BRIEFING PACKAGE

POTENTIAL EFFECTS OF THE COSUMNES FLOODPLAIN MITIGATION BANK PROJECT ON ANADROMOUS SALMONIDS OF THE COSUMNES AND MOKELUMNE RIVERS

Prepared for:

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE

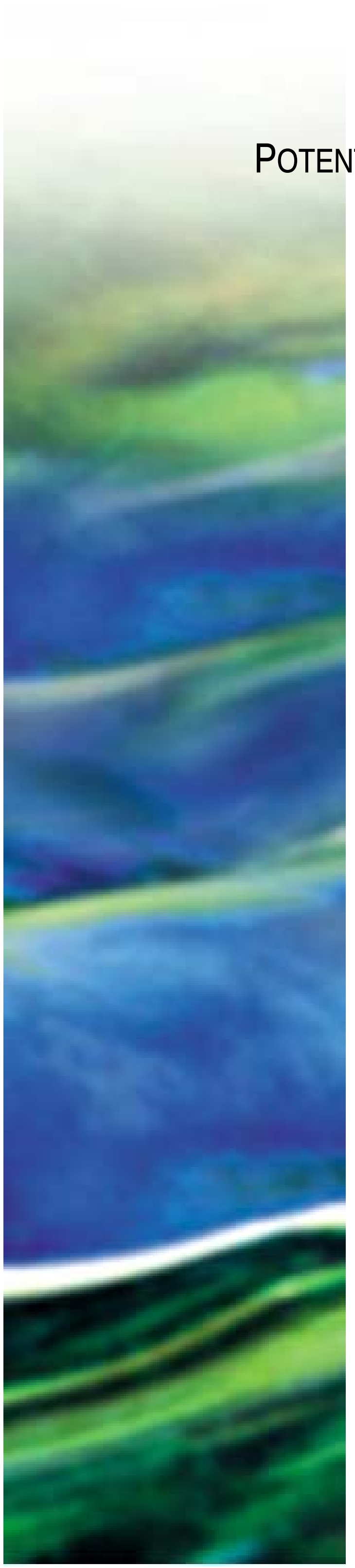
On Behalf of

WESTERVELT ECOLOGICAL SERVICES

Prepared by:

ROBERTSON - BRYAN, INC.
Solutions for Progress

March 2009



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ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
Basin Plan	Water Quality Control Plan for the Sacramento River and San Joaquin River Basins
BLM	Bureau of Land Management
BMI	benthic macroinvertebrates
BMPs	Best Management Practices
BOD	biochemical oxygen demand
CCC	criteria continuous concentration
CDEC	California Data Exchange Center
CDFG	California Department of Fish & Game
CESA	California Endangered Species Act
CEQA	California Environmental Quality Act
CMC	criteria maximum concentration
Corps	United States Army Corps of Engineers
CRG	Cosumnes Research Group
CTR	California Toxics Rule
DDT	dichloro-diphenyl-trichloroethane
DO	dissolved oxygen
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
ERPP	Ecosystem Restoration Program Plan
ESA	federal Endangered Species Act
ESU	Evolutionary Significant Unit
ft/s	feet per second
FMP	fishery management plans
Mg	mercury
L	liters
MDB&M	Mt. Diablo Baseline & Meridian
MeHg	methyl mercury
MSA	Magnuson-Stevens Conservation and Management Act
NGVD	National Geodetic Vertical Datum
NOAA	National Marine Fisheries Service
NOEC	no observed effects concentration
NTR	National Toxics Rule
NTU	Nephelometric Turbidity Units

OHW	ordinary high water
PCBs	polychlorinated biphenyls
RBI	Robertson-Bryan, Inc.
REC	Recognized Environmental Concerns
RM	river mile
SRA	Shaded Riverine Aquatic
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TNC	The Nature Conservancy
TSS	total suspended solids
U.S. EPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WES	Westervelt Ecological Services

1 INTRODUCTION

1.1 Project Overview

Westervelt Ecological Services (WES) has proposed a 472.44-acre floodplain restoration project on a 493-acre site located near the confluence of the Cosumnes and Mokelumne rivers in southern Sacramento County, north of the rural San Joaquin County community of Thornton (**Figure 1**). The Cosumnes Floodplain Mitigation Bank (Project) proposes to restore wetland and upland floodplain riparian forest through a combination of active planting and natural process restoration following reintroduction of natural tidal and flood flows on the site. Reintroducing natural tidal and flood flows will require the construction of an engineered breach in the existing perimeter levee adjacent to the Cosumnes River on the north side of the property.

The proposed Project will restore the entire property to naturally sustained riparian and wetland habitats through construction of a levee breach on the Cosumnes River, excavation and re-establishment of tidally influenced channels, construction of low-floodplain benches adjacent to channels, construction of mounds to increase topographic complexity, and strategic planting of native riparian plant species. Breaching the levee and excavating the channels will restore the hydrologic flood regime of the Cosumnes River to the Project site and will also re-introduce natural tidal flows to the site during low-flow periods (i.e., summer and fall).

The Project site will be primarily influenced by the hydrology of the Cosumnes River, however, Grizzly Slough, Bear Slough, and Dry Creek—three smaller tributaries that also drain to the vicinity of the Project site (**Figure 2**)—may contribute to the overall hydrologic function of the Project. A review of historical maps and a 1929 aerial photograph indicate that the site once supported several small distributary channels flanked on either side by riparian forest. The proposed Project will provide aquatic and terrestrial wildlife benefits and wetland services by restoring floodplain ecological function. The Project will also increase the flood capacity of the Cosumnes floodplain. Additionally, the Project will add to the larger regional conservation effort centered on the riparian and floodplain ecosystems of the Cosumnes River within the Cosumnes River Preserve, a joint conservation project spearheaded by The Nature Conservancy (TNC), Sacramento County (County), California Department of Fish and Game (CDFG), and Bureau of Land Management (BLM).

The restoration of natural (i.e., prior to anthropogenic alterations) riverine processes and habitats to the lower reaches of the Cosumnes River will benefit a variety of fishes endemic to California, many of which are adapted to annual flooding of the low-elevation lands adjacent to the lower reaches of Central Valley rivers and creeks. The native fishes that are expected to benefit from the proposed Project include Central Valley fall-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley steelhead (*O. mykiss*), Sacramento splittail (*Pogonichthys microlepidotus*), Sacramento blackfish (*Orthodon microlepidotus*), and hitch (*Lavinia exilicauda*).

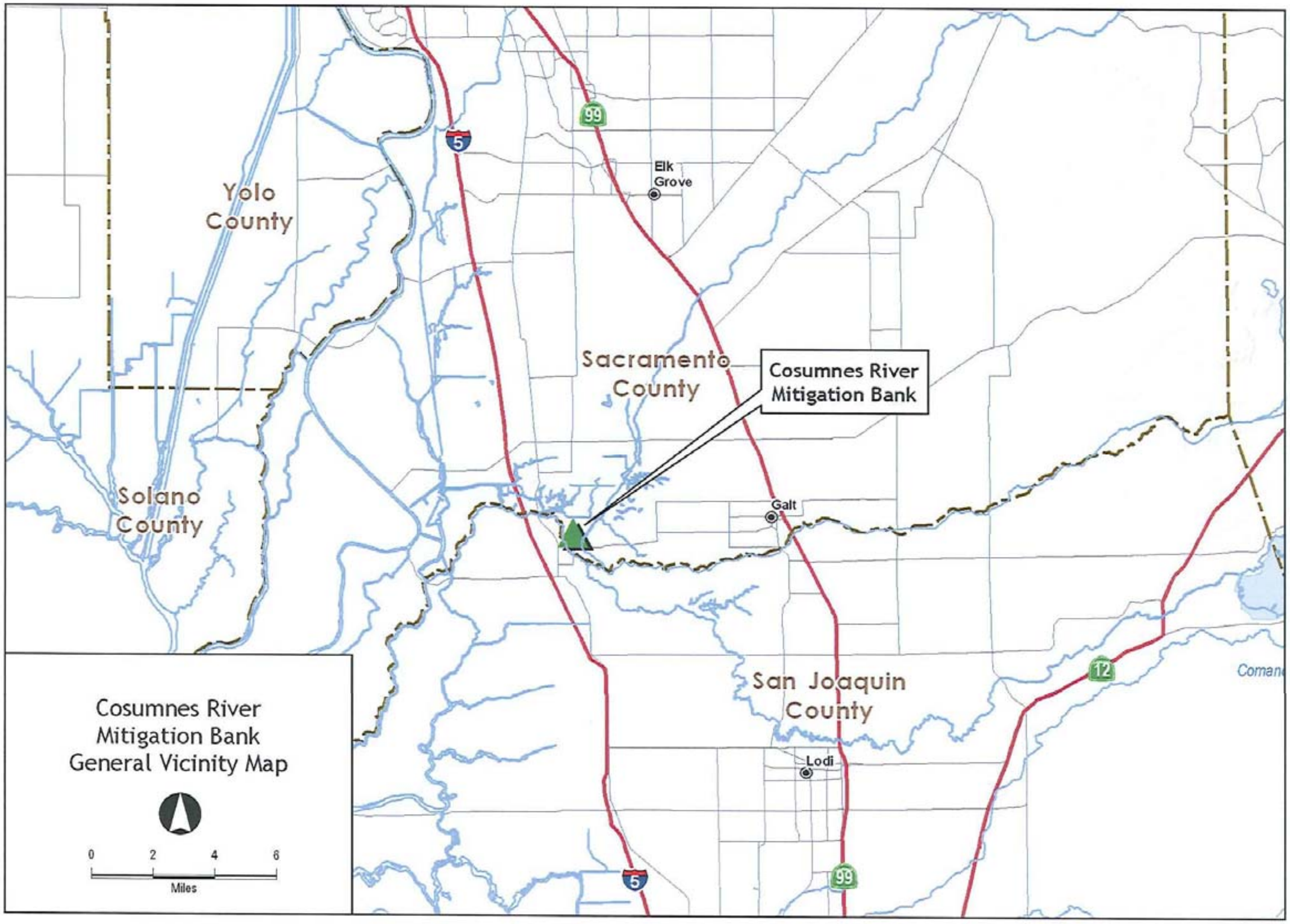

Figure 1. Regional map of the New Hope Mitigation Bank Project.

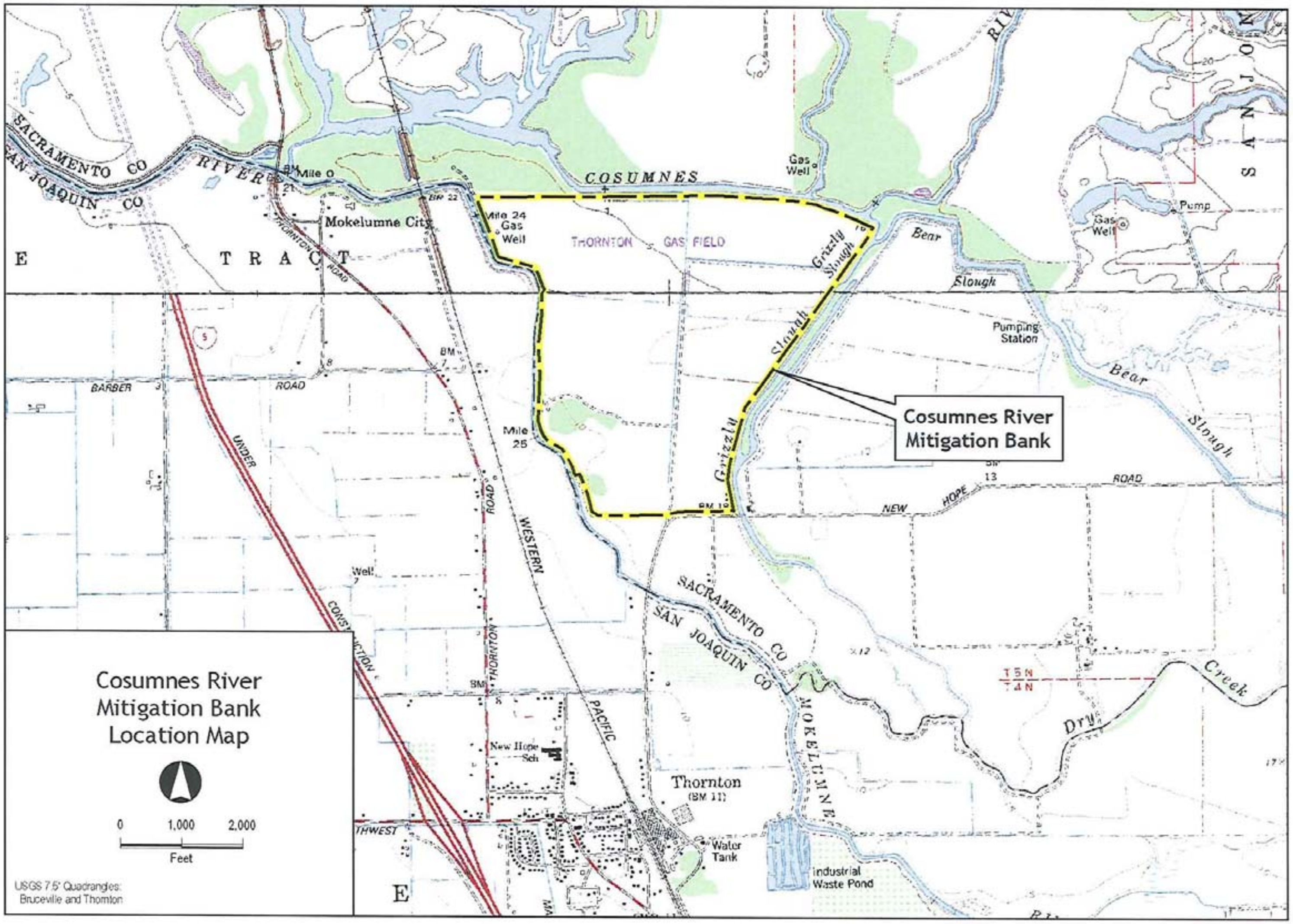

Figure 2. Location of the New Hope Mitigation Bank Project

1.2 Briefing Package Purpose

The purpose of this briefing package is to provide an overview of the proposed Project, the potential impacts of the proposed Project on anadromous fishes falling under NMFS' jurisdiction, and a preliminary assessment of the likelihood of those impacts to have population-level effects on those fishes and their habitat, including critical habitat or Essential Fish Habitat (EFH). The Project effects that have the potential to adversely affect steelhead and Chinook salmon, or their habitats, including any critical habitat, are:

1) temporary water quality and habitat alteration of the Cosumnes River associated with construction of the Project;
2) noise and disturbance associated with construction-related activities, which may temporarily delay or impede migration of anadromous salmonids past the Project site;
3) alteration of habitat, including Essential Fish Habitat and critical habitat, for anadromous salmonids potentially occurring in the Cosumnes and Mokelumne rivers;
4) stranding of juvenile anadromous salmonids on the floodplain habitats created by the Project;
5) increased predation of juvenile anadromous salmonids;
6) alteration of the water quality of the lower Cosumnes and Mokelumne rivers; and
7) altered in-stream thermal and dissolved oxygen (DO) conditions.

Each of these potential project effects is assessed in detail in Section 4 of this document.

2 PROJECT DESCRIPTION

This section summarizes the purpose of the Project, location and characterization of the physical characteristics of the Project site, Project design, construction methods and timing, monitoring and measures for avoiding or minimizing adverse environmental effects associated with construction and long-term maintenance and monitoring of the proposed Project.

2.1 Project Purpose

The Project is a mitigation bank proposed by WES that will serve as mitigation for impacts associated with projects occurring within the greater service area of the Project, rather than a mitigation proposal corresponding to specific impacts associated with a discrete project. Consequently, the habitat(s) proposed for creation within the Project are not intended to provide features, functions, or values that directly correlate to a specific project's wetlands or species.

Instead, the Project design has been developed with specific attention to the site-specific ecological characteristics that would allow for the greatest provision of wetland services of the habitat(s) being restored. Design factors have been targeted to create the best fit to landforms, habitats, and ecological processes on the site, with particular attention to topography, soils, and hydrology. Based upon the characteristics of the habitat features proposed in the Habitat Development Plan (WES 2008) for the proposed Project, the U.S. Army Corps of Engineers (Corps), U.S. Environmental Protection Agency (USEPA), and CDFG (collectively referred to as “Agencies”) will assess the applicability of Bank credits to serve as mitigation for Project-related impacts within the Bank’s service area.

2.2 Project Location and Characteristics

The 472.44-acre Project is located in an unincorporated portion of southern Sacramento County, south of the city of Elk Grove and west of the city of Galt (Figure 1). The 493-acre property on which the Project occurs is owned in fee title by WES. The Bank will be established within the following assessor parcel numbers: 146-140-003 and 146-140-004. Access to the Project site is off New Hope Road; the nearest major crossroad is Interstate 5 and West Walnut Grove/Thornton Road (Figure 2). The Project location corresponds to portions of Sections 26, 27, and 34 of Township 5 N, Range 5 E, MDB&M, of the Thornton, California 7.5 minute quadrangle [U.S. Department of the Interior, Geological Survey].

The Project site consists primarily of cultivated soils and has been used continuously for agricultural production since conversion to agriculture (i.e., levee construction and clearing). The site is bordered by levees, which contain oak and mixed riparian forest, with scattered patches of riparian scrub. One remnant stand of Great Valley valley oak occupies a small, circular area in the southwest portion of the property. The soils within the property are composed primarily of clay and sandy loam.

2.3 Project Design

As part of construction planning, a preliminary grading plan was completed for the property (**Figure 3**). The topographic contours in the grading plan are designed to re-establish daily tidal inundation over a portion of the property with a diversity of depths, velocities, and subsequent vegetative communities. Layout of wetland excavations will occur using a survey grade GPS system and laser level to create onsite conditions to within sub-inch accuracy to plans. Creation activities will be conducted using heavy equipment, which may include scrapers, bulldozers, skiploaders, and a water truck. Because the proposed Project is a balanced cut-and-fill project, no excavated materials (e.g., soils) will be transported offsite or away from the restored wetlands.

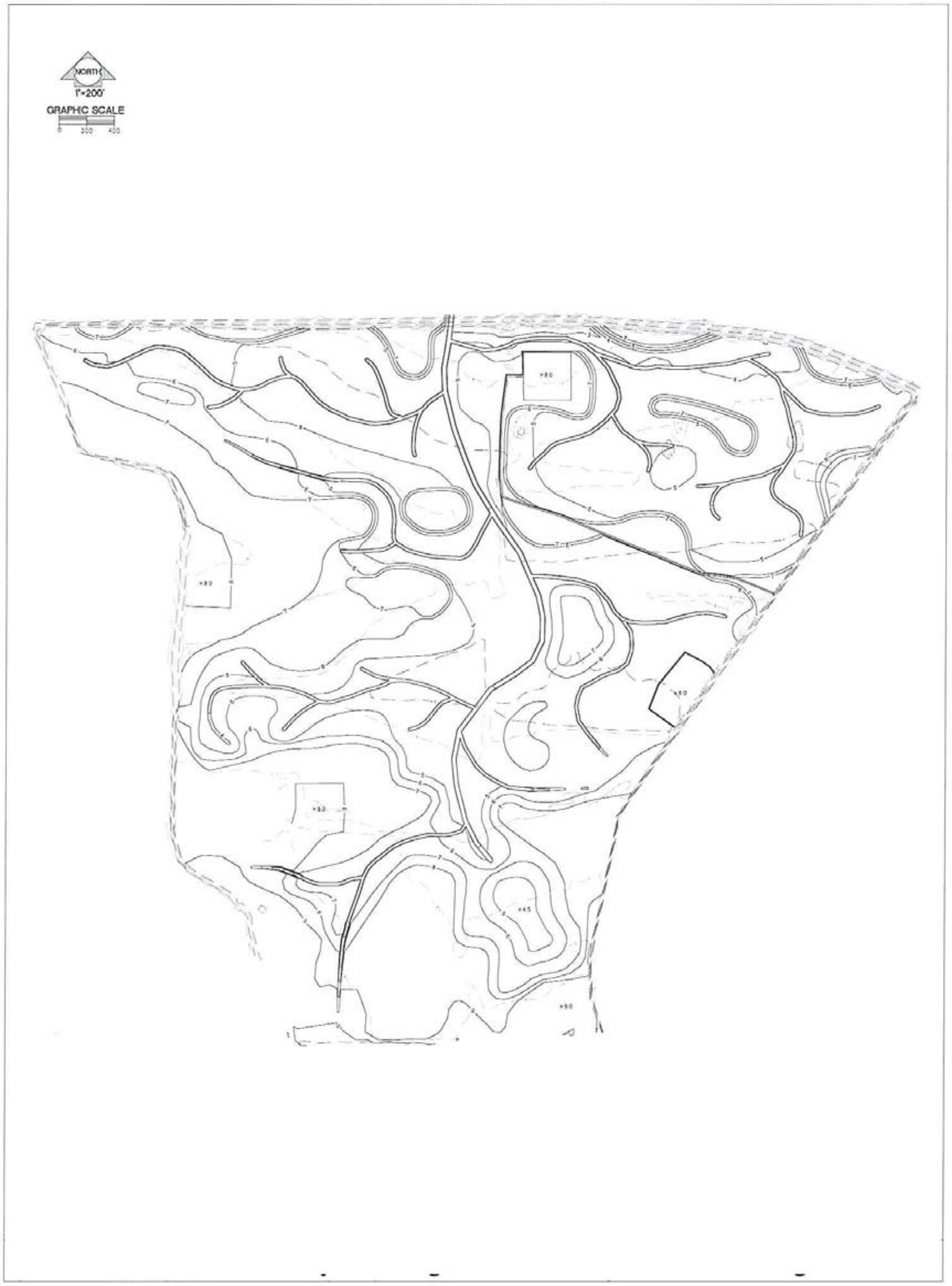

Figure 3. Preliminary grading plan for the Cosumnes River Mitigation Bank.

The Project design is intended to ensure that the restored wetlands replicate the functions and values of natural wetlands. A reference wetland, located at the adjacent Cosumnes River Preserve, was used as a model for the project design.

The Project design includes the jurisdictional wetland habitat, as well as associated riparian habitat and other waters of the United States. Each of these is discussed in the following subsections.

2.3.1 Jurisdictional Wetland Habitat

The jurisdictional wetland habitat (floodplain riparian wetlands) will be a mosaic of freshwater wetland types dominated by vegetation typically found in wetland environments that are subject to periodic inundation and saturation during the growing season. The intended wetland types include emergent, scrub-shrub and forest vegetation cover. The majority of the wetlands will be located in the northern half of the site, which has the lowest existing topography. The agricultural fields will be de-leveled to vary topography and create mounds, channels, and flats. Floodplain wetlands and shaded riverine aquatic (SRA) habitats will receive regular inundation by reintroduction of tidal action and flood flows to the site. The Project has been designed such that wetlands will occur just above the soil saturation point, at an expected elevation of 6.5 feet National Geodetic Vertical Datum (NGVD). Dendritic channels will be developed within the wetlands that connect to the levee breach.

2.3.2 Associated Riparian Habitat and Other Waters of the United States

The majority of the restored associated riparian habitat (Riparian) will be located on the southern half of the Project site. In addition, riparian areas will be located on higher mounds of excavated soil alongside cut channels and berms. The Riparian areas will cover the ground on the site above 6.5 NGVD. Snags may be added to provide nesting habitat for various bird species.

The project riparian areas will be planted with various native plant species that are associated with wetlands and floodplain environments. Floodplain Riparian Habitat (non-wetland) will likely be the only restored habitat type requiring irrigation. Because the site will be routinely flooded, drip irrigation systems cannot be used; therefore, all irrigation will be performed using border, furrow, or flood irrigation methods. The existing agricultural irrigation system, centered around a 24-inch mainline, will be adequate to provide water for any of these irrigation methods

Waters of the United States (Other Waters) are those areas subject to frequent flooding, but do not have the same three-parameter regulatory requirements (e.g., hydrological regime) as jurisdictional wetlands. Other Waters may include hydraulically connected "pockets" and "dry" channels created in the Riparian area to allow winter and spring flooding to reach the southern portion of the project site. These Other Waters are expected to be flooded from late winter/early spring runoff and are associated with the silt loam and sandy loam soils of the gently sloped floodplain landform.

2.4 Timing of the Proposed Project

Construction of the Project is proposed to occur over two seasons. The first phase of construction will entail excavating the tidal channels and floodplain benches and is scheduled to occur in summer 2009 and, barring any delays (e.g., weather, permitting), will be completed prior to the end of fall 2009. Floodplain riparian forest (non-wetland areas) plantings will occur in fall 2009. The second phase of construction planned for summer 2010 entails planting the constructed channel banks with riparian shrubs and trees and excavating the breach on the Cosumnes River. Any subsequent planting will occur in fall 2010.

2.5 Monitoring

Section E of the Habitat Development Plan (Appendix A) describes the Project's monitoring methods specifically related to wetland performance as mandated by the mitigation banking approval process. The floodplain wetlands will be monitored annually over a 5-year period for the following biotic and abiotic attributes:

- frequency and duration of overbank flooding,
- average depth of inundation,
- floodplain roughness,
- tree basal area,
- shrub stem density,
- herbaceous cover,
- plant species composition,
- organic horizon biomass,
- coarse woody debris volume, and
- surface water connections.

In addition, the total length of shaded riverine aquatic habitat will be quantified using low-level aerial photography during monitoring years 3 and 5. Floodplain riparian forest will be monitored during the summer using a complete count method during the first 2 years of monitoring. Wildlife monitoring and avian surveys will be conducted annually over the 5-year monitoring period. Ground-level photographic documentation will be conducted annually during early summer at a minimum of 15 fixed locations, including the breach site.

Performance monitoring related to potential impacts to anadromous salmonids will also be completed as part of the Project's overall monitoring program. This additional monitoring, which will include fisheries and water quality sampling, will be conducted to evaluate Project effects on anadromous salmonids utilizing the floodplain. Assumptions to be tested through this additional monitoring include: (1) juvenile anadromous salmonids will utilize the restored floodplain; (2) stranding and predation of salmonids will not occur on the restored floodplain; and (3) post-construction water quality will not adversely affect anadromous salmonids.

Following each year of monitoring, Westervelt will incorporate the results of the fisheries and water quality monitoring into a technical memo, which will include the results of that year's monitoring results, and an evaluation of impacts to salmonids and their habitats, and forward it on to NOAA Fisheries. After two years, NOAA Fisheries staff and Westervelt will agree on whether continued monitoring is necessary to determine if the Project is adversely affecting anadromous salmonids.

A monitoring plan for the Cosumnes Floodplain Mitigation Bank, including a detailed schedule, will be vetted with NOAA Fisheries prior to initiation of sampling, nevertheless, an overview of the fisheries and water quality monitoring components are detailed below.

Fisheries Monitoring

Fisheries monitoring will be conducted during season and tidal inundations beginning two weeks after the initial seasonal inundation of the Project site. Seasonal inundation sampling will occur for two years and tidal inundation sampling will occur for one year following the initial inundation. Sampling rates will be dependent on the frequency and duration of inundations, to be determined following an analysis of actual inundations patterns, including residence time, of the Project site. However, sampling frequency will occur on a frequent enough basis to assure adequate data for the purpose of determining species composition of fishes utilizing the Project site. Species composition and presence of juvenile anadromous salmonids will be determined by using beach seines to sample a minimum of five sites. The sites will include areas within and outside of the dendritic channels. If any piscivorous fishes (e.g., Sacramento pikeminnow, largemouth bass, sunfishes) are captured during these monthly samplings, stomach contents will be sampled to determine if predation on juvenile anadromous salmonids is occurring. In addition, during each sampling the entire Project site will be assessed for stranding potential. If areas of pooled water are located, beach seines will be used to determine if any fishes, including juvenile anadromous salmonids, are stranded.

Water Quality Monitoring

Constituents of concern that could adversely affect anadromous salmonids will be monitored, including pesticides, metals, dissolved oxygen, temperature, and suspended sediment. Dissolved oxygen, temperature and turbidity measurements will be taken during the monthly fisheries monitoring described above. Monitoring for pesticides, metals, and suspended sediment will require separate water quality samplings.

Construction of the Project will occur in two phases and will result a period of site stabilization over 1 year long before the levee breaching and inundation begins. The stabilization period will allow current-use pesticides and other constituents of concern to degrade and lessen the potential for adverse runoff effects. In addition, it is expected that the potential for long-term exposure of potential constituents of concern would decrease over time as the Project site becomes stabilized. Therefore, the critical time period for monitoring water quality constituents of concern is immediately following the initial inundations of the Project site.

Because it is expected that potential water quality impacts would decrease over time as the Project site becomes stabilized, water quality monitoring will only be conducted for the first year following the initial inundation. A total of four samplings will be completed, two during seasonal inundations and two during tidal exchanges. The first sampling will occur within two weeks of the initial seasonal inundation. Each sampling will consist of collecting water samples at three locations, 1) within the Project site, inland from the breach location, in order to ensure worst case water quality, 2) upstream of the breach, to be used as a baseline, and 3) downstream of the Project site, in order to determine if there are downstream effects of the project. Constituents to be sampled for include suspended sediment, pesticides, and metals. Results of the water quality monitoring will be forwarded on to NOAA Fisheries staff immediately following receipt of the results of each sampling period and will be included in the annual monitoring reports.

2.6 Maintenance

WES will be responsible for the long-term management and maintenance of the Bank. Should any deficiencies in infrastructure or changes in the biotic communities become apparent, maintenance activities will be implemented to rectify the situation. The Project site will be kept free of trash and debris. Existing fencing and gates will be repaired and replaced, as needed and additional fencing and gates may be constructed to control trespassing. Signs prohibiting trespassing will be posted and maintained, as necessary. Grazing on the Project site will be prohibited during the initial establishment period, but may be allowed on a limited and prescribed basis over the long-term to reduce the amount of vegetative biomass. If it is determined that non-native, invasive plants are identified as decreasing the function or value of the restored habitat, appropriate control measures (e.g., mechanical or chemical) will be implemented.

2.7 Avoidance Measures

Construction of a levee breach, channels and floodplain benches will result in the creation of approximately 285 acres of jurisdictional wetlands and associated riparian areas. Construction will be managed to ensure that the habitats are constructed as designed, and that any existing habitat features are avoided to the maximum extent feasible. To protect existing habitat at the Project site during construction, the following measures will be implemented:

- A WES ecologist or biologist familiar with restoration will observe and manage construction activities on a daily basis. The representative will have the authority to stop construction activities if situations arise that could be detrimental to the existing habitats. Construction will be allowed to resume only after corrective actions have alleviated the potential for detrimental activities.
- Erosion control Best Management Practices (BMPs) will be implemented as needed, including but not limited to: grading during the dry season, compaction of berms and upland spoils, and seeding and mulching areas of exposed soil.
- Prior to construction, existing wetland habitat to be preserved will be marked on construction drawings and protected during construction using exclosure fencing. Vehicle movement corridors and haul routes will be marked on construction drawings to minimize vehicle movement across the site.
- Careful application of water to the stockpiled soils will reduce the potential for air quality contamination by fugitive dust. Watering of other exposed soils related to construction activities will be necessary for dust control and soil compaction.
- All construction staging activities will occur within a designated area, to be identified by the restoration ecologist. This site will be located no closer than 200 ft from any existing threatened or endangered species habitat (e.g., valley elderberry), and will be marked in the field and on the construction plans. All refueling and maintenance activities will occur within the staging area. Any spill of hazardous materials will be cleaned up immediately, in accordance with all federal, state, and local regulations.
- Additional measures to minimize impacts to the site will be identified in the Storm Water Pollution Prevention Plan (SWPPP), which will be prepared and implemented prior to the initiation of construction.

3 PROJECT SETTING

3.1 Water Bodies Potentially Affected by the Project

Two water bodies will potentially be affected by the Project: the Cosumnes River and the Mokelumne River (Figure 1, Figure 2). Both of these water bodies are located within the Lower Cosumnes-Lower Mokelumne Hydrologic Unit (USGS Hydrologic Unit # 18040005). Each of these water bodies is described in the following sections.

3.1.1 Cosumnes River

JSA (2003) provides a comprehensive characterization of habitat in the Cosumnes River watershed. The Cosumnes River watershed originates at an elevation of approximately 7,500 ft on the west slope of the Sierra Nevada in Amador County and encompasses an area of more than

600,000 acres (JSA 2003). The river flows westward to its terminus at the Mokelumne River a short distance downstream of the Project site on the floor of the Central Valley at approximately sea level.

The Cosumnes River near the Project site is characterized as having a low-gradient slope, comprised of tidally influenced slough-like channels. Substrate composition in this lower reach is dominated by fine sediments (i.e., sand, silt, and clay) with abundant rooted vascular plants (JSA 2003). Annual average precipitation in the watershed ranges from approximately 60 inches in the upper watershed to 22 inches in the lower watershed. Riparian vegetation along the lower reach of the Cosumnes River consists primarily of cottonwood, valley oak, interior oak, walnut, elderberry, blackberry, white alder, and willows (JSA 2003; U.S. Army Corps of Engineers 1991). Land use in the lower reach of the Cosumnes River is dominated by agriculture, including cropland, orchards, and vineyards. Residential and industrial land uses comprise less than 3% of the total watershed and development in the lower reach, from Highway 16 (RM 33) down to its terminus, is restricted because the river is included in the Nationwide Inventory of Potential Wild and Scenic Rivers (JSA 2003) and because much of this reach has been designated by the State as a floodway.

The Cosumnes River carries a high suspended sediment load, which likely has adverse impacts on anadromous salmonid eggs and fry. The water quality of the Cosumnes River has received relatively little attention and thus little information is available for the project area. Ahearn and Dalgren (2000) examined the relationship of water quality in the upper and lower Cosumnes River watershed and concluded that the majority of the nutrients (i.e., nitrogen and phosphorus) and suspended sediments originate from both point (e.g., wastewater treatment facilities) and non-point (i.e., urban and agricultural runoff) sources in the lower watershed. These investigators also reported that water temperature, conductivity, and pH levels generally increase downstream. Nutrient and sediment transport is greatest during the wet season and little transport occurs under dry season base flow conditions.

3.1.2 Mokelumne River

The instream habitat of the Mokelumne River from Camanche Dam downstream to the San Joaquin River confluence was characterized most recently by Merz and Setka (2004a). Results of this study indicate that over 83% of the surface area of the study reach is tidally influenced. Glides, the most prevalent habitat type, comprise 100% of the channel in the lowest portion of the study reach and 42% of the overall study area. Riffles are scarce, comprising no more than 2% of available habitat types in all portions of the study area. Substrate composition ranges from gravel/cobble/sand mixture in reaches near Comanche Dam to a mixture of mud, sand, and rooted vascular plants near the San Joaquin River confluence. The shortage of riffles with suitable gravel for spawning led to a gravel addition pilot study (Merz and Setka 2004b), which resulted in improved conditions for and, subsequently, spawning use by Chinook salmon. The lower reaches of the Mokelumne River downstream of the Cosumnes River confluence is characterized as a large tidally influenced river with a relatively uniform channel cross-section. This open-water habitat in the vicinity of the Project site is utilized by anadromous salmonids almost exclusively as a migration corridor to and from upstream spawning and rearing habitats in the Mokelumne and Cosumnes rivers.

3.2 Listed Anadromous Fish, Critical Habitat and Essential Fish Habitat in the Project Area

The Cosumnes River and its terminal drainage, the Mokelumne River, support annual runs of Central Valley Evolutionarily Significant Unit (ESU) fall-run Chinook salmon (*Oncorhynchus tshawytscha*). In addition, the Mokelumne River supports and annual run of Central Valley ESU steelhead (*O. mykiss*) and some of these fish may opportunistically stray into the Cosumnes River on occasion. Given the proximity of the breach to the confluence of the Cosumnes and Mokelumne rivers (i.e., approximately 1.25 miles), steelhead may utilize the Project's restored floodplain habitat for short-term rearing. The life history periodicity of individual lifestages of each of these fish species is discussed below.

3.2.1 Fall-run Chinook Salmon

Central Valley ESU fall-run (and late fall-run) Chinook salmon were transferred from the federal candidate species list to the federal species of concern list in 2004 (64 FR 19975; April 15, 2004). Fall-run Chinook salmon currently maintain self-sustaining populations in the Cosumnes and Mokelumne rivers, partially supplemented by stocking from the Mokelumne River Fish Hatchery, which is owned by EBMUD and operated by CDFG.

Data collected from studies conducted by EBMUD and CDFG indicate that the long-term (1940–2007) mean annual Chinook salmon escapement in the Mokelumne River was 4,212 fish. Chinook salmon numbers in the Mokelumne River generally increased from 1991 through 2005, although escapement numbers in recent years have declined precipitously. Adult fall-run Chinook salmon migrate into the Mokelumne River from September to early January, with peak immigration occurring in November. Spawning generally occurs from late October through January. The salmon eggs incubate in the gravel and hatch between late October and April, depending on time of spawning and water temperature. Fry emergence occurs from January to April and a small portion of these fish may emigrate toward the Delta immediately following emergence as post-emergent fry; however, the majority rear in the spawning areas for a period of several weeks. Emigration from the Mokelumne River is complete by July.

The Cosumnes River historically supported moderate size runs of Chinook salmon, with escapement ranging from several hundred to more than 4,000 fish between 1953 and 1973 (Snider and Reavis 2000). In recent decades, however, annual runs have ranged from 0 to approximately 1,000 fish, but have typically been less than 200 (Snider and Reavis 2000). Fish from the Mokelumne River Hatchery have been planted in the Cosumnes River and strays from the Mokelumne River (as identified by coded wire tags) are found annually in the Cosumnes River. Declines in the Cosumnes River populations are apparently due to the altered hydrology of the system during the critical salmon migration period coupled with a short supply of suitable spawning and rearing habitat. Adult immigration begins immediately upon hydraulic connection with the Mokelumne River and spawning begins soon after fish reach suitable spawning reaches. Snider and Reavis (2000) reported that 69% of all Chinook salmon spawning during the 1998–99 season occurred between Meiss Road and Highway 16. The upstream limit for salmonid migration is a series of high-gradient cascades near Latrobe Road. Fry emergence occurs through May and emigration from the Cosumnes River occurs into June, with early emigration apparently triggered by episodic flow events and later migration triggered by increases in water temperature (Snider and Reavis 2000). Sampling conducted by Whitener and Kennedy (1998) indicate that reconnection of the Cosumnes River to its floodplain provides valuable rearing habitat for juvenile Chinook salmon.

3.2.2 Central Valley Steelhead

Central Valley DPS steelhead were listed as threatened under the federal ESA on January 5, 2006 (71 FR 834); no state designation has been made. Critical habitat was designated for the Central Valley Distinct Population Segment (DPS) steelhead on September 2, 2005 (70 FR 52488) and includes the lower Mokelumne River downstream of Camanche Dam, but does not include the Cosumnes River. The Cosumnes River is designated as “occupied but excluded” from critical habitat designation within the North Valley Floor Hydrologic Unit critical habitat for Central Valley steelhead due to the “balancing process for economic impacts” associated with the critical habitat designation process (70 FR 52531). Steelhead, the anadromous form of rainbow trout, was once abundant in California coastal and Central Valley drainages from the Mexican to Oregon borders. Populations have declined significantly in recent decades, primarily due to habitat loss stemming from dam construction.

Steelhead spawning migrations into the lower Mokelumne River begin as early as August, peak in October and November, and extend into March (Merz and Saldate 2004). Spawning occurs from December through April. The majority of fry emerge from the gravel in May and early June. Fry remain in the river for one to four years before undergoing smoltification—a physiological transformation preparing fish for living in saltwater environments—prior to emigration to the ocean. Steelhead mature in 1 to 4 years at sea before returning to their natal streams to spawn. Unlike Chinook salmon, steelhead are iteroparous (i.e., able to spawn repeatedly) and may spawn for up to four consecutive years before dying; however, it is rare for steelhead to spawn more than twice and the majority of repeat spawners are females (Busby et al. 1996). Although one-time spawners comprise the majority, Shapolov and Taft (1954) report that repeat spawners are relatively numerous (i.e., 17.2 percent) in California streams.

Steelhead from the Mokelumne River Hatchery are planted annually downstream of Woodbridge Dam. The number of steelhead spawning in the Mokelumne River is unknown; however, monitoring by EBMUD indicates that small numbers are detected annually at Woodbridge Dam during the Chinook salmon immigration period. The majority of spawning occurs in the reach extending from Woodbridge Dam upstream to Camanche Dam, where habitat suitability is greatest. Likewise, the vast majority of juvenile steelhead rear in this upstream reach, although they are found all the way down to the Cosumnes River confluence (Merz and Saldate 2004).

CDFG reported that the Cosumnes River historically supported runs of steelhead (Harris 1996). The current seasonal hydrology is not conducive for supporting steelhead due to the ephemeral nature of the lower reaches. Juvenile steelhead require perennial flow, as they rear in their natal stream for a period of 1 to 3 years. A short reach of river extending from Latrobe Road downstream to Rancho Murieta flows year-round. Thus, a potential exists for steelhead from the Mokelumne River to make opportunistic use of the Cosumnes River and anecdotal evidence indicates that this may be occurring in some years; however, the probability of juveniles surviving the summer months is low due to such factors as elevated water temperatures, depressed DO levels, and predation.

3.2.3 The Magnuson-Stevens Conservation and Management Act

The Magnuson-Stevens Conservation and Management Act (MSA), as amended (U.S.C. 180 et seq.), requires that Essential Fish Habitat be identified and described in federal fishery management plans (FMPs). Federal action agencies must consult with NMFS on any activity which 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 is defined as those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity. The Lower Cosumnes-Lower Mokelumne Hydrologic Unit is identified as EFH for Chinook salmon. Because consultation on EFH is often conducted concurrently with ESA Section 7 consultations by the National Marine Fisheries (NOAA), the assessments of potential adverse effects of the proposed Project on listed salmonids also will apply to EFH.

4 Discussion of Potential Impacts to Anadromous Salmonids in the Affected Water Bodes

4.1 Construction-related Impacts

As part of the Project, the northern levee would be breached at one location adjacent to the lower Cosumnes River approximately 1.25 miles upstream of the confluence of the Cosumnes and Mokelumne rivers. Construction activities will be completed in two phases over a 2-year period and all construction activities will occur during the summer and fall months (i.e., the dry season). The Cosumnes River and Mokelumne River, which form the north and west boundaries, respectively, of the Project site, are permanently wetted and tidally influenced in the Project vicinity. Consequently, early immigrating adult fall-run Chinook salmon and/or steelhead may be present in the vicinity of the Project during both phases of construction. The construction-related activities with the potential to affect anadromous salmonids and their habitat, including EFH, include excavation of the tidal channels and floodplain benches during the first year of the Project and breaching of the levee along the Cosumnes River during the second year of the Project.

For all impacts assessed in this section, it is assumed that the following permits will be acquired prior to initiation of any construction activities associated with excavation and inundation of the Project site:

1. CDFG 1600 Streambed Alteration Agreement,
2. Section 404 Permit, and
3. Section 401 Water Quality Certification.

These permits will provide terms and conditions that must be met, including BMPs, for minimizing disturbance of the streambed and riparian habitat. For the purposes of assessing the following construction-related impacts, it is assumed that the permits will include, at a minimum, the impact avoidance and minimization measures described in Section 2.6. In addition, it is assumed for the purposes of this impact assessment that the permits required for implementation of the proposed Project will require the following BMPs:

- During the construction of the levee breach, the area of land adjacent to the river bank to be cleared or disturbed will be minimized;
- Materials derived from excavation work will be kept out of the stream channel (i.e., below the OHW mark) at all times;
- Removal of trees and shrubs will be avoided or minimized, with the exception of those occupying the area of the levee to be breached;
- Following construction, the levee banks adjacent to the breach will be returned to a stable, non-erosion prone condition;
- Prior to construction, a spill prevention and countermeasure plan will be prepared. The plan will address strict on-site handling rules to keep construction, maintenance materials, and fuels out of the waterway;
- A mandate will be instituted to clean up any accidental spills immediately in accordance with the spill prevention and counter measure plan; and
- Hydraulically isolated staging and storage areas will be designated and used for storage and handling of equipment, materials, fuels, lubricants, solvents, and other potential contaminants.

4.1.1 Potential for Construction-related Activities to Impede or Delay the Migration of Fishes Past the Project Site

The presence of heavy machinery and associated noise during construction could delay or block the migration of fishes past the Project site, including the immigration of adult anadromous fishes to upstream spawning habitats and the emigration of juvenile anadromous fishes from the Cosumnes River. However, because construction of both phases of the Project will occur during the summer and fall period, juvenile anadromous salmonids will not be emigrating past the Project site during construction and will not be assessed further in this section.

Adult anadromous salmonids and juvenile steelhead have the potential to occur near the Project site during both phases of construction. Adult fall-run Chinook salmon immigration up the Cosumnes River begins immediately upon hydraulic connection of the spawning reach, near Highway 16, with the Mokelumne River, which typically occurs after significant rains have fallen in the upper watershed. Since 1997, the Cosumnes River has been hydraulically connected before November only once, with that connection occurring on October 31, 2000 (Per comm. Kennedy, 2009). Adult fall-run Chinook salmon migrate into the Mokelumne River from September to early January, with peak immigration occurring in November. Steelhead spawning migrations into the lower Mokelumne River begin as early as August, peak in October and November, and extend into March (Merz and Saldate 2004). Juvenile steelhead remain in their natal river for one to three years before undergoing smoltification, prior to emigration to the ocean. Thus, a potential exists for juvenile steelhead from the Mokelumne River to make opportunistic use of the lower Cosumnes River for rearing, however, because the steelhead population on the Mokelumne River is small, the relative potential for juvenile steelhead to be rearing in the lower Cosumnes River during construction activities is low.

As discussed in Section 2.4, the Project will be implemented in two phases. Under the first phase of the Project, which will occur in the summer and fall 2009, the tidal channels and floodplain benches will be excavated and floodplain riparian forest (non-wetland areas) will be planted. These activities will occur on the land side of the levee prior to excavation of the levee breach (i.e., before hydrologic connection), which will occur in the second year of construction. The majority of this work will occur during the summer months, when no anadromous fish are anticipated to be present near the Project site. However, immigration of adult anadromous fishes (i.e., fall-run Chinook salmon and steelhead) past the Project site on their way to upstream spawning reaches of both the Cosumnes and Mokelumne rivers and the movement of juvenile steelhead may occur during the late summer and fall months. However, because: (1) construction will occur during the dry season, the likelihood that adult anadromous salmonids or juvenile steelhead will be migrating past the Project site during this period is very low, (2) all machinery will remain on the land side of the un-breached levee a safe distance from both of these rivers during this phase of construction, and (3) construction-related noise levels are anticipated to be relatively low and no greater than potential noise-related impacts of the current farming operation, construction related activities are not anticipated to block or delay the migration of anadromous fish during Phase 1 activities.

Under the second phase of the Project, which will occur in the summer and fall 2010, the constructed channel banks will be planted with riparian shrubs and trees, followed by excavation of the breach on the Cosumnes River and subsequent inundation of the Project site. Planting of the channel banks will be done by hand and will, therefore, not generate excessive noise. Excavation of the breach will be conducted using heavy machinery operating from the land side of the Project, and may result in elevated noise levels during construction. Elevated noise levels will occur within the area surrounding the breach and may temporarily delay the migration of fish moving along the south bank of the Cosumnes River in the immediate vicinity of the breach, or may simply cause fish to move away from the construction area and seek a zone of passage further away from any noise sources (i.e., along the north bank of the river). Because excavation of the levee will likely occur over a few days, any delays in fish migration would be temporary and brief. Furthermore, construction activities will occur only during daylight hours, thereby leaving a night-time period in which fish can move past the Project site unaffected by elevated noise levels. Finally, excavation of the levee will occur during the dry season, in the summer or fall months, prior to hydrologic connection of the lower Cosumnes River with upstream spawning areas; therefore, the likelihood that adult anadromous salmonids or juvenile steelhead will be migrating past the breach location during this period is very low. Therefore, construction related activities are not anticipated to block or delay the migration of anadromous fish during Phase 2 activities.

Construction-related activities is not expected to delay fish migrations, during either phase of the Project construction because (1) construction will occur during the dry season and therefore, the likelihood that adult anadromous salmonids or juvenile steelhead will be migrating past the Project site during this period is very low, (2) the majority of the construction activities will occur during the first phase when the Project site will still be hydraulically disconnected from the Cosumnes River, (3) the construction-related noise is anticipated to be very low and no greater than potential noise-related impacts of the current farming operation, and (4) construction-related impacts of creating the breach are expected to be brief. Therefore, construction-related activities are not anticipated to cause adverse individual or population-level effects on anadromous salmonids, critical habitat, or EFH.

4.1.2 Decreased Water Quality Resulting from Construction-related Activities

Potential water quality impacts resulting from construction of the Project include the potential for contaminants associated with construction machinery to enter the Cosumnes and Mokelumne rivers and the potential for excavation of the breach to temporarily increase suspended sediments downstream of the Project site. As discussed above, all construction activities completed under the first phase of the Project will occur on the land side of the levee prior to breaching and, therefore, will not adversely affect water quality in the Cosumnes River and downstream water bodies, nor will it adversely affect fish or benthic macroinvertebrate communities (i.e., an important food source of juvenile anadromous salmonids) occurring in these rivers.

During the second phase of the Project, heavy construction equipment would be used to excavate the breach. These machines have the potential to leak oil, gasoline, and other related fluids into the Cosumnes River. However, the magnitude of dilution that would occur in the Cosumnes River following a spill event (based on the relatively small volumes of diesel fuel or other products that would be at risk for spill events) would be expected to prevent any substantial toxicological impacts to Cosumnes River aquatic biota downstream of the Project site. In addition, as discussed above, measures to avoid or minimize spills and a spill prevention plan will have been developed for the Project and additional BMPs would be required under the various permits required for the Project. Finally, as discussed in the previous section, because construction will occur during the dry season the likelihood of anadromous salmonids occurring near the Project site during construction is very low. Consequently, the risk of contaminants associated with construction equipment entering the Cosumnes River is low and is not anticipated to have adverse individual or population-level effects on anadromous salmonids or benthic macroinvertebrate communities of the Cosumnes or Mokelumne rivers.

Excavation of the levee that would occur under the second phase of the Project may temporarily increase suspended sediment loads in the Cosumnes and Mokelumne rivers immediately downstream of the breach. Suspended sediments can have numerous adverse effects on fish and benthic macroinvertebrates, including (but not limited to) reduced respiratory efficiency (Kemp 1949, Waters 1995) and reduced feeding efficiency (Madej 2004).

The breach will be created by excavating a wedge-shaped portion of the existing levee. The area to be excavated is anticipated to be approximately 115 feet long and 35 feet wide at the top of the levee, narrowing down to approximately 20 feet long and 45 feet wide at the base of the levee. Consequently, excavation of the breach will require the removal of approximately 2,000 cubic yards of material, which will likely be completed using an excavator. The excavated material will be distributed over the Project site. Some small portion of the soil removed from the levee may spill into the Cosumnes River during excavation and may result in a small, localized plume of increased suspended sediment along the south bank of the Cosumnes River immediately downstream of the breach. As discussed above, excavation of the breach will take no more than a few days to complete; therefore, any increases in suspended sediment load will be temporary.

As discussed above, excavation will likely occur when few, if any, anadromous fish are moving past the Project site and will be completed within a couple of days, therefore, the likelihood that anadromous fish moving into the Cosumnes River will encounter the plume is very low. If anadromous salmonids do attempt to immigrate upstream along the south bank of the Cosumnes River during excavation of the breach they may encounter a small localized plume, however those fish would be expected move toward the middle of the channel or along the north bank to avoid any such plume. Because any increases in suspended sediment could be readily avoided by anadromous salmonids, in no case would a plume of suspended sediment be expected to cause a substantial delay in fish migrations, nor would it be anticipated to cause direct physiological effects on fishes encountering the plume. Therefore, any temporary increases in suspended sediments would not be expected to cause adverse individual or population-level effects on anadromous fishes of the lower Cosumnes or Mokelumne rivers.

Construction-related activities are not expected to decrease water quality in the lower Cosumnes and Mokelumne rivers, and as a result, delay migration of anadromous salmonids because (1) construction will occur during the dry season and therefore, the likelihood that adult anadromous salmonids will be migrating past the Project site during this period is very low, (2) the risk of contaminants entering the Cosumnes River during construction-related activities is low, and (3) because any increases in suspended sediment downstream of the Project is anticipated to be small, temporary, and localized, any effects on water quality associated with construction of the Project are not anticipated to cause adverse individual or population-level effects on anadromous salmonids, critical habitat, or EFH.

4.2 Long-term Maintenance and Monitoring Impacts

4.2.1 Potential for Alteration of Aquatic and Riparian Habitat Resulting from the Project

Excavation of the levee along the bank of the lower Cosumnes River will alter near-shore instream and riparian habitats for fish and aquatic resources. Any disturbances would be confined to a small area of the bank of the Cosumnes River's riparian zone adjacent to the planned levee breach and the area of the river channel adjacent to the planned breach. The area of the levee to be excavated will be approximately 45 feet long at the crest and 115 feet long at the base. This area is a very small portion of the available near-shore and riparian habitat along the lower Cosumnes River. Furthermore, the loss of this small area of near-shore aquatic and riparian habitat will be offset by a net increase in availability of such habitats that will be restored under the proposed Project and will, therefore, not reduce the amount of available habitat or otherwise lead to adverse population-level effects on anadromous fish of the Cosumnes River. Consequently, construction of the Project is not anticipated to cause long-term adverse individual or population-level effects on anadromous salmonids, critical habitat, or EFH, moreover, the over-all net increase in shallow water and riparian habitat is expected to provide benefits to juvenile anadromous salmonids.

4.2.2 Potential for Stranding of Fish on the Restored Floodplain

The Project will be designed to flood during annual winter and early spring flood events. These flood events coincide with the seasonal occurrences of important reproductive and early life stages (i.e., rearing and emigration) of anadromous salmonids. The internal dendritic channels will be designed to fill and drain as a result of tidal action during the low-flow periods in a manner that minimizes water retention when flows recede, thereby favoring native fishes, including anadromous salmonids, while reducing the potential for non-native fishes to utilize the site. However, insufficient drainage resulting from improper design may result in the stranding of fish on the floodplain as flows recede and the floodplain becomes hydraulically disconnected from the river following seasonal and tidal inundations.

Numerous studies have looked at stranding on floodplains following flood events. Moyle et al. (2007) examined stranding on floodplains and found that the majority of fish exited the floodplain approximately 5–6 weeks following the last seasonal inflow. The majority of fish that were stranded on the floodplain following permanent and intermediate disconnection from the river were non-native fish species, particularly inland silversides (*Menidia beryllina*), western mosquitofish (*Gambusia affinis*), golden shiner (*Notemigonus chrysoleucas*), and common carp. However, relatively small numbers of native fishes, including Chinook salmon and cyprinids (e.g., Sacramento splittail, Sacramento blackfish), were stranded in some years. These native fish stranding occurrences were almost always associated with depressions or structures associated with historical farming operations and most were only stranded temporarily, until a subsequent inundation occurred, thereby, allowing the natives to disperse back into the open waters of the floodplain. No juvenile salmonids were found to be permanently stranded (i.e, isolated on the floodplain following the final disconnection of the year) during the four year study.

Notably, the Moyle et al. study found that native fishes were typically the first fish to leave the floodplain and return to the river prior to disconnection. This is not surprising, as the life histories of many native fishes, particularly anadromous salmonids, are adapted to the natural hydrologic regimes of floodplains and rivers and, as such, floodplain emigration by native fishes is likely to be triggered by environmental cues (e.g., increases in floodplain water temperatures as the water recedes, decreases in water surface elevations, increased photoperiod). Native fishes, including Chinook salmon, generally occurred on the floodplain habitats earlier (e.g., February through April) than non-native fishes and the emigration from the floodplain habitats by the majority of native fishes occurred rapidly (e.g., approximately one week or less) when daily maximum air temperatures rose from 20ºC to 25ºC (Moyle et al. 2007).

In order to minimize the potential for stranding, the following concepts have been incorporated into the design of the floodplain as a means to improve flooding and drainage.

- Ensure gradual draining of the Project site. Following flood events, gradual drainage is favored because it allows fish sufficient time to move off floodplain, thereby minimizing stranding.
- During the low flow periods the internal, dendritic channels should completely de-water during tidal cycles in order to minimize stranding..

- Avoid building permanent ponds or depressions (i.e. such as ponds for waterfowl habitat) in the floodplain and ensure depressions and/or structures from historical farming operations are eliminated prior to levee breaching. Depressions and structures that restrict natural drainage of floodplains have been proven to strand fish.
- Construct and maintain the Project in a manner that minimizes the potential for excessive sedimentation to obstruct the drainage of the floodplain and internal channels and potentially increase the likelihood of fish stranding.

Incorporation of these design elements will minimize the potential that fish will become stranded on the floodplain as water levels recede following periods of seasonal and tidal inundation. Given the timing and nature of anadromous salmonids' use of such floodplain habitats, the likelihood that any anadromous salmonids will become stranded is low. Moreover, the highly productive habitats provided by floodplains have been shown to increase abundance and growth rates of native fishes, including anadromous salmonids. Junk et al. (1991) concluded that fish yields are generally positively correlated with increases in floodplain area. In a notable study, Jeffres et al. (2008) compared the growth rates of juvenile Chinook salmon by rearing wild-caught fish in pens in floodplain and river habitats of the lower Cosumnes River, adjacent to the Project site. These researchers reported significantly higher growth rates among the floodplain-raised fish. Stomach content analyses of the test fish indicated that zooplankton, which ranged in biomass from 10 to 100 times greater at floodplain sites compared to river sites, comprised the largest proportion of the diets of fish reared in the floodplain. Likewise, Sommer et al. (2001) reported similar results in a study of juvenile Chinook salmon growth on floodplains of the Yolo Bypass (lower Sacramento River) compared to growth rates observed on fish reared in adjacent habitats on the lower Sacramento River. These studies demonstrate the importance of floodplains as forage habitats for rearing juvenile Chinook salmon prior to emigration and ocean entry. Therefore, because the floodplain habitat created under the Project is anticipated to generate a net increase in native fish abundance and biomass and because the risk of stranding is low, the Project is unlikely to have adverse population-level effects on native fishes using the floodplain.

Stranding of juvenile anadromous salmonids may occur as a result of the long term maintenance and monitoring of the Project, however given the Project design and the life history requirements of the anadromous salmonids known to occur in the vicinity of the Project it is not likely that the Project will result in the stranding of anadromous salmonids. Moreover, a substantial net increase in production of juvenile salmonids is anticipated as a result of increased food productivity and high quality habitat availability. Consequently, the Project is not anticipated to have adverse individual or population-level effects on anadromous salmonids, critical habitat, or EFH related to stranding and will likely create benefits for local anadromous salmonid populations.

4.2.3 Potential for Increased Predation

The Project will provide habitat for a wide variety of fishes occurring in the lower Cosumnes and Mokelumne rivers, including several species of native and non-native piscivorous fishes (e.g., Sacramento pikeminnow, largemouth bass, sunfishes). Furthermore, the floodplain habitat will likely attract a variety of mammalian (e.g., otters, raccoons) and avian (e.g., herons, egrets) piscivores. The presence of these piscivores introduces the potential for the restored floodplain habitat to serve as a biological "sink," in which large numbers of small fish, including juvenile salmonids, are concentrated in large numbers and are preyed upon by piscivorous fish and wildlife. In extreme cases, the increased fish production benefit that typically occurs on restored floodplain habitats could be outweighed by the abundance and biomass of fish consumed by piscivores, resulting in a net decrease in production of prey fish (e.g., juvenile Chinook salmon and steelhead).

Many of the Project design features intended to reduce the potential for fish stranding will also reduce the potential for predation of juvenile salmonids (Section 4.2.2). Designing the dendritic channels to completely drain following periods of seasonal and tidal inundation will hinder predators from utilizing the floodplain for predation. Permanent ponds or depressions, resulting from historical farming operations or those constructed as Project features, can create habitat for predators. Therefore, the project has been designed such that all remnant depressions from the farming operation are eliminated prior to inundation of the site and no ponds or other design features that may provide habitat for predatory fishes are constructed. In addition, the Project has been designed in a manner that minimizes the potential for excessive sedimentation to obstruct drainage of the floodplain, which could create pools in which predators could live. Finally, the abundance of cover that will be provided in the form of emergent vegetation and riparian growth will decrease the probability of a juvenile anadromous salmonid encountering a predator.

Other elements of the restored floodplain that will decrease the potential for predation on juvenile anadromous salmonids include shallow water, low water temperatures and increased turbidity. Each of these elements is further discussed below.

An important structural aspect of floodplain habitat is water depth. Nobriga and Feyrer (2007) noted that the relatively shallow depths of estuarine habitats in the Delta may serve as predation refugia. Other studies have shown that shallow water is correlated with decreased predation rates (Paterson and Whitfield 2000; McIvor and Odum 1988).

Increased water temperatures have been correlated with increased predation rates on juvenile salmonids (Tabor et al 2007). As temperatures approach 15 C, predators such as largemouth bass, become more active and increase their rates of predation. During periods of connectivity, water temperatures on the Cosumnes floodplain, ranged from approximately 10 to 15 C, during a four year study (Moyle et al 2007). Therefore, as a result of decreased water temperatures during periods of seasonal inundation, predation on juvenile salmonids would not be expected to occur. During periods of tidal inundation, when water temperatures will increase above 15 C and predators such as largemouth bass are more active, the dendritic channels will completely dry out during each low tide cycle, which will decrease the potential for predators to utilize these channels.

Seasonal and tidal inundations of floodplain habitats have been correlated with increased turbidity. Numerous studies have shown that increased turbidity can facilitate predator avoidance (Nobriga and Ferrer 2007; Gregory and Levings 1998).

Predation of juvenile anadromous salmonids may occur as a result of the long term maintenance and monitoring of the Project, however given the Project design, expected habitat elements and the life history requirements of the anadromous salmonids known to occur in the vicinity of the Project site it is not likely that the Project will result in the predation of anadromous salmonids. Moreover, a substantial net increase in production of juvenile salmonids is anticipated as a result of increased food productivity and high quality habitat availability. Consequently, the Project is not anticipated to have adverse individual or population-level effects on anadromous salmonids, critical habitat, or EFH related to predation and will likely create benefits for local anadromous salmonid populations.

4.2.4 Potential for Long-term Decreases in Water Quality

The San Joaquin Resource Conservation District has compiled a comprehensive summary of the lower Mokelumne River's water quality (SJRCD 2002). The Mokelumne River downstream of Pardee Dam is listed as an impaired water body under Section 303(d) of the Clean Water Act for copper, zinc, and aluminum—metals associated with abandoned mines in the Mokelumne River watershed. Remediation efforts are ongoing to reduce water-borne concentrations of these metals. The Mokelumne River periodically experiences depressed DO levels, possibly stemming from a combination of agricultural drainage and municipal stormwater runoff. The USGS and EBMUD conduct water quality sampling at several locations in the lower Mokelumne River for a variety of chemical constituents, including metals (e.g., aluminum, copper, iron, lead), nutrients (e.g., nitrogen, phosphorous, ammonia), and conventional water quality parameters (e.g., conductivity, DO, pH, hardness, temperature). In addition, the City of Lodi Public Works department monitors pathogens (e.g., fecal coliform) levels and has overseen a citizen monitoring program for conventional parameters since 2001.

The water quality of the Cosumnes River has received relatively little attention and thus little information is available for the Project area. Ahearn and Dalgren (year unknown) examined the relationship of water quality in the upper and lower Cosumnes River watershed and concluded that the majority of the nutrients (i.e., nitrogen and phosphorus) and suspended sediments originates from both point sources (e.g., wastewater treatment facilities) and non-point sources (i.e., urban and agricultural runoff) in the lower watershed. These investigators also reported that water temperature, conductivity, and pH levels generally increase downstream. Nutrient and sediment transport is greatest during the wet season and little transport occurs under dry season baseflow conditions. The Cosumnes River carries a high suspended sediment load, which likely has adverse impacts on anadromous salmonid eggs and fry. The Cosumnes Research Group (CRG) has proposed a long-term water quality monitoring strategy for the Cosumnes River watershed, but it is unclear if or when it will be implemented. Other available water quality data are generally associated with specific, localized research questions or hypotheses (e.g., Crain et al. 2004) and therefore cannot be reliably used to draw inferences for the larger river and/or reaches.

4.2.4.1 Project Site Characterization

The Project site has historically been managed for agriculture and although annual crop production has ceased, a wine grape vineyard is still being actively managed. Approximately one year after the vineyard is removed, the restored tidal wetland channels completed, and plantings have been established, the levee would be breached and the site would be subject to diurnal tidal inundation. Additionally, following levee breaching, the upper floodplain portion of the site would be subject to periodic inundation during high-water events. The potential exists for inundation of the Project site to result in short-term and long-term water quality changes both on-site and off-site as the Project site is exposed to daily tides and flood event inundation. Inundation of the site could mobilize a variety of water quality constituents of concern that may be present on the surface or buried in site soils. Constituents could be conveyed to the restored wetland channels or transported to the Cosumnes River from the site.

A Phase 1 environmental assessment was completed for the Project site. The Phase 1 report identified no current or historical Recognized Environmental Conditions (RECs) (ENGEO 2007). As part of this determination, the Phase 1 report stated that neither a site reconnaissance nor a review of regulatory databases found any documentation or physical evidence of soil or groundwater impairments associated with the use or past use of the Property. Although the Phase 1 report concluded that no RECs were identified at the Project site, there is still potential that anadromous salmonids could be affected by unknown water quality constituents of concern. Therefore, best professional judgment was used to identify potential water quality constituents of concern to anadromous salmonids that could be affected by the Project based on its design and the existing state of the science regarding water quality characteristics of restored wetlands.

Based on best professional judgment the following general categories identify potential constituents that could be present on the site.

- <u>Suspended Sediment/Turbidity:</u> While the restored channels will be stabilized after construction, since their configuration (i.e., channel invert elevations, width, length) will control the hydraulic forces of tidal exchange within the channels, the daily tidal action and periodic flood inundation will, nonetheless, result in localized areas of soil erosion and scour, as well as areas of sediment deposition on the site. Sediment scour and accretion will affect in-water concentrations of total suspended solids and turbidity in the restored wetlands and in the Cosumnes River.

- Inorganic and Organic Constituents: Potential constituents that may be present in a former agricultural site include organic matter (e.g., organic carbon, woody debris, animal wastes), pathogens, oil and grease, nutrients (e.g., nitrogen, phosphorus, minerals), inorganic salts, metals (e.g., arsenic, copper, zinc, lead), or synthetic organic chemicals.
- Pesticides: Tidal exchange and flood inundation may mobilize and convey residual agricultural pesticides, which have historically been used on the site, into the restored tidal wetlands or the Cosumnes River, at concentrations that may have toxic effects on salmonids. Pesticides of potential concern include current use pesticides and so-called "legacy" pesticides such as the persistent organochlorine pesticides that were largely phased out of use in the 1970s–1980s (e.g., DDT/DDD/DDE, chlordane, dieldrin).
- Mercury: The restored wetlands and periodic floodplain inundation may facilitate the formation of methyl mercury which is known to be associated with geochemical changes that occur in saturated anoxic soils containing mercury. Methyl mercury is known to bioaccumulate and biomagnify in the food chain, however is not known to be present at levels in the region that would cause toxicity directly to salmonids.

The potential for the Project to result in constituent concentrations that adversely affect salmonids will be a function of: (1) the length of time before inundation events occur following site stabilization, (2) the degree of soil erosion and scour that occurs when the Project is exposed to tidal exchange and flooding, (3) the magnitude and frequency of inundation, (4) the exposure and susceptibility of potential constituents to be mobilized and transported in runoff from the site, and (5) the degree to which mobilized constituents are dissolved in the water column or are attached to suspended sediment. Because the Project schedule provides a period of soil and vegetation stabilization, the potential amount of erosion, scour, and runoff of constituents from the site would be minimized.

4.2.4.2 Suspended Sediment/Turbidity Assessment

As described in Section 2.4, construction of the Project is proposed to occur over two seasons. The first phase of construction will entail excavating the tidal channels and floodplain benches and is scheduled to occur in summer 2009 and be completed prior to the end of fall 2009. Floodplain riparian forest (non-wetland areas) plantings will occur in fall 2009. The second phase of construction planned for summer 2010 entails planting the constructed channel banks with riparian shrubs and trees and excavating the breach on the Cosumnes River. The phased construction approach will result in a period of site stabilization over 1 year long before the levee breaching and inundation begins. This stabilization period and the inclusion of extensive plantings are expected to result in site specific suspended sediment and turbidity levels similar to naturally occurring levels.

Suspended sediment is associated with negative effects on the spawning, growth and reproduction of salmonids (Bash et al 2001). There is no spawning habitat located downstream of the project site, therefore, there is no potential for suspended sediment and turbidity to adversely effect the spawning and reproduction life history requirements of anadromous salmonids. Negative growth effects of suspended sediment are related to decreased ability to forage, decreased prey availability and disturbance of normal social behavior (Bash et al 2001). However, studies on the Cosumnes River floodplain and Yolo Bypass have shown increased growth rates associated with floodplain rearing versus riverine rearing (Jeffries et al 2008; Sommer et al 2001).

Therefore, because construction of the Project will include a stabilization period and extensive plantings and the Project is located in an area with no downstream spawning areas, the Project is not anticipated to have adverse individual or population-level effects on anadromous salmonids, critical habitat, or EFH related to suspended sediment and turbidity.

4.2.4.3 Organic and Inorganic Constituent Assessment

The Phase 1 environmental assessment for the Project site concluded that although the Project site has historically been used for agricultural production and it is conceivable that chemicals, including organic and inorganic constituents, may have been applied, significant residual concentrations of constituents of concerns are not expected to be found in site soils (ENGEO 2007). In addition, because active farming of the site would cease (i.e., tillage, farm chemical use), the potential mobilization and transport of organic and inorganic constituents would be expected to be reduced relative to existing conditions. Therefore, it is expected that the potential exposure of salmonids using the Project site to inorganic constituents (e.g., nutrients), organic matter and wastes, pathogens, or remnant trace metals, will be no greater than existing conditions, and probably considerably lower than other areas in the Delta receiving runoff from active urban and agricultural land uses.

Consequently, the Project is not anticipated to have adverse individual or population-level effects on anadromous salmonids, critical habitat, or EFH related to organic and inorganic constituents.

4.2.4.4 Mercury Assessment

Mercury (Hg) was used for historic Gold Rush era mining activities in the upper Cosumnes River watershed and is known to be present in the lower Cosumnes River channel and the Delta. Numerous investigations have been conducted in the Delta and tributary rivers to evaluate the magnitude and ecological implications of legacy mercury loading (Davis et al., 2003). The production of methyl mercury (MeHg), and related uptake and bioaccumulation in the food chain, is the focus of the CALFED program's mercury strategy (Wiener et al., 2003). In the aquatic environment, MeHg is formed through bacterial reduction of Hg^{+2} in both aerobic and anaerobic sediments by sulfate reducing bacteria. Maximum rates of mercury methylation occur at typically shallow depth (i.e., centimeters). Demethylation of mercury via bacteria or photodegradation is an important factor in reducing in-water MeHg concentrations (Central Valley Regional Water Quality Control Board (Regional Water Board) 2006).

In-water MeHg concentrations in the Delta range from 0.05 – 0.3 ηg/L and the maximum observed values (up to 0.7 ηg/L) have been found in dead-end sloughs (Regional Water Board 2006). Analysis of MeHg concentrations in the ebb and flood tide flows at wetland sites in the Delta have documented generally increased concentrations in wetland outflows compared to inflows, indicating the potential for wetlands to be net producers of MeHg (Heim et al. 2003). Typical total and MeHg concentrations in aquatic environments are not known to cause acute toxicity in salmonids; however, the 1987 compendium of toxicity reference concentrations for wildlife indicates that rainbow trout is among the most sensitive aquatic species to reduced growth with exposures to MeHg of 0.04 ηg/L over 64 days (Eisler 1987). The State Water Resources Control Board (SWRCB) has not adopted water quality criteria for total Hg or MeHg for the protection of aquatic life, however, the adopted California Toxics Rule criteria for human health protection is 50 ηg/L as total Hg.

Mercury accumulation has been found in a wide variety of habitats and species in the Delta (Heim et al. 2003, Schwarzbach and Adelsbach 2003). Generally, the large majority of mercury in fish tissues is present as MeHg with biosentinel studies of mercury in fish tissues of resident species (i.e., Mississippi silversides, largemouth bass, bluegill, redear sunfish, threadfin shad, golden shiner, and hitch) indicating that the Cosumnes River exhibits higher levels relative to other areas of the Delta (Slotton et al. 2007). The Bay-Delta Authority's ongoing 3-year Fish Mercury Program monitoring of fish tissue levels in resident and anadromous species throughout the Delta and upstream tributaries indicates that MeHg concentrations in salmonids are generally low with concentrations in rainbow trout less than 0.1 mg/Kg at all sites (SFEI 2007). Toxicity associated with tissue mercury levels in rainbow trout fry, juveniles, and adults has been observed; they include reduced growth and appetite, visual acuity, loss of equilibrium, and lethargy, at tissue levels ranging from 4–114 mg/kg based on exposure periods ranging from 12–270 days (NOAA 2005). Significant reduction in alevin survival (4-day post hatch) was observed at adult tissue levels as low as 0.26 mg/kg based on 400- to 528-day exposure periods (NOAA 2005). The SWRCB conducted scoping, and further action on a rule-setting process is pending, for the proposed adoption of water quality criteria for MeHg that would limit the concentration of MeHg in edible portions of fish and shellfish tissue to not exceed 0.3 mg/Kg (SWRCB 2006).

Based on the assessment of available information above, the Project site has the potential to increase methyl mercury formation. Consequently, the potential exists for exposure and intake of methyl mercury and bioaccumulation in tissues of salmonids that inhabit the site. However, based on data from biosentinel fish tissue studies conducted in the Delta and the relatively low period of potential exposure due to life history requirements, it is considered unlikely that the limited exposure of salmonids to in-water MeHg levels, or bioaccumulation in tissues, would rise to levels considered toxic or differ significantly in Cosumnes and Mokelumne river salmonids, relative to existing conditions. Consequently, the Project is not expected to have adverse individual or population-level effects on anadromous salmonids, critical habitat or EFH related to exposure to methyl mercury.

4.2.4.5 Pesticide Assessment

Site-specific information on agricultural chemicals used for historical farming operations and the existing vineyard is not available. However, the potential exists for insecticides, fungicides, herbicides, and biological pest control activities to have occurred recently and in the past. This analysis considered pesticides that may have been used recently and may still reside on vegetation or on the soil surface when inundation of the Project site first occurs, and legacy pesticides that may have been used onsite in the past, or transported to the site via aerial deposition, thus potentially residing in buried soil layers.

Pesticides can generally be grouped in classes in terms of their chemical properties and target species, including organophosphates, carbamates, thio- and dithiocarbamates, phenoxy and benzoic acid herbicides, pyrethroids, triazines, ureas, and organochlorines. Key factors to the fate and transport characteristics of pesticides includes their solubility in water, volatility, affinity for soil adsorption, degradation rates in different environmental media (e.g., water, saturated soil, etc.), soil structure and texture, vegetative cover, and chemical properties in the soil (e.g., temperature, organic content, and pH). However, the ability to predict the effects of floodplain restoration activities on fate and transport of pesticides is limited.

A recent assessment based on California Department of Pesticide Regulation reporting data for 2006 identified a total of 161 current-use pesticides in which more than 500 kg were used in urban and agricultural areas of the Delta watershed (Kuivila and Hladik 2008). The authors characterized seasonal patterns of pesticide transport events in the Delta as consisting of first flush events of dormant spray insecticides, first flush herbicides, spring detection of insecticides, spring and summer detection of rice pesticides, and summer detection of a variety of pesticides (Kuivila and Hladik 2008). An assessment of pesticide fate and transport in agricultural drainage waters of the Yolo Bypass, during periods when the area experienced flood inundation, identified that up to 13 current-use pesticides were routinely detected (USGS 2005). The study found that the highest pesticide concentrations were associated with the largest runoff events; however, many compounds were detected during events after runoff events when streamflow rates were receding. Higher pesticide concentrations were associated with suspended solids rather than bed sediments, indicating the potential for widespread transport of compounds during runoff events. Pesticide analyses of the Cosumnes River at Twin Cities Road in 12 samples between January 2005 and August 2006 identified only one detection of the herbicide simazine in March 2005 and thiobencarb in August 2005 (Regional Water Board 2007). Legacy organochlorine pesticides continue to be detected in water column samples and indications are that full degradation of the compounds will take decades (Connor et al. 2007).

Characterization of toxicity thresholds of salmonids to individual pesticide compounds that may or may not be mobilized at the Project site is beyond the scope of this analysis. Pesticides can result in several modes of acute and chronic toxicity to salmonids, including direct lethal exposure, reduced growth, and genotoxicity to organisms and offspring (USFWS 1981). The bioavailability of pesticides to fish generally decreases if the constituent is associated with suspended sediment or has been aged on soil for several years rather than in the water column. In general, newer pesticides undergo extensive testing and application procedure requirements are designed to limit the availability and exposure of the compound to sensitive organisms in the environment. However, agricultural runoff has the potential to contain pesticides at concentrations that can exceed concentrations known to cause toxicity. Acute toxicity tests with *Ceriodaphnia dubia* of riverine and agricultural drainage in the Delta and upstream tributaries has been attributed to the organophosphorus pesticides diazinon and chlorpyrifos in a number of studies (Kuivila and Hladik 2008). Acute toxicity to algae (i.e., *Selenastrum capricornutum*) also has been found in numerous studies, and attributed to the widely used organophosphate herbicide diuron (De Vlaming et al. 2005).

Based on the review of available information and the proposed Project, the potential for the Project to cause toxicity to salmonids resulting from exposure to current-use pesticides is considered unlikely. The Project schedule will result a period of site stabilization over 1 year long before the levee breaching and tidal inundation period begins. The stabilization period will allow current-use pesticides to degrade and lessen the potential for adverse runoff effects. Potential short-term exposure to legacy pesticides, if present, is uncertain and the potential for long-term exposure would decrease over time as the Project site becomes stabilized. Long-term sediment accretion at the site would be expected to further reduce the potential for exposure to legacy pesticides. Overall, the potential Project-related exposure of salmonids to pesticides is expected to be no greater, and probably considerably lower, than at other areas in the Delta receiving runoff from active urban and agricultural land uses. Based on the available information, the potential Project-related contribution of pesticides to the restored wetland channels or the Cosumnes River is not expected to have adverse individual or population-level effects on anadromous salmonids, critical habitat or EFH.

4.2.5 Potential for Water Temperature and Dissolved Oxygen Effects Associated with the Project

The proposed Project will increase the amount of shallow water habitat in the lower Cosumnes River. Shallow water habitats are subject to increased water temperatures as a result of direct solar radiation and influence from ambient air temperatures. The only known temperature monitoring station in the vicinity of the Project is the U.S. Geological Survey's gauge on the lower Mokelumne River near the San Joaquin River confluence (USGS Station ID: MOK), which was established in June 2008. The limited available monthly data compiled from the California Data Exchange Center (CDEC) for this station indicate that temperatures in the lower

Mokelumne River are well within suitable ranges for growth and survival of anadromous salmonids throughout the year, and particularly during the fall-spring months in which anadromous salmonids would be present at the Project site (**Table 1**). Although this data set is limited to approximately 8 months, it should be noted that it encompasses some of the warmest summer months on record. It is also important to note that water temperatures in the lower tidally influenced reaches of the Mokelumne River show relatively little variability, with monthly minima and maxima differing by 10.6ºF (December), based on available data. Although the Project site is located upstream of this monitoring station, the Project site is also tidally influenced and, therefore, water temperatures are not anticipated to be substantially different, particularly during the cool fall-spring months.

Although the Project would create shallow water habitat on the floodplain where water temperatures may be incrementally increased above that of the ambient river water, any such temperature increases are expected to be minimal and are unlikely to adversely affect anadromous salmonids for several reasons. First, juvenile salmonids (i.e., the most thermally intolerant life stage expected to utilize the Project site) would be present during the winter and spring months, when average and maximum daily temperatures are well within suitable ranges for growth and survival of anadromous salmonids. Second, ambient air temperatures during this time period are also generally within published literature values for survival of anadromous salmonids and would, therefore, not increase temperatures on the floodplain to levels that would adversely affect salmonid growth or survival. Third, the daily cycles of tidal exchange and cool nighttime temperatures will ameliorate any increases in temperature that may occur on the floodplain during the day. Fourth, any temperature increases would likely be limited to shallow and/or near-shore margins of the floodplain and would likely occur only on relatively warm days with little cloud cover (i.e., exposure to direct sunlight). Finally, if temperatures on the floodplain did reach critical levels, juvenile salmonids would be expected to exit the floodplain. In no case would the floodplain habitat created by the Project be expected to increase water temperatures on the floodplain or in the lower Cosumnes River to levels that would have adverse effects on anadromous salmonids. Conversely, any short-term incremental increases in floodplain water temperatures may be beneficial to rearing juvenile salmonids by increasing growth rates and by providing a temporary thermal refuge when temperatures in the lower Cosumnes and Mokelumne rivers become very low.

Table 1. Monthly water temperatures at the USGS' MOK monitoring station on the lower Mokelumne River at the San Joaquin River for June 16, 2008 through February 20, 2009 (Source: California Data Exchange Center).

Month	Temperature (ºF)			
	Average	Minimum	Maximum	Count
June [1]	72.7	69.8	75.7	1374
July	73.6	70.4	77.7	2940

August	73.1	70.6	75.8	2968
September	70.6	68.0	73.3	2856
October [2]	66.6	61.5	71.2	1560
November	58.4	54.5	62.6	2859
December	49.2	45.0	55.6	2970
January	48.1	45.6	54.8	2966
February [3]	50.3	47.5	52.0	1863
[1] no data available for 6/1 through 6/15. [2] no data available for 10/13 through 10/26. [3] data available through 2/20.				

Because the temperatures on the floodplain are not expected to reach critical levels, particularly at times when anadromous salmonids are expected to be present, the Project would also not be expected to cause any adverse temperature-related effects on DO concentrations on the floodplain or in the adjacent rivers. Consequently, the Project is not expected to have any adverse temperature or DO-related individual or population-level effects on anadromous salmonids, critical habitat or EFH and may in fact, provide benefits to anadromous salmonids by providing thermal refugia and increased growth rates.

5 CONCLUSIONS

The Cosumnes Floodplain Mitigation Bank Project is expected to increase and improve the availability of quality habitat in the lower Cosumnes and Mokelumne rivers for fall-run Chinook salmon and Central Valley steelhead. While the Project will have localized and seasonal effects on the hydrology, water quality, and fish community of these water bodies, it is not expected to have substantial adverse individual or population-level effects on anadromous salmonids.

To the contrary, the Project is expected to benefit populations of anadromous salmonids by increasing the amount of floodplain rearing habitat in the lower reaches of these water bodies. The habitat provided by the Project is anticipated to result in faster growth rates of juvenile salmonids that utilize the floodplain for short-term rearing, thereby increasing fitness and likelihood of survival.

Local and Delta-wide planning efforts have recognized the importance of restoring additional floodplain habitats in the Cosumnes and Mokelumne corridor. The Bay Delta Conservation Plan process has released draft conservation measures, including:

"*Restoring freshwater intertidal marsh and shallow subtidal aquatic habitats within the Cosumnes/Mokelumne River ROA is expected to reduce the adverse effects of stressors related to food and habitat availability for the covered fish species by: increasing rearing habitat area for Sacramento splittail and Cosumnes and Mokelumne River fall-run Chinook salmon and possibly* *steelhead (Healey 2001, Brown 2003); increasing the production of food for rearing salmonids, splittail, and other species migrating to and from the Cosumnes and Mokelumne Rivers (Kjelson et al. 1982, Siegel 2007); increasing the availability and production of food in the east and central Delta by exporting organic material from the marsh plain and phytoplankton, zooplankton, and other organisms produced in intertidal channels into the Delta* (Siegel 2007)*."* (BDCP 2008)

The Anadromous Fish Restoration Program's Final Restoration Plan includes high priority actions for the Delta and the Cosumnes and Mokelumne rivers that are related to floodplain restoration (USFWS 1997):

"Mokelumne River: Enhance and maintain the riparian corridor to improve streambank and channel rearing habitat for juvenile salmonids.:High Priority".

"Cosumnes River: Evaluate the feasibility of restoring and increasing available spawning and rearing habitat for salmonids:High Priority".

"Delta: Evaluate potential benefits of and opportunities for increasing salmonid and other anadromous fish production through improved riparian habitats in the Delta:High priority; Evaluate benefits of and opportunities for additional tidal shallow-water habitat as rearing habitat for anadromous fish in the Delta.: High Priority."

Finally, the Lower Mokelumne River Restoration Program includes the following element:

"improve riparian habitat, specifically, to provide SRA habitat for fish, reduce water temperature, and increase food production." (JSA 1999).

The Cosumnes Floodplain Mitigation Bank Project is expected to benefit anadromous salmonids populations in the Cosumnes and Mokelumne rivers. The Project is not expected to have adverse individual or population-level effects on Central Valley ESU steelhead or designated critical habitat for this DPS, nor is it expected to have adverse effects on EFH for Chinook salmon.

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ATTACHMENT A

COSUMNES RIVER MITIGATION BANK HABITAT DEVELOPMENT PLAN (WES 2008)