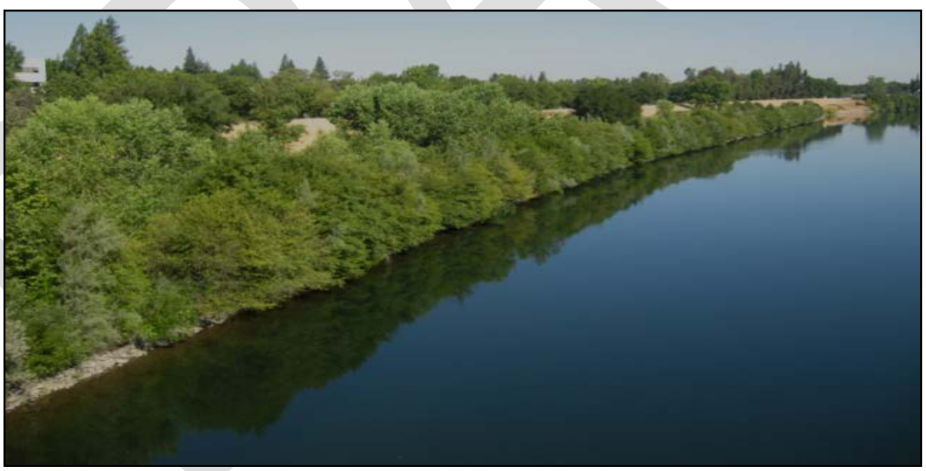
Biological Assessment

American River Common Features
General Reevaluation Report



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American River Common Features General Reevaluation Report (GRR) **Biological Assessment**

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1.0 Introduction

The U.S. Army Corps of Engineers (Corps) is requesting consultation with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Federal Endangered Species Act (ESA) to evaluate, on a biological assessment (BA) level, potential effects associated with levee modifications proposed for the American River Common Features (ARCF) Project. The purpose of this BA is to meet Section 7 consultation requirements as well as requirements of the Magnuson-Stevens Fishery Conservation and Management Act of 1997 (NMFS 1997). This BA was prepared in accordance with the Corps' Engineering Regulation 1105-2-100 (Corps 2000a).

Section 7 of the ESA requires Federal agencies to conserve listed species and their critical habitat, and to consult with USFWS and NMFS (the Services) to ensure that actions they fund, authorize, or perform do not jeopardize the existence of any listed species or result in the destruction or adverse modification of their designated critical habitat. The actions covered in this BA are associated with future levee modifications proposed for the ARCF Project (Figure 1).

The Magnuson-Stevens Fishery Conservation and Management Act of 1997 (MSA) governs the conservation and management of commercially harvested ocean fisheries. The purpose of the Act is to take immediate action to conserve, protect, and manage U.S. coastal fishery resources, anadromous species, and Essential Fish Habitat (EFH). EFH is the aquatic habitat (water and substrate) that is necessary for fish to spawn, breed, feed, or mature, and that allows production levels needed to: (1) support a long-term, sustainable commercial fishery, and (2) contribute to a healthy ecosystem (NMFS 1997). The ARCF study area is designated as EFH habitat for Pacific salmon under Section 305(b)(2) of the MSA. Species to be addressed in this BA include:

- Fish species with designated EFH under the MSA;
- Listed species under the Federal Endangered Species Act; and
- Species with designated critical habitat under the ESA.

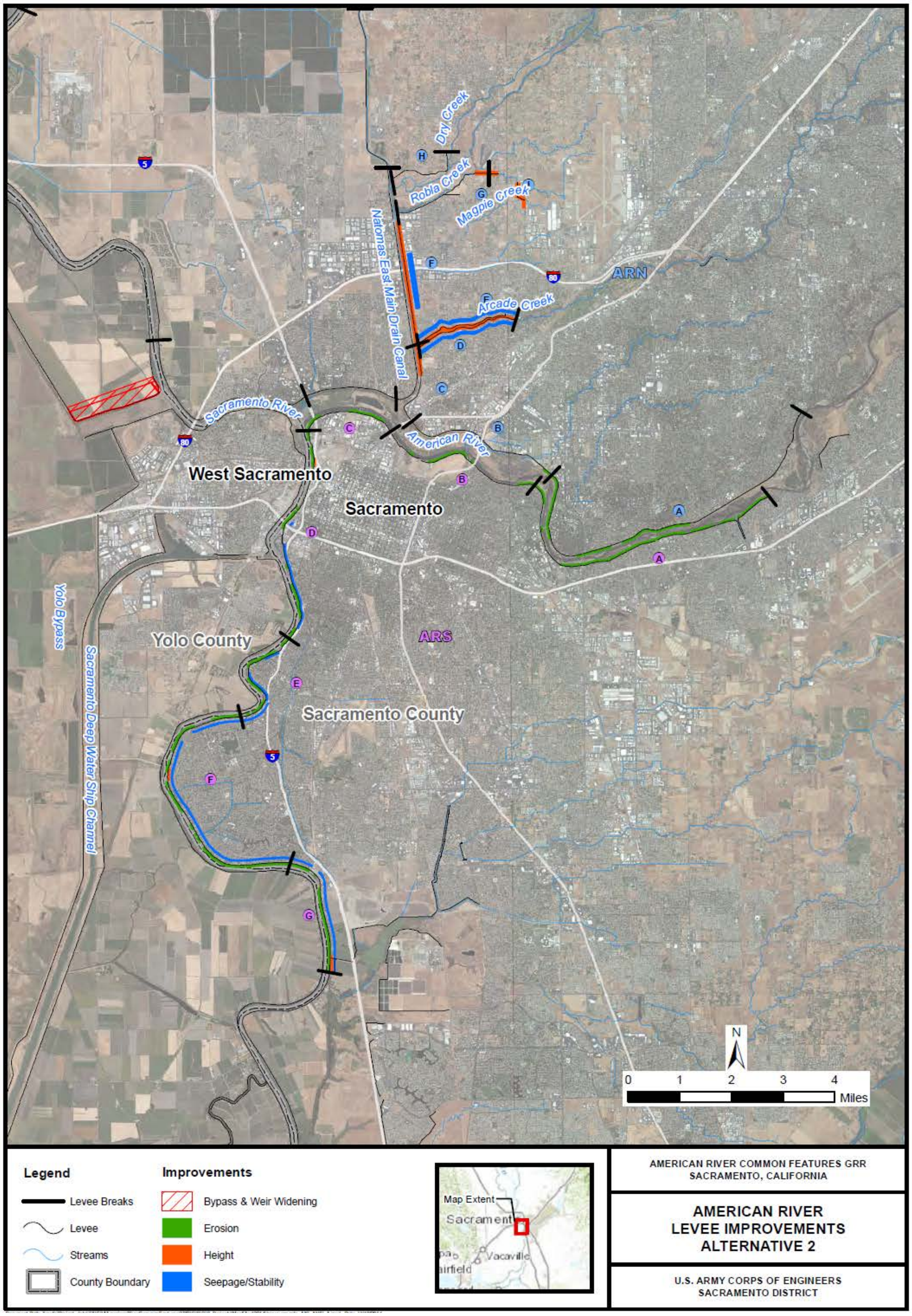

Figure 1. American River Common Features Study Area.

1.1 American River Common Features Study Area and Action Area

The study area is located within the Sacramento and American River Watersheds. The Sacramento River watershed covers approximately 26,000 square miles in central and northern California. Major tributaries of the Sacramento River include the Feather, Yuba, and American Rivers. The American River Watershed covers about 2,100 square miles northeast of the city of Sacramento and includes portions of Placer, El Dorado, Alpine, and Sacramento counties. The American River watershed includes Folsom Dam and Reservoir; inflowing rivers and streams, including the North, South, and Middle forks of the American River; and the lower American River downstream of Folsom Dam to its confluence with the Sacramento River in the city of Sacramento. The Sacramento and American Rivers, in the Sacramento area, form a flood plain covering roughly 110,000 acres at their confluence. The flood plain includes most of the developed portions of the city of Sacramento. Figure 1 shows the study area.

The city of Sacramento is the capitol of California, and thus is the government center for the state, which by itself has the 9th largest economy in the world. Many state offices located in downtown Sacramento, including the State Capitol building, are in areas that could be affected by flood events. Disruption of government services, and effects to emergency services and transportation corridors could have far ranging effects including life safety.

The ARCF study area includes: (1) approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; (2) the east bank of the Natomas East Main Drainage Canal (NEMDC), Dry, Robla, and Arcade Creeks and the Magpie Creek Diversion Channel (collectively referred to as the East Side Tributaries); (3) the east bank of the Sacramento River downstream from the American River to Freeport, where the levee ties into Beach Lake Levee, the southern defense for Sacramento; and (4) the Sacramento Weir and Bypass, located along the north edge of the city of West Sacramento (Figure 1). This BA analyzes the effects of repairing the levees in the Sacramento area and widening the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass and alleviate the need to raise levees along the Sacramento River downstream of the bypass.

The action area for the project includes the American River from below Folsom Dam to the confluence with the Sacramento River and the Sacramento River from the Sacramento Bypass down to below Freeport. In addition the action area includes the NEMDC, Dry, Robla, and Arcade Creeks, and the Magpie Creek Diversion Channel. The erosion repairs within the project area is likely to somewhat reduce the sediment supply for riverine reaches directly downstream because the erosion repair is holding the bank or levee in place. However, from a system sediment perspective, the bank material we are protecting in the project reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather and especially the Yuba River systems. All of the available sediment in the American River watershed is being contained behind Folsom Dam. For velocity, the site specific designs will be constrained from allowing any velocity increases outside the erosion repair site. Sediment impacts due to the bypass widening are not known at this time, except to say that the study would constrain the design to minimize impacts to sediment transport. Further studies associated with the Bypass widening would be conducted during the preconstruction engineering and design phase of the project, and any impacts to listed species that are discovered during these studies would be coordinated with the resource agencies at that time. The action area for the project is directly related to the study area where construction activities would occur.

The project is designed to allow for the release of 160,000 cubic feet per second (cfs) from Folsom Dam. The levees along the American River are unable to withstand these maximum flows for extended periods of time without increased risk of erosion and potential failure. The exact location where erosion would occur and to what extent erosion would occur during any given event is unknown. Erosion within the American River Parkway is being addressed as part of the Folsom Reoperation project currently under evaluation and a biological assessment is being prepared to initiate Section 7 consultation with both USFWS and NMFS. Therefore, the affects of erosion due to releases of 160,000 cfs from Folsom Dam are not analyzed in this BA.

The American River Common Features General Reevaluation Report (ARCF GRR) is being completed in accordance with the principles that have been outlined in the Corps' SMART Planning Guide (May 2012). SMART Planning requires that all feasibility studies should be completed within a target of 18 months (to no more than three years at the greatest), at a cost of no more than $3 million, utilizing 3 levels of vertical team coordination, and of a "reasonable" report size. The SMART Planning methodology and framework were developed to facilitate more efficient, effective, and consistent delivery of Planning Decision Documents. As a result of this effort, team members and decision makers are required to accept a lower level of detail and higher level of uncertainty during the pre-authorization study phase. All designs associated with this project are therefore preliminary, with the largest footprint design established to evaluate affects to listed species. The larger footprint will look at the maximum extent the project could affect species in the project area. As design refinements occur, consideration will be given to designs that reduce affects to listed species where practicable.

On-going coordination with the Services will occur as the project progresses to the preliminary engineering design phase to ensure compliance with Section 7. The Corps would coordinate potential design refinements with the Services to avoid, minimize, and compensate for affects to listed species and reinitiate consultation if necessary. The study area includes the protected species and critical habitat listed in Table 1, as well as fall-/late fall–run Chinook salmon, which has EFH within the study area.

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Table 1. Federally Protected Species and Critical Habitat Addressed in this Biological Assessment.

Common Name	Scientific Name	Federal Status
Threatened and Endangered Species		
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	T
Sacramento River winter-run Chinook salmon ESU	*Oncorhynchus tshawytscha*	E/MSA
Central Valley spring-run Chinook salmon ESU	*Oncorhynchus tshawytscha*	T/MSA
Central Valley steelhead DPS	*Oncorhynchus mykiss*	T
Delta smelt	*Hypomesus transpacificus*	T
Green sturgeon southern DPS	*Acipenser medirostris*	T
Giant garter snake	*Thamnophis gigas*	T
Vernal pool fairy shrimp	*Branchinecta lynchi*	T
Vernal pool tadpole shrimp	*Lepidurus packardi*	E
Critical Habitat		
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	
Sacramento River winter-run Chinook salmon ESU	*Oncorhynchus tshawytscha*	
Central Valley spring-run Chinook salmon ESU	*Oncorhynchus tshawytscha*	
Central Valley steelhead DPS	*Oncorhynchus mykiss*	
Delta smelt	*Hypomesus transpacificus*	
Green sturgeon southern DPS	*Acipenser medirostris*	

Note: ESU = Evolutionarily Significant Unit, DPS = Distinct Population Segment, T = Threatened, E = Endangered, MSA = Magnuson-Stevens Fishery Conservation and Management Act.

1.2 Project Background and Authority

The ARCF project was authorized by Section 106(a)(1) of the Water Resources Development Act (WRDA) of 1996, (Public Law [PL] 104-303) (110 Stat. 3658, 3662-3663), as amended by Section 130 of the Energy and Water Development and Related Agencies Appropriations Act of 2008, (PL 110-161) (121 Stat. 1844, 1947). Additional authority was provided in Sections 366 and 566 of WRDA 1999, (PL 106-53), (113 Stat. 269, 319-20). Section 366 directed the Secretary to include specific levee improvement features in the overall project and Section 566(b) directed the Secretary to undertake additional study of American and Sacramento River levee modifications. Significant changes to the project cost were recommended in the Supplemental Information Report of March 2002. This report was submitted to the Assistant Secretary of the Army for Civil Works, but before it could be forwarded to Congress, Section 129 of the Energy and Water Development Appropriations Act of 2003, (PL 108-137), (117 Stat. 269, 1839) increased the authorized total cost of the project to $205,000,000. The current estimated cost of the authorized project is $274,100,000. In accordance with Section 902 of WRDA 1986 (Pub. L. 99-662, § 902, Nov. 17, 1986, 100 Stat. 4183), the allowable cost limit is $284,000,000.

After the flood of 1986, Congress directed the Corps to investigate the feasibility of reducing flood risk of the city of Sacramento. The Corps completed feasibility studies in 1991 and 1996, recommending a concrete gravity flood detention dam on the north fork of the American River at the Auburn site along with levee improvements downstream of Folsom Dam. Other plans evaluated in the report were Folsom Dam improvements and a stepped release plan for Folsom Dam releases. These additional plans also included levee improvements downstream of Folsom Dam. Congress recognized that levee improvements were "common" to all candidate plans in the report and that there was a Federal interest in participating in these "common features." Thus, the ARCF Project was authorized in WRDA 1996 and a decision on Auburn Dam was deferred to a later date. Major construction components for ARCF in the WRDA 1996 authorization include construction of seepage remediation along approximately 22 miles of American River levees and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas.

Following the flood of 1986, significant seepage was experienced on the Sacramento River from Verona (upstream end of Natomas) at River Mile (RM) 79 to Freeport at RM 45.5. In addition, both the north and south bank of the American River from RM 0 to approximately RM 11.4 experienced seepage. Seepage on the Sacramento River was so extensive that Congress, soon after the 1986 flood event, funded remediation in the Sacramento Urban Levee Improvement Project (Sac Urban). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas at approximately RM 64 down to Freeport

Shortly thereafter, the Sacramento Valley experienced a flood event in 1997. Considerable seepage occurred on the Sacramento River as well as on the American River. Seepage on the American River was to be expected because remediation had yet to be constructed, but the occurrence of significant seepage on the Sacramento River in the reach remediated as part of the Sac Urban project was alarming and confirmed that deep underseepage was also of significant concern. As a result of this conclusion, seepage remediation on the American River (then in the late 1990s in the design phase) would need to be designed to remediate both through- and deep underseepage.

In 1999, Congress decided not to authorize Auburn Dam but instead to authorize improvements for Folsom Dam. By doing this, improvements to levees downstream of Folsom Dam could be fine tuned to work closely with the Folsom Dam improvements being discussed by Congress. Therefore, the ARCF project was modified by WRDA 1999 to include additional necessary features for the American River so that it could safely convey the proposed emergency release of 160,000 cfs from Folsom Dam. Major construction components for the ARCF project in the WRDA 1999 authorization include construction of seepage remediation and levee raises along four stretches of the American River, and construction of levee strengthening and raising of 5.5 miles of Natomas Cross Canal levee in Natomas. All American River features authorized in WRDA 1996 and 1999 have been constructed or are in design analysis for construction within a year or two.

Because of the considerable cost increase of seepage remediation on the American River, all funds appropriated by Congress throughout the late 1990s and the early part of the 2000s were used for construction activities on the American River instead of for design efforts in the Natomas Basin. Combining this with the recognition that all work in the Natomas Basin would also require significantly more effort than was anticipated at the time of authorization, it was decided in 2002 that a general reevaluation study would be required for at least the Natomas Basin portion of the ARCF project. This general reevaluation started in 2006.

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At approximately the same time that the reevaluation study was beginning, the Folsom Dam Post Authorization Change report (PAC) was being completed by the Sacramento District. Results of this study showed that additional levee improvements were needed on the American River and on the Sacramento River below the American River in order to truly capture the benefits of the Folsom Dam projects. These levee improvements consisted primarily of addressing erosion concerns on the American River and seepage, stability, erosion, and height concerns on the Sacramento River below the American River. However, the full extent of the levee improvements necessary to address these concerns was not known. With the construction of the Sac Urban project, it was thought that the seepage and stability problems had been addressed. However, the 1997 flood event proved otherwise. Because of this, it was realized that additional reevaluation studies are also needed to include the additional two basins comprising the city of Sacramento, as well as the Natomas Basin.

The purpose of the ARCF project is to reduce the flood risk for the city of Sacramento. The following problems were identified within the Sacramento levee system:

- Seepage and Underseepage;
- Levee Erosion;
- Levee Stability;
- Levee Overtopping;
- Access for Maintenance and Flood Fighting;
- Vegetation and Encroachments;
- Releases from Folsom Dam;
- Floodplain Management; and
- Additional Upstream Storage from Existing Reservoirs.

1.3 Future Consultation Approach

In order to evaluate the maximum affects to listed species this BA looks at the largest foreseeable footprint. The Corps will consult on Alternative 2 (Proposed Alternative) which is the tentatively selected plan and the Locally Preferred Plan. As we move into the design phase of the project, footprint changes will likely reduce the affects to listed species. Coordination with the resource agencies will continue into the design phase to obtain input which can help to avoid, minimize, or compensate for affects to listed species. This future coordination would attempt to reduce any mitigation required for the project and also would determine if additional consultation is needed for the project.

In addition, SAFCA, the project's local sponsor, is proposing to implement some reaches of the ARCF GRR in advance of the Federal project. SAFCA would seek permission from the Corps pursuant to 33 USC §408 (Section 408) for alteration of the Federal levee system. Additionally, SAFCA would seek credit from the Corps under Section 221 of the Flood Control Act of 1970. This BA supports implementation of SAFCA's Section 408 project should SAFCA choose to proceed without Federal participation.

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2.0 Description of the Action and Project Evaluation Approach

2.1 Introduction

The ARCF GRR has identified a number of problems associated with the flood risk management system protecting the city of Sacramento and surrounding areas. There is a high probability that flows in the American and Sacramento Rivers will stress the network of levees protecting Sacramento to the point that levees could fail. The consequences of such a levee failure would be catastrophic, since the area inundated by flood waters is highly urbanized and the flooding could be up to 20 feet deep.

The majority of the Sacramento River levee within the study area requires seepage, slope stability, height, and erosion improvements in order to meet Corps criteria. Construction of the levee improvement measures will require complete vegetation removal within the construction footprint required to install the cutoff wall and raise the levee for approximately one mile. On the waterside, where construction does not remove vegetation, on the lower one-half of the slope to 15 feet waterward of the waterside levee toe, the vegetation will be left in place and a Vegetation Variance (VV) will be sought by the Sacramento District. To show that the safety, structural integrity, and functionality of the levee would be retained, an evaluation of underseepage and waterside embankment slope stability was completed given that a tree fell resulting in scouring of the root ball area.

An analyses section/index point was chosen for the VV analyses which was considered to be representative of the most critical channel and levee geometry and the without project analyses showed the section does not meet underseepage and slope stability criteria. The cross-section geometry of the index point incorporated tree fall and scour by using a maximum depth of scour for cottonwoods as approximately 11.0 feet; the associated soil removed was projected at a 2:1 slope from the base of the scour toward both the landside, and waterside slopes. The base scour width was equal to the maximum potential diameter at breast height (dbh) of cottonwoods (12.0 feet) projected horizontally at a depth of 11.0 feet below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee meets Corps seepage and slope stability criteria considering the seepage and stability improvement measures are in place ("with project" conditions). Therefore, it is a reasonable conclusion that a VV to allow vegetation to remain would not jeopardize the safety, structural integrity, and functionality of the Sacramento River levee. The Sacramento Weir and Bypass levees would be constructed in compliance with the Corps ETL as these would be new levees. No vegetation removal would be required within the existing or expanded Sacramento Bypass. Table 2 below summarizes the project reaches and whether or not a variance would be requested outside of the construction footprint.

Table 2. Summary of ETL Compliance Method by Waterway.

	Vegetation Variance	SWIF
Sacramento River (lower ½ of levee slope which is outside construction footprint)		
Waterside	X	
Landside		X
American River		
Trench Landside[1]		X
Bank Protection		X
North Area Tributaries[2]		
NEMDC	X	X
Dry/Robla Creeks	X	X
Arcade Creek	X	X
Magpie Creek[3]	X	X

1 The waterside footprint for the trench construction would require removal of vegetation and therefore compliance with the ETL.
2 A variance is included for these tributaries waterside slopes outside of the construction footprint, and a SWIF would be prepared by the non-Federal partners for the landside slopes and access.
3 The new levee constructed along Raley Boulevard would be constructed in compliance with the ETL.

2.1.1 Alternative Formulation and Screening

A wide variety of management measures were developed to address the planning objectives. These measures were evaluated and then screened using the Corps planning process. Formulation strategies were then developed to address various combinations of the planning objectives and planning constraints. Based upon these strategies, various combinations of the measures were assembled to form an array of preliminary plans. The preliminary plans were then evaluated, screened and reformulated, resulting in a final array of alternatives.

The formulation strategies used to address the objectives and constraints included:

- Measures to reduce flood stages;
- Measures to address seepage and underseepage;
- Measures to address stability;
- Measures to achieve the urban levee level of protection;
- Measures to address erosion;
- Measures to address maintenance and emergency response access; and
- Non-structural measures.

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Approximately 35 different measures were developed to address these formulation strategies. The measures then went through a preliminary screening process prior to combing them into alternatives. This screening was done by evaluating the measures against the four planning criteria established in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies: completeness, efficiency, effectiveness, and acceptability. In addition, the local sponsor identified a planning criterion of ability to implement the project.

2.1.2 Measures Considered, But Eliminated From Future Consideration

Some measures originally identified that could contribute to addressing Sacramento's flood problems and needs were reviewed and dropped from further consideration. These measures included:

- Upstream storage on the American River (Auburn Dam);
- Transitory storage in upstream basins;
- Yolo Bypass improvements;
- Reoperation of upstream reservoirs: and
- Construction of a diversion structure just upstream of the existing I Street Bridge on the Sacramento River.

The Corps has a long history of studying upstream storage on the American River. Auburn Dam was proposed for authorization by the Corps in both 1991 and 1996, with no authorization granted by Congress. Since that time, Congress has consistently directed the Corps to focus on downstream elements rather than upstream storage under the scope of this study, as levee improvements are considered to be the first increment necessary to improve the overall system. As a result, this alternative was eliminated from consideration under this study. However, upstream storage may be considered to be a viable measure to further reduce the level of risk to the flood risk management system under future studies.

The I Street Bridge diversion structure was proposed to limit flood flows through the city of Sacramento and push excess flows into the Yolo Bypass in order to limit the need for levee repairs downstream of the structure. This measure was not carried forward for a variety of reasons. The estimated implementation time would leave the urban Sacramento River at risk for an unacceptably long period of time. Operation of the structure would inundate the Yolo Bypass more frequently than current operations, causing an unknown disruption to the Yolo County agricultural economy. In addition, the construction of a permanent structure in the Sacramento River channel is inconsistent with the goals and objectives of the Central Valley Flood Protection Plan, a key planning effort by the State of California; moving forward with a measure that is inconsistent with this plan could risk the partnership between the Corps and the State for the ARCF GRR.

The remaining three measures listed above include upstream transitory storage, Yolo Bypass improvements, and reoperation of upstream reservoirs. These three measures were all eliminated from further consideration because none would reduce flood stages to a low enough level to eliminate the need for downstream levee repairs. As a result, the downstream levee repairs remain the common element between these measures and remain the primary focus of Alternative 2, the tentatively selected plan, detailed in Section 2.2 below.

In addition, some non-structural measures were considered, and eliminated, including flood proofing individual structures, relocating residents out of the flood plain, and raising structures to above the floodplain. All of these non-structural measures were eliminated because the sheer number of residents in the floodplains, particularly in the American River South study area in the Pocket and Meadowview neighborhoods, made this alternative cost-prohibitive when compared to the proposed alternatives.

2.2 Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass

Alternative 2, the tentatively selected plan, involves the construction of fix-in-place levee remediation measures to address seepage, stability, erosion, and height concerns identified for the American River levees, NEMDC, Arcade, Dry/Robla, and Magpie Creeks. The levees along the Sacramento River would be improved to address identified seepage, stability, erosion, and a minimal amount of height concerns. Most height concerns along the Sacramento River would be addressed by a widening of the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass. A summary of the measures proposed under this study are included in Table 3.

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Table 3. Proposed Measures for the American River Common Features Project.

Waterway/Location	Extent of Action	Proposed Measure
American River	North and south levees from the confluence with the Sacramento River upstream for approximately 12 miles.	• Construct bank protection or launchable rock trenches
Sacramento River	East levee from the American River to Morrison Creek.	• Install cutoff walls • Construct bank protection • Construct levee raise
NEMDC	East levee from Dry/Robla Creek to the American River	• Install cutoff walls • Construct floodwalls
Arcade Creek	North and south levees from NEMDC to Marysville Boulevard	• Install cutoff walls • Raise floodwalls
Dry/Robla Creek		• Raise floodwalls
Magpie Creek Diversion Canal	Upstream of Raley Boulevard	• Construct floodwalls
Magpie Creek area	South of Raley Boulevard	• Construct new levee
Magpie Creek area	East of Raley Boulevard	• Acquire property to create a flood detention basin • Widen the Raley Boulevard/Magpie Creek bridge and raise the elevation of the roadway • Remove the Don Julio Creek culvert
Sacramento Weir and Bypass	North bypass levee to 1,500 feet north.	• Widen the Sacramento Weir and Bypass by approximately 1,500 feet • Construct a new section of weir and levee • Remove the existing Sacramento Bypass north levee

All proposed measures are detailed in Sections 2.2.1 through 2.2.4 below. Due to the urban nature and proximity of existing development within the American River North and South basins, Alternative 2 proposes fix in place remediation. The purpose of this alternative would be to improve the flood damage reduction system to safely convey flows to a level that maximizes net benefits. Table 4 summarizes the levee problems discussed above and the proposed measure for each waterway.

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Table 4. Alternative 2 - Proposed Remediation Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall	Bank Protection	Sacramento Bypass and Weir Widening, Levee Raise
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall
Arcade Creek	Cutoff Wall	Cutoff Wall	---	Floodwall
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek[2]	---	---	---	Floodwall, Levee Raise

1 American River seepage, stability, and overtopping measures were addressed in the American River Common Features, WRDA 1996 and 1999 construction projects.
2 In addition to the Floodwall, Magpie Creek will include construction of a new levee along Raley Boulevard south of the creek, and construction of a detention basin on both sides of Raley Boulevard. In addition, some improvements would need to occur on Raley Boulevard, including widening of the Magpie Creek Bridge, raising the elevation of the roadway, and removing the Don Julio Creek culvert.

2.2.1 Vegetation and Encroachments

In addition to the proposed levee improvements measures shown in Table 3, the following measures and policies would be addressed during construction:

- Utility encroachments will be brought into compliance with Corps policy as a part of project construction activities. Utilities that penetrate the levee would be removed during excavation of the levee and replaced with one of two fixes as construction commences. These two fixes include: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices.
- Private encroachments such as fences and stairs in the levee shall be removed by the non-federal sponsor prior to construction.

The Corps' Engineering Technical Letter (ETL) 1110-2-583, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures, calls for the removal of wild growth, trees, and other vegetation, which might impair levee integrity or flood-fighting access in order to reduce the risk of flood damage. In certain instances, to further enhance environmental values or to meet state or Federal laws and/or regulations, a variance can be requested from the standard vegetation guidelines set forth in this ETL. The vegetation requirements include a 15 foot waterside, landside, and vertical vegetation-free zone.

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The local sponsor (Central Valley Flood Protection Board) would bring the levees into compliance with the Corps' standard levee footprint and ETL 1110-2-583 vegetation requirements using a System Wide Implementation Framework (SWIF) process. A SWIF is a plan developed by the local maintaining agency (LMA) and accepted by the Corps to implement system-wide improvements to address system-wide issues, including correction of unacceptable inspection items, in a prioritized way to optimize flood risk reduction.

The intent of the SWIF is to collaboratively work with resource agencies and levee sponsors to transition existing levees to Corps standards while maintaining PL 84-99 rehabilitation assistance and adhering to the ESA and other environmental laws. The SWIF is a two-step process completed by the applicant that is composed of a Letter of Intent, which is followed by submission of a SWIF plan. The SWIF process allows eligible local sponsors to implement levee improvements in a prioritized "worst first" way to optimize the achievement of risk reduction. The Corps acknowledges that implementing system-wide improvements will need to be done within a collaborative intergovernmental framework and that it will take time to develop and implement improvements in complex situations. Challenges include ensuring that both environmental and ESA considerations as well as levee safety imperatives are adequately served.

The proposed SWIF would be implemented over the next 20 to 40 years and includes the following criteria:

- An engineering inspection and evaluation shall be conducted to identify trees and other woody vegetation (alive or dead) on the levee and within 15 feet of the levee toe that pose an unacceptable threat to the integrity of the levee. Identified trees shall be removed and associated root balls and roots shall be appropriately remediated. Based on the engineering inspection and evaluation, trees and other woody vegetation that do not pose an unacceptable threat need not be removed.
- In cases of levee repair or improvement project, vegetation within the project footprint shall be removed as part of construction activities.
- Trees and other woody vegetation that are not removed must be monitored as part of routine levee maintenance to identify changed conditions that cause any of these remaining trees and other woody vegetation to pose an unacceptable threat to levee integrity. Otherwise, such trees and woody vegetation are to be maintained according to the levee vegetation management criteria included in the CVFPP which establish a vegetation management zone (including the landside levee slope, crown and upper 1/3 of the waterside slope) in which trees are trimmed up to 5 feet above the ground (12-foot clearance above the crown road) and thinned for visibility and access while brush, trees and other woody vegetation less than four inches in diameter at breast height, weeds or other such vegetation over 12 inches high are to be removed in an authorized manner.

In addition to the SWIF, a variance from the vegetation policy would be sought during the preconstruction engineering and design phase of the project to allow vegetation to remain on the lower waterside slope and within the waterside 15 foot vegetation-free zone for all levees proposed for improvement within the study area. With receipt of a variance, vegetation would only be removed within the construction footprint during project implementation. .

The vegetation variance request requires the Corps to show that the safety, structural integrity, and functionality of the levee would be retained if the vegetation were to remain in place. An evaluation of underseepage and waterside embankment slope stability was completed for this study by Corps geotechnical engineers.

This analysis was completed for the section/index point at levee mile (LM) 5.92 on the Sacramento River. This index point was chosen for the variance analyses because it was considered to be representative of the most critical channel and levee geometry, underseepage and slope stability conditions, and vegetation conditions. The cross-section geometry of the index point incorporated tree fall and scour by using maximum potential diameter at breast height (dbh) of cottonwoods (12.0 feet) projected horizontally at a depth of 11.0 feet below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee meets Corps seepage and slope stability criteria considering the seepage and stability improvement measures are in place ("with project" conditions). Therefore, it is a reasonable conclusion that by allowing vegetation to remain as stated above, the safety, structural integrity, and functionality of the Sacramento River levee would be retained.

2.2.2 Borrow Sites and Staging Areas

It is estimated that a maximum of 1 million cubic yards (cy) of borrow material could be needed to construct the project. Because this project is in the preliminary stages of design, detailed studies of the borrow needs for each alternative have not been completed. Actual volumes exported from any single borrow site would be adjusted to match demands for fill. Borrow sites would be selected that do not cause an impact to endangered species or their habitat and therefore, consultation for borrow sites is not required.

To identify potential locations for borrow material, soil maps and land use maps were obtained for a 20-mile radius surrounding the project area. These potential borrow locations are shown on Figure 2. Borrow sites would be lands that are the least environmentally damaging and would be obtained from willing sellers. The criteria used to determine potential locations were based on current land use patterns and soil types from the Natural Resources Conservation Service (NRCS). The data from land use maps and NRCS has not been field verified, therefore, to ensure that sufficient borrow material would be available for construction the Corps looked at all locations within the 20 miles radius for 20 times the needed material. This would allow for sites that do not meet specifications or are not available for extraction of material.

The excavation limits on the borrow sites would provide a minimum buffer of 50 feet from the edge of the borrow site boundary. From this setback, the slope from existing grade down to the bottom of the excavation would be no steeper than 3H:1V. Excavation depths from the borrow sites would be determined based on available suitable material. The borrow sites would be stripped of top material and excavated to appropriate depths. Once material is extracted, borrow sites would be returned to their existing use whenever possible, or these lands could be used to mitigate for project impacts, if appropriate.

While staging areas have not been identified at this point in the planning phase, sites will be selected that do not require the removal of large vegetation or habitat that is valuable for endangered species. Staging areas would be selected that do not cause an impact to federally listed species or their habitat and therefore, this BA does not address staging areas and consultation for staging areas is not anticipated. Prior to construction, any staging areas would be cleared, grubbed, and stripped.

Construction of Alternative 2 is proposed to take approximately 13 years. The construction reaches have been prioritized based on a variety of factors, including the condition of the levee, the potential damages that would occur due to levee failure, and construction feasibility considerations, such as the availability of equipment at any given time. The tentative schedule of construction is shown in Table 5.

The following sections contain more detailed information on the specific measures proposed under this alternative for the American River North and South study areas.

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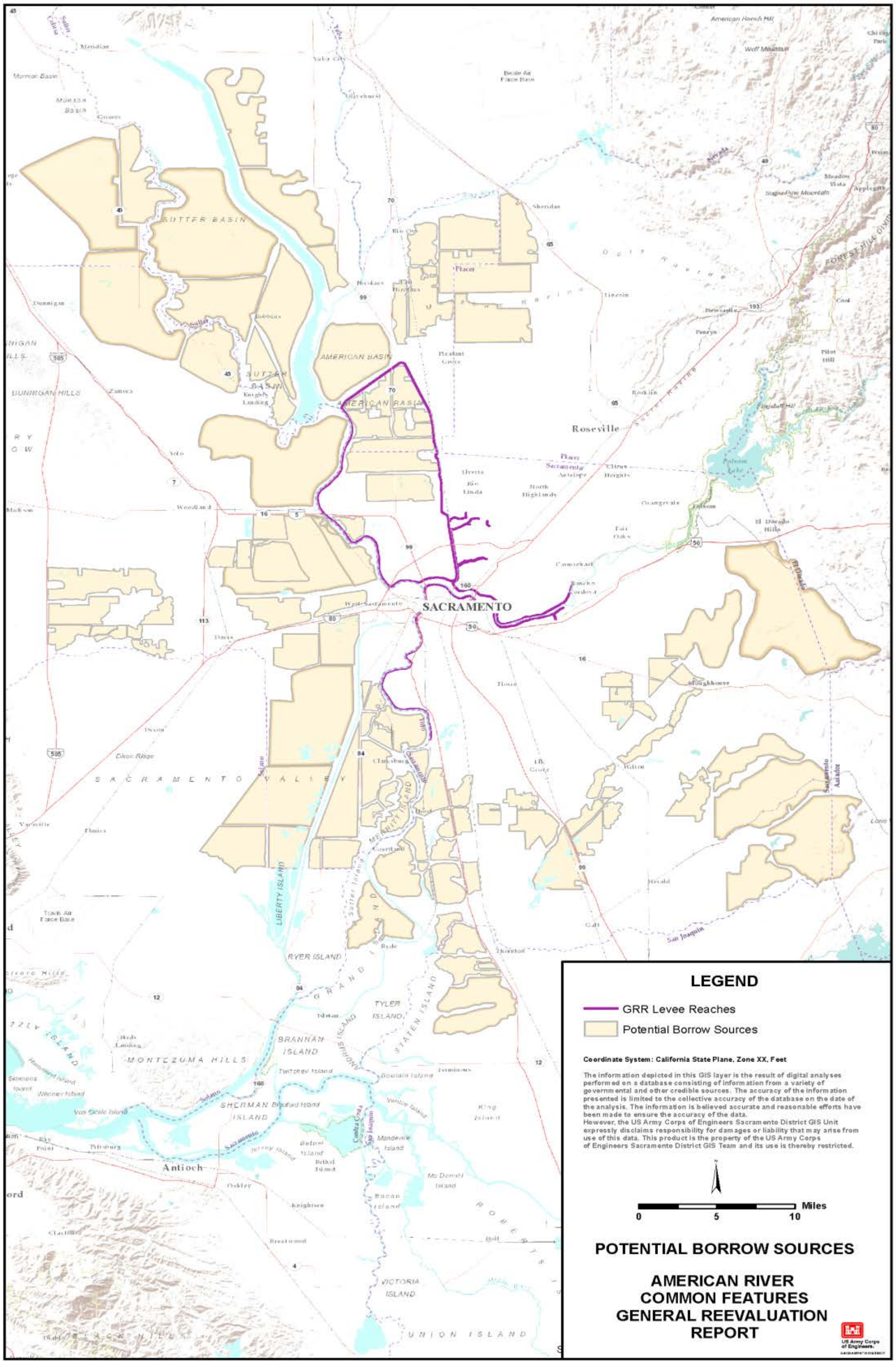

Figure 2. Potential Borrow Sites within 20-miles of Study Area.

Table 5. Tentative Construction Schedule for Alternative 2.

PRIORITY	WATERWAY	REACH[1]	YEAR OF PROJECT CONSTRUCTION												
			1	2	3	4	5	6	7	8	9	10	11	12	13
1	Sacramento River	ARS F	■	■	■	■	■								
2	Sacramento River	ARS E				■	■	■							
3	American River	ARS A	■	■	■	■									
4	Sacramento River	ARS G					■	■	■						
5	Sacramento River	ARS D						■	■	■					
6	American River	ARS B			■	■									
7	American River	ARN A							■	■	■	■			
8	American River	ARS C								■	■	■			
9	American River	ARN B								■	■				
10	Sacramento Weir & Bypass	--								■	■	■	■		
11	Arcade Creek	ARN D									■	■			
12	NEMDC	ARN F											■	■	
13	Arcade Creek	ARN E											■	■	
14	NEMDC	ARN C									■	■			
15	Dry/Robla Creek	ARN G											■	■	■
16	Magpie Creek	ARN I											■	■	■

[1] Individual reach ID's can be seen in Figure 9 below in Section 4.1.2.

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2.2.3 American River

Levees along the American River under Alternative 2 require improvements to address erosion. The proposed measures for these levees consist of waterside armoring to prevent erosion to the river bank and levee, which could potentially undermine the levee foundation. There are two measures proposed for the American River levees: (1) bank protection, and (2) launchable rock trench. Both of these measures are described in detail in the subsections below.

<u>Bank Protection</u>

The Corps conducts ongoing erosion repairs to sites on the Sacramento River levees under the Sacramento River Bank Protection Project (SRBPP). As part of the SRBPP NMFS Biological Opinions, the Corps is required to conduct post-construction monitoring in order to evaluate the relative success of on-site habitat features that are incorporated into the repairs. Under the SRBPP, bank protection designs have been constantly evolving, as the results of the monitoring help inform engineers to adapt the designs to optimize for site-specific conditions in meeting the objective of the habitat features. The Corps will use the best available information and SRBPP design templates as a basis for designing site-specific bank protection repairs for this project. As a result, the bank protection measure described below is a basic example of a typically designed bank protection site.

This measure consists of placing rock revetment on the river's bank to prevent erosion. This measure entails installing revetment along the stream bank based on site-specific analysis (Figure 5). When necessary, the eroded portion of the bank would be filled and compacted prior to the rock placement. The sites would be prepared by clearing and stripping of loose material and understory growth prior to construction. In most cases large vegetation would be permitted to remain at these sites. Temporary access ramps would be constructed, if needed, using imported borrow material that would be trucked on site.

The placement of rock onto the bank will occur from a land based staging area using long reach excavators and loader. The loader brings the rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the water side of the levee.

The revetment would be placed on the existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After revetment placement has been completed, a planting berm would be constructed in the rock to allow for revegetation of the site. The planting berm varies in width from 5 to 15 feet (Figure 3). In all cases the planting will occur outside the vegetation free zone as required by the ETL.

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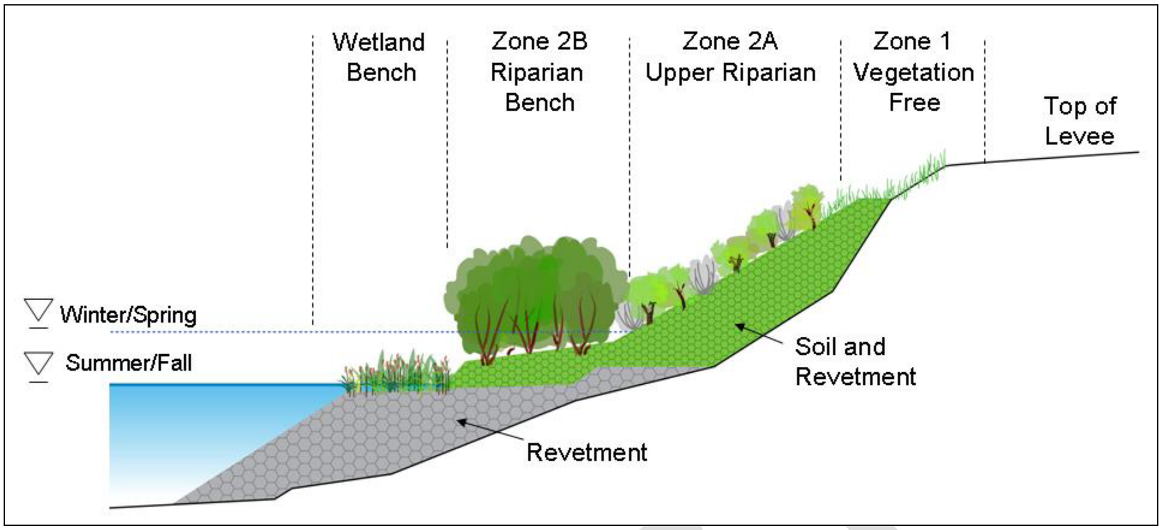

Figure 3. Planting Berms with Vegetation and Wetland Bench.

Launchable Rock Trench

This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it (Figure 4). All launchable rock trenches would be constructed outside of the natural river channel. The vegetation would be removed from the footprint of the trench and the levee slope prior to excavation of the trench. The trench configuration would include a 2:1 landslide slope and 1:1 waterside slope and would be excavated at the toe of the existing levee. All soil removed during trench excavation would be stockpiled for potential reuse. The bottom of the trench would be constructed close to the summer mean water surface elevation in order to reduce the rock launching distance and amount of rock required.

After excavation, the trench would be filled with revetment that would be imported from an offsite location. After rock placement the trench would be covered with a minimum of 3 feet of the stockpiled soil for a planting berm. Rock placed on the levee slope would be covered with 2 feet of stockpiled soil. All disturbed areas would be reseeded with native grasses and small shrubs where appropriate. Trees and shrubs could be permitted on the berm if planted outside the specified vegetation free zone as required by the ETL. This alternative would not increase flows in the American River that would cause additional erosion along the banks. If flow changes occur that could cause loss of floodplain between the levee and the existing natural channel (the Parkway land) it will be addressed under the Folsom Reoperation Biological Assessment and EIS/EIR if applicable.

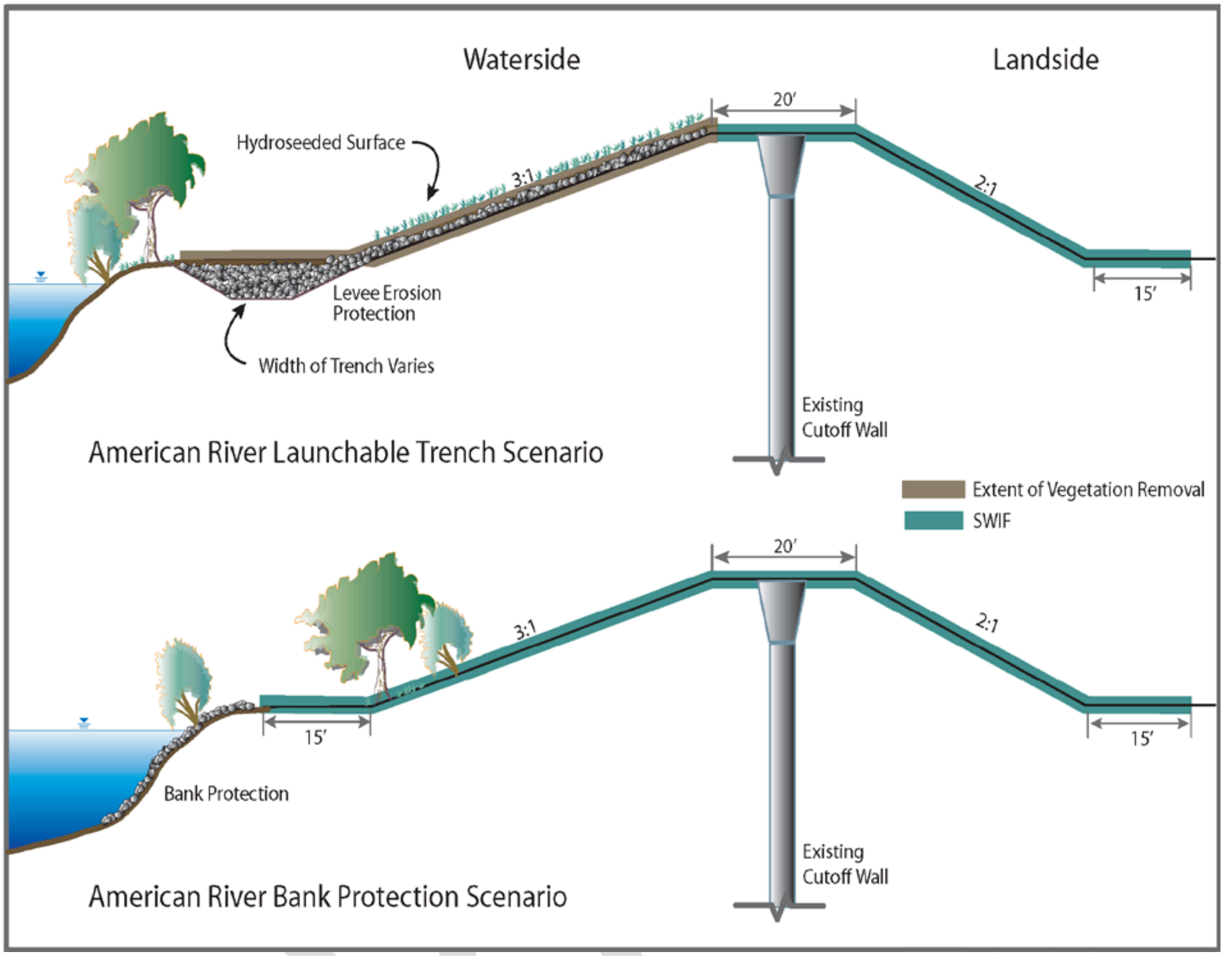

Figure 4. Erosion Protection – Launchable Rock Trench and Bank Protection Scenarios.

2.2.4 Sacramento River

Levees along the Sacramento River require improvements to address seepage, stability, and erosion. In addition, these levees require a total of one mile of intermittent height improvements in order to convey additional flows that exceed current design levels.

Where the existing levee does not meet the levee design requirements, as discussed in Section 2.2 above, slope flattening, crown widening, and/or a minimal amount of levee raise is required. This improvement measure addresses problems with slope stability, geometry, height and levee crest access and maintenance. To begin levee embankment grading, loose material and vegetation understory would be cleared, grubbed, stripped, and, where necessary, portions of the existing embankment would be excavated to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material (from nearby borrow sites) would be stockpiled at staging areas. Haul trucks and front end loaders would bring borrow materials to the site, which would then be spread evenly and compacted according to levee design plans.

The levee would be raised approximately 1 to 3 feet which would result in the levee footprint extending out a maximum of 5 feet on the landside from the existing levee. The levee crown patrol road would be re-established at the completion of construction. A typical design for these levees is shown in Figure 5 below.

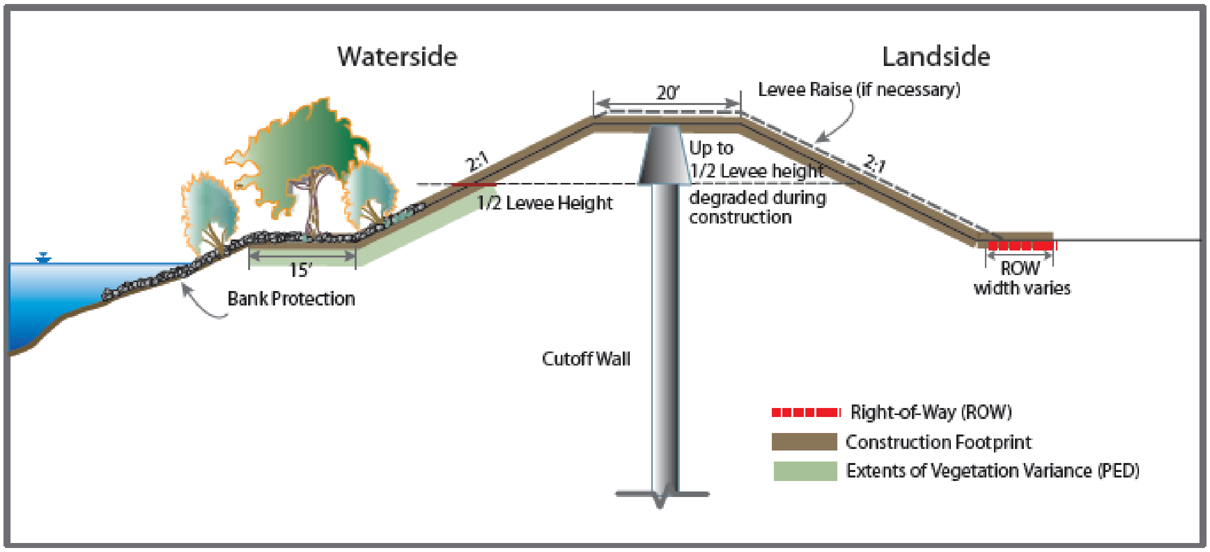

Figure 5. Fix-In-Place with Cutoff Wall and Levee Raise.

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__Cutoff Walls__

To address seepage concerns, a cutoff wall will be constructed through the levee crown (Figure 5). The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 85 feet. For cutoff walls of greater depth the DSM method would be utilized.

Prior to construction of either method of cutoff wall, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded up to half the levee height to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids. This method of slurry wall installation will also reduce the risk of slurry mixture following seepage paths and leaking into the river or into landside properties.

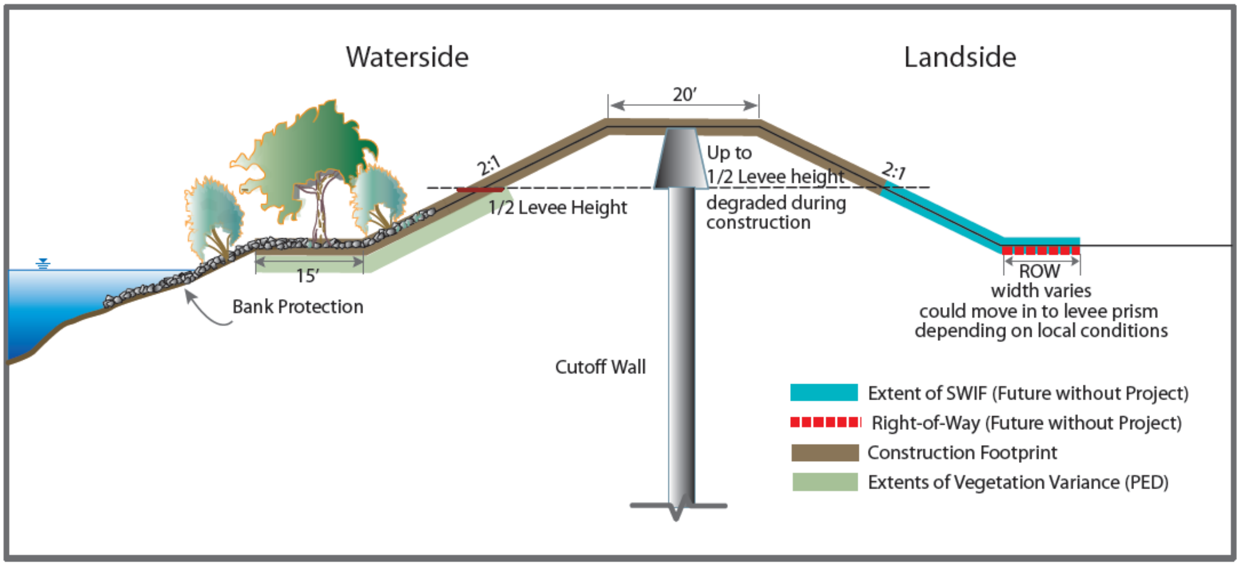

Figure 6. Fix-In-Place with Cutoff Wall and No Levee Raise.

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Open Trench Cutoff Wall

Under the open trench method, a trench approximately 3 feet wide would be excavated at the top of levee centerline and into the subsurface materials up to 85 feet deep with a long boom excavator. As the trench is excavated, it is filled with low density temporary bentonite water slurry to prevent cave in. The soil from the excavated trench is mixed nearby with hydrated bentonite, and in some applications cement. The soil bentonite mixture is backfilled into the trench, displacing the temporary slurry. Once the slurry has hardened, it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.

DSM Cutoff Wall

The DSM method involves a crane supported set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of approximately 140 feet. As the augers are inserted and withdrawn, a cement bentonite grout would be injected through the augers and mixed with the native soils. An overlapping series of mixed columns would be drilled to create a continuous seepage cutoff barrier. A degrade of up to one half the levee height would be required for construction of the DSM wall. For both methods, once the slurry has hardened it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.

<u>Bank Protection</u>

Bank protection on the Sacramento River would be addressed via either the launchable rock trench method described for the American River in Section 2.2.1 above, or by standard bank protection with planting berm (Figure 3). The standard bank protection measure for the Sacramento River consists of placing rock protection on the bank to prevent erosion. This measure entails filling the eroded portion of the bank, where necessary, and installing revetment along the waterside levee slope and streambank from streambed to a height determined by site-specific analysis. Large trees on the lower 1/2 slope will be protected in place to retain SRA habitat. The sites would be prepared by removing vegetation along the levee slopes at either end of the site for construction of a temporary access ramp, if needed. The ramp would then be constructed using imported borrow material that would be trucked on site.

The placement of rock onto the levee slope would occur from atop the levee and/or from the water side by means of barges. Rock required within the channel, both below and slightly above the water line at the time of placement, would be placed by an excavator located on a barge. Construction would require two barges: one barge would carry the excavator, while the other barge would hold the stockpile of rock to be placed on the channel slopes. Rock required on the upper portions of the slopes would be placed by an excavator located on top of the levee. Rock placement from atop the levee would require one excavator and one loader for each potential placement site. The loader brings the rock from a permitted source and stockpiles it near the levee in the construction area. The excavator then moves the rock from the stockpile to the water side of the levee.

The revetment would be placed via the methods discussed above on existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After revetment placement has been completed, a small planting berm would be constructed in the rock to allow for revegetation of the site (Figure 7).

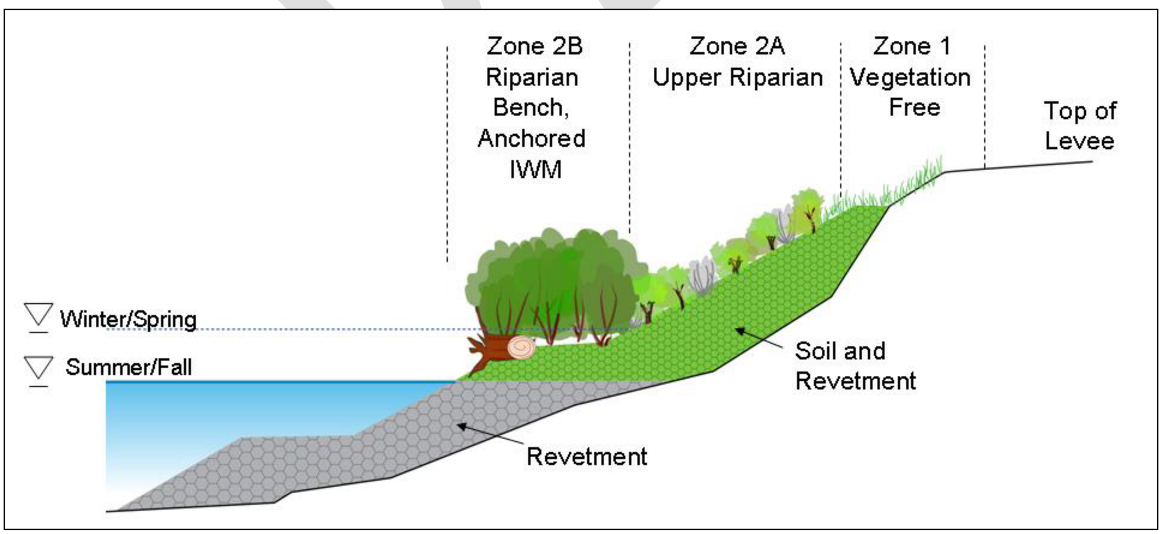

Figure 7. Planting Berm with Vegetation and Woody Material.

2.2.5 East Side Tributaries

Natomas East Main Drain Canal (NEMDC)

The east levee of the NEMDC requires improvements to address seepage and stability at locations where historic creeks had intersected the current levee alignment. A conventional open trench cutoff wall would be constructed at these locations to address the seepage and stability problems (Figure 8). The open trench cutoff walls would be constructed as described for the Sacramento River levee in Section 2.2.2 above.

The NEMDC east levee also has height issues which will be addressed with construction of a new floodwall. The floodwall would be placed at the waterside hinge point of the levee and would be designed to disturb a minimal amount of waterside slope and levee crown for construction (Figure 8). The height of the floodwall varies from 1 to 4 feet, as required by water surface elevations. The waterside slope would be re-established to its existing slope and the levee crown would grade away from the wall and be surfaced with aggregate base.

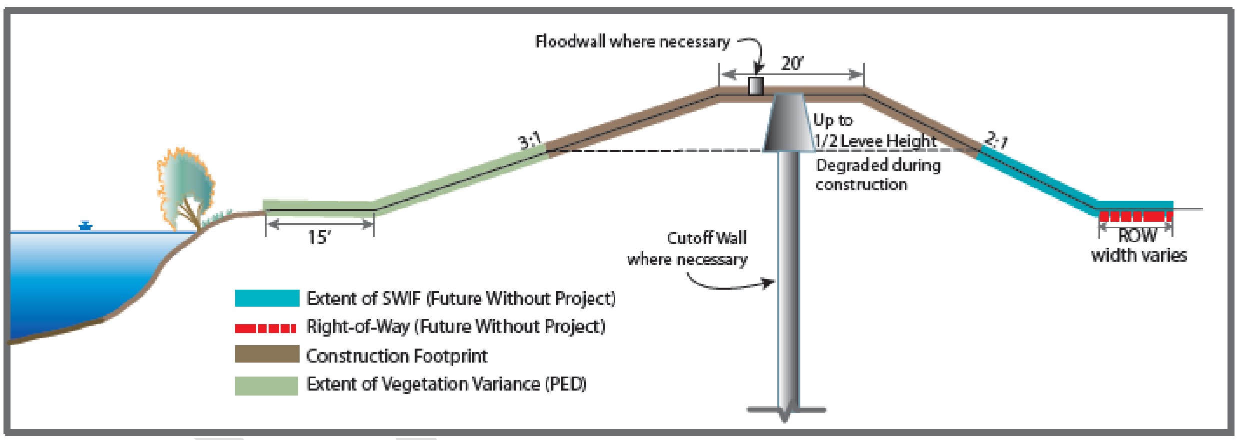

Figure 8. Conventional Open Trench Cutoff Wall or Floodwall Scenario.

Arcade Creek

The Arcade Creek levees require improvements to address seepage, slope stability, and overtopping when the event exceeds the current design. A cutoff wall would be constructed to address seepage (Figure 8) for about half of the total lengths of Reaches D and E (Figure 9). There is a ditch adjacent to the north levee at the landside toe which provides a shortened seepage path, and could affect the stability of the levee. The ditch would be replaced with a conduit or box culvert and then backfilled. This would lengthen the seepage path and improve the stability of the levee.

The majority of the Arcade Creek levees have existing floodwalls which vary in height from 1 to 4 feet, however there remains a height issue in this reach. A 1 to 4-foot floodwall raise would allow the levees to pass flood events greater than the current design level. The new floodwall or added height would result in a total floodwall height of approximately 4 to 6 feet. Construction of the floodwall would be consistent with the description for NEMDC, above.

Dry and Robla Creeks

The Dry and Robla Creeks levees require improvements to address overtopping for when flood events exceed the design level. Height improvements would be made with a new floodwall constructed to a height of 4 to 6 feet. The floodwall would be placed at the waterside hinge point of the levee and would be designed to disturb a minimal amount of waterside slope and levee crown for construction (Figure 9). Construction of the floodwall would be consistent with the description for NEMDC, above. The waterside slope would be re-established to its existing slope and the levee crown would grade away from the wall and be surfaced with aggregate base.

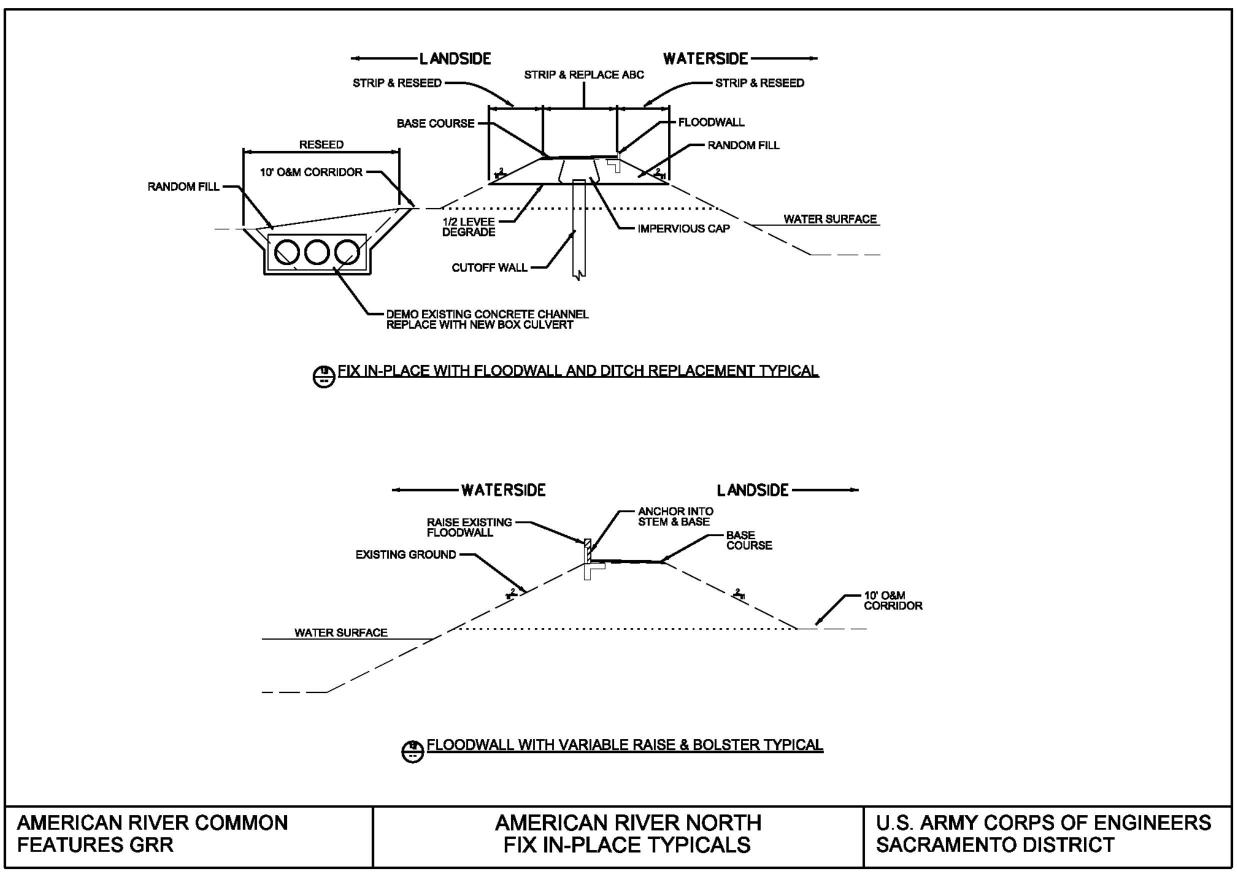

Figure 9. Floodwall with Variable Raise and Bolster Typical.

Magpie Creek Diversion Canal

A number of features are proposed for the Magpie Creek Diversion Canal. The existing project levee on the diversion canal would be strengthened, and an approximately 3 to 4-foot-tall floodwall would be constructed along the top of the existing levee for a distance of approximately 2,100 feet. Construction of the floodwall would be similar to the wall described for NEMDC above. A new, approximately 1,000-foot-long levee would be constructed along Raley Boulevard, south of the Magpie Creek bridge (Figure 10).

In addition to the above levee improvements, an approximately 79-acre flood detention basin would be created for the overflow of flood waters in the Magpie Creek area. The flood detention basin would mostly be created through the acquisition of properties in the floodplain that are currently flooded consistently during high water events. The flood detention basin would be located on both sides of Raley Boulevard near Magpie Creek.

Figure 10. Floodwall and New Levee along Magpie Creek.

Improvements would be made to Raley Boulevard and the surrounding area to improve conveyance of flood flows. These improvements include widening the Magpie Creek Bridge and raising the elevation of the roadway. In addition, the Don Julio Creek culvert would be removed.

2.2.6 Sacramento Weir and Bypass

The Sacramento Weir was completed in 1916. It is the only weir that is manually operated – all others overflow by gravity on their own. It is located along the right bank of the Sacramento River approximately 4 miles upstream of the Tower Bridge, and about 2 miles upstream from the confluence with the American River. Its primary purpose is to protect the city of Sacramento from excessive flood stages in the Sacramento River channel downstream of the American River. The weir limits flood stages (water surface elevations) in the Sacramento River to project design levels through the Sacramento/West Sacramento area. Downstream of the Sacramento Weir, the design flood capacity of the American River is 5,000 cfs higher than that of the Sacramento River. Flows from the American River channel during a major flood event often exceed the capacity of the Sacramento River downstream of the confluence. When this occurs, floodwaters flow upstream from the mouth of the American River to the Sacramento Weir.

The project design capacity of the weir is 112,000 cfs. It is currently 1,920 feet long and consists of 48 gates to divert floodwaters to the west through the mile-long Sacramento Bypass to the Yolo Bypass. Each gate has 38 vertical wooden plank "needles" (4 inches thick by 1 foot wide by 6 feet long). It is cumbersome and expensive to operate, and questions have long been asked about whether this 1916 design is appropriate for today's water management needs (DWR 2010).

Though the weir crest elevation is 24.75 feet, the weir gates are not opened until the river reaches 27.5 feet at the I Street gage with a forecast to continue rising. This gage is about 1,000 feet upstream from the I Street Bridge and about 3,500 feet upstream from the mouth of the American River. The number of gates to be opened is determined by the National Weather Service /Department of Water Resources (DWR) river forecasting team to meet either of two criteria: (1) to prevent the stage at the I Street gage from exceeding 29 feet, or (2) to hold the stage at the downstream end of the weir to 27.5 feet (DWR 2010). The weir gates are then closed as rapidly as practicable once the stage at the weir drops below 25 feet. This provides "flushing" flows to re-suspend sediment deposited in the Sacramento River between the Sacramento Weir and the American River during the low flow periods when the weir is open during the peak of the flood event (DWR 2010).

Under this alternative, the Sacramento Weir and Bypass would be expanded to roughly twice their current width to accommodate increased bypass flows. The existing north levee of the Sacramento Bypass would be degraded and a new levee would be constructed approximately 1,500 feet to the north. The existing Sacramento Weir would be expanded to match the wider bypass. At this time, it is not known whether the new segment of weir would be constructed consistent with the 1916 design described above, or whether it would be designed to be a gravity-type weir. The new north levee of the bypass would be designed to be consistent with the existing Sacramento Bypass north levee, however, it would also include a 300-foot-wide seepage berm on the landside with a system of relief wells. A hazardous, toxic, and radiological waste (HTRW) site near the existing north levee would be remediated by the non-Federal sponsor prior to construction.

The increase in Bypass flows would occur during high water situations only, otherwise the Sacramento Weir and Bypass would be operating at the pre-existing conditions described above. While not specifically modeled, there are not expected to be any water quality impacts. The approximate change in water diversions, which are shown in Table 6 below, would vary based on the size of the flood event. The frequency of water diversion is expected to be the same, which is to use the current Sacramento Weir operation based on a stream gage at the I Street Bridge (Schlunegger 2014). Under these operation assumptions, the TSP would result in a diversion of flows from the Sacramento River to the Yolo Bypass that would slightly raise water surface elevations in the Yolo Bypass during frequent events (10 year) compared to both the existing and future without project conditions.

To avoid potential effects to the Yolo Bypass, the widened portion of the Sacramento Weir will only be operated when the release from Folsom Dam is increased to above 115,000 cfs. With the Folsom Dam improvements in place, releases from Folsom Dam would be above 115,000 cfs for flood events greater than 1/100 ACE event. Therefore, for events up to and including the 1/100 ACE event, only the existing weir will be operated per the criteria previously established. For events greater than the 1/100 ACE event when the release from Folsom Dam will go above 115,000 cfs, the new weir will be opened. As a result of the increased flood storage space and anticipatory releases at Folsom Dam, this translates into a reduction of flows into the Yolo Bypass with Alternative 2 in place compared to the existing conditions. See Table 6 for a comparison of the flows at various locations for the Existing Condition, the Future Without Project Condition, and with Alternative 2 in place. For the 1/100 ACE event and greater, the benefits of the Folsom Dam improvements would be realized in the form of reduced flows compared to the Existing condition.

Table 6. Comparison of 10, 100 and 200 year Frequency Flows under Various Conditions.

10 year event	**Existing Condition**	**Future Without Project Condition (also Alternative 1)**	**Alternative 2**
American River	43,000cfs	72,000cfs	72,000cfs
Sacramento Bypass	50,000cfs	66,000cfs	66,000cfs
Yolo Bypass below Sac Bypass	270,000cfs	296,000cfs	296,000cfs
100 year event	**Existing**	**Future Without Project and Alt. 1**	**Alt. 2 (TSP)**
American River	145,000cfs	115,000cfs	115,000cfs
Sacramento Bypass	131,000cfs	115,000cfs	115,000cfs
Yolo Bypass below Sac Bypass	555,000cfs	535,000cfs	535,000cfs
200 year event	**Existing**	**Future Without Project and Alt. 1**	**Alt. 2 (TSP)**
American River	320,000cfs	160,000cfs	160,000cfs
Sacramento Bypass	183,000cfs	149,000cfs	164,000cfs
Yolo Bypass below Sac Bypass	656,000cfs	631,000cfs	643,000cfs

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The widening of the Sacramento Weir and Bypass diverts flood flows from the Sacramento and American River into the Yolo Bypass. The widened portion of the weir will only be operated when flood releases from Folsom Dam are above the existing objective release of 115,000 cfs which would occur during flood events greater than 1/100 ACE event. Therefore, for events up to the 1/100 ACE event, there would be no change in flow conditions in the Sacramento and Yolo Bypasses. For flood events greater than 1/100 ACE event when releases from Folsom Dam would go above 115,000 cfs (such as a 1/200 ACE event in which the Folsom release goes up to 160,000 cfs), because of the additional flood storage provided by anticipated operation and physical improvements to Folsom Dam coupled with the widened Sacramento Weir and Bypass, the net effect would be to slightly decrease the peak compared to the existing peak flow in the Yolo Bypass.

2.3 Operation and Maintenance

2.3.1 American River Flood Control District

Operation and maintenance would be in accordance with the existing manual. This would result in the trimming of up to 50 elderberry shrubs each year and up to 2,500 over the 50 year life of the project. The shrubs are located throughout the American River Parkway, Dry/Robla Creek, Arcade Creek, Magpie Creek, and NEMDC. Trimming consist of cutting overhanging branches along the levee slopes on both the landside and waterside. Some shrubs may be located adjacent to the levee with branches hanging over the levee maintenance road. All shrubs would be trimmed in accordance with the 1999 FWS approved Conservation Guidelines for the Valley Elderberry Longhorn Beetle. Trimming would occur during the elderberry shrubs dormant season, approximately November through the first two weeks in February, after they have lost their leaves.

2.3.2 Maintenance Area 9

Operation and maintenance would be in accordance with the existing manual. This would result in the trimming of up to 20 elderberry shrubs each year and up to 1,000 over the 50 year life of the project. The shrubs are located along the Sacramento River east levee. Trimming consist of cutting overhanging branches along the levee slopes on both the landside and waterside. Some shrubs may be located adjacent to the levee with branches hanging over the levee maintenance road. All shrubs would be trimmed in accordance with the 1999 FWS approved Conservation Guidelines for the Valley Elderberry Longhorn Beetle. Trimming would occur during the elderberry shrubs dormant season, approximately November through the first two weeks in February, after they have lost their leaves.

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2.3.3 Department of Water Resources

The operation of the expanded Sacramento Weir and Bypass would be similar to that of the existing weir. Releases into the weir will occur at the same intervals and durations as currently occur. The expanded weir however, would allow for larger volumes of water to be moved off the urban levees and into the bypass system in a large flood event. The operation of the weir is not expected to affect any species currently listed under the Endangered Species Act.

2.3.4 City of Sacramento

Operation and maintenance would be in accordance with the existing manual. This would result in the trimming of up to 20 elderberry shrubs each year and up to 1,000 over the 50 year life of the project. The shrubs are located along the Sacramento River east levee between the confluence with the American River and Sutterville Road. Trimming consist of cutting overhanging branches along the levee slopes on both the landside and waterside. Some shrubs may be located adjacent to the levee with branches hanging over the levee maintenance road. All shrubs would be trimmed in accordance with the 1999 FWS approved Conservation Guidelines for the Valley Elderberry Longhorn Beetle. Trimming would occur during the elderberry shrubs dormant season, approximately November through the first two weeks in February, after they have lost their leaves.

2.4 Full Consultation Biological Assessment Approach

The description of baseline conditions and the evaluation of potential impacts have been organized by waterway, which includes the American River, Sacramento River, NEMDC, Arcade Creek, Dry/Robla Creek, Magpie Creek, and the Sacramento Weir/Bypass areas. For species that are described and covered in this consultation, habitat preferences and distributions are based on published data, agency documents, and review of the California Natural Diversity Database (CNDDB) (CDFW 2013a). Species distributions were assessed throughout the ARCF study area, and where appropriate, within specific regions.

Descriptions of baseline conditions are based on information published in peer-reviewed scientific literature, resource agency publications, as well as aerial photography viewed in Google Earth Pro within the project area. Baseline conditions are described with a focus on features that affect habitat conditions for threatened and endangered species, including Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, delta smelt, green sturgeon, giant garter snake, valley elderberry longhorn beetle, vernal pool fairy shrimp, vernal pool tadpole shrimp, and special status bird species.

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2.5 Proposed Conservation and Mitigation Measures

2.5.1 Compensation Timing

Compensation timing refers to the time between the initiation of construction at a particular site and the attainment of the habitat benefits to protected species from designated compensation sites. In general, compensation time is the time required for on-site plantings to provide significant amounts of shade or structural complexity from instream woody material recruitment. Significant long-term benefits have often been considered as appropriate to offset small short-term losses in habitat for listed species in the past, as long as the overall action contributes to recovery of the listed species. The authority to compensate prior to or concurrent with project construction is given under WRDA 1986 (33 United States Code [USC] § 2283).

Depending on the species of interest (e.g., delta smelt), the severity of the short- term habitat losses due to bank erosion repair actions may not be compensated by long-term gains, whereas longer lived species (e.g., steelhead, Chinook) have longer periods for compensation to be provided. The following compensation time periods (based loosely on life expectancy) should be considered as guidelines for compensation:

- Green sturgeon, 15 years;
- Chinook salmon, 5 years;
- Central Valley steelhead, 4 years; and
- Delta smelt, 1 year.

2.5.2 Valley Elderberry Longhorn Beetle Conservation and Mitigation Measures

The following is a summary of measures based on the *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (USFWS 1999a). These measures will be implemented to minimize any potential effects on valley elderberry longhorn beetles or their habitat, including restoration and maintenance activities, long-term, protection, and compensation if shrubs cannot be avoided.

- When a 100-foot (or wider) buffer is established and maintained around elderberry shrubs, complete avoidance (i.e., no adverse effects) will be assumed.
- Where encroachment on the 100-foot buffer has been approved by the USFWS, a setback of 20 feet from the dripline of each elderberry shrub will be maintained whenever possible.
- During construction activities, all areas to be avoided will be fenced and flagged.

- Contractors will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.
- Signs will be erected every 50 feet along the edge of the avoidance area, identifying the area as an environmentally sensitive area.
- Any damage done to the buffer area will be restored.
- Buffer areas will continue to be protected after construction.
- No insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant will be used in the buffer areas.
- Trimming of elderberry plants will be subject to mitigation measures.
- Elderberry shrubs that cannot be avoided would be transplanted to an appropriate riparian area at least 100 feet from construction activities.
- If possible, elderberry shrubs would be transplanted during their dormant season (approximately November, after they have lost their leaves, through the first two weeks in February). If transplantation occurs during the growing season, increased mitigation will apply.
- Any areas that receive transplanted elderberry shrubs and elderberry cuttings will be protected in perpetuity.
- On-Site elderberry compensation would be planted above the new trench outside of the vegetation free zone along the American River Parkway. Sufficient lands are expected to be available to plant the shrubs and associated natives above the new trench area.
- If additional lands are needed, off-site plantings could occur at the existing Cal Expo mitigation site or adjacent to the existing River Bend Park mitigation site.
- The Corps will work to develop off-site compensation areas prior to or concurrent with any take of valley elderberry longhorn beetle habitat.
- Management of these lands will include all measures specified in USFWS's conservation guidelines (1999a) related to weed and litter control, fencing, and the placement of signs.
- Monitoring will occur for ten consecutive years or for seven non-consecutive years over a 15-year period. Annual monitoring reports will be submitted to USFWS.
- Off-site areas will be protected in perpetuity and have a funding source for maintenance (endowment).

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2.5.3 Giant Garter Snake Conservation and Mitigation Measures

The following measures will be implemented to minimize effects on giant garter snake habitat that occurs within 200 feet of any construction activity. These measures are based on USFWS guidelines for restoration and standard avoidance measures included as appendices in USFWS (1997).

- Unless approved otherwise by USFWS, construction will be initiated only during the giant garter snakes' active period (May 1–October 1, when they are able to move away from disturbance).
- Construction personnel will participate in USFWS-approved worker environmental awareness program.
- A giant garter snake survey would be conducted 24 hours prior to construction in potential habitat. Should there be any interruption in work for greater than two weeks, a biologist would survey the project area again no later than 24 hours prior to the restart of work.
- Giant garter snakes encountered during construction activities will be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from the construction site will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas, which will be located more than 200 feet away from giant garter snake aquatic habitat.
- Giant garter snake habitat within 200 feet of construction activities will be designated as an environmentally sensitive area and delineated with signs or fencing. This area will be avoided by all construction personnel.

If any giant garter snake habitat is impacted by construction, the following measures would be implemented to compensate for the habitat loss:

- Habitat (including aquatic and upland) temporarily impacted for one season (May 1–October 1) will be restored after construction by applying appropriate erosion control techniques and replanting/seeding with appropriate native plants.
- Habitat temporarily impacted for two seasons will be restored and replacement habitat will be created at a 2:1 ratio (disturbed to created acres).
- Habitat temporarily impacted for more than two seasons will be replaced at a 2:1 ratio (or restored plus 2:1 replacement).
- Habitat permanently impacted will be replaced at a 3:1 ratio.
- Habitat permanently or temporarily impacted outside of the May 1-October 1 work window will be created at a 2:1 ratio.

- All replacement habitats will include both upland and aquatic habitat components at a 2:1 ratio (upland to aquatic acres).
- One year of monitoring will be conducted for all restored areas. Ten years of monitoring will be conducted for created habitats. A monitoring report with photo documentation will be due to USFWS each year following implementation of restoration or habitat creation activities.
- The Corps will work to develop appropriate mitigation prior to or concurrent with any disturbance of giant garter snake habitat.
- Habitat will be protected in perpetuity and have an endowment attached for management and maintenance.

2.5.4 Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp Conservation and Mitigation Measures

Compensation for the loss of approximately 1 acre of vernal pool habitat would be mitigated through either the enhancement of the flood basin lands being acquired near Magpie Creek to support further vernal pool habitat, or through the purchase of an acre of vernal pool habitat from a mitigation bank. In addition, the following measures would be implemented to avoid and minimize impacts to potential vernal pools in the vicinity of the Magpie Creek construction area:

- Adequate fencing would be placed and maintained around any vernal pool habitat to prevent impacts from vehicles.
- All on-site construction personnel would receive instruction regarding the presence of vernal pool fairy shrimp and vernal pool tadpole shrimp and the importance of avoiding impacts to these species and their habitat.
- If vernal pools are found on site, then a USFWS-approved biologist would monitor any construction-related activities at the proposed project site to ensure that no unnecessary take of listed species or destruction of their habitat occurs. The biologist would have the authority to stop all activities that may result in such take or destruction until appropriate corrective measures have occurred. The biologist would be required to report any unauthorized impacts immediately to USFWS.

2.5.5 Additional Minimization and Conservation Measures

- Obtain an ETL approved vegetation variance exempting sites from vegetation removal prior to final design and construction phase for the Sacramento River.

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- Minimize the removal of existing vegetation in the proposed project area. Any disturbance or removal of vegetation will be replaced with native riparian vegetation, outside of the vegetation-free zone, as established in the ETL.
- Implement best management practices (BMPs) to prevent slurry seeping out to river and require piping system on land side only.
- Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.
- Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a 110% containment system.
- Erosion control measures (BMPs) including Storm Water Pollution Prevention Program and Water Pollution Control Program that minimize soil or sediment from entering the river. BMPs shall be installed, monitored for effectiveness, and maintained throughout construction operations to minimize effects to Federally listed fish and their designated critical habitat.
- Construction will be scheduled when listed terrestrial and aquatic species would be least likely to occur in the project area. If construction needs to extend into the timeframe that species are present, then coordination/reinitiation with the resource agencies will need to occur.
- Site access will be limited to the smallest area possible in order to minimize disturbance.
- Litter, debris, unused materials, equipment, and supplies will be removed from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.
- Immediately (within 24 hours) cleanup and report any spills of hazardous materials to the resource agencies. Any such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.
- Designating a Service approved biologist as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. This representative shall be identified to the employees and contractors during an all employee education program conducted by the Corps.
- Screen any water pump intakes, as specified by NMFS and USFWS screening specifications. Water pumps will maintain an approach velocity of 0.2 feet per second or less when working in areas that may support delta smelt.

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Furthermore, the Corps will seek to avoid and minimize construction effects on listed species and their critical habitat to the extent feasible. A number of measures will be applied to the entire project or specific actions, and other measures may be appropriate at specific locations within the study area. Avoidance activities to be implemented during final design and construction may include, but are not limited to, the following:

- Identifying all habitats containing, or with a substantial possibility of containing, listed terrestrial, wetland, and plant species in the potentially affected project areas. To the extent practicable efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
- Incorporating sensitive habitat information into project bid specifications.
- Incorporating requirements for contractors to avoid identified sensitive habitats into project bid specifications.
- Minimizing vegetation removal to the extent feasible.
- Minimizing, to the extent possible, grubbing and contouring activities.

2.5.6 Summary of Environmental Commitments

Items below present a general summary of environmental commitments that the Corps will adhere to as part of the ARCF GRR.

If our sites do not meet the requirements of creating shaded riverine aquatic (SRA) habitat, then we will purchase compensation at a Services-approved mitigation bank or work with the Services to determine where appropriate mitigation can be created.

- The Corps will obtain an ETL-approved vegetation variance exempting the Sacramento River sites from vegetation removal in the lower third of the waterside of the levee prior to final construction and design phase. The Corps will be complying with the ETL on the American River via a SWIF. Full ETL compliance would occur on the East Side Tributaries sites. This approval process is in alignment with the Corps' Levee Safety Program's goal of maintaining public safety as the primary objective and assuring application of consistent and well-documented approaches.
- The Corps will use a rock soil mixture to facilitate re-vegetation of the proposed project area. A (70:30) rock to soil ratio would be implemented. The soil-rock mixture would be placed on top of the of the rock revetment to allow native riparian vegetation to be planted to insure that SRA habitat lost is partially replaced or enhanced.

- In addition to an approved vegetation variance, the Corps will minimize the removal of existing vegetation in the proposed project area. Disturbance or removal of trees or larger woody vegetation will be replaced with native riparian species, outside of the vegetation-free zone, as established in the ETL.
- Construction will be scheduled when listed terrestrial and aquatic species would be least likely to occur in the project area, approximately May through October. If construction needs to extend into the timeframe that species are present coordination with the resource agencies will occur.

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3.0 Federally Protected Species and Critical Habitat

Federally protected species and critical habitat that may be affected by the proposed action within the ARCF study area were determined through consultation with USFWS and NMFS. The Central Valley fall-/late fall–run Chinook salmon, which is an Evolutionarily Significant Unit (ESU) of special concern but is not Federally listed, is included because the project's effects on EFH must also be assessed.

3.1 Plants

Federally listed plant species are associated with habitat such as, salt marsh, dunes, or cismontane woodland/valley and foothill grasslands. Salt marsh habitat and cismontane woodland/valley and foothill grasslands are also very unlikely to occur along or adjacent to the levees. Due to the general lack of supporting habitat, potential impacts to Federally listed plants are not considered in this BA.

3.2 Invertebrates

Most invertebrate species with the potential to occur in or near the ARCF study area are associated with vernal pool habitat that has not been identified along the levees in the ARCF study area. Although vernal pool habitat may occur adjacent to the project levees, these areas should not be subject to impacts, as described for Federally protected plant species (Section 3.1). However, if future studies identify vernal pool habitat in the ARCF study area the Corps will reinitiate formal consultation with the resource agencies. The only Federally protected invertebrate species that has a high potential to be impacted is the valley elderberry longhorn beetle.

3.2.1 Valley Elderberry Longhorn Beetle

Status and Distribution

The valley elderberry longhorn beetle is listed as a threatened species under the ESA (USFWS 1980). USFWS has undertaken a comprehensive study, known as a 12-month review, to determine whether or not to propose the beetle for delisting (USFWS 2011). According to the USFWS, delisting may be warranted because many new locations of the beetle have been identified since its listing, destruction of habitat has slowed greatly, and efforts have resulted in the protection of significant acreage of habitat (Talley et al. 2006).

The valley elderberry longhorn beetle's range extends from southern Shasta County to Fresno County (Talley et al. 2006). Along the eastern edge of the species' range, adult beetles have been found in the foothills of the Sierra Nevada at elevations up to 2,220 feet, and beetle exit holes have been located on elderberry plants at elevations up to 2,940 feet. Along the western edge of the species' range, adult beetles have been found on the eastern slopes of the Coast Ranges at elevations of up to 500 feet, and beetle exit holes have been detected on elderberry plants at elevations up to 730 feet (Barr 1991).

Critical habitat for the valley elderberry longhorn beetle occurs in two locations near the city of Sacramento (USFWS 1980). One area is enclosed by the Western Pacific railroad tracks and Highway 160, approximately one-half mile north of the American River near its confluence with the Sacramento River. The second site is located along the south bank of the American River at Goethe Park, just upstream of RM 13. Both of these areas are within the study area.

Life History and Habitat Requirements

Because historic loss of riparian habitat in the study area has already occurred, the rate of riparian habitat loss has slowed significantly over the last 30 years. During this period, incidental take of habitat has been authorized primarily for urbanization, transportation, water management, and flood control, on the order of 10,000 to 20,000 acres. Several habitat conservation plans are being developed to allow for continued urbanization of the Sacramento Valley (Talley et al. 2006).

Approximately 50,000 acres of existing riparian habitat in the Central Valley, primarily in the Sacramento Valley, have been protected by Federal, State, and local agencies as well as private organizations. Within the study area, large parcels of suitable habitat for the valley elderberry longhorn beetle have been protected, along the American River Parkway. Restoration of more than 5,000 acres of habitat has been initiated throughout the beetle's range (Talley et al. 2006). Mitigation for previous Corps projects has planted within the American River Parkway through agreements with Sacramento County Parks. Additional lands are currently available for mitigation that may be required for this project.

Valley elderberry longhorn beetle is only found in close association with its host plant, elderberry shrubs (*Sambucus* spp.). Elderberry shrubs are found in or near riparian and oak woodland habitats. The valley elderberry longhorn beetle's life history is assumed to follow a sequence of events similar to those of related taxa. Female beetles deposit eggs in crevices in the bark of living elderberry shrubs. Presumably, the eggs hatch shortly after they are laid, and the larvae bore into the pith of the trunk or stem. When larvae are ready to pupate, they move through the pith of the plant, open an emergence hole through the bark, and return to the pith for pupation. Adults exit through the emergence holes and can sometimes be found on elderberry foliage, flowers, or stems or on adjacent vegetation. The entire life cycle of the valley elderberry longhorn beetle is thought to encompass 1 or 2 years, from the time eggs are laid and hatch until adults emerge and die (USFWS 1984).

The presence of exit holes in elderberry stems indicates previous valley elderberry longhorn beetle habitat use. Exit holes are cylindrical and approximately 0.25 inch in diameter. Exit holes can be found on stems that are 1 or more inches in diameter. The holes may be located on the stems from a few inches to about 9 to 10 feet above the ground (Barr 1991).

Factors Affecting Abundance

The valley elderberry longhorn beetle distribution decline is most likely related to the extensive loss of riparian forests in the Central Valley, which has reduced the amount of available habitat for the species, and has most likely decreased and fragmented the species' range (USFWS 1984).

Insecticide drift from cultivated fields and orchards adjacent to elderberry plants may affect valley elderberry longhorn beetle populations, if drift occurs at a time when adults are present on the shrubs (Barr 1991). Herbicide drift from agricultural fields and orchards can likewise affect the health of elderberry plants, thereby reducing their quantity and quality as valley elderberry longhorn beetle habitat.

The invasive Argentine ant (*Linepithema humile*) has been spreading in riparian habitats and may affect survival of the valley elderberry longhorn beetle. Argentine ants may predate valley elderberry longhorn beetle eggs although this interaction needs further exploration (Huxel 2000). The spread of invasive exotic plants (e.g., giant reed [*Arundo donax*] may also negatively affect the valley elderberry longhorn beetle by affecting supporting riparian habitats. The presence of giant reed promotes a more frequent fire cycle and homogenous plant community (Talley et al. 2006).

3.2.2 Vernal Pool Fairy Shrimp

Status and Distribution

The vernal pool fairy shrimp is listed as a threatened species under the ESA (59 FR 48136). Fairy shrimp are endemic to vernal pools in the Central Valley, coast ranges, and a limited number of sites in the Transverse Range and Santa Rosa Plateau of California. . The most accurate indication of the distribution and abundance of vernal pool fairy shrimp is the number of inhabited vernal pool complexes. There are 32 known populations of the vernal pool fairy shrimp, extending from the Stillwater Plain in Shasta County through the Central Valley to Pixley in Tulare County. In addition, the shrimp occur along the central Coast Range from northern Solano County to Pinnacles National Monument in San Benito County.

Critical habitat for the vernal pool fairy shrimp is designated in the vicinity of the study area on lands surrounding Mather Field. There is no critical habitat for vernal pool fairy shrimp in the study area.

Life History and Habitat Requirements

Vernal pool fairy shrimp live in vernal pools, an ephemeral freshwater habitat. None are known to occur in riverine waters, marine waters, or other permanent bodies of water. They are ecologically dependent on seasonal fluctuations in their habitat, such as absence or presence of water during specific times of the year, duration of inundation, and other environmental factors that include specific salinity, conductivity, dissolved solids, and pH levels. Water chemistry is one of the most important factors in determining the distribution of fairy shrimp (Belk 1977).

Fairy shrimp and tadpole shrimp play an important role in the community ecology of many ephemeral water bodies (Loring et al. 1988). They are fed upon by waterfowl and other vertebrates, such as western spadefoot toad (*Scaphiopus hammondi*) tadpoles (Ahl 1991).

Fairy shrimp have delicate elongate bodies, large stalked compound eyes, no carapace, and 11 pairs of swimming legs. They swim or glide gracefully upside down by means of complex beating movements of the legs that pass in a wavelike, anterior-to-posterior direction. Nearly all fairy shrimp feed on algae, bacteria, protozoa, rotifers, and bits of detritus. Female shrimp drop their eggs to the pool bottom or eggs remain in the brood sac until the female dies and sinks. The "resting" or "summer" eggs are capable of withstanding heat, cold, and prolonged desiccation. When the pools refill in the same or subsequent seasons some, but not all, of the eggs may hatch. The egg bank in the soil may be comprised of the eggs from several years of breeding (Donald 1983). The eggs hatch when the vernal pools fill with rainwater. The early stages of the fairy shrimp develop rapidly into adults. These non-dormant populations often disappear early in the season long before the vernal pools dry up.

Vernal pools form in regions with Mediterranean climates where shallow depressions fill with water during fall and winter rains and then evaporate in the spring (Collie and Lathrop 1976). Downward percolation is prevented by the presence of an impervious subsurface layer, such as a claypan, hardpan, or volcanic stratum (Holland 1976, 1988). Due to local topography and geology, the pools are usually clustered into pool complexes (Holland and Jain 1988). Pools within a complex typically are separated by distances on the order of meters and may form dense, interconnected mosaics of small pools or a more sparse scattering of larger pools. Temporary inundation makes vernal pools too wet during the wetted period for adjacent upland plant species adapted to drier soil conditions, while rapid drying during late spring makes pool basins unsuitable for typical marsh or aquatic species that require a more permanent source of water. However, many indigenous plant and aquatic invertebrate species have evolved to occupy the extreme environmental conditions found in vernal pool habitats.

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Factors Affecting Abundance

Vernal pools are in danger due to a variety of human-caused activities, including urban development, water supply and flood control activities, and conversion of land to agricultural use. Changes in hydrologic pattern, overgrazing, and off-road vehicle use also imperil this aquatic habitat . Habitat loss occurs from direct destruction and modification of pools by filling, grading, discing, leveling, and other activities. Vernal pools can also be indirectly impacted when modifications of the surrounding uplands alter the vernal pool watershed (USFWS 1992b). Diversion of watershed runoff feeding the pools can result in premature pool dry-down before the life cycle of the fairy shrimp is complete. The fairy shrimp is also intolerant of flowing water that washes away the egg bank. Supplemental water from outside the natural watershed into vernal pools can change the habitat into a marsh-dominated or a permanent aquatic community that is unsuitable for the
vernal pool shrimp.

Other secondary impacts associated with urbanization include disposal of waste materials into habitat for the four species included in this final rule (Bauder 1986, 1987). Disposal of concrete, tires, refrigerators, sofas, and other trash adversely affects these animals by eliminating habitat, disrupting pool hydrology or, in some cases, through release of toxic substances. Dust and other forms of air or water pollution from commercial development or agriculture projects also may be deleterious to these animals. Introduction of the bullfrog (*Rana catesbeiana*) to areas inhabited by the vernal pool tadpole shrimp appears to increase the threat of predation facing this crustacean.

3.2.3 Vernal Pool Tadpole Shrimp

Status and Distribution

The vernal pool tadpole shrimp is listed as an endangered species under the ESA (59 FR 48136). They are endemic to vernal pools in the Central Valley, coast ranges, and a limited number of sites in the Transverse Range and Santa Rosa Plateau of California. The most accurate indication of the distribution and abundance of the vernal pool tadpole shrimp is the number of inhabited vernal pool complexes. There are 18 known populations of vernal pool tadpole shrimp in the Central Valley, ranging from east of Redding in Shasta County south to the San Luis National Wildlife Refuge in Merced County.

Critical habitat for the vernal pool tadpole shrimp is designated in the vicinity of the study area on lands surrounding Mather Field. There is no critical habitat for vernal pool fairy shrimp in the study area.

Life History and Habitat Requirements

The life history of the vernal pool tadpole shrimp is linked to the phenology of the vernal pool habitat. None are known to occur in riverine waters, marine waters, or other permanent bodies of water. After winter rainwater fills the pools, the populations are reestablished from diapaused eggs that lie dormant in the dry pool sediments (Ahl 1991). Tadpole shrimp are primarily benthic animals that swim with their legs down. They climb or scramble over objects, as well as plow along in bottom sediments. Their diet consists of organic detritus and living organisms, such as fairy shrimp and other invertebrates (Pennak 1989).

A female surviving to large size may lay up to six clutches of eggs, totaling about 861 eggs in her lifetime (Ahl 1991). The eggs are sticky and readily adhere to plant matter and sediment particles (Simovich and Fugate 1992). A portion of the eggs hatch immediately and the rest enter diapause and remain in the soil to hatch during later rainy seasons (Ahl 1991). Ahl (1991) found that eggs in one pool hatched within three weeks of inundation and maturated to sexually reproductive adults in another three to four weeks. Simovich and Fugate (1992) reported sexually mature adults occurred in another pool three to four weeks after the pools had been filled. The vernal pool tadpole shrimp matures slowly and is a long-lived species (Ahl 1991). Adults are often present and reproductive until the pools dry up in the spring (Ahl 1991; Simovich et al. 1992).

Factors Affecting Abundance

Vernal pools are in danger due to a variety of human-caused activities, including urban development, water supply and flood control activities, and conversion of land to agricultural use. Changes in hydrologic pattern, overgrazing, and off-road vehicle use also imperil this aquatic habitat . Habitat loss occurs from direct destruction and modification of pools by filling, grading, discing, leveling, and other activities. Vernal pools can also be indirectly impacted when modifications of the surrounding uplands alter the vernal pool watershed (USFWS 1992b). Diversion of watershed runoff feeding the pools can result in premature pool dry-down before the life cycle of the tadpole shrimp is complete. The tadpole shrimp is also intolerant of flowing water that washes away the egg bank. Supplemental water from outside the natural watershed into vernal pools can change the habitat into a marsh-dominated or a permanent aquatic community that is unsuitable for the vernal pool tadpole shrimp.

Other secondary impacts associated with urbanization include disposal of waste materials into habitat for the four species included in this final rule (Bauder 1986, 1987). Disposal of concrete, tires, refrigerators, sofas, and other trash adversely affects these animals by eliminating habitat, disrupting pool hydrology or, in some cases, through release of toxic substances. Dust and other forms of air or water pollution from commercial development or agriculture projects also may be deleterious to these animals. Introduction of the bullfrog (*Rana catesbeiana*) to areas inhabited by the vernal pool tadpole shrimp appears to increase the threat of predation facing this crustacean.

3.3 Fish

Six fish species' ESUs or Distinct Population Segments (DPSs) and critical habitats are addressed below. These include Sacramento River winter-run Chinook salmon ESU, Central Valley spring-run Chinook salmon ESU, Central Valley fall-/late fall–run Chinook salmon ESU, Central Valley steelhead DPS, delta smelt, and green sturgeon southern DPS.

3.3.1 Sacramento River Winter-Run Chinook Salmon Evolutionarily Significant Unit

Status and Distribution

The Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*) was listed as threatened under the Federal ESA on August 4, 1989 (NMFS 1989). NMFS subsequently upgraded the Federal listing to endangered on January 4, 1994 (NMFS 1994). NMFS designated critical habitat for Sacramento River winter-run Chinook salmon on June 16, 1993 (NMFS 1993a). The ESU includes all naturally spawned populations of winter-run Chinook in the Sacramento River and its tributaries, as well as populations from two artificial propagation programs, one at the Livingston Stone National Fish Hatchery and the other at Bodega Marine Laboratory (NMFS 2005a).

Prior to construction of Shasta Dam, winter-run Chinook salmon spawned in the upper reaches of the Sacramento River, the McCloud River, and the lower Pit River. Spawning is now restricted to approximately 44 miles of the mainstem Sacramento River, immediately downstream of Keswick Dam (Yoshiyama et al. 1998). The abundance of winter-run Chinook salmon in the Sacramento River before Shasta Dam was constructed, is unknown. Some biologists believe the run was relatively small, possibly consisting of a few thousand fish (Slater 1963). Others, relying on anecdotal accounts, believe the run could have numbered more than 200,000 fish (NMFS 1993b). During the mid-1960s, more than 20 years after the construction of Shasta Dam, the population exceeded 80,000 fish (USBR 1986). The population declined substantially during the 1970s and 1980s.

In 1988, winter-run Chinook salmon escapement was estimated at 696 adults. Escapement continued to decline, diminishing to an estimated 430 fish in 1989 and 211 fish in 1990 (CDFW 2013b). The rapid decline in escapement during the late 1980s and early 1990s prompted listing of the winter-run Chinook salmon as endangered under the California ESA and the Federal ESA. Escapement in 1991 was estimated to be 1,240 fish, indicating good survival of the 1988 class. NMFS data indicates that the population has increased during the late 1990s through 2001. In 1995, returning spawners numbered 1,337 fish and in 2012, returning adults were estimated to be 6,123 (CDFW 2013b). Despite increased efforts to maintain and enhance the population of winter-run Chinook salmon by various entities, in their final listing determination of June 28, 2005, NMFS again found "that the Sacramento River winter-run Chinook salmon ESU in total is in danger of extinction throughout all or a significant portion of its range" and concludes that the ESU continues to warrant listing as an endangered species under the Federal ESA (NMFS 2005a).

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Life History

Winter-run Chinook salmon spend 1 to 3 years in the ocean. Adult winter-run Chinook salmon leave the ocean and migrate through the Delta into the Sacramento River from December through July with peak migration in March. Adults spawn from mid-April through August (Moyle 2002). Egg incubation continues through October. The primary spawning habitat in the Sacramento River is above the Red Bluff Diversion Dam (RBDD) at RM 243, although spawning has been observed downstream as far as RM 218 (NMFS 2001). Spawning success below RBDD may be limited primarily by warm water temperatures (Hallock and Fisher 1985; Yoshiyama et al. 1998).

Downstream movement of juvenile winter-run Chinook salmon begins in August, soon after fry emerge. The peak abundance of juveniles moving downstream at Red Bluff occurs in September and October (Vogel and Marine 1991). Juvenile Chinook salmon move downstream from spawning areas in response to many factors, which may include inherited behavior, habitat availability, flow, competition for space and food, and water temperature. The numbers of juveniles that move and the timing of movement are highly variable. Storm events and their resulting high flows and turbidity appear to trigger downstream movement of substantial numbers of juvenile Chinook salmon.

Winter-run Chinook salmon smolts (i.e., juveniles that are physiologically ready to enter seawater) may migrate through the Delta and San Francisco Bay to the ocean from November through May (Yoshiyama et al. 1998). The Sacramento River channel is the main migration route through the Delta. However, the Yolo Bypass also provides significant outmigration passage during higher flow events.

During winter in the Sacramento–San Joaquin system, juveniles rear on seasonally inundated floodplains. Sommer et al. (2001) found higher growth and survival rates of juvenile Chinook salmon reared on the Yolo Bypass floodplain, than those that reared in the mainstem Sacramento River.

Factors Affecting Abundance

One of the main factors in the decline of Chinook salmon is habitat loss and degradation. On the Sacramento River, Shasta Dam blocked access to historical spawning and rearing habitat. Other factors affecting abundance include the effects of reservoir operations on water temperature, harvesting and fishing pressure, entrainment in diversions, contaminants, predation by non-native species, and interaction with hatchery stock (Corps 2000b).

In the Sacramento River, operation of the Central Valley Project (CVP) and State Water Project (SWP) influences river flow. Low flows can reduce habitat area and adversely affect water quality. The resulting warm water temperatures and low dissolved oxygen levels can stress incubating eggs and rearing juvenile winter-run Chinook salmon. Low flow may affect migration of juveniles and adults through increased water temperature or reduced velocity that slows downstream movement of juveniles. Low flow, in combination with diversions, may result in higher entrainment losses at the State and Federal pumping plants in the south Delta (Corps 2000b).

In the Delta, flow drawn through the Delta Cross Channel (DCC) and Georgiana Slough transports some percentage of downstream migrating salmon into the central Delta. The number of juveniles entering the DCC and Georgiana Slough is assumed to be proportional to the flow volume diverted from the Sacramento River (CDFG 1987). Survival of juvenile Chinook salmon that are drawn into the central Delta is lower than survival of juvenile Chinook salmon that remain in the Sacramento River channel.

Critical Habitat/Essential Fish Habitat

Within the ARCF GRR study area, the Sacramento River and Sacramento Bypass is considered to be critical habitat for winter-run Chinook salmon. Critical habitat includes the water column, river bottom, and adjacent riparian zone which fry and juveniles use for rearing (NMFS 2006b). The conservation value of critical habitat in the study area is high because it supports both recruitment and survival of juveniles and adults (NMFS 2006a).

EFH is defined as those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity. EFH includes currently and historically accessible habitat. All reaches within the ARCF study area are considered to be essential fish habitat for winter-run Chinook salmon.

3.3.2 Central Valley Spring-Run Chinook Salmon Evolutionarily Significant Unit

Status and Distribution

The Central Valley spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*) was Federally listed as threatened on September 16, 1999 (NMFS 1999). Their threatened status was reaffirmed in NMFS's final listing determination issued on June 28, 2005 (NMFS 2005a). Critical habitat for Central Valley spring-run Chinook salmon was designated by NMFS on September 2, 2005 (NMFS 2005b). The ESU includes all naturally spawned spring-run Chinook salmon in the Sacramento River and its tributaries. Naturally spawned fish of hatchery origin in the Feather and Yuba Rivers as well as hatchery spawned fish in the Feather River are also included as a part of this ESU (NMFS 2005a).

Spring-run Chinook salmon may have once been the most abundant of Central Valley Chinook salmon (Mills and Fisher 1994), historically occupying the upstream reaches of all major river systems in the Central Valley where there were no natural barriers. Central Valley spring-run Chinook salmon are now restricted to the upper Sacramento River downstream of Keswick Dam; the Feather River downstream of Oroville Dam; the Yuba River downstream of Englebright Dam; several perennial tributaries of the Sacramento River (e.g., Deer, Mill, and Butte creeks); and the Delta.

The abundance of Central Valley spring-run Chinook salmon escapement, as measured by the number of adults returning to spawn from 1960 to 2013, averaged 10,236 adults for in-river natural spawners and 2,364 average adults returning to hatcheries (CDFW 2013b). Spring-run Chinook salmon spawn in the early fall and have interbred with fall-run Chinook salmon in the Sacramento and Feather Rivers. Genetically uncontaminated populations may exist in Deer Creek, Mill Creek, Butte Creek, and other eastside tributaries of the Sacramento River.

Life History

Adult spring-run Chinook salmon enter the mainstem Sacramento River from March through September, with the peak upstream migration occurring from May through June (Yoshiyama et al. 1998). Adults generally enter tributaries from the Sacramento River between mid-April and mid-June (Lindley et al. 2006 as cited in NMFS 2006b). Spring-run Chinook salmon are sexually immature during upstream migration, and adults hold in deep, cold pools near spawning habitat until spawning commences in late summer and fall. Spring-run Chinook salmon spawn in the upper reaches of the mainstem Sacramento River and tributary streams (USFWS 1995), with the largest tributary runs occurring in Butte, Deer, and Mill Creek's (Yoshiyama et al. 1998). Spawning typically begins in late August and may continue through October. Juveniles emerge in November and December in most locations but may emerge later when water temperature is cooler. Newly emerged fry remain in shallow, low-velocity edgewater (CDFG 1998).

Juvenile spring-run Chinook salmon typically spend up to one year rearing in fresh water before migrating to sea as yearlings, but some may migrate downstream as young-of-year juveniles. Rearing takes place in their natal streams, the mainstem of the Sacramento River, inundated floodplains (including the Sutter and Yolo bypasses), and the Delta. Based on observations in Butte Creek and the Sacramento River, young-of-year juveniles typically migrate from November through May. Yearling spring-run Chinook salmon migrate from October to March, with peak migration in November (Cramer and Demko 1997; Hill and Webber 1999). Downstream migration of yearlings typically coincides with the onset of the winter storm season, and migration may continue through March (CDFG 1998).

Factors Affecting Abundance

Main factors in the decline of spring-run Chinook salmon populations are habitat loss and degradation. Dams have blocked access to historical spawning and rearing habitat. Other factors affecting abundance of spring-run Chinook salmon include harvest, entrainment in diversions, contaminants, predation by non-native species, and interbreeding with fall-run Chinook salmon and hatchery stocks (Corps 2000b).

In the Sacramento River and its major tributaries, operation of the CVP and SWP controls river flow. Low flows limit habitat area and adversely affect water quality, such as warm water temperature and low dissolved oxygen that stress incubating eggs and rearing juveniles. Low flow may affect migration of juveniles and adults through inadequate water depth to support passage, or through reduced velocity that slows the downstream movement of juveniles. Low flow, in combination with diversions, may result in higher entrainment losses (Corps 2000b).

In the Delta, flow drawn through the DCC and Georgiana Slough transports some portion of downstream migrants into the central Delta. The number of juveniles entering the DCC and Georgiana Slough is assumed to be proportional to the flow volume diverted from the Sacramento River (CDFG 1987). Survival of juvenile Chinook salmon that are drawn into the central Delta is lower than survival of juvenile Chinook salmon that remain in the Sacramento River channel.

Critical Habitat/Essential Fish Habitat

Critical habitat for spring-run Chinook salmon includes all river channels and sloughs within the ARCF GRR study area on the Sacramento River and on the American River from the confluence to the Watt Avenue bridge. (NMFS 2006b). Critical habitat includes the stream channels and the lateral extent as defined by the ordinary high-water line or bank-full elevation. Primary constituent elements (PCEs) of critical habitat in the study area include: (1) freshwater rearing sites that have adequate water quality and quantity, floodplain connectivity, and natural cover that supports juvenile growth and mobility, and (2) freshwater migration corridors that support adequate water quantity and quality as well as natural cover to provide food and migration pathways for juveniles as well as adults. (NMFS 2005e, 2006b). The conservation value of critical habitat in the study area is high because it supports both recruitment and survival of juveniles and adults (NMFS 2006a).

EFH is defined as those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity. EFH includes currently and historically accessible habitat. All reaches within the ARCF study area are considered to be EFH for spring-run Chinook salmon.

3.3.3 Central Valley Fall-/Late Fall–Run Chinook Salmon Evolutionarily Significant Unit

Status and Distribution

The Central Valley fall-/late fall–run Chinook salmon ESU (*Oncorhynchus tshawytscha*) is not listed under the Federal ESA. On March 9, 1998, NMFS issued a proposed rule to list fall-run Chinook salmon as threatened (NMFS 1998a). However, on September 16, 1999, NMFS determined that the species did not warrant listing (NMFS 1999). On April 15, 2004, NMFS classified Central Valley fall-/late fall–run Chinook salmon as a species of concern (NMFS 2004). However, EFH is designated for this species.

The Central Valley fall-/late fall–run Chinook salmon ESU includes all naturally spawned populations of fall-run Chinook salmon in the Sacramento and San Joaquin river basins and their tributaries. Central Valley fall-/late fall–run Chinook salmon are currently the most abundant and widespread salmon runs in California (Mills et al. 1997), representing about 80% of the total Chinook salmon produced in the Sacramento River drainage (Kjelson et al. 1982). The most abundant spawning populations of fall-/late fall–run Chinook salmon occur in the Sacramento, Feather, Yuba, and American rivers (Mills and Fisher 1994). Fall-run Chinook salmon in the Sacramento, Feather, and American rivers have a relatively large hatchery component, from 1952 to 2013 the average was 57,508 fish. The average escapement in-river on the Sacramento and San Joaquin system from 1960 to 2013 was 264,475 (CDFW 2013b).

Life History

Adult fall-run Chinook salmon migrate into the Sacramento River and its tributaries from June through December in mature condition and spawn from late September through December, soon after arriving at their spawning grounds (Yoshiyama et al. 1998). The spawning peak occurs in October and November. Emergence occurs from December through March, and juveniles migrate downstream to the ocean soon after emerging, rearing in fresh water for only a few months. Smolt outmigration typically occurs from March through July (Yoshiyama et al. 1998).

Late fall–run Chinook salmon migrate upstream before they are sexually mature, and hold near spawning grounds for 1 to 3 months before spawning. Upstream migration takes place from October through April and spawning occurs from late January through April, with peak spawning in February and March (Yoshiyama et al. 1998). Fry emerge from April through June. Juvenile late fall–run Chinook salmon rear in their natal streams during the summer, and in some streams they remain throughout the year. Smolt outmigration can occur from November through May (Yoshiyama et al. 1998).

Factors Affecting Abundance

Factors affecting abundance of fall-/late fall–run Chinook salmon are similar to factors affecting abundance of winter- and spring-run Chinook salmon, i.e., habitat loss and degradation. Fall-run Chinook salmon, however, typically use spawning habitat farther downstream than the spawning habitat used by spring- and winter-run Chinook salmon. The effect of dams on spawning habitat area for fall-run Chinook salmon is not as severe as for other runs, although access to substantial spawning habitat area has been blocked by dams.

Critical Habitat/Essential Fish Habitat

Critical habitat is not designated for fall-/late fall–run Chinook salmon, however EFH is designated for this species. EFH is defined as those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity. EFH includes currently and historically accessible habitat. All reaches within the ARCF GRR study area are considered to be EFH for fall-/late fall-run Chinook salmon.

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3.3.4 Central Valley Steelhead Distinct Population Segment

Status and Distribution

The Central Valley steelhead (*Oncorhynchus mykiss*) DPS was Federally listed as threatened on March 19, 1998 (NMFS 1998b). The threatened status of Central Valley steelhead was reaffirmed in NMFS's final listing determination on January 5, 2006 (NMFS 2006a); at the same time NMFS also adopted the term DPS, in place of ESU, to describe Central Valley steelhead and other population segments of this species. NMFS originally designated critical habitat for Central Valley steelhead on February 16, 2000 (NMFS 2000). However, following a lawsuit (*National Association of Home Builders et al. v. Donald L. Evans, Secretary of Commerce, et al.*), NMFS decided to rescind the listing and re-evaluate how to classify critical habitat for several DPSs of steelhead.

Critical habitat for Central Valley steelhead was re-designated by NMFS on September 2, 2005 (NMFS 2005b). The DPS includes 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. Artificially propagated fish from the Coleman and Feather River hatcheries are included in the DPS (NMFS 2006a).

Steelhead ranged throughout the tributaries of the Sacramento and San Joaquin rivers prior to dam construction, water development, and watershed perturbation dating from the 19^{th} and 20^{th} centuries. Wild stocks are now mostly confined to the upper Sacramento River downstream of Keswick Dam; upper Sacramento River tributaries such as Deer, Mill, and Antelope creeks; and the Yuba River downstream of Englebright Dam. Populations may also exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather rivers (McEwan and Jackson 1996). The abundance of naturally reproducing Central Valley steelhead, as measured by the number of adults returning to spawn, is largely unknown. Natural escapement in 1995 was estimated to be about 1,000 adults each for Mill and Deer creeks and the Yuba River (S. P. Cramer and Associates 1995). Hatchery returns have averaged around 10,000 adults (Mills and Fisher 1994). The most recent annual estimate of adults spawning upstream of RBDD is less than 2,000 fish (NMFS 2006a).

Life History

Central Valley steelhead have one of the most complex life histories of any salmonid species, exhibiting both anadromous and freshwater resident life histories. Freshwater residents typically are referred to as rainbow trout, and those exhibiting an anadromous life history are called steelhead (NMFS 1999). Steelhead exhibit highly variable life history patterns throughout their range but are broadly categorized into winter and summer reproductive ecotypes. Winter steelhead are the most widespread reproductive ecotype and the only type currently present in Central Valley streams (McEwan and Jackson 1996). Winter steelhead become sexually mature in the ocean, enter spawning streams in summer, fall or winter, and spawn a few months later in winter or late spring (Meehan and Bjornn 1991; Behnke 1992).

In the Sacramento River, adult winter steelhead migrate upstream during most months of the year, beginning in July, peaking in September, and continuing through February or March (Hallock 1987). Spawning occurs primarily from January through March, but may begin as early as late December and may extend through April (Hallock 1987). Individual steelhead may spawn more than once, returning to the ocean between each spawning migration.

Juvenile steelhead rear a minimum of one and typically two or more years in fresh water before migrating to the ocean as smolts. Juvenile migration to the ocean generally occurs from December through August. The peak months of juvenile migration are January to May (McEwan 2001). The importance of main channel and floodplain habitats to steelhead in the lower Sacramento River and upper Delta is not well understood. Steelhead smolts have been found in the Yolo Bypass during the period of winter and spring inundation (Sommer 2002), but the importance of this and other floodplain areas in the lower Sacramento River and upper Delta is not yet clear.

<u>Factors Affecting Abundance</u>

The decline in steelhead populations is attributable to changes in habitat quality and quantity. The availability of steelhead habitat in the Central Valley has been reduced by as much as 95% or more due to barriers created by dams (NMFS 1996a). Populations have been most severely affected by dams blocking access to the headwaters of all major tributaries; consequently, most runs are maintained through artificial production. The decline of naturally produced Central Valley steelhead has been more precipitous than that of hatchery stocks. Populations in the range's southern portion have experienced the most severe declines (NMFS 1996b). Other factors contributing to the decline of steelhead in the Central Valley are mining, agriculture, urbanization, logging, harvest, hatchery influences, flow management (including reservoir operations), hydropower generation, and water diversion and extraction (NMFS 1996a).

<u>Critical Habitat/Essential Fish Habitat</u>

Habitat for endangered or threatened anadromous fish is designated as critical habitat under the ESA and as EFH under the MSA. EFH has been designated for Chinook salmon, but not for steelhead. Critical habitat for Central Valley steelhead includes the stream channels and the lateral extent as defined by the ordinary high-waterline or bank-full elevation in the designated stream reaches of the Sacramento and American River, NEMDC and Dry/Robla creek portions of the ARCF GRR. Primary constituent elements of critical habitat are as described for spring-run Chinook salmon (NMFS 2006b).

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3.3.5 Delta Smelt

Status and Distribution

Delta smelt (*Hypomesus transpacificus*) was Federally listed as threatened on March 5, 1993 (USFWS 1993) and critical habitat was designated on December 19, 1994 (USFWS 1994). Population trends and abundance of delta smelt are poorly understood due to their short life span (1 year). Based on data from 21 years of monthly sampling in Suisun Marsh, delta smelt appear to be experiencing long-term declines (Matern et al. 2002). Summer tow-net and fall/mid-water trawl data show fluctuating annual abundance from 1991 through 1996, with an increasing trend in the late 1990s, followed by an overall decline in abundance since 1999 (Bryant and Souza 2004).

Life History

Delta smelt are endemic to the Sacramento–San Joaquin estuary and are found seasonally in Suisun Bay and Suisun Marsh. They typically are found in shallow water (less than 10 feet) where salinity ranges from 2 to 7 parts per thousand (ppt), although they have been observed at salinities between 0 and 18.4 ppt. Delta smelt have relatively low fecundity and most live for 1 year. They feed on planktonic copepods, cladocerans, amphipods, and insect larva (Moyle 2002).

Delta smelt are semi-anadromous. During their spawning migration, adults move into the freshwater channels and sloughs of the Delta between December and January. Spawning occurs between January and July, with peak spawning from April through mid-May (Moyle 2002). Spawning locations in the Delta have not been identified and are inferred from larval catches (Bennett 2005). Larval fish have been observed in Montezuma Slough; Suisun Slough in Suisun Marsh; the Napa River estuary; the Sacramento River above Rio Vista; and Cache, Lindsey, Georgiana, Prospect, Beaver, Hog, Sycamore, and Barker sloughs (Wang 1986, Moyle 2002, Stillwater Sciences 2006, and USFWS 1996). Spawning was also observed in the Sacramento River up to Garcia Bend (RM 51) during drought conditions, as a result of increased saltwater intrusion that moved delta smelt spawning and rearing farther inland (Wang and Brown 1993).

Laboratory experiments have found eggs to be adhesive, demersal, and usually attached to substrate composed of gravel, sand, or other submerged material (Moyle 2002, Wang 1991). Hatching takes approximately 9 to 13 days, and larvae begin feeding 4 to 5 days later. Newly hatched larvae contain a large oil globule that makes them semi-buoyant and allows them to stay near the bottom. As their fins and swim bladder develop, they move higher into the water column and are transported downstream to the open waters of the estuary (Moyle 2002).

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Factors Affecting Abundance

Diversions and Delta inflow and outflow may affect survival of delta smelt. In water exported at the South Delta CVP and SWP export facilities, estimates of delta smelt entrainment suggest a population decline in the early 1980s, mirroring the decline indicated by mid-water trawl, summer tow-net, Kodiak trawl, and beach seine data (Bennett 2005). Diversions and upstream storage, including operation of the CVP and SWP, control Delta inflow and outflow during most months. Reduced Delta flow may inhibit or slow movement of larvae and juveniles to estuarine rearing habitat and into deeper and narrower channels of the Delta, resulting in lower prey availability and increased mortality from predators (Moyle 2002). Low Delta flow also may increase entrainment in diversions, including entrainment at the CVP and SWP export pumps (Moyle 2002). Additional factors affecting delta smelt abundance include extremely high river outflow that increases entrainment at export facilities, changes in prey abundance and composition, predation by nonnative species, toxic substances, disease, and loss of genetic integrity through interbreeding with the introduced Wagasaki smelt (Moyle 2002; CDFG 2000; Bennett 2005).

Critical Habitat/Essential Fish Habitat

Critical habitat for delta smelt consists of all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the contiguous waters in the Delta (USFWS 1994). Critical habitat for delta smelt is designated in the following California counties: Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo (USFWS 2003). Critical habitat in the ARCF GRR study area includes the Sacramento River up to the I Street Bridge and the Yolo Bypass just above Interstate 80 at the railroad tracks. Primary constituent elements of critical habitat determined to be essential to the conservation of the species include: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration (USFWS 2006a).

3.3.6 Green Sturgeon Southern Distinct Population Segment

Status and Distribution

On January 23, 2003, NMFS determined that green sturgeon (*Acipenser medirostris*) are comprised of two populations, a northern and a southern DPS (NMFS 2003). The northern DPS includes populations extending from the Eel River northward, and the southern DPS includes populations south of the Eel River to the Sacramento River. The Sacramento River supports the southernmost spawning population of green sturgeon (Moyle 2002). On April 6, 2005, NMFS determined that the northern DPS does not warrant listing under the ESA, but it remains on the Species of Concern List (NMFS 2005c). On

April 7, 2006, NMFS determined that the southern DPS of green sturgeon was threatened under the Federal ESA (NMFS 2006c). On October 9, 2009, NMFS (74 CFR 52300) designated critical habitat for the green sturgeon southern DPS throughout most of its occupied range.

Green sturgeon were classified as a Class 1 Species of Special Concern by CDFG in 1995 (Moyle et al. 1995). Class 1 Species of Special Concern are those that conform to the state definitions of threatened or endangered and could qualify for addition to the official list. On March 20, 2006, emergency green sturgeon regulations were put into effect by CDFG requiring a year-round zero bag limit of green sturgeon in all areas of the state (CDFG 2006).

Life History

The green sturgeon is anadromous, but it is the most marine-oriented of the sturgeon species and has been found in near shore marine waters from Mexico to the Bering Sea (NMFS 2005c). The southern DPS has a single spawning population in the Sacramento River (NMFS 2005d) and more recently spawning has been observed in the lower Feather River, a tributary of the Sacramento River (Seesholtz et al. 2012). Adults typically migrate upstream into rivers between late February and late July. Spawning occurs from March to July, with peak spawning from mid-April to mid-June. Green sturgeon are believed to spawn every 3 to 5 years, although recent evidence indicates that spawning may be as frequent as every 2 years (NMFS 2005c). Little is known about the specific spawning habitat preferences of green sturgeon. Adult green sturgeon are believed to broadcast their eggs in deep, fast water over large cobble substrate, where the eggs settle into the interstitial spaces (Moyle 2002). Spawning is generally associated with water temperatures from 46 to 57 degrees Fahrenheit (°F). In the Central Valley, spawning occurs in the Sacramento River upstream of Hamilton City, perhaps as far upstream as Keswick Dam (Adams et al. 2002) and the lower Feather River (Seesholtz et al. 2012).

Green sturgeon eggs hatch in approximately 8 days at 55°F (Moyle 2002). Larvae begin feeding 10 days after hatching. Metamorphosis to the juvenile stage is complete within 45 days of hatching. Juveniles spend 1 to 4 years in fresh and estuarine waters and migrate to salt water at lengths of 300 to 750 millimeters (mm) (NMFS 2005c).

Little is known about movements, habitat use, and feeding habits of green sturgeon. Green sturgeon have been salvaged at the state and Federal fish collection facilities in every month, indicating that they are present in the Delta year-round. Juveniles and adults are reported to feed on benthic invertebrates, including shrimp and amphipods, and small fish (NMFS 2005c).

Factors Affecting Abundance

The historical decline of the southern DPS of green sturgeon has been largely attributed to the reduction of spawning habitat area. Keswick and Shasta Dams on the Sacramento River and Oroville Dam on the Feather River are impassable barriers that prevent green sturgeon from accessing what were likely historical spawning grounds upstream of these dams. Other potential migration barriers or

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impediments include the Sacramento Deep Water Ship Channel locks, Fremont Weir, Sutter Bypass, the Delta Cross Channel, and Shanghai Bench and Sunset Pumps on the Feather River. Other factors that have been identified as potential threats to green sturgeon are reductions in freshwater outflow in the Delta during larval dispersal and rearing, high water temperatures during spawning and incubation, entrainment by water diversions, contaminants, predation and other impacts by introduced species, and poaching (NMFS 2005c).

Critical Habitat/Essential Fish Habitat

There is no EFH designated for green sturgeon. Designated critical habitat for the southern DPS of green sturgeon includes the Sacramento River downstream of Keswick Dam, the Feather River downstream of Oroville Dam, and the Yuba River downstream of Daguerre Dam; portions of Sutter and Yolo Bypasses; the legal Delta, excluding Five Mile Slough, Seven Mile Slough, Snodgrass Slough, Tom Paine Slough and Trapper Slough; and San Francisco, San Pablo, and Suisun bays. Freshwater habitat of green sturgeon of the southern DPS varies in function, depending on location within the Sacramento River watershed. Spawning areas currently are limited to accessible reaches of the Sacramento River upstream of Hamilton City and downstream of Keswick Dam (CDFG 2002) and portions of the Feather River (Seesholtz et al. 2012). Preferred spawning habitats are thought to contain large cobble in deep and cool pools with turbulent water (CDFG 2002; Moyle 2002; Adams et al. 2002). Sufficient flows are needed to sufficiently oxygenate and limit disease and fungal infection of recently laid eggs (Deng et al. 2002). Within the Sacramento River, spawning appears to be triggered by large increases in water flow during spawning (Brown and Michniuk 2007).

3.4 Amphibians

Amphibians are generally associated with smaller creeks, lentic habitats, and/or vernal pools. These aquatic habitats are generally not found along the ARCF reaches or in adjacent areas; therefore, listed amphibians are not considered further in this BA.

3.5 Reptiles

Two protected reptile species were identified in USFWS database records: the Alameda whipsnake (*Masticophis lateralis euryxanthus*) and giant garter snake (*Thamnophis gigas*). The range of the Alameda whipsnake is limited to Contra Costa and Alameda counties, which is not within the ARCF study area.

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3.5.1 Giant Garter Snake

Status and Distribution

The giant garter snake (*Thamnophis gigas*) is Federally listed as a threatened species under the ESA. Currently, this species is only known from 13 isolated population clusters within the Central Valley, from Chico to an area just southwest of Fresno (USFWS 1997). Giant garter snake populations that occur within the ARCF study area are within and adjacent to the Sacramento Bypass, which includes both small canals and rice fields and the east side of the NEMDC .

Life History

The giant garter snake inhabits agricultural wetlands and associated waterways, including irrigation and drainage canals, rice fields, marshes, sloughs, ponds, low- gradient streams, and adjacent uplands. They have also been observed to use revetment as cover (Wylie et al. 2002). Giant garter snakes are believed to be most numerous in rice-growing regions (USFWS 1999b). Giant garter snakes are typically absent from the larger rivers; wetlands with sand, gravel, or rock substrates; and riparian areas lacking suitable basking sites or suitable prey populations (Hansen and Brode 1980; Brode 1988; USFWS 1999b). The giant garter snake hibernates from October to March in abandoned burrows of small mammals located above prevailing flood elevations (Fisher et al. 1994), and breeds during March and April.

Factors Affecting Abundance

Giant garter snakes have been reduced in distribution and abundance due to habitat loss and degradation throughout the Central Valley. Several factors may degrade habitat for giant garter snakes, including upstream watershed modifications, water storage and diversion projects, and urban and agricultural development. Contamination from agricultural runoff may also have detrimental effects. On-going agricultural practices such as tilling, grading, harvesting and operation of other equipment may also result in mortality and increased rates of predation. Clearing and maintenance of irrigation canals and draining of rice fields may also result in mortality and degradation of habitat (USFWS 1999b).

3.6 Birds

Birds that may occur near the ARCF study area (Table 7), such as the snowy plover (*Charadrius alexandrinus nivosus*) is associated with sandy, estuarine, or marine habitats that do not occur along or adjacent to the ARCF study area. The least Bell's vireo, a Federally endangered species, has one recorded occurrence in the southern portion of the Yolo Bypass Wildlife Area in 2010 and 2011, and would not likely occur within the action area.

Species protected under the Migratory Bird Treaty Act may occur seasonally. Some, such as the bald eagle (*Haliaeetus leucocephalus*) may occur transiently during the winter months, although suitable nesting habitat is not present. Others, such as the Swainson's hawk or white-tailed kite are known to nest within the study area and may be present during the spring and early summer months.

The western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) is currently a candidate species. Nesting western yellow-billed cuckoos no longer occur on the Sacramento River south of Colusa as the river has been channelized and riprapped from that point into the Sacramento-San Joaquin River Delta.

Table 7. California Natural Diversity Database Species List for Yolo and Sacramento County.

Common Name	Scientific Name	Federal Status
white-tailed kite	*Elanus leucurus*	None
Swainson's hawk	*Buteo swainsoni*	None
western snowy plover	*Charadrius alexandrinus nivosus*	Threatened
western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	Proposed Threatened
bank swallow	*Riparia riparia*	None
golden eagle	*Aquila chrysaetos*	None
least Bell's vireo	*Vireo bellii pusillus*	Endangered
California black rail	*Laterallus jamaicensis coturniculus*	None

Prior to construction activities, surveys would be conducted within the study area to determine where potential nest sites occur. The surveys would be conducted annually in close proximity to construction locations and within one-half mile of any anticipated construction. If any special status bird species are found, coordination with the resource agencies would occur and appropriate avoidance and minimization measures would be established prior to the start of construction.

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4.0 Environmental Baseline

This section describes the physical conditions and general vegetation, wildlife, and fisheries resources present within the ARCF action area. These conditions are first presented generally throughout the ARCF action area and then site specific SRA is analyzed as well as affected species in the ARCF action area. The environmental baseline provides information necessary to determine if the proposed action would jeopardize the continued existence of species being considered, and if the project can support long-term survival of these species in the action area.

The ARCF action area includes the mainstem Sacramento River from Freeport (RM 46) in the Delta upstream to the American River confluence (RM 60). The region also includes the lower American River from the confluence with the Sacramento River upstream to RM 11, NEMDC, Arcade Creek, Dry/Robla Creeks and Magpie Creek.

Downstream from the American River confluence, the Sacramento River is moderately sinuous (average sinuosity of 1.3), with the channel confined on both sides by man-made levees enhanced by decades of man-made additions. The channel in this reach is of uniform width, is not able to migrate, and is typically narrower and deeper relative to the upstream reach due to scour caused by the concentration of shear forces acting against the channel bed (Brice 1977). Channel migration is similarly limited along the lower American River because of man-made levees and regulated flows from Folsom Dam.

The natural banks and adjacent floodplains of both rivers are composed of silt- to gravel-sized particles with poor to high permeability. Historically, the flow regimes caused the deposition of a gradient of coarser to finer material, and longitudinal fining directed downstream (sand to bay muds). The deposition of these alluvial soils historically accumulated to form extensive natural levees and splays along the rivers, 5 to 20 feet above the floodplain for as far as 10 miles from the channel (Thompson 1961). The present day channels consist of fine-grained cohesive banks that erode due to natural processes as well as high flow events (Corps 2012).

Seasonal high flows enter the adjacent Yolo Bypass from this reach of the Sacramento River via the Sacramento Bypass (RM 63). Tidal influence emanating from Suisun Bay extends up the Sacramento River for 80 miles to Verona, with greater tidal variations occurring downstream during low river stages in summer and fall.

The environmental baseline in the ARCF GRR action area also includes the sites completed under the WRDA 1996 and WRDA 1999 authorizations for the project. The WRDA 1996 construction included installing slurry walls in the American River levees to address seepage and slope stability concerns. The WRDA 1999 construction included shape and slope improvements to specific reaches of the American River levee system, and some segments of the Sacramento River levees. Consultation has occurred on these sites throughout the construction period on an as-needed basis to ensure compliance with the ESA. The original project construction was coordinated with USFWS as the American River Watershed (Common Features) Project, Sacramento County, California. The Biological Opinions for these sites are on file with USFWS under Reference # 1-1-99-F-0078.

4.1 Vegetation

The ARCF action area consists of primarily riparian scrub-shrub habitat. Early riparian habitat may be called scrub-shrub. Scrub-shrub generally refers to areas where the woody riparian canopy is composed of trees or shrubs approximately 20 feet high. Species that are typically found in these habitats include young cottonwood, willow, elderberry, buttonbush, Himalaya blackberry, wild grape, and poison oak. In very dense stands there may be no understory; however, in open canopies, understory vegetation may consist of an herbaceous layer of sedges, rushes, grasses, and forbs. Provided disturbance of the area is low, the scrub-shrub may acquire enough overstory cover to become riparian forest within 20 years.

Riparian forest typically has a dominant overstory of cottonwood, California sycamore, or valley oak. Species found in the scrub-shrub would make up the sub canopy and could also include white alder and box elder. Layers of climbing vegetation make up part of the subcanopy, with wild grape being a major component, but wild cucumber and clematis are also found in riparian communities.

The herbaceous ruderal habitat is found on most levees along the Sacramento River. It occurs on the levees and also within gaps in the riparian habitats. Plant species include wild oats, soft chess, ripgut brome, red brome, wild barley, and foxtail fescue. Common forbs include broadleaf filaree, red stem filaree, turkey mullein, clovers, and many others. The majority of these plants are not native to the project area.

4.1.1 Historical Human Resource Use and Current Riparian Vegetation

Historical precipitation and runoff patterns resulted in the Sacramento River being bordered by up to 500,000 acres of riparian forest, with valley oak woodland covering the higher river terraces (Katibah 1984). However, human activities of the 1800s and 1900s have substantially altered the hydrologic and fluvial geomorphic processes that create and maintain riparian forests within the Sacramento basin, resulting in both marked and subtle effects on riparian communities. Riparian recruitment and establishment models (Mahoney and Rood 1998; Bradley and Smith 1986) and empirical field studies (Scott et al. 1997, 1999) emphasize that hydrologic and fluvial processes play a central role in controlling the elevational and lateral extent of riparian plant species. These processes are especially important for pioneer species that establish in elevations close to the active channel, such as cottonwood and willows (*Salix* spp.). Failure of cottonwood recruitment and establishment is attributed to flow alterations by upstream dams (Roberts et al. 2001) and to isolation of the historic floodplain from the river channel. In addition, many of these formerly wide riparian corridors are now narrow and interrupted by levees and weirs. Finally, draining of wetlands, conversion of floodplains to agricultural fields, and intentional and unplanned introduction of exotic plant species have altered the composition and associated habitat functions of many of the riparian communities that are able to survive under current conditions.

4.1.2 Site-Specific Analysis of Riparian Vegetation

Analysis of total linear feet (lf) of SRA was conducted using Google Earth Pro for the reaches only associated with bank protection on the American and Sacramento Rivers in the ARCF action area (Table 8). The East Side Tributaries were not evaluated because no bank erosion protection is planned. It should be noted however that there is minimal, if any, SRA associated with the tributaries except Arcade Creek. It is not anticipated that trees would need to be removed within the bypass. However, trees along the Sacramento River where the weir would be located would be removed to install the new 1,500 weir.

Identification of individual reaches in the ARCF action area can be seen in Figure 11 below. American River North (ARN) reaches A through I includes the north side of the American River and the East Side Tributaries. American River South (ARS) reaches A through G includes the south side of the American River and the east side of the Sacramento River.

Table 8. Summary of Reach-Specific SRA Analysis.

AMERICAN RIVER		SACRAMENTO RIVER	
REACH	**LINEAR FEET (lf) of SRA**	**REACH**	**LINEAR FEET (lf) of SRA**
A	31,174	D	9,643
B	7,259	E	7,709
C	6,934	F	21,263
		G	11,689
		Sac Weir	1,500
Total	**45,367**	**Total**	**51,804**

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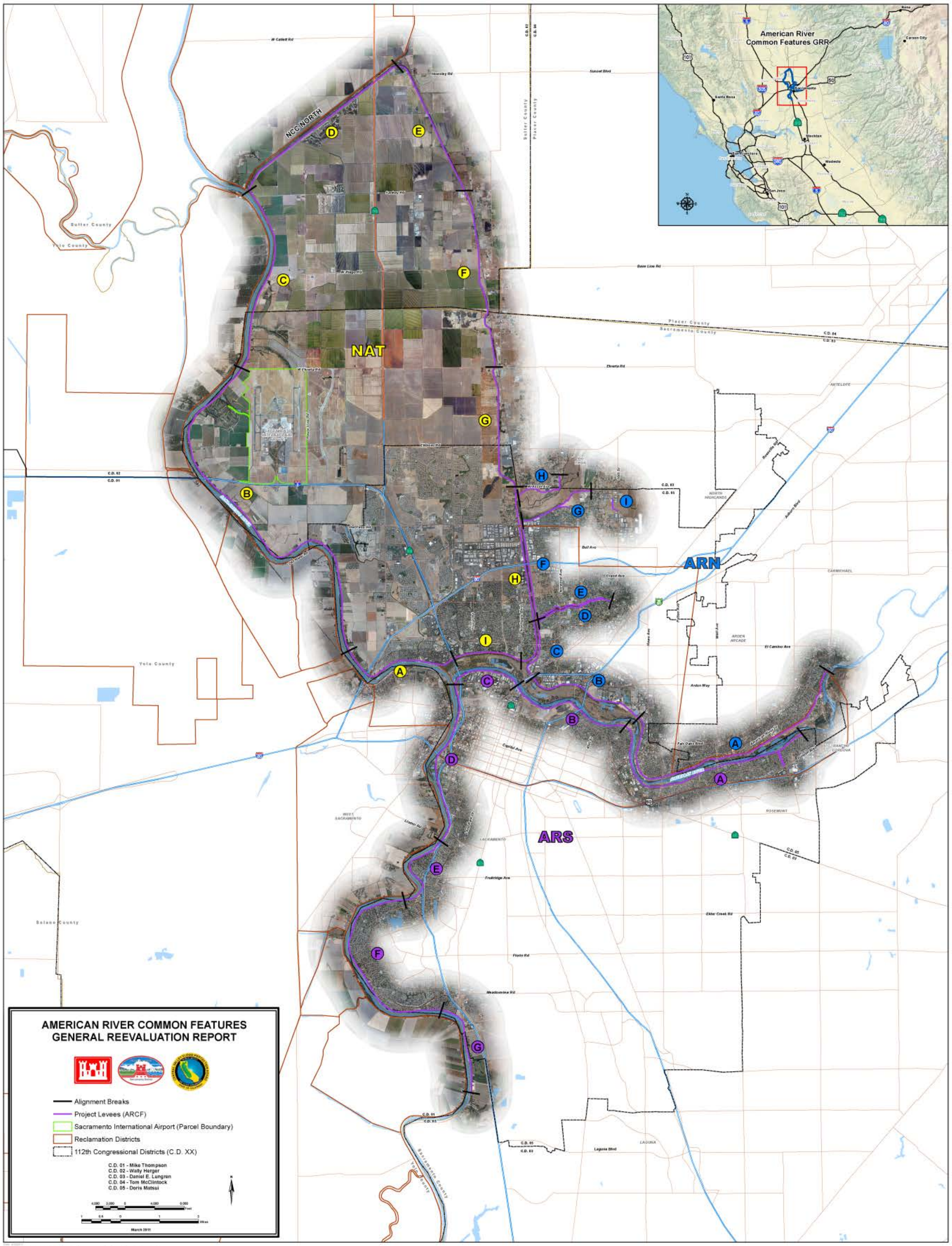

Figure 11. Individual Reach Identification in the ARCF Study Area.

4.2 Affected Species in the Action Area

4.2.1 Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle is listed as a threatened species under the ESA (USFWS 1980). USFWS has undertaken a comprehensive study, known as a 12-month review, to determine whether or not to propose the beetle for delisting (USFWS 2011). According to the USFWS, delisting may be warranted because many new locations of the beetle have been identified since its listing, destruction of habitat has slowed greatly, and efforts have resulted in the protection of significant acreage of habitat (Talley et al. 2006).

The valley elderberry longhorn beetle's range extends from southern Shasta County to Fresno County (Talley et al. 2006). Along the eastern edge of the species' range, adult beetles have been found in the foothills of the Sierra Nevada at elevations up to 2,220 feet, and beetle exit holes have been located on elderberry plants at elevations up to 2,940 feet. Along the western edge of the species' range, adult beetles have been found on the eastern slopes of the Coast Ranges at elevations of up to 500 feet, and beetle exit holes have been detected on elderberry plants at elevations up to 730 feet (Barr 1991).

Critical habitat for the valley elderberry longhorn beetle occurs in two locations near the City of Sacramento (USFWS 1980). One area is enclosed by the Western Pacific railroad tracks and Highway 160, approximately one-half mile north of the American River near its confluence with the Sacramento River. The second site is located along the south bank of the American River at Goethe Park, just upstream of RM 13. Additional habitat has been created as part of earlier Common Features project construction and Folsom Dam improvements. These sites are located at Cal Expo near RM 4.0, RM 11.5, and Sailor Bar at RM 13. These sites are currently being monitored and maintained by the Corps with annual reports provided to USFWS. Both the critical habitat and mitigation sites are located in areas Operated and Maintained by the American River Flood Control District.

Valley elderberry longhorn beetle is only found in close association with its host plant, elderberry (Sambucus spp.). Elderberry plants are found in or near riparian and oak woodland habitats. The valley elderberry longhorn beetle's life history is assumed to follow a sequence of events similar to those of related taxa. Female beetles deposit eggs in crevices in the bark of living elderberry plants. Presumably, the eggs hatch shortly after they are laid, and the larvae bore into the pith of the trunk or stem. When larvae are ready to pupate, they move through the pith of the plant, open an emergence hole through the bark, and return to the pith for pupation. Adults exit through the emergence holes and can sometimes be found on elderberry foliage, flowers, or stems or on adjacent vegetation. The entire life cycle of the valley elderberry longhorn beetle is thought to encompass 2 years, from the time eggs are laid and hatch until adults emerge and die (USFWS 1984).

The presence of exit holes in elderberry stems indicates previous valley elderberry longhorn beetle habitat use. Exit holes are cylindrical and approximately 0.25 inch in diameter. Exit holes can be found on stems that are 1 or more inches in diameter. The holes may be located on the stems from a few inches to about 9 to 10 feet above the ground (Barr 1991).

The valley elderberry longhorn beetle distribution decline is most likely related to the extensive loss of riparian forests in the Central Valley, which has reduced the amount of available habitat for the species, and has most likely decreased and fragmented the species' range (USFWS 1984). Insecticide drift from cultivated fields and orchards adjacent to elderberry plants may affect valley elderberry longhorn beetle populations, if drift occurs at a time when adults are present on the shrubs (Barr 1991). Herbicide drift from agricultural fields and orchards can likewise affect the health of elderberry plants, thereby reducing their quantity and quality as valley elderberry longhorn beetle habitat.

The invasive Argentine ant (*Linepithema humile*) has been spreading in riparian habitats and may affect survival of the valley elderberry longhorn beetle. Argentine ants may predate valley elderberry longhorn beetle eggs although this interaction needs further exploration (Huxel, 2000). The spread of invasive exotic plants (e.g., giant reed [*Arundo donax*] may also negatively affect the valley elderberry longhorn beetle by affecting supporting riparian habitats. The presence of giant reed promotes a more frequent fire cycle and homogenous plant community (Talley et al. 2006).

Documented occurrences of VELB are present along both the American and Sacramento Rivers. The Corps conducted surveys in 2012 of the levee systems within the action area. The survey area consisted of the levee structures and 15 feet on both the waterside and landside; where access was available. The survey located elderberry clusters, however, actual shrubs, stem size, nor exit hole presence were determined. The surveys found the greatest amount of clusters on the south side of the American River and determined that both basins contain shrubs. All shrubs are considered to be in a riparian zone. Within the East Side Tributaries surveys were conducted identical to the American and Sacramento River. The only area where shrubs were located was along Arcade Creek, which contained two clusters of shrubs.

4.2.2 Chinook Salmon and Steelhead

Four distinct runs of Chinook salmon occur in the ARCF action area: winter-run, spring-run, fall-run, and late fall–run. The runs are named after the season of adult migration, with each run having a distinct combination of adult migration, spawning, juvenile residency, and smolt migration periods. In general, fall- and late fall-run Chinook salmon spawn soon after entering their natal streams, while spring- and winter-run Chinook salmon typically hold in their natal streams for up to several months before spawning. Central Valley Steelhead also occurs in the ARCF action area. Immigration of adult steelhead in the Sacramento and American River's peaks in late September and October (Moyle 2002). The steelhead spawning season typically stretches from December through April. After several months,

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fry emerge from the gravel and begin to feed. Juveniles rear in fresh water from 1 to 4 years (usually 2 years), then migrate to the ocean as smolts in the spring (March through June).

During higher winter flow events in the East Side Tributaries there is suitable habitat in NEMDC, Arcade Creek and Dry/Robla Creek for the presence of fall/late-fall salmon and steelhead. During the intermittent years when the Sacramento Bypass is flooded in the winter and spring all four runs of juvenile Chinook salmon and steelhead can potentially use the floodplain for rearing and migration.

4.2.3 Green Sturgeon

Green sturgeon are known to occur in the lower reaches of large rivers, including the Sacramento River (Moyle 2002) and more recently spawning has been observed in the lower Feather River, a tributary of the Sacramento River (Seesholtz et al. 2012). Adults of this species tend to be associated with marine environments more than the more common white sturgeon, although spawning populations have been identified in the Sacramento and Klamath Rivers (Corps 1993). Juvenile rearing (natal stream to estuary) can occur year round in the Sacramento River action area.

Critical habitat for the green sturgeon extends into the American River upstream to the Highway 160 bridge where there is a potential to encounter adults and/or rearing juvenile green sturgeon. The Sacramento Bypass, when flooded, can support juvenile green sturgeon during downstream migration and rearing.

4.2.4 Delta Smelt

Adult delta smelt begin spawning migration into the upper Delta in December or January. Migration may continue over several months. Spawning occurs between January and July, with peak spawning during April through mid-May (Moyle 2002). Spawning occurs along the channel edges in the upper Delta, including the Sacramento River above Rio Vista, Cache Slough, Lindsey Slough, and Barker Slough. Spawning has been observed in the Sacramento River up to Garcia Bend below the confluence of the American River on the Sacramento River action area during drought conditions, possibly attributable to adult movement farther inland in response to saltwater intrusion (Wang and Brown 1993). The typical pattern is for delta smelt to inhabit the oligohaline to freshwater portion of the estuary for much of the year until late winter and early spring, when many migrate upstream to spawn (Sommer et al. 2011). There is evidence that some may not migrate to spawn. After hatching, their larvae and post-larvae subsequently migrate downstream in spring towards the brackish portion of the estuary (Dege and Brown 2004; Sommer and Mejia 2013).

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Key progress in our understanding of delta smelt is that they are strongly associated with turbid water (Feyrer et al. 2007). Their results showed that, during fall, delta smelt are only present at locations where Secchi depth is less than 1 meter. This finding is consistent with Grimaldo et al. (2009), who found that delta smelt were not present in upstream areas when turbidities were less than about 12 NTU (Sommer and Mejia 2013). It is likely that the lack of turbidity in the American River would be unsuitable for delta smelt.

The general pattern is that delta smelt cannot tolerate temperatures higher than 25 °C (Swanson et al. 2000). Hence, the 25 °C is used as a general guideline to assess the upper limits for delta smelt habitat (Wagner et al. 2011; Cloern et al. 2011). Downstream of the Delta, the smallest channel where adults and juveniles have been reported is Spring Branch Slough in Suisun Marsh, which averages about 15-m wide (Meng et al. 1994; Matern et al. 2002)(Sommer and Mejia 2013). Due to higher temperatures, tidal influence with associated salinity and lack of suitable channel width it is likely that the East Side Tributaries and the area around the Sacramento Bypass would not be suitable habitat for the delta smelt.

4.2.5 Giant Garter Snake

The giant garter snake inhabits agricultural wetlands and other waterways such as irrigation and drainage canals, sloughs, ponds, small lakes, low gradient streams, and adjacent uplands in the Central Valley. Because of the direct loss of natural habitat, the giant garter snake relies heavily on rice fields in the Sacramento Valley, but also uses managed marsh areas in Federal National Wildlife Refuges and State Wildlife Areas. Habitat loss and fragmentation, flood control activities, changes in agricultural and land management practices, predation from introduced species, parasites, water pollution, and continuing threats are the main causes for the decline of this species.

Rice fields and their adjacent irrigation and drainage canals serve an important role as aquatic habitat for giant garter snake as is the case adjacent to and within the Sacramento Bypass. GGS habitat in the Sacramento Bypass would be considered high quality habitat for the species. Habitat elements for GGS do occur along the east side of the NEMDC and other waterways of the east side tributaries. While GGS may be present along the NEMDC it is unlikely that they would occur in Arcade, Dry/Robla, or Magpie Creek because these areas lack year round water which makes for unsuitable habitat. Additionally, NEMDC and Arcade Creek are both highly vegetated, which reduces the potential habitat quality for these waterways. However, there are historic recorded occurrences of GGS in the vicinity of the East Side Tributaries, so these areas have the potential for GGS to occur. Large waterways, such as the Sacramento and American Rivers, do not provide suitable habitat for giant garter snake.

4.2.6 Vernal Pool Fairy Shrimp

The vernal pool fairy shrimp lives in vernal pools and swales containing clear to turbid water and grassy bottoms in unplowed grasslands. The shrimp is ecologically dependent on seasonal fluctuations in its habitat, such as presence or absence of water during specific times of the year, duration of water, temperature, and quantities of dissolved oxygen (USFWS 1992b).

There are 32 known populations of the vernal pool fairy shrimp, extending from the Stillwater Plain in Shasta County through the Central Valley to Pixley in Tulare County. In addition, the shrimp occur along the central Coast Range from northern Solano County to Pinnacles National Monument in San Benito County. Critical habitat is designated for a number of sub-populations of fairy shrimp throughout California. The closest critical habitat to the action area is a sub-population of vernal pool fairy shrimp in vernal pools near Mather Field in south-eastern Sacramento County. In the action area, vernal pools are known to occur near Magpie Creek, and there are recorded occurrences of vernal pool fairy shrimp in the CNDDB from 1995 (CNDDB 2015).

Alongside the Magpie Creek Diversion Canal, there are some lands which could support vernal pools or vernal pool fairy shrimp that would be impacted by project construction. At this time, a wetland delineation has not been conducted to verify the occurrence of vernal pools; however, a wetland delineation would occur prior to project construction. Additionally, there are recorded occurrences of fairy shrimp in the CNDDB on the land proposed for acquisition as a flood basin (CNDDB 2015).

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4.2.7 Vernal Pool Tadpole Shrimp

The vernal pool tadpole shrimp lives in vernal pools and swales containing clear to highly turbid water. The shrimp is ecologically dependent on seasonal fluctuations in its habitat, such as presence or absence of water during specific times of the year, duration of water, temperature, and quantities of dissolved oxygen (USFWS 1992b).

There are 18 known populations of vernal pool tadpole shrimp in the Central Valley, ranging from east of Redding in Shasta County south to the San Luis National Wildlife Refuge in Merced County. In the action area, vernal pools are known to occur near Magpie Creek, and there are recorded occurrences of vernal pool tadpole shrimp in the CNDDB from 1998 (CNDDB 2015).

Alongside the Magpie Creek Diversion Canal, there are some lands which could support vernal pools or vernal pool tadpole shrimp that would be impacted by project construction. At this time, a wetland delineation has not been conducted to verify the occurrence of vernal pools; however, a wetland delineation would occur prior to project construction. Additionally, there are recorded occurrences of fairy shrimp in the CNDDB on the land proposed for acquisition as a flood basin (CNDDB 2015).

5.0 Effects of the Proposed Action

5.1 Invertebrates

5.1.1 Valley Elderberry Longhorn Beetle

Effects to valley elderberry longhorn beetle may occur if elderberry shrubs are incidentally damaged by construction personnel or equipment. Impacts may also occur if elderberry shrubs need to be transplanted because they are located in areas that cannot be avoided by construction activities. Potential impacts due to damage or transplantation include direct mortality of beetles and/or disruption of their lifecycle. Since the project would occur over a 13 year period and construction would occur during beetle flight season, there could be direct mortality caused by construction activities. Elderberry shrubs that cannot be avoided would be transplanted between November and mid-February when the plants are doormat. Transplanting procedures will comply with the Conservation Guidelines for the Valley Elderberry Longhorn Beetle, USFWS, 9 July 1999.

Along the American River portion of the project, 250 shrubs would be transplanted within the American River Parkway outside of the 15 foot vegetation free zone. Since there are many shrubs in the Parkway, connectivity for the beetle would be similar to the existing condition. Additionally, seedlings and native plants could be planted on top of the constructed trench to create similar connectivity as the existing conditions. Temporal loss of habitat may occur due to transplantation of elderberry shrubs. Although compensation measures include restoration and creation of habitat, mitigation plantings would likely require one or more years to become large enough to provide supporting habitat. Furthermore, associated riparian habitats may take 25 years or longer to reach their full value.

Along the Sacramento River reach of the project, 13 elderberry shrubs would be transplanted between November and mid-February. These shrubs would be transplanted to the Cal Expo mitigation site within the American River Parkway. Connectivity for the beetle could be affected by the reduction in shrubs; however, there are many other shrubs along this reach of the project that would remain in place and provide sufficient connectivity. Compensation plantings would occur at the Cal Expo site where the transplants are located.

No shrubs were identified along the East Side Tributaries that would require removal for construction of the project. Elderberry surveys done in 2011 by the Corps looked at the project area including the levee itself and 15 feet landside and 15 feet waterside. Only the locations of the shrubs were surveyed in order to get an idea of the magnitude of potential impacts. In order to determine affects to the beetle, detail elderberry shrub surveys from previous projects within the American River Parkway are being used as a representative sample for this project. The previous surveys were completed for other ARCF Projects along the American River Parkway within the project vicinity. The representative sample calculations are as follows; each shrub contains 13 stems measuring between 1 and 3 inches with no exit holes; 5 stems between 3 and 5 inches with .02 exit holes; and 2 stems greater than 5 inches with .07 exit holes. All shrubs are assumed to be in riparian habitat. Tables 9 through 11 include calculations of stems that would be affected with the implementation of this project and proposed compensation.

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Table 9. American River Elderberry Shrub Effects and Proposed Compensation.

Location	Stems	Exit Holes	No. of Stems	Elderberry Ratios[1,2]	Elderberry Plantings	Associated Native Planting	Associated Native Ratios
non-riparian	greater than or = 1" & less than or = 3"	No	0	1	0	0	1
		yes	0	2	0	0	2
non-riparian	greater than 3" & less than 5"	No	0	2	0	0	1
		yes	0	4	0	0	2
non-riparian	greater than or = 5"	No	0	3	0	0	1
		yes	0	6	0	0	2
riparian	greater than or = 1" & less than or = 3"	No	1,998	2	3,996	3,996	1
		yes	0	4	0	0	2
riparian	greater than 3" & less than 5"	No	790	3	2,370	2,370	1
		yes	16	6	96	192	2
riparian	greater than or = 5"	No	312	4	1,248	1,248	1
		yes	23	8	184	368	2
TOTAL			**3,139**		**7,894**	**8,174**	
				Calculations:	natives-elderberries	280	
				basins or credits	1,578.8	28	
				total basins or credits=	1,606.8		
					2,892,240		
				total acres need for compensation	66.39669421		

1 Affected elderberry plant minimization ratios based on location, stem diameter, and presence of exit holes

2 Multiply No. of stems by this for planting counts

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Table 10. Sacramento River Elderberry Shrub Effects and Proposed Compensation.

Location	Stems	Exit Holes	No. of Stems	Elderberry Ratios[1,2]	Elderberry Plantings	Associated Native Plantings	Associated Native ratios
non-riparian	greater than or = 1" & less than or = 3"	No	0	1	0	0	1
		yes	0	2	0	0	2
non-riparian	greater than 3" & less than 5"	No	0	2	0	0	1
		yes	0	4	0	0	2
non-riparian	greater than or = 5"	No	0	3	0	0	1
		yes	0	6	0	0	2
riparian	greater than or = 1" & less than or = 3"	No	104	2	208	208	1
		yes	0	4	0	0	2
riparian	greater than 3" & less than 5"	No	40	3	120	120	1
		yes	1	6	6	12	2
riparian	greater than or = 5"	No	16	4	64	64	1
		yes	2	8	16	32	2
TOTAL			**163**		**414**	**436**	
				Calculations:	natives-elderberrys	22	
				basins or credits	82.8	2.2	
				total basins or credits=	85		
					153000		
				total acres need for compensation	3.512396694		

1 Affected elderberry plant minimization ratios based on location, stem diameter, and presence of exit holes

2 Multiply No. of stems by this for planting counts

Table 11. East Side Tributaries Elderberry Shrub Effects and Proposed Compensation.

Location	Stems	Exit Holes	No. of Stems	Elderberry ratios[1,2]	Elderberry Plantings	Associated Native Plantings	Associated Native Ratios
non-riparian	greater than or = 1" & less than or = 3"	No	0	1	0	0	1
		yes	0	2	0	0	2
non-riparian	greater than 3" & less than 5"	No	0	2	0	0	1
		yes	0	4	0	0	2
non-riparian	greater than or = 5"	No	0	3	0	0	1
		yes	0	6	0	0	2
riparian	greater than or = 1" & less than or = 3"	No	26	2	52	52	1
		yes	0	4	0	0	2
riparian	greater than 3" & less than 5"	No	10	3	30	30	1
		yes	1	6	6	12	2
riparian	greater than or = 5"	No	4	4	16	16	1
		yes	1	8	8	16	2
TOTAL			**42**		**112**	**126**	
				Calculations:	natives-elderberrys	14	
				basins or credits	22.4	1.4	
				total basins or credits=	23.8		
					42840		
				total acres need for compensation	0.983471074		

1 Affected elderberry plant minimization ratios based on location, stem diameter, and presence of exit holes

2 Multiply No. of stems by this for planting counts

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<u>Operation and Maintenance</u>

American River Flood Control District

Each year the ARFCD will survey the areas within their jurisdiction to determine if any elderberry shrubs with stems greater than one inch need to be trimmed. The survey will include number of shrubs that need to be trimmed, location of shrubs, and proposed dates for trimming. Up to 50 shrubs may be trimmed each year in order to comply with the O&M manual. Because the trimming will occur in the outer branches of the shrubs and during approved work windows it is unlikely that elderberry beetle mortality would occur. Branches trimmed would be placed around the base of the trimmed elderberry shrubs or other shrubs in the area as appropriate. To compensate for the trimming of 10 elderberry shrubs, 1 seedling and 2 native plants will be planted. The total number of trimming allowed under this consultation is 2,500 shrubs. Each year ARFCD will coordinate the amount of trimming required with the FWS through the Corps of Engineers to determine if plantings will occur or provide proof of purchase from a FWS approved mitigation bank. If the beetle is delisted in the next 50 years compensation would only occur until that delisting. Table 12 is a calculation for a 5 year period if the maximum amount of shrubs were trimmed. The calculations would be the same for the remaining 45 years.

Table 12. ARFCD O&M – 5 Year Elderberry Shrub Effects and Proposed Compensation.

Year	Shrubs Trimmed	Elderberry ratio	Elderberry plantings	Native ratio	Native Plantings	Bank Credits
1	50	1/10	5	2/10	10	1.5
2	50	1/10	5	2/10	10	1.5
3	50	1/10	5	2/10	10	1.5
4	50	1/10	5	2/10	10	1.5
5	50	1/10	5	2/10	10	1.5
Total	**250**		**25**		**50**	**7.5**

Maintenance Area 9

Each year MA 9 will survey the areas to determine if any elderberry shrubs with stems greater than one inch need to be trimmed. The survey will include number of shrubs that need to be trimmed, location of shrubs, and proposed dates for trimming. Up to 20 shrubs may be trimmed each year in order to comply with the O&M manual. Because the trimming will occur in the outer branches of the shrubs and during approved work windows it is unlikely that elderberry mortality would occur. Branches trimmed would be placed around the base of the trimmed elderberry shrubs or other shrubs in the area as appropriate. To compensate for the trimming of 10 elderberry shrubs, 1 seedling and 2 native plants will be planted or 3 credits would be purchased at a mitigation bank. The total number of trimming allowed under this consultation is 1,000 shrubs. Each year MA 9 will coordinate the amount of trimming required with the FWS through the Corps of Engineers to determine if plantings will occur or provide proof of purchase from a FWS approved mitigation bank. If the beetle is delisted in the next 50 years compensation would only occur until that delisting. Table 13 is a calculation for a 10 years period

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if the maximum amount of shrubs were trimmed. The calculations would be the same for the remaining 45 years.

Table 13. Maintenance Area 9 O&M – 5 Year Elderberry Shrub Effects and Proposed Compensation.

Year	Shrubs Trimmed	Elderberry ratio	Elderberry plantings	Native Ratio	Native Plantings	Bank Credits
1	20	1/10	2	2/10	4	.6
2	20	1/10	2	2/10	4	.6
3	20	1/10	2	2/10	4	.6
4	20	1/10	2	2/10	4	.6
5	20	1/10	2	2/10	4	.6
Total	**100**		**10**		**20**	**3**

City of Sacramento

Each year the City of Sacramento will survey the areas to determine if any elderberry shrubs with stems greater than one inch need to be trimmed. The survey will include number of shrubs that need to be trimmed, location of shrubs, and proposed dates for trimming. Up to 20 shrubs may be trimmed each year in order to comply with the O&M manual. Because the trimming will occur in the outer branches of the shrubs and during approved work windows it is unlikely that elderberry mortality would occur. Branches trimmed would be placed around the base of the trimmed elderberry shrubs or other shrubs in the area as appropriate. To compensate for the trimming of 10 elderberry shrubs, 1 seedling and 2 native plants will be planted or 3 credits would be purchased at a mitigation bank. The total number of trimming allowed under this consultation is 1,000 shrubs. Each year MA 9 will coordinate the amount of trimming required with the FWS through the Corps of Engineers to determine if plantings will occur or provide proof of purchase from a FWS approved mitigation bank. If the beetle is delisted in the next 50 years compensation would only occur until that delisting. Table 14 is a calculation for a 10 years period if the maximum amount of shrubs were trimmed. The calculations would be the same for the remaining 45 years.

Table 14. City of Sacramento O&M – 5 Year Elderberry Shrub Affects and Proposed Compensation.

Year	Shrubs Trimmed	Elderberry ratio	Elderberry plantings	Native ratio	Native Plantings	Bank Credits
1	20	1/10	2	2/10	4	.6
2	20	1/10	2	2/10	4	.6
3	20	1/10	2	2/10	4	.6
4	20	1/10	2	2/10	4	.6
5	20	1/10	2	2/10	4	.6
Total	100		10		20	3

5.1.2 Vernal Pool Fairy Shrimp

CNDDB records include historical occurrences of vernal pools and fairy shrimp in the vicinity of the Magpie Creek area. There is approximately 1 acre of land within the construction footprint of the new levee and floodwall that could potentially include vernal pool habitat. This 1 acre could be adversely affected from ground disturbing activities, operation of construction vehicles, or by construction of the new levee and maintenance road.

Prior to initiation of any construction activities, field surveys and a wetland delineation would occur to verify the occurrence of vernal pools in the construction footprint and to determine if any nearby vernal pools could be indirectly affected by construction. If any additional vernal pools were to be impacted, consultation would be reinitiated at that time to determine appropriate avoidance, minimization, or mitigation measures.

The land being acquired on the east side of Raley Boulevard to create a permanent flood basin is in an area with historical occurrences of vernal pools and fairy shrimp. While this land is being acquired as a part of project construction, no construction would occur on the site, and the land would be protected in perpetuity. Indirectly, acquisition of this property would allow for the protection of the vernal pool habitat on this land, and the maintenance of the land to allow for vernal pools to thrive. As a result, creation of the flood basin would have positive impacts to the vernal pool fairy shrimp by allowing for long-term protection of vernal pool habitat.

5.1.3 Vernal Pool Tadpole Shrimp

CNDDB records include historical occurrences of vernal pools and tadpole shrimp in the vicinity of the Magpie Creek area. There is approximately 1 acre of land within the construction footprint of the new levee and floodwall that could potentially include vernal pool habitat. This 1 acre could be adversely affected from ground disturbing activities, operation of construction vehicles, or by construction of the new levee and maintenance road.

Prior to initiation of any construction activities, field surveys and a wetland delineation would occur to verify the occurrence of vernal pools in the construction footprint and to determine if any nearby vernal pools could be indirectly affected by construction. If any additional vernal pools were to be impacted, consultation would be reinitiated at that time to determine appropriate avoidance, minimization, or mitigation measures.

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The land being acquired on the east side of Raley Boulevard to create a permanent flood basin is in an area with historical occurrences of vernal pools and tadpole shrimp. While this land is being acquired as a part of project construction, no construction would occur on the site, and the land would be protected in perpetuity. Indirectly, acquisition of this property would allow for the protection of the vernal pool habitat on this land, and the maintenance of the land to allow for vernal pools to thrive. As a result, creation of the flood basin would have positive impacts to the vernal pool tadpole shrimp by allowing for long-term protection of vernal pool habitat.

5.2 Fish Species

The assessment of effects on fish considers the potential occurrence of protected species and life stages relative to the location, magnitude, timing, frequency, and duration of project actions. Species habitat attributes potentially affected by project implementation include spawning habitat area and quality, rearing habitat area and quality, migration habitat conditions, and water quality.

Short-term construction related effects on fish species include effects on individuals (e.g., displacement, disruption of essential behaviors, mortality) and immediate, short-term effects on habitat. These short-term effects are evaluated qualitatively and generally mitigated through the use of construction BMPs and limitations on construction windows.

Long-term effects typically last months or years, and generally involve physical alteration of the bank and riparian vegetation adjacent to the water's edge, with consequent impacts upon SRA cover, nearshore cover, and shallow water habitat (Fris and DeHaven 1993).

The operation and maintenance of the bank protection sites would include allowing the vegetation to grow to maturity and provide SRA habitat.   There would be no sediment removal or clearing of vegetation along the planted bench after construction. The following statements will be added to the O&M manual once construction is completed to ensure sustainability of the created habitat.   Therefore, affects from O&M activities would not be affect listed fish species and are not discussed in detail below.

Trees, either preserved or planted, on the berm within the project footprint of the bank protection site shall not be removed as part of normal maintenance as long as they remain healthy. As unhealthy trees are removed or fall over, any subsequent cavities in the rock must be filled in a timely manner with rock material equal to the surrounding repair. Leave the fallen trees in place.

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Mitigation plantings installed on this site shall be left in a natural state. No additional maintenance such as irrigation or mowing shall be required as a part of normal maintenance.

Soil placed on/in rock as a part of the original repair and all associated vegetation (grasses & woody shrubs/trees) within the footprint of the bank protection site does not require replacement as a part of normal maintenance. In other words if the soil is washed out it does not need to be replaced and re-vegetated.

During typical summer-fall conditions, focus fish species which include salmon, steelhead, green sturgeon, and delta smelt are generally absent in the Sacramento and Yolo Bypass. During winter-spring conditions, assuming inundation, the Yolo Bypass provides a large amount of available floodplain habitat for migration and rearing. Under the "worst case scenario" assumptions, project actions along the Sacramento Bypass levee reach would result in the removal of all trees and vegetation; due to the abundance of floodplain habitat during increased inundation with the widening of the Sacramento Bypass, it is highly unlikely that the loss of these shoreline habitat features would impact overall habitat that would be available and most likely utilized by salmon, steelhead, green sturgeon, and delta smelt in the Sacramento Bypass during winter-spring conditions.

5.2.1 Sacramento River Winter-Run Chinook Salmon

Potential project effects from the actions are described below for each life stage and its habitat. Effects on designated critical habitat are addressed via description of habitat effects for each applicable species.

<u>Construction-Related Effects</u>

Adult Migration

Construction activities may affect but are not likely to adversely affect winter-run adults because construction will avoid the primary migration period (December through July), will be restricted to the channel edge, and will include implementation of the avoidance and minimization measures described in Section 2.5.

Spawning

Winter-run Chinook salmon do not spawn in the ARCF GRR action area. Therefore, the project will have no effect on winter-run Chinook salmon spawning or spawning habitat.

Juvenile Rearing and Migration

Rearing and emigrating juveniles and smolts may be found in the action area during the fall, winter, and spring. The abundance of juvenile winter-run Chinook salmon moving downstream peaks at Red Bluff in September and October and continues until mid March in drier years (Vogel and Marine 1991). Downstream migration may be triggered by storm events and the resulting high flow and turbidity, although the relative importance of various outmigration cues remains unclear.

Implementation of the bank erosion protection measures may result in adverse effects to juvenile and smolt winter-run Chinook salmon and their critical habitat. Construction activities that increase noise, turbidity, and suspended sediment may disrupt feeding or temporarily displace fish from preferred habitat. Rearing or outmigrating salmon may not be able to readily move away from nearshore areas that are directly affected by construction activities such as placement of rock revetment; these effects could result in stress, injury, or mortality. Take of juvenile or smolt winter-run Chinook salmon could therefore occur via mortality or injury during construction activity, or by the impairment of essential behaviors such as feeding or escape from predators. Substantial increases in suspended sediment could temporarily bury substrates that support benthic macroinvertebrates, an important food source for juvenile salmonids. However, due to the limited duration and spatial extent of project actions, effects on salmonid feeding are expected to be minimal. In addition, spills or leakage of gasoline, lubricants, or other petroleum products from construction equipment or storage containers could result in physiological impairment or mortality to rearing or outmigrating salmon in the vicinity of the project sites. With implementation of best management practices, the impacts due to spills should be minimal.

Restricting in-water activities to the August 1 through November 30 work window (beginning on July 1 for sites upstream of RM 60) and implementing the avoidance and minimization measures described in Section 2.5 will minimize, but but may affect and is likely to adversely affect potential construction-related effects on juveniles and smolts.

<u>Long-Term Effects</u>

The ARCF GRR action area does not support spawning habitat for winter-run Chinook salmon, therefore the projects long-term effects will have no effect to spawning habitat.

Winter-run Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River Standard Assessment Methodology (SAM) and American River SAM analysis reach over the lifetime of the project (Appendix B). Figures 12 through 14 below show the long term condition changes at a typical bank protection site over 10 years. Chinook salmon should exhibit a positive response by year 5. Short term habitat deficits are expected within the recommended recovery period for Chinook salmon. The maximum habitat deficit identified is -1,291 ft for the juvenile migration life stage of Spring-run Chinook salmon in the fall of year 11. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions.

Winter-run Chinook salmon are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Winter-run Chinook salmon should exhibit a negative response by year 1. The maximum habitat deficit identified is -188 ft for the juvenile migration life stage of Winter-run Chinook salmon in the spring of year 2. Short term and long term habitat deficits will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir.

Figure 12. 2001 at planting year site 4R on the American River after Bank Protection.

Figure 13. Site 4R in 2005

Figure 14. Site 4R in 2010.

5.2.2 Central Valley Spring-Run Chinook Salmon

Potential project effects for spring-run Chinook salmon are described below for each life stage and its habitat, including effects on designated critical habitat.

Construction-Related Effects

Adult Migration

Adult spring-run Chinook salmon migrate up the Sacramento River from March through September although most individuals have entered tributary streams by mid-June and will not be affected by construction activities. Therefore, potential for construction-related ARCF GRR project effects will be similar to that described for winter-run Chinook salmon.

Spawning

Spring-run Chinook salmon do not spawn in the ARCF GRR action area. Therefore, the project will have no effect on spring-run Chinook salmon spawning or spawning habitat.

Juvenile Rearing and Migration

Similar to winter-run Chinook salmon, spring-run Chinook salmon typically spend up to 1 year rearing in fresh water before migrating to sea. Therefore, potential for construction-related effects will be similar to that described for winter-run Chinook salmon above.

Restricting in-water activities to the August 1 through November 30 work window and implementing the avoidance and minimization measures described in Section 2.5 will minimize, but may affect and is likely to adversely affect potential construction-related effects on juveniles and smolts.

Long-Term Effects

The ARCF GRR area does not support spawning habitat for spring-run Chinook salmon, therefore the projects long-term effects will have no effect to spawning habitat.

Spring-run Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River SAM and American River analysis reaches over the lifetime of the project (Appendix B). Figures 12 through 14 show the long term condition changes at a typical bank protection site over 10 years. Spring-run Chinook salmon should exhibit a positive response by year 5. Short term habitat deficits are expected within the recommended recovery period for spring-run Chinook salmon. The maximum habitat deficit identified is -1,440 feet for the juvenile migration life stage of spring-run Chinook salmon in the summer of year 10. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions. For juvenile spring-run Chinook salmon, the bank protection measures will generally provide long-term increases in bank shading at project sites. The plantings of native grasses and willows are designed to benefit juvenile Chinook salmon by increasing the availability (habitat area) and quality (shallow water and instream cover) of nearshore aquatic habitat and SRA relative to current conditions. Long term effects may affect but are not likely to adversely affect critical habitat for spring-run Chinook salmon juvenile rearing and migration.

Spring –run Chinook salmon are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Chinook salmon should exhibit a negative response by year 1. The maximum habitat deficit identified is -188 feet for the juvenile migration life stage of spring-run Chinook salmon in the spring of year 2. Short term and long term habitat deficits will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir.

5.2.3 Central Valley Steelhead

Potential project effects for steelhead are described below for the relevant life stages and their habitat, including effects on designated critical habitat.

Construction-Related Effects

Adult Migration

In the Sacramento River, adult steelhead migrate upstream during most months of the year, beginning in July, peaking in September, and continuing through February or March. Adults use the river channel in the action area as a migration pathway to upstream spawning habitat, and may also use deep pools with instream cover as resting and holding habitat. The potential for construction-related effects on migrating adult steelhead would be similar to that described above for adult winter-run Chinook salmon with the determination being that the construction-related activities may affect but are not likely to adversely affect adult migration.

Spawning

Within the ARCF GRR action area, potential spawning habitat is present in the American River, NEMDC, and Dry/Robla Creek. Steelhead spawn in late winter and late spring outside of the August 1-November 30 construction window; therefore, construction-related effects may affect but are not likely to adversely affect steelhead spawning or their spawning habitat.

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Juvenile Rearing and Migration

Central Valley steelhead rear year-round in the cool upstream reaches of the mainstem Sacramento River and its major tributaries. Juveniles and smolts are most likely to be present in the action area during their downstream migration to the ocean, which may begin as early as December and peaks from January to May. The importance of main channel and floodplain habitats in the lower Sacramento River to rearing steelhead is becoming more understood.

Steelhead smolts have been found in the Yolo Bypass during the period of winter and spring inundation (Sommer 2002). Sommer et al. (2001) found that Juvenile Chinook salmon that reared within a large, engineered floodplain of the Sacramento River (the Yolo Bypass) had higher rates of growth and survival than fish that reared in the main-stem river channel during their migration. For purposes of this analysis, rearing juvenile steelhead are assumed to use nearshore and off-channel habitat in the action area. The potential for construction-related effects on steelhead juveniles and smolts and their habitat will therefore be similar to that described above for winter-run Chinook salmon which may affect and is likely to adversely affect.

Long-Term Effects

Steelhead are expected to show a long term positive response to project actions in the Sacramento River SAM and American River SAM analysis reaches over the lifetime of the project (Appendix B). Figures 12 through 14 show the long term condition changes at a typical bank protection site over 10 years. Steelhead should exhibit a positive response by year 5. Short term habitat deficits are expected within the recommended recovery period for Steelhead. The maximum habitat deficit identified is -1,330 ft for the juvenile migration life stage of Steelhead in the fall of year 11. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions.

Steelhead are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Steelhead should exhibit a negative response by year 1. The maximum habitat deficit identified is -174 ft for the juvenile migration life stage in the spring of year 2. Short term and long term habitat deficits will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir.

5.2.4 Delta Smelt

Primary Constituent Elements

In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation (50 CFR 424.12(b)). The Service is required to list the known primary constituent elements together with a description of any critical habitat that is proposed. Such physical and biological features (i.e., primary constituent elements) include, but are not limited to, the following:

- 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, rearing of offspring, germination, or seed dispersal; and
- Generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

The primary constituent elements essential to the conservation of the delta smelt are physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration (NMFS 1994a).

Spawning Habitat

Delta smelt adults seek shallow, fresh or slightly brackish backwater sloughs and edgewaters for spawning. To ensure egg hatching and larval viability, spawning areas also must provide suitable water quality (i.e., low concentrations of pollutants) and substrates for egg attachment (e.g., submerged tree roots and branches and emergent vegetation). Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay. The spawning season varies from year to year and may start as early as December and extend until July (NMFS 1994a).

Larval and Juvenile Transport

To ensure that delta smelt larvae are transported from the area where they are hatched to shallow, productive rearing or nursery habitat, the Sacramento and San Joaquin Rivers and their tributary channels must be protected from physical disturbance (e.g., sand and gravel mining, diking, dredging, and levee or bank protection and maintenance) and flow disruption (e.g., water diversions that result in entrainment and in-channel barriers or tidal gates). Adequate river flow is necessary to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay. Additionally, river flow must be adequate to prevent interception of larval transport by the State and Federal water projects and smaller agricultural diversions in the Delta. To ensure that suitable rearing habitat is available in Suisun Bay, the 2 ppt isohaline must be located westward of the Sacramento-San Joaquin River confluence during the period when larvae or juveniles are being transported, according to the historical salinity conditions which vary according to water-year type. Reverse flows that maintain larvae upstream in deep-channel regions of low productivity and expose them to entrainment interfere with these transport requirements. Suitable water quality must be provided so that maturation is not impaired by pollutant concentrations. The specific geographic area important for larval transport is confined to waters contained within the legal boundary of the Delta, Suisun Bay, and Montezuma Slough and its tributaries. The specific season when habitat conditions identified above are important for successful larval transport varies from year to year, depending on when peak spawning occurs and on the water-year type. The Service identified situations in the biological opinion for the delta smelt (1994) where additional flows might be required in the July-August period to protect delta smelt that were present in the south and central Delta from being entrained in the State and Federal project pumps, and to avoid jeopardy to the species. The long-term biological opinion on CVP-SWP operations will identify situations where additional flows may be required after the February through June period identified by EPA for its water quality standards to protect delta smelt in the south and central Delta (NMFS 1994a).

Rearing Habitat

Maintenance of the 2 ppt isohaline according to the historical salinity conditions described above and suitable water quality (low concentrations of pollutants) within the Estuary is necessary to provide delta smelt larvae and juveniles a shallow, protective, food-rich environment in which to mature to adulthood. This placement of the 2 ppt isohaline also serves to protect larval, juvenile, and adult delta smelt from entrainment in the State and Federal water projects. An area extending eastward from Carquinez Strait, including Suisun Bay, Grizzly Bay, Honker Bay, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break, defines the specific geographic area critical to the maintenance of suitable rearing habitat. Three Mile Slough represents the approximate location of the most upstream extent of tidal excursion when the historical salinity conditions described above are implemented. Protection of rearing habitat conditions may be required from the beginning of February through the summer (NMFS 1994a).

Adult Migration

Adult delta smelt must be provided unrestricted access to suitable spawning habitat in a period that may extend from December to July. Adequate flow and suitable water quality may need to be maintained to attract migrating adults in the Sacramento and San Joaquin River channels and their associated tributaries, including Cache and Montezuma sloughs and their tributaries. These areas also should be protected from physical disturbance and flow disruption during migratory periods (NMFS 1994a).

Construction-Related Effects

Delta smelt in the Sacramento River have been documented upstream as far as the city of Sacramento (RM 60) (Moyle 2002), and may be present throughout their life cycle. Potential project effects are described below for relevant life stages and their habitats, including effects on designated critical habitat.

Adult Migration

Adult Delta smelt migrate upstream between December and January and spawn between January and July, with a peak in spawning activity between April and mid-May (Moyle 2002). Potential construction-related effects to physical habitat, water, river flow, and salinity concentrations for migrating adult Delta Smelt will be avoided or minimized by restricting in water construction activities on the Sacramento River to the August 1 through November 30 work window allowing for unrestricted access to suitable and important spawning habitat. If there is any change in effect due to construction constraints outside the work window, consultation will be initiated. Construction-related effects may affect but are not likely to adversely affect adult migration.

Spawning

Potential spawning habitat includes shallow channel edge waters in the Delta and Sacramento River. Specific areas that have been identified below the ARCF GRR project area as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay. As a result, potential construction-related effects to delta smelt physical habitat would include disruption of spawning activities, disturbance or mortality of eggs and newly hatched larvae, alteration of spawning and incubation habitat, and loss of shallow water habitat for spawning.

The erosion repair is likely to somewhat reduce the sediment supply for riverine reaches directly downstream because the erosion repair is holding the bank or levee in place. However, from a system sediment prospective, the bank material we are protecting in the project reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather, and especially the Yuba River systems. All of the available sediment in the American River watershed is being contained behind Folsom Dam. The site specific designs will be constrained from allowing any velocity increases outside the erosion repair site (Schlunegger 2014).

In response to a USFWS request for more data on July 23, 2014, the Corps conducted an analysis of existing shallow water habitat in the ARCF GRR project area, and the effect of the proposed project on that habitat. The results of this analysis are included as Appendix C to this report. The conclusion of the

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analysis was that approximately 14.86 acres of shallow water habitat would be lost as a result of implementation of the ARCF GRR. This analysis was based on a conservative design and could be minimized as site-specific designs are developed during the PED phase of the project. Compensation for shallow water habitat would be refined during the PED phase and would occur either at a mitigation bank, through excess acreages created at the Southport setback for the West Sacramento GRR, or would be created by the Corps within the Delta region.

Construction-related effects on delta smelt spawning and incubation will be minimized by restricting in-water construction activities on the Sacramento River and Sacramento Weir and Bypass to the August 1 through November 30 work window, thereby avoiding the seasons when spawning is most likely to occur, however construction activities may affect and is likely to adversely affect delta smelt spawning habitat.

Juvenile Rearing and Migration

Juvenile delta smelt may be subject to disturbance or displacement caused by construction activities that would alter physical habitat, water, and river flow in the form of increased noise, turbidity, and suspended sediment. Delta smelt may not be readily able to move away from channel or nearshore areas that are directly affected by construction activities (i.e., removal or placement of instream woody material, placement of rock revetment). Larvae may be disrupted during summer months as they migrate downstream to rear in the Delta. Incidental take of delta smelt may occur from direct mortality or injury during a construction activity, or by the impairment of essential behavior patterns (i.e., feeding, escape from predators). Salinity concentrations would not be affected by the construction activity. Construction-related effects on delta smelt rearing and migration will be minimized by restricting in-water construction activities on the Sacramento River to the August 1 through November 30 work window, thereby avoiding the seasons when these life stages are most likely to occur. Construction-related activities may affect and is likely to adversely affect juvenile rearing and migration.

Long-Term Effects

Non-native species may exploit the warmer water temperature in the shallow bench habitat created as an on-site mitigation feature and prey on delta smelt eggs and larvae; however, bench habitat would most likely not bring in more predatory fish that don't already exist in the project area. A 2013 long-term aquatic monitoring program draft report by FishBio for the Corps noted that Black bass (largemouth and smallmouth bass) have the highest probability of habitat occupancy at both Sacramento River Bank Protection Project (SRBPP) sites with bench features and sites with no bench features. Unlike previous years, when highest bass abundance was typically associated with wetland trench designs (not included in the suite of monitored sites in 2013), the highest likelihood of encountering black bass was observed at no bench and bench sites, in particular those near rivermile 70, well above the project area (Corps 2013b). Proposed planting of emergent vegetation will enhance habitat complexity by providing cover and incubation habitat, especially during high winter and spring flows.

5.2.5 Green Sturgeon

Potential project effects are described below for each life stage of green sturgeon and its habitat. An accurate assessment of potential project effects on green sturgeon and its habitat is difficult due to the limited information available on distribution, seasonal abundance, habitat preferences, and other life history requirements of this species.

Construction-Related Effects

Adult Migration

Adult green sturgeon are believed to move upstream through the Sacramento River ARCF action area from February through late July (NMFS 2005c). Construction activities occurring outside of these time periods are not likely to affect migrating green sturgeon adults. Construction activities during July, however, may have adverse impacts on any adult green sturgeon that are still migrating upstream. Because construction activities will largely avoid the peak migration period, will be restricted to the channel edge, and will implement the avoidance and minimization measures described in Section 2.5, construction-related activities may affect but are not likely to adversely affect adult migration.

Spawning

Spawning migrations of Green Sturgeon typically occur during the months of March through June (Thomas et al. 2013). The Sacramento River downstream of Knights Landing (RM 90) is not believed to have suitable spawning habitat for green sturgeon, primarily due to lack of suitable coarse bottom substrate such as large cobbles (Corps 2012). Therefore, the ARCF GRR project will have no affect on spawning green sturgeon or their habitat.

Juvenile Rearing and Migration

Based on general knowledge of green sturgeon life history, larvae may occur in the Sacramento River and Delta shortly after spawning, from February through late July (peak spawning from April through June) (Emmett et al. 1991 as cited in Moyle 2002). Restricting in-water construction activities to the August 1 through November 30 work window and implementing the avoidance and minimization measures described in Section 2.5, will minimize potential impacts of in-water construction activities on green sturgeon larvae. However, if larvae or juveniles are present during construction, in-water activities could result in localized displacement and possible injury or mortality to individuals that do not readily move away from the channel or nearshore areas. Project actions associated with bank protection measures may increase sediment, silt, and pollutants, which may affect and is likely to adversely affect rearing habitat or reduce food production, such as aquatic invertebrates, for larval and juvenile green sturgeon.

Long-Term Effects

Project actions in the Sacramento River SAM analysis reach will mimic SRBPP repair site onsite mitigative features (Appendix B). SRBPP onsite mitigative features were designed to maximize habitat response for salmonid species; Green sturgeon will exhibit a negative response to these onsite mitigative features. Green sturgeon are expected to show long term negative response to project actions in the Sacramento River SAM analysis reach for the fry and juvenile rearing life stages in the winter and spring over the lifetime of the project. The maximum habitat deficit identified is -3,015 ft for the spawning and egg incubation life stage of Green sturgeon in the summer of year 50. Habitat deficits displayed a general trend toward increasing beyond the lifetime of the project. Habitat deficits for adult life stages will result from the creation of a 10:1 planted bench at winter/spring habitat conditions. Habitat deficits for larval/fry and spawning/ egg life stages will result from the change in substrate at summer/fall (rock revetment) and at winter/spring (natural) habitat conditions.

Green Sturgeon are expected to show a long term positive response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project for the fry and juvenile rearing life stages in the winter/spring/summer/fall of year 1. The maximum habitat deficit identified is -8 ft for the adult residence life stage of Green Sturgeon in the winter/spring/summer of year 1 which carries over through the life of the project into year 50.

5.3 Giant Garter Snake

Much of the project area is unlikely to provide GGS aquatic habitat because it consists of larger rivers and flood control features, often surrounded by riparian vegetation and steep banks. The East Side Tributaries (Dry/Robla, Magpie, NEMDC, and Arcade Creeks) have the potential for GGS occurrence, however, Arcade, Dry/Robla, and Magpie Creeks lack year round water and connectivity to rice fields, a major component of GGS habitat. The closest rice fields are about 5 miles away up the NEMDC and above a pump plant located on the NEMDC just above Dry/Robla Creek. Additionally, Arcade Creek has large cover vegetation between Norwood and Rio Linda Boulevard that would make this area undesirable for GGS. NEMDC and the Sacramento Bypass are considered GGS habitat, and there is a large rice field located in the area proposed for the bypass expansion.

Short-Term Effects

Prior to construction, surveys would be conducted in the East Side Tributaries area to determine whether GGS have the potential to be present in the construction area. If GGS are determined to be present, there is the potential for short-term effects to GGS upland habitat during construction. Construction activities could disturb GGS due to vibration, noise, and dust. Effects would occur over a single construction season and would return to the pre-existing conditions once completed. During construction equipment could possibility harm or kill a snake if the snakes are present. To minimize potential impacts to GGS, the avoidance and minimization measures discussed in Section 2.5 above would be implemented.

Temporary construction-related impacts to GGS during construction of the Sacramento Bypass expansion would be consistent with those for NEMDC. Additionally, there is an approximately 375 acre rice field located in the area proposed for the bypass expansion. This area could not be farmed during construction of the new Sacramento Bypass levee; therefore, there would be a temporary effect from the removal of rice habitat for a maximum of one season during the Sacramento Bypass levee construction. Following construction it is anticipated that the rice field could return to production within the Bypass. The area would be restored and returned to pre-project condition, to the extent practicable within the floodway. Any loss of GGS habitat would be compensated in accordance with the measures discussed in Section 2.5 above.

Long-term

GGS habitat in the East Side Tributaries area would be restored to pre-project conditions, resulting in no long-term loss of aquatic or upland GGS habitat in this portion of the project area. Long-term impacts could result from O&M activities. These activities include mowing, rodent control, and grouting rodent holes. These activities could remove habitat and disturb GGS. Additionally, driving near habitat could disturb GGS dur to vibration, noise, and dust. Maintenance activities would occur during the GGS active season to reduce impacts to the snake. Overall, these activities are considered less than significant, because they are short term activities and because O&M reduces the potential impacts associated with future levee repairs.

In the Sacramento Bypass, since the rice field would return to production following the construction period, there would be no long-term impacts associated with the loss of GGS habitat. O&M effects in the bypass would be similar to those described for the East Side Tributaries above.

5.4 Ongoing Project Actions

As described in Section 2.5, in-water construction work will be completed during established work windows for salmonids and delta smelt. Maintenance activities may occur year-round in the dry areas. Effects from on-going activities (e.g., maintenance) are expected to be similar to effects described in Section 5.2, although the effects' magnitudes will be less.

5.5 Effects on the Environmental Baseline

Effects of the proposed action include reductions in nearshore aquatic and riparian habitat that is used by aquatic and terrestrial species. Placement of revetment on earthen banks alters natural fluvial processes that sustain high-value nearshore and floodplain habitats in alluvial river systems.

5.6 Effects on Essential Elements of Critical Habitat

The project actions may affect designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and green sturgeon. Any project action within the Sacramento River waterway from the confluence of the American River downstream to Freeport RM 46 may also affect designated critical habitat for delta smelt (USFWS 2003). Potential impacts of the project actions on critical habitat for listed species are discussed separately for each species (Sections 5.1 to 5.3).

5.7 Cumulative Effects

The ESA requires the action agency, NMFS, and USFWS to evaluate the cumulative effects of the proposed actions on listed species and designated critical habitat, and to consider cumulative effects in formulating Biological Opinions (USFWS and NMFS 2002c. The ESA defines cumulative effects as "those effects of future State or private actions, not involving Federal activities that are reasonably certain to occur within the action area" of the proposed action subject to consultation (USFWS and NMFS 2002b). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the Federal ESA. For the purposes of this BA, the area of cumulative effects analysis is defined as the Sacramento River watershed.

A number of other commercial and private activities, including hatchery operations, timber harvest, recreation, as well as urban and rural development, could potentially affect listed species in the Sacramento River basin. Levee maintenance activities by state agencies and local reclamation districts are likely to continue, although any effects on listed species will be addressed through Section 10 of the ESA. Ongoing non-federal activities that affect listed salmonids, green sturgeon, delta smelt, valley elderberry longhorn beetle, giant garter snake and their habitat, will likely continue in the short-term, at intensities similar to those of recent years. However, some activities associated with the State's proposed Central Valley Flood Protection Plan or state or local efforts to implement the ETL could result in increased effects on listed species. The extent and pace of those activities are not yet known.

Cumulative effects may also include non-federal rock revetment projects. Some non-federal rock revetment projects carried out by State or local agencies (e.g., reclamation districts) that do not fill wetlands or occur above the ordinary high water line will not need Section 404 (Clean Water Act) permits from the Corps and resulting Section 7 (ESA) consultation, but any effects on listed species should be addressed through Section 10 of the ESA. These types of actions are possible at many locations throughout the ARCF action area, but are not included as part of the current project.

Potential cumulative effects on fish may include any continuing or future non-federal diversions of water that may entrain adult or larval fish or that may incrementally decrease outflows, thus changing the position of habitat for these species. Water diversions through intakes serving numerous small, private agricultural lands and duck clubs in the Delta, upstream of the Delta, and in Suisun Bay contribute to these cumulative effects. These diversions also include municipal and industrial uses and power production. Several new diversions are in various stages of action. The introduction of exotic species may also occur under numerous circumstances. Exotic species can displace native species that provide food for larval fish.

Potential cumulative effects on all species addressed in this BA could include: wave action in the water channel caused by boats that may degrade riparian and wetland habitat and erode banks; dumping of domestic and industrial garbage; land uses that result in increased discharges of pesticides, herbicides, oil, and other contaminants; and conversion of riparian areas for urban development. In addition, routine vegetation clearing and mowing associated with agricultural practices may affect or remove habitat for the valley elderberry longhorn beetle and giant garter snake.

5.8 Conclusion and Effects Determination for Listed Species

5.8.1 Valley Elderberry Longhorn Beetle

The project construction would result in the transplanting of a maximum of 270 elderberry shrubs during the 13 year construction timeframe. Compensation for the transplanting of the shrubs would be on-site where possible and within the same region when off-site. The replacement plantings would result in habitat connectivity for the beetle within the project area. In consideration of this information, the project actions are unlikely to result in long-term habitat losses to valley elderberry longhorn beetle, as long as the applicable mitigation and compensation measures are implemented. However, project actions may adversely affect valley elderberry longhorn beetles due to potential take during construction.

Additionally, approximately 90 shrubs could be trimmed each year by the maintaining agencies for O&M activities. The trimming are not expected to reduce the habitat overall for the beetle as the shrubs would remain in the existing location. The maintaining agencies would purchase credits in a mitigation bank to offset any potential affects that may occur due to trimming.

5.8.2 Fish

Anadromous Fish Species

The ARCF GRR is expected to result in adverse short-term, construction- and O&M-related effects on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, southern DPS North American green sturgeon, and their designated critical habitat. Project effects may include localized incidental take due to disturbance, displacement, or impairment of feeding or other essential behaviors of adult and juvenile salmon, steelhead, and green sturgeon during construction and operations and maintenance (O&M) activities. Injury or mortality of juvenile salmonids, and green sturgeon, could occur, if individuals are unable to readily move away from channel or nearshore areas directly affected by construction activities. Accidental discharge of toxic substances during construction could cause physiological impairment or mortality of listed fish and other aquatic species at or immediately downstream of project sites. Other potential stressors include noise, suspended sediment, turbidity, and sediment deposition generated during in-water construction activities. These effects could also occur in areas downstream of project sites, because noise and sediment may be propagated downstream. Restricting in-water activities to the August 1 through November 30 work window, and implementing BMPs, will minimize the potential for adverse effects.

Long-term project effects on the habitat of listed fish species include instream and overhead cover, and substrate conditions along the seasonal low- and high-flow shorelines of the erosion sites. Implementation of the project will result in temporary losses of instream structure and riparian vegetation along the summer-fall and winter-spring shorelines and will also limit long-term fluvial functioning necessary for the development and renewal of SRA habitat in the future.

Initial cover losses due to project actions will be partially offset by installing riparian plantings and native grasses along the lower slopes. These features will increase the availability of high quality shallow water habitat for juvenile Chinook salmon and steelhead, and possibly juvenile green sturgeon during the annual high-flow period (late fall, winter, and spring). Because we will not be removing any trees on the lower one-third of the waterside of the levees in the Sacramento River area, SRA will not be compromised thus maximizing existing SRA values in the action area. The establishment and growth of planted riparian vegetation is expected to increase habitat values over time by increasing the extent of overhead cover available to listed fish species.

Delta Smelt

These features will increase the availability of high quality shallow water habitat for juvenile Chinook salmon and steelhead, incubating delta smelt, and possibly juvenile green sturgeon during the

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annual high-flow period (late fall, winter, and spring). Because we will not be removing any trees on the lower one-third of the waterside of the levees in the Sacramento River area, SRA will not be compromised thus maximizing existing SRA values in the action area. The establishment and growth of planted riparian vegetation is expected to increase habitat values over time by increasing the extent of overhead cover available to listed fish species.

In consideration of the above information, the project actions are not likely to result in long-term habitat losses to Sacramento River winter-run Chinook salmon, Central Valley steelhead, Central Valley spring-run Chinook salmon, delta smelt, and green sturgeon as long as the applicable mitigation and compensation measures are implemented. This conclusion is based on the Corps' commitment to: (1) minimize temporary habitat losses through the incorporation of on-site mitigation features (e.g., vegetated riparian and wetland benches, riparian plantings, and no planned tree removal) in the project area measures; and (2) implementation of off-site habitat compensation measures (e.g., riparian planting, rock removal) prior to or concurrent with project construction. However, project actions may adversely affect these focus species due to: (1) incidental take during construction and; (2) fragmentation of existing natural bank habitats due to the placement of revetment; and (3) the potential loss of long-term fluvial functioning necessary for the development and renewal of shaded riverine aquatic habitat.

Determinations

Section 7 of the Endangered Species Act requires that Federal agencies ensure, in consultation with the U.S. Fish and Wildlife Service, that any action they authorize, fund, or carry out is not likely to result in the destruction or adverse modification of critical habitat. Effects to critical habitat are discussed for each fish species in Section 5.2. Based on those assessments, project actions:

- May affect, likely to adversely affect designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Green sturgeon;
- May affect, likely to adversely affect designated critical habitat for delta smelt within the ARCF GRR project area which includes the Sacramento River upstream to approximately RM 60 (U.S. Fish and Wildlife Service 2003a).

5.8.3 Giant Garter Snake

To minimize the potential for adverse effects on GGS in the East Side Tributaries and Sacramento Bypass areas, GGS habitat will be designated as an environmentally sensitive area delineated with signs or fencing, and if possible, avoided by all construction personnel. Additional measures and habitat compensation as outlined in Section 2.5.3 will also be implemented to avoid and minimize potential temporary effects to GGS during construction. The rice field will return to production after the bypass is widened and the area would be restored to the maximum extent practicable within the floodway. It is anticipated that there would be no permanent loss of GGS habitat; however, should any change in acreages occur due to the relocation of the Sacramento Bypass levee, compensation would occur in accordance with the measures discussed in Section 2.5.3. Temporary effects during construction could remove production of the rice field for one construction season. Compensation for these temporary impacts would occur in accordance with the measures discussed in Section 2.5.3.

In consideration of the above information, the project actions are unlikely to result in long-term habitat losses to the giant garter snake, as long as the applicable mitigation and compensation measures are implemented. However, even with on-site mitigation and off-site compensation, the project actions may adversely affect giant garter snakes due to: (1) take during construction and O&M activities; and (2) habitat fragmentation.

5.8.4 Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp

Approximately 1 acre of vernal pool habitat has the potential to be impacted by project construction near Magpie Creek. Prior to construction, a wetland delineation would be conducted to confirm the presence of vernal pool habitat and determine the full extent of the impact. If the presence of vernal pool habitat is confirmed, then the avoidance and minimization measures discussed in Section 2.5.4 above would be implemented, and compensation for the habitat loss would be required. The Corps proposes to either purchase 1 acre of credits at a mitigation bank, or compensate for the loss of 1 acre of habit through enhancement of the habitat in the 79 acres of land being acquired under this project as a flood overflow area.

In consideration of the above information, the project actions are unlikely to result in long-term habitat losses to the vernal pool fairy shrimp and vernal pool tadpole shrimp, with the implementation of the mitigation and compensation measures proposed. As a result, the project actions may affect, but are not likely to adversely affect the vernal pool fairy shrimp and vernal pool tadpole shrimp.

5.9 Effects of the Proposed Action on Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (U.S.C. 180 et seq.), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans. Federal action agencies must consult with NMFS on any activity that they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH of Pacific salmon pursuant to Section 305 (b) (2) of the MSA appropriate determinations for EFH as either; (1) will not adversely effect, or (2) may adversely affect. Important components of EFH for Chinook salmon spawning, rearing, and migration include:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
    a) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
    b) Water quality and forage supporting juvenile development; and
    c) 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.
- 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.
- Estuarine areas free of obstruction and excessive predation with:
    a) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;
    b) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and
    c) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The ARCF GRR includes habitat on the Sacramento River, American River, and the Sacramento Bypass that have been designated as EFH for Chinook salmon, a major contributor to Pacific Coast salmon fisheries. The Pacific Coast salmon fishery EFH extends along the Pacific Coast from Washington to Point Conception in California. Freshwater EFH includes all habitats currently and historically accessible to salmon and is based on descriptions of habitat used by coho and Chinook salmon. The EFH excludes areas above naturally occurring barriers such as waterfalls, which have been present for several hundred years, and impassible dams identified on large rivers (NMFS 1997). The following analysis of EFH does not include effects to the fish species, just the species habitat as defined in the MSA. Results for the effects of EFH for winter-run, spring-run, and fall/late-fall-run Chinook salmon in the ARCF GRR action area were based on the SAM analysis detailed in Appendix B.

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5.9.1 Effects of the Proposed Action on EFH

Site specific project designs were unavailable for the ARCF GRR project reach at the time of this SAM analysis. The following data sources were used to characterize SAM habitat conditions (as defined by bank slope, floodplain availability, substrate size, instream structure, aquatic vegetation, and overhanging shade) within the ARCF GRR project area under existing or pre-project conditions:

- The Corps' Sacramento River revetment database – This database was used to stratify the project reach into subreaches that encompass relatively uniform bank conditions based on their general physical characteristics (USACE 2007). This database was used to characterize existing habitat conditions within individual subreaches where more recent data were unavailable.
- Aerial images of the ARCF GRR project reach (Google™ Earth), provided current and historical images of bank conditions that were used to address gaps or uncertainties related to existing cover characteristics within individual subreaches.

The SAM employs six habitat variables to characterize near-shore and floodplain habitats of the winter-run, spring-run, and fall/late-fall-run Chinook species:

- Bank slope—average bank slope of each average seasonal water surface elevation;
- Floodplain availability—ratio of wetted channel and floodplain area during the 2-year flood, to the wetted channel area during average winter and spring flows;
- Bank substrate size—the median particle diameter of the bank (i.e., D50) along each average seasonal water surface elevation;
- Instream structure—percent of shoreline coverage of instream woody material along each average seasonal water surface elevation;
- Aquatic vegetation—percent of shoreline coverage of aquatic or riparian vegetation along each average seasonal water surface elevation; and
- Overhanging shade—percent of the shoreline coverage of shade along each average seasonal water surface elevation.

<u>Sacramento River SAM EFH Analysis</u>

The Sacramento River SAM analysis reach includes the entire left bank (east side) of the Sacramento River from the American River confluence to approximately 4,020 linear feet (lf) below the Freeport Bridge.

Short Term

Short term construction activities may adversely affect Chinook EFH. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions most positively associated with fry and juvenile rearing and migration.

Long Term

Long term construction actions will not adversely affect EFH on the Sacramento River portion of the ARCF GRR action area. EFH is expected to show a long term positive response to project actions in the Sacramento River SAM analysis reach over the lifetime of the project. Positive EFH response would be most likely associated with long term growth of SRA (overhanging shade) and aquatic vegetation.

American River SAM EFH Analysis

The American River SAM analysis (ARN A-B and ARS A-C) reaches include portions of the right and left bank of the American River from Goethe Park to the confluence of the Sacramento. It also includes portions of NEMDC, Arcade Creek, Magpie Creek, and Dry/Robla Creek.

Short Term

Short term construction activities may adversely affect Chinook EFH. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions most positively associated with fry and juvenile rearing and migration.

Long Term

Long term construction actions will not adversely affect EFH on the Sacramento River portion of the ARCF GRR action area. EFH is expected to show a long term positive response to project actions in the American River SAM (Appendix B) analysis reach over the lifetime of the project. Positive EFH response would be most likely associated with long term growth of SRA (overhanging shade) and aquatic vegetation.

Sacramento Bypass SAM EFH Analysis

The Sacramento Bypass SAM analysis reach includes the right bank (north side) of the Sacramento Bypass levee in its entirety from the confluence of the Sacramento River to its termination at the Yolo Bypass.

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Short Term

Short term construction activities may adversely affect Chinook EFH. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at the portion of the Sacramento Bypass associated with the removal of the SRA habitat to allow expansion of the Sacramento Bypass Weir. There is no planned vegetation removal for the levee widening.

Long Term

Chinook salmon are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Chinook salmon should exhibit a negative response by year 1. The maximum habitat deficit identified is -188 ft for the juvenile migration life stage of spring-run and winter-run Chinook salmon in the spring of year 2. Long term habitat deficits would be associated with the permanent removal of SRA habitat for the expansion of the weir portion of the project not the levee portion.

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Appendix A

Species Lists

U.S. Fish & Wildlife Service
Sacramento Fish & Wildlife Office
Federal Endangered and Threatened Species that Occur in or may be Affected by Projects in the Counties and/or U.S.G.S. 7 1/2 Minute Quads you requested

Document Number: 141222022932

Current as of: December 22, 2014

Quad Lists

CLARKSBURG (497A)
Listed Species

Invertebrates

Branchinecta conservatio
- Conservancy fairy shrimp (E)

Branchinecta lynchi
- vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
- valley elderberry longhorn beetle (T)

Lepidurus packardi
- vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
- green sturgeon (T) (NMFS)

Hypomesus transpacificus
- Critical habitat, delta smelt (X)
- delta smelt (T)

Oncorhynchus mykiss
- Central Valley steelhead (T) (NMFS)
- Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
- Central Valley spring-run chinook salmon (T) (NMFS)
- Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
- Critical habitat, winter-run chinook salmon (X) (NMFS)
- winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
- California tiger salamander, central population (T)

Rana draytonii
- California red-legged frog (T)

Reptiles

Thamnophis gigas
- giant garter snake (T)

Birds

Coccyzus americanus occidentalis

Western yellow-billed cuckoo (T)

RIO LINDA (512B)

Listed Species

Invertebrates

Branchinecta lynchi

vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus

valley elderberry longhorn beetle (T)

Lepidurus packardi

vernal pool tadpole shrimp (E)

Fish

Hypomesus transpacificus

delta smelt (T)

Oncorhynchus mykiss

Central Valley steelhead (T) (NMFS)

Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha

Central Valley spring-run chinook salmon (T) (NMFS)

winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense

California tiger salamander, central population (T)

Rana draytonii

California red-legged frog (T)

Reptiles

Thamnophis gigas

giant garter snake (T)

SACRAMENTO EAST (512C)

Listed Species

Invertebrates

Branchinecta lynchi

vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus

Critical habitat, valley elderberry longhorn beetle (X)

valley elderberry longhorn beetle (T)

Lepidurus packardi

vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris

green sturgeon (T) (NMFS)

Hypomesus transpacificus

delta smelt (T)

Oncorhynchus mykiss
- Central Valley steelhead (T) (NMFS)
- Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
- Central Valley spring-run chinook salmon (T) (NMFS)
- Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
- winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
- California tiger salamander, central population (T)

Rana draytonii
- California red-legged frog (T)

Reptiles

Thamnophis gigas
- giant garter snake (T)

Birds

Coccyzus americanus occidentalis
- Western yellow-billed cuckoo (T)

SACRAMENTO WEST (513D)
Listed Species

Invertebrates

Branchinecta lynchi
- vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
- valley elderberry longhorn beetle (T)

Lepidurus packardi
- vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
- green sturgeon (T) (NMFS)

Hypomesus transpacificus
- Critical habitat, delta smelt (X)
- delta smelt (T)

Oncorhynchus mykiss
- Central Valley steelhead (T) (NMFS)
- Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
- Central Valley spring-run chinook salmon (T) (NMFS)
- Critical Habitat, Central Valley spring-run chinook (X) (NMFS)
- Critical habitat, winter-run chinook salmon (X) (NMFS)
- winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
- California tiger salamander, central population (T)

Rana draytonii

California red-legged frog (T)

Reptiles

Thamnophis gigas

giant garter snake (T)

Birds

Coccyzus americanus occidentalis

Western yellow-billed cuckoo (T)

Vireo bellii pusillus

Least Bell's vireo (E)

County Lists

No county species lists requested.

Key:

(E) *Endangered* - Listed as being in danger of extinction.

(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.

(P) *Proposed* - Officially proposed in the Federal Register for listing as endangered or threatened.

(NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.

Critical Habitat - Area essential to the conservation of a species.

(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.

(C) *Candidate* - Candidate to become a proposed species.

(V) Vacated by a court order. Not currently in effect. Being reviewed by the Service.

(X) *Critical Habitat* designated for this species

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, **or may be affected by** projects within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.

Plants

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist and/or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list. See our Protocol and Recovery Permits pages.

For plant surveys, we recommend using the Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

Your Responsibilities Under the Endangered Species Act

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal.

> Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.

  During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.

- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.

  Should your survey determine that federally listed or proposed species occur in the area and are likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR 17.95). See our Map Room page.

Candidate Species

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Species of Concern

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern. However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts. More info

Wetlands

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6520.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be March 22, 2015.

Selected Elements by Scientific Name

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad is (Clarksburg (3812145))

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
Branchinecta lynchi vernal pool fairy shrimp	ICBRA03030	Threatened	None	G3	S2S3	
Buteo swainsoni Swainson's hawk	ABNKC19070	None	Threatened	G5	S3	
Carex comosa bristly sedge	PMCYP032Y0	None	None	G5	S2	2B.1
Coccyzus americanus occidentalis western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	G5T3Q	S1	
Hibiscus lasiocarpos var. occidentalis woolly rose-mallow	PDMAL0H0R3	None	None	G5T2	S2	1B.2
Juglans hindsii Northern California black walnut	PDJUG02040	None	None	G1	S1	1B.1
Lepidium latipes var. heckardii Heckard's pepper-grass	PDBRA1M0K1	None	None	G4T2	S2	1B.2
Lepidurus packardi vernal pool tadpole shrimp	ICBRA10010	Endangered	None	G3	S2S3	
Lilaeopsis masonii Mason's lilaeopsis	PDAPI19030	None	Rare	G2	S2	1B.1
Linderiella occidentalis California linderiella	ICBRA06010	None	None	G2G3	S2S3	
Melospiza melodia song sparrow ("Modesto" population)	ABPBXA3010	None	None	G5	S3?	SSC
Oncorhynchus mykiss irideus steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	G5T2Q	S2	
Pogonichthys macrolepidotus Sacramento splittail	AFCJB34020	None	None	G2	S2	SSC
Spirinchus thaleichthys longfin smelt	AFCHB03010	Candidate	Threatened	G5	S1	SSC
Taxidea taxus American badger	AMAJF04010	None	None	G5	S3	SSC
Thamnophis gigas giant garter snake	ARADB36150	Threatened	Threatened	G2	S2	
Trifolium hydrophilum saline clover	PDFAB400R5	None	None	G2	S2	1B.2
Xanthocephalus xanthocephalus yellow-headed blackbird	ABPBXB3010	None	None	G5	S3	SSC

Record Count: 18

Selected Elements by Scientific Name

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad is (Rio Linda (3812164))

Selected Elements by Scientific Name

California Department of Fish and Wildlife

California Natural Diversity Database

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
Agelaius tricolor tricolored blackbird	ABPBXB0020	None	Endangered	G2G3	S1S2	SSC
Ardea alba great egret	ABNGA04040	None	None	G5	S4	
Ardea herodias great blue heron	ABNGA04010	None	None	G5	S4	
Athene cunicularia burrowing owl	ABNSB10010	None	None	G4	S3	SSC
Branchinecta lynchi vernal pool fairy shrimp	ICBRA03030	Threatened	None	G3	S2S3	
Buteo swainsoni Swainson's hawk	ABNKC19070	None	Threatened	G5	S3	
Downingia pusilla dwarf downingia	PDCAM060C0	None	None	GU	S2	2B.2
Elanus leucurus white-tailed kite	ABNKC06010	None	None	G5	S3S4	FP
Emys marmorata western pond turtle	ARAAD02030	None	None	G3G4	S3	SSC
Fritillaria agrestis stinkbells	PMLIL0V010	None	None	G3	S3	4.2
Gratiola heterosepala Boggs Lake hedge-hyssop	PDSCR0R060	None	Endangered	G2	S2	1B.2
Legenere limosa legenere	PDCAM0C010	None	None	G2	S2	1B.1
Lepidurus packardi vernal pool tadpole shrimp	ICBRA10010	Endangered	None	G3	S2S3	
Linderiella occidentalis California linderiella	ICBRA06010	None	None	G2G3	S2S3	
Melospiza melodia song sparrow ("Modesto" population)	ABPBXA3010	None	None	G5	S3?	SSC
Northern Claypan Vernal Pool Northern Claypan Vernal Pool	CTT44120CA	None	None	G1	S1.1	
Northern Hardpan Vernal Pool Northern Hardpan Vernal Pool	CTT44110CA	None	None	G3	S3.1	
Oncorhynchus mykiss irideus steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	G5T2Q	S2	
Progne subis purple martin	ABPAU01010	None	None	G5	S3	SSC
Sagittaria sanfordii Sanford's arrowhead	PMALI040Q0	None	None	G3	S3	1B.2
Thamnophis gigas giant garter snake	ARADB36150	Threatened	Threatened	G2	S2	

Record Count: 21

Selected Elements by Scientific Name

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad is (Sacramento East (3812154))

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
Accipiter cooperii Cooper's hawk	ABNKC12040	None	None	G5	S4	WL
Ardea herodias great blue heron	ABNGA04010	None	None	G5	S4	
Athene cunicularia burrowing owl	ABNSB10010	None	None	G4	S3	SSC
Branchinecta lynchi vernal pool fairy shrimp	ICBRA03030	Threatened	None	G3	S2S3	
Buteo swainsoni Swainson's hawk	ABNKC19070	None	Threatened	G5	S3	
Desmocerus californicus dimorphus valley elderberry longhorn beetle	IICOL48011	Threatened	None	G3T2	S2	
Elanus leucurus white-tailed kite	ABNKC06010	None	None	G5	S3S4	FP
Elderberry Savanna Elderberry Savanna	CTT63440CA	None	None	G2	S2.1	
Lepidurus packardi vernal pool tadpole shrimp	ICBRA10010	Endangered	None	G3	S2S3	
Linderiella occidentalis California linderiella	ICBRA06010	None	None	G2G3	S2S3	
Melospiza melodia song sparrow ("Modesto" population)	ABPBXA3010	None	None	G5	S3?	SSC
Oncorhynchus mykiss irideus steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	G5T2Q	S2	
Progne subis purple martin	ABPAU01010	None	None	G5	S3	SSC
Riparia riparia bank swallow	ABPAU08010	None	Threatened	G5	S2	
Sagittaria sanfordii Sanford's arrowhead	PMALI040Q0	None	None	G3	S3	1B.2
Taxidea taxus American badger	AMAJF04010	None	None	G5	S3	SSC

Record Count: 16

Selected Elements by Scientific Name

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: Quad is (Sacramento West (3812155))

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
Agelaius tricolor tricolored blackbird	ABPBXB0020	None	Endangered	G2G3	S1S2	SSC
Archoplites interruptus Sacramento perch	AFCQB07010	None	None	G2G3	S1	SSC
Astragalus tener var. ferrisiae Ferris' milk-vetch	PDFAB0F8R3	None	None	G2T1	S1	1B.1
Athene cunicularia burrowing owl	ABNSB10010	None	None	G4	S3	SSC
Buteo swainsoni Swainson's hawk	ABNKC19070	None	Threatened	G5	S3	
Cicindela hirticollis abrupta Sacramento Valley tiger beetle	IICOL02106	None	None	G5TH	SH	
Desmocerus californicus dimorphus valley elderberry longhorn beetle	IICOL48011	Threatened	None	G3T2	S2	
Elderberry Savanna Elderberry Savanna	CTT63440CA	None	None	G2	S2.1	
Great Valley Cottonwood Riparian Forest Great Valley Cottonwood Riparian Forest	CTT61410CA	None	None	G2	S2.1	
Hibiscus lasiocarpos var. occidentalis woolly rose-mallow	PDMAL0H0R3	None	None	G5T2	S2	1B.2
Lasiurus cinereus hoary bat	AMACC05030	None	None	G5	S4	
Melospiza melodia song sparrow ("Modesto" population)	ABPBXA3010	None	None	G5	S3?	SSC
Oncorhynchus mykiss irideus steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	G5T2Q	S2	
Oncorhynchus tshawytscha chinook salmon - Central Valley spring-run ESU	AFCHA0205A	Threatened	Threatened	G5	S1	
Oncorhynchus tshawytscha chinook salmon - Sacramento River winter-run ESU	AFCHA0205B	Endangered	Endangered	G5	S1	
Pogonichthys macrolepidotus Sacramento splittail	AFCJB34020	None	None	G2	S2	SSC
Progne subis purple martin	ABPAU01010	None	None	G5	S3	SSC
Spirinchus thaleichthys longfin smelt	AFCHB03010	Candidate	Threatened	G5	S1	SSC
Symphyotrichum lentum Suisun Marsh aster	PDASTE8470	None	None	G2	S2	1B.2
Thamnophis gigas giant garter snake	ARADB36150	Threatened	Threatened	G2	S2	
Vireo bellii pusillus least Bell's vireo	ABPBW01114	Endangered	Endangered	G5T2	S2	

Record Count: 21

Appendix B

American River Common Features GRR SAM Analysis

ARCF GRR Project Reach SAM Analysis

1.0 Introduction

This document provides the background data, assumptions, analyses, and assessment of habitat compensation requirements for the following federally protected fish species considered by the Standard Assessment Methodology (SAM) as part of a pre-construction analysis for the ARCF project reaches.

Table 1. West Sacramento Project Focus Fish Species

Species/ESUs	Federal Status
Chinook salmon (*Oncorhynchus tshawytscha*)	
Central Valley spring-run ESU	Threatened
Central Valley fall-run ESU	Species of concern
Central Valley late fall-run ESU	Species of concern
Sacramento River winter-run ESU	Endangered
Central Valley steelhead DPS (*Oncorhynchus mykiss*)	Threatened
Delta smelt (*Hypomesus transpacificus*)	Threatened
Green sturgeon (*Acipenser medirostris*)	Threatened

The impact of project actions was assessed for each of these focus fish species only for reaches where Critical Habitat or Essential Fish Habitat has been identified. Although the ARCF GRR project reach is within a region critical to Delta smelt spawning, the species was excluded from this SAM analysis. Recent guidance from USFWS requires an alternative analysis (shallow water habitat assessment) for impacts to Delta smelt habitat. The alternative analysis focuses on quantifying impacts to potential spawning/ shallow water habitat.

Long-term effects of the ARCF GRR project reach on critical habitat and species responses to these effects were measured using the Standard Assessment Methodology (SAM) (USACE 2012). The SAM computations were performed using the SAM Electronic Calculation Template (ECT) Version 4.0 (April 2012) developed for the U.S. Army Corps of Engineers (USACE) and the Central Valley Flood Protection Board by Stillwater Sciences (USACE 2012). The SAM was used to quantify the responses of the target fish species and life stages to with-project conditions over a 50-year project period relative to the species and life stage responses under existing conditions. The following describes the data sources, methods, and assumptions used to characterize existing and with-project habitat conditions. The results of the SAM for each species, life stage, season of occurrence and target year, as applied to the ARCF GRR project reach, are presented below.

2.0 Project Description

The ARCF GRR project tentatively selected plan – Alternative 2 – Sacramento Bypass and Improve Levees, involves the construction of fix-in-place levee remediation measures throughout 17 sub-reaches to address seepage, stability, erosion, and height concerns identified for the American River levees, NEMDC, Arcade, Dry/Robla, and Magpie Creeks. The levees along the Sacramento River would be improved to address identified seepage, stability, erosion, and a minimal amount of height concerns.

Most height concerns along the Sacramento River would be addressed by a widening of the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass: American River North (ARN)(A-H), American River South (ARS)(A-G), Sacramento Bypass (SBP)(Figure 1). For this SAM analysis the 17sub-reaches were grouped into 3 SAM reaches based on hydrologic connectivity. The Sacramento River SAM analysis reach (SAC-SAM) includes the sub-reaches (ARS) (D-G). The American River SAM analysis reach (AMR-SAM) includes the sub-reaches (ARN) (A-H), and (ARS) (A-C). The Sacramento Bypass SAM analysis reach (SBP-SAM) includes the SBP sub-reach. Proposed repair actions for each sub-reach are presented below (Table 2).

Table 2. ARCF GRR Project Alternative 2 – Proposed Remediation Measures by Levee Sub-Reach.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River[1]	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall	Bank Protection	Sacramento Bypass and Weir Widening, Levee Raise
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall
Arcade Creek	Cutoff Wall	Cutoff Wall	---	Floodwall
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek[2]	---	---	---	Floodwall, Levee Raise

Notes: [1]American River seepage, stability, and overtopping measures were addressed in the American River Common Features, WRDA 1996 and 1999 construction projects.

[2]In addition to the Floodwall, Magpie Creek will include construction of a new levee along Raley Boulevard south of the creek, and construction of a detention basin on both sides of Raley Boulevard. In addition, some improvements would need to occur on Raley Boulevard, including widening of the Magpie Creek Bridge, raising the elevation of the roadway, and removing the Don Julio Creek culvert.

The ARCF GRR project reach will be implemented in increments. The timing of each project sub-reach (Table 3) is based on the proposed schedule provided in the Biological Assessment: American River Common Features General Reevaluation Report (USACE 2014).

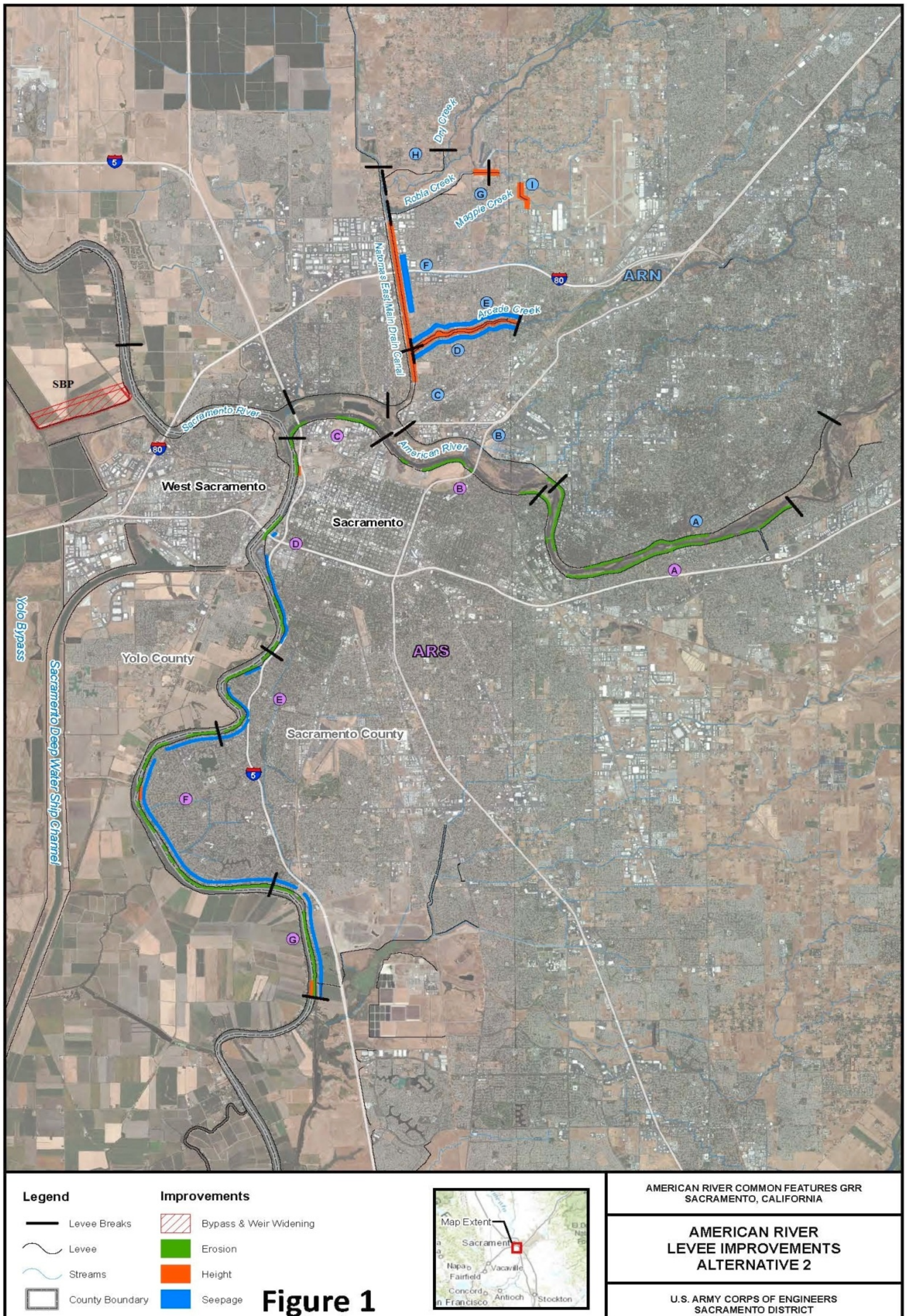
Dry Creek
Robla Creek
Magpie Creek
Natomas East Main Drain Canal
Arcade Creek
ARN
SBP
Sacramento River
American River
West Sacramento
Sacramento
ARS
Yolo County
Sacramento County
Yolo Bypass
Sacramento Deep Water Ship Channel
Legend
Levee Breaks
Levee
Streams
County Boundary
Improvements
Bypass & Weir Widening
Erosion
Height
Seepage
Map Extent
AMERICAN RIVER COMMON FEATURES GRR
SACRAMENTO, CALIFORNIA
AMERICAN RIVER
LEVEE IMPROVEMENTS
ALTERNATIVE 2
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

Figure 1

Table 3. ARCF GRR Project Alternative 2 – Construction Sequence and Duration

Priority	Construction Sequence	Reach	Construction Duration
1	Sacramento River	ARS F	5 years
2	Sacramento River	ARS E	3 years
3	American River	ARS A	4 years
4	Sacramento River	ARS G	3 years
5	Sacramento River	ARS D	3 years
6	American River	ARS B	2 years
7	American River	ARN A	4 years
8	American River	ARS C	3 years
9	American River	ARN B	2 years
10	Sacramento Weir & Bypass		4 years
11	Arcade Creek	ARN D	2 years
12	NEMDC	ARN F	2 years
13	Arcade Creek	ARN E	2 years
14	NEMDC	ARN C	2 years
15	Dry/Robla Creek	ARN G	3 years
16	Magpie Creek	ARN I	3 years

3.0 Characterization of Existing Conditions

Site specific project designs were unavailable for the ARCF GRR project reach at the time of this SAM analysis. In an effort to fairly assess the impacts of the project action, a "worst case scenario" approach was taken in applying the SAM analysis. The following data sources were used to characterize SAM habitat conditions (as defined by bank slope, floodplain availability, substrate size, instream structure, aquatic vegetation, and overhanging shade) within the ARCF GRR project area under existing or pre-project conditions:

USACE's Sacramento River revetment database – This database was used to stratify the project reach into subreaches that encompass relatively uniform bank conditions based on their general physical characteristics (USACE 2007). This database was used to characterize existing habitat conditions within individual subreaches where more recent data were unavailable.

Aerial images of the ARCF GRR project reach (Google™ Earth Pro), provided current and historical images of bank conditions that were used to address gaps or uncertainties related to existing cover characteristics within individual subreaches.

The SAM employs six habitat variables to characterize near-shore and floodplain habitats of listed fish species:

- *bank slope*—average bank slope of each average seasonal water surface elevation;
- *floodplain availability*—ratio of wetted channel and floodplain area during the 2-year flood, to the wetted channel area during average winter and spring flows;

- *bank substrate size*—the median particle diameter of the bank (i.e., D50) along each average seasonal water surface elevation;
- *instream structure*—percent of shoreline coverage of instream woody material along each average seasonal water surface elevation;
- *aquatic vegetation*—percent of shoreline coverage of aquatic or riparian vegetation along each average seasonal water surface elevation; and
- *overhanging shade*—percent of the shoreline coverage of shade along each average seasonal water surface elevation.

The following describes how input values for each of these attributes were derived for existing conditions in the SAM assessment.

3.1 Bank Slope

Existing bank slopes (rise-over-run ratio) were extrapolated from cross sections along the Sacramento River, American River, NEMDC, and existing SAM analyses performed on regionally analogous sites. Bank slope along all sub-reaches was assumed to be 2for existing conditions.

3.2 Floodplain Availability

The SAM attribute of floodplain inundation ratio, which represents floodplain availability, was assumed to have a value of 1, reflecting the absence of significant floodplain habitat above the winter-spring shoreline under existing conditions.

3.3 Bank Substrate Size

The median substrate size (D_{50}) along the summer-fall and winter-spring shorelines of the project reach was determined through by referencing the Revetment Database (USACE 2007) and current and historical aerial images. Sections of shoreline with natural substrate were assigned a D_{50} of 0.25 inches. Sections of shoreline with rock revetment were assigned a D_{50} of 10 inches.

3.4 Instream Structure

The shoreline coverage of Instream Woody Material (IWM) along the average summer-fall and winter-spring shorelines of the ARCF GRR project reach were determined by referencing the revetment database (USACE 2007). The revetment database uses four classes of instream structure, based on ranges of percent shoreline having IWM. Table 4 indicates how these revetment database attribute values were converted to a single value for input to SAM. These values were assumed to be appropriate for both the summer-fall and winter-spring seasons. For sub-reaches without available data, an estimate was based on shoreline conditions assessed from aerial images. Shorelines with dense riparian canopy were assigned 5% shoreline coverage of IWM. Shorelines without dense riparian canopy were assigned 0% shoreline coverage of IWM.

Table 4. Conversion of Revetment Database Instream Woody Material Classes to SAM Attribute Value for Instream Structure

Revetment Database IWM Class	SAM Input Value
None	0%
1 - 10%	5%
11 - 50%	30%
> 50%	75%

3.5 Aquatic Vegetation

The revetment database attribute for Emergent Vegetation was used for summer-fall aquatic vegetation characterization, and the Ground Cover attribute was used for winter-spring characterization. Within the ARCF GRR project reach, this approach generally gave a vegetation value of zero for summer-fall conditions, which is appropriate given the scarcity of emergent aquatic vegetation. Table 5 summarizes the conversion of revetment database attribute values for input to the SAM analysis.

Table 5. Conversion of Revetment Database Emergent Vegetation and Ground Cover Classes to SAM Attribute Values for Vegetation.

	Revetment Database IWM Class	SAM Input Value
Summer and Fall	False	0%
Revetment Database:	PEM 1 - 5%	3%
"Emergent Vegetation" Attribute	PEM 6 - 25%	15%
	PEM 26 – 75%	50%
	PEM >75%	85%
Winter and Spring	<25%	13%
Revetment Database:	26-50%	38%
"Ground Cover" Attribute	51-75%	63%
	>75%	88%

3.6 Overhanging Shade

The extent of overhanging shade along the summer-fall and winter-spring shorelines was determined through analysis of current and historic aerial images. Summer-fall conditions were analyzed using imagery from late summer and early fall months, typically representative of low water conditions. Winter-spring conditions were analyzes using imagery from late winter and early spring months, typically representative of high water conditions. Values for overhanging shade at winter and spring habitat conditions were modified by factors of 0.25 and 0.75 respectively to account for seasonal defoliation.

4.0 Characterization of With-Project Conditions

As previously stated, specific project designs were not available at the time of this analysis for the ARCF GRR project reach. The with-project conditions were characterized using the project description outlined for Alternative 2 in the Biological Assessment: American River Common Features General Reevaluation Report (USACE 2014). Similar to the assessment of existing conditions, with-project conditions were developed with "worst case scenario" assumptions. With-project conditions for the SAC and AMR sub-reaches were assumed to be analogous to a typical Sacramento River Bank Protection Project (SRBPP) repair site (bank armoring paired with onsite mitigative features including a planted riparian bench and installed IWM). A Vegetation Variance Request (VVR) was assumed to be in place for the SAC SAM and AMR SAM sub-reaches. Project actions along the SBP were assumed to result in removal of all woody and herbaceous vegetation.

The following describes how input values for each of the SAM habitat attributes were derived for with-project conditions:

4.1 Bank Slope

With-project bank slopes (rise-over-run ratio) were based on the description of project actions for each sub-reach. Bank slopes for the SAC and AMR sub-reaches were assumed to be analogous to SRBPP repair sites with a summer-fall slope of 2.5 and winter-spring slope of 10. Project actions at all other sub-reaches were not expected to result in any change to bank slope; therefore, bank slope for with-project conditions was assumed to be 2.5.

4.2 Floodplain Availability

Levee repair and bank stabilization actions typically do not increase floodplain availability (with exception of constructing setback levees). The ARCF GRR project reaches being analyzed under this SAM do not include construction of any setback levees; therefore, the SAM attribute of floodplain inundation ratio, which represents floodplain availability, was assumed to have a value of 1, reflecting the absence of significant floodplain habitat above the winter-spring shoreline under existing conditions.

4.3 Bank Substrate Size

The median substrate size (D_{50}) along the summer-fall and winter-spring shorelines of the project reach were based on the description of project actions for each sub-reach. Bank substrate size along the SAC and AMR sub-reaches were assumed to be analogous to SRBPP repair sites (10 inch rock revetment at summer-fall shoreline and 0.25 inch natural substrate at winter-spring shoreline).

4.4 Instream Structure

The shoreline coverage of Instream Woody Material (IWM) along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. IWM coverage along the AMR sub-reach was assumed to be analogous to SRBPP repair sites (installation of 40% shoreline coverage at summer-fall shoreline). Project actions at all other sub-reaches were not expected to result in a change in available IWM along both summer-fall and winter-spring shorelines; IWM values for these sub-reaches will mirror existing condition values.

4.5 Aquatic Vegetation

The shoreline coverage of aquatic vegetation along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. Aquatic vegetation along the SAC and AMR sub-reaches were assumed to be analogous to SRBPP repair sites. The vegetation growth models below applied to the SAC,AMR sub-reaches were taken from previous SAM analysis' conducted for Sac RM 62.5R (USACE, 2008). Relevant O&M activities were considered but excluded from this analysis. The assumed vegetation variance would apply to woody vegetation only and O&M activities would be expected to result in the removal of shrubs on the slope of the levee; however, it was assumed that typical SRBPP repair designs would locate the planted riparian bench at appropriate elevations and distance from the levee to allow for revegetation efforts. Any removal of shrubby vegetation as the result of O&M activities would take place above the winter/spring seasonal shoreline. The SAM analysis focuses on habitat attributes at and below the seasonal shoreline, therefore, removal of any shrubby vegetation above the winter/spring shoreline would not be considered in the analysis.

4.6 Overhanging Shade

The shoreline coverage of overhanging shade along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. Overhanging shade along the SAC and AMR sub-reaches were assumed to be analogous to SRBPP repair sites. It was assumed that a variance would be in place allowing for retention of woody vegetation along the lower 2/3 of the levee slope (applies to SAC and AMR sub-reaches only). As the result of constructing a planted bench, it was assumed that the with-project seasonal shoreline would be shifted away from the existing shade providing canopy. Under this assumption, existing summer-fall values for overhanging shade were taken as the starting point for with-project winter-spring conditions. The with-project winter-spring values were further reduced by 75% (winter) and 25% (spring) to account for defoliation. As a final step, these winter-spring values were reduced by 20% to account for trees removed for construction equipment access. With-project overhanging shade values were expected to start at 0% as the result of a constructed bench shifting the shoreline away from the existing canopy. The shade growth models below were applied to the starting seasonal values for overhanging shade described above along the SAC and AMR sub-reaches. This shade growth models were taken from previous SAM analysis' conducted for Sac RM 62.5R and FR 7.0L (USACE, 2008).

5.0 SAM Results

As described above, the ARCF GRR project sub-reaches were grouped into three SAM analysis reaches based on hydrologic connectivity. The SAM results presented below are based on a "worst case scenario" analysis. Following the procedures outlined in the SAM Users Manual (USACE 2012), the electronic calculation template (ECT version 4.0) was used to quantify the responses of the focus fish species and life stages to with-project conditions; the ECT uses a 50-year assessment timeline with baseline habitat values for each species and life stage described by pre-project conditions. The ECT was used to calculate a time series of the relative response indices for each pre-project and with-project scenario developed above. Relative response indices are weighted by project bankline and wetted area. This analysis includes only bankline weighted results as available information was insufficient to calculate wetted area except for the SBP SAM reach. Biological responses of each focus fish species life stage were predicted within each habitat unit and for each time step, based on habitat variable values and fish residency determined from region-specific timing tables (USACE 2012). The ECT automatically includes or excludes particular life stages of the focus fish by assessing the river mile locations of each bank repair site, with the encoded timing tables. In general, as calculated using the ECT, positive differences between the existing and with-project responses are assessed as a net benefit for the focus fish species (i.e., the bank repair action produced superior conditions than pre-project conditions). Negative differences indicate the bank repair actions produced inferior conditions when compared with pre-project conditions; they generally require additional habitat compensation.

Although the SAM ECT produces relative response indices which are not directly representative of actual lengths or areas, USACE has used those values to determine mitigative requirements. Deficits are evaluated for the juvenile life stages (spawning and egg incubation, fry and juvenile rearing, and juvenile migration) of focus fish species. The identification of maximum deficits is focused on the adequate mitigation of impacts to juvenile life stages of focus fish species within the recommended recovery periods (USACE 2012). Recommended recovery periods are 5 years for Chinook salmon, 4 years for steelhead, and 3 years for Green sturgeon (USACE 2012). By mitigating for the maximum deficit, lesser impacts are expected to be appropriately mitigated. Steelhead, Chinook, and juvenile life stages of Green sturgeon have similar habitat requirements and mitigating for the maximum deficit for either species is expected to fulfill mitigative requirements for the other. Habitat deficits may vary in magnitude between seasons. As a general rule, the SAM applies any habitat characteristics at summer/fall conditions to winter/spring conditions with the assumption that those characteristics would provide similar value during inundation. Onsite mitigation at summer/fall conditions is expected to provide similar mitigative values for winter/spring conditions. Offsite mitigation is expected to provide mitigative value at all seasonal habitat conditions. These variations in seasonal habitat values are taken into consideration when determining maximum habitat deficits to ensure that a single value can be identified to satisfy mitigative requirements.

5.1 Sacramento River SAM Analysis (ARS D-G)

The Sacramento River SAM analysis reach includes the entire left bank (east side) of the Sacramento River from the American River confluence to approximately 4,020 linear feet (lf) below the Freeport Bridge. The response of all runs of Chinook salmon, Steelhead, and Green sturgeon were included in the analysis of this reach.

5.1.1 Spring/ Fall/ Late-Fall/ Winter Run Chinook Salmon

Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River SAM analysis reach over the lifetime of the project. Chinook salmon should exhibit a positive response by year 5. Short term habitat deficits are expected within the recommended recovery period for Chinook salmon. The maximum habitat deficit identified is -1,440 ft for the juvenile migration life stage of Spring-run Chinook salmon in the summer of year 10. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions.

5.1.2 Steelhead

Steelhead are expected to show a long term positive response to project actions in the Sacramento River SAM analysis reach over the lifetime of the project. Steelhead should exhibit a positive response by year 5. Short term habitat deficits are expected within the recommended recovery period for Steelhead. The maximum habitat deficit identified is -1,330 ft for the juvenile migration life stage of Steelhead in the fall of year 11. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions.

5.1.3 Green Sturgeon

Project actions in the Sacramento River SAM analysis reach will mimic SRBPP repair site onsite mitigative features. SRBPP onsite mitigative features were designed to maximize habitat response for salmonid species; Green sturgeon will exhibit a negative response to these onsite mitigative features. Green sturgeon are expected to show long term negative response to project actions in the Sacramento River SAM analysis reach for the fry and juvenile rearing life stages in the winter and spring over the lifetime of the project. The maximum habitat deficit identified is -3,015 ft for the spawning and egg incubation life stage of Green sturgeon in the summer of year 50. Habitat deficits displayed a general trend toward increasing beyond the lifetime of the project. Habitat deficits for adult life stages will result from the creation of a 10:1 planted bench at winter/spring habitat conditions. Habitat deficits for larval/fry and spawning/ egg life stages will result from the change in substrate at summer/fall (rock revetment) and at winter/spring (natural) habitat conditions.

5.2 American River SAM Analysis (ARN A-B and ARS A-C)

The American River SAM analysis (ARN A-B and ARS A-C)reaches include portions of the right and left bank of the American River from Goethe Park to the confluence of the Sacramento. It also includes portions of NEMDC, Arcade Creek, Magpie Creek, and Dry/Robla Creek. The response of all runs of Chinook salmon, Steelhead, and Green sturgeon were included in the analysis of this reach.

5.2.1 Spring/ Fall/ Late-Fall/ Winter Run Chinook Salmon

Chinook salmon are expected to show a long term positive response to project actions in the American River SAM analysis reach over the lifetime of the project when both IWM and wetland benches are incorporated into the with project conditions. Chinook salmon should exhibit a positive response by year 5. Short term habitat deficits are expected within the recommended recovery period for Chinook salmon. The maximum habitat deficit identified is -3 ft for the juvenile migration life stage of Spring and Fall-run Chinook salmon in the summer and fall of year 5. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions.

5.2.2 Steelhead

Steelhead are expected to show a long term positive response to project actions in the American River SAM analysis reach over the lifetime of the project. Steelhead should exhibit a positive response by year 3. Short term habitat deficits are expected within the recommended recovery period for Steelhead. The maximum habitat deficit identified is -106 ft for the juvenile migration life stage of Steelhead in the spring of year 0. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions.

5.3 American River SAM Analysis (ARN C-G,I)

The American River SAM analysis (ARN C-G,I) reaches includes portions of NEMDC, Arcade Creek, Magpie Creek, and Dry/Robla Creek. The response of all runs of Chinook salmon and Steelhead were included in the analysis of this reach.

5.3.1 Spring/ Fall/ Late-Fall/ Winter Run Chinook Salmon

Chinook salmon are expected to show a long term positive response to project actions in the American River SAM (ARN C-G,I) analysis reach over the lifetime of the project. Chinook salmon should exhibit a positive response by year 5. Short term habitat deficits are expected within the recommended recovery period for Chinook salmon. The maximum habitat deficit identified is -57 ft for the adult migration life stage of Fall-run Chinook salmon in the fall of year 11. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions.

5.3.2 Steelhead

Steelhead are expected to show a long term positive response to project actions in the American River SAM (ARN C-G,I) analysis reach over the lifetime of the project. Steelhead should exhibit a positive response by year 4. The maximum habitat deficit identified is -86 ft for the adult residence and adult migration life stages of Steelhead in the fall and summer of year 10.

5.4 Sacramento Bypass SAM Analysis (SBP)

The Sacramento Bypass SAM analysis reach includes the right bank (north side) of the Sacramento Bypass levee in its entirety from the confluence of the Sacramento River to its termination at the Yolo Bypass. The response of all runs of Chinook salmon, Steelhead, and Green sturgeon were included in the analysis of this reach.

5.4.1 Spring/ Fall/ Late-Fall/ Winter Run Chinook Salmon

Chinook salmon are expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Chinook salmon should exhibit a negative response by year 1. The maximum habitat deficit identified is -188 ft for the juvenile migration life stage of Spring and Winter-run Chinook salmon in the spring of year 2. Short term and long term habitat deficits will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir.

5.4.2 Steelhead

Steelhead are also expected to show a small long term negative response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project. Steelhead should exhibit a negative response by year 1. The maximum habitat deficit identified is -174 ft for the juvenile migration life stage in the spring of year 2. Short term and long term habitat deficits will result from the loss of aquatic vegetation and over hanging shade at fall/summer/winter/spring habitat conditions during and after the construction of the extension to the Sacramento Bypass Weir.

5.4.3 Green Sturgeon

Green Sturgeon are expected to show a long term positive response to project actions in the Sacramento Bypass SAM analysis reach over the lifetime of the project for the fry and juvenile rearing life stages in the winter/spring/summer/fall of year 1. The maximum habitat deficit identified is -8 ft for the adult residence life stage of Green Sturgeon in the winter/spring/summer of year 1 which carries over through the life of the project into year 50.

6.0 Discussion

The SAM analysis indicates that the repairs in the Sacramento River SAM analysis reach, American River SAM analysis reach, and the Sacramento Bypass SAM analysis reach would result in short and longer-term impacts for focus fish species.

6.1 Chinook Salmon

Impacts to Chinook salmon were analyzed for the Sacramento River SAM analysis reach, American River SAM analysis reach, and the Sacramento Bypass SAM analysis reach. In the Sacramento River SAM analysis reach, habitat deficits are due to short term removal of aquatic vegetation and overhanging shade caused by the repair action. The SAM analysis indicates that repair actions would result in a maximum habitat deficit of -1,440 ft. This value is based on the maximum deficit observed for juvenile migration of Chinook salmon in the spring of year 10. USACE will mitigate for -1,440 ft of equivalent habitat through additional onsite mitigation, purchase of mitigative credits, or development of suitable created aquatic habitat.

In the American River SAM analysis reaches ARN A-B and ARS A-C habitat deficits are due to short term removal of aquatic vegetation and overhanging shade caused by the repair action. The SAM analysis incorporating wetland benches and IWM indicates that repair actions would result in a maximum habitat deficit of -3 ft. This value is based on the maximum deficit observed for fry and juvenile rearing of Chinook salmon in the fall and summer of year 5. USACE will mitigate for -3 ft of equivalent habitat through additional onsite mitigation, purchase of mitigative credits, or development of suitable created aquatic habitat.

In the American River SAM analysis reaches ARN C-G and I habitat deficits are due to short term removal of aquatic vegetation and overhanging shade caused by the repair action. The SAM analysis indicates that repair actions would result in a maximum habitat deficit of -86 ft. This value is based on the maximum deficit observed for adult residence and migration of Chinook salmon in the fall and summer of year 10. USACE will mitigate for -86 ft of equivalent habitat through additional onsite mitigation, purchase of mitigative credits, or development of suitable created aquatic habitat.

In the Sacramento Bypass SAM analysis reach habitat deficits are due to short and long term removal of aquatic vegetation and overhanging shade for the upstream extension of the Sacramento Bypass Weir. The SAM analysis indicates that repair and removal actions would result in a maximum habitat deficit of -146 ft. This value is based on the maximum deficit observed for juvenile migration of Chinook salmon in the winter of year 1. USACE will mitigate for -146 ft of equivalent habitat through additional onsite mitigation, purchase of mitigative credits, or development of suitable created aquatic habitat.

6.2 Steelhead

Impacts to Steelhead were analyzed for the Sacramento River SAM analysis reach, American River SAM analysis reach, and the Sacramento Bypass SAM analysis reach. The Sacramento River SAM analysis indicates that repair actions would result in maximum habitat deficits of -1,330 ft. This value is based on the maximum deficit observed for the juvenile migration life stage of Steelhead in the fall of year 11. This deficit is expected to be adequately compensated through mitigation of a greater deficit for Chinook salmon.

The American River SAM analysis ARN A-B and ARS A-C indicates that repair actions would result in no habitat deficits if wetland benches and IWM were incorporated into with project conditions.

The American River SAM analysis ARN C-G and I indicates that repair actions would result in maximum habitat deficits of -86 ft. This value is based on the maximum deficit observed for the adult migration and residence life stages of Steelhead in the fall and summer of year 10. This deficit is expected to be adequately compensated through mitigation of a greater deficit for Chinook salmon.

The Sacramento Bypass SAM analysis indicates that repair actions would result in maximum habitat deficits of -174 ft. This value is based on the maximum deficit observed for the juvenile migration life stage of Steelhead in the spring of year 4. This deficit is expected to be adequately compensated through mitigation of a greater deficit for Chinook salmon.

6.3 Green Sturgeon

Impacts to Green sturgeon were analyzed for the Sacramento River SAM and Sacramento Bypass analysis reaches. Although the Sacramento River SAM analysis indicates long term habitat deficits, USACE does not expect significant impacts to the Green sturgeon. The SAM indicated a maximum deficit of -3,015 ft for the spawning & egg incubation life stage in response to installation of fine substrate (natural) at winter/spring habitat conditions and to the installation of course substrate (10 inch rock revetment) at summer/fall habitat conditions. This value is based on the maximum deficit observed for larval & egg incubation life stage of Green sturgeon at summer conditions of year 50. A maximum deficit of -2,466 ft is expected for the larval, fry, & juvenile rearing and juvenile migration life stages in response to installation of fine substrate (natural) at winter/spring habitat conditions and to the installation of course substrate (10 inch rock revetment) at summer/fall habitat conditions. This value is based on the maximum deficit observed for fry & juvenile rearing life stage of Green sturgeon at winter/spring conditions of year 50.

The Sacramento Bypass SAM analysis indicates that repair actions would result in maximum habitat deficits of -8 ft in response to the removal of aquatic vegetation and SRA for the expansion of the Sacramento Bypass and Weir. This value is based on the maximum deficit observed for the adult residence life stage of Green sturgeon in the winter/spring /summer of year 1 continuing through the life of the project to year 50..

The habitat requirements of Green sturgeon are not well understood; assumptions built into the SAM on fish response to shoreline features were based on limited information. Habitat use of the Sacramento River and Sacramento Bypass project reaches by Green sturgeon are likely limited to use as a migration corridor by adults and potential rearing area by juvenile life stages. Although the SAM indicates negative response to habitat by adult life stages, it is unlikely that shoreline repair activities would significantly impact the river for residence or as a migration corridor. SRBPP style repairs are designed to mimic naturally occurring habitat types and are not expected to significantly alter the width of the river. USACE does not expect any significant impacts to the adult residence or adult migration life stages and does not propose any additional mitigation.

Although the SAM indicates negative response to habitat by the spawning & egg incubation life stage, no suitable spawning habitat exists in the Sacramento River and Sacramento Bypass project reaches. Green sturgeon spawning primarily takes place upriver of Colusa on the Sacramento River and in the lower Feather River. Because no suitable spawning habitat is present in the project reaches under existing conditions, USACE does not expect any significant impacts to the spawning & egg incubation life stage of Green sturgeon and does not propose any additional mitigation.

Little is known about the fry & juvenile rearing and juvenile migration life stages of Green sturgeon. The SAM does not evaluate response to specific habitat attributes for the juvenile migration life stage. For the purpose of this analysis it is assumed that these life stages exhibit similar responses to analogous life stages of Chinook and Steelhead. This approach assumes that fry & juvenile rearing and juvenile migration life stages of Green sturgeon will exhibit a positive response to “good riparian habitat” (i.e. increased shoreline coverage of overhanging shade, aquatic vegetation, and IWM). Although the SAM indicates that fry & juvenile rearing and juvenile migration life stages will exhibit a negative response to with-project conditions, short term deficits are expected to be offset by mitigation for Chinook and Steelhead. Long term deficits are expected to be lower than, and therefore offset by, long term habitat benefits expected for Chinook and Steelhead. USACE does not propose any additional mitigation.

Table 6
SAM data summary of existing conditions at site American River ARN A-B.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2024				
	2074				
Wetted Area (square feet)	2024	1	1	1	1
	2074	1	1	1	1
Shoreline Length (feet) [1]	2024	18,576	18,576	18,576	18,576
	2074	18,576	18,576	18,576	18,576
Bank Slope (dH:dV) [2]	2024	2	2	2	2
	2074	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2024	1	1	1	1
	2074	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2024	2.5	2.5	2.5	2.5
	2074	2.5	2.5	2.5	2.5
Instream Structure (% shoreline) [5]	2024	31	31	31	31
	2074	31	31	31	31
Vegetation (% shoreline) [6]	2024	0	88	88	0
	2074	0	88	88	0
Shade (% shoreline) [7]	2024	60	15	45	60
	2074	60	15	45	60

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 7
SAM data summary of with-project conditions at site American River ARN A-B.

Habitat Parameter	Water Year	Seasonal Values: Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2024				
	2074				
Wetted Area (square feet)	2024	1	1	1	1
	2074	1	1	1	1
Shoreline Length (feet) [1]	2024	18,576	18,576	18,576	18,576
	2074	18,576	18,576	18,576	18,576
Bank Slope (dH:dV) [2]	2024	2.5	2.5	2.5	2.5
	2025	2.5	2.5	2.5	2.5
	2074	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2024	1	1	1	1
	2074	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2024	10	0.25	0.25	10
	2025	10	0.25	0.25	10
	2074	10	0.25	0.25	10
Instream Structure (% shoreline) [5]	2024	31	0	0	0
	2025	40	40	40	40
	2074	40	40	40	40
Vegetation (% shoreline) [6]	2024	0	0	0	0
	2025	25	50	50	50
	2029	90	90	90	90
	2039	100	100	100	100
	2049	100	100	100	100
	2074	100	100	100	100
Shade (% shoreline)	2024	0	13	38	0
	2025	0	13	40	0
	2029	0	25	75	0
	2039	100	25	75	100
	2049	100	25	75	100
	2074	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.

[4] Assume installation of rock revetment. D50 of 10 inches.
[5] Assume change in instream structure recruitment with addition of IWM.
[6] Assume woody or herbaceous revegetation efforts with addition of wetland bench.

Table 8
SAM data summary of existing conditions at site American River ARS A.

Habitat Parameter	Water Year	Seasonal Values: Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2020				
	2070				
Wetted Area (square feet)	2020	1	1	1	1
	2070	1	1	1	1
Shoreline Length (feet) [1]	2020	14,345	14,345	14,345	14,345
	2070	14,345	14,345	14,345	14,345
Bank Slope (dH:dV) [2]	2020	2	2	2	2
	2070	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2020	1	1	1	1
	2070	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2020	1.2	1.2	1.2	1.2
	2070	1.2	1.2	1.2	1.2
Instream Structure (% shoreline) [5]	2020	1.7	1.7	1.7	1.7
	2070	1.7	1.7	1.7	1.7
Vegetation (% shoreline) [6]	2020	0	63	63	0
	2070	0	63	63	0
Shade (% shoreline) [7]	2020	42	11	32	42
	2070	42	11	32	42

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 9
SAM data summary of with-project conditions at site American River ARS A with IWM and WB.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2020				
	2070				
Wetted Area (square feet)	2020	1	1	1	1
	2070	1	1	1	1
Shoreline Length (feet) [1]	2020	14,345	14,345	14,345	14,345
	2070	14,345	14,345	14,345	14,345
Bank Slope (dH:dV) [2]	2020	2.5	2.5	2.5	2.5
	2021	2.5	2.5	2.5	2.5
	2070	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2020	1	1	1	1
	2070	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2020	10	0.25	0.25	10
	2021	10	0.25	0.25	10
	2070	10	0.25	0.25	10
Instream Structure (% shoreline) [5]	2020	1.7	0	0	0
	2021	40	40	40	40
	2070	40	40	40	40
Vegetation (% shoreline) [6]	2020	0	0	0	0
	2021	25	50	50	50
	2025	90	90	90	90
	2035	100	100	100	100
	2045	100	100	100	100
	2070	100	100	100	100
Shade (% shoreline)	2020	0	9	27	0
	2021	0	9	29	0
	2025	0	24	74	0
	2035	100	25	75	100
	2045	100	25	75	100
	2070	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.
[4] Assume installation of rock revetment. D50 of 10 inches.
[5] Assume change in instream structure recruitment with addition of IWM.
[6] Assume woody or herbaceous revegetation efforts with addition of wetland bench.

Table 10
SAM data summary of existing conditions at site American River ARS B.

Habitat Parameter	Water Year	Seasonal Values: Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2023				
	2073				
Wetted Area (square feet)	2023	1	1	1	1
	2073	1	1	1	1
Shoreline Length (feet) [1]	2023	5,472	5,472	5,472	5,472
	2073	5,472	5,472	5,472	5,472
Bank Slope (dH:dV) [2]	2023	2	2	2	2
	2073	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2023	1	1	1	1
	2073	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2023	1.5	1.5	1.5	1.5
	2073	1.5	1.5	1.5	1.5
Instream Structure (% shoreline) [5]	2023	5	5	5	5
	2073	5	5	5	5
Vegetation (% shoreline) [6]	2023	0	65	65	0
	2073	0	65	65	0
Shade (% shoreline) [7]	2023	30	7	22	30
	2073	30	7	22	30

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 11
SAM data summary of with-project conditions at site American River ARS B with IWM and WB.

Habitat Parameter	Water Year	Seasonal Values Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2023				
	2073				
Wetted Area (square feet)	2023	1	1	1	1
	2073	1	1	1	1
Shoreline Length (feet) [1]	2023	5,472	5,472	5,472	5,472
	2073	5,472	5,472	5,472	5,472
Bank Slope (dH:dV) [2]	2023	2.5	2.5	2.5	2.5
	2024	2.5	2.5	2.5	2.5
	2073	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2023	1	1	1	1
	2073	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2023	10	0.25	0.25	10
	2024	10	0.25	0.25	10
	2073	10	0.25	0.25	10
Instream Structure (% shoreline) [5]	2023	5	0	0	0
	2024	40	40	40	40
	2073	40	40	40	40
Vegetation (% shoreline) [6]	2023	0	0	0	0
	2024	25	50	50	50
	2028	90	90	90	90
	2038	100	100	100	100
	2048	100	100	100	100
	2073	100	100	100	100
Shade (% shoreline)	2023	0	7	20	0
	2024	0	7	22	0
	2028	0	22	67	0
	2038	100	25	75	100
	2048	100	25	75	100
	2073	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.
[4] Assume installation of rock revetment. D50 of 10 inches.
[5] Assume change in instream structure recruitment with addition of IWM.
[6] Assume woody or herbaceous revegetation efforts with addition of wetland bench.

Table 12
SAM data summary of existing conditions at site American River ARS C.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2026				
	2076				
Wetted Area (square feet)	2026	1	1	1	1
	2076	1	1	1	1
Shoreline Length (feet) [1]	2026	3,988	3,988	3,988	3,988
	2076	3,988	3,988	3,988	3,988
Bank Slope (dH:dV) [2]	2026	2	2	2	2
	2076	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2026	1	1	1	1
	2076	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2026	0.25	0.25	0.25	0.25
	2076	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [5]	2026	5	5	5	5
	2076	5	5	5	5
Vegetation (% shoreline) [6]	2026	0	88	88	0
	2076	0	88	88	0
Shade (% shoreline) [7]	2026	67	16	50	67
	2076	67	16	50	67

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).

[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 13
SAM data summary of with-project conditions at site American River ARS C with IWM and WB.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2026				
	2076				
Wetted Area (square feet)	2026	1	1	1	1
	2076	1	1	1	1
Shoreline Length (feet) [1]	2026	3,988	3,988	3,988	3,988
	2076	3,988	3,988	3,988	3,988
Bank Slope (dH:dV) [2]	2026	2.5	2.5	2.5	2.5
	2027	2.5	2.5	2.5	2.5
	2076	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2026	1	1	1	1
	2076	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2026	10	0.25	0.25	10
	2027	10	0.25	0.25	10
	2076	10	0.25	0.25	10
Instream Structure (% shoreline) [5]	2026	5	0	0	0
	2027	40	40	40	40
	2076	40	40	40	40
Vegetation (% shoreline) [6]	2026	0	0	0	0
	2027	25	50	50	50
	2031	90	90	90	90
	2041	100	100	100	100
	2051	100	100	100	100
	2076	100	100	100	100
Shade (% shoreline)	2026	0	14	42	0
	2027	0	14	44	0
	2031	0	25	75	0

	2041	100	25	75	100
	2051	100	25	75	100
	2076	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.
[4] Assume installation of rock revetment. D50 of 10 inches.
[5] Assume change in instream structure recruitment with addition of IWM.
[6] Assume woody or herbaceous revegetation efforts with addition of wetland bench.

Table 14
SAM data summary of existing conditions at site Sacramento River ARS D.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2025				
	2075				
Wetted Area (square feet)	2025	1	1	1	1
	2075	1	1	1	1
Shoreline Length (feet) [1]	2025	9,131	9,131	9,131	9,131
	2075	9,131	9,131	9,131	9,131
Bank Slope (dH:dV) [2]	2025	1.8	1.8	1.8	1.8
	2075	1.8	1.8	1.8	1.8
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2025	1	1	1	1
	2075	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2025	7.6	7.6	7.6	7.6
	2075	7.6	7.6	7.6	7.6
Instream Structure (% shoreline) [5]	2025	22	22	22	22
	2075	22	22	22	22
Vegetation (% shoreline) [6]	2025	0	88	88	0
	2075	0	88	88	0
Shade (% shoreline) [7]	2025	40	10	30	40
	2075	40	10	30	40

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 15
SAM data summary of with-project conditions at site Sacramento River ARS D.

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2025				
	2075				
Wetted Area (square feet)	2025	1	1	1	1
	2075	1	1	1	1
Shoreline Length (feet) [1]	2025	9,131	9,131	9,131	9,131
	2075	9,131	9,131	9,131	9,131
Bank Slope (dH:dV) [2]	2025	2.5	2.5	2.5	2.5
	2026	2.5	2.5	2.5	2.5
	2075	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2025	1	1	1	1
	2075	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2025	10	0.25	0.25	10
	2026	10	0.25	0.25	10
	2075	10	0.25	0.25	10
Instream Structure (% shoreline) [5]	2025	22	0	0	0
	2026	40	40	40	40
	2075	40	40	40	40
Vegetation (% shoreline)	2025	0	0	0	0
	2026	0	50	50	0
	2030	0	88	88	0
	2040	0	88	88	0
	2050	0	88	88	0
	2075	0	88	88	0

Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Shade (% shoreline)	2025	0	8	24	0
	2026	0	8	25	0
	2030	0	9	35	0
	2040	100	13	73	100
	2050	100	20	75	100
	2075	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.
[4] Assume installation of rock revetment. D50 of 10 inches.
[5] Assume change in instream structure recruitment with addition of IWM.

Table 16
SAM data summary of existing conditions at site Sacramento River ARS E.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2021				
	2071				
Wetted Area (square feet)	2021	1	1	1	1
	2071	1	1	1	1
Shoreline Length (feet) [1]	2021	9,149	9,149	9,149	9,149
	2071	9,149	9,149	9,149	9,149
Bank Slope (dH:dV) [2]	2021	1.7	1.7	1.7	1.7
	2071	1.7	1.7	1.7	1.7
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2021	1	1	1	1
	2071	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2021	7	7	7	7
	2071	7	7	7	7
Instream Structure (% shoreline) [5]	2021	30	30	30	30
	2071	30	30	30	30
Vegetation (% shoreline) [6]	2021	0	88	88	0
	2071	0	88	88	0
Shade (%	2021	60	15	45	60

shoreline) [7]	2071	60	15	45	60

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 17
SAM data summary of with-project conditions at site Sacramento River ARS E.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2021				
	2071				
Wetted Area (square feet)	2021	1	1	1	1
	2071	1	1	1	1
Shoreline Length (feet) [1]	2021	9,149	9,149	9,149	9,149
	2071	9,149	9,149	9,149	9,149
Bank Slope (dH:dV) [2]	2021	2.5	2.5	2.5	2.5
	2022	2.5	2.5	2.5	2.5
	2071	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2021	1	1	1	1
	2071	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2021	10	0.25	0.25	10
	2022	10	0.25	0.25	10
	2071	10	0.25	0.25	10
Instream Structure (% shoreline) [5]	2021	30	0	0	0
	2022	40	40	40	40
	2071	40	40	40	40
Vegetation (% shoreline)	2021	0	0	0	0
	2022	0	50	50	0
	2026	0	88	88	0
	2036	0	88	88	0
	2046	0	88	88	0

	2071	0	88	88	0
Shade (% shoreline)	2021	0	12	36	0
	2022	0	12	37	0
	2026	0	13	47	0
	2036	100	17	75	100
	2046	100	24	75	100
	2071	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.
[4] Assume installation of rock revetment. D50 of 10 inches.
[5] Assume change in instream structure recruitment with addition of IWM.

Table 18
SAM data summary of existing conditions at site Sacramento River ARS F.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2020				
	2070				
Wetted Area (square feet)	2020	1	1	1	1
	2070	1	1	1	1
Shoreline Length (feet) [1]	2020	21,379	21,379	21,379	21,379
	2070	21,379	21,379	21,379	21,379
Bank Slope (dH:dV) [2]	2020	1.8	1.8	1.8	1.8
	2070	1.8	1.8	1.8	1.8
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2020	1	1	1	1
	2070	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2020	8.7	8.7	8.7	8.7
	2070	8.7	8.7	8.7	8.7
Instream Structure (% shoreline) [5]	2020	17	17	17	17
	2070	17	17	17	17

Vegetation (% shoreline) [6]	2020	0	88	88	0
	2070	0	88	88	0
Shade (% shoreline) [7]	2020	73	18	54	73
	2070	73	18	54	73

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 19
SAM data summary of with-project conditions at site Sacramento ARS F.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2020				
	2070				
Wetted Area (square feet)	2020	1	1	1	1
	2070	1	1	1	1
Shoreline Length (feet) [1]	2020	21,379	21,379	21,379	21,379
	2070	21,379	21,379	21,379	21,379
Bank Slope (dH:dV) [2]	2020	2.5	2.5	2.5	2.5
	2021	2.5	2.5	2.5	2.5
	2070	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2020	1	1	1	1
	2070	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2020	10	0.25	0.25	10
	2021	10	0.25	0.25	10
	2070	10	0.25	0.25	10
Instream Structure (% shoreline) [5]	2020	17	0	0	0
	2021	40	40	40	40
	2070	40	40	40	40
Vegetation (% shoreline)	2020	0	0	0	0
	2021	0	50	50	0

	2025	0	88	88	0
	2035	0	88	88	0
	2045	0	88	88	0
	2070	0	88	88	0
Shade (% shoreline)	2020	0	14	43	0
	2021	0	14	44	0
	2025	0	15	54	0
	2035	100	19	75	100
	2045	100	25	75	100
	2070	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.
[4] Assume installation of rock revetment. D50 of 10 inches.
[5] Assume change in instream structure recruitment with addition of IWM.

Table 20
SAM data summary of existing conditions at site Sacramento River ARS G.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2024				
	2074				
Wetted Area (square feet)	2024	1	1	1	1
	2074	1	1	1	1
Shoreline Length (feet) [1]	2024	11,066	11,066	11,066	11,066
	2074	11,066	11,066	11,066	11,066
Bank Slope (dH:dV) [2]	2024	2	2	2	2
	2074	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2024	1	1	1	1
	2074	1	1	1	1
Bank Substrate Size (D50 in	2024	9.40	9.40	9.40	9.40

inches) [4]	2074	9.40	9.40	9.40	9.40
Instream Structure (% shoreline) [5]	2024	5.5	5.5	5.5	5.5
	2074	5.5	5.5	5.5	5.5
Vegetation (% shoreline) [6]	2024	0	88	88	0
	2074	0	88	88	0
Shade (% shoreline) [7]	2024	90	22	67	90
	2074	90	22	67	90

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 21
SAM data summary of with-project conditions at site Sacramento ARS G.

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2024				
	2074				
Wetted Area (square feet)	2024	1	1	1	1
	2074	1	1	1	1
Shoreline Length (feet) [1]	2024	11,066	11,066	11,066	11,066
	2074	11,066	11,066	11,066	11,066
Bank Slope (dH:dV) [2]	2024	2.5	2.5	2.5	2.5
	2025	2.5	2.5	2.5	2.5
	2074	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2024	1	1	1	1
	2074	1	1	1	1
Bank Substrate Size (D50 in	2024	10	0.25	0.25	10
	2025	10	0.25	0.25	10

inches) [4]	2074	10	0.25	0.25	10
Instream Structure (% shoreline) [5]	2024	5.5	0	0	0
	2025	40	40	40	40
	2074	40	40	40	40
Vegetation (% shoreline)	2024	0	0	0	0
	2025	0	50	50	0
	2029	0	88	88	0
	2039	0	88	88	0
	2049	0	88	88	0
	2074	0	88	88	0
Shade (% shoreline)	2024	0	18	54	0
	2025	0	18	55	0
	2029	0	19	65	0
	2039	100	23	75	100
	2049	100	25	75	100
	2074	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.
[4] Assume installation of rock revetment. D50 of 10 inches.
[5] Assume change in instream structure recruitment with addition of IWM.

Table 22
SAM data summary of existing conditions at site American River ARN C.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2027				
	2077				
Wetted Area (square feet)	2027	1	1	1	1
	2077	1	1	1	1
Shoreline Length (feet) [1]	2027	3,025	3,025	3,025	3,025
	2077	3,025	3,025	3,025	3,025
Bank Slope (dH:dV) [2]	2027	2	2	2	2
	2077	2	2	2	2
Floodplain Inundation	2027	1	1	1	1

Ratio (AQ2:AQavg) [3]	2077	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2027	0.25	0.25	0.25	0.25
	2077	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [5]	2027	0	0	0	0
	2077	0	0	0	0
Vegetation (% shoreline) [6]	2027	3	88	88	3
	2077	3	88	88	3
Shade (% shoreline) [7]	2027	78	19	58	78
	2077	78	19	58	78

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 23
SAM data summary of with-project conditions at site American ARN C.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2027				
	2077				
Wetted Area (square feet)	2027	1	1	1	1
	2077	1	1	1	1
Shoreline Length (feet) [1]	2027	3,025	3,025	3,025	3,025
	2077	3,025	3,025	3,025	3,025
Bank Slope (dH:dV) [2]	2027	2.5	2.5	2.5	2.5
	2028	2.5	2.5	2.5	2.5
	2077	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2027	1	1	1	1
	2077	1	1	1	1

Bank Substrate Size (D50 in inches) [4]	2027	10	0.25	0.25	10
	2028	10	0.25	0.25	10
	2077	10	0.25	0.25	10
Instream Structure (% shoreline) [5]	2027	0	0	0	0
	2028	0	0	0	0
	2077	0	0	0	0
Vegetation (% shoreline) [6]	2027	0	0	0	0
	2028	0	50	50	0
	2032	0	88	88	0
	2042	0	88	88	0
	2052	0	88	88	0
	2077	0	88	88	0
Shade (% shoreline)	2027	0	17	49	0
	2028	0	17	51	0
	2032	0	25	75	0
	2042	100	25	75	100
	2052	100	25	75	100
	2077	100	25	75	100

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.

Table 24
SAM data summary of existing conditions at site American River ARN D.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2027				
	2077				
Wetted Area (square feet)	2027	1	1	1	1
	2077	1	1	1	1
Shoreline Length (feet) [1]	2027	11,063	11,063	11,063	11,063
	2077	11,063	11,063	11,063	11,063
Bank Slope (dH:dV) [2]	2027	2	2	2	2
	2077	2	2	2	2

Floodplain Inundation Ratio (AQ2:AQavg) [3]	2027	1	1	1	1
	2077	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2027	0.25	0.25	0.25	0.25
	2077	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [5]	2027	0	0	0	0
	2077	0	0	0	0
Vegetation (% shoreline) [6]	2027	0	88	88	0
	2077	0	88	88	0
Shade (% shoreline) [7]	2027	36	9	27	36
	2077	36	9	27	36

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 25
SAM data summary of with-project conditions at site American ARN D.

Habitat Parameter	Water Year	Seasonal Values: Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2027				
	2077				
Wetted Area (square feet)	2027	1	1	1	1
	2077	1	1	1	1
Shoreline Length (feet) [1]	2027	11,063	11,063	11,063	11,063
	2077	11,063	11,063	11,063	11,063
Bank Slope (dH:dV) [2]	2027	2.5	2.5	2.5	2.5
	2028	2.5	2.5	2.5	2.5
	2077	2.5	2.5	2.5	2.5

Floodplain Inundation Ratio (AQ2:AQavg) [3]	2027	1	1	1	1
	2077	1	1	1	1
Bank Substrate Size (D50 in inches)	2027	0.25	0.25	0.25	0.25
	2028	0.25	0.25	0.25	0.25
	2077	0.25	0.25	0.25	0.25
Instream Structure (% shoreline)	2027	0	0	0	0
	2028	0	0	0	0
	2077	0	0	0	0
Vegetation (% shoreline)	2027	0	88	88	0
	2028	0	88	88	0
	2032	0	88	88	0
	2042	0	88	88	0
	2052	0	88	88	0
	2077	0	88	88	0
Shade (% shoreline)	2027	36	9	27	36
	2028	36	9	27	36
	2032	36	9	27	36
	2042	36	9	27	36
	2052	36	9	27	36
	2077	36	9	27	36

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.

Table 26
SAM data summary of existing conditions at site American River ARN E.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2028				
	2078				
Wetted Area (square feet)	2028	1	1	1	1
	2078	1	1	1	1
Shoreline	2028	11,063	11,063	11,063	11,063

Length (feet) [1]	2078	11,063	11,063	11,063	11,063
Bank Slope (dH:dV) [2]	2028	2	2	2	2
	2078	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2028	1	1	1	1
	2078	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2028	0.25	0.25	0.25	0.25
	2078	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [5]	2028	0	0	0	0
	2078	0	0	0	0
Vegetation (% shoreline) [6]	2028	0	88	88	0
	2078	0	88	88	0
Shade (% shoreline) [7]	2028	30	7	23	30
	2078	30	7	23	30

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 27
SAM data summary of with-project conditions at site American ARN E.

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2028				
	2078				
Wetted Area (square feet)	2028	1	1	1	1
	2078	1	1	1	1
Shoreline Length (feet) [1]	2028	11,063	11,063	11,063	11,063
	2078	11,063	11,063	11,063	11,063
Bank Slope (dH:dV) [2]	2028	2.5	2.5	2.5	2.5
	2029	2.5	2.5	2.5	2.5

	2078	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2028	1	1	1	1
	2078	1	1	1	1
Bank Substrate Size (D50 in inches)	2028	0.25	0.25	0.25	0.25
	2029	0.25	0.25	0.25	0.25
	2078	0.25	0.25	0.25	0.25
Instream Structure (% shoreline)	2028	0	0	0	0
	2029	0	0	0	0
	2078	0	0	0	0
Vegetation (% shoreline)	2028	0	88	88	0
	2029	0	88	88	0
	2033	0	88	88	0
	2043	0	88	88	0
	2053	0	88	88	0
	2078	0	88	88	0
Shade (% shoreline)	2028	30	7	23	30
	2029	30	7	23	30
	2033	30	7	23	30
	2043	30	7	23	30
	2053	30	7	23	30
	2078	30	7	23	30

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.

Table 28
SAM data summary of existing conditions at site American River ARN F.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2027				
	2077				
Wetted Area (square feet)	2027	1	1	1	1
	2077	1	1	1	1

Shoreline Length (feet) [1]	2027	13,038	13,038	13,038	13,038
	2077	13,038	13,038	13,038	13,038
Bank Slope (dH:dV) [2]	2027	2	2	2	2
	2077	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2027	1	1	1	1
	2077	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2027	0.25	0.25	0.25	0.25
	2077	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [5]	2027	0.3	0.3	0.3	0.3
	2077	0.3	0.3	0.3	0.3
Vegetation (% shoreline) [6]	2027	29	88	88	29
	2077	29	88	88	29
Shade (% shoreline) [7]	2027	7	1	5	7
	2077	7	1	5	7

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 29
SAM data summary of with-project conditions at site American River ARN F.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2027				
	2077				
Wetted Area (square feet)	2027	1	1	1	1
	2077	1	1	1	1
Shoreline Length (feet) [1]	2027	13,038	13,038	13,038	13,038
	2077	13,038	13,038	13,038	13,038
Bank Slope (dH:dV) [2]	2027	2.5	2.5	2.5	2.5
	2028	2.5	2.5	2.5	2.5

	2077	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2027	1	1	1	1
	2077	1	1	1	1
Bank Substrate Size (D50 in inches)	2027	0.25	0.25	0.25	0.25
	2028	0.25	0.25	0.25	0.25
	2077	0.25	0.25	0.25	0.25
Instream Structure (% shoreline)	2027	0.3	0.3	0.3	0.3
	2028	0.3	0.3	0.3	0.3
	2077	0.3	0.3	0.3	0.3
Vegetation (% shoreline)	2027	29	88	88	29
	2028	29	88	88	29
	2032	29	88	88	29
	2042	29	88	88	29
	2052	29	88	88	29
	2077	29	88	88	29
Shade (% shoreline)	2027	7	1	5	7
	2028	7	1	5	7
	2032	7	1	5	7
	2042	7	1	5	7
	2052	7	1	5	7
	2077	7	1	5	7

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.

Table 30
SAM data summary of existing conditions at site American River ARN G.

Habitat Parameter	Water Year	Seasonal Values: Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2027				
	2077				
Wetted Area (square feet)	2027	1	1	1	1
	2077	1	1	1	1

Shoreline Length (feet) [1]	2027	2,400	2,400	2,400	2,400
	2077	2,400	2,400	2,400	2,400
Bank Slope (dH:dV) [2]	2027	2	2	2	2
	2077	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2027	1	1	1	1
	2077	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2027	0.25	0.25	0.25	0.25
	2077	0.25	0.25	0.25	0.25
Instream Structure (% shoreline) [5]	2027	0	0	0	0
	2077	0	0	0	0
Vegetation (% shoreline) [6]	2027	0	88	88	0
	2077	0	88	88	0
Shade (% shoreline) [7]	2027	12	3	9	12
	2077	12	3	9	12

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 31
SAM data summary of with-project conditions at site American River ARN G.

Habitat Parameter	Water Year	Seasonal Values: Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2027				
	2077				
Wetted Area (square feet)	2027	1	1	1	1
	2077	1	1	1	1

Shoreline Length (feet) [1]	2027	2,400	2,400	2,400	2,400
	2077	2,400	2,400	2,400	2,400
Bank Slope (dH:dV) [2]	2027	2.5	2.5	2.5	2.5
	2028	2.5	2.5	2.5	2.5
	2077	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2027	1	1	1	1
	2077	1	1	1	1
Bank Substrate Size (D50 in inches)	2027	0.25	0.25	0.25	0.25
	2028	0.25	0.25	0.25	0.25
	2077	0.25	0.25	0.25	0.25
Instream Structure (% shoreline)	2027	0	0	0	0
	2028	0	0	0	0
	2077	0	0	0	0
Vegetation (% shoreline)	2027	0	88	88	0
	2028	0	88	88	0
	2032	0	88	88	0
	2042	0	88	88	0
	2052	0	88	88	0
	2077	0	88	88	0
Shade (% shoreline)	2027	12	3	9	12
	2028	12	3	9	12
	2032	12	3	9	12
	2042	12	3	9	12
	2052	12	3	9	12
	2077	12	3	9	12

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.

Table 32
SAM data summary of existing conditions at site American River ARN I.

Habitat Parameter	Water Year	Seasonal Values			
		Fall	Winter	Spring	Summer
Water Surface	2027				

Elevation (feet)	2077				
Wetted Area (square feet)	2027	1	1	1	1
	2077	1	1	1	1
Shoreline Length (feet) [1]	2027	2,097	2,097	2,097	2,097
	2077	2,097	2,097	2,097	2,097
Bank Slope (dH:dV) [2]	2027	2	2	2	2
	2077	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2027	1	1	1	1
	2077	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2027	10	10	10	10
	2077	10	10	10	10
Instream Structure (% shoreline) [5]	2027	0	0	0	0
	2077	0	0	0	0
Vegetation (% shoreline) [6]	2027	0	88	88	0
	2077	0	88	88	0
Shade (% shoreline) [7]	2027	0	0	0	0
	2077	0	0	0	0

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 33
SAM data summary of with-project conditions at site American ARN I.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2027				
	2077				
Wetted Area	2027	1	1	1	1

(square feet)	2077	1	1	1	1
Shoreline Length (feet) [1]	2027	2,097	2,097	2,097	2,097
	2077	2,097	2,097	2,097	2,097
Bank Slope (dH:dV) [2]	2027	2.5	2.5	2.5	2.5
	2028	2.5	2.5	2.5	2.5
	2077	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2027	1	1	1	1
	2077	1	1	1	1
Bank Substrate Size (D50 in inches)	2027	10	10	10	10
	2028	10	10	10	10
	2077	10	10	10	10
Instream Structure (% shoreline)	2027	0	0	0	0
	2028	0	0	0	0
	2077	0	0	0	0
Vegetation (% shoreline)	2027	0	88	88	0
	2028	0	88	88	0
	2032	0	88	88	0
	2042	0	88	88	0
	2052	0	88	88	0
	2077	0	88	88	0
Shade (% shoreline)	2027	0	0	0	0
	2028	0	0	0	0
	2032	0	0	0	0
	2042	0	0	0	0
	2052	0	0	0	0
	2077	0	0	0	0

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.
[3] Assume no significant increase in floodplain between seasonal water surface elevations or as a result of project construction. Assume floodplain inundation ratio of 1 for all seasons in all ARCF Reaches.

Table 34
SAM data summary of existing conditions at site Sacramento River SBP Levee.

		Seasonal Values			
Habitat Parameter	Water Year	Fall	Winter	Spring	Summer
Water Surface	2012				

Elevation (feet)	2062				
Wetted Area (square feet)	2012	8,799,296	8,799,296	8,799,296	8,799,296
	2062	8,799,296	8,799,296	8,799,296	8,799,296
Shoreline Length (feet) [1]	2012	9,047	9,047	9,047	9,047
	2062	9,047	9,047	9,047	9,047
Bank Slope (dH:dV) [2]	2012	2	2	2	2
	2062	2	2	2	2
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2012	1	1	1	1
	2062	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2012	2.4	2.4	2.4	2.4
	2062	2.4	2.4	2.4	2.4
Instream Structure (% shoreline) [5]	2012	3.9	3.9	3.9	3.9
	2062	3.9	3.9	3.9	3.9
Vegetation (% shoreline) [6]	2012	0	71	71	0
	2062	0	71	71	0
Shade (% shoreline) [7]	2012	48	12	36	48
	2062	48	12	36	48

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 35
SAM data summary of with-project conditions at site Sacramento River SBP Levee.

Habitat Parameter	Water Year	Seasonal Values Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2012				
	2062				
Wetted Area (square feet)	2012	23,022,296	23,022,296	23,022,296	23,022,296
	2062	23,022,296	23,022,296	23,022,296	23,022,296
Shoreline Length (feet) [1]	2012	9,047	9,047	9,047	9,047
	2062	9,047	9,047	9,047	9,047
Bank Slope (dH:dV) [2]	2012	2.5	2.5	2.5	2.5
	2013	2.5	2.5	2.5	2.5
	2062	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg)	2012	1	1	1	1
	2062	1	1	1	1
Bank Substrate Size (D50 in inches)	2012	2.4	2.4	2.4	2.4
	2013	2.4	2.4	2.4	2.4
	2062	2.4	2.4	2.4	2.4
Instream Structure (% shoreline)	2012	3.9	3.9	3.9	3.9
	2013	3.9	3.9	3.9	3.9
	2062	3.9	3.9	3.9	3.9
Vegetation (% shoreline)	2012	0	71	71	0
	2013	0	71	71	0
	2017	0	71	71	0
	2027	0	71	71	0
	2037	0	71	71	0
	2062	0	71	71	0
Shade (% shoreline)	2012	48	12	36	48
	2013	48	12	36	48
	2017	48	12	36	48
	2027	48	12	36	48
	2037	48	12	36	48
	2062	48	12	36	48

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).

[2] Assume no significant change to Bank Slope.

Table 36
SAM data summary of existing conditions at site Sacramento River SBP Weir.

Habitat Parameter	Water Year	Seasonal Values: Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2012				
	2062				
Wetted Area (square feet)	2012	283,968	283,968	283,968	283,968
	2062	283,968	283,968	283,968	283,968
Shoreline Length (feet) [1]	2012	1,500	1,500	1,500	1,500
	2062	1,500	1,500	1,500	1,500
Bank Slope (dH:dV) [2]	2012	2.5	2.5	2.5	2.5
	2062	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg) [3]	2012	1	1	1	1
	2062	1	1	1	1
Bank Substrate Size (D50 in inches) [4]	2012	10	10	10	10
	2062	10	10	10	10
Instream Structure (% shoreline) [5]	2012	0	0	0	0
	2062	0	0	0	0
Vegetation (% shoreline) [6]	2012	0	88	88	0
	2062	0	88	88	0
Shade (% shoreline) [7]	2012	48	12	36	48
	2062	48	12	36	48

[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Repairs not expected to affect slope, assume slope of 3 for consistency with USACE standards.
[3] Assume no significant increase in floodplain between seasonal water surface elevations. Assume floodplain inundation ratio of 1 for all seasons in all West Sac Reaches.
[4] Bank substrate data taken from USACE Revetment Database (2007) and confirmed with aerial imagery. Natural substrate assigned a D50 of 0.25 inches. Revetment substrate assigned a D_{50} of 10 inches.
[5] Instream Structure data taken from USACE Revetment Database (2007).
[6] Shoreline coverage of Vegetation taken from USACE Revetment Database and evaluated against aerial imagery. Summer/Fall values taken from "Emergent Veg" attribute. Winter/ Spring values taken from "Veg Cover%" attribute.
[7] Attribute coverage determined from analysis of aerial imagery. Winter/ Spring values modified by 0.25/ 0.75 respectively to represent seasonal defoliation.

Table 37
SAM data summary of with-project conditions at site Sacramento River SBP Weir.

Habitat Parameter	Water Year	Seasonal Values: Fall	Winter	Spring	Summer
Water Surface Elevation (feet)	2012				
	2062				
Wetted Area (square feet)	2012	742,968	742,968	742,968	742,968
	2062	742,968	742,968	742,968	742,968
Shoreline Length (feet) [1]	2012	1,500	1,500	1,500	1,500
	2062	1,500	1,500	1,500	1,500
Bank Slope (dH:dV) [2]	2012	2.5	2.5	2.5	2.5
	2013	2.5	2.5	2.5	2.5
	2062	2.5	2.5	2.5	2.5
Floodplain Inundation Ratio (AQ2:AQavg)	2012	1	1	1	1
	2062	1	1	1	1
Bank Substrate Size (D50 in inches)	2012	10	10	10	10
	2013	10	10	10	10
	2062	10	10	10	10
Instream Structure (% shoreline)	2012	0	0	0	0
	2013	0	0	0	0
	2062	0	0	0	0
Vegetation (% shoreline)	2012	0	0	0	0
	2013	0	0	0	0
	2017	0	0	0	0
	2027	0	0	0	0
	2037	0	0	0	0
	2062	0	0	0	0
Shade (% shoreline)	2012	0	0	0	0
	2013	0	0	0	0
	2017	0	0	0	0
	2027	0	0	0	0
	2037	0	0	0	0
	2062	0	0	0	0

-WY = water year; spans fall, winter, spring and summer; rock and soil placement and IWM installation assumed during Winter in the initial WY and revegetation planting assumed during Spring of the initial WY.
[1] Shoreline Length Estimated from Aerial images. Attribute surveyed in the field following the field data collection protocol for the USACE Revetment Database (2007).
[2] Assume no significant change to Bank Slope.

Table 38

Bankline weighted relative response (feet)
Comparison
NEMDC_Tribs_Analysis
Alternative Scenario(s): ARN_C_Project, ARN_D_Project, ARN_E_Project, ARN_F_Project, ARN_G_Project, ARN_I_Project
Baseline Scenario(s): ARN_C_Existing, ARN_D_Existing, ARN_E_Project, ARN_F_Existing, ARN_G_Existing, ARN_I_Existing

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Spring-run Chinook																				
Year 0			-1	-4				0	-6				0					-1		
Year 1			-3	-12				2	-5				2					-3		
Year 2			-5	-18				6	8				7					-5		
Year 3			-6	-24				10	21				12					-6		
Year 4			-8	-29				13	33				16					-8		
Year 5			-9	-34				17	44				20					-9		
Year 6			-10	-38				20	56				24					-10		
Year 7			-11	-41				23	66				28					-11		
Year 8			-11	-42				26	75				31					-11		
Year 9			-12	-43				29	83				34					-12		
Year 10			-12	-44				31	91				36					-12		
Year 11			-12	-43				33	98				39					-12		
Year 12			-11	-42				35	105				41					-11		
Year 13			-11	-41				37	111				43					-11		
Year 14			-10	-39				39	117				45					-10		
Year 15			-9	-36				41	122				47					-9		
Year 25			-4	-17				52	161				60					-4		
Year 50			3	6				66	206				75					3		
Fall-run Chinook																				
Year 0	-5	0	-1			0	0	0				0	0	-6					-4	
Year 1	-14	0	-3			-1	0	2				0	2	-4					-12	
Year 2	-23	0	-5			-1	0	6				0	7	10					-18	
Year 3	-30	0	-6			0	0	10				0	12	23					-24	
Year 4	-36	0	-8			0	0	13				0	16	34					-29	
Year 5	-42	0	-9			1	0	17				0	20	46					-34	
Year 6	-47	0	-10			1	0	20				0	24	56					-38	
Year 7	-51	0	-11			2	0	23				0	28	65					-41	
Year 8	-54	0	-11			2	0	26				0	31	74					-42	
Year 9	-55	0	-12			3	0	29				0	34	82					-43	
Year 10	-56	0	-12			4	0	31				0	36	89					-44	
Year 11	-57	0	-12			4	0	33				0	39	96					-43	
Year 12	-56	0	-11			4	0	35				0	41	102					-42	
Year 13	-55	0	-11			5	0	37				0	43	108					-41	
Year 14	-54	0	-10			5	0	39				0	45	113					-39	
Year 15	-52	0	-9			5	0	41				0	47	118					-36	
Year 25	-36	0	-4			8	0	52				0	60	154					-17	
Year 50	-18	0	3			11	0	66				0	75	196					6	
Steelhead																				
Year 0	-8		-2		-8	0	0	0		0	0	0	-1	-3	0			-2	-4	-8
Year 1	-22		-6		-22	-1	0	3		-1	-1	0	3	1	-1			-6	-11	-22
Year 2	-34		-10		-34	-1	0	10		-1	-1	0	11	15	-1			-10	-17	-34
Year 3	-45		-13		-45	-1	0	16		-1	-1	0	18	28	-1			-13	-23	-45
Year 4	-55		-16		-55	0	0	22		0	-1	0	25	39	-1			-16	-28	-55
Year 5	-64		-19		-64	1	0	28		1	0	0	31	50	0			-19	-32	-64
Year 6	-72		-21		-72	2	0	33		2	0	0	37	60	0			-21	-36	-72
Year 7	-77		-22		-77	3	0	38		3	1	0	42	69	1			-22	-38	-77
Year 8	-81		-23		-81	4	0	43		4	2	0	47	77	2			-23	-39	-81
Year 9	-84		-23		-84	5	0	47		5	2	0	51	84	2			-23	-40	-84
Year 10	-86		-23		-86	6	0	51		6	3	0	55	91	3			-23	-39	-86
Year 11	-86		-23		-86	6	0	54		6	3	0	59	97	3			-23	-38	-86
Year 12	-86		-22		-86	7	0	57		7	4	0	63	103	4			-22	-36	-86
Year 13	-85		-21		-85	8	0	60		8	4	0	66	108	4			-21	-34	-85
Year 14	-83		-19		-83	8	0	63		8	5	0	69	113	5			-19	-31	-83
Year 15	-80		-18		-80	9	0	66		9	5	0	71	118	5			-18	-28	-80
Year 25	-58		-5		-58	13	0	85		13	8	0	92	152	8			-5	-1	-58
Year 50	-32		11		-32	17	0	107		17	11	0	115	191	11			11	30	-32

4.0 defaults used for all response curves
4.0 defaults used for all timing tables

Table 39

Bankline weighted relative response (feet)

Comparison SBP_Analysis
Alternative Scenario(s): SBP_Project,
SBP_Project_Weir
Baseline Scenario(s): SBP_Existing,
SBP_Existing_Weir

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Spring-run Chinook																				
Year 0	0		0	0		0		0	0		0		0	0		0		0	0	
Year 1	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 2	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 3	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 4	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 5	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 6	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 7	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 8	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 9	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 10	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 11	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 12	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 13	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 14	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 15	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 25	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Year 50	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4	-26	
Fall-run Chinook																				
Year 0	0		0			0		0	0				0			0		0		
Year 1	-60		-4			-21		-9	-146				-21			-60		-4		
Year 2	-60		-4			-21		-9	-146				-21			-60		-4		
Year 3	-60		-4			-21		-9	-146				-21			-60		-4		
Year 4	-60		-4			-21		-9	-146				-21			-60		-4		
Year 5	-60		-4			-21		-9	-146				-21			-60		-4		
Year 6	-60		-4			-21		-9	-146				-21			-60		-4		
Year 7	-60		-4			-21		-9	-146				-21			-60		-4		
Year 8	-60		-4			-21		-9	-146				-21			-60		-4		
Year 9	-60		-4			-21		-9	-146				-21			-60		-4		
Year 10	-60		-4			-21		-9	-146				-21			-60		-4		
Year 11	-60		-4			-21		-9	-146				-21			-60		-4		
Year 12	-60		-4			-21		-9	-146				-21			-60		-4		
Year 13	-60		-4			-21		-9	-146				-21			-60		-4		
Year 14	-60		-4			-21		-9	-146				-21			-60		-4		
Year 15	-60		-4			-21		-9	-146				-21			-60		-4		
Year 25	-60		-4			-21		-9	-146				-21			-60		-4		
Year 50	-60		-4			-21		-9	-146				-21			-60		-4		
Late-fall-run Chinook																				
Year 0	0		0	0		0		0	0		0		0					0		
Year 1	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 2	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 3	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 4	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 5	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 6	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 7	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 8	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 9	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 10	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 11	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 12	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 13	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 14	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 15	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 25	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Year 50	-60		-4	-26		-21		-9	-146		-51		-21					-4		
Winter-run Chinook																				
Year 0	0		0	0		0		0	0		0		0	0		0		0		
Year 1	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 2	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 3	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 4	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 5	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 6	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		

Year 7	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 8	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 9	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 10	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 11	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 12	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 13	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 14	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 15	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 25	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Year 50	-60		-4	-26		-21		-9	-146		-51		-21	-188		-60		-4		
Steelhead																				
Year 0	0		0	0	0	0		0	0	0	0		0	0	0	0		0		0
Year 1	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 2	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 3	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 4	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 5	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 6	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 7	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 8	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 9	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 10	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 11	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 12	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 13	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 14	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 15	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 25	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Year 50	-100		-17	-35	-100	-40		-29	-127	-40	-87		-55	-174	-87	-100		-17		-100
Green Sturgeon																				
Year 0			0	0		0		0		0	0	0	0	0	0	0	0	0	0	0
Year 1			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 2			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 3			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 4			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 5			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 6			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 7			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 8			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 9			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 10			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 11			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 12			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 13			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 14			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 15			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 25			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8
Year 50			115	0		0		115		-8	0	0	115	0	-8	0	0	115	0	-8

4.0 defaults used for all response curves
4.0 defaults used for all timing tables

Table 40

Bankline weighted relative response (feet)
Comparison
AR_Analysis_IWM_WB
Alternative Scenario(s): ARN_A_B_Project_WB_IWM, ARS_A_Project_IWM_WB, ARS_B_Project_IWM_WB, ARS_C_Project_IWM_WB
Baseline Scenario(s): ARN_A_B_Existing, ARS_A_Existing, ARS_B_Existing, ARS_C_Existing

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Spring-run Chinook																				
Year 0			-15	-71				-15	-119				-22					-15		
Year 1			-20	-46				-6	-101				-8					-19		
Year 2			-6	112				36	120				54					-4		
Year 3			3	236				75	285				107					5		
Year 4			-4	290				101	256				138					-3		
Year 5			-3	385				156	313				210					-3		
Year 6			13	550				241	548				324					15		
Year 7			34	733				327	788				435					36		
Year 8			61	942				415	1,055				547					63		
Year 9			90	1,154				500	1,309				652					93		

Year 10			125	1,369				579	1,544				747					127		
Year 11			167	1,587				651	1,757				833					170		
Year 12			217	1,807				716	1,951				910					219		
Year 13			272	2,029				775	2,126				980					274		
Year 14			333	2,252				829	2,286				1,044					335		
Year 15			399	2,477				878	2,432				1,102					401		
Year 25			1,022	4,360				1,210	3,414				1,491					1,023		
Year 50			1,697	6,345				1,539	4,389				1,876					1,698		
Fall-run Chinook																				
Year 0	-34	0	-15			-11	0	-15				0	-22	-128					-77	
Year 1	-29	0	-20			41	0	-6				0	-8	-102					-29	
Year 2	30	0	-6			148	0	36				0	54	141					169	
Year 3	70	0	3			234	0	75				0	107	309					311	
Year 4	72	0	-4			259	0	101				0	138	261					316	
Year 5	54	0	-3			305	0	156				0	210	303					394	
Year 6	39	0	13			405	0	241				0	324	527					603	
Year 7	32	0	34			504	0	327				0	435	750					815	
Year 8	40	0	61			607	0	415				0	547	992					1,042	
Year 9	52	0	90			703	0	500				0	652	1,215					1,258	
Year 10	73	0	125			790	0	579				0	747	1,416					1,471	
Year 11	104	0	167			869	0	651				0	833	1,598					1,684	
Year 12	143	0	217			940	0	716				0	910	1,761					1,899	
Year 13	191	0	272			1,005	0	775				0	980	1,910					2,116	
Year 14	246	0	333			1,064	0	829				0	1,044	2,045					2,336	
Year 15	308	0	399			1,118	0	878				0	1,102	2,169					2,557	
Year 25	919	0	1,022			1,479	0	1,210				0	1,491	2,995					4,415	
Year 50	1,588	0	1,697			1,838	0	1,539				0	1,876	3,816					6,377	
Steelhead																				
Year 0	-57		-28		-57	-18	0	-28		-18	-20	0	-37	-106	-20			-28	-75	-72
Year 1	-28		-35		-28	93	0	-18		93	95	0	-22	-92	95			-34	-42	-54
Year 2	107		-5		107	314	0	46		314	327	0	62	97	327			-3	127	84
Year 3	204		13		204	493	0	101		493	514	0	132	224	514			17	243	172
Year 4	232		4		232	547	0	134		547	569	0	168	180	569			5	226	67
Year 5	226		12		226	644	0	210		644	669	0	260	208	669			13	268	-42
Year 6	222		50		222	849	0	332		849	883	0	411	381	883			52	428	-33
Year 7	234		92		234	1,054	0	455		1,054	1,096	0	559	551	1,096			96	588	-10
Year 8	270		144		270	1,266	0	581		1,266	1,315	0	709	737	1,315			148	764	40
Year 9	311		199		311	1,461	0	702		1,461	1,516	0	848	906	1,516			203	929	95
Year 10	363		261		363	1,640	0	815		1,640	1,698	0	975	1,058	1,698			266	1,093	160
Year 11	430		334		430	1,800	0	916		1,800	1,861	0	1,089	1,194	1,861			339	1,260	237
Year 12	511		417		511	1,946	0	1,009		1,946	2,009	0	1,192	1,317	2,009			421	1,430	327
Year 13	603		510		603	2,077	0	1,092		2,077	2,143	0	1,286	1,428	2,143			513	1,604	429
Year 14	707		610		707	2,197	0	1,169		2,197	2,265	0	1,371	1,530	2,265			613	1,782	540
Year 15	819		717		819	2,307	0	1,239		2,307	2,376	0	1,449	1,622	2,376			720	1,963	660
Year 25	1,905		1,715		1,905	3,042	0	1,709		3,042	3,119	0	1,967	2,239	3,119			1,718	3,507	1,794
Year 50	3,086		2,795		3,086	3,771	0	2,175		3,771	3,855	0	2,481	2,851	3,855			2,796	5,144	3,023

4.0 defaults used for all response curves
4.0 defaults used for all timing tables

Table 41

Bankline weighted relative response (feet)

Comparison
ARS_DEFG_Analysis
Alternative Scenario(s): ARS_D_Project, ARS_E_Project, ARS_F_Project, ARS_G_Project
Baseline Scenario(s): ARS_D_Existing, ARS_E_Existing, ARS_F_Existing, ARS_G_Existing

Focus Fish Species and Water Year	Fall					Winter					Spring					Summer				
	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence	Adult migration	Spawning and egg incubation	Fry and juvenile rearing	Juvenile migration	Adult residence
Spring-run Chinook																				
Year 0	-70		-22	-119		-90		-23	-296		-94		-31	-306		-154		-22	-192	
Year1	-185		-60	-329		-179		-12	-589		-189		-11	-596		-374		-61	-498	
Year 2	-271		-88	-502		-155		61	-509		-166		104	-486		-478		-89	-690	
Year3	-340		-108	-639		-98		142	-318		-107		229	-260		-528		-109	-810	
Year4	-422		-132	-786		-65		203	-217		-69		327	-130		-607		-133	-952	
Year5	-504		-161	-945		-39		266	-145		-38		430	-33		-712		-162	-1,130	
Year6	-554		-183	-1,072		24		351	53		32		563	193		-770		-184	-1,265	
Year7	-583		-196	-1,161		106		439	314		123		699	486		-784		-197	-1,341	
Year8	-596		-201	-1,225		179		518	550		206		822	750		-785		-202	-1,394	
Year9	-597		-201	-1,267		244		590	766		283		934	989		-776		-202	-1,426	

Year10	-587		-196	-1,290		303		654	964		354		1,035	1,206		-755		-197	-1,440	
Year11	-562		-184	-1,291		357		714	1,146		420		1,128	1,402		-722		-185	-1,433	
Year12	-525		-167	-1,273		407		769	1,312		481		1,213	1,579		-677		-168	-1,408	
Year13	-477		-145	-1,238		453		821	1,466		540		1,292	1,740		-622		-145	-1,367	
Year14	-420		-118	-1,189		496		869	1,609		594		1,365	1,887		-558		-119	-1,312	
Year15	-354		-88	-1,127		536		914	1,742		647		1,433	2,022		-486		-88	-1,244	
Year25	271		200	-473		844		1,279	2,747		1,027		1,914	2,932		179		199	-555	
Year50	944		509	244		1,233		1,763	3,965		1,416		2,401	3,840		892		509	197	
Fall-run Chinook																				
Year 0	-70		-22			-90		-23	-296				-31			-154		-22		
Year 1	-185		-60			-179		-12	-589				-11			-374		-61		
Year 2	-271		-88			-155		61	-509				104			-478		-89		
Year 3	-340		-108			-98		142	-318				229			-528		-109		
Year 4	-422		-132			-65		203	-217				327			-607		-133		
Year 5	-504		-161			-39		266	-145				430			-712		-162		
Year 6	-554		-183			24		351	53				563			-770		-184		
Year 7	-583		-196			106		439	314				699			-784		-197		
Year 8	-596		-201			179		518	550				822			-785		-202		
Year 9	-597		-201			244		590	766				934			-776		-202		
Year 10	-587		-196			303		654	964				1,035			-755		-197		
Year 11	-562		-184			357		714	1,146				1,128			-722		-185		
Year 12	-525		-167			407		769	1,312				1,213			-677		-168		
Year 13	-477		-145			453		821	1,466				1,292			-622		-145		
Year 14	-420		-118			496		869	1,609				1,365			-558		-119		
Year 15	-354		-88			536		914	1,742				1,433			-486		-88		
Year 25	271		200			844		1,279	2,747				1,914			179		199		
Year 50	944		509			1,233		1,763	3,965				2,401			892		509		
Late-fall-run Chinook																				
Year 0	-70		-22	-119		-90		-23	-296		-94		-31					-22		
Year 1	-185		-60	-329		-179		-12	-589		-189		-11					-61		
Year 2	-271		-88	-502		-155		61	-509		-166		104					-89		
Year 3	-340		-108	-639		-98		142	-318		-107		229					-109		
Year 4	-422		-132	-786		-65		203	-217		-69		327					-133		
Year 5	-504		-161	-945		-39		266	-145		-38		430					-162		
Year 6	-554		-183	-1,072		24		351	53		32		563					-184		
Year 7	-583		-196	-1,161		106		439	314		123		699					-197		
Year 8	-596		-201	-1,225		179		518	550		206		822					-202		
Year 9	-597		-201	-1,267		244		590	766		283		934					-202		
Year 10	-587		-196	-1,290		303		654	964		354		1,035					-197		
Year 11	-562		-184	-1,291		357		714	1,146		420		1,128					-185		
Year 12	-525		-167	-1,273		407		769	1,312		481		1,213					-168		
Year 13	-477		-145	-1,238		453		821	1,466		540		1,292					-145		
Year 14	-420		-118	-1,189		496		869	1,609		594		1,365					-119		
Year 15	-354		-88	-1,127		536		914	1,742		647		1,433					-88		
Year 25	271		200	-473		844		1,279	2,747		1,027		1,914					199		
Year 50	944		509	244		1,233		1,763	3,965		1,416		2,401					509		
Winter-run Chinook																				
Year 0	-70		-22	-119		-90		-23	-296		-94		-31	-306		-154		-22		
Year 1	-185		-60	-329		-179		-12	-589		-189		-11	-596		-374		-61		
Year 2	-271		-88	-502		-155		61	-509		-166		104	-486		-478		-89		
Year 3	-340		-108	-639		-98		142	-318		-107		229	-260		-528		-109		
Year 4	-422		-132	-786		-65		203	-217		-69		327	-130		-607		-133		
Year 5	-504		-161	-945		-39		266	-145		-38		430	-33		-712		-162		
Year 6	-554		-183	-1,072		24		351	53		32		563	193		-770		-184		
Year 7	-583		-196	-1,161		106		439	314		123		699	486		-784		-197		
Year 8	-596		-201	-1,225		179		518	550		206		822	750		-785		-202		
Year 9	-597		-201	-1,267		244		590	766		283		934	989		-776		-202		
Year 10	-587		-196	-1,290		303		654	964		354		1,035	1,206		-755		-197		
Year 11	-562		-184	-1,291		357		714	1,146		420		1,128	1,402		-722		-185		
Year 12	-525		-167	-1,273		407		769	1,312		481		1,213	1,579		-677		-168		
Year 13	-477		-145	-1,238		453		821	1,466		540		1,292	1,740		-622		-145		
Year 14	-420		-118	-1,189		496		869	1,609		594		1,365	1,887		-558		-119		
Year 15	-354		-88	-1,127		536		914	1,742		647		1,433	2,022		-486		-88		
Year 25	271		200	-473		844		1,279	2,747		1,027		1,914	2,932		179		199		
Year 50	944		509	244		1,233		1,763	3,965		1,416		2,401	3,840		892		509		
Steelhead																				
Year 0	-117		-45	-115	-117	-180		-43	-251	-180	-186		-54	-259	-186	-281		-45		-281
Year 1	-298		-117	-321	-298	-354		-42	-507	-354	-366		-46	-514	-366	-671		-119		-671
Year 2	-425		-167	-498	-425	-298		59	-461	-298	-304		97	-449	-304	-834		-169		-834
Year 3	-524		-201	-641	-524	-177		174	-326	-177	-171		259	-291	-171	-896		-204		-896
Year 4	-645		-246	-794	-645	-101		256	-271	-101	-83		381	-216	-83	-1,009		-248		-1,009
Year 5	-757		-300	-958	-757	-36		338	-247	-36	-4		503	-174	-4	-1,163		-302		-1,163
Year 6	-809		-341	-1,091	-809	103		455	-123	103	151		670	-30	151	-1,233		-343		-1,233
Year 7	-829		-362	-1,187	-829	279		579	55	279	346		847	171	346	-1,224		-364		-1,224
Year 8	-826		-371	-1,256	-826	435		690	214	435	521		1,005	350	521	-1,197		-373		-1,197
Year 9	-807		-369	-1,302	-807	574		791	358	574	680		1,148	512	680	-1,155		-371		-1,155
Year 10	-769		-358	-1,327	-769	701		882	489	701	825		1,280	658	825	-1,099		-360		-1,099

Year 11	-712		-336	-1,330	-712	816		966	609	816	958		1,400	791	958	-1,024		-337		-1,024
Year 12	-635		-302	-1,313	-635	921		1,043	720	921	1,080		1,510	911	1,080	-931		-304		-931
Year 13	-542		-260	-1,277	-542	1,019		1,115	823	1,019	1,193		1,612	1,021	1,193	-824		-262		-824
Year 14	-434		-210	-1,227	-434	1,109		1,183	919	1,109	1,299		1,707	1,123	1,299	-703		-211		-703
Year 15	-313		-153	-1,163	-313	1,193		1,246	1,009	1,193	1,398		1,795	1,216	1,398	-571		-154		-571
Year 25	801		386	-485	801	1,835		1,752	1,704	1,835	2,095		2,419	1,858	2,095	621		385		621
Year 50	1,993		966	258	1,993	2,625		2,417	2,580	2,625	2,801		3,051	2,501	2,801	1,891		966		1,891
Green Sturgeon																				
Year 0			-7	0		0		-334		-120	0	35	-334	0	-120	0	-93	-203	0	-120
Year 1			76	0		0		-822		-254	0	96	-822	0	-254	0	-295	-379	0	-254
Year 2			238	0		0		-1,060		-255	0	146	-1,060	0	-255	0	-499	-266	0	-255
Year 3			381	0		0		-1,173		-214	0	187	-1,173	0	-214	0	-665	-77	0	-214
Year 4			500	0		0		-1,340		-204	0	247	-1,340	0	-204	0	-823	53	0	-204
Year 5			669	0		0		-1,565		-208	0	323	-1,565	0	-208	0	-1,005	171	0	-208
Year 6			898	0		0		-1,711		-171	0	391	-1,711	0	-171	0	-1,190	379	0	-171
Year 7			1,114	0		0		-1,777		-109	0	450	-1,777	0	-109	0	-1,351	629	0	-109
Year 8			1,303	0		0		-1,835		-55	0	501	-1,835	0	-55	0	-1,491	848	0	-55
Year 9			1,470	0		0		-1,887		-7	0	547	-1,887	0	-7	0	-1,615	1,042	0	-7
Year 10			1,618	0		0		-1,932		36	0	587	-1,932	0	36	0	-1,725	1,214	0	36
Year 11			1,751	0		0		-1,973		74	0	623	-1,973	0	74	0	-1,823	1,368	0	74
Year 12			1,870	0		0		-2,010		108	0	656	-2,010	0	108	0	-1,912	1,506	0	108
Year 13			1,978	0		0		-2,043		139	0	685	-2,043	0	139	0	-1,992	1,632	0	139
Year 14			2,076	0		0		-2,073		167	0	712	-2,073	0	167	0	-2,065	1,746	0	167
Year 15			2,166	0		0		-2,101		193	0	736	-2,101	0	193	0	-2,131	1,850	0	193
Year 25			2,763	0		0		-2,284		365	0	899	-2,284	0	365	0	-2,575	2,543	0	365
Year 50			3,356	0		0		-2,466		535	0	1,061	-2,466	0	535	0	-3,015	3,230	0	535

4.0 defaults used for all response curves
4.0 defaults used for all timing tables

7.0 References

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Appendix C

Delta Smelt Shallow Water Habitat Analysis

SACRAMENTO RIVER D/S OF AMERICAN RIVER

RIVER STATION		AVG. WS ELEV (NAVD88)		SHA DEPTH
(mi)	MHHW	SHALLOW END	SUMMER	(ft)
60.39	8.76	-2.22	10.7	10.98
60.39	8.76	-2.22	10.7	10.98
60.25	8.73	-2.22	10.6	10.95
60.00	8.64	-2.25	10.6	10.89
59.75	8.59	-2.25	10.5	10.84
59.70	8.59	-2.25	10.5	10.84
59.69	8.59	-2.25	10.5	10.84
59.69	8.59	-2.25	10.5	10.84
59.68	8.59	-2.25	10.5	10.84
59.68	8.59	-2.25	10.5	10.84
59.68	8.59	-2.25	10.5	10.84
59.50	8.56	-2.25	10.5	10.81
59.29	8.55	-2.25	10.5	10.80
59.29	8.55	-2.25	10.5	10.80
59.27	8.55	-2.25	10.5	10.80
59.27	8.55	-2.25	10.5	10.80
59.25	8.55	-2.25	10.5	10.80
59.00	8.49	-2.26	10.5	10.75
58.75	8.42	-2.28	10.4	10.70
58.52	8.36	-2.29	10.4	10.65
58.52	8.36	-2.29	10.4	10.65
58.51	8.36	-2.29	10.3	10.65
58.50	8.36	-2.29	10.3	10.65
58.50	8.36	-2.29	10.3	10.65
58.50	8.36	-2.29	10.3	10.65
58.49	8.35	-2.29	10.3	10.64
58.49	8.35	-2.29	10.3	10.64
58.25	8.30	-2.30	10.3	10.60
58.00	8.25	-2.30	10.2	10.55
57.85	8.23	-2.30	10.2	10.53
57.64	8.19	-2.30	10.1	10.49
57.50	8.18	-2.30	10.1	10.48
57.25	8.13	-2.31	10.1	10.44
57.00	8.09	-2.31	10.0	10.40
56.75	8.05	-2.31	10.0	10.36
56.50	8.02	-2.31	10.0	10.33
56.25	7.98	-2.31	10.0	10.29
56.00	7.95	-2.32	9.9	10.27
55.75	7.93	-2.32	9.9	10.25
55.49	7.89	-2.32	9.9	10.21
55.25	7.87	-2.32	9.9	10.19
55.00	7.87	-2.32	9.9	10.19
54.75	7.84	-2.32	9.9	10.16

54.50	7.79	-2.32	9.8	10.11
54.25	7.76	-2.32	9.8	10.08
54.00	7.73	-2.32	9.8	10.05
53.75	7.69	-2.33	9.7	10.02
53.50	7.64	-2.33	9.7	9.97
53.25	7.61	-2.33	9.7	9.94
53.00	7.57	-2.33	9.7	9.90
52.75	7.50	-2.35	9.6	9.85
52.50	7.44	-2.36	9.6	9.80
52.25	7.39	-2.36	9.6	9.75
52.00	7.37	-2.36	9.5	9.73
51.75	7.33	-2.36	9.5	9.69
51.50	7.29	-2.37	9.5	9.66
51.25	7.21	-2.37	9.4	9.58
51.00	7.19	-2.37	9.4	9.56
50.75	7.16	-2.37	9.4	9.53
50.50	7.12	-2.38	9.4	9.50
50.25	7.08	-2.38	9.4	9.46
50.00	7.05	-2.38	9.3	9.43
49.75	7.00	-2.38	9.3	9.38
49.50	6.96	-2.39	9.3	9.35
49.25	6.91	-2.39	9.2	9.30
49.00	6.87	-2.39	9.2	9.26
48.75	6.84	-2.39	9.2	9.23
48.50	6.79	-2.39	9.2	9.18
48.25	6.75	-2.40	9.1	9.15
48.00	6.69	-2.41	9.1	9.10
47.75	6.62	-2.42	9.1	9.04
47.50	6.57	-2.42	9.0	8.99
47.25	6.53	-2.42	9.0	8.95
47.00	6.51	-2.42	9.0	8.93
46.75	6.49	-2.42	9.0	8.91
46.50	6.48	-2.42	9.0	8.90
46.43	6.47	-2.42	9.0	8.89
46.42	6.47	-2.42	9.0	8.89
46.42	6.47	-2.42	9.0	8.89
46.42	6.47	-2.42	9.0	8.89
46.25	6.44	-2.42	9.0	8.86
46.00	6.42	-2.42	9.0	8.84
45.75	6.39	-2.43	8.9	8.82
45.50	6.37	-2.43	8.9	8.80
45.25	6.34	-2.43	8.9	8.77
45.00	6.31	-2.43	8.9	8.74

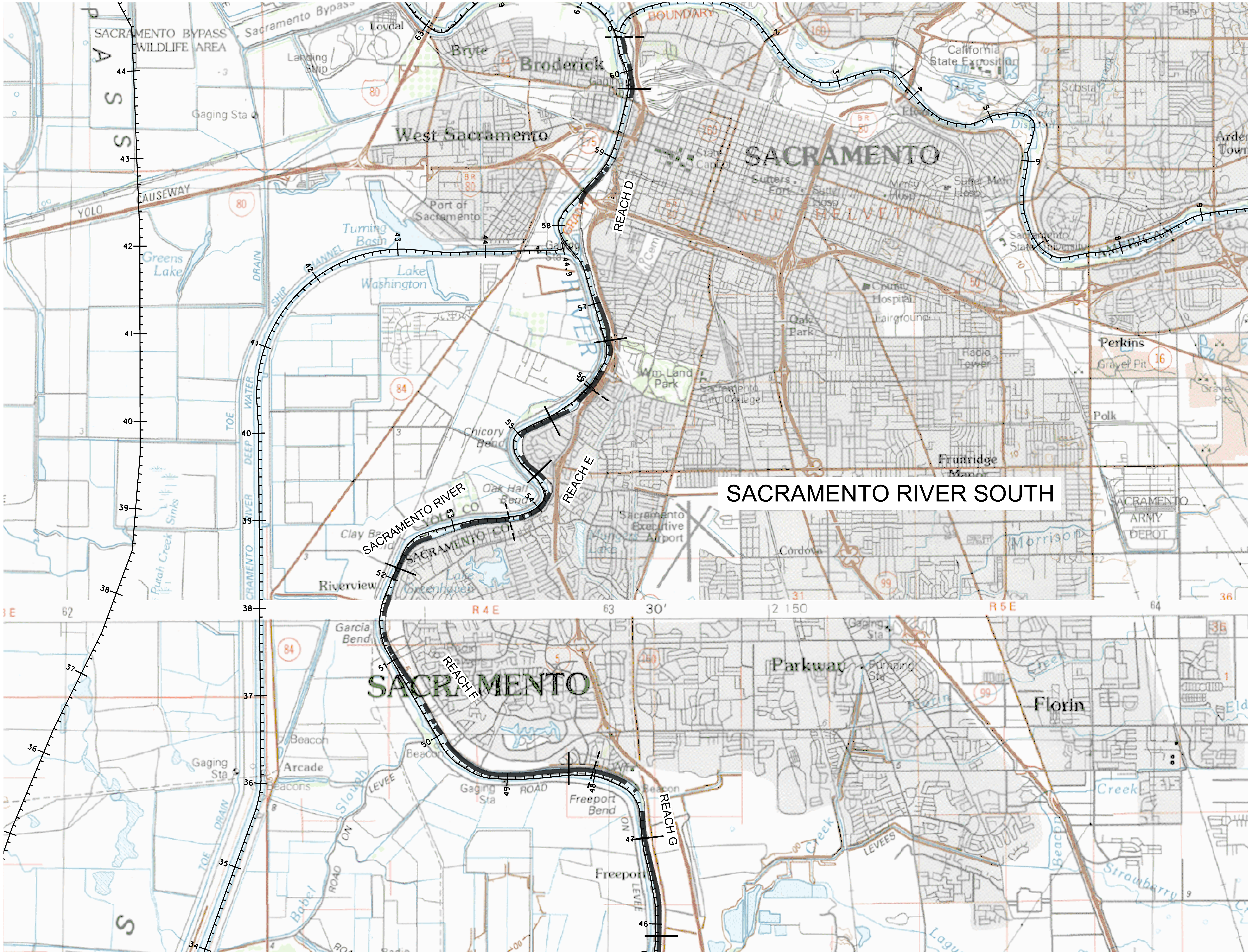
SHADED HABITAT AREA

SECTIONS ANALYZED

REACH	RM	STA	WATER SURFACE MHHW	SHALLOW END	SUMMER
D	59.80	32+00	8.6	-2.3	10.5
D	56.55	195+00	8.0	-2.3	10.0
E	55.41	260+00	7.9	-2.3	9.9
E	54.40	305+00	7.8	-2.3	9.8
F	52.13	430+00	7.4	-2.4	9.5
F	48.30	625+00	6.8	-2.4	9.1
G	46.99	700+00	6.5	-2.4	9.0
G	45.87	760+00	6.4	-2.4	8.9

IMPACTED SHADED HABITAT AREA

REACH	FEATURE LENGTH (ft)	SHA SWATH (ft) EXISTING	W/PROJECT	DIFFERENCE	IMPACTED AREAS SF	AC	WORST CASE
D	9,200	23.93	26.54	2.61	24,000	0.55	
D	9,200	53.17	26.33	-26.84	-246,900	-5.67	-5.67
E	8,850	22.84	27.97	5.13	45,400	1.04	
E	8,850	48.73	26.87	-21.86	-193,500	-4.44	-4.44
F	21,100	35.94	27.92	-8.02	-169,200	-3.88	-3.88
F	21,100	19.02	26.67	7.65	161,400	3.71	
G	11,150	29.55	26.17	-3.38	-37,700	-0.87	-0.87
G	11,150	21.05	26.07	5.02	56,000	1.29	



N

EROSION PROTECTION
REACH
ANALYSIS SECTION
RIVER MILE STATION

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SACRAMENTO, CA 95814-2922

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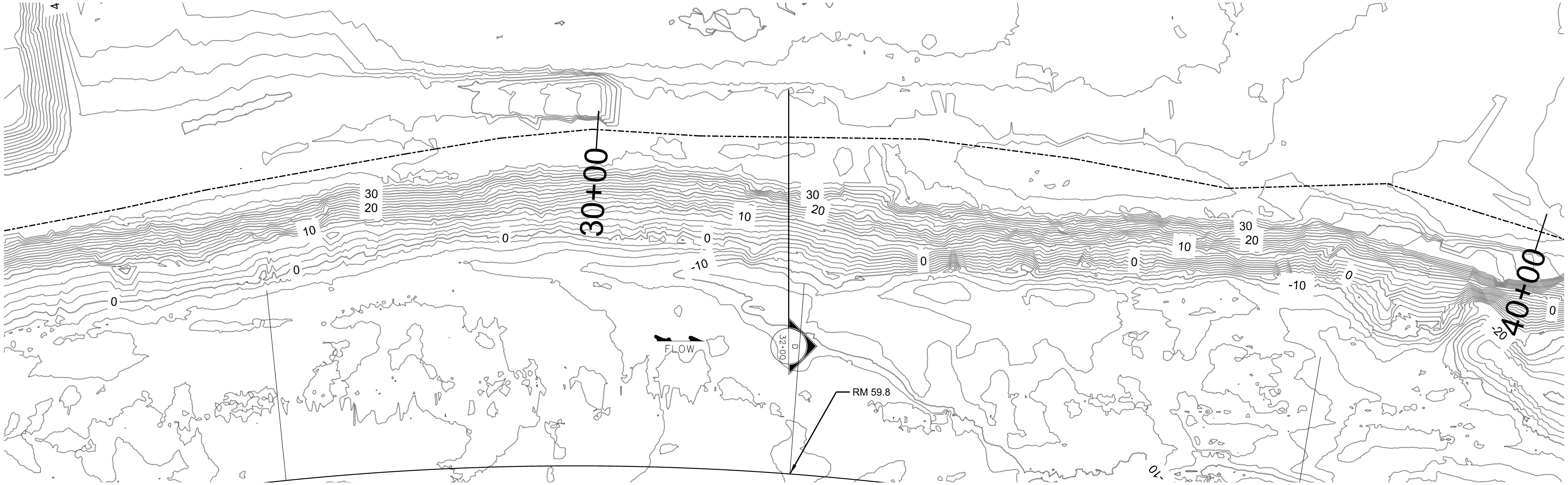
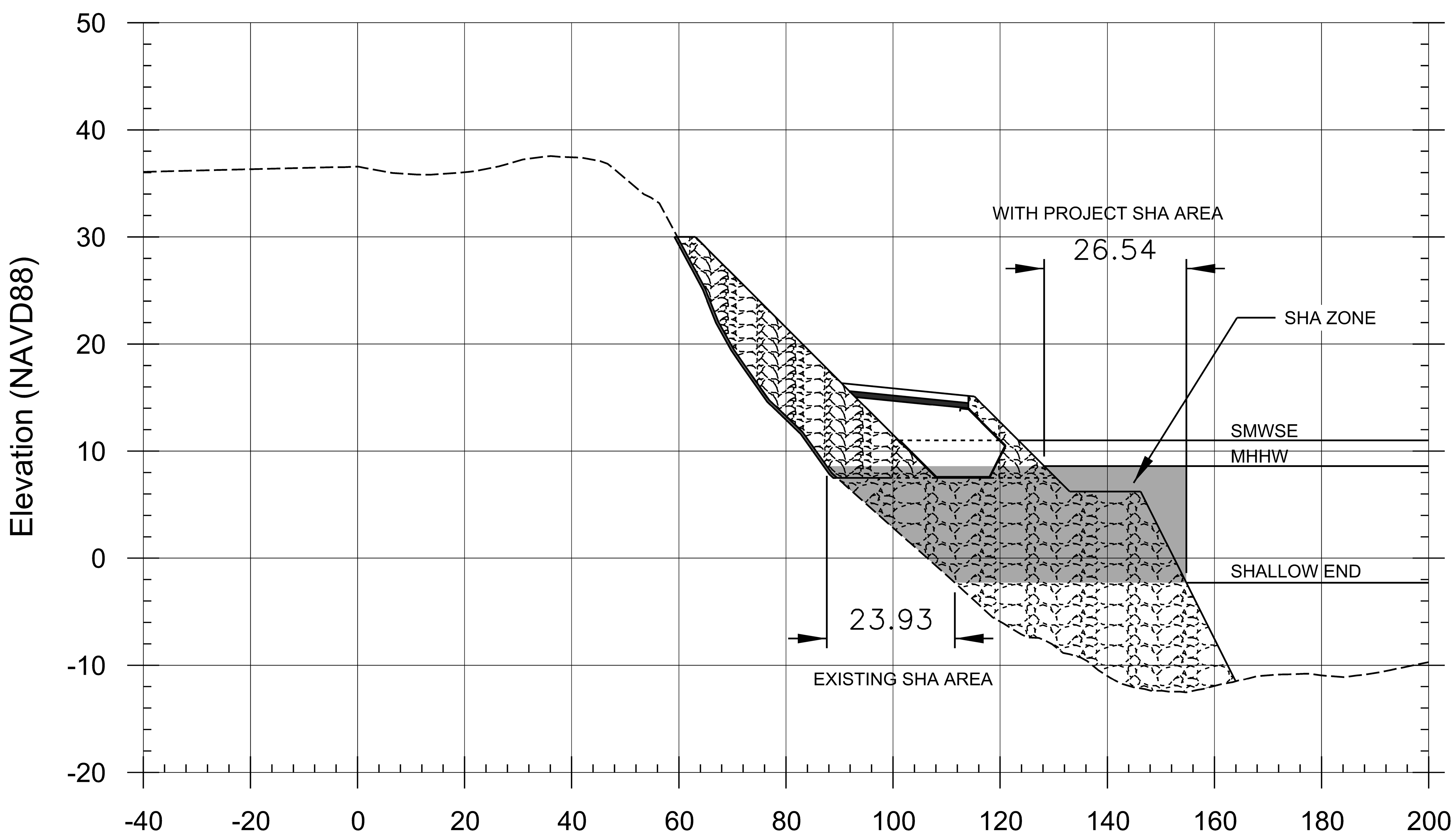
AMERICAN RIVER
COMMON FEATURES GRR

SACRAMENTO RIVER
SHA ANALYSIS OVERVIEW

Sheet reference number:
C-100





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REACH D - SHA ANALYSIS

Sheet reference number:
C-101

8.1.2
PLOT DATE: $$$$date$$$$
PLOT TIME: $$$$time$$$$
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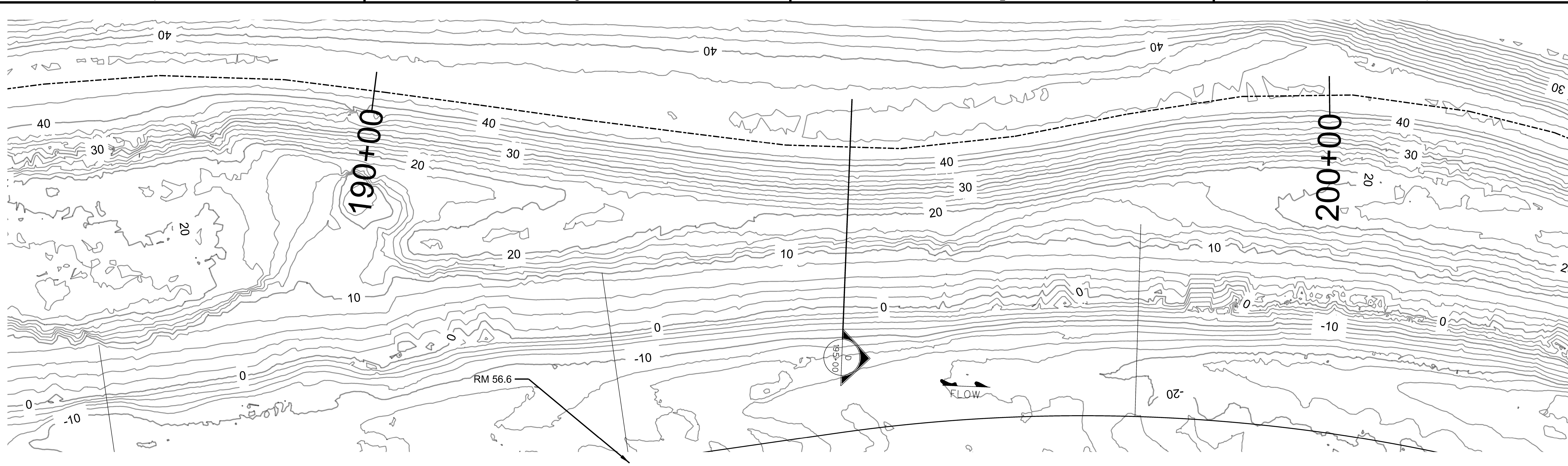

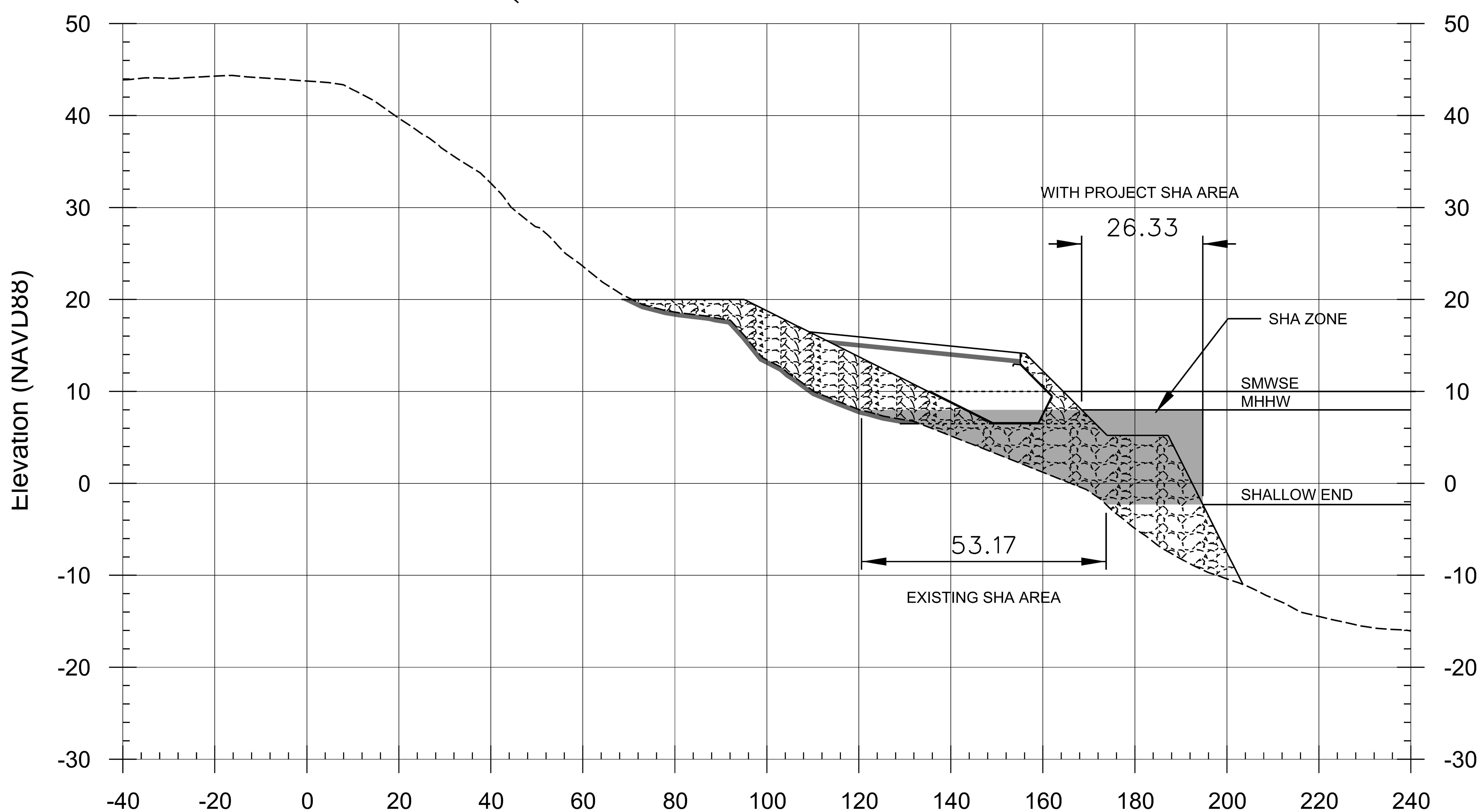

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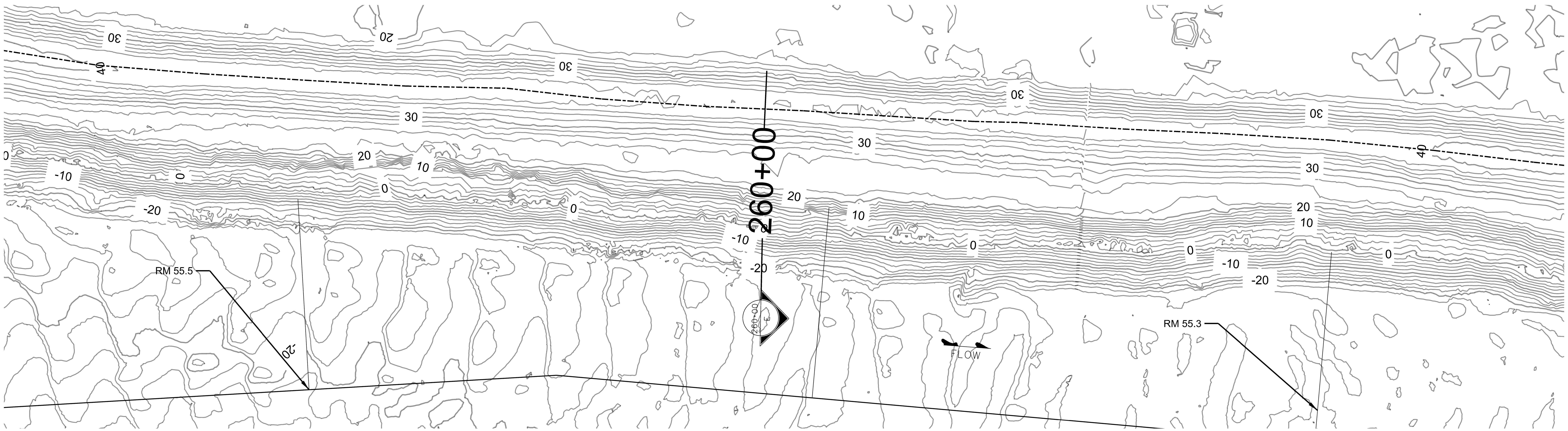
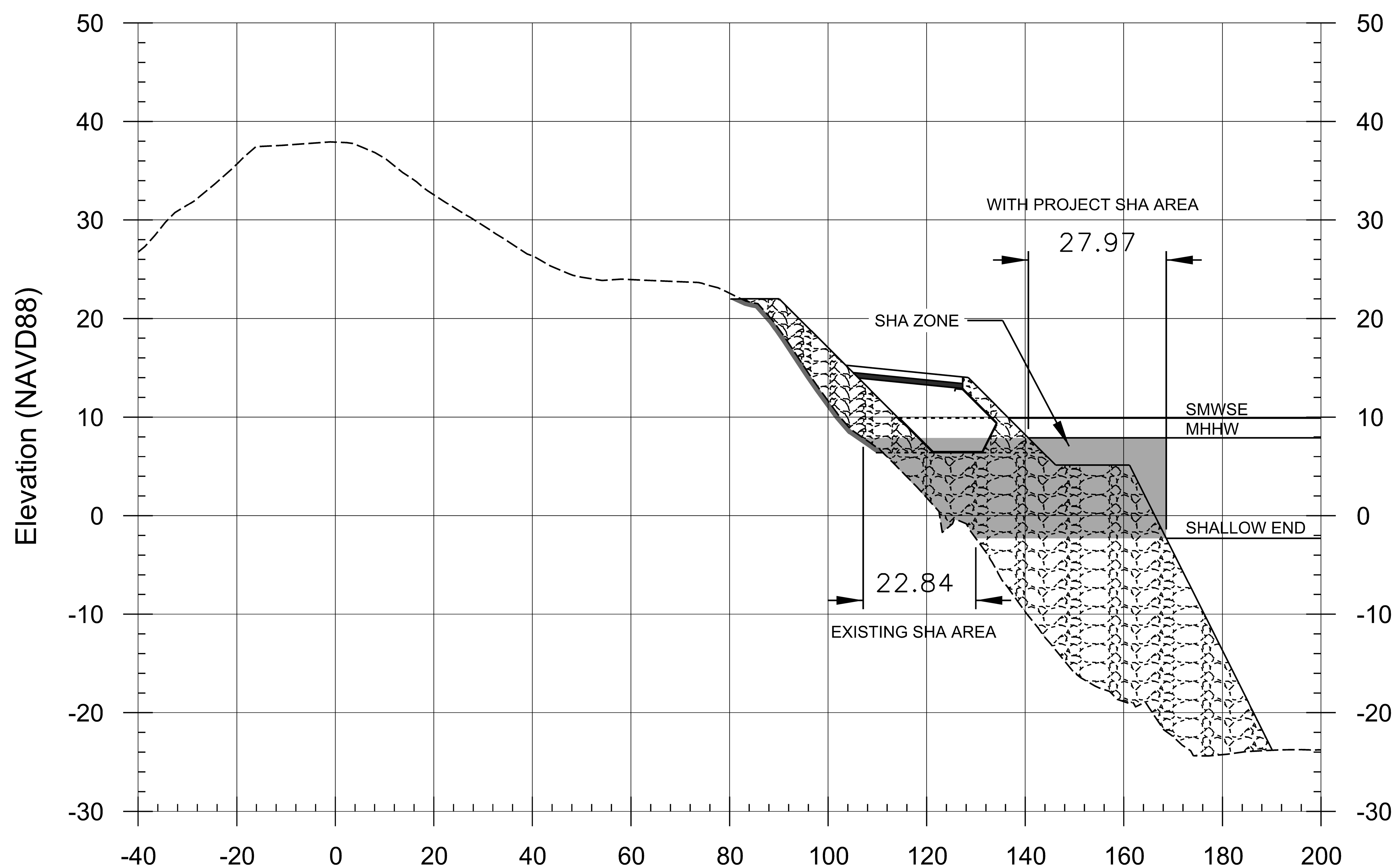
REACH D - SHA ANALYSIS

Sheet reference number: C-102

PLOT DATE: $$$$date$$$$ PLOT TIME: $$$$time$$$$ DGNSPEC





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SACRAMENTO DISTRICT IN-HOUSE DESIGN 1325 'J' STREET SACRAMENTO, CA 95814-2922	Reviewed by: REVIEWED_BY		Drawing Code: CODE
	Submitted by: / /PETER VALENTINE CHIEF, CIV ENGR DES SEC A		File name: Plot date: $$$$date$$$$ Plot scale:

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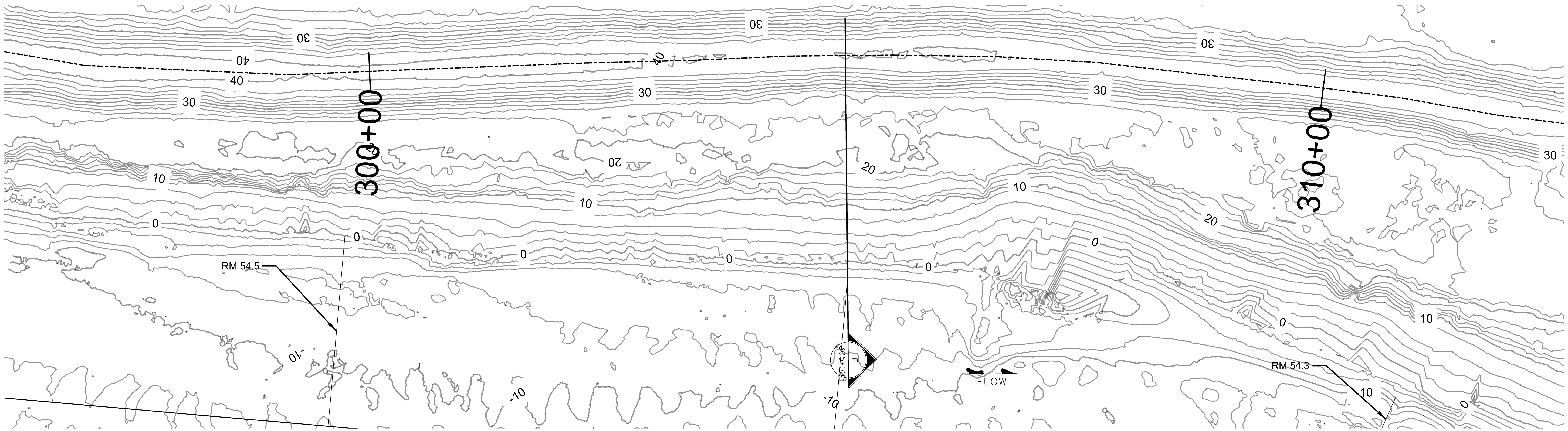
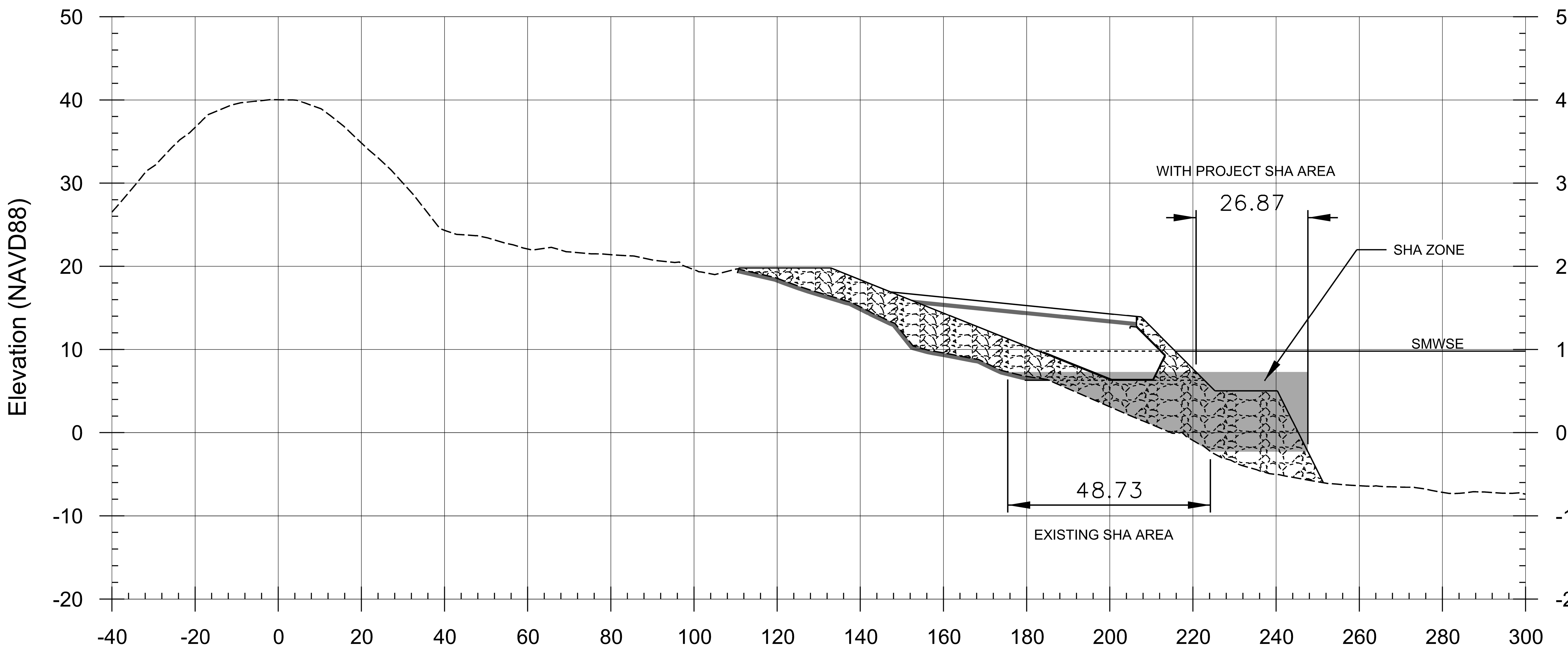
REACH E - SHA ANALYSIS

Sheet reference number:
C-103

8.1.2 PLOT DATE: $$$$date$$$$ PLOT TIME: $$$$time$$$$ DGNSPEC





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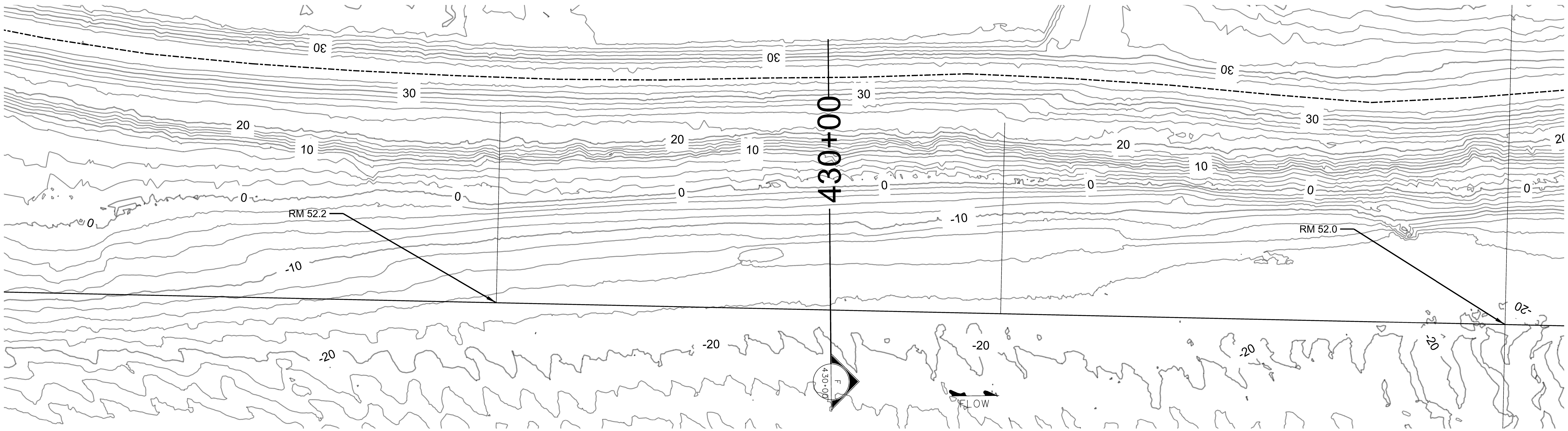
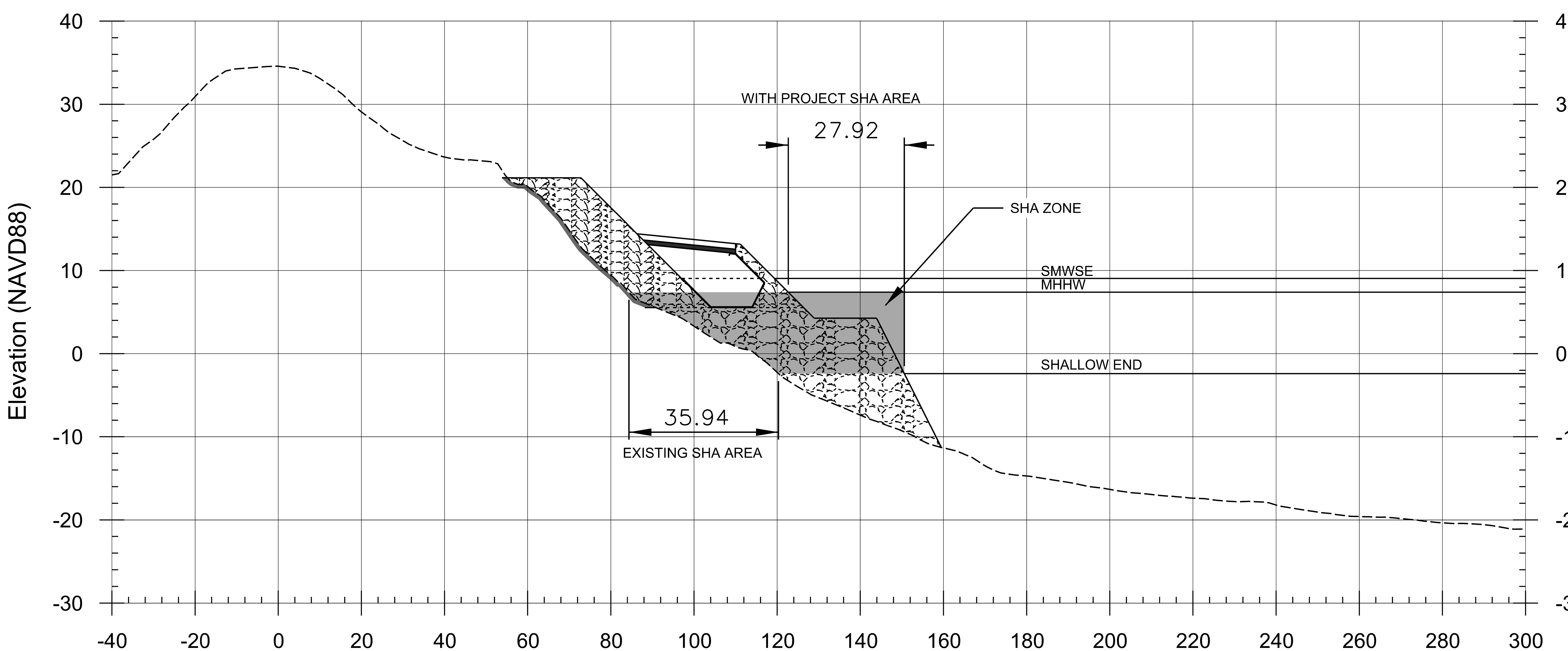
REACH E - SHA ANALYSIS

Sheet reference number:
C-104





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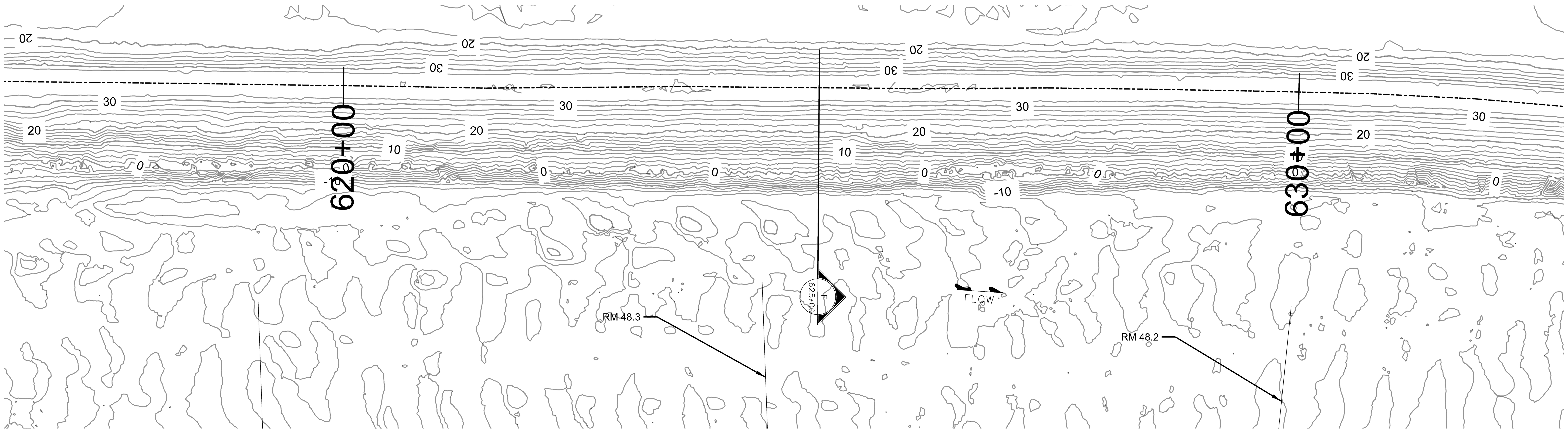
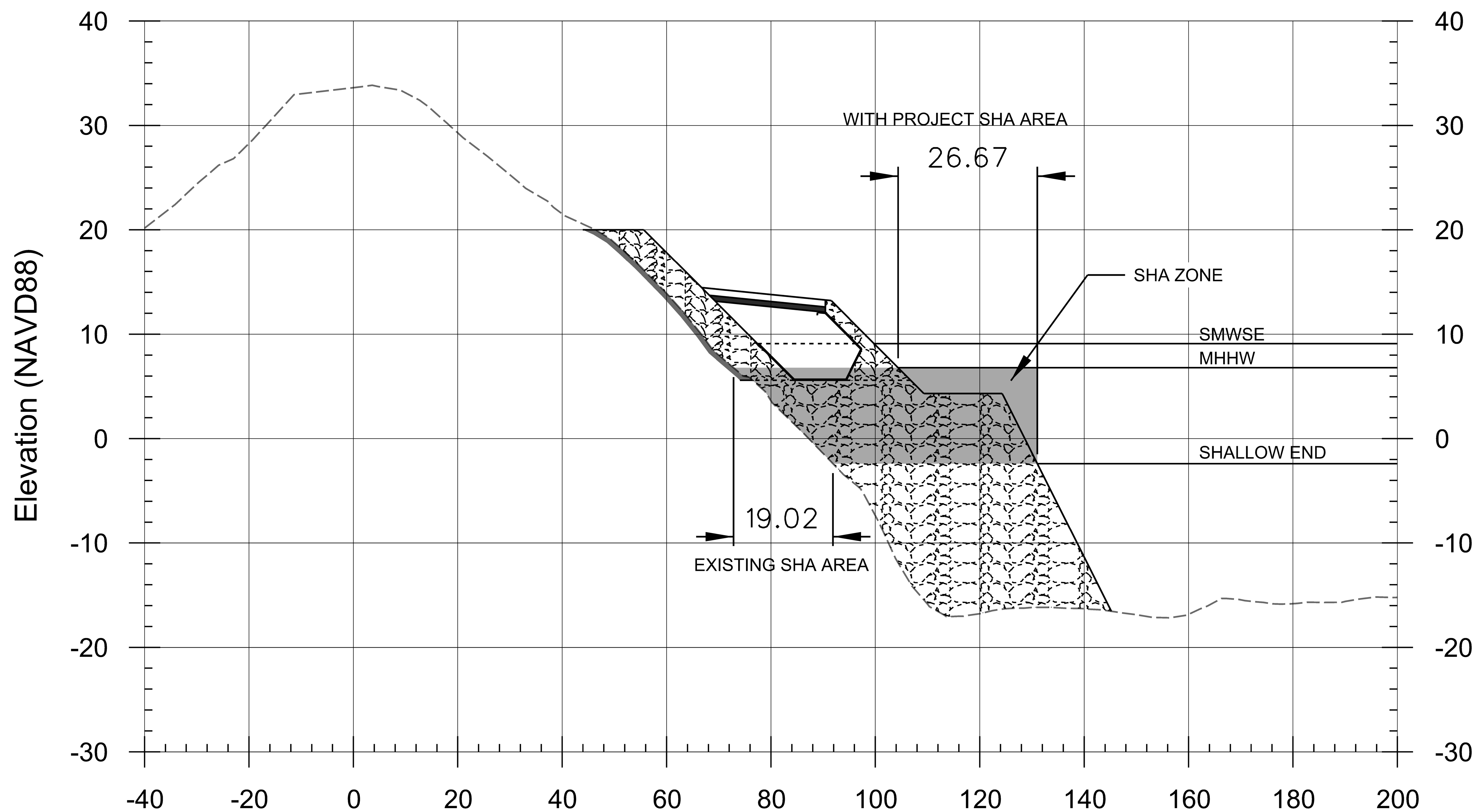
REACH F - SHA ANALYSIS

Sheet reference number:
C-105

8.1.2 PLOT DATE: $$$$date$$$$ PLOT TIME: $$$$time$$$$ DGNSPEC





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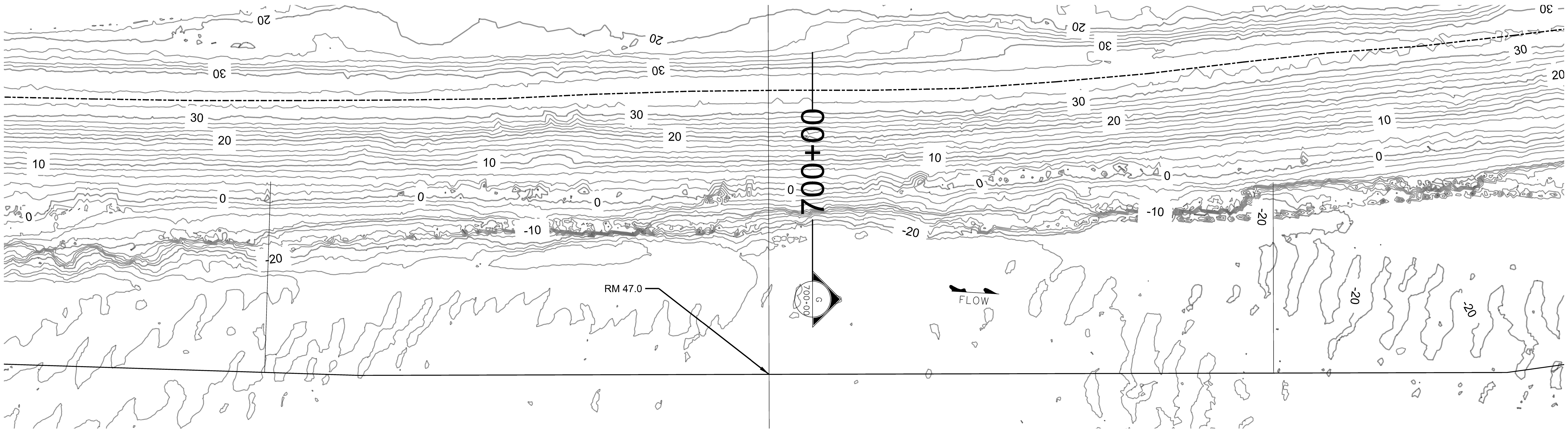
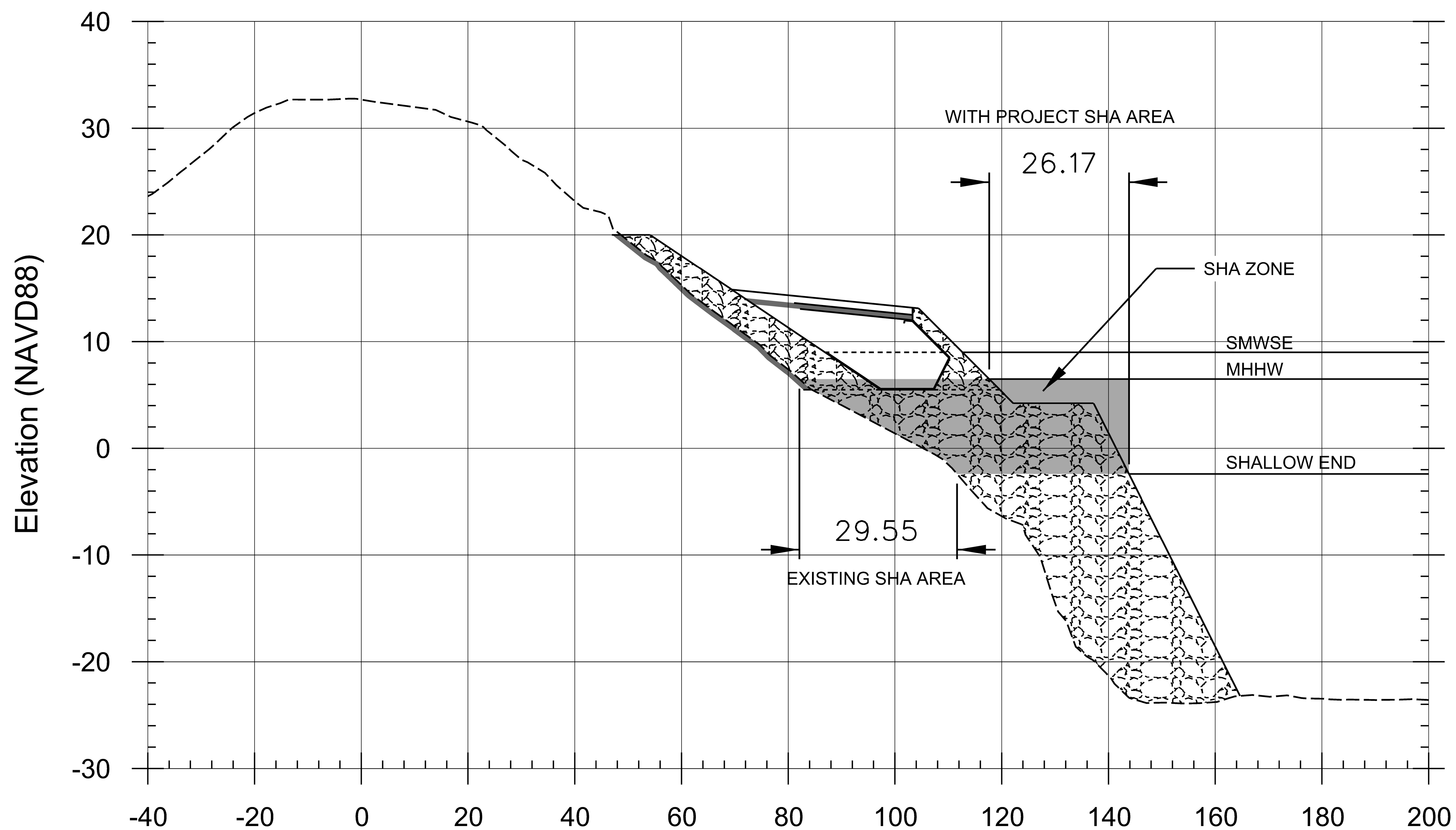
REACH F - SHA ANALYSIS

Sheet reference number:
C-106

PLOT DATE: $$$$date$$$$ PLOT TIME: $$$$time$$$$ DGNSPEC





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REACH G - SHA ANALYSIS

Sheet reference number:
C-107

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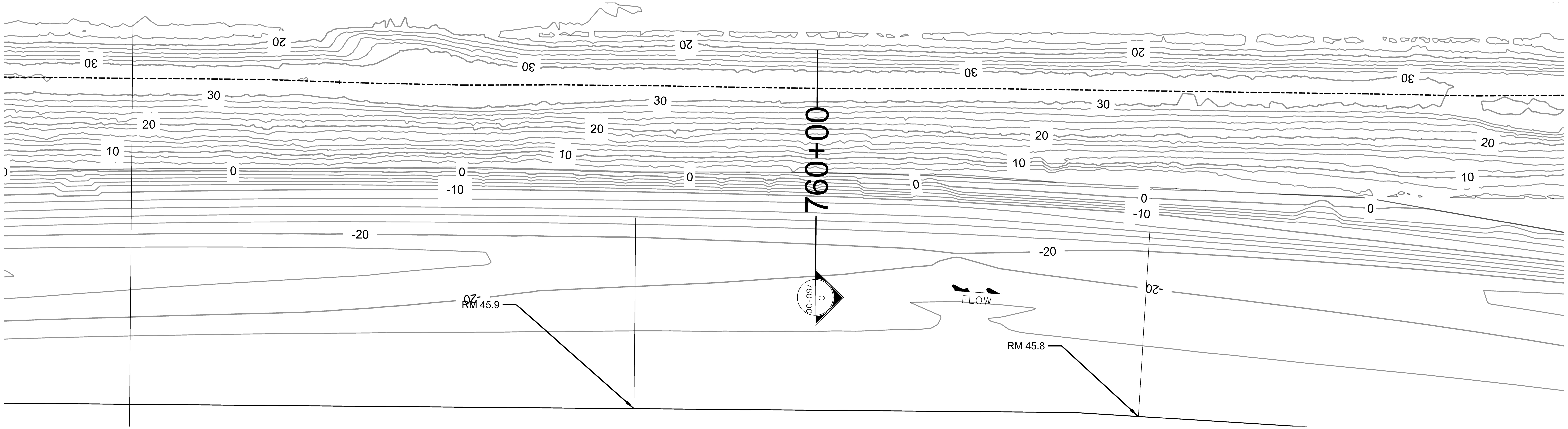

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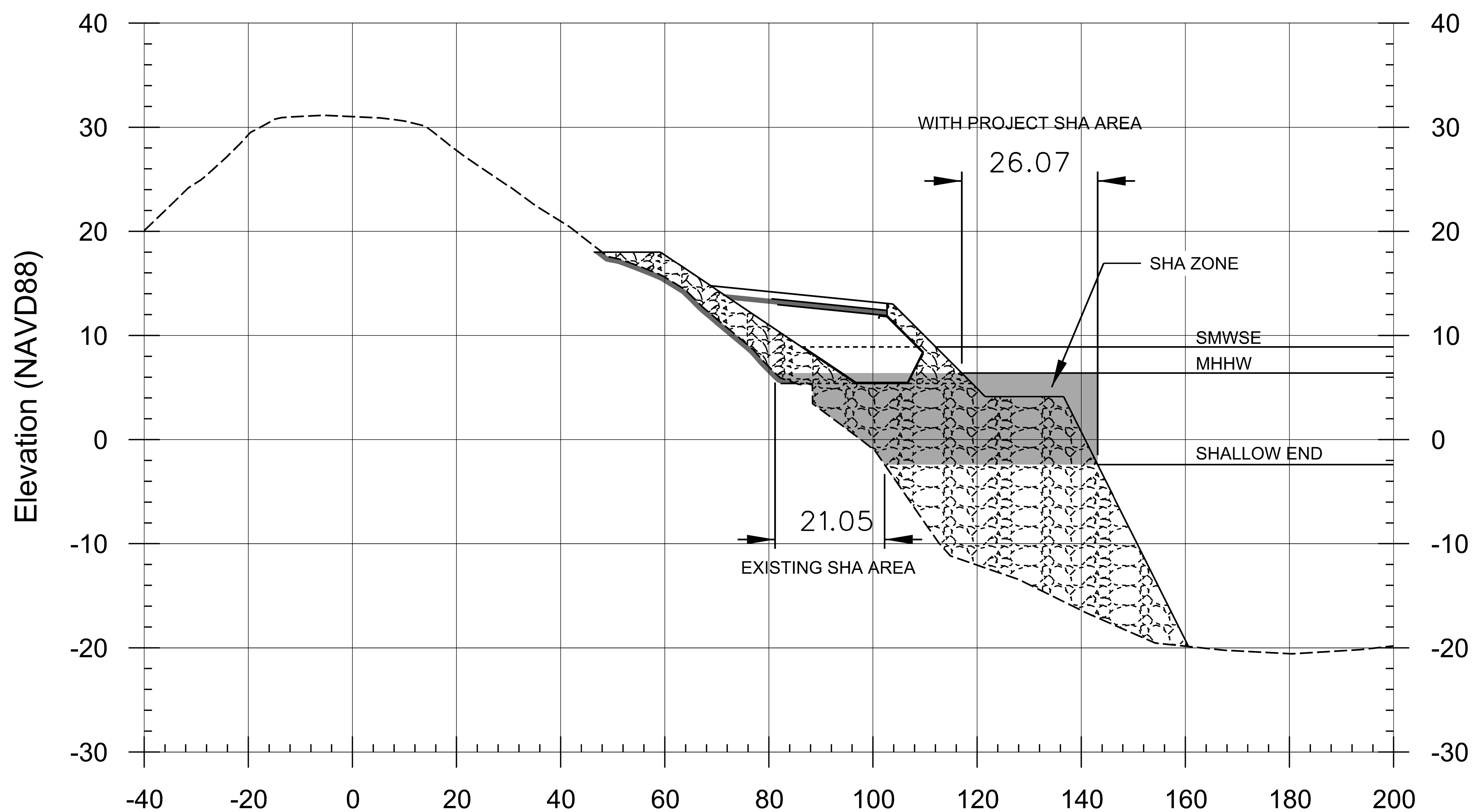

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REACH G - SHA ANALYSIS

Sheet reference number:
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