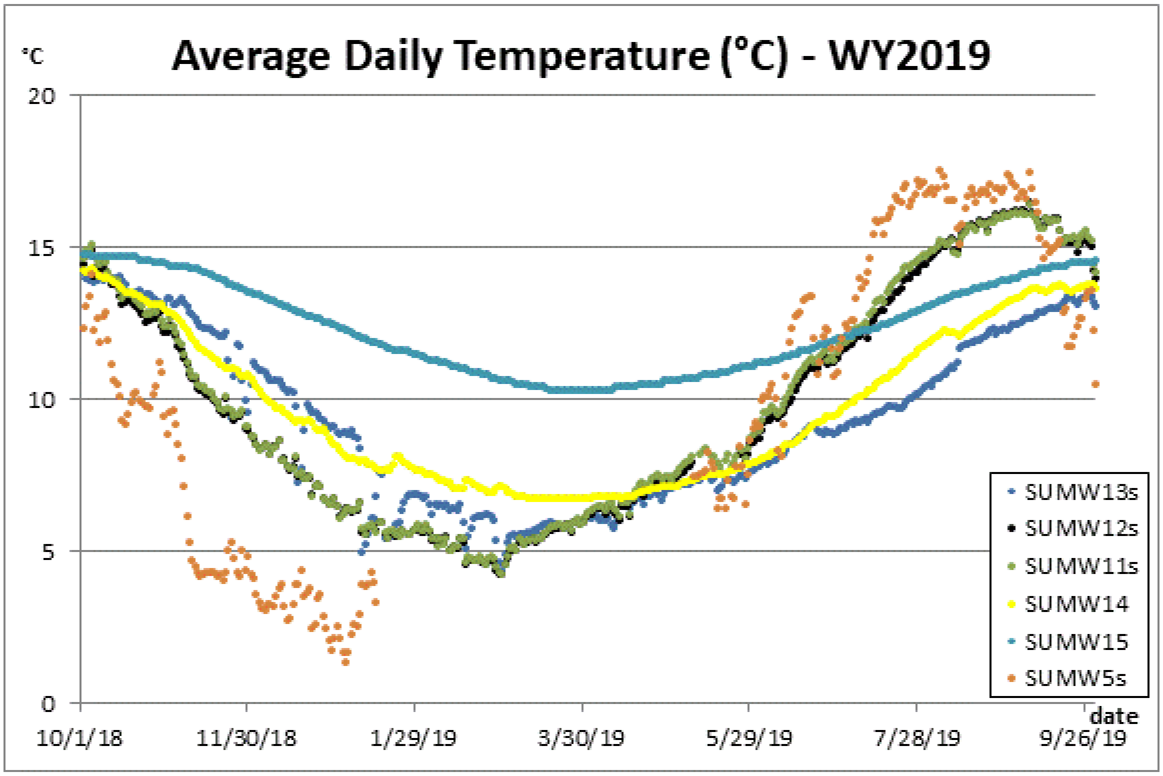


Figure 6 – Daily average temperature (°C) – WY2019

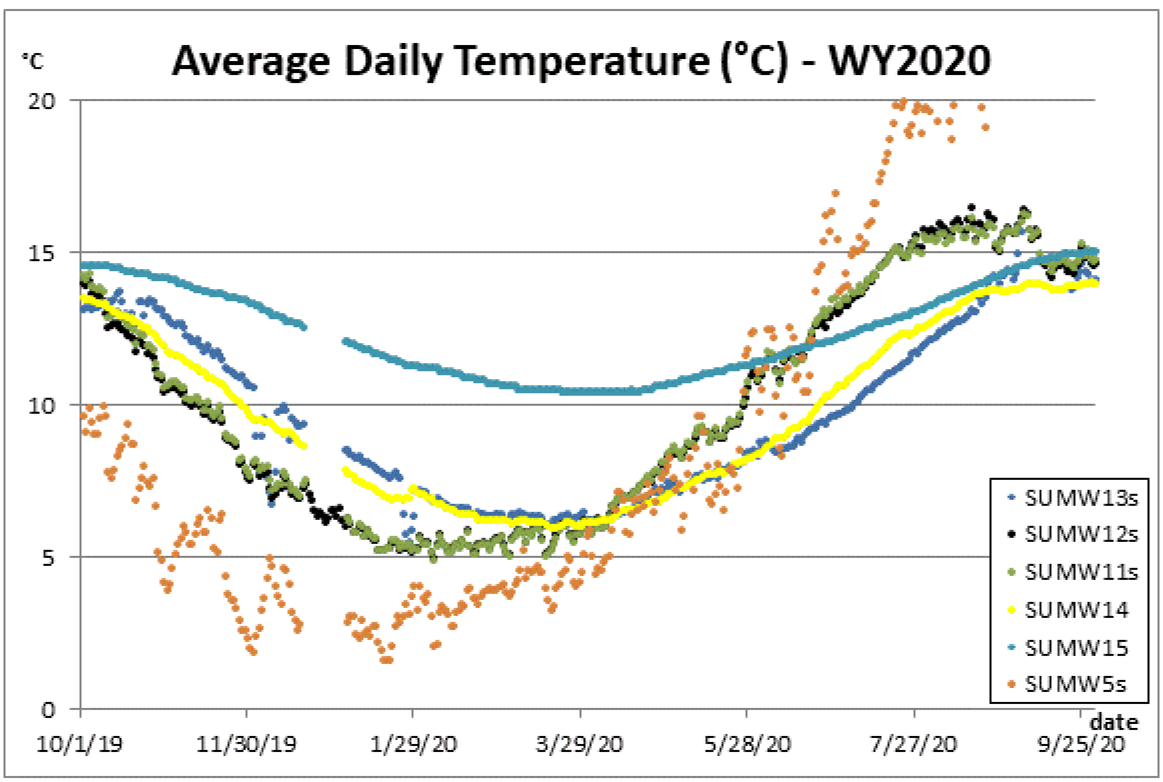


Figure 7 – Daily average temperature (°C) – WY2020

Dissolved oxygen monitoring during the base flow period of the critically dry WY2020 documented the water temperature (°C) and dissolved oxygen (mg/L) in the Long Pond (Figures 8 and 9), Sugar Off Channel Pond (OCP) (Figures 10 and 11) and Sugar Creek above Beaver Dam (Figures 12 and 13). The rapid decline in water levels in the Long Pond and the Sugar OCP during the base flow period resulted in the loggers become dewatered during periods. During the base flow period of WY2020 the Sugar Creek BDA Ponds 1 and 2 were dewatered from late August through early October with the surface water maintained above the natural beaver dam in Sugar Creek below Highway 3. During this period the Sugar OCP was disconnected from surface water with groundwater inputs. The dissolved oxygen in the Sugar OCP was not significantly impaired during this period of disconnection. A more significant reduction in dissolved oxygen was observed in the Long Pond during the base flow period of WY2020.

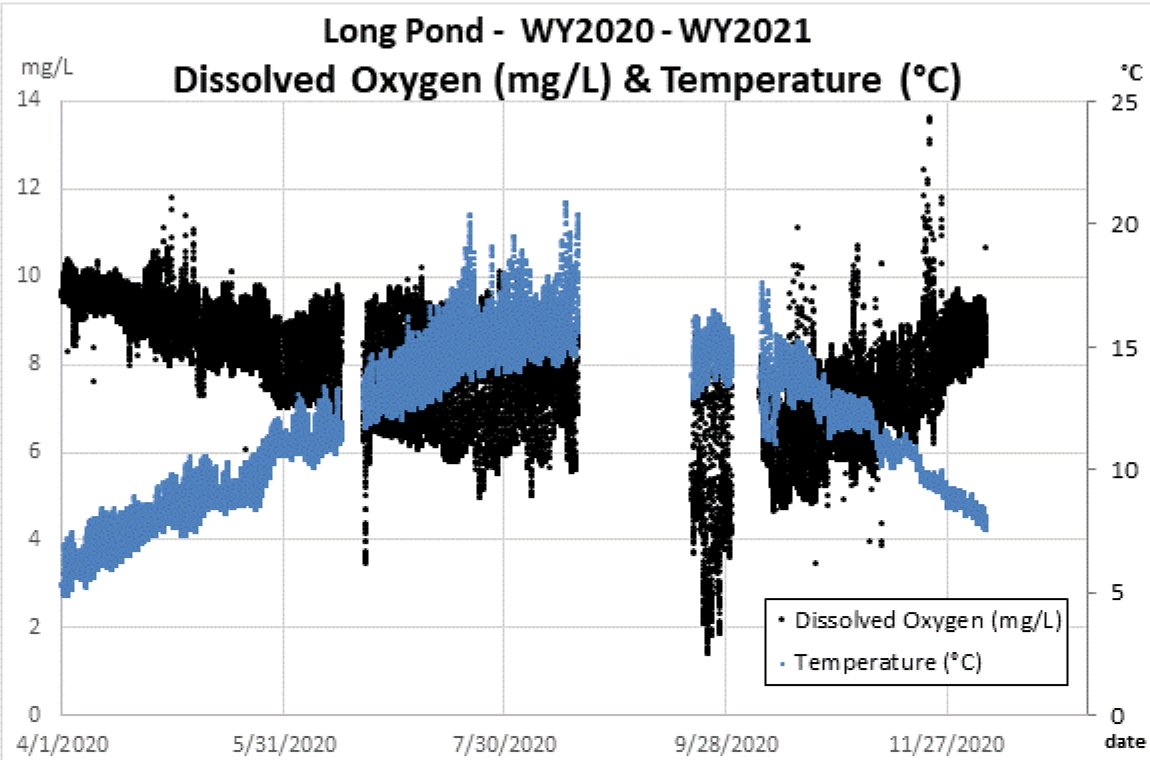


Figure 8 – Continuous dissolved oxygen (mg/L) and temperature (°C) – Long Pond – WY2020

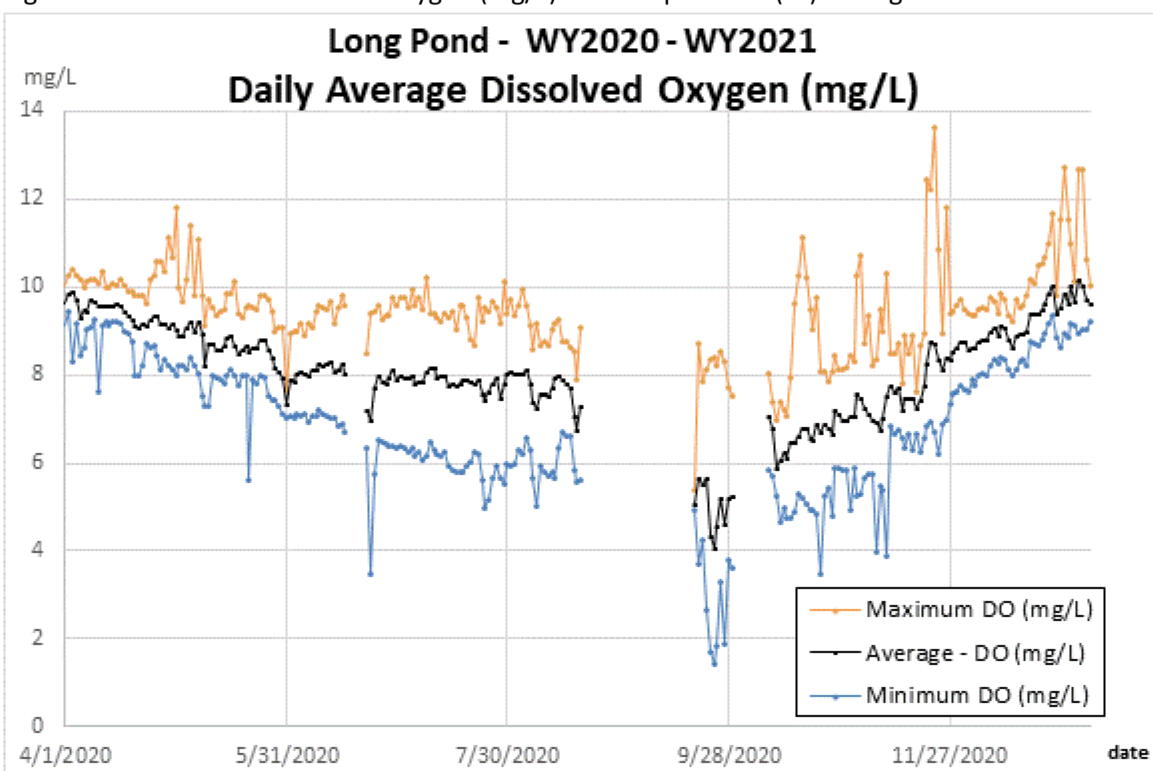


Figure 9 - Daily average dissolved oxygen (mg/L) – Long Pond – WY2020 – WY2021

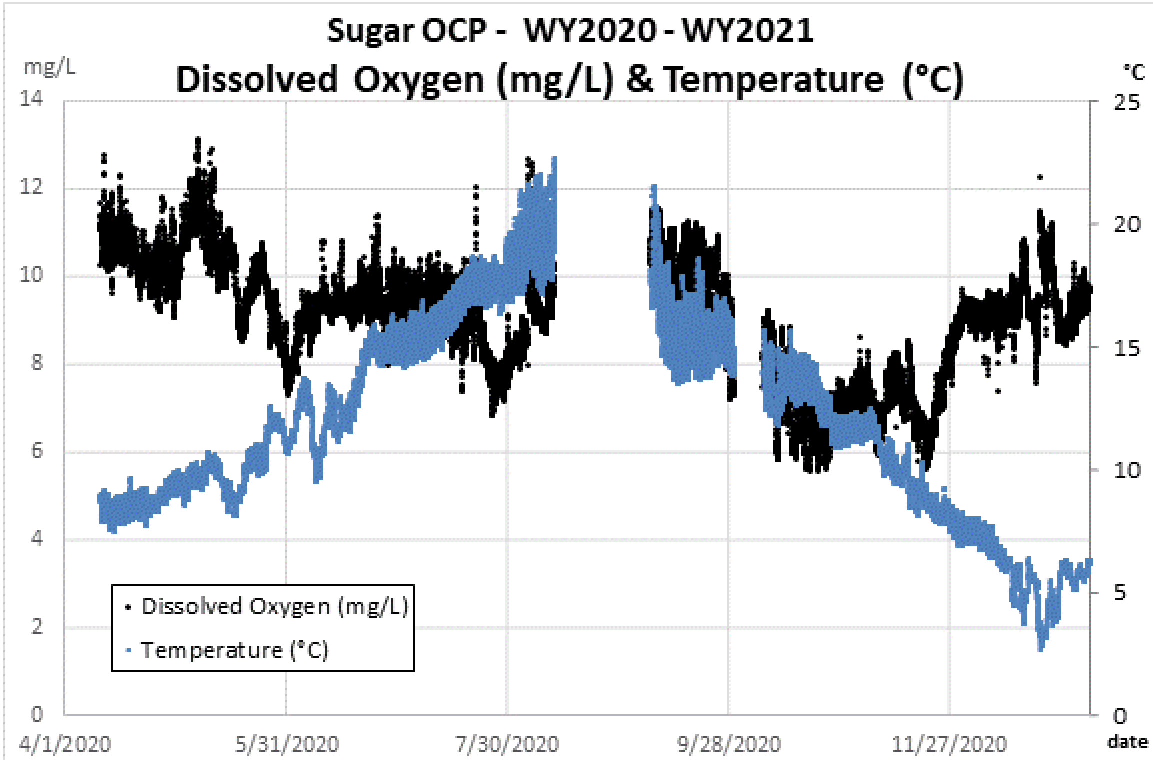


Figure 10 – Continuous dissolved oxygen (mg/L) and temperature (°C) – Sugar OCP – WY2020 – WY2021

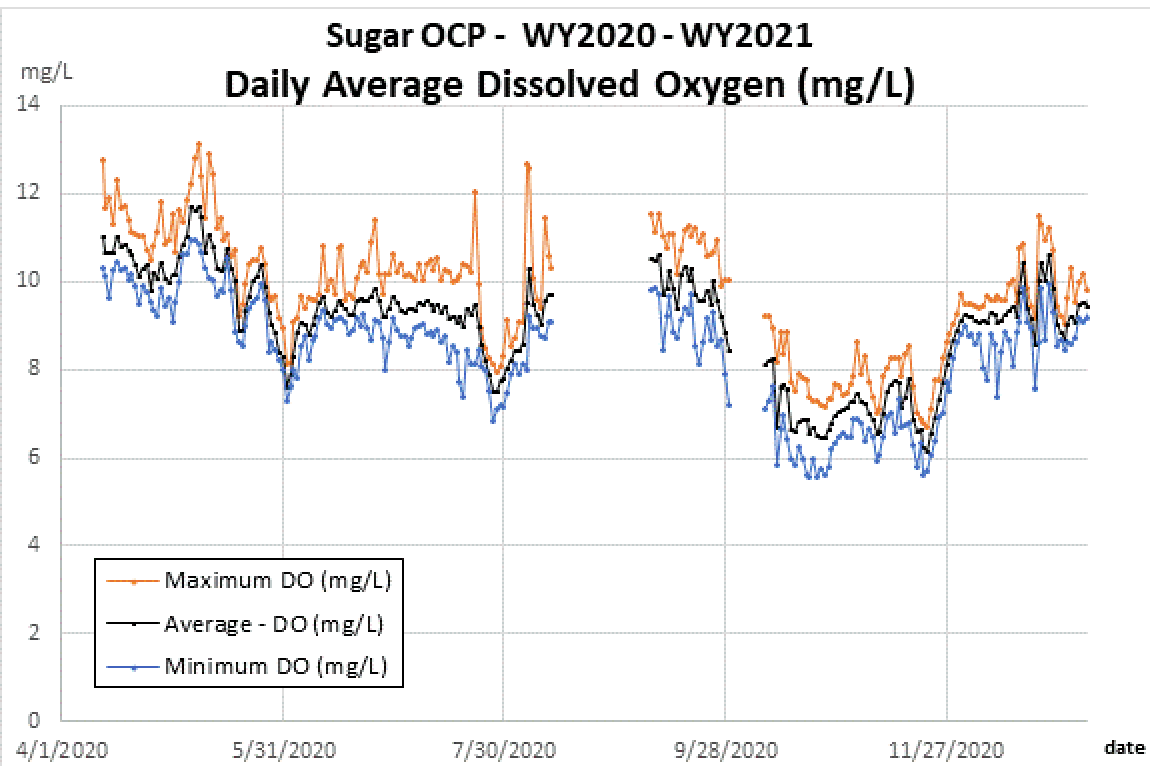


Figure 11 – Daily average dissolved oxygen (mg/L) - Sugar OCP – WY2020 – WY2021

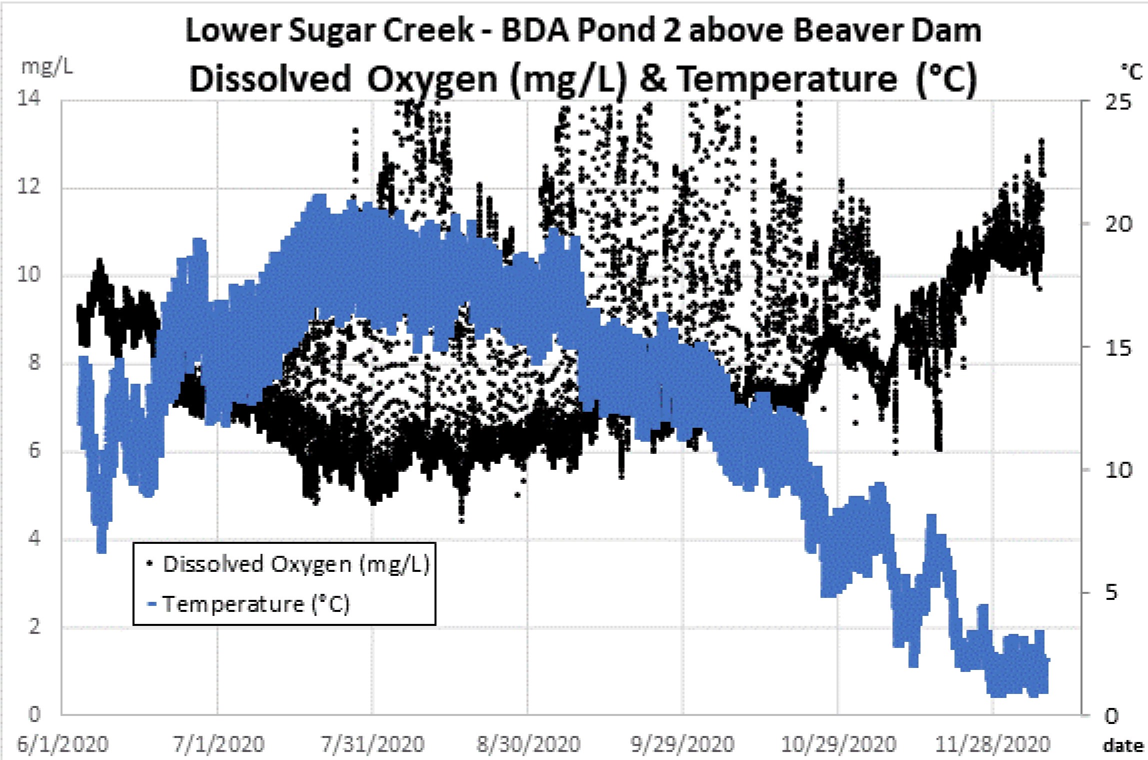


Figure 12 – Continuous dissolved oxygen (mg/L) and temperature (°C) – Sugar Creek above Beaver Dam – WY2020

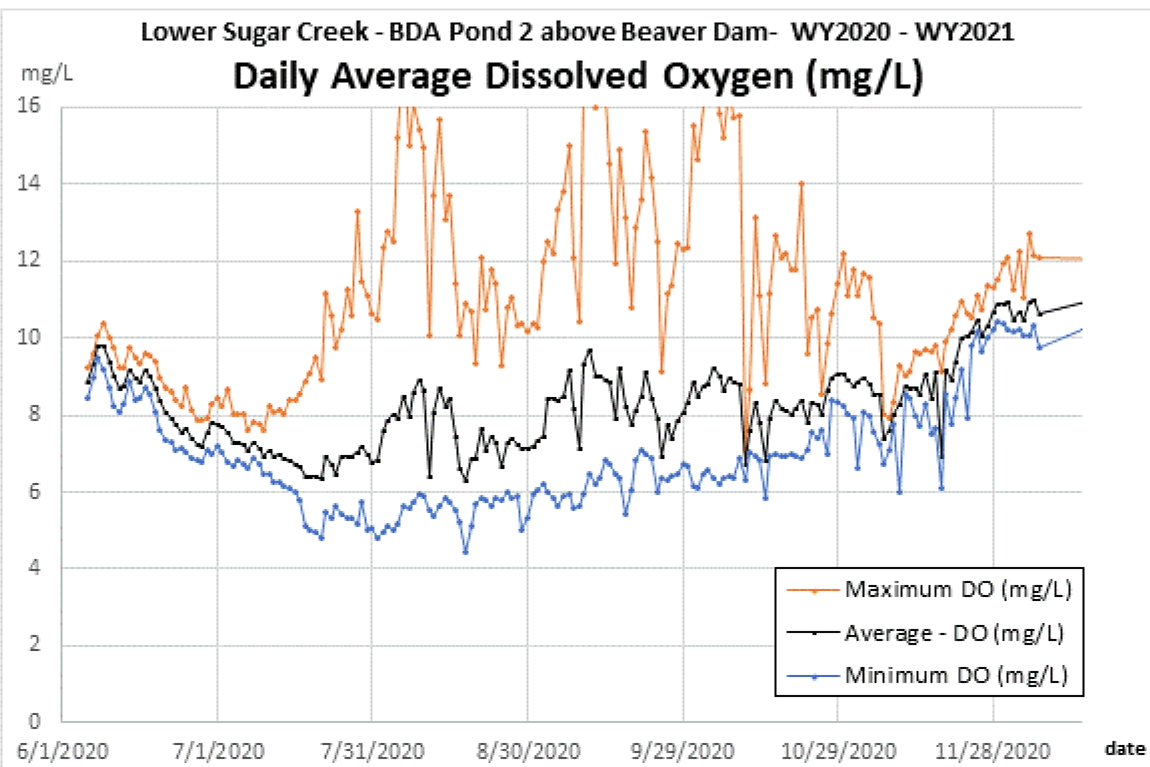


Figure 13 - Daily average dissolved oxygen (mg/L) – BDA Pond 2 above Beaver Dam – WY2020 – WY2021

WY2021

The documentation of continuous dissolved oxygen and temperature continued through WY2021. Dissolved oxygen during the fall, winter and early spring months was suitable for salmonids through the majority of the period for the Long Pond (Figure 14), the Sugar Off Channel Pond (Figure 17) and Sugar Creek BDA Pond 2 (Figure 20). The dissolved oxygen in the Long Pond decreased significantly for the period from January 25 to February 2, 2021 – a phenomena that was not observed at the other stations. During the early summer recession and base flow period of WY2021 more vigilant attempts to keep the logger in water of suitable depth were made in order to improve on the WY2020 data effort. Increases in water temperature associated with the logger residing in the top of the water column before movement to deeper water are observed in mid-July at the Long Pond (Figure 15) and Sugar Off channel Pond (Figure 18). Analysis of the daily average dissolved oxygen (mg/L) during the base flow period of WY2021 documents that the Long Pond has the lowest minimum dissolved oxygen (Figure 16) with the Sugar OCP having suitable dissolved oxygen levels through the period of record (Figure 19). The water surface elevation above the BDA Pond 2 beaver dam has been stable during the base flow period of WY2021 compared to the Long Pond and Sugar OCP (Figure 21). Significant fluctuations in dissolved oxygen at the BDA 2 above Beaver Dam station with periodic levels less than 6 mg/L (Figure 22).

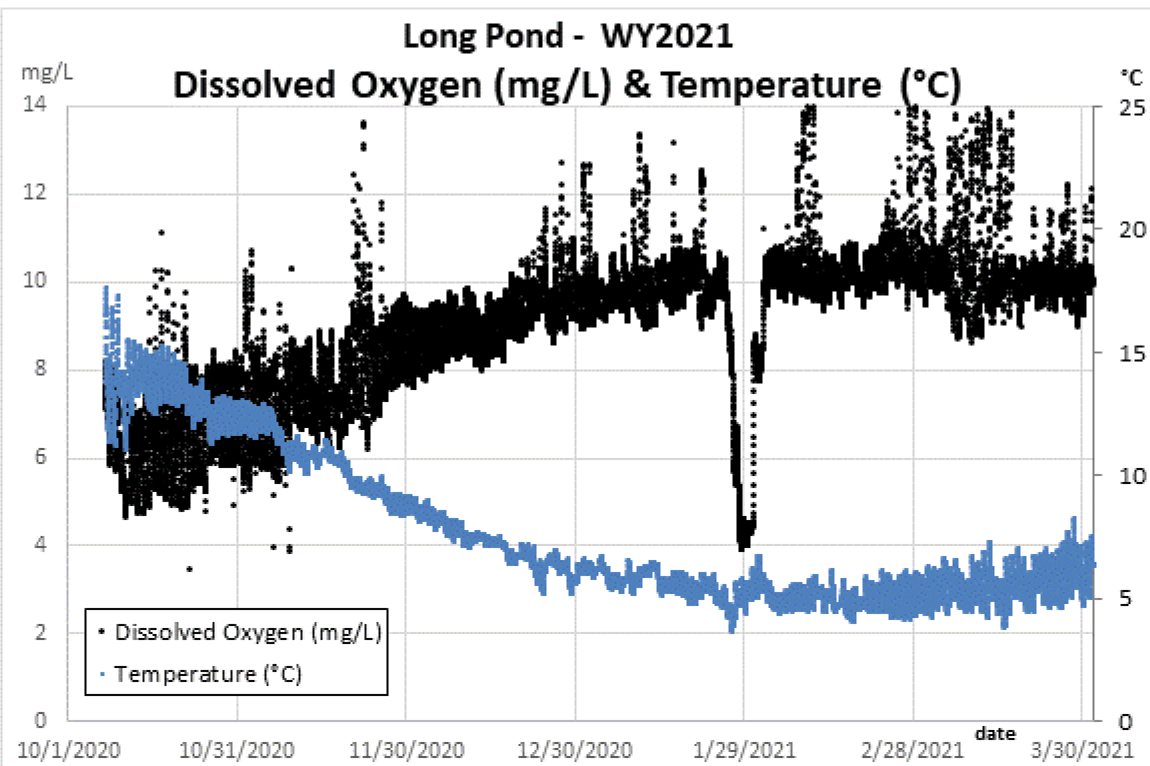


Figure 14 - Continuous dissolved oxygen (mg/L) and temperature (°C) – Long Pond – WY2021

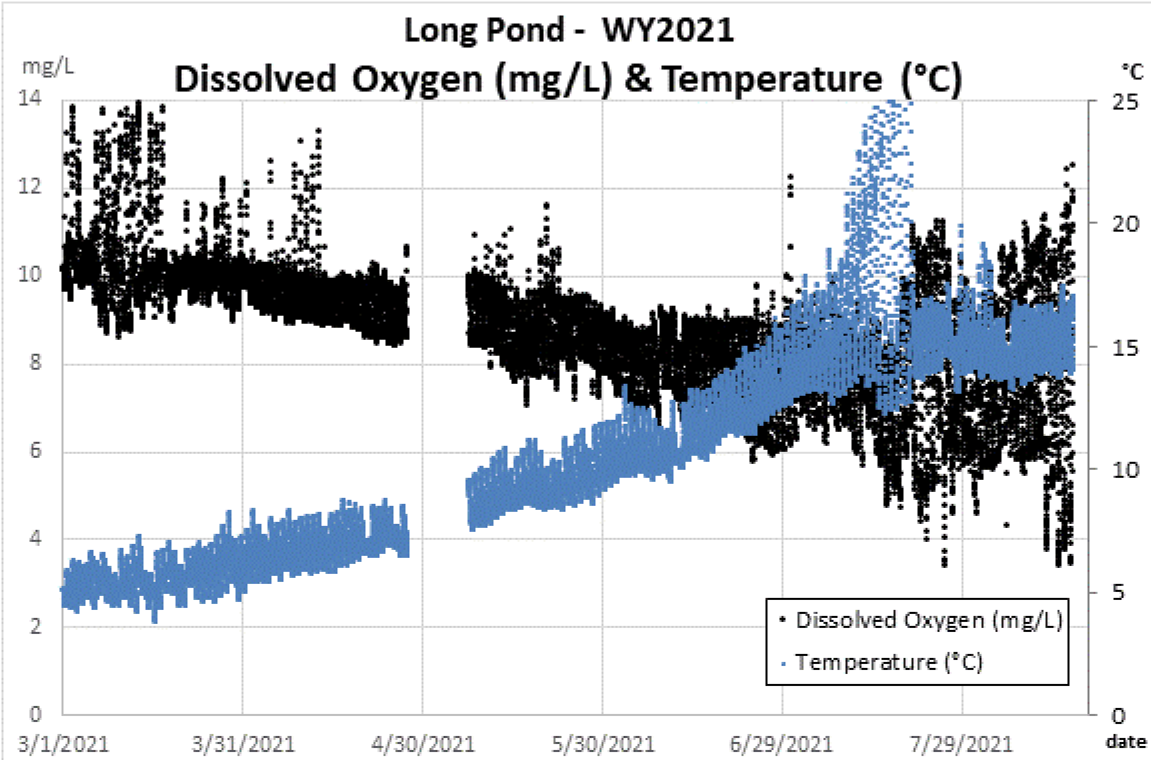


Figure 15 - Continuous dissolved oxygen (mg/L) and temperature (°C) – Long Pond – WY2021

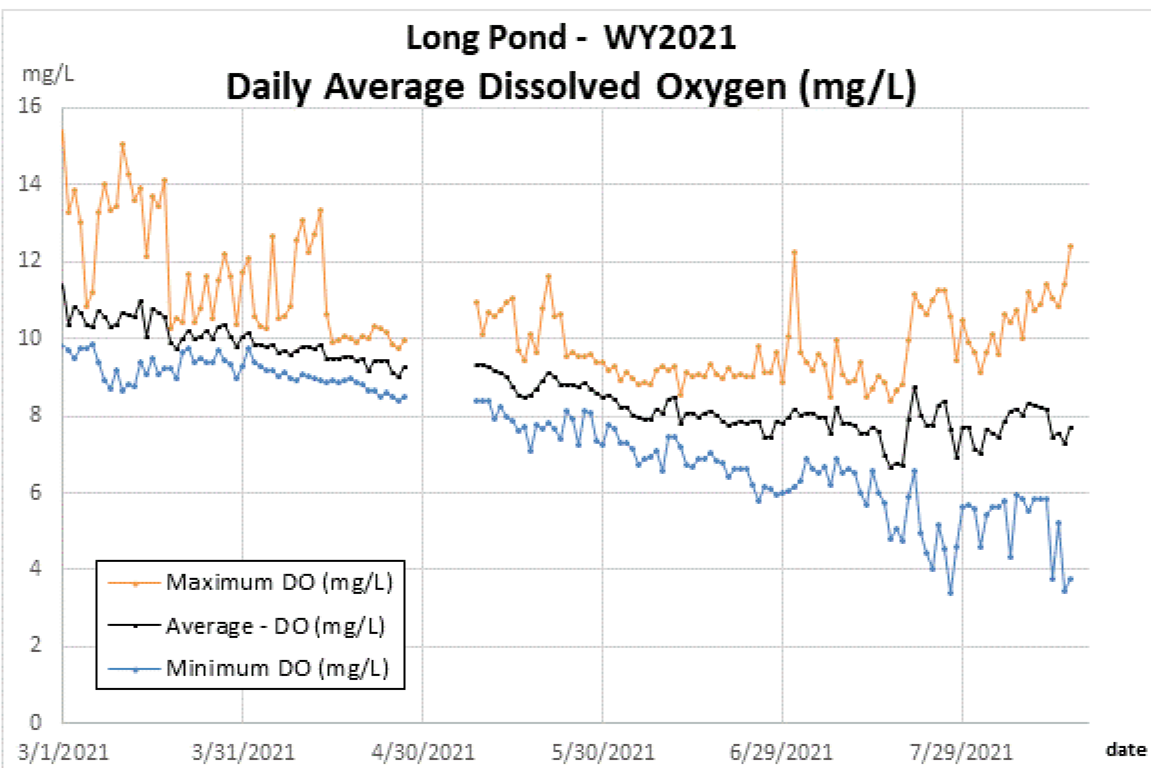


Figure 16 - Daily average dissolved oxygen (mg/L) – Long Pond – WY2021

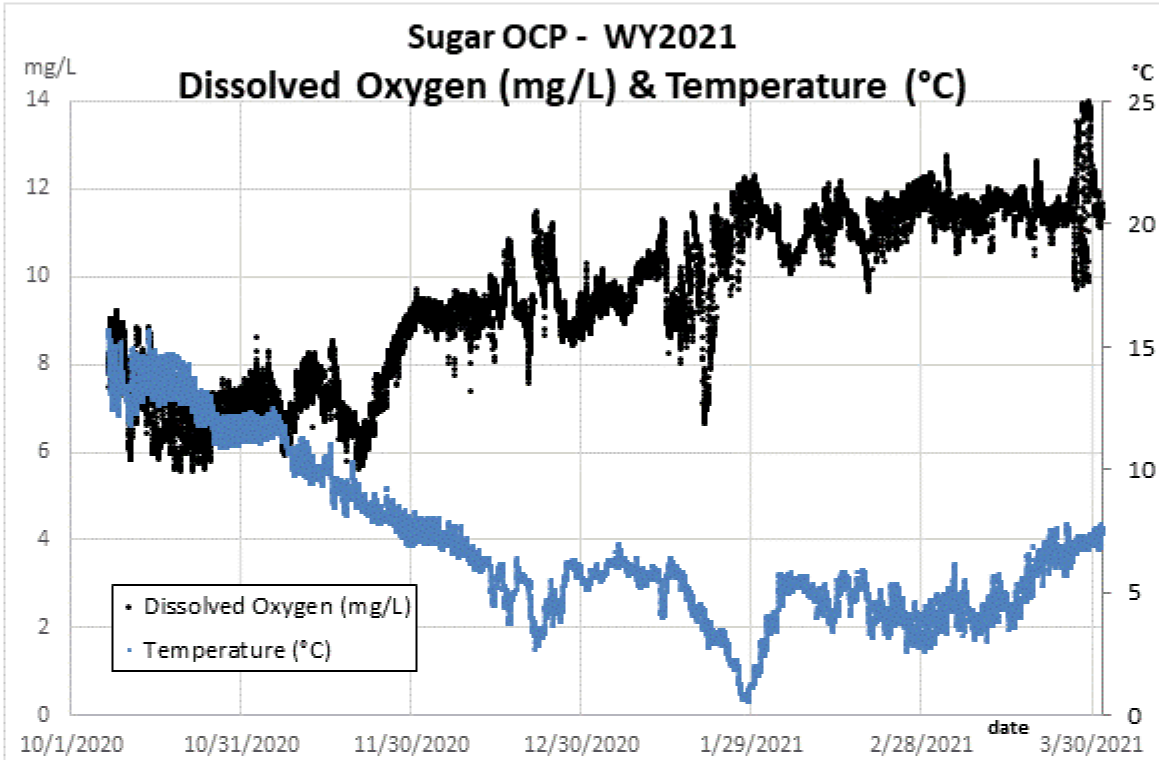


Figure 17 - Continuous dissolved oxygen (mg/L) and temperature (°C) – Sugar OCP – WY2021

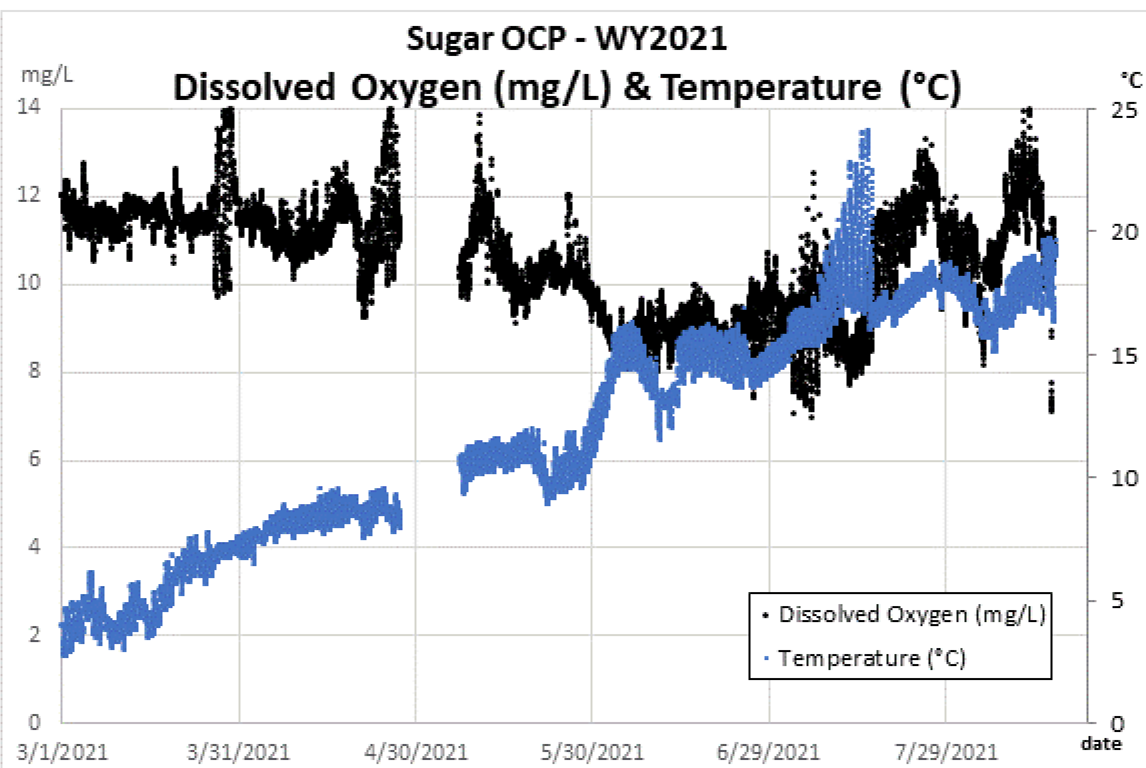


Figure 18 - Continuous dissolved oxygen (mg/L) and temperature (°C) – Sugar OCP – WY2021

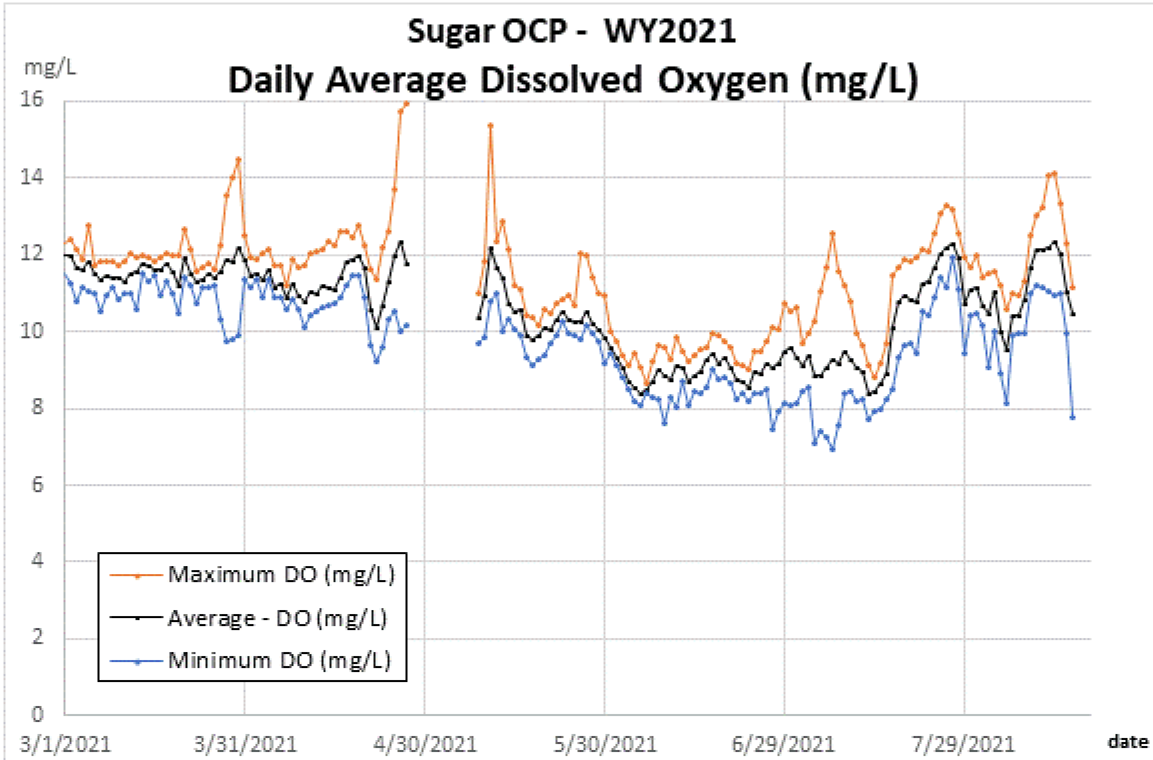


Figure 19 - Daily average dissolved oxygen (mg/L) – Sugar OCP – WY2021

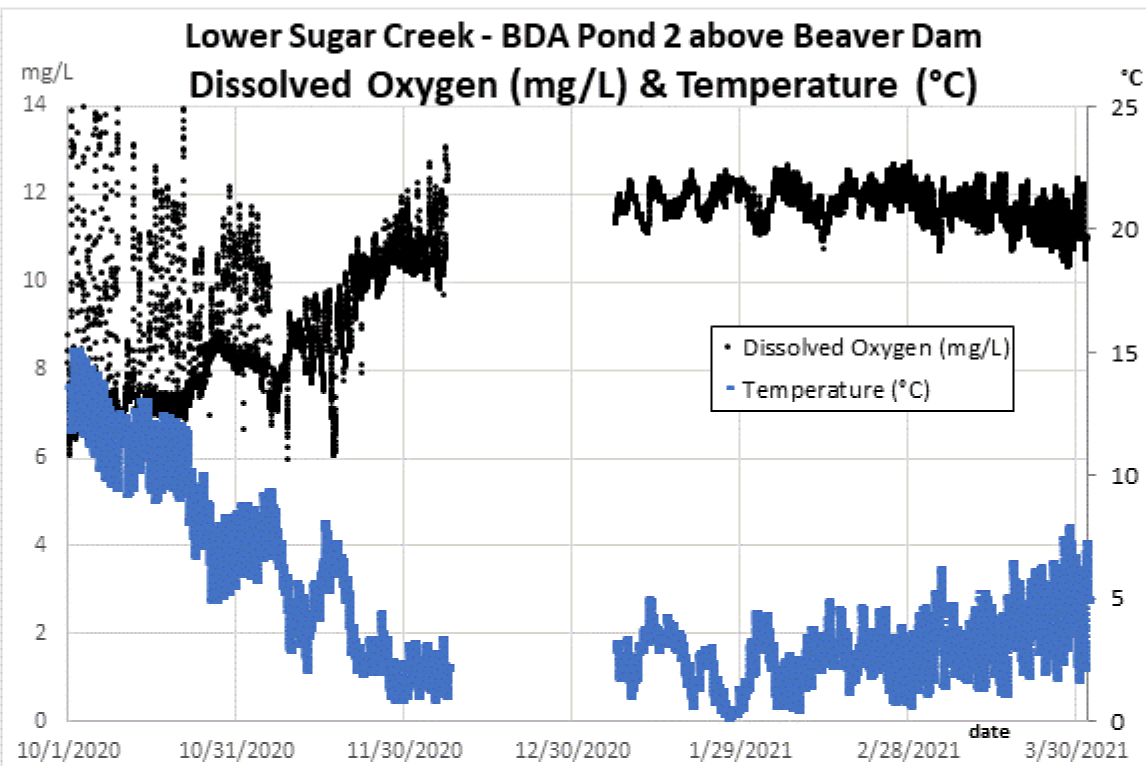


Figure 20 - Continuous dissolved oxygen (mg/L) and temperature (°C) – Sugar Creek above Beaver Dam – WY2021

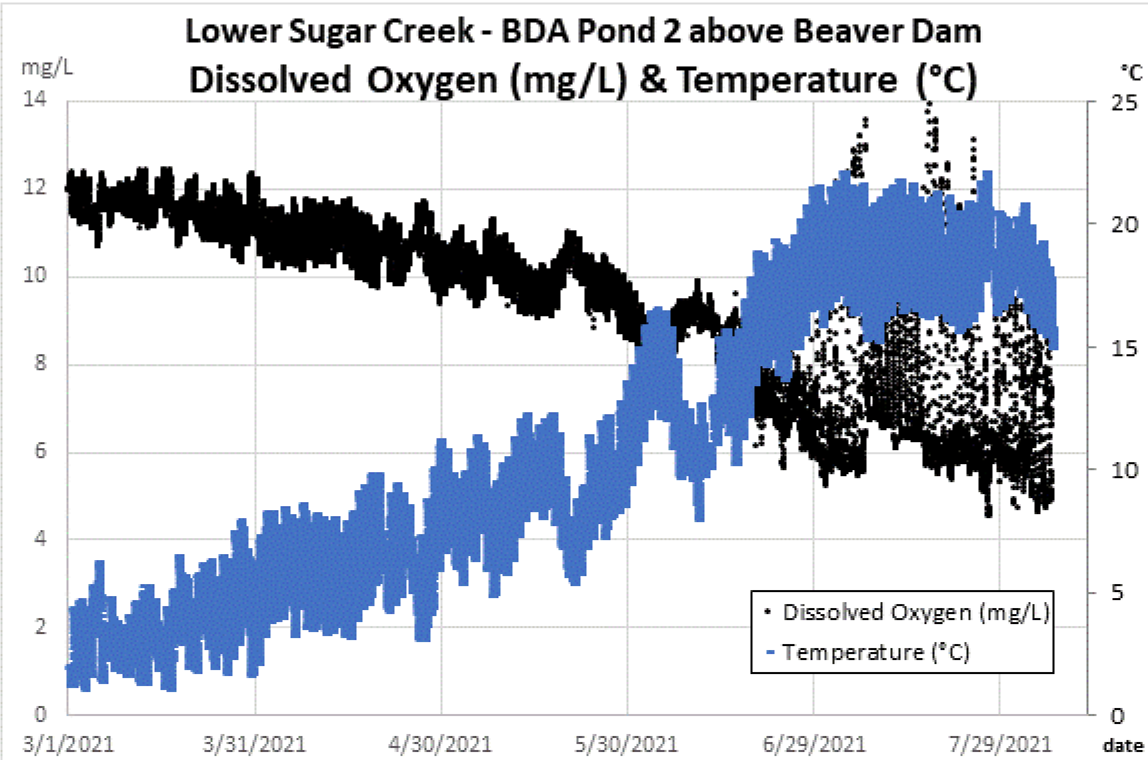


Figure 21 - Continuous dissolved oxygen (mg/L) and temperature (°C) – Sugar Creek above Beaver Dam – WY2021

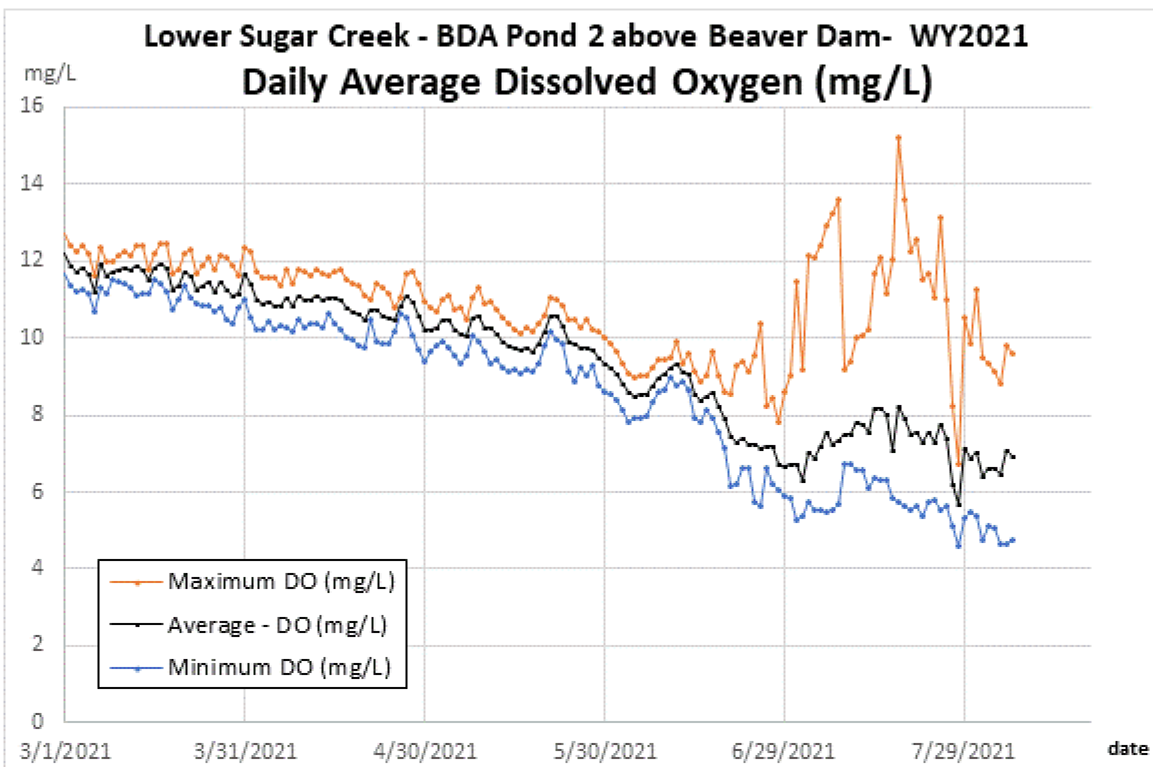


Figure 22 - Daily average dissolved oxygen (mg/L) – Sugar Creek above Beaver Dam – WY2021

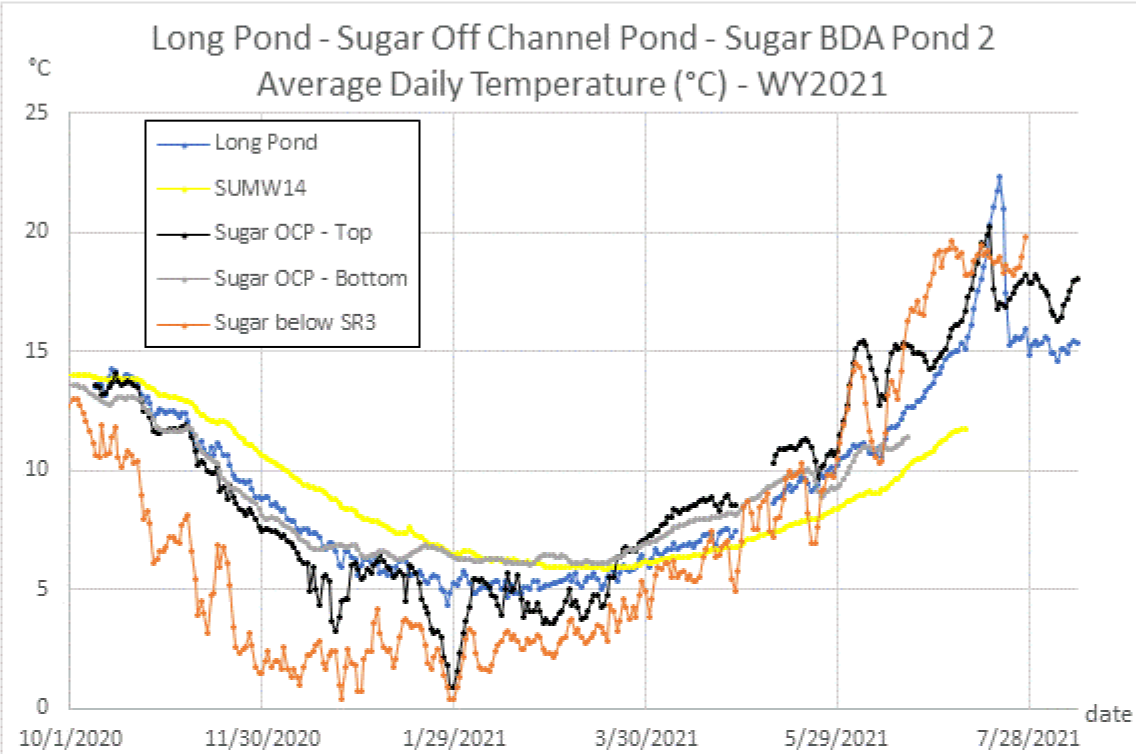
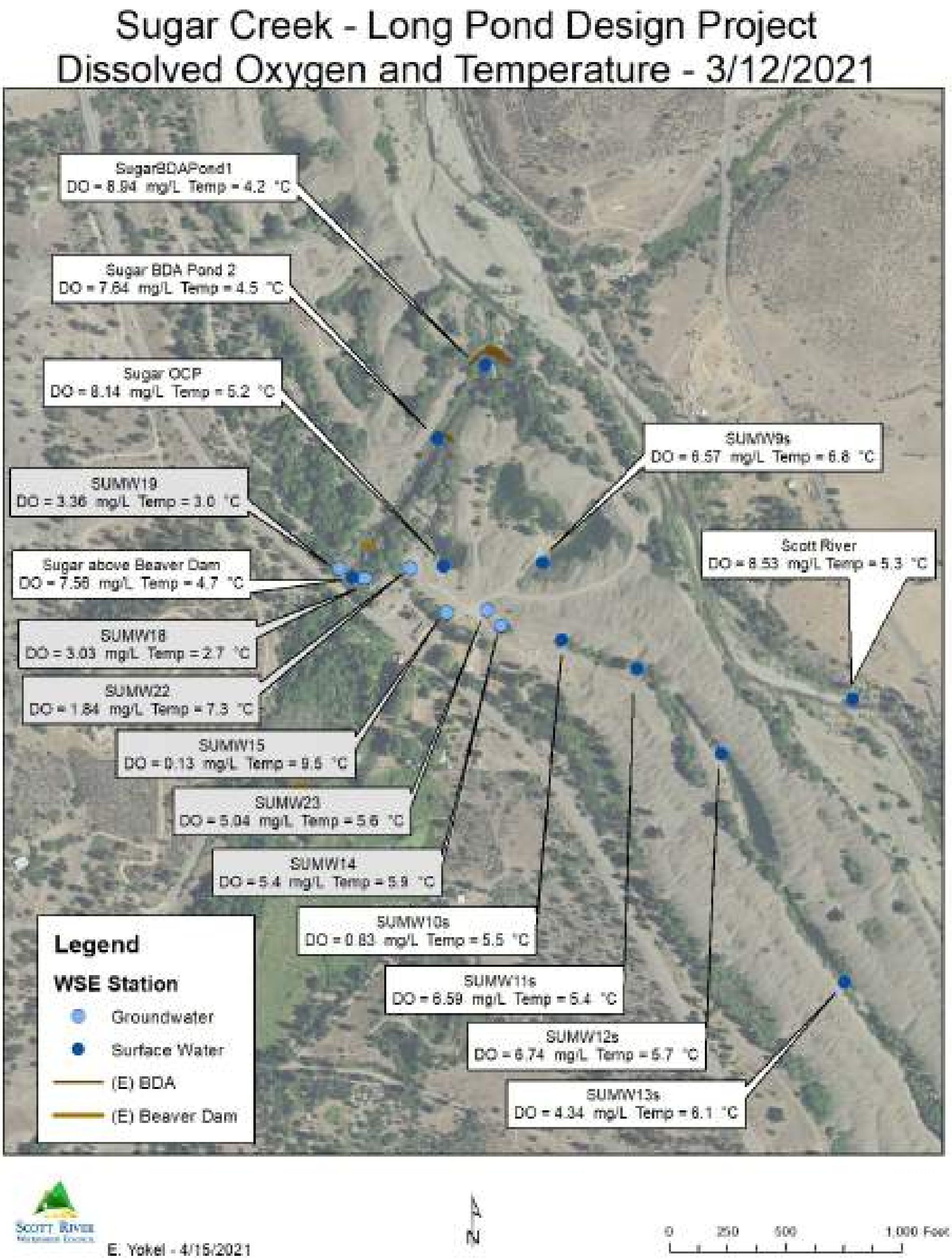


Figure 23 – Daily average water temperature – Long Pond, Sugar OCP and Sugar BDA Pond 2 above Beaver Dam – WY2021

Analysis of daily average water temperature (°C) in three surface water sites (Long Pond, Sugar OCP and Sugar below Highway 3) and a groundwater site (SUMW14) in the Long Pond Restoration Design footprint illustrates the groundwater affect on water temperatures in the Sugar OCP and Long Pond in comparison with the mainstem Sugar Creek site (Figure 23). Water temperatures in the Long Pond and Sugar OCP – Bottom are significantly warmer in winter and cooler in summer in comparison to Sugar Creek.



Map 2 – Periodic dissolved oxygen (mg/L) and temperature (°C) – 3/12/2021

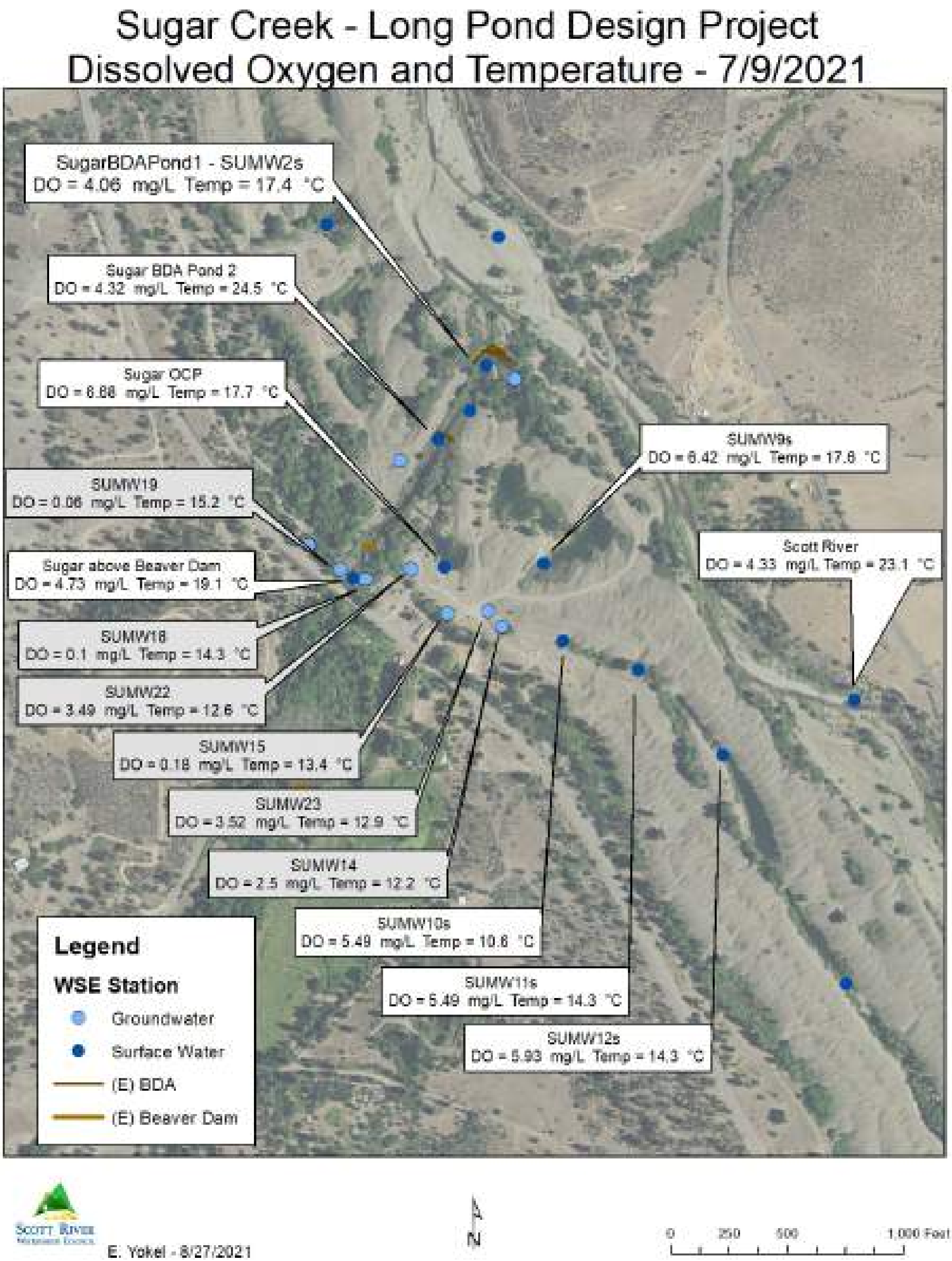
A periodic measurement of the dissolved oxygen and temperature at the WSE stations in the project area was performed on March 12, 2021 to attempt to characterize the WQ at the surface water and groundwater sites (Map 2). The dissolved oxygen was significantly lower at the groundwater (GW) station than the surface water (SW) stations, in general (Table 6). A notable exception is the SUMW10s station that had the second lowest dissolved oxygen value (0.83 mg/L) during the March 12th survey.

Station	DO (mg/L)	Temperature (°C)
SUMW15	0.13	9.5
SUMW10s	0.83	5.5
SUMW22	1.84	7.3
SUMW18	3.03	2.7
SUMW19	3.36	3.0
SUMW13s	4.34	6.1
SUMW23	5.04	5.6
SUMW14	5.40	5.9
SUMW9s	6.57	6.8
SUMW11s	6.59	5.4
Long Pond - SUMW12s	6.74	5.7
Sugar above Beaver Dam	7.56	4.7
Sugar BDA Pond 2	7.64	4.5
Sugar OCP	8.14	5.2
Scott River	8.53	5.3
Sugar BDA Pond1	8.94	4.2

Table 6 – Periodic dissolved oxygen (mg/L) and temperature (°C) - 3/12/2021

The periodic measurements of dissolved oxygen and temperature at the WSE stations were performed during the base flow period on July 9, 2021 (Map 3). The periodic dissolved oxygen values at the GW sites were consistently lower than the values at the SW sites (Table 7). The dissolved oxygen at the SUMW10s site was equivalent to the dissolved oxygen at the other SW sites (5.49 mg/L) bringing into question the value observed during the March 12th effort at this site.

Comparison of the periodic dissolved oxygen and temperature values observed during the March and July efforts show a decrease in dissolved oxygen at the majority of stations with a few stations showing a significant increase in dissolved oxygen (e.g., SUMW10s and SUMW22) (Table 8).



Map 3 - Periodic dissolved oxygen (mg/L) and temperature (°C) – 7/9/2021

	7/9/2021	
Station	DO (mg/L)	Temperature (°C)
SUMW19	0.06	15.2
SUMW18	0.10	14.3
SUMW15	0.18	13.4
SUMW21	1.13	17
SUMW3	2.47	16.7
SUMW14	2.50	12.2
SUMW22	3.49	12.6
SUMW23	3.52	12.9
SUMW2s	4.06	17.4
Sugar BDA Pond 2	4.32	24.5
Scott River	4.33	23.1
Sugar above Beaver Dam	4.73	19.1
SUMW10s	5.49	10.6
SUMW11s	5.49	14.3
Long Pond	5.93	14.3
SUMW9s	6.42	17.6
Sugar OCP	6.68	17.7
SUMW7s	6.88	16.1

Table 7 – Periodic dissolved oxygen (mg/L) and temperature (°C) - 7/9/2021

		3/12/2021		7/9/2021	
Well ID	GW or SW	DO (mg/L)	Temperature (°C)	DO (mg/L)	Temperature (°C)
SUMW15	GW	0.13	9.5	0.18	13.4
SUMW20	GW	0.30	4.3	0.12	10.8
SUMW10s	SW	0.83	5.5	5.49	10.6
SUMW22	GW	1.84	7.3	3.49	12.6
SUMW18	GW	3.03	2.7	0.1	14.3
SUMW19	GW	3.36	3.0	0.06	15.2
SUMW13s	SW	4.34	6.1	--	--
SUMW23	GW	5.04	5.6	3.52	12.9
SUMW14	GW	5.40	5.9	2.5	12.2
SUMW3	GW	6.30	5.6	2.47	16.7
SUMW9s	SW	6.57	6.8	6.42	17.6
SUMW11s	SW	6.59	5.4	5.49	14.3
SUMW7s	SW	6.72	6.0	6.88	16.1
SUMW12s	SW	6.74	5.7	5.93	14.3
SUMW21	GW	6.83	3.9	1.13	17.0
SUMW2s	SW	7.24	4.3	4.06	17.4
SUMW17s	SW	7.56	4.7	4.73	19.1
SUMW5s	SW	7.64	4.5	4.32	24.5
SCMW01	SW	7.83	5.4	2.4	18.1
SUMW1s	SW	8.14	5.2	6.68	17.7
SCMW0s	SW	8.53	5.3	4.33	23.1
SugarBDAPond1	SW	8.94	4.2	--	--

Table 8 – Periodic dissolved oxygen (mg/L) and temperature (°C) - 3/12/2021 and 7/9/2021

Appendix E

Water Year Ranking Based on the Historical Record of Accumulated Precipitation at Fort Jones, California

Appendix E. Water Year ranking based on the historical record of accumulated precipitation at Fort Jones, California.

Prepared by Erich Yokel – Scott River Watershed Council

The historic monthly accumulated precipitation at the USFS Ranger Station in Fort Jones California was acquired from CDEC (cdec.water.ca.gov). The accumulated precipitation (inches) from October 1 through March 31 for WY1938 to WY2020 was calculated (Figure 1). The average accumulated precipitation for three time periods was calculated: WY1938 – WY2020, WY1938 – WY2000 and WY2001 – WY2020. A significant decrease in the average precipitation was observed for the period of WY2001 to WY2020 compared to the longer period average (Table 1).

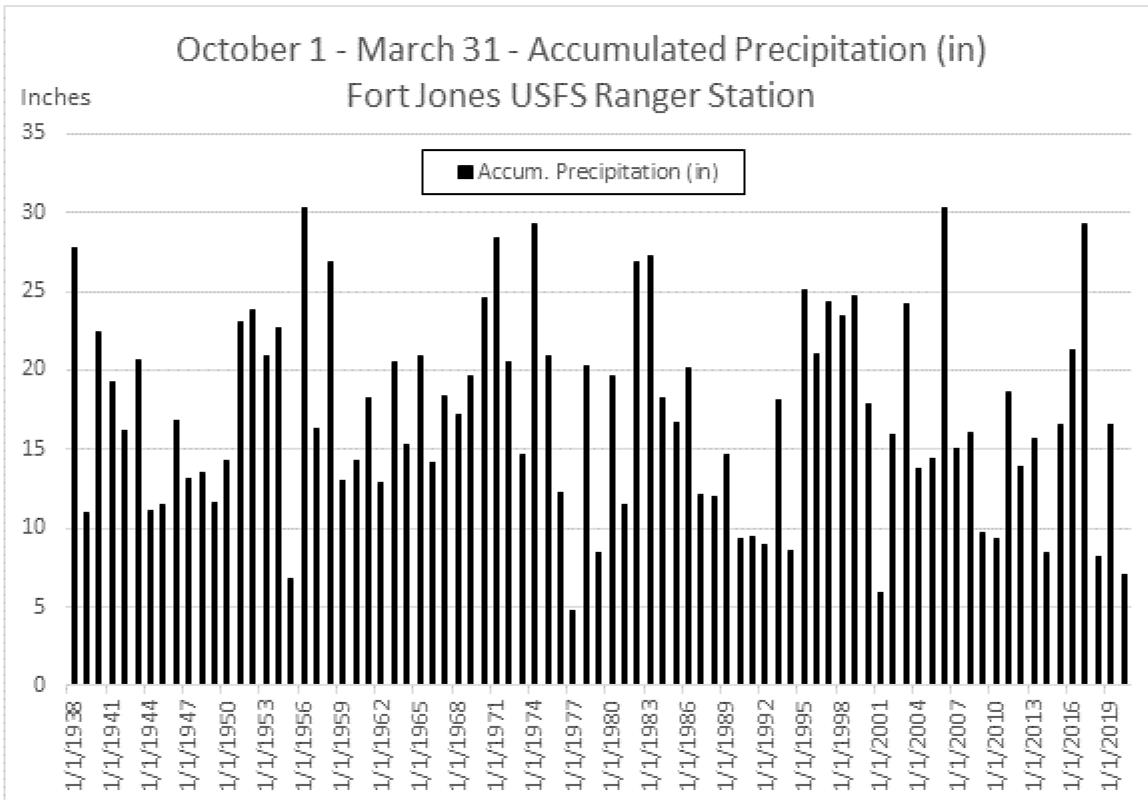


Figure 1 – Accumulated precipitation (inches) – October 1 – March 31

Average Accumulated Precipitation (in) - Fort Jones - USFS RS
October 1 - March 31

Water Years	Years	Inches
WY1938 - WY2020	83	17.2
WY1938 - WY2000	63	17.7
WY2001 - WY2020	20	15.5

Table 1 – Average accumulated precipitation (inches) – October 1 – March 31

The accumulated precipitation from October 1 – March 31 for the eighty-three (83) Water Years of record at the Fort Jones Ranger Station were ranked from the driest (Driest Rank = 1) to the wettest.

Analysis of the ten driest years of accumulated precipitation from October 1 – March 31 documents that three of the ten years have occurred since 2001 (Table 2).

Accumultated Precipitation (in) - October 1 - March 31

Water Year	Acc. Precip. (in)	Driest Rank
1977	4.78	1
2001	5.85	2
1955	6.85	3
2020	7.00	4
2018	8.12	5
1979	8.45	6
2014	8.49	7
1994	8.54	8
1992	8.98	9
1990	9.29	10
Average (83 years)	17.20	

Table 2 – October 1 – March 31 – Ten driest years of accumulated precipitation (in) – Fort Jones USFS RS

In addition to the accumulated precipitation from October 1 – March 31, the accumulated precipitation from October 1 – July 1 and from October 1 – September 30 was calculated and ranked for each Water Year.

The accumulated precipitation and April 1st snow water equivalence percent of average in the Scott River watershed for the last seven years (WY2014 – WY2020) during the period of record for the water quality data utilized for the Long Pond design considerations illustrates the different Water Year types including: multiple years of below average precipitation and snow pack (WY2018 and WY2020), the above average (Wet) WY2017 and average WY2019 (Table 3).

Water Year	Acc. Prec. (in) Oct. 1 - April 1	Dry Rank	Acc. Prec. (in) Oct. 1 - July 1	Dry Rank	Acc. Prec. (in) Oct. 1 - Sept.30	Dry Rank	April 1 Snowpack Water Equivalence % Average
WY14	8.5	7	9.8	4	12.1	5	9%
WY15	16.6	41	18.7	40	19.6	36	<1%
WY16	21.3	64	23.5	54	23.6	53	97%
WY17	29.3	81	32.3	77	33.5	79	100%
WY18	8.1	5	12.2	7	12.2	6	36%
WY19	16.6	42	19.2	41	20.8	41	134%
WY20	7.0	4	9.5	4	10.1	3	44%
Average (83 Years)	17.2	--	20.0	--	21.3		--

Table 3 – Accumulated precipitation and April 1 Snowpack water equivalence % average by WY

Appendix F

Hydrographs for Water Level Monitoring Stations and Water Level Surface Contours for Seasonal Design Conditions

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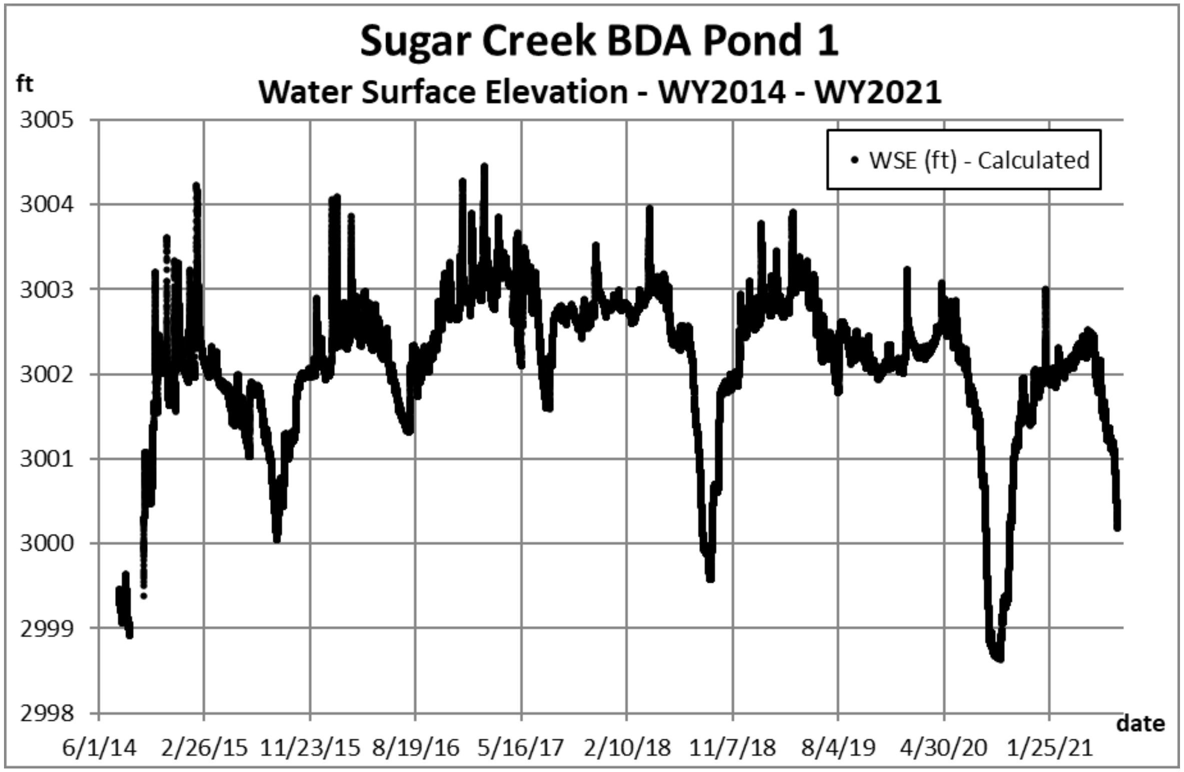

Figure F-1. Water levels recorded at logger SUMW2S.

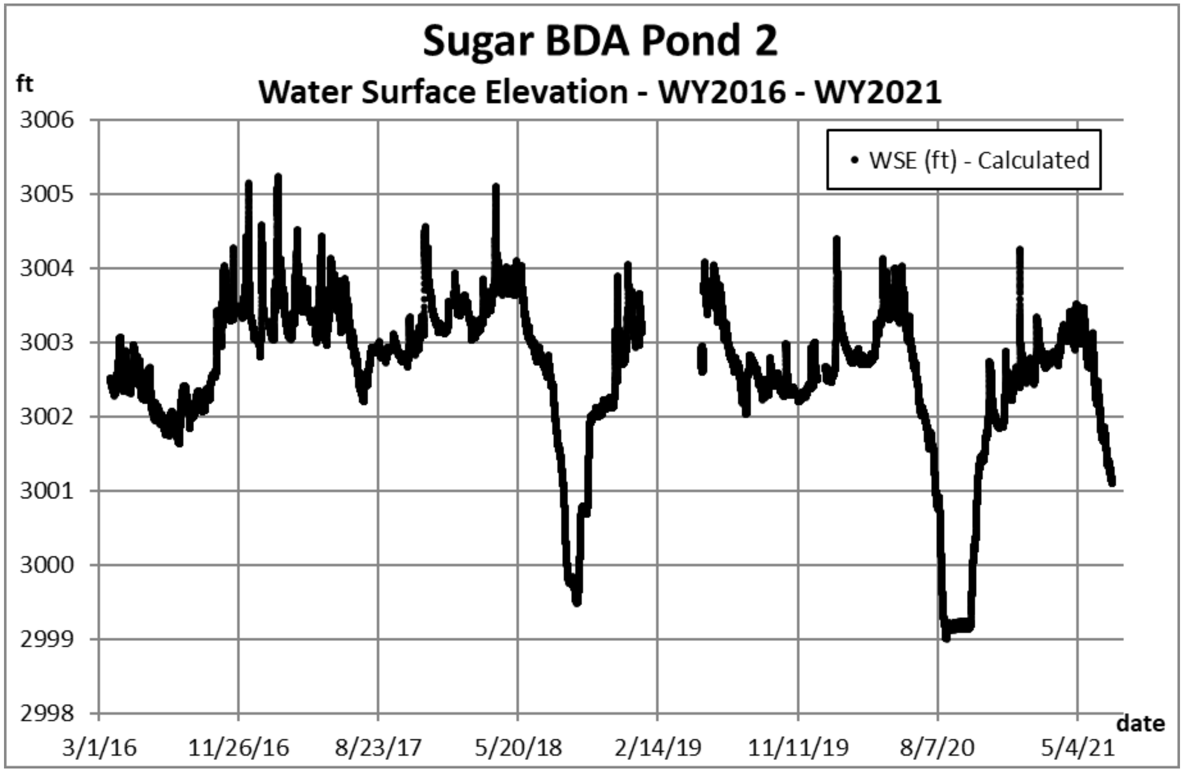

Figure F-2. Water levels recorded at logger SUMW5S.

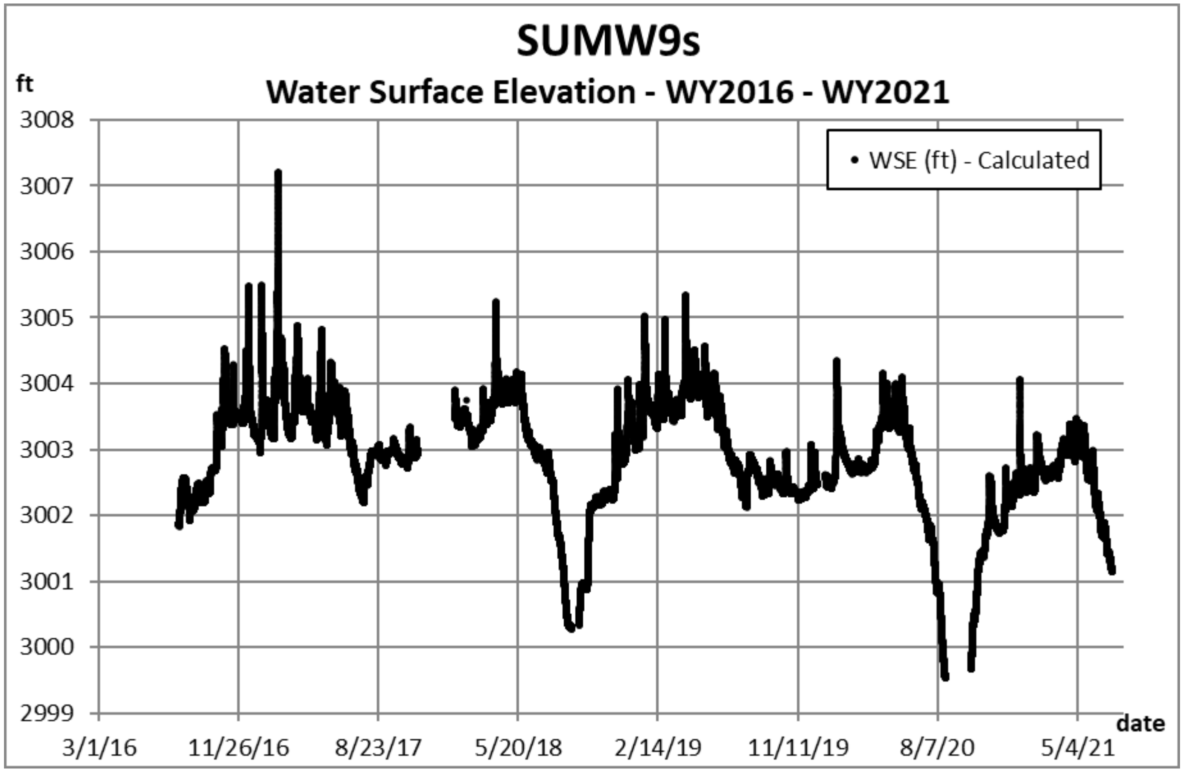

Figure F-3. Water levels recorded at logger SUMW9S.

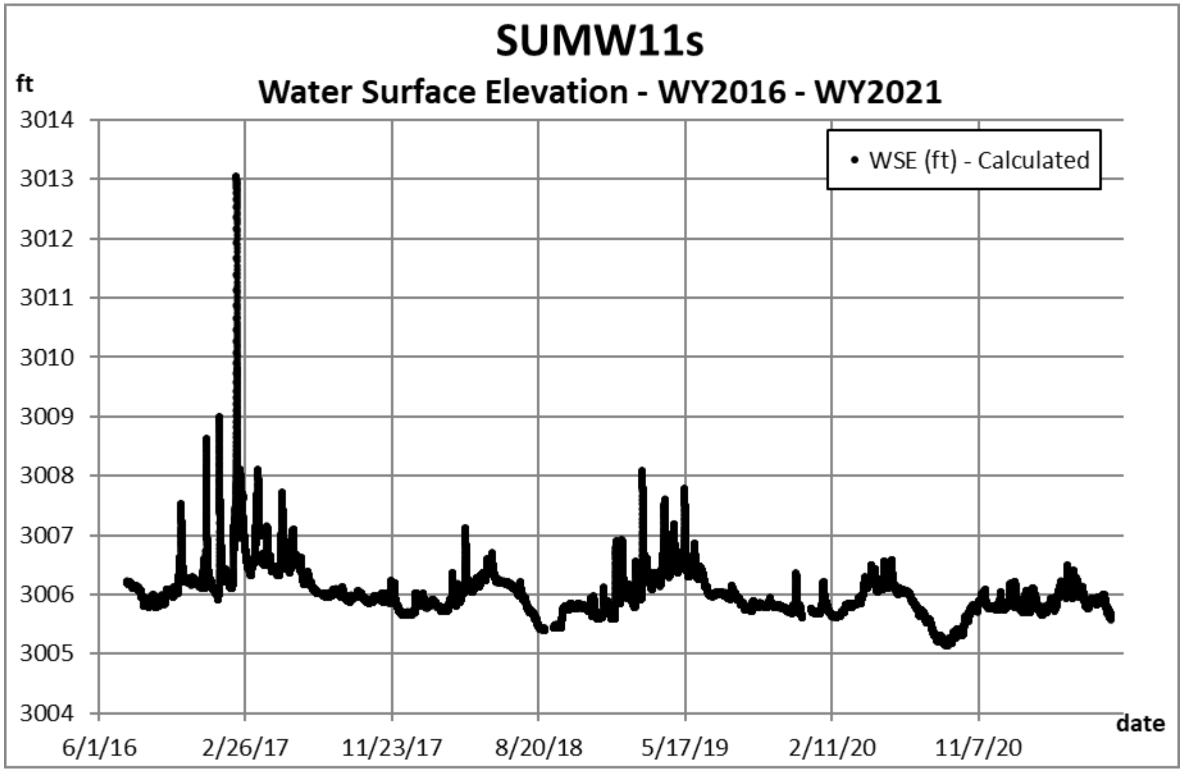

Figure F-4. Water levels recorded at logger SUMW11S.

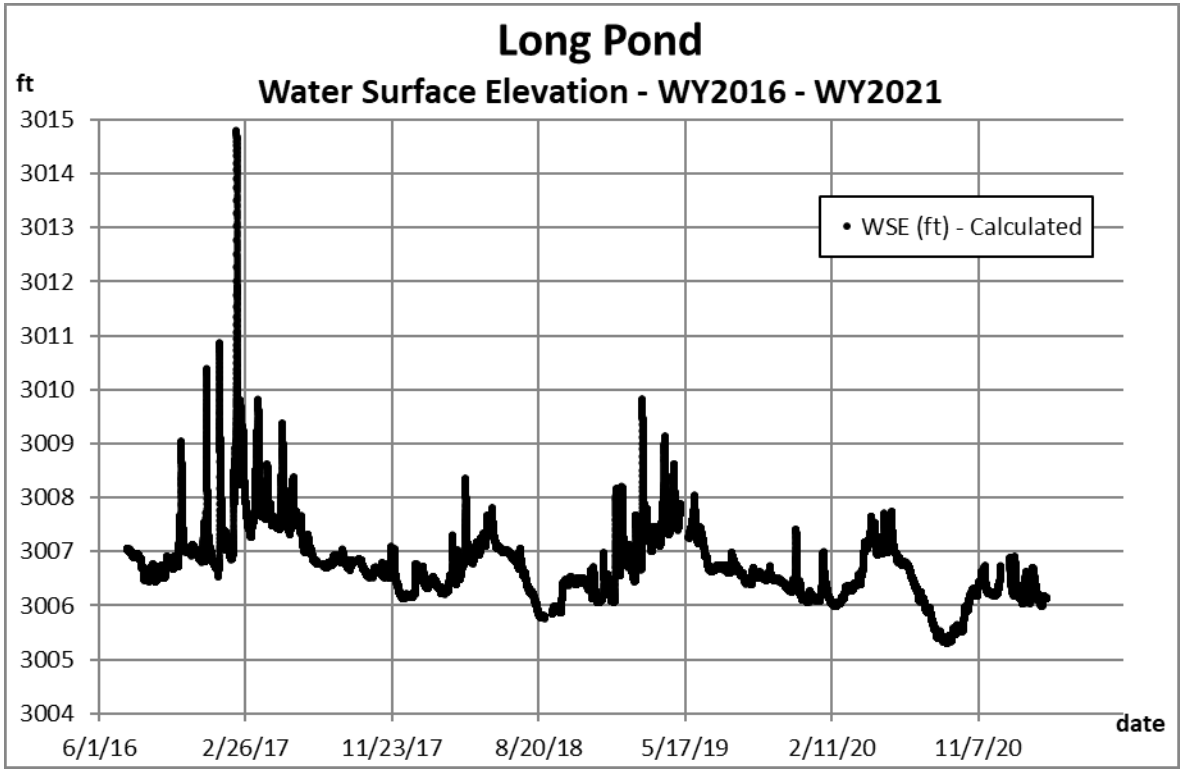

Figure F-5. Water levels recorded at logger SUMW12S.

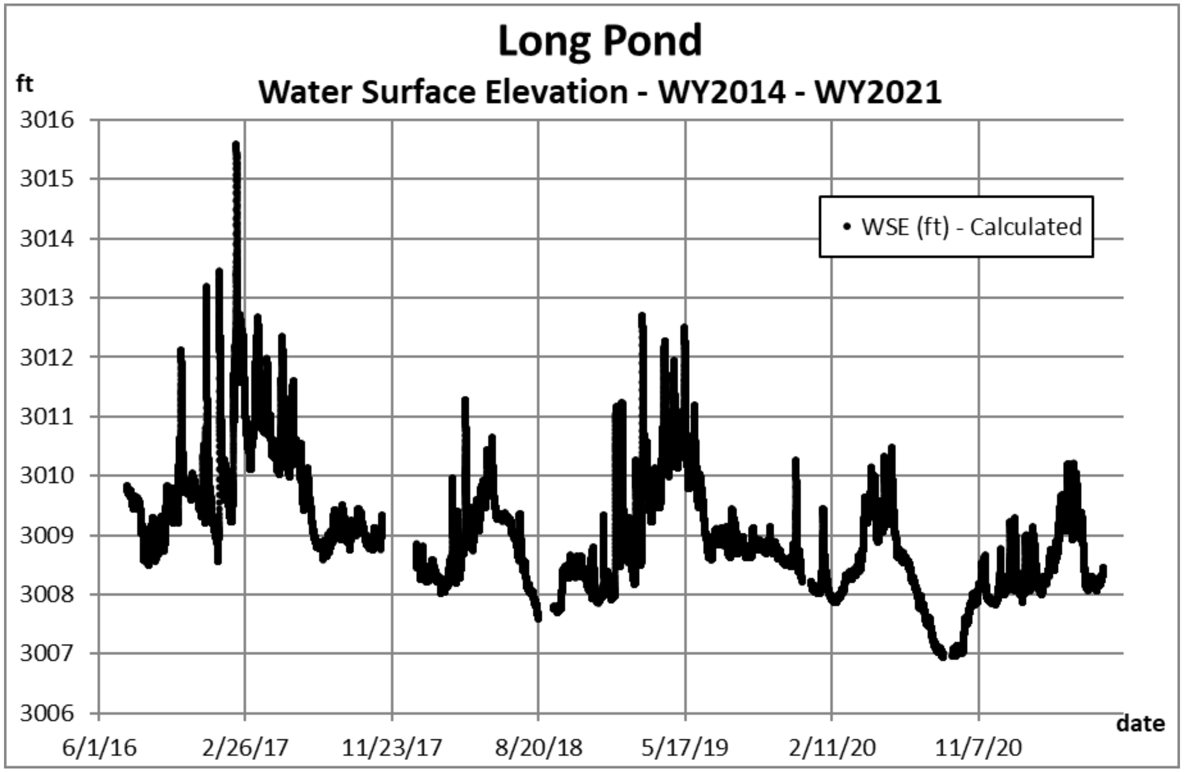

Figure F-6. Water levels recorded at logger SUMW13S.

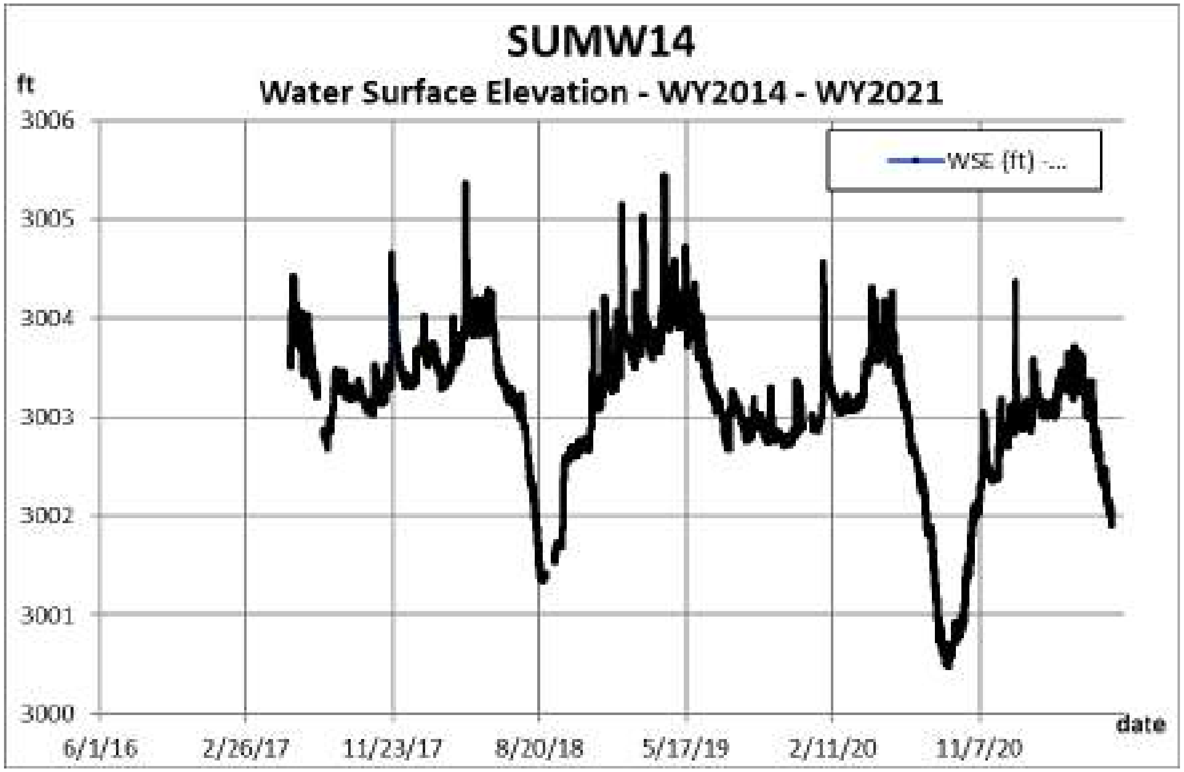

Figure F-7. Water levels recorded at logger SUMW14S.

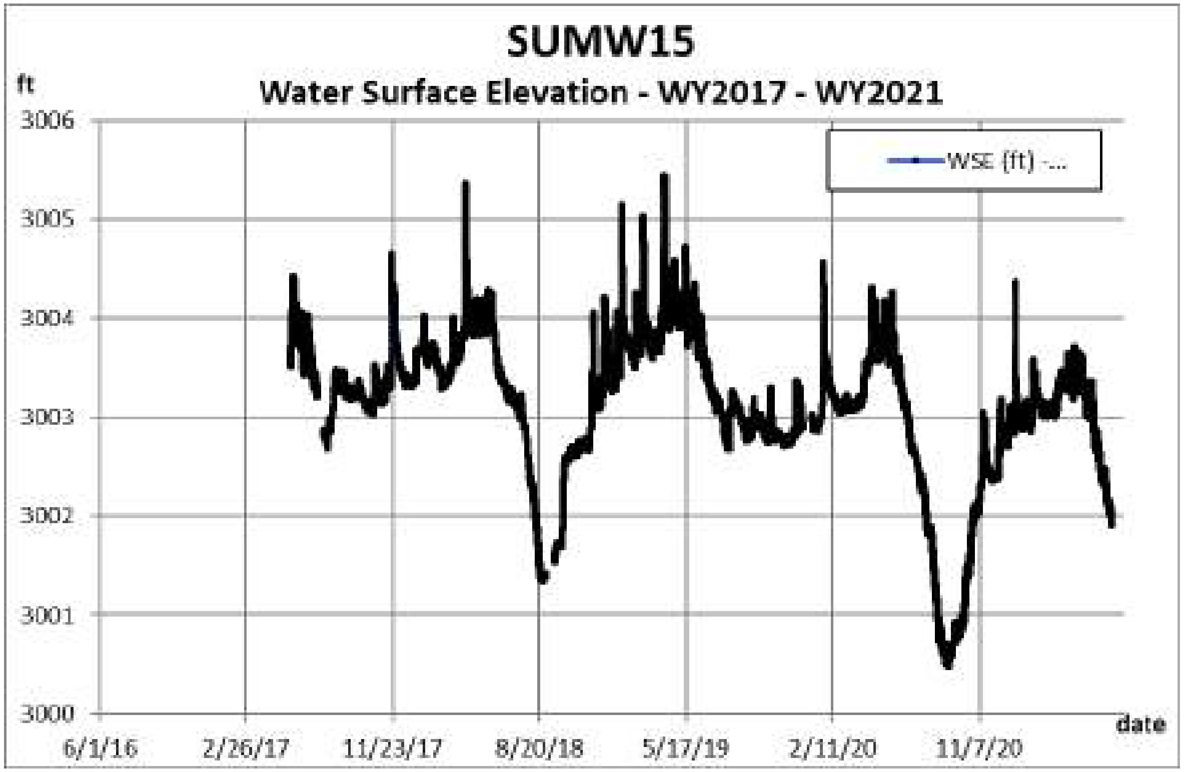

Figure F-8. Water levels recorded at logger SUMW15S.

Figure F-9. Water level surface contours shown for the 80-percent exceedance summer season design condition.

Figure F-10. Water level surface contours shown for the 50-percent exceedance winter season design condition.

Figure F-11. Water level surface contours shown for the 10-percent exceedance winter season design condition.

Appendix G

100% Design Plans
(Attached Separately)

Appendix H

Channel Sediment Conditions in Sugar Creek Downstream of State Route 3

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During the TAC meeting on 10 May 2021, the participants requested more information about sediment conditions in the Sugar Creek channel within the project reach to help inform any potential effects of channel erosion and sedimentation on the functionality and longevity of channels connecting Long Pond to Sugar Creek and the 2015 Sugar Off-Channel Habitat area. In response, the project team (1) analyzed changes in historical channel cross sections surveyed by the California Department of Transportation (CalTrans) at the State Route 3 bridge crossing of Sugar Creek, (2) evaluated changes in longitudinal profiles in Sugar Creek downstream of the State Route 3 bridge crossing, and (3) conducted a field reconnaissance of channel sediment conditions in the Project reach.

Changes in channel cross sections surveyed at the State Route 3 bridge crossing of Sugar Creek

Through a public records request to the California Department of CalTrans on 11 May 2021 (Reference # R010595-051121), Stillwater Sciences obtained historical cross section information surveyed between abutments at the upstream face of the SR 3 bridge over Sugar Creek. From construction in 1958 to 2019, CalTrans repeatedly surveyed cross sections by conducting differential measurements down from the top of the bridge deck. Stillwater Sciences used the top of deck elevation (3015.5 feet NAVD88) estimated from 2018 LiDAR to calculate channel bed elevations from the differential measurements. Pre-construction (1957) and as-built (1958) plans (including a design cross section and channel contours) provided by CalTrans were also digitized and adjusted to the NAVD88 datum.

From the cross sections, the channel appears to have aggraded about 2.5 feet from the 1958 as-built condition to the 2019 condition. The 2019 bed elevations, however, are close to the preconstruction condition in 1957 (Figure 1). Notes for most of the inspections indicate that the channel was comprised of “gravel and cobbles” or “dirt, gravel, and cobbles.” Many of the reports indicated that there were no signs of scour around the abutments, the structure was sound, and that the vertical clearance beneath the bridge was unimpaired.

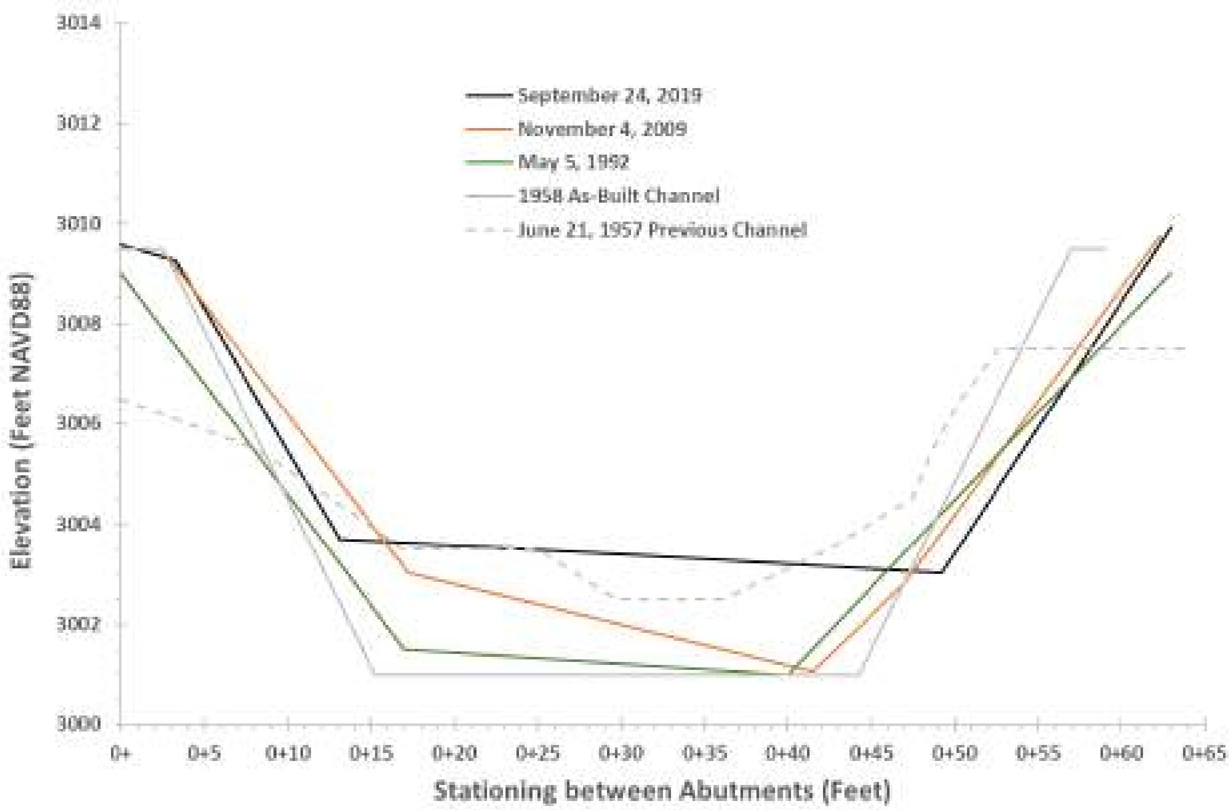

Figure H-1. Comparison of historical cross section surveys by CalTrans at the State Route 3 bridge crossing of Sugar Creek.

Comparison of longitudinal profile surveys in Sugar Creek downstream of the State Route 3 bridge crossing

Erich Yokel of the Scott River Watershed Council surveyed the Sugar Creek channel thalweg profile downstream of State Route 3 with a real-time kinematic positioning (RTK) differential global positioning system (DGPS) in 2015 and again in 2020 (Figure 2). The 2015 and 2020 longitudinal profiles were similar in length, 1,218 ft and 1,217 ft, respectively. Comparison of the two longitudinal thalweg profiles indicates minor aggradation (<1 foot) of predominantly sand in the reach between the State Route 3 bridge and the natural beaver dam (i.e., in the backwater pool and upstream riffle crest) (Figure 3). Downstream of the natural beaver dam, there appears to have been little change in thalweg elevations at pools or at riffle crests from 2015 to 2020. Channel degradation downstream of BDA 2 is apparent in the surveys, resulting from partial failure of the BDA structure during high flow. Downstream of approximately STA 825, minor aggradation (<1 foot) occurs within dense cattails. Comparison of longitudinal profiles suggests much of the sediment flux into the reach is trapped by the first natural beaver dam obstruction or transported downstream of the proposed Long Pond outlet connection points.

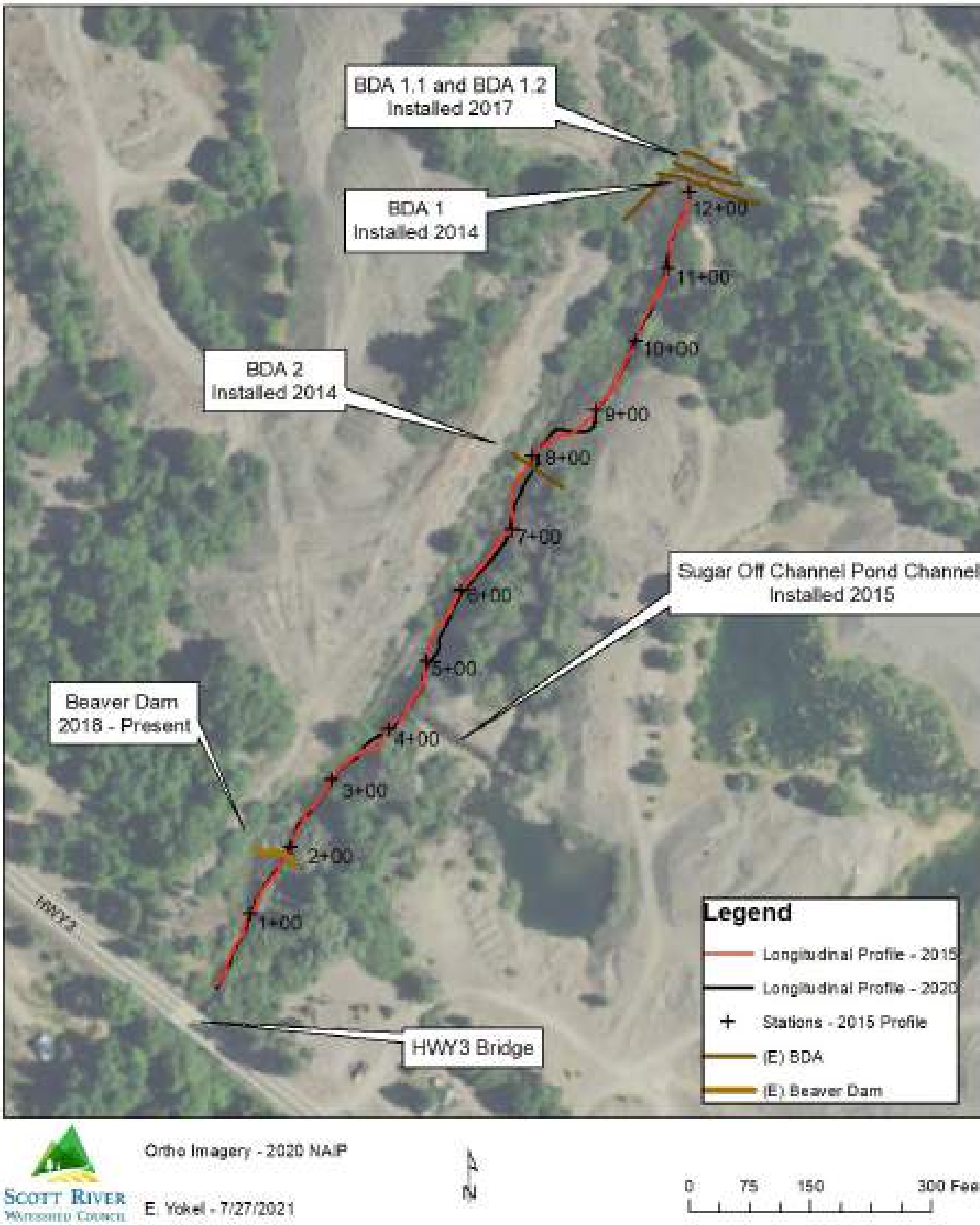

Figure H-2. Plan view of Sugar Creek longitudinal thalweg profile surveys in 2015 and 2020.

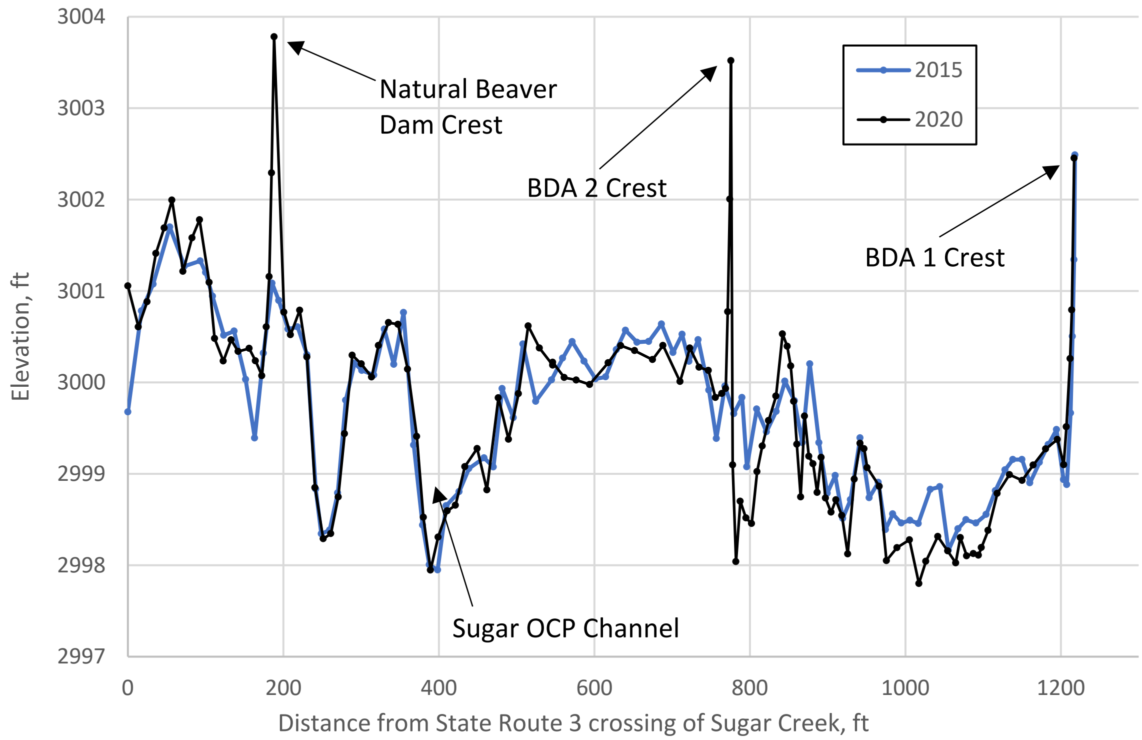

Figure H-3. Sugar Creek Longitudinal thalweg profile surveys in 2015 and 2020.

Field Reconnaissance of Sugar Creek channel sediment conditions in the Project reach

A field reconnaissance of sediment conditions in the Sugar Creek channel was conducted on 9 July 2021 from the State Route 3 bridge crossing downstream to the outlet channel from the 2015 Sugar Off-Channel Habitat area. The Sugar Creek channel bed at the upstream face of the State Route 3 bridge crossing was comprised of gravel and sand, with a prominent midchannel bar that separated flow between the main channel and a left bank backwater area (Figure 4). More significant sand deposits occurred underneath the bridge (Figure 5). Substrate in the downstream pool was a sandy veneer overlying coarser material at depth that could be felt underfoot (Figure 6). The left bank floodplain, upstream of the recently constructing left bank floodplain project, was covered with sand deposits (Figure 7). The outlet channel from the 2015 Sugar Off-Channel Habitat area was comprised of cobble and gravel, transitioning to organic deposits and sand further out into the Sugar Creek channel beyond the outlet connection (Figure 8).

Figure H-4. Sugar Creek channel bed immediately upstream of the State Route 3 bridge crossing.

Figure H-5. Sugar Creek channel bed underneath the State Route 3 bridge crossing.

Figure H-6. Sugar creek pool downstream of the State Route 3 bridge crossing.

Figure H-7. Sand deposits on left bank floodplain of Sugar Creek upstream of the constructed floodplain.

Figure H-8. Outlet channel to the 2015 Sugar Off-Channel Habitat area.

Summary

Analysis of historical channel cross section changes at the State Route 3 bridge crossing of Sugar Creek, changes in longitudinal profiles downstream of the State Route 3 bridge crossing, and field reconnaissance of channel sediment conditions in the Project reach indicate a relatively abundant supply of sand to lower Sugar Creek. A modest amount of bed elevation change related to sand deposition has occurred in the upstream portion of the project reach associated with local hydraulics at the State Route 3 bridge crossing, backwatering behind the natural beaver dam, and floodplain inundation on the downstream left bank. Little change in bed elevation due to sand deposition, however, is apparent in the main Sugar Creek channel downstream of the natural beaver dam and in the vicinity of the outlet from the 2015 Sugar Off-Channel Habitat area. These results suggest much of the sand and fine gravel flux into the reach is trapped by the first natural beaver dam obstruction, deposited on floodplains, and/or transported downstream of the proposed Long Pond connection points.

Appendix I

Construction Specifications

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1 GENERAL

The Contractor shall take all reasonable precautions to restrict their operations to the least area of work possible and shall not disturb private property beyond the areas of work. The Contractor shall make every effort to minimize their work area and keep the construction area clean and free of all excess trash, debris, pollutants, and dust at all times.

The Contractor shall be cognizant if the project involves work within the County road right of way or adjacent to private property. The Contractor shall not use or access the project site through private property without submitting written approval from the property owners to the Engineer or Geologist. Access to the creek shall be graded per the Design Plans. Unless otherwise indicated by the Design Plans or directed by the CAR, all trees shall be protected in place. The Contractor shall notify the CAR a minimum of one week prior to commencement of work.

The Contractor shall keep driveway access open at all times. Before existing site road closure or demolition, Contractor shall notify the CAR a minimum of 7 calendar days in advance of the roads and duration of closure. The Contractor shall provide all necessary signage and barricades to safely close roads, restrict access, and otherwise re-route existing site traffic. The closure area shall be barricaded at all times in order to protect the public from any open trenches.

Normal working hours for the work site shall not be earlier than 8:00 a.m. or later than 5:00 p.m. weekdays, unless otherwise approved by the Engineer or Geologist.

The Contractor shall not obstruct existing site road access without prior approval of closure for the purpose of temporary equipment and materials staging. The Contractor shall provide any additional equipment or material staging areas at their own expense. All staging and disturbed areas shall be restored per the Design Plans and specified seed mix listed herein and installation of erosion control per the approval of the Engineer or Geologist.

Any damage or use of private property, non-county-maintained road, or facility is the responsibility of the Contractor. The Contractor shall be responsible for any damage to existing utilities, adjacent roads, or property caused by their activities; and shall also use suitably sized equipment to prevent such damage.

Debris, soil, silt, bark, trash, 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 project-related activities, shall be prevented from contaminating the soil and/or entering public waters. Any of these materials, placed within or where they may enter a stream, by the Contractor or any party working under contract, or with permission of the applicant, shall be removed immediately. During project activities, all trash and food waste that may attract potential predators of salmonids will be properly contained, removed from the work site, and disposed of daily.

Dimensions noted on the Design Plans take precedent over scale.

1.1 Order of Work/Progress Schedule

Construction work for the site shall not commence until all materials are available.

The Contractor shall prepare and submit a Project Work Plan and Progress Schedule in a form provided by or acceptable to the Engineer or Geologist. The Project Work Plan and Progress Schedule shall clearly disclose the Contractor's proposed procedures and methods of operation, including identifying any special equipment intended for use on the project. The Contractor shall allow 5 working days for review and approval of this item by the Engineer or Geologist. The Contractor shall maintain the Progress Schedule weekly and provide revisions for review and approval by the CAR, and Engineer or Geologist. Contractor submitted modifications to the Progress Schedule will not constitute approval for a work schedule extension.

No work may begin under the contract until the Engineer or Geologist has approved the Progress Schedule. Time required for review and approval of these items shall not constitute a basis for time extension.

Full compensation for complying with these provisions shall be considered as included in the contract price paid for various items and no separate payment shall be made.

2 EXISTING FACILITIES

2.1 General

If the Contractor requires overhead power lines to be de-energized in order to facilitate work, the Contractor shall notify the power utility as soon as possible with the expectation of 2-3 weeks to de-energize lines.

Existing utility poles, communication, and telephone lines shall be protected in place during construction. If the contractor requires utilities to support the pole or lines during construction, the Contractor shall coordinate with relevant utilities prior to construction activities.

It is not the intent of the Design Plans to show the exact location of existing or relocated utilities, and the Engineer or Geologist assumes no responsibility therein. Whenever any such utilities are indicated therein, the Contractor shall be responsible for verifying their actual location and depth in the field. The Contractor shall notify the appropriate Underground Service Alert (USA) for their location 48 hours prior to excavation.

Where excavations are performed in the vicinity of underground utility services the Contractor shall, as necessary, perform initial exploratory excavations (e.g., potholing) to determine their exact depth and location. Payment for exploratory excavation shall be included in the various items of work needed to complete the excavation work.

Extreme care shall be exercised to avoid damage, and it will be the Contractor's responsibility to have repairs made to existing facilities at their expense in the event of damage. Where existing utilities require temporary or permanent relocation to accommodate proposed work the Contractor will work with the utilities to provide a minimum of interruption to local service.

Full compensation for complying with the above provisions shall be considered as included in the contract price for the various bid items and no separate payment will be made.

3 CONSTRUCTION STAKING

3.1 General

The CAR shall provide construction staking for the project. If it is desired that the Engineer conduct the staking, the Contractor shall submit a survey request to the Engineer at the preconstruction meeting. The Contractor shall notify the Engineer 10 working days in advance of when construction stakes will be required.

Any undue destruction of stakes by the Contractor shall constitute cause to hold the Contractor liable for the cost of re-staking and said cost shall be deducted from any monies due the Contractor.

Full compensation for complying with the above provisions shall be considered as included in the contract price for the various bid items and no separate payment will be made.

4 CLEARING AND GRUBBING

4.1 General

Clearing and grubbing, especially with concern for existing native vegetation, shall be limited to the minimum extent practicable to those areas actually affected by the planned construction, and for access as shown on the Design Plans. No other access shall be allowed unless otherwise approved by the Engineer or Geologist, and written approval is obtained from the property owner if desired access goes over private property.

Clearing and grubbing shall include, but not be limited to the following:

- Contractor shall salvage and stockpile for on-site reuse the upper soil layer and all woody vegetation per the direction of the CAR. Stockpiled soil and woody vegetation shall be incorporated into soil amendments and otherwise used to top dress finished ground surfaces.
- Removal of concrete, wooden debris, metal debris, abandoned pipe or other type of piping as encountered during the excavation.
- The Contractor may remove portions of abandoned utilities that are in conflict with project construction. Prior to such removal, the Contractor shall verify with the applicable utility entity that the subject facility is abandoned.
- Remove trees that are in conflict with the design as indicated on the Design Plans and that have been marked by the CAR for removal. Existing trees not marked for removal shall be protected in place.
- Protected trees may require trimming/limbing to accommodate equipment movement within the project limits. Tree trimming will be limited to the minimum amount necessary. Contractor shall not trim or limb trees without prior CAR approval. The Contractor shall protect the tree root systems for trees in the proximity of construction and make every effort to modify their operation to not jeopardize the health of the trees by not operating equipment within the tree dripline.
- Remove roots as necessary that interfere with the work being performed within the project limits (e.g., rock structure placement and excavation for new channel).

- Remove any debris, existing signs, or facilities that are in conflict with the proposed work and all other items conflicting with the work as shown on the Design Plans as necessary to accommodate construction operations, or as directed by the Engineer or Geologist.
- All removed materials, unless otherwise indicated on the Design Plans and specified herein, shall become the property of the Contractor and disposed of outside the road right-of-way at a legal dumpsite.

Full compensation for complying with the above provisions shall be considered as included in the contract price for the various bid items and no separate payment will be made.

5 EARTHWORK

5.1 General

This section includes excavation, site preparation and grading, fill placement, compaction, rough grading, and finish grading to the lines and grades shown on the Design Plans and as directed by the Engineer of Geologist.

Earthwork shall consist of performing all operations necessary to excavate and fill all materials, regardless of character and subsurface conditions per the Design Plans. Earthwork shall also include hauling and compacting of earthen materials, and the creation and removal of any necessary access ramps within roadways or stream channels, as shown on the Design Plans or otherwise necessary to establish the finished grade.

Earthwork includes channel realignment, crossing removal and replacement, floodplain excavation, as well as trenching and backfill for large wood structures. Cross sections are shown on the Design Plans to illustrate the intent, but grading may also be adjusted in the field as directed by the Engineer or Geologist.

5.2 Soil Amendments

Soil amendment materials listed on the Design Plans shall be Shasta Forest Products or Rogue Biochar™ or Engineer approved equivalent. Contractor shall provide a minimum 1 gallon bucket sample for soil amendment materials and associated vendor specification and technical documentation for CAR approval a minimum of 10 working days prior to proposed bulk material delivery. Mix soil amendments thoroughly and per vendor's recommendations to achieve a consistent and homogenous matrix to support native plant and seed establishment. Stabilize stockpiled soil amendment materials to prevent erosion and loss of material.

5.3 Rough Grading

Although encountering bedrock is not expected at the work site, the Contractor shall notify the CAR and adjust the grading as directed.

The Contractor shall excavate unsuitable subgrade below the lower limits of excavation as shown on the Design Plans, only when directed by the Engineer or Geologist. If this is necessary, the Contractor shall replace the excavated area below lower limits of excavation with structurally suitable material as directed by the Engineer or Geologist.

All excess excavated material as well as unsuitable and/or oversized native material which cannot be used for backfill purposes shall be placed in fill areas shown on the Design Plans or as otherwise directed. No extra or separate payment will be made for stockpiling or re-handling of any material.

5.4 Finish Grading

The Contractor shall fine grade all channel slopes to eliminate rough or low areas and maintain channel slope and all levels, profiles, and contours of subgrade. Grades at work areas shall conform to the Design Plans. Depressed or mounded surfaces shall not be accepted. Finished grades are to be within 0.2 feet of the elevation shown on the Design Plans. Finish each area to present a neat and uniform appearance satisfactory to the Engineer or Geologist.

Grades not otherwise indicated shall be uniform levels (1% minimum) or slopes between points where elevations are given. Finished grades shall be smooth, even, and on a uniform plane with no abrupt change of surface.

All finish grades shall provide for positive runoff to the creek channel without low spots or pockets of water ponding more than 2 inches in depth. The Engineer or Geologist shall inspect final grades prior to completing work.

Whenever reference to finish grade is made, it shall be considered to be the finished surface of graded channel embankments and/or any completed channel stabilization features (e.g., crossings, large wood habitat features, excavations, and etc.) as shown on the Design Plans.

Tolerances for finished grading shall be ±0.2 feet vertical and ±0.5 feet horizontal, unless otherwise specified in the Design Plans or by the Engineer or Geologist.

5.5 Erosion Prevention and Sediment Control

The Contractor shall employ best management practices (BMPs) to prevent erosion and control sediment, as described in the current California Stormwater BMP handbook for construction. Upon the completion of the site grading, all disturbed surfaces shall be treated in order to prevent erosion. Erosion control measures will be installed as shown on the Design Plans or per the Contractor submitted and approved Erosion and Sediment Control Plan. BMPs shall cover all disturbed and or graded surfaces, with the exception of river or stream bed. At a minimum, the following best management practices shall be implemented:

- Erosion and sediment control BMPs shall be installed prior to the wet season (1 October through 30 April).
- Sensitive areas and areas where existing vegetation is being preserved for erosion control objectives shall be protected with construction fencing; fencing shall be maintained throughout construction activities.
- All areas disturbed during grading activities shall be planted and seeded per the Design Plans.
- Prior to planting and seeding, disturbed areas should be roughened by track walking.
- All sediment control BMPs shall be maintained throughout the wet season until new vegetation has become established on all graded areas.

5.6 Temporary Access Features

The Contractor shall be entirely responsible and liable for stability and safety of all temporary access features. Prior to mobilization of construction equipment, the contractor shall provide the CAR with a Staging Area and Safety Plan that details the locations, materials, and methods for contractor proposed temporary access and staging routes, as well as describe emergency situation and vehicle access protocols. The Engineer or Geologist should be informed of any discrepancies on the Design Plans or other stability or safety concerns. The Contractor shall stay within specifically designated limits of work and access routes, as shown on the Design Plans. The Engineer or Geologist should be notified if any existing tree roots or existing geomorphological features, not noted on the Design Plans, will be impacted by temporary access features or construction equipment. Existing tree roots on banks should be preserved and protected by material specified by the Engineer or Geologist.

Temporary access features shall be composed of clean gravel installed in channels as shown on the Design Plans. Sites requiring dewatering shall be dewatered prior to installation of temporary access features unless otherwise noted on the Design Plans. Channel beds shall be thoroughly checked for structural stability to bear loads of construction equipment. Gravel ramps shall be entirely removed upon completion of project. Some temporary access features can be graded into the channel bed upon project completion if substrate size is suitable. If this option is not noted on the Design Plans, the Engineer or Geologist must be informed and provide approval before the beginning of project work; and gravel quality must be approved by the Engineer or Geologist.

5.7 Measurement

Earthwork quantities have been measured based on grading in AutoCAD using the limits shown on the Design Plans. Earthwork quantities are final, but may be adjusted in the field, as needed, under the direction of the Engineer or Geologist.

Reconstruction of engineered embankment fill using suitable native excavated material will not be measured or paid for. Excavation for habitat features (e.g., large wood habitat features, nurse logs, brush trenches, roughened channels, soil amendments, and etc.) or any other construction features is considered incidental to the construction of the feature will not be measured or paid for separately.

5.8 Payment

The price paid per cubic yard for earthwork shall be for the quantities stated in the Engineer's Cost Estimate and no additional payment will be made unless the dimensions, as shown on the Design Plans, are changed by the Engineer. Payment for earthwork, complete in place, will be made at the cubic yard price bid for earthwork as set forth on the bidding sheet.

The cubic yard price bid for earthwork shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all work involved in excavating, backfilling, compacting to the specified relative compaction, furnishing water necessary to moisten, place or otherwise aid in backfilling and compaction operation, stockpiling and moving excavated material regardless of number of times, rough and finish grading, and off-hauling of surplus material, complete in place, as shown on the Design Plans, as specified herein, and as directed by the Engineer or Geologist.

No separate payment for excavation necessary for temporary diversion or control of water shall be made. Payment for such excavation shall be considered included in the price bid for dewatering.

The cost of excavation and backfill below finish grade elevations for any individual channel enhancement or stabilization features shall be included in the individual cost of the various channel enhancement and stabilization features.

6 SITE DEWATERING AND AQUATIC SPECIES RELOCATION

6.1 General

The work site shall be dewatered, to the Engineer's or Geologist's satisfaction, to provide working conditions free of detrimental water, prior to the start of any construction. The amount of flow in the project area may fluctuate. This variance can be attributed to, but not limited to, storms, domestic runoff, irrigation practices upstream, etc. Although surface flow is not expected in the creek reach during construction, groundwater may be encountered.

The Contractor shall develop and submit a dewatering plan for dewatering the project site, even if the creek is dry, in the event of encountering groundwater, rain, other upstream discharge to the creek. The dewatering plan shall be approved by the Engineer or Geologist prior to beginning work.

The Contractor shall maintain the work site in a dewatered condition. No work shall begin until the dewatering system has been installed and such installation has been approved by the Engineer or Geologist.

The Contractor shall not lay claim against the Project Proponent for damages by surface and/or groundwater flows to their work, property, or materials. The Contractor shall comply with all applicable laws, statutes, and permit provisions with regards to their dewatering system.

The dewatering system shall be maintained by the contractor until all construction is completed.

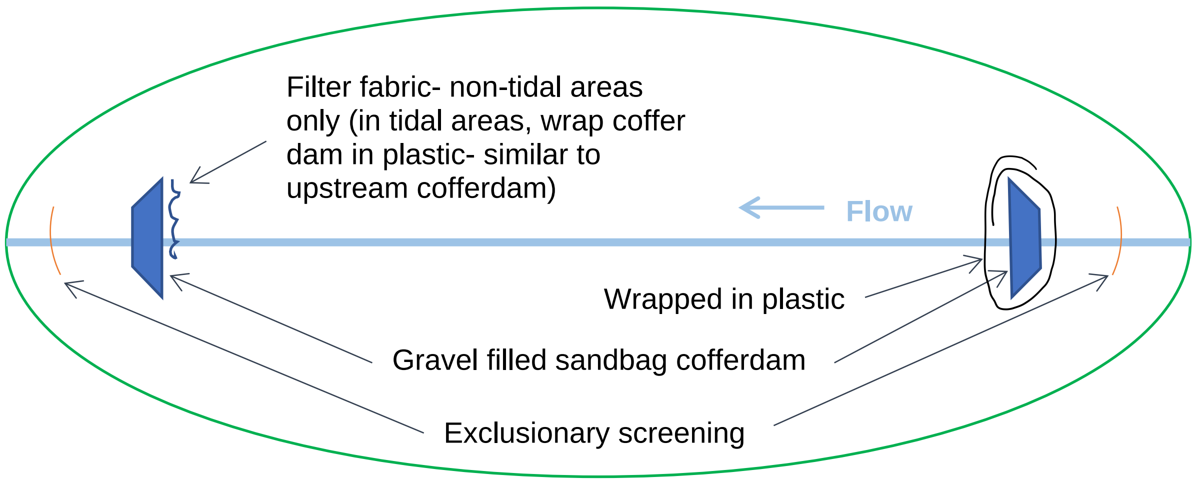
The dewatering system shall not be removed until authorized by the Engineer or Geologist.

Although surface flow in the creek reach is not expected during construction, if it is encountered, site dewatering work shall preferentially be performed on one reach at a time to ensure adequate time to thoroughly relocate the aquatic species within each project reach, dewater the individual reach and perform project construction and/or remove sediment, per the Design Plans, thereby creating a less significant impact to the overall length of the reach at any one time. An approved, qualified biologist shall coordinate timing on when to begin dewatering and sediment removal within each reach as each reach is isolated, and species sufficiently removed and relocated prior to starting work in the next reach.

The dewatering process typically includes the following steps (see figure below):

- Install exclusionary screening across channel upstream of location for upper cofferdam.
- Install exclusionary screening across channel downstream of location for lower cofferdam in this reach.

- Biologists seine low-flow channel and any pools between exclusionary screens to capture and relocate native freshwater fish and shall continue until as many fish as possible have been captured and relocated from the reach. Portable pumps shall be used as needed to complete dewatering of any pools.
- When biologists have completed fish relocation efforts, they will authorize installation of the cofferdams, to be installed just inside the exclusionary screening at the upstream and downstream limits of the reach.
- After cofferdams have been installed, further dewatering will occur (if necessary).
- After dewatering, construction and/or sediment removal may proceed.
- Removal of cofferdams and exclusionary screening.
- Complete any grading and install erosion control, and plantings as needed.



6.2 Project Biologist

To avoid conflicts the Contractor's work shall be coordinated with any work performed by biologists associated with fish relocation activities. Fish relocation activities must be completed by a qualified fish biologist, experienced with fish capture and handling.

A CDFW-approved "Qualified Biologist" will direct the native fish capture and relocation efforts, along with a team of their and the Engineer's or Geologist's choosing. Biologists shall have appropriate permits from CDFW (SC-806) and NMFS (1045-1) to capture and handle listed salmonids and other aquatic species, and shall, ideally, have experience performing this task in multiple other similar reaches. Biologists shall follow CDFW and NMFS guidelines and notify these agencies at least one week prior to beginning of fish capture activities.

6.3 Exclusionary Screening

Prior to fish removal, installing cofferdams, and dewatering, exclusionary screens shall be securely installed at the downstream and upstream work limits as shown on the Design Plans. Exclusionary netting shall be a fine mesh block net placed across the full wetted channel of the creeks within each individual reach to assist in isolating individual areas for more thorough fish capture by the Biologist.

All fish screens, including exclusionary netting, shall have openings no larger than 3/32 inch in diameter (or diagonally if rectangular) and shall comply with CDFW/NMFS screening criteria for salmonids. When used to screen intakes on portable pumps, the screen shall be in the form of a basket of sufficient size to comply with CDFW/NMFS criteria for water velocity across the screen face, in order to not entrain fish and cause them to be impinged against the screen.

Exclusionary screening may also be installed where the biologist determines the downstream limit of fresh-water fish capture should be. In this case, the Biologist will determine an appropriate location for the lower limit of freshwater aquatic species, and exclusionary screening will be placed across the channel in this location. Fish capture and relocation downstream of the limit of active freshwater fish capture will be per the recommendation of the Biologist.

The Biologist shall determine exact locations for exclusionary screening and netting in the field sufficient to minimize the length of creek that will require fish relocation and at the same time that adequately relocate fish that could be impacted by the planned work. The fish capture should begin only when the exclusionary screens and nets are in place for each reach.

6.4 Fish Salvage and Relocation

The Contractor shall coordinate with and provide assistance to the Project Proponent and the qualified project fisheries biologist to relocate any fish occupying the pools remaining throughout the project reach prior to start of work. The Contractor shall contact the Engineer or Geologist a minimum of one week prior to dewatering to arrange the specific day for this work to occur.

The Biologist shall walk through the upstream reaches of the project to identify pools, undercut areas, or other locations where native fish are more likely to be found. The Biologist shall also attempt to verify that native fish smolts appear to have emigrated, so only juveniles are expected. During this walkthrough the Biologist shall also direct the appropriate party to remove overhanging and in-stream vegetation that could interfere with fish removal efforts.

At least one “designated driver” will be constantly transporting buckets and/or tubs of fish to the relocation sites while a crew of “fishers” will assist the biologists in collecting fish with dip nets and seines. Fish will be relocated within 30 minutes of capture or less at the discretion of the Biologist. Designated drivers will handle the buckets/tubs in which fish will be transported carefully in order to avoid sloshing and minimize stress and injury to the relocated aquatic species. During transit, the designated driver will travel slowly and smoothly while another crewmember monitors the containers. After confirming that water temperature in the containers is within 2-3 degrees of ambient stream temperature at the relocation site, the buckets and tubs will be lowered slowly into the pools at the relocation sites, and not dumped. If there is a thermal difference of more than 2–3 degrees, stream water will gradually be mixed with the water in the containers over a few minutes time, to allow the fish to acclimate to the ambient stream water temperature before they are released.

The designated drivers shall use direct routes to the relocation sites to minimize the time that aquatic species will spend in transit. Sites shall, if possible, have easy and short access from the work site, expediting the fish relocation process. All relocation sites should be, if possible, either downstream of the project dewatering boundaries and areas of dewatering impact. Fresh water species shall be relocated to suitable freshwater habitat downstream of the project area. The Biologist shall inspect the sites before fish relocation begins. Fish shall not be relocated to any pools that do not also have good in-stream shelter for the fish (e.g., boulders, undercut ledges, rootwads, vegetation, etc.).

Multiple relocation sites shall be used, where feasible, in order to reduce competition for resources with resident fish and the sites shall be spaced far enough apart to facilitate fish dispersal. The buckets/tubs shall be filled with clean, clear water from the stream near where those fish are removed and shall be continuously aerated during fish capture to ensure dissolved oxygen concentration is near saturation. The buckets/tubs shall be large enough and contain small enough numbers of fish to avoid overcrowding. Steelhead shall be placed in insulated buckets (3-gal., covered bait buckets or in larger insulated coolers) and segregated by size classes and from all other species. To minimize stress and injury to the fish, waterlogged leaves or twigs may be added to the containers to provide shelter (and to reduce sloshing during transport). Toxic vegetation and most other live vegetation shall not be placed in the containers.

Wading gear and all equipment brought to the site shall be sterilized prior to entering the water according to CDFW's Aquatic Invasive Species Disinfection/Decontamination Protocols. Formula 409 disinfectant shall not be used. Gear shall be sterilized again at the end of each workday or before it is used in a different body of water.

Water temperatures shall be monitored with thermometers to ensure that water in the buckets/tubs are at or below water temperatures in the creek where the fish were collected. If necessary, sealed bags of ice may be floated in each container. All fish buckets/tubs will be kept in quiet, still, shaded areas and fish will be held in these containers for a minimal amount of time per the discretion of the Biologist.

Capture nets shall be made of non-abrasive, soft, knotless nylon and the mesh shall be small enough (1/8-3/16th-inch) to capture the smallest juveniles or fry encountered. As many as possible of the native fish encountered shall be captured and relocated, although it is not always feasible to capture all of the smallest (<0.5-inch) fry of native species potentially present. The seines, dip nets, crewmembers' hands, and all other materials/equipment used shall be washed with stream water and remain wetted prior to any contact with aquatic species and shall be free of any substances such as hand sanitizer, sunscreen, and insect repellent.

Portable pumps shall be used as needed to lower water surface elevations in isolated pools to increase fish capture efficiency. As water levels are brought down, fish are forced to leave hiding places and move to the center of the channel where they can be captured more easily. Pump intakes shall be screened per NMFS criteria for anadromous salmonids having openings no larger than 3/32 inches in diameter (or diagonally if rectangular). One two-inch portable pump and one three-inch portable pump, or as needed for the project area, shall be on hand to lower water surface elevations in pools during fish relocation. The appropriate size pump shall be selected based on the size of the pool to be dewatered. This water should be pumped downstream of the reach being dewatered as long as it is clean and clear of sediment. Otherwise, it should be pumped and discharged above and beyond the top of bank where it may diffusely infiltrate into the surrounding vegetation and soils.

Captured species shall be identified and counted, except for extremely abundant species, as determined by the Biologist. Non-native species found will be destroyed. All turtles encountered, including Western pond turtles, will be identified, measured and sexed by the Biologist prior to relocation.

If any salmonids are found dead or injured, the Biologist will contact CDFW/NMFS immediately by phone to determine if additional protective measures are to be taken. Mortalities will be retained in a sealed plastic bag with a label indicating the date and location of collection and fork length. They will be frozen as soon as possible and kept frozen until CDFW/NMFS gives specific instructions.

6.5 Installation of Cofferdams

Cofferdams shall be constructed upstream and downstream of the work area to bypass all flow from upstream of the upstream cofferdam to downstream of the downstream cofferdam. The cofferdams can be constructed of clean river gravel or sandbags. Clean river gravel may be left by grading into natural bed elevation following construction, if the Engineer or Geologist determines substrate size distribution is suitable, whereas sandbags (and sheet plastic) must be removed.

As each reach has been approved by the Biologist for completion of fish relocation, the Biologist shall authorize the crews to install the cofferdams and dewater as necessary. With the approval of the Biologist, once cofferdams and dewatering has occurred for each reach at a time, construction can begin.

The Biologist and team will monitor the project site throughout cofferdam installation and dewatering. The upstream cofferdam for each reach shall be installed first, then the lower cofferdam shall be installed. The Engineer or Geologist shall determine if bypass pumping from upstream of the upper cofferdam around the reach is necessary or if construction and/or sediment removal within each reach can be completed before significant ponding above the upper cofferdam occurs. Dewatering shall begin only after authorized by the Biologist.

The upstream cofferdams for each reach shall be constructed by excavating the top portion of pervious gravels from the creek bed, placing a large sheet of plastic sheeting down into the excavated bed, backfilling across the plastic sheeting in the creek channel with gravel filled sand bags, and then wrapping the gravel bag cofferdam with the plastic sheeting. Downstream cofferdams not located in tidal areas shall also be constructed from gravel filled sandbags, and shall be placed on top of the existing creek channel, and shall have geotextile fabric wrapped over the upstream face of the dam as a preventative measure to help filter any suspended sediment from flowing downstream.

Downstream cofferdams located in tidal areas shall be constructed similar to upstream cofferdams, with plastic sheeting, so as to keep the tidal water out of the reaches during dewatering and construction activities. The downstream cofferdam shall be installed at a very low tide to minimize the amount of tidal water to be pumped out of the project area.

6.6 Water Bypass

Water bypass shall be conducted using a gravity feed or pumped bypass line as recommended by the Design Plans. Bypass pipe diameter shall be sized to accommodate, at a minimum, twice the summer base flow. The Contractor is required to maintain free flowing water bypass at all times during the project including nighttime and weekends. Bypass water shall be discharged to the channel in a location approved by the Engineer or Geologist and may require energy dissipation at the outlet, which shall be installed and maintained at the Contractor's expense.

Existing stream flow and or existing pool water levels upstream of the project work area and downstream of the project work area shall be maintained at or near normal summer low flows during construction. Pumping rates should be monitored to ensure water levels upstream are not being inadvertently lowered by excessive pumping.

6.7 Dewatering

Pumps shall be placed in flat areas, well away from the wetted stream channel. Pumps shall be secured in place (staked or tied back) to prevent movement caused by vibration. Pumps shall be refueled in an area that is well away from the stream channel and be placed on top of fuel absorbent mats. Spill control kits shall be available at the project site at all times and construction personnel trained in the proper spill control procedures. In no case shall turbid, or any contaminated water be discharged directly to any waterway.

Pumped water shall be discharged to a filtration/settling system (i.e., filter fabric, turbidity curtain, or settling basin) downstream of work area to reduce turbidity, or discharged to vegetated upland areas for infiltration, where the water may be absorbed by the ground and not flow back into a stream within the work area. The Contractor is responsible for establishing infiltration or sediment basin locations to be approved by the Engineer or Geologist and the landowner (if on private property). All sediment collected from dewatering the construction area shall be disposed of off-site by the Contractor to an approved location.

6.8 Sediment Removal

Sediment shall be removed, where called for on the Design Plans, when the water surface is at its lowest level, with minimal surface water flows. To reduce turbidity, sediment removal shall occur only after wet project reaches are dewatered.

6.9 Removal of Exclusionary Screen and Cofferdams

All cofferdams, pumps, screens, gravel filled sandbags, and any other materials shall be removed from the stream upon construction completion as soon as possible and in a manner that will allow flow to resume with the least disturbance to the channel substrate. Cofferdams shall be removed carefully and methodically to prevent erosion and increased turbidity of water flow back into the downstream reach. Cofferdams shall be removed such that surface elevations of water impounded above the cofferdam will not be reduced by a rate greater than one inch per hour. This will minimize the risk of beaching and stranding fish as the water surfaces of areas upstream are lowered.

6.10 Reporting

Within 30 days of completion of aquatic species capture and relocation, the Project Proponent or other specified party shall submit a report to CDFW and NMFS including:

- Dates of construction start and finish,
- Date and time of relocation,
- Species encountered,
- Species capture methods,
- Methods used for handling and minimization of stress to aquatic species,

- Methods of equipment cleaning and disinfection,
- Sizes of containers used for transporting and holding species,
- Description(s), map(s), and photo(s) of relocation site(s),
- Numbers by species of all captured fish, and
- All instances of mortality and injury and description of any problems and unforeseen effects.

6.11 Measurement

Not applicable.

6.12 Payment

Payment for designing, implementing, operating, and removing the dewatering system will be made as set forth on the bidding sheet and no separate payment shall be made herein.

The contract lump sum price bid for dewatering shall include full compensation for furnishing all labor (filtering and cleaning), materials, tools, equipment (including baker tanks, if necessary), and incidentals, and for doing all work involved in designing, implementing, operating, and removing the dewatering system as specified herein, required by the permits as directed by the Engineer or Geologist.

7 ROCK STRUCTURES

7.1 General

This scope of work includes materials, purchase, delivery, site preparation, and placement of rock at the elevations and locations shown on the Design Plans and as directed by the Engineer or Geologist. The various mixtures of rocks and backfill required for each structure shall be placed to the dimensions and at the locations shown on the Design Plans or as directed by the Engineer or Geologist.

Rocks shall be placed by equipment suitable for handling material of the sizes required, and no dumping will be allowed. Caltrans Type A placement shall be used for all placement. In general, rocks should be placed in such a way to maximize stability with the largest flat side on the bottom, where possible. Plan view diagrams and cross sections shown on the Design Plans illustrate the rock placement intent, but adjustments may be made in the field as directed by the Engineer or Geologist.

These structures shall be constructed using the dimensions, elevations, and tolerances indicated on the Design Plans. All rock placement shall be reasonably homogeneous with larger rocks uniformly distributed and firmly in contact with one another and smaller rocks filling voids between larger rocks. Rocks shall be placed by equipment suitable for handling material of the sizes required. Hand or manual labor shall be used to place smaller rocks within the voids of the larger rocks to seal all gaps larger than 2–3 inches. No placed rock shall exhibit movement when walked upon. If necessary, iron bars and other methods such as manually manipulating the rock shall be used to ensure a solid mass of interlocking rock is constructed.

7.2 Rock Structure Materials

All of the rocks imported to the site shall be un-weathered, hard, resistant to water action, and of a suitable quality to ensure permanence in the climate in which they are to be used. They shall be reasonably well graded and shall range in size as shown on the Design Plans. No broken concrete or asphalt shall be allowed. If possible, neither the width nor the thickness of any rock shall be less than one-third of its length. The general rock specifications for all types and mixes shall be:

Density (apparent specific gravity)	2.5 min per Caltrans
Rock gradation types	Caltrans Standard 1 ton, ½ ton, ¼ ton, Backing No. 1, and Backing No. 2 (see table below for definition of each class)
Durability index	52 min. per Caltrans, California Test 229
Soil material	Backfill rocks with suitable native excavated materials
Color	Rocks shall be of color which blends into the natural conditions of the area and must be approved by the Engineer or Geologist

Prior to commencement of the contract, the Contractor shall locate potential sources of rock, and shall notify the CAR of the Contractor preferred quarry a minimum of one month prior to the start of construction.

Local sources of rock are preferred. Samples or documentation of rock color and durability shall be submitted to the Engineer or Geologist to determine whether the rock meets the requirements as set forth in these Construction Specifications. If imported rock is to be used for rock features shown on the Design Plans, then the Contractor shall be responsible for obtaining from the rock supplier a certification that the rock meets Caltrans Durability Specifications for rock riprap.

Rock class gradation table:

Rock Class	D_{50} Size[1] (in.)	D_{50} Weight (lb.)
1 Ton	36	2200
1/2 Ton	28	1100
1/4 Ton	23	550
Backing No. 1	12	75
Backing No. 2	8	25

[1] Assumes rock density = 165 lb/ft^3

7.3 Boulders

Boulders shown on the Design Plans have a variety of purposes including bank and channel protection, high-flow and debris deflection, habitat enhancement, wood habitat feature ballast, and oversized vehicle access deterrence.

Boulders shall be of Rock Class 1 ton unless otherwise specified on the Design Plans or directed by the Engineer or Geologist.

7.4 Engineered Streambed Material

Engineered Streambed Material (ESM) is used to emulate a naturally roughened streambed, such as that of riffles, provide vertical bed stability, and increase hydraulic turbulence to aerate the water column. The ESM is designed following the guidance of the *California Salmonid Stream Habitat Restoration Manual Part XII* (2009). The ESM is applied to the Roughened Channels (RC) and shall meet the gradation shown on the Design Plans. The ESM is assumed to be sourced from either imported rock or salvaged rock materials sorted from site excavation work using a Contractor proposed and Engineer or Geologist approved sorting method. The Contractor shall coordinate with the Engineer or Geologist for visual inspection of the ESM material prior to the initial RC application, and periodically during RC construction if so ordered by the Engineer or Geologist. The ESM layer is placed in a minimum of three lifts, with each lift having a maximum height of 0.5 feet, to ensure that the ESM layer achieves a stabilized and compacted unified form that reduces infiltration and flow loss into potential void space. Excavation, subgrade preparation, lift placement and compaction, and washing of native fines are considered incidental to construction of the RC features.

7.5 Measurement

Measurement for rock structures will be determined by the weight of boulder imported onto the site by the ton for each respective size and by cubic yard of ESM volume applied to the roughened channels shown on the Design Plans. To ensure that the Contractor is utilizing the appropriate tonnage and type of rock for each structure, each truckload of rock arriving on-site shall be accompanied by a certified weight ticket furnished by a licensed weigh master. The Contractor shall supply the Engineer or Geologist daily with a copy of each certified weight ticket for the Engineer's records.

7.6 Payment

Payment for all rock features will be paid for by item, linear foot, cubic foot, or tonnage as described above in and as set forth in the bidding sheet. The price bid per item, linear foot, cubic foot, or tonnage shall include but is not limited to full compensation for furnishing all labor, materials (including rock), tools, equipment and incidentals, and for doing all the work involved in constructing the structure, complete in place, including delivery and all necessary, mixing, placing, sealing/jetting, excavation below finish grade, compaction, and coir packing, and other incidentals as shown on the Design Plans, as specified herein, and as directed by the Engineer or Geologist.

The Contractor is responsible for verifying locations of each feature and no payment will be made for any excavation, compaction, rock placement, or other work resulting from misplacement of features. In addition, a copy of all rock weight slips shall be furnished to the Engineer or Geologist with a description of the location and type of structure for which the rock was used. No payment will be made until Engineer or Geologist verifies that the appropriate amount and type of rock was utilized for the installation of each enhancement and stabilization feature. No adjustment in the contract unit price for Rock Placement shall be made for increases or decreases of more than the percentage of the quantities as set forth in the schedule of bid prices.

8 WOOD HABITAT FEATURES

8.1 General

This scope of work includes purchase, delivery, site preparation, construction, and placement of Large Wood Habitat Features (LWHF), Nurse Logs (NL), and Brush Trenches, including all materials, excavation, fill, and compaction required to install the features at the elevations and locations shown on the Design Plans and as directed by the Engineer or Geologist. Plan view diagrams and cross sections shown on the Design Plans illustrate the wood habitat feature placement and functional intent, but adjustments may be made in the field as directed by the Engineer or Geologist.

The general anchoring techniques used for this project will follow procedures listed in the CDFW Restoration Manual for trenching and utilizing native material backfill to ballast partially embedded wood. Embedment depths shall be as shown on the Design Plans unless otherwise directed by the Engineer or Geologist.

8.1.1 Feature Locations

Install Wood Habitat Features as shown on the Design Plans. Wood Habitat Feature locations may be adjusted in the field per direction of the Engineer or Geologist.

8.1.2 Source of large wood

The contractor shall be responsible for sourcing of imported wood materials, unless otherwise agreed upon by the CAR prior to delivery to the site. Contractor is responsible for haul and transport of logs to the site. Multiple log types may be generated from a single imported or salvaged log. All wood will be inspected and approved by the CAR before installation. All undesirable growth from wood shall only be pruned if designated by CAR. All attached root systems shall not be pruned unless designated by CAR.

8.1.3 Materials

The Contractor shall furnish materials meeting the following requirements:

Salvaged Wood and Brush used for NL and BT features or wood chip substitution:

Prior to salvage of large wood, trees, shrubs, and herbaceous plants from onsite, CAR and Contractor shall coordinate to identify and mark proposed salvage materials. Marking of proposed salvaged materials shall be done in a manner that does not damage the bark, trunk, branches, leaves, or roots of the potential salvage materials. Flagging, CAR inspection, and CAR approval shall be coordinated by Contractor prior to clearing and grubbing. Trees, shrubs, and herbaceous plants removed during clearing and grubbing for grading preparation shall be salvaged and stockpiled for reuse. Salvaged materials that meet the dimensions and species types identified on the plans and these specifications may be reused for NL and BT features per CAR inspection and approval. Smaller woody materials embedded into the BT shall be smaller than 12 inches in diameter and less than 10 feet in length, unless otherwise approved by the CAR. Smaller materials, including limbs, leaves, and bark may be substituted, with Engineer or Geologist approval, where wood chips are specified on the Design Plans.

Habitat Logs:

- Shall conform to dimensions on the Design Plans and herein.
- Shall have a diameter not less than the diameter indicated on the Design Plans, measured as diameter at breast height (DBH).
- Shall be sourced from Ponderosa Pine, Western Juniper, Douglas Fir, or other conifer species with prior approval by the CAR.
- Shall include an intact rootfan mass (i.e., rootwad). The rootfan mass shall have a diameter equal to or greater than three (3) times the log DBH, or unless otherwise approved by the CAR. Care should be taken to preserve as much of the root material as possible in transport, as it provides critical fish habitat and debris retention capability.
- Shall be from sound stock and appropriate for the intended construction. The truck of the logs shall be reasonably straight and uniform, and free from excessive bends, bulges, and limbs that will impede the placement of additional logs in the applicable feature if constructing a multi-log feature. Logs exhibiting breakage, rot, cracks, large knots, splitting, holes, mold, fungus, decayed wood, pest infestation, foreign objects/finishes, vandalism, burn, and other damages are unacceptable and may be rejected by the CAR. Rejected logs shall be removed from the site and disposed of at the Contractor's expense.
- Limbs shall be trimmed within one inch of the face of the log. Limbs do not include the rootfan mass. Limbs removed by trimming shall be incorporated into other onsite habitat features as directed by CAR, and not removed from the site or otherwise disposed of.
- Rootfan mass shall not be trimmed unless designated by the Engineer or Geologist.
- Rootfan mass shall conform to the dimensions indicated on the Design Plans and herein.
- Rootfan masses shall be reasonably uniform and full; rootfans that are asymmetrical may be rejected by the CAR.
- All Contractor proposed Habitat Logs will be inspected and accepted by the CAR prior to installation.

8.1.4 Placement

Place wood habitat features as shown on the Design Plans or as otherwise directed by the Engineer or Geologist.

8.2 Measurement

Measurement and payment for installation of wood habitat features and nurse logs will be made per each feature. Measurement and payment for brush trenches will be per linear foot installed.

8.3 Payment

The price bid per each unit of wood habitat features shall include full compensation for furnishing logs, preparation of anchoring system as shown on the Design Plans, furnishing and placing specified number of rocks and sizes, excavation, placement of willow stakes, furnishing all labor (including drilling rock anchors), materials (including rolled erosion control product, soil amendment materials, rock, anchor bolts, fasteners, adhesives, etc.), tools, equipment, and incidentals, and for doing all work involved in installing wood habitat features as specified herein, as shown on the Design Plans and as directed by the Engineer or Geologist.

The Contractor is responsible for verifying locations of each feature and no payment will be made for any excavation, compaction, or work resulting from misplacement of features.

9 LIVE WILLOW AND COTTONWOOD STAKES

9.1 General

This section applies to the furnishing and planting of Live Willow and Cottonwood Stakes (Live Stakes) during construction of habitat enhancement and bank and channel stabilization features as directed by the Engineer or Geologist. Live Stakes must have sufficient sunlight and moisture to survive.

9.2 Materials

The Contractor shall source the Live Stakes on-site or other CAR approved source location. Live Stakes shall meet the species and dimensions requirements shown on the Design Plans.

9.3 Installation

- Live Stakes shall be collected (harvested) and soaked in water a minimum of 12 hours prior to placement, but no earlier than 7 days before placement. Live Stakes can be stored for up to seven (7) days in large watertight bins (e.g., trash cans) or other approved container filled with water and placed in the shade to prevent significant drying of ends.
- The Contractor must give a minimum of 48 hours notice to the Engineer or Geologist prior to construction of any features that require Live Stakes. The Engineer or Geologist will inspect conditions of stakes and ensure they are not desiccated. If the Engineer or Geologist approves Live Stake conditions, the Engineer of Geologist will direct the Contractor on installation procedures. Failure to properly store stakes may cause desiccation. Desiccated or otherwise rejected materials shall be replaced at the Contractor's expense. Failure to install properly may require the reconstruction of these features at no additional cost to the Project Proponent.
- When staking wood habitat features, Live Stakes shall be placed immediately after trenches are excavated so that they are in maximum contact with the underlying substrate. Small rocks and soil can then be placed in and around the stakes such that they are generally vertical and shall be trimmed as necessary to protrude as specified on the Design Plans.
- Live Stakes shall be planted during the placement of all features. Live STAKES SHALL NOT BE PLANTED AFTER FEATURES ARE INSTALLED.
- Minimize damage to cuttings by laying final course or rock by hand placement. If necessary, trim off damaged ends of cuttings and remove and replace damaged stakes at discretion of the Engineer or Geologist at no additional cost to the Project Proponent.
- Live Stakes shall be watered until the first significant rainfall of the season to ensure survival, unless otherwise directed by CAR.

9.4 Measurement

Live Stakes shall be measured by each stake installed and visible from the surface, complete in place and watered as necessary during construction. Payment for excessively damaged stakes (determined by the Engineer or Geologist) that are removed and replaced will not be paid for.

9.5 Payment

Payment for furnishing and planting Live Stakes will be made per each live stake, as set forth on the bidding sheet. The unit price bid for Live Stakes shall include full compensation for harvesting, transporting, furnishing, and installing Live Stakes including all storage, preparation, labor, materials, tools, equipment, and incidentals and for doing all work involved in planting Live Stakes as shown on the Design Plans, as specified herein, or as directed by the Engineer or Geologist.

10 ROAD-STREAM CROSSINGS

The project includes the installation of a road-stream crossing to provide private property access across the constructed habitat channels as shown in the Design Plans and described in the Basis of Design Report. The crossing structure shall be a prefabricated bridge (i.e., railroad flat car bridge, Kernen bridge, or other approved equivalent). Crossings shall be constructed following the details shown in the Design Plans, described in the Basis of Design Report, and under specific adherence to the manufacturer’s specifications and installation procedures.

11 PLANTING AND REVEGETATION

11.1 General

The Contractor shall furnish all labor, materials, tools, equipment, and incidentals to complete all planting shown on the Design Plans and related work for revegetating any areas disturbed by construction activities and those areas shown on the Design Plans. Planting and revegetation shall be performed by a C-27 licensed landscaping contractor.

Prior to excavation for planting or placing, the Contractor will locate all cables, conduits, and utility lines so that proper precautions may be taken not to damage such facilities. In the event of a conflict between such lines and plant locations, the Contractor will promptly notify the Engineer or Geologist, who will arrange for relocation of one or the other. Failure to follow this procedure places upon the Contractor the responsibility to repair damages, at their own expense, which result from work hereunder.

The Contractor shall plant the following species, numbers, and sizes of native plants as indicated by the location zones on the Design Plans or as directed by the Engineer or Geologist. Plant materials shall be those that have been propagated from local sources only.

The Contractor shall have plants delivered to the site no sooner than 2 days prior to planned installation. Prior to planting, the Contractor shall flag the location of all plantings for approval by the Engineer or Geologist. Unless shown or otherwise directed by the Engineer, plants shall be planted in holes that are a minimum of 1.5 times the diameter of the pot size and have a minimum 6 inches of backfilled soil underneath the potted plant.

Backfill for the holes shall be comprised of the soil amendments detailed on the Design Plans. The prepared soil shall be mixed in an adjacent area to the planting work and shall be accurately proportioned using a suitable measuring container such as a wheelbarrow of measured capacity. A minimum 2-inch thickness of mulch shall be placed around all plants to cover any loosened soil. If straw mulch is used, it shall be certified weed free. Plants shall be watered thoroughly on the same day they are planted.

Plants shall be well grown, free from insect pests and disease, and shall be grown in nurseries which have been inspected by the State Department of Agriculture and have complied with the regulations thereof. All plants shall comply with Federal and State laws requiring inspection for plant diseases and infestations. Only Phytophthora-free native plant nurseries shall be used.

Plants shall be of symmetrical growth typical for the species and variety. Plants shall be well-rooted, and roots shall show no evidence of having been restricted or deformed at any time. Root condition of plants in containers will be determined by removal of earth from the roots of not less than two plants nor more than two percent (2%) of the total number of plants of each species or variety. When container-grown plants are from several sources, the roots of not less than two plants of each species or variety from each source will be inspected by the Engineer or Geologist. In case the sample plants inspected are found to be defective, the Project Proponent or Engineer or Geologist reserves the right to reject the entire lot or lots of plants represented by the defective samples. Any plants rendered unsuitable for planting because of this inspection will be considered samples and will not be paid for.

All seed shall be in conformance with the California State Seed Law of the Department of Agriculture. Each seed bag shall be delivered to the site sealed and clearly marked as to species, purity, percent germination, dealer's guarantee, and dates of test. In addition, the container shall be labeled to clearly reflect the amount of Pure Live Seed (PLS) contained. Seed shall be purchased from Pacific Coast Seed (http://www.pcseed.com) or other CAR approved vendor.

Inspection certifications required by law shall accompany each shipment of plants, and certificates shall be delivered to the Engineer or Geologist. The Contractor shall obtain clearance from the County Agricultural Commissioner, as required by law, before installing plants delivered from outside the County. Evidence that such clearance has been obtained shall be presented to the Engineer or Geologist.

Plant names listed shall conform to the U.S. Department of Agriculture, Natural Resources Conservation Plants Database http://plants.usda.gov/java/. Common planting species and corresponding scientific names are shown on the Design Plans.

11.2 Installation

- Planting shall occur at the end of the project and the Engineer or Geologist shall approve the general location of tree plantings before installation.
- The species, size, and location of trees to be planted as part of this project have been defined on the Design Plans. The Engineer or Geologist shall approve final location of tree plantings before installation.

- Each plant shall be handled and packed in the approved manner for that species or variety and all necessary precautions shall be taken to ensure that the plants will arrive at the work site in proper condition for successful growth. Trucks used for transporting plants shall be equipped with covers to protect plants from windburn.
- No plants shall be transported to the planting area that are not thoroughly wet throughout the ball of earth surrounding the roots. Any plants that, in the opinion of the Engineer or Geologist, are dry or in a wilted condition when delivered to the planting area will not be accepted and shall be replaced by the Contractor at their expense.
- Any plants delivered to the site which are found to be not true to name, or unsuitable in growth or condition, shall be removed from the site immediately and replaced with acceptable plants. Plants shall not be pruned prior to delivery unless authorized by the Engineer or Geologist. Trees shall not be topped before delivery. The Contractor shall maintain each plant in a healthy growing condition from the time it is delivered until planting has been accepted.
- Planting operations shall be conducted in such a manner that no damage will result to adjacent site improvements and existing plantings. The Contractor shall be responsible for any damage resulting from their operations and shall repair or replace such damage at their expense.
- No planting shall be done in soil that is too wet or too dry or otherwise in a condition not generally accepted as satisfactory for planting from a horticultural standpoint.
- Vehicles of any kind will not be allowed to pass over curbs, planted areas, etc., unless proper protection is provided.
- Plants shall be removed from the containers in such a manner that the balls of earth surrounding the roots are not broken. Plants will be planted and watered as specified immediately after removal from the containers. Containers shall not be cut prior to delivery of the plants to the planting area.
- Pruning after planting shall be limited to the minimum necessary for the removal of injured twigs and branches. On any branches larger than one-half inch in diameter, the cuts shall be coated with tree wound compound.
- The Contractor shall maintain all container grown plants from the initial planting through acceptance of the planting phase. This includes but is not limited to regular watering and weeding, promptly replacing sick, dead, or lost plants, and controlling pests and infestations. The purpose of the Maintenance Period is to ensure that the plants are healthy and well-established prior to the acceptance of the plantings.
- Each plant shall be planted in the center of the pit. No soil in muddy condition shall be used for backfilling. No filling will be permitted around trunks or stems. All broken or frayed roots shall be properly cut off. Pits shall be backfilled with compacted prepared backfill to the bottom of the root ball. The top of the root ball after planting shall be 1 inch higher than the grade of the existing ground. The rest of the plant pit shall be filled with prepared backfill and compacted by tamping and watering.
- All pits for trees shall be dug with vertical sides and level bottoms. Scarify sides to remove the glaze if drilling is used to prepare pits. Foot-tamp backfill material below root ball to prevent settling of plant.
- After planting operations have been completed, the Contractor shall remove all trash, excess soil, empty plant containers, and other debris from the work site. All scars, ruts or other marks in the project area caused by the revegetation work, shall be repaired and the work site left in a neat orderly condition.

11.3 Native Grass Seed

The native erosion control grass seed shall be spread by hand broadcasting or other Engineer approved methods over all disturbed areas as shown on the Design Plans. Incorporate the seed uniformly at the specified rates per acre. Provide seed of the latest crop, labeled in accordance with the California Food Agricultural Code.

Seed Mix A shall be composed as follows:

Common Name	Scientific Name	Pounds Per Acre of Pure Live Seed (PLS)
Western Yarrow	*Achillea millefolium*	1
California Brome	*Bromus carinatus*	25
Clustered Field Sedge	*Carex praegracilis*	5
Blue Wildrye	*Elymus glaucus*	25
Barley	*Hordeum brachyantherum*	25
Beardless Wildrye	*Elymus triticoides*	15
Spanish Lotus	*Acmispon americanus*	10
Small Fescue	*Festuca microstachys*	5
Total Pounds PLS per acre =		**111**

11.4 Tree Stakes

- Double stake all trees higher than 3 feet.
- Double stakes shall be at right angles to the prevailing wind, except where otherwise indicated.
- Set stakes plumb.
- Use only 2-inch diameter stakes set outside rootball and driven 12 inches into undisturbed soil.
- Stakes must not protrude through root ball.

11.5 Inspections

The Contractor or their authorized representative shall be on the site at each inspection.

The Engineer or Geologist will conduct inspections at the following times:

- The first planting inspection will be when shrubs and trees are spotted for planting, but before planting holes are excavated. Final positioning of all trees is subject to approval of the Engineer or Geologist. The Contractor shall notify the Engineer or Geologist at least 3 days prior to the delivery date for plant materials. The number of plants delivered to the job site on any day will be no more than can be planted and watered on that day. Inspection of materials shall include quality, nomenclature, health, habit of growth, and root condition as specified herein.

- The second inspection will take place within 24 hours after the trees have been planted and the pits have been backfilled.
- The acceptance of planting inspection will be held when all specified work, except the Maintenance Period, has been completed.
- The final inspection will be at the completion of the 90-day Maintenance Period. The purpose of this inspection will be to inspect and to review the quality of maintenance, the health of the plants, and to determine which plants, if any, are to be replaced. Before final acceptance by the Engineer or Geologist, all plant basins shall be clean and free of debris and weeds, plant materials shall be living, healthy and free of infestations and all damaged or lost plants replaced.

11.6 Measurement

Measurement for Planting and Revegetation will be per each unit, complete in place as specified on the Design Plans.

12 PLANT ESTABLISHMENT AND MAINTENANCE PERIOD

12.1 General

The work required under this section includes but is not limited to all labor, tools, materials, equipment, and incidentals required to conduct the Establishment and Maintenance Period at the project site as shown on the Design Plans, contained in these Construction Specifications, and as directed by the Engineer or Geologist.

It is recommended that post-construction monitoring and/or maintenance is conducted in relation to four specific areas.

12.2 Implementation Effectiveness Monitoring

Following project completion, as-built Design Plans shall be created so that the actual constructed project can be compared to the proposed project. In addition, restoration effectiveness monitoring should be conducted using protocols described in the CDFW California Salmonid Stream Habitat Restoration Manual or other equivalent approach. The purpose of these activities is to ensure that specific habitat enhancement goals were met as described in the Design Plans.

12.3 Large Wood Structures Monitoring and Maintenance

Following storm events with 1.5-year recurrence or greater flow discharges, it is recommended that field monitoring be conducted to ensure that the bank stabilization and habitat enhancement features are functioning as designed. Field photos and observations should document any evidence of the following conditions:

- Scour beyond expected pool formation that could undermine the structure or cause extensive bank erosion.
- Significant shifting of a structure.

- Failure or potential failure of anchoring hardware.
- Extensive racking of new large wood on a structure.

Based on monitoring results, maintenance activities may be recommended such as removing excess racked wood or installing new anchoring hardware. Note that racking of new wood is generally considered to be a positive project outcome, and this wood should only be modified or removed if the Engineer or Geologist determines that the racked wood may lead to instability of an enhancement feature or excessive scour.

12.4 Riparian Plant Maintenance

It is recommended that a "3- to 5-year plant maintenance and replacement" clause is included in the contract with the landscape contractor who is hired to perform the project revegetation, as described in the Design Plan and in these Specifications. Three to five years of plant survival maintenance and monitoring is likely to be required as a part of project permitting. As soon as all planting is completed, a planting review and preliminary inspection and punch list for the plantings will be held by the Engineer or Geologist upon request of the Contractor.

- Upon written approval of the work by the Engineer or Geologist, the Plant Establishment and Maintenance Period shall begin. The first day of that period shall be specified in the Engineer's report, but not before all planting and irrigation punch list items are complete.
- It shall be the responsibility of the Contractor to notify the project inspector that maintenance crews will be on site to perform work during the Maintenance Period. The contractor shall notify the project inspector by either providing 24 hours notice in writing, or, provide a schedule for the entire Maintenance Period in writing, to be approved by the Engineer or Geologist. Upon notification, crews must meet the project inspector each day they are on site to verify their presence. Payment will not be made for those scheduled days if crews are on site without notification and verification by the project inspector, or if crews are not on site on scheduled days.
- The Contractor must have prior experience in maintaining native herbs, grasses, and shrubs in north coastal California. The Contractor must have successfully completed at least two other projects involving native plants. The Contractor must use maintenance techniques and practices appropriate for native wetland plants, and will plan for the appropriate level of effort to provide the required maintenance as described in this Section in a timely manner. The Contractor must be able to distinguish between native and non-native plants.
- The Contractor shall ensure that container plant survival and weeding performance standards are met through plant maintenance activities during the Maintenance Period. These activities shall include, but are not limited to, watering, replanting of diseased or dead plants, litter control, weed control, fertilizing, rolling, cultivating, repair of irrigation systems, erosion control and control of diseases and pests and the general care and nurturing of installed container plants and emergent seedlings.
- Provided that the Contractor has met all other previous requirements related to site preparation, earthwork, seeding and planting, and plant maintenance, the Engineer or Geologist has the discretion, at any time during the Maintenance Period, to reduce the performance standards, or otherwise modify them to lower levels, if there are environmental or biological factors beyond the control of the Contractor that could not be reasonably foreseen by the Contractor and that would clearly prevent the Contractor from achieving the stated performance standards. Failure to achieve performance standards shall require replanting by the Contractor, as approved by the Engineer or Geologist.

- In the event of a flood, severe drought, or windstorm, as determined by the Engineer or Geologist, the Contractor shall not be required to provide replacement plantings without a contract change order.
- During each inspection, the Contractor shall record general observations of plant survival and weed cover. The results of these observations shall be used to identify problems as they begin, so that corrective maintenance actions can be taken before a larger problem develops. The Engineer or Geologist will also conduct periodic independent assessments of plant survival.
- The performance standards for the Maintenance Period related to plant survival shall be formally measured by the Contractor at the end of the Contract Period:
  - At that time, 95% of all installed container plants present at the beginning of the Maintenance Period must be present, live, healthy, undamaged, and free from infestations.
  - Planting areas shall be free of all broadleaf and grass weeds.
  - Plantings that do not conform to these specifications shall be replaced and brought to a satisfactory condition before final acceptance of the work.

If these performance standards have not been met, the Engineer or Geologist shall specify the amount of replanting to be conducted by the Contractor at the end of the Maintenance Period necessary to achieve the performance standards. In the event that the plantings are not acceptable at the end of the Maintenance Period, liquidated damages may be assessed.

The performance standard for weed control throughout the Maintenance Period is that plant cover by noxious invasive weeds at the project site shall not exceed 5% of the total vegetative cover at any time. The cover of native and non-native plants will be measured on a periodic basis during the Maintenance Period by the Engineer or Geologist to determine if the performance standard has been achieved. Failure to meet the standard shall require the Contractor to increase weeding efforts.

12.5 Submittals

- MONTHLY INSPECTION REPORT. The Contractor shall submit a monthly inspection report to the Engineer or Geologist during the Maintenance Period. The report shall indicate the status of installed plants, condition of temporary irrigation system, and recommendations for future actions, as necessary.
- HERBICIDE TREATMENT PLAN. Contractor shall provide a description of the herbicide to be used at the project site for the plant maintenance including dilution and application rates; manufacturer's name; application equipment and methods; measures to protect park users, including signs, barriers, notifications, etc; measures to avoid spraying protected plants; measures to avoid discharge into creek water; evidence that the applicator is licensed to apply the herbicide; statement that the herbicide is approved by state and federal agencies for work in the type of environment at the project site.

12.6 Replacement Plants

For the sake of bidding, the Contractor shall assume 25% replacement plants (for purposes of labor estimate) to be installed at the end of the Maintenance Period.

Immediately replace any plant materials that die or are damaged. Replacements shall be made to the specifications as required for original plantings.

12.7 Pesticide and Herbicide

Pesticides and herbicides shall be approved by the Engineer or Geologist prior to use.

12.8 Water

Water for irrigation during the Maintenance Period shall be provided by the landowner from adjacent points of connection. The landowner shall supply water to the project irrigation system at no cost to the Contractor. The Contractor shall have full authority to use water as needed to meet these Construction Specifications.

12.9 Watering

- The Contractor shall be responsible for watering the installed plants with irrigation system as necessary to maintain the plants in a healthy and vigorous condition throughout the duration of the Maintenance Period and before final acceptance.
- The frequency and duration of watering operations shall depend on current weather patterns and site-specific soil moisture conditions. The Contractor shall be responsible for receiving approval from the Engineer or Geologist on the watering schedule and application rates.
- Watering shall provide an adequate supply of moisture within the root zone of each plant during the normal growth period of the plant. The moisture content in all planted areas shall be sufficient to insure healthy plants and vigorous growth. This shall be accomplished by means of visual observation of plant material and the surrounding surface soil conditions within any given area.
- Observed deficiencies or excesses in watering program will be corrected immediately by the adjustment of controllers, as required. Controllers shall be programmed to water deeply without runoff by use of short repeat cycles. Irrigation shall be controlled and individual heads adjusted to prevent overspray and runoff onto paved areas.
- The Contractor shall be responsible for conducting site investigations as necessary throughout the Maintenance Period to evaluate the condition of plants, the need for irrigation, and the application of water. These investigations will include inspection of all plants for signs of inappropriate watering, including water stress (caused by lack of water or overwatering), stunted growth, wilting, premature leaf loss, and premature yellowing of leaves. If most of the plant material appears to be stressed and in danger of perishing, the Contractor shall consult the Engineer or Geologist to determine the frequency and duration of additional or decreased watering. The Engineer or Geologist shall provide approval to the Contractor of any modifications to the approved watering schedule.
- At no time shall water be applied in a way that will cause erosion, damage to plants, runoff, or damage to existing or naturally colonizing vegetation. If the watering application rates need adjustment, the Contractor shall be responsible for immediately contacting the Engineer or Geologist. The Contractor will assume full responsibility for corrective actions resulting from inappropriate water applications and failure to contact the Engineer or Geologist for direction.

12.10 Replacement Planting

Replacement planting shall occur during the Maintenance Period unless otherwise directed by the Engineer or Geologist. The Contractor shall provide all replacement plants. The Contractor shall provide the Engineer or Geologist with 30 days advance written notice when requesting replacement plant materials.

- Installation methods for replacement plants shall be in strict conformance to the Design Plans, these Construction Specifications, and the Engineer's or Geologist's direction. Plants shall be installed as described in these Construction Specifications.
- After each replacement, the Contractor shall submit to the Engineer or Geologist a marked planting plan and written documentation recording the time, species, and location of all replacements.
- The Landowner shall assume responsibility of maintaining the replacement plants once the Engineer or Geologist accepts the plantings as conforming to these Construction Specifications.
- The Contractor may recommend a different native plant for replacement planting if the Contractor believes original plant species is not performing well at site; subject to discretion of the Engineer or Geologist.

12.11 Weed Control

- The Contractor is responsible for maintaining all individual plants and all areas in between, as shown on the record drawings, free of weeds during the duration of the Maintenance Period in accordance with these Construction Specifications.
- Throughout the Maintenance Period, weeds shall be removed before reaching 4 inches in height or forming flowering all times of the Maintenance Period.
- Weed removal at the trunks of individual plants, or within 10 inches, shall be done by hand pulling or mechanical methods. Weed removal shall cause minimal disruption to the root systems of the installed plants, adjacent trees, and seed germinated plants.
- Herbicide shall be used for weed control in selected areas upon approval by the Engineer or Geologist. When herbicides are to be used for weed control, the Contractor shall notify the Engineer or Geologist 5 days in advance, the type of herbicide and any additives to be used, and the rate of herbicide application.
- The Contractor shall be responsible for spot applications of herbicide to invasive weed species as directed by the Engineer or Geologist at the project site.
- Hand crews shall spray individual plants using backpack units with a narrow spray to minimize drift and accidental spraying of nearby native species. Herbicide shall be applied so that it will not drift, or show signs of drift, outside the designated re-vegetation planting area. At all times, existing and installed plants must be protected from herbicide drift. The applicator shall avoid spraying during windy conditions; if windy conditions persist, the applicator shall use a large droplet size and low tank pressure and shall use a movable impermeable barrier while spraying to protect against drift. The Contractor shall exercise great caution in applying the herbicide to the targeted plants only. Non targeted plants shall not be sprayed, nor shall not receive drift from nearby spraying.
- The Contractor shall be responsible for replacing plants that are killed due to herbicide drift or mistaken application at their sole cost, including plant material and installation labor.

- Dead weed material shall remain in place, except for large weeds, as indicated in the field by the Engineer or Geologist.
- The Contractor must adhere to best management practices and application procedures when applying herbicides.

12.12 Pruning

- Pruning shall be done only at the direction of the Engineer or Geologist.
- Pruning shall be done by thinning and shaping to achieve a natural appearance. Excessive pruning or stubbing back will not be permitted.
- Pruning cuts shall be allowed to heal naturally and not painted over with wound dressing or asphaltic emulsion.
- All pruning cuts shall be made flush to the bark curl and shall be cleanly cut with no tearing of the bark.
- All cuttings shall be removed from the site or used in BDA construction.
- Do not remove lower branches from low-branching or multi-trunk trees, unless directed to do so by the Engineer or Geologist.

12.13 Cleanup

Throughout the Maintenance Period, the Contractor shall keep the work site, areas adjacent to the work site, and access roads in a neat and orderly condition and free and clear from debris and discarded materials.

12.14 Record Drawings

- The Contractor shall keep up-to-date as-built record drawings during the Maintenance Period. These drawings shall be updated, as needed, and submitted to the Engineer or Geologist at the end of the contract period.
- The record drawings shall include information on the location and size of the planting indicated by species. A legend listing all materials shall be included on the record drawings.

12.15 Guarantee

- Plants installed under the contract shall be guaranteed for the length of the Maintenance Period against mortality resulting from defects in maintenance.
- Plant materials, including seeded areas and transplanted plants, that are dead, missing, or found to be unhealthy because of poor maintenance practices and that are therefore not in conformance with the Design Plans and Construction Specifications; shall be replaced according to the Engineer or Geologist at the Contractor's expense, by the Contractor within 15 days of written notification by the Project Proponent. All replacements shall be in strict conformance to the Design Plans and Construction Specifications.

12.16 Inspections and Final Acceptance

- The Engineer or Geologist will conduct periodic site inspections during the Maintenance Period.
- At the end of the Maintenance Period, at the Contractor's request, the Engineer or Geologist shall inspect the project site to evaluate the acceptability of the maintenance practices.
- Areas determined as unacceptable, due to lack of performance in accordance with the Construction Specifications, shall be reworked and replanted at the Contractor's expense, as necessary, according to the Construction Specifications. The Contractor shall be responsible for any resulting extension of the Maintenance Period and will do so at no additional cost.
- At the time of the final acceptance observation by the Engineer or Geologist, the Contractor shall have maintained the project in its entirety according to the performance standards, the Design Plans, these Construction Specifications, and the Engineer’s or Geologist's direction. If, after inspection, the Engineer or Geologist is satisfied with the maintenance practices and all plant survival and weed cover goals have been met, the Contractor shall be notified in writing of final project acceptance. If, after inspection, the Engineer or Geologist is dissatisfied with the maintenance to date and its conformance to the Design Plans and Construction Specifications, the Engineer or Geologist will prepare a written punch list of necessary corrective actions on defective work for that stage. The corrections must be completed by the Contractor within 10 days of the initial observation.

12.17 Measurement and Payment

The lump sum contract price paid for the Plant Establishment and Maintenance Period on the bidding sheet shall include full compensation for furnishing all labor, plants, materials, tools, equipment, and incidentals and for doing all the work covered in this section, complete in place as shown on the Design Plans, as required by these Construction Specifications, and as directed by the Engineer or Geologist.

Appendix J

Habitat Feature Stability Calculations

Table of Contents

LARGE WOOD HABITAT FEATURE, TYPE 1 (LWHF1): HABITAT LOG STABILITY ANALYSIS

Long Pond Habitat Enhancement Design Project

Spreadsheet developed by
Michael Rafferty, P.E.

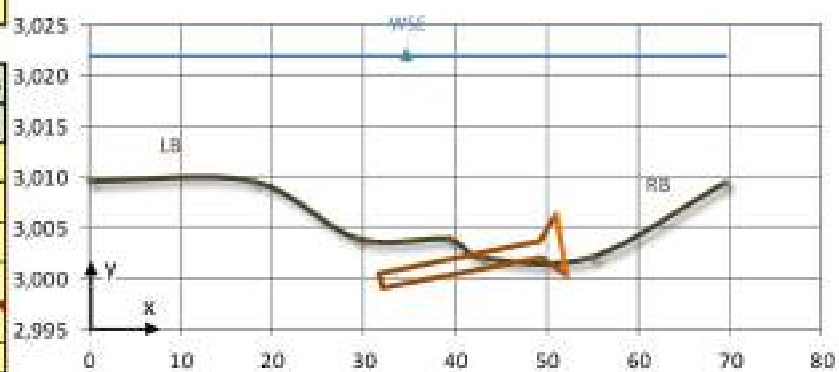
Single Log Stability Analysis Model Inputs

Site ID	Structure Type	Structure Position	Meander	Station	d_w (ft)	R_c/W_{BF}	u_{des} (ft/s)
stream of Cr	Rootwad	Left bank	Outside	53+00	18.00	15.53	9.22

Multi-Log Structures	Layer	Log ID
	N/A	1

Channel Geometry Coordinates		
Proposed	x (ft)	y (ft)
Fldpln LB	0.00	3,009.66
Top LB	17.76	3,009.66
Toe LB	29.24	3,004.00
Thalweg	39.25	3,003.92
Toe RB	42.83	3,002.13
Top RB	54.83	3,002.13
Fldpln RB	69.43	3,009.43

Proposed Cross-Section and Structure Geometry (Looking D/S)

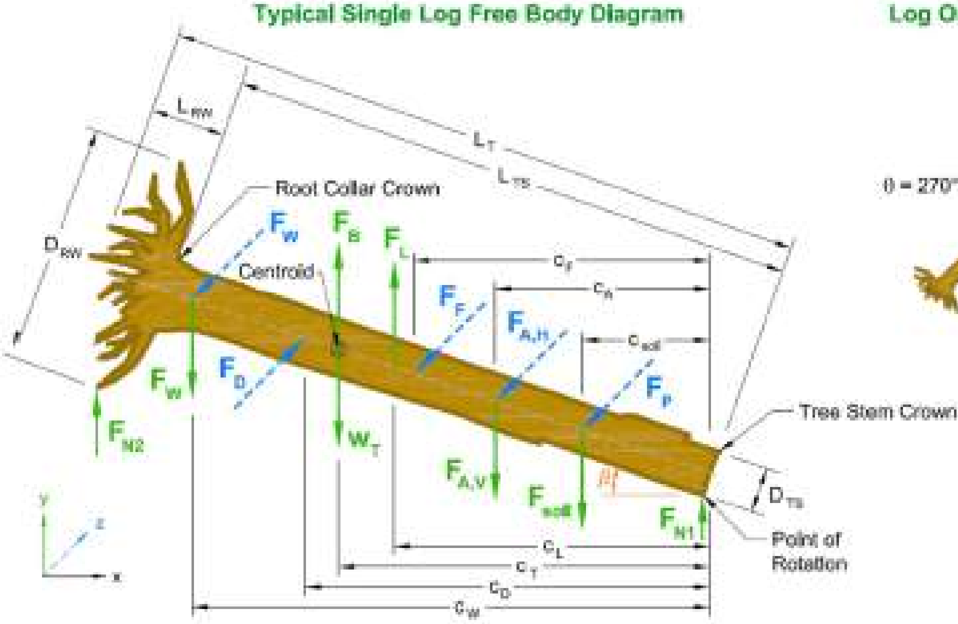


Wood Species	Rootwad	L_T (ft)	D_{TS} (ft)	L_{RW} (ft)	D_{RW} (ft)	γ_{Td} (lb/ft^3)	γ_{Tgr} (lb/ft^3)
Pine, Ponderosa	Yes	20.0	1.50	2.25	6.00	28.0	45.0

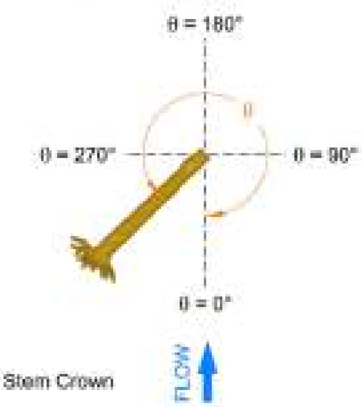
Structure Geometry	θ (deg)	β (deg)	Define Fixed Point	x_T (ft)	y_T (ft)	$y_{T,min}$ (ft)	$y_{T,max}$ (ft)	A_{Tp} (ft^2)
	90.0	-10.0	Root collar: Bottom	49.50	3,002.13	2,999.05	3,006.21	9.73

Soils	Material	γ_s (lb/ft^3)	γ'_s (lb/ft^3)	ϕ (deg)	Soil Class	$L_{T,em}$ (ft)	$d_{b,max}$ (ft)	$d_{b,avg}$ (ft)
Stream Bed	Very coarse gravel	131.4	81.8	40.0	5	11.24	3.45	2.26
Bank	Gravel/cobble	137.0	85.3	41.0	4	0.00	0.00	0.00

Typical Single Log Free Body Diagram



Log Orientation (Plan View)



stream of Cr Rootwad — Page 2

Vertical Force Analysis

Net Buoyancy Force

Wood	V_{TS} (ft^3)	V_{RW} (ft^3)	V_T (ft^3)	W_T (lbf)	F_B (lbf)
↑WSE	0.0	0.0	0.0	0	0
↓WS↑Thw	0.0	6.4	6.4	179	400
↓Thalweg	31.4	15.9	47.2	2,125	2,947
Total	31.4	22.3	53.6	2,304	3,347

Lift Force

C_{LT}	0.08
F_L (lbf)	66

Soil Ballast Force

Soil	V_{dry} (ft^3)	V_{sat} (ft^3)	V_{soil} (ft^3)	F_{soil} (lbf)
Bed	0.0	36.4	36.4	2,977
Bank	0.0	0.0	0.0	0
Total	0.0	36.4	36.4	2,977

Vertical Force Balance

F_B (lbf)	3,347	↑
F_L (lbf)	66	↑
W_T (lbf)	2,304	↓
F_{soil} (lbf)	2,977	↓
$F_{W,V}$ (lbf)	0	
$F_{A,V}$ (lbf)	0	
ΣF_V (lbf)	1,869	↓
FS_V	1.55	✓

Horizontal Force Analysis

Drag Force

A_{Tp} / A_W	Fr_L	C_{Di}	C_w	C_D*	F_D (lbf)
0.01	1.33	0.97	0.00	0.99	798

Passive Soil Pressure / Friction Force

Soil	K_P	F_P (lbf)	L_{Tf} (ft)	μ	F_F (lbf)
Bed	4.60	6,846	13.25	0.84	1,052
Bank	4.81	0	6.50	0.87	535
Total	-	6,846	19.75	-	1,587

Horizontal Force Balance

F_D (lbf)	798	→
F_P (lbf)	6,846	←
F_F (lbf)	1,587	←
$F_{W,H}$ (lbf)	0	
$F_{A,H}$ (lbf)	0	
ΣF_H (lbf)	7,635	←
FS_H	10.57	✓

Moment Force Balance

Driving Moment Centroids / Resisting Moment Centroids

$c_{T,B}$ (ft)	c_L (ft)	c_D (ft)	$c_{T,W}$ (ft)	c_{soil} (ft)	$c_{F\&N}$ (ft)	c_P (ft)
12.9	18.9	15.4	12.9	5.4	8.9	7.1

*Distances are from the stem tip

Point of Rotation: Stem Tip

Moment Force Balance

M_d (lbf)	55,852
M_r (lbf)	123,183
FS_M	2.21 ✓

LARGE WOOD HABITAT FEATURE, TYPE 2 (LWHF2): HABITAT LOG STABILITY ANALYSIS

Top Log

Long Pond Habitat Enhancement Design Project

Spreadsheet developed by Michael Rafferty, P.E.

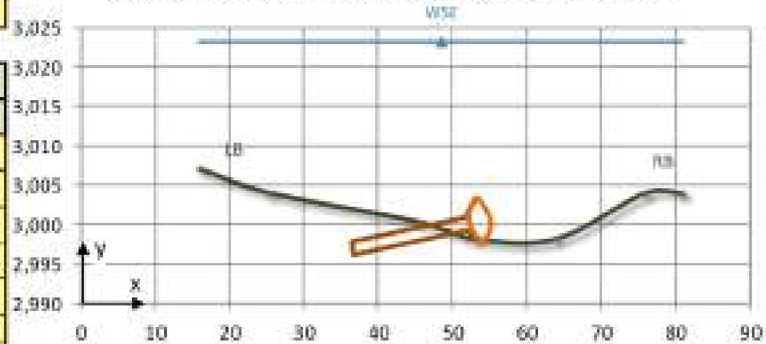
Single Log Stability Analysis Model Inputs

Site ID	Structure Type	Structure Position	Meander	Station	d_w (ft)	R_c/W_{BF}	u_{des} (ft/s)
Downstream of Crossing	Rootwad	Left bank	Outside	54+85	25.00	15.53	9.22

Multi-Log Structures	Layer	Log ID
	Stacked	TopLog

Channel Geometry Coordinates		
Proposed	x (ft)	y (ft)
Fldpln LB	15.88	3,007.11
Top LB	25.26	3,004.05
Toe LB	45.33	3,000.38
Thalweg	52.92	2,998.19
Toe RB	63.94	2,998.19
Top RB	75.88	3,004.00
Fldpln RB	80.89	3,004.00

Proposed Cross-Section and Structure Geometry (Looking D/S)

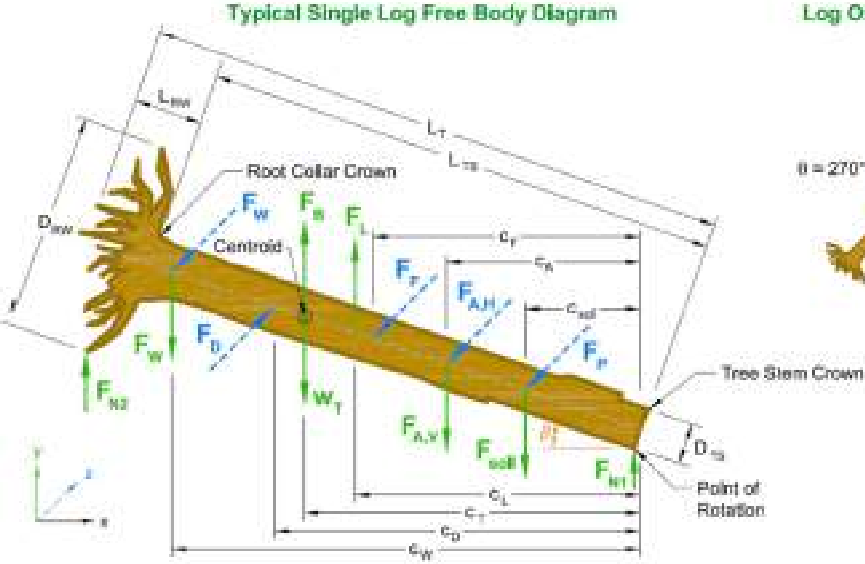


Wood Species	Rootwad	L_T (ft)	D_{TS} (ft)	L_{RW} (ft)	D_{RW} (ft)	γ_{Td} (lb/ft^3)	γ_{Tgr} (lb/ft^3)
Pine, Ponderosa	Yes	20.0	1.50	2.25	6.00	28.0	45.0

Structure Geometry	θ (deg)	β (deg)	Define Fixed Point	x_T (ft)	y_T (ft)	$y_{T,min}$ (ft)	$y_{T,max}$ (ft)	A_{Tp} (ft^2)
	60.0	-10.0	Root collar: Bottom	51.88	2,999.37	2,996.28	3,003.45	21.26

Soils	Material	γ_s (lb/ft^3)	γ'_s (lb/ft^3)	φ (deg)	Soil Class	$L_{T,ax}$ (ft)	$d_{b,max}$ (ft)	$d_{b,avg}$ (ft)
Stream Bed	Very coarse gravel	131.4	81.8	40.0	5	1.96	0.80	0.42
Bank	Gravel/cobble	137.0	85.3	41.0	4	10.35	4.23	2.53

Typical Single Log Free Body Diagram



Log Orientation (Plan View)

Downstream of Crossing Rootwad Stacked Log ID TopLog Page 2

Vertical Force Analysis

Net Buoyancy Force

Wood	V_{TS} (ft^3)	V_{RW} (ft^3)	V_T (ft^3)	W_T (lbf)	F_B (lbf)
↑WSE	0.0	0.0	0.0	0	0
↓WS↑Thw	19.5	21.9	41.4	1,157	2,583
↓Thalweg	11.9	0.4	12.3	552	766
Total	31.4	22.3	53.7	1,709	3,349

Lift Force

C_{LT}	0.05
F_L (lbf)	87

Vertical Force Balance

F_B (lbf)	3,349	↑
F_L (lbf)	87	↑
W_T (lbf)	1,709	↓
F_{soil} (lbf)	3,446	↓
$F_{W,V}$ (lbf)	0	
$F_{A,V}$ (lbf)	0	
ΣF_V (lbf)	1,720	↓
FS_V	1.50	

Soil Ballast Force

Soil	V_{dry} (ft^3)	V_{sat} (ft^3)	V_{soil} (ft^3)	F_{soil} (lbf)
Bed	0.0	1.2	1.2	98
Bank	0.0	39.3	39.3	3,348
Total	0.0	40.4	40.4	3,446

Horizontal Force Analysis

Drag Force

A_{Tp} / A_W	Fr_L	C_{Di}	C_w	C_D*	F_D (lbf)
0.03	1.33	1.19	0.00	1.25	2,195

Horizontal Force Balance

F_D (lbf)	2,195	→
F_P (lbf)	8,286	←
F_F (lbf)	1,473	←
$F_{W,H}$ (lbf)	0	
$F_{A,H}$ (lbf)	0	
ΣF_H (lbf)	7,564	←
FS_H	4.45	

Passive Soil Pressure / Friction Force

Soil	K_P	F_P (lbf)	L_{Tf} (ft)	µ	F_F (lbf)
Bed	4.60	225	7.51	0.84	606
Bank	4.81	8,061	10.36	0.87	867
Total	-	8,286	17.87	-	1,473

Moment Force Balance

Driving Moment Centroids / Resisting Moment Centroids

$c_{T,B}$ (ft)	c_L (ft)	c_D (ft)	$c_{T,W}$ (ft)	c_{soil} (ft)	$c_{F\&N}$ (ft)	c_P (ft)
12.7	16.7	16.2	12.7	6.1	7.9	8.1

*Distances are from the stem tip

Point of Rotation: Stem Tip

Moment Force Balance

M_d (lbf)	78,315
M_r (lbf)	133,436
FS_M	1.70

Anchor Forces

Additional Soil Ballast

V_{Adry} (ft^3)	V_{Awet} (ft^3)	c_{Asoil} (ft)	F_{AVsoil} (lbf)	F_{AHP} (lbf)
			0	0

Mechanical Anchors

Type	c_{Am} (ft)	Soils	F_{Am} (lbf)
			0
			0

Boulder Ballast

Position	D_r (ft)	c_{Ar} (ft)	$V_{r,dry}$ (ft^3)	$V_{r,wet}$ (ft^3)	W_r (lbf)	$F_{L,r}$ (lbf)	$F_{D,r}$ (lbf)	F_{AVr} (lbf)	F_{AHr} (lbf)
								0	0
								0	0
								0	0

Bottom Log

Long Pond Habitat Enhancement Design Project

Spreadsheet developed by Michael Rafferty, P.E.

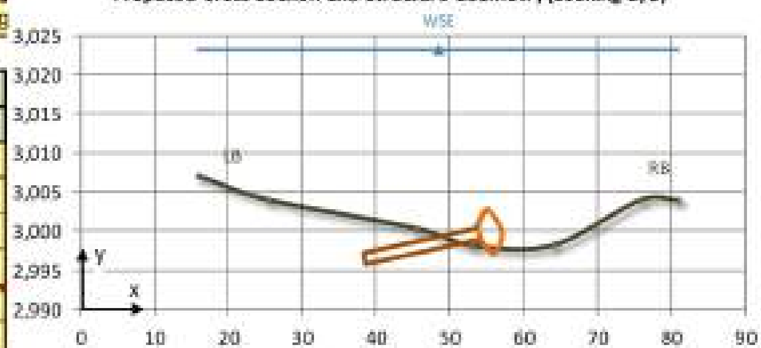
Single Log Stability Analysis Model Inputs

Site ID	Structure Type	Structure Position	Meander	Station	d_w (ft)	R_c/W_{BF}	u_{des} (ft/s)
Downstream of Crossing	Rootwad	Left bank	Outside	54+85	25.00	15.53	9.22

Multi-Log Structures	Layer	Log ID
	Stacked	BottomLog

Channel Geometry Coordinates		
Proposed	x (ft)	y (ft)
Fldpln LB	15.88	3,007.11
Top LB	25.26	3,004.06
Toe LB	45.33	3,000.38
Thalweg	52.92	2,998.19
Toe RB	63.94	2,998.19
Top RB	75.88	3,004.00
Fldpln RB	80.89	3,004.00

Proposed Cross-Section and Structure Geometry (Looking D/S)

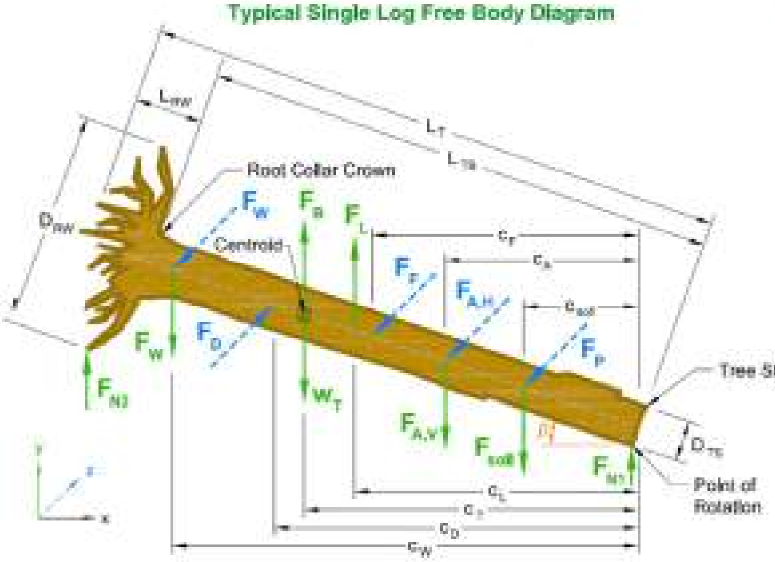


Wood Species	Rootwad	L_T (ft)	D_{TS} (ft)	L_{RW} (ft)	D_{RW} (ft)	γ_{Td} (lb/ft^3)	γ_{Tw} (lb/ft^3)
Pine, Ponderosa	Yes	20.0	1.50	2.25	6.00	28.0	45.0

Structure Geometry	θ (deg)	β (deg)	Define Fixed Point	x_T (ft)	y_T (ft)	$y_{T,min}$ (ft)	$y_{T,max}$ (ft)	A_{Tp} (ft^2)
	120.0	-10.0	Root collar: Bottom	53.71	2,998.77	2,995.69	3,002.85	19.74

Soils	Material	γ_s (lb/ft^3)	γ'_s (lb/ft^3)	ϕ (deg)	Soil Class	$L_{T,em}$ (ft)	$d_{b,max}$ (ft)	$d_{b,avg}$ (ft)
Stream Bed	Very coarse gravel	131.4	81.8	40.0	5	4.27	1.79	0.91
Bank	Gravel/cobble	137.0	85.3	41.0	4	8.19	4.49	3.16

Typical Single Log Free Body Diagram



Log Orientation (Plan View)

Downstream of Crossing | Rootwad | Stacked | Log ID | BottomLog | Page 2

Vertical Force Analysis

Net Buoyancy Force

Wood	V_{TS} (ft³)	V_{RW} (ft³)	V_T (ft³)	W_T (lbf)	F_B (lbf)
↑WSE	0.0	0.0	0.0	0	0
↓WS↑Thw	13.4	20.4	33.8	944	2,108
↓Thalweg	17.9	1.9	19.9	893	1,239
Total	31.4	22.3	53.6	1,838	3,347

Lift Force

C_{LT}	0.07
F_L (lbf)	107

Vertical Force Balance

F_B (lbf)	3,347	↑
F_L (lbf)	107	↑
W_T (lbf)	1,838	↓
F_{soil} (lbf)	3,764	↓
$F_{W,V}$ (lbf)	0	
$F_{A V}$ (lbf)	0	
Σ F_V (lbf)	2,148	↓
FS_V	1.62	

Soil Ballast Force

Soil	V_{dry} (ft³)	V_{sat} (ft³)	V_{soil} (ft³)	F_{soil} (lbf)
Bed	0.0	5.9	5.9	479
Bank	0.0	38.5	38.5	3,285
Total	0.0	44.4	44.4	3,764

Horizontal Force Analysis

Drag Force

A_{Tp} / A_W	Fr_L	C_{Di}	C_w	C_D*	F_D (lbf)
0.02	1.33	0.94	0.00	0.98	1,602

Horizontal Force Balance

F_D (lbf)	1,602	→
F_P (lbf)	9,009	←
F_F (lbf)	1,832	←
$F_{W,H}$ (lbf)	0	
$F_{A H}$ (lbf)	0	
Σ F_H (lbf)	9,239	←
FS_H	6.77	

Passive Soil Pressure / Friction Force

Soil	K_P	F_P (lbf)	L_{Tf} (ft)	μ	F_F (lbf)
Bed	4.60	1,102	9.80	0.84	984
Bank	4.81	7,907	8.15	0.87	848
Total	-	9,009	17.95	-	1,832

Moment Force Balance

Driving Moment Centroids / Resisting Moment Centroids

$c_{T,B}$ (ft)	c_L (ft)	c_D (ft)	$c_{T,W}$ (ft)	c_{soil} (ft)	$c_{F\&N}$ (ft)	c_P (ft)
12.6	17.4	16.3	12.6	6.2	8.0	8.3

*Distances are from the stem tip

Point of Rotation: Stem Tip

Moment Force Balance

M_d (lbf)	68,930
M_r (lbf)	150,247
FS_M	2.18

Anchor Forces

Additional Soil Ballast

V_{Adry} (ft³)	V_{Awet} (ft³)	c_{Asoil} (ft)	F_{AVsoil} (lbf)	F_{AHP} (lbf)
			0	0

Mechanical Anchors

Type	c_{Am} (ft)	Soils	F_{Am} (lbf)
			0
			0

Boulder Ballast

Position	D_r (ft)	c_{Ar} (ft)	$V_{r,dry}$ (ft³)	$V_{r,wet}$ (ft³)	W_r (lbf)	$F_{L,r}$ (lbf)	$F_{D,r}$ (lbf)	F_{AVr} (lbf)	F_{AHr} (lbf)
								0	0
								0	0
								0	0

NURSE LOG: HABITAT LOG STABILITY ANALYSIS

Long Pond Habitat Enhancement Design Project

Spreadsheet developed by Michael Rafferty, P.E.

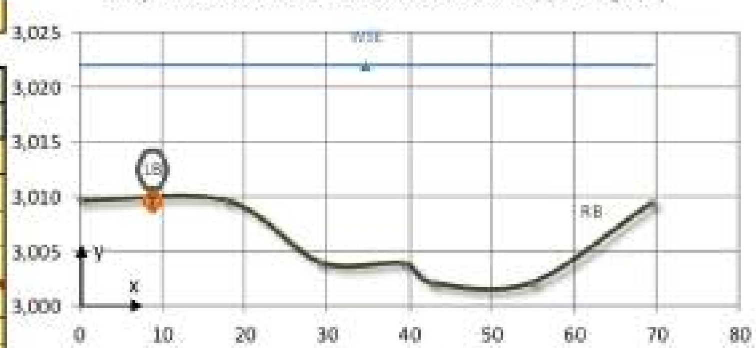
Single Log Stability Analysis Model Inputs

Site ID	Structure Type	Structure Position	Meander	Station	d_w (ft)	R_c/W_{BF}	u_{des} (ft/s)
Downstream of Crossing	Floodplain	Left bank	Outside	53+00	18.00	15.53	9.22

Multi-Log Structures	Layer	Log ID
	N/A	1

Channel Geometry Coordinates		
Proposed	x (ft)	y (ft)
Fldpln LB	0.00	3,009.66
Top LB	17.76	3,009.66
Toe LB	29.24	3,004.00
Thalweg	39.25	3,003.92
Toe RB	42.83	3,002.13
Top RB	54.83	3,002.13
Fldpln RB	69.43	3,009.43

Proposed Cross-Section and Structure Geometry (Looking D/S)

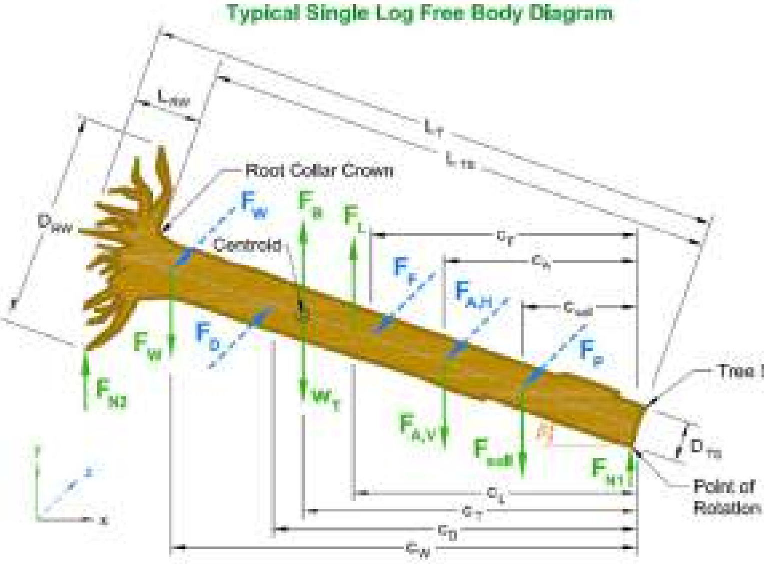


Wood Species	Rootwad	L_T (ft)	D_{TS} (ft)	L_{RW} (ft)	D_{RW} (ft)	γ_{Td} (lb/ft^3)	γ_{Tgr} (lb/ft^3)
Douglas-fir, Coast	No	20.0	2.00	-	-	33.5	38.0

Structure Geometry	θ (deg)	β (deg)	Define Fixed Point	x_T (ft)	y_T (ft)	$y_{T,min}$ (ft)	$y_{T,max}$ (ft)	A_{Tp} (ft^2)
	0.0	0.0	Root collar: Bottom	8.88	3,008.66	3,008.66	3,010.66	0.00

Soils	Material	γ_s (lb/ft^3)	γ'_s (lb/ft^3)	φ (deg)	Soil Class	$L_{T,se}$ (ft)	$d_{b,max}$ (ft)	$d_{b,avg}$ (ft)
Stream Bed	Very coarse gravel	131.4	81.8	40.0	5	0.00	0.00	0.00
Bank	Silt, soft	82.0	51.1	30.0	7	20.00	0.00	0.00

Typical Single Log Free Body Diagram



Log Orientation (Plan View)

Downstream of Crossing Floodplain

Vertical Force Analysis

Net Buoyancy Force

Wood	V_{TS} (ft^3)	V_{RW} (ft^3)	V_T (ft^3)	W_T (lbf)	F_B (lbf)
↑WSE	0.0	0.0	0.0	0	0
↓WS↑Thw	62.8	0.0	62.8	2,108	3,921
↓Thalweg	0.0	0.0	0.0	0	0
Total	62.8	0.0	62.8	2,108	3,921

Lift Force

C_{LT}	0.00
F_L (lbf)	0

Vertical Force Balance

F_B (lbf)	3,921
F_L (lbf)	0
W_T (lbf)	2,108
F_{soil} (lbf)	0
$F_{W,V}$ (lbf)	0
F_{AV} (lbf)	4,150
ΣF_V (lbf)	2,337
FS_V	1.60

Soil Ballast Force

Soil	V_{dry} (ft^3)	V_{sat} (ft^3)	V_{soil} (ft^3)	F_{soil} (lbf)
Bed	0.0	0.0	0.0	0
Bank	0.0	0.0	0.0	0
Total	0.0	0.0	0.0	0

Horizontal Force Analysis

Drag Force

A_{Tp} / A_W	Fr_L	C_{Di}	C_w	C_D*	F_D (lbf)
0.00	1.15	1.12	0.01	1.13	0

Horizontal Force Balance

F_D (lbf)	0
F_P (lbf)	0
F_F (lbf)	1,405
$F_{W,H}$ (lbf)	0
F_{AH} (lbf)	0
ΣF_H (lbf)	1,404
FS_H	4,343.27

Passive Soil Pressure / Friction Force

Soil	K_P	F_P (lbf)	L_{Tf} (ft)	μ	F_F (lbf)
Bed	4.60	0	2.00	0.84	178
Bank	3.00	0	20.00	0.58	1,226
Total	-	0	22.00	-	1,405

Moment Force Balance

Driving Moment Centroids / Resisting Moment Centroids

$c_{T,B}$ (ft)	c_L (ft)	c_D (ft)	$c_{T,W}$ (ft)	c_{soil} (ft)	$c_{F\&N}$ (ft)	c_P (ft)
10.0	0.0	10.0	10.0	0.0	10.0	0.0

*Distances are from the stem tip

Point of Rotation: Root Collar

Moment Force Balance

M_d (lbf)	39,210
M_r (lbf)	99,990
FS_M	2.55

Anchor Forces

Additional Soil Ballast

V_{Adry} (ft^3)	V_{Awet} (ft^3)	c_{Asoil} (ft)	F_{AVsoil} (lbf)	F_{AHP} (lbf)
			0	0

Mechanical Anchors

Type	c_{Am} (ft)	Soils	F_{Am} (lbf)
			0
			0

Boulder Ballast

Position	D_r (ft)	c_{Ar} (ft)	$V_{r,dry}$ (ft^3)	$V_{r,wet}$ (ft^3)	W_r (lbf)	$F_{L,r}$ (lbf)	$F_{D,r}$ (lbf)	F_{AVr} (lbf)	F_{AHr} (lbf)
Above	3.45	17.0	0.0	21.5	2,206	131	656	2,075	0
Above	3.45	3.0	0.0	21.5	2,206	131	656	2,075	0
Above								0	0

ROUGHENED CHANNEL (RC): ENGINEERED STREAMBED MATERIAL (ESM) SIZING

Estimates of flow in the proposed channel were developed using a high biased method with a normal depth calculation. The flow depth was assumed as the difference between the 1-Percent Annual Chance Exceedance event and the design finished grade in Civil 3D. The 1-Percent Annual Chance Exceedance water surface is not defined in the current effective Federal Emergency Management Agency (FEMA) Special Flood Hazard Area (SFHA) mapping since a detailed study was not performed for this segment of the Scott River or Sugar Creek as part of the current effective mapping. Therefore, the 1-Percent Annual Chance Exceedance water surface elevation was estimated as the elevation obtained from the 2018 LiDAR DEM at the point of intersection of the FEMA SFHA Zone A with State Route 3 just downstream of Sugar Creek. The hydraulic slope was assumed to be the steepest finished grade slope at each of the three ESM applications, including at Plug 1, Plug 2, and the proposed bridge crossing. The ESM gradation was determined using the methodology outlined in the California Department of Fish and Wildlife Salmonid Stream Habitat Restoration Manual Part XII Fish Passage Design and Implementation dated July 2009. The ESM gradation was selected from the calculation for the location that resulted in the coarsest ESM gradation to increase the longevity and stability of the RC features and homogenize the specified material for improved construction practicality and the potential for reuse of onsite salvaged materials.

Location: Plug 1

Hydraulic Slope (ft/ft)	Flow in Channel (cfs)	Active Channel Width (ft)	Unit Discharge (cfs/ft)	Design Unit Discharge for Rounded Rock (cfs/ft)	Percent Increase for Assumed Rounded Rock	D30-ACOE [inches]	D84-ESM [inches]	D50-ESM [inches]	D100-ESM [inches]	n (0.45-0.7)	D16-ESM [inches]	D8-ESM (Should roughly equate to 2 mm) [inches]	Thicknes s (0.67 x D100) [inches]	D84/D16 (typically 8-14)
0.0207	21.6	14.2	1.5	2.4	60.0	1.8	2.7	1.1	6.7	0.5	0.1	0.1	4.5	31.4

Location: Plug 2

Hydraulic Slope (ft/ft)	Flow in Channel (cfs)	Active Channel Width (ft)	Unit Discharge (cfs/ft)	Design Unit Discharge for Rounded Rock (cfs/ft)	Percent Increase for Assumed Rounded Rock	D30-ACOE [inches]	D84-ESM [inches]	D50-ESM [inches]	D100-ESM [inches]	n (0.45-0.7)	D16-ESM [inches]	D8-ESM (Should roughly equate to 2 mm) [inches]	Thicknes s (0.67 x D100) [inches]	D84/D16 (typically 8-14)
0.0163	200.0	14.2	14.1	22.5	60.0	6.9	10.4	4.2	26.0	0.5	0.3	0.1	17.4	31.4

Location: Crossing

Hydraulic Slope (ft/ft)	Flow in Channel (cfs)	Active Channel Width (ft)	Unit Discharge (cfs/ft)	Design Unit Discharge for Rounded Rock (cfs/ft)	Percent Increase for Assumed Rounded Rock	D30-ACOE [inches]	D84-ESM [inches]	D50-ESM [inches]	D100-ESM [inches]	n (0.45-0.7)	D16-ESM [inches]	D8-ESM (Should roughly equate to 2 mm) [inches]	Thicknes s (0.67 x D100) [inches]	D84/D16 (typically 8-14)
0.0207	21.6	14.2	1.5	2.4	60.0	1.8	2.7	1.1	6.7	0.5	0.1	0.1	4.5	31.4

ESM GRADATION

ESM COMPONENT	EFFECTIVE SIZE	PERCENT PASSING	PARTICLE SIZE (IN)
LARGEST FRAMEWORK ROCK	D100	100	24*
SMALLER FRAMEWORK ROCK	D84	84	10.5
	D50	50	4.2
SMALLER INTERSTITIAL VOID FILLING ROCK	D16	16	0.25
	D8	8	0.08**

* PARTICLE SIZE SHALL BE DETERMINED BY THE AVERAGE DIMENSION OF THE THREE AXES OF THE BOULDER (I.E., LENGTH, WIDTH, AND THICKNESS) BY USE OF THE FOLLOWING CALCULATION:

$$\frac{\text{LENGTH + WIDTH + THICKNESS}}{3} = \text{APPROXIMATE SIZE}$$

LENGTH IS THE LONGEST AXIS, WIDTH IS THE SECOND LONGEST AXIS, AND THICKNESS IS THE SHORTEST AXIS

** PARTICLE SIZE CORRESPONDS TO ASTM E11 NO. 10 SIEVE OPENING SIZE