Meeting of the Central Valley Flood Protection Board
January 23, 2013

Staff Report

Reclamation District 108, Knights Landing Outfall Gates Fish Barrier Project Request to Initiate Project Review Pursuant to Title 33, USC Section 408

1.0 – ITEM

Consider Central Valley Flood Protection Board (Board) approval of a letter to the U. S. Army Corps of Engineers (USACE) pursuant to federal Title 33, USC Section 408 requesting initiation of, in cooperation with Reclamation District 108 and other federal agencies, a joint review of possible improvements to the Knights Landing Outfall Gates structure (Attachment A).

2.0 – PROJECT PROPONENT

Reclamation District 108 (RD 108)

3.0 – PROJECT LOCATION

The Knights Landing Outfall Gates Fish Barrier project (KLOGFB), is located at the confluence of the Sacramento River and the Colusa Basin Drain near the town of Knights Landing in Yolo County (Attachment B).

4.0 –PROJECT DESCRIPTION

RD 108 is proposing to modify the existing Knights Landing Outfall Gates structure. Alterations to facilities of the State Plan of Flood Control and the federal flood control project could include construction of new concrete wing walls, installation of a metal picket weir, installation of rock slope protection, and removal of vegetation.

5.0 – STAFF RECOMMENDATIONS

Staff recommends the Board:

- **Approve** the draft letter to the USACE (Attachment A); and
- **direct** the Executive Officer to sign and send the letter to the USACE.

6.0 – LIST OF ATTACHMENTS

A. Draft Letter to the USACE
B. Project Location Map

Technical Review:	Deb Biswas, PE, Engineer, WR, Planning Branch
Document Review:	Nancy Moricz, PE, Senior Engineer, Planning Branch
	Eric Butler, PE, Supervising Engineer, Planning Branch
	Len Marino, PE, Chief Engineer
	Nicole Rinke, Board Counsel
	Leslie Gallagher, Acting Executive Officer

STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY **EDMUND G. BROWN JR.,** GOVERNOR

CENTRAL VALLEY FLOOD PROTECTION BOARD
3310 El Camino Ave., Rm. 151
SACRAMENTO, CA 95821
(916) 574-0609 FAX: (916) 574-0682
PERMITS: (916) 574-0685 FAX: (916) 574-0682

January 23, 2015

Colonel Michael J. Farrell, District Commander
U.S. Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814

Subject: Written Request to Initiate Project Review pursuant to Title 33, USC Section 408 for the Reclamation District 108, Knights Landing Outfall Gates Fish Barrier Project

Dear Colonel Farrell:

Pursuant to Title 33, USC Section 408 (Section 408) as described by the U. S. Army Corps of Engineers (USACE) Engineering Circular 1165-2-216, §7c(2), Reclamation District 108 (RD 108) has requested the Central Valley Flood Protection Board (Board) staff to initiate the Section 408 process for the joint review of possible alterations to the Knights Landing Outfall Gates structure. The purpose of this project is to reduce Chinook salmon losses to the Colusa Basin Drain. The enclosed documentation describes the project location along with proposed alterations.

Proposed alterations may include construction of new concrete wing walls, installation of a metal picket weir, installation of rock slope protection, and removal of vegetation. The proposed alterations are not part of an ongoing or authorized Federal project and are therefore not eligible for credit. Approval under Section 404 of the Clean Water Act is also anticipated to be required for these proposed alterations. The proposed project will require lands owned by the non-Federal sponsor, and will not require any lands owned by the USACE.

On behalf of RD 108, the Board requests the USACE, in cooperation with RD 108 and other federal agencies, to initiate a joint review of possible alterations for the Knights Landing Outfall Gates Fish Barrier project. The Board, on behalf of RD 108, will seek

approval from the USACE to make necessary alterations to the levee system to achieve the project purpose.

Thank you for your attention to this request. We look forward to working with you, your staff, and the RD 108 staff on this project. If you have any questions regarding this request, please contact Ms. Nancy Moricz of my staff at (916) 574-2381 or by email at nancy.moricz@water.ca.gov.

Sincerely,

Leslie Gallagher, Acting Executive Officer

Enclosure: 33 USC § 408 Request from TRLIA dated September 18, 2014

cc: Mr. Paul Brunner, Executive Director
Three Rivers Levee Improvement Authority

Ms. Claire Marie Turner, MBK Engineers

ATTACHMENT A - Draft Letter to USACE

RECLAMATION DISTRICT
108

975 Wilson Bend Road
P. O. Box 50
Grimes, CA 95950-0050
(530) 437-2221
Fax: (530) 437-2248
www.rd108.org

January 7, 2014

Ms. Leslie Gallagher, Acting Executive Officer
Central Valley Flood Control Board
3310 El Camino Avenue, Room 151
Sacramento, California

Subject: 33 USC § 408 Written Request for the Knights Landing Outfall Gates Fish Barrier Project

Dear Ms. Gallagher,

Reclamation District 108 (RD 108) is seeking permission from the U.S. Army Corps of Engineers (USACE) pursuant to 33 USC§ 408 (Section 408) for alteration of the Sacramento River Flood Control Project. We request your assistance in pursuing this permission by reviewing the enclosed document and forwarding our request to the USACE Sacramento District.

RD 108 is proposing to install a positive fish barrier immediately on the downstream side of Knights Landing Outfall Gates to prevent adult Chinook salmon entry into the Colusa Basin Drain. Currently adult Chinook salmon may enter into the Colusa Basin Drain from the Sacramento River through the Knights Landing Outfall Gates under certain flow conditions. Once salmon enter the Colusa Basin Drain, there is no upstream route for salmon to return to the Sacramento River; therefore the fish perish and are lost from production. Alterations could include construction of concrete wing walls, installation of a metal picket weir, installation of rock slope protection, and removal of vegetation. Enclosure 1 provides a more detailed description of the location and potential alterations. Approval under Section 404 of the Clean Water Act is anticipated to be required for the proposed alterations.

RD 108 will not be seeking credit for the project under Section 221 of the Flood Control Action of 1970. We not anticipate that the proposed alteration will require preparation of an Environmental Impact Statement. Therefore, based upon our understanding of most recent Section 408 guidance, we do not anticipate that USACE Headquarters approval of these alterations will be required.

The proposed project will require the use of lands owned by the non-Federal sponsor. It will not require use of lands owned by the USACE.

Should you have any questions regarding this request, please contact me at 530-437-2221, or Barry O'Regan at 209-323-9864.

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Sincerely,

Lewis Bair

Lewis Bair
General Manger
Reclamation District 108

Enclosure

DRAFT
(November 24, 2014)

Proposed Barrier to Prevent Adult Salmon Entry into the Colusa Basin Drain Through the Knights Landing Outfall Gates

Background

Adult Chinook salmon may enter into the Colusa Basin Drain (CBD) on the west side of the Sacramento Valley through two routes (Figure 1):

1) Migration up Cache Slough into the Yolo Bypass and through the Ridge Cut (when flowing) on the northwestern side of the Yolo Bypass, or
2) Migration through the Knights Landing Outfall Gates (KLOG) under certain flow conditions.

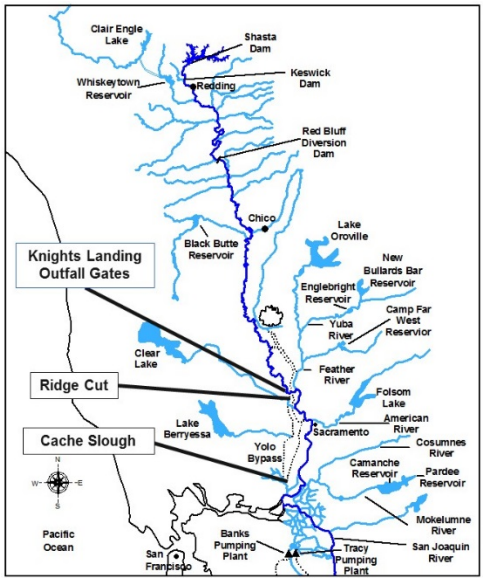

Figure 1. The Sacramento River basin showing the locations of the Knights Landing Outfall Gates, the Ridge Cut, Yolo Bypass, and Cache Slough.

This proposal only addresses the potential for salmon entry into the CBD through KLOG. The route of entry through the Yolo Bypass and Ridge Cut is being addressed through other forums.

Once salmon enter the CBD, there is no upstream route for salmon to return to the Sacramento River; the fish perish and are lost from production. Historically, significant numbers of adult salmon have been known to enter the CBD through KLOG. During the 1970s, the California Department of Fish and Game (presently the Department of Fish and Wildlife) used an electric barrier to prevent salmon entry at KLOG. The electric barrier was damaged and never replaced for a variety of reasons (CH2M HILL 1991) and no physical or behavioral fish barrier has been present since the 1970s. In 2013, large numbers of adult winter-run Chinook salmon (a

federally-listed endangered species) were estimated to have strayed and perished in upper reaches of the CBD.

Adult anadromous fish returning from the ocean and migrating upstream to spawning grounds face a variety of hazards. Protecting adult anadromous fish from time of entry into freshwater until successful reproduction in the upstream spawning habitats is critical. Those adults attaining the reproductive phase are the fewest in number among all the prior life stages. Fish reaching the spawning grounds are the oldest among all prior life stages and have already survived the vast majority of density-independent and density-dependent factors exerting the most influence on the population. Significant changes in the numbers of these adult fish can have resulting profound impacts on subsequent generations. Given the complexity of the anadromous fishes' life cycle, the upstream migrating adult fish should be the easiest to protect. [extracted from Vogel (2011)]

The mechanism for salmon entry into the CBD at KLOG may occur when water velocity is sufficient to attract the fish but low enough for the fish to overcome when migrating in an upstream direction. Salmon attraction to high water velocity is a well-known behavioral trait (Bell 1973). Experience at the Red Bluff Diversion Dam and the Tehama-Colusa Fish Facilities has shown that adult salmon readily swim through flows from hydraulic control structures when the hydraulic head differential between the upstream and downstream water bodies is less than about four feet (Vogel et al. 1988, USFWS 1990). Factors affecting the ability of salmon to pass through KLOG include CBD outflow and stage, gate openings, and Sacramento River stage. If the river level rises to an elevation higher than the CBD stage, flap gates on the downstream side of KLOG close to prevent backwater flooding into the CBD.

Colusa Basin Drain

The following information on the CBD was extracted from Huckabay (2012):

The Colusa Basin, a natural overflow basin on the west side of the Sacramento River, extends from south of Stony Creek to Knights Landing. Historically, the area within the basin was subject to periodic flooding from the Sacramento River. Flows in the basin generally discharges southeast to the river through a series of sloughs ending at Knights Landing above Fremont Weir. Agricultural land reclamation begun during the 1850's eventually drained much of the wetland area. The Colusa Drain, a levied channel completed in the 1930's, intercepts all drainage on the west side of the Sacramento River between Colusa and Knights Landing, where the drain releases flows to the Sacramento River. Levees along the west bank of the Sacramento River block flooding from the Sacramento River. Inflow into the basin comes from approximately 11 streams. Additionally, extremely high flows, greater than 300,000 cfs in the Sacramento River at Ord Ferry, would result in flows entering the Colusa Drain at that location. The Knights Landing Ridge Cut, on the southern end of the Colusa Drain, provides an outlet for flood flows (up to 20,000 cfs) to the Yolo Bypass when the outfall gates to the Sacramento River are closed. Flows to the Yolo Bypass through the Knights Landing Ridge Cut are limited to around 16,000 to 17,000 cfs when the Yolo Bypass is full. Flows from the Colusa Drain enter the Sacramento River via outfall gates at Knights Landing when the river is low.

Knights Landing Outfall Gates Structure

The following information on KLOG was extracted from DWR (2011):

The construction of the Knights Landing Outfall Gates occurred during three different periods. The structure was originally built by local interests in 1914 or 1915 and consisted of a concrete slab floor 84 feet wide with abutments at either side, 30 feet high. The space between the abutments was closed by two gate swing gate leaves that were constructed of timber held together with straps and bolts. During 1929 and 1930, the swinging gate leaves were replaced with a permanent concrete buttress to support steel flap gates. In 1949, new control gates replaced the steel flap gates. Eight manually operated slide gates on the Colusa Basin Drain side were replaced in 1985 with automated actuators that maintain a set water surface elevation on the Colusa Drain side of the structure. The Knights Landing Outfall Structure currently consists of a concrete slab foundation having a center section 84 feet wide with concrete abutments and concrete wing walls on each side. Flow is controlled by eight 66-inch and two 42-inch screw-operated slide gates on the Colusa Drain side, and by eight 66-inch and two 42-inch combination flap and slide gates on the Sacramento River side. Flow calculations at KLOG are based on flow conditions caused by the gate and flap gate settings of each gate relative to the head difference of the stage of the gage on Colusa Basin Drain (upstream of the gates) and that of the Sacramento River at Knights Landing gage (downstream of the gates) (Huckabay 2012).

In 2012, DWR rehabilitated the KLOG structure to replace all gate flaps, seals, and assemblies. Additionally, among other new features, outdated motor controllers and nonfunctional water level sensors were replaced. Together, the new control system and other existing water level sensors along the Sacramento River provide greater flexibility in the operation of the gates to protect CBD from the backwater effect of the Sacramento River and maintain the necessary water pool elevation on the CBD side for irrigation.

Conditions that May Allow Adult Salmon Passage through KLOG

During most periods of the year, adult salmon cannot pass through KLOG, primarily because of very high water velocities through the KLOG orifices when the head exceeds four feet. For the purposes of this proposal, it was assumed that adult salmon could migrate through KLOG if the differential between the water surface elevations in the CBD and Sacramento River is less than four feet, one or more gates are open at least one foot, and the KLOG gate orifices are submerged at least one foot from backwater influence of the Sacramento River (19 feet elevation, USED datum). Other scenarios for passage may be possible, but the foregoing conditions are suggested as probable conditions for salmon passage.

Example data to demonstrate conditions when adult salmon may enter the CBD through KLOG are shown for daily time steps during the 2011 water year in Figures 2 and 3. From January 8 through January 19, 2011, when winter-run and late-fall-run Chinook could have been in the vicinity of Knights Landing, the head at KLOG was less than four feet, Sacramento River elevations were greater than 19 feet (USED datum), and six of the eight center gates were nearly wide open (Figure 2). From September 10 through September 20, 2011, when fall-run Chinook could have been in the vicinity of Knights Landing, the head at KLOG was less than four feet,

Sacramento River elevations were greater than 19 feet (USED datum), and six of the eight center gates were open more than one foot (Figure 3). Many other examples are available in the historical record.

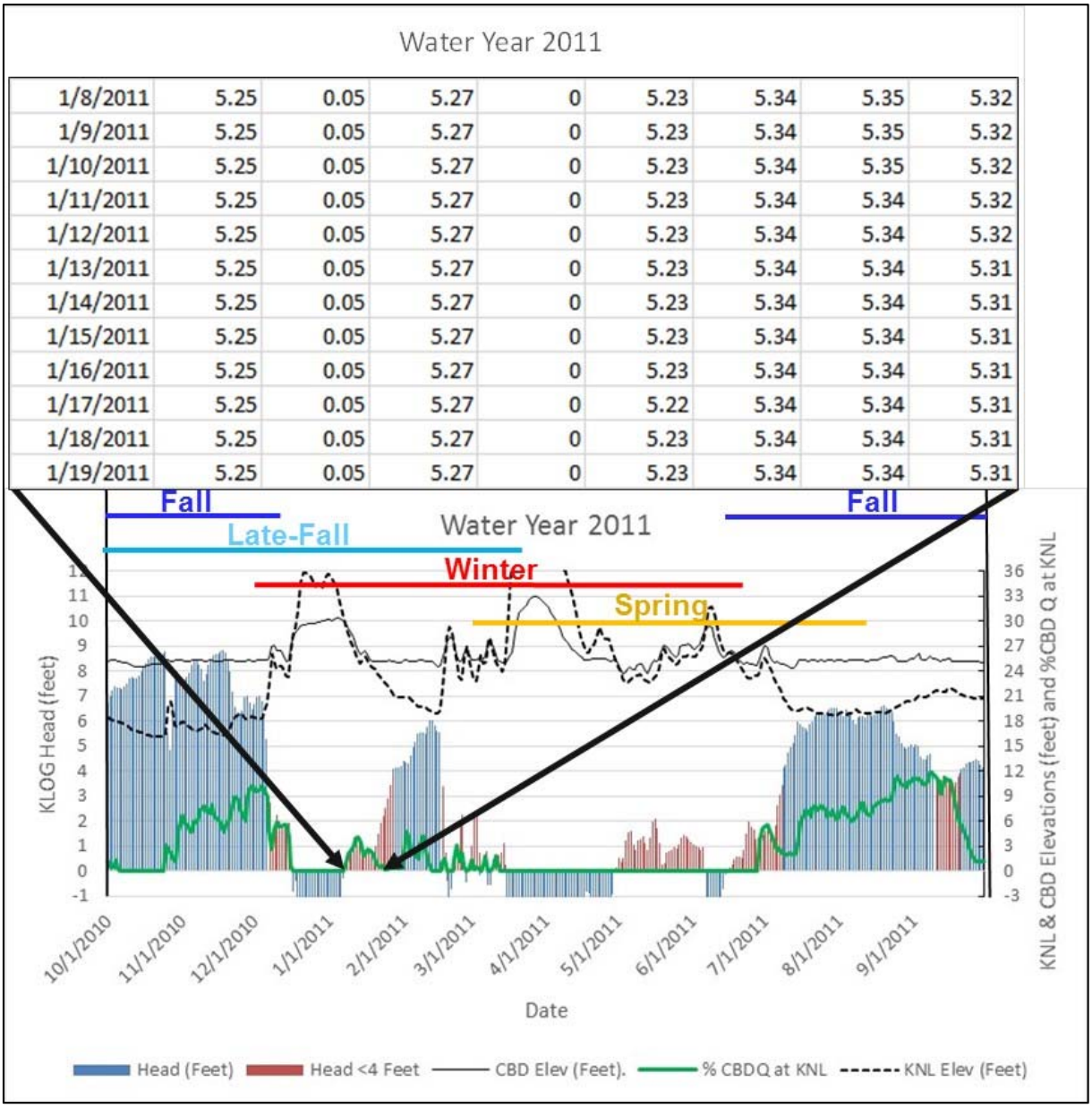

Figure 2. Water year 2011 daily water surface elevations and differentials in the CBD and Sacramento River, percent contribution of KLOG outflow to the Sacramento River, upstream migration timing of the four runs of Chinook salmon past Knights Landing, and gate openings (in feet) for the center eight KLOG gates on January 8 – January 19, 2011 (USED datum).

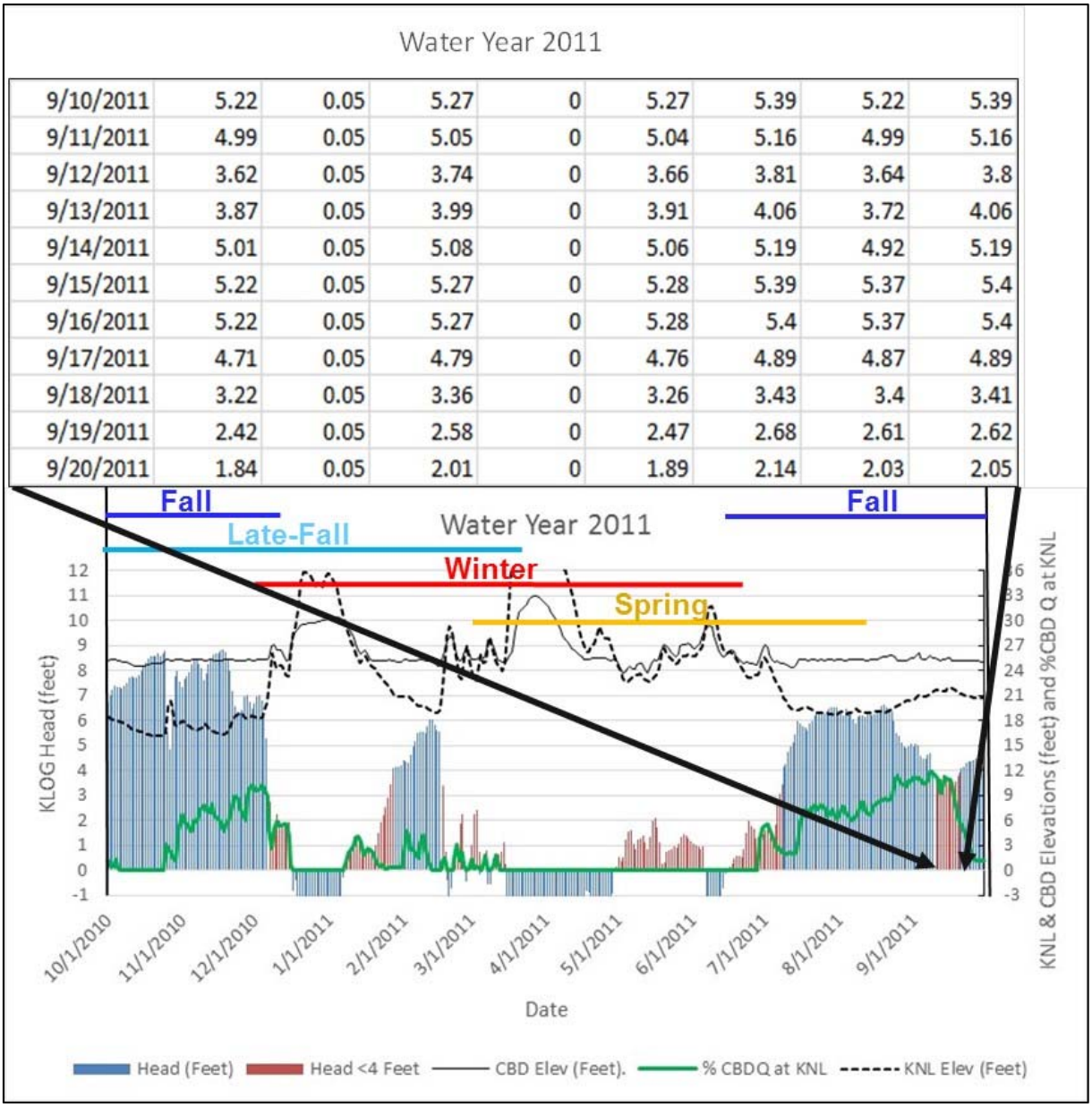

Figure 3. Water year 2011 daily water surface elevations and differentials in the CBD and Sacramento River, percent contribution of KLOG outflow to the Sacramento River, upstream migration timing of the four runs of Chinook salmon past Knights Landing, and gate openings (in feet) for the center eight KLOG gates on September 10 – September 20, 2011 (USED datum).

Proposal

This proposal seeks to install a positive barrier immediately on the downstream side of KLOG to prevent adult salmon entry into the CBD. The proportion of salmon straying into the CBD through KLOG as compared through the Ridge Cut is presently unknown. However, the cost associated with evaluating KLOG passage is in the range of approximately $200,000 - $250,000 annually (J. Newcomb, DWR, pers. comm.) and it would likely take many years to fully evaluate fish passage. Therefore, it is suggested here that it would be more-cost effective to place a

positive barrier at KLOG. The barrier would be a foam-filled picket[1] weir that would naturally raise and lower with variable Sacramento River stages, pivot on an anchor point on the concrete slab just downstream of the KLOG gates, and allow natural flushing of debris over the top of the pickets. The focus for exclusion of salmon is at the eight 66-inch diameter center gates. The two smaller 42-inch side gates were not examined for barrier installation because it was assumed that those gates could be shut off during periods when salmon could potentially migrate through KLOG and because barrier installation at those gates would be problematic and considerably more difficult because of asymmetrical problems on the downstream sides of KLOG. As described below, various configurations for barriers at the eight 66-inch diameter gates were considered.

The existing configurations of pertinent features on the downstream-side of KLOG are shown in Figures 4 - 6.

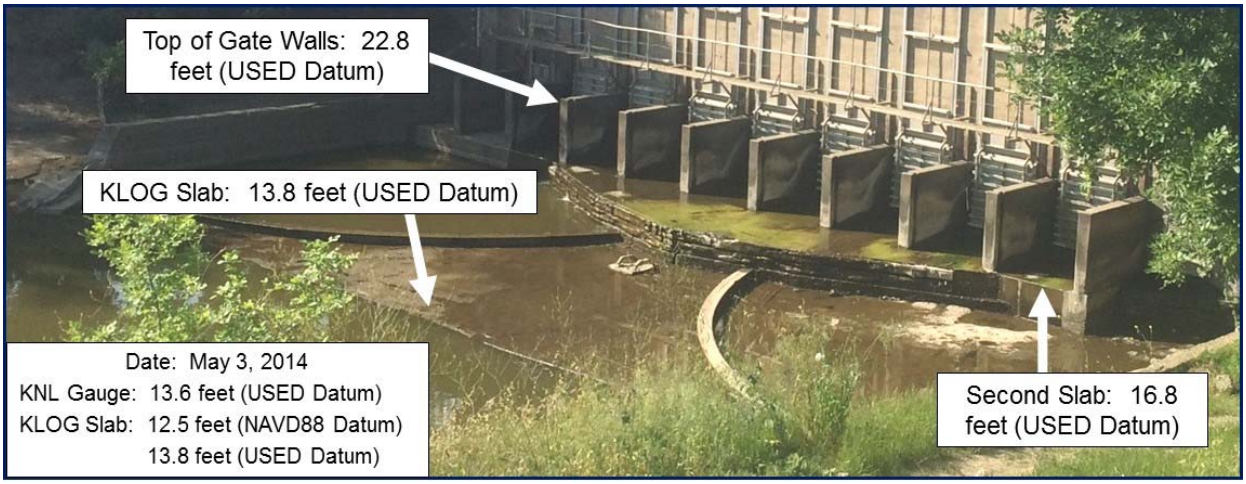

Figure 4. Picture of the downstream portion of KLOG taken by George Heise (DFW) on May 3, 2014. Note the curved concrete bullnose at the base of the gate wall slab (second slab) and the two curved metal rails that were used for the original large wood leaf gates nearly 100 years ago.

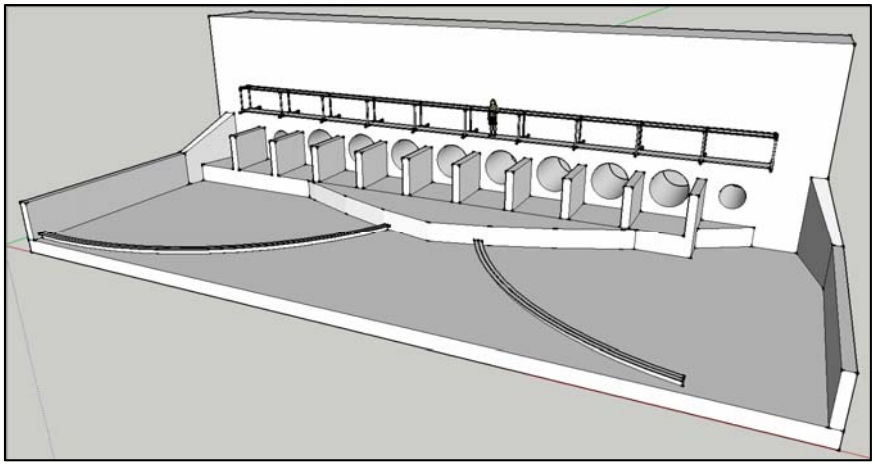

Figure 5. 3-dimensional view of existing features on the downstream side of KLOG. An animation of this graphic can be viewed at: https://www.youtube.com/watch?v=ByT5TOHXOw8

[1] The composition of the pickets has not yet been determined.

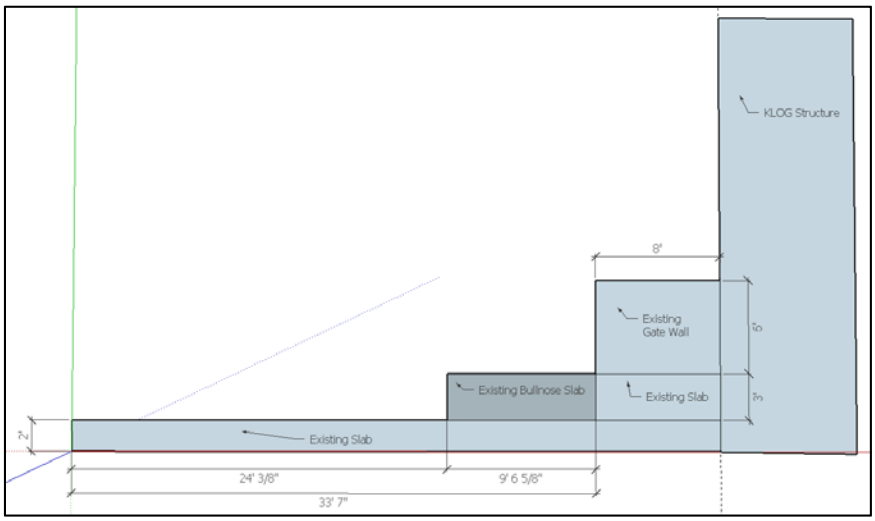

Figure 6. Side view and dimensions of existing features on the downstream side of KLOG.

If it is undesirable or infeasible to remove the old curved concrete bullnose originally used for the two large wood leaf gates, the pickets would need to be installed downstream of the bullnose as shown in Figures 7 and 8. Removal of the two curved metal rails on the downstream concrete slab would be necessary but easy to accomplish. Additionally, two walls on each side of the pickets would need to be installed to prevent salmon passage around either side of the pickets. The walls would rise approximately 2.2 to 3 feet above the existing gate walls (below the existing catwalk) to provide salmon blockage when Sacramento River stage exceeds 25 feet elevation (USED datum) and the flap gates close. This configuration would result in an approximate 27 degree angle on the pickets when the Sacramento River stage exceeds 25 feet elevation, reducing the debris-flushing and salmon exclusion effectiveness of the floating pickets.

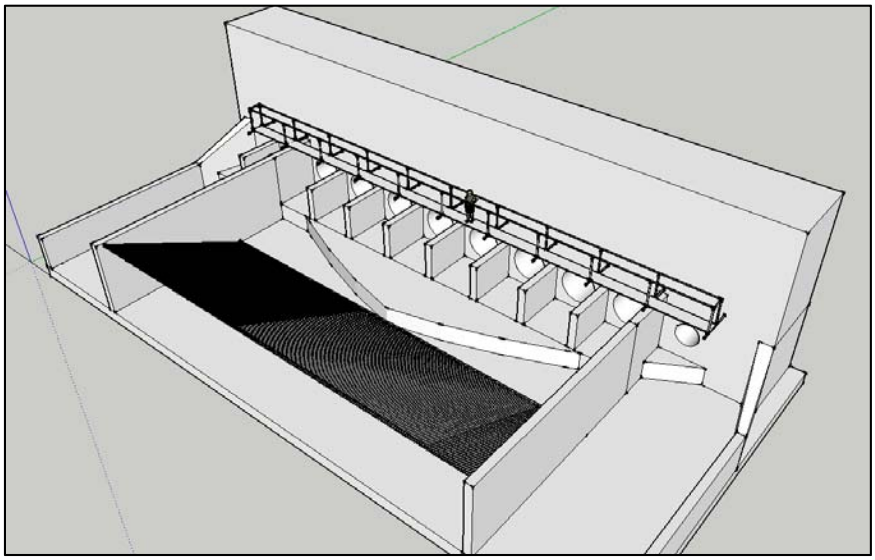

Figure 7. 3-dimensional view of features on the downstream side of KLOG with two raised side walls and a picket weir at the base of the existing concrete bullnose.

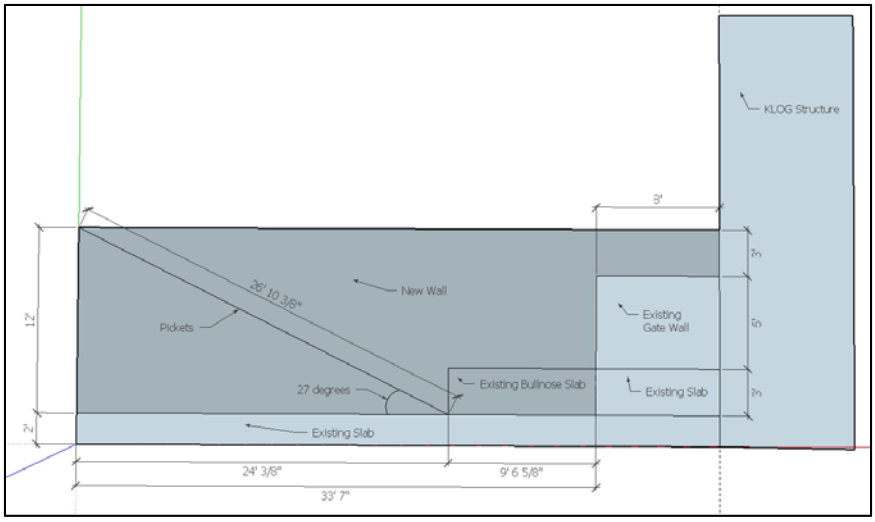

Figure 8. Side view and dimensions of features on the downstream side of KLOG with two raised side walls and a picket weir at the base of the existing concrete bullnose.

If the concrete bullnose could be removed, the pickets could be installed at the base of the existing gate wall slab as depicted in Figures 9 and 10. This configuration would result in an approximate picket angle of 20 degrees when the Sacramento River stage exceeds 25 feet.

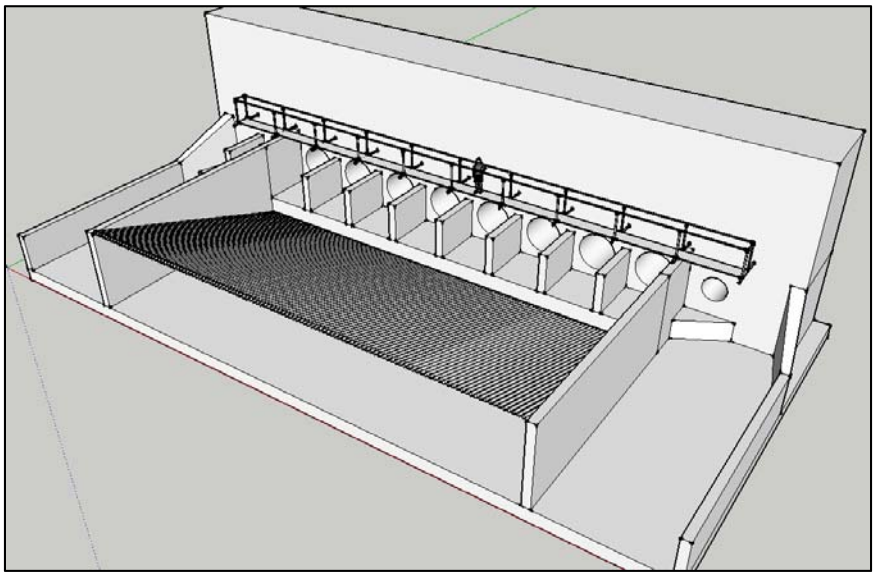

Figure 9. 3-dimensional view of features on the downstream side of KLOG with two raised side walls, the concrete bullnose removed, and a picket weir at the base of the existing gate wall slab.

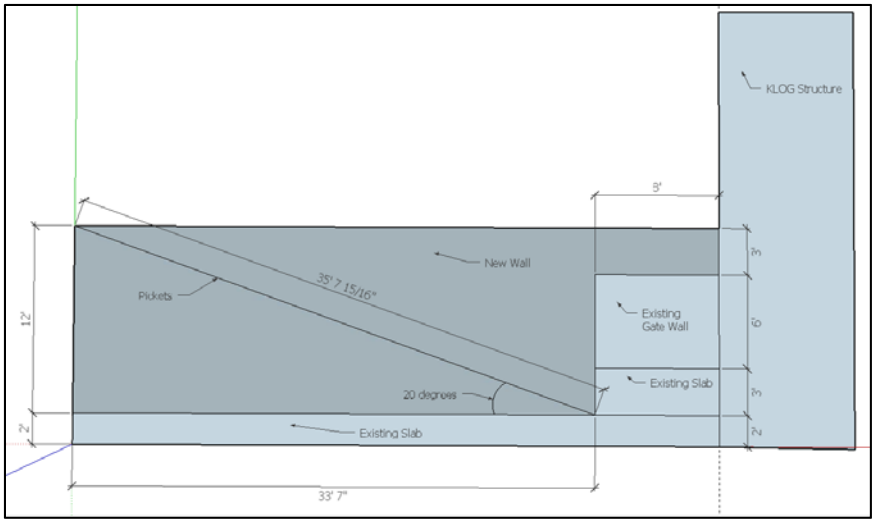

Figure 10. Side view and dimensions of features on the downstream side of KLOG with two raised side walls, the concrete bullnose removed, and a picket weir at the base of the existing gate wall slab.

To achieve a more-acute angle (16 degrees) on the pickets, a raised floor on the downstream slab could be installed with a reduced-elevation concrete bullnose (Figures 11 and 12).

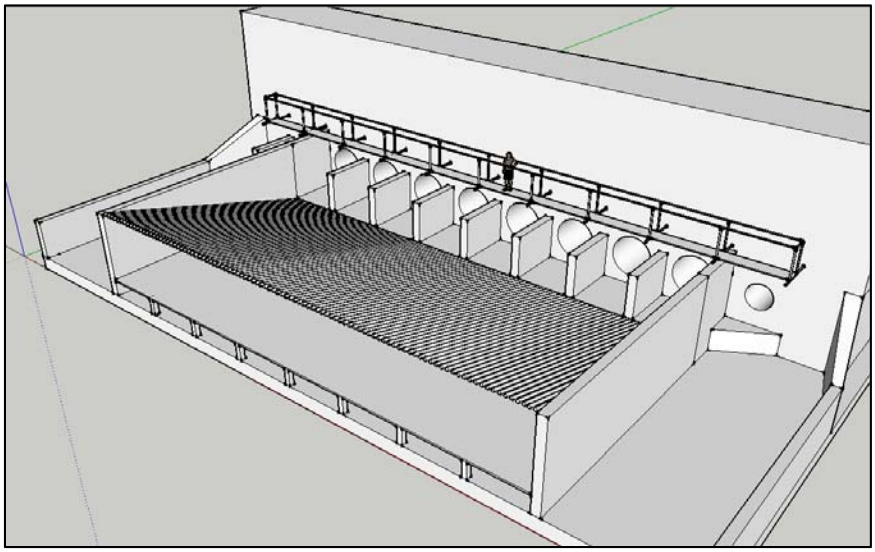

Figure 11. 3-dimensional view of features on the downstream side of KLOG with two raised side walls, a raised floor, the concrete bullnose remaining and a picket weir at the base of the existing gate walls.

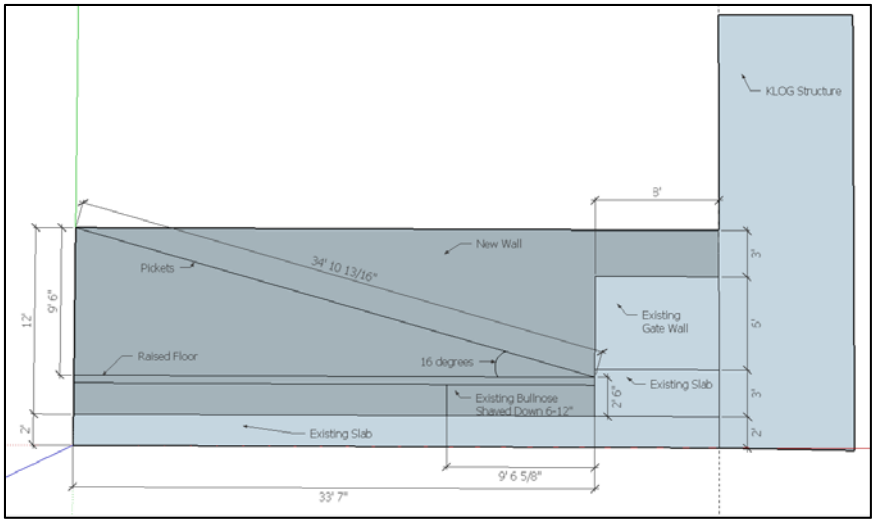

Figure 12. Side view of features on the downstream side of KLOG with raised side walls, a raised floor, a reduced-elevation concrete bullnose remaining and a picket weir at the base of the existing gate walls.

An additional alternative to obtain a smaller angle (14 degrees) on the pickets would entail raising the floor to just above the elevation of the concrete bullnose slap (without altering the bullnose) and compartmentalize barriers for two-gate combinations (Figures 13 and 14). This alternative would likely make operation and maintenance of the picket weirs more manageable than one continuous long picket weir in front of all eight gates. Flow deflectors installed in the gate wall stop log slots would protect the pivot point for the pickets (Figure 14). The picket panels would be designed to be lowered for installation and raised for maintenance on vertical guides on the side walls accessible from the existing catwalk.

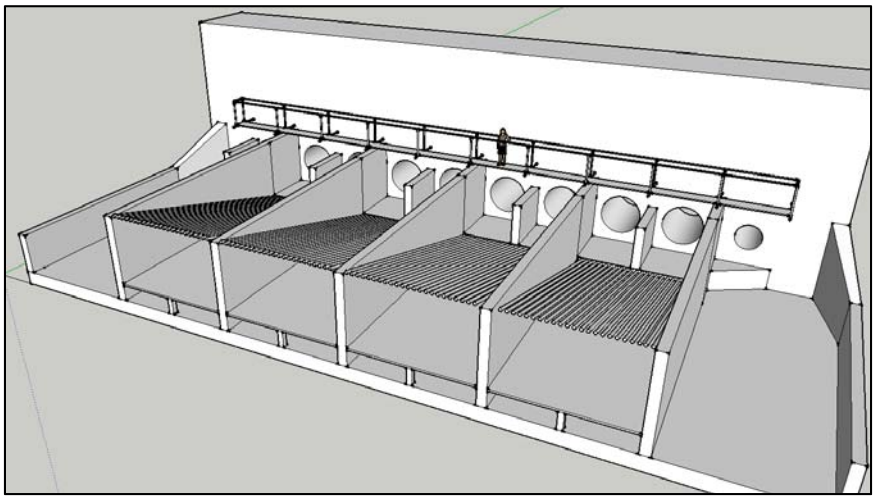

Figure 13. 3-dimensional view of features on the downstream side of KLOG with five raised side walls, a raised floor, the concrete bullnose remaining, and a picket weir at the base of the existing gate walls. An animation of this graphic can be viewed at: https://www.youtube.com/watch?v=5Kp4tNFWUQI

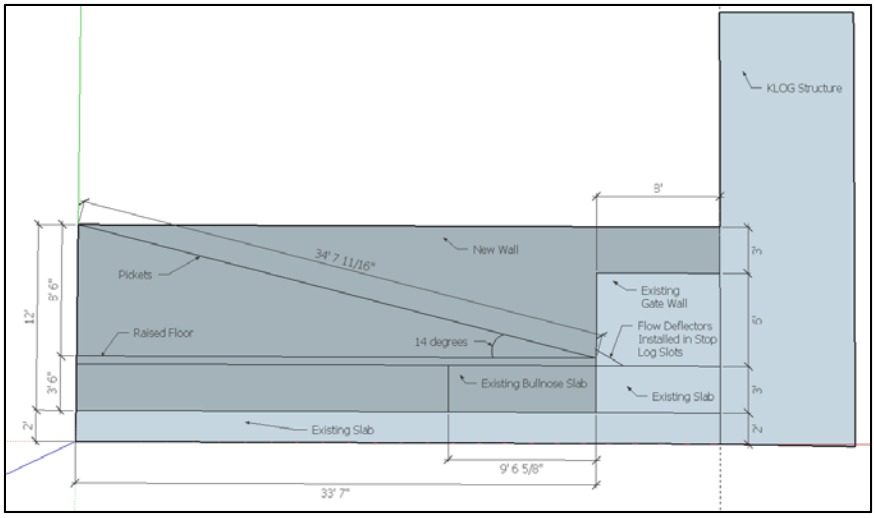

Figure 14. Side view and dimensions of features on the downstream side of KLOG with raised side walls, a raised floor, the concrete bullnose remaining, and a picket weir at the base of the existing gate walls.

Preferred Alternative

The probability of success of a resistance weir increases with more acute angles. The smallest angle could be achieved by installing a raised floor above the existing downstream concrete slab. The advantages of this configuration compared to the others is that the old concrete bullnose would not be disturbed and would provide the smallest picket weir angle allowing greater debris-flushing and salmon-exclusion capabilities. Therefore, this option (Figure 13 and 14) is considered the best alternative to install at KLOG. The raised floor could be made of relatively light material such as thick wood or a composite resistant to water. If this option is determined to be more feasible than other alternatives such as concrete, the picket weir side walls could be supported by cutting rectangular holes in the existing concrete slab, and driving vertical H-piles into the riverbed (Figure 15). Additional details on the barrier will be developed with more analyses.

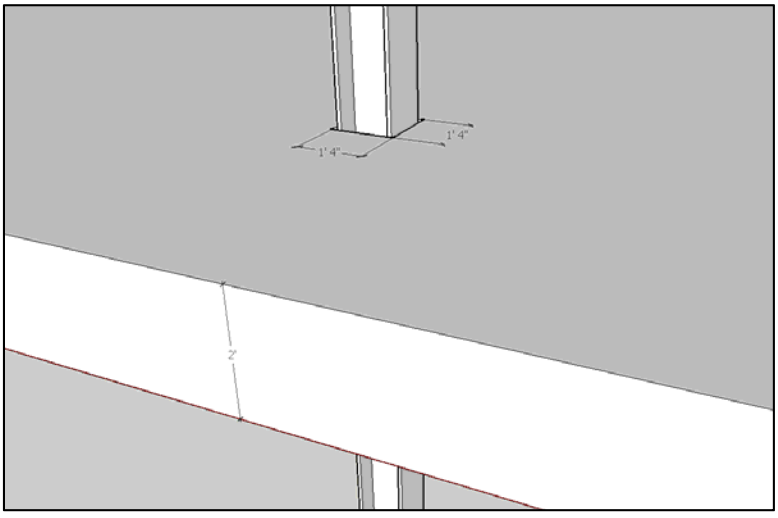

Figure 15. Conceptual 3-dimensional diagram of driving H-piles through rectangular holes cut in the existing concrete slab to support side walls for the picket weirs.

References

Bell, M.C. 1973. Fisheries Handbook of Engineering Requirements and Biological Criteria. U.S. Army Corps of Engineers. 522 p.

California Department of Water Resources. 2011. Draft Initial Study/Negative Declaration for the Knights Landing Outfall Gates Rehabilitation Project. Prepared by Division of Flood Management. May 2011. 83 p.

CH2M HILL. 1991. Assessment of options for excluding adult salmon from entry into the Colusa Basin Drain. Report prepared by Reclamation District No. 2047. September 1991. 19 p.

Huckabay, P. 2012. Metadata on A02945 – Colusa Basin Drain at Knights Landing (CDEC ID = N/A) SY Station. California Department of Water Resources. May 23, 2012.

U.S. Fish and Wildlife Service. 1990. Evaluation of the measure of raising the Red Bluff Diversion Dam gates on improving anadromous salmonid passage based on observations of radio-tagged fish. USFWS Report No. AFF1-FAO-90-10. September 1990. 21 p.

Vogel, D.A. 2011. Insights into the problems, progress, and potential solutions for Sacramento River basin native anadromous fish restoration. Report prepared for the Northern California Water Association and Sacramento Valley Water Users. Natural Resource Scientists, Inc. April 2011. 154 p.

Vogel, D.A., K.R. Marine, and J.G. Smith. 1988. Fish Passage Action Program for Red Bluff Diversion Dam, Final Report on Fishery Investigations. USFWS Report No. FR1/FAO-88-19. 77 p. plus appendices.

ATTACHMENT B - Location Map