Congressional Research Service

Memorandum September 27, 2007

TO: The Honorable Devin Nunes
Attn: Damon Nelson

FROM: Nicole T. Carter
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SUBJECT: Friant Water Supplies and Potential Impacts of the San Joaquin River Settlement

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This memorandum is 1 of 11 memos written in response to your questions of October 24, 2006, regarding the Settlement of the *Natural Resources Defense Council v. Rodgers* lawsuit. Per discussions with your staff, each of the memos is tailored to specific bullet points listed in your initial request. For a comprehensive review of the issues associated with the Settlement, this memo should be read in tandem with the other CRS memos. Also, many of the tables and figures in this memo are best viewed in color; black-and-white reproductions may lose some of the information contained in the tables and figures.

The Settlement aims to resolve a 19-year-old lawsuit between NRDC (plaintiffs) and the Bureau of Reclamation and Friant Division long-term water service contractors (defendants). As part of the lawsuit, a U.S. District Court judge ruled that operation of Reclamations Friant Dam violated California state law because of its destruction of downstream fisheries. Faced with mounting legal fees and considerable uncertainty, the parties agreed to negotiate a settlement on a remedy instead of proceeding to trial. The Settlement provides for water to be released to and remain in the San Joaquin River to restore fisheries. This contrasts with current operating protocols, under which the water is diverted to off-stream uses in the Friant Division Service Area of Reclamations Central Valley Project (CVP), as has been the practice since the late 1940s. Changes in water use and their impacts on Friant water contractors, landowners along the river downstream of the dam, and others have been contentious. The issue is before Congress because parts of the Settlement require federal authorization and appropriations. Such legislation was introduced in January 2007: H.R. 24 and S. 27. Both House and Senate Committees of jurisdiction have held hearings on the legislation.

You requested "statistical information on current water supplies from the federal project on the San Joaquin River and the impacts on those supplies as proposed in the Settlement — sorted by water districts within the Friant Division." At the outset, we note that it is difficult to predict the ultimate effect of the Settlement's increased releases from Friant Dam for fish restoration on future deliveries to water supply contractors served by the Friant Division. Complications include that few data are available on what actions Reclamation or water users might take to mitigate reduced Friant water deliveries, and that guidelines and other specifics regarding Settlement implementation remain to be determined. Although broad conceptual papers are available, decisions on one or more courses of action have not been made.

To respond to your request, CRS collected and reviewed available information. Generating new data sets on potential impacts is beyond the scope of this CRS analysis. Thus, this memo compiles and analyzes existing data and estimates of water supplies. This memo largely relies on two available data sets on the estimated reductions to Friant water supplies under the Settlement:

- Expert report of Daniel B. Steiner, *Effects to Water Supply and Friant Operations Resulting From Plaintiffs' Friant Release Requirements*, September 16, 2005 (hereafter referred to as Steiner 2005), prepared for Friant Water Users Authority; and

- U.S. Department of the Interior, Bureau of Reclamation, *Friant Division Allocations Based on SJR-Settlement Exhibit B Hydrographs for Restoration Releases,* table released December, 2006 (hereafter referred to as BOR 2006).

The data sets are described in **Appendix A**, Data Sources and Limitations of Analysis. The analysis herein was performed using both data sets when possible. However, many of the figures in the memo present information from only one data set; figures based on the other data set are included in **Appendix B**, Additional Figures.

Even though the data are imperfect — the estimates were made assuming no changes in Friant Dam or other Central Valley Project (CVP) operations, no changes in water use efficiency, and no other actions that might mitigate reduced Friant water supplies — they give some idea of the range of changes that water users might experience under the Settlement. The first part of this memo provides an overview of water supplies in the Friant Division Service Area, including not only releases from Friant Dam but also other surface water and groundwater supplies. The next part of the memo discusses how water needs for restoration flows under the Settlement might affect Friant Division water supplies. It addresses potential effects of the Settlement on *aggregate* Friant Division contract water supplies; it then analyzes estimates of the reduction in supplies for *individual* water districts (contractors). This memo attempts to present data that illustrate not only the average annual water supply reductions under the Settlement, but also the variation that might be experienced annually. Specific effects of the Settlement on groundwater supplies and potential economic impacts of water reductions and increased restoration flows are discussed in separate memos. Where reductions in water supply are discussed, they are relative to long-term average water deliveries, not the full amount of water supply contracts.

Summary — Friant Water Supply Results in Brief

The Settlement would use San Joaquin River water, which in recent history has been diverted and delivered to Friant Division contractors for off-stream uses, to maintain in-stream flows in the San Joaquin River for fish restoration. The Settlement would reduce Friant water deliveries to water districts absent offsetting measures. That is, the Settlement would redistribute a portion of the annual water supply away from agricultural and municipal water districts to achieve the restoration flows (hydrographs) agreed to under the Settlement. In a given year, how much less water would be available for off-stream uses in the Friant Division Service Area would depend largely on how much water would be released for fish restoration. Following a protocol established in the Settlement, the restoration flows would be determined annually based on the basin's estimated runoff for the year.

The restoration flows in the Settlement will be higher in wetter years and lower in drier years. The quantity of water used for restoration flows and the quantity by which water deliveries would be reduced are related, but the relationship is not always one-for-one. For instance, in some of the wettest years, much of the restoration flows would be met by flood water releases, not reduced deliveries. Under the Settlement, no water would be released for restoration purposes in the driest of years; thus, no reductions in Friant deliveries would be made due to the Settlement.

Using available data, it appears that annual water supplies for the Friant Division Service Area would be, *on average*, 15% to 16% less under the Settlement, than average supplies under current operating protocols. Although the average reduction could be 15-16%, water supply reductions could be as little as no reduction, to as high as 34% reduction in some years. The average annual reduction in the volume of water delivered under the Settlement is estimated to be between 204 thousand acre-feet (taf) and 225 taf less than average annual supplies without the Settlement; the range of total annual reductions is estimated to be between no reduction to 433 taf.

In addition to the overall reductions in off-stream supplies varying annually under the Settlement, reductions experienced by individual water districts would vary depending on their water service contracts. That is, the reduced delivery experienced in a given year by an individual water district would largely depend on how "firm" is the district's Friant water supply contract. Contracts with first priority delivery (referred to as Class I contracts) generally are held by the districts which serve municipalities and agricultural users without sources to other supplies — areas often in the foothills not underlain with adequate or reliable groundwater supplies. Assuming Reclamation reduces "supplemental" water deliveries (i.e., the water provided to Class II contract holders) before first priority deliveries, rough estimates of reductions in average annual Class I and Class II water supplies may include —

- 5% for the districts with only higher priority Class I contracts, representing 46% of the contractors;
- 6% to 15% for 36% of the districts;
- 16% to 20% for 11% of the districts; and
- 27% for the remaining 7% of the districts, which only have Class II contracts.

Possibilities exist to partially offset lower off-stream deliveries through water conservation, efficiency measures, water transfers and marketing, groundwater storage, and new infrastructure. However, at this time, it is unclear to what extent these measures could mitigate the lower deliveries, at what cost, and which measures might occur as part of the Settlement's water management goal. Further, some Class II supplies are used to recharge groundwater and to conjunctively manage seasonal or yearly surface and groundwater supplies; other Class II supplies are stored for future use. Because of this complication, it is unclear what effect water conservation and efficiency measures (which would reduce inflows to groundwater) would have on long-term water demands and supply management.

Water Supplies in the Friant Division Service Area

The Friant Division Service Area of the CVP extends from just north of the Merced/Madera County line north of the San Joaquin River, southeast to Bakersfield, CA. (See **Figure 1**.) Much of the area is naturally well-endowed with both surface and groundwater supplies, and has benefitted from extensive federal investment in the development of surface water supplies, as well as investment in private and public groundwater recharge projects. The waters of the service area support a substantial farm and food processing economy, as well as a growing population. The area is bisected by several large rivers and streams; the largest surface water source for the Friant Division Service Area is the San Joaquin River, which lies in the northern part of the service area. San Joaquin River water is stored behind Reclamation's Friant Dam in Millerton Lake and is delivered to long-term contractors (also referred to as water users or water districts) via the Madera Canal and Friant-Kern Canal. Friant Dam and the two canals are managed as part of the federal CVP. Even though the area is relatively rich in water resources compared to much of the West, groundwater overdraft has been a perennial problem since the area was intensely developed for agriculture early in the 20th Century.

Runoff entering Millerton Lake (i.e., the Millerton Lake drainage area) averages 1,700 taf, but can vary widely; from 1922 through 2004, runoff has varied from a low of 362 taf in 1977, to a high of 4,642 taf in 1983 (Steiner 2005). This large variation can lead to management difficulties, particularly in extremely dry and extremely wet years. Millerton Lake has a capacity of approximately 500 taf,[1] which is insufficient to provide multi-year storage. As a consequence of its capacity, the reservoir is operated on an annual basis and may refill multiple times in a wet year. Because the lake does not have multi-year storage, the quantity of water available for delivery in a given year is largely a function of that year's runoff.

In non-flood years, all but sufficient flows to satisfy water right holders below the dam (i.e., riparian releases representing approximately 117 taf annually in recent years) is diverted away from the San Joaquin riverbed into the Friant-Kern Canal and Madera Canal just below the dam. These canals transport the water for delivery to Friant water users. Once the riparian water rights holders (Reach 1) remove their water, the river generally runs dry or with little water for most of the year in the 24-mile stretch between Gravelley Ford and Mendota Pool

[1] [http://www.usbr.gov/dataweb/html/friant.html#general], accessed July 27, 2007.

(Reach 2). (See **Figure 2** for a map of the river reaches.) Except when there are flood releases, the water in the San Joaquin River between Mendota Pool and Sack Dam (Reach 3) is not San Joaquin River water; it is CVP water imported from northern California through the San Joaquin and Sacramento Rivers/San Francisco Bay Delta. A group of CVP contractors known as the San Joaquin River Exchange Contractors removes this imported Delta water from the river over the course of Reach 3.[2] After these non-Friant Division deliveries, the river is generally dry for 46 miles from Sack Dam to Bear Creek (Reach 4) except for inflows from high groundwater supplies and agricultural runoff.

Reclamation historically has operated Friant dam to maximize water deliveries in the Friant Division while first meeting water right obligations downstream — i.e., releasing water to the river only as necessary to meet downstream water right obligations and to manage flood waters. Because water deliveries to the Friant Division (after downstream water right obligations are met) are maximized each year, some reaches of the riverbed remain dry during portions of many years. According to the 2004 ruling of the U.S. District Court, Eastern District, California,[3] this management regime has resulted in untenable effects on downstream resources, particularly anadromous fish, under California state law.

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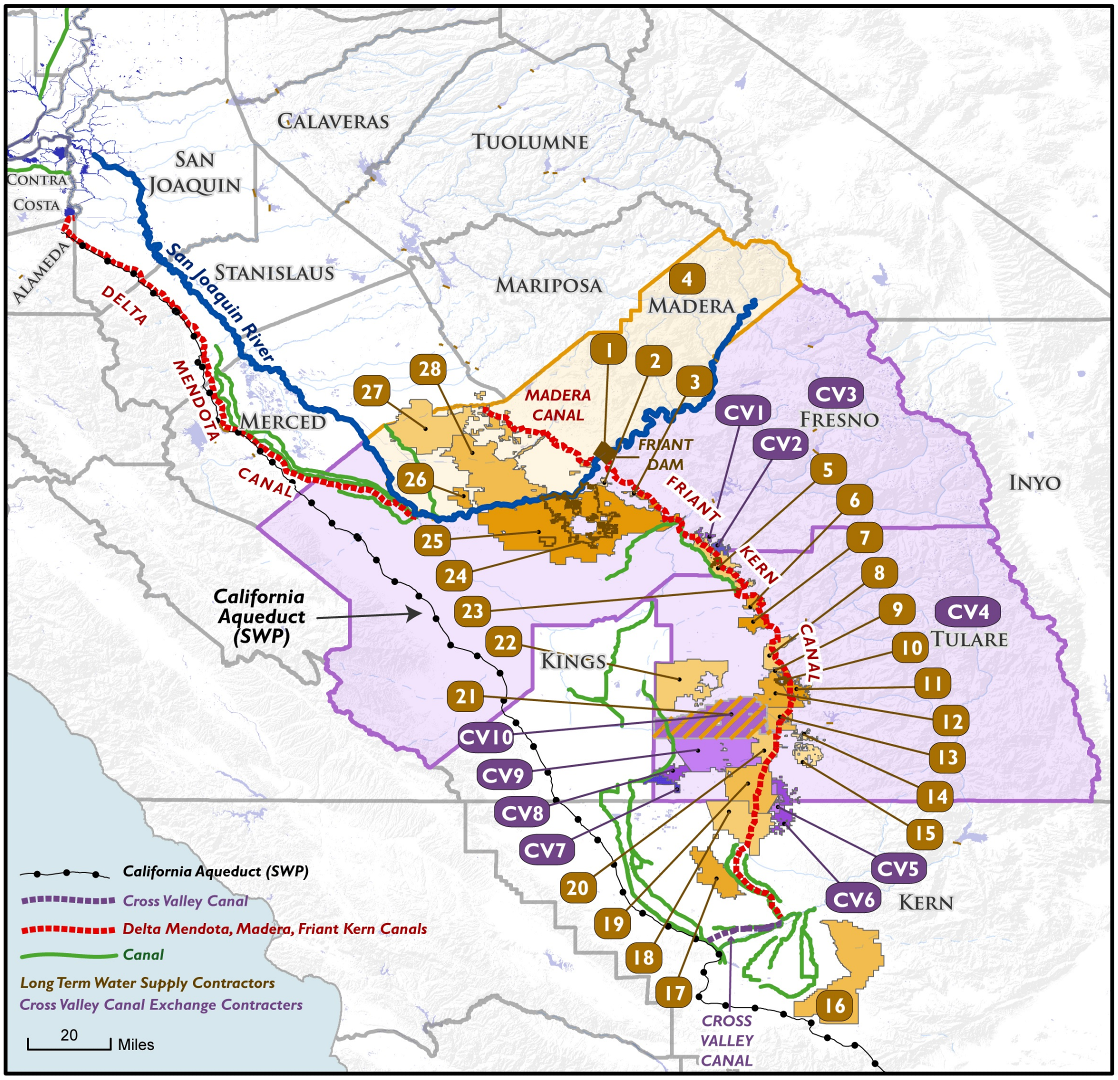
[2] San Joaquin River Exchange Contractors receive their water supplies via other CVP facilities, principally, the Delta-Mendota canal and Mendota pool. These contractors have senior San Joaquin River water rights which predate construction of Friant Dam. These contractors agreed to receive non-Friant CVP supplies in lieu of taking water directly from the San Joaquin River, as they had done prior to construction of Friant Dam; however, if such supplies are not available, they may take their supplies from Friant releases. In essence these contractors entered into contracts "exchanging" their river diversion for a supply of water from other CVP facilities; however, they retain a senior water right that predates construction of Friant Dam.

[3] NRDC v. Patterson, 333 F. Supp. 2d 906, 925 (E.D. Cal. 2004).

Figure 1. Friant Division Service Area



Source: Friant Water Authority; U.S. Bureau of Reclamation. Map: Congressional Cartography, Library of Congress, 2007

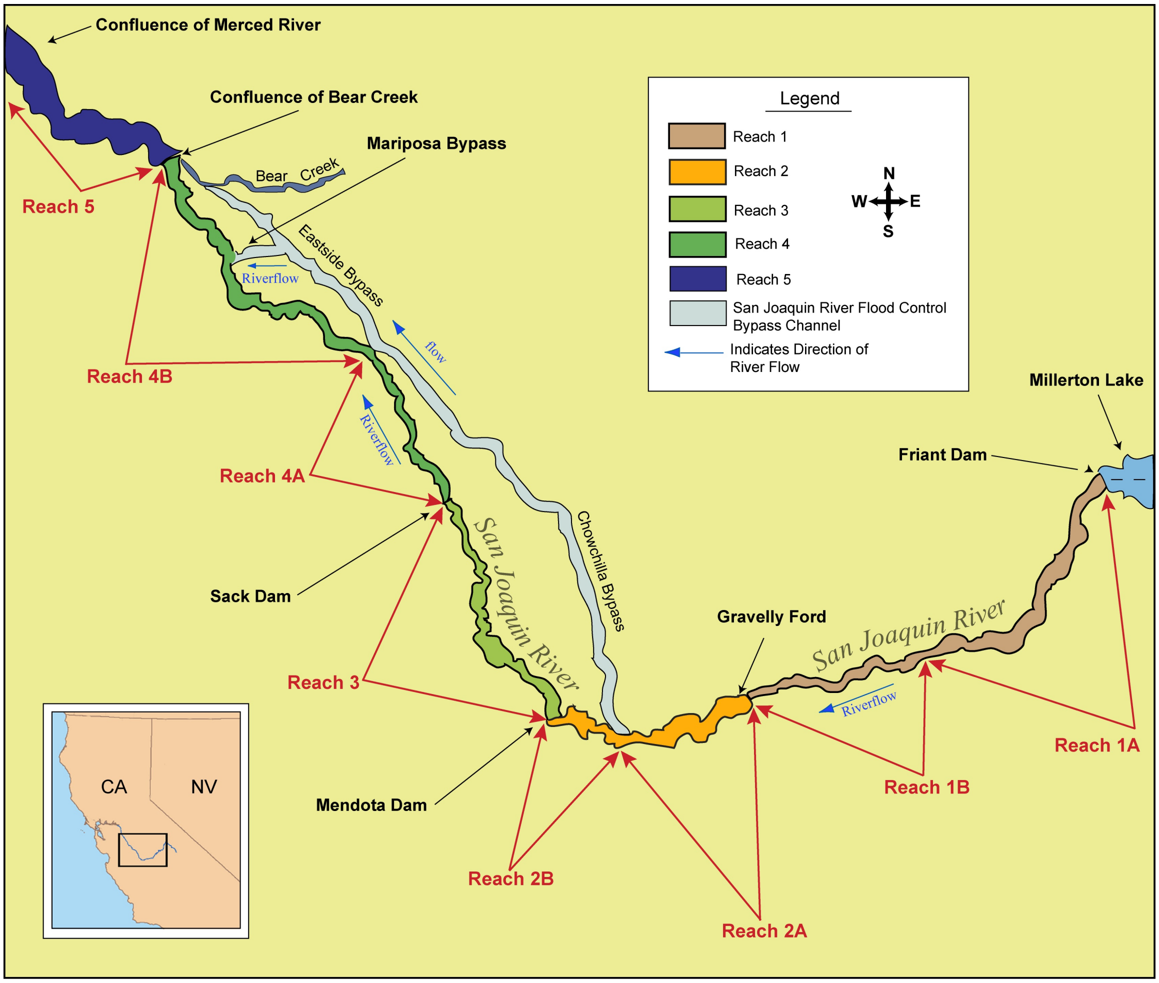
LONG TERM WATER SUPPLY CONTRACTORS

1 FRESNO CO. WATERWORKS NO. 18
2 GARFIELD WATER DISTRICT
3 INTERNATIONAL WATER DISTRICT
4 MADERA COUNTY
5 ORANGE COVE IRRIGATION DISTRICT
6 STONE CORRAL IRRIGATION DISTRICT
7 IVANHOE IRRIGATION DISTRICT
8 EXETER IRRIGATION DISTRICT
9 LEWIS CREEK WATER DISTRICT
10 CITY OF LINDSAY
11 LINDSAY-STRATHMORE IRRIGATION DISTRICT
12 LINDMORE IRRIGATION DISTRICT
13 PORTERVILLE IRRIGATION DISTRICT
14 TEA POT DOME WATER DISTRICT
15 TERRA BELLA IRRIGATION DISTRICT
16 ARVIN-EDISON W.S.D.
17 SHAFTER-WASCO IRRIGATION DISTRICT
18 SOUTHERN SAN JOAQUIN M.U.D.
19 DELANO-EARLIMART IRRIGATION DISTRICT
20 SAUCELITO IRRIGATION DISTRICT
21 LOWER TULE RIVER IRRIGATION DISTRICT
22 TULARE IRRIGATION DISTRICT
23 CITY OF ORANGE COVE
24 CITY OF FRESNO SERVICE AREA
25 FRESNO IRRIGATION DISTRICT
26 GRAVELLY FORD WATER DISTRICT
27 CHOWCHILLA WATER DISTRICT
28 MADERA IRRIGATION DISTRICT

CROSS VALLEY CANAL EXCHANGE CONTRACTORS

CV1 TRI-VALLEY WATER DISTRICT
CV2 HILLS VALLEY IRRIGATION DISTRICT
CV3 FRESNO COUNTY
CV4 TULARE COUNTY
CV5 RAG GULCH WATER DISTRICT
CV6 KERN-TULARE WATER DISTRICT
CV7 ATWELL ISLAND WATER DISTRICT
CV8 ALPAUGH IRRIGATION DISTRICT
CV9 PIXLEY IRRIGATION DISTRICT
CV10 LOWER TULE RIVER IRRIGATION DISTRICT

Figure 2. San Joaquin River Reaches



Surface Water Supplies

Friant Dam Releases. In January each year, Reclamation makes a preliminary projection of how much runoff is expected in the Millerton Lake drainage area. A formal estimate is made each February, and re-calculated monthly throughout the spring and summer. In most years, approximately 70% of the runoff occurs in spring and early summer (April - July). Using these projections, Reclamation decides how to "allocate" Friant water supplies. Water *releases* at Friant Dam fall into several categories:

- *Riparian flow releases* are made to supply water to water right holders below the dam who are not part of the Friant Division Service Area and are not party to the Settlement. These releases have been approximately 117 taf annually in recent years, and would not change under the Settlement Agreement or proposed implementing legislation.

- *Flood releases* may be necessary when forecast runoff is excessive or when water inflow exceeds the capacity of the reservoir. When additional releases above the minimum(riparian water rights releases) need to be made, portions of the flood releases may be used for temporary water contracts.

- *Releases for diversion* to canals that deliver water to long-term contractors in the Friant Division Service Area of the CVP.

Friant Division Water Supplies. Twenty-eight water districts in the Friant Division Service Area have long-term contracts with Reclamation for the delivery of water stored behind Friant Dam (see **Table 1**). This water supplies approximately 1 million acres of farmland and several cities and towns, including the City of Fresno. Water is delivered northwest via the 36-mile Madera Canal, and south via the 152-mile Friant-Kern Canal. (See **Figure 1**.) Annual deliveries are reported to average around 1,300 taf. In total, approximately 15,000 farms are served by Friant water supplies. Friant water supply deliveries and allocations fall into several categories:[4]

- *Class I* water, sometimes referred to as the "firm" supply,[5] is the first 800 taf of storable water (if available) in the Millerton Lake drainage area in excess of instream rights; it is allocated to Friant long-term water service contractors. It is delivered to districts with limited or no access to groundwater supplies, and as a base supply to other districts. Class I supplies are insufficient to meet the base supplies of all districts.

- *Class II* supplies are "supplemental" supplies. Class II water is allocated and delivered only when Class I demands can be fully met. Class II water often is used for irrigation supplies. In wetter years, Class II water also is used to directly recharge groundwater supplies through various means or used in lieu of groundwater (i.e., contractors use Class II surface water instead of pumping groundwater when it is available), thereby meeting water demands and partially restoring groundwater supplies.

- *§215* "temporary" water may be made available when flood waters must be released from Friant Dam. Under §215 of the Reclamation Reform Act of 1982 (P.L. 97-293), normal ownership and full cost pricing limitations of reclamation law are waived for lands that receive only a temporary (not to exceed one year) water supply. Under §215, the Secretary also is authorized to waive payments for such supplies.

Class II and §215 demands and deliveries are highly variable depending on runoff quantity and timing and Reclamation operating and contracting procedures. For example, there exists considerable financial incentive to take §215 water in lieu of Class II deliveries

[4] Adapted from Friant Water Users Authority Briefing Book, handout entitled, *About the Friant Division*, Sept. 2006, p. 2.

[5] Although Class I supplies are "firm" relative to other Friant supplies, they are subject to water availability; consequently, the full contract amount may not be delivered in some years.

when §215 fees are waived. When declaration of §215 water availability is made early in the season, many contractors reduce or sometimes forego Class II deliveries.

Table 1 lists the average annual Class I and Class II water supplies for the 28 Friant water districts, and the average §215 delivery for all districts. (See bottom of **Table 1**.) Total Class I water supplies ranged from 200 taf to 800 taf between 1962 and 2003 (Steiner 2005); combined Class II and §215 allocations ranged from nothing to 1,401 taf (BOR 2006). Average annual Class I, II, and §215 water supplies in **Table 1** total to 1,281 taf. **Table 1** shows a Class I average of slightly less than the full contract amount of 800 taf largely because runoff was insufficient in drought years to allow Reclamation to fully meet Class I contracts.

Table 1. Friant Contractor Annual Water Supply & Supply Diversity

Contractors	Avg. Est. Annual Friant Water Supply (acre-feet)		Non-Friant Water Supply	
	Class I	Class II	Surface Water	Ground water
Friant-Kern Canal				
Arvin-Edison WSD	37,700	87,295	Kern River	yes
Delano-Earlimart ID	102,545	20,866	none	yes
Exeter ID	10,839	5,322	none	yes
Fresno ID		21,006	Kings River	yes
Garfield WD	3,299		none	no
International WD	1,131		none	no
Ivanhoe ID	7,257	2,213	Wutchumna River	yes
Lewis Creek WD	1,367		none	no
Lindmore ID	31,103	6,162	none	yes
Lindsay-Strathmore ID	25,919		Kaweah River	yes
Lower Tule River ID	57,681	66,660	Lower Tule River	yes
Orange Cove ID	36,946		none	yes
Porterville ID	15,080	8,403	Tule River and others	yes
Saucelito ID	19,981	9,187	none	yes
Shafter-Wasco ID	47,125	11,091	none	yes
Southern San Joaquin MUD	91,423	14,004	none	yes
Stone Corral ID	9,425		none	yes
Tea Pot Dome WD	7,069		none	no
Terra Bella ID	27,333		none	no
Tulare ID	28,275	39,492	Kaweah River	yes
Madera Canal				
Chowchilla WD	51,838	44,813	Chowchilla River	yes
Madera ID	80,113	52,096	North Fork Willow Creek	yes
San Joaquin River				
Gravelly Ford WD		3,921	Cottonwood Creek	yes
Friant Division M&I				
City of Fresno	56,550		Kings River	yes
City of Orange Cove	1,320		none	yes[a]
City of Lindsay	2,356		none	no
Fresno County Water Works 18	141		none	no
Madera County	189		North Fork Willow Creek	yes
SUBTOTAL-Class I &II	***754,005***	***392,531***		
SUBTOTAL-§215		***134,303***		

Data Sources: Columns 2 and 3 show data for the 1922-2003 period, Steiner 2005. Columns 4 and 5, Department of the Interior, Bureau of Reclamation, *Water Needs Assessment*, 2004, provided to CRS by Reclamation, July 2007; and CRS phone interviews with staff of Friant contractors July 2007.

[a] Groundwater supplies are available; however, the groundwater is of insufficient quantity and quality to contribute significantly to water supplies for municipal and industrial customers.

Other Surface Water Supplies. Many parts of the Friant Division Service Area, particularly the southeast areas, have access to non-Friant surface water supplies. Several other rivers and streams bisect the area, including the Kings River, Cottonwood Creek, Johns River, Kaweah River, Tule River, Deer Creek, White River, and Poso Creek. The Kern River terminates near the southernmost portion of the Friant Division Service Area.

According to Reclamation water needs assessment data, many (43%) of the Friant districts have access to other, non-Friant surface water supplies, mostly from local river and stream sources.[6] In most cases, local sources are a much smaller percentage of total supplies than Friant surface water or groundwater supplies; however, in a few cases (e.g., City of Fresno and Fresno Irrigation District), it appears that other surface sources may supply more than 50% of their water supply. Water imports into the service area have been relatively modest; however, these may increase if Friant water deliveries are reduced. At the same time, limited water availability, cost of alternate supplies, and regulatory constraints on water transfers may restrict efforts to import water into the service area.

Table 1 (above) shows the diversity of water supply sources of the Friant long-term water contractors. Columns 2 and 3 show average water supplies for the Friant Division; columns 4 and 5 show other water supply indicators, such as whether a district has access to other surface or groundwater supplies.

Groundwater Supplies

Drawdown of groundwater levels in the Friant Division Service Area as a result of pumping in the early 20th Century motivated both Friant Dam construction in the early 1940s and efforts to reduce groundwater demand.[7] Deliveries from Friant Dam reduced demands on the aquifer as Friant water, in lieu of groundwater, was used for irrigation. Reduced pumping slowed the rate of watertable decline, but improved watertable levels in the southern San Joaquin Valley have not returned to pre-development elevations. Land subsidence, which occurred as a result of groundwater pumping, slowed considerably as additional surface water supplies became available and demand for groundwater dropped.

Facilities to pump groundwater are available throughout most of the Friant Division. (See **Table 1**.) The limited estimates of groundwater pumping that are available indicate that water users in the Arvin-Edison Water Storage District, Fresno Irrigation District, Tulare Irrigation District, Madera Irrigation District, Lower Tule River Irrigation District, and Chowchilla Water District generally pump the largest volumes of groundwater in the Friant Division Service Area.[8] In contrast, water users in the Garfield Water District, International Water District, Lewis Creek Water District, Tea Pot Dome Water District, and Stone Corral

[6] U.S. Dept. of the Interior, Bureau of Reclamation, *Water Needs Assessment*, 2004.

[7] Friant Water Users Authority, *Friant Division Cumulative Groundwater Storage USBR Water Supply Report & FWUA 2002 Update*, Appendix A, Section 1, April 9, 2002.

[8] *Expert Report of Charles M. Burt, Ph.D., P.E., on Friant Service Area, Reasonableness of Surface Water Use, Annual Gross Groundwater Pumping Requirement, and Estimated Increased Energy Use Under the Spring Run Scenario by 2025*, August 18, 2005.

Irrigation District typically pump the smallest amounts of groundwater annually.[9] Total volumes pumped in the Friant Division between 1987 and 2003 range from a peak of over 2,000 taf in 1990 to a low of 450 taf in 1998, nearly a five-fold difference. For more information on groundwater supplies and how they might be affected by the Settlement, see CRS memo *Settlement Impacts to Groundwater Supply and Quality for Friant Division Contractors and Surrounding Communities*, by Peter Folger and Mary Tiemann.

Contract Water Supplies Under the Settlement

The Settlement would establish a framework for achieving both restoration and water management goals. The viability of attaining both goals is uncertain and will depend upon many factors. Currently, the annual volume of water diverted for off-stream uses by Friant water contractors is a function of water availability (which depends on precipitation, storage capacity, and flood flow management), minus the riparian releases for water right holders below the dam. Under the Settlement, the quantity of water available for diversion to Friant contractors would be a function of water availability, minus the riparian releases for downstream water right holders *and* releases for restoration flows.

Under the Settlement, Reclamation would categorize runoff conditions for each year into one of six *water year types* — Wet, Normal-Wet, Normal-Dry, Dry, Critical High, or Critical Low, in decreasing order of wetness. The water year type is determined by comparing the runoff predictions for the year to past annual runoff volumes in the Millerton Lake drainage area. For more information on the water year type categories and assignment methodology, see **Appendix A**. Each water year type is associated with an annual restoration flow regime (i.e., a hydrograph) in Exhibit B of the Settlement. In other words, each year the quantity of water to be released from Millerton Lake for restoration would be determined by the designation of the basin's runoff as one of the six water year types. Under the Settlement, Reclamation would release water to achieve the target restoration flows. Multiple hydrographs were considered during litigation; the Settlement's hydrographs are based on the expert testimony of G. Mathias Kondolf prepared on behalf of the Natural Resources Defense Council (plaintiffs) and are often referred to as the Kondolf hydrographs.[10]

The restoration flows in the Settlement are higher in wetter years and lower in drier years. The quantity of water used for restoration flows and the quantity of water by which Friant water deliveries would be reduced are related, but the relationship is not always one-for-one. Many of the tables and figures in this memo depict *estimates* of lower Friant water deliveries under the Settlement. The data come from two sources that make estimates based on the water quantities required to create the flows in the six Kondolf hydrographs: Steiner 2005 and BOR 2006. There are limitations to these estimates, some of which are described below and in **Appendix A**.

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[9] Ibid.

[10] The option for a 10% buffer flow that could be used to augment the restoration base flow established in the hydrographs was added prior to finalizing the Settlement Agreement. For a discussion of why the buffer flow is not part of the analysis in this memo, see **Appendix A**.

Limitations of Water Supply Estimates and Mitigation for Reductions. **Figures 3** and **4**[11] show graphically the estimated reduced annual Friant water supplies using the Steiner 2005 and the BOR 2006 data sets, respectively; **Table 2** provides much of the same information in a tabular format. Both sources used historic conditions as proxies for estimating the future effect of the Settlement.[12] The two figures and the table are ordered according to annual runoff, with 1983 having the highest runoff and 1977 the lowest in the 1962 to 2003 period. **Appendix A** describes in more detail the different methodologies and constraints of the two data sets. Numerous factors (e.g., operational changes, water transfers and acquisitions, recirculation, recapture, and reuse projects) would affect the ultimate change experienced in diversions, water deliveries, and water availability for the water districts in the Friant Division Service Area. Thus, estimates of water reductions contained herein are simply estimates of the *magnitude* of how contract supplies might be reduced based on best available information. Because of the lack of available information and specific plans on possible operational changes, efforts to mitigate reduced Friant deliveries, and the viability of offsetting reduced deliveries, these estimates assume no change in operations and no water supply mitigation projects.

The ultimate impact on Friant water contractors is anticipated to be different than the available estimates if the Settlement is implemented. The Settlement, in Paragraph 16, calls for measures to mitigate lower Friant water supplies as restoration releases are implemented; these include establishing a Recovered Water Account, and efforts to recirculate, recapture, and reuse the restoration releases. The Friant Water Users Authority in February 2007 developed a report, titled *San Joaquin River Restoration Program Water Management Goal: Potential Programs & Projects,* which briefly outlines numerous projects that could be undertaken to mitigate or offset reduced water supplies. However, no specific water management projects are identified as part of the Settlement, nor is it clear how funding under the Settlement would be divided between efforts to achieve the restoration goal and efforts to achieve the water management goal. Consequently, this memo cannot estimate potential savings and how these savings may reduce the magnitude of the reductions in water supplies of the Friant water contractors.

There are additional reasons why available estimates could differ from the future supplies of Friant water contractors operating under the Settlement. Guidelines on how the Settlement would be implemented remain to be established and numerous provisions in the Settlement provide for implementation flexibility. For example, Paragraph 13, Section j of the Settlement Agreement states that the Secretary of the Interior shall develop guidelines, including "procedures for determining and accounting for reductions in water deliveries to Friant Division long-term contractors..." which will affect how Reclamation makes operational decisions at Friant Dam, and thus allocation decisions. Both BOR 2006 and Steiner 2005 adopt a reduction protocol (similar to the current protocol) for how to reduce contractor water supplies to obtain water for the restoration flows. Both data sets presume eliminating deliveries to §215 contracts and Class II water before reducing Class I water supplies. However, the guidelines to be established pursuant to the Settlement Agreement

[11] See **Appendix A** for an explanation of the 1998 data in BOR 2006.

[12] The potential impact of climate change on water supplies, particularly snow pack in California, has some stakeholders questioning past runoff as a predictor of future runoff quantity and timing.

could differ from the reduction protocol used by BOR 2006 and Steiner 2005. Further, districts may try to negotiate a different allocation for water supply reductions.

Figure 3. Estimated Friant Division Water Supply Under Settlement: Steiner 2005

(1962-2003, by decreasing runoff amount, not chronological order)

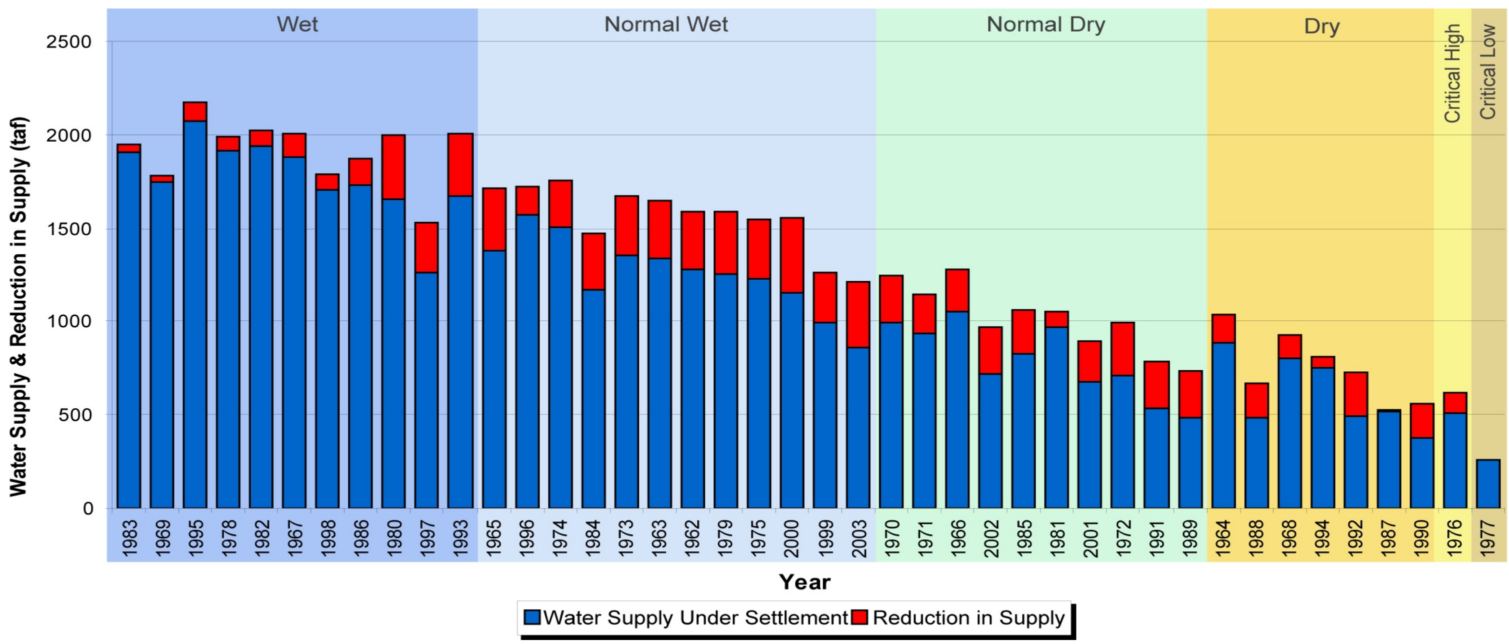


Figure 4. Estimated Friant Division Water Supply Under Settlement: BOR 2006

(1962-2003, by decreasing runoff amount, not chronological order)

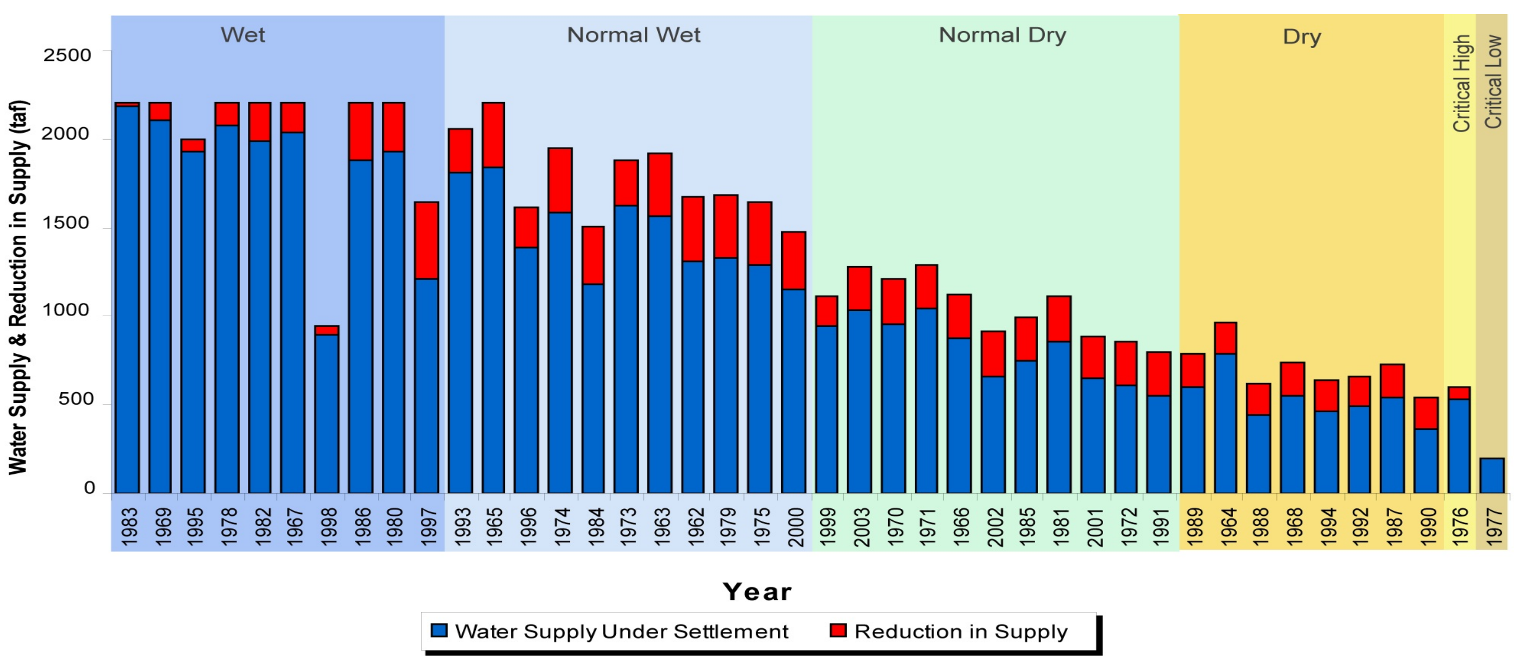


Table 2. Annual Runoff, Year Type, Friant Water Supply, & Estimated Reductions from Average Supply Under the Settlement, 1962-2003

Year	Water Year Type		Runoff (taf)	Friant Water Supply (taf)		Est. Annual Reduction (taf)		Reduction as % of Supply	
	Steiner	BOR		Steiner	BOR	Steiner	BOR	Steiner	
1983	Wet	Wet	4642	1947	2201	37	18	2	Wet
1969	Wet	Wet	4040	1780	2201	35	98	2	
1995	Wet	Wet	3878	2173	2001	98	75	5	
1978	Wet	Wet	3402	1993	2201	76	124	4	
1982	Wet	Wet	3316	2025	2201	83	216	4	
1967	Wet	Wet	3232	2004	2201	125	163	6	
1998	Wet	Wet	3160	1790	940	85	47	5	
1986	Wet	Wet	3031	1876	2201	142	316	8	
1980	Wet	Wet	2973	2000	2201	344	272	17	
1997	Wet	Wet	2782	1534	1641	268	433	17	
1993	*Wet*	*Normal Wet*	*2673*	2004	2061	331	250	17	
1965	Normal Wet	Normal Wet	2272	1715	2201	335	356	20	Normal Wet
1996	Normal Wet	Normal Wet	2203	1723	1613	154	225	9	
1974	Normal Wet	Normal Wet	2191	1755	1949	247	363	14	
1984	Normal Wet	Normal Wet	2049	1475	1501	302	322	20	
1973	Normal Wet	Normal Wet	2047	1670	1879	317	257	19	
1963	Normal Wet	Normal Wet	1945	1644	1921	303	356	18	
1962	Normal Wet	Normal Wet	1924	1586	1669	309	356	19	
1979	Normal Wet	Normal Wet	1830	1591	1683	338	356	21	
1975	Normal Wet	Normal Wet	1796	1543	1641	312	356	20	
2000	Normal Wet	Normal Wet	1742	1552	1477	397	323	26	
1999	*Normal Wet*	*Normal Dry*	*1527*	1259	1108	264	168	21	
2003	*Normal Wet*	*Normal Dry*	*1450*	1211	1277	352	244	29	
1970	Normal Dry	Normal Dry	1446	1244	1206	249	248	20	Normal Dry
1971	Normal Dry	Normal Dry	1418	1146	1291	212	248	18	
1966	Normal Dry	Normal Dry	1299	1282	1122	231	248	18	
2002	Normal Dry	Normal Dry	1171	967	912	246	248	25	
1985	Normal Dry	Normal Dry	1129	1064	996	239	248	22	
1981	Normal Dry	Normal Dry	1068	1051	1108	85	248	8	
2001	Normal Dry	Normal Dry	1065	892	885	217	235	24	
1972	Normal Dry	Normal Dry	1039	993	856	279	248	28	
1991	Normal Dry	Normal Dry	1034	782	800	245	248	31	
1989	*Normal Dry*	*Dry*	939	734	784	246	184	34	
1964	Dry	Dry	922	1038	968	154	184	15	Dry
1988	Dry	Dry	862	669	624	184	184	28	
1968	Dry	Dry	862	925	736	125	184	14	
1994	Dry	Dry	826	815	640	59	174	7	
1992	Dry	Dry	809	731	664	238	172	33	
1987	Dry	Dry	758	526	728	9	184	2	
1990	Dry	Dry	743	557	544	182	184	33	
1976	Critical High	Critical High	629	621	600	108	71	17	CLCH
1977	Critical Low	Critical Low	362	259	200	2	0	1	
Average			**1869**	**1337**	**1372**	**204**	**225**	**15**	

Source: Data adapted from Steiner 2005 and BOR 2006. *Italics* indicate inconsistent classifications.

Another example of flexibility provided in the Settlement Agreement, which could result in contract water supplies varying from the BOR 2006 and Steiner 2005 estimates, is found in Paragraph 3 of Exhibit B of the Settlement. This paragraph states that:

> The Parties agree to transform the stair step hydrographs to more continuous hydrographs prior to December 31, 2008 to ensure completion before the initiation of Restoration Flows, provided that the Parties shall mutually-agree that transforming the hydrographs will not materially impact the Restoration or Water Management Goal.

This process may or may not materially impact Friant deliveries. The intent of the process is to provide smooth operation of dam releases and to avoid large fluctuations on a daily basis.

Table 2 also illustrates the challenge of using estimates; it shows in *italics* that the two data sources — Steiner 2005 and BOR 2006 — do not agree on how the water year type classifications would be applied to historic runoff conditions. Four discrepancies in their classifications are shown: 1989 (Dry/Normal Dry), 1993 (Normal Wet/Wet), 1999 (Normal Dry/Normal Wet), and 2003 (Normal Dry/Normal Wet). (**Appendix A** describes the potential significance of these discrepancies.)

Friant Contract Water Supplies — The Big Picture

Estimated Water Supply Reductions Under the Settlement. **Table 3** displays average district water supplies for Class I and Class II water. The table shows the water supply without the Settlement (which is also shown in **Table 1**) and the Steiner 2005 and BOR 2006 estimates for how much, on average, the annual water supplies might be reduced under the Settlement. These figures are averages, however, and do not represent the full range of reductions that might be experienced in any given water year. The historical variation is depicted in **Figures 3** and **4** (above). **Figure 5** uses the BOR 2006 data to show the relationship between the volume of water released for restoration (in green) and the average annual reduction in water deliveries to contractors (in red). The figure illustrates that the restoration flows under the Settlement are higher in wetter years and lower in drier years. As one can see from the figure, the quantity of water for restoration flows and the quantity of water by which deliveries would be reduced are related, but the relationship is not always one-for-one. For instance, in some of the wettest years, much of the restoration flows would be met by flood water releases, not reduced deliveries. Under the Settlement, no water would be released for restoration purposes in the driest of years.

The last column in **Table 3** provides the estimates of the *average* reductions as a percentage of the contractor's Friant water supply — a range of 5% to 27%. These percentages represent reduction estimates only for Friant Dam releases, not reduction as a percentage of all the water supply sources (e.g., groundwater sources, other surface water supplies) that a district may have available. The two previous columns in **Table 3** illustrate that a district's average annual reductions would largely be a function of its ratio of Class I and Class II supplies. Districts with higher volumes of Class I water might experience less average reductions, *assuming* future guidelines developed by the Secretary of the Interior are based on the same or similar assumptions used in BOR 2006 and Steiner 2005 (i.e., eliminating Class II and §215 supplies before reducing Class I supplies).

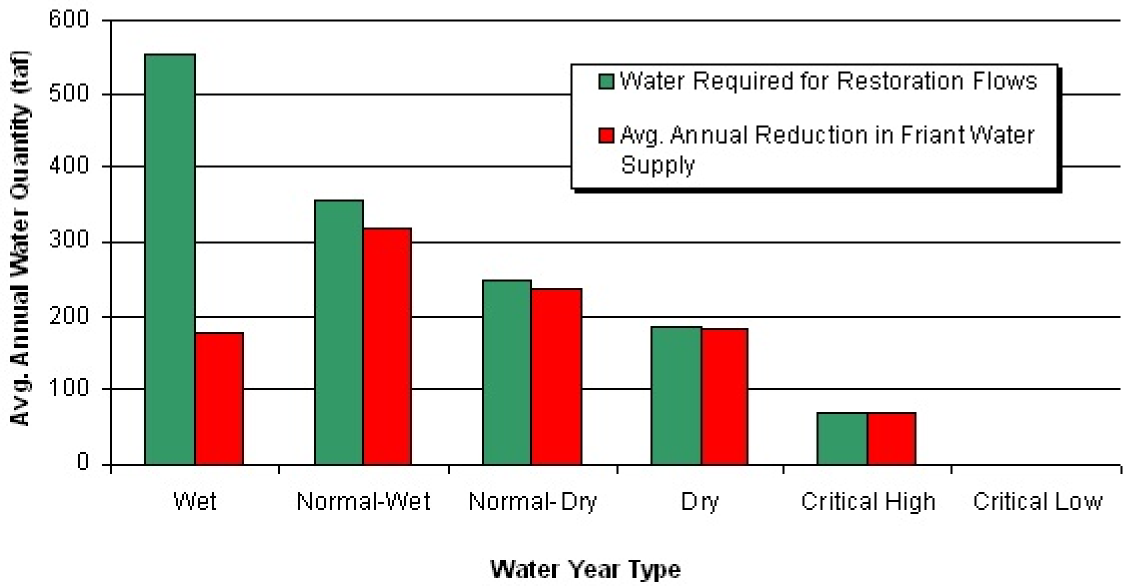
Table 3. Estimated Average Annual Reductions in Water Supplies

Contractors	Avg. Friant Supply w/o Settlement (af)		Avg. Reduction w/ Settlement (af)		Reduction as % of Avg. Supply		
	Class I	Class II	Class I	Class II	Class I	Class II	Total
Friant-Kern Canal							
Arvin-Edison WSD	37,700	87,295	1,915	23,655	5%	27%	20%
Delano-Earlimart ID	102,545	20,866	5,209	5,654	5%	27%	9%
Exeter ID	10,839	5,322	551	1,442	5%	27%	12%
Fresno ID		21,006		5,692		27%	27%
Garfield WD	3,299		168		5%		5%
International WD	1,131		57		5%		5%
Ivanhoe ID	7,257	2,213	369	600	5%	27%	10%
Lewis Creek WD	1,367		69		5%		5%
Lindmore ID	31,103	6,162	1,580	1,670	5%	27%	9%
Lindsay-Strathmore ID	25,919		1,317		5%		5%
Lower Tule River ID	57,681	66,660	2,930	18,063	5%	27%	17%
Orange Cove ID	36,946		1,877		5%		5%
Porterville ID	15,080	8,403	766	2,277	5%	27%	13%
Saucelito ID	19,981	9,187	1,015	2,489	5%	27%	12%
Shafter-Wasco ID	47,125	11,091	2,394	3,005	5%	27%	9%
Southern San Joaquin MUD	91,423	14,004	4,644	3,795	5%	27%	8%
Stone Corral ID	9,425		479		5%		5%
Tea Pot Dome WD	7,069		359		5%		5%
Terra Bella ID	27,333		1,388		5%		5%
Tulare ID	28,275	39,492	1,436	10,701	5%	27%	18%
Madera Canal							
Chowchilla WD	51,838	44,813	2,633	12,143	5%	27%	15%
Madera ID	80,113	52,096	4,070	14,117	5%	27%	14%
San Joaquin River							
Gravelly Ford WD		3,921		1,063		27%	27%
Friant Division M&I							
City of Fresno	56,550		2,873		5%		5%
City of Orange Cove	1,320		67		5%		5%
City of Lindsay	2,356		120		5%		5%
Fresno County WWD 18	141		7		5%		5%
Madera County	189		10		5%		5%
SUBTOTALS - CLASS I & II	***754,005***	***392,531***	***38,301***	***106,366***	*5%*	*27%*	*13%*
SUBTOTAL - §215		***134,303***		***63,390***			*47%*
TOTAL - Class I, II & §215	***754,005***	***526,834***	***38,301***	***169,756***			*16%*

Data Source: Steiner 2005, 1922-2003 data.

Figure 5. Estimated Restoration Flows & Estimated Reductions in Friant Water Supplies

(Restoration flow volumes from Settlement Exhibit B; Reduction estimates for 1962-2003, BOR 2006)



Steiner 2005 and BOR 2006 estimates of average percentage reductions by water year type, which are shown in **Table 2** and **Figures 3** and **4**, are more fully discussed below. As noted earlier, these figures represent estimates based on no changes in CVP operations or completion of other water management goals and objectives. As such, they are likely to represent the high end of what, *on average*, might be expected. As previously noted and as seen in **Figures 3** and **4**, within each water year category, there exists substantial potential variation in the magnitude of the reduction in contract water supply.

Figures 6 through 8 represent *average* estimated annual water supplies (in blue) and reductions (in red) using the Steiner 2005 data for the period 1962 to 2003. (See **Appendix A** for an explanation of the selection of the 1962 to 2003 period.) **Figure 6** shows in graphic form by water year type the estimated annual reduction in water deliveries under the Settlement, with the red representing the reduction from the water supply without the Settlement and the blue representing the quantity that would be available to contractors under the Settlement. For each water year type, one can see the proportion of water projected to be reduced. **Figure 7** builds on **Figure 6** by displaying the proportion of Class I, Class II, and §215 supplies. **Figure 8** is a blowup of the red portion of **Figures 6** and **7**, depicting the estimated reductions in the three types of supplies. **Appendix B** includes similar figures using BOR 2006 data.

Figure 6. Estimated Average Annual Friant Water Supply Under Settlement by Water Year Type

(1962-2003; Steiner 2005)

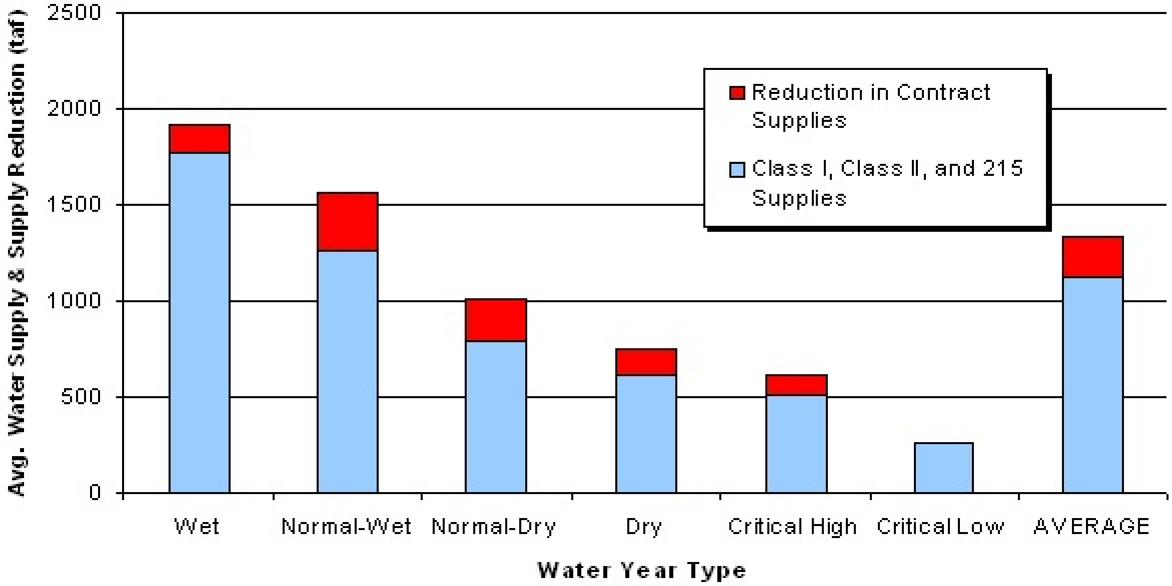


Figure 7. Estimated Average Annual Water Supply Under Settlement by Water Year Type and Class

(1962-2003; Steiner 2005)

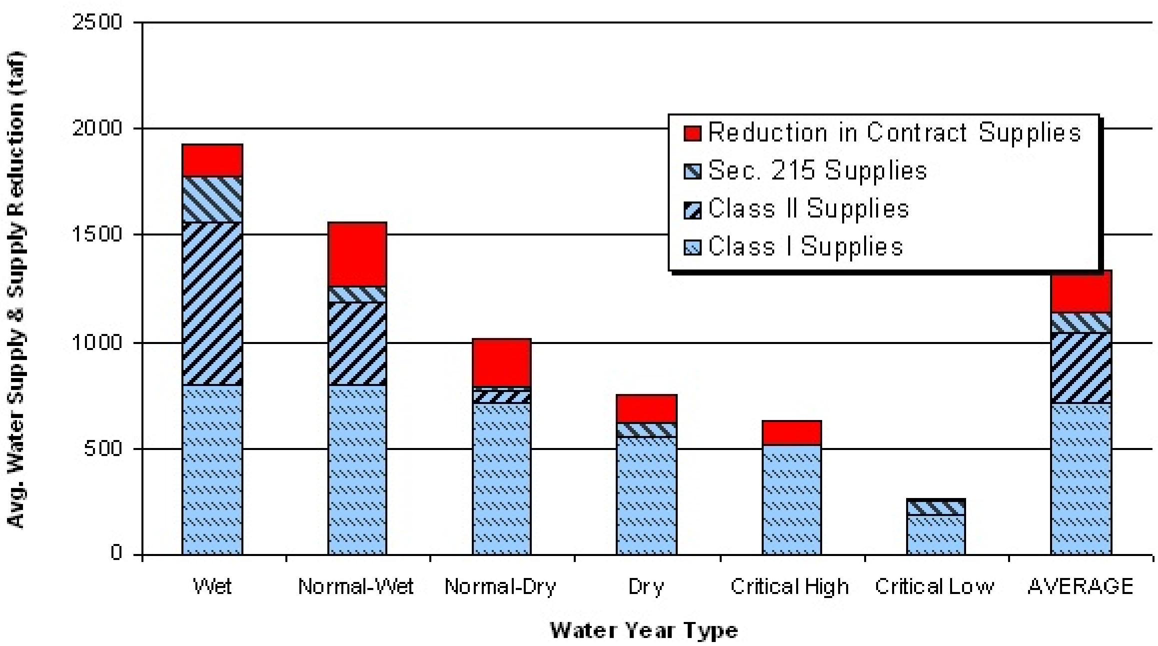
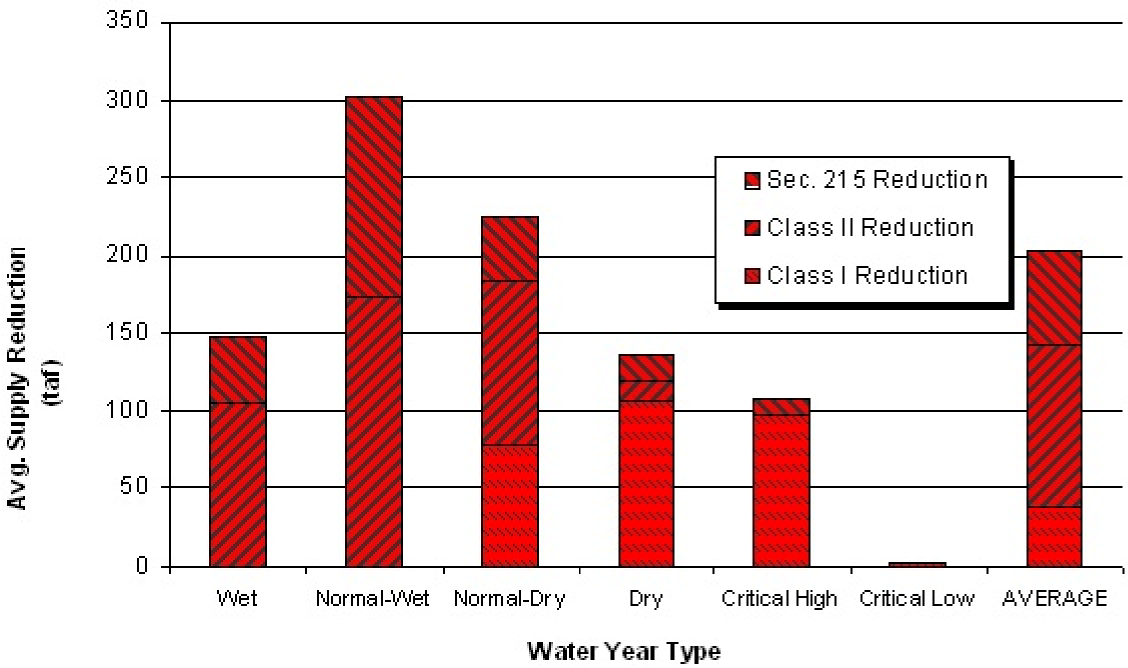


Figure 8. Estimated Average Reduction in Water Supply by Water Year Type

(1962-2003; Steiner 2005)



Average Annual Impact on Friant Water Supplies.

- According to available data for 1962 through 2003, annual water contractor supplies are estimated to be reduced, on average, between 204 taf[13] and 225 taf annually (see **Table 2)**, which would represent between 15% and 16% of average annual water supplies for Friant Division contractors.

Annual Impact on Friant Water Supplies by Water Year Type.

- *Wet.* Based on data for Wet years between 1962 and 2003, estimated average annual reductions in contract water supplies could be between 148 taf and 176 taf (see **Figures 8** and **B-4** in **Appendix B**), which could represent an average reduction between 8% and 9% of contractor annual water supplies. The 1962-2003 data in **Table 2** shows that the variation in the volume of the reduction and the significance of the reduction as a percentage of water supply would vary for Wet years, from 35 taf to 344 taf and from 2% to 17%. In Wet years, Class I supplies generally would be unchanged.

[13] Using a longer period from 1922 to 2003, Steiner 2005 estimated an average annual reduction of 208 taf.

- *Normal-Wet.* Based on data for Normal-Wet years (which have lower runoff than Wet years) between 1962 and 2003, estimated average annual reductions in contract water supplies could be between 302 taf and 320 taf (see **Figures 8** and **B-4**), which could represent an average reduction between 18% and 19% of annual contract water supplies. The Steiner 2005 data in **Table 2** shows that the variation in the volume of the reduction and the significance of the reduction as a percentage of water supply would vary for Normal-Wet years, from 154 taf to 397 taf and from 9% to 29%. In Normal-Wet years, Class I supplies generally would be unchanged.

.

- *Normal-Dry.* Based on data for Normal-Dry years between 1962 and 2003, estimated average annual reductions in contract water supplies could be between 225 taf and 239 taf (see **Figures 8** and **B-4),** which could represent an average reduction between 22% and 23% of annual contract water supplies. The Steiner 2005 data in **Table 2** shows that the variation in the volume of the reduction and the significance of the reduction as a percentage of water supply would vary for Normal-Dry years, from 85 taf to 279 taf and from 8% to 34%.

- *Dry.* Based on data for Dry years between 1962 and 2003, estimated average annual reductions in contract water supplies for like years could be between 136 taf and 181 taf (see **Figures 8** and **B-4**), which could represent an average reduction between 18% and 25% of annual contract water supplies. The Steiner 2005 data in **Table 2** shows that the variation in the volume of the reduction and the significance of the reduction as a percentage of water supply would vary for Dry years, from 9 taf to 238 taf and from 2% to 33%.

- *Critical High*. There was only one Critical High year between 1962 and 2003 — 1976; based on the limited available data, estimated contract water supplies reductions could be between 71 taf and 108 taf (see **Figures 8** and **B-4),** which could represent between 12% and 17% of annual water supplies. In Critical High years, Class I water might be reduced on average by 12% to 17%. Generally no Class II water is supplied in Critical High years with or without the restoration flows called for in the Settlement. Therefore, for Critical High years, generally there is no expected reduction in Class II water resulting from the Settlement. (See **Figures 8** and **B-4**). Some Critical High years without the Settlement could have §215 water according to Steiner 2005; these §215 deliveries generally would not be made under the Settlement. Steiner 2005 modeled 1976 to have 11 taf of §215 water without the Settlement, and no §215 water with the Settlement.

- *Critical Low.* No restoration releases are to be made in Critical Low years, thus there generally would be no changes to Friant Division water supplies under the Settlement (see **Figures 3**, **4**, **8** and **B-4**).

To summarize, within each water year type, variation could exist in the quantity and percent reduction in Friant Division water supplies for different contract types (see **Table 2** and **Figures 8** and **B-4**). It is unknown whether Reclamation would try to (or could) limit this annual variation.

Friant Water Supplies — The Contractor-Level Picture

The analysis in this section is based on data from Steiner 2005. BOR 2006 provides no estimates of the impact of the Settlement on individual long-term contractors. The longer data set available in Steiner 2005 allows the contractor-level analysis to encompass a longer period — 1922 to 2003 — than much of the previous section's analysis. Steiner 2005 contractor-level data are available for both Class I and Class II water. Data for §215 water at the contractor-level are not included in Steiner 2005. Therefore, the analysis in this section is limited to Class I and Class II water.

As noted earlier, reductions of individual contractors' water supplies under the Settlement depend largely on the contractor's proportion of Class I to Class II contracts and the water year type, which depend on the runoff in a given year.

- The average reduction for Class I contract deliveries is estimated at 5%; the estimated average reduction for Class II deliveries is 27% (see **Table 3**). The estimated average reduction for §215 deliveries is 47% (Steiner 2005).

- Many districts have both Class I and Class II contracts. Average annual reductions in average annual Class I and Class II water supplies are estimated at:

  — 5% for the districts with only Class I contracts, representing 46% of the contractors (i.e., 13 of the 28 districts);

  — 6% to 15% for 36% of the districts (i.e., 10 of the 28);

  — 16% to 20% for 11% of the districts (i.e., 3 of the 28); and

  — 27% for the remaining 7% of districts (i.e., 2 of the 28, which are Fresno ID and Gravelley Ford WD) with only Class II contracts. (See **Table 3**.)

- Under the Settlement, Class I water supplies would not be reduced in Wet and most Normal-Wet years (see **Figures 8** and **B-4** for no Class I reduction on average); that is, 800 taf generally could be delivered to Class I contractors both currently and under the Settlement.

- Currently, Class I contracts often (but not always) are fully met in Normal-Dry years; with the Settlement, estimates are that Class I contracts would not be fully met in almost half (46%) of the Normal-Dry years (Steiner 2005).

- Currently, Class I contracts generally are not fully met in Dry, Critical High, and Critical Low years (see **Figures 7** and **B-3** for average Class I deliveries below 800 taf). Under the Settlement, estimates are that Class I water supplies would be lower in Normal Dry, Dry, and Critical High years. (See **Figures 8** and **B-4**.)

- The Class I deliveries in Critical Low years generally would be unchanged by the Settlement because no restoration releases are made.
- Under the Settlement, estimates are that Class II and §215 water supplies would be lower in Wet, Normal-Wet, and most Normal-Dry years, and somewhat lower in Dry years. (See **Figures 8** and **B-4**.)
- Class II water generally is not supplied in most Dry and all Critical High and Critical Low years (Steiner 2005); under the Settlement, this would not change.

Conclusion

The ultimate effect of increased releases for fish restoration efforts from Millerton Lake on Friant water deliveries is difficult to predict. Using available data, it appears that annual water supplies for the Friant Division Service Area could be, *on average*, 15% to 16% less under the Settlement than average annual supplies under current operating protocols. Although the average reduction could be 15-16%, water supply reductions could be as little as no reduction to as high as 34% reduction in some years. The average annual reduction in the volume of water delivered under the Settlement is estimated to be between 204 thousand acre-feet (taf) and 225 taf; estimates put the range of annual reductions at no reduction to 433 taf.

In addition to the overall reductions in Friant Division supplies varying annually under the Settlement, reductions experienced by individual water districts would vary depending on their water service contracts. That is, the reduced delivery experienced in a given year by an individual water district would largely depend on how firm is the district's Friant water supply contract. Class I contracts generally are held by the districts which serve municipalities and agricultural users without sources to other supplies — areas often in the foothills not underlain with adequate or reliable groundwater supplies. Predictions of average annual Friant water supply reductions for individual water districts range from 5% to 27% — the low range being cutbacks to contractors with only the firmer Class I supplies (46% of contractors) and the high range applicable to those with only Class II (7% of contractors).

It remains unclear to what extent water reductions might be offset by projects and programs implemented pursuant to the Settlement, and at what cost. It is possible that a portion of the cutbacks could be mitigated via efficiency gains, water marketing (including voluntary sales and transfers), or new infrastructure development undertaken pursuant to the water management goal of the Settlement. However, the viability of further improving efficiencies in the Friant Division, securing funding, and attaining both the restoration and water management goals is uncertain and would depend on many factors.

Contact Nicole Carter at 7-0854 or Betsy Cody at 7-7229 if you have further questions on this subject.

Appendix A: Data Sources and Limitations of Analysis

Data Sources

Data sets used in the memo's analysis of water supply impacts come from two sources:

- a table, titled *Friant Division Allocations based on SJR - Settlement Exhbit B Hydrographs for Restoration Releases,* provided by Reclamation in December 2006 (BOR 2006); and
- a report, titled *Effects to Water Supply and Friant Operations Resulting From Plaintiffs' Friant Release Requirements*, dated September 16, 2005, by Daniel B. Steiner (Steiner 2005).

Steiner 2005 was produced as expert testimony on behalf of Friant Water Users Authority. Both sources use the Millerton Lake drainage area's past runoff conditions to illustrate the impact that the Settlement might have on contract water supplies.

Comparison of Sources

The two data sets are not identical, and both have some limitations for purposes of this analysis. Using actual historic *allocations* as a starting point, BOR 2006 recalculates what contract water supplies (i.e., supplies to Class I contractors, Class II contractors, and for §215 contracts) might have been in the past if restoration releases under the Settlement had been in place for 1957 through 2005. The analysis in BOR 2006 combines Class II and §215 water supplies. By using historic allocations as a starting point, the BOR 2006 data set does not necessarily reflect current Reclamation procedures for deciding allocations, and it reflects anomalies and changes in operating protocols that would not necessarily be replicated in the future. For example, 1958 was a year with high runoff in the basin; current operations would result in some Class II and §215 allocations. BOR 2006 does not show any such deliveries because in 1958 these types of contracts were not in use. Class II contracts were not active until 1962, and §215 water was first available mid-1995. Another example is from 1998; the relatively low allocations in 1998 partially resulted from Kings River water being pumped into the Friant Kern Canal to reduce flood potential in the Kings River basin. The BOR 2006 estimate includes data on the contract water supplies under the Settlement both with and without the 10% buffer flows.

In contrast, Steiner 2005 uses historic *runoff* data for 1922 through 2003 to *model* water diversion and delivery under the Settlement. The modeling applies current water management regimes and contracts with and without the Settlement to the historic runoff data; in other words, Steiner 2005 applies the current Class II and §215 contracts to the entire 1922 to 2003 time period. Unlike BOR 2006, the analysis in Steiner 2005 distinguishes between Class II and §215 contracts. The Steiner 2005 data set, however, does not include estimates with the 10% buffer flows; the buffer flow was added to the Settlement after Steiner's report was completed.

To take advantage of the comparable elements of the two data sets and because the implementation of the buffer flow remains to be determined, the analysis in this memo does not address the 10% buffer flow option. Although some data for 2004 are available in Steiner 2005, the last year for which Steiner 2005 presents a complete analysis is 2003. The model used in Steiner 2005 accounts for the distinction between runoff water year (October to September), the restoration flow year (February to January), and the contract year (March to February); BOR 2006 simplified its analysis by not trying to differentiate between the various kinds of timeframes, instead basing the entire analysis on the runoff water year (October to September).

Allocations and Deliveries. Additional limitations of the data occur because BOR 2006 presents data on reductions in *water allocations*, while much of the data on reductions presented in Steiner 2005 are in *water deliveries*. The differences between allocations and deliveries are: (1) the losses in the canals (e.g., evaporation), and (2) not all allocated water is demanded by the water contractors (i.e., some water may be allocated by Reclamation but is not delivered because of the lack of contractor demand). Steiner 2005 calculated average canal losses at 63 taf (i.e., less than 5% of average annual deliveries or allocations) and assumes that the allocated water is demanded by the contractors. Because the allocations estimated by BOR 2006 represent the quantity allocated before the canal losses occur, and the deliveries estimated by Steiner 2005 represent the quantity delivered after canal losses occur, the reduction estimates from BOR 2006 may be systematically higher than the deliveries estimated in Steiner 2005, but on average by only 5%. CRS consulted with Reclamation and others in an effort to identify a systematic way to account for differences in Reclamation allocations and deliveries, but no approach was identified. However, it appears that the two sets are reasonably similar. For this memo and to simplify comparison between the two data sets, we generally do not differentiate between the allocations and deliveries. The memo generally refers generically to *water supplies*.

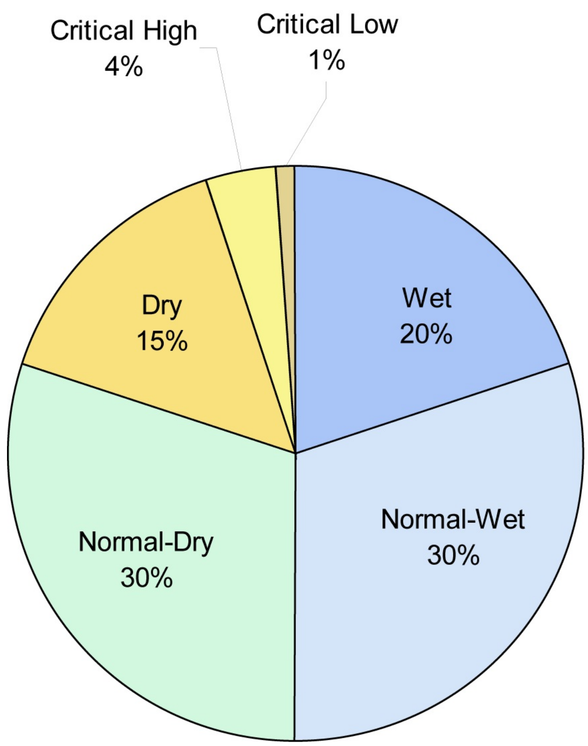
Runoff Categories — Water Year Type. Six categories of *water year type* are fundamental to the Settlement; they are used to select the restoration hydrograph to be used for a given year, which forms the basis for monthly water releases. The methodology used for defining the water year types is specified in Exhibit B, paragraph 2 of the Settlement Agreement. It states:

> The Base Flows are presented in Tables lA- IF as a set of six hydro graphs that vary in shape and volume according to wetness in the basin. The six year types are described as “Critical Low”, “Critical High”, “Dry”, “Normal-Dry”, “Normal-Wet”, and “Wet.” The total annual unimpaired runoff at Friant for the water year (October through September) is the index by which the water year type is determined. In order of descending wetness, the wettest 20 percent of the years are classified as Wet, the next 30 percent of the years are classified as Normal-Wet, the next 30 percent of the years are classified as Normal-Dry, the next 15 percent of the years are classified as Dry, and the remaining 5 percent of the years are classified as Critical (represented by the “Critical High” hydrograph). A subset of the Critical years, those with less than 400 TAF of unimpaired runoff, are identified for use of the “Critical Low” hydrograph. The hydrographs, Tables lA-1F, depict an annual quantity of water based upon the flow schedules identified. Components of the hydrograph are plotted for each water-year type with various types of flows (Fall Base and Spring Run Incubation Flow; Fall Run attraction Flow; Fall-Run

> Spawning and Incubation Flow; Winter Base Flows; Spring Rise and Pulse Flows; Summer Base Flows; Spring-Run Spawning Flows) in specified amounts throughout the year, some of which vary in amount and duration depending upon year type classification. To avoid a moving distribution of year-type assignment, water years 1922-2004 will be used to establish year types.

Figure A-1 provides a graphical presentation of the relative frequency of each of the water year types. Because only one year had a runoff of less than 400 taf in the 1922 to 2004 data set, the frequency of a Critical Low runoff year is shown as 1% in **Figure A-1**. Paragraph 13, Section j, in the Settlement states that the Secretary of the Interior shall develop guidelines for "procedures for determining water year types..." which may affect how the designation of water year type is implemented.

Figure A-1. Frequency of Water Year Types



An illustration of the significance of water year classifications and the methodology for the classifications can be seen when comparing BOR 2006 with Steiner 2005. There exist four differences in the classification of water year types used by BOR 2006 and Steiner 2005 (for years in which the data sets overlap). As shown in **Table 2**, Steiner 2005 classified four years in wetter water year types than BOR 2006. Classifying a year differently may have significant implications because generally, the wetter the classification, the more restoration releases are made. For example, in 1989 the runoff was 939 taf, Steiner 2005 classified this runoff as Normal Dry (see **Table 2**) which would lead to restoration releases of 247 taf under the Settlement; for the same runoff, BOR 2006 classified 1989 as Dry which would lead to restoration releases of 184 taf under the Settlement.

Scope and Limits of Analysis

In the portions of the memo analyzing aggregate reductions to Friant water supplies, CRS largely restricted analysis to the years 1962 to 2003, and does not distinguish between Class II water and §215 water. These parameters were chosen in order to use data from both BOR 2006 and Steiner 2005, and to present the data and analysis in as consistent and simple a format as possible. The following bullet points explain why these parameters were chosen.

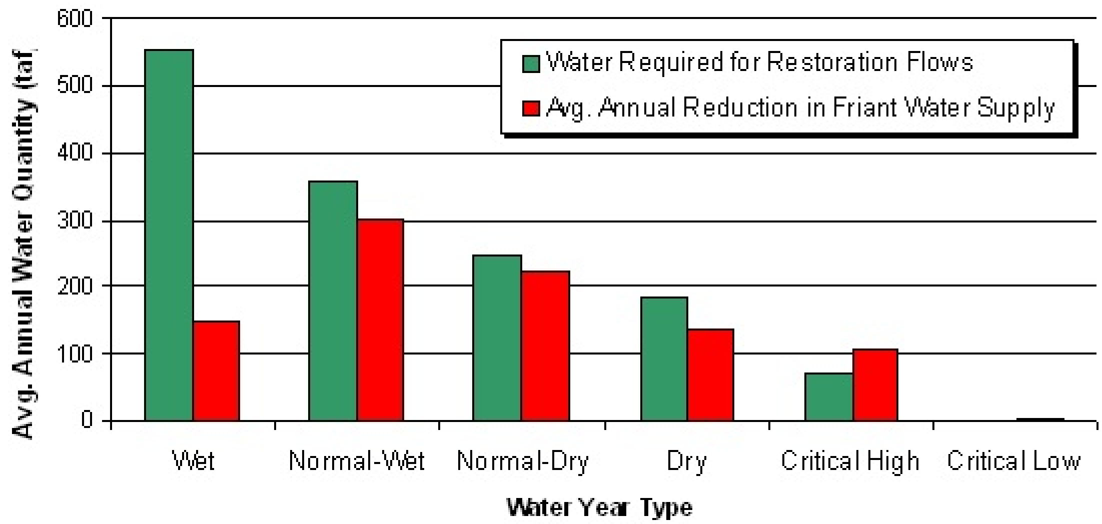
- 1962 is the lower time limit of the analysis because Class II water was not made available until 1962. The absence of Class II water allocations prior to 1962 makes the BOR 2006 data from 1957 through 1961 sufficiently different from the current water allocations to warrant its exclusion;
- 2003 was selected as the upper time limit of the analysis because that was the last complete year in Steiner 2005;
- BOR 2006 grouped Class II and §215 water; comparison of the data sets was facilitated by merging Class II and §215 data from Steiner 2005.

In the portions of the memo analyzing estimated annual reductions for individual Friant water districts, CRS used Steiner 2005 data because no district-level data were available in BOR 2006. The longer period — 1922 to 2003 — available in Steiner 2005 was used, since it was not necessary to shorten the period to fit with the BOR 2006 data. Steiner 2005 contractor-level data are available for both Class I and Class II water, but not for §215 water. Therefore, the contractor-level analysis is limited to Class I and Class II water.

Appendix B: Additional Figures

Figure B-1. Estimated Restoration Flows & Estimated Reductions in Friant Water Supplies

(Restoration flow volumes from Settlement Exhibit B; Reduction estimates for 1962-2003, Steiner 2005)



As noted in **Appendix A**, Steiner 2005 accounts for the distinction between runoff water year (October to September), the restoration flow year (February to January), and the contract year (March to February). Because of the different timeframes for the restoration flow year and the contract year, Steiner 2005 data shows the reductions in Critical High years exceeding the Critical High restoration flow volume. The multiple timeframes also explain the 2 taf reduction in **Table 2** for 1977, a Critical Low year.

Figure B-2. Estimated Average Annual Friant Water Supply Under Settlement by Water Year Type

(1962-2003; BOR 2006)

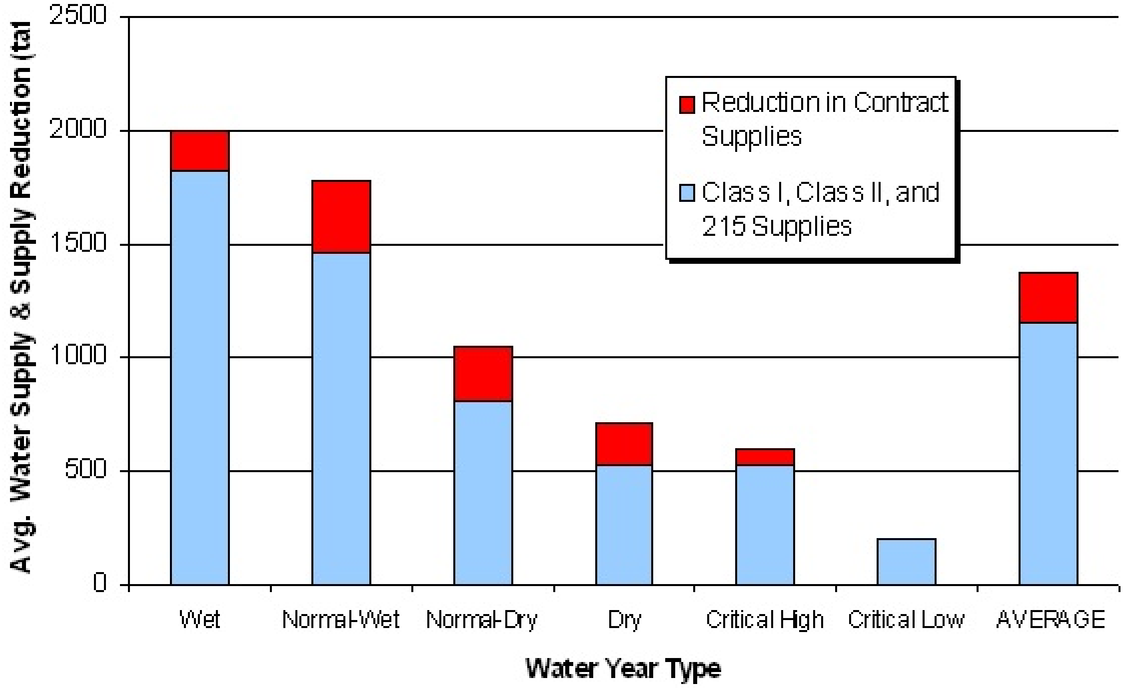


Figure B-3. Estimated Average Annual Water Supply Under Settlement by Water Year Type and Class

(1962-2003; BOR 2006)

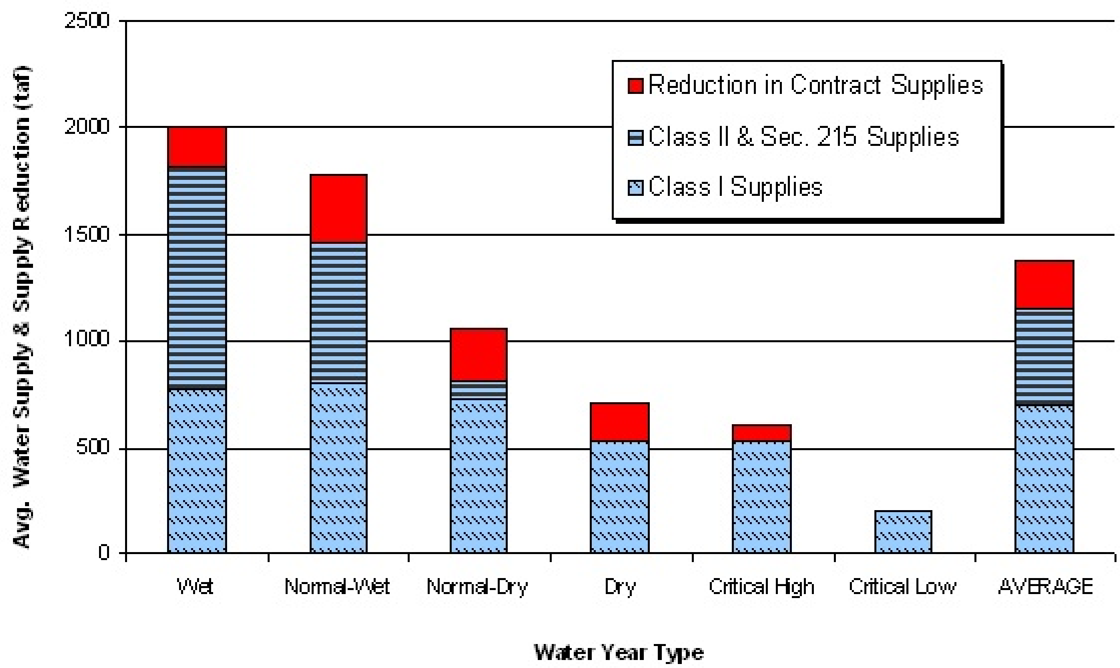


Figure B-4. Average Reduction in Water Supply by Water Year Type
(1962-2003; BOR 2006)