APPENDIX C

BACKGROUND REGARDING THE DEVELOPMENT OF THE PROPOSED YUBA ACCORD FISHERIES AGREEMENT

Appendix C
Background Regarding the Development of the Proposed Yuba Accord Fisheries Agreement

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Appendix C
Background Regarding the Development of the Proposed Yuba Accord Fisheries Agreement

1.0 DEVELOPMENT OF THE YUBA ACCORD

The development of the proposed agreements that comprise the Yuba Accord was a collaborative process that took place over a period of approximately two and a half years. The stakeholders that participated in the development of the Yuba Accord proposed agreements represent most of the fisheries agencies, water users, and other agencies and organizations concerned with lower Yuba River flows.[1]

The Yuba Accord was developed as an alternative to litigation over flow requirements in Revised Decision 1644 (RD-1644) of the State Water Resources Control Board (SWRCB). To accomplish a settlement of litigation, the stakeholders and participants in the discussions started with a set of objectives and criteria for the key elements of any settlement. Those objectives and criteria were ultimately carried forward as the objectives stated in Chapter 1 of this Environmental Impact Report/Environmental Impact Statement (EIR/EIS).

The initial development of the Yuba Accord focused on the development of the flow schedules for the lower Yuba River. The development of flow schedules included biological and other science-based considerations and a stressor analysis of key fisheries species and life stages, prioritized and weighted in a summary matrix. Six flow schedules, plus a conference year schedule, were developed to cover the entire range of Yuba Basin water availabilities. The flow schedules were developed to maximize fisheries benefits during wetter years, and to maintain fisheries benefits to the extent possible for drier years.

In addition to the fisheries stressor analysis, other key considerations in the development of the flow schedules included water supply demands and hydrologic constraints of the system (i.e., consumptive water use demands, flood control operations, and hydropower generation commitments). The Technical Team tasked with flow schedule development pursued a variety of analytic techniques and tools, and performed numerous evaluations of operations protocols,

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[1] Representatives of the following parties participated in various parts of the collaborative process to develop the Yuba Accord: BVID, CDFG, California Sportfishing Protection Alliance (CSPA), CID, FOR, NMFS, SYRCL, TBI, TU, USFWS, YCWA, DWR, Reclamation, PG&E, SWC, Central Valley Project Contractors Association, MWD, San Luis and Delta Mendota Water Authority, Westlands Water District, RWD, BWD, HIC, and DCMWC.

All of these entities signed an agreement providing that all documents and other information that any party prepared for the mediation or any associated settlement discussions and marked as "CONFIDENTIAL," and all associated discussions, would be treated as "Confidential Information," and that no party would disclose any Confidential Information that was prepared by any other party, except as required by applicable law.

All of these entities except for CSPA and CID have signed principles of agreement for one or more of the proposed Yuba Accord agreements. This appendix does not contain any Confidential Information that was prepared by CSPA or CID, and nothing in this appendix is based on any such Confidential Information or associated discussions. Accordingly, nothing in this appendix may be attributed to, or construed to be a position or statement of, CSPA or CID.

Except for CSPA and CID, all of the Confidential Information in this appendix was prepared by one or more of the entities that are listed above and that have consented to its public disclosure.

to mitigate and remove operational constraints that precluded providing an 'optimal' flow schedule in more years. Additionally, the development of a new Yuba Basin water availability index was required to allow a more precise determination of which flow schedule to use in the lower Yuba River during a particular water year.

After the development of the flow schedules, other technical working teams of the stakeholder collaborative undertook the codification of the flow schedules and other biological elements into the proposed Fisheries Agreement, developed the necessary supporting proposed Conjunctive Use and Water Transfer agreements, and cross-verified the 'fit' of the agreements into a total package. In many instances, elements or concepts in one agreement needed to be carefully tailored to avoid disruption of elements in another agreement; in other instances, the path to resolving an issue brought forth by a party to one agreement was found in new or modified elements in another agreement.

Throughout the nearly three year process that resulted in the Yuba Accord Alternative, all of the participating stakeholders were engaged and able to represent their own interests and perspectives. To meet all of those interests, innumerable different approaches, alternatives, concepts, and changes were described, discussed, debated, evaluated and either incorporated or discarded. For example, during development of the flow schedules as an initial component of the Fisheries Agreement, more than two dozen different flow schedule combinations were evaluated by the Technical Team. After several days of work, a dozen combinations of operational rules were evaluated to identify an approach for the proposed supplemental surface-water transfers. Notification and reporting requirements (and associated key dates) in each of the agreements went through multiple revisions, to accommodate all of the interests, to provide operational flexibility and to correspond to dates in the other agreements. The penalty and remedy provisions in each of the agreements were drawn from lists of potential provisions, and the agreements generally include different remedies for different situations that could be encountered in implementing the Yuba Accord.

In total, the aggregate number of different 'alternatives' or permutations to the final Yuba Accord Alternative that were evaluated and discarded by the technical and drafting teams numbered into the hundreds. During the entire duration of the development of the Yuba Accord Alternative, the various participants and technical teams remained mindful of the initial suite of objectives for the process. As a result, alternatives and permutations that were rejected were rejected as either technically insufficient, as failing to meet a key interest of one of the stakeholders, or as failing to meet one of the initial objectives of the process.

1.1 DEVELOPMENT OF THE FISHERIES AGREEMENT

The development of the proposed Fisheries Agreement was the first step taken in the process that led to the Yuba Accord. The Fisheries Agreement derived from a process focused on: (1) evaluating key fisheries stressors in the lower Yuba River; (2) developing new instream flow requirements; (3) developing a monitoring and evaluation program to oversee the success of the flow schedules; and (4) creating a funding mechanism to pay for monitoring and study activities and the proposed conjunctive-use program.

1.2 PURPOSE OF THIS APPENDIX

This appendix provides an overview of the development of the proposed Fisheries Agreement, including significant detail on the construction of the Stressor Matrix, evaluation, and integration of operational constraints, and the iterative process of development of flow schedules for the lower Yuba River. While this appendix does not attempt to enumerate or describe the dozens of permutations, alternatives, variations, and ideas that were put forth by all of the parties during the collaborative development of the Fisheries Agreement, this appendix does provide an overview of the Fisheries Agreement development process, and it describes the wide variety of different concepts and alternatives that were part of the establishment of the final Fisheries Agreement.

2.0 TECHNICAL TEAM WORKING GROUP

2.1 COMPOSITION OF THE TECHNICAL TEAM

The group primarily responsible for development of the biological aspects of the Fisheries Agreement was a technical working team comprised of representatives of various resource agencies (including NMFS, USFWS, and CDFG), representatives of various NGOs including Trout Unlimited, Friends of the River, South Yuba River Citizens League, and the Bay Institute. YCWA also participated in the technical working team, which became known as the Technical Team[2].

Participation in the Technical Team was voluntary, and each of the participating agencies and entities provided staff and other resources for the Technical Team. Each of the participating agencies and entities represented its own interests and provided extensive input and perspective into the process. As would be expected, there was a wide divergence of opinions on numerous issues. However, the Technical Team participants were able to reach consensus and agreement on most issues.

The Technical Team members did not have a formal mandate from their agency/organization to achieve a settlement or other agreement. However, Technical Team members were able to undertake a science-based discussion of technical issues, and an interest-based discussion of the potential solutions that ultimately did lead to a collaborative settlement.

From the earliest stages of discussion, the Technical Team recognized the following needs and challenges to developing an agreeable set of flow schedules:

- A history of sometimes acrimonious dialogues and debates over lower Yuba River operations and appropriate minimum flow requirements;
- Fisheries and aquatic habitat needs, and goals for protection and enhancement of fisheries and aquatic resources; and
- Operational constraints on the lower Yuba River system, including water delivery, power generation, flood control, and biological constraints.

To meet these needs and challenges, the Technical Team decided that it would be necessary to essentially "start over" using current science and data on the state and condition of the lower

[2] A representative of CSPA also participated in some of the Technical Team meetings. However, as discussed in footnote 1 above, CSPA has not signed the principles of agreement for the Fisheries Agreement and has not consented to the disclosure of any Confidential Information that its representative provided to the Technical Team. This appendix does not contain any confidential information provided by CSPA, and nothing in this appendix may be attributed to, or construed to be a position of, CSPA.

Yuba River. In addition, it was essential that every participant in the Technical Team clearly understand the goals and interests of each of the other participants, and have a clear and accurate understanding of the operational constraints for the lower Yuba River. As a result, considerable time and effort was expended by the Technical Team in discussing interests and operational constraints.

2.2 TECHNICAL TEAM GOALS

All of the participants in the Technical Team shared a common goal of ensuring an appropriate level of protection for various aquatic resources and fisheries species in the lower Yuba River, particularly for listed species such as Central Valley steelhead and Central Valley spring-run Chinook salmon. Additionally, all of the participants were interested in a long-term monitoring and studies program to further evaluate the effects of the Yuba Accord and the general health of the lower Yuba River.

Additionally, YCWA was interested in:

- Improving Yuba County water supply management and reliability;
- Implementing a comprehensive conjunctive use program for managing surface water and groundwater supplies within Yuba County to improve water use efficiency; and
- Developing a consistent source of revenues to fund both Yuba Accord actions (e.g., Conjunctive Use Program, River Management Team) and other YCWA projects such as Yuba County flood control and water supply improvements.

The Technical Team did not take the step of formally adopting in these specific goals and objectives during the early stages of development of what would become the Fisheries Agreement. However, these goals and objectives were a clear and pervasive thread through all of the discussions undertaken by the Technical Team.

In the process of pursuing the overarching goal of ensuring an appropriate level of protection for various aquatic resources and fisheries species in the lower Yuba River, the Technical Team worked toward achieving several subsidiary goals:

- Appropriate flows for the lower Yuba River, including development of an instream flow regime that addressed Yuba River-specific fisheries-related concerns and that enhanced the current regulatory baseline for stream flows and water temperatures, particularly for listed species such as Central Valley steelhead and Central Valley spring-run Chinook salmon;
- Operational flexibility for the lower Yuba River;
- Appropriate monitoring of conditions, flows, and the nexus between flows and species health; and
- Establishment of a collaborative river management process for New Bullards Bar Reservoir and lower Yuba River operations.

2.3 APPROACH DEVELOPED BY THE TECHNICAL TEAM

Several steps were taken to develop to the proposed Yuba Accord flow schedules:

- Develop a Stressor Matrix for key fisheries species in the lower Yuba River;
- Focus on key fish species and consider general aquatic habitat conditions and health in the lower Yuba River;
- Define general fisheries goals (e.g., maintenance, recovery, enhancement, etc.);
- Define specific fisheries-related goals of the new flow regime in terms of flow, temperature, habitat, etc.;
- Develop a comprehensive understanding of the hydrology and range of variability in hydrology for the Yuba Basin;
- Develop a comprehensive understanding of the operational constraints (regulatory, contractual, and physical) of the Yuba River Development Project (Yuba Project) and lower Yuba River, as well as an understanding of the flexibilities and inflexibilities of those constraints; and
- Develop flow regimes based on specific fisheries-related goals and water availability (as defined by operational constraints and hydrologic conditions).

3.0 DEVELOPMENT OF STRESSOR MATRICES FOR THE LOWER YUBA RIVER

The Technical Team recognized that a new flow regime for the lower Yuba River would need to achieve several objectives, including:

- Maximize the occurrence of "optimal" flows and minimize the occurrence of sub-optimal flows, within the bounds of hydrologic variation;
- Maximize occurrence of appropriate flows for Chinook salmon and steelhead immigration spawning, rearing, and emigration;
- Provide month-to-month flow sequencing in consideration of Chinook salmon and steelhead life history periodicities;
- Provide appropriate water temperatures for Chinook salmon and steelhead immigration and holding, spawning, embryo incubation, rearing and emigration.
- Promote a dynamic, resilient, and diverse fish assemblage;
- Minimize potential stressors to fish species and life stages; and
- Develop flow regimes that consider all freshwater life stages of salmonids and allocate flows accordingly.

To build a scientific basis for crafting a flow regime that would meet these objectives, the Technical Team needed a tool to be able to prioritize impacts on and benefits to the lower Yuba River aquatic resources. To meet this need, the Technical Team undertook development of a matrix of the primary "stressors" that affect anadromous salmonids in the lower Yuba River.

3.1 STRESSOR MATRIX DEVELOPMENT

While the Technical Team recognized the critical importance of having a dynamic and resilient aquatic community, the Technical Team also realized that developing a flow regime that considered the environmental and biotic requirements of each species in the entire aquatic community would not only be exceedingly complex and difficult, but probably also impossible, given the myriad of constraints (time, operations, finite water availability, water rights, conflicting requirements of aquatic species, etc.) confronting the process. The Technical Team decided that, to meet its goals, efforts would be focused on addressing "keystone" lower Yuba River species. The Technical Team agreed that a flow regime that supported key fish species such as Central Valley steelhead and Central Valley Chinook salmon generally would benefit other native fish species, recreationally important fish species such as American shad and striped bass, aquatic macroinvertebrates, and other aquatic and riparian resources. The Technical Team also realized that, above all else, the developed flow regime would be evaluated primarily on its perceived value or benefit to state and federally listed species, namely Central Valley steelhead and Central Valley spring-run Chinook salmon, and to fall-run Chinook salmon. For this reason, the lower Yuba River stressor prioritization process principally considered steelhead, spring-run Chinook salmon, and fall-run Chinook salmon. Other fish species considered, but ultimately excluded from the stressor prioritization process, were American shad, striped bass, and green sturgeon. The primary purpose of the stressor prioritization process was to provide specific input and rationale for seasonal flow regime development as well as to provide overall guidance for other management and potential restoration actions.

For the purpose of developing the lower Yuba River Anadromous Salmonid Stressor Matrix[3] — the ultimate product of the stressor prioritization process — the freshwater lifecycle for each species or race was broken up into six commonly acknowledged life stages. These life stages are: (1) adult immigration and holding; (2) spawning and egg incubation; (3) post-emergent fry outmigration (referred to as young-of-year (YOY) downstream movement/outmigration for steelhead); (4) fry rearing; (5) juvenile rearing; and (6) smolt outmigration (referred to as yearling (+) outmigration for steelhead). Each of the life stages was then assigned a temporal component reflecting the best available knowledge of the timing and duration of that life stage in the lower Yuba River.

Potential stressors (also referred to as "limiting factors") were then identified for the life stage of each species or race. Because most potential stressors were limited to a particular geographic reach or extent in the lower Yuba River, a geographical component was assigned to each stressor. The following is a listing of all of the potential stressors considered for the purpose of Stressor Matrix development.

[3] The original framework for the Stressor Matrix was developed for the Lower Yuba River Technical Fisheries Working Group's "Draft Implementation Plan for Lower Yuba River Anadromous Fish Habitat Restoration: Multi-Agency Plan to Direct Near-Term Implementation of Prioritized Restoration and Enhancement Actions and Studies to Achieve Long-Term Ecosystem and Watershed Management Goals (Implementation Plan)." The intent of the Implementation Plan is to facilitate the implementation of prioritized actions and studies that will protect, enhance, and restore: (1) the Yuba River aquatic and riparian habitats; (2) the key processes that create and maintain these habitats; and (3) the anadromous fish species that use such habitats, while increasing the understanding of ecosystem structure and function in the lower Yuba River.

- Water Temperature
- Flow Fluctuations
- Flow Dependent Habitat Availability
- Habitat Complexity and Diversity
- Predation
- Entrainment/Diversion Impacts
- Physical Passage Impediments
- Transport/Pulse Flows
- Poaching
- Spawning Substrate Availability
- Angler Impacts
- Attraction of Non-Native Chinook salmon
- Overlapping Habitat
- Physical Passage Impacts
- Lake Wildwood Operations/Deer Creek Flow Fluctuations
- Motor-powered Watercraft

The potential stressors presented were not necessarily considered to be an exhaustive list of stressors, but were the major perceived stressors, based on current information. In addition, the list of stressors included some elements that were not necessarily considered to be stressors by all Technical Team members. The stressor prioritization process was intended to serve as a tool to provide context for and assistance in the development of the flow schedules. To do this, the potential of each of these stressors to affect the particular species and life stage was evaluated; however, only five to eight of the stressors ultimately were considered to be potential limiting factors for each particular species and life stage.

Geographic and temporal considerations then were assigned to each stressor, further defining the extent of the potential stressors' effect on each species and life stage.

Several biological considerations were addressed during the evaluation of potential stressors. These considerations included: (1) the cumulative distribution of the anadromous salmonids in the lower Yuba River during different months of the year; (2) the relative contributions of the different life stages (e.g., fry vs. smolt) to the spawning population; (3) the importance of increasing initial-year-class strength of the population; (4) the degree of control over exogenous factors that may affect the environmental conditions experienced by the different life stages; (5) the duration that the examined life stage is present in the river; and (6) the temporal distribution associated with each examined life stage. The final assignments of potential stressors to each species and life stage reflect conclusions based on the above considerations. While the assignment of stressor relevance to the various life stages was generally based on the collective judgment of the Technical Team participants, there was considerable difference of opinion regarding some of the stressor relevance assignments. Thus, in many cases the relevance assignments represents a reasoned consensus of the group, rather than a unanimous decision. Overall, however, the Technical Team participants expended considerable effort to research, discuss, and otherwise work through appropriate relevance assignments to include in the Stressor Matrix.

The prioritization of stressors in the lower Yuba River consisted of a limiting factor analysis, by species and life stage, which is based on the existing hydrological and biological conditions of the river. Particular emphasis was placed on the instream conditions during the past 10 to 15 years, as recent historical information is likely reasonably representative of future hydrologic patterns, and most representative of current operational practices.

Calculation of Stressor Matrix weightings was accomplished by utilization of a decision tree with weights assigned to individual tiers within the tree. The individual tiers within the decision tree, from highest to lowest, are: (1) fish species/run, (2) life stage; and (3) stressor/limiting factor.

The individual tiers were related hierarchically. In other words, each variable within a tier had several associated variables at the next lower tier, except at the lowest (i.e., third) tier. The weights assigned to individual variables within each tier summed to a value of 1, and higher relative weight values were assigned *a priori* to reflect individual variables that had greater potential effects on species production. Variables were ranked relative to one another according to their biological significance. The fish species/runs were ranked in relative importance according to such considerations as ESA and population status. For example, spring-run Chinook salmon and steelhead were given an equal ranking that was higher than that of fall-run Chinook salmon because Central Valley spring-run Chinook salmon and Central Valley steelhead both are ESA threatened species and Central Valley fall-run Chinook salmon is not.

The individual life stages of each fish species/run were ranked in relative importance according to the assumed contribution of each freshwater life stage to overall population production. For example, for spring-run Chinook salmon, the spawning and egg incubation life stage was given the highest relative ranking because the Technical Team perceived this life stage to be the most important freshwater life stage in contributing to spring-run Chinook salmon production.

The individual limiting factors affecting each life stage were ranked in relative importance according to such considerations as the proportion of each life stage potentially affected, the magnitude and extent of potential adverse effects on each life stage, and the spatial or temporal occurrence of potentially limiting factors. Continuing with the example of spring-run Chinook salmon spawning and egg incubation life stage, water temperature was identified by the Technical Team as the most important limiting factor affecting this life stage and, thus was given the highest weight.

The numeric weights assigned to individual variables within each tier reflect the degree of relative importance of each variable (i.e., variables with a high relative ranking received a relatively high weight). The ranking of the individual tiers (species/run, life stage, and stressor/limiting factor) was accomplished through a "consensus" approach and was largely determined by best professional judgment. In some circumstances, a consensus represented a compromise because some individual weightings varied substantially among Technical Team members.

The stressor prioritization process consisted of developing a "composite weight" for each species, life stage, and stressor combination. The composite weight was calculated by multiplying the species weight, the life stage weight, the stressor weight, and 100. The resulting 215 species-life stage-stressor composite weights could then be summed, sorted, and ranked numerous ways depending on the specific consideration of interest. Two of the most illustrative rankings were the overall stressor ranking and the stressor ranking by month.

The sensitivity and precision of individual stressor ratings and the prioritization summary data that the Technical Team developed were limited, and were not considered to be an exact quantification of anadromous salmonid stressors in the lower Yuba River. Instead, the stressor rankings represented a broad index of relative importance, where only substantial differences between stressor ratings were considered by the Technical Team to be meaningful. A significant difference in the potential levels of stressor impacts were assumed when significant differences were illustrated in individual stressor weightings or the resulting composite totals. However, when only small differences between individual stressor weightings existed, differences in impacts were not assumed to be significant.

Table 3-1 lists the top four stressors that were determined for each month by this process, without their composite scores. These Stressor Matrix results provided the Technical Team with a quantitative context of the relative importance of stressors for each month The Technical Team members utilized the Stressor Matrix results, with, other information, for each month to help guide flow schedule development.

Table 3-1. Top Four Stressors to Anadromous Salmonids in the Lower Yuba River for Each Month

Month	Highest Ranked Stressor	2nd Highest Ranked Stressor	3rd Highest Ranked Stressor	4th Highest Ranked Stressor
January	Flow Fluctuation	Flow Dependent Habitat Availability	Habitat Complexity and Diversity	Predation
February	Flow Fluctuation	Flow Dependent Habitat Availability	Habitat Complexity and Diversity	Physical Passage Impediment
March	Flow Fluctuation	Habitat Complexity and Diversity	Flow Dependent Habitat Availability	Predation
April	Flow Fluctuation	Habitat Complexity and Diversity	Flow Dependent Habitat Availability	Predation
May	Water Temperature	Flow Fluctuation	Habitat Complexity and Diversity	Predation
June	Water Temperature	Flow Fluctuation	Habitat Complexity and Diversity	Entrainment/Diversion Impact
July	Water Temperature	Flow Fluctuation	Habitat Complexity and Diversity	Flow Dependent Habitat Availability
August	Water Temperature	Flow Fluctuation	Flow Dependent Habitat Availability	Habitat Complexity and Diversity
September	Water Temperature	Flow Fluctuation	Flow Dependent Habitat Availability	Habitat Complexity and Diversity
October	Water Temperature	Flow Fluctuation	Flow Dependent Habitat Availability	Habitat Complexity and Diversity
November	Flow Dependent Habitat Availability	Flow Fluctuation	Predation	Habitat Complexity and Diversity
December	Flow Fluctuation	Flow Dependent Habitat Availability	Habitat Complexity and Diversity	Entrainment/Diversion Impact

4.0 DEVELOPMENT OF INITIAL FLOW SCHEDULES

After the Stressor Matrix was developed, the Technical Team undertook development of an initial set of flow schedules for the lower Yuba River. A deliberate decision was made by the Technical Team to develop these flow schedules without consideration of historic or existing regulatory requirements. Essentially, this allowed a "blank paper" development of a new set of flow schedules based on scientific considerations and the Stressor Matrix, hydrologic probabilities, and basic operational constraints.

The lower Yuba River flow schedules would ultimately need to balance consideration of numerous elements, including specific biological objectives, annual variability in water availability, reservoir constraints for flood control and power generation, ramping and flow delivery constraints, water delivery obligations (contractual and by rights), and the complex interrelations among these elements. However, during initial flow schedule development efforts, the influence of anything other than hydrology, the basic physical parameters of the Yuba River Development Project, and the direction provided by the Stressor Matrix was minimized.

Although the flow schedule development process focused on anadromous salmonids, the Technical Team remained cognizant of the importance of a properly functioning river ecosystem and the aquatic resource community, including introduced species of management concern (American shad and striped bass).

The initial development of flow schedules included the following steps:

- Identify basic hydrologic conditions, physical parameters and operations objectives that influence flow;
- Development of an "optimal" flow schedule for years with virtually unlimited water availability;
- Development of a "survival" flow schedule for years with extremely low water availability; and
- Development of additional flows schedules between the high and low range, corresponding to varying the water availabilities between the very wet years and the extremely dry years.

4.1 BASIC HYDROLOGY, PHYSICAL PARAMETERS AND OPERATIONS OBJECTIVES

The hydrology of the Yuba River basin is tremendously variable, with total Yuba River system runoff ranging from 276,000 to 3.8 million acre-feet per year. The total operational storage available in the basin is less than 1 million acre-feet, less than necessary to fully attenuate the impacts of the varied hydrology. Thus, the lower Yuba River flow schedules must accommodate all conditions from extremely wet to extremely dry. During the wetter half of hydrologic years, total water supply is not an issue in the development of flow schedules – rather, flood control operations and the need to evacuate surplus water from the reservoir are key drivers in operations and planning.

Flows in the lower Yuba River are measured at the Smartville Gage (located just downstream of Englebright Dam, at the top of the lower Yuba River reach) and the Marysville Gage (located just above the confluence of the Yuba and Feather rivers, at the lower end of the lower Yuba River reach). Between these two gages, the bulk of consumptive deliveries from the lower Yuba River are diverted from the river at or near Daguerre Point Dam.

Flow schedules were developed for both the Smartville and Marysville gages. Due to the need to release flows for consumptive needs between the gages, the flow schedules may be very different for the two gages. The higher of the Smartville and Marysville requirement dictate flows in the river.

4.2 "OPTIMAL" FLOW SCHEDULE DEVELOPMENT

The first step in developing the flow schedules was the development of an "optimal" flow schedule that was not constrained by water availability limitations. Available information such as the Stressor Matrix results (and the species and life stage rankings, life stage periodicities, and geographical considerations developed for the Stressor Matrix), flow-habitat relationships (i.e., weighted usable area [WUA]) for Chinook salmon and steelhead spawning, and an understanding of the lower Yuba River flow-water temperature relationship was utilized. Obviously, even this flow schedule would not be "optimal" for all species and life stages that might be present in the river; however, it was the intent of the biologists on the Technical Team to construct a flow schedule that would provide the greatest benefit to the broadest suite of species and life stages.

Although the Technical Team generally was aware of the specific interim and long-term flow requirements in RD-1644, the Technical Team's goal was not to modify the RD-1644 flow requirements, but instead to develop an independent flow regime that principally considered the requirements of the species and life stages of anadromous salmonids in the lower Yuba River present during each month.

The development of the "optimal" flow schedule resulted in a "high" (Schedule 1) and a "low" (Schedule 2) range of ideal flows (**Table 4-1**). The development of the "high" and "low" range of ideal flows was representative of the variety of opinions among the Technical Team biologists. Through extensive discussion and collaboration, the Technical Team biologists and representatives came to a general agreement that the two flow schedules represented the range of the "optimal" flows.

Table 4-1. Initial Technical Team Schedule 1 and Schedule 2 Minimum Flow Requirements as Measured in cfs at the Marysville Gage

Schedule	Oct		Nov	Dec	Jan	Feb	Mar	Apr		May		Jun		Jul	Aug	Sep	Total Annual Volume (AF)
	1-15	16-31	1- 30	1-31	1-31	1-29	1-31	1-15	16-30	1-15	16-31	1-15	16-30	1-31	1-31	1-30	
1	500	500	500	500	500	500	700	1,000	1,000	2,000	2,000	1,500	1,500	600	500	500	555,984
2	500	500	500	500	500	500	700	700	800	1,000	1,000	800	400	400	400	400	408,078

Although flows were developed month by month, the year generally could be broken into three periods: (1) September through March; (2) April through June; and (3) July and August. The September through March period encompassed the entire Chinook salmon (fall-run and spring-run) spawning period and the majority of the steelhead spawning period, and spawning requirements guided flow-schedule development for this period. The April through June period is characterized by higher flows from the spring snowmelt and run-off, and is an important period for juvenile salmonid emigration. July and August are typically the warmest months of the year. During this period, juvenile anadromous salmonids are rearing and spring-run and fall-run Chinook salmon are migrating and holding in the lower Yuba River. Flows allocated during July and August were intended to provide appropriate water temperatures for these life stages. Also, development focused on the "control" period of April though November, when flows in the lower Yuba River generally were not subject to other operations requirements such as flood control, and when flows normally are controlled by reservoir releases.

4.2.1 SEPTEMBER THROUGH MARCH

The flows the Technical Team prescribed for the September through March period, which generally encompasses the spring-run Chinook salmon, fall-run Chinook salmon, and steelhead spawning periods, generally provided maximum (or near maximum) spawning habitat (as measured by flow at the Smartville Gage) as determined through instream flow incremental methodology (IFIM) physical habitat simulations (CDFG 1991) (see **Figure 4-1**). Because all of the spring-run Chinook salmon spawning (CALFED and YCWA 2005), the vast majority of the steelhead spawning, and approximately 60 percent of the fall-run Chinook salmon spawning occurs upstream of Daguerre Point Dam (SWRCB 2003), the Technical Team developed flow requirements at the Marysville Gage with the understanding that flows during the spawning periods were at least 200 cfs higher at the Smartville Gage than at the Marysville Gage during most years.

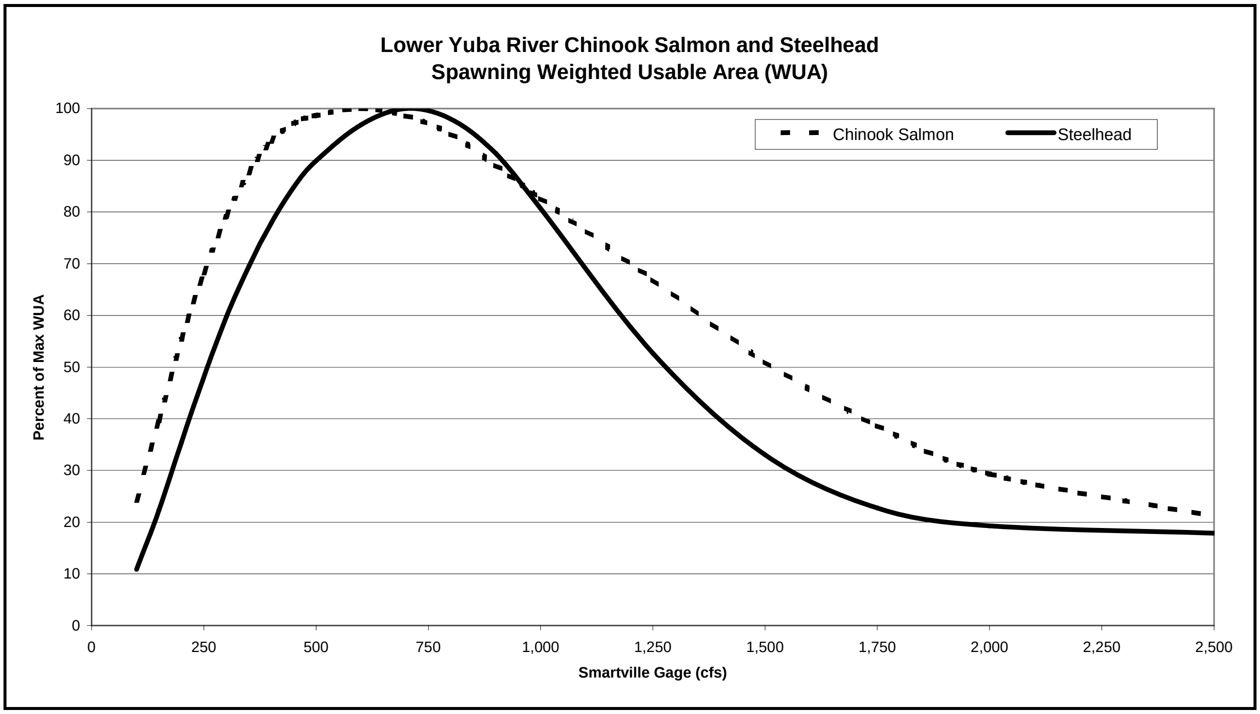


Figure 4-1. The Lower Yuba River Chinook Salmon and Steelhead Flow-Spawning Habitat Weighted Usable Area Curve

As indicated by the flow-habitat relationships developed for the lower Yuba River, a flow of 700 cfs as measured at the Smartville Gage provides 100 percent of available steelhead spawning habitat and 98.6 percent of available Chinook salmon spawning habitat (CDFG 1991). Later in the flow schedule development process, the Technical Team developed specific flow requirements for particular months for the lower Yuba River at the Smartville Gage. **Table 4-2** presents the Smartville Gage flow requirements that were developed, which are associated with the flow requirements at the Marysville Gage during Schedule 1 through 6 years.

Table 4-2. Technical Team Flow Requirements Associated with the Six Flow Schedules as Measured (in cfs) at the Smartville Gage

Schedule	Oct		Nov	Dec	Jan	Feb	Mar	Apr		May		Jun		Jul	Aug	Sep	Total Annual Volume (AF)
	1-15	16-31	1- 30	1-31	1-31	1-29	1-31	1-15	16-30	1-15	16-31	1-15	16-30	1-31	1-31	1-30	
A	700	700	700	700	700	700	700	700	0	0	0	0	0	0	0	700	--
B	600	600	600	550	550	550	550	600	0	0	0	0	0	0	0	500	--

Schedule A used with Schedules 1, 2, 3 and 4 at Marysville
Schedule B used with Schedules 5 and 6 at Marysville

During September and October of the September through March period, water temperature, particularly for spring- and fall-run Chinook salmon immigration, holding, spawning and egg incubation life stages, also was a particular concern. Because of the water diversions that occur in the lower Yuba River in the vicinity of Daguerre Point Dam during most months of the year, the progressive downstream ambient warming that occurs during warmer months, and the inflow of relatively warm water from the Yuba Goldfields, water temperatures downstream of Daguerre Point Dam typically are considerably warmer, especially at lower flows, than temperatures upstream. The Technical Team weighed the water temperature considerations and the flow-spawning habitat relationships and determined that 500 cfs at the Marysville Gage and 700 cfs at the Smartville Gage achieved the principal biological objectives for the September through March period.

4.2.2 April through June

During the April through June period, minimizing flow fluctuations and mimicking the natural unimpaired hydrological patterns for juvenile rearing and emigration were of particular concern to the Technical Team. During May and June, water temperature was a very important consideration for several species/run and life stage combinations, including spring-run Chinook salmon adult immigration and holding, juvenile rearing, and smolt emigration, fall-run Chinook salmon juvenile rearing and outmigration, and steelhead embryo incubation (May only), juvenile rearing, and smolt emigration (May only). Providing flows sufficient to transport emigrating juvenile salmonids also was of concern.

Flow fluctuations resulting from Yuba Project operations were identified by the Technical Team in the Stressor Matrix as a very important limiting factor for the spawning and egg incubation life stages and the fry and juvenile life stages of the anadromous salmonids the lower Yuba River. However, flow fluctuations were not a specific consideration when developing the flow schedules because the current flow fluctuation and ramping requirements and the on-going RD-1644-mandated redd dewatering and fry stranding study were sufficient to address any flow fluctuation concerns.

The Technical Team identified April through June 15 as the primary smolt emigration period for fall-run and spring-run Chinook salmon, and October through May for yearling (+) outmigration for steelhead in the lower Yuba River. In consideration of these life stages, the Technical Team sought to develop a flow regime that mimicked the unimpaired hydrological pattern (based on the available data) during spring, provided appropriate transport flows for emigrating juveniles, and provided appropriate water temperatures for rearing and emigrating juveniles. **Figure 4-2** presents the monthly average lower Yuba River unimpaired run-off by water year type. As illustrated in Figure 4-2, peak run-off during the wetter years occurs during May, with high run-off also occurring in April and June.

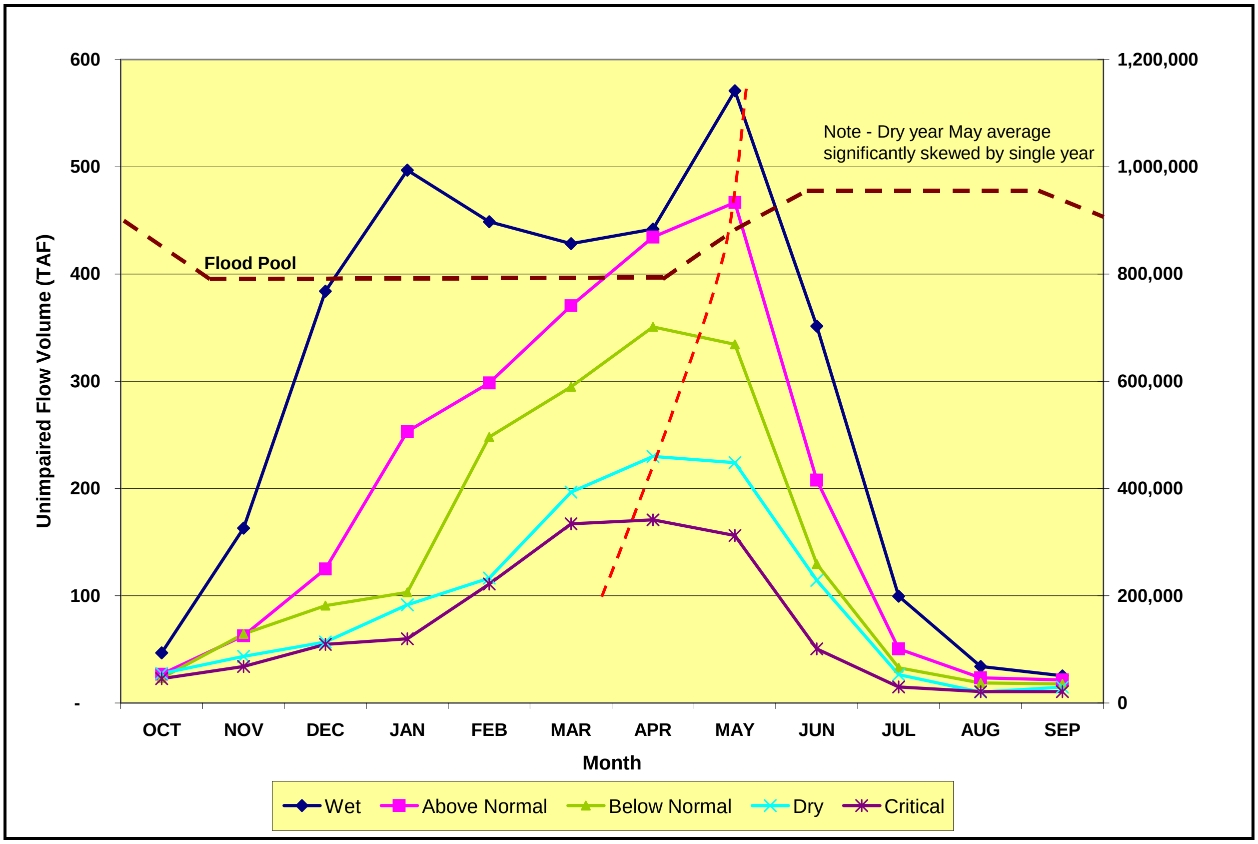


Figure 4-2. Simulated Unimpaired Monthly Flow Volume, by Water Year Type, Based on the 78-year Hydrologic Period of Record

When considering transport flows for juvenile salmonid emigration, the Technical Team was concerned with the conditions downstream of the lower Yuba River (i.e., in the Feather River, Sacramento River, and the Delta) to which juvenile Yuba River salmonids would be emigrating. The Technical Team was particularly concerned about providing "optimal" juvenile salmonid emigration conditions in the lower Yuba River and "encouraging" juvenile fish to emigrate to conditions in the lower Feather and Sacramento rivers that may be less favorable. However, the Technical Team ultimately concluded that the conditions in the lower Feather and lower Sacramento rivers, and the Delta were beyond the Technical Team's control, and therefore focused on providing anadromous salmonids the best possible conditions, under the given constraints, in the lower Yuba River.

The resulting Schedule 1 and Schedule 2 flows for April through June addressed the Technical Team's objectives of: (1) mimicking to the extent feasible the natural unimpaired hydrological run-off pattern; (2) providing sufficient transport flows for emigrating juvenile salmonids; and (3) providing appropriate water temperatures for rearing and emigrating juvenile salmonids.

4.2.3 JULY AND AUGUST

Water temperature, particularly downstream of Daguerre Point Dam, was the overriding consideration in the development of July and August flows. Anadromous salmonid life stages present in the lower Yuba River during July and August include steelhead juvenile rearing and adult immigration and holding (August only), spring-run Chinook salmon juvenile rearing and adult immigration and holding, and fall-run Chinook salmon adult immigration and holding (August only).

Although there was (and still is) much debate among Technical Team biologist regarding the water temperature requirements of specific life stages of the anadromous salmonid species in the lower Yuba River, the following water temperatures generally guided flow schedule development for Chinook salmon and steelhead:

- ❑ Over-summer Rearing: < 65°F
- ❑ Adult Holding and Pre-spawning: < 60°F
- ❑ Spawning: < 58°F
- ❑ Optimal Spawning: < 56°F

Because Daguerre Point Dam's fish ladders do not allow juvenile salmonid upstream movement, any juvenile fish that pass Daguerre Point Dam downstream would be restricted to rearing in the lower reach of the lower Yuba River (i.e., downstream of Daguerre Point Dam). Given the progressive warming that occurs in a downstream direction in the lower Yuba River during the warmer months, an important consideration for the Technical Team was that juvenile salmonids may be exposed to stressful water temperatures downstream of Daguerre Point Dam. The Technical Team concluded that the optimal high and low flow schedules (Schedules 1 and 2) would provide juvenile salmonids plenty of rearing habitat with suitably cool water temperatures downstream from Daguerre Point Dam during July and August. In addition, the Technical Team concluded that flow Schedules 1 and 2 also would provide suitable water temperatures for Chinook salmon immigration and holding.

4.3 "SURVIVAL" FLOW SCHEDULE DEVELOPMENT

The second step of the flow schedule development process was the development of a "worst case" flow schedule for years with extremely low water availability, targeting hydrologic year classes in the 5 percent of driest years. This flow schedule, which eventually became Schedule 6, was termed the "survival" flow schedule because the Technical Team sought to develop a flow regime that permitted survival of the year's cohort. The total annual Schedule 6 flow volume is approximately 174,000 acre-feet less than that in Schedule 2 years. **Table 4-3** presents the Schedule 6 flow requirements.

Table 4-3. Technical Team Schedule 6 Flow Requirements as Measured in cfs at the Marysville Gage

Schedule	Oct		Nov	Dec	Jan	Feb	Mar	Apr		May		Jun		Jul	Aug	Sep	Total Annual Volume (AF)
	1-15	16-31	1- 30	1-31	1-31	1-29	1-31	1-15	16-30	1-15	16-31	1-15	16-30	1-31	1-31	1-30	
6	300	400	400	350	350	350	350	350	450	500	500	300	150	150	150	300	234,135

Significant flow reductions from Schedule 2 were made in all months, particularly during the spring, to develop this schedule. Flows were reduced as little as possible during the fall to protect Chinook salmon spawning to the extent feasible. The Smartville Gage flow requirements (Table 4-2) are reduced during Schedule 6 years as well.

The 500 cfs requirement at Smartville during September of Schedule 6 years provides the same percent of maximum salmon spawning WUA (98.6 percent) as the 700 cfs requirement for Schedule 1 though 4 years. The October through November and April 1-15 requirement of 600 cfs provides 100 percent of maximum spawning WUA for Chinook salmon and approximately 97 percent of maximum spawning WUA for steelhead. The December through March Smartville Gage requirement of 550 cfs provides approximately 99 percent and 93 percent of maximum spawning WUA for Chinook salmon and steelhead, respectively.

4.4 REMAINING FLOW SCHEDULES DEVELOPMENT

Recognizing the year-to-year variations in lower Yuba River water availability, the Technical Team developed three additional flow schedules (Schedules 3, 4, and 5) to accommodate levels of water availability between the "optimal" flows and the "survival" flows. **Table 4-4** presents Schedules 3, 4, and 5. The step size between each successive flow schedule was adjusted to be large enough to cover the ranges of water availability without resulting in excessive jumps between flow schedules. The Technical Team considered utilizing more or fewer than a total of six flow schedules; however, it was ultimately determined that six flow schedules could adequately address nearly the entire spectrum of hydrological occurrences.

Table 4-4. Technical Team Schedule 3, Schedule 4, and Schedule 5 Flow Requirements as Measured in cfs at the Marysville Gage

Schedule	Oct		Nov	Dec	Jan	Feb	Mar	Apr		May		Jun		Jul	Aug	Sep	Total Annual Volume (AF)
	1-15	16-31	1- 30	1-31	1-31	1-29	1-31	1-15	16-30	1-15	16-31	1-15	16-30	1-31	1-31	1-30	
3	500	500	500	500	500	500	700	600	700	700	700	400	400	400	400	400	371,844
4	300	300	500	500	500	500	700	600	700	700	700	400	300	300	300	300	338,382
5	300	300	500	500	500	500	500	500	500	400	400	400	300	250	250	300	292,446

The previously presented Smartville flow schedules (Table 4-2) require that flows, as measured in cfs at the Smartville Gage, during September through April during Schedule 1, 2, 3, and 4 years must be at least 700 cfs, regardless of the requirements at the Marysville Gage. This requirement ensures that Chinook salmon and steelhead flow-related spawning habitat upstream of Daguerre Point Dam, which constitutes the majority of habitat, is protected during these years. The Smartville Gage requirements are slightly lower during Schedule 5 and 6 years to accommodate the reduced water availabilities of these years.

Flows were reduced from Schedule 2 to Schedule 3 during April, May, and the first half of June because of the overarching emphasis the Technical Team placed on summer and fall water temperatures to protect rearing juvenile salmonids and immigrating and holding Chinook salmon (particularly spring-run) and steelhead, and on fall flows for Chinook salmon spawning. When making this flow reduction, the Technical Team concluded that maintaining summer and fall flows was a top priority and that the resulting spring flows were sufficient to protect emigrating fry and juvenile salmonids.

The flow reductions from Schedule 3 to Schedule 4 resulted in lower flows from June 16 through October, while spring flows were maintained at the levels established in Schedule 3. The goal of this flow reduction was to maintain the shape of the unimpaired hydrograph (see Figure 4-2) with peak flows during the spring without sacrificing summer water temperatures. The Technical Team believed the 100 cfs reduction in flow (measured at the Marysville Gage) from June 16 through September might decrease the linear distance of river with suitable juvenile salmonid rearing water temperatures, but not to the extent that production would be dramatically compromised. The 200 cfs decrease at the Marysville Gage during October was justified because, although it can be warm, ambient temperature conditions typically cool during October. Water temperatures upstream of Daguerre Point Dam are not believed to be an issue during most Octobers.

Flow reductions from Schedule 4 to Schedule 5 resulted in lower flows during March through May and slightly lower flows during June 16 through August.

5.0 EVALUATION OF OPERATIONAL OBLIGATIONS AND CONSTRAINTS

5.1 LIMITATIONS ON THE LOWER YUBA RIVER

There are many limitations on YCWA's ability to provide flows in the lower Yuba River; chief among those is hydrologic variability. Runoff in the Yuba River Basin that ultimately flows to the lower Yuba River is highly variable, with total Yuba system runoff ranging from 276,000 to 3.8 million acre-feet per year. Even with wet year storage reservoirs to provide some inter-year flow balancing, there will still be occurrences of wet year and critically dry year classes.

In addition to hydrologic variability, there are a variety of legal, regulatory, and operational constraints that govern or dictate either storage volumes in the Yuba River Development Project reservoirs or releases to the lower Yuba River. Some of the constraints are "fixed", for which YCWA has very little ability to modify or vary from the constraint. Other constraints are more flexible.

In addition to hydrologic variation, key legal and regulatory constraints include:

- ❑ Consumptive demands, and legal requirements to meet those demands, in Yuba County that are supplied from the lower Yuba River
- ❑ Water rights of other consumptive users in the lower Yuba River
- ❑ Flood control requirements in New Bullards Bar Reservoir
- ❑ Required Releases from storage to meet power contract requirements
- ❑ Flow fluctuation and ramping constraints
- ❑ Key operational constraints include:
- ❑ Routine maintenance requirements, including periods during which facilities are shut down for maintenance
- ❑ Operations during flood control or storm runoff periods
- ❑ Maintenance of river flows in consideration of the ESA consequences (avoidance of dewatering salmon redds)

- ❑ Physical system limitations
- ❑ Reservoir carry-over requirements

Figure 5-1 graphically depicts the impacts of several New Bullards Bar Reservoir operations constraints.

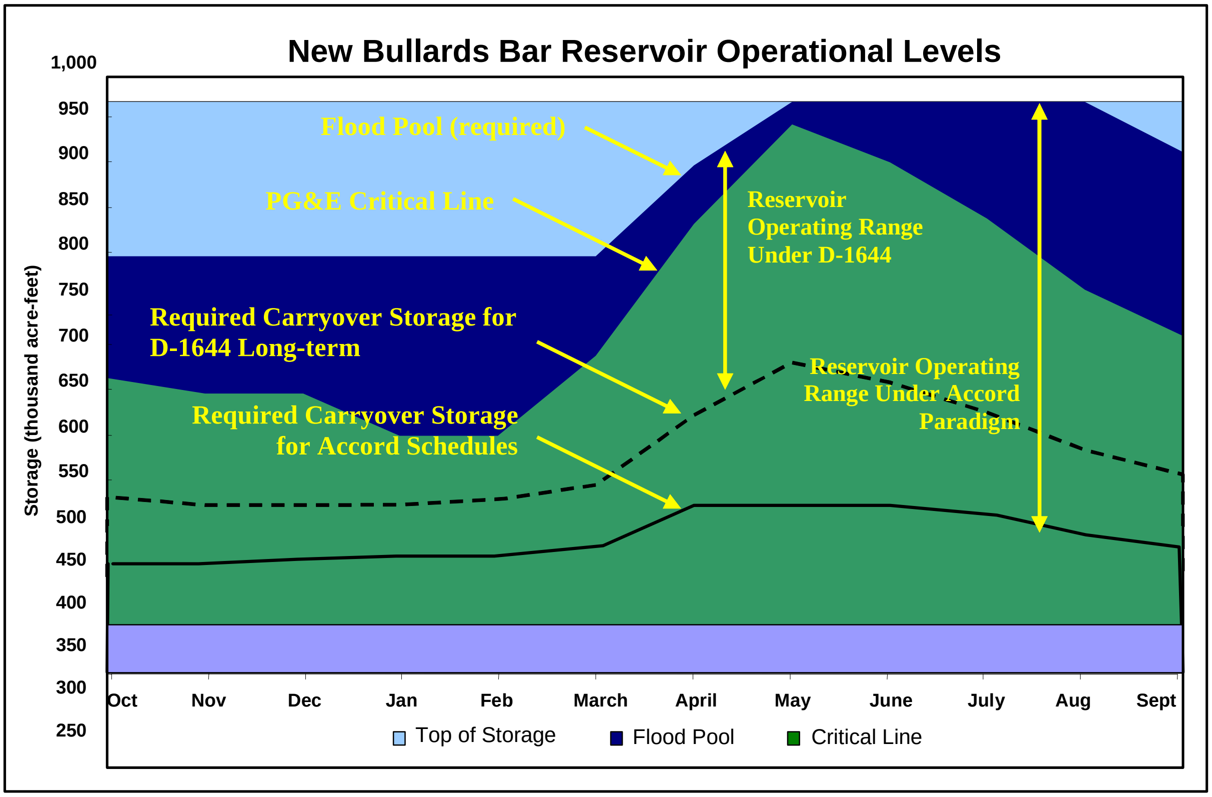


Figure 5-1. New Bullards Bar Reservoir Operations Constraints

The Technical Team spent considerable time investigating and understanding these constraints in the context of developing the flow schedules for the lower Yuba River. As mentioned previously, many of these constraints are relatively inflexible, for which YCWA has little potential to modify the constraint to facilitate a different flow release schedule. Of the relatively flexible constraints, one of the most critical to successful operations of lower Yuba River flows and diversions is the reservoir carry-over storage requirement. Given the variability of the year-to-year hydrologic conditions, it is imperative for YCWA to "carry-over" a volume of water in a New Bullards Bar Reservoir sufficient to meet the basic needs of the lower Yuba River during the subsequent (potentially dry) water year. Lack of sufficient carryover volume would result in delivery shortages in a subsequent dry year; excess carryover volume means that less water was utilized for in-river flows during the current year, and carries a higher risk of spill during the runoff season.

Two key factors affect the selection of an appropriate carryover volume: total potential demand, and a reliability target. The total potential demand includes both water required for instream flow requirements and water acquired for consumptive demands. The reliability target reflects the desire to be able to meet the potential demands without shortages. For example, a reliability target using a 1:200 dry year would still allow demands to be met in a year when inflow was in the 0.5 percent driest (1:200) of years. Historically, YCWA planned to meet the lowest flow schedule (corresponding to the driest year flow schedule), with a 1:200 reliability target.

5.2 North Yuba Index

Once the Technical Team had developed a set of flows schedules for the lower Yuba River, it was necessary to develop a methodology for determining when the appropriate flow schedule would be utilized. It was important that the method of assigning flow schedules be responsive, a good indicator of hydrologic year class, and provide a reasonable balance between releasing water in the current year and carrying over water to meet potential future dry years. The NYI was developed as the water year hydrologic classification system to be used for determining flow schedule release requirements.

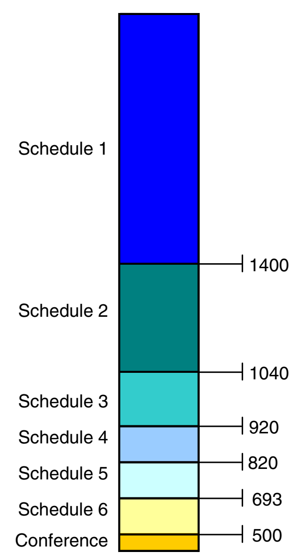
The NYI is an indicator of the amount of water available in the North Yuba River at New Bullards Bar Reservoir that can be utilized to maintain flows in the lower Yuba River through operations of New Bullards Bar Reservoir. The index is comprised of two components: (1) active storage in New Bullards Bar Reservoir for the current water year; and, (2) total inflow to New Bullards Bar Reservoir for the current water year, including diversions from the Middle Yuba River and Oregon Creek to New Bullards Bar Reservoir.

The Technical Team, with the support of YCWA and resource agency hydrologists and modelers, spent considerable time evaluating the components and 'inflection points' of the NYI, including variations on the structure of the Index (the relative inflow and reservoir influences on the index), Index inflection points for determining flow schedule assignments, and protocols for use of the Index (when the Index and corresponding flow schedule is updated during the year).

Determinations of a year's flow schedule type will be made in February, March, April, and May and for any subsequent updates. **Table 5-1** presents the North Yuba Index and resulting flow schedules. Additional detail regarding the North Yuba Index is presented in the Fisheries Agreement (Appendix E).

Table 5-1. North Yuba Index Hydrologic Classification and Flow Schedule Determination Criteria

Flow Schedule Year Type	North Yuba Index Thousand Acre-Feet (TAF)
Schedule 1	Equal to or greater than 1,400
Schedule 2	Equal to or greater than 1,040 and less than 1,400
Schedule 3	Equal to or greater than 920 and less than 1,040
Schedule 4	Equal to or greater than 820 and less than 920
Schedule 5	Equal to or greater than 693 and less than 820
Schedule 6	Equal to or greater than 500 and less than 693
Conference Year	Less than 500



5.3 PROBABILITY OF OCCURRENCE OF FLOW SCHEDULES

Once the Technical Team had developed both flows schedules and the North Yuba Index, it was then possible to statistically project the probability of occurrence of each of the flow schedules based on the historic hydrology of the Yuba River basin.

One of the Technical Team's objectives was to maximize the probability of occurrence of the higher flow schedules (1 and 2) while minimizing the probability of occurrence of the very low flow schedules (6 and Conference Year). **Table 5-2** presents the estimated probabilities of occurrence of the six flow schedules and the Conference Year[4], based on preliminary modeling of the Consensus Flow Schedules and the 78-year period of hydrologic record.

Table 5-2. Estimated Predicted Probabilities of Occurrence of the Six Flow Schedules and the Conference Year

Schedule	North Yuba Index (TAF)	Percent Occurrence	Cumulative
1	≥1,400	56%	56%
2	1,040 to 1,400	22%	78%
3	920 to 1,040	7%	85%
4	820 to 920	5%	90%
5	693 to 820	5%	95%
6	500 to 693	4%	99%
Conference	<500	1%	100%

Once the probability of occurrence of the different flow schedules was computed, the Technical Team was able to adjust the relative frequencies of the flow schedules by adjusting the volume of water in each of the flow schedules. In particular, the dry-year flow schedules had the greatest impact on the necessary carryover storage volume, and thus on the frequency of occurrence of the wetter-year flows schedules. Increasing the volume of water to be released during a Schedule 6 year therefore would reduce the frequencies the more desired Schedule 1 or 2 years, and thus would increase the frequency of the Schedule 6 year class. In subsequent phases of flows schedule development, the Technical Team was able to adjust the frequency of occurrence of the various flow schedules by adjusting the volume of water in each flow schedule.

6.0 EVALUATE OPTIONS FOR REMOVING OR LIMITING CONSTRAINTS

The Technical Team recognized the different ways in which the various constraints on the Yuba River system impacted the ability to maintain flows to the lower Yuba River. During the next phase of development of the lower Yuba River flow schedules, the Technical Team evaluated a variety of different options for removing, eliminating, or modifying constraints on the Yuba River system to allow either higher instream flows, or a higher frequency of the occurrence of those flows. Many different options for removing or minimizing constraints were identified and evaluated. Most had insufficient benefit (in terms of additional water or flexibility) for the cost (in terms of water or money), and were excluded from further evaluation. Ultimately, the Technical Team identified several key changes in operations that would yield significant

[4] Note: The Conference Year concept is discussed more fully in Section 6.3.

benefits in terms of water availability or operational flexibility for the lower Yuba River. The following sections describe some of the major changes to historic operations protocols that were developed by the Technical Team, and that will be implemented as a portion of the Yuba Accord.

6.1 CONJUNCTIVE USE OF YUBA COUNTY GROUNDWATER RESOURCES

The conjunctive use of ground water resources means that water demands within Yuba County can be met with either surface or ground water supplies. Essentially, the groundwater reservoir acts as a backup to New Bullards Bar Reservoir, allowing New Bullards Bar Reservoir to be cycled more aggressively.

Under the provisions of the flow schedules developed for the Yuba Accord, YCWA's Member Units (irrigation districts and mutual water companies within Yuba County) will be faced with the potential for shortages of surface water supply. Through conjunctive use agreements between YCWA and the Member Units, the Member Units will supplement the surface water supply provided by YCWA with groundwater pumping. Additionally, the Member Units will pump a minimum of 30,000 acre-feet of water in Schedule 6 years, making an equivalent amount of water (30,000 acre-feet) available for the lower Yuba River.[5]

6.2 MODIFICATIONS OF THE PACIFIC GAS AND ELECTRIC COMPANY POWER PURCHASE CONTRACT

Various contractual terms in the Power Purchase Contract (PPC) between YCWA and PG&E require certain minimum monthly power generation amounts, and maximum reservoir storage volumes. Since some of the terms in the PPC potentially conflict with the ability of YCWA to provide the flows schedules developed by the Technical Team, YCWA and PG&E have agreed to modify the terms of the PPC to relax some of the flow and storage obligations in the PPC.

6.3 CONFERENCE YEAR

The "Conference Year" concept was developed for the very driest water years. As discussed previously, carryover volume required to meet minimum flow requirements in the very driest year classes has a substantial impact on the ability to use a greater portion of the reservoir storage volume during normal year classes. A high instream flow requirement for extremely dry years necessitates that a large block of water be carried over to provide for those relatively high dry year flows. Conversely, if dry year flows are lower (in keeping with low runoff conditions), a smaller block of water is required to be carried over, and more water is available for use during current-year releases. The Technical Team developed a conference year concept that would apply during only the very driest 1 percent of water years. During these extremely dry years, there will be insufficient water to meet many of the demands within Yuba County.

During Conference Years, YCWA will operate the Yuba Project so that: (1) flows in the lower Yuba River comply with the instream flow requirements in YCWA's FERC License, except that YCWA will not pursue any of the flow reductions authorized by article 33(c) of that license, and

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[5] It should be noted that a necessary element of this conjunctive use program will be the funding provided by the Water Purchase Agreement, which allows YCWA to compensate the Member Units for pumping in support of lower Yuba River flows.

YCWA will provide any additional instream flows agreed to by the RMT Planning Group; and (2) total diversions at Daguerre Point Dam (including Browns Valley Irrigation District's diversions into its Pumpline Canal) will not exceed 250,000 acre-feet per year.

If Conference Year conditions are present or imminent, then YCWA, in consultation with its Member Units, will prepare a strategic management plan that will state affirmative steps that YCWA and the Member Units will undertake to ensure that total diversions will not exceed 250,000 acre-feet per year. YCWA will submit this plan to the RMT as soon as practicable after the determination that Conference Year conditions are present or imminent. YCWA will provide the RMT with any updates that YCWA makes to this plan, and YCWA will provide the RMT with monthly reports on the implementation of this plan. YCWA will ensure implementation and enforcement of the plan's requirements through its contracts with its Member Units.

6.4 DEMAND LIMITS AND CONSERVATION

YCWA is obligated to provide for consumptive demands within Yuba County, and County-wide demands have continued to grow through the years. However, YCWA, in consultation with the Member Units, has structured a limit on the consumptive demand for the duration of the Yuba Accord. This upper limit will both provide greater certainty in the delivery of the Yuba Accord flow schedules (manifested in a higher probability of delivery of Schedules 1 and 2), and will provide some incentive for additional conservation by YCWA and the Member Units.

6.5 LOWER RESERVOIR CARRYOVER TARGET LEVEL

The conjunctive use program, demand limits, and conference year described above would combine to allow a lower reservoir carryover target level. Additionally, YCWA modified the reliability target for deliveries within Yuba County. Prior to the Yuba Accord, YCWA had typically planned to provide full consumptive releases even if the following year was a 1:200 dry year. To increase the reservoir operations flexibility to accommodate the Technical Team flows, YCWA modified this planning criterion to a 1:100 reliability target. The 1:100 year reservoir carryover storage requirement allows New Bullards Bar to be operated more aggressively (e.g., allows the reservoir storage to be drawn down farther) than previously, but imposes more shortage risks on YCWA.

7.0 OPTIMIZATION OF FLOW SCHEDULES

Following the initial development of flow schedules by the Technical Team, Yuba Project operations were simulated using a spreadsheet-based Yuba Basin model with 78 years of available hydrologic records, the new flow schedules, and existing operational constraints. Modeling the flow schedules allowed YCWA and the Technical Team to identify the relative frequency of each flow schedule, hydrological risk factors, and the most confining operational constraints. Key factors and constraints were further evaluated to determine how to minimize shortage risk and maximize water availability. As described in the previous section, concepts that were explored in detail and ultimately included in the Yuba Accord include: (1) modifying the reservoir storage carryover requirement; (2) developing a new water availability index, eventually termed the North Yuba Index; (3) identifying a plan for the very driest, "Conference Years"; and (4) developing a conjunctive use program.

Even with the relaxation of some of the operational constraints on the Yuba River system, some flow schedule tradeoffs were still necessary. Fundamental flows tradeoffs included:

- Higher flows during drier years require higher reservoir carryover, making less water available for the current water year, and reducing the incidence of the higher flow schedules. As described in Sections 5.1 and 6.5, generally lower flow requirements in drier year classes allow more of the reservoir to be used in all years, because the carryover target is calculated based on the need to deliver the driest-year flow volumes during driest-year conditions.
- High spring flows (particularly during the months of May and June) often require the use of releases from storage, reducing the amount of water available for temperature mitigation during the warmer months and spawning flows in the dry fall months. As can be seen in Figure 4-2, peak runoff occurs earlier in dry year classes. If high spring flows are required later than the peak of the runoff cycle, there is a high likelihood that those spring flows would need to be released from storage, rather than being provided directly from the natural runoff.
- It is important to strike a balance between use of water in the current year and prudent carryover volumes, with a successful balance benefiting both fisheries and consumptive users. Excessive releases in the current water year, whether for consumptive or fisheries needs, would have the potential to result in shortages in subsequent dry years. Conversely, excessively cautious operations and high carryover volumes would make less water available in the current year, and increase the likelihood of spills in a subsequent wet year.

Once the Technical Team fully understood the operational constraints and flow tradeoffs, the team was able to reconsider the flow schedules to: (1) make use of the flexibilities discovered in some of the operational constraints, and (2) find an optimal balance in inter-month and inter-year flow tradeoffs.

7.1 AUGMENTED FLOW SCHEDULE DEVELOPMENT

The "second pass" of flow schedule development by the Technical Team yielded what was known within the Team as the Augmented Flow Schedules. The Augmented Flow Schedules are shown in **Table 7-1**. Flow modifications that resulted in the Augmented Flow Schedules were concentrated during the summer and fall months, which the Technical Team considered to be critical periods for lower Yuba River anadromous salmonid production.

Table 7-1. Augmented Flow Schedules

Schedule	Oct		Nov	Dec	Jan	Feb	Mar	Apr		May		Jun		Jul	Aug	Sep	Total Annual Volume (AF)
	1-15	16-31	1- 30	1-31	1-31	1-29	1-31	1-15	16-30	1-15	16-31	1-15	16-30	1-31	1-31	1-30	
1	500	500	500	500	500	500	700	1,000	1,000	2,000	2,000	1,500	1,500	600	600	600	574,002
2	500	500	500	500	500	500	700	700	800	1,000	1,000	800	500	500	500	500	429,264
3	500	500	500	500	500	500	700	600	700	700	700	500	500	500	500	500	396,000
4	400	400	500	500	500	500	700	600	700	700	700	400	400	400	400	400	365,706
5	350	350	500	500	500	500	500	500	500	400	400	400	400	400	400	350	322,839
6	325	325	350	350	350	350	350	350	450	500	500	300	150	150	150	300	229,532

Under the Augmented Flow Schedules, as measured at the Marysville Gage:

- Flows were increased by 100 cfs during June 1-15 in Schedule 3 years;
- Flows were increased by 100 cfs during June 16-30 in Schedule 2, 3, 4 and 5 years;
- Flows were increased by 100 cfs during July in Schedule 2, 3, and 4 years, and by 150 cfs in Schedule 5 years;
- Flows were increased by 100 cfs during August in Schedule 1, 2, 3, and 4 years, and by 150 cfs in Schedule 5 years;
- Flows were increased by 100 cfs during September in Schedule 1, 2, 3, and 4 years, and by 50 cfs in Schedule 5 years;
- Flows were increased by 100 cfs during October in Schedule 4 years, by 50 cfs in Schedule 5 years, and by 25 cfs during October 1-15 in Schedule 6 years;
- Flows were decreased by 75 cfs during October 16-31, and by 50 cfs during November, in Schedule 6 years; and
- The Smartville Gage flows were not changed.

The modifications resulting in the Augmented Flow Schedules were anticipated to: (1) provide higher flows and lower water temperatures during summer and early fall for adult salmonid immigration, holding, and spawning, and for juvenile salmonid rearing; and (2) provide higher flows and lower water temperatures during late spring for spring-run Chinook salmon immigration and holding, and for juvenile salmonid emigration. The small reductions in flows during October 16-31 and November in Schedule 6 years were acceptable given the aforementioned increase in flows during other years.

A concept that gained increasing importance throughout the flow schedule development process was that of probability of occurrence (e.g., the percentage of years which a particular Flow Schedule is expected to be implemented, based on the 78-year lower Yuba River hydrologic period of record). The Technical Team opted to develop a regime in which the schedules that resulted in the highest instream flows (i.e., Schedules 1 and 2) had a relatively high probability of occurrence. A probability of occurrence of approximately 75 percent for the "Optimal" Flow Schedules (1 and 2) was acceptable to the Technical Team. The trade-off of this approach was that the Schedules 1 and 2 flows could not be too high, which would have resulted in a reduced probability of occurrence.

7.2 FINAL TUNING OF FLOW SCHEDULES

The final step in the flow schedule development process was further refinement of the Augmented Flow Schedules to produce the Consensus Flow Schedules, which were ultimately adopted as the Yuba Accord flow schedules. The final series of refinements focused on further alleviating perceived lower Yuba River stressors, achieving additional biological enhancements, and providing month-to-month flow sequencing that was consistent with salmonid life history periodicities.

At this point, the Yuba River Index development was completed and the monthly flow volumes in the flow schedules could be adjusted to achieve the desired probabilities of occurrence. Additionally, conjunctive use concepts were further defined and could be used to reduce risk and make additional flow available.

7.2.1 CONSENSUS/YUBA ACCORD FLOW SCHEDULES

Table 7-2 presents the Consensus Flow Schedules. The changes in flows under the Consensus Flow Schedules were concentrated during the spring, but some modifications were made during the summer and fall.

Table 7-2. Consensus Flow Schedules

Schedule	Oct		Nov	Dec	Jan	Feb	Mar	Apr		May		Jun		Jul	Aug	Sep	Total Annual Volume (AF)
	1-15	16-31	1- 30	1-31	1-31	1-29	1-31	1-15	16-30	1-15	16-31	1-15	16-30	1-31	1-31	1-30	
1	500	500	500	500	500	500	700	1,000	1,000	2,000	2,000	1,500	1,500	700	600	500	574,200
2	500	500	500	500	500	500	700	700	800	1,000	1,000	800	500	500	500	500	429,066
3	500	500	500	500	500	500	500	700	700	900	900	500	500	500	500	500	398,722
4	400	400	500	500	500	500	500	600	900	900	600	400	400	400	400	400	361,944
5	400	400	500	500	500	500	500	500	600	600	400	400	400	400	400	400	334,818
6	350	350	350	350	350	350	350	350	500	500	400	300	150	150	150	150	232,155

Under the Consensus Flow Schedules, as measured at the Marysville Gage:

- Flows were decreased by 200 cfs during March in Schedule 3 and 4 years;
- Flows were increased by 100 cfs during April 1-15 in Schedule 3 years;
- Flows were increased by 200 cfs, 100 cfs, and 50 cfs during April 16-30 in Schedule 4, 5, and 6 years, respectively;
- Flows were increased by 200 cfs during May 1-15 in Schedule 3, 4, and 5 years, and during May 16-31 in Schedule 3 years;
- Flows were decreased by 100 cfs during May 16-31 in Schedule 4 and 6 years;
- Flows were increased by 100 cfs during July in Schedule 1 years;
- Flows were decreased by 100 cfs during September in Schedule 1 years;
- Flows were increased by 50 cfs during September in Schedule 5 and 6 years;
- Flows were increased by 50 cfs and 25 cfs during October 1-15 and 16-31, respectively, in Schedule 5 and 6 years; and
- The Smartville Gage flows were not changed.

The primary flow modifications occurred during the spring. The Technical Team attempted to mimic the form of the natural unimpaired run-off pattern (Figure 5-1) by providing peak flows during Mays of wetter years (Schedules 1, 2 and 3) and during the last half of April and first half of May during drier years (Schedule 4, 5, and 6). This patterning was implemented primarily to provide juvenile salmonid emigration flows.

7.2.2 SEPTEMBER THROUGH MARCH

During September through April 15, the Smartville Gage flow requirements (Table 4-2) ensure that appropriate Chinook salmon and steelhead flows will be provided upstream of Daguerre Point Dam, where the majority of salmonid spawning occurs. The 700 cfs requirement during September through April 15 in Schedules 1, 2, 3, and 4 equates to approximately 99 percent of maximum Chinook salmon spawning WUA and 100 percent of maximum steelhead spawning WUA. The Smartville Gage requirements in Schedules 4 and 5 provide:

- 98.6 percent of maximum Chinook salmon spawning WUA during September;
- 100 percent of maximum Chinook salmon spawning WUA during October through November;
- 99 percent of maximum Chinook salmon spawning WUA during December;
- 93 percent of maximum steelhead spawning WUA during January through March; and
- 97 percent of maximum steelhead spawning WUA during April 1-15.

Water temperature, particularly for Chinook salmon immigration, holding, spawning, and egg incubation, also was a primary consideration in developing the flow schedules during September and October.

7.2.3 APRIL THROUGH JUNE

During the April through June period, minimizing flow fluctuations and mimicking the natural unimpaired hydrological patterns for juvenile rearing and emigration were of particular concern to the Technical Team. Within this period, water temperature was a very important consideration during May and June for several anadromous salmonid life stages, including juvenile rearing and smolt emigration. Providing flows sufficient to transport emigrating juvenile salmonids, particularly yearling and older fish, including smolts, also was of concern.

Annual instream flow requirements are highest during the April through June period, reflecting the objective of maintaining the natural unimpaired hydrograph pattern to the extent feasible. Peak flow requirements in May during Schedule 1, 2, and 3 years, shifting to April 16-30 and May 1-15 during Schedule 4, 5, and 6 years, follow the pattern of shifting peak flows progressively earlier under progressively drier water years (Figure 5-1).

7.2.4 JULY AND AUGUST

Water temperature, particularly downstream of Daguerre Point Dam, was the overriding consideration in the development of July and August flows. Important anadromous salmonid life stages present in the lower Yuba River during July and August include steelhead juvenile rearing and adult immigration (August only), spring-run Chinook salmon juvenile rearing and adult immigration, and fall-run Chinook salmon adult immigration (August only).

For additional detail on the month-by-month flow development considerations, Section 4.0, Development of Initial Flow Schedules.

7.2.5 ADDITIONAL FLOWS FOR SCHEDULE 6

Through the development of the Consensus Flow Schedules, the Technical Team remained concerned with the Schedule 6 year flows. In particular, the 150 cfs flow requirement for June 16 through August 31 potentially could result in warm water temperatures, particularly downstream from Daguerre Point Dam. To address the Technical Team's concern, YCWA will operate a groundwater-substitution program in water years when Schedule 6 is in effect, which will result in an additional 30,000 acre-feet of water not shown in Schedule 6 flowing in the lower Yuba River at the Marysville Gage during the portions of such years when this water is transferable. Subject to the preceding requirement of transferability, the RMT, through a decision by its Planning Group, will determine the flow schedule for the 30,000 acre-feet during each Schedule 6 year. This flow schedule will be set to achieve maximum fish benefit during the transfer period. The transferable period is anticipated to be quite broad during this very dry year class, and it is anticipated that the additional water will be discharged during the lowest flow period (mid-June through August).

7.2.6 PROBABILITY OF OCCURRENCE OF FLOW SCHEDULES

One of the Technical Team's objectives was to maximize the probability of occurrence of the higher flow schedules (1 and 2) while minimizing the probability of occurrence of the very low flow schedules (6 and Conference Year). **Table 7-3** presents the estimated probabilities of occurrence of the six flow schedules and the Conference Year, based on preliminary modeling of the Consensus Flow Schedules and the 78-year period of hydrologic record.

Table 7-3. Estimated Predicted Probabilities of Occurrence of the Six Flow Schedules and the Conference Year

Schedule	North Yuba Index (TAF)	Percent Occurrence	Cumulative
1	≥1,400	56%	56%
2	1,040 to 1,400	22%	78%
3	920 to 1,040	7%	85%
4	820 to 920	5%	90%
5	693 to 820	5%	95%
6	500 to 693	4%	99%
Conference	<500	1%	100%

As presented in Table 7-3, the Technical Team's objectives of implementing the "optimum" flows (Schedule 1 and 2) at least 75 percent of the time and the "survival" flows (Schedule 6) 5 percent or less of the time were achieved.

8.0 DEVELOPMENT OF THE REMAINDER OF THE FISHERIES AGREEMENT

Once the Technical Team had completed its work on the flow schedules and modifications to the operational constraints on the lower Yuba River, all of the members of the Technical Team took the resulting work products to their respective managements for review and consultation. This management review step included peer review, scientific and technical scrutiny, verification of modeling results, and other investigations and scrutiny seeking to identify any potential flaws or problems with the technical work put forth by the Technical Team.

After the management and peer review, the entities that had participated in the Technical Team (resource agencies, NGOs, and YCWA) established a Drafting Team to turn the technical work of the Technical Team into a proposed formal agreement among all of the parties. The work of the Drafting Team took over 12 months to complete, and involved yet another layer of careful review and scrutiny of the work of the Technical Team. As with the Technical Team, all of the parties were represented on the Drafting Team, and were able to put forth and represent their own interests and ideas. As during the course of the discussions of the Technical Team, the Drafting Team considered numerous alternatives, permutations, variations and ideas both for the terms of the legal document that was being crafted, and as a 'test' and reconsideration of the work put forward by the Technical Team[6].

[6] On many occasions, members of the Technical Team were asked about the decisions and intent of various provisions of the flow schedules and NYI. Conversely, on many occasions Technical Team members reviewed the

In addition to codifying the work of the Technical Team, the Drafting Team crafted and developed several other key aspects of the Fisheries Agreement and of the Yuba Accord. Three of the key elements of the Fisheries Agreement developed by the Drafting Team included:

- Structuring a River Management Team for operational input, decision making, and direction for monitoring studies for the lower Yuba River;
- Establishing a River Management Fund, to pay for focused studies and monitoring work on the lower Yuba River; and
- Developing a comprehensive set of rights and remedies that will ensure the adherence to, and performance of, the Fisheries Agreement.

8.1 RIVER MANAGEMENT TEAM

The River Management Team (RMT) was established to provide a forum for dispute resolution, input into lower Yuba River operations, and oversight of studies and monitoring work under the terms of the Yuba Accord. The RMT includes both an Operations Group and a Planning Group, the duties of each of which is spelled out in the Fisheries Agreement. The RMT will include representatives of the participants in the Fisheries Agreement, plus the other participants in the Yuba Accord.

The Planning Group's authority is specified in the Fisheries Agreement includes setting the flow schedule for the 30,000 acre-feet of additional water that will occur in Schedule 6 years, developing and implementing studies of lower Yuba River fish or fish habitat, and making decisions to spend money in the RMF for any authorized purpose. The Planning Group may convene a Technical Working Group, which will include such members as the Planning Group may appoint.

The Operations Group's actions and efforts are time sensitive and will often be made in real-time or near real-time situations. The Operations Group will provide specific guidance to YCWA for YCWA's implementation of actions specified in the Fisheries Agreement, including the flow schedule set by the Planning Group for the 30,000 acre-feet of additional water during Schedule 6 years, any Planning Group decisions regarding the operations of the upper and lower outlets from New Bullards Bar Dam into the New Colgate Penstock or any temperature adjustment device that is constructed at Englebright Dam, and any other recommendations or directions from the Planning Group to the Operations Group.

8.2 RIVER MANAGEMENT FUND AND STUDY PROGRAM

The Fisheries Agreement will create a River Management Fund (RMF). The RMF is intended to provide a source of funding for ongoing monitoring and focused studies in the lower Yuba River.

The Technical Team developed a framework for prioritizing the monitoring and evaluation funding from the RMF to ensure reasonable and prudent disbursement of funds. Goals and priorities include monitoring and evaluating the effectiveness of the implementation of the flow schedules, obtaining baseline information for future application, and completing habitat

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work of the Drafting Team, to ensure that the intent and biological basis of various elements of the flow schedules were correctly captured in the Fisheries Agreement.

improvement actions and activities. The Technical Team's monitoring framework is composed of a core monitoring program, which is designed to assess long-term individual and population responses of fish in the lower Yuba River to implementation of the flow schedules, and a focused study program, which is designed to address specific, more proximate, objectives. Among other specific actions further detailed in the Fisheries Agreement, the RMF will be used for:

- Evaluating the condition of fish resources in the lower Yuba River;
- Evaluating the viability of lower Yuba River fall-run Chinook salmon and any subpopulations of the Central Valley steelhead and spring-run Chinook salmon ESUs that may exist in the lower Yuba River; and
- Implementing habitat improvement and non-flow enhancement actions and activities.
- YCWA will make contributions of $550,000 per year to the General Account of the RMF.

YCWA also will make a one-time contribution of $300,000 to the Restoration Projects Account of the RMF. Money from the Restoration Account may be used to provide parts of the costs of pilot projects for: (1) side channel restoration; (2) riparian habitat; and (3) woody debris. Any such projects must be simple, robust, and self-sustaining and demonstrate, verify or test some specific benefit.

Only the parties to the Fisheries Agreement, NMFS, and the USFWS will participate in making RMF decisions. Such decisions will be made by unanimous consent of all such parties and entities, or will be made pursuant to specific alternative dispute resolution process detailed in the Fisheries Agreement.

8.3 RIGHTS AND REMEDIES IN THE FISHERIES AGREEMENT

The Fisheries Agreement contains a comprehensive suite of rights and remedies for the various parties. These provisions are intended to ensure adherence to, and compliance with, the Fisheries Agreement by all of the parties to the Agreement. The focus of the remedies provisions is on ensuring the appropriate flows in the lower Yuba River. Key elements of the remedies provisions include:

- Dispute resolution provisions for the various aspects of the Fisheries Agreement. Different elements of the Fisheries Agreement may have different dispute resolution provisions.
- Remedies for minor and substantitive flow violations. There are also provisions for evaluating whether flow violations were accidental or deliberate.
- Provisions that seek to ensure continued collaboration, sharing of scientific data, and participation in the process of managing the lower Yuba River.

9.0 LITERATURE CITED

CALFED and YCWA. 2005. Draft Implementation Plan for Lower Yuba River Anadromous Fish Habitat Restoration. Prepared on Behalf of the Lower Yuba River Fisheries Technical Working Group by SWRI.

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