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Salmon River Floodplain Habitat Enhancement and Mine Tailing Remediation Project

Phase 2: Conceptual Design

PREPARED FOR

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1 INTRODUCTION

The Salmon River Restoration Council (SRRC), in collaboration with the US Forest Service, Karuk Tribe Department of Natural Resources, and other State and Federal resource agencies, initiated the Salmon River Floodplain Habitat Enhancement and Mine Tailing Remediation Project (project) in 2014. The project is a collaborative, science-based process focused on increasing the long-term productivity of anadromous salmonids in the Salmon River by strategically restoring and enhancing aquatic and riparian floodplain habitats, geomorphic functions, and stream temperatures within lower gradient, predominantly alluvial reaches of the mainstem, North Fork, and South Fork Salmon River. The proposed restoration and enhancement actions are needed to support conservation and recovery of listed and at-risk salmonid and lamprey populations. Whereas the SRRC, USDA Forest Service, and their partners have addressed many of the high-priority fish passage barriers in tributaries and the treatable upslope sediment sources within the watershed, this project will directly address limiting aquatic and riparian habitat conditions within mainstem channel and floodplain areas. The Klamath National Forest is the lead federal agency for purposes of NEPA compliance. The CEQA lead agency has yet to be determined.

1.1 Project Area

The project is located on the Salmon/Scott River Ranger District of the Klamath National Forest (KNF) in Siskiyou County, California. The project area spans from the confluence of Morehouse Creek with the Mainstem Salmon River (River Station [Sta] 0) upstream to the Marble Mountain Wilderness Area boundary near Russian Creek on the North Fork and the Trinity Alps Wilderness Area boundary near Rush Creek on the South Fork (Figure 1). The project area includes the channel, tributary confluences, floodplains, and adjacent low-lying river terraces within 55 river miles of the mainstem Salmon River (7 mi), mainstem North Fork Salmon River (19 mi), and mainstem South Fork Salmon River (29 mi) in the Salmon River subbasin (4th field watershed, HUC 18010210).

The project area encompasses most of the basin-wide channel network that is relatively low-gradient (typically less than 3%); has predominantly alluvial morphology; and provides critical spawning, over-wintering, and over-summering habitat for multiple species and runs of salmon and steelhead (Elder et al. 2002). The potential for floodplain and associated aquatic habitat enhancement in the lower mainstem Salmon River downstream of the project area is relatively low due to the predominantly bedrock-controlled channel, high stream power, and fewer hydraulically mined areas. Floodplain and associated aquatic habitat enhancement opportunities are similarly limited in the steep, confined, and bedrock-controlled tributary channel network within the project area, much of which occurs in wilderness areas with limited access and is upstream of the extent of anadromy.

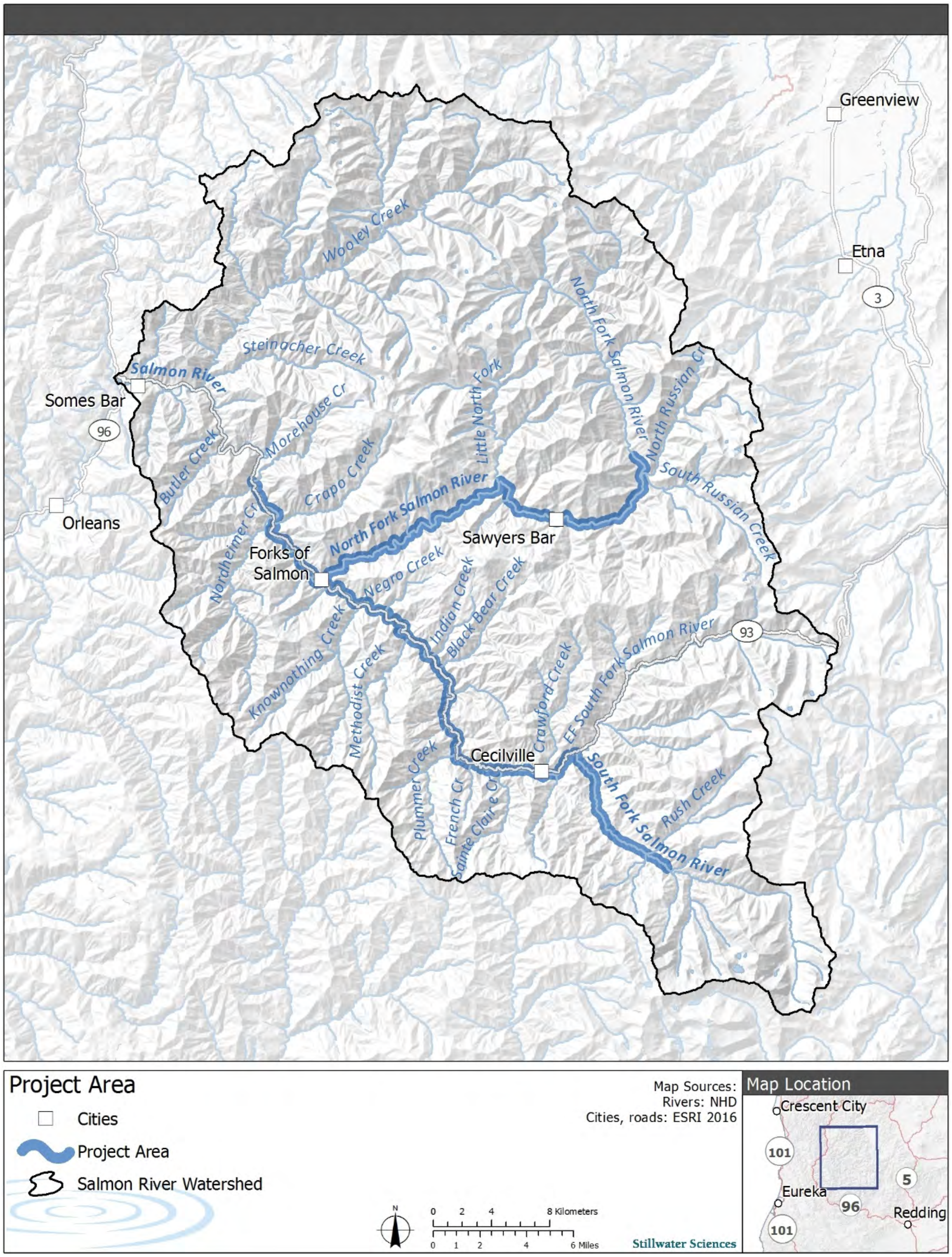


Figure 1. Salmon River Project area.

1.2 Background

The Salmon River hosts all of the native anadromous fish runs present in the Klamath River, including Southern Oregon/Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch*), Upper Klamath-Trinity Rivers (UKTR) fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and spring-run Chinook salmon (*Oncorhynchus tshawytscha*), Klamath Mountains Province (KMP) summer steelhead (*Oncorhynchus mykiss irideus*) and winter steelhead (*Oncorhynchus mykiss irideus*), Pacific lamprey (*Entosphenus tridentatus*), and green sturgeon (*Acipenser medirostris*). As one of the highest elevation Klamath River sub-basins that is primarily in federal ownership and has few consumptive water diversions, the Salmon River has some of the highest anadromous fisheries value in the basin (Elder et al. 2002) and is a key long-term refuge for these fish and other cold-water dependent aquatic species.

The Salmon River watershed is particularly important to the resiliency of threatened SONCC coho salmon (NMFS 2014), KMP summer steelhead, and UKTR spring-run Chinook salmon; all of which have juvenile life-histories that require over-summering in habitats with suitably cool water. The Salmon River has the largest self-sustaining population of UKTR spring-run Chinook salmon in the Klamath Basin and is the least influenced by hatcheries (SRF 2016). Approximately 110 miles of habitat is accessible to spring-run Chinook salmon in the Salmon River (West 1991). The South Fork and North Fork of the Salmon River support the majority of the remaining spawning population, although spawning also occurs in the larger tributaries, including Nordheimer, Knownothing, Methodist, and Wooley creeks (Moyle et al. 2017).

Wild spring-run Chinook and coho salmon runs in the Salmon River face a high risk of extinction, however, due to major stressors. These stressors include (NMFS 2014):

- Diminished structure in the baseflow channel, reduced floodplain connectivity, and degraded riparian conditions that limit juvenile rearing and overwintering habitat;
- Elevated summer water temperatures and a dependence on impacted summer thermal refuges that limit juvenile over-summering carrying capacity; and
- Coarsened bed material that limits suitable spawning habitat.

These stressors result from hydrologic, geomorphic, and vegetation changes related to disruption of the natural fire regime, timber harvest, sediment delivery from roads and landslides, scour by large floods and debris torrents, and historical mining (USDA Forest Service 1994a, 1994b, 1995a, 1995b). The North Coast Regional Water Quality Control Board listed the Salmon River as temperature impaired and attributed the impairment largely to loss of riparian shade cover and changes in channel geometry associated with aggradation (NCRWQCB 2005). As the primary federal land owner in the Salmon River watershed, the USDA Forest Service is primarily responsible for managing the Salmon River as a Wild and Scenic River and taking actions to reduce temperature impairments.

One of the most important factors leading to the decline and continued low abundance of anadromous salmonids in the Salmon River is the legacy effects of historical placer mining on channel and floodplain habitat conditions throughout the mainstem and larger tributary reaches (Stumpf 1979, SRRC 2017). Hydraulic and dredge placer mining in the Salmon River between about 1870 and 1950 led to profound and lasting changes, eroding over 1,859 acres adjacent to the mainstem and larger tributary channels and delivering an estimated 20.3 million cubic yards of sediment to the river (Figure 2) (Hawthorne 2017, de la Fuente and Haessig 1993). Placer mining denuded floodplains and adjacent river terraces and hillslopes, reduced riparian shade cover, and exposed the stream channel and surrounding areas to increased solar radiation.

Delivery of hydraulic mine debris resulted in as much as five meters of channel aggradation, on average, throughout the predominantly alluvial reaches within the project area. Aggradation by hydraulically mined sediment widened and shallowed alluvial reaches, filled pools, reduced the complexity and connectivity of floodplain habitats, and led to coarsening and armoring of the channel bed. Coarse sediment stored in the bankfull channel, denuded floodplains, and mine tailings on terraces along the river corridor continues to prevent riparian vegetation establishment, and due to the increased exposure to solar radiation and thermal mass, creates a severe heating effect. These impacts significantly reduce the amount and quality of spawning, over-summering, and over-wintering habitat and decrease the cumulative channel length that remains thermally suitable for salmonids during the summer, thereby constraining population productivity and increasing extinction risk. These legacy impacts to the channel and floodplain inhibit natural recovery and require intervention to recover within human and salmon population time scales.

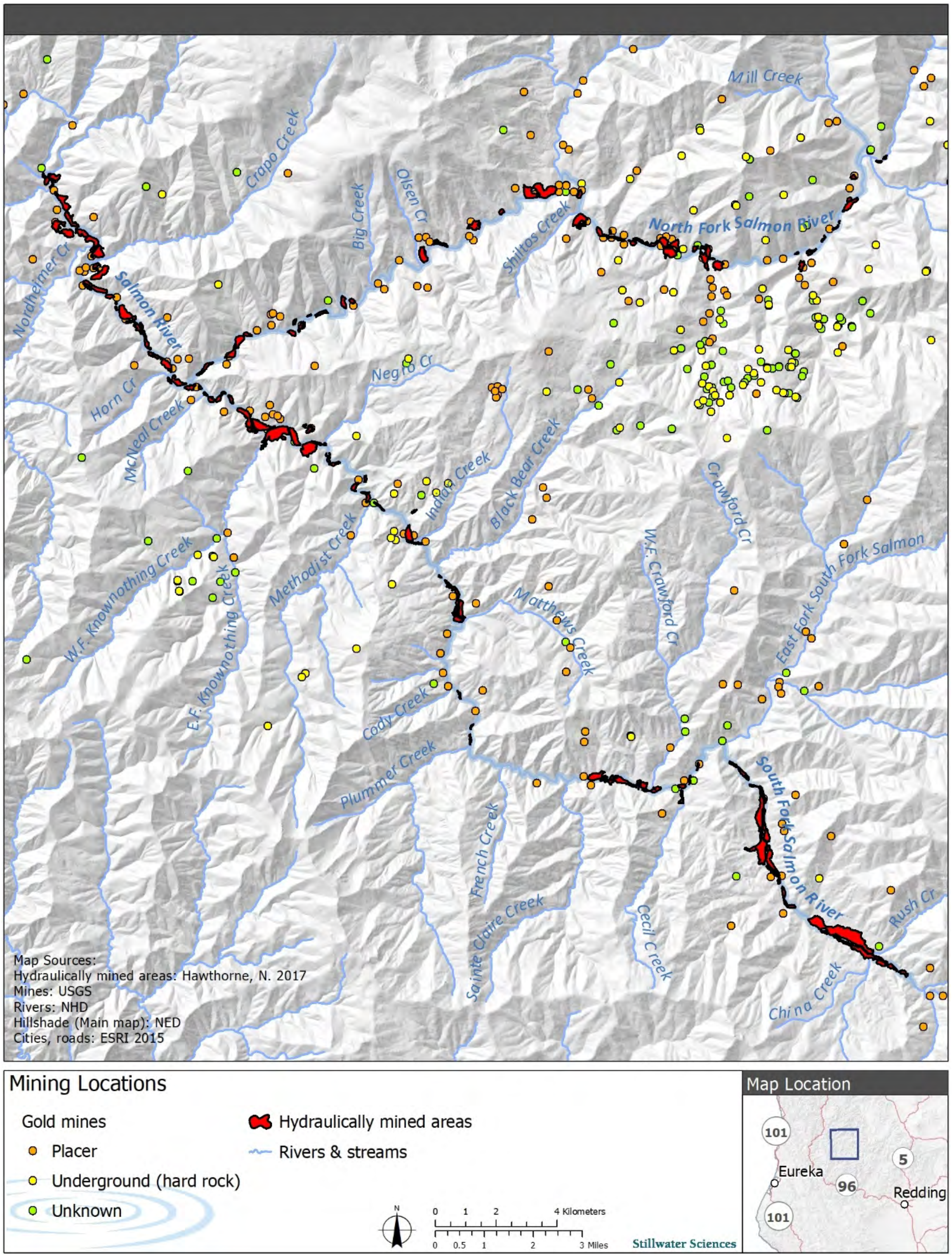


Figure 2. Gold mines and hydraulically mined areas within the Salmon River project area.

1.3 Objectives

The Salmon River Floodplain Habitat Enhancement and Mine Tailing Remediation Project is a comprehensive prioritized approach to strategically improving stream temperatures, geomorphic functions, and aquatic habitat in the Salmon River. Its goal is to increase long-term salmonid productivity and ensure that the Salmon River remains a long-term refuge for cold-water dependent aquatic species as climate change progresses.

The specific project objectives include:

1. Increasing the availability and quality of limiting over-wintering, over-summering, and spawning habitat for salmonids and lamprey;
2. Improving riparian functions (e.g., shade cover from riparian vegetation);
3. Improving hydrologic functions (e.g., floodplain inundation and hyporheic exchange); and
4. Protecting and enhancing thermally suitable habitats (e.g., cool-water reaches, thermally stratified pools, and summer thermal refuges associated with tributaries and springs).

In addition to benefiting at-risk salmonids and lamprey, restoring better-functioning hydrologic and hydraulic conditions and associated wetland and riparian vegetation within the project area would benefit many other species of concern, including neotropical migratory birds (willow flycatcher and others), Cascades frog, foothill yellow-legged frog, tailed frog, western pond turtle, American dipper, northern water shrew, long-tailed vole, and resident Rainbow Trout. While the project's purpose and need are focused primarily on accelerating recovery of listed species by restoring lotic, wetland, and riparian habitat; the project would also benefit local communities. Recovering anadromous fish populations in the Salmon River would help protect commercial, recreational, and sustenance fishing that is vital to local economies and tribal cultures.

The Proposed Action may include the following types of restoration and enhancement activities intended to reconnect the river's floodplain with the river, establish or expand side-channel and off-channel habitat, and enhance the bed and banks of the Salmon River.

- Recontouring (e.g., grading and/or adding structure) and revegetating degraded floodplains and mine tailings to promote development of functional riparian habitat, increase riparian shading, reduce heating, and improve hyporheic exchange. These activities would include grading to create and enhance topographic features but with no net change in the volume of earthen material within the activity areas.
- Constructing or lowering floodplain surfaces to improve hydrologic function and processes, primarily by expanding the surface area of the channel inundated at specific flows and by increasing flow connectivity (e.g., frequency and duration of inundation) and hyporheic exchange (i.e., interaction between shallow groundwater and surface flows) between the winter baseflow channel, secondary channels, and other off-channel areas. Newly inundated surfaces would provide rearing and low velocity habitat for juvenile salmonids and other native anadromous fish. These treatment areas would rely on a combination of natural recruitment of native riparian vegetation and riparian planting to establish a diverse assemblage of native vegetation.
- Modifying historical side channels or constructing new side channels to reconnect the Salmon River to its floodplain at targeted flows.
- Excavating alcoves to specific design elevations at the downstream end of side channels and other appropriate locations to provide continuous, year-round juvenile fish habitat.

- Creating, enhancing, and connecting off-channel ponds and wetlands to improve rearing habitat.
- Adding structural complexity to the summer baseflow channel of simplified reaches (e.g., those with plane-bed morphology) and in secondary channels and other off-channel areas to promote hydraulic complexity and pool depth, increase the amount and quality of low-velocity rearing habitat, and sort spawning gravel.
- Protecting and expanding cold water refuges at summer baseflow within the mainstem channels, the lower reaches of major tributaries, and in areas associated with seeps and springs to improve holding and summer rearing habitat conditions.
- Restoring vegetation to degraded riparian areas and terraces by manual or mechanical planting.
- Augmenting floodplain enhancements with structural elements, such as boulders and wood structures consisting of multiple large diameter logs with rootwads. Wood materials could be sourced from riparian reserves within or adjacent to project planning units or could be acquired from authorized off-site sources through purchases and private donations.

The highest priority restoration and enhancement actions include those identified in the SONCC Coho Salmon recovery plan (NMFS 2014) and Salmon River Temperature TMDL implementation plan (NCRWQCB 2005), as well as measures deemed most effective at recovering the spring-run Chinook salmon population within the Salmon River (West 1991, Moyle et al. 2017).

A project would involve implementing individual or small groups of restoration and enhancement activities within one or more planning units. Projects would be implemented over the course of several decades, beginning as early as 2022.

2 APPROACH

The restoration and enhancement actions were identified, prioritized, and conceptually designed as part of a phased approach organized into the following four steps:

Phase 1. Assessing floodplain habitat restoration and enhancement opportunities and constraints, including identifying and prioritizing channel segments for treatment;

Phase 2. Developing conceptual restoration and enhancement designs within priority channel segments;

Phase 3. Conducting the appropriate California State and Federal environmental review; and

Phase 4. Comprehensively implementing sequential, prioritized restoration and enhancement projects.

2.1 Phase 1

The project area includes 36 potential floodplain habitat enhancement segments that were delineated during Phase 1 based on analyses of geomorphic, hydraulic, biological, and land use conditions; assigned a suitability rating from 1 (most suited for floodplain habitat restoration) to 3 (less suited); and aggregated into planning units. Refer to *The Salmon River Floodplain Habitat Enhancement and Mine Tailing Remediation Project, Phase 1: Technical Analysis of Opportunities and Constraints* (Stillwater Sciences 2018) for details (including the project footprint) and a description of the analytical process used to identify and prioritize channel segments, planning units, and project activities.

2.1.1 Channel reaches

The overall approach to Phase 1 of the project involved first delineating reaches with wider and predominantly alluvial channel boundaries and floodplains that historically provided the greatest floodplain habitat values, have been most impacted by historical hydraulic mining and other disturbances, and provide the greatest opportunities for restoring floodplain habitat and remediating mine tailings (Figure 3). Once geomorphic reaches were delineated, additional analyses were conducted to identify restoration and enhancement opportunities. These analyses included evaluating the spatial distribution of summer water temperature deviations (i.e., relatively warmer and colder water) throughout the 55-mile project area to identify thermally suitable habitat and help distinguish between cool-water reaches, thermally stratified pools, and localized cold-water inputs. Flow inundation was modeled within the approximately 37 miles of predominantly alluvial reaches to assess existing and potential floodplain inundation, secondary flow paths, and winter and spring rearing habitats for anadromous salmonids.

2.1.2 Potential floodplain habitat enhancement segments

Historical aerial photos were used in combination with LiDAR topography and the results of thermally suitable habitat and flow inundation analyses to identify channel segments within predominantly alluvial reaches that provide site-specific opportunities to restore and enhance floodplain habitats and remediate mine tailings. We identified 36 potential floodplain habitat enhancement segments in predominantly alluvial reaches: 4 in the mainstem, 17 in the South Fork, and 15 in the North Fork (Figure 3, Table 1). Potential floodplain habitat enhancement segments encompass 12.9 miles (23% of the total project channel length and 38% of the total predominantly alluvial reach length). Figure 4 illustrates the distribution of potential floodplain habitat enhancement segments with respect to the channel longitudinal profile. Refer to Appendix A for the location and extent of floodplain habitat enhancement segments with respect to thermally suitable habitat and flow inundation.

2.1.3 Suitability rating

These segments offering site-specific restoration opportunities were assigned a preliminary suitability rating from 1 to 3 (1=higher suitability; 3=lower suitability) based on physical and biological site conditions, anticipated benefits of potential treatments, and feasibility (Table 1). Physical criteria included existing geomorphic characteristics and sediment dynamics; the type, areal extent, and frequency of flow inundation; physical constraints (i.e., bedrock control and developed infrastructure); and anticipated hydraulic and geomorphic responses to potential treatments. Biological criteria included the quantity and quality of existing spawning, over-wintering, and over-summering habitat; presence, size, and importance of thermally suitable habitat; location of the channel segments with respect to warming and cooling trends over the riverine longitudinal profile revealed in the analysis of median water temperatures; extent and quality of riparian cover (SRRC 2008); and anticipated ecological responses (e.g., spawning and rearing habitat creation) to potential treatments. More geomorphically complex segments (e.g., containing side channels and split-flow channels, alluvial bars, alcoves, off-channel ponds, etc.) with larger areas of low-lying topography that inundate more frequently and for longer duration but are highly disturbed and contain impaired in-stream and/or floodplain habitats were rated with higher suitability. Sites were also considered more suitable if they lacked lateral and/or vertical bedrock controls that could inhibit implementation (e.g., floodplains underlain by a bedrock strath surface or bedrock outcrop at the head/entrance of side channels, alcoves, ponds, etc.).

The project team conducted reconnaissance field review of all potential floodplain habitat enhancement segments to confirm analysis results, further assess opportunities and constraints to habitat restoration and mine tailing remediation, and refine preliminary suitability ratings. Channel segments with higher restoration potential (i.e., suitability rating 1 and 2) received more detailed field scrutiny than segments with relatively lower potential (i.e., suitability rating 3). Ratings for individual channel segments were further refined during detailed field studies conducted in support of Phase 2 development of conceptual restoration and enhancement designs (Refer to Section 2.2). Appendix B describes the physical and biological conditions, opportunities and constraints, suitability rating, and initial conceptual approaches to floodplain habitat enhancement and mine tailing remediation within each segment.

2.1.4 Planning units

Planning units encompass the main river channel, floodplains (including secondary channels and other off-channel habitats), tributary confluence areas, and selected adjacent river terraces and hillslopes within one or more enhancement segments, including the intervening river corridor. The planning units (totaling about 1,400 acres) are intended to help facilitate comprehensive environmental compliance and permitting, and to ensure that implementation considers interrelated actions that could more broadly affect channel and floodplain conditions within a reach. This step in the Phase 1 planning process also allows for inclusion of various types and scales of potential actions that may not otherwise be explicitly identified in the opportunities and constraints analysis or conceptual design plans.

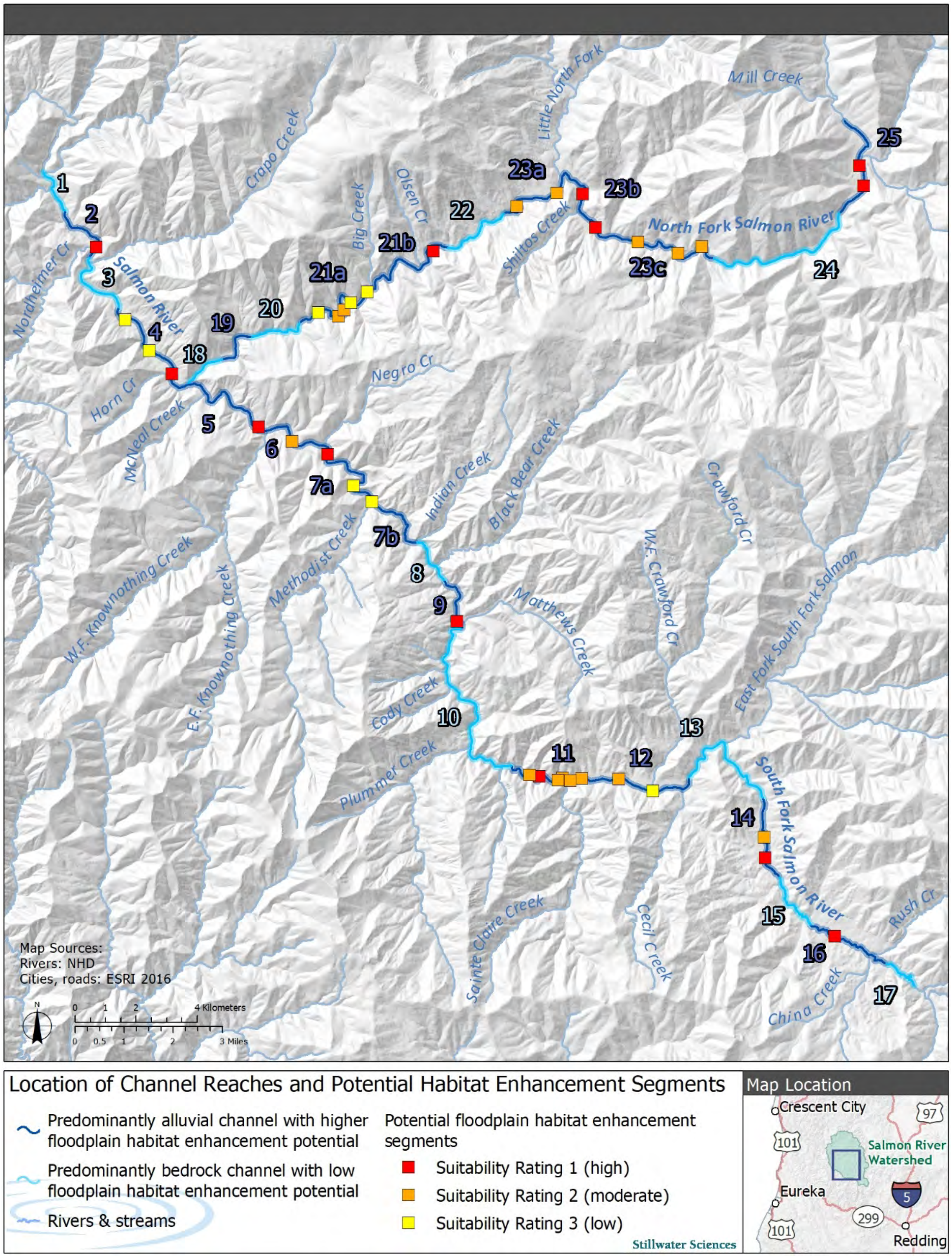


Figure 3. Location and suitability of potential floodplain habitat enhancement segments within the project area. Reaches are indicated by number.

Table 1. Potential floodplain habitat enhancement segments.

Segment[1]	Name	Reach Station (Sta)		Length (mi)	Gradient (%)	Suitability rating
		Up	Down			
SF16 Sta 137,100	Downstream of China Creek (Sommerville)	140,500	133,700	1.29	1.41	1
SF14 Sta 123,550	Blue Gulch (Upper Petersburg)	124,900	122,200	0.51	1.23	1
SF14 Sta 121,050	Lower Petersburg	122,100	120,000	0.40	1.43	2
SF12 Sta 96,500	Crawford Creek	96,800	96,200	0.11	1.04	3
SF12 Sta 92,450	Indian Gulch/Timber Gulch	93,400	91,500	0.36	0.60	2
SF11 Sta 87,950	Downstream of Orton Gulch	89,000	86,900	0.40	0.73	2
SF11 Sta 86,650	Upstream of Saint Claire Creek	87,000	86,300	0.13	0.84	2
SF11 Sta 85,550	Downstream of Saint Claire Creek	86,300	84,800	0.28	1.01	2
SF11 Sta 84,500	Mining site downstream of Saint Claire Creek	84,800	84,200	0.11	0.70	2
SF11 Sta 82,050	Footbridge	82,400	81,700	0.13	0.67	1
SF11 Sta 80,300	Upstream of Limestone Gulch	81,000	79,600	0.27	1.12	2
SF9 Sta 52,800	Matthews Creek	54,000	51,600	0.45	1.03	1
SF7a Sta 33,050	Methodist Creek	33,500	32,600	0.17	0.73	3
SF7a Sta 29,500	Downstream of Methodist Creek	30,100	28,900	0.23	1.21	3
SF7a Sta 22,050	Negro Creek	23,200	20,900	0.44	0.99	1
SF6 Sta 16,650	Henry Bell Gulch	17,200	16,100	0.21	0.84	2
SF6 Sta 11,750	Knownothing Creek	13,500	10,000	0.66	0.69	1
NF25 Sta 110,750	North Russian Creek	111,300	110,200	0.21	1.42	1
NF25 Sta 108,150	Near Robinson Flat	108,800	107,500	0.25	1.84	1
NF23c Sta 83,950	Eddy Gulch to Tanner Creek (Finley and Judge Mines)	84,700	83,200	0.28	1.33	2
NF23c Sta 80,300	Jessups Gulch (Sawyers Bar)	81,500	79,300	0.42	1.41	1
NF23c Sta 75,050	Upstream of Jackass Gulch (near Bestville)	76,300	73,800	0.47	1.05	2
NF23b Sta 69,600	Jackass Gulch to Shiltos Creek	71,500	67,700	0.72	0.92	1
NF23b Sta 64,850	Kelly Gulch	66,000	63,700	0.44	0.89	1

Segment[1]	**Name**	**Reach Station (Sta)**		**Length (mi)**	**Gradient (%)**	**Suitability rating**
		Up	**Down**			
NF23a Sta 59,000	Downstream of Little North Fork	59,600	58,400	0.23	1.05	2
NF23a Sta 53,300	Downstream of Cronan Gulch/Gallia Mine	55,200	51,400	0.72	0.80	2
NF21b Sta 40,850	Red Banks	43,200	38,500	0.89	1.37	1
NF21a Sta 29,000	Downstream of Big Creek	29,900	28,100	0.34	2.67	3
NF21a Sta 26,200	Dougherty Bluff	26,700	25,700	0.19	1.45	3
NF21a Sta 23,100	Downstream of China Gulch	23,600	22,600	0.19	1.07	2
NF21a Sta 21,900	Upstream of Sawpit Flat	22,600	21,200	0.27	1.12	2
NF21a Sta 19,100	Downstream of Sawpit Flat	19,800	18,400	0.27	0.81	3
MS4 Sta 32,800	Horn Creek	33,600	32,000	0.30	0.92	1
MS4 Sta 28,750	Lower Horn Field/Upper Brazille Flat/Fong Wah Gulch	29,300	28,200	0.21	0.77	3
MS4 Sta 23,700	Fong Wah Bar	24,200	23,200	0.19	0.80	3
MS2 Sta 11,650	Nordheimer Creek	12,100	11,200	0.17	0.59	1
Total				**12.90**		

[1] Floodplain habitat enhancement segments are identified based on the project reach and geomorphic reach in which they occur and the river station at the segment midpoint (e.g., SF16 Sta 137000 occurs in South Fork Salmon River in geomorphic reach 16 with the midpoint at Sta 137,000).

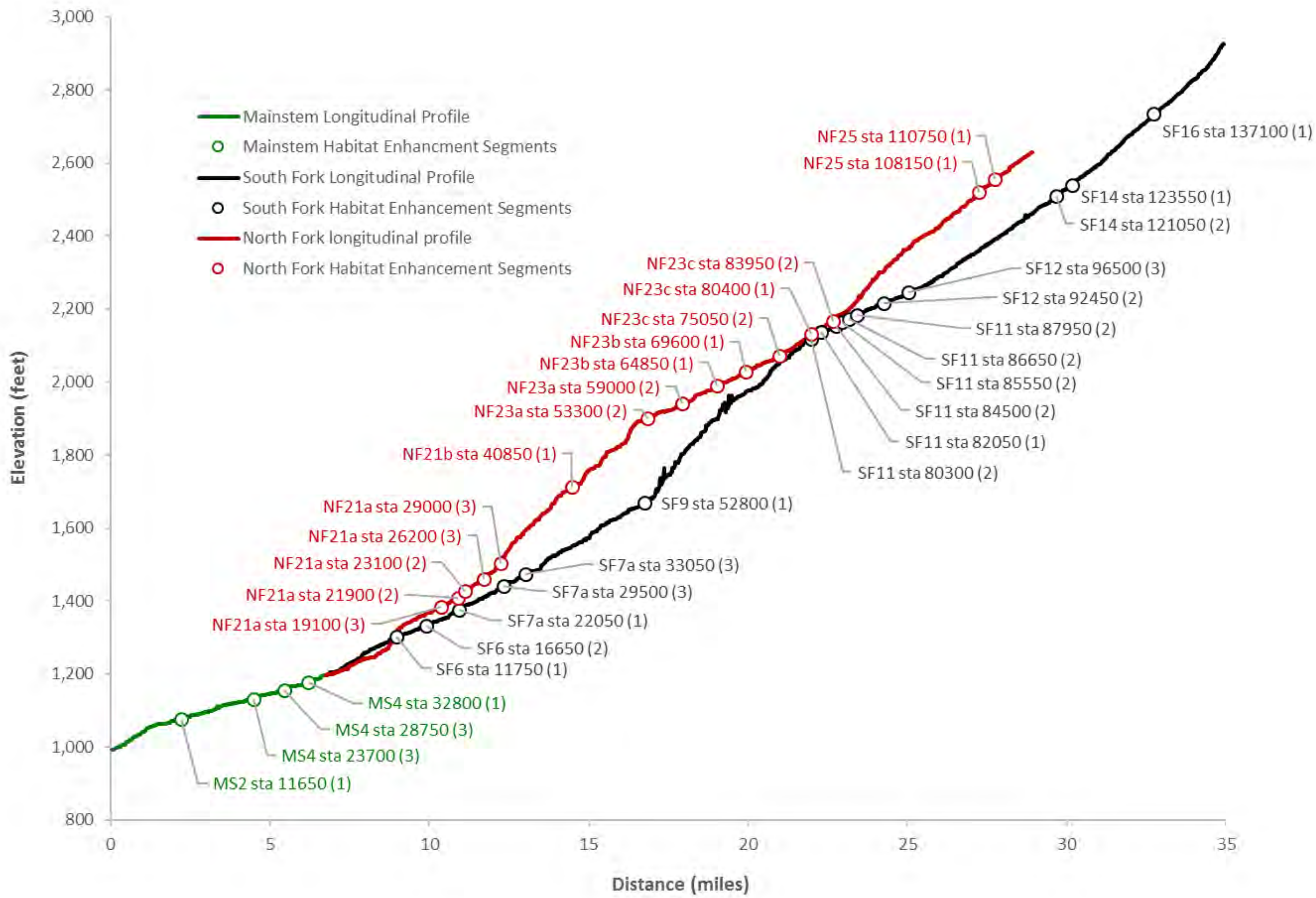


Figure 4. Location of potential floodplain habitat enhancement segments with respect to channel longitudinal profiles. Segments are identified based on the project reach and geomorphic reach in which they occur, the river station (ft) at the segment midpoint, and their suitability rating (e.g., SF16 Sta 137000 (1) occurs in South Fork Salmon River in geomorphic reach 16 with a midpoint of station 137,000 and suitability rating of 1). The origin (0) is the Morehouse Creek confluence with the mainstem Salmon River.

2.2 Phase 2

Phase 2 of the Salmon River Floodplain Habitat Enhancement and Mine Tailing Remediation Project involved selecting priority design sites and developing conceptual designs for restoration and enhancement within these sites. The Phase 2 effort advanced conceptual designs at high priority sites with the most feasible, cost effective opportunities for effectively restoring riparian and aquatic habitat and temperature conditions, with fisheries recovery as the primary objective. While cost and compatibility with existing land uses were considered, initial site prioritization and conceptual designs were primarily based on the potential to achieve ecological objectives within the Salmon River project area. Potential restoration opportunities within private lands or where these opportunities may be incompatible with current land use were therefore not excluded. Although this Phase 2 planning document includes conceptual designs for the 14 highest priority sites, additional opportunities exist within lower priority sites and elsewhere throughout the Salmon River project area. Conceptual designs were developed in the field for all the enhancement segments identified in Figure 3 and Table 1.

Several key channel segments with excellent opportunities for in-channel and floodplain fisheries habitat restoration were identified as high priority (i.e., Kelly Bar, Red Bank, and the Nordheimer confluence area) but were not included in the14 highest priority sites described within this Phase 2 report because these sites have been or are being designed and constructed as part of other parallel efforts led by SRRC.

2.2.1 Design site selection

All of the potential floodplain enhancement segments identified in Phase 1 (suitability rating 1-3) were investigated in the field by the technical project team during August and September 2017 and August 2018. The project team investigated all 36 potential enhancement segments encompassing 12.9 miles (23% of the total project channel length and 38% of the total predominantly alluvial reach length). Field investigations within each segment involved traversing the entire length, including secondary flow paths and floodplains; verifying desktop geomorphic mapping from an aerial photographic time series; mapping bed surface textures (i.e., facies); assessing existing vegetation and aquatic habitat characteristics; capturing photos of all key features (e.g., channel morphology and hydraulic controls, existing aquatic and riparian habitats, cold water sources, disturbance areas, potential access points, and potential enhancement opportunities); and developing preliminary conceptual design sketches.

The project team subsequently convened for a design workshop to discuss preliminary site-specific design concepts identified in the field and select priority design sites for further development of conceptual design plans (Figure 5, Table 2). Priority design sites were selected by the design team based on enhancement suitability rating; as well as information about the type and magnitude of historical disturbance to the channel and floodplain areas, sources of cold water from tributaries and springs that create or could support thermal refuge within the mainstem river corridor; existing rearing habitat conditions, and existing land uses and ownership.

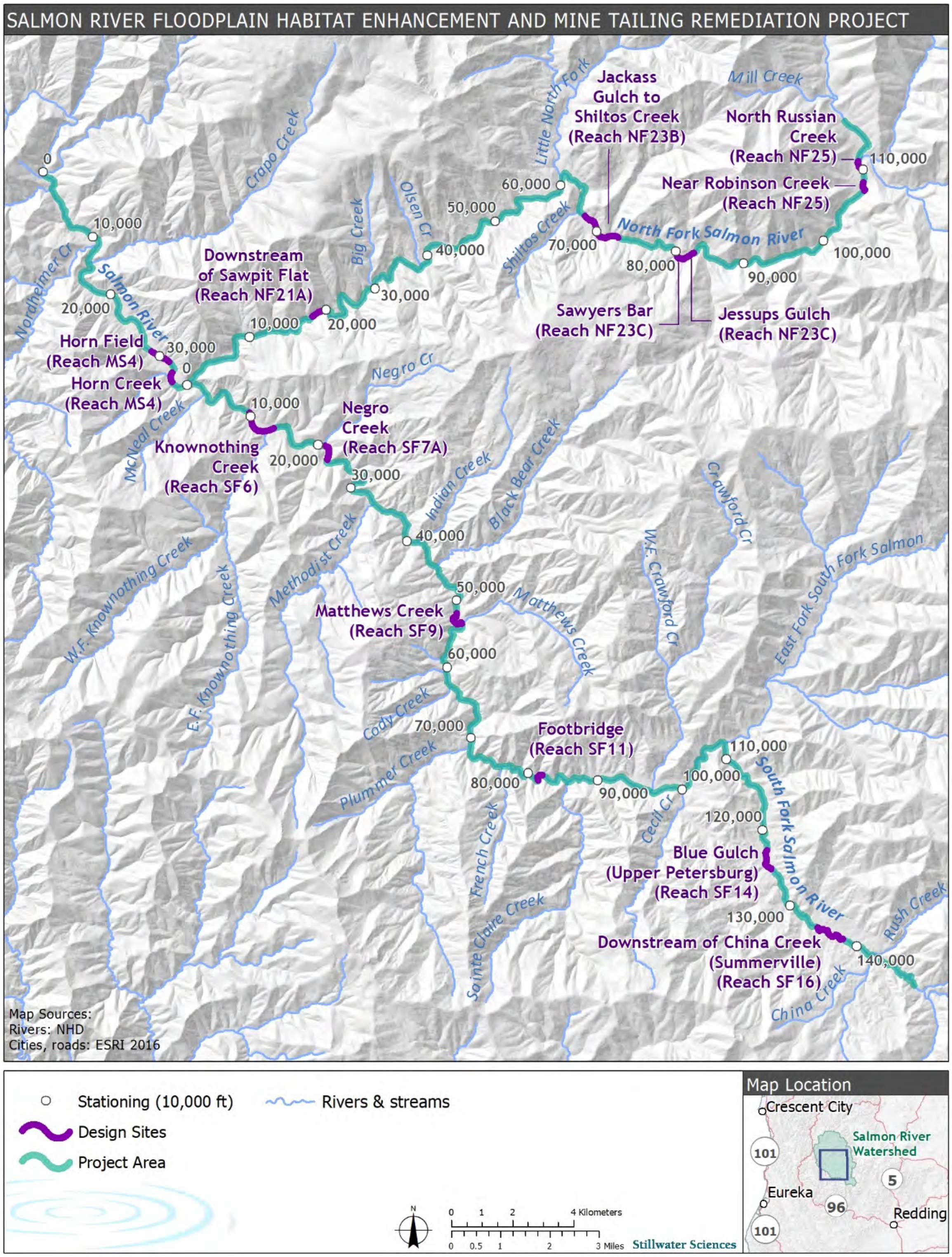


Figure 5. Priority design sites.

Table 2. Priority design site characteristics.

Design site	Reach	River Station			Length, ft
		Downstream	Midpoint	Upstream	
Horn Field	Mainstem 4	29,000	30,100	31,200	2,200
Horn Creek	Mainstem 4	32,600	33,150	33,700	1,100
Knownothing Creek	South Fork 6	9,600	11,550	13,500	3,900
Matthews Creek	South Fork 9	51,400	52,500	53,600	2,200
Negro Creek	South Fork 7A	20,800	21,650	22,500	1,700
Footbridge	South Fork 11	81,500	81,950	82,400	900
Blue Gulch (Upper Petersburg)	South Fork 14	122,600	123,800	125,000	2,400
Downstream of China Creek (Summerville)	South Fork 16	134,600	136,400	138,200	3,600
Downstream of Sawpit Flat	North Fork 21A	18,300	19,050	19,800	1,500
Jackass Gulch to Shiltos Creek	North Fork 23B	67,700	70,200	72,700	5,000
Jessups Gulch	North Fork 23C	80,000	80,825	81,650	1,650
Sawyers Bar	North Fork 23C	81,650	82,125	82,600	950
Near Robinson Creek	North Fork 25	107,500	108,050	108,600	1,100
North Russian Creek	North Fork 25	110,100	110,675	111,250	1,150

2.2.2 Conceptual design

Historical placer mining resulted in pervasive, lasting effects on channel and floodplain morphology and function in the Salmon River. These enduring physical changes in turn have had important implications for hyporheic exchange, system-wide thermal regulation of summer water temperatures, and aquatic habitat availability and quality during both summer and winter. The channel and floodplain impairments resulting from historical placer mining are therefore equally or more important to address than the more apparent mining impacts on upland river terraces (e.g., vegetative removal and lack of revegetation, soil loss, placement of coarse-grained mine tailings, and an overall increase in solar insolation load). The process-based approaches to restoration and enhancement at priority design sites in the Salmon River address these legacy placer mining impacts to the channel, floodplain, and adjacent terraces through different types of actions occurring at different spatial scales and with different expected recovery trajectories.

The conceptual designs depict large-scale habitat enhancement actions intended to reconnect the river's floodplain with the main channel, establish or expand side-channel and off-channel habitats, enhance the bed and banks of the mainstem Salmon River and major tributaries, protect and enhance thermal refuges at summer baseflow, and restore areas disturbed by mine tailings. Actions are organized into discrete types of activity areas ranging from in-channel and riverine areas to upland areas to the staging areas and roads required for construction. The conceptual designs also address at a programmatic level, effective strategies for remediating historical placer mining sites, including mechanical manipulation to recover floodplain elevations and hyporheic exchange; replacement of finer sediments and organic materials necessary to rebuild soils, and techniques to improve soil moisture and water availability for establishing native riparian vegetation.

Some important components of restoration and enhancement design require more detailed analysis of site conditions and engineering at a finer scale than could be addressed during this

Phase 2 planning and conceptual design process. These components include site-specific actions to protect and enhance thermal refuges (i.e., increased woody debris cover, riparian shade cover, increased hyporheic exchange, greater pool depth, and hydraulic controls on mixing); creation of small off-channel ponds and alcoves; design details regarding the number, geometry, and composition of large wood jams; and specific details regarding the location and species composition of riparian plantings. These components, although often not depicted on the conceptual design plans, were considered in the conceptual design process and will be incorporated at each site where the opportunity presents itself during future steps in the design process.

2.2.2.1 Topography

LiDAR data and aerial imagery of the Salmon River project area were acquired during February 23-25, 2014 and April 5, 2014 (Quantum Spatial 2014). The average ground classified density of LiDAR data for the Salmon River project area was 0.22 points/ft^2 (2.39 points/m^2). Average absolute accuracy was 0.004 feet (0.001 meters), and the relative vertical accuracy was 0.185 feet (0.056 meters). The LiDAR digital elevation model (DEM) was clipped into sections for use in hydraulic modeling and conceptual design within the Salmon River design sites.

2.2.2.2 Hydrology and hydraulics

Flow hydraulics were modeled within priority design sites to inform planning and conceptual design decisions. Two-dimensional (2D) hydrodynamic routing was conducted for existing conditions using the unsteady flow analysis portion of the US Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS 5.0) (Brunner 2016). The HEC-RAS 2D model was developed by importing the DEM derived from the 2014 LiDAR data into HEC-RAS. A 2D area boundary was drawn for each predominantly alluvial reach and a mesh cell center spacing of 20 DX by 20 DY was assigned. Due to the large amount of area included in the modeling and the limited detail in available land cover data for channel and floodplain areas, a Manning's n roughness value of 0.045 was assigned to all cells. The upstream and downstream ends of the mainstem reaches and larger tributary reaches were assigned 2D area boundary condition lines and flows. Due to the significant differences between upstream and downstream water surface elevations, the 2D area was initiated dry. To compensate, a 4-hour initial conditions ramp-up time assigned in the unsteady computation options and tolerances window allowed for the model to set up with a more appropriate initial conditions solution. After performing several runs, the 2D mesh was refined by adding resolution and strategic cell center orientation to minimize inundation fragmentation.

Hydrodynamic modeling was conducted at eight discharges ranging from the 20% exceedance flow to the 100-year recurrence interval flood flow (Appendix C). Exceedance flows and recurrence intervals are two different methods of identifying reference discharges significant to habitat function and restoration design. Exceedance flows represent the percent of time throughout the year when flows are above a specific discharge. Recurrence interval or flood frequency flows represent higher flows that are expected to occur at a specific frequency (e.g., a 100-year flow statistically has a 1% chance of occurring in any given year and would be expected to occur every 100 years, on average). Reference discharges determined by these methods have biological significance for restoration, especially related to over-wintering and spring rearing habitat for salmonids. The 20% exceedance flow represents typical winter and spring base flows (i.e., average snowmelt flows) that commonly occur during important rearing periods for juvenile salmonids. Higher flows, especially the 1.5-year (e.g., bankfull) to 5-year discharges, are also biologically significant because they occur relatively frequently and are swift enough to flush salmonids out of the system and cause mortality if sufficient low-velocity habitat is not available as refuge.

Because there are no long-term discharge records in project reaches, flow exceedances at design sites were estimated by prorating exceedances calculated from average daily discharge at USGS Gaging Station No. 11522500 (Salmon River at Somes Bar). Proration was conducted using the ratio of drainage areas at USGS No. 11522500 (751 mi^2) and the design site. Annual peak flow magnitudes and frequencies were determined by averaging two flow estimation methodologies. The first method utilized a Log-Pearson Type III (LP III) probabilistic analysis consistent with USGS Bulletin 17B (USGS 1982) to determine the peak flows at the USGS Gage No. 11522500. These values were then prorated by the ratio of drainage areas. The second method also used the Log-Pearson Type III distribution, but flows in design sites were determined using the USGS formula for calculating magnitude and frequency of floods in California:

Qu = Qg(Au/Ag)b

Where: b = 0.9 for a 2-year event and b = 0.87 for a 100-year event
Qu = Ungaged discharge
Qg = Gaged discharge
Au = Ungaged drainage area
Ag = Gaged drainage area.

The DEM’s of the modeled water surface elevations were imported from HEC-RAS to AutoCAD and used to inform design development. For more information about hydrodynamic modeling at priority design sites, refer to Stillwater Sciences (2018).

2.2.2.3 Habitat enhancement actions and activity areas

Proposed actions within design sites may include the following types of restoration and enhancement activities intended to reconnect the river’s floodplain with the main channel, establish or expand side-channel and off-channel habitats, enhance the bed and banks of the mainstem Salmon River and major tributaries, and restore areas disturbed by mine tailings.

- Recontouring (e.g., grading and/or adding structure) and revegetating degraded floodplains and mine tailings to promote development of functional riparian habitat, increase riparian shading, reduce heating, and improve hyporheic exchange. These activities would include grading to create and enhance topographic features but with no net change in the volume of earthen material within the activity areas.
- Constructing or lowering floodplain surfaces to improve hydrologic function and processes, primarily by expanding the surface area of the channel inundated at specific flows and by increasing flow connectivity (e.g., frequency and duration of inundation) and hyporheic exchange between the winter baseflow channel, secondary channels, and other off-channel areas. Newly inundated surfaces would provide rearing and low velocity habitat for juvenile salmonids and other native anadromous fish. These treatment areas would rely on a combination of natural recruitment of native riparian vegetation and riparian planting to establish a diverse assemblage of native vegetation.
- Modifying historical side channels or constructing new side channels to reconnect the Salmon River to its floodplain at targeted flows.
- Excavating alcoves to specific design elevations at the downstream end of side channels and other appropriate locations to provide continuous, year-round juvenile fish habitat.

- Creating, enhancing, and connecting off-channel ponds and wetlands to improve rearing habitat.
- Adding structural complexity (e.g., large wood and/or large boulders structures) to main channels, secondary channels and other off-channel areas to promote hydraulic complexity and pool depth, increase the amount and quality of low-velocity rearing habitat, and sort spawning gravel.
- Protecting and enhancing cold water refuges at summer baseflow within the mainstem channels, the lower reaches of major tributaries, and in areas associated with seeps and springs to improve holding and summer rearing habitat conditions.
- Restoring native vegetation to degraded riparian areas and terraces by manual or mechanical planting.

One or more of the actions listed above could be implemented within a design site.

Actions are organized into six discrete types of activity areas: In-Channel Activity Areas (IC), Riverine Activity Areas (R), Upland Activity Areas (U), Staging Areas (C), Roads (M=existing, N=new), and Temporary Crossings (X). Each action is assigned a unique label comprised of the activity area symbol followed by the number for the action followed by a letter code identifying the design site. For example, the first action in a riverine area of the Knownothing Creek site (Knownothing Creek [KC]) would be labeled R-1 KC. The following sections provide a brief description of each type of activity area.

In-channel Activity Areas (IC)

In-channel (IC) activity areas are intended to reestablish dynamic fluvial processes and geomorphology. A variety of construction techniques could be used to modify channel gradient, add coarse sediment, and diversify the type and location of alluvial features.

Riverine Activity Areas (R)

Riverine (R) activities would require removal of vegetation and excavation of alluvial material from the bed and banks of the Salmon River and/or tributaries; including alcoves, side channels, and overflow channels. Modifications at strategic locations would promote the river processes necessary for the restoration and maintenance of rearing habitat for juvenile salmonids and other native aquatic organisms over a range of flows.

Upland Activity Areas (U)

Upland (U) activity areas are locations for disposing excavated material (i.e., sand, gravel, cobble, and cleared vegetation, primarily from the riverine areas), stockpiling of coarse sediment for instream additions, and reestablishing native upland vegetation. Activities may also include measures to enhance upland and riparian habitat, while inhibiting the introduction and spread of noxious and invasive vegetation.

Staging Areas (C)

Staging areas are required for construction activities, including gravel processing, storage of equipment and materials, and temporary placement of topsoil. Additionally, these areas may be used for the processing and storage of coarse sediment.

Roads (M, N)

Existing roads and access routes (M) in the project vicinity would be evaluated and upgraded as necessary to provide the necessary access. Project activities may include construction of new temporary roads and access routes (N) to and between staging areas and activity areas. Any new roads and access routes would be constructed to the standard necessary to limit impacts from erosion and runoff. New roads would be decommissioned at project completion, where necessary and when requested.

Temporary Crossings (X)
Some activities and treatments may require construction of temporary water crossings (X) over the river or tributaries to provide access for vehicles and construction equipment. All temporary stream crossings would incorporate design specifications appropriate to address resource impacts.

This approach to identifying and describing actions and activity areas generally follows the approach used by the Trinity River Restoration Program in planning, designing, and permitting analogous channel rehabilitation projects on the mainstem Trinity River (TRRP 2009).

2.2.2.4 Mine tailing remediation

Historical placer mining has had large and enduring impacts on floodplain and off-channel habitat within the Salmon River project area, establishing the present-day physical template in many semi-alluvial reaches. Hydraulic excavation of floodplain and terrace deposits delivered millions of cubic yards of sediment to the river annually (Hawthorne 2017, de la Fuente and Haessig 1993), many tributary channels were realigned and altered at their confluence with the Salmon River, and aquatic and riparian habitats were simplified or destroyed entirely. Natural recovery from these impacts has been slow or has not occurred at all in many areas.

Restoration and enhancement within the project area focuses, to a large degree, on accelerating recovery where floodplain, off-channel, and riparian habitats have been most impacted by hydraulic and dredger placer mining. Effective remediation of historical mining impacts in these areas would include treating large tailing piles, excavated pits, aggraded channels, disconnected floodplains, altered tributary and secondary flow paths, and deforested valley bottom areas. Treatment of historical mining impacts would occur within priority design sites within the project area.

Mechanical manipulation to recover floodplain elevations and width
This set of actions would involve removing and/or regrading large tailings piles that prohibit floodplain inundation and riparian vegetation establishment and restoring floodplain functions and off-channel habitat features within reaches where historical mining operations aggraded floodplains and channels with coarse sediment. In most cases, extensive earthwork would be required to reestablish elevations that permit flow inundation; facilitate hyporheic exchange between floodplain, off-channel, and in-channel features; and allow riparian vegetation to access the summer phreatic zone. Much of the tailings material could be sorted, and the appropriate size classes used as coarse sediment additions to modify gradient and create dynamic alluvial features in the mainstem river channel. Where feasible, the remaining fractions of tailings material that are unsuitable for instream use could be crushed into merchantable aggregate or be used to fill mining pits. The large costs of excavating, processing, and hauling the enormous volume of existing floodplain tailings to suitable nearby disposal sites or other end users will require a long-term strategy that is phased over decades.

Replacing soil and organics
Tailings and other coarse sediment deposits resulting from hydraulic and dredger placer mining in the Salmon River are typically devoid of organic soil (including macronutrients [N, P, K], bacteria, and fungi) and finer sediment (e.g., sand, silt, and clay) required for cation exchange, soil moisture retention, and plant growth. In addition, the large void spaces in coarse-grained

tailings leads to low water-holding capacity, and combined with a lack of existing vegetative cover, creates a hot and dry environment for plant establishment and growth. Hydraulic mine tailings often have inverted stratigraphy within which finer sediments formerly near the surface are now positioned at the base of the deposit, and coarse sediments formerly near the base now overlying these finer materials. Where finer sediments exist within the profile, this material can be sorted and stockpiled for future top dressing after earthwork is completed. Mechanical manipulation of the mine tailings and aggraded channel and floodplain areas will also require application of materials to amend the substrate and reconstruct the soil ecosystem to provide an environment conducive to plant growth.

One strategy for restoring the soil ecosystem within some design sites in the project area is to lower floodplains or create depressions in strategic locations within the floodplain that will function as depositional zones. Another strategy is to bury organic material (e.g., large and small wood, slash, chip) in pits or trenches that extend to a depth of one to two feet below the lowest annual groundwater level (sometimes referred to as the hugelkultur technique). Burial to this depth allows the organic matter to act as a sponge, storing water and wicking it toward the surface, improving soil conditions as the organic material decays over time, and providing more suitable planting sites. These sites are typically backfilled with a mix of good spoils and mulch and may include burying willow and cottonwood to a depth of one to two feet below the low groundwater table before backfilling.

Further investigation is required to determine if mine tailings in the project area contain mercury and/or other toxic heavy metals.

Revegetating native plant species

Revegetating areas disturbed by mine tailings and aggraded coarse sediment deposits with native plant species is one of the most difficult components of placer mining remediation. As previously indicated, these environments usually lack the soil, groundwater, and microclimate conditions conducive to herbaceous and woody riparian plant establishment and growth. Successful revegetation requires developing a planting plan with native species adapted to the environment and that will ultimately achieve the desired ecological objectives; establishing the topographic, stratigraphic, and soil conditions conducive to plant establishment and growth; propagating and/or acquiring the necessary plant materials and storing these materials where they remain in good condition; designing and implementing a cost effective and resilient irrigation plan; controlling invasive plant species, and employing a monitoring program to inform adaptive management of the revegetation site over time.

The fourteen priority design sites encompass the majority of the areas in the Salmon River corridor where extensive hydraulic mining disturbances persist within low-lying floodplain areas that have potential for restoration and enhancement of off-channel salmonid rearing habitat. The mine tailing remediation treatments discussed above are key components of the conceptual design plans discussed below.

3 CONCEPTUAL DESIGN PLANS

The following sections summarize the conceptual designs for the priority design sites; including a site description, conceptual design plan and profiles, and a discussion of the proposed habitat enhancement activities.

3.1 Mainstem Reach 4 at Horn Field

3.1.1 Site description

The Horn Field design site in Mainstem Reach 4 is located downstream of Forks of Salmon between Sta 290+00 near the confluence of Dead Mule Gulch (entering from the right bank) and Sta 301+00 near Brazille Flat. Alternating Late Pleistocene and Holocene strath terraces confine the channel through the site (e.g., Horn Field), as well as in upstream (Bull Barn Flat and Forks of Salmon) and downstream (Brazille Flat and Fong Wong Bar) reaches. These terraces have been extensively hydraulically mined, stripping the alluvial cover sediments to bedrock and leaving mine tailings in many areas. Channel gradient through the site is approximately 0.0031 and average channel width is approximately 180 ft. The entire channel width is inundated at 20% exceedance, with little to no additional area inundated at higher flows due to confinement (Appendix A Figure A-6).

The site is relatively straight, confined, and hydraulically simple (i.e., uniform channel width and depth); with predominantly alluvial plane bed channel morphology and alternating low-lying lateral bars. The upstream left bank boulder-cobble bar has more relief than elsewhere within the site. The only notable hydraulic complexity occurs at a flow cross-over from the river right bank to the river left bank terrace between Sta 31,200 and Sta 30,700. Downstream of this point, the channel is more plane bed and predominantly cobble and cobble-gravel, with less bar relief and less low flow depth than in the upstream section. Horn Creek enters the mainstem Salmon River approximately 1,900 ft upstream of the site.

3.1.2 Proposed habitat enhancement activities

The Horn Field site is one of three sites selected for the potential to experiment with large wood structures designed to create habitat complexity and increase spawning and rearing habitat quality for salmonids in reaches with existing plane bed morphology and coarse substrate (Figure 6, Table 3). A large bar apex wood jam (IC-1 HF) located at the upstream end of the site is designed to split flow into existing left bank and right bank low flow channels and sort spawning gravel at a riffle crest where existing conditions are best suited for spawning. A second large bar apex wood jam (IC-2 HF) located approximately 300 ft downstream of IC-1 HF is also designed to split a portion of the flow into an existing right bank side channel and sort spawning gravel near the flow split. This existing right bank side channel (IC-3 HF) would be graded to increase inundation frequency and duration and promote flow depths and velocities that provide rearing habitat at winter and spring base flow. This side channel would also be loaded with large wood (IC-4 HF) to increase habitat complexity. Further downstream, three large engineered log jams (ELJs) (IC-5 HF, IC-6 HF, and IC-8 HF) would be constructed in the main channel to increase habitat complexity by promoting pool scour and sorting gravel into spawning patches. Large wood would also be placed along the right bank (IC-7 HF) to promote lateral scour in the vicinity of the right bank side channel outlet and to help stabilize the right bank in the vicinity of private property and structures in this area.

Equipment access to the channel may be available on the right bank via Salmon River Road, on the left bank at the top of the site near the existing mine tailings and point bar, and potentially through the private property on the right bank at the downstream end of the site.

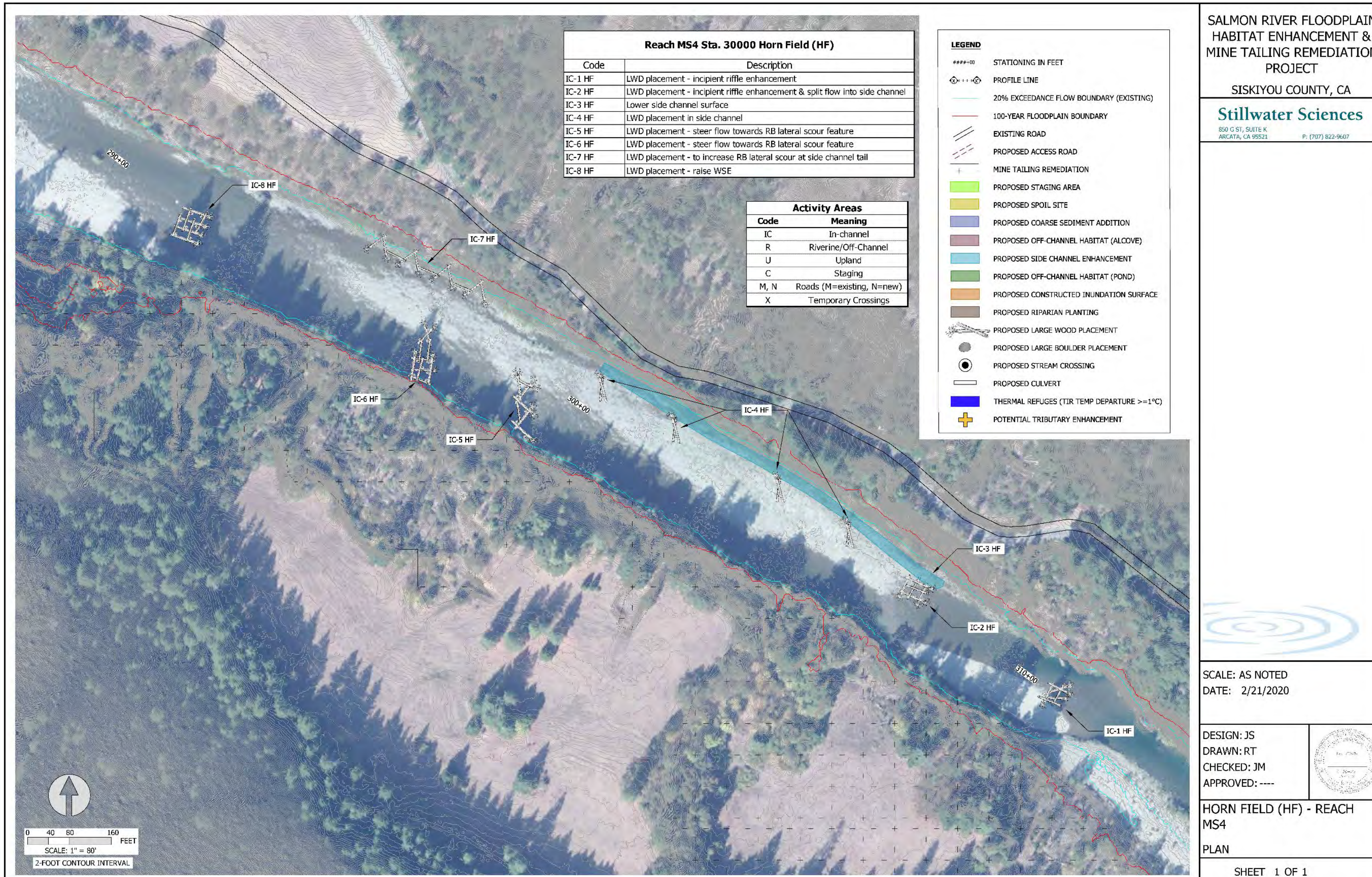


Figure 6. Design plan for Mainstem Reach 4 at Horn Field.

Table 3. Activity areas within Mainstem Reach 4 at Horn Field.

Code	Description
IC-1 HF	LWD placement to enhance spawning habitat
IC-2 HF	LWD placement to enhance spawning habitat and maintain flow split into side channel
IC-3 HF	Lower side channel surface
IC-4 HF	LWD placement in side channel
IC-5 HF	LWD placement to steer flow and promote pool scour
IC-6 HF	LWD placement to steer flow and promote pool scour
IC-7 HF	LWD placement at side channel tail
IC-8 HF	LWD placement to raise the water surface and enhance spawning habitat

3.2 Mainstem Reach 4 at Horn Creek

3.2.1 Site description

The Horn Creek design site in Mainstem Reach 4 is located downstream of Forks of Salmon between mainstem Sta 326+00 and mainstem Sta 337+00. The site occurs at the downstream portion of a large entrenched meander bend, with the confluence of the North Fork Salmon River and South Fork Salmon River located at the upstream end of the bend, the community of Forks of Salmon located on the broad river terrace occupying the inside of the bend, and Horn Field located on the left bank at the downstream end of the bend. Horn Creek enters the mainstem Salmon River from river left in the middle of the site. Alternating Late Pleistocene and Holocene strath terraces (e.g., Horn Field and the surface occupied by the town of Forks of Salmon) generally confine the channel through the site. These terraces have been extensively hydraulically mined, stripping the alluvial cover sediments to bedrock and leaving mine tailings in many areas.

Channel gradient through the site is approximately 0.0081. Active channel width is confined to approximately 210 feet by a bedrock pinch point at the upper end of the site. Channel width greatly expands through the site due to the presence of a broad floodplain and associated secondary flow paths on the right bank. The main side channel cutting through the back edge of this floodplain area is active at flows at or below the 1.5-year peak flow, and the intervening floodplain area separating the side channel from the main channel is inundated at 5 to 10-year peak flows (Appendix A Figure A-6). The active channel through the site has predominantly riffle-pool morphology, boulder and large cobble bed material with localized cobble and gravel patches, and bedrock-controlled banks. A large, deep lateral scour pool at the upstream end of the site transitions to a boulder and large cobble riffle, where flow separates into the mainstem and primary side channel.

3.2.2 Proposed habitat enhancement activities

The conceptual design at the Horn Creek site includes enhancing spawning habitat, enhancing and restoring winter refuge and rearing habitat in the right bank side channel and floodplain areas, and enhancing summer thermal refugia at the Horn Creek tributary junction (Figure 7, Figure 8. Table 4). Coarse sediment suitable for spawning would be added to the pool tail at the upstream end of the site (IC-1 HC). Ideally, this sediment would be obtained by sorting material stored in nearby tailings piles. A large ELJ or bar apex jam (IC-2 HC) constructed at the flow separation point into the right bank side channel would help stabilize and potentially expand the spawning gravel deposit at the pool tail by locally reducing the water surface slope. This wood structure would also be designed to help maintain the design flow split into the side channel. Given the wide channel and large amount of stream power within this site, additional large wood structures may be necessary in this location to achieve these design objectives. The right bank side channel would be excavated (R-1 HC) to provide refuge and rearing habitat during winter base flow. Large wood structures would be added to the side channel (IC-3 HC) to increase habitat complexity and sort bed material, and floodplain areas adjacent to the side channel would be planted with native riparian vegetation (R-2 HC and R-3 HC) to provide shade, instream cover, and food resources. Additional considerations would be given to potential enhancement of summer thermal refugia in lower Horn Creek and the confluence area.

Equipment access to the site for construction is readily available from the right bank by existing roads (M-1 HC and M-2 HC) that extend to the channel. A large, high, and relatively flat area with existing road access on the right bank at the downstream end of the site provides a potential location for construction staging (C-1 HC) and spoiling (U-1 HC). Existing road M-1 HC is a designated fire engine fill site and access to a river drafting site would need to be maintained.

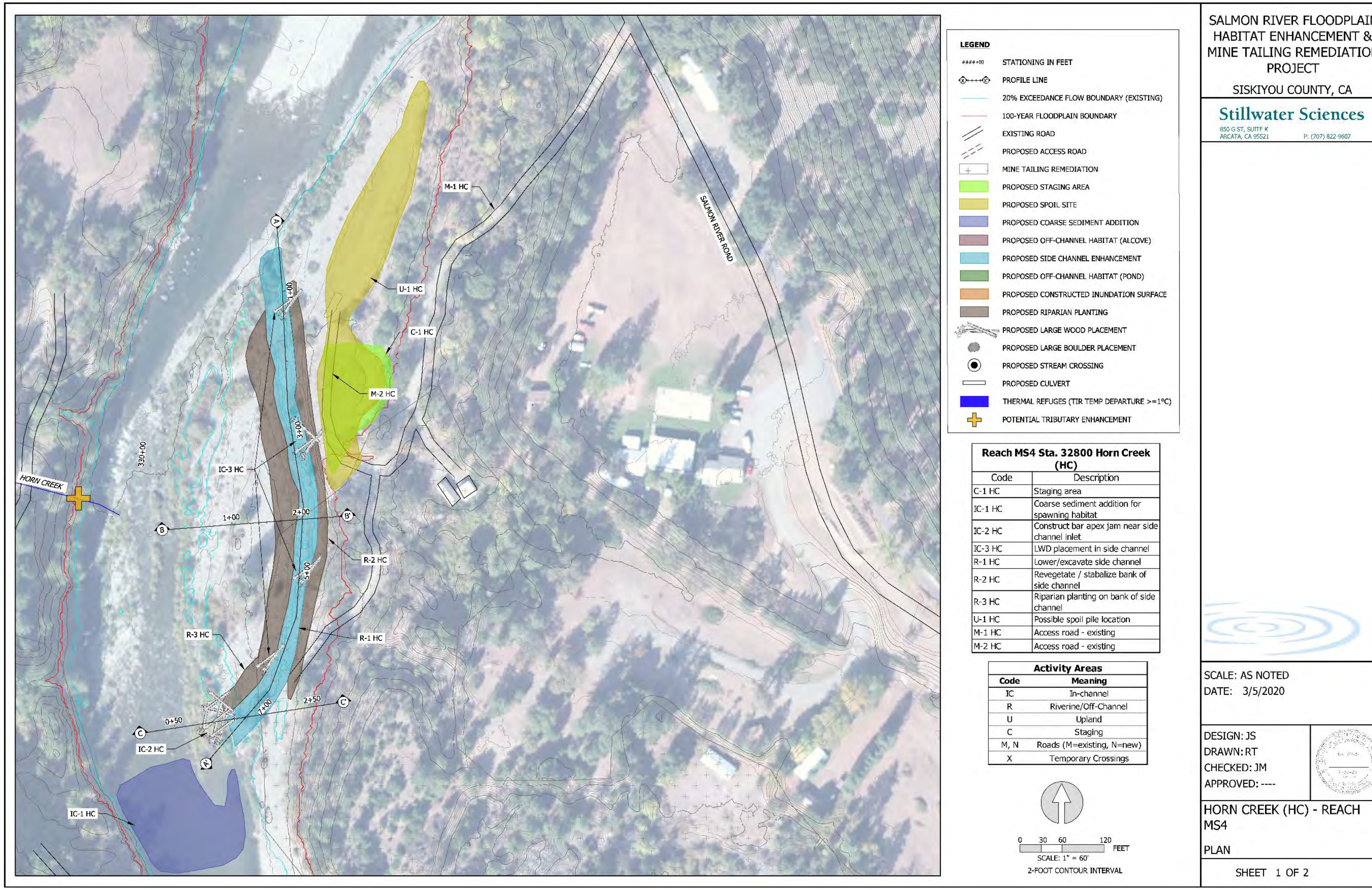


Figure 7. Design plan for Mainstem Reach 4 at Horn Creek.

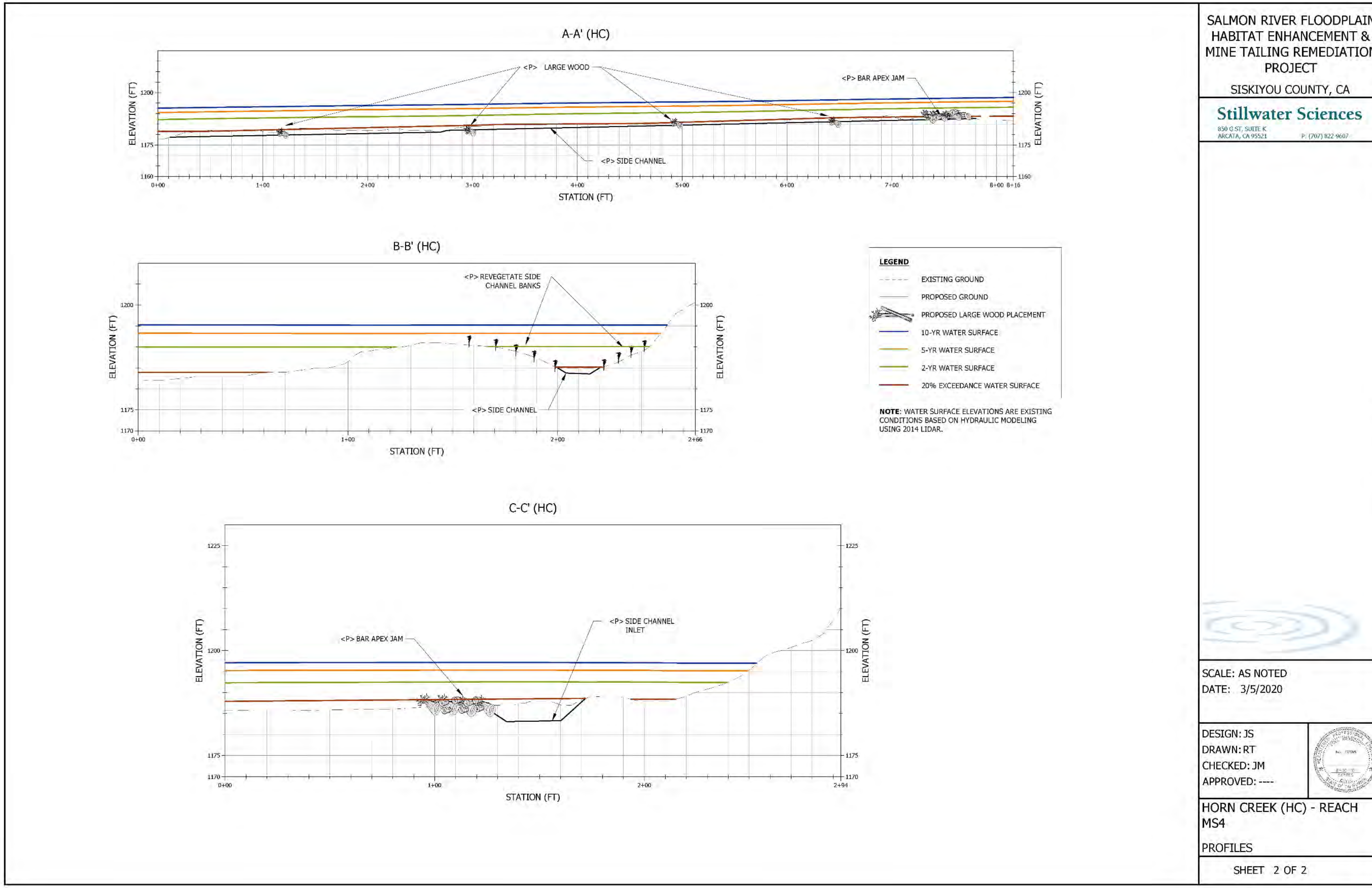


Figure 8. Design profiles for Mainstem Reach 4 at Horn Creek.

Table 4. Activity areas within Mainstem Reach 4 at Horn Creek.

Code	Description
C-1 HC	Staging area
IC-1 HC	Coarse sediment addition for spawning habitat
IC-2 HC	Bar apex jam near side channel inlet
IC-3 HC	LWD placement in side channel
R-1 HC	Lower/excavate side channel
R-2 HC	Stabilization/riparian revegetation of side channel banks
R-3 HC	Riparian revegetation of side channel banks
U-1 HC	Potential spoil site
M-1 HC	Access road – existing
M-2 HC	Access road – existing

3.3 South Fork Reach 6 at Knownothing Creek

3.3.1 Site description

The Knownothing Creek design site in South Fork Reach 6 is located between Sta 96+00 and Sta 135+00 at a broad, entrenched meander in the vicinity of Knownothing Creek. The site encompasses the Knownothing Creek confluence and a large Late Pleistocene terrace on river right, one of the most extensive areas of mine tailings in the Salmon River corridor. The downstream extent of this right bank terrace, however, is one of the few terrace remnants in the project area that was not heavily disturbed by historical placer mining. A prominent feature within the site is a high flow channel (currently inundated by 5-year peak flows and greater) cutting across the prominent right bank terrace (Appendix A Figure A-10). The 1.5 year peak flow inundates most of the main channel width, with the few areas of low velocity inundation during these higher flows located in the lower portion of Knownothing Creek, in the vicinity of the inlet to the right bank high flow channel, and across a right bank lateral bar and associated side channel at the downstream end of the site. Channel gradient through the site is approximately 0.0073, and average width of the active channel is approximately 120 ft. The active channel within the site is relatively simple, with a predominantly cobble-boulder to cobble-gravel bed locally controlled by bedrock outcrops, alternating lateral boulder-cobble bars, and bedrock-controlled banks. Much of the morphology within the site is comprised of relatively featureless shallow runs and riffles, although notable pools occur near the Knownothing Creek confluence and where flow impinges on bedrock outcrops along the left bank at the outside apex of the bend near Sta 117+00.

The Knownothing Creek confluence is a critical summer thermal refuge important for juvenile salmonids, and multiple species and runs of coho and Chinook salmon and steelhead spawn in the low gradient reaches of the creek. The SRRC and its partners implement projects to annually improve the thermal refuge and maintain conditions suitable for passage at the confluence. The SRRC also completed a habitat enhancement project involving wood loading in the lower reach of Knownothing Creek to increase habitat complexity.

3.3.2 Proposed habitat enhancement activities

The conceptual design at the Knownothing Creek site includes enhancing and lowering existing high flow channels within the right bank terrace, constructing alcoves for winter and summer rearing habitat, placing large wood, and grading and vegetating existing mine tailings (Figure 9, Figure 10. Table 5)

An alcove (R-1 KC) would be constructed along the right bank at the upstream end of the site. An existing drainage originating upslope of the terrace but that does not currently have a surface connection to the South Fork Salmon River would be aligned (R11-KC) to provide a surface water connection into the alcove. A second alcove (R-2 KC) would be constructed near the Knownothing Creek confluence to expand the summer thermal refuge, with a large wood structure (IC-1 KC) at its inlet to help maintain connection to Knownothing Creek and the South Fork Salmon River. Additional considerations would be given to potential enhancement of summer thermal refugia in lower Knownothing Creek and the confluence area during future design steps.

The largest proposed action within the site is the lowering of the right bank high flow channel (R-5 KC) to increase the inundation frequency and duration, thereby creating a potentially large area of winter refuge from high velocities. The excavated side channel would be constructed with two or more large ELJs at the inlet (IC-2 KC and IC-3 KC) to help split flow, numerous large wood structures along its length to create habitat complexity (IC-4), an inset floodplain (R-7 KC) to provided rearing habitat and substrate for riparian vegetation establishment, an alcove near the downstream end (R-8 KC and IC-5 KC), and a large wood structure at the outlet to help maintain the connection to the mainstem channel. The alcove at the downstream end of the side channel would inundate more frequently to provide winter rearing habitat at winter and spring base flow. The margins of the side channel would be revegetated with native riparian species (R-4 KC and R-6 KC), and the surrounding tailings piles would be recontoured and planted with native riparian and upland vegetation (U-1 KC through U-3 KC).

A second side channel (IC-7 KC) would be excavated along the existing secondary flow path located at the back edge of the right lateral bar at the downstream end of the site to provide winter refuge and rearing habitat. Numerous large wood structures (IC-8 KC) would be added to the side channel to increase habitat complexity and maintain the outlet, and an alcove (R-9 KC and IC-6 KC) would be constructed near the upstream end of the side channel.

Equipment access for site construction may occur in three potential locations: (1) over the bridge at the upstream end of the site and down an existing abandoned road along the inside edge of the tailings piles (M-1 KC), (2) down an existing unimproved road at a private residence located at the confluence of Knownothing Creek and across the shallow downstream riffle to the right bank (M-3 KC), and (3) through a private residence located on the left bank at the downstream end of the site and across the shallow riffle to the right bank terrace (M-2 KC). Construction staging areas would be located at pads graded within the existing mine tailings (C-1 KC and C-2 KC).

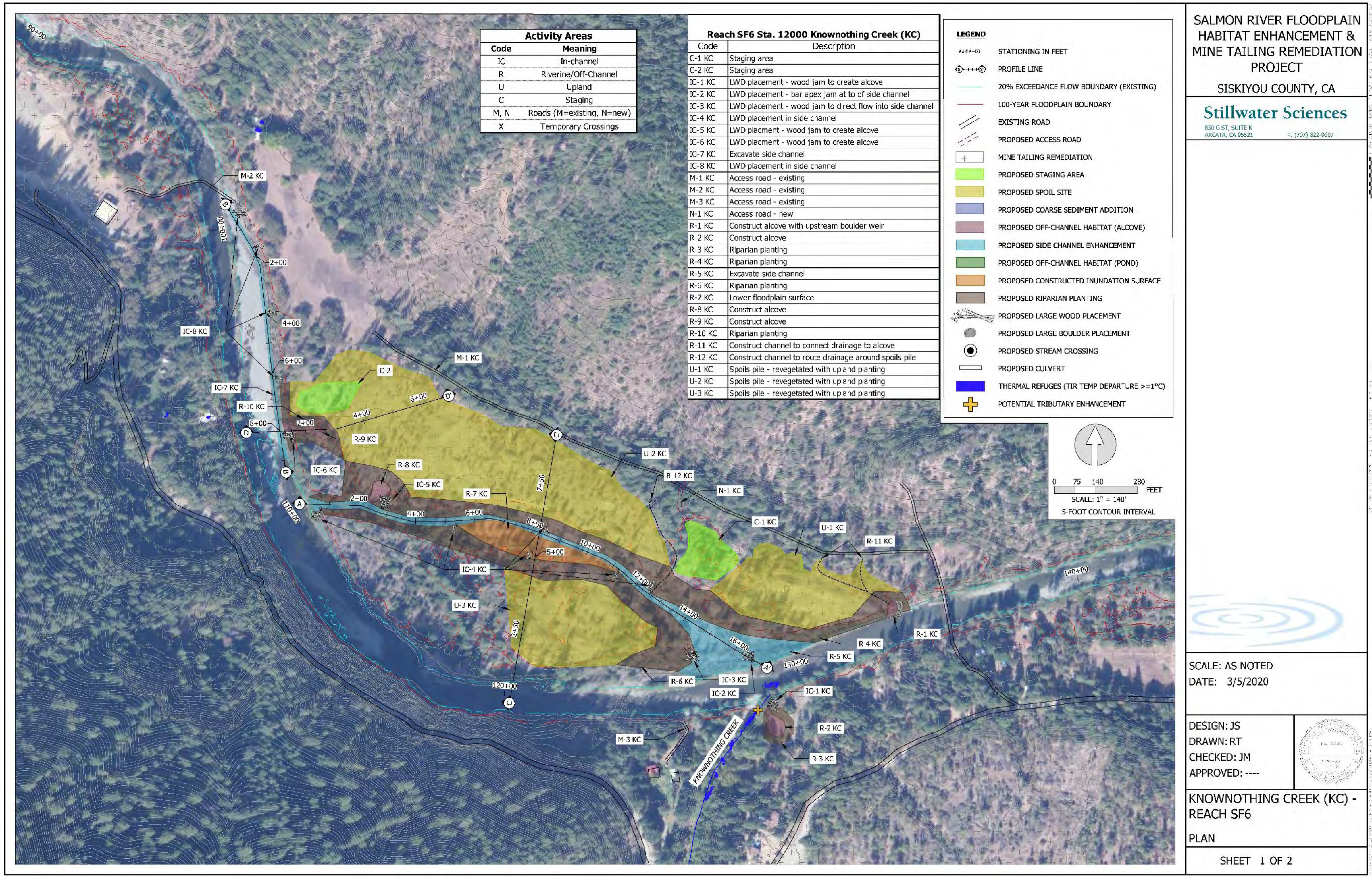


Figure 9. Design plan for South Fork Reach 6 at Knownothing Creek.

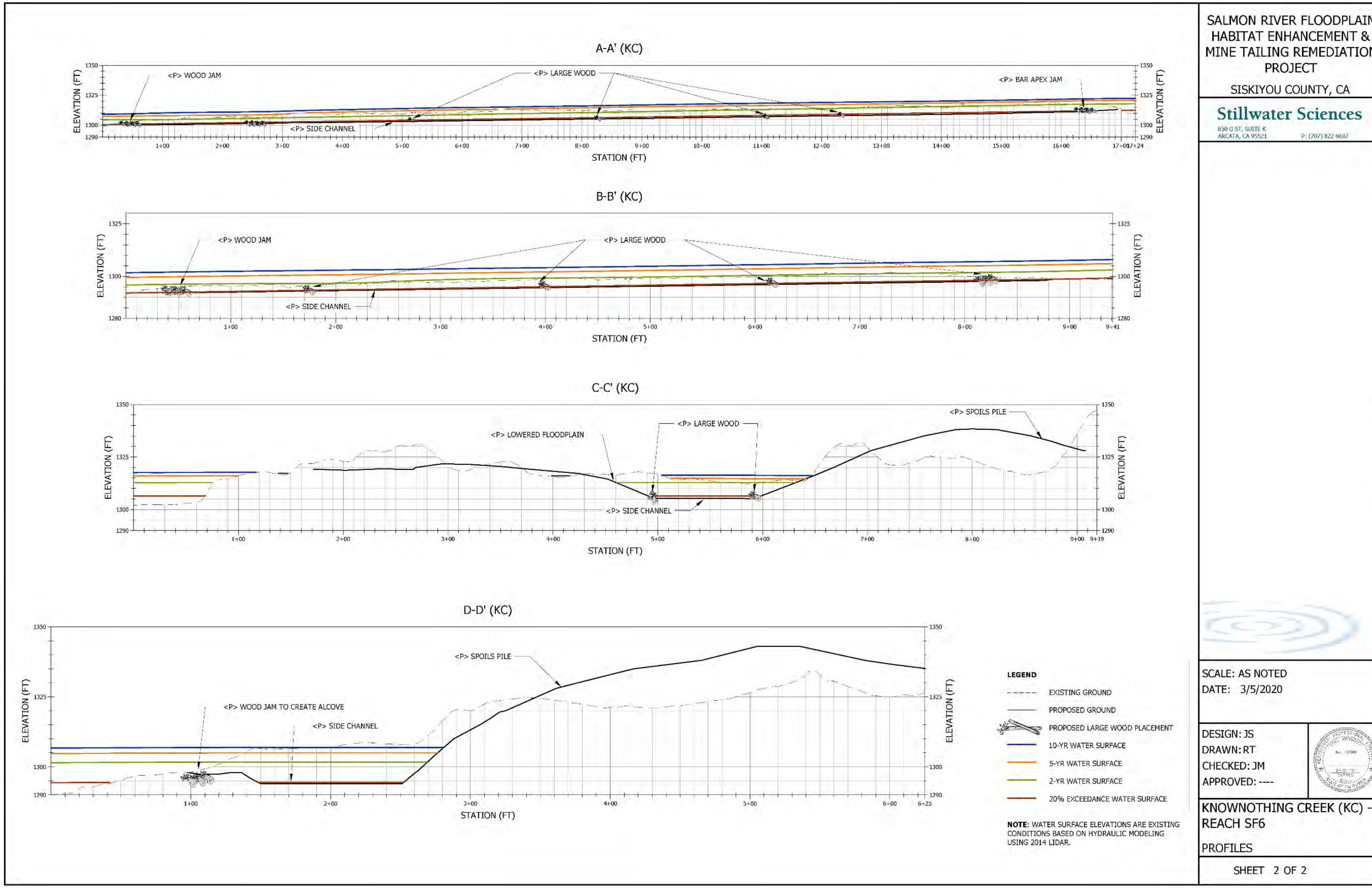


Figure 10. Design profiles for South Fork Reach 6 at Knownothing Creek.

Table 5. Activity areas within South Fork Reach 6 at Knownothing Creek.

Code	Description
C-1 KC	Staging area
C-2 KC	Staging area
IC-1 KC	LWD placement to create/maintain alcove
IC-2 KC	LWD placement in jam near side channel inlet
IC-3 KC	LWD placement in jam near side channel inlet
IC-4 KC	LWD placement in side channel
IC-5 KC	LWD placement to create/maintain alcove
IC-6 KC	LWD placement to create/maintain alcove
IC-7 KC	Lower/excavate side channel
IC-8 KC	LWD placement in side channel
M-1 KC	Access road – existing
M-2 KC	Access road – existing
M-3 KC	Access road – existing
N-1 KC	Access road – new
R-1 KC	Construct alcove with upstream boulder weir
R-2 KC	Construct alcove
R-3 KC	Riparian revegetation
R-4 KC	Riparian revegetation
R-5 KC	Excavate side channel
R-6 KC	Riparian planting
R-7 KC	Construct inundation surface
R-8 KC	Construct alcove
R-9 KC	Construct alcove
R-10 KC	Riparian planting
R-11 KC	Construct channel to connect drainage to alcove
R-12 KC	Construct channel to route drainage through tailings
U-1 KC	Spoils pile, revegetation with upland species
U-2 KC	Spoils pile, revegetation with upland species
U-3 KC	Spoils pile, revegetation with upland species

3.4 South Fork Reach 7A at Negro Creek

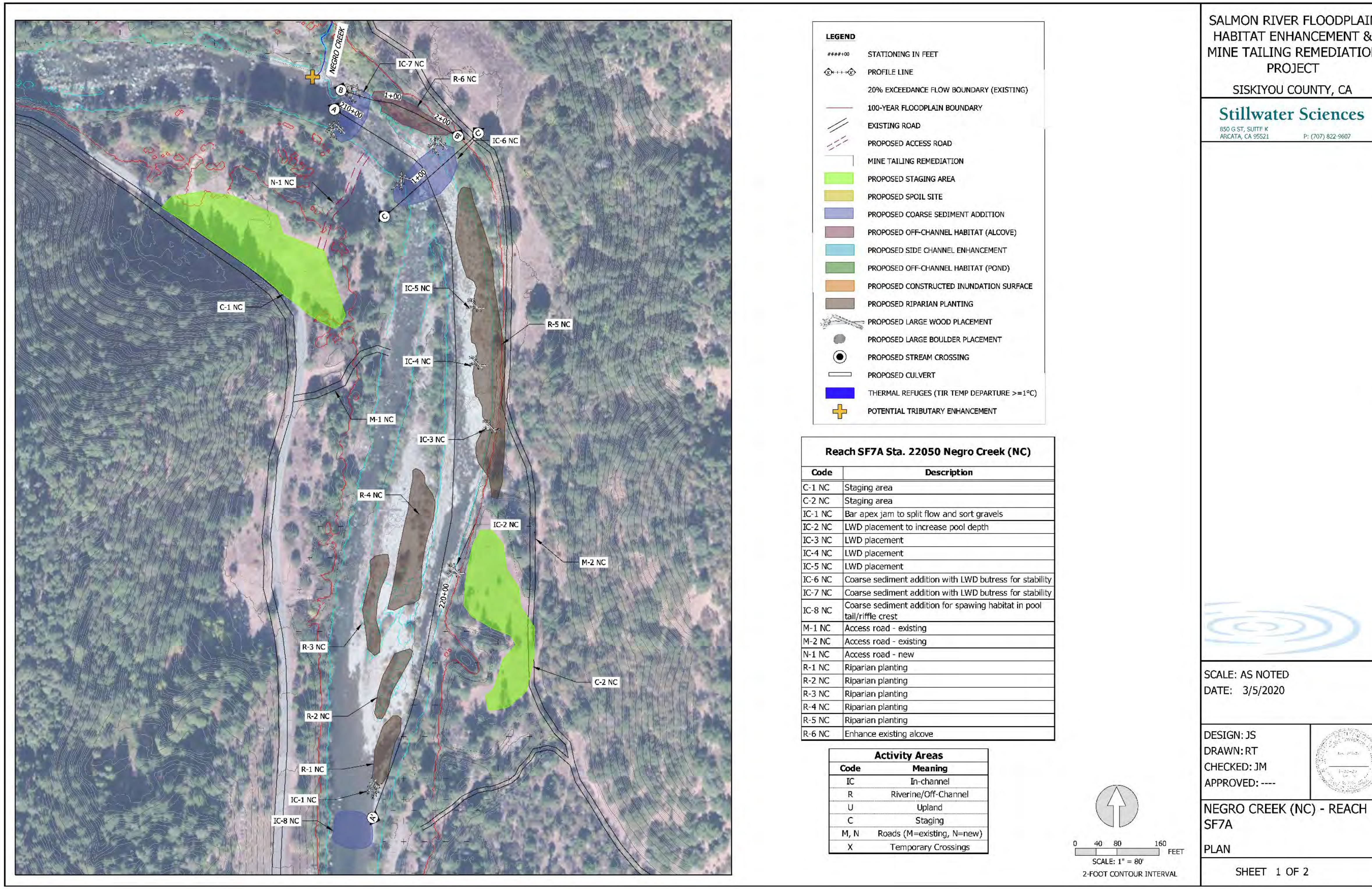
3.4.1 Site description

The Negro Creek design site in South Fork Reach 7A is located between Sta 208+00 and Sta 225+00. Channel gradient through the site is approximately 0.0096, average width of the active channel is highly variable due to floodplains and secondary flow paths, and bed surface texture is predominantly boulder and cobble. The dominant feature characterizing the site is a relatively extensive river right floodplain cut by a network of secondary channels. The primary side channel in this area remains active during winter base flow and lesser discharges (Appendix A Figure A-12). Bedrock exposure and large boulder substrate controls the grade at the entrance and exit of this side channel. The side channel has experienced extensive erosion where flow impinges on the right bank and undermines terrace cover sediments. The poorly vegetated midchannel bar between the main channel and primary side channel inundates at the 5-year peak flow. The channel and floodplain in this area obtain a maximum width of approximately 250 ft. Negro Creek enters the South Fork Salmon River at the downstream end of the site, where a bedrock pinch point narrows the active channel width to less than 100 ft.

3.4.2 Proposed habitat enhancement activities

The conceptual design at the Negro Creek site includes enhancing spawning habitat at the upstream and downstream ends of the site, enhancing and restoring winter refuge and rearing habitat in the river right side channel and floodplain areas, and enhancing summer thermal refugia at the Negro Creek tributary junction (Figure 11, Figure 12. Table 6). Coarse sediment suitable for coho and Chinook salmon and steelhead spawning would be added to the pool tail at the upstream end of the site (IC-8 NC). Ideally, this sediment would be obtained by sorting material stored in the extensive tailings piles located downstream near the confluence of Henry Bell Creek (approximately Sta 175+00). A large ELJ or bar apex structure (IC-1 NC) would be constructed to stabilize the sediment addition, sort gravel at the pool tail, and help achieve the design flow split into the right bank side channel. More large wood and/or boulder structures than are shown on the conceptual design plan may be necessary to achieve design objectives at this location. Multiple large wood jams and pieces would be added to right bank side channel (IC-3 NC, IC-4 NC, and IC-5 NC) to increase habitat complexity, provide cover, and help stabilize the bank. Riparian vegetation would be planted on the midchannel bar head and flanks (R-1 NC through R-4 NC), along the side channel (R-5 NMC), and in the vicinity of the existing downstream alcove (R-6 NC). Coarse sediment additions with large wood structures (IC-6 NC and IC-7 NC) would also be constructed at two locations at the downstream end of the site to help elevate the channel bed and water surface, increase the depth and duration of backwater conditions in the downstream portion of the side channel and existing alcove, and enhance spawning habitat. Additional considerations would be given to potential enhancement of summer thermal refugia in lower Negro Creek and the confluence area.

Equipment access to the site for construction may occur via the existing short spur road off Cecilville Road (M-1 NC) and the existing unimproved road along the right bank (M-2 NC), which may be accessed by bridges over the South Fork Salmon River located about a half mile upstream and downstream of the site. A large area with existing vehicle access located immediately adjacent to Cecilville Road near the downstream end of site is available for construction staging (C-1 NC). A second open and accessible area potentially suitable for construction staging is located on the right bank at the upstream end of the site (C-1 NC).



Reach SF7A Sta. 22050 Negro Creek (NC)	
Code	**Description**
C-1 NC	Staging area
C-2 NC	Staging area
IC-1 NC	Bar apex jam to split flow and sort gravels
IC-2 NC	LWD placement to increase pool depth
IC-3 NC	LWD placement
IC-4 NC	LWD placement
IC-5 NC	LWD placement
IC-6 NC	Coarse sediment addition with LWD butress for stability
IC-7 NC	Coarse sediment addition with LWD butress for stability
IC-8 NC	Coarse sediment addition for spawing habitat in pool tail/riffle crest
M-1 NC	Access road - existing
M-2 NC	Access road - existing
N-1 NC	Access road - new
R-1 NC	Riparian planting
R-2 NC	Riparian planting
R-3 NC	Riparian planting
R-4 NC	Riparian planting
R-5 NC	Riparian planting
R-6 NC	Enhance existing alcove

Activity Areas	
Code	**Meaning**
IC	In-channel
R	Riverine/Off-Channel
U	Upland
C	Staging
M, N	Roads (M=existing, N=new)
X	Temporary Crossings

Figure 11. Design plan for South Fork Reach 7A at Negro Creek.

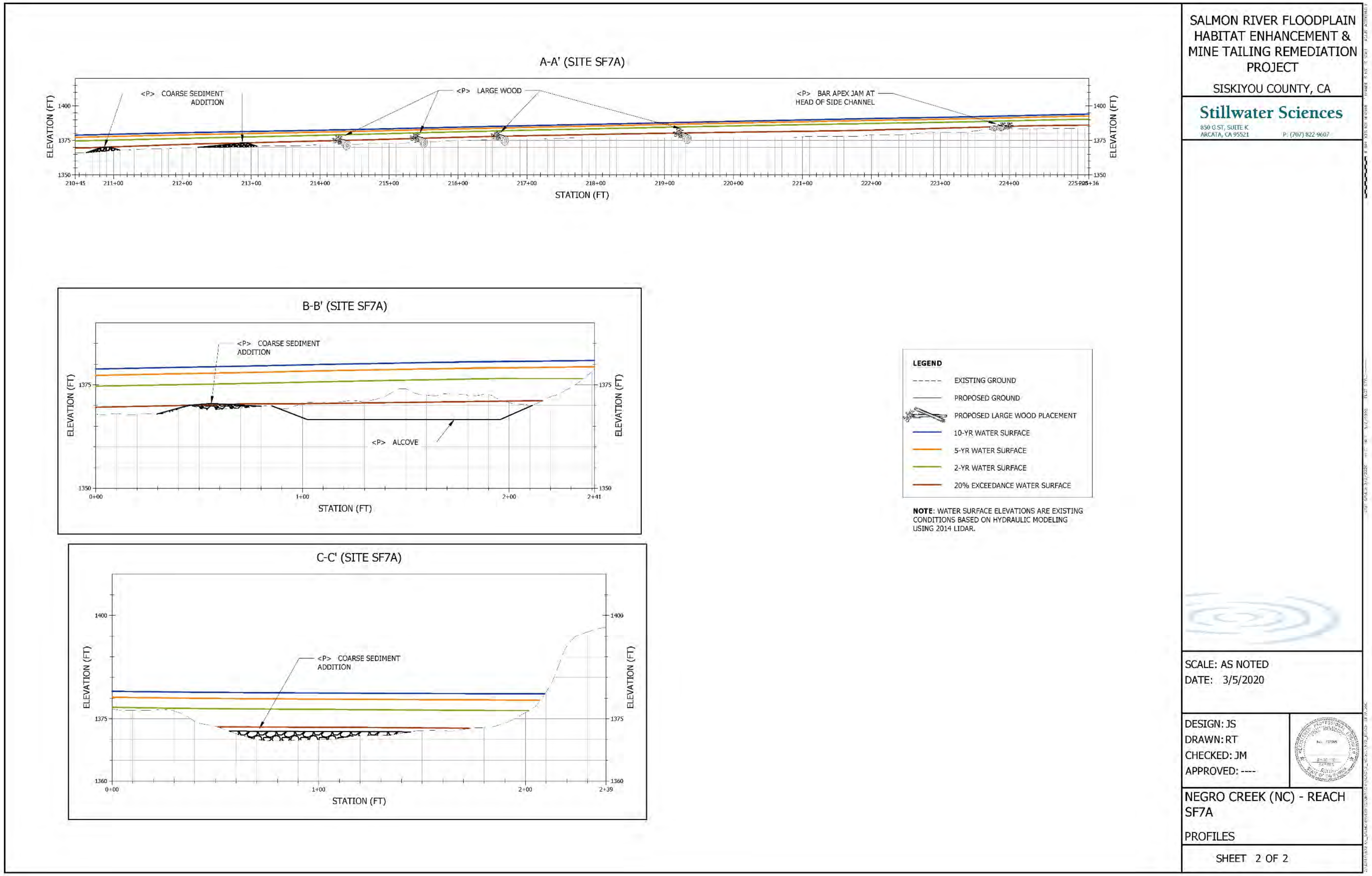


Figure 12. Design profiles for South Fork Reach 7A at Negro Creek.

Table 6. Activity areas within South Fork Reach 7A at Negro Creek.

Code	Description
C-1 NC	Staging area
C-2 NC	Staging area
IC-1 NC	Bar apex jam to split flow and sort gravel
IC-2 NC	LDW placement to increase pool depth
IC-3 NC	LWD placement in side channel
IC-4 NC	LWD placement in side channel
IC-5 NC	LWD placement in side channel
IC-6 NC	Coarse sediment addition to raise upstream water surface elevation
IC-7 NC	Coarse sediment addition to raise upstream water surface elevation
IC-8 NC	Coarse sediment addition to enhance spawning habitat
M-1 NC	Access road – existing
M-2 NC	Access road – existing
N-1 NC	Access road – new
R-1 NC	Riparian revegetation
R-2 NC	Riparian revegetation
R-3 NC	Riparian revegetation
R-4 NC	Riparian revegetation
R-5 NC	Riparian revegetation
R-6 NC	Enhance existing alcove

3.5 South Fork Reach 9 at Matthews Creek

3.5.1 Site description

The Matthews Creek design site in South Fork Reach 9 is located between Sta 514+00 and Sta 536+00 in the general vicinity of the Matthews Creek Campground administered by the Klamath National Forest. Matthews Creek enters the South Fork Salmon River at the upstream end of the site. Channel gradient through the site is approximately 0.0102, and average width of the active channel is variable, ranging from approximately 90 to 120 ft. The site includes a pair of bedrock entrenched meander bends that encompass the transition from a very steep and narrowly confined bedrock canyon upstream to a less steep channel with a wider valley bottom containing predominantly boulder and cobble bar and floodplain deposits. Point bars located at the inside of each bend have a side channel cutting the back edge. The upstream-most side channel cutting the river left point bar (the inlet is located in the large pool upstream of Matthew Creek) inundates at the 20% exceedance flow (Appendix A Figure A-18). Field investigation indicated that this side channel maintains a summer base flow and is in good functioning condition, with high quality aquatic habitat created by abundant large wood and riparian cover. The side channel cutting the river right point bar in the middle of the site just downstream of the Matthews Creek confluence conveys the 1.5 year peak flow through boulder substrate but offers little aquatic or riparian habitat value. There is little riparian vegetation established along the side channel and intervening bar, although numerous large wood pieces have accumulated at the bar crest, and there is not a well-defined outlet connecting this side channel to the main channel. At the downstream extent of this side channel, a large streamside landslide on the left bank actively delivers sediment and wood to the mainstem channel for approximately 800 lineal feet. In addition to the large-scale longitudinal change in slope and valley width at this site, the long-term sediment delivery from this landslide is partially responsible for the middle and lower point bar deposits, as well as more mobile cobble and gravel patches in downstream areas. A third point bar and back edge side channel occurs at the downstream end of the site. This point bar is lower and inundates more frequently (at the 1.5 year peak flow), with a poorly defined flow path along the back edge that inundates during winter base flow. Two deep, bedrock-controlled pools occur within the site, one at the upstream end of the site at the Matthews Creek confluence and the another associated with a large bedrock outcrop at the outside of the bend at the downstream end of the site. Each of these pools contain mobile cobble and gravel deposits along the margins and at the tailout that potentially provide spawning habitat. The site has a long history of historical mining disturbance, as indicated by tailings piles and large graded areas that serve as informal public parking areas on the river right.

3.5.2 Proposed habitat enhancement activities

The conceptual design at the Matthews Creek design site includes enhancing spawning habitat in pools tails at the upstream and downstream ends of the site, enhancing and restoring winter refuge and rearing habitat in side channels cutting the middle and lower bends, and enhancing summer thermal refugia at the Matthews Creek tributary junction (Figure 13, Figure 14. Table 7). Coarse sediment suitable for spawning coho and spring-run and fall-run Chinook salmon and steelhead would be added to the pool tail at the upstream end of the site (IC-5 MC). Ideally, this sediment would be obtained by sorting material stored in the tailings piles located on the river right terrace within the site or from other nearby locations. A large ELJ or bar apex structure (IC-1 MC) would be constructed to stabilize the sediment addition, sort gravel at the pool tail, and help achieve the design flow split into the right bank side channel. The right bank side channel inlet would be excavated (R-1 MC) and multiple large wood jams and pieces would be added (IC-4 MC) to increase habitat complexity, provide cover, and control grade. Riparian vegetation would be planted along the side channel and across the midchannel bar (R-2 MC and R-3 MC), and riparian and upland vegetation would be planted in the downstream floodplain and spoil areas (U-2 MC). Additional considerations would be given to potential enhancement of summer thermal refugia in lower Matthews Creek and the confluence area. Additional site investigation is needed to better understand potential limitations on side channel excavation imposed by shallow bedrock.

A similar design approach would be applied to the pool tail, point bar, and side channel at the downstream end of the site. Coarse sediment suitable for spawning Chinook salmon and steelhead would be added to the pool tail (IC-6 MC); a large ELJ or bar apex structure (IC-2 MC) would be constructed to stabilize the sediment addition, sort gravel at the pool tail, and help achieve the design flow split into the left bank side channel; the left bank side channel would be excavated (R-5 MC) and multiple large wood jams and pieces would be added (IC-3 MC) to increase habitat complexity and provide cover; and riparian vegetation would be planted along the side channel and across the bar (R-4 MC and R-6 MC).

Equipment access to the site for construction currently exists via an existing spur road (M-1 MC) off Cecilville Road that extends to the river right terrace and point bar in the middle of the site. Large flat areas with existing vehicle access are available for construction staging (C-1 NC) and spoil disposal (U-1 NC). The existing spur road M-1 MC is a designated engine fill site for emergency fire vehicles and will need to be maintained or improved for this purpose.

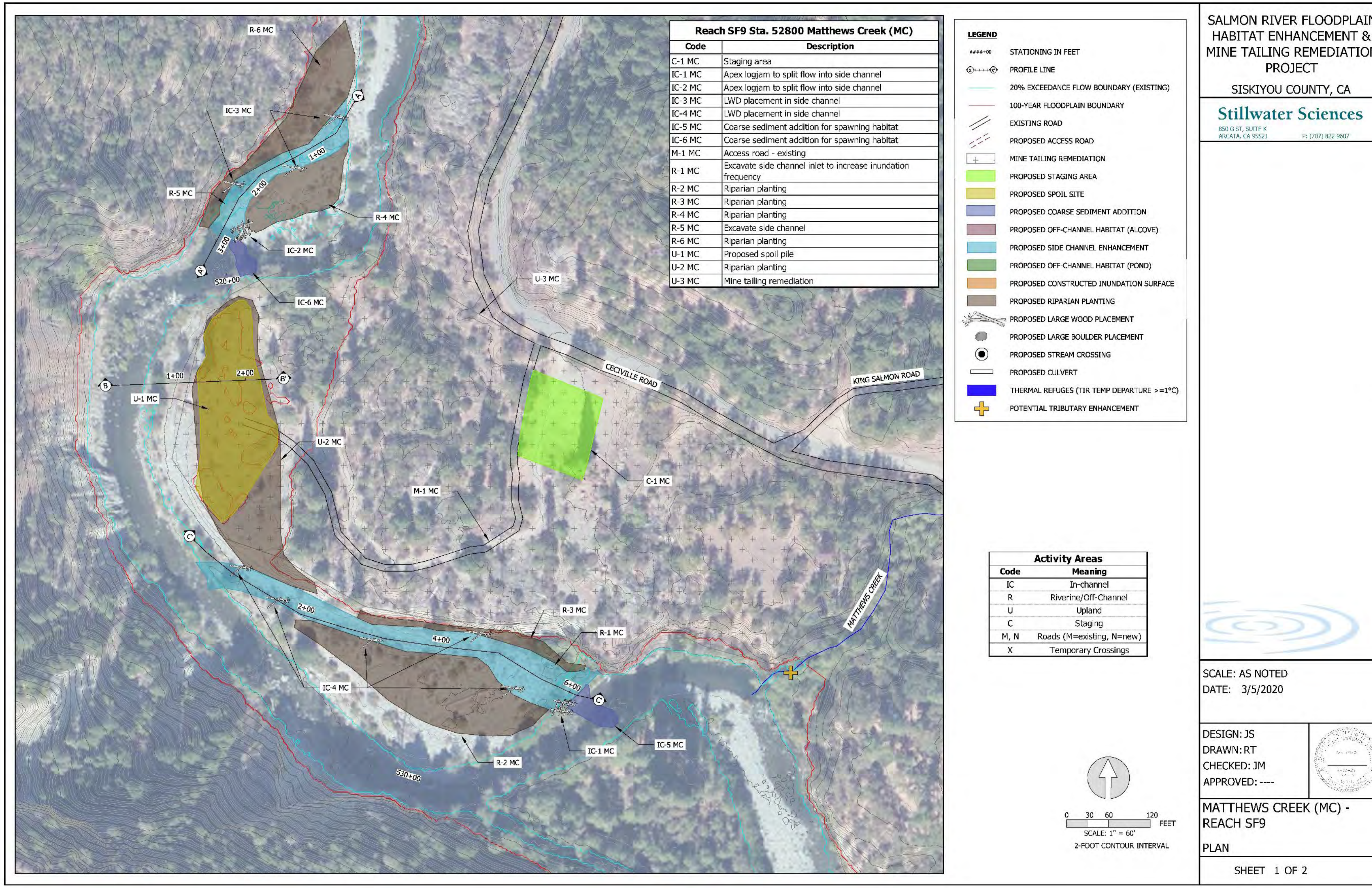


Figure 13. Design plan for South Fork Reach 9 at Matthews Creek.

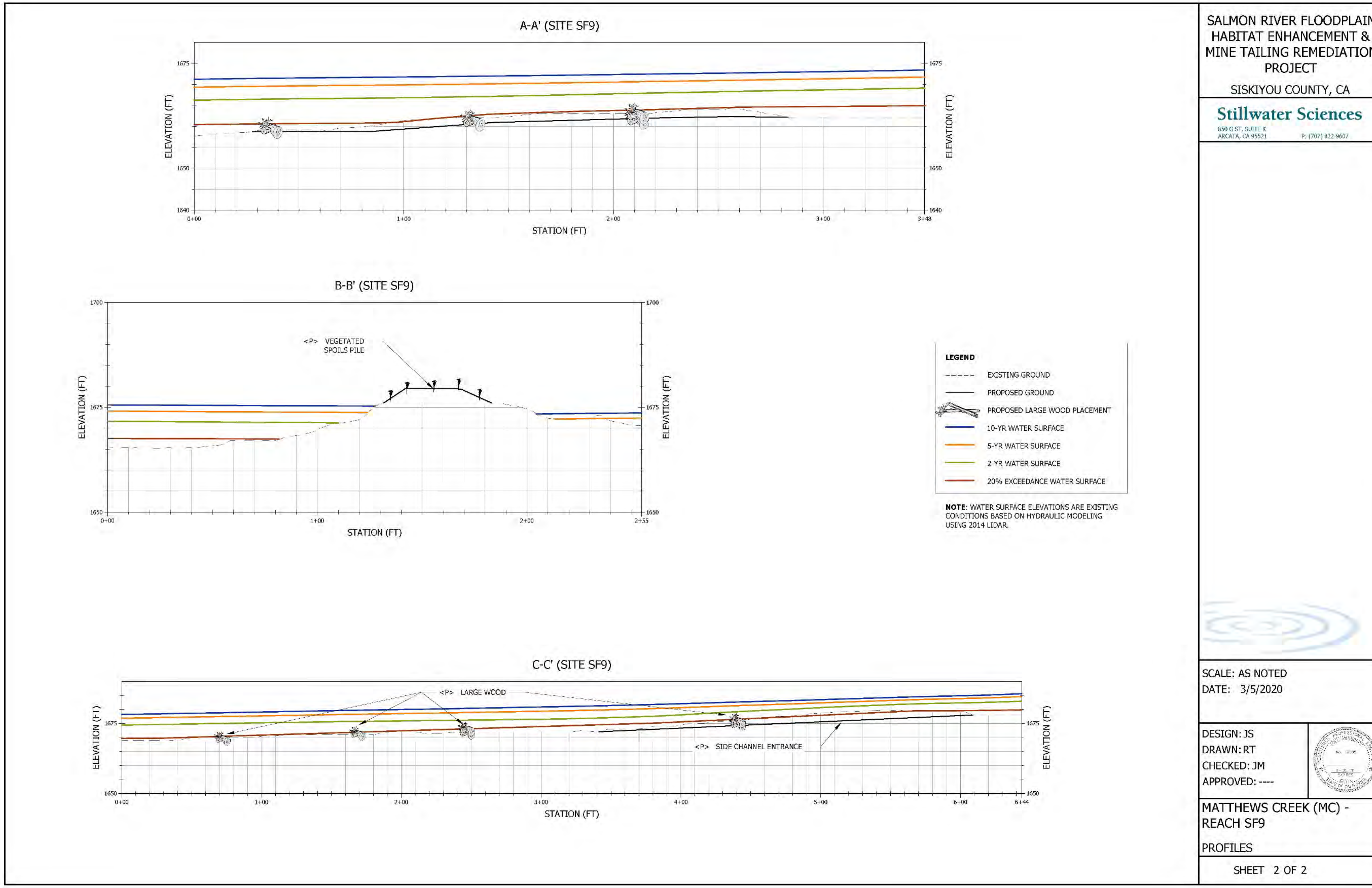


Figure 14. Design profiles for South Fork Reach 9 at Matthews Creek.

Table 7. Activity areas within South Fork Reach 9 at Matthews Creek.

Code	Description
C-1 MC	Staging area
IC-1 MC	Apex log jam to split flow into side channel and enhance spawning habitat
IC-2 MC	Apex log jam to split flow into side channel and enhance spawning habitat
IC-3 MC	LWD placement in side channel
IC-4 MC	LWD placement in side channel
IC-5 MC	Coarse sediment addition for spawning habitat enhancement
IC-6 MC	Coarse sediment addition for spawning habitat enhancement
M-1 MC	Access road – existing
R-1 MC	Excavate side channel inlet to increase inundation frequency
R-2 MC	Riparian revegetation
R-3 MC	Riparian revegetation
R-4 MC	Riparian revegetation
R-5 MC	Excavate side channel
R-6 MC	Riparian revegetation
U-1 MC	Proposed spoil site
U-2 MC	Riparian revegetation
U-3 MC	Mine tailing remediation

3.6 South Fork Reach 11 at Footbridge

3.6.1 Site description

The Footbridge design site in South Fork Reach 11 is located between Sta 815+00 and Sta 824+00 where tight planform curvature controlled by bedrock and localized expansion in valley bottom width allows for development of a left bank side channel with fine grain sizes (gravel, cobble, and sand) and the potential for higher quality winter rearing habitat. Channel gradient through the site is approximately 0.0078, and average width of the active channel varies depending on bedrock confinement and floodplain extent, ranging from is approximately 65 to 140 ft. Inundation of the river left side channel occurs at the 20% exceedance (Appendix A Figure A-20). Field investigation indicated no summer inundation or ponding. Several large boulders at the side channel inlet help to create and maintain an alcove at the upstream end of the site. These large roughness elements provide an analogue for how large ELJs and bar apex jams could be constructed to sort bedload material, deform the bed, and control flow splits at side channel inlets elsewhere in the project area. A bedrock-controlled pool riffle sequence at the downstream end of the site provides small patches of spawning gravel.

3.6.2 Proposed habitat enhancement activities

The conceptual design at the Footbridge design site includes enhancing rearing and refuge habitat in the existing side channel, creating more cover and structure in the existing alcove at the side channel inlet, improving and lengthening the side channel outlet, and improving spawning habitat in the mainstem channel (Figure 15, Figure 16. Table 8). A large wood structure would be constructed at the existing side channel inlet (IC-1 FB) to add structure and cover to the existing alcove, to create more alcove habitat area (R-2 FB), and to increase the proportion of channel flow entering the side channel. Rearing and refuge habitat in the side channel would be improved by adding multiple large wood structures (IC-2 FB, IC-3 FB, IC-5 FB, and IC-6 FB). An alcove (R-1 FB) and large wood structure IC-4 FB) would be constructed at the outlet of one of the side channel distributaries. Coarse sediment suitable for spawning coho and spring-run salmon and steelhead would be added to the mainstem channel (IC-7 FB) where a small patch of spawning gravel currently exists. A large wood structure (IC-7 FB) would be constructed to retain the sediment addition and help sort new spawning gravel.

Equipment access to the site for construction exists via an existing short unimproved spur road (M-1 FB) off Cecilville Road. A large flat area is available for construction staging (C-1 FB).

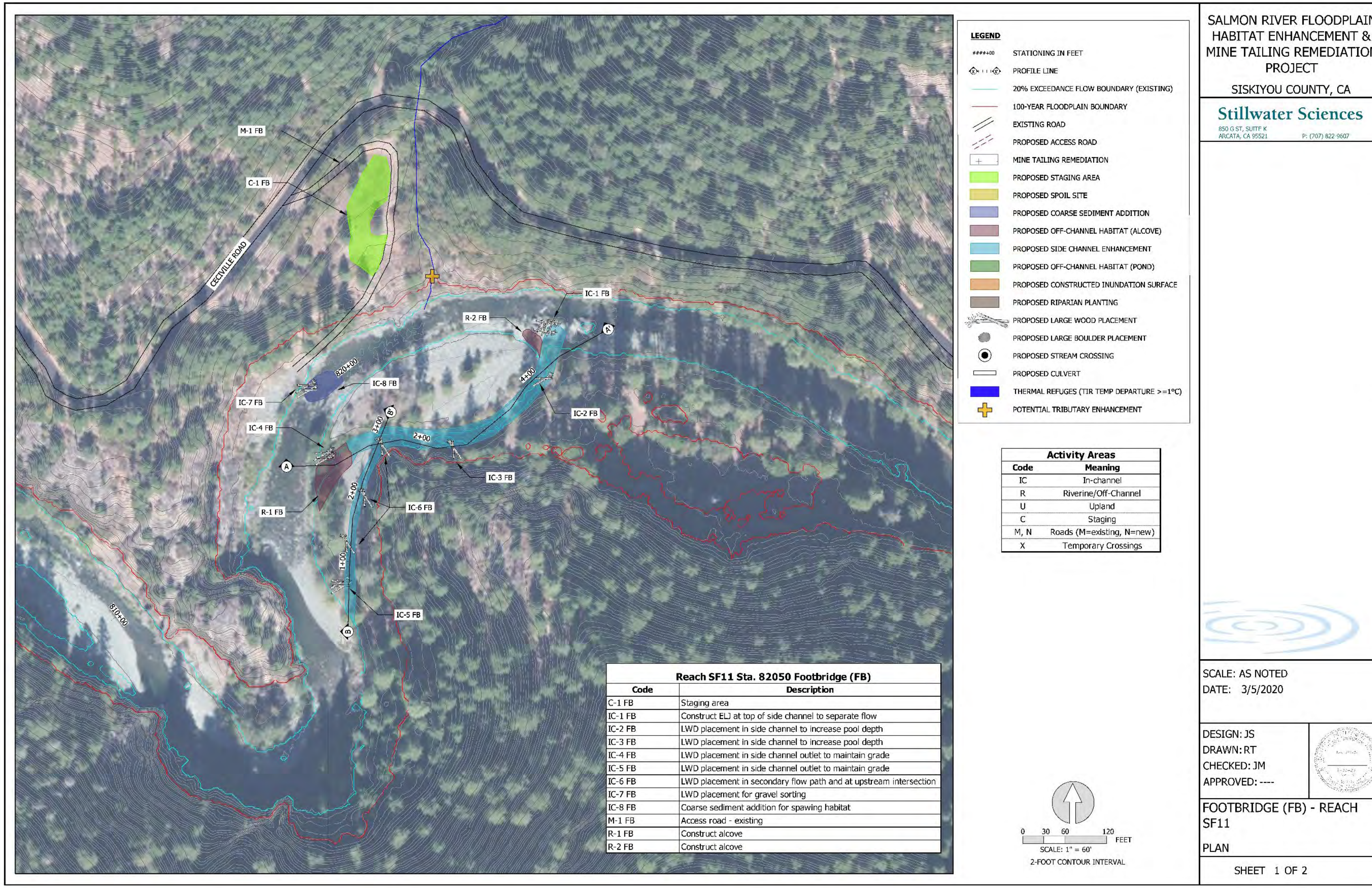


Figure 15. Design plan for South Fork Reach 11 at Footbridge.

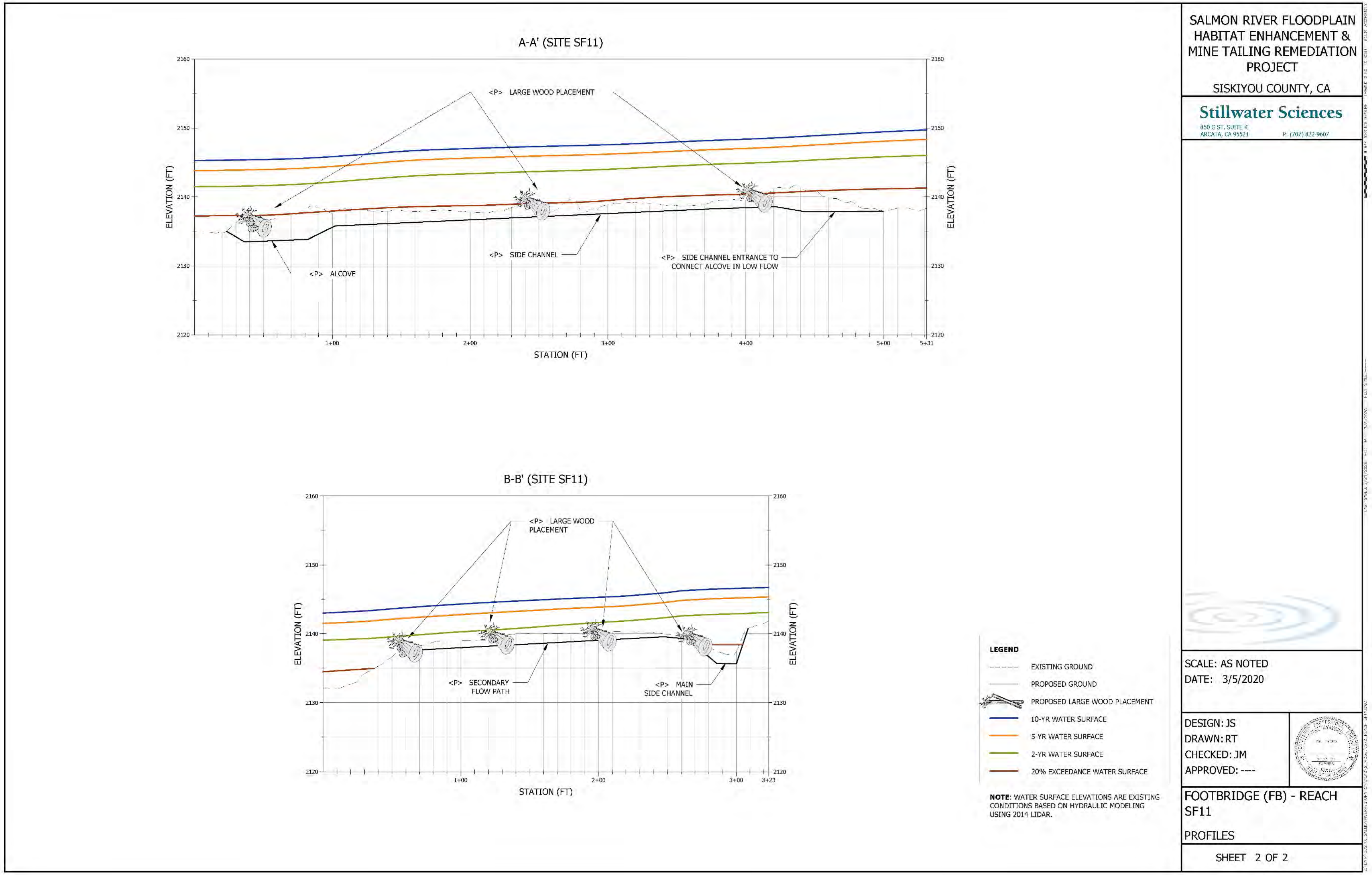


Figure 16. Design profiles for South Fork Reach 11 at Footbridge.

Table 8. Activity areas within South Fork Reach 11 at Footbridge.

Code	Description
C-1 FB	Staging area
!C-1 FB	Construct ELJ at top of side channel to separate flow
IC-2 FB	LWD placement in side channel to increase pool depth
IC-3 FB	LWD placement in side channel to increase pool depth
IC-4 FB	LWD placement in side channel outlet to maintain grade
IC-5 FB	LWD placement in side channel outlet to maintain grade
IC-6 FB	LDW placement in secondary flow path and at upstream intersection
IC-7 FB	LWD placement for gravel sorting
IC-8 FB	Coarse sediment addition for spawning habitat enhancement
M-1 FB	Access road – existing
R-1 FB	Construct alcove
R-2 FB	Construct alcove

3.7 South Fork Reach 14 at Blue Gulch

3.7.1 Site description

The Blue Gulch design site in South Fork Reach 14 is located between Sta 1,226+00 and Sta 1,250+00 near the Petersburg Workstation operated by the Klamath National Forest. Blue Gulch enters the South Fork Salmon River from the left bank at the upstream end of the site. Channel gradient through the site is approximately 0.0125, and average width of the active channel varies widely from about 90 to 150 ft. The site occurs at a transition in the longitudinal profile from a steeper and more narrowly confined channel upstream to a less steep channel with a wider valley bottom containing relatively broad floodplain areas cut by complex secondary channels (Appendix A Figure A-28). A relatively active point bar floodplain occurs on river right at the upstream end of site. The floodplain inundates at the 2 to 5 year peak flow and has a high-flow channel at the back edge that conveys the 1.5 year peak flow. The large river left floodplain and terrace in the middle of the site inundates less frequently (i.e., 10–25 year peak flow). This floodplain terrace is dissected by a complex network of secondary channels that coalesce into a primary high flow side channel along the back edge that conveys the 5 year peak flow. The river left lateral bar at the downstream end of the site inundates more frequently (i.e., the 1.5 year peak flow).

The main channel through the site has been dynamic, increasing sinuosity after the 1997 event and avulsing during the 2005 event. Since 2005, the channel at the upstream end of the site has migrated toward the right bank and away from the extensive river left floodplain. The channel has bedrock control in the middle of the site at about Sta 1237+00, however, there are no other indications of bedrock control elsewhere in the channel or floodplain areas. Substrates are predominantly boulder and cobble in the main channel; with cobble, gravel, and sand deposits on floodplains and in secondary channels.

Petersburg was one of the largest mining towns in the South Fork Salmon River basin from 1850 through the early twentieth century. The extensive hydraulic placer mining operations that occurred in this area profoundly altered the landscape by modifying alluvial floodplains within the South Fork Salmon River and major tributaries, denuding adjacent river terraces and hillslopes, and delivering enormous quantities of sediment to the mainstem river channel. Historical placer mining resulted in lasting effects on the channel in this reach, including widespread aggradation, widening and shallowing of the channel, filling of pools, reduced complexity and connectivity of floodplain habitats, coarsening and armoring of the channel bed, loss of upland and riparian vegetation, and increased stream temperatures. A large tailing pile remains within the left bank floodplain area in the middle of the site, and smaller tailings piles occur extensively in upstream and downstream floodplain areas.

3.7.2 Proposed habitat enhancement activities

The Blue Gulch design site provides a significant opportunity to restore spawning and rearing habitats for spring-run Chinook salmon and steelhead in a reach of the South Fork Salmon River that historically supported large numbers of spawning fish and continues to maintain relatively cool summer stream temperatures. The conceptual design includes enhancing spawning habitat in the mainstem channel by adding coarse sediment, enhancing rearing and refuge habitat in side channels and floodplains by increasing the frequency and duration of inundation and by adding large wood, and by revegetating extensive floodplain areas and adjacent upland river terraces. (Figure 17, Figure 18. Table 9). The large scope of the conceptual design approach will likely require multiple phases of implementation, monitoring, and adaptive management. Additional considerations would be given to potential enhancement of summer thermal refugia in lower Blue Gulch and the confluence area.

At the upstream end of the site, the existing side channel cutting the river right floodplain would be excavated (R-1 BG) to increase inundation frequency and duration, and numerous large wood pieces and jams would be added to increase complexity and cover. The adjacent terrace would be revegetated with upland species.

In the middle of the site, the long side channel cutting the back edge of the river left floodplain would be graded (R-2 BG) to increase flow connectivity and the frequency and duration of inundation, numerous large wood pieces and jams would be added to increase complexity and cover (IC-2 BG and IC-3 BG), and the intervening floodplain and terrace areas would be graded (R-5 BG) and extensively revegetated with upland and riparian vegetation (R-3 BG and R-4 BG). Coarse sediment would be added to the mainstem channel at several key locations near the side channel inlet (IC-5 BG through IC-7 BG) to locally reduce the channel slope and provide spawning habitat. The coarse sediment addition, working in combination with a large ELJ or bar apex jam (IC-1 BG), would help maintain the side channel inlet configuration and design flow split. An alcove (R-9 BG) would be constructed at the downstream end of the side channel, taking advantage of existing backwater conditions within the side channel outlet.

At the downstream end of the site, similar efforts would be implemented to enhance mainstem spawning habitat and rearing habitats in the river right high flow side channel and adjoining floodplain. The addition of coarse sediment (IC-8 BG), working in combination with a large ELJ or bar apex wood structure (IC-4 BG), would locally reduce the channel slope and help maintain the side channel inlet configuration and flow split while enhancing spawning habitat. The side channel would be excavated in places (R-6 BG) to increase flow connectivity and the frequency and duration of inundation, numerous large wood pieces and jams would be added to increase complexity and cover (IC-9 BG), and the intervening floodplain would be lowered (R-7 BG) and extensively planted with riparian vegetation (R-8 BG).

Equipment access for construction at the downstream end of the site would be provided by an existing unimproved road (M-1 BG) off Caribou Creek Road. A large flat area in this vicinity could be used for construction staging (C-2 BG). Equipment access for construction at the middle and upstream end of the site would be provided by constructing a new temporary road (N-1 BG) across the right bank terrace. The terrace is currently sparsely vegetated and occupied by numerous tailings piles. A large flat area is also available in this vicinity for construction staging (C-1 BG).

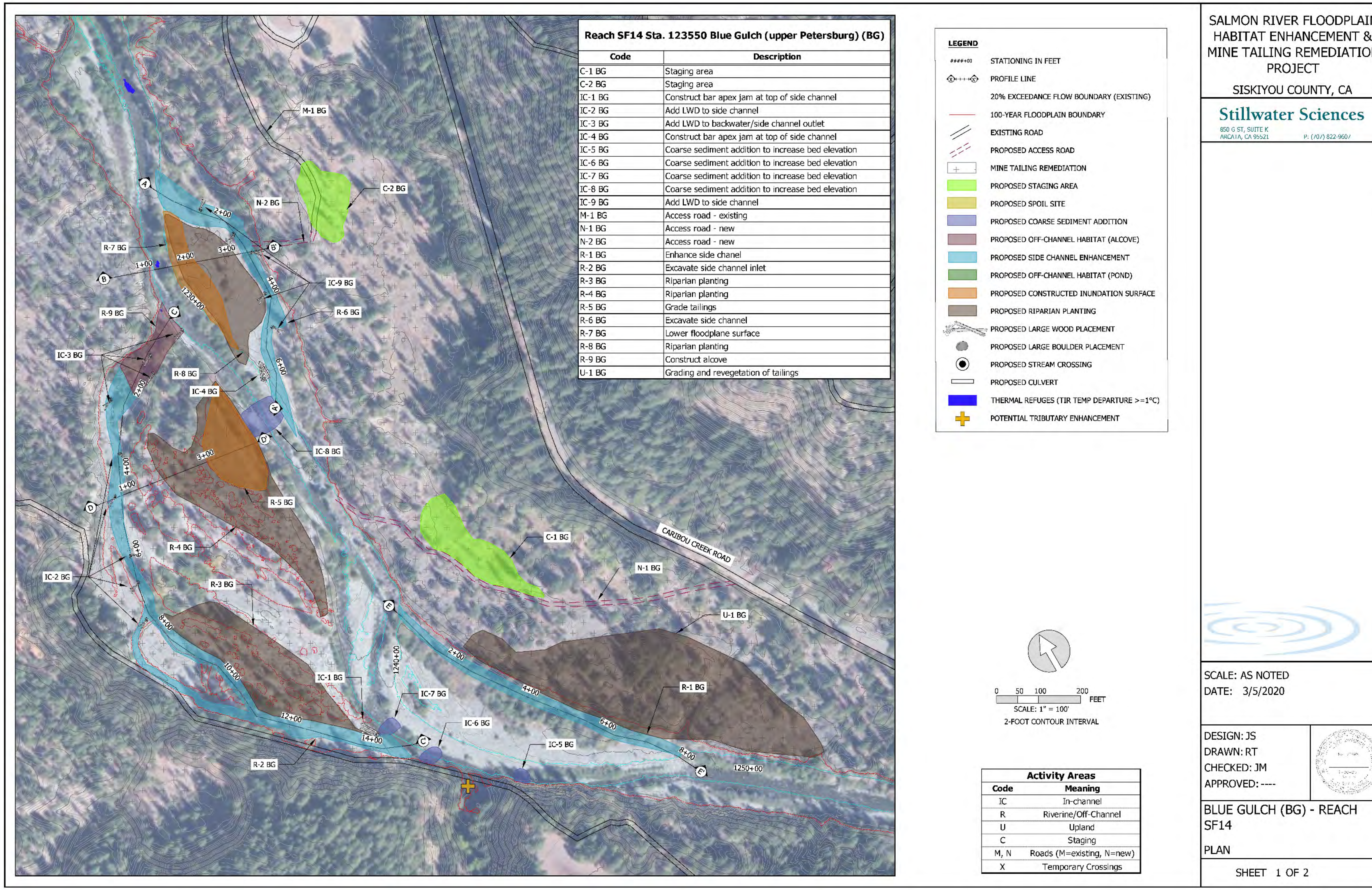


Figure 17. Design plan for South Fork Reach 14 at Blue Gulch.

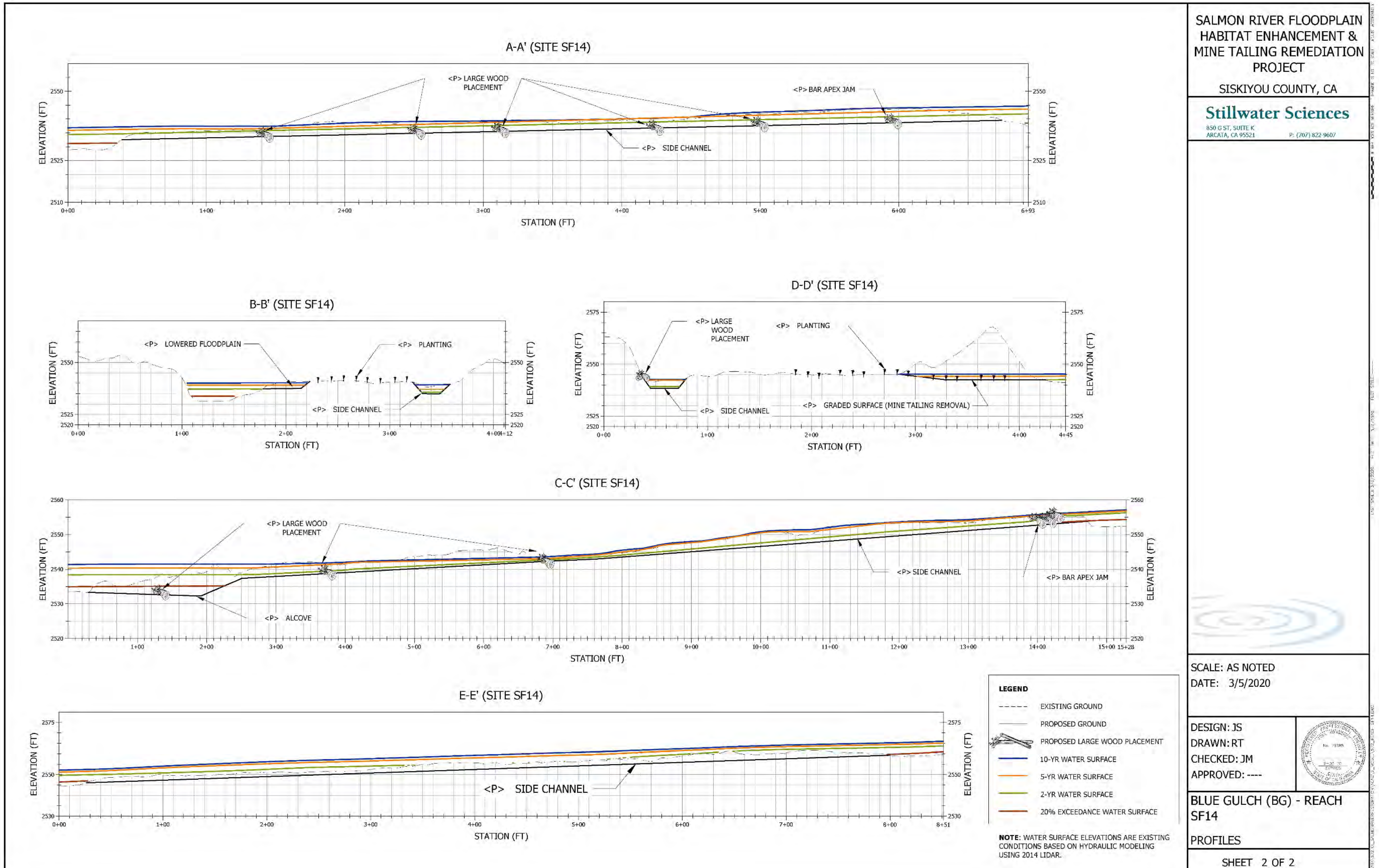


Figure 18. Design profiles for South Fork Reach 14 at Blue Gulch.

Table 9. Activity areas within South Fork Reach 14 at Blue Gulch.

Code	Description
C-1 BG	Staging area
C-2 BG	Staging area
IC-1 BG	Construct bar apex jam at top of side channel
IC-2 BG	Add LWD to side channel
IC-3 BG	Add LWD to backwater/side channel outlet
IC-4 BG	Construct bar apex jam at top of side channel
IC-5 BG	Coarse sediment addition to increase bed elevation
IC-6 BG	Coarse sediment addition to increase bed elevation
IC-7 BG	Coarse sediment addition to increase bed elevation
IC-8 BG	Coarse sediment addition to increase bed elevation
IC-9 BG	Add LWD to side channel
M-1 BG	Access road – existing
N-1 BG	Access road – new
N-2 BG	Access road – new
R-1 BG	Enhance side channel
R-2 BG	Excavate side channel inlet
R-3 BG	Riparian revegetation
R-4 BG	Riparian revegetation
R-5 BG	Grade tailings
R-6 BG	Excavate side channel
R-7 BG	Lower floodplain surface
R-8 BG	Riparian revegetation
R-9 BG	Construct alcove
U-1 BG	Grading and revegetation of tailings

3.8 South Fork Reach 16 Downstream of China Creek (Summerville)

3.8.1 Site description

The design site Downstream of China Creek in South Fork Reach 16 is located between Sta 1346+00 and Sta 1382+00. Channel gradient through the site is approximately 0.0141. The average width of the active channel is highly variable, ranging from approximately 75 to 150 ft. The site has plane bed and riffle pool morphology with planform characterized by low sinuosity meanders, split flow channels around island bars, alternating point bars and lateral bars, and numerous side channels. Many of the existing side channels are active during the 1.5 to 2 year peak flow and lesser discharges (Appendix A Figure A-30 and Figure A-32). The site is hydraulically very complex, and as result, bed grain size varies widely from boulder and large cobble in the steeper and straighter sections lacking wood structure to small cobble and gravel in less steep sections with more planform curvature and large wood structure. Large wood jams and pieces typically occur at bar heads (e.g., Sta 136,100 and Sta139,900). Spawning gravel patches are small and uncommon. The site has relatively little bedrock control except at the outside of bends and intermittent exposures at some riffle crossovers. This reach of the upper South Fork Salmon River maintains relatively cool summer stream temperatures.

The 1997 event dramatically modified this reach: removing most of the riparian forest within the flood prone area, mobilizing most bars, aggrading the valley bottom, and establishing the current geomorphic template. There has been a steady increase in riparian vegetation cover and redevelopment of split flow channels and side channels since 1997.

3.8.2 Proposed habitat enhancement activities

The conceptual design at the design site Downstream of China Creek focuses on increasing the quantity and quality of spawning and juvenile rearing habitats by taking advantage of the existing dynamic and complex channel morphology and hydraulics (Figure 19, Figure 20. Table 10). This design approach centers on constructing multiple large ELJs and bar apex jams at bar heads (IC-1 DCC, IC-3 DCC, IC-5 DCC, IC-9 DCC) to increase the flow splits into existing side channels and promote sediment sorting into larger and more frequent spawning gravel patches; modifying the bed elevation and grade in existing side channels (R-4 DCC, R-6 DCC, R-9 DCC) to increase flow connectivity and inundation frequency and duration; adding large wood structures to side channels (IC-2 DCC, IC-4 DCC, IC-6 DCC) to increase rearing habitat complexity and spawning habitat availability; and planting riparian vegetation (R-1 DCC, R-3 DCC, R-7 DCC) to steer flow, provide cover, and ultimately increase the source of large wood input.

Several constructed alcoves with large wood structures (R-2 DCC and R-8 DCC) are proposed near the outlets of side channels that are frequently inundated and backwater in their lower extents during base flow. Additional opportunities for enhancing tributary junctions (e.g., Sta 1367+00) and associated thermal refuges within the site will be evaluated during subsequent design steps.

Equipment access for construction at the downstream end of the site would be provided by an existing unimproved road (M-1 DCC) off Caribou Creek Road. A large flat area in this vicinity could be used for construction staging (C-1 DCC). Equipment access for construction at the upstream end of the site would be provided by a second existing unimproved road (M-2 DCC) off Caribou Creek Road and by constructing a new temporary road (N-1 DCC) to a construction staging area (C-2 DCC) located on the unvegetated bar.

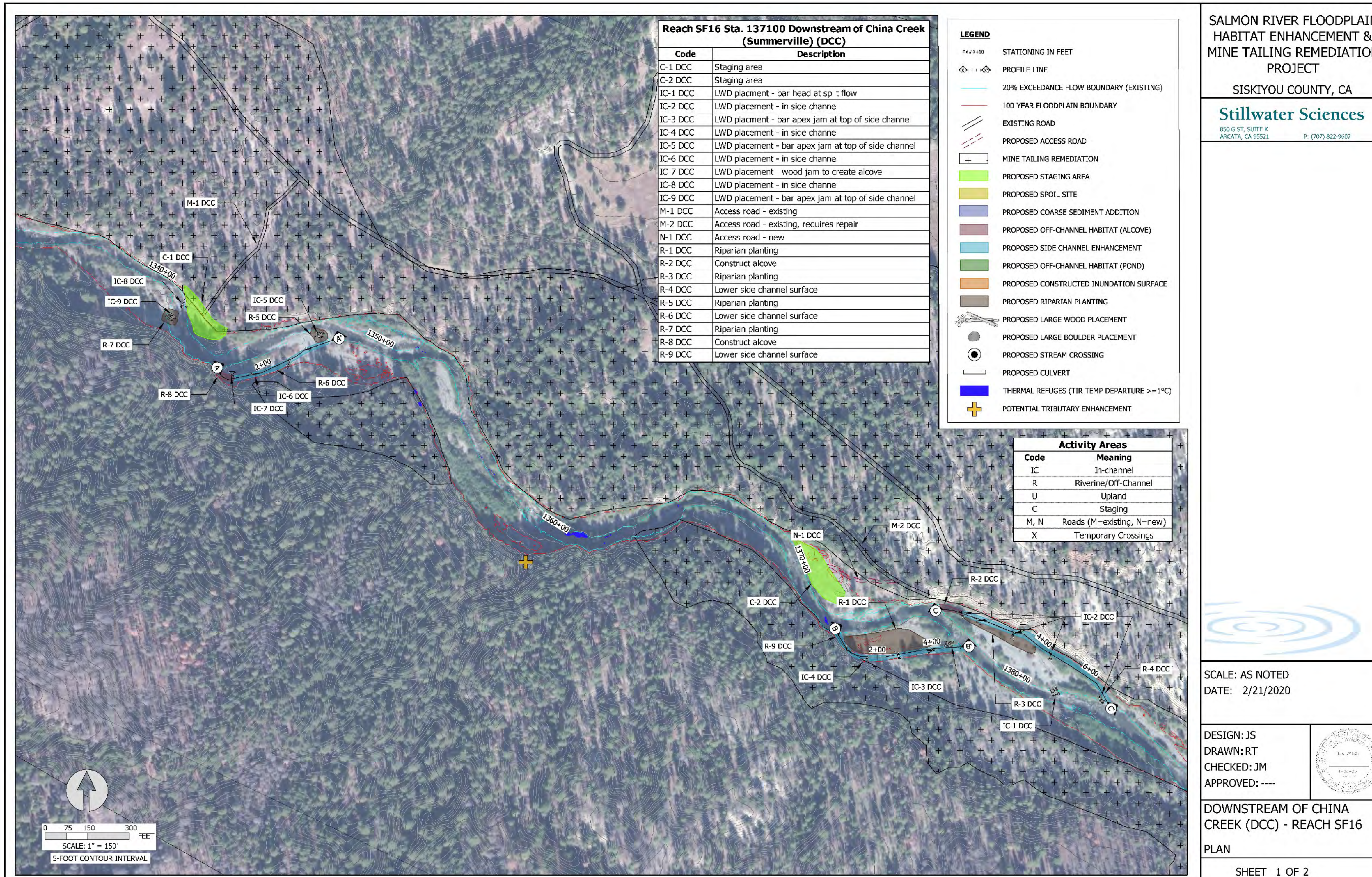


Figure 19. Design plan for South Fork Reach 17 Downstream of China Creek (Summerville).

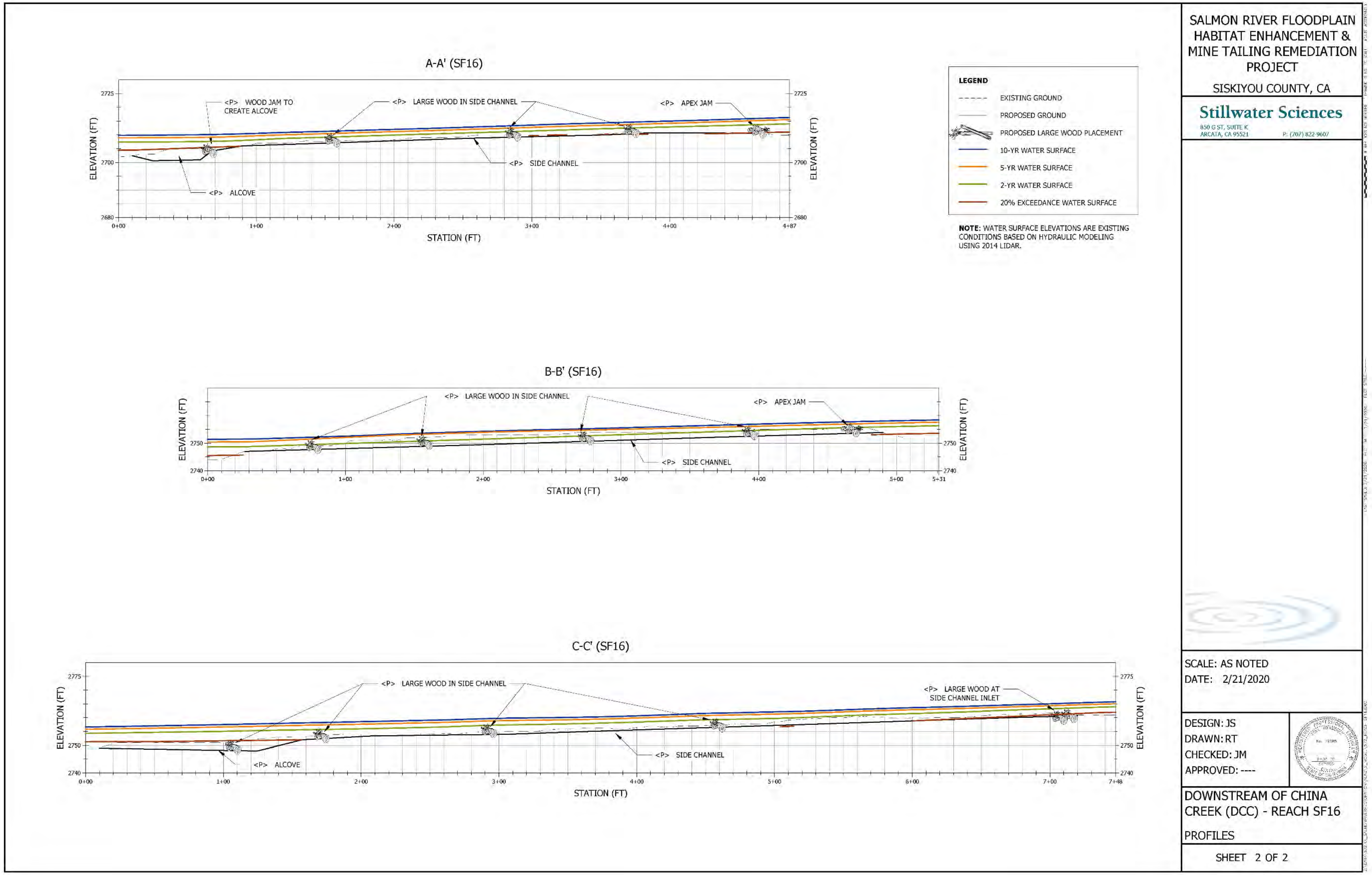


Figure 20. Design profiles for South Fork Reach 17 Downstream of China Creek (Summerville).

Table 10. Activity areas within South Fork Reach 17 Downstream of China Creek (Summerville).

Code	Description
C-1 DCC	Staging area
C-2 DCC	Staging area
IC-1 DCC	LWD placement – Bar head at split flow
IC-2 DCC	LWD placement – in side channel
IC-3 DCC	LWD placement – bar apex jam at top of side channel
IC-4 DCC	LWD placement – in side channel
IC-5 DCC	LWD placement – bar apex jam at top of side channel
IC-6 DCC	LWD placement – in side channel
IC-7 DCC	LWD placement – wood jam to create/maintain alcove
IC-8 DCC	LWD placement – in side channel
IC-9 DCC	LWD placement – bar apex jam at top of side channel
M-1 DCC	Access road – existing
M-2 DCC	Access road – existing
N-1 DCC	Access road – new
R-1 DCC	Riparian revegetation
R-2 DCC	Construct alcove
R-3 DCC	Riparian revegetation
R-4 DCC	Lower side channel surface
R-5 DCC	Riparian revegetation
R-6 DCC	Lower side channel surface
R-7 DCC	Riparian revegetation
R-8 DCC	Construct alcove
R-9 DCC	Lower side channel surface

3.9 North Fork Reach 21A Downstream of Sawpit Flat

3.9.1 Site description

The design site Downstream of Sawpit Flat in North Fork Reach 21A is located between Sta 183+00 and Sta 198+00. The extensive river left terrace was historically mined for gold, and active mining of the tailings piles still occurs at the downstream end. Channel gradient through the site is approximately 0.0085 and average width of the active channel is approximately 120 ft. The site is relative straight, confined, and hydraulically very simple, with predominantly alluvial boulder plane bed morphology and little channel complexity. Prominent geomorphic features within the site include a large pool tail and associated point bar deposit at the upstream end of the reach; a long and narrow midchannel boulder bar through the central portion of the reach; and a large, deep bedrock pool at the downstream end of the reach. The midchannel bar, a persistent feature that has progressively been colonized by riparian vegetation since 1993 but otherwise has experience little obvious change, splits low flow into two shallow plane bed channels and has accumulated large wood at points along its crest. The entire channel width is inundated at 20% exceedance, including all or most of the midchannel bar (Appendix A Figure A-35). There is little to no additional area inundated at higher flows due to confinement.

3.9.2 Proposed habitat enhancement activities

The design site Downstream of Sawpit Flat is the second of three sites selected for the potential to experiment with large wood structures designed to create habitat complexity and increase spawning and rearing habitat quality for focal salmonids in reaches with existing plane bed morphology and coarse substrate (Figure 21, Table 11). The design approach uses ELJ structures and bar apex jams to sort bed material to improve spawning habitat, steer flow to increase sinuosity within the existing active channel, and create more complexity within the existing plane bed. The large ELJ located at the upstream pool tail (IC-1 DSF) is intended to sort gravel and fine the bed in the area most likely to support spawning habitat; the two downstream ELJ structures (IC-2 DSF and IC-3 DSF) are designed to enhance the split flow around the midchannel bar and facilitate deposition on its crest and flanks, and the several large wood structures at the downstream end of the site (IC-4 DSF) where the existing channel is relatively featureless are intended to steer flow from bank to bank, sort spawning gravel, and facilitate pool scour.

Sawyers Bar Road and the spur road that drops to a wet ford provides potential access for construction equipment. The existing river left terrace provides large areas for staging and would benefit from increased revegetation.

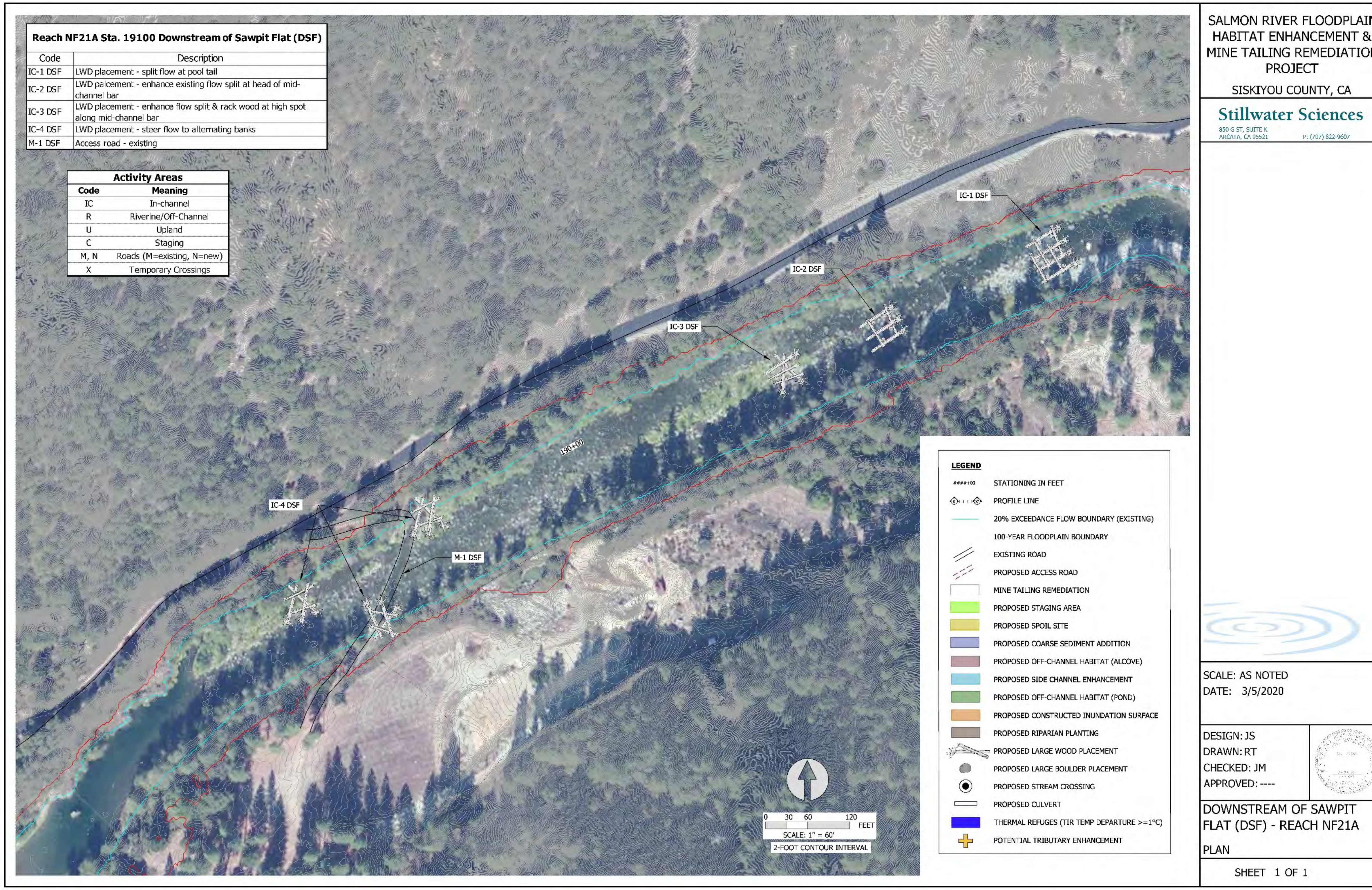


Figure 21. Design plan for North Fork Reach 21A Downstream of Sawpit Flat.

Table 11. Activity areas within North Fork Reach 21A Downstream of Sawpit Flat.

Code	Description
IC-1 DSF	LWD placement – split flow at pool tail
IC-2 DSF	LWD placement – enhance existing flow split at head of midchannel bar
IC-3 DSF	LWD placement – enhance flow split and rack wood at high spot along midchannel bar
IC-4 DSF	LWD placement – steer flow to alternating banks

3.10 North Fork Reach 23B Jackass Gulch to Shiltos Creek

3.10.1 Site description

The design site Jackass Gulch to Shiltos Creek in North Fork Reach 23B is located between Sta 677+00 and Sta 727+00 about 1.7 mi downstream of Sawyers Bar and 1.3 mi upstream of the Little North Fork Salmon River. Jackass Gulch enters the North Fork Salmon River from river right at the upstream end of the site, and Shiltos Creek enters the North Fork Salmon River from river left near the downstream end of the site. A private swinging bridge crosses the channel at Sta 682+00.

Channel gradient through the site is approximately 0.0087. Active channel width is highly variable, ranging from approximately 100 to 130 ft. Channel planform within the site is meandering, tending toward an anabranching pattern at high flows, with multiple flow paths branching around stable midchannel bars and terraces (Appendix A Figures A-46 and A-48). Many of these side channels are relatively frequently inundated (20% exceedance to a 2 year peak flow), although the inlets typically become inundated at higher, less frequent flows. Channel bed substrates in the site are predominantly boulder and boulder-cobble with very patchy sand and gravel, little of which provides suitable spawning habitat for coho and spring-run Chinook salmon or steelhead. Bar crests within the site tend to accumulate large wood (e.g., Sta 683+00 and Sta 708+00).

The large side channel and intervening bar near the upstream end of the site generally lacks riparian vegetation and currently provides little aquatic habitat due to a lack of flow connectivity, structure and cover. The river left floodplain and associated side channels in the middle of the site have extensive riparian cover and offer higher quality aquatic habitat. The river right side channel near the downstream end of the site has little vegetation cover near the bar head, but riparian and aquatic habitat values improve in the downstream direction as vegetation cover and channel structure increase. The cliff edge above this large bar on river right at the downstream end of the site is a historical dump, where trash was dropped from the top of the cliffs to the bar below. The historical significance and potential cleanup of the dump site will need to be taken into consideration in restoring this reach.

The North Fork of the Salmon River between North Russian Creek and the Little North Fork confluence is a warming reach where thermal refugia are especially important to the survival and growth of juvenile salmonids. Although the site generally lacks large, deep pools; several smaller pools provide important thermal refugia (e.g., Sta 678+00 and Sta 706+00) (Appendix A Figure A-45 and Figure A47).

3.10.2 Proposed habitat enhancement activities

The conceptual design at the Jackass Gulch to Shiltos Creek design site focuses primarily on (1) increasing the quality of juvenile rearing habitats by enhancing existing side channels, off channel ponds, and thermal refugia; and (2) increasing the quantity of spawning habitat by promoting coarse sediment deposition and sorting at riffles and pool tails (Figure 22, Figure 23. Table 12).

At the upstream end of the site, historical placer mining on the river left terrace resulted in a perennial pond and additional seasonally ponded depressions that provide opportunities to create off channel rearing habitat. The conceptual design includes enlarging and connecting these ponds to each other and to the mainstem North Fork Salmon River (R-8 SC). The channel connecting the ponds to the North Fork Salmon River (R-7 SC) would be located a short distance upstream of the Jackass Gulch confluence.

Downstream of Jackass Gulch, a large ELJ and bar apex jam (IC-2 SC and IC-3 SC) would be constructed to stabilize coarse sediment additions (IC-1 SC) and sort gravel at the existing pool tail, as well as help achieve the design flow split into the right bank side channel. The side channel inlet (R-1 SC) and sections of the downstream side channel alignment (R-2 SC) would be excavated to the limits of the shallow underlying bedrock to improve flow connectivity and increase inundation frequency and duration. An alcove would be constructed at the downstream end of the side channel (R-6 SC), taking advantage of existing riparian cover and backwater conditions. The side channel banks and intervening bar would be extensively planted with native riparian vegetation (R-3 SC and R-5 SC).

At the downstream end of the site, a large ELJ and bar apex jam (IC-5 SC and IC-6 SC) would be constructed to stabilize coarse sediment additions (IC-4 SC), sort gravel at the existing riffle crest, and achieve the design flow split into the river right side channel. Numerous large wood jams and pieces would be added to the side channel to increase habitat complexity. A portion of the floodplain along the mainstem channel downstream of the riffle would be lowered (R-4 SC) to create a local expansion in channel width that would slow flow velocities and promote sediment deposition conducive to channel margin rearing habitat and riparian vegetation establishment.

Additional site-specific opportunities for improving thermal refuges and the habitat value of tributary junctions (e.g., Jackass Gulch and Shiltos Creek) would be identified in the field during future design steps.

Equipment access for construction at the upstream end of the site would be provided by an existing unimproved road (M-1 BG) off Sawyers Bar Road. A large unvegetated area at the bar head could be used for construction staging (C-2 BG). This unimproved road is a designated engine fill site and needs to be maintained for emergency fire vehicle access and drafting as a part of the restoration efforts.

Equipment access for construction at the downstream end of the site is difficult. Access would need to occur off Sawyers Bar Road, at an existing unimproved road below the existing swinging bridge. Construction equipment would then cross the side channel at its confluence with the main channel and access the central bar from its lower end. Staging would likely need to occur in the vicinity of the large, unvegetated bar head and on the flat where the unimproved road accesses the river below the swinging bridge. Care would have to be taken to avoid negatively impacting the existing habitat at the downstream end of the side channel.

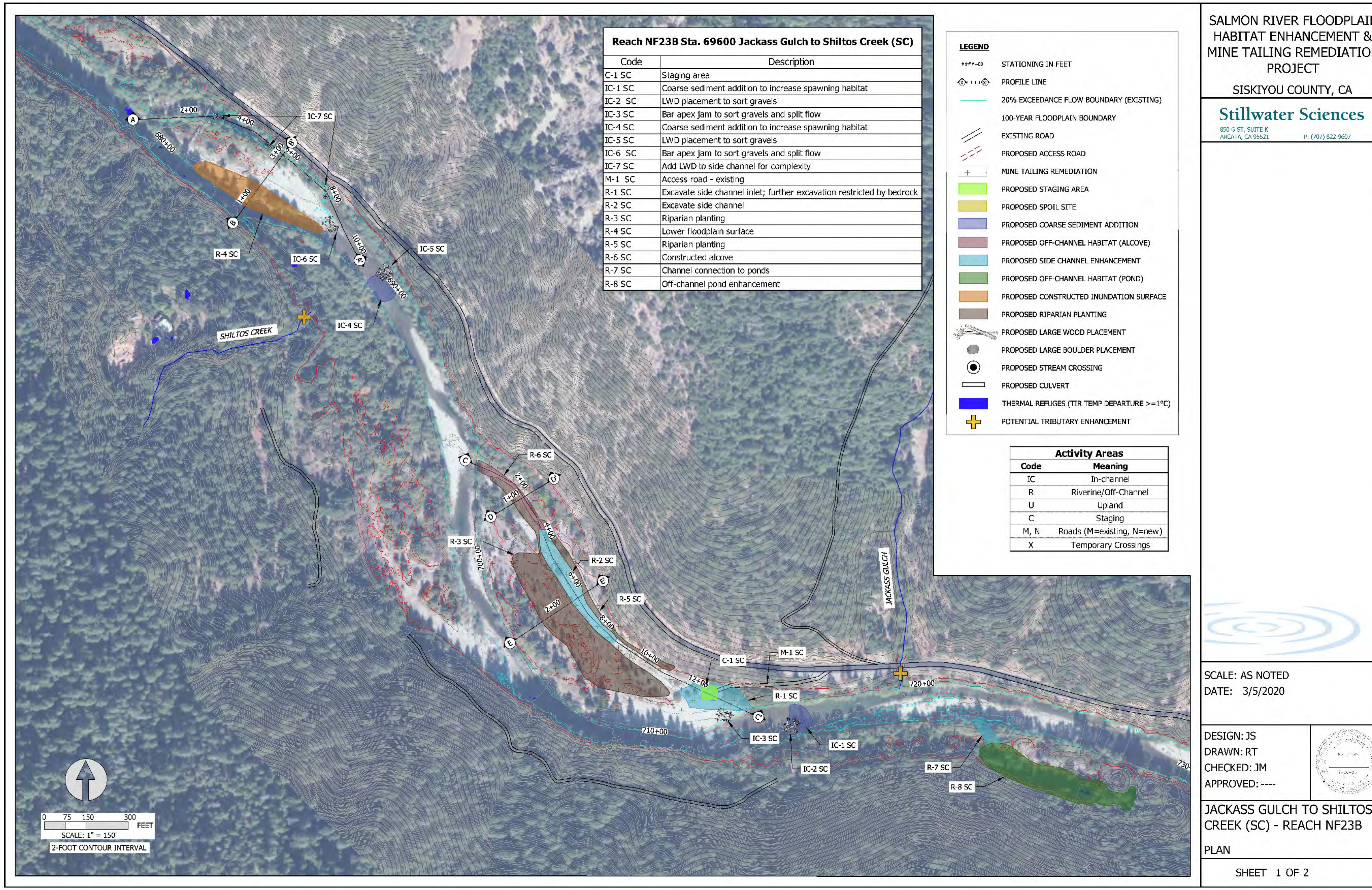


Figure 22. Design plan for North Fork Reach 23B Jackass Gulch to Shiltos Creek.

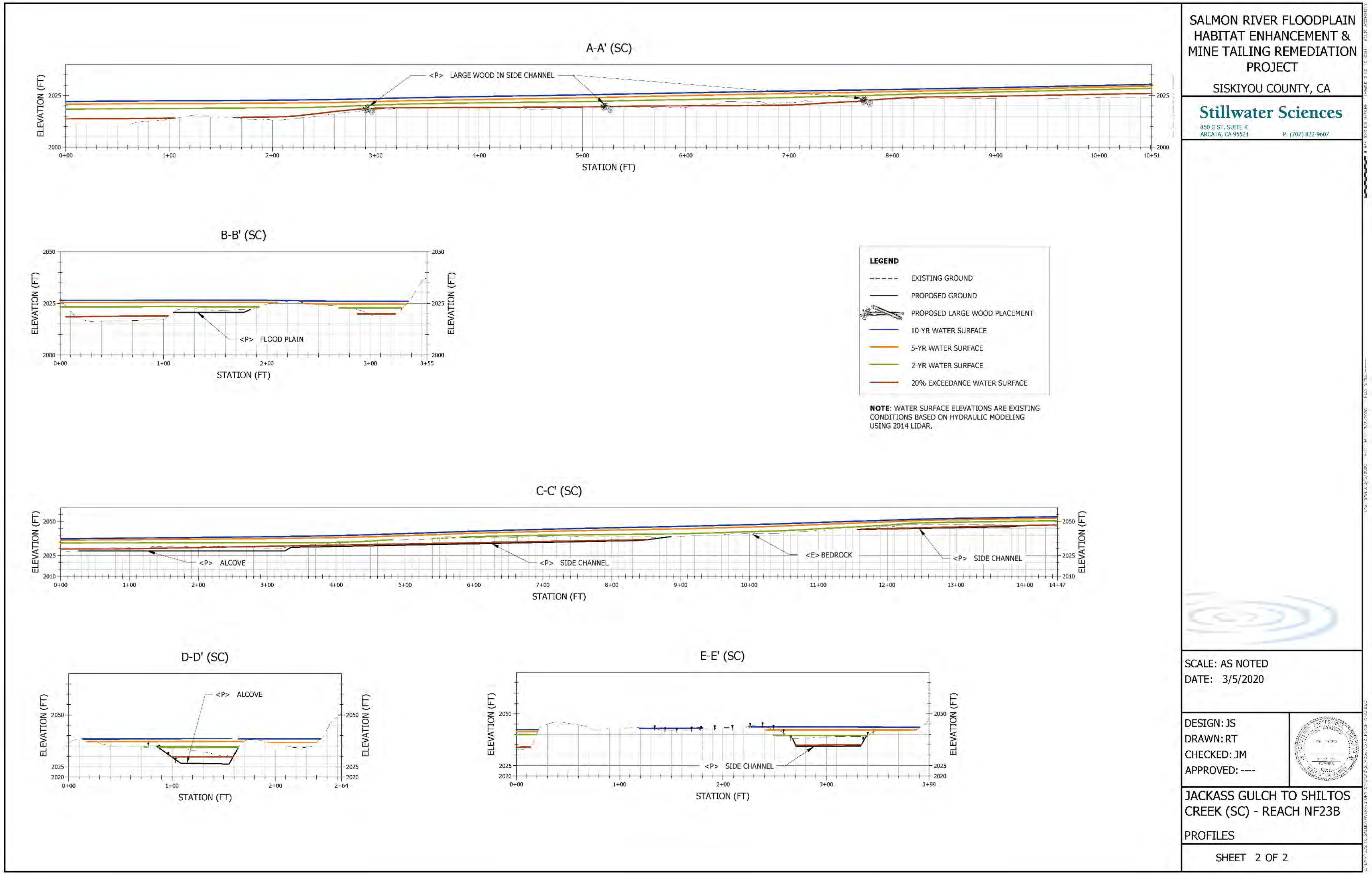


Figure 23. Design profiles for North Fork Reach 23B Jackass Gulch to Shiltos Creek.

Table 12. Activity areas within North Fork Reach 23B Jackass Gulch to Shiltos Creek.

Code	Description
C-1 SC	Staging area
IC-1 SC	Coarse sediment addition to increase spawning habitat
IC-2 SC	LWD placement to sort gravel
IC-3 SC	Bar apex jam to split flow and sort gravels
IC-4 SC	Coarse sediment addition to increase spawning habitat
IC-5 SC	LWD placement to sort gravel
IC-6 SC	Bar apex jam to split flow and sort gravels
IC-7 SC	Add LWD to side channel for complexity
M-1 SC	Access road – existing
R-1 SC	Excavate side channel inlet
R-2 SC	Excavate side channel
R-3 SC	Riparian revegetation
R-4 SC	Lower floodplain surface
R-5 SC	Riparian revegetation
R-6 SC	Constructed alcove
R-7 SC	Channel connection to ponds
R-8 SC	Off channel pond enhancement

3.11 North Fork Reach 23C at Jessups Gulch

3.11.1 Site description

The Jessups Gulch design site in North Fork Reach 23C is located between Sta 800+00 and Sta 816+50 about in the vicinity of the Sawyers Bar community. Jessups Gulch enters the North Fork Salmon River from the left bank in the middle of the site.

Channel gradient through the site is approximately 0.0133. Active channel width is variable due to the sinuous and relative unconfined channel morphology, ranging from approximately 90 to 120 ft. Channel planform within the site is similar to that described for the Jackass Gulch to Shiltos Creek design site, where the meandering channel form tends toward an anabranching pattern at high flows with two prominent side channels branching around high, stable bars or terraces (Appendix A Figures A-50). The right bank side channel cutting the back edge of the upstream point bar terrace inundates at the 1.5 year peak flow and connects to the second side channel at its downstream end. This second right bank side channel conveys winter base flow around a large and relatively high midchannel terrace. The main channel bed has plane bed morphology with predominantly boulder and boulder-cobble substrates. Although small cobble-gravel patches occur within the site, they provide little suitable spawning habitat for coho, spring-run Chinook salmon or steelhead.

The large side channel and intervening terrace at the upstream end of the site lacks riparian vegetation and provides little riparian or aquatic habitat value due to a lack of flow connectivity, structure and cover. Riparian vegetation is more extensive in the low floodplain area on river right at the upstream end of this side channel. An existing unimproved road crosses the side channel to accesses a large, highly disturbed flat area in the middle of the terrace.

The large side channel and intervening terrace at the downstream end of the site have more extensive riparian vegetation and better-quality aquatic habitat. Analysis of thermal infrared imagery and field investigation indicates the presence of several perennial pools with cool, spring-fed water along the course of this side channel (Appendix A Figures A-49). This source of cool water combined with shade afforded by the dense overhead riparian canopy would allow this area to provide potentially important late spring and summer thermal refuge in an otherwise warm reach of the North Fork, if these habitats were better connected to the mainstem channel during low flow.

3.11.2 Proposed habitat enhancement activities

The conceptual design at the Jessups Gulch design site involves increasing juvenile rearing habitats by enhancing existing side channels and increasing the quantity of spawning habitat by promoting coarse sediment deposition and sorting at riffles and pool tails (Figure 24, Figure 25. Table 13).

At the upstream end of the reach, coarse sediment suitable for spawning coho, spring-run Chinook salmon and steelhead would be added to the riffle crest (IC-1 JG), and a large ELJ (IC-2 JG) would be constructed to help stabilize the sediment deposit and sort gravel. These treatments would work in combination with the design treatments in the adjoining upstream design site (Sawyers Bar) to create channel complexity and increase spawning habitat quality within existing plane bed morphology and coarse substrate.

In the middle of the site, one or more large ELJs or bar apex jams (IC-3 JG) would be constructed at the head of the large point bar to help achieve the design flow split into the river right side channel. The side channel would be excavated (R-1 JG) to improve flow connectivity and increase inundation frequency and duration. An off-channel pond (R-7 JG), would be constructed within the existing low-lying floodplain area along the right bank near the side channel inlet. Numerous large wood jams and pieces would be added to the side channel (IC-4 JG) to increase habitat complexity, and the mainstem and side channel banks and intervening bar would be extensively planted with native riparian vegetation (R-2 JG, R-3 JG, R-4 JG, R-6 JG).

In the downstream end of the site, one or more large ELJs or bar apex jams (IC-5 JG) would be constructed at the head of the midchannel bar to help achieve the design flow split into the river right side channel. The head of the side channel would be excavated (R-5 JG) to improve flow connectivity and increase inundation frequency and duration.

Additional site-specific opportunities for improving thermal refuges and the habitat value of the Jessups Gulch tributary junction would be identified in the field during future design steps.

Equipment access for construction at the upstream end of the site would be provided by an existing unimproved road (M-1 JG) off Sawyers Bar Road. The large unvegetated area in the middle of the point bar terrace could be used for construction staging (C-1 JG).

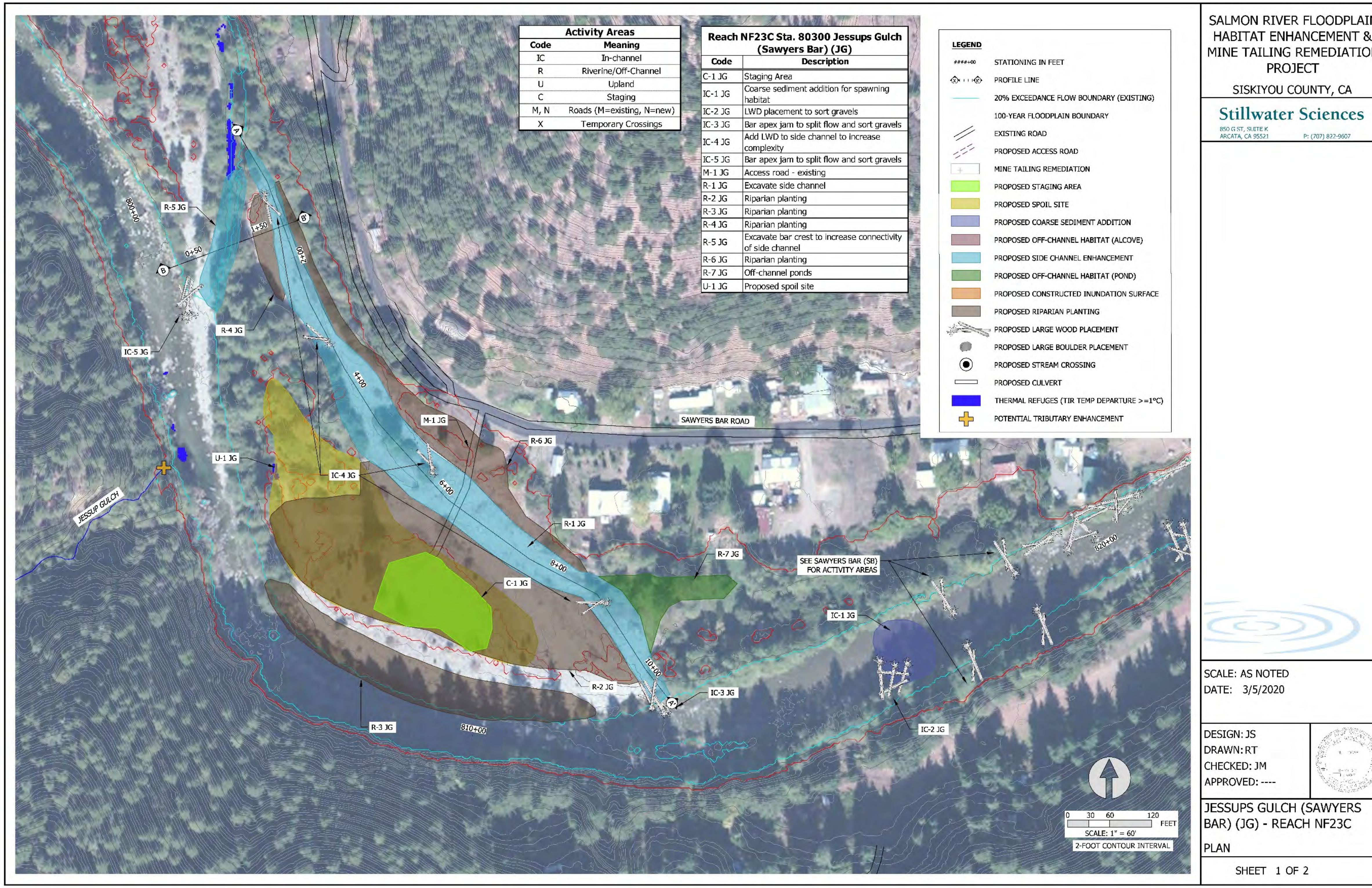


Figure 24. Design plan for North Fork Reach 23C at Jessups Gulch.

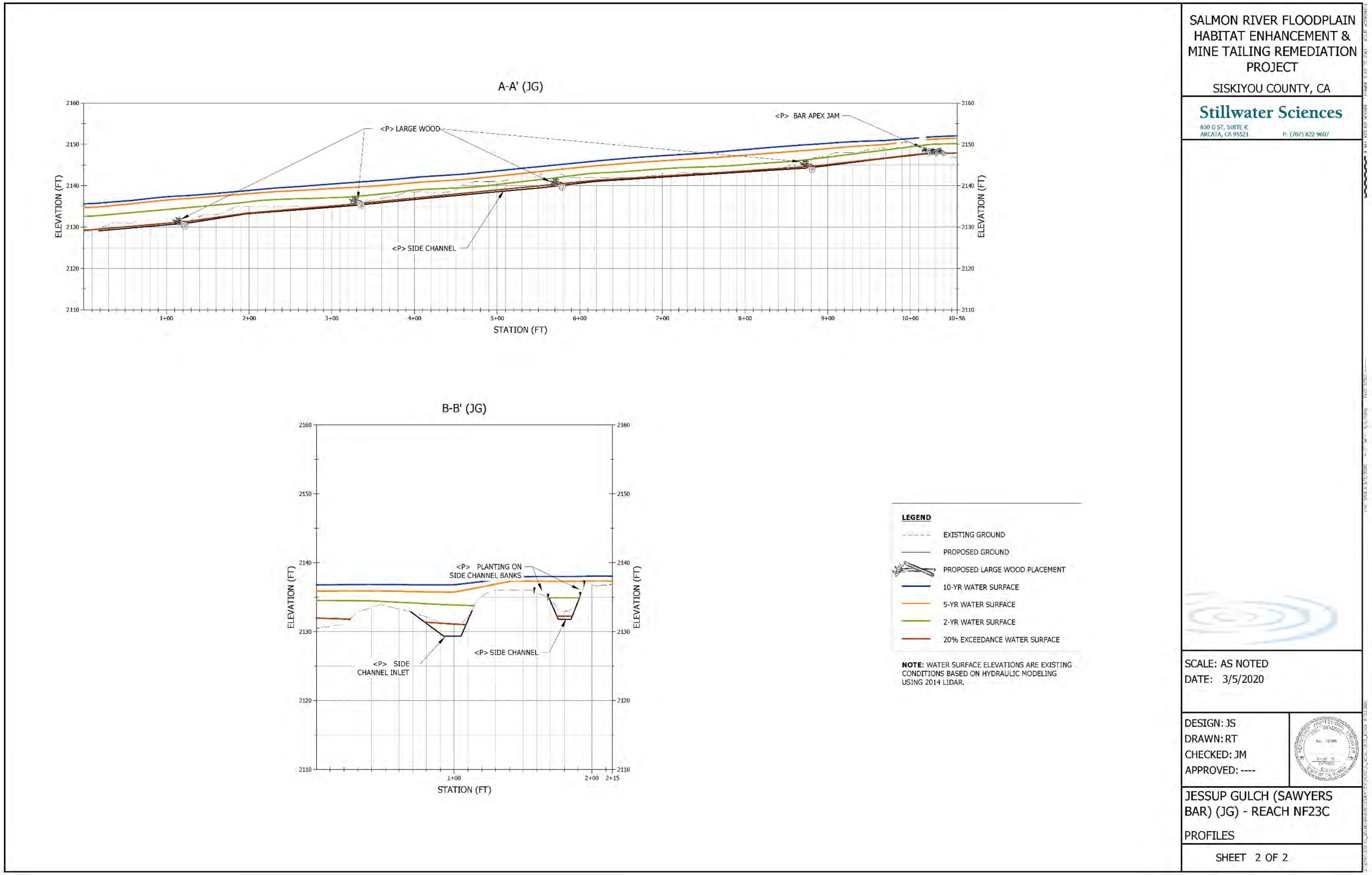


Figure 25. Design profiles for North Fork Reach 23C at Jessups Gulch.

Table 13. Activity areas within North Fork Reach 23C at Jessups Gulch.

Code	Description
C-1 JG	Staging area
IC-1 JG	Coarse sediment addition for spawning habitat
IC-2 JG	LWD placement to sort spawning gravel
IC-3 JG	Bar apex jam to split flow and sort gravel
IC-4 JG	Add LWD to side channel to increase complexity
IC-5 JG	Bar apex jam to split flow and sort gravel
M-1 JG	Access road – existing
R-1 JG	Excavate side channel
R-2 JG	Riparian revegetation
R-3 JG	Riparian revegetation
R-4 JG	Riparian revegetation
R-5 JG	Excavate to increase connectivity to side channel
R-6 JG	Riparian revegetation
R-7 JG	Off-channel ponds
U-1 JG	Proposed spoil site

3.12 North Fork Reach 23C at Sawyers Bar

3.12.1 Site description

The Sawyers Bar design site in North Fork Reach 23C is located adjacent to the community of Sawyers Bar between Sta 816+50 and Sta 826+00. Tanner Gulch enters from river right at the upstream end of the site just downstream of the Eddie Gulch Road bridge. Channel gradient through the site is approximately 0.0067. The average width of the active channel is approximately 110 ft through most of the site. Most of the active channel width is inundated at 20% exceedance, with little to no additional area inundated at higher flows due to confinement. At the downstream end of the site, the active channel width widens and includes more floodplain inundated at the 5-year peak flow and higher (Appendix A Figure A-50).

The site is straight, confined, and hydraulically very simple, with predominantly coarse (boulder and large cobble) plane bed channel morphology and bedrock-controlled banks. The 1997 flood event extensively scoured riparian vegetation from the reach and mobilized the bed in downstream areas, with little apparent change in upstream areas.

3.12.2 Proposed habitat enhancement activities

The Sawyers Bar site is the third of three sites selected for the potential to experiment with large wood structures designed to create habitat complexity and increase spawning and rearing habitat quality for focal salmonids in reaches with existing plane bed morphology and coarse substrate.

Expanding channel width at the site will help promote deposition of finer bedload material with the addition of large, tall structures that resist, separate, and steer flow (Figure 26, Table 14). A large wood structure would be constructed slightly downstream of the existing incipient riffle crest/hydraulic control (IC-1) to influence upstream water surface elevations and slope, deform the bed, and force deposition of spawning gravel at a location with depths and velocities conducive to spawning. This structure would also help to steer flow from the right bank to the left bank just upstream of an area of existing right bank erosion. Large wood structures proposed in this general vicinity and immediately downstream (IC-2) are oriented bank parallel to help stabilize the bank. Flow steered from the right bank to the left bank by the large upstream-most structure would encounter the large left bank structure (IC-2). This structure would interrupt those concentrated flow velocities, deform the bend, sort bedload, and steer flow back toward the middle over a wide flow range. Moving downstream, the opposing pairs of large wood structures (IC-3) would narrow width and concentrate higher flow velocities and bedload transport in the middle of the channel, where it would encounter the third large structure (described in the Jessups Gulch design site). Channel width expansion downstream of this structure would promote deposition of spawning gravel well upstream of the point of separation into the river right side channel (helping to minimize bed elevation changes at the side channel inlet) and would help steer flow toward this side channel inlet. Due to the low sinuosity of the existing channel and valley bottom, the flow field during higher flows is likely to be oriented down the middle of the channel, and the alternating structures would provide velocity refuge along the margins.

Access to this site for construction would occur through the Jessups site, located just downstream from the design site.

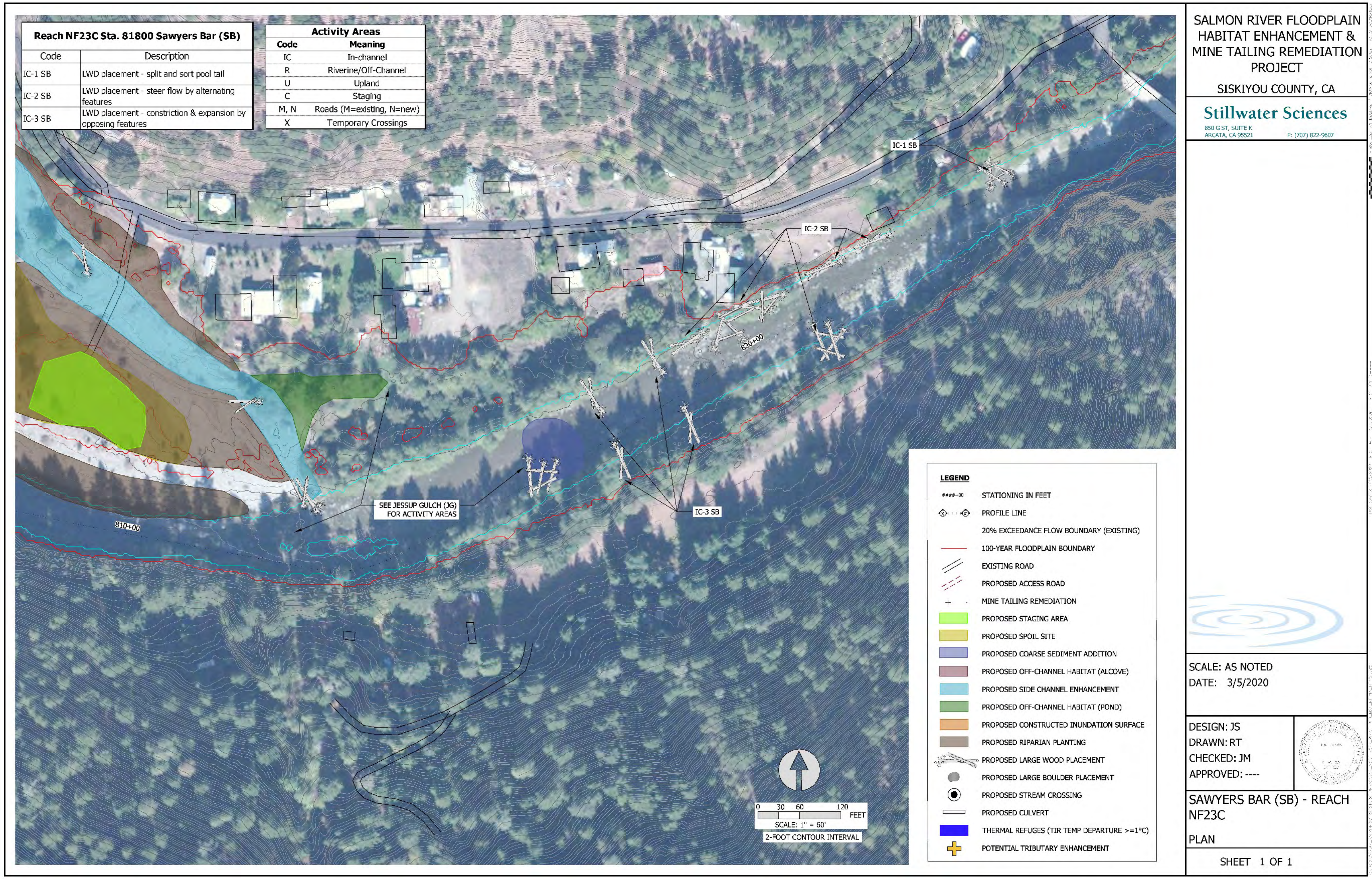


Figure 26. Design plan for North Fork Reach 23C at Sawyers Bar.

Table 14. Activity areas within North Fork Reach 23C at Sawyers Bar.

Code	Description
IC-1 SB	LWD placement – split flow and sort gravel to enhance spawning habitat
IC-2 SB	LWD placement – steer flow by alternating jam features
IC-3 SB	LWD placement – channel width constriction and expansion

3.13 North Fork Reach 25 Near Robinson Flat

3.13.1 Site description

The design site Near Robinson Flat in North Fork Reach 25 is located between Sta 1075+00 and Sta 1086+00. Channel gradient through the site is approximately 0.0175 and average width of the active channel ranges from 90 to120 ft. The site encompasses a bend in the river where a network of secondary channels cut through the river left floodplain and around terrace remnants within a locally wide valley bottom relative to adjacent upstream and downstream reaches. The two primary secondary channels currently inundate at a 1.5- to 5-year peak flow (Appendix A Figure A-52). The side channel inlets are relatively high and inundate less frequently than the outlets. Large wood has accumulated in small jams at the bar head (e.g., near Sta 1084+00) but is generally absent from the main channel. The side channels all coalesce into single flow path that connects back to the main channel at the downstream end of the bend near Sta 1077+50.

A smaller secondary flow path cuts the back edge of the river right lateral bar at the top of the site. This side channel is inundated at the 20% exceedance flow but channel head forms mid-bar as flow crossing the bar coalesces at the back edge, resulting in a poorly defined inlet that can potentially disconnect the feature during some winter base flows (Appendix A Figure A-52). The side channel also lacks structure or complexity.

The mainstem channel is steep and has simple plane bed morphology with predominantly boulder and cobble substrate through most of the site. Gravel patches are sparse, small, and provide little spawning habitat. Pools occur at the downstream end of the reach where flow impinges on the river left bedrock valley wall. Shallow streamside landslides actively deliver sediment at this location and at a similar location at the upstream end of the reach where flow impinges on the river left valley wall.

The 1997 flood event extensively scoured vegetation and caused geomorphic changes throughout the site, except on the upland crests of the terrace remnants. The 2005 event had less effect on vegetation and geomorphology within the site, but riparian vegetation was still scoured from the bar flanks and side channels.

3.13.2 Proposed habitat enhancement activities

The approach at the design site Near Robinson Flat involves increasing the inundation frequency and duration in side channels and increasing the quantity of spawning habitat by promoting coarse sediment deposition and sorting in the main channel (Figure 27, Figure 28. Table 15).

At the upstream end of the site, numerous large wood jams and pieces would be added to the river right side channel (IC-1 RF) to increase complexity. Two or more large ELJs (IC-2 NRF and IC-3 NRF) would be constructed at the bar head in the vicinity of the side channel inlets to sort gravel and help achieve the design flow split into the side channels. The side channel inlets would be excavated (R-1 NRF and R-3 NRF) to improve flow connectivity and increase inundation frequency and duration. Numerous large wood jams and pieces would be added to the side channels (IC-4 NRF and IC-5 NRF) to increase habitat complexity, and the side channel banks and intervening areas would be extensively planted with native riparian vegetation (R-2 NRF, R-6 NRF through R-10 NRF). The outlet at the downstream end of the side channel network would be excavated (R-5 NRF) to provide a better connection to the main channel during winter base flows.

Access and staging are difficult at this site due to the steep topography and lack of existing roads. A new access road (N-1 NRF) would need to be constructed to access staging areas on river right at the upstream (C-1 NRF) and downstream (C-2 NRF) ends of the site. Alternatively, access may be possible using the private road at the upstream end of the site, moving construction equipment and materials across the channel at the upstream end and down the river left side of the valley bottom. Under this alternative scenario, staging would occur on the upland terrace remnants.

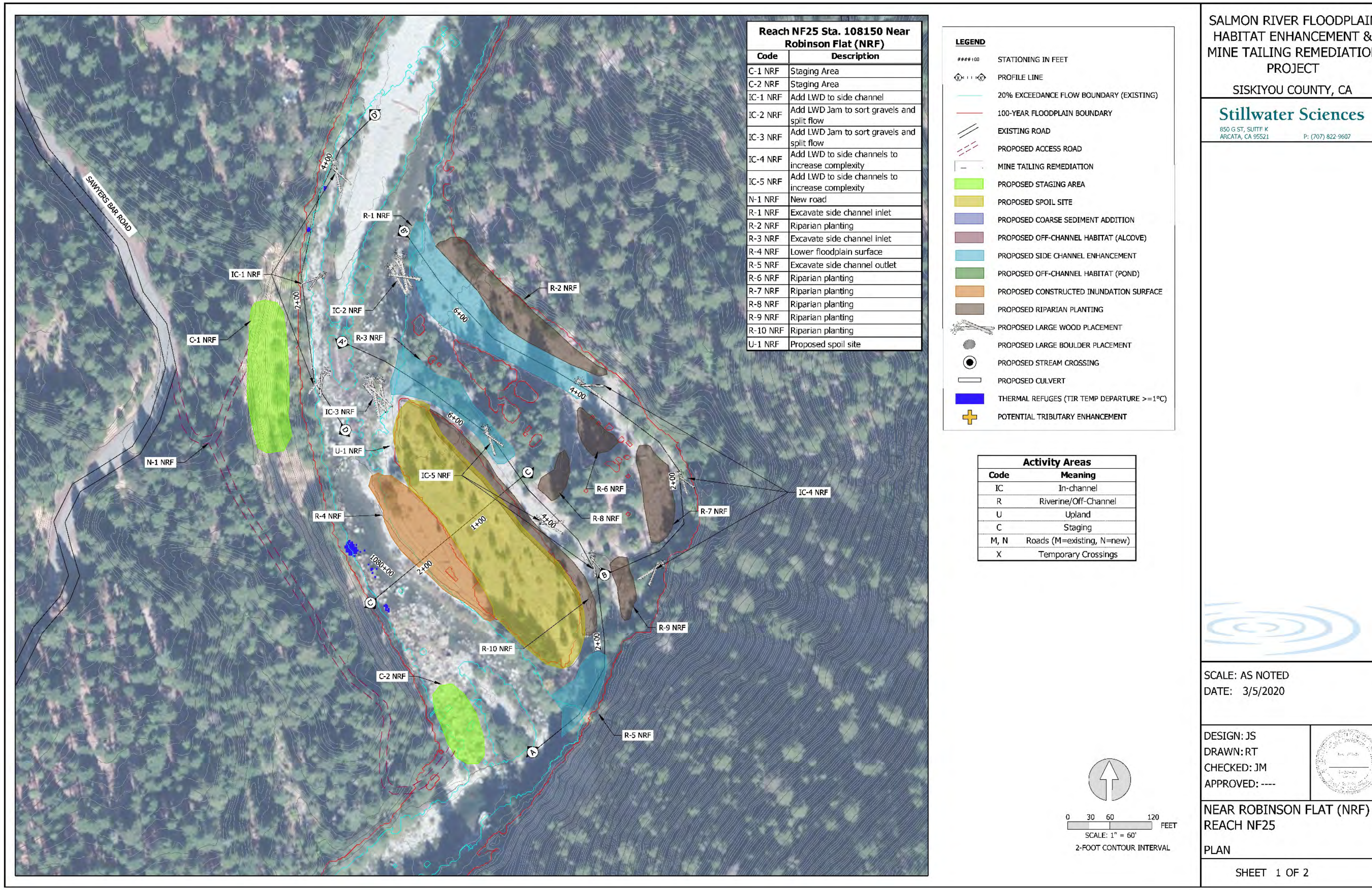


Figure 27. Design plan for North Fork Reach 25 Near Robinson Flat.

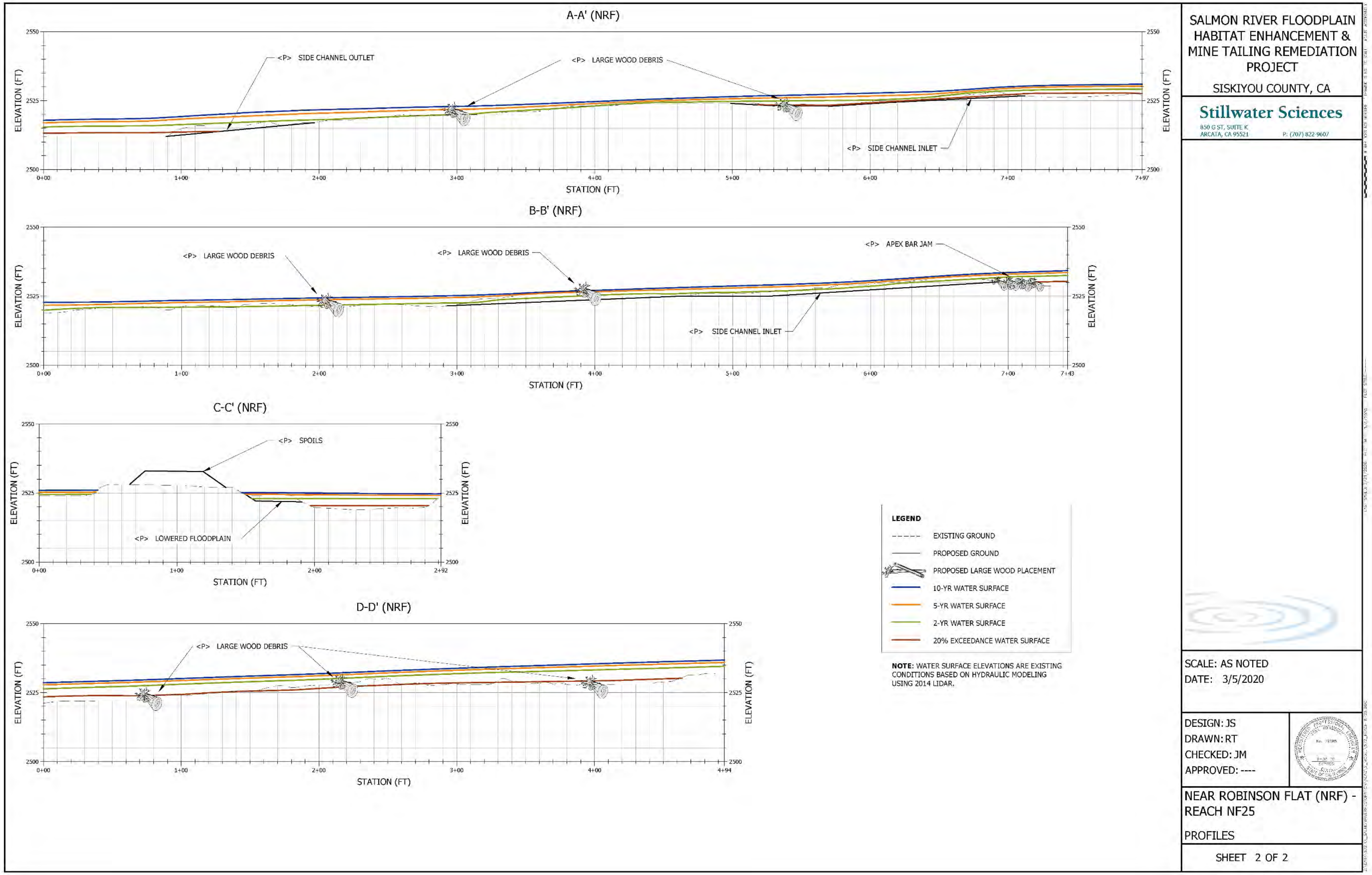


Figure 28. Design profiles for North Fork Reach 25 Near Robinson Flat.

Table 15. Activity areas within North Fork Reach 25 Near Robinson Flat.

Code	Description
C-1 NRF	Staging area
C-2 NRF	Staging area
IC-1 NRF	Add LWD to side channel
IC-2 NRF	Add LWD jam to split flow and sort gravel
IC-3 NRF	Add LWD jam to split flow and sort gravel
IC-4 NRF	Add LWD to side channel to increase complexity
IC-5 NRF	Add LWD to side channel to increase complexity
N-1 NRF	Access road – new
R-1 NRF	Excavate side channel inlet
R-2 NRF	Riparian revegetation
R-3 NRF	Excavate side channel inlet
R-4 NRF	Lower floodplain surface
R-5 NRF	Excavate side channel outlet
R-6 NRF	Riparian revegetation
R-7 NRF	Riparian revegetation
R-8 NRF	Riparian revegetation
R-9 NRF	Riparian revegetation
R-10 NRF	Riparian revegetation
U-1 NRF	Proposed spoil site

3.14 North Fork Reach 25 at North Russian Creek

3.14.1 Site description

The design site at North Russian Creek in North Fork Reach 25 is located between Sta 1101+00 and Sta 1112+50 and is the most upstream design site in the North Fork Salmon River. Channel gradient through the site is approximately 0.0137, and average width of the active channel is highly variable due to the wide floodplain and complex secondary channels that convey high flows from river right across an extensive midchannel bar to a prominent side channel flowing along the river left valley wall. This main side channel has extensive riparian cover, good habitat complexity, and remains active at winter base flow (20% exceedance) (Appendix A Figure A-54). Analysis of thermal infrared imagery and field investigation indicates the presence of perennial pools with cool, spring-fed water along the course of this side channel (Appendix A Figures A-53).

North Russian Creek, an important tributary with abundant cool summer flow, enters the North Fork Salmon River at the downstream end of the site. The introduction of cool water leads to lower overall temperatures in the North Fork Salmon River and an important thermal refuge in the pool located at the North Russian Creek confluence.

The relatively steep mainstem channel within the site is predominantly plane bed, with boulder and cobble substrate. Spawning gravel within the site is limited to a small patch at the upstream end near the most upstream side channel inlet at the bar head. The 1997 flood event extensively scoured vegetation and caused geomorphic changes throughout the site, except along the river left valley wall.

Remnant tailings piles oriented in a berm parallel to the right bank of the mainstem channel confine flow and limit floodplain inundation along the right bank. The large, flat, and mostly unvegetated uplands on the river right side of the channel and in upstream and downstream areas near the Russian Creek design site also have a long history of land use disturbance.

3.14.2 Proposed habitat enhancement activities

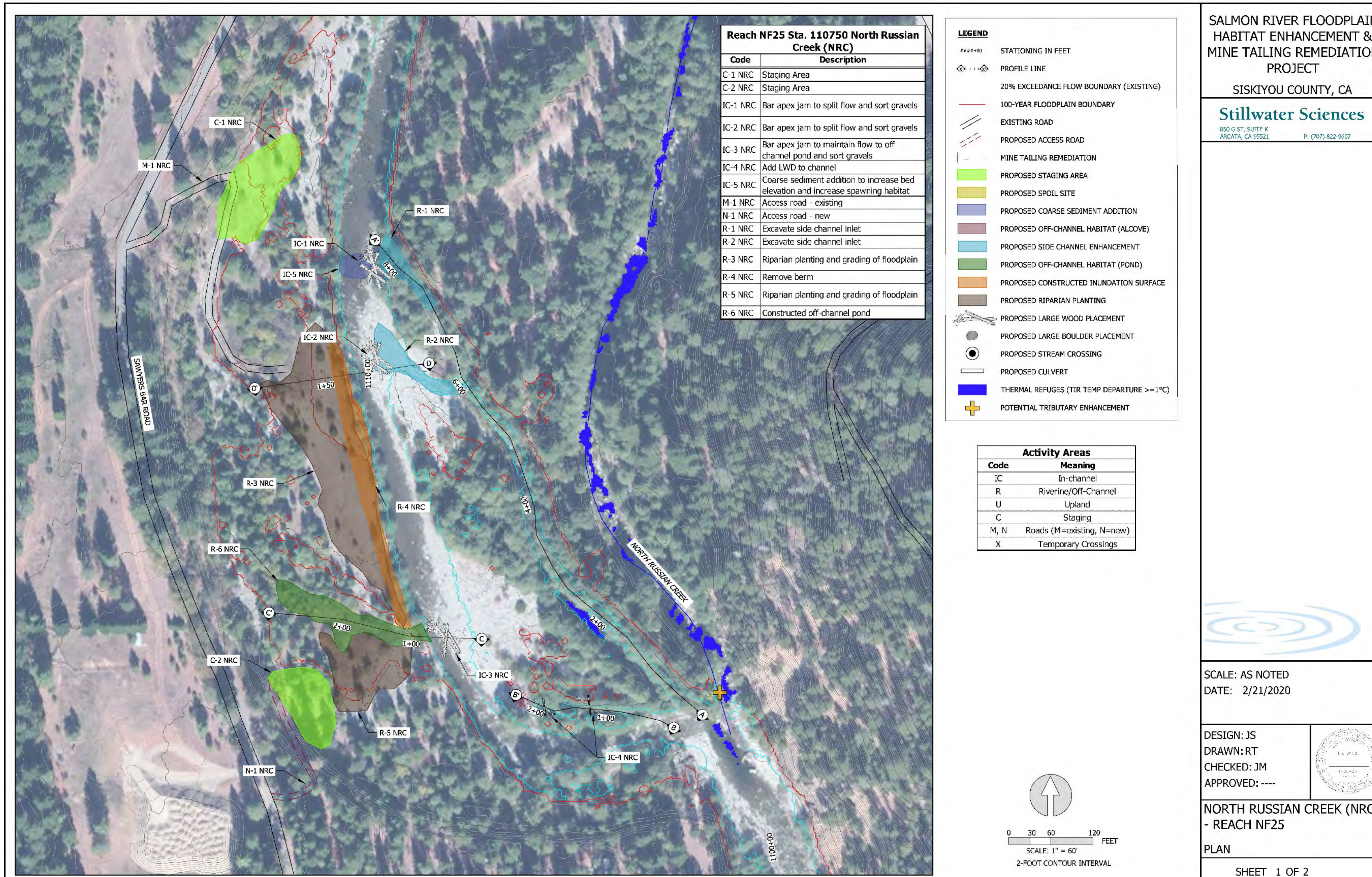
The conceptual approach at the North Russian Creek design site involves increasing the inundation frequency and duration in side channels, increasing the quantity of spawning habitat by promoting coarse sediment deposition and sorting in the main channel, creating additional winter rearing habitat by constructing an off channel pond (Figure 29, Figure 30. Table 16).

At the upstream end of the site, large ELJs or bar apex jams (IC-1 NRC and IC-2 NRC) would be constructed at the bar head in the vicinity of the side channel inlets to help achieve the design flow split into the side channels and sort gravel. The side channel inlets would be excavated (R-1 NRC and R-2 NRC) to improve flow connectivity and increase inundation frequency and duration. Coarse sediment suitable for coho, and spring-run Chinook salmon and steelhead spawning would be added (IC-5 NRC) in the vicinity of the existing riffle crest where a small patch of spawning gravel was mapped.

Downstream of the side channel inlets, the existing berm comprised of tailings along the river right channel bank would be removed and the floodplain would be lowered (R-4 NRC) to create a local expansion in channel width, increasing the aerial extent of floodplain inundation and promoting sediment deposition conducive to channel margin rearing habitat and riparian vegetation establishment. At the downstream end of this lowered floodplain, an off channel pond (R06 RRC) would be excavated in the broad, unvegetated floodplain area and a large wood structure (IC-3 NRC) would be constructed in the vicinity of the pond outlet to maintain connectivity between the mainstem channel and pond during winter baseflow. The lowered floodplain and areas surrounding the off channel pond would be extensively planted with native riparian vegetation (R-3 NRC, R-5 NRC). Numerous large wood jams and pieces would be added to the side channel (IC-4 NRC) downstream of the pond outlet to increase habitat complexity.

Additional site-specific opportunities for improving thermal refuges and the habitat value of the North Russian Creek tributary junction would be identified in the field during future design steps.

An existing short spur (M-1 NRC) off Sawyers Bar Road provides readily available access to the upstream end of the site for construction and staging in a large and unvegetated area occupied by tailings (C-1 NRC). A new temporary road (N-1 NRC) would be constructed to access site treatments and a staging area (C-2 NRC) at the downstream end of the site.



Reach NF25 Sta. 110750 North Russian Creek (NRC)

Code	Description
C-1 NRC	Staging Area
C-2 NRC	Staging Area
IC-1 NRC	Bar apex jam to split flow and sort gravels
IC-2 NRC	Bar apex jam to split flow and sort gravels
IC-3 NRC	Bar apex jam to maintain flow to off channel pond and sort gravels
IC-4 NRC	Add LWD to channel
IC-5 NRC	Coarse sediment addition to increase bed elevation and increase spawning habitat
M-1 NRC	Access road - existing
N-1 NRC	Access road - new
R-1 NRC	Excavate side channel inlet
R-2 NRC	Excavate side channel inlet
R-3 NRC	Riparian planting and grading of floodplain
R-4 NRC	Remove berm
R-5 NRC	Riparian planting and grading of floodplain
R-6 NRC	Constructed off-channel pond

Activity Areas

Code	Meaning
IC	In-channel
R	Riverine/Off-Channel
U	Upland
C	Staging
M, N	Roads (M=existing, N=new)
X	Temporary Crossings

Figure 29. Design plan for North Fork Reach 25 at North Russian Creek.

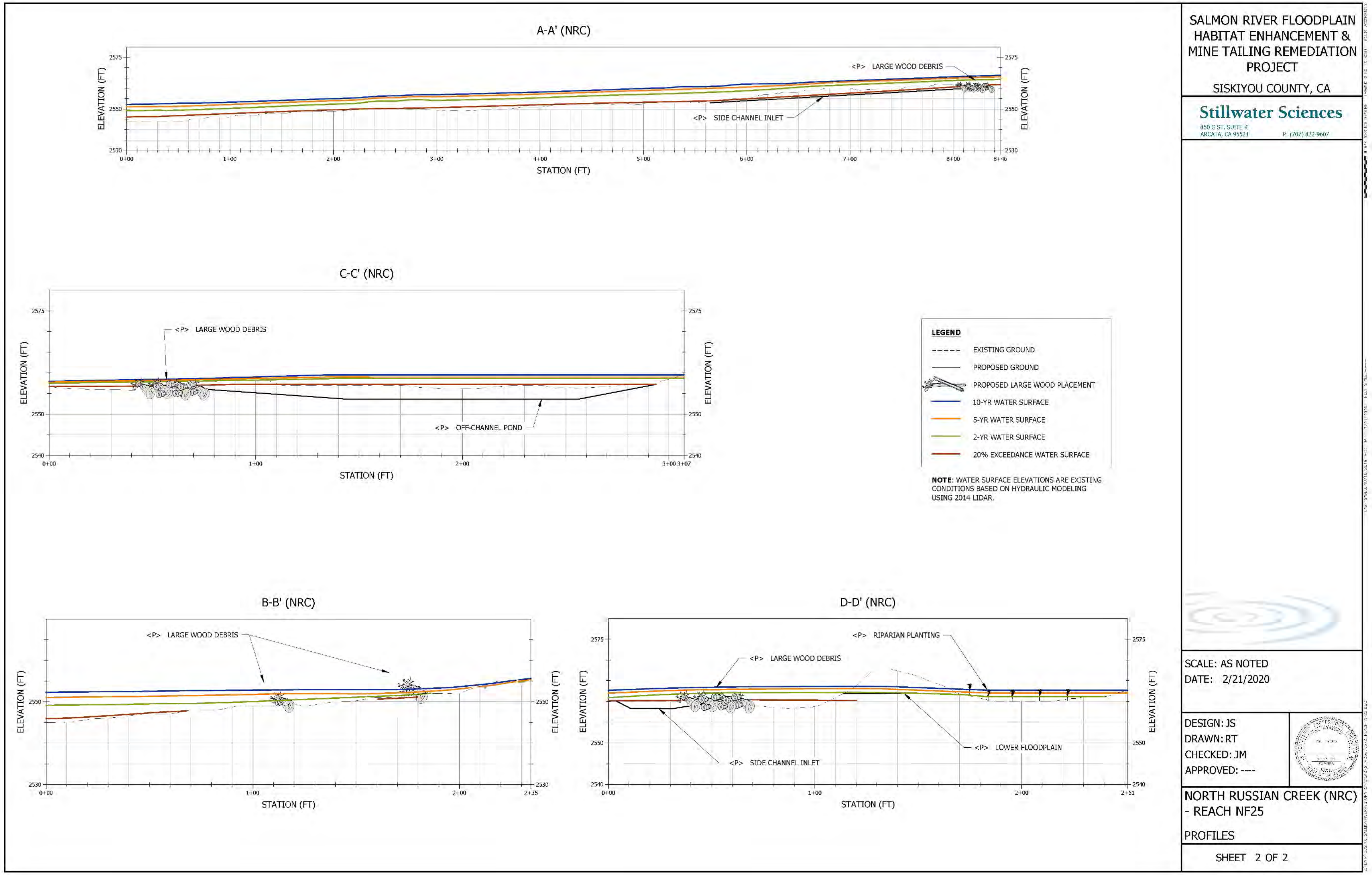


Figure 30. Design profiles for North Fork Reach 25 at North Russian Creek.

Table 16. Activity areas within North Fork Reach 25 at North Russian Creek.

Code	Description
C-1 NRC	Staging area
C-2 NRC	Staging area
IC-1 NRC	Bar apex jam to split flow and sort gravel
IC-2 NRC	Bar apex jam to split flow
IC-3 NRC	Bar apex jam to maintain flow to off channel pond and sort gravel
IC-4 NRC	Add LWD to increase complexity
IC-5 NRC	Coarse sediment addition to increase bed elevation and increase spawning habitat
M-1 NRC	Access road – existing
N-1 NRC	Access road – new
R-1 NRC	Excavate side channel inlet
R-2 NRC	Excavate side channel inlet
R-3 NRC	Floodplain grading and riparian revegetation
R-4 NRC	Remove berm
R-5 NRC	Floodplain grading and riparian revegetation
R-6 NRC	Construct off channel pond

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Appendices

Appendix A

Thermally Suitable Habitat and Flow Inundation in Predominantly Alluvial Reaches Within the Salmon River Project Area

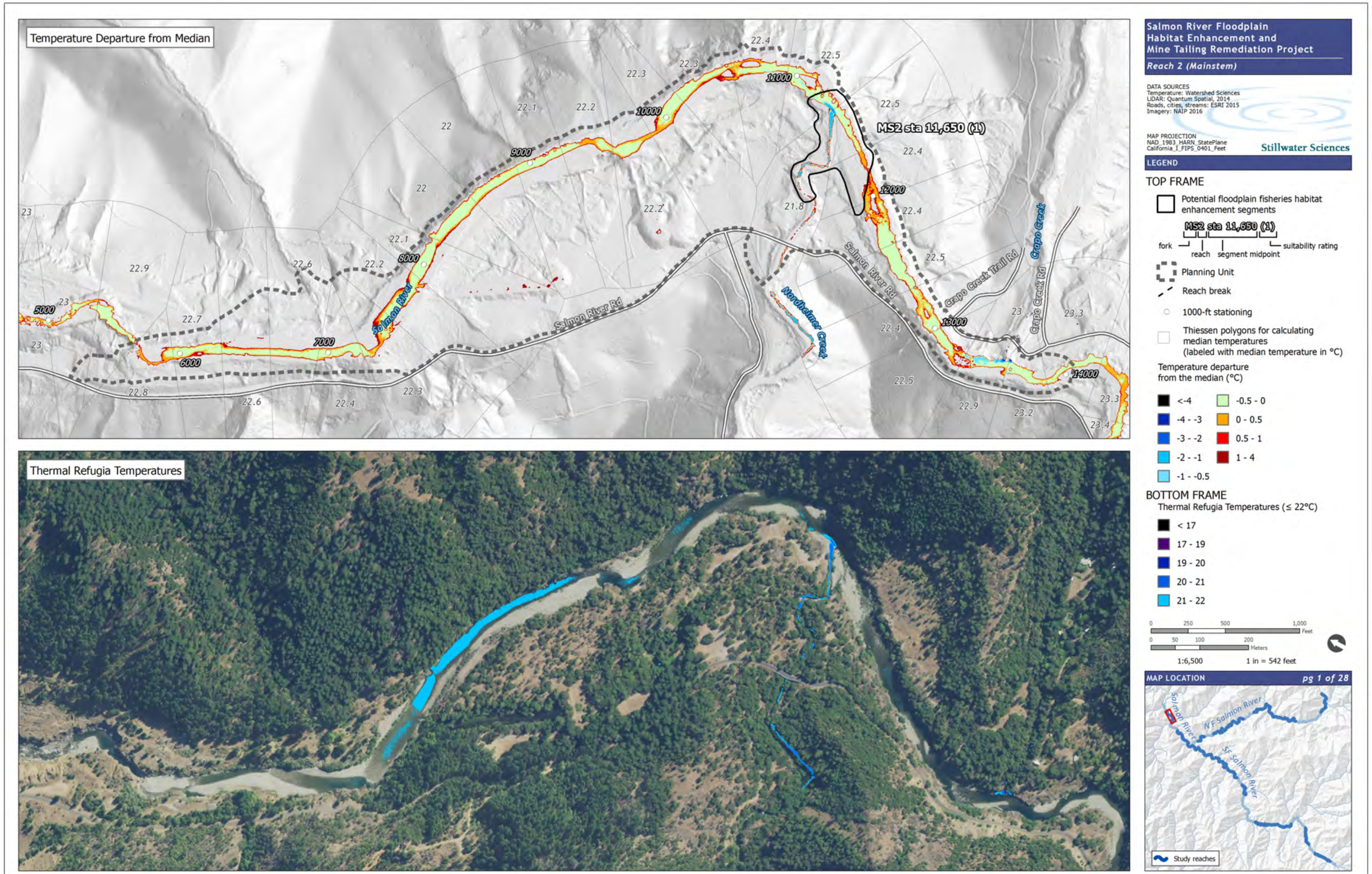


Figure A-1. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River Project area based on 2009 TIR data, Tile 1 of 28.

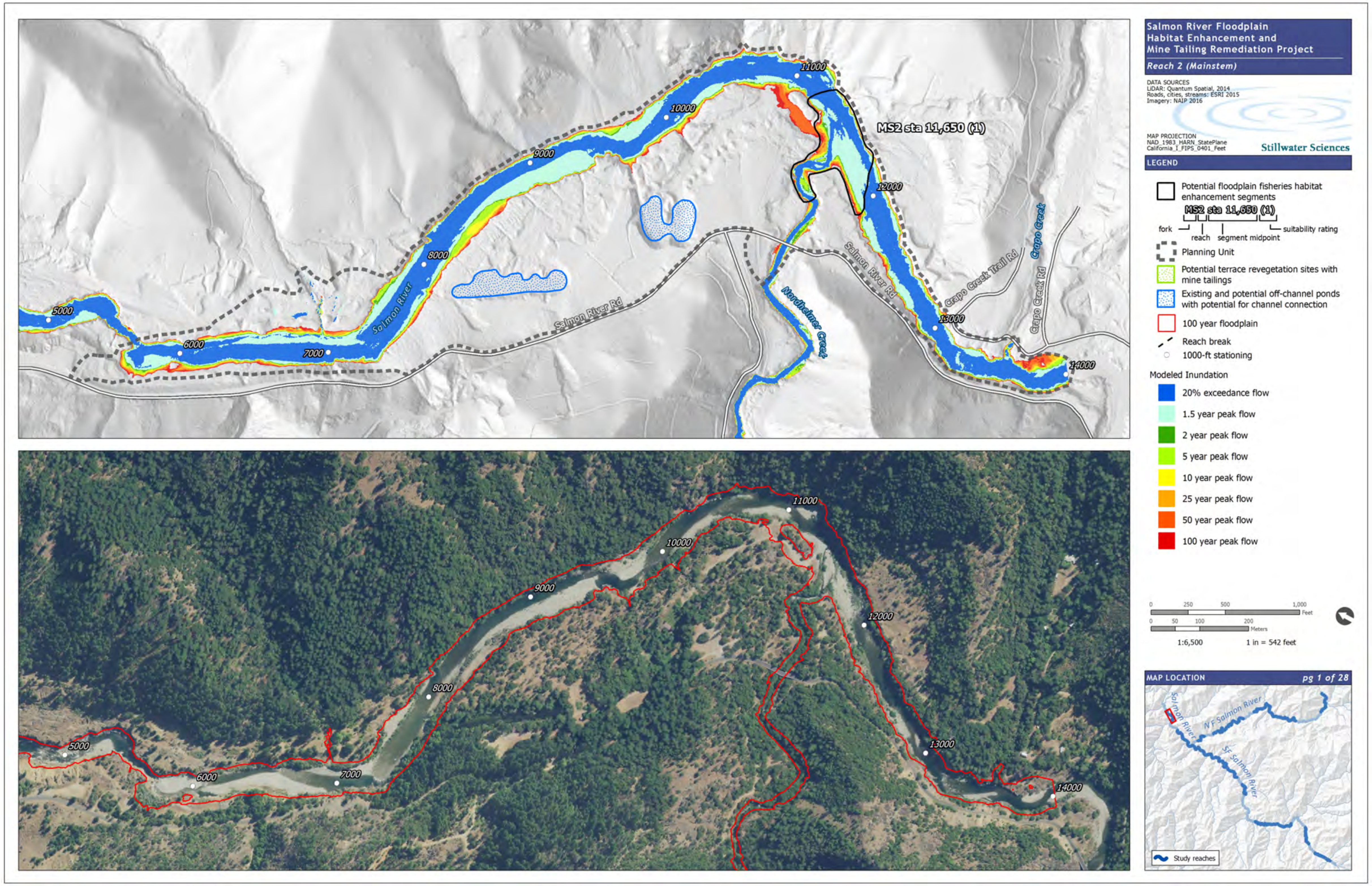


Figure A-2. Flow inundation in predominantly alluvial reaches within the Salmon River Project area, Tile 1 of 28.

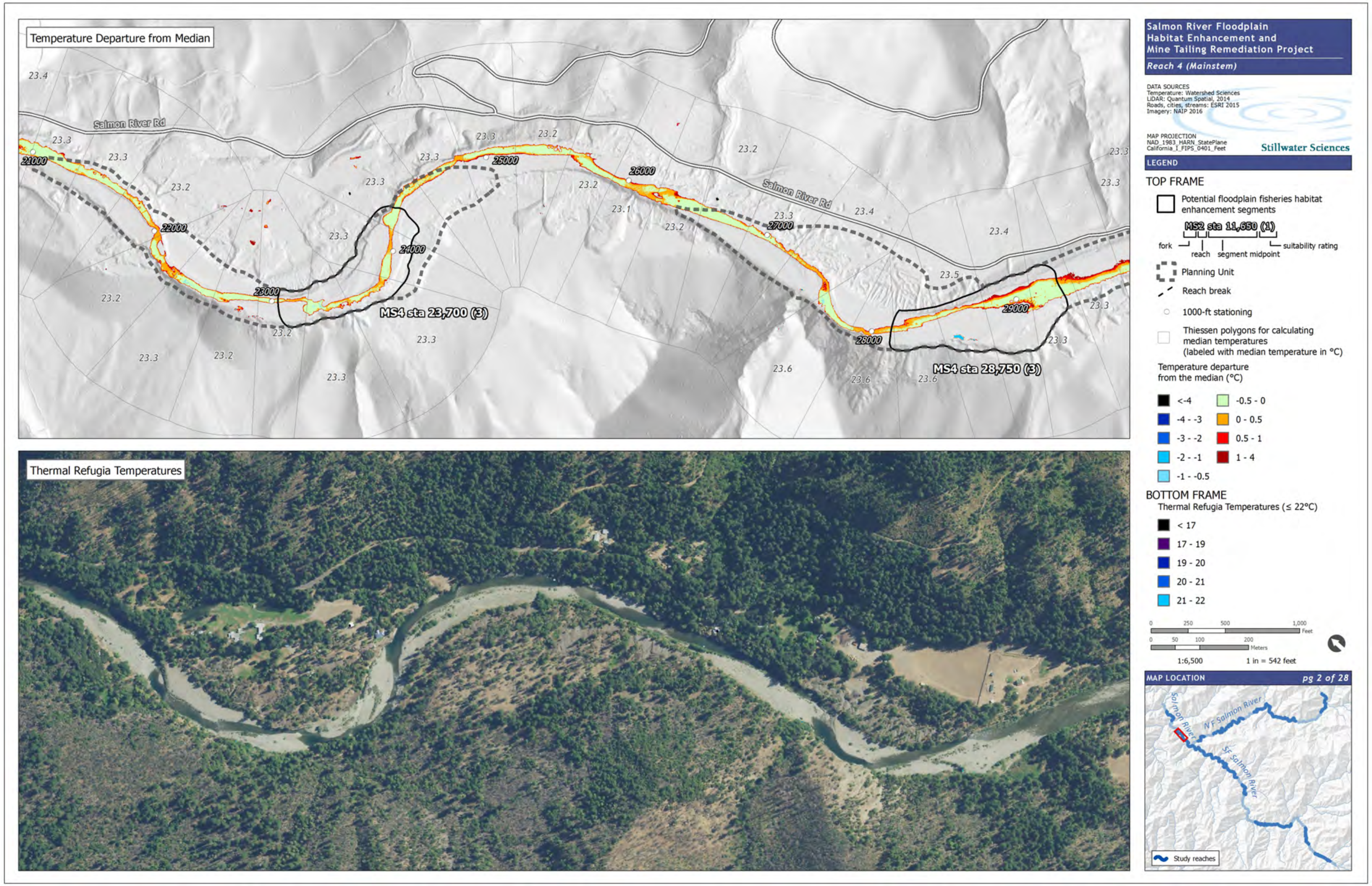


Figure A-3. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 2 of 28.

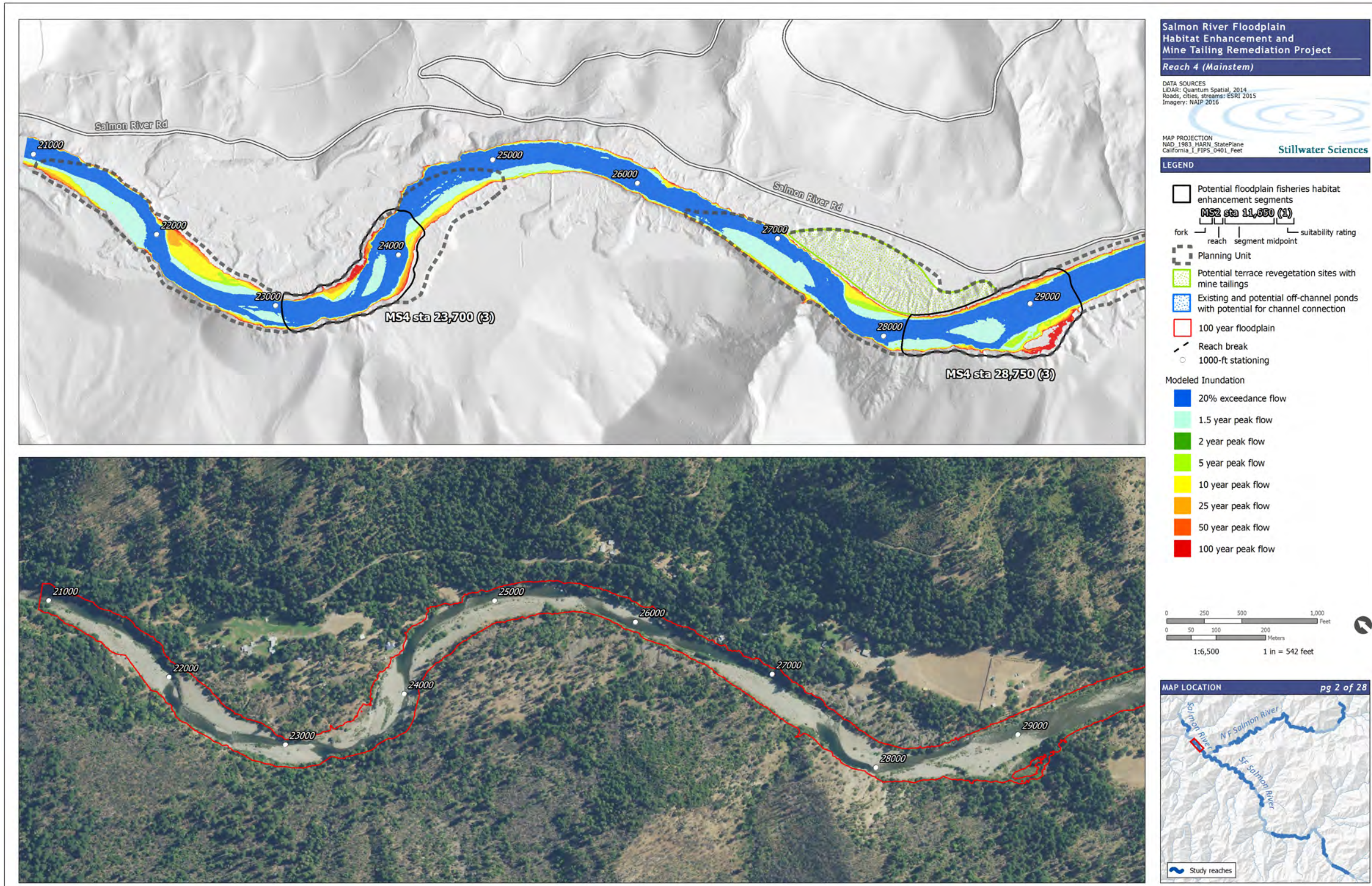


Figure A-4. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 2 of 28.

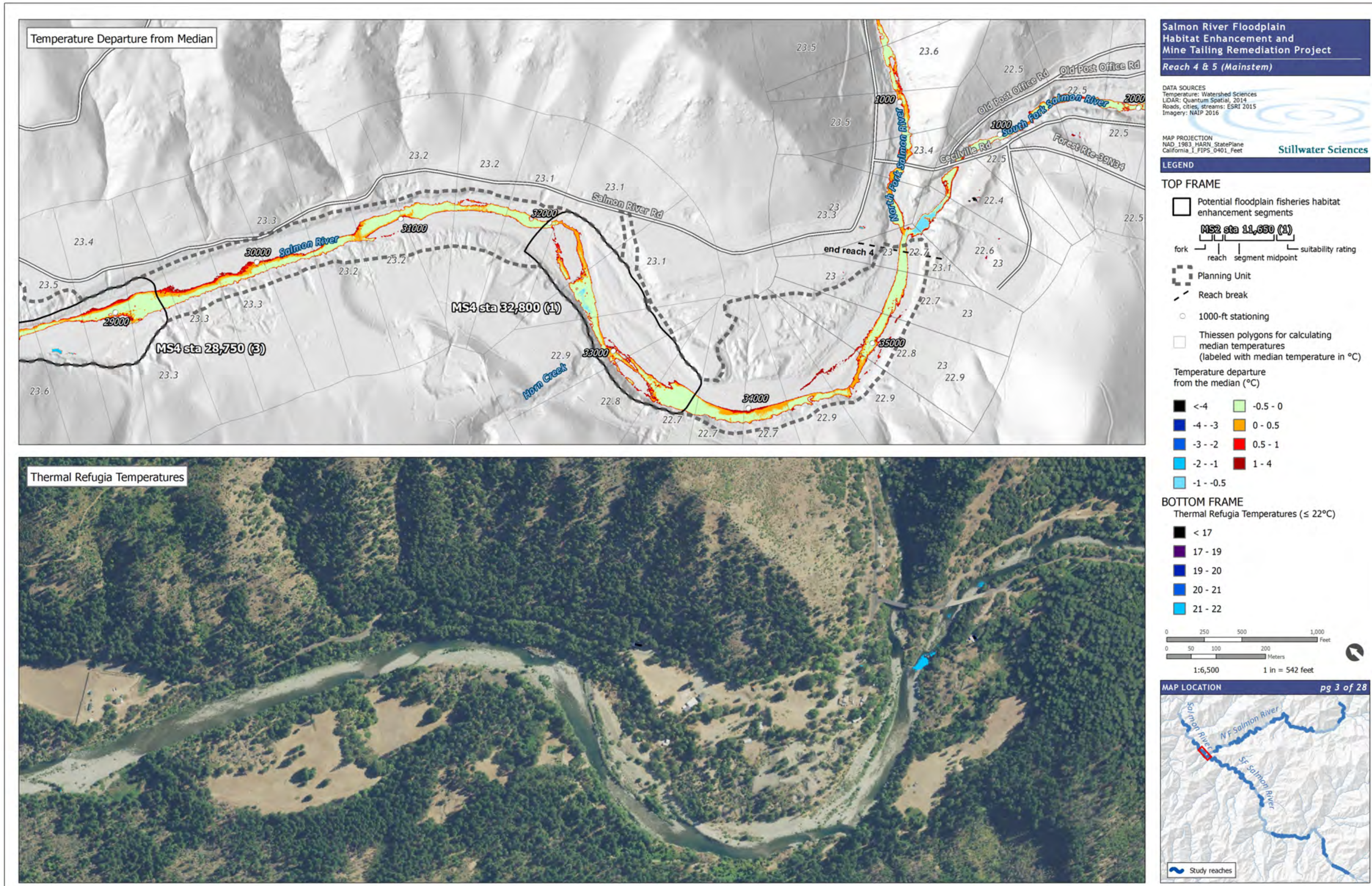


Figure A-5. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 3 of 28.

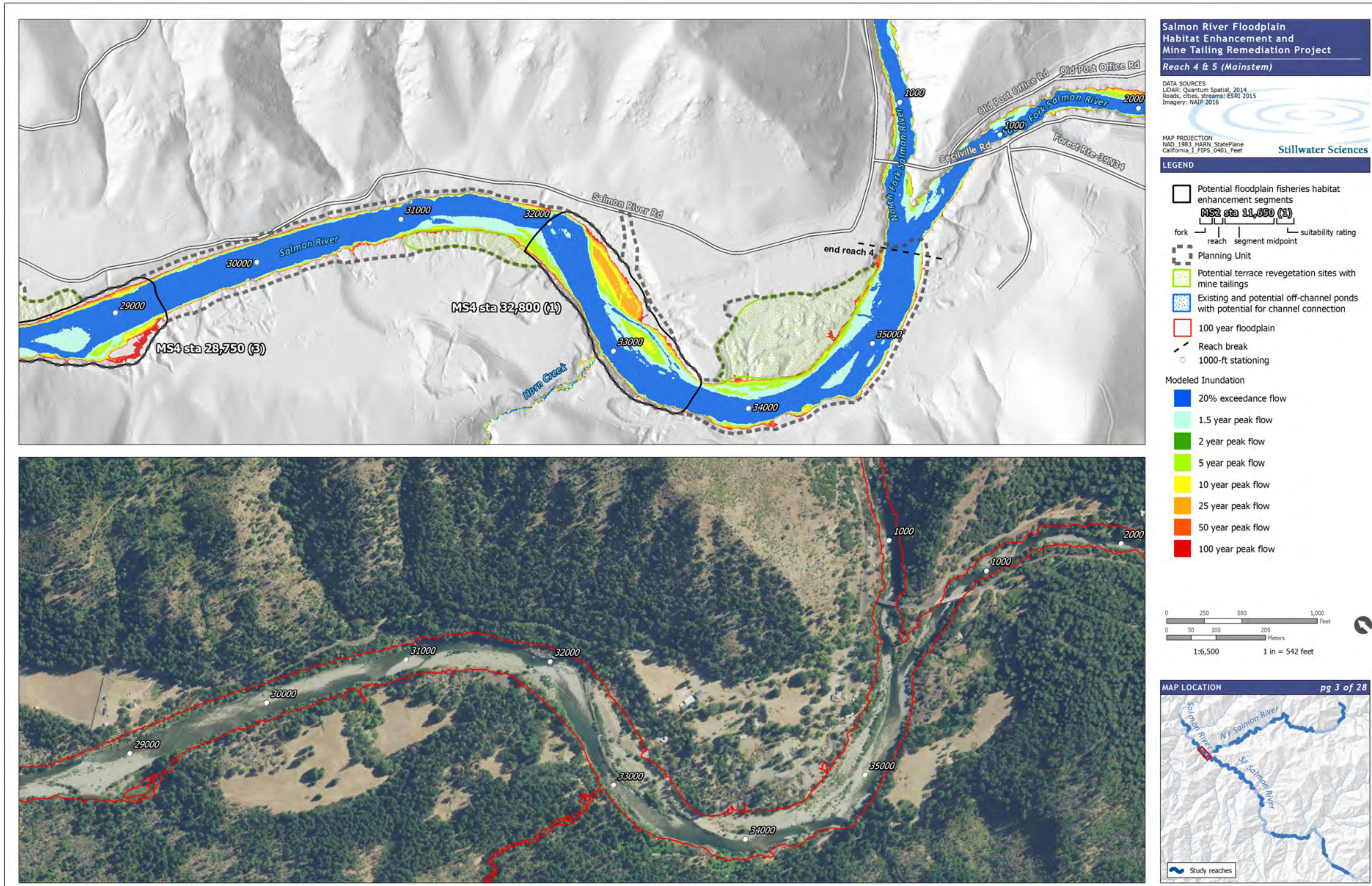


Figure A-6. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 3 of 28.

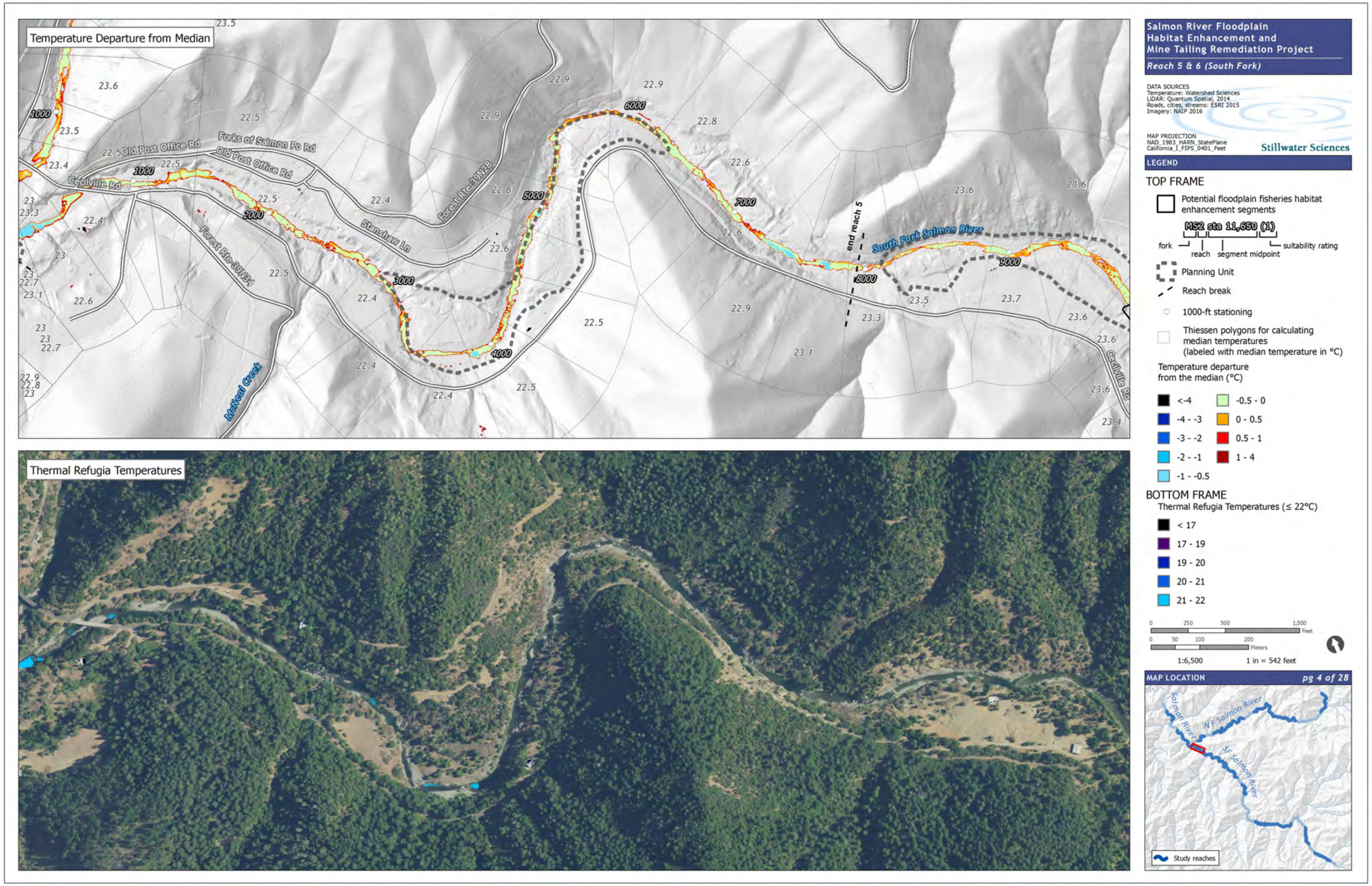


Figure A-7. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 4 of 28.

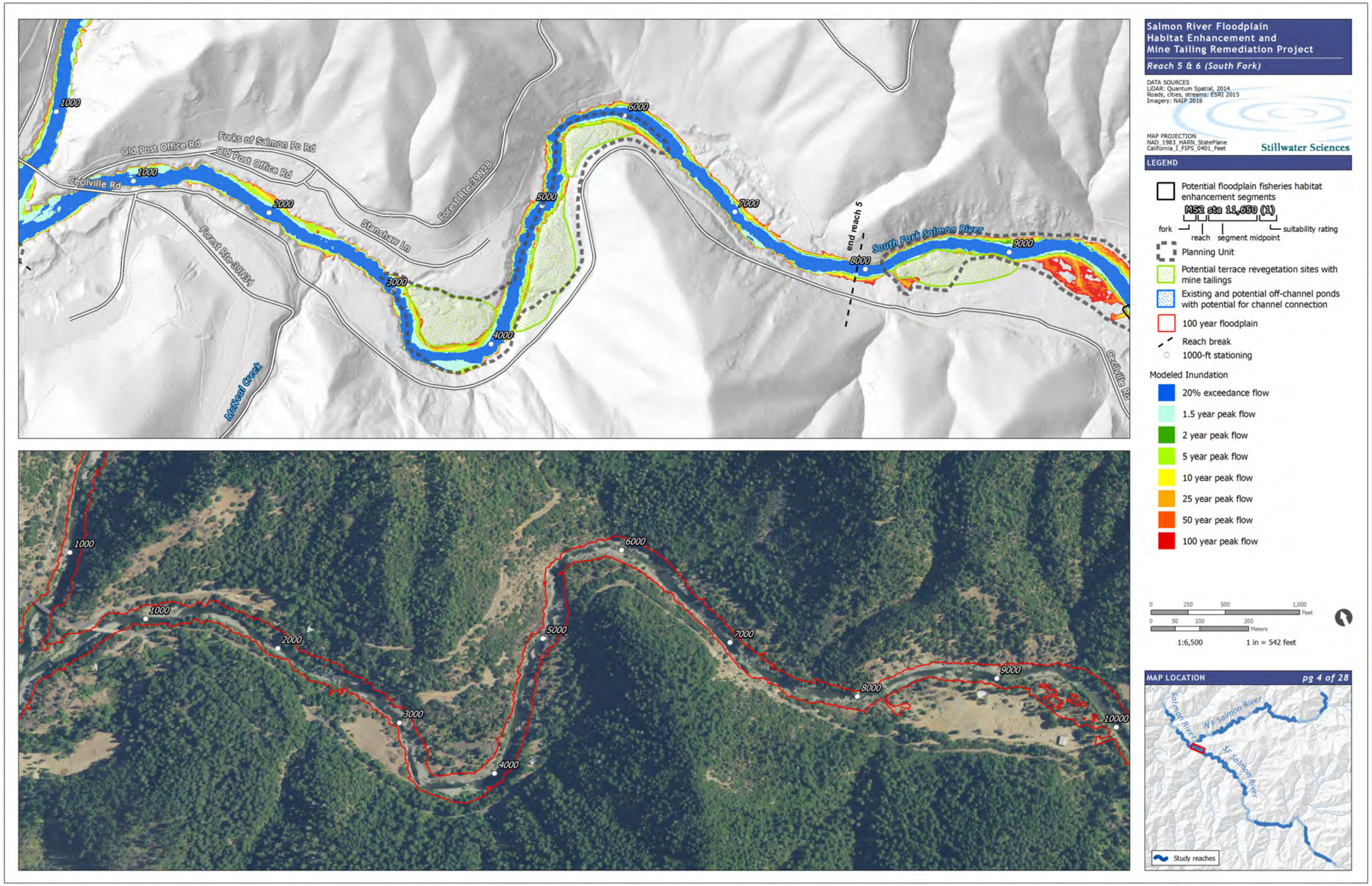


Figure A-8. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 4 of 28.

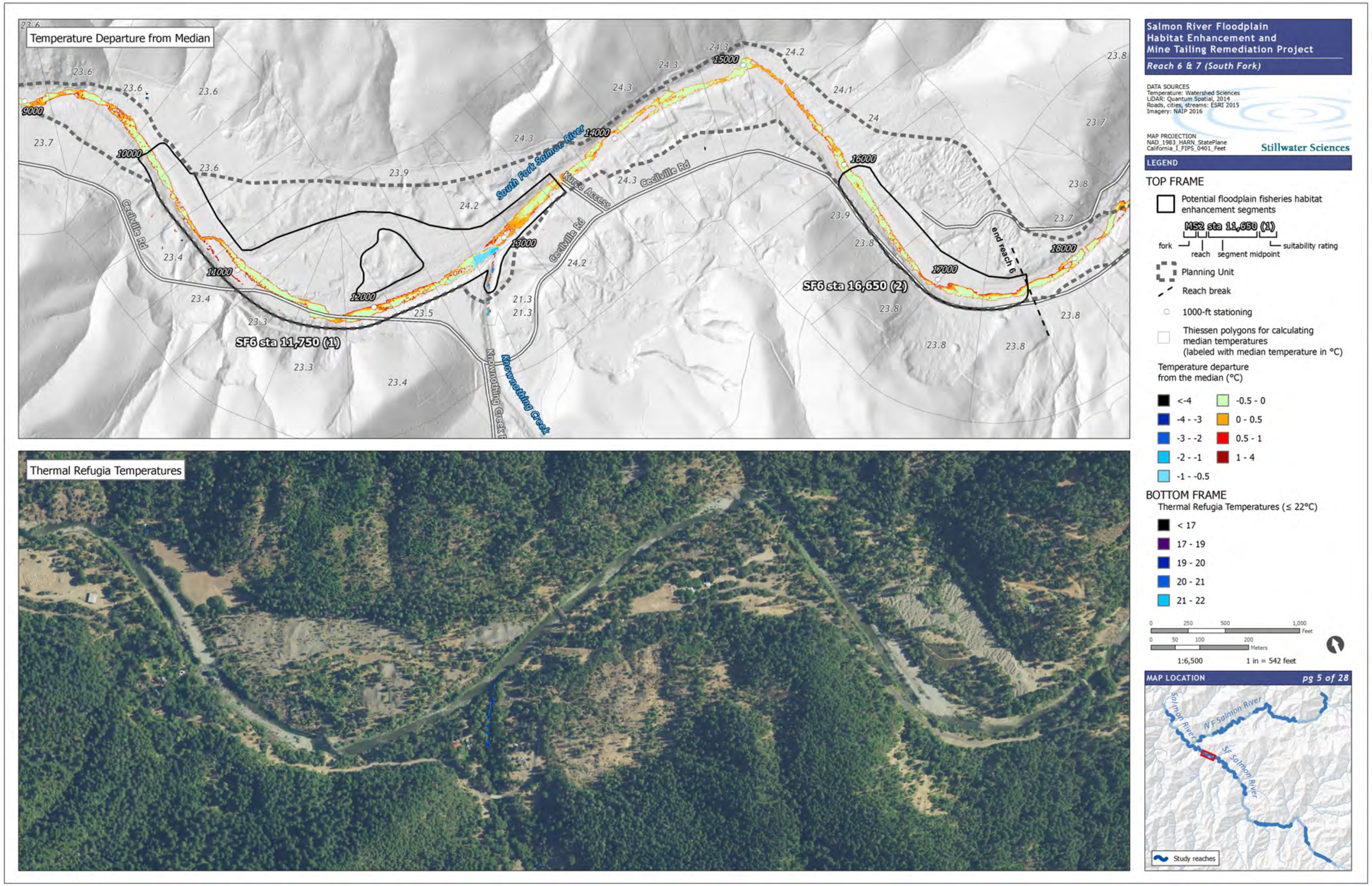


Figure A-9. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 5 of 28.

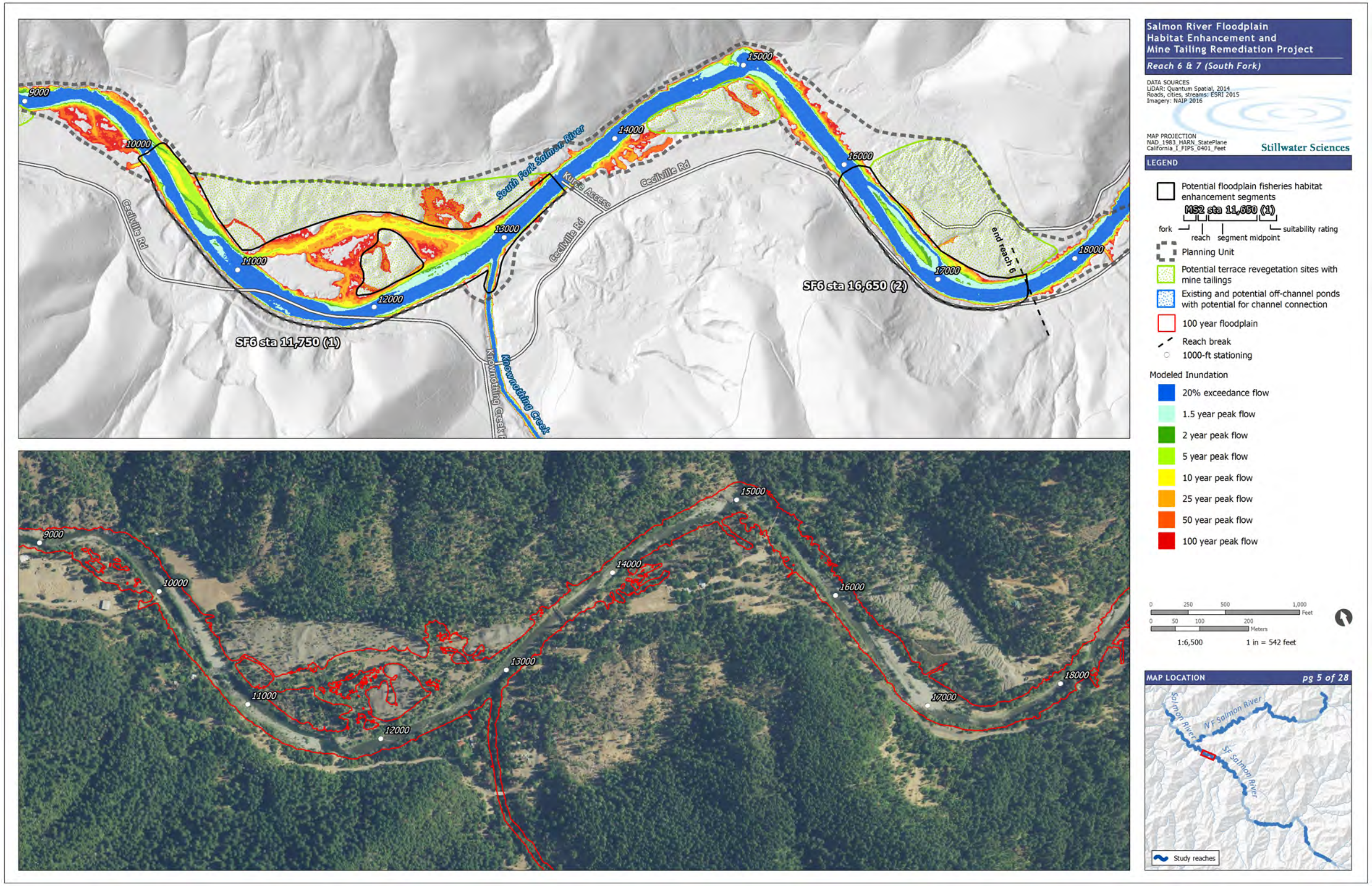


Figure A-10. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 5 of 28.

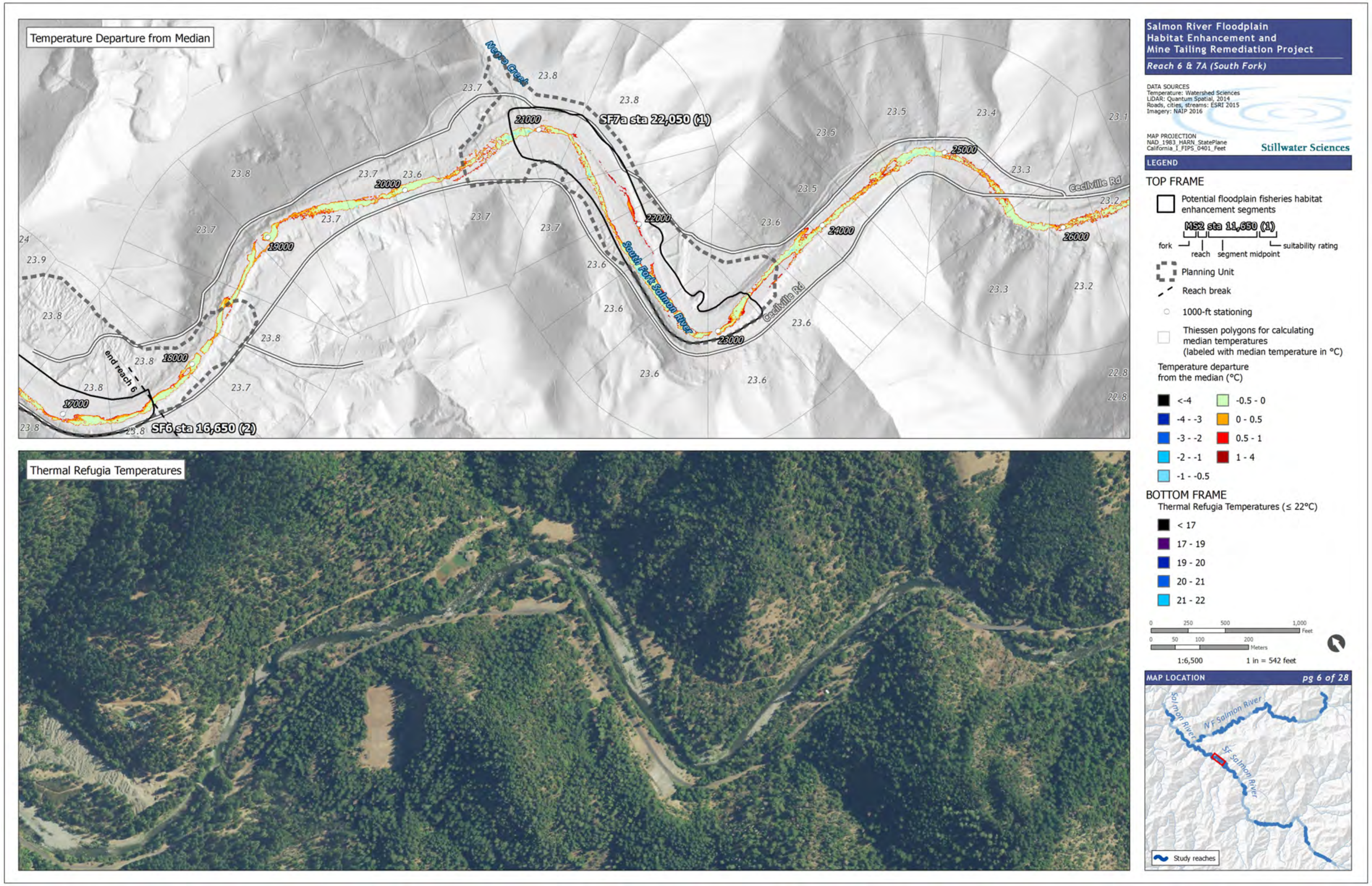


Figure A-11. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 6 of 28.

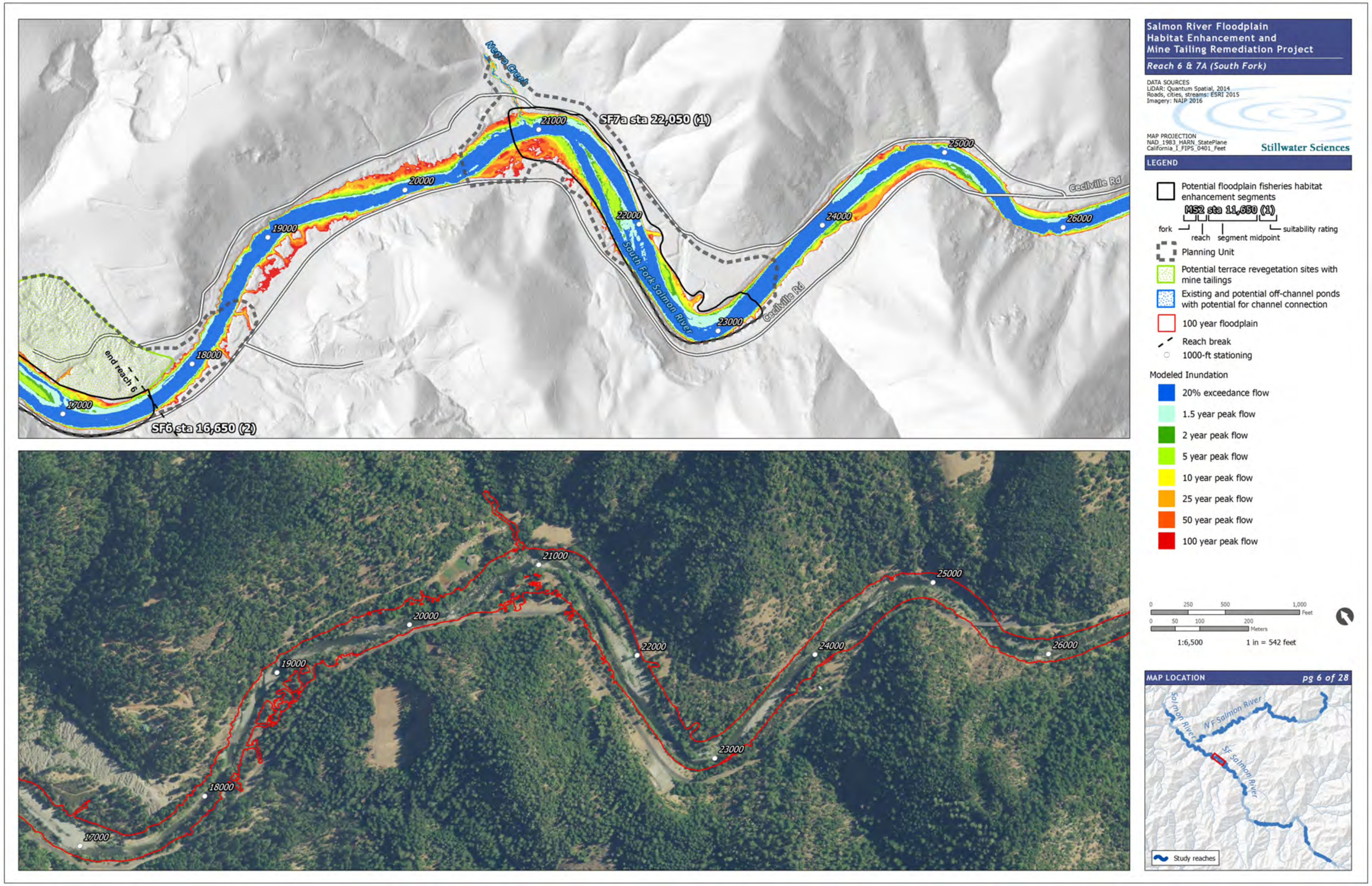


Figure A-12. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 6 of 28.

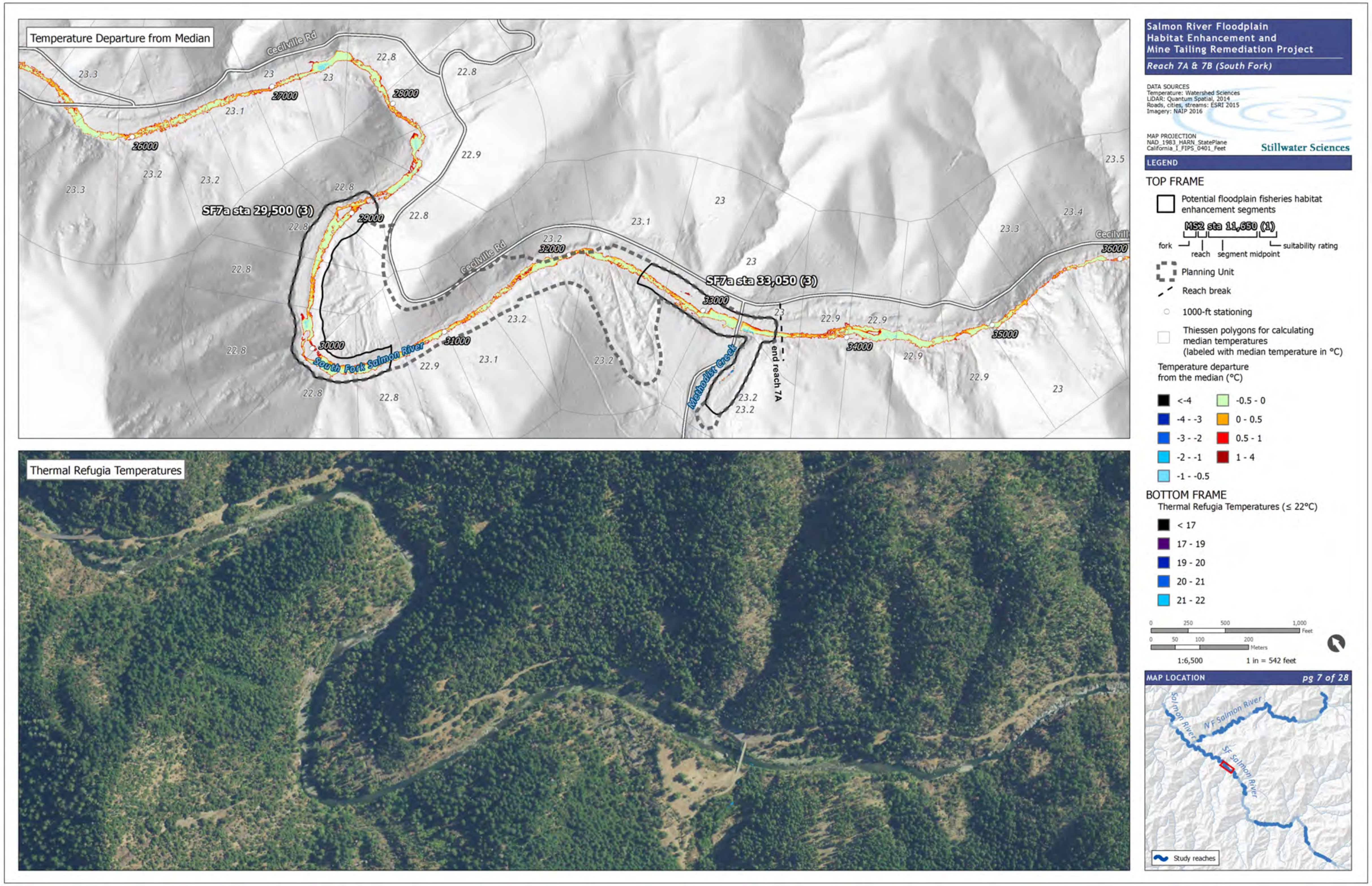


Figure A-13. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 7 of 28.

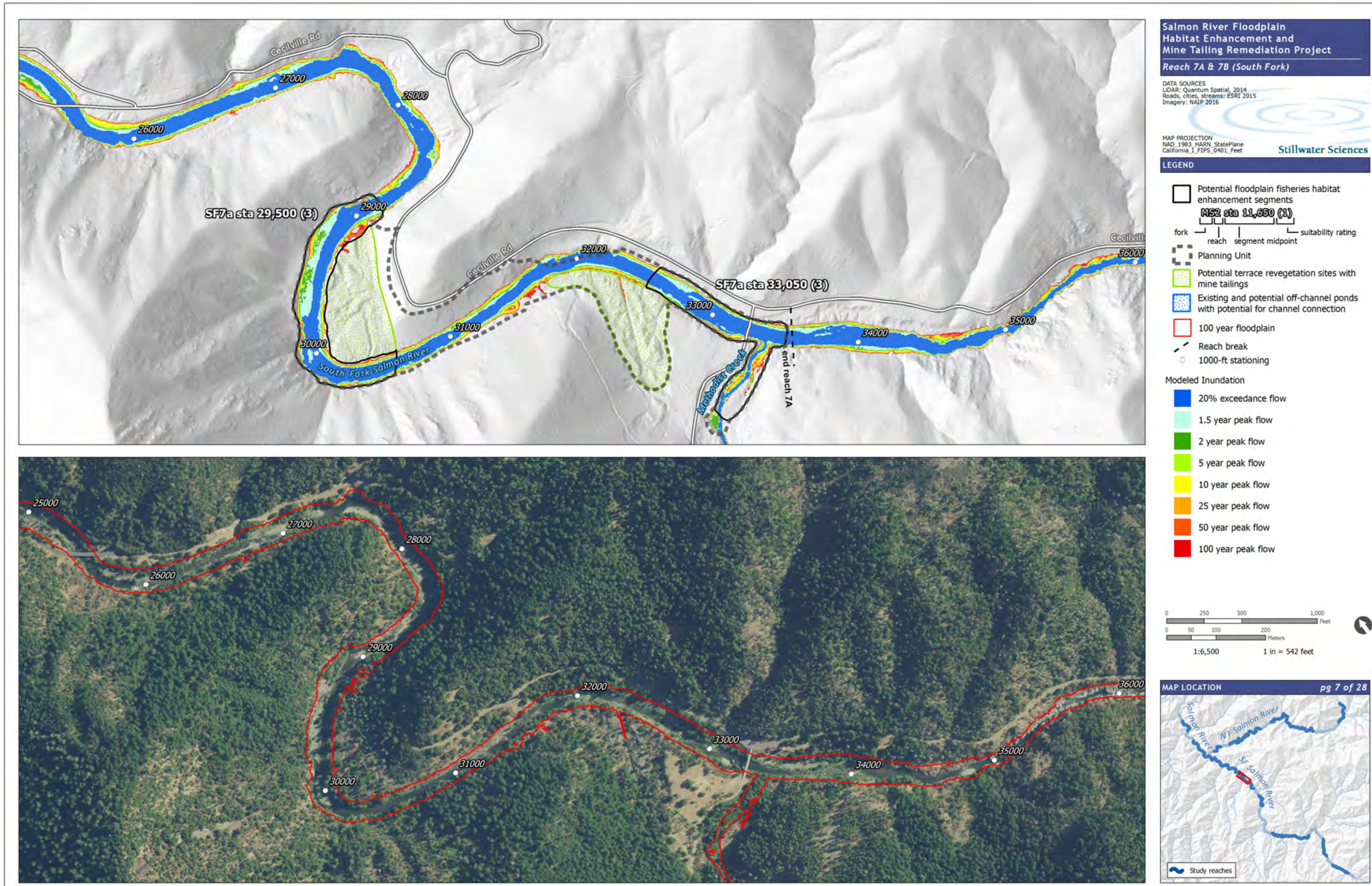
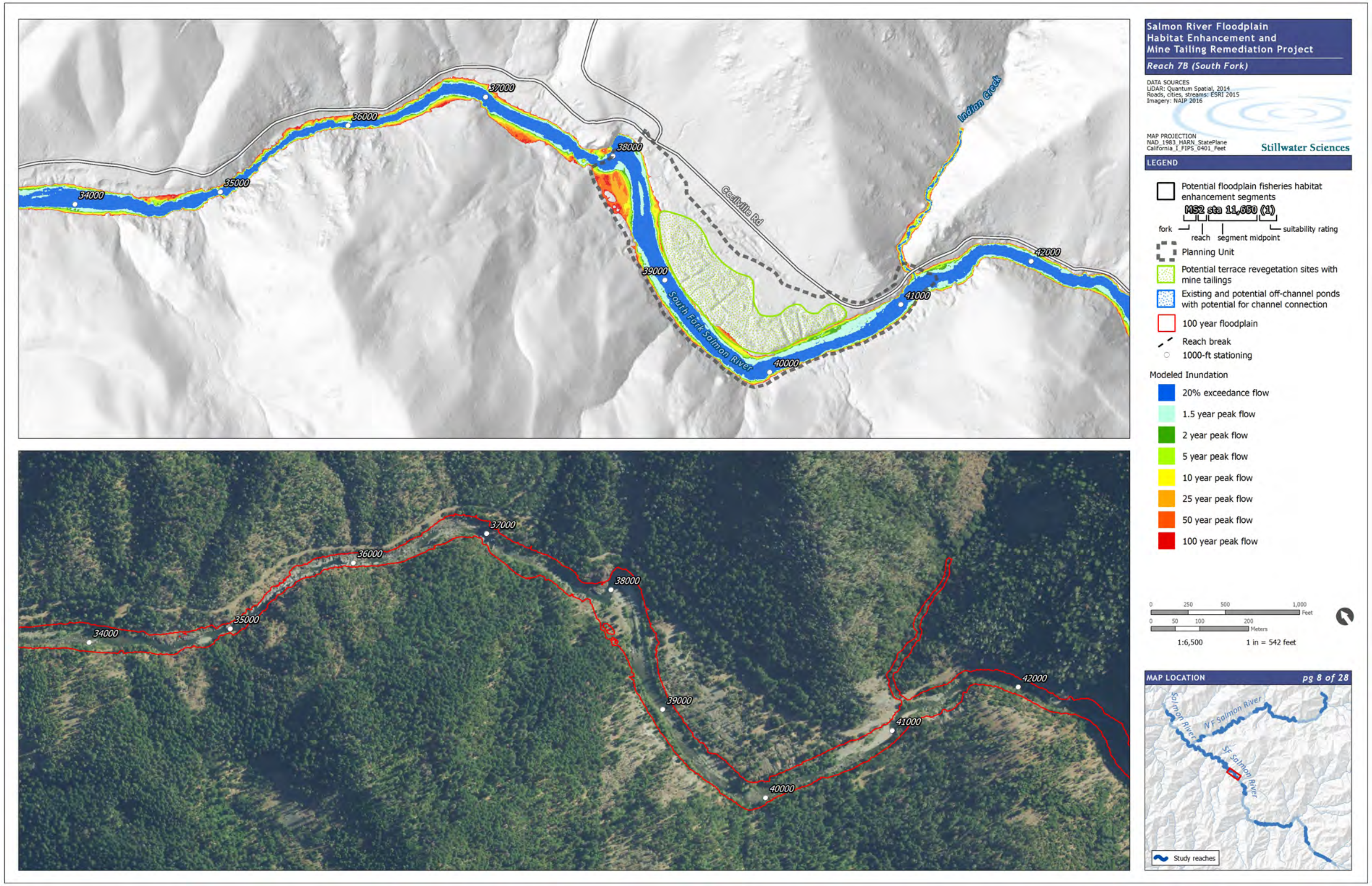


Figure A-14. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 7 of 28.

Figure A-15. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 8 of 28.



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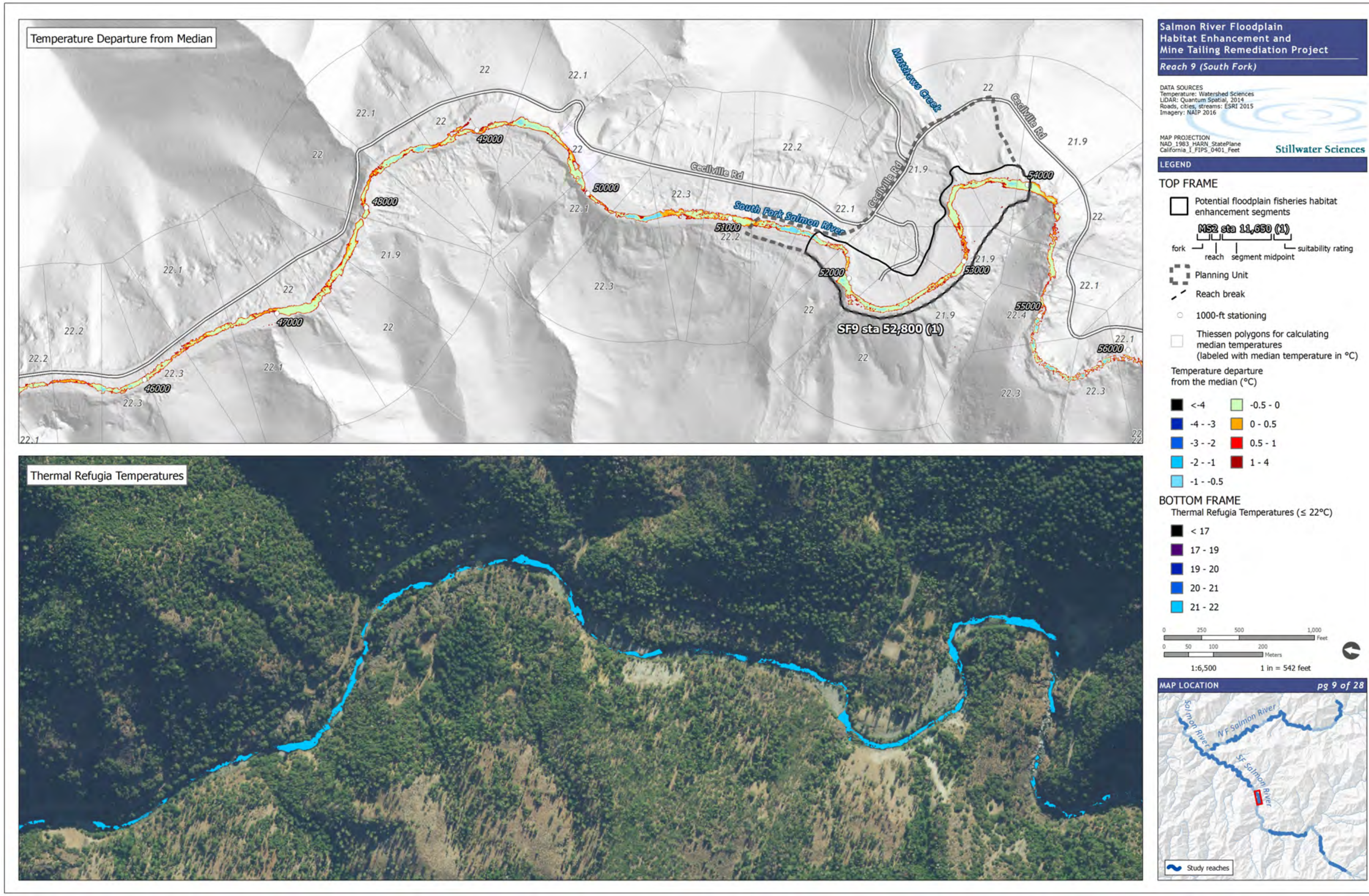


Figure A-17. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 9 of 28.

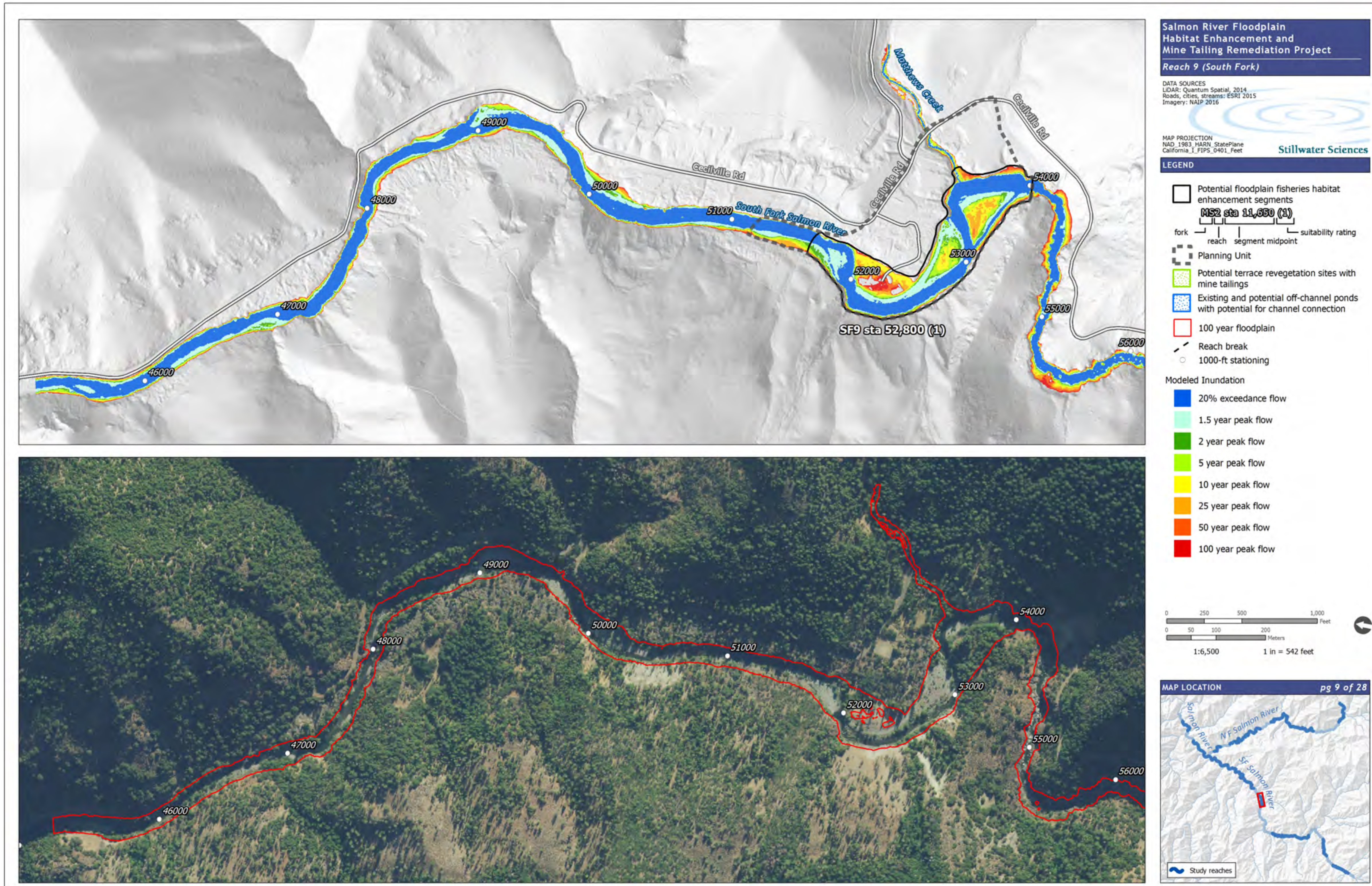


Figure A-18. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 9 of 28.

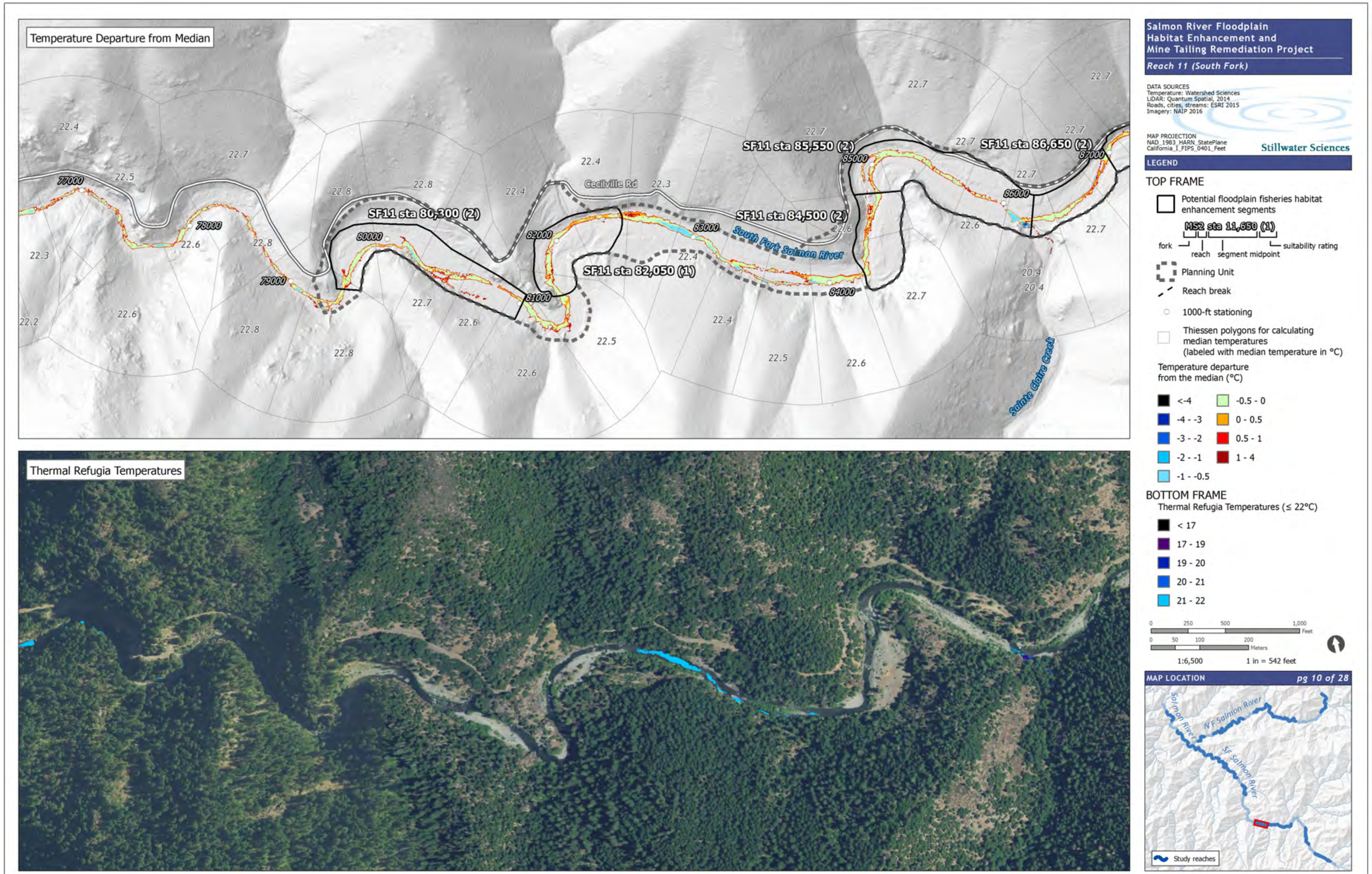
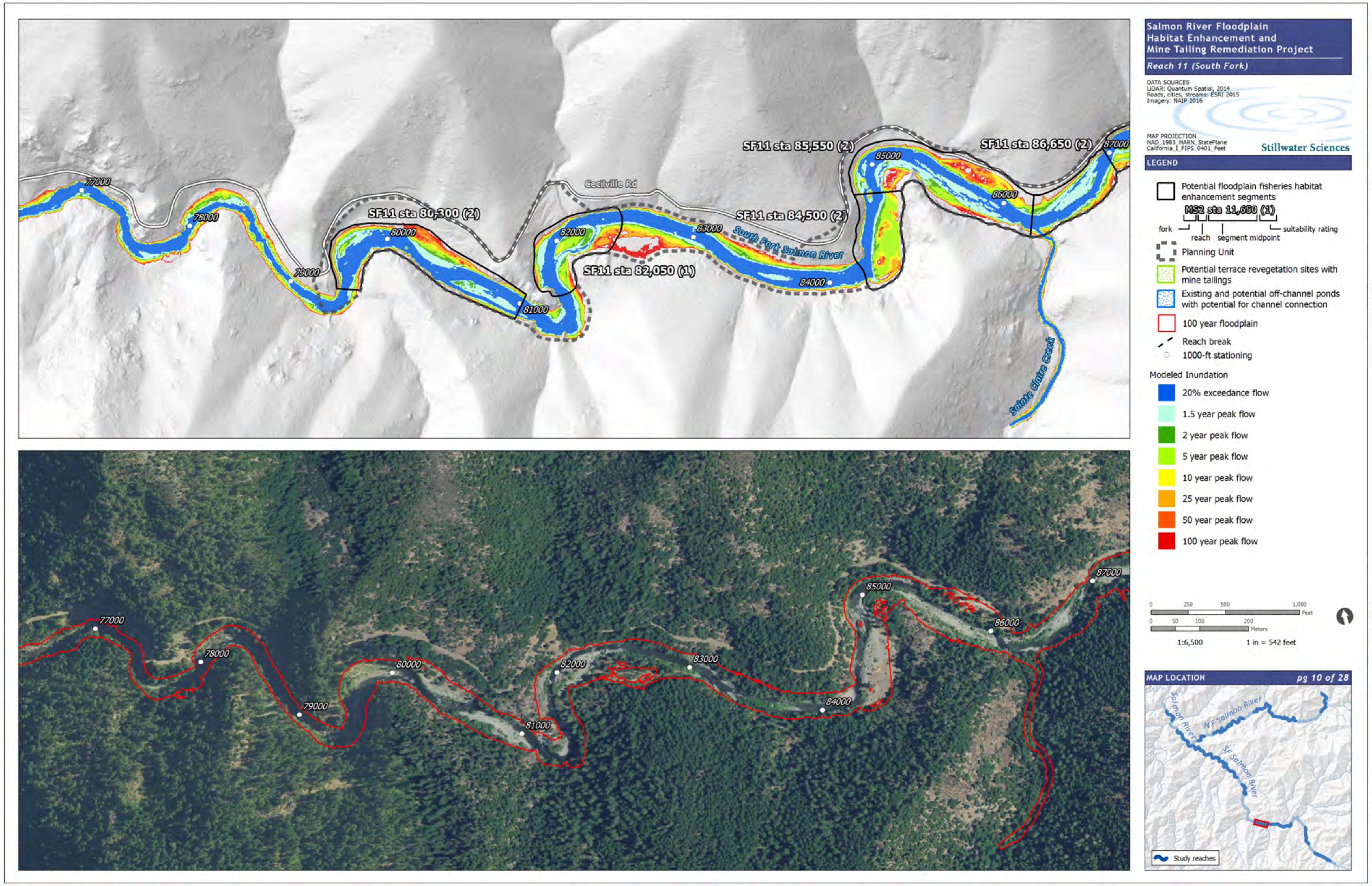


Figure A-19. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 10 of 28.



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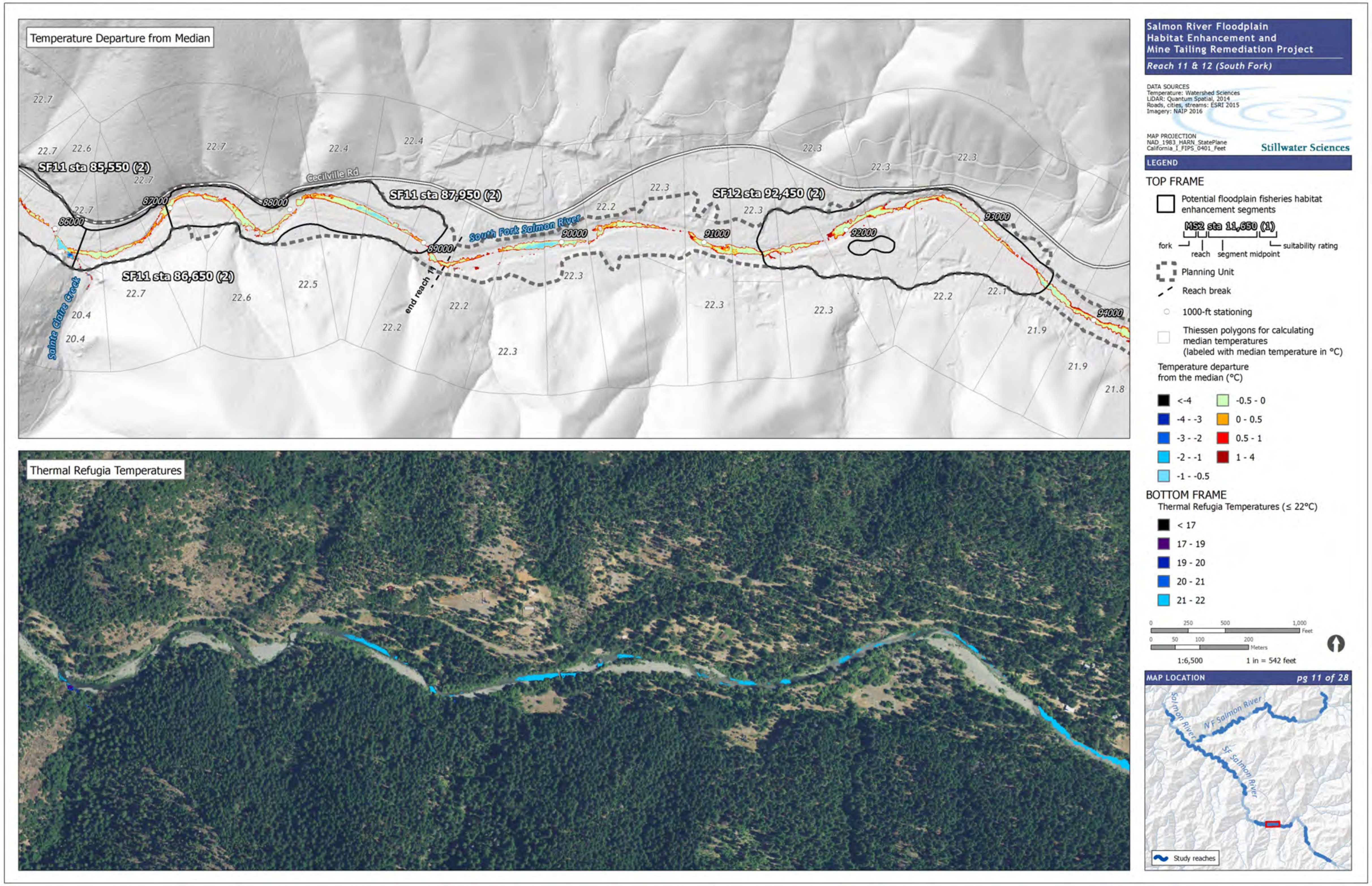


Figure A-21. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 11 of 28.

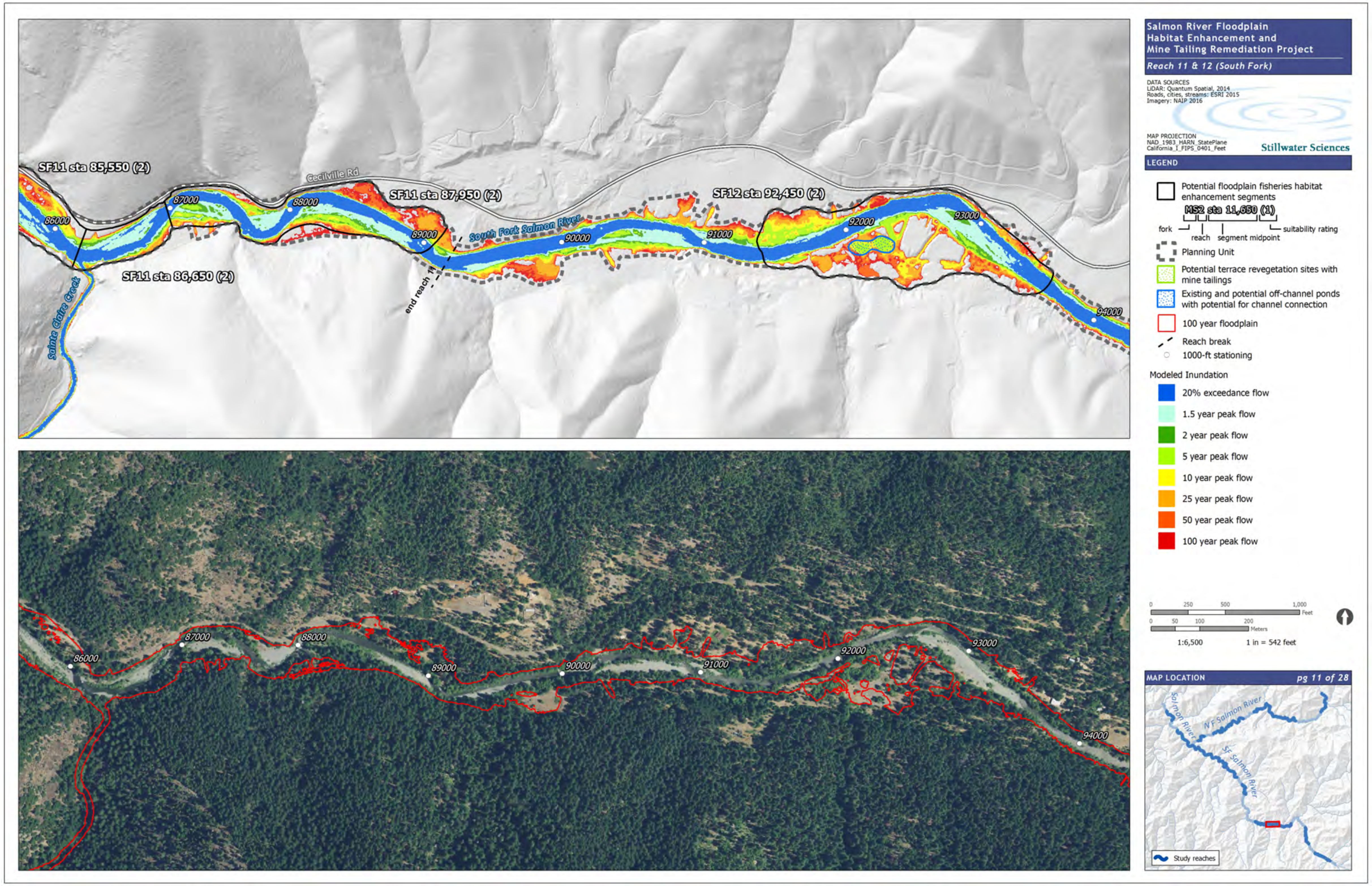


Figure A-22. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 11 of 28.

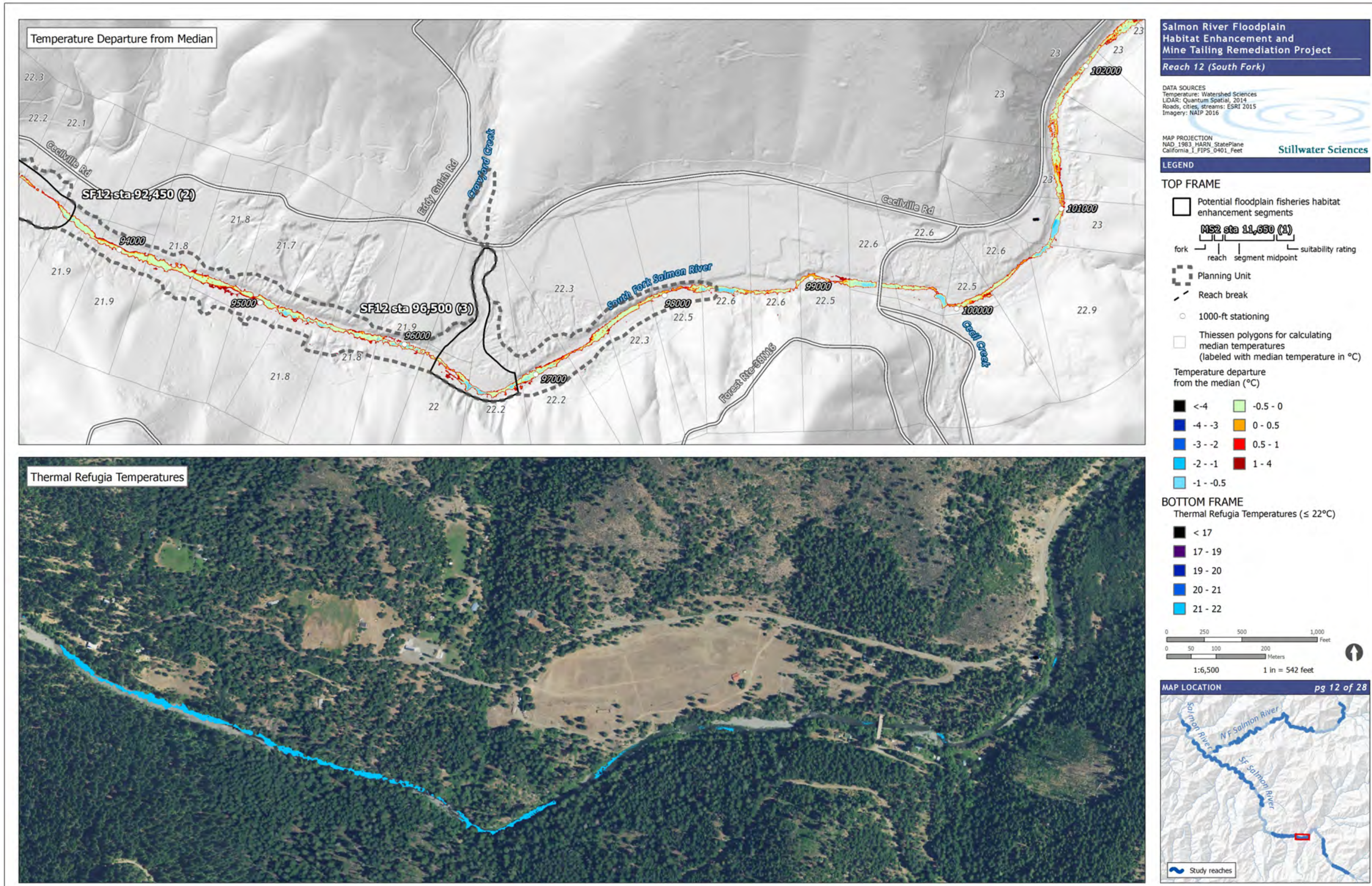


Figure A-23. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 12 of 28.

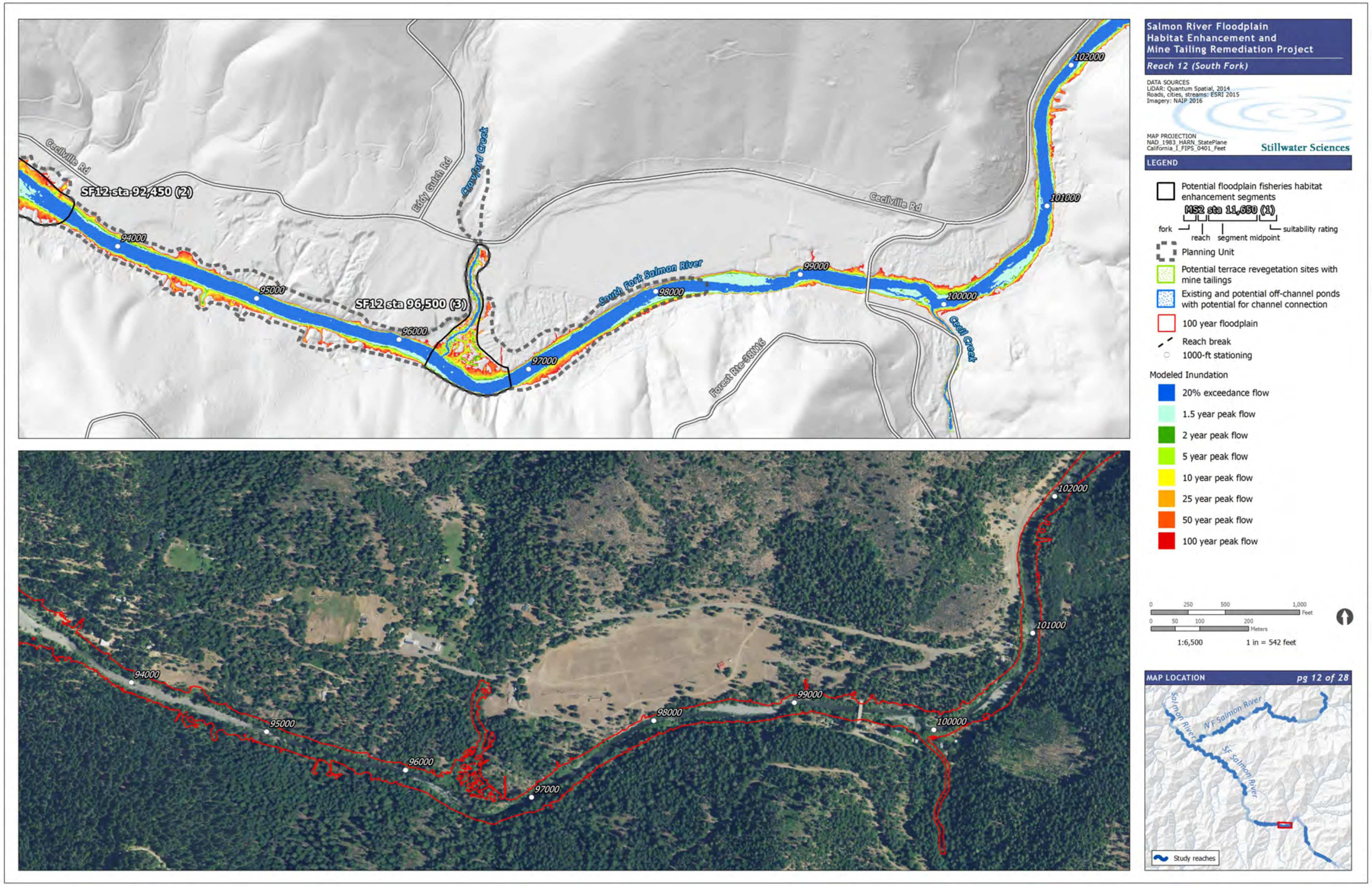
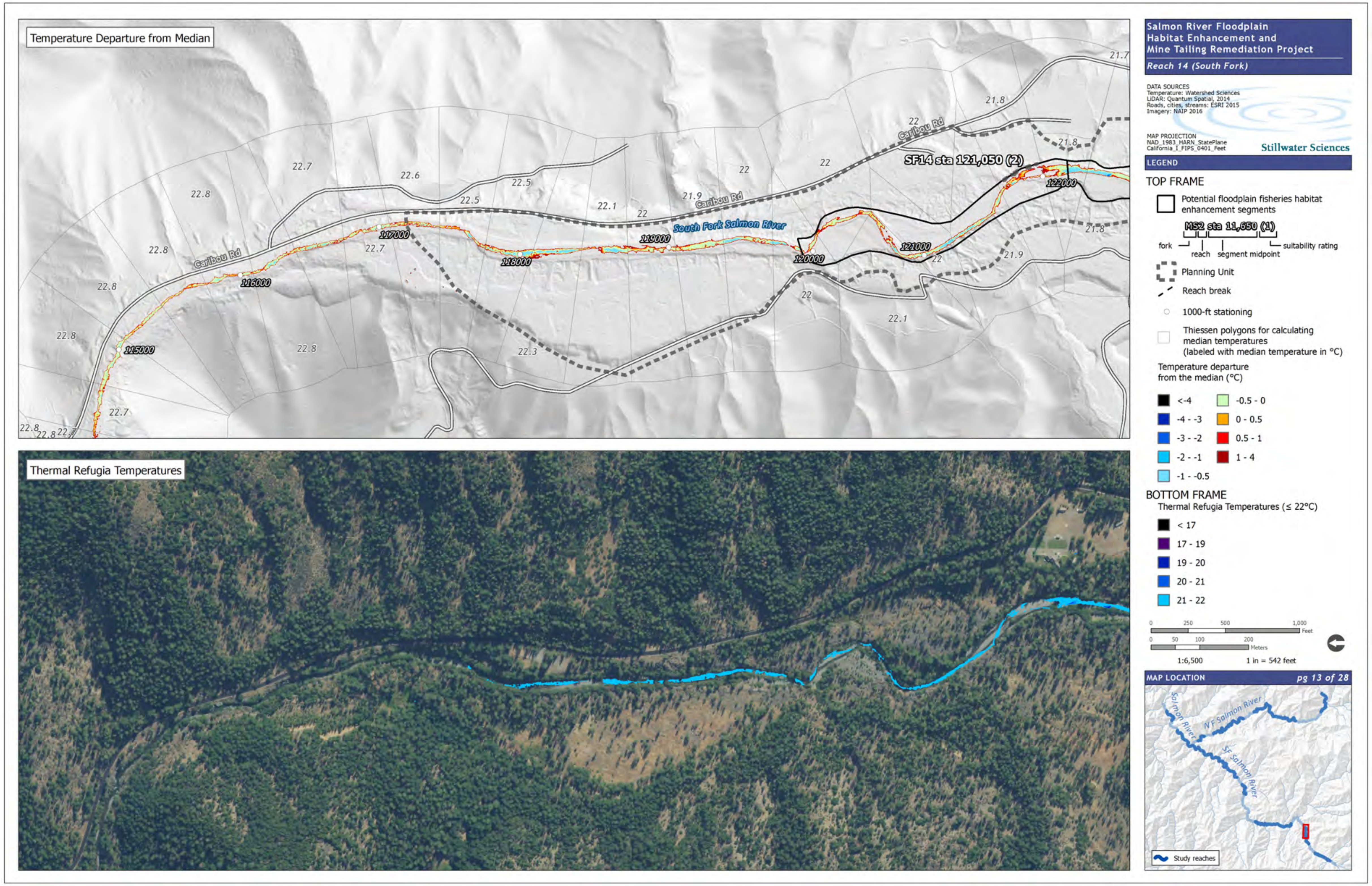


Figure A-24. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 12 of 28.



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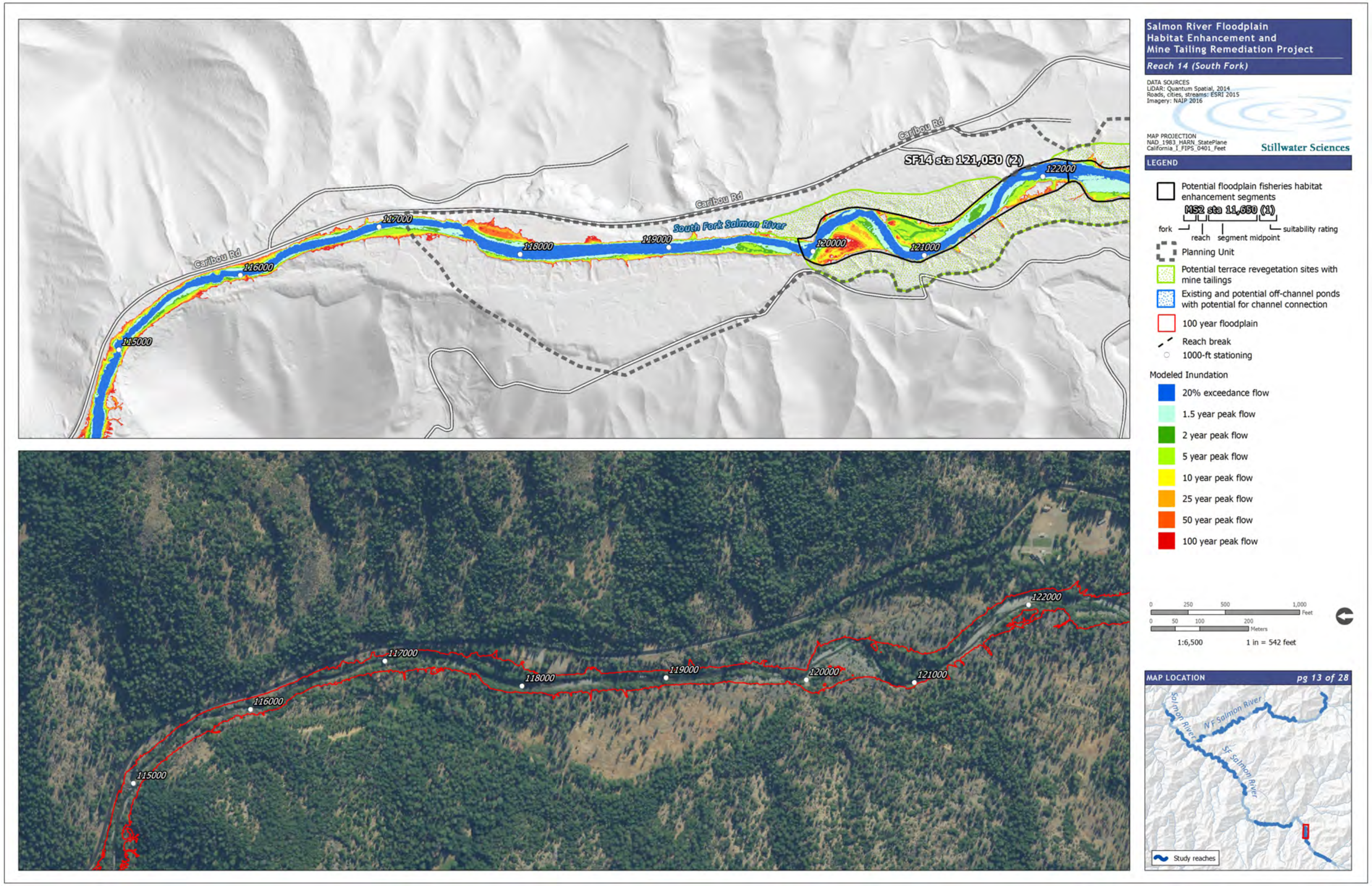

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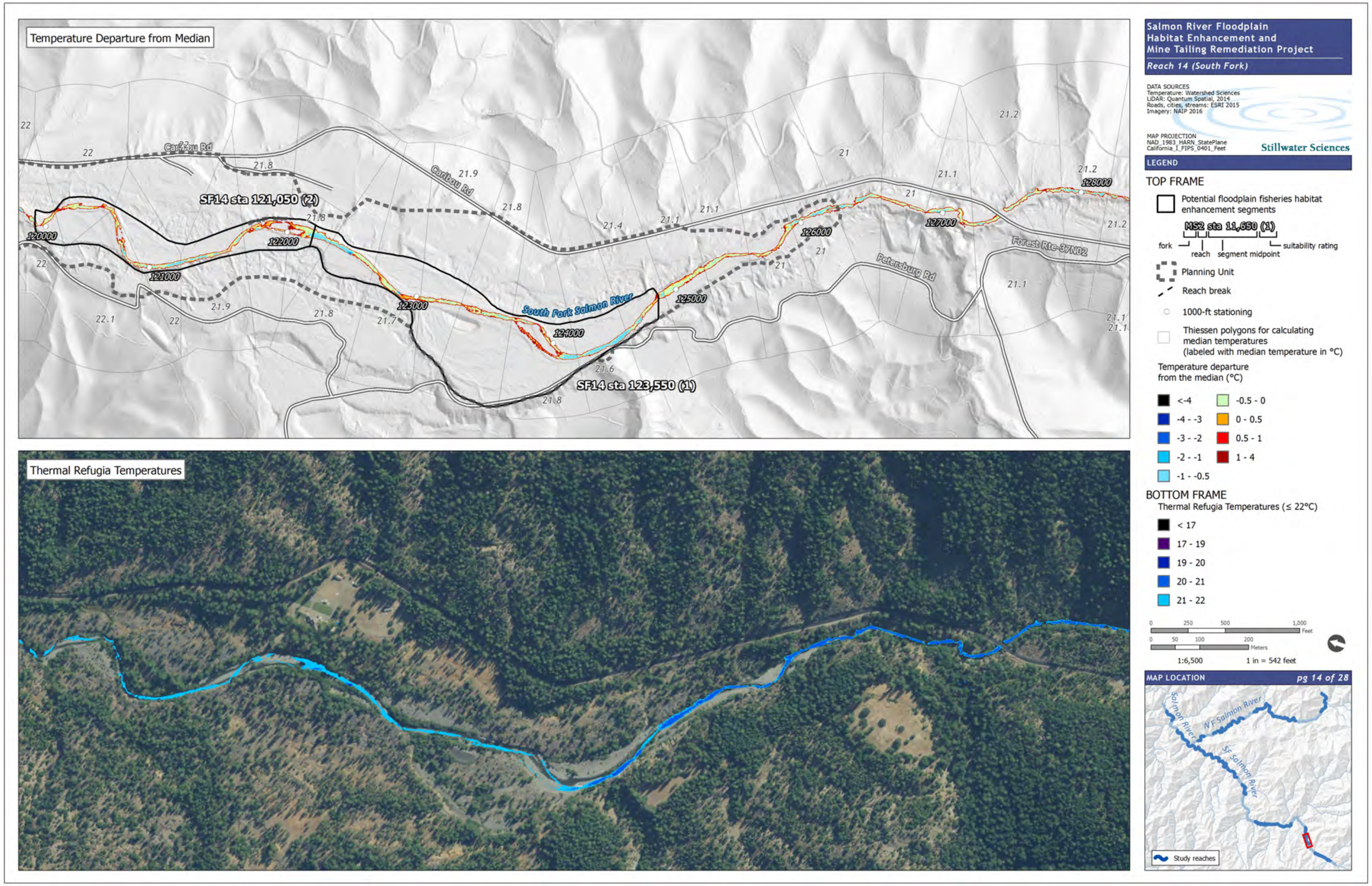

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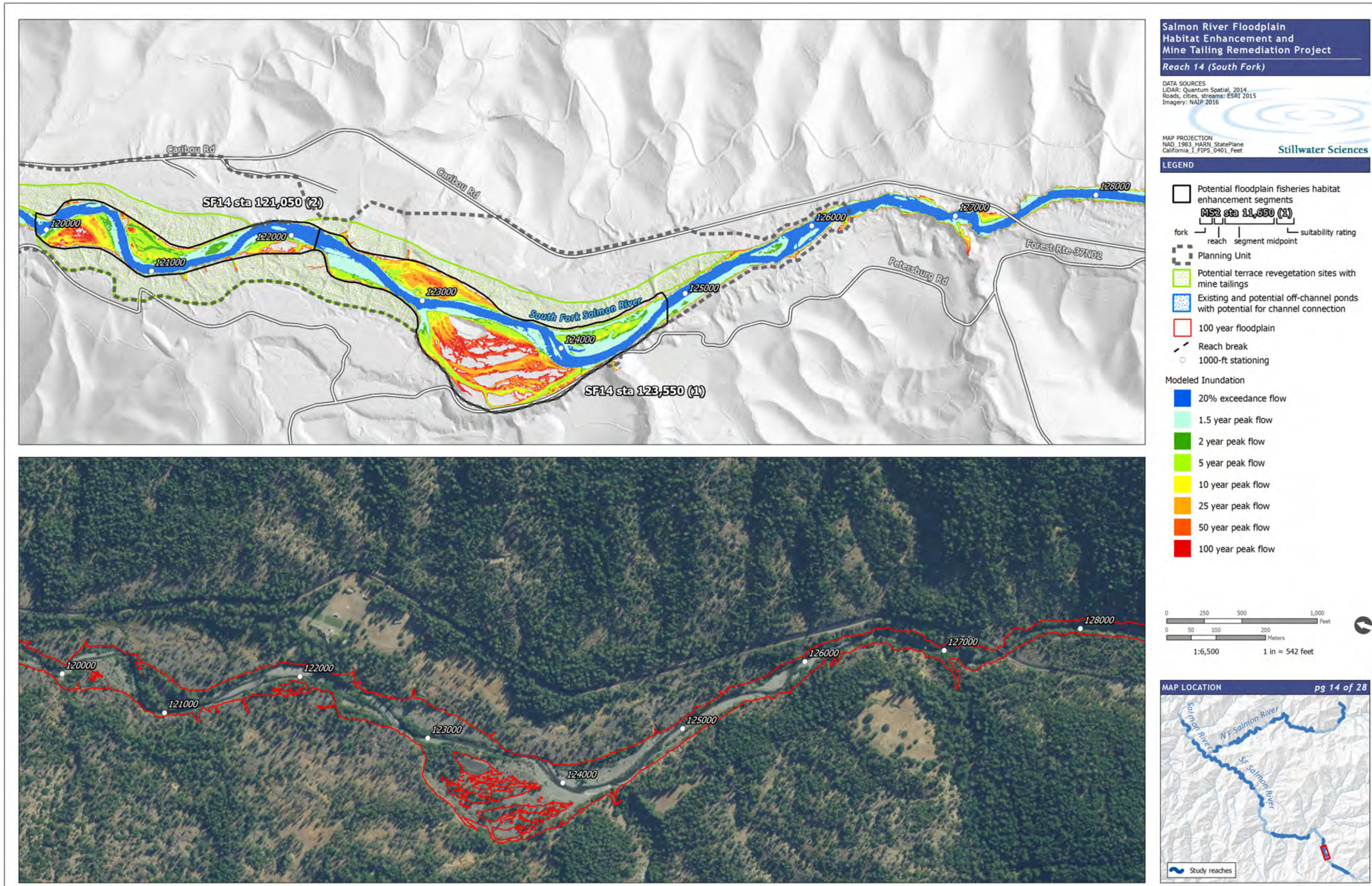
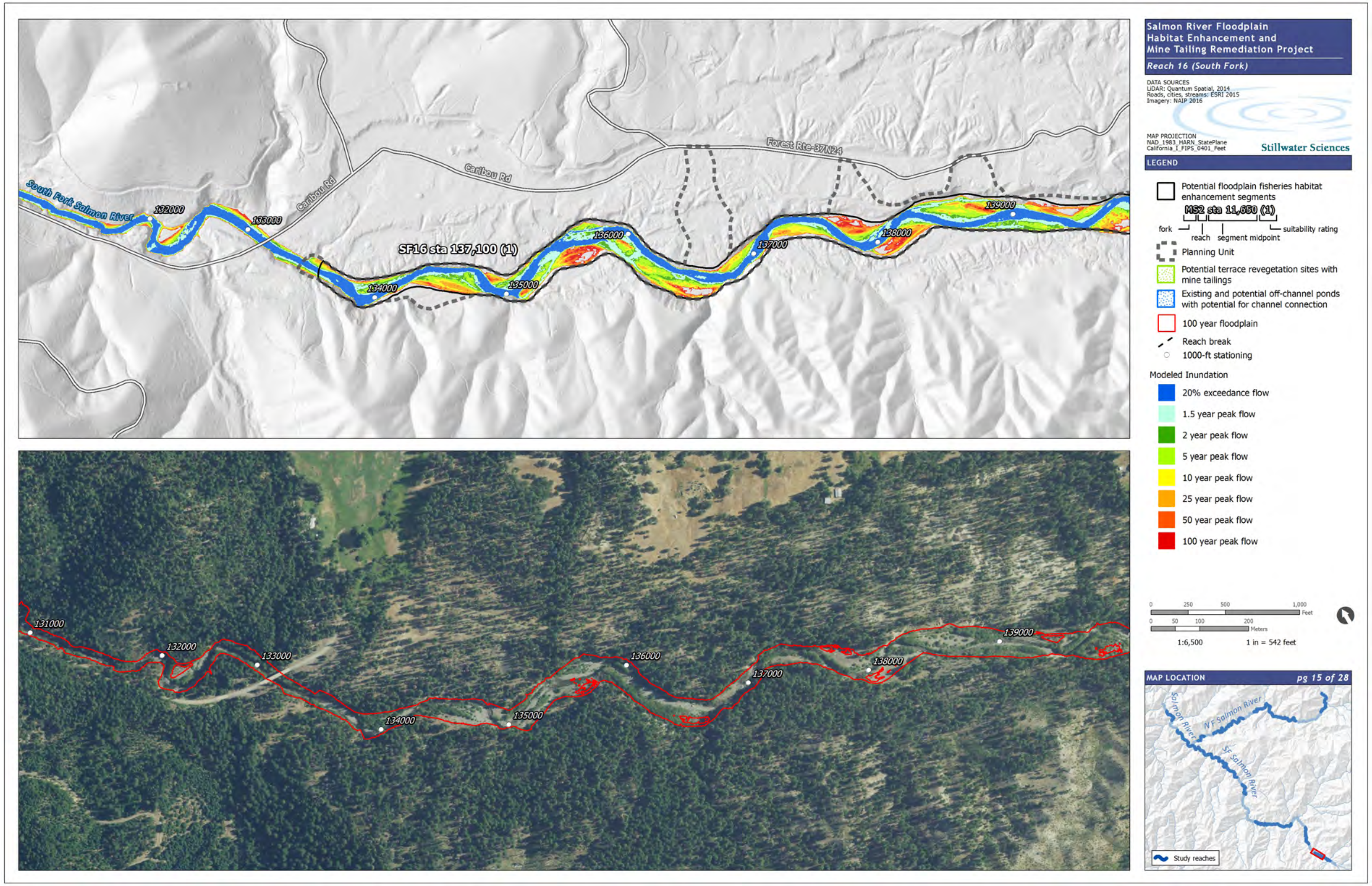


Figure A-28. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 14 of 28.

Figure A-29. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 15 of 28.



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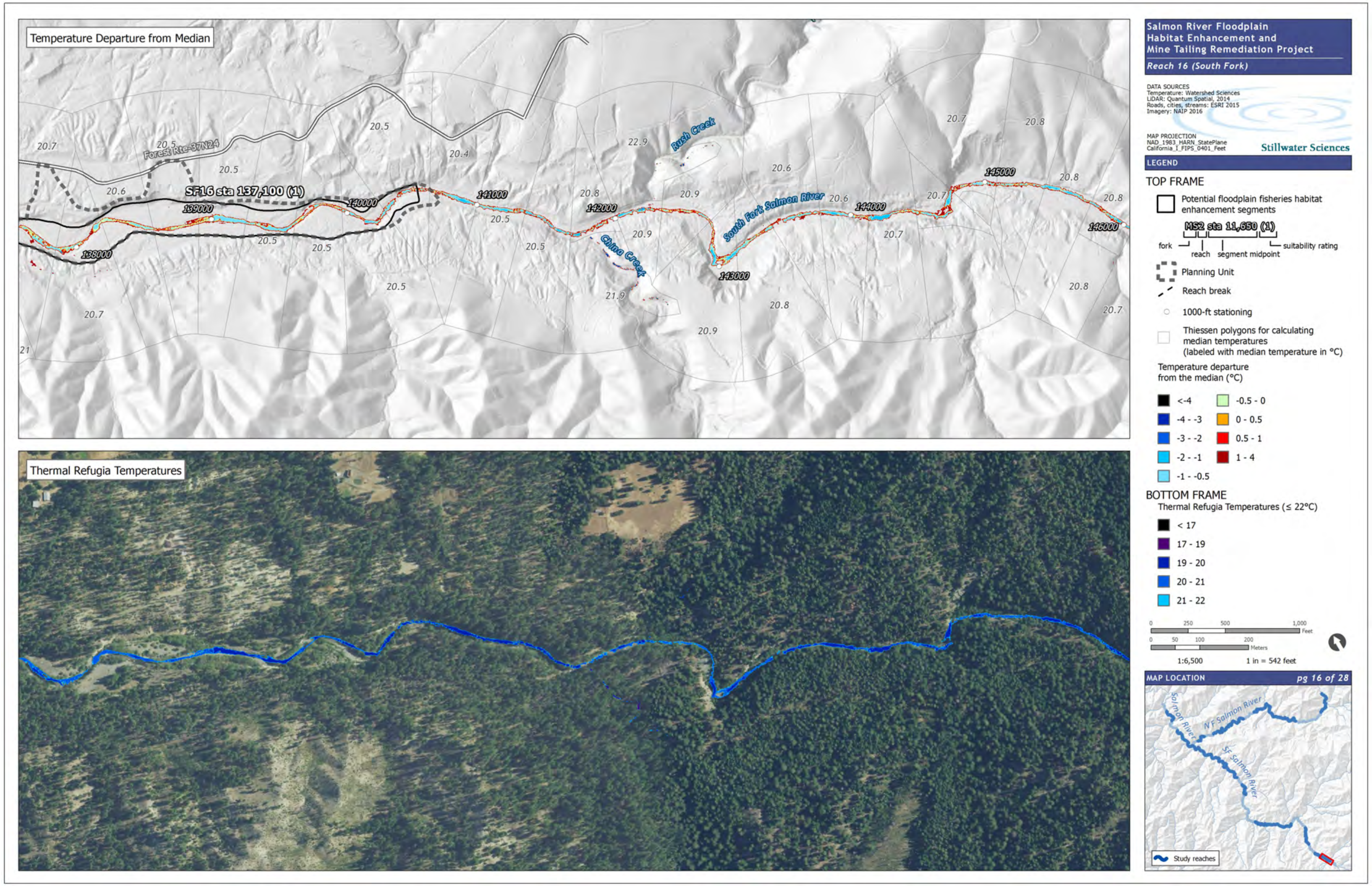

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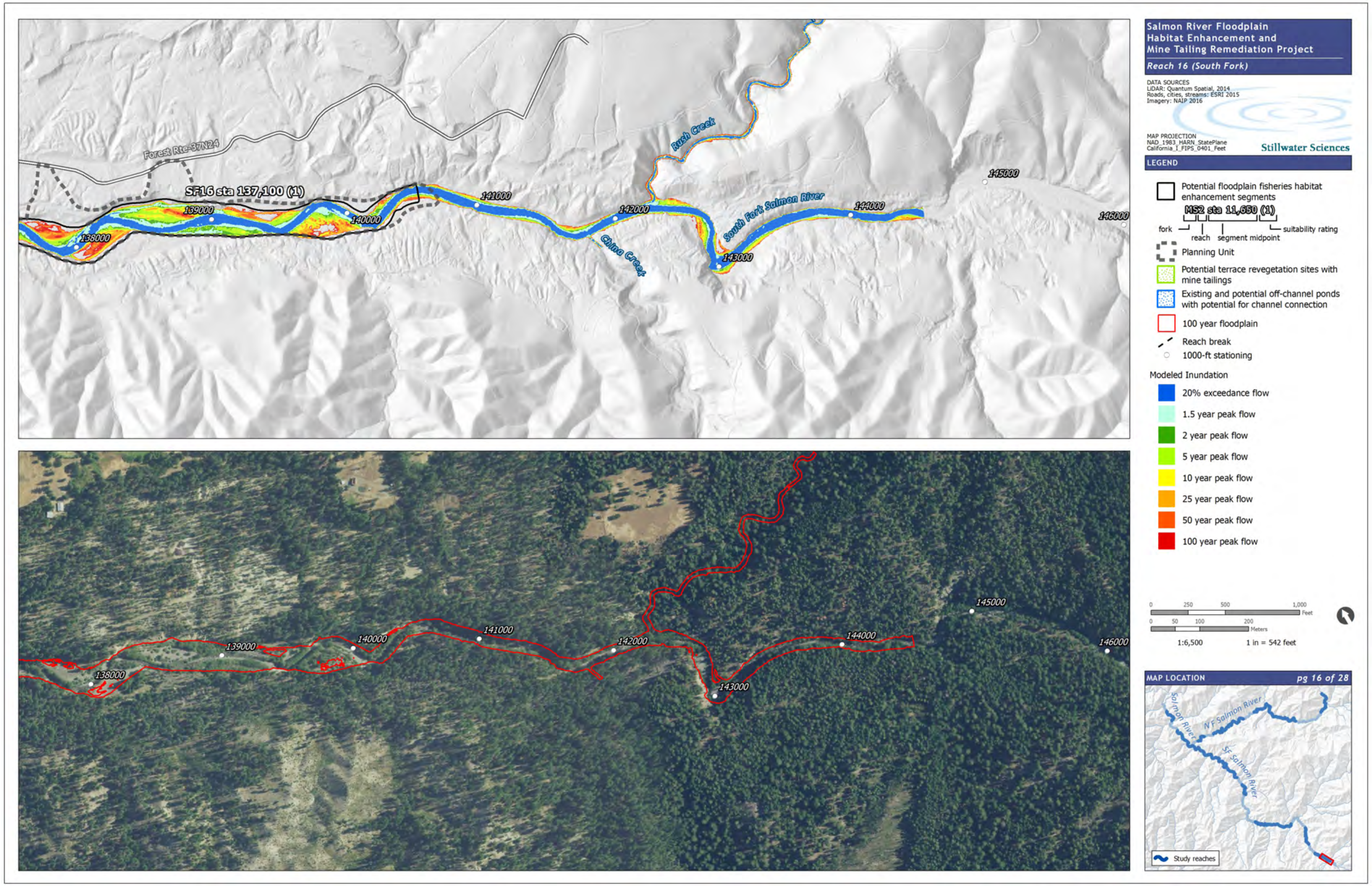

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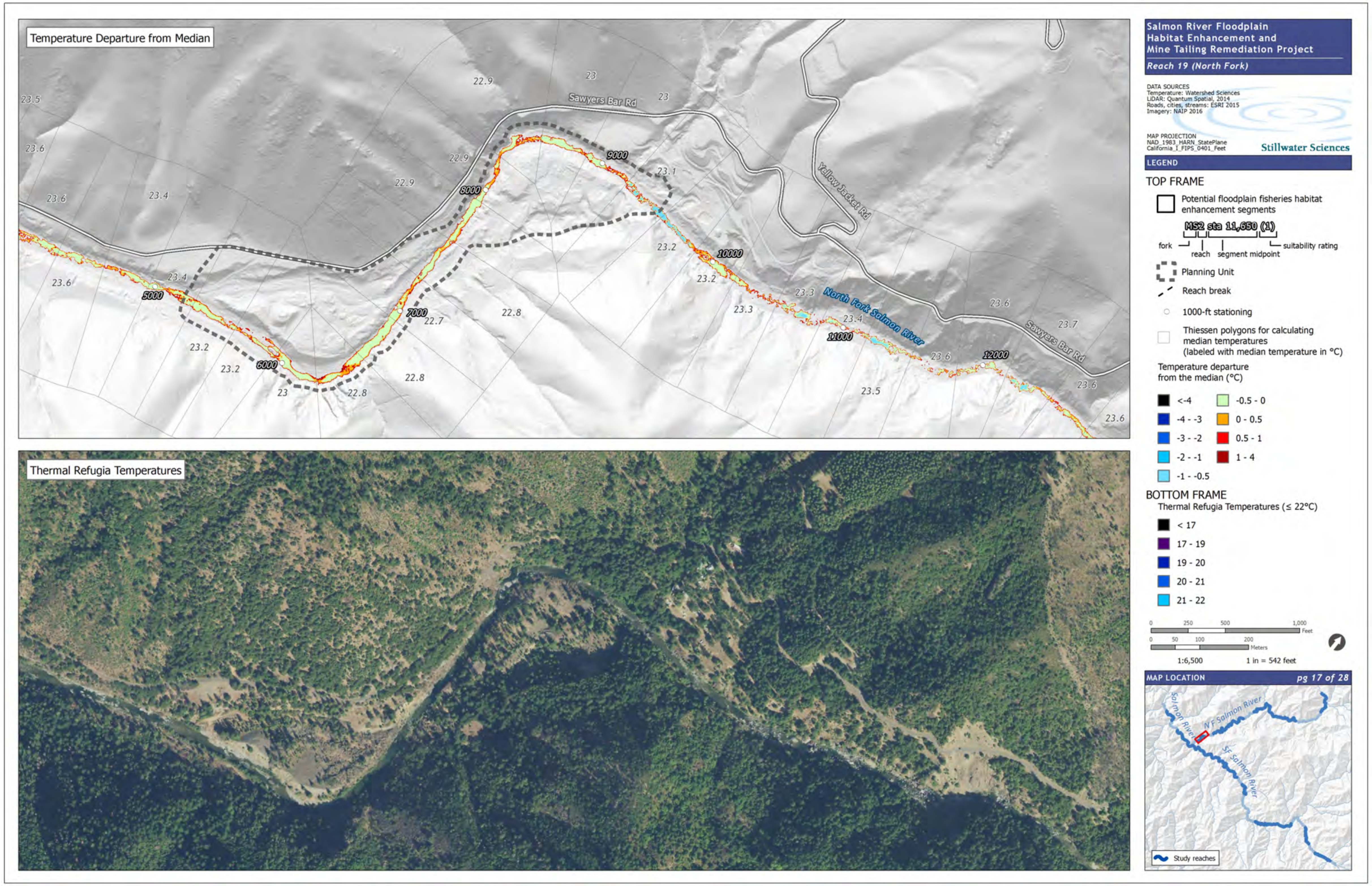

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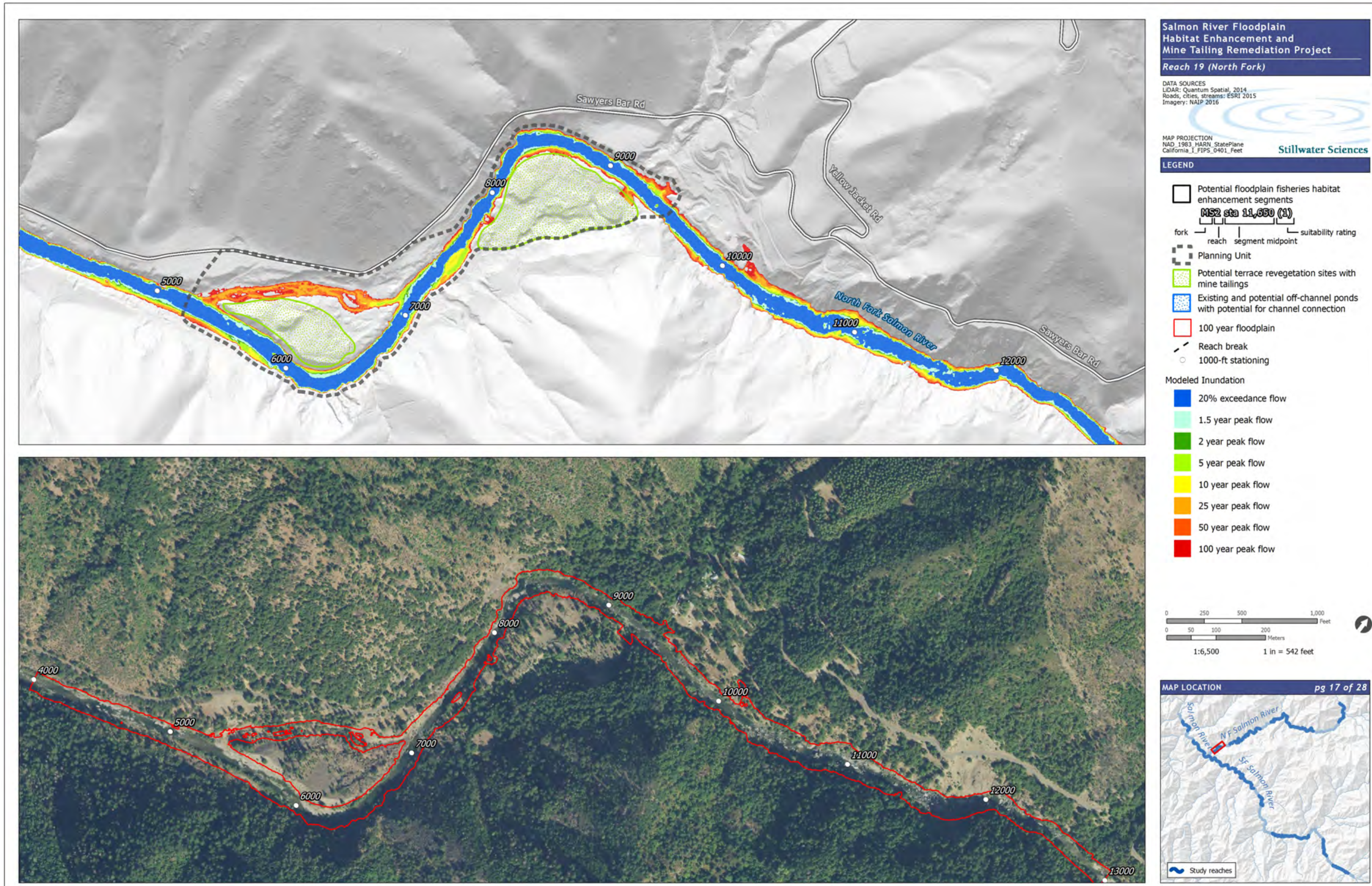

Figure A-34. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 17 of 28.

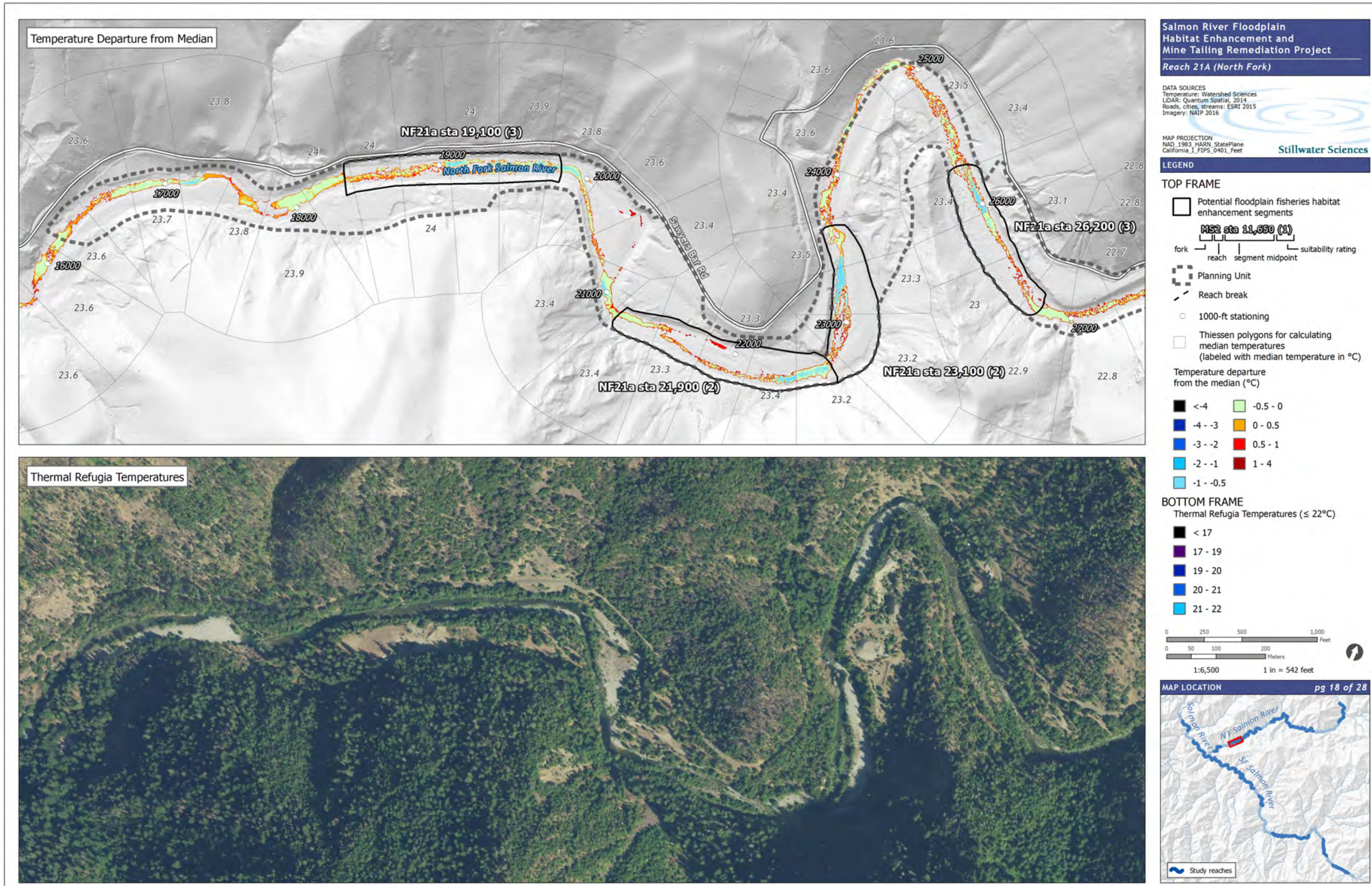

Figure A-35. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 18 of 28.

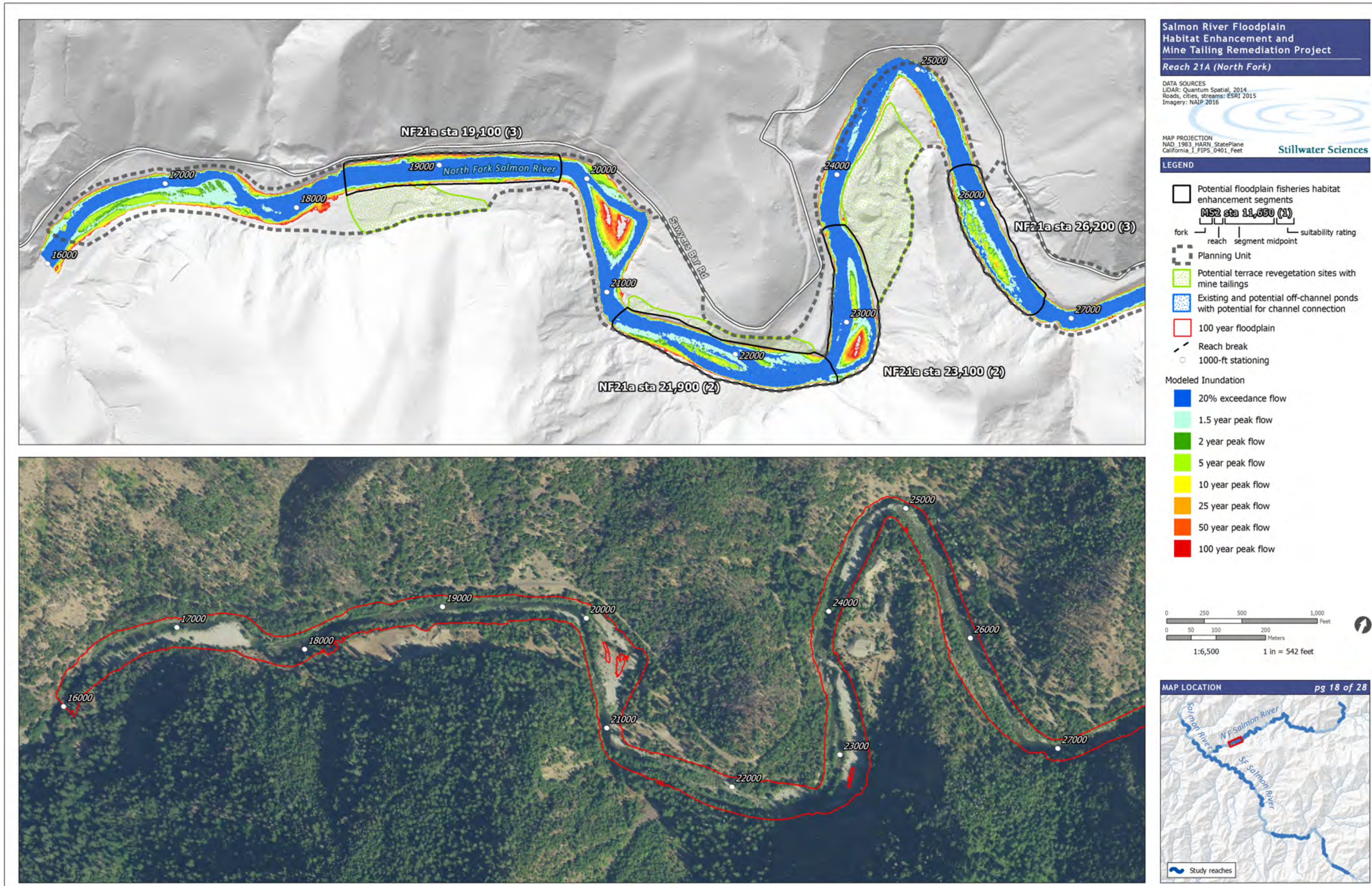

Figure A-36. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 18 of 28.

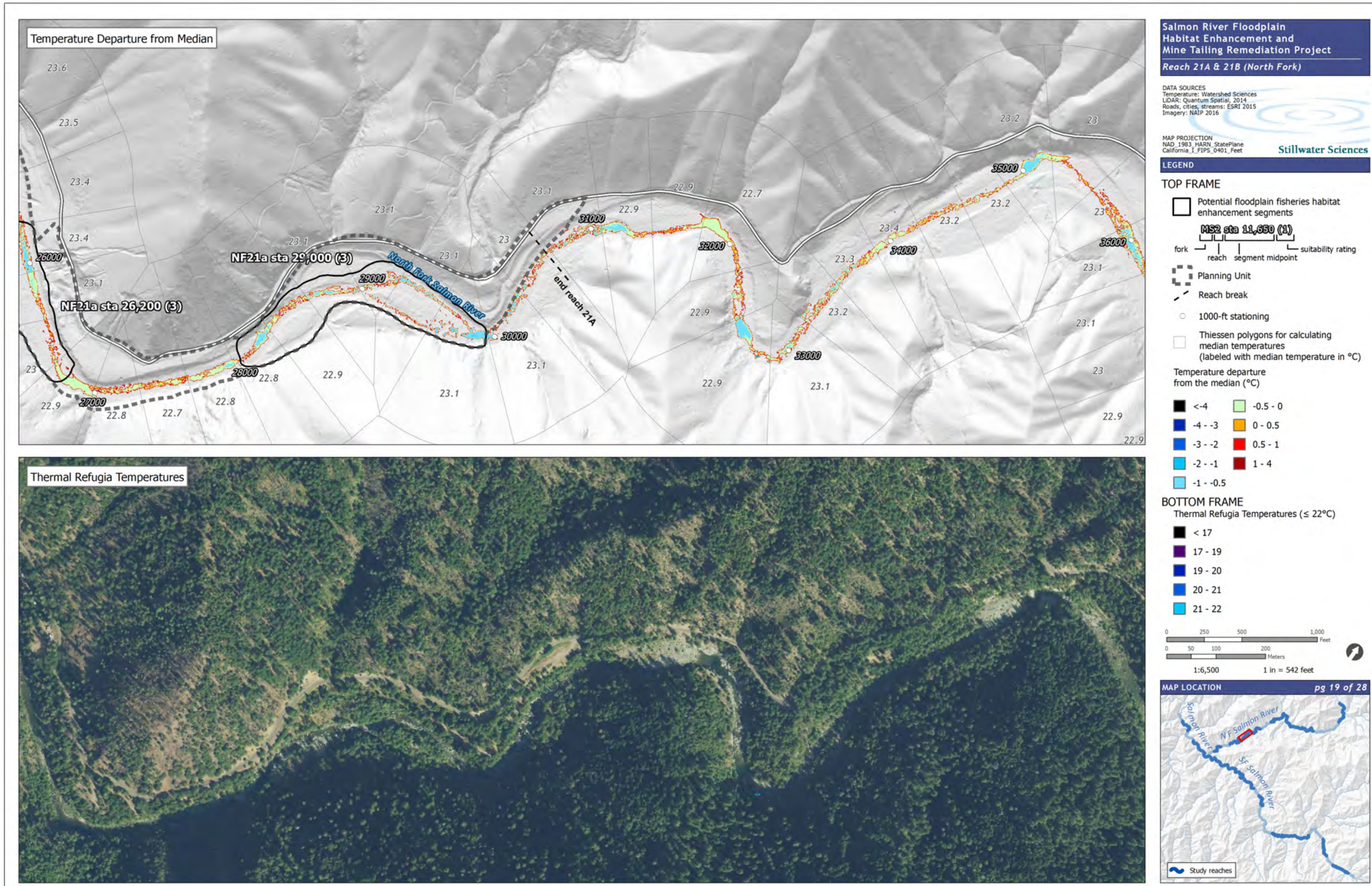

Figure A-37. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 19 of 28.

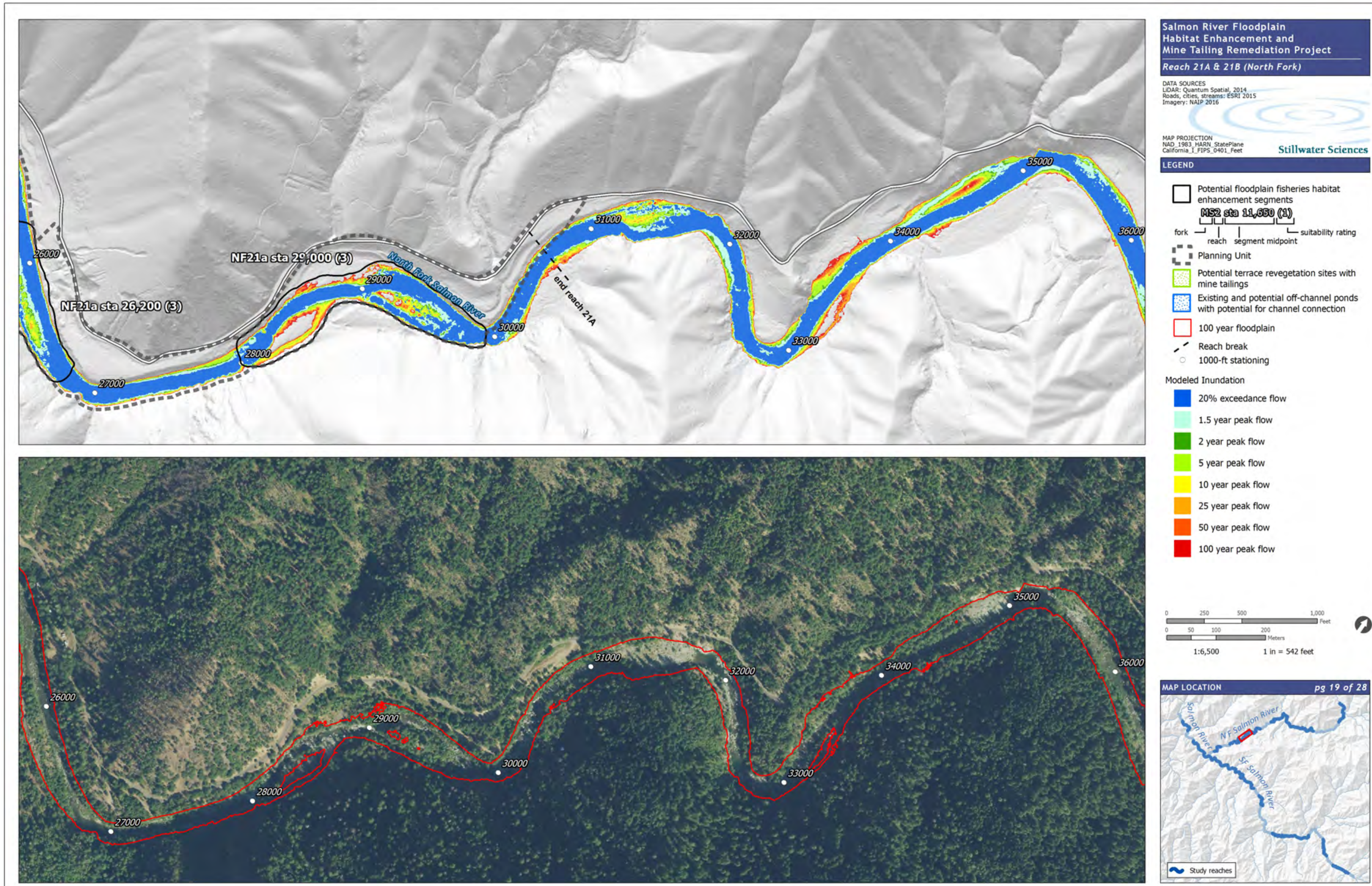

Figure A-38. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 19 of 28.

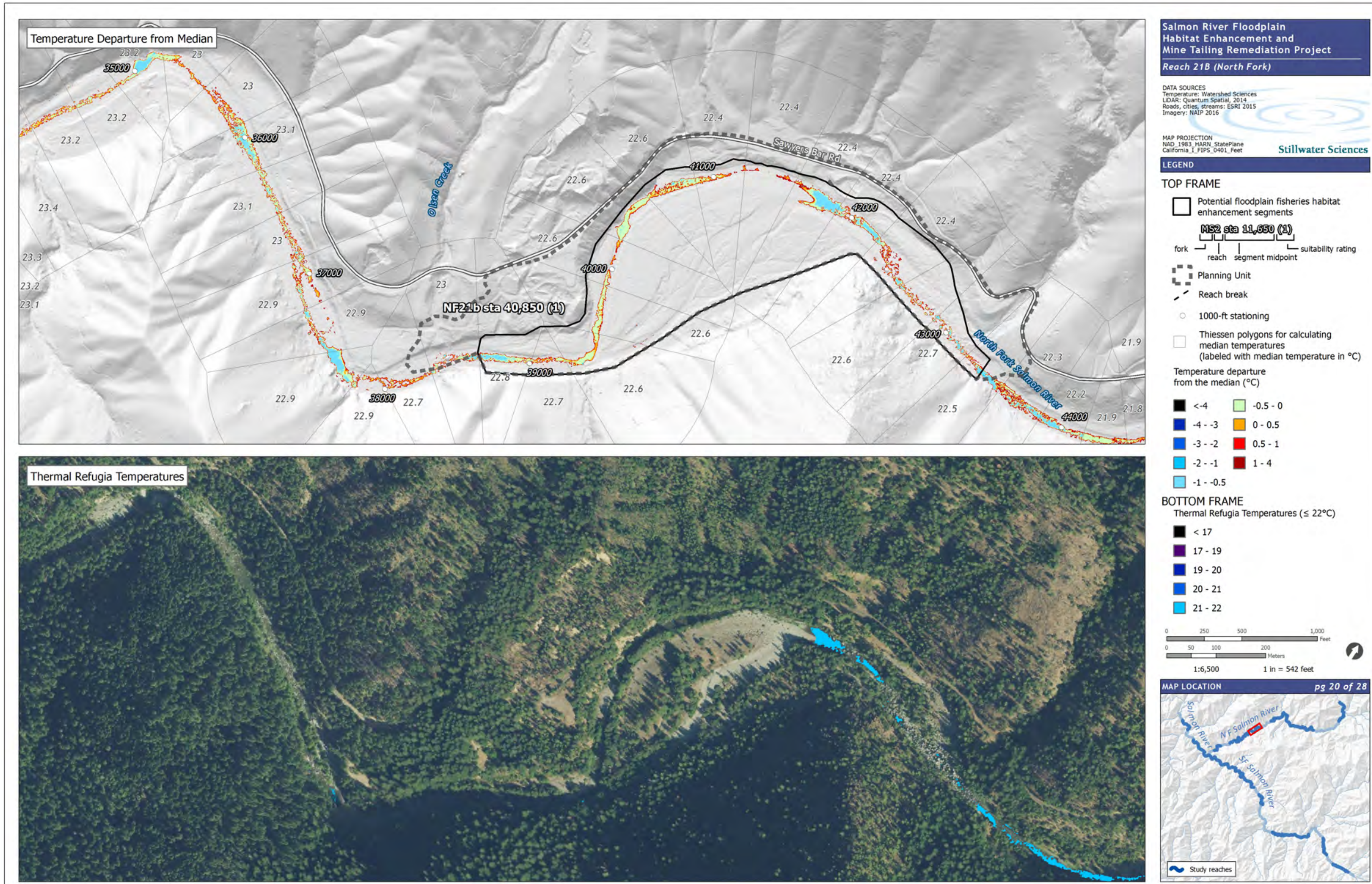

Figure A-39. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 20 of 28.

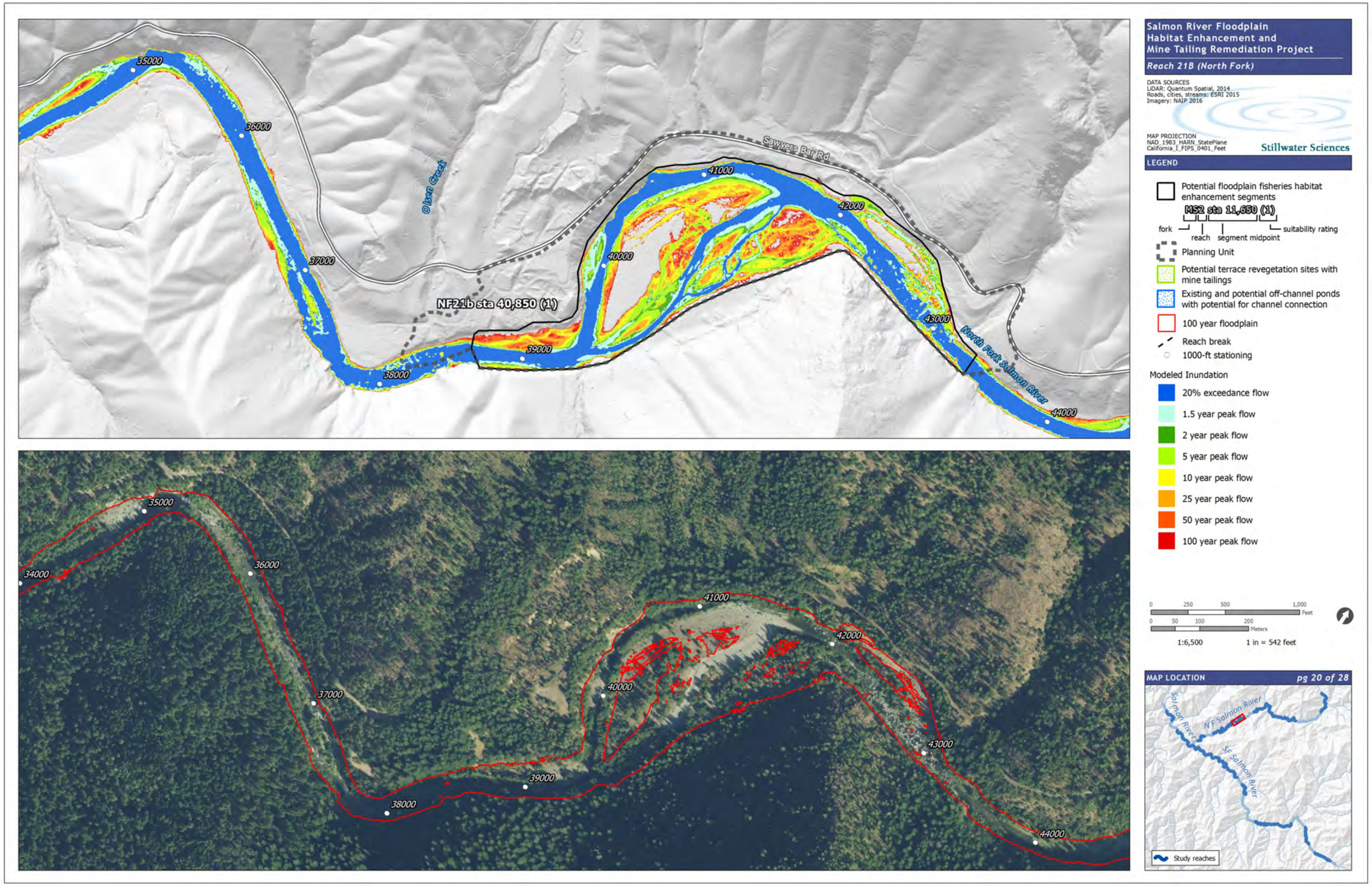

Figure A-40. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 20 of 28.

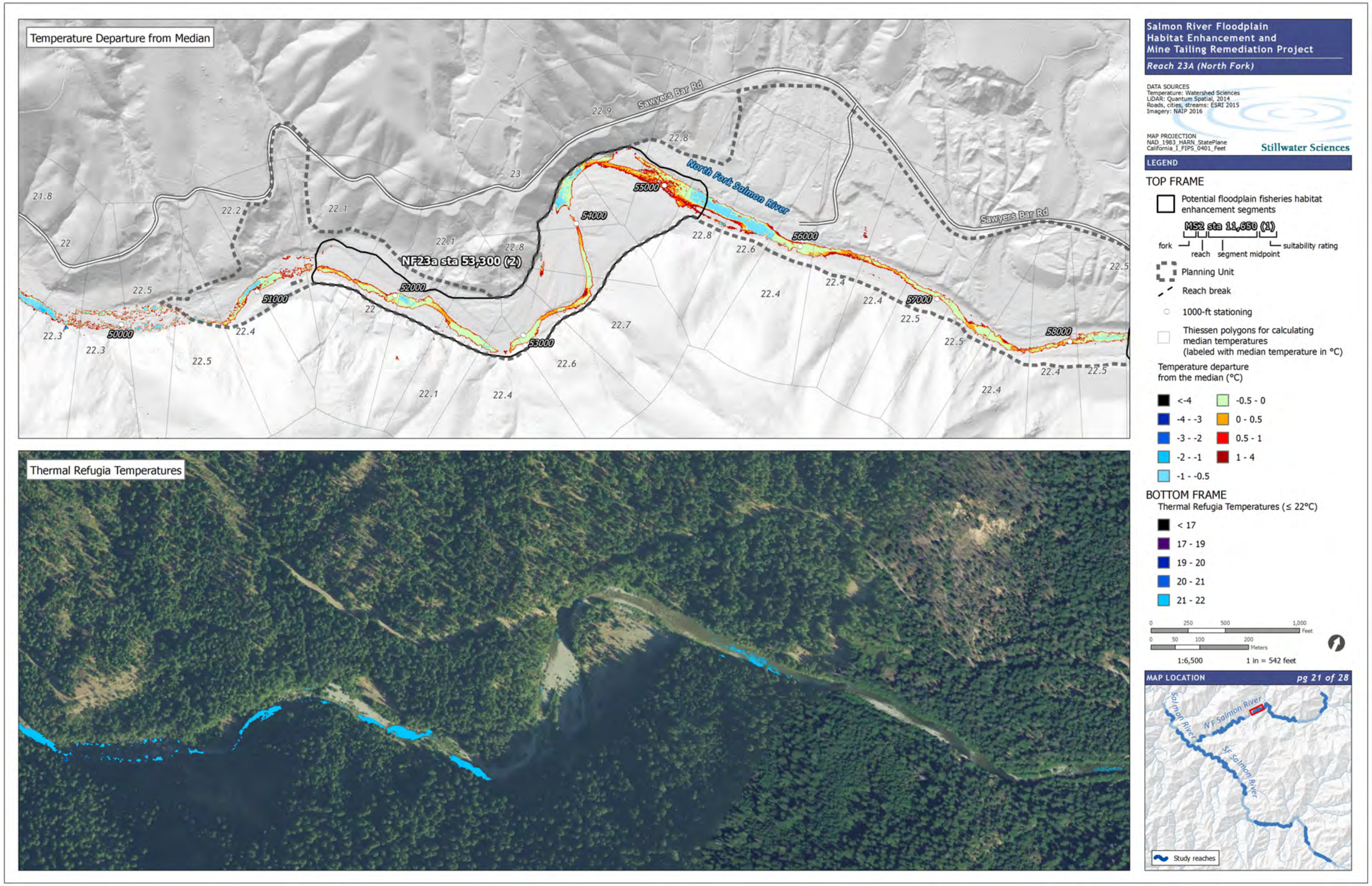

Figure A-41. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 21 of 28.

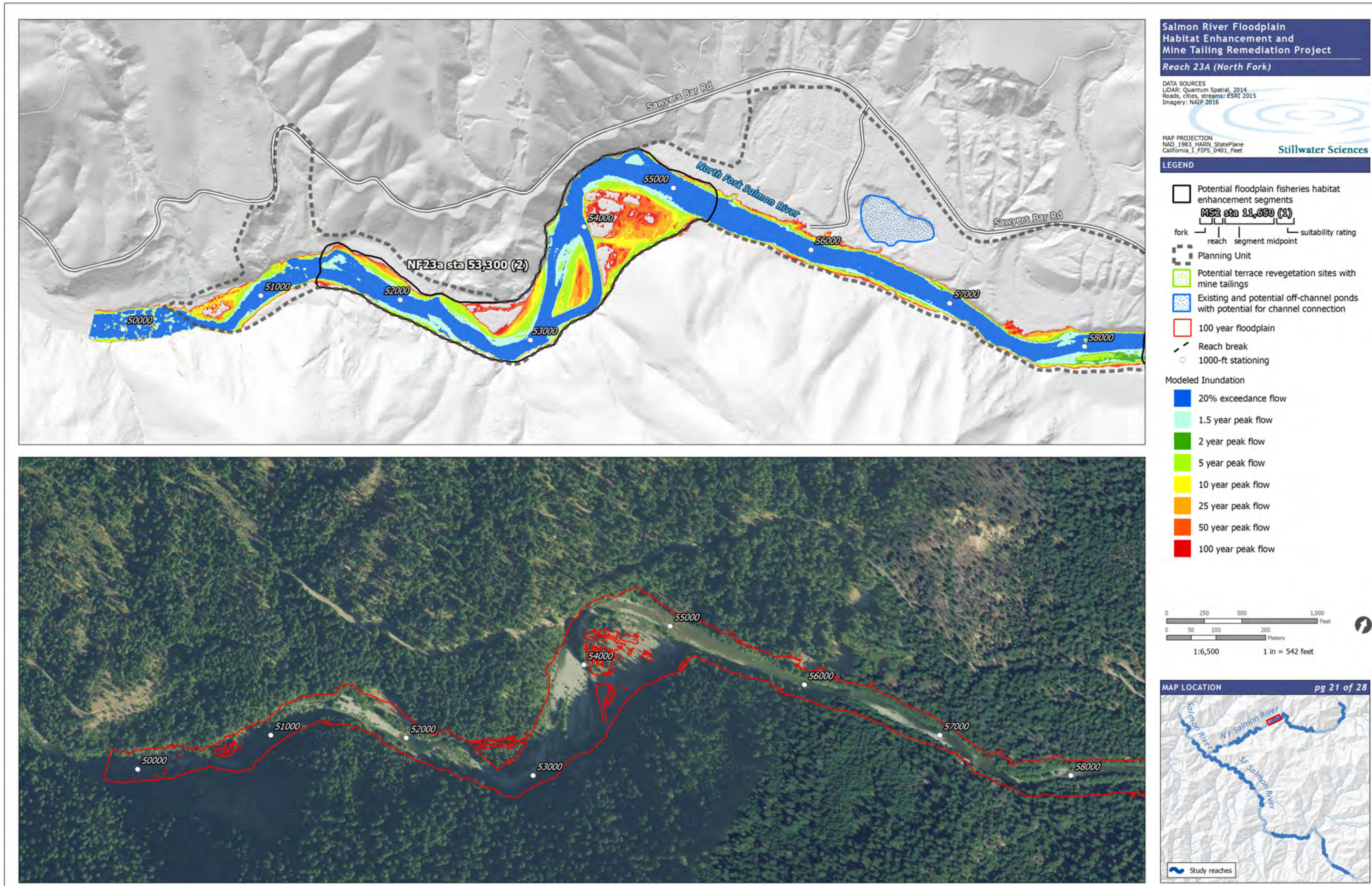

Figure A-42. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 21 of 28.

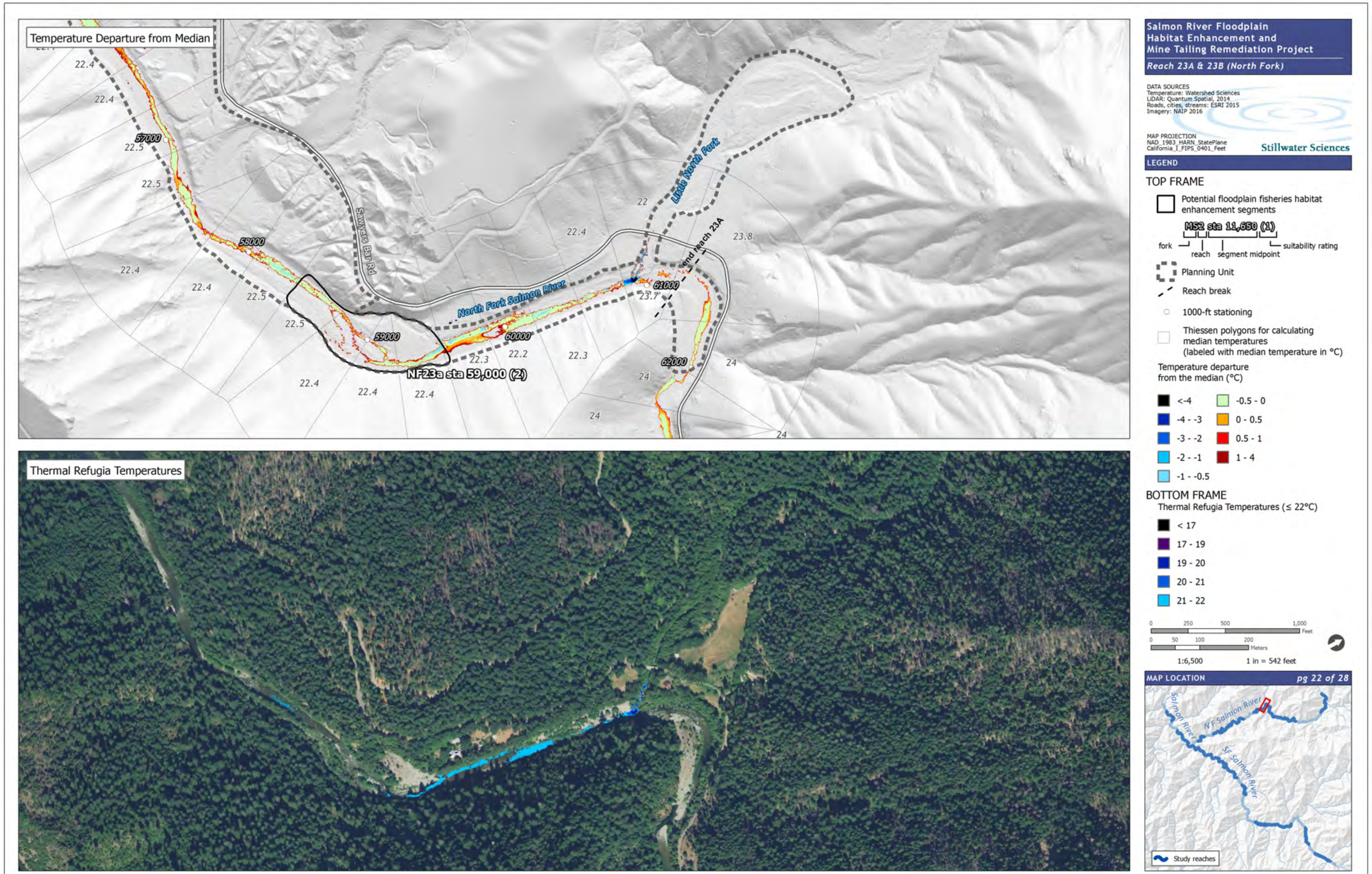

Figure A-43. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 22 of 28.

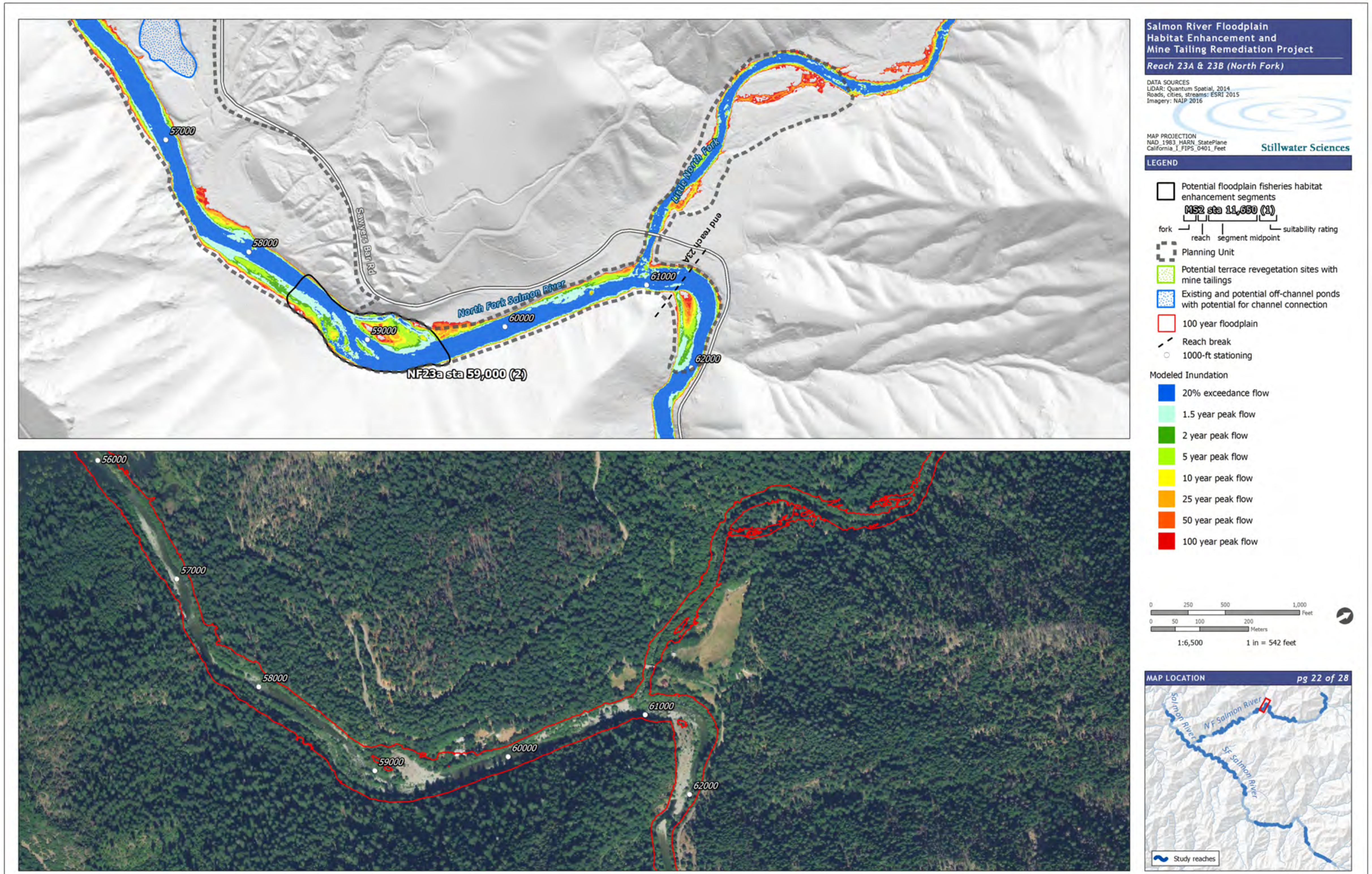

Figure A-44. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 22 of 28.

Figure A-45. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 23 of 28.

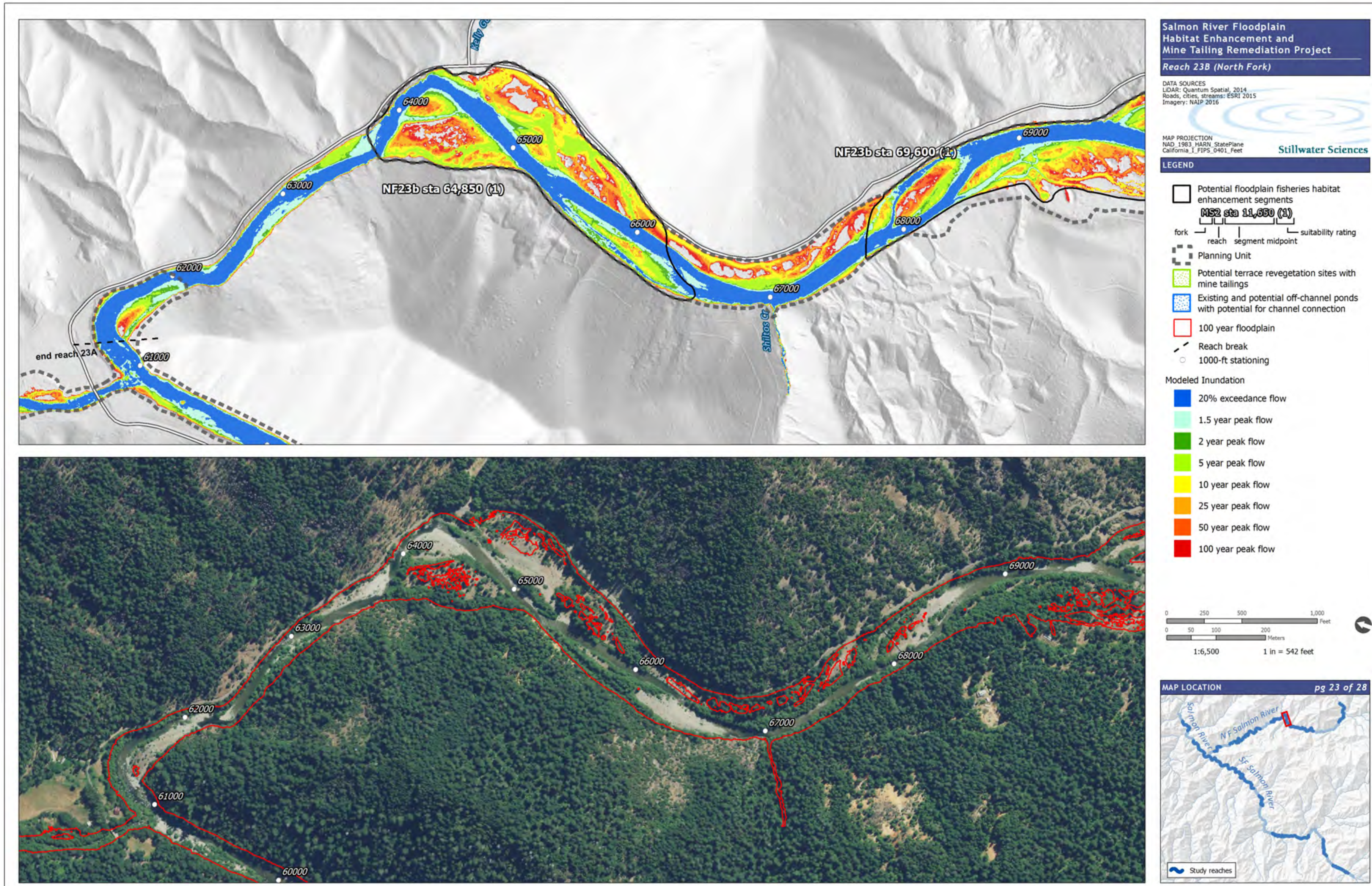

Figure A-46. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 23 of 28.

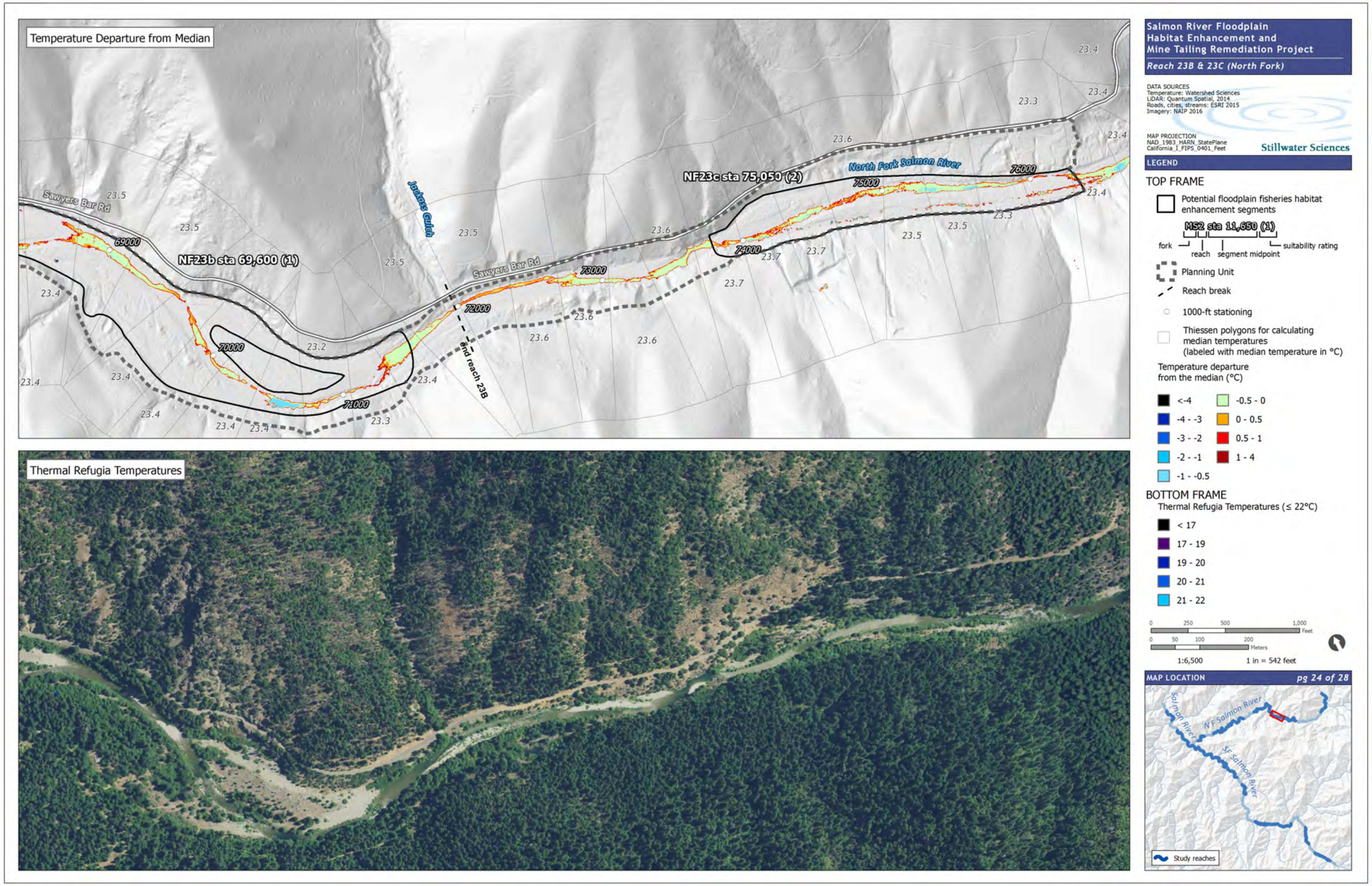

Figure A-47. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 24 of 28.

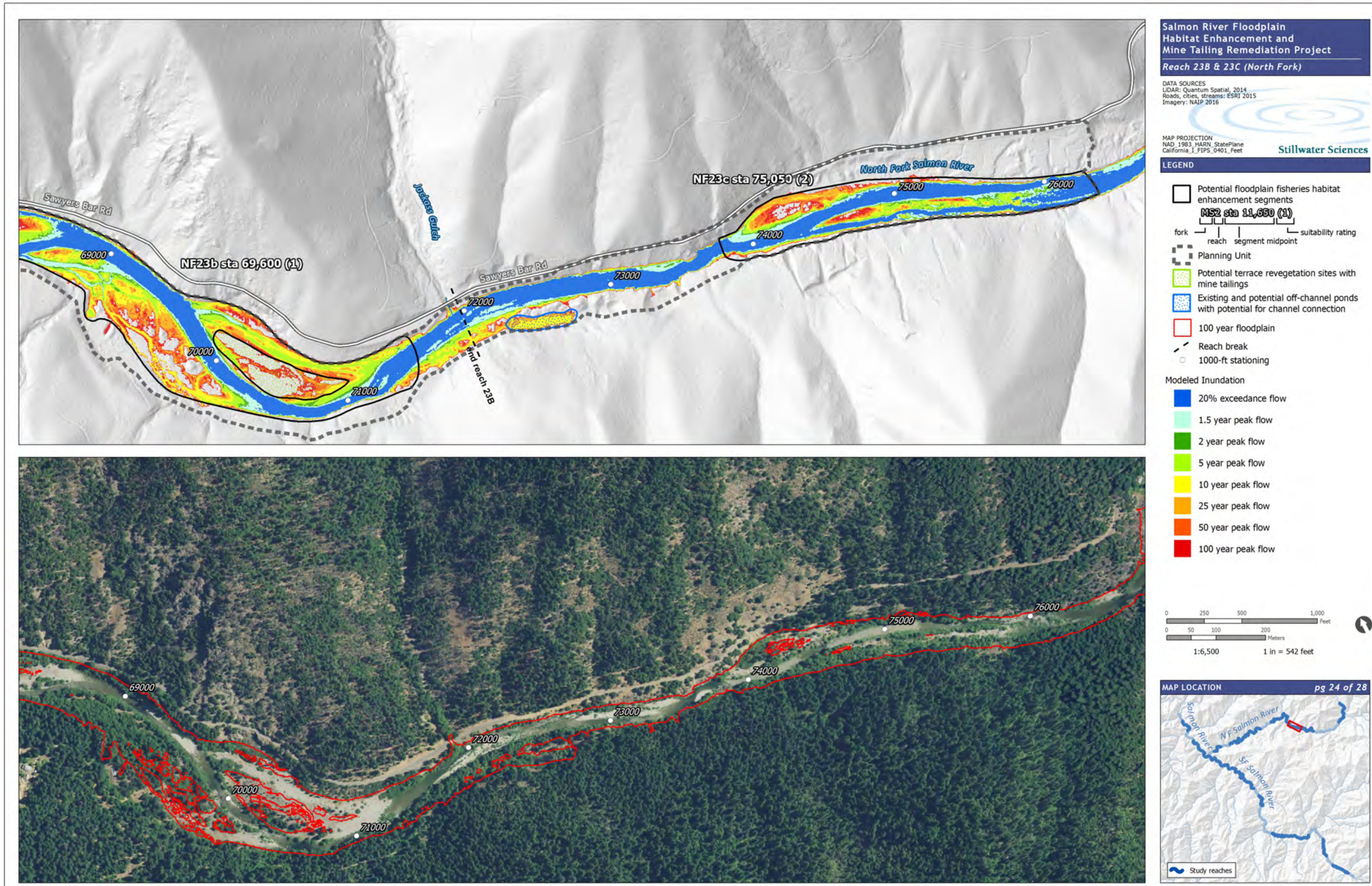

Figure A-48. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 24 of 28.

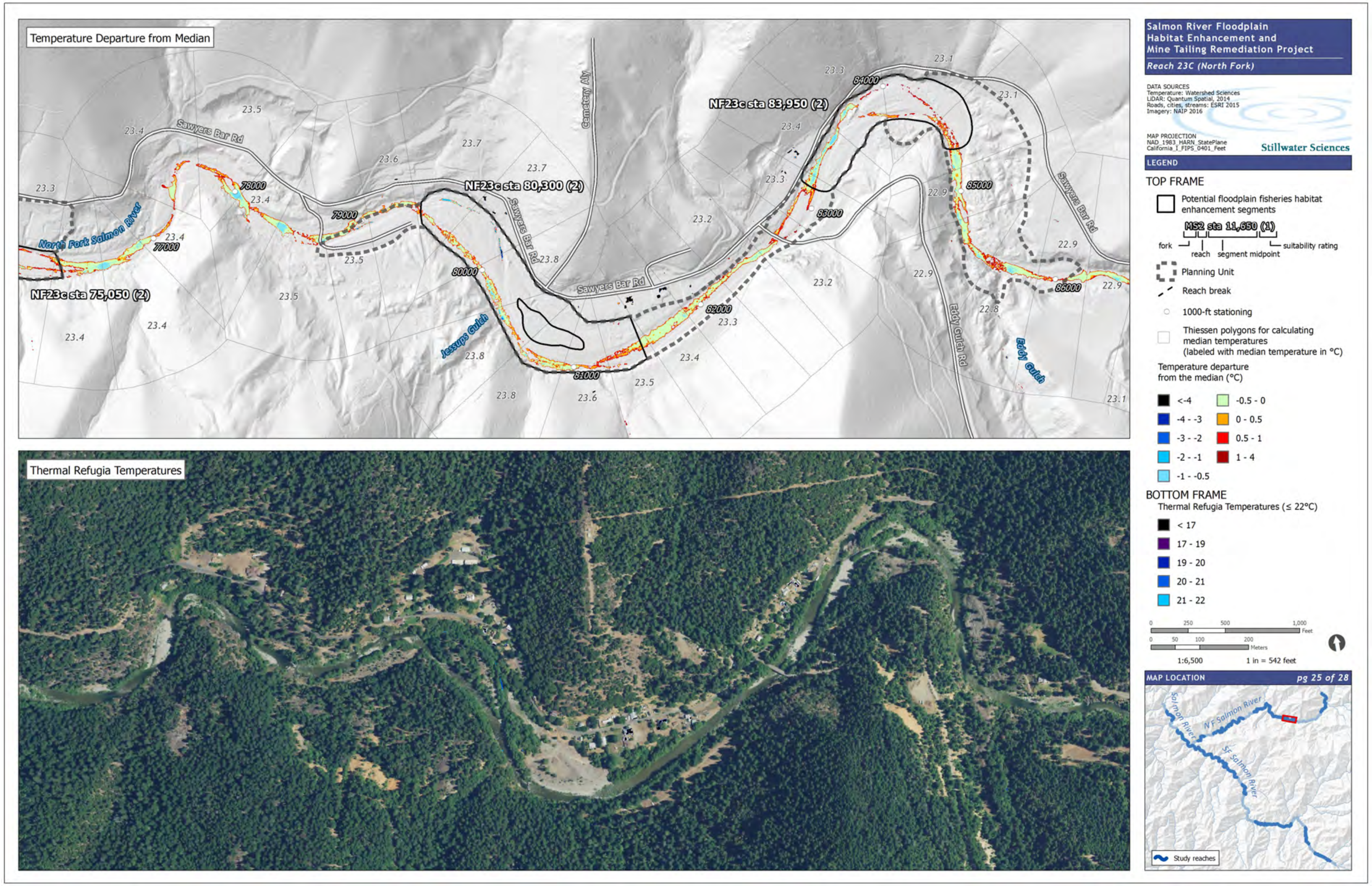

Figure A-49. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 25 of 28.

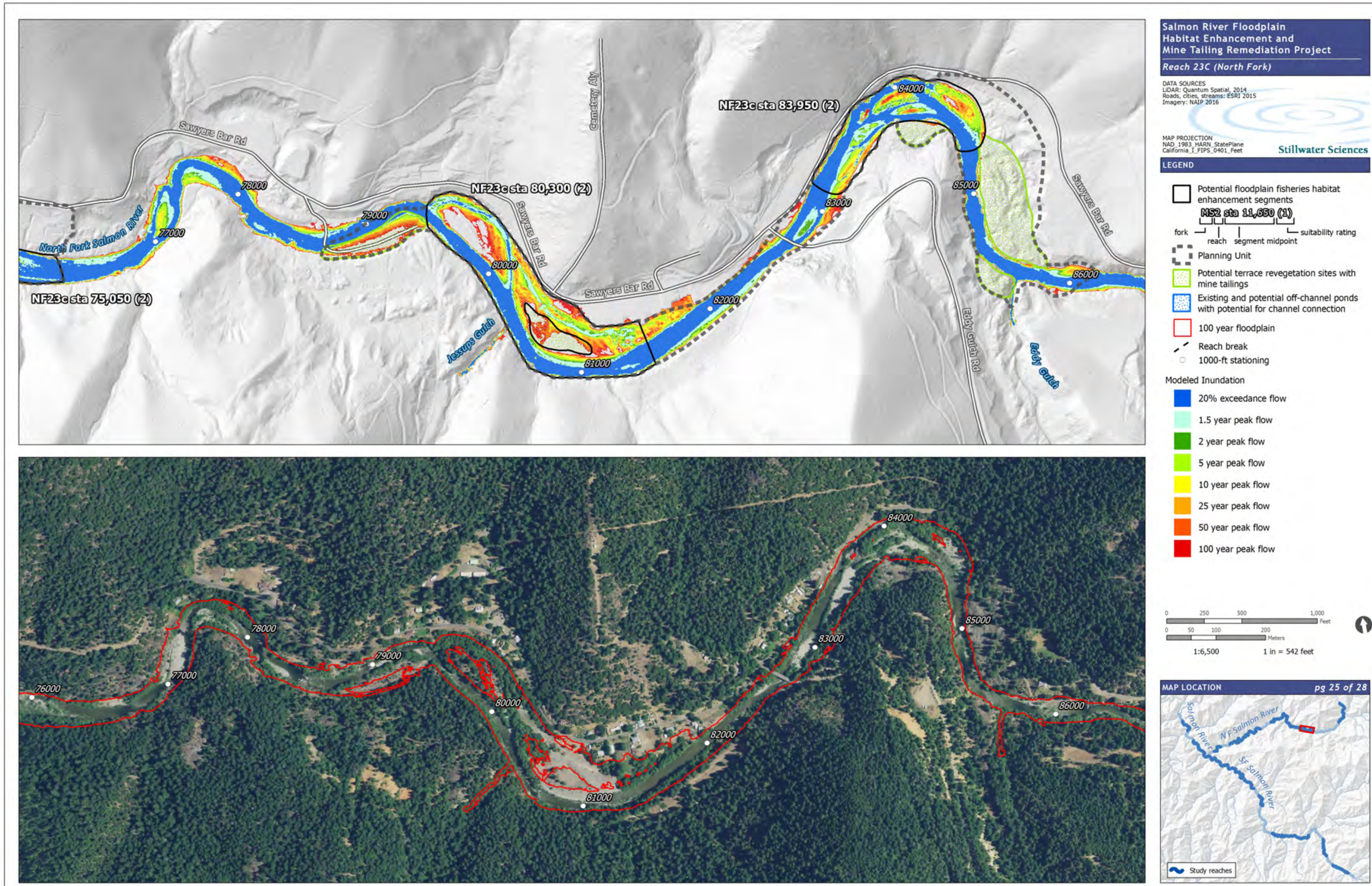

Figure A-50. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 25 of 28.

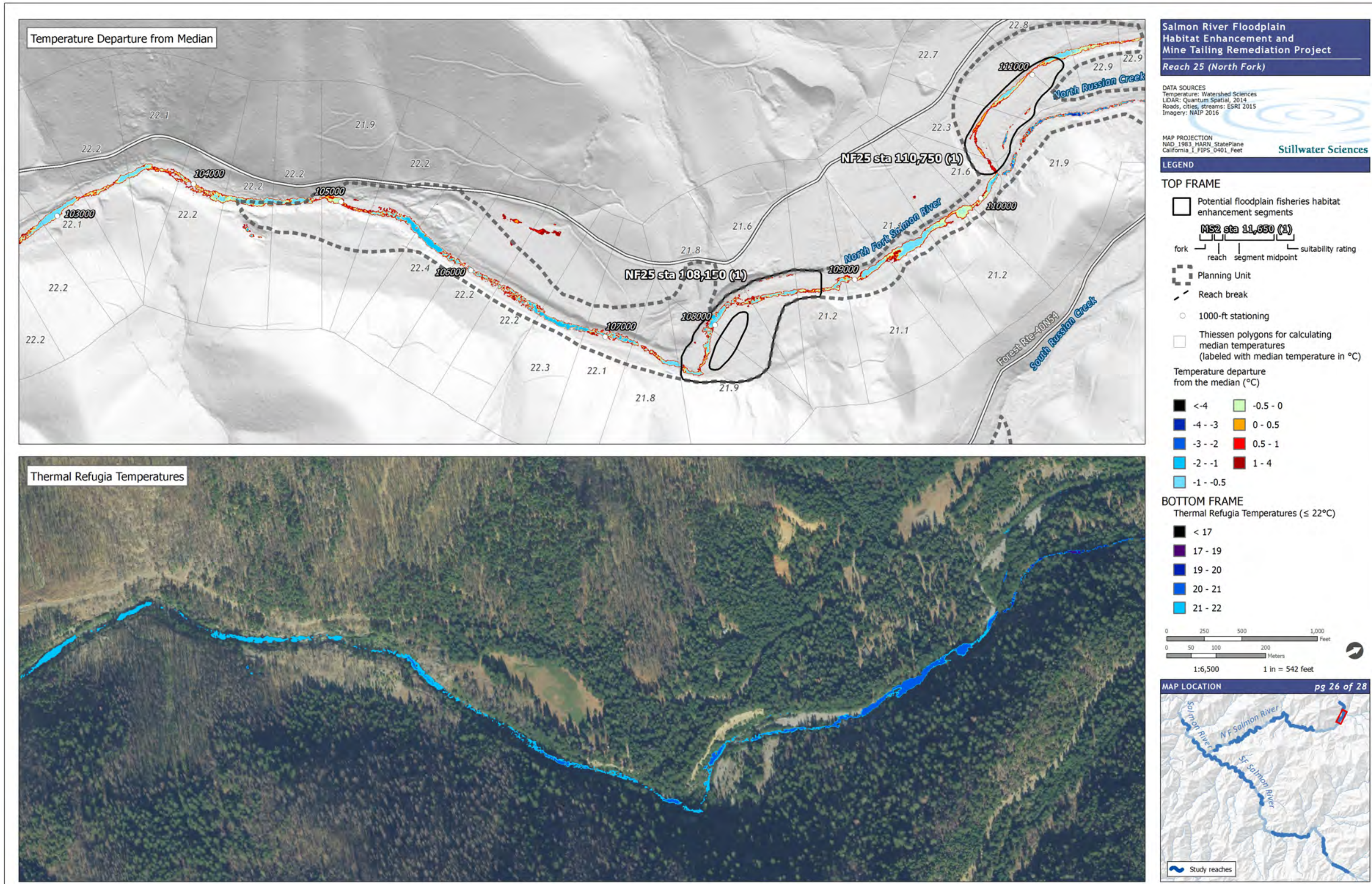

Figure A-51. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 26 of 28.

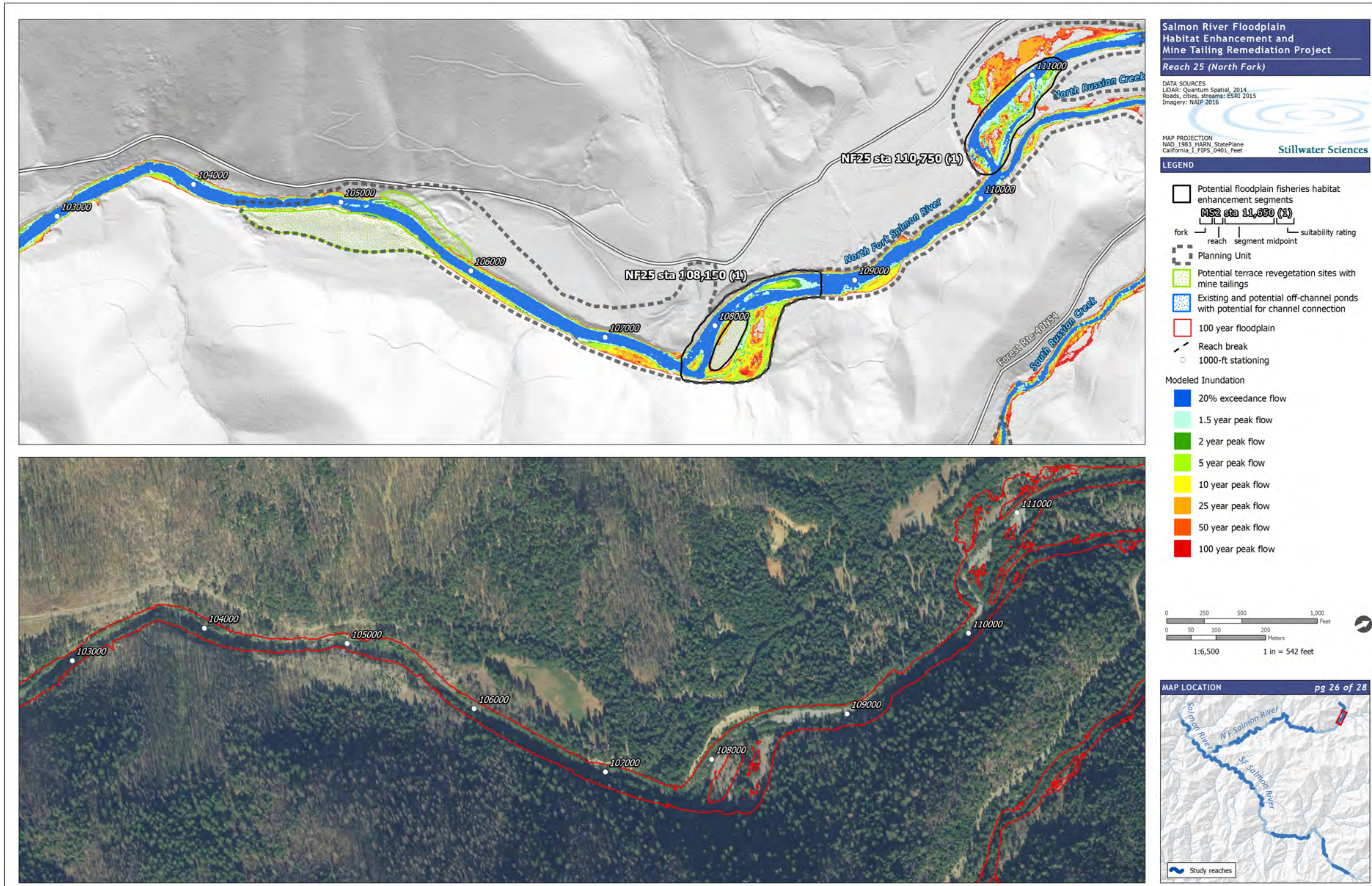

Figure A-52. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 26 of 28.

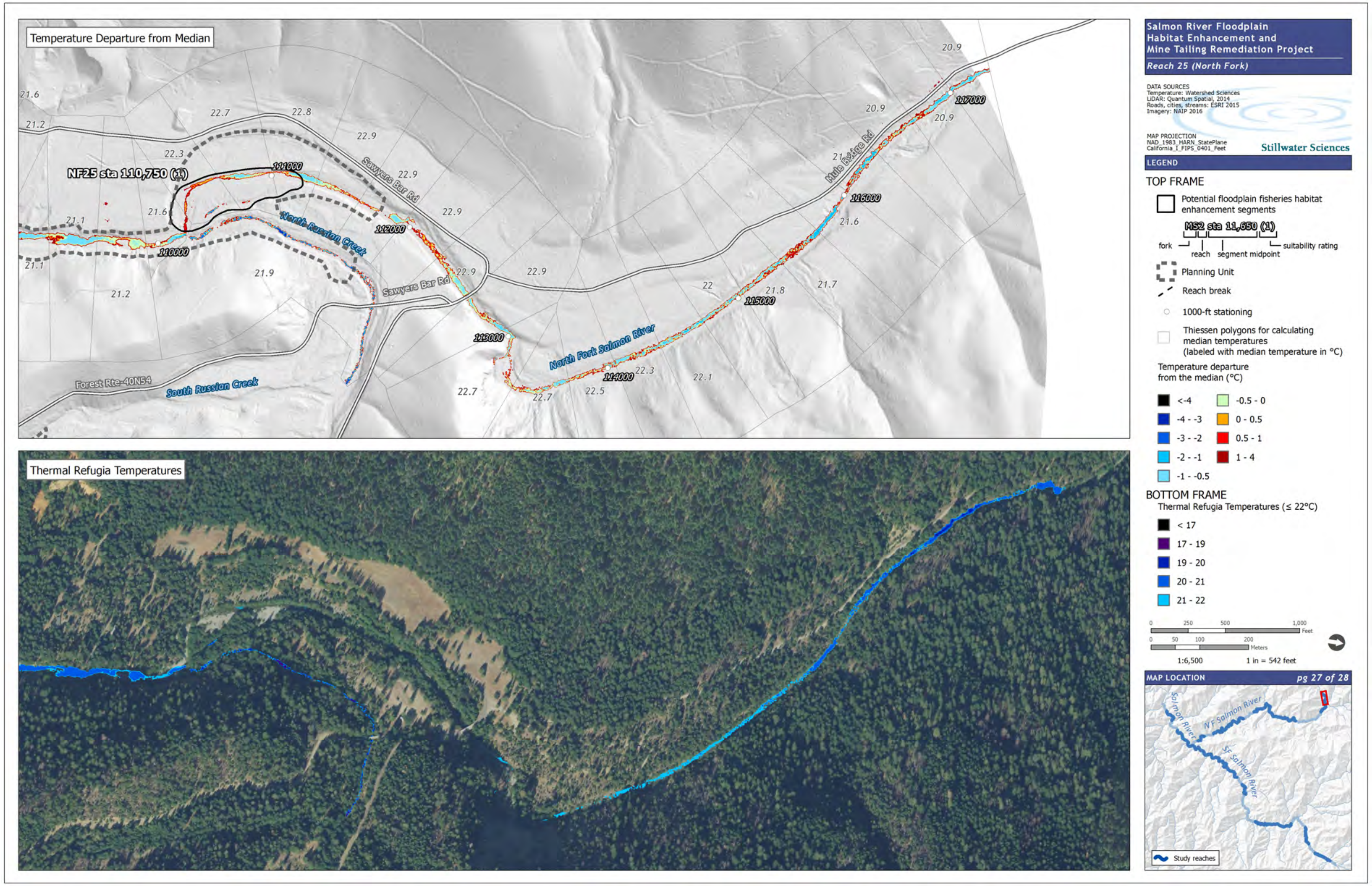

Figure A-53. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 27 of 28

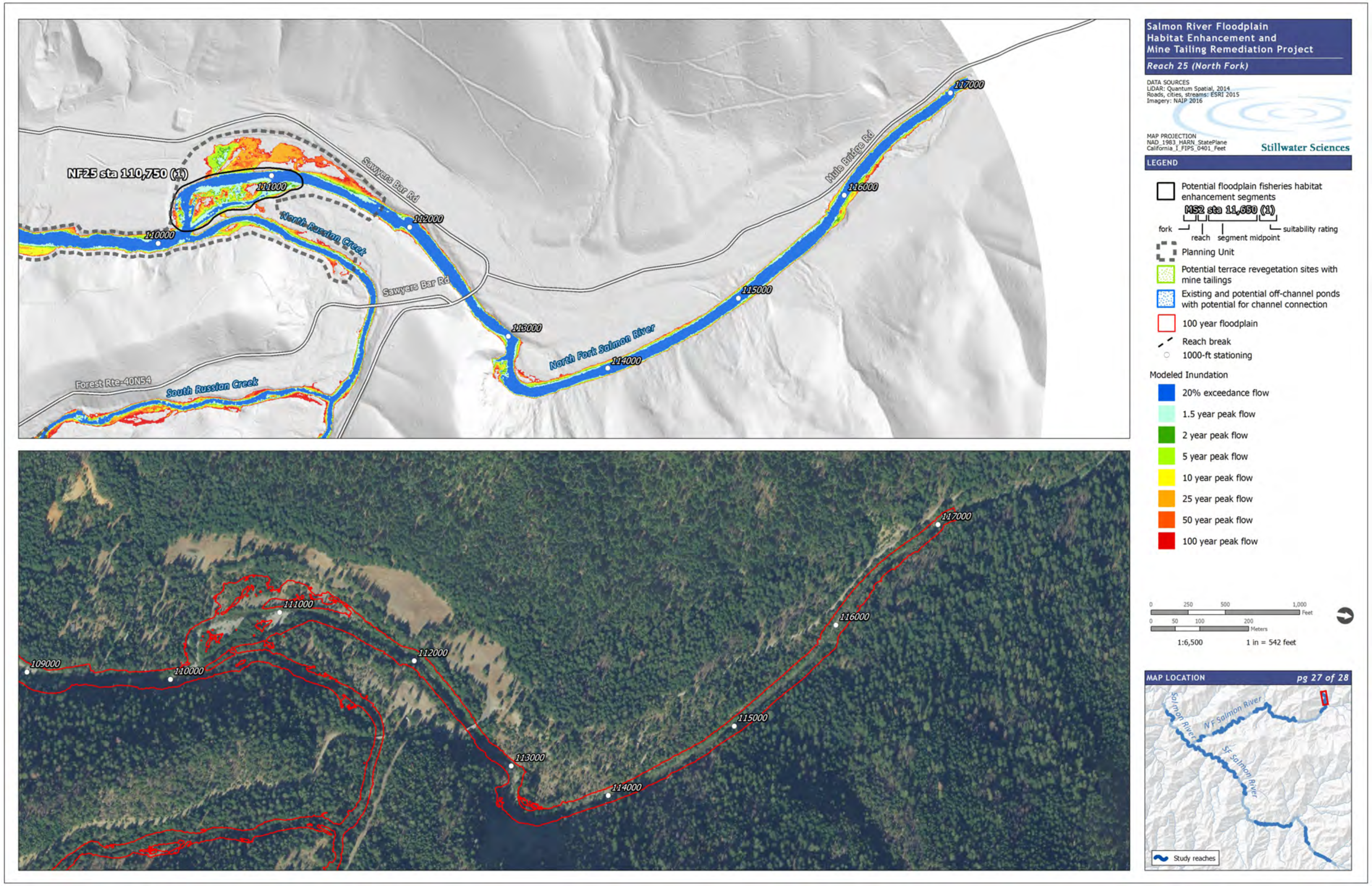

Figure A-54. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 27 of 28

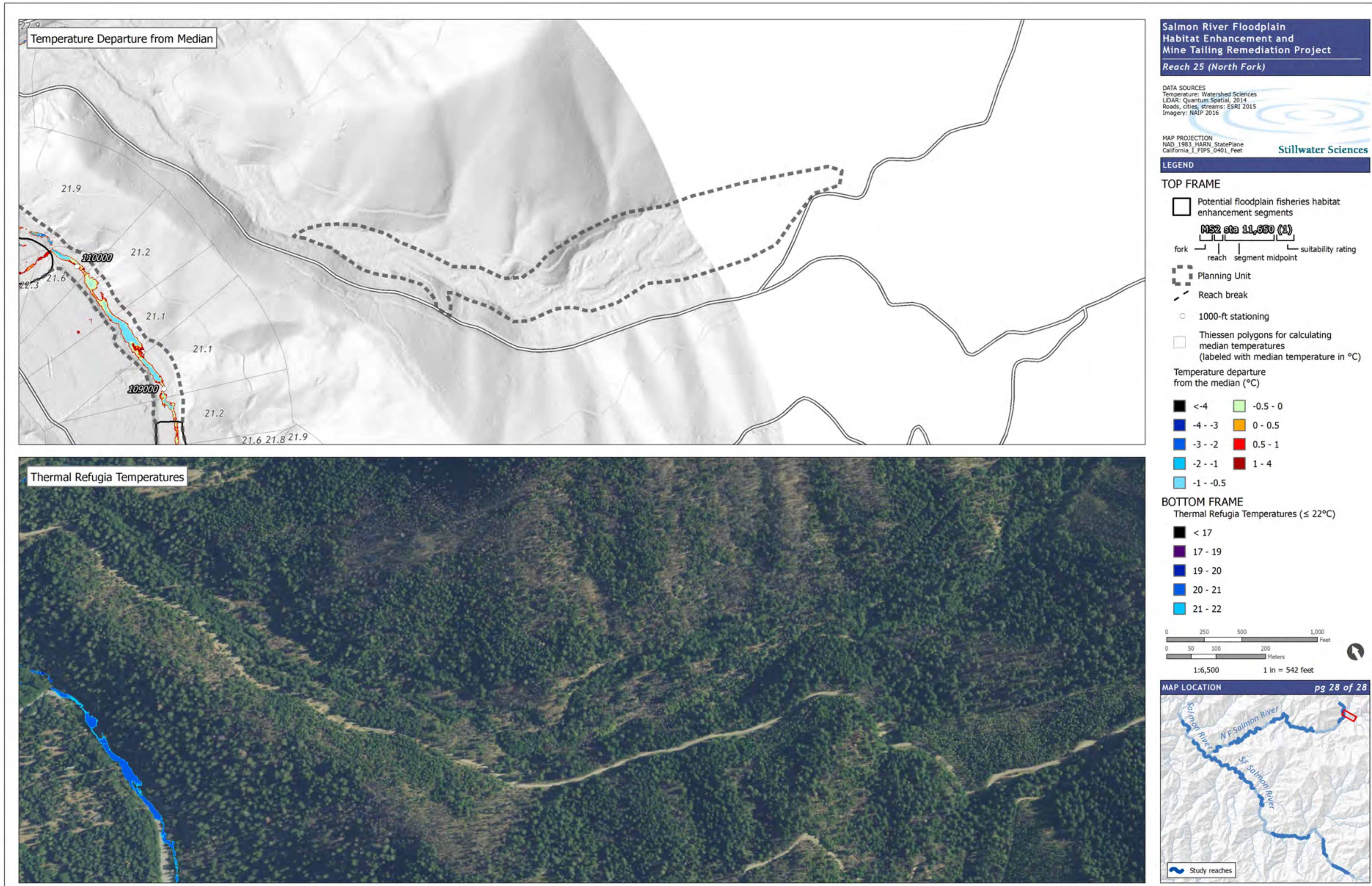

Figure A-55. Thermally suitable habitat and localized thermal refuges in predominantly alluvial reaches within the Salmon River project area based on 2009 TIR data, Tile 28 of 28

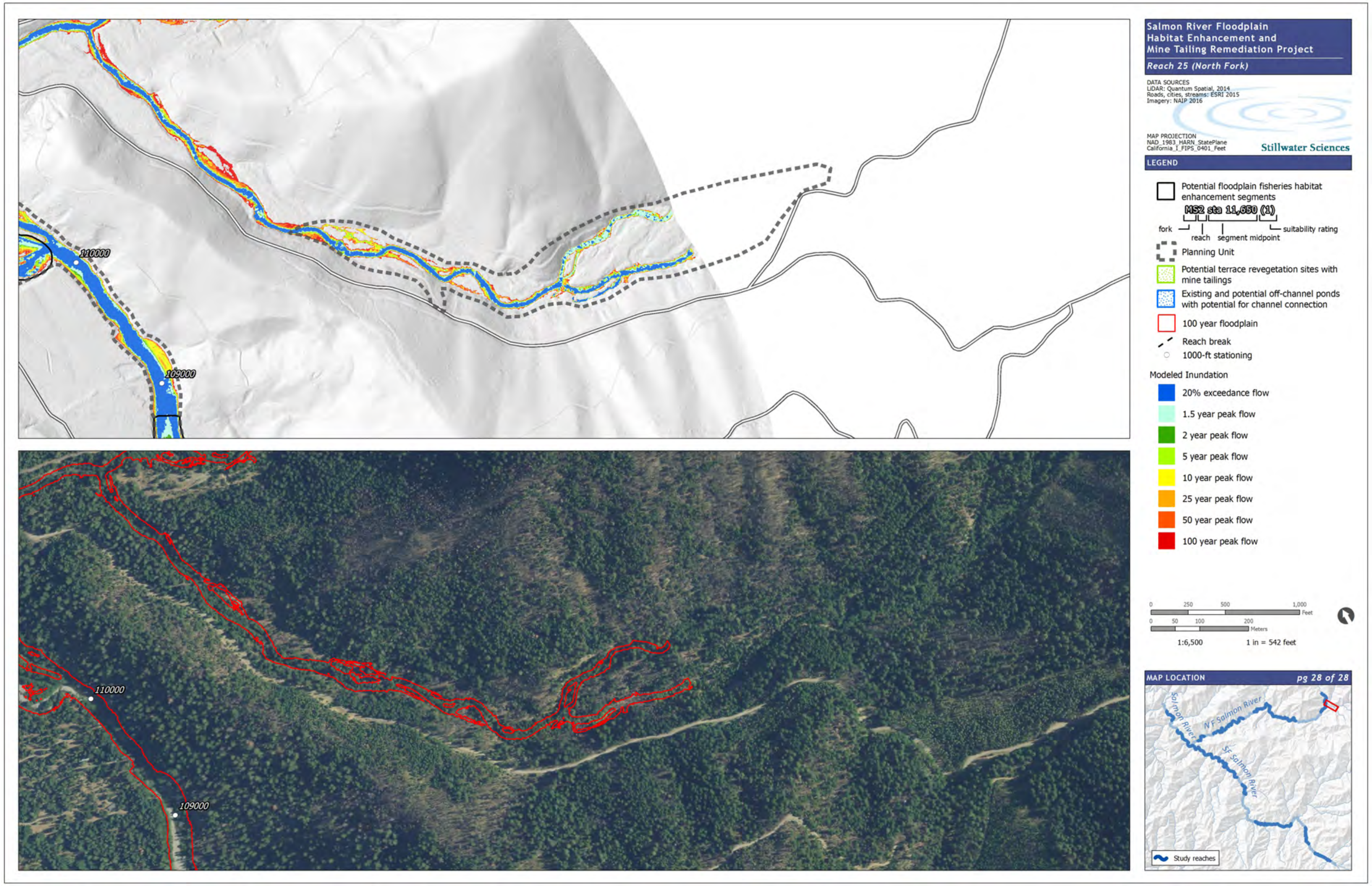

Figure A-56. Flow inundation in predominantly alluvial reaches within the Salmon River project area, Tile 28 of 28

Appendix B

Opportunities and Constraints in Potential Floodplain Habitat Enhancement Segments

Table B-1. Opportunities and constraints in potential floodplain habitat enhancement segments.[1]

Project reach	Geom reach	Segment[2]	Station[3] Down	Station[3] Up	Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
Mainstem	2	Overall MS2	5,400	12,800	7,400	0.55%	Very limited ≤5-year inundation areas: (1) Nordheimer Ck entering LB at sta 11,500 and (2) large LB bar at sta 8,500-9,500. Large, linear pond on LB with outlet near 7,800.	Generally unsuitable temperatures (max >22 C). Significant reach-scale cooling due to cool inputs from Crapo and Nordheimer creeks. The Crapo Creek confluence area provides one of the most important refugia for adult spring-run Chinook in the Salmon River.	Sediment storage in alternating bars through central portion of reach related to downstream bedrock channel constriction at Nordheimer rapid. Little change in bars since 1993, except at ~sta 6,500–7,000, where channel shifted from RB to LB.	Extensive hydraulic mining excavation of LB terrace from sta 7,800-11,000. No infrastructure. Nordheimer camp on high terrace.	Little change. 1997 event substantially cleared bars of vegetation. Minor colonization of bar flanks by woody veg since 2005.	Connect pond to base flow channel at 7,800 to provide winter off-channel habitat. Field observations needed to verify feasibility of connecting based on bedrock control and elevation change in connecting channel. Other mine tailing excavations are too high above the river to function as connected ponds. Very little opportunity to lower floodplain/ terrace surfaces due to shallow bedrock. Little opportunity to influence habitat associated with large alternating bars. Consider increasing complexity and steering flow across poorly vegetated bars through live willow planting. Small, dense patches of revegetation could serve as seed sources.	na
		MS2 sta 11,650 (1)	11,200	12,100	900	0.50%		Nordheimer Creek is key cold-water refuge for juveniles, one of better tributaries for salmonids.	Nordheimer delta is dynamic. No evidence of scour on LB terrace ds of confluence. Extensive bedrock outcrop in this area.			The primary restoration opportunity in this reach is lower Nordheimer Creek and its confluence. The confluence of Nordheimer Creek has good potential for enhancement of thermal refugia, including along the river bar. LWD structures in the lower reaches of the creek would enhance summer and winter rearing and spawning habitat. Treatments could include wood jams, brush bundles, and seasonal dam pools.	1

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
Mainstem	4	Overall MS4	22,000	35,600	13,600	0.54%		Generally unsuitable (max >22 C). Notable warming from Forks confluence to Brazille Flat.	Hydraulically simple straight reaches with large alternating bars connecting more geomorphically and hydraulically complex bends with point bars and high flow side channels.	Extensive hydraulic mining excavation and tailings at upstream end of reach near Forks and at downstream end of the reach.	Little change. 1997 event and aquatic habitat. substantially cleared bars of vegetation. Minor colonization of bar flanks by woody veg since 2005. Reach provides spawning habitat, primarily for Fall Run Chinook.	Reach contains lowest gradient in mainstem. Could provide better coho spawning habitat but lacks structure and gravel sorting to be functional. Consider approaches to sorting substrate to increase spawning gravel quantity and quality. Limited opportunity for floodplain enhancement outside of the segments described below due to high stream power and lack of inundation area.	na
		MS4 sta 23,700 (3)	23,100	24,200	1,000	0.68%	Inundation of RB side channel at 20% exceedance with summer ponding over multiple years since 1993.		Larger side channel is stable feature since 1993, smaller side channel is more dynamic and not always present (present after 1997 event, gone after 2005 event, reformed recently). Side channel features probably related to local channel expansion onto LB floodplain terrace at ~sta 23700-24100. Shallow depth to bedrock on floodplain terrace. Bedrock controls channel along terrace riser.			Potential for enhancing RB side channel (e.g., LWD structure). High stream power in this reach makes suitability uncertain.	3
		MS4 sta 28,750 (3)	28,200	29,300	1,100	0.82%	20% exceedance to 5-yr inundation of LB side channel, 5–10 yr inundation of small adjacent LB floodplain.		Side channel formed after 1997. Adjacent floodplain terrace has been in same configuration since 1993.	Extensive mine tailings on right bank at ~sta 27,300–28,400		Investigate depth to bedrock in LB high flow channel with 100 yr inundation area. Potential for enhancing side channel and alcove at downstream end. Potential for riparian restoration on RB terrace with extensive tailings (sta 28,700–27,000). This is easily accessible area on private and County property.	3
		MS4 sta 32,800 (1)	32,000	33,600	1,600	0.81%	5- to 10-yr inundation of RB bar dissected by 20% exceedance–1.5 yr high-flow channel along back edge. Second, less-frequently inundated (10 yr) RB high flow channel at downstream end of bar. Horn Creek enters LB at sta 33,000.			Excavation and tailings throughout outer half of RB point bar terrace. Structures on high interior part of RB terrace. Vehicle access to RB bar and side channel.		Some potential for large ELJ bar apex jam designed to route more flow into lowered RB high flow channels. Some limited opportunities along inset floodplain areas on both banks. Recent tailing excavation may provide useful information regarding substrate composition and stratigraphy at depth with deposits to help assess restoration/revegetation suitability.	1

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
South Fork	5	Overall SF5	400	7,900	7,500	0.95%	Very little 5 yr inundation area	Reach-scale cooling to marginal temperatures (20–22C). Cooler temperatures may correspond with cooler tributary input (e.g., Knownothing Creek) and steeper channel gradient with more deep bedrock pools and fewer long shallow riffles and runs. May also relate to cool groundwater inputs.	Steep and coarse grained. Predominantly bedrock controlled. Only alternating bar sequences occur from sta 900–1,700 related to supply from McNeil Creek and sta 3,200–3,900 related to channel width expansion and curvature. Little past or potential for future geomorphic change. Paired strath terraces in the middle part of the reach are high and have bedrock at shallow depth.	Extensive excavation at upstream and downstream ends, tailing piles of strath cover sediments.	Little change. 1997 event substantially cleared bars of vegetation. Minor colonization of bar flanks by woody vegetation since 2005.	Little restoration and enhancement opportunities. Limited opportunities for terrace revegetation in vicinity of mine tailing piles and increasing riparian shading along bar flanks sta 3,200–3,800.	na
South Fork	6	Overall SF 6	7,900	17,600	9,700	0.72%	Minimal 25–50 yr inundation in excavated areas of LB in vicinity of sta 13,800–14,300	Warm reach with median temperatures typically ≥22C. Warmest temperatures in the SF occur in this reach upstream of Knownothing. Notable warming (2–4 C) from Indian Creek (sta 41,000) to Knownothing Creek (sta 13,000) corresponding with lower gradient, large armored gravel bars, and increased mining impacts and tailings.			Juvenile coho observations only above warming reach. Few observations of spring-run Chinook juveniles. Juvenile coho observed in Knownothing Creek.	Mining excavations along LB may have potential for enhancing off-channel ponds. Excavated areas may be too high with bedrock at shallow depth. Potential for off-channel pond in old mine-tailing depression at lower end of Missouri Bar depending on gradient, depth to bedrock, and landowners located at sta 8,100.	na
		SF6 sta 11,750 (1)	10,000	13,500	3,500	0.73%	Knownothing Creek enters LB at sta 12,800. Large RB high flow channel with 5–10 yr inundation. At downstream end, RB bar has 2–5 yr inundation.	Median temperatures typically ≥22C but notable cooling at Knownothing Creek (20–22 C).	Sandy inlet to RB side channel. Field observations of scour along high flow channel. Fine sediment deposits observed at the downstream end substantiate more frequent inundation of last ~200 feet. No evidence of bedrock control along high-flow channel alignment, but bedrock exposure occurs in intervening upland areas.	Extensively disturbed by mining. Large mine tailings confine floodplain extent and contribute to heating.		Important area for protecting and enhancing thermal refuge. Potential for increasing inundation frequency in RB side channel and revegetating surrounding tailings. Potential to create alcove at downstream end of side channel. Knownothing Creek confluence also has opportunity for enhancing thermal refuge and winter refuge.	1
		SF6 sta 16,650 (2)	16,100	17,200	1,100	0.86%	Local expansion of ≤5 yr flow inundation. RB bar with 2–5 yr inundation of surface and 20%–1.5 yr concentrated flow along back edge.	Little variation in median temperatures but small disconnected pockets of cold water (19C) observed in RB winter base flow side channel.	RB lateral bar.	Extensive mine tailing field on high RB river terrace.	Little riparian vegetation cover. Poor structure and cover in RB winter baseflow side channel.	Potential for bar apex structure to sort gravel at pool tail and enhance RB side channel flow, RB side channel enhancement, and revegetation of lateral bar flanks and adjacent mine tailings.	2

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
South Fork	7a	Overall SF7a	18,000	35,600	17,600	0.87%		Warming reach with median temperatures ≥22 C. Highly localized cooling to 21-22 C at confluence of Methodist Creek and in some large, deep pools.	Reach is generally bedrock controlled with little sediment storage, all associated with planform curvature and in pools associated with large bedrock obstructions (e.g., 18800 and 19000). Long Bo plane bed reaches between bends.		Little change	Little floodplain inundation and little opportunity for floodplain habitat restoration. Some opportunity to revegetate mine tailings on terraces.	na
		SF7a sta 22,050 (1)	20,900	23,200	2,300	0.96%	Summer baseflow channel split upstream of Negro Ck (enters RB at ~sta 20,900). Relatively more extensive 1.5–5 yr inundation of midchannel bar and upstream/downstream point bars.	Median temperature typically >23 C, with up to 1C cooling in deeper runs and pools (especially at Negro Creek confluence).	Split flow channel. Little change in midchannel bar. Some bedrock/large boulder control at head and tail. Flow vectors move left to right approaching bend. Extensive right bank erosion. Bedrock control along both valley margins.	Unimproved road along RB undermined by bank erosion.	Poorly vegetated midchannel bar.	Potential for bar apex structure to sort gravel at pool tail and enhance RB side channel flow, RB side channel enhancement, and revegetation of lateral bar flanks. Potential for alcoves at ST 22,100 and sta 22,700. Potential opportunity to enhance summer refugia in lower Negro Creek.	1
		SF7a sta 29,500 (3)	28,900	30,100	1,200	0.98%	Left bank bar has 1.5 to 5-year inundation		Large wood jams on left bank Bo bar/low floodplain racked in front of riparian forest established after 1997 event. Little organized flow path/channelization across surface. Coarse and progressively more bedrock control in downstream direction. Little to no opportunity to influence channel morphology.	Extensive excavation and reorganization of strath cover sediments into piles on high RB terrace		Potential enhancement of low bar on LB and revegetation of tailings on RB terrace.	3
		SF7a sta 33,050 (3)	32,600	33,500	900	0.82%	RB side channel inundated at 20% exceedance, pool in side channel persists during most years. Methodist Creek enters LB at sta 33,400.	Highly localized cooling to 21-22 C at confluence of Methodist Creek.	Little to no change over time	Adjacent road	Little change	Opportunities to enhance mainstem RB side channel with pool, revegetate LB mine tailings on terrace, and enhance lower Methodist Creek.	3

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
South Fork	9	Overall SF9	46,700	54,000	7,300	0.92%	Typically confined with little floodplain inundation, except in vicinity of Mathews Creek.	Reach-wide median temperatures typically 21- 22C. Moving in upstream direction, SF9 is generally where temperatures first reach this marginally suitable range.	Typically narrow, bedrock confined channel with shallow depth to bedrock, some large Bo riffle controls. Large LB landslide at ST 50,000–50,700. Landslide sediment input creates alternating bars upstream and downstream. Very dynamic channel at toe of landslide.	Cover sediments mined and piled on high strath terraces	Little riparian vegetation. Alcove around sta 48,900	Some potential for revegetation of tailings on terraces. Potential to enhance RB side channel and vegetate intervening bar and adjacent high terrace immediately downstream of Matthews Creek.	na
		SF9 sta 52,800 (1)	51,600	54,000	2,400	1.02%	5-10 yr inundation cutting back edge of highly disturbed RB point bar terrace at downstream end. Extensive 1.5-5 yr inundation of alternating point bars at upstream end, each with channel cutting their back edge (1.5 yr inundation in the downstream side channel and 20% exceedance inundation in the upstream side channel.	Median temperatures typically 21- 22C, ~20 C in the deeper pools at upstream and downstream ends and at Matthews Creek confluence.	RB terrace from sta 52,000–52,500 has high flow path across back edge. Coarse sediment deposited along this path. Two alternating point bars have side channels cutting back edge. Upstream-most side channel passes through higher, heavily vegetated area. May cut bedrock, requires field investigation. Little geomorphic change over time. Active streamside landslide across from lower point bar at sta 52,800–53,000.	RB terrace highly disturbed with little to no existing habitat value.	High quality habitat in LB summer baseflow/winter baseflow side channel at upstream end of reach. Good analogue. Poor habitat in RB winter base/bankfull side channel in middle of reach. This side channel and intervening bar devoid of riparian vegetation.	Potential for bar apex structures to sort gravel at pool tails and enhance side channel flow, RB side channel enhancement, and revegetation of midchannel bar. Need to better understand potential limitations on excavation imposed by shallow bedrock. Good river access at downstream end.	1

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
South Fork	11	Overall SF11	71,000	89,200	18,200	1.16%	Typically confined floodplain with little inundation extent outside of the segments identified below.	Median temperatures are warm relative to upstream and downstream reaches, typically 22-23 C. Significant cooling at and for short distance downstream of Saint Claire Creek (key thermal refuge).		Little evidence of large-scale hydraulic mining in this reach.	Start of potential spring Chinook spawning. Quantity and quality of spawning habitat becomes important.	Some opportunities for LWD on functioning inset floodplains from sta 79,500–81,500, other potential opportunities for locally lowering floodplain surfaces. A lot of private property in reach.	na
		SF11 sta 80,300 (2)	79,600	81,000	1,400	1.01%	RB side channel with 20%–1.5 yr inundation at outside of bend at sta 79,600–79,900; alcove at downstream end. LB side channel that inundates at 20% exceedance at back edge of large lateral bar at sta 80,500–81,100.	Median temperatures typically > 22 C, locally cools to 19 in pools.	Bar/RB side channel at sta 79,800: bedrock control with thin, discontinuous alluvial cover. Lack of LWD across crest of downstream bar indicative of high energy environment at outside of bend. Bar/LB side channel at sta 80,500–81,100: LB lateral bar controlled by large LB bedrock outcrop, channel width expansion, and abrupt reduction in planform curvature. Dynamic.	None	Little veg cover across bar flanks. Little change. Existing high value left bank alcove.	May be potential to add structure to LB side channel. Bedrock may limit opportunities to create deeper, more persistent holding habitat. Difficult access.	2
		SF11 sta 82,050 (1)	81,700	82,400	700	0.78%	Inundation of LB side channel at 20% exceedance at sta 81,800–82,400; no summer inundation or ponding.	Median temperatures > 22 C.	Bar/side channel at sta 81,800–82,400: locally wider reach with tight downstream curvature and large bedrock outcrops creating hydraulic control/backwater. High LB terrace immediately upstream. Little change since 1993. Extensive bedrock control along channel margins.			Potential site for large ELJ/bar apex jam in vicinity of sta 82,250 to build head and route water into LB side channel. Large bedrock outcrops in this vicinity already provided similar functions. LB side channel enhancement.	1
		SF11 sta 84,500 (2)	84,200	84,800	600	0.82%	Broad LB floodplain with 5 yr inundation sta 84,200–84,800.	Median temperatures > 22 C with no thermal refuge.	Bedrock extensively exposed in banks at shallow depth but none at surface across LB floodplain. Little organized flow path or channeling across floodplain surface. Wood transported into center of floodplain and rafted up along downstream edge.	Tailing piles across LB floodplain. Likely old mine site.	Little to no riparian vegetation across LB floodplain.	Potential LB floodplain enhancement, including side channel excavation, increased veg cover. Potential limitations imposed by shallow bedrock. Equipment access difficult.	2

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
South Fork	11 (cont.)	SF11 sta 85,550 (2)	84,800	86,300	1,500	0.92%	LB side channel with inundation at 20% exceedance at inside of bend sta 84,800– Low-relief LB lateral bar with 1.5 yr inundation, flow converges in side channel at downstream end with inundation at 20% exceedance. Saint Clair Creek enters LB at sta 85,300.	Median temperatures typically 22-23 C. Significant cooling at and for short distance downstream of Saint Claire Creek enters (key thermal refuge) at upstream end.	LB point bar at downstream end of segment has complex flow across. LB lateral bar cut by incipient high flow side channels. Lots of wood accumulated in jams on the upstream end of the bar. Dynamic.	Secondary road accesses RB floodplain area across from Saint Claire Creek.	Good cover on point bar at the downstream end of segment. Little cover on LB lateral bar further upstream.	Potential for bar apex structure to sort gravel at pool tail and enhance LB side channel flow, RB side channel enhancement, and revegetation of midchannel bar downstream of Saint Clair Creek at sta 85,300–85,900. Saint Claire Creek is key thermal refuge, enhance confluence vicinity (e.g., LWD, brush bundles). Equipment access may be possible via road across from St. Clair Creek.	2
		SF11 sta 86,650 (2)	86,300	87,000	700	0.76%	Low-relief LB bar with 1.5 yr inundation; side channel cutting back edge with inundation at 20% exceedance.	Median temperatures typically 22-23 C. Saint Claire Creek enters (key thermal refuge) at downstream end.	Large LB bar cut by incipient high flow side channels. Saint Claire Creek enters at downstream end.	none		Potential for bar apex structure to sort gravel at pool tail and enhance RB side channel flow, RB side channel enhancement and revegetation.	2
		SF11 sta 87,950 (2)	86,900	89,000	2,100	0.77%	Broad areas of 1.5 to 2 yr inundation across alternating point bars.	Median temperatures typically 22-23 C. Pool in middle of segment has good shading, cools to 16 C.	A series of three alternating point bars. Downstream most point bar has evidence of complex flow paths/side channel development along back edge.	none	little change	Potential for bar apex structure to sort gravel at pool tail and enhance LB side channel flow, LB side channel enhancement and revegetation at downstream point bar.	2

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
South Fork	12	Overall SF12	89,200	101,500	12,300	0.76%		Cooler and more wide-ranging median temperatures compared to reaches upstream and downstream. Coolest temperatures in reach (<20 C) occur in confined areas downstream of Crawford Creek.	Mostly very confined BoCb plane bed with alternating lateral bars.	More extensive hydraulic mining impacts in this segment compared to SF11. A lot of infrastructure at upstream end of near Cecil Creek confluence ~sta 100,000.	Little riparian vegetation on large bars in reach.	Potential to load wood along gravel bars and long, straight runs to enhance rearing habitat and potentially sort substrate into better spawning habitat. Potential small alcove at sta 90,500, potential off-channel site at sta 92,000.	na
		SF12 sta 92,450 (2)	91,500	93,400	1,900	0.67%	1.5 yr inundation of large LB bar at upstream end of segment from sta 92,600–93,300. Areas of 5 yr inundation on disturbed LB terrace, including two small ponds at ~sta 92,000. Areas of 5 yr inundation on inset RB floodplain at downstream end of segment.	Median temperatures typically 22-23 C.	Large LB lateral bar with incipient high flow channel along back edge. There was a much better-defined side channel in this location prior to 1997 event, which shifted channel toward RB and filled side channel. Alcove on RB at ds end.	Extensive excavation and piling of strath cover sediments on high LB terrace. Houses on RB at upstream and downstream end.		Potential for bar apex structure to sort gravel at pool tail and enhance LB side channel flow at upstream end of segment. Potential for enlarging and connecting existing ponds on LB terrace in middle of segment. Shallow bedrock may limit excavation.	2
		SF12 sta 96,500 (3)	96,200	96,800	600	0.98%	Complex pattern of infrequent inundation at confluence of Crawford Creek. Little geomorphic evidence of active floodplain inundation or channeling in this area.		Large Bo controls near confluence.	Larger right bank area upstream of Crawford Creek extensively excavated		Unclear what opportunities may exist near Crawford Creek confluence. Lower gradient reach of creek could be good coho habitat and has potential for instream habitat enhancement. Low lying area adjacent to RB of Crawford Creek confluence could have opportunities for enhancing off-channel winter and summer refuge. Need to know more about flow characteristics of Crawford Creek (e.g., persistence of spring/summer flow and consumptive water use). A lot of private land in this area.	3

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
South Fork	14	Overall SF14	116,400	126,200	9,800	1.22%		Median temperatures typically 21–22 C but notable warming from upstream reaches down to this point. Significant heating in this reach due to wide floodplain, mine tailings, and shallow channel with large unvegetated CoBo bars. Some cold pools and refugia related to hyporheic flow through transverse bars.	Very simple, confined Bo plane bed in lower third of reach up to sta 120,000.	Large, broad, very extensively mined high terraces throughout reach. Most out of inundation zone.	This segment has the good combination of cold water and relatively low channel gradient.	Needs treatments to improve thermal refugia and protect/enhance overall temperature conditions to avoid warming. Some potential for off-channel ponds and wetlands. Connectivity for fish may be difficult due to gradient.	na
		SF14 sta 121,050 (2)	120,000	122,100	2,100	1.35%	Gradational (1.5–10 yr) inundation of large, coarse-grained LB point bar sta 120,000–120,700. 2–5 yr inundation of RB terrace sta 120,600–121,200. Ponds exist on back edge of disturbed RB terrace.	Several good examples of small refugia created by emerging hyporheic flow at the downstream end of transverse bars.	Alternating RB and LB point bar terraces. Downstream end has dynamic LB bar that has changed a lot since 1993. Upstream end of segment has a wide and dynamic plane bed channel. Coarse grained.	Upper RB terrace looks like it may be undisturbed. Rest of area has reworked strath cover sediments in tailings piles.		Potential for bar apex structure at upstream end to sort gravel at pool tail and enhance flow into split channels. Second bar apex jam at head of bar near sta 121,600 to split flow. Potential for connecting ponds to mainstem looks challenging. Depth to bedrock may be an impediment. Grade and revegetate tailings on terraces.	2
		SF14 sta 123,550 (1)	122,200	124,900	2,700	1.25%	LB bar at downstream end with 1.5 yr inundation; veg suggests concentrated flow along back edge but unsupported by hydraulic modeling. Middle of segment has RB and LB terraces with 10–25 yr inundation. Large, low LB terrace is dissected by complex flow paths, high flow path at back edge is more frequently occupied (5 yr). More active RB bar at upstream end of segment has 2–5 yr inundation with a 1.5-yr high-flow channel at the back edge.	Median temperatures 21-22 C.	Broad RB and LB floodplain areas with complex flow patterns. Main channel has been dynamic through this area since 1993, shifting/increasing sinuosity after the 1997 event and bifurcating after the 2005 event. Channel at upstream end of reach migrated toward RB and away from LB floodplain in 2017. No obvious signs of bedrock control within the inundated areas.	Very extensively disturbed by hydraulic mining. Largest excavated area in South Fork.	Little change. 1997 event substantially cleared bars of vegetation. Minor colonization of bar flanks by woody veg since 2005.	Major floodplain restoration potential for rearing and spawning for coho and spring Chinook. Riparian revegetation will be key component. Needs considerable evaluation and potential phased approach to ensure desired response given extreme armoring, high floodplain surfaces, and magnitude of high flow events. Site of USFS project to enhance instream habitat in the 1990's.	1

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
South Fork	16	Overall SF16	133,700	144,200	10,500	1.44%	Significant 20% to 5 yr inundation of alternating point bars, floodplains, and high flow side channels from sta 133,700–140,500. Little floodplain inundation upstream of sta 140,500.	Cold water reach. Median temperatures typically 19-21 C.	Channel in this reach is smaller and dynamic. Lots of high flow channels cutting across large alternate bars and low floodplain terraces. Several locations where secondary channels at the back edge of the bar inundate at 1.5–2 yr. Large wood plays key role in channel and floodplain morphology. A lot of large wood rafted onto bar apex and crest locations. Above sta 140,500, channel is relatively straight and confined with plane bed morphology. Bo Bdrx controls. Rush Creek enters at sta 142,300. Upstream of confluence, the canyon narrows significantly and the channel is steeper, coarser grained, and more bedrock controlled.	Pervasively mined/stripped terraces and valley side slopes exposing bedrock in many locations. Dense network of secondary/tertiary roads and trails.	Key reach for spawning.		na
		SF16 sta 137,100 (1)	133,700	140,500	6,800	1.41%	Significant 20% to 5 yr inundation of alternating point bars, floodplains, and high flow side channels up.	Cold water reach. Median temperatures typically 19-21 C.	Uniform plane bed and riffle pool morphology with BoCb channel bed and relatively little bedrock control except at outer meander bends and forming control at some riffle crossovers. Regular meander pattern and slope. Coarse sediment storage in alternating point bars and lateral bars. Large wood jams at bar heads (e.g., 136,100 and 139,900). 1997 event had a large effect in this reach, mobilizing most bars within the flood prone area. 2005 event had little effect.		1997 event removed most of the riparian forest from the flood prone area. 2005 event had little effect, steady increase in riparian veg cover since 1997.	Lots of functioning inset floodplains on alternating bars. Channel size, alluvial character, and existing bar/floodplain inundation create numerous opportunities for habitat enhancement with bar apex wood jams to enhance flow into cutoff channels and side channel construction/ enhancement. Potential for more significant side channel/ backwater at sta 138,000.	1

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
North Fork	19	Overall NF19	5,100	10,200	5,100	0.76%	25–50 yr inundation of RB high flow channel cutting across inside of high strath terrace.	Median temperatures are typically 22-24 C. This reach is slightly cooler than upstream and downstream reaches.	Bedrock channel and bedrock exposed or at very shallow depth across alternating point bar strath terraces.	Extensive excavation and tailing piles, exposing bedrock over much of terrace areas.		Little opportunity for floodplain habitat enhancement in this reach. Focus on revegetating tailings and creating more thermal refugia, but overall temperatures of incoming flow is a challenge.	na
North Fork	21a	Overall NF21a	16,500	30,600	14,100	1.32%		Median temperatures are typically 23-24 C. Notable warming throughout the reach, related to alluvial channel with large cobble-gravel bars and more denuded areas from mining.	Pool riffle with long stretches of intervening plane bed. Larger pools at bends. Predominantly very coarse bed (Bo and BoCb). Large, very coarse midchannel storage features split flow. Upstream of 28,000, very coarse with cascade/step pool morphology.	Less overall terrace excavation by hydraulic mining, but all strath terrace cover sediments have been reworked, large tailing piles are common, some current aggregate extraction/mining of tailings.	Juveniles are observed in summer upstream of reach only.	Not many good opportunities for floodplain restoration but potential for instream enhancements for spawning habitat. Higher gradient then most other alluvial reaches.	na
		NF21a sta 19,100 (3)	18,400	19,800	1,400	0.75%	20% inundation of midchannel bar.	Median temperatures are typically 24 C with little deviation.	Long BoCo plane bed segment with little complexity. Large wood rafted onto midchannel bar crest. Persistent features with little change since 1993.		Little vegetation change. Spawning gravel could be important here.	May be suitable reach for enhancing spawning habitat by using ELJ structures to sort bed material.	3
		NF21a sta 21,900 (2)	21,200	22,600	1,400	1.18%	20%–1.5 yr inundation of split flow channels around midchannel bars with predominantly 2–5 yr inundation.	Median temperatures are typically 23 C with cooling in large pool at head of segment.	Flow splits around large, very coarse midchannel bar. Bo plane bed channel morphology.		Little vegetation change. Spawning gravel could be important here.	Potential for bar apex structure at upstream end to sort gravel at pool tail and enhance flow into split channels.	2
		NF21a sta 23,100 (2)	22,600	23,600	1,000	1.19%	20% inundation of LB side channel and 1.5–2 yr inundation of midchannel bar flanks.	Median temperatures are typically 23 C with cooling in large pools at upstream and downstream ends.	Flow splits around large, coarse midchannel bar. Significant flow separation and sorting at head by large bedrock outcrop. LB channel inlet controlled by dynamic GrCo pool tail deposit. Downstream channel is Bo plane bed.		Spawning gravel could be important here. Good holding pools at upstream and downstream ends	Potential for large bar apex structure at upstream end to sort gravel at pool tail and enhance flow split into LB side channel and maintain inlet.	2

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
North Fork	21a (cont.)	NF21a sta 26,200 (3)	25,700	26,700	1,000	1.21%	20% exceedance –1.5 yr inundation of LB side channel around highly vegetated midchannel Bo bar with predominantly 2–5 yr inundation.	Median temperatures are typically 23 C.	Coarse sediment storage feature with split flow. High flow side channel not well defined from inlet to outlet and conveys less flow than others in reach. Large wood jams at bar head, in side channel, and across bar. 1997 event scoured the side channel but left riparian veg on downstream half of bar crest. Limited opportunity for side channel enhancement due to steep, coarse bed. Bedrock exposure may limit excavation potential.		Spawning gravel could be important here. Good holding pool at upstream end.		3
		NF21a sta 29,000 (3)	28,100	29,900	1,800	2.48%	LB side channel with 20% inundation at upstream end of bend, 2-5yr inundation at downstream end of bend.	Median temperatures are typically 23 C with cooling in large pools at upstream and downstream ends.	Coarse sediment storage features with split flow. Very steep and very coarse bedded (large Bo) main channel and side channel. At upstream end of bend, LB high flow side channel is well defined. At downstream end, side channel cutting LB terrace is less defined with less frequent inundation.		Spawning gravel could be important here	Little opportunity for side channel enhancement due to very steep, coarse bed. May be limited opportunity to improve LB side channel at downstream end of bend if shallow depth to bedrock.	3
North Fork	21b	Overall NF21b	30,600	43,200	12,600	1.61%		Median temperatures are typically 22-23 C.	Steep Bo bed with localized bedrock controls. Predominantly plane bed with bedrock controlled pools formed at bends.			Bedrock control with little feasible restoration potential with exception of Red Bank (design by MLA in progress).	na
		NF21b sta 40,850 (1)	38,500	43,200	4,700	1.41%	Complex 20% to 5 yr inundation patterns across inside of large point bar terrace	Median temperatures are typically 22-23 C.	Much wider valley bottom with much lower slope, finer grain size. Olsen Creek enters at downstream end. Not much geomorphic change since 1993.		Little riparian veg change since 1993. Past revegetation project beginning ~ 2004.	Red Bank, one of the best sites on the NF for side channel enhancement, potential off-channel features, and riparian enhancement. Refer to MLA design report.	1

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
North Fork	23a	Overall NF 23a	51,400	61,200	9,800	0.77%	Little floodplain inundation except in locally wider sections at ~59,000 and ~54,000.	This reach is warmer than NF 22 located downstream but cooler than NF 21b upstream due to the influence of the Little North Fork (key thermal refugia). Median temperatures are typically 22-23 C.	Reach predominantly confined BoCb plane bed with locally wide valley bottom at ~59,000 and ~54,000.	Two very large hydraulic mine sites north of river likely have contributed large quantities of sediment to lower 2/3 of the reach and contribute to heating.	One potential significant restorable floodplain, existing off-channel pond, and some long plane bed runs.	Potential for connecting large year-round pond (Galia Pond) at ~sta 56,430. The pond currently connects during ≥10 yr event. May be potential for creating a longer connecting channel extending further downriver that would be connected more frequently. This pond is one of the best opportunities for connecting existing pond for winter refuge habitat in the Project area. May also be potential for instream and off-channel enhancement in lower Little North Fork.	na
		NF23a sta 53,300 (2)	51,400	55,200	3,800	0.80%	At downstream end of segment, 20% exceedance inundation in side channel at back edge of RB bar at sta 51,400–52,000 and in high flow channel at back edge of LB bar at sta 52,200–52,400. Split flow channels (20% exceedance) around mid-channel island bar (2-5 yr). At upstream end of segment, high flow channel with 5 yr exceedance cuts across large point bar terrace.	Median temperatures are typically 22-23 C.	Locally much wider and less steep valley. BoCb bed. No obvious signs of bedrock across LB point bar. No well-defined high-flow channels or erosion/deposition. Split flow channel around large midchannel bar on downstream end of bend.	Extensive hydraulic mine excavation located on north side of river immediately upstream. Likely large amount of sediment delivery to and aggradation in this reach due to these mines.	1997 event largely cleared the large point bar of riparian vegetation, except for a stand in the interior area near apex where more mature trees currently are.	Potential for large bar apex structures at upstream end to sort gravel at pool tail and enhance flow split into constructed LB. Second bar apex structure near sta 54,000. Their near 52,000. Extensive riparian revegetation component to increase shading and maintain cool hyporheic flow under bar. Depth to bedrock could limit opportunities.	2
		NF23a sta 59,000 (2)	58,400	59,600	1,200	1.06%	RB side channel with well-defined 20% inundation. Several channels with 20% inundation cut left to right across very coarse transverse Bo bar.	Median temperatures are typically 22-23 C.	Relatively short side channel cuts around back edge of RB BoCb bar. Inlet controlled by large boulder/ bedrock outcrop. Large wood accumulated on bar head/crest. Complex flow patterns across coarse transverse bar.	Compound with multiple structures near side channel inlet at upstream end of the reach.	Side channel heavily forested throughout imagery.	Potential for large bar apex jam or ELJ at upstream end of site to sort gravel and separate flow into RB side channel. Large bed boulder bedrock outcrop already provides these functions. Enhance RB side channel and revegetate upstream length.	2

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
North Fork	23b	Overall NF23b	61,200	72,000	10,800	0.80%	Extensive and complex ≤5yr inundation patterns in locally wider segments. Complex flow patterns around mid-channel large mid-channel bars.	Significantly warmer median temperatures than downstream in 23b. Median temperatures typically 23 to >24 C.	Lower gradient reach with BoCo and CbGr bed. Riffle pool morphology with long intervening plane bed segments. A lot of sediment storage in midchannel bars within the reach. Sediment potentially sourced from Shitos Creek and/or mined LB slopes just upstream.			Significant floodplain areas with existing habitat and floodplain habitat enhancement potential.	na
		NF23b sta 64,850 (1)	63,700	66,000	2,300	0.84%	Complex high flow paths with 5 yr inundation across RB floodplain. Two high flow channels cut LB point bar/point bar terrace, one with 1.5 yr inundation at the back edge of the more active point bar and the other with 5 yr inundation at the back edge of the higher terrace.	Median temperatures typically 23-24 C.	Appears that LB streamside landslide at upstream end of segment resulted in downstream LB bar with side channel along back edge.			Kelly Bar enhancement site. Refer to MLA design report. In addition to the existing MLA Kelly Bar project design, there is potential opportunity to enhance a long RB side channel from 65,300 to 67,200 (high quality existing riparian floodplain).	1
		NF23b sta 69,600 (1)	67,700	71,500	3,800	0.87%	Numerous secondary flow paths inundate at 20% to 5-year flow. Inlets to these channels are typically less frequently inundated and may not activate until 5 yr.	Median temperatures typically 23-23.5 C	Anabranching channel pattern. CoBo and CoGr bed material. Bar flanks and side channels scoured in 2005.	Small bridge crosses channel at 68200	Not much significant change in riparian vegetation in reach since 1993	Potential for large bar apex jam or ELJ at upstream end of site to sort gravel and separate flow into constructed/enhanced RB side channel. Second opportunity for large bar apex jam or ELJ at upstream end of bar near sta 68,700 to sort gravel and separate flow into RB side channel. Good existing riparian vegetation in places, but good opportunities for increasing riparian cover in other areas.	1

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
North Fork	23c	Overall NF23c	72,000	86,200	14,200	1.05%		Median temperatures typically 23-24 C. Notable warming starting about 1.5 miles below Whites Gulch and extending downstream to the Little NF. NF 23b and NF2c are major warming reaches overall and would benefit from treatments that improve temperature conditions (e.g., riparian shading, tailing revegetation, and increased hyporheic exchange/floodplain restoration).		Extensive tailings on terraces around 84,800 to 86,000.		Several notable and large inset floodplain areas in this reach that may benefit from enhancement. Some surfaces are too high. Assess spawnable substrate in long runs in this reach. Priority reach given significant warming and more extensive floodplain restoration opportunities then in upstream reaches. Existing mining pit/excavation on left bank at sta 72,500 may be one of the better opportunities for enhancing off-channel pond and connecting to main channel.	na
		NF23c sta 75,050 (2)	73,800	76,300	2,500	0.94%	Long LB side channel with 20% inundation. RB high flow side channel with infrequent inundation (10–25 yr) at the downstream end.	Median temperatures typically 23-23.5, with locally much cooler mainstem and side channel pools.	Straight reach with shallow pools and long riffles approaching plane bed. BoCb substrate. Long LB side channel separated from main channel by long linear bar. Large wood jams on bar crest and in side channel. RB high flow channel at ds end is in bedrock with no opportunity for lowering. 1997 event scoured the long midchannel bar and removed a lot of riparian vegetation but did not alter overall flow paths.	Some hydraulic mine excavation on high terraces and distal margin of steep fans.	Significant riparian revegetation since 1997 event. High existing aquatic and riparian habitat values.	High existing habitat value. Otherwise steep, coarse, and bedrock controlled. Little opportunity for habitat enhancement.	2

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
North Fork	23c (cont.)	NF23c sta 80,400 (1)	79,300	81,500	2,200	1.33%	Long RB side channel with 20% inundation in the downstream half of the segment. High flow RB side channel with 1.5-yr inundation in the upper half.	Median temperatures typically 23.5-24 C, with locally much cooler (16-18 C) mainstem and side channel pools.	Side channel at downstream end densely vegetated. Inlet does not look open at 20% exceedance but open water areas apparent along its course. RB floodplain at us end has obvious high flow scour but is highly disturbed. Main channel is Bo plane bed with bedrock controls. 1997 event extensively scoured riparian veg and mobilized bed in downstream areas. Little change in upstream areas. Jessups Gulch enters on LB in middle of reach.	Community of Sawyers Bar lies just above RB in reach. Unimproved road traverses RB floodplain at us end.	Highly disturbed aquatic and riparian habitat conditions.	Excellent opportunities for enhancement based on existing features and extent of disturbance. Potential for large bar apex jam at bar head near sta 80,150 to sort gravel and separate flow into enhanced RB side channel. Potential for second large bar apex jam near sta 81,250 to increase inundation of RB constructed/enhanced side channel. Floodplain in upstream portion of segment is mostly unvegetated. Lots of private land in this vicinity.	1
		NF23c sta 83,950 (2)	83,200	84,700	1,500	1.35%	Multiple flow paths with inundation at 20% exceedance dissect the point bar.	Median temperatures typically 23-23.5 C, with locally much cooler (16-18 C) mainstem and side channel pools	Extensive bedrock control at outside and downstream end of bend, with large outcrops forcing pools. Point bar predominantly alluvial (BoCb and CbBo). Flow shifted to outside of bend following 1997 event then reestablished split flow across point bar following 2005 event. Steep, coarse, high stream power, dynamic.	Large tailing piles at back edge of point bar and along RB upstream of site. Road along RB. Community of Sawyers Bar immediately ds.	1997 event scoured riparian veg, significant regrowth since then.	Limited opportunity to create more habitat in secondary channel crossing. Potential for sequential large bar apex jams/ELJs sta 84,200 and sta 84,400 to sort gravel and separate flow. Potential to create summer refuge by routing summer flow from gulches entering RB at sta 84,500 into a backwater or old mining excavation at sta 84,800.	2

Project reach	Geom reach	Segment[2]	Station[3]		Length, ft.	Channel gradient	Flow inundation	Thermal conditions	Geomorphology	Disturbance and infrastructure	Riparian vegetation and aquatic habitat	Habitat enhancement opportunities	Suitability rating
			Down	Up									
North Fork	25	Overall NF25	104,000	117,000	13,000	1.29%	Highly confined with little floodplain inundation or secondary flow paths except in three segments with locally wider valley bottom.	Generally, the coolest of any North Fork reaches in the Project Area. Median temperatures typically 21-23. Rapid warming downstream of Russian Creek.	Much of reach is confined, relatively straight, Bo plane bed. Plane bed runs continue up to Mule Bridge at Wilderness Boundary. Three segments with locally wider valley bottom.	Mining disturbances not as extensive as in other reaches.	Geographically important reach for spawning.	Assess quality of spawning habitat and consider potential for ELJs to improve sorting.	na
		NF25 sta 108,150 (1)	107,500	108,800	1,300	1.75%	Two high flow channels dissect LB floodplain, one with discontinuous 1.5-yr inundation and the other with less frequent 5-yr inundation. Intervening island bar probably flooded during 1964 event. RB side channel with 20% inundation at back edge of bar at upstream end of the reach.	Median temperatures typically 21-22.	Large LB bar dissected by channels and dispersed flood flow. Extensively scoured during 1997 event except upland of intervening island bar crest and two stands of riparian forest. Lesser scour in 2005, but still apparent in side channels and bar flanks. Large wood dispersed across head of bar where flow separates.	Valley bottom mining disturbance not as apparent but upland on bar crest may be capped by remnant mine tailings dispersed by 1964 event.	1997 event scoured riparian veg, some regrowth since then but slow.	Potential for sequential large bar apex jams/ELJs at sta 108,250 and sta 108,450 to sort gravel and separate flow. Excavate side channel inlets and potentially lower RB floodplain to create more channel width expansion. Revegetate side channel margins.	1
		NF25 sta 110,750 (1)	110,200	111,300	1,100	1.37%	Flow splits across point/transverse bar. Main channel is at outside of bend, significant side channel with inundation at 20% exceedance cuts across back edge of bar. pond in side channel apparent during summer. Numerous secondary channels dissect bar, routing flow from main channel to side channel.	Median temperatures typically 22-23.	2012 and older air photos show second channel at outside of bend with surface flow in July, so channel is very active here. Significant scour during 1997 event but little to no change in 2005.	RB floodplain looks like it has been scraped/excavated. Currently road access to this area.	1997 event scoured riparian veg, significant regrowth since then.	Potential for sequential large bar apex jams/ELJs at sta 111,050 and sta 110,650 to sort gravel and separate flow. Excavate inlet and enhance LB side channel. Potential for off-channel pond in RB floodplain area. Good access.	1

1 Abbreviations in the text include the following: left bank (LB), right bank (RB), large woody debris (LWD), engineered log jam (ELJ), boulder (Bo), cobble (Co), gravel (Gr), and sand (Sa).
2 River station (sta) begins at the Morehouse Creek confluence on the mainstem Salmon River (sta 0) and extends upstream.
3 Floodplain habitat enhancement segments are identified based on the Project reach and geomorphic reach in which they occur, the river station at the segment midpoint, and their suitability rating (e.g., SF16 sta 137000 (1) occurs in South Fork Salmon River in geomorphic reach 16 with a midpoint of station 137,000 and suitability rating of 1). Project reaches are abbreviated as follows: mainstem (MS), South Fork (SF), and North Fork (NF).

Appendix C

Discharge Estimates for Predominantly Alluvial Reaches and Tributaries

Table C-1. Discharge estimates for predominantly alluvial reaches and tributaries.

Reach and tributaries	20% Exceedance discharge (cfs)	1.5-Year discharge (cfs)	2-Year discharge (cfs)	5-Year discharge (cfs)	10-Year discharge (cfs)	25-Year discharge (cfs)	50-Year discharge (cfs)	100-Year discharge (cfs)
Reach 2—Unnamed Tributary	4	30	42	80	111	156	187	219
Reach 2—Crapo Creek	67	386	539	998	1,364	1,871	2,241	2,622
Reach 2—Nordheimer Creek	120	667	930	1,717	2,337	3,192	3,824	4,474
Reach 2	1,950	9,292	1,2953	23,519	31,475	42,270	50,644	59,257
Reach 4-7—Horn Creek	7	47	65	123	171	238	286	334
Reach 4–7—North Fork	792	3,957	5,516	10,066	13,537	18,271	21,891	25,614
Reach 4–7—Knownothing Creek	88	500	696	1,288	1,757	2,405	2,882	3,372
Reach 4–7—Negro Creek	16	98	137	257	355	492	590	690
Reach 4–7—Methodist Creek	49	288	402	746	1,022	1,405	1,683	1,969
Reach 4–7—Indian Creek	20	123	172	321	443	614	735	860
Reach 4–7	902	4,473	6,235	11,369	15,278	20,605	24,687	28,886
Reach 9—Matthews Creek	28	170	237	442	607	839	1,005	1,176
Reach 9	805	4,016	5,599	10,215	13,737	18,539	22,212	25,990
Reach 11–12—Saint Claire Creek	41	244	340	633	868	1,194	1,431	1,674
Reach 11-–12—Crawford Creek	51	296	413	767	1,050	1,443	1,729	2,023
Reach 11–12—Cecil Creek	22	136	190	355	489	677	811	949
Reach 11–12	572	2,906	4,051	7,406	9,980	13,495	16,169	18,919
Reach 14	289	1,523	2,123	3,898	5,274	7,162	8,581	10,041
Reach 16—Rush Creek	46	269	375	697	955	1,314	1,575	1,842
Reach 16—China Creek	18	114	159	298	412	570	683	799
Reach 16	230	1,228	1,712	3,148	4,266	5,802	6,951	8,133
Reach 19	782	3,909	5,448	9,942	13,372	18,050	21,626	25,304
Reach 21	721	3,621	5,048	9,215	12,400	16,746	20,063	23,475

Reach and tributaries	20% Exceedance discharge (cfs)	1.5-Year discharge (cfs)	2-Year discharge (cfs)	5-Year discharge (cfs)	10-Year discharge (cfs)	25-Year discharge (cfs)	50-Year discharge (cfs)	100-Year discharge (cfs)
Reach 23—Jackass Gulch	169	921	1,284	2,364	3,210	4,375	5,242	6,133
Reach 23—Little North Fork	126	699	975	1,799	2,448	3,343	4,005	4,686
Reach 23—Jessups Gulch	12	76	106	199	276	383	459	537
Reach 23—Eddy Gulch	27	164	228	425	585	808	968	1,133
Reach 23—Shiltos Creek	9	59	82	154	213	297	356	417
Reach 23	473	2,428	3,385	6,194	8,356	11,313	13,554	15,859
Reach 25—North Russian Creek	70	403	561	1,040	1,421	1,948	2,334	2,731
Reach 25—South Russian Creek	72	410	572	1,059	1,447	1,984	2,377	2,781
Reach 25	244	1,298	1,809	3,324	4,503	6,122	7,334	8,582