<u>Expert Report of Daniel B. Steiner</u>

Effects to Water Supply and Friant Operations due to Changes in Releases to the San Joaquin River

August 19, 2005

Introduction

1. Friant Dam regulates runoff of the San Joaquin River. It is a feature of the Bureau of Reclamation (Reclamation) Central Valley Project's Friant Division (Friant). The reservoir created behind Friant Dam is called Millerton Lake and has a capacity of approximately 520,000 acre-feet. In addition to the dam and reservoir, the main features of the division are the Friant-Kern Canal and Madera Canal. The facilities of the division provide deliveries of irrigation and municipal and industrial water supplies through the Friant-Kern Canal and Madera Canal and from Millerton Lake, downstream releases to meet diversions above Mendota Pool, and flood control for the San Joaquin River.

2. For the purpose of restoring salmonid runs that historically existed in the San Joaquin River upstream of the confluence with the Merced River, additional releases from Friant Dam to the San Joaquin River in excess of current requirements have been estimated.

3. My assignment was to describe the current operation of Friant in terms of the management of runoff with Friant Dam, diversions to the Friant-Kern Canal and Madera Canal, and releases to the San Joaquin River. My assignment further required me to describe the changes to the operation that may occur if the flow estimated to restore salmonid runs downstream of Friant Dam is required. This report describes the effect upon existing water supplies and Friant operations that may occur if the alternative regime described in this report is required from Friant Dam.

Data and Information Considered and Incorporated

4. The opinions presented in this report are founded upon the interpretation of the results derived from an operations simulation model of the Friant facilities. I relied upon this model, which I developed, and the underlying hydrologic data in the model. The model itself performs systematic decisions that depict the current decision processes that guide the operation of Friant. The systematic decisions incorporated into the model were developed from my general knowledge of water system and reservoir operations, specific experience of Friant system operations gained during employment with the Bureau of Reclamation, and subsequent acquired refined knowledge of Friant's operation through communication with current and past representatives of Reclamation and water users of Friant. The data within the model is available from records available to the public.

5. The simulation model requires several hydrologic inputs as underlying information. Basic to performing a sequential monthly reservoir operation study is the hydrologic data that remain the same regardless of the operational scenario investigated:

- Millerton Lake Inflow and Mammoth Pool Operation. The runoff of the San Joaquin River upstream of Friant Dam is impaired by projects operated by the Southern California Edison Company and Pacific Gas and Electric Company. The impaired inflow to Millerton Lake is equal to that modeled by Reclamation's USAN model (Upper San Joaquin River Basin Model) for the "Base Plan".[1] The time-series data for Millerton Lake inflow and Mammoth Pool storage for the October 1921 through September 1999 is derived from that same model simulation. Millerton Lake Inflow and Mammoth Pool storage for October 1999 through September 2004 are equal to the actual recorded values. A record of historical inflow for Millerton Lake is found at (http://www.usbr.gov/mp/cvo/reports.html). A record of historical Mammoth Pool storage is found at ('http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=MPL). The values for each of these parameters are provided in Appendix A, Tab A-1 and Tab A-2.

- Unimpaired flow at Friant. The record of unimpaired flow at Friant is used to establish the water year type. The water year type establishes the flow required below Friant Dam. The year type also provides the basis for grouping summaries of data and results. The unimpaired flow at Friant is found at ('http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=SJF). The record is provided in Appendix A, Tab A-3

- Releases to the San Joaquin River below Friant Dam. Based on an analysis of the historical record of recent releases from Friant Dam, the required release each month to meet downstream requirements above Mendota Pool is estimated to be 116,700 acre-feet in a year. The record of recent releases from Friant Dam to the San Joaquin River is found at ('http://www.usbr.gov/mp/cvo/reports.html). The record is provided in Appendix A, Tab A-4.

- Flood Control Storage Constraints. Modeled flood control operations for Millerton Lake and the lower San Joaquin River are based on the rainflood space reservation requirements specified by the U.S. Corps of Engineers. Extracts from the Corps of Engineers reservoir regulation report are provided in Appendix A, Tab A-5. The Corps of Engineers reservoir regulation report also provides tables relating reservoir elevation, storage and surface area. These data have been summarized for modeling purposes and are provided in Appendix A, Tab A-6.

- Historical Water Deliveries and Diversions. Several sources of information concerning water deliveries and diversions were used during the development of the operations simulation model. Differences may occur among the data for the apparent same parameter. These differences could be attributable to changing reporting practices, subsequent revision of the record and data entry errors. Recent delivery data from the Friant-Kern Canal, Madera Canal and Millerton Lake and downstream are found at ('http://www.usbr.gov/mp/cvo/deliv.html) and included in electronic format in Appendix A, Tab A-7. Additional delivery information is available from a Reclamation database (referred to as the "705 Database"). This database is also included in electronic format in Appendix A, Tab A-7. Historical diversions to the Friant-Kern Canal and Madera Canal are found in the records of the USGS, and are summarized in monthly totals in Appendix A, Tab A-8.

- Friant Long-term Water Supply Contracts. To provide a modeled distribution of water supplies to each Friant Division contractor, the contract amounts for each contractor were used. Appendix A, Tab A-9 lists the contract amounts used for each contractor. The information can be found in *Information Report, Friant-Kern Canal and Supporting Facilities,* Friant Water Users Authority, November 1, 2000.

- Friant River Release Hydrograph. In addition to the information used to develop the current release requirements of 116,700 acre-feet in a year, an additional river release regime estimated

[1] *Evaluation of Potential Increases in Millerton Lake Water Supply Resulting from Changes in Upper San Joaquin River Basin Projects Operation, Phase 2,* United States Bureau of Reclamation, October 2000.

to be required to restore salmonid runs below Friant was evaluated. The "Spring-run Hydrograph" was provided to me by Dr. Charles Hanson. This hydrograph has been incorporated into the simulation modeling as an alternative release requirement from Friant Dam. The hydrograph is illustrated in Appendix A, Tab A-10.

Methods and Analysis

6. A computerized operations simulation model (model) is used to depict anticipated Friant operations under a) current release requirements and operational objectives, and b) the estimated flow requirement to restore salmonid runs below Friant, referred in this report as the Spring-run Hydrograph. The change in water supply to Friant contractors and the change in Friant operation are determined by comparing the results of the alternative release scenario with the results of the current release scenario.

7. The model produces an operations study for a given set of assumptions. The model simulates the month-to-month and year-to-year operation of Millerton Lake, the Friant-Kern Canal and Madera Canal, and releases to the San Joaquin River with consideration given to flood control requirements, downstream release requirements and the contractual circumstances between Reclamation and the Friant contractors. The model attempts to reflect the operational decisions that currently guide the operation of Friant facilities.

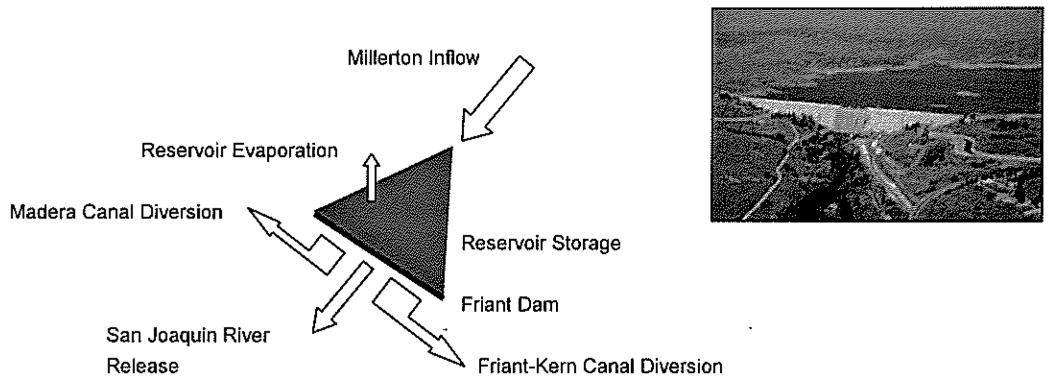
8. The model performs a simulation of operations over a sequential monthly period, capturing the variance of hydrology during droughts and floods. The period investigated includes water years 1922 through 2004, which spans a period typically used to evaluate California water resources. The water supply available for diversion to the canals results from a forecast of available water after considering flood control requirements and the provision of water for downstream requirements. The water supply available for diversion to the canals is directly dependent upon the downstream flow requirement. In simple terms, as more water is required to be released downstream, less water is available for diversion to the canals.

9. The model is a derivation of the model developed for the Friant Water Users Authority and the Natural Resources Defense Council Coalition. Modifications were made to the model to accommodate the additional flow scenario and to provide additional computations and reporting. Several refinements have also been made to the model during the course of using the model for other investigations. This model's logic and data are currently incorporated into the Department of Water Resources and Reclamation's CALSIM II model that supports state-wide water planning investigations, including the CALFED storage investigation for the upper San Joaquin River Basin. The version of the model used for this analysis was developed and validated by me, and is documented in Appendix C of this report. I chose to use this spreadsheet version of the model because of its simplicity and its availability for use by others.

10. The model performs a computation balance of inflow and releases each month of the simulation. The hydrologic components of the computation are shown in Figure 1 and include reservoir inflow, releases to the San Joaquin River, diversions to the Friant-Kern Canal and Madera Canal, reservoir net evaporation, and reservoir storage. This form of reservoir balance model is typically used by

me and others in my profession to evaluate operations of a reservoir system over varying hydrologic sequences and under alternative objectives for operations. The monthly time step of the model is also typically used for this type of study that evaluates year-to-year and long-term hydrologic effects.

Figure 1 – Reservoir Balance Components



11. Inflow to the reservoir is known for a month along with the required release to the San Joaquin River. Also known for the month are the beginning-of-month reservoir storage (the result of the previous month's computation) and the limit to reservoir storage (if any) for the end of the month. Through several algorithms that consider the reservoir balance in that particular month and the projected operation in the months ahead, diversions to the canals are established. At times the computation will result in inflow exceeding the minimum required downstream flow, canal diversions, and available reservoir space, which then results in a release to the river in excess of minimum requirements.

12. The same model is used for the Spring-run Hydrograph release scenario, applying the same algorithms for a higher downstream release requirement. Results of the operations studies represent the simulation of Friant operations over an analysis period spanning water years 1922 through 2004, as though Friant had been in existence the entire analysis period. The inflow to Millerton Lake is assumed to be affected by the existing current facilities upstream of Millerton Lake, also as though those facilities had been in existence during the entire analysis period. Performing the analysis for the Spring-run Hydrograph release scenario requires the substitution of the model's minimum release requirement of 116,700 acre-feet per year with the monthly varying flow requirement associated with the Spring-run Hydrograph.

13. The model provides a monthly time-series of results for numerous hydrologic parameters. The most salient parameters include releases to the San Joaquin River, reservoir storage and elevation, diversions to the Friant-Kern Canal and Madera Canal, system-wide deliveries associated with those diversions including the projected classification of the deliveries in terms of Class 1, Class 2 and Other water. The system-wide water delivery information is further disaggregated among the contractors by allocating the modeled deliveries to each contractor in proportion to each contractor's contractual

entitlement contribution to the system-wide contractual total. Results are presented in terms of the effects that providing the Spring-run Hydrograph releases to the San Joaquin River will have upon the operation of Friant and the amount of water available to Friant contractors. These results are a comparison of the separate operation studies representing current Friant operations, and operations using the Spring-run Hydrograph for the downstream release requirement.

14. The Spring-run Hydrograph is a set of four different hydrographs that vary in shape and volume according to wetness in the basin. A year-type ranking was necessary to apply the hydrographs to the 83 years of different hydrology. Four different year types have been defined, and are described as "dry", "normal-dry", "normal-wet", and "wet". The total annual unimpaired runoff at Friant for the water year is the index by which the year type is determined. The wettest 20 percent of the years of analysis period (1922-2004) are classified to be wet, the driest 20 percent of the years of the analysis are classified to be dry, and the remaining 60 percent of the years are divided equally by ranking between a normal-wet and normal-dry classification. Table 1 illustrates the categorization of the water years used in this analysis, presented in chronological order and by ranking by year type.

15. Within the modeling, the change in designation from one year type to another (e.g., a flow requirement changing from a wet year designation to a dry year designation) is assumed to occur at the beginning of February. This point in time is coincident with the early availability of a runoff forecast by Reclamation for the ensuing contract year.

16. The daily flow requirements provided in the Spring-run Hydrograph are converted into monthly flow volume requirements for use in the model. These flow requirements are shown in Table 2 for each hydrograph, by year type, and by annual weighted average over the 83 years of analysis.

17. The model develops a sequential simulation of operation for Friant in continuum from one month to the next, one year to the next. The algorithms that provide this operation are consistent each year, differing only in result due to a change in water available for diversion and flood control requirements. These algorithms are based on the operating objectives that guide current operations, which recognize the current downstream requirements.

18. The method used to incorporate the Spring-run Hydrograph (by year type) at times creates a shortage of water between inflow and available reservoir storage and the release necessary to satisfy the monthly timing of the hydrograph. During those instances (months and sometimes a sequence of months) the simulation of operations is adjusted manually to result in an operation that maintains reservoir at or above minimum storage while making releases to the river. The manual adjustments follow a hierarchy that provides priority to satisfying the downstream release hydrograph while attempting to maintain the current allocation to canal deliveries. The following adjustments to operation occur:

- Reduce canal deliveries to zero if necessary to retain storage for later release to the river. The current contract year's deliveries, beginning in March, can be reduced in order to meet a projected shortage in river release.
- If, after canal deliveries have been reduced to zero there remains a shortage of inflow and available storage to satisfy the hydrograph, reduce the hydrograph to provide an operation that maintains minimum reservoir storage. The hydrograph is reduced proportionately among the months of the season of shortage (e.g., if the shortage would occur during May of a year, the

reduction in the hydrograph would be spread among the February through May portion of the hydrograph).

- Reductions to canal deliveries will be rescheduled, as much as possible, to later times of the year to maintain the annual allocation of deliveries.

A reduction of canal deliveries in the spring-time during the March through May period, at times a reduction to zero, was made in this model to provide the Spring-run Hydrograph releases. Historically, diversions for deliveries of irrigation supplies have been required during this period. The assumption regarding reduced deliveries and subsequent rescheduling was made with no consideration given to its impact to Friant contractors and their users, or its feasibility.

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Table 1
Year Type Classification

Year	Year Type	Unimpaired Runoff at Friant Dam - TAF Apr-Jul	WY Total	Year	Year Type	Unimpaired Runoff at Friant Dam - TAF Apr-Jul	WY Total
1922	2	1,914	2,355	1983	1	2,860	4,642
1923	2	1,225	1,654	1969	1	2,898	4,040
1924	4	310	444	1995	1	2,616	3,878
1925	3	1,097	1,439	1938	1	2,573	3,688
1926	3	915	1,161	1978	1	2,332	3,402
1927	2	1,475	2,001	1982	1	2,294	3,316
1928	3	781	1,154	1967	1	2,327	3,232
1929	4	702	862	1998	1	2,306	3,160
1930	4	683	859	1986	1	1,801	3,031
1931	4	349	480	1980	1	1,911	2,973
1932	2	1,512	2,047	1956	1	1,778	2,960
1933	3	901	1,111	1952	1	2,181	2,840
1934	4	409	692	1997	1	1,251	2,782
1935	2	1,517	1,923	1993	1	1,947	2,673
1936	2	1,357	1,853	1941	1	1,926	2,653
1937	2	1,625	2,208	1958	1	2,068	2,631
1938	1	2,573	3,688	1922	2	1,914	2,355
1939	4	602	921	1965	2	1,421	2,272
1940	2	1,308	1,881	1942	2	1,681	2,254
1941	1	1,926	2,653	1937	2	1,625	2,208
1942	2	1,681	2,254	1996	2	1,518	2,203
1943	2	1,342	2,054	1974	2	1,508	2,191
1944	3	971	1,265	1945	2	1,481	2,138
1945	2	1,481	2,138	1943	2	1,342	2,054
1946	2	1,172	1,730	1984	2	1,120	2,049
1947	3	707	1,126	1932	2	1,512	2,047
1948	3	1,036	1,215	1973	2	1,546	2,047
1949	3	976	1,164	1927	2	1,475	2,001
1950	3	1,009	1,311	1963	2	1,413	1,945
1951	2	917	1,859	1962	2	1,486	1,924
1952	1	2,181	2,840	1935	2	1,517	1,923
1953	3	900	1,227	1940	2	1,308	1,881
1954	3	1,016	1,314	1951	2	917	1,859
1955	3	900	1,161	1936	2	1,357	1,853
1956	1	1,778	2,960	1979	2	1,295	1,830
1957	3	1,024	1,327	1975	2	1,413	1,796
1958	1	2,068	2,631	2000	2	1,251	1,742
1959	3	606	949	1946	2	1,172	1,730
1960	4	608	829	1923	2	1,225	1,654
1961	4	451	647	1999	2	1,070	1,527
1962	2	1,486	1,924	2003	2	1,058	1,450
1963	2	1,413	1,945	1970	3	907	1,446
1964	4	643	922	1925	3	1,097	1,439
1965	2	1,421	2,272	1971	3	970	1,418
1966	3	837	1,299	1957	3	1,024	1,327
1967	1	2,327	3,232	1954	3	1,016	1,314
1968	4	552	862	1950	3	1,009	1,311
1969	1	2,898	4,040	1966	3	837	1,299
1970	3	907	1,446	1944	3	971	1,265
1971	3	970	1,418	1953	3	900	1,227
1972	3	653	1,039	1948	3	1,036	1,215
1973	2	1,546	2,047	2002	3	846	1,171
1974	2	1,508	2,191	1949	3	976	1,164
1975	2	1,413	1,796	1926	3	915	1,161
1976	4	350	629	1955	3	900	1,161
1977	4	262	362	1928	3	781	1,154
1978	1	2,332	3,402	2004	3	735	1,131
1979	2	1,295	1,830	1985	3	786	1,129
1980	1	1,911	2,973	1947	3	707	1,126
1981	3	783	1,068	1933	3	901	1,111
1982	1	2,294	3,316	1981	3	783	1,068
1983	1	2,860	4,642	2001	3	795	1,065
1984	2	1,120	2,049	1972	3	653	1,039
1985	3	786	1,129	1991	3	836	1,034
1986	1	1,801	3,031	1959	3	606	949
1987	4	554	758	1989	3	668	939
1988	4	563	862	1964	4	643	922
1989	3	668	939	1939	4	602	921
1990	4	514	743	1929	4	702	862
1991	3	836	1,034	1988	4	563	862
1992	4	568	809	1968	4	552	862
1993	1	1,947	2,673	1930	4	683	859
1994	4	602	826	1960	4	608	829
1995	1	2,616	3,878	1994	4	602	826
1996	2	1,518	2,203	1992	4	568	809
1997	1	1,251	2,782	1987	4	554	758
1998	1	2,306	3,160	1990	4	514	743
1999	2	1,070	1,527	1934	4	409	692
2000	2	1,251	1,742	1961	4	451	647
2001	3	795	1,065	1976	4	350	629
2002	3	846	1,171	1931	4	349	480
2003	2	1,058	1,450	1924	4	310	444
2004	3	735	1,131	1977	4	262	362

Year Type

1	Wet	20 percent
2	Normal-Wet	30 percent
3	Normal-Dry	30 percent
4	Dry	20 percent

Year Type Averages

Wet	2,192	3,244
Normal-Wet	1,385	1,957
Normal-Dry	866	1,166
Dry	513	736
All Years	1,206	1,723

Table 2
Summary of Downstream Flow Requirements

Monthly Flow Volume - 1,000 Acre-feet													
Current													
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
All Years	10.1	7.4	6.7	4.5	5.0	6.6	9.0	10.9	12.9	14.4	15.7	13.4	116.7
Spring-run Hydrograph													
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Dry	23.1	22.3	23.1	23.1	44.6	96.8	139.1	49.1	22.3	23.1	23.1	22.3	511.9
Normal Dry	30.1	29.2	30.1	30.1	55.4	124.8	184.3	72.9	29.2	30.1	30.1	29.2	675.6
Normal Wet	35.7	34.5	35.7	35.7	64.4	143.9	211.8	89.1	34.5	35.7	35.7	34.5	791.1
Wet	35.7	34.5	35.7	35.7	80.5	199.3	309.9	160.0	34.5	35.7	35.7	34.5	1,031.6
											Weighted Average:		748.7

Average Monthly Flow - CFS												
Current												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
All Years	164	125	109	74	91	108	150	177	217	234	256	225
Spring-run Hydrograph												
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Dry	375	375	375	375	804	1,575	2,338	798	375	375	375	375
Normal Dry	490	490	490	490	998	2,030	3,098	1,186	490	490	490	490
Normal Wet	580	580	580	580	1,161	2,340	3,560	1,449	580	580	580	580
Wet	580	580	580	580	1,451	3,241	5,208	2,602	580	580	580	580

Opinions and Conclusions

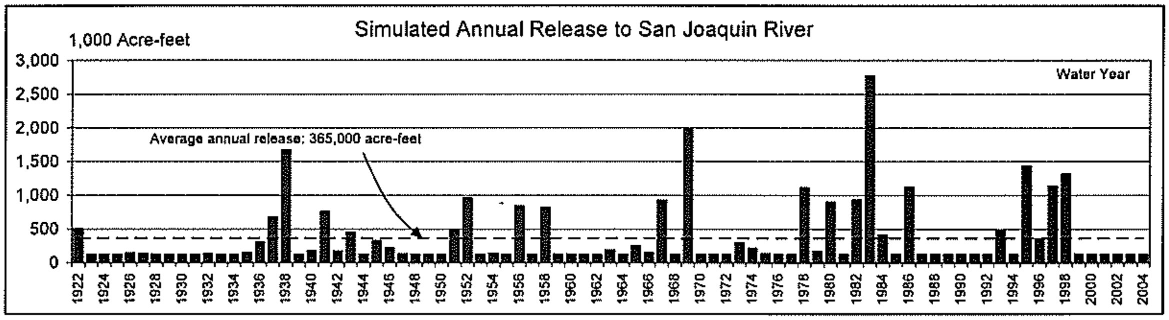
19. The current operation of Friant is described through use of a computerized model. The effects of the Spring-run Hydrograph flow requirement below Friant Dam upon the operation of Millerton Lake and the diversions to the Friant-Kern Canal and Madera Canal is also evaluated through use of the same computerized model. The model employed in this evaluation is well suited to for this investigation and is typical of the type of model used by others in my profession to evaluate effects to water project operations due to alternative operation assumptions.

20. The model produces results in terms of numerous hydrologic parameters that depict the simulated operation of Friant over an 83-year sequence of months. Projected water supply impacts to Friant contractors due to the alternative downstream flow regime is determined by comparing the results of the Spring-run Hydrograph simulation to the results of the depiction of current operations for Friant. Similarly, changes to river releases and reservoir operations can be compared between the scenarios. Results can be compared month-to-month, year-to-year, season-to-season, and by year type, depending on the appropriate need for detail and resolution. The results are fully available in electronic format and included in Appendix B, Tab B-1. Included are the final simulations that depict a) the current operation of Friant, and b) the projected operation of facilities when assuming the Spring-run Hydrograph for the downstream release requirement. The hydrologic parameters include:

- Millerton Reservoir Storage
- Millerton Reservoir Evaporation
- Diversion to Friant-Kern Canal
- Diversion to Madera Canal
- Release to San Joaquin River
- Water Deliveries by Classification
- Millerton Lake Elevation
- Millerton Lake Surface Area
- Water Delivery Allocations
- Flow past Gravelly Ford

21. The downstream release to meet the current requirements above Mendota Pool is approximately 116,700 acre-feet in a year. At times during wet conditions releases in excess of these requirements will occur. The average annual release from Friant Dam to the San Joaquin River is simulated to be approximately 365,000 acre-feet, inclusive of the 116,700 acre-feet of required releases. The simulated annual river release ranges from the minimum 116,700 acre-feet to 2,767,000 acre-feet, and is illustrated in Figure 2. Noticeable releases in excess of the minimum requirement generally occur only in the wettest 25 percent of the years.

Figure 2



21. The current diversion of water to the Friant-Kern Canal and Madera Canal is simulated to be an average annual 1,344,000 acre-feet, varying from 322,000 acre-feet in a year to 2,236,000 acre-feet in a year.

22. The modeled deliveries from the canals are distinguishable by water delivery classification. The deliveries of water can be classified as Class 1, Class 2, and Other. The current delivery of each of these classifications of water is shown in Table 3.

Table 3
Current Total System Water Deliveries by Classification – Acre-feet

	Class 1	Class 2	Other
Average Annual	754,000	393,000	134,000
Minimum Annual	187,000	0	0
Maximum Annual	800,000	1,066,000	384,000

Values are reported for Contract-year (March-February) period

23. Deliveries to the Friant contractors and diversions to the canals will differ by the amount of losses within the canals. This water is estimated to be approximately 63,000 acre-feet a year. This water reconciles the difference between average annual canal diversions (1,344,000 acre-feet) and average annual system deliveries (1,281,000 acre-feet).

24. Diversions to the Friant-Kern Canal and Madera Canal, and deliveries, will be reduced if the Spring-run Hydrograph is prescribed for required downstream releases from Friant Dam. The total canal diversions for current operations are simulated to average 1,344,000 acre-feet per year during the 1922-2004 period of analysis. The analysis indicates that an annual average reduction in canal diversions of 452,000 acre-feet per year will occur due to use of the Spring-run Hydrograph. Diversions to the canals will be affected as shown in Table 4. In addition to describing projected reductions in terms of an average over the entire 83-year analysis period, the results can also be shown year-to-year and by averages for

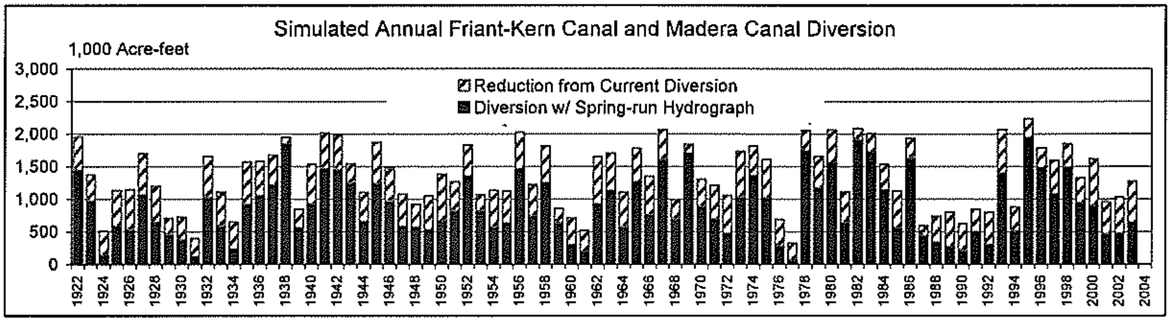
each year type. The reduction in total canal diversions ranges greatly year-to-year. Table 5 shows the annual total canal diversions for each simulation, and the reductions in diversions as compared to the current operation of the Friant Division. Figure 3 graphically illustrates the same information.

Table 4
Total Canal Diversions – Acre-feet

	Current	Spring-run Hydrograph	Difference from Current
Average Annual	1,344,000	892,000	-452,000
Minimum Annual	322,000	77,000	-245,000
Maximum Annual	2,236,000	2,029,000	-207,000

Values are reported for Contract-year (March-February) period

Figure 3



25. The reduction in canal diversions mirrors the increase in total river releases. On a long-term average basis, the increase in river releases must be met with a comparable reduction in canal diversions. Differences between the changes in a year's river release will not always exactly match a change in canal diversions due to the year-to-year operation of reservoir storage. Table 6 shows the annual total river release for each simulation, and the increases in releases as compared to the current operation of Friant. The releases to the San Joaquin River include the minimum release requirement and flood control releases.

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Table 5
Total Canal Diversions (TAF)

Chronological Listing				Descending Order of Wetness				
Year	Current Release	Spring-run Hydrograph	Difference	Year		Current Release	Spring-run Hydrograph	Difference
1922	1,962	1,470	-491	1983	Wet	2,010	1,842	-168
1923	1,373	946	-427	1969		1,843	1,683	-160
1924	506	122	-384	1995		2,236	2,029	-207
1925	1,130	601	-529	1938		1,952	1,832	-120
1926	1,144	537	-606	1978		2,056	1,869	-187
1927	1,701	1,100	-601	1982		2,088	1,933	-155
1928	1,202	628	-574	1967		2,067	1,639	-428
1929	707	458	-250	1998		1,853	1,605	-248
1930	727	380	-347	1986		1,938	1,603	-335
1931	394	115	-279	1980		2,063	1,603	-460
1932	1,651	1,058	-593	1956		2,027	1,396	-631
1933	1,104	577	-527	1952		1,833	1,433	-400
1934	649	228	-421	1997		1,597	1,020	-576
1935	1,573	948	-625	1993		2,066	1,448	-618
1936	1,578	1,057	-521	1941		2,022	1,551	-471
1937	1,675	1,360	-315	1958		1,818	1,293	-525
1938	1,952	1,832	-120	1922	Normal-wet	1,962	1,470	-491
1939	848	428	-420	1965		1,777	1,166	-611
1940	1,538	949	-590	1942		1,983	1,452	-531
1941	2,022	1,551	-471	1937		1,675	1,360	-315
1942	1,983	1,452	-531	1996		1,786	1,434	-351
1943	1,545	1,204	-342	1974		1,818	1,326	-492
1944	1,102	657	-445	1945		1,873	1,290	-583
1945	1,873	1,290	-583	1943		1,545	1,204	-342
1946	1,475	893	-582	1984		1,539	1,014	-525
1947	1,073	575	-499	1932		1,651	1,058	-593
1948	920	574	-346	1973		1,733	1,107	-626
1949	1,048	534	-514	1927		1,701	1,100	-601
1950	1,383	806	-576	1963		1,707	1,149	-558
1951	1,265	697	-568	1962		1,649	951	-698
1952	1,833	1,433	-400	1935		1,573	948	-625
1953	1,066	750	-316	1940		1,538	949	-590
1954	1,130	567	-563	1951		1,265	697	-568
1955	1,125	749	-375	1936		1,578	1,057	-521
1956	2,027	1,396	-631	1979		1,653	1,070	-583
1957	1,226	705	-522	1975		1,606	1,001	-605
1958	1,818	1,293	-525	2000		1,615	902	-713
1959	855	602	-253	1946		1,475	893	-582
1960	704	295	-408	1923		1,373	946	-427
1961	518	198	-320	1999		1,321	836	-486
1962	1,649	951	-698	2003		1,274	654	-620
1963	1,707	1,149	-558	1970	Normal-dry	1,306	784	-522
1964	1,101	680	-421	1925		1,130	601	-529
1965	1,777	1,166	-611	1971		1,208	690	-518
1966	1,346	762	-583	1957		1,226	705	-522
1967	2,067	1,639	-428	1954		1,130	567	-563
1968	988	788	-200	1950		1,383	806	-576
1969	1,843	1,683	-160	1966		1,346	762	-583
1970	1,306	784	-522	1944		1,102	657	-445
1971	1,208	690	-518	1953		1,066	750	-316
1972	1,056	470	-586	1948		920	574	-346
1973	1,733	1,107	-626	2002		1,030	475	-555
1974	1,818	1,326	-492	1949		1,048	534	-514
1975	1,606	1,001	-605	1926		1,144	537	-606
1976	684	264	-420	1955		1,125	749	-375
1977	322	77	-245	1928		1,202	628	-574
1978	2,056	1,869	-187	2004			Partial Year	
1979	1,653	1,070	-583	1985		1,127	624	-502
1980	2,063	1,603	-460	1947		1,073	575	-499
1981	1,114	594	-520	1933		1,104	577	-527
1982	2,088	1,933	-155	1981		1,114	594	-520
1983	2,010	1,842	-168	2001		955	454	-501
1984	1,539	1,014	-525	1972		1,056	470	-586
1985	1,127	624	-502	1991		845	512	-333
1986	1,938	1,603	-335	1959		855	602	-253
1987	589	392	-197	1989		797	272	-525
1988	732	341	-392	1964	Dry	1,101	680	-421
1989	797	272	-525	1939		848	428	-420
1990	620	209	-411	1929		707	458	-250
1991	845	512	-333	1988		732	341	-392
1992	794	302	-493	1968		988	788	-200
1993	2,066	1,448	-618	1930		727	380	-347
1994	878	526	-352	1960		704	295	-408
1995	2,236	2,029	-207	1994		878	526	-352
1996	1,786	1,434	-351	1992		794	302	-493
1997	1,597	1,020	-576	1987		589	392	-197
1998	1,853	1,605	-248	1990		620	209	-411
1999	1,321	836	-486	1934		649	228	-421
2000	1,615	902	-713	1961		518	198	-320
2001	955	454	-501	1976		684	264	-420
2002	1,030	475	-555	1931		394	115	-279
2003	1,274	654	-620	1924		506	122	-384
2004		Partial Year		1977		322	77	-245
				Wet Ave		1,967	1,611	-356
Ave	1,344	892	-452	Normal-wet Ave		1,627	1,081	-546
Max	2,236	2,029		Normal-dry Ave		1,095	604	-491
Min	322	77		Dry Ave		692	341	-351

Note: Values are summed for contract year - March though February

Note: Wetness based on water year unimpaired runoff to Friant

Table 6
Total River Release (TAF)

Chronological Listing				Descending Order of Wetness				
Year	Current Release	Spring-run Hydrograph	Difference	Year		Current Release	Spring-run Hydrograph	Difference
1922	500	870	371	1983		2,767	2,828	62
1923	117	791	674	1969		1,985	2,053	68
1924	117	509	392	1995		1,430	1,572	143
1925	117	648	531	1938		1,667	1,849	182
1926	137	676	539	1978		1,109	1,241	133
1927	130	769	639	1982		929	1,140	211
1928	118	698	580	1967		918	1,245	327
1929	117	409	292	1998	Wet	1,313	1,409	95
1930	117	468	351	1986		1,112	1,154	42
1931	117	381	264	1980		896	1,290	394
1932	126	741	615	1956		837	1,220	383
1933	117	648	531	1952		955	1,159	203
1934	117	540	423	1997		1,131	1,755	624
1935	142	741	599	1993		469	982	513
1936	309	794	485	1941		754	1,068	314
1937	671	928	257	1958		811	1,084	273
1938	1,667	1,849	182	1922		500	870	371
1939	117	562	445	1965		242	756	514
1940	169	741	572	1942		164	793	629
1941	754	1,068	314	1937		671	928	257
1942	164	793	629	1996		351	796	445
1943	452	830	378	1974		205	796	591
1944	117	698	581	1945		320	769	449
1945	320	769	449	1943		452	830	378
1946	212	797	585	1984		400	1,045	644
1947	122	698	576	1932		126	741	615
1948	117	493	376	1973		286	777	491
1949	117	634	517	1927		130	769	639
1950	117	676	559	1963	Normal-wet	181	791	610
1951	469	995	526	1962		117	741	624
1952	955	1,159	203	1935		142	741	599
1953	117	701	584	1940		169	741	572
1954	130	676	546	1951		469	995	526
1955	117	645	528	1936		309	794	485
1956	837	1,220	383	1979		163	791	628
1957	117	698	581	1975		129	791	663
1958	811	1,084	273	2000		119	791	672
1959	117	698	581	1946		212	797	585
1960	117	530	413	1923		117	791	674
1961	117	447	330	1999		120	796	676
1962	117	741	624	2003		117	749	632
1963	181	791	610	1970		117	698	581
1964	119	562	443	1925		117	648	531
1965	242	756	514	1971		117	676	559
1966	141	698	557	1957		117	698	581
1967	918	1,245	327	1954		130	676	546
1968	117	562	445	1950		117	676	559
1969	1,985	2,053	68	1966		141	698	557
1970	117	698	581	1944		117	698	581
1971	117	676	559	1953		117	701	584
1972	117	676	559	1948		117	493	376
1973	286	777	491	2002		117	676	559
1974	205	796	591	1949		117	634	517
1975	129	791	663	1926	Normal-dry	137	676	539
1976	117	562	445	1955		117	645	528
1977	117	301	184	1928		118	698	580
1978	1,109	1,241	133	2004		117	698	581
1979	163	791	628	1985		119	698	579
1980	896	1,290	394	1947		122	698	576
1981	117	698	581	1933		117	648	531
1982	929	1,140	211	1981		117	698	581
1983	2,767	2,828	62	2001		117	654	537
1984	400	1,045	644	1972		117	676	559
1985	119	698	579	1991		117	451	334
1986	1,112	1,154	42	1959		117	698	581
1987	117	562	445	1989		117	648	531
1988	117	512	395	1964		119	562	443
1989	117	648	531	1939		117	562	445
1990	117	540	423	1929		117	409	292
1991	117	451	334	1988		117	512	395
1992	117	540	423	1968		117	562	445
1993	469	982	513	1930		117	468	351
1994	117	562	445	1960		117	530	413
1995	1,430	1,572	143	1994		117	562	445
1996	351	796	445	1992	Dry	117	540	423
1997	1,131	1,755	624	1987		117	562	445
1998	1,313	1,409	95	1990		117	540	423
1999	120	796	676	1934		117	540	423
2000	119	791	672	1961		117	447	330
2001	117	654	537	1976		117	562	445
2002	117	676	559	1931		117	381	264
2003	117	749	632	1924		117	509	392
2004	117	698	581	1977		117	301	184
				Wet Avg		1,193	1,441	248
Ave	365	823	459	Normal-wet Avg		248	807	559
Max	2,767	2,828		Normal-dry Avg		119	662	543
Min	117	301		Dry Avg		117	503	386

Note: Values are summed for water year - October through September

26. The deliveries from the canals will correspondingly decrease with the reductions to canal diversions. Table 7 expresses the projected deliveries in terms of total system water deliveries and reductions from current total system deliveries.

Table 7
Average Total System Water Deliveries by Classification and Year Type
1,000 Acre-feet

Year Type	Current Total Deliveries	Spring-run Hydrograph Total Deliveries	Difference from Current Total Deliveries
Wet	1,904	1,548	-356
Normal-wet	1,564	1,018	-546
Normal-dry	1,032	541	-491
Dry	629	278	-351
All Years Ave	1,281	829	-452

Values are reported for Contract-year (March-February) period

27. The average projected deliveries by classification and year type as affected by prescribing the Spring-run Hydrograph are shown in Table 8. The affect of the alternative hydrograph upon water deliveries varies by year type. The total average annual reduction in water deliveries for all classes of water due to the Spring-run Hydrograph amounts to 452,000 acre-feet.

Table 8
Average Total System Water Deliveries by Classification and Year Type – 1,000 Acre-feet

Year Type	Class 1			Class 2			Other		
	Current	SR	Difference	Current	SR	Difference	Current	SR	Difference
Wet	800	797	-3	872	632	-240	232	120	-112
Normal-wet	800	784	-16	559	208	-351	205	26	-178
Normal-dry	796	519	-277	173	0	-173	63	22	-41
Dry	584	258	-326	5	0	-5	40	21	-19
All Years Ave	754	600	-154	393	187	-206	134	42	-92

Values are reported for Contract-year (March-February) period

28. The year-to-year changes in total system water deliveries due to the Spring-run Hydrograph being required below Friant are shown in Table 9. This illustration of year-to-year simulated operations shows a reduction to deliveries every year. Table 9 also illustrates the data by year type, and in order of wetness from the wettest of years the driest of years.

29. The modeled canal diversions are the sum of deliveries of Class 1, Class 2 and Other water, and estimated losses from the canals. The annual change in deliveries, by classification, can vary greatly. In a sequence of years such as the 1987 through 1992 drought, the reduction in deliveries due to the Spring-run Hydrograph occurs almost entirely from Class 1 supplies. Under current operations, during this drought period only Class 1 supplies are available. With additional water required downstream these Class 1 supplies would be reduced. Table 10 shows the year-to-year simulation and year type grouping of annual Class 1 water deliveries for each simulation and the reductions to Class 1 deliveries as compared to the simulated current operation of Friant. An annual average reduction in Class 1 deliveries of 154,000 acre-feet is projected when operating to the Spring-run Hydrograph. The reductions will typically occur during Normal-dry and Dry years as less Class 2 water is available to meet the downstream requirement,

Table 9
Annual Total System Water Deliveries (TAF)

Chronological Listing				Descending Order of Wetness				
Year	Current Release	Spring-run Hydrograph	Difference	Year		Current Release	Spring-run Hydrograph	Difference
1922	1,899	1,407	-491	1983		1,947	1,779	-168
1923	1,310	883	-427	1969		1,780	1,620	-160
1924	443	59	-384	1995		2,173	1,966	-207
1925	1,067	538	-529	1938		1,889	1,769	-120
1926	1,081	474	-606	1978		1,993	1,806	-187
1927	1,638	1,037	-601	1982		2,025	1,870	-155
1928	1,139	565	-574	1967		2,004	1,576	-428
1929	644	395	-250	1998	Wet	1,790	1,542	-248
1930	664	317	-347	1986		1,875	1,540	-335
1931	331	52	-279	1980		2,000	1,540	-460
1932	1,588	995	-593	1956		1,964	1,333	-631
1933	1,041	514	-527	1952		1,770	1,370	-400
1934	586	165	-421	1997		1,534	957	-576
1935	1,510	885	-625	1993		2,003	1,385	-618
1936	1,515	994	-521	1941		1,959	1,488	-471
1937	1,612	1,297	-315	1958		1,755	1,230	-525
1938	1,889	1,769	-120	1922		1,899	1,407	-491
1939	785	365	-420	1965		1,714	1,103	-611
1940	1,475	886	-590	1942		1,920	1,389	-531
1941	1,959	1,488	-471	1937		1,612	1,297	-315
1942	1,920	1,389	-531	1996		1,723	1,371	-351
1943	1,482	1,141	-342	1974		1,755	1,263	-492
1944	1,039	594	-445	1945		1,810	1,227	-583
1945	1,810	1,227	-583	1943		1,482	1,141	-342
1946	1,412	830	-582	1984		1,476	951	-525
1947	1,010	512	-499	1932		1,588	995	-593
1948	857	511	-346	1973		1,670	1,044	-626
1949	985	471	-514	1927		1,638	1,037	-601
1950	1,320	743	-576	1963	Normal-wet	1,644	1,086	-558
1951	1,202	634	-568	1962		1,586	888	-698
1952	1,770	1,370	-400	1935		1,510	885	-625
1953	1,003	687	-316	1940		1,475	886	-590
1954	1,067	504	-563	1951		1,202	634	-568
1955	1,062	686	-375	1936		1,515	994	-521
1956	1,964	1,333	-631	1979		1,590	1,007	-583
1957	1,163	642	-522	1975		1,543	938	-605
1958	1,755	1,230	-525	2000		1,552	839	-713
1959	792	539	-253	1946		1,412	830	-582
1960	641	232	-408	1923		1,310	883	-427
1961	455	135	-320	1999		1,258	773	-486
1962	1,586	888	-698	2003		1,211	591	-620
1963	1,644	1,086	-558	1970		1,243	721	-522
1964	1,038	617	-421	1925		1,067	538	-529
1965	1,714	1,103	-611	1971		1,145	627	-518
1966	1,283	699	-583	1957		1,163	642	-522
1967	2,004	1,576	-428	1954		1,067	504	-563
1968	925	725	-200	1950		1,320	743	-576
1969	1,780	1,620	-160	1966		1,283	699	-583
1970	1,243	721	-522	1944		1,039	594	-445
1971	1,145	627	-518	1953		1,003	687	-316
1972	993	407	-586	1948		857	511	-346
1973	1,670	1,044	-626	2002		967	412	-555
1974	1,755	1,263	-492	1949		985	471	-514
1975	1,543	938	-605	1926	Normal-dry	1,081	474	-606
1976	621	201	-420	1955		1,062	686	-375
1977	259	14	-245	1928		1,139	565	-574
1978	1,993	1,806	-187	2004		Partial Year		
1979	1,590	1,007	-583	1985		1,064	561	-502
1980	2,000	1,540	-460	1947		1,010	512	-499
1981	1,051	531	-520	1933		1,041	514	-527
1982	2,025	1,870	-155	1981		1,051	531	-520
1983	1,947	1,779	-168	2001		892	391	-501
1984	1,476	951	-525	1972		993	407	-586
1985	1,064	561	-502	1991		782	449	-333
1986	1,875	1,540	-335	1959		792	539	-253
1987	526	329	-197	1989		734	209	-525
1988	669	278	-392	1964		1,038	617	-421
1989	734	209	-525	1939		785	365	-420
1990	557	146	-411	1929		644	395	-250
1991	782	449	-333	1988		669	278	-392
1992	731	239	-493	1968		925	725	-200
1993	2,003	1,385	-618	1930		664	317	-347
1994	815	463	-352	1960		641	232	-408
1995	2,173	1,966	-207	1994		815	463	-352
1996	1,723	1,371	-351	1992	Dry	731	239	-493
1997	1,534	957	-576	1987		526	329	-197
1998	1,790	1,542	-248	1990		557	146	-411
1999	1,258	773	-486	1934		586	165	-421
2000	1,552	839	-713	1961		455	135	-320
2001	892	391	-501	1976		621	201	-420
2002	967	412	-555	1931		331	52	-279
2003	1,211	591	-620	1924		443	59	-384
2004	Partial Year			1977		259	14	-245
				Wet Ave		1,904	1,548	-356
Ave	1,281	829	-452	Normal-wet Ave		1,564	1,018	-546
Max	2,173	1,966		Normal-dry Ave		1,032	541	-491
Min	259	14		Dry Ave		629	278	-351

Note: Values are summed for contract year - March though February. Wetness based on water year unimpaired flow at Friant.

Table 10
Class 1 Water Deliveries (TAF)

Chronological Listing				Descending Order of Wetness				
Year	Current Release	Spring-run Hydrograph	Difference	Year		Current Release	Spring-run Hydrograph	Difference
1922	800	800	0	1983		800	800	0
1923	800	800	0	1969		800	800	0
1924	443	59	-384	1995		800	800	0
1925	800	538	-262	1938		800	800	0
1926	799	474	-325	1978		800	800	0
1927	800	800	0	1982		800	800	0
1928	800	565	-235	1967		800	778	-22
1929	644	395	-250	1998		800	770	-30
1930	664	317	-347	1986	Wet	800	800	0
1931	312	52	-260	1980		800	800	0
1932	800	800	0	1956		800	800	0
1933	800	514	-286	1952		800	800	0
1934	569	165	-404	1997		800	800	0
1935	800	800	0	1993		800	800	0
1936	800	800	0	1941		800	800	0
1937	800	799	-1	1958		800	798	-2
1938	800	800	0	1922		800	800	0
1939	741	365	-376	1965		800	795	-5
1940	800	800	0	1942		800	800	0
1941	800	800	0	1937		800	799	-1
1942	800	800	0	1996		800	800	0
1943	800	800	0	1974		800	800	0
1944	800	558	-242	1945		800	800	0
1945	800	800	0	1943		800	800	0
1946	798	800	2	1984		799	800	1
1947	800	512	-288	1932		800	800	0
1948	800	511	-289	1973		800	800	0
1949	800	471	-329	1927		800	800	0
1950	800	541	-259	1963		800	800	0
1951	799	634	-165	1962	Normal-wet	800	800	0
1952	800	800	0	1935		800	800	0
1953	800	687	-113	1940		800	800	0
1954	800	504	-296	1951		799	634	-165
1955	800	500	-300	1936		800	800	0
1956	800	800	0	1979		800	800	0
1957	800	642	-158	1975		800	800	0
1958	800	798	-2	2000		800	800	0
1959	792	539	-253	1946		798	800	2
1960	641	232	-408	1923		800	800	0
1961	455	135	-320	1999		800	773	-27
1962	800	800	0	2003		800	591	-209
1963	800	800	0	1970		800	721	-79
1964	800	481	-319	1925		800	538	-262
1965	800	795	-5	1971		800	627	-173
1966	799	677	-122	1957		800	642	-158
1967	800	778	-22	1954		800	504	-296
1968	779	579	-200	1950		800	541	-259
1969	800	800	0	1966		799	677	-122
1970	800	721	-79	1944		800	558	-242
1971	800	627	-173	1953		800	687	-113
1972	800	407	-393	1948		800	511	-289
1973	800	800	0	2002		800	412	-388
1974	800	800	0	1949		800	471	-329
1975	800	800	0	1926	Normal-dry	799	474	-325
1976	610	201	-410	1955		800	500	-300
1977	187	0	-187	1928		800	565	-235
1978	800	800	0	2004		Partial Year		
1979	800	800	0	1985		800	489	-311
1980	800	800	0	1947		800	512	-288
1981	800	520	-280	1933		800	514	-286
1982	800	800	0	1981		800	520	-280
1983	800	800	0	2001		800	391	-409
1984	799	800	1	1972		800	407	-393
1985	800	489	-311	1991		782	449	-333
1986	800	800	0	1959		792	539	-253
1987	526	329	-197	1989		734	209	-525
1988	669	278	-392	1964		800	481	-319
1989	734	209	-525	1939		741	365	-376
1990	557	146	-411	1929		644	395	-250
1991	782	449	-333	1988		669	278	-392
1992	659	239	-421	1968		779	579	-200
1993	800	800	0	1930		664	317	-347
1994	669	410	-260	1960		641	232	-408
1995	800	800	0	1994		669	410	-260
1996	800	800	0	1992	Dry	659	239	-421
1997	800	800	0	1987		526	329	-197
1998	800	770	-30	1990		557	146	-411
1999	800	773	-27	1934		569	165	-404
2000	800	800	0	1961		455	135	-320
2001	800	391	-409	1976		610	201	-410
2002	800	412	-388	1931		312	52	-260
2003	800	591	-209	1924		443	59	-384
2004	Partial Year			1977		187	0	-187
				Wet Ave		800	797	-3
Ave	754	600	-154	Normal-wet Ave		800	784	-16
Max	800	800		Normal-dry Ave		796	519	-277
Min	187	0		Dry Ave		584	258	-326

Note: Values are summed for contract year - March though February. Wetness based on water year unimpaired flow at Friant.

necessitating the taking of Class 1 water for downstream releases. During Dry years, the current average annual Class 1 deliveries are simulated to be 584,000 acre-feet. This quantity is reduced by an annual average 326,000 acre-feet when using the Spring-run Hydrograph.

30. Class 2 water deliveries will also be reduced from the level currently delivered by Friant. Table 11 shows the year-to-year simulation and year type grouping of annual Class 2 water deliveries for each simulation and the reductions to Class 2 deliveries as compared to the simulated current operation of Friant. An annual average reduction in Class 2 deliveries of 206,000 acre-feet is projected when assuming the Spring-run Hydrograph. The reductions due to the higher downstream release requirements will typically occur during Normal-dry and wetter years when Class 2 water would have been otherwise available under current operations.

31. Other water, delivered during periods when under current operations the water would have been released to the San Joaquin River in excess of downstream requirements, is shown in Table 12. With current downstream requirements the annual average delivery of this water is 134,000 acre-feet, typically occurring during wetter years, but can occur in any year depending upon reservoir operations, and the pattern of water deliveries and reservoir inflow. Reductions to Other water deliveries due to the higher downstream release requirements will be an annual average 92,000 acre-feet using the Spring-run Hydrograph. Table 12 also shows the simulated delivery of Other water grouped by year type.

32. The delivery of Class 1 and Class 2 water to each Long-term Friant Division water contractor has been calculated by the model for each downstream release scenario. The system-wide Class 1 and Class 2 water deliveries is disaggregated among the contractors by allocating the modeled system-wide deliveries to each contractor in proportion to each contractor's contractual entitlement contribution to the system-wide contractual total. Results of this disaggregation procedure are shown in tables included in Appendix B, Tab B-2 for the comparison of current deliveries with deliveries using the Spring-run Hydrograph. The simulated annual delivery of Class 1 and Class 2 water to each contractor by year and by year type grouping is provided.

33. The annual average delivery of Class 1 and Class 2 water to each Long-term Friant Division water contractor is shown in Table 13 for current operations and the reduction to deliveries using the Spring-run Hydrograph. The reduction in delivery of Other water is noted in the tables, but is not disaggregated among the contractors.

34. The effects of operating to the Spring-run Hydrograph will also manifest in the month-to-month results for releases to the San Joaquin River, the Friant-Kern Canal and Madera Canal. The change in releases will affect power generation associated with those release points. Table 14A displays the simulated monthly release to the San Joaquin River from Friant Dam for current operations. Table 14B displays the release information for the Spring-run Hydrograph scenario. Table 15A and Table 15B display monthly diversion information for the Friant-Kern Canal for each downstream release scenario, and Table 16A and Table 16B display similar diversion information for the Madera Canal.

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Table 11
Class 2 Water Deliveries (TAF)

Chronological Listing				Descending Order of Wetness				
Year	Current Release	Spring-run Hydrograph	Difference	Year		Current Release	Spring-run Hydrograph	Difference
1922	858	566	-292	1983	Wet	893	704	-188
1923	510	83	-427	1969		888	716	-172
1924	0	0	0	1995		1,066	932	-134
1925	267	0	-267	1938		925	793	-132
1926	124	0	-124	1978		979	835	-144
1927	569	237	-332	1982		842	730	-112
1928	223	0	-223	1967		967	655	-312
1929	0	0	0	1998		845	612	-233
1930	0	0	0	1986		835	562	-273
1931	0	0	0	1980		879	740	-139
1932	636	195	-441	1956		850	533	-317
1933	241	0	-241	1952		869	492	-377
1934	0	0	0	1997		487	156	-331
1935	500	85	-415	1993		889	585	-303
1936	548	194	-353	1941		881	642	-239
1937	608	294	-313	1958		859	426	-433
1938	925	793	-132	1922	Normal-wet	858	566	-292
1939	0	0	0	1965		695	308	-387
1940	388	83	-305	1942		735	549	-186
1941	881	642	-239	1937		608	294	-313
1942	735	549	-186	1996		617	396	-221
1943	590	341	-250	1974		640	402	-239
1944	233	0	-233	1945		672	359	-313
1945	672	359	-313	1943		590	341	-250
1946	363	30	-333	1984		498	151	-347
1947	115	0	-115	1932		636	195	-441
1948	57	0	-57	1973		558	180	-377
1949	185	0	-185	1927		569	237	-332
1950	237	0	-237	1963		695	286	-409
1951	331	0	-331	1962		579	88	-491
1952	869	492	-377	1935		500	85	-415
1953	203	0	-203	1940		388	83	-305
1954	187	0	-187	1951		331	0	-331
1955	189	0	-189	1936		548	194	-353
1956	850	533	-317	1979		535	202	-333
1957	291	0	-291	1975		559	138	-421
1958	859	426	-433	2000		483	39	-444
1959	0	0	0	1946		363	30	-333
1960	0	0	0	1923		510	83	-427
1961	0	0	0	1999		411	0	-411
1962	579	88	-491	2003		408	0	-408
1963	695	286	-409	1970	Normal-dry	381	0	-381
1964	92	0	-92	1925		267	0	-267
1965	695	308	-387	1971		346	0	-346
1966	198	0	-198	1957		291	0	-291
1967	967	655	-312	1954		187	0	-187
1968	0	0	0	1950		237	0	-237
1969	888	716	-172	1966		198	0	-198
1970	381	0	-381	1944		233	0	-233
1971	346	0	-346	1953		203	0	-203
1972	124	0	-124	1948		57	0	-57
1973	558	180	-377	2002		167	0	-167
1974	640	402	-239	1949		185	0	-185
1975	559	138	-421	1926		124	0	-124
1976	0	0	0	1955		189	0	-189
1977	0	0	0	1928		223	0	-223
1978	979	835	-144	2004		Partial Year		
1979	535	202	-333	1985		145	0	-145
1980	879	740	-139	1947		115	0	-115
1981	153	0	-153	1933		241	0	-241
1982	842	730	-112	1981		153	0	-153
1983	893	704	-188	2001		92	0	-92
1984	498	151	-347	1972		124	0	-124
1985	145	0	-145	1991		0	0	0
1986	835	562	-273	1959		0	0	0
1987	0	0	0	1989		0	0	0
1988	0	0	0	1964	Dry	92	0	-92
1989	0	0	0	1939		0	0	0
1990	0	0	0	1929		0	0	0
1991	0	0	0	1988		0	0	0
1992	0	0	0	1968		0	0	0
1993	889	585	-303	1930		0	0	0
1994	0	0	0	1960		0	0	0
1995	1,066	932	-134	1994		0	0	0
1996	617	396	-221	1992		0	0	0
1997	487	156	-331	1987		0	0	0
1998	845	612	-233	1990		0	0	0
1999	411	0	-411	1934		0	0	0
2000	483	39	-444	1961		0	0	0
2001	92	0	-92	1976		0	0	0
2002	167	0	-167	1931		0	0	0
2003	408	0	-408	1924		0	0	0
2004	Partial Year			1977		0	0	0
				Wet Avg		872	632	-240
Ave	393	187	-206	Normal-wet Avg		559	208	-351
Max	1,066	932		Normal-dry Avg		173	0	-173
Min	0	0		Dry Avg		5	0	-5

Note: Values are summed for contract year - March though February. Wetness based on water year unimpaired flow at Friant.

Table 12
Other Water Deliveries (TAF)

Chronological Listing				Descending Order of Wetness				
Year	Current Release	Spring-run Hydrograph	Difference	Year		Current Release	Spring-run Hydrograph	Difference
1922	241	41	-200	1983	Wet	254	275	20
1923	0	0	0	1969		92	104	12
1924	0	0	0	1995		307	235	-72
1925	0	0	0	1938		163	176	12
1926	157	0	-157	1978		214	171	-43
1927	269	0	-269	1982		383	341	-43
1928	115	0	-115	1967		237	143	-94
1929	0	0	0	1998		145	160	15
1930	0	0	0	1986		241	178	-62
1931	19	0	-19	1980		321	0	-321
1932	152	0	-152	1956		315	0	-315
1933	0	0	0	1952		101	78	-23
1934	17	0	-17	1997		247	1	-246
1935	211	0	-211	1993		315	0	-315
1936	168	0	-168	1941		278	46	-232
1937	205	204	-1	1958		96	6	-90
1938	163	176	12	1922	Normal-wet	241	41	-200
1939	44	0	-44	1965		220	0	-220
1940	288	3	-285	1942		384	40	-345
1941	278	46	-232	1937		205	204	-1
1942	384	40	-345	1996		306	175	-130
1943	92	0	-92	1974		315	61	-254
1944	6	35	30	1945		338	68	-270
1945	338	68	-270	1943		92	0	-92
1946	251	0	-251	1984		178	0	-178
1947	96	0	-96	1932		152	0	-152
1948	0	0	0	1973		312	64	-248
1949	0	0	0	1927		269	0	-269
1950	283	202	-81	1963		149	0	-149
1951	72	0	-72	1962		207	0	-207
1952	101	78	-23	1935		211	0	-211
1953	0	0	0	1940		288	3	-285
1954	80	0	-80	1951		72	0	-72
1955	72	186	114	1936		168	0	-168
1956	315	0	-315	1979		256	6	-250
1957	72	0	-72	1975		184	0	-184
1958	96	6	-90	2000		269	0	-269
1959	0	0	0	1946		251	0	-251
1960	0	0	0	1923		0	0	0
1961	0	0	0	1999		48	0	-48
1962	207	0	-207	2003		3	0	-3
1963	149	0	-149	1970	Normal-dry	63	0	-63
1964	146	136	-10	1925		0	0	0
1965	220	0	-220	1971		0	0	0
1966	285	22	-263	1957		72	0	-72
1967	237	143	-94	1954		80	0	-80
1968	146	146	0	1950		283	202	-81
1969	92	104	12	1966		285	22	-263
1970	63	0	-63	1944		6	35	30
1971	0	0	0	1953		0	0	0
1972	69	0	-69	1948		0	0	0
1973	312	64	-248	2002		0	0	0
1974	315	61	-254	1949		0	0	0
1975	184	0	-184	1926		157	0	-157
1976	11	0	-11	1955		72	186	114
1977	72	14	-58	1928		115	0	-115
1978	214	171	-43	2004		Partial Year		
1979	256	6	-250	1985		119	72	-47
1980	321	0	-321	1947		96	0	-96
1981	98	11	-87	1933		0	0	0
1982	383	341	-43	1981		98	11	-87
1983	254	275	20	2001		0	0	0
1984	178	0	-178	1972		69	0	-69
1985	119	72	-47	1991		0	0	0
1986	*241*	*178*	*-62*	*1959*		*0*	*0*	*0*
1987	0	0	0	1989		0	0	0
1988	0	0	0	1964	Dry	146	136	-10
1989	0	0	0	1939		44	0	-44
1990	0	0	0	1929		0	0	0
1991	0	0	0	1988		0	0	0
1992	72	0	-72	1968		146	146	0
1993	315	0	-315	1930		0	0	0
1994	146	54	-92	1960		0	0	0
1995	307	235	-72	1994		146	54	-92
1996	306	175	-130	1992		72	0	-72
1997	247	1	-246	1987		0	0	0
1998	145	160	15	1990		0	0	0
1999	48	0	-48	1934		17	0	-17
2000	269	0	-269	1961		0	0	0
2001	0	0	0	1976		11	0	-11
2002	0	0	0	1931		19	0	-19
2003	*3*	*0*	*-3*	*1924*		*0*	*0*	*0*
2004	Partial Year			1977		72	14	-58
				Wet Avg		232	120	-112
Ave	134	42	-92	Normal-wet Avg		205	26	-178
Max	384	341		Normal-dry Avg		63	22	-41
Min	0	0		Dry Avg		40	21	-19

Note: Values are summed for contract year - March though February. Wetness based on water year unimpaired flow at Friant.

Table 13 Average Deliveries and Reductions to Deliveries by Contractor - Acre-feet						
			Current Releases		Spring-run Hydrograph	
	Full Contract		Current Ave Delivery		Average Reduction	
	Class 1	Class 2	Class 1	Class 2	Class 1	Class 2
Friant-Kern Canal Agricultural						
Arvin-Edison WSD	40,000	311,675	37,700	87,295	-7,716	-45,753
Delano-Earlimart ID	108,800	74,500	102,545	20,866	-20,988	-10,936
Exeter ID	11,500	19,000	10,839	5,322	-2,218	-2,789
Fresno ID		75,000		21,006		-11,010
Garfield WD	3,500		3,299		-675	
International WD	1,200		1,131		-231	
Ivanhoe ID	7,700	7,900	7,257	2,213	-1,485	-1,160
Lewis Creek WD	1,450		1,367		-280	
Lindmore ID	33,000	22,000	31,103	6,162	-6,366	-3,230
Lindsay-Strathmore ID	27,500		25,919		-5,305	
Lower Tule River ID	61,200	238,000	57,681	66,660	-11,806	-34,937
Orange Cove ID	39,200		36,946		-7,562	
Porterville ID	16,000	30,000	15,080	8,403	-3,086	-4,404
Saucelito ID	21,200	32,800	19,981	9,187	-4,090	-4,815
Shafter-Wasco ID	50,000	39,600	47,125	11,091	-9,645	-5,813
Southern San Joaquin MUD	97,000	50,000	91,423	14,004	-18,712	-7,340
Stone Corral ID	10,000		9,425		-1,929	
Tea Pot Dome WD	7,500		7,069		-1,447	
Terra Bella ID	29,000		27,333		-5,594	
Tulare ID	30,000	141,000	28,275	39,492	-5,787	-20,698
Madera Canal Agricultural						
Chowchilla WD	55,000	160,000	51,838	44,813	-10,610	-23,487
Madera ID	85,000	186,000	80,113	52,096	-16,397	-27,304
San Joaquin River Agricultural						
Gravelly Ford WD		14,000		3,921		-2,055
Friant Division M&I						
City of Fresno	60,000		56,550		-11,574	
City of Orange Cove	1,400		1,320		-270	
City of Lindsay	2,500		2,356		-482	
Fresno County Water Works District No. 18	150		141		-29	
Madera County	200		189		-39	
Total	800,000	1,401,475	754,004	392,531	-154,322	-205,731
Current Other water delivered:	134,303		Reduction of Other water:			-92,173

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Table 14A
Simulated Total Release to the San Joaquin River from Friant Dam - Current Operations
1,000 Acre-feet

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY Total
1922	10	7	8	15	40	13	113	167	83	14	16	13	500
1923	10	7	7	5	5	7	9	11	13	14	16	13	117
1924	10	7	7	5	5	7	9	11	13	14	16	13	117
1925	10	7	7	5	5	7	9	11	13	14	16	13	117
1926	10	7	7	5	5	7	9	31	13	14	16	13	137
1927	10	7	7	5	5	7	11	11	24	14	16	13	130
1928	10	7	7	6	5	7	9	11	13	14	16	13	118
1929	10	7	7	5	5	7	9	11	13	14	16	13	117
1930	10	7	7	5	5	7	9	11	13	14	16	13	117
1931	10	7	7	5	5	7	9	11	13	14	16	13	117
1932	10	7	7	5	5	7	18	11	13	14	16	13	126
1933	10	7	7	5	5	7	9	11	13	14	16	13	117
1934	10	7	7	5	5	7	9	11	13	14	16	13	117
1935	10	7	7	5	5	7	26	19	13	14	16	13	142
1936	10	7	7	5	80	7	95	43	13	14	16	13	309
1937	10	7	7	5	112	112	189	173	13	14	16	13	671
1938	10	7	7	9	237	328	311	406	258	65	16	13	1667
1939	10	7	7	5	5	7	9	11	13	14	16	13	117
1940	10	7	7	5	5	7	18	55	13	14	16	13	169
1941	10	7	7	7	155	24	177	173	151	14	16	13	754
1942	10	7	7	6	13	18	9	24	27	14	16	13	164
1943	10	7	7	38	24	147	115	48	13	14	16	13	452
1944	10	7	7	5	5	7	9	11	13	14	16	13	117
1945	10	7	7	5	192	7	26	11	13	14	16	13	320
1946	10	7	36	27	5	7	9	54	13	14	16	13	212
1947	10	7	7	9	5	7	9	11	13	14	16	13	122
1948	10	7	7	5	5	7	9	11	13	14	16	13	117
1949	10	7	7	5	5	7	9	11	13	14	16	13	117
1950	10	7	7	5	5	7	9	11	13	14	16	13	117
1951	10	22	229	84	40	7	9	11	13	14	16	13	469
1952	10	7	7	54	22	206	213	214	180	14	16	13	955
1953	10	7	7	5	5	7	9	11	13	14	16	13	117
1954	10	7	7	5	5	7	9	24	13	14	16	13	130
1955	10	7	7	5	5	7	9	11	13	14	16	13	117
1956	10	7	196	278	42	20	29	115	96	14	16	13	837
1957	10	7	7	5	5	7	9	11	13	14	16	13	117
1958	10	7	7	5	22	193	220	207	96	14	16	13	811
1959	10	7	7	5	5	7	9	11	13	14	16	13	117
1960	10	7	7	5	5	7	9	11	13	14	16	13	117
1961	10	7	7	5	5	7	9	11	13	14	16	13	117
1962	10	7	7	5	5	7	9	11	13	14	16	13	117
1963	10	7	7	5	69	7	9	11	13	14	16	13	181
1964	10	7	7	7	5	7	9	11	13	14	16	13	119
1965	10	7	7	88	46	7	9	11	13	14	16	13	242
1966	10	10	20	10	5	7	11	11	13	14	16	13	141
1967	10	7	7	9	25	120	207	211	66	228	16	13	918
1968	10	7	7	5	5	7	9	11	13	14	16	13	117
1969	10	7	7	114	248	274	316	478	403	98	16	13	1985
1970	10	7	7	5	5	7	9	11	13	14	16	13	117
1971	10	7	7	5	5	7	9	11	13	14	16	13	117
1972	10	7	7	5	5	7	9	11	13	14	16	13	117
1973	10	7	7	5	5	93	10	85	21	14	16	13	286
1974	10	7	7	42	13	13	26	17	26	14	16	13	205
1975	10	7	7	5	5	7	20	11	13	14	16	13	129
1976	10	7	7	5	5	7	9	11	13	14	16	13	117
1977	10	7	7	5	5	7	9	11	13	14	16	13	117
1978	10	7	7	5	126	208	195	274	152	96	16	13	1109
1979	10	7	7	9	5	10	26	33	13	14	16	13	163
1980	10	7	7	152	213	107	123	121	84	41	16	13	896
1981	10	7	7	5	5	7	9	11	13	14	16	13	117
1982	10	7	7	7	117	119	236	219	163	14	16	13	929
1983	10	77	210	238	346	385	268	356	528	319	16	13	2767
1984	10	33	205	65	5	7	9	11	13	14	16	13	400
1985	10	7	7	7	5	7	9	11	13	14	16	13	119
1986	10	7	7	5	301	240	118	200	181	14	16	13	1112
1987	10	7	7	5	5	7	9	11	13	14	16	13	117
1988	10	7	7	5	5	7	9	11	13	14	16	13	117
1989	10	7	7	5	5	7	9	11	13	14	16	13	117
1990	10	7	7	5	5	7	9	11	13	14	16	13	117
1991	10	7	7	5	5	7	9	11	13	14	16	13	117
1992	10	7	7	5	5	7	9	11	13	14	16	13	117
1993	10	7	7	5	26	23	131	120	96	14	16	13	469
1994	10	7	7	5	5	7	9	11	13	14	16	13	117
1995	10	7	7	15	133	211	210	278	146	384	16	13	1430
1996	10	7	7	5	19	114	23	110	13	14	16	13	351
1997	10	7	108	680	75	47	22	125	13	14	16	13	1131
1998	10	7	7	5	192	125	247	219	168	305	16	13	1313
1999	10	7	7	8	5	7	9	11	13	14	16	13	120
2000	10	7	7	5	5	9	9	11	13	14	16	13	119
2001	10	7	7	5	5	7	9	11	13	14	16	13	117
2002	10	7	7	5	5	7	9	11	13	14	16	13	117
2003	10	7	7	5	5	7	9	11	13	14	16	13	117
2004	10	7	7	5	5	7	9	11	13	14	16	13	117
Avg 22-04	10	9	18	27	39	43	51	62	45	32	16	13	365

Table 14B

Simulated Total Release to the San Joaquin River from Friant Dam - Spring-run Hydrograph

1,000 Acre-feet

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY Total
1922	36	35	36	36	64	144	212	168	35	36	36	35	870
1923	36	35	36	36	64	144	212	89	35	36	36	35	791
1924	36	35	36	36	38	81	117	41	22	23	23	22	509
1925	23	22	23	23	55	125	184	73	29	30	30	29	648
1926	30	29	30	30	55	125	184	73	29	30	30	29	676
1927	30	29	30	30	64	144	212	89	35	36	36	35	769
1928	36	35	36	36	55	125	184	73	29	30	30	29	698
1929	30	29	30	30	27	58	84	30	22	23	23	22	409
1930	23	22	23	23	39	79	124	44	22	23	23	22	468
1931	23	22	23	23	28	58	78	35	22	23	23	22	381
1932	23	22	23	23	64	144	212	89	35	36	36	35	741
1933	36	35	36	36	49	111	163	64	29	30	30	29	648
1934	30	29	30	30	45	97	139	49	22	23	23	22	540
1935	23	22	23	23	64	144	212	89	35	36	36	35	741
1936	36	35	36	36	64	144	215	89	35	36	36	35	794
1937	36	35	36	36	75	157	230	170	48	36	36	35	928
1938	36	35	36	40	115	431	449	374	212	52	36	35	1849
1939	36	35	36	36	45	97	139	49	22	23	23	22	562
1940	23	22	23	23	64	144	212	89	35	36	36	35	741
1941	36	35	36	36	111	199	311	165	35	36	36	35	1066
1942	36	35	36	38	64	144	212	89	35	36	36	35	793
1943	36	35	36	46	64	157	227	89	35	36	36	35	830
1944	36	35	36	36	55	125	184	73	29	30	30	29	698
1945	30	29	30	30	64	144	212	89	35	36	36	35	769
1946	36	35	36	41	64	144	212	89	35	36	36	35	797
1947	36	35	36	36	55	125	184	73	29	30	30	29	698
1948	30	29	30	30	31	50	124	49	29	30	30	29	493
1949	30	29	30	30	50	113	166	66	29	30	30	29	634
1950	30	29	30	30	55	125	184	73	29	30	30	29	676
1951	30	29	199	87	64	144	212	89	35	36	36	35	995
1952	36	35	36	36	81	220	310	266	35	36	36	35	1159
1953	36	35	36	39	55	125	184	73	29	30	30	29	701
1954	30	29	30	30	55	125	184	73	29	30	30	29	676
1955	30	29	30	30	51	116	171	68	29	30	30	29	645
1956	30	29	63	208	81	199	310	160	35	36	36	35	1220
1957	36	35	36	36	55	125	184	73	29	30	30	29	698
1958	30	29	30	30	81	206	310	228	35	36	36	35	1084
1959	36	35	36	36	55	125	184	73	29	30	30	29	698
1960	30	29	30	30	44	93	135	48	22	23	23	22	530
1961	23	22	23	23	37	78	111	39	22	23	23	22	447
1962	23	22	23	23	64	144	212	89	35	36	36	35	741
1963	36	35	36	36	64	144	212	89	35	36	36	35	791
1964	36	35	36	36	45	97	139	49	22	23	23	22	562
1965	23	22	23	38	64	144	212	89	35	36	36	35	756
1966	36	35	36	36	55	125	184	73	29	30	30	29	698
1967	30	29	30	30	81	199	291	235	35	215	36	35	1245
1968	36	35	36	36	45	97	139	49	22	23	23	22	562
1969	23	22	23	66	110	419	322	542	370	86	36	35	2053
1970	36	35	36	36	55	125	184	73	29	30	30	29	698
1971	30	29	30	30	55	125	184	73	29	30	30	29	676
1972	30	29	30	30	55	125	184	73	29	30	30	29	676
1973	30	29	30	30	64	144	212	97	35	36	36	35	777
1974	36	35	36	41	64	144	212	89	35	36	36	35	796
1975	36	35	36	36	64	144	212	89	35	36	36	35	791
1976	36	35	36	36	45	97	139	49	22	23	23	22	562
1977	23	22	23	23	21	31	44	23	22	23	23	22	301
1978	23	22	23	23	81	293	310	232	82	83	36	35	1241
1979	36	35	36	36	64	144	212	89	35	36	36	35	791
1980	36	35	36	143	218	213	310	160	35	36	36	35	1290
1981	36	35	36	36	55	125	184	73	29	30	30	29	698
1982	30	29	30	30	81	203	427	170	35	36	36	35	1140
1983	36	81	213	239	268	454	310	324	528	306	36	35	2628
1984	36	64	212	84	64	144	212	89	35	36	36	35	1045
1985	36	35	36	36	55	125	184	73	29	30	30	29	698
1986	30	29	30	30	164	246	323	161	35	36	36	35	1154
1987	36	35	36	36	45	97	139	49	22	23	23	22	562
1988	23	22	23	23	45	97	139	49	22	23	23	22	512
1989	23	22	23	23	55	125	184	73	29	30	30	29	648
1990	30	29	30	30	45	97	139	49	22	23	23	22	540
1991	23	22	23	23	21	76	114	30	29	30	30	29	451
1992	30	29	30	30	45	97	139	49	22	23	23	22	540
1993	23	22	23	23	81	199	310	160	35	36	36	35	982
1994	36	35	36	36	45	97	139	49	22	23	23	22	562
1995	23	22	23	24	81	308	313	249	74	384	36	35	1572
1996	36	35	36	36	64	148	212	89	35	36	36	35	796
1997	36	35	114	681	81	199	310	160	35	36	36	35	1755
1998	36	35	36	36	99	224	357	160	69	288	36	35	1409
1999	36	35	36	40	64	144	212	89	35	36	36	35	796
2000	36	35	36	36	64	144	212	89	35	36	36	35	791
2001	36	35	36	36	50	113	165	65	29	30	30	29	654
2002	30	29	30	30	55	125	184	73	29	30	30	29	676
2003	30	29	30	30	62	139	203	85	35	36	36	35	749
2004	36	35	36	36	55	125	184	73	29	30	30	29	698
Avg 22-04	31	31	39	48	65	147	206	104	44	45	31	30	823

Table 15A
Simulated Diversion to the Friant-Kern Canal - Current Operations
1,000 Acre-feet

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY Total
1922	5	4	15	75	69	134	194	113	253	236	223	141	1460
1923	99	31	28	28	96	55	108	141	194	210	184	100	1275
1924	36	9	6	6	44	21	26	38	79	102	62	35	465
1925	27	11	1	1	13	46	90	117	161	175	153	83	878
1926	31	8	5	5	36	45	123	183	140	152	138	71	939
1927	27	8	5	5	59	65	178	215	275	221	194	105	1356
1928	38	9	6	22	59	82	109	168	150	167	147	78	1036
1929	29	8	5	5	26	30	36	53	112	145	87	49	584
1930	37	15	1	1	18	30	53	76	107	117	106	55	616
1931	21	7	4	4	18	16	19	28	58	74	46	27	321
1932	20	9	1	1	27	57	182	223	213	231	202	109	1277
1933	39	10	7	7	48	45	88	114	157	171	150	82	918
1934	30	8	5	5	36	27	48	47	100	129	77	43	556
1935	33	13	1	1	16	53	173	216	241	213	187	101	1248
1936	37	9	6	6	31	124	105	225	204	221	194	105	1266
1937	38	9	6	6	24	34	89	147	279	237	207	112	1190
1938	40	10	7	55	114	23	58	114	231	286	237	170	1346
1939	120	37	34	34	117	34	59	84	119	129	117	61	944
1940	23	7	4	4	61	104	167	207	215	194	170	92	1247
1941	34	9	6	33	33	136	103	112	259	266	227	144	1362
1942	101	32	29	42	164	133	191	180	254	235	209	132	1703
1943	93	29	26	19	118	34	96	230	211	229	201	109	1396
1944	39	10	7	7	48	45	88	114	157	171	150	82	917
1945	30	8	5	5	29	69	185	233	219	238	208	112	1341
1946	40	10	81	80	64	59	155	203	162	176	154	84	1269
1947	31	8	8	62	74	74	82	163	141	153	138	72	1005
1948	27	8	5	5	24	38	67	96	136	147	133	69	755
1949	26	8	5	5	23	43	84	109	150	167	147	78	843
1950	29	8	5	5	26	47	103	167	156	170	149	81	946
1951	30	12	79	78	88	49	95	124	170	185	162	88	1160
1952	32	9	6	6	104	43	52	105	255	249	229	154	1244
1953	109	34	31	31	106	44	85	111	152	165	145	79	1090
1954	29	8	5	5	34	46	89	190	147	164	144	77	938
1955	29	8	5	5	26	44	85	110	152	165	145	79	851
1956	29	8	6	5	88	136	175	185	264	246	220	139	1501
1957	98	31	28	28	95	47	92	119	164	178	156	85	1121
1958	31	8	5	5	104	56	46	114	252	240	226	152	1240
1959	107	33	30	30	104	36	63	90	127	138	125	65	947
1960	25	7	4	4	22	29	36	53	112	144	86	48	570
1961	37	15	1	1	18	22	27	39	81	105	63	36	443
1962	28	12	1	1	13	56	174	206	206	222	195	105	1218
1963	38	10	7	7	113	64	179	173	221	234	210	125	1378
1964	53	16	13	37	49	40	70	100	141	153	138	72	881
1965	27	8	5	78	88	62	121	125	242	235	211	126	1328
1966	53	47	81	78	64	72	163	167	146	162	143	76	1251
1967	28	8	5	55	91	150	74	116	231	286	227	163	1435
1968	115	35	32	32	112	35	62	89	125	136	123	64	959
1969	24	7	4	78	88	39	36	108	153	286	232	167	1223
1970	117	36	33	33	114	78	98	128	176	191	167	91	1264
1971	33	9	6	6	71	49	96	124	171	186	163	89	1004
1972	33	9	6	6	39	76	79	103	141	157	139	74	861
1973	28	8	5	5	53	52	178	141	276	222	194	105	1266
1974	38	10	7	80	109	128	182	229	286	233	204	110	1616
1975	40	10	7	7	48	55	177	221	227	220	192	104	1306
1976	38	9	6	6	46	38	34	50	107	138	82	46	602
1977	35	14	1	1	17	11	13	19	37	47	30	18	244
1978	14	7	1	1	73	52	76	140	231	286	231	166	1280
1979	117	36	33	84	111	126	177	222	214	220	192	104	1637
1980	38	9	6	7	24	55	143	199	250	306	221	148	1407
1981	105	32	29	29	102	42	82	106	146	162	143	76	1053
1982	28	8	5	31	91	143	39	207	254	254	229	165	1454
1983	154	107	25	9	34	9	60	96	128	286	247	177	1332
1984	125	110	32	106	119	112	134	184	190	207	181	98	1597
1985	36	9	6	31	62	54	140	151	142	158	139	74	1002
1986	28	8	5	5	24	32	173	189	256	240	227	143	1328
1987	101	31	28	28	98	25	30	44	93	120	72	41	712
1988	31	13	1	1	15	31	54	77	108	117	106	56	610
1989	22	7	4	4	19	33	58	84	118	128	116	61	653
1990	23	7	4	4	20	26	32	46	98	126	76	43	505
1991	33	13	1	1	16	35	62	89	125	136	123	64	698
1992	24	7	4	4	21	30	53	76	107	116	105	55	602
1993	21	7	4	4	85	135	173	190	258	244	230	145	1496
1994	102	32	29	29	99	31	54	77	108	117	106	56	840
1995	22	7	4	78	85	63	161	130	231	286	245	176	1488
1996	124	38	35	35	188	51	184	231	280	234	205	111	1717
1997	40	10	7	7	88	127	179	224	194	208	182	99	1363
1998	36	9	6	8	24	55	38	112	131	286	219	157	1082
1999	111	34	31	68	121	61	101	147	200	195	171	93	1333
2000	34	9	6	6	41	127	172	213	222	208	182	99	1317
2001	36	9	6	6	43	39	70	100	141	153	138	72	813
2002	27	8	5	5	24	42	83	107	147	164	144	77	832
2003	29	8	5	5	26	52	100	131	183	196	171	93	997
2004	34	9	6	6	41	54	94	116	139	155	136	73	862
Avg 22-04	48	16	13	22	62	59	101	134	176	190	162	94	1077

Table 15B

Simulated Diversion to the Friant-Kern Canal - Spring-run Hydrograph

1,000 Acre-feet

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY Total
1922	5	4	1	1	34	58	111	146	234	219	192	104	1107
1923	38	9	6	6	45	39	69	99	140	151	137	71	812
1924	27	8	5	5	24	3	4	5	6	9	19	32	145
1925	10	6	1	1	4	25	9	67	95	122	74	42	455
1926	32	13	1	1	15	23	27	40	84	109	66	37	448
1927	28	12	1	1	14	45	88	114	157	170	149	81	861
1928	30	8	5	5	36	26	32	47	99	128	77	43	537
1929	33	13	1	1	16	3	4	38	80	102	62	35	388
1930	27	11	1	1	13	3	4	28	68	83	44	37	320
1931	23	10	1	1	11	3	4	5	6	7	18	31	120
1932	5	4	7	1	3	43	85	110	151	168	148	79	804
1933	29	8	5	5	26	3	4	5	113	145	86	49	478
1934	36	14	1	1	18	10	12	17	33	26	34	26	229
1935	13	7	1	1	6	39	69	99	140	152	137	71	736
1936	27	8	5	5	24	44	82	111	153	166	146	79	849
1937	29	8	5	5	24	37	77	114	243	184	162	88	977
1938	32	9	6	54	103	26	52	97	249	304	220	148	1300
1939	104	32	29	29	101	18	22	32	66	85	46	36	603
1940	23	10	1	1	11	39	69	99	140	151	137	71	752
1941	27	8	5	5	24	60	116	149	213	231	202	109	1148
1942	39	10	7	34	64	57	110	145	199	216	189	103	1173
1943	37	9	6	7	81	37	82	127	175	190	166	90	1008
1944	33	9	6	6	39	3	4	51	110	141	85	48	535
1945	37	14	1	1	50	50	97	126	174	189	166	90	996
1946	33	9	13	67	37	37	65	94	132	143	130	67	828
1947	25	7	4	4	22	24	29	43	90	117	70	40	478
1948	30	12	1	1	15	3	4	48	101	130	78	44	467
1949	33	13	1	1	17	3	4	45	93	121	73	41	445
1950	31	13	1	1	14	25	31	45	95	123	74	42	495
1951	32	13	75	75	66	29	35	52	111	143	85	48	763
1952	36	14	1	1	18	41	46	132	235	229	196	106	1055
1953	38	10	7	44	45	31	55	79	111	120	109	57	706
1954	22	7	4	4	19	24	29	42	89	115	69	39	463
1955	30	12	1	1	14	3	4	47	98	127	77	43	458
1956	33	13	75	75	52	56	110	143	197	214	187	101	1256
1957	37	9	6	6	44	29	26	63	112	145	86	48	612
1958	37	15	1	1	18	54	17	161	195	213	186	101	998
1959	37	9	6	6	44	25	31	45	95	123	74	42	536
1960	32	13	1	1	15	3	4	24	49	60	40	27	269
1961	17	8	1	1	9	3	4	5	10	39	40	31	168
1962	12	6	1	1	7	39	69	99	140	152	138	71	736
1963	27	8	5	5	24	47	91	119	163	177	156	85	905
1964	31	8	5	5	37	23	28	41	85	110	66	38	478
1965	29	12	1	75	71	47	93	120	166	180	158	86	1037
1966	32	8	5	5	37	31	54	78	109	119	108	56	643
1967	22	7	4	5	38	74	65	93	232	307	216	129	1191
1968	54	16	13	13	51	27	33	48	101	131	79	44	611
1969	34	14	1	75	83	36	36	84	169	307	218	138	1194
1970	97	30	27	27	94	33	57	82	116	126	114	60	864
1971	23	7	4	4	20	29	35	51	109	142	85	47	556
1972	36	14	1	1	18	20	24	35	73	71	57	56	407
1973	25	11	1	1	12	43	84	102	150	167	147	78	822
1974	29	8	5	67	26	52	99	130	235	194	170	92	1109
1975	34	9	6	6	40	40	36	112	154	170	150	79	836
1976	30	8	5	5	25	3	4	5	29	49	42	52	258
1977	15	7	1	1	7	3	4	5	6	7	7	6	69
1978	5	4	1	1	15	49	69	119	250	307	223	141	1184
1979	99	31	28	28	96	44	86	112	153	167	146	80	1070
1980	30	8	5	5	24	52	103	129	230	243	219	130	1179
1981	55	16	13	13	52	24	30	44	92	118	71	40	569
1982	31	13	1	1	25	140	36	190	245	246	228	144	1300
1983	130	103	21	8	34	12	60	96	128	300	233	148	1274
1984	104	104	25	87	69	42	81	106	145	162	142	76	1142
1985	28	8	5	5	25	23	28	41	87	112	68	38	468
1986	29	12	1	1	81	32	178	223	224	224	196	106	1307
1987	38	10	7	7	46	17	20	29	60	78	48	28	387
1988	21	9	1	1	10	14	18	26	52	67	41	24	285
1989	19	9	1	1	9	3	6	20	41	52	36	33	230
1990	15	7	1	1	7	3	4	5	17	41	42	29	173
1991	14	7	1	1	7	3	4	42	89	115	69	40	392
1992	29	13	1	1	15	13	16	23	45	58	37	22	272
1993	17	8	1	1	8	29	97	194	204	221	194	105	1078
1994	38	9	6	6	46	20	24	35	74	95	58	33	445
1995	25	11	1	17	47	61	159	130	231	286	224	151	1344
1996	106	33	30	30	103	48	101	186	229	198	173	94	1331
1997	34	9	7	6	83	42	82	106	146	163	143	76	896
1998	28	8	5	5	24	53	32	95	150	307	221	132	1059
1999	55	17	20	65	71	35	61	88	124	134	122	63	855
2000	24	7	4	4	21	37	66	95	133	145	131	68	736
2001	26	7	4	4	23	3	4	38	78	102	61	35	386
2002	26	11	1	1	14	20	15	45	74	95	58	33	394
2003	25	11	1	1	12	3	4	55	115	149	89	50	515
2004	38	15	1	1	19	18	22	32	67	86	53	30	382
Avg 22-04	34	13	7	13	34	30	48	78	126	148	115	67	713

Table 16A
Simulated Diversion to the Madera Canal - Current Operations
1,000 Acre-feet

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY Total
1922	0	0	0	0	6	33	37	60	64	59	55	37	351
1923	22	4	0	0	15	24	27	42	48	60	46	21	309
1924	3	3	0	0	5	0	0	9	25	31	22	3	100
1925	0	0	0	0	0	0	0	21	61	76	53	8	219
1926	0	0	0	0	0	0	3	25	48	61	42	6	186
1927	0	0	0	0	3	25	32	50	58	64	49	23	304
1928	3	3	0	0	7	22	2	25	55	69	48	7	241
1929	0	0	0	0	0	0	0	12	35	44	30	5	125
1930	0	0	0	0	0	0	0	12	36	45	31	5	128
1931	0	0	0	0	0	0	0	7	18	23	16	2	67
1932	0	0	0	0	1	25	33	53	54	68	51	24	311
1933	3	3	0	0	6	0	0	20	59	74	51	8	224
1934	0	0	0	0	0	0	1	11	31	39	27	4	113
1935	0	0	0	0	0	23	30	49	53	61	46	22	284
1936	3	3	0	0	11	29	33	52	52	64	49	23	317
1937	3	3	0	0	11	29	33	55	61	70	53	25	342
1938	3	3	0	0	12	38	57	77	76	77	68	47	458
1939	28	5	0	0	19	0	0	14	39	49	34	5	193
1940	0	0	0	0	3	26	29	45	47	54	41	19	264
1941	2	2	0	0	10	35	39	62	67	63	56	38	375
1942	23	4	0	0	21	33	37	56	60	55	51	34	373
1943	20	3	0	0	12	30	34	54	54	67	51	24	350
1944	3	3	0	0	6	0	0	20	59	74	51	8	224
1945	0	0	0	0	6	27	34	55	56	70	53	25	327
1946	3	3	0	0	7	23	28	44	61	77	53	8	308
1947	0	0	0	0	3	3	0	23	49	61	42	7	187
1948	0	0	0	0	0	0	0	16	46	58	40	6	166
1949	0	0	0	0	0	0	0	19	55	69	48	7	198
1950	0	0	0	0	0	0	1	25	59	73	51	8	216
1951	0	0	0	0	6	20	22	36	41	51	39	18	232
1952	2	2	0	0	6	35	50	66	71	66	61	41	401
1953	25	4	0	0	16	0	0	19	56	71	49	8	248
1954	0	0	0	0	0	0	0	27	54	67	46	7	201
1955	0	0	0	0	0	0	0	19	56	71	49	8	202
1956	0	0	0	0	6	34	39	59	63	58	54	36	350
1957	22	4	0	0	14	0	0	21	63	78	54	9	265
1958	0	0	0	0	6	35	49	65	70	65	60	41	389
1959	24	4	0	0	16	0	0	14	42	53	36	6	195
1960	0	0	0	0	0	0	0	12	34	43	30	4	124
1961	0	0	0	0	0	0	0	9	25	32	22	3	92
1962	0	0	0	0	0	25	32	50	52	64	49	23	295
1963	3	3	0	0	11	27	34	54	57	71	54	25	339
1964	3	3	0	0	6	0	0	17	49	61	42	7	188
1965	0	0	0	0	6	28	31	50	59	71	54	26	324
1966	3	3	0	0	7	22	6	24	53	67	46	7	238
1967	0	0	0	0	6	43	61	77	76	77	65	44	449
1968	27	4	0	0	18	0	0	14	41	52	36	5	197
1969	0	0	0	0	6	39	57	77	76	77	67	45	444
1970	27	5	0	0	18	24	23	37	43	53	41	19	290
1971	2	2	0	0	7	20	23	36	41	52	39	18	241
1972	2	2	0	0	5	3	0	17	51	64	44	7	195
1973	0	0	0	0	2	29	32	51	58	64	49	23	308
1974	3	3	0	0	11	30	34	54	61	68	52	24	339
1975	3	3	0	0	6	24	32	51	53	63	48	23	306
1976	3	3	0	0	6	1	0	12	33	41	29	4	131
1977	0	0	0	0	0	0	0	5	12	15	11	1	45
1978	0	0	0	0	6	42	59	77	76	77	66	45	448
1979	27	5	0	0	18	28	32	51	52	63	48	23	347
1980	3	3	0	0	10	38	51	67	72	73	58	39	415
1981	24	4	0	0	16	0	0	18	53	66	46	7	234
1982	0	0	0	0	6	38	54	72	74	74	66	45	429
1983	30	4	0	0	12	48	65	77	76	77	72	49	510
1984	29	5	0	0	17	29	29	46	47	59	45	21	328
1985	3	3	0	0	7	1	4	22	51	64	44	7	206
1986	0	0	0	0	6	32	38	61	65	61	56	38	356
1987	23	4	0	0	15	0	0	10	29	36	25	4	146
1988	0	0	0	0	0	0	0	13	36	45	31	5	129
1989	0	0	0	0	0	0	0	14	39	49	34	5	141
1990	0	0	0	0	0	0	0	11	30	38	26	4	110
1991	0	0	0	0	0	0	0	14	41	52	36	5	149
1992	0	0	0	0	0	0	0	12	35	44	31	5	127
1993	0	0	0	0	6	34	39	62	66	61	57	38	363
1994	23	4	0	0	15	0	0	13	36	45	31	5	171
1995	0	0	0	0	6	48	65	77	76	77	71	49	469
1996	29	5	0	0	25	30	34	55	61	69	52	25	385
1997	3	3	0	0	6	29	32	52	48	59	45	21	298
1998	3	3	0	0	11	45	61	77	76	77	62	42	457
1999	25	4	0	0	18	23	24	40	46	55	42	19	296
2000	2	2	0	0	5	29	30	48	50	59	45	21	292
2001	3	3	0	0	5	0	0	17	49	61	42	7	186
2002	0	0	0	0	0	0	0	18	54	68	47	7	194
2003	0	0	0	0	0	22	24	38	44	55	42	19	245
2004	2	2	0	0	5	1	1	18	50	62	43	7	192
Avg 22-04	6	2	0	0	7	17	20	37	52	60	46	18	264

Table 16B

Simulated Diversion to the Madera Canal - Spring-run Hydrograph

1,000 Acre-feet

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY Total
1922	0	0	0	0	3	25	28	50	54	63	48	23	294
1923	3	3	0	0	6	0	0	16	48	60	42	6	184
1924	0	0	0	0	0	0	0	2	3	4	7	6	22
1925	0	0	0	0	0	0	0	10	29	37	26	4	106
1926	0	0	0	0	0	0	0	9	26	33	23	3	95
1927	0	0	0	0	0	0	0	20	59	74	51	8	211
1928	0	0	0	0	0	0	0	11	31	39	27	4	111
1929	0	0	0	0	0	0	0	8	22	28	19	3	81
1930	0	0	0	0	0	0	0	7	18	23	16	2	67
1931	0	0	0	0	0	0	0	2	3	7	5	4	21
1932	0	0	0	0	0	0	0	19	56	70	48	8	201
1933	0	0	0	0	0	0	0	2	30	38	27	5	102
1934	0	0	0	0	0	0	0	5	11	14	10	1	41
1935	0	0	0	0	0	0	0	17	48	60	42	6	173
1936	0	0	0	0	0	0	0	19	57	71	49	8	204
1937	0	0	0	0	0	21	23	42	48	51	39	18	241
1938	2	2	0	0	6	37	52	66	71	73	58	39	406
1939	24	4	0	0	16	0	0	8	21	26	18	3	119
1940	0	0	0	0	0	0	0	16	48	60	42	6	173
1941	0	0	0	0	3	27	29	47	54	68	51	24	304
1942	3	3	0	0	7	25	27	44	50	62	47	22	291
1943	3	3	0	0	9	21	23	37	42	53	40	19	249
1944	2	2	0	0	5	0	0	11	30	38	26	4	119
1945	0	0	0	0	3	21	23	37	42	53	40	19	237
1946	2	2	0	0	0	0	0	15	44	56	38	6	164
1947	0	0	0	0	0	0	0	10	28	35	25	4	102
1948	0	0	0	0	0	0	0	10	28	35	24	4	101
1949	0	0	0	0	0	0	0	9	26	33	23	3	94
1950	0	0	0	0	0	0	0	11	30	37	26	4	107
1951	0	0	0	0	4	0	0	12	34	43	30	4	127
1952	0	0	0	0	0	28	21	52	55	66	49	23	294
1953	3	3	0	0	6	0	0	13	37	46	32	5	144
1954	0	0	0	0	0	0	0	10	28	35	24	4	100
1955	0	0	0	0	0	0	0	10	27	35	24	3	99
1956	0	0	0	0	3	25	27	43	49	61	47	22	277
1957	3	3	0	0	5	0	0	12	34	43	30	4	135
1958	0	0	0	0	0	27	0	49	49	61	46	22	253
1959	3	3	0	0	5	0	0	10	29	37	26	4	117
1960	0	0	0	0	0	0	0	6	14	18	13	2	52
1961	0	0	0	0	0	0	0	2	5	14	14	4	39
1962	0	0	0	0	0	0	0	17	48	61	42	6	174
1963	0	0	0	0	0	0	0	21	62	78	54	8	223
1964	0	0	0	0	0	0	0	10	27	33	23	3	96
1965	0	0	0	0	5	19	22	34	40	49	37	17	224
1966	2	2	0	0	4	0	0	13	36	46	31	5	139
1967	0	0	0	0	2	36	47	62	67	69	56	26	364
1968	3	3	0	0	7	0	0	11	31	39	27	4	126
1969	0	0	0	0	6	38	53	63	68	69	53	36	384
1970	21	4	0	0	14	0	0	13	38	48	33	5	178
1971	0	0	0	0	0	0	0	12	34	42	29	4	122
1972	0	0	0	0	0	0	0	8	23	29	20	3	83
1973	0	0	0	0	0	0	0	19	55	70	48	7	199
1974	0	0	0	0	0	22	24	38	48	54	41	19	248
1975	2	2	0	0	5	0	0	18	52	65	45	7	195
1976	0	0	0	0	0	0	0	2	10	16	13	7	49
1977	0	0	0	0	0	0	0	2	3	4	3	0	12
1978	0	0	0	0	1	40	54	64	69	70	55	37	389
1979	22	4	0	0	15	0	0	19	57	72	49	8	246
1980	0	0	0	0	6	30	33	52	60	74	56	27	338
1981	3	3	0	0	7	0	0	10	28	36	25	4	116
1982	0	0	0	0	1	37	49	62	65	61	56	38	369
1983	25	4	0	0	11	47	65	77	76	77	59	39	479
1984	24	4	0	0	8	0	0	18	53	66	46	7	225
1985	0	0	0	0	0	0	0	10	27	34	24	3	98
1986	0	0	0	0	6	26	32	52	54	65	49	23	307
1987	3	3	0	0	6	0	0	7	19	24	17	2	81
1988	0	0	0	0	0	0	0	6	17	21	15	2	61
1989	0	0	0	0	0	0	0	5	13	17	12	1	49
1990	0	0	0	0	0	0	0	2	11	14	10	1	38
1991	0	0	0	0	0	0	0	9	25	32	22	3	91
1992	0	0	0	0	0	0	0	6	15	19	13	2	54
1993	0	0	0	0	0	26	29	45	52	64	49	23	287
1994	3	3	0	0	6	0	0	8	23	29	20	3	95
1995	0	0	0	0	3	47	63	77	76	77	59	40	443
1996	24	4	0	0	16	23	24	43	49	56	42	20	301
1997	2	2	0	0	5	0	0	18	53	67	46	7	201
1998	0	0	0	0	1	38	50	61	67	73	57	27	374
1999	3	3	0	0	8	0	0	14	41	51	35	5	162
2000	0	0	0	0	0	0	0	15	45	56	39	6	162
2001	0	0	0	0	0	0	0	8	22	28	19	3	80
2002	0	0	0	0	0	0	0	8	23	29	20	3	84
2003	0	0	0	0	0	0	0	11	32	40	28	4	115
2004	0	0	0	0	0	0	0	8	21	27	18	3	76
Avg 22-04	2	1	0	0	3	8	10	22	38	46	33	10	173

34. Millerton Lake water surface elevation, surface area and storage will also be affected by the Spring-run Hydrograph release requirement below Friant. Simulated Millerton Lake storage for the current operation and Spring-run Hydrograph are provided in Appendix B, Tab B-3. Simulated lake surface area for each scenario is provided in Appendix B, Tab B-4, and the corresponding lake elevation for each scenario is provided in Appendix B, Tab B-5.

Daniel B. Steiner

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Exhibits

All tables, graphs and figures previously provided in this report may be used as exhibits during trial. Additional graphical illustrations of the data may be developed. The following pages include additional exhibits that may be used during trial.

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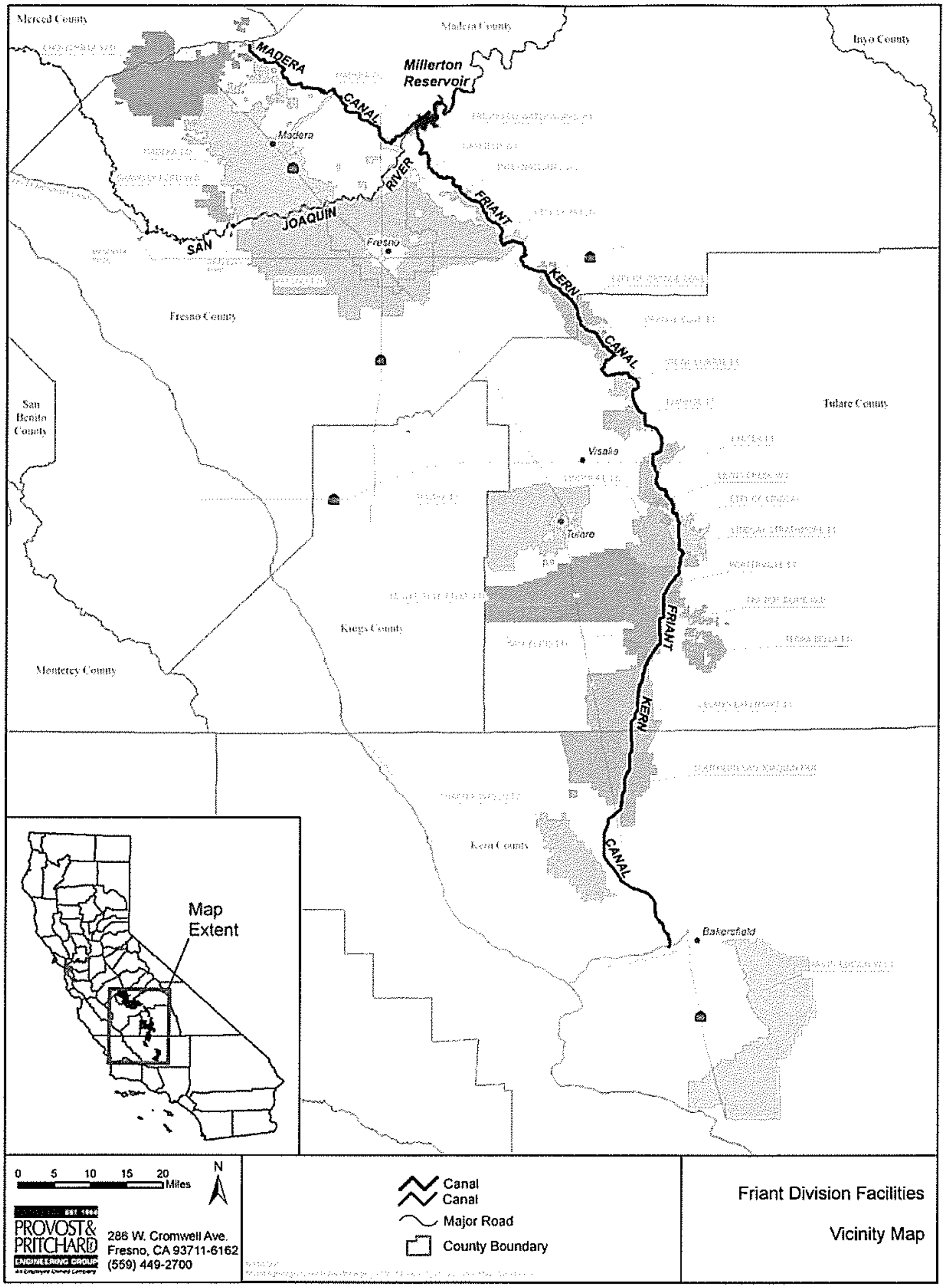
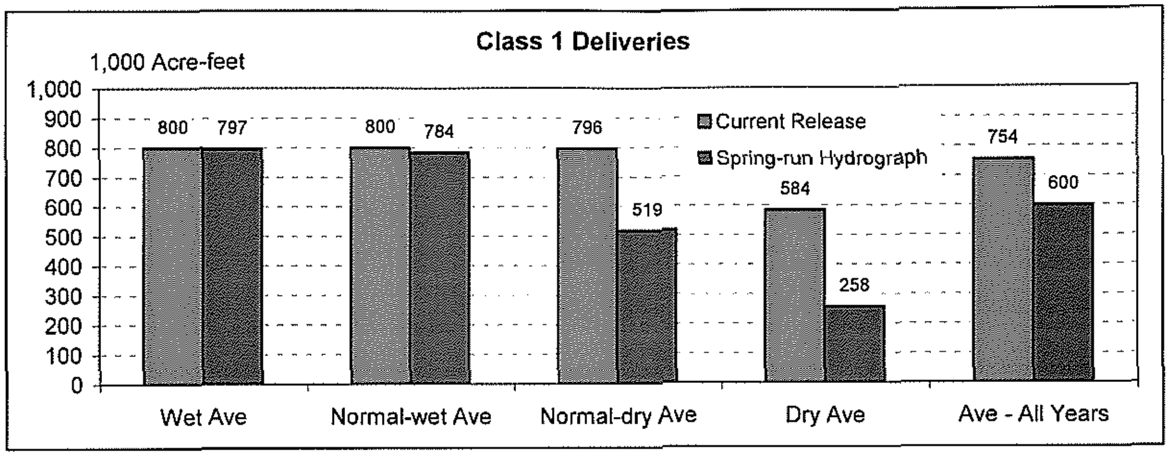
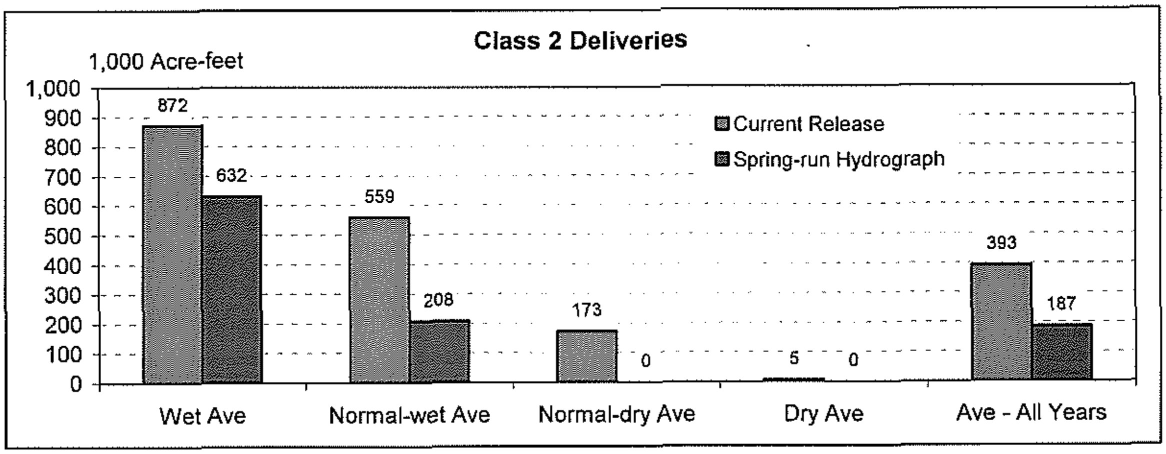
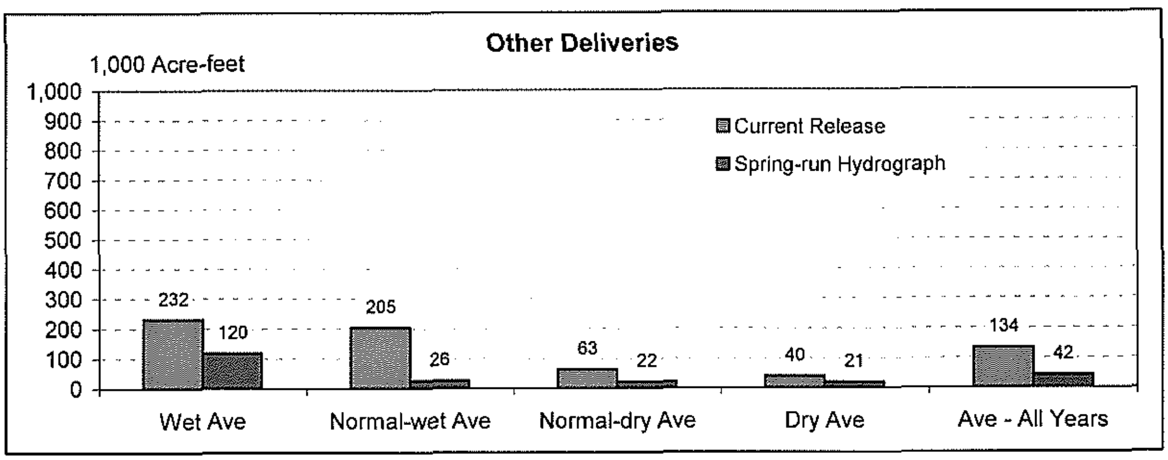
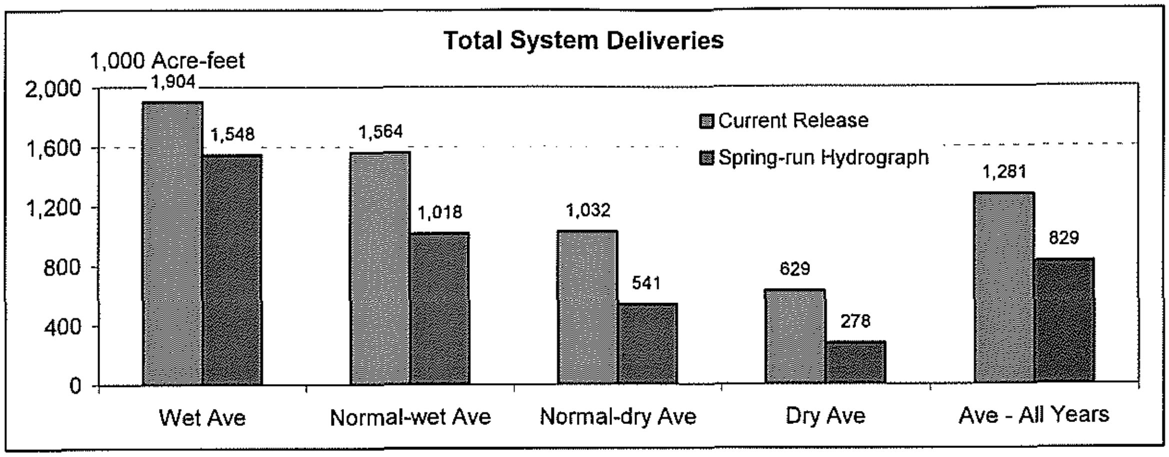
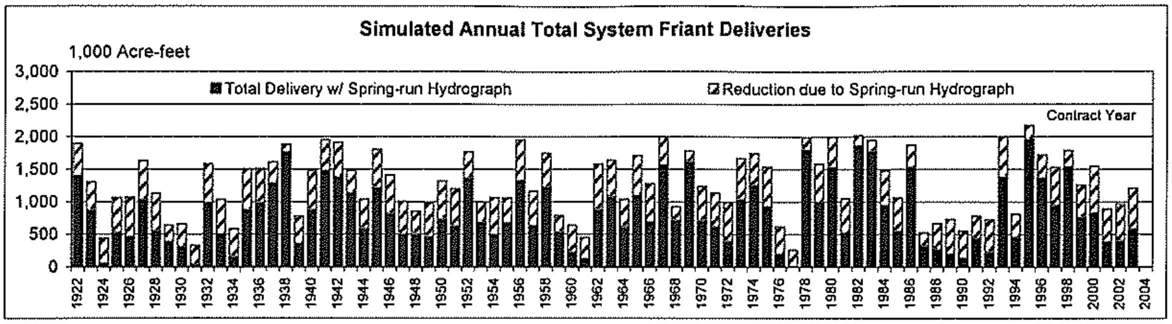

Merced County
Madera County
Inyo County
Millerton Reservoir
MADERA CANAL
Madera
SAN JOAQUIN RIVER
Fresno
FRIANT KERN CANAL
Fresno County
San Benito County
Visalia
Tulare County
Tulare
Kings County
Monterey County
Kern County
Bakersfield
Map Extent
0 5 10 15 20 Miles
N
PROVOST& PRITCHARD
ENGINEERING GROUP
286 W. Cromwell Ave.
Fresno, CA 93711-6162
(559) 449-2700
Canal
Canal
Major Road
County Boundary
Friant Division Facilities
Vicinity Map

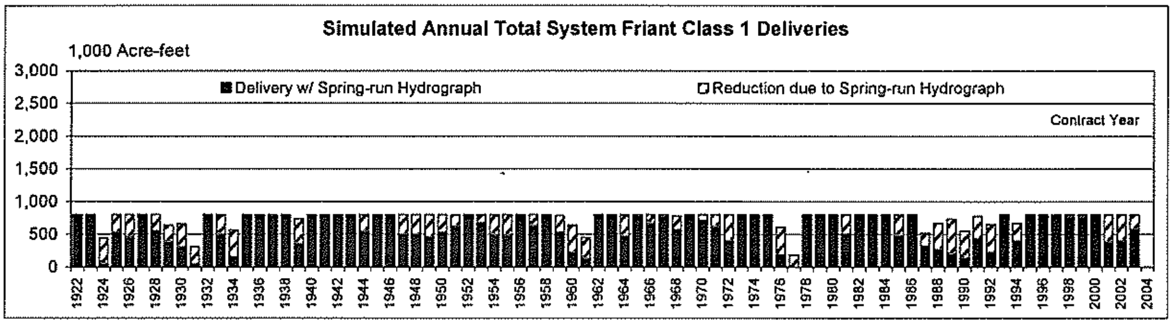

Class 1 Deliveries
1,000 Acre-feet
1,000
900
800
700
600
500
400
300
200
100
0
800
797
800
784
796
519
584
258
754
600
Current Release
Spring-run Hydrograph
Wet Ave
Normal-wet Ave
Normal-dry Ave
Dry Ave
Ave - All Years

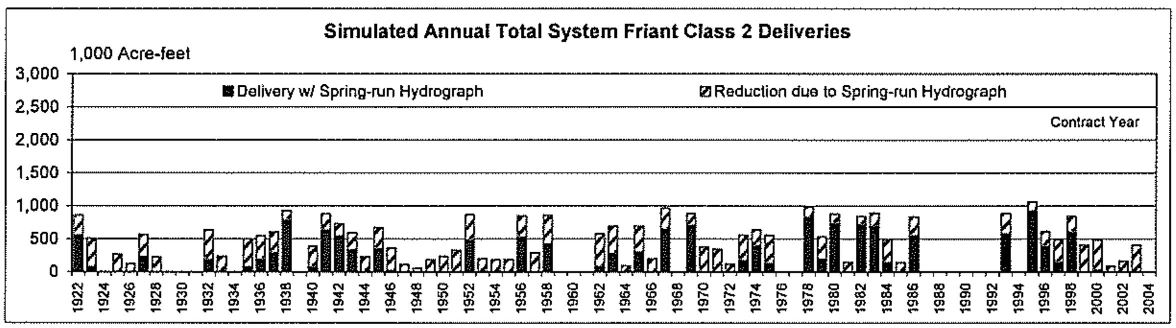

Class 2 Deliveries
1,000 Acre-feet
1,000
900
800
700
600
500
400
300
200
100
0
872
632
559
208
173
0
5
0
393
187
Current Release
Spring-run Hydrograph
Wet Ave
Normal-wet Ave
Normal-dry Ave
Dry Ave
Ave - All Years

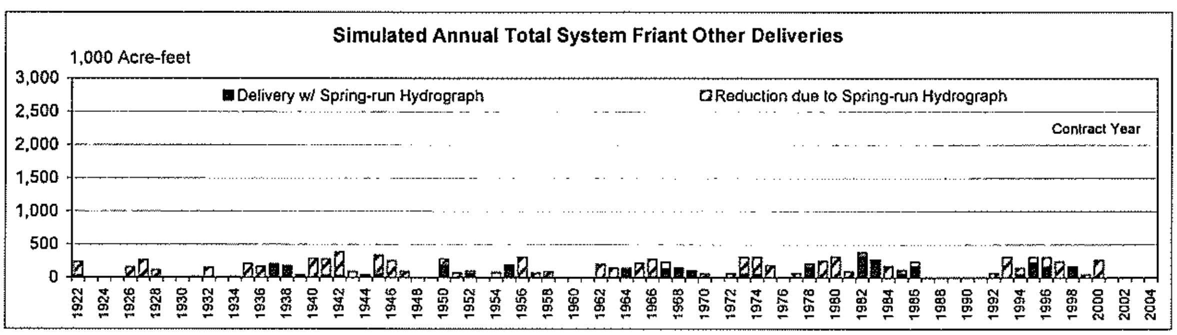

Other Deliveries
1,000 Acre-feet
1,000
900
800
700
600
500
400
300
200
100
0
232
120
205
26
63
22
40
21
134
42
Current Release
Spring-run Hydrograph
Wet Ave
Normal-wet Ave
Normal-dry Ave
Dry Ave
Ave - All Years


Total System Deliveries
1,000 Acre-feet
2,000
1,600
1,200
800
400
0
1,904
1,548
1,564
1,018
1,032
541
629
278
1,281
829
Current Release
Spring-run Hydrograph
Wet Ave
Normal-wet Ave
Normal-dry Ave
Dry Ave
Ave - All Years


Simulated Annual Total System Friant Deliveries
1,000 Acre-feet
Total Delivery w/ Spring-run Hydrograph
Reduction due to Spring-run Hydrograph
Contract Year


Simulated Annual Total System Friant Class 1 Deliveries
1,000 Acre-feet
Delivery w/ Spring-run Hydrograph
Reduction due to Spring-run Hydrograph
Contract Year


Simulated Annual Total System Friant Class 2 Deliveries
1,000 Acre-feet
Delivery w/ Spring-run Hydrograph
Reduction due to Spring-run Hydrograph
Contract Year


Simulated Annual Total System Friant Other Deliveries
1,000 Acre-feet
Delivery w/ Spring-run Hydrograph
Reduction due to Spring-run Hydrograph
Contract Year

Qualifications

RESUME

Mr. Steiner is a registered Civil Engineer with 28 years of experience in water resources planning, development and management, including operations planning for multipurpose water systems which have water and power supply, flood control, recreation, fishery and wildlife enhancement and water quality objectives. He also provides analyses of water rights, contractual and court decreed entitlements, and project operation requirements to develop water availability assessments. He has significant experience working within interdisciplinary teams in the formulation and execution of operation plans for major multi-purpose water projects.

PROFESSIONAL HISTORY

Self-employed: Daniel B. Steiner, Consulting Engineer
Bookman-Edmonston Engineering, Inc., 1991-1993
Resource Management International, Inc., 1983 to 1991
U.S. Bureau of Reclamation, 1977 to 1983

REGISTRATION AND EDUCATION

Registered Civil Engineer, California (Certificate No. 32226)
B.S., Civil Engineering, University of California, Davis, 1977

REPRESENTATIVE EXPERIENCE

Assisted with the development of a hydrologic database for the San Joaquin Valley for implementation into the CALSIM II State-wide simulation model. The effort included research and development of a long-term hydrologic record of streamflows, depletions and accretions. The effort also developed the depiction of current water project operations throughout the Valley. The operations include considerations for water supply, power generation, flood control, water quality and fisheries. The result of the effort is being used within on-going State-wide water modeling and planning.

Assisted with the formulation and documentation of hydro-generation system operation analyses for the Upper American River Project of the Sacramento Municipal Utility District. Assistance included the preparation of model documentation and the presentation of analyses results during public workshops.

Assisted with the formulation and analysis of opportunities to exchange water from the State Water Project into the Kings River Water Association service area for water originating from the Kings River. The exchange has an objective to improve the quality of water delivered to Southern California. Other aspects of the project included flood control, and water supply for environmental enhancement purposes. Assistance included the formulation and development of a model to simulate the operation of the exchange, assuming existing conveyance systems and proposed new storage and conveyance systems.

Directed and performed the hydrologic analyses for the development of water supply alternatives for use in the restoration of habitat in the San Joaquin River. The analyses included the formulation of water supply and management alternatives and the development of models for their evaluation. The scope of the analyses incorporated water conveyance and storage opportunities within the San Joaquin Valley, with an objective to develop water for the restoration of the San Joaquin River below Friant Dam while maintaining diversions to the Friant Division of the Central Valley Project.

Assisted with the development of a system operation planning model for the Marin Municipal Water District. This effort included direct interaction with District staff and its Board of Directors in formulating a model that could simulate the operations of the existing system, and proposed changes to that system in terms of contracted purchases and a potential desalination plant. The current operational criteria and objectives of the system were incorporated into the model to provide a simulation of operations over various hydrologic sequences. Modified criteria were developed to simulate potential operations with changes in assumptions for the availability of water supply resources.

Assisting with the annual transfer of water from members of the San Joaquin River Exchange Contractors Water Authority to various Central Valley Project water users within the San Joaquin Valley. During this process assistance was provided with the development of the hydrologic analysis for the program's Environmental Assessment and Initial Study. Also assisted with the development of an EIR/EIS for the transfers. Assistance was provided for the development of monitoring and reporting protocols to document the transfers. Currently providing an on-going evaluation and reporting function on behalf of the Authority.

Assisted the South San Joaquin Irrigation District in developing a water sales arrangement with several municipal water entities within the San Joaquin Valley. The project involves the development of a surface water treatment plant to deliver water that has previously been used for irrigation purposes. The assistance included performing analyses of Stanislaus River operations considering the proposed project, and has involved working with the Bureau of Reclamation in identifying potential hydrologic impacts.

Participated in the California State Water Resources Control Board hearing process regarding the implementation of the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. On behalf of the City and County of San Francisco and other major water right holders in the San Joaquin Valley, provided analyses and testimony regarding alternative methods of implementing the Water Quality Control Plan. The analyses included the determination of anticipated water supply impacts to various water right holders under different theories of responsibility. Parallel to the Bay-Delta hearing process, participated in the scoping and development of the environmental documentation of an implementation plan by the State Board, including the development of comments to the State Board's Environmental Impact Statement.

Concurrent with the implementation process of the 1995 Water Quality Control Plan, participated in the development of an implementation plan for the San Joaquin River portion of the Water Quality Control Plan. Assistance included technical analyses that supported the negotiation and development of the San Joaquin River Agreement, which incorporates a plan for improving fishery and water quality conditions in the San Joaquin River. Those analyses evaluated viable water project operation alternatives for the Stanislaus, Tuolumne, Merced and San Joaquin rivers. Subsequently developed and performed the hydrologic analyses that were incorporated into the environmental documentation for the agreement.

Participated in the technical and regulatory forums leading up to the issuance of State Water Resources Control Board Orders for the interim implementation of the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. On behalf of the City and County of San Francisco, provided technical review, analyses and testimony regarding the technical basis of proposed water quality and biological standards and their potential effects to water supplies. Participation in this effort included working within numerous technical and policy groups which were comprised of water supply, public agency and environmental interests. Represented the City during the negotiation of the water quality standards and principles included in the December 15, 1994 "Principles for Agreement on Bay-Delta Standards Between the State of California and the Federal Government."

Participating as a representative of the San Joaquin River Group Authority within the CalFed Operations Coordination Group. This activity concerns the discussion and coordination of water operations within the Bay-Delta watershed to enhance water supply and ecological benefits, and accomplishing the principles set forth in the December 15, 1994, Principles for Agreement, the objectives of the 1995 Water Quality Control Plan, and various Endangered Species Act requirements. Currently providing on-going assistance with the implementation of the San Joaquin River Agreement, and the monitoring and reporting the agreement's affect on Central Valley Project and State Water Project operations.

Assisted with the preparation and update of the Urban Water Management Plan report for the City and County of San Francisco. This report to the California legislature includes identification of the City's water supplies and demands, conservation efforts and a plan of operation during drought. In support of this report, directed the development of an end-use water demand forecast model that incorporates factors that represent water conservation programs.

Provided peer review on a proposed groundwater aquifer storage and recovery project in Sacramento County. On behalf of Sacramento County, the project proponent's water demand and water supply concept were reviewed. The water supply concept involved the storage of surface water in a groundwater basin to meet within-year and year-to-year demands, and the intensive management and use of reclaimed water. Assistance was provided to the County with the development of project operation requirements and mitigation measures.

Assisted the Klamath Water Users Association evaluate the potential impact of a proposed operation plan for the Klamath River Project upon water deliveries to its members. The analysis identified conflicts between water deliveries and proposed project operations for Endangered Species Act requirements.

Responsible for the development and performance of technical analyses to determine the yield of the water supply of the City and County of San Francisco. These analyses include evaluation of surface water hydrology and contractual, legislated and water rights entitlements, and the development of operational criteria for a water supply system that provides water to over 2.3

million people. Recent investigations include opportunities to enhance dry-year water supply reliability with the development of reservoir and groundwater storage in the Bay Area, and the exercise of water purchase opportunities.

Participated in the negotiation of a settlement agreement concerning water diversions within the Tuolumne River basin and the mitigation of impacts to the lower Tuolumne River. As the result of a Federal Energy Regulatory Commission evaluation of the New Don Pedro Project, an agreement was reached among water users, resource agencies and environmental and recreation interests for instream flows and non-flow programs for the lower Tuolumne River. Participated as a representative of the City and County of San Francisco in this forum which included the negotiation of an agreement to mitigate potential water supply impacts to the City.

Participated in the review of the Programmatic Environmental Impact Statement and implementation plan for the Central Valley Project Improvement Act. On behalf of the City and County of San Francisco, in collaboration with other urban water agencies, provided technical review of the alternatives being considered for evaluation and implementation. Reviews and comments were provided regarding development of the Anadromous Fish Restoration Program, water transfers and dedicated use of Central Valley Project water supplies for fish and wildlife purposes.

Participated in the Sacramento Area Water Forum process which developed an area-wide water plan that will provide a safe, reliable, and environmentally sound water supply to meet the needs of the Sacramento area community. On behalf of the City of Sacramento, and as a consultant to the Forum's staff, provided assistance with the development of alternative solutions for the allocation and management of Sacramento area water supplies among consumptive uses and environmental purposes. Provided assistance with the development of a flow management plan for the American River.

Responsible for the formulation and development of the water demand and supply analysis to support the combined EIS/EIR for the implementation of Public Law 101-514 which provides for a Central Valley Project water supply contract to the Sacramento County Water Agency and the San Juan Water District. Responsible for the development of the analysis which evaluated water delivery alternatives associated with the water supply contracts, including the formulation of hydrologic and operational assumptions for surface water diversions from alternative sites along the American and Sacramento rivers.

Responsible for the development of a statement of need and purpose for an expansion of the City of Sacramento's water supply system. Also developed the analysis of alternatives to be included in the investigation supporting the EIR for the expansion project. The alternatives included alternative diversion locations for the City's water rights and entitlements, and alternative management of the diversions through conjunctive use opportunities.

Responsible for the development of a water system master plan for the City of Patterson, California, including the evaluation of infrastructure required to integrate groundwater and surface water supply sources. Strategies to acquire a surface water supply were also investigated as part of the planning process.

Researched the water rights affecting the availability of water, and provided an assessment of the conformance of water use to those rights for the Wild Horse Sanctuary, Shasta County, California.

Responsible for the development of a water management investigation for Sacramento County, including testimony to the State Water Resources Control Board and the State Superior Court regarding competing uses of water from the American River, California. Alternative operations procedures were developed to accommodate the competing demands of water supply, power generation, flood control, fish and wildlife, and recreation. Extensive interaction was required with biological consultants during the formulation of the alternative operation procedures.

Analyzed hydrologic and hydraulic conditions that led to flooding events in Sacramento, El Dorado, Placer, Napa and Yolo Counties. Evaluations included the review of drainage design plans and hydro-meteorological data, and computer modeling of hydrologic and hydraulic phenomena. Stream channels and urban drainage systems were analyzed.

Developed operation simulation models for projects incorporating water and hydroelectric attributes at both existing and proposed facilities. The models facilitated the review of alternative project features and operational variations. Over 25 hydroelectric projects throughout the western United States were evaluated with those models, including run of river projects and reservoir systems.

Directed the operation of Central Valley Project facilities in California, including Trinity, Shasta, Folsom, New Melones, Millerton and San Luis Reservoirs and associated water conveyance facilities. These operations required the satisfaction of water quality objectives for the Sacramento-San Joaquin Delta and flood control requirements for project facilities.

Developed and performed forecasts of Central Valley Project operations. These forecasts included the estimation of stream runoff and diversion demands, and were applied on a daily and annual basis.

Coordinated daily Central Valley Project operations with State Water Project operations in accordance with the Coordinated Operations Agreement which is a State-Federal agreement that specifies the availability of water to each project and responsibility for meeting water quality objectives.

Developed and presented testimony before the California State Water Resources Control Board regarding water availability from the Central Valley Project concerning standard permit Term 91 On behalf of the Bureau of Reclamation developed an accounting procedure to determine when supplemental water is being provided from the CVP and SWP.

Recent Testimony

The following is a listing of instances where I have recently provided testimony and declarations to a court or regulatory body.

Developed analysis of the operation of the San Joaquin River Agreement. On behalf of the San Joaquin River Group Authority, the analysis was provided in support of an opposition to a temporary restraining order concerning Central Delta Water Agency, et al. v. United States Department of the Interior, et al. The analysis determined the hydrologic effect of implementing the San Joaquin River Agreement during 1999 in terms of flow and water quality within the San Joaquin River and its tributaries. Declaration provided, 1999. Developed additional written testimony concerning the implementation of the SJRA for a long-term period of implementation. Deposition provided, 2003.

On behalf of the San Joaquin River Group Authority, submitted an expert analysis and provided testimony to the State Water Resources Control Board regarding the potential hydrologic impact of implementing the provision of up to 47,000 acre-feet of supplemental water for San Joaquin River Agreement. Testimony provided, April 2003.

On behalf of Friant Water Users Authority, developed an analysis of the potential effect to the water deliveries of the Friant Division of the Central Valley Project, California if supplemental releases are required below Friant Dam for river restoration purposes. Natural Resources Defense Council, et al. v. Roger Paterson, etc., et al. Declarations provided, January 2004 and June 2004.

Compensation

The preparation of this report has been done on a time-and-materials basis. My billing rate is $143.50 per hour, and to date the compensation for developing this report has been approximately $50,000. Providing expert testimony under oath will be compensated at $215.25 per hour.