Appendix G
Agency Comments

United States Department of Agriculture
Forest Service
Mendocino N.F.
Supervisor's Office
825 N. Humboldt Ave.
Willows, CA 95988
(530) 934-3316
TTY: (530) 934-7724

File Code: 1920, 1950

Date: *

Mr. Art Bullock
Tehama-Colusa Canal Authority
P.O. Box 1025
Willows, CA 95988

Dear Mr. Bullock:

This letter provides comment from the U.S. Forest Service, Mendocino National Forest on the proposal to address needs for water delivery and fish passage at the Red Bluff Diversion Dam (RBDD). The focus of these comments is the Alternative 1b fish bypass channel option, located and designed as shown in Volume II of the Phase II Preliminary Design Report (CH2MHill, February 2001), and as discussed during our meeting in Willows on May 3, 2001. As you know, the Forest Service was first informed of planning for this alternative in late February 2001. This letter therefore represents our initial formal response to the fish bypass channel proposal.

The U.S. Forest Service manages the 488-acre Red Bluff Recreation Area on the east bank of the Sacramento River at the RBDD site (Attachment A). The U.S. Bureau of Reclamation transferred jurisdiction of the site to the Forest Service in 1988 with the assurance that the Forest Service would develop a management plan for the area, with appropriate documentation under the National Environmental Policy Act. The Mendocino National Forest undertook planning for the Red Bluff Recreation Area in 1988, conducting numerous meetings and receiving input from hundreds of agencies, organizations, businesses, and individuals. Many of these agencies and organizations agreed to act as partners with us in implementing the selected alternative of the Red Bluff Recreation Area Development Plan (Record of Decision signed in 1991). This plan was subsequently incorporated into the Mendocino National Forest Land and Resource Management Plan (Record of Decision signed in 1995).

Recreation development of the Red Bluff site plays a key role in the U.S. Fish and Wildlife Service's plan for a Sacramento River National Wildlife Refuge (SRNWR). The environmental assessment for the SRNWR identifies sites such as the Red Bluff Recreation Area as appropriate locations for achieving the dual objectives of preserving Sacramento River riparian habitat while meeting increased demand for outdoor recreation. By concentrating public use and interpretive facilities at nodes such as the Red Bluff Recreation Area, both the public and natural systems benefit.

The Red Bluff Recreation Area plan emphasizes interpretation of natural systems through displays, facilities, and programs. The Recreation Area plan re-creates on the site the type of riparian habitat that existed prior to 1800, and provides facilities for interpreting the relationship between the river's aquatic system and its riparian and upland surroundings.

The bypass channel as presently envisioned (CH2MHill 2001: 1-G-15) lies entirely within the Red Bluff Recreation Area. The only sizeable portion of the recreation area above the 100-year flood plain, and thus available for facility construction, is located within the area between the proposed bypass channel and the river. If the bypass channel were built according to the present design, the site's existing and proposed interpretive facilities would be cut off from the riparian and upland habitat they are intended to interpret by a ninety-foot-wide moat surrounded by an eight-foot-tall fence (CH2MHill 2001: 90-C-1, 90-C-2). The only suitable sites for day-use facilities on the riverbank would also be lost. The value of the Red Bluff Recreation Area for the interpretation of interconnected natural systems would be effectively destroyed.

During the ten years since completion of the Red Bluff Recreation Area plan, the Mendocino National Forest and its partners have been actively engaged in its implementation. Several million dollars and thousands of hours of volunteers' time have been invested in restoring riparian habitat and constructing recreation and interpretive facilities. The Forest Service has contributed over $950,000 in construction funds for recreation, interpretive, and administrative facilities. Partners including the State of California, Bureau of Reclamation, and the Red Bluff Chamber of Commerce have contributed an additional $810,000 for facility construction.

The Forest Service has invested another $350,000 in restoring riparian forests, wetlands, and oak woodlands on the site. Partners including the State of California Wildlife Conservation Board, the Sacramento River Discovery Center, Pacific Gas and Electric, and Ben's Trucking have contributed an additional $600,000 toward this effort.

The facilities that would be removed to allow for the fish bypass channel as currently designed could be replaced. What could not be replaced is the unique quality of the Red Bluff Recreation Area; the good faith efforts made by our many partners; the thousands of hours that volunteers have devoted to the site; or the potential to educate future students and visitors about the interconnected ecosystems of Sacramento River Valley.

For these reasons Alternative 1b would not comply with our Land and Resource Management Plan. It would significantly alter the character of the Lake Red Bluff Recreation Area from desired condition set forth in the Plan. It would also significantly impair our ability to achieve the interpretive objectives established in the Plan. Consequently, implementation of Alternative 1b would require a Plan amendment.

The Forest Service understands the need and supports the proposal to respond to biological and social needs at the RBDD site. However, in view of the concerns outlined above, we believe there is a strong basis for not considering Alternative 1b as a viable alternative to meet those needs. Specifically, Alternative 1b has a high project cost, a significant conflict with established uses and management of Lake Red Bluff Recreation Area, but no clearly superior fish passage efficacy compared to the other alternatives. These significant shortcomings do not commend a great deal of investment of time, effort, and expense in a detailed analysis.

Nevertheless, we recognize that there may be other considerations that might cause you to decide to analyse Alternative 1b in detail. In that event, we request that the draft EIS for the fish passage improvement project respond to the following questions:

- Have designs for bypass channels located outside the Red Bluff Recreation Area been considered in detail?

- Have the potential social and land-use impacts of various bypass options been compared to those associated with the current design?
- Have improved fish ladders been carefully considered and compared to bypass options?
- Would a bypass channel provide for fish passage so much better than the current or improved fish ladders as to warrant the additional expense, disturbance to the site, and opportunities foregone?
- Have other alternatives designed to allow for sturgeon passage, such as locks, been considered?

We appreciate the opportunity to comment on this project, and are hopeful that these initial comments will assist in preparation of the draft EIS. Should you have any questions regarding these comments, please contact me. Or, have your staff contact our Forest Planner, Mike Van Dame, at (530) 934-1141.

Sincerely,

JAMES D. FENWOOD
Forest Supervisor

Cc: Mike Ryan, Area Manager
U.S. Bureau of Reclamation, Shasta Lake Office

Max Stodolski
U.S. Bureau of Reclamation, Red Bluff Office

United States Department of the Interior

BUREAU OF RECLAMATION
Northern California Area Office
16349 Shasta Dam Boulevard
Shasta Lake, California 96019-8400

IN REPLY REFER TO:

NC-600
PRJ-8.10

NOV 0 2 2001

MEMORANDUM

To: Acting Regional Director
Attention: MP-100

Through: Chet Bowling
Acting Deputy Regional Director

From: Max J. Stodolski
Chief, Red Bluff Division

Subject: Tehama-Colusa Canal Authority Fish Passage Improvement Project at the Red Bluff Diversion Dam – Response to Proposed Alternatives

Reclamation has received, and is currently reviewing, the attached Planning Aid memorandum from the Fish and Wildlife Service, dated October 19, 2001. Letters of concurrence from the California Department of Fish and Game and the National Marine Fisheries Service are also attached.

The Fish and Wildlife Service memorandum discusses their concerns, and the opinions of other agencies, regarding the alternatives offered in the Tehama-Colusa Canal Authority's most recent planning document for this project.

This correspondence is being forwarded to you for informational purposes. Please send any comments you might have to me, at the address above, no later than November 30, 2001. You can also provide comments by electronic mail to mstodolski@mp.usbr.gov, or by fax to (530) 529-3895.

If you have any questions, please contact me at (530) 529-3890; TDD: (530) 275-8991.

Attachments

Mr. Ralph Hinton
California Department of Water Resources
2440 Main Street
Red Bluff, California 96080

Mr. Arthur Bullock
Tehama-Colusa Canal Authority
PO Box 1025
Willows, California 95988

Mr. Dale Canon
CH2M Hill
PO Box 492478
Redding, California 96049-2478

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1886

October 19, 2001

Memorandum

To: Chief, Red Bluff Division, Bureau of Reclamation, Red Bluff, California

From: Acting Field Supervisor, Sacramento Fish and Wildlife Office, Sacramento, California

Subject: Planning Aid Memo on the Fish Passage and Water Reliability Improvement Project Red Bluff Diversion Dam, Red Bluff, California

This Planning Aid Memorandum (Memorandum) transmits the U.S. Fish and Wildlife Service's (Service) comments on alternatives for the Tehama-Colusa Canal Authority (TCCA) Fish Passage Improvement Project at the Red Bluff Diversion Dam (RBDD). These comments have been prepared under the authority, and in accordance with the provisions of Section 2(b) of the Fish and Wildlife Coordination Act [(FWCA) 48 stat. 401, as amended: 16 U.S.C. 661 et seq.]. The purpose of the FWCA is to provide for equal consideration of fish and wildlife conservation with other project features of federally funded or permitted water resource development projects. Pursuant to the FWCA, the Service has coordinated with the National Marine Fisheries Service (NMFS) and the California Department of Fish and Game (DFG) before providing these comments. We have been assured that these co-trustee agencies will be affirming the content of this Memorandum in subsequent submittals to the lead agencies under the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA) requirements. These comments have been developed in coordination with our Red Bluff Fish and Wildlife Office.

On October 1, 2001, the Service began collaborations with DFG and NMFS biologists in an effort to jointly develop this memorandum to assist the Bureau of Reclamation (Reclamation) with the interagency planning process for the Fish Passage Improvement at RBDD. Reclamation is the Federal nexus cooperator to the TCCA, the project lead agency.

A multi-agency team has been working on evaluating the existing conditions and alternatives for the fish passage project for over two years. This planning process has resulted in the development of the following alternatives, including the current condition (No Action):

No Action	Dam Gates in four months existing fish ladders.
Alternative 1(a)	Gates-in 4 months; new fish ladders; 1,700 cfs total pumping capacity.
Alternative 1(b)	Gates-in 4 months; new right bank fish ladder; bypass channel; 1,700 cfs total pumping capacity
Alternative 1(c)	Gates-in 4 months; old fish ladders; develop water supply from Stony Cr.
Alternative 2(a)	Gates-in 2 months; old fish ladders; 2,000 cfs total pumping capacity.
Alternative 2(b)	Gates-in 2 months; new fish ladders; 2,000 cfs total pumping capacity.
Alternative 3	Gates-out year-round; 2,500 cfs total pumping capacity.

The Service, in collaboration with NMFS and DFG, has arrived at the following preliminary recommendations:

Alternative 1(c) does not appear to meet the intent of the presently established "Project Need, Purposes, and Goal" ("needs and purpose") listed in the CH2MHILL February 2001 document, *"Tehama-Colusa Canal Authority Fish Passage Improvement Project at the Red Bluff Diversion Dam", Phase II, Preliminary Design Report, Volume I of II."* This needs and purpose clearly states the project must "substantially improve the long-term reliability" of both water delivery and adult and juvenile fish passage at the dam. Alternative 1(c) appears unlikely to substantially improve the reliability of water deliveries due to the many uncertainties associated with the water supply on Stony Creek. In April, 2001, CH2MHILL conducted a preliminary investigation of the reliability of the Stony Creek water supply, indicating that in one of every four years no water would be available for rediversion to the Tehama-Colusa Canal (TCC). There are additional uncertainties regarding the use of Stony Creek water dependant on the outcome of ongoing biological analyses and regulatory reviews of Stony Creek water management practices.

Most importantly, from our perspective, Alternative 1(c) does not improve fish passage over the No Action Alternative (gates in four months); especially for focus species of the alternatives, including spring-run chinook salmon and green sturgeon. Therefore, we recommend this alternative be dropped from further consideration. All remaining alternatives appear to meet, to various degrees, the intent of the "needs and purpose" statements.

The following list ranks the remaining alternatives, beginning with the alternative that we feel provides the greatest fishery resource benefits, to the alternative with the least fishery benefits:

1 Alternative 3
2 Alternative 2(b)
3 Alternative 2(a)
4 Alternative 1(a)
5 Alternative 1(b)

To date, the lead agency and the multi-agency planning process has generated certain amounts of fisheries information to enable this preliminary evaluation of the alternatives. However, a similar level of evaluation in relation to project alternative effects to terrestrial wildlife resources has not been possible. Therefore, as such information becomes available, issuance of additional planning aid memos may be necessary.

Discussion:

Our analysis is based upon the proceedings of numerous multi-agency technical teams spanning two decades. These efforts examined biological consequences of impaired passage at RBDD for both adult and juvenile anadromous fish as well as remedial alternatives. The most significant biological finding from this process is that populations of winter and spring-run chinook salmon, natal to the main-stem Sacramento River, require reliable and unimpaired passage at RBDD because one hundred percent of their spawning habitat is located above the dam. Likewise, salmon and steelhead populations natal to Battle, Cottonwood, Cow, and Clear creeks require reliable and unimpaired passage to sustain their separate populations. The need for restoration and recovery of these specific populations is exemplified by existing efforts to provide extensive and costly habitat restoration in the Sacramento River above RBDD, and in its major tributaries.

New ladder designs being considered as part of Alternatives 1(a), 1(b), and 2(b) are not known to produce substantial improvements in fish passage efficiency and reliability over the existing ladders. However, existing ladders at RBDD are 40 years old and engineering advancements could provide some measure of incremental improvement. Of the two permanent ladders at the dam, the west bank facility is a good candidate for modernization (size, attraction flow, baffling etc.) and effectiveness monitoring.

There are many uncertainties attached to the bypass being considered as part of alternative 1(b). While a bypass or even a fish ladder of this scale has never been tried before, the bypass does represent experimental technology that may pass non-salmonids. Clearly, there is no predictive capability that non-salmonids such as sturgeon, Sacramento pikeminnow, American shad, and striped bass will find the opening of the bypass or swim completely through the bypass if they enter it. There are also a number of operation and maintenance concerns, including seasonal closure of the facility and handling all the entrained fish during dewatering.

Our analysis of Alternatives 2(a) and 2(b) concludes there is a substantial improvement in the long-term reliability of adult and juvenile fish passage at RBDD over the No Action condition.

While we are not able to determine the incremental benefits provided by new ladders associated with the 2(a) and 2(b) alternatives, we believe the beneficial increment is not substantial in comparison to the benefit provided by the additional two months of gate openings. There are a number of specific benefits with alternatives 2(a) and 2(b). For example, the upstream migration of adult Sacramento pikeminnow would be facilitated during the gates up period, minimizing harmful accumulation of these predatory species on juvenile salmonids at the dam. Adult spring-run chinook salmon would have unimpaired passage up to the end of their migration period in late June. Unimpaired passage is particularly important for spring-run chinook salmon migrating to their natal tributaries on the Sacramento River above RBDD during the drier months. Delays in migration can result in late arrival to natal tributaries where low flow and high temperatures would prevent passage. Many of the Sacramento River tributaries above RBDD are undergoing comprehensive and expensive restoration, focusing on spring-run chinook salmon. Spring-run broodstock are extremely rare above the dam, making it essential to recruit the maximum number of natural spawners possible. Downstream migrating juveniles would be less susceptible to predation since during the gates up operation, they would not pass underneath the gates of the RBDD and become disorientated or impaired. Additonally, the spawning migration of adult green sturgeon would be unimpaired through the last portion of their spawning migration in the spring.

Alternative 3, except for diversions and their associated construction and operational impacts, provides a situation closest to the original ecosystem form and function. A free-flowing condition year-round under Alternative 3 would eliminate upstream or downstream impediments to migration and associated predation problems for all species and life-stages. Therefore, this is the best alternative for passage of all fish species and their associated life stages.

The migration timing for all anadromous fish species past Red Bluff is such that the increment of the populations migrating in July and August is relatively small. Therefore, the direct incremental benefit of totally unimpaired passage for anadromous fish species with Alternative 3, compared to that for Alternative 2, is relatively small. However, we think overall ecosystem-level benefits will be greater with Alternative 3. If the gates are up year-round, Lake Red Bluff would no longer exist, and a large amount of currently inundated shoreline would be exposed. If the natural river conditions were allowed to continue year-round, riparian vegetation would once again become established along and adjacent to the river. Shaded Riverine Aquatic (SRA) habitat, a Resource Category 1 type habitat along the Sacramento River, would become established providing shade, large woody debris, temperature attenuation, and food organisms for fish species, including salmon and steelhead.. SRA is important for biodiversity and increases fish and wildlife habitat values. Other species of native vegetation could also become established along and adjacent to the Sacramento River, further enhancing habitat, and fish and wildlife diversity. A year-round, free flowing river would greatly reduce predator "feeding stations" currently created when juvenile salmonids pass under the gates. Alternative 3 would also eliminate the need for fish ladders, reducing migration related stress and delay on adult fish attempting to pass upstream.

A related planning analysis is needed to consider how the RBDD alternative selection would affect the river as a navigable water of the state. Most angler use on the Sacramento River is by boat and river navigability does affect angler opportunities when pursing migratory fish species.

If you have any further questions regarding these comments, please contact Ryan Olah of my staff at (916) 414-6639 or Tom Kisanuki of the Red Bluff Fish and Wildlife Office at (530) 527-3043.

cc: Michael Aceituno, NMFS, Sacramento, CA
Donald Koch, CDFG, Redding CA
James Smith, USFWS, Red Bluff

State of California - The Resources Agency
DEPARTMENT OF FISH AND GAME
http://www.dfg.ca.gov
601 Locust Street
Redding, California 96001
(530) 225-2300

GRAY DAVIS, *Governor*

Flex your POWER

October 23, 2001

Dear Interested Parties:

Tehama-Colusa Canal Authority Fish Passage Improvement Project
at the Red Bluff Diversion Dam

The Department of Fish and Game concurs with the enclosed "Planning Aid Memorandum" (Memorandum) prepared by the U.S. Fish and Wildlife Service for the draft alternatives prepared for the subject project. The purpose and need of the alternatives is to improve the reliability and performance of both fish passage and water supply at the Red Bluff Diversion Dam. As described in the Memorandum, there is an identified need to improve upon the existing conditions of operation which installs the dam gates for four months each year and relies on existing fish ladders for fish passage.

Thank you for considering the recommendations in the Memorandum during the environmental decision-making processes under the California Environmental Quality Act. If there are any questions regarding this matter, please contact Environmental Specialist IVs Steve Turek (530) 225-2380 or Harry Rectenwald at (530) 225-2368.

Sincerely,

Donald Koch

DONALD B. KOCH
Regional Manager

Enclosure

cc: Messrs. Harry Rectenwald and Steve Turek
Northern California-North Coast Region
Department of Fish and Game
601 Locust Street
Redding, CA 96001

Conserving California's Wildlife Since 1870

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

October 26, 2001

In Reply Refer To:
SWR-99-SA-1048:MET

Mr. Max Stodolski
Chief, Red Bluff Division
U. S. Bureau of Reclamation
16349 Shasta Dam Boulevard
Shasta Lake, California 90802-4213

Dear Mr. Stodolski:

This is in regards to the Planing Aid Memorandum sent to you by the acting Field Supervisor of the Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service (FWS), on October 19, 2001. That memorandum discusses the various alternatives being considered by the Bureau of Reclamation (Reclamation) for improving the long term reliability of both fish passage and water delivery at Red Bluff Diversion Dam on the Sacramento River in Red Bluff, California.

The National Marine Fisheries Service (NMFS) has been working closely with Reclamation and FWS as a member of the multi-agency team that has been evaluating the existing conditions and developing alternatives for this fish passage improvement project for over two years. Recently, NMFS began working collaboratively with FWS and the California Department of Fish and Game (DFG) to develop the subject memorandum in order to provide our input on the biological merits of the various alternatives that have been developed within this process. NMFS has reviewed the final memorandum and we fully concur with the statements and determinations put forth by FWS.

Thank you for the opportunity to participate in this very important process. If you have any questions regarding this correspondence or if NMFS can provide of further assistance, please contact Mr. Michael Tucker in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814. Mr. Tucker may be reached by telephone at (916) 930-3604 or by Fax at (916) 930-3629.

Sincerely,

for Rodney R. McInnis
Acting Regional Administrator

cc: NMFS-PRD, Long Beach, CA
Stephen A. Meyer, ASAC, NMFS, Sacramento, CA

United States Department of the Interior

BUREAU OF RECLAMATION
Northern California Area Office
16349 Shasta Dam Boulevard
Shasta Lake, California 96019-8400

IN REPLY REFER TO:

NC-600
PRJ-8.10

FEB 1 3 2002

Mr. Arthur Bullock
Tehama-Colusa Canal Authority
P.O. Box 1025
Willows, California 95988

Subject: Red Bluff Diversion Dam Fish Passage Improvement Project

Dear Mr. Bullock:

Reclamation received a letter from the California Department of Water Resources (DWR), regarding the Red Bluff Diversion Dam Fish Passage Improvement Project (Project).

In their January 8, 2002, letter, DWR provides their comments concerning the three alternatives being considered for the Project. We have enclosed a copy of that letter for your information.

If you have any comments or questions, please contact me at (530) 529-3890;
TDD: (530) 275-8991

Sincerely,

Max J. Stodolski
Chief, Red Bluff Division

Enclosure

cc: Mr. Dale Cannon
CH2M Hill
P.O. Box 492478
Redding, California 96049-2478

Mr. Tom Kisanuki
Fish and Wildlife Service
10950 Tyler Road
Red Bluff, California 96080

Mr. Harry Rectenwald
California Department of Fish and Game
601 Locust Street
Redding, California 96001

Mr. Mike Tucker
National Marine Fisheries Service
650, Capitol Mall, Suite 6070
Sacramento, California 95814

Mr. Ralph Hinton
California Department of Water Resources
2440 Main Street
Red Bluff, California 96080
(w/encl)

STATE OF CALIFORNIA THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
2440 MAIN STREET
RED BLUFF, CA 96080-2356

GRAY DAVIS, Governor

January 8, 2002

Mr. Max Stodolski
Chief, Red Bluff Division
U. S. Bureau of Reclamation
Post Office Box 159
Red Bluff, California 96080

Tehama-Colusa Canal Authority Fish Passage Improvement Project
at the Red Bluff Diversion Dam

Dear Mr. Stodolski:

The Department of Water Resources concurs with the attached "Planning Aid Memorandum" prepared by the U. S. Fish and Wildlife Service to evaluate the draft alternatives prepared for the Fish Passage Improvement Project. The purpose of this project is to substantially improve the reliability of both fish passage and water supply at the Red Bluff Diversion Dam.

The Department supports an alternative that best balances the fishery and water supply needs. We also prefer an alternative that provides the capability of diverting approximately 2,000 cfs into the Tehama-Colusa Canal during the winter months as a potential source of water for an offstream storage project, such as Sites Reservoir. As you know, such a project is currently under consideration as part of the CALFED planning process.

The alternatives that best fit these considerations are those which have the Red Bluff Diversion Dam gates out year-round or for 10 months and a total pumping capacity of 2,000 cfs or more, i.e. Alternatives 2 and 3.

Change to a two-month operation, or gates out year-round would lead to an increase in riparian vegetation in the existing Lake Red Bluff footprint. This vegetation would include both native and invasive introduced species, based on the species present in the Lake Red Bluff area today. So, from an aesthetic and wildlife standpoint, this increased growth would have both beneficial and detrimental effects.

The 1992 USBR Appraisal Report (page IV-7) indicates about 234 acres are within the fluctuation zone of Lake Red Bluff, so this is the area subject to increased growth with a two-month operation, or certainly with a gates out year-round alternative. This additional vegetation in the floodplain could have significant effects on water surface elevations in the Red Bluff area during high water events.

Improvement of Sale Lane and construction of the Bell Mill Shopping Center several years ago both placed considerable fill in the floodplain. In addition, gradual urban development and growth of vegetation during the last 30 years in the several overflow channels through the Antelope area has reduced the flood capacity of these bypass channels. The presence of Lake Red Bluff also has allowed deposition of a considerable amount of cobbles and sediment in the floodway, especially just below the Antelope Boulevard Bridge.

Additional riparian growth due to the Red Bluff Diversion Dam project will further reduce the flood carrying capacity of the Sacramento River in the Red Bluff area. This potential impact must be evaluated following Executive order 11988 and FEMA guidelines to determine if the reduction will increase water surface elevations. We believe that FEMA, the State Reclamation Board, Tehama County, and City of Red Bluff will all have concerns about this potential impact.

Winter-run Chinook salmon counts at the Red Bluff Diversion Dam originally were the basis for determining the allowable incidental take of juvenile winter-run salmon by the State Water Project and the federal Central Valley Project pumps in the Delta. Since the change to a four month gates-in operation several years ago, the estimates of winter-run Chinook have been made mostly by less accurate indirect methods. A two-month operation, or gates open year-round, would mean that only a very small percentage, or even no winter-run, could be directly counted and run-size estimates would be even less accurate. The same considerations also apply to the recently listed spring-run Chinook salmon. Therefore, if one of these alternatives is selected, additional effort should be made to increase the accuracy of the winter- and spring-run Chinook population estimates above Red Bluff.

Thank you for the opportunity to participate in this planning process. If you have any questions, please contact me at (530) 529-7342, or Ralph Hinton at (530) 529-7393.

Sincerely,

Dwight P. Russell

Dwight P. Russell, Chief
Northern District

Attachment

cc: Mr. Art Bullock, General Manager
Tehama-Colusa Canal Authority
Post Office Box 1025
Willows, California 95988

United States Department of the Interior

BUREAU OF RECLAMATION
Northern California Area Office
16349 Shasta Dam Boulevard
Shasta Lake, California 96019-8400

IN REPLY REFER TO:

NC-600
PRJ-8.10

FEB 13 2002

Mr. Brian Laheney
President
Red Bluff-Tehama County Chamber of Commerce
P.O. Box 850
Red Bluff, California 96080

Mr. Marshall Pike
Chairman
Red Bluff-Tehama County Convention and Visitor Bureau
P.O. Box 850
Red Bluff, California 96080

Subject: Red Bluff Diversion Dam Fish Passage Improvement Project

Dear Mr. Laheney and Mr. Pike:

Thank you for your letter of January 3, 2002, and your continuing interest in the Red Bluff Diversion Dam Fish Passage Improvement Project (Project).

Reclamation and the Tehama-Colusa Canal Authority (TCCA), as co-leads for their respective agencies, have considered many alternatives for the improvement of a reliable water supply delivery system to the Tehama-Colusa and Corning canals, and improvement for fish passage at the Red Bluff Diversion Dam (RBDD). Currently, Reclamation and TCCA are considering three basic alternatives:

Alternative 1 (Gates-in four months): This alternative would operate the RBDD with the gates-in, creating Lake Red Bluff to provide gravity flow to the Canals for four months each year, from May 15 to September 15. New fish ladders would be constructed. Pump capacity would increase to 1700 ft^3/s

Alternative 2 (Gates-in two months): This alternative would operate the RBDD with gates-in, creating Lake Red Bluff to provide gravity flow to the Canals for two months each year, from July 1 to September 1. No new fish ladders would be constructed. Pump capacity would increase to 2000 ft^3/s.

Alternative 3 (Gates out twelve months): This alternative would eliminate the operations of the RBDD gates, and would not create a lake for gravity flow. Pump capacity would increase to 2500 ft^3/s.

Although the TCCA Board of Directors has express their preference for Alternative 3, and the U.S. Fish and Wildlife Service, with the concurrence from the National Marine Fisheries Service and the California Departments of Fish and Game, ranked the alternatives in order of fishery resource benefits, (Alternative 3: greatest; Alternative 2: next, and Alternative 1: least beneficial), these are simply statements of resource-specific preferences, and do not represent decisions based upon an analysis of multiple interests.

Reclamation and the TCCA are seeking public input, primarily through the Stakeholders Working Group, to assist in evaluating the alternatives that are being considered. Through this process we will consider other viable alternatives, as well as modifications to the current alternatives being considered.

We appreciate your participation in planning and evaluating the Project, and look forward to continuing to work with the Red Bluff - Tehama County Chamber of Commerce. A copy of your comments has been forwarded to the Project team members noted below.

If you have any other comments or questions, please contact me at (530) 529-3890.

Sincerely,

Max J. Stodolski
Chief, Red Bluff Division

Enclosure

cc: Mr. Arthur Bullock
Tehama-Colusa Canal Authority
P.O. Box 1025
Willows, California 95988

Mr. Dale Cannon
CH2M Hill
P.O. Box 492478
Redding, California 96049-2478

Mr. Tom Kisanuki
Fish and Wildlife Service
10950 Tyler Road
Red Bluff, California 96080

Mr. Harry Rectenwald
California Department of Fish and Game
601 Locust Street
Redding, California 96001

Mr. Mike Tucker
National Marine Fisheries Service
650, Capitol Mall, Suite 6070
Sacramento, California 95814

Mr. Ralph Hinton
California Department of Water Resources
2440 Main Street
Red Bluff, California 96080
(w/encl)

Red Bluff – Tehama County
CHAMBER OF COMMERCE
Web Page: www.redbluffchamberofcommerce.com
E-mail: rbchamber@tco.net

January 3, 2002

Mr. Max Stodolski
Bureau of Reclamation, Red Bluff Division
P.O. Box 159
Red Bluff, CA 96080

Dear Max:

In light of the pending decision of the TCCA regarding the future of the Red Bluff Diversion Dam and since the public agencies including the US Fish & Wildlife Service, California State Fish & Game, National Marine Fisheries Service and the US Forest Service have found it necessary to make their preferences known to you in writing, the Red Bluff Tehama County Chamber of Commerce and its Convention and Visitors Bureau feel that you should know our position regarding this decision as well.

The Chamber represents over 400 businesses in the Red Bluff and greater Tehama County area not including Los Molinos or Corning both of which have separate Chambers of their own. Our Chamber and Convention and Visitors Bureau have been active participants in the ongoing discussion of this issue for many years.

We have considered the full range of options and alternatives presented to TCCA by the technical advisory committee and concur with the overall purpose and need that the TCCA has adopted for the project with the clearest of understandings that the non-agricultural related features of the diversion dam and any changes to its regimen of use including modification to the four-month seasonal impoundment of the Sacramento River require mitigation as developed in the final record of decision. We understand that public comment will be welcomed at that time and we expect to participate fully.

TCCA and the Bureau of Reclamation should, however, be aware that the Chamber of Commerce will actively oppose any alternative chosen that eliminates the seasonal impoundment of the Sacramento River behind the gates of the Red Bluff Diversion Dam.

As such, we reaffirm our recommendation that the gates be operated in their "gates in" condition for 4 months beginning in May and ending in September of each year. Modification, particularly reduction in the number of months, must only be considered on a year by year basis with consideration given to the true and measurable biological results regarding the stock of those species that require protection under regulations existing at that time. Actions or decisions to elimate the opportunity for a full 4 month "gates in operation" when conditions are acceptable as determined by measurable biological study will be opposed. We are also concerned regarding any increase in

pumping capacity that will allow future water export beyond the legitimate demands of the Authority and its approved District users.

We request that the lead agencies maintain the utmost flexibility as they address the questions of reliable water and reliable protection of the species of concern. The human species is also of concern and many people take joy and life enriching sustenance from the Sacramento River in both its free running state and its lake-like condition each summer. To eliminate that opportunity would be a sad and irreparable disservice to as well as devaluation of the economic base of the community.

Sincerely,

Brian Laheney, President
Red Bluff-Tehama County
Chamber of Commerce

Marshall Pike, Chair
Red Bluff-Tehama County
Convention & Visitors Bureau

cc. Wally Herger, U.S. Congress
Doug Ose, U. S. Congress

Tehama-Colusa Canal Authority

5513 Highway 162
P.O. Box 1025
Willows, CA 95988

F . (530) 934-2125
Fax: (530) 934-2355
EMAIL: tcwaterman@aol.com

January 28, 2002

Mr. Brian Laheney, President
Red Bluff-Tehama County Chamber of Commerce
P.O. Box 850
Red Bluff, CA 96080

Mr. Marshall Pike, Chair
Red Bluff-Tehama County Convention & Visitors Bureau
P.O. Box 850
Red Bluff, CA 96080

Re: Comment Letter of January 3, 2002 regarding the TCCA Fish Passage Improvement Project at the Red Bluff Diversion Dam

Dear Mr. Laheney and Mr. Pike:

Thank you for your letter of January 3, 2002 regarding the "gates in" period at the Red Bluff Diversion Dam and your recommendation that the gate operation be maintained at the current 4 months "gates in" cycle beginning in mid May and ending in mid September of each year. Your position regarding the operation of the dam gates is noted and will be considered and incorporated in the environmental documents currently under preparation.

No final decision has been made on any of the Project alternatives being reviewed and evaluated, nor is any decision expected in the near future. An additional alternative to establish a "flexible" approach to gate closures was proposed at our last Stakeholders Working Group meeting on January 8th and we are currently developing the details on how such an alternative could work. We will then review the alternative with both the Stakeholders Working Group and the Technical Advisory Group to determine if it is feasible and should be more formally evaluated.

Your participation as a member of the Stakeholders Working Group insures that the viewpoints and concerns of the Chamber of Commerce are fully considered. We look forward to continuing the process over the ensuing months to complete the alternative evaluation process and develop the most appropriate solution to the fish passage and water supply reliability problems at the Red Bluff Diversion Dam.

Sincerely,

Arthur R. Bullock
General Manager & Chief Engineer

Red Bluff – Tehama County
CHAMBER OF COMMERCE
Web Page: www.redbluffchamberofcommerce.com E-mail: rbchamber@tco.net

January 3, 2002

Mr. Art Bullock
Tehama Colusa Canal Authority
P. O. Box 1025
Willows, CA 95988

Dear Art:

In light of the pending decision of the TCCA regarding the future of the Red Bluff Diversion Dam.....and, since the US Fish & Wildlife Service, California Department of Fish & Game, the National Marine Fisheries Service, and the US Forest Service have found it necessary to make their preferences known to you in writing, the Red Bluff Tehama County Chamber of Commerce and its Convention and Visitors Bureau feel that you should know our position regarding this decision as well.

The Chamber represents over 400 businesses in Red Bluff and the greater Tehama County area, not including Los Molinos or Corning both of which have separate Chambers of their own. Our Chamber and Convention and Visitors Bureau have been active participants in the ongoing discussion of this issue for many years. Mr. Stodolski has been a regular attendee at our meetings, knows the discussions, and has provided us with assistance in understanding the process. We are grateful to him for his active interest in the community and for his understanding of the overall impact that the Diversion Dam has on the travel and tourism industry in our community as well.

We have considered the full range of options and alternatives presented to TCCA by the technical advisory committee and concur with the overall purpose and need that the TCCA has adopted for the project with the clearest of understandings that the non-agricultural related features of the diversion dam and any changes to its regimen of use (including modification to the four-month seasonal impoundment of the Sacramento River) require mitigation as developed in the final record of decision. We understand that public comment will be welcomed at that time and we expect to participate fully.

The Tehama Colusa Canal Authority and the Bureau of Reclamation should, be aware that the Chamber of Commerce will actively oppose any alternative chosen that eliminates the seasonal impoundment of the Sacramento River behind the gates of the Red Bluff Diversion Dam.

As such, we reaffirm our recommendation that the gates be operated in their "gates in" condition for 4 months beginning in May and ending in September of each year. Modification, particularly reduction in the number of months, must only be considered on a year by year basis with consideration given to the true and measurable biological results regarding the stock of those species that require protection under regulations existing at that time. Actions or decisions to elimate the

opportunity for a full 4 month "gates in operation" when conditions are acceptable as determined by measurable biological study will be opposed. We are also concerned regarding any increase in pumping capacity that will allow future water export beyond the legitimate demands of the TCCA and its approved District users.

We request that the lead agencies maintain the utmost flexibility as they address the questions of reliable water and reliable protection of the species of concern. The human species is also of concern and many people take joy and life enriching sustenance from the Sacramento River in both its free running state and its lake-like condition each summer. To eliminate that opportunity would be a sad and irreparable disservice to as well as devaluation of the economic base of the community.

Sincerely,

Brian Laheney, President
Red Bluff-Tehama County
Chamber of Commerce

Marshall Pike, Chair
Red Bluff-Tehama County
Convention & Visitors Bureau

cc: Wally Herger, U.S. Congress
Doug Osc, U. S. Congress

STATE OF CALIFORNIA - THE RESOURCES AGENCY
GRAY DAVIS, *Governor*
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
2440 MAIN STREET
RED BLUFF, CA 96080-2356

January 8, 2002

Mr. Max Stodolski
Chief, Red Bluff Division
U. S. Bureau of Reclamation
Post Office Box 159
Red Bluff, California 96080

Tehama-Colusa Canal Authority Fish Passage Improvement Project
at the Red Bluff Diversion Dam

Dear Mr. Stodolski:

The Department of Water Resources concurs with the attached "Planning Aid Memorandum" prepared by the U. S. Fish and Wildlife Service to evaluate the draft alternatives prepared for the Fish Passage Improvement Project. The purpose of this project is to substantially improve the reliability of both fish passage and water supply at the Red Bluff Diversión Dam.

The Department supports an alternative that best balances the fishery and water supply needs. We also prefer an alternative that provides the capability of diverting approximately 2,000 cfs into the Tehama-Colusa Canal during the winter months as a potential source of water for an offstream storage project, such as Sites Reservoir. As you know, such a project is currently under consideration as part of the CALFED planning process.

The alternatives that best fit these considerations are those which have the Red Bluff Diversion Dam gates out year-round or for 10 months and a total pumping capacity of 2,000 cfs or more, i.e. Alternatives 2 and 3.

Change to a two-month operation, or gates out year-round would lead to an increase in riparian vegetation in the existing Lake Red Bluff footprint. This vegetation would include both native and invasive introduced species, based on the species present in the Lake Red Bluff area today. So, from an aesthetic and wildlife standpoint, this increased growth would have both beneficial and detrimental effects.

The 1992 USBR Appraisal Report (page IV-7) indicates about 234 acres are within the fluctuation zone of Lake Red Bluff, so this is the area subject to increased growth with a two-month operation, or certainly with a gates out year-round alternative. This additional vegetation in the floodplain could have significant effects on water surface elevations in the Red Bluff area during high water events.

Improvement of Sale Lane and construction of the Bell Mill Shopping Center several years ago both placed considerable fill in the floodplain. In addition, gradual urban development and growth of vegetation during the last 30 years in the several overflow channels through the Antelope area has reduced the flood capacity of these bypass channels. The presence of Lake Red Bluff also has allowed deposition of a considerable amount of cobbles and sediment in the floodway, especially just below the Antelope Boulevard Bridge.

Additional riparian growth due to the Red Bluff Diversion Dam project will further reduce the flood carrying capacity of the Sacramento River in the Red Bluff area. This potential impact must be evaluated following Executive order 11988 and FEMA guidelines to determine if the reduction will increase water surface elevations. We believe that FEMA, the State Reclamation Board, Tehama County, and City of Red Bluff will all have concerns about this potential impact.

Winter-run Chinook salmon counts at the Red Bluff Diversion Dam originally were the basis for determining the allowable incidental take of juvenile winter-run salmon by the State Water Project and the federal Central Valley Project pumps in the Delta. Since the change to a four month gates-in operation several years ago, the estimates of winter-run Chinook have been made mostly by less accurate indirect methods. A two-month operation, or gates open year-round, would mean that only a very small percentage, or even no winter-run, could be directly counted and run-size estimates would be even less accurate. The same considerations also apply to the recently listed spring-run Chinook salmon. Therefore, if one of these alternatives is selected, additional effort should be made to increase the accuracy of the winter- and spring-run Chinook population estimates above Red Bluff.

Thank you for the opportunity to participate in this planning process. If you have any questions, please contact me at (530) 529-7342, or Ralph Hinton at (530) 529-7393.

Sincerely,

Dwight P. Russell

Dwight P. Russell, Chief
Northern District

Attachment

cc: ✓Mr. Art Bullock, General Manager
Tehama-Colusa Canal Authority
Post Office Box 1025
Willows, California 95988

Appendix H
Draft Adaptive Management Program

APPENDIX H

Draft Adaptive Management Program

Background

An Adaptive Management Program (AMP) is an important element of the Tehama-Colusa Canal Authority (TCCA) Fish Passage Improvement Project at the Red Bluff Diversion Dam (RBDD). The planning, development, and organizational components for implementing an AMP for all project alternatives considered in this Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) is similar. Prior to project implementation, a specific AMP that is unique for that alternative will be developed and finalized through a Memorandum of Understanding (MOU) between TCCA and the appropriate resource agencies. The following discussion outlines the process for creating and the elements for implementing an effective AMP for any project that may be selected from those considered in the EIS/EIR process.

Definition and Overview

For the purposes of this project, adaptive management is a process that: (1) uses monitoring and research to identify and define problems, (2) examines various alternative strategies and actions for meeting measurable biological goals and objectives, and (3) if necessary, makes timely adjustments to strategies and actions based upon best scientific information available.

The primary reason for using an adaptive management process is to allow for changes in RBDD operating strategies or actions that may be necessary to achieve the long-term goals and/or biological objectives of the Fish Passage Improvement Project. Using adaptive management, activities conducted under the project will be monitored and analyzed to determine if they are producing the desired results (i.e., improvement in adult fish passage).

As implementation of the project proceeds, results will be monitored and assessed. If the anticipated goals and objectives of the project are not being achieved, then adjustments in operations or management actions will be considered and monitored through the Adaptive Management Plan.

Organization

Memorandum of Understanding

The organization for the AMP will follow the guidance provided and agreed upon in an MOU between the cooperating resource agencies and TCCA. The AMP MOU will memorialize an agreement of roles, responsibilities, the range of possible adaptive management measures that may be implemented to meet the goals of the Fish Passage Improvement Project, and the term of the AMP. The AMP will be generally organized as provided below.

Structure

The organizational structure of the AMP will consist of two major elements: the Adaptive Management Policy Committee (AMPC) and the Adaptive Management Technical Advisory Committee (AMTAC) (see Figure 1). Following an initial period of AMPC organizational meetings and discussions, there may be a need to create a(n) additional advisory committee(s). The AMPC will direct the creation or dissolution of any technical advisory committee(s).

Adaptive Management Policy Committee

This AMPC is the decision-making body for the AMP and consists of representatives of the cooperative member parties. A representative from each of the agreeing parties to the MOU will periodically meet and make final decisions on adaptive management strategies and actions relating to this AMP. A committee Chairman will be elected by AMPC and the Chair will rotate as agreed upon by the policy committee.

Members

The AMPC will consist of a management representative from each of the following parties:

- Tehama-Colusa Canal Authority
- U.S. Bureau of Reclamation
- U.S. Fish and Wildlife Service
- California Department of Fish and Game

Roles and Responsibilities

AMPC provides policy direction and resolves disputes and recommendations received from AMTAC. All final adaptive management strategies, actions, and decisions will be made through a consensus of AMPC. During the initial organizational meetings of this committee, AMPC will develop guidelines and processes for dispute resolution. These guidelines will assist in resolving non-consensus decisions within the committee. AMPC will provide strategy and direction for implementing all actions relating to the AMP.

Adaptive Management Technical Advisory Committee

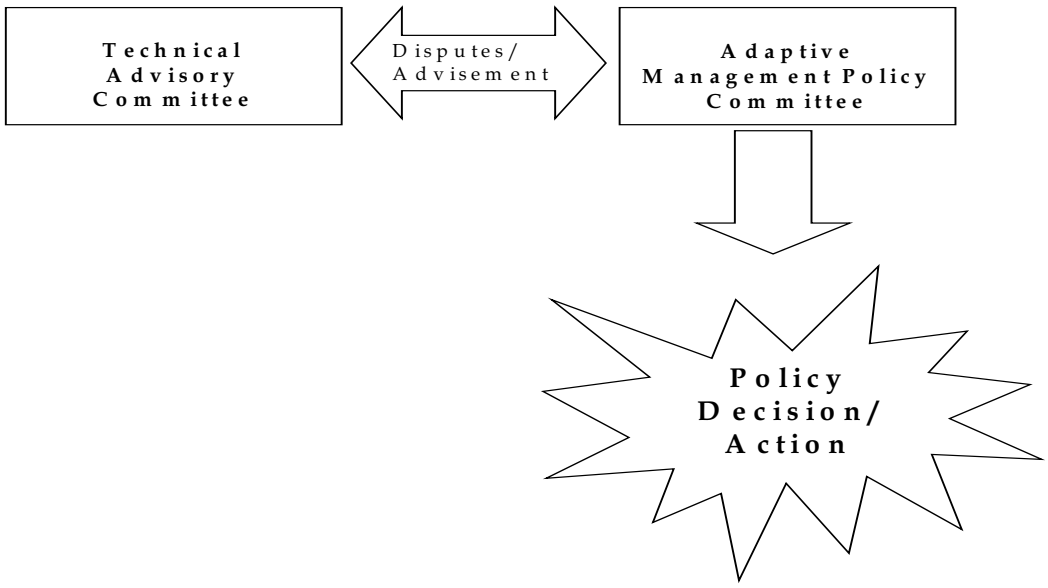
AMTAC will periodically meet, discuss and make recommendations to AMPC on the technical aspects of implementing the AMP. Voting members of AMTAC will consist of a fixed number of representatives who will be appointed by AMPC. The voting members of this Technical Committee will have appropriate education, training, and experience in fisheries and aquatic sciences; hydrology; and/or other expertise as recommended by AMPC. Other non-voting members may be added to the Technical Committee as deemed necessary by agreement of the voting members of AMTAC.

Members

It is anticipated that AMTAC will consist of one voting member from or representing each of the following agencies and groups:

- Tehama-Colusa Canal Authority
- Red Bluff Chamber of Commerce
- California Department of Fish and Game
- A&J Events

Figure 1. Organization of the Adaptive Management Program for the TCCA Fish Passage Improvement Project



- National Marine Fisheries Service
- Sacramento River Discovery Center
- Mendocino National Forest
- U.S. Fish and Wildlife Service
- City of Red Bluff
- U.S. Bureau of Reclamation

Roles and Responsibilities

AMTAC will meet, develop, and make recommendations to AMPC on strategies and actions for implementing the AMP. Following final decisions by AMPC, implementation of all AMP actions will be made by AMTAC. The Chairman of AMTAC will be selected from the voting members of the Technical Committee and will rotate regularly as agreed upon by the voting members of AMTAC.

Funding

Funding for the provisions of the AMP will come from several sources as identified and agreed upon in the AMP MOU. Provisions establishing and administering an interest-bearing Adaptive Management Fund (AMF) for implementing the AMP will be described and agreed upon in the MOU. In addition, terms for any cost-sharing agreement will be provided through agreements reached and memorialized in this MOU. The purpose of the AMF is to provide a readily available source of money to be used for possible actions or changes to the Fish Passage Improvement Project as identified through the adaptive management process.

Term

The term of the AMP will begin following the signing of the Record of Decision for the project. It is anticipated that the effective term of the AMP will be at least 10 years. Any decision to terminate or extend the AMP beyond that period will be made by AMPC. Any AMF funds remaining and uncommitted at the termination of AMP will revert to the original source of funding or as agreed to in the MOU.

Adaptive Management Objectives

The AMP will be based on objectives that meet the goals of improving migratory fish passage at RBDD. The final and specific AMP objectives will be developed by AMPC and AMTAC. It is anticipated that the primary focus of these objectives will be to provide passage of migratory fish species at the RBDD facilities. The AMP objectives will likely seek to provide management actions for RBDD operations sufficient to prevent impedance to migratory fish species and allow recovery of their populations. It is likely that these objectives will include or be similar to those outlined in Table 1.

TABLE 1
Potential Adaptive Management Objectives for the TCCA Fish Passage Improvement Project

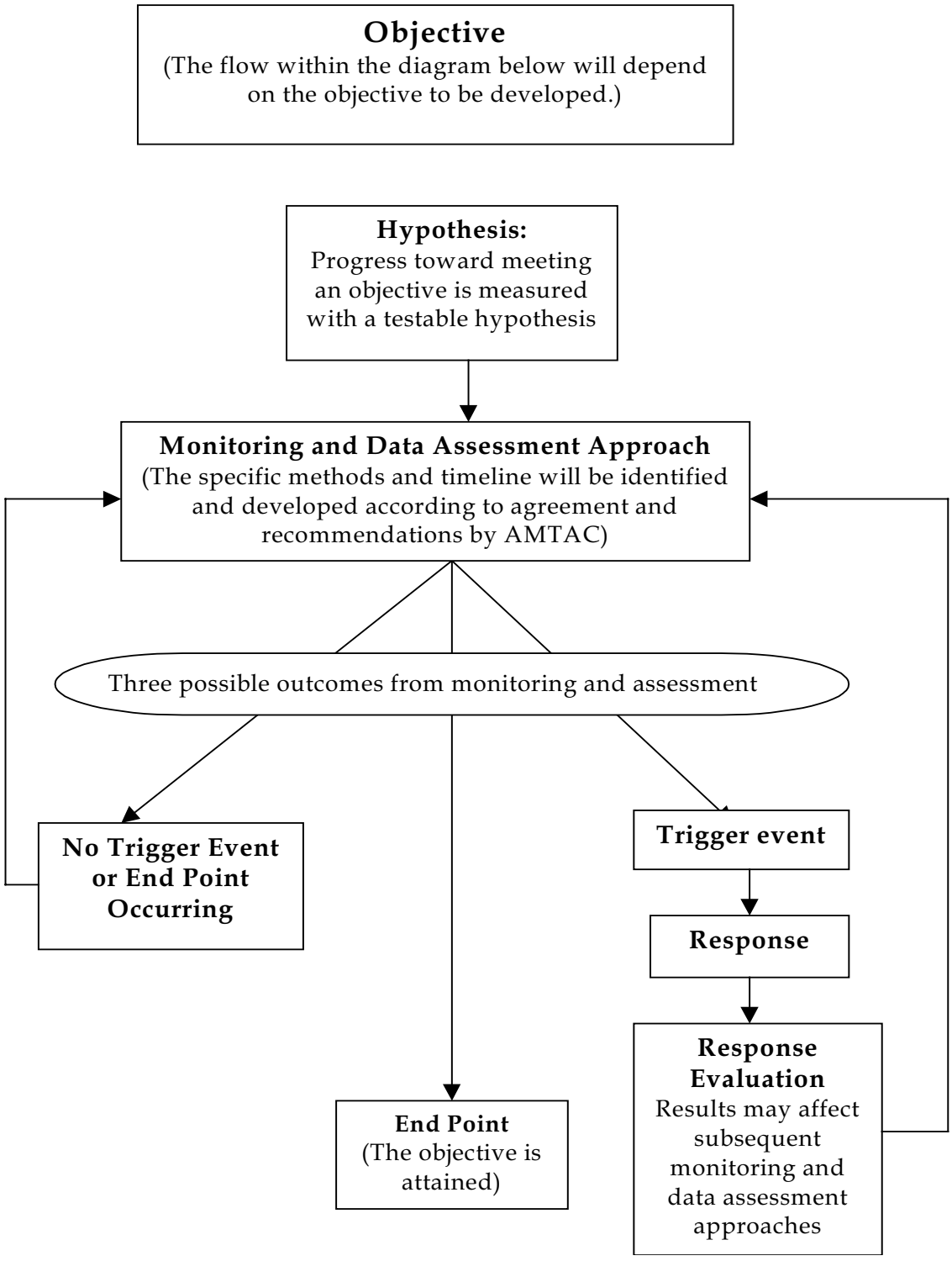
Salmon and Steelhead Passage Objectives
1. Allow upstream passage of adult salmon and steelhead at levels sufficient to ensure that the facilities at RBDD do not impede the overall survival and recovery of these species.
2. Allow downstream passage of juvenile salmon and steelhead at levels sufficient to ensure that the facilities at RBDD do not impede the overall survival and recovery of these species.
Sturgeon and Other Anadromous Fish Passage Objectives
1. Allow upstream passage of adult green sturgeon and lamprey at levels sufficient to ensure that the facilities at RBDD do not impede the overall survival and recovery of these species.
2. Allow downstream passage of juvenile green sturgeon and lamprey transformers at levels sufficient to ensure that the facilities at RBDD do not impede the overall survival and recovery of these species.
Predatory Fish Management Objectives
1. Ensure upstream passage of adult predatory fish at levels sufficient to ensure that their presence at the RBDD facilities does not impede the overall survival and recovery of anadromous species.
2. Minimize congregations of adult predatory fish downstream of the RBDD facilities at levels sufficient to ensure that their presence at the RBDD facilities does not impede the overall survival and recovery of anadromous species.

For any objective eventually selected, all reasonable and implementable measures within the boundaries discussed below will be considered in developing study designs for testing hypotheses and management actions and programs for this AMP. The components of each objective analysis include:

- A hypothesis
- A monitoring and data assessment approach
- A timeline
- Trigger events
- Response(s)
- Response limits
- A response evaluation
- End point(s)
- Reporting of results
- Responsibilities and funding

A generalized flow chart identifying the steps and components of an AMP objectives' evaluation is shown on Figure 2. For each objective identified, the Adaptive Management process will use hypothesis testing to determine if an objective is being met. The methods used to test hypotheses is are shown as the "Monitoring and Data Assessment Approach" box in Figure 2. These methods will likely use existing surveys and data analysis currently being conducted in the upper Sacramento River Watershed (e.g., the California Department of Fish and Game Stream Evaluation Program's annual carcass surveys).

Figure 2. Flow Chart of the Components of Adaptive Management Objectives and Their Relationships



The three possible outcomes of the Monitoring and Data Assessment step include reaching the objective, not reaching the objective, and meeting an objective partially (Figure 2). Monitoring and adaptive management based on the results of monitoring are iterative and long-term processes (Williams et al., 1997). Feedback of the final two scenarios into the Monitoring and Assessment step would result in continued re-definition and subsequent monitoring until the objective has been obtained or the objective timeline expires.

Adaptive Management Boundaries

Boundaries that would constrain adaptive management actions, for any project selected for implementation, would likely include:

- Temporal boundaries (e.g., RBDD gates-in operational periods)
- Spatial boundaries (e.g., geographical vicinity of Lake Red Bluff)
- Physical boundaries (e.g., project structural facilities)
- Operational boundaries (e.g., RBDD gate operational settings)
- Biological boundaries (e.g., native anadromous fish species)

For example, the RBDD gates-in operational periods, as they are presently defined in the Biological Opinion for the Long-term Operation of the Central Valley Project and State Water Project (National Marine Fisheries Service, 1993), may constitute a temporal boundary for adaptive management. This boundary would constrain any adaptive management action for any project alternative selected.

Therefore, for any project alternative selected for implementation, it will be necessary to define all boundary conditions to guide adaptive management study design and subsequent hypothesis testing. These boundary conditions for adaptive management purposes will be developed and specified by AMTAC and AMPCs.

Project-specific Adaptive Management Plans

No Action Alternative

If this alternative is selected, possible management actions would likely be limited to the period from mid-May through mid-September. Therefore, study designs, which would be developed to test hypothesis relating to improving passage of adult or juvenile anadromous fish at RBDD, would likely be restricted to this time interval. Any adaptive management action requiring gate-in operations outside of the existing 4-month operational period (mid-May through mid-September) would necessitate reconsultation with the National Marine Fisheries Service before the action could be implemented.

The physical and operational boundaries would include the existing fish ladders, fish protection facilities, and the RBDD gate operational limitations.

4-month Gates-in with Improved Ladder Alternative

If this alternative is selected, possible management actions would also likely be limited to the period from mid-May through mid-September. Study designs, which would be developed to test hypotheses relating to improving passage of adult or juvenile anadromous

fish at RBDD, would likely be restricted to this time interval. An adaptive management action requiring gate-in operations outside of the existing 4-month operational period (mid-May through mid-September) would necessitate reconsultation with the National Marine Fisheries Service before the action could be implemented.

The physical and operational boundaries would include new fish ladders, any newly constructed pumping and fish protection facilities, and RBDD gate operational limitations.

4-month Gates-in with Bypass Channel Alternative

If this alternative is selected, possible management actions would also likely be limited to the period from mid-May through mid-September. Study designs, which would be developed to test hypotheses relating to improving passage of adult or juvenile anadromous fish at RBDD, would likely be restricted to this time interval. An adaptive management action requiring gate-in operations outside of the existing 4-month operational period (mid-May through mid-September) would necessitate reconsultation with the National Marine Fisheries Service before the action could be implemented.

The physical and operational boundaries would include the new right bank fish ladder, the existing left bank fish ladder, a newly constructed bypass channel, any new pumping plant and fish protection facilities, and RBDD gate operational limitations.

2-month Gates-in with Improved Ladder Alternative

If this alternative is selected, possible management actions would also likely be limited to the period from mid-May through mid-September. Study designs, which would be developed to test hypotheses relating to improving passage of adult or juvenile anadromous fish at RBDD, would likely be restricted to this time interval. An adaptive management action requiring gate-in operations outside of the existing 4-month operational period (mid-May through mid-September) would necessitate reconsultation with the National Marine Fisheries Service before the action could be implemented. However, AMP actions within the existing 4-month gates-in operational period would likely not require reconsultation.

The physical and operational boundaries would include new right and left bank fish ladders, removal of the center fish ladder, any newly constructed pump stations and fish protection facilities, and RBDD gate operational limitations.

2-month Gates-in with Existing Fish Ladders Alternative

If this alternative is selected, possible management actions would also likely be limited to the period from mid-May through mid-September. Study designs, which would be developed to test hypotheses relating to improving passage of adult or juvenile anadromous fish at RBDD, would likely be restricted to this time interval. An adaptive management action requiring gate-in operations outside of the existing 4-month operational period (mid-May through mid-September) would necessitate reconsultation with the National Marine Fisheries Service before the action could be implemented. However, AMP actions within the existing 4-month gates-in operational period would likely not require reconsultation.

The physical and operational boundaries would include the existing right and left-bank fish ladders, removal of the center fish ladder, any newly constructed pump stations and fish protection facilities, and RBDD gate operational limitations.

Gates-out Alternative

If this alternative is selected, possible management actions would also likely be limited to the period from mid-May through mid-September. Any AMP study designs, which would be developed to test hypotheses relating to the efficiency of the passage of adult or juvenile anadromous fish at RBDD, would likely be restricted to this time interval. An adaptive management action requiring gate-in operations outside of the existing 4-month operational period (mid-May through mid-September) would necessitate reconsultation with NMFS before the AMP action could be implemented. However, AMP actions within the existing 4-month gates-in operational period would likely not require reconsultation.

The physical and operational boundaries would include the existing right and left bank fish ladders, removal of the center fish ladder, any newly constructed pump stations and fish protection facilities, and RBDD gate operational limitations.

Linkages with Other Programs

For any project alternative selected, a disclosure and acknowledgement of the linkages between the project's AMP and all pertinent state, federal, and local programs and directives will be prepared and included in the AMP for that project. These linkages would include internal project planning elements (e.g., Project Operations and Management Plans) and non-project program elements (e.g., Central Valley Project Improvement Act-Anadromous Fish Restoration Program) within the Sacramento River. Understanding the linkages of this project with ongoing actions within the Sacramento River watershed and the Central Valley will assist in planning, funding, and Implementing the AMP.

Protocols

Specific guidance protocols for conducting elements the AMP must be developed by the AMTAC under the direction of AMPC. These protocols will provide standards for AMP activities and outline specific responsibilities, methods, and procedures for the activities of the AMP. The following is a partial list of potential protocols that will be needed for the project AMP.

- Data management
- Process
    1. Meeting schedule
    2. Meeting processes
    3. Reporting
    4. Adaptive response process
    5. Prioritizing response proposals
    6. Budget review
- Monitoring and data assessments
- Funds management
- Dispute resolution

Appendix I
Draft Fish and Wildlife Coordination Act Report

State of California - The Resources Agency
DEPARTMENT OF FISH AND GAME
http://www.dfg.ca.gov

601 Locust Street
Redding, CA 96001
(530) 225-2300

GRAY DAVIS, *Governor*

August 19, 2002

Mr. Wayne White, Field Supervisor
Sacramento Office
U.S. Fish and Wildlife Service
2800 Cottage Way, Room W. 2605
Sacramento, California 95825

Dear Mr. White:

The Department of Fish and Game (Department) has reviewed the "Draft Fish and Wildlife Coordination Act Report: Tehema-Colusa Canal Authority Fish Passage Improvement Project, Red Bluff Diversion Dam, Red Bluff, Tehema County, California." The US Fish and Wildlife Service (USFWS) prepared the report in consultation with biologists from the Department and the National Marine Fisheries Service. The report builds on the USFWS biological analysis of problems at Red Bluff Diversion Dam (RBDD) presented in a final report that was previously endorsed by the Department titled "Supplemental Fish and Wildlife Coordination Act Report: Red Bluff Diversion Dam and the Tehama-Colusa Canal". At this time the Department concurs with the findings and recommendations presented in the current Draft Coordination Act Report which is focused on implementing a solution. The RBDD fish passage problem is considered one of the highest priority projects to attain the objectives for salmon and steelhead restoration.

The draft report supports implementation of the "Gates-out Alternative" to correct adverse effects to fish and wildlife caused by the Central Valley Project's RBDD. Removal of the gates on a year-round basis will reestablish riverine environment at Red Bluff while supplying water to the Tehama-Colusa Canal using a pumping plant with a state of the art fish screen. The performance of this alternative is absolutely certain for providing unimpeded passage of anadromous fish that must move both upstream and downstream of Red Bluff to successfully complete their life cycle. Achieving a remedy with long-term certainty at this site is consistent with the Cal Fed Multispecies Conservation Plan (2000), Draft Sacramento River Winter-run Recovery Plan (1997), Status Review of the Spring-run Chinook in the Sacramento River (1998) and the California Fish and Game Commission (correspondence dated March 22, 1994). In addition, unimpeded passage of migratory fish at RBDD is essential to repopulate the unique and important habitats being restored at great expense in the watershed upstream to Keswick Dam.

Implementing the Gates-out Alternative represents an ecosystem approach to restoration consistent with the Cal Fed Ecosystem Restoration Plan. A significant restoration opportunity is provided along the Sacramento River by allowing the lake to

revert to riverine habitat to provide continuity in the river's riparian corridor. Providing year-round riverine habitat is environmentally superior to seasonal lake habitat for the fish and wildlife that evolved in the river basin. In addition, taking the gates out of the river returns full navigability to this river reach for boat anglers and others. The Cal Fed Program expects this form of recreation to grow in the future as the basinwide restoration efforts restore the fishery.

Thank you for the opportunity to participate in the effort to restore this valuable section of the Sacramento River. If there are any questions regarding our comments, please contact Environmental Specialist IV Harry Rectenwald at (530) 225-2368.

Sincerely,

Donald Koch

DONALD B. KOCH
Regional Manager

cc: Attention Mr. Mike Urkoff
CH2MHill
Post Office Box 492478
Redding CA 96049-2478

Attention Mr. Jim Smith
Central Valley Fish and Wildlife Office
US Fish and Wildlife Service
10950 Tyler Road
Red Bluff CA 96080

Attention Max J. Stodolski, Chief
Red Bluff Division
US Bureau of Reclamation
Post Office Box 159
Red Bluff CA 96080-0159

U.S. Department of the Interior
Fish and Wildlife Service

Draft
Fish and Wildlife Coordination Act Report

Tehama-Colusa Canal Authority Fish Passage Improvement Project, Red Bluff Diversion Dam, Tehama County, California

Prepared By
U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
Sacramento, California

Prepared For
U.S. Bureau of Reclamation
Mid-Pacific Region
Sacramento, California

August 2002

EXECUTIVE SUMMARY

This document constitutes the U. S. Fish and Wildlife Service's (Service) Draft Fish and Wildlife Coordination Act (FWCA) report to the U.S. Bureau of Reclamation (Reclamation) for the Tehama-Colusa Canal Authority Fish Passage Improvement Project. The FWCA provides that Federal agencies consult with the Service before undertaking or approving projects carried out under Federal permits and licenses that control or modify any bodies of water for any purpose, and that fish and wildlife resources receive equal consideration and be coordinated with other features of the projects. The purpose of FWCA consultation is to conserve fish and wildlife resources by preventing their loss or damage, and by developing and improving these resources. This report addresses expected beneficial and adverse effects on fish and wildlife resources due to project alternatives, and provides recommendations for implementing the project.

A primary purpose of the project is to substantially improve the long-term capability to reliably pass anadromous fish, both upstream and downstream, past Red Bluff Diversion Dam (RBDD), Tehama County, California. A preferred alternative has not been selected by the Reclamation at the time of this writing. The focus of this report is to assess biological benefits and adverse effects of proposed alternatives in coordination with the California Department of Fish and Game (CDFG) and National Marine Fisheries Service (NMFS), and recommend an alternative to Reclamation that can be supported by the Service, CDFG, and NMFS. The report addresses both construction and operation of the proposed alternatives, and provides mitigation and enhancement recommendations to Reclamation.

Section 3406(b)(10) of the Central Valley Project Improvement Act (CVPIA; Public Law 102-575) authorized and directed the Department of the Interior to develop and implement measures to minimize fish passage problems for anadromous fish at the RBDD. No specific measures were identified. Reclamation is the lead Federal agency for project compliance with the National Environmental Policy Act (NEPA) and the Tehama-Colusa Canal Authority (TCCA) is the State lead agency for compliance with the California Environmental Quality Act (CEQA). The CDFG is a Responsible Agency under CEQA, with respect to issuing a Streambed Alteration Agreement (Fish and Game Code sections 1600 ***et seq***.) and for the purposes of the California Endangered Species Act (Fish and Game Code sections 2080 ***et seq***.). In addition, the California Department of Water Resources (DWR), NMFS, and the Service have been involved as cooperating agencies at both the technical and management levels of project planning.

This report provides support for minimizing the length of time that fish passage is impaired at RBDD. The Gates-out Alternative eliminates the gates-in position entirely, and is the recommended alternative in this report. The alternatives that reduce the gates-in position to two months from four months also provide improved fish passage at RBDD compared to present gate operations; however, the 2-month gates-in alternatives maintain a gravity dam in the river and do not maximize the benefits to resident and anadromous fish. The 2-month gates-in alternatives also do not provide CALFED Bay-Delta Program-supported ecosystem benefits, which would result from restoring the river channel and riparian corridor, nor meet the CVPIA priority for measures that protect and restore natural channel and riparian habitat values.

In addition to maximizing fish passage benefits at the dam, the Gates-out Alternative provides the opportunity to restore two linear miles of riverbank and associated riparian habitat. This habitat presently is adversely affected by the temporary Lake Red Bluff, which forms from backed up river water when the RBDD gates are down.

The Gates-out Alternative is a significant restoration opportunity along the Sacramento River, as restoring one linear mile of riparian forest corridor would help link other riparian forest areas along the river. This would be an ecosystem-wide benefit that has the potential to positively affect numerous aquatic and terrestrial species in the Central Valley of California that use shaded riverine aquatic cover and other components of riparian forest. Many of these species have State or Federal protection status. Restoring the riparian community at Lake Red Bluff, therefore, has the potential to benefit a wide range of the Central Valley's fish and wildlife resources.

Lastly, this section of the Sacramento River is designated as a navigable reach of the river under State of California Harbors and Navigation Code, Section 105, and navigation is an authorized purpose of the Shasta Unit of the Central Valley Project (CVP). The Gates-out Alternative returns this reach of the river to year-round navigation access.

The preparation of this report was coordinated with the Service's Red Bluff Fish and Wildlife Office, CDFG, and NMFS. Concurrence letters from CDFG and NMFS for the findings and recommendations provided in this report are included in Appendix F.

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INTRODUCTION

This is the U.S Fish and Wildlife Service's (Service) Fish and Wildlife Coordination Act (FWCA) report for the proposed Tehama-Colusa Canal Authority (TCCA) Fish Passage Improvement Project at the Red Bluff Diversion Dam (RBDD). The report addresses expected beneficial and adverse effects on fish and wildlife resources due to the project. This report has been prepared under the authority, and in accordance with Section 2(b) of the FWCA (Public Law 85-624; 16 U.S.C. 661-667e). The FWCA provides that fish and wildlife resources receive equal consideration and be coordinated with other features of Federal projects and projects carried out under Federal permits and licenses that control or modify any bodies of water for any purpose. The FWCA requires Federal agencies to consult with the Service before undertaking or approving such projects. The purpose of the consultation is to conserve fish and wildlife resources by preventing their loss or damage, and by developing and improving these resources.

This report has been coordinated with the Service's Red Bluff Fish and Wildlife Office, U.S. Bureau of Reclamation (Reclamation), California Department of Fish and Game (CDFG), and National Marine Fisheries Service (NMFS), and augments the Service's 1998 and 1967 FWCA reports. The CDFG and NMFS have reviewed this report and their concurrence letters are provided in Appendix F. The Service's findings and recommendations would need to be updated should the proposed project change from that presented in this report.

Guidance for the Service's recommendations contained in this report is provided, in part, by goals and objectives of the Service's Anadromous Fish Restoration Program (AFRP). The AFRP was developed in accordance with Section 3406(b)(1) of the CVPIA, which directs the Secretary of the Interior to develop and implement a program which makes all reasonable efforts to double natural production of anadromous fish in Central Valley streams. The AFRP's Final Restoration Plan (USFWS 2001) presents the goal, objectives, and strategies of the AFRP.

The purpose of the proposed project is twofold:

- Substantially improve the long-term ability to reliably pass anadromous fish, including endangered winter-run chinook salmon, threatened spring-run chinook salmon, threatened steelhead, and other species of concern, both upstream and downstream, past RBDD.

- Substantially improve the long-term ability to reliably and cost-effectively move sufficient water into the Tehama-Colusa Canal (TCCA) and Corning Canal systems to meet the needs of the water districts served by TCCA.

Both beneficial and adverse effects on fish and wildlife resources due to the project are evaluated in this report. Impacts to federally listed or proposed species, have been addressed under the Endangered Species Act of 1973, as amended (ESA) (Appendix A). The Service's analysis is based on biological and engineering information provided by the State and Federal lead, responsible, trustee, and cooperating agencies. This report's evaluation also is based on site visits to the project area, review of project-related literature, personal communications with recognized experts, and best professional judgment.

Recommendations to compensate for adverse effects are based on the Service's Mitigation Policy (***Federal Register*** 46:15; January 23, 1981). The Service's Mitigation Policy provides internal guidance for appropriate mitigation recommendations. Under the Mitigation Policy, resources are divided into four categories to assure that recommended mitigation is consistent with fish and wildlife habitat values affected by a project. The categories range from habitat values considered to be unique and irreplaceable (Resource Category 1) to those believed to be of relatively low value (Resource Category 4). How a proposed action affects selected evaluation species occupying these habitats determines the mitigation the Service will seek for the project. In addition, the Service has a Regional policy of "no net loss of wetland values or acreage," whichever is greater.

The Council of Environmental Quality regulations for implementing NEPA define mitigation to include: 1) avoiding the impact; 2) minimizing the impact; 3) rectifying the impact; 4) reducing or eliminating the impact over time; and 5) compensating for the impact. The Service's Mitigation Policy uses this same definition of mitigation and considers those elements, in that order, to represent the desired sequence in the mitigation planning process. The Mitigation Policy outlines internal guidance for Service personnel to protect and conserve fish and wildlife resources while facilitating the balanced development of the Nation's natural resources.

Each of the four Resource Categories has designation criteria and specific mitigation goals (Table 1). The planning goal of Resource Category 2 is "no net loss of in-kind habitat value." To achieve this goal, any unavoidable losses would need to be replaced in-kind. As defined in the Service's Mitigation Policy, "in-kind replacement" means providing or managing substitute resources to replace the habitat value of the resources lost, where such substitute resources are physically and biologically the same or closely approximate those lost.

Table 1. Resource Categories and mitigation planning goals, as provided by the Fish and Wildlife Service Mitigation Policy.

Resource Category	Designation Criteria	Mitigation Planning Goal[1]
1	High value for evaluation species and unique and irreplaceable	No loss of existing habitat value
2	High value for evaluation species and scarce or becoming scarce	No net loss of in-kind habitat value
3	High to medium value for evaluation species and abundant	No net loss of habitat value while minimizing loss of in-kind habitat value
4	Medium to low value for evaluation species	Minimize loss of habitat value

[1]Unavoidable losses of habitat value would need to be replaced in-kind. In-kind replacement means providing or managing substitute resources to replace the habitat value of the resources lost, where such substitute resources are physically and biologically the same or closely approximate to those lost.

In applying the Mitigation Policy, the Service first identifies each specific habitat or cover type that may be impacted by the project. Evaluation species which utilize each habitat or cover type are then selected for resource category determination. Selection of evaluation species can be based on several rationales, including: 1) species known to be sensitive to specific land and water use actions; 2) species that play a key role in nutrient cycling or energy flow; 3) species that utilize a common environmental resource; or 4) species that are associated with important resource problems, such as anadromous fish and migratory birds, as designated by the Director or Regional Directors of the Service.

Based on the relative importance of each specific habitat to selected evaluation species and the habitat's relative abundance, uniqueness, and replaceability, the appropriate Resource Category and associated mitigation planning goal are determined. Recommendations to mitigate unavoidable adverse impacts, as well as to enhance fish and wildlife resource, are provided.

PROJECT BACKGROUND

RBDD is located in north-central California on the Sacramento River about 2 miles southeast of the City of Red Bluff. The dam and the lake formed by the dam, Lake Red Bluff, are owned and operated by Reclamation. The lake is about 3 miles long and contains 3,900 acre-feet of water at normal water surface elevation.

The dam and lake are part of the Sacramento Canals Unit of CVP. The unit was designed to provide irrigation water in the Sacramento Valley, mainly in Tehama, Glenn, and Colusa counties. Also, a part of the unit are the Tehama-Colusa (TC) and Corning canals, which deliver the irrigation water to areas in Tehama, Glenn, and Colusa counties.

The dam is a concrete structure 52 feet high and 740 feet long. It consists of 11 gates, each 18 feet high and 60 feet long. The gates are raised and lowered to control the level of Lake Red Bluff and enable diversions to the TC canal. The headworks of the dam, which is a structure through which water from the lake is diverted into the TC canal, is located on the right abutment of the dam.

The dam gate closest to the right abutment (#11) is operated as a sluice gate to remove sediment accumulation near the headworks. The first section of the TC canal, downstream from the headworks, is enlarged to act as a sediment basin. Sediment deposited in the basin is removed by dredging. The diversion capacity of the first section of the TC and Corning canals is 3,030 cubic feet per second (cfs). A series of drum screens downstream from the headworks prevents fish passing through the headworks from entering the canals. A bypass system then returns those fish to the river.

A fish ladder is located on each abutment of the dam. The steps of the fish ladders drop the water surfaces in the ladders in 1-foot increments as flows pass downstream. Auxiliary flow is added to the ladders near their downstream ends to create a higher flow velocity in the ladders where they enter the river below the dam. This higher velocity is intended to attract upstream

migrating fish to the entrance of the fish ladder. A temporary ladder ("center ladder") is installed annually in gate #6, and operates during the gates-in period. The center ladder was not installed during the 2001 and 2002 gates-in periods due to an experiment whereby the majority of the dam's discharge is released through Gate Nos. 5, 6, and 7. This experiment is referred to as the "Crowning Flow" study and is intended to determine whether this flow release pattern aids fish passage.

Prior to the completion of RBDD, anadromous fish had unimpeded passage through the current dam site. Construction of the dam created a partial barrier in the Sacramento River, by impeding, delaying, and sometimes blocking passage to spawning and rearing habitat in the river and its tributaries above the dam. During 1983, the Service, along with Reclamation, CDFG, NMFS, and DWR initiated a five-year Fish Passage Action Program aimed at developing methods to improve upstream and downstream anadromous fish passage at RBDD (USFWS 1988). This study concluded that the delay of adult chinook salmon was as long as 50 days and blockage was as high as 44 percent (USFWS 1988). Another conclusion was that the RBDD fish ladders operated at maximum design flow capacity do not provide adequate attraction for adult salmon. Since the studies took place in the mid-1980's, the east and west fish ladders have remain unchanged. Radio-telemetry studies conducted on adult fall-run chinook during 2000 and 2001 by the Service suggest that delays are still occurring at RBDD (USFWS, unpublished data).

Constructed in the mid-1960's, the dominant feature of RBDD are its gates. When the gates are lowered into the Sacramento River, the elevation of the water surface behind the dam is raised, allowing gravity diversion into the TC and Corning canals for delivery to irrigation districts. Raising the gates allows the river to flow virtually unimpeded but precludes gravity diversion into the canals. When the gates are lowered, RBDD presents a barrier for both upstream- and downstream-migrating fish because fish ladders, included in the original dam design, have proven to be inefficient at certain flows to pass anadromous fish to upstream spawning grounds. Additionally, the tailrace and lake created by the dam provide habitat for species that prey on juvenile salmon, reducing their overall survival rates and impeding passage downstream of the dam. When the dam gates are lowered, predators congregate below the dam, creating difficult conditions for juvenile downstream passage. Juveniles are forced to pass RBDD in their migration either by using the fish ladders or under the dam gates. Most juveniles pass below the gates, and in the process, are likely disoriented and vulnerable to predation.

A Biological Opinion for endangered winter-run chinook salmon, issued in 1993 by the NMFS, requires that the gates be kept in the raised (non-diverting) position (gates-out) for a greater portion of the year (September 15 to May 14) than had been required previously. This has significantly improved fish passage at RBDD, but does not include the entire time that winter-run and spring-run chinook salmon are migrating upstream.

The removal of the gates has made the facility less effective as a water source for agriculture. The current schedule for gates in the lowered (diverting) position may be subject to further reduction, if it is found to be a reasonable and prudent action, to avoid jeopardy to species recently listed as endangered under the Federal ESA or the California Endangered Species Act if the facility becomes the property of a state or private entity. Species of consideration include

winter-, spring-, and fall/late fall-run chinook salmon, steelhead, and Sacramento splittail. However, further reduction of the gates-in period would further reduce RBDD's ability to divert water for agriculture.

In general, the proposed alternatives focus on the operation of RBDD. Fish ladders constructed under the original dam design have proven to be inefficient (causing delay and blockage of adult fish) at certain flows to pass anadromous fish to upstream spawning grounds as well as fish that predate on juvenile salmonids, creating congregations of predators that impair downstream passage of juveniles. The direct and indirect impacts of the alternatives occur within the Sacramento River basin.

A more thorough description of the project background is provided in the Service's Supplemental FWCA Report dated February 19, 1998.

PROJECT ALTERNATIVES

The planning process has focused on five major alternatives. These alternatives involve modifying or replacing the existing fish ladders, creating a bypass channel, and/or shortening the length of time that the diversion dam gates are lowered. All alternatives include a new pump station at the Mill Site, which is located on the west bank of the Sacramento River immediately north of the existing facilities. The Service ranked these alternatives in order of which provide the most substantial improvements in reliable upstream passage in an earlier Planning Aid Memorandum to Reclamation, dated October 19, 2001 (Appendix B).

Subsequent to issuance of this Service memorandum, decisions at the technical and agency management level have dismissed an early alternative to develop a water diversion from Stony Creek. This alternative would not have improved fish passage conditions at RBDD over the No-Action Alternative. Various changes were also made to other alternatives. All action alternatives accommodate future demand by the water users of TCCA in design of diversion facilities (Table 2). It is therefore anticipated that TCCA will eventually divert the maximum amount of water allowed by their contract. Currently, TCCA diverts less than their maximum allowable amount.

At the time of this writing, Reclamation has not selected a preferred alternative. The state lead agency, TCCA, voted on December 5, 2001 to select the Gates-out Alternative as their preferred alternative. All of the five remaining alternatives will be examined in the NEPA document and in this report. Alternatives are named by the number of months that gates are down and the fish passage solution (improved or existing ladders or bypass)

Alternative 1A: 4-month Improved Ladders

The dam gates would remain down from May 15 to September 15, which is the current dam operation. This alternative includes construction of a 1,380 cfs capacity pump station with a fish screen at the Mill site and continued pumping at the Research Pumping Plant (RPP). A

Table 2. Tehama-Colusa Canal Authority Water Demands (CH2MHill 2002a).		
Period	**Peak Historical Water Order**	**Facilities Design Assumptions**
May 1-15	1901 cfs	1700 cfs
May 16-31	1231 cfs	2000 cfs
June	1545 cfs	2000 cfs
July	2209 cfs	2500 cfs
August	1125 cfs	2500 cfs
September 1-15	1049 cfs	2000 cfs

conveyance facility would be installed across Red Bank Creek to convey water from the pump station to the TC canal.

Alternative 1B: 4-month Bypass

This alternative continues the current operation of the dam with gates down from May 15 to September 15. A new higher flow fish ladder (right bank only) and a 1,000 cfs bypass channel on the left bank would be constructed to achieve improved fish passage. This alternative includes construction of a 1,380 cfs pumping capacity pump station with fish screen at the Mill site and continued pumping at the RPP. A conveyance facility would be installed across Red Bank Creek to convey water from the pump station to the TC canal.

The bypass channel concept that is being evaluated for this project has been configured to reduce costs, limit flood impacts and liability, and minimize adverse water quality changes to the Sacramento River near RBDD. Specifically, the objective has been to establish physical characteristics that allow for fish passage.

Alternative 2A: 2-month with Improved Ladders

This alternative reduces the current gates-in operation of the dam to July 1 to August 31. Improvements to fish passage would be achieved through the reduction in gate operations and with construction and operation of new, higher-flow fish ladders. This alternative includes construction of a 1,680 cfs pumping capacity pump station with a fish screen at the Mill site and continued pumping at the RPP. A conveyance facility would be installed across Red Bank Creek to convey water from the pump station to the TC canal.

Alternative 2B: 2-month with Existing Ladders

This alternative reduces the current gates-in operation of the dam to July 1 to August 31. Improvements to fish passage would be achieved through the reduction in gate operations. Existing ladders would continue to be operated at the right and left abutments. This alternative includes construction of a 1,680 cfs pump station with a fish screen at the Mill site and continued

pumping at the RPP. A conveyance facility would be installed across Red Bank Creek to convey water from the pump station to the TC canal.

Alternative 3: Gates Out

This alternative leaves the dam gates in the raised position year-round, allowing the Sacramento River to return to its unimpeded flow pattern at RBDD. This alternative would allow unimpeded access above and below the dam to all fish in the Sacramento River that occur in the project area. This alternative includes construction of a 2,180 cfs pump station with a fish screen at the Mill site and continued pumping at the RPP. A conveyance facility would be installed across Red Bank Creek to convey water from the pump station to the TC canal.

A fish bypass system may be needed, depending on the length of the fish screens and the type of the pumping system. A minimum of three internal fish bypasses would be required for the Mill site vertical pump station option at the maximum 2,180 cfs pumping capacity. A pumped bypass system would use the fish-friendly screw or helical pumps that have been tested at RPP over the past several years. Fish bypasses would be designed to limit the exposure along the fish screen to 120 seconds, which is the current exposure time criterion, assuming a variance would be granted by NMFS.

BIOLOGICAL RESOURCES

Aquatic Resources

Riverine habitat is defined primarily by water depth, water quality, temperature, velocity, and substrate. Some of these factors at RBDD are tightly controlled by upstream releases from Keswick and Shasta dams. RBDD operations impact river surface elevations upstream of the dam. During the gates-in period, surface-water elevation at the dam is maintained at 252.5 feet. During the gates-out period, surface-water elevations at RBDD range from approximately 238.5 feet to 254 feet. The estimated 100-year flood elevation at RBDD is 262.3 feet. The dam and lake are part of the Sacramento Canals Unit of CVP. The unit was designed to provide irrigation water in the Sacramento Valley, mainly in Tehama, Glenn, and Colusa counties. Also, the TC and Corning canals are a part of the unit which delivers the irrigation water to areas in those counties.

The fluctuations in water levels between the gates-in and gates-out periods of RBDD operations result in a draw-down zone when the dam gates are out. This draw-down zone is void of permanent vegetation or cover of any kind, resulting in habitat with little, if any, value to wildlife. This area also has lesser value to fish when the dam gates are down, as there is no vegetation on the banks to provide nutrients, shading or instream woody cover.

The fishery resources in the Sacramento River near RBDD consist of a diverse assemblage of fish species including native anadromous salmonids, other native anadromous fish, non-native anadromous fish, and resident native and non-native fish. This portion of the Sacramento River

provides essential habitat for the freshwater life stages of chinook salmon and steelhead. Within California's Central Valley, the Sacramento River provides a corridor for the anadromous salmonid resources between upstream reaches and the tributaries to the Sacramento River and the Pacific Ocean. The Sacramento River is the largest river system in California with more than 90 percent of the Central Valley salmon spawning and rearing within the Sacramento River system. The Sacramento River supports four runs (races) of chinook salmon: fall-, late fall-, winter-, and spring-run.

Each of the five salmonid runs have distinct periods when the adults are actively immigrating upstream through the project area (Table 3). Factors that may affect the timing of adult passage include water-year type, river flows, weather events, and RBDD operations. RBDD operations which can affect fish passage includes the length of time the dam gates are down, thus delaying or blocking passage to fish. The range in estimated delay time at RBDD for fish which use the fish ladders during the gates-in period is 16 to 21 days (Table 4). This represents a significant delay for migrating chinook salmon and steelhead, while many fish are not able to locate or use the ladders to bypass the dam. In some cases the delay is so long that it results in blockage of a

Table 3. Life history timing for native anadromous salmonids in the Sacramento River near Red Bluff Diversion Dam, Tehama County, California.

Name	Adult Immigration	Spawning	Incubation	Rearing	Juvenile Emigration
Fall-run Chinook	July-December	October-December	October-March	December-June	December-July
Late Fall-run Chinook	October-April	January-April	January-June	April-November	April-December
Spring-run Chinook	April-July	August-October	August-December	October-April	October-May
Winter-run Chinook	December-July	April-August	April-October	July-March	July-March
Steelhead	August-March	December-April	December-June	Year-round (1 to 2 years)	January-October

portion of the population. The consequences of blockage and/or passage delay at RBDD can result in:

- changes in spawning distribution;
- hybridization between different runs of chinook salmon;
- increased adult pre-spawning mortality;

Table 4. Estimated number of days of delay for each of the facility structures at Red Bluff Diversion Dam, Tehama County, California. Based on Radio Telemetry Data for fall-run chinook salmon from 1999 through 2001 (CH2MHill 2002a).

Species	Old Ladders	New Ladders	Bypass	Old Ladders and Bypass	New Ladders and Bypass
Winter-run Chinook	21	18	19	19	16
Spring-run Chinook	21	18	19	19	16
Fall-run Chinook	21	18	19	19	16
Late Fall-run Chinook	21	18	19	19	16
Sacramento Pikeminnow	21	18	19	19	16
Steelhead	21	18	19	19	16
Sacramento Splittail	21	18	19	19	16
Green Sturgeon	21	18	19	19	16
White Sturgeon	21	18	19	19	16
Pacific Lamprey	21	18	19	19	16
Rive Lamprey	21	18	19	19	16
Striped Bass	21	18	19	19	16
Hardhead	21	18	19	19	16
American Shad	21	18	19	19	16
Sacramento Sucker	21	18	19	19	16

- substantial expenditure of energy;
- decreased egg viability;
- temperature induced mortality to developing eggs, which results in the reduction in annual recruitment of chinook salmon;

- delays that prevent spring-run chinook salmon natal to Beegum Creek, Battle Creek, and Clear Creek from entering their natal streams due to thermal blockage at the mouth of the streams in the late spring to early summer period; and

- juvenile salmonid passage at RBDD with the current gates-in period also is vulnerable to the operational effects of the dam and its associated diversion facilities, due to the congregations of predators that can occur below the dam while the gates are down.

CH2MHill (2002a) states the average delays for fish passage through the ladders, but does not estimate the extent to which fish populations would be blocked from passage as a result of these average delays. The widely accepted standard for delay of salmonids over fish ladders that avoids the risk of blockage is three days (DWR 2000). The average delay for salmonids at the proposed new fish ladders is 18 days. It is not known what the average blockage will be with the new fish ladders, but it is safe to assume that blockage will occur with this high estimate for delays.

Habitat needs of the four runs of salmon and steelhead generally are similar, but each species differs somewhat in its freshwater habitat requirements. The habitat needs of salmon and steelhead include physical habitat for adult migration and holding, spawning and egg incubation, fry and juvenile rearing, and smolt emigration. Adequate flows, water temperatures, water depths and velocities, appropriate spawning and rearing substrates, and the availability of in-stream cover and food are critical for the propagation and survival of all salmonids in the Sacramento River.

In the vicinity of RBDD, the Sacramento River acts primarily as a transport corridor for adults immigrating upstream, juvenile fry rearing and dispersing, and smolts emigrating downstream. All winter- and spring-run chinook spawning habitat within the mainstem Sacramento River occurs upstream of RBDD, making the passage of these runs of salmon at the dam of increased significance for their recovery. In addition, fall-run chinook salmon and other salmon species are known to spawn in the vicinity of RBDD both immediately upstream and, to a lessor degree, downstream of RBDD. However, salmon are known to spawn in the bed of Lake Red Bluff when the gates are removed and the river is allowed to flow more naturally.

The periods when juveniles (fry, pre-smolt, and smolt salmon; and fry, sub-yearling, and yearling steelhead) are migrating downstream past RBDD are shown on Table 3. In addition to passage, fry and pre-smolt salmon and sub-yearling and yearling steelhead may rear or reside in the vicinity of RBDD. Timing of smolt emigration is dependent on species, flow conditions, and water-year type.

In addition to the native anadromous salmonid species found in the vicinity of the project area, several other native anadromous species occupy or have the potential to occupy the Sacramento River at various stages of their life history and during seasonal intervals. They include: white sturgeon, green sturgeon, Pacific lamprey, and river lamprey.

Shaded Riverine Aquatic (SRA) Cover is defined as the unique, near shore aquatic area occurring at the interface between a river (or stream) and adjacent woody riparian habitat (USFWS 1992). Key attributes of this aquatic area include the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water. The water contains variable amounts of woody debris, such as leaves, logs, branches and roots, and often substantial detritus. Often much of the instream vegetation consists of dead woody debris that has fallen from the overhanging riparian vegetation. However, whole trees, which periodically become dislodged from the adjacent eroding banks, often also contribute to the instream structure of SRA Cover. Water velocities, depths, and flows are variable. The Service designated SRA Cover along the Sacramento River from Keswick Dam (River Mile (RM) 302) to Rio Vista (RM 13) as Resource Category 1. CH2MHill (2002a) has determined that approximately 200 linear feet of SRA Cover occurs in the project area, most of which occurs along the left bank of the Sacramento River, immediately downstream of the left bank fish ladder.

Due to the anticipated future need of TCCA to divert their maximum allowable amount of water under their contract, it is assumed that flows downstream of RBDD will decrease from the existing amounts. This may decrease the likelihood that the unmet needs of salmon and steelhead described in the Final Restoration Plan (USFWS 2001) for the AFRP will be met in the future.

The AFRP recognizes that under the existing conditions the legal minimum flows downstream of RBDD do not appear to provide all the habitat requirements for salmon and steehead. Action #1 under this plan calls for minimum recommended flows at RBDD. The Service also is completing instream flow studies to better define the flow needs downstream of RBDD. The results of these studies are anticipated to provide technical information that will aid in the recovery of salmon and steelhead in the Sacramento River.

Terrestrial Resources

The project area consists of approximately 100 acres near and adjacent to RBDD. The project consists of land on both sides of the Sacramento River. The project site contains seven primary habitats: riparian, freshwater marsh, mixed woodland, annual grassland, disturbed land, and parkland.

Riparian habitat provides important resources to both obligate riparian species and upland species. Riparian habitat along the Sacramento River has been substantially reduced as a result of flood control, water supply projects, and urban and agricultural development. The project area contains about 26 acres of riparian habitat. Most of the riparian habitat occurs along Red Bank Creek, with additional narrow bands located along the mainstem of the Sacramento River. Cottonwood, willow, and sycamore are the primary plant species at this location. The current operations of RBDD have resulted in a seasonal lake draw-down zone surrounding the Sacramento River which contains no vegetation.

The campground on the east bank of the Sacramento River has retained some of the mature sycamores, but shrubs and native forbs or grasses are largely absent. Small amounts of riparian habitat occur adjacent to seasonal Lake Red Bluff. Isolated cottonwood trees and riparian shrubs such as willows and blackberry occur in a narrow band on the margins of the lake.

Wildlife associated with riparian areas include a variety of Neotropical migratory birds, raptors, reptiles, amphibians, and mammals. Special-status species associated with riparian habitat along the Sacramento River include, among others, Swainson's hawks, bald eagles, bank swallows, western yellow-billed cuckoos, and valley elderberry longhorn beetles.

The project site supports about 2.1 acres of freshwater marsh habitat in two distinct areas. A 1.56 acre area is located in a low-lying band parallel to Red Bank Creek and is adjacent to a disturbed area located just southwest of RBDD. A 0.45 acre area occurs on the west side of Red Bank Creek in the adjacent industrial area. This is an artificially created marsh. Freshwater marsh habitats are among the most productive wildlife habitats in California. They provide food, cover, and water for more than 160 species of birds, and numerous mammals, amphibians, and reptiles.

The project area contains a 7.5 acre area of mixed woodland habitat. This is an isolated block northwest of RBDD adjacent to the road entering the campground. Vegetation consists of a mix of ponderosa pine, Oregon white oak, and sycamore with shrubs and grasses covering the remainder of the area. This parcel is surrounded by disturbed land, parkland, grassland, and restored habitat.

The project site supports about 64 acres of restored habitat consisting of mitigation plantings to create oak woodland and riparian forest habitat. Plants used in this site consist of oaks, sycamores, pines, and cottonwoods. These sites have been established for less than 10 years. The restoration sites are planned to augment the existing mixed woodland habitat. They also will provide habitat for species associated with riparian habitat and oak woodland. Annual grassland occurs on about 9.25 acres of the project site and is adjacent to the mixed woodland habitat.

Most of the project site consists of disturbed areas. About 79 acres are classified as disturbed habitat on both sides of the Sacramento River. These areas have relatively low value to wildlife.

Parkland comprises approximately 38 acres on the north side of the Sacramento River adjacent to RBDD. These areas are subjected to high levels of human use.

Special Status Species

Federal and State special status species potentially occurring on the project area and potential project impacts on these species are identified below. A species list provided to Reclamation for the project can be found in Appendix D.

Anadromous Fish

All four anadromous salmon runs and steelhead are present at RBDD during some period in their life history are either listed by the California Endangered Species Act and/or the Federal ESA, or are listed as candidates under the Federal ESA. The following list of anadromous salmonids, termed Ecologically Significant Units (ESU) for ESA purposes, includes status, date of listing, and date of Critical Habitat Designation, if applicable:

- Winter-run chinook salmon (Sacramento River Winter-run ESU):
  California Endangered; September 22, 1989
  Federal Endangered; January 4, 1994
  Habitat Designated March 31, 1999

- Spring-run chinook salmon (Central Valley Spring-run ESU):
  California Threatened; February 2, 1999
  Federal Threatened; September 16, 1999
  Habitat Designated February 16, 2000; rescinded April 30, 2002

- Steelhead (California Central Valley ESU):
  Federal Threatened; March 19, 1998
  Habitat Designated February 16, 2000; rescinded April 30, 2002

- Fall/Late Fall-run chinook salmon (Central Valley Fall/Late Fall-run ESUs):
  Federal Candidate/Not warranted for listing; September 16, 1999

For the Sacramento River winter-run chinook salmon ESU, critical habitat is designated to include the Sacramento River from Keswick Dam, Shasta County (RM 302), to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta; all waters from Chipp Island westward to Carquinez Bridge including Honker Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge.

For the Central Valley spring-run chinook salmon ESU, critical habitat is designated to include the Sacramento River and its tributaries in California. Also included are river reaches and estuarine areas of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay from San Pablo Bay to the Golden Gate Bridge.

Critical habitat for Central Valley steelhead ESU was designated to include all river reaches accessible to listed steelhead in the Sacramento and San Joaquin rivers and their tributaries in California. Also included were adjacent riparian zones, as well as river reaches and estuarine areas of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San

Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded were areas of the San Joaquin River upstream of the Merced River confluence, tribal lands, and areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). The rescinded critical habitat designation is currently under reconsideration by NMFS.

The Service routinely observes adult sturgeon in the vicinity and downstream of RBDD when the dam gates are down. It is unclear if these are all adult green sturgeon, or if some are white sturgeon as well. However, to date, all sturgeon larvae that have been captured at RBDD and grown out to determine species have been green sturgeon. The estimated time of spawning green sturgeon passing in the vicinity of RBDD is March through June. Green sturgeon was petitioned for listing under the Act (June 11, 2001). The only time that juvenile sturgeon have been documented above RBDD is following periods that the gates were removed during adult migration. During 2001, the Service documented green sturgeon spawning upstream of RBDD by sampling for eggs collected on artificial substrates.

Sacramento Splittail

The Sacramento splittail was first listed by the Service as threatened on February 8, 1999. This listing applies to its entire range in California, which historically extended as far north as Redding on the Sacramento River. However, due to flow reductions caused by dams and diversions, they currently migrate up the Sacramento River as far as RBDD only during wet years (CH2MHill 2002a).

Delta Smelt

The delta smelt was not identified as a species occurring on or near the project area, but occurs in the Sacramento-San Joaquin Delta, downstream of RBDD. Delta smelt could be affected by diversions and changes in river flow related to RBDD if these effects reached the Delta.

Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle (VELB) is entirely dependent on its host plant, elderberry (***Sambucus*** spp.) for food and reproduction. Mating occurs on the plants and eggs are laid in the cracks and crevices of the bark. First larval instars then bore into the plant, creating galleries within the pith. Upon emergence, the larvae bore into the plant and remain in the spongy pith of the plant for the majority of their lifetime. The developing beetle remains inside of the plant for 2 years or longer, after which time the adults emerge and reproduce. Elderberry shrubs were identified at 35 locations in and around the project area (CH2MHill 2002a). Potential VELB exit holes were observed on five of the shrubs.

Vernal Pool Fairy Shrimp and Vernal Pool Tadpole Shrimp

Vernal pool fairy shrimp was identified in the EIS/EIR as having no habitat on the project area (CH2MHill 2002a), but absence of this species was not further discussed. Vernal pool tadpole shrimp were on the project area species list provided by the Service, but are not mentioned in the EIS/EIR.

Giant Garter Snake and California Red-legged Frog
The giant garter snake and California red-legged frog were identified on the Service's species list for the project area, but were determined not to occur in the project area because there was no suitable habitat and/or the project area was outside the species' ranges (CH2MHill 2002a). These species were not further evaluated by the project proponents.

Bald Eagle
In the project area, bald eagles could use riparian trees as perch sites for foraging for fish in the Sacramento River (CH2MHill 2002a). Bald eagles are rare breeders in Tehama County and are not known to nest in or near the project area. They are more common during the winter and have been recently observed in Red Bluff during 1999 Audubon Christmas bird counts.

Peregrine Falcon
The peregrine falcon has been delisted, but is being monitored by the Service for a 5- year period from the date of delisting. It is not known to nest in the vicinity of the project area, but was observed in the Red Bluff area during the 1999 Audubon Christmas bird counts (CH2MHill 2002a). Peregrine falcons also have been observed on rare occasions during breeding bird surveys in the area.

Western Yellow-billed Cuckoo
The western yellow-billed cuckoo has historically nested at Todd and Mooney Islands, several miles to the southeast of the project area, but there have been no recent observations in the vicinity of the project area (CH2MHill 2002a). Riparian habitat is poor for cuckoos in the project area because it does not consist of mature and dense cottonwood-willow stands. Also, the riparian habitat occurs as narrow bands along the Sacramento River and Red Bank Creek that would not accommodate the species' breeding territory requirements. Therefore, yellow-billed cuckoos are not likely to occur on the project area, although individuals could occur sporadically in the project area during spring and fall migrations.

Osprey
Two osprey nests were observed on the south side of the Sacramento River, and are within the project area (CH2MHill 2002a).

Swainson's Hawk
One nesting pair of Swainson's hawks was observed approximately 1/5 mile northeast of the project site along Salt Creek in 1993 (CH2MHill 2002a). Some of the trees in riparian areas in the project area are large enough to support nesting by Swainson's hawks.

Special Status Bats
Bats were observed using the factory on the PACTIV Corporation property as a roost (CH2MHill 2002a). The species of bats using the factory were not determined, however, most bat species in the Central Valley are special status species (Federal species of Concern). The factory buildings will not be removed with the construction of this project.

Other Species

In addition to the species listed above, 31 other species (all are "species of concern") are present on the species list provided to Reclamation for the project, and could be present on the project area. Among these are four species of raptors, several Neotropical migrant bird species, western pond turtle, foothill yellow-legged frog, and western spadefoot toad.

FUTURE CONDITIONS WITHOUT THE PROJECT

The projected future condition without the project is operation of the existing diversion dam and fish ladders with a gates-in period of May 15 to September 15. Present delay or blockage of fish would continue during these months. The dam with the existing fish ladders have proven to impair fish passage at certain flows to pass anadromous fish to upstream spawning grounds.

The current operations do not meet CVPIA section 3406 requirements. Section 3406(b)(1) states that when all the sections of 3406 have been implemented, the mitigation for the CVP has been completed. Under the future conditions without the project, Reclamation would still need to mitigate for the CVP to meet the requirements under CVPIA section 3406.

There is uncertainty in regard to reliable water deliveries for the TCCA associated with the future without the project conditions. TCCA has expressed that the current operations of RBDD does not allow them to provide stable, reliable water deliveries to their customers. It is forseeable that a change will need to occur with either operations of RBDD, or a new pumping facility will need to be constructed to fulfill TCCA's responsibilities to deliver water.

A large amount of taxpayer-supported funding has been invested in anadromous restoration programs on Clear Creek, Battle Creek, Cottonwood Creek, and Cow Creek, all of which are tributaries upstream of RBDD. The mainstem Sacramento River above RBDD is also integral to the overall efforts to restore and recover anadromous salmonids. The restoration potential of anadromous salmonid populations in the mainstem and these streams is partly dependent upon improved fish passage at RBDD. Without the RBDD project, fish passage at the dam would not improve, thus diminishing the potential for success of these tributary restoration projects.

The AFRP has determined that existing flows downstream of RBDD do not meet all the habitat requirements of salmon and steelhead in the Sacramento River. This unmet need would continue into the future under the conditions without the project.

FUTURE CONDITIONS WITH THE PROJECT

Project Features/Operations

Project features are briefly described under the alternatives section. A detailed description of the proposed project components is provided in CH2MHill (2002a).

Reclamation has stated that water deliveries for TCCA will be consistent with water rights and water contracts (CH2MHill 2002a). The Service expects that conformance of water supply management with existing ESA Biological Opinions for the long-term operation of the Central Valley Project, and with existing water quality standards imposed for the Sacramento River and Bay/Delta, would not change substantially under present diversions. It is uncertain how future increased diversions at the TC and Corning Canals would affect conformance with these regulatory measures.

Effects on biological resources with the project are related to project construction and the long-term operation of the facility. These impacts are summarized in the following sections.

Alternative 1A: 4-month Improved Ladders

Aquatic Resources

This alternative likely would not result in a significant benefit to fish passage past RBDD for chinook salmon and steelhead, even with installment of higher flow fish ladders (Appendix C). Delays and blockages in upstream adult migration would continue to occur during the gates-in period.

Potential effects from the proposed project include, but are not limited to, modification of aquatic habitats, fish passage and survival, alteration of river hydraulics and sedimentation, changes in predation, and water quality effects. In-river construction and channel maintenance activities would result in temporary water quality impacts from increased turbidity and sediment mobilization.

Construction of the proposed pumping plant at the Mill site could result in direct and indirect losses of adult and juvenile fish, unless adequate mitigation measures are incorporated into the project. These impacts would principally occur during installation of cofferdams. The construction areas would include areas near the existing east and west bank fish ladders and the new pump station location at the Mill site. At the Mill site, a large sheet pile cofferdam would be required, up to approximately 1,400 linear feet.

Construction of the right bank fish ladder would require 270 linear feet of sheet pile cofferdam. Construction of the left bank fish ladder would require installation of a 166 linear foot sheet pile cofferdam. In addition, impacts could occur at these locations because of dewatering active channel areas following sheet pile installation. Percussion from large scale pile-driving activities could cause mortality to salmon embryos during their first two weeks of life if they are located within 200 to 600 feet of high energy pile driving equipment. Both adults and juveniles could be crushed during earth movement or sheet pile installation. Both adults and juveniles could be stranded and lost during dewatering actions following the installation of sheet piling.

The Service is concerned that the implementation of the proposed alternatives could result in a change in the diversion patterns over the historical diversions at RBDD. The CALFED environmental documents recognize that the RBDD Fish Passage Program, together with a series of specific water supply activities, could lead to, or involve, increased storage and diversion of

water for consumptive use. Cumulatively, these projects could affect river flows or hydrodynamics in the riverine system. An increase in diversions over historical amounts due to implementation of a project alternative could increase terrestrial impacts if more land would be irrigated or converted to municipal or industrial developments. Also, an increase in diversions over historical amounts could reduce flow volumes in the Sacramento River downstream of RBDD. This could increase warming of water temperatures, reduce fish habitat by reducing wetted perimeter, change sediment transport capacity and other geomorphic conditions. These potential impacts should be analyzed to determine their extent and associated mitigation needs.

Terrestrial Resources

Short-term impacts may result from increased noise and construction related disturbances in the local project area. This disturbance may influence the behavior, movements, and distribution of wildlife in the local project area. Impacts from the long-term operation and maintenance of the new screening facility should be similar to without project conditions with the exception that access to, and maintenance of, project features may require intermittent disturbance to terrestrial habitats.

Between 750,000 and 800,000 cubic yards of material would need to be excavated to complete construction for each of the five alternatives. This includes excavation for the pumping station and forebay for all alternatives, as well as the fish ladders, which are included in two of the alternatives. Approximately 580,000 to 600,000 cubic yards of this material would be stored onsite. It is unclear how this material would be stored onsite and what types of habitat would be impacted for this storage.

Disturbed land is the primary habitat impacted by the alternative, and the largest (area) impacts to all habitats are temporary. Acreage of habitats expected to be impacted by Alternative 1A is provided in Table 5.

Special Status Species

Anadromous salmonids and Sacramento splittail. Potential juvenile salmonid impingement on the proposed fish screen would need to be addressed. Sweeping velocities along the screen face would need to meet state and federal guidelines for salmonids in the Sacramento River. A pumped bypass system also might be required by these guidelines to reduce the chances for impingement on the screen face.

Delta smelt. The delta smelt was not identified as a species occurring on or near the project area, but occurs in the Sacramento-San Joaquin Delta, downstream of RBDD. Delta smelt could be affected by diversions and changes in river flow related to RBDD if these effects reached the Delta.

Valley elderberry longhorn beetle. This alternative likely would impact all elderberry shrubs on the south side of the river and several shrubs on the north side of the river (CH2MHill 2002a). Approximately 14 elderberry shrubs would be impacted. These shrubs contain 28 stems between one and three inches in diameter, 16 stems between three and five inches in diameter, and 12 stems more than five inches in diameter. At least five shrubs show signs potential VELB use.

Table 5. Acreage of terrestrial habitat impacts for project alternatives

	No Action Alt.	1A: 4-month Improved Ladder Alt.		1B: 4-month Bypass Alt.		2A: 2-month Improved Ladder Alt.		2B: 2-month with Existing Ladder Alt.		3: Gates-out Alt.	
Habitat		Perm	Temp	Perm	Temp	Perm	Temp	Perm	Temp	Perm	Temp
Riparian	0	2.18	5.56	2.60	6.30	2.18	5.56	2.05	4.76	2.05	4.76
Freshwater Marsh	0	0.05	0.71	0.05	0.71	0.05	0.71	0.05	0.71	0.05	0.71
Mixed Woodland	0	0	0	1.37	4.30	0	0	0	0	0	0
Restored Habitat	0	0	0	4.96	4.80	0	0	0	0	0	0
Annual Grassland	0	0	0	0	0	0	0	0	0	0	0
Disturbed	0	11.75	44.12	12.90	51.70	11.75	44.12	11.36	41.35	11.36	41.30
Parkland	0	0.19	4.86	4.19	12.32	0.19	4.86	0	0	0	0

Vernal pool fairy shrimp and vernal pool tadpole shrimp. Potential effects on vernal pool fairy shrimp and vernal pool tadpole shrimp are not discussed in the project EIS/EIR, but habitat for vernal pool fairy shrimp is indicated to be lacking on the project area. Further clarification is needed for potential effects on these species.

Giant garter snake and California red-legged frog. The project EIS/EIR indicates that adverse effects on the giant garter snake and California red-legged frog are not expected to occur, due to lack of habitat on the project area (CH2MHill 2002a). Methods for this determination are not provided in the EIS/EIR. Additional information on survey methods and species-specific habitat assessment would be necessary to further support these conclusions.

Bald eagle. Bald eagles are not known to nest in the project area, but occasionally occur during the winter. Trees in the riparian zone that could be used as perches by foraging bald eagles would be lost under Alternative 1A, but the level of use by bald eagles in the project area is low, and other trees would be available as perch sites. Disturbance of foraging bald eagles from construction activity could occur, but other undisturbed foraging sites would be available nearby.

Peregrine falcon. The peregrine falcon is not known to nest in the vicinity of the project area, but has been observed in the Red Bluff area. The project EIS/EIR indicates that adverse effects on the peregrine falcon are not expected to occur, because of minimal habitat on the project area and availability of prey (waterfowl) on Sacramento Valley wildlife refuges.

Western yellow-billed cuckoo. The western yellow-billed cuckoo has historically nested several miles to the southeast of the project area, but there have been no recent observations in the

vicinity of the project area (CH2MHill 2002a). The project EIS/EIR indicates that adverse effects on the western yellow-billed cuckoo are not expected to occur, due to lack of suitable riparian habitat on the project area, although individuals could occur occasionally in the project area during spring and fall migrations. These individuals could be subject to human disturbance.

Osprey. The two osprey nests located on the south side of the Sacramento River would need to be removed during construction for each of the alternatives. This would be a significant impact to the species.

Swainson's Hawk. Known use of the project area by Swainson's hawks is thought to be low, possibly because of human disturbance and lack of foraging habitat nearby, although suitable nesting habitat appears to exist (CH2MHill 2002a). Some of the potential nesting habitat (riparian woodland) would be lost due to project construction.

Special status bats. Bats were observed using a nearby factory structures as a roost (CH2MHill 2002a), but potential presence in wooded habitats or facilities on the project area were not discussed in the EIR/EIS. The factory buildings will not be removed with the construction of this project, but the Service is concerned that other bats in forested areas or facilities on the project area could be affected by construction, if present.

Other species. Other special status species not federally listed (Appendix D) could also be affected by the project. Among these are four species of raptors, several Neotropical migrant bird species, western pond turtle, foothill yellow-legged frog, and western spadefoot toad.

Alternative 1B: 4-month Bypass

The future with this alternative would have similar effects as for Alternative 1A. Additional impacts are described below.

Aquatic Resources

This alternative is reported in the EIS/EIR to improve fish passage during the four months of gates-in. However, the results of analyses conducted by CH2MHill (2002a), and summarized in Appendix C, show either no change or no measurable benefit to all targeted fish under this alternative. Therefore, a bypass channel will not likely improve passage sufficiently over conditions without the project for the target species of fish. Additionally, the Service is concerned whether the proposed bypass channel would be passable by all species of concern (especially adult sturgeon), structurally stable, and safe. The Service does not believe these concerns have been adequately addressed in the EIR/EIS (CH2MHill 2002a).

The majority of SRA Cover impacts (approximately 200 linear feet in the project area) would occur under the 4-month Bypass Alternative. Approximately 20 linear feet of SRA Cover occurs at the Mill site, which likely would be impacted under all proposed alternatives.

Other potential effects on aquatic resources related to construction and the long-term operation of facilities would be similar to those described under Alternative 1A.

Terrestrial Resources
Disturbed land is the primary habitat impacted by the alternative, and the largest (area) impacts to all habitats are temporary. Acreage of habitats expected to be impacted by Alternative 1B is provided in Table 5. Construction of the proposed bypass channel would result in permanent or temporary impacts to mixed woodland and restored habitat, which are not affected by the other alternatives (Table 5).

The potential for channel capture at the bypass channel site during extremely high flow/flood events may result in a range of both short-term and long-term impacts. Site erosion and inundation would be the expected outcomes, with an unknown level of severity to existing terrestrial resources.

Other potential effects on terrestrial resources related to construction would be similar to those described under Alternative 1A.

Special Status Species
Potential impacts on juvenile fish described under Alternative 1A, including fish impingement and sweeping velocities, also would apply to this alternative. Delta smelt could be affected by diversions and changes in river flow related to RBDD if these effects reached the Delta.

Operation of the proposed bypass channel would result in stranding and loss of listed salmonid species during the annual dewatering of the channel. This loss would be an annual occurrence in contrast to the short-term stranding losses associated with cofferdam construction. Other impacts to special status species would be similar as to those for Alternative 1A.

This alternative likely would impact elderberry shrubs on the south and north side of the river (CH2MHill 2002b). Approximately 19 elderberry shrubs would be impacted. These shrubs contain 47 stems between one and three inches in diameter, 21 stems between three and five inches in diameter, and 17 stems more than five inches in diameter.

Other potential effects on special status species would be similar to those described under Alternative 1A.

Alternative 2A: 2-month with Improved Ladders

Aquatic Resources
This alternative provides substantially improved passage for adult spring-run adults compared to No Action and both 4-month gates-in alternatives. Analysis indicates that no measurable benefit to winter-, fall-, or late fall-run chinook salmon or steelhead is achieved under this alternative (Table C-1, Appendix C). Adult spring-run chinook salmon obtain a large measurable benefit from this alternative. Green sturgeon adults receive a large measurable benefit and juveniles receive a measurable benefit (Table C-3 C-3 and C-4, Appendix C). River lamprey adults and juveniles receive a measurable benefit, and Pacific lamprey adults receive a measurable benefit from the 2-month gates-in Alternative.

During the gates-in period under this alternative, the improved fish ladders would be expected to provide at least a small level of improvement in fish passage over current conditions at RBDD. The tributaries currently being restored upstream of RBDD will benefit from the improved fish passage anticipated from the future with project conditions for this alternative. These large restoration efforts depend partly on fish passage being improved at RBDD.

Other potential effects on aquatic resources related to construction and the long-term operation of facilities would be similar to those described under Alternative 1A.

Terrestrial Resources
Disturbed land is the primary habitat impacted by the alternative, and the largest (area) impacts to all habitats are temporary. Acreage of habitats expected to be impacted by Alternative 2A is provided in Table 5. Impacts to other terrestrial resources would be similar as to those for Alternative 1A.

Special Status Species
Adverse impacts to special status species would be similar as to those for Alternative 1A. Benefits to fish passage from this alternative are described under Aquatic Resources for Alternative 2A.

Alternative 2B: 2-month with Existing Ladders

Aquatic Resources
Impacts on fish passage from this alternative would be similar to those for Alternative 2A. Other potential effects on aquatic resources related to construction and the long-term operation of the facility would be similar to those described under Alternative 1A.

Terrestrial Resources
Disturbed land is the primary habitat impacted by the alternative, and the largest (area) impacts to all habitats are temporary. Acreage of habitats expected to be impacted by Alternative 2B is provided in Table 5. Other terrestrial impacts would be similar to those for Alternative 1A.

Special Status Species
Potential impacts on fish described under Alternative 1A also would apply to this alternative. Benefits to fish passage from this alternative are similar to those described under Aquatic Resources for Alternative 2A.

Approximately nine elderberry shrubs would be impacted under this alternative. These shrubs contain 18 stems between one and three inches in diameter, six stems between three and five inches in diameter, and six stems more than five inches in diameter. Fish passage benefits to special status species from this alternative would be similar to those of Alternative 2A. Other special status species effects would be similar to Alternative 1A.

Adverse impacts to other special status species would be similar as to those for Alternative 1A.

Alternative 3: Gates Out

Aquatic Resources

The Gates-out Alternative represents an improvement in fish passage over the 2-month alternatives and a substantial improvement in fish passage over the 4-month alternatives (CH2MHill 2002a). The Gates-out Alternative is the only alternative that presents no delay to fish passage year-round at RBDD. With gates-in alternatives, migrating juvenile salmonids are forced to pass RBDD either by using the fish ladders or passing under the dam gates. Most juveniles pass below the gates, and in the process, are likely disoriented and vulnerable to predation. With the Gates-out Alternative, juvenile fish migrating downstream would not be subject to difficult conditions passing under the gates, nor exposed to predators that congregate near the gates.

Under the Gates-out Alternative, a measurable benefit to adult winter- and fall-run chinook salmon and steelhead is achieved (Table C-1, Appendix C). This is the only alternative providing these benefits. A large measurable benefit is provided to spring-run chinook salmon by this alternative, and constitutes an incrementally larger benefit than provided by the 2-month gates-in alternatives. Green sturgeon adults and juveniles receive a large measurable benefit, river lamprey adults and juveniles receive a measurable benefit, and Pacific lamprey adults receive a measurable benefit from the Gates-out Alternative (Tables C-3 and C-4, Appendix C). The benefit to juvenile green sturgeon is greater than that provided by the 2-month gates-in alternatives (Table C-4, Appendix C).

The tributaries currently being restored upstream of RBDD will benefit from the improved fish passage anticipated from the future with project conditions for this alternative. These large restoration efforts depend partly on fish passage being improved at RBDD to maximize their benefits.

The Draft Sacramento Winter-run Recovery Plan (NMFS 1997) includes the following specific recommendations for RBDD to contribute significantly to the recovery of winter-run chinook:

1. Operate the RBDD in a gates-up position from September 1 through May 14 of each year, until a permanent remedy for the facility is implemented.

2. Develop and implement a permanent remedy that provides maximum free passage for adult and juvenile winter-run chinook past the Red Bluff area, while minimizing losses of juveniles in water diversion and fish bypass facilities.

Under the Gates-out Alternative, Lake Red Bluff would not be formed. Restoring the seasonal Lake Red Bluff to riverine habitat would reduce vulnerability of juvenile anadromous salmonids to predation during out-migration through the lake zone. Restored riverine habitat in the lake zone also would provide additional spawning habitat for anadromous fish in this section of the Sacramento River.

Over time, the Lake Red Bluff area, which is presently seasonally inundated (draw-down zone), would become re-vegetated as plants colonized the area. This would potentially produce SRA Cover, which would benefit both aquatic, including species listed under the ESA, as well as terrestrial species. With a re-vegetated inundation zone, overall quantity and quality of fisheries habitat within this zone would increase under the Gates-out Alternative. The ultimate value of a re-vegetated riparian zone to SRA Cover would depend on location of re-vegetation, resulting plant species composition, and the type and magnitude of human activity in the area.

Other potential effects on aquatic resources related to construction and the long-term operation of facilities would be similar to those described under Alternative 1A.

Terrestrial Resources

Where sufficient soil moisture is present, riparian vegetation would be expected to become established. In drier portions, annual grasses and forbs and more drought tolerant shrubs would be expected to occur. Invasion by star thistle also is likely, given the proximity of areas dominated by this species, but active restoration of vegetation could help ensure that desirable plant species become established. Riparian forests provide habitat to numerous species living in the Central Valley of California. Riparian forests also contribute shade and woody material for SRA Cover, which benefits terrestrial, as well as aquatic species.

It is not known to what extent SRA Cover would become established at Red Bluff, should this alternative be implemented. Nearby areas with existing SRA Cover could provide a reference for what might be expected to become established at Red Bluff. The Service is planning to examine some of these areas in September, 2002, to determine the quality of habitat they contain. It is reasonable to expect that active restoration would expedite the establishment and enforce the quality of SRA Cover at Red Bluff. Active restoration could consist of native plantings, which would require a limited amount of maintenance after becoming established.

Both SRA Cover and riparian habitat in general, have been much reduced from human alterations to the Central Valley. This alternative offers the rare opportunity to allow the riparian forest, and SRA Cover, to become established in the portion of the river currently affected by formation and draw-down of Lake Red Bluff. If allowed to establish, riparian forest could provide important habitat for a great diversity of terrestrial and aquatic species. The Gates-out Alternative also would allow the Sacramento River to flow more naturally at the Lake Red Bluff site and, therefore, return sediment transport and other fluvial dynamics to a more natural state.

Creating a riparian park at Red Bluff would present an opportunity for the community to create multi-use trails, interpretive signs, and multi-use parks. Other communities have created similar riparian areas, such as the City of Redding (Sacramento River) and City of Sacramento (American River).

Disturbed land is the primary habitat adversely impacted by the alternative, and the largest (area) impacts to all habitats are temporary. Acreage of habitats expected to be adversely impacted by Alternative 3 is provided in Table 5. Other potential effects on terrestrial resources related to construction of facilities would be similar to those described under Alternative 1A.

Special Status Species

Under the Gates-out Alternative, ESA issues for passage fish species would be minimized. However, potential impingement of juvenile fish on the proposed fish screen would need to be addressed. Sweeping velocities along the screen face would need to meet state and federal guidelines for salmonids in the Sacramento River. A pumped bypass system also might be required by these guidelines to reduce the chances for impingement on the screen face. Delta smelt could be affected by diversions and changes in river flow related to RBDD if these effects reached the Delta.

As with the other action alternatives, a new pumping plant would be constructed at the Mill site, and terrestrial/aquatic adverse impacts resulting from site excavation and construction, as described under Alternative 1A, would also occur under the Gates-out Alternative. Adverse impacts of this alternative to VELB and other special status species would be similar as to those for Alternative 1A.

As described above for terrestrial and aquatic resources, re-vegetation of the area within Lake Red Bluff would provide multiple benefits to fish and wildlife, including special status species. Ecosystem-level enhancements to riparian forest and SRA Cover, and riverine habitat, in particular, would benefit of species such as anadromous fish, Neotropical migrant birds, bats, and VELB.

MITIGATION

General Recommendations

Recommendations to compensate for adverse effects are based on the Service's designated Resource Categories, which consider the relative biological importance of each specific habitat to selected evaluation species and the habitat's relative abundance, uniqueness, and replaceability. Resource Categories designated for each habitat on the project area and associated mitigation planning goals are provided in Table 6. In addition, the Service has a Regional policy of "no net loss of wetland values or acreage," whichever is greater.

The Service's recommendation for SRA Cover, as a Resource Category 1 habitat under the Mitigation Policy, would generally be avoidance of existing habitat value. Strict adherence to the Mitigation Policy would require the Service to support the No Action Alternative. For this project to achieve the expected long-term fishery benefits of substantially improving the long-term ability to reliably pass anadromous fish and other species of concern past RBDD, losses of SRA Cover would be unavoidable. The "acceptance" of these SRA Cover losses by the Service is predicated on the lead agencies' environmental commitment to compensate for any unavoidable SRA Cover losses. The best biological compensation for lost SRA Cover values would be planting woody riparian vegetation along natural erodible shoreline of the Sacramento River. Natural erodible shoreline could result from the select removal of site-specific bank revetment. The Gates-out Alternative would be an excellent opportunity to achieve this compensation.

Table 6. Habitat types, representative species, Resource Categories, and mitigation goals for projected impacts due to the proposed Fish Passage Improvement Project for Red Bluff Diversion Dam, Colusa County, California

Habitat Type	Representative Species	Resource Category	Mitigation Goal
SRA Cover	winter-run chinook salmon, spring-run chinook salmon	1	No loss of existing habitat value
Riparian Forest	Swainson's hawk, VELB, Neotropical migrant birds	2	No net loss of in-kind habitat value
Freshwater Marsh	tricolor blackbird, white-faced ibis, western pond turtle	2	No net loss of in-kind habitat value
Mixed Woodland	Cooper's hawk, sharp-shinned hawk	3	No net loss of habitat value, minimize in-kind loss
Restored Woodland	bewick's wren, pocket mouse	3	No net loss of habitat value, minimize in-kind loss
Annual Grassland	California ground squirrel	4	Minimize loss of habitat value

Impacts to VELB habitat (elderberry plants with one or more stems measuring 1.0 inch or greater in diameter at ground level) that cannot be avoided with a minimum 100-foot buffer should be mitigated following the Service's Conservation Guidelines for the Valley Elderberry Longhorn Beetle (USFWS 1999). The required conservation area should be located, if possible, on-site or adjacent to the project area. Should Reclamation select the Gates-out Alternative for implementation, the Service recommends that any mitigation for VELB be performed in conjunction with restoring the riparian corridor at Lake Red Bluff. Impacts to elderberry shrubs would require consultation with the Service for potential impacts to VELB.

Some project construction activities could result in incidental adverse effects to listed species under the jurisdiction of NMFS (spring- and winter-run chinook salmon and steelhead). These effects would likely be minimal and temporary if conservation measures identified in the project's Biological Opinion are successfully incorporated into the project. Potential measures could include limiting construction activities affecting stream channels to periods (construction windows) to avoid or minimize impacts, placing exclusionary fencing to prevent spawning in areas subjected to percussive impacts to embryos (if the incubation period cannot be avoided), minimizing the disturbance in the streambed, and using the least-impacting construction methods.

To adequately compensate for the removal of the osprey nests, new nesting platforms should be constructed using CDFG guidelines prior to removal of the nests. The removal of these nests should be done outside of the breeding season.

Other special status species not federally listed (Appendix D) could also be affected by the project. Among these are five raptors, several Neotropical migrant birds, anadromous fish (fall/late fall-run chinook salmon), western pond turtle, foothill yellow-legged frog, western spadefoot toad, and, potentially, several bat species. Implementation of mitigation measures recommended by the Service should help protect these species. Additional mitigation measures for the project might be recommended by the Service in the future.

To compensate impacts to freshwater wetland habitat, the Service recommends a ratio of three acres created/restored wetland habitat to one acre permanently impacted. For temporary impacts to freshwater wetland habitat, a ratio of one acre restored to one acre impacted is recommended.

The California Regional Water Quality Control Board should be consulted to ensure proper discharge of dredged material on or off the project site. To minimize soil erosion, movement of sediments, loss of topsoil, and associated water quality impacts, Best Management Practices should be developed prior to construction.

If impacts occur to terrestrial habitat from increases in diversions over the historical diversion pattern, proper measures should be developed in collaboration with the Service and other appropriate state and federal agencies to fully mitigate those impacts.

Specific Recommendations

Alternative 1A: 4-month Improved Ladders

With either the 1A or 1B alternatives, the Service recommends that Reclamation investigate the feasibility of either improving the temporary center ladder or the installation of a permanent center ladder. In addition to the improved ladders, the Service recommends that Reclamation rigorously pursue both operational modifications and physical modifications to the RBDD that would improve adult and juvenile fish passage of ESA-listed and target fish species.

Approximately 14 elderberry shrubs would be impacted under this alternative. These shrubs contain 28 stems between one and three inches in diameter, 16 stems between three and five inches in diameter, and 12 stems more than five inches in diameter. Following the Conservation Guidelines for the Valley Elderberry Longhorn Beetle (USFWS 1999), Reclamation estimated that mitigation for these impacts would be approximately 148 elderberry seedlings and 215 native seedlings planted in a conservation area (CH2MHill 2002b). Final compensation needs for impacts to elderberry shrubs under this alternative would require consultation with the Service for potential impacts to the VELB, and would be calculated under guidelines being employed at that time.

Alternative 1B: 4-month Bypass

The upstream end of the channel will need to incorporate a special chamber for electronic or video monitoring fish to enable counting migrating adult fish, or a viewing chamber to allow "live" counts by fish counting personnel. The fish will need to enter into a physically constricted area of the bypass channel that will be conducive for either electronic or manual counting. Depending upon the methodology employed (e.g., manual or direct video counting), an on-site or

remote facility will be needed to house the fish counters and other personnel and equipment necessary.

Approximately 19 elderberry shrubs would be impacted under this alternative. These shrubs contain 47 stems between one and three inches in diameter, 21 stems between three and five inches in diameter, and 17 stems more than five inches in diameter. Following the Conservation Guidelines for the Valley Elderberry Longhorn Beetle (USFWS 1999), Reclamation estimated that mitigation for these impacts would be approximately 203 elderberry seedlings and 328 native seedlings planted in a conservation area. Final compensation needs for impacts to elderberry shrubs under this alternative would require consultation with the Service for potential impacts to the VELB.

Alternative 2A: 2-month with Improved Ladders

For this alternative, the Service recommends that Reclamation continue to research operational modifications that would improve fish passage during the 2-month gates-in period

Impacts to elderberry shrubs for this alternative would be similar as to those for Alternative 1A. The impacts to elderberry shrubs under this alternative would require consultation with the Service for potential impacts to the VELB.

Alternative 2B: 2-month with Existing Ladders

For this alternative, the Service recommends that Reclamation continue to research operational modifications that would improve fish passage during the 2-months gates-in period

Approximately nine elderberry shrubs would be impacted under this alternative. These shrubs contain 18 stems between one and three inches in diameter, six stems between three and five inches in diameter, and six stems more than five inches in diameter. Following the Conservation Guidelines for the Valley Elderberry Longhorn Beetle (USFWS 1999), Reclamation estimated that mitigation for these impacts would require approximately 73 elderberry seedlings and 124 native seedlings planted in a conservation area. Final compensation needs for impacts to elderberry shrubs under this alternative would require consultation with the Service for potential impacts to the VELB.

Alternative 3: Gates Out

Impacts to elderberry shrubs for this alternative would be similar as to those for Alternative 2B. The impacts to elderberry shrubs under this alternative would require consultation with the Service for potential impacts to VELB.

DISCUSSION AND CONCLUSIONS

The Gates-out and 2-month gates-in Alternatives should work toward the CVPIA goal of doubling anadromous fish populations in the Central Valley of California. Section 3406 (b)(10) of the CVPIA directs the Department of the Interior to develop and implement measures to minimize fish passage problems for anadromous fish at RBDD. Existing conditions do not meet

the objectives of section 3406 (b)(10) of the CVPIA because of unmet needs for spring- and winter-run chinook salmon. It is feasible to provide for unmet fish passage needs at RBDD, such as the Gates-out and 2-month gates-in Alternatives. The Gates-out and 2-month gates-in Alternatives also should work toward the CALFED goal of restoring or enhancing fisheries habitat and improving water management for beneficial uses of the Bay-Delta system (CALFED 2000).

The RBDD Fish Passage Program includes evaluating possible long-term solutions to fish passage and water delivery at RBDD. Operation of the dam under the NMFS biological opinion has reduced, but not minimized, fish passage problems for all the anadromous species of concern, particularly spring-run chinook and green sturgeon. In addition, the operations have reduced the reliability of adequate water delivery for certain agricultural operations and maintenance of wetland habitat in the Sacramento National Wildlife Refuge complex.

The North-of-the-Delta Offstream Storage Project north of the Bay-Delta in the northern Sacramento Valley could result in offstream reservoir capacity of up to 1.9 million acre feet (CH2MHill 2002a). Sites Reservoir is a potential offstream storage project presently being examined. The TC canal is one of three water conveyance methods under consideration to fill Sites Reservoir. It is not clear if the proposed fish passage alternatives for RBDD take into account the potential need to fill Sites Reservoir, or if they would preclude filling the reservoir.

The Service has identified priority species for improved fish passage at RBDD (Appendix E). First priority species include Pacific salmon, steelhead, splittail, Pacific and river lamprey, green and white sturgeon, American shad, striped bass, and Sacramento pikeminnow (as a predator of juvenile chinook salmon). The second priority includes Sacramento sucker, hardhead, and other native fish.

The NMFS also has identified priority species for consideration of improved fish passage alternatives for RBDD (Appendix E). The first priority species are winter-run and spring-run chinook salmon, steelhead, and splittail. Second priority species are fall/late fall-run chinook salmon, green and white sturgeon, and Pacific and river lamprey. All other native species are listed as third priority. Due to the varied life-history traits of the first and second priority species, alternatives that rely only on fish ladders to improve fish passage would not effectively obtain improved fish passage for all species of concern. Improved fish passage for all first and second priority species is realized by a selection of alternatives for RBDD that decrease the length of time that the dam gates remain in the down position, when blockage occurs.

The Service supports minimizing the length of time that fish passage is impaired at RBDD. The Gates-out Alternative returns the Sacramento River to flow without restrictions at Red Bluff, allowing unrestricted passage in all months of the year for all priority species of fish around RBDD. Also, due to the necessity to construct a pumping facility for every alternative, each with a similar footprint and similar impacts to fish and wildlife resources, the Service supports the selection of the Gates-out Alternative (Alternative 3). This alternative represents a significant improvement in fish passage at RBDD compared to the future without the project and the 4-month Gates-in Alternatives. The Gates-out Alternative is the only proposed alternative that

provides a measurable benefit to adult winter- and fall-run chinook salmon and steelhead. A large measurable benefit is provided to spring-run chinook salmon by this alternative, and constitutes an incrementally larger benefit than provided by the 2-month gates-in alternatives. Restoring the seasonal Lake Red Bluff to riverine habitat would reduce vulnerability of juvenile anadromous salmonids to predation during out-migration through the lake zone. Restored riverine habitat in the lake zone also would provide additional spawning habitat for anadromous fish in this section of the Sacramento River.

The Service does not support alternatives that do not minimize the length of time that RBDD gates remain in the down position. The 4-month Improved Ladders and 4-month Bypass alternatives include a gates-in period that is similar to the future without the project conditions. The Service assumes that delays and blockage to migrating fish that would occur under the future without project conditions would be the same, or similar, under the 4-month Bypass alternative. The greatest impacts to SRA Cover also would occur under this alternative. The 4-month Improved Ladders alternative provides minimal improvement to fish passage. Should USBR choose to proceed with this alternative, an adaptive management plan would be needed in the event that the anticipated improvements in fish passage are not realized.

The alternatives that shorten the length of time that RBDD gates remain in the down position, but do not eliminate the gates-in period entirely (Alternatives 2A and 2B) provide substantial benefits to fish passage over the No Action alternative. The 2-month with Improved Ladders and 2-month with Existing Ladders alternatives both reduce the time that the gates remain in the down position from four months to two months. This represents a substantial improvement in fish passage around RBDD over the future without the project conditions.

However, the Service recommends that, if either of these 2-month alternatives are selected as the preferred alternative, an adaptive management plan should be prepared in the event that adequate improvements in fish passage are not observed at RBDD, as might be expected under these alternatives. The Service recommends that, in the event adequate improvements are not observed, the gates should remain in the up position year-round, thus returning the Sacramento River to unrestricted flow at Red Bluff.

Full and successful implementation of the Fish Passage Program would produce the following biological benefits:

2-month Gates-in Alternatives

1. Permanently provide unimpaired passage between the migratory corridor below RBDD to river reach that constitutes the sole spawning area for populations of winter-run and spring-run chinook that are natal to the main stem Sacramento river. This attains goals identified in:

    - CALFED Stage 1 Expectation for Dams (page 436, last bullet);

- CALFED Ecosystem Restoration Program (ERP) milestone for Sacramento River dams and other structures (Record of Decision (ROD), Volume 3, Attachment 7, page 18);

- CALFED Multi-Species Conservation Plan prescription/conservation measure at RBDD for winter-run and spring-run chinook salmon;

- Winter-run Chinook Salmon Recovery Plan;

- California Fish and Game Spring-run Chinook Status Review; and

- CALFED Multi-Species Conservation Plan conservation action for spring-run and winter-run chinook salmon.

2. Permanently provide unimpaired passage between the migratory corridor below RBDD and the unique tributary spawning areas for winter-run natal to Battle Creek and spring-run natal to Battle Creek, Begum Creek, and Clear Creek. This attains goals identified in:

    - CALFED Stage 1 Expectation for Dams (page 436, last bullet);

    - CALFED ERP milestone for Sacramento River dams and other structures (ROD, Volume 3, Attachment 7, page 18);

    - CALFED Multi-Species Conservation Plan prescription/conservation measure at RBDD for winter-run and spring-run chinook salmon;

    - Winter-run Chinook Salmon Recovery Plan;

    - California Fish and Game Spring-run Chinook Status Review;

    - CALFED Multi-Species Conservation Plan conservation action for spring-run and winter-run chinook; and

    - Tributaries are identified as contributing to the recovery of winter-run and spring-run chinook salmon in the CALFED species recovery goals (ERP Plan, Volume 1, page 214).

3. Increase survival of juvenile winter-run and spring-run chinook salmon produced in the Sacramento River and tributaries upstream of RBDD. This is accomplished by reducing the level of predation by preventing predatory fish from congregating below RBDD, while removing the disorienting effect of the hydraulics at the dam. This attains goals identified in:

    - CALFED Stage 1 actions in the ERP Plan (Volume 1, page 499, Predation for RBDD);

- CALFED Stage 1 Expectation for Dams (page 436, last bullet);
- CALFED ERP milestone for Sacramento River dams and other structures (ROD, Volume 3, Attachment 7, page 18);
- CALFED Multiple Species Conservation Plan Prescription/Conservation Measure at RBDD for winter-run and spring-run chinook;
- Winter-run Chinook Salmon Recovery Plan;
- California Fish and Game Spring-run Chinook Status Review; and
- CALFED Multiple Species Conservation Plan conservation action for spring-run and winter-run chinook salmon.

Gates-out Alternative

In addition to the benefits gained under the 2-month Gates-in Alternatives, the Gates-out Alternative adds the following benefits:

1. Restoring two miles of riparian habitat along the mainstem Sacramento. In addition, the Gates-out Alternative should restore floodplain and flood processes on one mile of the mainstem Sacramento River to a more natural level and establish aquatic, wetland, and riparian floodplain habitats, including shaded riverine aquatic cover. This attains goals identified in:
    - CALFED Stage 1 Expectation for Sacramento River Floodplain Processes (Page 17, first bullet, and Habitat on page 17, second bullet);
    - AFRP Action No. 9 for the upper mainstem Sacramento River, which directs that opportunities should be pursued that recruit large woody debris (a component of SRA Cover) to moderate temperatures and enhance nutrient input; and
    - CVPIA Section 3406 (b)(1)(A) directs that first priority be given to restoring natural channel and riparian habitat values.

RECOMMENDATIONS

The Service supports and recommends the alternative that returns the Sacramento River at Red Bluff to pre-dam conditions, the Gates-out Alternative. This alternative provides unrestricted passage to all targeted fish species. This alternative provides the opportunity for a substantial natural riparian area to become established at the seasonal Lake Red Bluff, which would provide increased benefits to fish and wildlife resources, while protecting sensitive fish species with a positive barrier fish screen. The Service also recommends that Reclamation remove RBDD

should Reclamation select the Gates-out Alternative, or have a new permit issued from the State Water Sources Control board that aligns operations with whichever alternative is selected. Should Reclamation decide to remove the structure, additional environmental measures would need to be determined to minimize adverse effects to the Sacramento River and the associated riparian areas.

The Central Valley Project Improvement Act mandates changes in the management of the CVP consistent with revised purposes of the CVP to include fish and wildlife mitigation, protection and restoration (CVPIA Section 3406 (a)). Programs and activities are authorized at RBDD that minimize fish passage problems for adult and juvenile anadromous fish and provide water delivery to the Sacramento National Wildlife Refuge complex (CVPIA Section 3406 (b)(10)). A decision that all activities at RBDD minimize passage problems for adults and juveniles and provide reliable water delivery, both now and in the future, will result in a determination that the CVPIA activities at RBDD are fully implemented and deemed to meet the mitigation, protection and restoration purposes of the CVP, thus fulfilling Reclamtion's responsibilities for mitigation of the CVP at RBDD.

In addition to maximizing fish passage benefits at the dam, the Gates-out Alternative provides the opportunity to restore two linear miles of riverbank and associated riparian habitat. This habitat presently is adversely affected by the temporary Lake Red Bluff, which forms from backed up river water when the RBDD gates are down.

The Gates-out Alternative is a significant restoration opportunity along the Sacramento River, as restoring one linear mile of riparian forest corridor would help link other riparian forest areas along the river. This would be an ecosystem-wide benefit that has the potential to positively effect numerous aquatic and terrestrial species in the Central Valley of California that use shaded riverine aquatic cover and other components of riparian forest. Many of these species have State or Federal protection status. Restoring the riparian community at Lake Red Bluff, therefore, has the potential to benefit a wide range of the Central Valley's fish and wildlife resources.

The Service acknowledges that should Reclamation select the Gates-out Alternative, Lake Red Bluff would no longer form. This would result in the loss of some forms of recreation that Lake Red Bluff has been used for historically. However, the Service anticipates that an economic benefit should result from the subsequent expected recreational opportunities to fishermen, other recreational opportunities afforded by a river and associated riparian area, and tourism for the City of Red Bluff.

CALFED environmental documents recognize that projects like RBDD fish passage program together with similar fish restoration actions, would result in cumulative beneficial impact on recreation resources that should increase opportunities for recreation in the CALFED project area and improve commercial fishing. In addition, removal of the gates allows for navigation of the river by recreational interests and fishing guides (this corridor is a designated navigable reach of river under State of California Harbors and Navigation Code Section 105).

The Service recommends that Reclamation issue a formal declaration that the Dual-Purpose Canal and Single Canals and all appurtenant facilities will not be utilized for any future salmonid propagation and/or mitigation purposes. Federal efforts to operate these facilities for production and mitigation purposes were not successful. Formal and permanent closure is necessary by the Department of the Interior to establish an official record to ensure that future Federal, State, and/or private individuals and organizations do not attempt to resurrect these facilities.

The gravels of the Dual Purpose Canal and the Single Canals are an integral component of these federal facilities. Although Reclamation is pursuing current efforts to remove some of the gravel for long-term stockpiling, the Service considers the gravel a federal resource, and hence reserves the ability to influence both the short and long-term disposition of the material. The gravel was originally acquired for resource benefits, and should be reserved for uses that are compatible with resource enhancement, conservation, and mitigation.

The Service recommends that in conjunction with the formal declaration of closure, the Bureau assume operations and maintenance responsibilities for the Single Canals, the associated network of roads, the Lower Control Building, the Lower Wet Lab, Coyote Creek Weir, Coyote Creek Turnout Facility, and various other facility features.

The proposed project is designed to improve the long-term ability to reliably pass anadromous fish both upstream and downstream, past RBDD. Construction of some project components would have temporary adverse impacts in the stream channel, and some upland, riparian, and wetland habitats within construction footprints would be lost. To help maximize the project's contribution to overall ecosystem quality in the project area, the Service provides the following additional recommendations:

24. Minimize and compensate unavoidable impacts to SRA Cover, wetland habitats, and other fish and wildlife habitats, and minimize and compensate adverse impacts that are unavoidable. This would reduce losses of existing biological values in the project area, as well as reduce planning, land acquisition, and funding needed for mitigation.

    A) Reduce bank revetment at the Mill Creek site to the minimum length needed for hydraulic performance and structural integrity of the fish screen.

    B) Avoid dredging and instream cover removal.

2. Develop and implement, in cooperation with the Service, NMFS, CDFG, DWR, and TCCA, a mitigation plan for all aquatic and terrestrial habitats adversely affected by the project.

    C) Minimize and avoid to the extent practicable impacts to SRA Cover. Compensate for unavoidable habitat losses, including impacts to SRA Cover off-site at a 3:1 ratio in addition to revegetating over bank revetment on-site. Compensation for SRA Cover losses should be based on linear feet of SRA Cover impacted and

replaced on non-vegetated, naturally erodible shoreline. Pursuant to the Service's Mitigation Policy, the Service recommends the compensation area ratios in Table 7 for temporary and permanent habitat losses.

D) Compensation for SRA Cover losses should be done in conjunction with the compensation for habitat losses to the valley elderberry longhorn beetle.

E) Implement the selected mitigation options prior to, or concurrent with, project construction to expedite replacement of habitat values lost due to the project.

F) Biological monitoring of terrestrial and aquatic habitat compensation should occur for a minimum of 10 years in combination with the mitigation monitoring for valley elderberry longhorn beetle. Photographic reference points should be established to document on- and off-site compensation area habitat conditions. An annual report of monitoring for terrestrial and aquatic habitat mitigation should be provided to the Service within 45 days of the end of the calendar year. Compensation areas should be self-sustaining for a period of three years without intervention to be determined successful.

Table 7. Compensation ratio recommendations for fish and wildlife impacts.

Impacted Resource	**Permanent Impacts**	**Temporary Impacts**
SRA Cover	3:1	Not applicable
Natural erodible shoreline	1:1	Not applicable
Riparian habitat	3:1	1:1
Freshwater marsh	3:1	1:1
VELB	Follow guidelines in the Service's Conservation Guidelines for VELB	

3) Develop and implement, in cooperation with the Service, NMFS, CDFG, and TCCA, an evaluation and monitoring plan to assess the adequacy of the fish screen in meeting biological and engineering design criteria and propose corrective measures.

A) Monitor screen criteria for the period of time necessary to evaluate screen performance at a range of river flows and pumping rates.

B) Identify operational flexibilities that would provide the greatest level of fisheries protection at various river flows and pumping rates.

C) Perform biological evaluations using available technology (direct observation, video, acoustic/sonar, etc.), as appropriate, to evaluate the effectiveness and/or impacts of the screens to juvenile salmonids and other target species.

4) Initiate ESA section 7 consultation with the Service's Sacramento Fish and Wildlife Office and NMFS to determine potential project effects on listed and other special status species, and incorporate appropriate conservation measures for affected species into project implementation. It also will be necessary to consult with CDFG for State listed species.

5) In the event that a 4-months gates-in scenario alternative is selected for implementation, the Service recommends that Reclamation:

A) Initiate investigations to determine whether the temporary center ladder could be designed or construction of a permanent ladder to improve fish passage.

B) Research feasibility of operational and structural changes to the RBDD that may benefit fish passage. These efforts would need to be coordinated with the resource agencies (CDFG, NMFS, and the Service).

C) Coordinate with the resource agencies to ensure that the results of the "Crowning Flow" experiments are analyzed, and determine whether such efforts (in conjunction with biological monitoring of fish passage response to the experiments) need continuation.

6) For alternatives that incorporate a gates-in condition, the Service recommends that Reclamation assume responsibility for the O&M of the fish ladders (including the temporary center ladder) at the RBDD, and for performing the fish counting work during the gates-in periods. Currently, these responsibilities are held by the Service.

7) For alternatives that incorporate a gates-in condition with a bypass channel, the Service recommends that Reclamation assume responsibility for the operations and maintenance of the bypass channel, the fish counting facilities (RBDD ladders and bypass channel), and performing the fish counting work associated with the operation of the bypass channel.

The Service's recommendations in this report may need to be reconsidered and updated pending potential operations decisions for the Trinity Division of the CVP that are outside of the Service's control, or that modify conditions under which RBDD and related facilities would operate.

REFERENCES

CALFED Bay-Delta Program. 2000. Final Programmatic Environmental Impact Statement/Environment Impact Report. July.

CH2M Hill. 2002a. Administrative draft EIR/EIS: Fish Passage Improvement Project at the Red Bluff Diversion Dam, Tehama County, California.

CH2M Hill. 2002b. Technical Memorandum: TCCA Fish Passage Improvement Project Elderberry Shrub Survey. April.

DWR (California Department of Water Resources). 2000. Battle Creek Salmon and Steelhead Restoration Project Fish Ladder and Fish Screen Features: Inskip Diversion, North Battle Creek Feeder Diversion, Eagle Canyon Diversion, Preliminary Engineering Concepts Technical Report. May.

NMFS (National Marine Fisheries Service). 1997. Sacramento Winter-run Draft Recovery Plan.

USFWS (U.S. Fish and Wildlife Service). 1992. Shaded Riverine Aquatic Cover of the Sacramento River System: Classification as Resource Category 1 under the FWS Mitigation Policy. October.

USFWS. 1998. Red Bluff Diversion Dam and the Tehama-Colusa Canal, Tehama County, California. Supplemental Fish and Wildlife Coordination Act Report. Ecological Services, Sacramento Field Office, Sacramento, California.

USFWS. 1999. Conservation Guidelines for the Valley Elderberry Longhorn Beetle. Sacramento Field Office, Sacramento, California.

USFWS. 2001. Final Restoration Plan for the Anadromous Fish Restoration Program.

APPENDIX A

Federal Agencies' Responsibilities under Section 7(a) and (C)
of the Endangered Species Act.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, W-2605
Sacramento, California 95825-1846

IN REPLY REFER TO:

August 16, 2002

Memorandum

To: Regional Director, U.S. Bureau of Reclamation, Sacramento, California

From: for Field Supervisor, Sacramento Fish and Wildlife Office, Sacramento, California

Subject: Fish and Wildlife Coordination Act Report for the Fish Passage Improvement Project, Red Bluff Diversion Dam

The Fish and Wildlife Service (Service) has reviewed alternatives for the *Fish Passage Improvement Project, Red Bluff Diversion Dam,* Tehama County, California. This memorandum transmits the Service's Fish and Wildlife Coordination Act Report, which was prepared under the authority of, and in accordance with provisions of section 2(b) of the Fish and Wildlife Coordination Act (48 stat. 401, as amended; 16 U.S. C. 661 et seq.). The report documents assessment of potential project effects on fish and wildlife resources, and provides our recommendations to maximize biological benefits and minimize adverse effects of the project. Project effects on federally listed species, pursuant to section 7 of the Endangered Species Act of 1973, as amended, are being addressed separately.

If you have any questions, please contact A. Leigh Bartoo at (916) 414-6725.

Attachment

David J. Hanlon

cc:

AES, Portland, Oregon
FWS, Red Bluff, California (Attn: Jim Smith)
USBR, Red Bluff, California (Attn: Max Stodolski)
CDFG, Redding, California, (Attn: Harry Rectenwald)
NMFS, Sacramento, California (Attn: Michael Tucker)
DWR, Red Bluff, California (Attn: Ralph Hinton)
CH2MHill, Redding, California (Attn: Mike Urkov)
TCCA, Willows, California

Federal agencies responsiblities under Sections 7(a) and (c) of the Endangered Species Act

SECTION 7 (a) Consultation/Conference

Requires: 1) Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species 2) Consultation with FWS when a Federal action may affect a listed endangered or threatened species to insure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the Federal agency after determining the action may affect a listed species; and 3) Conference with FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or adverse modification of proposed critical habitat.

SECTION 7 (c) Biological Assessment--Major Construction Activity (1)

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for major construction activities. The BA analyzes the effects of the action (2) on listed and proposed species. The process begins with a Federal agency requesting from FWS a list of proposed and listed threatened and endangered species. The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of this list, the accuracy of the species list should be informally verified with our Service. No irreversible commitment of resources is to be made during the BA process which would foreclose reasonable and prudent alternatives to protect endangered species. Planning, design, and administrative action may proceed; however, no construction may begin.

We recommend the following for inclusion in the BA: an on-site inspection of the area affected by the proposal which may include a detailed survey of the area to determine if the species or suitable habitat are present; a review of literature and scientific data to determine species' distribution, habitat needs, and other biological requirements; interviews with experts, including those within FWS, State conservation departments, universities and others who may have data not yet published in scientific literature; an analysis of the effects of the proposal on the species in terms of individuals and populations, including consideration of indirect effects of the proposal on the species and its habitat; and an analysis of alternative actions considered. The BA should document the results, including a discussion of study methods used, any problems encountered, and other relevant information. The BA should conclude whether or not a listed or proposed species will be affected. Upon completion, the BA should be forwarded to our office.

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(1) A construction project (or other undertaking having similar physical impacts) which is a major Federal action significantly affecting the quality of the human environment as referred to in NEPA (42 U.S.C. 4332(2)C).

(2) "Effects of the action" refers to the direct and indirect effects on an action of the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action.

APPENDIX B

Fish and Wildlife Service Planning Aid Memorandum on the Fish Passage and Water Reliability Improvement Project, Red Bluff Diversion Dam, Tehama County, California.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1886

October 19, 2001

Memorandum

To: Chief, Red Bluff Division, Bureau of Reclamation, Red Bluff, California

From: Acting Field Supervisor, Sacramento Fish and Wildlife Office, Sacramento, California

Subject: Planning Aid Memo on the Fish Passage and Water Reliability Improvement Project Red Bluff Diversion Dam, Red Bluff, California

This Planning Aid Memorandum (Memorandum) transmits the U.S. Fish and Wildlife Service's (Service) comments on alternatives for the Tehama-Colusa Canal Authority (TCCA) Fish Passage Improvement Project at the Red Bluff Diversion Dam (RBDD). These comments have been prepared under the authority, and in accordance with the provisions of Section 2(b) of the Fish and Wildlife Coordination Act [(FWCA) 48 stat. 401, as amended: 16 U.S.C. 661 et seq.]. The purpose of the FWCA is to provide for equal consideration of fish and wildlife conservation with other project features of federally funded or permitted water resource development projects. Pursuant to the FWCA, the Service has coordinated with the National Marine Fisheries Service (NMFS) and the California Department of Fish and Game (DFG) before providing these comments. We have been assured that these co-trustee agencies will be affirming the content of this Memorandum in subsequent submittals to the lead agencies under the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA) requirements. These comments have been developed in coordination with our Red Bluff Fish and Wildlife Office.

On October 1, 2001, the Service began collaborations with DFG and NMFS biologists in an effort to jointly develop this memorandum to assist the Bureau of Reclamation (Reclamation) with the interagency planning process for the Fish Passage Improvement at RBDD. Reclamation is the Federal nexus cooperator to the TCCA, the project lead agency.

A multi-agency team has been working on evaluating the existing conditions and alternatives for the fish passage project for over two years. This planning process has resulted in the development of the following alternatives, including the current condition (No Action):

No Action	Dam Gates in four months existing fish ladders.
Alternative 1(a)	Gates-in 4 months; new fish ladders; 1,700 cfs total pumping capacity.
Alternative 1(b)	Gates-in 4 months; new right bank fish ladder; bypass channel; 1,700 cfs total pumping capacity
Alternative 1(c)	Gates-in 4 months; old fish ladders; develop water supply from Stony Cr.
Alternative 2(a)	Gates-in 2 months; old fish ladders; 2,000 cfs total pumping capacity.
Alternative 2(b)	Gates-in 2 months; new fish ladders; 2,000 cfs total pumping capacity.
Alternative 3	Gates-out year-round; 2,500 cfs total pumping capacity.

The Service, in collaboration with NMFS and DFG, has arrived at the following preliminary recommendations:

Alternative 1(c) does not appear to meet the intent of the presently established "Project Need, Purposes, and Goal" ("needs and purpose") listed in the CH2MHILL February 2001 document, *"Tehama-Colusa Canal Authority Fish Passage Improvement Project at the Red Bluff Diversion Dam", Phase II, Preliminary Design Report, Volume I of II."* This needs and purpose clearly states the project must "substantially improve the long-term reliability" of both water delivery and adult and juvenile fish passage at the dam. Alternative 1(c) appears unlikely to substantially improve the reliability of water deliveries due to the many uncertainties associated with the water supply on Stony Creek. In April, 2001, CH2MHILL conducted a preliminary investigation of the reliability of the Stony Creek water supply, indicating that in one of every four years no water would be available for rediversion to the Tehama-Colusa Canal (TCC). There are additional uncertainties regarding the use of Stony Creek water dependant on the outcome of ongoing biological analyses and regulatory reviews of Stony Creek water management practices.

Most importantly, from our perspective, Alternative 1(c) does not improve fish passage over the No Action Alternative (gates in four months); especially for focus species of the alternatives, including spring-run chinook salmon and green sturgeon. Therefore, we recommend this alternative be dropped from further consideration. All remaining alternatives appear to meet, to various degrees, the intent of the "needs and purpose" statements.

The following list ranks the remaining alternatives, beginning with the alternative that we feel provides the greatest fishery resource benefits, to the alternative with the least fishery benefits:

1 Alternative 3
2 Alternative 2(b)
3 Alternative 2(a)
4 Alternative 1(a)
5 Alternative 1(b)

To date, the lead agency and the multi-agency planning process has generated certain amounts of fisheries information to enable this preliminary evaluation of the alternatives. However, a similar level of evaluation in relation to project alternative effects to terrestrial wildlife resources has not been possible. Therefore, as such information becomes available, issuance of additional planning aid memos may be necessary.

Discussion:

Our analysis is based upon the proceedings of numerous multi-agency technical teams spanning two decades. These efforts examined biological consequences of impaired passage at RBDD for both adult and juvenile anadromous fish as well as remedial alternatives. The most significant biological finding from this process is that populations of winter and spring-run chinook salmon, natal to the main-stem Sacramento River, require reliable and unimpaired passage at RBDD because one hundred percent of their spawning habitat is located above the dam. Likewise, salmon and steelhead populations natal to Battle, Cottonwood, Cow, and Clear creeks require reliable and unimpaired passage to sustain their separate populations. The need for restoration and recovery of these specific populations is exemplified by existing efforts to provide extensive and costly habitat restoration in the Sacramento River above RBDD, and in its major tributaries.

New ladder designs being considered as part of Alternatives 1(a), 1(b), and 2(b) are not known to produce substantial improvements in fish passage efficiency and reliability over the existing ladders. However, existing ladders at RBDD are 40 years old and engineering advancements could provide some measure of incremental improvement. Of the two permanent ladders at the dam, the west bank facility is a good candidate for modernization (size, attraction flow, baffling etc.) and effectiveness monitoring.

There are many uncertainties attached to the bypass being considered as part of alternative 1(b). While a bypass or even a fish ladder of this scale has never been tried before, the bypass does represent experimental technology that may pass non-salmonids. Clearly, there is no predictive capability that non-salmonids such as sturgeon, Sacramento pikeminnow, American shad, and striped bass will find the opening of the bypass or swim completely through the bypass if they enter it. There are also a number of operation and maintenance concerns, including seasonal closure of the facility and handling all the entrained fish during dewatering.

Our analysis of Alternatives 2(a) and 2(b) concludes there is a substantial improvement in the long-term reliability of adult and juvenile fish passage at RBDD over the No Action condition.

While we are not able to determine the incremental benefits provided by new ladders associated with the 2(a) and 2(b) alternatives, we believe the beneficial increment is not substantial in comparison to the benefit provided by the additional two months of gate openings. There are a number of specific benefits with alternatives 2(a) and 2(b). For example, the upstream migration of adult Sacramento pikeminnow would be facilitated during the gates up period, minimizing harmful accumulation of these predatory species on juvenile salmonids at the dam. Adult spring-run chinook salmon would have unimpaired passage up to the end of their migration period in late June. Unimpaired passage is particularly important for spring-run chinook salmon migrating to their natal tributaries on the Sacramento River above RBDD during the drier months. Delays in migration can result in late arrival to natal tributaries where low flow and high temperatures would prevent passage. Many of the Sacramento River tributaries above RBDD are undergoing comprehensive and expensive restoration, focusing on spring-run chinook salmon. Spring-run broodstock are extremely rare above the dam, making it essential to recruit the maximum number of natural spawners possible. Downstream migrating juveniles would be less susceptible to predation since during the gates up operation, they would not pass underneath the gates of the RBDD and become disorientated or impaired. Additonally, the spawning migration of adult green sturgeon would be unimpaired through the last portion of their spawning migration in the spring.

Alternative 3, except for diversions and their associated construction and operational impacts, provides a situation closest to the original ecosystem form and function. A free-flowing condition year-round under Alternative 3 would eliminate upstream or downstream impediments to migration and associated predation problems for all species and life-stages. Therefore, this is the best alternative for passage of all fish species and their associated life stages.

The migration timing for all anadromous fish species past Red Bluff is such that the increment of the populations migrating in July and August is relatively small. Therefore, the direct incremental benefit of totally unimpaired passage for anadromous fish species with Alternative 3, compared to that for Alternative 2, is relatively small. However, we think overall ecosystem-level benefits will be greater with Alternative 3. If the gates are up year-round, Lake Red Bluff would no longer exist, and a large amount of currently inundated shoreline would be exposed. If the natural river conditions were allowed to continue year-round, riparian vegetation would once again become established along and adjacent to the river. Shaded Riverine Aquatic (SRA) habitat, a Resource Category 1 type habitat along the Sacramento River, would become established providing shade, large woody debris, temperature attenuation, and food organisms for fish species, including salmon and steelhead.. SRA is important for biodiversity and increases fish and wildlife habitat values. Other species of native vegetation could also become established along and adjacent to the Sacramento River, further enhancing habitat, and fish and wildlife diversity. A year-round, free flowing river would greatly reduce predator "feeding stations" currently created when juvenile salmonids pass under the gates. Alternative 3 would also eliminate the need for fish ladders, reducing migration related stress and delay on adult fish attempting to pass upstream.

5

A related planning analysis is needed to consider how the RBDD alternative selection would affect the river as a navigable water of the state. Most angler use on the Sacramento River is by boat and river navigability does affect angler opportunities when pursing migratory fish species.

If you have any further questions regarding these comments, please contact Ryan Olah of my staff at (916) 414-6639 or Tom Kisanuki of the Red Bluff Fish and Wildlife Office at (530) 527-3043.

cc: Michael Aceituno, NMFS, Sacramento, CA
Donald Koch, CDFG, Redding CA
James Smith, USFWS, Red Bluff

APPENDIX C

Fishery Benefits Tables

Table C-1
Index Value, Relative Difference, and Improvement in Passage Index for Adult Anadromous Salmonids between Existing Conditions and NAA, and NAA Project Alternatives (CH2MHill 2002a).

Alternative	Index Value	Difference	Percent Improved	Effect
Winter-run Chinook Salmon				
No Action Alternative	98	n/a	n/a	*No Change*
4-Month Improved Ladder Alternative	91	2	2	*No Measurable Benefit*
4-Month Bypass Alternative	91	1	1	*No Measurable Benefit*
2-Month Improved Ladder Alternative	98	8	9	*No Measurable Benefit*
2-Month with Existing Ladders Alternative	98	8	9	*No Measurable Benefit*
Gates-out Alternative	100	10	12	*Measurable Benefit*
Spring-run Chinook Salmon				
No Action Alternative	52	n/a	n/a	*No Change*
4-Month Improved Ladder Alternative	61	8	16	*No Measurable Benefit*
4-Month Bypass Alternative	57	5	9	*No Measurable Benefit*
2-Month Improved Ladder Alternative	94	41	79	*Large Measurable Benefit*
2-Month with Existing Ladders Alternative	93	40	77	*Large Measurable Benefit*
Gates-out Alternative	100	48	91	*Large Measurable Benefit*
Fall-run Chinook Salmon				
No Action Alternative	83	n/a	n/a	*No Change*
4-Month Improved Ladder Alternative	86	3	4	*No Measurable Benefit*
4-Month Bypass Alternative	85	2	2	*No Measurable Benefit*
2-Month Improved Ladder Alternative	91	8	9	*No Measurable Benefit*
2-Month with Existing Ladders Alternative	89	6	8	*No Measurable Benefit*

Gates-out Alternative	100		17	20	*Measurable Benefit*
Late fall-run Chinook Salmon					
No Action Alternative	100	n/a		n/a	*No Change*
4-Month Improved Ladder Alternative	100	0		0	*No Change*
4-Month Bypass Alternative	100	0		0	*No Change*
2-Month Improved Ladder Alternative	100	0		0	*No Change*
2-Month with Existing Ladders Alternative	100	0		0	*No Change*
Gates-out Alternative	100	0		0	*No Change*
Steelhead					
No Action Alternative	89	n/a		n/a	*No Change*
4-Month Improved Ladder Alternative	91	2		2	*No Measurable Benefit*
4-Month Bypass Alternative	90	1		1	*No Measurable Benefit*
2-Month Improved Ladder Alternative	97	8		9	*No Measurable Benefit*
2-Month with Existing Ladders Alternative	96	7		8	*No Measurable Benefit*
Gates-out Alternative	100	11		12	*Measurable Benefit*

Table C-2
Index Value, Relative Difference, and Improvement in Passage Index for Juvenile Anadromous Salmonids between Existing Conditions and NAA, and NAA and Project Alternative (CH2MHill 2002a).

Alternative	Index Value	Difference	Percent Improved	Effect
Winter-run Chinook Salmon				
No Action Alternative	96	n/a	n/a	*No Change*
4-Month Gates-in	96	0	0	*No Change*
2-Month Gates-in	99	3	3	*No Measurable Benefit*
Gates Out	100	4	4	*No Measurable Benefit*
Spring-run Chinook Salmon				
No Action Alternative	100	n/a	n/a	*No Change*
4-Month Gates-in	100	0	0	*No Change*
2-Month Gates-in	100	0	0	*No measurable Benefit*
Gates Out	100	0	0	*No Measurable Benefit*
Fall-run Chinook Salmon				
No Action Alternative	97	n/a	n/a	*No Change*
4-Month Gates-in	97	0	0	*No Change*
2-Month Gates-in	100	2	2	*No Measurable Benefit*
Gates Out	100	3	3	*No Measaurable Benefit*
Late fall-run Chinook Salmon				
No Action Alternative	93	n/a	n/a	*No Change*
4-Month Gates-in	93	0	0	*No Change*
2-Month Gates-in	96	4	5	*No Measurable Benefit*
Gates Out	100	7	7	*No Measurable Benefit*

Steelhead					
	No Action Alternative	92	n/a	n/a	*No Change*
	4-Month Gates-in	92	0	0	*No Change*
	2-Month Gates-in	99	6	7	*No Measurable Benefit*
	Gates Out	100	8	8	*No Measurable Benefit*

Table C-3

Index Value, Relative Difference, and Improvement in Passage Index for Adult Other Native Anadromous Species between Existing Conditions and NAA, and NAA and Project Alternatives (CH2MHill 2002a).

Alternative	Index Value	Difference	Percent Improved	Effect
Green Sturgeon				
No Action Alternative	65	n/a	n/a	*No Change*
4-Month Improved Ladder Alternative	65	0	0	*No Change*
4-Month Bypass Alternative	69	4	6	*No Measurable Benefit*
2-Month Improved Ladder Alternative	100	35	54	*Large Measurable Benefit*
2-Month with Existing Ladders Alternative	100	35	54	*Large Measurable Benefit*
Gates-out Alternative	100	35	54	*Large Measurable Benefit*
Pacific Lamprey				
No Action Alternative	83	n/a	n/a	*No Change*
4-Month Improved Ladder Alternative	86	3	4	*No Measurable Benefit*
4-Month Bypass Alternative	85	2	2	*No Measurable Benefit*
2-Month Improved Ladder Alternative	97	14	17	*Measurable Benefit*
2-Month with Existing Ladders Alternative	96	13	16	*Measurable Benefit*
Gates-out Alternative	100	17	20	*Measurable Benefit*
River Lamprey				
No Action Alternative	83	n/a	n/a	*No Change*
4-Month Improved Ladder Alternative	86	3	4	*No Measurable Benefit*
4-Month Bypass Alternative	85	2	2	*No Measurable Benefit*
2-Month Improved Ladder Alternative	97	14	17	*Measurable Benefit*
2-Month with Existing Ladders Alternative	96	13	16	*Measurable Benefit*
Gates-out Alternative	100	17	20	*Measurable Benefit*

Table C-4
Index Value, Relative Difference, and Improvement in Passage Index for Juvenile (and transformer) for Other Native Anadromous Species between Existing Conditions and NAA, and NAA and Project Alternatives (CH2MHill 2002a).

Alternative	Index Value	Difference	Percent Improved	Effect
Green Sturgeon				
No Action Alternative	73	n/a	n/a	*No Change*
4-Month Gates-in	73	0	0	*No Change*
2-Month Gates-in	88	15	21	*Measurable Benefit*
Gates out	100	27	38	*Large Measurable Benefit*
Pacific Lamprey				
No Action Alternative	99	n/a	n/a	*No Change*
4-Month Gates-in	99	0	0	*No Change*
2-Month Gates-in	100	1	1	*No Measurable Benefit*
Gates out	100	1	1	*No Measurable Benefit*
River Lamprey				
No Action Alternative	87	n/a	n/a	*No Change*
4-Month Gates-in	87	0	0	*No Change*
2-Month Gates-in	100	13	15	*Measurable Benefit*
Gates out	100	13	15	*Measurable Benefit*

APPENDIX D

Federally Listed, Proposed, Candidate, and Species of Concern That Could Occur in the Red Bluff Diversion Dam Service Area, or May Be Affected by the Project.

Endangered and Threatened Species that May Occur in
or be Affected by Projects in the Selected Quads Listed Below
Reference File No. -
August 16, 2002

QUAD: 610B RED BLUFF EAST

Listed Species

Birds

bald eagle, *Haliaeetus leucocephalus* (T)

Reptiles

giant garter snake, *Thamnophis gigas* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

delta smelt, *Hypomesus transpacificus* (T)

Central Valley steelhead, *Oncorhynchus mykiss* (T) NMFS

Critical habitat, winter-run chinook salmon, *Oncorhynchus tshawytscha* (E) NMFS

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E) NMFS

Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T) NMFS

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (T) NMFS

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

vernal pool fairy shrimp, *Branchinecta lynchi* (T)

valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

vernal pool tadpole shrimp, *Lepidurus packardi* (E)

Candidate Species

Birds

Western yellow-billed cuckoo, *Coccyzus americanus occidentalis* (C)

Fish

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C) NMFS

Critical habitat, Central Valley fall/late fall-run chinook, *Oncorhynchus tshawytscha* (C) NMFS

Species of Concern

Mammals

pale Townsend's big-eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)

Pacific western big-eared bat, *Corynorhinus (=Plecotus) townsendii townsendii* (SC)

spotted bat, *Euderma maculatum* (SC)

small-footed myotis bat, *Myotis ciliolabrum* (SC)

long-eared myotis bat, *Myotis evotis* (SC)
fringed myotis bat, *Myotis thysanodes* (SC)
long-legged myotis bat, *Myotis volans* (SC)
Yuma myotis bat, *Myotis yumanensis* (SC)
San Joaquin pocket mouse, *Perognathus inornatus* (SC)

Birds

tricolored blackbird, *Agelaius tricolor* (SC)
grasshopper sparrow, *Ammodramus savannarum* (SC)
short-eared owl, *Asio flammeus* (SC)
western burrowing owl, *Athene cunicularia hypugaea* (SC)
oak titmouse, *Baeolophus inornatus* (SLC)
Aleutian Canada goose, *Branta canadensis leucopareia* (D)
Swainson's hawk, *Buteo Swainsoni* (CA)
ferruginous hawk, *Buteo regalis* (SC)
Lawrence's goldfinch, *Carduelis lawrencei* (SC)
Vaux's swift, *Chaetura vauxi* (SC)
black tern, *Chlidonias niger* (SC)
white-tailed (=black shouldered) kite, *Elanus leucurus* (SC)
little willow flycatcher, *Empidonax traillii brewsteri* (CA)
American peregrine falcon, *Falco peregrinus anatum* (D)
loggerhead shrike, *Lanius ludovicianus* (SC)
Lewis' woodpecker, *Melanerpes lewis* (SC)
long-billed curlew, *Numenius americanus* (SC)
Nuttall's woodpecker, *Picoides nuttallii* (SLC)
white-faced ibis, *Plegadis chihi* (SC)
bank swallow, *Riparia riparia* (CA)
rufous hummingbird, *Selasphorus rufus* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

Amphibians

foothill yellow-legged frog, *Rana boylii* (SC)
western spadefoot toad, *Spea hammondii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)
river lamprey, *Lampetra ayresi* (SC)
longfin smelt, *Spirinchus thaleichthys* (SC)

Reference File No. -

Invertebrates

Antioch Dunes anthicid beetle, *Anthicus antiochensis* (SC)

Sacramento anthicid beetle, *Anthicus sacramento* (SC)

California linderiella fairy shrimp, *Linderiella occidentalis* (SC)

Plants

silky cryptantha, *Cryptantha crinita* (SC)

adobe lily, *Fritillaria pluriflora* (SC)

Red Bluff (dwarf) rush, *Juncus leiospermus var. leiospermus* (SC)

KEY:

(E)	*Endangered*	Listed (in the Federal Register) as being in danger of extinction.
(T)	*Threatened*	Listed as likely to become endangered within the foreseeable future.
(P)	*Proposed*	Officially proposed (in the Federal Register) for listing as endangered or threatened.
(PX)	*Proposed Critical Habitat*	Proposed as an area essential to the conservation of the species.
(C)	*Candidate*	Candidate to become a *proposed* species.
(SC)	*Species of Concern*	May be endangered or threatened. Not enough biological information has been gathered to support listing at this time.
(SLC)	*Species of Local Concern*	Species of local or regional concern or conservation significance.
(MB)	*Migratory Bird*	Migratory bird
NMFS	NMFS species	Under the jurisdiction of the National Marine Fisheries Service. Contact them directly.
(D)	*Delisted*	Delisted. Status to be monitored for 5 years.
(CA)	*State-Listed*	Listed as threatened or endangered by the State of California.
(*)	*Extirpated*	Possibly extirpated from this quad.
(**)	*Extinct*	Possibly extinct.
	Critical Habitat	Area essential to the conservation of a species.

APPENDIX E

Planning Aid Memorandum from the Fish and Wildlife Service and Letter from the National Marine Fisheries Service on Species of Concern for the Fish Passage Improvement Project at the Red Bluff Diversion Dam.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

IN REPLY REFER TO:

September 20, 2000

Memorandum

To: Area Manager, Bureau of Reclamation, Northern California Area Office, Shasta Lake, California

From: Acting Field Supervisor, Sacramento Fish and Wildlife Office, Sacramento, California

Subject: Species of Concern for the Fish Passage Improvement Project for the Red Bluff Diversion Dam

This memorandum is in response to the Bureau of Reclamation's (Reclamation) letter, dated August 18, 2000, which asked for the Fish and Wildlife Service's (Service) guidance as to what fish species should be considered when designing fish passage facilities at the Red Bluff Diversion Dam (RBDD).

Improving fish passage at the Red Bluff Diversion Dam is a priority for the Service. As recommended in the Service's February 1998 Supplemental Fish and Wildlife Coordination Act Report on the Red Bluff Diversion Dam and the Tehama-Colusa Canal, Reclamation, in consultation with the Service, the National Marine Fisheries Service (NMFS) and The California Department of Fish and Game (CDFG), should continue to develop a long term solution to minimize fish passage problems for adults and juveniles of all anadromous fish. In addition to anadromous fish, the Service is also concerned with listed species and native fish of the Sacramento River. By listing which fish are important to pass both upstream and downstream of RBDD, we will be able to more clearly determine if an alternative for the Tehama-Colusa Canal Authority's (TCCA) Fish Passage Improvement Project will be acceptable.

We propose three levels of priority for fish passage considerations at RBDD:

The first level would include all federally and State listed species, proposed and candidate species, and all agency and academically recognized species of concern (See Table 1). This group would include steelhead and all runs (fall, late-fall, winter, and spring) of chinook salmon. Non-native anadromous also should be included in this group based on the Central Valley Project

Improvement Act (P.L. 101-575), which states that the Secretary of the Interior is authorized and directed to "develop and implement measures to minimize fish passage problems for adult and juvenile anadromous fish at Red Bluff Diversion Dam." All life stages for the species in this first level should be considered for upstream and downstream passage. In addition, any unlisted species that adversely affects listed species due to the congregation of the unlisted species above or below the dam due to impaired passage should be included. Specifically, this applies to Sacramento pikeminnow. If pikeminnow, cannot pass the dam, they can adversely affect migrating juvenile listed species by depredation. By allowing passage to the pikeminnow, these adverse impacts can be lessened.

The second level would include all native fish species occurring in the Sacramento River. This group would include such fish as Sacramento sucker and hardhead.

The third level would include non-native fish species in the Sacramento River.

Table 1

Priority Level	Type of Fish Included	Specific Fish Species
Level 1	Federal and state listed fish, proposed and candidate species, species of concern	Pacific salmon (*Oncorhynchus tshawytscha* spp.) Steelhead (*Oncorhynchus mykiss*) Splittail (*Pogonichthys macrolepidotus*) Pacific lamprey (*Lampetra ayresi*) River lamprey (*Lampetra tridentata*) Green sturgeon (*Acipenser medirostris*) White sturgeon (*Acipenser transmontanus*)
	Anadromous fish (covered under CVPIA)	American shad (*Alosa sadidissima*) Striped bass (*Morone saxatilis*)
	Fish, that if they cannot pass the RBDD, could have an adverse effect to juvenile listed species.	Sacramento pikeminnow (*Ptychocheilus grandis*)
Level 2	Native fish of the Sacramento River	Sacramento sucker (*Catostomus occidentalis*) Hardhead (*Mylopharodon conocephalus*) Others
Level 3	Non-native fish of the Sacramento River	Various

If you have any further questions regarding these comments, please contact Ryan Olah of the Sacramento Fish and Wildlife Office at (916) 414-6725, or Tom Kisanuki of the Northern Central Valley Fish and Wildlife Office (NCVFWO) at (530) 527-3043.

Dale A. Pierce

cc: AES, Portland, OR
Dale Cannon, CH2M HILL, Redding, CA
Art Bullock, TCCA, Willows, CA
Harry Rectenwald, CDFG, Redding, CA
Michael Tucker, NMFS, Sacramento, CA
Jim Smith, NCVFWO, Red Bluff, CA

APPENDIX F

Concurrence Letters from the California Department of Fish and Game
and National Marine Fisheries Service.

Sacramento Area Office
650 Capitol Mall, Suite 6070
Sacramento, California 95814

October 11, 2000

In Response Refer To:
SWR-00-SA-0152:MET

Mr. Michael J. Ryan, Area Manager
Bureau of Reclamation
Northern California Area Office
16349 Shasta Dam Blvd.
Shasta Lake, California 96019-8400

Dear Mr Ryan:

This is in response to your letter of August 18, 2000, requesting identification of those species of fish which the National Marine Fisheries Service (NMFS) would recommend consideration as you develop a plan for improvement of fish passage at the Red Bluff Diversion Dam (RBDD). I have broken down this list into three levels of priority with the highest level including all federally and state listed species. The second level includes other native species of concern which have demonstrated decreasing population trends, have experienced significant habitat degradation and/or are known to be highly migratory, relying on passage of RBDD to reach historic spawning grounds. The third level includes all other native species known to inhabit this area of the river. All life stages of these species should be considered as the demise of any one stage would mean the eventual loss of the species.

First Priority:

Sacramento River winter-run chinook salmon *(Oncorhynchus tshawytscha)*
Central Valley spring-run chinook salmon *(O. tshawytscha)*
Central Valley steelhead *(O. mykiss)*
Sacramento splittail *(Pogonichthys macrolepidotus)*

Second Priority:

Central Valley fall/late fall-run chinook salmon *(O. tshawytscha)*
Green sturgeon *(Acipenser medirostris)*
White sturgeon *(A. transmontanus)*
Pacific lamprey *(Lampetra tridentata)*
River lamprey *(L. Ayresi)*

Third Priority:

All other native species

If you have any questions regarding this correspondence or if NMFS can provide further assistance on this project, please contact Mr. Michael Tucker in our Sacramento Area Office, 650 Capitol Mall, Suite 6070, Sacramento, CA 95814. Mr. Tucker may be reached by telephone at (916) 498-8988 or by fax at (916) 498-6697.

Sincerely,

Michael E. Aceituno
Sacramento Area Office Supervisor

A:\passage consideration species ltr.wpd\MTucker

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

August 16, 2002

In Reply Refer To:
SWR-99-SA-1048:MET

Mr. Wayne White
Field Supervisor
Sacramento Office
U.S. Fish and Wildlife Service
2800 Cottage Way, Room W. 2605
Sacramento, California 95825

Dear Mr. White:

The National Marine Fisheries Service (NOAA Fisheries) has reviewed the Administrative Draft Fish and Wildlife Coordination Act Report (report) on the Fish Passage Improvement Project at the Red Bluff Diversion Dam which was sent out via electronic mail from your office on August 6, 2002. We appreciate the opportunity to participate in the development of this document and offer the following comments.

NOAA Fisheries staff have been working closely with the U.S. Fish and Wildlife Service (FWS) as a member of the multi-agency team that has been evaluating the existing conditions and developing alternatives for this fish passage improvement project for over two years. Recently, NOAA Fisheries was invited to work collaboratively with FWS and the California Department of Fish and Game (DFG) to provide input to the subject report on the fisheries benefits and impacts associated with the various alternatives that have been developed for the project. NMFS has reviewed the draft report and we fully concur with the statements and determinations put forth by FWS.

Of particular importance is the evaluation of the "gates out" alternative and the many important fisheries and other ecological benefits that are unique to this alternative. The gates out alternative is the only one that ensures free passage of migrating salmonids and other fish, throughout the year. This alternative also provides the greatest level of certainty to water users, including the national wildlife refuges that use this water to create and enhance habitat for fish and wildlife resources. Finally, this alternative is the only one that is likely to create conditions upstream of the dam that will allow the regeneration of high quality riparian vegetation and shaded riverine aquatic habitat for approximately one mile on each side of the river. The opportunity to create such a large amount of this critically important category one habitat is very rare on the highly developed Sacramento River.

Again, we appreciate the opportunity to participate in the development of this important report. If you have any questions regarding this correspondence or if NOAA Fisheries can provide further assistance on this project, please contact Mr. Michael Tucker in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814. Mr. Tucker may be reached by telephone at (916) 930-3604 or by Fax at (916) 930-3629.

Sincerely,

for Rodney R. McInnis
Acting Regional Administrator

cc: NOAA Fisheries-PRD, Long Beach, CA
Stephen A. Meyer, ASAC, NOAA Fisheries, Sacramento, CA

Again, we appreciate the opportunity to participate in the development of this important report. If you have any questions regarding this correspondence or if NOAA Fisheries can provide further assistance on this project, please contact Mr. Michael Tucker in our Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814. Mr. Tucker may be reached by telephone at (916) 930-3604 or by Fax at (916) 930-3629.

Sincerely,

ORIGINAL SIGNED BY
MICHAEL ACEITUNO FOR
Rodney R. McInnis
Acting Regional Administrator

cc: NOAA Fisheries-PRD, Long Beach, CA
Stephen A. Meyer, ASAC, NOAA Fisheries, Sacramento, CA

A:\FWCA report concurance.wpd\MTucker

Appendix J
Red Bluff Diversion Dam
Fishway Attraction Study
Spillway Operation Test

United States Department of the Interior

BUREAU OF RECLAMATION
Northern California Area Office
16349 Shasta Dam Boulevard
Shasta Lake, California 96019-8400

IN REPLY REFER TO:

APR 16 2002

NC-350
ENV-4.10/PRJ-8.10

To: Technical Advisory Group - Red Bluff Fish Passage Improvement Project

From: Max J. Stodolski
Chief, Red Bluff Division

Subject: Final Reports for the Fishway Attraction Study

Two reports, developed by Reclamation in conjunction with the Red Bluff Fish Passage Improvement Project, are attached for your information and use. Both reports provide the results of a study, conducted in August 2001, to evaluate the effects of mid-river dominated flows at the Red Bluff Diversion Dam (RBDD). The study objective was to determine if such flows would improve Chinook salmon attraction to the left and right abutment fish ladders. During the study the U.S. Fish and Wildlife Service, and the California Department of Fish and Game, evaluated the effects of these flows on fish passage. Hydraulic conditions, erosion, and the sedimentation associated with the mid-river flows, were evaluated by Reclamation, and are the topics of the enclosed reports.

The "*Red Bluff Diversion Dam, Fishway Attraction Study, Spillway Operation Test*" report summarizes the results of field tests conducted to evaluate hydraulic conditions resulting from the mid-river dominated flows. The "*Underwater Inspection of Red Bluff Diversion Dam, Fishway Attraction Study*" report summarizes the findings of a Reclamation dive team's inspection of erosion and sediment deposition in the stilling basin and river bed resulting from the mid-river flows.

If there are any questions or for clarification regarding the findings of these reports, please direct them either to me, at 530-529-3890, or to Ms. Sandy Borthwick, Red Bluff Division's Fishery Biologist, at 530-528-0512; TDD 530-275-8991.

Attachments - 2

cc Mr. Arthur Bullock
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Redding, California 96049-2478

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825 North Humboldt Avenue
Willows, California 95988

UNDERWATER INSPECTION OF RED BLUFF DIVERSION DAM

FISHWAY ATTRACTION STUDY

AUGUST 13 THROUGH 17, 2001

BUREAU OF RECLAMATION

U.S. BUREAU OF RECLAMATION
LOWER COLORADO REGION DIVE TEAM
DECEMBER 2001

September 16, 2001(Rev 11/01)

To: Max J. Stodolski, Chief, Red Bluff Division

From: Joel Sturm and Rodney Tang

Subject: **UNDERWATER INSPECTION OF RED BLUFF DIVERSION DAM STILLING BASIN -- AUGUST 13 THROUGH 17, 2001 FISHWAY ATTRACTION STUDY**

INTRODUCTION

The subject underwater inspection was conducted by members of the Lower Colorado Regional Dive Team as part of an ongoing effort to improve the attraction of spawning salmon to the right and left abutment fish ladders. All diving took place during a week-long test to observe three different gate configurations and their effects on fish attraction to the ladders and erosion and sediment deposition in the stilling basin and river bed. The asymmetric gate opening configurations (middle gates significantly more open than the outer gates) were intended to produce mid-river dominated releases (high flows in the mid channel and low flows near the channel edges) that would push fish toward the two abutments where they would encounter attraction flows from the fish ladders. Three separate gate configuration tests (Tests 1, 2 and 3) were conducted. Spillway releases for each test lasted approximately 20 hours. The Fishway Attraction Study and proposed testing are described in a letter from Max J. Stodolski to Rebecca Lent, PhD, National Marine Fisheries Service dated June 21, 2001.

STUDY OBJECTIVES

As stated in the June 21, 2001 letter,

The proposed study will investigate hydraulic conditions in the stilling basin and downstream river that result from non-uniform spillway gate operation. A field investigation will study the effect of center river dominated flow releases with respect to stability of the hydraulic jump, abrasion damage potential and erosion downstream of the endsill.

SCOPE OF WORK

Divers made four separate underwater inspections (dives) in the stilling basin as follows:

DIVE	DATE	TIME	PURPOSE
1	August 13	2 PM to 5 PM	Initial inspection to establish baseline (pre-test) conditions
2	August 15	8 AM to NOON	Followed Test 1
3	August 16	8 AM to 11 AM	Followed Test 2
4	August 17	8 AM to 11 AM	Followed Test 3

On each dive, divers inspected and documented:

- The distribution of bedload sediment within the stilling basin
- The condition of the endsill and extent of concrete erosion
- The condition of riprap downstream of the endsill

Divers also documented the sediment deposited at the base of the Pumping Plant Trashrack Structure at the request of Red Bluff Diversion Dam site personnel.

Documentation included continuous, real-time color video and detailed notes and sketch maps prepared by topside dive team personnel based on diver descriptions of underwater conditions received via a two-way communication system.

PARTICIPANTS

Divers

Name	Position	Office	Phone Number
Rodney Tang	Civil Engineer	Phoenix, AZ	(602) 216-3935
Joel Sturm	Geologist	Sacramento, CA	(916) 978-5305
Tim Dewey	Civil Engineering Tech	Boulder City, NV	(702) 293-8556
Randy Calvert	Electrician	Hoover Dam, AZ/NV	(702) 293-8370
Greg Clune	Biologist	Boulder City, NV	(702) 293-8635

TSC, Red Bluff and NorCal Area Office Personnel

Name	Position	Office	Phone Number
Brent Mefford	Civil Engineer	Denver, CO	(303) 445-2149
Tracy Vermeyen	Civil Engineer	Denver, CO	(530) 445-2154
Paul Freeman	CE, Chief O&M Branch	Red Bluff, CA	(700) 450-7352
Sandy Borthwick	Biologist	Red Bluff, CA	(530) 528-0512
Max Stodolski	Division Chief	Red Bluff, CA	(530) 529-3890
June Borgwat	Safety Officer	NorCal Area Office	(700) 450-6000

DIVING EQUIPMENT AND PROCEDURES AND LOCK OUT/TAG OUT PROCEDURES

Described in Attachment 3.

DISCUSSION OF FINDINGS

Underwater conditions observed in the stilling basin are documented in Tables, Photographs and Figures as follows:

Table 1. Volume of Sediment in Spillway Stilling Basin
Table 2. Condition of Riprap, Concrete and Rebar in Spillway Stilling Basin

Table 3. Video Log – August 15, 2001 Inspection Dive
Photographs 1 through 27: Typical Underwater Stilling Basin Conditions
Figures 1 through 5. Distribution of Sediment in Stilling Basin

Table 2 also includes a list and definitions of descriptors used to describe riprap, concrete and rebar (ex. R = Rough Concrete; VSU = Very Severely Undercut rebar).

Concrete Erosion

1) Concrete erosion is most severe along the top of the stilling basin endsill and at the base of its upstream face (the cove area).

2) Erosion has exposed and severely undercut rebar along the top of the endsill. The average amount of vertical undercut below rebar is 1 to 2 inches.

3) Small eroded pockets and short lengths of exposed, but not undercut, rebar are present at the downstream bases of chute blocks in Gates 6 and 11.

4) The stilling basin apron is relatively uneroded and is mostly smooth or slightly rough concrete. Rough concrete is present on the apron near the downstream pier noses.

5) Erosion of the stilling basin endsill, chute blocks and apron - before and after the tests - appears unchanged from the last underwater inspection in 1999.

6) Observed erosion appears to be the result of over 50 years of operation and bedload movement.

7) No evidence of new or unusual erosion patterns was observed following the gate tests.

8) No evidence of significant "ball mill" erosion was observed during or following the testing.

Concrete Erosion During Test Period

In an effort to identify any changes in the pattern and rate of concrete erosion during the test period in response to the asymmetric gate opening configuration, divers observed, commented on and documented on video tape the condition of algae coatings at several locations on the stilling basin apron, on several chute blocks and on the endsill and cove areas in the course of each inspection dive. Prior to initiating the test, the algae coating on the apron was more evident downstream of the middle gates and less evident downstream of the outer gates. Over the course of the test period, algae coatings on the apron and chute blocks remained generally intact and unscarred indicating minimal to no erosion during the test period. Some degree of removal or thinning of the algae coating on the apron downstream of the middle gates was apparent, most likely as a result of the high releases through the middle gates. Algae coatings were absent in the cove area and on top of the endsill (where ongoing erosion is most active) and varied from absent to intact and unscarred on the upstream face of the endsill. From these observations, it can be

concluded that the pattern of erosion did not change appreciably during the test period and that what erosion, if any, may have occurred during the test period occurred in the same areas where ongoing erosion had been occurring prior to the test.

Sediment Distribution

1) Prior to the *center channel dominant* gate tests, most sediment in the stilling basin (volume estimated at 74 cubic yards) was deposited at the upstream toe of the endsill (the cove area), downstream of Gates 5, 6, 7 and 8 (the middle four gates). A large gravel bar was also present for a few hundred feet downstream of these gates. This distribution of sediment was the result of routing river flows through the outer gates while a temporary fish ladder was installed in Gate 6.

2) Following the week-long *center channel dominant* gate tests, much of this sediment was removed from the stilling basin and transported downstream to form a gravel bar that extended several hundred feet below the dam. Only a small amount of sediment remained in the cove area downstream of Gates 5, 6 and 7 (volume estimated at 3 cubic yards). An estimated 26 cubic yards of sediment were present downstream of Gates 8 and 10 (right side) and Gate 4 (left side) as follows:

- Gate 8 17 yds
- Gate 10 5 cubic yards
- Gate 4 4 cubic yards

3) A 9 cubic yard sediment deposit in the cove area of Gate 11, the sluice gate, was present prior to the gate tests and remained unchanged following the tests, despite releases of up to 8000 cfs through that gate.

Sediment at Base of Pumping Plant Trashracks

The Pumping Plant Trashracks were inspected on August 15 and 17. Observed underwater conditions are described in Table 4. Sediment consisting of rounded gravel and cobbles is present along the base of the entire trashrack structure. Sediment levels range from 1 foot below the concrete bottom slab to 5 feet above the slab and are typically even with or 1 foot above the slab. An approximately 3-foot high mound of gravel is present on the bottom slab a few feet upstream (inside) of the trashracks. All metalwork is in satisfactory condition. No damage, severe rusting or rust nodules were observed.

CONCLUSIONS AND RECOMMENDATIONS

1) The week-long *center channel dominant* gate tests had no adverse effect on the stilling basin including the endsill, apron and chute blocks.

2) Concrete erosion is an ongoing process caused by downstream transport of river bedload combined with ball-milling of gravel and cobbles in the stilling basin. This process was not accelerated or intensified as a result of the center dominant gate tests, nor was it reduced in intensity by the tests.

3) Long-term operation of Red Bluff Diversion Dam using a center channel dominant gate configuration is an acceptable mode of operation that should not accelerate or exacerbate the ongoing process of concrete erosion at the endsill.

4) Endsill erosion should continue at approximately the same rate as it has for the past 40 years. Rebar undercutting at the top of the endsill will increase. Breakage and loss of rebar should be expected.

5) If a center channel dominant gate setting is maintained, a gradual build-up of sediment should be expected in the cove areas downstream of the outer gates: Gates 1, 2, 3 and 4 (left side) and 8, 9 and 10 (right side).

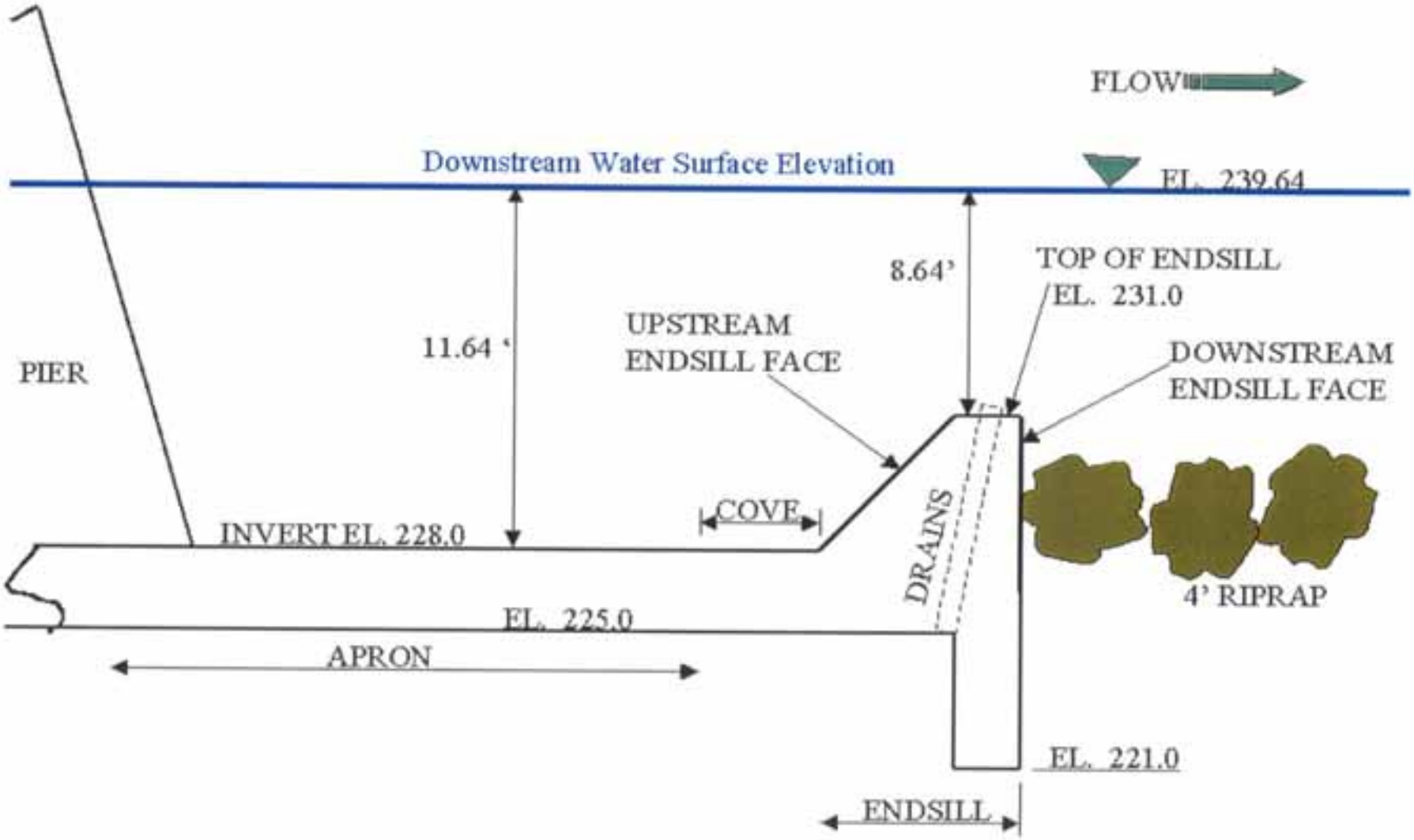
ATTACHMENTS

1) *Proposed Testing for Fishway Attraction Study at the Red Bluff Diversion Dam, June 21, 2001.* Letter from Max J. Stodolski, Chief, Red Bluff Division, to Rebecca Lent, PhD, Regional Administrator, National Marine Fisheries Service

2) *Request for Services of the Lower Colorado Regional Underwater Investigation Team (Dive Team).* Standard dive request, plan and hazard analysis.

3) *Gate and Diving Operations and Lock Out/Tag Out Procedure, August 8, 2001.* Prepared by diver Joel F. Sturm as part of the pre-dive planning.

RED BLUFF DIVERSION DAM



STILLING BASIN CROSS SECTION

TABLE 1. VOLUME OF SEDIMENT IN SPILLWAY STILLING BASIN (1)

GATE NUMBER	BASELINE VOLUME (cubic yards) 8/13/01	VOLUME FOLLOWING : (cubic yards)		
		TEST 1 8/15/01	TEST 2 8/16/01	TEST 3 8/17/01
1				
2				
3		7	1	
4		13	3	4
5	22	9		
6	22			1
7	20			2
8	10	5	8	17
9				
10				5
11	9	9	9	9
TOTAL	83	43	21	38

(1) Based on measurements by divers as shown on Figures 1 through 5.

TABLE 2. CONDITION OF RIPRAP, CONCRETE AND REBAR IN SPILLWAY STILLING BASIN

GATE NUMBER	RIPRAP	ENDSILL			APRON	CHUTE BLOCKS		COMMENTS
		TOP		COVE				
		REBAR	CONCRETE			REBAR	CONCRETE	
1	I, F, R	EX/U	VR	S/R	S			
2	WS, F, R/SR	U/VSU	VR	VR				7' transverse x 3' longitudinal area of exposed rebar in cove downstream of Pier 1/2
3	WS, F	EX/SU	R	VR				
4	WS, F	SU/VSU		VR	S/R			
5	WS, F, R/SR	SU/VSU		R				Exposed rebar in cove
6	I, O	SU		R	S/R		VR	Erosion at bases of chute blocks
7	I	SU	R	R/VR				
8	I, F	SU	VR	R	S/R			
9	I, F	EX/SU	VR	R	S/R			
10	I/WS, R/SR	EX/U	VR	R/VR	S/R			

RIPRAP DESCRIPTORS

I	INTERLOCKED	4-foot diameter blocks of hard basalt riprap tightly interlocked to barely touching, apparently unchanged from their original condition.
WS	WIDELY SPACED	4-foot diameter basalt blocks spaced 4 to 5 feet apart.
R	ROUNDED	Basalt blocks are smooth and rounded with no edges.
SR	SUBROUNDED	Edges of basalt blocks are defined but blunt; surfaces are smooth.
SA	SUBANGULAR	Edges of basalt blocks are defined and slightly sharp; surfaces are smooth.
O	OPEN	Interstitial spaces or gaps between blocks of riprap are empty.
F	FILLED	Interstitial spaces or gaps between blocks of riprap are filled with 1/4- to 3-inch gravel.

CONCRETE DESCRIPTORS

S	SMOOTH	Relief less than ½ inch
R	ROUGH	1- to 2-inch relief
VR	VERY ROUGH	2- to 3-inch relief

REBAR DESCRIPTORS

EX	EXPOSED	Rebar exposed but not undercut
U	UNDERCUT	Rebar undercut ½ to 1 inch
SU	SEVERELY UNDERCUT	Rebar undercut 1 to 3 inches
VSU	VERY SEVERELY UNDERCUT	Rebar undercut 3 to 5 inches. Bar diameter ranges from 1/4 to ½ inch (normal diameter is ½ inch [#4 bar])

TABLE 3. VIDEO LOG – AUGUST 15, 2001 INSPECTION DIVE

TAPE 1			GATES 1 - 8
GATE	PIER	TIME	COMMENTS
1		5:00 to 10:00	10:00: 7' transverse x 3' longitudinal area of exposed rebar at cove invert. Transverse = Cross Channel Longitudinal = Parallel to Channel
	1/2		
2			13:33: Centerline of Gate 2 14:59: Severely Undercut (SU) rebar
	2/3		
3		16:16 to 24:25	16:51: Rebar exposed but not undercut (EX) 18:09: Very Rough (VR) concrete in cove 22:00: Gravel deposit
	3/4	24:25	
4		26:03 to 32:33	26:03-29:00: Left longitudinal joint 29:30: Cobble deposit; 3-6" cobbles
	4/5	32:33	
5		35:31 to 45:05	40:38: Rounded to Subrounded (R/SR) riprap 41:15: Very Severely Undercut (VSU) rebar
	5/6	45:05	
6			46:57-48:00: Riprap near left longitudinal joint 48:48: Bent exposed rebar 50:03: Right longitudinal joint 50:50: Intersection of transverse joint and right longitudinal joint 51:10: Vertical pin 1:18-1:21: Chute Blocks
	6/7	51:30 1:17:44	
7			52:00: Intersection of transverse joint and left longitudinal joint 53:00 to 54:45: Sheetpile cofferdam 55:08: Rough toVery Rough (R/VR) concrete at cove 58:06: 5' deep hole near cofferdam 59:24: Centerline Gate 7 1:00:00: Relief Drain on top of endsill 1:15-1:17: Chute Blocks
	7/8	1:01:20	
8			1:02:05: Gravel/cobble deposit; 1-6" gravel and cobbles 1:03:29-1:05:55: Left longitudinal joint 1:06:40: Intersection of transverse joint and left longitudinal joint; relief on apron. 1:08:20: Right longitudinal joint 1:11:00: Very Rough (VR) concrete on top of endsill
	8/9		

TAPE 2			PUMPING PLANT TRASHRACKS & GATES 9 - 11
GATE	**PIER**	**TIME**	**COMMENTS**
PUMPING PLANT TRASH RACKS		0:00 to 12:18	Underwater conditions at the base of the Pumping Plant Trashracks as viewed by divers on 8/15 and 8/17 are described in Table 3. 2:50: Base of Upstream End Guide 3:30: Base of Intermediate Guide 1 12:18: Base of Intermediate Guide 6 **Note: Video documents diver's inspection route from PP Trashracks to Gate 11, Gate 10 and Gate 9 (last).**
11		18:11 to 42:22	18:15: Left endsill 19:00: Riprap on downstream side of endsill 21:00: Right longitudinal joint 22:24: Rough concrete 23:20: 1/8- to 3-inch gravel deposited upstream of endsill 24:15: 3, 2-foot diameter concrete cores 29:50 - 34:12: **Downstream Chute Blocks** 29:50: Chute Block 1 (left block) 30:00: Chute Block 2 30:10: Chute Block 3 30:37-31:46: Chute Block 4 34:12: Chute Block 7. Rough (R) concrete. 34:33: Chute Block 6. Rough (R) concrete. 34:50: Chute Block 5. 2-inch length of Exposed (EX) rebar. 40:15: Apron. Smooth (S) concrete. 40:29 - 42:22: **Upstream Chute Blocks** 40:29: Chute Block 2 40:56: Chute Block 1 41:25: Chute Block 3 41:35: Chute Block 4 41:46: Chute Block 5 41:57: Chute Block 6 42:07: Chute Block 7 42:22: Chute Block 8
	10/11	45:27	
10		45:27 to 52:11	48:25: Top of endsill. Very Rough (VR) concrete. Widely Spaced (WS) Riprap with interstitial spaces Filled (F) with gravel. 49:30: Centerline of Gate 10. 51:40: Left longitudinal joint
	9/10	52:11	
9		52:11 to 1:03:08	54:17: Riprap and Undercut to Severely Undercut (U/SU) rebar. 54:30: Centerline Gate 9 55:48: Left longitudinal joint 56:50: Exposed (EX) rebar
	8/9	1:03:23	

TABLE 4.
DEPTH OF SEDIMENT AT BASE OF PUMPING PLANT TRASHRACK STRUCTURE

NUMBER OF GUIDE (1)	8/15/01			8/17/01		
	DEPTH SEDIMENT (ft) (2)	TYPE SEDIMENT (3)	HEIGHT OF INTERIOR MOUND (ft)	DEPTH SEDIMENT (ft) (2)	TYPE SEDIMENT (3)	HEIGHT OF INTERIOR MOUND (ft)
U/S END GUIDE	- 1.5	g/c	2 (4)	-1.5	g/c	(4)
INTER GUIDE 1	- 1.5	g/c	2	-1.5	g/c	
INTER GUIDE 2	- 1.0	g/c	2	-1.0	g/c	
INTER GUIDE 3	- 0.5	g/c	2	-1.0	g/c	+/- 3
INTER GUIDE 4	- 0.5	g/c	2	-0.7	g/c	Range: 2.5-3.5
INTER GUIDE 5	0	g/c	1-2	-0.5	g/c	
INTER GUIDE 6	0	s/g	1-2	0	s/g	
INTER GUIDE 7	+1.0	s/g	1-2	+1.0	s/g	
D/S END GUIDE	+2.5	s/g	2	+3.0	s/g	

NOTES:
1) INTER – INTERMEDIATE
2) - = vertical distance **below** concrete base slab; + – vertical distance **above** base slab: 0 = **even** with base slab.
3) g/c = gravel and cobbles; s/g – sand and gravel
4) Interior mound consists of sand and minus 3-inch gravel; located about 3 feet inside of trashracks; height is vertical distance above base slab (estimated).

Photo 1

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

EXPOSED REBAR – GATE 1

Exposed Rebar (EX) on top of endsill downstream of Gate 1.

Rodney Tang

August 15, 2001

Photo 2

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

RIPRAP – GATE 1

Interlocked, Rounded to Subrounded (I, R/SR) blocks of hard basalt riprap downstream of Gate 1.

Rodney Tang

August 15, 2001

Photo 3

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

EXPOSED REBAR – COVE AREA -- GATE 1

A 7-foot long (transverse direction) by 3-foot wide (longitudinal direction) area of Exposed Rebar (EX) is present in the cove area of Gate 1, approximately downstream of Pier 1/2. Endsill is at photo left. View is toward the right abutment, parallel to the endsill.

Rodney Tang

August 15, 2001

Photo 4

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

SEVERELY UNDERCUT REBAR – GATE 2

Severely Undercut Rebar (SU) on top of endsill downstream of Gate 2. The ruler shows 3 to 4 inches of undercutting. Loose fine and coarse gravel covers much of the endsill.

Rodney Tang

August 15, 2001

Photo 5

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

GRAVEL DEPOSIT – GATE 3

Deposit of fine and coarse gravel in cove area downstream of Gate 3.

Rodney Tang

August 15, 2001

Photo 6

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

EXPOSED REBAR AND ROUGH CONCRETE -- GATE 3

Exposed Rebar (EX) and Rough Concrete (R) with 1- to 2-inch relief on top of endsill downstream of Gate 3.

Rodney Tang

August 15, 2001

Photo 7

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

VERY ROUGH CONCRETE IN COVE – GATE 3

Very Rough Concrete (VR) in cove area downstream of Gate 3.

Rodney Tang

August 15, 2001

Photo 8

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

ROUGH CONCRETE ON APRON -- GATE 4

Rough Concrete (R) is present to either side of the left longitudinal joint in Gate 4, near the downstream nose of Pier 3/4.

Rodney Tang

August 15, 2001

Photo 9

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

COBBLE DEPOSIT – GATE 4

Deposit of 3- to 6-inch diameter rounded cobbles and coarse, rounded gravel in cove area downstream of Gate 4.

Rodney Tang

August 15, 2001

Photo 10

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

RIPRAP – GATE 5

Widely Spaced (WS), Rounded to Subrounded (R/SR) blocks of hard basalt riprap downstream of Gate 5.

Rodney Tang

August 15, 2001

Photo 11

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

VERY SEVERELY UNDERCUT REBAR – GATE 5

Very Severely Undercut Rebar (VSU) on top of endsill downstream of Gate 5. Ruler shows 4 to 5 inches of undercutting which is extensive downstream of Gate 5. Top of endsill is covered by fine and coarse gravel.

Rodney Tang

August 15, 2001

Photo 12

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

JOINT INTERSECTION AND SMOOTH TO ROUGH APRON CONCRETE – GATE 6

Intersection of right longitudinal joint and transverse joint downstream of Gate 6. Concrete on apron is Smooth to Rough (S/R)

Rodney Tang

August 15, 2001

Photo 13

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

ROUGH TO VERY ROUGH CONCRETE IN COVE – GATE 7

Rough to Very Rough Concrete (R/VR) with 1- to 3-inch relief is present in the cove area at the right longitudinal joint (under diver's fingers) downstream of Gate 7.

Rodney Tang

August 15, 2001

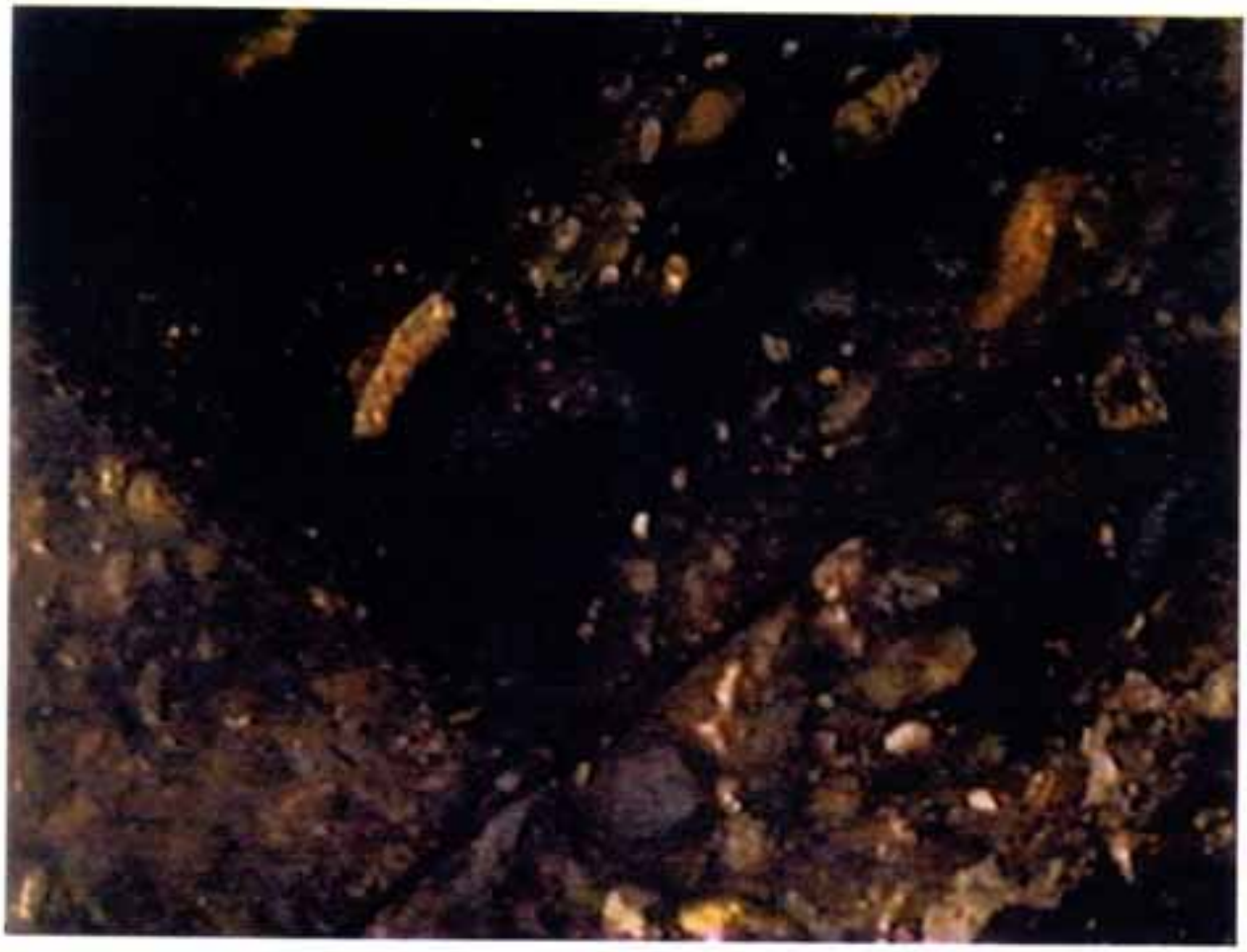


Photo 14

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

CHUTE BLOCK – GATE 7

Very Rough Concrete (VR) at base of a chute block downstream of Gate 7.

Rodney

August 15, 2001

Photo 15

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

CHUTE BLOCK – GATE 7

Exposed Rebar (EX) at base of a chute block downstream of Gate 7. A relief drain is visible at the upper left.

Rodney Tang

August 15, 2001

Photo 16

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

SEVERELY UNDERCUT REBAR – GATE 9

Severely Undercut Rebar (SU) and loose gravel and cobbles on top of endsill downstream of Gate 9.

Rodney Tang

August 15, 2001

Photo 17

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

VERY ROUGH CONCRETE – GATE 9

Very Rough Concrete (VR) on top of endsill downstream of Gate 9.

Randy Calvert

August 15, 2001

Photo 18

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

VERY ROUGH CONCRETE – GATE 10

Very Rough Concrete (VR) on top of endsill downstream of Gate 10. A relief drain is visible at the lower edge. The downstream face of the endsill and fine gravel deposited on the downstream side are visible at upper right

Randy

August 15, 2001

Photo 19

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

RIPRAP – GATE 10

Widely Spaced, Filled, Subrounded riprap (WS, F, SR) downstream of Gate 10. Riprap blocks are spaced about 5 feet. Spaces between riprap blocks are filled with fine and coarse gravel.

Randy

August 15, 2001

Photo 20

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

RIPRAP – GATE 11

Interlocked, Subrounded to Subangular (I, SR/SA) riprap downstream of Gate 11. Riprap blocks are in direct contact with the endsill (at photo right).

Randy Calvert

August 15, 2001

Photo 21

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

RIPRAP – GATE 11

Interlocked, Subrounded to Subangular (I, SR/SA) riprap downstream of Gate 11.

Randy Calvert

August 15, 2001

Photo 22

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

GRAVEL DEPOSIT AND CONCRETE ROUNDS -- GATE 11

Fine and coarse gravel deposited in cove area downstream of Gate 11. Concrete "rounds" came from 2-foot diameter holes drilled through the extreme right edge of the concrete apron to accommodate H-Piles as part of the pumping plant project in the 1980's.

Randy Calvert

August 15, 2001

Photo 23

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

DOWNSTREAM CHUTE BLOCKS – GATE 11

Exposed Rebar (EX) at the base of Chute Block 3 (downstream row of chute blocks) downstream of Gate 11. Rebar is angled at 45 degrees. Similar concrete erosion and exposed rebar is present at most downstream chute blocks in Gate 11.

Randy Calvert

August 15, 2001

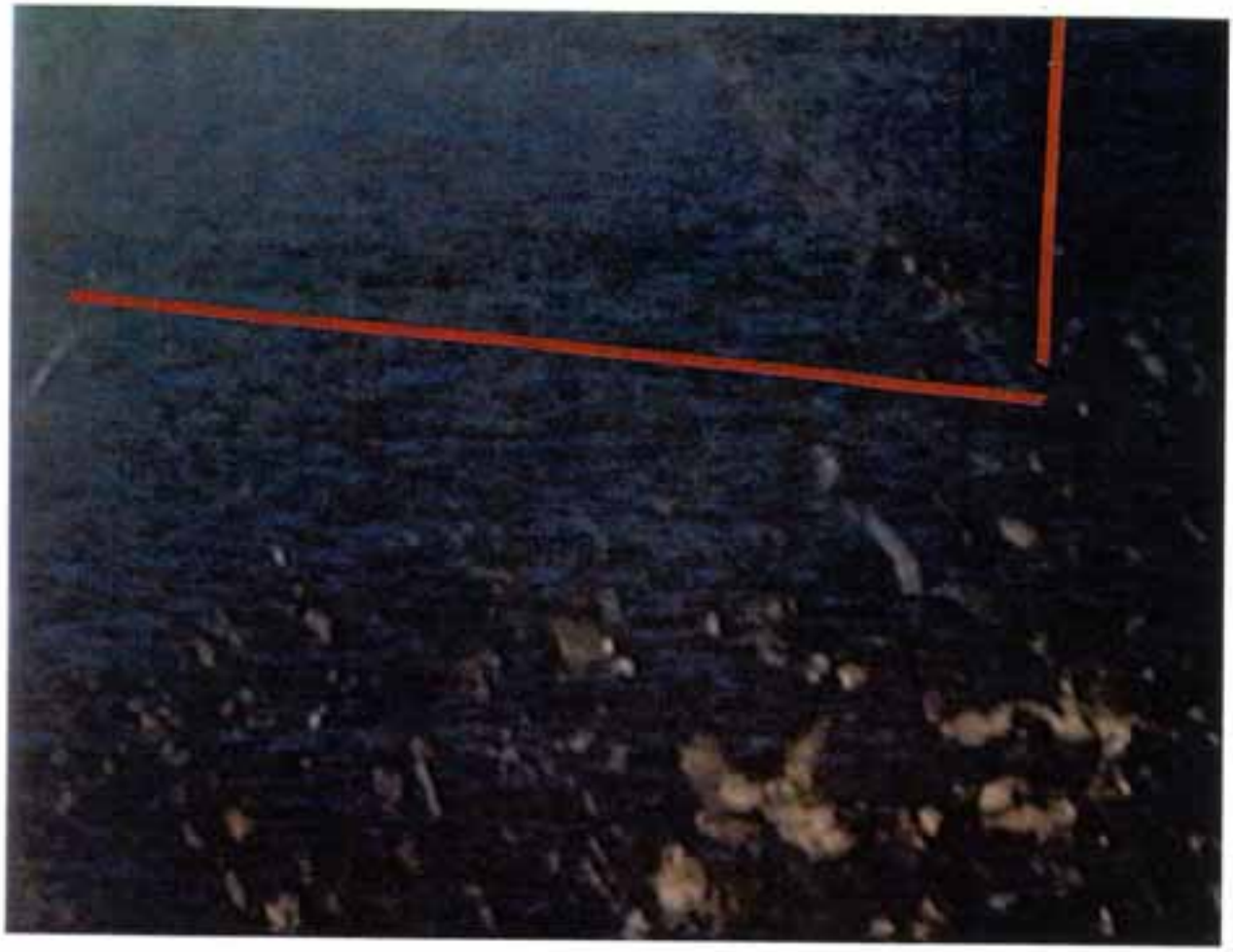


Photo 24

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

UPSTREAM CHUTE BLOCKS – GATE 11

Smooth, uneroded concrete (S) at base of Chute Block 3 (upstream row of chute blocks) downstream of Gate 11. The photo shows the downstream lower left corner of Chute Block 3 (outlined in red). All upstream chute blocks showed minimal to no erosion in Gate 11.

Randy Calvert

August 15, 2001

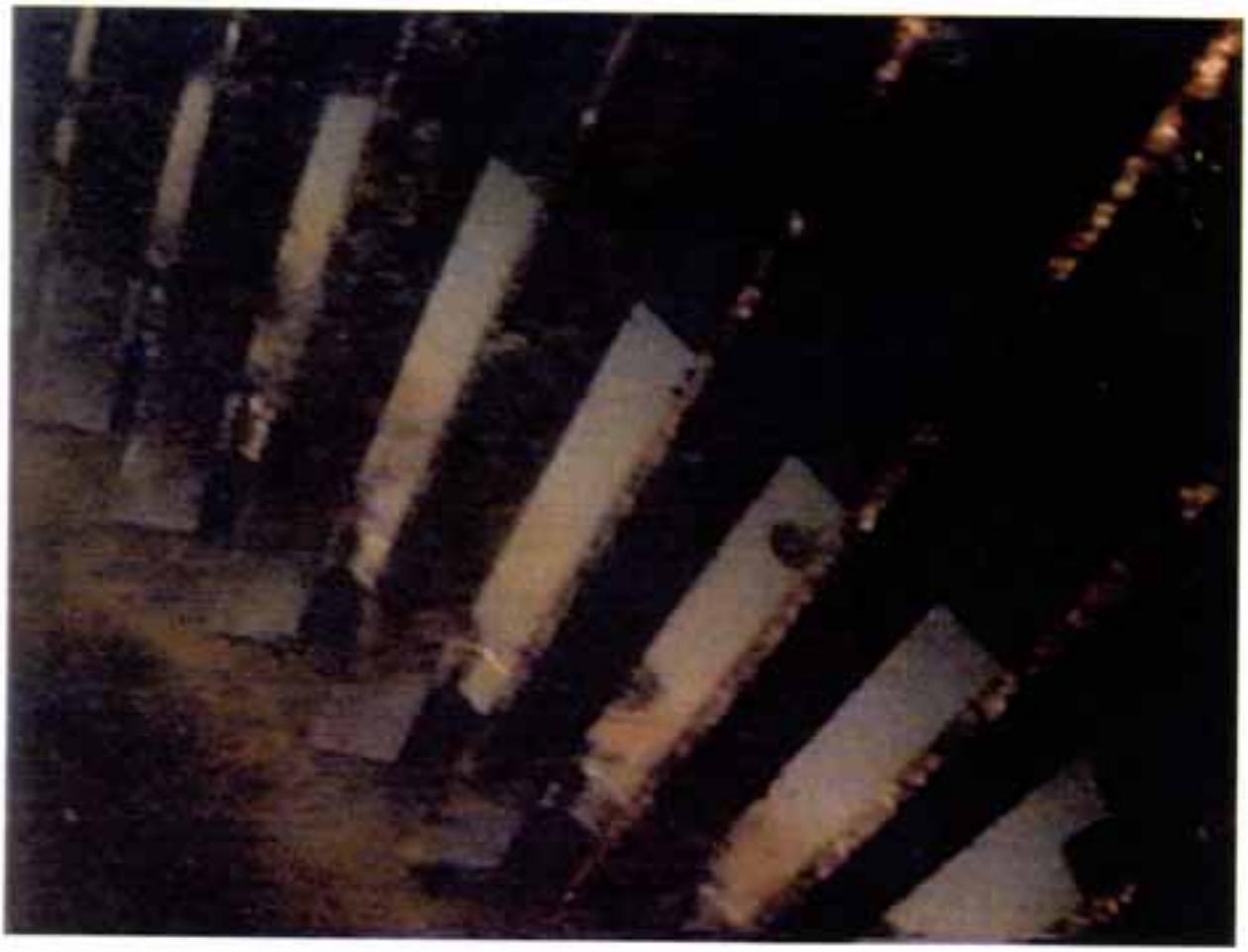


Photo 25

Fishway Attraction Study
Red Bluff Diversion Dam

PUMPING PLANT TRASHRACK STRUCTURE

Trashrack bars near the upstream end guide.

Randy Calvert

August 15, 2001

Photo 26

Fishway Attraction Study
Red Bluff Diversion Dam

PUMPING PLANT TRASHRACK STRUCTURE

2- to 3-foot thick mound of sand and fine gravel located a few feet inside of the trashracks.

Randy Calvert

August 15, 2001

Photo 27

Fishway Attraction Study
Red Bluff Diversion Dam

PUMPING PLANT TRASHRACK STRUCTURE -- BASE OF INTERIOR GUIDE 1

Sediment consisting of gravel and cobbles was approximately 1.5 feet below the top of the concrete base slab at the base of interior guide 1 (the first guide downstream of the upstream end guide).

Randy Calvert

August 15, 2001

NC-350
ENV-4.10/PRJ-8.10

JUN 2 1 2001

Rebecca Lent, Ph.D.
Regional Administrator,
National Marine Fisheries Service
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

Subject: Proposed Testing for Fishway Attraction Study at the Red Bluff Diversion Dam

Dear Dr, Lent:

The Red Bluff Diversion Dam (RBDD), located on the Sacramento River near the town of Red Bluff, California, was constructed to provide irrigation water for agricultural lands in Tehama and Colusa counties. Since its construction in the mid-1960's, the dam has impeded passage of anadromous salmonids to their upstream spawning habitat.

Existing fish passage facilities at the RBDD consist of two primary fish ladders located on the right and left abutments of the RBDD, and a temporary center ladder located in bay six of the dam. Past studies have revealed that salmon passage has been significantly blocked or delayed due to the inability of salmon to locate the ladder entrances. Previous efforts to modify gate operations of the RBDD within the Standing Operating Procedure, in an attempt to improve fish attraction to the ladders, have had limited success.

To improve fish attraction to the right and left abutment ladders, Reclamation is proposing to conduct tests which would alter gate operations at the dam. A week-long test, consisting of three different gate configurations, is proposed for August, 2001, (reference the *Proposed Test Plan for Red Bluff Diversion Dam Fishway Attraction Study,* copy enclosed).

The gate settings for each of the three proposed tests would result in spillway releases that create mid-river dominated flows. This would test he concept that concentrating flows through the three gates in the center of the dam, with minimal or no flows through the other gates, would force salmon to the sides of the dam where they would encounter attraction flows from the fish ladders. Once fish locate ladder entrances, they usually swim up the ladders.

ATTACHMENT 1

The proposed tests will differ from previous gate manipulation tests. They will violate the Standing Operating Procedure for spillway gate operation by exceeding a 1-foot difference between openings of adjacent gates 1 through 10. During each test, surface flow patterns and velocities will be mapped, and the stilling basin and river bed will be inspected by divers to assess potential erosion and deposition. Details are outlined in the enclosed study plan.

The tests involve releasing the greatest amount of flow through the center gates of the dam; therefore, early removal of the center fish ladder would be required. Reclamation proposes initiating removal of the center ladder on August 1, 2001 to allow testing to begin on August 13, 2001.

Data provided by the California Department of Fish and Game, Red Bluff Office, reveals that adult spring-run chinook salmon migrate past the RBDD prior to August 1; therefore, the spring-run chinook salmon would not be impacted by early removal of the center ladder. The two other listed species in the Sacramento River, winter-run Chinook salmon and steelhead, migrate past the dam earlier in the year, and would not be impacted by early removal of the center ladder.

The center ladder was installed at the RBDD in 1984, and has been in use since then for some, or all, of the gates-lowered time periods. The 1993 Biological Opinion for the Operation of the Federal Central Valley Project and the California State Water Project describes the RBDD as operating with the center ladder in place during the gates-lowered period.

Reclamation requests an amendment to the 1993 Biological Opinion to allow removal of the center ladder to begin on August 1, 2001, 6 weeks before the gates are raised. This would allow Reclamation to evaluate the effects of mid-river dominated flows on the physical features of the dam and the downstream environment. Testing would occur over a 1-week period, after which the selected gate configuration would be in place for the remainder of the gates-in period (i.e., through September 15). The right and left abutment ladders would continue to operate during the study.

From early August through September 15, a companion study would be conducted to evaluate the effectiveness of the altered spill configurations in an effort to attract salmonids to the left and right abutment ladders. A separate investigation plan will be prepared for that study.

Reclamation appreciates your consideration of this request for an amendment to the 1993 Biological Opinion. Please respond by July 16, 2001, so we can complete final plans before August 1, 2001.

If you have any questions, or need further clarification, please call me at (530) 529-3890; TDD: (530) 275-8991.

Sincerely,

Max J. Stodolski
Chief, Red Bluff Division

Enclosure

cc: Mr. Randy Benthin
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Redding, CA 96001

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California Department of Fish & Game
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Sacramento CA 95821

Mr. Steve Herbst
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Sacramento CA 95821

WBR:MStodolski:jel:06/18/2001:529-3890
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Proposed Test Plan for
Red Bluff Diversion Dam
Fishway Attraction Study

Background

Red Bluff Dam was constructed in the mid 1960's. The dam spans the Sacramento River with eleven 60-ft wide spillway gates. Plan and sections of Red Bluff Dam and stilling basin are presented in figure 1. Gates one through ten are not automated. These gates are changed in response to large changes in river flow. Downstream of gates one through ten is a Type Two hydraulic jump stilling basin with a sloping concrete apron and solid endsill. Gate 11 is automated and used for regulating the upstream watersurface for gravity diversion to the Tehama Colusa Canal. Downstream of gate 11 is a Type Three hydraulic jump stilling basin. The stilling basin has experienced significant abrasion damage over the past 40 years. Damage has occurred primarily near the basin chute blocks and endsill. The designer's operating criteria (DOC) for spillway gate operation was revised in 1970 to address the problem of concrete abrasion in the stilling basin. The criteria places two constraints on spillway operation. First, the DOC requires gate 11 (sluice gate) be operated at a minimum of 2,500 cfs prior to opening any of the other 10 spillway gates. This ensures hydraulic jump stability. Second, gate openings of adjacent gates 1 through 10 shall not exceed a 1.0 ft difference. These operating criteria ensure flow releases through the gates are sufficiently uniform to produce a stable hydraulic jump and reduce erosion and abrasion damage to the downstream apron.

Fishway attraction has been recognized as a problem at RedBluff Diversion Dam since about 1975. Previous work in this area includes a hydraulic model study of a concept for constructing enlarged ladders, (research report R-97-08) and a field study of the flow conditions at the entrance to the right bank ladder, (research report R-97-07). These studies show the fishway attraction flows are often masked by uniform spillway releases. Current spillway operating criteria limits lateral adjustment of flow releases that could improve attraction to the two abutment fishways.

Study Objective

The proposed study will investigate hydraulic conditions in the stilling basin and downstream river that result from non-uniform spillway gate operation. A field investigation will study the effect of center river dominated flow releases with respect to stability of the hydraulic jump, abrasion damage potential and erosion downstream of the endsill.

Test Plan

Proposed Test Conditions - Tests of three different gate operations are proposed for the field evaluation. Gate settings, gate discharge and estimated flow velocity at the stilling basin endsill for each test are given in table 1 and plotted in figure 2. The gate settings proposed for the field tests are designed to evaluate hydraulic performance of the stilling basin and fishway attraction for spillway releases that create mid-river dominated flows. Test 1 represents a sharply river

centered flow release assuming a minimum gate opening of 0.5 ft for all gates. The established 1 foot maximum difference in gate settings between adjacent gates is exceed for bays 4 through 8. Test 1 provides 63 percent of river flow releases through gates 5, 6 and 7 with 29 percent of the total river flow released through gate 6. Test 2 gate settings further concentrate flow releases toward the center of the river. Gate settings proposed for test 2 exceed the 1 ft maximum gate opening difference required between adjacent gates in bays 4 through 7. To increase mid-river centered flow, bays 1 and 10 will be closed. Test 2 provides 70 percent of river flow releases through gates 5, 6 and 7 with 30 percent of the total river flow released through gate 6. Test 3 has gates 1, 2, 9 and 10 closed. Test 3 provides 78 percent of river flow releases through gates 5, 6 and 7 with 32 percent of the total river flow released through gate 6. Gate settings proposed for bays 4,5 and 7,8 have a maximum difference between adjacent gates of 2.0 ft.

Flow surface mapping - After spillway gates are set for each test, a video record of the surface flow pattern will be recorded using three deck mounted video cameras. The video cameras will be solid mounted to achieve similar views for all tests.

Velocity Mapping - A boat mounted Acoustic Doppler Profiler will be used to map far field attraction velocities during each test. Flow velocities at multiple depths will be measured across the full river in an area lying between the pumping plant and the fishscreen bypass outfall.

Erosion and Deposition Inspection of the Stilling Basin and River Bed - During each test the location of gravel deposits within the stilling basin will be mapped by divers and boat mounted bottom survey equipment. A dive inspection is expected to provide the best indication of changes in material deposition or erosion near the basin chute blocks and endsill. The survey boat will be used to map bed elevation over a broad area of the basin apron and downstream river channel. The basin inspection will look for changes in deposition downstream of gates operated at small openings. The river bed survey will look for erosion downstream of gates operated at large openings. During stilling basin inspections river releases will have to be maintained. Therefore, the inspection will be conducted following protocol established during previous operation and maintenance inspections. Two to three adjacent gates will be closed while the downstream basin and river bed are inspected by divers and boat mounted fathometer. The sluiceway gate will be used to regulate river flow as gates are closed for the inspection. The area behind gates operated at small openings will be inspected first to minimize the potential for altering deposition patterns as a result of gate changes required for inspection. First, gates 1-3 will be closed for basin inspection. Second, gates 1-3 will be reopened and gates 8-10 closed for basin inspection. Third, Gates 8-10 will be reopened and gates 4-7 will be partially closed to permit boat access over the river bed downstream of these gates.

Test Plan Schedule

Aug. 1 through Aug. 11,

Remove the center ladder.

Aug. 13,

A.M. - Meet with divers,

P.M. - Conduct pretest dive and boat ADCP survey of stilling basin, setup cameras and GPS base station.

Aug. 14,

8 a.m. - Set gates for Test1 followed by far field boat survey of attraction velocity.

Aug. 15,

8 a.m. - Dive inspection of stilling basin and boat survey of downstream channel aggregation / degradation.

1p.m - Set gates for Test2 followed by far field boat survey of attraction velocity.

Aug. 16,

8 a.m. - Dive inspection of stilling basin and boat survey of downstream channel aggregation / degradation.

1p.m - Set gates for Test3 followed by far field boat survey of attraction velocity.

Aug. 17,

8 a.m. - Dive inspection of stilling basin and boat survey of downstream channel aggregation / degradation.

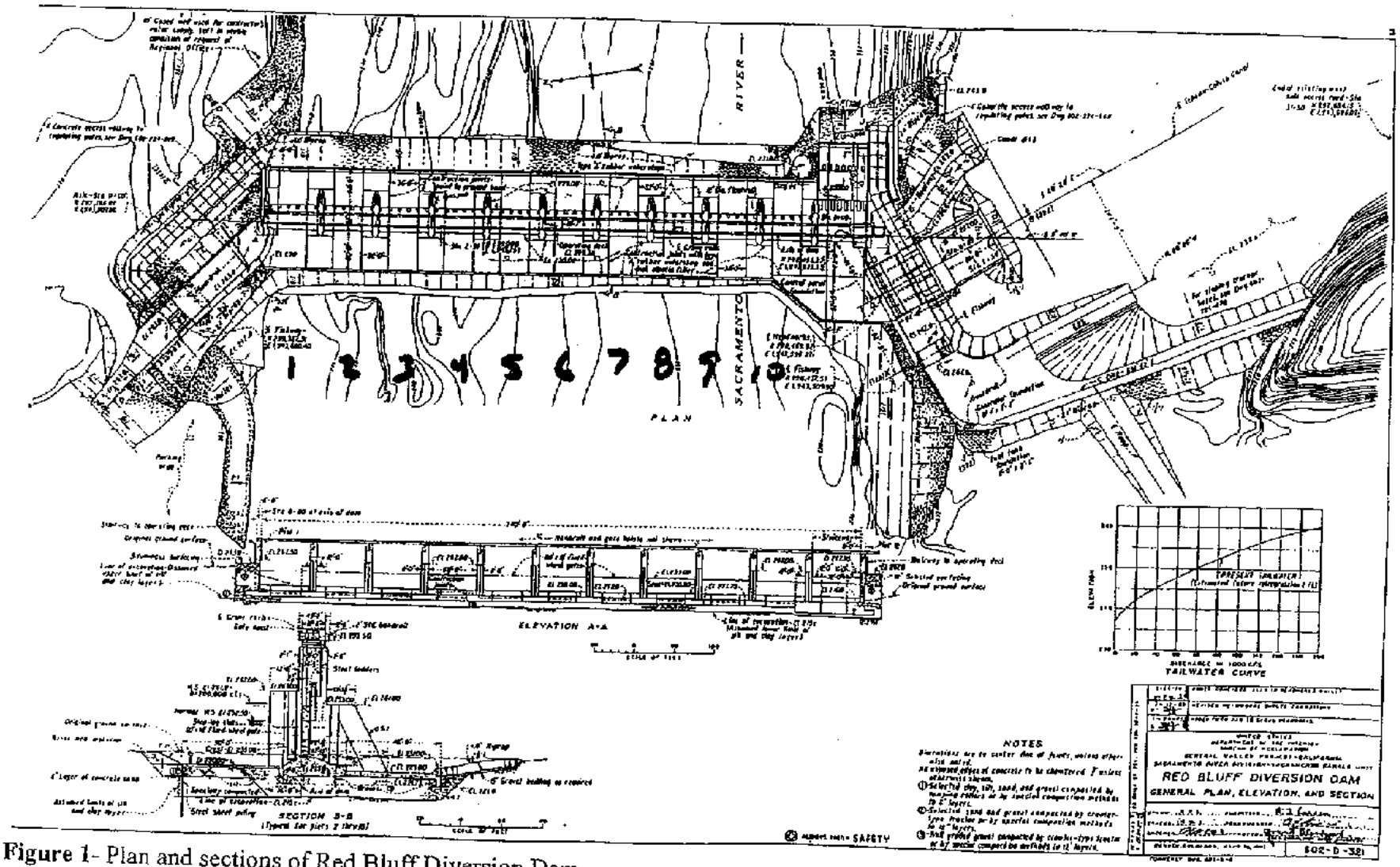
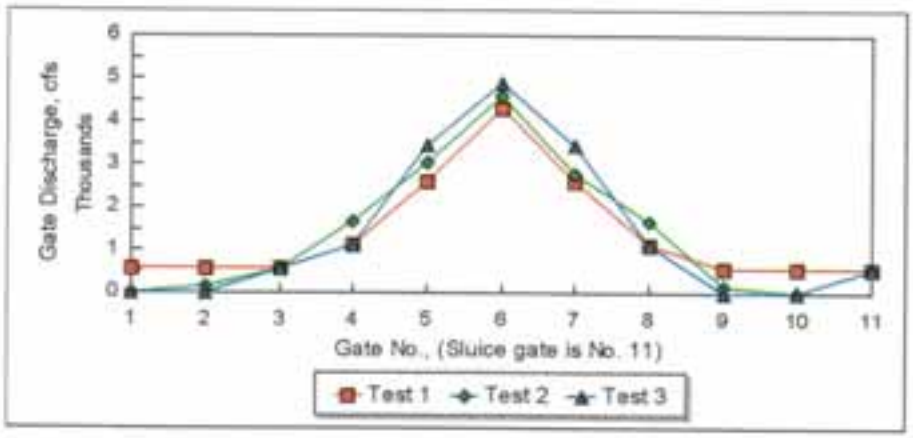


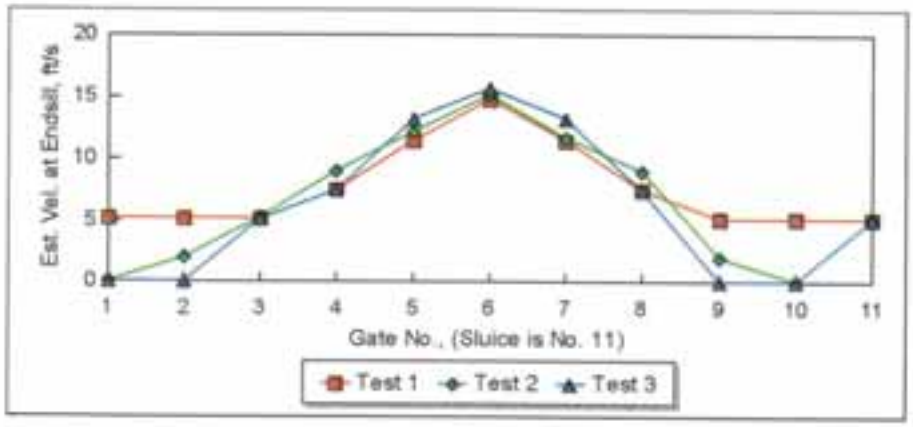
Figure 1- Plan and sections of Red Bluff Diversion Dam.

Table 1 - Proposed spillway gate relcases for Red Bluff Diversion Dam stilling basin testing.

River Flow =	15000.00	cfs
Reservoir elevation =	252.00	ft
Tailwater elevation =	241.20	ft
Sill Elevation =	235.00	ft

		Gate No.										Total Flow cfs
Test # 1	1	2	3	4	5	6	7	8	9	10	11	
											Sluice	
Opening, ft	0.50	0.50	0.50	1.00	2.25	3.75	2.25	1.00	0.50	0.50	0.50	
H1/b	34.00	34.00	34.00	17.00	7.56	4.53	7.56	17.00	34.00	34.00	34.00	
H2/b	12.40	12.40	12.40	6.20	2.76	1.65	2.76	6.20	12.40	12.40	12.40	
Cd	0.55	0.55	0.55	0.56	0.58	0.58	0.58	0.56	0.55	0.55	0.55	
S/b	24.00	11.00	10.00	5.00	1.00	1.00	1.00	5.00	10.00	11.00	11.00	
Q/gate	545.95	545.95	545.95	1111.75	2590.77	4317.95	2590.77	1111.75	545.95	545.95	545.95	14998.68
Hd	5.00	11.50	12.00	12.00	14.75	13.25	14.75	12.00	12.00	11.50	11.50	
Vel. gate	26.00	26.00	26.00	26.47	27.42	27.42	27.42	26.47	26.00	26.00	26.00	
Endsill vel	5.08	5.08	5.08	7.32	11.37	14.68	11.37	7.32	5.08	5.08	5.08	
Test # 2	1	2	3	4	5	6	7	8	9	10	11	
											Sluice	
Opening, ft	0.00	0.25	0.50	1.50	2.75	4.00	2.50	1.50	0.25	0.00	0.50	
H1/b	0.00	68.00	34.00	11.33	6.18	4.25	6.80	11.33	68.00	0.00	34.00	
H2/b	0.00	24.80	12.40	4.13	2.25	1.55	2.48	4.13	24.80	0.00	12.40	
Cd	0.00	0.30	0.56	0.56	0.56	0.58	0.56	0.56	0.30	0.00	0.55	
S/b	0.00	11.00	7.00	7.00	7.00	5.00	1.00	1.00	1.00	0.00	5.00	
Q/gate	0.00	148.89	555.87	1667.62	3057.31	4605.82	2779.37	1667.62	148.89	0.00	545.95	15177.36
Hd	0.00	14.25	13.50	6.50	-2.25	-3.00	14.50	15.50	16.75	0.00	14.50	
Vel. gate	0.00	14.18	26.47	26.47	26.47	27.42	26.47	26.47	14.18	0.00	26.00	
Endsill vel	0.00	1.96	5.18	8.96	12.14	15.16	11.57	8.96	1.96	0.00	5.08	
Test # 3	1	2	3	4	5	6	7	8	9	10	11	
											Sluice	
Opening, ft	0.00	0.00	0.50	1.00	3.00	4.25	3.00	1.00	0.00	0.00	0.50	
H1/b	0.00	0.00	34.00	17.00	5.67	4.00	5.67	17.00	0.00	0.00	34.00	
H2/b	0.00	0.00	12.40	6.20	2.07	1.46	2.07	6.20	0.00	0.00	12.40	
Cd	0.00	0.00	0.55	0.56	0.58	0.58	0.58	0.56	0.00	0.00	0.55	
S/b	0.00	0.00	7.00	7.00	7.00	5.00	1.00	1.00	0.00	0.00	5.00	
Q/gate	0.00	0.00	545.95	1111.75	3454.36	4893.68	3454.36	1111.75	0.00	0.00	545.95	15117.80
Hd	0.00	0.00	13.50	10.00	-4.00	-4.25	14.00	16.00	0.00	0.00	14.50	





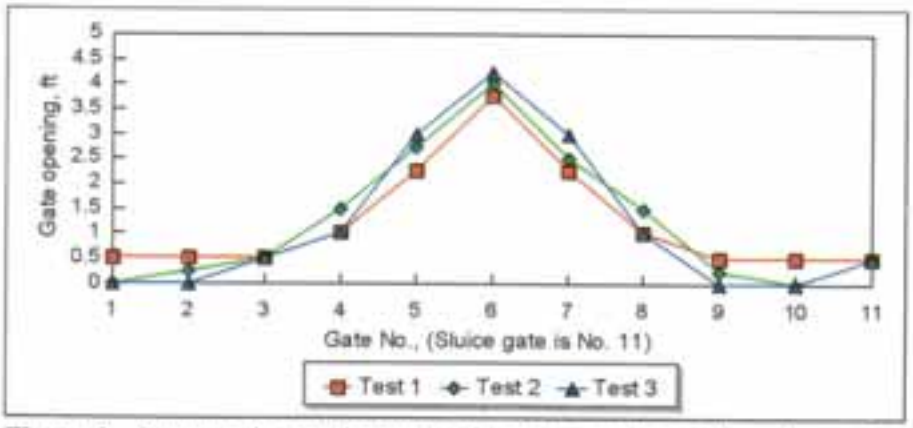


Figure 2 - Proposed tests for evaluating river centered flow through the Red Bluff spillway gates.

LC-4850
PRJ-12.00

MEMORANDUM

To: Chairman, Regional Diving Advisory Committee

From: Joel F. Sturm, Diver, Mid-Pacific Regional Office

Through: Rodney L. Tang, Divemaster

Through: Gregory Finnegan, Lower Colorado Region Dive Team Leader

Subject: Request for Services of the Lower Colorado Regional Underwater Investigation Team (Diving Team).

Note: A minimum of three divers for SCUBA dives and four divers for surface supplied air dives are required and approval of a diving request is subject to availability of divers as determined by their supervisors.

Date(s) of requested diving: August 13 through 17, 2001

Alternate date (s) requested: N/A

Deadline of requested diving: N/A

Is request of an emergency nature: No

Location(s) - list all - of requested diving: Red Bluff Diversion Dam, California

General diving conditions and any known hazards: All diving will be downstream of the dam, primarily on the downstream apron. Divers will stay downstream of a group of at least three adjacent, closed gates when submerged. Visibility is good (15 to over 20 feet). Some current will be present during the diving.

Purpose of dive: Describe and document the gradation and distribution of bottom sediment (gravel and cobbles) prior to and following each of three 24hr tests at specified different gate settings

Expertise required: Experience with Surface Supplied Air (SSA) and SCUBA diving. Operation of underwater still and video cameras. Boat operations.

Special equipment required: SSA and SCUBA diving equipment, underwater video and still cameras.

Cost authority number: A30-0725-6342-001-91-0-0-2

Will there be a series of multiple dives required for the same purpose or period reoccurring dives for minor maintenance or inspections? No

If so, estimate the number and time period of occurrence. N/A

Are other agencies involved? No If so, list them: N\A

Do they intend to participate in the diving? No

Are their divers certified by a nationally recognized agency? N\A

If so, name agency and certification level: N\A

Are they willing to participate under the restraints of the Bureau of Reclamation Diving Regulations? N\A

A dive plan must be completed and approved prior to providing services. Requesting office should provide assistance, as necessary.

Where a multiple dive request is approved by the Regional Diving Advisory Committee, each diving event must be further approved by the Regional Supervisor, Division of Water, Land, and Power.

Please contact Messrs. Greg Finnegan, at extension 702-293-8672 or Bill Rinne, at extension 8414, if there are any questions.

NOTE: ALL EMERGENCY NUMBERS WERE CONFIRMED ON JULY 26, 2001

Signed: _____ Date: _____
(Dive Team Leader)

ADDITIONAL REMARKS:

Approved: _____ _____ _____
Name Title Date

Approved: _____ _____ _____
Name Title Date

Approved: _____ _____ _____
Name Title Date

Approved: _____ _____ _____
Name Title Date

Approved: _____ _____ _____
Name Title Date

Approved: _____ _____ _____
Name Title Date

DIVE HAZARD ANALYSIS

ITEM	REMARKS
PREVIOUS DIVING IN AREA	Yes
ACCESS AND EXIT	Support boat equipped with swing-down dive ladder
DEPTH ACTUAL	25 feet
ALTITUDE	NWS: EL. 252.5
DEPTH CORRECTED	N\A
NON DECOMP LIMIT	310 min @ 30 feet
MAX BOTTOM TIME	2 hrs
BOTTOM CONDITION	Concrete variably covered by sand, gravel and cobbles.
ENTANGLEMENT	Downlines, monofilament fishing line and wood and brush debris. All divers carry knives.
BOAT TRAFFIC	One other Reclamation boat will be operating near the diving area. Divers will enter and exit the water from the dive support boat.
VERTICAL ASCENT	Yes
LIGHTS REQUIRED	No
TETHER LINE RECOMMENDED	Yes. Divers will be using SSA which includes a divers umbilical (air line, communications cable, pneumofathometer and strength member).
SURFACE SUPPORT	Yes. The diver's air, bottom time and depth will be monitored by the surface support crew. Diver to surface communication will be maintained throughout each dive.
EMERGENCY AID AT SITE OXYGEN BREATHER FIRST AID SUPPLIES AIR DECOMP TABLES	Yes
HOSPITAL	Mercy Medical Center, Redding, CA (530) 246-5400 St. Elizabeth Hospital, Red Bluff, CA ER: (530) 529-8300
PHYSICIAN	Dr. Fred Grabiel, Director ER: (530) 225-7247
RECOMP. CHAMBER	Hyperbaric Facility, Travis Air Force Base 101 Bodi Fairfield, CA (Air Base Pkwy South) (707) 423-3987
GROUND AMBULANCE	911 Ground Ambulance, Tehama Cty CDF, Red Bluff, CA
AIR AMBULANCE	(530) 225-6294 (Mercy Med Center, Redding, CA)
TELEPHONE	On site
RADIO	Yes. Boat to shore and boat to boat radio communication will be available.
LOCAL CONTACT	Max Stodolski, Chief, Red Bluff Division, USBR: (530) 529-3890

ITEM	REMARKS
Divers Alert Network (DAN)	**24hr Diving Emergency Hotline: (919) 684-8111** First Aid & Chamber Information
ALL DIVE PERSONNEL TRAINED IN DIVER FIRST AID, CPR, LIVE SUPPORT AND LIFE SAVING:	Yes

Signed: _____ Date: _____

(Dive Team Leader)

DIVE PLAN AND POST DIVE DATA

TEAM ASSIGNMENT BUDDY SYSTEM:

TEAM	NAMES	POST DIVE DATA (TRAVEL(date,time); TIMESHEET)
No. 1	Tang/divemaster /diver	
No. 2	Calvert/diver	
No. 3	Dewey/diver	
No. 4	Sturm/diver	
No. 5	Clune/diver	

Notes:
1) Divers will make solo dives using SSA. A 3-person surface support crew (standby diver, tender and timekeeper/air manifold operator) will be provided for each dive.
2) All divers will be traveling via GOV. No flying is required. No high altitude passes are present on the route of travel.

TEAM WORK ASSIGNMENT:

TEAM	ASSIGNMENT	POST DIVE DATA (ACTUAL WORK)
NO. 1		
NO. 2		
NO. 3		
No. 4		
No. 5		

TEAM EXPERIENCE FOR WORK ASSIGNMENT AND DIVE CONDITIONS:

TEAM	EXPERIENCE/PROF	POST DIVE DATA (ACTUAL NOTABLE CONDITIONS)
No. 1	All divers are experienced in the use of SSA and SCUBA. Sturm and Tang are certified ADC SSA Diving Supervisors.	
No. 2		
No. 3		
No. 4		
No. 5		

ADC: Association of Diving Contractors

TEAM	DEPTH/TIME 1	DEPTH/TIME 2
No. 1		
No. 2		
No. 3		
No. 4		
No. 5		

WEATHER: Clear, hot WATER CONDITION: Calm ICE: No	AIR TEMP.: 90-100 deg WATER TEMP.: 70 deg VISIBILITY WATER: 15-20'	WINDS: Light CURRENTS: Yes

RECOMMENDATIONS AND CONCLUSIONS: All divers have the required diving experience. The divers are familiar with the dive site, equipment and diving operations. All divers have obtained permission from their supervisors to participate in this diving activity. Divers Tang and Dewey are certified boat operator/trainers with experience operating small power boats in rivers and lakes. The requested diving is recommended.

Divers Review and Initial:

Signed: _____ Date: _____
(Dive Team Leader)

July 28, 2001
(Rev August 8, 2001)

To: Red Bluff Diversion Dam Dive Team Files

From: Joel F. Sturm, Supervisory Geologist/Diver, MP-221

Subject: **GATE AND DIVING OPERATIONS AND LOCK OUT/TAG OUT PROCEDURES** – Fishway Attraction Study, August 13 through 17, 2001 -- Red Bluff Diversion Dam, California

GENERAL INFORMATION

Red Bluff Diversion Dam is a 740-foot long, 67-foot high concrete gated weir that consists of 10, 60-foot wide fixed wheel gates (Gates 1 through 10 from left to right) and a 60-foot wide sluice gate adjacent to the right abutment (Gate 11). Each gate has a capacity of about 1200 cfs per foot of vertical gate opening. Total flow in the Sacramento River during the week of August 13 through 17 is anticipated to be about 12,000 to 14,000 cfs. NWS upstream of the dam is El. 252.5.

DIVING EQUIPMENT AND PROCEDURES

All diving will be staged from a 18-foot aluminum work boat equipped with a 150 hp outboard motor. All dives are currently planned as solo dives with Surface Supplied Air (SSA) diving equipment (Superlight 17 helmet, air hose, two-way communications system, pneumofathometer (depth gauge) and helmet-mounted submersible color video camera). As an alternative to SSA, SCUBA-equipped diver buddy pairs and a surface standby diver may be employed. Divers will observe, describe and photograph/videograph bottom sediment distribution, riprap condition and concrete erosion. Divers will establish their locations by following either construction joints in the downstream concrete apron (if visible) or a weighted , 100-foot-long line marked at 10 foot intervals. Diver movement will also be tracked by watching the divers' bubbles at the surface. A surface support team consisting of a tender, standby diver and air manifold operator/timekeeper and the divemaster will be present in the dive boat whenever a diver is in the water. Continuous communications will be maintained with the diver throughout each dive.

TERMINATION OF DIVING OPERATIONS

Diving can be terminated at any time by the divemaster or diver. Possible reasons for terminating the dive are:

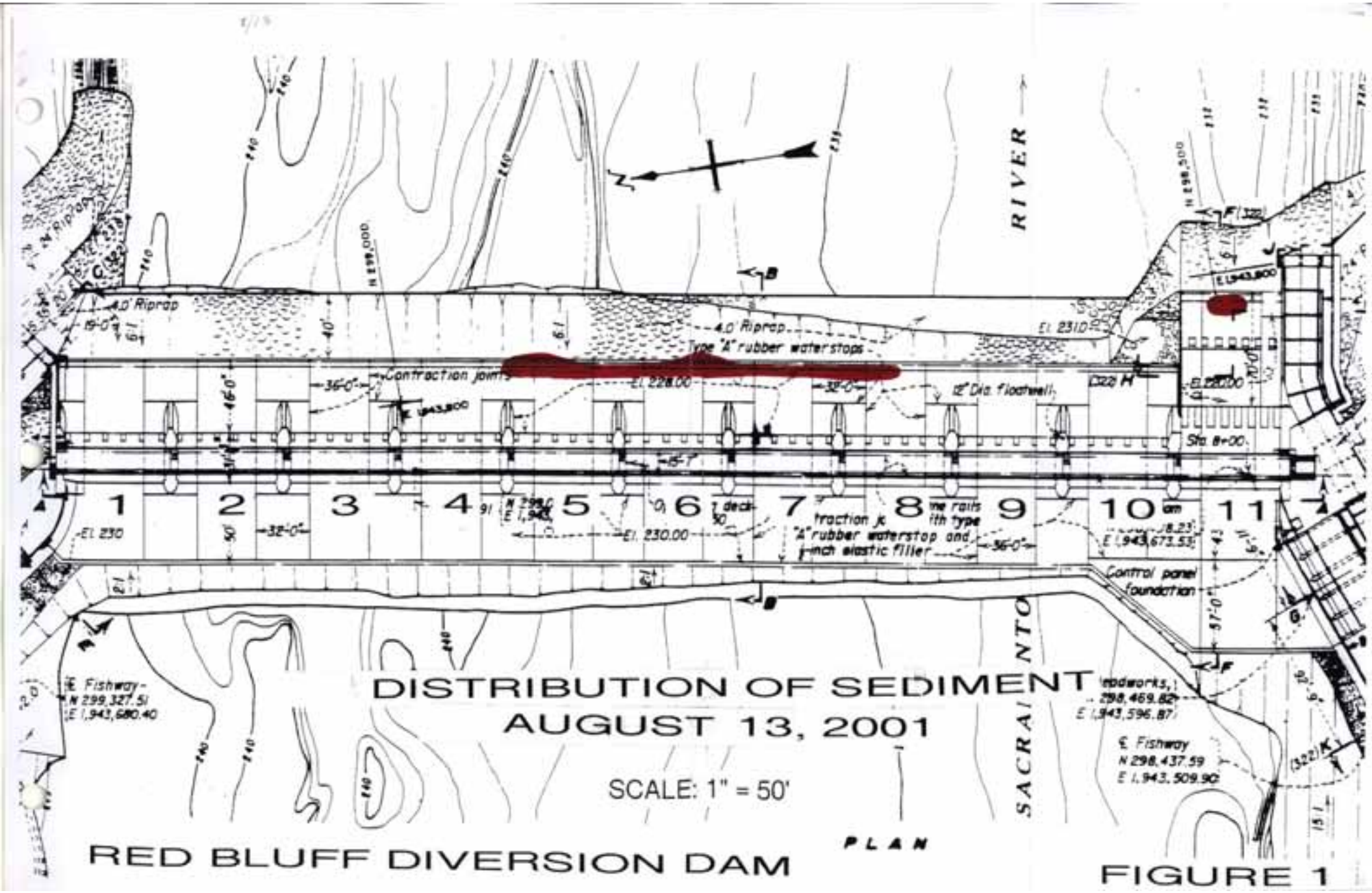
- an unexpected increase in current velocity or direction
- the need to open a gate
- diver fatigue or extreme cold

GATE AND DIVING OPERATIONS

1) Depending on flow conditions, all flow will be routed through either four or five open gates

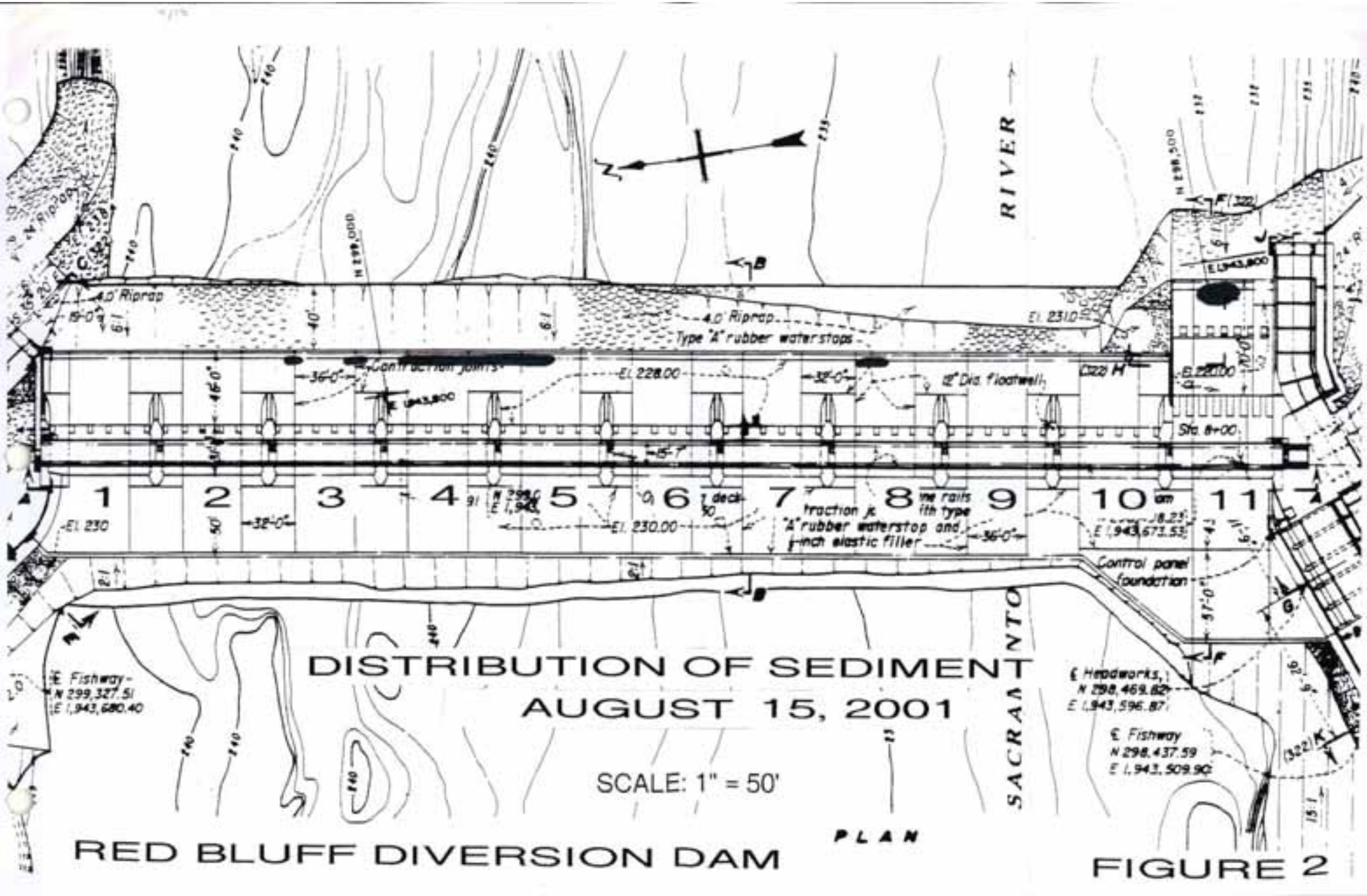
while the remaining six or seven gates will be closed (Example: Gates 1- 4 open, Gates 5-11 closed).
2) The lock out/tag out procedure described below will be put into effect.
3) The dive boat will be anchored near the mid-point of the closed gates (centerline of Gate 8 in the above example).
4) The diver will enter the water and conduct an underwater inspection of the apron, riprap and bottom sediment downstream of the closed gates (Gates 5-11).
5) The diver will exit the water into the dive boat and the divemaster will communicate this to the gate operator via radio who will temporarily remove the gate clearance while the gates are repositioned.
6) Gates 8-11 will be opened and Gates 1-7 closed.
7) The lock out/tag out procedure described below will be put into effect.
8) The dive boat will be anchored at the centerline of Gate 4.
9) The diver will enter the water and conduct an underwater inspection of the apron, riprap and bottom sediment downstream of closed Gates 1-7.
10) The diver will exit the water into the dive boat, the divemaster will communicate that diving operations have been completed and that the diver is in the dive boat to the gate operator via radio and the gate clearance will be removed.

LOCK OUT/TAG OUT PROCEDURES
1) Gates will positioned as described above by the designated Red Bluff Division employee (referred to here as the gate operator).
2) The gate hoists will be de-energized (i.e. electric power to all gates will be disconnected rendering raising of the gates impossible).
3) The electrical breakers will be red-tagged for non-operation with the clearance held by the gate operator.
4) The gate operator will communicate this to the divemaster in the dive boat who will then initiate diving operations.
5) Gate hoists will be de-energized and on clearance whenever a diver is in the water.



RED BLUFF DIVERSION DAM

FIGURE 1



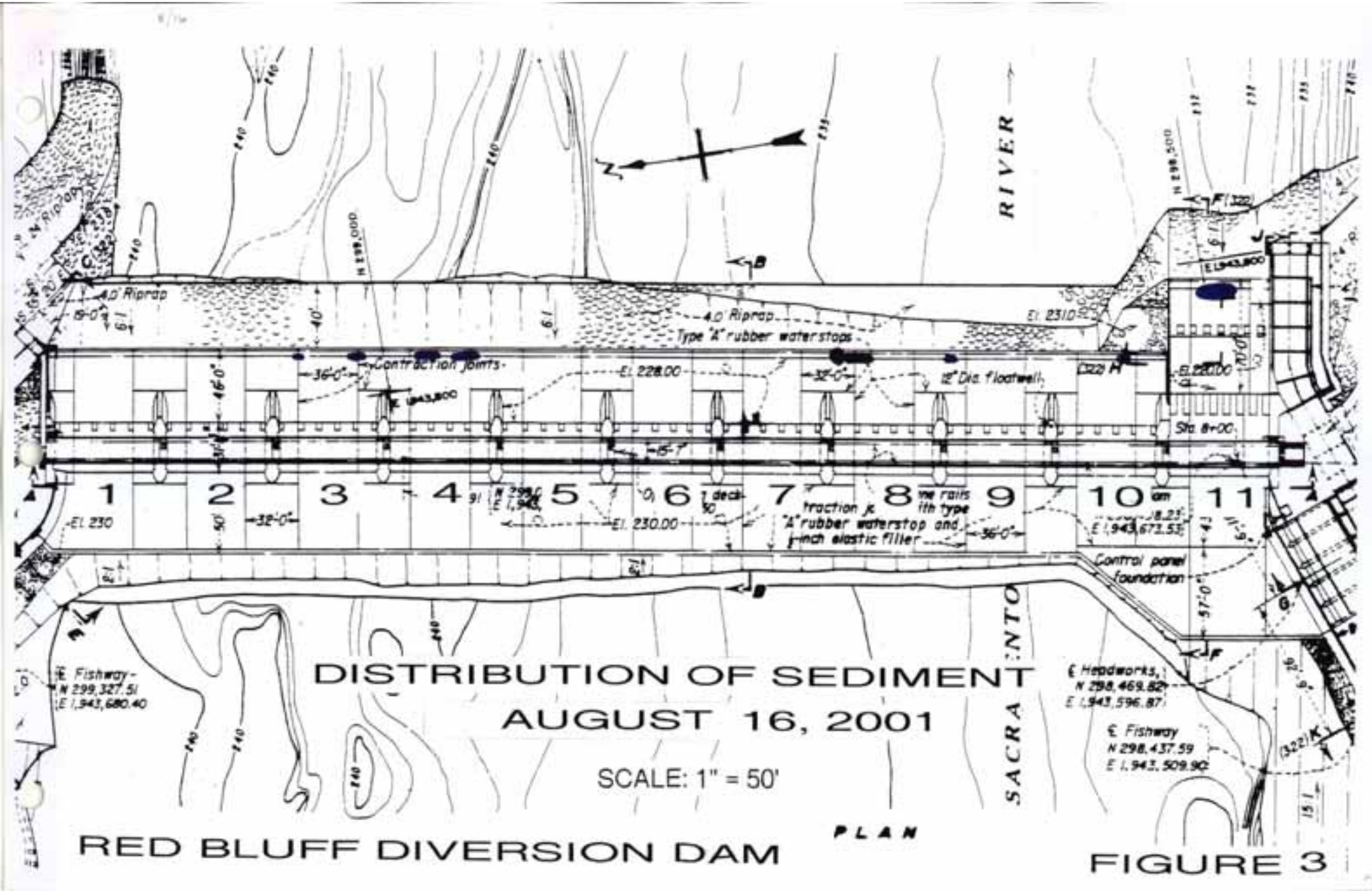
DISTRIBUTION OF SEDIMENT
AUGUST 15, 2001

SCALE: 1" = 50'

PLAN

RED BLUFF DIVERSION DAM

FIGURE 2



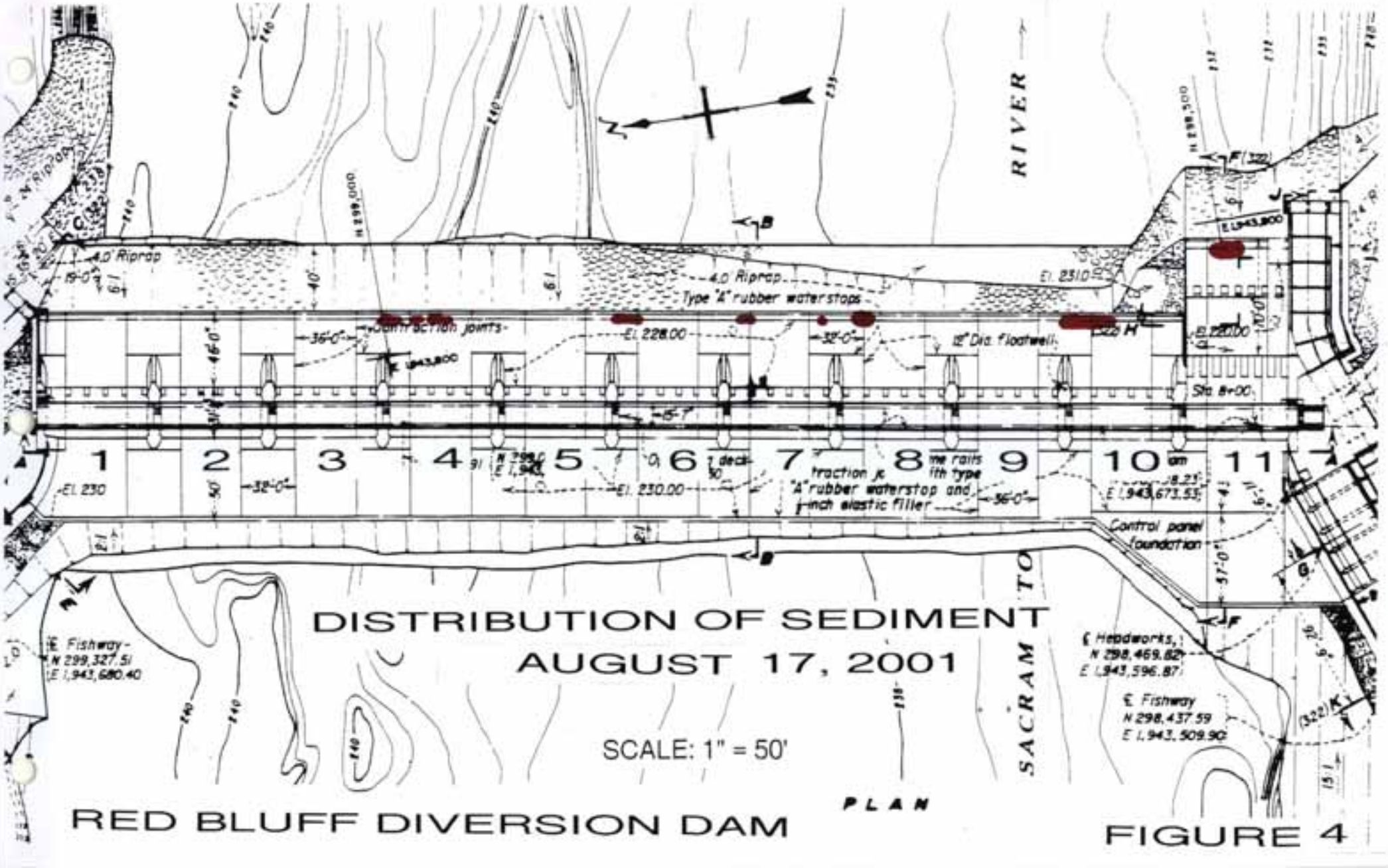
DISTRIBUTION OF SEDIMENT
AUGUST 16, 2001

SCALE: 1" = 50'

PLAN

RED BLUFF DIVERSION DAM

FIGURE 3



DISTRIBUTION OF SEDIMENT
AUGUST 17, 2001

SCALE: 1" = 50'

RED BLUFF DIVERSION DAM

FIGURE 4

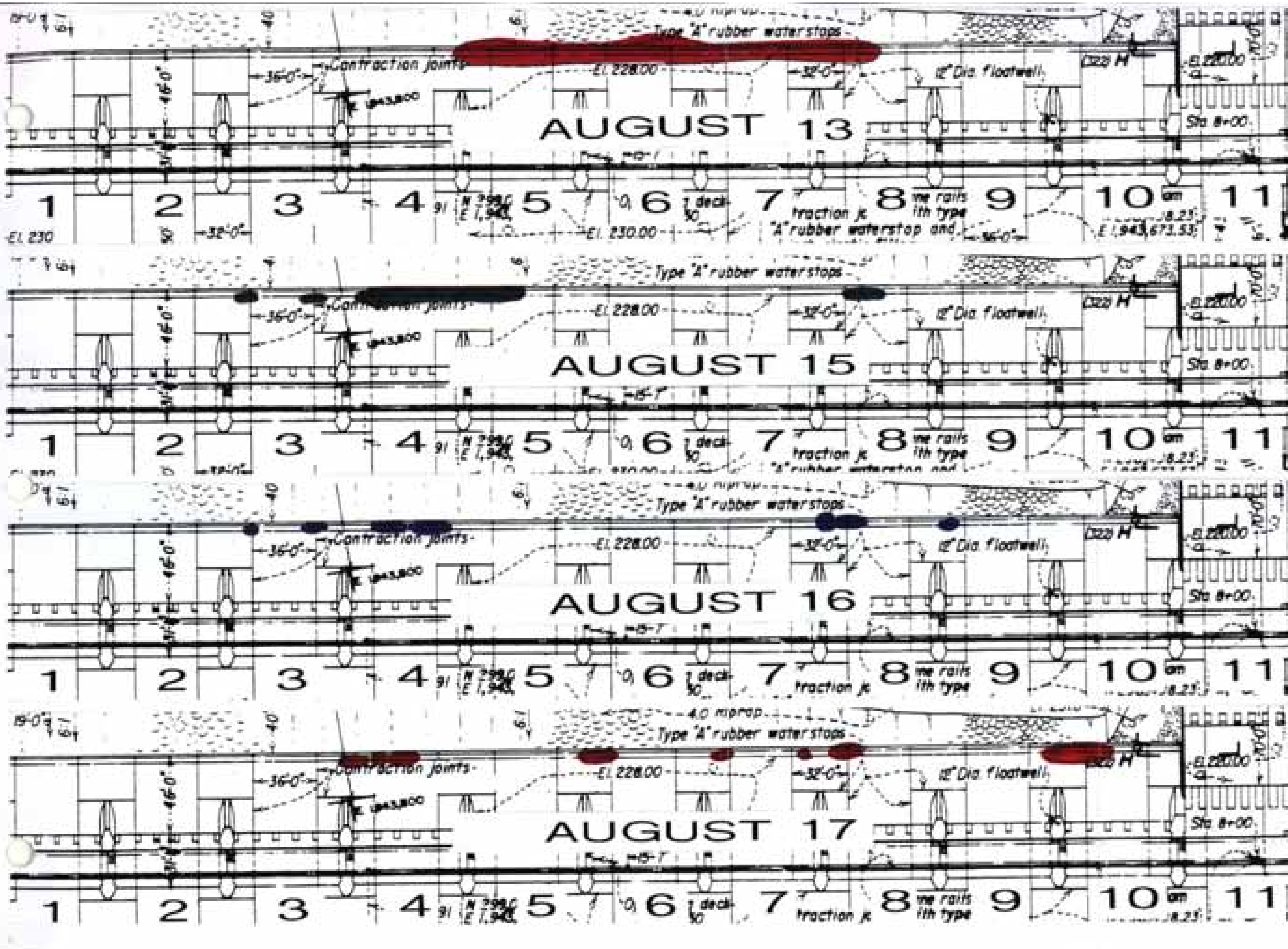
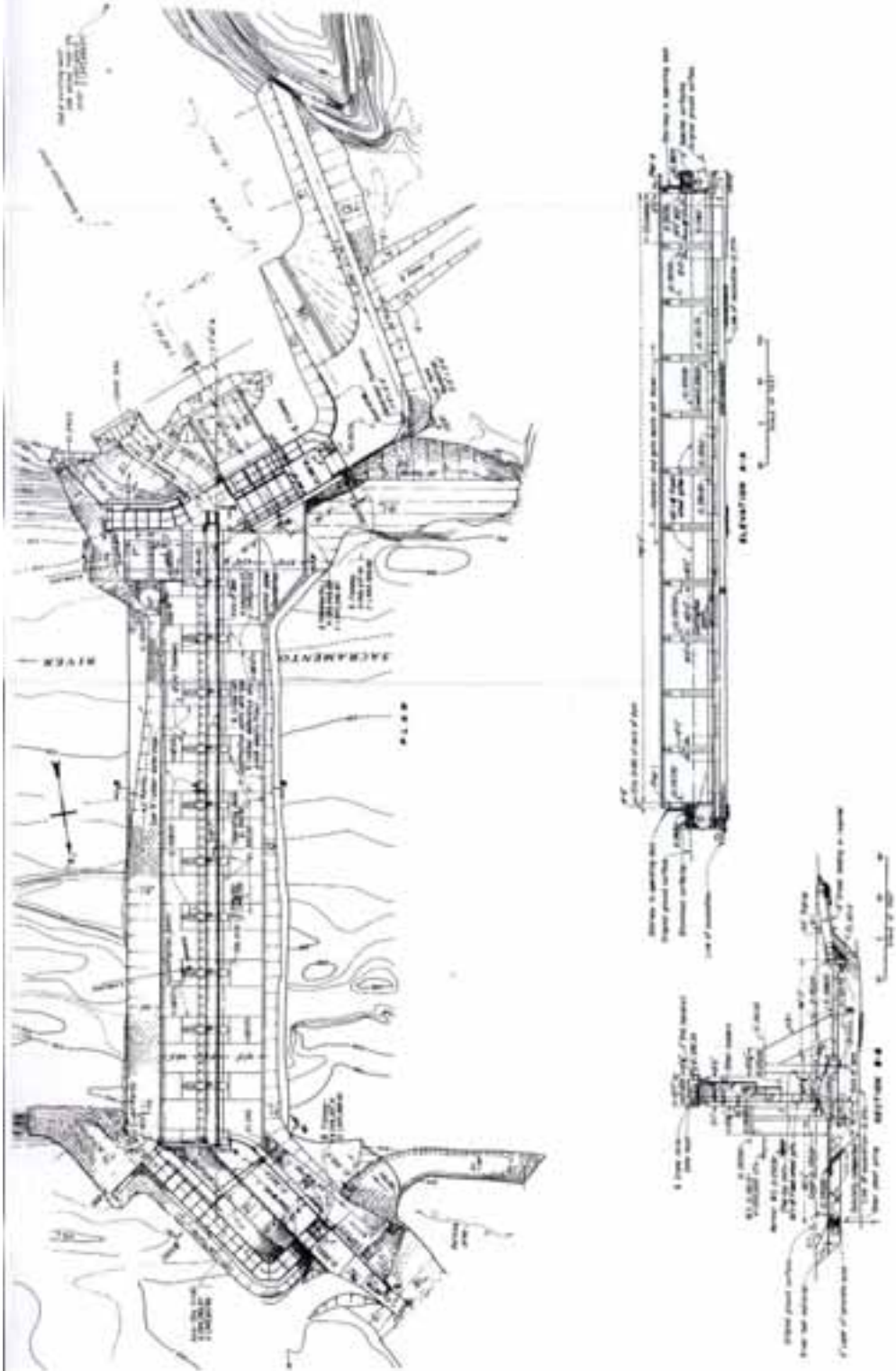
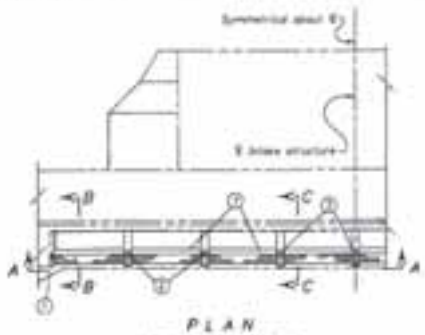


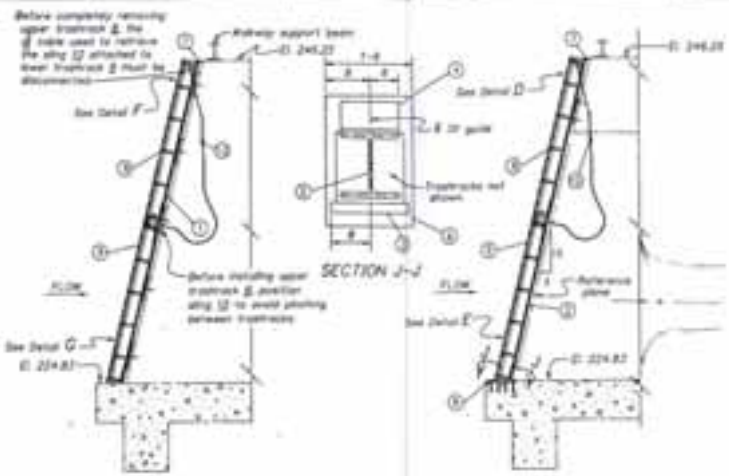
FIGURE 5
RED BLUFF DIVERSION DAM
DISTRIBUTION OF SEDIMENT
AUGUST 13–17, 2001



Red Bluff Diversion Dam, Plan and Sections

602-D-4031

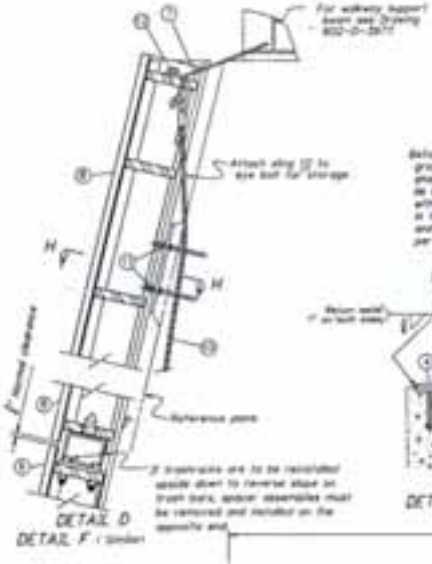


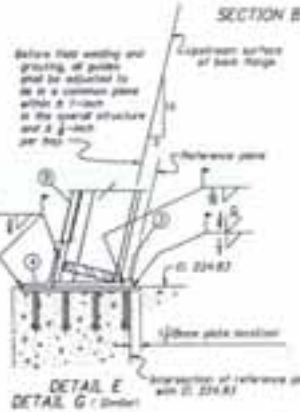


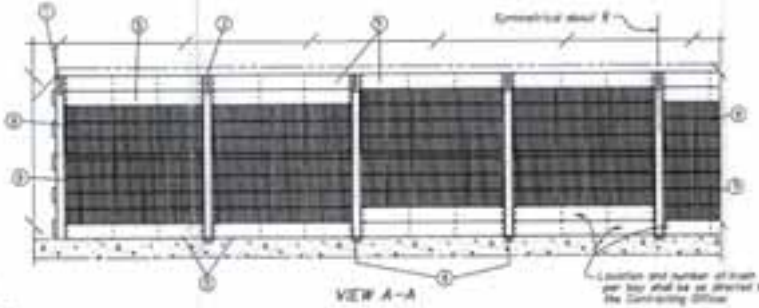
LIST OF PARTS

PART NO.	DRAWING NUMBER	NO. REQ'D	DESCRIPTION	MATERIAL*
1	602-D-4032	2	End guide	Structural steel
2	-	7	Intermediate guide	
3	-	1	Bar	
4	-	1	Angle	
5	-	24	Trash cover	Steel
6	-	1	Base plate	Structural steel
7	-	8	Trash plate	Steel
8	602-D-4033	8	Upper trashrack	Structural steel
9	-	8	Lower trashrack	
10	-	8	Sling	Steel
11	See Detail	48	5/8in. capsule anchor	Stainless Steel
12	-	72	1"(UNC)-2A x 7' rod for cap screw	

* See detail of part for material specification.
† See Notes.
Estimated weight ..... 185,000 lbs.







NOTES

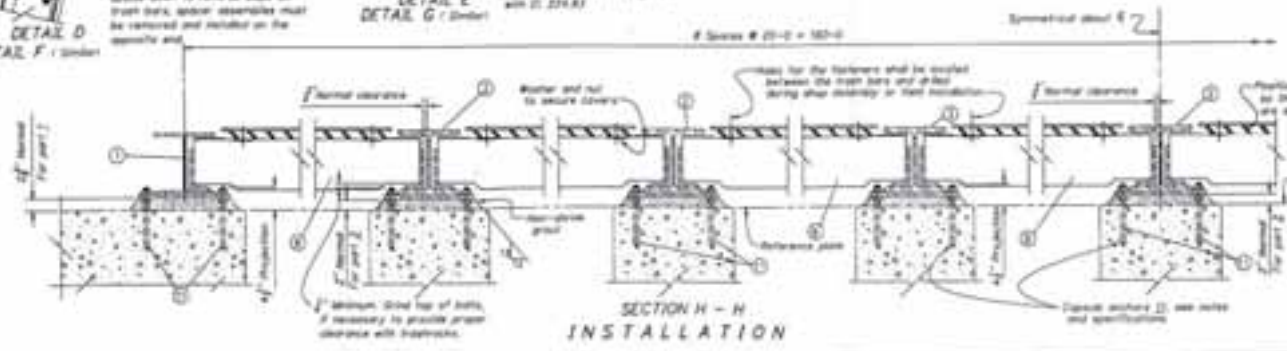
Capsule anchor shall be Molly Parabolt Capsule anchor as manufactured by Ehrlich, Molly Threaded Fastener Division, 304 est. Laurel Ave., Temple PA, 19560, or equal. Provide a stud assembly for each anchor consisting of a threaded 5/8 rod, two bronze hex nuts, and two 2½ plain washers. The threaded rod shall have a double chamfered point and be of sufficient length for projection shown on the drawing plus the manufacturer's recommended embedment depth.
Repair all paint damage due to field welding.

LIST OF DRAWINGS

DRAWINGS
INSTALLATION - ASSEMBLY - LIST OF PARTS 602-D-4031
GUIDES - BASE PLATE - DETAILS 602-D-4032
UPPER AND LOWER TRASHRACKS - SLING 602-D-4033

REFERENCE DRAWINGS

PUMP GENERATION PROJECT
INTAKE STRUCTURE
PLAN, SECTIONS AND DETAILS 602-D-3967
MISCELLANEOUS METAL WORK
INTAKE STRUCTURE WALKWAY 602-D-3977



ALWAYS THINK SAFETY

RED BLUFF DIVERSION DAM
PUMP GENERATION PROJECT
INTAKE STRUCTURE
TRASHRACKS
INSTALLATION - ASSEMBLY - LIST OF PARTS

602-D-4031

Appendix K
Underwater Inspection of Red Bluff Diversion Dam Fishway Attraction Study
August 13 through 17, 2001

Red Bluff Diversion Dam
Fishway Attraction Study

Spillway Operation Test

Red Bluff Diversion Dam
Fishway Attraction Study

Spillway Operation Test

Conducted for
Red Bluff Field Office

by

Brent Mefford
Tracy Vermeyen
Joe Kubitschek
Joel Sturm

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Background

Red Bluff Diversion Dam was constructed in the mid 1960's. The dam spans the Sacramento River with eleven 60-ft wide spillway gates. Plan and sections of Red Bluff Diversion Dam and stilling basin are presented in figure 1. All spillway gates can be operated in automatic mode using an upstream lake elevation target. However, typical operation of the spillway gates has gates one through ten manually changed in response to large changes in river flow. Gate 11 operates in auto mode to regulate the upstream water surface for gravity diversion to the Tehama Colusa Canal. Downstream of gates one through ten is a Type II hydraulic jump stilling basin with a concrete apron and solid endsill. Downstream of gate 11 is a Type III hydraulic jump stilling basin. Both stilling basins have experienced significant abrasion damage over the past 40 years. Damage has occurred primarily near the basin chute blocks and endsill. The Designer's Operating Criteria (DOC) for spillway gate operation was revised in 1970 to address the problem of concrete abrasion in the stilling basins. The criteria places two constraints on spillway operation. First, the DOC requires gate 11 (sluice gate) be operated at a minimum of 2,500 cfs prior to opening any of the other 10 spillway gates. This ensures hydraulic jump stability by providing sufficient tailwater for Type II stilling basins. Second, gate openings of adjacent gates 1 through 10 shall not exceed a 1.0 ft differential. These revised operating criteria ensure flow releases through the gates are sufficiently uniform to produce a stable hydraulic jump and reduce erosion and abrasion damage to the downstream apron. Current gate operation criteria were established via a memorandum to central files by Ray Willis, Irrigation and Operation Branch, Division of Water and Land Operations, July 22, 1971.

The issue of fish passage attraction and spillway gate operation has been the subject of discussion since the early 1970's. The three main references prior to this report are; a travel report by Carlson and Kuemmich (1971), a Memorandum to Director of Design and Construction, 1975 and a Memorandum from Johnson to the Red Bluff Program Manager, 1995. In addition, other related work includes a hydraulic model study of a concept for constructing enlarged ladders, (Kubitschek, J., 1997) and a field study of the flow conditions at the entrance to the right bank ladder, (Kubitschek, J., et al. 1997). These studies show the fishway attraction flows are often masked by uniform spillway releases and more flexibility in lateral adjustment of flow releases could potentially improve attraction to the abutment fishways.

Study Objective

In August 2001, a series of field tests were conducted to investigate hydraulic conditions in the stilling basin and downstream river that result from non-uniform spillway gate operation. The tests focused on the effect of center dominated spillway releases with respect to stability of the hydraulic jump, abrasion damage potential, erosion downstream of the endsill and downstream flow patterns near the north and south bank fishway entrances.

Test Plan

Three tests of different spillway gate openings that provided center dominated spillway releases were conducted during the week of August 13, 2001. Test procedures followed a pre-test plan

submitted to Red Bluff Diversion Dam Field Office June, 2001. Each spillway test consisted of examining the spillway apron, riprap, and downstream bathymetry, videoing surface flow conditions, and measuring the velocity field downstream of the spillway apron for a distance of approximately 1000 feet. Each test condition was held constant for about 20 hours to allow sufficient time for alluvial material to move in response to the flow conditions. After each test period, bays 10 and 11 were inspected. Spillway releases were then moved from the center bays to bays 10 and 11 to complete the inspection of other bays. During this period, downstream bathymetry was also mapped to identify changes that took place during the previous test. The velocity field in the river downstream of the spillway was measured during each centered dominated spillway release.

Testing

During the test period, river flows were 3,000 to 4,000 ft^3/s below expected levels. Because of this, proposed spillway gate openings cited in the original test plan had to be reduced. River flows past the dam started at 11,550 ft^3/s on 8/13/01 and decreased daily to 10,110 ft^3/s on 8/17/01. River flows are a combination of spillway flow and right and left bank fishway flows. Spillway flows during tests 1, 2, and 3 were approximately 9,200 ft^3/s, 9,000 ft^3/s and 8,500 ft^3/s, respectively.

A dive inspection of the spillway apron and downstream riprap was conducted prior to the first test and following each test. Please refer to attached dive report for detailed information. Divers were asked to identify major movement in sediment deposits on the spillway apron, conditions of downstream riprap and document damaged spillway concrete for future reference.

Spillway hydraulic parameters are based on a previous hydraulic model study conducted by Dodge in 1963. Spillway gate setting, reservoir elevation and tailwater elevation were recorded during the testing. Test conditions during each test are given in tables 1, 2, and 3 and are plotted in figure 2. During testing large flows were released through gates 5, 6, and 7 with little or no flow through the remaining gates. The largest test flows were always passed through gate 6.

During pre-test and river centered operations, river flow velocities and depth were measured in the area starting approximately 40 ft downstream of the spillway endsill and extending about 250 ft downstream of the fish screen bypass outfall. Velocity profiles and bottom depth were measured using a boat-mounted Acoustic Doppler Current Profiler (ADCP). Boat access for making measurements was limited to areas outside the bubble plume downstream of large gate openings and areas where flow depth was greater than two feet. Because of changes in river bathymetry, boat traverses could not be exactly repeated during each test, therefore the measured data was interpolated onto a square grid for comparison of different tests. River bathymetry was measured following each test concurrent with the dive inspection of the spillway. This data was also interpolated onto a square grid.

Pretest Conditions - Due to fish passage concerns in recent years, operation of the dam has changed to 4 months with spillway controlled flow releases referred to as "gates-in" and 8 months with "gates-out" (gates fully open). The gates are typically used to control flow releases from May 15 to September 15. During "gates-in" operation, a temporary fish ladder is installed in bay 6 that

prevents the gate operation. The fish ladder was removed one week prior to the spillway tests. Existing guidelines for spillway releases with the center fish ladder installed and without the center ladder in place are given in tables 4 and 5. The existing gate position guidelines restrict the difference between adjacent gate openings to less than 1 ft and recommend the highest flows in the outer bays adjacent to the left and right bank fishway entrances. The Red Bluff Diversion Dam record of operation prior to the tests for the month of August 2001 is given in table 6. The flow field as denoted by depth averaged velocity vectors measured downstream of the spillway on August 13 is given on figure 3. The velocity vectors show flows from the outer gates merge as the river narrows about 700 ft downstream of the dam. Flow patterns closer to the dam were fairly chaotic. The bank weighted flow releases and the influence of downstream sediment deposits caused a large area of poorly defined flow direction downstream of bays 3 through 8 for a distance of about 600 feet. The concave spillway flow release pattern results in bed material deposits in the center of the river and deep near-bank channels downstream of each fishway entrance. In the center of the river, the gravel bar started on the spillway apron and extended well downstream from the dam. Divers estimated gravel deposits of about 20 yd^3 in spillway bays 5, 6, and 7, and 10 yd^3 in bay 8. Please refer to the attached dive report. River bathymetry measured downstream of the spillway is given on figure 4. The bathymetry data reveals scoured areas greater than 10 ft deep downstream of the gates 1 and 2 near the west banks and gates 10 and 11 on the east bank. There was a large area downstream from gates 5, 6, and 7 where flow depth was less than 2 feet. The scoured areas are probably characteristic of the pre-test gate opening pattern, however, a major influx of sediment from Red Bank Creek in the past year and short term sediment flushing operation using bays 10 and 11 also contributed to the pre-test bathymetry.

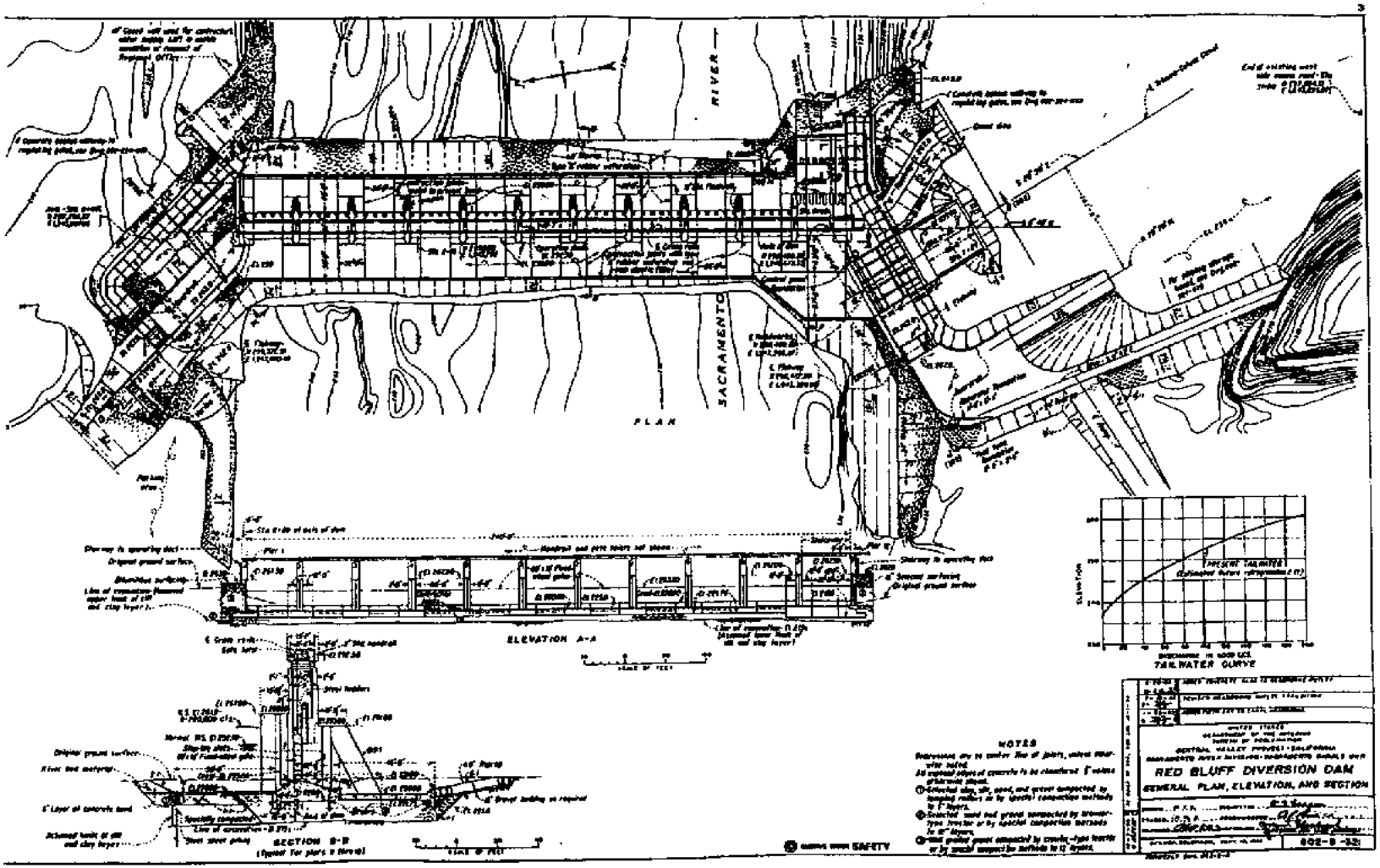
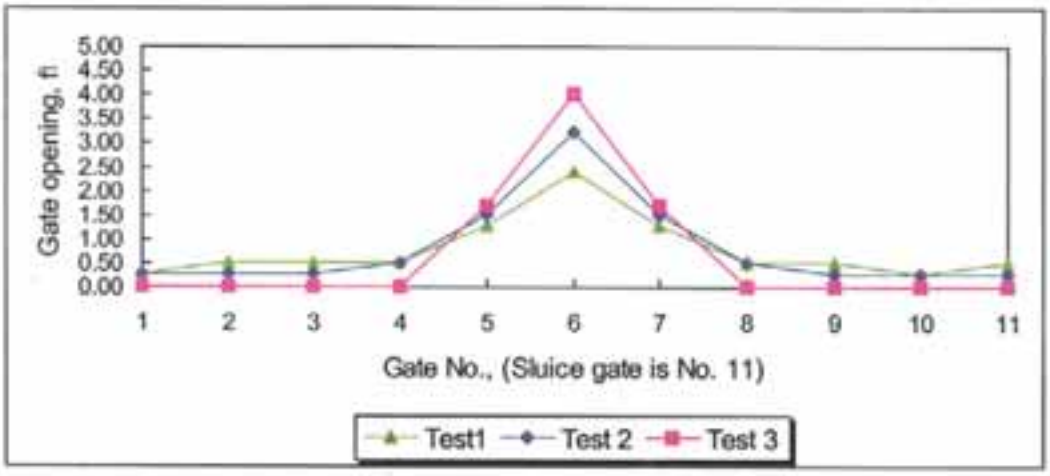
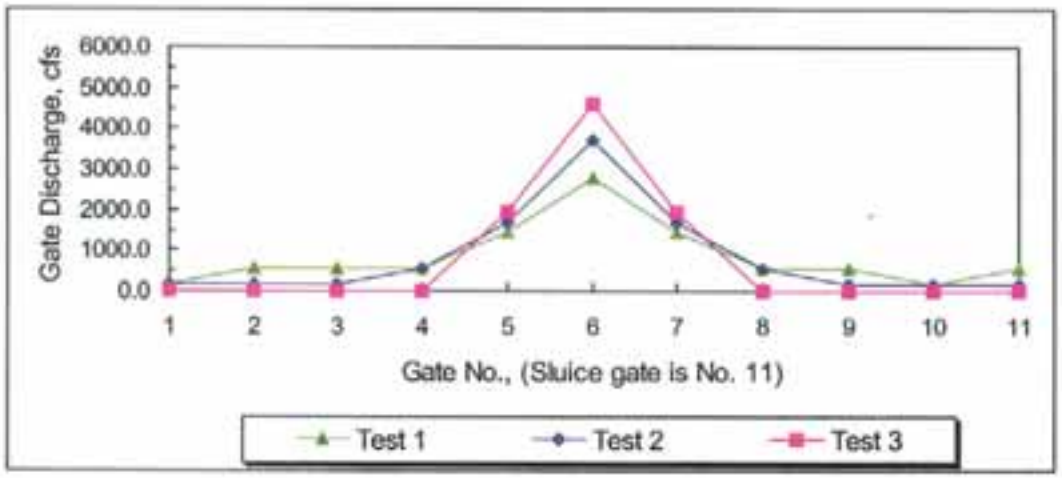


Figure 1- Plan and sections of Red Bluff Diversion Dam.





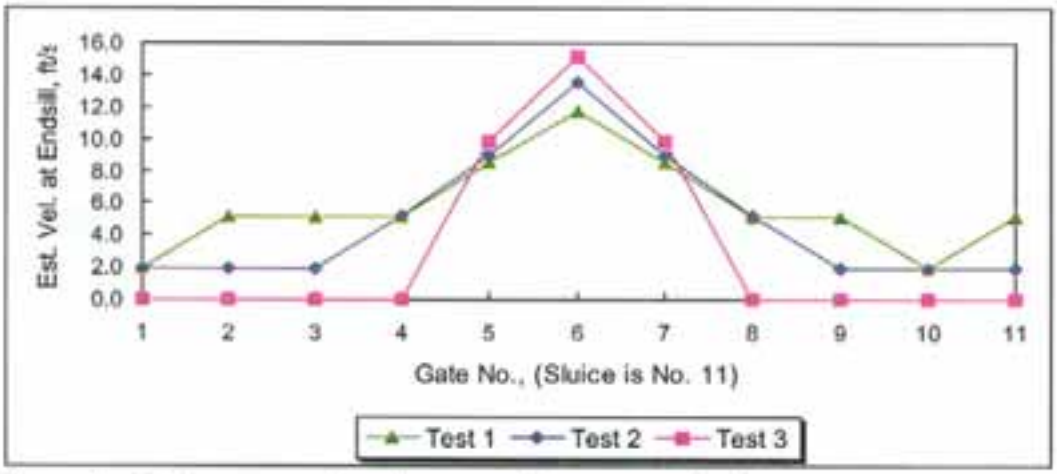


Figure 2 - Spillway operation for tests of river centered releases.

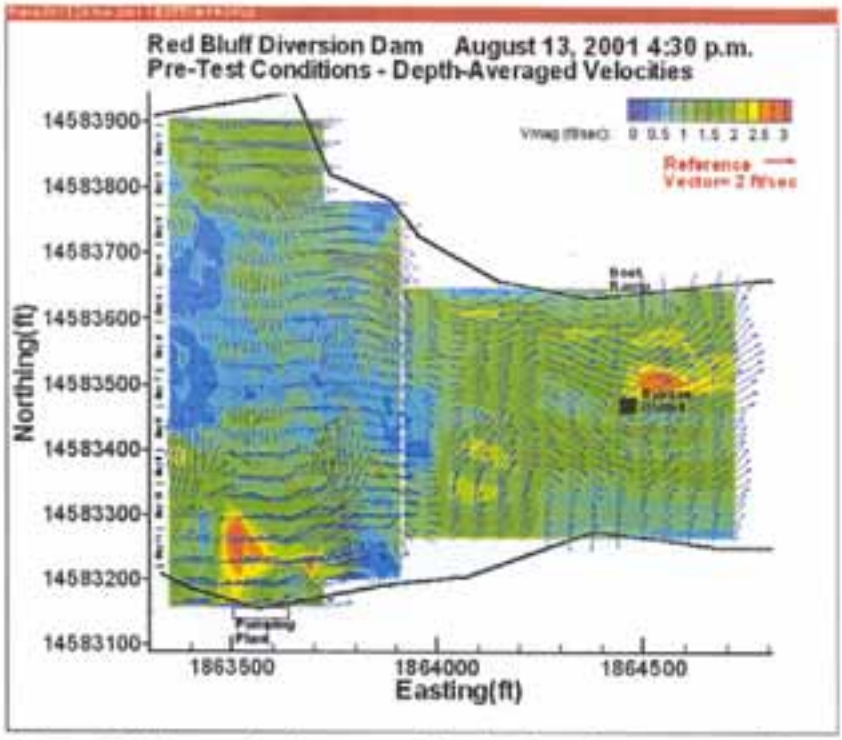


Figure 3 - Pretest depth-averaged velocities downstream of Red Bluff Diversion Dam.

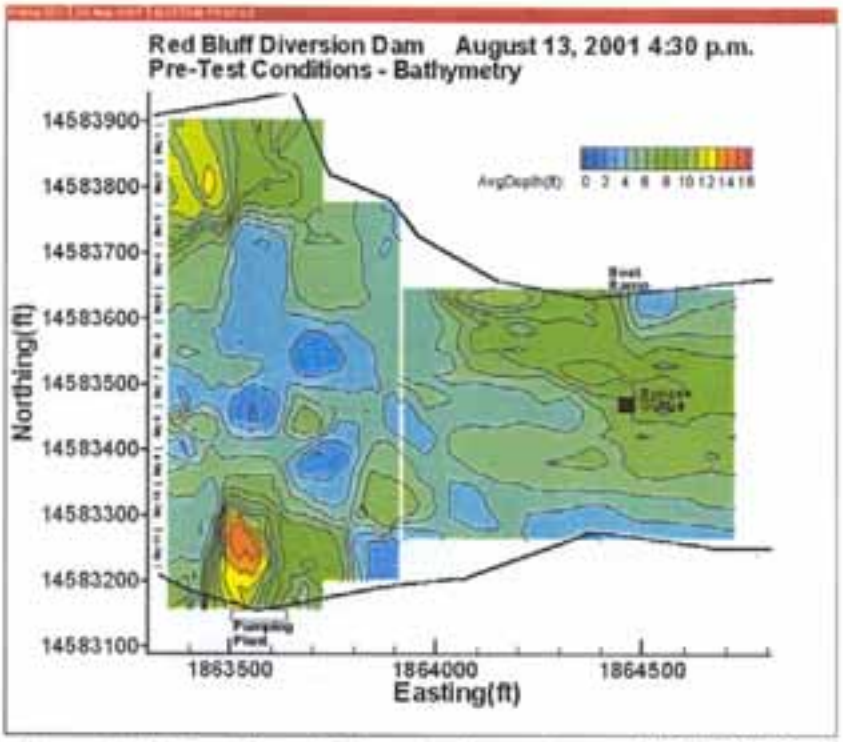


Figure 4 - Pretest river bathymetry downstream of Red Bluff Diversion Dam.

Results

River Center Spillway Release Test 1

The objective of test 1 was to evaluate spillway hydraulic conditions during a strong centered spillway release combined with smaller sediment flushing flows from all other gates. Gates 2, 3, 4, 8, 9, and 11 were opened 0.5 feet. Gates 1 and 10 were only opened 0.25 feet due to low river flow. Gates 5, 6, and 7 were opened 1.25, 2.4 and 1.25 feet respectively, giving a 1.15 feet difference between adjacent gates. The 0.5 ft gate opening used for outer gates was selected based on an estimated average flow velocity at the endsill of 5 ft/s.

Hydraulic Jump Stability - Releases from gates 5,6, and 7 produced a bubble plume that extended to approximately the spillway endsill (figure 5). The hydraulic jump downstream of gates 5, 6, and 7 appeared very stable. The gate openings tested provided a ratio of tailwater depth to hydraulic jump conjugate depth greater than one for all gates (table 1). Reclamation Engineering Monograph 25 recommends a ratio greater than 1 for good jump stability.

Spillway Apron Abrasion Damage Potential - The large gravel deposit downstream of the spillway center gates significantly effected downstream flow conditions. River bathymetry and the downstream flow field continually changed during the tests as material was scoured from the center of the channel and redeposited to the sides and downstream. The flow from gates 5, 6, and 7 spread to both sides of what was almost an island of alluvial material. Significant amounts of gravel were flushed from the spillway apron during the test. Divers estimated that the quantity of gravel on the spillway apron was about 50 percent of pre-test conditions after test 1 (Dive Report - table 1). All material was removed from bays 6 and 7 and the amount of material in bays 5 and 8 was reduced by about one-half. Some material did redeposit near the endsill in Bays 3 and 4 where no material was found during the pretest inspection. All alluvial material found on the spillway apron was located near the endsill.

River Bathymetry and Flow Conditions Downstream of the Spillway - Figure 6 gives the post test river bathymetry. Figure 7 shows the change in depth between pre and post test 1 conditions. Scouring in the center of the river was accompanied by deposition near each bank downstream of the fishway entrances. The large river center flows scoured material downstream of gates 5,6, and 7 exposing the spillway apron endsill and downstream riprap. Deposition of 6 ft to 8 ft occurred in front of the pumping plant downstream of bays 10 and 11 and downstream of bays 1 and 2. The rapid movement of material toward the river banks was driven by the lateral spread of spillway releases as the flow impacted the extensive alluvial deposit immediately downstream of the center gates. The dive inspection indicated the riprap was not affected by the test flow. River velocities measured during the test using an ADCP are given in figure 8. The flow field for a distance of nearly 600 ft downstream of the dam is poorly defined due to sediment deposits and the wide channel. Strong flows were measured about 300 ft downstream of the spillway apron along both river banks. The flow likely resulted from the movement of spillway flow around the river centered deposits rather than fishway flows. The ADCP data shows fishway flow rapidly mixed with spillway flows. Fishway flow velocities were not discernable from other spillway driven flow velocities beyond 50 to 75 ft downstream of the fishway entrance.

Figure 5 - Photographs of surface flow conditions during test 1.

View of white water turbulence downstream of gates 5, 6 and 7.

View of surface flow conditions downstream of the left bank fishway.

View of surface flow conditions downstream of the right bank fishway.

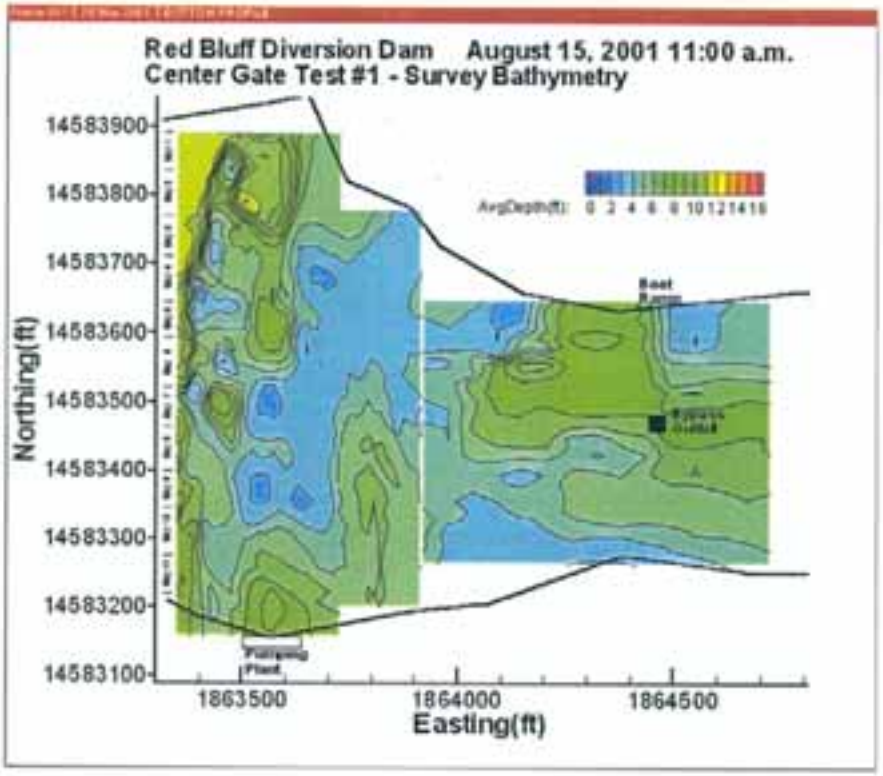


Figure 6 - River bathymetry downstream of Red Bluff Diversion Dam after test 1.

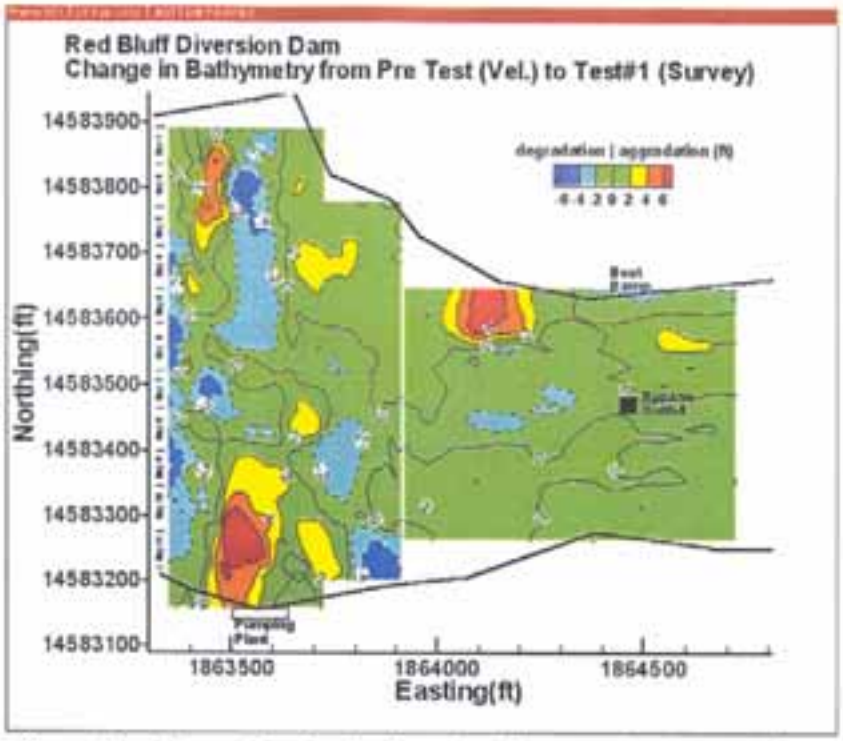


Figure 7 - Change in river bathymetry from pre-test to test 1.

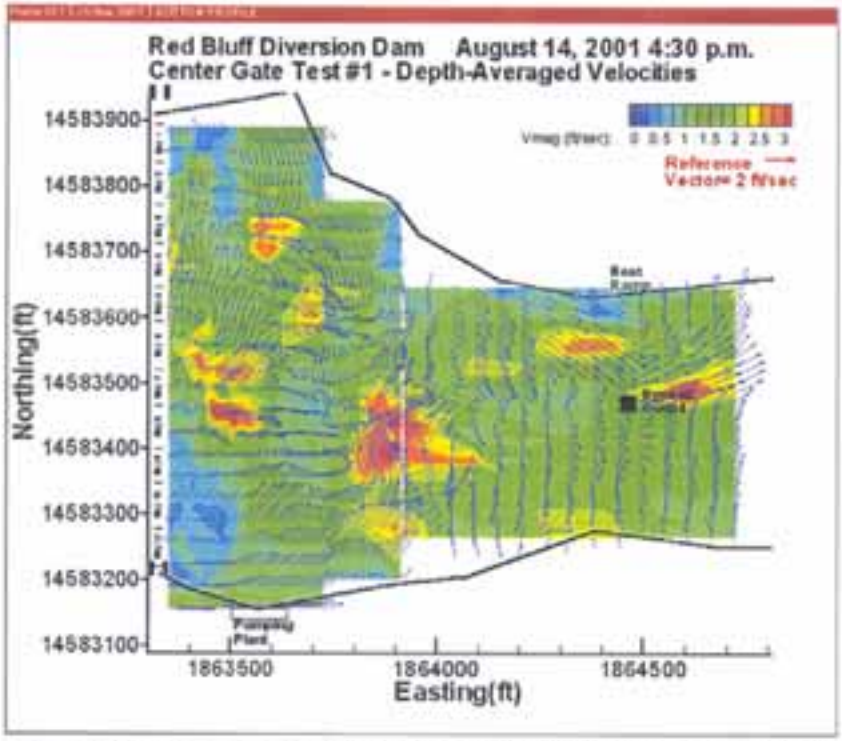


Figure 8 - Test 1 depth-averaged velocities downstream of Red Bluff Diversion Dam.

River Center Spillway Release Test 2

The objective of the second test was to further concentrate flows to the center of the spillway and test a gate opening differential between adjacent center gates significantly higher than 1 foot. Prior to test 2, center releases were increased and outer gate flows decreased. Gates 1, 2, 3, 9, 10, and 11 were opened 0.25 feet. Gates 4 and 8 remained at a 0.5 ft gate opening. Gates 5, 6, and 7 were opened 1.5, 3.2, and 1.5 ft respectively, giving a 1.7 ft differential between adjacent gates, (table 2). The 0.25 ft gate opening used for outer gates produced an estimated average flow velocity at the endsill of 2 ft/s. Gates 4 and 8 were maintained at a 0.5 ft opening to provide a stronger spillway apron flushing flow adjacent to the larger gate openings.

Hydraulic Jump Stability - Releases from gates 5, 6, and 7 produced a bubble plume that extended well beyond the spillway endsill, as shown in figure 9. The hydraulic jump downstream of gates 5, 6, and 7 remained stable with the increased flow of test 2. The gate openings tested provided a ratio of tailwater depth to hydraulic jump conjugate depth greater than one for all gates, (table 2).

Spillway Apron Abrasion Damage Potential - After a day of operation the flow scoured alluvial material from the spillway apron and cut several new channels through the large downstream gravel deposit. Following the test, divers found about 50 percent of the material remaining in the basin after test 1 had been removed. Material in bays 3, 4, and 5 was reduced by about 90 percent and material in bay 8 increased by about 60 percent. All gravel deposits were again located immediately upstream of the spillway apron endsill. Divers noted that a fine cover of moss attached to the spillway apron showed no evidence of abrasion upstream of the endsill as a result of the concentrated high velocity flows.

River Bathymetry and Flow Conditions Downstream of the Spillway - The high river centered releases continued to move alluvial material downstream and toward both banks. The dive inspection found no indication that the riprap apron was affected by the test flow. Figure 10 gives the post test 2 river bathymetry and figure 11 shows the change in depth between test 1 and post test 2 conditions. By the end of test 2, the flow releases had cut channels toward each bank through the remaining alluvial deposit in the center of the river. The flow resulted in 4 to 6 ft of material deposition in the river downstream of bays 1, 2, 3, 4, and 11. River velocities measured during the test are given in figure 12. The large river center alluvial deposit continued to control flow patterns upstream of the fish screen bypass outfall. Similar to test 1, fishway flows were not distinguishable in the velocity measurements taken 100 ft downstream of the spillway endsill.

Figure 9 - Photographs of surface flow conditions during test 2.

View of white water turbulence downstream of gates 5, 6 and 7.

View of surface turbulence downstream of the left bank ladder.

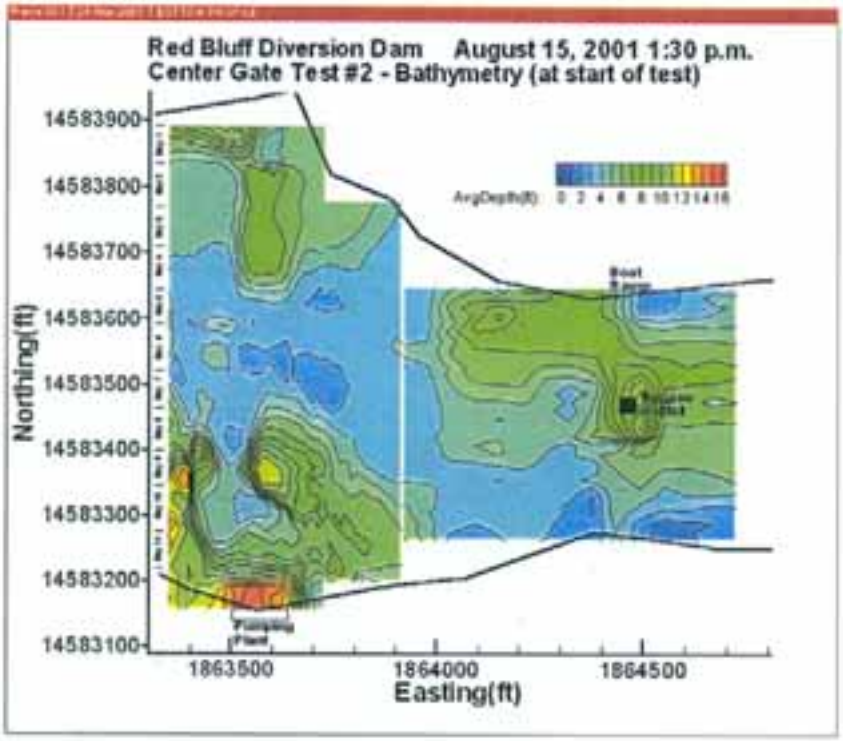


Figure 10 - River bathymetry following test 2.

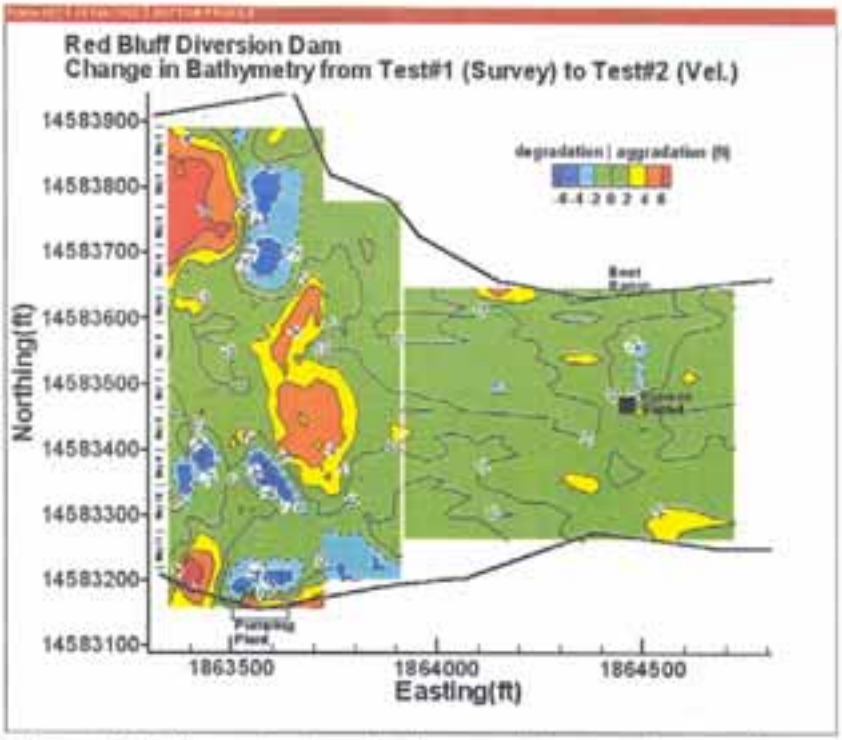


Figure 11 - Change in river bathymetry from test 1 to test 2.

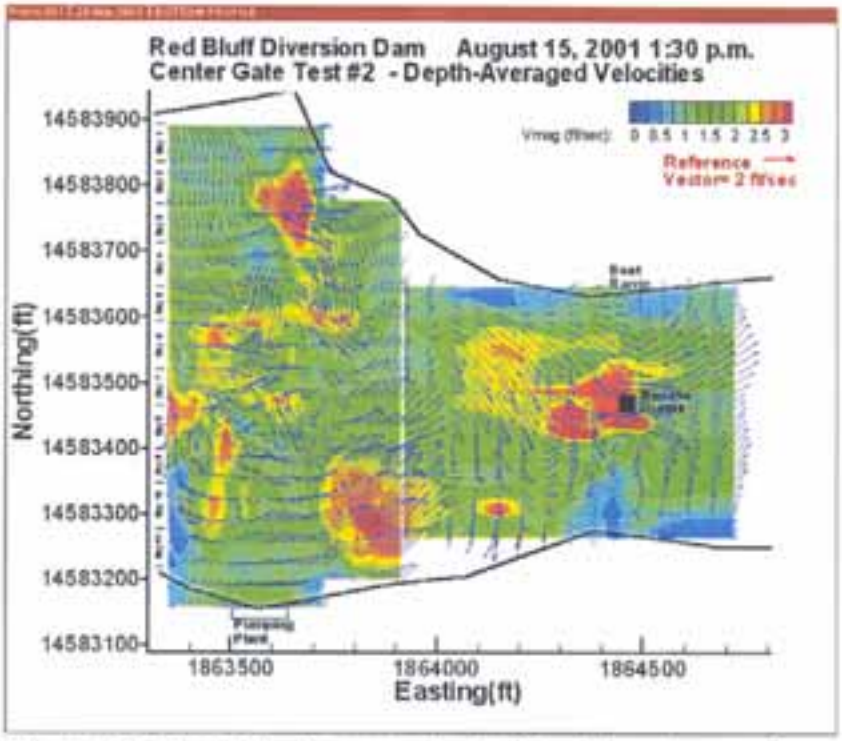


Figure 12 - Test 2 depth averaged velocities downstream of Red Bluff Diversion Dam.

River Center Spillway Release Test 3

The objective of the third test was to concentrate all spillway flows to the center of the spillway with no sediment flushing flows from adjacent gates. For test 3, center releases were increased and gates 1, 2, 3, 4, 8, 9, 10, and 11 were closed. Gates 5, 6, and 7 were opened 1.7, 4.0 and 1.7 ft respectively, giving a 2.3 ft difference between adjacent gates (table 3).

Hydraulic Jump Stability - Releases from gates 5, 6, and 7 produced a bubble plume that extended well downstream of the spillway endsill, as shown in figure 13. The hydraulic jump downstream of gates 5, 6, and 7 remained stable. The flow through gate 6 yielded a ratio of tailwater depth to hydraulic jump conjugate depth of just under 1.0, (table 3).

Spillway Apron Abrasion Damage Potential - Following test 3, the amount of material deposited on the spillway apron roughly doubled. Refer to table 1of the Dive Report. New material was found in bays 4, 6, 7, 8, and 10. The greatest increase in material occurred in bay 8. All gravel deposits were again located immediately upstream of the spillway apron endsill.

River Bathymetry and Flow Conditions Downstream of the Spillway - The high river centered releases continued to move alluvial material downstream and toward both banks. Test 3 flows scoured a channel that extended about 800 ft downstream of the spillway (figure 14). Material removed during test 3 deposited downstream of bays 1 through 4 and 8 through 11 (figure 15). The dive inspection found no indication the riprap apron was affected by the test flow. River velocities measured during the test are given in figure 16. Similar to tests 1 and 2, fishway flows were not distinguishable in velocity measurements taken 100 ft downstream of the spillway endsill.

Figure 13 - Photographs of surface flow conditions during test 3.

View of white water turbulence downstream of gates 5, 6 and 7. Surface turbulence extended well downstream of the stilling basin endsill.

View of surface flow conditions exiting the left bank fishway.

View of surface flow conditions exiting the right bank fishway.

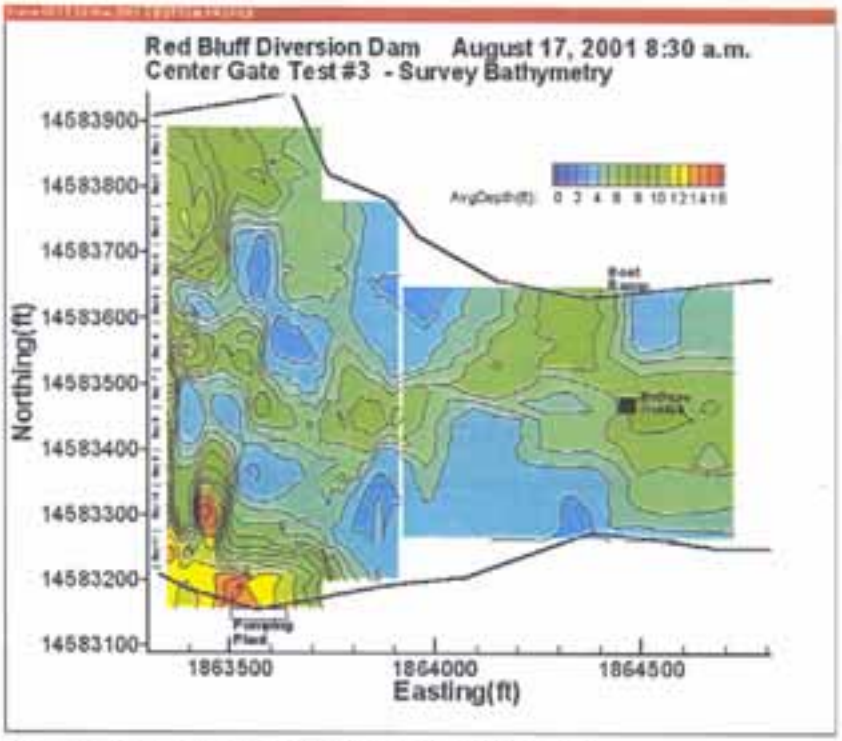


Figure 14 - River bathymetry following test 3.

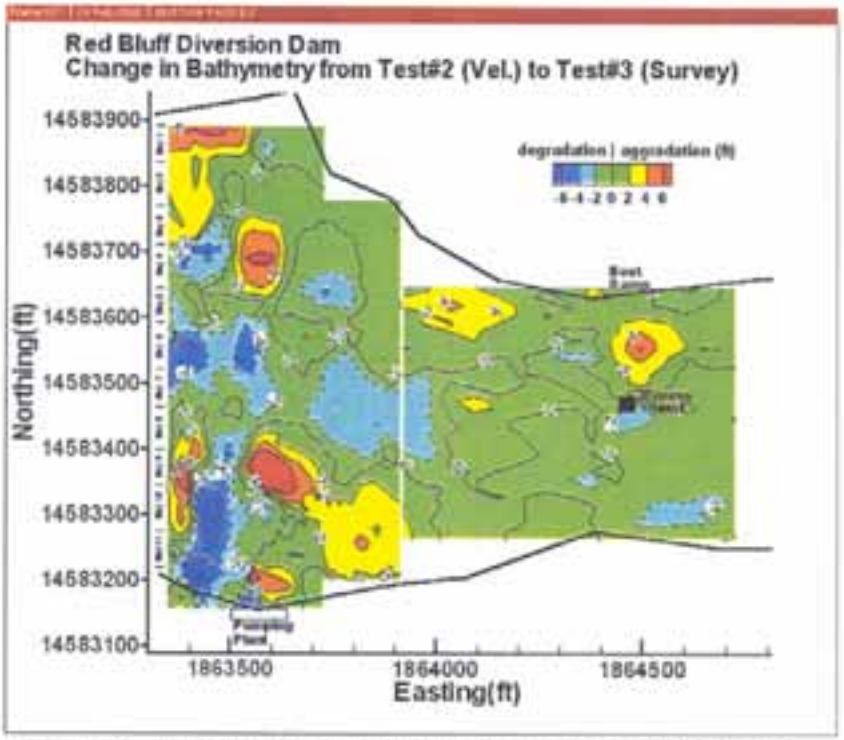


Figure 15 - Changes in river bathymetry from test 2 to test 3.

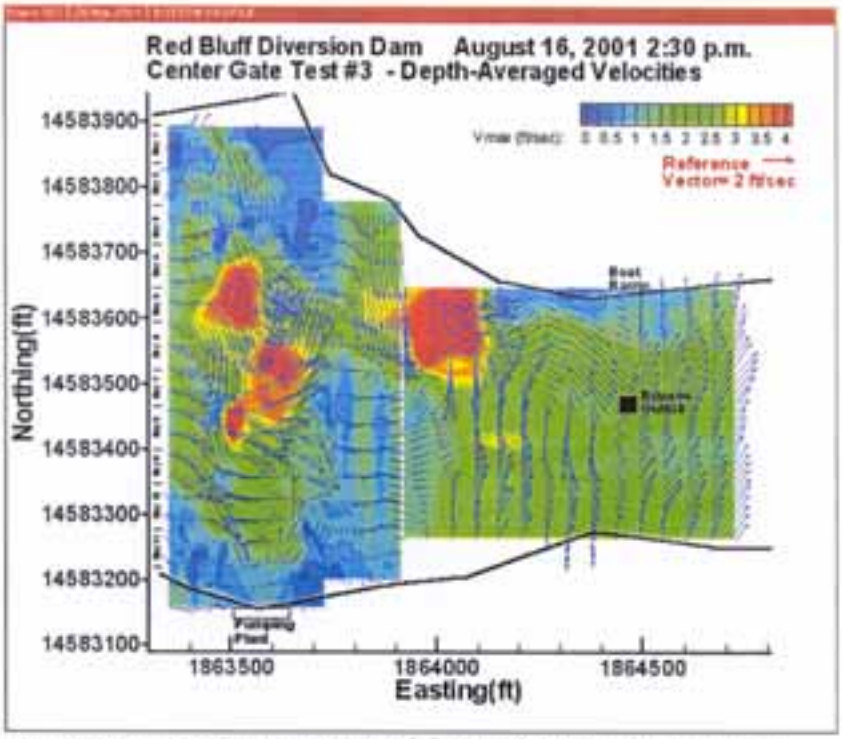


Figure 16 - Test 3 depth averaged velocities downstream of Red Bluff Diversion Dam.

Conclusions

The tests show the hydraulic jump downstream of the spillway gates is stable for conditions where the ratio of tailwater depth to hydraulic jump conjugate depth is 1.0 or greater. Low river flow conditions at the time of the testing did not allow testing tailwater depth to hydraulic jump conjugate depth ratios less than one. A value of 1.0 or greater is consistent with Reclamation Engineering Monograph 25 recommendations.

Exceeding a 1.0 ft differential gate opening between adjacent gates was not found to increase the potential for spillway apron abrasion for tests 1 and 2 where a flushing flow was provided adjacent to large gate openings. However, test 3 showed an increase in material moved upstream onto the spillway apron. Test 3 was unique in that spillway gate openings greater than 1 ft were used adjacent to closed gates. These tests indicate that spillway gate operation criteria can be relaxed to allow a differential gate opening of up to 2.0 ft between adjacent open gates if a 0.5 ft to 1.0 ft gate opening is maintained adjacent to a closed gate. The low river flow conditions at the time of the testing limited the range of non-symmetric gate operations that could be evaluated. Future tests during higher river flows would be required to evaluate adjacent gate openings of greater than 2 ft. Symmetric gate operation is recommended when fish attraction or sediment flushing is not required. Due to the limited extent of these tests, the spillway apron should be dive inspected and the criteria reevaluated after accumulating 6 months of operation with differential openings between adjacent gates of greater than 1.0 ft.

Between Red Bluff Diversion Dam and the Tehama Colusa Canal fish screen bypass outlet structure, river bathymetry and flow patterns vary greatly as a function of flow, sediment deposits, upstream bed load and spillway gate operation. The testing resulted in major changes in scour and redeposition patterns downstream of the dam. Flow patterns and depths measured in the downstream river are not necessarily indicative of future conditions resulting from spillway centered flow releases. However, the redistribution of river center deposits toward the river banks would be expected.

Table 1 - Spillway gate settings and hydraulic conditions during spillway Test No. 1

Test No.1

Sill Elevation 235.0 ft
Basin floor 228.00 ft

Reservoir elevation = 252.3 ft
Tailwater elevation = 239.8 ft

Gate No.	1	2	3	4	5	6	7	8	9	10	11 Sluice	Total Flow cfs
Opening, ft	[illegible]											
H1/b	69.2	34.6	34.6	34.6	13.8	7.2	13.8	34.6	34.6	69.2	34.6	
H2/b	19.1	9.5	9.5	9.5	3.8	2.0	3.8	9.5	9.5	19.1	9.5	
Cd	0.30	0.55	0.55	0.55	0.58	0.58	0.58	0.55	0.55	0.30	0.55	
Q/gate	148.9	545.9	545.9	545.9	1439.3	2763.5	1439.3	545.9	545.9	148.9	545.9	9216
Vel. gate, ft/s	14.2	26.0	26.0	26.0	27.4	27.4	27.4	26.0	26.0	14.2	26.0	
Endsill vel	2.0	5.1	5.1	5.1	8.5	11.7	8.5	5.1	5.1	2.0	5.1	
Fr1	5.0	6.5	6.5	6.5	4.3	3.1	4.3	6.5	6.5	5.0	6.5	
D2, ft	1.65	4.34	4.34	4.34	7.04	9.45	7.04	4.34	4.34	1.65	4.34	
TW(depth)/ D2	7.15	2.71	2.71	2.71	1.67	1.25	1.67	2.71	2.71	7.15	2.71	

Table 2 - Spillway gate settings and hydraulic conditions during spillway Test No. 2

Test No. 2

Reservoir elevation = 252.5 ft
Tailwater elevation = 239.8 ft

Gate No.	1	2	3	4	5	6	7	8	9	10	11 Sluice	Total Flow cfs
Opening, ft	[illegible]											
H1/b	70.0	70.0	70.0	35.0	11.7	5.5	11.7	35.0	70.0	70.0	70.0	
H2/b	19.0	19.0	19.0	9.5	3.2	1.5	3.2	9.5	19.0	19.0	19.0	
Cd	0.30	0.30	0.30	0.56	0.56	0.58	0.56	0.56	0.30	0.30	0.30	
Q/gate	148.9	148.9	148.9	555.9	1667.6	3684.7	1667.6	555.9	148.9	148.9	148.9	9025
Vel.@gate, ft/s	14.2	14.2	14.2	26.5	26.5	27.4	26.5	26.5	14.2	14.2	14.2	
Vel. @ Endsill, ft/s	2.0	2.0	2.0	5.2	9.0	13.6	9.0	5.2	2.0	2.0	2.0	
Fr1	5.0	5.0	5.0	6.6	3.8	2.7	3.8	6.6	5.0	5.0	5.0	
D2, ft	1.65	1.65	1.65	4.42	7.36	10.73	7.36	4.42	1.65	1.65	1.65	
TW(depth) /D2	7.14	7.14	7.14	2.66	1.60	1.10	1.60	2.66	7.14	7.14	7.14	

Table 3 - Spillway gate settings and hydraulic conditions during spillway Test No. 3

Test No. 3

Reservoir elevation = 252.6 ft
Tailwater elevation = 239.7 ft

Gate No.	1	2	3	4	5	6	7	8	9	10	11 Sluice	Total Flow cfs
Opening, ft	0.00	0.00	0.00	0.00	1.70	4.00	1.70	0.00	0.00	0.00	0.00	
H1/b					10.2	4.3	10.2					
H2/b					2.8	1.2	2.8					
Cd					0.58	0.58	0.58					
Q/gate					1957.5	4605.8	1957.5					8521
Vel. gate					27.4	27.4	27.4					
Endsill vel					9.9	15.2	9.9					
Fr_1					3.7	2.4	3.7					
D2					8.10	11.81	8.10					
TW(depth)/D2					1.44	0.99	1.44					

Symbol definitions:

b - spillway gate opening
B - width of gates
Cd - spillway gate coefficient of discharge, $Q/(bB\sqrt{2gH1})$
D2 - hydraulic jump conjugate depth
Endsill vel. - estimated jet velocity at the stilling basin endsill
Fr_1 - Froude Number of the flow entering the stilling basin
H1 - head upstream of spillway gate referenced to the spillway crest
H2 - head downstream of spillway gate referenced to the spillway crest Q/gate - discharge per gate
Vel. gate - flow velocity through the gate opening
TW/D2 - ratio of tailwater depth to conjugate depth

References

Carlson, E.J., and Kuemmich, R.H., "Travel to Tehama-Colusa Fish Facilities, Red Bluff, California". Hydraulics Branch Travel Report, October 1971.

Dodge, R. A., "Hydraulic downpull studies of fixed-wheel spillway gates for Red Bluff Diversion Dam Central Valley Project, California," USBR Hydraulics Branch Report No. Hyd-511, 1963.

Johnson, Perry, "Gate options for possible improvement of out-migrant fish passage at Red Bluff Diversion Dam", Memorandum, April 1995.

Kubitschek, Joseph, "Physical Model Study of Enlarged Fish Ladders for Red Bluff Diversion Dam", USBR Water Resources Research Laboratory Research Report, R-97-08, September 1997.

Kubitschek, J., Mefford, B., Vermeyen, T., Robinson, D., "Hydraulic Field Evaluation of the Right Abutment Fish Ladder at Red Bluff Diversion Dam", USBR Water Resources Research Laboratory Research Report, R-97-07, September, 1997.

Memorandum to Director of Design and Construction, "Designers Operation Criteria - Gate Openings - Red Bluff Diversion Dam and Fish Facility", July 17, 1975.

Willms, Ray, "Spillway Gate Opening Criteria - Red Bluff Diversion Dam", Note to Central Files, July 22, 1975.

Appendix L
Draft Biological Assessment

Draft Biological Assessment

Chinook Salmon, Steelhead Trout and Sturgeon for the Proposed Tehama Colusa Canal Authority Fish Passage Improvement Project at the Red Bluff Diversion Dam

Chapter 1 – Introduction

Note: The Draft Biological Assessment has not been updated to reflect the most recent draft USFWS Coordination Act Report.

Introduction

This biological assessment (BA) describes the Bureau of Reclamation's (Reclamation) proposed operation of the Red Bluff Diversion Dam Fish Passage Improvement Project (Project). Reclamation is submitting this BA pursuant to Section 7(a)(2) of the Endangered Species Act (ESA) to both the Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) to ensure that the proposed action is not likely to jeopardize the continued existence of listed species and to ensure that there is coordination between what may otherwise be conflicting needs between multiple listed species.

Under the relevant regulations, the "contents of a biological assessment are at the discretion of the Federal agency and will depend on the nature of the Federal action." 50 CFR Section 402.12 (f). In the event that FWS or NMFS determine that the proposed action is likely to jeopardize the continued existence of listed species, Reclamation has identified in Appendix A to this BA a list of actions that could be implemented as reasonable and prudent alternatives to the proposed action or as reasonable and prudent measures to reduce incidental take associated with the proposed action, or to promote conservation and recovery of listed species pursuant to Section 7(a)(1) of the ESA.

Purpose of Biological Assessment

Reclamation's goal is to work with the Services toward developing an operations plan that meets Reclamation's legal commitments with respect to the Project in a manner that is consistent with the requirements of the ESA. Reclamation prepared this BA to describe and analyze the effects of its proposed actions related to operation of the Project on listed species. It covers proposed actions for __ years, from Date to Date.

Chapter 2 – Description of the Action

Introduction

Reclamation proposes, through consultation and development of a subsequent operations plan, to operate the Project to improve fish passage around the Red Bluff Diversion Dam (RBDD) and deliver reliable water to the Tehama-Colusa Canal Authority member districts. After completion of consultation with both the FWS and NMFS, Reclamation will develop an operations plan that provides for the continued operation of the Project while meeting its legal obligations under the Endangered Species Act; namely, to (1) avoid any discretionary action that is likely to jeopardize the continued existence of listed species; (2) take listed species only as permitted by the relevant Service; (3) and use Reclamation's authorities to conserve listed species. For the purposes of this BA, impacts to listed species are assessed with respect to the separate acts of construction and operation of the Project.

Summary of Project Background, Programs and Studies, and Legislative and Regulatory Influences Relevant to the Action

Introduction

Previous programs and studies; and legislative and regulatory influences guide Reclamation's proposed action. This section of the BA elaborates on the authorities, responsibilities and obligations related to Project operation.

Project Background, Authorization of the CVP, RBDD, TCC, and TCFF

The Central Valley Project (CVP) was initially authorized under the Act of October 26, 1937 (50 Stat. 844,850), and re-authorized under the Act of October 17, 1940 (54 Stat. 1198, 1199). The TCC at the time called the Tehama-Colusa Conduit), including all necessary damns, pumping plants and other appurtenant works, was a unit of the CVP, as authorized under State law prior to 1946 (Senate Document 113 1949). Senate Document 113 (1949), a report updating progress on the CVP, proposed for further investigations the Red Bluff-Dunnigan canal (similar in location to the TCC) and distribution system, with a cost of $22.4 million, length of 115 miles, and capacity of 3,000 cfs, for irrigation of 100,000 acres.

Although Senate Document 113 does not mention RBDD, it does state that flow for the Red Bluff-Dunnigan canal would be diverted by gravity from the west bank of the Sacramento River just below Red Bluff. A USFWS report included as part of Senate Document 113 recommended screens at the diversion point of the Red Bluff-Dunnigan canal, siphons on the canal at stream crossings to reduce impacts on salmon, and estimated water requirements of 55 cfs (40,000 acre-feet/year) for the Sacramento National Wildlife Refuge.

On September 26, 1950, Public Law 839 (81st Congress; 64 Stat. 1036) was approved by President Truman, authorizing the Sacramento Canals Unit of the CVP, and re-authorizing

the entire CVP, for the purposes of "…regulating flow…controlling floods, providing for the storage and for the delivery of the stored waters thereof…for the reclamation of arid lands and…other beneficial uses" The features authorized in the 1950 legislation included the "Tehama-Colusa Conduit, to be located on the west side of the Sacramento River and equipped with all necessary pumping plants…beginning at the Sacramento River near Red Bluff, California, and extending southerly through Tehama, Glenn, and Colusa Counties…"

Section 5 of the 1950 legislation provided that no expenditure of funds would be made for construction of the Sacramento canals Unit until the Secretary of the Interior, with approval of the President, submitted to Congress a completed report finding the project feasible under provisions of the Federal reclamation laws. The selected plan for development presented in that report (House Document No. 73, 83rd Congress, 1st Session) provided for the Corning Canal, the TCC and RBDD.

1951 Preliminary Evaluation Report. USFWS issued a preliminary evaluation report on fish and wildlife resources affected by the Sacramento Canals Unit of the CVP. This report identified potential impacts, the need for fish passage and screening facilities, and the potential of incorporating fish spawning areas in the TCC as mitigation features of the canal complex. The service made an assessment of the project impacts that were based on the assumption that the RBDD gates would be open from November through March.

1963 Interim Evaluation Report. USFWS conducted further evaluation of the RBDD in conjunction with Reclamation and CDFG. This led to an interim report that contained updated assessment of project impacts and mitigation and enhancement recommendations. The report stated that there would be a considerable loss of downstream migrant salmon without effective screening of the TCC intake. In addition, there would be a loss of spawning habitat as a result of inundation from the impoundment of Lake Red Bluff. As part of the proposed mitigation, a dual-purpose salmon spawning and water conveyance channel, and downstream access channel to the dual-purpose spawning channel was designed as part of the facility.

Support for fishery spawning in the canal was not shared by Reclamation because of the many problems and unknowns associated with the design criteria, the construction, and the operation and maintenance of said facilities.

1967 Fish and Wildlife Coordination Act Report. A Fish and Wildlife Coordination Act Report (FWCA) was submitted by USFWS to Reclamation on January 5, 1967. The report described RBDD and TCC project features, identified fish and wildlife resources, and addressed project impacts. The report also estimated that releases of water to Thomes and Stony Creek from the TCC would result in salmon enhancement and compensation from the proposed project. The report supported the TCFF plan for compensating salmon impacts and taking advantage of large-scale enhancement opportunities. In addition, the report listed several mitigation measures to reduce project impacts.

1992 Appraisal Report. In 1992, together with the USFWS, NMFS, and CDFG, Reclamation created the Red Bluff Fish Passage Program (Program). The purpose and need for the Program was to improve fish passage capability at RBDD for salmon migrating upstream and downstream of the river. The Program was undertaken to develop solutions to

identified causes of declines in anadromous fish populations attributed to RBDD. The primary objectives of the report included the following:

- Identify alternative solutions to the causes (items 1 through 4, above);
- Perform a preliminary comparative evaluation and screening of those alternatives;
- Determine if any of the alternatives are reasonable;
- Identify additional analyses required to perform a final comparative evaluation of the reasonable alternatives for the ultimate purpose of selecting a preferred plan.

The report summarized all of the proposed alternatives, and reviewed details of the 11 selected alternatives. Additional analysis of the selected alternatives included hydrology, design and costs, economic, social factors, recreation and water quality.

The report concluded that four of the eleven selected alternatives are reasonable to consider for further development.

1998 Supplemental Fish and Wildlife Coordination Act Report. The 1998 Supplemental Fish and Wildlife Coordination Act Report (Report) was a joint effort by Reclamation and USFWS. The purpose of the Report was to: 1) supplement the 1967 FWCA; 2) address previous and current impacts of RBDD and the TCC on fish and wildlife resources; 3) recommend interim mitigation actions that can be implemented in a short timeframe; and 4) provide recommendations to identify the long-term solution at RBDD. Based on historical and current data, the Report made several recommendations to Reclamation regarding short-term and long term procedural and operational changes. These recommendations were made to further mitigate previously identified RBDD/TCC specific impacts and also benefit fish and wildlife resources on a basin-wide scope.

Programs and Studies

Juvenile Salmon Marking Studies. Hallock (1980) examined losses of outmigrating yearling steelhead trout due to RBDD. Three consecutive brood years of yearling steelhead were marked with fin clips and released into the Sacramento River above (at Coleman Hatchery) and below RBDD in relative equal numbers. Adult returns of fish released at both sites were compared to estimate the loss of outmigrating yearling steelhead due to RBDD.

Hallock also examined the effects of RBDD on the survivial of outmigrating chinook salmon fingerlins in 1981. Marked fingerlings of fall-run chinook salmon from 1974, 1975, and 1976 brood years were released above and below RBDD. The relative survival of salmon released above and below the diversion dam was measured by the percent recovery of fingerlings in the lower Sacramento River, as well as marked adults captured in the ocean and returning as spawning stock.

In 1980, Hallock and Reisenbichler examined the contribution of winter-run chinook salmon from the Sacramento River to the sport and commercial fisheries along the Pacific Coast of California, Oregon, and Washington, and to the spawning stocks of the Sacramento river.

Predation Studies. In 1977, Hall conducted a study to assess squawfish predation on juvenile chinook salmon. Predation rates were estimated using population estimates and digestion rates measured for Northern squawfish, a close relative of the Sacramento squawfish.

In 1983, Vondracek and Moyle (1983) reexamined squawfish predation on juvenille chinook salmon at RBDD. The sampling periods were chosen to coincide with releases of juvenile chinook salmon from Coleman National Fish Hatchery. Daily consumption rates were calculated using ladder counts of squawfish, mean amount of food in the digestive tract, and the gastric evacuation rate for Sacramento squawfish.

Fish Passage Action Program Fishery Investigations. The Northern Central Valley Fish and Wildlife Office (NCVFWO) conducted a five-year study, starting in October 1983, to develop methods to improve upstream and downstream anadromous fish passage at RBDD (Vogel and Smith 1984, Vogel et al. 1987 and Vogel et al. 1988). The study focused on overall mortality estimates of downstream migrant salmon, delays in downstream passage of yearling salmon and steelhead, juvenile salmonid passage at RBDD, and the associated effect of predation. Additionally, effects on adult salmonid passage were evaluated. The study concluded that dam spill configuration and spill manipulations with RBDD Standard Operating Procedures were ineffective in improving fish passage conditions for adult salmonids. The principle recommendations of this study included construction of new, larger fish ladder on east side of RBDD, enlarging the size and flow capacity of the existing ladders, raising the dam gates during the non-irrigation season, and establishing a permanent program to ensure proper operation and maintenance of all fish passage facilities.

TCC Diversion and Fishery Problems. The NCVFWO conducted a six-year study, starting in 1982, to gather data on fish entrainment through the TCC headworks, and to determine factors (principally entrainment into the Corning Calnal and the TCC, predation, and spawning habitat) limiting chinook salmon production of the DPC portion of the TCFF (USFWS 1985a, Vogel 1984b, Vogel 1989). Entrainment into the Corning Canal was estimated using fyke nets covering the pump outlets (Vogel 1989). Results of this study and the fish Passage Action Program Fisheries Investigations provided the justification for the construction of the rotary drum screens at the TCC headworks.

Interim Action Program. The interim action program, developed in 1983, involved measures, which required little or no additional studies prior to implementation to reduce fish passage problems at RBDD and increase fish production of the TCFF (USBR 1985). These measures included: 1) conversion of the lower 1,000 feet of the SPCs into rearing ponds; 2) regrading of the spawning gravel in the DPC; 3) providing radio transmitting tags for adult salmon; 4) modification of the west-bank fish ladder; 5) installation of drum screens at the head end of each SPC; 6) installation of a temporary ladder in Gate 6; 7) turning off the lights at RBDD at night; 8) cleaning equipment for the fish ladder auxiliary water diffuser grates; 9) modification of the louver bypass terminal box; 10) squawfish control at RBDD; and 11) installation of a new flip gate on RBDD Gate 11.

All of these measures were implemented, with varying results and are summarized in the 1998 FWCA.

TCC Deer Study. Prior to the completion of the construction of the canal, CDFG expressed concern to Reclamation regarding anticipated deer losses along sections of the canal that would skirt foothill areas in Glenn, Colusa, and Yolo counties. Reclamation then initiated consultation with CDFG and USFWS to reduce deer losses in the already constructed reaches and the yet to be constructed reaches. The result of these consultations was the Reaches 5-8 would have a 6-foot fence, and evaluation of fencing needs for Reaches 3 and 4 would be requested from USFWS, and Reaches 1 and 2 would not need fencing because of low reported deer losses. By 1979, with high numbers of deer losses continuing in canal Reaches 1-4 fenced with standard stock fencing, and Reaches 5-8 fenced to 6 feet (approx. 56 miles), it was evident fencing was not excluding deer from the canal right-of-way.

Reclamation again worked with CDFG and USFWS, to develop a study that 1) analyzed the history of the deer losses in the canal; 2) attempted to correlate deer losses to characteristics along the canal; 3) reviewed all possible alternatives of reducing deer losses; and 4) provided recommendations for reducing existing and potential future deer losses in the canal. Several recommendations for rehabilitation projects resulted from the study. These recommendations were aimed at improving the integrity of the existing fences, construction of new fencing, and improving monitoring of deer and animal losses. Additionally, a multi-year evaluation program was suggested, and was implemented in 1983. This program assess the success of the improvements and compared the 8 foot test fence to the existing 6 foot fence.

In 1986, USFWS outlined a plan for reducing up to 96% of deer losses in the TCC. The plan subsequently developed into a comprehensive study and analysis of historical deer loss data with segments of the canal. The results of the study are detailed in the *USFWS Tehama-Colusa Canal Deer Study Report*, October 1989. The plan recommended the construction of new fencing, upgrading existing fencing, installation of deer crossings, and the placement of watering devices at selected locations along the exterior of the right-of-way fencing. Reclamation initiated this plan with the installation of additional 8 foot fencing in certain locations along the canal, and modification of a canal overshoot into a deer crossing. Implementation of the recommended improvements reduced deer losses along certain segments of the canal significantly (USBR 1993).

Other Developments

1960 Memorandum of Agreement. Reclamation and CDFG signed a Memorandum of Agreement (MOA) for the protection and preservation of fish and wildlife resources of the Sacramento River as affected by the operation of Shasta and Keswick dams. The MOA was formalized and signed on April 5, 1960 through a State Water Rights Board action. Article I of the MOA specified minimum flow releases into the Sacramento River from Keswick Dam for the maintenance of fish and wildlife resources. Table 1 shows the minimum flow releases from Keswick per the 1960 MOA.

TABLE 1
Minimum Flow Releases from Keswick Dam per the 1960 Memorandum of Agreement

Period	Baseline Releases	Critical Dry Year Releases
January 1 through February 28	2,600 cfs	2,000 cfs

TABLE 1
Minimum Flow Releases from Keswick Dam per the 1960 Memorandum of Agreement

Period	Baseline Releases	Critical Dry Year Releases
March 2 through August 31	2,300 cfs	2,300 cfs
September 1 through November 30*	3,900 cfs	2,800 cfs
December 1 through December 31	2,600 cfs	2,000 cfs

*An agreement was formed in 1981 between Reclamation and CDFG that modified the flow requirement to 3,250 cfs to eliminate the possibility of a dramatic decrease in instream flow on December 1 (CDFG 1981).

Releases of water from Keswick Dam during the period September 1 through December 31 will be made with a minimum of fluctuation or change to achieve the best possible conditions for salmon reproduction to the extent it is compatible with other operational requirements. In addition, Article IV provides for the renegotiation of this agreement if additional water development projects are constructed on the Sacramento River or its tributary streams below Shasta Dam.

1966 Intra-agency Agreement. A Memorandum of Agreement (MOU) was made on November 28, 1966 between USFWS and Reclamation to delegate responsibility and cost allocation for the RBDD, TCC and TCFF fish facilities. The MOU designated Reclamation responsible for all of the construction of the facilities such as the fish trap and visitor's facilities on the east bank; canal headworks and louvers; settling basin; velocity barrier; trash rack; mechanical control mechanism for aquatic weed growth' the spawning channel; monitoring equipment; cleaning system; spawned-out rack; drum screen and check structure for the DPC; the turnout; fish ladder; headquarters building; counting facilities at the head and terminus; provisions for fry collecting tanks; spawning channels for the SPC's; turnout structures and channel improvements for Coyote, Thomes, and Stony Creeks; access roads and supplemental fresh water supply ponds and acquisition of land for fish facilities for Thomes and Stony Creeks; and a crossing for the GCID canal at Stony Creek.

USFWS was the take over subsequent operation, maintenance and replacement of these structures except the turnouts, access roads and fish channel on Thomes and Stony Creeks. Additionally, the MOU stipulated the following minimum flows in Thomes and Stony Creeks:

	Thomes Creek	Stony Creek
Oct 1 – Dec 31	250 cfs	500 cfs
Jan 1 – Apr 30	115 cfs	350 cfs
May 1 – Sep 30	50 cfs	100 cfs

USFWS was also responsible for maintaining necessary channel capacity in the DPC and for cleaning the DPC gravel without compromising the primary function of the DPC (to make adequate irrigation deliveries). In the SPCs, USFWS was to define, operate, maintain and replace any needed cleaning equipment. They are also responsible for acquiring and

administering fishery enhancement features on Thomes and Stony creeks and at RBDD that would have public access. Mitigation costs were to include all of the headworks fish louver system and 7% of all other fish facility costs, with the remaining 93% of those costs allocated as enhancement. The service was to request direct appropriation of funds from Congress for operation, maintenance and replacement of all the facilities and furnish statements of estimated and actual costs to Reclamation twice a year.

1977 Intra-agency Agreement. On November 17, 1977, another agreement was reached between Reclamation and USFWS that limited the responsibility of the Service for operation, maintenance and replacement to the east and west bank fishways, east bank trash rake, trash rack and public visitation center, monitoring equipment and counting facilities in the DPC, the bypass channel, and the terminal complex. Operation, maintenance and replacement of the SPCs from the control gates to the Sacramento River and all facilities in the right-of-way except farm roads and the interceptor drain system, were also included in the Service's responsibilities, as was Coyote Creek from the wasteway turnout to the Sacramento River, and the Fish and Wildlife Headquarters area and support facilities.

The USFWS was also responsible for removing spawned-out salmon carcasses from the project facilities. Reclamation was responsible for all but the aforementioned facilities and for cleaning the gravel and controlling aquatic pests in the DPC. This was to be done upon annual request by the Service and at other times of mutual agreement but would not interfere with the TCC irrigation purposes or be detrimental to fishery activity. Responsibility for any further additional facilities would be determined by mutual agreement.

Establishment of the NCVFWO. The USFWS NCVFWO was established in Red Bluff in 1977 as the Red Bluff Fisheries Assistance Office. One of the main purposes for establishing the NCVFWO was to evaluate fishery problems associated with RBDD and the TCFF.

Legislative and Regulatory Influences Relevant to the Action

Endangered Species Act. The ESA, most recently amended in 1988 (16 USC 1536), establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants and the preservation of the ecosystems upon which they depend. Section 7(a) of the ESA requires federal agencies to consult with USFWS and/or NMFS on any activities that may affect species listed as endangered or threatened. The federal co-leads will consult with USFWSand NMFS as appropriate.

California Endangered Species Act. The current version of the CESA was enacted in 1984 and patterned after the federal ESA. CDFG is responsible for CESA implementation. The CESA requires lead agencies to consult before implementing projects to ensure that any action carried out by the lead agency is not likely to jeopardize the continued existence of any listed threatened or endangered species, or destroy or adversely modify "essential habitat." Essential habitat is defined as habitat necessary for the continued existence of the species. Trinity County will consult with CDFG regarding impacts to state-listed endangered and threatened species as appropriate.

Fish and Wildlife Coordination Act. The FWCA requires consultation with USFWS when any water body is impounded, diverted, controlled, or modified for any purpose by any agency under a federal permit or license. USFWS and state agencies charged with

managing fish and wildlife resources are to conduct surveys and investigations to determine the potential damage to fish and wildlife and the mitigation measures to be taken. USFWS may incorporate the concerns and findings of state agencies and other federal agencies. Compliance with the FWCA will be coordinated with consultation for ESA, as described above.

Magnuson-Stevens Fishery Conservation and Management Act. The Magnuson-Stevens Act was passed in 1976, and is the primary law dealing with fisheries resources and fishing activities in Federal waters. The primary function of the act was the conservation and management of United States fishery resources via the development of domestic fisheries, and the reduction, and eventual elimination of foreign fishing activities within Federal waters. The Act provided the National Marine Fisheries Service (NMFS) legislative authority for fisheries regulation in the United States, in the area between three-miles to 200 miles offshore and established eight "Regional Fishery Management Councils (Councils) that manage the harvest of the fish and shell fish resources in these waters.
In 1995, Congress re-authorized the act with a number of provisions that intended on addressing specific problems or perceived problems with current fisheries management or Council procedures. One of the notable provisions affecting the FPIP is to protect essential habitat for fish in the fishery for spawning, breeding, feeding or growth to maturity.

Description of the Proposed Action

Purpose and Need

The purpose of proposed action is twofold:

- To substantially improve the long-term ability to reliably pass anadromous fish and other species of concern, both upstream and downstream, past RBDD and,
- Substantially improve the long-term ability to reliably and cost effectively move sufficient water into the TC Canal and Corning Canal systems to meet the needs of the water districts served by the Tehama-Colusa Canal Authority (TCCA).

The need for the project is driven by the continued and well-documented fish passage and agricultural water diversion reliability problems associated with the operation of RBDD. Even with the current fish ladders in operation, RBDD continues to act as an impediment to fish passage during the gates-in period. The 4-month window of operation has constrained operation of the dam for diversion purposes to the point that TCCA cannot reliably meet the water needs of its customers when the gates are out.

Process of Selecting the Proposed Project

In the process of selecting a proposed project a series of screening criteria were developed. The initial alternative screening exercise concluded that alternatives requiring an increase in gates-in operations would not improve fish passage, and therefore would not meet the purpose of the project. Even with improvements to existing ladders, it was determined that maximum fish passage efficiency is achieved with gates out; therefore, an increase in gates-in operations would reduce fish

passage by some degree. Therefore, all of the alternatives that were considered in greater detail 4-month-or-less-gates-in operations. This resulted in alternatives that were largely similar in their gate operation assumptions, but covered a wide variety of facility options for pumping water for agricultural deliveries or providing improved fish passage.

From these considerations three primary alternatives were developed:

- Alternative 1 – Current 4-months gate operation with fish passage facility improvements and 1,700-cfs total pumping capacity,
- Alternative 2 – A reduction in gate operation to the 2 months correlating with peak agricultural demand (July and August), fish passage facility improvements, and 2,000-cfs total pumping capacity,
- Alternative 3 – Elimination of gates-in operation and need for fish ladders; 2,500-cfs total pumping capacity.

Additionally, the California Environmental Quality Act (CEQA) requires that the preferred alternative be compared to an existing conditions baseline, whereas the National Environmental Policy Act (NEPA) requires comparison with a No Action Alternative. The No Action Alternative represents ongoing activities and operations and corresponds to the "No Project" definition as outlined in the state CEQA *Guidelines*, Section 15126, as a "condition that would be reasonably expected to occur if the project were not approved."

Additional screening criteria were developed to narrow the list of potentially feasible alternatives. The express purpose was to identify facility options that would create alternatives that have the greatest likelihood of success. Facility options were compared and evaluated against the following criteria:

- Effectiveness – technology, management of water delivery, and biological requirements that combine to provide a high likelihood of long-term success,
- Implementation – practical execution, including potential public acceptance issues, permitting, and land use issues, and constructibility,
- Environmental – impacts to resources with emphasis on special-status species, including native fish species, including both short-term (construction-related) and long-term impacts,
- Cost – relative comparison of estimated life-cycle costs for each alternative, including initial capital costs and operation and maintenance (O&M) costs.

Following the full consideration of the facility options and gate operation restrictions the following alternatives were proposed for full environmental analysis and were analyzed in the Fish Passage Improvement Project Environmental Impact Study/Environmental Impact Report (EIS/EIR). The final alternatives selected are summarized in Table 2 below.

TABLE 2

Summary of Final Alternatives

	Gates-in Operation		Fish Passage Facilities			Gates-out Water Supply				
Name	**Duration**	**Timing**	**Right Bank (cfs)**	**Center (cfs)**	**Left Bank (cfs)**	**Research Pumping Plant (cfs)**	**Right Fish Ladder (cfs)**	**Mill Site (cfs)**	**Stony Creek (cfs)**	**Total (cfs)**
Existing Conditions	4 months	May 16-Sept 15	Existing 338	Existing 100	Existing 338	240	165		600	1,005
No Action Alternative	4 months	May 16-Sept 15	Existing 338	Existing 100	Existing 338	320	165			485
1A: 4-month Improved Ladder Alternative	4 months	May 16-Sept 15	New 800	Add if needed	New 831	320		1,380		1,700
1B: 4-month Bypass Alternative	4 months	May 16-Sept 15	New 800	Add if needed	Bypass channel 1,000; existing 338	320		1,380		1,700
2A: 2-month Improved Ladder Alternative	2 months	July 1-August 31	New 800	Add if needed	New 831	320		1,680		2,000
2B: 2-month with Existing Ladders Alternative	2 months	July 1-August 31	Existing 338	Existing 100	Existing 338	320		1,680		2,000
3: Gates-out Alternative	0 months					320		2,180		2,500

Following the secondary screening and the final selection of alternatives a request to the resource trustees was made by Reclamation to provide comments on the alternatives proposed by the TCCA. As a response to that request, the U. S. Department of Interior's Sacramento Fish and Wildlife Service (Service) Office began collaborations with California Department of Fish and Game (CDFG) and National Marine Fisheries Service biologists in preparation of a Planning Aid Memo (Memo) under the authority of provisions of Section 2(b) of the Fish and Wildlife Coordination Act (FWCA) 48 Stat. 401 as amended: 16 U.S.C. 661 et seq. The comments contained in the Memo were developed in coordination with the FWS's Red Bluff Fish and Wildlife Office (USFWS, 2001). In the Memo dated October 19, 2001, the Service provided a ranking of the proposed alternative based on the benefits to the fishery resources at RBDD. The Memo provided the list below ranking the alternatives (for alternative number and its description see Table 2 above) with the most benefit to fishery resources first and the alternative with the least benefit last:

- (1) Alternative 3
- (2) Alternative 2(b)*
- (3) Alternative 2(a)**
- (4) Alternative 1(a)
- (5) Alternative 1(b)

Letters to Reclamation from CDFG and NMFS dated October 23, 2001 and October 26, 2001 respectively, concurred with the Services's comments and rankings provided in the Planning Aid Memo dated October 19, 2001. In a letter to Reclamation, dated January 8, 2002, the California Department of Water Resources concurred with the comments contained in the Service's Planning Aid Memo (DWR, 2002) finding that either Alternative 3 or the 2 month gates-out alternatives [2(a) or 2(b)] would best meet the balance of fishery benefits and water supply needs. Finally, the Red Bluff-Tehama County Chamber of Commerce (RB-TCCC)has stated in a letter (dated January 3, 2002) to both the TCCA and Reclamation that they oppose any alternative that eliminates the seasonal impoundment of the Sacramento River behind the gates of the RBDD (RB-TCCC, 2002).

Proposed Project for the Purposes of Developing this Biological Assessment

To facilitate the timely review of the draft BA by the Authority and the preparation of the Biological Opinion by NMFS, the following project description was used:

- 2-month gates-in operation of the RBDD (July 1-August 31),
- 2,180 cubic feet per second (cfs) pump station footprint at the Mill Site with 1,680 cfs installed capacity,
- Existing fish ladders.

For the purposes of impacts assessment, and through discussions with the Technical Advisory Group over several months, the above project description represents the "worst-case likely project" and is the Proposed Project of this Biological Assessment.

Improved agricultural water deliveries would be achieved with operation of 2,000 cfs of pumping capacity (320 cfs at RPP; 1,680 cfs at Mill Site). Water would be conveyed via a pipeline from the Mill Site Diversion Facility across Red Bank Creek to the TC Canal Headworks. Improvements to fish passage would be achieved through the reduction in gate operations. Existing ladders would continue to be operated at the right and left abutments (right 338 cfs, left 338 cfs, for a total of 676 cfs) during the gates-in period (July-August). The current center fish ladder would not be installed in RBDD under this Proposed Alternative. Finally an Adaptive Management Program would be implemented to provide decision making guidance in future year's operations.

Implementation of the project is a five phase process. The five phases include: 1) Feasibility Study; 2) Preliminary Design and Environmental Documentation; 3) Final Design and Permit Coordination; 4) Construction; 5) Monitoring. Currently, the project is in the Environmental Documentation Phase (Phase 2). As of the 2002 Administrative Draft EIS/EIR construction is scheduled to be completed in late 2006. Timely completion of Phases 3, 4, and 5 depend primarily on funding, however other factors such as land and permit acquisition can also influence the schedule. Until such funding is found, and the Construction Phase (Phase 4) of the project has been completed, current operation of all RBDD and TCCA facilities, including diversions from Stony Creek, will continue uninterrupted.

Proposed Facilities

Mill Site Pump Station

The preferred pump station option is a conventional vertical propeller pump station at the Mill Site used in conjunction with the existing RPP to meet the water delivery needs. The Mill Site is located upstream from RBDD and Red Bank Creek.

The station site configuration consists of trashracks or fish screens, a forebay or intake piping, pump station, and conveyance facilities. A fish bypass system may be needed, depending on the length of the fish screens and the type of pumping system. There are several potential combinations of intake and pumping facility options.

For the vertical propeller pump option, the discharge piping would be routed to a new discharge outlet structure at the sedimentation basin. It is assumed that the drum screens would be removed under this option. When the gates are in, water would be diverted by gravity through the fish screens into the new forebay and would then bypass the pump station into the conveyance system for delivery to the sedimentation basin.

The Mill Site Pump Station facilities would include a fish screen along the river. The screens would be designed to provide a 0.33-fps approach velocity. The length of the screen depends on the the characteristics of the river (i.e., depth, channel geometry, flow volume, and velocity under various operating conditions) at the screen location, which would be determined during preliminary design. Because the pumpstation footprint will be designed to accommodate the full 2,180 cfs pumping capacity, the length of the screen would be approximately 1,100 feet. The screens would be installed in approximately 60 bays. Blowout

panel(s) would be provided as an emergency hydraulic relief system in the event of differential heads between the river and the forebay. The top of bulkheads would be set at the 25-year flood elevation to limit the amount of debris in the forebay for most extreme flood events. A cofferdam would be constructed around the screens and the site dewatered to allow construction of the screens.

Water would flow through the fish screens into the pump station forebay and into the vertical propeller pump station. Approximately 6pumps would be required to achieve a pumping capacity of 1,680 cfs. The location of the pump station relative to the fish screens would be determined during preliminary design. Considerations for the location would include the cost of excavating the forebay versus piping, as well as the hydraulic flow characteristics entering the pump station.

The pumps would lift the water to the pump station outlet box. The water would flow by gravity from the outlet box through a siphon under Red Bank Creek. The water would discharge downstream of the fish drum screens in the sedimentation basin. The site plan area requirements and sizes of conveyance facilities are based on the pumping capacity requirement for 2,180 cfs pumping capacity.

The land where the pump station and conveyance facilities would be constructed is adjacent to land owned by the federal government for RBDD and is currently available for purchase. Power supply is nearby, and access is in place. Direct access to the pump station site from the existing RBDD site would likely require a bridge across Red Bank Creek.

Fish Screen Design Criteria

The objective of the fish screen design is to provide safe fish passage for juvenile fish (primarily salmon and steelhead) past TCCA water diversion facilities. This would be accomplished through the use of positive barrier on-river fish screens.

The required approach velocity of 0.33 fps would be used for on-river applications to meet CDFG criteria. The lengths and depths of the screens for each option were derived from preliminary hydrographic field surveys at each of the proposed pump station sites.

Fish Bypass System

A minimum of three internal fish bypasses would be required for the Mill Site vertical pump station option at the maximum 2,500-cfs pumping capacity, assuming the normal riverflow of 12,000 cfs during the irrigation season. A pumped bypass system would use the fish-friendly screw or helical pumps that have been tested at RPP over the past several years.

The fish bypass piping system would be sized to achieve a minimum velocity of 4 fps to convey fish back to the river and minimize sediment deposition in the pipeline. At the minimum bypass entrance velocity of 2 fps, the required flow for each bypass pipeline at normal river elevations is about 36 cfs. The fish bypass would outlet just below the down-stream end of the fish screen in the river channel. Alternatively, the fish could be conveyed in a separate pipeline from the fish bypass pumps to the existing drum screen bypass system pipeline. This would require a piped bypass system paralleling the discharge conveyance system to the sedimentation basin, about ½ mile long. The pipeline would be

constructed across the sedimentation basins and connect to the existing fish bypass pipe from the drum screen bypass.

Fish bypasses would be designed to limit the exposure along the fish screen to 120 seconds, which is the current exposure time criterion, assuming a variance would be granted by NMFS. Separate pipelines from the entrance of each fish bypass would convey water and fish to a screw/helical pump station located on the east side of the forebay. An exception to the current "no pumped fish bypass" criterion would be required from NMFS, or an exception to the maximum exposure time would be required to eliminate the need for the fish bypass system.

The fish bypass pump station would be similar to the existing RPP located downstream of the irrigation gates. Two 30- to 50-cfs pumps would be required for the 4 for the 1,680 cfs pumping capacity. The pumps would convey the water and fish back to the river upstream of the current gravity-flow intake gates.

Conveyance Facilities across Red Bank Creek

The conveyance system across Red Bank Creek would consist of pipes or culverts or a combination of both. The most advantageous combination would be considered in the preliminary design. The conveyance system would be sized for a maximum velocity of 8 fps at peak flow. The discharge structure at the sedimentation basin could be located anywhere along the westerly side of the sedimentation basin. The best apparent location and the specific design would be determined during the preliminary design.

A vehicle access bridge would most likely be constructed across Red Bank Creek to provide access for maintenance vehicles between the Mill Site and the existing TCCA facilities.

- Major project Benefits

Chapter 3 – Listed Species Potentially Affected by the Proposed Action

Species Found in Action Area that have status under ESA/CESA

The Sacramento River provides habitat for the freshwater life stages of chinook salmon as well as steelhead. Within California's Central Valley, the Sacramento River provides a corridor for the anadromous salmonid resources between upstream reaches and the tributaries to the Sacramento River and the Pacific Ocean. The Sacramento River is the largest river system in California with more than 90 percent of the Central Valley salmon spawning and rearing within the river system. The Sacramento River supports four runs (races) of chinook salmon: fall, late-fall, winter, and spring run. Life history characteristics for native anadromous species found near RBDD are shown in Table 3 .

The fall-run chinook salmon is the predominant salmon in the Central Valley. Fall-run steelhead are also found in the Central Valley with almost the entire population restricted to the Sacramento River watershed The number of chinook salmon and steelhead spawners estimated passing upstream of RBDD from 1960 through 1966 are summarized in Table 4.

TABLE 3
Life History Characteristics of for Anadromous Salmonid and Green Sturgeon found near RBDD

Name	Adult Immigration	Spawning	Incubation	Rearing	Juvenile Emigration
Fall Chinook Salmon	July-December	September-December	October-March	December-June	December-July
Late-fall Chinook Salmon	October-April	December-April	January-June	April-November	April-December
Spring Chinook Salmon	April-July	August-October	August-December	October-April	October-May
Winter Chinook Salmon	December-July	April-August	April-October	July-March	July-March
Steelhead	Year-round	December-April	December-June	Year-round (1-2 years)	January-December
Green sturgeon	February-June	March-July	Embryos planktonic	Larvae in river, juveniles in Delta	June-August

TABLE 4
Estimated adult salmonids passing RBDD from 1960-1966 (Hallock 1987)

Year	Winter-run	Spring-run	Fall-run	Late-fall-run	Steelhead

	Chinook	Chinook	Chinook	Chinook	
1960	183,529	45,760	244,705	78,306	21,289
1961	121,153	30,207	161,537	51,692	14,054
1962	115,346	28,759	153,794	49,214	7,771
1963	127,421	31,770	169,895	54,366	11.092
1964	124,094	30,941	165,459	52,947	14,752
1965	86,891	21,665	115,855	37,074	14,236
1966	95,461	23,801	127,281	40,730	15,803

Winter-run Chinook Salmon

Winter-run begin their migration up the Sacramento river in mid-December and may spawn from mid-April through mid-August. The egg incubation period extends from mid-April through mid-September. Historically, before the construction of Shasta and Keswick Dams and other barriers to fish migration on tributaries of the Sacramento River, winter-run chinook salmon (possibly more than 200,000) spawned in the upper reaches of the Little Sacramento, McCloud, Calaveras, and lower Pit Rivers (NMFS 1993a), tributaries of the Sacramento River upstream of Shasta Dam. Winter-run chinook were blocked from their historic spawning areas by the construction of Shasta and Keswick Dams in the early 1940's, but can reproduce in the Sacramento river downstream of Keswick Dam because of cooler summer water temperatures resulting from Shasta Reservoir releases.

In the 1960's, 98% of winter-run chinook salmon spawned in the upper Sacramento River (Hallock and Fry 1967). The other 2% were not accounted for, but no satisfactory escapement records are available for winter- or spring-run chinook before RBDD.

For Sacramento River winter-run chinook salmon, ESU critical habitat is designated to include the following: Sacramento River from Keswick Dam in Shasta County (River Mile [RM] 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge including Honker Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 9,329 square miles in California. The following counties lie partially or wholly within these basins: Butte, Colusa, Contra Costa, Glenn, Napa, Nevada, Placer, Plumas, Sacramento, Shasta, Solano, Sutter, Tehama, Trinity, Yolo, and Yuba.

Spring-run Chinook Salmon

Spring-run chinook salmon migrate upstream during the spring beginning in mid-March, hold over in deep pools during the summer months and spawn from mid-August through mid-October. Egg incubation occurs from mid-August to mid-January. Spring-run in the Sacramento river exhibit an ocean-type life history, emigrating as fry, subyearlings, and

yearlings. Based on timing observations observed at RBDD, spring-run emigration from the upper Sacramento river typically occurs from November through April.

Prior to Keswick Dams, and other barriers to fish migration on tributaries of the Sacramento River, spring-run chinook salmon spawned in the upper reaches of the Sacramento River and its tributaries. Approximately 8% of spring-run chinook salmon passing RBDD spawns in tributaries of the Sacramento River, including Battle, Cottonwood, South Cow and Clear Creeks.

Spring-run chinook salmon run size estimates for the Sacramento river have declined substantially in recent years. Since 1991, adult spring-run population estimates have remained below 1,000 fish. Coded wire tag recoveries and genetic testing between fall/late-fall and spring-run chinook salmon from Feather River Hatchery have lead to speculation that these two runs may have hybridized in recent years (63 FR 11487). The remaining genetically pure spring-run chinook salmon are thought to occur only in Deer, Mill, and Butte Creeks. Spring-run chinook salmon population levels are described as sporadic in Battle Creek, Big Chico Creek, Antelope Creek, Cottonwood Creek, Yuba River and the Sacramento River (CDFG 1996).

Critical habitat for federal Central Valley spring-run chinook salmon ESU is designated to include all river reaches accessible to listed chinook salmon in the Sacramento River and its tributaries in California. Also included are adjacent riparian zones, as well as river reaches and estuarine areas of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are tribal lands and areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 9,329 square miles in California. The following counties lie partially or wholly within these basins (or contain migration habitat for the species): Alameda, Butte, Colusa, Contra Costa, Glenn, Marin, Napa, Nevada, Placer, Sacramento, San Francisco, San Mateo, Shasta, Solano, Sonoma, Sutter, Tehama, Yolo, and Yuba.

Fall-run Chinook Salmon

The fall/late-fall runs constitute the largest population of chinook salmon in the river in recent years. Between 1967 and 1997, run size estimates have ranged from approximately 50,000 to over 200,000 adults. The fall/late-fall-run spawn from October through February and eggs may incubate in the gravel through the end of April. Due to the prolonged spawning and incubation period, juvenile rearing and emigration is dispersed nearly throughout the entire year.

It is estimated that 25 to 60% of the fall-run chinook salmon passing RBDD are Coleman National Fish Hatchery fish (USFWS 1993a), on Battle Creek. For example, in 1996 an estimated 110,000 fall-run chinook passed RBDD; approximately 73,000 (66%) escaped to Battle Creek of which 21,000 (19%) were taken by the hatchery and 52,000 (47%) spawned in

Battle Creek, the remainder spawned in the mainstem Sacramento River (30,000; 27%) and Clear Creek (6,000; 5%) (Rich Johnson, USFWS-NCVFWO).

The estimated number of fall-run chinook from 1956 to 1966, ranged from 61,887 to 292,704, with an average of 159,251 salmon (Hallock 1987).

Late-fall-run Chinook Salmon

Approximately 4% of the late-fall run chinook salmon passing RBDD spawn in Sacramento River tributaries, including Cottonwood, Cow, and Clear Creeks. For the period of 1967 to 1991, the average number of late-fall-run chinook naturally spawning upstream of RBDD was 14,159 fish based on escapement estimates and approximately 1,000 late-fall-run chinook salmon were spawned annually at the Coleman National Fish Hatchery from 1967-1991 (CDFG 1994).

Steelhead

Based on data from 1967 to 1974, 28% of the adult steelhead migrating past RBDD spawn in the upper reaches of Sacramento River tributaries, including Battle, Cottonwood, and Cow Creeks, between RBDD and Keswick Dam, and 28% are spawned at the Coleman National Fish Hatchery, while the remaining 46% are caught by sport anglers; very few, if any, steelhead spawn in the mainstem Sacramento River (Leidy et al. 1984).

Hallock (1989) gives calculated population estimates of steelhead in the Sacramento River above the Feather River from 1962 to 1970. Numbers of steelhead migrating upstream past RBDD for 1962 to 1966, as shown in table 2 below were calculated by multiplying the above population estimates by 42.8% (the average percentage, for 1967-70, of steelhead in the Sacramento River above the Feather River that passed RBDD). Based on the data for 1962-66, the number of steelhead passing RBDD was 8.7% of the number of fall-run. Thus, numbers of steelhead in the Sacramento River in 1960 and 1961, as shown in Table 2, were calculated by multiplying the number of fall-run in table 2 by 8.7%.

Critical habitat for Central Valley steelhead ESU is designated to include all river reaches accessible to listed steelhead in the Sacramento and San Joaquin Rivers and their tributaries in California. Also included are adjacent riparian zones, as well as river reaches and estuarine areas of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are areas of the San Joaquin River upstream of the Merced River confluence, tribal lands, and areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 13,096 square miles in California. The following counties lie partially or wholly within these basins (or contain migration habitat for the species): Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Glenn, Marin, Merced, Nevada, Placer, Sacramento, San Francisco, San Joaquin, Shasta, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tuolumne, Yolo, and Yuba.

Green Sturgeon

Green sturgeon have been caught in saltwater from Ensanada, Mexico, to the Bering Sea (Miller and Lea, 1972). In California, green sturgeon have been recorded in lower reaches of the Sacramento-San Joaquin River system, the Eel River, Mad River, Klamath River, and Smith River (Moyle, 1976). In California, spawning has been confirmed only in the Sacramento River and the Klamath River (Moyle et al., 1995). After the construction of Keswick Dam and storage of the reservoir in 1948, the primary spawning areas were from Keswick Dam to Hamilton City (USFWS, 1998).

USFWS routinely observes adult sturgeon in the vicinity and downstream of RBDD when the dam gates are in (K. Brown, pers. com.).. It is unclear if all or the majority of these are green or white sturgeon (D. Killam, pers. com.). Green sturgeon have been observed downstream of RBDD at Dairyville, Tehama County (RM 234), in the 10-mile reach of the Sacramento River downstream of RBDD, and near Hamilton City, Glenn County (RM 197) (Moyle et al., 1995). Green sturgeon life history characteristics are summarized in Table 1.

The habitat requirements and characteristics for green sturgeon are poorly known, but spawning and larval ecology is likely similar to that of white sturgeon (Moyle et al., 1995). Green sturgeon are thought to require colder and cleaner water than do white sturgeon (Moyle et al., 1995). Spawning occurs between March and July when water temperatures reach between 46°C and 57°C (Moyle et al., 1995). Spawning takes place in swift, deep water (>10 feet) where eggs are broadcast over clean sand to large cobble substrates.

Following egg hatching, larvae drift passively downstream and reach juvenile stages beginning at about 2 cm in length. Juvenile sturgeon are routinely captured in traps at RBDD during the summer months (K. Brown, pers. com.).As indicated by trapping data, the majority of juveniles pass through the vicinity of RBDD from June through August. Juvenile green sturgeon are transported and rear in the Sacramento-San Joaquin Delta and Suisun-San Pablo Bay estuary for one or more years before entering the deeper San Francisco Bay and exiting into the ocean. They enter the ocean primarily during the summer and fall before they are 2 years old (Moyle et al., 1995).

Juvenile green sturgeon are transported and rear in the Sacramento-San Joaquin Delta and Suisun-San Pablo Bay estuary for one or more years before entering the deeper San Francisco Bay and exiting into the ocean primarily during the summer and fall before they are 2 years old (Moyle et al., 1995). Individual green sturgeon have been tagged in San Pablo Bay and recovered from Santo Cruz, California, to Gray's Harbor, Washington (Chadwick, 1959 and Miller, 1972 as cited by Moyle, 1995). Little is known about the age and growth of green sturgeon except that they are long lived and reach a maximum size of 2.3 meters fork length and 159 kilograms (Skinner, 1962).

Chapter 4 – Environmental Baseline

Introduction

This chapter on the environmental baseline describes the impacts of past and ongoing human and natural factors leading to the present status of the species and its habitat within the action area. The environmental baseline provides, in effect, a "snapshot" of the relevant species' health at a specified point in time (i.e. the present). It does not include the effects of the discretionary action proposed in the current consultation, but it does include past and present impacts of all federal, state, or private actions and other human activities in the action area. 50 CFR Section 402.02. For purposes of this BA, the current effects of all past activities including those associated with construction of the Project, historic operation of the Project, and the associated natural environment. The baseline also includes Federal, State, local, and private actions already affecting the species or habitat in the action area or actions that will occur contemporaneously with the consultation in progress. The environmental baseline assists both the action agency and the Services in determining the effects of the proposed action on the listed species.

Past and Present Impacts of Current Operations, all Federal, State, or Private Actions and Other Human Activities in the Action Area.

RBDD Operational Impacts

Impacts of current operations to Winter-run Chinook Salmon

Under current operations, approximately 15 percent of winter chinook adult spawners passing through the project area may be blocked or delayed by the current 4 months of gates-in operation. The percentages of entire adult population of winter-run chinook that are attempting to pass RBDD and may be impacted are listed by month as follows:

- Late May—4 percent of annual total
- June—4 percent of annual total
- July—10 percent of annual total

For winter chinook salmon, the earliest dispersing and outmigrating juveniles may be subjected to adverse effects from RBDD operations. Approximately 39 percent of winter chinook salmon are subjected to the operational effects of RBDD and its associated diversion facilities. The percentage of the annual juvenile winter-run chinook salmon passing RBDD that are presently subject to operational impacts are listed by month as follows:

- July—1 percent

- August—12 percent
- Early September—26 percent

Impacts of current operations to Central Valley ESU Spring-run Chinook Salmon

By far, the greatest effect of RBDD operations on adult salmonids is to spring-run chinook salmon. Approximately 75 percent of the annual adult spring chinook spawners passing through the project area must do so during the current gates-in operation. The approximate percentages of the annual adult population passing RBDD are listed by month as follows:

- Late May—22 percent
- June—38 percent
- July—9 percent
- August—2 percent

Impedance of these adult spring chinook by RBDD operations may adversely affect their ability to successfully pass upstream into and through the Sacramento River and into tributary streams and headwater reaches. It is in these headwater reaches in the tributaries and the most upstream portion of the mainstem Sacramento River that the majority of spring-run chinook salmon must hold throughout the summer months before spawning in the early fall. The biological consequences of blockage or passage delay at RBDD results in changes in spawning distribution, hybridization with fall chinook, increased adult pre-spawning mortality, and decreased egg viability, which result in the reduction of annual recruitment of this species.

Currently, it is difficult to precisely characterize the temporal distribution of adult spring-run chinook salmon as they past RBDD. This is because prior to mid-May the gates-out operations at RBDD preclude the use of the fish ladders and therefore the enumeration of adults as they pass RBDD. However, once the RBDD gates go in during in May, spring run chinook are identified as they pass. The exact effect of lowering the gates during this species peak immigration period is unknown but as this species is threatened, it is not be desirable to interrupt their migration.

For juvenile spring-run chinook salmon , approximately less than 1 percent of the annual number of juveniles passing RBDD are vulnerable to operations and facilities at RBDD.

Impacts of current operations to Central Valley ESU Fall/Late-Fall Run Chinook Salmon

Up to 25 percent of the annual run of adult fall chinook salmon may be affected by the current gates-in operation. The percentages of the annual population passing RBDD that may be impacted are listed by month as follows:

- July—2 percent
- August—13 percent
- Early September—10 percent

As previously stated adult late-fall chinook salmon are not presently blocked or impeded by operations of the RBDD.

The annual percentage of juvenile fall-run chinook salmon passing RBDD that are presently subject to operational impacts are listed by month as follows:

- Late May—2 percent
- June—3percent
- July—2 percent
- August—1 percent

The annual percentage of juvenile late-fall run chinook salmon passing RBDD that are presently subject to operational impacts are listed by month as follows:

- Late-May—4 percent
- June—4 percent
- July—7 percent
- August—14 percent
- Early September—5 percent

Impacts of current operations to Central Valley ESU Steelhead

For migrating adult steelhead, approximately 17 percent of the annual adult steelhead run may be affected by the current gates-in operation. The percentages of the annual run of adult steelhead passing RBDD that may be affected are listed by month as follows:

- June—1 percent
- July—1 percent
- August—5 percent
- Early September—10 percent

Approximately 36 percent of juvenile steelhead passing RBDD during the gates-in period subject to operational impacts are listed by month as follows:

- Late May—6 percent
- June—4 percent
- July—4 percent
- August—12 percent
- Early September—10 percent

Impacts of Current operations to Green Sturgeon

When the dam gates are placed in the river, a physical barrier is created that prevents passage of adult sturgeon. Currently, a large portion of the adult green sturgeon successfully passes RBDD unimpeded because they are immigrating during the period prior to May 15 when the RBDD gates go in. However, because sturgeon prefer lower water velocity and do not readily jump fish ladder weirs like salmonids, the existing fish ladders that operate during gates-in operations prevents any upstream passage of adult green sturgeon.

Under current operations, approximately 35 percent of adult green sturgeon spawners passing through the project area may be blocked by RBDD. The percentages of entire adult population of green sturgeon that are attempting to pass RBDD and may be impacted are listed by month as follows:

- Late May—approximately 15 percent
- June—approximately 20 percent of the annual upstream of RBDD

In addition, some adult green sturgeon are delayed in their down-river migration by RBDD after spawning occurs upstream of the dam prior to May 15 if these fish arrive at RBDD on or after May 16 when the dam gates go in.

During gates-in periods at RBDD, approximately 99 percent of the larval or juvenile life stages of anadromous green sturgeon that were spawned upstream of RBDD migrate downstream through the project facilities. During gates-in operation, existing pathways for these life stages includes passage under the dam gates or through the fish ladders and their auxiliary water systems, or they are subjected to impingement, entrainment, and passage through diversion bypass systems at RPP and TC Canal headworks. An additional effect of the existing operations of RBDD on larvae or juvenile green sturgeon includes predation by both fish and avian species while passing through Lake Red Bluff and downstream of the dam.

With the current gates-in operations, approximately 99 percent of annual juvenile green sturgeon passing RBDD are subjected to the operational effects of the dam and its associated diversion facilities. The annual percentage of juvenile green sturgeon passing RBDD that are presently subject to operational impacts are listed by month as follows:

- Late May—less than 1 percent
- June—37 percent
- July—50 percent
- August—11 percent

Impacts to Habitat

Chinook salmon spawn in waters with depths greater than 0.5 feet, with velocities just above the substrate of 1.5 to 2.5 ft/s, and with an uncompacted gravel substrate of one to 6-inches diameter. Eggs generally hatch after 40 to 60 days depending on water temperatures.

Pre-emergent fry incubate in the gravel for approximately 2 to 4 weeks before emerging from the redds.

The construction of Shasta and Keswick dams eliminated the major source of gravel recruitment (USFWS, 1997). Since the construction of Whiskeytown dam and extensive gravel extraction from Clear Creek the remaining source of spawning gravel is from the Cottonwood watershed (op. cite.). Loss of gravel recruitment is believed to be a major contributing factor to declining chinook salmon productivity in the upper Sacramento River below Keswick Dam. The Upper Sacramento River Fisheries and Riparian habitat Management Plan ranks restoration of spawning habitat third in a list of twenty action items to restore the salmon fishery (Upper Sacramento River Fisheries and Riparian Habitat Advisory Council 1989). The California Department of Water Resources (CDWR) began a gravel restoration project within the upper river in 1990. Through 1996 a total of 125,000 cubic yards of spawning gravel have been introduced into the upper Sacramento River at nine sites, two of which were upstream of the ACID diversion dam (Rectenwald pers comm as cited by NSR, 1999). Gravel introductions upstream of ACID diversion dam have substantially increased the amount of spawning habitat since 1987. Good and fair quality spawning habitat areas upstream of the ACID diversion now cover approximately 49% of the river bed (Bigelow 1996).

Flood control projects between Collinsville (Sacramento River RM 0) and Chico Landing (RM 194) have profoundly affected the quantity and quality of chinook salmon and steelhead habitats in the Sacramento Valley (NMF, 1997). Presently over 1,300 miles of levees, overflow weirs, pumps and bybass channels exist within this reach of the Sacramento River. Currently, riparian forests along the river constitutes approximately 3% (16,000 acres) of the historic riparian forest that bordered the river in 1850 (approximately 500,000 acres) (NMFS, 1997). The degradation and fragmentation of riparian habitats has resulted in losses of instream and above stream cover, elimination of slow and slack water areas, reduction in food production and raising of water temperature all detrimental to juvenile salmon and steelhead (op. cite.).

Similar to the discussion of the impacts of habitat modification and losses for chinook salmon it is likely that suitable flows and channel conditions in the Sacramento River and Delta for spawning and rearing of green sturgeon occur less frequently now than they once did (Moyle at al., 1995). Because Red Bluff Diversion Dam has apparently been a barrier to green sturgeon migration until recently, it is possible that they have been forced to spawn in suboptimal conditions in the lower Sacramento River (CDFG, Website).

Impacts to Water Quality/Temperature

Maximum survival of incubating eggs occurs at water temperatures between 40°F and 56°F, while maximum survival of pre-emergent fry occurs at water temperatures between 40°F and 58°F. Sublethal effects begin to occur to eggs and fry at temperatures greater than 56°F.

Water temperature is an important factor in controlling survival, development, and growth of fish during all life history stages, and is the only water quality constituent in the Sacramento River at RBDD that exceeds state water quality standards or objectives. According to the State Water Resources Control Board's Order 90-5, the temperature

objective for the operation of CVP for the upper Sacramento River from Keswick Dam to RBDD is less than or equal to 56°F (CALFED Bay-Delta Program, 1999).

The water temperature objective that was stipulated by Order 90-5 was exceeded 85 percent of the time during the gates-in period for 1998 through 2000. The average temperature of Lake Red Bluff for the gates-in period during this interval was 56.7°F. Newly spawned and incubating eggs and fry are the most sensitive life stages to elevated temperatures (NMFS, 1997). Mortality of eggs begins at 56 °F. and is 100% at 62 °F. (numerous authors as cited by NMFS, 1997). The problem of inadequate water temperatures has occured over the last 2+ decades due to increased demand for CVP water. Since 1992, CVP operations have been modified due to water temperature needs for the protection of winter-run chinook salmon as required by the Endangered Species Act (ESA). Water temperatures in the middle and lower reaches of the Sacramento River are generally influenced by releases from Shasta (NMFS, 1997). Recent research has found that spring to early summer water temperatures in the Sacramento River may have risen from 2° to 7° F. since the late 1970's (op. cite.). It is thought that this temperature increase near Red Bluff, Butte City, and Grimes may be a result of streamflow reductions in this reach (op. cite.).

Pollution sources such as acid mine drainage containing large concentrations of copper, zinc, and cadmium from the Iron Mountain Mine near Redding are thought to be responsible for numerous fish kills since 1940 when Sasta Dam was being constructed. The State Water Resources Control Board has set Basis Plan objectives for metals in the upper Sacramento River which provide for the protection of early life stages of salmon. These objectives are: 5.6 ppb for copper, 16 ppb for zinc, and 0.22 ppb for cadmium (NMFS, 1997). These objectives are often exceeded in the Sacramento River downstream of Keswick (op. cite.). Continued implementation of the EPA's Superfund Program is expected to eventually remedy these heavy metal discharges and impacts to chinook salmon in the Sacramento River.

Impacts from Entrainment

Entrainment of juvenile fish has been identified as contributing to the decline in anadromous fish populations. A primary source of entrainment is unscreened or inadequately screened diversions. Entrainment of juvenile salmonids is one of the most ubiquitous causes of mortality in the Sacramento River and the Sacramento-San Joaquin Delta. (NMFS, 1997). According to the California Advisory Committee on Salmon an Steelhead Trout (CACSST) it was estimated that the were over 330 unscreened diversions on the Sacramento River between Redding and Sacramento (CACSST, 1987). A more recent survey found that there were approximately 350 unscreened diversions along the Sacramento River downstream of Hamilton City alone (NMFS, 1997). Additionally, over 2,000 unscreened diversions are estimated to be located in the Sacramento-San Joaquin Delta (op. cite.). The actual number of juvnile salmonids lost through entrainment into unsrceened diversions is unknown but Hallock (1987) estimated approximately 10 million juvenile salmonids may be lost annually in the Sacramento River. Numerous protective actions by resources agencies have been recently been implemented to reduce losses of juvenile salmonids at diversions along the Sacramento River and Delta.

Juvenile and occasionally adult green sturgeon are entrained in the South Delta fish facilities of the State Water Project and the Central Valley Project (Moyle, et al., 1995). The extent of the impact on their population is unknown, but it is likely that larval and juvenile green sturgeon are entrained into unscreened diversions throughout the Sacramento River and Delta when these lifestages encounter them.

Impacts from Migration Barriers

Following the closure of the RBDD gates in 1966, chinook salmon and steelhead counts have decreased dramatically (USFWS, 1998). Counts at RBDD have decreased approximately 3% per year for chinook salmon and 4.5% per year for steelhead (op. cite.). Principal factors associated with the declines of adult salmon and steelhead populations in the Sacramento River upstream of RBDD are attributed to the delay and blockage of spawning adults occurring at RBDD (Hallock et al., 1982, Vogel et al., 1988 as cited by USFWS, 1998). Other physical impediments that have measurably resulted in delay or blockage of adult chinook salmon in the Sacramento River include: Keswick Dam stilling basin; the A.C.I.D. diversion dam; reverse flows and attraction of adults into the eastern Delta; and the attraction of adults into the Suisun Marsh Salinity Control Structure (NMFS, 1997).

Delay, blockage and losses of juvenile chinook salmon are or have been attributed to the ineffective fish screens at the A.C.I.D. diversion in Redding; the disorientation and loss to predators RBDD in Red Bluff; diversion from the mainstem river channel and losses at the pumping plant at Glenn-Colusa Irrigation District's pumping plant near Hamilton City; the diversion into Sacramento Deepwater Ship Channel, near Sacramento and the Delta Cross Channel and Georgiana Sloughs near Walnut Grove; and dealy and blockage of juveniles at the Suisun Marsh Salinity Control Structure near Suisun. Collectively these structure have or had the capacity to delay, divert, or block juvenile salmonids during their downstream migration (NMFS, 1997).

Predation Impacts

Striped bass are present near RBDD from May through October. During this period, adult striped bass congregate downstream of RBDD to prey on any appropriately sized juvenile fish, including salmonids that pass through the diversion complex (under the dam gates, through the fish ladders, or through the diversion bypasses). In the case of the highly predatory Sacramento pikeminnow current RBDD gates-in operations result in large congregations of adults that are known to prey heavily on chinook salmon smolts as they pass through RBDD. Several investigators have conducted predation assessments on pikeminnows and have concluded that predation is a serious threat to juvenile salmonids passing RBDD.

In studies conducted by USFWS it was determined that predation is the primary cause of downstream migrant salmon mortalities at RBDD (Vogel, et al., 1988). This investigation estimated that losses from predation, primarily by pikeminnows, are substantial and may range up to 55 percent of smolts passing RBDD. Tucker et al. (1998) found that in their investigations, the relative abundance of predatory pikeminnows at RBDD was lower than previous estimates. However, from their studies, Tucker et al. (1998) determined that the highest densities of pikeminnows occurred in the spring and early summer months when RBDD gates are in and when pikeminnows were attempting to migrate upstream to spawn.

The stomach contents of pikeminnows captured near RBDD consisted predominately of juvenile salmonids but only during months when the RBDD gates were in (Tucker, et al., 1998).

Investigations to determine the abundance, food habitats, and life history of predatory Sacramento squawfish and striped bass were included in the RPP biological evaluations. Squawfish and striped bass were visually very abundant in the spring of 1994 below RBDD after the gates were lowered on May 2 (USFWS 1995d). In 1995, squawfish did not congregate in large numbers below the dam (USFWS 1995e). One possible explanation is that RBDD gates went in two weeks later (May 15) in 1995. Also, Sacramento squawfish may have migrated earlier in relation to high Sacramento River flows.

Given the accounts of squawfish congregating below RBDD and preying on juvenile salmonids in the past, compared with the reduced number of fish collected and recaptured in the RPP studies presently, suggests that the predation of downstream migratin juvenile salmonids has been greatly reduced following RBDD extended gates-up operations.

Reducing the time RBDD inundates Lake Red Bluff likewise reduces predation losses of outmigrating juvenile salmonids to levels similar to run-of-the-river conditions. Based on average run timing, approximately 36.5% (wet years) of fall-run (11% during dry years), 26% of late-fall run, 26% of the winter-run juvenile chinook populations and 5% of the juvenile steelhead population still migrate out of the upper Sacramento River when Lake Red Bluff exists (USFWS 1995a, SRWCSRT 1996).

Impacts from Stony Creek CHO Rediversions

Not only did the original enhancement feature associated with Stony Creek not get implemented, but under current operations, additional negative impacts to Stony Creek are occurring in relation to revised operations at RBDD. As part of the interim measures to provide supplemental water to the TCC service area during the early (September 15-October 29) and latter periods (April 1-May 15) of gates-up operation at RBDD, CVP water stored in Black Butte Reservoir ahs been diverted in increasing amounts since 1993. Existing SWRCB permit conditions (SWRCB 1996) limit CHO rediversions to 38,293 acre-feet per year.

Impacts related to CHO rediversions are detailed in 3 FWCA reports (USFWS 1993b, 1994c, 1996b) and 2 fishery study reports (Brown 1994d, 1995). No juvenile slamonids were collected during spring and fall entrainment studies. However, large numbers of native and introduced resident fish species were entrained. Entrainment losses were related primarily to diversion rates and seasonal differences in the spawning timing of fish species. Water availability in Black Butte Reservoir was low in 1994 when studies were conducted and fall CHO rediversion was limited to only 1,262 acre-feet which affected fyke net collection efficiency. Juvenile fish of springtime spawning fish were entrained at higher rates during spring CHO rediversions and likewise late-summer and fall spawning species were entrained at higher numbers during fall rediversions.

Water released for CHO rediversion "competes" with the use of this CVP water for fish and wildlife purposes. Fish and wildlife uses include the maintenance and stabilization of the water surface elevations and the conservation pool (20,000 acre-feet) in Black Butte Reservoir and Stony Creek instream flow releases below Black Butte Dam for the

maintenance and/or enhancement of resident or anadromous fish species. One of the permitted purposes of CHO diverted water is for wildlife refuge use.

Anticipated impacts of all proposed federal actions in the action area that have already undergone early or formal section 7 consultation

CALFED Bay-Delta Program

The San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta) is the largest estuary on the West Coast. It consists of a maze of tributaries, sloughs, and islands and is a haven for plants, fish, and wildlife-supporting more than 750 plant and animal species. The Bay-Delta includes over 738,000 acres in five counties and is critical to California's economy, supplying drinking water for two-thirds of all Californians and irrigation water for over 7 million acres of the most highly productive agricultural land in the world. Although all agree on its importance for both habitat and as a reliable source of water, few have agreed on how to manage and protect this valuable resource.

The Bay-Delta Program, a cooperative State and Federal effort, was established to reduce conflicts in the system by solving problems in ecosystem quality, water quality, water supply reliability, and levee and channel integrity. The CALFED process includes representatives from agriculture, urban areas, environment, fishing, business and rural counties.

The Programmatic Endangered Species Act Section 7 Biological Opinions for both U.S. Fish and Wildlife and National Marine Fisheries Service was completed on August 28, 2000.

Central Valley Project Improvement Act (CVPIA)

The Central Valley Project Improvement Act (CVPIA) was created to implement major changes in the operation of the Central Valley Project water delivery system. One of the main goals of the CVPIA is to restore the Central Valley's anadromous fish populations by implementing provisions dedicating water to in-stream use for fish and wildlife.

Central Valley and State Water Projects

The Winter-run Chinook Salmon Biological Opinion (BO) for Long-Term Operation of the CVP and the California State Water Project by National Marine Fisheries Service was completed in February 1993. In this BO, NMFS identified numerous "Reasonable and Prudent Alternatives" to the Bureau of Reclamation to avoid jeopardy to the species. These included (but are not limited to) a 4-month gates-in operation at RBDD, a minimum Shasta carryover storage requirement, set minimum flow levels for the Sacramento River from Keswick, set water temperature requirements for the protection of eggs, alevins and fry lifestages, and operational guidelines in the Delta.

Impact of state or private actions that are contemporaneous with the consultation

State Water Project

See Central Valley Project Discussion above.

Proposition 13: Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Act 2000 (Water Bond 2000)

In March 2000, California voters approved Water Bond 2000, which authorizes the State of California to sell $1.97 billion in general obligation bonds to support safe drinking, water quality, flood protection and water reliability projects throughout the state.

Proposition 204: Safe, Clean, Reliable, Water Supply Act

In 1996, Proposition 204 was approved. This authorized $995 million in general obligation bonds for Bay-Delta ecosystem restoration, Bay-Delta improvement projects, clean water and water recycling, water supply reliability, flood control and prevention.

Sacramento Valley Water Management Agreement

In April 2001, the Sacramento Valley water users, the California Department of Water Resources, the U.S. Bureau of Reclamation, and export water users developed the Sacramento Valley Water Management Agreement. This agreement was created as an effort to increase water supplies for farms, cities and the environment.

Current Baseline Condition Without the Proposed Action

Current operation of RBDD under the 1993 Winter-run Chinook salmon Biological Opinion (NMFS, 1993) includes a 4-month period of time (mid-May through mid-September) when the dam gates are placed in the river. When the gates are in-river velocity barrier and whitewater turbulence is created that delays, prevents or impedes adult salmon and steelhead passage. Placement of the dam gates into the river results in total blockage of migrating adult green sturgeon. Fish ladders are currently operational on the east and west ends and at the center of RBDD. Green sturgeon are not known to successfully use these ladders (K. Brown, pers. com.). These ladders operate during the gates-in period to provide upstream passage of adult salmonids. Currently adult late-fall chinook salmon pass unimpeded at RBDD because they immigrate during months (October through March) when the RBDD gates are out of the river and, therefore, no barrier exists.

During gates-in periods at RBDD, juvenile life stages of all anadromous salmonids migrate downstream (emigrate) through the project facilities. During gate-in operation, existing pathways for juvenile salmonids at RBDD include passage under the dam gates or through the fish ladders and their auxiliary water systems; or they are subjected to impingement, entrainment, and passage through diversion bypass systems at the Research Pumping Plant (RPP) and Tehama-Colusa Canal (TC Canal) headworks. The greatest threat to any of the juvenile salmonids passing through the project area are the direct losses related to passing under the RBDD gates and subsequent predation by Sacramento River pikeminnows and

striped bass congregated immediately below the dam. Additionally, predation by avian and fish species within Lake Red Bluff may also be a significant threat to all juvenile life stages in the vicinity of RBDD.

All five of the anadromous salmonids that are present at RBDD during some period in their life history are either listed by the California Endangered Species Act (CESA) and/or the federal Endangered Species Act (ESA), or are listed as candidates under ESA.

Anadromous Salmonid Populations and Habitat

As shown on Figure 1, each of the five salmonid species have distinct periods when the adults are actively immigrating upstream through the project area. Factors that may affect the timing adult passage include water-year type, river flows, weather events, and RBDD operations.

Habitat needs of the four runs of salmon and steelhead are similar, but each species differs somewhat in its freshwater habitat requirements. These differences are important and have implications from a resource management standpoint. The habitat needs of salmon and steelhead include physical habitat for adult migration and holding, spawning and egg incubation, fry and juvenile rearing, and smolt emigration. Adequate flows, water temperatures, water depths and velocities, appropriate spawning and rearing substrates, and the availability of in-stream cover and food are critical for the propagation and survival of all salmonids in the Sacramento River.

Each of the life stages of these species has its own specific habitat requirements. Adult spawning and egg incubation requires suitable water velocity, temperature, depth, and substrate (gravel) size. Adult spring-run chinook salmon and steelhead have additional habitat needs for longer-term holding habitat, in which pool size and depth, temperature, cover, and proximity to cover and spawning areas are important requirements. Newly emerged fry and juvenile salmonids require rearing habitat where low velocities, open cobble substrate for predator refuge, cool water temperatures, and adequate food production are critical features. Emigration of smolts to the ocean and the immigration of spawning adults require adequate barrier-free passage, adequate transport flows, and adequate water depths and temperatures to complete those migrations.

In the vicinity of RBDD the Sacramento River acts primarily as a transport corridor for adults immigrating upstream, juvenile fry rearing and dispersing, and smolts emigrating downstream. In addition, fall-run chinook salmon and, to a lessor degree, the winter-run and other salmon species are known to spawn in the vicinity of RBDD both immediately upstream and, to a lessor degree, downstream of RBDD. Inundation of Lake Red Bluff may act to discourage these fish from spawning in the reach of the Sacramento River immediately upstream of RBDD because of inadequate velocities and excessive water depths during RBDD gates–in operations.

The periods when juveniles (fry, pre-smolt, and smolt salmon and fry, sub-yearling, and yearling steelhead) are migrating downstream past RBDD are shown on Figure 2. In addition to passage, fry, pre-smolt salmon, and sub-yearling, and yearling steelhead may rear or reside in the vicinity of RBDD. These life stages are particularly vulnerable to predation by either fish or avian predators as they pass through or reside in the project locale. Timing of smolt emigration is dependent on species, flow conditions, and water year.

Figure 1 Adult Salmonid Passage at RBDD

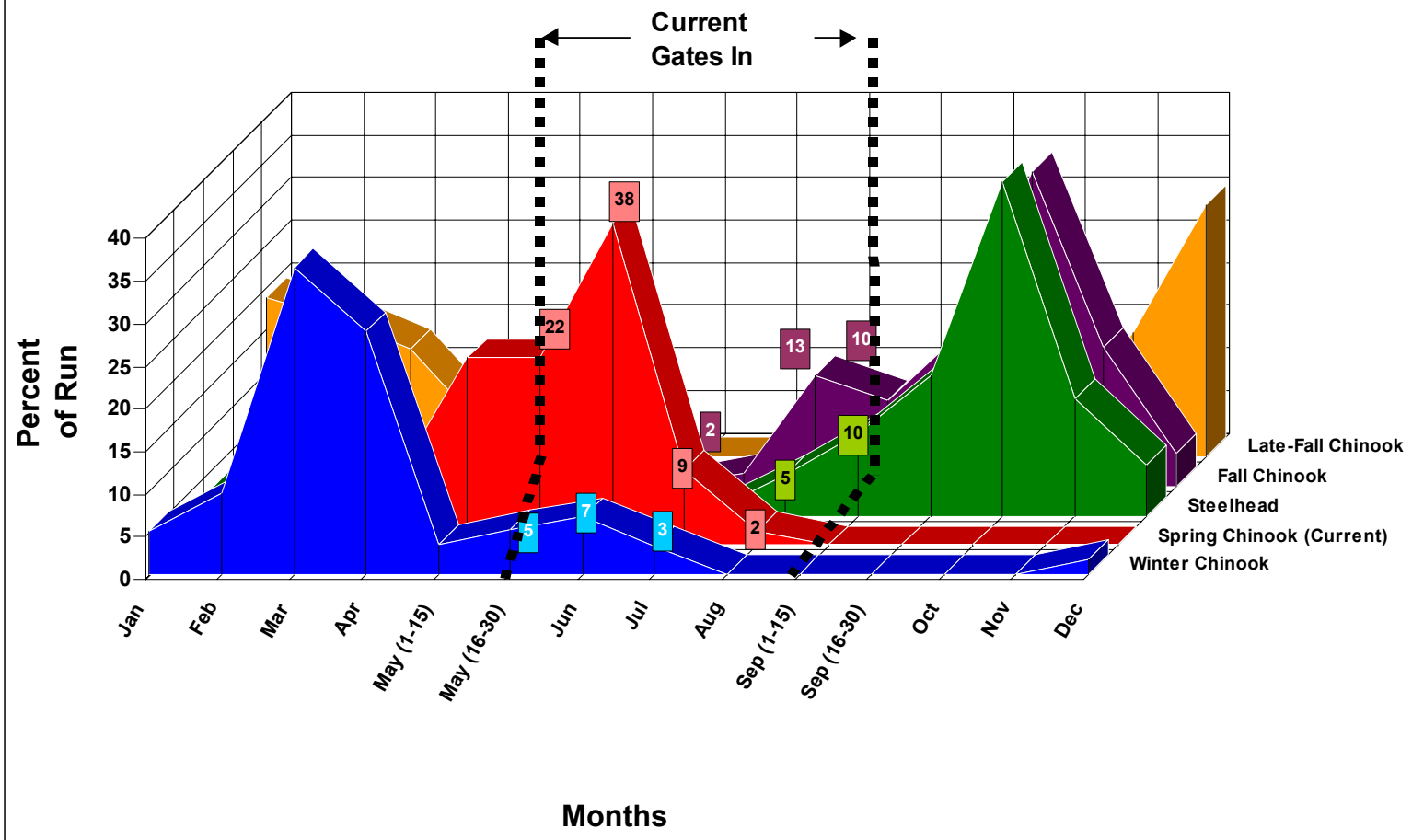


Figure 2 Juvenile Salmonid Passage at RBDD

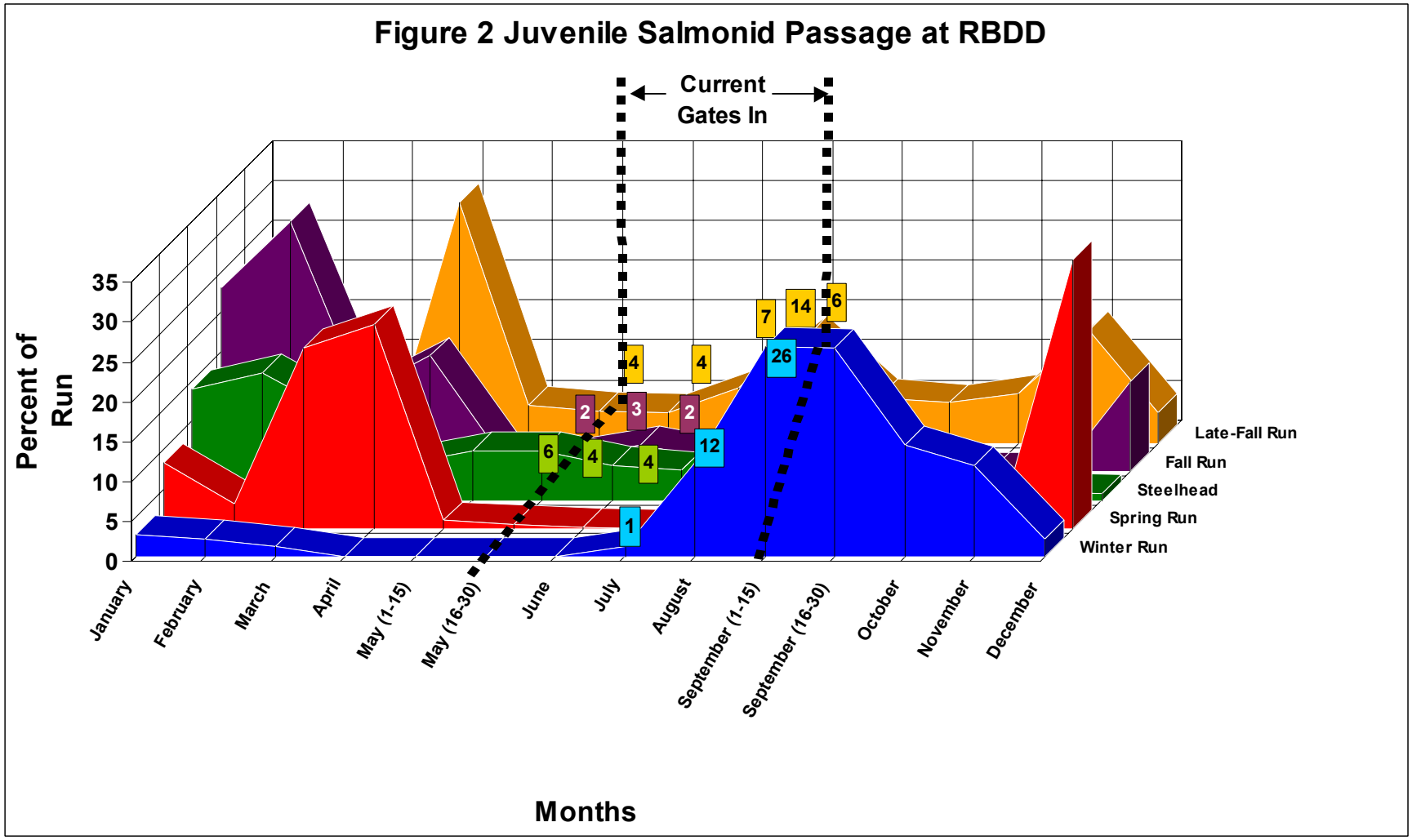


TABLE 5
Estimated Chinook Salmon Spawning Escapement Upstream of RBDD (1970 to 2000)

Species	Average	Low (year)	High (year)
Fall	75,017	29,898 (1977)	205,487 (1997)
Late-fall	10,131	291(1994)	19,261 (1975)
Winter	10,783	189 (1994)	53,089 (1971)
Spring	6,960	163 (1998)	25,095 (1976)
Steelhead	4,189	104 (1998)	13,240 (1970)

Winter-Run Chinook Salmon

Annual winter-run chinook salmon escapement has also averaged approximately 10,000 adults upstream of RBDD. The annual escapement of winter-run upstream of RBDD has declined significantly over the 30 years since 1970 (Figure 3). As shown in Table 5, winter chinook salmon escapement upstream of RBDD in 1971 was greater than 53,000 adults. Also as shown on Figure 3, except for the year 1981, annual estimates of winter-run chinook passing RBDD since 1977 have never exceed 5,000 adults, a decrease greater than 10-fold over the last 30 years.

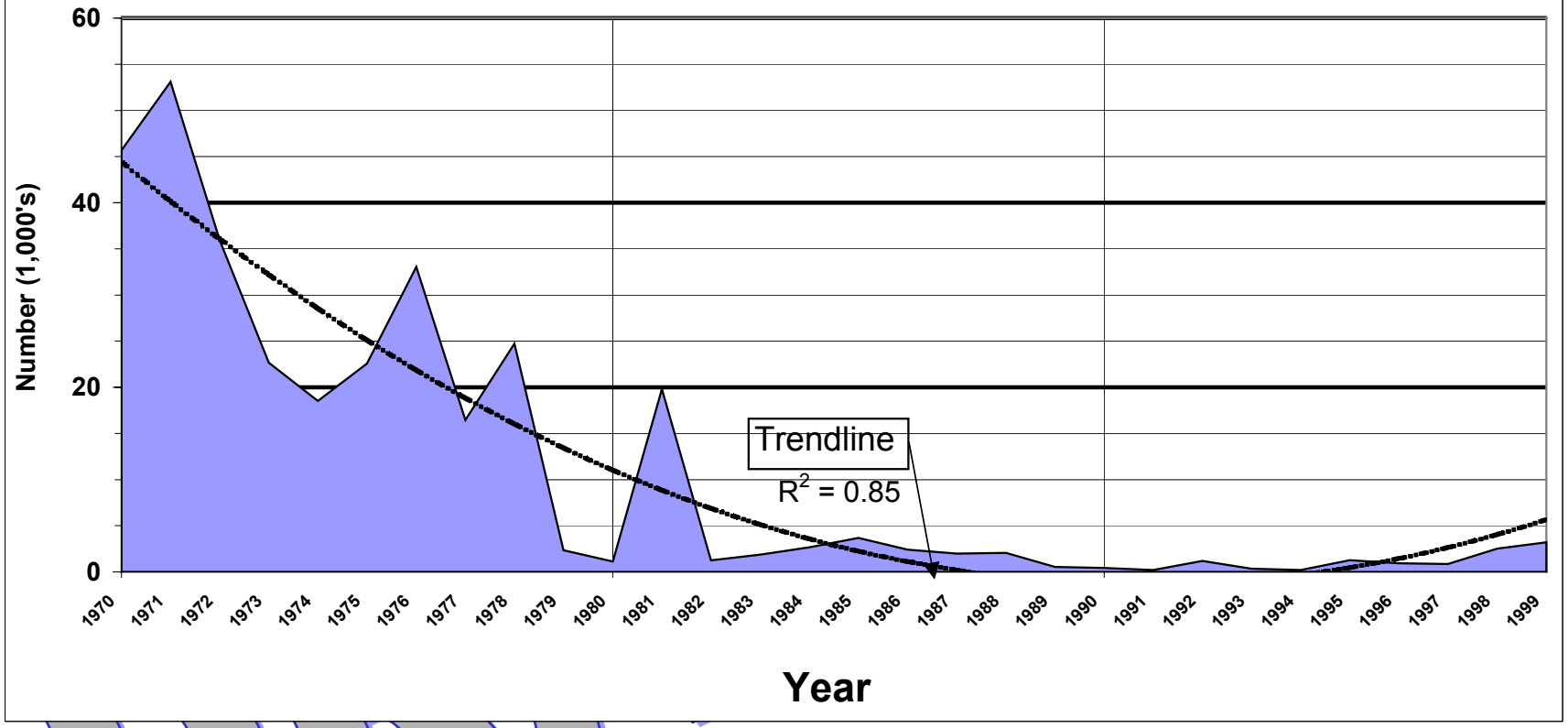
Winter-run were listed Federal Endangered on January 4, 1994 and California Endangered on September 22, 1989. Critical habitat for winter-run chinook salmon was designated on March 22, 1999

Central Valley ESU Spring-run Chinook Salmon

Spawning escapement of Central Valley spring-run chinook salmon has also varied since 1970 (Table 5). The annual spring-run chinook salmon escapement upstream of RBDD in the last 30 years has averaged less than 7,000 spawners and has ranged from greater than 25,000 in 1975 to less than 200 adults in 1998. Since 1990, spring-run chinook salmon spawning escapement upstream of RBDD has not exceeded 1,000 adults (Figure 4)..

Spring-run chinook salmon were listed as Federal Threatened on September 16,1999, and State Threatened on February 5, 1999. Critical Habitat for spring-run was designated on February 16, 2000.

Figure 3 Winter Run Chinook Salmon Spawning Escapement Upstream of RBDD(1970-1999)



Central Valley ESU Fall-run Chinook Salmon

Fall-run chinook salmon are the dominate salmon run in the watershed, and on the average over the 30-year period, escapement upstream of RBDD exceeded all other chinook runs by greater than 7-fold (Table 5). However, as shown on Figure 6, the annual escapement of fall chinook salmon upstream of RBDD has varied greatly over the last 30 years. The annual fall chinook escapement upstream of RBDD has ranged from over 205,000 (1997) to less than 30,000 (1977) with an increasing trend in escapement over that period (Figure 6).. The status of this species is summarized with late-fall run chinook salmon as discussed below.

Central Valley ESU Late-fall Run Chinook Salmon

Since 1970, late-fall-run chinook salmon escapement upstream of RBDD has averaged approximately 10,000 adults and has ranged from greater than 53,000 (1971) to less than 300 (1994) (Table 5). The trend for late-fall chinook escapement upstream of RBDD has been a gradual decline since 1970 (Figure 7).

Central Valley fall/late-fall chinook salmon ESUs were found to not warrant federal listing on September, 16,1999.However, the ESU is designated as a candidate for listing because of concerns over specific risk factors. The ESU includes all naturally spawned populations of fall-run (including Late-fall run) chinook salmon in the Sacramento and San Joaquin River Basins and their tributaries east of Carquinez Strait, California. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 13,760 square miles in California. The following California counties lie partially or wholly within these basins: Alameda, Butte, Calaveras, Colusa, Contra Costa, Glenn, Mariposa, Merced, Napa, Nevada, Placer, Plumas, Sacramento, San Joaquin, Santa Clara, Shasta, Solano, Stanislaus, Sutter, Tehama, Trinity, Tuolumne, Yolo, and Yuba.

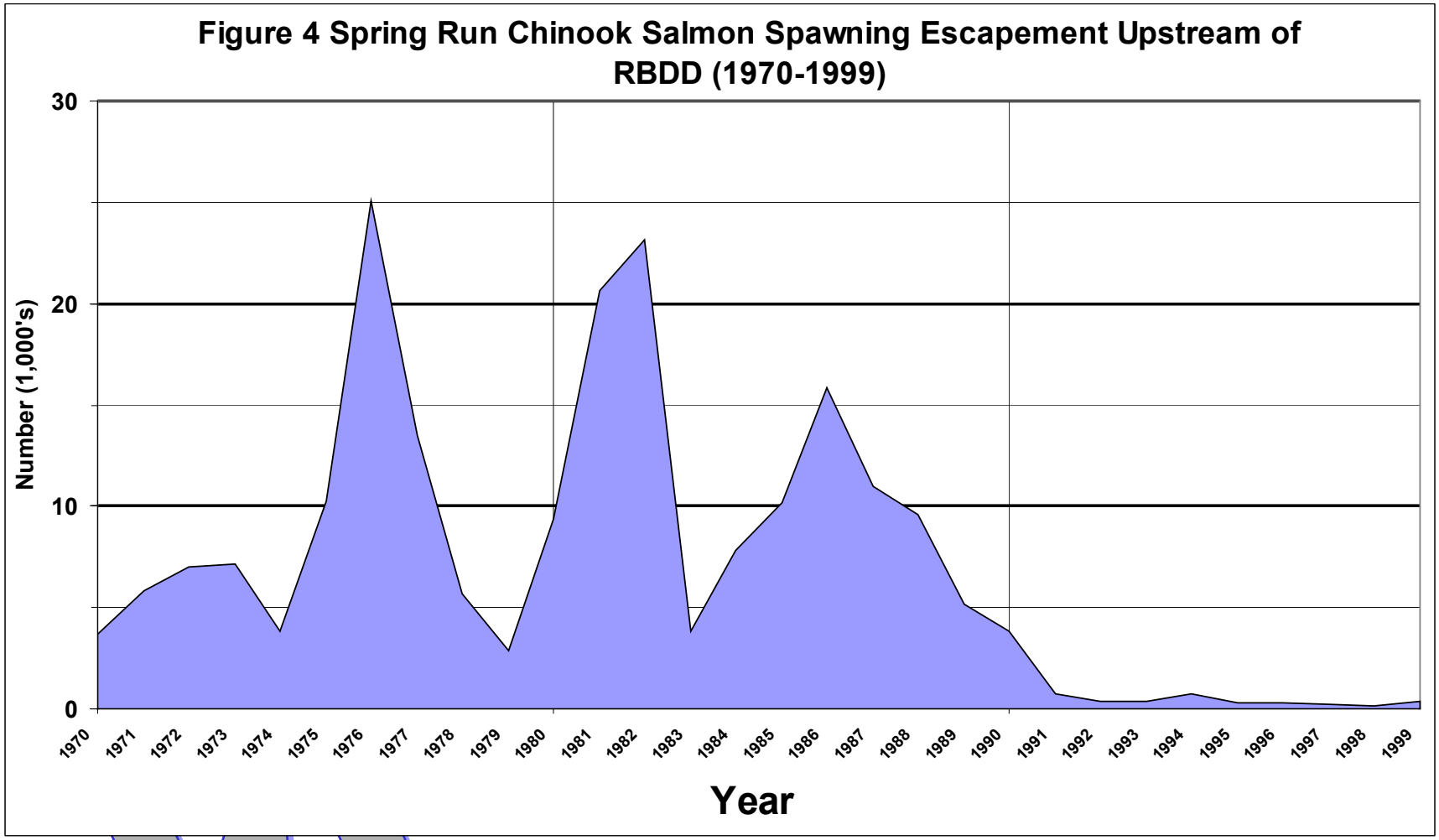


Figure 4 Spring Run Chinook Salmon Spawning Escapement Upstream of RBDD (1970-1999)
Number (1,000's)
30
20
10
0
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Year

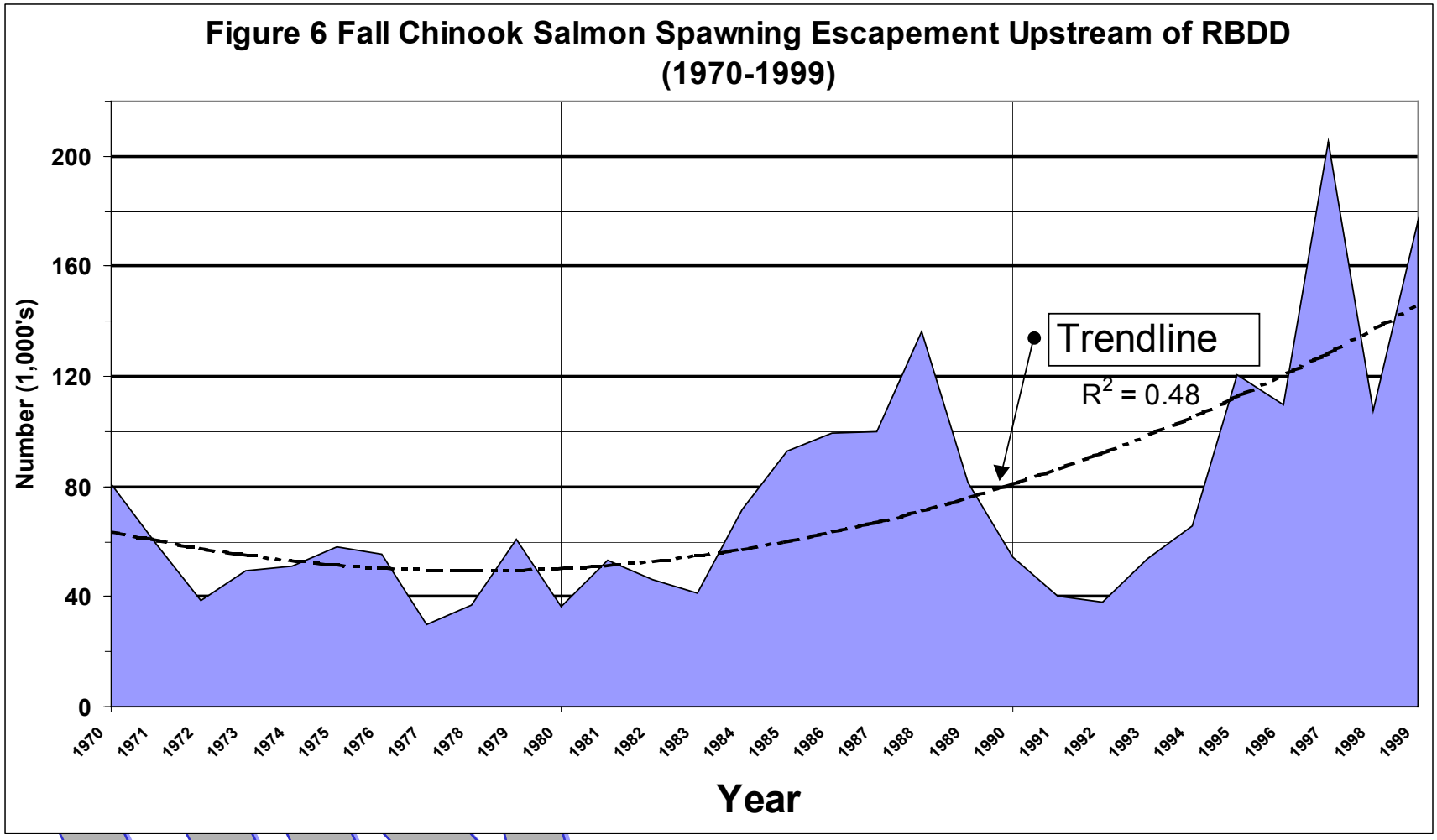


Figure 6 Fall Chinook Salmon Spawning Escapement Upstream of RBDD
(1970-1999)
Number (1,000's)
200
160
120
80
40
0
Trendline
R2 = 0.48
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Year

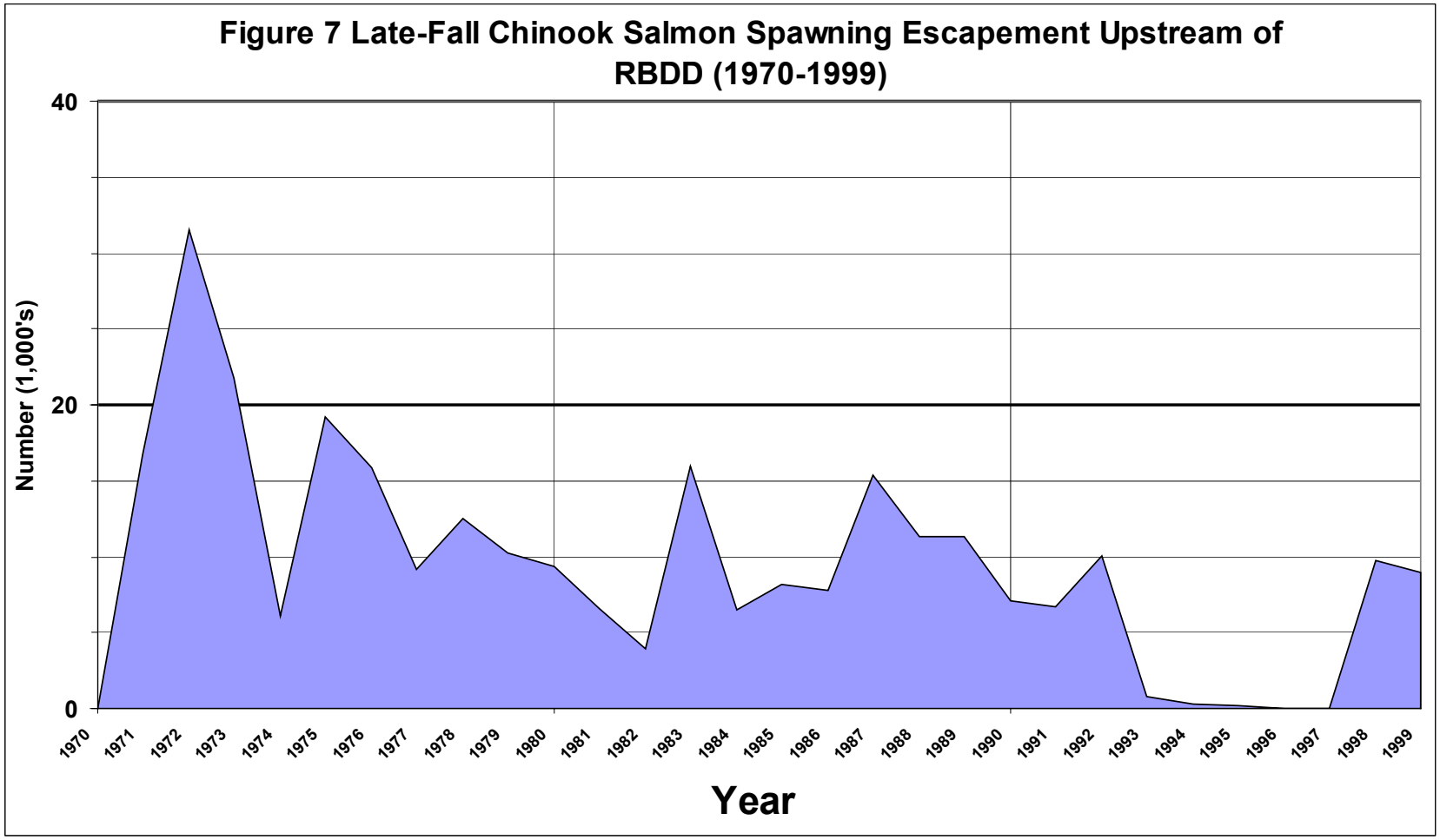


Figure 7 Late-Fall Chinook Salmon Spawning Escapement Upstream of RBDD (1970-1999)
Number (1,000's)
40
20
0
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Year

Essential Fish Habitat for Chinook Salmon

Congress has determined that one of the greatest long-term threats to the viability of commercial and recreational fisheries was the continuing loss of marine, estuarine, and other aquatic habitats. They stated the habitat considerations should receive increased attention for the conservation and management of fishery resources of the United States (16 U.S.C. 1801 (A)(9)). The re-named Magnuson-Stevens Act mandated the identification of Essential Fish Habitat (EFH) for managed species as well as measures to conserve and enhance the habitat necessary to fish to carry out their life cycles. The Act requires cooperation among NMFS, the Fishery Management Councils, fishing participants, Federal and state agencies, and others in achieving EFH protection, conservation, and enhancement. Congress defined EFH as "those **waters** and **substrate necessary** to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). Regulations interprets the EFH definition as follows:

- **Waters** include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate;
- **substrate** includes sediment, hard bottom, structures underlying the waters, and associated biological communities;
- **necessary** means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service issued its final EFH regulations on January 17, 2002. The regulations provide guidelines to fishery management councils for developing the EFH sections of fishery management plans, and establish procedures to be used by NOAA Fisheries and other agencies to consult and coordinate regarding Federal and state agency actions that may adversely affect EFH. The Pacific Fisheries Management Council (PFMC) in 1999 provided Amendment 14 to the Pacific Coast Salmon Plan which identified Pacific salmon EFHs, provided descriptions of Pacific salmon EFHs and described adverse effects on Pacific salmon EFHs.

In summary the PFMC found that in estuaries and marine areas, salmon habitat extends from the shoreline to the 200-mile limit of the Economic Exclusion Zone (EEZ) ("200 miles limit") and beyond. In freshwater, salmon EFH includes all the lakes, streams, ponds, rivers, wetlands, and other bodies of water that have been historically accessible to salmon. The description of essential habitat also includes areas above artificial barriers, except for certain barriers and dams that fish cannot pass. However, activities that occur above these barriers and that are likely to affect salmon below the barriers may be affected by EFH rulings. The PFMC is required to minimize the negative impacts of fishing activities on essential salmon habitat.

The ocean activities that the PFMC is concerned with include the effects of fishing gear, removal of salmon prey by other fisheries, and the effect of salmon fishing on reducing nutrients in streams due to fewer salmon carcasses in the spawning grounds. The PFMC

may use gear restrictions, time and area closures, and harvest limits to reduce negative impacts on salmon EFH. The PFMC is also required to comment and make recommendations regarding other agencies' non-fishing activities and actions that may effect salmon EFH. This usually takes the form of endorsing an enhancement program or other type of program, requesting information and justification for actions that might effect salmon habitat; and promoting the needs of the salmon fisheries. The PFMC works with many other agencies to identify cumulative impacts on salmon habitat, to encourage conservation, and to take other actions to protect salmon habitat.

The PFMC (1999) has designated the EFH for Pacific coast salmon fishery to mean those waters and substrates necessary for salmon production needed to support a long-term sustainable fishery and salmon contributions to a healthy ecosystem. In freshwater, EFH must include all those streams, lakes, ponds, wetlands, and other currently viable water bodies and most of the habitat historically accessible to salmon in Washington, Oregon, Idaho, and California. The PFMC has defined the freshwater EFH as all viable waters within United States Geological Survey (USGS) hydrological units accessible to Pacific Salmon.

For chinook salmon, in the vicinity of the proposed project, the PFMC includes numerous USGS Hydrological Units for the upper Sacramento River and numerous Sacramento River tributaries as freshwater EFH (PFMC, 1999). The extent of the upstream access of chinook salmon within the Sacramento River is defined as Keswick Dam (PFMC, 1999). The PFMC (1999) further defines the four major components of chinook salmon EFH as:

- spawning and incubation habitat;
- juvenile rearing habitat;
- juvenile migration corridors and;
- adult migration corridors and adult holding habitats.

Central Valley ESU Steelhead

The annual steelhead spawning escapement upstream of RBDD since 1970 is summarized in Table 5. As shown in Table 5, the annual number of steelhead spawners has averaged approximately 4,000 adults. The trend over the last 30 years has indicated a steady decline in the annual numbers of spawners (Figure 5) from over 10,00 in the early 1970s to less than a thousand by the later 1990s (Figure 5). Furthermore, it is estimated that, currently, approximately 10 percent to 30 percent of adult steelhead in the Sacramento River are of natural (non-hatchery) origin (CDFG, 1996).

Central Valley steelhead were listed as Federal Threatened on March 19, 1998. Critical habitat was designated on February 16, 2000.

Green Sturgeon

The presumed timing of spawning green sturgeon passing in the vicinity of RBDD is shown on Figure 8. This figure illustrates that the adult green sturgeon pass RBDD during March though June. The presence of juvenile green sturgeon in the vicinity of RBDD as indicated by trapping data is shown on Figure 9. The majority of juveniles pass through the vicinity of RBDD from June through August (Figure 9).

Species Listed or Proposed for Listing under ESA

Green sturgeon was petitioned for listing under ESA on June 11, 2001) but NMFS has not yet issued findings of the review of the Petition for Listing. Green sturgeon are also a California State Species of Special Concern (SSC), Class 1 (Moyle, et al., 1995).

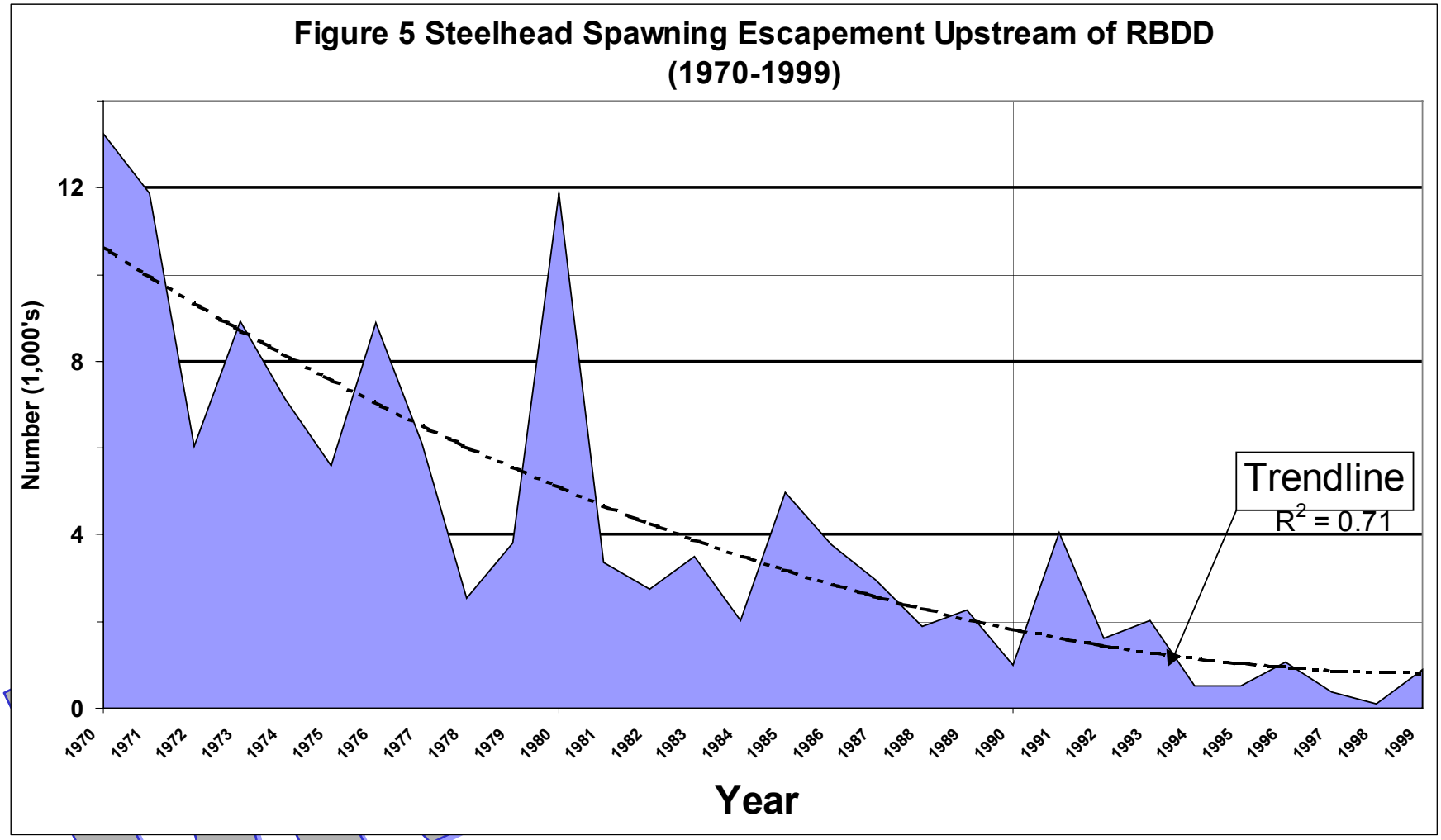


Figure 5 Steelhead Spawning Escapement Upstream of RBDD
(1970-1999)
Number (1,000's)
0
4
8
12
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Year
Trendline
R2 = 0.71

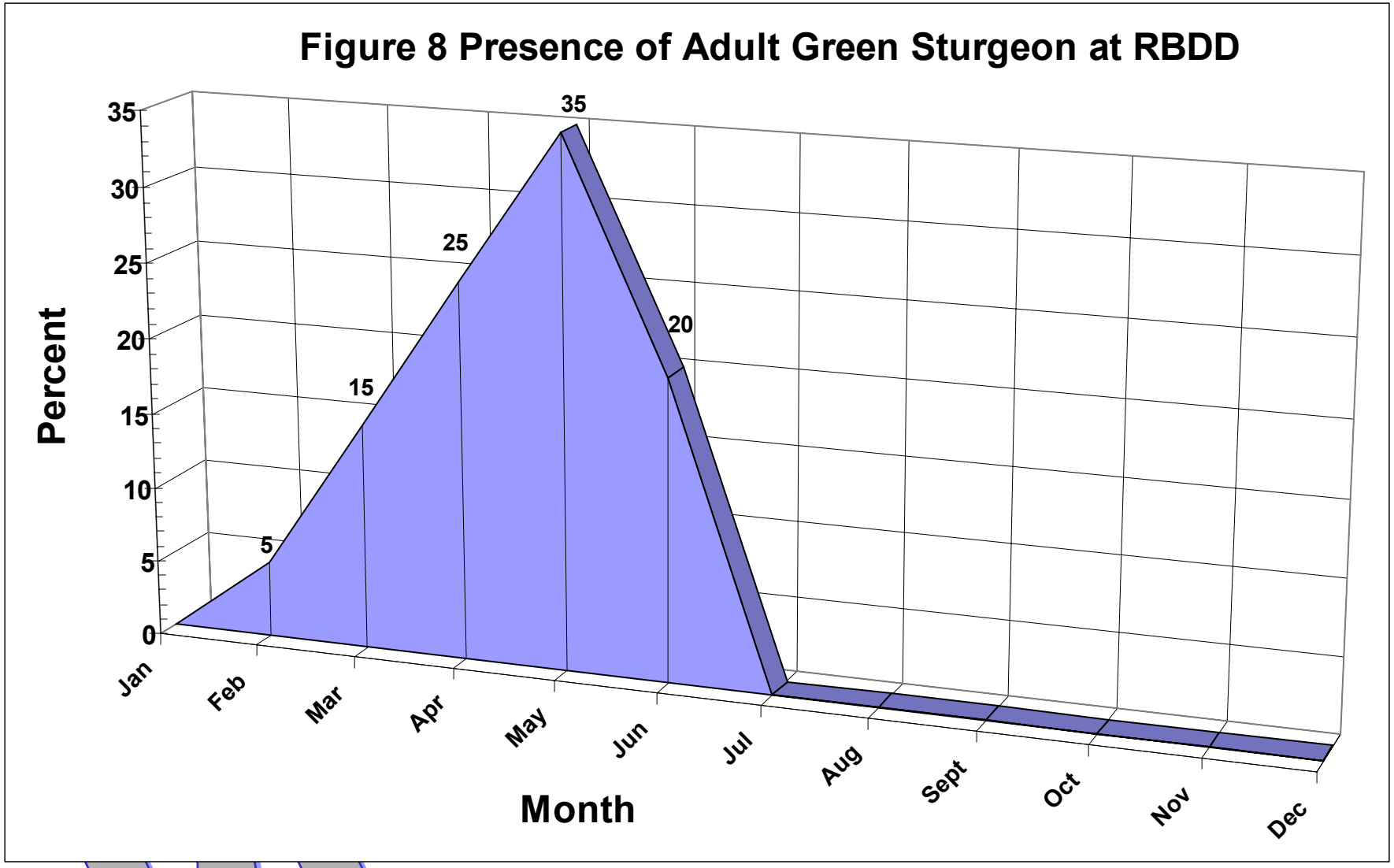
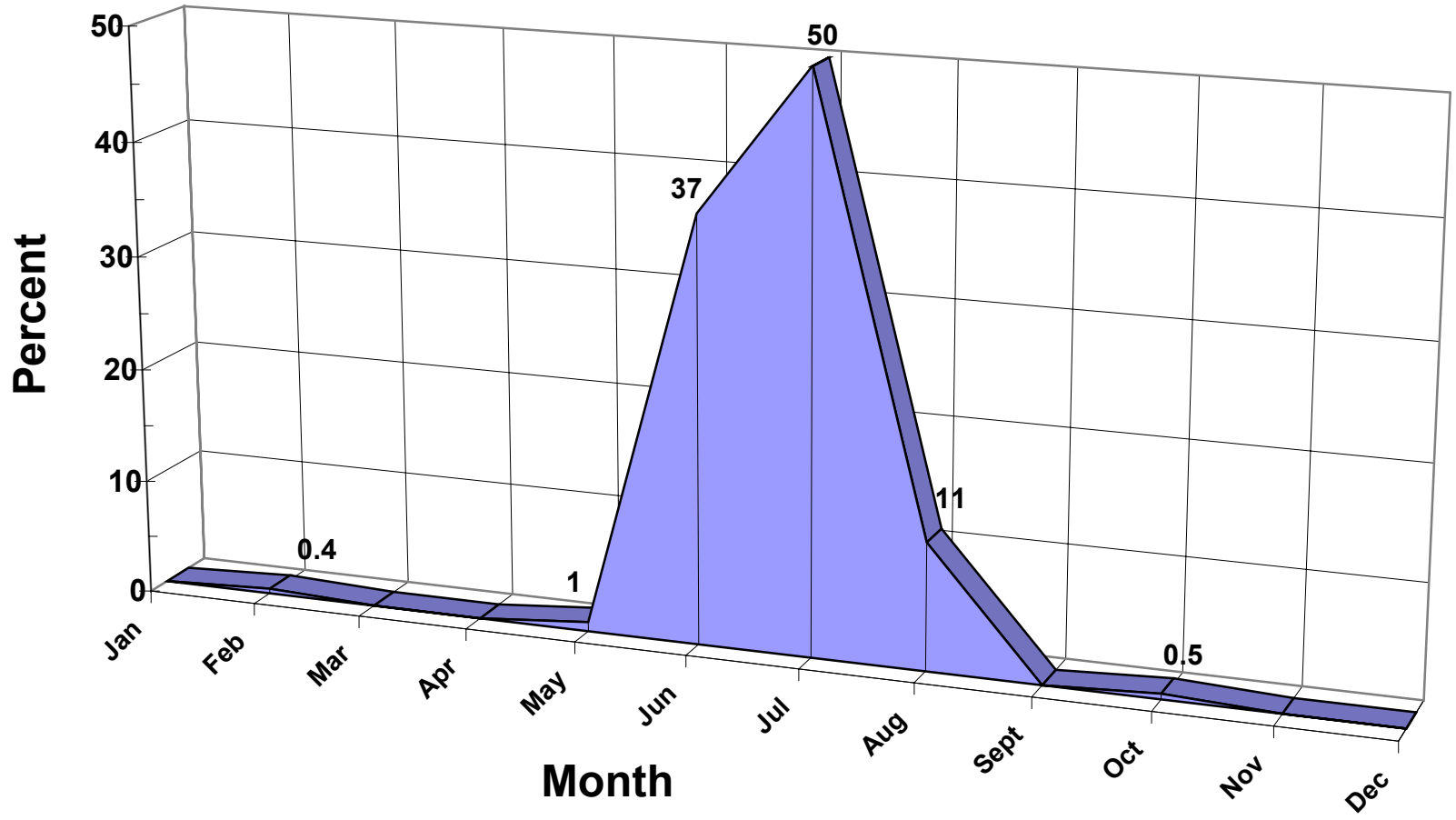


Figure 8 Presence of Adult Green Sturgeon at RBDD
Percent
35
30
25
20
15
10
5
0
35
25
20
15
5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec
Month

Figure 9 Presence of Juvenile Green Sturgeon at RBDD



Hydrology

The following summarizes the streamflows measured in the Sacramento River in the vicinity of RBDD. The hydrologic data utilized in this analysis was derived from daily stream gage records collected by both DWR and U.S. Geological Survey (USGS) at the USGS gaging station on the Sacramento River at Bend Bridge upstream of the present RBDD. Accretion streamflows from tributary creeks and groundwater inflows between Bend Bridge and RBDD also contribute to the total flow of the Sacramento River. These flows were not quantified in this assessment.

Figure X provides a comparison of the minimum, average, and maximum recorded flows in the Sacramento River following construction of RBDD. These data are presented for the period 1980 to 2000, and as with the data presented for the period prior to dam construction, this information was also determined on a monthly basis. The time period from 1980 to 2000 was selected to coincide with the completion of Reach Eight, the final section of T-C Canal completed on May 30, 1980, and diversion of water to the reach. The average daily flow data were compiled by month to develop the statistical results presented on Figure X.

Water Quality

The following summarizes water quality data including temperature, dissolved oxygen, and turbidity for the Sacramento River in the vicinity of RBDD. These data were collected from a water quality monitoring station located immediately upstream of RBDD.

The range of temperatures measured by DWR at the RBDD monitoring station from January 1998 through December 2000 is presented on Figure X. The average year-round temperature during this period was 53.8°F, with roughly 38 percent of the data exceeding the 56°F water temperature standard. The highest temperature recorded during this period was 60.8°F (on September 18, 2000).

The trend in average daily temperature at RBDD, as shown on Figure 3.3-10, illustrates that temperatures have decreased since 1990. While temperatures in Lake Red Bluff peaked at 62°F to 63°F during the 1990 through 1992 gates-in period, temperatures recorded for the same period during more recent years have declined and peaked at 58°F to 59°F. Only three daily average measurements exceeded 60°F during the period of 1998 through 2000.

Average dissolved oxygen (DO) concentrations at RBDD do not exceed water quality criteria, and thus, do not pose a significant risk to the aquatic habitat in the Sacramento River.

The Regional Water Quality Control Board Basin Plan (Basin Plan) does not set specific turbidity levels for the Sacramento River, but rather, it prescribes limits that are based on incremental increases in turbidity over natural conditions. According to a review of water quality data and comparison to the limits in the Basin Plan, the turbidity of the Sacramento River is not a water quality concern, although it does contribute to sediment deposition upstream of RBDD.

Figure X Minimum, Average, and Maximum Monthly Sacramento River Flows Following RBDD Construction (1980 to 2000)

Figure
3.3-9 Average Daily Temperatures at Bend Bridge and RBDD

Since the Sacramento River consists mainly of discharge originating from Shasta and Keswick Reservoirs, flows from these sources are fairly low in sediment concentrations (less than 10 mg/L). However, the river receives tributary flows that have much greater sediment concentrations. In particular, Red Bank Creek, which enters the Sacramento River just upstream of RBDD, contributes a large amount of sediment to the river. The average annual contribution of sediment to the Sacramento River by Red Bank Creek is 41 acre-feet (66,000 CY) (USBR, 1992). Bedload sediment depths upstream of the RBDD foundation have been measured at 3 to 7 feet deep (Ken Iceman, 1999, personal communication).

Chapter 5 - Effects of the Proposed Action

Introduction

"Effects of the action" refers to the direct and indirect effects of a proposed action on listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with the action. These effects are considered along with the environmental baseline and the predicted cumulative effects to determine the overall effects on the species. 50 CFR Section 402.02.

For the purposes of this BA, effects on listed species and critical habitat are analyzed individually with respect to the proposed action (i.e. diversion, storage, and release or delivery of water). In accordance with the provisions of the ESA implementing regulations and the FWS Section 7 Handbook, Reclamation used the following definitions to makes it effects determinations for each listed species:

> **"Likely to adversely affect:"** Any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not: discountable, insignificant, or beneficial (see definition of "is not likely to adversely affect"). In the event the overall effect of the proposed action is beneficial to the listed species, but is also likely to cause some adverse effects, then the proposed action "is likely to adversely affect" the listed species. If incidental take is anticipated to occur as a result of the proposed action, and "is likely to adversely affect" determination should be made.
>
> **"Not likely to adversely affect:"** Effects on listed species are expected to be discountable, insignificant, or completely beneficial. "Beneficial effects" are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgement, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.
>
> **"No effect:"** when the action agency determines its proposed action will not affect listed species or critical habitat.

As part of analyzing the effects of the proposed actions on the species, this section of the BA provides information about river conditions that will likely result from the proposed action. Reclamation has provided this information to help analyze the effects of the proposed action and to assist FWS and NMFS in developing coordinated biological opinions. The effects analysis compares the effects of the proposed action to the environmental baseline.

Effects of Construction on Listed Species Populations and Habitat

Impacts to listed or canditate species and their habitats would occur from constructing a new pump station at the "Mill Site", and trenching for the installation of the diversion conveyance pipelines across Red Bank Creek. These impacts include the potential for direct losses, injury, and indirect impacts to adult or juvenile salmon, steelhead and green sturgeon and their habitats. At the "Mill Site", impacts could occur from activities related to the grading of the site and excavation of the streambank, the installation of a large (up to approximately 1,400 lf) sheet pile cofferdam, and from stranding of fishes within the cofferdamed areas. At the Red Bank Creek crossing, impacts to fry and juvenile lifestages of all species would occur from activities related to site-grading and preperation, cofferdam installation, and stranding of fish within the cofferdamed areas. For the discussion below, "Adults" and "Juveniles" refers to all adult and juvenile salmonid and sturgeon species discussed in the BA.

Mill Site Pump Station

Adults

Impact A-1. Excavation and grading along the banks of the Sacramento River could result in soils entering the active channel and an increase in sediments and turbidity in the water column downstream of the construction areas. Excessive sedimentation and increased turbidity would reduce dissolved oxygen concentrations in the water column resulting in stress, egg mortality, and increased pre-spawning mortality due to suffocation. These impacts would be likely to adversely affect adult species, and would require conservation measures to reduce the impacts.

During sheetpile installation, adult salmon, steelhead and/or green sturgeon would likely avoid the areas where these cofferdams are being installed. Death or injury to adults would not likely occur from any percussion impacts, as these adults would disperse from the area affected. Similarly, death or injury to adults would not likely occur from heavy equipment operated within the active channel, as adults would avoid this area. Therefore, adults of these species would not be adversely affected by these activities.

Juveniles

Impact J-1. Excavation of the bank along the Sacramento River could result in soils entering the active channel and an increase in sediments and turbidity in the water column downstream of this activity. Excessive sedimentation and increases in turbidity would result in stress and possibly death from suffocation. Indirect effects of sedimentation could include smothering of benthic (bottom) habitat areas resulting in losses of macroinvertebrate food production utilized by fry and juvenile salmon and steelhead. Increased turbidity could reduce light penetration into the water column resulting in diminished phytoplankton and zooplankton production. These impacts would reduce food availability for larval and juvenile green sturgeon. These impacts would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Impact J-2. Impacts to fry or juvenile lifestages present in the vicinity of the "Mill Site" would occur during installation of cofferdams. Direct physical loss or injury and indirect impacts due to stress could occur during installation of sheetpile cofferdams. Juvenile salmon, steelhead or green sturgeon could be killed or injured from the percussion impacts

during sheet pile installation. These impacts would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Impact J-3. Death or injury to juveniles may also occur from any heavy equipment operated within the active channel before, during sheetpile installation or during sheetpile removal. Impacts of heavy equipment operation to fry and or juvenile lifestages would be be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Impact J-4. Direct losses, injuries, and stress to fry and juvenile lifestages could occur from isolation and stranding during the installation of cofferdams and from de-watering within the cofferdamed area. Within the cofferdamed areas water temperatures would increase, dissolved oxygen would diminish, and predation by avian and mammalian species would increase in areas isolated during sheetpile installation. These impacts would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Red Bank Creek

Adults

Impact A-2. Excavation and grading along the banks of the Red Bank Creek could result in soils entering the active channel and an increase in sediments and turbidity in the water column downstream of the construction area. Excessive sedimentation and increased turbidity would reduce dissolved oxygen concentrations in the water column resulting in stress, egg mortality, and increased pre-spawning mortality due to suffocation. These impacts would be likely to adversely affect adult species, and would require conservation measures to reduce the impacts.

During sheetpile installation, adult salmon, steelhead and/or green sturgeon would likely avoid the areas where these cofferdams are being installed. Death or injury to adults would not likely occur from any percussion impacts, as these adults would disperse from the area affected. Similarly, death or injury to adults would not likely occur from heavy equipment operated within the active channel, as adults would avoid this area. Therefore, adults of these species would not be adversely affected by these activities.

Juveniles

Impact J-5. Excavation and grading along the banks of Red Bank Creek could result in soils entering the active channel, an increase in sediments and in turbidity in the water column downstream of this activity. Excessive sedimentation and increases in turbidity would result in stress and possibly death to fry and juveniles from suffocation. Indirect effects of sedimentation could include smothering of benthic (bottom) habitat areas resulting in loss of macroinvertebrate food production utilized by fry and juvenile salmon and steelhead. Increased turbidity could reduce light penetration into the water column resulting in diminished phytoplankton and zooplankton production. These impacts would reduce food availability for larval and juvenile green sturgeon. These impacts would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Impact J-6. Impacts to fry or juvenile lifestages present in the vicinity of the conveyance crossing at Red Bank Creek could occur during installation of cofferdams. Direct physical

loss or injury and indirect impacts due to stress could occur during installation of sheetpile cofferdams. Juvenile salmon, steelhead or green sturgeon could be killed or injured from the percussion impacts during sheet pile installation. Death or injury to juveniles may also occur from any heavy equipment operated within the active channel before, during sheetpile installation or during sheetpile removal. Impacts of sheetpile cofferdam installation to fry and or juvenile lifestages would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Impact J-7. Death or injury to juveniles may also occur from any heavy equipment operated within the active channel of Red Bank Creek before, during sheetpile installation or during sheetpile removal. Impacts of heavy equipment operation to fry and or juvenile lifestages would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Impact J-8. Direct losses, injuries, and stress to fry and juvenile lifestages could occur from isolation and stranding during the installation of cofferdams and from de-watering within the cofferdamed area. Within the cofferdamed areas water temperatures would increase, dissolved oxygen would diminish, and predation by avian and mammalian species would increase in areas isolated during sheetpile installation. These impacts would be likely to adversely affect juvenile species, and would require conservation measures to reduce the impacts.

Effects of Operations on Listed Species Populations and Habitats

Analysis Approach

A fish passage evaluation was conducted for preferred alternative using a spreadsheet tool developed expressly for the Fish Passage Improvement Project at the Red Bluff Diversion Dam (RBDD). The fish passage tool (informally referred to as "Fishtastic!") was used as a tool for evaluating RBDD Fish Passage Improvement Project alternatives against one another. Although the methodology is built upon biological data, it is not a biological evaluation of fish passage conditions at RBDD. It is intended solely to focus attention on aspects of the alternative that have the greatest potential for improving fish passage at RBDD and to provide a means for conducting sensitivity analyses on different assumptions.

Fishtastic! uses temporal species distribution to determine when different life stages of fish are expected to encounter RBDD. The "cost" or "effect" of encountering RBDD was assigned a score of zero to one (where zero is completely ineffective and one is totally effective) based on subjective assumptions about the relative effect of existing facilities compared to potential future facilities. The effects of the dam were separated into two distinct parts – upstream effect on adults and downstream effect on juveniles. A number of studies on the physical effects of the dam were reviewed and updated based on current investigations and professional judgement.

For adults, the primary effects are based on delay at the dam and ability to pass the existing ladders . For juveniles, the primary effects are the combined presence of predators below the dam and juveniles migrating downstream. Other factors considered included flow, size of the facilities, and physiology of different species of fish. The degree of effect for the various facilities were estimated using existing information and studies that have been conducted at

the dam, peer reviewed research at other facilities and professional judgement. The results of the Fishtastic! analysis have been reviewed by the agency development team.

Fishtastic! results are characterized by the degree of effect the prefered alternative has on the annual percentage of fish species, both adult and juvenile, that passes the dam. When the dam gates are raised, there is no effect. When the gates are lowered, there is a variable amount of effect that depends on the physical characteristics of the fish, facility assumptions, and flows. The maximum fish passage index is 100, which would be interpreted as 100 percent of either adult or juvenile fish passing the dam with no effect.

Fishtastic! evaluated impacts to the four runs of chinook salmon (winter, spring, fall, and late-fall runs), anadromous steelhead, and green sturgeon. Results of the Fishtastic! analysis were compared to the passage indices for each species under the No Action Alternative and are summarized in Tables 6 and 7.

TABLE 6
Summary of the Results of the Fishtastic! Adult Passage Impact Assessment.

Adults	No Action Index	Preferred Alternative Index	Percent Improvement
Winter-run salmon	89	98	9
Spring-run salmon	52	93	77
Fall-run salmon	83	89	9
Late-fall-run salmon	100	100	0
Steelhead	89	96	8
Green sturgeon	65	100	54

TABLE 7
Summary of the Results of the Fishtastic! Juvenile Passage Impact Assessment.

Juveniles	No Action Index	Preferred Alternative Index	Percent Improvement
Winter-run salmon	96	99	3
Spring-run salmon	100	100	0
Fall-run salmon	97	100	2
Late-fall-run salmon	93	98	5
Steelhead	92	99	7
Green sturgeon	73	88	21

The information contained in this BA contains a summary of effects for the operation of the preferred alternative, and its affect on winter-run chinook salmon, spring-run chinook salmon, fall-run chinook salmon, late fall-run chinook salmon, steelhead, and green sturgeon. Overall, for the preferred alternative the passage indices for the species evaluated were greater than those calculated for the No-action Alternative. Therefore, there are no significant adverse impacts to either adults or juveniles of any species from the preferred alternative.

Effects of Operation of the Preferred Alternative on Winter-run Chinook Salmon

Adults

There is a modest improvement in the adult passage index for winter-run chinook. When compared to the No Action Alternative, the proposed project shows a 9 percent improvement of fish passage. The main benefit of the proposed project is from the removal of the gates during the early to mid-summer months. Operation of the proposed project is not likely to adversely affect adult winter-run salmon.

Juveniles

There is a modest improvement in the juvenile passage index for winter-run chinook salmon. When compared to the No Action Alternative, the proposed project shows a 3 percent improvement in juvenile passage. There would be a potentially small impingement impact to fry and/or juvenile winter-run salmon at the Pump Station fish protection screens but this impact would be less than significant. This impact would not require additional conservation measures. Operation of the proposed project facilities are not likely to adversely effect juvenile winter-run chinook salmon.

Effects of Operation of the Preferred Alternative on Spring-run Chinook Salmon

Adults

The principal benefit of the preferred alternative occurs for adult spring-run chinook salmon where there was a passage improvement of approximately 77 percent compared to No Action. The main benefit of the proposed project is from the removal of the gates during the early to mid-summer months. Operation of the proposed project is not likely to adversely affect adults of this species.

Juveniles

There is no measurable improvement in the juvenile passage index for spring-run chinook. When compared to the No Action Alternative, the proposed project shows a 0 percent improvement of fish passage. There would be a potentially small impingement impact to fry and/or juvenile spring-run chinook salmon at the Pump Station fish protection screens but this impact would be less than significant. This impact would not require additional conservation measures. Operation of the project will have no effect on juvenile spring-run chinook salmon.

Effects of Operation the Preferred Alternative on Fall-run Chinook Salmon

Adults

There is a modest improvement in the adult passage index for fall-run chinook. When compared to the No Action Alternative, the proposed project shows a 9 percent improvement of fish passage. The main benefit of the proposed project is from the removal of the gates during the early to mid-summer months. Operation of the proposed project is not likely to adversely affect adults of the species.

Juveniles

There is a modest improvement in the juvenile passage index for fall-run chinook. When compared to the No Action Alternative, the proposed project shows a 2 percent improvement of fish passage. There would be a potentially small impingement impact to fry and/or juvenile fall-run chinook salmon at the Pump Station fish protection screens but this impact would be less than significant. This impact would not require additional conservation measures. Operation of the proposed project is not likely to adversely affect juvenile fall-run chinook salmon.

Effects of Operation of the Preferred Alternative on Late-Fall-run Chinook Salmon

Adults

There is no change in the adult passage index for late-fall chinook salmon with this alternative. Because fish are not present during the early to mid-summer months, there will be no effect on adults of this species.

Juveniles

There is a modest improvement in the juvenile passage index for late-fall-run chinook. When compared to the No Action Alternative, the proposed project shows a 5 percent improvement of fish passage. There would be a potentially small impingement impact to fry and/or juvenile late-fall run chinook salmon at the Pump Station fish protection screens but this impact would be less than significant. This impact would not require additional conservation measures. Operation of the proposed project is not likely to adversely affect juvenile late-fall run chinook salmon.

Effects of Operation of the Preferred Alternative on Steelhead

Adults

There is a modest improvement in the adult passage index for steelhead. When compared to the No Action Alternative, the proposed project shows a 8 percent improvement of fish passage. The main benefit of the proposed project is from the removal of the gates during the early to mid-summer months. Operation of the proposed project is not likely to adversely affect the species.

Juveniles

There is a modest improvement in the juvenile passage index for steelhead. When compared to the No Action Alternative, the proposed project shows a 7 percent improvement of fish passage. There would be a potentially small impingement impact to fry and/or juvenile steelhead at the Pump Station fish protection screens but this impact would be less than significant. This impact would not require additional conservation measures. Operation of the proposed project is not likely to adversely affect juvenile steelhead.

Effects of Operation of the Preferred Alternative on Adult Green Sturgeon

Adults

There a large measurable improvement in the adult passage index for green sturgeon. When compared to the No Action Alternative, the proposed project shows a 54 percent improvement of fish passage. The main benefit of the proposed project is from the removal of the gates during the early to mid-summer months. Operation of the proposed project is not likely to adversely affect the species.

Juveniles

There is alarge measurable improvement in juvenile passage indes for green sturgeon. When compared to the No Action Alternative, the proposed project shows a 21 percent improvement of juvenile fish passage. Operation of the proposed project is not likely to adversely affect juvenile green sturgeon.

Effects of the Preferred Alternative on Water Quality

Impact WQ-1.

Construction activities will result in disturbances of soil during grading and bank excavation at the "Mill Site" and the conveyance crossing in Red Bank Creek. Soil will potentially enter the active channel as sediment discharges resulting in increased turbidity and violation of the State Water Quality Standards (Basin Plan for the Sacramento River). This impact is significant and will require measures to reduce this to less than significant.

Impact WQ-2.

Transport, storage, or spills of hazardous materials or spills from leaking or from re-fueling and servicing construction equipment on the bank or in the active channel may result in discharges of contaminants into the Sacramento River in violation of the State Water Quality Standards (Basin Plan for the Sacramento River). This impact is significant and will require measures to reduce this to less than significant.

Proposed Conservation Measures to Reduce Impacts

Measure A-1.

Impacts to adults of all listed and candidate species from sediments discharged into the active channel and from increases in turbidity as a result of site grading and bank excavation at the "Mill Site" construction area will be reduced through implementation of the following measures:

- Preparation of an erosion control plan as part of the Storm Water Pollution Prevention Plan (SWPPP);
- Control of sediment discharges through implementation of Best Management Practices (BMPs) including but not limited to:
    1. Slope grading,
    2. Temporary and or permanent seeding and mulching,
    3. Dust control measures,
    4. Installation of erosion control fabrics, and fiber rolls,
    5. Installation of temporary stream crossings,
    6. Installation of energy dissipaters, check dams, silt fences, and straw bale dikes,

    Installation of sediment basins, and sediment traps.
- Cofferdams will be placed to isolate construction activities that have the potential for discharging soils and sediments into the active stream channel.
- Bank excavation techniques will be implemented to minimize and prevent, to the greatest extent possible, soil material from entering the active channel.
- Turbidity will be monitored during cofferdam placement and construction so-as to ensured that all activities do not result in increased turbidity resulting in deleterious effects on listed or candidate species in the vicinity of the project location.

- Construction activities will cease when turbidity approaches and exceeds acceptable criteria established by the Central Valley Regional Water Quality Control Board (CV-RWQCB). Construction activities may resume only after turbidity levels downstream of the project construction site return to acceptable levels established by the CV-RWQCB.

Measure A-2.

Impacts to adults of all listed and candidate species from sediments discharged into the active channel and from increases in turbidity as a result of site grading and bank excavation at the diversion conveyance pipeline construction area at Red Bank Creek will be reduced through implementation of the measures outlined in Measure A-1 above.

Measure J-1.

Impacts to juveniles of all listed and candidate salmonid species and to larvae and juvenile green sturgeon from sediments discharged into the active channel and from increases in turbidity as a result of site grading and bank excavation at the "Mill Site" construction area will be reduced through implementation of the measures outlined in Measure A-1 above.

Measure J-2.

Losses, injuries, and or stress to fry and/or juvenile lifestages of listed or candidate species from the impacts of percussion from sheet pile installation at the "Mill Site" construction area will be reduced by avoiding critical periods of time when these lifestages are present. To avoid percussion impacts to sensitive lifestages the following sheet pile-driving schedule will be implemented:

- No sheet pile driving will occur during the months of July through October (inclusive),
- The preferred period for sheet pile driving with no restrictions is November through January (inclusive),
- Sheet pile driving may occur, with approval from NMFS and CDFG during February through June (inclusive).

Measure J-3.

Losses, injuries and stress to fry and juveniles of listed and candidate species resulting from operation of heavy equipment in the active stream channel at the "Mill Site" prior to, during or following the installation of cofferdams will be reduced through the implementation of the following conservation measures:

- Any heavy equipment necessary for installation or removal of sheetpile cofferdams will be operated from either a floating barge or from the top of stream bank,
- No more than one vehicle with tracks or wheels will be permited to enter or operate within any wet portion of the stream channel at any time,
- All vehicles operated within the wet portion of the stream channel will enter and exit the active channel via one location (access point),

- All other vehicle accessing work areas adjacent to and within the wet portion of the stream channel will be operated on existing roads, hardened access ramps, or within contained areas inside cofferdams,
- Any vehicle operated within the wet portion of the stream channel shall be free of petroleum residues and that any vehicle's fuel, lubricant, and/or fluids shall be contained within watertight reservoirs,
- Operation of any vehicle within the wet portion of the stream channel shall be minimized and only as necessary to accomplish construction related tasks.

Measure J-4.

Direct losses, injuries, and stress to fry and juvenile lifestages of salmonid species or larvae and juvenile green sturgeon occurring from isolation and stranding during the installation of cofferdams and from de-watering within the cofferdamed area would be through the following measures:

- Wet portions of the work area that become separated or isolated to the main river channel shall be immediately seined to salvage any fry and or juvenile lifestages present,
- All salvaged fish shall be captured and handled by experienced fisheries biologists and in a manner insuring minimizing injury and stress and maximizing survival rates,
- During salvage operations, captured fish shall be placed into suitable vessels containing adequate volumes and quality of receiving water,
- Salvaged fish shall be quickly transport and to released at locations downstream and out of the immediate vicinity of the construction site in the Sacramento River,
- Salvage will continue until no additional listed or candidate species are recovered,
- If additional areas become isolated and stranding listed or candidate species occurs, salvage and release shall continue until no additional listed or candidate species are recovered.

Measure J-5.

Impacts to juveniles of all listed and candidate salmonid species and to larvae and juvenile green sturgeon from sediments discharged into the active channel and from increases in turbidity as a result of site grading and bank excavation at the diversion conveyance pipeline construction area at Red Bank Creek will be reduced through implementation of the measures outlined in Measure A-1 above.

Measure J-6.

Losses, injuries, and or stress to fry and/or juvenile lifestages of listed or candidate species from the impacts of percussion from sheet pile installation at the diversion conveyance pipeline crossing location at the Red Bank Creek construction area will be by avoiding critical periods of time when these lifestages are present. To avoid percussion impacts to sensitive lifestages the sheet pile driving schedule shown in Measure J-2 above shall be implemented.

Measure J-7.

Losses, injuries and stress to fry and juveniles of listed and candidate species resulting from operation of heavy equipment in the active stream channel at the diversion conveyance pipeline at Red Bank Creek prior to, during or following the installation of cofferdams will be reduced through the implementation of the conservation measures shown in Measure J-3 above.

Measure J-8.

Direct losses, injuries, and stress to fry and juvenile lifestages of salmonid species or larvae and juvenile green sturgeon occurring from isolation and stranding during the installation of cofferdams will be reduced through the following measures:

- Installation of sheetpile cofferdams will occur during the period after September

15th and prior to any discharge within Red Bank Creek,

- Placement of cofferdams within Red Bank Creek during the period when no live channel is present will ensure no losses, injuries, or stress occurs to fry, and/or juvenile listed or candidate salmonid species or larvae and/or juvenile green sturgeon .

Measure WQ-1.

Impacts to water quality from discharges of soil, sediment and increased turbidity in violation of the State Water Quality Standards (Basin Plan for the Sacramento River) will be reduced through implementation of the conservation measures outlined in Measure A-1 above.

Measure WQ-2.

Impacts to water quality from hazardous construction materials, fuels, lubricants, and or hydraulic fluids leaking or spills from construction equipment resulting in discharges of contaminants in violation of the State Water Quality Standards will be by implementation of the following conservation measures:

- Preparation of construction materials handling, and vehicle maintenance, fueling, and spill prevention procedures as part of the Storm Water Pollution Prevention Plan (SWPPP),
- Implementation of BMPs for hazardous material storage, handling and disposal including but not limited to:
    1. Proper labeling,
    2. Proper disposal practices,
    3. Proper transport and storage of hazardous materials.
- Implementation of BMPs for fuel spill prevention and control, and vehicle service and maintenance including but not limited to:
    1. Designation of fueling areas,

2. Secondary fuel containment proceedures,
3. Fuel spill clean-up and disposal,
4. Maintaining vehicle service and maintenance areas,
5. Reporting hazardous materials spills.

Chapter 6 – Cumulative Effects

Introduction

Cumulative effects are those effects of future non-Federal (State, local governments, or private) activities on endangered and threatened species or critical habitat that are reasonable certain to occur within the action area of the Federal activity subject to consultation.

Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Bond Act. (Water Bond 2000)

Water Bond 2000 provides for a bond issue of over $1.9 billion to provide funds for safe drinking water, water quality, flood protection, and water reliability programs. State agencies responsible for implementing programs funded by the Water Bond include the California Department of Water Resources, Reclamation Board, Resources Agency, California Department of Fish and Game, State Water Resources Control Board, and Department of Health Services. The State Water Resources Control Board will be allocating a portion of these funds (approximately 40%) to local projects throughout California.

Grants are used to develop local watershed management plans or to implement projects that are consistent with local watershed management and regional water quality control plans. Grants may be awarded for projects that implement methods for attaining watershed improvements or for a monitoring program described in a local watershed management plan. Eligible projects under this article may do any of the following:

- Reduce chronic flooding problems or control water velocity and volume using vegetation management or other nonstructural methods.
- Protect and enhance greenbelts and riparian and wetlands habitats.
- Restore or improve habitat for aquatic or terrestrial species.
- Monitor the water quality conditions and assess the environmental health of the watershed.
- Use geographic information systems to display and manage the environmental data describing the watershed.
- Prevent watershed soil erosion and sedimentation of surface waters.
- Support beneficial groundwater recharge capabilities.
- Otherwise reduce the discharge of pollutants to state waters from storm water or non-point sources.

There are several grant applications that are currently being processed under this act, however currently there are no completed project associated with the Water Bond.

Safe, Clean, Reliable, Water Supply Act (Proposition 204)

The Safe, Clean, Reliable, Water Supply Act provides funds for ongoing programs in the Bay-Delta watershed and for the administrative expenses of CALFED studies and planning activities. Programs that receive funding include: Central Valley Project Improvement Program, Bay-Delta Agreement Program (Category III projects), Delta-Levee Rehabilitation Program, South Delta Barriers Program, and CALFED Planning and Feasibility.

Also, the act provides loans and grants to improve water quality and promote water recycling reuse. These types of projects include:

- Clean Water Loans –assists local agencies with construction of waste water treatment plants with the goal of meeting applicable water quality standards.
- Small Community Grants – provides funds to local agencies with populations of 5,000 which have demonstrated financial hardships, to construct treatment facilities.
- Water Recycling Program – Provides loans to local agencies for design and construction of recycling projects, with the goal of providing a cost-effective way to stretch water supplies while meeting applicable water quality and public health requirements.
- Drainage Management – Provides loans to local agencies to construct facilities to treat agricultural drainage water and to remove or substantially reduce the level of pollutants, with preference given to source reduction projects and programs.
- Delta Tributary Watershed Program – Provides financing to develop watershed rehabilitation projects to reduce contaminants in drinking water, improve riparian and fisheries habitat, improve forest health, and increase the water retention capacity of watershed.
- Sea Water Intrusion Control – Provides loans to local agencies to combat sea water intrusion into coastal groundwater aquifers that provide water for municipal, industrial and agricultural use.
- Lake Tahoe Water Quality – Provides funds for construction of soil erosion control facilities and for the restoration and preservation of environmentally sensitive lands to improve Lake Tahoe's water quality.

The act also provides funding for statewide projects to enhance water supplies, improve water management, and improve the management of demand for water. Such projects include:

- Feasibility Projects – Provides funds to investigate concepts such as conveying waste water from the Bay Area to the Central Valley to use as irrigation, building a conveyance facility from Imperial Valley to San Diego, and creating off-stream water storage facilities in the Sacramento Valley.
- Water Conservation and Groundwater Recharge – Provides financing to acquire land and develop facilities for replenishing groundwater. Priority would be given to projects in over-drafted groundwater basins. Funds would also be used for capital investments in agricultural and urban water conservation facilities, resulting in a net saving of water.

- Local Projects – Provides loans for feasibility studies and projects to increase water supplies in rural counties, such as diversion from existing facilities.
- River Parkways Program – Provides funds to acquire land and develop parkways along river corridors under laws governing conditions for parkway development.
- Sacramento Valley Water Management and Habitat Protection – Provides funds for water management and habitat improvements in the Sacramento Valley, including conservation and fish protection projects.

Additionally, a portion of the bond money funded the CALFED Bay-Delta Ecosystem Restoration Program, and Flood Control Subvention Program.

Sacramento Valley Water Management Agreement

The Sacramento Valley Water Management Agreement (Agreement) is a collaborative effort to increase water supplies for farms, cities and the environment. The Agreement was created in April 2001, after a series of water right proceedings held by the State Water Resources Control Board (Control Board) to determine responsibility for meeting water quality standards set by the 1994 Bay-Delta Accord (Accord). Phases 1 through 7 of the water rights proceedings involved the San Joaquin Valley and other Delta issues. The controversial Sacramento Valley issues (Phase 8) was the final phase of these proceedings. Proceeding with Phase 8 could involve litigation and judicial review for nearly 10 years. In order to avoid the consequences of delay, the Sacramento Valley water users, the California Department of Water Resources, The U.S. Bureau of Reclamation, and export water users developed the Agreement. The Agreement provides the foundation for a regional strategy to ensure that local water needs are fully met while helping improve water supplies throughout the state.

To implement the Agreement, the parties involved are preparing joint workplans. The workplans will describe certain Sacramento Valley projects and will provide an estimate of the quantity of water or other water management benefits that can be realized by implementing these projects. The workplans will identify several voluntary water management measures that will lead to an integrated water management program. The program will include the coordinated use of storage facilities, management and recovery of tailwater through major drains, water conservation, conjunctive management of surface water and groundwater, and transfers and exchanges among Sacramento Valley water users and other water users in the state.

Some of the anticipated benefits of the Agreement include increased water supplies; development of additional supplies; sustainable water supply solutions; environmental restoration including benefits to fish and wildlife in the Sacramento River watershed; and meeting Control Board water quality standards.

Chinook Salmon Cumulative Effects

Activity

Activity

Chapter 7 – Determination of Effects

Introduction

The following determination of effects for the (Species) consider direct and indirect effects of the proposed action on the listed species together with the effect of other activities that are interrelated or interdependent with the action. These effects are considered along with the environmental baseline and the predicted cumulative effects.

Adult Winter-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect adult species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that modest improvements (approximately 9% increase) to adult passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Juvenile Winter-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect juvenile species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that modest improvements (approximately 3% increase) to juvenile passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Adult Spring-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect adult species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that large measurable improvements (approximately 77% increase) to adult passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Juvenile Spring-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect juvenile species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that no measurable improvement to juvenile passage will result from operation of the proposed project. Therefore, the project will have no affect on the species.

Adult Fall-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect adult species. Measures will be implemented to reduce the impacts of construction activity.

- It is anticipated that modest improvements (approximately 9% increase) to adult passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Juvenile Fall-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect juvenile species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that modest improvements (approximately 2% increase) to juvenile passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Adult Late-Fall-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect adult species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that no measurable improvement to adult passage will result from operation of the proposed project. Therefore, the project will have no affect on the species.

Juvenile Late-Fall-run Chinook Salmon

- Construction of the proposed project may affect, and is likely to adversely affect juvenile species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that modest improvements (approximately 5% increase) to juvenile passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Adult Steelhead

- Construction of the proposed project may affect, and is likely to adversely affect adult species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that modest improvements (approximately 8% increase) to adult passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Juvenile Steelhead

- Construction of the proposed project may affect, and is likely to adversely affect juvenile species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that modest improvements (approximately 7% increase) to juvenile passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Adult Green Sturgeon

- Construction of the proposed project may affect, and is likely to adversely affect adult species. Measures will be implemented to reduce the impacts of construction activity.

- It is anticipated that large measurable improvements (approximately 54% increase) to adult passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

Juvenile Green Sturgeon

- Construction of the proposed project may affect, and is likely to adversely affect juvenile species. Measures will be implemented to reduce the impacts of construction activity.
- It is anticipated that large measurable improvements (approximately 21% increase) to juvenile passage will result from operation of the proposed project. Therefore, it is not likely to adversely affect the species.

References

Senate Document 113. 1949. Central Valley Basin: A comprehensive report on the development of the water and related resources of the Central Valley Basin for irrigation, power production, and other beneficial uses in California, and comments by the State of California and Federal agencies. U.S. Department of the Interior, August 1949, 81st Congress, 1st session.

USBR. 1992. Appraisal report, Red Bluff Diversion Dam fish passage program. February, 1992.

Hallock, R.J. 1981. Returns from steelhead trout, *Salmo Gairdneri*, released as yearlings at Coleman Hatchery and below Red Bluff Diversion Dam.

Hall, F. 1977. Memorandum dated August 7, 1977 to predation files. California Department of Fish and Game.

Vondracek, B. and P.B. Moyle. 1982. The biology of the Sacramento squawfish, *ptychocheilus grandis*, and predation on juvenile salmon, *oncorhynchus tshawytscha*, in the Sacramento river. Annual report to California Department of Water Resources.

Vondracek, B. and P.B. Moyle. 1983. Squawfish predation at Red Bluff Diversion Dam. Contract report for California Department of Water Resources.

Vogel, D.A. and J.G. Smith. 1984. Fish passage action program for Red Bluff Diversion Dam, annual progress report. USFWS Report No. FR1/FAO-85-04.

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.

Vogel, D.A., K.R. Marine, and J.G. Smith. 1987. Fish passage action program for Red Bluff Diversion Dam, 1986 annual progress report. USFWS Report No. FR1/FAO-87-6.

Vogel, D.A., and J.G. Smith. 1984b. Data on daily entrainment of fry and juvenile chinook salmon into the Tehama-Colusa (dual-purpose) and Corning Canals, California, January 1982 through December 1983. USFWS Report No. FR1/FAO-84-1.

Vogel, D.A. 1989. Tehama-Colusa Canal diversion and fishery problems study. USFWS Report No. AFF1/FAO-89-6.

USBR. 1985. CentralValley fish and wildlife management study. Fishery problems at Red Bluff Diversion Dam and Tehama-Colusa Canal Fish Facilities. Special report, December 1985.

USBR. 1993. Memorandum, dated June 8, 1993, from Regional Director, U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, California to Regional Director, U.S. Fish and Wildlife Service, Portland, Oregon.

CDFG. 1981. Letter, dated October 8, 1991, from Director, California Department of Fish and Game to Acting Regional Director of U.S. Bureau of Reclamation, Sacramento, California. Subject: modification of the 1969 minimum Sacramento river flow agreement.

USBR. 1969. Memorandum, dated April 22, 1969, from Assistant Regional Director, Bureau of Reclamation, Sacramento, California to Chief Engineer, Bureau of Reclamation, Denver, Colorado.

USBR. 1977. Memorandum of agreement – project facilities at Red Bluff Diversion Dam and Tehama-Colusa Canal. November, 1977.

NMFS. 1993a. Biological Opinion on the effects of the Bureau of Reclamation's proposed long-term operation of the Central Valley Project on Sacramento River winter-run chinook salmon. February 1993.

Hallock, R.J. and Fry D.H. 1967. Five species of slamon, *oncorhynchus*, spawning in the Sacramento River, California.

Hallock. R.J. 1987. Sacramento River system salmon and steelhead problems and enhancement opportunities, a report to the California advisory committee on salmon and steelhead.

CDFG. 1994. Central Valley anadromous sport fish annual run-[size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report, revised August 1994.

Leidy, G.R., T.H. Richardson and G.C. Adams. 1984. Evaluation report of the potential impacts of the proposed Lake Red Bluff water power project on the fishery resources of the Sacramento River. U.S. Fish and Wildlife Service, Division of Ecological Services, Sacramento, CA.

Hallock, R.J. 1989. Upper Sacramento River steelhead, Oncorhynchus macaws, 1952-1988.

Moyle, P.B. 1976. Inland fishes of California University of California Press, Berkely.

Moyle, P.B., R.M. Yoshiyama, L.E. Williams, E.D. Wikramanayake. 1995. Fish species of special concern. Prepared for the California Department of Fish and Game. Final report for contract No. 21281F. June 1995.

Bigelow, Patricia E. 1996. Evaluation of the Sacramento River Spawning Gravel Restoration Project and winter-run chinook salmon redd survey, 1987-1993. Final Report. U.S. Fish and Wildlife Service, Northern Central Valley Fish and Wildlife Office, Red Bluff California.

SRWCSRT (Sacramento River Winter-run Chinook Salmon Recovery Team). 1996. Recommendations for the recovery of the Sacramento River winter-run chinook salmon prepared under the direction of the National Marine Fisheries Service.

SWRCB. 1996. Order approving addition of point of rediversion and purpose of use, and amending the permit, Application 18115, Permit 13776. Dated April 1, 1996.

USFWS. 1963a. Special interim report to Regional Director, USBR, from the Regional Director, USFWS, regarding the Tehama-Colusa Canal, Sacramento River Division, Central Valley Project, California. Dated July 19, 1963.

USFWS. 1967a. Fish and wildlife aspects with Tehama-Colusa Canal, Sacramento Canals unit, Sacramento River division, Central Valley project, California. Fish and Wildlife

Coordination Act Report from the Regional Director, Bureau of Sports Fisheries and Wildlife, to the Regional Director, USBR dated January 5, 1967.

USFWS. 1995e. Red Bluff Research Pumping Plant Biological Evaluation. Quarterly Report (April 1-June 30, 1995) – Objective K: Abundance, food habits and life history of Sacramento Squawfish and striped bass near the research pumping plant intake structure and Red Bluff Diversion Dam, Sacramento River, California. August 28, 1995.

USFWS. 1997a. Red Bluff Research Pumping Plant Biological Evaluation. Quarterly Report (January 1-March 31, 1997) – Objective K: Abundance, food habits and life history of Sacramento Squawfish and striped bass near the research pumping plant intake structure and Red Bluff Diversion Dam, Sacramento River, California. May 6, 1997.

USFWS. 1995f. Quarterly progress report, Fiscal Year 1994, 1 April – 30 June 1994. Prepared by Fish and Wildlife Service, Northern Central Valley Fisheries Resource Office for RPP Bioengineering Evaluations, Scope of Work #36.

USFWS. 1995a. Working Paper of restoration needs: habitat restoration actions to double natural production of anadromous fish in the Central Valley of California. Volume 3. May 9, 1995. Prepared for U.S. Fish and Wildlife Service under the direction of the Anadromous Fish Restoration Program Core Group. Stockton, CA.

USFWS. 1998. Supplemental Fish and Wildlife Coordination Act Report: Red Bluff Diversion Dam and the Tehama-Colusa Canal. February, 1998.

USFWS. 1985a. Annual Progress Report for the Tehama-Colusa Canal Diversion and Fishery Problems Study, Fiscal Year 1984.

USFWS. 1993a. Biological assessment on the effects of Coleman National Fish Hatchery operations on winter-run chinook salmon. Prepared by the Northern Central Valley Fishery Resource Office. June 1993.

USFWS. 1995d. Red Bluff Research Pumping Plant Biological Evaluation. Quarterly Report (October 1-December 31 1994.)—Objective K: Abundance, food habits and life history of Sacramento squawfish and striped bass near the research pumping plant intake structure and Red Bluff Diversion Dam, Sacramento River, California. January 31, 1995.

USFWS. 1993b. Reverse Operation of the Constant Head Orifice located along Stony Creek, Glenn County, California. Fish and Wildlife Coordination Act Report. Ecological Services, Sacramento Field Office, Sacramento, California.

USFWS. 1994c. Tehama-Colusa Canal Change in permanent point of rediversion on Stony Creek, Glenn County, California. Fish and Wildlife Coordination Act Report. Ecological Services, Sacramento Field Office, Sacramento, California.

USFWS. 1996b. Supplemental Fish and Wildlife Coordination Act report: Tehama-Colusa Canal change in permanent point of rediversion on Stony Creek, Glenn County, California. Ecological Services, Sacramento, CA.

NMFS. 1993. Biological Opinion on the effects of the Bureau of Reclamation's proposed long-term operation of the Central Valley Project on Sacramento River winter-run chinook salmon. February 1993.

CALFED Bay-Delta Program. 1999. *Revised Draft Ecosystem Restoration Program Plan*, Volume 2. February.

Max Stodolski/ U.S. Bureau of Reclamation. 1999. Personal Communication with Ken Iceman/CH2M HILL. October 7.

USBR. Appraisal Report. 1992.

CDFG. 1996. Status of actions to restore Central Valley spring-run chinook salmon, A special report to the Fish and Game Commission. State of California, The Resources Agency, Department of Fish and Game, Inland Fisheries Division, Sacramento, CA.

Johnson, R.R., C.D. Martin, and C.M. Williams. 1996. Abundance and seasonal, spatial and diel distribution pattern of juvenile salmonids passing the Red Bluff Diversion Dam, Sacramento River, July 1994-June 1995. Annual report, Northern Central Valley Fish and Wildlife Office, Red Bluff, CA.

Miller and Lea, 1972.

USFWS, 1998.

K. Brown personal communication, Tim Hamaker/CH2M HILL. Date?

Skinner, 1962.

Upper Sacramento River Fisheries and Riparian Habitat Advisory Council. 1989. Upper Sacramento River fisheries and riparian habitat management plan. State of California Resources Agency.

USFWS. 1987. Survey of the chinook salmon spawning substrate in the Sacramento river from Highway 273 bridge to Keswick Dam, July-August, 1987. Joint Report by Fisheries Assistance Office, Red Bluff, CA and Division of Ecological Services Office, Sacramento, CA.

North State Resources, Inc. 1999. Biological Assessment, chinook salmon and steelhead trout for the proposed Anderson-Cottonwood Irrigation District Fish Passage Improvement Project.

CALFED Bay-Delta Program. 1999. Draft PEIS/EIR.

K. Brown, personal communication with Tim Hamaker/CH2M HILL. Date?

Moyle, et. al. 1995.