UNITED STATES BUREAU OF RECLAMATION
NEW MELONES RESERVOIR – WATER RIGHT PERMITS 16597, 16600, 20245
(APPLICATIONS 14858, 19304, 14858B)

PETITION TO CHANGE STANISLAUS RIVER DISSOLVED OXYGEN (DO) COMPLIANCE POINT

- OID/SSJID and SEWD prepared this petition for Reclamation to request the State Water Board change the compliance point for dissolved oxygen on the Stanislaus River in Reclamation water right permits for New Melones Reservoir.
- Petition contains a summary of the water right process leading up to issuance of the permits, including testimony regarding the fishery needs on the Stanislaus River.
- Monitoring of fishery resources in the Stanislaus River, as well as a review of the temperature data, indicates that fish are not rearing at Ripon as temperatures exceed what is needed for the fish.
- Petition requests the State Water Board exercise its reserved jurisdiction to move the Stanislaus River DO compliance point from Ripon (River Mile 16) to Orange Blossom Bridge (River Mile 46.9) from June 1 through August 31.

UNITED STATES BUREAU OF RECLAMATION
NEW MELONES RESERVOIR – WATER RIGHT PERMITS 16597, 16600, 20245
(APPLICATIONS 14858, 19304, 14858B)

PETITION TO CHANGE STANISLAUS RIVER DISSOLVED OXYGEN COMPLIANCE POINT

I. INTRODUCTION.

Pursuant to the requirements of State Water Resources Control Board ("SWRCB") Decision 1422 ("D-1422), Decision 1616 ("D-1616"), Decision 1641 ("D-1641") and the Water Quality Control Plan, Central Valley Region, Fourth Edition, for the Sacramento River Basin (5A) and San Joaquin River Basin (5B) ("2004 CRWQCB Basin Plan"), the United States Bureau of Reclamation ("USBR") is required to release stored water from New Melones Reservoir to maintain a dissolved oxygen ("DO") concentration of 7.0 mg/L in the Stanislaus River as measured at Ripon.

The establishment of the 7.0 mg/L DO concentration is intended to preserve or enhance aquatic habitats, and spawning and rearing of salmon and steelhead. While the Stanislaus River contains fish and aquatic habitat that benefit from a minimum DO concentration of 7.0 mg/L, such fish and aquatic habitat are located far upstream of the Ripon compliance point during the summer months. As such, the USBR contends that the SWRCB should exercise its reserved jurisdiction to move the Stanislaus River DO compliance point from Ripon (River Mile 16) to Orange Blossom Bridge (River Mile 46.9) from June 1 through August 31.

II. BACKGROUND.

A. D-1422

In D-1422, the SWRCB required the USBR to release conserved water from New Melones Reservoir for water quality control purposes, including DO in the Stanislaus River. (D-1422, Condition 8). The SWRCB did not identify the DO concentration that the USBR would need to achieve in D-1422, but rather required the USBR to meet whatever DO concentration was required by any current and applicable Water Quality Control Plan. (Id.). Although no DO concentration requirement was established, D-1422 did establish that any Stanislaus River DO concentration requirement was to be met at Ripon, unless an alternative compliance location was approved by the SWRCB. (Id.).

The express purpose of the original request that a DO concentration in the Stanislaus River be met was "to protect the salmon fishery." (D-1422, p. 12, citing RT 526). However, it is unclear from the hearing transcripts and written testimony considered at the hearings which culminated in D-1422 how the DO requirement would protect the salmon fishery generally, or why the compliance point was established at Ripon.

Mr. Maurice Fjelstad authored a large portion of Chapter 2 of the California Department of Fish and Game's ("CDFG") "Report to the California State Water Resources Control Board On Effects of the New Melones Project on Fish and Wildlife Resources of the Stanislaus River and Sacramento-San Joaquin Delta ("1972 CDFG Report") which dealt with the predicted impact of the New Melones Project on the existing fishery resources of the Stanislaus River. (RT 520). His testimony is cited by the SWRCB in D-1422 in that the DO concentration is necessary to protect the salmon fishery of the Stanislaus River. (D-1422, p. 12). However, the citation relied upon by the SWRCB is of little specific assistance as to the importance of the DO concentration to salmon as it was just one part of a general answer given by Mr. Fjelstad in response to the question "Could you tell the board the specifics of – well, what the salmon need to survive?" Mr. Fjelstad responded to this question as follows:

> "Well,..., the salmon's primary requirement is water at the right time and at the right place. They require suitable water temperature. Fifty to fifty-two degrees is ideal for spawning. The temperature during spawning should be below 58 degrees. After spawning, after incubation, the temperatures should remain below 70 degrees. They require suitable dissolved oxygen which should be no less than seven parts per million. And, as I said before, they require adequate flows for upstream migration, spawning, incubation of the eggs, and downstream migration." (RT 526).

While Mr. Fjelstad further testified in detail about the specific needs of the various life-stages of salmon, as was also provided in Chapter 2 of the 1972 CDFG Report, neither Mr. Fjelstad nor the 1972 CDFG Report provide any further detail as to the what particular life stages of salmon require a minimum DO concentration.

This lack of a discussion about how DO affects any or all of the salmon life stages is critical, as virtually all of the other proposed requirements are associated with a specific life stage. For example, CDFG recommended a minimum flow of 200 cfs from Goodwin Dam to the confluence with the San Joaquin River between October and December for purposes of allowing upstream migration and spawning and incubation of eggs. (1972 CDFG Report, p. 2-11, 2-12 and Errata Sheet).CDFG recommended a minimum flow of 150 cfs from January 1 through February 28 between Goodwin Dam and the confluence with the San Joaquin River for incubation and a variety of flows between Goodwin Dam and Ripon during the January through June migration period. (1972 CDFG Report, p. 2-12 – 2-17 and Errata Sheet). CDFG further recommended a flow of 100 cfs between Goodwin Dam and the confluence with the San Joaquin River during July, August and September to control vegetative encroachment on spawning gravels, maintain suitable temperature and maintain suitable DO. (1972 CDFG Report, p. 2-17).

While there is a specific reference to DO during the summer months, this reference is particularly vague when compared to the other recommendations. In fact, it is not at all clear whether or not the reference to DO in the summer months has anything to do with fall run salmon at all. CDFG specifically stated

> "Summer flows are essential...in maintaining suitable dissolved oxygen and temperature levels for resident fishes and any steelhead and spring-run salmon populations which might develop in the Stanislaus River and will sustain juvenile salmon that stay in fresh water for one year."
> (1972 CDFG Report, p. 2-17).

From the construction of the sentence, CDFG is certainly stating that DO will assist resident fish and any steelhead or spring-run salmon, but it is not clear if CDFG is stating that DO is needed by juvenile salmon, or if the recommended summer *flows* will "sustain" such fish. Indeed, given that Mr. Paul Jensen, testifying on behalf of CDFG, stated that "juvenile fall run king salmon would not normally be expected to be in the river much beyond June," (RT 620) and that therefore summer temperatures were not a concern or limiting factor for salmon, it seems that the statement on page 2-17 of the 1972 CDFG Report must be read to state that DO in the summer is only important for steelhead and spring-run salmon if such populations might develop. This conclusion is bolstered further by Mr. Jensen's testimony that "[i]n July, August and September the salmon are gone." (RT 635).

A complete review of the evidence and testimony submitted to the SWRCB does not resolve the ambiguity. Clearly, at least as a general matter, the CDFG is recommending that a DO requirement is needed to protect the salmon fishery in the Stanislaus River. However, since there is no specific discussion as to the specific life stage or stages that the DO requirement is to protect or promote, there is no geographic area at which such DO requirement must be met. As noted above, the specific purpose that the other recommended conditions – such as flow or temperature – was to promote or protect determined where, in a geographic sense, such condition would be applicable. Thus, flows recommended for upstream migration were applicable throughout the Stanislaus River, whereas other flow recommendations were applicable primarily between Goodwin Dam and Ripon.

Despite the lack of specificity as to the purpose of the DO requirement requested by CDFG (beyond the general "for the protection of the salmon fishery") and therefore the lack of geographic location(s) at which such requirement must be met, the SWRCB nonetheless agreed to condition the USBR's permits on, among other things, the requirement that the USBR make releases of conserved water from New Melones for the purpose of meeting DO. (D-1422, p. 31, Condition 5). Additionally, although there is apparently no discussion as to the purpose of the DO requirement, and therefore no geographic area of compliance, the SWRCB nonetheless established the DO compliance point at Ripon. (Id.).[1]

B. D-1616

D-1422 dealt with the USBR's request for permits to divert water into New Melones for storage. In D-1616, the SWRCB considered the USBR's request for permits for direct diversion at New Melones.

While granting the permits requested by the USBR, the SWRCB prohibited any direct diversion for consumptive use if the DO concentration, as measured at Ripon, is less than that specified in the April 1975 version of the SWRCB's Water Quality Control Plan, San Joaquin River Basin 5C. (D-1616, Condition 12 and 13). As in D-1422, the SWRCB left open the possibility that it would consider and approve an alternate location for measuring compliance with the Stanislaus River DO concentration requirement. (D-1616, Condition 13).

CDFG did initially protest the USBR's permit application, but the protest was resolved before the conclusion of D-1616 through an agreement between the USBR and CDFG. As such, the SWRCB made no specific statements or findings regarding either the purpose of the continued DO concentration requirement or the continued use of Ripon as the compliance point of such requirement.

C. Current Permit Conditions

The USBR's permits for the New Melones Project were modified by the SWRCB in D-1641. These modifications were minor and still require the USBR to release stored water and/or refrain from directly diverting water unless and until the DO concentration at Ripon is met. (D-1641, p. 160 and 162).

The DO concentration requirement itself has changed over time since it was first required in D-1422. Now, the DO concentration requirement at Ripon is that specified in the 2004 CRWQCB Basin Plan. According to this plan, DO objectives are established based upon general needs of the fishery resource specific to a particular river or stream in the basin. That is, as a general matter, streams are designated as "WARM," meaning the fishery resources of that water body are rely primarily on warm water habitat (such as sunfish or catfish), "COLD," meaning the fishery resources of that water body rely primarily on cold water habitat (such as rainbow trout or sculpins) and "SPWN," meaning the fishery resources of that water body utilize the water body for reproduction and early development (such as salmon or steelhead trout), and a general DO

---

[1] In a personal communication with Mr. John Renning of the USBR in 2004, he suggested that Ripon was chosen as the compliance point not because of salmon, but rather due to the existence of numerous canneries in Ripon. These canneries had discharges of effluent that were high in biological or chemical oxygen demand. Mr. Renning's suggestion makes sense, as the SWRCB noted in D-1422 that the then-applicable water quality control plan included a requirement in the Stanislaus River for DO "as a result of waste discharges..." (D-1422, p. 12).

concentration is established for each of these fishery purposes. Unless an exception is made that requires either less or more stringent concentrations, water bodies designated as WARM shall not have DO concentrations that fall below 5.0 mg/L and water bodies designated as COLD or SPWN shall not have DO concentrations fall below 7.0 mg/L. (2004 CRWQCB Basin Plan, page III-5.00).

Since the Stanislaus River is designated COLD and SPWN, the DO concentration requirement is 7.0 mg/L. (2004 CRWQCB Basin Plan, p. II-8.00). Although the 2004 CRWQCB Basin Plan does not establish compliance points, the DO concentration of 7.0 mg/L must be met at Ripon as required by the USBR's permits for the New Melones Project.

III. DO CONCENTRATION COMPLAINCE POINT AT RIPON IS NOT NEEDED YEAR ROUND TO PROTECT THE SALMON OR STEELHEAD FISHERY.

The CDFG originally recommended a DO concentration requirement in the Stanislaus River "to protect the salmon fishery." (D-1422, p. 12, citing RT 526). Similarly, the current DO concentration requirement established by the CWRQCB is designed to protect the cold-water fishery and spawning fishes, which in the Stanislaus are primarily salmon and steelhead. While it is undisputed that salmon and steelhead exist in the Stanislaus River and that a DO concentration in the Stanislaus River for the protection of such fishery is appropriate, the compliance point of Ripon is not always appropriate for the protection of such fishery.

Geographically, the Stanislaus River extends approximately 60 miles from Goodwin Dam to the confluence with the San Joaquin River. Ripon is located approximately 44 miles downstream of Goodwin Dam, and approximately 16 miles upstream from the confluence of the Stanislaus and San Joaquin Rivers. As noted earlier, many requirements regarding flow, temperature, water quality, gravel size and other items are designed and intended to support, enhance or protect certain specific salmonid life stages. Salmon and steelhead in the Stanislaus River have five basic life stages: adult migration, spawning, egg incubation, juvenile rearing, and juvenile migration. By examining the timing and locations of these five life stages of salmon utilizing the Stanislaus River, it can be seen that the DO concentration requirement is not needed at Ripon on a year-round basis.

A. Fishery Resources

1. Fall-Run Chinook Salmon

a. Adult Fall-Run Chinook Migration

In 1972, the CDFG reported that adult salmon migrated up the Stanislaus River between early October and late December, with migration reaching a peak in Late October and early November. (1972 CDFG Report, p. 2-4). Although this description of migration timing is over 30 years old, it remains fairly accurate. Since 1972, data collected by private fishery consultants, non-profit organizations, and the CDFG demonstrate the majority of adults migrate upstream from late September through December with peak migration occurring from late October through early November (Table 1, Cramer Fish Sciences [CFS] unpublished data; Fishery Foundation of California [FFC] unpublished data; CDFG annual spawning survey reports). Yet, some adult migration has been observed as early as September and as late as January (Table 1).

In terms of location, adult migration in the Stanislaus River extends upstream from the river's confluence with the San Joaquin River to the spawning grounds located between Riverbank (River Mile 33) and Goodwin Dam (River Mile 58.4).

Table 1. Generalized upstream migration timing pattern observed at the Stanislaus River Weir near Riverbank (River Mile 31.2) during 2003-2005.

Date	***% Adult Chinook***
Sep 1-15	0.02%
Sep 16-30	2.72%
Oct 1-15	18.35%
Oct 16-31	26.60%
Nov 1-15	32.69%
Nov 16-30	12.68%
Dec 1-15	5.60%
Dec 16-31	1.16%
Jan 1-15	0.15%
Jan 16-31	0.02%

b. Fall-Run Chinook Spawning

Adult fall-run Chinook salmon spawn soon after they complete their upstream migration and arrive at the spawning grounds. For Stanislaus River salmon, spawning generally takes place between October and December based on spawning surveys (Table 2). However, there is evidence from spawning surveys (Table 2) that indicates a small amount (i.e., 1.2%) of spawning activity may occur as early as September or as late as January. In addition, juvenile outmigration studies (CFS unpublished data) indicate that spawning activity can occur as late as February based on estimated incubation requirements (i.e., 40 to 60 days) and the presence of newly emerged fry observed in late April.

According to the Stanislaus River Fish Group's (SRFG) "A summary of fisheries research in the lower Stanislaus River" ("SRFG 2004"), the spawning reach is about 25 miles long and extends from Goodwin Dam (River Mile 58.4) downstream to Riverbank (River Mile 33).

//
//
//

Table 2. Generalized timing pattern of spawning in the Stanislaus River based on redd counts from CDFG spawning surveys conducted 1998 to 2005. (CDFG annual reports).

Date	***% redds observed***
Before Oct 1	0.1%
Oct 1-15	1.5%
Oct 16-31	10.5%
Nov 1-15	29.4%
Nov 16-30	29.4%
Dec 1-15	19.0%
Dec 16-31	9.0%
Jan 1-15	1.1%

c. Fall-Run Chinook Egg Incubation

The duration of salmon egg incubation varies significantly with water temperature, and Chinook salmon eggs require the accumulation of 888 Fahrenheit degree days (e.g., 1°F above freezing for one day) from the time that they are deposited by spawning adults until juveniles hatch and emerge from the gravel. (Piper and others 1982). Temperatures vary between years, within years, and by location, but based on typical fall/winter temperatures in the Stanislaus this translates to an incubation period of approximately 40 to 60 days. Based on documented spawn timing (CDFG annual reports) and the estimated number of days until hatching and emergence based on degree days, egg incubation generally extends from October through March.

Incubation occurs within the 25 mile spawning reach that extends from Goodwin Dam (River Mile 58.4) downstream to Riverbank (River Mile 33).(SRFG 2004).

d. Fall-Run Chinook Juvenile Rearing

Juvenile Chinook rearing in the Stanislaus River primarily occurs from mid December through May between Goodwin and Riverbank. However, some rearing may occur at different times and locations. For instance, some rearing may occur throughout the lower river below Riverbank from mid December through May when temperatures in the lower river are within tolerable ranges. However, the number of juveniles rearing in this lower reach is anticipated to be small based on abundance trends, migration timing, and fish size observed between Oakdale and Caswell; and any rearing that occurs below Orange Blossom Bridge is generally believed to be associated with fish migration or with displacement during pulse flows or flood control events

In addition, although most rearing juveniles migrate prior to June, some juveniles may continue to rear in the river above Orange Blossom Bridge (River Mile 46.9) throughout the summer and fall where temperatures are within tolerable ranges. However, based on snorkel surveys and outmigration data, it appears that very few juvenile salmon oversummer in the river. For instance, relatively low salmon densities are observed within the river after mid September (FFC unpublished data) and very few juveniles are observed migrating the following winter (i.e., three to 29 individuals captured annually at Oakdale and Caswell combined; CFS unpublished data).

e. Fall-Run Chinook Juvenile Migration

For over a decade, rotary screw traps located at Caswell (River Mile 8.6) have collected data on out-migrating juvenile salmon. Rotary screw trap data indicate that about 99% of salmon juveniles migrate out of the Stanislaus River from January through May. (SRFG 2004). Fry migration generally occurs from January through March, followed by smolt migration from April through May. However, some juveniles have been captured at Caswell as early as December 22 (<1% migrating prior to January) and as late as July 3 (<1% migrating after May). (CFS unpublished data reports).

In the Stanislaus River, out-migration of juvenile salmon extends from rearing areas below Goodwin Dam (River Mile 58.4) to the river's confluence with the San Joaquin River (River Mile 0.0).

f. Summary Fall-run Chinook Salmon Life Stage Timing and Geographic Location

From the above information, fall-run Chinook salmon life stage timing and geographic location within the Stanislaus River can be generalized as follows:

Stage	Timing	Geographic Location
Adult Migration	Late September - December	Goodwin Dam to confluence
Spawning	October – December	Goodwin Dam to Riverbank
Egg Incubation	October – March	Goodwin Dam to Riverbank
Juvenile Rearing	mid December – May	Goodwin Dam to Riverbank
	June – mid December	Goodwin Dam to Orange Blossom Bridge
Juvenile Migration	January – May	Goodwin Dam to confluence

2. Steelhead

a. Steelhead Adult Migration

Steelhead adults typically migrate from the ocean and into tributaries to spawn. However, unlike salmon, some adult steelhead may repeat their migration downstream out of the river after spawning to return to the ocean. (Shapovalov and Taft 1954; McEwan 2001).

In the Stanislaus River, there is little data regarding the migration patterns of adult steelhead since adults generally migrate during periods when river flows and turbidity are high making fish difficult to observe with standard adult monitoring techniques. A counting weir has been operated on the Stanislaus River from September to March in 2003-2004, September to April in 2004-2005, and September to December in 2005. Only two adult steelhead upstream migrants have been observed during these three years of monitoring. Of these two adult upstream migrants, one was observed in early January 2005 and the other during mid October 2005. Based upon this very limited data, it appears that adult steelhead may migrate into the Stanislaus River from at least October through January (CFS unpublished data). On the neighboring Mokelumne River, a longer time series of data (i.e., 12 years) exists to describe adult steelhead migration timing in the San Joaquin Basin. Results from the Mokelumne River study suggest that 97.7% of adult steelhead migration occurs from late September through March, although some fish have been observed as early as August 16 (Table 3; East Bay Municipal Utilities District unpublished data).

Limited data exists to describe the timing and frequency of occurrence of downstream migration after spawning. During three years of weir monitoring, nine spawned out adults that may have been migrating downstream out of the river to return to the ocean have been observed as early as December 27 and as late as March 18. It is generally believed that downstream migration of spawned out adults occurs soon after they have spawned. Based on this coupled with the few observations at the weir, adult downstream migration may occur from December through March.

Adult migration takes place in the Stanislaus River between the confluence with the San Joaquin River (River Mile 0.0) and Goodwin Dam (River Mile 58.4).

Table 3. Generalized adult steelhead upstream migration timing pattern observed on the Mokelumne River at Woodbridge Dam during 1990-2001. Source: East Bay Municipal Utility District unpublished data.

Date	***% Adult Steelhead***
Aug 1-15	0.0%
Aug 16-31	1.1%
Sep 1-15	1.1%
Sep 16-30	4.6%
Oct 1-15	7.4%
Oct 16-31	8.3%
Nov 1-15	14.0%
Nov 16-30	8.3%
Dec 1-15	9.5%
Dec 16-31	10.9%
Jan 1-15	7.2%
Jan 16-31	10.3%
Feb 1-15	8.9%
Feb 16-28	3.2%

Mar 1-15	3.4%
Mar 15-31	1.7%

b. Steelhead Spawning

As a result of poor visibility from high flows and turbid water conditions, there is little hard data regarding the spawning of steelhead in the Stanislaus River. However, based upon observations in the nearby Sacramento Basin (Hallock and others 1961) and limited data from the Stanislaus River (i.e., CFS unpublished weir and juvenile migration data), it is believed that steelhead spawn primarily between December and March.

During three years of weir monitoring, spawned out steelhead kelts have been observed as early as December 27 and as late as March 18 suggesting that spawning extends from at least late December through mid March (Table 4). Fry emergence is also an indicator of spawn timing and typically occurs 47 to 122 days after spawning (Barnhart 1986; Shapovalov and Taft 1954). Newly emerged rainbow/steelhead trout fry (i.e., ≤45 mm) are typically observed in the Oakdale screw trap from March through May, and have been captured as early as January 24. Similarly, young rainbow/steelhead trout have been observed during snorkel surveys conducted by the FFC beginning in April. (Kennedy and Cannon 2002). These fry observations corroborate that spawning may extend from late December through mid March.

Table 4. Monthly observations of steelhead kelts at the Stanislaus River weir during three seasons of monitoring.

	2003-2004	2004-2005	2005-2006
December	1	0	0
January	2	1	No sample
February	2	0	No sample
March	1	2	No sample

Although no steelhead spawning surveys have been conducted in the Stanislaus River, it is believed that steelhead spawning primarily takes place between Goodwin Dam and Orange Blossom Bridge. (SRFG 2004).

c. Steelhead Egg Incubation

Steelhead egg incubation occurs from the time that eggs are deposited by spawning adults until they hatch and juveniles emerge. Length of time required for eggs to develop and hatch is dependant on water temperature and is quite variable; hatching varies from about 19 days at an average temperature of 60EF to about 80 days at an average of 42EF. (Barnhart 1986) After hatching, pre-emergent fry remain in the gravel living on yolk-sac reserves for another four to six weeks. (Shapovalov and Taft 1954); thus, incubation (i.e., deposition to emergence) may extend from 47 to 122 days. Based on estimated spawn timing, typical incubation temperatures, and emergent fry observations (CFS unpublished juvenile migration data and FFC unpublished snorkel survey data observations), incubation in the Stanislaus River may occur from December through June.

d. Steelhead Juvenile Rearing

Juvenile rainbow/steelhead trout rearing in the Stanislaus River occurs year-round primarily between Goodwin Dam (River Mile 58.4) and Orange Blossom Bridge (River Mile 46.9). (CFS unpublished data; Kennedy and Cannon 2002). However, some rearing may occur at different times and locations. For instance, snorkel surveys by FFC indicate that the majority of steelhead rearing in the summer months takes place upstream of Orange Blossom Bridge, with the greatest abundance observed at Goodwin (River Mile 57.5) and Two-Mile Bar (River Mile 56.6). (Kennedy and Cannon 2002). In addition, some rearing may occur throughout the lower river below Orange Blossom Bridge during the winter months when temperatures in the lower river are within tolerable ranges. However, the number of juveniles rearing in this lower reach is anticipated to be small based on habitat suitability, angler observations, and limited snorkel survey data; and any rearing that occurs below Orange Blossom Bridge is generally believed to be associated with fish migration or with displacement during pulse flows or flood control events.

e. Steelhead Juvenile Migration

Over the past decade, the rotary screw traps at Caswell have typically been operated from January through June and the data indicates that steelhead outmigrate primarily from February through May (i.e., 95%). However, migration can begin as early as January and extend into June (CFS unpublished data reports).

The migration timing suggested by the Caswell data is also corroborated by observations made downstream at Mossdale on the San Joaquin River and in the neighboring Sacramento River Basin. To monitor emigration from the San Joaquin Basin, CDFG and the U.S. Fish and Wildlife Service (USFWS) operate a Kodiak trawl on the San Joaquin River near Mossdale on more of a year-round schedule and the trawl is believed to be more effective than rotary screw traps in capturing steelhead smolts. Similar to the timing suggested by catches at Caswell, steelhead were only captured from February through early June and 95% of the catch occurred from mid-March through May (USFWS unpublished data; Table 5). Additionally, Hallock and others (1961) found that juvenile steelhead in the Sacramento Basin migrated downstream during most months of the year, but the peak period of emigration occurred in the spring.

//

Table 5. Generalized timing pattern of steelhead outmigration from the San Joaquin Basin developed from Mossdale trawl catch data collected by CDFG and the USFWS from 1996 to 2004.

Date	***% Juvenile Steelhead***
Feb 1-15	1.6%

Feb 16-29	0.0%
Mar 1-15	1.6%
Mar 16-31	3.1%
Apr 1-15	21.9%
Apr 16-30	29.7%
May 1-15	29.7%
May 16-31	10.9%
Jun 1-15	1.6%
Jun 16-30	0.0%

In the Stanislaus River, out-migration of juvenile steelhead extends from rearing areas below Goodwin Dam (River Mile 58.4) to the river's confluence with the San Joaquin River (River Mile 0.0).

f. Summary Steelhead Life Stage Timing and Geographic Location

From the above, steelhead life stage timing and geographic location within the Stanislaus River can be expressed as follows:

Stage	Timing	Geographic Location
Adult Migration	Late September – March	Goodwin Dam to confluence
Spawning	December - March	Goodwin Dam to Orange Blossom Bridge
Egg Incubation	December – July	Goodwin Dam to Orange Blossom Bridge
Juvenile Rearing	Year-round	Goodwin Dam to Orange Blossom Bridge
Juvenile Migration	February – May	Goodwin Dam to confluence

B. Change in DO Compliance Point is Appropriate

The above information shows that neither salmon nor steelhead are located anywhere in the Stanislaus River downstream of Orange Blossom Bridge from June through August each year. Orange Blossom Bridge is located 31 miles upstream of Ripon. Yet, even though no salmon or steelhead are located between downstream of Orange Blossom Bridge from June through August, the current USBR permits require the DO concentration objective of 7.0 mg/L to be met at Ripon during this time period. Since the express purpose of the DO concentration requirement in the Stanislaus River is to support, protect and enhance the river's salmon and steelhead fishery, it does not make any sense to require the USBR to continue to meet the DO concentration requirement at

Ripon during times of the year when there are no salmon or steelhead to benefit from such concentration.[2] In order to continue to protect the salmon and steelhead fishery while maximizing the available New Melones water for other beneficial uses,[3] the DO concentration compliance point for the period between June 1 and August 31 each year should be changed from Ripon to Orange Blossom Bridge.

Such a change is not unprecedented. Currently, there are four locations where more stringent DO concentration requirements than the general requirements established by the CRWQCB apply during certain specific times of the year. In the Sacramento River, the DO concentration between Keswick Dam and Hamilton City is 9.0 mg/L from June 1 through August 31. (2004 CRWQCB Basin Plan, p. III-5.00). In the Feather River, the DO concentration between Fish Barrier Dam to Honcut Creek is 8.0 mg/L from September 1 to the following May 31. (Id.). In the Merced River, the DO concentration is 8.0 mg/L all year from Cressy to New Exchequer Dam. (Id.). Finally, in the Tuolumne River, the DO concentration from Waterford to La Grange is 8.0 mg/L from October 15 to the following June 15. (Id.). Except for these specified times and locations, the general DO concentration limits established by the CRWQCB apply.

In each of these four instances, while it is not entirely clear as to the rationale behind the establishment of the more stringent DO concentration requirements for these specific reaches of river,[4] it appears that the reaches themselves constitute the primary spawning and rearing areas for salmon and/or steelhead. (*See* S.P. Cramer & Associates for Tuolumne and Merced Rivers; “Factors Affecting Chinook Salmon Spawning in the Lower Feather River (Fish Bulletin 179; Vol. 1 (2001)) p. 272 for Feather River, and NMFS (1997) for Sacramento River [winter run Chinook salmon]). That is, the DO concentration selected was then applied only to that portion of the river necessary to achieve the goal associated with the establishment of the DO concentration in the first place.

The same type of analysis should apply in the Stanislaus River. There are no salmon or steelhead downstream of Orange Blossom Bridge between June 1 and August 31 of each year. As such, the establishment and maintenance of the 7.0 mg/L DO concentration for some 31 miles between Orange Blossom Bridge and Ripon does not provide any benefit to either the salmon or steelhead fishery. The SWRCB should exercise the jurisdiction it has expressly reserved itself and change the DO concentration

---

[2] The DO concentration of 7.0 mg/L requirement adopted by the CRWQCB is far in excess of what is needed by non-salmonid fishery resources. According to the E.P.A., DO concentrations in excess of 6.5 mg/L have no negative impact on non-salmonid fish at any life stage. (USEPA 1986).

[3] It must be remembered that the USBR’s permits require it to “release” water from water stored by the New Melones project to meet and maintain the DO concentration at Ripon. Since Orange Blossom Bridge is significantly closer to New Melones than is Ripon, it is expected that changing the compliance point will result in significant water savings during the critical summer months that could be made available for other beneficial uses consistent with the enumerated purposes of the New Melones project and the CVP.

[4] At least for the more stringent DO concentrations on the Tuolumne and Merced Rivers, there are no written records explaining how or why the reaches were chosen or the more stringent DO concentrations selected. (Personal communication between S.P. Cramer & Associates and Betty Yee of the CRWQCB, 2005).

compliance point between June 1 and August 31 of each year from Ripon to Orange Blossom Bridge.

IV. CONCLUSION

The over-riding legal and policy consideration regarding the development and use of water is to avoid waste and to maximize the reasonable and beneficial use of the scarce resource. In the case of the Stanislaus River salmon and steelhead fishery, the existing requirement that the DO concentration level be met year-round at Ripon is not in accordance with the overall policy of reasonable use. The needs of the salmon and steelhead fishery, for which the DO concentration level was specifically adopted, demonstrate that the compliance point for the DO concentration can be changed to Orange Blossom Bridge from June 1 through August 31 of each year. By so doing, the salmon and steelhead fisheries in the Stanislaus River will continue to be protected, and valuable water in New Melones reservoir can be applied to other beneficial uses that are not presently being met in full.

The USBR strongly urges the SWRCB to amend its permits for both storage at New Melones and direct diversion from the Stanislaus River at New Melones to change the DO compliance point from Ripon to Orange Blossom Bridge between June 1 and August 31 of each year.

Dated: October 1, 2006

REFERENCES

Barnhart, R.A. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)—steelhead. USFWS Bio. Rep. 82(11.60). 21 pp.

Carl Mesick Consultants [CMC]. 2002. Task 5 initial post-project evaluation report, fall 2000, Knights Ferry Gravel Replenishment Project. Final report produced for the CALFED Bay Delta Program and the Stockton East Water District. Carl Mesick Consultants, El Dorado, California. 14 January 2002.

Hallock, R.J., W.F. Van Woert, and L. Shapovalov. 1961. An evaluation of stocking hatchery-reared steelhead rainbow trout (*Salmo gairdnerii gairdnerii*), in the Sacramento River system. Calif. Dept. Fish and Game, Fish Bulletin 114, 73 pp.

McEwan, D.R. 2001. Central Valley steelhead. In Brown, R.L. ed. Contributions to the biology of Central Valley salmonids. Calif. Dept. of Fish and Game Fish Bull. No. 179, vol 1:1-43.

Piper, R.G., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, and J.R. Leonard. 1982. Fish Hatchery Management. Department of the Interior, U.S. Fish and Wildlife Service. Washington, D.C.

Shapovalov, L., and A.C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdnerii gairdnerii*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. Calif. Dept. Fish and Game, Fish Bulletin 98. 375 pp.

Stanislaus River Fish Group [SRFG] 2004. A summary of fisheries research in the lower Stanislaus River. Working draft, March 2004. Available online at http://www.delta.dfg.ca.gov/srfg/restplan.asp

S.P. Cramer and Associates, Inc. 2001. 2001 Stanislaus River Data Report. Final Data Report, S.P. Cramer & Associates, Gresham, Oregon.

S.P. Cramer and Associates, Inc. 2002. 2002 Stanislaus River Data Report Supplement. Final Data Report, S.P. Cramer & Associates, Gresham, Oregon.

S.P. Cramer and Associates, Inc. 2003. 2003 Stanislaus River Data Report Supplement. Final Data Report, S.P. Cramer & Associates, Gresham, Oregon.

S.P. Cramer and Associates, Inc. 2004. 2004 Stanislaus River Data Report Supplement. Final Data Report, S.P. Cramer & Associates, Gresham, Oregon.

S.P. Cramer and Associates, Inc. 2005. 2005 Stanislaus River Data Report Supplement. Final Data Report, S.P. Cramer & Associates, Gresham, Oregon.

COUNSEL IDENTIFICATION AT END

IN THE UNITED STATES DISTRICT COURT

FOR THE EASTERN DISTRICT OF CALIFORNIA

CONSOLIDATED SALMON CASES	LEAD CASE NO: 1:09-cv-1053 OWW-DLB
SAN LUIS & DELTA-MENDOTA WATER AUTHORITY, et al. v. LOCKE, et al.	Consolidated Cases: 1:09-cv-1090 OWW-DLB 1:09-cv-1378 OWW-DLB 1:09-cv-1520 OWW-SMS 1:09-cv-1580 OWW-DLB 1:09-cv-1625 OWW-SMS
STOCKTON EAST WATER DISTRICT v. NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, et al.	**DECLARATION OF AVRY DOTAN IN SUPPORT OF STANISLAUS RIVER PLAINTIFFS' MOTION FOR SUMMARY JUDGMENT**
STATE WATER CONTRACTORS v. LOCKE, et al.,	
KERN COUNTY WATER AGENCY, et al. v. U.S. DEPARTMENT OF COMMERCE, et al.	Date: November 18-19, 2010 Time: 9:00 A.M. Courtroom: 3 Judge; Hon. Oliver W. Wanger
OAKDALE IRRIGATION DISTRICT, et al. v. U.S. DEPARTMENT OF COMMERCE, et al.	
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA v. NATIONAL MARINE FISHERIES, et al.	

Declaration of Avry Dotan

1. I, Avry Dotan, declare that the facts set forth below are true and correct based on my own personal knowledge and I could and would testify to them if called to do so.
2. I am a hydrologist and the owner and sole principal of AD Consultants, 15 Sullivan Drive, Moraga, CA 94556.
3. I have over 25 years experience in modeling for water resources, environmental and hydroelectric projects. I am specializing in computer modeling of complex water supply projects, hydrology analysis, water temperature modeling, project operations, feasibility and economic studies, and FERC licensing and re-licensing.
4. Since 1999 I have been the acting project manager and co-developer of the Stanislaus River Water Temperature Model, Stanislaus-Lower SJR Temperature Model (CALFED ERP-02-P28) and the San Joaquin River Basin-wide Water Temperature Model (CALFED ERP-06D-S20).
5. I have developed these models in association with my sub-consultants Resource Management Associates, Inc. (RMA) and Watercourse Engineering, Inc.

DEVELOPMENT OF STANISLAUS RIVER TEMPERATURE MODEL

6. Water temperature modeling of the San Joaquin River basin started as a grass-root project in December 1999 when a group of Stanislaus river stakeholders decided to analyze the relationship between operational alternatives, water temperature regimes and fish mortality in the Stanislaus River. These stakeholders included the United States Bureau of Reclamation (“USBR”), United States Fish and Wildlife Service (“FWS”), California Department of Fish and Game (“CDFG”), Oakdale Irrigation District (“OID”), South San Joaquin Irrigation District (“SSJID”), and Stockton East Water District (“SEWD”) (collectively the “Stanislaus Stakeholders”). The Stanislaus Stakeholders decided to join resources and fund the development of a high resolution reservoir operation - water temperature computer model built on the HEC-5Q computer program.
7. The HEC-5Q is a generalized water quality computer program (software) designed by the US Army Corps of Engineers that can be configured for any reservoir-river system. The HEC-5Q

is public domain software and can be obtained at no cost from the US Army Corps of Engineers.

8. The HEC-5Q is widely accepted software that has been applied to numerous reservoir-river systems in the US and worldwide. Examples of application of the HEC-5Q in the State of California in recent years (other than the Stanislaus and San Joaquin River) are: Russian River (Sonoma County Water Agency), Sacramento River (US Bureau of Reclamation) and the reach below Friant Dam in the upper San Joaquin River (US Bureau of Reclamation). The latter was subsequently connected to the San Joaquin Basin Wide Model, as discussed further.

9. The HEC-5Q allows assessing temperature and a conservative water quality constituent (such as dissolved oxygen and electrical conductivity) in basin-scale planning and management decision-making. For the Stanislaus (and later the San Joaquin River), however, only water temperature was considered.

10. The steps necessary to apply the HEC-5Q to a given system include: representation of the physical system (e.g, characteristics of reservoirs, water conveyers, rivers geometry, etc.), assembling hydrological and meteorological data (e.g., flows and weather data) and defining operating rules (e.g., flood control rules, diversions, in-stream flow requirements).

11. Once all of the above is implemented, the model is then calibrated. Calibration is a process in which various parameters are adjusted (e.g, heat exchange coefficients for air-water and sediment-water interface, stream bed roughness coefficients, etc.) until a good-fit of observed vs. simulated conditions (e.g, temperature profile in the reservoirs and temperatures along the stream) is obtained.

12. Model set up and calibration is usually the most labor intensive effort in the implementation of the HEC-5Q. Once the model is calibrated, running hypothetical scenarios are usually straight forward tasks as they involved replacing the historical data sets with new data sets that are usually defined outside the model itself (e.g, hypothetical diversions and in-stream flow scenarios). For example, some of the scenarios that we studied for the Stanislaus Stakeholders during the course of the work for the group were based on output from the

CALSIM II model.

13. For the Stanislaus Water Temperature Model, physical representation of the system included the characteristics of New Melones Reservoir, Tulloch Reservoir, Goodwin Pool and approximately 60 miles downstream to the confluence of the San Joaquin River.

14. In addition, special code was added to the model to accommodate several unique attributes, including complex geometry of the submerged (old) dam in New Melones Reservoir and the short residence time and unique diversion characteristics of Goodwin Pool

15. The old-new dam interaction came into play during the 1992 drought when New Melones was drawn down to almost dead-storage levels. Fortunately (modeling wise), extensive flow and temperature data were collected during that period that allowed us to calibrate the model for those critical conditions and ensure that this special code is properly implemented in the model. The old-new dam interaction is especially important when operating the system more aggressively as appears to be the case when operating for temperature control per Action III.1.2 of the BO.

16. The Stanislaus Water Temperature Model was calibrated for temperature data collected during the 1990 - 1999 historical period. The simulation period (i.e., the period for which the model conducted operations studies) was 1980 to 1999. This period was selected because it covered the full period since New Melones started filling up after the construction of the new Dam to the study date at the time. The simulation period was subsequently extended as the model evolved over the years.

17. The simulation period could have been extended to years prior to 1980, similar to the period modeled with CALSIM II, relatively easily using pre-processor tools already developed by RMA for this purpose. However, the Stanislaus Stakeholders agreed that the proposed study period 1980 to 1999 covers sufficient range of hydrologic condition (wet, normal, dry and critically dry), as well as filling and emptying cycle of New Melones, to provide the insight for temperature response in the system under hypothetical operational scenarios.

18. Furthermore, when modeling water temperature in a reservoir-stream system, the level of resolution of the model is by far more important than the length of the simulation period

itself. In the case of the Stanislaus River temperature modeling, the need to compute the temperature variation and extremes was very important as they are directly related to fish habitat conditions (i.e, egg development, fish survival and growth, out-migration, in-migration, etc.).

19. Once the Stanislaus Water Temperature was completed in 2001, the model was used by the Stanislaus Stakeholders to evaluate water temperature objectives at critical points in the river system that would enhance habitat conditions for fall-run Chinook salmon and Steelhead rainbow trout. This was done by running the model for different operational scenarios proposed, primarily, by the irrigation districts and CDFG (objectives were examined for each fish species individually, and then combined into one envelope of conditions for the two).

20. The HEC-5Q can simulate temperature conditions at any specified time interval resolution. For the Stanislaus Water Temperature Model, a 6-hour time interval was selected as it provided an adequate balance between run time (the shorter the time step the longer it takes to execute a run) and the level of resolution needed in order to capture the diurnal temperature variability in the stream (6-hour interval captures the minimum daily temperature, usually around 6:00 AM, and maximum daily temperature usually around 6:00 PM). This “sub-daily” modeling is very important factor when studying temperature response in streams as temperatures could fluctuate significantly throughout the day as function of travel time and meteorological conditions (the farther the water travels from the source the closer it gets to ambient conditions). Sub-daily modeling is especially important when temperature objectives are also defined on a sub-daily basis. Modeling that would have coarse time steps (e.g., daily, weekly and monthly) tend to be biased towards the average and underestimate the extremes. **As a rule, modelers should employ time steps that are compatible with the level of resolution by which the results are tested**. This rationale was one of the primary reasons why the Stanislaus Water Temperature Model was developed, as the Stanislaus Stakeholders realized the need to evaluate the temperature regime in the basin on a sub-daily basis.

21. The Stanislaus Water Temperature Model was peer reviewed by Dr. Michael Deas, a

consultant retained by the Stanislaus Stakeholders to evaluate the suitability of the model for its intended purpose. After Dr. Deas submitted the peer review report in 2002 the model was unanimously accepted by the Stanislaus Stakeholders and adopted as the primary water temperature planning tool for the Stanislaus River. The Stanislaus River Water temperature Model has since been used by/on behalf the irrigation districts, CDFG and USBR.

FIRST EXPANSION OF THE MODEL

22. Upon reviewing modeling results, the Stanislaus Stakeholders recognized the need to extend the model to the Lower San Joaquin River thus enabling it to study the relationship between Stanislaus River operations and the temperature regime in the lower San Joaquin River as it flows to the Bay-Delta.

23. Due to limited funding available to the group, the Stanislaus Stakeholders asked me to submit a proposal to CALFED for the extension of the model.

24. In 2003, CALFED decided to fund the extension of the Stanislaus River Water Temperature Model to include the lower San Joaquin River (CALFED ERP-02-P28). A principal priority of this CALFED sponsored project was to develop a model capable of evaluating a wide range of alternatives for flow and water temperature management in the Stanislaus River and lower San Joaquin River. The project team was expanded and included Watercourse Engineering, Inc. and a peer review panel was assigned to assist in developing temperature criteria for the evaluation of model alternatives.

25. Once the model expansion was completed, the Stanislaus Stakeholders authorized the model to be used again to simulate different Stanislaus River operation scenarios, using water temperature objectives at critical points developed by CDFG, to estimate the magnitude and duration of water temperature conditions at critical points in the river and the effect on water supply and storage at New Melones. In 2006 I submitted a draft report to the Stanislaus Stakeholders describing the expanded model, the simulations conducted, and identifying the results of each simulation. In 2007 I submitted the final report to CALFED and released the final version of the model to the Stanislaus Stakeholders.

SECOND EXPANSION OF THE MODEL

26. The success of the Stanislaus work and the interest in this model expressed by the stakeholders from adjacent tributaries to the San Joaquin River (e.g. Tuolumne and Merced rivers), prompted CALFED to amend our existing contact and fund a second expansion of the model in 2004 (the work was done in parallel to finalizing our project report for the Stanislaus – Lower San Joaquin River Model). This extended the model to the entire San Joaquin River Basin below Stevinson (see the model extent on the map below). A beta version of the extended model, called the San Joaquin River Water Temperature Model ("SJRWTM") was completed in 2006, peer reviewed by a group of scientists selected by CALFED, and approved by CALFED as a Directed Action (CALFED ERP-06D-S20) for further refinement and completion.

27. Through this second expansion, the Stanislaus Water Temperature Model became one component of the overall SJRWTM (the model can be run separately for each San Joaquin River tributary or for the entire San Joaquin River Basin as a whole).

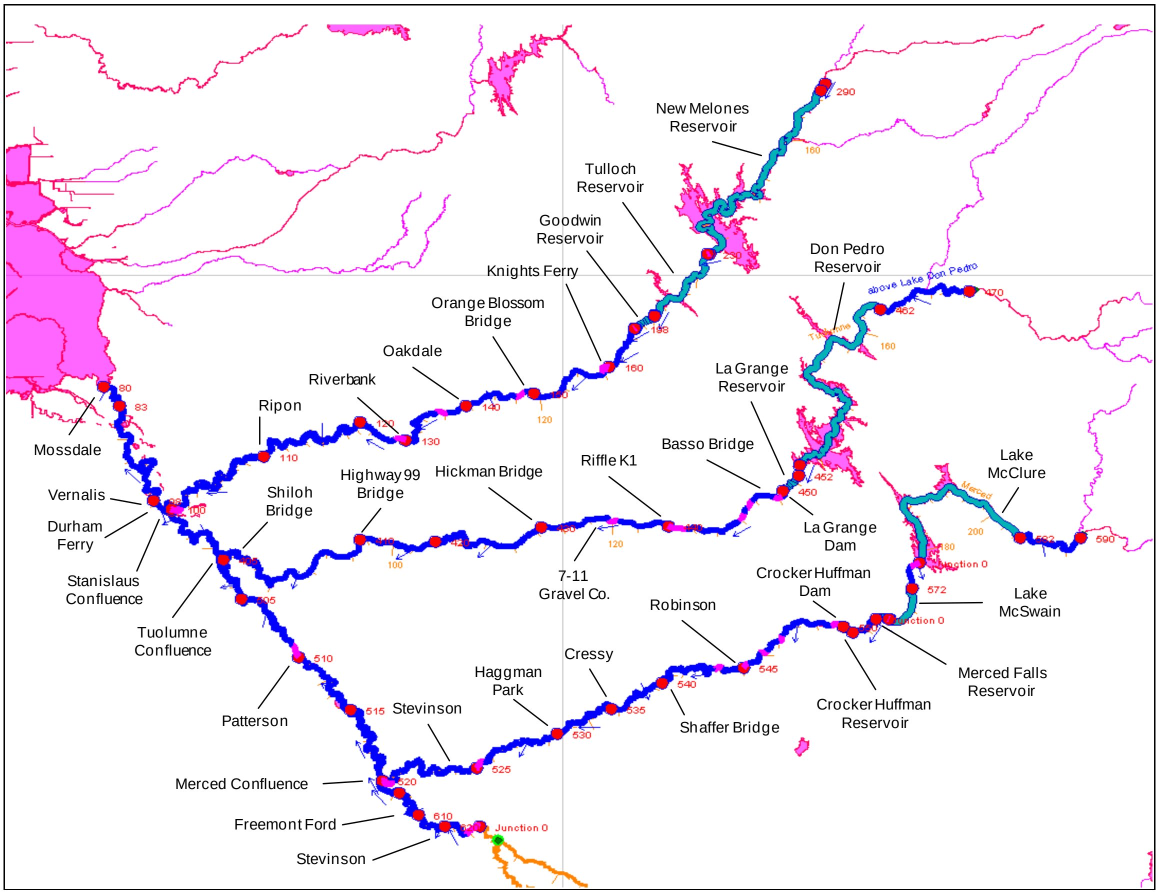
28. As such, any references from now on in my declaration to the Stanislaus River Water Temperature Model imply the model developed for the Stanislaus River <u>prior</u> to the implementation of SJRWTM. Any references in my declaration to the SJRWTM imply the Stanislaus component within the SJRWTM.

29. As part of the development of SJRWTM, the simulation period was also extended through December 2007 and the model was re-calibrated given the additional data collected over this time period (hydrological, meteorological and observed temperature in reservoirs and streams).

30. In addition, more features were coded into the model to automate the computation process. Until then, the model was designed to compute the temperature response downstream to the reservoirs given prescribed release schedule. This so-called "top-down" approach is the classical way by which the original HEC-5Q operates. The new features used the "bottom-up" approach where target temperatures at compliance points are identified (could be at multiple locations and times in the year) and the model computes how much water should be

released from the reservoirs and when (taking into account travel time) in an attempt to meet the target temperature. Special constraints are imposed to ensure that the model's proposed releases are compatible with the physical system as well as with the operator's ability to manage those releases (e.g., ramping rates, channel capacity, maximum volume of water available to managers to mitigate temperature violations, etc.).

31. Upon finalizing the model, the HEC-5Q representation of the Friant reach, a separate model developed by the USBR under a contract with my sub-contractor RMA, was added to the model, thus making it a full San Joaquin Basin-wide model.



The San Joaquin River basin, including the Stanislaus, Tuolumne, and Merced River systems, as represented in the SJR Basin Water Temperature Model (SJRWTM).

32. As with the Stanislaus Water Temperature Model, the SJRWTM is designed to simulate the thermal regime of main-stem reservoirs and river reaches at 6-hour intervals for alternative conditions such as operational changes, physical changes and combinations of the two. In the

testing phase of the model, the model was used to perform three broad categories of modeling studies: historical operations, alternative operations, and temperature target specification scenarios.

- Historical operations scenario – utilized historical hydrology and operations to form a baseline for comparative analysis with the other scenarios.
- Alternative operations scenario – focused primarily on the Stanislaus, where a set of prescriptive operations, such as instream flows, water allocations, and structural and/or operational changes, were implemented into the model.
- Temperature target specification scenarios – applied to the four-river model (all basins); temperature at key locations was specified and the system was re-operated to achieve those values.

33. The SJRWTM has already been used in several proceedings, including: analyses related to instream/temperature studies for the Stanislaus River, Friant Restoration Project, presentations for the SWRCB [303(d)/305(b)] workshop in 2007 (studies performed by the San Joaquin River Group Authority and CDFG), USBR Delta-Mendota Canal Recirculation Project, Tuolumne instream studies, and Tuolumne and Merced hydropower relicensing.

34. It is my understanding that the SJRWTM is intended to be the primary modeling and decision support tool for water temperature management in the San Joaquin River basin in the future.

OUTREACH, COLLABORATION AND TRAINING

35. Since both the Stanislaus Water Temperature Model (including the expansion to include the lower San Joaquin River) and the SJRWTM were developed collaboratively by a variety of stakeholders, and beginning in 2002 with grant funding from CALFED, regular meetings were held by and among the stakeholders to discuss refinement, development, calibration and use of the two models.

36. Regarding the Stanislaus River Water Temperature Model, a standing committee known as the “Technical Advisory Committee” (“TAC”) was created. The TAC included representatives from the USBR and FWS.

37. On September 25, 2001, as part of the meetings of the TAC, we conducted a training session at the offices of OID in Oakdale and on how to run and use the Stanislaus River Water Temperature Model. Participants were asked to bring their individual laptops. During the training session the model was installed on their computers. Donald Smith, my sub-contractor from RMA presented an overview of the model's graphical user interface (GUI) which allows users to view modeling results, and then showed the steps needed to perform an actual run of the model. The model remained in the possession of the participants, and they were encouraged to continue to practice running the model after the training session. Two of the attendees at this training session were Randi Field of the USBR and Cesar Blanco of FWS. (See attendance sheet attached hereto as Exhibit A).

38. Regarding the SJRWTM, a kick-off meeting was held on April 22, 2005 at my office in Moraga, California. Representatives from NMFS, USBR and FWS all attended. The USBR attendee, Chief of Planning Lloyd Peterson, stated that the USBR was very pleased with their experience in using the HEC-5Q for the Sacramento River developed by exclusively for the USBR by RMA. He also mentioned the fact that the USBR is in the process of constructing a further extension of the model that would cover the area between Stevinson and Friant Dam on the upper San Joaquin River. The attendee from NMFS, Mr. Jeff McClain, indicated that one of NMFS' goals for the SJRWTM was to have a tool that would assess temperature on a sub-daily time step. (See Meeting Notes for April 22, 2005 meeting, attached hereto as Exhibit B).

39. During the April 22, 2005 kick-off meeting for the SJRWTM, a standing committee known as the "Super TAC" was established. The purpose of the Super TAC was to oversee implementation of the SJRWTM and development of alternatives to be evaluated with the SRJWTM. The Super TAC was expected to meet 4-5 times per year, and included representatives from the USBR, FWS and NMFS. (Also in Exhibit B).

40. Since 2000, there have been numerous TAC, Super TAC and other stakeholder meetings regarding the Stanislaus Water Temperature Model and the SJRWTM. Attendees have included Jack Rowel, Lloyd Peterson, Dave Robinson, Bill Green, Brian Deason, John

Hannon, Randi Field, Ken Yokoyama, Michael Tansey, Peggy Manza, Rick Johnson, Meri Moore, Lenore Thomas, Claire Hsu and Russ Yaworsky from the USBR, Madelyn Martinez, Jeff Mclain, Dennis Smith, Craig Anderson, and Erin Strange from NMFS, and Derek Hilts, Joseph Terry, Craig Fleming, Scott Spaulding, Carl Mesick, Cesar Blanco, J.D. Wikert and Andrew Hamilton from FWS. (See various sign-up sheets, attached hereto as Exhibit C).

41. On October 30, 2007, we conducted another training session, this time for SJRWTM. The training session took place at the offices of Modesto Irrigation District in Modesto. The training was in the form of a presentation using a computer and projector by Donald Smith of RMA, and included step by step instruction on how to run the SJRWTM and view results. All the participants already had the SJRWTM installed on their laptop computer (the model itself and instructions how to install the model, run it, and view results were provided to the stakeholders several weeks in advance). During the presentation, a staff member of RMA and I walked around the room and provided assistance to people who struggled with keeping up with the pace of the training. Once again, the model loaded onto the participants' laptops remained in their possession and the participants were encouraged to continue practice using the model. Attendees at this training session included, among other stakeholders, Claire Hsu, David Mooney and John Hannon from the USBR, and Joseph Terry from FWS. (See attendance sheet attached hereto as Exhibit D).

42. On November 19, 2008, I sent again an email to all of the stakeholders for the SJRWTM, including the USBR, FWS and NMFS, which provided links to ftp site where the most recent version SJRWTM could be downloaded and detailed instructions for installing and running the model. (See, eg., AR 00089085-00089086). This was essentially the official pre-release of the SJRWTM with the intent to provide access to the model to stakeholders other than those who participated in the training session a year earlier.

43. On October 2009, I submitted the final project report to CALFED along with the final version of the model. Although the 2009 version was almost identical in terms of its functionality to the 2008 one, I have encouraged the stakeholders to use the latest version of the model as the best and final to eliminate any confusion about the various versions.

REVIEW AND EVALUATION OF TEMPERATURE MODELING DONE FOR BO

44. I was asked by the Stanislaus River Plaintiffs to review and evaluate the temperature modeling for the June 2009 Biological Opinion (BO), as it relates to the Stanislaus River. Based on this review, I have formed the following opinions:

45. **Opinion 1 - The absence in the record of the actual temperature modeling tool used by Reclamation and NMFS limits the ability to assess whether the temperature modeling performed by the agencies provides any support for the Temperature Requirements of Action III.1.2**

46. On Wednesday, July 7, 2010, counsel for Stanislaus River Plaintiffs sent to me via e-mail one (1) Excel spreadsheet file, identified by the title "Field attached file – OCAP_2008_WaterTemp_Stanislaus_FWSFlows_042109.xls." ("Federal Defendants' Stanislaus Temperature Results"). This file contains the results of a model run by the USBR regarding the impacts to temperature under one of the draft RPAs developed in 2009, but not of the RPA actually contained in the final BO. Counsel also forwarded to me, on the same day, a .pdf version of an e-mail from the NMFS administrative record, identified as NMFS AR 00211982. This email identifies the specific CALSIM II simulation that was the subject of the temperature run. On July 14, 2010 I received from counsel for Stanislaus River Plaintiffs a DVD which contained the specific CALSIM II simulation identified in NMFS AR 00211982, including all of the assumptions, inputs and other related materials. These materials can be found in the AR in the modeling DVD provided by the USBR.

47. In May 2010, and again in July 2010, I reviewed Appendix H of the August 2008 OCAP Biological Assessment which generally describes what is variously identified as either the "Reclamation Temperature Model" or "USBR Temperature Model." According to information provided to me by counsel for Stanislaus River Plaintiffs, the USBR Temperature Model" described in Exhibit H of the August 2008 OCAP BA is the model used to generate the results contained in the Federal Defendants' Stanislaus River Temperature Results.

48. Appendix H to the 2008 OCAP BA does not contain a copy of the USBR Temperature

Model. It directs readers to look at three reports, written by Rowell in 1979, 1990 and 1997, for a more detailed explanation of the USBR Temperature Model. I was not able to find any of those reports on-line, nor are they in the administrative record for this case.

49. Since the actual USBR Temperature Model that was used by Reclamation and NMFS was not made available in the administrative record for this case I was not able to evaluate its code to determine exactly how it works or to verify the results that are reported in the record. Moreover, without the actual model source code and/or its documentation, especially model calibration results, I was unable to determine whether the results it yields are valid or not. Thus, my review of the temperature modeling performed by the agencies relies on the limited information about the model that is in the record.

50. It is my understanding, and as explained in Appendix H to the 2008 OCAP BA, that "No formal process documented the quality assurance and data quality of the Reclamation Temperature Model. This model was developed at a time where specific documentation requirements were less stringent. A peer review of the Reclamation Temperature model has not been performed".

51. Moreover, in absence of model calibration results, the agency modelers should have at least performed quality assurance (QA) checks for the USBR Temperature Model as part of the documentation of the BO itself. This could have been accomplished by simply simulating with the model the historical conditions in the river (e.g., a period for which water temperature data have been recorded) and comparing the simulated results with the observed data. I have not found any evidence in the record that the agency modelers performed these QA checks with the USBR Temperature Model in connection with the development of the BO.

52. **Opinion 2 – Mean Monthly Water Temperature data provide meaningless information regarding the temperature regime in the Stanislaus River in the context of meeting the temperature requirements of Action III.1.2.**

53. The BO specifies that compliance with the Stanislaus River temperature criteria set forth in Action III.1.2 "shall be measured based on a seven-day average daily maximum

temperature." (BO, p. 621). The 7DADM is computed at the end of each day by adding the maximum temperature of the past seven consecutive days and dividing by seven. In practicality, this means that water managers must: a) keep track of the maximum temperature observed at the compliance point in the river every day and b) operate the system in any given day (i.e., make the appropriate release from Goodwin Dam for temperature control at the compliance location) in a way where the maximum temperature in that day added to the maximum temperature in the past six days and divided by seven, would not exceed the temperature required per Action III.1.2.

54. The fundamental question that a reasonably prudent temperature modeler must address, before even dealing with which is the appropriate computer model to be used in connection with the BO is how does the temperature in the river vary throughout the day and month and what level of resolution will provide meaningful information to assess temperature compliance per Action III.1.2.

55. To answer that question, I examined the observed water temperature at Orange Blossom Bridge (OBB), as recorded by the California Data Exchange Center (CDEC) maintained by the California Department of Water Resources (DWR). Figure 1 shows temperature variation in March 2010 at OBB. The figure shows that temperature could vary over 4˚ Fahrenheit (F) per day and over 8˚ F, from approximately 50˚ F to 58˚ F, throughout the month. The Mean Monthly Temperature in this case is 54˚ F, which is approximately 4˚ F below the monthly maximum and 4˚ F above the monthly minimum.

56. Figure 2 shows the computed 7DADM per the specification of Action III.1.2. The figure clearly shows that if the target temperature for the month is 55˚ F (which happened to be the temperature requirements for the month of March), then a Mean Monthly Temperature measurement would have shown 100% compliance with this requirements. However, if the measure for compliance is 7DADM, rather than a monthly mean, then approximately 50% of the time temperature would exceed the target and be out of compliance.

57. The USBR Temperature Model results provided by Federal Defendants, and which I reviewed, present temperature solely on a Mean Monthly basis with no mention to daily

maximums and/or 7DADM. From the description of the Reclamation Temperature Model in the record, this is the only type of temperature measurement that this model was capable of producing.

58. No reasonably prudent modeler could conclude that using a model that is only capable of assessing Mean Monthly Temperature should be used to predict compliance with respect to Action III.1.2, which requires compliance using the much finer 7DADM temperature measurement.

59. **Opinion 3 – The USBR Temperature Model is Too Coarse to Simulate, Predict or Evaluate the Feasibility of or the Impacts Associated With Meeting the Stanislaus River Temperature Requirements of Action III.1.2.**

60. To verify my Opinion 2, I sought to duplicate the analysis that Reclamation performed with the USBR Temperature Model with the SJRWTM to determine if there was a substantial difference in the results. Given that the record did not contain the USBR Temperature Model or any documentation about the methodology and assumptions embedded in the model to simulate temperatures in the Stanislaus River system, I had to evaluate the merit of the model as a modeling tool in the context of establishing the Stanislaus River Temperature Requirements per Action III.2.1, by reviewing the model results provided by the Federal Defendants. The evaluation process involved three steps:

61. First – I ran the SJRWTM for one case study produced by the Federal Defendants, as explained below.

62. Second – I compared the temperature variability at OBB, one of two compliance locations per Action III.1.2, as computed by the SJRWTM and the USBR Temperature Model.

63. Third – I evaluated the results of the two models in relation to the Temperature Requirements of Action III.1.2.

64. The case study that I have selected was labeled “Study 8.0 w/FWS Flows”. This case was identified to me by the Stanislaus River Plaintiff’s Counsel as the most conservative case upon which Action III.1.2 was ultimately based.

65. In order to produce the run with the SJRWTM, I had to match the total diversions at

Goodwin Dam and total release from Goodwin Dam to the Stanislaus River with those obtained from the CALSIM II results for this case. The CALSIM II results were extracted from the file: "20090409_OCAP_Future_Study8_wQ4WQCPvnsQreqts_&_StanRPAw98\CONV\DSS\2020D09EDV.DSS". This file was given to me by Mr. Dan Steiner, a consultant to the Stanislaus River Plaintiff's Counsel. Mr. Steiner told me that this run contains the input hydrology that was used to run the USBR Temperature Model for the "Study 8.0 w/FWS Flows" case.

66. For quality assurance I have compared the New Melones storage as computed by the two models, as shown in Figure 3. The figure shows an overall good match between the two runs with minor mismatches in 1980 and early 2000. These mismatches are attributed to different boundary conditions in the two runs (CALSIM II starts at 1922 while the SJRWTM starts from the flood control rule curve in 1980) and probably slight differences in flood control rules between the two models. However, these mismatches are insignificant, in my opinion, as far as temperature outflow from New Melones is concerned.

67. My conclusion from the quality control check is that if there are discrepancies between the temperatures computed with the SJRWTM and the USBR Temperature Model, they must be attributed to the accuracy of the models themselves and not to the mass-balance calculations (i.e., inflow to New Melones, Goodwin diversion, Goodwin release, and the resulting storage in New Melones).

68. Next, I have examined the temperature at OBB as computed by the SJRWTM and the USBR Temperature Model. As shown in the example in Figure 4, temperature at OBB varies on an hourly basis within the day and on a daily basis within the month. While the SJRWTM computes the temperature variation throughout at 6-hour intervals and thus captures the daily maximums (and minimums), the USBR Temperature Model assumes constant temperature for the entire month.

69. Like with the previous example (observed data for the month of March 2010), the Mean Monthly Temperature as computed by the USBR Temperature Model, erroneously predicts

100% compliance with respect to the target, as shown in Figure 5. The SJRWTM, however, uses the 7DADM as a measure for compliance and shows a violation approximately 50% of the time, as also shown in Figure 5.

70. Figure 6 shows more examples where the Mean Monthly Temperature computed by the USBR Temperature Model predicts compliance with regard to the target while the SJRWTM that uses the 7DADM as a measure for compliance shows a violation.

71. It should be emphasized that none of results produced with the USBR Temperature Model that I was able to find in my review of the model discussed the relationship between the Mean Monthly Temperature and 7DADM which is the governing criterion for compliance.

72. In conclusion - the results generated by the USBR Temperature Model were so inaccurate that no reasonably prudent modeler could conclude that the USBR Temperature Model could serve as a useful tool for predicting compliance based upon a 7DADM compliance criterion.

73. **Opinion 4 – Even with the inaccuracy of the USBR Temperature Model, the modeling results demonstrate that the temperature requirements per Action III.1.2 are not attainable a significant percent of the time. This observation is even more pronounced using the SJRWTM.**

74. Figure 7 is a summary showing frequencies of meeting temperature targets (and violation of targets) specified for OBB per Action III.1.2. The case study again is “Study 8.0 w/FWS Flows”. The table in Figure 7 shows two columns for each month. One for modeling results produced by the SJRWTM (labeled “5Q”) and one produced by the USBR Temperature Model (labeled “NMFS”).

75. As shown in Figure 7, the NMFS’ results underestimate violations of the target 8 months out of the year (February to September). The NMFS violations are higher for October and November.

76. Given the above mentioned observation it is not clear to me what the rationale was for the temperature requirements set forth in Action III.1.2 as it is quite apparent that those objectives are not attainable a significant amount of the time even using the USBR Temperature Model as a predictive tool.

77. In conclusion – had the Federal Defendants used the SJRWTM to simulate the temperature condition under "Study 8.0 w/FWS Flows", it would have been apparent that the temperature requirements under Action III.1.2 are not attainable even more often than estimated with the USBR Temperature Model.

78. **Opinion 5 – The USBR Temperature Model is deficient because it failed to evaluate the impact on New Melones storage when Action III.1.2 would be in place and therefore the feasibility of this proposed action.**

79. To analyze the feasibility of Action III.1.2, modeling wise, requires a two-step approach: First – minimum instream flow below Goodwin Dam is imposed on the system. Instream flow is the required minimum releases from Goodwin Dam downstream to the Stanislaus River as defined in Table 2E of the BO (Action III.1.3). Second – the temperature response to the minimum instream flow at the compliance locations is computed. If the 7DADM at the compliance location exceeds the target set forth in Action III.1.2 (temperature violation) there is a need to augment the minimum flow until the target is met. This type of analysis could be done either by a trial and error (probably the only option available when using the USBR Temperature Model) or by activating the "bottom up" feature in the SJRWTM as described above.

80. I have already discussed the fact that the USBR Temperature Model is not capable of assessing the 7DADM but rather is using Mean Monthly Temperature. But even at this coarse level of resolution, there is nothing in the record that indicates that the federal agencies took the second step and tried to quantify how much water is needed over and above the minimum flows specified in Table 2E (Action III.1.3) to prevent violations of the new temperature restrictions in Action III.1.2. Without this analysis, agency staff could not determine the additional impact on water system storage of imposing Action III.1.2.

81. The SJRWTM on the other hand, was available and could have been used to perform exactly this analysis. To illustrate the impact of Action III.1.2, I did so. I ran the SJRWTM in the two modes explained earlier: "top-down" mode where instream flows per Table 2E were imposed and "bottom-up" where minimum flows prescribed in Table 2E were augmented to

mitigate temperature violations at the compliance location (OBB in case). The difference between the two runs: 2E and Augmented 2E (labeled as case 2EA) provided the answers to key questions: 1) What would be the impact of the augmentation for temperature on New Melones storage, 2) To what extent the augmentation succeed to mitigate temperature violation, and 3) Are there any consequences for this type of operation (i.e., would aggressive operation for temperature in some years cause unmitigated conditions the following years, especially in dry and critically dry years).

82. It should be noted that one of the assumptions used in this analysis is that in any given month, only up to 1000 cfs could be used for temperature control (i.e., augmenting the amounts specified in Table 2E by up to 1000 additional cfs). The logic was to set a limit on the total release to prevent from draining the reservoir indefinitely.

83. The need to define this limit raises another fundamental question regarding the concepts associated with the development of the terms and conditions set forth in Action III.1.2. Modeling of reservoir-river system is essentially mathematical representation of the physical system and the rules by which it operates. When simulating system operation, models are design to mimic as close as possible a real-life decision making of water managers and facility operators by employing a set of rules and considerations for system limits and constraints. In the case of temperature control, rules and considerations could include: Are there ramping rates (how fast to increase or decrease releases from the dam when operating for temperature control)? How much water should be released before operators’ give-up the ability to lower temperature to meet the target? Should releases for temperature control be made at all if the temperature outflow from the dam already exceed the target (but yet could improve temperature conditions at the target)? Should a minimum storage volume in the reservoirs be defined as a threshold for ceasing temperature control?

84. To the best of my knowledge, none of the above mentioned rules and considerations are mentioned as part of Action III.1.2, only temperature targets and the fact the water should be released to meet those targets. To me it appears that there is disconnect between Action III.1.2 and the practical aspects of this action, or, at best, that Action III.1.2 is simply

incomplete

85. Figures 8 to 12 show the results for the above-mentioned analysis, as follows:

86. Figure 8 shows the New Melones storage under cases 2E and 2EA. The figure shows that New Melones storage would be depleted by as much as 717 TAF during the 1987-1995.

87. Figure 9 shows the amount of water needed on a monthly and annual basis for temperature control. The figure shows that the annual amount would vary between 22 TAF and 190 TAF with average amount equal to almost 84 TAF.

88. Figure 10 shows the effectiveness of the temperature control: In the summer, temperature at OBB could be reduced down to the target levels as measured using the 7DADM criterion. However, the model shows that an additional 1000 cfs would not be sufficient to lower the temperature to the target in the spring and fall.

89. Figure 11 shows that successive operation for temperature would eventually cease to be effective as New Melones' cold pool of water would be depleted. In other words, conserving water in New Melones by limiting releases in the spring and fall, when the ability to reduce the temperature to the target is questionable, could be a more effective way for temperature control in the long run.

90. Figure 12 shows that even after operating for temperature control (from 2E to 2EA), there are still significant violations of the target temperatures.

91. **In conclusion – The USBR Temperature Model failed to provide the level of analysis necessary to allow the regulatory agencies to realize all the impacts associated with imposing the terms and conditions set forth in Action III.1.2.**

92. **In contrast, the SJRWTM is the most advanced temperature model that has ever been developed for the Stanislaus and the San Joaquin River, as whole. The SJRWTM was designed to directly address all the implications associated with temperature response to flow and storage in the system thus providing a realistic check about what can and cannot be achieved as far as temperature control is concerned. Also, the SJRWTP has a built-in logic to model the old-new dam interaction. This unique feature is especially important when operating the system more aggressively, as appears to be the case when**

operating for temperature control per Action III.1.2 of the BO, because as the water level in New Melones approaches the crest of the old dam, the cold pool of water behind the old dam is isolated and cannot be released for temperature control. Instead, warmer water is skimmed of the top layer of the pool behind the old dam, which exacerbates the thermal condition downstream. Based on the information in the record describing the USBR Temperature Model, there is nothing to suggest that the USBR Temperature Model has the capability to address this issue.

93. **It should be noted that in 2006, in the peer review report of the OCAP, the panel addressed the weaknesses of monthly time-step models when applied to the needs of anadromous fish. The panel also identified the Stanislaus River Temperature Model as the preferred model for this task.**

94. **The Stanislaus River Temperature Model and then the SJRWTP were available to the Federal Defendants for almost six years. Unfortunately, they have not been used by the very same people who funded, supported and actively participated in their development since their infancy. Instead, the Federal Defendants have chosen an inferior model that raises more doubts about the validity of the results then insightful information that could lead to making informed decisions.**

95. **Beyond my conclusion that temperature targets are not attainable a significant amount of time, Action III.1.2 also has number of deficiencies that surfaced during my water temperature investigation and modeling. Action III.1.2 lacks in my opinion, basic rules, guidelines and constraints as to how the system should be operated for temperature control. There is disconnect between Action III.1.2 and the practical aspects of this action, or at best, Action III.1.2 is simply incomplete.**

Executed this 5th of August, 2010 in Moraga, California.

Avry Dotan

AVRY DOTAN

IDENTIFICATION OF COUNSEL:

JEANNE M. ZOLEZZI, SBN: 121282
KARNA E. HARRIGFELD, SBN: 162824
JENNIFER L. SPALETTA, SBN: 200032
ALEXIS GALBRAITH, SBN: 260756
HERUM \ CRABTREE
A California Professional Corporation
2291 West March Lane, Suite B100
Stockton, CA 95207
Telephone: (209) 472-7700

Attorneys for Plaintiff
STOCKTON EAST WATER DISTRICT

TIM O'LAUGHLIN
WILLIAM C. PARIS III
KENNETH PETRUZZELLI
KATIE J. SHEA
O'LAUGHIN & PARIS LLP
2571 California Park Drive, Suite 210
Chico, CA 95928
Telephone: (530) 899-9755
Facsimile: (530) 899-1367

Attorneys for Plaintiffs
OAKDALE IRRIGATION DISTRICT and
SOUTH SAN JOAQUIN IRRIGATION DISTRICT

MODELING DEMONSTRATES THAT NEW MELONES IS INCAPABLE OF REALSING SUFFICIENT WATER TO MEET THE REQUIREMENTS OF RPA ACTION III.1.2

Action III.1.2 requires USBR to make cold water releases from New Melones to provide suitable temperatures for CV steelhead. (BO, p. 621). The compliance point is at Orange Blossom Bridge (OBB) downstream of Goodwin Dam, and temperature compliance shall be measured based on a seven (7) day average daily maximum temperature (7DADM). (BO, p. 622).

1. USBR used the Reclamation Temperature Model (not provided in the AR, described in Appendix H to the 2008 OCAP BA) to evaluate feasibility of meeting the temperature criteria.
    a. The Reclamation model was not peer reviewed. (H-6)
    b. The Reclamation model present temperature on a mean monthly basis, and cannot depict daily maximums or 7DADM. (H-9; Milligan Decl., ¶ 12)
    c. The Reclamation model does not capture diurnal temperature variability. (Milligan Decl., ¶ 12).
    d. Reclamation model cannot simulate actual operations strategies used to meet temperature objectives. (Milligan Decl., ¶ 12).
    e. No modeling was done to assess potential impacts on storage due to flows released for temperature compliance. (Reed Decl., ¶ 30).
    f. NMFS/USBR did not quantify how much water would need to be released to meet temperature. (Reed Decl., ¶ 31).

2. Modeling performed using the Reclamation model showed that there will be temperature exceedances. (BO, p. 622; US Reply Br., p. 132; Reed Decl. ¶ 25).

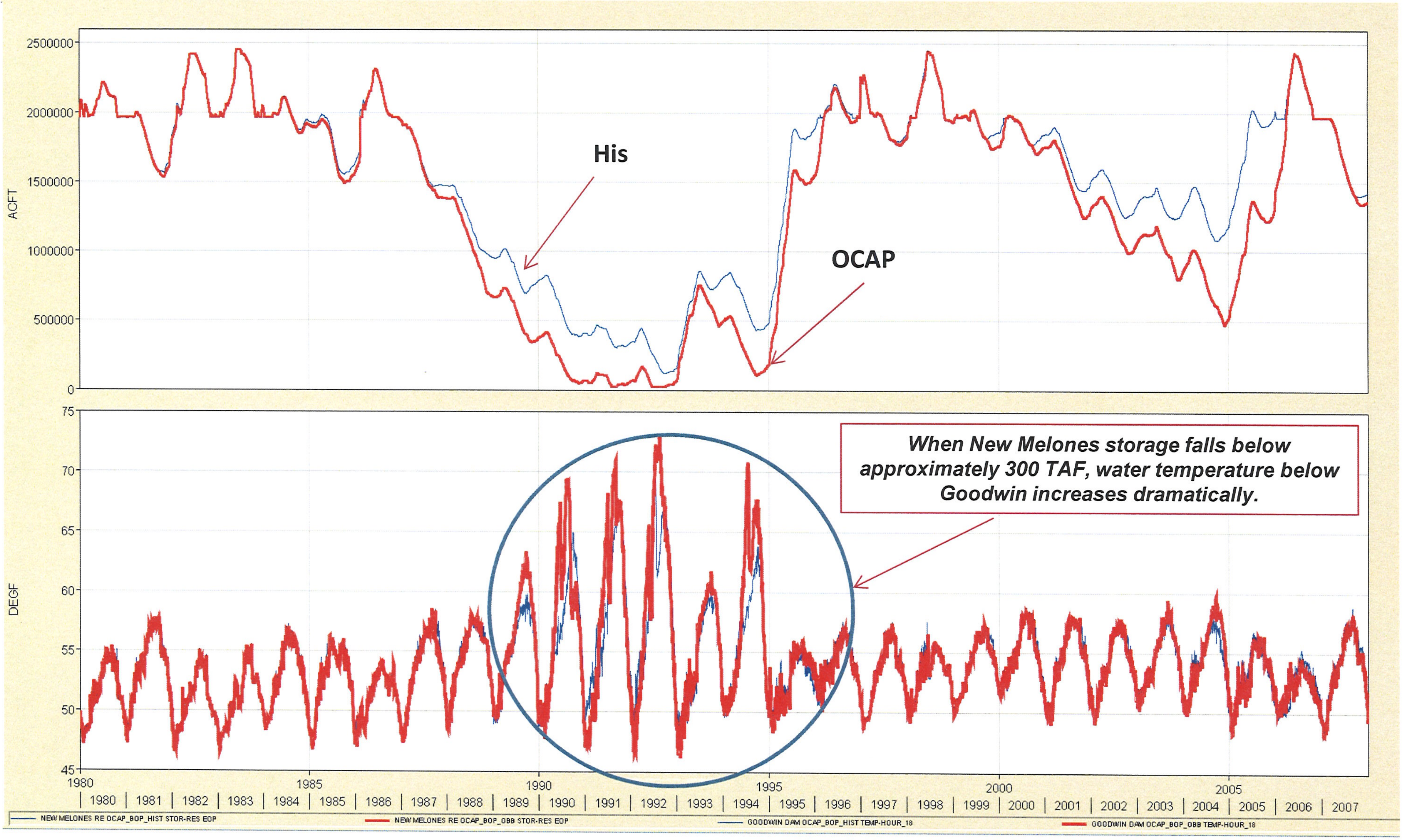
3. Dotan replicated the use of the Reclamation model using the San Joaquin River Water Temperature Model (SJRWTM). (Dotan Decl., ¶ ¶ 60-77).
    a. The model run shows that there are temperature exceedances in every month except December, January and February, exceedances occur more than 25% of the time in the months of May, July, October and November, and 92% of the time in October. (Dotan Decl., ¶¶ 73-77, Fig. 7).
    b. Dotan ran same data using the SJRWTM, which has a 6 hour timestep. Those runs found exceedances in all months except December and January, exceedances occur more than 18% of the time in the months of March, April, May, June, July, August, September, October and November, and exceedances of more than 40% of the time occur in the months of April, May, July, and October. (Dotan Decl., Fig. 7).

4. Dotan used the SJRWTM to model impacts to New Melones storage in releasing water to meet temperature requirement. Dotan modeled the required Appendix 2E flows, and ordered the model to use up to an additional 1,000 cfs to meet temperature. (Dotan Decl., ¶ 82).
    a. In the period 1987-1995, New Melones storage would need to be depleted by as much as 717,000 AF when compared with required 2E releases to meet temperature. (Dotan Decl., ¶ 86, Fig. 8).
    b. Even using up to an additional 1000 cfs does not result in 100% compliance. Still exceedances occur in every month except January, with exceedances occurring

25% of the time or more in March, April, May, June, July, August, and October. (Dotan Decl., ¶ 90, Fig. 12).

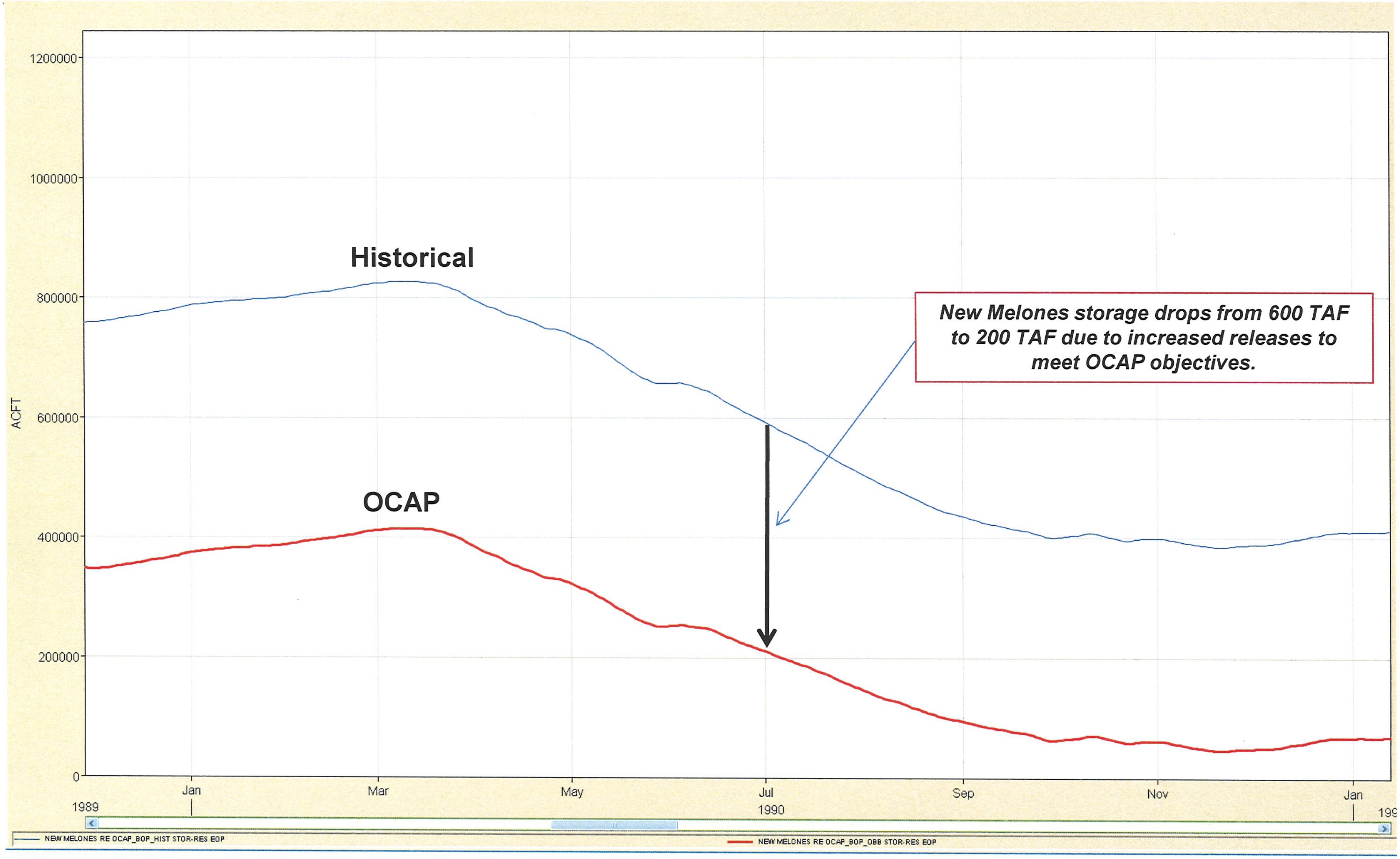
c. Successive operation to meet temperature will eventually deplete cold water pool. (Dotan Decl., ¶ 89, Fig. 11).

New Melones Storage is depleted due to increased releases above Historical to meet OCAP Temperature Targets
(1980-2007)



When New Melones storage falls below approximately 300 TAF, water temperature below Goodwin increases dramatically.

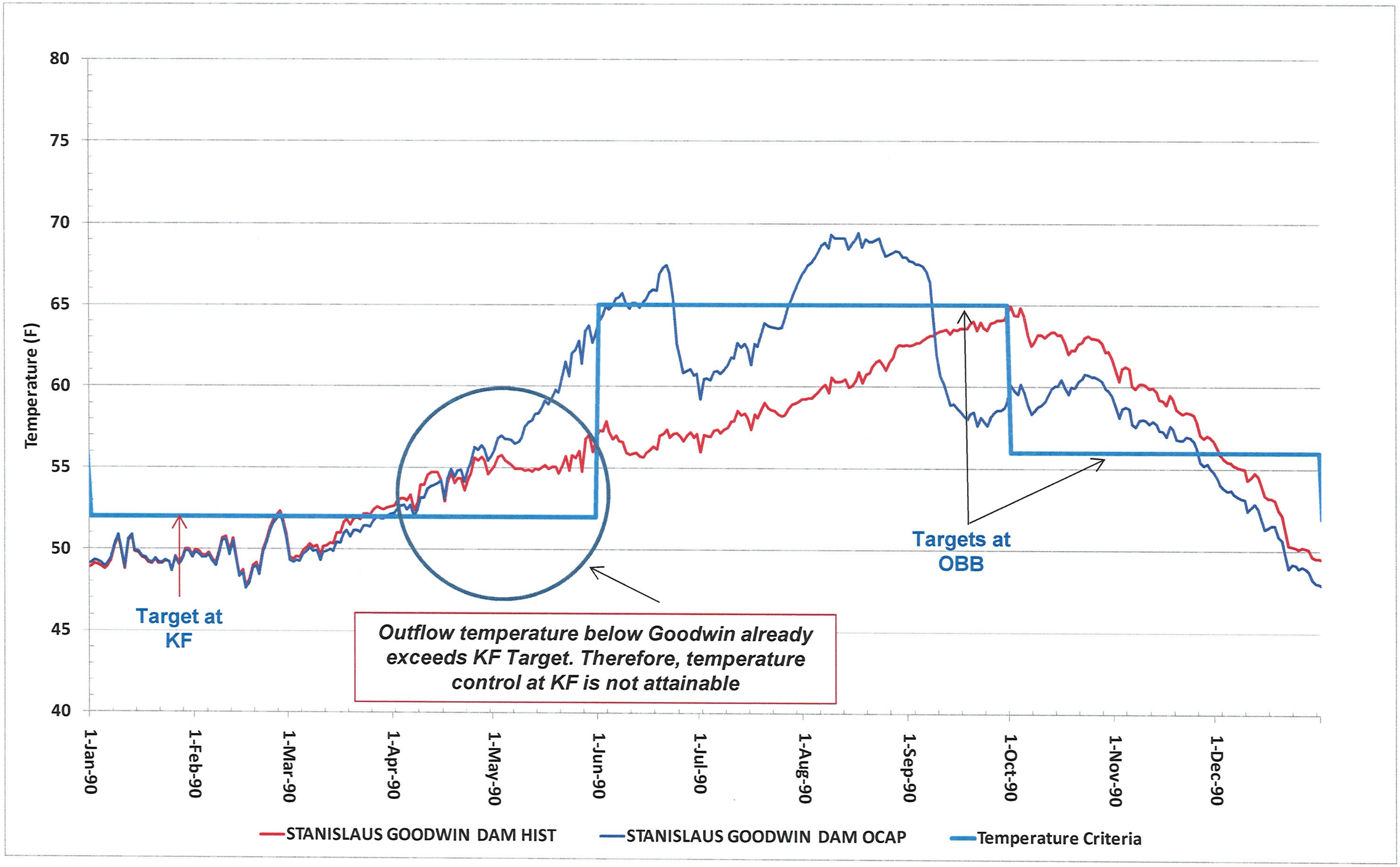
New Melones Storage - Critical Year 1990



New Melones storage drops from 600 TAF to 200 TAF due to increased releases to meet OCAP objectives.

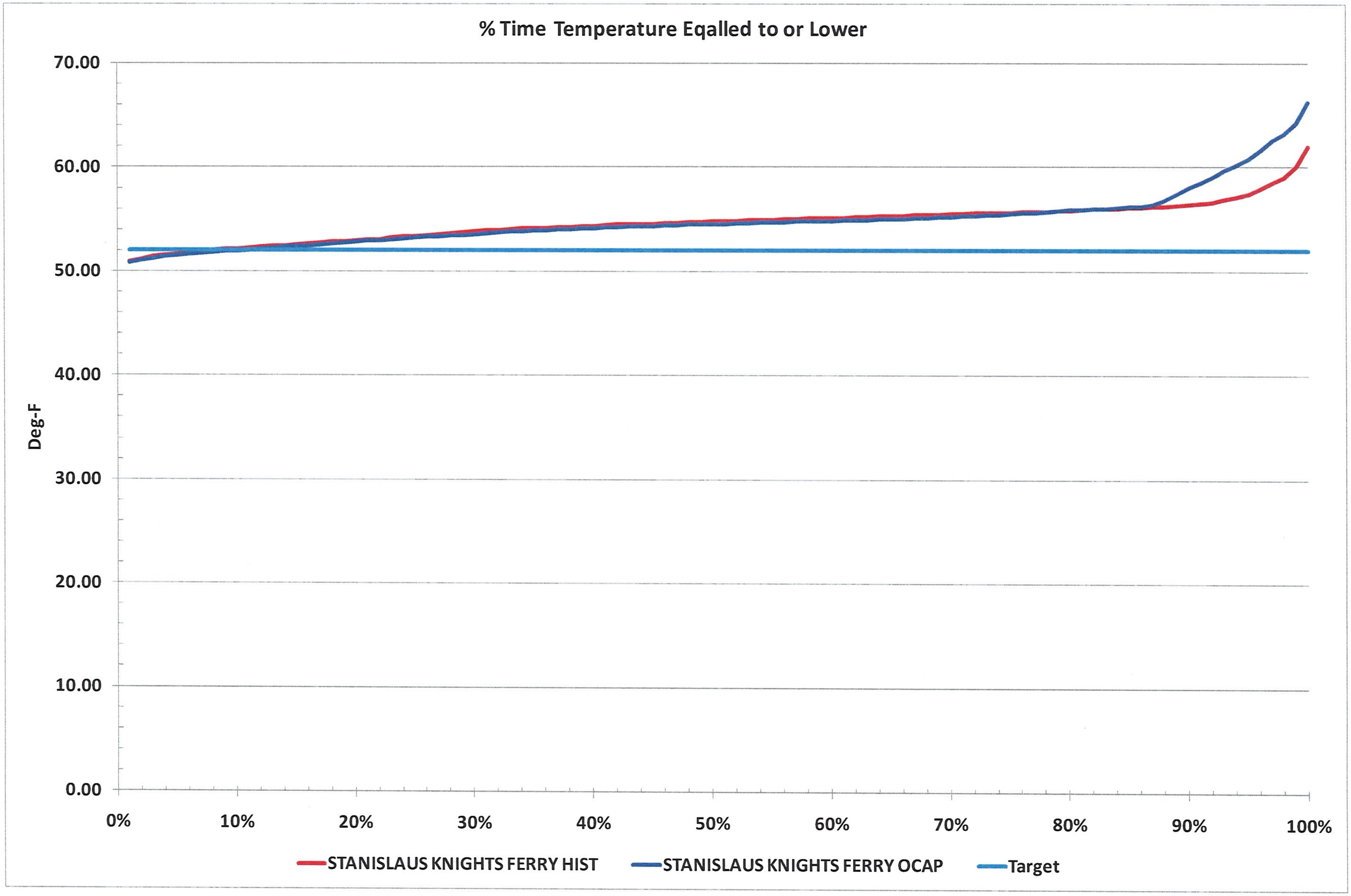
Temperature Below Goodwin Dam in Relation to Target Temperature at Knights Ferry (KF) and Orange Blossom Bridge (OBB)

Example: 1990 (similar phenomenon would occur 90% of the time)



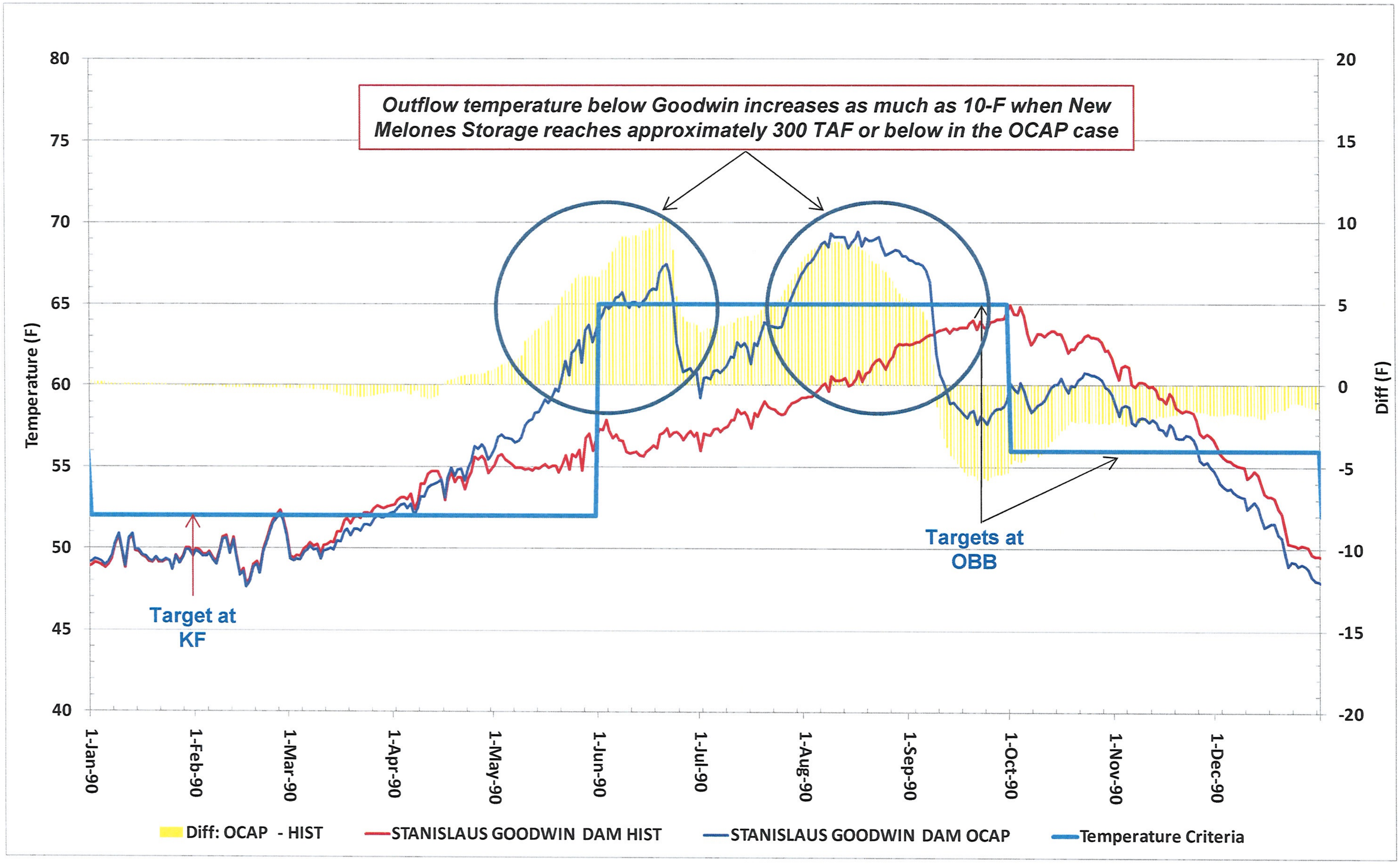
Outflow temperature below Goodwin already exceeds KF Target. Therefore, temperature control at KF is not attainable

Target temperature at Knights Ferry can be met only about 10% of the time in the month of May with or without flow augmentation



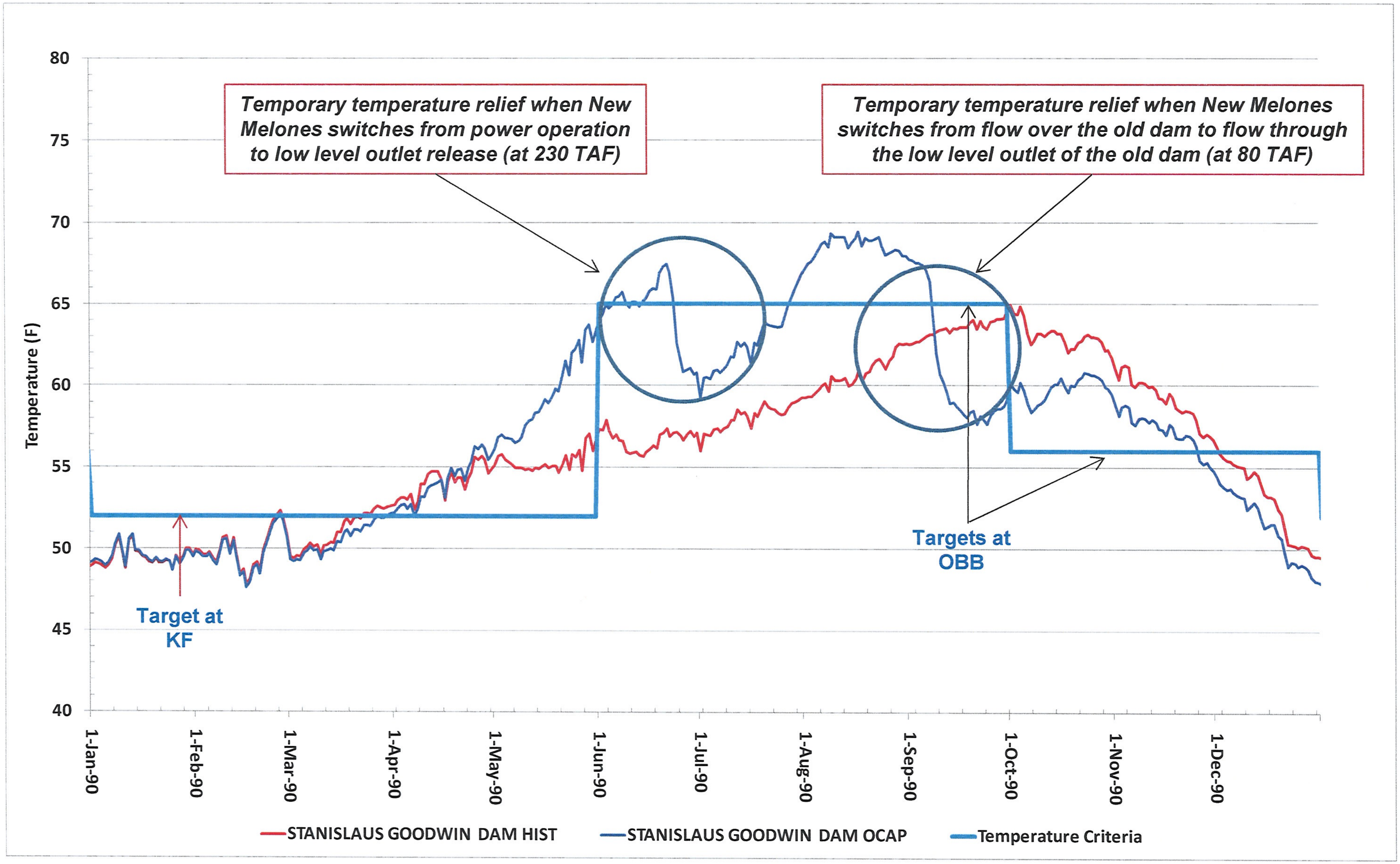
Temperature Below Goodwin Dam in Relation to Target Temperature at Knights Ferry (KF) and Orange Blossom Bridge (OBB)

Example: 1990



Outflow temperature below Goodwin increases as much as 10-F when New Melones Storage reaches approximately 300 TAF or below in the OCAP case

Temperature Below Goodwin Dam in Relation to Target Temperature at Knights Ferry (KF) and Orange Blossom Bridge (OBB)
Example: 1990



Temporary temperature relief when New Melones switches from power operation to low level outlet release (at 230 TAF)

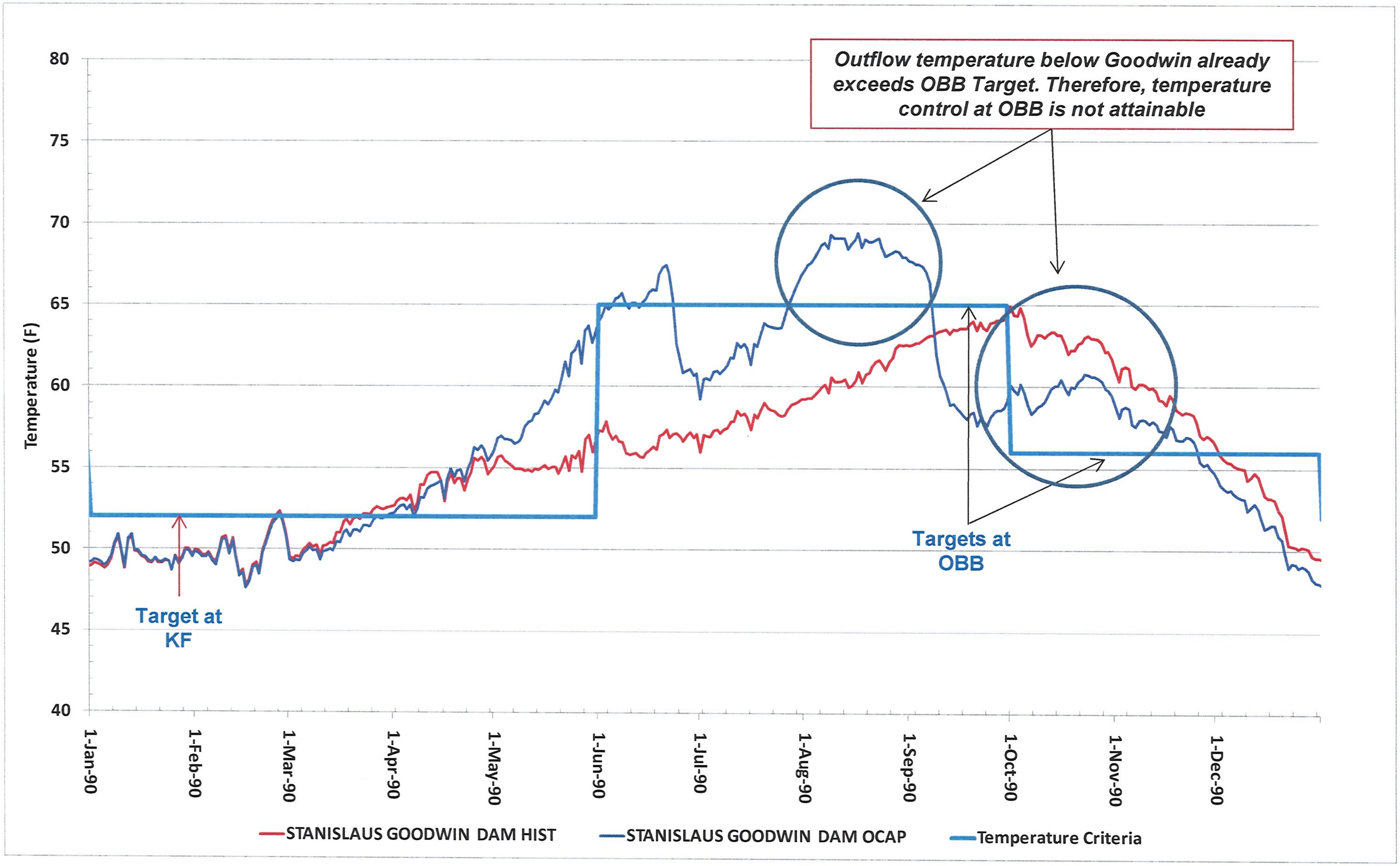
Temporary temperature relief when New Melones switches from flow over the old dam to flow through the low level outlet of the old dam (at 80 TAF)

Target at KF

Targets at OBB

Temperature Below Goodwin Dam in Relation to Target Temperature at Knights Ferry (KF) and Orange Blossom Bridge (OBB)

Example: 1990



Target temperature at Orange Blossom Bridge can be met only about 50% of the time in the month of October even after flow augmentation (about 15% increase over Historical)

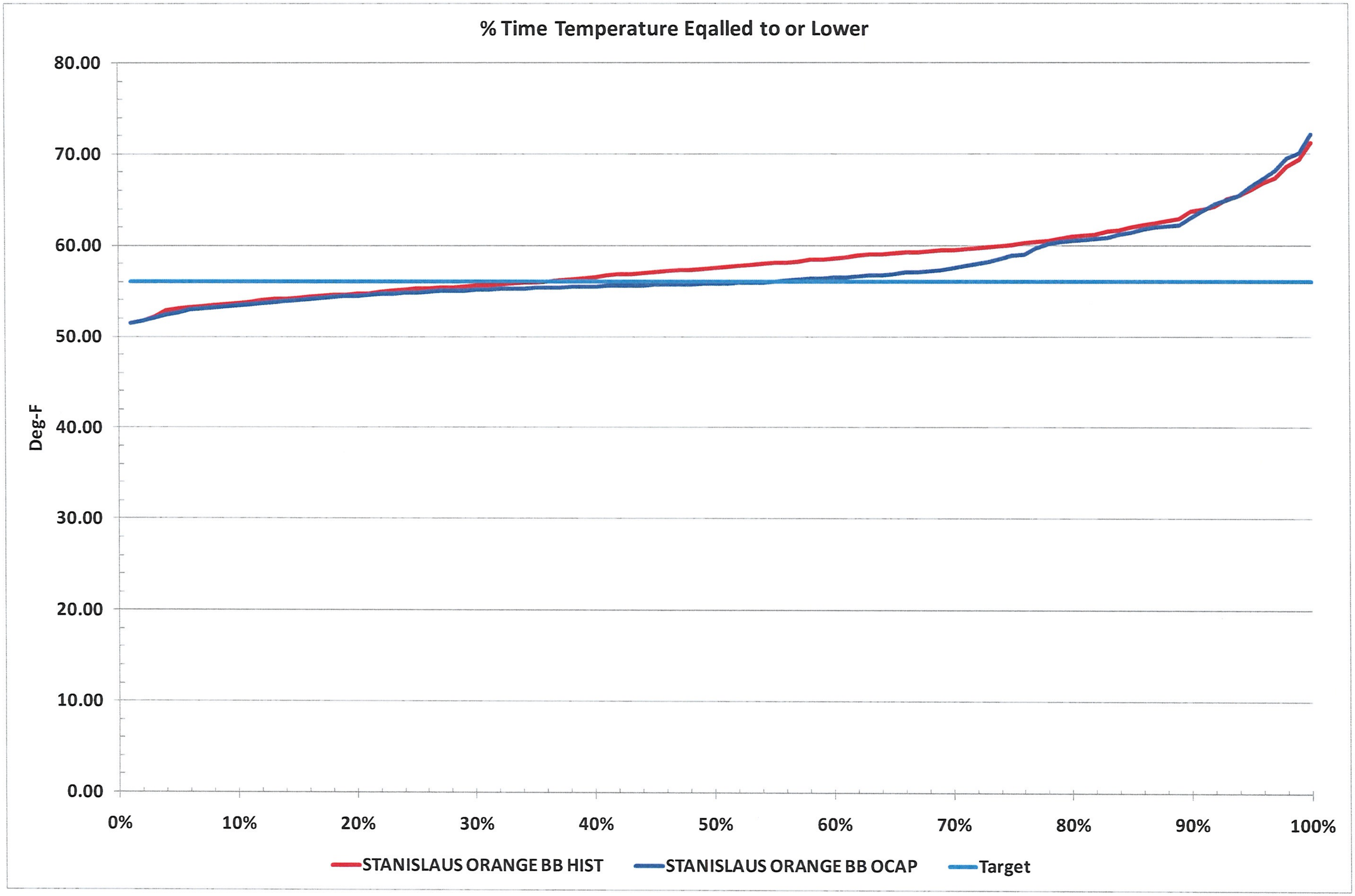


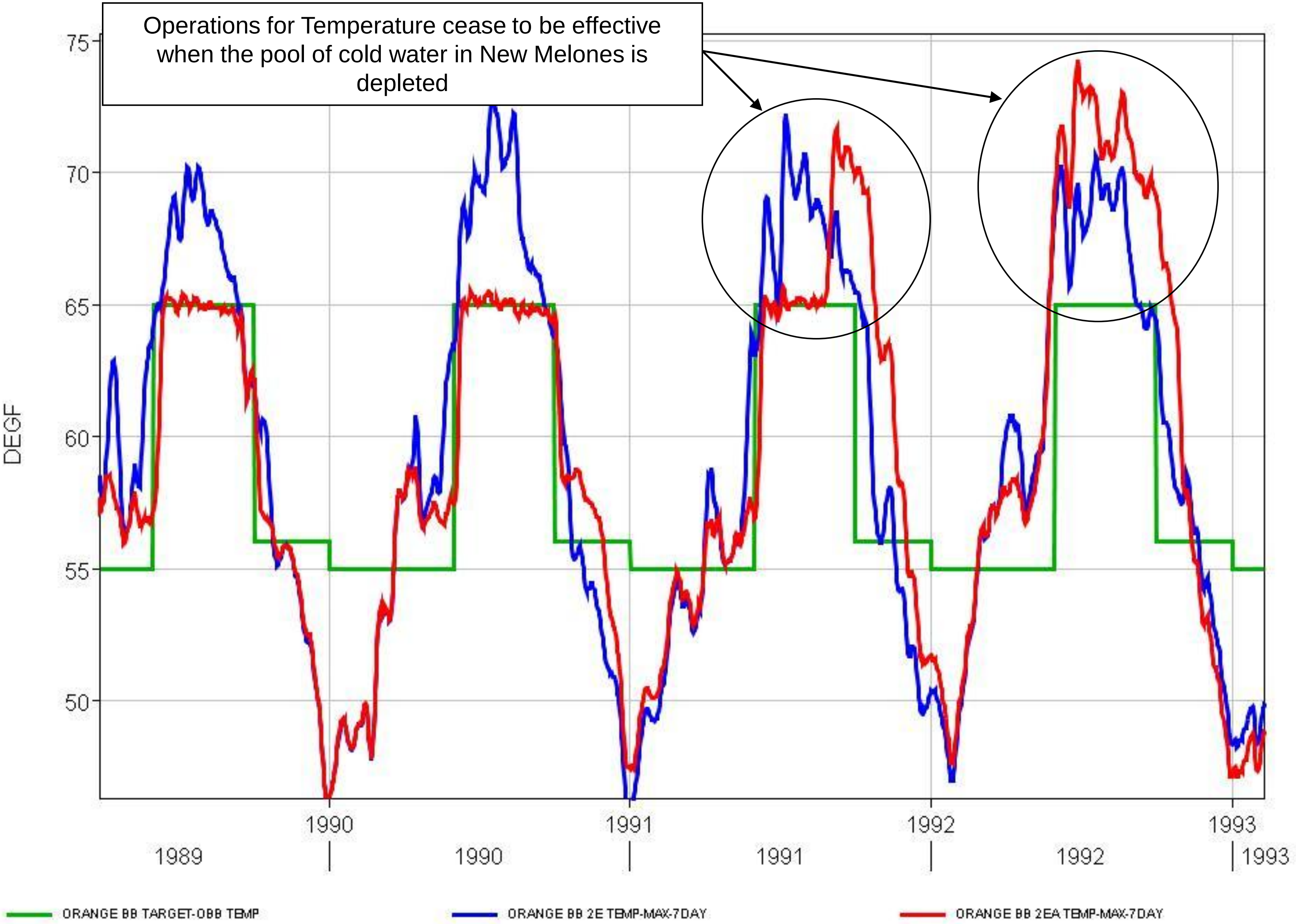
Figure - 7

% EXC	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
2%	45.8	45.8	47.8	46.1	49.1	47.7	50.3	48.0	51.4	49.2	53.0	52.4	54.5	55.5	55.5	57.5	53.8	55.4	52.3	55.0	49.7	52.0	46.6	47.6
4%	46.2	45.8	48.1	46.1	49.3	47.7	50.5	48.0	51.8	49.2	53.6	52.4	55.2	55.5	56.1	57.5	54.7	55.4	52.6	55.0	50.7	52.0	47.6	47.6
6%	46.4	45.9	48.4	46.4	49.6	48.3	50.7	48.0	52.3	50.0	54.2	52.5	58.0	58.1	58.9	59.0	55.1	57.3	53.4	56.6	51.0	53.4	48.1	48.7
8%	46.7	45.9	48.6	46.4	49.7	48.3	50.9	48.0	52.5	50.0	54.4	52.5	59.4	58.1	59.3	59.0	55.4	57.3	53.7	56.6	51.5	53.4	48.5	48.7
10%	47.0	45.9	48.8	47.2	50.0	48.5	51.1	48.6	52.6	50.0	54.6	53.4	59.9	58.7	59.6	59.9	56.2	57.9	53.9	57.6	51.8	53.5	48.7	48.8
12%	47.2	45.9	48.9	47.2	50.2	48.5	51.4	48.6	52.9	50.0	54.8	53.4	60.1	58.7	59.9	59.9	56.6	57.9	54.2	57.6	52.0	53.5	48.9	48.8
14%	47.3	46.3	49.0	47.3	50.5	49.5	51.7	48.8	53.1	50.7	54.9	54.5	60.3	60.6	60.1	61.2	57.6	58.7	54.3	57.8	52.2	53.5	49.0	49.0
16%	47.5	46.3	49.1	47.3	50.9	49.5	51.8	48.8	53.3	50.7	55.2	54.5	60.7	60.6	60.4	61.2	58.0	58.7	54.4	57.8	52.3	53.5	49.2	49.0
18%	47.6	46.3	49.2	48.6	51.2	49.7	52.0	49.3	53.5	50.9	55.5	54.6	61.1	61.8	60.7	61.2	58.7	60.2	54.6	57.8	52.5	53.5	49.3	49.0
20%	47.7	46.3	49.3	48.6	51.3	49.7	52.2	49.3	53.6	50.9	55.7	54.6	61.5	61.8	61.0	61.2	59.0	60.2	54.7	58.1	52.6	55.1	49.4	49.4
22%	47.8	46.4	49.4	48.7	51.4	49.7	52.5	49.5	53.7	51.9	55.8	55.8	61.9	62.0	61.3	62.0	59.3	60.9	54.8	58.1	52.7	55.1	49.6	49.4
24%	47.9	46.4	49.6	48.7	51.6	49.7	52.7	49.5	54.1	51.9	56.1	55.8	62.2	62.0	61.5	62.0	59.5	60.9	55.0	58.1	53.0	55.1	49.6	50.0
26%	48.0	46.4	49.6	48.8	51.7	49.7	52.9	49.5	54.3	52.0	56.5	55.9	62.5	62.0	61.8	62.1	59.8	61.1	55.1	58.1	53.2	55.1	49.7	50.0
28%	48.1	47.1	49.7	48.8	51.9	50.1	53.1	49.7	54.4	53.0	56.8	56.3	62.6	62.3	61.9	62.8	60.1	62.2	55.2	58.7	53.4	55.2	49.9	50.0
30%	48.2	47.1	49.8	48.8	52.0	50.1	53.3	49.7	54.6	53.0	57.1	56.3	62.7	62.3	62.1	62.8	60.3	62.2	55.3	58.7	53.5	55.2	50.0	50.0
32%	48.3	47.5	49.9	48.9	52.2	50.4	53.4	50.1	54.8	53.1	57.3	57.1	62.9	62.6	62.2	63.2	60.4	62.4	55.4	58.9	53.7	55.3	50.1	50.0
34%	48.4	47.5	49.9	48.9	52.3	50.4	53.6	50.1	54.9	53.1	57.5	57.1	63.0	62.6	62.4	63.2	60.6	62.4	55.6	58.9	53.8	55.3	50.2	50.0
36%	48.5	47.8	50.0	49.2	52.4	50.8	53.7	50.5	55.1	53.7	57.6	57.9	63.2	62.6	62.5	63.2	60.8	62.8	55.7	58.9	53.9	55.3	50.3	50.0
38%	48.6	47.8	50.1	49.2	52.5	50.8	53.8	50.5	55.3	53.7	57.9	57.9	63.5	62.6	62.6	63.2	60.9	62.8	55.8	59.2	54.1	55.4	50.4	50.1
40%	48.6	48.1	50.2	49.6	52.6	51.0	54.0	50.6	55.4	54.2	58.0	58.6	63.8	62.8	62.8	63.2	61.0	62.9	56.0	59.2	54.2	55.4	50.5	50.1
42%	48.7	48.1	50.3	49.6	52.7	51.0	54.1	50.6	55.6	54.2	58.2	58.6	63.9	62.8	62.9	63.2	61.1	62.9	56.2	59.2	54.3	55.5	50.6	50.1
44%	48.8	48.1	50.5	49.8	52.8	51.4	54.2	51.6	55.7	55.5	58.4	58.7	64.1	63.1	63.1	63.3	61.2	63.0	56.3	59.2	54.5	55.5	50.7	50.1
46%	48.9	48.1	50.5	49.8	52.9	51.4	54.3	51.6	55.9	55.5	58.8	58.7	64.3	63.1	63.3	63.3	61.3	63.0	56.4	59.2	54.5	55.8	50.7	50.5
48%	49.0	48.1	50.6	50.1	53.0	51.5	54.5	51.9	56.0	55.5	59.6	61.5	64.4	63.2	63.4	63.3	61.5	63.3	56.6	59.2	54.6	55.8	50.8	50.5
50%	49.0	48.1	50.7	50.1	53.2	51.5	54.6	51.9	56.2	55.5	60.2	61.5	64.6	63.2	63.6	63.3	61.7	63.3	56.7	59.4	54.7	56.0	50.9	50.5
52%	49.1	48.1	50.8	50.2	53.3	51.5	54.8	51.9	56.3	55.5	60.9	61.5	64.7	63.2	63.7	63.3	61.7	63.3	56.8	59.5	54.8	56.2	51.0	50.6
54%	49.2	48.2	51.0	50.2	53.4	51.7	54.9	53.2	56.5	55.9	61.6	61.7	64.9	63.4	63.9	63.8	61.9	63.7	57.0	59.5	54.9	56.2	51.1	50.6
56%	49.3	48.2	51.1	50.2	53.5	51.7	55.0	53.2	56.6	55.9	62.1	61.7	65.0	63.4	63.9	63.8	62.1	63.7	57.2	59.6	54.9	56.3	51.3	50.8
58%	49.3	48.2	51.3	50.5	53.6	52.3	55.1	53.2	56.8	56.2	62.4	61.8	65.1	63.7	64.1	63.9	62.3	63.9	57.3	59.6	55.1	56.3	51.3	50.8
60%	49.4	48.2	51.3	50.5	53.8	52.3	55.2	53.2	56.9	56.2	62.8	61.8	65.1	63.7	64.2	63.9	62.4	63.9	57.5	59.7	55.2	56.3	51.5	51.0
62%	49.5	48.6	51.4	50.6	54.0	52.4	55.3	53.2	57.1	56.6	63.1	62.0	65.3	64.7	64.3	64.0	62.5	64.2	57.8	59.7	55.3	56.3	51.6	51.0
64%	49.6	48.6	51.6	50.6	54.1	52.4	55.5	53.2	57.3	56.6	63.4	62.0	65.4	64.7	64.5	64.0	62.7	64.2	57.9	59.7	55.4	56.6	51.7	51.3
66%	49.7	48.8	51.7	50.8	54.2	52.8	55.6	53.5	57.4	56.8	63.7	62.9	65.5	64.7	64.6	64.2	62.8	64.4	58.1	59.7	55.6	56.6	51.8	51.3
68%	49.8	48.8	51.8	50.8	54.4	52.8	55.8	53.5	57.6	56.8	64.0	62.9	65.6	64.7	64.7	64.2	63.0	64.4	58.3	59.7	55.8	56.6	52.0	51.3
70%	49.9	49.2	51.9	51.5	54.6	53.3	55.9	53.8	57.8	57.3	64.2	63.1	65.7	65.1	64.8	64.3	63.2	64.4	58.6	60.3	55.9	56.8	52.1	51.4
72%	50.0	49.2	52.0	51.5	54.7	53.3	56.1	53.8	58.0	57.3	64.4	63.1	65.9	65.1	64.9	64.3	63.4	64.4	59.0	60.3	56.1	56.8	52.3	51.4
74%	50.1	49.2	52.2	51.6	54.8	53.6	56.3	54.4	58.2	57.4	64.5	63.9	66.0	65.3	65.1	64.5	63.7	64.7	60.0	60.7	56.3	56.9	52.4	51.6
76%	50.2	49.4	52.3	51.6	55.0	53.6	56.5	54.5	58.4	57.4	64.7	64.0	66.2	65.3	65.1	64.5	64.1	64.7	60.3	60.7	56.4	56.9	52.5	51.6
78%	50.3	49.4	52.4	51.6	55.1	53.6	56.6	54.5	58.6	57.4	64.9	64.0	66.4	65.3	65.3	64.5	64.3	64.7	60.6	61.1	56.7	57.2	52.6	52.0
80%	50.5	49.7	52.5	51.7	55.4	54.1	56.8	54.6	58.8	57.5	65.1	64.0	66.5	65.6	65.5	64.8	64.8	64.7	60.9	61.1	56.9	57.2	52.7	52.0
82%	50.7	49.7	52.7	51.7	55.6	54.1	57.1	54.6	59.0	57.5	65.3	64.0	66.7	65.6	65.7	64.8	65.1	64.7	61.3	61.8	57.1	57.4	52.8	52.0
84%	50.8	49.8	53.0	51.9	55.9	54.2	57.3	54.8	59.3	57.6	65.5	64.1	66.9	65.8	66.0	65.3	65.6	65.0	61.8	61.8	57.4	57.4	53.0	52.0
86%	51.0	49.8	53.1	51.9	56.1	54.2	57.6	54.8	59.5	57.6	65.8	64.1	67.2	65.8	66.4	65.3	66.2	65.0	62.0	61.8	57.6	57.4	53.1	52.0
88%	51.2	50.3	53.3	51.9	56.3	54.4	57.8	55.8	59.7	58.6	66.0	64.3	67.5	66.0	67.1	65.3	68.2	65.5	63.0	62.1	58.0	57.5	53.3	52.5
90%	51.5	50.3	53.6	51.9	56.6	54.4	58.0	55.8	60.1	58.6	66.3	64.3	67.8	66.0	67.8	65.3	68.6	65.5	64.0	62.1	58.3	57.5	53.5	52.5
92%	51.7	50.9	54.0	53.1	57.0	54.7	58.3	56.2	60.5	58.8	66.6	65.5	68.3	66.1	69.1	66.0	68.9	66.6	65.2	64.5	58.6	58.8	54.0	52.8
94%	52.0	50.9	54.3	53.1	57.4	54.7	58.5	56.2	61.1	58.8	67.0	65.5	69.4	66.1	69.8	66.0	69.2	66.6	66.2	64.5	59.1	58.8	54.2	52.8
96%	52.4	52.1	54.8	54.0	58.2	56.6	58.9	57.5	63.4	61.6	67.4	65.8	70.1	68.3	70.7	66.2	69.5	68.3	66.8	65.9	60.2	59.4	54.5	52.8
98%	53.2	52.1	55.1	54.0	59.0	56.6	60.0	57.5	65.4	61.6	68.0	65.8	70.9	68.3	71.6	66.2	69.9	68.3	67.4	65.9	61.9	59.4	54.7	52.8
100%	53.9	52.1	58.4	54.0	60.8	56.6	63.9	57.5	67.6	61.6	69.6	65.8	74.0	68.3	73.1	66.2	71.0	68.3	69.7	65.9	63.3	59.4	55.5	52.8
Case	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS	5Q	NMFS
Target	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	56.0	56.0	56.0	56.0	56.0	56.0

🟨 Above target
🟦 Below Target

Figure - 11

Augmentation for Temperature from 2E to 2EA



Operations for Temperature cease to be effective when the pool of cold water in New Melones is depleted

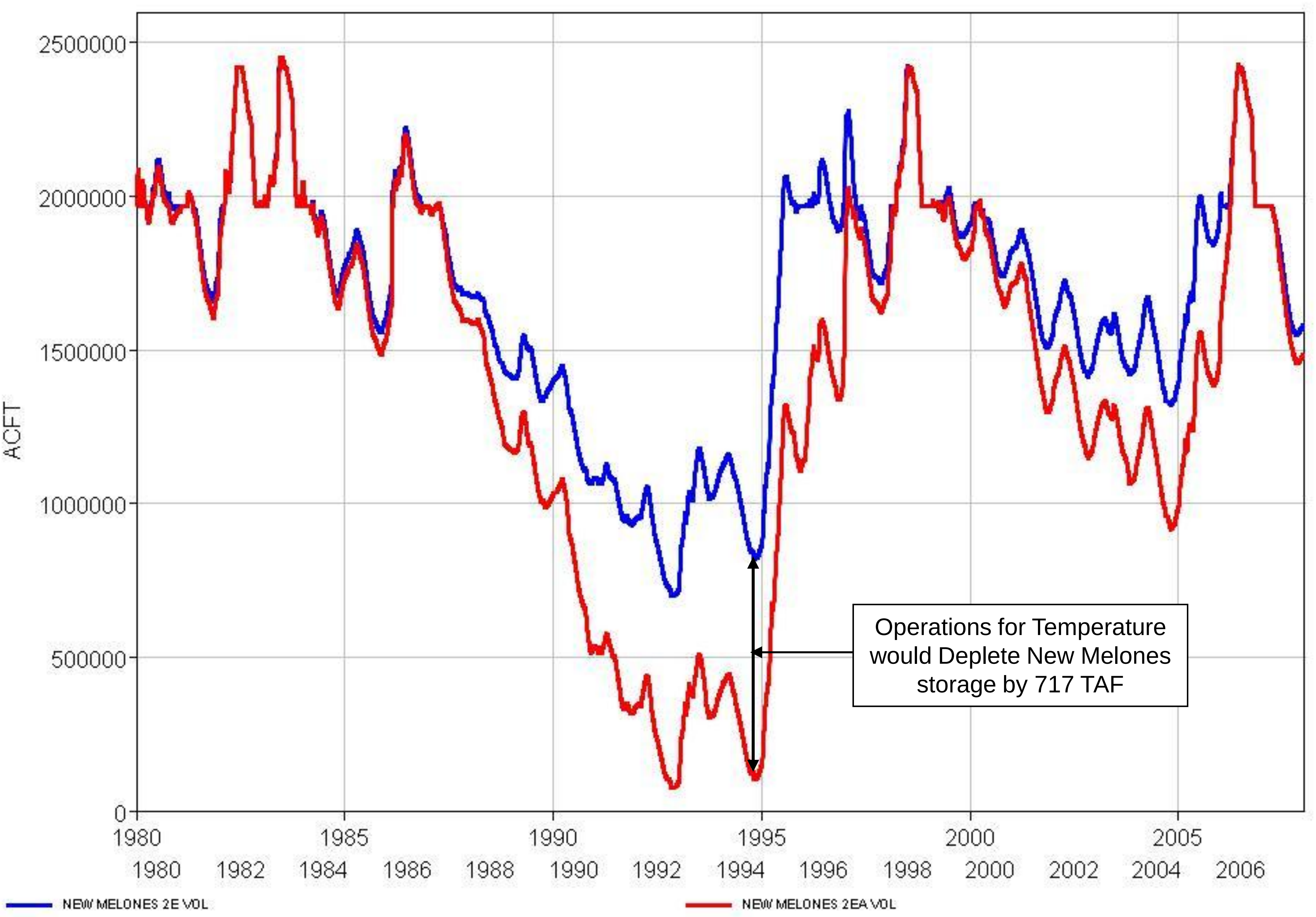
Figure - 12

% EXC	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
2%	45.4	45.4	47.8	47.7	49.0	48.8	50.3	50.3	52.5	51.8	52.3	52.5	54.4	54.4	59.3	59.2	55.6	55.5	52.1	51.9	49.9	49.9	46.1	46.1
4%	46.1	46.1	48.2	48.0	49.2	49.1	50.8	50.7	53.0	52.4	53.7	53.7	56.6	56.8	59.4	59.4	56.3	56.2	52.7	52.3	50.6	50.5	46.4	46.8
6%	46.5	46.5	48.5	48.4	49.4	49.3	51.3	50.9	53.4	52.9	54.1	54.0	58.0	57.8	59.7	59.6	57.4	57.1	53.1	52.9	50.8	50.8	47.4	47.4
8%	46.7	46.7	48.7	48.6	49.7	49.5	51.5	51.2	53.7	53.2	54.6	54.4	58.7	58.3	59.9	59.9	57.7	57.6	53.2	53.1	51.1	51.0	47.9	47.7
10%	46.9	46.9	48.8	48.7	49.9	49.8	51.9	51.5	53.9	53.5	54.8	54.7	59.6	58.8	60.1	60.1	58.1	58.0	53.5	53.3	51.4	51.3	48.3	48.1
12%	47.1	47.1	49.0	48.8	50.2	50.0	52.1	51.8	54.1	53.7	55.3	55.1	60.1	59.6	60.5	60.4	58.3	58.4	53.7	53.5	51.6	51.6	48.6	48.5
14%	47.4	47.4	49.1	49.0	50.5	50.2	52.3	52.0	54.2	53.9	55.5	55.4	60.4	60.1	60.7	60.7	58.5	58.6	53.9	53.6	51.7	51.7	48.8	48.7
16%	47.6	47.5	49.2	49.1	50.8	50.5	52.5	52.2	54.3	54.1	55.7	55.6	60.8	60.3	60.9	60.9	58.8	58.9	54.0	53.7	51.8	51.8	49.0	48.9
18%	47.8	47.7	49.4	49.2	51.0	50.7	52.7	52.4	54.5	54.3	56.0	55.8	61.0	60.6	61.1	61.0	59.0	59.0	54.1	54.0	51.9	52.0	49.1	49.0
20%	47.9	47.8	49.4	49.3	51.2	51.0	52.9	52.6	54.6	54.4	56.3	56.2	61.4	61.1	61.2	61.2	59.3	59.3	54.3	54.3	52.1	52.2	49.2	49.1
22%	48.1	47.9	49.5	49.4	51.4	51.1	53.2	52.7	54.8	54.6	56.6	56.4	61.6	61.4	61.4	61.4	59.4	59.4	54.4	54.5	52.2	52.3	49.3	49.2
24%	48.2	48.1	49.7	49.5	51.6	51.3	53.3	52.9	54.9	54.7	56.8	56.6	61.9	61.9	61.5	61.5	59.6	59.7	54.6	54.7	52.3	52.4	49.5	49.3
26%	48.3	48.2	49.8	49.5	51.7	51.5	53.4	53.1	55.0	54.8	57.0	56.7	62.2	62.2	61.7	61.8	59.7	59.9	54.8	54.9	52.5	52.5	49.6	49.5
28%	48.4	48.3	49.9	49.6	51.9	51.6	53.6	53.3	55.2	54.9	57.2	57.0	62.5	62.4	61.9	62.1	59.8	60.1	55.0	55.0	52.6	52.7	49.7	49.6
30%	48.5	48.4	50.0	49.8	52.1	51.8	53.8	53.5	55.4	55.1	57.4	57.2	62.7	62.7	62.1	62.3	60.0	60.3	55.2	55.2	52.8	52.9	49.8	49.6
32%	48.6	48.4	50.1	49.9	52.2	52.0	54.0	53.7	55.5	55.2	57.6	57.4	63.0	63.0	62.3	62.5	60.1	60.5	55.3	55.3	52.9	53.0	49.9	49.7
34%	48.6	48.5	50.1	50.0	52.3	52.1	54.1	53.8	55.6	55.3	57.8	57.6	63.2	63.2	62.4	62.7	60.3	60.7	55.5	55.4	53.1	53.2	49.9	49.8
36%	48.7	48.6	50.2	50.1	52.4	52.3	54.3	54.0	55.7	55.4	58.0	57.8	63.4	63.5	62.6	62.9	60.5	60.9	55.6	55.5	53.1	53.3	50.0	49.9
38%	48.8	48.7	50.3	50.2	52.5	52.4	54.4	54.2	55.8	55.5	58.2	58.0	63.7	63.7	62.9	63.2	60.7	61.0	55.8	55.6	53.3	53.4	50.1	50.0
40%	48.9	48.8	50.4	50.3	52.6	52.6	54.5	54.3	55.9	55.7	58.4	58.1	63.9	64.0	63.1	63.4	60.9	61.2	55.9	55.6	53.4	53.5	50.2	50.1
42%	48.9	48.8	50.5	50.4	52.8	52.7	54.7	54.4	56.0	55.8	58.6	58.3	64.2	64.2	63.4	63.7	61.0	61.4	56.0	55.7	53.5	53.5	50.2	50.2
44%	49.0	48.9	50.6	50.6	52.9	52.8	54.8	54.6	56.0	55.9	58.9	58.6	64.6	64.4	63.6	63.8	61.2	61.5	56.1	55.8	53.6	53.6	50.3	50.3
46%	49.0	49.0	50.7	50.7	53.0	53.0	55.0	54.8	56.2	56.0	59.6	58.9	65.0	64.6	63.8	64.0	61.4	61.6	56.2	55.9	53.7	53.8	50.4	50.4
48%	49.1	49.0	50.8	50.7	53.1	53.1	55.2	55.1	56.4	56.1	60.5	59.4	65.3	64.7	64.1	64.2	61.5	61.8	56.4	55.9	53.8	53.9	50.5	50.5
50%	49.1	49.1	50.9	50.8	53.3	53.3	55.3	55.2	56.5	56.2	61.5	60.0	65.9	64.7	64.3	64.3	61.6	61.9	56.5	56.0	53.9	54.0	50.6	50.6
52%	49.2	49.2	51.0	51.0	53.4	53.4	55.5	55.4	56.7	56.3	62.9	60.5	66.3	64.8	64.5	64.4	61.8	62.0	56.7	56.0	54.0	54.1	50.7	50.7
54%	49.3	49.3	51.1	51.1	53.5	53.5	55.6	55.5	56.8	56.4	63.9	61.0	66.5	64.8	64.6	64.5	61.9	62.2	56.9	56.1	54.1	54.3	50.8	50.8
56%	49.3	49.3	51.2	51.2	53.7	53.7	55.7	55.7	56.9	56.5	64.3	61.5	66.8	64.9	64.9	64.6	62.1	62.4	57.0	56.2	54.2	54.4	50.9	50.9
58%	49.4	49.4	51.3	51.3	53.8	53.9	55.9	55.8	57.1	56.6	64.6	62.6	67.1	64.9	65.1	64.6	62.2	62.5	57.1	56.3	54.3	54.5	50.9	51.0
60%	49.5	49.5	51.4	51.4	54.0	54.0	56.0	56.0	57.2	56.7	64.9	63.4	67.2	65.0	65.3	64.7	62.4	62.7	57.2	56.4	54.4	54.6	51.0	51.0
62%	49.5	49.6	51.4	51.5	54.2	54.2	56.2	56.0	57.5	56.8	65.2	64.0	67.4	65.0	65.5	64.7	62.6	62.9	57.3	56.6	54.4	54.8	51.1	51.1
64%	49.7	49.7	51.5	51.5	54.5	54.4	56.4	56.1	57.7	56.9	65.5	64.3	67.5	65.0	65.7	64.8	62.8	63.1	57.7	56.7	54.5	54.9	51.2	51.2
66%	49.7	49.8	51.6	51.7	54.7	54.7	56.5	56.3	57.8	56.9	65.8	64.6	67.7	65.1	66.0	64.8	62.9	63.2	57.8	56.8	54.5	55.0	51.3	51.3
68%	49.8	49.9	51.7	51.8	55.0	55.0	56.7	56.4	58.1	57.0	66.0	64.7	67.9	65.1	66.1	64.9	63.1	63.4	58.0	56.9	54.6	55.1	51.3	51.4
70%	49.9	50.0	51.9	51.9	55.3	55.2	56.8	56.6	58.3	57.1	66.2	64.8	68.1	65.1	66.3	64.9	63.3	63.7	58.2	57.1	54.7	55.2	51.4	51.5
72%	50.0	50.1	52.1	52.1	55.5	55.5	57.0	56.7	58.6	57.1	66.4	64.9	68.3	65.2	66.5	65.0	63.5	63.9	58.5	57.2	54.8	55.3	51.5	51.6
74%	50.2	50.2	52.2	52.2	55.9	55.9	57.2	56.8	58.8	57.2	66.7	65.0	68.5	65.2	66.7	65.0	63.7	64.1	58.7	57.4	54.8	55.4	51.6	51.7
76%	50.2	50.3	52.3	52.4	56.3	56.2	57.4	56.9	59.2	57.3	67.0	65.0	68.8	65.2	66.9	65.0	64.0	64.3	59.0	57.7	55.0	55.5	51.7	51.8
78%	50.3	50.4	52.5	52.6	56.6	56.5	57.6	57.0	59.6	57.4	67.2	65.1	69.0	65.3	67.1	65.1	64.2	64.5	59.2	57.9	55.1	55.7	51.8	51.8
80%	50.5	50.5	52.7	52.9	56.9	56.7	57.8	57.1	60.3	57.5	67.4	65.2	69.2	65.3	67.3	65.1	64.4	64.7	59.5	58.3	55.2	55.9	51.9	51.9
82%	50.6	50.6	52.8	53.1	57.2	56.9	58.1	57.4	61.3	57.6	67.7	65.3	69.4	65.4	67.6	65.1	64.6	64.9	59.6	58.7	55.5	55.9	52.0	52.1
84%	50.7	50.8	53.0	53.4	57.4	57.2	58.5	57.5	62.0	57.7	68.0	65.4	69.6	65.4	67.9	65.2	64.8	65.0	59.8	59.2	55.6	56.1	52.0	52.3
86%	50.9	50.9	53.2	53.5	57.7	57.4	58.9	57.8	62.5	57.8	68.1	65.5	69.8	65.5	68.1	65.3	65.0	65.8	60.1	61.4	55.8	56.6	52.1	52.5
88%	51.1	51.1	53.4	53.8	57.9	57.7	59.2	58.0	63.0	57.9	68.4	65.6	70.1	65.6	68.2	65.3	65.2	66.7	60.3	62.7	56.2	56.9	52.3	52.6
90%	51.2	51.3	53.6	53.9	58.2	57.8	59.6	58.3	63.4	58.0	68.8	65.7	70.4	65.7	68.4	65.5	65.5	68.1	60.5	63.5	56.5	57.2	52.4	52.8
92%	51.4	51.6	54.0	54.2	58.4	58.0	59.8	58.5	64.0	58.1	69.2	66.0	70.7	65.9	68.7	65.8	65.9	68.9	60.8	64.5	56.7	57.6	52.5	53.1
94%	51.6	51.8	54.3	54.5	58.8	58.3	60.3	58.8	64.4	58.4	69.5	68.3	71.1	71.2	69.0	69.5	66.2	69.6	61.2	65.4	56.9	57.9	52.7	53.6
96%	52.0	52.2	54.6	54.8	59.3	58.6	60.8	59.0	65.4	59.5	69.8	70.0	71.5	73.2	69.4	70.5	66.5	69.9	62.1	66.5	57.3	58.6	52.9	54.4
98%	52.5	52.9	55.0	55.2	60.0	59.0	61.6	59.3	67.1	66.2	70.3	71.9	72.0	74.6	70.1	71.8	68.0	70.6	63.7	68.3	57.8	61.4	53.3	55.1
100%	54.0	54.0	56.6	56.7	60.8	59.7	63.3	60.0	69.9	71.1	71.0	74.9	74.0	75.9	73.0	73.6	70.2	72.5	65.6	70.5	59.3	63.9	54.5	56.7
Case	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA	2E	2EA
Target	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	56.0	56.0	56.0	56.0	56.0	56.0

🟨 Above target 🟦 Below Target

Figure - 8

New Melones Storage: 2E vs. 2EA



Operations for Temperature would Deplete New Melones storage by 717 TAF

Summary of Floodplain Modeling and Geomorphic Flows

cbec conducted modeling (SRH-2D) for a 5.7 mile reach extending from Orange Blossom Bridge (OBB; RM 46.9) to Lovers Leap (RM 52.6). This reach was selected because LiDAR and bathymetry data was available and the reach represents much of the primary juvenile salmon rearing habitat. The model was developed with the intent to (1) identify the presence, or lack thereof, of floodplain habitat along the Lower Stanislaus River that would be available for salmon rearing, and (2) understand the behavior of geomorphically significant flows in forming and maintaining the channel and transporting sediment.

Floodplain inundation modeling results indicate the following:

- Total floodplain inundation area in the modeled reach was essentially 0 acres at <3,000 cfs. A total of 35 acres was available at 5,000 cfs, and 82 acres at 8,000 cfs.
- It would take (1) at least a 2-year post-dam flow to begin to inundate some fraction of the 35 acres of near-channel floodplain; (2) at least a 5-year post-dam flow to inundate some fraction of an additional 47 acres of overflow channel floodplain; and (3) a post-dam 100-year base flood (approximately 8,000 cfs) to inundate the entire 82 acres of available floodplain. It would be expected that floodplain areas below and above 5,000 cfs would be inundated on average 19 days and 6 days, respectively, in a given year.
- Based on extrapolations, the total acreage for the entire primary rearing reach is estimated to be 85 acres at 5,000 cfs and 200 acres at 8,000 cfs. As such, the flow release schedule stated in the National Marine Fisheries Service (NMFS 2009) Biological Opinion would result in very little floodplain inundation, which will provide little benefit to salmonids, particularly in the case of steelhead since floodplain is probably "not important to steelhead… given that there is little evidence of their extensive use of floodplain habitat in California" (Moyle 2009), and their preference for mid-channel and margin habitat as observed in the Stanislaus River (FISHBIO, personal observations).
- Based on this study, much larger pulse flows (than 8,000 cfs) would be required and/or topographic manipulation (e.g., Honolulu Bar Floodplain Enhancement Project- see description below) to reconnect floodplains to the present day river.

Channel forming and maintenance flows results indicate the following:

- Based on assumption that channel maintenance flows refer to mobilization of d_{50}-sized particles and greater, flows in the 3,000-5000 cfs range may provide some limited mobilization since modeled depth-averaged shear stresses were sufficient to mobilize d50 in this range at 43% of sites (i.e., 3 of 7) analyzed.
- Based on the assumption that channel forming flows refer to mobilization of d_{84}-sized particles and greater (which is our best assumption for total mobility of the channel bed, although not necessarily indicative of channel forming flows), channel forming flows will not be achieved under existing flood control limitations (i.e., no flows greater than 8,000 cfs released). At no modeled flow (i.e., 3,000 to 8,000) was the depth-averaged shear stress above that required to mobilize d_{84}-sized material. Channel forming flows would realistically require a minimum of a 5-year pre-dam flow, and as determined by Kondolf et al. (2001), the 5-year pre-dam flow that was partially responsible for forming the river prior to gravel mining and flow regulation was 19,100 cfs.
- Mobilization of spawning gravels may actually be detrimental to existing and restored

gravel supplies within the river channel. For instance, flows in the 5,000 to 6,000 range have been observed to displace gravel from restored gravel augmentation sites below Goodwin Dam into deep, downstream pools (FISHBIO personal observations) where it is of no use to spawning and rearing fish. Due to the severe gravel deficit and existence of several deep pools in the canyon, restored gravels can be expected to be lost to these mined areas at flows greater than 5,000 cfs.

Honolulu Bar Floodplain Enhancement Project

The Honolulu Bar Floodplain Enhancement Project (RM 49 to RM 50.5) was recently completed (end of September 2012; Figure 1). It was designed to restore several aquatic and riparian habitat elements in the Stanislaus River including 2.4 acres of floodplain habitat on the inside edge of a mid-channel island, 0.7 acres of floodplain bench in the south side of the river upstream of the mid-channel island, 0.4 acres of spawning riffle in the river adjacent to the mid-channel island, 3.85+ acres of native vegetation, and increased frequency and duration of flow connectivity in one mile of side channel habitat (Figure 2). Objectives of the Project include (1) restoring seasonally inundated floodplain habitat, (2) restoring year-round rearing habitat, (3) addressing an existing adult stranding issue, (4) increasing usable spawning habitat area, (5) increasing hiding cover, velocity refugia, habitat complexity, and instream habitat types, and (6) restoring native vegetation.

Figure 1. Side channel and restored floodplain looking northeast. Approximately 4.5-6 feet of materials were removed to lower gradient to increase amount of juvenile salmon rearing habitat over a wider range of flows.

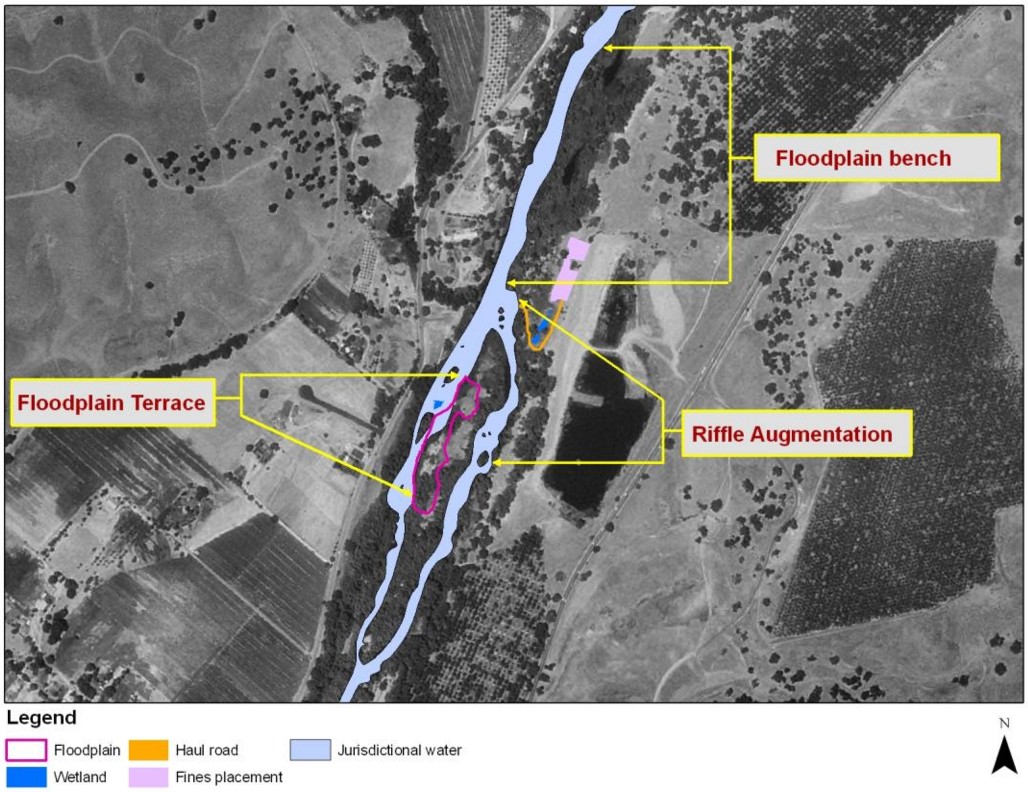


Figure 2. Honolulu Bar Floodplain Enhancement Project general footprints.

Summary of Key Findings from Stanislaus River Studies

Juvenile Migration Timing

- Juvenile Chinook migration can be temporarily stimulated by changes in flow, but the effect is short lived (few days) (Demko et al. 2001, 2000, 1996; Demko and Cramer 1995).
- Juvenile salmon migration typically begins in January and most juveniles migrate by May 15 (Table 1).
- Except in wet and above normal years, 0.7% or less of total juvenile salmon (i.e., fry, parr, and smolts), and 0.8% or less of salmon smolts outmigrate during June.
- Juvenile *O. mykiss* may be found migrating downstream throughout the year, but the majority of outmigration to the ocean occurs episodically between March and May. Based on Caswell RST catches, the majority of juvenile *O. mykiss* outmigrate by mid to late May (Table 2).

Juvenile Outmigrant Survival

- Over a decade of rotary screw trap monitoring in the Stanislaus River shows that
    - flow has a strong positive relationship with migration survival of Chinook fry (Pyper et al. 2006). Benefits to adult escapement of increased fry survival in the Stanislaus are uncertain (Baker and Morhardt 2001; SRFG 2004; SJRGA 2008; Pyper and Justice 2006).
    - abundance ratios for parr and smolts were only weakly correlated with flows (Pyper and Justice 2006).
- Smolt survival (CWT) studies conducted by CDFG at flows ranging from 600 cfs to 1,500 cfs and at 4,500 cfs have shown that smolt survival is highly variable and not improved by higher flows in the Stanislaus River (SRFG 2004; CDFG unpublished data), which is consistent with Pyper and Justice (2006) results above.

Adult upstream migration timing

- Operations at the Stanislaus River Weir (2003-2011) indicate that more than 97% of adult FRCS migrate after October 1 (Figure 1).
- Adult FRCS migration rate and timing are not dependent upon flows, water temperature or dissolved oxygen concentrations (Pyper and others 2006).
- Prolonged, high-volume fall pulse flows are not warranted, since equivalent stimulation of adult migration may be achieved through modest pulses (Pyper and others 2006). Relatively modest pulse-flow events (increase of ~200 cfs for 3 days) were found to stimulate migration for a short duration (2-3 day migration); while longer duration high-volume pulses did not substantially increase migration duration or magnitude (3-4 day migration).

Spawn timing and distribution

- The majority (98%) of Chinook salmon spawning occurs between October 15 and December 31.
- Historically, the spawning reach of the Stanislaus was described by G.H. Clark in the 1920s as extending from Knights Ferry to Oakdale, and this continues to be the reach where most spawning activity occurs. A small proportion of late-season spawning

(less than 5%) occurs down to Riverbank, and 95% of this activity occurs after November 30.

O. mykiss Abundance and Distribution

- Snorkel surveys conducted since 2002 have provided the most extensive data set on the distribution and between-year abundance of adult and juvenile *O. mykiss*. Surveys are performed bi-weekly at seven sample reaches between Goodwin Dam (RM 58.4) and Valley Oak (RM 41). Data indicate O. *mykiss* distribution is highest in the first four miles of river below Goodwin Dam–which consists primarily of high gradient canyon environment–with over 80% of the *O. mykiss* population inhabiting this reach of river.
- Summer population estimates calculated from intensive snorkel surveys between Goodwin Dam and Oakdale during 2009-2011 indicate that abundance is relatively stable across years, ranging from approximately 13,000-17,000 individuals.

Table 1. Stanislaus River juvenile Chinook salmon outmigration timing at Caswell (RM 8.6; 1998-2005).

		Wet (n=2)	Above Normal (n=2)	Below Normal (n=1)	Dry (n=3)	Critical (n=0)
Fry	Jan 1-15	0.7%	0.0%	0.0%	0.0%	-
	Jan 16-31	22.5%	12.4%	39.3%	0.1%	-
	Feb 1-15	22.6%	26.0%	3.3%	0.4%	-
	Feb 16-28	11.8%	27.4%	1.4%	14.4%	-
	Mar 1-15	8.8%	8.9%	2.9%	17.6%	-
	Mar 16-31	7.9%	7.7%	8.3%	5.3%	-
Smolt	Apr 1- 15	3.9%	4.5%	4.5%	16.3%	-
	Apr 16-30	3.9%	5.1%	26.5%	21.0%	-
	May 1-15	8.6%	3.5%	11.3%	17.8%	-
	May 16-31	7.0%	3.3%	2.5%	6.4%	-
	Jun 1- 15	2.1%	1.0%	0.1%	0.7%	-
	Jun 16-30	0.3%	0.2%	0.0%	0.0%	-

Table 2. Stanislaus River juvenile *O. mykiss* outmigration timing by water year type at Caswell (RM 8.6; 1995-2011).

	Wet (n=7)	Above Normal (n=3)	Below Normal (n=2)	Dry (n=3)	Critical (n=2)
Jan 1-15	0.0%	0.0%	0.0%	1.0%	0.0%
Jan 16-31	0.0%	4.4%	10.0%	0.0%	0.0%
Feb 1-15	7.1%	7.2%	13.8%	2.7%	0.0%
Feb 16-28	10.1%	7.2%	3.8%	23.0%	10.9%
Mar 1-15	2.6%	2.8%	37.7%	27.0%	0.0%
Mar 16-31	17.2%	5.0%	7.7%	9.2%	6.5%
Apr 1- 15	16.8%	8.3%	0.0%	5.3%	8.7%
Apr 16-30	15.8%	13.9%	23.1%	12.0%	4.3%
May 1-15	2.6%	38.3%	3.8%	16.1%	54.3%
May 16-31	10.0%	5.0%	0.0%	3.7%	8.7%
Jun 1- 15	17.9%	2.8%	0.0%	0.0%	6.5%
Jun 16-30	0.0%	5.0%	0.0%	0.0%	0.0%

Table 3. Geographic and temporal distribution of spawning in the Stanislaus, 2000-2005.

STANISLAUS RIVER					
		Distribution of Redds[2]			
Date	%Redds Observed[1]	Goodwin	Knights Ferry to Horseshoe	Horseshoe to Oakdale	Oakdale to Riverbank
Before Oct 1	0.1%	100.0%	0.0%	0.0%	0.0%
Oct 1-15	1.5%	32.1%	61.3%	4.8%	1.8%
Oct 16-31	10.5%	17.5%	55.0%	24.5%	3.0%
Nov 1-15	29.4%	15.1%	51.4%	31.1%	2.5%
Nov 16-30	29.4%	13.6%	49.5%	33.6%	3.3%
Dec 1-15	19.0%	19.7%	38.9%	33.2%	8.2%
Dec 16-31	9.0%	14.5%	44.6%	34.3%	6.6%
Jan 1-15	1.1%	0.0%	46.5%	43.9%	9.7%

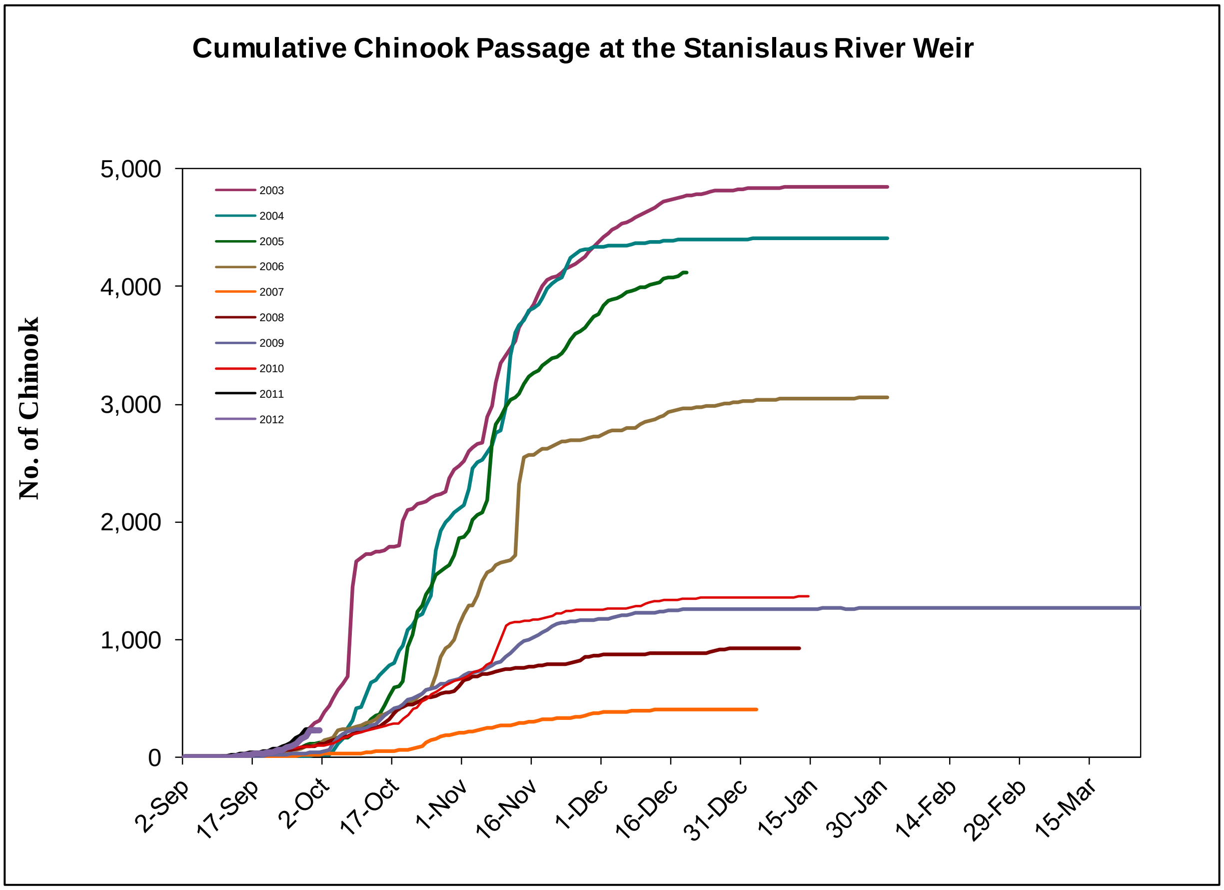


Figure 1. Cumulative Chinook salmon passage at the Stanislaus River weir.

Three Settings:

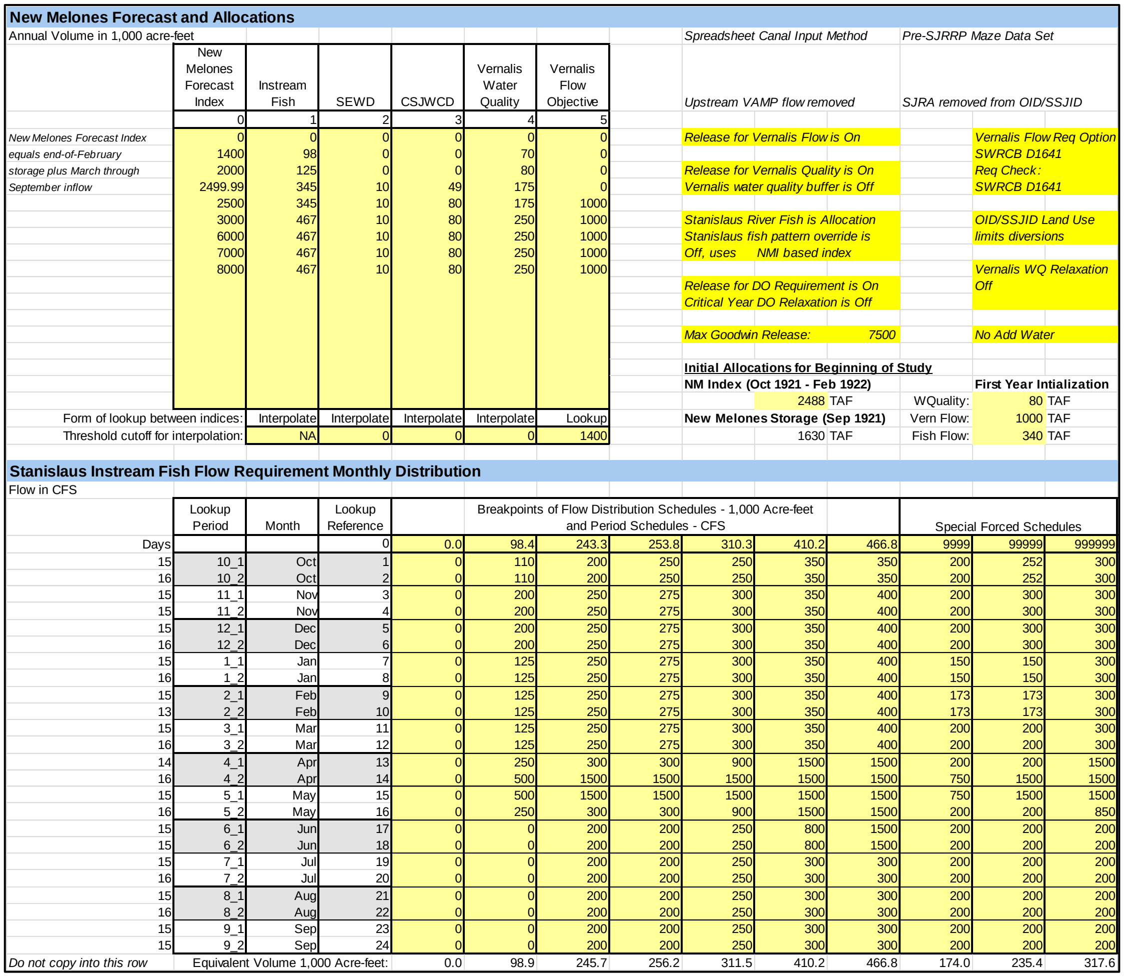
- 1997 IOP – Current SJR
- Current River – RPA
- September 2012 District Proposal

General Assumptions:

- Upstream San Joaquin River (above Stanislaus River Confluence)
  - Existing FERC and other Tributary instream flow requirements
  - Pre-SJRRP Friant
  - No SJRA/VAMP
- "Add Water" incorporated when necessary to maintain New Melones Storage > 150 TAF during 1986-1992 drought sequence.

New Melones

- 1997 IOP – Current SJR
  -



New Melones Forecast and Allocations

Annual Volume in 1,000 acre-feet

	New Melones Forecast Index	Instream Fish	SEWD	CSJWCD	Vernalis Water Quality	Vernalis Flow Objective
	0	1	2	3	4	5
New Melones Forecast Index	0	0	0	0	0	0
equals end-of-February	1400	98	0	0	70	0
storage plus March through	2000	125	0	0	80	0
September inflow	2499.99	345	10	49	175	0
	2500	345	10	80	175	1000
	3000	467	10	80	250	1000
	6000	467	10	80	250	1000
	7000	467	10	80	250	1000
	8000	467	10	80	250	1000
Form of lookup between indices:		Interpolate	Interpolate	Interpolate	Interpolate	Lookup
Threshold cutoff for interpolation:		NA	0	0	0	1400

Spreadsheet Canal Input Method

Upstream VAMP flow removed

Pre-SJRRP Maze Data Set

SJRA removed from OID/SSJID

Release for Vernalis Flow is On

Release for Vernalis Quality is On
Vernalis water quality buffer is Off

Stanislaus River Fish is Allocation
Stanislaus fish pattern override is
Off, uses NMI based index

Release for DO Requirement is On
Critical Year DO Relaxation is Off

Max Goodwin Release: 7500

Vernalis Flow Req Option
SWRCB D1641
Req Check:
SWRCB D1641

OID/SSJID Land Use
limits diversions

Vernalis WQ Relaxation
Off

No Add Water

Initial Allocations for Beginning of Study

NM Index (Oct 1921 - Feb 1922)
2488 TAF
New Melones Storage (Sep 1921)
1630 TAF

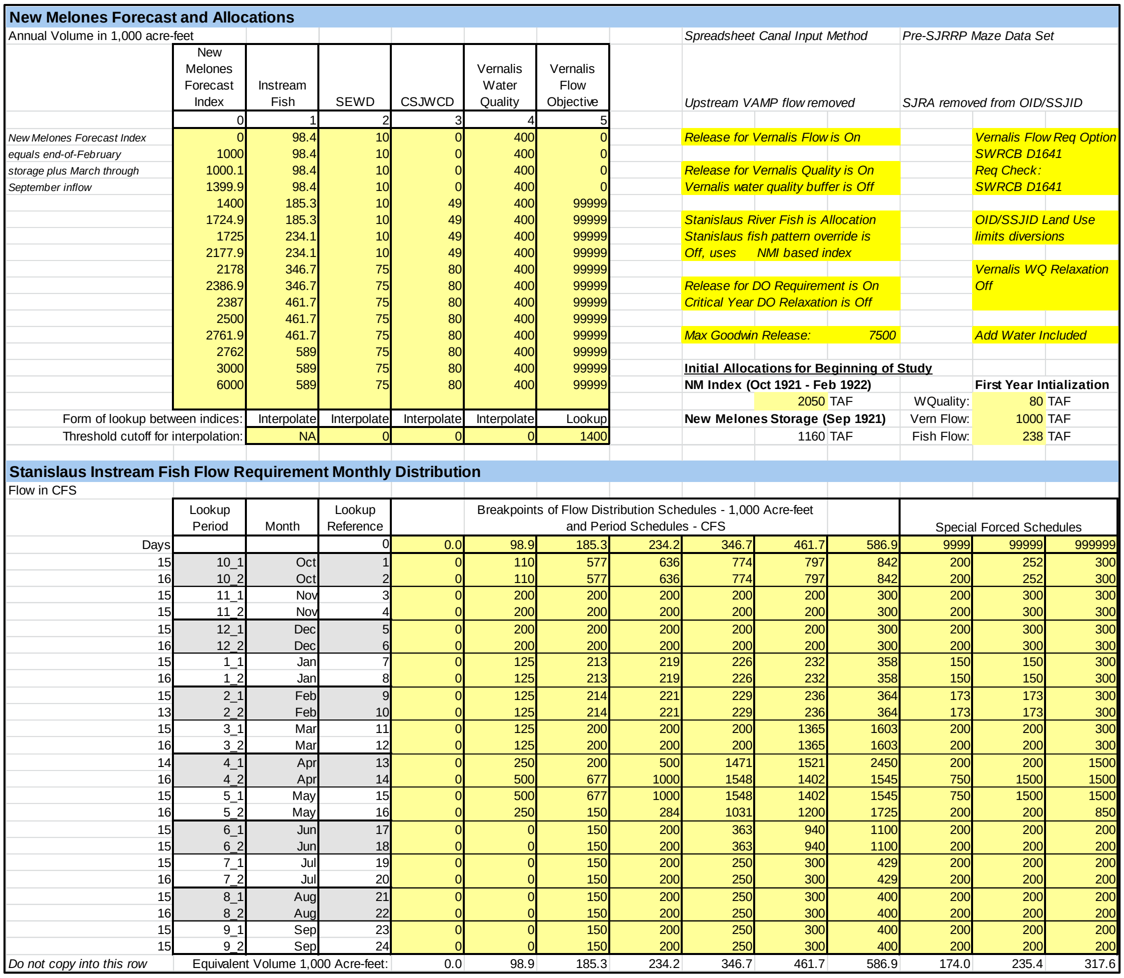
First Year Intialization
WQuality: 80 TAF
Vern Flow: 1000 TAF
Fish Flow: 340 TAF

Stanislaus Instream Fish Flow Requirement Monthly Distribution

Flow in CFS

	Lookup Period	Month	Lookup Reference	Breakpoints of Flow Distribution Schedules - 1,000 Acre-feet and Period Schedules - CFS							Special Forced Schedules		
Days			0	0.0	98.4	243.3	253.8	310.3	410.2	466.8	9999	99999	999999
15	10_1	Oct	1	0	110	200	250	250	350	350	200	252	300
16	10_2	Oct	2	0	110	200	250	250	350	350	200	252	300
15	11_1	Nov	3	0	200	250	275	300	350	400	200	300	300
15	11_2	Nov	4	0	200	250	275	300	350	400	200	300	300
15	12_1	Dec	5	0	200	250	275	300	350	400	200	300	300
16	12_2	Dec	6	0	200	250	275	300	350	400	200	300	300
15	1_1	Jan	7	0	125	250	275	300	350	400	150	150	300
16	1_2	Jan	8	0	125	250	275	300	350	400	150	150	300
15	2_1	Feb	9	0	125	250	275	300	350	400	173	173	300
13	2_2	Feb	10	0	125	250	275	300	350	400	173	173	300
15	3_1	Mar	11	0	125	250	275	300	350	400	200	200	300
16	3_2	Mar	12	0	125	250	275	300	350	400	200	200	300
14	4_1	Apr	13	0	250	300	300	900	1500	1500	200	200	1500
16	4_2	Apr	14	0	500	1500	1500	1500	1500	1500	750	1500	1500
15	5_1	May	15	0	500	1500	1500	1500	1500	1500	750	1500	1500
16	5_2	May	16	0	250	300	300	900	1500	1500	200	200	850
15	6_1	Jun	17	0	0	200	200	250	800	1500	200	200	200
15	6_2	Jun	18	0	0	200	200	250	800	1500	200	200	200
15	7_1	Jul	19	0	0	200	200	250	300	300	200	200	200
16	7_2	Jul	20	0	0	200	200	250	300	300	200	200	200
15	8_1	Aug	21	0	0	200	200	250	300	300	200	200	200
16	8_2	Aug	22	0	0	200	200	250	300	300	200	200	200
15	9_1	Sep	23	0	0	200	200	250	300	300	200	200	200
15	9_2	Sep	24	0	0	200	200	250	300	300	200	200	200
Do not copy into this row	Equivalent Volume 1,000 Acre-feet:			0.0	98.9	245.7	256.2	311.5	410.2	466.8	174.0	235.4	317.6

-
  - OID/SSJID: Formula Water, occasionally not fully used according to land use and commitments calculation.
  - Vernalis flow requirement (February-June, including pulse) per D1641, using forecasted 75% exceedence parameters.

- Current River – RPA
    - 

New Melones Forecast and Allocations

Annual Volume in 1,000 acre-feet

	New Melones Forecast Index	Instream Fish	SEWD	CSJWCD	Vernalis Water Quality	Vernalis Flow Objective
	0	1	2	3	4	5
New Melones Forecast Index	0	98.4	10	0	400	0
equals end-of-February	1000	98.4	10	0	400	0
storage plus March through	1000.1	98.4	10	0	400	0
September inflow	1399.9	98.4	10	0	400	0
	1400	185.3	10	49	400	99999
	1724.9	185.3	10	49	400	99999
	1725	234.1	10	49	400	99999
	2177.9	234.1	10	49	400	99999
	2178	346.7	75	80	400	99999
	2386.9	346.7	75	80	400	99999
	2387	461.7	75	80	400	99999
	2500	461.7	75	80	400	99999
	2761.9	461.7	75	80	400	99999
	2762	589	75	80	400	99999
	3000	589	75	80	400	99999
	6000	589	75	80	400	99999
Form of lookup between indices:		Interpolate	Interpolate	Interpolate	Interpolate	Lookup
Threshold cutoff for interpolation:		NA	0	0	0	1400

Spreadsheet Canal Input Method

Upstream VAMP flow removed

Pre-SJRRP Maze Data Set

SJRA removed from OID/SSJID

Release for Vernalis Flow is On

Release for Vernalis Quality is On
Vernalis water quality buffer is Off

Stanislaus River Fish is Allocation
Stanislaus fish pattern override is Off, uses NMI based index

Release for DO Requirement is On
Critical Year DO Relaxation is Off

Max Goodwin Release: 7500

Vernalis Flow Req Option SWRCB D1641
Req Check: SWRCB D1641

OID/SSJID Land Use limits diversions

Vernalis WQ Relaxation Off

Add Water Included

Initial Allocations for Beginning of Study

NM Index (Oct 1921 - Feb 1922)
2050 TAF

New Melones Storage (Sep 1921)
1160 TAF

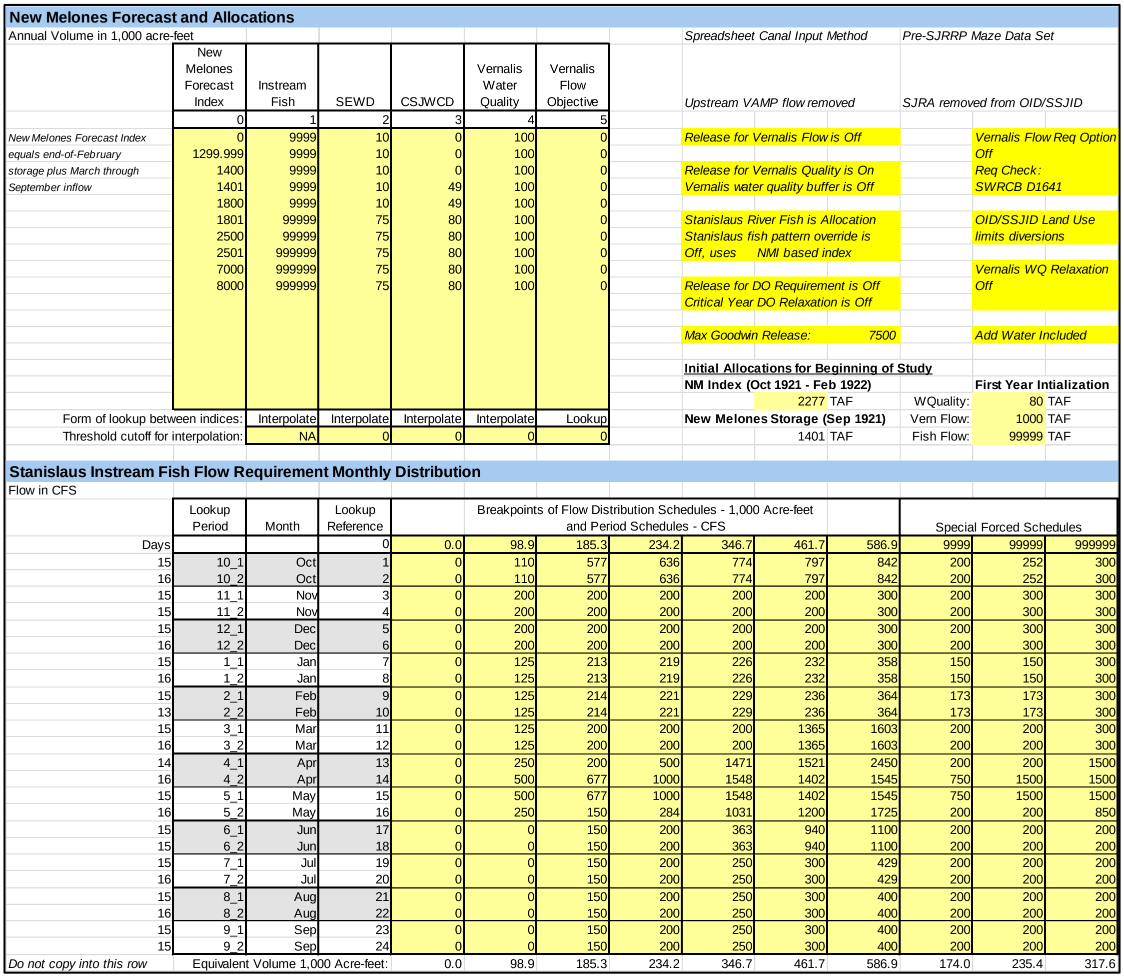
First Year Intialization
WQuality: 80 TAF
Vern Flow: 1000 TAF
Fish Flow: 238 TAF

Stanislaus Instream Fish Flow Requirement Monthly Distribution

Flow in CFS

	Lookup Period	Month	Lookup Reference	Breakpoints of Flow Distribution Schedules - 1,000 Acre-feet and Period Schedules - CFS							Special Forced Schedules		
Days			0	0.0	98.9	185.3	234.2	346.7	461.7	586.9	9999	99999	999999
15	10_1	Oct	1	0	110	577	636	774	797	842	200	252	300
16	10_2	Oct	2	0	110	577	636	774	797	842	200	252	300
15	11_1	Nov	3	0	200	200	200	200	200	300	200	300	300
15	11_2	Nov	4	0	200	200	200	200	200	300	200	300	300
15	12_1	Dec	5	0	200	200	200	200	200	300	200	300	300
16	12_2	Dec	6	0	200	200	200	200	200	300	200	300	300
15	1_1	Jan	7	0	125	213	219	226	232	358	150	150	300
16	1_2	Jan	8	0	125	213	219	226	232	358	150	150	300
15	2_1	Feb	9	0	125	214	221	229	236	364	173	173	300
13	2_2	Feb	10	0	125	214	221	229	236	364	173	173	300
15	3_1	Mar	11	0	125	200	200	200	1365	1603	200	200	300
16	3_2	Mar	12	0	125	200	200	200	1365	1603	200	200	300
14	4_1	Apr	13	0	250	200	500	1471	1521	2450	200	200	1500
16	4_2	Apr	14	0	500	677	1000	1548	1402	1545	750	1500	1500
15	5_1	May	15	0	500	677	1000	1548	1402	1545	750	1500	1500
16	5_2	May	16	0	250	150	284	1031	1200	1725	200	200	850
15	6_1	Jun	17	0	0	150	200	363	940	1100	200	200	200
15	6_2	Jun	18	0	0	150	200	363	940	1100	200	200	200
15	7_1	Jul	19	0	0	150	200	250	300	429	200	200	200
16	7_2	Jul	20	0	0	150	200	250	300	429	200	200	200
15	8_1	Aug	21	0	0	150	200	250	300	400	200	200	200
16	8_2	Aug	22	0	0	150	200	250	300	400	200	200	200
15	9_1	Sep	23	0	0	150	200	250	300	400	200	200	200
15	9_2	Sep	24	0	0	150	200	250	300	400	200	200	200
Do not copy into this row	Equivalent Volume 1,000 Acre-feet:			0.0	98.9	185.3	234.2	346.7	461.7	586.9	174.0	235.4	317.6

    - OID/SSJID: Formula Water, occasionally not fully used according to land use and commitments calculation.
    - Vernalis flow requirement (February-June, including pulse) per D1641, using forecasted 75% exceedence parameters.
    - Additional critical year RPA schedule (98.4 TAF) added for years when NMI < 1,400 TAF consistent with BO modeling. Such schedule is not included in Table 2E. Flow schedules do not include releases for BO temperature requirements.
    - Allocation for CVP Contractors is arbitrary but contributes to viable operation during all periods except during 1987-1992 drought.

- September 2012 District Proposal
  - 

New Melones Forecast and Allocations

Annual Volume in 1,000 acre-feet

	New Melones Forecast Index	Instream Fish	SEWD	CSJWCD	Vernalis Water Quality	Vernalis Flow Objective
	0	1	2	3	4	5
New Melones Forecast Index	0	9999	10	0	100	0
equals end-of-February	1299.999	9999	10	0	100	0
storage plus March through	1400	9999	10	0	100	0
September inflow	1401	9999	10	49	100	0
	1800	9999	10	49	100	0
	1801	99999	75	80	100	0
	2500	99999	75	80	100	0
	2501	999999	75	80	100	0
	7000	999999	75	80	100	0
	8000	999999	75	80	100	0
Form of lookup between indices:		Interpolate	Interpolate	Interpolate	Interpolate	Lookup
Threshold cutoff for interpolation:		NA	0	0	0	0

Spreadsheet Canal Input Method

Upstream VAMP flow removed

Release for Vernalis Flow is Off

Release for Vernalis Quality is On
Vernalis water quality buffer is Off

Stanislaus River Fish is Allocation
Stanislaus fish pattern override is
Off, uses NMI based index

Release for DO Requirement is Off
Critical Year DO Relaxation is Off

Max Goodwin Release: 7500

Pre-SJRRP Maze Data Set

SJRA removed from OID/SSJID

Vernalis Flow Req Option
Off
Req Check:
SWRCB D1641

OID/SSJID Land Use
limits diversions

Vernalis WQ Relaxation
Off

Add Water Included

Initial Allocations for Beginning of Study

NM Index (Oct 1921 - Feb 1922)			**First Year Intialization**	
2277	TAF	WQuality:	80	TAF
New Melones Storage (Sep 1921)		Vern Flow:	1000	TAF
1401	TAF	Fish Flow:	99999	TAF

Stanislaus Instream Fish Flow Requirement Monthly Distribution

Flow in CFS

	Lookup Period	Month	Lookup Reference	Breakpoints of Flow Distribution Schedules - 1,000 Acre-feet and Period Schedules - CFS							Special Forced Schedules		
Days			0	0.0	98.9	185.3	234.2	346.7	461.7	586.9	9999	99999	999999
15	10_1	Oct	1	0	110	577	636	774	797	842	200	252	300
16	10_2	Oct	2	0	110	577	636	774	797	842	200	252	300
15	11_1	Nov	3	0	200	200	200	200	200	300	200	300	300
15	11_2	Nov	4	0	200	200	200	200	200	300	200	300	300
15	12_1	Dec	5	0	200	200	200	200	200	300	200	300	300
16	12_2	Dec	6	0	200	200	200	200	200	300	200	300	300
15	1_1	Jan	7	0	125	213	219	226	232	358	150	150	300
16	1_2	Jan	8	0	125	213	219	226	232	358	150	150	300
15	2_1	Feb	9	0	125	214	221	229	236	364	173	173	300
13	2_2	Feb	10	0	125	214	221	229	236	364	173	173	300
15	3_1	Mar	11	0	125	200	200	200	1365	1603	200	200	300
16	3_2	Mar	12	0	125	200	200	200	1365	1603	200	200	300
14	4_1	Apr	13	0	250	200	500	1471	1521	2450	200	200	1500
16	4_2	Apr	14	0	500	677	1000	1548	1402	1545	750	1500	1500
15	5_1	May	15	0	500	677	1000	1548	1402	1545	750	1500	1500
16	5_2	May	16	0	250	150	284	1031	1200	1725	200	200	850
15	6_1	Jun	17	0	0	150	200	363	940	1100	200	200	200
15	6_2	Jun	18	0	0	150	200	363	940	1100	200	200	200
15	7_1	Jul	19	0	0	150	200	250	300	429	200	200	200
16	7_2	Jul	20	0	0	150	200	250	300	429	200	200	200
15	8_1	Aug	21	0	0	150	200	250	300	400	200	200	200
16	8_2	Aug	22	0	0	150	200	250	300	400	200	200	200
15	9_1	Sep	23	0	0	150	200	250	300	400	200	200	200
15	9_2	Sep	24	0	0	150	200	250	300	400	200	200	200
Do not copy into this row	Equivalent Volume 1,000 Acre-feet:			0.0	98.9	185.3	234.2	346.7	461.7	586.9	174.0	235.4	317.6

  - OID/SSJID: Formula Water, occasionally not fully used according to land use and commitments calculation.
  - No Vernalis flow requirement (assumed satisfied with tributary contributions)
  - Stanislaus River DO requirements modified – non-controlling.
  - Instream flow requirement:
    - Proposed schedule (monthly schedule providing the following annual total)

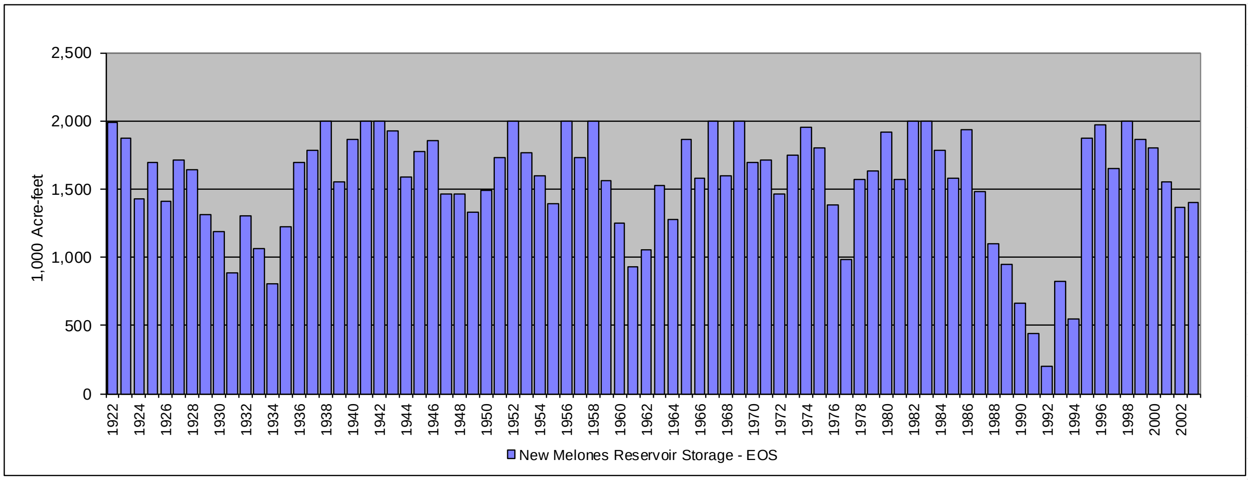
New Melones Storage Plus Inflow		Fishery (TAF)
From	To	
0	1,800	174
1,800	2,500	235
2,500	6,000	318

  - CVP Contractors annual allocation

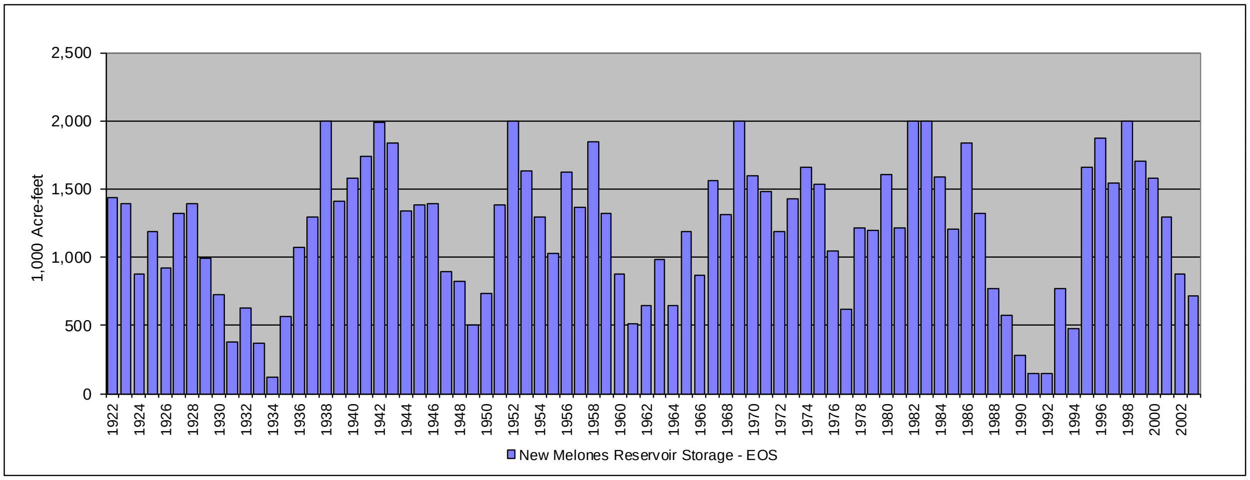
New Melones Storage Plus Inflow		Contractors (TAF)
From	To	
0	1,400	10 (SEWD)
1,400	1,800	59 (10 SEWD)
1,800	6,000	155

New Melones End-of-September Reservoir Storage

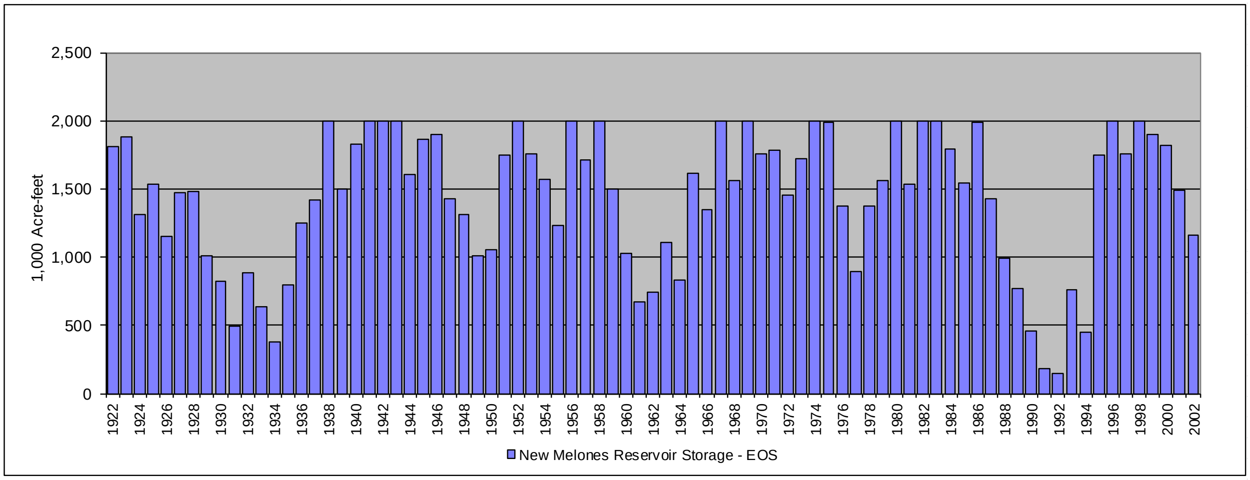
1997 IOP – Adapted to Current SJR



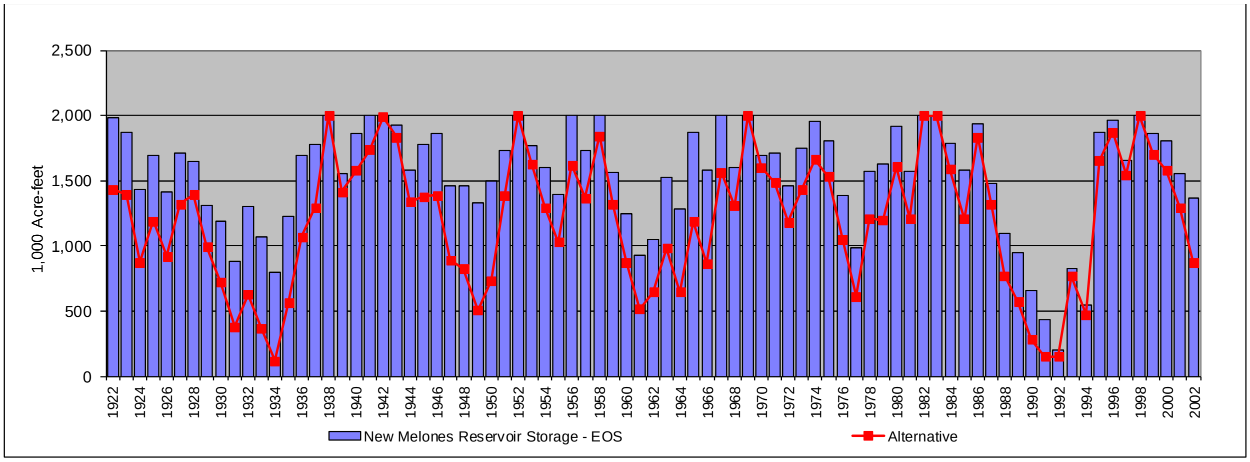
Current River – RPA



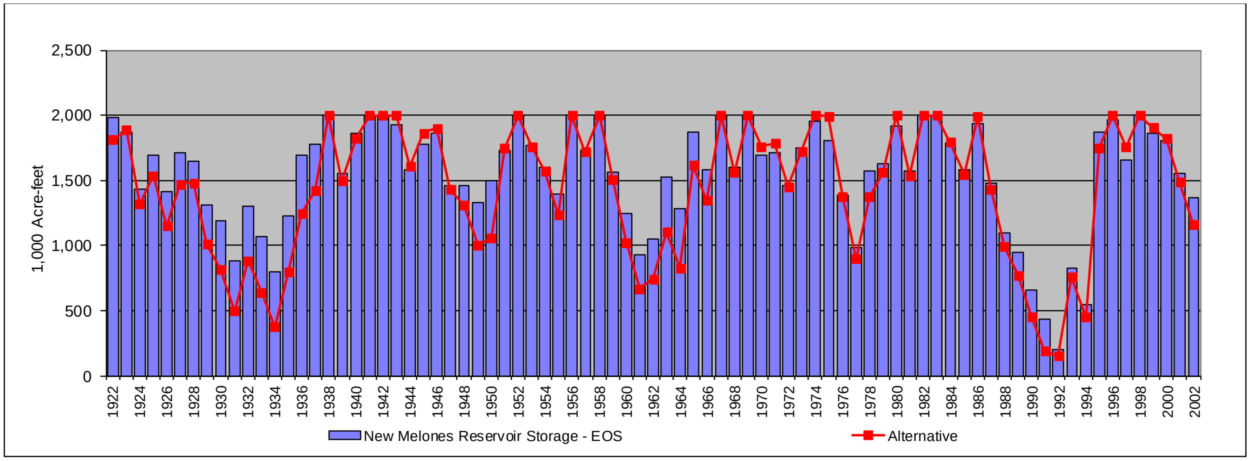
September 2012 District Proposal



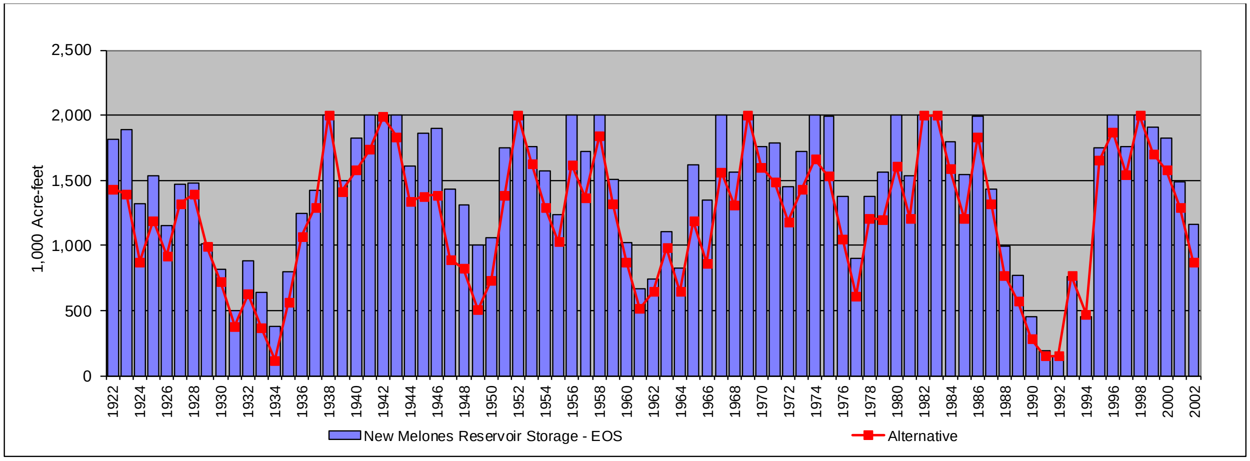
1997 IOP – Adapted to Current SJR (Blue Bar) v Current River RPA (Red Line)



1997 IOP – Adapted to Current SJR (Blue Bar) v September 2012 District Proposal (Red Line)

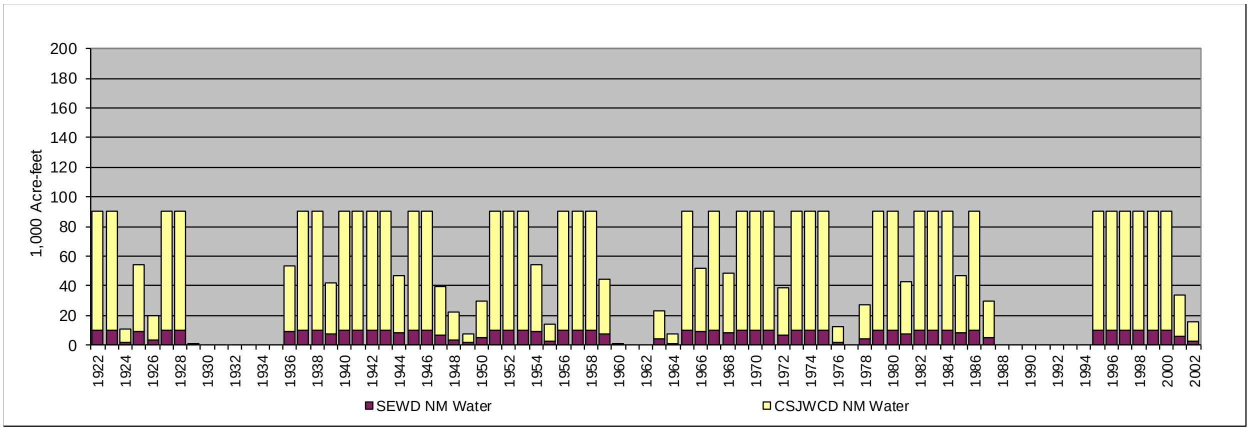


September 2012 District Proposal (Blue Bar) v Current River RPA (Red Line)

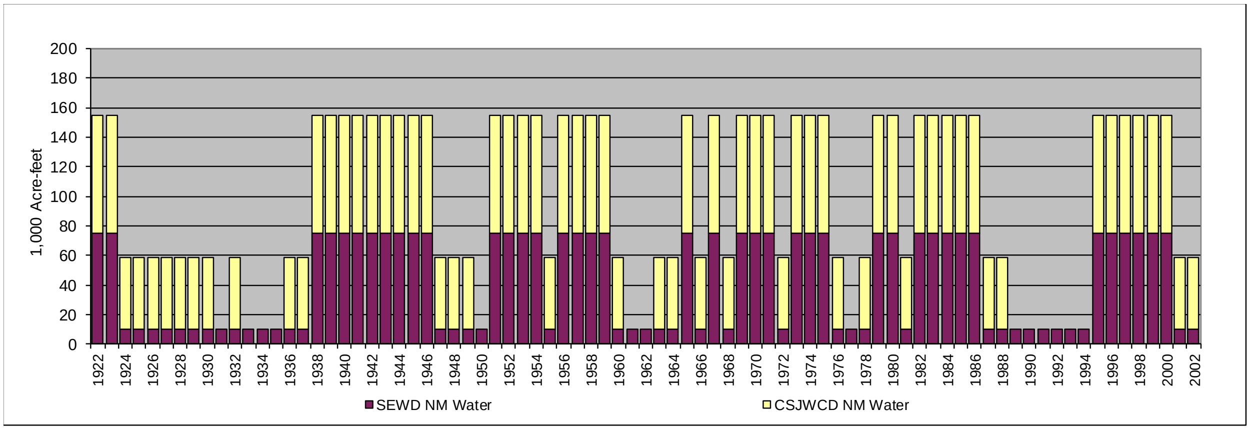


CVP Contractor Annual Allocations

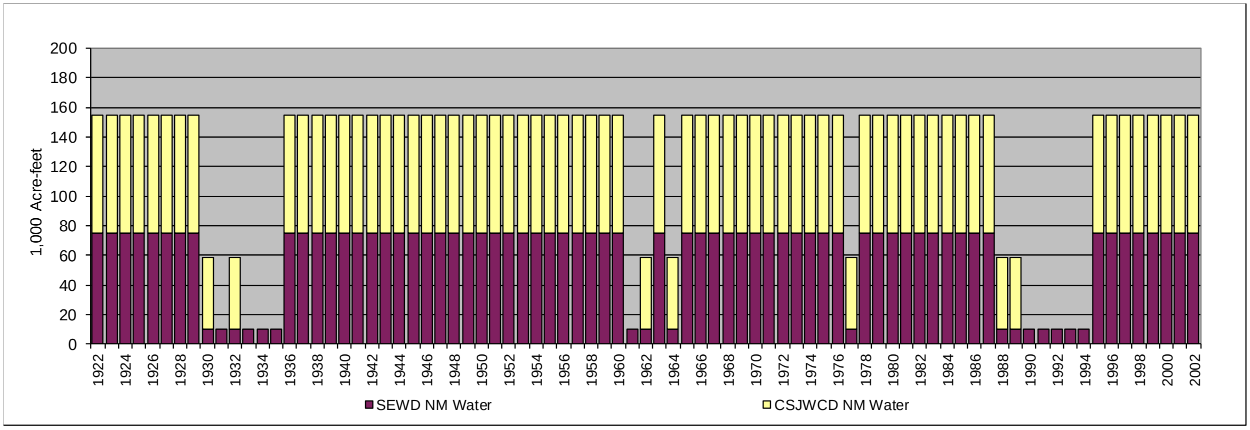
1997 IOP – Adapted to Current SJR



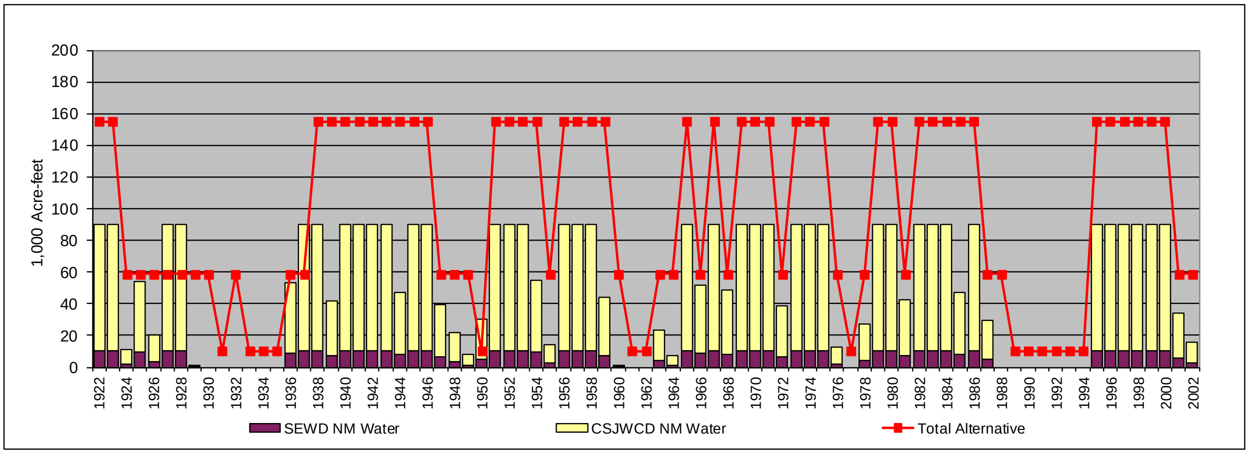
Current River – RPA



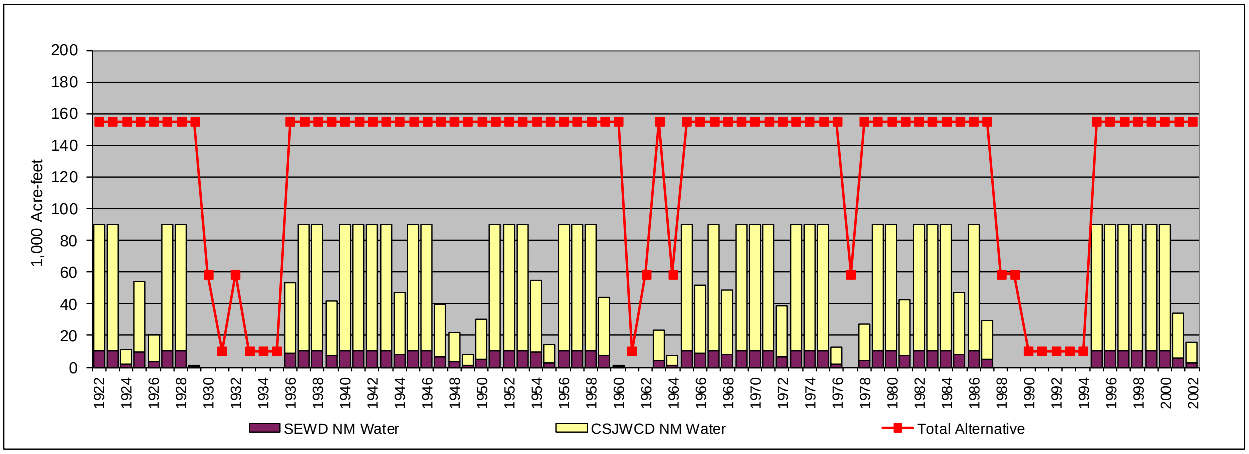
September 2012 District Proposal



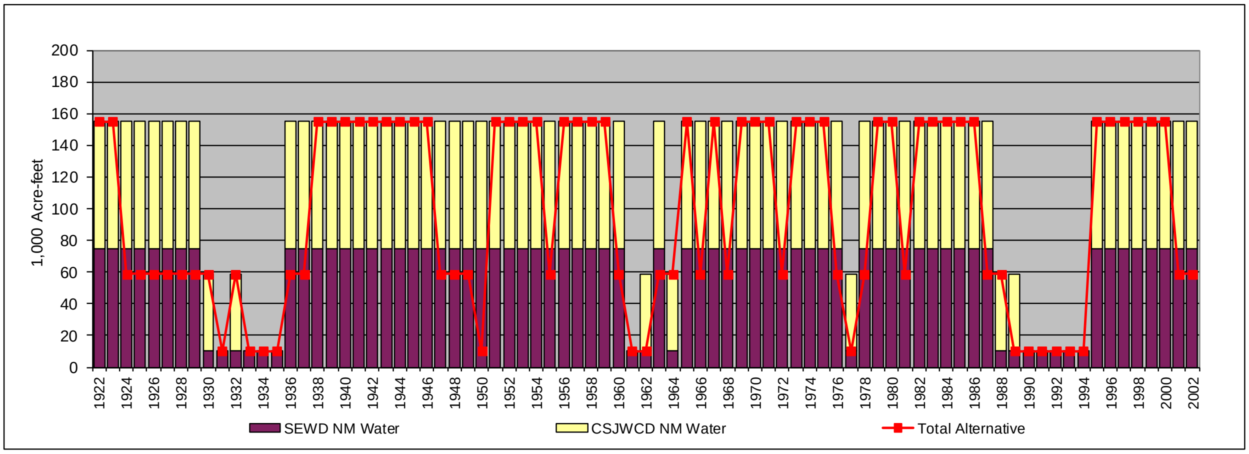
1997 IOP – Adapted to Current SJR (Bars) v Current River RPA (Red Line)



1997 IOP – Adapted to Current SJR (Bars) v September 2012 District Proposal (Red Line)

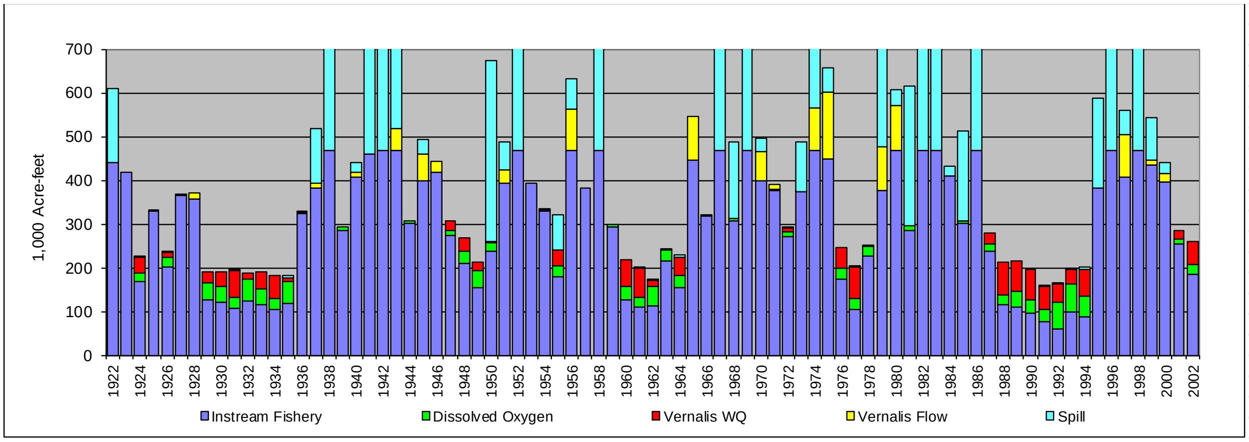


September 2012 District Proposal (Bars) v Current River RPA (Red Line)

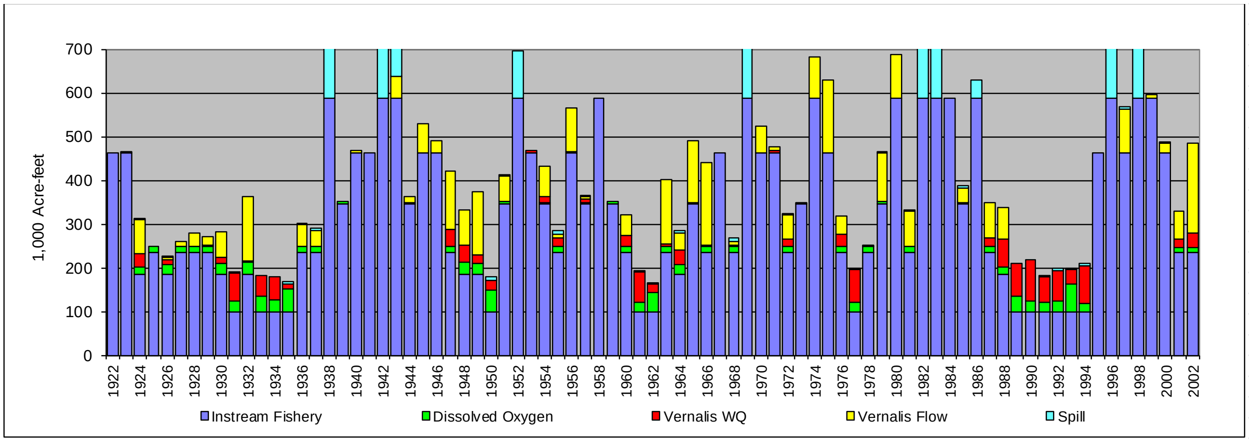


Goodwin Dam Annual Releases to Stanislaus River

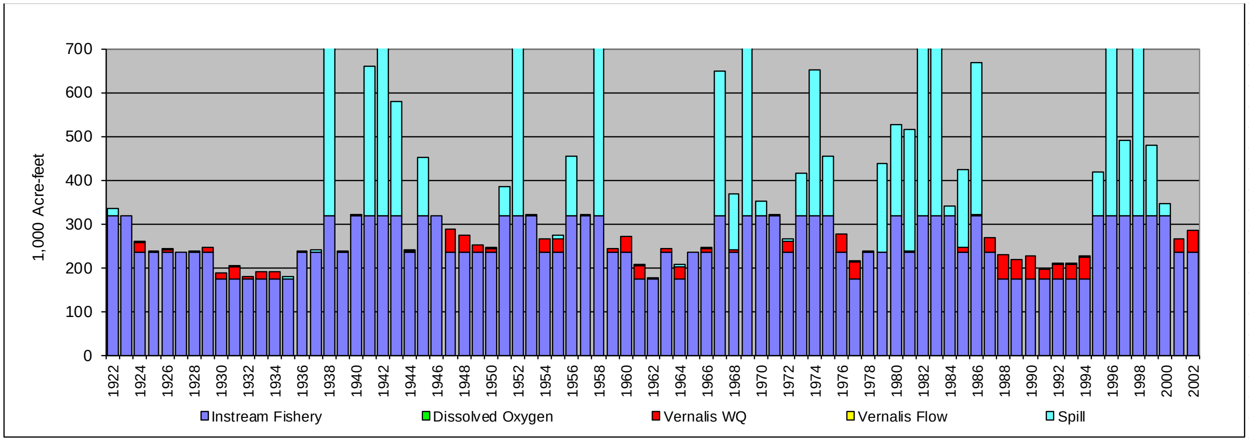
1997 IOP – Adapted to Current SJR



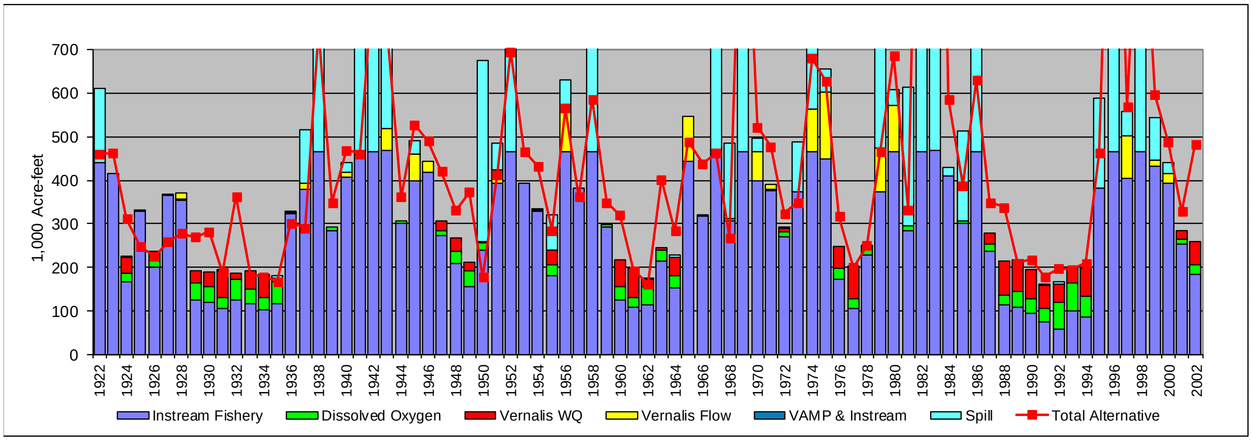
Current River – RPA



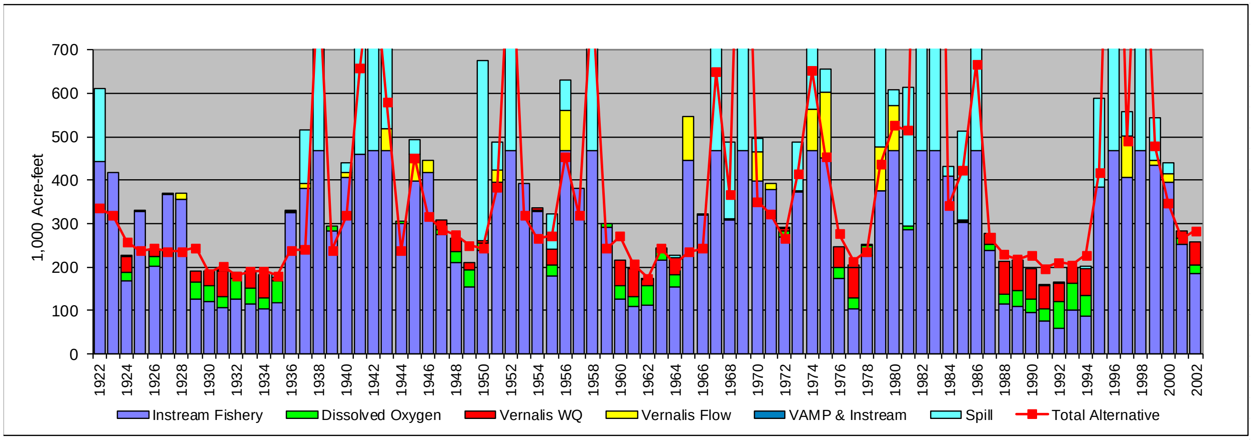
September 2012 District Proposal



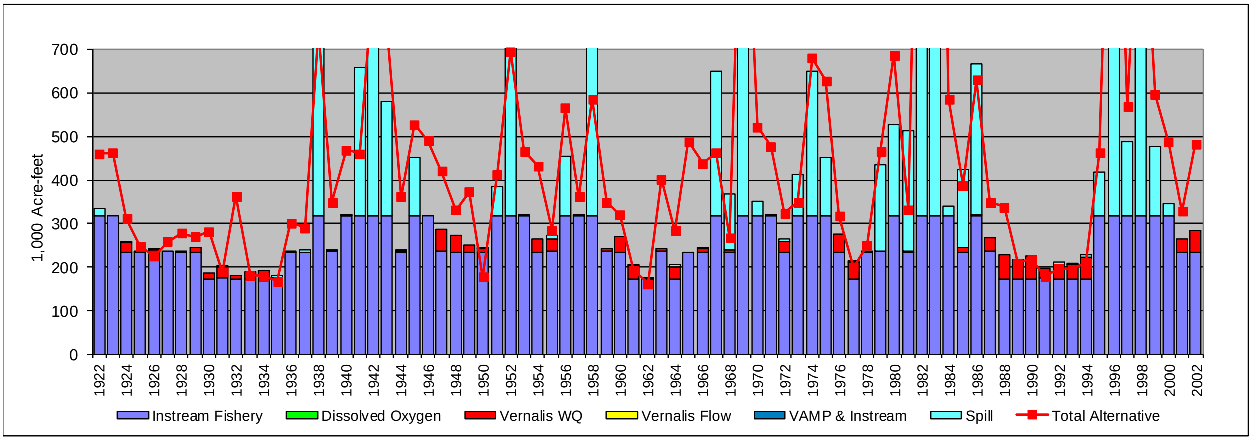
1997 IOP – Adapted to Current SJR (Bars) v Current River RPA (Red Line)



1997 IOP – Adapted to Current SJR (Bars) v September 2012 District Proposal (Red Line)



September 2012 District Proposal (Bars) v Current River RPA (Red Line)



Minimum Instream Flow Requirements

1997 IOP – Adapted to Current SJR v Current River RPA

September 2012 Baseline - RPA
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	760	760	220	220	220	220	253	253	256	256	1,531	1,531	2,171	1,502	1,502	1,567	1,052	1,052	390	390	370	370	370	370
25% AN Ave	707	707	235	235	235	235	262	262	266	266	794	794	1,446	1,427	1,427	1,067	643	643	276	276	275	275	275	275
25% BN Ave	670	670	219	219	219	219	240	240	242	242	200	200	535	991	991	330	206	206	195	195	195	195	195	195
25% D Ave	371	371	200	200	200	200	173	173	174	174	150	150	261	588	588	229	55	55	55	55	55	55	55	55
10% D Ave	272	272	199	199	199	199	155	155	155	155	124	124	249	497	497	249	0	0	0	0	0	0	0	0
All Avg	624	624	218	218	218	218	231	231	234	234	657	657	1,086	1,119	1,119	786	480	480	227	227	221	221	221	221

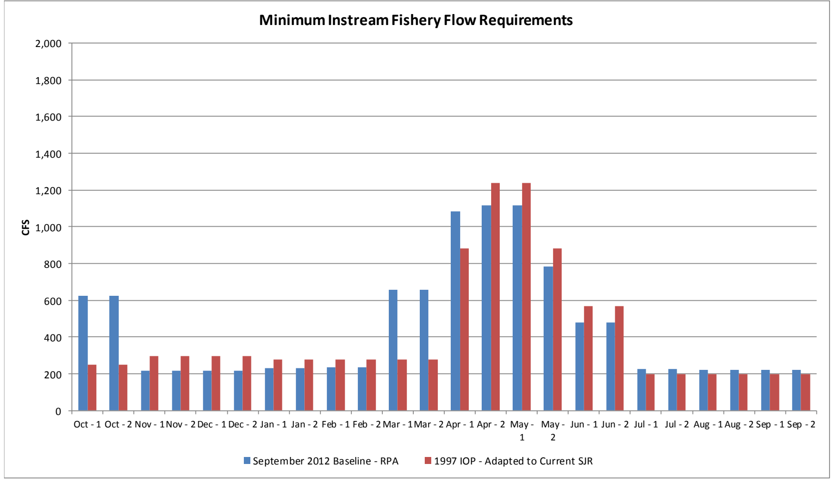
1997 IOP - Adapted to Current SJR
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	311	311	342	342	342	342	340	340	340	340	393	393	1,500	1,500	1,500	1,500	1,402	1,402	300	300	300	300	300	300
25% AN Ave	290	290	330	330	330	330	324	324	324	324	333	333	1,247	1,500	1,500	1,247	638	638	279	279	279	279	279	279
25% BN Ave	271	271	315	315	315	315	304	304	304	304	255	255	579	1,319	1,319	579	237	237	188	188	188	188	188	188
25% D Ave	135	135	210	210	210	210	158	158	158	158	142	142	249	658	658	249	35	35	35	35	35	35	35	35
10% D Ave	109	109	189	189	189	189	125	125	125	125	118	118	229	485	485	229	6	6	6	6	6	6	6	6
All Avg	251	251	298	298	298	298	280	280	280	280	279	279	882	1,238	1,238	882	568	568	198	198	198	198	198	198

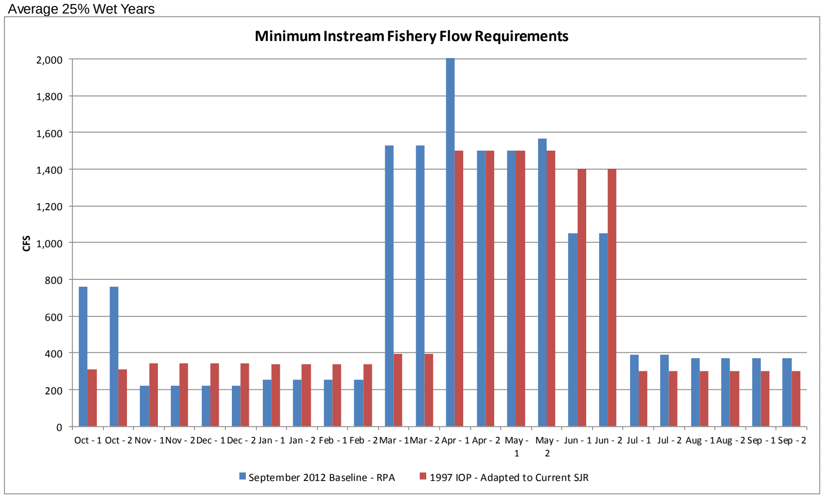
Difference (September 2012 Baseline - RPA minus 1997 IOP - Adapted to Current SJR)
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	449	449	-122	-122	-122	-122	-88	-88	-84	-84	1,138	1,138	671	2	2	67	-350	-350	90	90	70	70	70	70
25% AN Ave	417	417	-95	-95	-95	-95	-62	-62	-58	-58	461	461	199	-73	-73	-180	5	5	-2	-2	-4	-4	-4	-4
25% BN Ave	398	398	-96	-96	-96	-96	-64	-64	-61	-61	-55	-55	-43	-329	-329	-249	-31	-31	7	7	7	7	7	7
25% D Ave	236	236	-11	-11	-11	-11	15	15	16	16	7	7	12	-69	-69	-21	19	19	19	19	19	19	19	19
10% D Ave	163	163	11	11	11	11	29	29	30	30	7	7	20	13	13	20	-6	-6	-6	-6	-6	-6	-6	-6
All Avg	374	374	-80	-80	-80	-80	-49	-49	-46	-46	378	378	204	-119	-119	-96	-87	-87	28	28	23	23	23	23

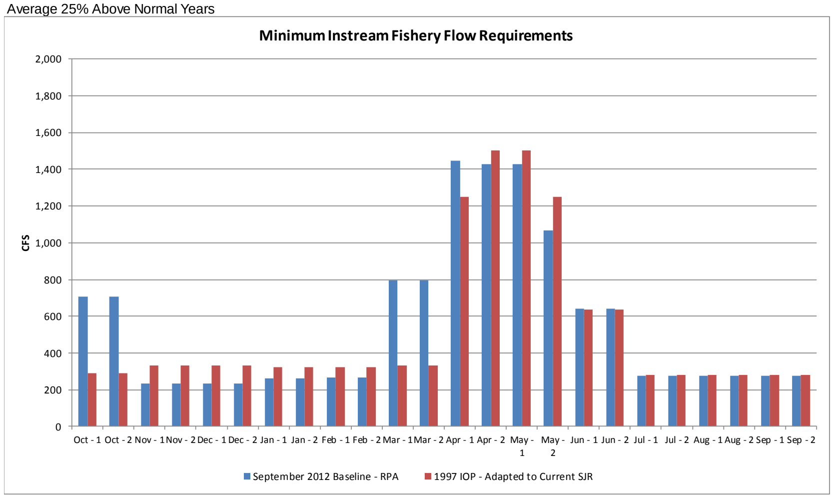
Average All Years



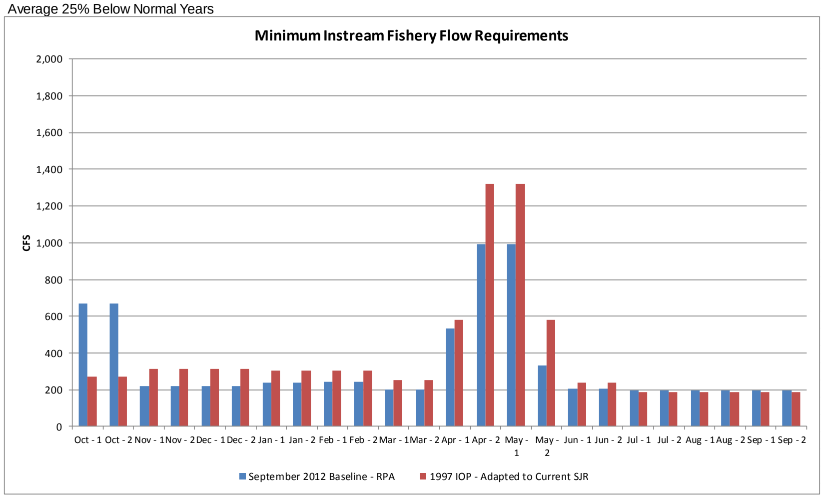
Average 25% Wet Years



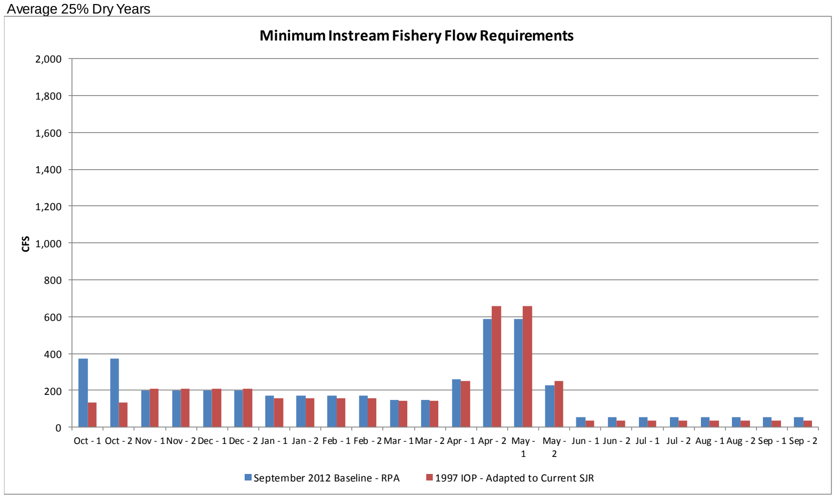
Average 25% Above Normal Years



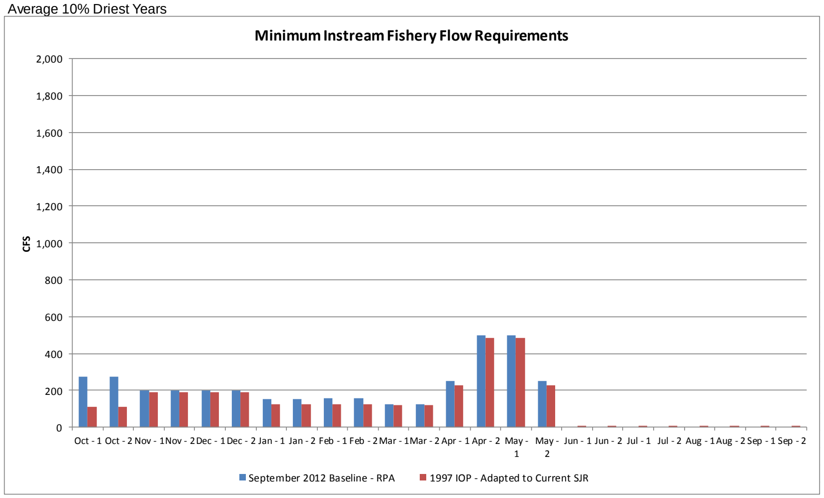
Average 25% Below Normal Years



Average 25% Dry Years



Average 10% Driest Years



1997 IOP – Adapted to Current SJR v September 2012 District Proposal

September 2012 District Proposal
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	283	283	300	300	300	300	248	248	256	256	300	300	1,500	1,500	1,500	850	200	200	200	200	200	200	200	200
25% AN Ave	276	276	290	290	290	290	240	240	249	249	265	265	1,045	1,500	1,500	623	200	200	200	200	200	200	200	200
25% BN Ave	265	265	290	290	290	290	207	207	221	221	200	200	200	1,500	1,500	200	200	200	200	200	200	200	200	200
25% D Ave	220	220	238	238	238	238	150	150	173	173	200	200	200	893	893	200	200	200	200	200	200	200	200	200
10% D Ave	206	206	211	211	211	211	150	150	173	173	200	200	200	750	750	200	200	200	200	200	200	200	200	200
All Avg	261	261	279	279	279	279	210	210	224	224	240	240	723	1,345	1,345	462	200	200	200	200	200	200	200	200

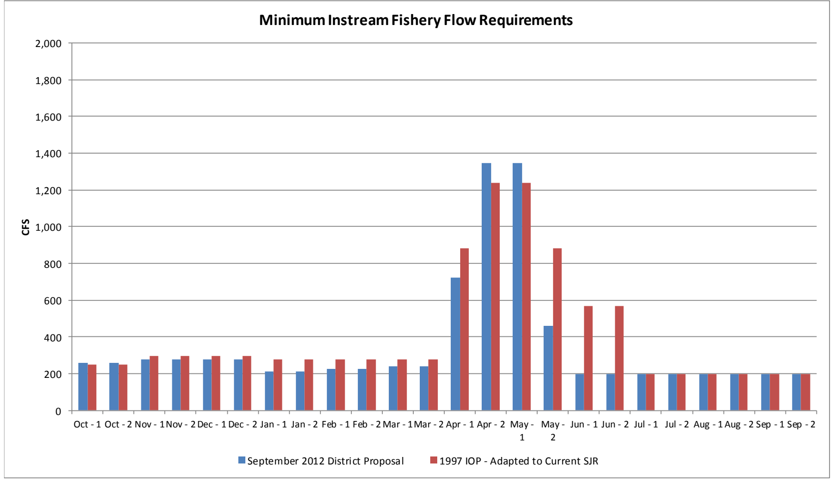
1997 IOP - Adapted to Current SJR
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	311	311	342	342	342	342	340	340	340	340	393	393	1,500	1,500	1,500	1,500	1,402	1,402	300	300	300	300	300	300
25% AN Ave	290	290	330	330	330	330	324	324	324	324	333	333	1,247	1,500	1,500	1,247	638	638	279	279	279	279	279	279
25% BN Ave	271	271	315	315	315	315	304	304	304	304	255	255	579	1,319	1,319	579	237	237	188	188	188	188	188	188
25% D Ave	135	135	210	210	210	210	158	158	158	158	142	142	249	658	658	249	35	35	35	35	35	35	35	35
10% D Ave	109	109	189	189	189	189	125	125	125	125	118	118	229	485	485	229	6	6	6	6	6	6	6	6
All Avg	251	251	298	298	298	298	280	280	280	280	279	279	882	1,238	1,238	882	568	568	198	198	198	198	198	198

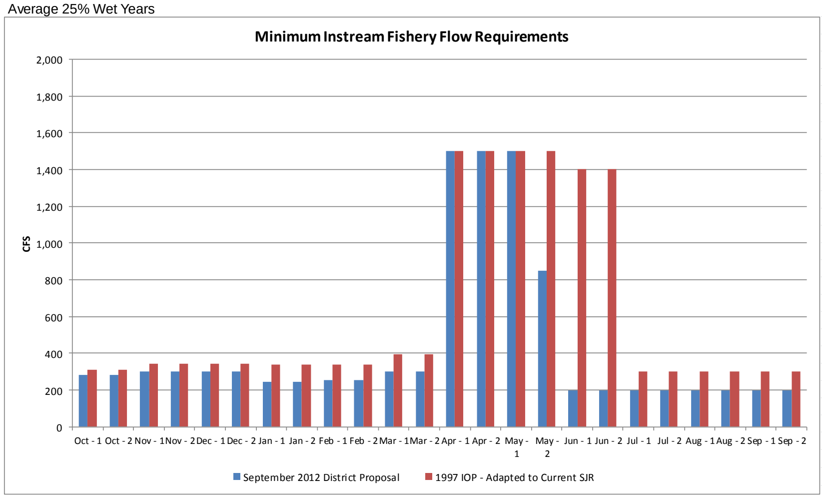
Difference (September 2012 District Proposal minus 1997 IOP - Adapted to Current SJR)
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	-28	-28	-42	-42	-42	-42	-93	-93	-85	-85	-93	-93	0	0	0	-650	-1,202	-1,202	-100	-100	-100	-100	-100	-100
25% AN Ave	-14	-14	-40	-40	-40	-40	-84	-84	-75	-75	-68	-68	-202	0	0	-625	-438	-438	-79	-79	-79	-79	-79	-79
25% BN Ave	-6	-6	-24	-24	-24	-24	-97	-97	-82	-82	-55	-55	-379	181	181	-379	-37	-37	12	12	12	12	12	12
25% D Ave	85	85	28	28	28	28	-8	-8	15	15	58	58	-49	235	235	-49	165	165	165	165	165	165	165	165
10% D Ave	97	97	22	22	22	22	25	25	48	48	82	82	-29	265	265	-29	194	194	194	194	194	194	194	194
All Avg	10	10	-19	-19	-19	-19	-70	-70	-56	-56	-39	-39	-159	106	106	-420	-368	-368	2	2	2	2	2	2

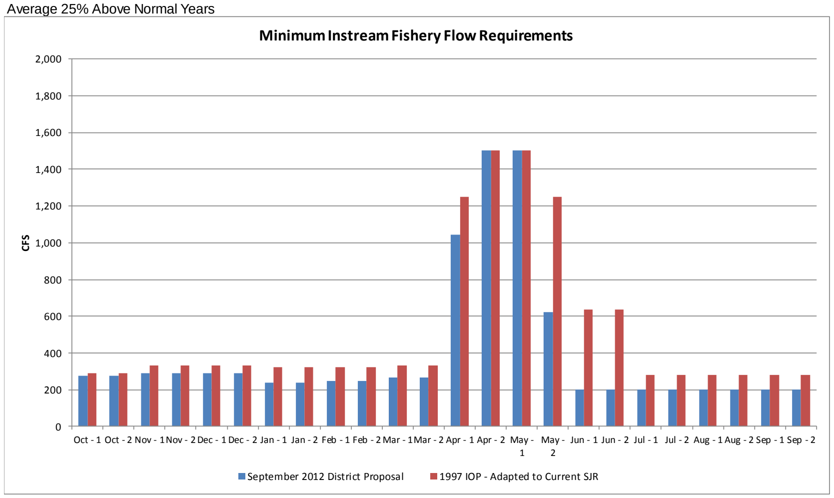
Average All Years



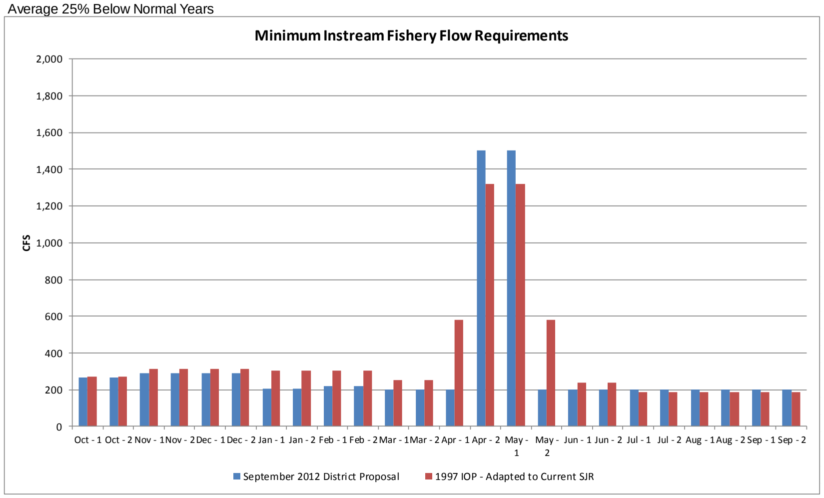
Average 25% Wet Years



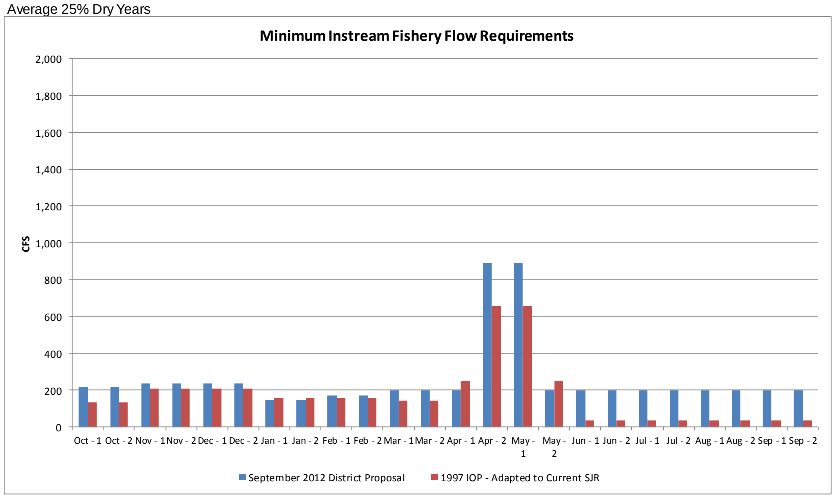
Average 25% Above Normal Years



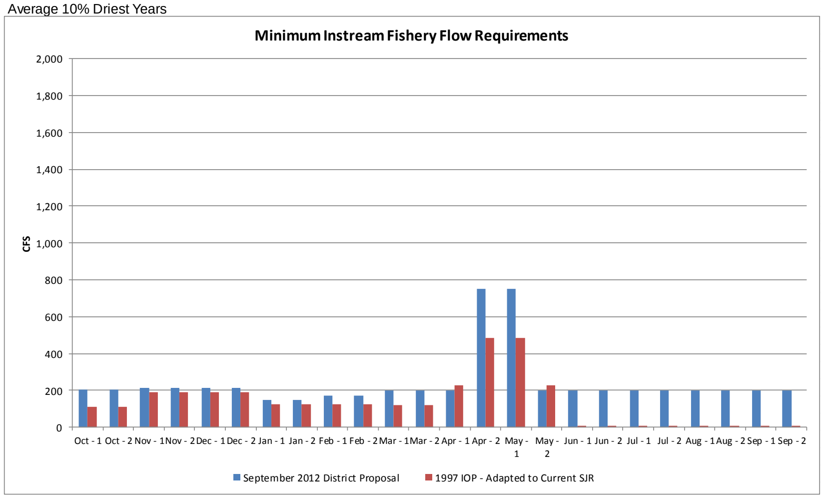
Average 25% Below Normal Years



Average 25% Dry Years



Average 10% Driest Years



September 2012 District Proposal v Current River RPA

September 2012 District Proposal
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	283	283	300	300	300	300	248	248	256	256	300	300	1,500	1,500	1,500	850	200	200	200	200	200	200	200	200
25% AN Ave	276	276	290	290	290	290	240	240	249	249	265	265	1,045	1,500	1,500	623	200	200	200	200	200	200	200	200
25% BN Ave	265	265	290	290	290	290	207	207	221	221	200	200	200	1,500	1,500	200	200	200	200	200	200	200	200	200
25% D Ave	220	220	238	238	238	238	150	150	173	173	200	200	200	893	893	200	200	200	200	200	200	200	200	200
10% D Ave	206	206	211	211	211	211	150	150	173	173	200	200	200	750	750	200	200	200	200	200	200	200	200	200
All Avg	261	261	279	279	279	279	210	210	224	224	240	240	723	1,345	1,345	462	200	200	200	200	200	200	200	200

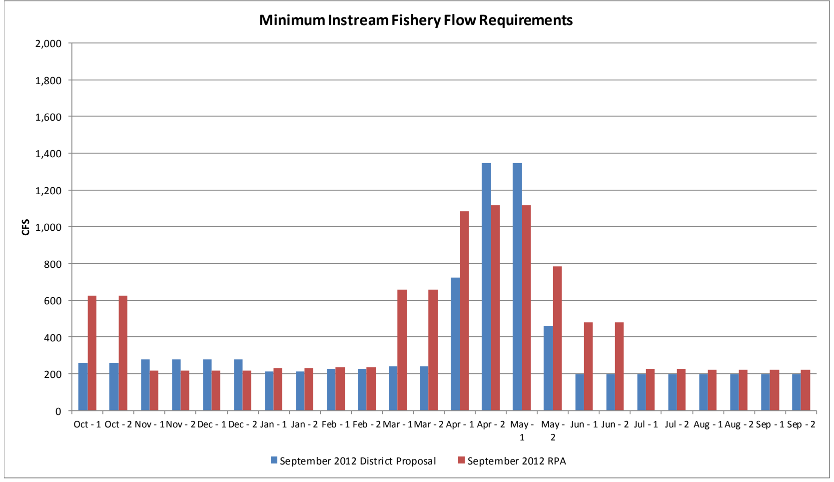
September 2012 RPA
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	760	760	220	220	220	220	253	253	256	256	1,531	1,531	2,171	1,502	1,502	1,567	1,052	1,052	390	390	370	370	370	370
25% AN Ave	707	707	235	235	235	235	262	262	266	266	794	794	1,446	1,427	1,427	1,067	643	643	276	276	275	275	275	275
25% BN Ave	670	670	219	219	219	219	240	240	242	242	200	200	535	991	991	330	206	206	195	195	195	195	195	195
25% D Ave	371	371	200	200	200	200	173	173	174	174	150	150	261	588	588	229	55	55	55	55	55	55	55	55
10% D Ave	272	272	199	199	199	199	155	155	155	155	124	124	249	497	497	249	0	0	0	0	0	0	0	0
All Avg	624	624	218	218	218	218	231	231	234	234	657	657	1,086	1,119	1,119	786	480	480	227	227	221	221	221	221

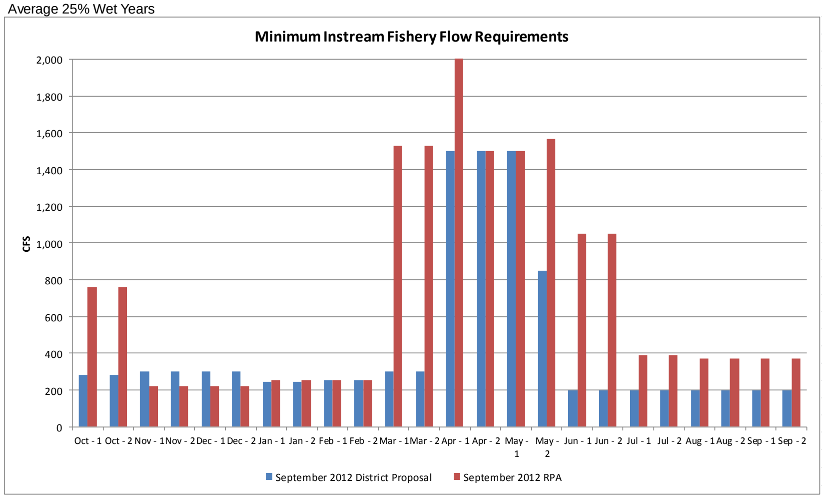
Difference (September 2012 District Proposal minus September 2012 RPA)
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	-477	-477	80	80	80	80	-5	-5	-1	-1	-1,231	-1,231	-671	-2	-2	-717	-852	-852	-190	-190	-170	-170	-170	-170
25% AN Ave	-431	-431	55	55	55	55	-22	-22	-16	-16	-529	-529	-401	73	73	-445	-443	-443	-76	-76	-75	-75	-75	-75
25% BN Ave	-404	-404	72	72	72	72	-32	-32	-21	-21	0	0	-335	509	509	-130	-6	-6	5	5	5	5	5	5
25% D Ave	-151	-151	39	39	39	39	-23	-23	-1	-1	50	50	-61	305	305	-29	145	145	145	145	145	145	145	145
10% D Ave	-66	-66	12	12	12	12	-5	-5	18	18	76	76	-49	253	253	-49	200	200	200	200	200	200	200	200
All Avg	-364	-364	61	61	61	61	-21	-21	-10	-10	-417	-417	-363	226	226	-324	-280	-280	-27	-27	-21	-21	-21	-21

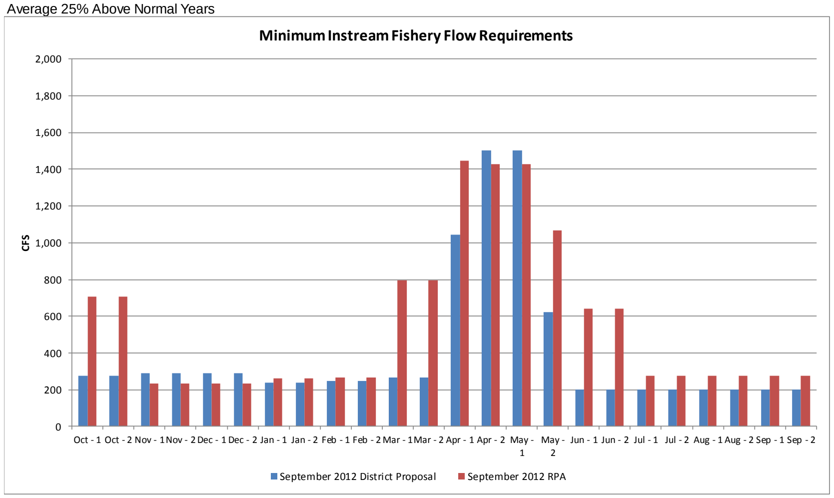
Average All Years



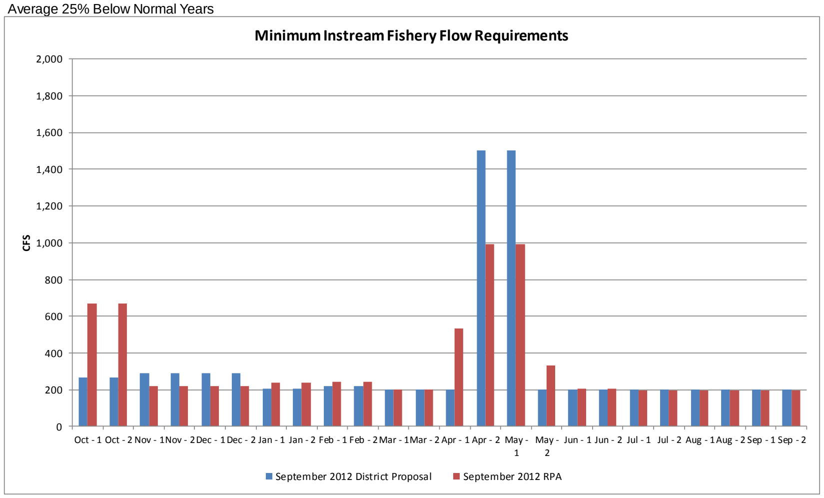
Average 25% Wet Years



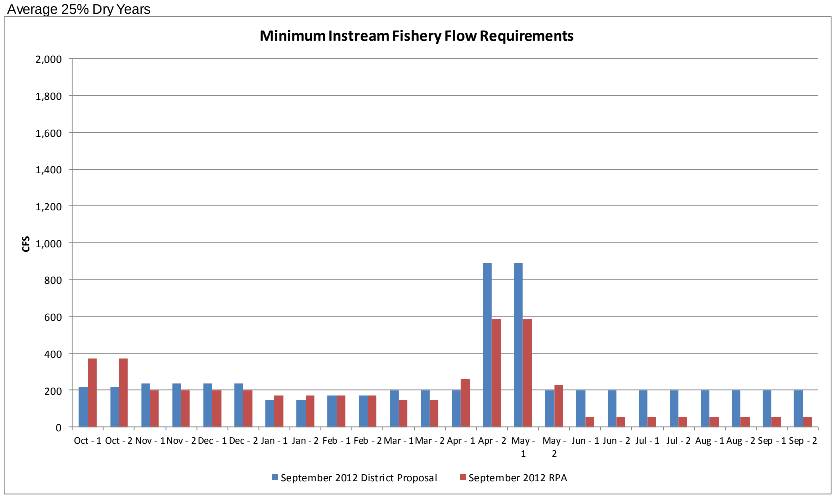
Average 25% Above Normal Years



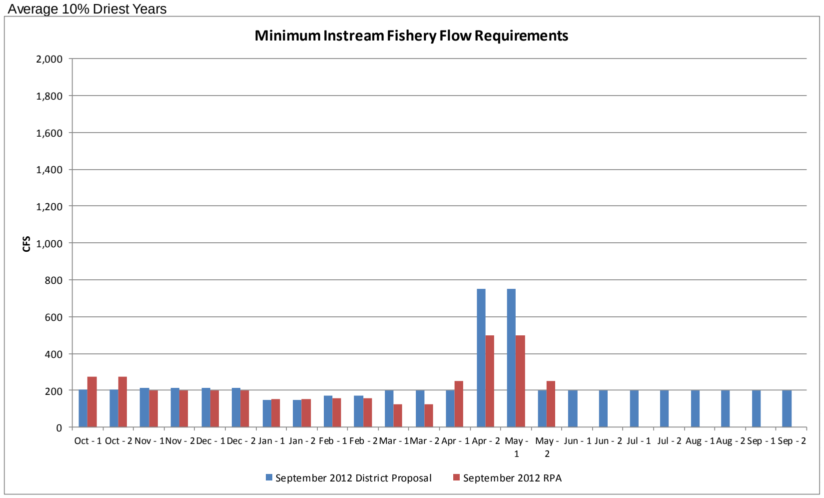
Average 25% Below Normal Years



Average 25% Dry Years



Average 10% Driest Years



Total Goodwin River Release

1997 IOP – Adapted to Current SJR v Current River RPA

September 2012 Baseline - RPA
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	885	774	337	349	406	411	637	638	803	801	1,858	2,042	2,171	1,848	2,069	1,582	1,052	1,438	713	818	743	720	755	789
25% AN Ave	768	707	368	392	557	687	1,129	1,136	695	677	847	847	1,451	1,880	1,873	1,107	765	765	289	289	297	297	280	280
25% BN Ave	693	670	219	219	219	219	241	241	330	339	320	318	662	1,608	1,742	488	393	393	265	265	283	283	249	249
25% D Ave	371	371	200	200	200	200	178	178	300	300	339	339	448	907	937	431	343	343	265	265	283	283	249	249
10% D Ave	272	272	199	199	199	199	167	167	279	279	353	353	464	497	497	447	255	255	265	265	283	283	249	249
All Avg	676	628	279	288	342	375	538	540	527	524	829	873	1,168	1,553	1,648	891	632	726	380	406	398	393	380	388

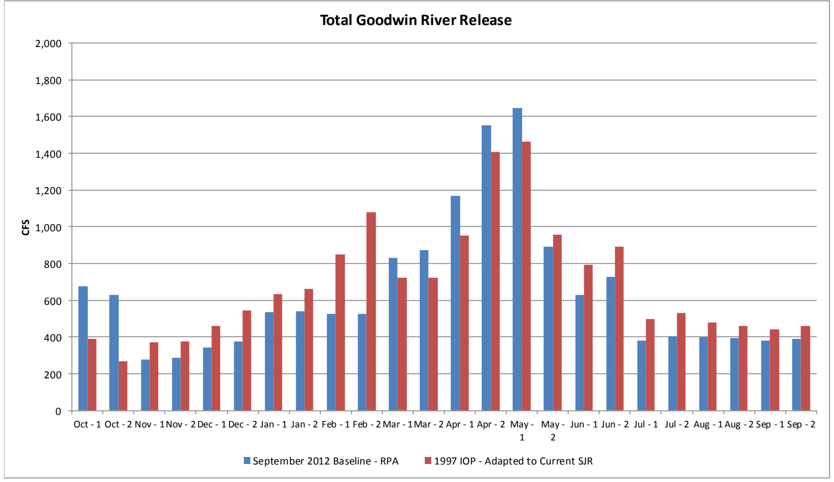
1997 IOP - Adapted to Current SJR
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	580	364	461	473	564	590	830	936	1,931	2,794	1,867	1,851	1,532	1,870	2,067	1,598	1,926	2,340	1,205	1,329	1,078	1,006	1,010	1,084
25% AN Ave	510	304	508	511	768	1,085	1,283	1,293	889	969	429	446	1,256	1,820	1,826	1,254	715	715	285	285	290	290	282	282
25% BN Ave	347	271	315	315	315	315	305	305	384	400	330	329	658	1,319	1,342	637	319	319	267	267	283	283	254	254
25% D Ave	135	135	210	210	210	210	162	162	243	241	315	315	410	658	658	386	255	255	265	265	283	283	249	249
10% D Ave	109	109	189	189	189	189	136	136	230	230	350	350	464	485	485	447	255	255	265	265	283	283	249	249
All Avg	389	267	371	374	459	543	635	663	848	1,082	725	725	953	1,406	1,462	958	791	892	500	530	479	461	444	462

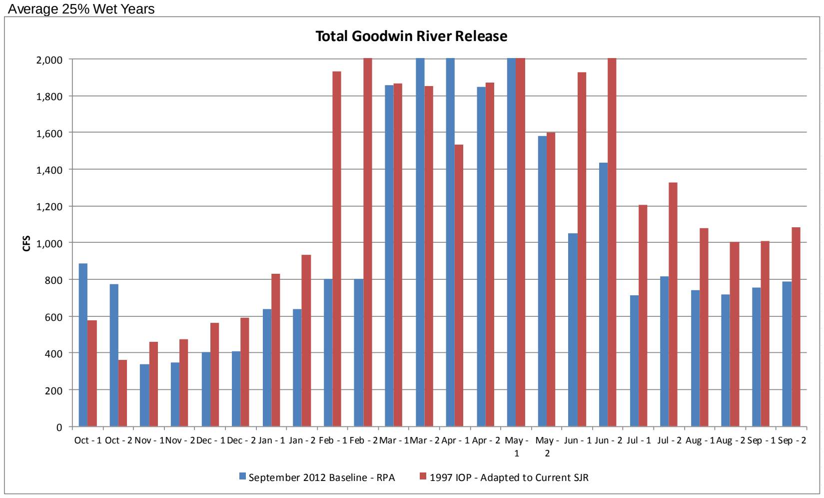
Difference (September 2012 Baseline - RPA minus 1997 IOP - Adapted to Current SJR)
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	305	411	-124	-124	-158	-179	-193	-298	-1,128	-1,993	-9	191	639	-21	3	-17	-874	-902	-492	-510	-336	-286	-255	-294
25% AN Ave	259	403	-140	-119	-211	-398	-154	-156	-194	-292	418	401	196	60	46	-148	50	50	4	4	7	7	-2	-2
25% BN Ave	346	398	-96	-96	-96	-96	-64	-64	-54	-61	-10	-11	4	289	400	-149	73	73	-2	-2	0	0	-5	-5
25% D Ave	236	236	-11	-11	-11	-11	16	16	58	60	24	24	37	249	280	44	88	88	0	0	0	0	0	0
10% D Ave	163	163	11	11	11	11	31	31	49	49	3	3	0	13	13	0	0	0	0	0	0	0	0	0
All Avg	287	361	-92	-87	-117	-168	-97	-123	-322	-558	103	148	214	147	186	-67	-160	-167	-120	-124	-80	-68	-64	-74

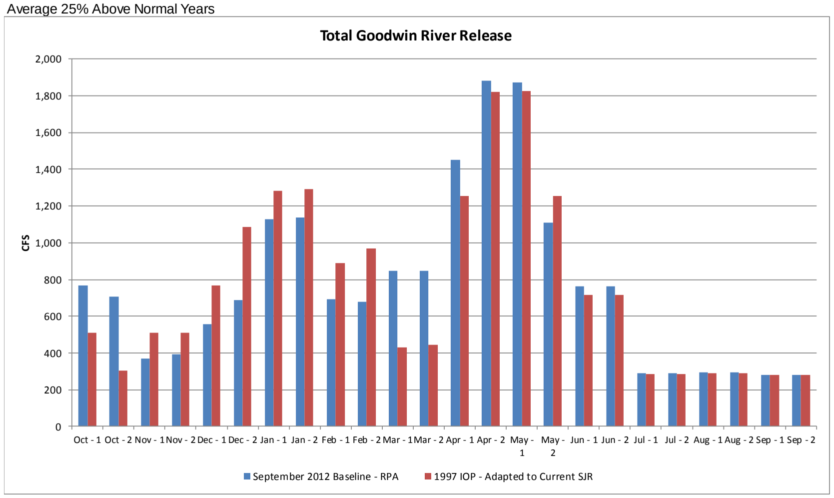
Average All Years



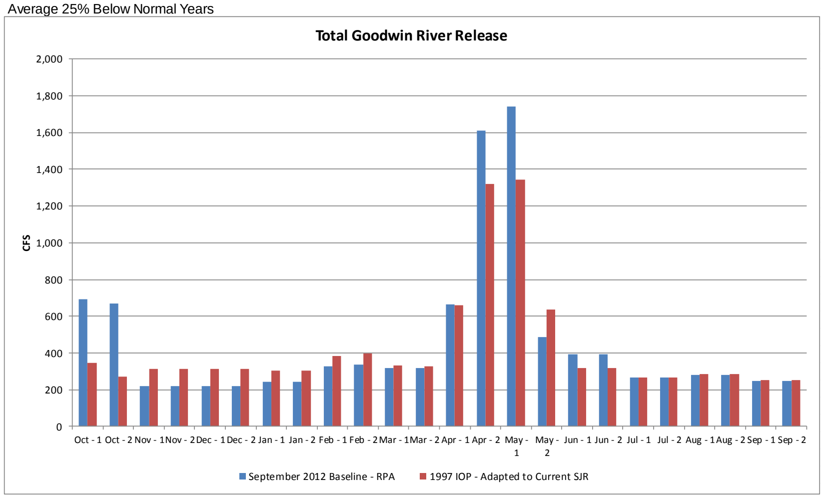
Average 25% Wet Years



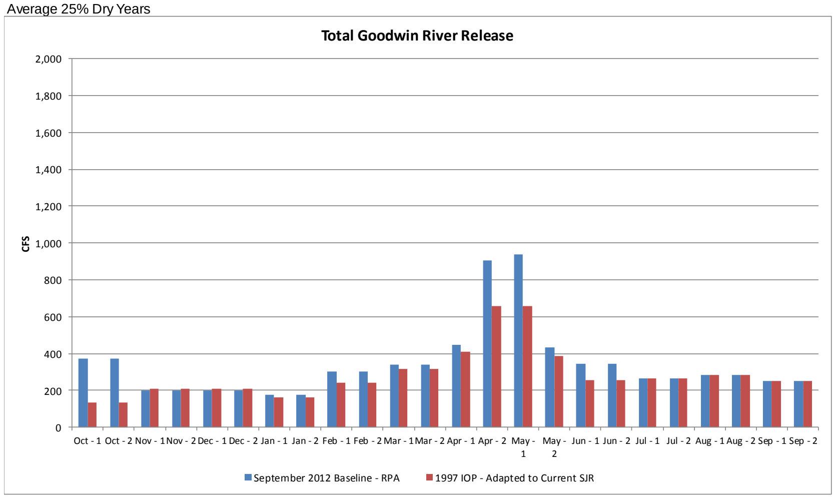
Average 25% Above Normal Years



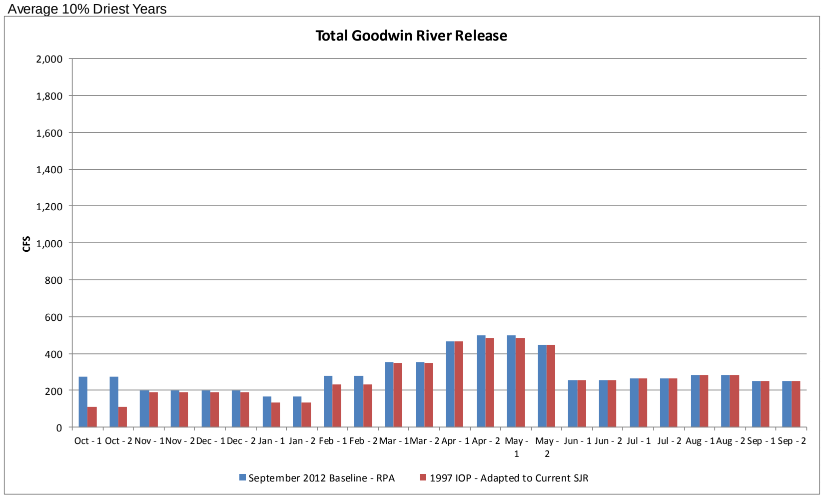
Average 25% Below Normal Years



Average 25% Dry Years



Average 10% Driest Years



1997 IOP – Adapted to Current SJR v September 2012 District Proposal

September 2012 District Proposal
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	606	341	431	451	508	572	787	816	1,525	2,499	1,711	1,705	1,523	1,547	1,500	939	981	1,526	1,084	1,147	925	907	1,096	1,222
25% AN Ave	602	295	480	491	743	772	1,141	1,168	854	859	362	376	1,095	1,500	1,500	644	200	200	204	204	200	200	200	200
25% BN Ave	475	267	298	298	305	315	255	287	371	370	278	276	338	1,500	1,500	323	207	207	211	211	200	200	200	200
25% D Ave	220	220	238	238	238	238	153	153	280	280	330	329	399	893	893	369	208	208	211	211	208	208	200	200
10% D Ave	206	206	211	211	211	211	158	158	290	290	370	368	464	750	750	447	213	213	221	221	212	212	200	200
All Avg	473	280	360	367	444	470	575	597	747	986	661	663	827	1,356	1,345	564	394	527	422	438	379	374	419	449

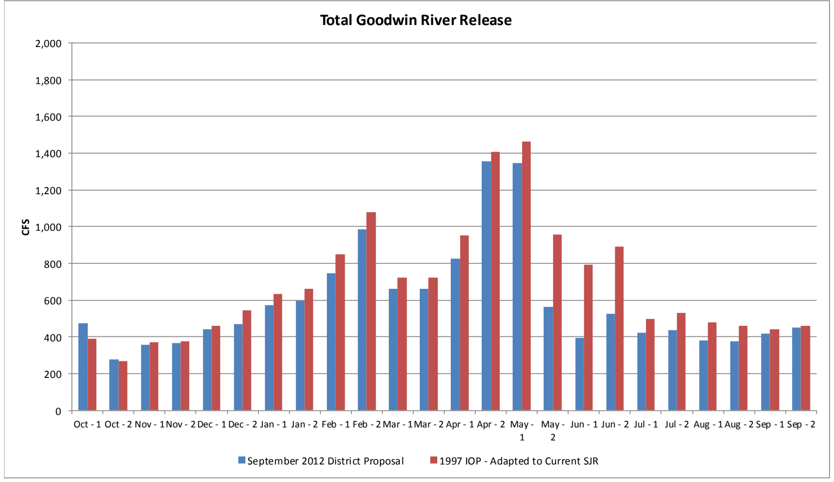
1997 IOP - Adapted to Current SJR
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	580	364	461	473	564	590	830	936	1,931	2,794	1,867	1,851	1,532	1,870	2,067	1,598	1,926	2,340	1,205	1,329	1,078	1,006	1,010	1,084
25% AN Ave	510	304	508	511	768	1,085	1,283	1,293	889	969	429	446	1,256	1,820	1,826	1,254	715	715	285	285	290	290	282	282
25% BN Ave	347	271	315	315	315	315	305	305	384	400	330	329	658	1,319	1,342	637	319	319	267	267	283	283	254	254
25% D Ave	135	135	210	210	210	210	162	162	243	241	315	315	410	658	658	386	255	255	265	265	283	283	249	249
10% D Ave	109	109	189	189	189	189	136	136	230	230	350	350	464	485	485	447	255	255	265	265	283	283	249	249
All Avg	389	267	371	374	459	543	635	663	848	1,082	725	725	953	1,406	1,462	958	791	892	500	530	479	461	444	462

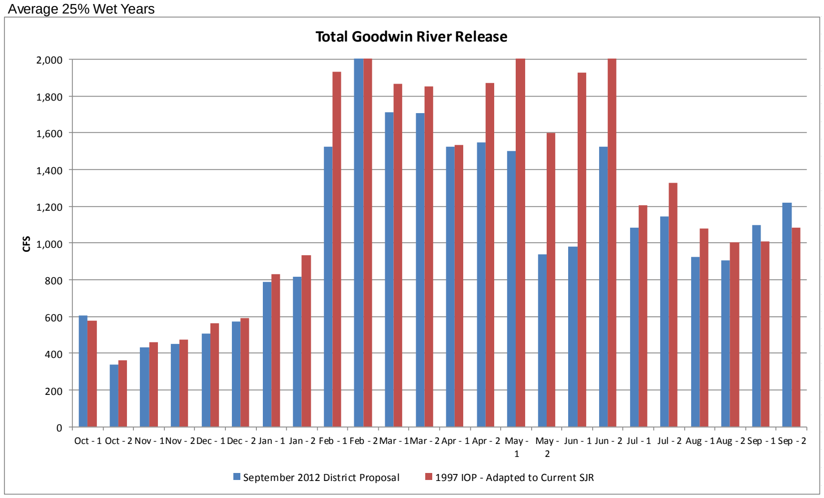
Difference (September 2012 District Proposal minus 1997 IOP - Adapted to Current SJR)
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	26	-23	-29	-22	-56	-18	-43	-120	-405	-295	-156	-146	-9	-323	-567	-660	-945	-813	-121	-182	-153	-99	86	138
25% AN Ave	93	-9	-28	-20	-26	-313	-142	-125	-35	-110	-67	-70	-161	-320	-326	-610	-515	-515	-81	-81	-90	-90	-82	-82
25% BN Ave	128	-4	-17	-17	-10	1	-50	-18	-12	-30	-52	-53	-320	181	158	-314	-112	-112	-56	-56	-83	-83	-54	-54
25% D Ave	85	85	28	28	28	28	-9	-9	38	40	15	14	-12	235	235	-17	-48	-48	-54	-54	-75	-75	-49	-49
10% D Ave	97	97	22	22	22	22	22	22	60	60	20	19	0	265	265	0	-42	-42	-44	-44	-71	-71	-49	-49
All Avg	84	13	-11	-7	-15	-74	-60	-66	-101	-96	-64	-63	-126	-50	-117	-394	-397	-365	-77	-92	-100	-87	-25	-12

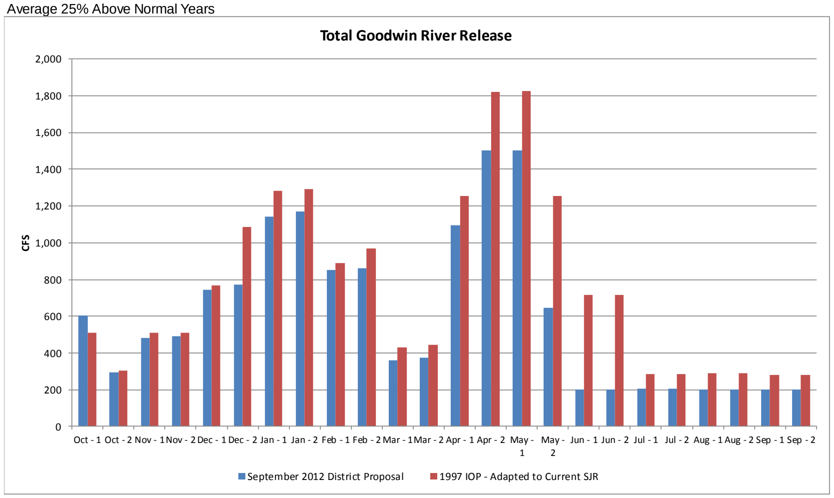
Average All Years



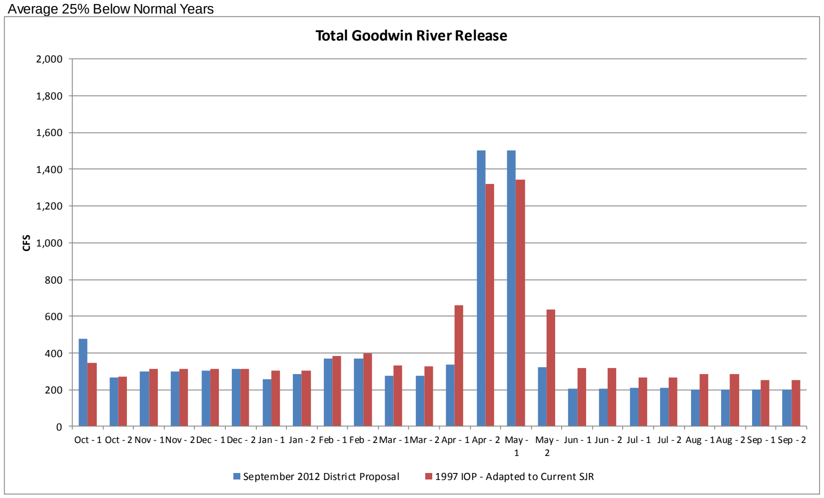
Average 25% Wet Years



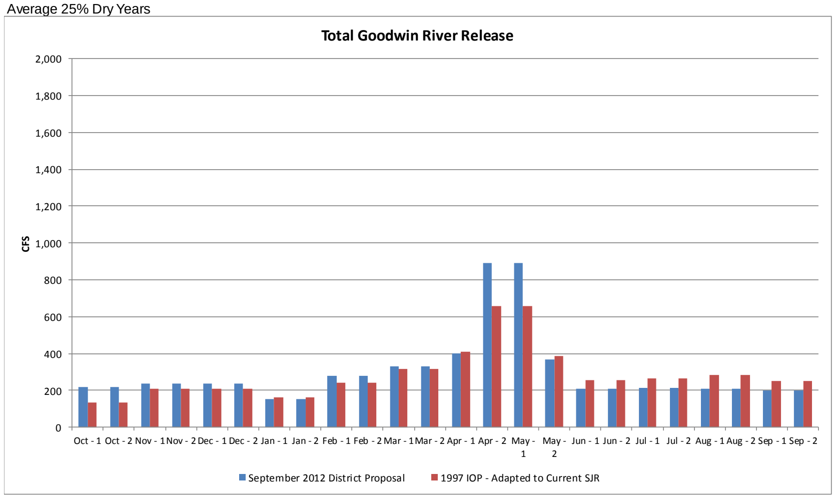
Average 25% Above Normal Years



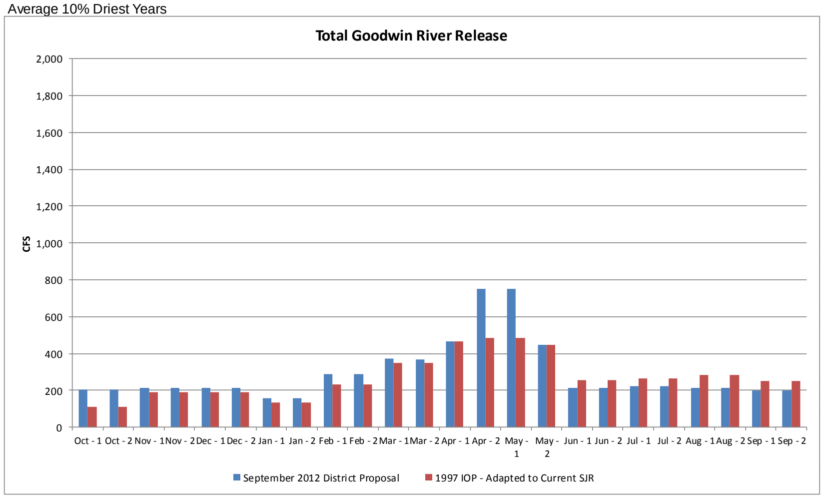
Average 25% Below Normal Years



Average 25% Dry Years



Average 10% Driest Years



September 2012 District Proposal v Current River RPA

September 2012 District Proposal
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	606	341	431	451	508	572	787	816	1,525	2,499	1,711	1,705	1,523	1,547	1,500	939	981	1,526	1,084	1,147	925	907	1,096	1,222
25% AN Ave	602	295	480	491	743	772	1,141	1,168	854	859	362	376	1,095	1,500	1,500	644	200	200	204	204	200	200	200	200
25% BN Ave	475	267	298	298	305	315	255	287	371	370	278	276	338	1,500	1,500	323	207	207	211	211	200	200	200	200
25% D Ave	220	220	238	238	238	238	153	153	280	280	330	329	399	893	893	369	208	208	211	211	208	208	200	200
10% D Ave	206	206	211	211	211	211	158	158	290	290	370	368	464	750	750	447	213	213	221	221	212	212	200	200
All Avg	473	280	360	367	444	470	575	597	747	986	661	663	827	1,356	1,345	564	394	527	422	438	379	374	419	449

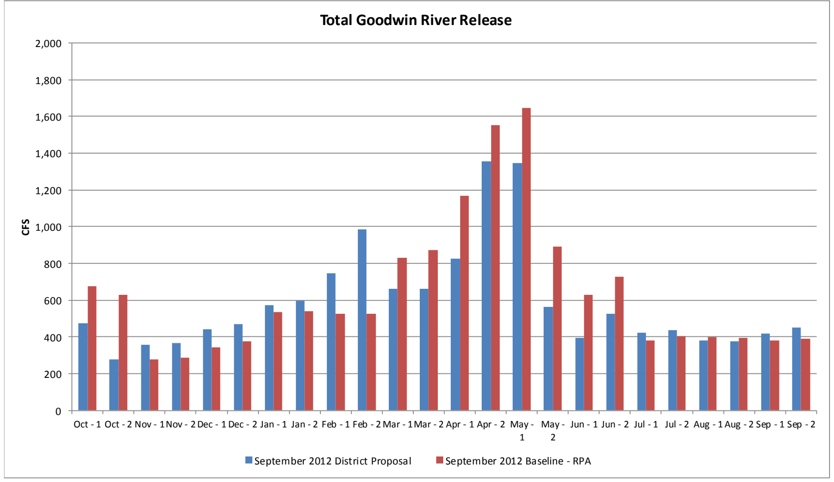
September 2012 Baseline - RPA
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	885	774	337	349	406	411	637	638	803	801	1,858	2,042	2,171	1,848	2,069	1,582	1,052	1,438	713	818	743	720	755	789
25% AN Ave	768	707	368	392	557	687	1,129	1,136	695	677	847	847	1,451	1,880	1,873	1,107	765	765	289	289	297	297	280	280
25% BN Ave	693	670	219	219	219	219	241	241	330	339	320	318	662	1,608	1,742	488	393	393	265	265	283	283	249	249
25% D Ave	371	371	200	200	200	200	178	178	300	300	339	339	448	907	937	431	343	343	265	265	283	283	249	249
10% D Ave	272	272	199	199	199	199	167	167	279	279	353	353	464	497	497	447	255	255	265	265	283	283	249	249
All Avg	676	628	279	288	342	375	538	540	527	524	829	873	1,168	1,553	1,648	891	632	726	380	406	398	393	380	388

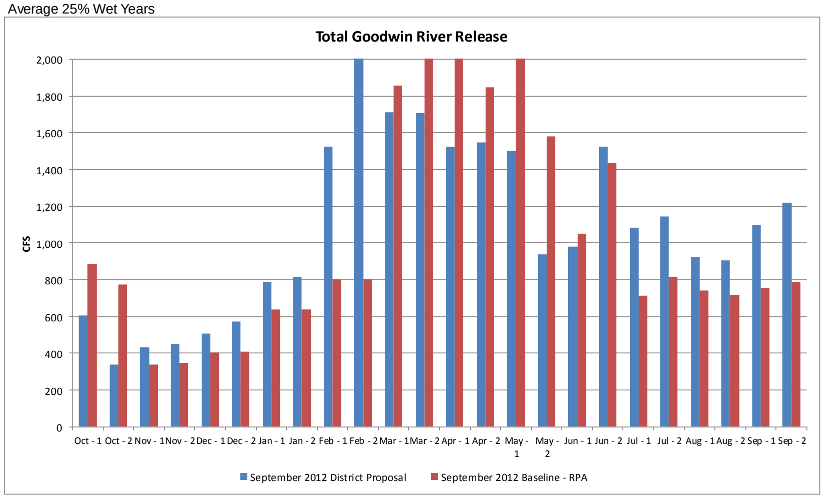
Difference (September 2012 District Proposal minus September 2012 Baseline - RPA)
Minimum Instream Fishery Requirement
Average Period CFS

Year Type	Oct - 1	Oct - 2	Nov - 1	Nov - 2	Dec - 1	Dec - 2	Jan - 1	Jan - 2	Feb - 1	Feb - 2	Mar - 1	Mar - 2	Apr - 1	Apr - 2	May - 1	May - 2	Jun - 1	Jun - 2	Jul - 1	Jul - 2	Aug - 1	Aug - 2	Sep - 1	Sep - 2
25% W Ave	-279	-434	94	102	101	160	150	179	723	1,698	-147	-337	-648	-301	-569	-643	-71	89	371	329	182	187	341	433
25% AN Ave	-166	-412	112	99	185	85	12	32	159	182	-485	-471	-357	-380	-373	-462	-565	-565	-85	-85	-97	-97	-80	-80
25% BN Ave	-218	-402	79	79	86	96	14	46	42	31	-43	-42	-324	-108	-242	-164	-185	-185	-54	-54	-83	-83	-49	-49
25% D Ave	-151	-151	39	39	39	39	-25	-25	-20	-20	-9	-10	-49	-14	-45	-61	-136	-136	-54	-54	-75	-75	-49	-49
10% D Ave	-66	-66	12	12	12	12	-9	-9	10	10	17	15	0	253	253	0	-42	-42	-44	-44	-71	-71	-49	-49
All Avg	-203	-348	80	79	102	94	37	57	221	461	-167	-210	-341	-197	-303	-327	-237	-198	42	32	-20	-18	39	61

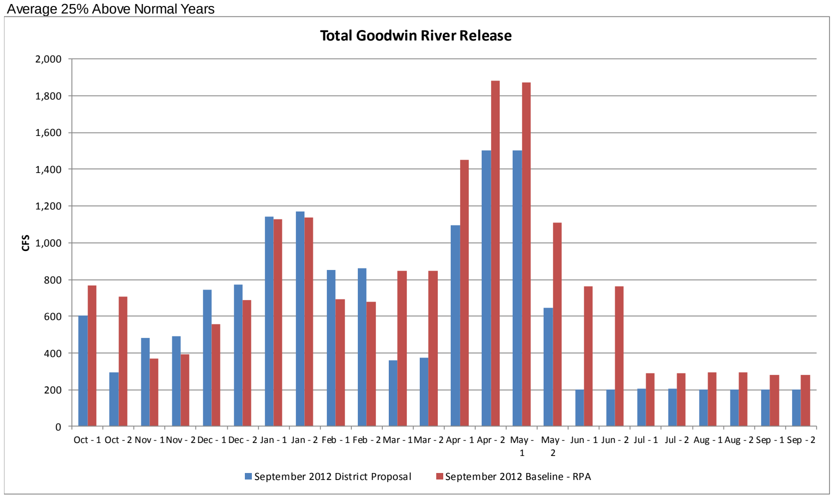
Average All Years



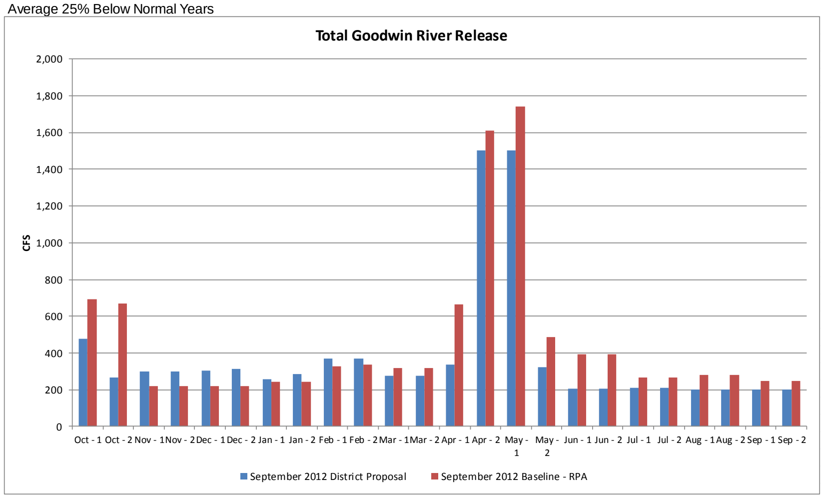
Average 25% Wet Years



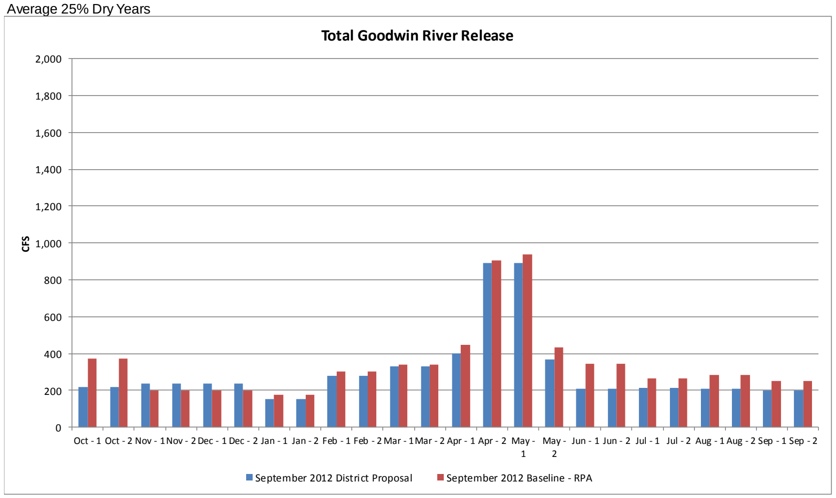
Average 25% Above Normal Years



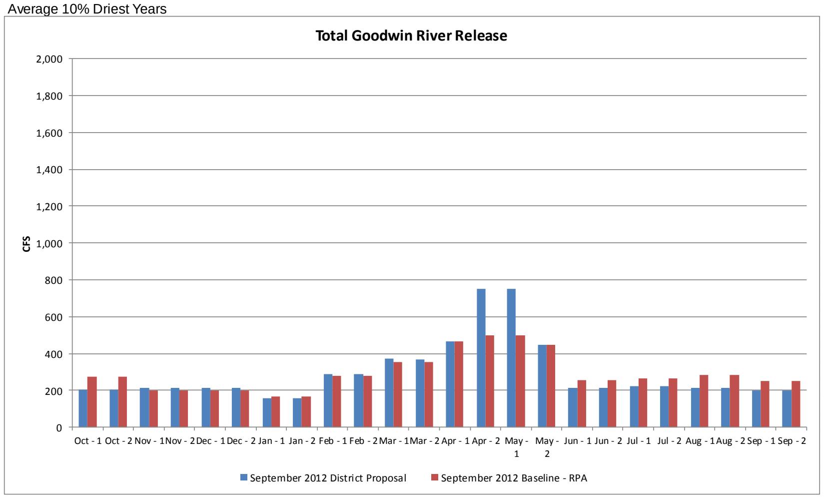
Average 25% Below Normal Years



Average 25% Dry Years



Average 10% Driest Years



1997 IOP – Current SJR

New Melones Operations Model - Annual Summary

1997 IOP - Adapted to Current SJR

	New Melones			Goodwin											
	New Melones Inflow	New Melones Storage	Added Water	OID & SSJID Canals	SEWD NM Water	CSJWCD NM Water	Instream Fish	Dissolved Oxygen	Vernalis Water Quality	Vernalis Flow Objective	Total Goodwin Release to River	Release above Minimum	NM Forecast Index	Missed Vernalis WQ Release	Missed Vernalis Flow Release
Avg	1087			509	6	46	301	13	15	13	496	154		0	41
	WY	EOS	WY	WY	M-F	M-F	M-F	M-F	M-F	M-F	M-F	M-F		M-F	M-F
1922	1391	1986	0	506	10	80	441	0	0	0	611	169	2895	0	0
1923	1109	1869	0	507	10	80	417	0	0	0	417	0	2791	0	0
1924	385	1430	0	457	2	9	168	20	36	0	225	2	2094	0	60
1925	1092	1695	0	444	9	45	329	2	0	0	331	0	2461	0	0
1926	619	1410	0	559	3	17	202	23	11	0	238	2	2170	0	0
1927	1256	1709	0	515	10	80	366	0	0	0	367	0	2582	0	0
1928	952	1643	0	509	10	80	356	1	0	14	370	0	2541	0	0
1929	506	1312	0	530	0	0	126	40	26	0	191	0	2000	0	39
1930	671	1191	0	559	0	0	120	36	34	0	191	0	1877	0	60
1931	438	882	0	492	0	0	106	24	61	0	194	2	1567	0	93
1932	1160	1303	0	531	0	0	125	48	15	0	188	0	1979	0	148
1933	586	1065	0	574	0	0	116	35	41	0	191	0	1775	0	29
1934	498	802	0	532	0	0	103	27	52	0	183	0	1503	0	134
1935	1082	1223	0	464	0	0	118	49	8	0	181	6	1818	0	102
1936	1291	1690	0	480	9	44	325	2	0	0	329	2	2451	0	32
1937	1080	1781	0	498	10	80	381	0	0	13	517	123	2645	0	0
1938	2032	2000	0	495	10	80	467	0	0	0	1156	689	3556	0	0
1939	562	1556	0	529	7	35	284	9	0	0	294	0	2357	0	0
1940	1327	1861	0	514	10	80	408	0	0	11	441	22	2757	0	0
1941	1290	2000	0	486	10	80	460	0	0	0	725	266	2970	0	0
1942	1450	2000	0	454	10	80	467	0	0	0	982	515	3100	0	0
1943	1538	1930	0	484	10	80	468	0	0	51	713	194	3090	0	0
1944	649	1584	0	547	8	39	301	5	0	0	307	0	2397	0	15
1945	1228	1776	0	474	10	80	399	0	0	60	492	32	2722	0	0
1946	1175	1858	0	481	10	80	418	0	0	26	444	0	2801	0	0
1947	634	1460	0	600	7	33	274	11	22	0	308	0	2334	0	103
1948	853	1463	0	489	4	18	209	27	30	0	267	0	2186	0	58
1949	732	1328	0	583	1	6	155	39	18	0	211	0	2065	0	131
1950	1027	1494	0	549	5	25	239	18	4	0	674	413	2254	0	66
1951	1656	1733	0	505	10	80	394	0	0	30	486	63	2697	0	0
1952	1844	2000	0	496	10	80	467	0	0	0	1063	596	3430	0	0
1953	965	1763	0	546	10	80	393	0	0	0	393	0	2695	0	0
1954	882	1596	0	590	9	45	329	2	4	0	335	0	2462	0	71
1955	656	1395	0	516	2	12	180	25	35	0	322	82	2121	0	8
1956	1825	2000	0	527	10	80	467	0	0	95	631	70	3082	0	0
1957	878	1729	0	557	10	80	382	0	0	0	382	0	2649	0	0
1958	1599	2000	0	419	10	80	467	0	0	0	896	429	3200	0	0
1959	624	1560	0	556	7	37	292	8	0	0	299	0	2374	0	0
1960	574	1247	0	583	0	0	126	30	61	0	217	0	2001	0	68
1961	446	929	0	497	0	0	109	23	66	0	199	2	1623	0	103
1962	863	1050	0	540	0	0	113	44	15	0	172	0	1715	0	42
1963	1227	1526	0	481	4	19	214	26	4	0	244	0	2198	0	139
1964	632	1281	0	578	1	6	154	29	40	0	228	5	2062	0	26
1965	1666	1867	0	500	10	80	445	0	0	102	547	0	2910	0	0
1966	733	1582	0	552	9	43	319	2	0	0	322	0	2439	0	125
1967	1831	2000	0	486	10	80	468	0	0	0	939	471	3297	0	0
1968	670	1600	0	534	8	40	308	4	0	0	487	175	2413	0	0
1969	2118	2000	0	502	10	80	467	0	0	0	1465	999	3474	0	0
1970	1321	1695	0	528	10	80	399	0	0	67	496	30	2720	0	0
1971	1066	1716	0	528	10	80	377	0	1	13	391	0	2627	0	0
1972	764	1460	0	600	7	32	270	12	7	0	291	2	2325	0	35
1973	1237	1751	0	490	10	80	374	0	0	0	488	113	2618	0	0
1974	1500	1951	0	439	10	80	467	0	0	97	719	155	3045	0	0
1975	1210	1805	0	492	10	80	450	0	0	152	656	54	2927	0	0
1976	467	1381	0	511	2	10	173	26	48	0	247	0	2105	0	40
1977	271	982	0	381	0	0	105	23	72	0	203	3	1540	0	103
1978	1311	1574	0	454	5	22	227	21	0	0	249	1	2228	0	0
1979	1139	1630	0	529	10	80	375	0	0	100	722	247	2619	0	0
1980	1721	1920	0	481	10	80	467	0	0	104	607	36	3005	0	0
1981	634	1573	0	540	7	35	286	9	0	0	614	320	2361	0	48
1982	2229	2000	0	429	10	80	467	0	0	0	1880	1413	3419	0	0
1983	2900	2000	0	413	10	80	468	0	0	0	2320	1853	3965	0	0
1984	1621	1783	0	549	10	80	410	0	0	0	431	21	2765	0	0
1985	744	1577	0	510	8	39	302	4	1	0	514	206	2400	0	36
1986	1869	1932	0	475	10	80	467	0	0	0	777	310	3149	0	0
1987	497	1480	0	531	5	24	237	16	25	0	278	0	2248	0	53
1988	390	1099	0	460	0	0	115	23	76	0	214	0	1759	14	78
1989	648	950	0	548	0	0	110	36	70	0	216	0	1648	0	101
1990	491	658	0	527	0	0	95	32	68	0	195	0	1354	21	110
1991	502	437	0	526	0	0	75	29	53	0	159	1	1068	3	141
1992	459	198	0	506	0	0	58	63	41	0	166	4	830	0	141
1993	1275	827	0	477	0	0	100	63	33	0	197	1	1428	0	449
1994	501	546	0	529	0	0	88	47	62	0	201	4	1244	0	84
1995	2160	1869	0	452	10	80	383	0	0	0	589	206	2653	0	0
1996	1512	1968	0	517	10	80	467	0	0	0	1623	1157	3024	0	0
1997	1902	1653	0	556	10	80	406	0	0	97	559	56	2749	0	0
1998	1876	2000	0	444	10	80	467	0	0	0	1322	856	3374	0	0
1999	1326	1866	0	508	10	80	433	0	0	12	544	99	2860	0	0
2000	1062	1802	0	488	10	80	394	0	0	21	441	26	2702	0	0
2001	588	1549	0	469	6	28	253	12	19	0	284	0	2286	0	33
2002	710	1369	0	548	3	13	185	21	53	0	259	0	2132	0	198
2003	896	1405	0	530									2155		

All units in 1,000 acre-feet unless otherw ise noted. Vernalis WQ Release from Goodw in (1) DO Release from Goodw in (1)

September 2012 Baseline - RPA

New Melones Operations Model - Annual Summary **September 2012 Baseline - RPA - WQ - D1641 - DO (Added Water)**

	New Melones			Goodwin											
	New Melones Inflow	New Melones Storage	Added Water	OID & SSJID Canals	SEWD NM Water	CSJWCD NM Water	Instream Fish	Dissolved Oxygen	Vernalis Water Quality	Vernalis Flow Objective	Total Goodwin Release to River	Release above Minimum	NM Forecast Index	Missed Vernalis WQ Release	Missed Vernalis Flow Release
Avg	1087			509	42	56	327	12	15	38	465	73		0	22
	WY	EOS	WY	WY	M-F	M-F	M-F	M-F	M-F	M-F	M-F	M-F		M-F	M-F
1922	1391	1434	0	506	75	80	462	0	0	0	462	0	2425	0	0
1923	1109	1391	0	507	75	80	462	0	1	0	463	0	2421	0	0
1924	385	873	0	457	10	49	185	17	30	78	312	2	1623	0	0
1925	1092	1191	0	444	10	49	234	15	0	0	249	0	1873	0	0
1926	619	920	0	559	10	49	185	22	10	6	226	2	1667	0	0
1927	1256	1325	0	515	10	49	235	15	0	9	258	0	2068	0	0
1928	952	1391	0	509	10	49	234	15	0	29	278	0	2173	0	0
1929	506	990	0	530	10	49	234	15	2	19	270	0	1762	0	0
1930	671	725	0	559	10	49	185	25	13	58	282	0	1508	0	0
1931	438	381	0	492	10	0	99	25	64	0	189	2	1060	0	96
1932	1160	629	0	531	10	49	185	27	4	146	363	0	1481	0	0
1933	586	366	0	574	10	0	98	36	47	0	182	0	1062	0	36
1934	498	121	0	532	10	0	98	27	54	0	180	0	810	0	136
1935	1082	563	0	464	10	0	99	53	10	0	168	6	1142	0	106
1936	1291	1072	0	480	10	49	234	15	0	50	302	3	1797	0	0
1937	1080	1295	0	498	10	49	234	15	0	35	290	6	2023	0	0
1938	2032	2000	0	495	75	80	587	0	0	0	745	158	3201	0	0
1939	562	1414	0	529	75	80	347	3	0	0	350	0	2357	0	0
1940	1327	1579	0	514	75	80	462	0	0	8	469	0	2589	0	0
1941	1290	1738	0	486	75	80	462	0	0	0	462	0	2715	0	0
1942	1450	1991	0	454	75	80	587	0	0	0	868	281	3049	0	0
1943	1538	1835	0	484	75	80	588	0	0	50	757	120	3090	0	0
1944	649	1338	0	547	75	80	347	3	0	12	362	0	2289	0	0
1945	1228	1380	0	474	75	80	462	0	0	67	528	0	2455	0	0
1946	1175	1388	0	481	75	80	462	0	0	29	491	0	2441	0	0
1947	634	891	0	600	10	49	235	15	38	134	421	0	1872	0	0
1948	853	821	0	489	10	49	185	27	39	80	331	0	1607	0	0
1949	732	506	0	583	10	49	185	25	19	144	373	0	1400	0	0
1950	1027	733	0	549	10	0	98	51	22	0	178	6	1397	0	130
1951	1656	1386	0	505	75	80	347	3	0	60	414	3	2371	0	0
1952	1844	2000	0	496	75	80	587	0	0	0	697	110	3125	0	0
1953	965	1630	0	546	75	80	462	0	5	0	467	0	2695	0	0
1954	882	1294	0	590	75	80	347	3	12	72	433	0	2325	0	0
1955	656	1028	0	516	10	49	235	13	20	10	285	8	1791	0	0
1956	1825	1621	0	527	75	80	462	0	3	101	565	0	2759	0	0
1957	878	1369	0	557	75	80	347	3	8	4	362	0	2329	0	0
1958	1599	1844	0	419	75	80	587	0	0	0	587	0	2843	0	0
1959	624	1319	0	556	75	80	347	3	0	0	350	0	2267	0	0
1960	574	874	0	583	10	49	234	15	23	48	321	0	1737	0	0
1961	446	516	0	497	10	0	98	24	69	0	193	2	1206	0	107
1962	863	647	0	540	10	0	98	46	18	0	163	1	1305	0	48
1963	1227	982	0	481	10	49	235	15	4	148	402	0	1799	0	0
1964	632	647	0	578	10	49	185	22	33	38	284	5	1483	0	0
1965	1666	1188	0	500	75	80	347	3	0	140	490	0	2243	0	0
1966	733	863	0	552	10	49	234	14	2	189	439	0	1777	0	0
1967	1831	1564	0	486	75	80	462	0	0	0	462	0	2528	0	0
1968	670	1308	0	534	10	49	234	15	1	11	269	8	2070	0	0
1969	2118	2000	0	502	75	80	587	0	0	0	1273	686	3337	0	0
1970	1321	1601	0	528	75	80	462	0	0	62	523	0	2720	0	0
1971	1066	1484	0	528	75	80	462	0	7	9	478	0	2536	0	0
1972	764	1184	0	600	10	49	234	15	15	58	325	3	2087	0	0
1973	1237	1430	0	490	75	80	347	3	0	0	350	0	2329	0	0
1974	1500	1662	0	439	75	80	587	0	0	94	681	0	2839	0	0
1975	1210	1531	0	492	75	80	462	0	0	167	629	0	2699	0	0
1976	467	1048	0	511	10	49	234	14	29	40	317	0	1845	0	0
1977	271	615	0	381	10	0	98	22	77	0	200	3	1171	0	106
1978	1311	1211	0	454	10	49	234	15	0	0	250	1	1863	0	0
1979	1139	1197	0	529	75	80	347	3	0	113	466	3	2231	0	0
1980	1721	1606	0	481	75	80	587	0	0	101	688	0	2818	0	0
1981	634	1211	0	540	10	49	234	15	0	79	333	5	2034	0	0
1982	2229	2000	0	429	75	80	587	0	0	0	1761	1175	3362	0	0
1983	2900	2000	0	413	75	80	588	0	0	0	2256	1668	3965	0	0
1984	1621	1589	0	549	75	80	587	0	0	0	587	0	2765	0	0
1985	744	1204	0	510	75	80	347	2	1	33	388	5	2182	0	0
1986	1869	1835	0	475	75	80	587	0	0	0	630	44	2954	0	0
1987	497	1324	0	531	10	49	235	15	20	80	350	0	2139	0	0
1988	390	773	0	460	10	49	185	15	64	74	338	0	1551	0	0
1989	648	570	0	548	10	0	98	37	74	0	210	0	1265	0	105
1990	491	282	0	527	10	0	98	26	94	0	218	0	978	0	109
1991	502	150	116	526	10	0	99	23	57	0	180	1	673	0	134
1992	459	150	275	506	10	0	98	24	71	0	197	4	536	0	129
1993	1275	766	0	477	10	0	98	64	33	0	196	1	1381	0	450
1994	501	474	0	529	10	0	98	19	88	0	209	4	1183	0	81
1995	2160	1655	0	452	75	80	462	0	0	0	462	0	2577	0	0
1996	1512	1871	0	517	75	80	587	0	0	0	1548	961	3013	0	0
1997	1902	1545	0	556	75	80	462	0	0	102	569	5	2749	0	0
1998	1876	2000	0	444	75	80	587	0	0	0	1185	598	3295	0	0
1999	1326	1706	0	508	75	80	588	0	0	9	597	0	2860	0	0
2000	1062	1580	0	488	75	80	462	0	0	24	488	3	2587	0	0
2001	588	1292	0	469	10	49	234	12	18	64	328	0	2062	0	0
2002	710	874	0	548	10	49	234	11	35	203	483	0	1846	0	0
2003	896	712	0	530									1612		

All units in 1,000 acre-feet unless otherwise noted. Vernalis WQ Release from Goodwin (1) DO Release from Goodwin (1)

September 2012 District Proposal

New Melones Operations Model - Annual Summary **Districts' September 2012 Proposal - 174-235-318**

	New Melones			Goodwin											
	New Melones Inflow	New Melones Storage	Added Water	OID & SSJID Canals	SEWD NM Water	CSJWCD NM Water	Instream Fish	Dissolved Oxygen	Vernalis Water Quality	Vernalis Flow Objective	Total Goodwin Release to River	Release above Minimum	NM Forecast Index	Missed Vernalis WQ Release	Missed Vernalis Flow Release
Avg	1087			509	61	67	256	0	12	0	426	158		0	54
	WY	EOS	WY	WY	M-F	M-F	M-F	M-F	M-F	M-F	M-F	M-F		M-F	M-F
1922	1391	1812	0	506	75	80	318	0	0	0	335	18	2675	0	0
1923	1109	1886	0	507	75	80	318	0	0	0	318	0	2791	0	0
1924	385	1316	0	457	75	80	235	0	21	0	259	2	2127	0	27
1925	1092	1538	0	444	75	80	235	0	2	0	238	0	2320	0	0
1926	619	1148	0	559	75	80	235	0	6	0	243	2	2023	0	0
1927	1256	1471	0	515	75	80	236	0	0	0	236	0	2301	0	0
1928	952	1481	0	509	75	80	235	0	0	0	236	0	2330	0	14
1929	506	1008	0	530	75	80	235	0	10	0	245	0	1863	0	0
1930	671	820	0	559	10	49	174	0	12	0	186	0	1537	0	54
1931	438	497	0	492	10	0	174	0	26	0	202	2	1182	0	80
1932	1160	885	0	531	10	49	174	0	6	0	180	0	1589	0	145
1933	586	640	0	574	10	0	174	0	16	0	190	0	1343	0	20
1934	498	375	0	532	10	0	174	0	17	0	191	0	1074	0	120
1935	1082	797	0	464	10	0	174	0	0	0	180	6	1384	0	102
1936	1291	1247	0	480	75	80	235	0	0	0	238	3	2022	0	39
1937	1080	1420	0	498	75	80	235	0	0	0	241	6	2208	0	39
1938	2032	2000	0	495	75	80	318	0	0	0	878	561	3334	0	0
1939	562	1496	0	529	75	80	236	0	3	0	239	0	2357	0	0
1940	1327	1826	0	514	75	80	318	0	0	0	319	1	2699	0	46
1941	1290	2000	0	486	75	80	318	0	0	0	660	342	2970	0	0
1942	1450	2000	0	454	75	80	318	0	0	0	917	599	3100	0	0
1943	1538	2000	0	484	75	80	318	0	0	0	580	261	3090	0	51
1944	649	1606	0	547	75	80	235	0	1	0	238	1	2464	0	15
1945	1228	1865	0	474	75	80	318	0	0	0	452	134	2748	0	76
1946	1175	1902	0	481	75	80	318	0	0	0	318	0	2801	0	26
1947	634	1431	0	600	75	80	236	0	51	0	287	0	2395	0	103
1948	853	1312	0	489	75	80	235	0	39	0	275	0	2152	0	53
1949	732	1006	0	583	75	80	235	0	15	0	251	0	1893	0	93
1950	1027	1056	0	549	75	80	235	0	7	0	243	0	1901	0	69
1951	1656	1747	0	505	75	80	318	0	0	0	385	67	2661	0	77
1952	1844	2000	0	496	75	80	318	0	0	0	998	680	3430	0	0
1953	965	1761	0	546	75	80	318	0	2	0	319	0	2695	0	0
1954	882	1569	0	590	75	80	235	0	30	0	266	0	2470	0	78
1955	656	1235	0	516	75	80	236	0	29	0	273	8	2098	0	12
1956	1825	2000	0	527	75	80	318	0	0	0	454	137	2979	0	95
1957	878	1717	0	557	75	80	318	0	2	0	320	0	2649	0	14
1958	1599	2000	0	419	75	80	318	0	0	0	828	510	3197	0	0
1959	624	1502	0	556	75	80	236	0	7	0	243	0	2374	0	0
1960	574	1025	0	583	75	80	235	0	35	0	271	0	1947	0	18
1961	446	668	0	497	10	0	174	0	31	0	207	2	1365	0	91
1962	863	746	0	540	10	49	174	0	0	0	174	0	1449	0	35
1963	1227	1104	0	481	75	80	236	0	7	0	243	0	1877	0	139
1964	632	829	0	578	10	49	174	0	26	0	206	5	1620	0	37
1965	1666	1617	0	500	75	80	235	0	0	0	235	0	2453	0	178
1966	733	1347	0	552	75	80	235	0	7	0	243	1	2232	0	170
1967	1831	2000	0	486	75	80	318	0	0	0	650	332	3071	0	0
1968	670	1559	0	534	75	80	235	0	5	0	368	128	2413	0	0
1969	2118	2000	0	502	75	80	318	0	0	0	1413	1096	3474	0	0
1970	1321	1761	0	528	75	80	318	0	0	0	350	33	2720	0	99
1971	1066	1782	0	528	75	80	318	0	3	0	321	0	2706	0	37
1972	764	1453	0	600	75	80	235	0	25	0	265	5	2407	0	35
1973	1237	1725	0	490	75	80	318	0	0	0	414	96	2603	0	0
1974	1500	2000	0	439	75	80	318	0	0	0	652	334	3045	0	97
1975	1210	1993	0	492	75	80	318	0	0	0	453	135	2927	0	172
1976	467	1372	0	511	75	80	235	0	41	0	276	0	2240	0	9
1977	271	896	0	381	10	49	174	0	38	0	214	2	1502	0	92
1978	1311	1373	0	454	75	80	235	0	0	0	236	1	2128	0	0
1979	1139	1562	0	529	75	80	236	0	0	0	436	201	2402	0	124
1980	1721	2000	0	481	75	80	318	0	0	0	526	209	3005	0	104
1981	634	1535	0	540	75	80	235	0	1	0	515	278	2381	0	53
1982	2229	2000	0	429	75	80	318	0	0	0	1823	1505	3419	0	0
1983	2900	2000	0	413	75	80	318	0	0	0	2255	1937	3965	0	0
1984	1621	1792	0	549	75	80	318	0	0	0	341	24	2765	0	29
1985	744	1548	0	510	75	80	235	0	11	0	424	178	2423	0	37
1986	1869	1991	0	475	75	80	318	0	2	0	667	347	3149	0	0
1987	497	1430	0	531	75	80	236	0	33	0	269	0	2297	0	50
1988	390	991	0	460	10	49	174	0	55	0	229	0	1692	0	69
1989	648	771	0	548	10	49	174	0	43	0	217	0	1508	0	90
1990	491	456	0	527	10	0	174	0	53	0	227	0	1159	0	93
1991	502	187	0	526	10	0	174	0	22	0	197	0	838	0	120
1992	459	150	257	506	10	0	174	0	33	0	211	4	563	0	116
1993	1275	757	0	477	10	0	174	0	32	0	206	0	1381	0	430
1994	501	452	0	529	10	0	174	0	50	0	228	4	1169	0	65
1995	2160	1752	0	452	75	80	318	0	0	0	418	100	2550	0	0
1996	1512	2000	0	517	75	80	318	0	0	0	1558	1240	3024	0	0
1997	1902	1755	0	556	75	80	318	0	0	0	489	171	2749	0	118
1998	1876	2000	0	444	75	80	318	0	0	0	1260	942	3374	0	0
1999	1326	1903	0	508	75	80	318	0	0	0	478	160	2860	0	23
2000	1062	1820	0	488	75	80	318	0	0	0	346	29	2702	0	21
2001	588	1486	0	469	75	80	235	0	30	0	266	0	2316	0	35
2002	710	1162	0	548	75	80	235	0	49	0	284	0	2060	0	174
2003	896	1047	0	530									1921		

All units in 1,000 acre-feet unless otherwise noted. Vernalis WQ Release from Goodwin (1) #N/A