

1 **EXPERT REPORT OF KENNETH W. KIRBY, Ph.D.**

2

3 **QUALIFICATIONS AND EXPERIENCE**

4 1. I am a licensed Professional Civil Engineer (California Lic. No. 49279) and
5 member of the American Society of Civil Engineers (ASCE), with over 17 years of experience
6 working in water resources and environmental engineering. Since 1993, I have specialized in the
7 area of large scale systems analysis, and the development and application of technical
8 information for the purposes of natural resources policy making. I have been hired to advise
9 CALFED, the California Department of Water Resources (DWR), California Bay-Delta
10 Authority (CBDA), and the United States Bureau of Reclamation (USBR) regarding large-scale
11 planning efforts since 1999.

12 2. I earned a Bachelor of Science degree in Civil Engineering from Texas A&M
13 University in 1988; a Master of Science degree in Civil and Environmental Engineering from the
14 University of California, Davis in 1994; and in 2000, I earned a Ph.D. in Civil and Environment
15 Engineering from the University of California, Davis, majoring in Water Resources Engineering
16 with an emphasis on Systems Engineering and Operations Research while minoring in
17 Environmental Economics and Policy.

18 3. I have extensive experience analyzing and providing high-level advice to state
19 and federal agencies on issues involving California's complex and interconnected water system.
20 For example, I was hired to advise the Water Management section of CALFED regarding work
21 on developing a Water Management Strategy per the agreements reached in the CALFED
22 Record of Decision (ROD). In that capacity, I consulted with CALFED staff and helped
23 formulate and oversee a comprehensive analysis of how various projects being considered under
24 the ROD could be analyzed and potentially operated considering system-wide implications. This
25 approach included linking a series of models that considered surface storage operations,
26 groundwater, urban and agricultural economics, water quality, and social implications. I advised
27 CALFED, DWR, and USBR regarding the initiation of a Common Assumptions effort to
28 compile and create commensurate information needed to perform analyses related to the
CALFED Surface Storage Investigation. And I advised CALFED and DWR regarding the
synthesis of complex technical information and the communication of this information in

1 relevant ways to their stakeholders. Most recently, I was asked by DWR to serve as a
2 contributing author for the draft California Water Plan Update 2005. In that capacity, I have
3 focused primarily on the use of technical information for large-scale water resources planning
4 and for the development of quantitative capability that is more supportive of the statewide and
5 regional planning needs for California over the next 25 years.

6 4. I also have substantial expertise relating to the development and application of
7 complex computer models relating to large water system. I managed the CALVIN development
8 team at UC Davis, a project funded by the State of California with the intent to evaluate the
9 potential for attracting private investment for improving water management systems in
10 California. The result was an engineering and economic optimization model that can analyze
11 changes to the entire interconnected water management system in California. I developed and
12 applied a large-scale water management optimization model of the Central and South Florida
13 water management system for the U.S. Army Corps of Engineers Hydrologic Engineering Center
14 and the South Florida Water Management District. Also on behalf of the U.S. Army Corps of
15 Engineers, I developed and applied an optimization and simulation model to analyze operational
16 trade-offs (including competing environmental interests) related to the multi-objective reservoir
17 formed by Alamo Dam on the Bill Williams River in Arizona. While an employee of the
18 Hydrologic Engineering Center, I applied an optimization model of the Columbia River System
19 to explore promising operational improvements that could balance changing multiple objectives
20 including increasing environmental requirements.

21 5. Other relevant professional experience includes advising DWR Division of
22 Planning and Local Assistance regarding the development and processing of applications for
23 groundwater banking and conjunctive management as part of Proposition 13. In particular, I
24 focused on developing a methodology to characterize and evaluate potential yield that can be
25 produced from new groundwater management projects. I have also advised DWR and USBR
26 regarding the storage investigation under way for the North of Delta Off-Stream Storage project;
27 advised the DWR California Water Plan Update team regarding the use and development of
28 quantitative information and analytical tools for long-term statewide and regional planning;
advised the California Bay Delta Authority (CBDA) regarding a quantitative approach to support
the development of a CALFED finance plan; worked with the Mojave Water Agency to develop

1 a comprehensive water management plan to prepare for future needs of their constituency; and
2 conducted (along with my former consulting partner, Anthony Saracino) a screening level
3 evaluation of the potential for groundwater banking in the area of Gravelly Ford along the San
4 Joaquin River.

5 6. I have authored or co-authored the following publications in the previous ten
6 years:

- 7 Contributing author, California Water Plan Update 2005, Public Review Draft.
8 Primary contribution related to use of technical information for large-scale
9 water resources planning and development of quantitative capability more
10 supportive of statewide and regional planning needs for California over the
11 next 25 years.
- 12 Watkins, D.W. Jr., K.W. Kirby, and R.E. Punnett, "Water for the Everglades: The
13 South Florida Systems Analysis Model," *Journal of Water Resources
14 Planning and Management*, ASCE, 130(5): 359-366, 2004.
- 15 Draper, A.J., M.W. Jenkins, K.W. Kirby, *et. al.*, "Economic Engineering
16 Optimization for California Water Management", *Journal of Water Resources
17 Planning and Management*, May / June 2003, pp. 155-164.
- 18 Kirby, K.W., *Beyond Common Knowledge: The Use of Technical Information in
19 Policymaking*, Dissertation for Ph.D. in Civil and Environmental Engineering,
20 University of California, Davis, 2000.
- 21 Kirby, K.W., *Resolving Conflict Over Reservoir Operation: A Role for
22 Optimization and Simulation Modeling*, U.S. Army Corps of Engineers,
23 Hydrologic Engineering Center, RD-45, June 1999.
- 24 Kirby, K.W., *Technical Considerations for Alamo Lake Operation*, U.S. Army
25 Corps of Engineers, Hydrologic Engineering Center, PR-37, April 1998.
- 26 Kirby, K.W., *Managing Conflicting Demands from Endangered Species: Taking
27 the Challenge*, ASCE North American Water Congress '96, Anaheim,
28 California, June 22-28, 1996.
- Kirby, K.W. and M. Burnham, *Hydrologic Engineering Center Prescriptive
Reservoir Model: A Planning Model for Integrated River Basin Operation*,
ASCE Fifth Water Resource Operations Management Workshop, Arlington,
Virginia, March 4-6, 1996.
- Kirby, K.W., *Prescriptive Reservoir Model Applications for Bill Williams River,
Arizona*. US Army Corps of Engineers Policy and Procedures for Water
Management, Allocation, and Conflicting Use Resolution, Santa Barbara,
California, January 30 - February 1, 1996.
- Lund, J.R. and K.W. Kirby, *Preliminary Operating Rules for the Columbia River
System from HEC-PRM Results*, U.S. Army Corps of Engineers, Hydrologic
Engineering Center, PR-26, June 1995.
- Kirby, K.W., *Applying a Prescriptive Model to Help Resolve Conflict Over Alamo
Lake, AZ*, Integrated Water Resources Planning for the 21st Century;
Proceedings for the 22nd Annual Conference, ASCE, May 1995, pp. 568-
571.

7. I have not testified as an expert witness in any past legal proceeding.

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2 **COMPENSATION**

3 8. My time spent on this project is billed at \$250 per hour per the terms of a contract
4 between NRDC and Active Curiosity, Inc. Through the same contract, my colleague Susan
5 Tatayon has provided technical support to me at the rate of \$150 per hour.

6 **MATERIALS RELIED UPON TO FORM MY OPINION**

7 9. In formulating the opinions stated in this expert report, I have considered the
8 materials specifically identified in this report, and appended hereto as Appendix A (“Information
9 Considered”).

10 **QUESTIONS ADDRESSED**

11 10. My report answers the following question: How will the water management
12 system that includes the Friant Division, a unit of the Bureau of Reclamation’s Central Valley
13 Project (CVP), be affected when the Bureau begins releasing sufficient water to comply with
14 California Fish and Game Code § 5937? Please describe the likely changes that could occur, and
15 how the potentially affected water users could respond to the changes.

16 **UNDERSTANDING WATER MANAGEMENT SYSTEMS**

17 11. In order to discuss potential changes to a system, it is useful to establish an overall
18 sense of the system being evaluated. Historically, the term water resources management has
19 been used to describe actions people can take to change the movement of water across the
20 surface of the earth in a way that they deem advantageous. The manipulation of the hydrologic
21 system to increase the value of beneficial uses typically focuses on: (a) the location of water
22 (e.g., transporting water to grow crops some distance away from a river, or routing large flood
23 flows around urban areas that could experience costly damages); (b) the timing of water
24 availability (e.g., storing water when it is plentiful in the system for use later when water is
25 scarce); and (c) the quality¹ of the water (e.g., releasing stored water to reduce temperatures
26 along a particular stream reach or to reduce salinity at a specific point in the Delta).

27 12. Physical components of the system that are often employed to affect one of the
28 three objectives above include storage, conveyance (including distribution systems), and

¹ Water quality usually refers to the physical properties of the water such as concentrations of chemicals and biological matter, temperature, clarity, taste and odor

1 treatment. Storage is accomplished through surface impoundments, groundwater aquifers, and
2 snow accumulation. Conveyance takes place on a variety of scales through objects such as river
3 and stream channels, aqueducts, canals, ditches and pipe networks. Treatment, or the intentional
4 alteration of water's physical attributes, can be done in many ways such as blending water
5 sources, aeration, filtration, and adding chemical and biological compounds.

6 13. In addition to the physical components of water management, there also exists a
7 well-developed policy (or institutional) infrastructure that allows for the productive manipulation
8 of the water system. This policy infrastructure includes legal entities (such as water districts),
9 economic markets, law, regulatory bodies, and government agencies.

10 14. These system infrastructures tend to be very dynamic, both physically and
11 institutionally. Elements of the physical water management system are constantly changing as
12 people add conveyance, storage, recharge, pumping, treatment facilities, etc. Elements of the
13 institutional infrastructure are also constantly changing as legal entities merge and divide, law
14 changes, bureaucratic procedures evolve, and changing public interests shift the relative value of
15 beneficial uses.

16 15. Most water management systems within California are highly managed, and
17 typically very interconnected with other aspects of water use. Recently, some groups have
18 leveraged the high level of interconnection and institutional sophistication to devise and
19 implement some very creative agreements that provide mutual benefits. In fact, the system is so
20 interconnected that it is possible for an urban agency in southern California to acquire water
21 from an irrigation district in the San Joaquin Valley and effectively "store" that water in
22 reservoirs on the Colorado system, even though the water from the San Joaquin Valley will never
23 physically be located in the Colorado system.

24 16. The water management system related to the Friant Division has all of the
25 elements mentioned above: multiple sources of water, significant amounts of storage, and highly
26 interconnected conveyance infrastructure. Entities along the San Joaquin River are also engaged
27 in managing some very challenging water quality problems. Reestablishing continuing flow
28 along the entire length of the San Joaquin will change the location, timing and quality of water
available within the connected water management system, well beyond the service areas of water
users currently receiving water directly from Friant. For example, once continuing flows are

1 reestablished along the entire San Joaquin, the CVP will have a more robust system at their
2 disposal to help meet their overall objectives and requirements in the San Joaquin River Valley
3 and the Delta. In particular, the CVP will better be able to coordinate Friant operations with
4 New Melones operations to meet objectives such as Delta water quality and flow standards, the
5 Environmental Water Account (EWA), and CVPIA.

6 **STATEMENT OF OPINIONS**

7 17. Since the water management system in California is very complex and
8 interconnected, and the future hydrology and demands for water are uncertain, I cannot (nor can
9 anyone else) say precisely how the water management system will change when the required
10 water is released. However, we can draw on much existing information to help us understand the
11 context of the changes and describe the range of likely effects and potential responses within the
12 system. Based on my experience with large-scale water resource systems analysis and planning,
13 I offer the following observations and opinions:

14 A. The Friant Division of the CVP is one piece of an interconnected regional water
15 management system spanning two hydrologic regions. It delivers an average of
16 1,378 TAF each year via the Friant-Kern and Madera Canals. Water delivered
17 from Millerton Lake makes up about 20% of the annual CVP deliveries and about
18 5.5% of the water supply used in the San Joaquin River and Tulare Lake
19 hydrologic regions.

20 B. The release of the water required to comply with California Fish and Game Code
21 § 5937 (hereinafter referred to as “restoration flows”²) will alter how water moves
22 through the affected hydrologic regions. These changes will motivate additional
23 changes (or responses) within the water management system to adjust to the new
24 conditions.

25 C. The San Joaquin Valley water management system (comprised of the various
26 facilities and features of the San Joaquin and Tulare Lake Hydrologic Regions) is
27

28 ² “Restoration flows” as used herein means *additional* water that would need to be released from Friant Dam to meet the restoration flow needs. As reported in the Water Supply Study (URS 2002), the Bureau already releases an average of 117,000 acre feet per year to satisfy riparian water right diversions below the dam. The amount of water released from Friant Dam in excess of these existing releases to provide the flows specified by Dr. Kondolf are the “restoration flows.”

1 well-equipped to adapt to change, due to the highly developed infrastructure
2 including surface storage, groundwater storage, various sources of supply, and
3 institutional sophistication.

4 D. The gross quantity of water required to provide the restoration flows is a small
5 percentage – less than 2% – of the 25.1 MAF of water supply used within the San
6 Joaquin Valley water management system during a normal year, and the net
7 quantity of water required for restoration flows is less than 1%.

8 E. The gross quantity is likewise a small percentage – less than 5% – of the 7 MAF
9 water supply delivered annually by the CVP³. By comparison, the 800 TAF
10 reallocated from the CVP to environmental purposes through the passage of
11 CVPIA in 1992 represents about 11% of the CVP deliveries.

12 F. The effect of allocating the required volume of water needed for restoration will
13 cause significantly less than a one-for-one reduction in available supply for use by
14 Friant contractors.

15 G. If additional management actions are not taken, the dedication of the water
16 required for restoration has the potential to adversely affect some parties within
17 the Friant service area, but many opportunities exist to address and reduce these
18 potential adverse effects.

19 H. From a broader CVP perspective, the effect of allocating the required volume of
20 water needed for restoration from Friant Dam will likewise cause significantly
21 less than a one-for-one reduction in available CVP supply. This is because, in
22 addition to the less than one-for-one effect within the Friant Division, water
23 supply benefits from increased flows in the San Joaquin will likely accrue to non-
24 Friant CVP contractors.

25 I. The Bureau of Reclamation has demonstrated the ability to develop and
26 implement creative and collaborative water management solutions within
27 California's highly complex, interconnected water management system.
28

³See <http://www.usbr.gov/mp/cvp/about.html>

1 J. The release of restoration flows could cause some affected parties to compensate
2 by increasing their use of groundwater in the short term. The extent to which
3 increased groundwater pumping occurs, and the effects the increased pumping
4 will have in any given area will depend on several factors.

5 K. Several studies have been conducted that identify water management alternatives
6 that can increase the quantity of water available for beneficial use within the
7 region potentially affected by the dedication of Friant releases to satisfy
8 restoration flows.

9 L. Many of these water management alternatives would be available to the Bureau
10 and/or affected water users if they choose to pursue them in order to avoid or
11 minimize potential water supply reductions or potential groundwater overdraft.

12 M. Several of these alternatives could be implemented with little lead-time, while
13 others, depending on the resources provided and other factors, would require
14 longer amounts of time to implement.

15 The basis for these opinions is described below.

16 **ANALYSIS**

17 18. Experience and academic theory suggests that entities are motivated by many
18 factors, but ultimately tend to take actions that best satisfy their own objectives. So, when an
19 entity decides whether to invest in system improvements or not, they are typically making the
20 choice regarding whether the investment is likely to return an adequate benefit to make the risk
21 of the investment worthwhile. As a matter of public policy, federal, state or local governments
22 may encourage (through direct investments or other financial support to change the cost/benefit
23 calculation), or even require, entities to take certain actions to achieve desired water management
24 objectives. This report does not attempt to provide adequate economic information to say with
25 certainty whether a given alternative would likely seem attractive to a given entity, or whether
26 federal, state or local governments would choose to promote a given alternative.

27 19. The analysis I present in this report is based on (a) preliminary description of the
28 required restoration flows as they were provided to me to conduct this analysis;⁴ (b) technical

⁴ The restoration flow estimates provided to me were identified as preliminary and potentially subject to change. I have not seen Dr. Kondolf's expert report or his "final" restoration flow estimates. If his final restoration flow

1 studies and reports as listed in the *Information Considered* section of this report; (c) modeled
2 information developed during the Water Supply Study (URS 2002);⁵ and (d) my experience
3 working with large-scale systems analysis for long-term water resources planning.

4 ***Proposed Friant Releases***

5 20. I based my analysis of potential system effects on the preliminary restoration flow
6 schedules that I received from Dr. Kondolf. The flow requirements are expected to vary
7 according to hydrologic conditions and other physical and biological conditions that can be
8 observed along the river. The total required releases below Friant Dam (*i.e.*, current releases for
9 riparian diversions plus restoration flows) and the additional water required for restoration are
10 presented in Table 1 as average flow rates during the time period specified. The flow rates
11 shown in Table 1 do not necessarily represent the expected actual flows on a daily basis, but
12 rather represent a budget of water to be used at times during the specified period. Table 2
13 presents the total quantity of flow and additional required restoration releases expressed as TAF
14 per month. Depending upon the year type⁶, the average annual additional Friant releases needed
15 for restoration range between 565 TAF in a wet year to 184 TAF in a dry year. In the driest of
16 years, the additional flow needed would be between 0-71 TAF. The expected average annual
17 amount is between 329 and 333 TAF. The expected average annual quantity of restoration
18 flows represents approximately 18% of the average annual inflow⁷ to Millerton Lake (1,863
19 TAF⁸).

21 estimates differ materially from what I used in this report, and if those differences would have resulted in significant
22 changes to the analyses or conclusions stated in this report, then I will supplement this report to address those
23 changes.

24 ⁵ Much of the quantitative information I offer in this report is taken from, or derived from information in the Water
25 Supply Study (URS 2002). While I am aware that DWR and USBR continue to work on developing computer
26 models and analytical tools to study possible changes in the San Joaquin and Tulare Lake regions, the recent
27 improvements to analytical tools are not widely available and are currently under peer review. I believe information
28 from the published Water Supply Study that was developed jointly under the direction of the Friant Water Users and
the Natural Resources Defense Council is adequate to provide general quantitative information to inform the
question posed to me for this report.

⁶ The year type used here is based on the exceedance probability of annual inflow to Millerton Lake: 20% Wet,
30% Normal Wet, 30% Normal Dry, 15% Dry, and 5% Critical.

⁷ There are multiple quantities reported related to inflow at Millerton in various sources, using different periods-of-
record. For example, the Background Report (McBain & Trush, 2002) reports that “The unimpaired average annual
water yield (WY 1906-2002) of the San Joaquin River as measured immediately above Millerton Reservoir is
1,801,000 acre-ft.” The Background Report also cites an average annual water yield of 1,828,000 AF from the
hydrologic period of 1896-1999 (Table 2-6). The Water Supply Study (URS, 2002) states on p. 4-15 that “The San
Joaquin River near Friant Dam has a long-term average annual (1909–2001) unimpaired runoff of about 1,774,000

1 21. However, as mentioned above, the additional releases necessary to meet
2 restoration objectives do not represent a one-for-one trade of supply that must be taken from
3 some other use. More accurately, this change in release pattern changes the timing and location
4 of water availability within the region. The additional flow in the river will mean that in some
5 years, some lesser quantity of water will be available for diversion upstream of Friant Dam, but
6 will also mean that more surface water will infiltrate into the groundwater aquifers in reaches of
7 the San Joaquin that are currently dry, such as below Gravelly Ford, and also that more water
8 will be flowing in the lower reaches of the San Joaquin and potentially into the Delta. These
9 additional flows in the lower portions of the river and into the Delta will likely help improve
10 water quality in some historically problematic areas. This, in turn, translates to likely water
11 supply benefit for downstream water users whose supply has been greatly affected by water
12 quality challenges in the lower San Joaquin River and the Delta.

13 22. Determining the exact net reduction of water available from Millerton Lake for
14 use by contractors in the Friant Division service area due to the required restoration flows is
15 difficult, for all of the reasons listed above. Nevertheless, from the simplest perspective, there
16 are times during current operations where some or all of these required restoration flows could
17 already be satisfied, based on the flows released to meet downstream water rights and/or during
18 flood control releases and reservoir spills. This overlap reduces the net reduction of available
19 water for use by the Friant contractors. The frequency and quantity of this overlap are explored
20 later in this report.

21 23. Furthermore, the Bureau of Reclamation can make some minor adjustments to the
22 operation of Friant Dam in ways that do not require significant investments. These adjustments
23 would include prudent fine tuning of operational strategy in order to get the best performance
24 from the reservoir while attempting to satisfy Class 1 and Class 2 deliveries to their contractors,
25 and also providing the required restoration releases. Such fine tuning could result in a slight

26
27 acre-feet.” Then on p. 4-16 the Water Supply Study states that “The long-term average inflow to Millerton Lake
(1944–2001) is 1,783,000 acre-feet, and the unimpaired runoff during the same period is 1,785,000 acre-feet.”

28 ⁸ Based on 1961-2001 computed inflow average from Water Supply Study (URS 2002). The 1961-2001 base
period is used for computed inflow in order to compare with historic deliveries to the Friant-Kern Canal during the
same time period. Deliveries began through the Friant-Kern Canal in 1949, but according to the WSS, the record of
deliveries to the Friant-Kern canal “since 1961 is essentially indicative of full project delivery build-up as limited by
the supply available each year.”..

1 improvement in the long-term average reservoir yield. As demand for water increases on the
2 reservoir, additional space is sometimes available to capture more water during periods of high
3 inflows where some portion of those inflows would have been uncontrollable under the previous
4 operational policies.

5 24. Then, beyond the simple procedural adjustments, there are many other ways the
6 system can respond to the change in location and timing of water availability stemming from the
7 restoration releases. These include actions such as creating additional storage within the region,
8 utilizing existing surface and groundwater storage to increased conjunctive management,
9 transfers and exchanges, water purchases (both short-term and long-term), and land use
10 modifications (including cropping changes, fallowing or land retirement).

11 25. The following sections describe how the required restoration flows compare to the
12 rest of the system, and how the system could be affected on net, depending on what management
13 actions various potentially affected water users take.

14 ***Regional Context***

15 26. We want to know how the water management system will be affected by
16 requiring the release of restoration flows. When considering the total and net quantities required,
17 it is useful to be able to compare those numbers to what else is happening in the region.

18 27. The San Joaquin River and the Friant Division of the Central Valley Project are
19 located in the southern portion of the Central Valley. While operation of the Friant Division has
20 effects extending virtually throughout the state, the discussion of potential system effects and
21 responses in this report focuses primarily on the two hydrologic regions where the most direct
22 effects would occur and where the Friant Division facilities and contractors are located: the San
23 Joaquin River Hydrologic Region, and the Tulare Lake Hydrologic Region.

24 28. The San Joaquin River and its tributaries are located within the San Joaquin River
25 Hydrologic Region. This region encompasses the entire San Joaquin system watershed and
26 extends to the river's confluence with the Sacramento River, including about half of the Delta
27 overlay region. However, most of the water diverted at Friant Dam is delivered to the
28 neighboring Tulare Lake Hydrologic Region via the Friant-Kern Canal. This region
encompasses the southern end of the San Joaquin Valley and the watershed which historically
drained into Tulare Lake, Buena Vista Lake, and Kern Lake. It is separated from the San

1 Joaquin River Hydrologic Region by a low broad ridge between the Kings and San Joaquin
2 rivers.

3 29. Collectively, these two hydrologic regions comprise 20.3 % of the State by area.
4 The *California Water Plan Update 2005* (DWR 2005) includes a map of the state's hydrologic
5 regions, which I have included in this report as Figure 1. Finally, Table 3 presents a summary of
6 relevant statistics about the two hydrologic regions drawn from the CWP Update document.

7 ***Regional Water Supply and Use***

8 30. The water management system within these two hydrologic regions has a rich
9 variety of surface water and groundwater supply sources, significant quantities of storage (both
10 surface and groundwater), and extensive natural and man-made conveyance that links most of
11 the supply and storage assets, both within the region and to other supply sources and demand
12 centers outside the region. (See Figure 2, CWP Update 2005 Map of California with major
13 rivers and facilities.) This water is actively managed to support a substantial agricultural
14 industry and growing urban centers. Furthermore, the various entities that put the water to
15 beneficial use have demonstrated that they are sophisticated water managers with the ability to
16 continue to improve system performance.

17 31. This diversity of supply and extensive storage and conveyance infrastructure
18 allows water resource system managers to respond to the variable climactic conditions while
19 continuing to produce substantial economic benefits from the water used in this region. (See
20 Table 4 for recent water use and supply during a normal year.) The following is a summary of
21 the relevant water management system facilities and features of the two hydrologic regions,
22 again drawn largely from the recent CWP Update document.

23 ***San Joaquin River Hydrologic Region***

24 32. Surface water sources: The primary surface water sources are rivers that drain the
25 western slope of the Sierra Nevada, including the San Joaquin and its major tributaries, the
26 Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Cosumnes. Other tributaries include
27 the Chowchilla and Fresno rivers originate in the Sierra Nevada foothills. In 2000, an average
28 water year, the San Joaquin region's developed water supply consisted of: 44 percent local
surface sources; 23 percent imported surface supplies; 33 percent groundwater.

1 33. Surface water system, generally: Like other places in the western Sierra, the
2 surface water system in the San Joaquin region follows a basic pattern. In the mountain valleys,
3 small reservoirs capture snowmelt runoff and then release it to generate hydropower. While
4 there are some diversions in local communities for consumptive use, most flows are recaptured
5 in larger reservoirs in the foothills and along the eastern edge of the valley. Many of these
6 reservoirs were built primarily for flood control, but they also have additional storage for water
7 supply and other uses. Water is diverted from or below these reservoirs through irrigation canals
8 and municipal pipelines. On the valley floor, large irrigation districts provide most of the water
9 deliveries to agricultural and municipal users.

10 34. Upper San Joaquin River: Most of the water in the upper San Joaquin River
11 (upstream of the confluence with the Merced river) is diverted at Friant Dam and conveyed north
12 through the Madera Canal and south through the Friant-Kern Canal. Average annual diversions
13 from Friant Dam are about 1.5 million acre feet,⁹ and releases to the river are generally limited to
14 those required to satisfy downstream water rights above Gravelly Ford, and for flood control.
15 The river usually dries up in the vicinity of Gravelly Ford due to the combination of low flows,
16 riparian diversions and high channel losses to the ground water basin. Consequently, in most
17 years the only surface flows in the lower San Joaquin River are flows originating in the major
18 downstream tributaries plus agricultural and municipal return flows.

19 35. Major tributaries: The major tributaries of the San Joaquin River, which provide
20 high-quality water and most of the region's surface water supplies, are regulated by reservoirs
21 and used primarily on the east side of the valley. Some water is diverted west across the valley to
22 the Bay Area via the Mokelumne Aqueduct to the East Bay Municipal Utility District, and the
23 Hetch Hetchy Aqueduct to San Francisco and several other Bay Area cities. Average annual
24 diversions exported via the Mokelumne Aqueduct are 245,000 acre feet, and average annual
25 diversions exported via the Hetch-Hetchy Aqueduct are 267,000 acre feet. Major dams on the
26 tributary streams include Pardee and Camanche dams on the Mokelumne River, New Melones,
27 Donnell, and Beardsley dams on the Stanislaus River, O'Shaunessy and New Don Pedro dams
28 on the Tuolumne River, and Exchequer Dam on the Merced River.

⁹ This number differs from what is reported in the Water Supply Study (URS Corp. 2002) and other sources. It is unclear what methodology DWR used to calculate average annual diversions of 1.5 MAF.

1 36. Imported water: The federal Central Valley Project delivers most of the region’s
2 imported supplies, about 1.9 million acre feet per year. The State Water Project delivers about
3 4,500 acre feet per year to the Oak Flat Water District.

4 37. Water Use: Agriculture accounts for most of the region’s total developed water
5 use -- 57 percent in 2000, an average water year. Urban water use was about 5 percent and
6 environmental water use for dedicated purposes, including refuges, instream requirements, and
7 wild and scenic flows, was 38 percent of the total.¹⁰ Regional average urban per capita water use
8 was about 304 gpcd.

9 38. Groundwater: The regions water supply needs are met in any given year by a mix
10 of available surface water supplies and groundwater. In wet years like 1998 excess water supply
11 is added into ground water storage, while in dry years like 2001 the amount of groundwater
12 pumped to meet water needs results in a net loss of groundwater storage.

13 ***Tulare Lake Hydrologic Region***

14 39. Surface water sources: Primary surface water sources are the Kings, Kaweah,
15 Tule, and Kern rivers.

16 40. Surface water system: Follows the same general pattern described above for the
17 San Joaquin River Hydrologic Region. Most of the agricultural land in the region lies in
18 organized water districts, many of which in recent years have actively been changing water
19 management practices and physical structures to improve the efficiency of water delivery and
20 use.

21 41. Major conveyance facilities: California Aqueduct, the Friant-Kern Canal, and the
22 Cross Valley Canal. In addition, water districts in the region have developed an extensive
23 network of canals, channels, and pipelines to deliver developed water to customers.

24 42. Flood flows: While water storage facilities and conveyance systems control and
25 retain runoff from the watersheds in this region most of the time, in about one-third of the years
26 floodwaters leave the region by flowing down the north fork of the Kings River toward Mendota
27 Pool and on to the San Joaquin River. In the wettest years, Kings River floodwaters reach the
28

¹⁰ As can be seen in Table 4, most of the “environmental water use” under the CWP’s methodology for categorizing water use is not “depleted.” This is because while the majority of this water is used for instream purposes, such as “Wild and Scenic” river flows, it is available for subsequent downstream withdrawals and consumptive uses.

1 normally dry Tulare Lake via the south fork of the river. Excess runoff from the Kaweah and
2 Tule Rivers also flows into Tulare lakebed, flooding low-lying agricultural fields. In very wet
3 years, generally when the absorptive capacity of the ground water systems in the region has been
4 exceeded, water is diverted into the Kern River intertie and exported out of the basin northward
5 and southward via the California Aqueduct.

6 43. Major statewide water projects: these include the State Water Project's California
7 Aqueduct along the western side of the valley, which brings Delta water into the region. CVP
8 water is also sent down from the Delta through the state/federal joint use portion of the aqueduct
9 known as the San Luis Canal to federal water contractors on the west side of the valley, such as
10 Westlands Water District. The CVP's Friant-Kern Canal runs south along the eastern side of the
11 valley and transports San Joaquin River water to agencies along the valley's eastern side and
12 Kern County.

13 44. Imported water: The SWP provides an average of 1.2 million acre-feet of surface
14 water annually to the region, which is used for both agricultural and urban purposes. The U.S.
15 Bureau of Reclamation supplies an average of 2.7 million acre-feet from the CVP via Mendota
16 Pool, the Friant-Kern Canal, and the San Luis Canal, primarily for agricultural uses. Actual
17 deliveries to contractors vary from year to year based upon a number of factors, primarily
18 hydrologic conditions in Northern California.

19 45. Water use: urban water use is about 5 percent of developed water supplies,
20 agricultural water use is 84 percent and dedicated environmental water use (see explanation
21 provided earlier) is about 11 percent.

22 46. Groundwater: Groundwater accounts for 33 percent of the region's total annual
23 supply and 35 percent of all groundwater use in the State. Additionally, the region's groundwater
24 represents about 10 percent of the State's overall supply for agricultural and urban uses. On the
25 east side of the valley, most municipalities including Fresno, Visalia and Bakersfield, rely
26 primarily on groundwater. On the valley's western side, due to the poor quality of groundwater,
27 smaller cities like Avenal, Huron, and Coalinga rely on imported surface water from the San
28 Luis Canal. There are numerous groundwater recharge programs in the region to help ensure the
long-term viability of the groundwater supply.

1 47. Water use: Because many urban water users in the region are not metered, and
2 because of the high concentration of industrial water uses within the region’s urban areas, it is
3 difficult to calculate per capita urban water use and the CWP Update offers no estimate.

4 ***Friant Division of CVP***

5 48. As can be seen from the descriptions above, the Friant Division of the CVP is one
6 piece of an interconnected regional water management system spanning two hydrologic regions.
7 As cited previously, and according to numbers published in the *Water Supply Study* (URS,
8 2002), the Friant Division of the CVP delivers an average of 1,378 TAF via the Friant-Kern and
9 Madera canals each year.¹¹ The *Water Supply Study* assumes that approximately 117 TAF per
10 year are released downstream to satisfy prior-right riparian water user demands. This is
11 accomplished by managing an average annual inflow of 1,863 TAF to Millerton Lake¹² (a
12 reservoir with a storage capacity of 520 TAF). The remaining 368 TAF of average annual
13 inflow shows up as flood control releases into the San Joaquin River. Modeling from the Water
14 Supply Study indicate that flood control releases occur in over half of the years.¹³

15 49. Water from the Friant Division can be delivered to a number of entities under a
16 variety of contractual agreements. There are currently 28 entities with long-term water service
17 contracts for Friant Division water supply. The long-term contractors can receive water via
18 different contractual classifications (Class 1 and Class 2, with Class 1 being a higher priority
19 delivery; as well as discretionary deliveries from the Bureau of surplus water, including 215 and
20 flood water).¹⁴ In addition to the long-term contracts, water can be delivered to the Friant
21 Division via water exchange through the Cross Valley Canal Contracts. These contracts provide
22 Westside CVP water from the Delta to eight Cross Valley Contractors who have historically
23 exchanged some of their Westside CVP water for roughly equivalent amounts of Friant Division
24 water that would otherwise be delivered to the Arvin-Edison Water Storage District (AEWSD).

25 _____
26 ¹¹ 1,378 TAF is the 1961-2001 actual deliveries; the modeled amount in the Water Supply Study is similar.

27 ¹² From URS, 2002 on hydrologic period (1961 – 2001) to match period used to compute average deliveries.

28 ¹³ The historical record of Friant releases indicates that flood control releases have occurred in nearly half the years (46%) since 1961 and 54% of the years in the 1976-2001 period, as shown in Chapter 4 of the Water Supply Study and the CALSIM 2 documentation.

¹⁴ The term “215” water refers to section 215 of the Reclamation Reform Act of 1982, which provides that the Bureau can deliver such water to lands that do meet acreage limitation requirement applicable to other deliveries. In some years (such as 2005), this water is priced at lower rates than the Class 1 or 2 water to provide incentives to districts to take the water in wet periods. The Bureau also conveys flood waters to districts that are willing to take it. The districts are usually not charged for taking this water.

1 Table 5 contains a list of the contractors by type of contract and the amounts of water in their
2 contracts.

3 50. In addition to delivering water to long-term Friant contractors, the Bureau makes
4 available on a discretionary basis surplus water (including 215 and flood water) for delivery to
5 short-term or temporary contract users in Fresno, Kings, Tulare, and Kern Counties. These
6 deliveries generally occur when flood control releases are being made or are anticipated to be
7 made from Friant Dam. As reported in the Water Supply Study, the temporary users have
8 historically included one or more of the following:

- 9 • Buena Vista Water Storage District
- 10 • Cawelo Water District
- 11 • Consolidated Irrigation District
- 12 • Corcoran Irrigation District
- 13 • Deer Creek & Tule River Authority
- 14 • Kaweah Delta Water Conservation District
- 15 • Kern County Water Agency
- 16 • Kern Delta Water District
- 17 • Kern Water Bank
- 18 • Kings County Water District
- 19 • Kings River Conservation District
- 20 • Lakeside Irrigation Water District
- 21 • Liberty Water District
- 22 • North Kern Water Storage District
- 23 • Rosedale-Rio Bravo Water Storage District
- 24 • Semitropic Water Storage District
- 25 • Tulare Lake Basin Water Storage District

26 51. When surplus water deliveries are available, the amounts vary greatly from year
27 to year and are often quite substantial, exceeding 660,000 acre feet in 1998. (Water Supply
28 Study, Appendix A, Section 2). As modeled in the Water Supply Study, surplus water deliveries
would be available in 70% of the water years and the long-term average was calculated at
140,000 acre feet per year. The current year is the most recent example of significant amounts of
surplus water being delivered. While I have not yet received final data on the precise amount of
such deliveries or the water users who received the deliveries, it appears from newspaper
accounts that large volumes of surplus water were delivered this year to several water users,
including Friant CVP and short-term contractors, via the Friant-Kern Canal.

1 52. Entities within the Friant Division grow a wide variety of crops (close to 50
2 different varieties in some years) on a total irrigated area of approximately 1,000,000 acres. The
3 top five crops (vineyards, cotton, subtropical orchard, alfalfa, and almonds) accounted for 70
4 percent of the total irrigated acres within the entire Friant Division from 1979 to 1997. The
5 calculated gross irrigation requirement in 1995 for the Friant Division (including the Cross
6 Valley Canal Service Area) shown in the *Water Supply Study* (URS 2002) was approximately
7 2,988 TAF.

8 53. If the gross irrigation requirement of 2,988 TAF is being met on an average basis
9 then at least 1,610 TAF¹⁵ (~ 54%) is being supplied from some source other than the Friant
10 Division. Most Friant water contractors have access to other supplies such as groundwater,
11 locally developed surface supplies, or imported supplies via the CVP from the Sacramento-San
12 Joaquin Delta. Locally-developed surface supplies result from storage projects on the
13 Chowchilla, Fresno, Kings, Kaweah, Tule, and Kern Rivers. Table 6 provides a summary of
14 water supply sources by contractor.

15 54. In summary, the entities within the Friant Division account for approximately
16 19% of the irrigated acreage within the San Joaquin River and Tulare Lake Hydrologic Regions.
17 The gross irrigation requirement for entities within the Friant Division of 2,988 TAF accounts
18 for approximately 16.8 % of the 17,835 TAF of applied water used for agriculture in this region
19 during an average year. The average amount of water supplied from Millerton Lake (1,378
20 TAF) represents approximately 5.5 % of the 25,124 TAF of water supplies applied in a normal
21 water year across the region (see Table 4).

22 ***Net Water Required for Restoration***

23 55. As stated above, the effect of allocating the required volume of water needed for
24 restoration will cause significantly less than a one-for-one reduction in available supply for other
25 uses. While it is impossible to determine exactly how the availability of water that can be
26 diverted from Friant Dam will change, I used previously modeled data from the Water Supply
27

28 _____
¹⁵ 2,988 TAF irrigation demand minus 1,378 TAF average annual deliveries from Friant Division equals 1,610 TAF that must come from some other source. The amount of alternative supply is likely slightly higher given the contracts for Class 1 water of 64.25 TAF that is delivered to urban contractors in most years is not available to meet irrigation demand.

1 Study (WSS) (URS 2002) to illustrate the primary factors that must be considered in this type of
2 analysis.

3 56. As part of the WSS, a Baseline Model was constructed to produce an existing
4 condition simulation of the Friant Division. Historical hydrologic and meteorological data from
5 water year 1922 through 1999 were imposed on the model's representation of existing facilities
6 and operation criteria to produce a simulation of operations over the entire hydrologic period.
7 The Baseline Model represents Millerton operations and deliveries through the Friant-Kern and
8 Madera canals. Two versions of the Baseline Model were constructed to reflect different
9 assumptions for surplus water deliveries:

- 10 • Case X – represents delivery of Class 1, Class 2, and surplus water to match recent
11 historical recorded operations (*i.e.*, no reduction in surplus deliveries to help meet
12 restoration flow requirements)
- 12 • Case Y – represents delivery of Class 1, Class 2, but does not simulate additional
13 deliveries of surplus water (*i.e.*, surplus water is deemed available to help meet
14 restoration flow needs)

14 57. Using the time-series results of these two versions of the Baseline model, I
15 compare the simulated releases to the San Joaquin River to the required total flows as being
16 considered in this report. Figure 3 is a plot of the simulated annual releases minus the required
17 annual release according to year type, ranked in order from highest quantity to lowest. These
18 quantities are plotted as an exceedance curve and provide a reasonable estimate of how often the
19 required flows are likely to be satisfied or exceeded by releases that would be made in the course
20 of current operations. Positive flow values represent that the annual simulated releases are
21 greater than the requirements for that year. Where the curve crosses the X axis indicates what
22 percentage of the years would be met by existing operations.

23 58. As can be seen in Figure 3, for recent historical operations (Case X), the
24 simulated releases satisfy or exceed the required flows for restoration in approximately 23% of
25 the years.¹⁶ When deliveries to the contractors are simulated to not include surplus water (Case
26 Y), the required flows for restoration are satisfied in about 39% of the years. It is important to
27
28

¹⁶ In nine out of the 26 years (34% of the years) in the 1976-2001 period, the actual annual river releases exceed the total release required for restoration and riparian water rights.

1 note that even under Case Y, some surplus water would still be available and presumably
2 delivered to Friant and non-Friant contractors.

3 59. Based on this simple comparison, we can see that the potential for direct reduction
4 in deliveries to all water users currently receiving water from the Friant Division (Case X) would
5 occur in about 3 out of every 4 years. However, if we only consider reductions to occur that are
6 related to Class 1 and Class 2 deliveries, the expect frequency of potential adverse effect is
7 reduced to about 60% annually, or 6 out of every ten years. These results represent the
8 frequency of potential reduction in deliveries as compared to recent operations if no other
9 management actions are implemented to adjust for increase in downstream releases.

10 60. As seen in Figure 3, the quantities of restoration flows not met in these
11 simulations vary from almost zero to approximately 370 TAF per year for Case X¹⁷, and from
12 almost zero to about 257 TAF per year for Case Y¹⁸. The average annual amount of additional
13 releases needed to satisfy the required flow below Friant (in the years not already satisfied) is
14 218 TAF per year for Case X and 160 TAF per year for Case Y. Since the unmet restoration
15 flows only occur in some years, the expected value of unmet restoration needs in any year is
16 lower: 168 TAF for Case X and 103 TAF for Case Y. It is also worth noting, that during the
17 years the restoration flows are met or exceeded by the modeled reservoir releases, the average
18 surplus is 540 TAF for Case X and 537 TAF for Case Y.

19 61. Since most of the surplus flows are flood control releases, relying on annual
20 numbers can sometimes overestimate the amount of available surplus that can be applied
21 beneficially. Figures 5 and 6 illustrate how recent historic releases compare to the desired
22 restoration flow hydrograph. Figure 5 demonstrates that the annual volume of the actual release
23 hydrograph for water year 1998 is greater than the annual volume of required release in wet
24 years, and that the monthly wet year requirements could be met with relatively minor reservoir
25 reoperation. Figure 6, on the other hand, shows that the actual 1996 release hydrograph would
26 require greater reservoir reoperation or additional storage to meet monthly requirements in a wet
27 normal year.

¹⁷ For Case X, the largest unmet restoration flows occur in Wet Normal and Dry Normal years.

¹⁸ For Case Y, the largest unmet restoration flows occur in Dry Normal and Dry years.

1 62. In order to quantify the difference that stems from using different temporal
2 resolutions, I compared the modeled monthly releases from both cases of the Baseline Model
3 with the monthly required releases for restoration. The results are in Figure 4.

4 63. As expected, the percentage of months that the restoration flows are met or
5 exceeded is less than the percentage of years from the annual comparison. Without any changes
6 to the operating policy of Friant, restoration flows are met or exceeded during 15% of the
7 modeled months for Case X, and 24% for Case Y. The average monthly amount of additional
8 releases needed to satisfy the required flow below Friant (in the months not already satisfied) is
9 21 TAF per month for Case X and 20 TAF per month for Case Y.

10 64. Since the unmet restoration flows do not occur in all months, the expected value
11 of unmet restoration needs in any month is lower: 18 TAF per month for Case X and 15 TAF
12 per month for Case Y. Thus, based on the monthly analysis, the expected annual amount of
13 additional flows need to satisfy restoration requirements is 216 TAF per year for Case X and 180
14 TAF per year for Case Y. If some of the larger surplus flows that occur can be stored for a few
15 months, then the results of the monthly analysis can approach the results of the annual
16 comparison.

17 65. Based on this comparative analysis at different temporal resolution, I believe the
18 expected amount of water that will need to be reallocated to satisfy the recommended restoration
19 flows is somewhere between 168 TAF and 216 TAF per year for Case X and between 103 and
20 180 TAF per year for Case Y. This means that water currently released as flood control releases
21 will satisfy somewhere between 35 and 49% under Case X. If additional surplus flows are used
22 to meet restoration flows before being delivered to other contractors (Case Y), the portion
23 satisfied with surplus and flood control releases increases to between 46 and 69%.

24 66. These simple comparisons provide a rough idea of the potential quantity that
25 would not be available for delivery through the diversion canals at Millerton Reservoir.
26 However, even though the water would not be available for diversion via the canals, some of it
27 will infiltrate into the groundwater and will be available for use by others in the region. This
28 additional infiltration could be managed by Reclamation, or could be allowed to accrue to other
users in the hydrologic basins. Furthermore, the increased flows in the San Joaquin will provide

1 some benefit to non-Friant CVP contractors, such as reduced releases from New Melones to
2 meet salinity standards near the Delta.

3 67. Under both Case X and Case Y, the amount of water reallocated to satisfy the
4 recommended restoration flows would be less than 1% of the 25.1 MAF of water supply used
5 within the San Joaquin Valley water management system during a normal year; about 2-3% of
6 the CVP's average annual supply of 7 MAF; and 12-16% of the average annual deliveries from
7 the Madera and Friant-Kern Canals.

8 ***Likely Effects on Management System Due to Providing Restoration Flows***

9 68. I expect the following effects based on reoperating Millerton Lake to provide the
10 restoration flows described above:

11 A. The quantity of water available for delivery via Friant-Kern and Madera canals
12 from Friant will be reduced by about 168 to 216 TAF per year. In order to
13 characterize how these reductions would affect different contractors, I post-
14 processed results¹⁹ from the WSS Baseline model, Case X and found the
15 following:

- 16 ■ Average annual net restoration requirement = 220 TAF²⁰
- 17 ■ Reallocation of surplus deliveries = 106 TAF
- 18 ■ Reallocation of Class 2 deliveries = 86 TAF
- 19 ■ Reallocation of Class 1 deliveries = 28 TAF

20 B. For this simulation, this represents a 78% reduction in surplus water deliveries, a
21 22% reduction in Class 2 deliveries, and a 4% reduction in Class 1 deliveries.

22 The largest single year reduction in Class 1 deliveries was 257 TAF, which was a
23 34% reduction in modeled Class 1 deliveries of 762 TAF in WY 1991 (classified
24 as dry year). Based on this approximate look at how reductions would be
25 allocated, I do not believe any of the urban contractors (such as the City of
26 Orange Cove) will be severely impacted. While modeling suggests some Class 1
27 contractors in the worst year of record could see up to a 34% supply reduction, the
28 Bureau gives highest priority to urban users in its contractual shortage provisions.

¹⁹ I credited monthly modeled releases as possible towards total monthly required flows. Then, I reallocated water in order from modeled Surplus Deliveries, Class 2 Deliveries, and Class 1 Deliveries on an annual basis.

²⁰ While the 220 TAF result here is slightly higher than the 216 TAF computed from the previous method, this is within the range of precision acceptable for present purposes.

1 In addition to this contractual protection, urban users can make arrangements
2 through transfers and exchanges to make up for shortfalls.

3 C. Based on my previous experience and discussions with others about the
4 possibility of a groundwater bank near Gravelly Ford, I expect there will be an
5 increase in groundwater recharge along the San Joaquin River in the area around
6 Gravelly Ford that is often dry under current operations. Based on recent
7 discussions with Dr. Steve Deverel, I understand that his analysis indicates that
8 the increase in recharge could be significant. The increased groundwater will be
9 available for beneficial use by USBR, should they choose to manage it, or to other
10 groundwater users within the region.

11 D. Other CVP contractors will experience benefits resulting from increased flows in
12 the lower San Joaquin River from Friant. This could result in improved water
13 quality near Vernalis, and as such reduce the demand for water quality induced
14 releases from New Melones designed to dilute the salinity in the lower San
15 Joaquin.

16 E. The CVP will gain additional operational options by “reconnecting” Friant
17 operations with the Delta. Under current operations, New Melones is the primary
18 water management asset CVP managers have used to respond to undesirable
19 conditions in the Delta. Once the San Joaquin is regularly hydraulically
20 reconnected with the Delta, CVP operators can coordinate releases from Friant
21 and New Melones to best meet multiple objectives. This can be helpful with
22 regards to meeting water quality standards, addressing fish related pumping
23 concerns, and delivering water for use with the Environmental Water Account
24 (EWA).

25 ***Likely System Responses***

26 69. Given the likely changes due to providing the recommended restoration flows,
27 potentially affected parties can respond in a number of ways. There are numerous water
28 management “tools” available for implementation in the region. Some of these management

1 actions require broad participation and coordination (like at the CVP and SWP level) and others
2 can be implemented by individual landowners.

3 70. Some promising management actions available to lessen the local effect of the
4 reduction of available water that can be diverted from Friant for use by current Friant Division
5 contractors include:

- 6 A. Reoperation -- the CVP has the authority to adjust the operation of Friant
7 to better meet the new combined objectives. As discussed earlier, this is a
8 relatively easy action that will slightly reduce the net effect described
9 using previous WSS Baseline model results.
- 10 B. Coordinated operation with other CVP and local reservoirs – again the
11 CVP has the authority and experience to maximize the potential benefits
12 of using Friant to better meet objectives currently being met primarily
13 through the use of New Melones. This coordinated operation will likely
14 increase available deliveries from New Melones.
- 15 C. Increase the use of groundwater banking of surplus flow and broad
16 conjunctive management – this approach is already underway in the
17 region, and has been proven highly effective, both physically and
18 economically.²¹ Preliminary numbers from the WSS evaluation of
19 alternatives suggests that increased conjunctive use along the Friant-Kern
20 canal can provide 50 – 80 TAF of additional yield.
- 21 D. Develop new or expanded surface storage – several possibilities have been
22 identified in WSS and are currently being considered by the upper SJR
23 storage investigation.
- 24 E. Integrate solutions for multiple challenges being faced by CVP – for
25 example, if land is retired in CVP west-side districts to help address
26 drainage problems, CVP can manage the reduced demand for water in that
27 region in ways that are beneficial to Westside and Eastside interests.²²
- 28 F. Recirculation: Recirculate flows at Mendota pool and Delta or new
recirculation facility as possible within the required flows for restoration.

²¹ Examples of how this approach is already being implemented and could contribute to restoration include Kern-Delta’s commitment to provide free storage for environmental purposes as part of their recent Proposition 13 grant; and the Madera Ranch project – described in a newspaper account as a project that can provide 40-50 TAF annual yield that could be used by current users of San Joaquin River water (see Fresno Bee, 7/9/05, “Madera Co. Water Bank Plan Creates Waves”). There are currently several Friant Division contractors that are recipients of conjunctive use construction grants and feasibility study grants from Prop. 13. See <http://www.grantsloans.water.ca.gov/grants/storageconstr.cfm>. In 2002-03 11 construction grants were awarded to districts in the Friant Service Area including 3 long-term Friant contractors (Arvin-Edison W.S.D., Fresno I.D., and Lower Tule I.D.). In 2001-02 Kern County Water Agency (KCWA) was awarded a grant for improvements to the Friant-Kern canal and the Cross Valley Canal. These recipients of Prop. 13 conjunctive use funds have access to multiple sources of water including surplus San Joaquin River water. Moreover, the KCWA proposal will increase the ability to bring in replacement water supplies from the SWP and other sources via the Cross Valley Canal and the Friant-Kern Canal.

²² I am informed that well over 200,000 acres have been identified as potential for retirement in the Bureau’s recent Drainage EIS.

- G. Continue and increase ongoing transfers and exchanges – for example, recent Forbearance agreements; Exchange Contractors purchase program, and within Division transfers.
- H. Release EWA water or other environmental purchase program water down the SJR from Friant or Mendota Pool.
- I. Temporarily increase groundwater pumping. Sometimes this is a viable solution to system change, depending on local conditions.²³
- J. The pump-in of flood flows from Tulare Basin/Eastside rivers into the Friant-Kern Canal, as identified in the Water Supply Study and already being pursued by the Bureau (see recent NEPA/CEQA documentation for Reclamation District 770 project).
- K. Reduce demand for water while maintaining economic benefits by crop shifting, fallowing, and land retirement.
- L. Improve urban and agricultural water use efficiency – can reduce diversion and pumping requirements and provide some additional supply where irrecoverable losses can be reduced.

71. I am confident that given the alternatives available, if people choose to invest in the options identified above, there are sufficient opportunities to completely offset the potential adverse water supply effects of reduced CVP Friant Division water deliveries associated with the additional releases from Friant Dam to meet restoration flow needs.

72. Many of these alternatives – including re-operation, improved coordination within the CVP, transfers and exchanges, land use related actions, re-circulation, increased groundwater pumping and groundwater banking in existing facilities -- can be implemented with minimal lead time, and in some cases almost immediately. These readily implementable alternatives can go a long way toward mitigating water supply reductions relating to increased releases for restoration flows. Further, these types of actions tend to be some of the most economically efficient water supply alternatives. Implementation of capital-intensive actions such as new surface storage requires longer lead times and tends to be more expensive.

Conclusions

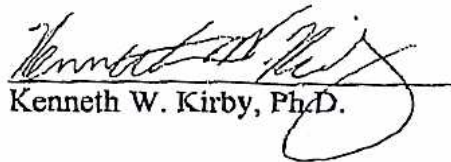
73. The dedication of water from Friant Dam to provide required restoration flows will affect the water management system related to the San Joaquin River. These changes are relatively small from a system-level perspective, but can be significant for some water users.

²³ As shown in a recent Prop. 13 grant report to the Department of Water Resources, Gravelly Ford Irrigation District, a Class 2 Friant Contractor, has chosen as a matter of basic economics to continue pumping groundwater rather than invest in a recharge program because current pumping practices are less expensive than the recharge program. (Gravelly Ford I.D. Report to DWR, 2005).

1 However, there are ample opportunities to offset any localized adverse effects. There is
2 sufficient water within the system to offset the net reduction in water available to contractors of
3 the Friant Division, if sufficient resources are applied to implement new water management
4 solutions.

5 74. The schedule for implementation of the proposed restoration flows will be
6 important in determining short-term effects and responses. If potentially affected parties have
7 time to plan and implement water management solutions, the potential localized adverse affects
8 can be mitigated or even eliminated. The amount of mitigation achieved, however, will depend
9 on the extent to which parties at various levels of the water management system – from the
10 Bureau to the individual grower -- choose to invest in developing and implementing new water
11 management actions to improve the system's capability for meeting multiple objectives.

12
13 Dated: August 14, 2005


Kenneth W. Kirby, Ph.D.

EXHIBITS

Table 1 - Summary of Required Releases for Restoration

Time Period	Water Year Type ²⁴						
	Critical - Low	Critical - High	Time Period	Dry	Normal Dry	Normal Wet	Wet
Total Required Releases (Including Riparian Releases)							
Oct. 1 - October 31	160	160		350	375	350	350
Nov. 1- 6 Pulse	130	400	Nov. 1- 10 Pulse	700	700	700	700
Nov. 7 - Dec 31	120	120	Nov. 11 - Dec 31	350	350	350	350
Jan. 1 - Feb. 28	100	110		350	350	350	350
March 1-15	130	500		500	500	500	500
March 16-31	130	1,500		1,500	1,500	1,500	1,500
April 1-15	150	200		350	2,500	2,500	2,500
April 16 - 30	150	200		350	350	4,000	4,000
May 1 - Jun 30	190	215		350	375	400	2,000
July 1 - Aug. 31	230	255		350	375	400	400
Sept. 1 - Sept. 30	210	260		350	375	400	400
Restoration Releases							
Oct. 1 - October 31	0	0		190	215	190	190
Nov. 1- 6 Pulse	0	270	Nov. 1- 10 Pulse	570	570	570	570
Nov. 7 - Dec 31	0	0	Nov. 11 - Dec 31	230	230	230	230
Jan. 1 - Feb. 28	0	10		250	250	250	250
March 1-15	0	370		370	370	370	370
March 16-31	0	1,370		1,370	1,370	1,370	1,370
April 1-15	0	50		200	2,350	2,350	2,350
April 16 - 30	0	50		200	200	3,850	3,850
May 1 - Jun 30	0	25		160	185	210	1,810
July 1 - Aug. 31	0	25		120	145	170	170
Sept. 1 - Sept. 30	0	50		140	165	190	190
Total Release (acre-ft)	116,662	187,457		300,762	373,725	488,169	681,417
Assumed Riparian Release	116,662	116,662		116,741	116,741	116,741	116,741
Restoration Release	0	70,795		184,021	256,984	371,428	564,676

Flows for Restoration are expressed as an average flow rate (cfs) during Time Period.

²⁴ Based on annual inflow to Friant Dam. (20% Wet, 30% Normal Wet, 30% Normal Dry, 15% Dry, 5% Critical)

Table 2 –Flows for Restoration as Monthly Quantities (TAF)

Month	Water Year Type ²⁵					
	Critical Low	High	Dry	Normal Dry	Normal Wet	Wet
Total Required Releases (Including Riparian Releases)						
Oct	9.8	9.8	21.5	23.0	21.5	21.5
Nov	7.2	10.5	27.7	27.7	27.7	27.7
Dec	7.4	7.4	21.5	21.5	21.5	21.5
Jan	6.1	6.8	21.5	21.5	21.5	21.5
Feb	5.5	6.1	19.4	19.4	19.4	19.4
Mar	8.0	62.4	62.4	62.4	62.4	62.4
Apr	8.9	11.9	20.8	84.6	193.1	193.1
May	11.7	13.2	21.5	23.0	24.6	122.8
Jun	11.3	12.8	20.8	22.3	23.8	118.8
Jul	14.1	15.7	21.5	23.0	24.6	24.6
Aug	14.1	15.7	21.5	23.0	24.6	24.6
Sep	12.5	15.4	20.8	22.3	23.8	23.8
Annual	116.7	187.5	300.8	373.7	488.2	681.4
Restoration Releases						
Oct	0.0	0.0	11.7	13.2	11.7	11.7
Nov	0.0	3.2	20.4	20.4	20.4	20.4
Dec	0.0	0.0	14.1	14.1	14.1	14.1
Jan	0.0	0.6	15.3	15.3	15.3	15.3
Feb	0.0	0.6	13.9	13.9	13.9	13.9
Mar	0.0	54.4	54.4	54.4	54.4	54.4
Apr	0.0	3.0	11.9	75.7	184.1	184.1
May	0.0	1.5	9.8	11.4	12.9	111.1
Jun	0.0	1.5	9.5	11.0	12.5	107.5
Jul	0.0	1.5	7.4	8.9	10.4	10.4
Aug	0.0	1.5	7.4	8.9	10.4	10.4
Sep	0.0	3.0	8.3	9.8	11.3	11.3
Annual	0.0	70.8	184.0	257.0	371.4	564.7

Weighted average annual required total flows = 445.8 - 449.3 TAF
Weighted average annual for restoration releases = 329.1 – 332.6 TAF

²⁵ Based on annual inflow to Friant Dam. (20% Wet, 30% Normal Wet, 30% Normal Dry, 15% Dry, 5% Critical)

1 **Table 3 – Summary Statistics for Region**

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	<i>Hydrologic Region</i>		
	San Joaquin River	Tulare Lake	<i>Combined</i>
3 Area (sq. miles)	15,214	17,033	32,247
4 Year 2000 population	1,751,010	1,884,675	3,635,685
5 2030 projected population	3,385,885	3,121,625	6,507,510
6 Total reservoir storage capacity (TAF)	11,477	2,046	13,523
7 2000 irrigated agriculture (acres)	2,050,400	3,219,000	5,269,400

8 *Source: Draft California Water Plan Update 2005*

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Table 4 – Summary of Water Use and Supplies for Water Year 2000

Water Year 2000 (A Normal Year)²⁶			
	Applied Water Use[†]	Net Water Use	Depletion[†]
Water Use			
San Joaquin River Hydrologic Region			
Urban	594.0	375.3	375.3
Agriculture	7,034.1	5,655.9	4,706.8
Environmental	4,637.1	278.0	151.3
Total Use & Losses	12,265.2	6,309.2	5,233.4
Tulare Lake Hydrologic Region			
Urban	653.4	236.1	236.1
Agriculture	10,800.9	8,231.1	8,231.1
Environmental	1,404.9	44.0	41.5
Total Use & Losses	12,859.2	8,511.2	8,508.7
Dedicated Water Supplies			
San Joaquin River Hydrologic Region			
Surface Water			
Local Deliveries	3,540.7	3,540.7	2,837.2
CVP Base and Project Deliveries	1,803.5	1,803.5	1,445.2
Other Federal Deliveries	65.8	65.8	52.7
SWP Deliveries	4.7	4.7	3.8
Groundwater			
Net Withdrawal	892.6	892.6	892.6
Artificial Recharge	356.6		
Deep Percolation	1,407.1		
Reuse/Recycle			
Reuse Surface Water	4,192.3		
Recycled Water	1.9	1.9	1.9
Total Supplies	12,265.2	6,309.2	5,233.4
Tulare Lake Hydrologic Region			
Surface Water			
Local Deliveries	2,275.6	2,275.6	2,274.7
CVP Base and Project Deliveries	2,272.3	2,272.3	2,271.4
SWP Deliveries	1,955.5	1,955.5	1,954.7
Groundwater			
Net Withdrawal	2,007.8	2,007.8	2,007.8
Artificial Recharge	324.7		
Deep Percolation	2,692.2		
Reuse/Recycle			
Reuse Surface Water	1,331.1		
Recycled Water	0.0	0.0	0.0
Total Supplies	12,859.2	8,511.2	8,508.7

Source: *Draft California Water Plan Update 2005*

[†] “Applied Water” is the gross amount diverted or released for a particular purpose. The amount of applied water subsequently available for other uses within or outside the region varies. “Net Water Use” is the portion of applied water no longer available for use within the region, either because it was depleted or flowed beyond the boundary of the region. “Depletion” is that quantity of applied water no longer available for use anywhere in the system. This occurs through evaporation, transpiration, or by flowing into areas no longer viable for water supply (e.g. salt sinks). The percentage of applied water available subsequently for other uses varies widely by use type: Urban ~ 51%, Agriculture ~ 27%, Environmental ~ 97%. Depletion rates are low for Environmental water because most such water is for instream uses that can be diverted elsewhere in the system.

²⁶ 113% and 93% of normal precipitation in San Joaquin River and Tulare Lake Hydrologic Regions, respectively.

Table 5
Long-Term Friant Division Water Contractors and
Cross Valley Canal Exchange Contractors²⁷

Contract Type / Contractor	Contract Amount (acre-feet)	
	Class 1	Class 2
Friant-Kern Canal Service Area Agriculture Water Contracts		
Arvin-Edison WSD	40,000	311,675
Delano-Earlimart ID	108,800	74,500
Exeter ID	11,500	19,000
Fresno ID		75,000
Garfield WD	3,500	
International WD	1,200	
Ivanhoe WD	7,700	
Lewis Creek WD	1,450	
Lindmore ID	33,000	22,000
Lindsay-Strathmore ID	27,500	
Lower Tule River ID	61,200	238,000
Orange Cove ID	39,200	
Porterville ID	16,000	30,000
Saucelito ID	21,200	32,800
Shafter-Wasco ID	50,000	39,600
Southern San Joaquin MUD	97,000	50,000
Stone Corral ID	10,000	
Tea Pot Dome ID	7,500	
Terra Bella ID	29,000	
Tulare ID	30,000	
Sub-total	595,750	1,041,475
Madera Canal Service Area Agriculture Water Contracts		
Chowchilla WD	55,000	160,000
Madera ID	85,000	186,000
Sub-total	140,000	346,000
Downstream San Joaquin River Service Area Water Contract		
Gravelly Ford WD		14,000
Total Friant Division Agricultural Water Contracts	735,750	1,401,475
Friant Division Municipal Water Supply Contracts		
City of Fresno	60,000	
City of Orange Cove	1,400	
City of Lindsay	2,500	
Fresno County Water Works District No. 18	150	
Madera County	200	
Total Friant Division Municipal Water Supply Contracts	64,250	
Total Friant Division Contract Supply	800,000	1,401,475

²⁷ Does not include other supplies from Friant Dam, including unscheduled Class 2 and surplus deliveries (215 and flood water).

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	Contract Amount (acre-feet)
Cross Valley Canal Exchange Contracts	
County of Fresno	3,000
County of Tulare	5,308
Hills Valley ID	3,346
Kern-Tulare WD	40,000
Lower Tule River ID	31,102
Pixley ID	31,102
Rag Gulch WD	13,300
Tri-Valley WD	1,142
Total Cross Valley Canal Exchange Contracts	128,300

Source: URS, 2002.

Table 6 – Water Sources of Friant Water Contractors and Cross Valley Contractors

Contractor	Friant Division Facility	Non-Friant Source	Groundwater Facilities²⁸
Arvin-Edison WSD	Friant-Kern Canal		Pumping, Recharge
Chowchilla WD	Madera Canal	Chowchilla River	Pumping, Recharge
Delano-Earlimart ID	Friant-Kern Canal		Pumping, Recharge
Exeter ID	Friant-Kern Canal		Pumping
Fresno Co. WWD No. 18			
Fresno County	Cross Valley Canal		
Fresno ID	Friant-Kern Canal	Kings River	Pumping, Recharge
City of Fresno			Pumping, Recharge
Garfield WD	Friant-Kern Canal		
Gravelly Ford WD		Cottonwood Creek	Pumping, Recharge
Hills Valley ID	Cross Valley Canal		Pumping
International WD	Friant-Kern Canal		
Ivanhoe ID	Friant-Kern Canal	Wutchumna	Pumping
Kern-Tulare WD	Cross Valley Canal	Kern River	Pumping
Lewis Creek WD	Friant-Kern Canal		
Lindmore ID	Friant-Kern Canal		Pumping, Recharge
City of Lindsay	Friant-Kern Canal		
Lindsay-Strathmore ID	Friant-Kern Canal	Wutchumna	Pumping
Lower Tule River ID (also a Cross Valley Canal contractor)	Friant-Kern Canal	Tule River, Cross Valley	Pumping, Recharge
Madera County			
Madera ID	Madera Canal	Fresno River	Pumping, Recharge
Orange Cove ID	Friant-Kern Canal		Pumping
City of Orange Cove	Friant-Kern Canal		
Pixley ID	Cross Valley Canal	Deer Creek	Pumping, Recharge
Porterville ID	Friant-Kern Canal	Tule River	Pumping, Recharge
Rag Gulch WD	Cross Valley Canal	Kern River	Pumping
Saucelito ID	Friant-Kern Canal		Pumping, Recharge
Shafter-Wasco ID	Friant-Kern Canal		Pumping
So. San Joaquin MUD	Friant-Kern Canal		Pumping, Recharge
Stone Corral ID	Friant-Kern Canal		Pumping
Tea Pot Dome WD	Friant-Kern Canal		
Terra Bella ID	Friant-Kern Canal		Pumping
Tri-Valley WD	Cross Valley Canal		
Tulare County	Cross Valley Canal		
Tulare ID	Friant-Kern Canal	Kaweah River	Pumping, Recharge

Source: URS, 2002

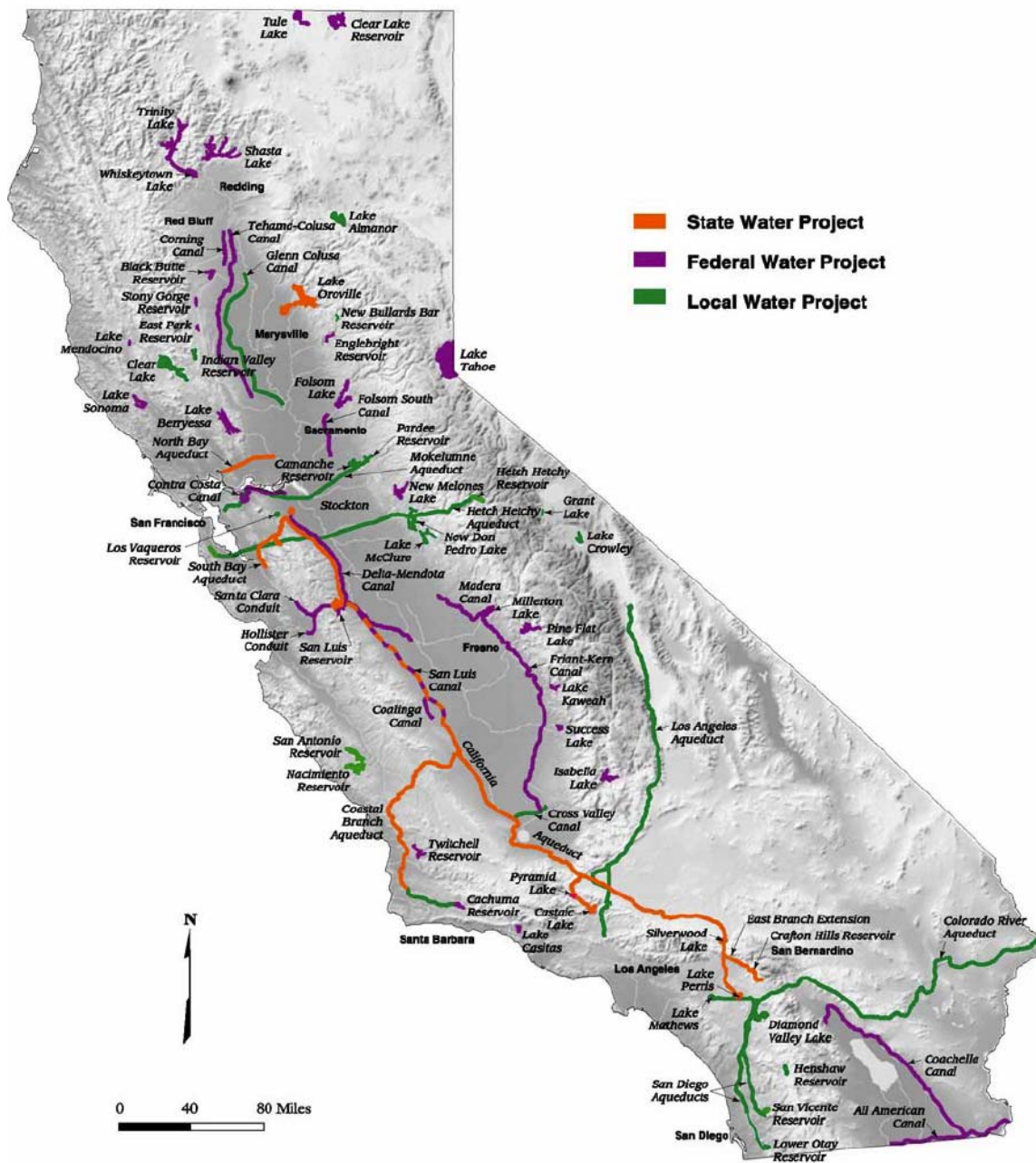
²⁸ Information on the use of district wells or private wells by district is not readily available.

Figure 1



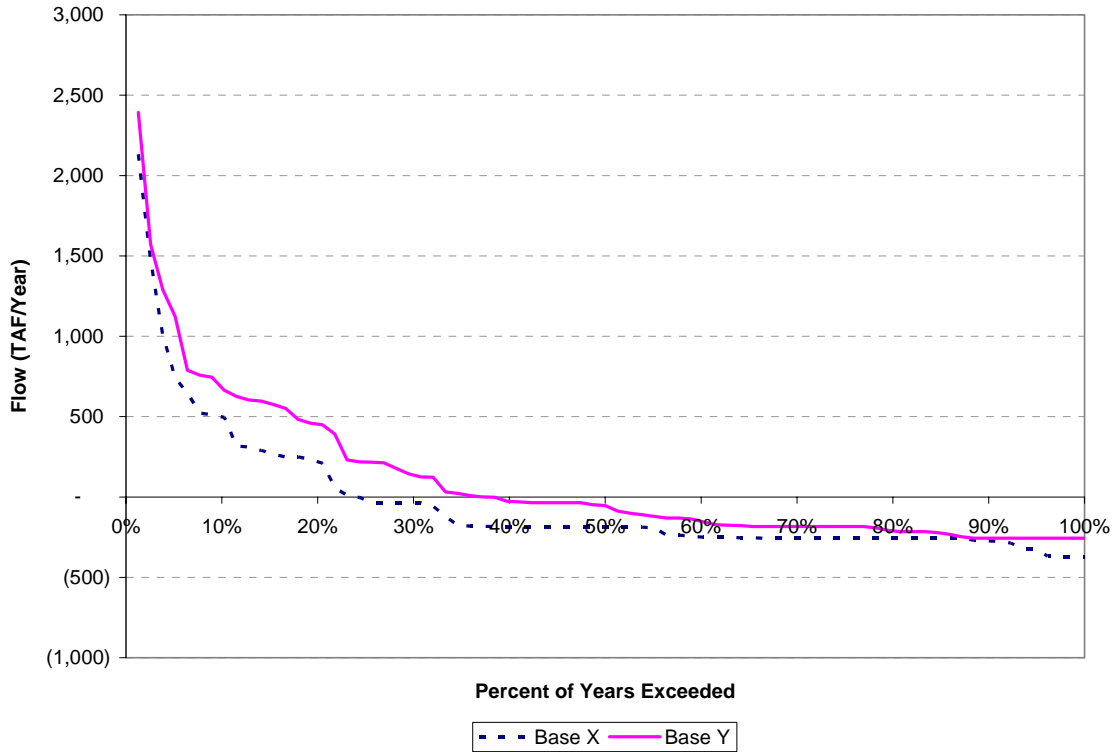
Source: Draft CWP Update 2005, Figure 3-8 Map of California's 10 Hydrologic Regions, the Delta, and Mountain Counties (p. 3-48).

Figure 2

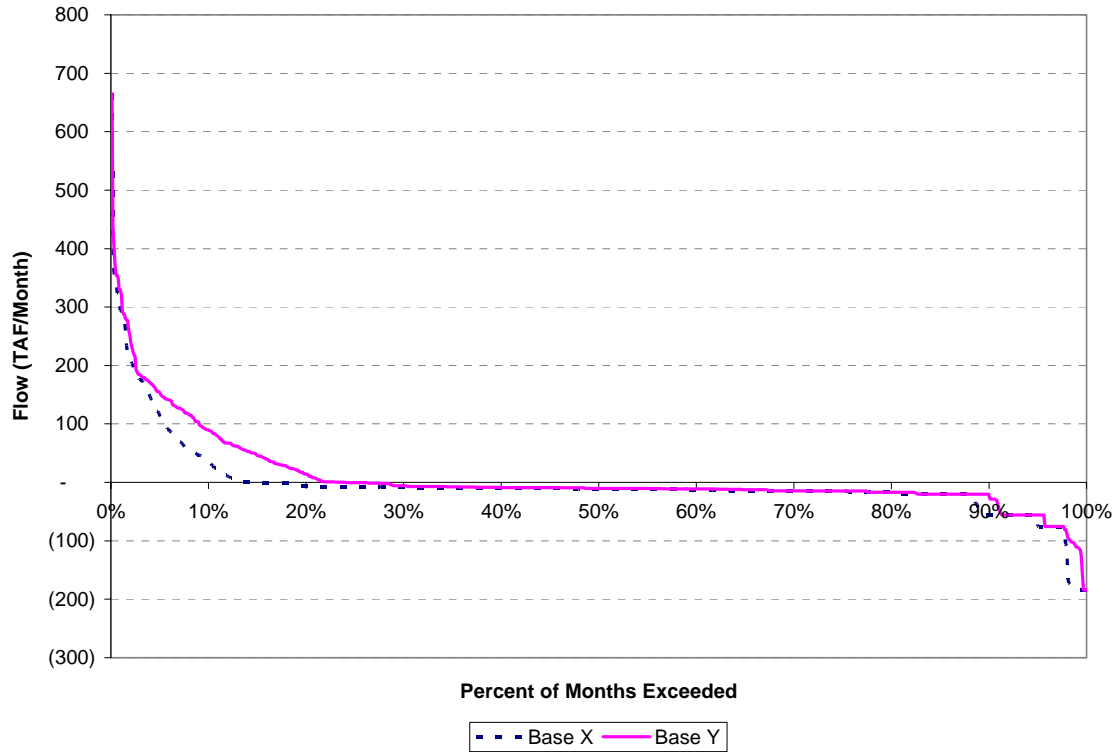


Source: Draft CWP Update 2005, Figure 3-2 Map of California with major rivers and facilities (p. 3-40).

Figure 3
 Percentage of Years WSS Modeled Releases to San Joaquin River
 Meet or Exceed Required Flow



1 **Figure 4**
 2 Percentage of Months WSS Modeled Releases to San Joaquin River
 3 Meet or Exceed Required Flow



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Figure 5
Wet Year Example - 1998

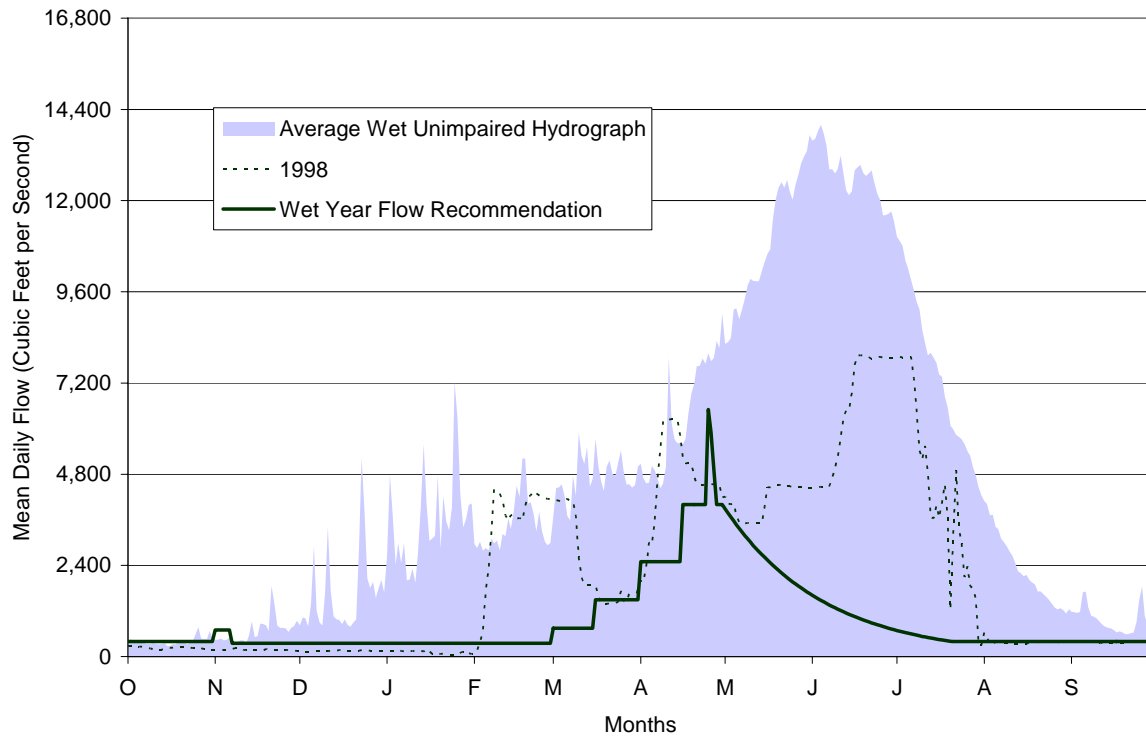
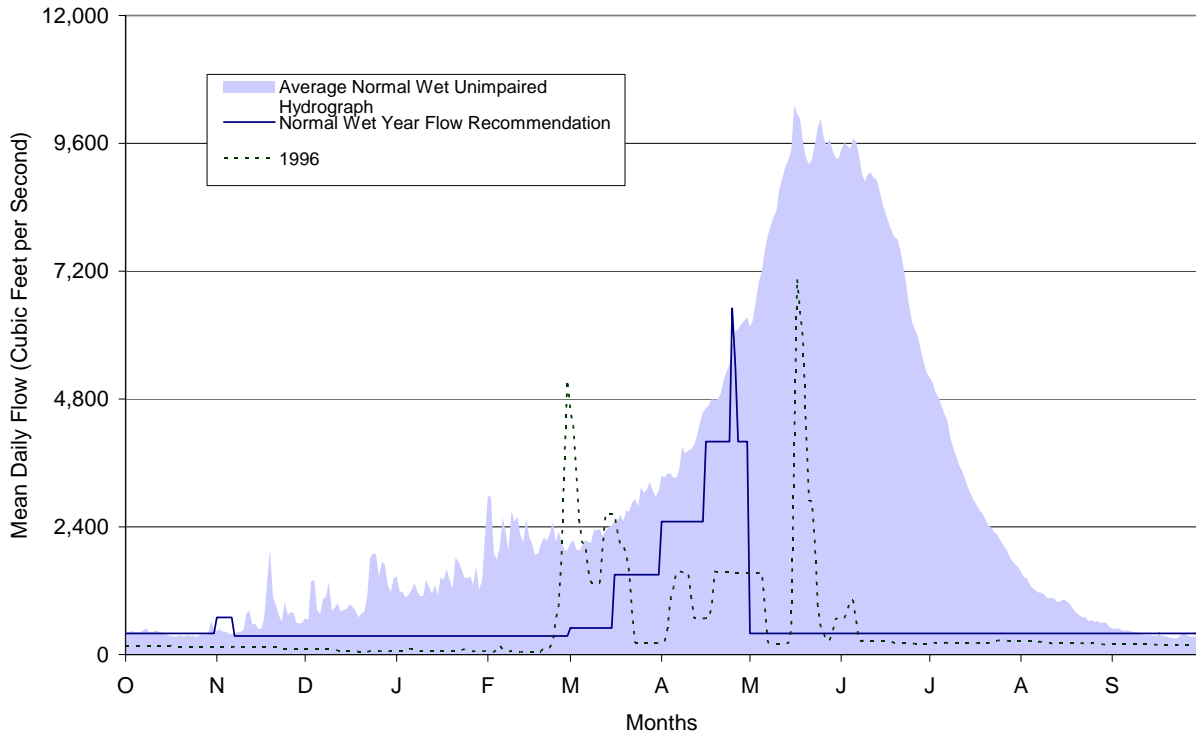


Figure 6
Normal Wet Year Example - 1996



1 **Appendix A – INFORMATION CONSIDERED**

2 In addition to the materials and information cited in the body of my report, I considered
3 information from the following sources:

4 Bookman-Edmonston Engineering, Inc., 1979. *Water Resources Management in the Southern*
5 *San Joaquin Valley California; A Study of the Physical and Institutional Management*
6 *Practices for Surface and Groundwater Utilization*, January.

7 California Bay-Delta Authority, 2004. *Delta Improvements Package Implementation Plan*
8 *Regarding CALFED Bay-Delta Program Activities in the Delta*, August 12.

9 CALFED Bay-Delta Program, 2005. *Upper San Joaquin River Basin Storage Investigation;*
10 *Water Supply Subcommittee Briefing*, Presentation Slides, March 9.

11 Calphee, Christopher, 2005. *The Water Report*, July 15, Best Best & Krieger, LLP, Sacramento.

12 Department of Water Resources, 2005. *California Water Plan Update 2005 – A Framework for*
13 *Action*, Public Review Draft prepared by the Department of Water Resources,
14 Sacramento, CA.

15 Department of Water Resources, 2003. *Notice of Preparation of Programmatic Environmental*
16 *Impact Report/Statement; Sacramento Valley Water Management Program*
17 *Implementation of Short-term Projects*, August 6.

18 *Federal Register* / Vol. 68, No. 150 / Tuesday, August 5, 2003 / Notices; Department of the
19 Interior, Bureau of Reclamation, Sacramento Valley Water Management Program—
20 Implementation of Short-term Projects.

21 Jones & Stokes, 2001. *Draft Alternatives Report. Gravelly Ford to Chowchilla Bypass*
22 *Bifurcation Structure levee modification ecosystem improvement initial project for the*
23 *Sacramento and San Joaquin River Basins comprehensive study*, December (J&S 01-
24 371), Sacramento, CA. Prepared for U.S. Bureau of Reclamation, Fresno, California.

25 McBain & Trush, Inc. (eds.), 2002. *San Joaquin River Restoration Study Background Report*,
26 prepared for Friant Water Users Authority, Lindsay, CA, and Natural Resources Defense
27 Council, San Francisco, CA.

28 *The Sacramento Water Management Agreement Scoping Report for the EIS/EIR*, November
29 2003.

The Sacramento Water Management Agreement Short-Term Workplan, October 2001.

Sheikh, Pervase and Cody, Betsy, 2005. *CALFED Bay-Delta Program: Overview of Institutional*
and Water Use Issues, Congressional Research Service Report to Congress, February 2.

State Water Resources Control Board, 2005. *Notice of Petition for Temporary Change Involving*
the Transfer of 20,000 acre-feet of Water to Several Central Valley Wildlife Refuges

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E.D. Cal. No. Civ. 88-1658 LKK

1 *Under California Department of Water Resources Permit 16482 (Application 17512),*
2 *April 21.*

3 URS Corporation 2004. *Water Transfer Program for the San Joaquin River Exchange*
4 *Contractors Water Authority 2005–2014; Final EIS / EIR SCH #2003101106.* Prepared
5 for U.S. Department of the Interior, Bureau of Reclamation, Sacramento and Fresno,
6 California and San Joaquin River Exchange Contractors Water Authority, Los Banos,
7 California, December.

8 URS Corporation, 2002. *Water Supply Study – Development of Water Supply Alternatives for*
9 *Use in Habitat Restoration for the San Joaquin River,* prepared for Friant Water Users
10 *Authority, Lindsay, CA and Natural Resources Defense Council, San Francisco, CA.*

11 U.S. Bureau of Reclamation, 2004. *San Luis Unit Draft Environmental Impact Statement Long-*
12 *Term Contract Renewal,* November.

13 U.S. Bureau of Reclamation, 2001. *Environmental Assessment for the Proposed Forbearance*
14 *Agreement among Sacramento River Settlement Contractors, Westlands Water District,*
15 *and the U.S. Bureau of Reclamation Through December 31, 2001, Central Valley*
16 *Project, California, Mid-Pacific Region, 2800 Cottage Way, Sacramento, CA 95825-*
17 *1898, April.*

18 U.S. Department of the Interior, 2005a. *Finding of No Significant Impact; Temporary*
19 *Acquisition of Water for San Joaquin Valley Wildlife Refuges from Kern-Tulare Water*
20 *District and Rosedale-Rio Bravo Water Storage District, U.S. Bureau of Reclamation,*
21 *April 27.*

22 U.S. Department of the Interior, 2005b. *Final Environmental Assessment; Temporary*
23 *Acquisition of Water for San Joaquin Valley Wildlife Refuges from Kern-Tulare Water*
24 *District and Rosedale-Rio Bravo Water Storage District, U.S. Bureau of Reclamation,*
25 *April 22.*

26 U.S. Department of the Interior, 2004. *Article 5 Exchanges Between The Cross Valley*
27 *Contractors And Other Water Districts For Delivery Of CVP Water; Fresno, Tulare,*
28 *Kings And Kern Counties; Draft Environmental Assessment EA-04-28, Bureau of*
29 *Reclamation, South Central California Area Office, January.*

30 U.S. Department of the Interior, 2003. *Finding Of No Significant Impact and Environmental*
31 *Assessment For Reclamation’s Consent To A Water Sale And Transfer Under The Glenn-*
32 *Colusa Irrigation District Sacramento River Settlement Contract For The 2003 Irrigation*
33 *Season Water Transfer Program, Bureau Of Reclamation, Mid-Pacific Region*
34 *Sacramento, California, February.*

35 U.S. Department of the Interior, 2002. *Finding Of No Significant Impact (FONSI); Temporary*
36 *Forbearance of a Water Right Entitlement Held by the Orange Cove Irrigation District*
37 *on Mill Creek, Tehama County, California, Bureau Of Reclamation, Mid-Pacific Region*
38 *Sacramento, California, September 26.*

1
2 Gravelly Ford Irrigation District, Gravelly Ford Groundwater Recharge Feasibility Study Report,
3 2005 (submitted to DWR in connection with Prop. 13 study grant)

4 Biological Opinion for Operational Criteria and Plan (OCAP), October 2004

5 FONSI for Temporary Forbearance of a Water Right Entitlement Held by Orange Cove
6 Irrigation District on Mill Creek, Tehama County, September 26, 2002.

7 Notice of Petition for Temporary Change Involving the Transfer of 20,000 Acre-Feet of Water to
8 Several Central Valley Wildlife Refuges under California Department of Water
9 Resources' Permit 16482 (Application 17512), April 21, 2005.

10 FONSI and Environmental Assessment for Temporary Acquisition of Water for San Joaquin
11 Valley Wildlife Refuges from Kern-Tulare Water District and Rosedale-Rio Bravo Water
12 Storage District, April 27, 2005.

13 FONSI and Environmental Assessment for Reclamation's Consent to a Water Sale and Transfer
14 under the Glenn-Colusa Irrigation District Sacramento River Settlement Contract for the
15 2003 Irrigation Season Water Transfer Program, February 2003.

16 Environmental Assessment for the Proposed Forbearance Agreement among Sacramento River
17 Settlement Contractors, Westlands Water District, and the U.S. Bureau of Reclamation
18 through December 31, 2001, April 2001.

19 Environmental Water Account, Water Acquisitions for fiscal years 2000-2001, 2002-2003, 2003-
20 2004 and Environmental Acquisition Strategy for 2005, April 28, 2005.

21 Work Plans for Fiscal Year 2005 for the following CVPIA programs: 3406(b)(2); 3406(b)(3);
22 3406(c)(1); 3406(d)(5); 3406(g); and 3406(b)(1)(B) and 3406(b)12.

23 Delta-Mendota Canal Intertie Draft E.A., Chapter 2:
24 <http://www.usbr.gov/mp/mp150/envdocs/chapter2.pdf>

25 2004-2006 Stevinson water acquisition Environmental Assessments (and other documents
26 relating to USBR's Section 3406(b)(3) Water Acquisition Program):
27 http://www.usbr.gov/mp/cvpia/3406b3_wap/env_docs/

28 Documents from the CALFED Ops Group, 2001, relating to the Environmental Water Account
and water acquisitions: <http://wwwoco.water.ca.gov/calfedops/2001ops.html>

CALSIM II Documentation: <http://science.calwater.ca.gov/workshop/calsim>

USBR, "Reclamation District 770 Pump-In Project Environmental Assessment" (February 25,
2004)

U.S. Dept. of Interior Ten-Year CVPIA Report, "Ten Years of Progress" (May 2004):
http://www.usbr.gov/mp/cvpia/docs_reports/docs/cvpia_10yr_progress_final.pdf

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1
2 USBR Long-term Water Service Contracts, Friant Division:
3 http://www.usbr.gov/mp/cvpia/3404c/lt_contracts/cts_executed/index.html

4 DWR Dry Year Water Purchase Program:
5 <http://wwwowe.water.ca.gov/newsreleases/2004/08-13-04dryyear.cfm>

6 USBR, "Final EIS/EIR for the San Joaquin River San Joaquin River Exchange Contractors
7 Water Authority, 2005 to 2014 Transfer Program" (December 2004)

8 Final EIR for Environmental Water Account:
9 [http://calwater.ca.gov/Programs/EnvironmentalWaterAccount/EIS_EIR_2004/CoverPage
10 .htm](http://calwater.ca.gov/Programs/EnvironmentalWaterAccount/EIS_EIR_2004/CoverPage.htm)

11 Other Materials and Information:

12 Miscellaneous documents received from Peter Vorster: Spreadsheets on Friant releases,
13 San Joaquin/Tulare climate cycles, and Friant regional supplies; USBR Friant
14 delivery database; Steiner/Bourez compilation of actual/modeled deliveries;
15 spreadsheet on Friant surplus delivery calculations; USBR forecast and 2005 draft
16 Friant operational guidelines.

17 Newspaper articles including: Lewis Griswold, *Rainfall's windfall helps trees along
18 canal*, Fresno Bee 5/15/05; Juliana Barbassa, *Extra water flows down San
19 Joaquin, allowing groundwater recharge*, Associated Press 5/31/05; Steve
20 Swenson, *Soaking up the excess*, Bakersfield Californian 4/21/05.

21 I also considered information from the following individuals: Susan Tatayon of Active
22 Curiosity, Inc. conducted research and information synthesis under my direction
23 during the formulation of this report; conversations with Peter Vorster of the Bay
24 Institute and Jared Huffman of NRDC; conversations with Dr. Steve Deverel
25 regarding his analysis of potential groundwater implications relating to the
26 recommended restoration flows; conversations with Monty Schmitt of NRDC
27 regarding preliminary restoration flow requirements developed by Dr. G. Matt
28 Kondolf; conversations with Larry Dale regarding what the economists will need
related to water management information for their analyses.