ENTRIX

RUSSIAN RIVER BIOLOGICAL ASSESSMENT

ALTERNATIVES: EVALUATION OF MANAGEMENT ACTIONS

Prepared for:

U.S. ARMY CORPS OF ENGINEERS
San Francisco District
San Francisco, California

AND

SONOMA COUNTY WATER AGENCY
Santa Rosa, California

Prepared by:

ENTRIX, INC.
Walnut Creek, California

Project No. 364704

September 13, 2002

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FLOW ALTERNATIVES

ADDENDUM TO "ALTERNATIVES: EVALUATION OF MANAGEMENT ACTIONS" dated September 13, 2002

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San Francisco District
San Francisco, California 94105

AND

SONOMA COUNTY WATER AGENCY
Santa Rosa, California 95406

Prepared by:

ENTRIX, INC.
590 Ygnacio Valley Road, Suite 200
Walnut Creek, California 94596

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Page

Page

Page

af	acre-feet
BA	biological assessment
CDFG	California Department of Fish and Game
cfs	cubic-feet per second
CVD	Coyote Valley Dam
DO	dissolved oxygen
DOI	Department of Interior
D1610	Decision 1610
el.	elevation
ENFP	Enhanced Natural Flow Proposal
Estuary	Russian River Estuary
ESA	Endangered Species Act of 1973
FEIS	final environmental impact statement
FERC	Federal Energy Regulatory Commission
ft/hr	feet per hour
fps	feet per second
MCIWPC	Mendocino County Inland Water and Power Commission
MCRRFCD	Mendocino County Russian River Flood Control and Water Conservation Improvement District
MOU	Memorandum of Understanding
MSL	mean sea level
NMFS	National Marine Fisheries Service
NFP	Natural Flow Proposal
PG&E	Pacific Gas and Electric Company
PVID	Potter Valley Irrigation District
PVP	Potter Valley Project
RRSM	Russian River System Model
RVIT	Round Valley Indian Tribes
RWQCB	North Coast Regional Water Quality Control Board
SCWA	Sonoma County Water Agency
SWRCB	State Water Resources Control Board
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WSD	Warm Springs Dam
WSE	water surface elevation

1.1 SECTION 7 CONSULTATION

The Sonoma County Water Agency (SCWA), the U.S. Army Corps of Engineers (USACE), and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) are undertaking a Section 7 consultation under the Federal Endangered Species Act (ESA) with the National Marine Fisheries Service (NMFS) to evaluate effects of operations and maintenance activities on listed anadromous fish species and their habitats. The activities of SCWA, USACE, and MCRRFCD span the Russian River watershed from Coyote Valley Dam (CVD) and Warm Springs Dam (WSD) to the Russian River Estuary (Estuary), as well as some tributaries. The Russian River watershed provides spawning and rearing habitat for threatened stocks of coho salmon, steelhead, and Chinook salmon. SCWA, USACE, and MCRRFCD operate and maintain facilities and conduct activities related to flood control, channel maintenance, water diversion and storage, hydroelectric power generation, estuary management, and fish production. SCWA, USACE, and MCRRFCD are also participants in a number of institutional agreements related to the fulfillment of their respective responsibilities in the Russian River watershed.

Federal agencies such as the USACE are required under the ESA to consult with the Secretary of Commerce to insure that their actions are not likely to jeopardize the continued existence of protected species or adversely modify or destroy habitat. The USACE, SCWA, and NMFS have entered into a Memorandum of Understanding (MOU) that establishes a framework for the consultation and conference required by the ESA with respect to the activities of the USACE, SCWA, and MCRRFCD that may directly or indirectly affect coho salmon, steelhead, and Chinook salmon in the Russian River. The MOU acknowledges the involvement of other agencies including the California Department of Fish and Game (CDFG), the State Water Resources Control Board (SWRCB), the North Coast Regional Water Quality Control Board (RWQCB), the State Coastal Conservancy, and the Mendocino County Inland Water and Power Commission (MCIWPC).

1.2 SCOPE OF THE BIOLOGICAL ASSESSMENT

As part of the Section 7 consultation, the USACE and SCWA will submit to NMFS a biological assessment (BA) that provides a description of the actions subject to consultation, including the facilities, operations, maintenance, and existing conservation actions. The BA will describe existing conditions, including information on hydrology, water quality, habitat conditions, and fish populations. The BA will provide the basis for NMFS to prepare a biological opinion that will evaluate the potential effects of the proposed action.

The BA will integrate information from a series of interim reports, which evaluated the effects of current operations on protected species in the Russian River basin. All of the interim reports have been completed and are available online at http://www.spn.usace.army.mil/ets/rrsection7:

Report 1 - Flood Control Operations
Report 2 - Fish Facility Operations
Report 3 - Flow-Related Habitat
Report 4 - Water Supply and Diversion Facilities
Report 5 - Channel Maintenance
Report 6 - Restoration and Conservation Actions
Report 7 - Hydroelectric Projects Operations
Report 8 - Estuary Management Plan

The current project operations may be modified if feasible management actions are identified that reduce potential adverse effects or improve habitat conditions for protected species. The BA will evaluate the effects of the entire project including the modified project activities.

This addendum to *Alternatives: Evaluation of Management Actions* (ENTRIX 2002c) presents alternative flow scenarios to be considered.

1.3 FLOW REGULATION IN THE RUSSIAN RIVER SYSTEM

On March 8, 1985 SCWA and the CDFG entered into an agreement stipulating the minimum flows necessary for instream beneficial uses on both Dry Creek and the Russian River. The stipulation provided a minimum flow of 25 cubic-feet per second (cfs) in the East Fork Russian River from CVD to the confluence with the Russian River. From that junction to Dry Creek the minimum Russian River flow was specified as 185 cfs from April through August and 150 cfs from September through March during Normal water supply conditions with reductions allowed under specified unusually dry hydrologic conditions. From Dry Creek to the ocean the minimum flow was specified as 125 cfs during Normal water supply conditions with reductions to 85 cfs and 35 cfs respectively during Dry and Critically Dry water supply conditions. In Dry Creek the minimum flow was specified as 75 cfs from January through April, 80 cfs from May through October and 105 cfs in November and December during Normal water supply conditions. During Dry and Critically Dry water supply conditions these were reduced to 25 cfs from April through October and 75 cfs from November through March.

On April 17, 1986 the SWRCB issued its Decision 1610 (D1610) on SCWA's appropriative water rights permit applications (SWRCB 1986). The permits issued by the SWRCB under SCWA's applications incorporated, as permit terms, the above agreement entered into by SCWA and the CDFG specifying the minimum flows necessary for instream beneficial uses on both Dry Creek and the Russian River. These permit terms control SCWA's regulation of the flow of the Russian River.

1.3.1 Water Supply and Transmission System Project Flow Criteria

SCWA has again filed appropriative water right applications and petitions with the SWRCB. In these, SCWA is seeking the permits needed for the operation of SCWA's Water Supply and Transmission System Project. The Water Supply and Transmission System Project did not contemplate that a change in the 1986 criteria that currently regulate the flow of the Russian River would be necessary. However, the SWRCB may change the 1986 criteria in response to other developments, including, but not limited to: 1) the pending amendment by the Federal Energy Regulatory Commission (FERC) of the terms of the license held by Pacific Gas and Electric Company (PG&E) for the operation of the Potter Valley Project (PVP), and 2) the current Section 7 consultation being conducted between the NMFS, the USACE and SCWA under the ESA of 1973.

1.4 Potential Management Actions

The MOU governing the USACE's Section 7 consultation for the Russian River outlined a process to consider modifications to principal activities occurring in the watershed. Potential management actions related to instream flow have been developed. The management actions presented in this document were address issues regarding potential adverse effects to protected species raised in the review of ongoing operations and maintenance activities in the interim reports, comments received from the Agency Working Group, the Public Policy Facilitating Committee, and the general public on the interim reports. Discussions and meetings with SCWA, USACE, NMFS, and CDFG also contributed to the development of the flow alternatives.

This addendum to *Alternatives: Evaluation of Management Actions* (ENTRIX 2002c) discusses salmonid habitat under the current D1610 flow requirements and alternative flow scenarios in the Russian River. The current flow regime in the Russian River is determined by the SWRCB D1610. The flow alternatives presented in this document were developed as part of the Section 7 consultation process to address concerns regarding habitat related to the current flow regime. These alternatives are based on the flow-habitat study conducted in the fall of 2001, the desire to return the Russian River and Dry Creek to a more natural flow regime, and the results of simulations of flow in the Russian River conducted by SCWA. This report evaluates habitat availability and suitability under D1610 and two flow alternatives. In addition, two pipeline (WSD to the Russian River or to SCWA diversion facilities at Mirabel) alternatives are described. The pipeline alternatives could be used with D1610 flows to further manage flows in Dry Creek while providing sufficient water at Mirabel to meet SCWA water supply needs during the summer months.

This section of the report (Section 2) provides descriptions of the individual flow alternatives. Each description includes the operational and infrastructure changes that would occur as part of the action, an assessment of the effect of those changes on listed salmonids and their habitat, and a summary of the relevant physical, operational, or economic constraints and institutional controls that are associated with each action.

Before beginning with the description of the flow alternatives, the approach used in evaluating the various alternatives is described in Section 2.1. Sections 2.2 through 2.7 present descriptions and the effects on protected salmonid species of various flow alternatives. The flow alternatives described include D1610 (the baseline condition)(Section 2.2), the Natural Flow Proposal (NFP)(Section 2.3), and the Enhanced Natural Flow Proposal (ENFP)(Section 2.4). Section 2.5 describes the D1610 condition with a pipeline to bypass flow from Lake Sonoma around Dry Creek. The objective of this is to provide more suitable flows for salmonids during the summer months in Dry Creek, when water demand is at its peak. The pipeline could be configured in two ways. In one configuration, a portion of the water to be released from WSD to meet water supply needs would be sent through a pipeline and be discharged into the Russian River near the mouth of Dry Creek. In the other configuration, the pipeline would extend to SCWA's infiltration ponds at Mirabel, with some of the water being discharged into these ponds and some being discharged to the Russian River at various points between the mouth of Dry Creek and Mirabel. The final alternative is the ENFP with an Additional Measures (ENFP-AM)(Section 2.7). This alternative would maintain suitable flow levels for salmonids in Dry Creek and the Upper and Middle Russian River as water demand increases in the future, similar to those described for the ENFP with current demand. As demand increases, SCWA would implement any of a variety of solutions to meet this increased demand. Additional measures being considered for this alternative include both institutional and physical measures. Institutional measures would address water rights compliance in the Upper and Middle Russian River. Physical measures may include a pipeline as described above, an aquifer storage and retrieval program (ASR), small off-stream storage facilities elsewhere in the basin, alternative measures still to be developed or some combination or phased implementation of these options.

Alternative management programs for the Estuary have been presented (ENTRIX 2002c). Current project operations affect the Estuary primarily in the low-flow months when minimum instream flow requirements under D1610 result in augmented flow to the Estuary (*Interim Report 3* [ENTRIX 2001]). These augmented flows result in a need for an artificial sandbar breaching program to prevent flooding of local property. Action 25 in the *Alternatives: Evaluation of Management Actions* (ENTRIX 2002c) proposed to manage inflow to the Estuary so that a stable water surface elevation (as feasible) would be maintained during the dry season once the sandbar has formed across the river mouth. The system would then be managed as a lagoon (sandbar closed) rather than an estuary open to tidal flushing (sandbar open). However, implementation of this action would require implementation of a flow alternative that would reduce flow to the Estuary so that the need for breaching is minimized. Based on an analysis of the relationship between flow at the Hacienda gage and stage change at Jenner, the inflow to the lagoon needed to maintain a water surface elevation of 8.0 to 8.5 feet was estimated to be approximately 35 to 45 cfs. However, inflow would need to be adaptively managed to maintain this water surface elevation depending on conditions in the ocean and at the sandbar.

2.1 APPROACH TO ANALYSIS OF FLOW ALTERNATIVES

SCWA has modeled D1610, the NFP, the ENFP, and the pipeline proposals using the Russian River System Model (RRSM, Flugum 1996) and the Russian River Water Quality Model (RRWQM, RMA 2001). These models were used to simulate the flow and water quality conditions that would exist under each of the alternatives. Each alternative flow scenario was modeled under current and projected future (buildout) water demand conditions. The flow alternatives were modeled for each of four locations - the Upper, Middle, and Lower Russian River and Dry Creek. These locations are shown in Figure 2-1.

Model results and analyses to support the evaluation of relative effects between alternatives are provided in Appendix A. These results include:

- 50 percent exceedence plots for flow from upstream to downstream in the four reaches; and
- 50 percent exceedence plots for temperature from upstream to downstream in Dry Creek and the Upper Russian River for July, September and October, to represent the warmest months and the lowest flows.

The modeling results for the ENFP-AM alternative presented are based on the use of a pipeline around Dry Creek. These results may vary slightly depending on the final solution implemented. This is discussed in more detail in Section 2.7.

These alternatives were evaluated based upon criteria developed previously in the BA process. The criteria for temperature and dissolved oxygen (DO) were presented in Report 3 (ENTRIX 2002a). These criteria were based on information provided in the literature regarding the optimal and suitable ranges of these parameters for the target species. Flow criteria were developed based in part upon a flow study conducted by SCWA, USACE, NMFS, and CDFG in late 2001, as well as knowledge of the system, conversations with biologists familiar with the Russian River, and professional judgement. The flow, temperature and DO criteria are presented in Appendix B.

The evaluation focuses on those species/life history stages of listed fish species that are likely to be affected and those parameters the alternatives may substantially affect. Project operations generally store water in the winter and augment flows in the summer. In most years, these operations generally result in relatively small changes in flow during the wet winter period when many important life history activities occur. These include upstream passage, spawning, incubation, emergence, and downstream passage of salmonids.

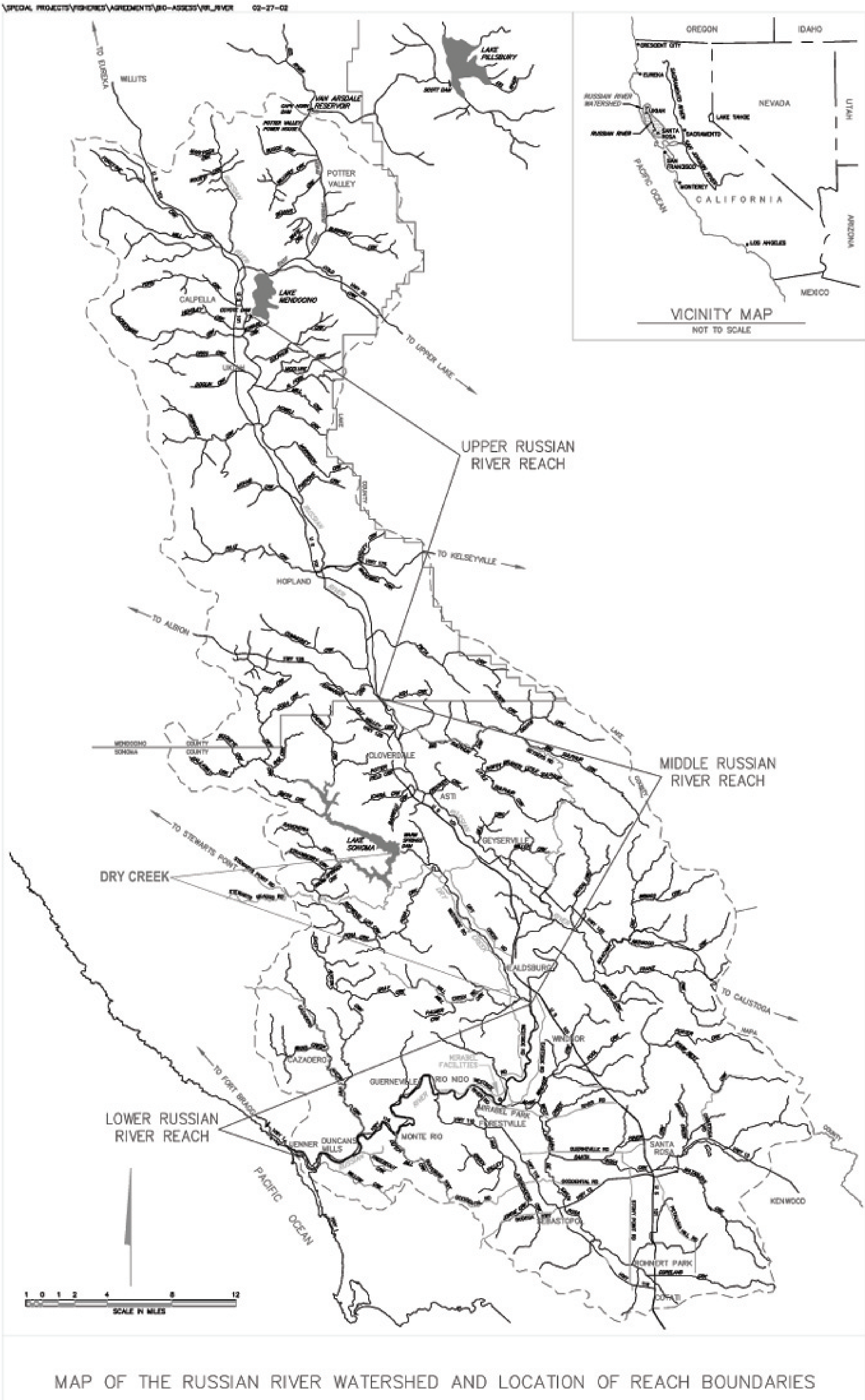


Figure 2-1. Russian River Watershed and Location of Reach Boundaries.

During the winter months, conditions are similar among the various alternatives. It is from June through October (summer and early fall) that the operation of CVD and WSD have the greatest potential to affect conditions in the Russian River and Dry Creek. Flows during the summer and early fall are augmented by minimum flow requirements under D1610 and water supply deliveries. During this period, steelhead rearing occurs in the mainstem of the Russian River and in Dry Creek. Chinook juveniles migrate out of the system by the end of June. Coho juveniles may rear in Dry Creek. Implementation of any of the proposed alternatives will have the largest effect on steelhead rearing in the Upper Russian River mainstem and on coho salmon and steelhead rearing in Dry Creek.

2.2 D1610

Lake Sonoma and Lake Mendocino are currently operated in accordance with criteria established in 1986 by the SWRCB's D1610, which established minimum instream flow requirements for Dry Creek and the Russian River under Normal, Dry, and Critically Dry water supply conditions. D1610 represents the baseline conditions evaluated in the BA.

2.2.1 Action

Lake Sonoma (on Dry Creek) and Lake Mendocino (on the East Fork of the Russian River) are operated for flood control, water supply, and hydroelectric generation. Water imported from the Eel River via the PVP and flow from the East Fork Russian River upstream of Lake Mendocino are stored in Lake Mendocino and released from CVD. Lake Sonoma stores water from the upper portion of Dry Creek during the wet season (November through April) and releases this water during the dry season (June through October). The timing and magnitude of flow releases from these dams are determined by the USACE when the dams are being operated principally for flood control, and by SCWA when the dams are being operated principally for water supply.

The flow requirements for the Russian River from Lake Mendocino to the Dry Creek confluence in D1610 were based in part upon an evaluation of fish habitat and barriers to fish migration performed by Winzler and Kelly Consulting Engineers (1978) under a contract with USACE. These flow requirements were intended to maintain the highest sustainable flows possible to support the steelhead and salmon fishery below CVD and instream recreation (SWRCB 1986). The instream flow requirements for the Russian River downstream from its confluence with Dry Creek during Normal water supply conditions were based primarily on a desire to maintain historic flows upon which the substantial recreational canoeing industry on the Russian River had developed. The reduced instream flow requirements for Dry and Critical by Dry water supply conditions were determined in consideration of warmwater fish and wildlife needs, particularly for the lower portion of the Russian River.

The flow requirements for Dry Creek were based upon an instream flow needs investigation performed by the CDFG in 1975 and 1976 (Barraco 1997). These requirements were intended to meet the fish spawning, passage, and rearing needs as determined by CDFG at that time. These flows were intended to sustain the native fish populations below WSD, to provide an enhanced steelhead and salmon spawning and nursery habitat in Dry Creek, and to facilitate operations of the Don Clausen Fish Hatchery at WSD.

Under D1610, minimum flows in both the Upper and Lower Russian River vary depending upon water supply condition. Water supply condition is determined based on the cumulative inflow to Lake Pillsbury on the first of each month between January and June and is represented as Critically Dry, Dry, or Normal. The water supply condition can vary from month to month until June 1 when it becomes stable until the following January. Within the Normal water supply condition minimum flow criteria for Lake Mendocino releases, there is a separate schedule referred to as the "Dry Spring" criteria that is dependent upon the total combined storage in Lake Mendocino and Lake Pillsbury on May 31 of each year. These criteria allow successive reductions in minimum flows for the mainstem Russian River when the combined storage falls below 90 percent and 80 percent of the combined capacities of Lake Pillsbury and Lake Mendocino. This provision reflects the importance of the storage space in Lake Pillsbury and the storage space within the flood pool of Lake Mendocino in sustaining the flows in the Russian River system, and the fact that this storage space cannot be fully utilized in Dry Spring conditions. In about 11 percent of years, “Dry Spring” water supply conditions prevail from June through December. “Dry Spring” conditions do not apply to the January through May period.

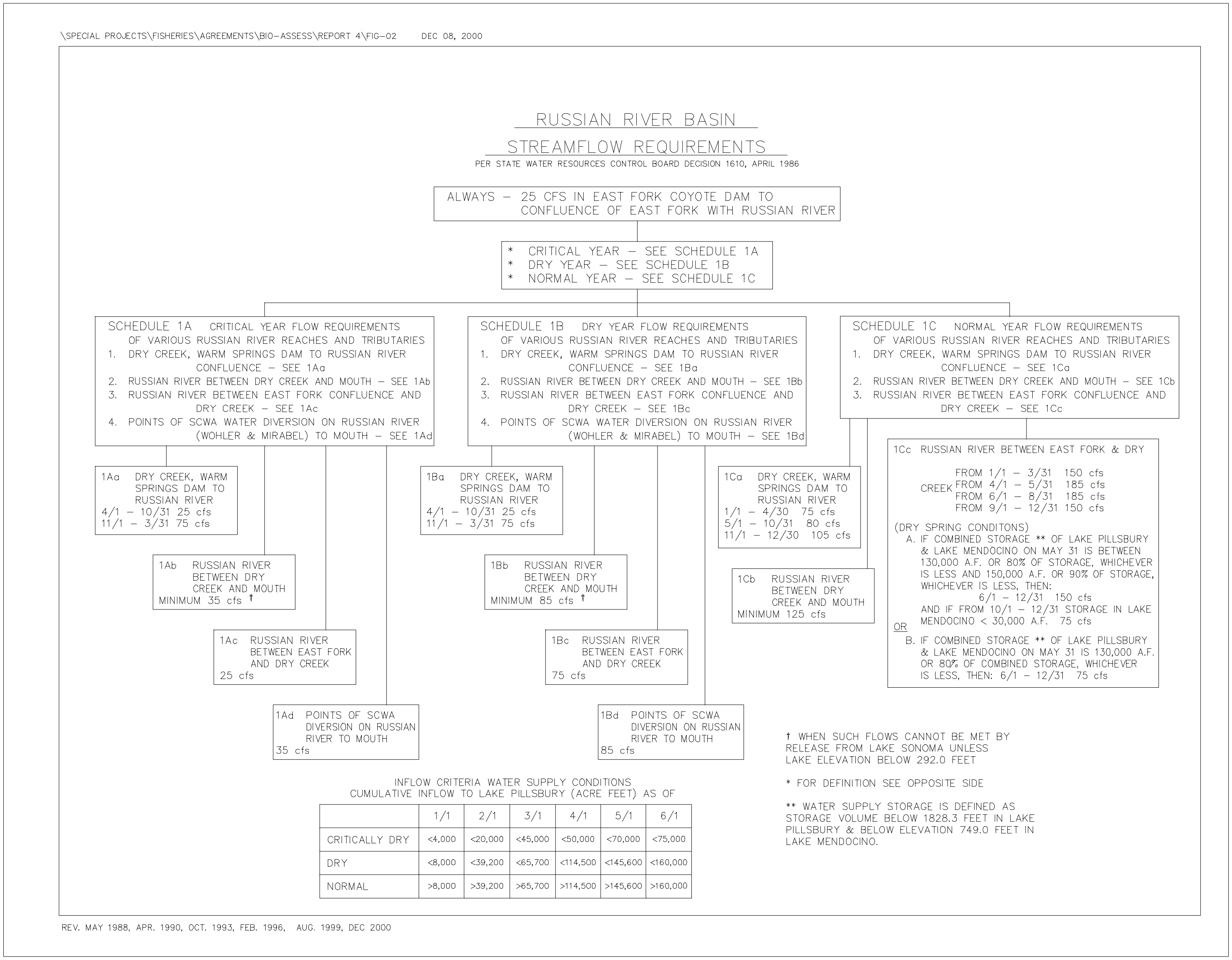
The Russian River from Healdsburg to its mouth at Jenner operates in much the same manner as the Russian River above Healdsburg. Lake Sonoma, like Lake Mendocino, has distinct water supply and flood control pools. The general operating rule for Lake Sonoma water supply releases is to discharge water needed to satisfy demands (mostly SCWA's) between Dry Creek and the Hacienda gage, and meet the minimum flow requirement at Hacienda. Under current demands, during normal summer conditions, water supply releases from Lake Sonoma are typically controlled by the required minimum flows in Dry Creek and the Russian River.

Russian River Basin streamflow requirements under D1610 are summarized in Figure 2-2.

2.2.2 Effects on Protected Species

The flow-habitat study conducted in fall 2001 indicated that the best potential habitat for salmonid rearing was present in Dry Creek when flow releases from WSD were approximately 50 to 90 cfs (ENTRIX 2000b). Steelhead habitat in Dry Creek was generally more abundant at flow releases from WSD of 47 cfs than at 130 cfs. Habitat availability at flow releases of 90 cfs was more similar to that at 47 cfs than that at 130 cfs. The data also indicated that habitat availability for Chinook salmon fry and juveniles was similar at flow releases of 47 and 90 cfs. There was little available habitat for coho salmon.

The flow-habitat study indicated that the best potential habitat conditions for salmonid rearing in the upper mainstem Russian River occurred when flow releases from CVD were



	1/1	2/1	3/1	4/1	5/1	6/1
CRITICALLY DRY	<4,000	<20,000	<45,000	<50,000	<70,000	<75,000
DRY	<8,000	<39,200	<65,700	<114,500	<145,600	<160,000
NORMAL	>8,000	>39,200	>65,700	>114,500	>145,600	>160,000

Figure 2-2. Russian River Basin Streamflow Requirements.

approximately 125 cfs. Flow releases of 190 cfs provided good rearing habitat conditions, but flow releases of 275 cfs or greater were unsuitable for salmonid rearing in the upper mainstem.

Based on the analyses of the effects of D1610 flows presented in *Interim Report 3* and a habitat/flow study conducted in the fall of 2001, the following issues were identified:

Issue 1 – Velocities in Dry Creek are higher than optimum for salmonid rearing.

Issue 2 – Velocities in the upper mainstem of the Russian River are higher than optimum for salmonid rearing.

Issue 3 – Current operations result in frequent breaching of sandbar at the mouth of the Estuary during some parts of the year. This creates unstable conditions in the Estuary that are unsuitable for salmonids and their food base. Other estuaries in California appear to provide good rearing conditions for anadromous salmonids when closed during the summer. Estuary management is dependent on flows in the Russian River.

Issue 4 – Storage levels in Lake Mendocino may be inadequate to maintain a cold-water pool sufficient to regulate temperatures in the Upper Russian River during the late summer and early fall.

Issue 5 – Expanded warmwater habitat in the Middle and Lower Russian River favor fish species that prey on or compete with steelhead and salmon.

The alternatives presented in the following sections attempt to address some or all of the issues above. The flow and temperature conditions that would prevail under these alternatives are compared with those that occur under current D1610 operations, which serves as the baseline for the BA.

2.3 ACTION A. IMPLEMENT THE NATURAL FLOW PROPOSAL.

The objective of the NFP is to mimic as closely as possible the flow regime that would be present in the mainstem Russian River under unregulated conditions, while meeting the requirements of water rights in the Russian River that are senior to those associated with the CVD Project.

2.3.1 ACTION

The streamflows in the Russian River that have resulted from the flow requirements of D1610 and previous regulated flow regimes vary dramatically from the natural flow regime of the river. These changes have affected the magnitude, frequency, duration, timing and rate of change of the hydrological conditions in the river.

In recent years there has been an increasing recognition that human alterations of river flow regimes, whether incidentally associated with other human activities or with the specific intent to “improve” the river ecosystem, change the established pattern of natural hydrologic variation, thereby altering habitat dynamics and creating new conditions to which the native biota may be poorly adapted (Poff *et al.* 1997).

The NFP for the Russian River was formulated in 1999 to mimic the natural flow condition in the mainstem Russian River to the extent possible (Beach 1999). It proposed to make releases from storage necessary to maintain the unimpaired flow of the river at Healdsburg and at the Hacienda Bridge up to a specified transition flow rate, above which inflow into Lake Mendocino could be retained in storage (Table 2-1). Under the NFP the transition flow rate at Healdsburg would be 150 cfs from June through the following March and 185 cfs during April and May except for the “Critically Dry” month exception described below. The transition flow rate at Hacienda Bridge would be 125 cfs from June through the following March and 150 cfs during April and May. Releases would be made from storage in Lake Mendocino as necessary to replace Russian River water consumptively used upstream from Healdsburg. Releases would be made from Lake Sonoma as necessary to replace Russian River water consumptively used between Healdsburg and Hacienda Bridge. If the months of January through September were Critically Dry, the transition flow rate would be reduced to the current 25 cfs at Healdsburg and 35 cfs at Hacienda Bridge.

Table 2-1. Transitional Flow Rates under the NFP during Various Water Supply Conditions.

	Guerneville			Healdsburg		
Month	Normal	Dry	Critical	Normal	Dry	Critical
Oct	125	125	125	150	150	150
Nov - Dec	125	125	125	150	150	150
Jan - Mar	125	125	35	150	150	150
Apr	150	150	35	185	185	25
May	150	150	35	185	185	25
Jun - Sep	125	125	35	150	150	25

If the unimpaired flow is greater than the tabulated value, no additional releases from storage would be made.

The NFP is based upon the use of regression analysis to relate multi-day running average flows in selected tributaries to unimpaired flows in the mainstem Russian River at discrete locations. Daily unimpaired flows for these locations would be estimated from real-time tributary flow data, resulting in operations that would calculate releases on a daily basis.

Based upon the biological data available at the time it was formulated, the NFP did not propose any changes in the D1610 flow criteria for Dry Creek, although subsequent studies have indicated such changes would result in significant fishery benefits.

Flow regulation in the mainstem Russian River and Dry Creek would be modified to conform to flows specified in the NFP (Beach 1999). Releases from CVD and WSD would approximate unimpaired flow conditions in the Russian River at Healdsburg (U.S. Geological Survey [USGS] gage number 11464000) and at Hacienda Bridge (USGS gage number 11467000) during the low-flow period. Flows downstream of CVD would include releases to meet senior water rights in the Russian River. Approximately 31,000 acre-feet (af) of annual consumptive use is associated with these senior rights.

Water supply releases would continue to be made from Lake Sonoma, and diversions at the Wohler/Mirabel facilities would continue according to current practices. Summer flows would vary between 25 and 100 cfs under current demand, and between 100 and 190 cfs under future demand, depending on water supply conditions. Minimum flows in Dry Creek would be set as shown in Table 2-2.

Table 2-2. Minimum Required Flows in Dry Creek under Various Water Supply Conditions under the Natural Flow Proposal.

	Dry Creek Minimum		
Month	Normal	Dry	Critical
Oct	80	25	25
Nov - Dec	105	75	75
Jan - Mar	75	75	75
Apr	75	25	25
May	80	25	25
Jun – Sep	80	25	25

2.3.2 Effects on Protected Species

With implementation of the NFP, flow and water temperature regimes would change in all reaches. Flows during winter months would be similar to existing conditions, as natural runoff comprises most of the river flow during that time.

Flows would change from D1610 primarily during the summer months of June through October. In the Russian River, flows would decrease substantially from those under D1610 for both current and future demand scenarios (Figures A3 to A10). This decrease in flow would result in more favorable velocities for rearing steelhead during these months. Flows would be near the optimal range identified during the flow assessment study (ENTRIX 2002b). This period would overlap the end of the emigration season for both Chinook and steelhead. The lower flows may slow emigration for these species to some degree, but would not be likely to impair emigration substantially. Chinook salmon may be migrating upstream in September and October. The low flows under the NFP would make upstream passage more difficult for adult Chinook salmon by decreasing depths over shallow riffles. However, upstream migration in September would usually be prevented by the sandbar at the mouth of the river in September. In October, higher flow levels would likely result in the sandbar being open. These flows would be high enough to provide upstream passage. Coho salmon are not present during these months and would not be affected. During Normal water supply conditions, flows in the Russian River during the spawning periods for all species would be similar to those observed with D1610 and would not alter the availability and suitability of spawning habitat. Under Dry water supply conditions, flows would be somewhat higher under the NFP than D1610 in the Russian River. This would make spawning conditions for Chinook and steelhead spawning less suitable in these months. This would occur under both current and future demand scenarios.

The lower flows under the NFP would result in warmer water temperatures than currently occur in the Upper Russian River (Figures A-15 to A-18). During July and August, the warmest months, about 14 more miles of habitat would be warmer than 20°C in the Upper Russian River under NFP than under D1610 (Figure A-15). Approximately six more miles of habitat would be warmer than 22°C in the Middle Russian River under the NFP relative to D1610.

These higher temperatures under the NFP could be more stressful for rearing steelhead than those under D1610 (Chinook migrate out of the river by the end of June). This would occur if the steelhead were unable to obtain enough food to meet their metabolic and energetic demands. Because of the ample food supply available in the Russian River, these demands would likely be met and thus the warm temperatures would likely not result in reduced production. Fish captured in SCWA's various sampling activities (SCWA unpublished data) appear to be large and robust. The lower flows provide a temperature benefit relative to D1610 in September (Figure A-16). This occurs because under D1610, the cold-water pool in Lake Mendocino is exhausted in September, and release temperatures increase to over 20°C. Under the lower flows with the NFP, the cold-water pool is not exhausted and release temperatures remain low (18°C). These lower temperatures provide better conditions for juvenile steelhead during the late summer. Flows and temperatures in the Upper and Middle Russian River would be similar under the NFP under both current and future demand scenarios and under normal and Dry water supply conditions.

While flows in the Russian River decrease under the NFP relative to D1610, water demand is expected to increase over the coming years. Because under the NFP, less water would be available from CVD to meet increasing demand, this demand would be met out of WSD. Under current demand, flows in Dry Creek would be slightly increased and flows in the Russian River between Dry Creek and SCWA's diversion facilities at Wohler and Mirabel would be slightly decreased relative to D1610 (Figures A-1 and A-7). The magnitude of these flow changes under the current demand scenario would make conditions slightly less favorable for rearing steelhead and coho than under D1610 during the summer months in Dry Creek. The habitat in the portion of the Russian River between Dry Creek and Mirabel would not be affected greatly, although this portion of the river is not currently a principal rearing area for steelhead or used at all by coho during the summer.

Under the future demand scenario, the NFP flows in both Dry Creek and the Russian River between Dry Creek and Mirabel would substantially increase over what would be expected under D1610. Under the future demand scenario, flows in Dry Creek would be about 200 cfs during some months. This would result in very unsuitable conditions for rearing salmonids. During Dry water supply conditions, flows would be similar to those under Normal water supply conditions (Figure A-2). Under the NFP under future water demand, flows in February would be decreased relative to D1610. This would provide better conditions for spawning coho and steelhead during this month. Flows during the remainder of the spawning season for each species would be similar, and spawning habitat value under NFP would not change relative to D1610.

The larger mass of cold water moving down Dry Creek under the NFP in the future demand scenario would improve temperature conditions in the Russian River below Dry Creek relative to D1610. Temperatures in Dry Creek are currently quite suitable under D1610 and would remain so under the NFP (Figures A-11 to A-14). In the Russian River, the higher flows under the NFP may make temperatures in the reach between Dry Creek and Mirabel more habitable for steelhead. Under the NFP, about two miles of the river would have temperatures less than 20°C, while about seven miles would have temperatures less than 22°C (Figure A-15). These temperatures would be considered good and moderately stressful, respectively. Under D1610, temperatures in the Russian River below Dry Creek always exceed 22°C and are considered very stressful.

Action 25 of *Alternatives: Evaluation of Management Actions* (ENTRIX 2002c) proposes to reduce summer flow to the Estuary and eliminate artificial breaching of the sandbar during the summer months, potentially improving habitat for salmonids. The NFP proposal would result in lower flows at Hacienda Bridge than D1610; however, these flows would not be sufficiently low to allow the sandbar to remain closed throughout the summer. Artificial breaching would still be required to avoid local flooding, except possibly in August and September. The lower flows under the NFP would result in the sandbar being closed for longer periods of time, but it would still need to be opened periodically to prevent flooding. The less frequent breaching schedule would be worse for salmonids and their foodbase than D1610. Under D1610 breaching is frequent enough that the system operates almost like an open estuary. As currently operated, the severity and duration of poor water quality events are limited. Under the NFP, the less frequent breaching would allow water quality to deteriorate more substantially, but the Estuary would not have sufficient time to turn into the desirable freshwater lagoon before breaching became necessary again. Thus, conditions under NFP would be more unstable and would likely result in poorer conditions for salmonids and their foodbase in the Estuary.

Altered flows may potentially negatively affect juvenile salmonid rearing if habitat is altered in a way that favors the warmwater fish community. If summer rearing habitat is warmer, competition for habitat and food could reduce the availability of rearing habitat for salmonids. However, reduced flows in the mainstem may reduce the amount of habitat available to predatory species, and could potentially result in a decline in the population of predatory fish. The NFP would result in warmer conditions in the Upper Russian River than currently occur under D1610 during June, July, and August. This increase could improve temperature conditions for predatory species such as bass and pikeminnow. This may improve their reproductive success and thus increase their populations. The reduction in flow would result in the reduction of pool size (these species tend to inhabit pool areas), but this decrease is unlikely to substantially affect their populations. The net effect on the size of predator populations is unknown, but it would likely increase. This could in turn lead to increased predation on fry and juvenile salmonids. In Dry Creek and the Russian River below Dry Creek, the situation would be reversed with conditions becoming worse for predator populations. However, Dry Creek is not thought to have a significant predator population, so this would likely not benefit salmonids in Dry Creek. It may benefit them in the Russian River below Dry Creek for two to seven miles, due to cooler water temperatures.

2.3.3 Other Considerations

The NFP would not address concerns that under the D1610 criteria flow velocities are higher than optimum for rearing steelhead and salmon in Dry Creek. That problem would be exacerbated under future demand conditions during Normal water supply conditions under both the D1610 and NFP criteria since, under both sets of criteria, most releases for SCWA diversions would come from additional releases from Lake Sonoma. For the same reason, the implementation of the NFP also would result in reduced storage in Lake Sonoma under future water demand conditions. This could result in a reduced cold-water pool available to regulate water temperatures in Dry Creek during periods of prolonged drought. This could also result in a reduced water supply available to SCWA from Lake Sonoma during these times.

The recreational canoeing industry and other recreational users, which rely on elevated flows in the river, would be affected by this action. Implementation of the NFP would result in a reduction in mid-summer flows of approximately 8 to 70 percent during Dry water supply conditions and 29 to 78 percent during Normal water supply conditions at Ukiah and Cloverdale as compared to the flows under D1610. Flow reductions at Hacienda under the NFP would be approximately 65 to 80 percent under both normal and Dry water supply conditions.

The lower flows in the Russian River under the NFP would reduce dilution of nutrients, pesticides, or coliform bacteria and could result in water quality impacts, which may impair beneficial uses of the river, including contact recreation, fishing, and potentially aquatic habitat value.

This action would require changing the SWRCB minimum flow requirements as set forth in D1610. Therefore this action would require approval from the SWRCB.

2.4 Action B. Implement the Enhanced Natural Flow Proposal.

The ENFP was designed to address some issues that the NFP does not. These issues include high summer flows in Dry Creek and reducing or eliminating the need to breach the Estuary during the summer months.

The ENFP also addresses concerns that under D1610 operations, flows are higher than optimum for rearing steelhead and salmon in the Upper Russian River, and release rates from Lake Mendocino deplete the cold-water pool prior to the end of the summer rearing season. The latter results in stressful water temperatures in the Upper Russian River during September.

2.4.1 ACTION

The ENFP includes the following elements:

2.4.1.1 Dry Creek

The D1610 mandated minimum flow rates in Dry Creek would be modified so that the optimum range of flow rates for rearing steelhead and Chinook salmon in Dry Creek are normally not exceeded. The optimum range of flows for rearing habitat is 50 to 90 cfs. The current normal year minimum flow rate requirement under D1610 is 80 cfs from May through October; however, operational considerations and the satisfying of consumptive uses along Dry Creek, at times, currently make it necessary to make releases from Lake Sonoma at rates in excess of 90 cfs. Under D1610, the future demand conditions would require releases from Lake Sonoma at substantially higher rates than currently occur. Under the ENFP, the D1610 flow requirements for Dry Creek would be modified so that the normal year May through October minimum requirement of 80 cfs throughout Dry Creek is replaced with a permitted range of flows with a target minimum flow rate of 50 cfs at the mouth of Dry Creek and a target maximum release rate of 90 cfs from Lake Sonoma. Releases from Lake Sonoma could be varied within this range to satisfy operating requirements, with a targeted flow of 70 cfs at the mouth of Dry Creek. At buildout, releases from Lake Sonoma in excess of 90 cfs only would be made about 20 percent of the time, corresponding to the summer under Dry water supply conditions, to ensure that Lake Mendocino does not become dewatered.

2.4.1.2 Russian River above Dry Creek Confluence

Under current demand, D1610 flow rates in the Upper and Middle Russian River would be reduced to provide suitable conditions for rearing salmonids during the summer months and to meet the optimal estuary inflow described below. This would be accomplished in coordination with the flow rates in Dry Creek and water supply needs at Mirabel. As demand increases, additional water would be released from CVD to meet this demand. As demand approaches the maximum buildout, flows in the Upper and Middle Russian River would begin to approach (but would not reach) those currently present in this portion of the river.

2.4.1.3 Russian River below Wohler Dam

Flows in the Russian River below Wohler Dam would be managed to meet optimum estuary inflow. Inflow to the Estuary would be adaptively managed to maintain a constant water surface elevation of 8.0 to 8.5 feet, as recorded on the Jenner gage, during the dry season, thereby eliminating the need to artificially breach the sandbar that forms across the river mouth. It is currently estimated that a flow of 35 to 45 cfs at Guerneville would maintain this water level when the Estuary is closed. This would be the goal from June through September. There may be times, especially during the early part of this season, when natural inflow from tributaries below Wohler Dam would prevent the optimum estuary inflow from being reached. During these times, flows would resemble the natural flows in this portion of the river.

2.4.2 EFFECTS ON PROTECTED SPECIES

With implementation of the ENFP, flow and water temperature regimes would change in all reaches. Flows during winter months would generally be similar to D1610 and the NFP, as natural runoff would continue to make up most of the river flow.

Flows would change from D1610 primarily during the summer months of June through October (Figures A-1 to A-10). Although flows in the Russian River would be decreased under the ENFP under current demand, an increase in water demand over the coming years is anticipated. Much of the future demand would be met from the water supply pool of Lake Mendocino, resulting in higher mainstem flows that begin to approach those under D1610 (Figures A-3 to A-10). However, summer flows close to optimal conditions for salmonids would be maintained in Dry Creek in most years, resulting in a substantial benefit to rearing habitat for steelhead and coho salmon in Dry Creek (Figures A-1 and A-2).

In the Russian River, flows would decrease substantially from those under D1610 with the current demand scenario (Figures A-3 to A-10). In the lower Russian River, flow would be less than D1610 and very similar to the NFP in both demand scenarios, because flows from Dry Creek would be reduced (Figures A-7 to A-10). A decrease in flow in the mainstem would result in more favorable water velocities for rearing steelhead during the summer months. Flows would be near the optimal range identified during the flow assessment study (ENTRIX 2002b) under the current demand scenario. This period would overlap the end of the emigration season for both Chinook and steelhead. The lower flows under the current demand scenario could slow emigration for these species to some degree, but would not be likely to impair emigration substantially. Coho emigration would be complete in May, when flows would be similar to those under D1610.

Chinook salmon may be migrating upstream in September and October. The lower flows under the ENFP under existing demand would make upstream passage more difficult for adult Chinook salmon by decreasing depths over shallow riffles. However, upstream migration in September would likely be prevented by the sandbar at the mouth of the river. In October, flows would be high enough to allow passage.

Under the future demand, flows would increase, but would remain lower than current D1610 levels in the Upper and Middle Russian River. Under the future demand, summer flows would be higher than optimal for steelhead rearing in the Middle and Upper Russian River, but would still be acceptable. Chinook salmon are not present during these months and would not be affected. Flows in the Russian River would generally be similar during the spawning season, and spawning conditions would be similar under either demand scenario for all species in most months. An exception would occur in November under the future demand scenario for All water supply conditions. Under the ENFP, flows would decline substantially, resulting in a sharp decrease in Chinook spawning habitat. Coho do not use the mainstem for spawning and would not be affected.

The lower flows under the ENFP in the Upper Russian River would result in warmer water temperatures than currently occur under the current demand (Figures A-15 to A-18). For example, in the hot month of July under the current demand, approximately nine additional miles of habitat would be warmer than 20ºC in the Upper Russian River under the ENFP relative to D1610. Approximately five additional miles of habitat would be warmer than 22ºC in the Middle Russian River under the ENFP than under D1610 (Figure A-15). The ENFP would provide cooler water temperatures than D1610 in September, as it would not exhaust the cold-water pool in Lake Mendocino (Figure A-16). Under future demand, July water temperatures would be very similar to those under D1610, but temperatures in September would be slightly cooler, because the ENFP conserves the cold-water pool in Lake Mendocino longer than D1610.

Flows from Dry Creek would result in cooling of water temperature in the mainstem directly downstream of the confluence relative to temperatures under D1610 (Figures A-15 to A-16). Near Hacienda Bridge, water temperature would be warmer than D1610 under both demand scenarios and would also be warmer than the NFP. Under both demand scenarios, water temperatures in July downstream of Dry Creek would generally be higher than 22ºC and thus would be considered very stressful for rearing salmonids (Figure A-15).

Summer flow in Dry Creek under the ENFP would be adjusted to remain close to those required for optimal rearing conditions for steelhead and coho salmon under both the current and future demand scenarios. These flows would be lower than under D1610, particularly under the future demand scenario (Figures A-1). During Dry water supply conditions, which occur about 20 percent of the time, flow in Dry Creek would increase to meet water supply needs, but would increase substantially less than under D1610 (Figures A-2). Flows during the majority of the outmigration season would remain similar to those under D1610 and thus would be unaffected by this alternative. During May and June, which is the latter part of the emigration season (coho emigrate through May; steelhead and Chinook emigrate through June), the lower flows under the ENFP may slow emigration, but are unlikely to affect emigration success. Increases in flow during February and March under Normal water supply conditions would decrease spawning habitat for coho and steelhead during these months. In Dry water supply conditions, flow increases in April would improve conditions for steelhead spawning relative to D1610.

With the ENFP, flows in Dry Creek were designed to provide improved water velocities for rearing steelhead and coho. These flows would result in slightly warmer water temperatures than D1610, but would still provide good rearing temperatures (Figures A-11 and A-12). Under Dry water supply conditions when flow would increase, temperatures would drop but water velocities would be higher than optimum (Figures A-12 and A-13).

The ENFP would result in lower flows at the Hacienda Bridge relative to D1610. These flows would generally be sufficiently low to eliminate artificial breaching of the sandbar during the summer months. Inflow to the Estuary would be adaptively managed to maintain a constant water surface elevation of 8.0 to 8.5 feet, as recorded on the Jenner gage, during the dry season, and the system would be managed as a closed lagoon with freshwater habitat. This could potentially improve summer rearing habitat in the Estuary. The flows needed to maintain a closed estuary are currently estimated to be 35 to 45 cfs at Hacienda Bridge, but flows would need to be adaptively managed to maintain this water surface elevation.

Altered flows may potentially negatively affect juvenile salmonid rearing if habitat is altered in such a way that favors the warmwater fish community. However, the flow changes and resultant temperature changes under the ENFP are unlikely to substantially affect predator populations.

2.4.3 Other Considerations

In the portion of the river below Mirabel, the recreational canoeing industry and other recreational users, which rely on elevated flows in the river, would be affected by this action. Implementation of the ENFP would result in a reduction in mid-summer flows to 40 to 60 cfs during Normal water supply conditions as compared to 130 to 150 cfs currently existing under D1610. Flows in the Upper and Middle Reaches of the Russian River would be reduced, but by amounts that are unlikely to affect these types of recreational opportunities. At Ukiah, summer flows would range from 130 to 250 cfs during the summer months under the ENFP as compared to current levels of 175 to 260 under D1610.

The lower flows below Mirabel under the ENFP would reduce dilution of nutrients, pesticides, or coliform bacteria and could result in water quality impacts, which may impair beneficial uses of the river, including contact recreation, fishing, and potentially aquatic habitat value.

Flows in Dry Creek are a mixture of direct releases from the dam and hatchery discharges. The fish hatchery requires flows of approximately 35 to 50 cfs. The hatchery discharges its wastewater after passing it through settling ponds to Dry Creek a short distance downstream of the dam. By reducing the total flow in Dry Creek, the relative contribution of return water from the hatchery would increase. The hatchery currently meets all the requirements for its discharge under its NPDES permit from the RWQCB prior to being released to Dry Creek. The reduced dilution of this discharge when releases from the flows are decreased is unlikely to affect salmonid populations in Dry Creek.

Reduction of releases from WSD may affect operation of the hydroelectric facility. This would reduce power generation from this facility. SCWA is currently under contract with PG&E to produce a minimum of 1.246 MW of electricity during June, July and August. This contract would have to be amended to implement this action. In addition, the FERC license to operate the hydroelectric generation facility states that in Normal water supply conditions from May 1 to October 31, the minimum releases from the dam shall not be less than 80 cfs. The FERC license for this project would also have to be amended to implement these flow reductions. The turbine can be operated with a minimum flow of approximately 70 cfs and an approximate maximum design flow of 175 cfs. Furthermore, if the generator is shut down, a USACE low-flow valve must be manually opened to maintain releases for hatchery water and minimum releases to Dry Creek. An untested and unused telemetry control of this valve could be tested, but there remains a concern that the USACE flow valve could be inadvertently placed in the closed position and stop all releases when the turbine shuts down.

This action would require changing the SWRCB minimum flow requirements as set forth in D1610. Therefore this action would require approval from the SWRCB.

2.5 Action C. Continue D1610 with a Pipeline to the Mouth of Dry Creek.

The objective of this action is to provide a mechanism whereby flows in Dry Creek can be reduced to maximize salmonid rearing habitat while continuing to meet water supply obligations of SCWA.

2.5.1 Action

A new pipeline would be installed in the wet well or outlet structure of WSD. This pipeline would discharge to the mainstem of the Russian River immediately below its confluence with Dry Creek. The pipeline would be implemented in coordination with the D1610 flow scenarios for the system. With the pipeline in place, releases to Dry Creek would be in the range of 50 to 90 cfs (the current target in this model run was 70 cfs). Any additional flow needed to meet water supply needs would be conveyed through the pipeline. This action would not affect flow in the Russian River. The temperature in the Russian River below Dry Creek would be affected. Water traveling through the pipeline from WSD to the Russian River would not be significantly warmed, and thus would enter the Russian River at a cooler temperature than the equivalent amount of water traveling down Dry Creek. Flows and temperatures in Upper and Middle Reaches of the Russian River would be the same as under D1610. The effects of this alternative on these portions of the river are discussed in Section 2.2.2 of this report.

This action would require acquisition of a right-of-way for construction of the pipeline from WSD to the Russian River. A potential route would be along Dry Creek Road. This action would maintain flows in the mainstem Russian River below Dry Creek, ensuring that sufficient flows reach the Mirabel and Wohler diversion facilities to meet current and future water supply needs. The inflatable dam at Mirabel would continue to be operated for recharge and to fill the pond at Wohler and Mirabel. The aquifer would be recharged and water would continue to be extracted by the Ranney collectors at Wohler and Mirabel.

2.5.2 Effects on Protected Species

Under either of the pipeline alternatives, the summer flows in Dry Creek would be reduced to between 50 and 90 cfs, with any additional water needed to meet demand being conveyed through the pipeline (Figures A-1 and A-2). These lower flows would improve conditions for rearing salmonids in Dry Creek from May through October relative to the current D1610 flows. Under future water demand, the flows would be substantially improved by the pipeline when compared to D1610. Thus, the pipeline would provide substantial benefit to salmonid rearing habitat in Dry Creek. Spawning habitat would not be affected, as flows during the spawning period of all species would be the same as under D1610.

Under the D1610 pipeline alternative, temperatures in Dry Creek would warm by about 1°C relative to D1610 above the mouth of Dry Creek under either demand scenario

(Figures A-11 to A-14). Temperatures would remain below 19°C and remain suitable for salmonid rearing. Therefore, the increased temperatures would likely not substantially affect rearing success.

With the D1610 Pipeline alternative, temperatures in the Russian River below Dry Creek would be improved slightly relative to D1610 and more substantially (by about 0.5°C) in the future demand scenario (Figures A-15 to A-18). This alternative would provide benefits to rearing steelhead in the Russian River, although coho are unlikely to benefit as this portion of the river does not provide suitable habitat for this species.

Inflow to the Estuary under the D1610 pipeline alternatives above would be the same as under D1610. Inflow would remain too high to operate the Estuary as a closed system under either current or future demand scenarios. The Estuary would continue to be operated as an open system.

2.5.3 Other Considerations

Implementation of this action would require redesigning and reconstructing portions of the wet well within the dam. The location of the tap of the pipeline to the wet well or outlet structure is a key design consideration as it could affect operations of the hydroelectric facility. If the pipeline were to tap into the wet well above the hydroelectric facility, there would be insufficient flow to operate the facility as currently configured. If the pipeline tapped into the outlet structure below the hydroelectric facility it would ensure that sufficient flows were available to power the turbines; however, back pressure from the pipeline could reduce the turbine's efficiency. Other alternate configurations for the hydroelectric facility may include reconfiguring the generator to operate at flows of 50 cfs, or installing two small generators along the pipeline. Additionally, this alternative would modify existing instream minimum flow requirements in Dry Creek. This modification would require approval from both the FERC and SWRCB.

Flows in Dry Creek would be a mixture of direct releases from the dam and hatchery discharges. By reducing the total flow in Dry Creek, the relative contribution of return water from the hatchery would increase, with potential effects on water quality. However, as the hatchery currently meets its NPDES requirements prior to dilution, this would likely not affect salmonid production in Dry Creek.

Recharge to the aquifer along Dry Creek would be reduced during summer flows as compared to current conditions, or conditions under the NFP. Recharge of the aquifer along the Russian River would be unaffected by this action.

Several operational concerns would have to be addressed. The pipeline is likely to have fluctuating pressures and surges, and would have to be operated to reduce the potential to generate turbidity where water is released to the river. Design of the pipeline discharge at the mouth of Dry Creek would address the potential for sediment scour and public safety. During repair and inspection of the pipeline system, releases would have to be made to Dry Creek.

This alternative would be considerably more expensive than the other proposed alternatives. Substantial funding would be required to implement this action. State and federal contributions would be required. The timeframe for developing a project description, completing the environmental compliance, acquiring right-of-way, and obtaining funding for this action could be as long as 10 to 15 years.

2.6 Action D. Continue D1610 with a Pipeline to the Mirabel Diversion Facility.

The objective of this action is to provide a mechanism whereby flows in Dry Creek and the Russian River can be reduced to maximize salmonid rearing habitat, while continuing to meet water supply needs of SCWA.

2.6.1 Action

This action would be similar to Action C, with the exception that the pipeline would not discharge directly and completely to the Russian River at the mouth of Dry Creek. Instead, the pipeline would continue to the Mirabel infiltration ponds or potentially to a water treatment plant. To enhance aquifer recharge, water would be released from the pipeline at multiple points (outlets) along the Russian River below Dry Creek and at the Mirabel ponds. The multiple outlets to the Russian River would provide for aquifer recharge over a larger area than a single point discharge. Russian River flows between the mouth of Dry Creek and Mirabel would be reduced by the amount of water traveling through the pipeline. The amount of flow in the river would depend on the amount of water discharged at each outlet and the location of those outlets along the river. The outlets would consist of both constant flow and variable flow outlets. This action would provide increased operational flexibility relative to Action C with respect to the location and release of water to the Russian River. Additionally, this action could allow greater flexibility in the management of the inflatable dam at Mirabel.

2.6.2 Effects on Protected Species

The pipeline extension to Mirabel would only affect the Russian River differently than the pipeline alternative described in Action C between the mouth of Dry Creek and Mirabel. Conditions in the Russian River above Dry Creek and below Wohler Dam and in Dry Creek would remain the same as the previous alternative (Action C). The RRSM and RRWQM cannot predict the specific effects of this alternative on this portion of the Russian River. Generally, the flow below Dry Creek would be reduced for an undetermined distance downstream until all the water transported through the pipeline had been released to the river. Around each outlet, a cool water refugia might be provided that could provide relief from the warm temperatures present under D1610. This could provide a benefit to any juvenile steelhead rearing in this portion of the river.

As this option could deliver water directly to the Mirabel diversion facility, it could be used to supply water to the Mirabel infiltration ponds during periods when the inflatable dam is deflated. This may reduce the need to raise the dam during dry conditions in the spring (March to April). A delay in raising the dam would benefit smolts by reducing potential delays in juvenile outmigration. The dam would still need to be inflated during peak demand season (May into November), however.

2.6.3 Other Considerations

The issues raised under "Other Considerations" for Action C would apply to this alternative as well. These include issues associated with hatchery water supply, water quality, and hydroelectric operations, and timeline for implementation. The considerations relating to the location of the tap of the pipeline to the wet well are the same as for Action C. This action would also require that a longer right-of-way be obtained than for Action C, as the pipeline would travel to the Mirabel ponds. However, this action would also reduce evaporative losses of water that are incurred during conveyance of water along the stream and riverbed.

2.7 Action E. Implement the Enhanced Natural Flow Proposal with Additional Measures.

The objective of this action is to provide a mechanism whereby flows in Dry Creek and the Russian River can be reduced to maximize salmonid rearing habitat while continuing to meet water supply obligations of SCWA under the future water demand scenario. An additional objective would be to allow the Estuary to be operated as a closed system during the summer months.

The ENFP –AM alternative would involve the development of a mechanism whereby flows in the Upper Russian River and Dry Creek could be maintained at levels that provide excellent habitat values, while still meeting future water demand. Additional measures being considered for this alternative include both institutional and physical measures. Institutional measures would address water rights compliance in the Upper and Middle Russian River. Physical measures may include a pipeline as described in the previous section, implementation of an Aquifer Storage and Retrieval Program (described below), or other options to be developed. The final alternative may include some combination or phased implementation of these options.

2.7.1 Action

Under this alternative, SCWA would attempt to provide flows into the future at levels similar to those described for the ENFP under the current demand scenario. With the ENFP, flows increase over time in the Upper and Middle Russian River to meet anticipated future demand to levels; approaching those under current D1610 operations. These flow levels result in velocities that are higher than optimal for rearing salmonids. Under the ENFP-AM alternative, the additional water demand will be met through a mechanism that does not require putting additional water down either the Upper and Middle Russian River or Dry Creek. This mechanism may include a suite of additional measures. These would include institutional measures to address water rights compliance in the Upper and Middle Russian River as well as physical solutions. The primary physical solutions being considered for this alternative are an ASR program, a pipeline from WSD to the mouth of Dry Creek, or development of smaller off-stream storage facilities elsewhere in the basin.

The final alternative will likely be a combination of these options, other options yet to be determined, or a phased implementation of these options, as demand increases.

The ASR option would involve the development of groundwater recharge facilities in areas such as the Sonoma Valley, Santa Rosa Plain, or Petaluma. Water would be diverted into the aquifer from the existing transmission system during high-flow conditions. The recharge system would consist of injector wells. The stored water could then be extracted to provide an additional source of water. This action would require an evaluation of groundwater management practices and, potentially, land use management restrictions.

If a pipeline option were pursued, a new pipeline would be installed in the wet well or outlet structure of WSD, as described for Action C, requiring acquisition of a right-of-way. This pipeline could terminate either at the mouth of Dry Creek or at Mirabel as described in Actions C and D. The pipeline could potentially feed into a water treatment plant. The pipeline would be implemented in coordination with the ENFP flow scenarios for the system. Releases from WSD to Dry Creek would be in the range of 50 to 90 cfs, with a target flow of 70 cfs. Any additional flow needed to meet water supply needs would be conveyed through the pipeline.

2.7.2 Effects on Protected Species

Under both the current and future demand scenarios, this alternative would result in flows and temperatures in the Upper and Middle Russian River and in Dry Creek similar to those described for the ENFP under current demands, as described in Section 2.2.2. In the Russian River below Mirabel, flows would remain as described for the ENFP under current demands, but temperatures may change somewhat depending on the option implemented. The ability to improve conditions for salmonids throughout most of the system, both now and in the future, could provide a substantial benefit to these species.

Flow and temperature could be affected in the Russian River between Dry Creek and Wohler Diversion Dam depending on the option implemented. The values of flow and temperature values provided in Appendix A are based upon the implementation of the pipeline option and assume that the pipeline will terminate at the mouth of Dry Creek. If the other options were implemented, flows and temperatures would not be expected to vary from these values to the extent that they would substantially modify the habitat value in this portion of the river. These changes are described in more detail below.

Additional water needed to meet future water demand would be obtained from one of the options discussed above, but would not be conveyed via Dry Creek or the Upper and Middle Russian River.

Flow levels during the summer months in the Upper and Middle Russian River would be reduced from those currently existing under D1610, to levels that provide excellent habitat for rearing steelhead and Chinook salmon. The lower flows could slow emigration rates in June, but would not be likely to substantially impair emigration success. The lower flows could also make conditions for the early upstream migration of Chinook salmon more difficult. However, as one of the goals of this alternative is to maintain the Estuary as a closed system, adult Chinook would not be able to enter the system until the sandbar was opened, which would likely coincide with storm events that would bring flows to adequate levels to provide passage. Flows in the Russian River would generally be similar during the spawning season, and spawning conditions would be similar under Both D1610 and the ENFP-AM for all species in most months. An exception would occur in November under the future demand scenario for All water supply conditions. Under the ENFP-AM flows would decline substantially, resulting in a sharp decrease in Chinook spawning habitat.

In the Upper and Middle Russian River, the lower flows would result in slightly warmer water temperatures than occur with D1610 under the current water demand. Temperatures would not warm to levels considered very stressful, however. These conditions would continue under the future water demand scenario as well.

Summer flow in Dry Creek under the ENFP-AM alternative would be adjusted to provide excellent rearing conditions for steelhead and coho salmon under both the current and future demand scenarios. During Dry water supply conditions, which occur about 20 percent of the time, flow in Dry Creek would increase to meet water supply needs, but would increase substantially less than under D1610 (Figures A-2). During the latter part of the emigration season, the lower flows under the ENFP-AM may slow emigration, but would not be low enough to effect emigration success. Increases in flow during February and March under All water supply conditions would decrease spawning habitat for coho and steelhead during these months. In Dry water supply conditions, flow increases in April would improve conditions for steelhead spawning relative to D1610.

The lower flows during the summer months would result in slightly warmer water temperatures than D1610, but would still provide good rearing temperatures (Figures A-11 and A-12). Under Dry water supply conditions when flow would increase, temperature would drop but water velocities would be higher than optimum (Figures A-13 and A-14).

If the pipeline option is used, the additional water needed to meet future water demand would be delivered from WSD via a pipeline and discharged to the Russian River near the mouth of Dry Creek. Flows between the mouth of Dry Creek and Mirabel would initially be those described for the ENFP alternative, but would increase with increasing water demand. Under the future water demand scenario, flows in this portion of the river would be similar to those under the ENFP with future demand. Water temperatures in this reach would be altered depending on the mix of water from Dry Creek, the Russian River, and the pipeline. These temperatures would be cooler than those under D1610 and warmer than those under the D1610 Pipeline alternative. If the ASR option is used, then flows in the Russian River between Dry Creek and Wohler diversion would be similar to those under the ENFP with current water demand. This would affect salmonid habitat as described in Section 2.4.2.

Under the ENFP-AM alternative, inflow the Estuary would be adaptively managed to maintain the Estuary in a closed state during the summer months. Flows would be managed to keep the Estuary level at the Jenner gage at 8 to 8.5 feet. This could enhance summer habitat for salmonid juveniles and their foodbase in the Estuary. Optimal estuary inflow is estimated to be 35 to 45 cfs, but would need to be adaptively managed to maintain this water surface elevation.

2.7.3 Other Considerations

This alternative would share the other considerations for recreation, water quality, and hydroelectric power production discussed for the ENFP in the Russian River below Mirabel in Section 2.4.3. If the pipeline option were incorporated as part of this alternative, the ENFP-AM alternative would also share the other considerations regarding construction, aquifer recharge along Dry Creek, cost, and implementation timeframe discussed for the D1610 Pipeline alternative in Section 2.5.3. As this alternative would modify minimum instream flows in the Russian River and Dry Creek, it would require the approval of the SWRCB and the FERC.

ASR would provide the benefit of reducing diversions on the Russian River system during the peak demand season by more equally distributing Russian River diversions throughout the year. Water would then be stored in other aquifers distinct from the Russian River to help offset peak demand. Additional considerations for the ASR option would include siting, groundwater management requirements, ability to recover the water stored in the aquifer, and potential water quality issues associated with differences in composition between Russian River and native groundwater. If this option were to be pursued, a groundwater management plan would likely need to be developed to ensure that the water stored in an aquifer would be available when needed, and not withdrawn by other water users. Each of these considerations would need to be evaluated carefully prior to implementing this option. An additional benefit of this alternative would include improved system reliability.

Before smaller off-stream reservoirs were to be developed, siting and water availability would need to be considered.

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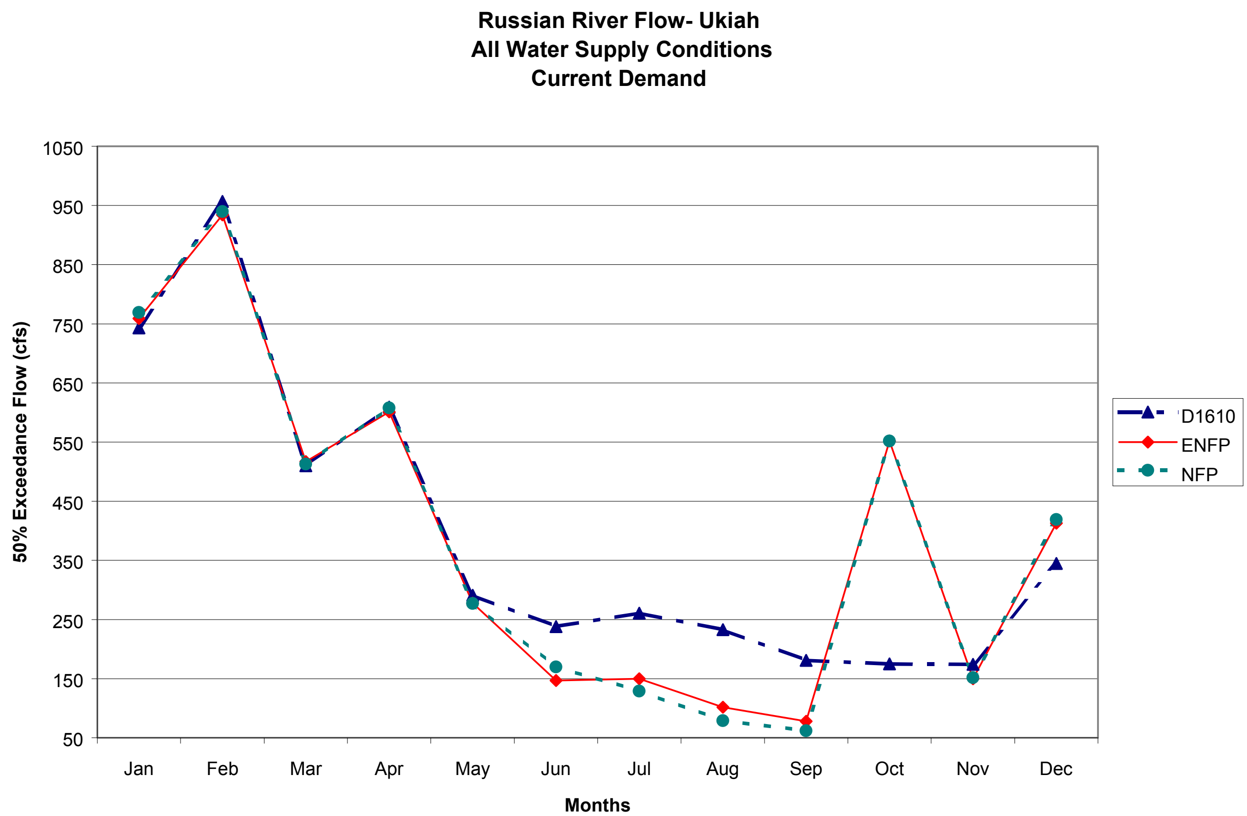
APPENDIX A

FIFTY PERCENT EXCEEDANCE FLOW AND TEMPERATURE GRAPHS



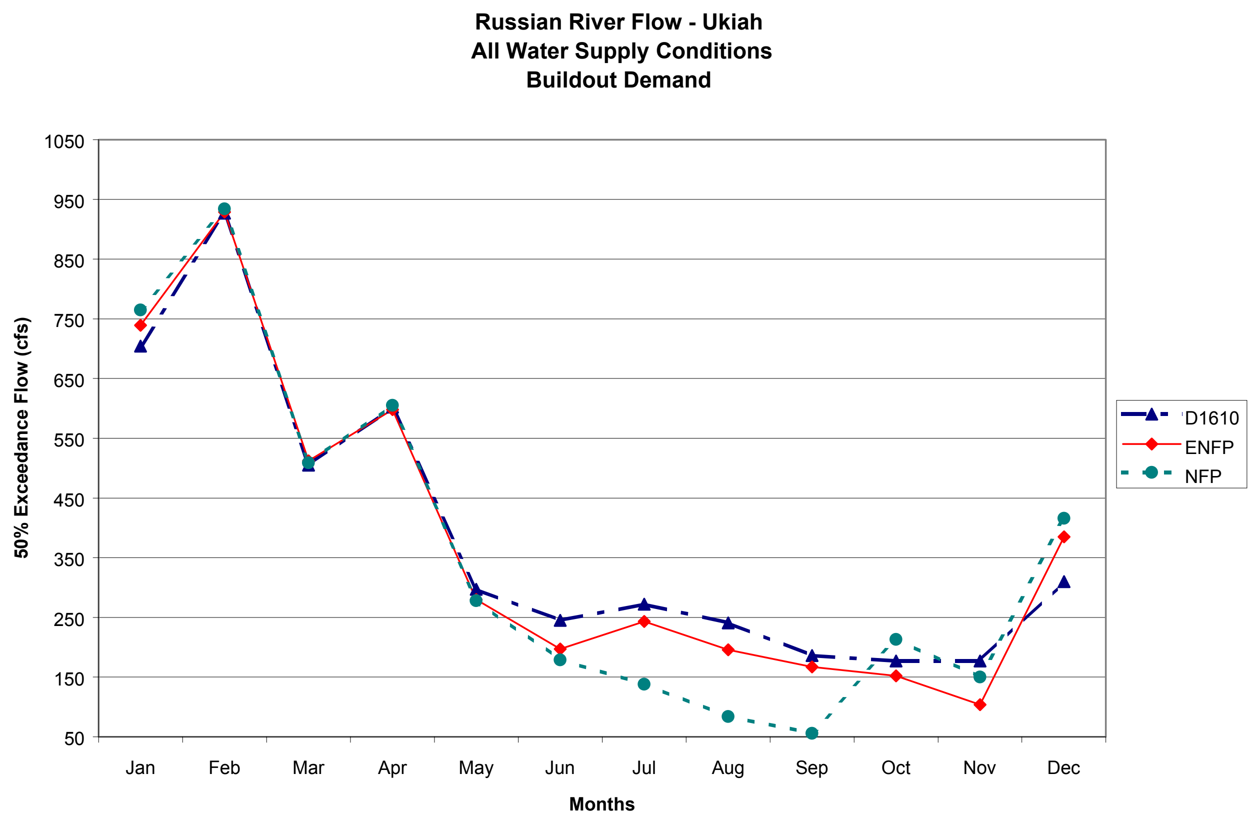
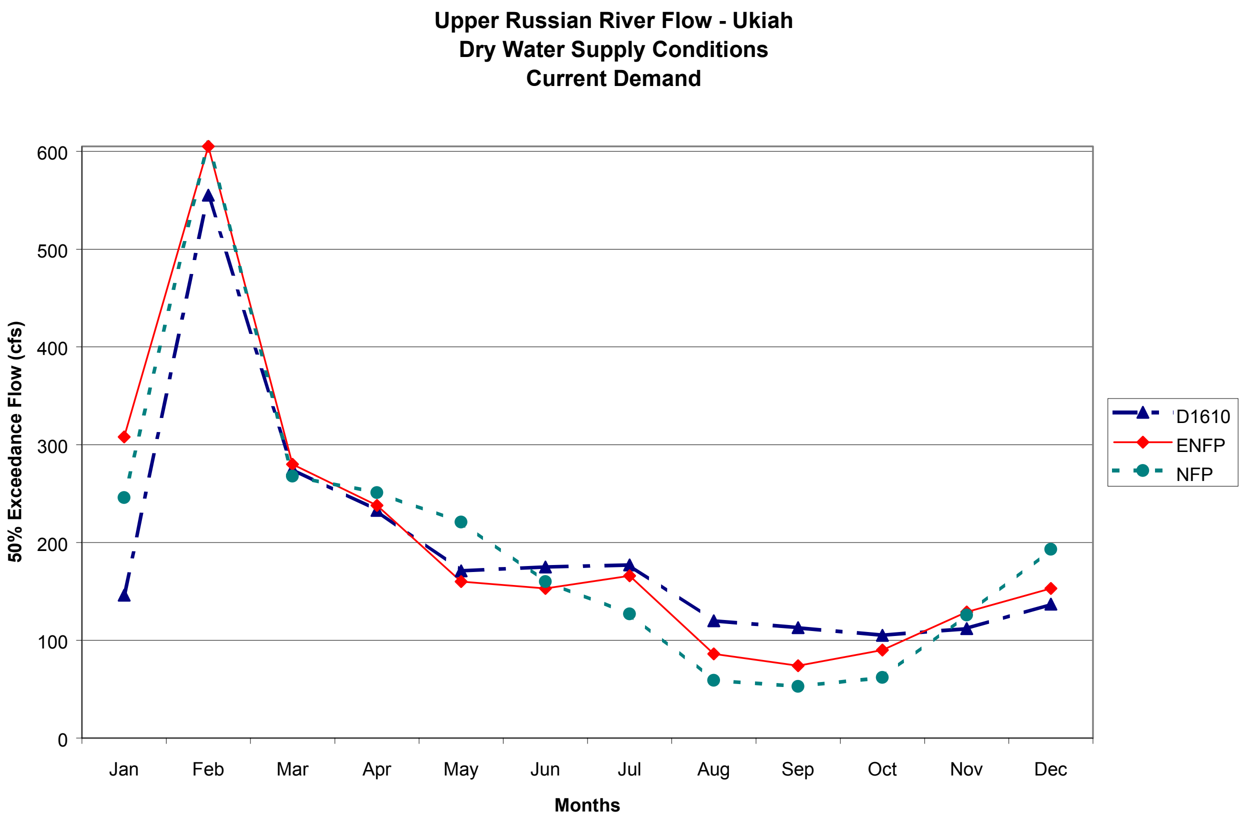


Figure A-1. Monthly Flows in Ukiah under All Water Supply Conditions.



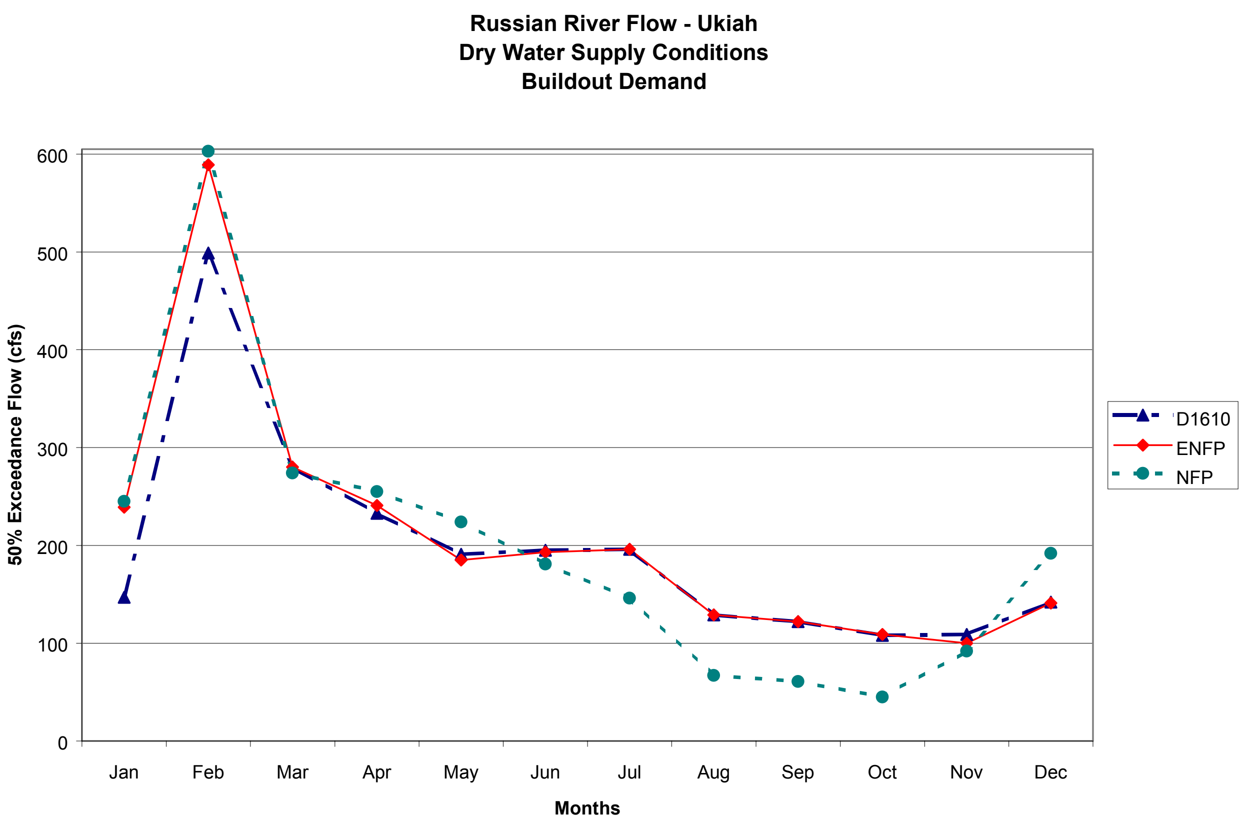
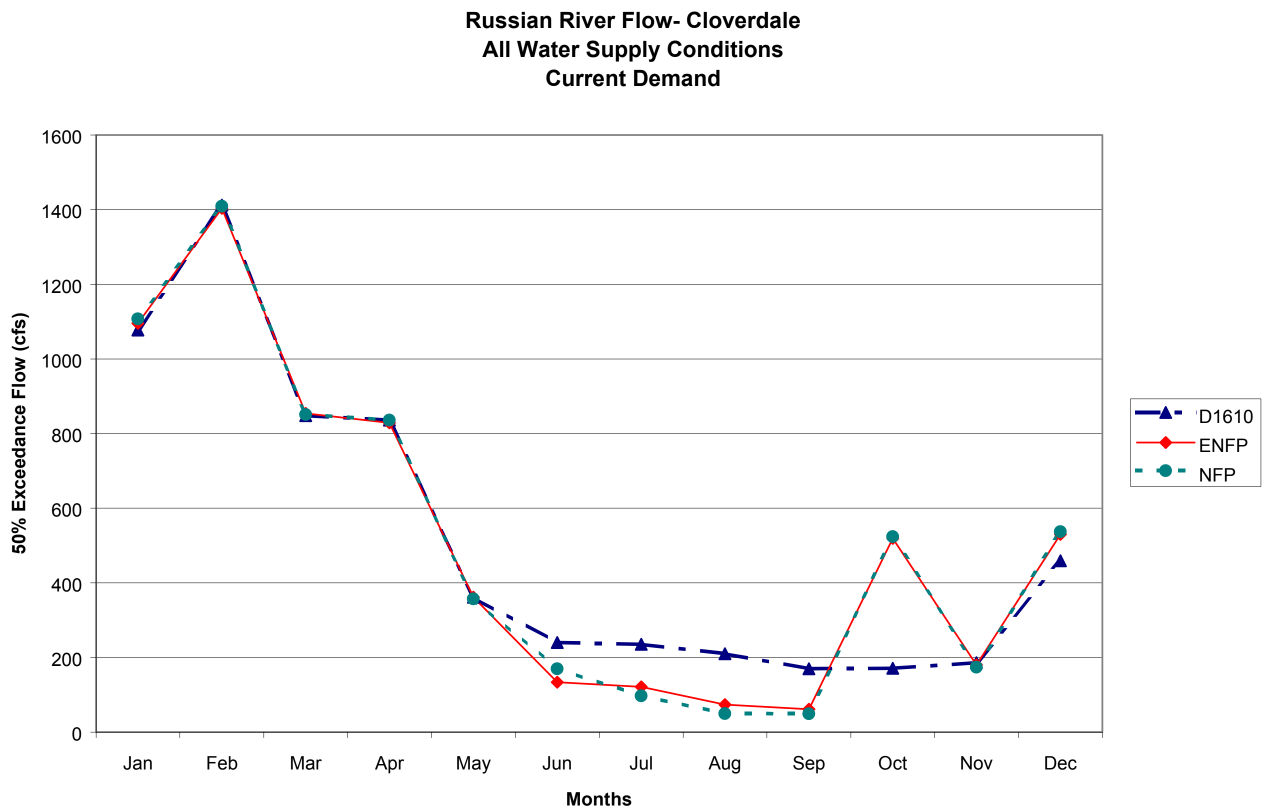


Figure A-2. Monthly Flows in Ukiah under Dry Water Supply Conditions.



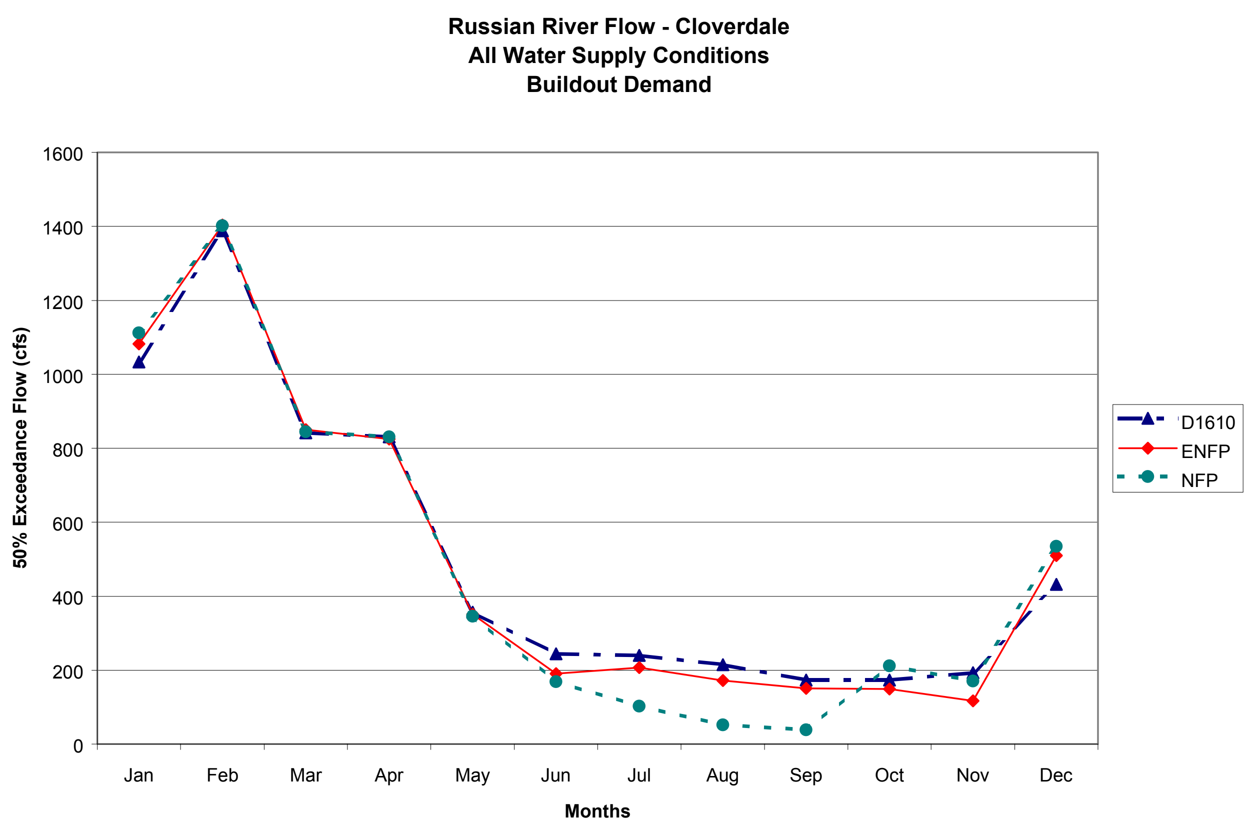
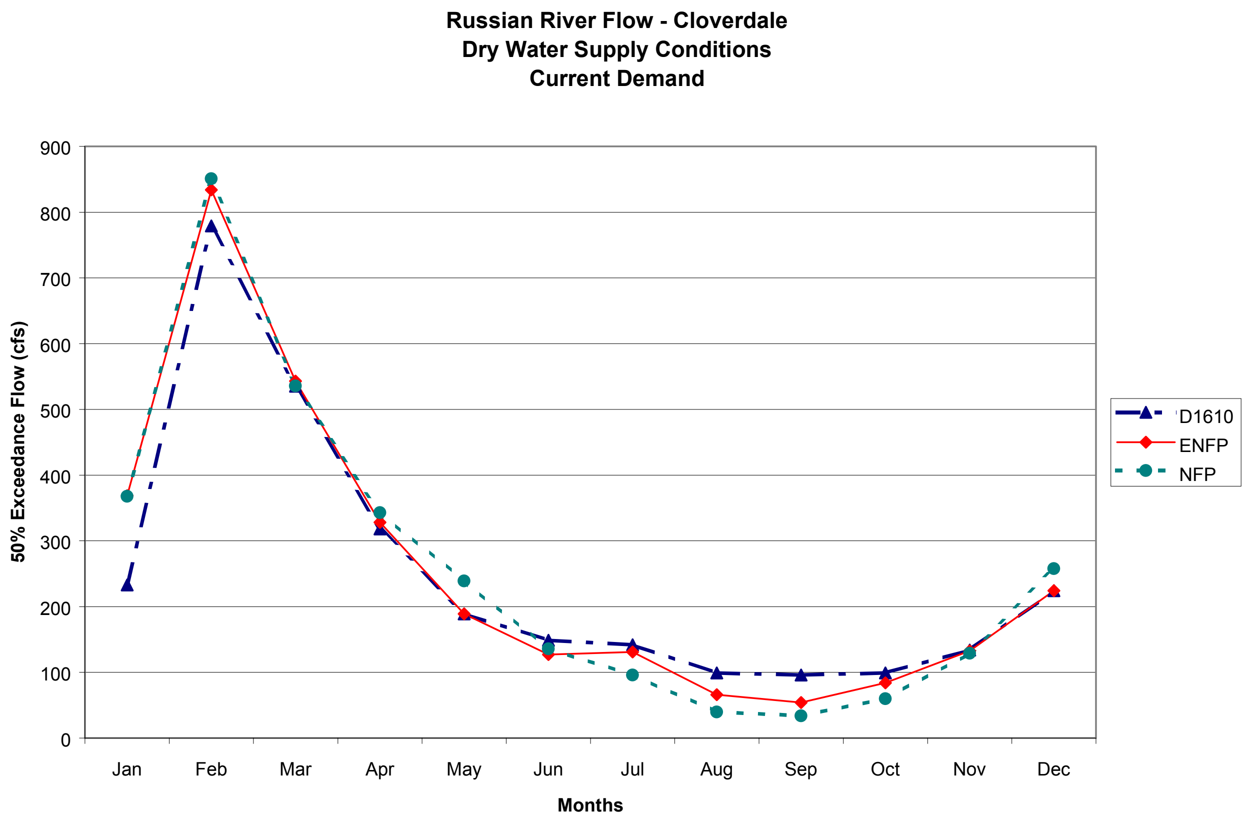


Figure A-3. Monthly Flows in Cloverdale under All Water Supply Conditions.



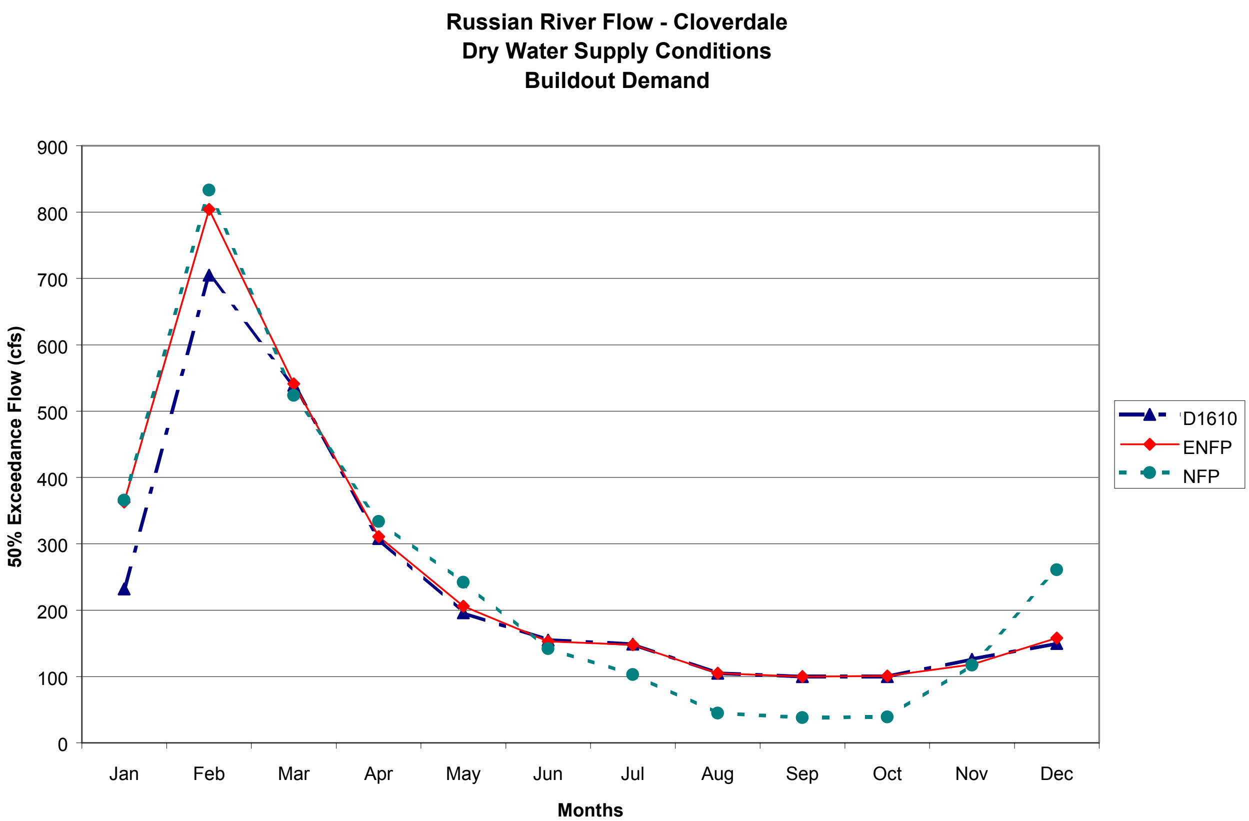
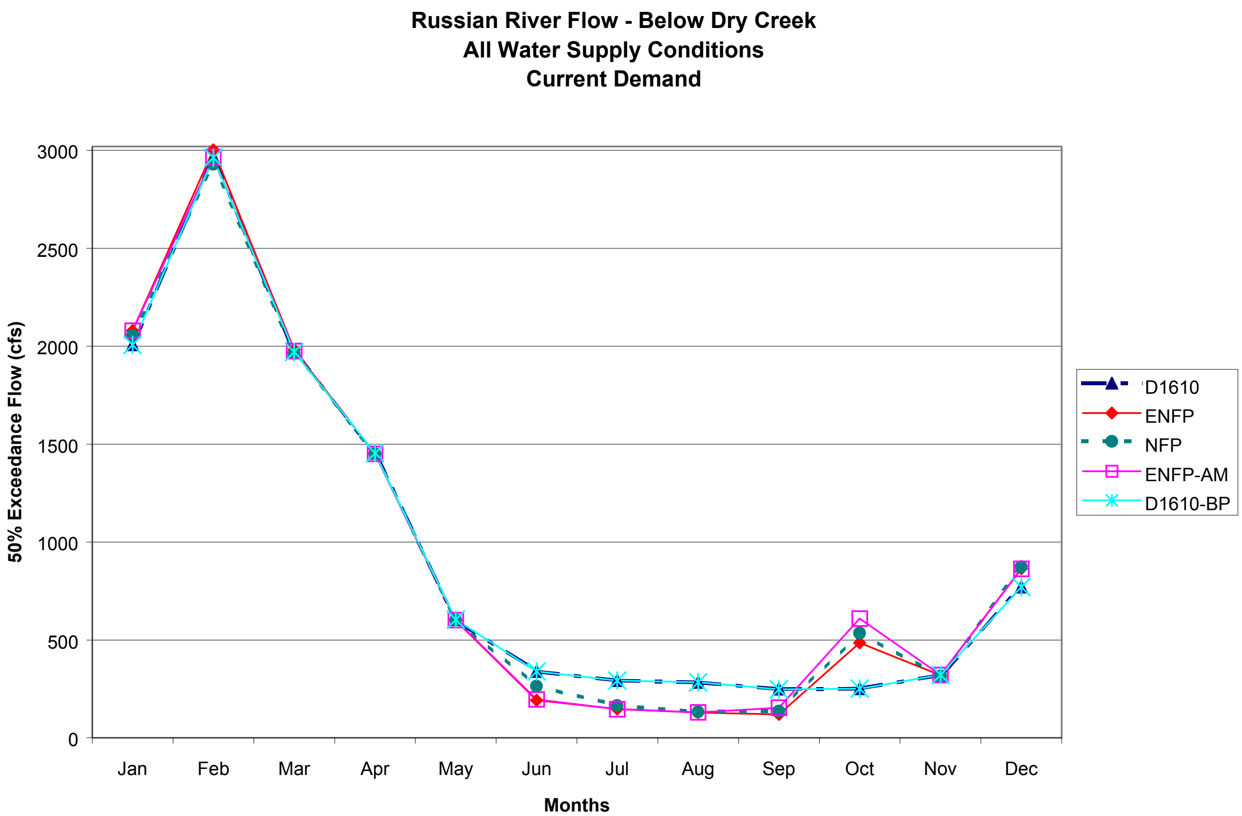


Figure A-4. Monthly Flows in Cloverdale under Dry Water Supply Conditions.



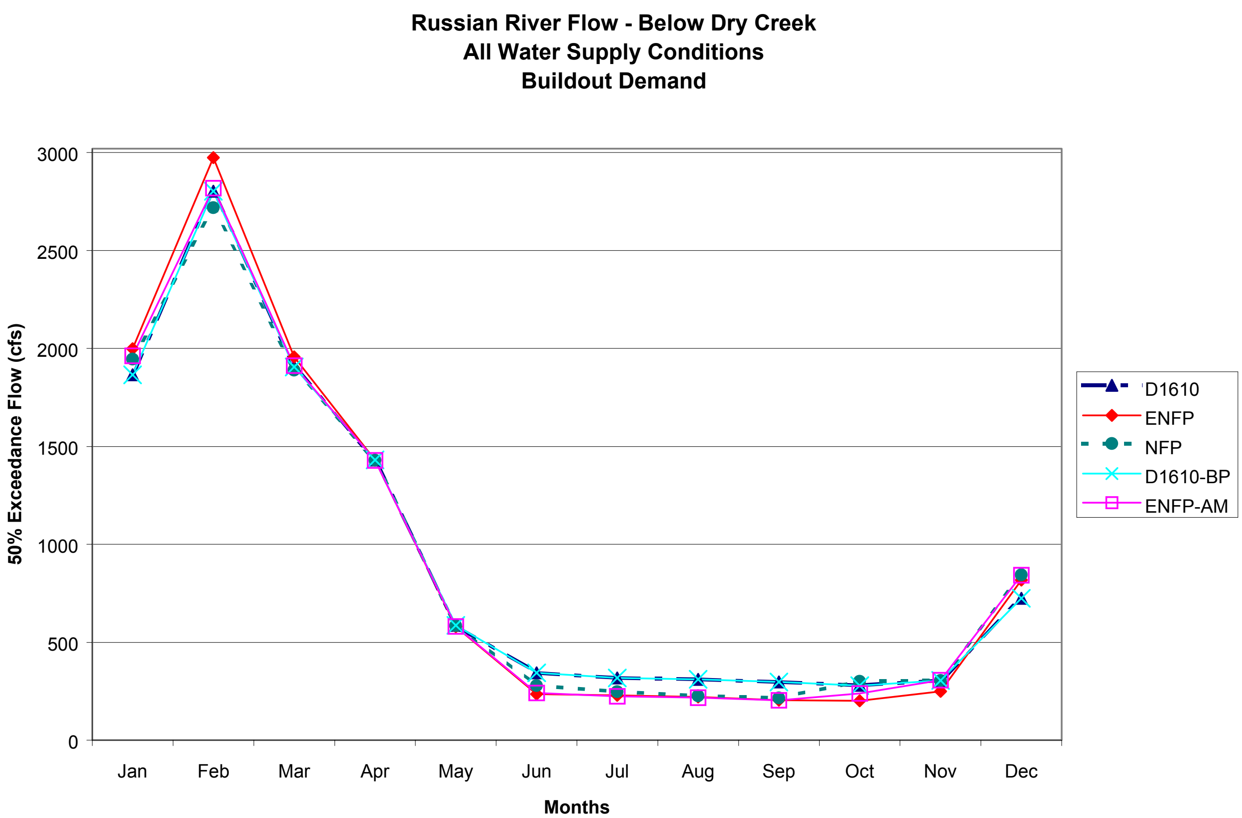
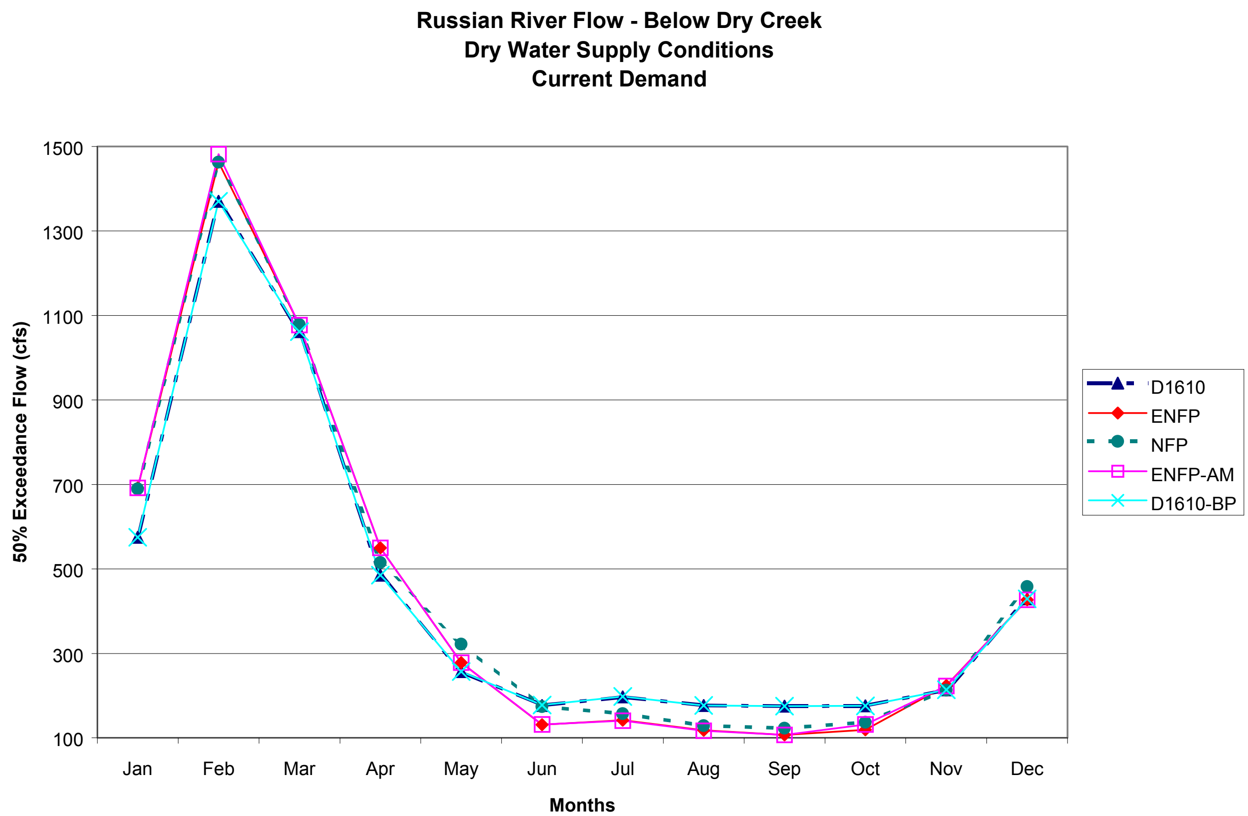


Figure A-5. Monthly Flows in the Russian River below the mouth of Dry Creek under All Water Supply Conditions.



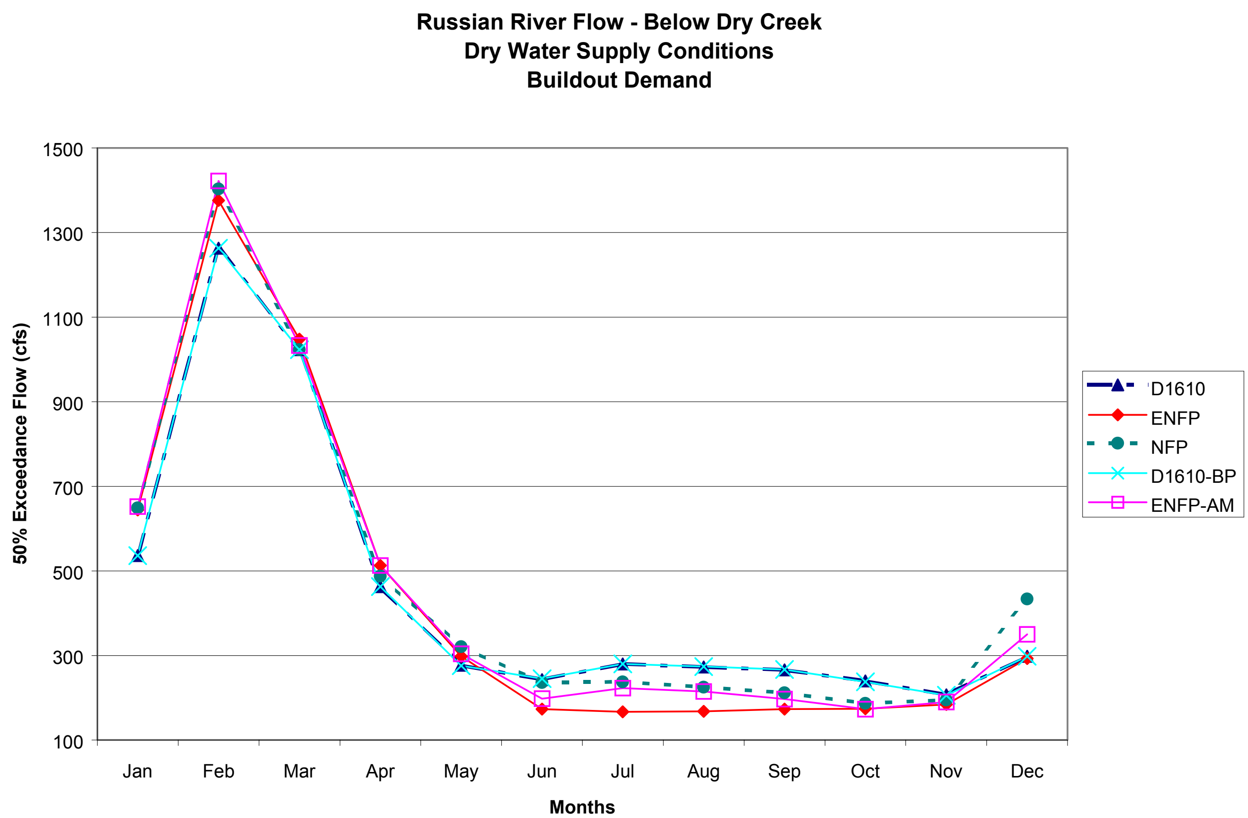
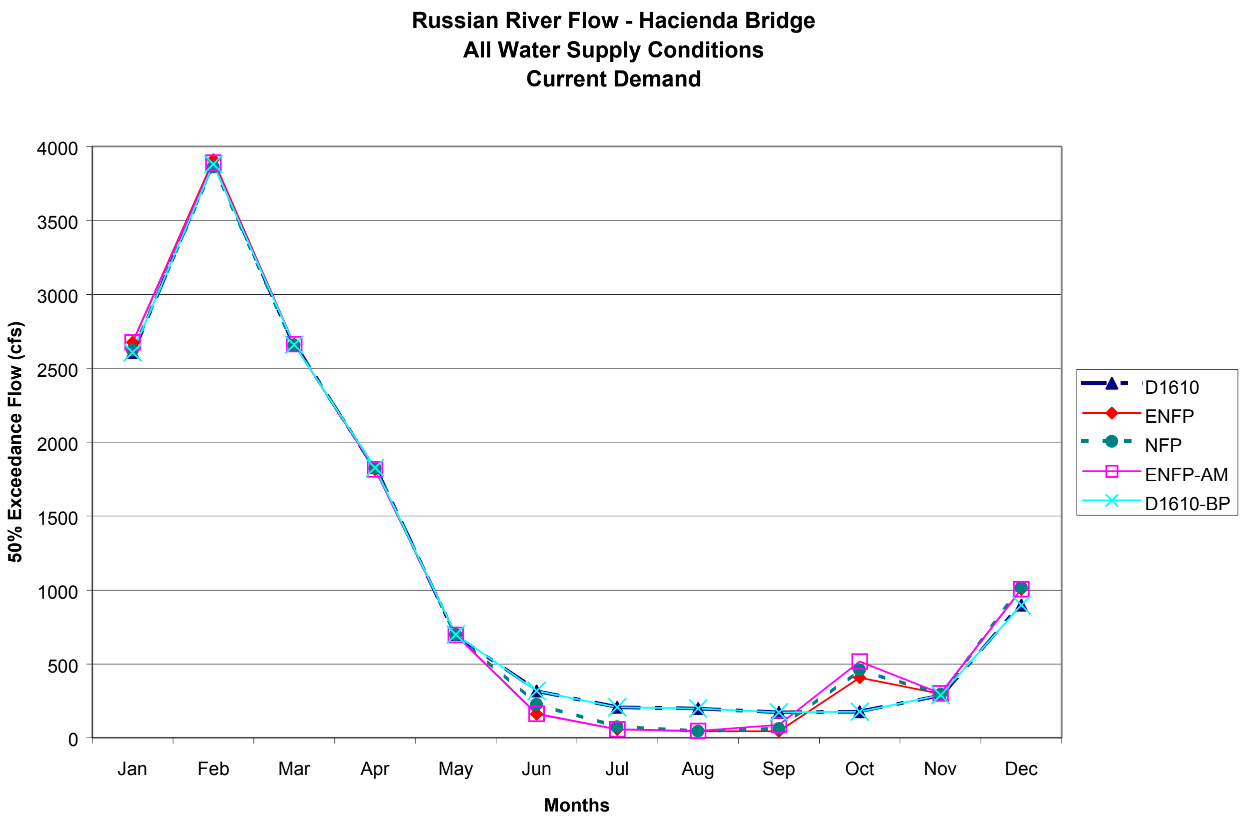


Figure A-6. Monthly Flows in the Russian River below the mouth of Dry Creek under Dry Water Supply Conditions.



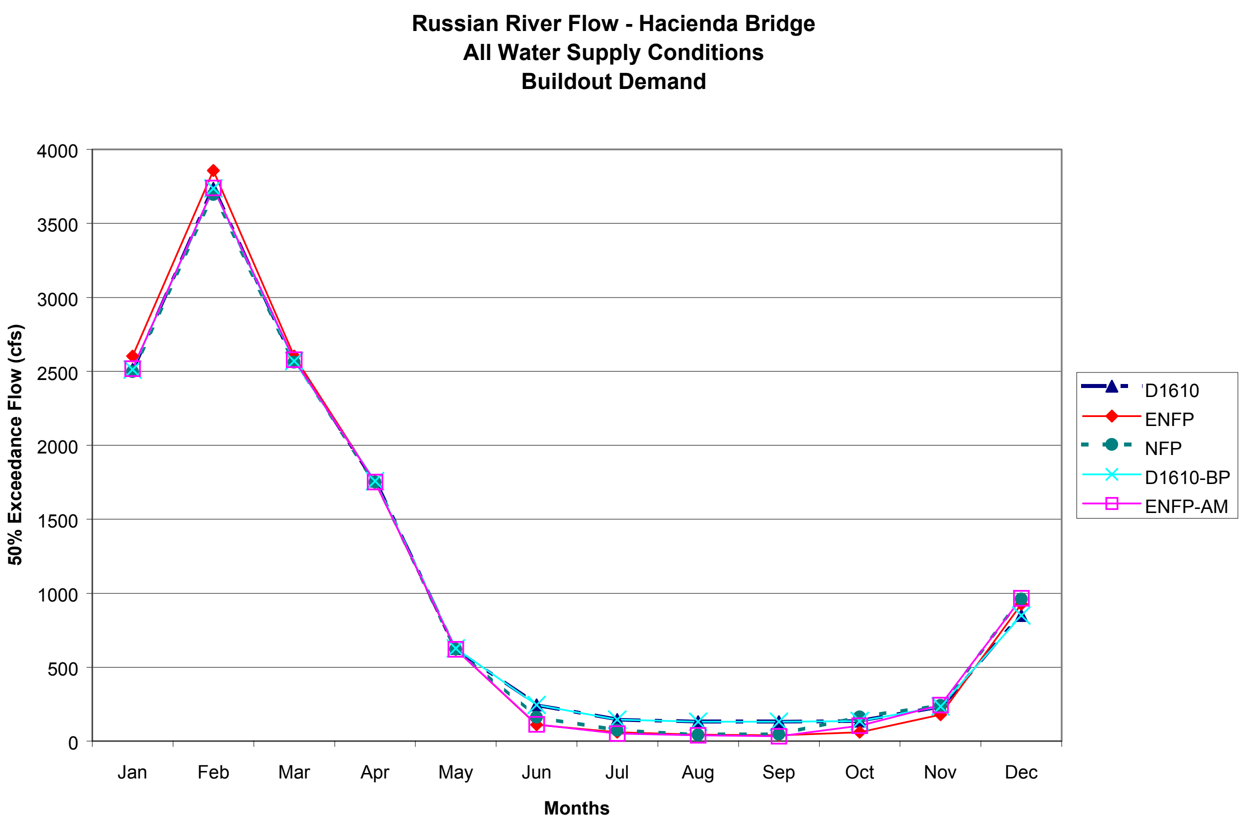
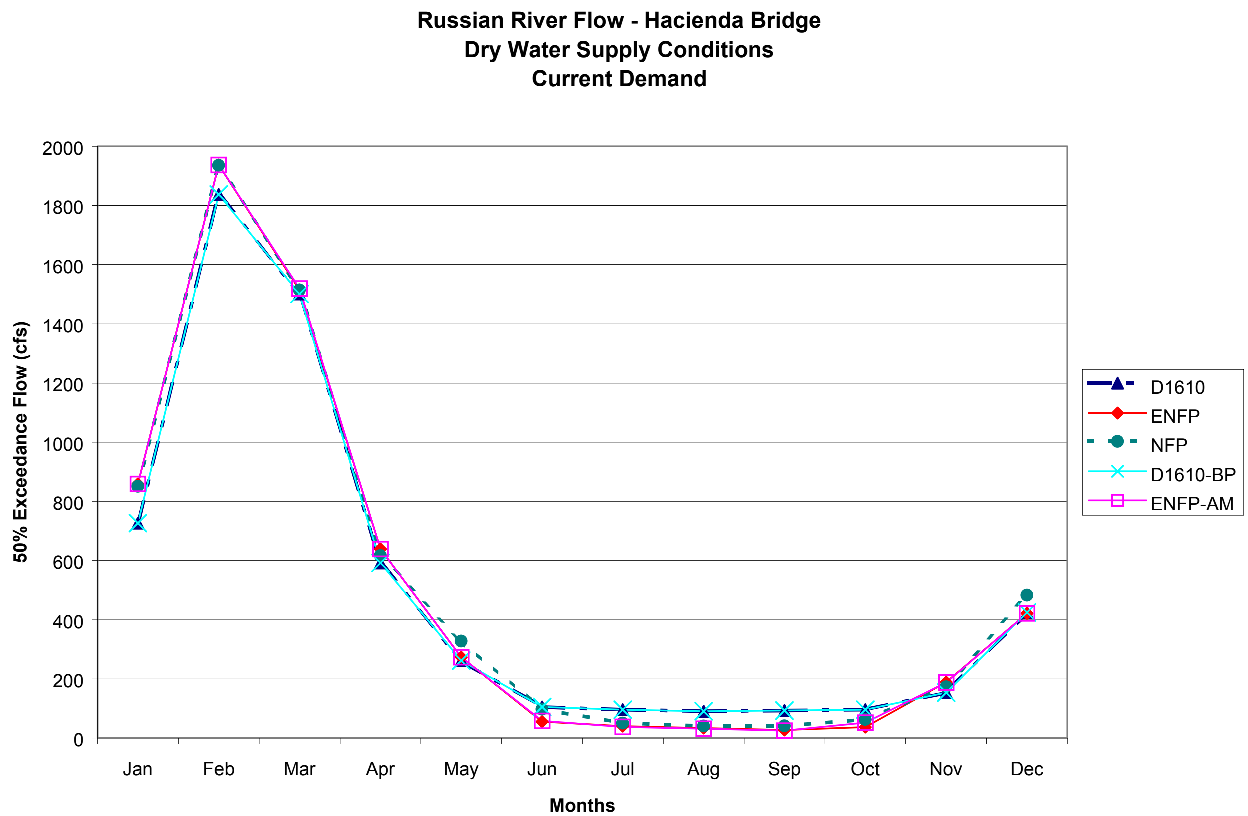


Figure A-7. Monthly Flows at Hacienda Bridge under All Water Supply Conditions.



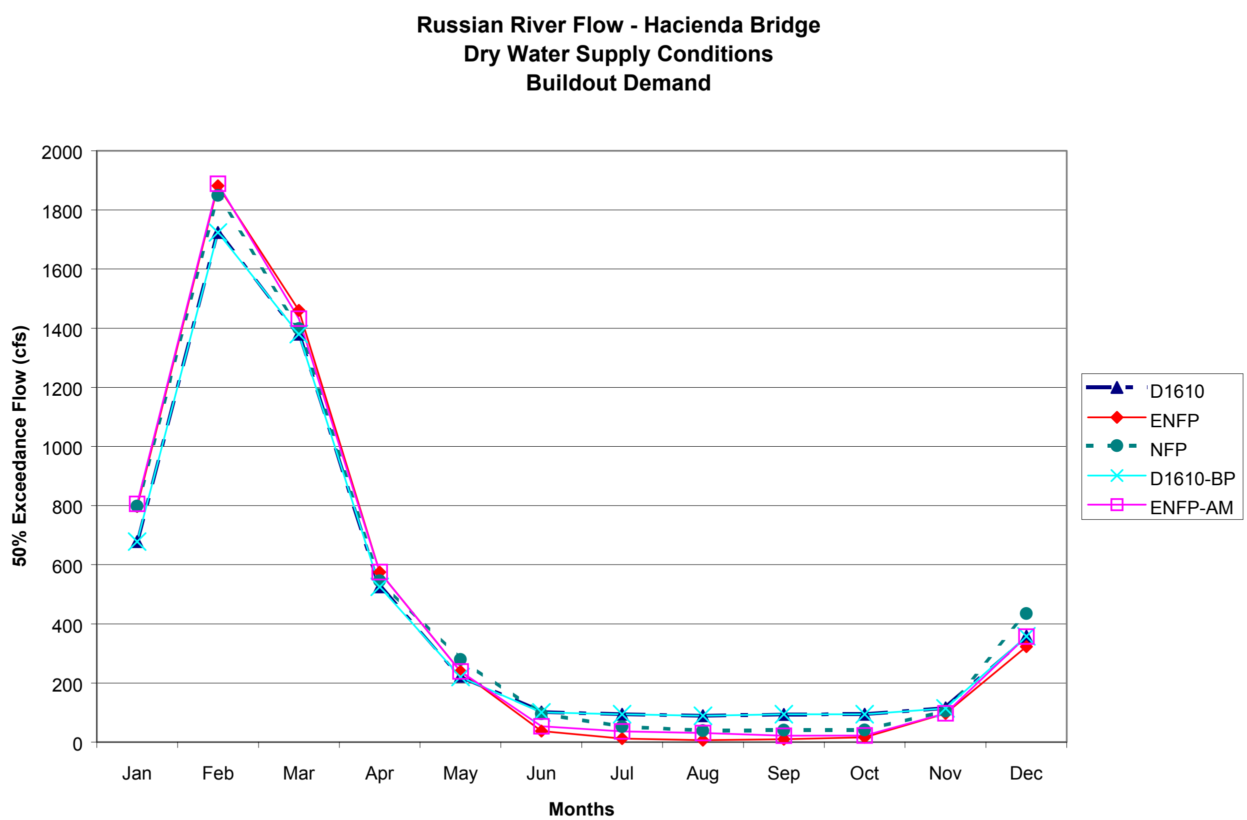
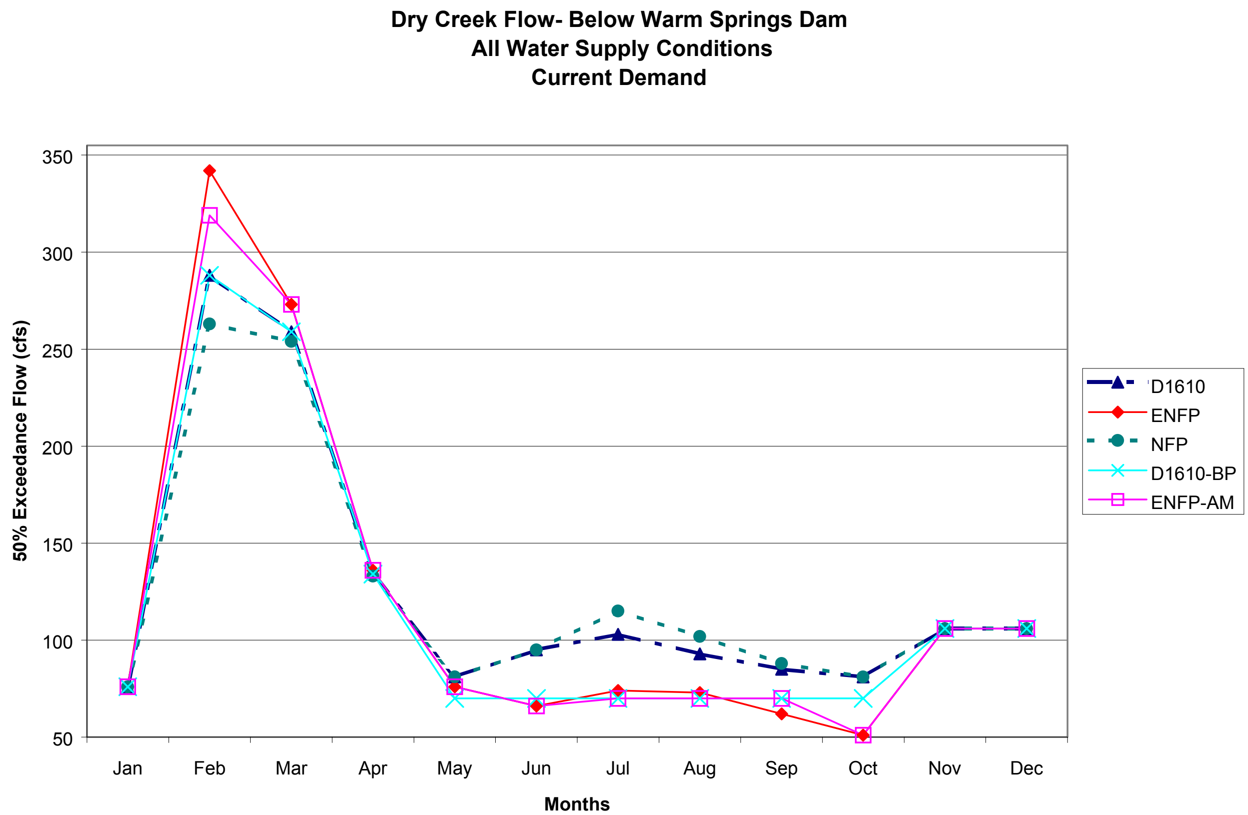


Figure A-8. Monthly Flows at Hacienda Bridge under Dry Water Supply Conditions.



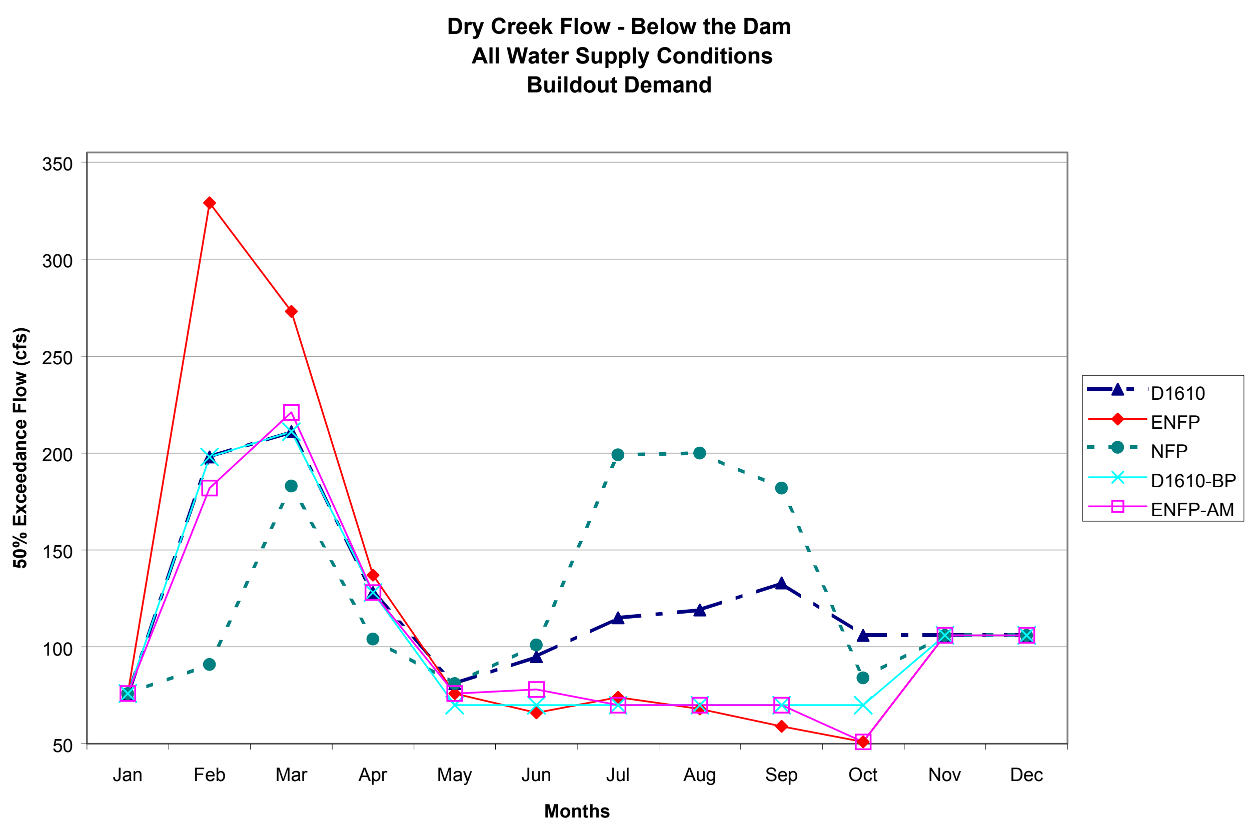
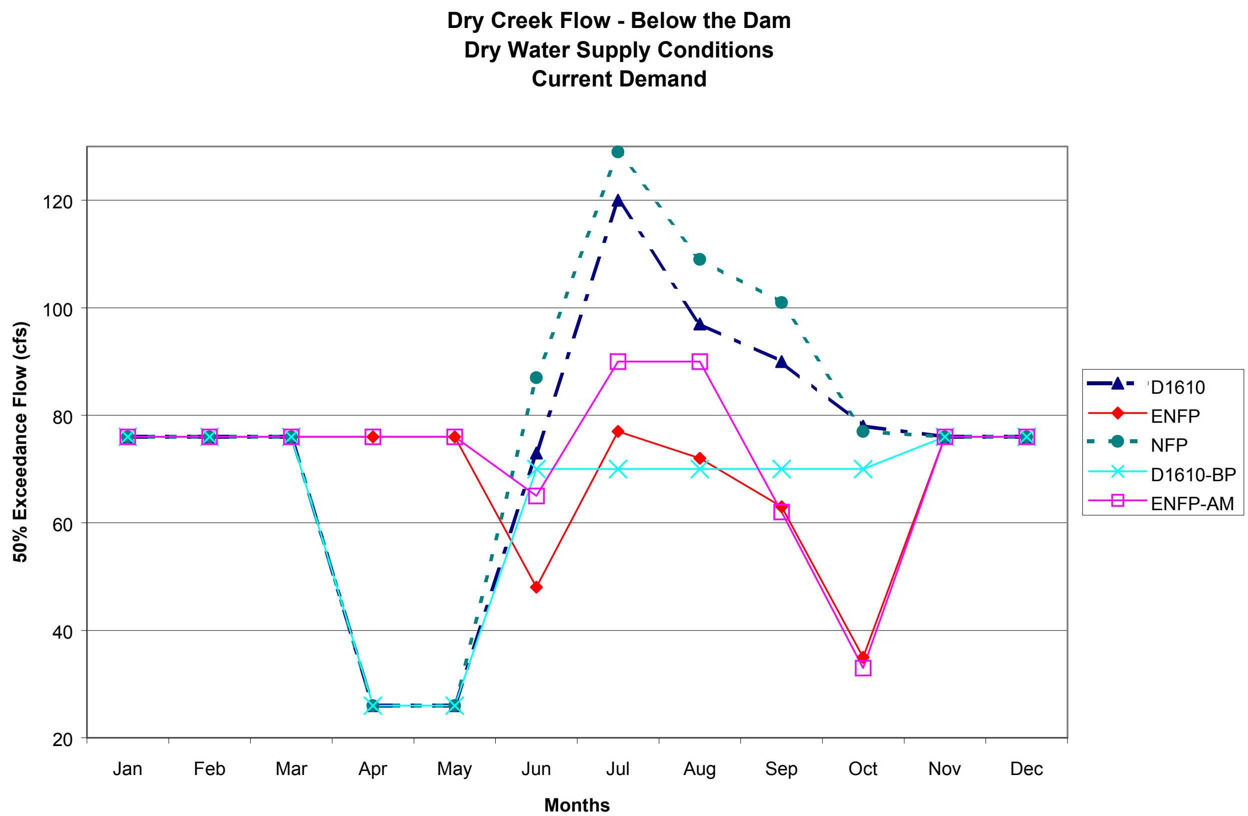


Figure A-9. Monthly Flows in Dry Creek below the Dam under All Water Supply Conditions.



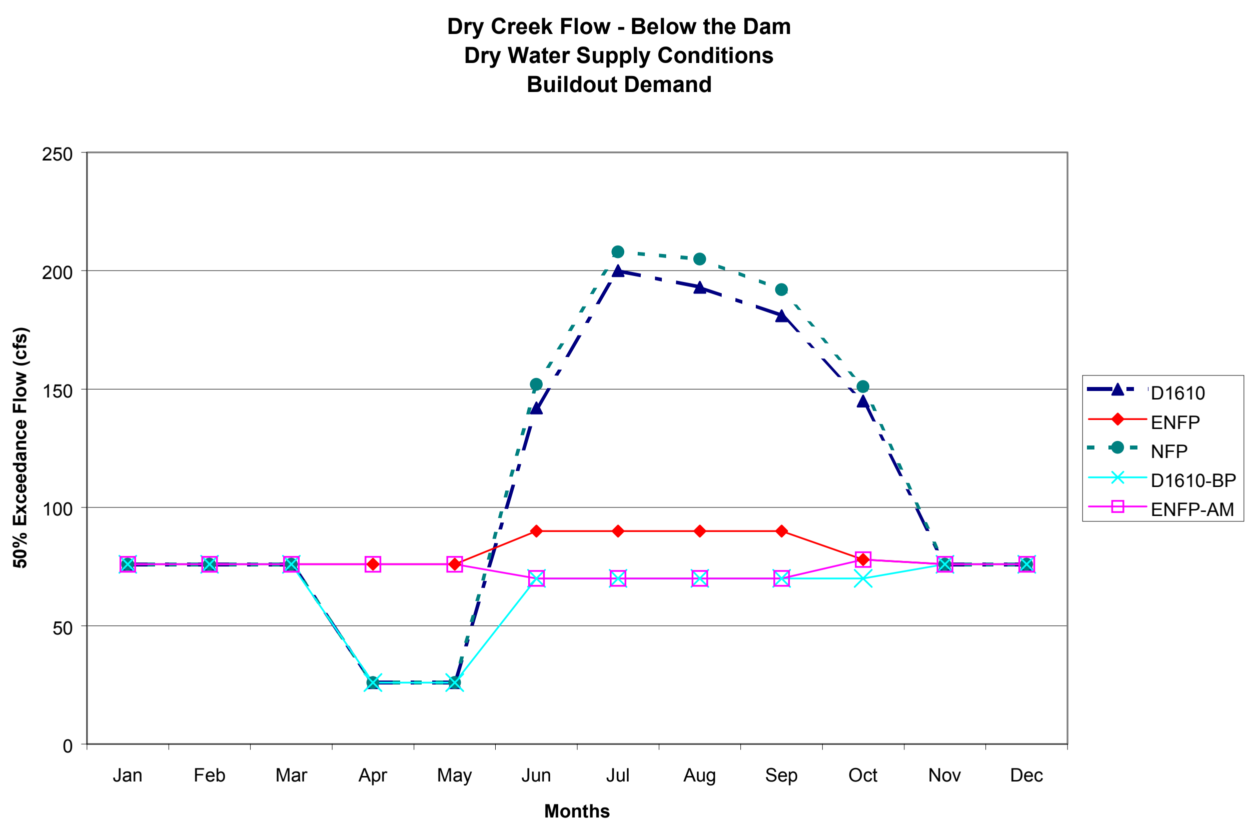
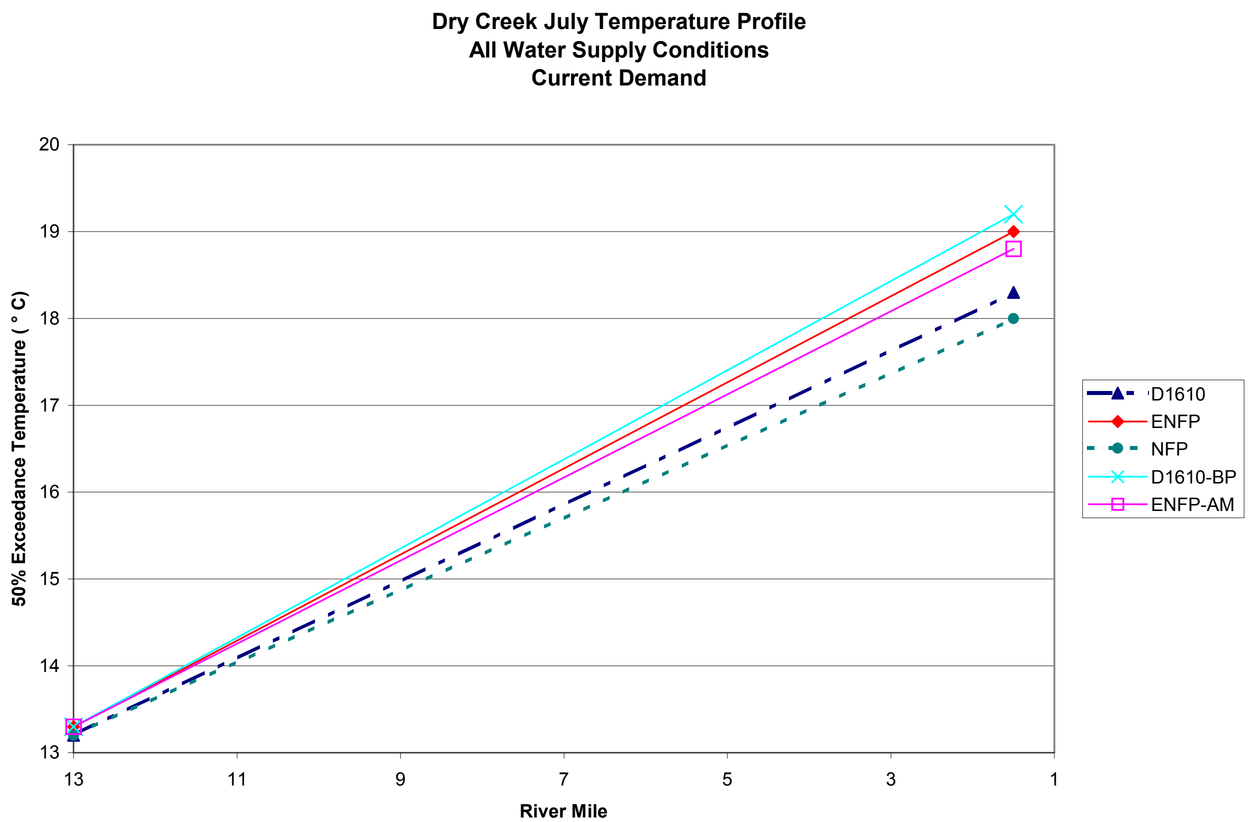


Figure A-10. Monthly Flows in Dry Creek below the Dam under Dry Water Supply Conditions.

Table A-1. Description of Water Quality Nodes for Temperature Plots.

	River Mile	Description
Dry Creek	13	below Warm Springs Dam
	1.5	near Mouth
Russian River	88.5	near Ukiah
	80.5	near Hopland
	68	near Cloverdale
	34	near Healdsburg (above Dry Creek)
	31	below Dry Creek
	20.9	at Hacienda Bridge



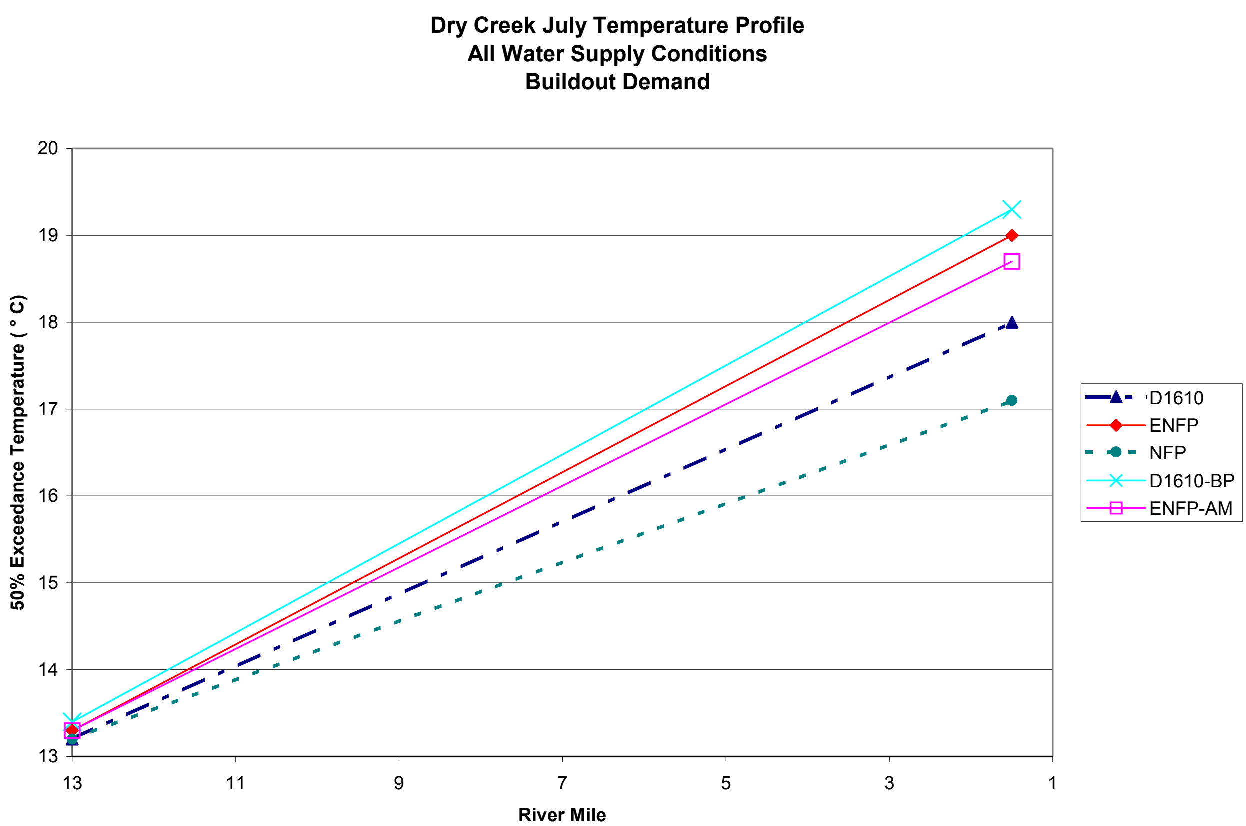
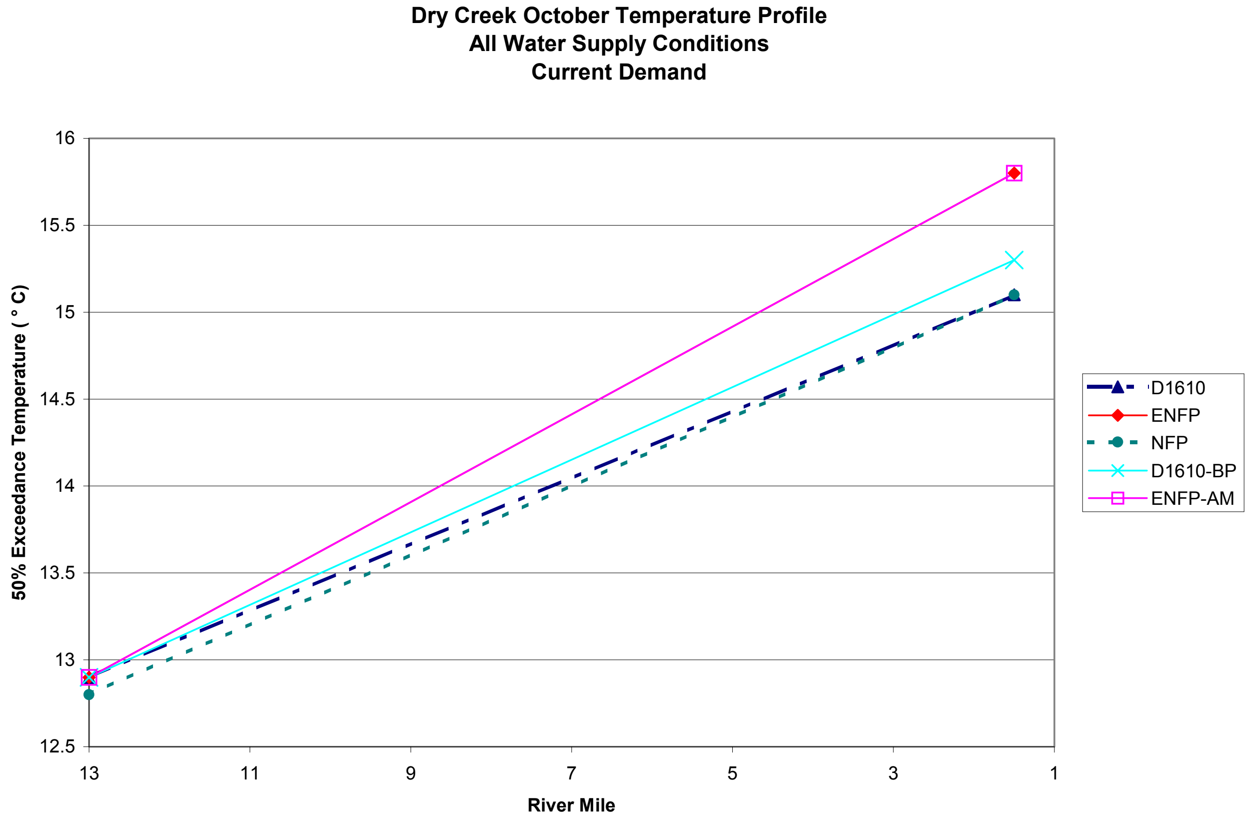


Figure A-11. Longitudinal Temperature Profile in Dry Creek in July under All Water Supply Conditions.



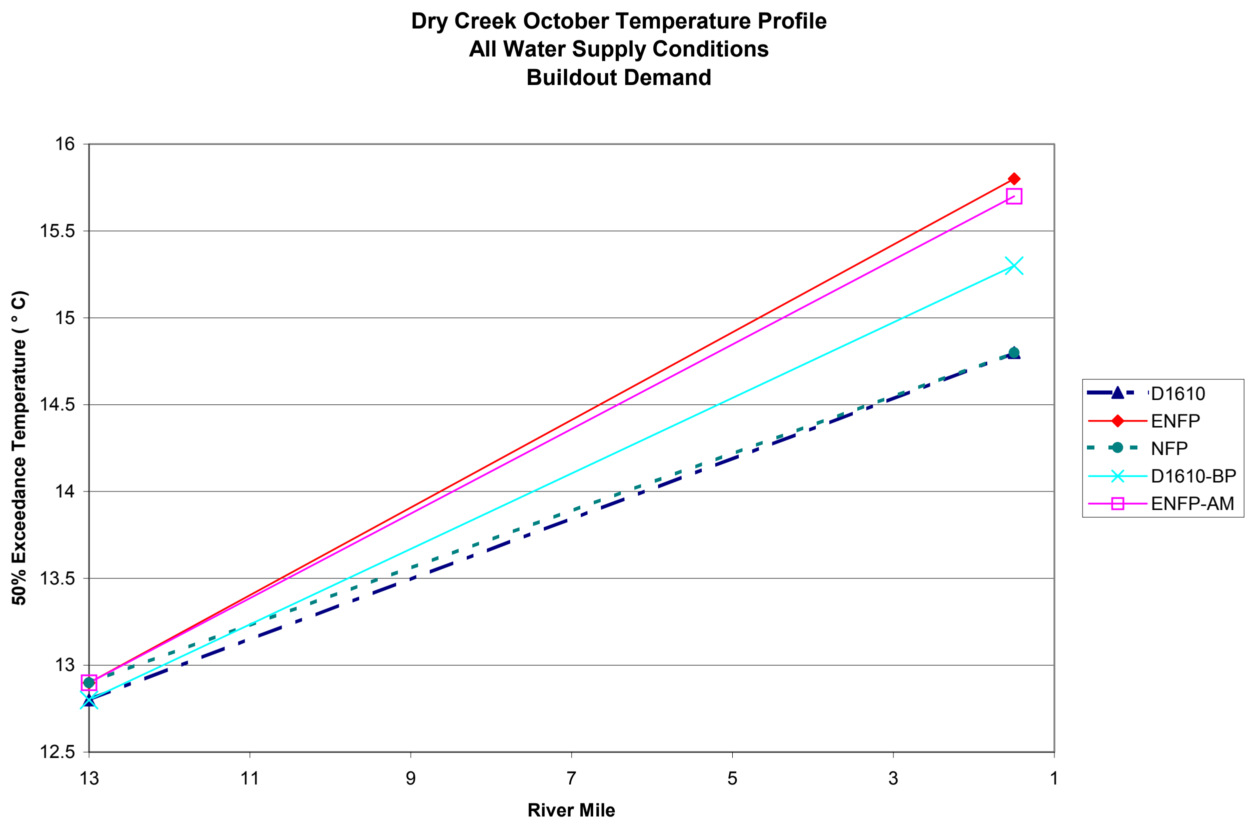
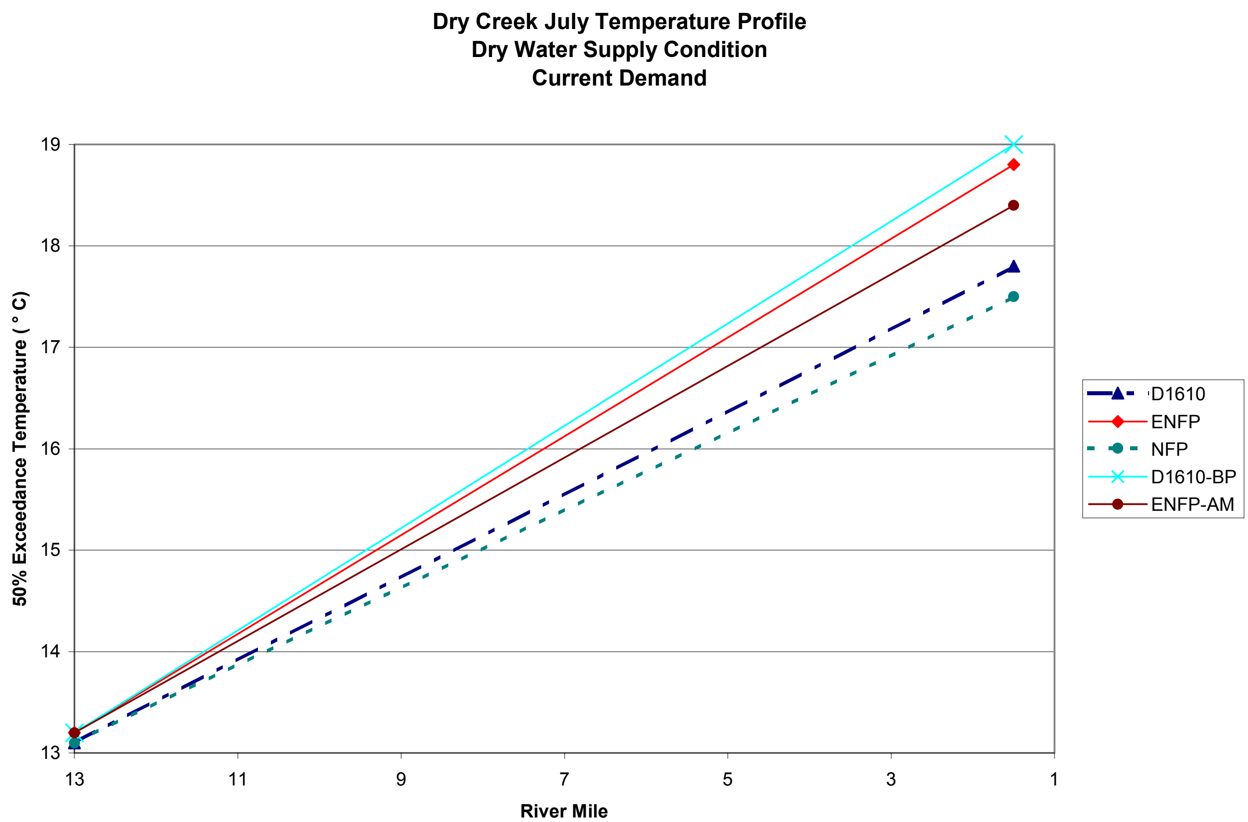


Figure A-12. Longitudinal Temperature Profile in Dry Creek in October under All Water Supply Conditions.



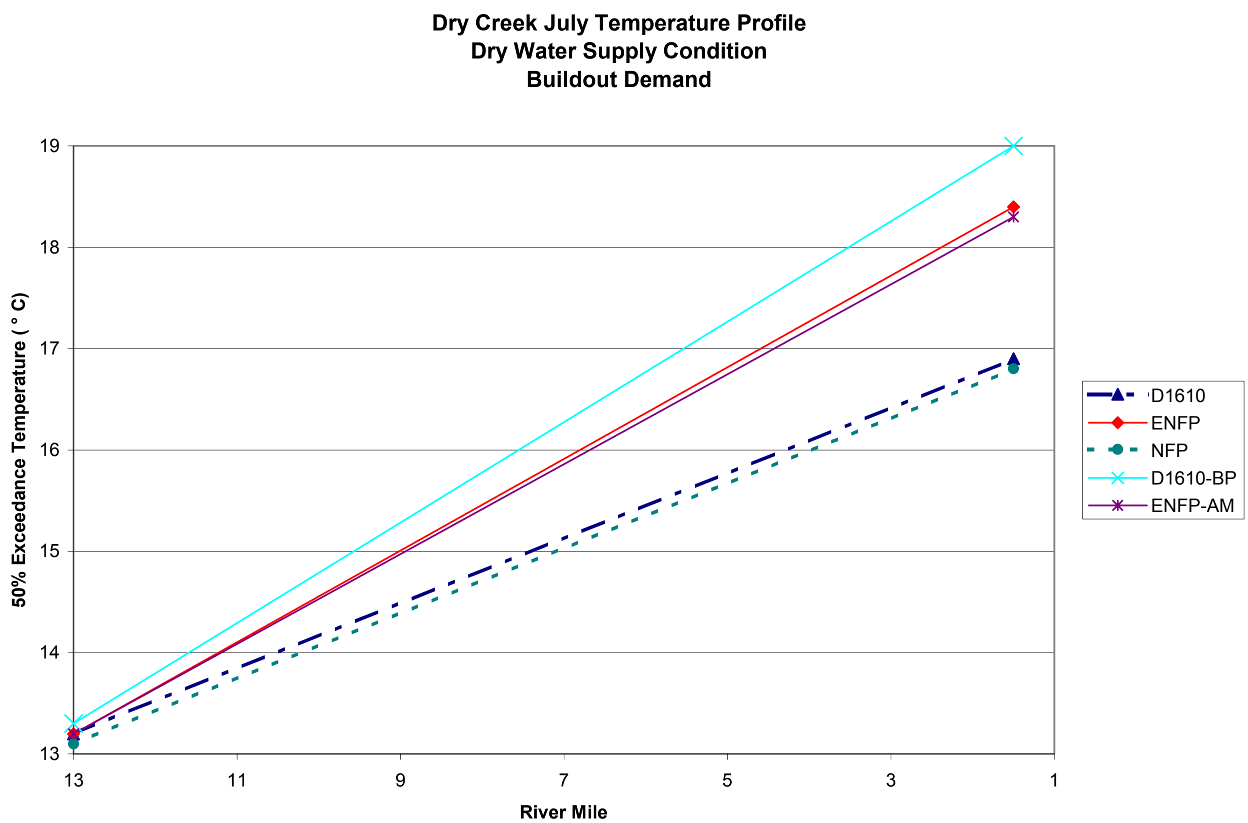
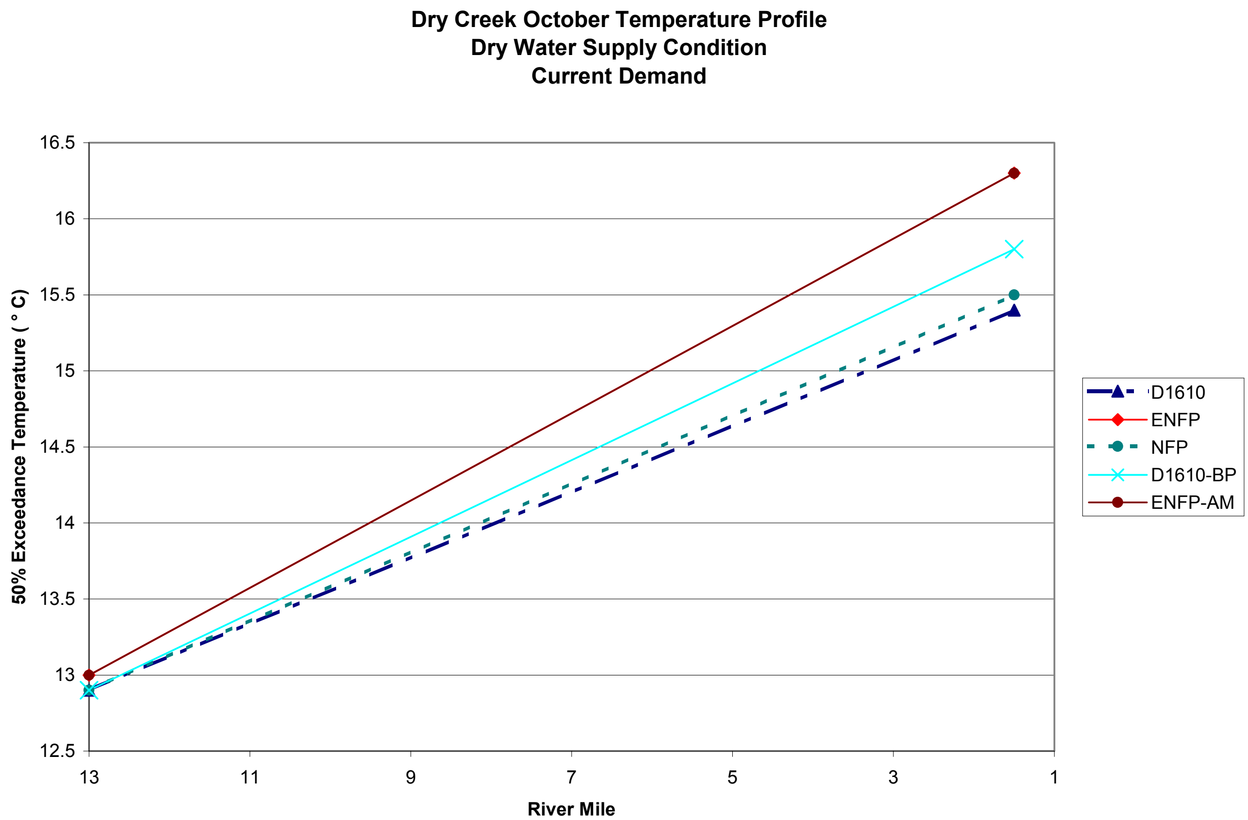


Figure A-13. Longitudinal Temperature Profile in Dry Creek in July under Dry Water Supply Conditions.



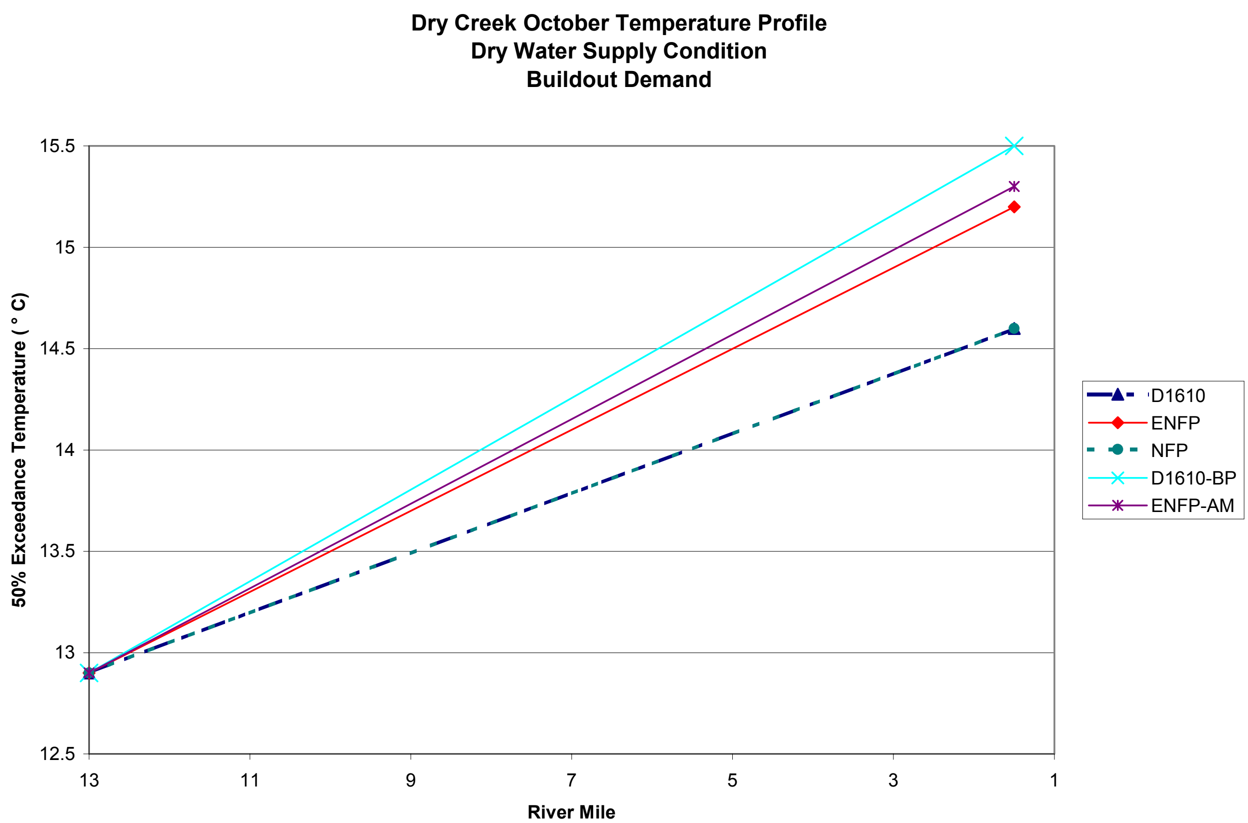
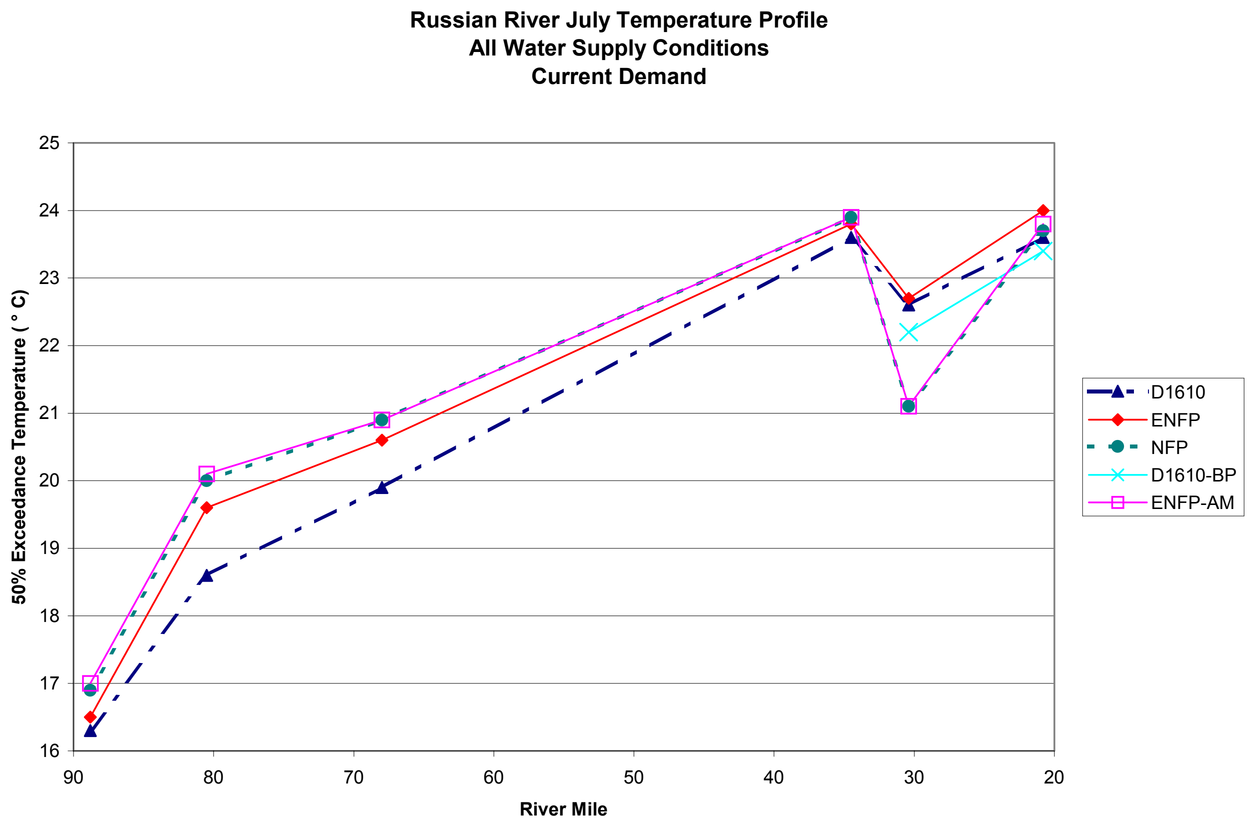


Figure A-14. Longitudinal Temperature Profile in Dry Creek in October under Dry Water Supply Conditions.



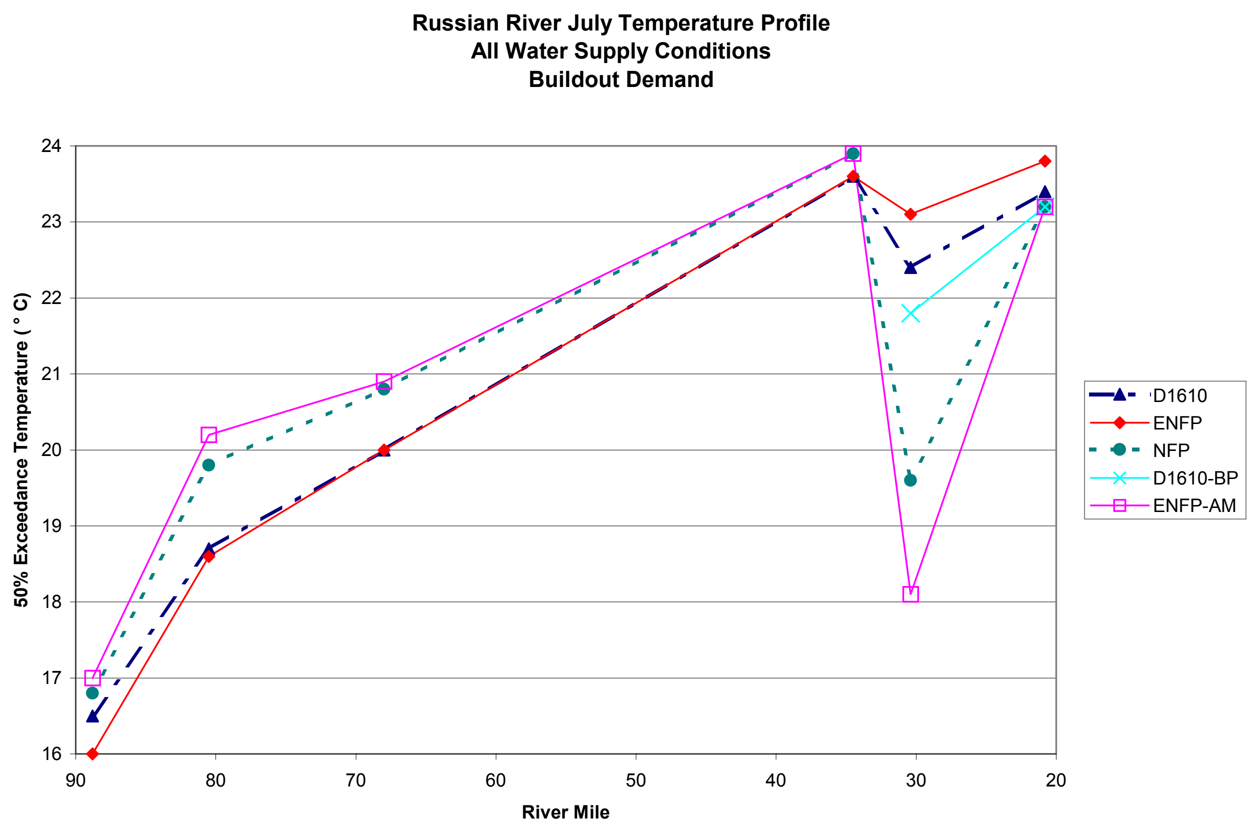
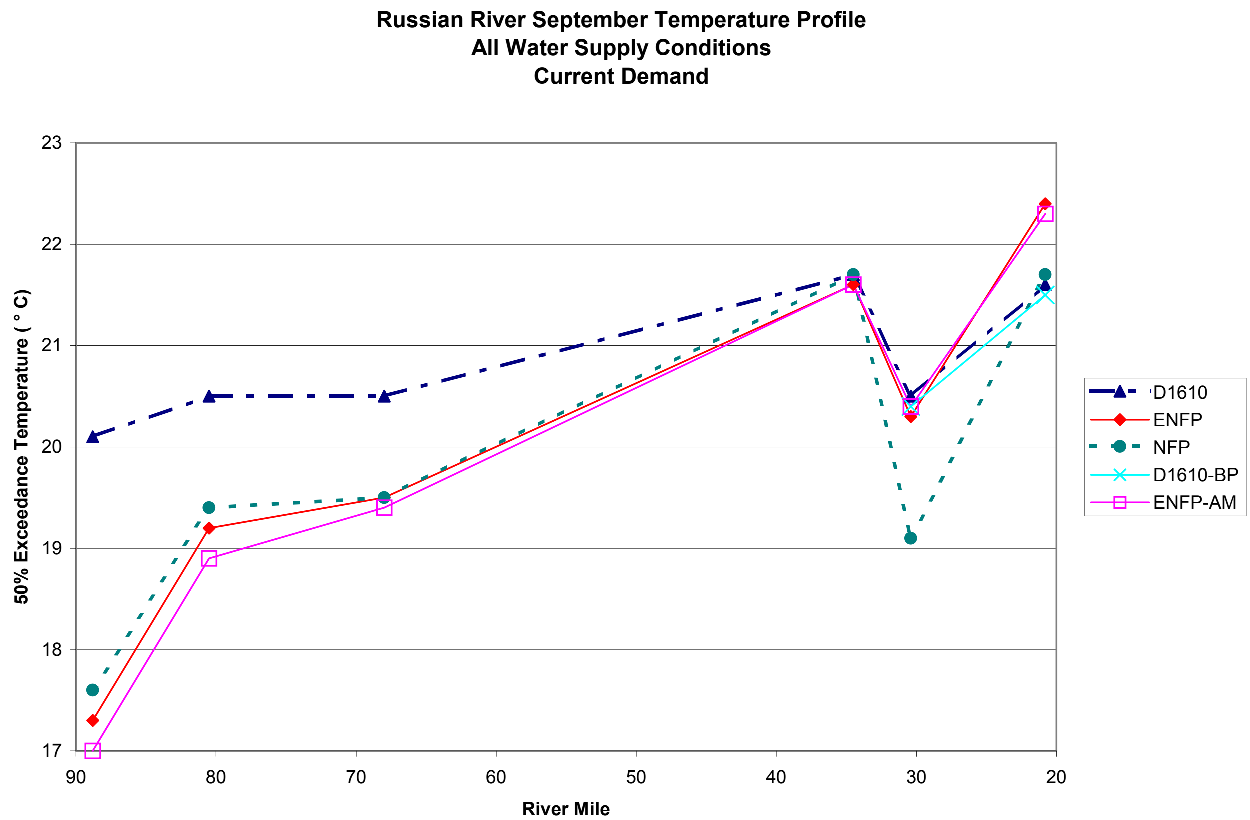


Figure A-15. Longitudinal Temperature Profile in the Russian River in July under All Water Supply Conditions.



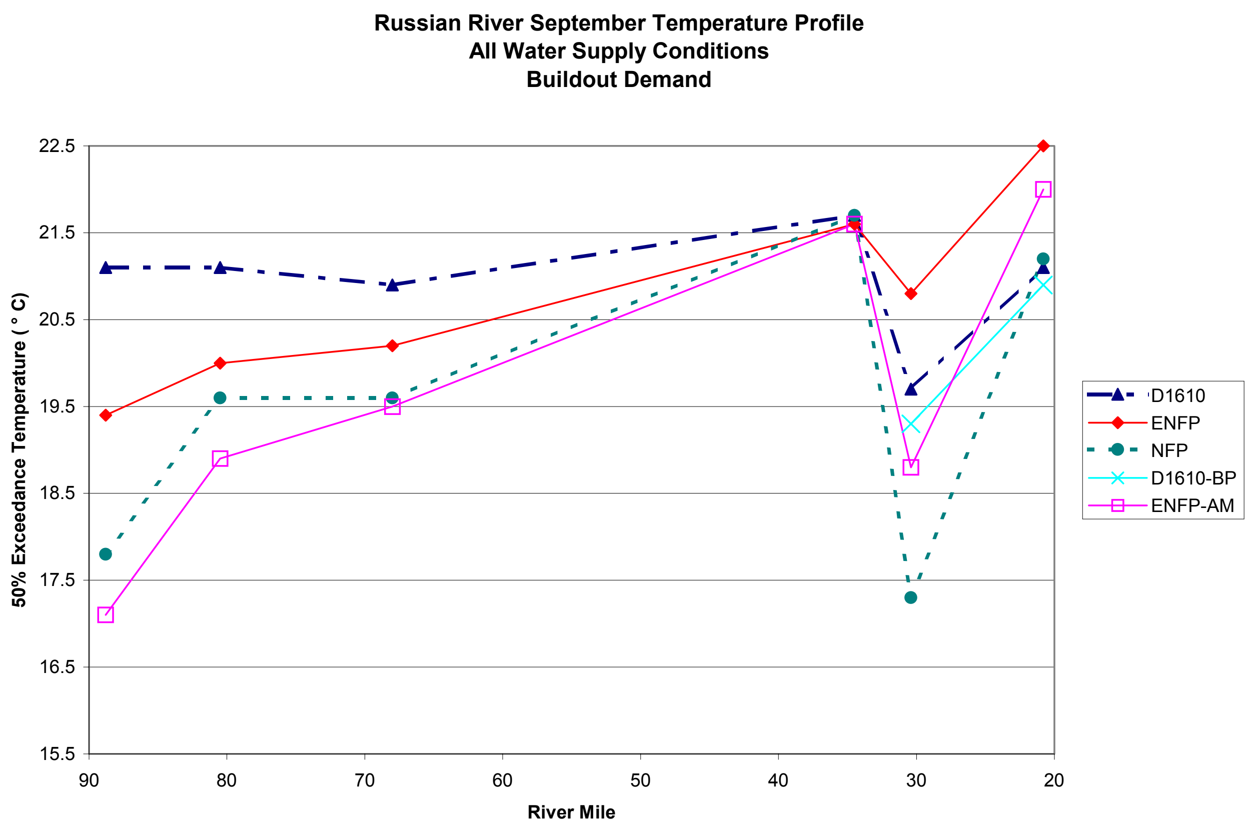
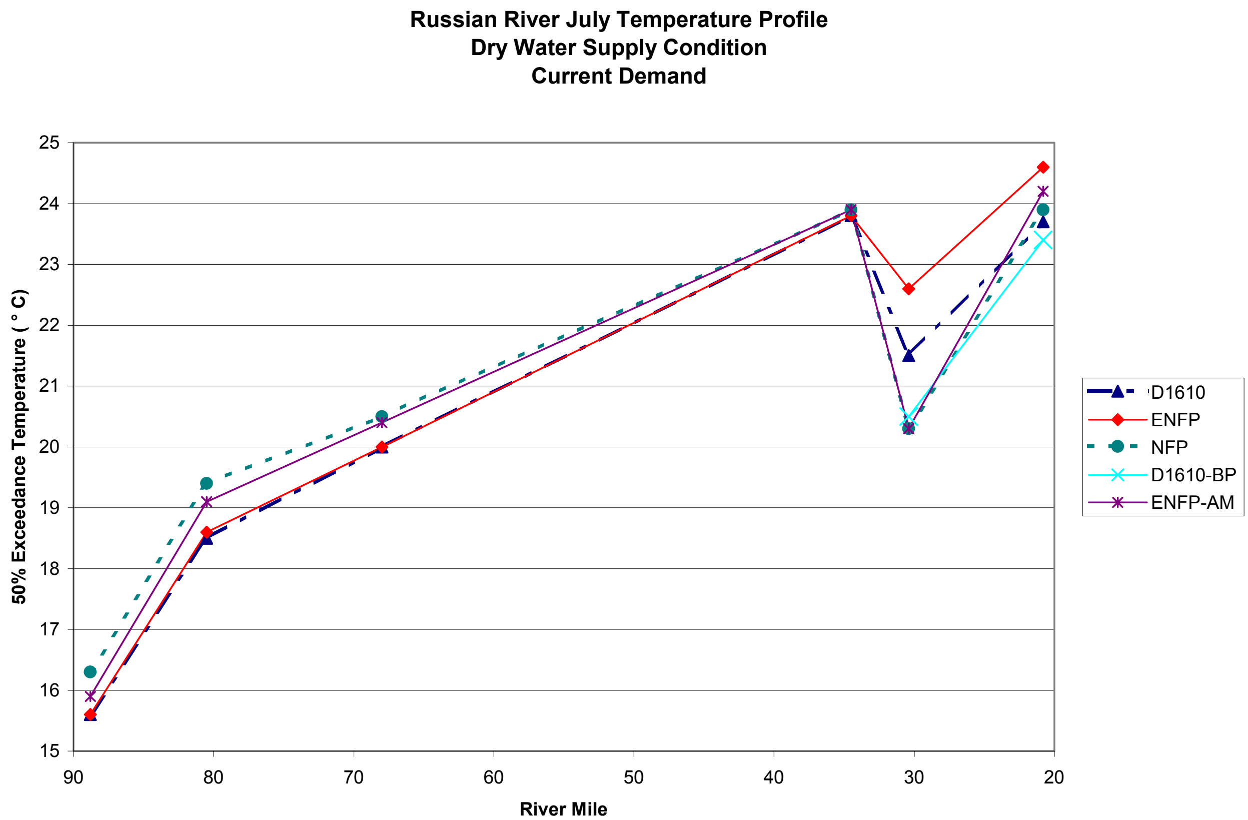


Figure A-16. Longitudinal Temperature Profile in the Russian River in September under All Water Supply Conditions.



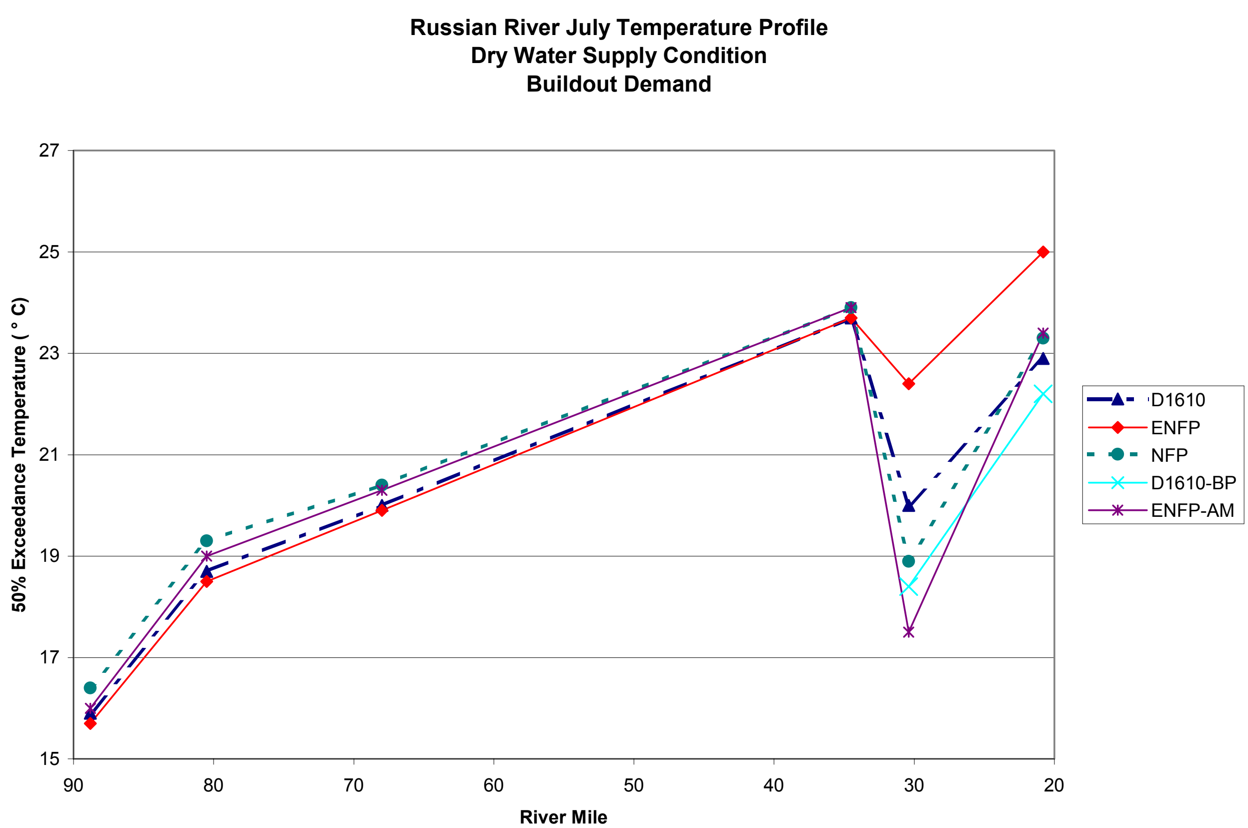
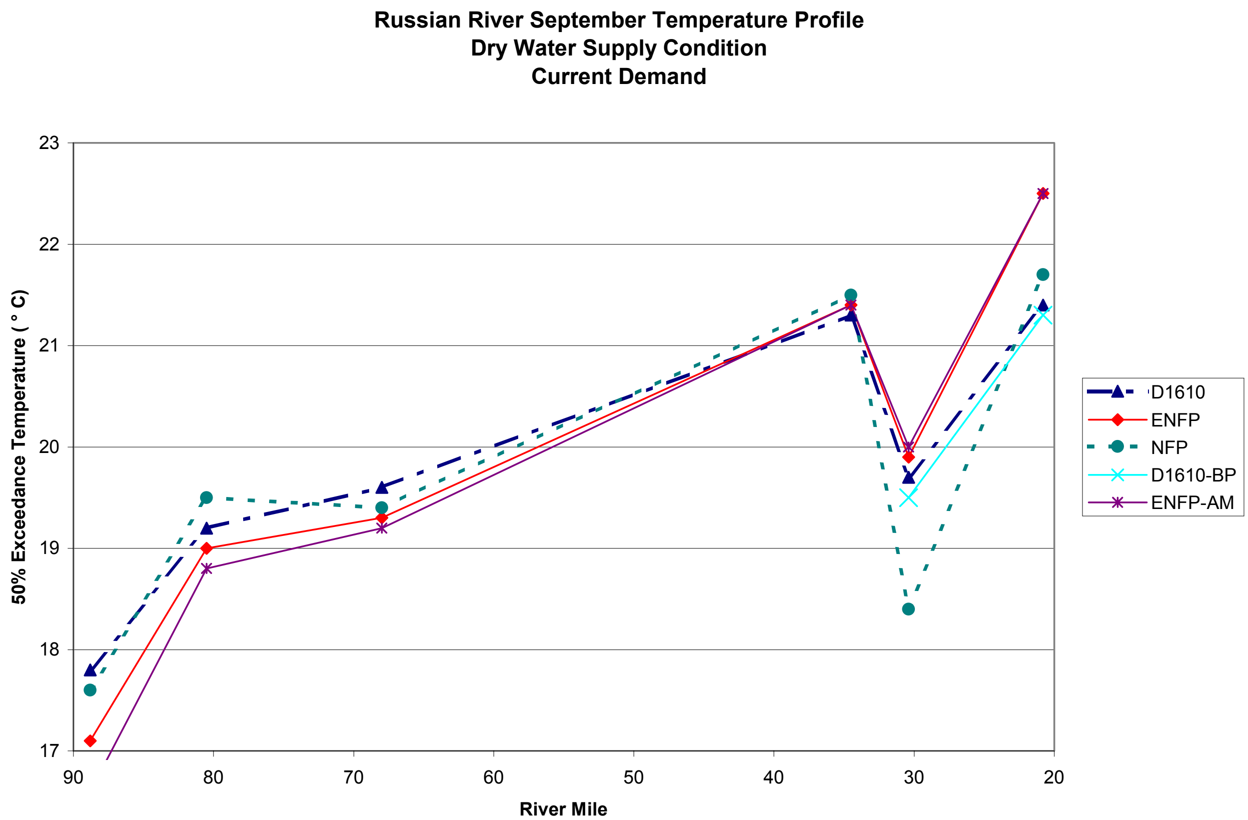


Figure A-17. Longitudinal Temperature Profile in the Russian River in July under Dry Water Supply Conditions.



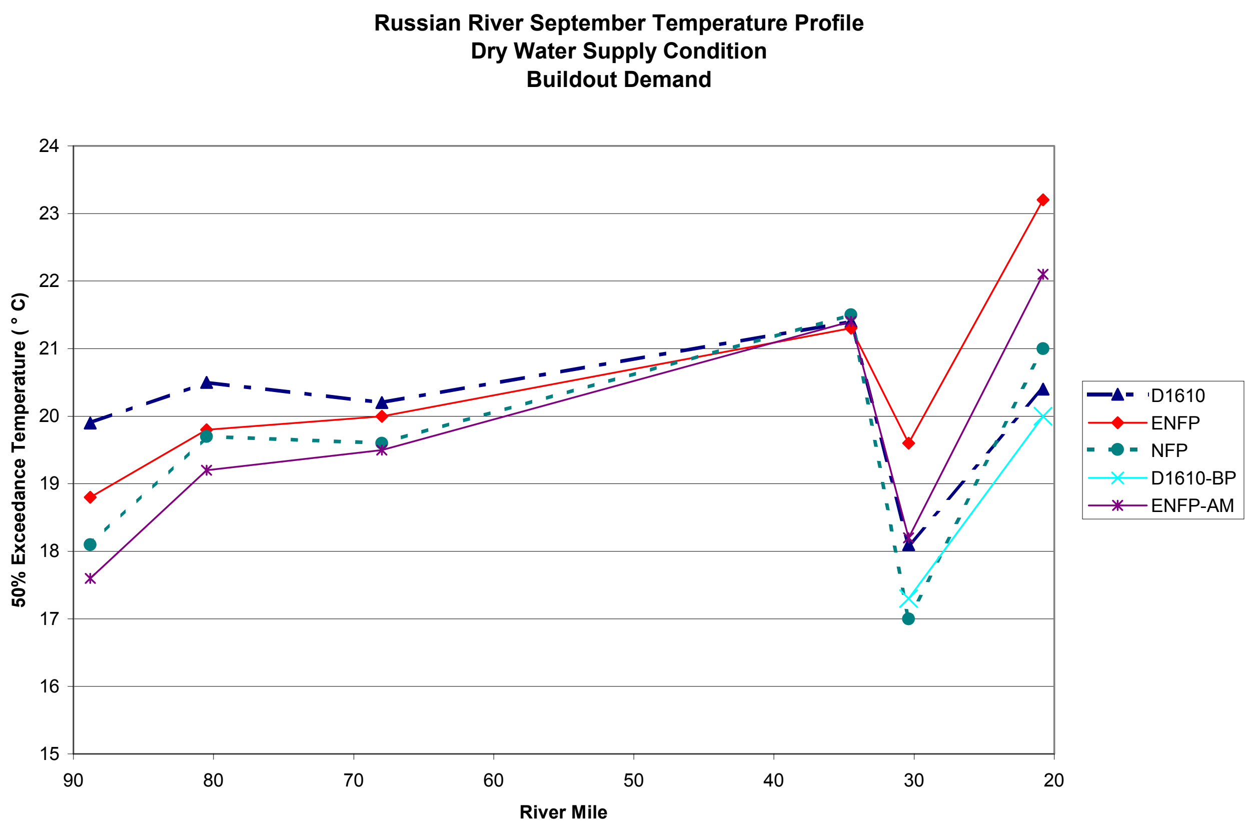


Figure A-18. Longitudinal Temperature Profile in the Russian River in September under Dry Water Supply Conditions.

APPENDIX B

EVALUATION CRITERIA FOR FLOW, TEMPERATURE, AND DISSOLVED OXYGEN

PHYSICAL HABITAT CRITERIA RELATED TO FLOW

Habitat may be affected by a number of factors. These include flow, water temperature, and water quality, among others. This section addresses flow-related physical habitats and criteria to evaluate those habitats.

HABITAT SUITABILITY INFORMATION

Criteria for flow-related habitat in Dry Creek and the Russian River are presented in Tables B-1 and B-2, respectively. The rearing criteria are based in part upon the Flow Assessment Study conducted by SCWA, NMFS and CDFG in 2001 (Russian River Flow Related Habitat Assessment Panel 2002). Outside of the range of flows addressed in that study, the criteria are based upon knowledge of the system, discussions with biologists familiar with the system, and professional judgement. The flow criteria for spawning in the Russian River are also based in part upon the results of this study. Flow criteria for upstream migration were not addressed in the Flow Assessment Study and these scoring criteria are based upon knowledge of the system, discussions with biologists familiar with the system, and professional judgement.

Table B-1. Flow Evaluation Criteria for Dry Creek by Species and Lifestage.

Coho Habitat Score	Nov 1 to Jan 31 Q (cfs) Upmigration	Dec 1 to Feb 15 Q (cfs) Spawning	Feb 1 to Apr 30 Q (cfs) Fry Rearing	All Year Q (cfs) Juvenile Rearing
0	≤ 10	≤ 5	≤ 0	≤ 0
1	>10 ≤ 20	> 5 ≤ 20	> 0 ≤ 10	> 0 ≤ 10
2	> 20 ≤ 30	> 20 ≤ 30	> 10 ≤ 20	> 10 ≤ 25
3	> 30 ≤ 90	> 30 ≤ 45	> 20 ≤ 30	> 25 ≤ 45
4	> 90 ≤ 125	> 45 ≤ 60	> 30 ≤ 40	> 45 ≤ 60
5	> 125 ≤ 200	> 60 ≤ 80	> 40 ≤ 70	> 60 ≤ 85
4	> 200 ≤ 250	> 80 ≤ 100	> 70 ≤ 90	> 85 ≤ 100
3	> 250 ≤ 325	> 100 ≤ 125	> 90 ≤ 130	> 100 ≤ 120
2	> 325 ≤ 400	> 125 ≤ 250	> 130 ≤ 200	> 120 ≤ 200
1	> 400 ≤ 500	> 250 ≤ 800	> 200 ≤ 500	> 200 ≤ 500
0	> 500	> 800	> 500	> 500

Chinook Habitat Score	Aug 15 to Jan 15 Q (cfs) Upmigration	Nov 1 to Jan 31 Q (cfs) Spawning	Feb 1 to Apr 30 Q (cfs) Fry Rearing	Apr 1 to Jun 30 Q (cfs) Juvenile Rearing
0	≤ 10	≤ 5	≤ 0	≤ 0
1		> 5 ≤ 25	> 0 ≤ 10	> 0 ≤ 10
2	> 10 ≤ 45	> 25 ≤ 40	> 10 ≤ 20	> 10 ≤ 25
3	> 45 ≤ 60	> 40 ≤ 60	> 20 ≤ 30	> 25 ≤ 45
4	> 60 ≤ 90	> 60 ≤ 80	> 30 ≤ 45	> 45 ≤ 60
5	> 90 ≤ 125	> 80 ≤ 105	> 45 ≤ 60	> 60 ≤ 90
4	> 125 ≤ 200	> 105 ≤ 130	> 60 ≤ 90	> 90 ≤ 100
3	> 200 ≤ 325	> 130 ≤ 150	> 90 ≤ 110	> 100 ≤ 110
2	> 325 ≤ 400	> 150 ≤ 290	> 110 ≤ 150	> 110 ≤ 200
1	> 400 ≤ 500	> 290 ≤ 3000	> 150 ≤ 500	> 200 ≤ 500
0	> 500	> 3000	> 500	> 500

Steelhead Habitat Score	Jan 1 to Mar 31 Q (cfs) Upmigration	Jan 1 to Apr 30 Q (cfs) Spawning	Mar 1 to Jun 30 Q (cfs) Fry Rearing	All Year Q (cfs) Juvenile Rearing
0	≤ 10	≤ 5	≤ 0	≤ 0
1	>10 ≤ 20	> 5 ≤ 20	> 0 ≤ 5	> 0 ≤ 5
2	> 20 ≤ 30	> 20 ≤ 30	> 5 ≤ 15	> 5 ≤ 15
3	> 30 ≤ 90	> 30 ≤ 60	> 14 ≤ 30	> 14 ≤ 30
4	> 90 ≤ 125	> 60 ≤ 80	> 30 ≤ 40	> 30 ≤ 40
5	> 125 ≤ 200	> 80 ≤ 110	> 40 ≤ 55	> 40 ≤ 55
4	> 200 ≤ 250	>110 ≤ 135	> 55 ≤ 70	> 55 ≤ 70
3	> 250 ≤ 325	> 135 ≤ 150	> 70 ≤ 90	> 70 ≤ 90
2	> 325 ≤ 400	> 150 ≤ 250	> 90 ≤ 110	> 90 ≤ 110
1	> 400 ≤ 500	> 250 ≤ 1300	> 110 ≤ 500	> 110 ≤ 500
0	> 500	> 1300	> 500	> 500

Table B-2. Flow Evaluation Criteria for the Russian River by Species and Lifestage.

Coho Habitat Score	Nov 1 to Jan 31 Q (cfs) Upmigration			
0	≤ 50			
1	> 50 ≤ 75			
2	> 75 ≤ 100			
3	>100 ≤ 125			
4	> 125 ≤180			
5	> 180 ≤ 400			
4	> 400 ≤ 800			
3	> 800 ≤ 2000			
2	> 2000 ≤ 4000			
1	> 4000			
0				
Chinook **Habitat Score**	**Aug 15 to Jan 15** **Q (cfs)** **Upmigration**	**Nov 1 to Jan 31** **Q (cfs)** **Spawning**	**Feb 1 to Apr 30** **Q (cfs)** **Fry Rearing**	**Apr 1 to Jun 30** **Q (cfs)** **Juvenile Rearing**
0	≤ 50	≤ 25	≤ 0	≤ 0
1	> 50 ≤ 75	> 25 ≤ 100	> 0 ≤ 20	> 0 ≤ 20
2	> 75 ≤ 100	> 100 ≤ 130	> 20 ≤ 40	> 20 ≤ 50
3	>100 ≤ 125	> 130 ≤ 150	> 40 ≤ 80	> 50 ≤ 100
4	> 125 ≤180	> 150 ≤ 190	> 80 ≤ 115	> 100 ≤115
5	> 180 ≤ 400	> 190 ≤ 210	> 115 ≤ 135	> 115 ≤ 145
4	> 400 ≤ 800	> 210 ≤ 300	> 135 ≤ 175	> 145 ≤ 190
3	> 800 ≤ 2000	> 300 ≤ 400	> 175 ≤ 250	> 190 ≤ 275
2	> 2000 ≤ 4000	> 400 ≤ 700	> 250 ≤ 500	> 275 ≤ 1000
1	> 4000	> 700 ≤ 2500	> 500 ≤ 1500	> 1000 ≤ 2500
0		> 2500	> 1500	> 2500
Steelhead **Habitat Score**	**Jan 1 to Mar 31** **Q (cfs)** **Upmigration**	**Jan 1 to Apr 30** **Q (cfs)** **Spawning**	**Mar 1 to Jun 30** **Q (cfs)** **Fry Rearing**	**All Year** **Q (cfs)** **Juvenile Rearing**
0	≤ 50	≤ 25	≤ 0	≤ 0
1	> 50 ≤ 75	> 25 ≤ 70	> 0 ≤ 20	> 0 ≤ 20
2	> 75 ≤ 100	> 70 ≤ 100	> 20 ≤ 40	> 20 ≤ 50
3	>100 ≤ 125	> 100 ≤ 130	> 40 ≤ 80	> 50 ≤ 80
4	> 125 ≤180	> 130 ≤ 180	> 80 ≤ 100	> 80 ≤ 115
5	> 180 ≤ 400	> 180 ≤ 200	> 100 ≤ 125	> 115 ≤ 145
4	> 400 ≤ 800	> 200 ≤ 250	> 125 ≤ 150	> 145 ≤ 190
3	> 800 ≤ 2000	> 250 ≤ 350	> 150 ≤ 200	> 190 ≤ 275
2	> 2000 ≤ 4000	> 350 ≤ 700	> 200 ≤ 500	> 275 ≤ 1000
1	> 4000	> 700 ≤ 2500	> 500 ≤ 1500	> 1000 ≤ 2500
0		> 2500	> 1500	> 2500

Criteria based on: Anonymous 1971; Bell 1986; Bjornn and Reiser 1991; Boles *et al*. 1988; Brett 1952, Brett *et al*. 1982; CDFG 1991; California Resources Agency 1989; Cramer 1992; Fryer and Pilcher 1974; Hallock *et al.* 1970; Hanel 1971; McMahon 1983; Raleigh *et al.* 1984; Rich 1987; Seymour 1956; and USEPA 1974.

WATER QUALITY CRITERIA

A scoring system was developed for water-quality parameters, including temperature and dissolved oxygen.

TEMPERATURE

Scoring criteria for temperature by species and life history stage are summarized in Table B-3.

Table B-3. Evaluation Criteria for Temperature (ºC) by Species and Life-History Stage.

Coho				
Score	**Nov 1 to Jan 31 Up Migration**	**Dec 1 to Feb 15 Spawning**	**Dec 1 to Mar 31 Incubation**	**All Year Rearing**
0	≤ 3.0	≤ 1.7	≤ 0.0	≤ 1.7
1	> 3.0 ≤ 4.0	> 1.7 ≤ 3.0	> 0.0 ≤ 3.0	> 1.7 ≤ 4.0
2	> 4.0 ≤ 5.0	> 3.0 ≤ 4.0	> 3.0 ≤ 3.5	> 4.0 ≤ 7.0
3	> 5.0 ≤ 6.0	> 4.0 ≤ 6.0	> 3.5 ≤ 4.0	> 7.0 ≤ 8.0
4	> 6.0 < 7.2	> 6.0 < 7.0	> 4.0 < 4.4	> 8.0 < 12.0
5	≥ 7.2 ≤ 12.7	≥ 7.0 ≤ 13.0	≥ 4.4 ≤ 13.3	≥ 12.0 ≤ 14.0
4	> 12.7 ≤ 14.0	> 13.0 ≤ 14.0	> 13.3 ≤ 14.0	> 14.0 ≤ 15.0
3	> 14.0 ≤ 15.0	> 14.0 ≤ 15.0	> 14.0 ≤ 15.0	> 15.0 ≤ 16.0
2	> 15.0 ≤ 16.0	> 15.0 ≤ 16.0	> 15.0 ≤ 16.0	> 16.0 ≤ 20.0
1	> 16.0 < 21.1	> 16.0 < 17.0	> 16.0 < 18.0	> 20.0 < 26.0
0	≥ 21.1	≥ 17.0	≥ 18.0	≥ 26.0

Steelhead				
Score	**Jan 1 to Mar 31 Up Migration**	**Jan 1 to Apr 30 Spawning**	**Jan 1 to May 31 Incubation**	**All Year Rearing**
0	≤ 4.0	≤ 4.0	≤ 1.5	≤ 0.0
1	> 4.0 ≤ 5.0	> 4.0 ≤ 5.0	> 1.5 ≤ 3.0	> 0.0 ≤ 2.0
2	> 5.0 ≤ 6.0	> 5.0 ≤ 6.0	> 3.0 ≤ 4.5	> 2.0 ≤ 4.0
3	> 6.0 ≤ 7.0	> 6.0 ≤ 7.0	> 4.5 ≤ 6.0	> 4.0 ≤ 8.0
4	> 7.0 < 7.8	> 7.0 < 7.8	> 6.0 < 7.8	> 8.0 < 12.8
5	≥ 7.8 ≤ 11.0	≥ 7.8 ≤ 11.1	≥ 7.8 ≤ 11.1	≥ 12.8 ≤ 15.6
4	> 11.0 ≤ 13.0	> 11.1 ≤ 14.0	> 11.1 ≤ 13.0	> 15.6 ≤ 18.0
3	> 13.0 ≤ 15.0	> 14.0 ≤ 16.0	> 13.0 ≤ 15.0	> 18.0 ≤ 20.0
2	> 15.0 ≤ 17.0	> 16.0 ≤ 18.0	> 15.0 ≤ 17.0	> 20.0 ≤ 22.0
1	> 17.0 < 21.1	> 18.0 < 20.0	> 17.0 < 20.0	> 22.0 < 23.9
0	≥ 21.1	≥ 20.0	≥ 20.0	≥ 23.9

Table B-3. Evaluation Criteria for Temperature (°C) by Species and Life-History Stage (continued).

Chinook

Score	Aug 15 to Jan 15 Up Migration	Nov 1 to Jan 31 Spawning	Nov 1 to Mar 31 Incubation	Feb 1 to Jun 30 Rearing
0	≤ 0.8	≤ 1.0	≤ 1.0	≤ 1.0
1	> 0.8 ≤ 3.0	> 1.0 ≤ 2.5	> 1.0 ≤ 2.0	> 1.0 ≤ 4.0
2	> 3.0 ≤ 5.2	> 2.5 ≤ 3.5	> 2.0 ≤ 3.0	> 4.0 ≤ 6.0
3	> 5.2 ≤ 7.9	> 3.5 ≤ 4.5	> 3.0 ≤ 4.0	> 6.0 ≤ 8.0
4	> 7.9 < 10.6	> 4.5 < 5.6	> 4.0 < 5.0	> 8.0 < 12.0
5	≥ 10.6 ≤ 15.6	≥ 5.6 ≤ 13.9	≥ 5.0 ≤ 12.8	≥ 12.0 ≤ 14.0
4	> 15.6 ≤ 17.0	> 13.9 ≤ 14.5	> 12.8 ≤ 14.2	> 14.0 ≤ 17.0
3	> 17.0 ≤ 18.4	> 14.5 ≤ 15.2	> 14.2 ≤ 15.0	> 17.0 ≤ 20.0
2	> 18.4 ≤ 19.8	> 15.2 ≤ 16.0	> 15.0 ≤ 15.8	> 20.0 ≤ 23.0
1	> 19.8 < 21.1	> 16.0 < 16.7	> 15.8 < 16.7	> 23.0 < 26.0
0	≥ 21.1	≥ 16.7	≥ 16.7	≥ 26.0

DISSOLVED OXYGEN

Criteria for dissolved oxygen are presented in Table B-4.

TableB-4. Dissolved Oxygen Evaluation Criteria by Species and Life-History Stage.

Coho

Habitat Score	Nov 1 to Jan 31 DO (mg/l) Up migration	Dec 1 to Mar 31 DO (mg/l) Spawning/ incubation	All Year DO (mg/l) Rearing	Feb 1 to May 15 DO (mg/l) Down migration
5	6.5	11	8.0	8.0
4	6.0	9.5	6.5	6.0
3	5.5	8	6.0	5.5
2	5.2	7.5	5.2	5.2
1	4.8	4.5	4.5	4.6
0	< 4.8	< 4.5	3.0	3.0

Table B-4. Dissolved Oxygen Evaluation Criteria by Species and Life-History Stage (continued).

Steelhead				
	Jan 1 to Mar 31	**Jan 1 to May 31**	**All Year**	**Mar 1 to Jun 30**
Habitat Score	**DO (mg/l) Up migration**	**DO (mg/l) Spawning/ incubation**	**DO (mg/l) Rearing**	**DO (mg/l) Down migration (Juveniles)**
5	6.5	9	8.0	8.0
4	6.0	7.3	6.5	6.0
3	5.5	6.5	6.0	5.5
2	5.2	5.9	5.2	5.2
1	4.8	5.4	4.5	4.6
0	< 4.8	< 5.0	3.0	3.0

Chinook				
	Aug 15 to Jan 15	**Nov 1 to Mar 31**	**Feb 1 to Jun 30**	**Feb 1 to Jun 30**
Habitat Score	**DO (mg/l) Up migration**	**DO (mg/l) Spawning/ incubation**	**DO (mg/l) Rearing**	**DO (mg/l) Down migration**
5	6.5	11	8.0	8.0
4	6.0	9.5	6.5	6.0
3	5.5	8	6.0	5.5
2	5.2	7.5	5.2	5.2
1	4.8	4.5	4.5	4.6
0	< 4.8	< 4.5	3.0	3.0

RUSSIAN RIVER BIOLOGICAL ASSESSMENT ALTERNATIVES: EVALUATION OF MANAGEMENT ACTIONS

Prepared for:

U.S. ARMY CORPS OF ENGINEERS
San Francisco District
San Francisco, California 94105

AND

SONOMA COUNTY WATER AGENCY
Santa Rosa, California 95406

Prepared by:

ENTRIX, INC.
590 Ygnacio Valley Road, Suite 200
Walnut Creek, California 94596

Project No. 364704

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Page

Page

Page

af	acre-feet
BA	Biological Assessment
CDFG	California Department of Fish and Game
cfs	cubic-feet per second
CVD	Coyote Valley Dam
CVFF	Coyote Valley Fish Facility
DCFH	Don Clausen Fish Hatchery
DO	dissolved oxygen
D1610	Decision 1610
El.	Elevation
Estuary	Russian River Estuary
ESA	Endangered Species Act of 1973
ESU	Evolutionary Significant Unit
ft/hr	feet per hour
fps	feet per second
hr	hour
MCIWPC	Mendocino County Inland Water and Power Commission
MCRRFCD	Mendocino County Russian River Flood Control and Water Conservation Improvement District
MOU	Memorandum of Understanding
MSL	Mean sea level
NMFS	National Marine Fisheries Service
NFP	Natural Flow Proposal
PVP	Potter Valley Project
RRSM	Russian River System Model
RWQCB	North Coast Regional Water Quality Control Board
SCWA	Sonoma County Water Agency
SWRCB	State Water Resources Control Board
USACE	U.S. Army Corps of Engineers
USGS	Unites States Geological Survey
WSD	Warm Springs Dam
WSE	water surface elevation
YOY	young of year

1.1 SECTION 7 CONSULTATION

The Sonoma County Water Agency (SCWA), the U.S. Army Corps of Engineers (USACE), and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) are undertaking a Section 7 Consultation under the Federal Endangered Species Act (ESA) with the National Marine Fisheries Service (NMFS) to evaluate effects of operations and maintenance activities on listed anadromous fish species and their habitats. The activities of the SCWA, USACE, and MCRRFCD span the Russian River watershed from Coyote Valley Dam (CVD) and Warm Springs Dam (WSD) to the Russian River Estuary (Estuary), as well as some tributaries. The Russian River watershed provides spawning and rearing habitat for threatened stocks of coho salmon, steelhead, and Chinook salmon. SCWA, USACE, and MCRRFCD operate and maintain facilities and conduct activities related to flood control, channel maintenance, water diversion and storage, hydroelectric power generation, estuary management, and fish production. SCWA, USACE, and MCRRFCD are also participants in a number of institutional agreements related to the fulfillment of their respective responsibilities in the Russian River watershed.

Federal agencies such as the USACE are required under the Endangered Species Act (ESA) to consult with the Secretary of Commerce to insure that their actions are not likely to jeopardize the continued existence of protected species or adversely modify or destroy habitat. The USACE, SCWA, and NMFS have entered into a Memorandum of Understanding (MOU) that establishes a framework for the consultation and conference required by the ESA with respect to the activities of the USACE, SCWA, and MCRRFCD that may directly or indirectly affect coho salmon, steelhead, and Chinook salmon in the Russian River. The MOU acknowledges the involvement of other agencies including the California Department of Fish and Game (CDFG), the State Water Resources Control Board (SWRCB), the North Coast Regional Water Quality Control Board (RWQCB), the State Coastal Conservancy, and the Mendocino County Inland Water and Power Commission (MCIWPC).

1.2 SCOPE OF THE BIOLOGICAL ASSESSMENT

As part of the Section 7 Consultation, the USACE and SCWA will submit to NMFS a biological assessment (BA) that provides a description of the actions subject to consultation, including the facilities, operations, maintenance, and existing conservation actions. The BA will describe existing conditions, including information on hydrology, water quality, habitat conditions, and fish populations. The BA will provide the basis for NMFS to prepare a biological opinion that will evaluate the potential effects of the proposed action.

The BA will integrate information from the Interim Reports, which evaluated the effects of current operations on protected species in the Russian River basin. All of the Interim Reports have been completed and are available online at http://www.spn.usace.army.mil/ets/rrsection7:

Report 1 - Flood Control Operations
Report 2 - Fish Facility Operations
Report 3 - Flow-Related Habitat
Report 4 - Water Supply and Diversion Facilities
Report 5 - Channel Maintenance
Report 6 - Restoration and Conservation Actions
Report 7 - Hydroelectric Projects Operations
Report 8 - Estuary Management Plan

The current project operations may be modified if feasible management actions are identified that reduce potential adverse effects or improve habitat conditions for protected species. The BA will evaluate the effects of the entire project including the modified project activities.

1.3 POTENTIAL MANAGEMENT ACTIONS

The MOU governing the USACE's Section 7 Consultation for the Russian River outlined a process to consider modifications to the four principal activities occurring in the watershed. Potential management actions have been developed for *Interim Reports 1 through 4: Flood Control Operations* (ENTRIX 2000a), *Fish Facilities Operations* (FishPro and ENTRIX 2000), *Flow-Related Habitat* (ENTRIX 2002a), and *Water Supply and Diversion Facilities* (ENTRIX 2001). The management actions presented below were developed to address issues regarding potential adverse effects to protected species raised in the review of ongoing operations and maintenance activities in the interim reports, comments received from the Agency Working Group, the Public Policy Facilitation Committee, and the general public on the interim reports. In addition, management actions were also developed based on discussions and meetings with SCWA, USACE, NMFS, and CDFG.

To begin the process, a preliminary list of issues was developed from the issues explicitly identified in the interim reports, and from the public and agency review process. For each selected issue, potential management actions to avoid or reduce adverse effects were identified.

After identifying the preliminary list of issues and associated management actions, additional actions were suggested in a series of discussions with SCWA, USACE, NMFS, and CDFG. Subsequent discussions further refined the management actions under consideration.

The potential management actions included in this document are intended to be a starting point for further discussions. New actions may be suggested as a part of this process. It is not anticipated that all management actions would, or could, be implemented. In some cases, management actions that may ameliorate one issue may make conditions worse relative to another issue. Some actions may be mutually incompatible, or require that another action be completed prior to implementing the selected action. Some management actions may mitigate the effects of more than one issue. Others may not be economically or operationally feasible.

The objective of this document is to provide descriptions and preliminary evaluations of the potential management actions being considered by SCWA and USACE. This document is organized by facility or operational activity. Individual issues associated with each facility are identified and are followed by potential management actions that address one or more of the issues. From these potential actions, a suite of preferred management actions will be combined into operational alternatives and evaluated in detail in the BA. Potential management actions were developed for:

1. Operations of CVD,
2. Operations of WSD,
3. Operations of fish production facilities,
4. Management of flow-related habitat, and
5. Operation of Mirabel/Wohler facilities.

The descriptions of the individual management actions consist of three parts. First, the management action is described in terms of the operational and infrastructure changes that would occur as part of the action. This is followed by a discussion of the potential benefits or effects of the proposed action to protected salmonid species in the Russian River system. The third component, other considerations, is a summary of the relevant physical, operational, or economic constraints and institutional controls that are associated with each action.

Lake Mendocino, located 3 miles east of the City of Ukiah, is the major feature of the USACE Coyote Valley Dam Project (Figure 2-1). Lake Mendocino is impounded by CVD, located on the East Fork Russian River, 0.8 miles upstream of the East Fork Russian River's confluence with the Russian River. CVD is a rolled earth embankment dam with a crest elevation of 784 feet above mean sea level (msl), which is 160 feet above the original streambed. The CVDP was authorized by Section 204 of the Flood Control Act of 1950.

Lake Mendocino, which began storing water in 1959, has a capacity of 116,470 acre-feet at the spillway crest elevation of 764.8 feet above msl, and captures a drainage area of approximately 105 square miles. When the water level rises above the top of the water supply pool (seasonally between elevations 737.5 feet and 748 feet above msl) and into the flood control pool, USACE determines releases. USACE also determines releases during inspections and for maintenance and repair of the project. Subject to the provisions of SCWA's water right permits, SCWA determines releases to be made from the water supply pool.

During the rainy season (November through May), natural streamflow (rather than storage releases) accounts for most of the flow of the Russian River. From June through October, however, most of the flow in the Russian River downstream of CVD and above Dry Creek is comprised of releases of stored water from Lake Mendocino.

The potential effects of flood control operations were evaluated in *Interim Report 1* (ENTRIX 2000a). These included: 1) changes to channel geomorphology including scour of spawning gravels, bank erosion, and channel maintenance, 2) changes in instream flow as releases from the dam are reduced (ramping), and 3) effects from inspection and maintenance of the dams. In general, the analysis presented in the report indicated that there is a moderate risk of adverse effects to protected populations related to maintenance and pre-flood inspection activities at CVD.

The evaluation of channel geomorphology in *Interim Report 1* (ENTRIX 2000a) indicated that flood control operations at CVD have not caused prolonged flows above the threshold for streambank instability and erosion. Furthermore, flood flow releases from CVD are timed such that they are a relatively insignificant contributor to total flow in the mainstem Russian River.

Reduced ramping rates are generally required when flows must be curtailed for dam inspections, or during transitioning between hydroelectric operations and either water supply or flood control operation periods.

Annual and periodic (5-year) pre-flood inspections take place at both CVD and WSD. During 1998 and 1999, inspections at CVD took place during the months of September and June, respectively. In 2000, pre-flood inspection activities took place during May. Flows must be reduced or completely shut down in order to accomplish the inspections. Typically, annual

\SPECIAL PROJECTS\FISHERIES\AGREEMENTS\BIO-ASSESS\REPORT1\FIGURE1-1 MARCH 17, 2000

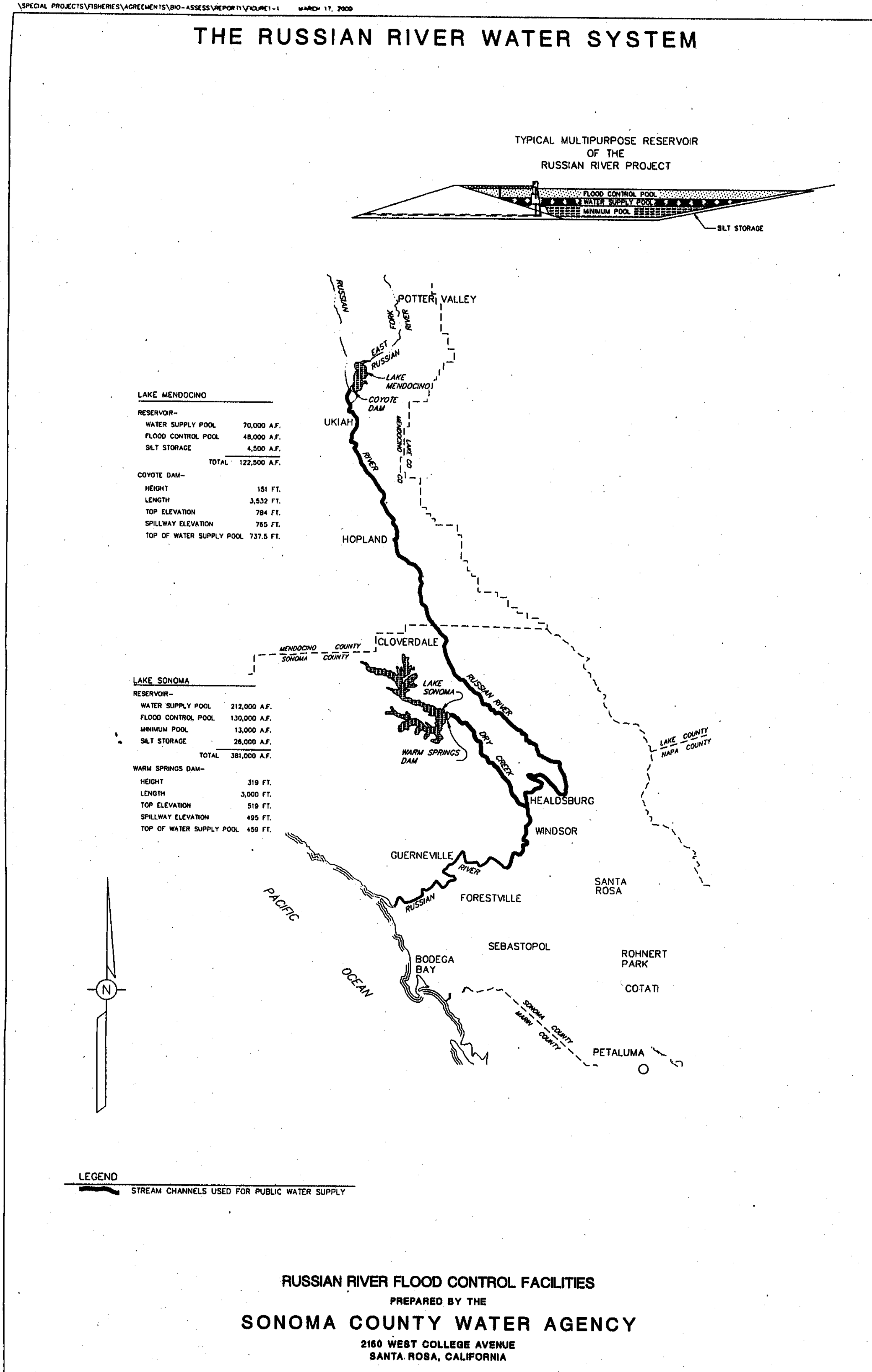

Figure 2-1 Russian River Flood Control Facilities

inspections require that flows be ceased for approximately 2 hours, whereas the periodic (5-year) inspections may require up to six hours to complete. Depending upon the maintenance activities to be performed, flows may be reduced or shut down for periods lasting from an hour to several days. Ramping rates and reduced streamflow conditions (dewatering of habitat) are the two primary issues of concern associated with annual and periodic dam inspections and maintenance at CVD. Prior to pre-flood inspection and maintenance activities, flows are reduced at a rate of 50 cfs/hr at CVD. During May 2000, a ramping rate of 50 cfs/hr at CVD did not provide adequate protection, and resulted in stranding fry on the mainstem Russian River downstream of the Forks.

The other time when releases from CVD are interrupted is when switching from flood control or water supply operations to hydroelectric operations. When hydroelectric operations commence, the Tainter gate must be operated manually, which requires that releases be halted for safety reasons. This results in a short interruption of flow in the East Fork of the Russian River. The interruption of flow can potentially strand young fish in the East Fork of the Russian River.

Based on the review of *Interim Report 1* (ENTRIX 2000a) and the public and agency review process, the following issues were identified at CVD.

Issue CVD-1 – Currently maintenance and inspection activities require ramping down of flows at 50 cfs/hr and stoppage of all releases from the dam, thereby virtually eliminating flow in the East Fork Russian River. This results in the potential for stranding of fry and juveniles, and potential for dewatering the East Fork and mainstem Russian River because of flow stoppage in May through September.

Issue CVD-2 – The cessation of flow for safety reasons when switching operations between power generation and non-operational periods. This results in an interruption of releases from CVD, creating the potential for stranding of fry and juveniles in the East Fork Russian River.

2.1 ACTION 1. SLOW RAMPING RATES TO 25 CFS/HR WHEN RELEASES FROM THE COYOTE VALLEY DAM ARE LESS THAN 250 CFS. RAMPING RATES WOULD REMAIN AT CURRENT LEVELS WHEN FLOWS ON THE MAINSTEM RUSSIAN RIVER EXCEED 1,000 CFS.

The objective of this action is to reduce the risk of stranding of salmonid fry and juveniles by reducing the rate at which the river stage changes at low flow conditions (*i.e.*, less than 250 cfs).

2.1.1 ACTION

Automated controls would be installed to control the closing of the outlet gates within CVD. Ramping rates would be reduced to 25 cfs/hr when releases from the dam are 250 cfs or less (Table 2-1).

Ramping of release flows from 250 to 0 cfs typically take place in winter or spring as flood control operations reduce flows from much higher rates following storm events and during summer water supply flows. Flows are also ramped down in preparation for maintenance and inspection activities conducted in the summer and fall. Reducing the ramping rates when releases from the dam are low would slow the rate at which the stream stage declines in the East

Fork and the mainstem Russian River. This would enable fry and juvenile salmonids to swim into deeper water and avoid stranding as the water recedes.

Interim Report 1 found that under releases from CVD of 250 or higher, there was little opportunity for stranding when the existing ramping criteria were used. USACE has developed interim guidelines for flow release changes in consultation with NMFS and CDFG. When Releases from CVD exceed 250 cfs, the ramping rates would be maintained at current levels.

Table 2-1 Existing and Proposed Ramping Rates

Reservoir Outflow	Existing Ramping Rates	Proposed Ramping Rates
0-250 cfs	125 cfs/hour	25 cfs/hour
250-1,000 cfs	250 cfs/hour	250 cfs/hour
>1,000 cfs	1,000 cfs/hour	1,000 cfs/hour

2.1.2 EFFECTS ON PROTECTED SPECIES

Ramping rates are of particular concern in the mainstem when ramping takes place during periods when flows are low, as there is less attenuation of ramping effects. Stage changes associated with 25 cfs/hr incremental flow reductions beginning at 250 cfs and progressing to 50 cfs were modeled for four cross-sections on the mainstem Russian River below the Forks (ENTRIX 2000a). A stage change of 0.16 ft/hr or less provides sufficient protection for juvenile salmonids (Hunter 1992). At 25 cfs/hr reductions, the 0.16 ft/hr criterion is met at most flow intervals in all four of the cross-sections for flow ranges below 250 cfs. Stage changes ranged from 0.04 to 0.36 ft/hr. At 50 cfs/hr reductions, the 0.16 ft/hr criteria was generally exceeded, and stage changes were generally in the range of 0.24 to 0.32. Therefore, a ramping rate of 25 cfs/hr when flows are below 250 cfs would be protective of young salmonids based on Hunter's (1992) criteria.

2.1.3 OTHER CONSIDERATIONS

Decreasing ramping rates would require installation of automated controls to offset additional manpower requirements. Implementing decreased ramping rates would also require increasing the time necessary to complete the ramping process.

2.2 ACTION 2. ADJUST TIMING OF ROUTINE INSPECTION AND MAINTENANCE ACTIVITIES AT COYOTE VALLEY DAM TO PERIODS WHEN SALMONID FRY ARE NOT PRESENT.

The objective of this action is to minimize the potential for routine maintenance and inspection activities to adversely affect salmonid fry.

2.2.1 ACTION

Currently, routine pre-flood inspection and maintenance activities are conducted between May and September. During the inspection, flows are interrupted for 2 hours for annual inspections and up to 6 hours for 5-year inspections. Interruption of flows can adversely affect young salmonids (fry) in the East Fork of the Russian River and the mainstem Russian River below the Forks. This proposed modification would limit scheduling of routine maintenance and inspection activities from late July through September because fewer young salmonids are likely to be present during that time than during May and June. Shifting routine inspection and maintenance activities to late July through September would allow the young salmonids to grow to a size that is less susceptible to being stranded during declining flows.

2.2.2 Effect on Protected Species

Fry are weak swimmers and are especially susceptible to stranding when flows decline rapidly. In the East Fork and mainstem Russian River below CVD, Chinook salmon fry may be present from February to June and steelhead fry and juveniles may be present throughout the year. During May, 2000, when higher spring flows might have been expected to attenuate the effects of ramping below the Forks, fry were present and were susceptible to stranding. During low flow months later in the season, there is less attenuation from mainstem flow, but the fish are larger and more readily avoid stranding. Also, there are fewer young salmonids present since the majority of smolt emigration occurs by the end of June.

At CVD, during inspection and maintenance activities that took place in September 1998, the stream became dewatered and rescue of juvenile steelhead was necessary on the East Fork and further downstream on the mainstem Russian River. During inspection and maintenance in June 1999, streamflow was near 0 cfs. No stranding was documented, nor was rescue necessary, as pools were maintained on the East Fork to provide refuge, except for a very small area of the stream near the dam at the streamflow gaging weir (T. Marks, USACE, pers. comm. 2000). The presence of pools and lack of stranding may have in part been due to dewatering of the stilling basin, which provided about 5 cfs for several hours following cessation of releases from the dam. In addition, flow accretion from seepage or groundwater contributions has also contributed to maintaining pools and a small streamflow.

Efforts are currently being undertaken to implement this recommendation and avoid scheduling inspections during periods when fry are present. No stranding was observed during maintenance activities in late September to early October 2001, which avoided the period when fry were present. This action can be implemented immediately and would serve to further minimize adverse effects to young salmonids. However, the interruption of flow for up to 6 hours for the 5-year inspections would still pose a threat to young salmonids in the East Fork Russian River.

Adult Chinook salmon may enter the Russian River as early as mid-August, and spawning typically occurs after mid-November. However, in the unlikely event that spawning adults and redds are observed in the East Fork Russian River during inspection and maintenance activities (July to September), the inspection and maintenance activities would be adjusted to reduce impacts.

2.2.3 Other Considerations

Advance notice of pre-flood inspections (1 month) is generally required to coordinate with hydroelectric operations. This should not interfere with the implementation of this alternative. Changing the timing of the annual inspections would reduce potential risks to young fish.

However, without additional actions, releases to the East Fork Russian River would continue to be interrupted when inspections and maintenance activities take place potentially exposing young fish to stranding and desiccation.

2.3 Action 3. Install two pumps, approximately 250 horsepower each, to pump water over Coyote Valley Dam to provide approximately 25-cfs flow. Operate pumps during periods when maintenance and inspection activities are being conducted.

The objective of this action is to provide continuous instream flows and prevent dewatering of the East Fork Russian River and reduced flows in the mainstem Russian River during inspection and maintenance activities, when flows through the dam are halted.

2.3.1 Action

Two 250-horsepower (maximum) pumps would be installed in the wet well within the control tower at CVD. The pumps would be operated as independent systems, thereby maintaining flow should one of the pumps fail. Pumps would draw water from the wet well of the dam and discharge the water via a bypass pipeline over the dam. The bypass pipeline could be incorporated into the retrofitting of the bridge to the outlet facility. The bypass pipeline would discharge 25 cfs to the East Fork downstream of the weir below the dam.

2.3.2 Effects on Protected Species

This action would prevent the stream channel from dewatering during inspection and maintenance activities. Currently, when inspections occur flow is halted and the wetted area of the channel recedes to isolated pools. Under this action, 25 cfs would be released to the East Fork Russian River, preventing dewatering, reducing the risk stranding of juveniles and maintaining rearing habitat in the East Fork and in the mainstem Russian River below the Forks where stranding has been observed in the past.

2.3.3 Other Considerations

Pumps larger than 250 horsepower are expected to result in cavitation and suction problems at their intakes. These problems could result in damage to the pumps, or associated structures, and result in pump failure. Because the pumps would be used only for short periods each year, they should have a long effective lifespan.

A 15-cfs diversion could be incorporated into the system to provide water supply to the fish rearing facility at the base of the dam if maintenance occurs when the fish facility is in operation. This action would provide an uninterrupted flow of good quality water when the pumps were operating.

In addition to operating the pumps during maintenance and inspection activities, the pumps could also be used to supplement flows when releases from the dam are being ramped down. This would slow the rate of change of flow below the dam at flows less than 50 cfs and would have the effect of reducing the potential for stranding of salmonid fry due to declines in stream stage.

The pump bypass flow could also be used to provide flow when operations switch between the hydroelectric project operations and water supply operations. Currently the releases from the dam are halted to make the switch.

2.4 ACTION 4. CONSTRUCT TWO HOLDING PONDS AT COYOTE VALLEY FISH FACILITY, WITH A CAPACITY OF 50 ACRE-FEET EACH TO PROVIDE FLOWS DURING PERIODS WHEN RELEASES FROM DAM ARE CURTAILED.

The objective of this action is to maintain flow in the East Fork Russian River when flows from the dam are curtailed for maintenance and inspection activities, or to switch to hydroelectric generation operations.

2.4.1 ACTION

Two 50 acre-foot capacity holding ponds, tanks, or other storage facilities would be constructed adjacent to the CVFF. The ponds would be shaded to maintain low water temperatures (< 70° F) in the ponds. Prior to curtailing releases from CVD in preparation for maintenance and inspection activities, or switching to hydroelectric generation operations, the holding ponds would be filled with water from the dam. Once flows from the dam are curtailed, the water in the ponds would be released directly to the East Fork Russian River, or pumped through the CVFF and discharged below the weir. This action would provide flows of up to 10 cfs for a period of up to 5 days while maintenance activities are being conducted. Flows of up to 15 cfs could be maintained for up to 3 days.

2.4.2 EFFECTS ON PROTECTED SPECIES

This would be sufficient to allow the annual (2-hour) and periodic (6-hour) inspections to be completed without stopping flows. This action would provide continual flow in the stream channel and would help maintain water quality in the deeper pools that serve as a refuge for juveniles as the wetted area shrinks.

This action would provide flow in the East Fork for a sufficient time to allow most planned routine maintenance to be conducted. A typical repair would require one to two days to complete. However, should a major repair be required, CVD could be off line for as long as 6 weeks. In this case, the instream flow needs for fish would not be met.

2.4.3 OTHER CONSIDERATIONS

The storage facility could also function as a means of maintaining the quality of the water supplied to the CVFF. The ponds could be used to reduce turbidity and achieve dissolved gas balance in the water prior to delivering it to the rearing facility. Should this option be implemented, the ponds or tanks would be kept full during rearing operations, and would not necessarily need to be filled prior to shutting down releases from the dam for inspection activities. A constant flow through the ponds or tanks of approximately 5 cfs would be provided to maintain temperature and exchange water.

2.5 Action 5. Release water from the stilling basin at the base of the dam to provide flows during periods when releases from dam are curtailed.

The objective of this action is to maintain flow in the East Fork Russian River when flows from the dam are curtailed for maintenance and inspection activities, or to switch to hydroelectric generation operations.

2.5.1 Action

During periods when the flows from the dam are curtailed, water would be pumped from the impoundment below the stilling basin, through the CVFF, and discharged below the weir. This action would supplement flows and maintain refuge habitat for a short period of time. Observations made in 1999 indicate that flows of approximately 5 cfs could be maintained for a period of 1 to 2 hours.

2.5.2 Effects on Protected Species

This action would slow the dewatering of the stream channel and would help maintain water quality in the deeper pools that serve as a refuge for juveniles as the wetted area shrinks. Flows of 5 cfs in the East Fork Russian River could not be maintained for the 6 hours required to inspect the dam. This suggests that this action could be beneficial for short periods such as the time needed to switch to, or from, hydroelectric operations.

2.5.3 Other Considerations

This action would not suffice to maintain habitat throughout the entire inspection period and dewatering would continue to occur. Therefore, this action, by itself, may not be effective at reducing effects to protected species.

2.6 Action 6. Create an enlarged embayment below Coyote Valley Dam.

The objective of this action is to create an impoundment to store water to provide minimum release flows during dam maintenance and inspection activities.

2.6.1 Action

This action is similar to Action 5, but would provide a greater amount of water that could be used to maintain minimal flows. Structures present below CVD include a stilling basin, an embayment, a rock weir, and a gaging station. This alternative would involve the raising of the height of the rock weir in height on a permanent basis, or the installation of an inflatable dam or flashboard system to provide water storage on a temporary basis. When releases from the dam are curtailed for maintenance or inspection activities, the water stored within the embayment would be released to provide minimum flows and prevent dewatering of the East Fork Russian River.

The inflatable dam or flashboard system could be placed at an angle in the outlet structure to allow minimum flows past the powerhouse while conducting extended maintenance or repairs. Alternatively, for short duration inspections or repairs, the dam or flashboard system could be placed on top of the weir until the water begins to overtop it, then it could be gradually lowered. This would probably provide up to 5 cfs for up to 4 to 5 hours. Raising the weir would provide comparable flows to the inflatable dam and have the advantage of providing more water to the fish facilities that are downstream of the powerhouse.

2.6.2 Effects on Protected Species

Flows of 5 cfs in the East Fork Russian River could not be maintained for the 6 hours required for the 5-year inspections, but it would provide minimum flow of approximately 5 cfs for the 2-hour annual inspections. A flow of 4 to 5 cfs would maintain some refuge habitat for young salmonids and would represent a considerable improvement over present circumstances of 0 flow. At flows this low habitat conditions would be marginal at best.

2.6.3 Other Considerations

This action would not suffice to maintain minimal habitat throughout the entire inspection period because the 5-year inspections and dewatering would continue to occur. Therefore, this action by itself may not be effective in preventing dewatering of the East Fork Russian River.

2.7 Action 7. Notify Water Diverters Along the Mainstem Russian River Between Coyote Valley Dam and Cloverdale and Request Stoppage of Water Diversions During Inspection and Maintenance Activities.

The objective of this action is to reduce effects to protected fish in the mainstem Russian River downstream of the Forks by minimizing the demand for water below CVD during maintenance and inspection activities.

2.7.1 Action

This action would consist of notifying known diverters in the upper Russian River in advance of maintenance and inspection activities, and requesting that they discontinue diversions during scheduled inspection activities. This action would require voluntary compliance with the request.

2.7.2 Effects on Protected Species

This management action would reduce water diversions from the Russian River during inspection and maintenance operations, if they occur during the irrigation season. This action could result in more water remaining in the Russian River to provide habitat for fish.

This action may provide only a small change in streamflow in the Russian River and may not appreciably ameliorate stranding when releases from CVD are halted. The relatively short section of the East Fork Russian River below the dam would likely continue to be dewatered under this alternative.

2.7.3 Other Considerations

Effects on water diverters between the dam and Cloverdale are likely to be of short duration (less than 8 hours). However, the amount of coordination required to effectively implement this action is substantial. Notification of permit holders by mail and instructions regarding the expected actions could be complex. Since participation is voluntary, the reliability of this measure is questionable. In addition, the area of greatest effect is in the East Fork Russian River, and most water users draw water directly from the mainstem Russian River.

2.8 Action 8. Upgrade the Tainter Gate at the City of Ukiah's Hydroelectric Facility to Allow Transition Between Flood Control and Hydropower Operations Without Shutting Off Releases.

The objective of this action is to reduce short-term dewatering of the East Fork Russian River during transitions to or from hydroelectric operations.

2.8.1 Action

Currently, releases from the CVD must be stopped for approximately 5 hours to allow switching of the Tainter gate before hydroelectric operations may be initiated or terminated. Upgrading the Tainter gates to allow a gradual transition between flood releases and hydroelectric generation would minimize the potential disruptions of flow in the East Fork Russian River. The necessary upgrades would involve replacing the bullnose seals and designing and constructing a 250-cfs bypass to the hydroelectric facility. Modifications to the Tainter gate are required to enable the gate to operate safely under all flow conditions. This action would be implemented by the USACE in cooperation with the City of Ukiah, who owns the hydroelectric plant at CVD.

2.8.2 Effects on Protected Species

Implementing this action would allow the Tainter gate to be operated safely at flows of up to 250 cfs. Under these conditions, releases from the dam would have to be reduced to a maximum of 250 cfs during transition, but would not need to be terminated. This would allow flows in the East Fork and mainstem Russian River to be maintained. The potential for stranding fry or juvenile salmonids would be reduced.

2.8.3 Other Considerations

The time required for making the repairs and upgrades to the Tainter gate would be approximately 1 week during which time there would be no releases from the dam. As a result, the East Fork Russian River would be dewatered during the repairs, unless bypass flows are provided. Rescue activities for fry and juveniles in the East Fork Russian River would need to be conducted. Dewatering the East Fork could be prevented if bypass facilities (Action 3) are installed prior to making the repairs.

Repairs to the Tainter gates would benefit hydroelectric operations at CVD by making it easier to initiate hydroelectric generation. It would also reduce risk to workers who currently manually operate the Tainter gates.

Lake Sonoma is impounded by WSD at the confluence of Warm Springs Creek and Dry Creek, about 10 miles northwest of the City of Healdsburg. WSD is a rolled-earth embankment dam with a crest elevation of 519 feet above msl, which is 319 feet above the original streambed. Lake Sonoma began storing water in 1984. The WSD and Lake Sonoma Project, including downstream channel improvements, was authorized by the Flood Control Act of 1962.

Lake Sonoma has a gross capacity of 381,000 acre-feet at the spillway crest elevation of 495 feet above msl and captures a drainage area of about 130 square miles. Under a contract with the federal government, SCWA has appropriative rights to the 245,000 acre-feet of water supply storage space in Lake Sonoma. The contract gives SCWA the exclusive right to determine the rate of release of water from the water supply pool in Lake Sonoma, subject to SCWA's water right permits. USACE determines releases when the water level rises above the top of the water supply pool (elevation 451 feet above msl) and into the flood control pool. USACE determines releases during inspections, maintenance, and repairs of the project scheduled outside of the flood control season.

USACE's primary objective for flood control operation at WSD is to reduce peak flood discharges in Dry Creek and in the Russian River below Healdsburg. Flood releases from WSD are controlled so that flooding does not occur along Dry Creek (*i.e.*, maximum flows are less than 5,000 cfs), and flow at Guerneville, about 25 miles downstream, does not exceed the channel capacity of 35,000 cfs. Because of the long travel time for water flow between CVD and the Russian River/Dry Creek confluence, WSD is operated independently of the CVD flood control operation, but is coordinated with CVD to avoid flooding at Guerneville.

Interim Report 1 (ENTRIX, Inc. 2000) evaluated the effects of flood control operations on steelhead, Chinook, and coho salmon in Dry Creek and the Russian River utilizing the results from the USACE HEC-5 model. The analyses indicate that there is a reasonably good balance between expected periodic streambed mobilization and spawning gravel stability for successful reproduction of Chinook salmon and steelhead. Coho salmon, utilizing smaller gravels for spawning, would be subject to a greater frequency of scour of redds than either Chinook or steelhead. However, some mobilization and scour of spawning gravels to transport fine sediments is necessary over the long term in order to maintain the quality of spawning gravels.

Sustained releases of flood flows have been cited as a potential cause of streambank instability in both Dry Creek and the mainstem Russian River. Prolonged release of moderate to high streamflows may influence bank erosion and thereby affect habitat conditions by contributing sediment to the channel or altering cover, shading, and other factors relevant to the riparian corridor.

Channel geomorphology refers to the form of a river, which includes channel dimensions (*i.e.*, width, depth, confinement, entrenchment), gradient, planform, and bed material sizes. Channel geomorphology is intimately linked to the type and quality of fish habitat present. The change in hydrologic regime associated with flow regulation by dams influences channel geomorphic response.

Flood control operations at WSD have influenced peak flood frequencies and expected bed mobilization on Dry Creek. Flood flow magnitudes and frequencies are likely insufficient to maintain channel geomorphic conditions within Dry Creek, and may result in periodic sedimentation of the streambed that could impair spawning or rearing habitat.

Based on the analyses presented in *Interim Report 1*, the following issues were identified at WSD.

Issue WSD-1 – Lack of high flows suitable for the maintenance of geomorphic function and salmonid habitat quality.

Issue WSD-2 – Potential for streambank erosion if flows are decreased too rapidly (bank sloughing).

Issue WSD-3 – Potential for scour of coho salmon spawning gravels in Dry Creek.

3.1 Action 9. Manage Releases from Warm Springs Dam to Provide Channel Maintenance Flows from the Flood Pool of at Least 5,000 cfs above Pena Creek at a Planned Frequency of at Least Two Events per 3 Years.

The objective of this action is to restore geomorphic function to Dry Creek downstream of WSD by releasing flows of sufficient magnitude and frequency to improve habitat diversity, mobilize spawning gravels, and flush fine particulates from the system.

3.1.1 Action

In most river systems, the natural frequency of channel maintenance flows is two events per 3 years, over the long-term. Currently, channel maintenance flows in Dry Creek below the Pena Creek confluence occur at an average frequency of one event per 6 years, and have occurred only once in the reach upstream of the Pena Creek confluence since operation of the dam. This action would release water from the flood control pool in WSD to approximate more closely the natural frequency of channel forming flows. The actual frequency would vary in response to interannual hydrologic variation. Releases would be made for channel maintenance flows when flows are high such as after storms on the descending limb of a flood peak. On Dry Creek, the natural channel maintenance discharge was estimated to be 7,000 cfs (as a 1-day flow) downstream of the Pena Creek confluence and 5,000 cfs upstream of Pena Creek (ENTRIX 2000a). Reestablishment of overflow channels (Action 13) would allow higher flows to be conveyed downstream without extensive bank erosion. Implementation of this action would require the acquisition of conservation easements along Dry Creek to provide a connected flood plain with improved riparian function, and to allow lateral movement of the stream bank (*i.e.*, erosion).

3.1.2 Effects on Protected Species

Channel maintenance flows are necessary to maintain diversity in stream morphology important to habitat quality, such as meanders, pools, and riffles. Channel maintenance flows also serve to refresh spawning gravels by mobilizing the streambed and winnowing the fine sediments from the gravels. A detailed discussion of the effects of channel maintenance flows is provided in *Interim Report 1*.

Releases made to increase the frequency of channel maintenance flows, which would be of sufficient magnitude to mobilize coarser bed materials, could help ensure equilibrium between sediment supply from tributaries with sediment transport capacity. Hence, the channel would neither aggrade nor degrade. This would help to restore more natural channel morphology, reduce potential sedimentation of the streambed, and recreate spawning and rearing habitat.

Insufficient channel maintenance flows are likely to result in excess sedimentation of the streambed that could impair spawning or rearing habitat. This concern is greatest at locations downstream of Pena Creek where tributaries deliver sediment to Dry Creek. Excess sediment input can "smother" spawning gravels, eggs, and alevins, and pool habitat can be diminished by sedimentation. Sedimentation can also reduce the availability of habitat for the invertebrate foodbase of salmonids. Releases made to increase the frequency of channel maintenance flows would flush fine sediments from the streambed so that spawning and rearing habitat would be restored.

A negative effect on habitat for protected species is that an increase in the frequency of channel maintenance flows could result in loss of spawning gravel. This is of particular concern for coho salmon because they typically utilize smaller sized gravels that are more likely to be scoured and transported downstream. This action may require augmentation of spawning gravel in the stream. The most critical area to consider for augmentation would be in the reach between Pena Creek and Warm Springs Dam because there are no significant tributaries that may provide a source of spawning gravels suitable for coho salmon. A supplemental source of gravels in the upper portions of Dry Creek may be required. These gravels may be available from channel maintenance activities in the lower portions of Dry Creek, or from activities along the upper and middle mainstem Russian River.

3.1.3 Other Considerations

Ramping up flows to achieve the required 5,000 cfs for 1 day would require approximately 20,000 acre-feet of water, which would be obtained from the flood control pool. Releases of this magnitude would likely also damage the hatchery's emergency water supply line, which runs along the top of the outlet tunnel, thereby interrupting flows to the hatchery. This action would necessitate replacement of the hatchery emergency water supply line from the outlet tunnel (see Actions 20 and 21) to prevent disruption of hatchery water supplies.

Increasing the frequency of channel maintenance flows may increase the potential for erosion or flooding. On Dry Creek, sustained flows above 2,500 cfs initiate bank erosion. However, a 1-day flow of 5,000 cfs coupled with a slower ramping rate on the descending limb (Action 11) may not result in increased stream bank erosion. Studies of historic floods have shown that when flow past the dam location exceeded 5,000 cfs, flooding is likely to occur on Dry Creek (USACE 1998). Consequently, reservoir outflows are reduced to the minimum amount necessary to meet fishery requirements when inflows to the reservoir exceed 5,000 cfs. The dam is also operated to ensure that flow in the Russian River at Guerneville does not exceed 35,000 cfs. This action also has the potential to increase channel incision.

When the magnitude of peak flood discharge is reduced, there is the potential for sediment deposition and encroachment by riparian vegetation; which can result in a narrowing of the channel cross sectional area. Channel incision may accompany channel narrowing if the flood peaks are of sufficient magnitude to mobilize bed materials and the coarse sediment supply from upstream is reduced due to capture by WSD. This would result in over-steepened streambanks and subsequent streambank erosion. A different channel response is also possible if flood peaks are sufficiently reduced, so that coarser bed material is no longer entrained by high flows and only fine materials (*i.e.,* sands, silts, and clays) are transported, leading to a coarsening of the channel bed. The channel then becomes armored, preventing further channel bed adjustments, although the streambank may remain susceptible to erosion. Channel aggradation may result if there is little or no transport of coarse sediments, but there is a sediment supply from local tributary input.

Significant channel geomorphic changes were apparently already underway on Dry Creek prior to the construction of Warm Springs Dam. A study conducted by USACE concluded that gravel mining on Dry Creek and on the mainstem Russian River had caused about 10 feet of incision along the 14-mile channel length by the mid-1970's (USACE 1987). The channel incision on Dry Creek initiated lateral instability and subsequent bank erosion so that channel width had increased from about 90 feet to over 450 feet in some locations in the 1970's (USACE 1987). The 1987 study concluded that it was unlikely that further channel degradation would occur, but that continued lateral instability and erosion of the incised channel banks was likely.

A monitoring program would be implemented to verify the channel capacity prior to implementation of this action. The monitoring program would include measurements to detect potential channel incision or bank erosion. In addition, bulk sediment samples will be collected to determine the quality of spawning gravels and the need to flush fine sediments.

Any action that increases the magnitude or frequency of flood releases to provide channel maintenance flows (*i.e.,* > 5,000 cfs) would require cooperative efforts with adjacent landowners before it is implemented. Landowners bordering on Dry Creek become concerned about erosion when releases from the dam reach 1,500 cfs.

To fully implement this action, purchase of conservation easements and the establishment of riparian zones along the banks would be required (see Action 14). Riparian vegetation is essential for building and maintaining stream structure and for buffering the stream from incoming sediments and pollutants. When bank vegetation is reduced, flood events are more likely to accelerate changes in channel morphology such as widening or incision. The banks of Dry Creek are presently too steep to readily allow establishment of riparian vegetation. The banks would have to be graded to a shallower slope prior to planting vegetation.

3.2 ACTION 10. MANAGE RELEASES FROM THE FLOOD POOL OF WARM SPRINGS DAM TO PROVIDE CHANNEL MAINTENANCE FLOWS OF BETWEEN 1,500 AND 2,500 CFS ABOVE PENA CREEK.

The objective of this action is to restore partial geomorphic function to Dry Creek downstream of WSD by releasing flows of sufficient magnitude and frequency to improve habitat diversity, mobilize spawning gravels, and flush fine particulates from the system. This action represents an attempt to balance efforts to improve habitat quality (*i.e.*, spawning gravel conditions) with the desire to limit the potential for bank erosion.

3.2.1 ACTION

In most alluvial river systems with a pool-riffle bed morphology characteristic of Dry Creek, the natural frequency of occurrence of channel maintenance flows (*i.e.*, approximately bankfull discharge) is typically two events per 3 years. Currently, channel maintenance flows in Dry Creek below the Pena Creek confluence occur at an average frequency of one event per 6 years, and have occurred only once in the reach upstream of the Pena Creek confluence since operation of the dam. On Dry Creek, the natural channel maintenance discharge was estimated to be 7,000 cfs (as a 1-day flow) downstream of the Pena Creek confluence and 5,000 cfs upstream of Pena Creek (ENTRIX 2000a). However, providing flows of that magnitude would require the acquisition of conservation easements (Action 14) along Dry Creek to provide a connected flood plain with improved riparian function.

This action would require that 1,500 to 2,500 cfs would be released as an annual peak flood. This action would provide frequent flows of sufficient magnitude to potentially flush fine sediments from the spawning gravels but not result in excessive streambank erosion. Therefore, conservation easements would not need to be obtained. Determination of the effectiveness of 1,500-2,500 cfs flows to flush fine sediments and maintain good spawning gravel habitat would require further evaluation through a monitoring program. Actual releases of 1,500-2,500 cfs would vary in response to interannual hydrologic variation. Releases would be made for channel maintenance flows when flows are high, such as after the major peak of a storm hydrograph. Reestablishment of overflow channels (Action 13) would allow higher flows to be conveyed downstream without extensive bank erosion.

When the magnitude of peak flood discharge is reduced, there is the potential for sediment deposition and encroachment by riparian vegetation; which can result in a narrowing of the channel cross sectional area. Channel incision may accompany channel narrowing if the flood peaks are of sufficient magnitude to mobilize bed materials and the coarse sediment supply from upstream is reduced due to capture by WSD. This would result in over-steepened streambanks and subsequent streambank erosion. A different channel response is also possible if flood peaks are sufficiently reduced, so that coarser bed material is no longer entrained by high flows and only fine materials (*i.e.*, sands, silts, and clays) are transported, leading to a coarsening of the channel bed. The channel then becomes armored, preventing further channel bed adjustments, although the streambank may remain susceptible to erosion. Channel aggradation may result if there is little or no transport of coarse sediments, but there is a sediment supply from local tributary input.

Significant channel geomorphic changes were apparently already underway on Dry Creek prior to the construction of Warm Springs Dam. A study conducted by USACE concluded that gravel mining on Dry Creek and on the mainstem Russian River had caused about 10 feet of incision along the 14-mile channel length by the mid-1970's (USACE 1987). The channel incision on Dry Creek initiated lateral instability and subsequent bank erosion so that channel width had increased from about 90 feet to over 450 feet in some locations in the 1970's (USACE 1987). The 1987 study concluded that it was unlikely that further channel degradation would occur, but that continued lateral instability and erosion of the incised channel banks was likely.

3.2.2 Effects on Protected Species

Channel maintenance flows are necessary to maintain variation in stream morphology important to habitat quality, such as meanders, pools, and riffles. Channel maintenance flows also serve to refresh spawning gravels by mobilizing the streambed and winnowing the fine sediments from the gravels. A detailed discussion of the effects of channel maintenance flows is provided in *Interim Report 1: Flood Control Operations at Coyote Valley and Warm Springs Dams*.

Insufficient channel maintenance flows are likely to result in excess sedimentation of the streambed that could impair spawning or rearing habitat. This concern is greatest at locations downstream of Pena Creek where tributaries deliver sediment to Dry Creek. Excess sediment input can "smother" spawning gravels, eggs, and alevins, and pool habitat can be diminished by sedimentation. Sedimentation can also reduce the availability of habitat for the invertebrate foodbase of salmonids.

Releases made to increase the frequency of channel maintenance flows are intended to flush fine sediments from the streambed so that spawning and rearing habitat are maintained in good condition to permit successful reproduction. Currently, flows of between 1,500 cfs and 2,500 cfs have a return period of approximately 1.5 to 2.0 years (US Corps of Engineers, 1998).

This action may affect coho salmon, because they typically utilize smaller sized gravels that are more likely to be scoured when subjected to flows of this magnitude. This action may require augmentation of spawning gravel in the stream. A supplemental source of gravels in the upper portions of Dry Creek may be required.

3.2.3 Other Considerations

Ramping up flows to achieve the required 1,500 to 2,500 cfs for 1 day could be accomplished as part of normal flood control releases. Periodically, releases of up to 6,000 or 8,000 cfs may be required for flood control. As discussed in Action 9, the channel maintenance flow above the confluence with Pena Creek is estimated to be 5,000 cfs. A monitoring program would need to be implemented to assess the effectiveness of flows of 1,500 to 2,500 cfs in maintaining spawning gravels.

Increasing the frequency of channel maintenance flows may increase the potential for erosion or flooding. On Dry Creek, sustained flows above 2,500 cfs initiate bank erosion. However, a 1-day flow of 1,500 to 2,500 cfs may not result in increased stream bank erosion. This action has the potential to increase channel incision. A monitoring program would be implemented to verify the channel capacity prior to implementation of this action, and would include measurements to detect potential channel incision or bank erosion. A survey of spawning gravels in Dry Creek would be conducted to determine whether they are currently impacted by high fine sediment content. If gravels are not currently impacted by accumulation of fine sediments, the need to provide channel maintenance flows would be reduced.

3.3 ACTION 11. ALLOW FLOOD CONTROL FLOWS FROM WARM SPRINGS DAM TO RAMP UP FASTER ON THE ASCENDING LEG OF THE HYDROGRAPH, AND SLOW THE RATE OF RAMPING ON THE DESCENDING LEG.

The objective of this action is to reduce loss of edge habitat by minimizing bank sloughing due to rapid dewatering of the soils in the bank during flood control operations.

3.3.1 ACTION

This action would reduce the ramping rate of the declining limb of a flood release to prevent a rapid change in pore pressure in the stream banks. When high flows are rapidly decreased, significant changes occur in the pore pressure of saturated stream banks, potentially resulting in bank slumping. (This is a different erosional process than sustained high-magnitude flow releases). Reducing the rate at which flows are decreased would allow water that has accumulated within the stream banks to gradually drain. By allowing water to drain from the banks slowly, this action would help to minimize bank sloughing.

To accomplish a slower rate of change in the descending limb of the storm hydrograph, space in the reservoir may be increased. The action would also allow more rapid discharge of storm flows from the dam during the ascending limb of the storm hydrograph when runoff into the dam is increasing. This change would provide enough storage capacity in the reservoir to ramp releases down more slowly on the descending limb, providing greater protection to streambanks.

3.3.2 EFFECTS ON PROTECTED SPECIES

Periodic stream bank erosion is part of a properly functioning condition for salmonid habitat, providing spawning gravels and woody debris to the stream. However, frequent bank erosion can deleterious. By reducing frequent bank sloughing, this action would reduce sedimentation of aquatic habitat and protect edge habitat. Chronic streambank instability can reduce the amount of riparian vegetation and shading, which can in turn, increase thermal loading and increase water temperatures. A reduction in riparian vegetation adjacent to the stream can also reduce the terrestrial input into the aquatic food base. Salmonids feed on both terrestrial and aquatic insects.

By reducing frequent bank erosion, salmonid habitat and stream function would be improved.

3.3.3 OTHER CONSIDERATIONS

Releases from the dam must be made fairly soon after a storm to restore sufficient flood control capacity before the next storm. If the flood control capacity of the reservoir is not restored sufficiently by the next storm, it may be too late to release enough water and the risk of flooding increases. However, the amount of water that can be released from Lake Sonoma at one time is limited by the capacity of the Russian River to carry water without flooding low lying areas such as Guerneville. By extending the descending leg of the hydrograph, the flood control pool behind the dam would be reduced more quickly than at present.

This action would also address a concern of landowners along Dry Creek, the loss of property. If Action 9 or 10, channel maintenance flows, is also implemented, there would still be some shifting of the channel and stream bank erosion as is characteristic of a healthy geomorphic condition. This action would reduce erosion due to pore pressure, but could also allow for a longer period of sustained flows. Sustained flows may increase erosion of stream banks through entrainment of sediments.

3.4 ACTION 12. PLACE LARGE WOODY DEBRIS OR LARGE BOULDER STRUCTURE IN DRY CREEK TO ENHANCE HABITAT DIVERSITY AND PROVIDE DEPOSITIONAL AREAS FOR SPAWNING GRAVELS FOR COHO SALMON AND OTHER ANADROMOUS FISHES.

The objective of this alternative is to enhance spawning and rearing habitat for anadromous salmonids, and in particular for coho salmon.

3.4.1 ACTION

Habitat improvement structures would be constructed at suitable locations in Dry Creek using boulders and redwood or fir trees. This would increase habitat complexity, available cover, and provide areas that would hold coho spawning gravels. Coho spawning gravels are smaller than those used by steelhead or Chinook salmon (Kondolf and Wolman 1993). Therefore, as discussed in *Interim Report 1*, the high flows in Dry Creek more readily transport coho gravels out of the upper reach (ENTRIX 2000a).

In order to remain in place and be effective at trapping coho-sized gravels, the structures would need to be quite large; typically consisting of three or four, 3- to 5-ton rocks and a tree with attached limbs and root ball. Individual trees should be at least 18 inches in diameter and 35 to 40 feet in length. The structure would resemble a grounded sweeper and debris pile along the channel margin. Debris clusters would be anchored in place by burying the downstream end of the tree and placing a large rock on top of the back filled excavation. Two large boulders would hold the root ball in place. This action may require periodic maintenance/modification of the debris to maintain its effectiveness. Initially, root wads or other structures would be placed at intervals of 500 feet, on average, providing a total of 150 structures along a 14-mile length of channel. These would not be placed at even intervals, but rather clustered in areas where geomorphic conditions and access afford the best opportunities.

3.4.2 EFFECTS ON PROTECTED SPECIES

Structures such as logs, large woody debris, cross-vane rock weirs, boulder clusters, or root wads in the stream channel would be placed within the stream to create combinations of shear zones and pockets of slower moving water velocities surrounding the structures. Structures will serve to trap sediments during high flow events. Deposits of clean, well-sorted gravels are likely to form near these structures, creating high-quality spawning sites. Protected gravels are less likely to scour than gravels at some distance from the structures.

Redds are most likely to be constructed in areas where periodic scour and fill of streambed gravels provide clean gravels that resist transport under all but the highest flows. Coho salmon redds are more prone to scouring than steelhead or Chinook redds due to the smaller size of gravels that are used. Coho redds are more vulnerable to redd-scouring stormflows, as they typically spawn early in the winter season, and in areas with smaller, more easily eroded gravel. Subsequent storms may be numerous, and peak flow events often occur after redd construction and egg laying has been completed by coho salmon.

There is little habitat available for coho within Dry Creek (ENTRIX 2002b) due to poor channel structure (*i.e.*, general lack of pools or edge habitat with complex cover), and the general lack of woody debris. These features constrain production of both fry and juvenile coho. Substantially increasing the amount and quality of habitat for coho juveniles by adding structure would allow this stream to support larger numbers of fry and juveniles, and most importantly would lead to higher production of smolts. Placement of large woody debris within the channel would also improve rearing habitat for anadromous salmon and steelhead by providing refuge from high water velocities, supplying cover within which to escape avian predators, and encouraging deposition of loose gravels and cobbles favored by invertebrate prey.

Habitat for young steelhead and Chinook in Dry Creek is affected in part by low habitat complexity. Habitat structures placed adjacent to high velocity areas would benefit steelhead juveniles by providing velocity refugia adjacent to feeding lanes with abundant prey. All young salmonids would benefit from increased protection from high velocities associated with flows greater than 130 cfs (ENTRIX 2002b).

3.4.3 OTHER CONSIDERATIONS

Large woody debris or other structures placed in the stream channel may reduce channel capacity and increase the risk of flooding and/or bank erosion. Large woody debris may slow or alter currents in a way that could increase the potential for flooding of adjacent land. Instream structures could, in some cases, redirect flows to streambanks and encourage bank erosion. Establishment of an expanded riparian zone (see Action 14) for flood protection and education of the public relative to the benefits of this action may be required. Bank stabilization using bioengineered structures may reduce the potential for bank erosion. If structures placed in the stream become mobile they may cause flooding due to obstruction of flows. The effectiveness of this action is to related to the number of locations where it can be implemented. While a larger number of structures would promise greater habitat gains, restricted stream access and the need to obtain permission from landowners may constrain the number of sites where structures could be placed. Some loss of structures may subsequently occur as a consequence of stormflow events and weathering of materials. This would require monitoring and periodic replacement of structures.

3.5 ACTION 13. RESTORATION OF THE HIGH-FLOW CHANNELS ON DRY CREEK.

The objective of this action is to restore the high-flow channels on Dry Creek to provide additional flood capacity and reduce the potential for bank erosion, and to increase the channel complexity and improve habitat conditions for salmonids.

3.5.1 Action

This action would include selectively removing riparian vegetation from the flood (*i.e.*, high flow) channel of selected portions of Dry Creek, thereby removing obstructions to flow from the high-flow channel. Woody vegetation between the high-flow bank edge and the edge of the low-flow channel would be removed. A band of riparian vegetation along the low-flow channel would be left intact. Some recontouring may be required to connect the high-flow channels with the main channel. The width of the vegetation band would be determined on a reach-by-reach basis to ensure that sufficient vegetation is left to shade the low-flow channel and ensure stability of the vegetation. Site-specific conditions would be evaluated to ensure floodplain continuity and habitat connectivity.

The high-flow channels would carry water during high flows. The channels would be recontoured, as necessary, to drain back to the main channel as flows recede. The slope and gradient of the high-flow channels would be adjusted to reduce the potential for young fish to become trapped or stranded in when the channels dewater.

In addition, the construction of high-flow channels may require some additional site grading and bank contouring to reconnect the main and high-flow channels. This construction activity would take place during the low flow period to minimize the opportunity for sediment to reach the active channel. Heavy equipment would be used following construction BMPs, which would reduce the risk to young fish and minimize habitat disruption. Periodic maintenance of high-flow channels may be required to prevent vegetation encroachment.

3.5.2 Effects on Listed Species

The main benefit of this action is to increase the channel complexity in Dry Creek and improve habitat conditions for salmonids. The high-flow channels would reduce river stage and velocity during flood flows and may also reduce the amount bank erosion occurring in Dry Creek. The channels may provide refuge habitat for young fish during flood flows. Even though the channels would be constructed to minimize the potential for young salmonids to become trapped or stranded, some fish may be trapped in isolated pools and later lost to predators or desiccation.

3.5.3 Other Considerations

To fully implement this action, purchase of conservation easements and the establishment of riparian zones along the banks would be required (see Action 14) as the overflow channels may require more space than is currently available along Dry Creek.

3.6 Action 14. Purchase Conservation Easements or Rights-of-Way to Facilitate Restoration of the Riparian Corridor.

This action is intended to expand the riparian zone along Dry Creek to provide long-term habitat benefits. It would enhance instream conditions and the quality and amount of fish habitat by providing a floodplain management zone capable of supporting riparian and floodplain ecological functions linked to in-channel habitat conditions. By allowing high flow events to scour and deposit sediments, and to transport and deposit woody debris within an adequatelybroad riparian/floodplain zone, habitat for anadromous salmonids would be enhanced in terms of diversity and complexity.

3.6.1 ACTION

Procurement, from willing sellers, of an approximately 300-foot easement along both banks would provide substantial opportunities for construction of a new floodplain surface. Options may include establishment of riparian buffer zones, development of conservation easements, landowner education/outreach, land purchase from willing sellers, and riparian planting programs.

3.6.2 EFFECTS ON PROTECTED SPECIES

In Dry Creek, channel incision and loss of functional floodplains have resulted in a relatively narrow and steep channel often with precipitous banks. In reaches confined by bank protection efforts, the stream has little opportunity to meander, and has decreased sinuosity. Flood control operations have greatly altered the frequency, timing, duration, and magnitude of high flow events. Relatively stable summer flows, in concert with attenuated flood flows, have facilitated encroachment by willows and other riparian plants. Under the existing conditions, habitat in Dry Creek is characterized by low diversity and complexity.

Once a meandering stream, Dry Creek below WSD is now less sinuous, steeper, and narrower, and flows between steep banks often revetted with riprap or other erosion-resistant surfaces. Riparian vegetation, although abundant in many places, contributes little to habitat quality except by providing temperature control by shading the stream.

A more natural condition would incorporate a diversity of ages and species of riparian plants, including trees large enough to provide substantial instream benefits. As flood flows are again able to create a sinuous channel, more complex mosaic of instream and riparian habitats would develop. Over time, trees maturing along the banks would fall into the stream channel at irregular intervals and locations, thereby helping to promote and maintain variation in stream morphology. In addition, this large woody debris would provide improved conditions for rearing by providing reduced flow velocities and cover for the fry and juvenile salmon and steelhead. This would provide an alternative to the continued replenishment of large woody debris likely to be required if Action 12 (placement of large woody debris or other structures in Dry Creek) is implemented on its own.

In Dry Creek, production of salmon and steelhead has in part been limited by the low quality and amount of instream habitat. The quality and amount of habitat could be substantially enhanced by encouraging development of a healthy floodplain, riparian zone, and stream channel. Fish production for each of the listed salmonid species would be expected to increase in response to rehabilitation of the river corridor. Rearing lifestages would benefit substantially from increases in the availability of high-quality feeding stations adjacent to instream cover. Mortality associated with storm flow events (*e.g.*, flushing of juveniles during floods) would decrease. Increased food production from the larger number and size of riffles found in a meandering channel would support larger populations of fry and juveniles. An enlarged riparian zone would likely also provide increased input of terrestrial invertebrates to the stream.

3.6.3 Other Considerations

Expanding the riparian management zone along Dry Creek through conservation agreements or rights-of-way has been investigated at least twice in the past; however it has not been successful primarily due to lack of landowner participation. This action does hold considerable long-term promise and should continue to be considered. Implementation would require willing landowner participation.

3.7 Action 15. Clear and repair upper water discharge tunnel at Warm Springs Dam.

The objective of this action is to obtain full use of the discharge tunnel array to obtain improved temperature regulation of waters discharged from WSD.

3.7.1 Action

There are four low-flow discharge tunnels that convey water from Lake Sonoma into the wet well and associated control structures of the dam. The lowermost is located near the bottom of the reservoir, where the water has low dissolved oxygen (DO) and is too turbid to be used for water supply to the hatchery. The uppermost of the four outlet tunnels is blocked and is no longer functional. Currently, only the middle two tunnels can be used to control releases from the dam and meet water quality objectives for the hatchery.

This action would involve clearing the upper low flow tunnel leading into the wet well of the dam's control structure.

3.7.2 Effects on Protected Species

Clearing the top tunnel would improve the ability of managers to control the temperature of the water discharged from Lake Sonoma. During periods when reservoir surface waters are cool, water could be drawn from the upper discharge tunnel. By releasing a blend of water from the surface and the cold bottom in the winter and early spring, when water temperatures are cooler overall, the deeper, colder water would be conserved for discharge later in the summer when cool water releases are most needed.

This action would allow improved control of the quality (temperature and DO) of the water delivered to the Don Clausen Fish Hatchery (DCFH) and released to Dry Creek. Conservation of the cold water pool for use during the summer months would improve the ability to reduce stressful summer water temperatures in Dry Creek. By improving the quality of the water released to Dry Creek, conditions for rearing of juvenile salmonids would be improved.

Under current operations, the seasonal temperature requirements of the fish hatchery are met by the water supplied from WSD. Based on current water usage, it is estimated that only during the year of maximum drawdown, or about once in 50 years, would the reservoir be unable to provide water that meets hatchery temperature requirements (*Interim Report 4* [ENTRIX 2001]). If the hatchery is expanded in the future, then additional water would be needed. Conservation of the cold water pool at the bottom of the reservoir, and improved control of water quality supplied to the fish hatchery would improve conditions for hatching and rearing juvenile salmonids.

3.7.3 OTHER CONSIDERATIONS

Repairing the upper discharge tunnel would also help to eliminate plunge cavitation problems in the discharge from the dam. Access to the tunnel is only available when the level of Lake Sonoma is below 426 feet msl. The top of the water supply pool is at 451 feet msl. Therefore, this action would need to be implemented during drought conditions to avoid significant incursions into the water supply pool.

Most California hatcheries, including the DCFH and Coyote Valley Fish Facility (CVFF), were established for the purposes of mitigation and enhancement. The USACE has goals for both DCFH and CVFF that include production goals for both juvenile releases and adult returns, yet these two goals may be in conflict with one another due to environmental conditions beyond the control of the hatchery. The mitigation goals of the USACE should be formally revised to provide objectives that are realistic and feasible under today's environmental and regulatory conditions.

With the listing of salmonid species under the ESA, efforts are underway in the Russian River to utilize the hatchery facilities to supplement naturally-spawning coho populations and aid in their recovery. A key question that remains to be answered is whether hatchery production can provide sustainability for naturally spawning populations.

Hatchery operations generally consist of some combination of mitigation, enhancement, or conservation activities.

- Mitigation activities are designed to replace fish production that was lost due to elimination of habitat required for natural spawning and rearing.
- Enhancement activities are designed to increase the fish population above that which would naturally occur, generally to provide an increased opportunity for harvest.
- Conservation activities are designed to maintain the genetic integrity of the naturally-occurring fish population.

NMFS has defined several types of hatchery programs as follows:

Integrated Recovery Program is an artificial propagation project primarily designed to aid in the recovery, conservation, or reintroduction of particular natural populations(s), and fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population(s). Sometimes referred to as "supplementation."

Integrated Harvest Program is a project in which artificially-propagated fish produced primarily for harvest are intended to spawn in the wild and are fully reproductively integrated with a particular natural population.

Isolated Harvest Program is a project in which artificially-propagated fish produced primarily for harvest are not intended to spawn in the wild or be genetically integrated with any specific natural population.

NMFS has noted that hatchery production of Pacific salmon may be consistent with the purposes of the ESA in two situations: 1) when the hatchery production facilitates the recovery of a protected species, or 2) when the enhancement of unlisted populations does not impede the recovery of a protected species or compromise the viability or distinctiveness of an unlisted species (Hard *et al*. 1992).

Based on the analyses presented in *Interim Report 2: Fish Production Facilities* (FishPro and ENTRIX 2000) and in *Hatchery and Genetics Management: Monitoring and Evaluation Plan and Benefit Risk Analyses for Russian River Fish Production Facilities* (FishPro and ENTRIX 2002), the following issue was identified.

Issue FHO-1 – Hatchery operations may have adverse effects on listed fish species through increased competition and predation, and effects on genetic integrity.

Actions 16 through 19 compare different hatchery programs and assess their ability to reduce potential effects to listed fish species and fit into other recovery efforts within the basin. Four hatchery actions are presented including the current mitigation program (Action 16), a conservation hatchery program (Action 17), and two alternatives that combine elements of a conservation hatchery program with a mitigation program (Actions 18 and 19). The types of hatchery programs associated with alternative actions are summarized in Table 4-1.

Table 4-1 Type of Hatchery Programs Associated with Hatchery Alternative Actions

Action #	Steelhead	Coho	Chinook
16	Isolated harvest	Isolated harvest	Isolated harvest
17	No production or integrated recovery	Captive broodstock or integrated recovery	No production or integrated recovery
18	Isolated harvest, integrated harvest or integrated recovery	Captive broodstock or integrated recovery	No production, integrated recovery, or integrated harvest
19	Isolated harvest	Isolated harvest and integrated recovery (captive broodstock/ supplementation)	Isolated harvest

In the following section, the approach to analysis of the risks and benefits of these alternatives is outlined. Then a description of these actions is provided and the risks and benefits to each of the listed fish species are summarized.

<u>Approach to Analyses</u>

Hatchery-bred fish may affect naturally-reproducing stocks through competition, predation, and effects to genetic integrity. Fish production for the purpose of supplementation differs from traditional production or mitigation by preserving demographic, genetic, and ecological characteristics of natural populations (Hard *et al*. 1992).

The potential risks of hatchery production to protected species can be categorized into two areas, genetic risks and ecological risks. Genetic risks may include loss of diversity within and between populations, outbreeding depression, and inbreeding depression. Ecological risks to protected species may include increased competition for food, habitat, or mates; increased predation; disease transfer; altered migration behavior; long-term viability; artificial selection; disproportional survival; and harvest bycatch.

Hatchery operations may contribute to genetic and ecological risks in the following ways:

- The source of broodstock has the potential to contribute to genetic risks to listed populations primarily through outbreeding depression, but also, depending on specific circumstances, to loss of within-population or between-population diversity, inbreeding depression, or straying of the hatchery reared component. It can also contribute to artificial selection. By utilizing local stocks as the source of broodstock, this risk can be minimized, provided that collection of broodstock does not endanger the population.

- The number of broodstock collected may have risks associated with within-population diversity, inbreeding depression, and disproportional survival. By utilizing the minimum number of broodstock necessary to maintain the genetic variability of the population, the risk of genetic effects can be minimized.

- Broodstock sampling and mating operations may affect within-population diversity, outbreeding depression, and disproportional survival.

- Rearing techniques may affect within-population diversity, disease transfer, long-term viability, and artificial selection.

- Release strategies may affect between population diversity, competition, predation and outmigration behavior. To reduce potential effects related to competition and predation, a hatchery may release smolts in the same size range of wild smolts, and volitional release and acclimation can help reduce straying.

- The duration in hatchery captivity may affect within-population diversity and artificial selection. The risk of artificial selection in a hatchery increases the longer the duration of captivity.

- Harvest management may affect the wild population primarily through unintended harvest bycatch of the non-target population. If harvest is allowed on one or more non-listed marked populations with minimal survey activity, as is currently the case with steelhead, this risk is high.

Although numerical data to quantify the benefits and risks associated with these alternatives are lacking, risks and benefits of production alternatives are evaluated qualitatively for each of the three listed salmonid species. A detailed benefit risk analysis for alternative hatchery programs has been developed separately in *Hatchery and Genetics Management: Monitoring and Evaluation Plan and Benefit Risk Analyses for Russian River Fish Production Facilities* (FishPro and ENTRIX 2002). A summary of the relative risks and benefits between these alternatives is presented in this document.

A detailed monitoring and evaluation plan has been developed (FishPro and ENTRIX 2002). While there are several evaluation parameters that are considered the responsibility of the hatchery owner, many of the evaluation factors identified are associated with recovery planning and therefore may fall under the stewardship responsibility of the state and federal fisheries resource agencies. Significant coordination efforts are required to identify available funding, staffing, and support logistics to allow full implementation of a monitoring and evaluation plan.

Currently, the DCFH steelhead program operates as an isolated harvest program. The purpose of the program is to mitigate for lost habitat capacity resulting from the construction of the Warm Springs and Coyote Valley dams and to provide harvest opportunities. CDFG submitted a draft Hatchery and Genetic Management Plan (HGMP) for the steelhead program to NMFS in January, 2001. Although mitigation and enhancement goals for coho salmon are set at the DCFH, an interim operations plan called for a cessation of hatchery production for coho salmon in 1999. In 2001, a pilot program was implemented to analyze the effectiveness of a conservation hatchery program for coho salmon supplementation (captive broodstock) in the Russian River. Beginning in 1999, USACE, CDFG, and NMFS established an interim operations plan that called for a cessation of hatchery production of Chinook salmon until additional data are available.

4.2 ACTION 16. "MITIGATION HATCHERY." MAINTAIN THE EXISTING HATCHERY PRODUCTION GOALS FOR MITIGATION OF STEELHEAD AND COHO POPULATIONS AND ENHANCEMENT OF COHO AND CHINOOK SALMON POPULATIONS.

The objective of this action is to attempt to fulfill the existing mitigation goals for loss of steelhead and coho spawning habitat above the CVD and WSD. This action would also provide enhancement of coho and Chinook populations, thereby providing an increased opportunity for harvest of hatchery fish. This mitigation program can be defined as an isolated harvest program.

4.2.1 ACTION

Fish production facilities were developed at the DCFH and CVFF to mitigate for the loss of steelhead and coho salmon spawning and rearing habitat upstream of WSD and CVD, and to enhance coho and Chinook salmon populations for harvest (Table 4-2). No quantitative assessments were conducted to determine the actual carrying capacity of affected areas, and goals were instead developed from estimates of run size within the subbasins and additional estimates of spawning habitat upstream of the dam locations. However, insufficient data exist to support these estimates. Adult escapement goals have generally not been met, and this is likely due to factors beyond the control of the hatchery management practices.

A monitoring program would be implemented to assess the population status of listed fish species, the habitat production capacity, and the ecological interactions between hatchery-reared and naturally-reproducing stocks. Hatchery operations would incorporate adaptive management practices, which could lead to changes in hatchery production guidelines (such as number of juveniles released, size of juveniles released, or use of wild fish for broodstock) based on findings of the monitoring program. The adaptive management approach could lead to the construction of new facilities if, for example, it were found that lower fish densities or volitional release resulted in significant improvements in adult return rates.

Table 4-2 Existing Hatchery Program Goals for Don Clausen Fish Hatchery and Coyote Valley Fish Facility

Location/Species	Mitigation/ Enhancement	Egg Harvest	Juvenile Releases	Adult Escapement
Don Clausen Fish Hatchery				
Steelhead	Mitigation	600,000	300,000 yearling	6,000
Coho salmon	Mitigation	20,000	10,000 yearling	100
Coho salmon	Enhancement	200,000	100,000 yearling	1,000
Chinook salmon	Enhancement	1,400,000	1,000,000 smolts	1,750
Coyote Valley Fish Facility				
Steelhead	Mitigation	320,000	200,000 yearling	4,000

4.2.2 EFFECTS ON PROTECTED SPECIES

Steelhead

The isolated harvest program would derive all broodstock from the supply of adult steelhead returning to the hatchery, and no broodstock would come from naturally spawned fish. Since 1982, the source of broodstock for Russian River hatchery reared steelhead has been limited to progeny of fish returning to DCFH and CVFF rather than from out-of-basin stocks. Given this shift in broodstock collection protocols, the risk of outbreeding depression is low. However, given the mixed stock history of the hatchery population, the risk of outbreeding depression is potentially higher than would be the case had broodstock always been collected locally.

There are insufficient data to determine if the Russian River system supports the minimum number of wild steelhead to maintain genetic diversity. The total steelhead spawning aggregate in the Russian River appears to be greater than the minimum broodstock threshold level, but individual tributary populations may be too rare or isolated to allow random mating. A conservative course of action would be to assume that the isolated harvest alternative may have a greater risk of genetic effects to the remaining Russian River steelhead population than a supplementation program would, at least until it can be shown that the wild steelhead population is at or above the minimum broodstock threshold.

The risk of artificial selection may be minimized by decreasing the selective gradient between the hatchery and instream environment. Currently broodstock is collected systematically across the entire adult return, suggesting broodstock collection practices are unlikely to adversely affect the naturally-spawning population components. DCFH and CVFF utilize traditional rearing techniques with high rearing densities, suggesting that there is a risk of artificial selection within the hatchery environment. Since naturally-spawned individuals are not utilized, there is a risk of domestication as a result of repeated artificial selection on the hatchery-reared component. An isolated harvest program that rears fish through the smolt life stage has a higher risk of artificial selection than a no production alternative. Adherence to NMFS recommended guidelines for fish health management will likely minimize potential risk of disease transfer from the hatchery to wild populations.

To minimize ecological interactions, managers can consider releasing fish to increase the spatial and temporal separation between hatchery and wild fish. Hatchery-reared fish released as smolts soon migrate to the ocean and they consequently exhibit little likelihood of competing for freshwater resources utilized by naturally-spawned fish in the system. By targeting release size for the existing isolated harvest program to be the same as wild steelhead smolts, the risk of direct predation could be minimized. The risk of predation is somewhat minimized by the volitional release strategy employed at CVFF.

Harvest allowed on one or more non-listed, distinguishable/marked population has the potential to affect the wild population primarily through unintended harvest bycatch of the non-target population. Budget limitations have precluded the ability of CDFG to conduct harvest surveys in recent years, but funding may be available in the future (R. Gunter, CDFG, pers. comm. 2002).

To preserve the genetic variability found within the Russian River spawning aggregate, a supplementation alternative may be the most appropriate, even in the face of scientific uncertainty. However, if additional data indicate that wild steelhead productivity is increasing, then there is little risk in implementing an isolated harvest program.

Coho

All available data suggest that the Russian River coho spawning aggregate is at risk from demographic stochasticity and the loss of genetic variation. There is every reason to believe that without intervention, there is a substantial risk of extirpation of the Russian River population after several generations. Further, if the Russian River coho aggregate survives unaided until the factors contributing to their decline are mitigated, recovery would likely be hindered by the loss of genetic variation.

The pilot program for coho salmon (captive broodstock) was implemented to analyze the effectiveness of a conservation hatchery program for coho salmon in the Russian River. Given the available presence/absence data for coho salmon, it is clear that without intervention, the Russian River spawning aggregate is at risk of extirpation. Therefore, a harvest alternative poses substantial risks to the population.

Chinook Salmon

Production goals were implemented at the DCFH to provide enhancement of Chinook salmon. Beginning in 1999, USACE, CDFG, and NMFS established an interim operations plan that called for a cessation of hatchery production of Chinook salmon until additional data were available regarding the genetic makeup of fish returning to the hatchery and those found in the wild. While there is some debate regarding the historical presence of Chinook salmon in the Russian River basin, the more conservative stance would be adopted which provides the naturally-reproducing population full protection under the ESA.

Recent data from the SCWA Mirabel Inflatable Dam fish sampling program suggest that the Russian River system supports the minimum number of naturally spawned Chinook necessary to maintain genetic diversity. This suggests that the no production alternative may result in the least genetic effect to the remaining Russian River Chinook population, since any hatchery program would divert wild Chinook from the natural spawning population.

Appropriate broodstock sampling and mating protocols may minimize genetic risks. It is unknown whether spawning aggregates in the Russian River are too isolated to allow random mating. For harvest programs, approved protocols for broodstock sampling and mating would be implemented to ensure that the maximum genetic variability would be incorporated in the hatchery component of the overall population.

The isolated harvest program is at greater risk of artificial selection than a supplementation or integrated harvest program due to repeated broodstock selection from hatchery stock. Isolated harvest programs that rear fish through the smolt life stage have a higher risk of artificial selection than the no production alternative.

Based on the limited current abundance data for Chinook, the Russian River spawning aggregate of the California Coastal Chinook Evolutionary Significant Unit (ESU) does not appear to be at immediate genetic risk. However, additional data are needed to assess long-term population trends and the level of genetic variation within the basin. Until additional data determine the status of naturally-spawning Russian River Chinook, the no production alternative may be the preferred action. Alternatively, if additional data indicate that wild Chinook productivity is increasing, then there is little risk in implementing an isolated harvest program.

4.2.3 Other Considerations

A recreational fishery for hatchery-reared steelhead is currently permitted in the mainstem Russian River below the East Fork. This fishery would continue under this action. CDFG is responsible for regulating and enforcing the recreational fishery. Funding for CDFG efforts comes, in part, from the sale of steelhead catch report cards. Data on steelhead populations are obtained from the return of these catch report cards.

Implementation of the current coho captive broodstock or an additional conservation program above the current mitigation program is likely to require modification of the current hatchery facility to accommodate additional production. Additional water supply lines from the WSD to the hatchery would be required. Furthermore, water discharges to Dry Creek from the hatchery would be coordinated with alternatives that may affect flow through the control structure of the dam or in Dry Creek.

4.3 Action 17. "Conservation Hatchery." Establish a conservation hatchery program to protect genetic resources and avoid extirpation of critically depressed populations.

This action would set aside existing mitigation and enhancement goals for all three species. In its place, there would be a conservation program to protect the genetic resources of salmonids. This would reduce the short-term risk of extirpation of species before other recovery efforts in the Russian River basin take effect.

4.3.1 ACTION

This program can be defined as an integrated recovery program, or supplementation. The program would initially involve coho salmon, though steelhead and Chinook components might be added later pending results of monitoring efforts. The pilot captive broodstock program implemented by CDFG in 2001 is a supplementation program.

Required facilities would include one central rearing and incubation facility, plus at least one acclimation pond for each species of concern. (If the DCFH were not being used for other hatchery programs [*i.e.*, mitigation or enhancement], it would likely assume the role of the central incubation and rearing facility following minor modifications.) The acclimation pond(s) would be located along a tributary and would be used to imprint fish prior to release. A monitoring program would be implemented to assess the population status of listed fish species and the habitat production capacity. Naturally-spawned fish would be used as broodstock, minimizing potential genetic differences between wild and hatchery stocks. Releases of juvenile fish would occur into areas inhabited by the wild population, thereby adding abundance to the natural run. Predation of hatchery fish on wild stocks would be avoided or reduced by releasing fish of equal size to the wild stocks.

4.3.2 EFFECTS ON PROTECTED SPECIES

Coho Salmon

By utilizing local stocks as the source of broodstock, the source of genetic material in the first-generation hatchery component of the captive broodstock program is presumably identical to that of the wild population, reducing the risk of outbreeding depression and the loss of within or between population diversity. Therefore, for both the pilot captive broodstock and a supplementation program that would, in the future, utilize wild fish, there is no difference in risk level between these alternatives and the no production alternative in the earliest stages of the program.

An estimated minimum of 840 wild, instream spawners is needed to maintain genetic variation over a period of 15 years (the estimated timeframe to achieve objectives). Based on the extremely low incidence of observed presence of coho adults in the Russian River in recent years, there may be less than half this number spawning naturally. This suggests that a no production alternative would result in unacceptable genetic effects to the remaining coho population, and further suggests the supplementation program is preferable if the decision remains to attempt recovery of the species.

The current status of coho in the basin suggests that spawning aggregates may be too rare and/or too isolated to allow random mating, and therefore there is a risk of inbreeding. For the supplementation and captive broodstock alternatives, protocols for broodstock sampling and mating could ensure that the maximum genetic variability would be incorporated in the hatchery component of the overall population.

By decreasing the selective gradient between the hatchery and instream environment, the risk of artificial selection may be minimized. At a minimum, it is expected that coho supplementation and captive brood programs would operate under low density rearing conditions, and that NATURES features would be added as appropriate.

To reduce potential effects related to competition and predation, any hatchery program should release smolts in the same size range of wild smolts, and volitional release and acclimation can help reduce straying. The limited access to streams on private property in the Russian River watershed may greatly restrict the opportunity for acclimation/volitional release facilities. By releasing fish for supplementation purposes only into locations where the habitat capacity exceeds the requirements of the local naturally-spawning population, competitive interactions can be reduced. Monitoring and evaluation over time can provide data to guide future release strategies as coho salmon abundance changes.

The risk of artificial selection in a hatchery increases the longer the duration of captivity. Captive broodstock programs, which derive spawners from hatchery-reared individuals collected as juveniles, have a greater risk of accumulation of artificially-selected phenotypes than standard supplementation programs that derive broodstock from naturally-spawned adult returns. The risk of artificial hatchery selection for a supplementation program is greater than a no production alternative.

Supplementation and captive broodstock programs can likely result in healthy, self-sustaining populations only if at least one of the following conditions are met: 1) factors responsible for the original decline are addressed concurrently; or 2) supplementation helps to propel a population out of a stable but depressed state into a higher equilibrium abundance. Supplementation would speed recovery of coho salmon.

Given the available presence/absence data for coho salmon, it is clear that without intervention, the Russian River spawning aggregate is at risk of extirpation. Therefore, the no production alternative poses substantial risks to the population. Overall, a properly maintained and managed supplementation program, such as the pilot captive broodstock program implemented by CDFG, NMFS, and USACOE in 2001, offers the opportunity to address many of the uncertainties surrounding the role of hatcheries in conservation. The results of this analysis suggest that a supplementation-oriented coho program would be invaluable as a means to avoid further genetic degradation of the Russian River aggregate, and would provide a buffer against demographic risks of low adult returns.

Steelhead

If local stocks are the source of broodstock for supplementation, there is no difference in risk level for loss of genetic diversity between a supplementation alternative and the no production alternative.

By determining and utilizing the minimum number of broodstock necessary to maintain the genetic variability of the population, the risk of genetic effects (primarily inbreeding depression and loss of within-population diversity) can be minimized. There are insufficient data to determine if the Russian River system supports the minimum number of wild steelhead to maintain genetic diversity. The total steelhead spawning aggregate in the Russian River appears to be greater than the minimum broodstock threshold level, but individual tributary populations may be too rare or isolated to allow random mating. This suggests that the no production (and isolated harvest) alternative has the potential to result in genetic effects to the remaining Russian River steelhead population and that a supplementation program may be preferable. A supplementation program would divert wild steelhead from the natural spawning population to an extent proportional to the benefit derived by reducing the potential for divergence between the hatchery-reared and wild populations. Implementation of a supplementation program provides an increased survival advantage for early life history stages that should promote increased numbers of spawners.

The risk of loss of within-population diversity and outbreeding depression may be minimized by appropriate broodstock sampling and mating protocols. For a supplementation program, approved protocols for broodstock sampling and mating would be implemented to ensure that the maximum genetic variability would be incorporated in the hatchery component of the overall population.

By decreasing the selective gradient between the hatchery and instream environment, the risk of artificial selection may be minimized. It is proposed that, at the minimum, a supplementation program would operate under low-density rearing conditions, and that NATURES features would be added as appropriate.

To reduce potential effects related to competition and predation, any hatchery program should release smolts in the same size range of wild smolts, and volitional release and acclimation can help reduce straying. By releasing fish for supplementation purposes only into locations where the habitat capacity exceeds the requirements of the local naturally spawning population, competitive interactions can be reduced.

A supplementation program that rears fish through the smolt life stage has a higher risk of artificial selection than the no production alternative.

Increased egg-to-adult survival experienced with hatchery supplementation programs may reduce short-term extirpation risks faces by natural populations. For very small populations, demographic and environmental variability pose the greatest short-term risks, but genetic risks such as inbreeding can also be important. The supplementation alternative can help to reduce these risks, resulting in reduced extirpation risk and conservation of genetic diversity.

Supplementation could help speed recovery through increased population abundance for steelhead. However, factors responsible for the original decline must be addressed.

A properly maintained and managed supplementation program offers the opportunity to address many of the uncertainties surrounding the role of hatcheries in conservation. To preserve the genetic variability found within the Russian River spawning aggregate, the supplementation alternative may be the most appropriate, even in the face of scientific uncertainty.

Chinook Salmon

If local stocks are the source of broodstock for supplementation, there is no difference in risk level between the supplementation program and the no production alternative. However, until there are adequate numbers of wild Chinook to assure that broodstock harvest would not affect the target stock, it may be recommended that a mix of local broodstock and broodstock collected from nearby watersheds be utilized.

By determining and utilizing the minimum number of broodstock necessary to maintain the genetic variability of the population, the risk of genetic effect (primarily inbreeding depression and loss of within-population diversity) can be minimized. It appears that the Russian River system supports the minimum number of naturally-spawned Chinook necessary to maintain genetic diversity. This suggests that the no production alternative may result in the least genetic effect to the remaining Russian River Chinook population, since all other programs would divert wild Chinook from the natural spawning population to an extent proportional to the benefit derived by reducing the potential for divergence between the hatchery-reared and wild populations.

The risk of loss of within-population diversity and outbreeding depression may be minimized by appropriate broodstock sampling and mating protocols. It is unknown whether spawning aggregates in the Russian River are too isolated to allow random mating. For the proposed supplementation program, approved protocols for broodstock sampling and mating would be implemented to ensure that the maximum genetic variability would be incorporated in the hatchery component of the overall population.

It is proposed that, at the minimum, the supplementation program would operate under low-density rearing conditions, and that NATURES features would be added as appropriate.

To reduce potential effects related to competition and predation, any hatchery program should release smolts in the same size range of wild smolts, and volitional release and acclimation can help reduce straying. By releasing fish for supplementation purposes only into locations where the habitat capacity exceeds the requirements of the local, naturally-spawning population, competitive interactions can be reduced.

Supplementation programs that rear fish through the smolt life stage have a higher risk of artificial selection than the no production alternative.

Supplementation could help speed recovery through increased population abundance for Chinook. However, factors responsible for the original decline (if one exists) must be addressed. Previous CDFG estimates for Chinook were 100 to 500 adults, but recent data from video monitoring at the Mirabel Inflatable Dam indicate there currently is a naturally-reproducing population in the Russian River in excess of 1,300 adults (S. White, SCWA, pers. comm. 2002a). Long term data are needed to assess the status of Chinook in the Russian River.

Based on the current short-term abundance data for Chinook, the Russian River spawning aggregate of the California Coastal Chinook ESU does not appear to be at immediate genetic risk. However, additional data are needed to assess long-term population trends and the level of genetic variation within the basin. Until additional data determine the status of naturally-spawning Russian River Chinook, the alternative with no production may be the preferred action.

4.3.3 Other Considerations

Under this action, the recreational fishery for hatchery reared steelhead would be discontinued. Local income from sale of fishing equipment and local guide services would be lost.

4.4 Action 18. Maintain existing mitigation elements for steelhead, and establish new interim conservation, restoration, or research programs for coho and Chinook salmon.

4.4.1 Action

This action would continue to fulfill the mitigation goals for loss of steelhead spawning and rearing habitat. The mitigation and enhancement goals for coho and Chinook salmon would be put on hold for an interim period while information is collected to determine the most effective use of artificial propagation. Emphasis would be placed on data collection to identify the needs for a conservation program aimed at conserving genetic resources and preventing extirpation of these species. No enhancement activities would be conducted during the interim period, though a long-term goal would be to revise and identify a means of achieving mitigation and/or enhancement goals with no adverse impact to natural populations. As with all hatchery alternatives, a monitoring program would be implemented. Hatchery operations would incorporate adaptive management practices which could lead to changes in hatchery production guidelines (such as number of juveniles released, size of juveniles released, or use of wild fish for broodstock) based on findings of the monitoring program.

The coho supplementation program would require a central rearing and incubation facility located at DCFH and at least one acclimation pond. The acclimation pond(s) would be located in tributaries of the Russian River where there is good quality but underutilized habitat appropriate for the species of concern.

4.4.2 Effects on Protected Species

Steelhead

This alternative would implement a hatchery program to meet mitigation requirements rather than the no production alternative. The current program is an isolated harvest program, but an integrated program could be implemented if genetic and ecological monitoring indicate it is appropriate.

If local stocks are the source of broodstock for supplementation and integrated harvest production alternatives, there is no difference in risk level between these alternatives and the no production alternative. However, until there are adequate numbers of wild steelhead to assure that broodstock harvest would not affect the target stock, a mix of hatchery-reared and naturally-spawned broodstock should be utilized.

By determining and utilizing the minimum number of broodstock necessary to maintain the genetic variability of the population, the risk of genetic effect (primarily inbreeding depression and loss of within-population diversity) can be minimized. There is some uncertainty whether the Russian River system supports the minimum number of wild steelhead necessary to maintain genetic diversity. This suggests that the no production and isolated harvest alternatives have potential to result in genetic effects to the remaining Russian River steelhead population and an integrated program may be preferable. A supplementation and integrated harvest program would divert wild steelhead from the natural-spawning population to an extent proportional to the benefit derived by reducing the potential for divergence between the hatchery reared and wild populations. Implementation of a supplementation or integrated harvest program provides an increased survival advantage for early life history stages that should promote increased numbers of spawners.

The risk of loss of within-population diversity and outbreeding depression may be minimized by appropriate broodstock sampling and mating protocols. The total steelhead spawning aggregate in the Russian River appears to be greater than the minimum broodstock threshold level, but individual tributary populations may be too rare or isolated to allow random mating. For supplementation and integrated harvest programs, approved protocols for broodstock sampling and mating would be implemented to ensure that the maximum genetic variability would be incorporated in the hatchery component of the overall population.

It is proposed that, at the minimum, an integrated program would operate under low-density rearing conditions, and that NATURES features would be added as appropriate to minimize the risk of artificial selection.

To reduce potential effects related to competition and predation, any hatchery program should release smolts in the same size range of wild smolts, and volitional release and acclimation can help reduce straying. By releasing fish for supplementation purposes only into locations where the habitat capacity exceeds the requirements of the local naturally-spawning population, competitive interactions can be reduced.

Supplementation integrated harvest and isolated harvest programs that rear fish through the smolt life stage have a higher risk of artificial selection than the no production alternative.

Harvest management may affect the wild population primarily through unintended harvest bycatch of the non-target population. If harvest is allowed on one or more non-listed, distinguishable/marked populations (such as hatchery steelhead) with no harvest surveys, the risk to protected species increases under any alternative.

There are insufficient data to support recent or historic population estimates for the Russian River spawning aggregates. A properly maintained and managed supplementation program offers the opportunity to address many of the uncertainties surrounding the role of hatcheries in conservation. To preserve the genetic variability found within the Russian River spawning aggregate, the supplementation alternative may be the most appropriate, even in the face of scientific uncertainty. Alternatively, if additional data indicate that wild steelhead productivity is increasing, then there is little risk in implementing an integrated or isolated harvest program.

<u>Coho Salmon</u>

See the analysis for coho salmon presented in Action 17.

Chinook Salmon

The effects on Chinook salmon for a no production or integrated recovery program are presented in Action 17. No enhancement activities would be conducted during an interim period, though a long-term goal would be to identify a means of achieving mitigation and enhancement goals with no adverse effect to natural populations. An analysis of risks and benefits of a future integrated harvest program would be similar to the integrated harvest analysis provided for steelhead in Action 18.

Based on the current short-term abundance data for Chinook, the Russian River spawning aggregate of the California Coastal Chinook ESU does not appear to be at immediate genetic risk. However, additional data are needed to assess long-term population trends and the level of genetic variation within the basin. Until additional data determine the status of naturally-spawning Russian River Chinook, the no production alternative may be the preferred action. Alternatively, if additional data indicate that wild Chinook productivity is increasing, then there may not be a substantial risk in implementing an integrated harvest program. Benefits associated with implementation of hatchery programs could include fulfillment of mitigation goals and increased harvest opportunity.

4.4.3 Other Considerations

Under this action, the fishery for hatchery-reared steelhead would be temporarily discontinued until stocks have recovered sufficiently. Local income from the sale of fishing equipment and local guide services would be lost in interim.

Implementation of the current coho captive broodstock or an additional conservation program above the current mitigation program is likely to require modification of the current hatchery facility to accommodate additional production. Additional water supply lines from the WSD to the hatchery would be required. Furthermore, water discharges to Dry Creek from the hatchery would be coordinated with alternatives that may affect flow through the control structure of the dam or in Dry Creek.

4.5 Action 19. Maintain Existing Mitigation and Enhancement Hatchery Functions and Establish New Conservation Facility.

4.5.1 Action

This option would fulfill the existing mitigation goals for loss of steelhead and coho spawning and rearing habitat and enhancement goals for coho and Chinook populations. In addition, this option would seek to protect the genetic resources of the critically-depressed coho population through implementation of a conservation program. As with all alternatives, a monitoring program would be implemented to assess critical parameters. Hatchery operations would incorporate adaptive management practices which could lead to changes in hatchery production guidelines (such as number of juveniles released, size of juveniles released, or use of wild fish for broodstock) based on findings of the monitoring program.

In this alternative, the DCFH would be at full capacity with its mitigation and enhancement programs. Consequently, a new facility would be required to conduct the central rearing and incubation functions for the conservation program. In addition, at least one acclimation pond would be required, located in a tributary where there is good quality but underutilized habitat appropriate for the species of concern.

4.5.2 Effects on Protected Species

The component of this alternative that would implement existing mitigation and enhancement goals for steelhead, coho salmon, and Chinook salmon can be defined as an isolated harvest program. The effects of an isolated harvest program were analyzed in Action 16. In addition, this alternative would implement a conservation program for coho salmon. The effects of a coho captive broodstock or supplementation program were analyzed in Action 17. Overall, a properly maintained and managed supplementation program, such as the pilot captive broodstock program implemented by CDFG in 2001, would be invaluable as a means to reduce genetic risks to the Russian River aggregate, in addition to providing a buffer against demographic risks of low adult returns.

Implementation of an isolated harvest program for steelhead and Chinook would allow harvest on one or more non-listed, distinguishable/marked population. Harvest management has the potential to affect the wild population primarily through unintended harvest bycatch of the non-target population. Budget limitations have precluded the ability of CDFG to conduct harvest surveys in recent years that could help managers address this risk, but funding may be available in the future (R. Gunter, CDFG, pers. comm. 2002).

4.5.3 Other Considerations

A recreation fishery for hatchery-reared steelhead is currently permitted in the mainstem Russian River below the East Fork. This fishery would continue under this action. CDFG is responsible for regulating and enforcing the recreational fishery. Funding for CDFG efforts comes, in part from the sale of steelhead catch report cards. Data on steelhead populations are obtained from return of these catch report cards.

Implementation of the current coho captive broodstock or an additional conservation program above the current mitigation program is likely to require modification of the current hatchery facility to accommodate additional production. Additional water supply lines from the WSD to the hatchery would be required. Furthermore, water discharges to Dry Creek from the hatchery would be coordinated with alternatives that may affect flow through the control structure of the dam or in Dry Creek.

4.6 Action 20. Install an Independent Water Supply Pipeline to Provide an Improved Water Source to the Hatchery.

The objective of this action is to provide a reliable and independent water supply to the DCFH that is not dependent on other dam facilities.

4.6.1 Action

This action would supplement the existing hatchery supply line with redundant primary supply lines capable of providing flows of 100 cfs to the hatchery (*i.e.*, two lines of 50 cfs each). Dual

30-inch lines would be installed in the wet well where the existing emergency supply line is now located. These lines would have independent controls. The existing water supply line would remain in place and would function as a backup supply should flows through the wet well be curtailed. This action would also include removal of the hatchery's existing emergency water supply line that runs along the top of the outlet structure.

4.6.2 Effects on Protected Species

The hatchery requires flows of 35 to 50 cfs for its current operations. However, modifications to hatchery operations are being considered. These changes in hatchery operations may require additional water (up to 75 cfs total), which is not available through the existing pipeline and backup supply.

This action would result in a more reliable water supply source to the hatchery and would minimize effects to incubation and rearing facilities due to unscheduled shut downs of water supply.

4.6.3 Other Considerations

Discharge from the hatchery is directed into Dry Creek. Therefore, releases from the hatchery need to be accounted for when estimating flows in Dry Creek under any reduced flow alternative. This action could be implemented irrespective of any change in flow regime, or other modification to the infrastructure of the dam. The action would also correct the dam safety problem associated with the presence of the emergency supply line in the flood control tunnel by removing the line.

4.7 Action 21. Install a Diversion (30-inch) from a New 72-inch Pipeline Stub to Provide an Increased and More Reliable Source of Water to the Hatchery.

The objective of this action is to provide a reliable water supply to the DCFH.

4.7.1 Action

A 30-inch pipe, capable of providing flows of 50 cfs, would tap into a 72-inch pipeline stub to provide primary water supply flows to the hatchery. This action would involve a single modification to the wet well: the installation of a 72-inch pipeline stub through the dam. The existing hatchery water supply line from the header box at the weir would be used as a backup supply. The existing emergency supply line would be removed from the top of the outlet structure of the dam.

4.7.2 Effects on Protected Species

The fish hatchery currently requires flows of approximately 35 to 50 cfs. However, modifications to hatchery operations are being considered. These changes in hatchery operations are likely to require additional water (up to 75 cfs total), which is not available through the existing pipeline and backup supply.

The 30-inch pipeline to the hatchery would provide a more reliable source of water than the current pipeline configuration. The current water delivery system to the hatchery periodically fails, resulting in degradation of water quality in the hatchery and potential harm to fish in the hatchery. Replacing the water supply pipeline would improve water supply reliability for hatchery operations.

4.7.3 OTHER CONSIDERATIONS

Only a single modification to the wet well is considered feasible. Any other actions, which would require modifications to the wet well, would be integrated with the construction of the 72-inch pipeline stub. The 72-inch stub could be subsequently connected to the pipeline to the Russian River as contemplated in Actions 23 and 24.

The hatchery would continue on an interim water supply system while the 72-inch pipeline stub is installed. The current hatchery water supply configuration is insufficient to meet the needs of the hatchery program.

Lake Sonoma (on Dry Creek) and Lake Mendocino (on the East Fork of the Russian River) are operated for flood control, water supply, and hydroelectric generation (Figure 5-1). Water imported from the Eel River via the PVP and flow from the East Fork Russian River upstream of Lake Mendocino are stored in Lake Mendocino and released from CVD. Lake Sonoma stores water from the upper portion of Dry Creek during the wet season (November through April) and releases this water during the dry season (June through October).

The timing and magnitude of flow releases from these dams are determined by the USACE when the dams are being operated principally for flood control, and by SCWA when the dams are being operated principally for water supply. They are operated in accordance with criteria established by the SWRCB Decision 1610 (D1610)(SWRCB 1986), which established minimum instream flow requirements for Dry Creek and the Russian River under normal, dry, and critical water supply conditions.

Under D1610, minimum flows in both the upper and lower Russian River vary depending upon water supply condition. Water supply condition is determined based on the cumulative inflow to Lake Pillsbury on the first of each month between January and June and is represented as critically dry, dry, or normal. The water supply condition can vary from month to month until June 1 when it becomes stable until the following January. Within the normal year minimum flow criteria for Lake Mendocino releases, there is a separate schedule referred to as the "dry spring" criteria that is dependent upon the total combined storage in Lake Mendocino and Lake Pillsbury on May 31 of each year. These criteria allow successive reductions in minimum flows for the mainstem Russian River when the combined storage falls below 90 percent and 80 percent of the capacities of Lake Pillsbury and Lake Mendocino, respectively. This provision reflects the importance of the storage space in Lake Pillsbury and the storage space within the flood pool of Lake Mendocino in sustaining the flows in the Russian River system, and the fact that this storage space cannot be fully utilized in dry spring conditions. In about 11 percent of years, "dry spring" water supply conditions prevail from June through December. Dry spring conditions do not apply to the January through May period.

The Russian River from Healdsburg to its mouth at Jenner operates in much the same manner as the Russian River above Healdsburg. Lake Sonoma, like Lake Mendocino, has distinct water supply and flood control pools. However, no encroachment is permitted into the flood pool of Lake Sonoma for water supply purposes.

The general operating rule for Lake Sonoma water supply releases is to discharge water needed to satisfy demands (mostly SCWA's) between Dry Creek and the Hacienda gage, and meet the minimum flow at Hacienda. Under current demands, during normal summer conditions, water supply releases from Lake Sonoma are typically controlled by the required minimum flows in Dry Creek and the Russian River.

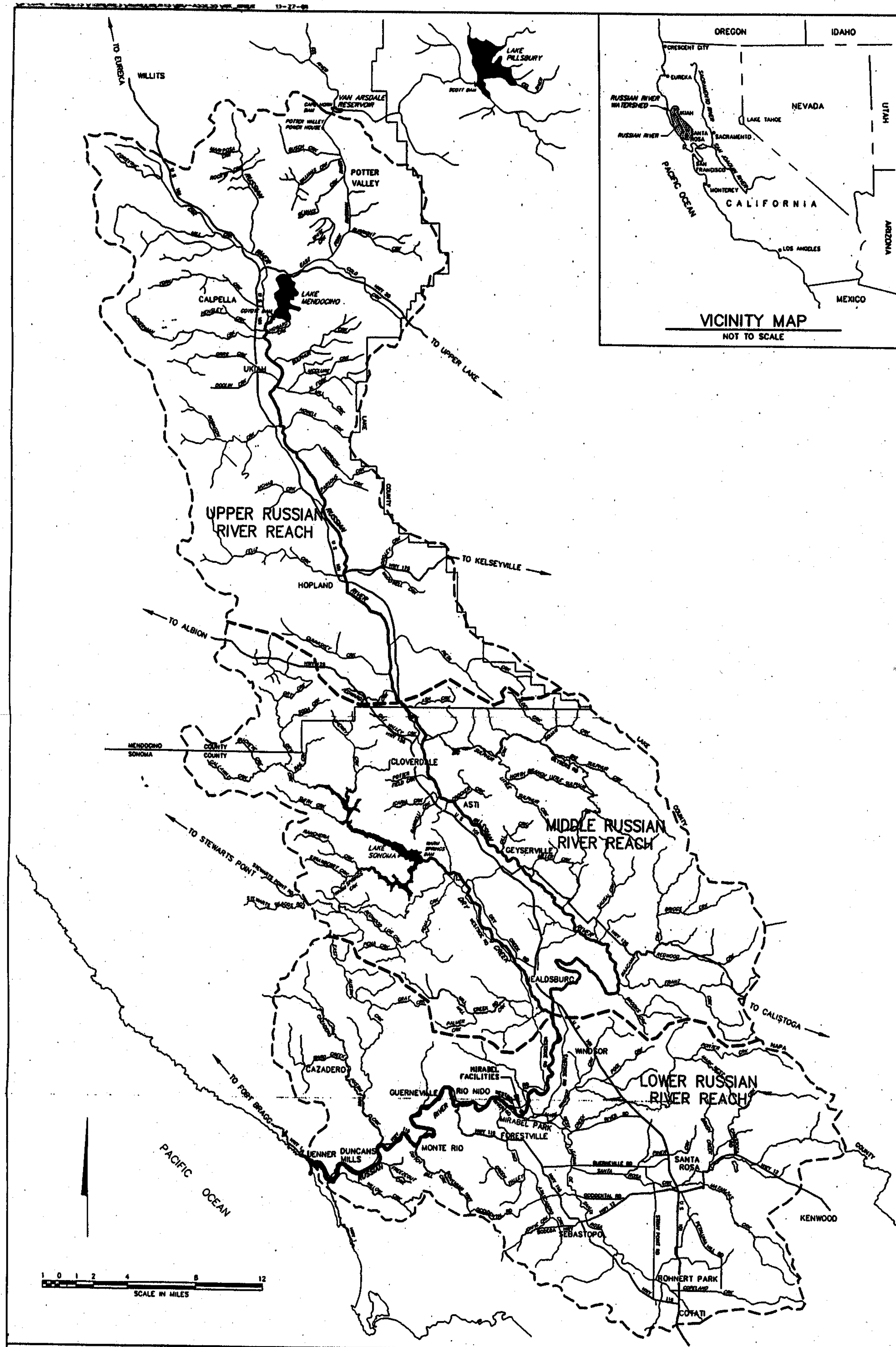

Figure 5-1

MAP OF THE RUSSIAN RIVER WATERSHED AND LOCATION OF REACH BOUNDARIES

Based on this period of record, Russian River and Dry Creek streamflows were evaluated using a flow simulation model based on a hydrologic record from 1910 to 1998. The vast majority of months (70 to nearly 90 percent) are classified as having normal water supply conditions, while between 9 and 13 percent are classified as dry, and 1.5 to 6 percent as critical (ENTRIX 2002). Seven years had one or more months with critical water supply conditions. In four of these years, conditions improved to normal, and in two other years, conditions improved to dry. Only 1977 had critical water supply conditions for the entire year.

Interim Report 3 addressed the suitability of flow related habitat for protected coho salmon, steelhead, and Chinook salmon, and their designated critical habitat in the Russian River and Dry Creek under current project operations at CVD and WSD. That report provided an assessment of the suitability of habitat under current operations for these species based on existing flow regimes and associated water temperatures and DO concentrations.

Based on the analyses presented in *Interim Report 3* the following issues were identified.

Issue FRH-1 – Velocities in Dry Creek are of limited suitability for salmonid rearing.

Issue FRH-2 – Temperatures in the lower reaches of Dry Creek during the late summer may be too high relative to salmonid rearing requirements.

Issue FRH-3 – Velocities in the upper mainstem of the Russian River are of limited suitability for salmonid rearing.

Issue FHR-4 – Current Estuary management results in early fall breaching that allows adult salmonids access to the river when flows and temperature may be unsuitable.

Issue FHR-5 – Estuary management is dependent on flows in the Russian River. Opportunities to potentially improve rearing habitat in the Estuary are available under alternative flow management actions.

5.1 ACTION 22. IMPLEMENT THE NATURAL FLOW PROPOSAL.

The objective of the Natural Flow Proposal (NFP) is to mimic as closely as possible the flow regime that would be present in the mainstem Russian River under unregulated conditions, while meeting the requirements of senior water rights in the Russian River.

5.1.1 ACTION

Flow regulation in the mainstem Russian River and Dry Creek would be modified to conform to flows specified in the NFP (Beach 1999). Releases from CVD and WSD would approximate unimpaired flow conditions in the Russian River at Healdsburg (U.S. Geological Survey [USGS] gage number 11464000) and at Hacienda Bridge (USGS gage number 11467000) during the low-flow period. Flows downstream of CVD would include releases to meet senior water rights in the Russian River. Approximately 31,000 af in Lake Mendocino are associated with these senior rights. To provide storage for water supply, release from project reservoirs would be limited by a maximum flow rate above which no additional releases would be required (Table 5-1). Releases would be made from CVD to provide the maximum required flow on a year round basis. During the high flow period of the year, flow in the Russian River would exceed the maximum flow levels as runoff from storms finds its way into the stream. The maximum flow rates only apply to releases from storage. For example, the maximum required flow rate at Healdsburg in December is 150 cfs (Table 5-1). If the natural flow in the Russian River is 100 cfs, then an additional 50 cfs would be released from storage to meet the criterion. However, if the natural flow is 500 cfs, no releases would be required from the water supply pool. Historically, the flow at Healdsburg in December are 600 to 700 cfs.

Table 5-1 Flow Criteria for Maximum Releases from Storage under Various Water Year Conditions[1]

	Guerneville			Healdsburg		
Month	Normal	Dry	Critical	Normal	Dry	Critical
Oct	125	125	125	150	150	150
Nov - Dec	125	125	125	150	150	150
Jan – Mar	125	125	35	150	150	150
Apr	150	150	35	185	185	25
May	150	150	35	185	185	25
Jun - Sep	125	125	35	150	150	25

[1] If the unimpaired flow is greater than the tabulated value, no additional releases from storage would be made.

Water supply releases would continue to be made from Lake Sonoma, and diversions at the Wohler/Mirabel facilities would continue according to current practices. Fifty percent exceedance flows in Dry Creek remain unchanged from current operations. Summer flows vary between 25 and 100 cfs under current demand, and between 100 and 190 cfs under 2020 demand, depending on water supply conditions. Minimum flows in Dry Creek would be set as shown in Table 5-2.

Table 5-2 Minimum Required Flows in Dry Creek under Various Water Year Conditions

	Dry Creek Minimum		
Month	Normal	Dry	Critical
October	80	25	25
Nov – Dec	105	75	75
Jan – Mar	75	75	75
Apr	75	25	25
May	80	25	25
Jun – Sep	80	25	25

The NFP is based upon the use of regression analysis to relate multi-day running average flows in selected tributaries to unimpaired flows in the mainstem Russian River at discrete locations. Daily unimpaired flows for these locations would be estimated from real-time tributary flow data, resulting in operations that would calculate releases on a daily basis.

5.1.2 Effects on Protected Species

The effects of the NFP on protected species may be classified relative to hydrology, rearing habitat, and fish passage. Each of these effects is discussed below.

Hydrology

The Russian River System Model (RRSM) was used to predict flows in the Russian River and Dry Creek under the conditions specified in the NFP for both 2000 and 2020 water supply demands. Monthly median flows (50 percent exceedance flows) were derived from the model output for three water supply conditions and two estimates of demand (Table 5-3 and Table 5-4). Flows at two stations in the Russian River, and at one station on Dry Creek are presented as hydrographs in Figures 5-2 through 5-7.

Currently, flows in the Russian River and Dry Creek are managed in accordance with operational criteria established in 1986 by D1610. With implementation of the NFP, flow and water temperature regimes would change in all reaches. Flows during winter months would be similar to existing conditions, as releases from the dams would be controlled by flood control operations and natural runoff would make up most of the river flow. As compared to existing conditions, the following would be expected to occur during the months of June through September (approximately), under both the year 2000 and year 2020 demand scenarios:

- In the mainstem Russian River between the East Fork Russian River and the mouth of Dry Creek, summer flows would decrease in magnitude, becoming much lower during dry and normal water supply conditions, and become substantially more variable. These characteristics appear under both demand scenarios.
- In the mainstem between Dry Creek and Mirabel/Wohler, summer flows would generally be lower under both demand scenarios under normal water supply conditions and virtually the same in dry and critical water supply conditions.
- Between Mirabel/Wohler and the Estuary, flows would decrease slightly under both demand scenarios.
- In Dry Creek, flows would increase in magnitude under the 2020 demand scenario.

Table 5-3 Fifty Percent Exceedances (cfs) for 2000 Water Supply Conditions (page 1 of 2)

Station	Water Supply Condition	Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Russian River near Ukiah	Critical	D1610	53	60	177	64	75	96	97	149	163	157	80	78
		NFP	45	152	177	109	103	98	102	164	173	158	70	68
	Dry	D1610	102	95	97	91	470	164	195	156	188	194	123	118
		NFP	52	119	152	188	518	183	195	214	188	164	75	71
	Normal	D1610	173	166	298	603	756	305	516	261	247	279	242	184
		NFP	282	137	365	615	758	306	516	246	185	160	100	67
Russian River near Hopland	Critical	D1610	45	104	386	111	129	186	70	102	111	104	55	53
		NFP	39	197	386	160	150	187	83	116	115	111	46	42
	Dry	D1610	95	97	161	168	606	350	233	151	147	145	101	97
		NFP	45	123	207	282	678	344	270	217	144	119	52	47
	Normal	D1610	168	168	375	841	1082	607	670	302	224	236	212	168
		NFP	309	147	453	852	1099	609	674	288	165	120	65	48
Russian River near Cloverdale	Critical	D1610	43	160	616	168	183	272	77	102	107	93	50	47
		NFP	37	239	656	214	198	279	83	117	105	99	41	37
	Dry	D1610	94	102	237	251	791	548	324	179	144	137	96	93
		NFP	44	136	266	417	858	545	339	240	153	111	49	42
	Normal	D1610	168	178	471	1119	1435	866	850	362	235	231	209	168
		NFP	325	178	551	1143	1452	871	853	361	173	113	60	45
Russian River near Healdsburg	Critical	D1610	39	297	1193	281	259	435	88	89	48	40	38	37
		NFP	32	388	1193	471	392	435	89	104	56	40	28	28
	Dry	D1610	93	123	341	453	1266	931	434	195	106	92	88	88
		NFP	45	175	343	564	1414	956	468	280	121	63	43	38
	Normal	D1610	170	207	656	1814	2479	1536	1282	525	240	206	200	166
		NFP	238	244	778	1896	2469	1540	1281	525	185	81	52	43
Russian River below Dry Creek	Critical	D1610	128	406	1481	422	361	560	123	129	138	157	135	130
		NFP	112	488	1497	586	480	560	127	136	125	132	112	105
	Dry	D1610	177	205	425	582	1463	1194	516	228	179	197	182	176
		NFP	125	253	433	694	1662	1190	535	315	187	156	124	112
	Normal	D1610	249	316	846	2207	3202	2069	1543	630	314	287	282	246
		NFP	323	363	943	2300	3183	2084	1542	630	272	174	138	127
Russian River at Hacienda Bridge	Critical	D1610	46	512	1974	406	365	667	93	51	44	45	43	44
		NFP	26	577	1974	529	458	667	98	63	36	20	20	18
	Dry	D1610	96	140	392	624	1916	1546	601	236	96	96	93	94
		NFP	41	218	445	803	2048	1542	615	327	117	53	38	32
	Normal	D1610	172	268	916	2666	4017	2710	1906	742	279	196	196	172
		NFP	221	393	1037	2745	3988	2720	1901	743	238	84	53	51

Table 5-3 Fifty Percent Exceedances (cfs) for 2000 Water Supply Conditions (page 2 of 2)

Station	Water Supply Condition	Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Dry Creek below Warm Springs Dam	Critical	D1610	88	76	76	76	76	76	26	28	101	136	110	99
		NFP	79	76	76	76	76	76	26	26	89	115	94	82
	Dry	D1610	80	76	76	76	76	76	26	26	81	122	99	93
		NFP	76	76	76	76	76	76	26	26	75	115	91	80
	Normal	D1610	81	106	106	76	281	253	133	81	95	103	94	86
		NFP	81	106	106	76	280	259	135	81	95	104	94	86
Dry Creek near mouth	Critical	D1610	88	111	231	115	103	126	57	28	84	113	98	93
		NFP	78	113	231	115	103	126	49	28	68	92	82	76
	Dry	D1610	81	77	107	130	195	201	60	43	64	102	91	88
		NFP	73	79	110	130	195	199	62	45	59	95	82	74
	Normal	D1610	81	112	155	274	599	438	234	102	85	85	84	82
		NFP	81	112	156	274	600	449	236	103	86	89	84	82

Table 5-4 Fifty Percent Exceedances (cfs) for the 2020 Water Supply Conditions (page 1 of 2)

Station	Water Supply Condition	Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Russian River near Ukiah	Critical	D1610	55	59	177	72	79	96	111	179	192	174	72	58
		NFP	50	152	177	83	91	98	126	193	203	183	82	78
	Dry	D1610	107	96	114	116	437	165	191	175	217	219	133	127
		NFP	54	60	152	188	520	181	219	233	216	187	87	79
	Normal	D1610	176	166	223	574	749	305	511	271	259	293	253	190
		NFP	87	125	364	614	751	304	515	255	196	177	107	74
Russian River near Hopland	Critical	D1610	47	104	386	104	126	184	86	117	124	109	51	44
		NFP	44	197	386	124	139	185	99	130	126	120	53	47
	Dry	D1610	98	103	119	167	569	352	219	162	158	154	107	102
		NFP	47	73	197	298	679	343	272	218	155	125	59	52
	Normal	D1610	170	172	344	801	1061	606	670	298	227	242	217	172
		NFP	83	134	446	860	1075	606	673	283	165	127	68	52
Russian River near Cloverdale	Critical	D1610	44	160	615	169	182	270	81	115	112	95	47	41
		NFP	41	239	655	172	193	271	97	129	113	105	47	41
	Dry	D1610	97	111	139	251	720	550	305	182	151	143	101	97
		NFP	45	84	227	396	862	542	340	251	159	115	54	46
	Normal	D1610	170	184	435	1073	1426	862	843	356	238	235	213	171
		NFP	85	166	550	1140	1445	859	849	354	175	119	62	49
Russian River near Healdsburg	Critical	D1610	37	287	1169	252	221	388	72	95	49	39	35	35
		NFP	33	381	1169	377	277	406	85	108	60	41	28	29
	Dry	D1610	91	107	193	414	1159	911	412	194	111	93	89	88
		NFP	40	87	301	522	1366	925	449	286	124	65	44	38
	Normal	D1610	168	191	603	1704	2395	1507	1257	510	243	206	200	165
		NFP	75	216	755	1826	2430	1503	1260	508	184	81	51	42
Russian River below Dry Creek	Critical	D1610	158	401	1457	364	336	525	145	141	175	206	222	211
		NFP	177	481	1473	518	373	531	161	177	196	215	209	198
	Dry	D1610	233	205	298	542	1366	1140	478	246	245	278	277	268
		NFP	185	190	403	668	1567	1130	507	321	248	236	221	203
	Normal	D1610	279	300	756	2034	3062	1993	1510	616	316	316	316	302
		NFP	217	337	920	2172	3039	1981	1514	615	284	253	228	209
Russian River at Hacienda Bridge	Critical	D1610	43	459	1927	360	319	561	55	49	46	47	44	47
		NFP	28	512	1927	472	344	613	62	52	38	23	22	22
	Dry	D1610	95	108	326	575	1802	1494	532	195	96	99	96	97
		NFP	40	88	403	747	1967	1489	555	281	102	55	39	36
	Normal	D1610	140	210	820	2547	3867	2637	1820	670	203	141	136	135
		NFP	73	299	989	2596	3865	2613	1832	669	167	81	47	44

Table 5-4 Fifty Percent Exceedances (cfs) for the 2020 Water Supply Conditions (page 2 of 2)

Station	Water Supply Condition	Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Dry Creek below Warm Springs Dam	Critical	D1610	127	76	76	76	76	76	34	51	146	201	197	187
		NFP	143	76	76	76	76	76	26	55	160	194	191	171
	Dry	D1610	137	76	76	76	76	76	26	26	148	202	197	185
		NFP	141	76	76	76	76	76	26	26	143	193	188	169
	Normal	D1610	108	106	106	76	179	206	123	81	96	123	125	136
		NFP	108	106	106	76	124	186	104	81	102	186	186	167
Dry Creek near mouth	Critical	D1610	135	113	231	115	103	126	80	54	127	179	186	181
		NFP	144	113	231	115	106	126	79	58	137	171	180	166
	Dry	D1610	138	95	109	130	187	186	63	52	129	181	187	178
		NFP	140	102	113	130	185	182	69	49	124	174	178	164
	Normal	D1610	110	114	157	273	500	402	229	102	91	107	116	132
		NFP	124	115	158	269	471	388	224	106	111	168	176	163

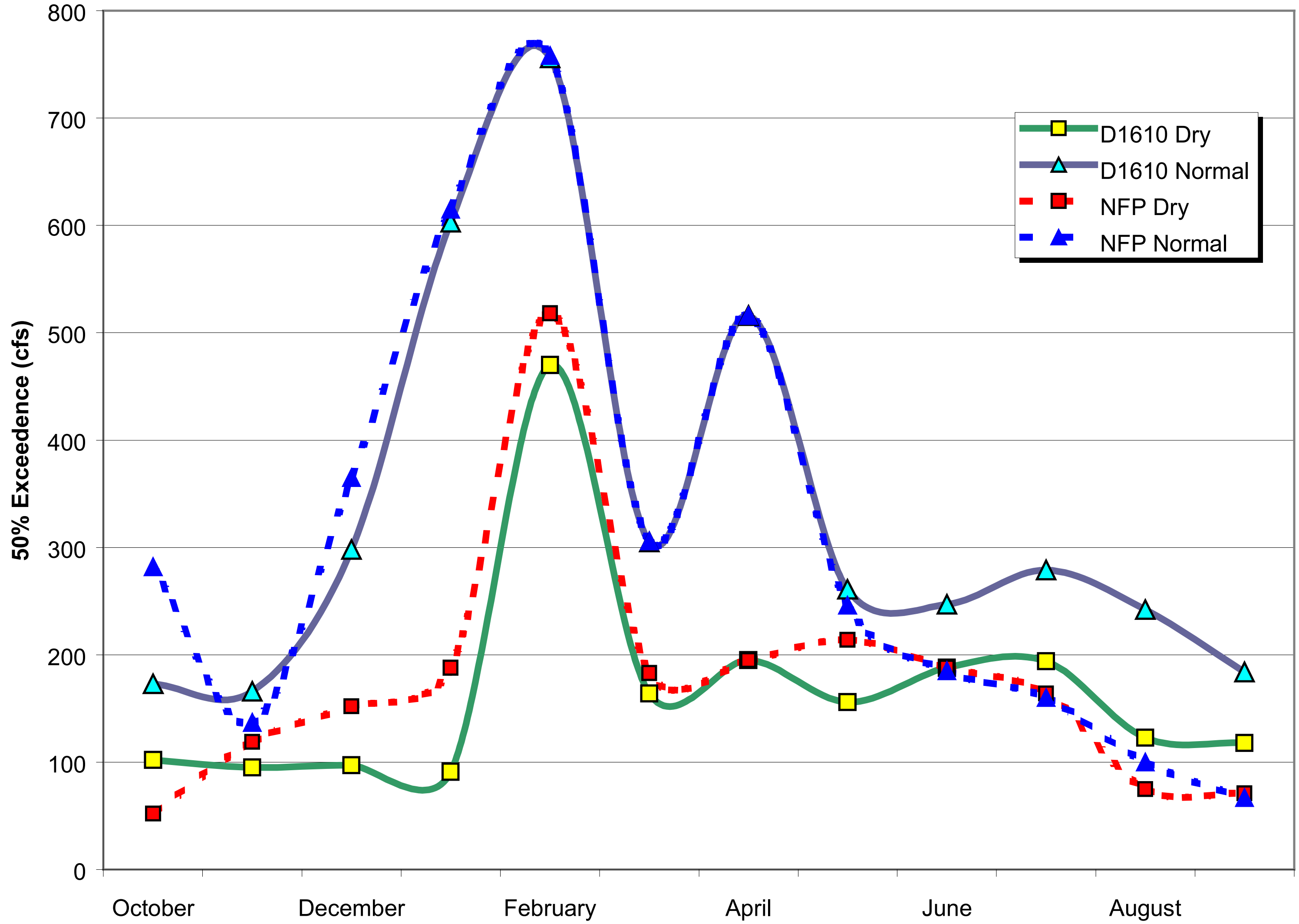

Figure 5-2 Russian River near Ukiah Monthly Average Flows Year 2000 Water Demand

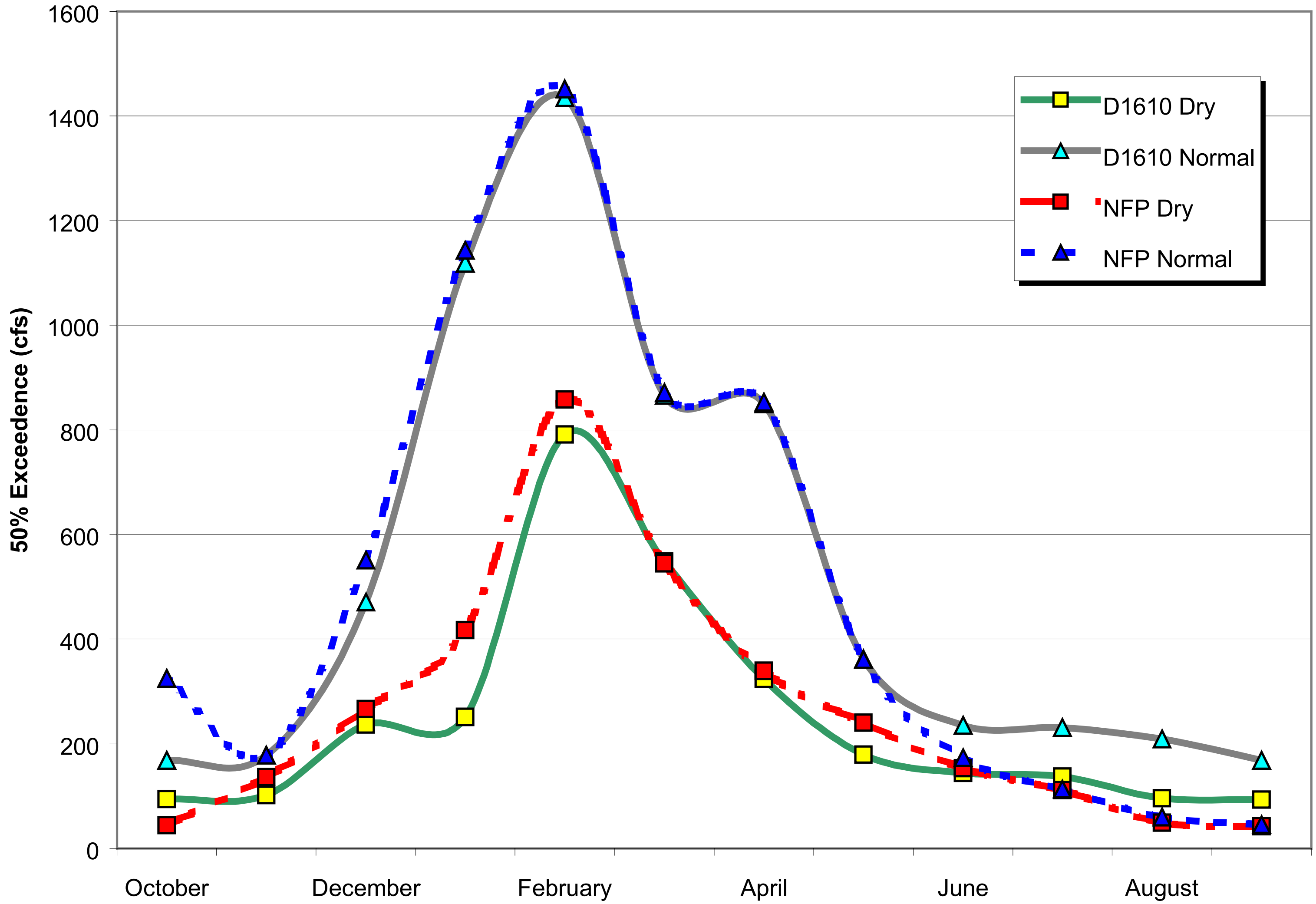

Figure 5-3 Russian River near Cloverdale Monthly Average Flows Year 2000 Water Demand

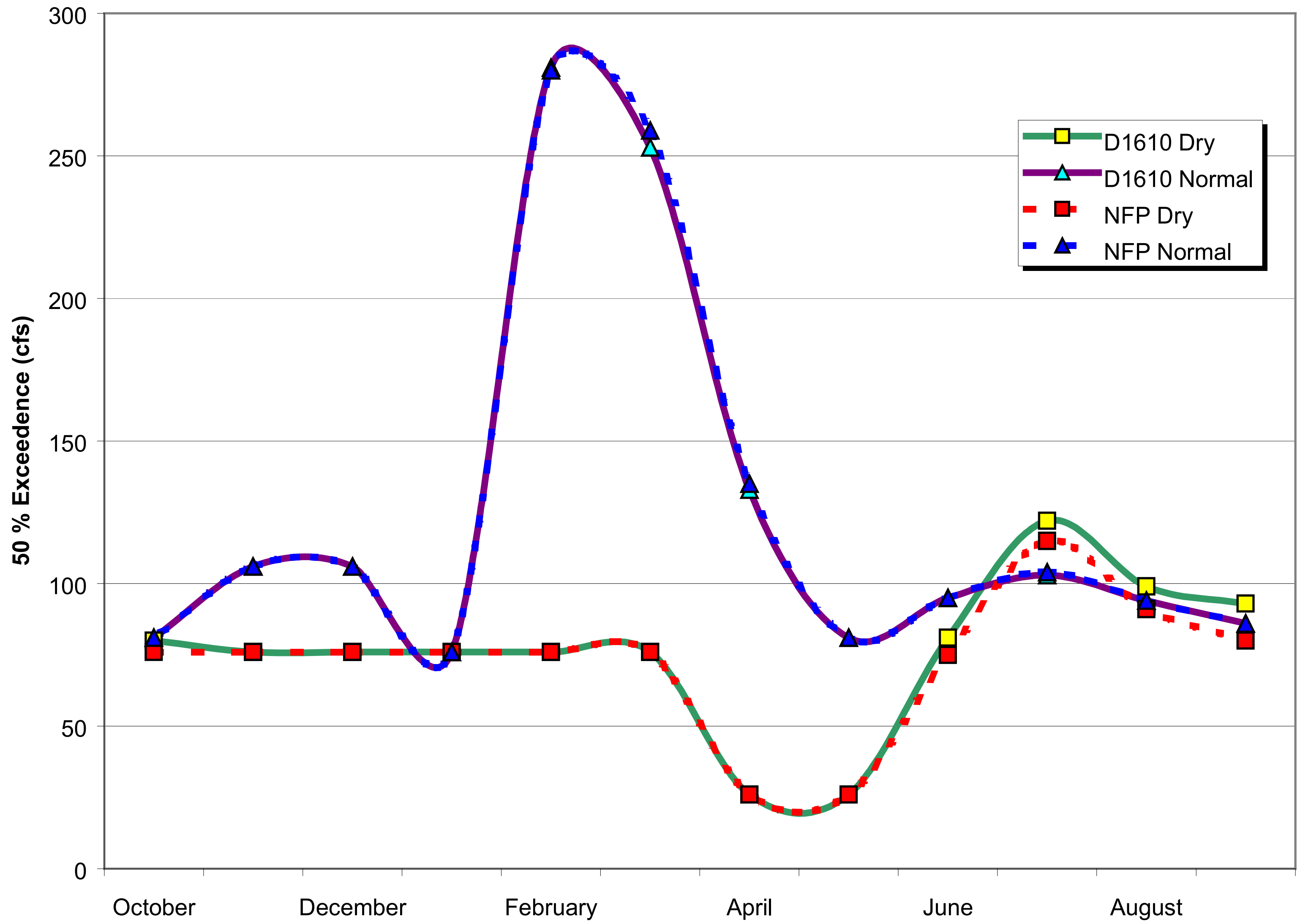

Figure 5-4 Dry Creek below Warm Springs Dam Monthly Average Flows Year 2000 Water Demand

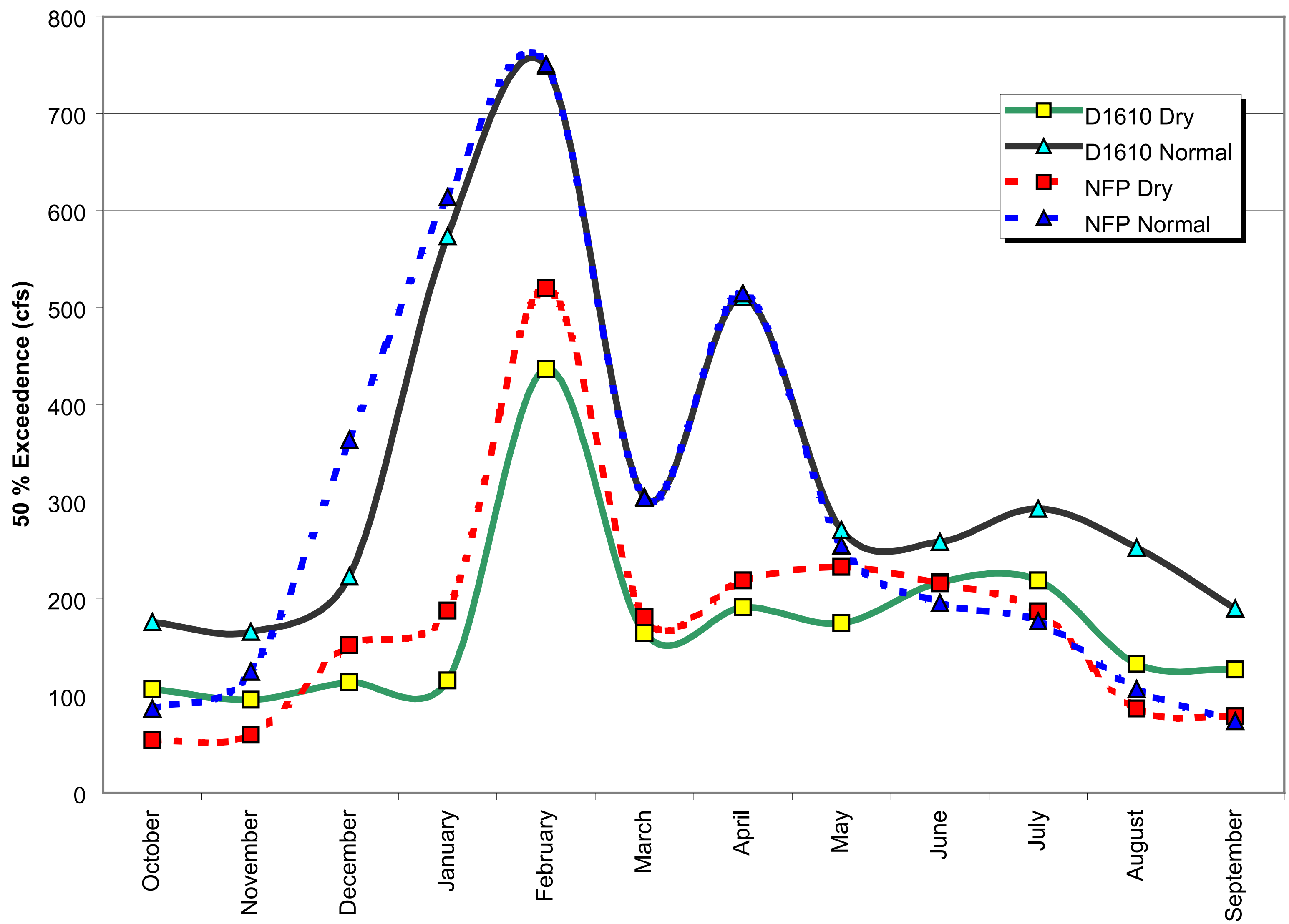

Figure 5-5 Russian River near Ukiah Monthly Average Flows Year 2020 Water Demand

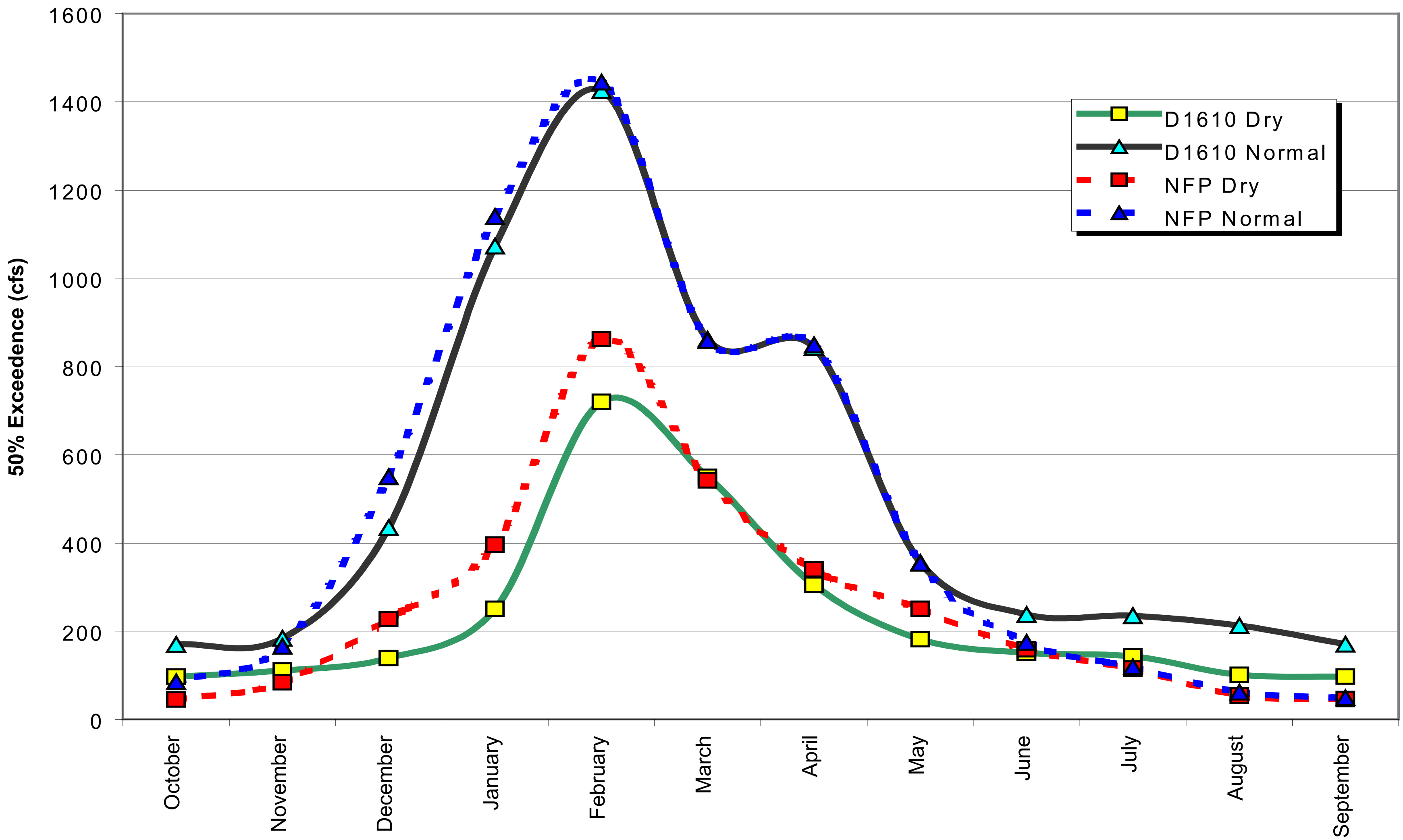

Figure 5-6 Russian River near Cloverdale Monthly Average Flows Year 2020 Water Demand

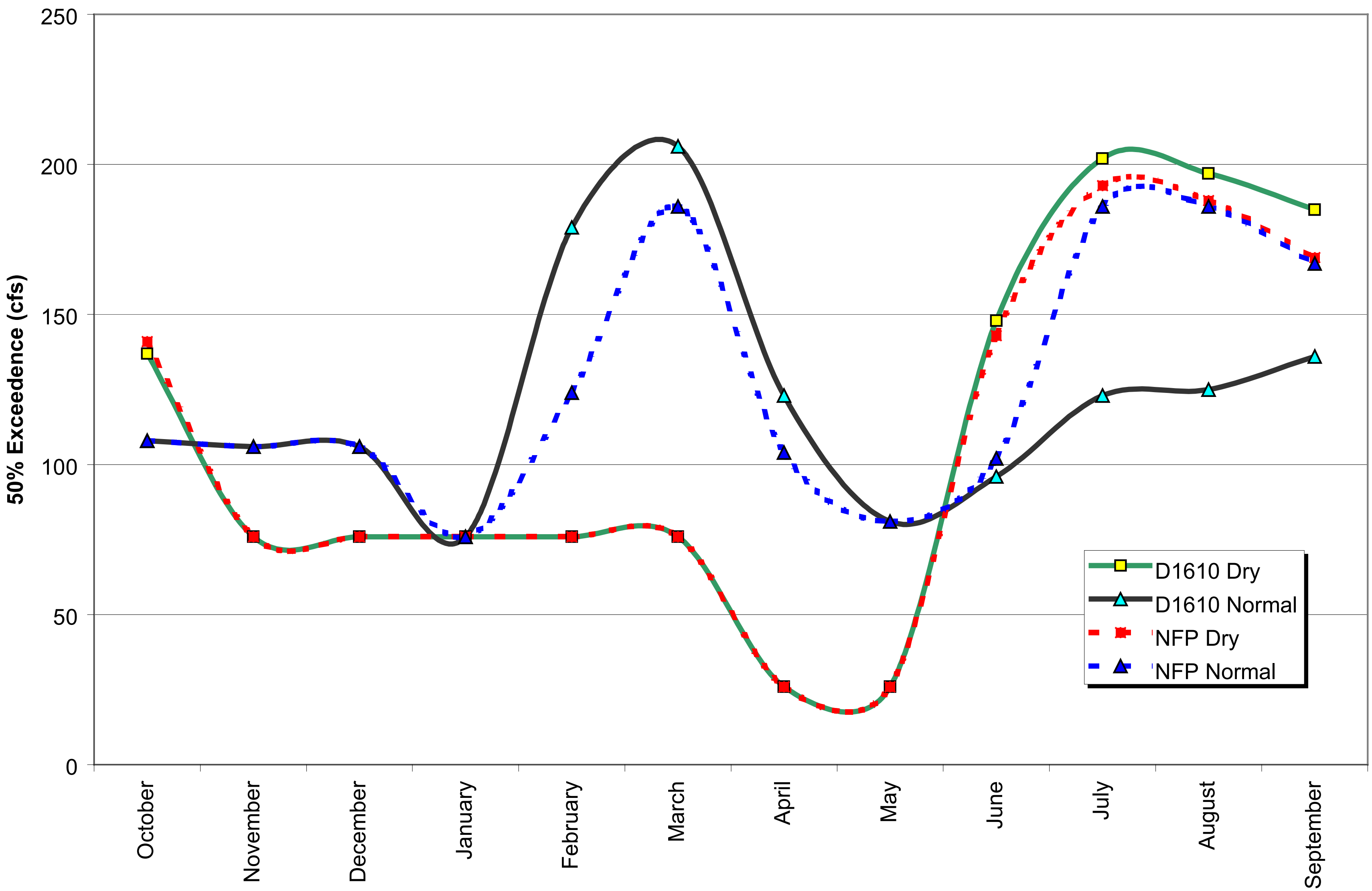

Figure 5-7 Dry Creek below Warm Springs Dam Monthly Average Flows Year 2020 Water Demand

Rearing Habitat

Mainstem habitats are used by adult, egg, fry, and juvenile lifestages of Chinook salmon and steelhead. Chinook are present only during a portion of the year, entering as adults in the fall and exiting as smolts in the spring. Therefore, flow changes proposed in this action would likely have little effect on Chinook salmon. Steelhead lifestages are present throughout the year. During the month of July, habitat conditions between the base of CVD and Cloverdale may significantly improve over existing conditions, if water temperatures remain within acceptable limits. In August and September, habitat conditions are improved over current levels, but water temperature problems may occur. Under D1610, summer water temperatures exceed suitable temperatures for salmon and steelhead somewhere between Cominsky Station and Cloverdale.

Under the NFP, increased water temperatures may diminish the amount of, and impair the quality of salmonid habitat below CVD. Habitat near Cominsky Station, which is of uniformly high quality, may become less suitable due to increased water temperatures. Reduction in habitat value due to increased water temperatures may offset gains due to more favorable velocities.

Flow reductions would result in less dilution of runoff or seepage from agricultural or residential properties along the river. Runoff may provide a source of nutrients or pesticides to the river. These may alter the productivity of the salmonid foodbase, or exhibit toxicity to plants, invertebrates, or fish. However, during the summer low-flow season, the amount of agricultural runoff would be small due to efficient irrigation practices.

Dry Creek provides habitat for coho salmon, Chinook salmon, and steelhead. Under the NFP, summer flows in Dry Creek change little under the year 2000 demand scenario, but increase substantially under year 2020 demand. While moderate habitat is provided for some months under year 2000 demand, flow related habitat degrades substantially under the year 2020 demand scenario due to the increased flow and associated high velocities. Due to the influence of increased flow on water temperatures, downstream areas that are now too warm would become more suitable as temperatures become favorable but may be unsuitable due to high velocities. Habitat availability would decline overall in Dry Creek as operations accommodate year 2020 demands.

Because Chinook salmon enter Dry Creek in late summer or early fall, and then exit in spring, they are least likely to be adversely affected by changes in summer flow and temperature regimes. Coho, on the other hand, are present year round, though in very low abundance. Coho habitat is substantially limited by poor channel structure in Dry Creek; changes in flow and temperature would have no direct effect on channel structure, but increased flows under the year 2020 demand scenario would intensify existing problems. Coho production in Dry Creek would likely remain low under the NFP. Steelhead are relatively abundant in Dry Creek, and are present year round. Potential habitat gains due to more favorable water temperatures resulting from higher releases from WSD would be negated by habitat losses associated with high water velocities.

Changes in water temperature may alter the balance between salmonids and the warmwater fish community. Water temperature is of particular concern if the summer flow regime creates more habitat for a warmwater fish community that includes predators such as Sacramento pikeminnow or various non-native bass species (*e.g.* smallmouth bass, striped bass) while creating stressful conditions for salmonids. However, reduced flows in the mainstem may reduce the amount of habitat available to predatory species, and could result in a decline in the population size of predatory fish. Predator habitat criteria are based on water temperatures favorable to warmwater predators, especially centrarchids and Sacramento pikeminnow. The optimum temperature for Sacramento pikeminnow is 26.3°C (Knight 1985). Warm water temperatures favor these predators at the same time that they negatively affect protected salmonids and their ability to avoid predation. Since adult salmonids are generally not preyed on by species found in the Russian River, fry and juvenile salmonids are the life history stage of concern.

Fish Passage

Criteria for fish passage were developed for use in the Russian River and Dry Creek (Table 5-5). Flows under the NFP appear adequate for adult migration, with the exception of dry year conditions from August through October. This was the case for D1610 flows as well. Because upstream migrations of Chinook salmon, Coho salmon, and steelhead do not peak until after this period, flow conditions under the NFP appear to provide suitable passage for returning adults, for both the year 2000 and year 2020 demand scenarios.

Table 5-5 Fish Passage Criteria for Russian River and Dry Creek

	Rating	Streamflow
Dry Creek	Good	>50 cfs
	Marginal	15 cfs -50 cfs
	Infeasible	<15 cfs
Russian River	Good	>125 cfs
	Marginal	125 cfs - 80 cfs
	Infeasible	<80 cfs

Source: W. Cox, CDFG Pers. Comm. 2001; S. White, SCWA Pers. Comm. 2001

5.1.3 Other Considerations

The recreational canoeing industry and other recreational users, which rely on elevated flows in the river, would be affected by this action. Implementation of the NFP would result in a reduction in mid-summer flows of approximately 35 to 50 percent during dry years and 60 to 70 percent during normal years at Ukiah and Cloverdale as compared to the flows under D1610 (Tables 5-3 and 5-4). Flow reductions at Hacienda under the NFP would be approximately 60 to 70 percent under both normal and dry years.

Altered flows may potentially affect juvenile salmonid rearing if habitat is altered to favor the warmwater fish community. If summer rearing habitat is warmer, competition for habitat and food could affect the availability of rearing habitat for salmonids.

Reduced dilution of nutrients, pesticides, or coliform bacteria could result in water quality impacts, which may impair beneficial uses of the river. Inputs of nutrients and pesticides are likely to be small during the summer months. Residential septic tanks and domestic animals may provide a source of coliform bacteria or nutrients.

In addition, SWRCB approval would be required to adopt any change to the flows mandated in SWRCB D1610.

5.2 ACTION 23. DIVERT A PORTION OF THE WATER FROM LAKE SONOMA VIA A NEW 72-INCH PIPELINE WITH AN OUTLET TO THE MAINSTEM RUSSIAN RIVER, BYPASSING DRY CREEK.

The objective of this action is to provide a mechanism whereby flows in Dry Creek can be reduced to maximize salmonid rearing habitat, while continuing to meet water supply obligations of SCWA.

5.2.1 ACTION

A new 72-inch pipeline would be installed in the wet well or outlet structure of WSD. The 72-inch pipeline would have a flow capacity of up to 350 cfs, and would discharge to the mainstem of the Russian River immediately below its confluence with Dry Creek. Flows in Dry Creek below WSD would be reduced to 50 to 80 cfs.

This action would require purchase of a right-of-way for the pipeline from WSD to the Russian River. The likely route would be along Dry Creek Road. This action would maintain flows in the mainstem Russian River below Dry Creek, ensuring that sufficient flows reach the Mirabel and Wohler diversion facilities to meet current and future water supply needs. The inflatable dam at Mirabel would continued to be operated for recharge and to fill the pond at Wohler and Mirabel. The aquifer would be recharged and water would continue to be extracted by the Ranney collectors at Wohler and Mirabel.

5.2.2 EFFECTS ON PROTECTED SPECIES

The flow habitat study conducted in fall 2001 indicated that the best potential habitat for salmonid rearing was present in Dry Creek when flows were approximately 50 to 90 cfs. This action would implement those flow levels and increase availability of the best potential habitat. The flow-habitat study (ENTRIX 2000b) found that steelhead habitat in Dry Creek was generally more abundant at flows of 47 cfs that at 130 cfs. Habitat availability at flows of 90 cfs was close to that at 47 cfs. The data also indicated that habitat availability for Chinook salmon fry and juveniles was similar at 47 and 90 cfs. There was little available habitat for coho salmon.

Under the lowest flow conditions, temperature effects may limit the amount of habitat than could be occupied by juvenile salmonids. The intermediate flow (90 cfs) would provide a greater amount of habitat with suitable temperatures than the lowest flow. The intermediate flow would also allow for releases from the DCFH.

Flows in Dry Creek would be a mixture of direct releases from the dam, and hatchery discharges. The fish hatchery currently requires flows of approximately 35 to 50 cfs. The hatchery discharges its wastewater, after passing it through settling ponds, to Dry Creek a short distance below the dam. To provide flows of 80 cfs in Dry Creek, between 30 and 45 cfs could be released directly from the WSD, and the remaining water would be cycled through the hatchery and then released to Dry Creek.

By reducing the total flow in Dry Creek, the relative contribution of return water from the hatchery would increase. Discharge standards for the hatchery were established by the RWQCB based on designated beneficial uses for the subject waters. Monitoring of the hatchery discharge is conducted twice a month, with the results submitted in a monthly report to the RWQCB. The hatchery has been in continuous compliance with its NPDES permit requirements. During times of high turbidity in the influent water, the hatchery may actually discharge water less turbid than that received, thereby benefiting the receiving waters. The DO level in the receiving waters during times of low flows may drop below the 7 mg/L limit and therefore may benefit from the hatchery maintaining an effluent limit that is greater than 7 mg/L. Effluent from the hatchery will contribute to the total load of solids in the receiving waters. The settleable and suspended solid level discharged are slightly higher that incoming water, but are within the limits of the NPDES permits.

All water would be discharged from the pipeline near the mouth of Dry Creek. Flows in the Russian River below Dry Creek would be increased by the pipeline flow (up to 350 cfs) within a short distance as a result of the discharge. This could result in scour of the river bed in this area and increased short term turbidity. Water temperatures at the point of discharge would decline, resulting in a localized cold water pool. However, the water temperatures would increase as the water moved downstream.

Flows in the Russian River below Dry Creek and the pipeline discharge would not be altered from conditions under D1610 or the NFP as the pipeline would move water out of Dry Creek, but discharge it to the Russian River at the same location. Recharge of the aquifer along the Russian River would be unaffected by this action.

This action would improve rearing habitat in Dry Creek, but would not affect flow or habitat conditions in the Russian River below the confluence. Recharge to the aquifer along Dry Creek would be reduced during summer flows as compared to current conditions, or conditions under the natural flow proposal.

5.2.3 Other Considerations

The location of the tie-in of the 72-inch pipeline to the wet well or outlet structure is a key design consideration as it could affect operations of the hydroelectric facility. If the pipeline were to tie into the wet well above the hydroelectric facility, there would be insufficient flow to operate the facility as currently configured. Tying the pipeline into the outlet structure below the hydroelectric facility would ensure that sufficient flows were available to power the turbines, however backpressure from the pipeline could reduce the turbine's efficiency. Other alternate configurations for the hydroelectric facility may include reconfiguring the generator to operate at flows of 50 cfs, or installing two small generators along the 72-inch pipeline.

Implementation of this action would require redesigning and reconstructing portions of the wet well within the dam. This action could be integrated with either of the hatchery water supply actions discussed as Actions 20 or 21. Action 21 could not be implemented until the 72-inch pipeline stub was installed, whereas Action 20 could be implemented without installing the 72-inch pipeline stub.

Design of the pipeline discharge at the mouth of Dry Creek would address the potential for sediment scour and public safety.

The timeframe for developing a project description, completing the environmental compliance, acquiring right of way, and obtaining funding for this action could be as much as 10-15 years.

5.3 ACTION 24. PIPE WATER FROM LAKE SONOMA TO THE MIRABEL COLLECTION FACILITIES OR TO THE MIRABEL WATER TREATMENT PLANT VIA A NEW 72-INCH PIPELINE. INCORPORATE MULTIPLE OUTLETS TO RUSSIAN RIVER BETWEEN DRY CREEK AND THE MIRABEL DIVERSION FACILITY.

The objective of this action is to provide a mechanism whereby flows in Dry Creek can be reduced to maximize salmonid rearing habitat, while continuing to meet water supply needs of SCWA.

5.3.1 ACTION

This action would be similar to Action 23 (above), with the exception that the pipeline would not discharge directly and completely to the Russian River at the mouth of Dry Creek. Rather, the pipeline would be continued to the Mirabel infiltration ponds. Water would be released from the pipeline at multiple points along the Russian River below Dry Creek. The multiple outlets to the Russian River would provide for aquifer recharge over a larger area than a single point discharge, and would maintain flows in the river above Wohler, ensuring that sufficient flows reach the Mirabel and Wohler diversion facilities to meet water supply needs. The outlets would consist of both constant flow and variable flow outlets. The aquifer recharge would be subsequently extracted by the Ranney collectors at Wohler and Mirabel. This action would provide increased operational flexibility relative to Action 23 with respect to the location and release of water to the Russian River. Additionally, this action would allow greater flexibility in the management of the inflatable dam at Mirabel.

5.3.2 EFFECTS ON PROTECTED SPECIES

The effects of this action on flow, habitat, and temperature in Dry Creek would be the same as for Action 23.

Habitat conditions in the Russian River would be improved by this action, as compared to Action 23. The constant flow outlets located along the Russian River portion of the pipeline are anticipated to result in the development of cold water refugia for rearing salmonids. These outlets would maintain continual flow throughout the summer. The size of the refugia would be dependent on the flow from the pipeline and the flow in the Russian River. The variable flow outlets would be used to adjust that amount of flow entering the Russian River from the pipeline, and would be dependent on the water supply demand at Mirabel and Wohler.

During the summer months (July to September), 50 percent exceedance flows at Healdsburg range from 166 to 206 cfs under D1610 conditions. Flows in the pipeline would be 5 to 23 cfs under 2000 demands and 35 to 54 cfs under 2020 demand. Therefore, the pipeline discharges would create only limited refugia under D1610 conditions.

Under the NFP, 50 percent exceedance flows at Healdsburg would range from 42 to 81 cfs. Pipeline flows would range from 6 to 24 cfs under 2000 demands, and 87 to 106 cfs under 2020 demands. Under 2000 water supply demands, pipeline discharges would create small refugia. However, under 2020 demands, the size of the refugia would be substantially larger as the pipeline would carry more flow than the Russian River at Healdsburg.

As this option would deliver water directly to the Mirabel diversion facility, it could be used to supply water to the Mirabel infiltration ponds during periods when the inflatable dam is deflated. This may reduce the need to raise the dam during dry conditions in the spring (March to April). A delay in raising the dam would benefit smolts by reducing the potential delays in juvenile outmigration.

5.3.3 Other Considerations

The issues raised in the other consideration for Action 23 would apply here as well including issues associated with hatchery water supply, water quality, and hydroelectric operations and CEQA and NEPA compliance. The considerations relating to the location of the tie-in of the 72-inch pipeline to the wet well are the same as for Action 23. This action would also require that a longer right-of-way be obtained than for Action 23, as the pipeline would travel to the Mirabel ponds. However, this action would also reduce evaporative losses of water that are incurred during conveyance of water along the stream and riverbed.

Implementation of this action would require redesigning and reconstructing portions of the wet well within the dam. This action could be integrated with either of the hatchery water supply actions discussed as Actions 20 or 21. Action 21 could not be implemented until the 72-inch pipeline stub was installed, whereas Action 20 could be implemented without installing the 72-inch pipeline stub.

The timeframe for developing a project description, completing the environmental compliance, acquiring right of way, and obtaining funding for this action could be as much as 10-15 years.

5.4 Action 25. Reduce Inflows to the Estuary, Thereby Eliminating the Need to Artificially Breach the Sand Bar During Summer Months. Allow Breaching of Sand Bar at Onset of Winter High Flows.

The objective of this action is to improve potential habitat availability in the Estuary by increasing habitat stability through the elimination of artificial breaching of the sand bar during the dry season.

5.4.1 Action

A barrier beach (sandbar) typically forms across the mouth of the Russian River during the dry season, impounds water, and forms a lagoon. The sandbar opens when hydraulic conditions in the Russian River and Pacific Ocean change, or when the sandbar is artificially breached as part of the estuary management program. Current project operations affect the Estuary primarily in the low flow months when minimum instream flow requirements under D1610 result in augmented flow to the Estuary (*Interim Report 3* [ENTRIX 2001]). These augmented flows result in a need for an artificial sandbar breaching program to prevent flooding of local property.

Under this action, no artificial breaching during the low flow season would occur. Inflow to the Estuary would be managed so that a constant water surface elevation (WSE) would be maintained once the sandbar has formed across the river mouth in the dry season, and the Estuary would be managed as a closed lagoon. Flow to the lagoon would be reduced to maintain a WSE of 8.0 to 8.5 feet, as recorded on the Jenner gage. Based on an analysis of the relationship between flow at the Hacienda gage and stage change at Jenner, the flow needed to maintain a constant WSE is estimated to be approximately 35 to 45 cfs. Releases to the lower river downstream of the Mirabel diversion facilities would be adaptively managed to maintain the target WSE. This action would be implemented as part of a flow regime that is reduced from the one currently implemented under D1610.

Artificial breaching of the sandbar would occur, if needed, to prevent flooding of adjacent property prior to the first major storm or as needed during the rainy season. Breaching criteria would be developed based on the WSE in the lagoon and projected inflows. Timing of breaching actions would be scheduled relative to the tidal cycle and water level changes in the lagoon. Artificial breaching would occur when the WSE of the lagoon, as recorded at the Jenner gage, is rising at a rate that indicates it would reach the 10-foot flooding elevation within 6 hours. Repeat breaching may be necessary if inflow is insufficient to maintain an open river mouth.

5.4.2 Effects on Protected Species

When the sandbar forms, it ponds water in a lagoon. A salt-water layer is trapped on the lagoon bottom under a freshwater layer and through a natural process, warm, low DO conditions form in this saltwater layer. These conditions reduce habitat quality for salmonids. Given enough time and adequate inflow, the lagoon would convert to freshwater conditions and water quality would improve. When the sandbar is breached, the Estuary is opened to tidal mixing and suitable water quality is eventually restored.

Estuaries and coastal lagoons have been found to provide important salmonid rearing habitat in the southern portion of the Central California Coast steelhead ESU (Smith 1990) and elsewhere (Larson 1987, Anderson 1995, 1998, 1999, Reimers 1973). If the sandbar of one of these central California estuaries remains open, good water quality can be maintained with tidal mixing or high river flows. In a lagoon (sandbar-closed), good water quality develops as the system is converted to freshwater, resulting in lower water temperatures and higher bottom DO levels. Infrequent breaching of lagoons, especially during low-flow summer months, impairs water quality because a long transition period with salinity stratification results in high water temperatures and low DO levels in the bottom layers (Smith 1990).

Rapid or fluctuating changes in salinity and water can have substantial effects on the invertebrate foodbase. Smith (1990) found that when sandbar formation resulted in anoxic conditions over the majority of the substratum, amphipods were eliminated, and invertebrate populations crashed as the lagoons went through the transition to fresh water. Once these lagoons had converted to freshwater conditions, invertebrate production was sufficient to result in accelerated salmonid growth. Continuous breaching, such as occurred at San Gregorio lagoon in summer of 1986, resulted in low overall invertebrate populations as the system fluctuated between anoxic saline conditions and freshwater.

Water quality monitoring has shown that when the sandbar initially forms across the mouth of the Russian River, water quality degrades over a period of a week or two and anoxic conditions can form in bottom waters (Merritt Smith Consulting 2000). Under D1610 stream flow conditions, the sandbar is breached soon after it forms, and the intensity and duration of the poor water quality event is small. However, if reduced flows result in infrequent breaching, it may result in an overall reduction of habitat quality and invertebrate production (salmonid foodbase).

Artificial breaching is currently conducted when the WSE at the Jenner gage is at 7.5 feet. Implementation of a reduced flow alternative could make it easier for the sandbar to form across the river mouth and reduce the need to breach the sandbar as often. Therefore, there could be a longer time between artificial breaching events, resulting in a program of infrequent artificial breaching. Infrequent breaching would increase the duration of poor water quality events and result in poor rearing conditions for salmonids. However, if flow were reduced sufficiently to eliminate summer breaching, the lagoon may convert to freshwater conditions over time and summer rearing habitat could potentially be improved.

This management action would allow a freshwater dominated system to develop, stabilizing water quality during periods when the lagoon is closed, thereby improving rearing habitat conditions. Balancing rates of inflow with natural seepage through the sandbar, losses from evaporation, and tidal influences would allow water levels to be maintained below 8.0 to 8.5 feet, and allow maintenance of habitat area.

The reduced flows required to implement this action may result in higher summer temperatures in the lower mainstem. However, coastal influences in the Estuary and lower mainstem tend to reduce summer water temperatures. While water temperatures in the mainstem downstream of the Mirabel facilities may increase under a reduced flow alternative, reduced flow to the Estuary is likely to offset temperature effects in the lagoon.

Where water temperature is increased in the mainstem of the Russian River, conditions favorable to the warmwater community of fish species, which includes predators on salmonids, could be created. However, summer water temperatures in this portion of the mainstem are likely to be too high to support salmonid rearing under most flow alternatives. Therefore, there would not likely be an increase in the risk of predation on salmonids.

With artificial breaching of the sandbar, adult salmonids, particularly Chinook salmon, may be encouraged to enter the Estuary and begin their upstream migration before water temperatures and flow in the river are suitable. Analyses presented in *Interim Report 8* determined that the risk to the Chinook population under the current breaching protocols is low (ENTRIX 2000b). This management action would reduce the risk even further.

If dry season flows are reduced and the sandbar remains closed, there is a potential that water quality may be reduced if dilution of nutrients or point and nonpoint sources of pollution to the lagoon is reduced. With current flow conditions, the SWRCB has proposed two locations in the Russian River be listed on the Section 303 (d) list for pathogens: Monte Rio between Dutch Bill Creek and Fife Creek, and Healdsburg Memorial Beach. It is possible that conditions could change with a reduced flow alternative.

The biological effects of artificial breaching events during the rainy season are evaluated separately for early season breaches and late season breaches.

Early season artificial breach events occur at the onset of the rainy season. One of the critical factors in minimizing effects to salmonids in the lagoon during the fall/winter season is to implement artificial breaching as close as possible to the time when a natural breach might occur. If artificial breaching occurs during this time, it is more likely to occur at a time when smolts are naturally adapted to migrate out of the Estuary.

If WSE elevation exceeds 10 feet at the Jenner gage, flooding to local property is likely to occur. The frequency of unauthorized local "illegal" breaching is likely to increase if this were allowed to happen, and this may result in negative effects to salmonids. By generally keeping WSE at approximately 8 feet during the dry season and no higher than 10 feet during the rainy season, the probability of such breaching events can be reduced.

Late season breach events are defined as events that occur near the end or after the end of the rainy season. Because water quality conditions in the lagoon during summer appear to be an important factor for steelhead rearing in the lagoon, late season breaches are examined for possible effects on water quality. Factors that most likely influence water quality conditions during the summer include:

- The amount of summer inflow from the Russian River;
- The amount of salt water in the lagoon at the time the sandbar forms and closes the lagoon;
- The amount of salt water inflow to the lagoon after sandbar closure;
- The amount of freshwater inflow that occurs in the period immediately following the closure of the lagoon; and
- Water loss from the lagoon through sandbar leakage, evaporation, and evapotranspiration.

Late season breaches would only be conducted if runoff from a rainfall event is likely to result in WSE greater than 10 feet, to minimize the frequency of late season artificial breaching events. Freshwater summer inflow to the lagoon would be managed to maintain a WSE of approximately eight feet at the Jenner gage when the sandbar is closed. These measures are likely to minimize potential effect to summer water quality.

5.4.3 OTHER CONSIDERATIONS

Implementation of this action would require significant reductions in summer flows, which could affect the recreational canoeing industry and other recreational uses in the area downstream of the Mirabel Dam. Beach areas at Monte Rio and Jenner are likely to be unaffected by this action as it would result in stable river elevations at these locations.

5.5 ACTION 26. ELIMINATE ARTIFICIAL BREACHING OF THE ESTUARY.

The objective of this action is to allow the Estuary to be breached naturally by flows in the Russian River, thereby eliminating all effects of an artificial breaching program on salmonids.

5.5.1 ACTION

Under this action, no artificial breaching at the Estuary mouth would occur. The sandbar would be allowed to breach naturally as a result of flows in the Russian River. This action would address many of the same issues as Action 25 (above).

5.5.2 EFFECTS ON PROTECTED SPECIES

If the sandbar were to remain closed, the biological effects to salmonids would be expected to be similar to those described in Action 25, with the exception of the analyses related to early and late season breaches. This management alternative would allow a freshwater dominated system to develop, thereby stabilizing water quality during periods when the lagoon is closed, and improving rearing habitat conditions.

Uncontrolled and unauthorized breaching to prevent flooding of local property would likely occur, with negative effects on salmonids and their habitat. Artificial breaching may potentially cause juvenile salmonids to be swept out of the Estuary before they are physiologically ready to migrate to the sea, particularly if artificial breaching is conducted improperly or at a higher WSE. Adult salmonids, particularly Chinook salmon, may also be encouraged to enter the Estuary and begin their upstream migration before water temperatures and flow in the river are suitable.

5.5.3 OTHER CONSIDERATIONS

This alternative could result in increased flooding of local property should water levels in the Estuary exceed 10 feet at the Jenner gage. Under the current Estuary Management Plan, artificial breaching is conducted to prevent flooding and applies a breaching protocol designed to minimize potential effects of artificial breaching on salmonids. However, because of potential property damage, implementation of this action may result in unauthorized artificial breaching by local property owners. It may result in infrequent breaching or timing of breaching events that would increase the frequency or duration of poor water quality conditions. The resulting poor water quality conditions would likely result in an overall reduction of habitat quality and invertebrate production (salmonid foodbase) from conditions documented under the current estuary management plan. The SCWA would not be able to control effects due to unauthorized breaching.

5.6 ACTION 27. MODIFY BREACHING CRITERIA.

The objective of this action is to maximize water quality for salmonids if a dry season breaching program is necessary to prevent flooding of local property.

5.6.1 ACTION

This management action would maintain tidal flushing in the Estuary using frequent artificial breaching. Water quality would be maintained by tidal flushing.

The frequency of the existing artificial breaching program is currently tied to the water level at the Jenner gage, which has effectively resulted in sandbar closures lasting three to ten days under current flow conditions. This management action would modify the existing program slightly to ensure that sandbar closure does not last longer under current or alternative flow conditions, particularly during dry or critically dry years. Under the proposed action, breaching would be conducted so that the sandbar does not remain closed for longer than 7 to 10 days.

5.6.2 EFFECTS ON PROTECTED SPECIES

By breaching the sandbar soon after it forms, the duration of poor water quality events would be reduced. This action would tend to maintain tidal flushing within the Estuary. Effects to water quality and salmonid habitat may occur from artificial breaching events because poor water quality begins to develop very rapidly after the sandbar re-closes, particularly if flows are low. However, these effects would be minimized by keeping the duration of sandbar closed conditions short. Additionally, tidal flushing would reduce potential water quality effects due to nutrient or pollution loading that may occur during lower flows.

Adult and juvenile salmonid passage requirements are: 1) passage through the Estuary from the ocean, and 2) good water quality when a passage opportunity exists. Artificial breaching provides more passage opportunities than would naturally occur. A key consideration is whether water quality is sufficient when those additional passage opportunities are made available. Under the proposed action, increased passage opportunities may be provided for juvenile salmonids in the spring and summer. By maintaining tidal flushing this action would also provide adequate water quality during those passage opportunities.

Chinook salmon begin to appear at the river mouth in August. Artificial breaching in the fall may produce a freshet of water that attracts early adult Chinook spawners into the watershed when water quality may be poor in the lower mainstem Russian River. There is a potential for fish to be stranded or subjected to increased stress, predation, or poaching, and angling pressure. However, video monitoring at SCWA's inflatable dam at Mirabel indicate that the peak spawning runs begin in November, which is when the rains normally begin. Therefore, while some individual fish may be affected, the overall risk to the population is likely to be low.

Under very low flow conditions, for example in dry or critically dry years, the sandbar may tend to reclose very quickly after an artificial breaching event. Monitoring has shown that water quality is restored fairly quickly near the river mouth when tidal flushing is introduced, but that it may take a few days for water quality to be restored in upstream sites. Therefore, there is a potential under low flow conditions that the duration of tidal flushing would be insufficient to restore water quality at all sites. In this case, breaching may have to be more frequent or eliminated entirely as discussed in Action 25.

5.6.3 Other Considerations

Under the proposed action, the sandbar may be breached before it reaches an elevation of 3.5 to 4 feet during critically dry years, which is the elevation at which the Estuary mouth typically closes. Under low flow conditions, the sandbar would tend to close fairly quickly, and it may be difficult to keep it open.

5.7 Action 28. Install a structure to pass excess flows from the Russian River during summer months and maintain a constant water level in the lagoon. Allow artificial or natural breaching of the sand bar at onset of winter high flows.

The objective of this action is to allow the mouth of the Russian River to remain closed during the summer months by providing a physical structure by which excess water could bypass the Estuary, thereby improving salmonid habitat.

5.7.1 Action

This action would involve installation of a bypass structure that would maintain lagoon elevations below a set maximum level (*e.g.*, 8.0 to 8.5 feet), thereby preventing flooding of adjacent land and eliminating the need to artificially breach the sand bar during the summer. The structure may consist of a pipe or an artificial channel with a tide gate at the Estuary that would allow water to spill when the lagoon reaches a predetermined level. This action would maintain the lagoon as a freshwater dominated system until the winter rains start and juvenile salmonids are ready to migrate out of the estuary.

The sandbar would be breached immediately prior to the first major winter storm as discussed under Action 25. This would prevent flooding of low lying properties near the Estuary and would allow adult Chinook to enter the watershed.

5.7.2 Effects on Protected Species

This action would have several potential benefits to salmonid populations. Habitat and water quality conditions for rearing juveniles would remain consistent. Water quality in the Estuary would shift from an estuarine brackish system to a freshwater system within a short period of time after the mouth closed. This would eliminate the physiological stress to the ecosystem associated with shifting fluctuating salinities and degradation of water quality associated with summer breaching. Juveniles would be retained in the lagoon until they were physiologically ready to migrate to sea. Water elevations would remain stable, allowing juvenile salmonids access to emergent shoreline vegetation for shelter and feeding. This action would also prevent adult salmonids from entering the river and attempting to move upstream before conditions are suitable for migration.

5.7.3 Other Considerations

Placing a structure in the sand spit near the mouth of the Estuary could result in sand accumulating in front of, or within, the pipe or channel, thereby limiting its effectiveness. The pipe (or other type of structure) would function better as a seasonal structure that is placed each year at the beginning of summer. That way, it would not be susceptible to damage from winter storms.

It is not certain that a stable or permanent structure could be maintained on an dynamic beach. Remnants of a jetty built on the south side of the Estuary between 1929 and 1941 still exist along the spit that extends northward from the headland near Goat Rock. If a structure was built and it failed, artificial breaching would be needed to prevent local property damage due to flooding.

SCWA operates the diversion facilities along the Russian river in the vicinity of Wohler and Mirabel areas (Figure 6-1). The SCWA operates five Ranney collector wells adjacent to the Russian River (a sixth is under construction). These wells extract groundwater from the aquifer beneath the streambed and deliver it into the transmission system. The other facilities at Mirabel and Wohler facilitate recharging of the aquifer to provide a reliable water supply to the Ranney collector wells. SCWA operates two sets of infiltration ponds and an inflatable dam to facilitate recharge.

The Mirabel Diversion Facilities are located at approximately River Mile 24.6, roughly 0.5 miles downstream of the Wohler Road bridge crossing. The facility consists of an intake structure equipped with a fish screen, an inflatable dam and concrete foundation, a pump caisson and control structure, conveyance piping, an outlet structure, and two Denil fish ladders at opposing sides of the river. The facility was originally constructed in 1976.

SCWA operates several infiltration ponds near Mirabel (four ponds) and Wohler (two ponds) to provide the required rate of recharge to the Russian River aquifer, and allow the Ranney collectors to operate efficiently. A water-filled inflatable dam on the Russian River upstream of the Mirabel area raises the water level to increase recharge of the aquifer, and to facilitate the diversion of water into the infiltration ponds. When inflated, the dam at Mirabel impounds water for approximately 2 miles upstream creating the Wohler Pool. The increased pressure head and wetted area result in increased recharge to the underlying aquifer.

The inflatable dam submerges the intakes to three diversion pumps that transport water to the Mirabel infiltration ponds. The water is pumped through pipes into a lined ditch, which conveys the water to four infiltration ponds. The two infiltration ponds at Wohler are also filled when the dam is in operation. Canals convey water to the two independently-operated Wohler infiltration ponds located on the east side of the Russian River. Filling of the Wohler ponds is controlled by a slide gate at the terminus of each canal.

The effect of the operations and maintenance activities of the diversion facilities at Wohler and Mirabel were evaluated in *Interim Report 4*, Water Supply and Diversion Facilities (ENTRIX 2001). The report evaluated the effects of raising and lowering the dam, the effectiveness of the fish ladders at the inflatable dam, performance of the fish screens at the Mirabel and Wohler Diversions, and the potential of entrainment and trapping of fish in the infiltration ponds due to flood flows. The maintenance activities associated with water treatment facilities were also addressed.

Adults of all three protected species successfully pass upstream through the Mirabel facilities. The fish ladders are designed and operated to facilitate passage. Attraction flow is provided under nearly all flow conditions. The period of peak upstream migration for all three species

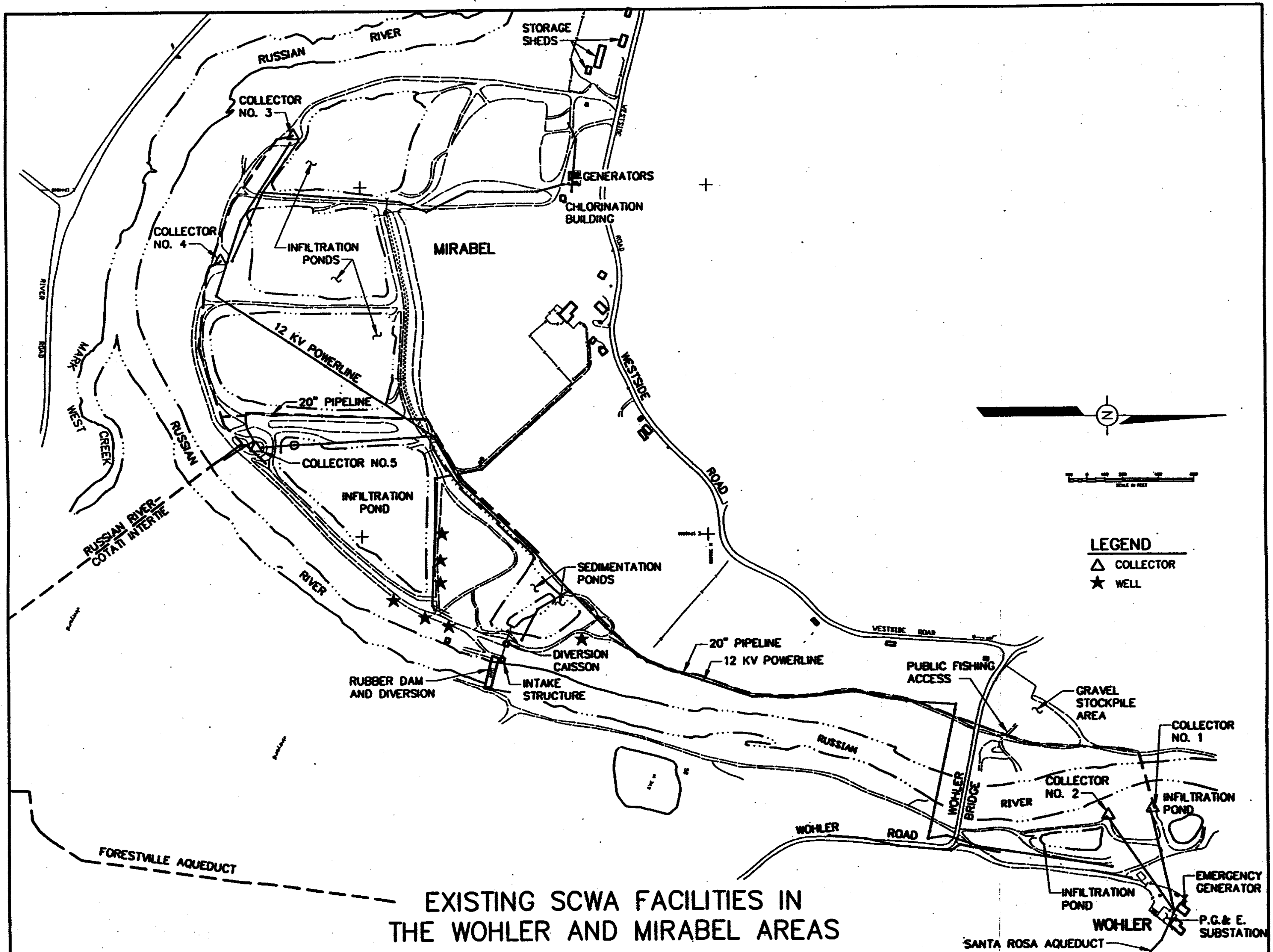

Figure 6-1 Existing SCWA Facilities in Mirabel and Wohler Areas

usually occurs while the dam is deflated. Recent data from video monitoring of adult migration through the ladders indicate successful passage by adult salmonids, and even shows passage by less proficient swimmers, such as Pacific lamprey.

Factors affecting juvenile downstream migration were evaluated in *Interim Report 4* (ENTRIX 2001). There is a potential to adversely affect juvenile downstream migration through the facilities through delays in the impoundment or the inflatable dam, or entrainment into the infiltration ponds. The fish screens at Mirabel were mostly protective of juvenile fish, but they were not as protective of smaller, YOY steelhead (ENTRIX 2001).

The Mirabel facilities present two challenges for downstream migrating smolts. The first is the impoundment, which decreases current velocities in the 2.5-mile long reach and the second is the inflatable dam itself. Smolts often ride the velocity current on their downstream migration. When they encounter areas of low velocity such as impoundments or large pools, they must actively swim downstream. Short reaches of slack water, such as the Wohler Pool, do not pose significant difficulties for outmigrants, but the slack water combined with high water temperatures may result in some residualization, causing the smolts to halt their downstream movement. The second challenge for smolts occurs after they have passed through the impoundment and are seeking a pathway past the dam. Flows near the inflatable dam can have confusing velocity patterns and it appears that young fish have difficulty finding the fish ladders.

As part of a 5-year monitoring program, SCWA is using radio telemetry to measure the length of time required for hatchery steelhead smolts to emigrate through the impounded reach of the river before and after inflation of the dam. SCWA biologists surgically implant uniquely coded radio tags in smolts, record their movements in the river above the dam by boat using a manual receiver, and passage around the dam site with a fixed data-logging receiver. Data were collected in the spring months of 2000, 2001, and 2002. The data will provide information about the average time elapsed from release to passage, the percentage of fish that passed the dam, the percentage of fish that were detected by the receiver but failed to pass the dam, smolt behavior in Wohler Pool, and the physiological stage of smoltification in released fish. Preliminary results indicate that the presence of the inflated dam may reduce the rate of emigration. The data suggest that the delay in emigration is due to the inability of the smolts to locate the fish ladders once they reach the dam rather than due to decreased current velocities within the impounded reach.

Another factor affecting young fish is the potential for entrainment into the infiltration ponds during high flows and becoming trapped in the ponds as flows recede. This was a particular issue at the Wohler ponds where the levees surrounding the infiltration ponds are overtopped during floods almost every year. The levees at the Mirabel ponds are overtopped infrequently. When overtopping occurs, fish rescue operations are conducted to return the trapped fish to the Russian River.

Based on the evaluation conducted in *Interim Report 4* (ENTRIX 2001), the following issues were identified.

Issue MWF-1 – Potential for impingement of salmonid fry and juveniles on fish screens at the Mirabel diversion facility.

Issue MWF-2 – Potential for stranding of fry or juvenile salmonids during emergency deflation of the inflatable dam at Mirabel.

Issue MWF-3 – Potential for delay of juvenile salmonid outmigration at the inflatable dam.

Issue MWF-4 – Potential for entrainment of salmonid fry and juveniles at the Wohler infiltration ponds.

Issue MWF-5 – Potential for entrainment of salmonid fry and juveniles as a result of overtopping of the levees at the Wohler infiltration ponds.

Issue MWF-6 – Predation by warmwater fishes on salmonid fry and juveniles.

MIRABEL FACILITIES

6.1 ACTION 29. LIMIT TIMING OF OPERATIONS OF THE INFLATABLE DAM TO PERIODS WHEN JUVENILE SALMONIDS ARE UNLIKELY TO BE PRESENT OR MIGRATING.

The objective of this action is to reduce potential delay of juvenile downstream migration through the Mirabel facilities by delaying the onset of operations of the inflatable dam.

6.1.1 ACTION

This action would delay operation of the inflatable dam until July, after the majority of juvenile salmonids have migrated downstream. This action could only be implemented in conjunction with another action that could supply water to the Mirabel diversion facility (*e.g.*, Action 24, a pipeline from Lake Sonoma to Mirabel). The inflatable dam at Mirabel would be raised in July and operated through January or to whenever high flows occurred allowing the dam to be deflated. The inflatable dam may be placed in operation sooner than July if the majority of fish have outmigrated. In dry years when the dam is needed most, young fish often move out of the system earlier than in wetter years. Criteria would be developed to determine when the dam would be inflated based on the status of outmigration and water temperatures rather than a temporal criteria such as a date.

6.1.2 EFFECTS ON PROTECTED SPECIES

Implementation of this action would reduce the risk of delay associated with operation of the inflatable dam of outmigrating juvenile salmonids. In the absence of the inflatable dam and the impoundment, the flowing water conditions would allow unimpeded passage by outmigrating salmonids.

6.1.3 OTHER CONSIDERATIONS

This alternative would substantially reduce the ability of the SCWA to meet its water supply obligations during a portion of the year unless other actions were identified to compensate for the loss of production. The SCWA relies on operation of the inflatable dam and the Mirabel and Wohler facilities to meet the peak water demand during the summer. As demand increases under projected 2020 demand, these facilities will be increasingly relied upon to meet peak demands in the spring and fall months. Therefore, any alternative that substantially restricts the operation of these facilities must be accompanied by an action that would compensate for lost infiltration and production by the Ranney collectors. Even if Action 24 were implemented, and water was delivered directly to the Mirabel infiltration ponds, it would not be sufficient to recharge the aquifer. The Ranney collectors would be unable to provide enough water to meet peak demand. Wohler Pool, the impoundment created by the dam, increases pressure head and wetted area in the River causing an increased recharge to the underlying aquifer. The Wohler ponds are also an important component of the recharge system, and fill only when the inflatable dam is in operation.

6.2 ACTION 30. PARTIALLY LOWER THE INFLATABLE DAM ON A PERIODIC BASIS DURING THE OUTMIGRATION PERIOD.

The objective of this action is to create flows over the dam to provide an additional passage route for juvenile salmonids over the dam. This action would reduce potential downstream migration delay through the Mirabel facilities and reduces potential delay associated with passage through the impoundment.

6.2.1 ACTION

The Mirabel Inflatable Dam would be partially lowered for up to 48 hours at a time on a weekly to biweekly frequency through the end of June. This option would temporarily increase flows over the center of the dam and would serve to flush outmigrating salmonids from behind the dam and into the lower Russian River. The dam would lowered approximately 6 ft, the minimum height sufficient to allow continued flows through the bypass pipelines associated with the fish ladders.

6.2.2 EFFECTS ON PROTECTED SPECIES

When inflated, the dam at Mirabel impounds water for approximately 2 miles upstream. This impoundment (Wohler Pool) decreases current velocity, which has the potential to delay emigrating smolts. As part of a 5-year monitoring program, SCWA is using radio telemetry to measure the length of time required for hatchery steelhead smolts to emigrate through the impounded reach of the river before and after inflation of the dam. SCWA biologists surgically implant uniquely coded radio tags in smolts, record their movements in the river above the dam by boat using a manual receiver, and passage around the dam site with a fixed data-logging receiver. Data were collected in the spring months of 2000 and 2002. The data will provide information about the average time elapsed from release to passage, the percentage of fish that passed the dam, the percentage of fish that were detected by the receiver but failed to pass the dam, smolt behavior in Wohler Pool, and the physiological stage of smoltification in released fish. Preliminary results indicate that the presence of the inflated dam reduces the rate of emigration. The data suggest that the delay in emigration is due to the inability of the smolts to locate the fish ladders once they reach the dam rather than due to decreased current velocities within the impounded reach.

Lowering the dam would concentrate and increase the velocity of flow over the dam and provide a migration pathway for fish, thereby inducing the outmigrating salmonids to swim over the dam.

By lowering the dam on a regular basis, outmigrating smolts would be flushed from behind the dam and the potential downstream migration delay through the Mirabel facilities could be reduced.

This action could potentially increase the potential for stranding of juveniles upstream of the dam if the dam is lowered too rapidly, and downstream of the dam when the structure is being inflated. River stage upstream of the dam is regulated by the height of the dam. As the dam is lowered, the river stage would decline which could cause stranding of juveniles along the edges of the river. However, the river channel above the dam consists of uniformly sloping banks that would limit the potential for stranding.

Downstream of the dam, flows would be temporarily reduced while the dam is filling. Because the dam would not be deflated below the level of the fish ladder bypass pipes, flows would be maintained. These pipes could provide flows up to 22 cfs each.

6.2.3 Other Considerations

This action would lower the WSE at the Mirabel and Wohler diversion facilities, and would reduce infiltration to the aquifer and the efficiency of the diversion facility. By maintaining bypass flows, the rate at which the impoundment would be filled would be reduced. This would affect SCWA's ability to meet peak water demand during the spring and early summer months. Therefore, under dry year, or dry spring conditions, the frequency and duration of lowering the dam may be reduced or curtailed.

6.3 Action 31. Create a notch in the crest of the inflatable dam at Mirabel.

The objective of this action is to provide a direct pathway for outmigrating juvenile salmonids to pass over the dam and move downstream, and thereby reduce potential downstream migration delay through the Mirabel facilities.

6.3.1 Action

This action would create a depression, or multiple depressions, in the dam crest that would concentrate flows over the top of the dam into smaller areas. Straps would be used to depress portions of the water filled bladder. Alternatively, the dam could be partially filled with water and then air forced in from either side to create a notch. Straps have been implemented in other locations and have been successful. A combination of straps and partial air filling may also be implemented.

Preliminary data from the Mirabel monitoring program suggests that juvenile downstream migrants may be delayed in the impoundment directly upstream the inflatable dam. To reduce juvenile delay, the inflatable dam would be depressed at strategic location(s) within its mid-section. This would provide concentrated flow at point(s) along the dam, as opposed to uniform flow over its entire breadth, and would provide localized points of discovery for fish trying to move over the dam. In addition, the fish ladders at either end of the dam would continue to provide two supplementary routes for outmigration.

The apparatus for depressing the dam with straps would involve an adjustable, high-strength nylon web strap anchored to the dam foundation at the upstream side and draped over the bladder of the dam. The downstream end of the strap would be wound at a hydraulic winch that would be permanently attached to the downstream edge of the dam foundation. This mechanism would be operated via a single-source hydraulic power unit installed in the existing pump station control building.

6.3.2 Effects on Protected Species

This action would take advantage of the natural tendency of juvenile salmonids to occupy the upper portion of the water column as they migrate downstream (Ransom and Steig 1995) to direct fish over the dam. This tendency to swim near the surface of the water is caused by an enlargement of the fish's swim bladder following its smoltification.

Observations at dams have revealed juvenile salmonids are attracted to surface oriented spillways (Christensen and Wielick 1995). Orifices were placed in the dam walls near the surface of the dam forebay to provide a surface collector system. When applied properly, these systems have generated fish guidance efficiencies typically in excess of 90 percent. Although the facilities to which this technique has been applied are substantially larger than the Mirabel diversion facility, the theory is still relevant.

Water spilled over the inflatable dam is a continuous width of shallow sheet flow reducing the current immediately upstream of the dam to a point that may be virtually undetectable to outmigrants. The dam is not extremely long (approximately 175 feet); therefore, it is feasible that a depression mechanism could produce a concentrated region of increased current velocity to improve passage over the dam. The refinement of the level of depression would likely require in-field research and development to produce an optimum arrangement.

In the spring of 2002, SCWA and NMFS conducted a series of experiments that manipulated the bladder to produce an irregular crest. These experiments included filling the bladder with water to a base elevation and then introducing pressured air from both ends. The team was able to create a stable notch of approximately 1 to 1.5 feet in the dam crest at a consistent location. Monitoring of flows along a series of transects above the dam showed that pockets of still water previously located at either end of the dam structure were eliminated when the notch was formed (J. Mann, NMFS, pers. comm. 2002). Smolts subsequently moved over the dam crest through the notch.

Another important consideration is the relationship between tailwater levels, subsequent plunge pool depths, and river flow. Currently there is a 10-foot deep plunge pool immediately below the dam. A reinforced concrete weir sill or series of baffle piers would be constructed at the downstream edge of the existing dam foundation to expand the plunge pool and reduce the risk of injury to fish from potential impact with the concrete foundation.

The notch may also make the fish ladders easier to find for upstream migrating adults by removing the diffuse sheet flow over the top of the dam.

6.3.3 Other Considerations

This action may affect water levels at the Mirabel and Wohler diversion facilities, thereby resulting in a small decrease in production capacity. The notch would result in a lower WSE behind the dam. This would reduce the rate of infiltration to the aquifer. A lower WSE would also reduce the height of the water at the diversion facility, potentially lowering its efficiency.

6.4 Action 32. Reduce ramping rates during deflation or inflation of the Mirabel Inflatable Dam to minimize the potential for stranding of juveniles.

The objective of this action is to reduce the potential for stranding of juveniles when the Mirabel Dam is deflated or is inflated after the late rains.

6.4.1 Action

The inflatable dam is generally inflated in the spring and lowered at the onset of winter rains. The dam may also be lowered in response to rising flows from late season rains to prevent damage. Other situations (*i.e.*, gravel bar maintenance) also exist that necessitate deflating the dam during other flow conditions. When the dam is inflated, flows downstream of the dam may be temporarily stopped or reduced until the water reaches the elevation of the bypass structures at the fish ladders. These flow recessions have the potential to dewater habitat and strand juvenile fish below the dam. When the dam is deflated, stage declines upstream of the dam have the potential to strand fish.

This action would reduce the rate of inflation or deflation of the inflatable dam during low flow conditions to conform more closely to the Washington Department of Fisheries guidelines for stage changes (Hunter 1992). During juvenile rearing periods, which occur year round for coho salmon and steelhead in the Russian River and February through May for Chinook salmon in the area of the inflatable dam, a 2 inch per hour (0.16 feet per hour [ft/hr]) stage change would apply. It should be noted that the Hunter (1992) guidelines are considered to represent a conservative ramping standard for the Russian River. Hunter developed his guidelines based on streams located in the northwest, a hydrologic regime that is dominated by snowmelt processes. Snowmelt streams usually have relatively gradual changes in runoff conditions. In contrast, the Russian River drainage has very “flashy” runoff conditions and therefore relatively larger changes in stage compared with snowmelt runoff conditions.

6.4.2 Effects on Protected Species

The dam is generally deflated when flows in the river are increasing. Without storm flows, current deflation procedures result in an estimated stage change upstream of the dam of 0.46 feet per hour over the 24-hour period required to deflate the dam. When the dam is deflated in response to a storm, rising river flows attenuate this stage change, resulting in an actual stage change that is less. However, there may be an infrequent need to deflate the dam during low flows, for example, if a maintenance need arises. Lowering the inflatable dam changes the water level in approximately 3.2 linear kilometers (2 linear miles) of the Russian River upstream of the inflatable dam. As the dam is deflated, water levels recede.

When water levels recede, stranding or displacement of salmonids can occur. Unnaturally rapid changes in the river stage can dewater habitat occupied by juvenile and adult salmonids. Stranding occurs when fish are separated from flowing water, and can occur in riffles, gravel bars, side channels, and backwater pools. Mortality may result if fish become desiccated or suffocate when trapped in isolated pools with low DO. Juvenile salmonids are more vulnerable to stranding than adults. Vulnerability drops significantly when steelhead juveniles reach 40 mm and Chinook juveniles reach 50 to 60 mm (Beck Assoc. 1989).

Habitat features associated with an increased risk of stranding include low gradient channel, presence of long side channels, and larger substrate type. A river with many side channels, potholes, and low gradient gravel bars has a greater incidence of stranding than a single channel river with steep banks.

Habitat conditions within the Wohler Pool are such that there is little potential for stranding of juvenile salmonids when flow recessions occur. SCWA characterized the habitat in the area above the inflatable dam (SCWA 2000). When the dam is not inflated, the habitat is described as "swiftly flowing reaches with little surface agitation and no major flow obstructions," and "often appears as flooded riffles." When the dam is inflated, the area above the dam is primarily pool habitat. Typical substrate consists of gravel, cobble, and boulders. Winzler and Kelly (1978) describe a similar habitat for the same general area but add that there are considerable amounts of fine sediments. Examination of aerial photographs (SCWA 1999) and field reconnaissance in the area in late 1999 indicate a single channel river that has a relatively smooth trajectory with a long sweeping curve.

The river above the dam has relatively few structural features that would create low areas outside of the main channel. The slopes of the river margins are relatively low gradient, but are sloped to the main channel. Bradford *et al*. (1995) found that stranding of juvenile coho was reduced when the slope of the bar exceeded 6 percent. A steeper slope results in less shallow area along the margins of the stream where fish are vulnerable to stranding. In the Russian River, the wetted channel extends from bank to bank whether the dam is inflated or deflated, so it is unlikely that dewatering of the riverbed is a concern.

Habitat conditions decrease the risk of stranding juvenile fish when the dam is inflated or deflated during low flow condition. Reducing the ramping rate may reduce this risk even further. Given the estimated stage change of 0.46 feet per hour upstream of the dam over the 24-hour period during deflation, it may be prudent to reduce the ramping rate.

6.5 Action 33. Upgrade the Mirabel Intake Structure and Screens with a Design that Meets NMFS Criteria.

The objective of this action is to provide an intake and screen design that would reduce the risk of impingement of salmonid fry, and improve flows past the diversion facility to meet NMFS and CDFG criteria.

6.5.1 Action

The Mirabel diversion facility and fish screens, located on the west bank of the Russian River, would be reconfigured by modifying the intake structure to provide improved approach and sweeping velocities, and replacing the current rotating drum screens with a system consisting of flat plate screens. The design would include mechanisms for adjusting the relative magnitudes of the approach and sweeping velocities to enable fry and juveniles to swim past the screens and avoid impingement. The upgraded intake structure would facilitate passage of fry and juveniles past the dam, and would effectively use river flows to provide sweeping velocities.

The intake structure would be configured to accommodate a commonly used screen configuration, and would be connected to the fish ladder structure immediately downstream of the proposed screen bank. By directing both diversion flow and fish ladder flow through a single structure, the flows can be better utilized to produce a sweeping velocity parallel to the screen face. The combined flow would also make it easier for outmigrating smolts to find their way to the fish ladder.

The modified intake structure would provide an approximate two feet per second (fps) transport velocity at the upstream end with a minor deceleration over the length of the screen, and would conform with the fish ladder exit velocity, or 1.33 fps. The limited range of transport velocity magnitude would limit juvenile exposure time at the screen bank to less than 60 seconds, and would comply with the sweeping velocity component required parallel to the screen face. The proposed modifications would include augmenting the existing intake structure and fish ladder exit with additional walls and extended foundation slabs. With potentially increased flow through the fish ladder, the effectiveness of the fish ladders may be affected. With the proposed design, flow velocities through the ladder and the exit velocities would continue to meet design criteria for Denil-style fish ladders as presented in *Interim Report 4* (ENTRIX 2001).

To comply with NMFS and CDFG criteria and provide an improved screen configuration to prevent impingement and entrainment of juvenile salmonids, the drum screens would be replaced with a series of vertical plate fish screen panels. The new screens would be would be integrated into the modified intake structure and fish ladder to:

1. Maintain approach and sweeping velocities within criteria limits;
2. Enhance uniform approach velocity distribution;
3. Reduce entrainment;
4. Minimize turbulence and improve passage of outmigrant juveniles; and
5. Reduce operation and maintenance demands.

The design modifications for the Mirabel diversion facility would take into account the following critical operating parameters.

1. A maximum diversion rate of 100 cfs (maximum upper limit of existing lift station capacity);
2. A maximum juvenile flow rate of 20 cfs in the bypass pipeline (for continued provision of supplemental attraction flows at the fish ladder entrance);
3. A maximum fish ladder flow rate of 20 cfs; and
4. An impoundment operating stage at El. 38.0.

The final screen facility would be designed to accommodate the maximum water diversion or the maximum future diversion rate whereby it does not become a constraint in meeting projected SCWA water demand.

The screens would be constructed of wedge-wire with a 50 percent open area. The wedge-wire material is commonly used in present-day screen designs due to the increased structural integrity and better cleaning performance when leaves and woody debris are present. The screens would be cleaned using an electrically operated, traveling brush system that traverses the entire screen bank in both directions. This operation assists in transporting debris outside the limits of the screen array.

The fish screen panels could be configured 9 feet high by 5 feet wide. Ten panels would be required to completely screen the entire opening of the modified intake structure, and would be designed to mechanically attach to allow the screen panels to be individually removed for periodic cleaning or maintenance. The total screen surface area provided would be roughly 450 square feet, approximately 25 percent greater than that required to satisfy the criteria for a maximum approach velocity of 0.33 fps. Providing additional surface area provides a margin of safety to avoid violation of approach velocity criteria.

The hydraulic approach to the screen is often unique to each particular screen structure. Since a lack of symmetry exists at most screen structures and velocities at the screen face cannot be accurately predicted, articulating porosity control baffles would be installed in the intake structure immediately behind or downstream of the screen panels. The baffles would provide an adjustable means of velocity control with respect to individual, predetermined depth ranges to ensure that "hot spots" or localized areas of high velocity would not occur at the screen face. The baffles would optimize the use of the entire screen surface area. The baffles would consist of self-contained units constructed of corrosion resistant aluminum. The baffles would require a one-time adjustment and periodic cleaning. Facility performance testing and monitoring would likely be required following completion of the project.

6.5.2 Effects on Protected Species

Improperly designed diversion facilities can cause impingement or entrainment of juvenile fish or delay migration, which may cause death and injury directly or may cause stress-related injury or death. Entrainment in the infiltration ponds may potentially result in increased predation on juvenile salmonids or may result in stranding.

Because the current fish screens do not meet NMFS and CDFG criteria, there is presently a risk of impingement and entrainment for juvenile salmonids, particularly for fry. This action would install fish screens that conform to NMFS and CDFG fish screen guidelines for both juvenile fish and fry, and reduce the risks. Additionally, the intake structure would be modified to make efficient use of river flows to provide sufficient sweeping velocities past the screens, thereby improving their function. This new intake structure would be designed to concentrate flows more effectively to improve the ability of juvenile downstream migrants to locate the fish ladder, which would further decrease the risk for migration delays outlined in Action 34.

6.5.3 Other Considerations

A monitoring program would need to be implemented to evaluate screen performance, once the facility is updated. Operations or facility adjustments may be needed to fine tune screen performance.

Construction activities would require approximately three to four months, and would coincide with the SCWA diversion season. This would substantially affect the ability of SCWA to deliver water to their customers during that period.

6.6 Action 34. Modify the structure of the upstream end of the eastern fish ladder at Mirabel Dam to direct outmigrating salmonids to the fish ladder.

The objective of this action is to direct outmigrating juvenile salmonids out of still water areas behind the dam to the fish ladders and improve fish passage conditions.

6.6.1 Action

This action would involve moving the upper end of the eastern fish ladder closer to the dam, or installing a buoyed curtain to exclude juveniles from the pocket of still water to help direct them towards the fish ladder. This action would not modify the intake structure of the diversion facility or integrate the western fish ladder into that facility.

6.6.2 Effects on Protected Species

Measurements of flow velocities by SCWA and NMFS during spring 2002 identified a pocket of still water at the eastern end of the dam between the dam structure and the upper end of the fish ladder (S. White, SCWA, pers. comm. 2002b). Fish tend to hold in this pocket of slow moving water and find it difficult to discover the fish ladder.

Increased water velocities at the intake of the redesigned diversion facility would help direct outmigrating juvenile salmonids to the fish ladder. The addition of a buoyed curtain could also help direct outmigrating juvenile fish away from still water and towards the fish ladders. Experiments involving creating a notch in the dam (see Action 31) indicate that the presence of the notch effectively removes the zone of still water at the eastern end of the dam. The fish ladder could be reconfigured to account for changes in WSE associated with other management actions.

6.7 Action 35. Refurbish bypass structure at eastern side of the Mirabel Inflatable Dam.

The objective of this action is to improve conditions for outmigrating juvenile salmonid by providing an alternative route by which the juveniles may pass the dam.

6.7.1 Action

During construction of the Mirabel diversion facility, a bypass channel was constructed at the eastern side of the dam to allow the streambed near the dam and diversion facilities construction site to be dewatered. This action would involve conducting any necessary repairs to the bypass structure. These repairs may include the addition of gates to control flows through the bypass structure. No water would be allowed to flow over the top of the inflatable dam, but would be diverted through the bypass. The sheet pilings that are in place could be of use in operating the dam in this manner.

6.7.2 Effects on Protected Species

Preliminary data from the Mirabel monitoring program suggest that outmigrating smolts may not be able to find passage past the dam. Refurbishment of the bypass structure would provide concentrated flow only through the refurbished bypass structure or the existing fish ladders, as opposed to uniform flow over the entire breadth of the dam. This action would potentially enhance downstream fish passage by concentrating flow past the dam through a single area.

The action could be implemented to benefit salmonid downstream migration. The bypass structure would not be used during upstream spawning migration periods because the fish ladders currently provide sufficient passage, and because it may distract adults from the fish ladders.

6.7.3 Other Considerations

This action would necessitate lowering the WSE behind the inflatable dam by a sufficient distance (1 to 1.5 feet) to prevent water flowing over the dam crest. Reducing the WSE may affect the efficiency of the water supply diversion facility on the western bank of the river.

This action could create a public hazard if recreational users try to navigate through the bypass, rather than portaging around the dam as they currently do. The bypass channel is currently used as the portage route. Conversion of this channel to a bypass flow channel would remove the portage trail. Construction of fencing around the bypass facility may not be effective at keeping people out, and may make any rescue activities difficult.

6.8 Action 36. Delay Installation of Video Monitoring Equipment Until After Outmigration of Smolts (*i.e.,* August).

The objective of this action is to remove a potential impediment to juvenile outmigration.

6.8.1 Action

Time-lapse video monitoring has been used to document fish passage through the fish ladders. This action would delay installment of the video monitoring equipment for any given year until the majority of downstream juvenile migration is complete.

6.8.2 EFFECTS ON PROTECTED SPECIES

This action addresses the possibility that installation of the video monitoring equipment may affect the ability of the juvenile salmonids to find and move through the opening to the fish ladders. Although it is not certain that the equipment results in juvenile downstream migration delay, if the video monitoring equipment is not installed until after the peak migration period, the potential impact to juvenile salmonids may be reduced.

6.8.3 OTHER CONSIDERATIONS

Scientific research is an important component of efforts to manage protected species and their critical habitat. The video monitoring at the Mirabel Dam has yielded valuable information on timing of upstream and downstream salmonid migrations, as well as additional data on the strength of those spawning runs. These data have been invaluable in helping managers to make informed decisions for protected fish species. Implementation of this action means that some data on the numbers of early season upstream migrating adults may be lost due to the delay. Although Chinook salmon begin their spawning runs as early as August, the majority of the run occurs in November. Steelhead and coho salmon runs also occur later. Therefore, even when the video equipment installation is delayed, it is still be possible to collect sufficient data to support management decisions. This action was implemented in 2001.

WOHLER FACILITIES

6.9 ACTION 37. REPLACE EXISTING FISH SCREENS AT THE WOHLER DIVERSION FACILITY WITH SCREENS THAT MEET CURRENT NMFS CRITERIA FOR SALMONID FRY AND JUVENILES.

The objective of this action is to prevent entrainment of salmonids at Wohler diversion facilities and bring the fish screens at the Wohler diversion into compliance with NMFS and CDFG fish screen criteria.

6.9.1 ACTION

This action would replace fish screens at the Wohler diversion facility that do not meet NMFS and CDFG fish screen criteria with ones that do. Modifications at the Wohler ponds would be made to reduce potential entrainment, impingement, or stranding of anadromous fish.

The Wohler diversion facility operates in the dry season when the Mirabel Dam is raised. The action would involve installation of continuously cleaned screens and redesigned slide gates housed in permanent intake structures. Further evaluation, and potentially modifications, would be necessary to ensure that the screens are meeting NMFS fish screen criteria, particularly with regard to approach and sweeping velocities.

The Wohler diversion facilities would be upgraded, as necessary, to prevent the potential entrainment and impingement of anadromous fish, and would be consistent with operations currently performed to reduce fish stranding within the Wohler diversion facilities after flooding.

This action would include construction of permanent reinforced-concrete intake structures at the terminus of the intake canals. These intake structures would facilitate installing and removing the proposed screen modules and would allow for permanent attachment of the proposed slide gates. The intake structures would be sized to accommodate the required screen area and keyed into competent foundation material and would include riprap revetments to maintain stability and soil/structure integrity. The intake configurations would be designed to fit in with their respective locations and to mitigate erosion that might otherwise occur during extreme flood events. The structures would include concrete decks to catch debris removed from the screen face and facilitate removal/disposal. In addition, the decks would provide all-weather access for gate operation.

Removable, pre-assembled, self-cleaning screen modules would be designed in accordance with regulatory criteria. The screen modules would include self-contained, stainless-steel framework, electro-mechanical, brush-cleaning systems, and permanent support infrastructure attached to the intake structures for simple removal and installation. Power would be provided from the adjacent pump houses.

Two new permanently-anchored slide gates would be installed within the intake structures, and would be protected by the intake structures. The gates would include non-rising stems to maintain a low profile and have no protruding parts that could be damaged during flood events.

Assuming all proposed physical modifications are implemented, changes in operation and maintenance activities would be relatively minor in comparison with those currently in operation. Operation and maintenance of the new facilities would entail the following:

- Annual preparation of the infiltration ponds and diversion facilities.
- Annual removal and installation of the screen modules.
- Limited maintenance pertaining to the screen modules.
- Automatic screen cleaning operations.
- Manual adjustment of the intake slide gates.

Other diversion and fish ladder operations would remain as previously operated.

6.9.2 Effects on Protected Species

By replacing fish screens at the Wohler with screens that meet NMFS and CDFG criteria, this action would reduce the potential for entrainment of juvenile salmonids during operating the Wohler Diversion. Furthermore, operation and maintenance protocols will ensure that the screens function to design specifications.

Since the Wohler Diversion Facilities are located at the ends of their respective side channels, and because there is no practical means of providing bypass flows, sweeping velocities would not exist at the faces of the screens. NMFS fish screen criteria provide criteria for minimum sweeping velocities, but in cases like this where still water conditions exist, it is not possible to provide sweeping velocities. However, increasing the surface areas of the screens would provide sufficient protection for juvenile fish. The surface area of the screens would be increased (four to five times required area) to reduce approach velocities well below the NMFS criteria. These low approach velocities would make it easy for juvenile fish to avoid the screens.

6.9.3 Other Considerations

Facility performance testing and monitoring would likely be required following completion of the project. Fish would continue to enter the ponds when they overtopped at high flow, but could escape through the open slide gates.

6.10 Action 38. Regrade Wohler Ponds 1 and 2, to allow fish to escape from the ponds to the Russian River.

The objective of this action is to allow juvenile salmonids that become entrained in the Wohler Ponds when winter storm flows overtop the levees to return back to the Russian River, thereby reducing the need for fish rescues.

6.10.1 Action

Fry and juveniles may become trapped in the Wohler ponds when storm flows overtop the levees surrounding the ponds. Fish rescues are conducted after the levees overtop, but at times they were delayed for up to 2 weeks until water levels receded to a level safe for fish rescues.

The SCWA began implementation of interim measures in 1999 to minimize potential effects. Currently, each pond is independently connected to the Russian River via a culvert. These culverts function as both inlet and outlet to the ponds. Both ponds would be regraded such that they have minimal residual volume when drained as river flows recede after storms (presently only Pond 2 has been completed). During the wet season, the slide gates to the ponds would be left fully open to allow water to drain from the ponds back to the river.

6.10.2 Effects on Protected Species

Entrainment of fish in the infiltration ponds has the potential to delay migration, cause stress-related injury or death, result in increased predation on juvenile salmonids, or result in fish stranding when water levels recede.

This action would reduce potential effects on juvenile fish by allowing them to leave the infiltration ponds via an outlet structure. When water levels recede in the ponds due to receding river flows or lowering of the Mirabel Dam, there is a potential to strand fish. However, as water levels in the ponds drop along the graded surface, the risk of stranding is greatly reduced, and receding waters would help safely direct juvenile fish back into the Russian River.

In the past, fish rescues have reduced the potential effects associated with entrapment. However, high water levels have sometimes delayed fish rescue efforts for up to 2 weeks. This action would reduce the necessity of conducting fish rescue operations for juveniles. Furthermore, by limiting rescues to a smaller, shallow area, fish rescues could be conducted more effectively, reducing potential stress to fish. As a result of these modifications and improved interim fish screens, fish rescues were minimized during 2000 and 2001 (S. White, SCWA, pers. comm. 2002b).

The ponds and the blind channels leading to the intake structures from the Russian River contain backwater areas during high flow events that may also act as velocity refuges for juvenile fish. With an effective connection to the river, the ponds are less likely to trap fish and more likely to provide valuable refuge habitat in this "flashy" river.

6.10.3 Other Considerations

The Wohler ponds would need to be periodically regraded as part of normal maintenance activities. Maintenance would be required to remove accumulated silt and debris to maintain infiltration rates, and to ensure that the ponds drain properly.

6.11 Action 39. Effectively Screen Discharge Intakes at Coyote Valley Dam and Warm Springs Dam to Minimize Release of Warmwater Fish. Modify Intakes to Prevent Live Fish Passing Through the Structure.

The objective of this action is to minimize the potential for release of predatory warmwater fish from the dam to the Russian River.

6.11.1 Action

Screens would be installed on the intakes of discharge facilities. The intakes are located between the bottom of the flood control pool and the bottom of the reservoirs.

6.11.2 Effects on Protected Species

This management action would minimize the potential for warmwater fish present in the reservoirs above the dams from escaping to the Russian River or Dry Creek through the wet well and outlet structure. These fish could supplement and help maintain existing populations in the river.

Fish species that prey on salmonids have been and are stocked in the reservoirs to maintain a recreational fishery. By reducing the chance that these predators can be passed through the dams, the risk of increased levels of predation is reduced. However, populations of predators are already established throughout the Russian River system. Therefore, this action is not likely to eliminate or substantially reduce predation on salmonids.

6.11.3 Other Considerations

A submersible or remotely operated vehicle would be required to install and maintain the deeper screens. The intake at CVD is 160 feet below the bottom of the flood control pool. Maintenance of the screens to prevent fouling would result in an increase in maintenance costs. Due to the depth of the intakes and volume of flow, it may not be possible to clean the screens safely. Fish could still be released from Lake Mendocino should flood flows result in releases over the spillway.

6.12 ACTION 40. ESTABLISH A MONITORING PROGRAM TO ASSESS NUMBERS OF PREDATORY FISH ESCAPEES FROM LAKE MENDOCINO AND LAKE SONOMA.

The objective of this action is to estimate the number of predatory warmwater fish that escape from the reservoirs to the Russian River.

6.12.1 ACTION

USACE, in cooperation with CDFG, would establish a sampling program to determine the presence of predatory fish, particularly striped bass, immediately below CVD. The reservoir is considered a potential source for the presence of striped bass in the East Fork and upper mainstem Russian River. The sampling program would consist of sampling of the stilling basin and weir below the dam during dam inspection activities. Sampling would also be conducted at selected locations in the East Fork and upper mainstem Russian River. The sampling program would primarily focus on striped bass, as they are not known to breed in the River and would have to be introduced from the reservoir. Other predatory species including Sacramento pikeminnow, largemouth bass, and smallmouth bass are resident in the mainstem Russian River. Therefore, the abundance of these species may be used to assess the level of potential predation, but not escapage from the reservoir.

A similar program would be established in Dry Creek below WSD. Since striped bass are not stocked in Lake Sonoma, this effort would focus on determining the abundances of resident predatory species.

6.12.2 EFFECTS ON PROTECTED SPECIES

The number of predatory fish escapees from Lake Mendocino and Lake Sonoma is unknown. This program would provide data to assess the probability of escape from the reservoirs. This action would help identify the effects of warm water predatory fish from the reservoirs on protected species. If effects are identified, appropriate corrective actions would be identified and implemented.

6.12.3 OTHER CONSIDERATIONS

Data on the nature or extent of potential effects could help identify alternative actions, or whether any action is needed. SCWA and the USACE are not responsible for conducting stocking operations in the reservoirs. The USACE would need to coordinate with CDFG and NMFS to implement this action.

7.1 ACTION 41. GRAVEL BAR MAINTENANCE AND OVERFLOW CHANNELS IN THE MAINSTEM RUSSIAN RIVER.

The objective of this action is to reduce bank erosion in the mainstem Russian River by regrading instream gravel bars that contribute to bank erosion and creating site-specific overflow channels, utilizing protocols that reduce effects to salmonid habitat.

7.1.1 ACTION

SCWA and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) were designated as the local agencies responsible for channel maintenance downstream of the CVD following completion of the dam. The USACE provided SCWA and the MCRRFCD with the *Water Control Manual for Coyote Valley Dam* (USACE 1986) which included procedures for operating and maintaining the flood control improvements on the Russian River channels. In addition to channel improvements installed as part of the project for CVD, SCWA and MCRRFCD have responsibility for maintaining certain channel improvement sites that were constructed between 1956 and 1963.

The channel improvement sites are located at various places in Sonoma and Mendocino counties extending from river mile 98 near Calpella to river mile 21 near Mirabel Park. The "river mile" designation refers to the distance from the mouth of the river at the estuary upstream to the site referenced. The Russian River has been subjected to substantial meandering and erosion problems near these sites since they were constructed.

The channel improvement sites and levees are inspected periodically by SCWA and USACE. USACE then recommends maintenance work that may be needed. In general, SCWA has been required to keep the project levees free from vegetation, remove instream gravel bars that may be impeding flow, and inspect and maintain the channel improvement sites. These activities help to maintain flood control capacity.

This action specifically addresses gravel bar grading and creation of overflow channels at sites where the formation or growth of gravel bars is likely to cause bank erosion. Bank erosion occurs when flow is directed into the riverbank by large gravel bars that are often well-vegetated. Maintenance work is directed toward reshaping and removing a portion of these bars. In order to prevent bank erosion, SCWA and MCRRFCD propose to grade gravel bars and create overflow channels to direct the river channel away from susceptible banks. Under baseline conditions, the work could potentially be performed on extensive sections of the Russian River on a regular basis, which is likely to have a substantial effect on steelhead and Chinook salmon habitat. Gravel bar grading activities under the proposed project would be more limited, and protocols would be implemented to reduce the potential for negative effects on salmonid habitat.

The USACE plans, in consultation with California Department of Fish and Game (CDFG) and NMFS, to review the sediment and vegetation control obligations contained in the USACE manuals to see if they should be modified to minimize the effects of channel maintenance activities on protected fish species, while still maintaining flood control capacity. These modifications would be identified in the Section 404 permits required for the channel maintenance activities.

Much of the work in recent years has been performed in Mendocino County. MCRRFCD surveys one-third of the 36-mile reach (approximately 12 miles) annually to identify specific sites where vegetation and sediment maintenance work may be needed. CDFG staff participate in site visits and evaluate site selection. Historically, up to four or five sites with the potential to cause "blowouts" of streambeds or banks have been identified. Generally, three to four sites have been worked on annually. The selected sites ranged in size from very small areas to reaches up to 100 yards in length. Under the proposed project, MCRRFCD would continue to assess approximately 12 miles of river each year and would limit the size of the sites to between 10 feet and 200 to 300 feet in length. Some sites would continue to be selected on the basis of bank protection and maintaining flow in the middle of the channel and away from the stream banks.

The MCRRFCD would continue to assist property owners with bank stabilization on the upper Russian River in Mendocino County. When necessary, they have been the lead agency for obtaining public-law funding when major bank failures have occurred. MCRRFCD also encourages property owners to stabilize their banks by planting native vegetation along the banks to reduce erosion.

<u>Gravel Bar Grading Protocols in the Russian River</u>

Certain conditions may warrant some degree of channel maintenance. Channel maintenance activities may be conducted if one or more of these conditions exist:

1. Occurrence of severe bank erosion;

2. Recent substantial changes in channel morphology that might lead to severe bank erosion;

3. Evidence of weakened levees; or

4. Threats of flooding to infrastructure or private property.

Channel maintenance work would not be conducted unless there is evidence of bank erosion, or recent substantial changes in channel morphology suggest that severe bank erosion is likely during the next rainy season. Channel maintenance activities would be conducted in a manner that provides increased protection for the low flow channel and native vegetation, and reduces the need for channel bar grading. A qualified fish biologist would evaluate the habitat and biological features of each proposed site prior to implementation of grading activities. Project planning would be coordinated with CDFG.

The maintenance work would consist of grading bars in the channel during the dry summer season during low flow periods and creating an overflow channel if needed. Maintenance work would occur between June 1 and October 1 to avoid spawning and incubation periods.

Gravel removed from the lower Russian River may be relocated to Dry Creek as part of restoration activities, in consultation with CDFG and NMFS. Channel bar grading would be limited to that material necessary to reduce the risk of bank erosion.

No channel maintenance work would be conducted in the low flow channel. Buffers (*i.e.*, areas of undisturbed habitat) would be maintained along the edge of the low flow channel to help maintain bar form, prevent deposition of material into the river, and to keep heavy equipment out of the wetted channel. Where vegetation is present, a buffer width of at least 50 feet would be maintained along the edge of the low flow channel. Where no vegetation is present, a buffer width of at least 25 feet would be maintained. A buffer along the bank/levee side of the bar would be maintained to reduce erosion along the bank.

If a channel bar is graded, the elevation of the post-graded bar would be at least 1.5 feet higher than the elevation of the edge of the low flow channel to maintain the thalweg of the channel. Sediment would be contoured to create a slope that runs up and away from the centerline of the main low flow channel at a 2 percent grade from the WSE at low flow, or baseline elevation at the water surface, whichever is higher. The slope parallel to the flow of the river would be consistent with the adjacent stream grade.

Openings would be provided on the downstream end of the bar on the buffer zone to provide even drainage and to decrease the risk of juvenile salmonid stranding when high flows recede. A maximum of four openings per bar would be provided within the downstream-most twenty percent of the bar. These openings would not substantially exceed the width of a single bulldozer blade.

Any large woody debris that is moved or extracted would be deposited either on the upstream buffer area or along the low flow channel buffer where it can be redistributed in the high flows of the next rainy season.

This work would be primarily performed using an excavator with an extended arm and thumb as well as a small bulldozer. Equipment fueling and maintenance would be conducted outside of and away from the river channel. Because gravel bars do not always form in the same river sections over the years, new access roads may be required. Where possible, existing access roads would be utilized, and construction of new access roads would be limited to the fullest extent possible. Road widths would be limited to a width that allows one vehicle to pass. If needed, up-slope sediment control measures such as silt fences would be installed to reduce sediment input to the stream channel.

7.1.2 Effects on Protected Species

Potential short-term effects are limited to juvenile steelhead because they are the only protected species/life history stage present in the Russian River during the summer. Because work would be conducted on gravel bars during the dry season and away from the wetted channel, there is not likely to be a risk of direct effects on protected salmonids. If needed, up-slope sediment control measures would be implemented to control sediment input to the stream. Grading of the gravel bar to no more than a two percent grade and maintaining the longitudinal grade of the bar to be consistent with upstream and downstream sections of the river are likely to minimize the risk of stranding juvenile salmonids during high flow recessions.

Long-term effects of gravel bar grading may include alterations to salmonid spawning, rearing, or migration habitat. The upper and middle Russian River contain steelhead and Chinook spawning and rearing habitat, and all three species utilize these reaches as migration corridors. Alterations to mainstem habitat are most likely to affect Chinook spawning and rearing because the upper Russian River may contain primary habitat for those life history stages.

Gravel bar grading and construction of an overflow channel in the Russian River is likely to affect the geomorphology of the channel. If stable bar development is prevented, the channel becomes straightened and sinuosity decreases. Decreased sinuosity reduces bank erosion, but also reduces the opportunity for pool development by limiting scour on the outside of meander bends. In addition, gravel bar grading generally results in a flatter streambed, reducing the hydraulic diversity and associated aquatic habitat diversity represented in the channel. This lack of hydraulic diversity probably includes reduced availability of high-flow refuge habitat due to limited bedform topography as bars are regularly graded.

Potential effects to the geomorphology of the channel are likely to be reduced compared to baseline conditions because the work would be conducted on a more limited basis over the area SCWA and MCRRFCD are required to assess for bank erosion risk (combined total of nearly 60 miles). Potential effects would also be reduced because buffer strips would be maintained to protect the low-flow channel. By maintaining the low flow channel with vegetated buffer strips, long-term habitat effects related to changes in channel geomorphology are likely to be substantially reduced.

Disturbance of sediments within the channel during the low flow season may potentially result in increased mobilization of fine sediments during the high flow season. This could result in sedimentation of spawning gravel and sedimentation of rearing habitat both within the immediate area where work was done and in downstream areas. Sedimentation of aquatic habitat may also affect aquatic insect production that forms the food base for juvenile salmonids. Peak levels of sediment transport (with combined sediment input occurring from a number of sources) are most likely to occur during the first, early storms (in November and December). However, transport of a sediment load through the mainstem may take a much longer period of time, which could result in long-term sedimentation of habitat if the work is conducted on a regular basis over a number of years.

The North Coast Regional Water Quality Control Board (NCRWQCB) has listed the Russian River on the California 303(d) list as impaired for sedimentation/siltation. Although contribution of sediment loading due the proposed project may be limited, moderate increases may further degrade salmonid habitat. However, by reducing the extent of the work that may be done, these potential effects are substantially reduced. Furthermore, the work would be limited to sites that are likely to experience severe bank erosion. By reducing sediment input due to bank erosion, there may be a tradeoff in the overall sedimentation of aquatic habitat.

Although effects to salmonid habitat are likely to occur, particularly sedimentation of salmonid habitat and a reduction in channel sinuosity, the more limited nature of the work is likely to substantially reduce effects compared to baseline conditions. Furthermore, there is likely to be a tradeoff between sedimentation due to gravel bar grading and a reduction of sedimentation due to severe bank erosion events.

7.2 ACTION 42. VEGETATION MAINTENANCE IN THE MAINSTEM RUSSIAN RIVER.

The objective of this action is to remove vegetation from gravel bars that contribute to bank erosion in the mainstem Russian River.

7.2.1 ACTION

Sediment and vegetation maintenance is provided by MCRRFCD to control bank erosion. In Mendocino County, the summer flow, or low water, channel is approximately 25 percent of the width of the winter flow, or high water channel. The summer flow channel typically meanders from one side of the high-water channel to the other. In this configuration, willows have a tendency to take root on the inside bend of the low-flow channel during the summer and collect gravel during the ensuing winter. This process forms a bar running parallel with the flow of the river. If left unchecked, this process continues until a willow-reinforced bar has developed to a size that is sufficient to divert the river into the high-water stream bank, causing extensive bank erosion and river siltation. MCRRFCD has stated that if left unchecked, the bars can, and have, developed into 10-feet high, 1000-feet long, willow-covered obstacles that obstruct and divert winter high-flows and increase the risk of bank erosion.

Under baseline conditions, the work could potentially be performed on extensive sections of the Russian River on a regular basis, which is likely to have a substantial effect on steelhead and Chinook salmon habitat. Vegetation maintenance under the proposed project would be more limited, and protocols would be implemented to reduce the potential for negative effects on salmonid habitat.

<u>Vegetation Maintenance Protocols in the Russian River</u>

Vegetation maintenance activities may be conducted if one or more of these conditions exist:

1. Areas with substantial encroachment by *Arundo donax* or other exotic pest plant species;

2. Occurrence of severe bank erosion;

3. Recent substantial changes in channel morphology that might lead to severe bank erosion;

4. Evidence of weakened levees; or

5. Threats of flooding to infrastructure or private property.

Vegetation maintenance may be conducted in conjunction with gravel bar grading activities related to stream bank erosion control. Vegetation maintenance activities would be conducted in a manner that provides increased protection for the low flow channel and native vegetation, and reduces the need for channel bar grading. A qualified fish biologist would evaluate the habitat and biological features at each site prior to implementation of vegetation removal. Project planning would be coordinated with CDFG.

Vegetation maintenance would not be performed unless there is evidence of severe bank erosion, or recent substantial changes in channel morphology suggest that severe bank erosion is likely during the next wet season. The vegetation maintenance work would be implemented during the dry summer season during low flow periods. Maintenance work would occur between June 1 to October 1 to avoid spawning and incubation periods.

Vegetation removal would occur in a managed zone consisting of an area outside of the low flow channel and outside a 25-foot vegetation buffer zone next to the low-flow channel. In channels that are wider than 200 feet, a vegetation buffer zone of at least 50 feet wide would be maintained.

Vegetation in the buffer zone along the low flow channel may be cropped. This excludes the use of bulldozing and limits the method to hand removal methods for vegetation that is too large to mow.

If removal of willows and other vegetation in the managed zone cannot be accomplished through mowing, other heavy equipment such as bulldozers may be used. To the extent possible, mechanical methods that leave roots of native species intact in the sediment surface would be selected to minimize sediment resuspension and changes to gravel bar morphology during elevated flows. In some cases, more aggressive practices may be required to reduce the frequency of vegetation maintenance. In these cases, stumps of larger trees may be treated with stump killer, or willow roots may be removed.

Native vegetation that is removed in the management zone would be relocated. The removal of vegetation would include the subsurface material so that the root structure would be included. Willow saplings would be replanted along the low flow channel buffer, along the outer riverbank, or within the upper bar buffer to encourage new riparian growth. Planting trenches would be prepared to accept larger willow plants that could sprout new plants. Trenches would be excavated to five to six feet wide and about three to five feet deep, or deep enough to reach groundwater. Any vegetation removal that requires gravel bar grading would be conducted utilizing protocols outlined in Action 41.

Invasive plant species like *Arundo donax* may be burned in place or uprooted and destroyed outside of the river channel. *Arundo donax* may be mulched using equipment appropriate for this species. In areas where infestations are extensive, heavy equipment such as backhoes, front-end loaders, and bulldozers may be used. Alternatively, *Arundo* may be cut off near ground level and the stump treated with stump killer. If effective new treatments are developed for *Arundo* control, they may be implemented. The objective of these treatments is to kill all *Arundo donax* to prevent recolonization by plant tissue.

Vegetation removal would be scheduled so that gravel bars are worked on in succession over a course of three to five years. Gravel bars would be assessed to identify those that require work. These gravel bars would then be scheduled for work during different years. Once a gravel bar has been worked on, it would be left alone for a period of three to five years before it is worked on again. In this way, some bars would always have willows that provide high-flow velocity refuge areas for salmonids.

7.2.2 Effects on Protected Species

Potential short-term effects are limited to juvenile steelhead because they are the only protected species/life history stage present in the Russian River during the summer. Because vegetation maintenance would be conducted on gravel bars during the dry season and away from the wetted channel, there is not likely to be a risk of direct effects on protected salmonids. If needed, up-slope sediment control measures would be implemented to control sediment input to the stream.

Long-term effects of vegetation maintenance may include alterations to salmonid spawning, rearing and migration habitat. The upper and middle Russian River contain steelhead and Chinook spawning and rearing habitat, and all three species utilize these reaches as migration corridors. Alterations to mainstem habitat are most likely to affect Chinook spawning and rearing because the upper Russian River may contain primary habitat for those life history stages.

Vegetation maintenance in the Russian River channel has the potential to affect the geomorphology of the channel. Vegetation roots stabilize the channel sediment. When velocity-retarding vegetation is removed, bar accretion is minimized and sites available for sediment deposition and storage are reduced. If stable bar development is prevented, the channel becomes straightened and sinuosity decreases. Decreased sinuosity reduces bank erosion, but also reduces the opportunity for pool development by limiting scour on the outside of meander bends. Combined with gravel bar grading, this generally results in a flatter streambed, reducing the hydraulic diversity and associated aquatic habitat diversity represented in the channel. The removal of riparian vegetation on bars likely reduces the availability of high flow refugia and generally decreases hydraulic and associated aquatic habitat diversity.

Shamrock Materials, Inc. (SMI) stream habitat typing data show that summer habitat conditions throughout the Alexander Valley are typical of a simplified channel (Jensen and Halligan 1999, cited in NMFS 2002). There are low shelter ratings, low occurrence of backwater habitats, low values of vegetated areas on banks, and other indications of poor velocity refuge conditions. Further loss of these shelter components could potentially contribute to additional degradation of habitat in portions of the mainstem.

Protocols implemented under this action would substantially reduce the risk of these potential effects compared to baseline conditions. By leaving root structures in place where possible and maintaining a buffer along the low flow channel, habitat values associated with gravel bars (including low-flow refugia) are more likely to be retained. Furthermore, willows would be allowed to develop on some gravel bars in any given year, thereby assuring this habitat is available in those years.

As with gravel bar grading, removal of vegetation on channel bars may potentially result in increased mobilization of fine sediments during the high flow season. This could result in sedimentation of steelhead and Chinook salmon spawning and rearing habitat. By reducing the extent of the work that may be done, the risk of these potential effects is substantially reduced. Sedimentation due to vegetation removal is likely to be offset somewhat, because the work would be limited to sites that are likely to experience severe bank erosion. Native vegetation would be replanted along the low flow channel buffer, along the outer riverbank, or within the upper bar buffer to encourage new riparian growth, thereby stabilizing the channel or riverbank. By reducing sediment input due to bank erosion, there is likely to be a tradeoff in the overall sedimentation of aquatic habitat.

Although effects to salmonid habitat are likely to occur, particularly sedimentation of salmonid habitat and changes in channel geomorphology, the more limited nature of the work is likely to substantially reduce effects compared to baseline conditions. Furthermore, there is likely to be a tradeoff between sedimentation due to vegetation maintenance and a reduction of sedimentation due to severe bank erosion problems.

7.3 ACTION 43. IDENTIFICATION OF SITE SPECIFIC BANK STABILIZATION AREAS ALONG THE MAINSTEM RUSSIAN RIVER.

The objective of this action is to identify areas along the mainstem Russian River where frequent and/or extensive channel maintenance actions are required to prevent bank erosion. This information could then be used to assess whether these sites may be candidates for bank stabilization projects.

7.3.1 ACTION

The location, frequency, and extent of channel maintenance work would be recorded as work is conducted. If specific areas require maintenance work involving gravel bar grading and construction of an overflow channel on a frequent basis (*e.g.*, 3 out of 5 years), the potential to use other bank stabilization methods would be evaluated with the participation of USACE, CDFG and NMFS. Under this arrangement, bank stabilization projects other than bank revegetation would not be required. Where appropriate, revegetation plans to enhance the riparian habitat and bank protection would be limited to planting of native riparian species. MCRRFCD encourages property owners to stabilize their banks by planting native vegetation along the banks to reduce erosion.

SCWA or the MCRRFCD may coordinate potential bio-engineered or engineered bank stabilization projects with local landowners or with the USACE, if areas with persistent and severe bank erosion are identified in areas that threaten the integrity of structures. SCWA or MCRRFCD may be the lead agency on public-law funding when major bank failures occur. Implementation of bank stabilization structures would be coordinated with CDFG and NMFS. If more than 1,000 feet of channel are to be affected by any single project or if the project would be within 1,000 feet of a previously armored site, a separate Endangered Species Act (ESA) Section 7 consultation would be initiated for that action. The intent is to avoid large segments of continuous hard-armoring within the mainstem from cumulatively developing. If bank stabilization activities are implemented, bio-engineered structures would be utilized whenever possible. Where bio-engineered bank stabilization methods are not deemed to be practical, then priority would be given to incorporating vegetative plantings into the hard-armoring techniques that are implemented. Fish habitat restoration elements (such as native material revetments) would be incorporated into bank stabilization practices when feasible with the intention of replacing lost habitat.

Installation of engineered, hard-armor bank stabilization structures may increase the risk that future streambank erosion problems may appear upstream or downstream of the bank stabilization site. Therefore, it may be preferable to implement gravel bar grading and overflow channels on a regular basis at some sites, rather than to implement such bank stabilization projects.

7.3.2 Effects on Protected Species

This action has the potential to reduce the need for gravel bar grading and vegetation maintenance. In cases where bank revegetation projects are implemented, there may be a net benefit to salmonid habitat when stream bank erosion is controlled and a native riparian corridor is established. Furthermore, revegetation projects may increase the formation of stable, vegetated gravel bars that in turn can increase the quantity and quality of salmonid habitat.

Potential habitat altering effects may occur if engineered bank stabilization structures are required. However, such projects would only be implemented in coordination with the USACE, CDFG, and NMFS, and would be limited in size and number. Furthermore, guidelines for incorporating bio-engineered, revegetated, and fish habitat elements into the bank stabilization work would likely help to minimize negative effects to salmonid habitat.

7.4 Action 44. Construction of Off-Stream or On-Stream Detention Basins on Constructed Channels.

The objective of this action is to help maintain flood control channel capacity and reduce the need for sediment or vegetation maintenance activities, thereby reducing potential effects to salmonid habitat.

7.4.1 Action

On-stream or off-stream detention basins would be sited on constructed channels, in natural creeks upstream of constructed channels, or in urban parks and parking lots where frequent channel maintenance has the potential to alter habit for protected fish species.

Urbanization increases stormwater runoff volumes and peak flow rates, while often decreasing the area of historical flood plains. Detention facilities temporarily store stormwater runoff and limit peak runoff rates. Ponds, parking lots, and parks are examples of common off-stream detention facilities that temporarily store storm runoff and empty after a storm ends. Cooke Creek has an on-stream detention structure that is designed to capture a portion of the sediment load in that creek, thereby decreasing sedimentation of downstream areas.

Detention basins are often required for new development. However, a number of small facilities within a watershed may cumulatively have uncertain hydrologic effects. There may be an advantage to having a slightly larger, regional detention basin designed, operated, and maintained by a public agency that reduces existing channel maintenance needs downstream.

Some of the constructed flood control channels of the Mark West Creek Watershed, especially those in the Rohnert Park area that carry substantial sediment loads from the Sonoma Mountains, require more extensive sediment removal and vegetation management to retain flood control capacity. In such areas, off-stream or on-stream detention basins may be appropriate. An off-stream detention basin could be designed to capture a portion of flood flows and release them over a longer period of time, thereby increasing the flood control capacity of the channel. An on-stream detention basin may be appropriate in a channel with large sediment loads. It would function to concentrate sediment deposition in an area where minimal disturbance would be required to remove it, thereby decreasing the need perform extensive sediment maintenance downstream.

Design criteria would be site-specific. In general, a detention basin would be designed to capture the storage volume needed to control runoff for a specified set of design storms and release it at a rate that would reduce flood risk downstream. It would operate passively. The outflow structure would be at a lower elevation than the inflow structure. Inflow and outlet structures would be designed to account for erosion, deposition, and maintenance, to minimize clogging, and to minimize unauthorized tampering. The primary function for these basins would be for flood control or sediment deposition rather than for water quality control. Therefore, outflow rates would be high and water residence time would be low.

When possible, detention basins would be sited where they would have the least effect on salmonid rearing or migration. An on-stream basin would typically be located on a section of stream that widens, thereby taking advantage of the opportunity to decrease flow velocities and increase sediment deposition. Sites selection and detention basin design would be conducted with participation of a qualified fish biologist.

7.4.2 Effects on Protected Species

Off-stream detention basins have the potential to entrap salmonids, and on-stream detention basins have the potential to affect salmonid migration. By capturing streamflow in detention storage until they fill and spill, onstream detention basins alter the magnitude and timing of downstream flow. Altered sediment transport can affect downstream habitat.

An off-stream detention basin has the potential to entrain salmonids, as does Spring Lake. However, Spring Lake is a retention basin designed to hold water over a long period of time. A detention basin could have design features that minimize the risk. Residence time of the water in a detention basin would be short, typically less than a day or two. Therefore, the period of time that fish would be entrained would be short. The outlet structure could be designed so that it passes fish. The basin could be graded to minimize fish stranding as floodwaters recede, and to direct fish toward the outlet structure. This design would minimize the risk of predation on fish entrained in the basin. Therefore, with a proper design, the risks associated with entrapment may be low.

On-stream detention basins have the potential to create hard structures that delay or prevent migrating salmonids from passing. By altering flow patterns, new areas of deposition and scour may be created that make fish passage difficult at certain flows. Therefore, fish passage design considerations may need to be implemented to decrease potential effects to fish passage.

Because detention basins are generally designed to decrease the magnitude of and alter the timing of downstream flow, changes to downstream habitat may occur. However, detention basins are designed to compensate for altered flow patterns due to increasing urbanization. They can help restore a reduced runoff rate in an urbanized stream channel. Downstream salmonid habitat could potentially be improved if flows were to approximate a more natural hydrograph. This runoff rate would be determined by the design of the basin and site-specific conditions. This effect would likely be attenuated in a downstream direction with inflow from downstream sources.

A detention basin may have the potential to reduce coarse sediment input and transport downstream (*i.e.* spawning sized gravels). However, spawning habitat and rearing habitat in the channels that require frequent maintenance, such as those found in the valley of the Cotati and Rohnert Park region, is most likely already degraded due to sediment aggradation and the need to frequently excavate to maintain flood capacity. The sediment in these channels is usually composed of silt, clay, sand, or gravel, or a mixture of fine particles and coarser materials. These fine sediments can degrade spawning and rearing habitat. An on-stream detention basin would concentrate a portion of the sediment load into one easily accessible area. This could potentially reduce the need for frequent or extensive channel maintenance in downstream reaches. If sediment removal is performed less frequently, or if less extensive vegetation removal is required to maintain sufficient flood control capacity, fish passage and rearing or spawning habitat may be improved downstream. Therefore, there is likely to be a net benefit in some channels.

An on-stream detention basin would likely alter salmonid habitat within the footprint of the facility. Because an area of sediment deposition would be created, frequent sediment removal is likely to be required. However, disturbance within one short segment of stream channel, especially one that may have minimal habitat value for salmonids to begin with due to heavy sediment loads within the stream, may be substantially offset by the need to perform less channel maintenance or less aggressive vegetation maintenance in downstream reaches. Potential negative or beneficial effects are likely to be site specific. Care would have to be taken in the design and maintenance of the basin to maintain fish passage during migration seasons.

A properly designed detention basin would help maintain flood capacity within the constructed flood control channel, may have minimal direct effects on salmonids, and, depending on site-specific features, may have benefits for salmonid habitat in downstream reaches.

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