RECLAMATION

Managing Water in the West

Upper Sacramento River Anadromous Fish Habitat Restoration Program

Biological Assessment for NMFS-Jurisdictional Species and Essential Fish Habitat for Pacific Salmon

U.S. Department of the Interior
Bureau of Reclamation

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Mission Statements

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Upper Sacramento River Anadromous Fish Habitat Restoration Program

Biological Assessment for NMFS-Jurisdictional Species and Essential Fish Habitat for Pacific Salmon

Prepared by:

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Mid-Pacific Region
Bay-Delta Office

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Summary of Findings, Conclusions, and Determinations

The U.S. Bureau of Reclamation (Reclamation) proposes to implement an Upper Sacramento River Anadromous Fish Habitat Restoration Program (proposed action), which includes several related anadromous fish habitat restoration activities in the Upper Sacramento River between Keswick Dam (river mile [RM] 302) and Red Bluff Diversion Dam (RM 243). The purpose of the proposed action is to restore, enhance, and protect aquatic and riparian habitat suitability to facilitate increases in the overall anadromous fish production of the Upper Sacramento River. The proposed action will implement a suite of river corridor restoration activities through December 31, 2039, including gravel augmentation, floodplain and side channel habitat enhancements, and placement of instream habitat structures (e.g., woody material and boulders). The proposed activities include a continuation of ongoing anadromous fish restoration activities authorized under the Central Valley Project Improvement Act of 1992 (CVPIA) Section 3604(b)(13). Funding has been authorized and directed by various sources including, but not limited to, the CVPIA-Anadromous Fish Restoration Program and CALFED Bay-Delta Ecosystem Program. Since 1978, implemented restoration projects have contributed to increases in anadromous fish spawning and rearing habitat within the Upper Sacramento River (DWR 1992).

Section 9 of the Endangered Species Act (ESA) prohibits acts that result in the “take” of threatened or endangered plant and animal species. “Take” is defined as “to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.” “Harm” is further defined as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering.

Although the purpose of the proposed action is to enhance anadromous fish habitat to facilitate increases in anadromous fish populations, work proposed to be conducted within the active channel of the Upper Sacramento River has the potential to result in “take” of listed anadromous fish. This Biological Assessment (BA) has been prepared for submission to the National Marine Fisheries Service (NMFS) to evaluate potential impacts on federally listed anadromous species and their designated critical habitat, including endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) evolutionarily significant unit (ESU), threatened Central Valley (CV) spring-run Chinook salmon, threatened California CV steelhead (*O. mykiss*) distinct population segment (DPS), and threatened Southern DPS of North American green sturgeon (*Acipenser medirostris*). Additionally, this BA serves to evaluate potential impacts on essential fish habitat for Pacific salmon stocks that may be found in the Upper Sacramento River, including fall/late-fall run Chinook salmon ESU.

The proposed action was designed to avoid and minimize adverse effects on federally listed fish species and their habitat to the maximum practicable extent. Conservation and avoidance measures that have been incorporated into the proposed action include:

1) restricting instream work to in-river work windows that minimize impacts and the potential for take of vulnerable life stages of the listed species;

2) implementing best management practices to control erosion, sedimentation, and potential spills of hazardous materials (e.g., fuel, oil, hydraulic fluids) to minimize effects on water quality;

3) using heavy equipment operation practices that minimize the potential for injury or death of vulnerable life stages of listed fishes; and

4) replacement of any riparian vegetation removed during construction to restore shaded riparian aquatic habitat values in the action area.

It is determined that the proposed action *may affect and is likely to adversely affect* Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Southern DPS of North American green sturgeon, and *may affect, but is not likely to adversely modify* their critical habitats. While take of listed salmonid species and some habitat modifications may occur during construction activities associated with habitat restoration, these impacts will be short-term and the long-term benefits of the resulting habitat improvements will far outweigh the short-term effects on the listed species.

Additionally, it is determined that the proposed action is *not likely to eliminate or significantly diminish or disrupt* Essential Fish Habitat for Pacific salmon inhabiting the Upper Sacramento River.

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Chapter 1 Introduction

The Bureau of Reclamation (Reclamation) proposes to implement an Upper Sacramento River Anadromous Fish Habitat Restoration Program (proposed action), which includes several related habitat restoration activities in the Upper Sacramento River watershed. The proposed action area encompasses the Upper Sacramento River between Keswick Dam (river mile [RM] 302) and Red Bluff Diversion Dam (RM 243), Shasta and Tehama Counties, California. Activities include spawning gravel augmentation, floodplain and side channel habitat enhancements, and placement of instream habitat structures (e.g., woody material and boulders). The proposed activities are a continuation of ongoing anadromous fish habitat restoration efforts in the Upper Sacramento River authorized under the Central Valley Project Improvement Act of 1992 (CVPIA) Section 3604(b)(13). Since 1978, habitat restoration projects have contributed to increases in anadromous fish spawning and rearing habitat within the Upper Sacramento River (DWR 1992).

Section 9 of the ESA of 1973 prohibits acts of disturbance that result in the "take" of threatened or endangered plant and/or animal species. "Take" is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." "Harm" is further defined as an act that actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering. This Biological Assessment (BA) has been prepared by Reclamation, in accordance with legal requirements set forth under Section 7 of the ESA (16 United States Code [USC] 1536[c]). The purpose of this BA is to describe and evaluate the potential effects of the proposed action on federally listed anadromous fish species and applicable critical habitats that may be found in the action area including:

- endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) evolutionarily significant unit (ESU), and its associated designated critical habitat;
- threatened Central Valley (CV) spring-run Chinook salmon (*O. tshawytscha*) ESU, and its associated designated critical habitat;
- threatened California CV steelhead (*O. mykiss*) distinct population segment (DPS), and its associated designated critical habitat; and
- threatened Southern DPS of North American green sturgeon (*Acipenser medirostris*), and its associated designated critical habitat.

This document has also been prepared in conformance with the 1996 amendments to the Magnuson-Stevens Fishery Management and Conservation Act (CFR 62[244] December 19, 1997) to address potential impacts on Essential Fish Habitat (EFH)[1] for commercially managed

[1] EFH refers to those waters and substrate necessary to salmon for spawning, breeding, feeding, or growth to maturity.

anadromous Pacific salmon that inhabit the Upper Sacramento River during freshwater life stages, pursuant to Amendment 14 of the Pacific Coast Salmon Plan (PFMC 2003). For this proposed action, the waters and substrate associated with the Upper Sacramento River in the proposed action area are designated as EFH for Chinook salmon.

1.1 Biological Assessment

This BA is intended to define environmental conditions and habitat restoration procedures under which implementation of specific salmonid restoration and management activities within the Upper Sacramento River can proceed without separate consultations with NMFS for each individual project. The principal provision of this proposed action is that the habitat restoration procedures and associated environmental effects on listed species are consistent with the effects analysis of this BA. Reclamation has implemented similar restoration actions for over 30 years, and the analyses presented in this assessment consider this experience. The future actions and associated environmental consequences are expected to be similar to these past actions. Uncertainties for several features and locations of the proposed restoration action are identified and addressed to the extent possible; in these cases, the worst case effects were determined and are within the range of effects described for all other features and restoration locations.

If changed circumstances occur that result in different effects than those analyzed in this document (e.g., environmental conditions change substantially, new construction technologies will be used, increased knowledge of the biology of listed species, or the listing of new species under the ESA during the lifetime of the proposed action), Reclamation will prepare a supplemental BA and reinitiate consultation with NMFS with a request to append the new effects analysis to the existing consultation.

Chapter 2 Project Description

2.1 Project Need and Objectives

The restoration and rehabilitation of spawning and rearing habitat for anadromous fish in the proposed action area is a high priority for federal and state resource agencies. The CVPIA 3406(b)(13), the CALFED Bay-Delta Authority's Ecosystem Restoration Program, and other sources have authorized and directed funding for much of the river channel, floodplain, and riparian restoration work completed to date in the Upper Sacramento River. Salmonids have benefited from past and ongoing restoration activities within the Upper Sacramento River watershed.

Between 2002 and 2013, gravel has been placed each year at two sites in the Upper Sacramento River[2]. The Keswick injection site is located on the right bank approximately 300 yards

[2] Upper Sacramento River refers to the reach between Shasta Dam and Red Bluff as defined by the CVRWQCB (2002).

downstream from Keswick Dam and the Salt Creek injection site is approximately 1.5 miles downstream from Keswick Dam. In both locations, gravel has been placed on the edge of the channel and high flows have distributed the gravel within the river channel to be used for spawning and rearing. Since 1997, the CVPIA program has placed approximately 213,000 tons of gravel at these two sites. CDFW aerial redd surveys and instream gravel locations show that Chinook salmon are preferentially using injected gravel that was placed at the Keswick Dam and Salt Creek sites. Survey data on substrate/particle size, intergravel permeability, and water quality have shown that spawning gravel quality is the highest upstream of the ACID dam (North State Resources 2012).

In August 2013, North State Resources, Inc. (NSR), prepared for Reclamation the "Sacramento River Spawning Gravel Restoration and Monitoring: Alternatives Information for Spawning Gravel Injection and Restoration Sites between Keswick Dam and Clear Creek." The purpose of NSR's (2013) report was to identify potential augmentation sites, particularly in depleted reaches of the Upper Sacramento River. Potential restoration methods, quantities, site design and basis for selection in the report informed the development of this document.

The CVPIA (b)(13) Sacramento River Restoration Team (SRRT) is an interagency group with members including Reclamation, National Marine Fisheries Service (NMFS), California Department of Water Resources (DWR), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and State Water Resources Control Board (SWRCB). The group was formed to provide technical support in the development of future salmonid habitat restoration projects in the upper Sacramento River.

Reclamation, in collaboration with the SRRT, has identified a need to combine several restoration and management activities into one long-term proposed action that will allow managers some flexibility to tailor habitat restoration projects (within pre-established limitations), and to reprioritize and schedule activities based on the most current monitoring results. This flexibility will allow Reclamation to use fishery and physical habitat monitoring information and available funding levels to meet established restoration goals and objectives, respond to any environmental changes, and optimize overall performance of the CVPIA (b)(13) Habitat Restoration Program. The objectives of the proposed action are to: improve adult spawning and juvenile rearing habitat conditions for anadromous fish species, including Sacramento River winter-run Chinook salmon, CV steelhead, CV spring-run Chinook salmon, and CV fall-/late-fall run Chinook salmon. Rearing habitat improvements may secondarily benefit green sturgeon juveniles.

2.2 Project Action Area

The project action area, the area subject to the proposed federal action, encompasses an approximately 59-mile reach of the Upper Sacramento River and adjacent land between Keswick Dam and Red Bluff Diversion Dam. This area of evaluation is large enough to encompass both the potential direct impacts on listed species, such as mortality of rearing juveniles, and the potential indirect impacts, such as elevated turbidity that may extend beyond the individual project sites.

The upper Sacramento River between Keswick Dam and Red Bluff Diversion Dam presents several opportunities for improving and restoring salmonid spawning and rearing habitats. As of 2014, an interagency group of experts has identified 13 specific restoration sites that are intended to maintain flexibility for providing salmonid spawning and rearing habitat enhancement through long-term gravel replenishment, in-channel gravel placements, and side channel and floodplain enhancements to meet the goals of the CVPIA (b)(13) Habitat Restoration Program. The criteria used to select sites and develop conceptual designs include: biological need, site suitability and access, engineering feasibility, environmental compliance and permitting, gravel availability and transportation, and cost-benefit. The proposed action includes these 13 sites (Table 1; Figure 1) as well as several unknown sites as described in the following sections.

2.3 Proposed Action

Reclamation proposes to accomplish the project objectives with the following activities:

- gravel augmentation,
- floodplain and side channel enhancements, and
- placement of instream habitat structures (e.g., woody material and boulders).

The proposed activities are designed to minimize potential direct and indirect effects on listed fish species during construction and installation, while meeting long-term restoration goals established by the SRRT. Because the anadromous fish species inhabiting the Upper Sacramento River range throughout the Central Valley, Sacramento-San Joaquin River Delta, San Francisco Bay Estuary, and portions of the Pacific Ocean during their various life stages, meeting these goals will have ecosystem and fisheries benefits that extend well beyond the action area.

Instream work will be conducted during times of the year that are least likely to result in take of Chinook salmon, steelhead, and green sturgeon.

Work will be conducted within portions of a 59-mile reach of the river downstream of Keswick Dam. A total of 13 sites have been identified where one or more restoration activities are needed. In the future, the SRRT may identify additional sites where similar restoration activities (i.e., similar types, size, and construction methods) would be beneficial.

2.3.1 Gravel Augmentation

A severe limitation of suitable spawning substrate has been identified as a limiting factor for anadromous fishes in the Upper Sacramento River (NMFS 2009, 2014). Natural spawning gravel recruitment to the project area is prevented due to upstream dams; therefore, ongoing gravel restoration will occur in several locations in or along the Upper Sacramento River between Keswick Dam and Red Bluff Diversion Dam using construction equipment. There are nine specific gravel augmentation projects included under the proposed action (Table 1, Figure 1) with a combined total area of up to approximately 40 acres. Gravel augmentation projects have occurred at several of these sites in previous years. In addition to specifically identified restoration projects, the proposed action includes potential implementation of similar gravel augmentation activities (i.e., similar types, size, and construction methods) at currently unspecified locations between Keswick Dam and Red Bluff Diversion Dam. Gravel

Table 1. Upper Sacramento River Anadromous Fish Habitat Restoration Sites.

Site	RM	Restoration Type	Method*	Approximate Maximum Dimensions	Approximate Maximum Quantity	Frequency	Approximate Duration of Activity
Site 1-Keswick	302	Gravel Augmentation	EDTC	0.5 acres	20,000 yd^3	As needed	4 weeks
Site 2-Salt Creek	300.7	Gravel Augmentation	LB	0.5 acres	20,000 yd^3	As needed	4 weeks
Site 3-Market Street	298.3	Gravel Augmentation	RS	3.5 acres	15,000 yd^3	As needed	4 weeks
Site 4-Turtle Bay Island	297	Side Channel Creation; Instream Habitat Structure	EX, HS	Each: 1.1 acres	4 new side channels	Once	8 weeks***
Site 5-Kutras Lake	296	Instream Habitat Structure	HS	40 acres**	20 structures	Pilot-once, then as needed	3 weeks
Site 6- Cypress Avenue Bridge	295	Side Channel Reconnection; Instream Habitat Structure	EX, HS	3 acres	2 modified side channels	Once	6 weeks***
Site 7-Cypress Avenue Bridge South		Side Channel Creation; Instream Habitat Structure	EX; HS	4 acres	1 new side channel with possible small branches	Once	5 weeks***
		Gravel Augmentation	RS	8 acres**	15,000 yd^3	As needed	5 weeks
Site 8-Tobiasson Island	291.6	Side Channel Creation; Instream Habitat Structure	EX, RS, HS	Each: 1.7 acres**	3 new side channels	Once	8 weeks***
		Gravel Augmentation in West Side Channel	EX, RS, HS	1.5 acres	6,000 yd^3	Once	3 weeks
		Gravel Augmentation in Main Channel	RS	6 acres	12,000 yd^3	As needed	5 weeks
Site 9- Shea Island	289.6	Gravel Augmentation	RS	12 acres**	12,000yd^3	As needed	5 weeks
		Side Channel Reconnection; Instream Habitat Structure	EX, HS	3 acres	3 reconnected side channels	Once	8 weeks***
Site 10- South Shea Levee	289	Gravel Augmentation	RS	3.3 acres**	10,000 yd^3	Once	4 weeks
Site 11-Kapusta Island	288	Side Channel Creation/Modification; Instream Habitat Structure	EX, HS	1.4 acres	1 new & 3 modified side channels	Once	8 weeks***
		Gravel Augmentation	RS	4 acres	12,000 yd^3	Once	6 weeks
Site 12-Anderson River Park	282	Side Channel Reconnection	EX, HS	11.5 acres	1 side channel reconnected	Once	6 weeks***

Site	RM	Restoration Type	Method*	Approximate Maximum Dimensions	Approximate Maximum Quantity	Frequency	Approximate Duration of Activity
Site 13- Reading Island	275	Side Channel Reconnection	EX, HS	7.4 acres	1 side channel reconnected	Once	6 weeks***
Unspecified Locations	243-300.5	Gravel Augmentation	EDTC	Per site: 0.5 acres	20,000 yd^3 per site; 5 sites	As needed	4 weeks
			LB	Per site: 0.5 acres	20,000 yd^3 per site; 5 sites	As needed	4 weeks
			RS	Per site: 12 acres**	12,000yd^3 per site; 10 sites	As needed	5 weeks
		Side Channel Creation/ Modification	EX, HS	Per site: 4 acres	4 new/ modified side channels per site; 10 sites	Once per site	2-6 weeks***
		Instream Habitat Structure	HS	Per site: 4 acres**	Per Year: 30 boulder clusters, 100 log structures; 3 sites	As needed	3-8 weeks***

*Method codes are: EDTC = End Dump Talus Cone; LB = Lateral Berm; RS = Riffle Supplementation; EX = Excavation; HS =Habitat Structure Placement
**Number represents potential action area; the actual project footprint location within the area is unknown but will be smaller.
***Values represent overall construction timeframe; actual duration of instream work will be less than half of this timeframe (i.e., less than 1.5-4 weeks dependent on project type and site).

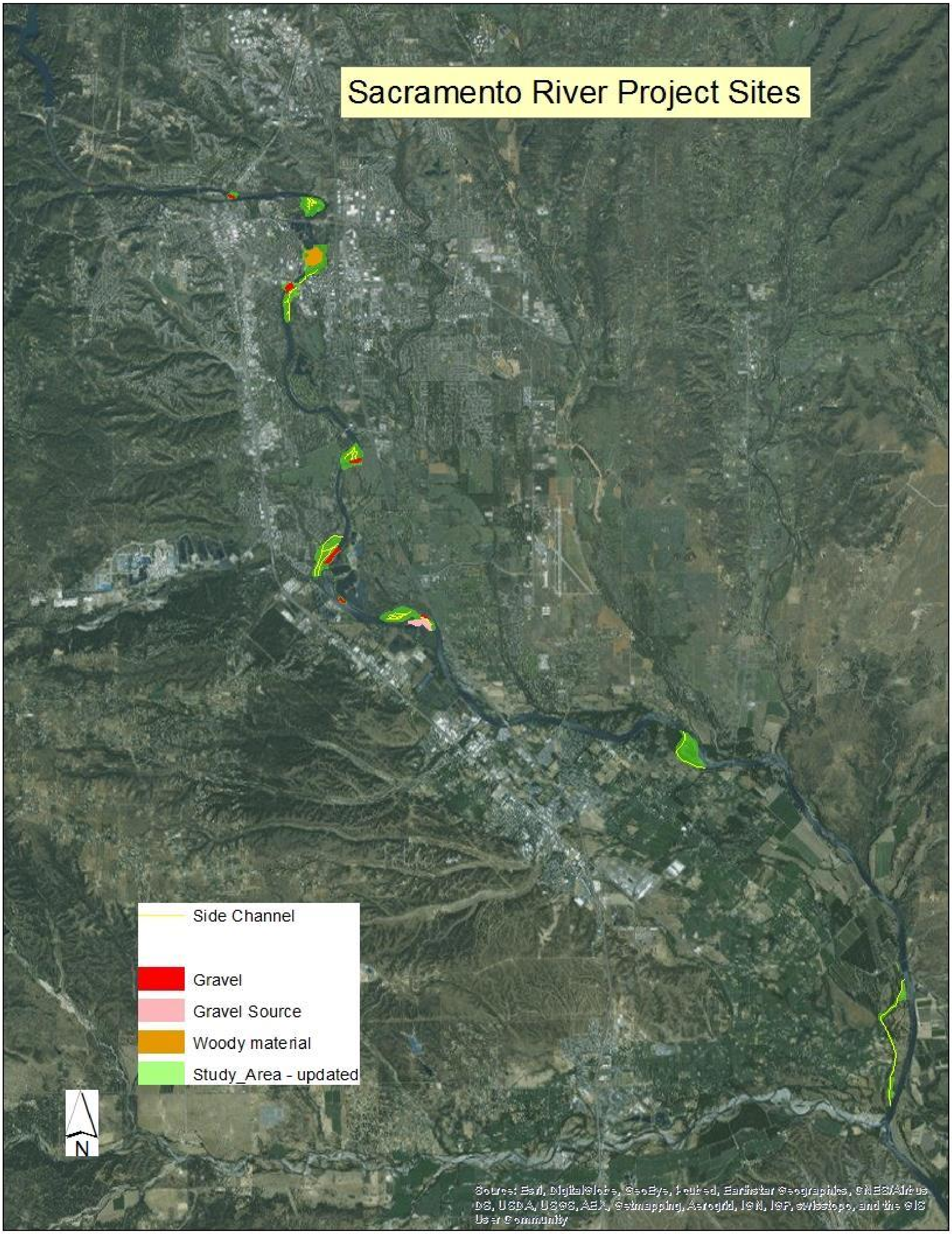

Figure 1. Overview of Upper Sacramento River Anadromous Fish Habitat Restoration Sites.

augmentation will not necessarily occur at all sites every year and some sites may not be implemented at all, depending on evaluation of monitoring data and the judgment of the SRRT. Some sites may be implemented as needed up to once a year (e.g., recurring gravel injection at Keswick Dam), and other sites will be implemented only once (e.g., Tobiasson Island West Side Channel). In a given year, up to three individual project sites will be implemented with up to 20,000 cubic yards of gravel placed at any one location and up to a total of 60,000 cubic yards for all three sites within the project area. Following an adaptive management approach, the SRRT will select sites for a given year based on the results of ongoing monitoring within the Upper Sacramento River.

The gravel placed would be uncrushed, rounded “natural river rock” with no sharp edges. It would be a reasonably well-graded mix, designed for spawning use by salmonids, made using an approximately ¼” screen on the bottom. The D_{50} (median diameter of sample) of the mix would be around 1 inch to 1-1/2 inch. The gravel would be processed prior to delivery to the sites to remove excessive fine materials and minimize introduction of excessive fine sediments into the river. The gravel would be free of oils, clay, debris, and organic material. Materials excavated from side-channel work could be used for onsite gravel placement and sorted as needed to meet design criteria. The larger gravel and cobble resulting from sorting operations would be used as needed to enhance stability of habitat features.

Stockpile areas would be located near project sites or within the site boundaries. Existing improved and unimproved roads would be used by transport trucks to deliver gravel to stockpile areas. Stockpile areas adjacent to the river generally would be about one half acre or less and would be placed in existing clearings where ground disturbance would be minimized by using existing dredger tailings or similar type of material.

For purposes of this analysis, tandem transfer trucks (trucks pulling a trailer that can be telescoped into the truck bed) capable of carrying 24 tons per load would be used for transporting gravel to project sites. Single bed off road trucks capable of carrying 12 to 50 tons would be used for transporting gravel within project work sites off of public roads.

For riffle supplementation, gravel would be placed in the river using dump trucks and front end loaders. At some sites the substrate would be graded with a bulldozer prior to gravel additions to remove armoring (surface layer of larger rock) or to meet topographic design specifications. A bulldozer would be used to distribute the materials in areas unworkable for loaders. For the gravel placement, front end loaders would pick up a bucket of gravel from the stockpile and drive from the stockpile into the river and carefully dump the gravel in a manner as to distribute it across the river bottom according to design parameters. Placement would proceed starting from the river access site and working out into the river. This would allow the loaders to drive on the newly placed gravel, thereby avoiding driving in overly deep water and distributing fines from the existing substrate. Off-road dump trucks would haul the material into the river in areas where the travel distance to an onshore stockpile is excessively long for multiple loader trips. The loaders would distribute the gravel along the river bottom to create the hydraulic conditions necessary for salmonid spawning. This work would use two or three front end loaders for 4-6 weeks at a location, dependent on project site. A tracked bulldozer or excavator would be used for grading the existing substrate and larger placed rock as needed.

For EDTC and Lateral Berm sites, gravel would be dumped directly onto the riverbank from dump trucks or dumped using front end loaders. The trucks would originate from a stockpile area or an off-site processing plant.

2.3.2 Floodplain and Side Channel Habitat Enhancements

Floodplain and side channel habitats serve as important refuge and rearing areas for salmonids and these habitats likely contribute substantially to the productive capacity and life history diversity of Chinook salmon (Lindley et al. 2009, Yoshiyama et al. 1998; Martens and Connolly 2014). However, the number and quality of these habitats have been reduced in the Upper Sacramento River as a result of activities such as channel modifications and levee construction (Lindley et al. 2009). There are six specific floodplain and side channel enhancement projects included under the proposed action (Table 1, Figure 1, Appendix A) resulting in up to approximately 37 acres of new or re-established floodplain and side channel habitat. In addition to specifically identified restoration projects, the proposed action includes potential implementation of similar habitat restoration activities (i.e., similar types, sizes, and construction methods) at currently unspecified locations between RM 300.5 (i.e., 1.5 miles downstream of Keswick Dam) and Red Bluff Diversion Dam.

Floodplain and side channel habitat enhancements may consist of new or reconnected side channels and floodplain modifications that are designed to function under flows within the main channel ranging between 3,250 cfs to 7,000 cfs. Physical characteristics will be variable with average water velocities ranging between 1.5 fps to 4.0 fps, water depths averaging between one to three feet deep, and channel widths ranging between 12 to 50 feet wide for new channels and potentially larger for existing channels. Water velocities would be designed to be variable and range up to about five feet per second at design flows. Floodplain and side channel habitats will be created, reconnected, or modified by excavation using heavy equipment (i.e., bulldozer, front end loader, excavator). Where the excavated material is of the appropriate size distribution it would be sorted and placed into side channel or main channel areas to enhance habitat features. The fines would be distributed over the floodplain to assist in vegetating the area. Gravel placed into the main channel may be used to help back water up into side channels. Low elevation gently sloping benches would be created along channels in opportune areas to provide juvenile rearing habitat through a range of flows.

Instream habitat structure (e.g., woody material such as, trees, trunks, rootwads, and willows; and variable sized large rocks) would be incorporated into the side channels to enhance habitat quality. The woody material would be held in place by partially burying it in the existing substrate or banks or keying into existing material to provide some stability under higher flows.

2.3.3 Placement of Instream Habitat Structures

Large woody debris (LWD) contributes to habitat diversity and creates and maintains foraging, cover, and resting habitat for both adult and juvenile anadromous fish. LWD recruitment into the Upper Sacramento River has been affected by various factors including agricultural conversion of riparian habitat, dam and levee construction, bank protection and streamflow regulation (CALFED Science Program, n.d.). In order to improve conditions within this reach, instream habitat structures consisting of logs, rootwads, and boulders will be placed into the active channel of the Upper Sacramento River using construction equipment (e.g., front end loaders, excavators) and/or hand tools. Placement of instream habitat structures in the active main channel and/or side channels is expected to create instantly available juvenile salmonid rearing habitat. Structures that create quiet water or debris accumulation at the stream margins are beneficial for salmonid fry survival following emergence. Coupled with gravel augmentation, both log structures and boulder clusters help to sort augmented gravels that become mobilized during high flows, and help to direct flows that hydraulically scour and maintain pools. The enhancement or creation of large, deep pools with abundant cover can improve rearing habitat for juvenile salmonids.

Instream habitat structures will be placed, as needed, within gravel augmentation and side channel enhancement sites within the Upper Sacramento River. Using an adaptive management approach, the SRRT will identify potential placement sites based on the results of ongoing anadromous fisheries monitoring within the area. Access to placement sites will use existing roads, when feasible, to minimize impacts on vegetation or other sensitive biological or cultural resources. Up to 30 boulder clusters and 100 log structures will be placed within the Upper Sacramento River in a given year. The designs for instream habitat structures will be consistent with guidance provided in the California Salmonid Stream Habitat Restoration Manual, 4th Edition (CDFG 2010).

2.3.4 Features Common to All Sites

Instream work will be done at lower river flows (<15,000 cfs at Keswick Dam and Salt Creek sites and <10,000 cfs at other locations) and during time periods to minimize effects on Chinook salmon, steelhead, and green sturgeon as specified in permits. Work mobilizing gravel and equipment to the sites and work out of the wetted channel or within wetted areas disconnected from the river channel could occur outside of fish timing windows, but work in areas with flowing water that are accessible to fish would be confined to timing windows and suitable flows.

Any equipment used in or near the river would be properly cleaned to prevent any hazardous materials from entering the river, and spill containment materials would be on site in case of an accidental discharge. Reclamation and other personnel will regularly monitor equipment operators to insure environmental compliance.

Although the proposed action area is between Keswick Dam and Red Bluff Diversion Dam, the actual gravel placement and channel work would occur in a smaller total length of river. Gravel placement would cover approximately 40 acres, and floodplain and side channel enhancement would result in approximately 37 acres of new or reconnected floodplain and side channel habitats.

Designs will be prepared as needed for site specific work. Gravel augmentation will be completed without formal engineering designs at some sites (e.g., Keswick Dam, Salt Creek). Sites that incorporate floodplain and side channel enhancement activities will include more formal engineering designs (see Appendix B for example designs). Detailed design features (i.e., features more detailed than needed for permitting processes) for each site will be prepared as funding becomes available to conduct the work and will be coordinated annually with the SRRT.

2.4 Construction Methods and Criteria

2.4.1 Gravel Augmentation Activities

Three different gravel augmentation methods (Figure 2; modified from McBain and Trush 2001) are proposed and include:

- **Lateral Berm** – A recruitment-pile of gravel is placed as a steeply sloping bar parallel to the channel to provide a long-term supply of spawning gravel and is mobilized into the river channel during high flows;
- **Riffle Supplementation** – Gravel is placed, contoured within the channel (partial or entire channel width), and graded to appropriate depths to provide immediate spawning habitat;
- **End Dump Talus Cone** – A large pile of gravel is placed on the riverbank for recruitment into the river during high flows.

Up to 20,000 cubic yards of cleaned and sorted river-run gravel will be placed at individual sites each year with up to a combined total of 60,000 cubic yards within the project action area annually. The gravel will generally be sized between 1/4 inches and 5 inches following USFWS guidance (Table 2). Some site specific project features will require deviations from these size criteria to meet project goals such as smaller gravel to provide spawning habitat for smaller fish or larger material to maintain site stability. The gravel will be transported to augmentation sites or staging areas using dump trucks, and then either placed directly from the truck, or by an excavator or sluice. Some augmentation sites may also require floodplain modification and recontouring of the channel, and up to approximately 25,000 cubic yards of material at each site may need to be excavated, sorted, and redeposited in the nearby channel. Where additional instream grading of gravel is required, an excavator or bulldozer will be used. Existing access routes will be used whenever possible, but some additional clearing or grading may be necessary to provide equipment access to the gravel augmentation sites. Instream work will be conducted during seasons of the year that are least likely to result in the take of winter-run and spring-run Chinook salmon, steelhead, and green sturgeon.

Table 2. Gravel Augmentation Size Gradation

Particle Size (inches)	Percent Passing	Percent Retained
4" or 5"	95%-100%	0%-5%
2”	75%-85%	15%-30%
1”	40%-50%	50%-60%
3/4”	25%-35%	60%-75%
1/2”	10%-20%	85%-90%
1/4”	0%-5%	95%-100%

Source: USFWS 2006

2.4.2 Floodplain and Side Channel Habitat Enhancements

Up to five acres of floodplain and side channel enhancements may occur at individual sites each year with up to a combined total of 10 acres within the project action area annually. Enhancement activities will require heavy construction equipment (e.g., front end loaders, bulldozers, and excavators), as well as hand tools. During the majority of construction, a gravel berm would be left at both the upstream and downstream ends of each site to isolate the project area from the main channel.

Up to approximately 30,000 cubic yards of material may need to be excavated, sorted, and redeposited in the channel at these sites. Gravel in excess of what would be needed for creating or modifying the floodplain and side channel to their design specifications may be placed in mid-channel or river bank areas within the vicinity of the excavation. Any instream work will be conducted during seasons of the year that are least likely to result in the take of winter-run and spring-run Chinook salmon, steelhead, and green sturgeon.

2.4.3 Placement of Instream Habitat Structures

Three potential habitat structure designs have been identified:

- **Boulder Clusters** – structures placed in the active channel and along riverbanks.
- **Digger Logs** – logs placed with one end anchored on the bank and the other extending into a pool.
- **Spider Logs** – several logs placed together, at angles, to mimic a log jam.

2.4.3.1 Boulder Clusters

Boulder structures will be placed in the active channel and along river or side channel banks to diversify flows in a particular reach, to provide instream cover for juvenile salmonids and spawning adults, or to retain spawning gravel. It is desirable to create a variety of flow velocities, because juvenile salmonids select different velocities depending on whether they are feeding or resting. Different water velocities also help sort gravel and create diversity in the substrate. Boulders are well-suited for diversifying flows because they are resistant to being displaced by high flows. Because of this, they can be placed mid-channel without constructing a full-channel spanning structure. The interstices within boulder clusters and between large boulders can provide escape cover for juvenile and adult salmonids.

The range of flows to which a particular structure, or series of structures, may be subjected will dictate the size of boulders to be used. Generally, clusters are located in straight, stable, moderately to well-confined, low gradient riffles (0.5 to 1 percent slope) for habitat enhancement. At least three- to five-foot diameter boulders are recommended. To be effective in creating scour pockets and habitat niches around individual boulders, the correct distance between adjacent boulders and the configuration of the boulder clusters must be determined. In general, adjacent boulders will be 0.5 to 1-foot apart.

The proposed design includes a triangle cluster of three boulders that are independent (i.e., not cabled together). Several of these clusters may be aggregated together in a particular location to increase scour area and create greater habitat complexity. Heavy equipment (i.e., dump trucks, excavators, loaders, and/or bulldozers) will be required for transporting and positioning boulders.

2.4.3.2 Woody Material

Woody material placement will consist of digger logs and/or spider logs. Digger logs will be placed with one end buried or anchored in the bank and the other end plunging into the bottom of

Lateral Berm Method

Riffle Supplementation Method

End Dump Talus Cone Method

Figure 2. Gravel Augmentation Method Examples.

a pool. The primary use of digger logs is to enhance rearing habitat by creating diverse cover for rearing juveniles as well as for migrating adults. They are also used to scour the channel, creating or expanding pool habitat. Logs with rootwads intact would be positioned with the rootwad end extending down into the pool to create complexity for increasing rearing habitat and maximizing scour.

Digger logs will typically be buried or held in place using cable and polyester resin adhesive, or secured to live trees or downed wood with threaded rebar. The log will be anchored in at least two places, with anchors spaced as far apart on the log as possible to keep it secure during high flows. Digger logs may also be set in a trench dug into the riverbank using heavy equipment. At least one-third of the length of the log would be placed in the riverbank. This buried portion of the log would be covered with boulders to anchor the structure. Digger logs will usually be positioned to point downstream, although there may be some situations where pointing them upstream will be appropriate (e.g., where the intention of the log placement is to create scour). The vertical angle of the log is variable, usually 10 to 45 degrees to the bank.

Spider logs are several logs placed at angles to provide cover for juvenile rearing and adult spawning and collect woody debris to increase diversity. Their use is restricted to areas where there is no danger of causing bank failure or channel migration. Pools and backwater eddy areas on the channel margins are the best locations for these structures. These structures will be constructed of several logs placed across each other, in the shape of a triangle, to imitate natural debris or log jam. Each of the logs will be partially buried in the bank or channel or secured to bedrock or large boulders in the channel with cable and polyester resin adhesive, or to live trees with threaded rebar. The logs will be secured together with threaded rebar. Several other logs with branches and rootwads attached are then fastened to these primary structural logs with cable or threaded rebar.

2.5 Regulatory Context

2.5.1 Central Valley Project Improvement Act of 1992

Reclamation's authority to implement the Upper Sacramento River Anadromous Fish Habitat Restoration Program ultimately derives from Public Law 102- 575, the Central Valley Project Improvement Act of 1992. Congress passed this act to address impacts of the Central Valley Project on fish and wildlife and their associated habitats. Specifically, CVPIA § 3406(b)(13) directs the Secretary of the Interior to:

> Develop and implement a continuing program for the purpose of restoring and replenishing, as needed, spawning gravel lost due to the construction and operation of Central Valley Project dams, bank protection projects, and other actions that have reduced the availability of spawning gravel and rearing habitat in the Upper Sacramento River from Keswick Dam to Red Bluff Diversion Dam in the American and Stanislaus Rivers downstream from the Nimbus and Goodwin Dams, respectively. The program will include preventive measures, such as re-establishment of meander belts and limitations on future bank protection activities, in order to avoid further losses of instream and riparian habitat.

2.5.2 CALFED Bay-Delta Program Record of Decision (2000)

The California Bay-Delta Program was established in 1995 to improve the state's water supply and improve the ecological health of the San Francisco Bay and the Sacramento-San Joaquin Delta. It is a collaboration among 25 state and federal agencies tasked with managing California's water resources. One of the four primary objectives of the CALFED Program is to "Restore the ecological health of the fragile and depleted Bay-Delta ecosystem." Anadromous fish, particularly salmonids, are ecologically important in the Bay-Delta estuary, but fulfill critical life stages outside the geographic boundaries of the estuary. The program funds anadromous fish restoration projects throughout the greater Bay- Delta ecosystem. In the 2000 CALFED Bay-Delta Program Record of Decision on the programmatic EIR/EIS, CALFED was directed to implement an Ecological Restoration Program (ERP) in order to:

> improve aquatic and terrestrial habitats and natural processes to support stable, self-sustaining populations of diverse and valuable plant and animal species through an adaptive management process. Implementation of the ERP includes recovery of species listed under the state and federal Endangered Species Acts.

Actions identified in the CALFED ROD relevant to this proposed action include "protecting, restoring, and managing diverse habitat types representative of the Bay-Delta and its watershed," "modify in-channel structures or features to eliminate predator habitat," "maintain, improve, or supplement gravel recruitment and natural sediment transport in streams; improve spawning gravel and gravel availability in streams; relocate instream and floodplain gravel mining and artificially introduce gravels to compensate for sediment trapped by dams; and develop and implement appropriate land use plans that allow the natural recruitment of sediments," "restoring aspects of the sediment regime …by artificially introducing gravels to compensate for sediment trapped by dams."

Past and current restoration efforts in the Upper Sacramento River support CALFED's directives, including spawning gravel augmentation and implementation of an anadromous fish restoration and management program.

2.5.3 Biological Opinion on the Long-term Operations of the Central Valley Project and State Water Project – June 2009

In June 2009, NMFS issued a Biological Opinion (BO) and Conference Opinion on the Long-Term Operating Criteria and Procedures (OCAP) of the Central Valley Project and State Water Project that indicated that dams block the downstream transport of spawning gravel that would replenish gravel below the dams and dam operations have mobilized gravel remaining below the dams, which has led to a degradation of the quality and quantity of available salmonid spawning gravels. Spawning gravel augmentation addresses these issues within the constraints imposed by dam operations.

2.5.4 Federal Endangered Species Act

The ESA protects federally listed threatened and endangered species. Section 9 of the ESA prohibits "take" of threatened or endangered species. Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." Sections 7 and 10(a) of the ESA provide a method for exempting an activity that may result in an "incidental take" of a federally listed species. Incidental take refers to take of a listed species that is incidental to, but not the primary purpose of, an otherwise lawful activity.

2.5.5 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance Essential Fish Habitat (EFH) for those species regulated under a federal fisheries management plan (FMP). EFH refers to those waters and substrates necessary for the spawning, breeding, feeding, or growth to maturity. ‘Waters’ include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; ‘substrate’ includes sediment, hard bottom, structures underlying the waters, and associated biological communities; ‘necessary’ means the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem; and ‘spawning, breeding, feeding, or growth to maturity’ covers a species’ full life cycle. ‘Adverse effect’ means any impact that reduces the quality and/or quantity of EFH, and may include direct, indirect, site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions. The MSA requires federal agencies to consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (MSA §305[b][2]). A component of this consultation process is the preparation and submittal of an EFH assessment. All EFH assessments must include the following information: 1) a description of the proposed action; 2) an analysis of the effects, including cumulative effects, of the proposed action on EFH, the managed species, and associated species, such as major prey species, including affected life history stages; 3) the federal agency’s views regarding the effects of the proposed action on EFH; and 4) proposed mitigation, if applicable. In instances where MSA and ESA issues overlap, NMFS encourages an integrated approach for consultation.

The EFH mandate applies to all species managed under a FMP. For the Pacific Coast (excluding Alaska), there are three FMPs covering groundfish, coastal pelagic species, and Pacific salmon. Reclamation’s proposed action has the potential to affect EFH for Chinook salmon in the Upper Sacramento River.

2.5.6 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act, as amended in 1964, was enacted to protect fish and wildlife when Federal actions result in the control or modification of a natural stream or body of water. The statute requires Federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife resources. Consultation and coordination with USFWS and State fish and game agencies are required to address ways to prevent loss of and damage to fish and wildlife resources and to further develop and improve these resources.

2.6 Proposed Conservation and Avoidance Measures

2.6.1 Measures to Minimize Injury and Mortality of ESA Species

Due to the nearly year-round presence of at least one freshwater life stage of one or more listed fish species in the action area, the use of zones and in-river work windows to entirely avoid and prevent injury or mortality to listed anadromous fish is not possible. However, the least mobile life stages, incubating eggs and pre-emergent fry, are the life stages most likely to experience direct injury and mortality from construction activities. Therefore, instream work will be restricted to specific windows in specific locations, developed with consideration of the spatial and temporal distribution of spawning winter-run and spring-run Chinook salmon, steelhead, and green sturgeon (Table 3).

These work zone locations and windows, along with pre-construction salmonid redd surveys in Zones 2 and 3, are designed to avoid or minimize harm to incubating salmonid eggs and pre-emergent fry. No pre-construction surveys for green sturgeon spawning adults are necessary since zone locations and in-river work windows have been designed to avoid construction activities when green sturgeon are spawning or eggs may be present.

Table 3. Work Zone Locations and In-River Work Windows.

Zone	Location	In-River Work Window
Zone 1	Keswick Dam (RM 302) to approximately 1.5 miles downstream	Year-round (anytime flows are <15,000 cfs)
Zone 2	Approximately 1.5 mile downstream of Keswick Dam (RM 300.5) to Cow Creek (RM 280)	October 1 to May 15* (anytime flows are <10,000 cfs; pre-construction salmonid redd surveys conducted)
Zone 3	Cow Creek (RM 280) to Red Bluff Diversion Dam (RM 243)	October 1 to March 1* (anytime flows are <10,000 cfs; pre-construction salmonid redd surveys conducted)

*Construction may be conducted year-round in areas, such as floodplains and side channels, when flowing water is absent due to separation from the main channel by gravel berms that are either naturally present or artificially created.

Zone 1 extends from Keswick Dam to approximately 1.5 miles downstream and the in-river work window is year-round during periods when flows are less than 15,000 cfs. The only proposed projects in this zone are the Keswick Dam and Salt Creek gravel augmentation sites. No other restoration activities are planned for this zone. Very little spawning has been documented near these sites and the nearest redds have been constructed farther than 200 meters away. In order to maintain and increase the amount of suitable spawning habitat in this reach, these gravel augmentation sites may need to be maintained long-term. When augmentation occurs, approximately 80 percent of the gravel is retained on the banks until mobilized by high flows (approximately >25,000 cfs), and about 20 percent of the gravel falls into the river. The area of the river bank and channel affected at these sites are not salmonid spawning or juvenile rearing habitat and no green sturgeon have been documented this far upstream. Therefore, potential adverse effects in Zone 1 are extremely unlikely to occur and considered discountable.

Zone 2 extends from approximately 1.5 miles downstream of Keswick Dam (RM 300.5) to Cow Creek (RM 280) and the in-river work window is October 1 to May 15 when flows are less than 10,000 cfs. Construction work may occur year-round in areas where fish will not have access (i.e., areas where flowing water is absent due to separation from the main channel by gravel berms that are either naturally present or artificially created). This in-river work window was selected to provide maximum flexibility for project implementation while minimizing potential exposure to spawning or incubating eggs.

The majority of winter-run Chinook salmon spawn in this zone, as well as spring-run Chinook salmon albeit in much smaller numbers. Most winter-run Chinook salmon spawning and egg incubation and all of spring-run Chinook salmon spawning periods are avoided during the in-river work window. For winter-run Chinook salmon, the peak of spawning occurs from late May through June and only a very small percentage of redds are documented prior to mid-May (<1%; USFWS unpublished data). Based on timing of redd observations, approximately 50% of winter-run Chinook salmon emergence is estimated to occur prior to the in-river work window (USFWS unpublished data), while spring-run Chinook salmon emergence is estimated to occur from October through December. Although some large *O. mykiss* are observed spawning in the mainstem during aerial flights and carcass surveys, it is unknown whether these individuals are resident trout or anadromous steelhead. Large numbers of these rainbow/steelhead trout are observed in March and April spawning in locations where good smaller-sized gravels exist, and since smaller gravels are typically degraded at restoration sites, these sites are “not likely to have large numbers of [adult *O. mykiss*] on them during construction” (Killam 2014), so the potential for exposure of steelhead redds and incubating eggs is considered insignificant.

Since some salmonids may spawn and/or incubate during the in-river work window, pre-construction salmonid redd surveys will be conducted to identify whether a site may affect egg survival and avoidance measures will be implemented if appropriate. Since juvenile salmonids, including steelhead that migrate into the Upper Sacramento River from natal tributaries, may occur in Zone 2 during varying time frames within the in-river work window (i.e., winter-run Chinook= October-March; spring-run Chinook= October-April; steelhead= October through mid-May), conservation measures will be implemented to reduce the potential for adverse effects on juvenile salmonids.

Within Zone 2, there are seven identified potential gravel augmentation sites, seven identified potential floodplain and side channel enhancement sites, and one instream habitat structure placement site. Additional restoration sites may be identified in the future but the number of additional possible sites is low due to various constraints. All three gravel augmentation methods may be used at these sites with riffle supplementation requiring instream work using heavy equipment. Floodplains and side channels will be created or modified by excavation with much of the work conducted in areas where fish will not have access (i.e., where flowing water is absent due to separation from the main channel by gravel berms that are either naturally present or artificially created) and instream work will be limited to inlet/outlet areas during the last stage of reconnection to the main channel. Instream habitat structures may be placed as needed where juvenile rearing habitat is identified as limited. Placement of habitat structures in floodplains and side channels would occur in areas where fish will not have access, as described above.

Zone 3 extends from Cow Creek (RM 280) to the RBDD (RM 243) and the in-river work window is October 1 to March 1 when flows are less than 10,000 cfs. Construction work may occur year-round in areas where fish will not have access (i.e., where flowing water is absent due to separation from the main channel by gravel berms that are either naturally present or artificially created).

Very few winter-run Chinook salmon spawn in Zone 3 (USFWS unpublished data), so the potential for exposure winter-run Chinook redds and incubating eggs is considered extremely unlikely to occur and considered discountable. For spring-run Chinook, up to 30% may spawn in this zone (USFWS unpublished data). Based on timing of redd observations, spring-run Chinook emergence is estimated to occur from October through December. Although some large *O. mykiss* are observed spawning in the mainstem during aerial flights and carcass surveys, it is unknown whether these individuals are resident trout or anadromous steelhead. Large numbers of these rainbow/steelhead trout are observed in March and April spawning in locations where good smaller-sized gravels exist, and since smaller gravels are typically degraded at restoration sites, these sites are "not likely to have large numbers of [adult *O. mykiss*] on them during construction" (Killam 2014), so the potential for exposure of steelhead redds and incubating eggs is considered insignificant.

Since some salmonids may spawn and incubate during the in-river work window, pre-construction salmonid redd surveys will be conducted to identify whether a site may affect egg survival and avoidance measures will be implemented if appropriate. Since juvenile salmonids, including steelhead that migrate into the Upper Sacramento River from natal tributaries, may occur in Zone 3 during varying time frames in the in-river work window (i.e., winter-run Chinook= October-March; spring-run Chinook= October- April; steelhead= October through mid-May), conservation measures will be implemented to reduce the potential for adverse effects on juvenile salmonids.

Within Zone 3, there is one identified potential floodplain and side channel enhancement site. Additional restoration sites may be identified in the future but the number of additional possible sites is low due to various constraints. All three gravel augmentation methods may be used at these sites with riffle supplementation requiring instream work using heavy equipment. Floodplains and side channels will be created or modified by excavation with much of the work conducted in areas where fish will not have access (i.e., where flowing water is absent due to separation from the main channel by gravel berms that are either naturally present or artificially created); instream work will be limited to inlet/outlet areas during the last stage of reconnection to the main channel. Instream habitat structures may be placed as needed where juvenile rearing habitat is identified as limited. Placement of habitat structures in floodplains and side channels would occur in areas where fish will not have access, as described above.

2.6.2 Measures to Prevent Loss of Potential Spawning and Rearing Habitat

The proposed action will not destroy any suitable salmonid or green sturgeon spawning or rearing habitat; therefore, no net loss of habitat will occur. Conservation measures are not necessary.

2.6.3 Measures to Control Turbidity and Suspended Sediment during Construction

Measures to avoid and minimize the potential for adverse effects of turbidity or resuspension of sediment during instream work on the listed anadromous species will include the following:

- Appropriate BMPs to control erosion and storm water sediment runoff will be implemented. This may include, but is not limited, straw bales, straw wattles, silt fences, and other measures as necessary to minimize erosion and sediment-laden runoff from project areas.

- Equipment operation in the active channel will be kept to the minimum necessary to meet the project goals. When in-channel work is unavoidable, spawning gravel will be used where feasible to create a pad in the channel from which equipment will operate.
- Turbidity and settleable solids will be monitored to maintain compliance with permit requirements. If exceedances occur, work will be slowed or halted to allow turbidity to subside.
- Instream work that may cause turbidity within 200 ft upstream of active redds will be avoided if possible.

2.6.4 Measures to Avoid Adverse Effects on Riparian Vegetation
The following measures will be taken to minimize the loss and disturbance of riparian vegetation:

- Impacts to existing vegetation will be avoided to the extent practical.
- Disturbed areas adjacent to the river, not intended for future road access or gravel placement, will be covered with river rock or revegetated with native plant species and/or mulched with certified weed-free hay following the completion of construction activities.
- Equipment used for the project will be thoroughly washed off-site to remove invasive plant seed, stems, etc. and inspected to prevent transfer of aquatic invasive species, such as quagga mussel and New Zealand mud snail, prior to arriving at the construction area.
- Project activities will avoid impacts to wetlands to the extent practicable. Wetlands located near construction areas, and at risk of inadvertent disturbance, will be protected with high-visibility fencing.

2.6.5 Measures to Prevent and Manage Potential Spills of Hazardous Materials
The following measures will be taken to prevent and manage potential spills of hazardous materials:

- Spill prevention and cleanup kits will be in close proximity to construction areas and workers will be trained on their use.
- Heavy equipment operating in the river will use biodegradable hydraulic fluid.
- Equipment will be checked daily for leaks and any leaks fixed prior to activities in sensitive areas
- All construction equipment refueling and maintenance will be restricted to designated staging areas located away from the river and sensitive habitats.

Chapter 3 Environmental Setting and Baseline

The Sacramento River originates in the Klamath Mountains near Mt. Shasta from the springs of Mt. Eddy (Hallock et al. 1961), and flows south for 447 miles before reaching the Sacramento–San Joaquin River Delta and San Francisco Bay.

Shasta Dam—located at river mile (RM) 311 on the Sacramento River near Redding, California—was completed in 1945. It serves to control floodwaters and store surplus winter runoff for irrigation in the Sacramento and San Joaquin Valleys, maintain navigation flows, provide flows for the conservation of fish in the Sacramento River and water for municipal and industrial use, protect the Sacramento-San Joaquin Delta from intrusion of saline ocean water, and generate hydroelectric power. Keswick Dam (RM 302) was constructed nine miles downstream from Shasta Dam to create a 23,800 acre-foot afterbay for Shasta Lake and the Trinity River Division, which stabilizes uneven water releases from the powerplants. Below Keswick Dam, the Anderson-Cottonwood Irrigation District Diversion Dam (ACID Dam; RM 297) is seasonally in place to raise the water level for diversions into the ACID canal. The 59 mile reach of the Sacramento River between Keswick Dam and RBDD is commonly referred to as the Upper Sacramento River and is the geographical setting of this BA.

Coarse sediment from the upper watershed is prevented from being transported downstream by Shasta and Keswick Dams, resulting in an alluvial sediment deficit and reduction in fish habitat quality within the Upper Sacramento River reach (Wright and Schoellhamer 2004). In addition to the reduction of sediment supply, recruitment of large woody material to the river channel and floodplain has also declined due to a reduction in bank erosion and blockage of wood transport by Shasta Dam.

Shasta and Keswick Dams have presented impassable barriers to anadromous fish since 1943 (Moffett 1949 as cited in Poytress et al. 2014). ACID Dam and RBDD presented partial barriers to salmonid migration until improvements were made in 2001 and 2012 (NMFS 2009, 2014), respectively. ACID Dam continues to present an impassable barrier to green sturgeon (NMFS 2009). Since 2007, between 50-62% of winter-run Chinook salmon spawning occurs between RBDD and ACID Dam (NMFS 2009, NMFS 2014). Green sturgeon spawning has been documented from Gianella Bridge (RM 198) to Ink's Creek (RM 264.7), and is considered possible up to Cow Creek (RM 280) based on adult presence observed at this location during the spawning time frame (Poytress et al. 2013).

The combination of degraded physical habitat characteristics, fish passage barriers, and changes in hydrology resulting from dams, and diversions since the mid-1800s has been associated with salmonid and green sturgeon declines within the Sacramento River watershed.

3.1 Hydrology

Flows in the Sacramento River in the 65 mile reach between Shasta Dam and RBDD are regulated by Shasta Dam and reregulated downstream at Keswick Dam. Water stored in upstream reservoirs during the winter and spring is released in the summer and fall for municipal and industrial supply, irrigation, water quality, power generation, recreation and fish and wildlife purposes. Historically, the Upper Sacramento River was highly responsive to periodic precipitation events and seasonal variation. Since completion of the dams, flows are now lower in the winter and spring and higher in the summer and fall. In this reach, flows are influenced by tributary inflow. Major west-side tributaries to the Sacramento River in this reach of the river include Clear and Cottonwood creeks. Major east-side tributaries to the Sacramento River in this reach of the river include Battle, Bear, Churn, Cow, and Paynes creeks.

3.2 Water Quality

The main sources of water in the Sacramento River below Keswick Dam are rain and snowmelt that collect in upstream reservoirs and are released in response to water needs or flood control. The quality of surface water downstream of Keswick Dam is also influenced by other human activities along the Sacramento River downstream of the dam, including historical mining, agricultural, and municipal and industrial (M&I) activities. Water quality issues within the primary study area of the Sacramento River include the presence of mercury, pesticides, trace metals, turbidity, and toxicity from unknown origin (CALFED 2000).

The CVRWQCB has determined that the 25-mile segment of the Upper Sacramento River between Keswick Dam and Cottonwood Creek is impaired by levels of dissolved cadmium, copper, and zinc that periodically exceed water quality standards developed to protect aquatic life (CVRWQCB 2002). Elevated levels of metal have resulted in fish population declines and even mortality. The impairment results primarily from inactive mines in the watershed, predominantly the Iron Mountain site upstream of Keswick Dam. The reach is also listed under CWA 303(d) by the CVRWQCB for unknown sources of toxicity (CVRWQCB 2007).

Water temperature in the Sacramento River is controlled by releases from Shasta, Whiskeytown, and Keswick Reservoirs. On June 4, 2009, NMFS issued a biological opinion (BiOp) for listed anadromous fishes and their critical habitats governing the coordinated long-term operation of the CVP and SWP. The 2009 BiOp established Upper Sacramento River water temperature requirements.

State and federal law mandates a series of programs for the management of surface water quality. In the State of California, water resources are protected under the federal Clean Water Act (CWA) and the State Porter-Cologne Water Quality Control Act, which created the State Water Resources Control Board (SWRCB) and nine Regional Water Quality Control Boards (RWQCB). Each RWQCB is responsible for preparing and updating a water-quality control plan (basin plan) every three years; the basin plan for a specific region identifies water quality protection policies and procedures for that region (CVRWQCB 1998).

In the project action area, the Central Valley RWQCB (CVRWQCB) is responsible for designating beneficial uses and establishing water quality objectives for the American and Sacramento River basins and the Delta to support the protection of these beneficial uses.

3.3 Covered Species and Habitats

The following federally listed species ESUs or DPSs and designated critical habitats occur in the action area and may be affected by the proposed Upper Sacramento River Anadromous Fish Habitat Restoration and Management Program:

- **Sacramento River winter-run Chinook salmon ESU and designated critical habitat** (*Oncorhynchus tshawytscha*) endangered (June 28, 2005, 70 FR 37160); (June 16, 1993, 58 FR 33212)
- **Central Valley spring-run Chinook salmon ESU and designated critical habitat** (*O. tshawytscha*) threatened (September 16, 1999, 64 FR 50394); (September 2, 2005, 70 FR 52488)
- **California Central Valley steelhead DPS and designated critical habitat** (*O. mykiss*) threatened (January 5, 2006, 71 FR 834); (September 2, 2005, 70 FR 52488)
- **Southern DPS of North American green sturgeon and designated critical habitat** (*Acipenser medirostris*) threatened (April 7, 2006, 71 FR 17757);(October 9, 2009, 74 FR 52300)

In addition to detailed analysis of effects on the listed species addressed above, information relevant to life history timing and essential fish habitat for CV fall/late fall-run Chinook salmon is provided to facilitate the Magnuson-Stevens EFH consultation. Table 4 presents the potential temporal occurrence of these fish species in the proposed action area.

3.3.1 Sacramento River Winter-run Chinook Salmon

NMFS designated winter-run Chinook salmon federally endangered June 28, 2005 (70 FR 37160). Critical habitat for winter-run Chinook salmon was designated on June 16, 1993 (June 16, 1993, 58 FR 33212) and includes the Sacramento River from Keswick Dam to Chipps Island (RM 0).

The Sacramento River winter-run Chinook salmon ESU consists of one population confined to the Upper Sacramento River. At present, the freshwater life stages of winter-run Chinook salmon are found only in the Sacramento River below Keswick Dam, thus all winter-run production occurs in the Sacramento River. Access to approximately 58 percent of the original winter-run Chinook salmon habitat has been blocked by dam construction (CDFG 2003). Adult Sacramento River winter-run Chinook salmon migrate upstream past the Red Bluff Diversion Dam (RBDD)[3] beginning in mid-December and continuing into early August. The majority of the run passes RBDD between January and May, with the peak in mid-March (Hallock and Fisher 1985). Winter-run Chinook only spawn in the Sacramento River with the majority of redds (99%) documented upstream of Airport Road Bridge (RM 284) based on combined totals of aerial redd survey data from 2001 and 2014 (USFWS unpublished data). During this period that corresponds to post-passage improvements at ACID Dam, almost half (48%) of winter-run Chinook redds

[3] Red Bluff Diversion Dam is no longer operational. References to RBDD are included because of the geographical location of this structure.

Table 4. Temporal Occurrence of Special Status Fish Species in the Upper Sacramento River.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River Winter-run Chinook salmon												
Adult Immigration	X	X	X	X	X	X	X				X	X
Adult Holding	X	X	X	X	X							
Spawning					X	X	X	X				
Egg Incubation					X	X	X	X	X	X		
Juvenile Rearing	X	X	X				X	X	X	X	X	X
Juvenile Emigration	X	X	X				X	X	X	X	X	X
Central Valley Spring-run Chinook salmon												
Adult Immigration			X	X	X	X	X					
Adult Holding					X	X	X	X	X			
Spawning								X	X			
Egg Incubation								X	X	X	X	X
Juvenile Rearing	X	X	X	X						X	X	X
Juvenile Emigration	X	X	X	X						X	X	X
Central Valley Fall-run Chinook salmon												
Adult Immigration							X	X	X	X	X	X
Spawning										X	X	X
Egg Incubation	X	X	X							X	X	X
Juvenile Rearing	X	X	X	X	X	X						X
Juvenile Emigration	X	X	X	X	X	X	X					X
Central Valley Late Fall-run Chinook salmon												
Adult Immigration	X	X	X	X						X	X	X
Spawning	X	X	X	X								
Egg Incubation	X	X	X	X	X	X						
Juvenile Rearing				X	X	X	X	X	X	X	X	
Juvenile Emigration				X	X	X	X	X	X	X	X	X
Central Valley Steelhead												
Adult Immigration	X	X	X	X	X	X	X	X	X	X	X	X
Adult Holding					X	X	X	X	X	X	X	X
Spawning	X	X	X	X								X
Egg Incubation	X	X	X	X	X	X						X
Juvenile Rearing	X	X	X	X	X	X	X	X	X	X	X	X
Juvenile Emigration	X	X	X	X	X	X	X	X	X	X	X	X
Southern Green Sturgeon												
Adult Immigration		X	X	X	X	X	X					
Adult Holding			X	X	X	X	X	X	X	X	X	
Spawning				X	X	X	X					
Egg Incubation				X	X	X	X					
Juvenile Rearing					X	X	X	X				
Juvenile Emigration					X	X	X	X	X	X	X	X

Sources: Vogel and Marine 1991, NMFS 2014 were observed upstream of this structure. Although some adults migrate upstream through August, spawning occurs from May through July with the peak in late May through June. Between 44 and 81 percent of winter-run juveniles used areas downstream of RBDD for nursery habitat and the relative usage above and below RBDD appeared to be influenced by river discharge during fry emergence (Martin et al. 2001). Juvenile emigration past RBDD (RM 243) may begin in late July, generally peaks in September, and can continue until mid-March in drier years (Vogel and Marine 1991). Juveniles are found upstream of the Deer Creek confluence with the Sacramento River (RM 220) from July through September and spread downstream to Princeton (RM 164) between October and March (Johnson et al. 1992).

3.3.2 Central Valley Spring-run Chinook Salmon

Central Valley spring-run Chinook salmon were listed as threatened on September 16, 1999 (64 FR 50394). This ESU consists of all spring-run Chinook salmon occurring in the Sacramento River basin. Critical habitat was designated for Central Valley spring-run Chinook salmon on September 2, 2005 and includes the Sacramento River (70 FR 52488).

The Central Valley spring-run Chinook salmon ESU is comprised mainly of three self-sustaining wild populations (Mill, Deer and Butte Creeks) (Lindley et al. 2007), which are outside of the action area. These three populations have been experiencing positive growth rates since the low abundance levels of the late 1980s.

Recent estimates indicate roughly 2,000 miles of salmon spawning and rearing habitat were available before dam construction and mining, but 82 percent of that habitat is unavailable or inaccessible today (Yoshiyama et al. 1996). Currently, the bulk of the remaining spring-run Chinook are produced in Deer, Mill, and Butte creeks, the Feather River, and perhaps the mainstem Sacramento River.

Spring-run Chinook may spawn in the Sacramento River between RBDD and Keswick Dam in very low densities with only a total of 449 redds documented between 2001 and 2014 (average 35/year; range= 0-105; no data available for 2009 or 2011). During this period, most spring-run Chinook redds (93 percent) were documented upstream of Jelly's Ferry Bridge (RM 265.9). Spring-run spawning is not as concentrated in the upstream area immediately above and below ACID Dam as is the winter-run spawning distribution.

Sacramento River mainstem spring-run abundance has declined sharply since the mid-1980s. The criteria for run classification at RBDD have changed so no reliable conclusions can be reached about spring-run abundance changes in the Sacramento River. The variable abundance estimates may be an artifact of the counting methods used in different years and categorization of fish between runs. The 5-year geometric mean abundance reported by NMFS (1999a) was 435 fish. There is evidence that the spring-run that pass RBDD are spring-run/fall-run hybrids. Historically, the onset of fall-run spawning occurred well after spring-run had completed spawning. The increasing overlap in spring-run and fall-run spawning periods is evidence that introgression is occurring. Because spring-run and fall-run Chinook salmon now use the same spawning riffles, fall-run Chinook salmon spawners may reduce survival of eggs in the spring-run redds. This redd displacement is called superimposition. The criteria used to distinguish spring-run from fall-run between 1970 and 1988 (timing) probably resulted in many fall-run

Chinook salmon being classified as spring-run Chinook salmon (CDFG 2003), so the increasing overlap may be simply an artifact of the variable run classification.

In fresh water, juvenile spring-run Chinook salmon rear in natal tributaries, the Sacramento River mainstem, and non-natal tributaries to the Sacramento River (CDFG 1998a). Emigration timing is highly variable. Pulse flows that occur during precipitation events tend to stimulate downstream movement along the Sacramento River. Spring-run juveniles that remain in the Sacramento River over the summer are confined to approximately 100 miles of the upper mainstem, where cool water temperatures are maintained by dam releases.

3.3.3 Central Valley Steelhead

Central Valley steelhead were listed as threatened under the ESA on January 5, 2006 (71 FR 834) and include all naturally spawned populations of steelhead in the Sacramento and San Joaquin rivers and their tributaries, excluding steelhead from San Francisco and San Pablo bays and their tributaries and two artificial propagation programs: the Coleman National Fish Hatchery and Feather River Fish Hatchery steelhead hatchery programs. Critical habitat was designated for Central Valley steelhead on September 2, 2005 and includes the Sacramento River (70 FR 52488).

Populations of naturally spawned Central Valley steelhead are at lower levels than were found historically and are composed predominantly of hatchery fish (Lindley et al. 2007, McEwan 2001). In general, the majority of Central Valley steelhead are confined to non-historical spawning and rearing habitat below impassable dams, but the existing spawning and rearing habitat can sustain steelhead at current population levels. In addition, monitoring data indicates that much of the anadromous form of the species is hatchery supported. There is also a strong resident component to the population (referred to as rainbow trout) that interacts with and produces both resident and anadromous offspring. Rotary screw trap data at RBDD indicate that most juvenile steelhead observed there are resident forms, based on timing and size (Poytress et al. 2014).

Recent steelhead monitoring data are scarce for the Upper Sacramento River system. Hallock (1989) reported that steelhead have declined drastically above the mouth of the Feather River. In the 1950s, the average estimated spawning population size in the Upper Sacramento River was 20,540 fish (Hallock et al. 1961). In 1991–1992, the annual run size for the total Sacramento River system was likely less than 10,000 adult fish (McEwan and Jackson 1996)). From 1967 to 1993, the estimated number of steelhead passing RBDD ranged from a low of 470 to a high of 19,615 (California HSRG 2012). Based on otolith sampling of *O. mykiss* in the Upper Sacramento River system, Zimmerman et al. (2009) found that less than 25 percent of age 0 to 4 fish sampled were progeny of an anadromous (steelhead) mother.

3.3.4 Green Sturgeon

The Southern DPS of North American green sturgeon (green sturgeon) includes all green sturgeon populations south of the Eel River, with the main spawning population in the Sacramento River and some of its tributaries. The Southern DPS of North American green sturgeon was listed as threatened on April 7, 2006 (71 FR 17757) and is designated as a California species of special concern. The green sturgeon Southern DPS presently contains only a single spawning population within the Sacramento River basin, which primarily spawns in the mainstem Sacramento River downstream of Keswick Dam (RM 302), but spawning has also been documented in the Feather River downstream of Oroville Dam (NMFS 2005) and potentially in the Yuba River where adults exhibiting spawning behavior have been observed (AFRP 2011). Critical habitat was designated for the Southern population North American green sturgeon DPS on October 9, 2009 (74 FR 52300).

The Sacramento River provides spawning, adult holding, foraging, and juvenile rearing habitat for green sturgeon. Although the upstream extent of historical green sturgeon spawning in the Sacramento River is unknown, the observed distribution of sturgeon eggs, larvae, and juveniles indicates that spawning occurs from Hamilton City (RM 200) to as far upstream as Ink's Creek confluence (RM 281) and possibly up to the Cow Creek confluence (RM 280)(Brown 2007; Poytress et al. 2013). Peak spawning is believed to occur from late April through June. Optimal spawning temperatures and spawning substrate exist for sturgeon in the Sacramento River well above and well below RBDD (Reclamation 2008).

Spawning migrations by green sturgeon in the Upper Sacramento River mainstem have been well documented over the last 15 years (Beamesderfer et al. 2004). Anglers fishing for white sturgeon or salmon commonly report catches of green sturgeon from the Sacramento River at least as far upstream as Hamilton City (Beamesderfer et al. 2004). Eggs, larvae, and post larval green sturgeon are now commonly reported in sampling directed at green sturgeon and other species (Beamesderfer et al. 2004, Brown 2007). Young-of-the-year (YOY) green sturgeon have been observed annually since the late 1980s in fish sampling efforts at RBDD and the Glenn-Colusa Canal (Beamesderfer et al. 2004). Acoustically tagged green sturgeon were detected upstream of RBDD in 2004–2006 (Heublein et al. 2009).

Green sturgeon from the Sacramento River are genetically distinct from their northern counterparts indicating a spawning fidelity to their natal rivers (Israel et al. 2004). Larval green sturgeon were regularly captured during their dispersal stage at about two weeks of age (24–34 mm fork length) in rotary screw traps at RBDD (CDFG 2002). Larval green sturgeon are regularly captured during their dispersal stage at about three weeks old when captured at the Glen-Colusa facility at RM 205.5 (CDFG, unpublished data; Van Eenennaam et al. 2001). Young green sturgeon appear to rear for the first one to two months in the Sacramento River upstream of Hamilton City (CDFG 2002). Rearing habitat condition and function may be affected by variation in annual and seasonal flow and temperature characteristics. Empirical estimates of green sturgeon abundance are not available for the Sacramento River population or any west coast population (Reclamation 2008) and the current population status of Southern DPS green sturgeon is unknown (Beamesderfer et al. 2007, Adams et al. 2007). A genetic analysis of green sturgeon larvae captured in the Sacramento River estimated that the number of adult spawning pairs upstream of RBDD ranged from 32 to 124 between 2002 and 2006 (Israel 2006). NMFS (2009a) noted that the restriction of spawning habitat for the Southern DPS green sturgeon to one reach of the Sacramento River increases the vulnerability of this spawning population to catastrophic events.

3.3.5 Critical Habitat

The Upper Sacramento River is designated by NMFS to contain critical habitat for the Sacramento River winter-run Chinook salmon ESU, CV spring-run Chinook salmon ESU, CV steelhead DPS, and the Southern DPS of North American green sturgeon. The ESA defines critical habitat as those specific areas within the geographic area occupied by the species, at the time of listing, containing physical and biological features essential to the conservation of the species that may require special management considerations; and occupied areas that are essential to the conservation of the species. ESA regulations state that the physical and biological features essential to the conservation of the species include, but are not limited to, space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, and rearing of offspring; and habitats that are protected from disturbance or are representative of the historical geographical and ecological distribution of a species. These principal biological and physical features are known as primary constituent elements (PCEs). NMFS developed a list of four PCEs specific to freshwater riverine systems for CV spring-run Chinook salmon and steelhead (70 FR 52536, Sept. 2, 2005) with the first three applicable within the Upper Sacramento River, including:

(1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
(2) Freshwater rearing sites with:
  (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
  (ii) Water quality and forage supporting juvenile development; and
  (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
(3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
(4) Estuarine areas free of obstruction and excessive predation with:
  (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;
  (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and
  (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

NMFS developed a list of seven PCEs specific to freshwater riverine systems for Southern DPS of North American green sturgeon (74 FR 52345, Oct. 9, 2009) that are applicable within the Upper Sacramento River, including:

(i) *Food resources.* Abundant prey items for larval, juvenile, subadult, and adult life stages.
(ii) *Substrate type or size (i.e., structural features of substrates).* Substrates suitable for egg deposition and development (*e.g.*, bedrock sills and shelves, cobble and gravel, or hard clean sand, with interstices or irregular surfaces to “collect” eggs and provide protection

from predators, and free of excessive silt and debris that could smother eggs during incubation), larval development (*e.g.*, substrates with interstices or voids providing refuge from predators and from high flow conditions), and subadults and adults (*e.g.*, substrates for holding and spawning).

(iii) *Water flow.* A flow regime (*i.e.*, the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages.

(iv) *Water quality.* Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.

(v) *Migratory corridor.* A migratory pathway necessary for the safe and timely passage of Southern DPS fish within riverine habitats and between riverine and estuarine habitats (*e.g.,* an unobstructed river or dammed river that still allows for safe and timely passage).

(vi) *Depth.* Deep (≥5 m) holding pools for both upstream and downstream holding of adult or subadult fish, with adequate water quality and flow to maintain the physiological needs of the holding adult or subadult fish.

(vii) *Sediment quality.* Sediment quality (*i.e.*, chemical characteristics) necessary for normal behavior, growth, and viability of all life stages.

3.3.6 Essential Fish Habitat

The Upper Sacramento River is designated by NMFS to contain EFH for Chinook salmon, as defined by the Magnuson-Stevens Fisheries Conservation and Management Act of 1994, as amended. EFH refers to those waters and substrates necessary for spawning, breeding, feeding, or growth to maturity. Freshwater EFH for salmon consists of four major components: spawning and incubation habitat; juvenile rearing habitat; juvenile migration corridors; and adult migration corridors and adult holding habitat (PFMC 2003). Important components of EFH for spawning, rearing, and migration include suitable substrate composition; water quality (e.g., dissolved oxygen, nutrients, temperature); water quantity, depth and velocity; channel gradient and stability; food; cover and habitat complexity (e.g., large woody debris, pools, channel complexity, aquatic vegetation); space; access and passage; and floodplain and habitat connectivity (PFMC 2003).

As defined, the term “waters” includes aquatic areas (and their associated physical, chemical, and biological properties) that are used by fish or, where appropriate, have historically been used by fish. The term “substrate” includes sediment, hard-bottom, structures underlying the waters, and associated biological communities. “Necessary” means the habitat required for a sustainable fishery and the managed species’ contribution to a healthy ecosystem. Finally, “spawning, breeding, feeding, or growth to maturity” refers to a species’ full life cycle.

The Upper Sacramento River provides all four major components of freshwater EFH for salmon. The purpose, and anticipated effect, of the proposed action is to increase the amount of available habitat and enhance stream and riparian habitat suitability for Chinook salmon.

Chapter 4 Effects of the Proposed Action

This assessment considers the nature, duration, and extent of the effects of the proposed action relative to the migration timing, behavior, and habitat requirements of federally listed Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and Southern DPS of North American green sturgeon and the magnitude, timing, frequency, and duration of project impacts to these listed species. Specifically, the assessment considers the potential impacts related to adverse effects to these species and their habitat resulting from the Sacramento River Anadromous Fish Habitat Restoration Program. The program includes avoidance and minimization measures for potential impacts.

4.1 Presence of Listed Species

Due to the life history timing of winter-run Chinook salmon, spring-run Chinook salmon, steelhead, it is possible for one or more life stages (i.e., migrating, holding, or spawning adults; incubating eggs; or rearing and emigrating juveniles) to be present at some point within the action area throughout the year. Additionally, it is possible for one or more life stages of green sturgeon (i.e., migrating and holding adults; or rearing and emigrating juveniles) to be present in the lower 37 miles of the action area (RM 280 to RM 243). The timing of in-river work windows varies between three zones within the action area (Table 3). These different in-river work windows are designed to minimize harm to incubating eggs and pre-emergent fry for winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon. However, in-river work windows will overlap with some salmonid spawning and incubation periods. Pre-construction salmonid redd surveys will be conducted in Zones 2 and 3 by a qualified biologist prior to any construction activities that will occur during spawning and incubation periods and instream work that causes increased turbidity to occur at active redds will be minimized.

4.2 Construction impacts of spawning gravel augmentation, floodplain and side channel enhancements, and placement of instream habitat structures

4.2.1 Hazardous Materials

The potential spill of hazardous materials (e.g., fuel, lubricants, hydraulic fluid) during construction and staging activities into the upper Sacramento River could have deleterious effects on all life stages of winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon. Additionally, operation of construction equipment in or adjacent to the river presents the risk of a spill of hazardous materials into the river (e.g., construction equipment leaking fluids).

Construction activities that include refueling of construction equipment on location can result in minor fuel and oil spills. Without rapid containment and clean up, these materials could have deleterious effects on all salmonid life stages within close proximity to construction activities.

Incubating fry would be at greatest risk due to their limited mobility and their physiological kinetics of toxicant metabolism. Juvenile and adult fish exhibit a greater level of mobility and thus possess a greater ability to avoid potentially hazardous materials. The use of conservation measures for the handling and containment of hazardous materials will minimize the risk of injury or mortality to all life stages of winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon.

Reclamation, or a designated contractor, will develop and implement a Spill Prevention Containment and Countermeasures Plan (SPCCP) prior to the onset of construction. The SPCCP will include measures to be implemented onsite that will keep construction and hazardous materials out of waterways and drainages. The SPCCP will include provisions for daily checks for leaks; hand-removal of external oil and grease. In addition, all construction equipment refueling and maintenance will be restricted to designated staging areas located away from the river channel and sensitive habitats.

Reclamation expects that adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway because the prevention and contingency measures will require frequent equipment checks to prevent leaks, will keep stockpiled materials away from the water, and will require that absorbent booms are kept on-site to prevent petroleum products from entering the river in the event of a spill or leak. Heavy equipment operated in the river will use biodegradable hydraulic fluid. Reclamation expects that implementation of BMPs will prevent fuel spills or toxic compounds from causing injury or death to individual fish. Therefore, the likelihood of this potential impact is extremely unlikely to occur and is considered discountable.

4.2.2 Loss of Riparian Vegetation

Impacts to existing vegetation will be avoided to the extent practicable. Disturbed riparian areas, not intended for future road access or gravel placement, will be revegetated with native plant species and mulched with certified weed-free hay following the completion of construction activities. The loss of riparian vegetation is an indirect effect of creating and maintaining access points to the river, and covering vegetation with gravel. Riparian vegetation provides overhead cover and a substrate for food production for juvenile salmonids and green sturgeon. The loss of riparian vegetation can therefore increase predation rates and reduce feeding rates for juveniles. Most riparian loss will be replanted and effects will be temporary (approximately 1-2 growing seasons to be replaced); only a few areas may not be replanted in order to maintain road access. Loss of riparian vegetation is unlikely at lateral berms due to the placement in cobbled or graveled portions of the channel that contain little soil for the production of riparian vegetation. Riffle supplementation and end-dump talus cone gravel augmentation methods and the construction of instream habitat structures would impact little, if any, of the riparian vegetation surrounding the site. Some vegetation may be temporarily or permanently removed at floodplain and side channel sites. Overall, the amount of riparian vegetation that would be lost is extremely small, and juveniles will have access to adjacent suitable rearing habitat. The impacts are considered to be insignificant.

4.2.3 Increased Turbidity

The re-suspension and deposition of instream sediments is an indirect effect of construction equipment and gravel entering the river. Short-term increases in turbidity and suspended sediment levels associated with construction may negatively impact fish populations temporarily through reduced availability of food, reduced feeding efficiency, and exposure to toxic sediment released into the water column. Fish responses to increased turbidity and suspended sediment can range from behavioral changes (alarm reactions, abandonment of cover, and avoidance) to sublethal effects (e.g., reduced feeding rate), and, at high suspended sediment concentrations for prolonged periods, lethal effects (Newcombe and Jensen 1996). If this occurs while embryos are incubating, injury or mortality to incubating eggs or alevins may occur through the infiltration of fine sediment into salmonid redds with a reduction of intra-gravel water circulation and in severe cases entombment of salmonid eggs and through preventing green sturgeon eggs from adhering to each other. The deposition of fine sediments in food producing riffles could also reduce the abundance and availability of aquatic insects on which juveniles feed, and result in the loss of rearing cover for juveniles; in the action area, silt and sand on the river bottom will be disturbed during placement of new materials, however, the amount of sediment that may be re-suspended during project installations is not likely to be significant; any re-suspension and re-deposition of instream sediments is expected to be localized and temporary and would not reach a level that would acutely affect aquatic organisms. The use of in-river work windows will generally prevent the siltation of winter-run Chinook salmon, spring-run Chinook salmon, and steelhead redds and will avoid green sturgeon eggs. In Zones 2 and 3, pre-construction surveys for spawning salmonids and redds will minimize the likelihood of injury resulting from the re-suspension and re-deposition of instream sediments.

Suspended solids and turbidity generally do not acutely affect aquatic organisms unless they reach extremely high levels. At high levels, suspended solids can adversely affect the physiology and behavior of aquatic organisms and may suppress photosynthetic activity at the base of food webs, affecting aquatic organisms either directly or indirectly (Alabaster and Lloyd 1980). Riffle supplementation sites and floodplain and side channel enhancement sites, however, require applying the gravel directly to the riverbed and/or grading it, thereby increasing the likely exposure and chance for adverse effects to listed juvenile salmonids (all zones) and juvenile green sturgeon (Zone 3). Nonetheless, a majority of gravel augmentation activities will occur within the middle of the channel (>90%) where fewer juveniles are expected to be rearing. Previous studies indicate that juvenile salmonids tend to be found within 10-20 feet of river banks (Allen 2000, FISHBIO and Normandeau Associates 2012, Palmer and Hellmair 2012). There is limited information regarding habitats occupied by juvenile green sturgeon; however, “habitat preference… in the laboratory suggests that wild juveniles should be in deep pools with some rock structure” (Kynard et al. 2005). Although some rearing and migrating juveniles may be found further from the banks, the area disturbed by gravel placement or excavation and associated turbidity at any given time is expected to be less than 25 percent of the river width, and to be most concentrated within about 200 feet downstream of the project site; therefore, juveniles will have opportunities to move to other portions of the channel where they can avoid potential injury or death from turbidity increases. Additionally, the Clean Water Act § 401Water Quality Certification that will be issued for the Sacramento River Anadromous Fish Habitat Restoration Program will limit the potential effects of fine sediment on fish by limiting the maximum increase of turbidity over background levels.

BMPs to control erosion and storm water sediment runoff will be implemented including, but not limited to, straw bales, straw wattles, silt fences, and other measures as necessary to minimize erosion and sediment-laden runoff from project areas. Instream construction will proceed in a manner that minimizes sediment discharge. Following completion of restoration activities, spawning gravel used for temporary crossing will be removed from the channel or spread evenly across the bottom of the channel, consistent with existing gravels. All crossings within the main channel will be designed to ensure that conditions are maintained for effective upstream and downstream fish passage, at all times and under all flow conditions. Instream work that may cause increased turbidity within the immediate vicinity of active redds and up to 200 feet downstream of the project footprint will be avoided whenever possible. Impacts of potential increased turbidity are expected to be minimal due to timing of gravel augmentation to avoid sensitive life stages, implementation of BMPs, and ability of juveniles to move to adjacent habitat.

4.2.4 Physical Disturbance

Physical disturbance is a direct result of construction activities and the placement of materials, which has the potential to affect all life stages of salmonids and green sturgeon (except incubating embryos) through displacement and disruption of normal behaviors. Displacement may temporarily expose juvenile fish to a greater risk of predation in all zones, but—considering potential exposure for multiple species— limiting the in-river work window to the fall and winter months will minimize effects to juveniles to the maximum extent practicable. Repeated disturbance may potentially lower reproductive success in holding adult winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon, but holding habitat is not limiting in the Upper Sacramento River; therefore, disturbance—followed by fish movement to other holding sites— would not be a significant stressor for adults. During construction activities, juvenile fish will not be able to utilize portions of the project footprint where equipment is actively working or within the associated turbidity plume, which is expected to be less than 25 percent of the river width, and to be most concentrated within about 200 feet downstream of the project site. However, rearing habitat for juvenile fish is generally well-distributed allowing for juvenile movement to other areas to avoid the physical disturbance of construction activities. Disturbance to listed fishes resulting from riffle supplementation, floodplain and side channel enhancement, and habitat structure placement is expected to be short-term due to the nature and duration of proposed instream and shoreline work. The duration of potential exposure from instream work is temporary and varies by restoration site (Table 1), and is expected to be less than 1.5 weeks for instream habitat structure placement and for excavation/contouring in the active main channel associated with reconnection of floodplain and side channel habitats to less than 4 weeks for riffle supplementation.

Direct injury or death may occur during instream construction activities during the installation of spawning gravel and instream habitat structures, and while grading the riverbed. Materials added to the riverbed and equipment working in the river could injure or kill salmonid and green sturgeon adults, eggs, and juveniles. Adult salmonids and green sturgeon would be potentially vulnerable when they are holding in deep pools and when they are actively spawning. However, the risk is higher for juvenile salmonids, which rear in shallow water.

The location of sites and the use of pre-construction surveys will minimize the risk to holding or spawning salmonid and green sturgeon adults, and incubating eggs. Additional conservation measures are designed to alert fish to equipment operation in the channel before gravel is placed in the water (e.g., slow, deliberate equipment operation and tapping water surface prior to entering river channel). Adult salmonids and green sturgeon are expected to move out of the area to adjacent suitable habitat before equipment enters the water or before gravel, logs, or boulders are placed over them. Therefore, the potential impact to adult salmonids and green sturgeon and their eggs are considered extremely unlikely to occur and considered discountable.

Although there is risk to juveniles, the peak of winter-run juvenile migration past Red Bluff generally occurs in September (Martin et al. 2001, Gaines and Martin 2002) with 58% (on average) of the broodyear passing Red Bluff prior to October 1 when instream construction activities may begin. The risk of exposure for juvenile spring-run and steelhead from many activities is greater because they may inhabit the Upper Sacramento River throughout the construction season. Additionally, juvenile green sturgeon may inhabit areas within Zone 3 during the construction season. However, juvenile spring-run and steelhead generally originate from tributaries and migrate at larger sizes and juvenile green sturgeon have grown past the larval stage prior to construction. These larger juvenile salmonids and sturgeon are more mobile, which enables them to avoid disturbance and move to adjacent suitable habitat. For activities where gravel is deposited on previously formed augmentation sites, such as lateral berms or end-dump talus cones, potential impacts are very low, as gravel is very unlikely to contact and adversely affect juveniles; therefore, potential impacts from these methods are extremely unlikely to occur and considered discountable. Riffle supplementation sites and floodplain and side channel enhancement sites, however, require applying the gravel directly to the riverbed and/or grading it, thereby increasing the likely exposure and chance for adverse effects to listed juveniles. Nonetheless, a majority of gravel augmentation activities will occur within shallow areas within the middle of the channel (>90%) where fewer juveniles are expected to be rearing. Previous studies indicate that juvenile salmonids tend to be found within 10-20 feet of river banks (Allen 2000, FISHBIO and Normandeau Associates 2012, Palmer and Hellmair 2012). There is limited information regarding habitats occupied by juvenile green sturgeon; however, “habitat preference… in the laboratory suggests that wild juveniles should be in deep pools with some rock structure” (Kynard et al. 2005). Although some rearing and migrating juveniles may be found further from the banks, the area disturbed by gravel placement or excavation and associated turbidity at any given time is expected to be less than 25 percent of the river width, and to be most concentrated within about 200 feet downstream of the project site; therefore, juveniles will have opportunities to move to other portions of the channel where they can avoid potential injury or death. Although juveniles are expected to avoid areas where equipment is actively placing or excavating gravel, an undetermined number of juvenile salmonids (all zones) and juvenile green sturgeon (Zone 3 only) may attempt to find shelter in the substrate and be injured or killed by equipment. Materials placed at riffle supplementation sites are intended to be used immediately and will only be mobilized under higher flows that occur infrequently. Placement of habitat structures in areas accessible by fish using heavy equipment and/or requiring temporary crossings for placement may impact juveniles. However, placement in the active channel will generally occur along non-vegetated channel margins where juvenile fish presence is expected to be minimal due to the lack of vegetation cover, which reduces the potential for exposure and associated injury or death from equipment. Due to BMPs designed to encourage fish movement out of the area prior to construction, minimal effects to juveniles are expected to occur as a result of the riffle supplementation method, floodplain and side channel enhancement, as well as placement of habitat structures within the channel.

4.4 Description of Gravel Augmentation, Floodplain and Side Channel Habitat Enhancements, and Instream Habitat Structure Construction Effects by Zone

4.4.1 Zone 1

No riffle supplementation sites, floodplain and side channel enhancement sites, or instream habitat structures are anticipated in Zone 1, and the only planned gravel augmentation activity is replenishing the Keswick Dam and Salt Creek end-dump talus cone augmentation sites. The in-river work window in this zone is year-round anytime flows are <15,000 cfs. Only about 20 percent of the deposited gravel is expected to enter the river at the time of placement, along approximately 200 linear feet of shoreline. Gravel will be cleaned prior to placement minimizing introduced turbidity. Equipment re-fueling and maintenance will not occur near the riverbank where gravel is dumped, so the likelihood of a hazardous material spill is extremely low. The area of the river bank and channel affected at these sites are not salmonid spawning or juvenile rearing habitat and no green sturgeon have been documented this far upstream. Therefore, potential adverse effects in Zone 1 are extremely unlikely to occur and considered discountable.

4.4.2 Zone 2

All three methods of gravel augmentation, floodplain and side channel enhancement, and various instream habitat structure placements are proposed in Zone 2 in both specified and unspecified locations (Table 1). The in-river work window in this zone is October 1 to May 15 anytime flows are <10,000 cfs. Construction work may occur year-round in areas where fish will not have access (i.e., where flowing water is absent due to separation from the main channel by gravel berms that are either naturally present or artificially created). Pre-construction salmonid redd surveys will be conducted to identify whether a site may affect egg survival and avoidance measures will be implemented if necessary. Potential exposure of various life stages of winter-run and spring-run Chinook salmon, and steelhead to project activities and potential effects are shown in Table 5. Green sturgeon have not been documented this far upstream; therefore adverse effects to this species are extremely unlikely to occur and are considered discountable.

Pre-construction surveys by a qualified biologist are necessary in this zone because some salmonid redds may be present during portions of the in-river work window and may contain incubating eggs and alevin of winter-run (May and October), spring-run (October-December), and steelhead (December-April 15). Similar surveys are not required for green sturgeon since they do not spawn in this zone. Whenever possible, sites will be avoided if redds are documented within the immediate project footprint to within 200 feet downstream to avoid harm to incubating eggs. If avoidance of redds is not possible, Reclamation will consult with NMFS to determine site-specific contingency measures for mitigating unavoidable impacts. Winter-run incubating eggs and juveniles; spring-run Chinook adults, incubating eggs, alevins, and juveniles; and steelhead adults and juveniles could be affected by hazardous materials spills. Conservation measures and pre-construction surveys will minimize this exposure and the

Table 5. Potential Exposure of Winter-Run and Spring-Run Chinook Salmon, Steelhead, and Green Sturgeon Life Stages to Project Activities and Associated Potential Effects.

Zone	Construction Window	Potential Exposure[a]	Activities: Not Likely to Adversely Affect	Activities: Likely to Adversely Affect
Zone 1	All Year	None expected	• End Dump Talus Cone	• None
Zone 2	October 1 to April 15[b] (anytime flows are <10,000 cfs; pre-construction salmonid redd surveys conducted)	Oct-Mar: juvenile winter-run rearing and outmigrating Oct-Apr 15: juvenile spring-run and steelhead rearing and outmigrating	• End Dump Talus Cone • Lateral Berm	• Riffle Supplementation • Floodplain and Side Channel Enhancement • Habitat Structure Placement
Zone 3	October 1 to March 1[b] (anytime flows are <10,000 cfs; pre-construction salmonid redd surveys conducted)	Oct-Mar 1: juvenile winter-run, spring-run, and steelhead rearing and outmigrating Oct-Dec: juvenile green sturgeon outmigrating[c]	• End Dump Talus Cone • Lateral Berm	• Riffle Supplementation • Floodplain and Side Channel Enhancement • Habitat Structure Placement

[a] Due to pre-construction surveys, site characteristics (e.g., shallow depths), and implementation of BMPs, the risk of exposure is extremely unlikely to occur and considered discountable for immigrating, holding, or spawning adults; incubating eggs; and pre-emergent fry.
[b] May be conducted year-round in areas, such as floodplains and side channels, when flowing water is either naturally or artificially (e.g., cofferdam) absent.
[c] Hypothetical (but undocumented) juvenile migration to overwintering areas may occur 180 days post hatch (Poytress et al. 2013, 2014).

potential for adverse effects to a level that is insignificant or extremely unlikely to occur and considered discountable.

Adult winter-run and steelhead may hold in, and migrate through this zone during portions of this in-river work window. Juvenile winter-run and spring-run Chinook salmon, and steelhead may rear and migrate through this zone during the in-river work window. Due to life stages that may be present, any winter-run and spring-run Chinook salmon, and steelhead in the area would have adjacent space to temporarily avoid project areas and direct injury from in-river construction activities. Since adults are most likely to be found in deeper parts of the channel than where equipment would be operated, the potential for adverse effects to adults is considered insignificant. Due to the possibility that juveniles may be present in shallow water work areas, some impacts may occur to juveniles during instream gravel placement and grading activities for riffle supplementation, instream excavation activities for floodplain and side channel enhancement, and instream placement of habitat structures.

Most potential impacts from the end-dump talus cone and lateral berm methods to all life stages of listed salmonids are considered discountable, as winter-run and spring-run Chinook salmon, and steelhead are extremely unlikely to be injured or killed from these methods via direct injury, turbidity, physical disturbance, or hazardous materials spills. These impacts are extremely unlikely because the majority of work is done outside of the river channel and relatively little gravel enters the river at the time of placement. However, there will be some loss of riparian vegetation where new lateral berms are placed over existing riparian vegetation, which could effect juvenile rearing; but this effect is expected to be insignificant because of the relatively small amount of riparian habitat that would be affected, and the availability of suitable adjacent riparian habitat.

The riffle supplementation gravel augmentation method, instream excavation activities for floodplain and side channel enhancement, and instream placement of habitat structures in this zone have the potential for impacts to winter-run and spring-run Chinook incubating eggs and alevin from turbidity, re-suspension and re-deposition of instream sediments, and hazardous materials spills; however, these impacts are discountable due to timing, pre-construction surveys, and use of BMPs. Winter-run and spring-run Chinook salmon and steelhead juveniles and adults could be affected by direct injury, turbidity, physical disturbance, and hazardous materials spills from these activities in this zone. Because gravel and instream habitat structures will be placed in water that is not sufficiently deep to provide holding habitat for adult winter-run and spring-run Chinook salmon, and steelhead, direct mortality to adults is extremely unlikely and considered discountable. A majority of gravel augmentation activities will occur within the middle of the channel (>90%) where fewer juveniles are expected to be rearing and gravel augmentation and excavation at any given time is expected to be less than 25 percent of the river width, and to be most concentrated within about 200 feet downstream of the project site; therefore, juveniles will have opportunities to move to other portions of the channel where they can avoid potential injury or death. Although salmonids are expected to avoid areas where equipment is actively placing or excavating gravel, an undetermined number of juvenile salmonids may attempt to find shelter in the substrate and be injured or killed by equipment. Placement of habitat structures in areas that are accessible by fish using heavy equipment and/or requiring temporary crossings for placement may impact juveniles. However, placement in the active channel will generally occur along non-vegetated channel margins where juvenile fish presence is expected to be minimal due to the lack of vegetation cover, which reduces the potential for exposure and associated injury or death from equipment. Conservation measures will minimize the risk to juvenile winter-run and spring-run Chinook salmon, and steelhead but some level of take may occur.

4.4.3 Zone 3

All three methods of gravel augmentation, floodplain and side channel enhancement, and various instream habitat structures are proposed in Zone 2 in both specified and unspecified locations (Table 1). The work window in this zone is October 1 to March 1 anytime flows are <10,000 cfs. Potential exposure of various life stages of winter-run and spring-run Chinook salmon, steelhead, and green sturgeon to project activities and potential effects are shown in Table 5.

Pre-construction surveys by a qualified biologist are necessary because some salmonid redds may be present during portions of the in-river work window and may contain incubating eggs and alevin of winter-run (May and October) and spring-run (October-December). Similar surveys are not required for green sturgeon since very few green sturgeon spawn or incubate during the in-river work window. Whenever possible, sites will be avoided if redds are documented within the immediate project footprint to within 200 feet downstream to avoid harm to incubating eggs. If avoidance of redds is not possible, Reclamation will consult with NMFS to determine site-specific contingency measures for mitigating unavoidable impacts. Winter-run incubating eggs and juveniles; spring-run Chinook adults, incubating eggs, alevins, and juveniles; steelhead adults and juveniles; and green sturgeon adults and juveniles could be affected by hazardous materials spills. Conservation measures and pre-construction surveys will minimize this exposure and the potential for adverse effects to a level that is insignificant or extremely unlikely to occur and considered discountable.

Adult winter-run, steelhead, and green sturgeon may hold in, and migrate through this zone during portions of the in-river work window. Juvenile winter-run and spring-run Chinook salmon, steelhead, and possibly green sturgeon may rear and migrate through this zone during the in-river work window. Due to life stages that may be present, any winter-run and spring-run Chinook salmon, steelhead, and green sturgeon in the area would have adjacent space to temporarily avoid the area and direct injury from instream construction activities. Since adults are most likely to be found in deeper parts of the channel than where equipment would be operated, the potential for adverse effects to adults is considered insignificant. Due to the possibility that juveniles may be present in shallow water work areas, some impacts may occur to juveniles during instream gravel placement and grading activities for riffle supplementation, instream excavation activities for floodplain and side channel enhancement, and instream placement of habitat structures.

Most potential impacts from the end-dump talus cone and lateral berm methods to all life stages of listed salmonids and green sturgeon are considered discountable, as winter-run and spring-run Chinook salmon, steelhead, and green sturgeon are extremely unlikely to be injured or killed from these methods via direct injury, turbidity, physical disturbance, or hazardous materials spills. These impacts are extremely unlikely because the majority of work is done outside of the river channel and relatively little gravel enters the river at the time of placement. However, there will be some loss of riparian vegetation where new lateral berms are placed over existing riparian vegetation, which could effect juvenile rearing; but this effect is expected to be insignificant because of the relatively small amount of riparian habitat that would be affected, and the availability of suitable adjacent riparian habitat.

The riffle supplementation gravel augmentation method, instream excavation activities for floodplain and side channel enhancement, and instream placement of habitat structures in this zone have the potential for impacts to winter-run and spring-run Chinook and steelhead incubating eggs and alevin from turbidity, re-suspension and re-deposition of instream sediments, and hazardous materials spills; however, these impacts are discountable due to timing, pre-construction surveys, and use of BMPs. Winter-run and spring-run Chinook salmon, steelhead, and green sturgeon juveniles and adults could be affected by direct injury, turbidity, physical disturbance, and hazardous materials spills from riffle supplementation in this zone. Because gravel and instream habitat structures will be placed in water that is not sufficiently deep to provide holding habitat for adult winter-run and spring-run Chinook salmon, steelhead, and green sturgeon, direct mortality to adults is very unlikely (discountable). A majority of gravel augmentation activities will occur within the middle of the channel (>90%) where fewer juveniles are expected to be rearing. Gravel augmentation and excavation at any given time is expected to be less than 25 percent of the river width, and associated turbidity is expected to be most concentrated within about 200 feet downstream of the project site; therefore, juveniles will have opportunities to move to other portions of the channel where they can avoid potential injury or death. Although juvenile salmonids and green sturgeon are expected to avoid areas where equipment is actively placing or excavating gravel, an undetermined number of juvenile salmonids and green sturgeon may attempt to find shelter in the substrate and be injured or killed by equipment. Placement of habitat structures in areas that are accessible by fish using heavy equipment and/or requiring temporary crossings for placement may impact juveniles. However, placement in the active channel will generally occur along non-vegetated channel margins where juvenile fish presence is expected to be minimal due to the lack of vegetation cover, which reduces the potential for exposure and associated injury or death from equipment. Conservation measures will minimize the risk to juvenile winter-run and spring-run Chinook salmon, steelhead, and green sturgeon but some level of take may occur.

4.5 Effects to Critical Habitat

Overall the proposed action will not diminish, but will improve and increase the conservation value of the spawning habitat and rearing habitat PCEs for CV spring-run Chinook salmon, CV steelhead, and Southern DPS of North American green sturgeon. Some short-term effects to the action area's water quality have the potential to occur. The potential for hazardous materials to enter the Upper Sacramento River is extremely unlikely as a result of BMP implementation. There may be temporary or permanent loss of some riparian habitat as a result of access to restoration sites. Impacts to existing vegetation will be avoided to the extent practicable, and most disturbed areas will be revegetated. A few areas that will continue to be used for access to long-term gravel augmentation sites will not be revegetated; however, these areas are minimal and because the majority of the Upper Sacramento River contains adjacent riparian habitat, the potential effect to riparian habitat is considered to be insignificant.

Gravel augmentation, floodplain and side channel enhancement, and placement of instream habitat structures may cause a temporary increase in turbidity and may redistribute and deposit silt or sand into the Upper Sacramento River, which could temporarily degrade current spawning gravel and reduce food availability. In addition, physical disturbance to spawning or rearing habitat could occur during gravel augmentation, floodplain and side channel enhancement, or instream habitat structure placement. BMPs will be employed during implementation of the proposed action so that spawning gravel will not be negatively affected. Implementation of these BMPs will ensure these potential effects are insignificant.

4.6 Beneficial Effects

All coarse sediment from the upper watershed is trapped by Shasta and Keswick Dams, which has resulted in a sediment deficit and reduction in fish habitat quality. In addition to the reduction of sediment supply, recruitment of LWM to the river channel and floodplain has also declined in the Upper Sacramento River after Shasta and Keswick Dams were built. As a result of project activities to augment spawning gravel, enhance floodplain and side channel habitats, and place instream habitat structures, spawning and rearing habitat are expected to improve and increase based on previous monitoring, which has indicated that similar restoration activities have created new spawning and rearing habitat for salmonids.

Gravel augmentation through injection (i.e., Keswick Dam and Salt Creek Sites) provides a source of appropriately sized gravels to restore spawning habitats once gravels are mobilized and re-deposited downstream by high flows. Riffle supplementation will create instantly available spawning habitat up to 15 acres per year.

Floodplain and side channel habitats serve as important refuge and rearing areas for salmonids. Excavation and contouring activities to enhance floodplain and side channel habitats will create instantly available habitat for rearing by up to 15 acres per year.

Instream habitat structures such as woody material and boulders contribute to habitat diversity and create and maintain foraging, cover, and resting habitat for both adult and juvenile anadromous fish. Placement of instream woody material on the banks of the active channel will create instantly available habitat by creating diverse cover for juvenile rearing, and possibly for holding adults, by up to 12 acres.

4.7 Cumulative Effects

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion.

Non-Federal actions that may affect the action area include angling and State angling regulation changes, voluntary State or private sponsored habitat restoration activities, agricultural practices, water withdrawals and diversions, adjacent mining activities, and increased population growth resulting in urbanization and development of floodplain habitats. While state angling regulations have moved towards restrictions on selected sport fishing to protect listed fish species, incidental hooking of Chinook salmon, hook and release mortality of steelhead, and trampling of redds by wading anglers may continue to cause a threat. Habitat restoration projects may have short-term negative effects associated with instream construction activities, but these effects are temporary, localized, and the outcome is expected to benefit listed species and habitats. Increased water turbidity levels for prolonged periods of time may result from agricultural practices, adjacent mining activities, and increased urbanization and/or development of riparian habitat, and could adversely affect the ability of young salmonids to feed effectively, resulting in reduced growth and survival. Turbidity may cause harm, injury, or mortality to juvenile Chinook or steelhead in the vicinity and downstream of the project area. High turbidity concentration can cause fish mortality, reduce fish feeding efficiency and decrease food availability (Berg and Northcote 1985, McLeay et al. 1984). Farming and ranching activities within or adjacent to the action area may have negative effects on water quality due to runoff laden with agricultural chemicals.

Water withdrawals and diversions may result in entrainment of individuals into unscreened or improperly screened diversions, and may result in depleted river flows that are necessary for migration, spawning, rearing, flushing of sediment from spawning gravels, gravel recruitment, and transport of LWM. Future urban development may adversely affect water quality, riparian function, and aquatic productivity.

4.8 Synthesis of Effects of the Proposed Action on Covered Species

Although winter-run and spring-run Chinook salmon, steelhead, and green sturgeon have the potential to be exposed to hazardous materials as a result of the proposed action, the BMPs and conservation measures in place make this a discountable effect. Loss of riparian vegetation due to road maintenance or gravel placement may occur as a result of the proposed action, but Reclamation will be replanting where possible, and any additional loss is considered to be at an insignificant level to affecting listed species. Increased turbidity as a result of the proposed action may occur, although temporary in nature. Depending on the life stage of the listed species, impacts from increased turbidity would vary. Juvenile and adult salmonids and green sturgeon would have adjacent suitable habitat to temporarily move to if needed, but a small amount of take of juveniles may occur. Due to their immobility, incubating eggs generally have the highest risk; however, with measures in place to avoid incubating eggs (i.e., in-river work windows and zones and pre-construction surveys for spawning salmonids and redds), this potential impact is considered to be insignificant.

The impact of instream work during gravel augmentation, floodplain and side channel enhancement, or habitat structure placement has the highest likelihood to affect listed species. The effects vary depending on the activity. The end dump talus cone and lateral berm gravel augmentation methods are unlikely to result in take of a listed species; therefore, the potential for impacts from these gravel augmentation methods is discountable. The riffle supplementation gravel augmentation method, instream excavation activities for floodplain and side channel enhancement, and instream habitat structure placement have the highest likelihood of killing, injuring, or harassing juvenile salmonids and green sturgeon when they are outmigrating or rearing in larger numbers during augmentation or placement and some level of take may occur. However, adverse impacts will only be temporary; while long-term impacts will be beneficial.

Overall, implementation of spawning gravel augmentation, floodplain and side channel enhancement, and placement of instream habitat structures is expected to increase and improve spawning and rearing habitats for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CV steelhead, as well as for Southern DPS of North American green sturgeon. Subsequently, population abundances are expected to increase and be maintained as a long-term benefit of the continued proposed action.

4.9 Impacts of the Proposed Action on ESU/DPS Survival and Potential for Recovery

Long-term gravel augmentation and restoration of riparian and floodplain ecosystems along the Sacramento River (including gravel bars, side channels, and shady vegetated banks) were identified as high priority recovery actions in the Central Valley Salmon and Steelhead Recovery Plan. The "Effects of the Action" section acknowledges and analyzes the potential effects of the Sacramento River Anadromous Fish Habitat Restoration Program. Some potential effects of the implementation of the proposed action may result in take of listed anadromous fish in the action area, although negative effects are expected to be minimal. Most significant immediate and long-term effects of the habitat restoration program will be to improve overall conditions for listed salmonids and green sturgeon by increasing and improving habitat. This improvement of habitat will be achieved through increasing spawning and rearing habitat.

The temporary adverse effects that are anticipated to result from the implementation are not the type or magnitude that would be expected to appreciably reduce the likelihood of survival and recovery of the affected species in the action area, or at the ESU/DPS level. VSP parameters of spatial structure, diversity, abundance, and productivity are not expected to be reduced; in contrast, implementing this proposed action is expected to improve these parameters, which will be necessary for the Upper Sacramento River populations to reach and/or maintain a viable status. The Central Valley Salmon and Steelhead Recovery Plan indicates that the winter-run Chinook population in the Upper Sacramento River watershed has the highest priority for recovery (Core 1), while spring-run Chinook salmon (Core 2) and steelhead (Core 2) populations have the second highest priority. Reclamation expects that any temporary adverse effects of this proposed action will be outweighed by the immediate and long-term benefits to species survival and increased abundance produced by the improvement in habitat for winter-run and spring-run Chinook salmon, steelhead, and green sturgeon.

4.10 Impacts of the Proposed Action on Critical Habitat

Overall, the Sacramento River Anadromous Fish Habitat Restoration Program will not diminish, but will improve and increase the conservation value of the PCEs spawning habitat and rearing habitat, for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead, and green sturgeon. The immediate and long-term effects of the program are anticipated to be beneficial to designated critical habitat for these species.

Gravel injections, excavation, and placement of instream habitat structures may cause a temporary increase in turbidity and may deposit silt or sand into the Upper Sacramento River, which could degrade current spawning habitat conditions and reduce food availability. In addition, physical disturbance to spawning or rearing habitat could occur during gravel placement, floodplain and side channel habitat enhancement, or instream habitat structure placement. BMPs will be employed during implementation of these activities, including construction windows that avoid spawning timing, so that spawning habitat will not be negatively affected. In addition, BMPs to wash the gravel prior to injecting will minimize and localize the extent of turbidity plumes. Implementation of these BMPs will ensure these potential effects remain insignificant.

Chapter 5 Amount or Extent of Take

Reclamation anticipates some incidental take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and Southern DPS of North American green sturgeon through the implementation of the Upper Sacramento River Anadromous Fish Habitat Restoration Program. Specifically, Reclamation anticipates that juvenile winter-run and spring-run Chinook salmon, steelhead, and green sturgeon may be killed, injured, or harassed during the implementation of restoration activities.

Ecological surrogates are those elements of the proposed action that are expected to result in take, and that are also somewhat predictable and/or measurable, and can be monitored to determine the level of take that is occurring. The most appropriate threshold for minimal take is an ecological surrogate of temporary habitat disturbance during the riffle supplementation method of gravel augmentation, instream excavation activities for floodplain and side channel enhancements, and instream placement of instream habitat structures. Estimated amounts of maximum areas used for floodplain and side channel enhancements and placement of instream habitat structures differs from overall project footprints because the impact areas are limited to those portions of these activities that will occur instream versus construction occurring in areas non-accessible to fish. The amount and extent of take was identified using the description of ecological surrogates associated with the action and the estimated number of fish based on fish density data. Actual take is anticipated to be very low because instream activities will occur during periods that will minimize fish exposure to the maximum extent practicable, will be implemented according to BMPs, and only small numbers of fish are expected to rear within or near project sites.

Anticipated annual take is presented in Table 6 and is limited to the following:

(1) Take in the form of harm to rearing/migrating juvenile Sacramento River winter-run and CV spring-run Chinook salmon, CV steelhead, and Southern DPS of North American green sturgeon and temporary loss of up to 1,100 foot sections of main channel riffle rearing habitat per project site resulting from the physical placement of up to 20,000 cubic yards of spawning gravel per project site and occurring at up to three project sites per year in the Upper Sacramento River via the riffle supplementation gravel augmentation method.

Harassment of juveniles may occur associated with displacement. Injury or death may result if gravel lands on juvenile fish, or if fine sediment from turbidity plumes enters their gills and causes respiratory distress or failure. The area disturbed by gravel placement or excavation and associated turbidity at any given time is expected to be less than 25 percent of the river width, and to be most concentrated within about 200 feet downstream of the project site. Based on previous snorkel surveys (CDFG 1998b)[4], average juvenile salmonid densities for the Upper Sacramento River are approximately 0.04 salmon per foot and 0.5 rainbow/steelhead trout. Therefore, we estimate that the maximum number of juvenile Chinook salmon and rainbow/steelhead trout affected by gravel placement and turbidity (amount of take) will be no more than 39 juvenile winter-run salmon (13 per site and up to 3 sites), 39 juvenile spring-run salmon (13 per site and up to 3 sites), and 51 juvenile rainbow/steelhead trout (17 per site and up to 3 sites) per year. Of this potential level of take, mortality is likely no more than 2 winter-run Chinook and 2 spring-run Chinook (i.e., no more than 5.1% of total take for each salmon race) and no more than 3 rainbow/steelhead trout (i.e., no more than 5.9% of total take). There are no data available for green sturgeon, but a conservative estimate is their density is likely to be less than half of Chinook salmon

[4] Snorkel surveys were conducted in 150 foot sections of the Upper Sacramento River parallel to the river bank at 109 sites between Keswick Dam (RM 302) and Battle Creek (RM 271) from October through December 15, 1996. Reported density estimates were in "per foot" measurements, instead of per square foot. Surveys were conducted during overlapping juvenile salmonid rearing and migration periods; therefore, take estimates generated from reported densities represent combined rearing and migration lifestages.

density; therefore, we estimate that the maximum number of juvenile green sturgeon that will be adversely affected by gravel placement (amount of take) will be no more than 21 fish per year (7 per site and up to 3 sites). Of this potential level of take, mortality is likely no more than 1 green sturgeon (i.e., no more than 16.7% of total take). There is not a stronger ecological surrogate based on the information available at this time because it is not possible to quantify the exact numbers of individuals that may be affected.

(2) Take in the form of harm to rearing/migrating juvenile Sacramento River winter-run and CV spring-run Chinook salmon, CV steelhead, and Southern DPS of North American green sturgeon and temporary loss of up to 100 foot sections of main channel riffle rearing habitat per project site resulting from floodplain and side channel excavation activities occurring at up to three project sites per year in the Upper Sacramento River.

Harassment of juveniles may occur associated with displacement. Injury or death may result if gravel lands on juvenile fish, or if fine sediment from turbidity plumes enters their gills and causes respiratory distress or failure. The area disturbed by excavation and associated turbidity at any given time is expected to be less than 25 percent of the river width, and to be most concentrated within about 200 feet downstream of the project site. Based on previous snorkel surveys (CDFG 1998b)[4], average juvenile salmonid densities for the Upper Sacramento River are approximately 0.04 salmon per foot and 0.5 rainbow/steelhead trout. Therefore, we estimate that the maximum number of juvenile salmonids affected by excavation, gravel placement, and turbidity (amount of take) will be no more than 9 juvenile winter-run Chinook salmon (3 per site and up to 3 sites), 9 juvenile spring-run Chinook salmon (3 per site and up to 3 sites), and 12 juvenile rainbow/steelhead trout (4 per site and up to 3 sites) per year. Of this potential level of take, mortality is likely no more than 1 winter-run Chinook and 1 spring-run Chinook (i.e., no more than 11.1% of total take for each salmon race) and no more than 1 rainbow/steelhead trout (i.e., no more than 8.3% of total take). There are no data available for green sturgeon, but a conservative estimate is their density is likely to be less than half of the Chinook salmon density; therefore, we estimate that the maximum number of juvenile green sturgeon that will be adversely affected by gravel placement (amount of take) will be no more than 6 juvenile green sturgeon per year (2 per site and up to 3 sites). Of this potential level of take, mortality is likely no more than 1 green sturgeon (i.e., no more than 16.7% of total take). There is not a stronger ecological surrogate based on the information available at this time because it is not possible to quantify the exact numbers of individuals that may be affected.

(3) Take in the form of harm to rearing/migrating juvenile Sacramento River winter-run and CV spring-run Chinook salmon, CV steelhead, and Southern DPS of North American green sturgeon and temporary loss of up to 1,100 foot sections of margin rearing habitat per project site resulting from instream habitat structure placement of up to 15 boulder clusters and 50 log structures per project site occurring underwater or near the water's edge at up to three project sites per year in the main channel of the Upper Sacramento River.

Table 6. Ecological surrogates of annual take anticipated as a result of proposed action activities.

Species and Life Stage	Activity by Zone	Life Stage Presence	Habitat Disturbance Amount	Maximum Amount and Extent of Take
Sacramento River winter-run Chinook salmon Juveniles	Zone 2: RS- 5 sites EX- 5 sites HS- 5 sites Zone 3: RS- 3 sites EX- 4 sites HS- 2 sites	Zone 2: Oct 1-Mar 30 juvenile winter-run rearing and outmigrating Zone 3: Oct 1-Mar 1 juvenile winter-run rearing and outmigrating USR Juvenile Salmon Rearing/Migrating Density: 0.04 salmon per foot	RS and HS: up to 1,300 foot sections EX: up to 300 foot sections	RS and HS: 39 juvenile winter-run salmon (up to 13 per site and up to 3 sites per year); Of this potential level of take, mortality is likely no more than 2 winter-run Chinook (i.e., no more than 5.1% of total take). EX: 9 juvenile winter-run salmon (up to 3 per site and up to 3 sites per year); Of this potential level of take, mortality is likely no more than 1 winter-run Chinook (i.e., no more than 11.1% of total take).
Central Valley spring-run Chinook salmon Juveniles		Zone 2: Oct 1-Apr 15: juvenile spring-run rearing and outmigrating Zone 3: Oct 1-Mar 1: juvenile spring-run rearing and outmigrating USR Juvenile Salmon Rearing/Migrating Density: 0.04 salmon per foot		RS and HS: 39 juvenile spring-run salmon (up to 13 per site and up to 3 sites per year); Of this potential level of take, mortality is likely no more than 2 spring-run Chinook (i.e., no more than 5.1% of total take). EX: 9 juvenile spring-run salmon (up to 3 per site and up to 3 sites per year); Of this potential level of take, mortality is likely no more than 1 spring-run Chinook (i.e., no more than 11.1% of total take).

Species and Life Stage	Activity by Zone	Life Stage Presence	Habitat Disturbance Amount	Maximum Amount and Extent of Take
Central Valley steelhead Juveniles	Zone 2: RS- 5 sites EX- 5 sites HS- 5 sites Zone 3: RS- 3 sites EX- 4 sites HS- 2 sites	Zone 2: Oct 1-Apr 15: juvenile steelhead rearing and outmigrating Zone 3: Oct 1-Mar 1: juvenile steelhead rearing and outmigrating USR Juvenile Rainbow/ Steelhead Rearing/Migrating Density: 0.5 rainbow/steelhead trout per foot	RS and HS: up to 1,300 foot sections EX: up to 300 foot sections	RS and HS: 51 juvenile rainbow/steelhead trout (up to 17 per site and up to 3 sites per year); Of this potential level of take, mortality is likely no more than 3 rainbow/steelhead trout (i.e., no more than 5.9% of total take). EX: 12 juvenile rainbow/steelhead trout (up to 4 per site and up to 3 sites per year); Of this potential level of take, mortality is likely no more than 1 rainbow/ steelhead trout (i.e., no more than 8.3% of total take).
Southern DPS of North American green sturgeon Juveniles	Zone 3: RS- 3 sites EX- 4 sites HS- 2 sites	Zone 3: Oct 1-Dec 30: juvenile green sturgeon outmigrating USR Juvenile Green Sturgeon Rearing/Migrating Density: 0.2 green sturgeon per foot		RS and HS: 21 juvenile green sturgeon per year (up to 7 per site and up to 3 sites); Of this potential level of take, mortality is likely no more than 1 green sturgeon (i.e., no more than 16.7% of total take) EX: 6 juvenile green sturgeon per year (2 per site and up to 3 sites). Of this potential level of take, mortality is likely no more than 1 green sturgeon (i.e., no more than 16.7% of total take)

Codes- RS: riffle supplementation gravel augmentation; EX: floodplain and side channel excavation; HS: habitat structure placement; USR: Upper Sacramento River (between Keswick and Red Bluff Diversion Dams).

Harassment of juveniles may occur associated with displacement. Injury or death may result if gravel lands on juvenile fish, or if fine sediment from turbidity plumes enters their gills and causes respiratory distress or failure. The area disturbed by instream habitat structure placement and associated turbidity at any given time is expected to be less than 25 percent of the river width, and to be most concentrated within about 200 feet downstream of the project site. Based on previous snorkel surveys (CDFG 1998b)[4], average juvenile salmonid densities for the Upper Sacramento River are approximately 0.04 salmon per foot and 0.5 rainbow/steelhead trout. Therefore, we estimate that the maximum number of juvenile salmonids affected by gravel placement and turbidity (amount of take) will be no more than 39 juvenile winter-run salmon (13 per site and up to 3 sites), 39 juvenile spring-run salmon (13 per site and up to 3 sites), and 51 juvenile rainbow/steelhead trout (17 per site and up to 3 sites) per year. Of this potential level of take, mortality is likely less than 5% per race of salmon (i.e., <2) and rainbow/steelhead trout (i.e., <1). There are no data available for green sturgeon, but a conservative estimate is their density is likely to be less than half of the Chinook salmon density; therefore, we estimate that the maximum number of juvenile green sturgeon that will be adversely affected by gravel placement (amount of take) will be no more than 21 juvenile green sturgeon per year (7 per site and up to 3 sites). Of this potential level of take, mortality is likely no more than 1 green sturgeon (i.e., no more than 16.7% of total take). There is not a stronger ecological surrogate based on the information available at this time because it is not possible to quantify the exact numbers of individuals that may be affected.

Chapter 6 Findings and Determination

The potential proposed action effects on listed anadromous fishes and their habitat were analyzed. Construction activities may result in temporary and localized increases in turbidity and suspended sediment, and direct mortality and disturbance may result from instream work. With the incorporation of conservation measures, any temporary negative impacts on populations or habitat will be inconsequential in the long-term. The proposed action has been designed to the greatest extent possible to alleviate the potential for take to occur. Additionally, the proposed action will result in the addition or enhancement of salmonid spawning and rearing habitat, which is expected to support an increased number of salmonids over the long-term.

Based on this analysis, it is determined that the proposed Upper Sacramento River Anadromous Fish Habitat Restoration Program *may affect, and is likely to adversely affect* Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CV steelhead, and Southern DPS of North American green sturgeon, and *may affect, but is not likely to adversely modify* critical habitat. While take of listed salmonid species and some habitat modifications may occur during construction activities associated with habitat restoration, these impacts will be short-term and the long-term benefits of the resulting habitat improvements will far outweigh the short-term effects on the listed species.

In addition, it is determined that the proposed action *is not likely to eliminate or significantly diminish or disrupt*, essential fish habitat (EFH) for Pacific salmon inhabiting the Upper Sacramento River.

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APPENDIX A

Upper Sacramento River Anadromous Fish Habitat Restoration Site Descriptions

Upper Sacramento River Anadromous Fish Habitat Restoration Site Descriptions

The upper Sacramento River between Keswick Dam and Red Bluff presents several opportunities for improving and restoring salmonid spawning and rearing habitats. Sites were selected throughout the study reach by an interagency group of experts. Sites are intended to maintain flexibility for providing salmonid spawning and rearing habitat enhancement through long-term gravel replenishment, in-channel gravel placements, and side channel and floodplain enhancements to meet the goals of the CVPIA program. The criteria used to select sites and develop conceptual designs include: biological need, site suitability and access, engineering feasibility, environmental compliance and permitting, gravel availability and transportation, and cost-benefit. The proposed action includes 13 sites (Table A-1; Figure A-1) where restoration activities were identified for providing improved habitat. Site specific projects are described in the following sections.

Side Channel Enhancement

Side channel work would be completed to create new side channel habitat and reconnect existing side channels at a wider range of flows. Side channels would have varying cross sections and the water would be mostly in the range of one to three feet deep in the flow range of 4,000 cfs to 7,000 cfs and would include some deeper pools. The channels would vary in width in the range of approximately 12 to 50 feet wide for new channels and potentially larger for existing channels. Water velocities would be designed to be variable and range up to about five feet per second at design flows. The side channels would be excavated as needed and excavated material would be spread on the adjacent terrain using heavy equipment (bulldozer, front end loader, excavator). Where the excavated material is of the appropriate size distribution it would be sorted and placed into side channel or main channel areas to enhance habitat features. The fines would be distributed over the floodplain to assist in vegetating the area. Gravel placed into the main channel may be used to help back water up into side channels. Low elevation gently sloping benches would be created along channels in opportune areas to provide juvenile rearing habitat through a range of flows.

Instream habitat structure (e.g., woody material such as, trees, trunks, rootwads, and willows; and variable sized large rocks) would be incorporated into the side channels to enhance habitat quality. The woody material would be held in place by partially burying it in the existing substrate or banks or keying into existing material to provide some stability under higher flows.

Gravel Placement

The gravel placed would be uncrushed, rounded “natural river rock” with no sharp edges. It would be a reasonably well-graded mix, designed for spawning use by salmonids, made using an approximately ¼” screen on the bottom. The D_{50} (median diameter of sample) of the mix would be around 1 inch to 1-1/2 inch. The gravel would be processed prior to delivery to the sites to

Table A-1. Upper Sacramento River Anadromous Fish Habitat Restoration Sites.

Site	RM	Restoration Type	Method*	Approximate Maximum Dimensions	Approximate Maximum Quantity	Frequency	Approximate Duration of Activity
Site 1-Keswick	302	Gravel Augmentation	EDTC	0.5 acres	20,000 yd^3	As needed	4 weeks
Site 2-Salt Creek	300.7	Gravel Augmentation	LB	0.5 acres	20,000 yd^3	As needed	4 weeks
Site 3-Market Street	298.3	Gravel Augmentation	RS	3.5 acres	15,000 yd^3	As needed	4 weeks
Site 4-Turtle Bay Island	297	Side Channel Creation; Instream Habitat Structure	EX, HS	Each: 1.1 acres	4 new side channels	Once	8 weeks***
Site 5-Kutras Lake	296	Instream Habitat Structure	HS	40 acres**	20 structures	Pilot-once, then as needed	3 weeks
Site 6- Cypress Avenue Bridge	295	Side Channel Reconnection; Instream Habitat Structure	EX, HS	3 acres	2 modified side channels	Once	6 weeks***
Site 7-Cypress Avenue Bridge South		Side Channel Creation; Instream Habitat Structure	EX; HS	4 acres	1 new side channel with possible small branches	Once	5 weeks***
		Gravel Augmentation	RS	8 acres**	15,000 yd^3	As needed	5 weeks
Site 8-Tobiasson Island	291.6	Side Channel Creation; Instream Habitat Structure	EX, RS, HS	Each: 1.7 acres**	3 new side channels	Once	8 weeks***
		Gravel Augmentation in West Side Channel	EX, RS, HS	1.5 acres	6,000 yd^3	Once	3 weeks
		Gravel Augmentation in Main Channel	RS	6 acres	12,000 yd^3	As needed	5 weeks
Site 9- Shea Island	289.6	Gravel Augmentation	RS	12 acres**	12,000yd^3	As needed	5 weeks
		Side Channel Reconnection; Instream Habitat Structure	EX, HS	3 acres	3 reconnected side channels	Once	8 weeks***
Site 10- South Shea Levee	289	Gravel Augmentation	RS	3.3 acres**	10,000 yd^3	Once	4 weeks
Site 11-Kapuesta Island	288	Side Channel Creation/Modification; Instream Habitat Structure	EX, HS	1.4 acres	1 new & 3 modified side channels	Once	8 weeks***
		Gravel Augmentation	RS	4 acres	12,000 yd^3	Once	6 weeks
Site 12-Anderson River Park	282	Side Channel Reconnection	EX, HS	11.5 acres	1 side channel reconnected	Once	6 weeks***
Site 13- Reading Island	275	Side Channel Reconnection	EX, HS	7.4 acres	1 side channel reconnected	Once	6 weeks***

Site	RM	Restoration Type	Method*	Approximate Maximum Dimensions	Approximate Maximum Quantity	Frequency	Approximate Duration of Activity
Unspecified Locations	243-300.5	Gravel Augmentation	EDTC	Per site: 0.5 acres	20,000 yd^3 per site; 5 sites	As needed	4 weeks
		Gravel Augmentation	LB	Per site: 0.5 acres	20,000 yd^3 per site; 5 sites	As needed	4 weeks
		Gravel Augmentation	RS	Per site: 12 acres**	12,000yd^3 per site; 10 sites	As needed	5 weeks
		Side Channel Creation/ Modification	EX, HS	Per site: 4 acres	4 new/ modified side channels per site; 10 sites	Once per site	2-6 weeks***
		Instream Habitat Structure	HS	Per site: 4 acres**	Per Year: 30 boulder clusters, 100 log structures; 3 sites	As needed	3-8 weeks***

*Method codes are: EDTC = End Dump Talus Cone; LB = Lateral Berm; RS = Riffle Supplementation; EX = Excavation; HS =Habitat Structure Placement
**Number represents potential action area; the actual project footprint location within the area is unknown but will be smaller.
***Values represent overall construction timeframe; actual duration of instream work will be less than half of this timeframe (i.e., less than 1.5-4 weeks dependent on project type and site

remove excessive fine materials and minimize introduction of excessive fine sediments into the river. The gravel would be free of oils, clay, debris, and organic material. Materials excavated from side-channel work could be used for onsite gravel placement and sorted as needed to meet design criteria. The larger gravel and cobble resulting from sorting operations would be used as needed to enhance stability of habitat features.

Stockpile areas would be located near the project sites or within the site boundaries. Existing improved and unimproved roads would be used by transport trucks to deliver gravel to stockpile areas. Stockpile areas adjacent to the river generally would be about one half acre or less and would be placed in existing clearings where ground disturbance would be minimized by using existing dredger tailings or similar type of material.

For purposes of this analysis, tandem transfer trucks (trucks pulling a trailer that can be telescoped into the truck bed) capable of carrying 24 tons per load would be used for transporting gravel to project sites. Single bed off road trucks capable of carrying 12 to 50 tons would be used for transporting gravel within project work sites off of public roads.

Gravel would be placed in the river using dump trucks and front end loaders. At some sites the substrate would be graded with a bulldozer prior to gravel additions to remove armoring (surface layer of larger rock) or to meet topographic design specifications. A bulldozer would be used to distribute the materials in areas unworkable for loaders.

For the gravel placement, front end loaders would pick up a bucket of gravel from the stockpile and drive from the stockpile into the river and carefully dump the gravel in a manner as to distribute it across the river bottom according to design parameters. Placement would proceed starting from the river access site and working out into the river. This would allow the loaders to drive on the newly placed gravel, thereby avoiding driving in overly deep water and distributing fines from the existing substrate. Off-road dump trucks would dump haul the material into the river in areas where the travel distance to an onshore stockpile is excessively long for multiple loader trips. The loaders would distribute the gravel along the river bottom to create the hydraulic conditions necessary for salmonid spawning. This work would use two or three front end loaders for about one month per project site each year. A tracked bulldozer or excavator would be used for grading the existing substrate and larger placed rock as needed.

For sites using the Stockpile Injection approach, gravel would be dumped directly into the river from dump trucks or dumped using front end loaders. The trucks would originate from a stockpile area or an off-site processing plant. A front end loader would be used as needed to distribute the gravel into the river.

Features Common to All Sites

Instream work would be done at river flows and during time periods to minimize effects on Chinook salmon, steelhead, and green sturgeon as specified in permits. Work mobilizing gravel and equipment to the sites and work out of the wetted channel or within wetted areas disconnected from the river channel could occur outside of fish timing windows, but work in water accessible to fish from the main river channel would be confined to timing windows and suitable flows.

Any equipment used in or near the river would be properly cleaned to prevent any hazardous materials from entering the river, and spill containment materials would be on site in case of an accidental discharge. Reclamation and other personnel would regularly monitor equipment operators to insure environmental compliance.

Although work would occur between Keswick Dam and Red Bluff, the actual gravel placement and channel work would occur in a smaller total length of river. Gravel placement would cover approximately 37 acres and side-channel enhancement would result in approximately 8 miles of new or re-connected side-channel habitat.

Designs will be prepared as needed for site specific work. Gravel augmentation would be completed without formal designs at some sites (e.g. Keswick, Salt Creek). Sites that incorporate side channel work would include more formal designs. The detailed design features for each site will be prepared as funding becomes available to conduct the work each year. The detailed design features (i.e. features more detailed than needed for permitting processes) will be coordinated annually with an interagency technical group.

Site Specific Descriptions

Site 1 – Keswick Dam (RM 302)

Site 1-Keswick is located at river mile (RM) 302.0 on the west bank of the Sacramento River just downstream of Keswick Dam (Figure A-2). This site will involve long-term gravel augmentation via end-dumping, which has been implemented at this site numerous times since 1989 for spawning habitat improvements. In a given year, up to approximately 20,000 cubic yards of gravel will be end-dumped from a 100-ft high bank resulting in an approximately one-half acre Talus Cone shaped pile (up to 200 ft long by 100 ft wide by 100 ft high) along the west (right) river bank. Most of the material will initially be retained on the river bank outside of the wetted channel (about 75%) as indicated by Figure A-3 and Figure A-4. Gravel will remain in this configuration until periodic winter flows greater than about 25,000 cfs at Keswick, expected to occur approximately every other year, mobilize it downstream. Although annual gravel placement along the river bank is not expected to create immediate benefits to fish, it will provide long-term benefits to Chinook salmon and steelhead as gravel washes downstream under high flow events where it will create and maintain spawning habitat.

The property and existing facilities are owned by Reclamation which allows direct access to the site throughout the year. Site modifications to allow gravel placement are not necessary. Access will be through Iron Mountain Road and Keswick Dam Road from the west. Loaded dump trucks will not cross Keswick Dam.

Approximate location 122° 26'46.8161" W 40° 36'32.5579" N (Section 21, T32N, R5W MDM) in the USGS 7.5 Minute Redding Quadrangle.

Site 2 – Salt Creek (RM 300.7)

Site 2-Salt Creek is located at RM 300.7 on the west bank of the river channel approximately 500 feet downstream from where Salt Creek enters the Sacramento River (Figure A-5). This site would involve long-term gravel augmentation via end-dumping, which, similar to Site 1-Keswick, has been done at this site numerous times since 1989 for spawning habitat improvements (Figure A-6). In a given year, up to approximately 20,000 cubic yards of gravel would be dumped from an approximately ten foot high terrace resulting in an approximately one-half acre pile along the right bank of the river (up to 200 ft long by 100 ft wide). Similar to Site 1-Keswick, most of the material would initially be retained in the pile until periodic high winter flows greater than about 25,000 cfs, expected to occur about every other year, mobilize it downstream. Although annual gravel placement along the river bank is not expected to create immediate benefits to fish, it would provide long-term benefits to Chinook salmon and steelhead as gravel washes downstream under high flow events where it will create and maintain spawning habitat.

The property is managed by the City of Redding and BLM. Access would be through an existing unpaved trail that runs parallel to the Sacramento River Trail. Trucks would enter the trail by crossing a portion of the Shasta Rail Trail via Middle Creek Road. Damage to existing paved trails would be minimized by using unpaved trails and limiting the area that trucks cross to a single intersection. A temporary crossing of Salt Creek (an intermittent stream) would be necessary and would be accomplished by placing spawning gravel across this channel where an existing Trail, created by vehicle traffic, crosses. At the completion of work each season, the gravel in this temporary crossing would be graded so that stream flow is not impeded.

Approximate location 122° 26'1.25" W 40° 35'38.73" N (Section 33 T32N, R5W MDM) in the USGS 7.5 Minute Redding Quadrangle.

Site 3 – Market Street South (RM 298.3)

Site 3-Market Street is located at RM 298.32 on the west bank of the Sacramento River (Figure A-7). The site is located just downstream of the Anderson Cottonwood Irrigation District (ACID) Diversion Dam to avoid impacts to existing infrastructure (Figure A-8). This location involves gravel placement using front end loaders. Gravel has not previously been added at this site; however, field reconnaissance indicates that river conditions are conducive to gravel placement and may support long-term gravel augmentation activities. In a given year, up to approximately 15,000 cubic yards of gravel would be placed within the river during low river flow conditions (i.e., < 10,000 cfs). Gravel would be placed along the bank and spread as far as is feasible into the channel using front end loaders under the flow conditions occurring during construction. Approximately 3.5 acres (510 feet long x 300 feet wide) of improved spawning habitat could be directly used by salmonids. Additionally, a portion of the gravel would be mobilized under high flows and transported downstream to areas where it can also provide fisheries benefits.

The upland property adjacent to the channel and associated facilities are owned by ACID. Access would be on an existing City of Redding gated road and then through ACID's Diversion Dam and fish screen facility. The low river bank in the area will allow easy access to the river so that front end loaders can transport and place gravel into the river channel (Figure A-9). River access points will be through gaps in vegetation and will be selected to avoid the removal of, or disturbances to, large mature riparian trees and any sensitive plant species or habitats (e.g., elderberry, wetlands). Due to the project's proximity to ACID's existing facilities, site development will be limited to clearing access points to the river and vehicle staging and gravel stockpile areas will be located near these facilities in previously disturbed areas devoid of vegetation.

Approximate location 122° 23'34.0933" W 40° 35'30.6504" N (Section 35 and 36, T32N, R5W MDM) in the USGS 7.5 Minute Redding Quadrangle.

Site 4 – Turtle Bay Island (RM 297)

Site 4-Turtle Bay Island is located at RM 297.0 on an island at a bend in the river known as Turtle Bay (Figure A-10). This site was historically part of a large gravel quarry where aggregate was removed for Shasta Dam construction in the 1940s. More recently, a side channel spawning habitat rehabilitation project was completed in 1988 along the western edge of the Turtle Bay area, which converted the historic floodplain bar into a year-round island (Figure A-11; Figure A-12). The rehabilitated side channel has provided suitable spawning and rearing habitat over a broad range of river flows. This location involves constructing up to four additional perennial side channels on the island with associated placement of instream habitat structures to provide juvenile salmonid rearing and spawning habitat.

Up to four perennial side channels will be created on the island through excavation and grading. Each will be constructed up to 1,000 feet long and each channel will be designed to have variable widths (up to 50 feet wide), depths (up to 16 feet deep), and velocities (up to about five feet per second) to provide habitat complexity. Variably inundated floodplain benches will be created along the channel margins to provide juvenile salmonid rearing habitat over a range of river flows. Channel substrates will be graded below existing elevations by approximately 4-6 feet at the upstream end and 13-16 feet at the downstream end. Instream habitat structures (e.g., woody material such as, trees, trunks, rootwads, and willows; and variable sized large rocks) will be incorporated into the newly created side channels to enhance habitat quality and channel persistence. Woody material will be incorporated by partially burying pieces in the channel bed and adjacent banks to provide some stability under higher flows.

The property is owned by the City of Redding and the California State Lands Commission. Access will be through City of Redding property at Turtle Bay and will be coordinated with the City of Redding. A temporary crossing may need to be created by pushing gravel across the upper end of the existing side channel to create a temporary driving surface for equipment. The crossing will be removed by grading into the surrounding terrain at the completion of the work.

Gravel excavated to create each channel will be processed (i.e., sorted according to size) and redistributed on the island and surrounding river. If the underlying channel's substrate composition is not appropriately sized for spawning, appropriately sized gravel that was processed from nearby excavation areas (or transported from a local gravel distributor) may be added; however, it is unlikely that gravel additions will be necessary since field reconnaissance indicates that suitable material is likely present.

Approximate location 122° 22'7.9095" W 40° 35'25.0966" N (Section 31, T32N, R4W MDM) in the USGS 7.5 Minute Enterprise Quadrangle.

Site 5 – Kutras Lake (RM 296)

Site 5-Kutras Lake is located at RM 296 (Figure A-13) on the west (right) side of the river. Kutras Lake is approximately 40 acres and remains connected to the Sacramento River year-round. Juvenile salmonids may use this area for rearing; however, existing rearing habitat is limited by low levels of cover. This location would initially serve as a small-scale pilot project involving placement of instream habitat (i.e., large woody material) in the area. The woody material would be held in place by driving piles and attaching clusters of woody material to the piles. Based on results of the pilot project (i.e., observed fish usage), additional instream habitat structure may be added at the site or may be placed in other habitats within the project reach.

The property is owned by a private landowner. Access will be through Park Marina Drive and the Kutras boat ramp.

Approximate location 122° 22'2.03" W 40° 34'39.81" N (Section 36, T32N, R5W MDM) in the USGS 7.5 Minute Enterprise Quadrangle.

Site 6 – Cypress Avenue Bridge North (RM 295)

Site 6- Cypress Avenue Bridge North is located at RM 295 just upstream of the Cypress Avenue Bridge along the east (left) river bank (Figure A-14). This location involves reconnecting two partially functional side channels (northern and southern) to the main channel to increase juvenile salmonid rearing habitat.

Under existing conditions, the upstream half of the northern side channel is disconnected from the main channel at low flows while the downstream half currently functions as a backwater slough due to its continued connectivity with the main channel at all flows (Figure A-15). To provide a functional side channel under main channel flow conditions > 3,250 cfs, excavation would occur at the upstream portion of the northern channels and will encompass an approximately three acre area. Some grading within the remainder of the side channel may be done to improve habitat. The total length of the reconnected side channels would be approximately 1,000 feet.

The southern channel is currently disconnected at the downstream end at low flows. To provide a functional side channel under main channel flow conditions > 3,250 cfs, excavation would include widening a small opening at the upstream side of an existing pond, which would encompass an approximately one-half acre area. A downstream outlet would be created through excavation in approximately a one acre area. Some grading within the remainder of the side channel may be done to improve the habitat. The total length of the downstream reconnected side channel would be approximately 800 feet.

The property is owned by Shasta Enterprises. Access to the site will be coordinated with Shasta Enterprises and the City of Redding. Existing unpaved trails would provide a route covering the length of the project area. Trucks would likely access the trails by crossing under the Cypress Avenue Bridge from the south.

Approximate location 122° 22'10.21" W 40° 34'25.13" N (Section 6, T31N, R4W MDM) in the USGS 7.5 Minute Enterprise Quadrangle.

Site 7 – Cypress Avenue Bridge South (RM 295)

Site 7-Cypress Avenue Bridge South is located at RM 295.0 immediately downstream of the Cypress Avenue Bridge (Figure A-13). This location involves creation of a side channel complex through the Henderson Open Space Area (Figure 16) and gravel augmentation within the main river channel (Figure 17).

Side Channel Creation Under existing conditions, the Henderson Open Space Area includes several existing ponds that are disconnected from the main channel. These ponds would be connected to provide a constant flow through to provide habitat for coldwater species and reduce habitat quality for invasive fish species. Excavation will encompass up to approximately three acres and would be roughly balanced by fill of ponded areas currently occupied by invasive species. The total length of the new side channel would be approximately 3,000 feet long and there would be multiple connections with the main channel.

The property is owned by the City of Redding and includes the Henderson Open Space Area (HOSA), which is a recreational area that is maintained in a relatively natural state (Figure A-12) with some unpaved pedestrian trails and disc golf course. Access is likely to occur over existing unpaved pedestrian trails and may require temporary closure of some portions of the HOSA for up to five weeks, which will be coordinated with the City of Redding.

Gravel Augmentation The river bed substrate is coarse and armored in this area so gravel would be added across the main channel. Although gravel augmentation aimed at creating spawning habitat has not previously been applied at this site, spawning sized gravel was recently placed within the river channel during Cypress Avenue Bridge construction activities to function as temporary construction platforms and was left in place to provide long-term habitat benefits. In a given year, up to 15,000 cubic yards of gravel would be placed within the river during low flow conditions (i.e., less than about 7,000 cfs). Gravel would be placed along the bank and spread as far as is feasible into the channel using under the flow conditions occurring during construction.

The site will provide up to approximately eight acres (600 ft long x 400 ft wide) of spawning habitat that can be directly used by salmonids. A portion of augmented gravels would be mobilized under high flows and transported downstream to areas where they can also provide fisheries benefits.

Approximate location 122° 22'29.5486" W 40° 34'18.1779" N (Section 1, T31N, R5W and Section 6, T31N, R4W MDM) in the USGS 7.5 Minute Enterprise Quadrangle.

Site 8 – Tobiasson Island Area (RM 291.6)

Site 8-Tobiasson Island Area is located at RM 291.6 at Tobiasson Island and includes adjacent main and side channels (Figure A-18). The island is about 26 acres, forming a triangular shape measuring about 1,500 ft long by 1,500 ft wide at its widest point. This site involves constructing up to three perennial side channels on the island and implementing gravel improvements in the west (right) side channel and also within the main river channel along the east (left) bank. The creation of perennially flowing channels on the island is expected to increase juvenile salmonid rearing and adult spawning habitat at this site. Although the western side channel provides suitable depths and velocities for salmon to spawn at most flows up to about 15,000 cfs, much of the substrate is too coarse for spawning so gravel placement or grading of the channel substrate would provide substrate more conducive to spawning.

Side Channel Creation Up to three perennial side channels would be constructed on Tobiasson Island (Figure A-19) to increase juvenile salmonid rearing and adult spawning habitat. The channels would be up to 1,500 feet long and will be designed to have variable widths (up to 50 feet wide), with variable depths and velocities to provide habitat complexity. The channels would be created by grading the existing material on the island to provide the appropriate depths and velocities to improve juvenile salmonid habitat potential. Variably inundated floodplain benches would be created along the channels to provide vegetated juvenile habitat at a range of river flows. Excavated materials would be sorted and larger materials placed in the active main river channel near the upstream end of the island to provide control of flow splits between the different channels. Spawning sized materials would be placed in the existing west side channel and/or the main river channel along the east bank as a source of spawning gravel.

Gravel Augmentation The substrate of the existing side channel is largely armored with cobble too large for Chinook spawning. Portions of the surface of the side channel would be graded and/or spawning sized material added to provide habitat more conducive to spawning for Chinook and steelhead. Up to 1.5 acres (610 ft long x 110 ft wide) of this substrate would be graded and/or spawning sized gravel (up to 6,000 cubic yards) added to provide habitat more conducive for Chinook and steelhead spawning.

Gravel would be placed along the east (left) bank of the main river channel across from the downstream end of the island (Figure A-20). In a given year, up to 12,000 cubic yards of gravel would be placed within the river. . Gravel would be spread as far as is feasible into the channel using front end loaders and other heavy equipment under the flow conditions occurring during construction. Gravel placement would provide up to approximately 6 acres (1,100 ft long x 250 ft wide) of spawning habitat that can be directly used by salmonids. A portion of the gravel would be mobilized under high flows and transported downstream to areas where it can also provide fisheries benefits.

Access from the west would be provided from South Bonnyview Road via South Wixon Lane. The land on the west bank of the side-channel is privately owned. There is approximately 1,000 ft of existing gravel road that would be used with permission of the private landowner. The island would be accessed by crossing the side channel with the heavy equipment. A base layer of spawning gravel would be added to provide a driving surface if needed and minor cuts and fills would be made to facilitate access by equipment. Access for gravel placement in the main channel would be from the east over private land. A section of low bank would be utilized to access the river where minimal improvement would be needed. This location could serve as a long-term gravel placement site depending on how rapidly material is mobilized from the placement area.

Approximate location 122° 21'24.0196" W 40° 31'59.3017" N (Section 19, T31N, R4W MDM) in the USGS 7.5 Minute Enterprise Quadrangle.

Site 9 – Shea Island and Levee (RM 289.6)

Site 9-Shea Island is located at RM 289.6 just upstream of the Clear Creek confluence to the Sacramento River and along the Shea Levee adjacent to the Shea Sand and Gravel Company (Figure A-21). This location involves gravel augmentation along the east (left) bank and side channel habitat reconnection along the west (right) bank of the river. The east bank area is owned by a private landowner and CDFW, while the west bank area is owned by the City of Redding.

Side Channel Connectivity An existing side channel complex contains good salmonid spawning and rearing habitat at flows greater than about 5,000 cfs. At lower flows, the side channels become disconnected from the main channel (Figure A-22; Figure A-23). When the channels are disconnected, juvenile salmonids are often left in isolated pools until higher flows return or until they perish. When redds are present, they can become dewatered and the eggs can perish if higher flows are not available for emergence. Excavation would include lowering the elevations at each upstream connection of the side channels with the main channel so that connectivity is maintained at flows as low as 3,250 cfs.

Gravel Augmentation The gravel augmentation would consist of placing gravel along approximately 1,600 feet of the east bank and extending into the channel as far as is feasible under the flow conditions occurring during the work. Up to approximately 12,000 cubic yards of gravel would be placed at the site and cover up to approximately 12 acres. The river bank is primarily open ground so minimal vegetation disturbance would occur. Although gravel placement only along the river bank is not expected to create immediate benefits, it would provide long-term benefits to Chinook salmon
and steelhead as it washes downstream under high flow events where it would create and maintain spawning habitat.

Access would occur from the end of Knighton Road, via an existing dirt road that runs along the top of Shea Levee. Equipment would be staged on pre-disturbed areas away from the river, as necessary. Access to the side channel complex on the west side of the river is through City of Redding property adjacent to Cascade Park.

Approximate location 122° 21'41.2068" W 40° 30'37.1494" N (Section 30, T31N, R4W MDM) in the USGS 7.5 Minute Enterprise Quadrangle.

Site 10 – South Shea Levee (RM 289)

Site 10-South Shea Levee is located at RM 289 approximately half a mile downstream of Shea Island (Figure A-21). This location involves placement using front end loaders. Up to approximately 10,000 cubic yards of gravel would be placed within the river. Gravel would be placed along the bank and spread as far as is feasible into the channel using front end loaders under the flow conditions occurring during construction. Approximately 3.3 acres (600 ft long x 100 ft wide) of spawning habitat that can be directly used by salmonids would be improved. Additionally, a portion of augmented gravel would be mobilized under high flows and transported downstream to areas where it can also provide fisheries benefits.

The adjacent river bank is owned by a private landowner. Access would occur from the end of Knighton Road, via an existing dirt road that runs along the top of Shea Levee.

Approximate location 122° 21'34.62" W 40° 30'0.51" N (Section 31, T31N, R4W MDM) in the USGS 7.5 Minute Enterprise Quadrangle.

Site 11 – Kapusta Island Area (RM 288)

Site 11-Kapusta Island is located at RM 288 at Kapusta Island and includes an area downstream in the main channel and on the west side of the river (Figure A-24). This location involves constructing up to one and enhancing up to three existing perennial side channels and augmenting spawning gravel downstream of the island on the south (right) side of the river.

Side Channel Creation Although existing channels on the island provide spawning and rearing habitat, there are opportunities to enhance habitat complexity within them and add additional side channel habitat. An additional perennial side channel complex can be created on the island to the south of the existing channels. This side channel complex would be created on the island through excavation and grading. The interconnecting channels would be up to approximately 1.4 acres (2,000 ft long x 30 ft wide). The side channels would have variable widths (up to 50 feet wide), depths (up to 10 feet deep), and velocities (up to five feet per second) throughout to provide habitat complexity. Variably inundated nearshore benches would be created along the channels to provide vegetated juvenile habitat at a range of river flows.

An approximately 1,300 foot long side channel would be created along the right bank of the river downstream of the island, adjacent to the gravel placement area. The channel would be designed to flow down to a river flow of 3,250 cfs include variable width and depth throughout for habitat complexity.

Gravel Augmentation In a given year, up to 12,000 cubic yards of gravel would be placed within the river. Gravel would be spread as far across the channel as is feasible under the flow conditions occurring during construction. Up to approximately 4 acres (600 ft long x 300 ft wide) of spawning habitat that can be directly used by salmonids would be provided. A portion of the gravel would be mobilized under high flows and transported downstream to areas where it can also provide fisheries benefits.

The island is state land**.** Access to the island would be through City of Redding property located on the south (right) bank of the river via a county road from Highway 273. In order for equipment to access the island, a temporary river crossing river would be created by grading the existing river rock or adding spawning sized material into a drivable path, which would be re-graded into the surrounding terrain at the completion of the project. The property adjacent to the south (right) side of the main river downstream of the island is owned by the City of Redding (Figure A-25). Access to the island would occur from the south (right) bank. Gravel will be placed into the river as far as is feasible from the bank under the flow conditions occurring during implementation.

Gravel at this site would come from the uplands which are all City of Redding property. The existing material would be sorted onsite to separate the spawning sized material from other material. The oversized material would be used in areas as needed to provide increased longevity to the site. Fines would be used in areas to be revegetated.

Approximate location 122° 20'29.44" W 40° 29'51.07" N (Section 32, T31N, R4W MDM) in the USGS 7.5 Minute Cottonwood Quadrangle.

Site 12 – Anderson River Park (RM 282)

Site 12-Anderson River Park is located at RM 282 within the naturally maintained area of Anderson River Park (Figure A-26). This location involves reconnecting a partially functional side channel to the main channel and providing additional perennial side channel habitat to increase juvenile salmonid rearing habitat.

Under existing conditions, the upper 30% of the side channel is disconnected from the main channel at flows less than about 15,000 cfs, while the lower 60% is currently connected to the river year- round and consists of a stagnant backwater area with good habitat for warmwater invasive species (Figure A-27). The existing channel has a well-established riparian area that could provide immediate juvenile rearing habitat if appropriate flows were provided through the channel (Figure A-28). To provide a connected functional side channel under main channel flow conditions down to 3,250 cfs, excavation will occur at the upstream end of the side channel. Additional new interconnected channels may also be created across the large gravel bar between the existing side channel and the main river channel. Excavation would encompass an approximately 11.5 acre (5,000 ft long x 100 ft wide) area. Variably inundated floodplain benches will be created along the side channel margins to provide juvenile salmonid rearing habitat over a range of river flows. The total length of the reconnected side channel would be approximately 5,000 foot long.

The property is owned by the State of California and maintained by the City of Anderson. Access would be through the Anderson River Park area on existing roads and drivable trails.

Approximate location 122° 15'37.76" W 40° 27'54.12" N (Sections 12 and 13 T30N, R4W MDM) in the USGS 7.5 Minute Cottonwood Quadrangle.

Site 13 – Reading Island (RM 275)

Site 13-Reading Island is located at RM 275 along the west (right) bank of the river (Figure A-29). This location involves reconnecting a partially functional side channel (Figure A-30) to the main channel to increase juvenile salmonid rearing habitat opportunities. Historically, a 12,000 foot side-channel of the Sacramento River joined Anderson Creek creating Reading Island. A 4,000 foot stretch of the upper side channel is no longer connected to the main channel but the lower 8,000 feet receives flows from Anderson Creek resulting in year-round connectivity of the lower portion with the Sacramento River. Due to the lack of connectivity with the main channel at the upper end of the side channel and the low flows provided by Anderson Creek at the lower end, the existing side channel currently functions as a stagnant backwater area with good habitat for invasive warm water species (Figure A-31).

Excavation will include grading the 4,000 foot upper section of the historic side channel so that it reconnects with the main channel under low flows. Excavation will encompass up to an approximately 7.4 acre (4,000 ft long x 80 ft wide) area. The total length of the reconnected side channel would be approximately 12,000 feet long.

The northern portion of the island is privately owned, while the southern end is owned by the Bureau of Land Management (BLM). Access will be through BLM property, but coordination with private landowners will also be necessary to connect the upstream end of the channel.

Approximate location 122° 12'1.52" W 40° 24'16.56" N (Section 33 and 34 T30N, R3W and Sections 3 and 4 T29N, R3W MDM) in the USGS 7.5 Minute Balls Ferry Quadrangle.

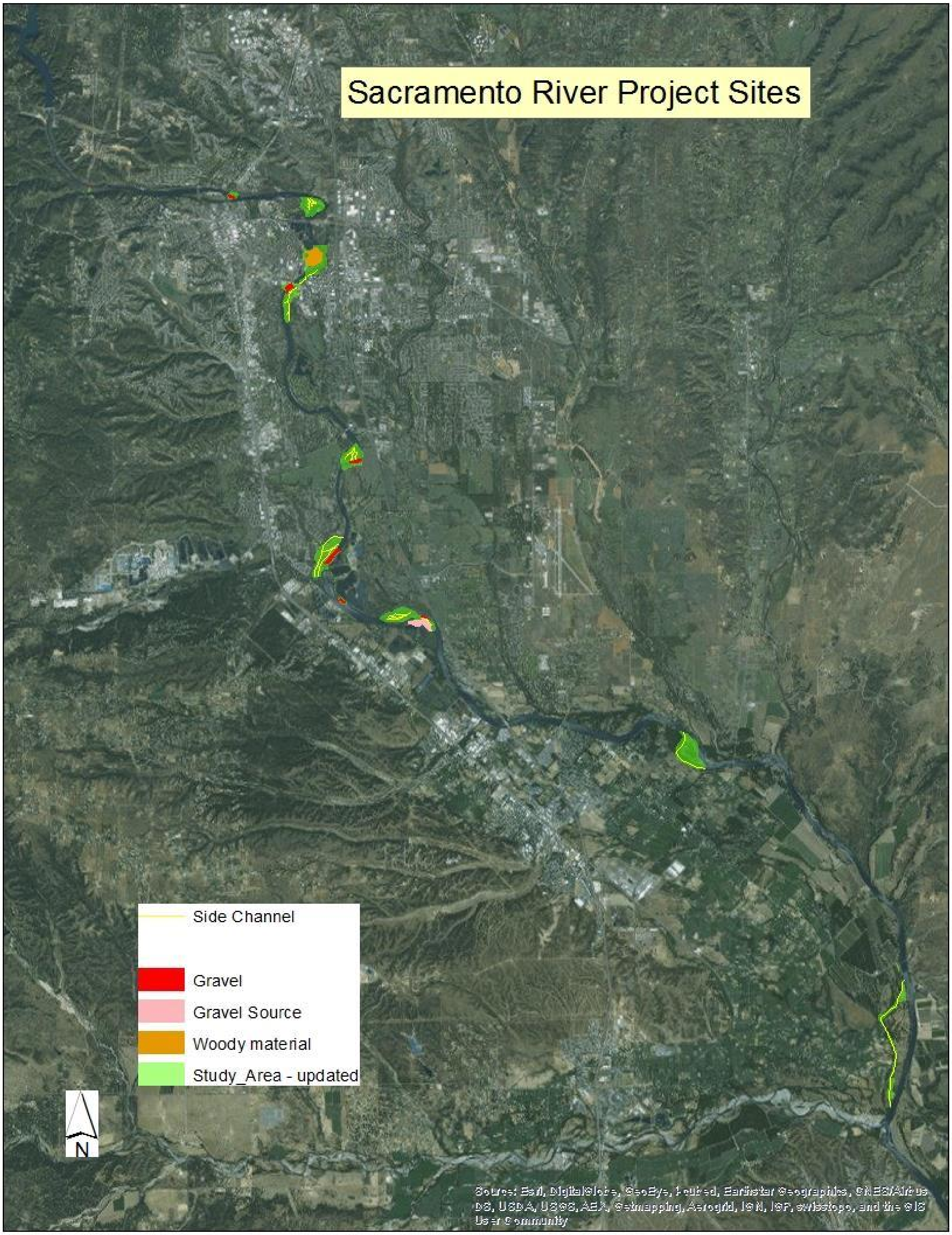


Figure A-1. Overview of Upper Sacramento River Anadromous Salmonid Habitat Restoration Sites.

Site 1 – Keswick Dam (RM 302)

Figure A-2. Site 1 – Keswick Dam (RM 302). Approximate location 122°26'46.8161" W 40°36'32.5579" N (Section 21, T32N, R5W MDM) in the USGS 7.5 Minute Redding Quadrangle.

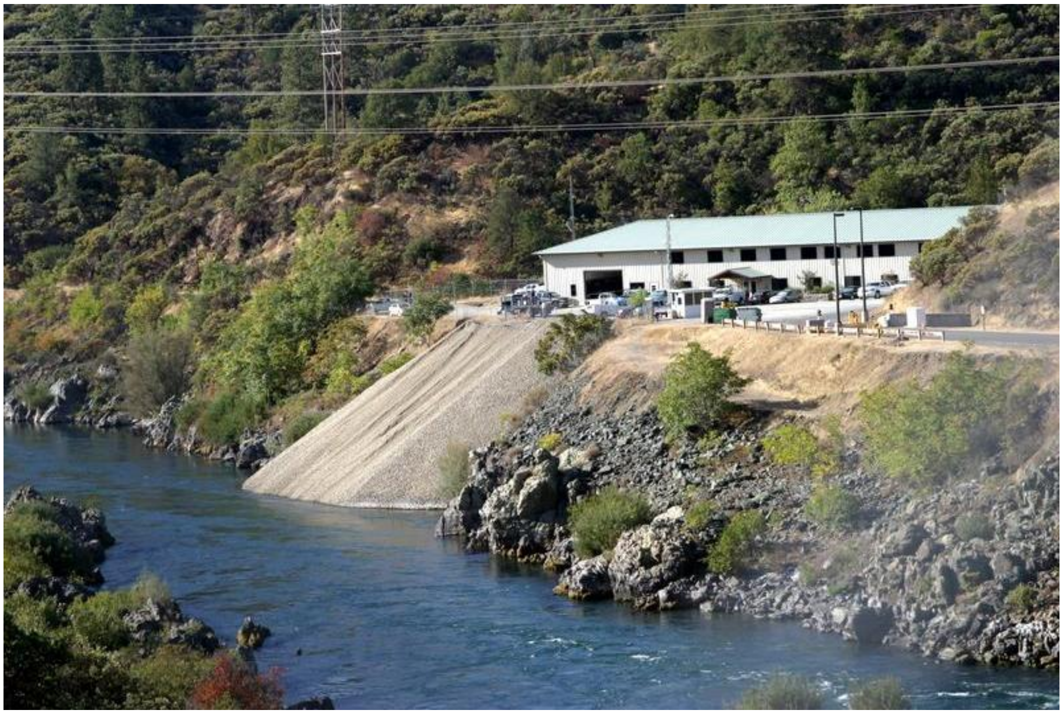


Figure A-3. Keswick gravel augmentation site following 15,000 tons placed in 2012, looking downstream.

Figure A-4. Keswick gravel augmentation site looking upstream (river right) in 2014.

Site 2 – Salt Creek (RM 300.7)

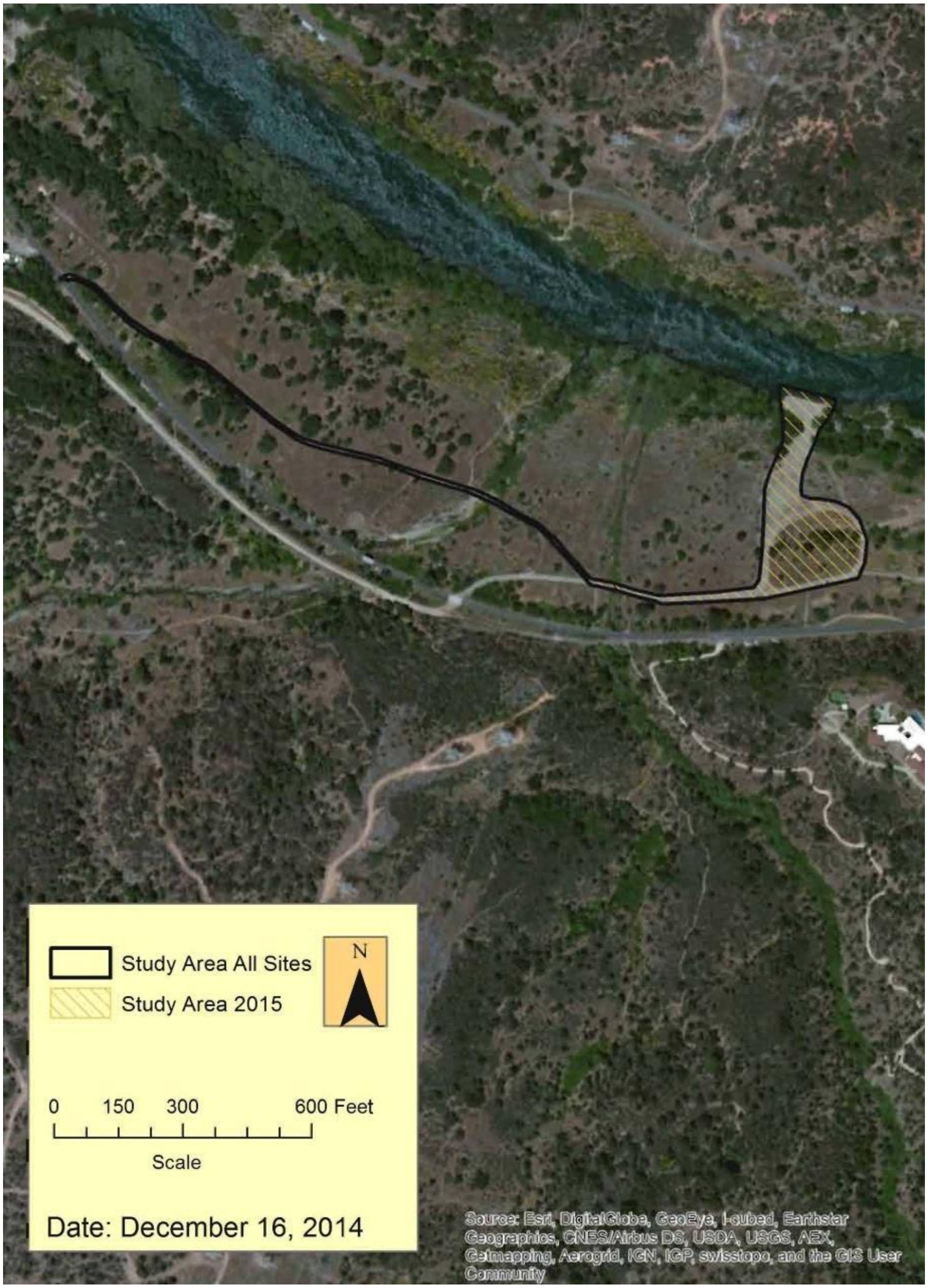


Figure A-5. Site 2 – Salt Creek (RM 300.7). Approximate location 122°26'1.25" W 40°35'38.73" N (Section 33 T32N, R5W MDM) in the USGS 7.5 Minute Redding Quadrangle.

Figure A-6. Salt Creek gravel augmentation site looking downstream (river right).

Site 3 – Market Street South (RM 298.3)

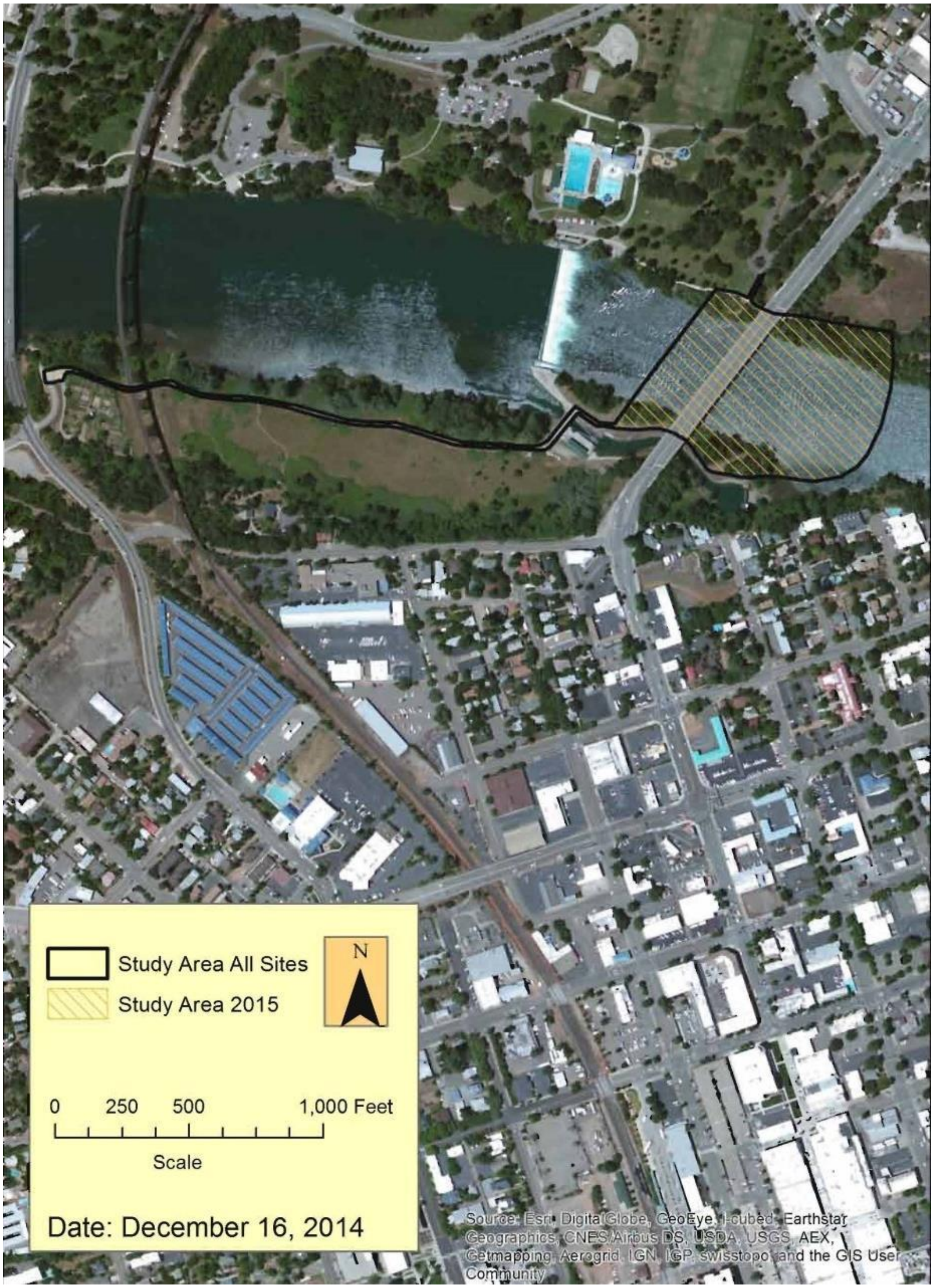


Figure A-7. Site 3 – Market Street South (RM 298.3). Approximate location 122°23'34.0933" W 40°35'30.6504" N (Section 35 and 36, T32N, R5W MDM) in the USGS 7.5 Minute Redding Quadrangle.

Figure A-8. Looking downstream (river right) under the Market Street bridge.

Figure A-9. Looking upstream (river left) across the river to Site 3.

Site 4– Turtle Bay Island (RM 297)

Figure A-10. Site 4 – Turtle Bay Island (RM 297). Approximate location 122°22'7.9095" W 40°35'25.0966" N (Section 31, T32N, R4W MDM) in the USGS 7.5 Minute Enterprise Quadrangle.

Figure A-11. Turtle Bay Island looking northwest at the side channel.

Figure A-12. Turtle Bay Island.

Sites 5-7 – Kutras Lake and Cypress Ave Bridge North and South (RM 295-296)

Figure A-13. Sites 5-7 – Kutras Lake and Cypress Avenue Bridge North and South (RM 295-296). Approximate location 122°22'2.03" W 40°34'39.81" N (Section 36, T32N, R5W; Section 6, T31N, R4W; Section 1, T31N, R5W MDM) in the USGS 7.5 Minute Enterprise Quadrangle.

Figure A-14. Cypress Avenue Bridge North (Site 6) looking upstream across the river at the southeastern end of site.

Figure A-15. Cypress Avenue North (Site 6) lower slough looking upstream.

Figure A-16. Cypress Avenue Bridge South (Site 7) pond.

Figure A-17. Cypress Ave Bridge South (Site 7) on river right.

Site 8 – Tobiasson Island Area (RM 291.6)

Figure A-18. Site 8–Tobiasson Island Area (RM 291.6). Approximate location 122°21'24.0196" W 40°31'59.3017" N (Section 19, T31N, R4W MDM) in the USGS 7.5 Minute Enterprise Quadrangle.

Figure A-19. Upstream end of Tobiasson side channel looking downstream (river right) at approximately 3,250 cfs.

Figure A-20. Looking downstream (river left) on the main channel across from the downstream end of Tobiasson Island.

Sites 9 and 10– Shea Island and Levee, and South Shea Levee (RM 289-289.6)

Figure A-21. Sites 9 and 10 – Shea Island and Levee and South Shea Levee (RM 289-289.6). Approximate location 122°21'41.2068" W 40°30'37.1494" N (Section 30, T31N, R4W; Section 31, T31N, R4W MDM) in the USGS 7.5 Minute Enterprise Quadrangle.

Figure A-22. Shea Island middle side channel looking upstream (river right) at approximately 3250 cfs.

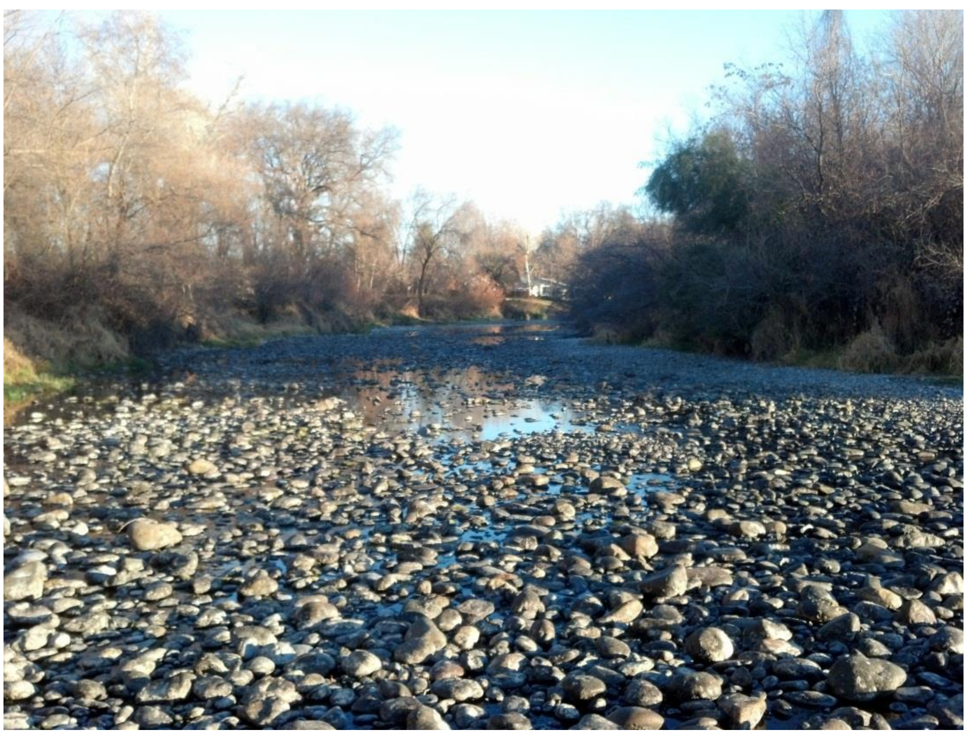


Figure A-23. Shea Island main side channel looking upstream (river right, far right channel) at approximately 3250 cfs.

Site 11– Kapusta Island Area (RM 288)

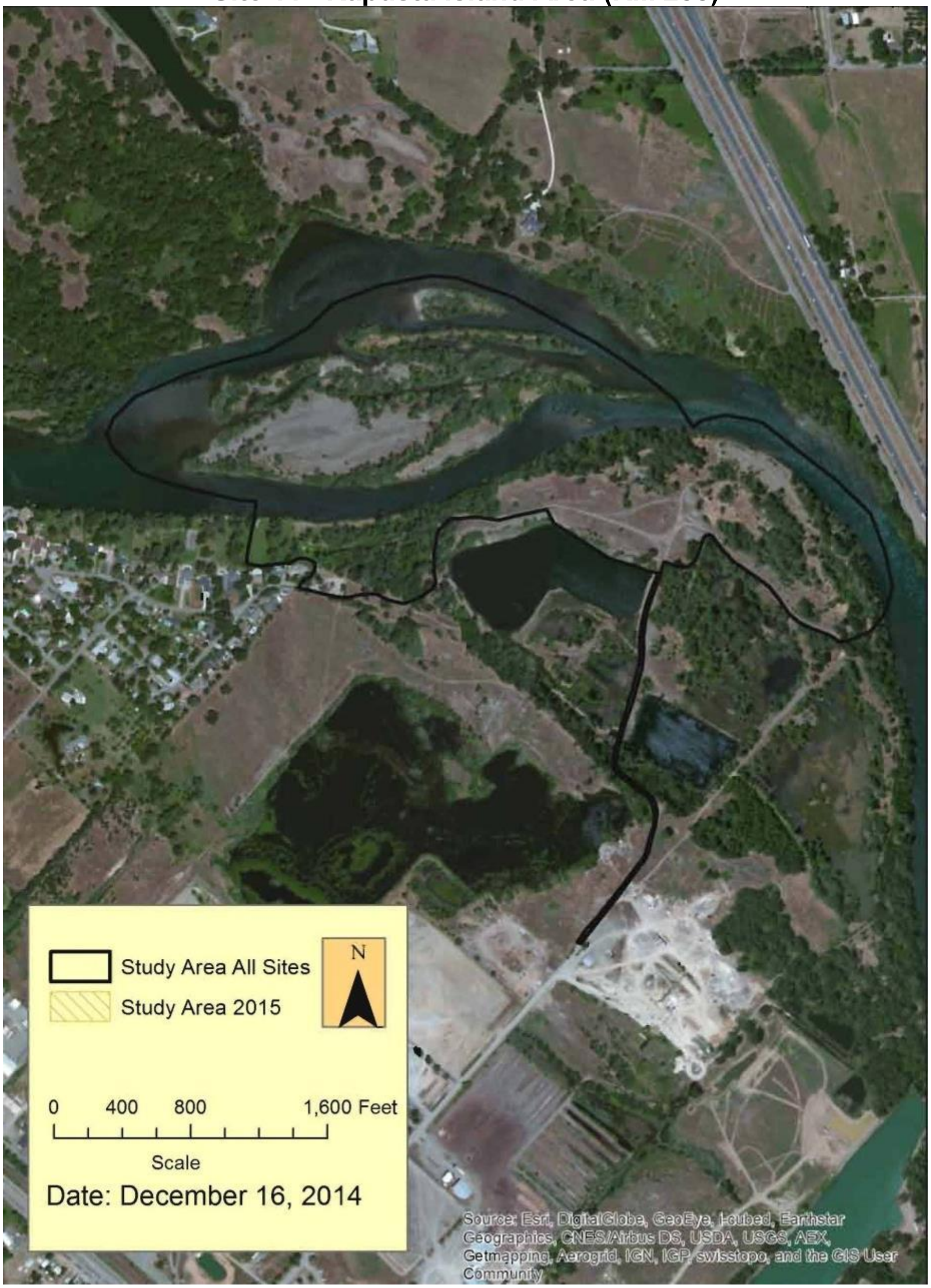


Figure A-24. Site 11– Kapusta Island (RM 288). Approximate location 122°20'29.44" W 40°29'51.07" N (Section 32, T31N, R4W MDM) in the USGS 7.5 Minute Cottonwood Quadrangle.

Figure A-25. Kapusta Island Area riparian vegetation on mainland area (river right).

Site 12– Anderson River Park (RM 282)

Figure A-26. Site 12 – Anderson Island (RM 282). Approximate location 122°15'37.76" W 40°27'54.12" N (Sections 12 and 13 T30N, R4W MDM) in the USGS 7.5 Minute Cottonwood Quadrangle.

Figure A-27. Anderson Park side channel backwater.

Figure A-28. Anderson Park side channel riparian vegetation.

Site 13– Reading Island (RM 275)

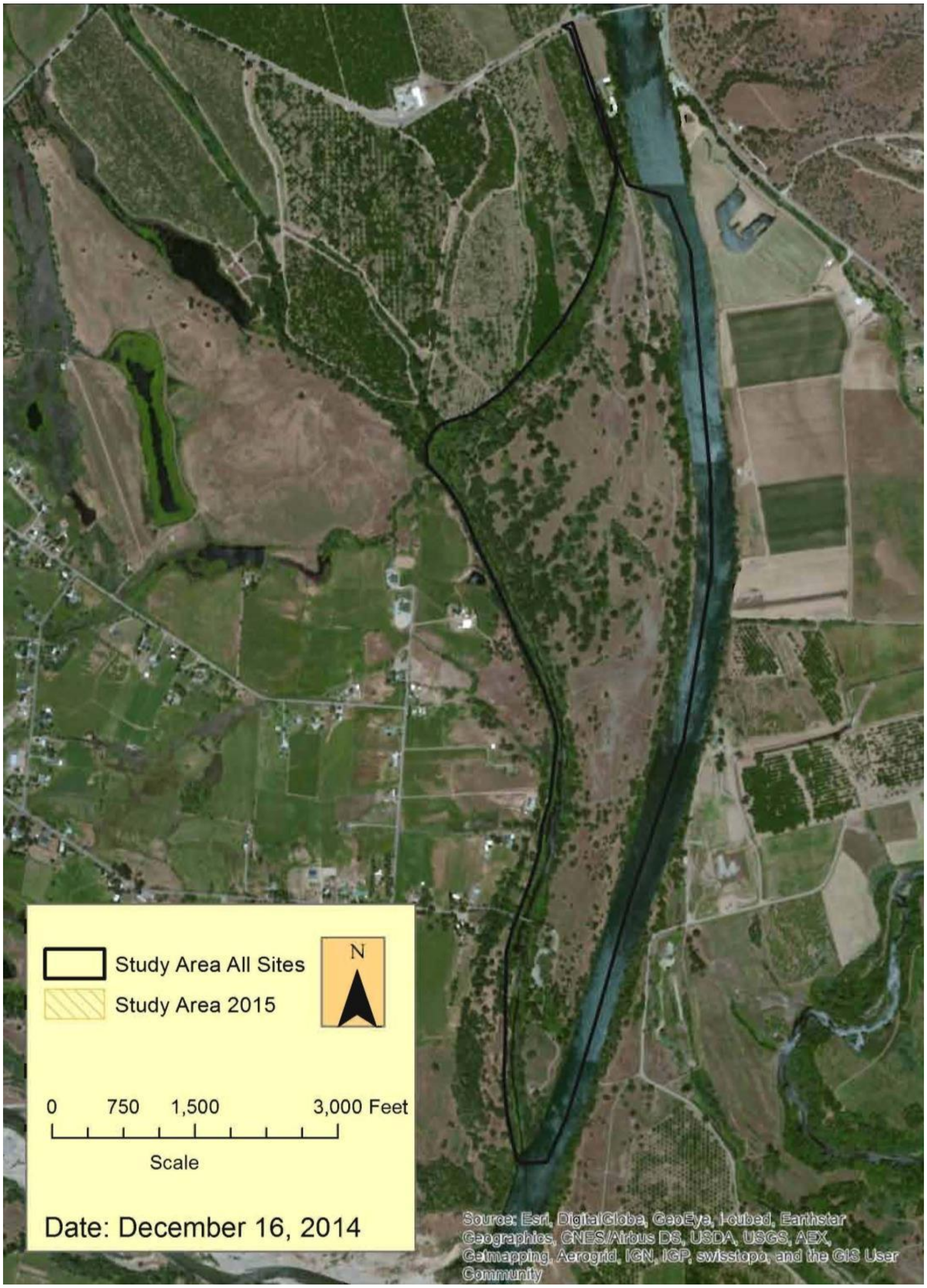


Figure A-29. Site 13 – Reading Island (RM 275). Approximate location 122°12'1.52" W 40°24'16.56" N (Section 33 and 34 T30N, R3W and Sections 3 and 4 T29N, R3W MDM) in the USGS 7.5 Minute Balls Ferry Quadrangle.

Figure A-30. Reading Island former boat ramp site.

APPENDIX B

Upper Sacramento River Anadromous Fish Habitat Restoration Example Side Channel Design

Upper Sacramento River Anadromous Fish Habitat Restoration Example Side Channel Design

Project sites that incorporate floodplain and side channel enhancement activities will include more formal engineering designs as needed for site specific work. It is expected that designs will provide similar information to previous work; therefore, the following side channel design (excerpt from pages 12-13 of Glenn-Colusa Irrigation District's [GCID] 2014 Mitigated Negative Declaration/Initial Study for the Painter's Riffle Anadromous Fish Habitat Enhancement Project) is provided as an example of the information that will be developed and presented to permitting agencies for individual sites. Detailed design features (i.e., features more detailed than needed for permitting processes) for each site will be prepared as funding becomes available to conduct the work and will be coordinated annually with the Sacramento River Restoration Team (members include U.S. Bureau of Reclamation [Reclamation], National Marine Fisheries Service, U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, California Department of Water Resources, and State Water Resources Control Board).

Side Channel Design- Painter's Riffle Anadromous Fish Habitat Enhancement Project

Painter's Riffle is a site located on the east bank near river mile 296.2 (Attachment A) where gravel deposition from an upstream construction project filled in a previously restored side channel. The project is intended to restore the fisheries benefits of the site through removal of the gravel blockage and redistribution of the existing material.

Topographic surveys and hydraulic modeling (HEC-RAS) of the site performed by the Bureau of Reclamation (Reclamation) and its Technical Service Center were used to develop and evaluate a design that would provide for salmon and steelhead spawning and rearing and avoid future blockage.

Since Chinook salmon utilize a range of near-bed water velocities for spawning, the side channel would be designed to have a range of depths and velocities to provide salmon with the ability to select preferred conditions over a broad area and range of flows. The entrance elevation to Painter's Riffle would be configured to allow the side channel to remain inundated at all flows, including the minimum Keswick Dam release of 3,250 cfs to avoid Chinook redd dewatering that can occur with the existing channel configuration. The side channel would also be designed to provide one to three feet of depth during peak fall-run spawning (October to early November), when average flows are approximately 6,000 cfs. The Technical Service Center simulated these two flows in HEC-RAS to determine the minimum entrance elevation of 463 feet to provide approximately ½ foot of depth at 3,250 cfs.

Plan and profile view engineer drawings and cross sections illustrating the existing and proposed topography are shown in Attachment B. The existing side channel would be excavated to maintain a channel approximately 800 ft-long by 100 ft-wide. No excavation of or shaping of the side channel banks, or vegetation removal is anticipated. The proposed profile of the side channel is approximately 0.00125, with an upstream elevation of 463 feet (at station 100 feet) and an elevation of 462.25 feet at station 700 feet shown in Figure 1 of Attachment B. Reclamation's Technical Service Center estimates that GCID would need to remove between 6,600 and 8,000 yd^3 of gravel; however, due to uncertainties in the survey data and longitudinal extent of the deposits, the estimated quantities could range up to 10,000 yd^3.

The Project will require a combination of front end loaders, paddle wheel scrapers, bulldozers, dump trucks, and excavators (referred to as "equipment") to operate for an approximate span of two to three weeks in November 2014 to redistribute the gravel within the side channel and river bed. The exact combination of equipment will be determined as river water levels decrease and the site can be better surveyed and inspected. Larger boulders and rocks found during gravel redistribution would be placed in the bend of the east bank on the upstream side of the side channel.

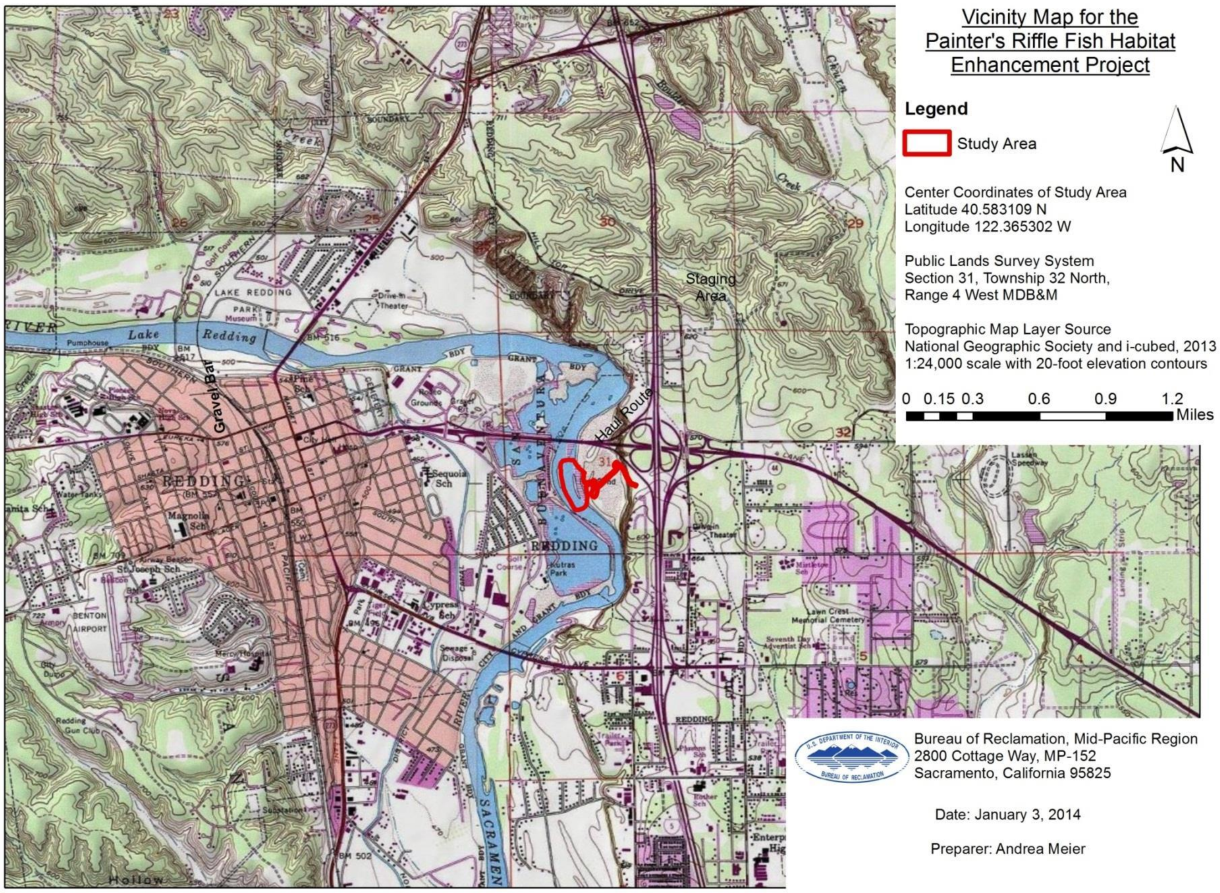
A gravel berm would be left at the mouth of Painter's Riffle to isolate the Project area from the main channel. The gravel blocking the mouth originated from the gravel work pad placed during the Highway 44 Bridge construction. This gravel is uncrushed, rounded natural river rock between one and four inches in diameter, and prior to its placement had a cleanliness value of no less than 85 percent to minimize the introduction of fine sediments into the river (CDFW 2007). Approximately one-third of the gravel pile is expected to be in excess of what would be needed to return the side channel to its original design, and would either be pushed into the main channel from the side channel inlet or placed within 200 feet downstream of the side channel bar, in lateral berms (across the channel) along the steep bank of the east bend of the main river where velocities are highest and the potential for downstream transport within the short-term is greatest. This activity would proceed by building a gravel pad from the side channel outlet and downstream to allow equipment to reach the lateral berm designation, and then gradually pushing the gravel pad into the main channel for distribution once construction activities conclude. See Attachment C for a map of the Project area and location of gravel movement.

In-river work would be performed with equipment to push the gravel out. The gravel will be placed to allow mobilization during high flows and in accordance with Clean Water Act and Endangered Species Act permits. All work will be performed in a manner that meets the established Best Management Practices (BMPs). GCID will stage equipment above the high water mark in the adjacent Turtle East Bay Regional Park, outside of wetlands and the flow paths of natural swales. GCID will coordinate with the City of Redding to ensure that there is not Project interference with landscaping planned for the Turtle East Bay Regional Park.

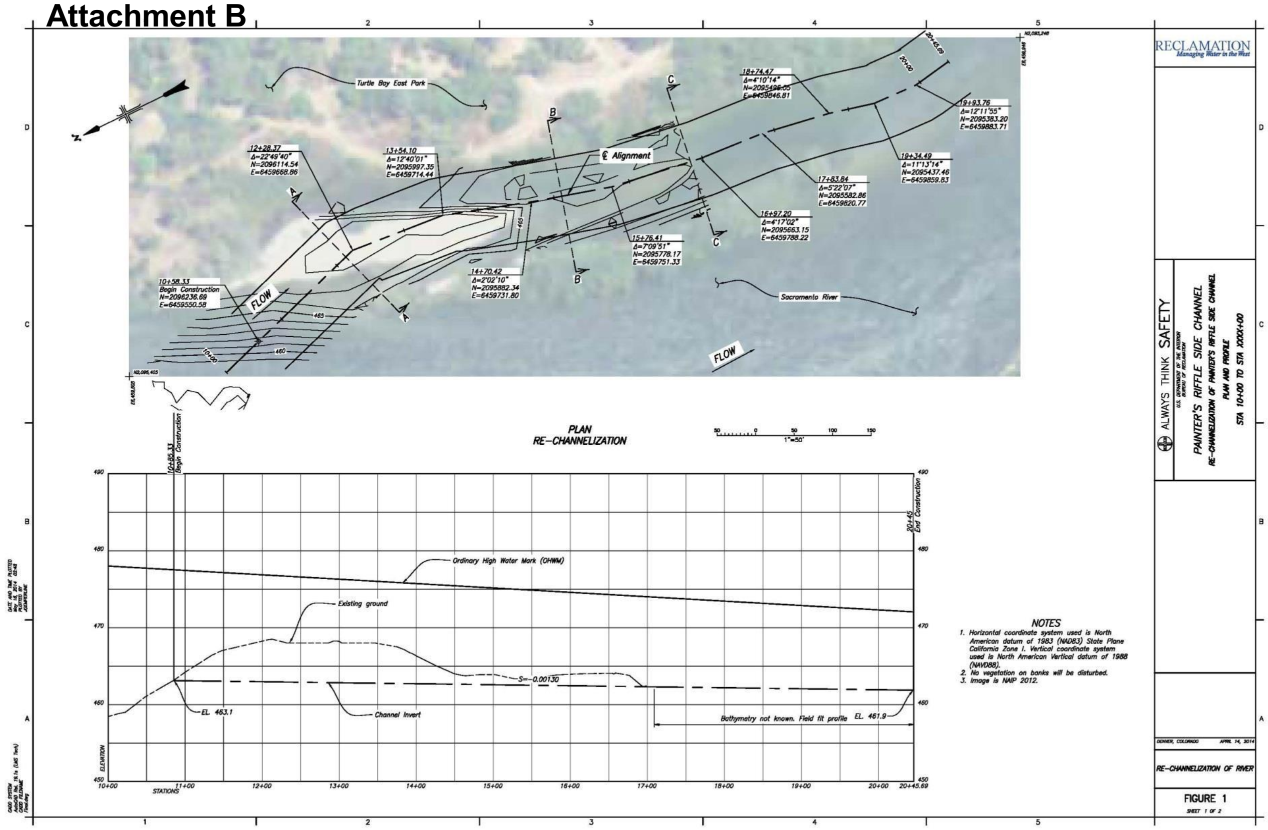
Reference

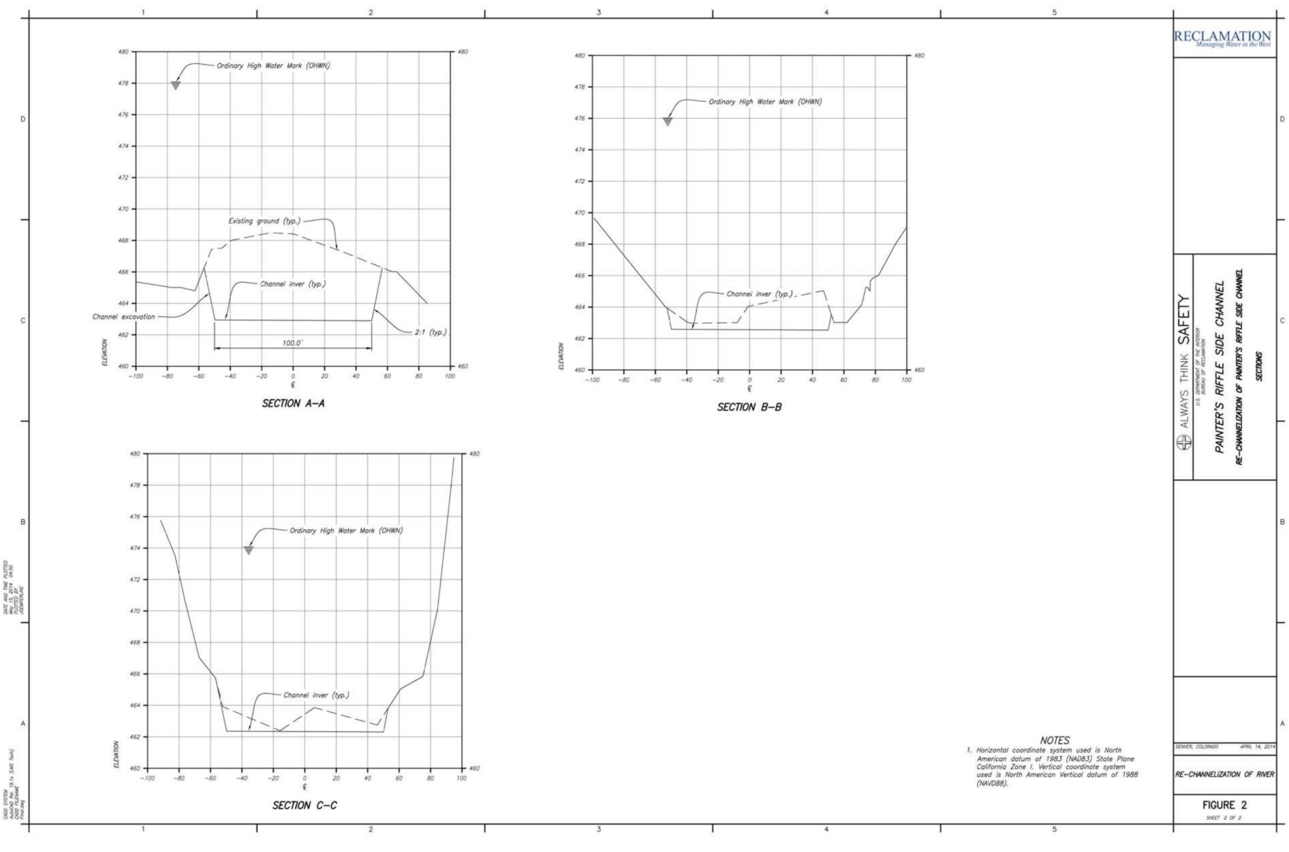
CDFW [California Department of Fish and Wildlife]. 2007. Agreement Regarding Proposed Lake or Streambed Alteration. CDFW, Northern California – North Coast Region. October 19.

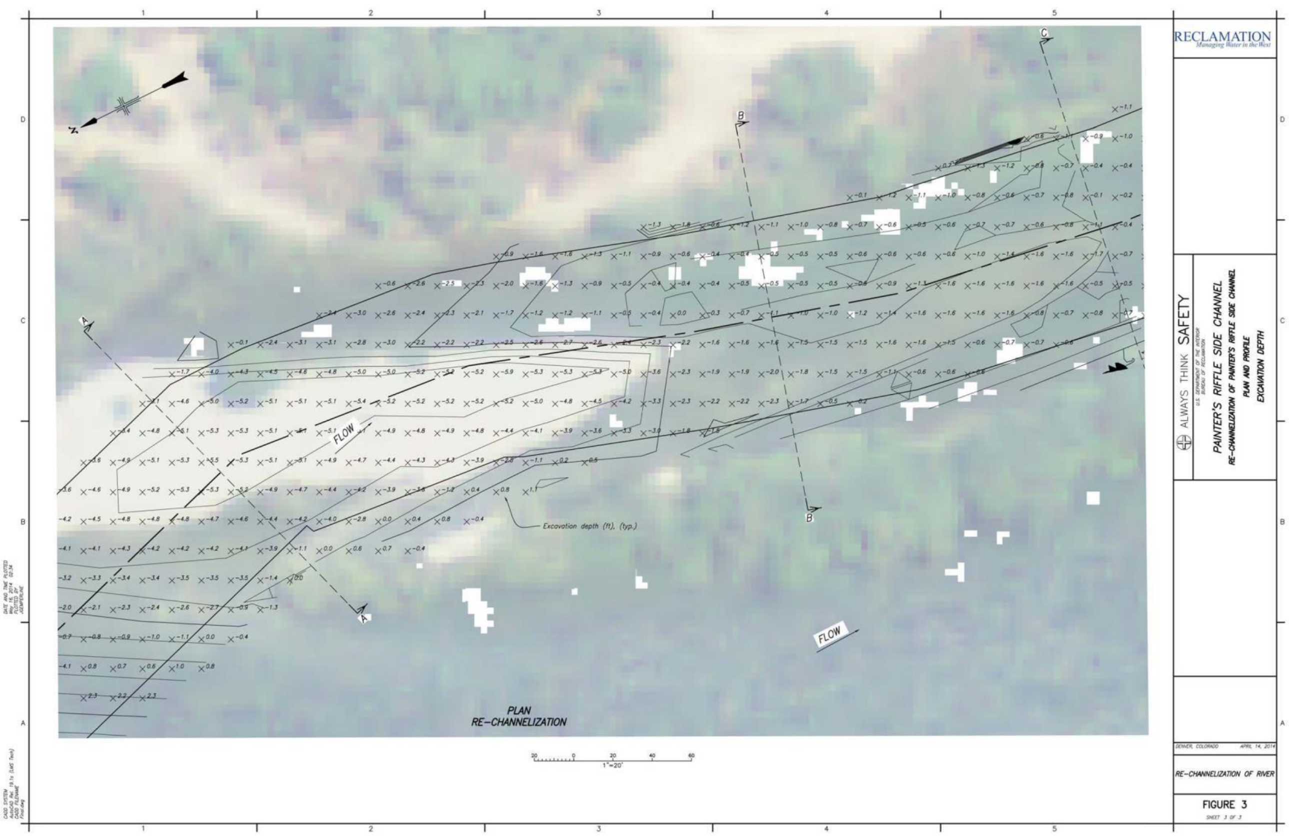
Attachment A



Attachment B




RECLAMATION
Managing Water in the West
Ordinary High Water Mark (OHWM)
Existing ground (typ.)
Channel invert (typ.)
Channel excavation
2:1 (typ.)
100.0'
ELEVATION
SECTION A–A
SECTION B–B
SECTION C–C
NOTES
1. Horizontal coordinate system used is North American datum of 1983 (NAD83) State Plane California Zone I. Vertical coordinate system used is North American Vertical datum of 1988 (NAVD88).
ALWAYS THINK SAFETY
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PAINTER'S RIFFLE SIDE CHANNEL
RE–CHANNELIZATION OF PAINTER'S RIFFLE SIDE CHANNEL
SECTIONS
DENVER, COLORADO
APRIL 14, 2014
RE–CHANNELIZATION OF RIVER
FIGURE 2
SHEET 2 OF 2


RECLAMATION
Managing Water in the West
ALWAYS THINK SAFETY
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
PAINTER'S RIFFLE SIDE CHANNEL
RE-CHANNELIZATION OF PAINTER'S RIFFLE SIDE CHANNEL
PLAN AND PROFILE
EXCAVATION DEPTH
DENVER, COLORADO
APRIL 14, 2014
RE-CHANNELIZATION OF RIVER
FIGURE 3
SHEET 3 OF 3
FLOW
FLOW
Excavation depth (ft), (typ.)
PLAN
RE-CHANNELIZATION
1"=20'

Attachment C