CHAPTER 6

Alternative water-system components

This chapter describes a variety of components, for possible use in place of the Hetch Hetchy Reservoir, that would maintain or even improve the reliability and safety of San Francisco's water-supply system. Most of these components are already being considered—either in the SFPUC's Water Supply Master Plan, its Capital Improvement Program (CIP), or both[1]—as they could enhance system performance even if Hetch Hetchy Valley were not restored. Such improvements are evaluated without expansion of local conservation and recycling programs, and *with* significant increases in Bay Area water use over the next 25 years—though a final plan should include serious examination of these issues.

The components fall into three basic categories:

- **Conveyance.** Establishing reliable conveyance from all potential sources of supply is the best way of ensuring uninterrupted delivery of water to the SFPUC's Bay Area customers. But at present, SFPUC does not have direct access to most of its water storage in Sierra Reservoirs. Also, as addressed in detail by the CIP, in many places the system's reliance on a very limited set of tunnels and pipelines makes it too vulnerable to earthquakes, droughts, and other adverse events.
- **Supply.** Even without Hetch Hetchy Reservoir, the total storage capacity in SFPUC reservoirs would be more than three times its annual delivery objectives. In dry years, however, the SFPUC's water rights are very limited, and alternative supplies would be needed. This report examines alternatives for providing those supplies through increased local surface storage, groundwater exchanges, or transfers, but acknowledges that other options are available as well.
- **Treatment.** The existing SFPUC system applies conventional water treatment methods only to its releases from its Bay Area reservoirs; it is not required to filter its Tuolumne River supplies and therefore does not have the physical capacity to do so. Under the restoration alternatives considered in this report, significant supplies would be diverted from locations downstream of Hetch Hetchy Valley and the SFPUC would expand its conventional treatment capacity to cover all of its supplies.

Conveyance options

While Hetch Hetchy is the best-known component of San Francisco's present system, it holds less than 25 percent (360,000 out of a total of 1,533,000 acre-feet) of total system storage. But given its limited conveyance and treatment capabilities, it is often difficult for the SFPUC to make full use of its water storage in the other reservoirs—Cherry, Eleanor and Don Pedro—in the Tuolumne watershed. Getting full access to these supplies is critical to maximizing the reliability of SFPUC's water supply, with or without Hetch Hetchy Reservoir.

Under all restoration alternatives, San Francisco would continue to divert Tuolumne River flows during winter and spring months, and diversions might even be increased under some circumstances and stored in local reservoirs closer to Bay Area customers. Diversions from the Tuolumne River in the summer and fall would have to be made farther downstream, drawn from

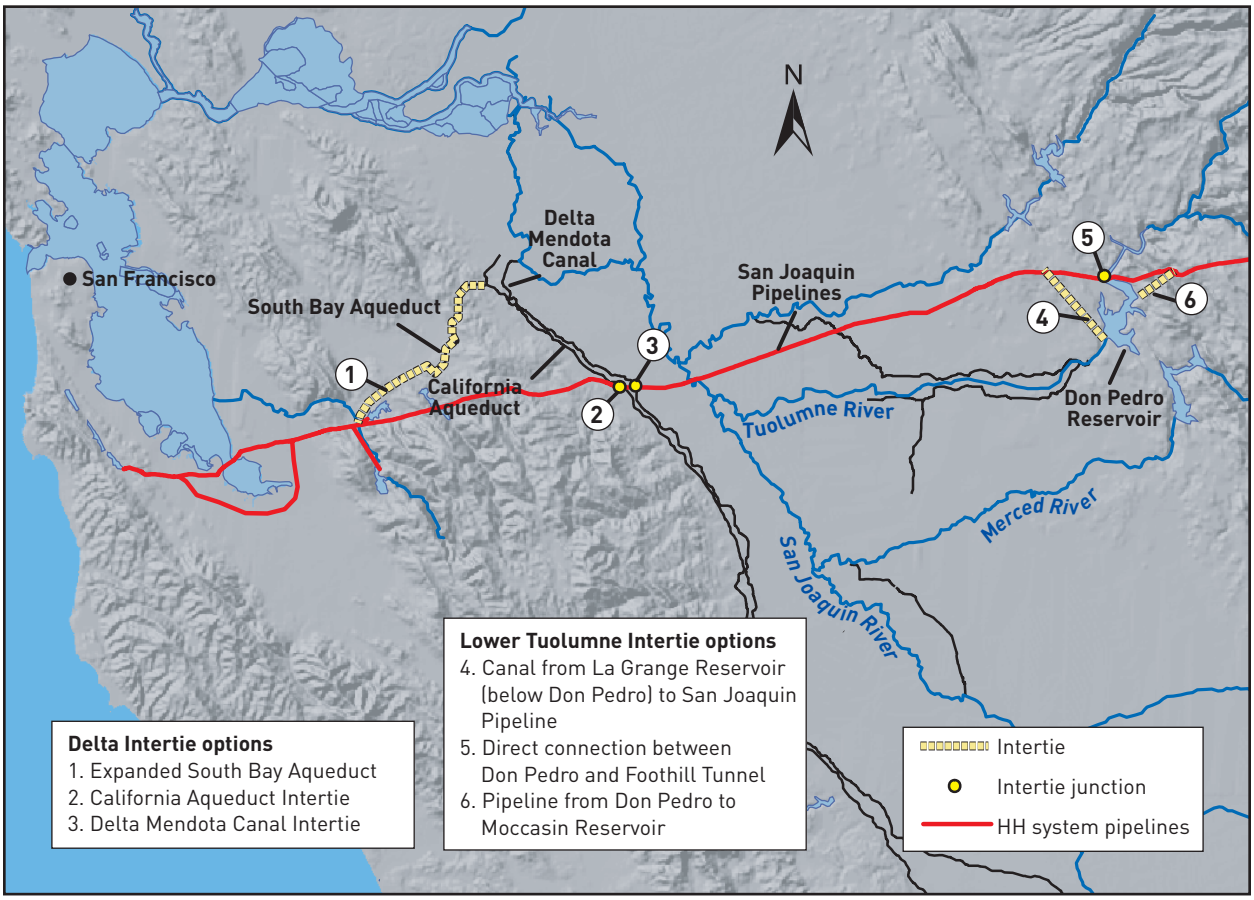
the SFPUC's supplies stored in other Tuolumne watershed reservoirs.

The simplest approach would be to build a new intertie between the Tuolumne River and San Francisco's aqueduct. If the intertie were at or below Don Pedro Reservoir, the City would have access to its supplies stored in Don Pedro itself, as well as upstream in Cherry and Eleanor Reservoirs. Alternatively, water could be released from Don Pedro Reservoir, flow down the Tuolumne and San Joaquin Rivers to the Sacramento-San Joaquin Delta, and be diverted to the SFPUC via the state or federal export pumps. While the intertie to Don Pedro would provide higher-quality water already under San Francisco's control, an intertie to the California Aqueduct would establish a link to most water systems in the state and allow the SFPUC much greater flexibility in purchasing water from other water agencies or exchanging supplies. Constructing *both* interties would offer additional alternatives to San Francisco, and would help ensure reliable supplies in the future.

INTERTIE TO LOWER TUOLUMNE RIVER

Don Pedro Reservoir, completed in 1970, holds over 2 million acre-feet, almost six times the storage of the

FIGURE 6-1
Potential locations for lower Tuolumne or Delta intertie



An intertie on the lower Tuolumne River could provide the SFPUC access to more than 1,000,000 acre-feet of water supply stored in Cherry and Eleanor Reservoirs and its water bank in Don Pedro Reservoir. An intertie to the State-federal Delta system could provide access to additional supplies, particularly in critically dry years or under emergency conditions, but would require negotiation with a variety of agencies which rely on supplies from the Delta.

TIM CONNOR

San Francisco's water bank in Don Pedro holds more than twice as much water as Hetch Hetchy Reservoir.

Hetch Hetchy Reservoir. While San Francisco owns up to 740,000 acre-feet of "water bank" storage in Don Pedro, the SFPUC does not currently draw this water directly. Rather, when the SFPUC diverts water upstream that belongs, under the water-rights criteria, to the Turlock and Modesto Irrigation Districts, it repays these districts from its bank.

San Francisco shared the cost of constructing Don Pedro Dam with the Turlock and Modesto Irrigation Districts through a complex set of agreements. As a result, SFPUC has access to storage in Don Pedro even when Tuolumne flows are below the levels at which it possesses recognized water rights. The City has no infrastructure for conveying its Don Pedro supplies to the Bay Area, however, nor has it established the legal right to build any such infrastructure. Thus construction of an intertie between Don Pedro reservoir and the SFPUC's conveyance system would require the active cooperation of the Turlock and Modesto Irrigation Districts.

Without storage in the Hetch Hetchy Reservoir, the SFPUC might divert directly from its bank in Don Pedro Reservoir (assuming that the aforementioned legal and infrastructural issues were resolved). There are in fact several ways that the SFPUC's supplies in Don Pedro Reservoir could be moved into the Hetch Hetchy Aqueduct for transport to the Bay Area, either for immediate use or storage in local reservoirs. Water could be:

- pumped directly from Don Pedro into the Foothill Tunnel, which runs directly beneath the reservoir;
- released through the Don Pedro Powerhouse and diverted farther downstream, perhaps via a new pipeline or canal from La Grange Reservoir to the Hetch Hetchy Aqueduct;
- pumped to Moccasin Reservoir (the entrance to the SFPUC's Foothill Tunnel), where present-day releases from Hetch Hetchy enter the aqueduct.

Schlumberger Water Services has estimated that constructing such an

TIM CONNOR

The California Aqueduct carries water from the Sacramento-San Joaquin Delta to a number of Bay Area communities and much of urban Southern California.

intertie directly to Don Pedro Reservoir, with the capacity to pump up to 407 cfs, would cost $29.7 million. Incorporating estimates for engineering, legal and administrative costs, and a standard range for the uncertainty of construction factors indicates that the cost of the intertie could range from $25 million to $53.5 million (see Appendix A).

INTERTIE TO THE STATE WATER PROJECT

Most of California diverts at least some of its water supply from the Sacramento-San Joaquin Delta, but the SFPUC has rarely done so, even though its San Antonio Reservoir is physically connected to the Delta via the State Water Project's South Bay Aqueduct. In the future, however, releases from San Francisco's water bank in Don Pedro Reservoir could be timed to coincide with diversions from the Delta.

Delta pumping plants are often operated at full capacity, but San Francisco's most critical needs might coincide with periods when some spare capacity is available.[2] Delta pumping constraints are most restrictive in the spring, when the SFPUC would normally be able to divert the Tuolumne's flows. During wet years, when these plants are often at full capacity as they move water supplies from northern California to urban southern California and irrigated agriculture in the Tulare Basin, San Francisco's needs for diversion would be smallest. Of course, SFPUC could also pump Delta supplies, when available, into its local storage reservoirs for delivery at a later time.

With improved access to its Tuolumne River supplies, an intertie to the State Water Project's California Aqueduct would not be used in most years. In critically dry years, however, such an

The San Francisco Public Utilities Commission diverted 71,000 acre-feet from the Delta in 1991 and 1992, when its storage at Hetch Hetchy as well as its water bank in Don Pedro Reservoir reached low levels.

intertie would allow the SFPUC access to purchase supplies from a wide variety of agencies throughout the state. Without improved access to its Tuolumne River supplies, the SFPUC would need to use an intertie to the State Water Project much more frequently, requiring significant negotiations with SWP contractors.

Supply alternatives

The supply alternatives discussed below—increased local surface storage, groundwater exchange and transfers from willing sellers—are options that urban water districts throughout California have been adopting in recent years as they have diversified their portfolios to assure reliable water supplies for their customers. Other options should be considered as well; for example, the SFPUC and its customers are in the midst of a comprehensive effort to identify and implement cost-effective conservation measures.

SFPUC

MIKE MULLEN

Calaveras Reservoir (top) lies on a tributary of Alameda Creek (bottom). Expansion of the reservoir would create challenges for protecting sensitive species in the watershed, but also opportunities to provide enhanced flows for native steelhead restoration in nearby Alameda Creek.

LOCAL SURFACE STORAGE

The SFPUC owns five principal storage reservoirs in the Bay Area, with a total capacity of about 239,000 acre-feet, which could be expanded to offset the storage capacity lost if Hetch Hetchy Valley were restored. The most obvious opportunity is the expansion of the Calaveras Reservoir—at 97,000 acre-feet, the largest of the SFPUC's Bay Area reservoirs—which must be rebuilt anyway because it has been declared unsafe by the state's Division of Safety of Dams (a unit of California's Department of Water Resources). The SFPUC has proposed that the dam be increased to hold as much as 420,000 acre-feet, an increase that is nearly equivalent to the storage capacity of Hetch Hetchy Reservoir.

For the analysis in this report, Schlumberger Water Services has reviewed the SFPUC's investigation of an expanded Calaveras Reservoir and has estimated that the cost of reconstruction would be $23 million (to rebuild Calaveras at its current size of 97,000 acre-feet) or $90 million (to enlarge it to 420,000 acre-feet). The inclusion of additional expenses—for engineering, legal and administrative costs, and a standard range for the uncertainty of construction factors—indicates that rebuilding the reservoir at its current size would cost from $19.3 million to $41.4 million and that enlarging

the reservoir to 420,000 acre-feet would cost between $75.6 million and $162 million (see Appendix A).

In addition, Schlumberger has estimated that the cost of building facilities to pump up to 204 cfs of Tuolumne supplies into Calaveras would be $43.4 million. Incorporating estimates for engineering, legal and administrative costs, and a standard range for the uncertainty of construction factors indicates that the pumping station and pipeline would cost from $36.5 million to $78.2 million (see Appendix A).

The SFPUC, in its Water Supply Master Plan and supporting documents, has also considered a long list of other new or expanded storage sites. For example, it has investigated a partnership role in the proposed expansion of Los Vaqueros Reservoir in Contra Costa County.

GROUNDWATER EXCHANGE

Many agricultural and urban water agencies throughout California rely on groundwater as part of their long-term water supply for the simple reason that groundwater storage increases a system's reliability and flexibility. San Francisco's Water Supply Master Plan has also identified groundwater opportunities—in the Westside Basin in San Francisco, Daly City and San Bruno, as well as in exchange programs throughout the Central Valley and in the Tuolumne watershed.

In the latter case, diversions from Don Pedro would be made during wet years to replenish groundwater storage. In dry years, surface-water diversions from Don Pedro would decrease and groundwater pumping would increase. Such changes in Don Pedro operations for the management of groundwater resources would require agreements with the Turlock and Modesto Irrigation Districts—whose officials might in turn act as intermediaries for deals with other districts in the eastern San Joaquin Valley—together with incentives for the area's agencies and landowners to participate.

Schlumberger Water Services has evaluated the physical potential of groundwater-management opportunities in or near the lower Tuolumne watershed. Schlumberger estimated total costs of $119.2 million to install infrastructure for a 400,000 acre-foot groundwater bank, with extraction capability of 200 cfs and recharge capability of between 283 and 386 cfs. Incorporating estimates for engineering, legal and administrative costs, and a standard range for the uncertainty of construction factors indicates developing the lower-Tuolumne groundwater bank would incur a total cost between $100.1 million and $214.5 million (see Appendix A).

Alternatively, the SFPUC could bank groundwater in a number of locations throughout the Central Valley. Under such an agreement, dry-year supplies would likely be provided through a State Water Project intertie.

In any case, while significant new groundwater-storage capacity might be developed as one way of replacing the storage in Hetch Hetchy Valley, it would probably not be accessed during most years. This supply could, however, provide important additional capacity during dry years and extended droughts.

TRANSFERS

With or without the storage provided by O'Shaughnessy Dam in Hetch Hetchy Valley, the biggest challenges generally facing water managers in California, and the SFPUC in particular, arise in dry years when the perennial conflicts between users of water for beneficial agricultural, urban and environmental purposes are exacerbated. But in some parts of the state, these conflicts have been resolved, and agreements between water-rights

holders and buyers have helped to improve water-supply reliability while respecting legal ownership rights. Such transfers are not easy to negotiate, and for a variety of reasons—including a lack of clarity over who "owns" the water, a perceived weakening of rights when they are leased or sold, and potential impacts on third parties and the environment. Nevertheless, the potential benefits of agreements between willing sellers and buyers have made transfers a significant part of water portfolios for many districts.

Analysis for this report considers potential transfers from agricultural districts to the SFPUC during dry years. As in the case of groundwater, the simplest water transfers would involve agreements with water rights holders in the Tuolumne River area. With an intertie to the California Aqueduct, however, the SFPUC could purchase water from a wide variety of sellers statewide.

It is not known what the costs of these transfer agreements would be. The price per acre-foot of water purchased only in dry years would likely be significantly higher than if transfers were executed every year or in wetter years. For the purpose of this report's analysis, we assume transfer costs of $500 per acre-foot—a conservative estimate that is significantly higher than the transfer and groundwater-banking costs identified in Chapter 3.

Expanded water-treatment facilities

Whatever the restoration alternatives pursued, San Francisco would have to filter all of its supplies. But to do so, the SFPUC would need to increase treatment capacities beyond the levels identified in its CIP.

While a variety of locations, either in the Bay Area or the Central Valley, might be suitable for the expanded treatment facilities, this report assumes that the increase would occur at the SFPUC's existing Sunol Treatment Plant. Schlumberger Water Services has estimated that expanding the capacity of the plant by 160 million gallons per day (beyond the SFPUC's planned 80 million gallons per day expansion) would incur a total cost of between $134 million and $288 million (see Appendix A).

Integrating water-system components

Combining many of the components described above could not only preserve the level of reliability currently provided by O'Shaughnessy Dam and Hetch Hetchy Reservoir, but meet projected increases in water-delivery objectives as well. They could also provide the SFPUC with additional options in case its San Joaquin pipelines were rendered inoperable.

Chapter 7 examines several possible alternatives, using computer-based simulation modeling, for these components' integration into the SFPUC water-supply system. The total costs of implementing these scenarios, including the costs of forgone hydropower and additional water treatment, are provided in Chapter 10.