Responses to Comments on Draft Environmental Impact Report

Volume 2 of 2

For the San Francisco Public Utilities Commission's

Regional Groundwater Storage and Recovery Project

July 9, 2014

Important Dates:

Draft EIR Publication Date:	April 10, 2013
Draft EIR Hearing Dates:	May 14, 2013 in San Mateo County May 16, 2013 in San Francisco
Draft EIR Public Comment Period:	April 10, 2013 through June 11, 2013
Final EIR Certification Meeting Date:	August 7, 2014

City and County of San Francisco Planning Department
Case No. 2008.1396E
State Clearinghouse No. 2009062096

Regional Groundwater Storage and Recovery Project

Responses to Comments on Draft EIR

Volume 2 of 2

San Francisco Planning Department Case No. 2008.1396E
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	May 16, 2013, San Francisco
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Written comments should be sent to:

Sarah Jones, Environmental Review Officer
Regional Groundwater Storage and Recovery Project
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

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Draft EIR Comment Letters and Emails

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G-San Mateo PW-Chow	Mark Chow	Letter	GC-1, Unrelated to Adequacy of the Draft EIR
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			PD-5, Well Facility Design and Construction
			HY-3, Storm Water Pollution Prevention Plan and Site-specific Discharge Plan
			HY-4, San Mateo County Flood Control District Policy
			HY-5, Operational Well Maintenance Discharges to Storm Drains
G-BAWSCA-Sandkulla	Nicole M. Sandkulla	Letter	GC-1, Unrelated to Adequacy of the Draft EIR
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			PD-8, Treatment for Volatile Organic Compounds
			PD-15, Project Operational Triggers
			PD-19, Maintenance Pumping Rates
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			HY-44, Amount of Overdraft

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Draft EIR Comment Letters and Emails

Comment Code	Full Name	Comment Type	Topic Code
G-BAWSCA-Sandkulla	Nicole M. Sandkulla	Letter	HY-48, Mitigation of Groundwater Depletion Impacts
G-Daly City-Sweetland	Patrick Sweetland	Letter	GC-1, Unrelated to Adequacy of the Draft EIR
			OV-1, Cumulative Projects
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			HY-29, Cumulative Seawater Intrusion Impacts
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G-San Mateo RS-LoCoco	Joseph A. LoCoco	Email	GC-1, Unrelated to Adequacy of the Draft EIR
			GC-5, Not Related to GSR Project Draft EIR
			PD-2, Required Permits and Approvals
			PD-5, Well Facility Design and Construction
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G-Colma-Laughlin	Michael P. Laughlin	Letter	GC-1, Unrelated to Adequacy of the Draft EIR
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			PD-5, Well Facility Design and Construction
			PP-1, Colma Spanish/Mediterranean Architectural Requirement
			AE-1, Visual Impact of Tree Removal and Replanting at Site 7
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			AE-3, Visual Impacts at Site 9
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			HY-3, Storm Water Pollution Prevention Plan and Site-specific Discharge Plan

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Draft EIR Comment Letters and Emails

Comment Code	Full Name	Comment Type	Topic Code
G-San Bruno-Fabry	Klara A. Fabry	Letter	GC-1, Unrelated to Adequacy of the Draft EIR
			PD-6, Facility Classifications
			PD-9, Use of Portable Generators
			PD-10, Pumping at Peak Capacity
			PD-13, Project Operations during Put Periods
			PD-14, Operating Agreement
			PD-16, SFPUC Storage Account
			OV-2, References
			RE-1, Sea Level Elevations
			HY-24, Compressibility Values and Subsidence Monitoring
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O-TRT-Drekmeier	Peter Drekmeier	Letter	GC-1, Unrelated to Adequacy of the Draft EIR
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			HY-50, Diversions from the Tuolumne River
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			HY-52, Data After Publication of the WSIP PEIR, including the Kirkwood Agreement
			AL-1, Additional Alternatives to the Proposed Project
O-RHH-Rosekrans	Spreck Rosekrans	Letter	GC-1, Unrelated to Adequacy of the Draft EIR
			GC-2, Project Merit
			GC-7, Water Supply Planning
			HY-51, Raker Act
			AL-1, Additional Alternatives to the Proposed Project
O-CGC-Maddow	Robert B. Maddow	Letter	GC-1, Unrelated to Adequacy of the Draft EIR
			GC-2, Project Merit
			PD-18, Recharge Test and Scaling Up from Pilot Test to Basin-wide Implementation
			PD-24, Project Implementation Alternatives

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Draft EIR Comment Letters and Emails

Comment Code	Full Name	Comment Type	Topic Code
O-CGC-Maddow	Robert B. Maddow	Letter	HY-9, Groundwater Rights
			HY-15, Well Interference and Mitigation Measure M-HY-6
			HY-34, Nitrate in Irrigation Water
O-CLMP-Quick	Deborah E. Quick	Letter	GC-1, Unrelated to Adequacy of the Draft EIR
			GC-3, Adequacy of the Draft EIR
			GC-6, CEQA Process
			PD-4, Facility Site Locations
			PD-11, Using Partner Agency Wells for GSR Pumping
			PD-12, Project Operating Period
			PD-16, SFPUC Storage Account
			PD-17, Groundwater Recharge from Precipitation
			PD-20, Hydrogeology, Well Screening Intervals and Seals
			PD-21, Project Pumping in Prolonged Drought
			PD-22, Emergency Pumping
			PD-23, Project Pumping in WSIP PEIR
			PD-26, Commenter's Description of Project
			OV-1, Cumulative Projects
			OV-3, Modeling Climate Change
			OV-4, Groundwater Modeling
			OV-5, Uncertainty of Model Results
			LU-5, Importance of Irrigation for Cemetery and Golf Course Land Uses
			AE-6, Project's Effects on the Aesthetic Quality of Cypress Lawn Memorial Park and Other Cemeteries
			AE-7, Project's Effects on Water Quality Aesthetics
			CR-2, Historic Value of Resources at Cypress Lawn and Other Cemeteries
			GG-1, Operational Greenhouse Gas Emissions
			GG-2, Electricity Use
			UT-1, Water Supply Sources

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Draft EIR Comment Letters and Emails

Comment Code	Full Name	Comment Type	Topic Code
O-CLMP-Quick	Deborah E. Quick	Letter	UT-2, Wastewater System Capacity
			HY-1, North and South Westside Groundwater Basins
			HY-2, Hydrologic Setting
			HY-6, Duration and Frequency of Monitoring
			HY-7, Pumping Costs
			HY-8, Significance Criterion for Project Impacts to the Aquifer
			HY-9, Groundwater Rights
			HY-10, Well Interference Thresholds
			HY-11, Significance Thresholds for Groundwater Levels Falling below the Well Screen
			HY-12, Well Interference Monitoring
			HY-13, Methods for Determining if Well Interference Impacts are Due to the Project
			HY-14, Reduction of Well Interference Impacts to Less than Significant
			HY-15, Well Interference and Mitigation Measure M-HY-6
			HY-16, Well Interference Mitigation Measure Performance Standards
			HY-17, Participation of Irrigators for Mitigation Measure M-HY-6
			HY-18, Representation of Existing Irrigators
			HY-19, Effects of Climate Change on Irrigation Demand
			HY-20, Operation of Multiple Wells Simultaneously
			HY-21, Cypress Lawn Discharge Capacity
			HY-22, Barrier Boundaries relative to Well Interference Estimates
			HY-23, Subsidence
			HY-25, Significance Thresholds for Subsidence
			HY-26, Inclusion of a Subsidence Map in the Draft EIR
			HY-27, Adequacy of Seawater Intrusion Analysis
			HY-28, Saltwater/Freshwater Interface and Upconing

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Draft EIR Comment Letters and Emails

Comment Code	Full Name	Comment Type	Topic Code
O-CLMP-Quick	Deborah E. Quick	Letter	HY-29, Cumulative Seawater Intrusion Impacts
			HY-30, Use of Averages in the Draft EIR Seawater Intrusion Analysis
			HY-31, Sea Level Rise for Seawater Intrusion
			HY-34, Nitrate in Irrigation Water
			HY-35, Vertical Stratification of Constituents
			HY-36, Contamination Limited to the First 50 Feet
			HY-37, Using Time-averaged Water Levels in the Draft EIR Water Quality Evaluation
			HY-38, Drinking Water Quality
			HY-39, Irrigation Water Quality
			HY-40, Groundwater Contamination in Areas not Near GSR or Partner Agency Wells
			HY-42, Impacts on Safe Yield or Sustainable Yield of the Westside Groundwater Basin
			HY-43, System Losses
			HY-45, Groundwater Budget
			HY-46, Local and Regional Impacts of Pumping
			HY-48, Mitigation of Groundwater Depletion Impacts
			HY-49, Cumulative Impacts of Groundwater Depletion
			HY-53, Need for More Details on Monitoring and Mitigation Measures
			AL-2, Environmentally Superior Alternative
I-King	Christopher King	Letter	PD-3, Project Figures
I-Robert	Robert in San Bruno	Letter	GC-1, Unrelated to Adequacy of the Draft EIR
			GC-2, Project Merit
			PD-1, Project Objectives
			LU-4, Land Use Decisions
I-Lawrence (1)	Steve Lawrence	Email	GC-1, Unrelated to Adequacy of the Draft EIR
			HY-23, Subsidence

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Draft EIR Comment Letters and Emails

Comment Code	Full Name	Comment Type	Topic Code
I-Lawrence (1)	Steve Lawrence	Email	HY-32, Project's Effects on Lake Merced
			HY-44, Amount of Overdraft
			HY-54, Rising Groundwater Levels and Land Use Impacts Therefrom
I-Lawrence (2)	Steve Lawrence	Email	GC-2, Project Merit
			HY-32, Project's Effects on Lake Merced
			AL-1, Additional Alternatives to the Proposed Project

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G-VA-MADDEROM

DEPARTMENT OF VETERANS AFFAIRS
Office of Construction & Facilities Management
Washington DC 20420

May 25, 2013

Greg Bartow
Groundwater Program Manager
San Francisco Public Utilities Commission
525 Golden Gate Ave., 10th floor
San Francisco, CA 94102

RE: VA's Comments to San Francisco Public Utilities Commission's (SFPUC) Draft Environmental Impact Report (EIR) for the Regional Groundwater Storage and Recovery Project

The U.S. Department of Veterans Affairs (VA) has reviewed the EIR for the Regional Groundwater Storage and Recovery Project, San Francisco, CA released for public review on April 10, 2013 by the San Francisco Planning Department. GC-1

Thank you for providing VA with the opportunity to comment on the Draft EIS document. Here are VA's review comments.

A) The Draft EIS fails to recognize the fact that the two wells that are being proposed to be placed on Golden Gate National Cemetery (GGNC) property will adversely and negatively impact the environment, by eliminating VA's future ability to utilize Federally owned groundwater located below the cemetery, for cemetery irrigation needs and purposes. VA is planning to re-establish existing irrigation wells on GGNC property, in order to reduce dependence on SFPUC potable water currently being used for cemetery irrigation purposes, and to support and enhance National Cemetery Administration operations and mission of honoring and providing dignified burial services to Veterans and their families. Establishment of two SFPUC owned wells on VA national cemetery property will have significantly adverse and negative effects upon VA, including environmental impacts impinging on VA's ability to reduce the use of potable water to maintain the national cemetery grounds. OV-1

B) SFPUC's proposed plan to establish two wells on GGNC cemetery grounds would have negative impact to the aesthetic environment and operation of the national cemetery. AE-5 As demonstrated by preliminary plans that have been sent to VA, SFPUC's plan reflects definite adverse impacts to the architectural, historical, and aesthetics of these historic national cemetery grounds. CR-3

C) SFPUC proposed plan to establish two wells on GGNC cemetery grounds would negatively impact the national cemetery operations and security. Proposed installation of SFPUC operational facilities on the GGNC property carries with it a new level of perpetual non-VA access to the facility. This would lead to non-VA personnel, equipment, and potential SFPUC subcontractors needing to enter upon the cemetery grounds, to perform maintenance and repair on the proposed new facilities. LU-2

D) There are substantial environmental benefits that will be obtained thru VA re-establishing irrigation wells to reduce reliance on SFPUC potable water system, in lieu of SFPUC placing two OV-1 wells on GGNC property. It would benefit the environment by reducing the quantity of potable water needed to maintain the national shrine appearance of the cemetery grounds, while at same time increasing the availability of SFPUC potable water to be supplied for other public uses within the SFPUC water distribution district. This benefits SFPUC and the environment, by lessening the GGNC potable water usage impact on their infrastructure, and eliminating the associated energy, chemical, processing, labor, and conveyance costs of providing potable water to GGNC for irrigation purposes. By investing in new irrigation well infrastructure and associated well operational costs, NCA will be able to reduce annual irrigation expenses, so that those cost savings can be used to benefit veterans in other ways. This is a very responsible approach to acquiring resources necessary for operation of the GGNC. It also demonstrates NCA's prudent stewardship of taxpayer dollars, and VA being environmentally responsible, while supporting and enhancing NCA's mission of honoring and providing dignified burial services to Veterans and their families. OV-1 Cont.

Project Description (starting Page 3-102) Comments:

1. The description indicates that the "... well facility would be located on an existing SFPUC easement ..." – the existing easement is only for conveyance of water (i.e. underground piping passing through) – it does not cover installation and operation of water production well (s). PD-7

2. With respect to Proposed Well 14 - the analysis presented in Table 5.2-1 similarly incorrectly notes the easement status – it is noted under the column heading: "On SFPUC Land?" as "Yes, SFPUC Right of Way".

3. With respect to Proposed Well 14 - in this same table – it notes that the construction is "adjacent" to the land use of "Cemetery" – when in fact, it is in the middle of a Veterans National Cemetery. LU-6

4. With respect to Proposed Well 14 – p 5.2-13 repeats this assertion of "existing SGPUC easement".

The Summary of Impacts - Land Use Table 5.2-2 presents several errors in analyses:

5. VA is certainly not in agreement with the analyses of LS for Site 14, which alleges that "Project operations would not result in substantial long-term or permanent impact on the existing character or disrupt or displace land uses." The well pumps will make substantial noise during operation – not in character with a National Cemetery. LU-2 More problematic would be the access to the well house for either "normal" maintenance or "emergency" repairs. It is presumed that "normal" O&M activities, either by in-house personnel and equipment or by SFPUC contractors, would not take into account the operating requirements of a National Cemetery with respect to funeral corteges, committal services, visitors seeking quiet solitude at gravesites, interment operations, ceremonies, etc LU-2

6. Same comment for Site 15. LU-2

7. With respect to Site 14 - one cannot conclude that a "Cumulative Impact" can be "Less than Significant" if there is a Direct Impact (see comment #5 above). LU-3

8. Same comment for Site 15. LU-3

9. The justification provided on p 5.2-32 for (construction) "Impact Conclusion: Less than Significant with Mitigation" regarding Land Use for Site 14 is quite faulty. It "" over 1,100 feet of new pipeline construction, yet the only land use under analyzed regards vehicular traffic internal to the Cemetery. It proposes Mitigation Measure M-LU-1 (Maintain Internal Cemetery Access) LU-1

as the only necessary Mitigation. It speaks nothing of other types of land use impacts such as: dust, visual, vibration, etc. on National Cemetery operations, including funeral corteges, committal services, interment operations, ceremonies, etc. LU-1 Cont.

10. The justification provided on p 5.2-32 for (construction) "Impact Conclusion: Less than Significant with Mitigation" regarding Land Use for Site 14 is quite faulty. Presented in this same section is an analysis of the noise impacts to the adjacent residences – however – it does not present any information, data, or analyses w/r to noise impacts to the National Cemetery operations. LU-1

11. The justification provided on p 5.2-32 for (construction) "Impact Conclusion: Less than Significant with Mitigation" regarding Land Use for Site 14 is quite faulty. In the noise analyses (only for residences) it presents, for the first time, the concept of nighttime drilling for installation of the wells. No VA National Cemetery nation-wide is allowed to be open after dark. If this nighttime drilling concept is actually proposed, there are no analyses thereof – and regardless, VA would not approve. LU-1

12. Section 5.2.3.5 Operation Impact and Mitigation Measures is likewise faulty in its analyses. This section lumps Sites 14 and 15 in with many others as: "Less than Significant with Mitigation." VA disagrees with the statement concluding: "... the cemetery land use would, therefore, not be disrupted or displaced." It talks of daily visitations during periods of groundwater pumping. It says nothing regarding scheduling of such visitations, nor their interaction with National Cemetery operations. LU-2

13. With respect to Site 14 - Table 5.3-4 presents a "Less than Significant" conclusion regarding night-time light during construction – how can this conclusion be correct when p5.2-32 speaks of night-time well drilling? There is minimal lighting in any National Cemetery – primarily honor flag and security lighting only – any night-time construction lighting would stand out tremendously. AE-5

14. Same comment for Site 15.

15. Page 5.3-70 notes that "... relatively few visitors would be affected by the construction activities over the 16-month duration at this location." This conclusion is quite incorrect. GGNC typically performs approximately 500 burials per year and typically receives hundreds of visitors throughout the cemetery grounds on a daily basis for activities such as gravesite visitation, funeral corteges, committal services, and ceremonial activities.
16. Page 5.3-70 also notes that "... less-than-significant level ... and inconspicuous construction area during the entire construction period and for all phases of construction in the GGNC." How does SFPUC plan to construct an 1,100' trenching operation for installation of water and storm water pipelines and an electrical feed "inconspicuously? How does SFPUC intend to require this in their Statement of Work? How does SFPUC intend to enforce said conditions of "inconspicuousness"? VA does not believe inconspicuous construction would be feasible in this scenario. AE-5

17. Similar comments for Site 15 as #15 and #16 above.

18. Page 5.3-94 presents a statement regarding to access to the proposed well pump house during construction, which is in contradiction to that of operation. "The mitigation measure requires that the well facility be located as close to the north GGNC fence ... It also requires the use of plywood temporarily placed on the ground to access the well facility, thereby eliminated the need for permanent grass pavers . . ." M-CR-5a states there will be grass pavers. Which is it? AE-5

G-VA-MADDEROM cont.

19. Page 5.3-94 regarding Mitigation Measure M-CR-5a – this MM fails to recognize and address the fact that the National Cemetery itself is nationally listed as a historic landmark listed, nor presents any discussion with respect to impact of the proposed SFPUC well structures on the National Cemetery itself. CR-3

Under this SFPUC proposal, there would be a great need for SFPUC to satisfactorily address the cultural, historical, and environmental impacts relative to the Golden Gate National Cemetery. In that regard, of considerable concern is that the Draft EIR fails to identify with any specificity impacts to this national shrine as required under Section 106 of the National Historic Preservation Act (NHPA) (16 U.S.C. § 470f). CR-3 As VA maintains burial operations at this facility, these impacts will greatly affect Veterans, Veterans families, visitors and VA personnel. VA believes that the proposed SFPUC wells on the NCA property would have a significant, adverse impact on NCA's operations and mission; preclude NCA from accessing the much needed, Federally-owned groundwater located below the NCA property; have significant environmental and historic preservation impacts; and reflect a true failure of the SFPUC to duly consider and pursue other viable alternatives besides attempting to locate their wells on NCA property. GC-3 Consequently, VA strongly urges SFPUC to select an alternative that does not impact the Golden Gate National Cemetery. AL-1

In closing, VA appreciates SFPUC's efforts in engaging the community, in order to ensure that the most viable solution is selected. VA would like to have further discussions on the issues discussed above, and appreciates the opportunity to work more closely with SFPUC with regard to ensuring full and proper analysis of the potential significant adverse impacts associated with the contemplated SFPUC wells, as well as due consideration of any requisite mitigations and/or alternatives. GC-4

We also thank SFPUC for providing us with the opportunity to comment. Please don't hesitate to contact me at 317-916-3797 or via e-mail at Glenn.Madderom@va.gov, to discuss our comments further.

Thank you in advance for your consideration and attention to this matter. GC-1

Sincerely yours,

G Madderom

Glenn Madderom
Chief, Cemetery Development and Improvement Service
575 N. Pennsylvania St, Room 495
Indianapolis, IN 46204-1581

COUNTY OF SAN MATEO

Department of Public Works

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May 17, 2013

G-San Mateo PW-CHOW

Ms. Sarah B. Jones, Acting Environmental Review Officer
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

Re: Notice of Availability of Public Review of Draft Environmental Impact Report for the Regional Groundwater Storage and Recovery Project, northern San Mateo County

Dear Ms. Jones:

The San Mateo County Department of Public Works, in its capacity as the Administrator of the San Mateo County Flood Control District (District), which includes the Colma Creek Flood Control Zone and the San Bruno Creek Flood Control Zone, hereinafter collectively referred as "Zones," has reviewed the Draft Environmental Impact Report for the subject project and offers the following comments: GC-1

- Our records confirmed that proposed project sites 5 through 14 and alternate sites 17, 18, and 19 are located within the Colma Creek Flood Control Zone and project site 15 is located within the San Bruno Creek Flood Control Zone. The District requires that the discharge rates from the various sites not exceed the existing rates prior to development, and drainage calculations showing existing and future discharge rates must be submitted to the District for review. HY-4

- The San Mateo County Flood Control District should be listed as a Permitting Agency in Table 3-11, on page 3-144, of the DEIR, in order to gain access onto the District's property. For example, the District would need to approve the use of the access road to Site 9. Conditions of approval would need to be met, such as, but not limited to, all gates shall be locked when the contractor is not working at the site, any removed fence sections shall be restored to existing or better condition, and SFPUC shall repair or replace any damage to the access road pavement or fence sections as a result of its operations. PD-2

- The DEIR states on Page 5.16-70, "The building and parking areas at all sites would result in limited amounts of new impervious surfaces. Therefore, project-related increases in stormwater runoff resulting from increases in impervious surfaces would not increase the potential for on- or off-site flooding and the impact would be less than significant." The District's policy described above of requiring that project proponent demonstrate that the post development discharge rate from the site not exceed the existing rate prior to development would still apply. Therefore, drainage calculations showing existing and future discharge rates must be submitted for review. If it is determined that the future discharge rate exceeds the existing rate, an on-site storm water detention system which would release surface runoff at a rate comparable to the existing flow rate of the site must be designed and incorporated into the project. HY-4

- The DEIR, on pages 5.16-71 and 5.16-72, states that Impact HY-5 would be less than significant, therefore requiring no mitigation measures. Discharges as a result of the weekly or monthly exercising of the production wells must still comply with the San Francisco Bay Region Municipal Regional Stormwater NPDES Permit (Order R2-2009-0074, NPDES Permit No. CAS612008). Therefore, the District requests that Impact HY-5 comply with the same conditions to be set by the RWQCB for Impact HY-2, which is discussed on page 5.16-68 of the DEIR. At a minimum, the District would like to be notified at least 14 days in advance of any HY-5

G-San Mateo PW-CHOW cont.

planned discharge. Additionally, no discharges shall occur during storm events. It should also be noted that the Permit Order cited on page 5.16-68 (listed as Order No. 99-059, NPDES Permit No. CAS002992) is not the permit currently in effect and should be corrected. HY-5 Cont.

- The Storm Water Pollution Prevention Plan and/or the Erosion and Sediment Control Plan to be prepared in accordance with Mitigation Measure M-HY-1, on Page 5.16-63, shall be submitted to the District for review. Tracking of dirt/mud will not be allowed onto the access road to Site 9. No trash and debris shall be allowed to be discarded along the access road and flood control channel. HY-3

- Discharge plans prepared in accordance with Mitigation Measure M-HY-2, on Page 5.16-67, shall be submitted to the District for review. Sediment laden and contaminated water shall not be discharged into the District's flood control channels without prior treatment to remove sediment and other contaminants. HY-3

- The District advocates that trash management measures be incorporated into the design elements of the storm drainage system and appurtenances. Please ensure that trash collecting devices are installed at storm drain inlets and maintained by the owner. PD-5

If you have any questions, please contact me at (650) 599-1489. GC-1

Very truly yours,

Mark Chow, P.E.
Principal Civil Engineer
Utilities-Flood Control-Watershed Protection

MC:EVG:ac
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cc: Ann M. Stillman, P.E., Deputy Director, Engineering and Resource Protection
Joe LoCoco, P.E., Deputy Director, Road Services

BAWSCA

Bay Area Water Supply & Conservation Agency

G-BAWSCA-SANDKULLA

May 24, 2013

Ms. Sarah B. Jones
Acting Environmental Review Officer
Regional Groundwater Storage and Recovery Project Draft EIR Comments
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103-2479

Subject: **<u>Case No. 2008.1396E</u> – Regional Groundwater Storage and Recovery Project, Draft Environmental Impact Report, State Clearinghouse No. 2005092026**

Dear Ms. Jones,

Thank you for the opportunity to provide the following comments from the Bay Area Water Supply & Conservation Agency (BAWSCA). BAWSCA represents the interests of 24 cities and water districts, an investor-owned utility, and a university, that purchase water wholesale from the San Francisco Regional Water System. These agencies, in turn, provide water to 1.7 million people, businesses, and community organizations in Alameda, Santa Clara, and San Mateo Counties. BAWSCA member agencies are highly dependent on the SFPUC Regional Water System (RWS) to provide a reliable supply of potable drinking water critical to the health and safety of consumers in the region. GC-1

These comments address the Draft Environmental Impact Report (DEIR) for the Regional Groundwater Storage and Recovery project dated April 10, 2013.

1. **One clear, definitive description of the Groundwater Storage and Recovery Project (Project) should be decided on and used consistently throughout the document.** The Project is described multiple times and in multiple ways. One consistent description should be used that includes the following: PD-25

    - Clear description of how the en-lieu recharge will work;
    - Clear description of how the dry-year groundwater pumping from the Westside basin by the Project Partners results in additional water being added to the RWS (i.e., directly through adding groundwater into the RWS and also by reducing surface water use by the Project Partners, which in turn makes that water available to other RWS users);
    - Which specific entities should expect to receive groundwater pumped from the Westside Basin during drought years or other uses of the Project; and
    - Clarify that the Project can be used in drought years, but also under other circumstances (e.g., emergencies).

155 Bovet Road, Suite 650 • San Mateo, CA 94402 • *ph* 650 349 3000 • *fx* 650 349 8395 • www.bawsca.org

G-BAWSCA-SANDKULLA cont.

2. **A robust system of actual water level measurements should be used to ensure that the water is actually being stored at the rate, and in the locations, that it is assumed to be.** The DEIR states multiple times that the volume of water in storage in the Westside Basin will be calculated using metered surface water deliveries (the Put) and metered groundwater extractions (the Take). Given the importance of this supply to regional water supply reliability, the calculated storage should be confirmed using actual field data, and using the groundwater basin model, as appropriate. HY-48

3. **The projected maintenance pumping rates for the Project wells are very different from that of the Project Partner wells.** The document should discuss the difference in assumptions regarding the maintenance of the Project wells and the Project Partner wells. If the Project wells need to be exercised more than the currently projected rates, please address the impact that will have on the Project operations and yield. PD-19

4. **A clear description, perhaps in chart form, that describes the triggers/conditions under which the Project would be operated would be helpful.** For example, if the basin has not reached full storage capacity, will the Project be used in a dry year? The relationship of the Put water to the SFPUC's self-imposed Interim Supply Limitation should also be clarified as part of this description. PD-15

5. **The yield of the Project needs to be clarified given the modeling results cited in the DEIR that suggest that the Westside Bain is in overdraft by about 1,000 AFY.** The proposed mitigation is to add additional Put years to offset the storage losses. Please clarify the how the project yield might, or might not be, decreased as a result of the need to do additional Put years as opposed to Hold or Take Years. The relationship of the Put water to the SFPUC's self-imposed Interim Supply Limitation should also be clarified as part of this description. HY-44

6. **Section 2.1 – Introduction (page 2-4).** The DEIR needs to be revised to correctly reflect the purpose of the WSIP as adopted by the Commission on October 30, 2008. San Francisco has a perpetual obligation to provide 184 mgd to the Wholesale Customers. The obligation is documented in the <u>2009 Water Supply Agreement Between San Francisco and its Wholesale Customers</u>. With the WSIP, the Commission deferred a decision to provide water supply in excess of 184 mgd to the Wholesale Customers (or 265 for the entire water system) until 2018. IN-1

7. **Section 3.4.2 – Production Wells and Associated Facilities (page 3-16).** The last sentence notes that certain additional treatment may be needed at some sites for certain water quality constituents. The text identifies Volatile Organic Compounds (VOCs) as a possible constituent for treatment. Table 3-3 (pages 3-18 through 3-22) indicates which sites are expected to need treatment and what constituents would be addressed. No sites indicate VOC treatment and there is no discussion of any specific treatment process or chemicals associated with VOC PD-8

G-BAWSCA-SANDKULLA cont.

removal in the section on "Well Plus Chemical Treatment" (page 3-29). Page 5.16-136 does suggest blending as a possible way to treat VOCs. The water quality discussion on page 5.16-29 notes that detected VOCs are rare and if detected are at low levels in the groundwater basin. Samples from Sites 1 and 11 detected VOCs in one sampling but only at Site 11 upon additional sampling. If there is a reasonable potential that VOCs may be encountered at one or more sites, the expected treatment scheme should be discussed in this section. PD-8 Cont.

8. **Section 3.4.1 – Groundwater Storage and Recovery, Figure 3-2 (page 3-9).** The volume of surface water deliveries should be added to the Project Conditions portion of Figure 3-2. Also, for Figure 3-2, please clarify what year the demand is representative of (i.e., is it current conditions or 2035 conditions). PD-3

9. **Section 5.16.3.7 – Operation Impacts and Mitigation Measures – Groundwater (page 5.16-93).** The text describes an ongoing monitoring program and analysis of groundwater data to understand project operation impacts on nearby wells. If the groundwater model is to be used for analysis purposes, the periodic recalibration of the model is important for accurate results. Please clarify the expected interval for model recalibration. HY-15

Thank you for the opportunity to provide these comments on the DEIR for the Regional Groundwater Storage and Recovery Project dated April 10, 2013. If you have any questions, please contact me at (650) 349-3000. GC-1

Sincerely,

Nicole M. Sandkulla, P.E.
Water Resources Planning Manager

cc: J. Labonte, SFPUC
T. Roberts, Terry Roberts Consulting
File

G- DALY CITY- SWEETLAND

CITY OF DALY CITY

Department of Water and Wastewater Resources
153 Lake Merced Boulevard
Daly City, CA 94015
(650) 991-8200
Fax (650) 991-8220

Patrick Sweetland, Director

June 10, 2013

Sarah B. Jones
Acting Environmental Review Officer
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

Subject: Regional Groundwater Storage and Recovery Project

Dear Ms. Jones:

The City of Daly City welcomes the opportunity to comment on the Draft Environmental Impact Report (DEIR) for the Regional Groundwater Storage and Recovery Project. Daly City would again acknowledge a well established track record of mutual cooperation with San Francisco aimed at preserving the Westside Groundwater Basin as a potable drinking water supply. Our agencies joint efforts include securing grant funding to install a series of groundwater sentinel wells, activities to construct and distribute recycled water, creating a fully vetted groundwater aquifer model, ongoing semi-annual groundwater monitoring among basin users, and efforts aimed at developing a Lake Management Plan addressing sustainable water levels at Lake Merced. It is from that vantage the City of Daly City offers the following comments. GC-1

HY-7: Project operation would not result in substantial land subsidence due to decreased groundwater levels in the Westside Groundwater Basin where the historical low water levels are exceeded (*Less than Significant*). Daly City concurs. The subsidence analysis provides reasonable results given the tools and data available. However, in "Approach to Analysis," the DEIR states that "laboratory test results of the compressibility of clays in the Westside Groundwater Basin were not available and, therefore, typical soil compressibility values of the Merced Formation (which underlies much of the Westside Groundwater Basin) were used in the estimations of subsidence." The November 19, 2012 memorandum "Response to Comment on Subsidence TM" provides additional explanation on the consideration of sediment age and burial depth in the selection of assumed compressibility values utilized in the calculations.[1] Nevertheless, the issue remains that the compressibility values used in the subsidence calculations are assumed. Furthermore, the proposed project will significantly increase HY-24

[1] Memorandum from Peter Leffler to Greg Bartow, *"Response to Comment on Subsidence TM,"* November 19, 2012.

groundwater extractions from the deepest parts of the aquifer system (the "deep" aquifer), which is beneath the thickest and most extensive continuous clay bed identified in the basin (the "W-clay"). It is prudent to establish baseline land surface elevation information from which future data can be compared to reliably conclude whether or not subsidence occurs. The South Westside Basin Groundwater Management Plan specifies actions to collect evidence of active subsidence should basin water levels decrease below historic levels. HY-24 Cont.

HY-9 and C-HY-5: Project operation could have a substantial, adverse effect on water quality that could affect the beneficial uses of Lake Merced (*Less than Significant with Mitigation*). Daly City concurs. The impacts to Lake Merced are also a concern for the San Francisco Groundwater Project. Modeled lake levels are for the project conditions are lower than the existing condition scenario. Corrective actions are proposed that include adding supplemental water (either SFPUC system water, treated storm-water, or recycled water), if available, and/or altering or redistributing pumping patterns. GC-1 Daly City is working in conjunction with San Francisco on a Lake Merced Management Plan as part of its efforts associated with the Vista Grande Drainage Basin Improvement Project. OV-1

HY-12: Project operation would not cause a violation of water quality standards due to mobilization of contaminants in groundwater from changing groundwater levels in the Westside Groundwater Basin (*Less than Significant*). Daly City concurs with the following caveat. The basis for the *Less than Significant* impact seems to depend in part on the DEIR text describing shallow groundwater zones as being isolated, hydraulically separated, and disconnected hydraulically from the Primary Production Aquifer. The following observations indicate the Primary Production Aquifer is not isolated from land surface and percolating groundwater recharge.

- If the Primary Production Aquifer were isolated/hydraulically separated from groundwater recharge, as purported by the DEIR, then water and dissolved constituents in recharge are not expected to migrate downwards into the Primary Production Aquifer. However, monitoring data from Primary Production and deeper Deep Aquifer wells has detected constituents like nitrate (pg. 5-16.28), and VOCs (pg. 5.16-29), which are associated with land surface activities. These constituents conceivably reached these depths by migrating downwards with recharge. HY-33

- In-lieu recharge depends on a hydraulic connection between groundwater recharge and the Primary Production Aquifer, although the characteristics of that connection are spatially variable. Conjunctive use pilot projects have shown that in-lieu recharge to the shallow aquifer over large basin areas contribute significant volumes of water that can be extracted by wells constructed in the Primary Production and Deep Aquifers (pg. 5-16.20). An in-lieu recharge project would be infeasible if the Primary Production Aquifer was isolated, hydraulically separated or disconnected from groundwater recharge.

However, changes to vertical gradients primarily influence the potential for constituents near land surface to reach the Primary Production Aquifer in groundwater recharge. On average, the project reduces vertical hydraulic gradients relative to existing conditions, and significant groundwater quality changes due to the project are therefore not expected. We request that the importance of vertical gradients be emphasized in the next EIR document by removing phrases like "assuming there is a hydraulic connection," "disconnected hydraulically," and "limited hydraulic connectivity." We believe this can be easily achieved by incorporating the information as was presented in the January 31, 2013 memorandum "Clarification of Task 10.6 Technical Memorandum Aquifer Nomenclature and Physical Processes Affecting Water Quality in the South Westside Groundwater Basin." [2] HY-33 Cont.

Therefore, Daly City concurs that water quality impacts, if any, should be *Less than Significant*. Groundwater monitoring and analyses as part of managing the project under the Operating Agreement as well as water supply monitoring by the Participating Pumpers should identify the presence of constituents of concern, and the extracted groundwater would be treated to ensure all drinking water standards are met.

Additionally, please note that the Hillside Class III Disposal Site located in Colma is closed, but it is a community concern in regards to potential water quality impacts. Daly City is aware of some community members that have identified it as a potential threat to the basin groundwater supply.[3] The disposal site location is shown in Appendix H of the DEIR – Technical Memorandum 10.6 "Groundwater Quality" (Figure B-1, Solid Waste Facility Location <u>in</u> Attachment 10.6-B *Existing Regulated Sites – Geotracker, SWIS, DTSC, and SLIC*), and the DEIR concludes that the Hillside Class III Disposal Site is outside of the Groundwater Protection Zone for the proposed project wells.

HY-41

Information from the Westside Basin Groundwater Monitoring Program indicates that in the vicinity of the Hillside Disposal Site, groundwater flow in the Primary Production Aquifer is away from Daly City wells and south towards Colma and South San Francisco. Although groundwater and dissolved constituents originating at the site are likely moving away from Daly City, they could be moving toward pumping wells located south of Daly City. Daly City wants to express the importance of water quality monitoring in this and all parts of the basin, and notes that should water quality at proposed wells be impacted by groundwater originating at the Hillside Disposal Site, monitoring and analyses required under the Operating Agreement as well as bi-annual water supply monitoring should identify the presence of constituents of concern. Any violation of

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[2] Memorandum from Greg Bartow to Tim Johnston, *"Clarification of Task 10.6 Technical Memorandum Aquifer Nomenclature and Physical Processes Affecting Water Quality in the South Westside Groundwater Basin,"* January 31, 2013.

[3] Steve Bond and Associates, Inc., March 14, 2008 letter to Mr. Vic Pal, San Francisco Bay Regional Water Quality Control Board, "March 2008 Tentative Order, Waste Discharge Requirements for Hillside Landfill, Colma, San Mateo County."

drinking water standards would be addressed by treatment, such as blending, to ensure all drinking water standards are maintained. HY-41 Cont.

Lastly, the DEIR correctly notes that rising groundwater levels would not dilute nitrate concentrations. Furthermore, it correctly notes that pumping and in-lieu recharge could result in changes in groundwater flow directions and conceivably transport existing elevated concentrations of dissolved nitrates in groundwater towards Project wells or Partner Agency wells. The DEIR indicates that should this occur, the elevated nitrate concentrations in the water produced by the wells would be addressed through treatment, such as blending, to ensure that all drinking water standards for nitrate are met. GC-1

HY-14: <u>Project operation may have a substantial adverse effect on groundwater depletion in the Westside Groundwater Basin over the very long term (*Less than Significant with Mitigation*)</u>. Daly City concurs. The groundwater modeling conducted for the DEIR revealed that the basin leaks stored groundwater, and therefore all the water delivered for storage most likely will not be available for extraction during drought periods. The modeling analysis however assumes that all of the surface water delivered for storage is available for extraction, and as a consequence there is a simulated net reduction in groundwater storage. As modeled, the groundwater projects therefore appear unsustainable. The DEIR concludes that because the depletion volume is small relative to the total volume of groundwater stored in the basin, the impact of this long-term depletion is insignificant. However, the comparison to total groundwater in storage is a misleading metric because a substantial portion of the groundwater volume is not accessible for extraction and use.

HY-47

Under project operations, these concerns are addressed because by the terms of the Operating Agreement future groundwater extraction is limited to the water in the SFPUC Storage Account, and the Operating Agreement specifies that the Storage Account shall account for these water losses. Furthermore, the proposed mitigation allows additional in-lieu recharge to be added when surplus SFPUC system water is available, which will help maximize the Storage Account available for extraction during drought periods.

The hydraulic relationships between recharge, well locations, extraction rates, groundwater level changes, and basin leakage are complex. Additionally, the hydrologic sequence utilized for modeling the effects of these relationships under project operations has less rainfall recharge than occurred historically, and the design drought was inserted late in the simulation period. As a consequence, simulated groundwater storage never fully recovers and additional water deliveries are required to maintain the Storage Account balance. However, the timing and magnitude of these additional deliveries is not intuitive. For example, storage is increased by in-lieu recharge, which occurs at varying rates and magnitudes across the entire basin, but the pumping reductions occur at specific Participating Pumper well locations. The Operating

Agreement will address these concerns because it specifies that future groundwater monitoring and hydrologic analyses are required to adaptively manage the project, determine actual leakage losses, and account for losses in the SFPUC Storage Account. HY-47 Cont.

C-HY-4: <u>Operation of the proposed Project would not have a cumulatively considerable contribution to seawater intrusion. (*Less than Significant*)</u>. Daly City concurs. Sea water intrusion is an issue for the San Francisco Groundwater Project, which is located in the North Westside Basin, and less of an issue for the Regional Groundwater Storage and Recovery Project proposed for the South Westside Basin. The DEIR concludes that the San Francisco Groundwater Project could result in a significant cumulative impact on groundwater quality from seawater intrusion in the North Westside Basin, but the GSR Project would not have a considerable contribution to seawater intrusion in the South Westside Basin. The seawater intrusion analysis could benefit from more thorough spatial analysis of modeled groundwater fluxes. However, the Operating Agreement provides for groundwater monitoring, which presumably includes sentinel wells located near the Pacific Ocean in the North Westside Basin and San Francisco Bay in the South Westside Basin. These sentinel wells are located some distance away from portable production wells, and their purpose is to identify early intrusion should it occur and initiate actions to correct and manage it. For example, the San Francisco Groundwater Project proposes to mitigate seawater intrusion in the North Westside Basin, should it occur, by adjusting the distribution and magnitude of pumping rates at proposed project wells, thereby protecting production wells located in the South Westside Basin. HY-29

C-HY-8: <u>Operation of the proposed Project would have a cumulatively considerable contribution to a cumulative impact related to groundwater depletion effect (*Less than Significant with Mitigation*)</u>. Daly City concurs. Daly City notes that the combined impacts from the Regional Groundwater Storage and Recovery Project and the San Francisco Groundwater Supply Project, when considered cumulatively, provide mutually beneficial impacts in some respects. By itself, the Regional Groundwater Storage and Recovery Project increases groundwater outflow (leakage) to the Pacific Ocean by raising onshore groundwater levels during “PUT” and “HOLD” periods. By capturing a large part of that outflow, the San Francisco Groundwater Supply Project reduces the leakage losses that would otherwise occur and increase the total yield of the San Francisco Groundwater Project and the Regional Groundwater Storage and Recovery Project. Conversely, by elevating groundwater levels in the northern part of the South Westside Groundwater Basin, the Groundwater Storage and Recovery Project reduces the risk of seawater intrusion created by the San Francisco Groundwater Supply Project. The DEIR does not explicitly point out these potentially mutually beneficial impacts. HY-49

Thank you Ms. Jones, for your consideration of our comments. Should you have any questions or require additional information, please do not hesitate to contact me directly. GC-1

Sincerely,

Patrick Sweetland
Director of Water and Wastewater Resources

Cc: Greg Bartow, SFPUC
John Fio, HydroFocus, Inc.
Timothy Johnson, SF Planning (via email)
Kelly Capone, SFPUC (via email)

G - SAN MATEO RS - LOCOCO

From: Joe Lo Coco [mailto:jlococo@smcgov.org]
Sent: Tuesday, June 11, 2013 12:14 PM
To: Jaimes, Daniel
Cc: Diana Shu; Huey, Calvin
Subject: Fwd: SFPUC EIR extension

Daniel,

San Mateo County's comments to the EIR for the SFPUC's Regional Groundwater and Storage Project are as follows: GC-1

1)At the Garden Village Elementary School, we suggest that the SFPUC consider planting a hedge against the fence that surrounds the new facility that is intended to be constructed near the intersection of Park Plaza Drive and 87th Street. We are also concerned that the fencing be adequately secured, in light of its proximity to a local school. PD-5

2)Because of the proximity of this facility to the Park Plaza Drive/87th Street intersection, it'll be important that traffic controls be set up well in advance of the intersection to advise motorists when the work is actively occurring and lane or parking restrictions apply. TR-1

3)At Westborough Boulevard, access points to the 12' x 7' culvert need to be identified. GC-5

4)The County will require that the existing storm drain culvert on Westborough Boulevard immediately adjacent to the SFPUC's new jack and bore operations, be videoed before and after the SFPUC's construction to ensure that the SFPUC project does not result in settlement of the storm culvert or displacement of the storm culvert joints. Any settlement will need to be corrected by the project. GC-5

5)The contractor will be required to pay encroachment permit fees in conjunction with encroachments received to perform work in the County right of way. PD-2

We thank you for the opportunity to comment. GC-1

Joseph A. LoCoco, Deputy Director, Road Services

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G-COLMA-LAUGHLIN
cont.

TOWN OF COLMA
PLANNING DEPARTMENT
1190 El Camino Real • Colma, California 94014
Phone: (650) 757-8888 • FAX: (650) 757-8890

May 28, 2013

Via Email to: Mr. Tim Johnson, timothy.johnston@sfgov.org

Ms. Sarah Jones
San Francisco Planning Department 1650 Mission Street, Suite 400
San Francisco, CA 94103-2479

Re: Case No. 2008.1396E - SFPUC Regional Groundwater Project EIR Comments – Colma Sites 7, 8 and 17 (Alternative). South San Francisco Site 9

Dear Ms. Jones,

Thank you for the opportunity to comment on the SFPUC Regional Groundwater Storage and Recovery Project EIR. We have also appreciated the outreach and informational meetings provided by SFPUC staff regarding this project. After reviewing the document, we are in agreement with all the mitigation measures that will be applied to the project, and where we have not commented, we concur with the recommended mitigation measure. We would like to make the following comments on the document and regarding several of the mitigation measures: GC-1 GC-3 GC-1

Global Comment for all Colma Sites: Spanish/Mediterranean Architectural Requirement. The Land Use Element (pg. 5.02.13 Commercial Land Use Development Guidelines and pg. 5.02.33, Land Use Policy 5.02.3110), requires that all new buildings visible from public roads should incorporate a Spanish/Mediterranean architectural theme. This is also a policy in the Open Space and Conservation Element. In addition, the Colma Municipal Code has a "DR" zoning overlay for all of the sites that requires Spanish/Mediterranean design. For the structure proposed on Site 8 and possible structures on Sites 7 and Alternate Site 17, the exteriors should incorporate Spanish/Mediterranean elements which include articulated building walls, tile roof elements, trellis' and other features. PP-1
The Town has worked very hard to create a cohesive design style, and we consider any variation for the proposed structures to be a significant impact, requiring mitigation. This must be addressed in the Final EIR with the inclusion of compliance with Town of Colma design requirements. In addition, the general discussion about the Town of Colma in the Aesthetics section should be updated to include this information. AE-4

Site 8, Aesthetics, pg. 5.3-24. The Town is in strong disagreement with the statements regarding the characteristics of Site 8. The site is visible from the Town's highly successful and visually pleasing auto row, behind a successful renovated retail building (Kohl's) and across the street from the historic Town Hall. Visual quality of the AE-2 area is not moderately low – it would be moderate to moderately high. Site 8 also has high (not low) viewer concern, especially from our auto dealer community and the Town. Over the past year, the Town has had numerous meetings with SFPUC staff only to be disappointed with their reluctance to make any substantive changes to the structure proposed on Site 8 that would make it more attractive than a concrete bunker that will serve to substantially degrade the visual character of our auto row. The site is in close proximity to auto dealerships which have invested millions of dollars in facilities and upgrades to existing facilities. The new 28 million dollar Lexus dealership is just northwest of the site. The Final EIR must address compliance with Town of Colma design requirements. Based on the Table 5.3-3, the Town finds that the proposed building on Site 8 would have a significant impact based on moderate to moderately high visual contrast/change and moderate to moderately high visual sensitivity. AE-2 Cont.

Site 9 Overhead Electrical Connection. Figure 3-4 shows that Site 9 requires an electrical connection through a commercial business in the Town of Colma. This electrical connection is proposed to be above ground, which is unacceptable. The line would impact the existing commercial business and visually impact views from the Verano neighborhood. The Town of Colma requires undergrounding of utilities for all new construction, from the pole to the project site pursuant to Municipal Code Section 5.09. In addition, General Plan policy 5.02.361 requires that all new construction projects to place utilities underground. Power for this site should be taken from the South San Francisco side or undergrounded if on the Colma side. PD-5

Site 9 Visual Impacts. Figure 3-23 shows that a chemical treatment and filtration building will be highly visible from the back windows of 4-5 historic residences to the east within Colma, in addition to residences at the Verano neighborhood. The Final EIR must address this visual impact and mitigation. AE-3 This impact should also be addressed in a discussion to Cultural Resources in the Final EIR. The reviewer should view the Historic Resources Element of the Colma General Plan. CR-1

Traffic Control Plan, Mitigation Measure M-TR-1: The Town looks forward to receiving and reviewing the Traffic Control plan, and working with the SFPUC on traffic control measures that will lessen the extent of traffic impacts in Colma. Colma is a regional shopping destination for automobiles (along Serramonte Boulevard) and other retail establishments. From Thanksgiving weekend through New Year's, traffic increases for holiday shopping – especially on weekends. While construction of the project could take place during this timeframe, additional provisions would need to be made to manage the project so as not to impact businesses during this time. TR-1

Noise Control and Expanded Noise Control Plans, Mitigation Measures M-NO-1, M-NO-3: The Town looks forward to receiving and reviewing the Noise Control plans, and working with the SFPUC on noise control measures that will lessen noise impacts to our existing cemeteries and sensitive receptors in close proximity to the sites (especially Cypress Lawn at Alternate Site 17 in Colma). NO-1

G-COLMA-LAUGHLIN
cont.

TOWN OF COLMA
PLANNING DEPARTMENT
1190 El Camino Real • Colma, California 94014
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Site Maintenance, Mitigation Measure M-AE-1a: We agree that construction will have a temporary visual impact on the visual character of the site or its surroundings. However, we believe that there is also a visual impact at Site 8, which is along one of our primary commercial thoroughfares (Serramonte Boulevard) and should be included as one of the sites requiring mitigation. Once applied (for site 8), there would be a less than significant impact. We agree with the conclusion of this Mitigation Measure as applied to Site 7. AE-2

Tree Removal and Replacement, Mitigation Measure M-AE-1e: The project includes the removal of trees within a tree mass recognized in the General Plan. While the General Plan does not preclude modification of tree masses or tree removal, it is the Town's expectation and desire that replacement trees and landscaping be provided in strategic locations along Colma Boulevard to maintain and even enhance its scenic quality and to visually screen proposed improvements. Specifically, the Town would like to see a slightly bermed planting in the island currently occupied by dirt and weeds directly behind the sidewalk along Colma Boulevard, and in additional locations along and surrounding site, with a majority of the improvements close to Colma Boulevard. With this additional clarification, we concur with the Mitigation Measure as written. AE-1

Landscape Screening, Mitigation Measure M-AE-3a: We concur with this Mitigation Measure as applied to Site 7. We believe that the addition of a building at Site 8 will create a significant visual impact that will require landscape screening and this impact should be discussed in the Final EIR. Over the past year we have had meetings with the SFPUC concerning the aesthetics of the building proposed at Site 8, expressing strong concerns about the visual impact of the proposed structure to our surrounding commercial businesses and our historic Town Hall to the north. During one of the meetings, we concluded that 2-3 trees could be planted to the north of the building to screen views of the building as viewed from Serramonte Boulevard without conflict to the Integrated Vegetation Management Policy. In addition, we have requested planting of approved vegetation on the slope directly adjacent to Serramonte Boulevard to resolve a long-standing property maintenance issue with overgrown weeds. We request that this Mitigation Measure, with the provisions stated above, be applied to Site 8. AE-2

Implementation of a Storm Water Pollution Prevention Plan, Mitigation Measure M-HY-1: The Town welcomes the opportunity to review and comment on the plan to assure that illicit discharges are not made into any Town storm drain facilities. Town and the sewer district approval for any discharges to the storm drain or sanitary sewer system are required. HY-3

Please feel free to contact me if you have any questions concerning the Town's comments. GC-1

Sincerely,

Michael P. Laughlin, AICP City Planner

CC (via email):

Mr. Greg Bartow, gbartow@sfwater.org
Ms. Kelley Capone, kcapone@sfwater.org

G-SAN BRUNO-FABRY

City Of SAN BRUNO

CITY OF SAN BRUNO

Klara A. Fabry
Public Services Director

PUBLIC SERVICES DIRECTOR
ADMINISTRATION AND ENGINEERING

June 13, 2013

Sarah Jones, Acting Environmental Review Officer
Regional Groundwater Storage and Recovery Project
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

Subject: City of San Bruno comments on the Draft Environmental Impact Report for the Regional Groundwater Storage and Recovery Project (State Clearinghouse No. 2005092026)

Dear Ms. Jones:

The City of San Bruno provides the following comments on the Draft Environmental Impact Report for the Regional Groundwater Storage and Recovery Project ("DEIR"). GC-1

1. DEIR, pages 3-39, 5.2-17, 5.8-15, 5.8-19, 5.8-29, and 5.8-30. The potential selection of drive-up portable generators should be included in the project description to allow for this potential. The DEIR should also include the analysis and potential impacts associated with the potential use of permanent, on-site generators to allow for this potential and provide flexibility in the project implementation. PD-9

2. DEIR, page 5.15-14. The classification of facilities as "Important" (Class II) with an associated restoration time of 30 days may not be consistent with San Bruno's desire for emergency supplies. The project design should allow for more rapid restoration of service. PD-6

3. DEIR, page 5.16-136. The DEIR does not acknowledge the potential for a project-related rise in groundwater levels to intercept nitrate mass in the vadose zone, resulting in an increase in nitrate concentration in groundwater. The potential for this mechanism should be included in the analysis and monitoring developed to capture any evidence that this may be occurring. HY-39

4. DEIR, page 5.16-152. Given the significant proposed change in the groundwater pumping regime and the lack of understanding of historical subsidence and of the compressibility of subsurface materials, land subsidence monitoring should be performed, including development of a baseline of land surface elevation for future comparison. HY-24

5. DEIR, page 3-10: The potential impacts of pumping at the peak pumping capacity of 8.3 mgd (Section 3.4.2) should be modeled if such higher rates are being considered for the project as part of normal operations. Impacts of pumping at 8.3 mgd rather than the modeled 7.2 mgd will be more severe near the pumping locations and during the period of pumping. This is true even if the annual volume pumped is the same under both the 8.3 mgd and 7.2 mgd pumping rates. If the 8.3 mgd pumping rate is only intended to be used in the event of unscheduled down time then the document should state that production at 8.3 mgd would only occur as a result of unscheduled down time in order to meet the annual target of 8,100 AFY. Additionally, an estimate of the frequency of pumping at this rate should be made and the corresponding analysis conducted. PD-10

6. DEIR, page 3-141. The statement in Section 3.8.2 that "…when groundwater is pumped to provide a dry year supply, pumping would reduce the balance of water in the SFPUC Storage Account" does not reflect that maintenance and temporary usage of project facilities by SFPUC would also reduce the balance of water in the SFPUC storage account. The text must be updated to reflect all conditions that would reduce the balance of water in the SFPUC Storage Account. PD-16

7. DEIR, page 5.1-12. The citation of San Bruno 2011 in Section 3.8.1 is incorrect. The reference section includes San Bruno 2011 as

   San Bruno, City of. 2011. History. *Website accessed April 15, 2011 at: http://sanbruno.ca.gov/city_history.html.*

   which has no reference to the apportionment of groundwater production. OV-2

8. DEIR, page 5.11-3, footnote. Elevations are not correct in the footnote. Mean sea level is 0.52 ft NGVD 29 and 3.23 ft NAVD 88. Information on tidal datums can be found at http://www.ngs.noaa.gov/Tidal_Elevation/diagram.jsp?PID=HT0027&EPOCH=1983-2001. RE-1

9. DEIR, page 3-10. In order to be consistent with the Operating Agreement, the following edits should be made and the environmental analysis conducted consistent with the edits set forth below. PD-14

   Change from:

   During dry years, Partner Agency water deliveries from the regional water system would be comprised of reduced surface water deliveries and groundwater pumped from Project wells, as identified in the Operating Agreement. The Partner Agencies' pumping from their existing wells would not exceed the annual average rates consistent with the pumping limits expressed in the Operating Agreement.

   to:

   During dry years, Partner Agency water deliveries from the regional water system would be comprised of reduced surface water deliveries and groundwater pumped from Project wells, as identified in the Operating Agreement. The Partner Agencies' pumping from their existing wells would not exceed rates consistent with the pumping limits expressed in the Operating Agreement.

G-SAN BRUNO-FABRY
cont.

10. DEIR, page 5.16-146. Measured data may not be sufficient to account for losses, thus the usage of the groundwater model as a tool should be included in the mitigation measure, with guidance from the Operating Committee. Additionally, losses will occur during Put, Take, and Hold conditions, so the accounting and environmental analysis should not be limited to only Put and Hold years.

    Change text from:

    > *The SFPUC Storage Account monitoring program will use data from metered SFPUC in-lieu water deliveries to the Partner Agencies and regularly measured changes in groundwater elevations during a series of Put and Hold Years to determine the volume of stored water while developing rules to account for losses in groundwater storage, based on generally accepted principles of groundwater management.*

    to:

    > *The SFPUC Storage Account monitoring program will use data from metered SFPUC in-lieu water deliveries to the Partner Agencies, regularly measured changes in groundwater elevations, and from the regional groundwater model to determine the volume of stored water while developing rules to account for losses in groundwater storage, based on generally accepted principles of groundwater management.*

HY-48

11. DEIR, page 3-140. The following statement should be changed to reflect operations during Put Periods. The DEIR analysis should be consistent with this change in project description as well.

    Change from:

    > *Neither Project wells nor Partner Agency wells would be pumped in these Put Periods, apart from volumes needed to periodically exercise the wells.*

    to:

    > *Pumping from Project wells and Partner Agency wells during Put Periods would be limited to volumes needed to periodically exercise the wells, emergency usage, and other functions described in the Operating Agreement.*

PD-13

12. DEIR, page 3-141. Change the following text to accurately reflect accounting from:

    > *During these Take Periods, when groundwater is pumped to provide a dry-year supply, pumping would reduce the balance of water in the SFPUC Storage Account.*

    to:

    > *During these Take Periods, when groundwater is pumped from Project wells for Project purposes, such as providing a dry-year supply or performing maintenance, pumping would reduce the balance of water in the SFPUC Storage Account.*

PD-16

G-SAN BRUNO-FABRY
cont.

13. Mitigation Measure M-HY-14: Prevent Groundwater Depletion. This proposed mitigation measure should recognize the Operating Committees role in the development of the accounting for basin losses. Not only will the SFPUC work with the Operating Committee on the development of the accounting methodology, but also the Partner Agency's will be working with the Operating Committee as provided in the Operating Agreement. HY-48

San Bruno appreciates the opportunity to review and provide comments on the DEIR. Please do not hesitate to contact me should you have any questions regarding these comments. GC-1

Sincerely,

Klara A. Fabry
Public Services Director

CELEBRATING 30 YEARS

Tuolumne River Trust

O-TRT-DREKMEIER

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June 5, 2013

Sarah B. Jones, Acting Environmental Review Officer
Regional Groundwater Storage and Recovery Project
San Francisco Planning Department
1650 Mission St., Suite 400
San Francisco, CA 94103

Dear Ms. Jones:

The Tuolumne River Trust (TRT) appreciates the opportunity to comment on Case No: 2008.1396E – the Regional Groundwater Storage and Recovery Project (Project). GC-1

TRT is concerned the Project will increase diversions from the Tuolumne River in normal and wet years, potentially resulting in negative impacts on the stretch of River below O'Shaughnessy Dam. HY-50 The Project EIR simply tiers off the 2008 Water System Improvement Program (WSIP) PEIR, and fails to incorporate new conditions and information that have become available since the WSIP was approved. HY-52

The approved Modified WSIP capped water sales in the SFPUC service territory at 265 mgd until at least 2018. Historically, 85% of SFPUC water has come from the Tuolumne River and 15% from the SFPUC's Bay Area reservoirs.

Conditions related to management of the SFPUC's Bay Area reservoirs have changed since the WSIP was approved. Most notably, the SFPUC will be required to release an additional 7.4 mgd into Alameda and San Mateo Creeks for fish and wildlife upon completion of upgrades to the Calaveras and Crystal Springs Dams. HY-50

Presumably, to make up for this shortfall diversions from the Tuolumne River would need to increase in order to provide supplemental surface water to the agencies that currently pump groundwater. The cumulative impacts of diverting more water from the Tuolumne River must be analyzed in the Project EIR. The Project EIR also should study the potential of augmenting aquifer replenishment with injection wells utilizing local stormwater or recycled water to reduce impacts on the Tuolumne River. AL-1

Another issue that must be addressed regards the Raker Act. The Raker Act prohibits the SFPUC from selling water from the Tuolumne River to private companies. Since Cal Water is one of the utilities that would receive surface water from the SFPUC under the Project, the EIR should address whether this could be accomplished without violating the Raker Act, especially considering that yield from the SFPUC's Bay Area reservoirs will be reduced by 7.4 mgd. HY-51

The Project EIR must consider new information that has become available since the WSIP PEIR was approved. For example, on April 16, 2012, the SFPUC HY-52 released a report titled, "Sensitivity of Upper Tuolumne River Flow to Potential Climate Change Scenarios" (Attachment A). This information must be considered when determining potential impacts on the Tuolumne River of increasing diversions from Hetch Hetchy Reservoir.

After the WSIP was approved, the SFPUC embarked on its Upper Tuolumne River Ecosystem Program (UTREP) that is studying the stretch of the Tuolumne River between O'Shaughnessy Dam and Early Intake. The UTREP is "An ongoing effort to conduct long-term, collaborative, science-based investigations designed to: 1) Characterize historical and current river ecosystem conditions; 2) Assess their relationship to Hetch Hetchy Project operations; and 3) Provide recommendations for improving ecosystem conditions on a long-term, adaptively managed basis." HY-52 Cont.

The UTREP is a legally required program with which the SFPUC must comply to meet its obligations under the Kirkwood Agreement. While completion of the UTREP is behind schedule, the information that is currently available must be incorporated into the environmental review for the Regional Groundwater Storage and Recovery Project.

TRT is concerned that increased diversions from Hetch Hetchy could have negative impacts on Poopenaut Valley and other sensitive ecosystems downstream of O'Shaughnessy Dam, especially in light of likely changes in the timing of runoff in the coming era of climate change. An up-to-date analysis, with current data using current analysis protocol, needs to be part of the Project EIR. HY-50

TRT is concerned that current operations of O'Shaughnessy Dam are in violation of the Kirkwood Agreement. Following is some background information.

On January 31, 1985, the City and U.S. Interior Department entered into a Stipulation (Attachment B) that required a study of the impacts on fish, wildlife, recreational and aesthetic values, as a condition of any modification (including expansion) of the City's Hetch Hetchy System that might affect the flow of the Tuolumne River between O'Shaughnessy Dam and Early Intake. The 1985 Stipulation further provides that the purpose of the study is to determine what change, if any, should be made to the flow release schedule. It reserves the Interior Department's authority to require such change after consideration of any objection. HY-52

On November 4, 1985, the City entered into an Interim Agreement (Attachment C) with the Tuolumne River Trust and other conservation organizations, confirming this obligation with respect to the third generating unit of the Kirkwood Powerhouse. The Interim Agreement also granted the groups standing to enforce the conditions of a subsequent agreement between the City and the Interior Department relating to a fisheries study.

On March 10, 1987, the City and Interior Department entered into a Stipulation (Attachment D) requiring the City, or the U.S. Fish and Wildlife Service (FWS), to undertake a study "…to determine what, if any effect, the Kirkwood Powerhouse and Kirkwood Addition would have or have had on the habitat for and populations of resident fish species, between O'Shaughnessy Dam and Early Intake…" The condition requires the study to be completed by December 1992, subject to extension only if the USFWS determines that the study is inconclusive or inaccurate as a result of climatic or other environmental conditions. The Stipulation specifies adjustments to the minimum flow releases, if the USFWS determines that flow in the Tuolumne River "…should be increased."

USFWS issued a draft report in 1992 (Attachment E) titled "Instream Flow Requirements for Rainbow and Brown Trout in the Tuolumne River Between O'Shaughnessy Dam and Early Intake." This report was never finalized, however, it states, "In 1988, the U.S. Fish and Wildlife Service's Instream Flow Incremental Methodology (IFIM) was applied to the Tuolumne River below Hetch Hetchy Reservoir…An annual fishery allocation of between 59,207 acre-feet and 75,363 acre-feet is recommended, based on the findings of the instream flow study."

The report recommended increasing instream flows from O'Shaughnessy Dam. For example, in the months of December and January, it recommended an increase in flows from a minimum of 35 cfs to 50 cfs in dry years, from a minimum of 40 cfs to 70 cfs in normal years, and from a minimum of 50 cfs to 85 cfs in wet years.

However, Table 5.3.1-2 of the WSIP PEIR (Vol. 3, Section 5.3, pp. 5.3.1-13) shows the "Schedule of Average Daily Minimum Required Releases to Support Fisheries Below O'Shaughnessy Dam" based on a 1985 agreement. Attachment F compares flows listed in the WSIP PEIR with those recommended by the draft USFWS report.

HY-52
Cont.

On March 20, 2006 the Tuolumne River Trust, represented by the Natural Heritage Institute, gave notice that the SFPUC was in violation of the "Modification for Kirkwood Powerhouse Unit No. 3 to Stipulation for Amendment of Rights-of-Way for Canyon Power Project Approved by Secretary of the Interior on May 26, 1961 to Fulfill the Conditions Set Forth in Provision 6 of Said Amended Permit." Our letter (Attachment G) asserted that the study required by the Stipulation had not been published and the minimum flow release schedule had not been adjusted.

On February 5, 2008, the SFPUC responded (Attachment H), stating, "The purpose of this letter is to propose a collaborative process to resolve these implementation issues by December 2009." The SFPUC proposed, among other things, "the following measures, schedule and conditions to resolve the outstanding issues from the 1987 Stipulation."

"The SFPUC, the USFWS, Yosemite National Park Service staff, and SFPUC consultants will work together to gather the information necessary to develop physical and biological objectives for an adaptive management plan for O'Shaughnessy Dam flow releases. It is anticipated that these initial studies shall be completed by December 2009."

"The SFPUC and the USFWS, in consultation with the Yosemite National Park, the US Forest Service, the California Department of Fish and Game, SFPUC consultants, and the Trust, will review ongoing study material and work together to develop an adaptive management plan for releases into the affected reach to enhance a wider range of resource values. This plan will include a monitoring program, and may also include annual consultations between the USFWS and the

SFPUC regarding water releases into the affected reach. The SFPUC and USFWS agree to make best efforts to complete the adaptive management plan by December 2009." HY-52 Cont.

On May 26, 2009, the Tuolumne River Trust accepted the proposed measures, schedule, and conditions proposed by the SFPUC. To meet the obligations of the agreement, the SFPUC initiated its Upper Tuolumne River Ecosystem Program (UTREP).

We sincerely hope the Final EIR for the Regional Groundwater Storage and Recovery Project will address the issues raised in this letter. The Project EIR must address current conditions and potential violations of the Kirkwood Agreement, and incorporate up-to-date information. GC-3

Thank you for the opportunity to comment on the Draft Project EIR. GC-1

Sincerely,

Peter Drekmeier

Peter Drekmeier
Bay Area Program Director

Attachments included on enclosed CD.

Attachment A

O-TRT-DREKMEIER Cont.

San Francisco Water Power Sewer
Services of the San Francisco Public Utilities Commission

1155 Market Street, 11th Floor
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April 16, 2012

TO: Commissioner Anson B. Moran, President
Commissioner Art Torres, Vice President
Commissioner Ann Moller Caen
Commissioner Francesca Vietor
Commissioner Vince Courtney

THROUGH: Ed Harrington, General Manager

FROM: David Behar, Climate Program Director, Water Enterprise

RE: Final Report: "Sensitivity of Upper Tuolumne River Flow to Potential Climate Change Scenarios"

HY-52 cont.

Please find enclosed the above named final report. This report was the subject of the summary and oral report provided to the Commission on January 10, 2012, and we promised to forward the full report upon completion. No changes to the conclusions or analysis presented on January 10 were made prior to finalization of the report.

NEXT STEPS

As reported on January 10, this report identified runoff projections utilizing a range of possible changes to temperature and precipitation due to climate change. Two subsequent analyses are in the works now:

1) Estimate the potential effects on water supply these changes in runoff might indicate. This analysis will utilize the Hetch Hetchy Local System Model (HHLSM), our water supply planning model. Timeframe: Completed Summer 2012.

2) Scope and implement a comprehensive climate change assessment utilizing the most advanced climate science available, careful characterization of uncertainty, and the use of decision-making approaches that account for that uncertainty. This assessment will use the results of this report and the newly calibrated hydrologic model for Hetchy. Timeframe: Scope and contract completed mid-2012, assessment completed calendar 2013.

Edwin M. Lee
Mayor

Anson Moran
President

Art Torres
Vice President

Ann Moller Caen
Commissioner

Francesca Vietor
Commissioner

Vince Courtney
Commissioner

Ed Harrington
General Manager

Attachment A

O-TRT-
DREKMEIER
Cont.

Sensitivity of Upper Tuolumne River Flow

to Climate Change Scenarios

Prepared by:

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Turlock Irrigation District
333 East Canal Drive
Turlock, CA 95381

HY-52
cont.

JANUARY 2012

O-TRT-DREKMEIER Cont.

Sensitivity of Upper Tuolumne River Flow to Climate Change Scenarios

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O-TRT-
DREKMEIER
Cont.

Sensitivity of Upper Tuolumne River Flow to Climate Change Scenarios

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Sensitivity of Upper Tuolumne River Flow to Climate Change Scenarios

Glossary of Terms and Acronyms

Albedo
The fraction of short wave solar radiation reflected by a surface or object, often expressed as a percentage. Snow covered surfaces have a high albedo; the albedo of soils ranges from high to low; vegetation covered surfaces and oceans have a low albedo.

Algorithm (modeling)
Software or a sequence of instructions for functions that model a physical process.

Anthropogenic
Resulting from or produced by human beings.

Aspect (Geography)
The direction that a mountain slope faces. Snow will melt out on south facing slopes while snow remains on north facing slopes.

Calibration (Hydrologic Models)
The adjustment of parameters in hydrologic process algorithms in a hydrologic model so that simulated streamflow and snowpack information more closely matches recorded streamflow and snow course measurements.

HY-52
cont.

CDEC
The California Data Exchange Center collects data with the cooperation of 140 other agencies and provides real-time forecast and historical hydrologic data.

Climate
Climate is the "average weather", or more rigorously, is the statistical description of weather in terms of the mean and variability of relevant quantities (temperature, precipitation, wind) over a period of time ranging from months to tens or hundreds of years.

Climate Model (Global Climate Model or General Circulation Model, GCM)
A numerical representation of the climate system based on the physical, chemical and biological properties of its components and feedback processes. The climate system can be represented by models of varying complexity, with the complexity increasing with the number of spatial dimensions and the physical, chemical or biological processes that are explicitly represented, or the level at which empirical parameterizations are involved. Coupled atmosphere/ocean/sea-ice General Circulation Models (AOGCMs) provide the most comprehensive representation of the climate system.

Climate System
The climate system is the highly complex system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere, the land surface and the biosphere.

Diurnal Temperature Range (DTR)
The difference between the maximum and minimum temperature during a day.

El Niño-Southern Oscillation (ENSO)
El Niño is a warm water current which periodically flows toward the coast of Ecuador and Peru. This is associated with a fluctuation of the inter-tropical surface pressure pattern and circulation in the Indian and Pacific oceans, called the Southern Oscillation. This coupled atmosphere-ocean phenomenon is collectively known as El Niño-Southern Oscillation, or ENSO.

Evapotranspiration
The combined process of evaporation from the Earth's surface and transpiration from vegetation. *Potential* evapotranspiration is the total evapotranspiration that could occur if moisture were continuously available. *Actual* evapotranspiration is the evapotranspiration that occurs given the available moisture supply.

Exceedance Probability
The likelihood that an event or condition will be exceeded expressed as the ratio of the number of actual occurrences of exceedance to the number of possible occurrences of exceedance. Exceedance probability is often used in environmental risk modeling.

HY-52 cont.

GNL, HRS, SLI, PDS, TUN, CHV, HTH, BKM, MCN, MSR, MID
Acronyms used by the California Data Exchange Center (CDEC) for hydrometeorological stations in the Tuolumne watershed.

Greenhouse Gas (GHG)
Greenhouse gases trap heat within the surface-troposphere system. They are natural and anthropogenic gases that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds. Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the atmosphere.

HFAM
Hydrologic Forecast and Analysis Modeling developed by Hydrocomp, Inc. HFAM version 2.3, completed in 2011, was used for the climate change analysis. HFAM is a continuous simulation model that operates on hourly time steps. The model interface is the computer screens used to operate the model and view results.

Historic Meteorological Database
Historic data refers to observed and extended historic data. Meteorological data were processed to provide hourly timeseries when observed hourly data were not available. Processing included:

- Temperature – estimating hourly values from max-min daily records, correlations with other sites.
- Precipitation – daily to hourly distributions from other sites or from prior events at the same site. Correlations with other sites.
- Solar radiation – top of atmosphere data reduced by atmospheric absorption and cloud cover.

- Potential Evapotranspiration – diurnal patterns and seasonal median values.
- Wind – diurnal patterns and seasonal median values.

(See also Static Meteorological Database)

Hydrologic Model
A numerical representation of processes in the hydrologic cycle (snow accumulation and melt, soil moisture, infiltration, evapotranspiration, runoff and streamflow) based on continuous meteorological timeseries (precipitation, potential evapotranspiration, solar radiation, wind, air temperature). HFAM is a hydrologic model that has been calibrated to represent hydrologic processes in the Tuolumne River.

IPCC
The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization and the United Nations Environmental Program.

Land Segment
A portion of the land surface for which hydrologic processes are modeled. Land segments in HFAM have unique characteristics (elevation, slope, aspect, vegetal cover, soils, etc.). Runoff from land segments enters stream reaches that carry flows through the channel network.

Lapse Rate HY-52 cont.
The decrease in temperature in the atmosphere per unit of elevation. A typical lapse rate for moist air is 3 ˚F per 1000 ft. of elevation but lapse rates are highly variable.

Median
A value in an ordered set of values that separates the higher half of the values from the lower half.

MID
Modesto Irrigation District

NCDC
National Climate Data Center, NOAA, Ashville, NC

Parameterization
In climate and hydrologic models, this is the technique of representing processes that cannot be explicitly resolved at the spatial or temporal resolution of the model (sub-grid scale processes).

PDO
The Pacific (inter) Decadal Oscillation, or PDO, is a long-lived El Niño-like oscillatory pattern of climate variability centered over the Pacific Ocean and North America. The PDO has considerable influence on climate sensitive natural resources in the Pacific and over North America, including the water supplies and snowpack in some selected regions in North America (Mantua N.J. 2002)

Response Time (or Time to Equilibrium)
The response time or adjustment time is the time needed for the climate system or its components to re-equilibrate to a new state, following a forcing resulting from external and internal processes or feedbacks. Atmospheric response times are relatively short (days to weeks). Ocean response times, due to their large heat capacity, are much longer (decades to centuries).

SFPUC
San Francisco Public Utilities Commission

Simulation
The imitation of a real process or processes that entails representing certain key characteristics or behaviors of a selected physical system to gain insight into their functioning. Simulation can be used to show the eventual real effects of alternative conditions and courses of action. Hydrologic models and climate models are examples of simulation models. Output from these models may be called 'simulated data'.

SNOWCF
The snow correction factor is a HFAM model parameter which increases precipitation when precipitation falls as snow to compensate for reduced catch at gages.

Soil Moisture
Water stored in or at the land surface and available for evaporation or transpiration. HY-52 cont.

Solar Radiation
Radiation emitted by the Sun. It is also referred to as short-wave radiation.

Static Meteorological Data Base
Historic data that have been adjusted by removing historic trends. Only air temperature records at Hetch Hetchy Reservoir and Cherry Valley Dam were adjusted. The static meteorological database is used to create weather inputs for 2010 current conditions and future conditions under climate change scenarios. (See also Historic Meteorological Database)

SRES
Special Report on Emissions Scenarios developed by the IPCC.

Surficial Hydrologic Processes
Hydrologic processes (snow accumulation and melt, infiltration, soil moisture storage, evapotranspiration, etc.) that occur at the land surface, or (typically) within a few meters of the land surface.

TID
Turlock Irrigation District

Trend Analysis
Analyzing information or data with the goal of identifying a pattern, or trend, in the data. In climate change studies, trends in meteorological timeseries are evaluated by fitting a straight line

to the data over twenty or more years (least squares fit) to separate climate change effects from the chaotic variability of weather.

XML (Extensible Markup Language)
XML is a general purpose specification for creating custom markup languages. Its purpose is to aid information systems in sharing structured data. It is used by HFAM so that input and output can be shared easily with WORD, EXCEL and other XML conversant software.

HY-52 cont.

O-TRT-DREKMEIER Cont.

Sensitivity of Upper Tuolumne River Flow to Climate Change Scenarios

Executive Summary

Climate change is a concern to water managers with facilities within the Tuolumne watershed. The purpose of this study was to determine streamflow sensitivities to possible increases in temperature and change in precipitation due to climate change. For this study, the likelihood of any particular climate future was not assessed, and the report did not seek to comprehensively frame all the changes climate scientists expect from global warming. Nor did the report seek to address potential water supply impacts of climate change. The goal of the study was simply to assess the sensitivity of reservoir inflows to a range of changes in two variables, temperature and precipitation. For that reason, a physically-based conceptual hydrology simulation model was calibrated against past conditions and used to assess potential changes in the timing and volume of runoff that may occur for the years 2040, 2070 and 2100 as compared to the conditions in 2010. A review of the literature and consultation with climate science experts allowed selection of climate scenarios that encompassed a range of temperature and precipitation changes that may be experienced through 2100 so that potential changes in watershed runoff could be simulated and analyzed.

Climate Change Scenarios

HY-52 cont.

Climate change scenarios for this study were selected to represent a range of possible future climate conditions based on the range of predictions by global climate models.

Table ES-1 lists the potential future climate condition in terms of a change in temperature and precipitation from the 2010 conditions for the years 2040, 2070 and 2100 for each climate change scenario. A 34-year stationary meteorological database was developed and the increments shown in Table ES-1 were used to create adjusted temperature and precipitation timeseries that represent potential future conditions for each climate change scenario. This technique allowed the analysis of a 34-year period with consistent climate conditions at three future dates, each of which had six combinations of temperature and precipitation changes.

Hydrologic Simulation Model

The HFAM hydrologic model of the Tuolumne, developed by Hydrocomp over a twelve year period for the Turlock Irrigation District (TID), was used in this study to simulate the watershed's hydrologic response to precipitation, temperature, evaporation, solar radiation and wind. The model calculates the hydrologic response of more than 900 land segments in the watershed above Don Pedro and routes runoff downstream to reservoirs through 75 channel reaches. Each land segment represents the elevation, soil and rock outcrop, vegetation and aspect associated with a portion of the watershed. The model performs detailed mass and energy budget calculations to simulate the hydrologic cycle on each land segment. By combining and routing the flow from each segment, the model provides detailed information on the effects of basin-wide temperature and precipitation changes on runoff, snow, evapotranspiration and soil moistures.

Table ES-1. Constructed climate change scenarios with temperature increases and precipitation changes

Scenario	Description	Mean Annual Temperature (˚F (˚C))[1]			Mean Annual Precipitation (in)[1]		
Current Conditions	2010 conditions	55.1 (12.8)			36.9		
Future Climate Change Scenarios		Change from Base (˚F (˚C))[2]			Change from Base (%)[3]		
		2040	2070	2100	2040	2070	2100
1A	Low temperature increase no precipitation change	+1.1 (0.6)	+2.3 (1.3)	+3.6 (2)	0	0	0
2A	Moderate temperature increase no precipitation change	+1.8 (1)	+4.0 (2.2)	+6.1 (3.4)	0	0	0
2B	Moderate temperature increase precipitation decrease	+1.8 (1)	+4.0 (2.2)	+6.1 (3.4)	-5	-10	-15
2C	Moderate temperature increase Precipitation increase	+1.8 (1)	+4.0 (2.2)	+6.1 (3.4)	+2	+4	+6
3A	High temperature increase no precipitation change	+3.0 (1.65)	+6.3 (3.5)	+9.7 (5.4)	0	0	0
3B	High temperature increase Precipitation decrease	+3.0 (1.65)	+6.3 (3.5)	+9.7 (5.4)	-5	-10	-15

[1] Mean annual temperature and precipitation at HTH station.
[2] Temperature increases are given in degrees F (degrees C) added to the 2010 current conditions static meteorological database.
[3] Precipitation changes are given in percent change to the 2010 current conditions static meteorological database.

HY-52 cont.

Simulated Reservoir Inflows

Climate change in the Tuolumne River affects snow accumulation and melt, soil moisture and forests, reservoir inflows, and the water supplies available for all purposes. Table ES.2 summarizes the modeling results in terms of the change in simulated median annual runoff at O'Shaughnessy and Don Pedro dams for the different future climate conditions (climate change scenario at future climate date).

Simulated changes in median annual runoff do not fully describe how water supplies would be affected. When firm yield from reservoirs is evaluated, low runoff years are critical. Climate change effects are exacerbated in low runoff years. Table ES.3 summarizes the modeling results in terms of the change in simulated 5 (extremely wet), 50, and 95 (critically dry) percent exceedance annual runoff for two climate change scenarios, 2A moderate temperature increases with no precipitation change, and 3B high temperature increases with precipitation decreases.

O-TRT-DREKMEIER Cont.

Table ES.2. Change in median runoff volume for future climate conditions

Climate Change Scenario		O'Shaughnessy Runoff (% change from 2010)			Don Pedro Runoff (%change from 2010)		
		2040	2070	2100	2040	2070	2100
1A	low temperature increase no precipitation change	-0.7%	-1.5%	-2.6%	-1.1%	-2.4%	-3.6%
2A	moderate temperature increase no precipitation change	-1.2%	-2.9%	-5.4%	-1.8%	-4.0%	-6.4%
2B	moderate temperature increase precipitation decrease	-7.6%	-15.8%	-24.7%	-9.5%	-19.1%	-28.7%
2C	moderate temperature increase precipitation increase	1.4%	2.2%	2.4%	1.1%	2.0%	2.8%
3A	high temperature increase no precipitation change	-2.1%	-5.6%	-10.2%	-3.0%	-6.5%	-10.1%
3B	high temperature increase precipitation decrease	-8.6%	-18.6%	-29.4%	-10.7%	-21.6%	-32.3%

Table ES.3. Change in runoff volume for future climate conditions for extremely wet, median, and critically dry years (based on results from 1975-2008)

HY-52 cont.

Climate Change Scenario		Example years	O'Shaughnessy Runoff (% change from 2010)			Don Pedro Runoff (% change from 2010)		
			2040	2070	2100	2040	2070	2100
2A	moderate temperature increase no precipitation change	Extremely wet	-0.6%	-1.4%	-2.4%	-1.1%	-2.6%	-3.7%
2A	moderate temperature increase no precipitation change	Median	-1.2%	-2.9%	-5.4%	-1.8%	-4.0%	-6.4%
2A	moderate temperature increase no precipitation change	Critically dry	-3.4%	-8.8%	-15.1%	-4.2%	-9.8%	-16.1%
3B	high temperature increase precipitation decrease	Extremely wet	-7.1%	-14.3%	-21.8%	-8.7%	-16.7%	-24.3%
3B	high temperature increase precipitation decrease	Median	-8.6%	-18.6%	-29.4%	-10.7%	-21.6%	-32.3%
3B	high temperature increase precipitation decrease	Critically dry	-14.7%	-30.9%	-46.5%	-16.6%	-33.3%	-48.1%

Runoff timing within the water year changes under the future climate conditions. Figure ES-1 shows the average monthly median runoff volume at O'Shaughnessy for the current climate and for the 2040, 2070 and 2100 future climate condition for two climate change scenarios (2A moderate temperature increases with no precipitation change and 2B moderate temperature increases with precipitation decreases). Reservoir operations may need to be revised to manage increased runoff in November through April, and decreased runoff in May for most scenarios, and in June and July for all scenarios.

O-TRT-DREKMEIER Cont.

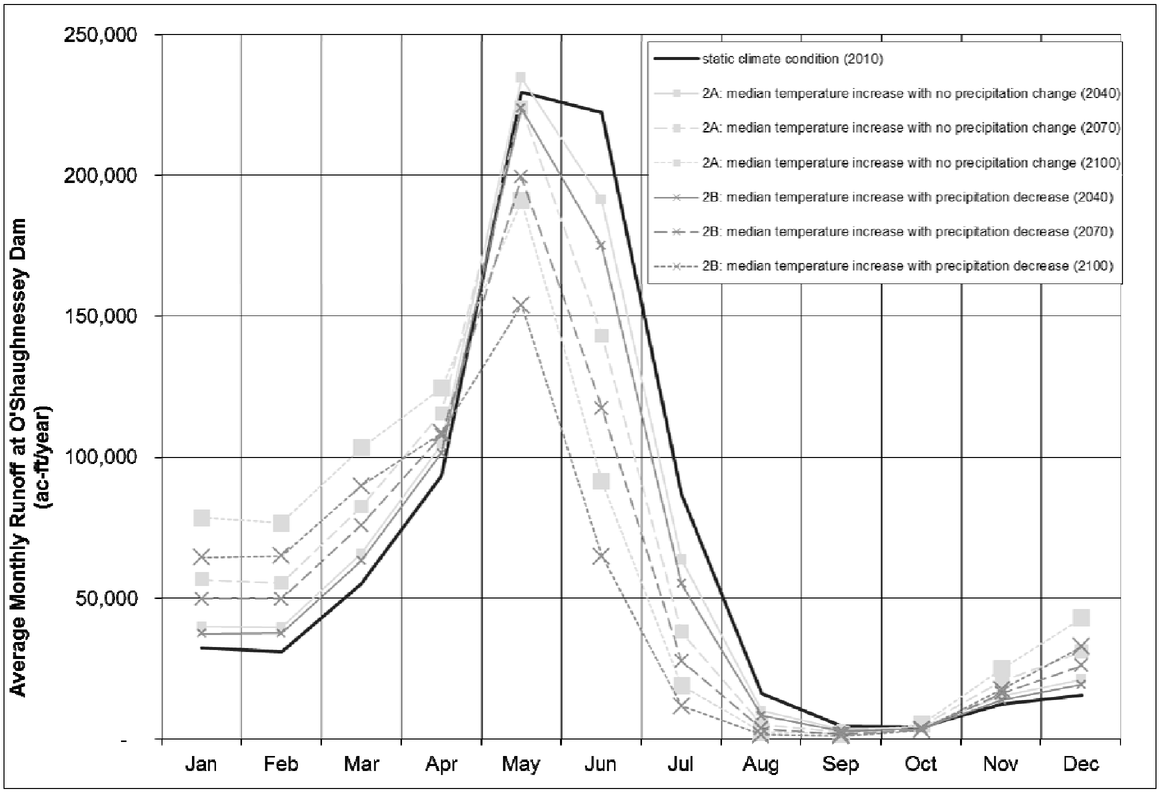


Figure ES-1. Average monthly runoff at O'Shaughnessy Dam for moderate temperature increase and precipitation change scenarios at future climate dates

HY-52 cont.

Conclusions

The simulated change in 2040, 2070 and 2100 hydrologic conditions based on the climate change scenarios results in a progressively altered snow and runoff regime in the watershed. Snow accumulation is reduced and snow melts earlier in the spring. Fall and early winter runoff increases while late spring and summer runoff decreases, and these changes become more significant at the later time periods. Total runoff is projected to decrease under the climate change scenarios evaluated, in some cases marginally and others significantly.

The reliability of projected changes in reservoir inflows for the climate change scenarios is good because the model is physically-based and has been calibrated over a 34-year period to accurately represent hydrologic conditions in the Tuolumne watershed during a range of temperature and precipitation conditions. The temperature and precipitation timeseries used for the climate change scenarios increases are within the range of temperatures experienced in the Tuolumne during the calibration period. For example, a climate change scenario may have higher temperatures than experienced in the same period historically but similar temperatures would have been observed at other times in the calibration period.

This study created daily reservoir inflow data during the 34-year analysis period (water years 1974 to 2008) for all climate change scenarios which can be used for subsequent water resources planning studies by TID and SFPUC.

O-TRT-DREKMEIER Cont.

Reduced snow accumulation and a resulting shift of runoff from the spring to the winter runoff in the Tuolumne were expected due to the temperature increases of the climate change scenarios. In addition, the climate change scenario results showed that:

- Climate change effects are most exacerbated in low runoff years because of increased evapotranspiration results, particularly when expressed as a percent of runoff.

- Soil moisture reductions in summer would be significant by 2070 and 2100. The predicted reduction in summer soil moistures would be expected to change vegetation distribution within the watershed. The potential changes in vegetation would cause a secondary change in the hydrologic response of some land segments but this effect was not modeled in this study.

- The future climate condition in year 2040 of climate change scenario 3B (high temperature increases with precipitation decrease) results in reductions in median runoff of -8.6% at O'Shaughnessy Dam and -10.7% at Don Pedro Dam. Relatively large reductions in runoff may take place in 30 years if both temperature rise and precipitation decrease occurs.

- The future climate condition in year 2040 of climate change scenario 1A (low temperature increase and no precipitation change) results in minimal runoff reductions of 0.7% at O'Shaughnessy Dam and 1.1% at Don Pedro Dam. The 1A results in terms of runoff and timing changes are small compared to the year-to-year variation that is currently experienced.

HY-52 cont.

1. Introduction

The Tuolumne River, located on the western slopes of the Sierra Nevada in California, provides 85 percent of the San Francisco Public Utilities Commission (SFPUC)'s water supply for 2.5 million Bay Area residents and water to 8,000 agricultural customers and over 200,000 electrical customers of the Turlock and Modesto Irrigation Districts (TID/MID).

1.1 Purpose and Objectives

Water managers with facilities within the Tuolumne watershed are concerned about the potential impact that climate change may have on their future water availability. Water resources in the Tuolumne watershed, like any mountainous watershed in the Western United States, depend on snowpack, which accumulates precipitation during winter months and releases melt water to the river during spring and early summer months. Changes to precipitation would affect reservoir inflow through changes in snowpack accumulation. Similarly, changes to temperature would also affect reservoir inflow through watershed evapotranspiration, snow accumulation and snowmelt. The SFPUC and TID are working together to better understand the possible impacts of climate change on Tuolumne River streamflow.

HY-52 cont.

The key objective of this study is to assess changes in streamflow and watershed hydrologic response to potential temperature and precipitation changes for the years 2040, 2070 and 2100 as compared to the conditions in 2010. Scenarios of temperature and precipitation changes through 2100 were constructed based on literature review and interviews with climate experts. The scenarios encompass a range of temperature and precipitation changes that may occur in the 21st century as a result of climate change. These climate scenarios, however, are not ranked or characterized in terms of their likelihood, and do not represent a "projection" of climate change in the watershed. To characterize possible future changes to climate more precisely, the use of climate model ensemble output, careful characterization of uncertainties contained in that output, lessons learned from paleoclimate reconstructions, and other climate science assessment techniques are required.

A physically-based conceptual model, Hydrologic Forecast and Analysis Model (HFAM) (Hydrocomp, Inc., 2011, HFAM II Reference and User's Manual), was calibrated and used to simulate hydrologic processes (snow accumulation and melt, infiltration, runoff, channel flow). Simulation results were used to assess changes in the timing and volume of runoff. The analysis compared simulated unimpaired inflows (full natural flow) to Hetch Hetchy, Eleanor, Cherry and Don Pedro reservoirs under the 2010 current climate condition with the constructed potential future climate conditions. Results of the analysis will help water resource planners understand the sensitivity of water supply, irrigation and power generation to potential changes in streamflow resulting from climate change.

This report describes the study area, which consists of the 1,532- square miles drainage area above La Grange Dam; the evidence of climate change; the study approach with assumptions, methods and limitations, and the construction of climate change scenarios. The report also describes model set-up and calibration of the HFAM hydrologic model of the Upper Tuolumne watershed and simulations made with the model to determine the potential effects of temperature and precipitation changes on streamflows.

1.2 Scope

The scope of this study was limited to:

1. Reviewing climate change studies applicable to the Central Sierra Nevada and the Tuolumne watershed and seeking expert advice.
2. Constructing six scenarios of temperature and precipitation changes that represent a range of 18 potential future climate conditions in 2040, 2070 and 2100.
3. Examining the 79-year (1930 to 2008) historical weather observations to identify trends in historical climate and create a 34-year (1975 to 2008) static weather sequence to represent current climate condition (2010).
4. Creating 34-year weather sequences based on 1975 to 2008 but adjusted to represent the future climate condition in 2040, 2070, and 2100 for each of the six climate change scenarios.
5. Improving calibration of the existing HFAM model, particularly at Hetch Hetchy, Cherry and Eleanor reservoirs.
6. Simulating unimpaired inflows (full natural flow) to Hetch Hetchy, Eleanor, Cherry and Don Pedro reservoirs using the Tuolumne HFAM model for the current climate condition and for each of the eighteen future climate conditions.
7. Analyzing changes in runoff and hydrologic processes from the current condition for all climate change scenarios at the 2040, 2070 and 2100 time horizons.

HY-52
cont.

1.3 Acknowledgements

This report was jointly prepared by Hydrocomp, SFPUC and TID. Hydrocomp was responsible for watershed model setup, model calibration, simulations of climate change scenarios and interpretation of the model results. Hydrocomp produced sections 4, 5, 6 and 7.

1.4 Study Area

The Tuolumne River, which drains a 1,960-square-mile watershed on the western slope of the Sierra Nevada range (Figure 1-1), is the largest of three major tributaries to the San Joaquin River. The mainstem of the river originates in Yosemite National Park and flows southwest to its confluence with the San Joaquin River, approximately 10 miles west of Modesto. The study area consists of the drainage area above La Grange Dam which encompasses 1,532 square miles. This watershed extends from the crest of the Sierra Nevada near 13,200 feet to the base of the foothills in the Central Valley of California near 800 feet. The sub-study areas are the watersheds of Cherry Lake, Lake Eleanor and Hetch Hetchy (Figure 1-1).

Attachment A

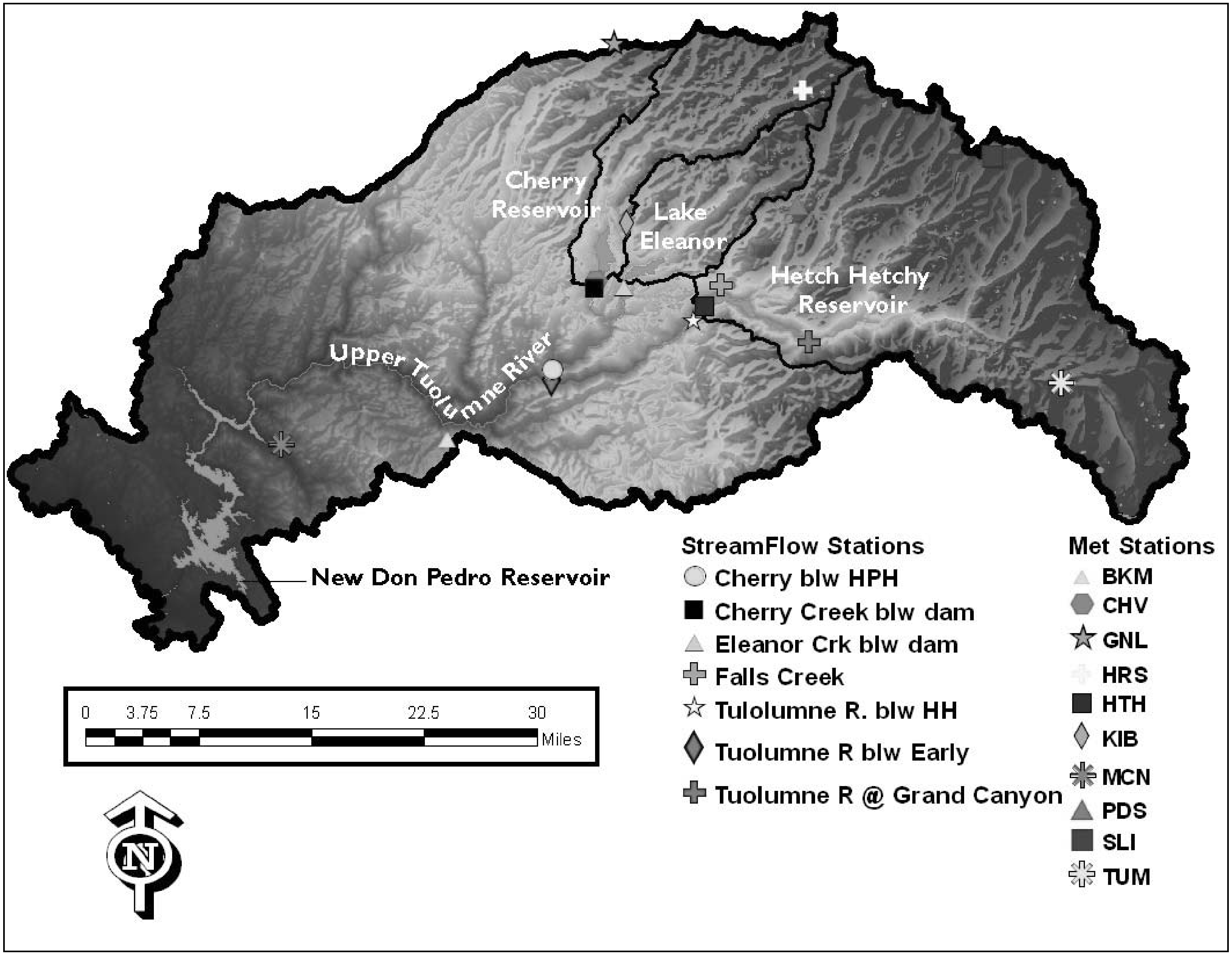


Figure 1-1 Tuolumne River Watershed, stream and meteorological station locations and key reservoirs

O-TRT-DREKMEIER Cont.

HY-52 cont.

The distribution of watershed area for the Tuolumne basin above Don Pedro exhibits a nearly linear trend (Fig 1-2). Nearly 10% of the watershed is contained in each 1,000 ft elevation band up to about 10,000 ft. Only a small fraction of the watershed exists at higher elevations. The SFPUC-managed watersheds show a similar pattern with much of the watershed area lying between 5,000 and 9,000 ft.

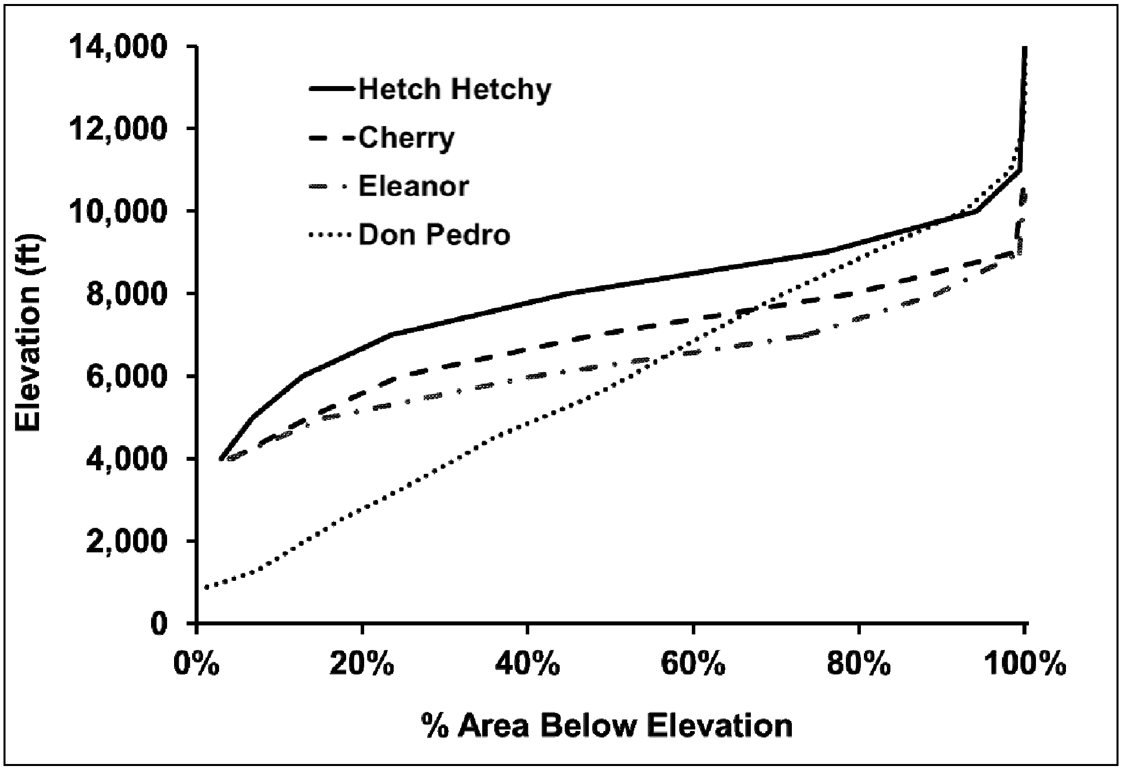


Figure 1-2. Hypsometry for the major Tuolumne River basin reservoirs

HY-52 cont.

Given the great range in elevation, the Tuolumne watershed has vast variation in vegetation, soil structure and morphology. At higher elevations (6,000 -13,200 ft), the watershed is exposed granitic bedrock that was scoured by glaciers during the Tioga and earlier glacial periods, with steep mountains and deep canyons. The mountainous middle elevations (3,500-6,000 ft) are dominated by coniferous forest which begin to transition to oak dominated forests. Lower elevations (800-3,500) are composed of oak forests and oak savannah with a mix of rural land use and townships and grassy hillslopes. These variations in natural vegetation coverage are controlled by the large variation in available moisture due to a strong orographically-driven precipitation pattern.

Mean annual precipitation ranges from 8 inches to above 60 inches in the mountains. The watershed is dominated by a Mediterranean climate with hot, dry summers and cool, wet winter periods (Figure 1-3). The winter storm season may begin as early as October and extend into May. Typically winter snowline is near 5,500 feet but varies from year to year. The snow transition zone is between 4,000 and 5,500 feet, with snow events occurring often in the winter, but the snow accumulation may ablate. Snow events at elevations as low as 2,000 feet are not uncommon and occur nearly every year.

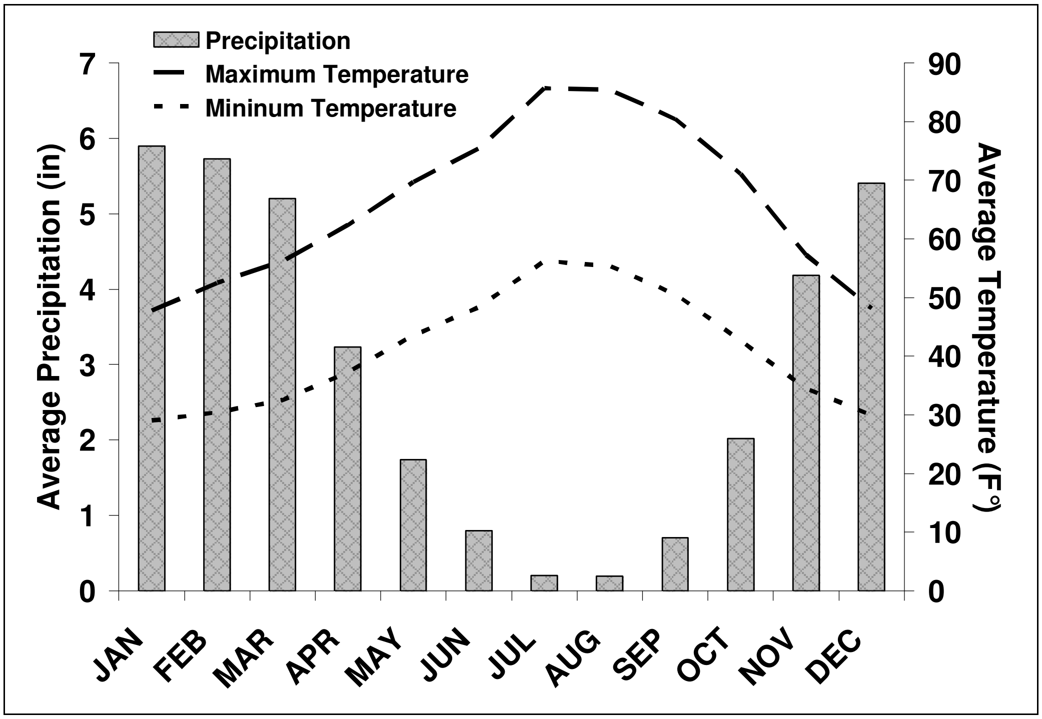


Figure 1-3. Climograph for the Hetch Hetchy meteorological station.

HY-52 cont.

Annual variation in precipitation and hydrologic conditions results in a large disparity of annual inflow – ranging from 20 to 250% of average inflow. This variation is controlled by the snow accumulation during the winter season as typically 75% of the annual runoff occurs during the April thru July snowmelt runoff period. Due to this pattern reservoir management typically focuses on this period.

Table 1-1. Watershed Characteristics at Primary Reservoirs in the Study Area

Reservoir	Drainage Area (sq. mi.)	Elevation range (ft)	Average annual inflow (thousand acre-feet)
Hetch Hetchy	459	3,800-13,200	747
Eleanor	79	4,650-10,400	171
Cherry	117	4,700-10,800	281
New Don Pedro	1,532	800-13,200	1,844

Two main water projects exist on the Tuolumne River. The SFPUC owns and operates the Hetch Hetchy Water and Power Project (Hetch Hetchy Project). This system, located in the upper Tuolumne River watershed, includes dams and flow diversions on the Tuolumne River, Cherry Creek (a tributary to the Tuolumne River), Eleanor Creek (a tributary to Cherry Creek), and Moccasin Creek (tributary to Don Pedro Reservoir). Water from this project is utilized for the Hetch Hetchy Regional Water System which delivers water to the San Francisco Bay area. The second major project is New Don Pedro Reservoir which is owned and operated by Turlock Irrigation District and Modesto Irrigation District. The two irrigation districts utilize watershed runoff and reservoir storage to meet irrigation demands, domestic water supply and power generation needs. Water that is released from Don Pedro Dam can be diverted into two diversion canals (Turlock Canal and Modesto Canal) which serve as the main distribution for each district's operations.

1.5 Evidence of changing climatic conditions

The world's climate has been changing and the vast majority of scientists attribute this change to an increase in the emission of carbon dioxide (CO2) and other greenhouse gases (Intergovernmental Panel on Climate Change, 2007). The global average surface temperature has risen between 1.08˚F and 1.26˚F (0.6˚C and 0.7˚C) since the start of the 20th century (World Meteorological Organization, 2005). Figure 1-4 presents the trend in annual global average temperature.

HY-52 cont.

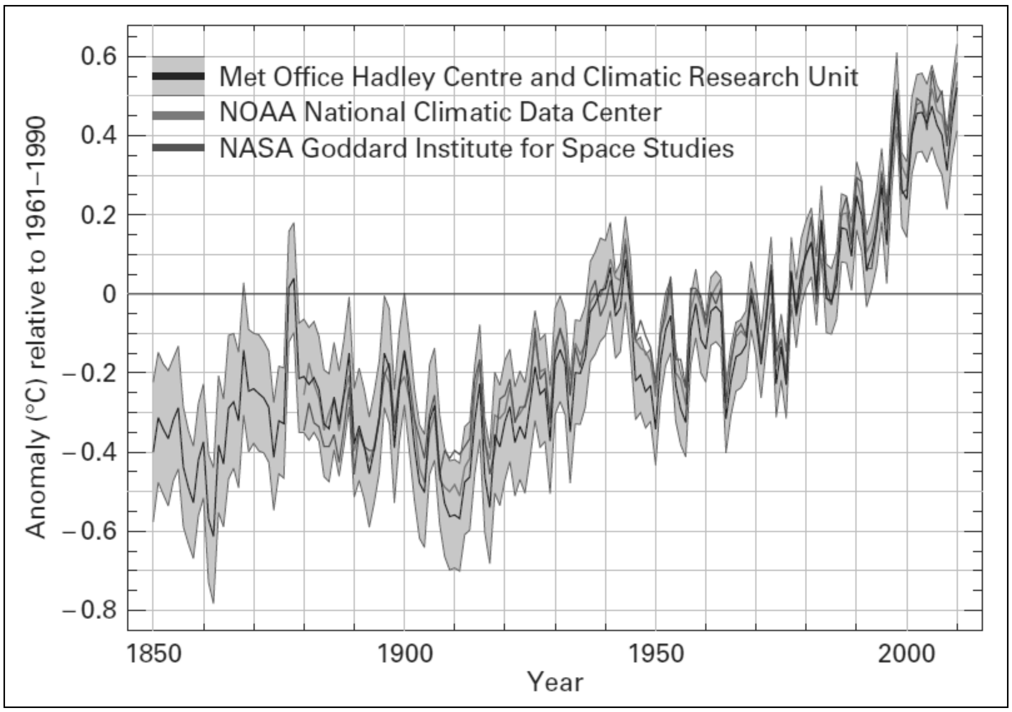


Figure 1-4. Annual global average temperature anomalies (relative to 1961–1990) from 1850 to 2010 from the Hadley Centre/CRU (HadCRUT3) (black line and grey area, representing mean and 95 per cent uncertainty range), the NOAA National Climatic Data Center (red); and the NASA Goddard Institute for Space Studies (blue) (Source: WMO, 2011)

2. Study Approach

This study analyzes the hydrologic response of the Upper Tuolumne watershed to changes in temperature and precipitation. To assess this response, a physically-based conceptual model, HFAM was used. The Hydrocomp Forecast and Analysis Model or HFAM was completed in 2007 and is the most recent edition in the Stanford (Crawford and Linsley 1966), Hydrologic Simulation Program (Hydrocomp, Inc., 1976), Hydrologic Simulation Program-Fortran (HSPF, Bicknell et al. 1997) and Seattle Forecasting Model (SEAFM), (Hydrocomp, Inc., 1993) family of continuous simulation models. An application of HFAM to the Tuolumne (Tuolumne HFAM model) has been developed over the last twelve years by Hydrocomp for TID (Hydrocomp 2000, 2007). It has been used in operations at Don Pedro Reservoir since 1999. The Tuolumne HFAM model simulates hydrologic processes (snow accumulation and melt, infiltration, runoff, channel flow and reservoir operations) using hourly input meteorological data (precipitation, temperature, evaporation, solar radiation and wind speed). The model set-up and calibration are discussed in Section 3.

A historical meteorological database was developed by Hydrocomp for the Tuolumne HFAM model for the period of 1930 to 2008. Historic meteorological records at real-time stations that report to CDEC were extended prior to the period of record by correlations to the long-term stations. This study focuses on the “Historic” 34-year period from 1975 to 2008 to rely more on observed weather data rather than extended data and to use better reservoir inflow records for calibration and validation. In addition, this period covers a reasonable cross-section of wet, dry and average years to represent long-term variability. Using the water year type classification at Hetch Hetchy Reservoir, the study period includes 10 extremely wet years, 3 wet years, 9 normal years, 4 dry years and 8 critically dry years[1].

HY-52 cont.

A warming pattern has been detected in the Sierra Nevada (Barnett et al. 2008, Bonfils et al. 2008), and upward trends in temperature were observed at stations within the study area as well (Section 5.1). Trends over several decades are an integral part of climate and have been observed in the past. However, recent warming trends are significant because they “differ in length and strength from trends expected as a result of natural variability” (Barnett et al. 2008). The anthropogenic influence on the climate system is changing the means and variability of hydrologic variables (IPCC, 2007, Milly et al. 2008). These upward trends in temperature indicate a non-stationary process and so undermine the assumption of stationarity used in water resources engineering.

Stationarity is the property of natural systems to fluctuate within an unchanging envelope of variability. This is a fundamental concept in the practice of water resources engineering. Most hydrologic analyses used in water resources planning assume that hydrologic data are stationary, which means that probabilistic behavior of any variable is time invariant. Weather and streamflow data that includes progressive climate effects may be outside of this unchanging

[1] The classification is based on a runoff indictor representing the cumulative inflow to Hetch Hetchy Reservoir since October 1 of the current water year. Extremely wet, wet, normal, dry and critically dry represent 15%, 20%, 30%, 20%, 15% of the years on record, respectively.

O-TRT-DREKMEIER Cont.

envelope and this creates difficulties for reservoir system yield or reliability analysis. To determine reservoir system yield and reliability, one needs the average yield of the river basin and the variability of the flows over time. The purpose of storage is to even out the variability of flows to give a sustained firm yield over time. Yield/reliability analysis with climate change effects, e.g. without a stationary record to rely upon, is uncharted territory. Traditional analysis is not applicable, and research will be needed to develop analysis methods. For that reason, it was decided that records needed to be adjusted to a hypothetical quasi-steady condition at each of the time horizons of interest. For each of those quasi-steady state conditions, a firm yield can be computed and storage needs assessed.

Because streamflow simulated with the Tuolumne HFAM model may later be used in water resources planning analysis, a "Current Condition" 34-year weather sequence was developed by increasing earlier temperature records to remove upward trends in the "Historic" weather sequence and hence creating a stationary (quasi-steady or static) weather sequence (Figure 2-1 and Section 5.2) that represents the climate in 2010.

HY-52 cont.

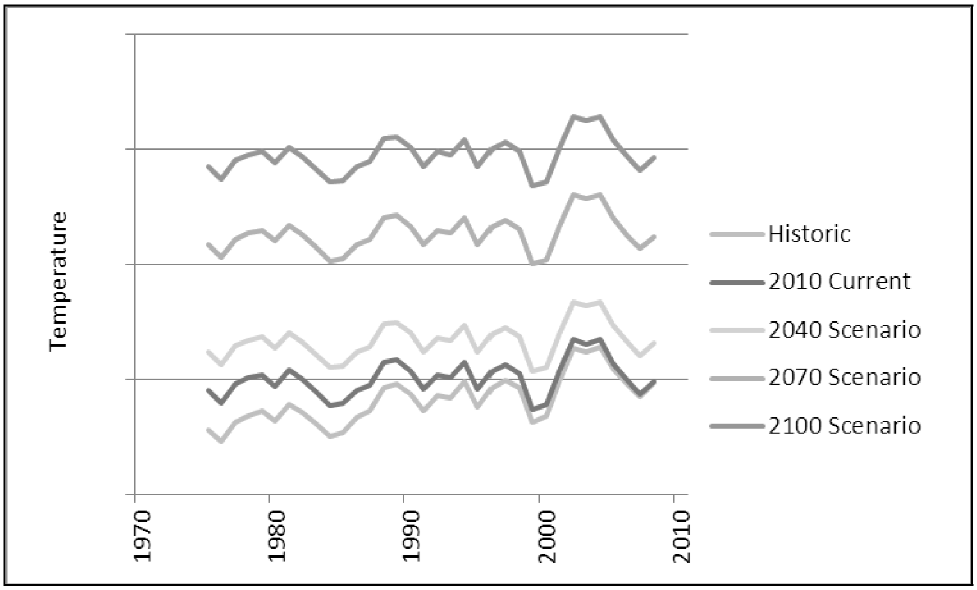


Figure 2-1. Conceptual representation of "Historic" weather sequence, "2010 Current Condition", and potential conditions in 2040, 2070 and 2100 time horizons using delta method

The well-known approach of scenario planning was selected to incorporate potential changes in future climate rather than using climate model outputs. Constructed climate change scenarios were developed through review of climate science, climate modeling, current climate projections and discussion with climate experts. The result of this process is six climate change scenarios of changing temperature and precipitation that represent a plausible range of climate uncertainties (Section 3).

The climate change scenarios consist of changes in mean annual temperature and precipitation over the study area. The "Current Condition" 34-year weather sequence is adjusted using the delta method to include the effects of changing mean annual temperature or mean annual precipitation (Figure 2-1). The delta method is described by Bader et al. (2008) as: "Climate model output is used to determine future change in climate with respect to the model's present-day climate, typically a difference for temperature and a percentage change for precipitation. Then, these changes are applied to observed historical climate data for input to an impacts model". The application of the delta method is discussed in Section 5.2.

This study approach has some limitations. First, climate projections indicate not only changes in annual precipitation and temperature but also indicates greater climate variability during the 21st century. They indicate both a greater frequency in extreme temperature events and diurnal range, as well as greater frequency of extreme precipitation events – both wet and dry (IPCC, 2007). The change in frequency of events and seasonal shift are not captured by this study approach.

Secondly, the Tuolumne HFAM model parameters are calibrated for current watershed vegetation conditions but studies show that vegetation may change as climate changes. With changes in temperature and precipitation, ecosystem structure (e.g. vegetation patterns, drainage network, soil properties) will change. Panek et al. (2009) modeled vegetation shifts in Yosemite National Park for the next century based on IPCC climate scenarios. Under all scenarios, alpine vegetation disappeared, the spatial extent of subalpine conifer forests decreased and shifted upwards, while montane chaparral and hardwoods expanded and desert vegetation appeared. Evapotranspiration and runoff will change as new vegetation is established. The water balance will also be affected by an increase in forest fires and the death of current vegetation, which will temporarily decrease transpiration and increase storm runoff. The Tuolumne HFAM model setup assumes that the types and spatial extent of vegetation will remain the same as today. Addressing this variable would require adjustments to the calibrated land segment parameters based on expert judgment, a potential task for future model development.

HY-52
cont.

3. Defining Climate Change Scenarios

Considering the wide range of climate change projections from different emission scenarios and different climate models, as well as the complexity of using climate model outputs in the Tuolumne HFAM model, it was decided that for a first assessment of streamflow sensitivity to temperature and precipitation changes, a selection of constructed scenarios that represents a plausible range of future climate conditions would be sufficient.

The construction of scenarios was guided by consultations with two experts in the state of climate change science and the current literature for California, Joel B. Smith[2] and Dan Cayan[3]. In addition to their expertise, both have extensive experience working with utilities in understanding vulnerability to climate change. The experts' guidance was based on review of climate science, climate modeling, and climate projections as of 2008-2009.

The six constructed scenarios are described by changes in mean annual temperature and precipitation from 2010 conditions for time horizons 2040, 2070 and 2100 (Table 3-1).

The climate change scenarios have temperature increases from the present-day conditions (2010) to 2100 ranging from 3.6 ˚F (low increase) to 9.72 ˚F (high increase). Mean annual precipitation changes in three of the six scenarios. The dry scenarios have a 15% reduction from the present-day in 2100 whereas the wet scenario has a 6% increase by the end of the 21st century. HY-52 cont.

Following the work done by Cayan et al. (2009) for the 2008 California Climate Change Scenarios Assessment, the changes in temperature and precipitation were based on projections from six GCMs that contributed to the IPCC Fourth Assessment (IPCC 2007) using two Special Report on Emissions Scenarios (SRES) emissions scenarios – a moderately low emissions scenario (B1) and a medium-high emissions scenarios (A2). Models were chosen on the basis of having a climatology which gives reasonable representation of precipitation in California, having a semblance of ENSO, having reasonable spatial resolution, and providing daily output.

[2] Joel B. Smith, Principal at Stratus Consulting (http://www.stratusconsulting.com) and lead author for the Synthesis Report on climate change impact for the Third Assessment Report of the IPCC in 2001.
[3] Dr. Daniel R. Cayan. Researcher meteorologist at the Scripps Institution of Oceanography, University of California San Diego and U. S. Geological Survey. He heads the California Nevada Applications Program and the California Climate Change Center.

Attachment A

O-TRT-DREKMEIER Cont.

Table 3-1. Constructed climate change scenarios

Scenario	Description	Mean Annual Temperature (˚F (˚C))[1]			Mean Annual Precipitation (in)[1]		
Current Conditions	2010 conditions	55.1 (12.8)			36.9		
Future Climate Change Scenarios		**Change from Base (˚F (˚C))[2]**			**Change from Base (%)[3]**		
		2040	**2070**	**2100**	**2040**	**2070**	**2100**
1A	Low temperature increase no precipitation change	+1.1 (0.6)	+2.3 (1.3)	+3.6 (2)	0	0	0
2A	Moderate temperature increase no precipitation change	+1.8 (1)	+4.0 (2.2)	+6.1 (3.4)	0	0	0
2B	Moderate temperature increase precipitation decrease	+1.8 (1)	+4.0 (2.2)	+6.1 (3.4)	-5	-10	-15
2C	Moderate temperature increase Precipitation increase	+1.8 (1)	+4.0 (2.2)	+6.1 (3.4)	+2	+4	+6
3A	High temperature increase no precipitation change	+3.0 (1.65)	+6.3 (3.5)	+9.7 (5.4)	0	0	0
3B	High temperature increase Precipitation decrease	+3.0 (1.65)	+6.3 (3.5)	+9.7 (5.4)	-5	-10	-15

[1] Mean annual temperature and precipitation at HTH station.
[2] Temperature increases are given in degrees F (degrees C) added to the 2010 current conditions static meteorological database.
[3] Precipitation changes are given in percent change to the 2010 current conditions static meteorological database.

HY-52 cont.

Figure 3-1 presents evolution of annual temperature and precipitation for the Sacramento Region based on projections from six GCMs for two emissions scenarios (Cayan et al. 2009).

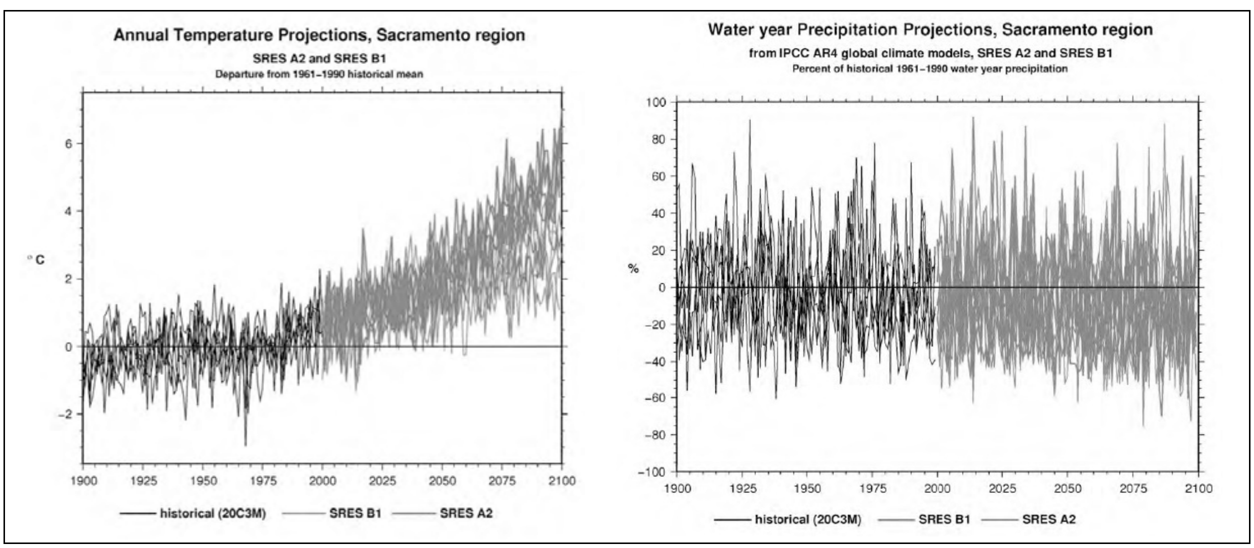


Figure 3-1. Annual temperatures and precipitation near Sacramento, for six for the six GCMs (CNRM CM3.0, GFDL CM2.1 MIROC3.2, MPI ECHAMS, NCAR CCSM3, NCAR PCM1) for the 1901-1999 historical period (black) and for the projected 2000–2100 periods under the A2 (red) and B1 (blue) GHG emissions scenarios. In this case, the values plotted are taken directly from the GCMs from the grid point nearest to Sacramento (Source: Cayan et al. 2009).

Temperatures in California are projected to rise significantly over the 21st century. According to Smith (2008), "there is virtually no doubt that temperatures will continue to rise in California (and over the entire United States), so assuming a rise in temperature is reasonable." It is important to note that the two main sources of uncertainty in the temperature projections are the imperfect physics in modeling the many complex atmospheric processes and the emissions scenarios themselves. Cayan states (pers. comm. June 2008): "The choice of emissions scenario does not make a big difference on the temperature change until after 2050. At 2100, the choice of scenario makes a big difference." Overall, these GCMs project warming in the mid-century from about 1.8˚F to 5.4˚F (1˚C to 3˚C), and rising by the end of the 21st century from about 3.6˚F to 9˚F (2˚C to 5.4˚C).

It is fair to say that there is no conclusive evidence the region will become drier, but there is a reasonable possibility that annual precipitation will decrease. At Sacramento, change in precipitation lacks consensus for the early period, but by mid and late 21st century the models tend toward drier, especially for the SRES A2 scenario (Figure 3-2). Median of results range from just a couple of percent drier to about 8 percent drier for A2 at end-of-Century but some individual models project up to 15 percent drier. Because winter precipitation in Sacramento is well correlated to that in the Sierra Nevada, these precipitation projections are considered at this time to be representative of precipitation variability in the central Sierra Nevada (Cayan et al. 2009). HY-52 cont.

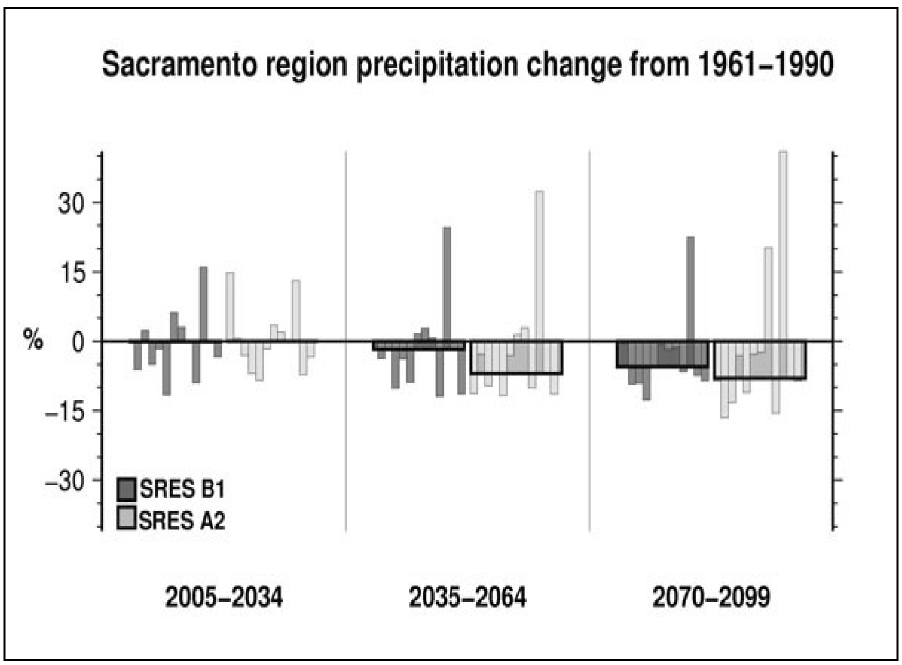


Figure 3-2. Differences in 30-year mean annual precipitation for early, middle and late 21st century relative to 1961-1990 climatology for 12 GCMs for SRES B1 and A2. Light bars are individual model averages and heavy lines are the median of the 12 GCMs. Precipitation is taken directly from the GCMs from the grid point nearest to Sacramento (Cayan, pers. comm., Jan 2009).

4. Tuolumne HFAM Model

4.1 Model Setup

The current Tuolumne HFAM model system includes:

- HFAM program, version 2.3
- watershed input files that describe the physical characteristics of the watershed (topography, soils, vegetation, channel reaches) and the operations of reservoir spillways and outlets, diversions, tunnels and power houses
- a historical meteorological database of precipitation, temperature, evaporation, wind movement and solar radiation
- data management software and spreadsheets

The Tuolumne HFAM model includes the following components:

- land segments: simulate surficial hydrologic processes (snow accumulation and melt, infiltration, evapotranspiration and soil moisture storage, and runoff)
- river reaches: simulate channel processes (flow velocity, stage in channel reaches)
- reservoirs: simulate the storage and release of flow from natural lakes and reservoirs

HY-52
cont.

The current Tuolumne HFAM model set up is described in detail in previous reports (Hydrocomp, Inc., 2000, 2007)

Figure 4-1 shows a schematic of river reaches and reservoirs in the Tuolumne HFAM model. For the analysis of climate and hydrologic changes, reservoirs are simulated as reaches with no storage. This allows calculation of the total unregulated inflow to each reservoir.

The drainage area of each river reach was subdivided into land segments, areas with quasi-homogeneous hydrologic characteristics, such as mean annual precipitation, soils and vegetation cover. Selected physical processes in land segments, e.g. infiltration and interflow outflow, are modeled as frequency distributions. Figure 4-2 shows the land segments within the drainage area of the Dana Fork of the Tuolumne River (reach 3010). The Dana drainage area is 27 square miles and was divided into 14 land segments based on elevation and aspect. Land segments need not be contiguous and some land segments are composed of non-contiguous areas.

The Tuolumne HFAM model calculates the hydrologic response of more than 900 land segments in the watershed above Don Pedro and routes runoff downstream to reservoirs through 75 channel reaches. Each land segment represents the elevation, soil and rock outcrop, vegetation and aspect associated with a portion of the watershed. The model performs detailed mass and energy budget calculations to simulate the hydrologic cycle on each land segment. By combining and routing the flow from each segment, the model provides detailed information on the effects of basin-wide temperature and precipitation changes on runoff, snow, evapotranspiration and soil moistures.

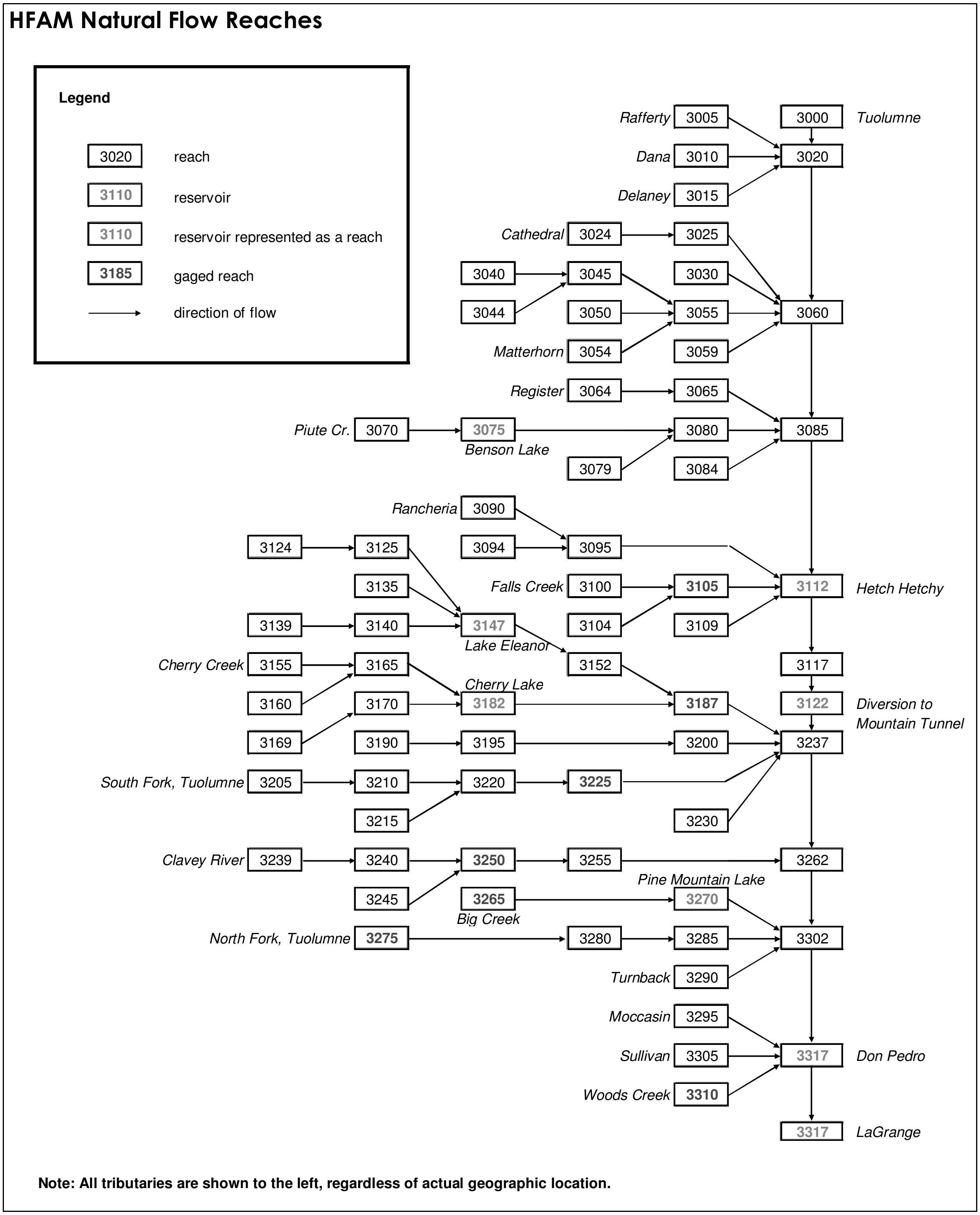


Figure 4-1. Tuolumne HFAM model reaches and reservoirs

HY-52 cont.

O-TRT-DREKMEIER Cont.

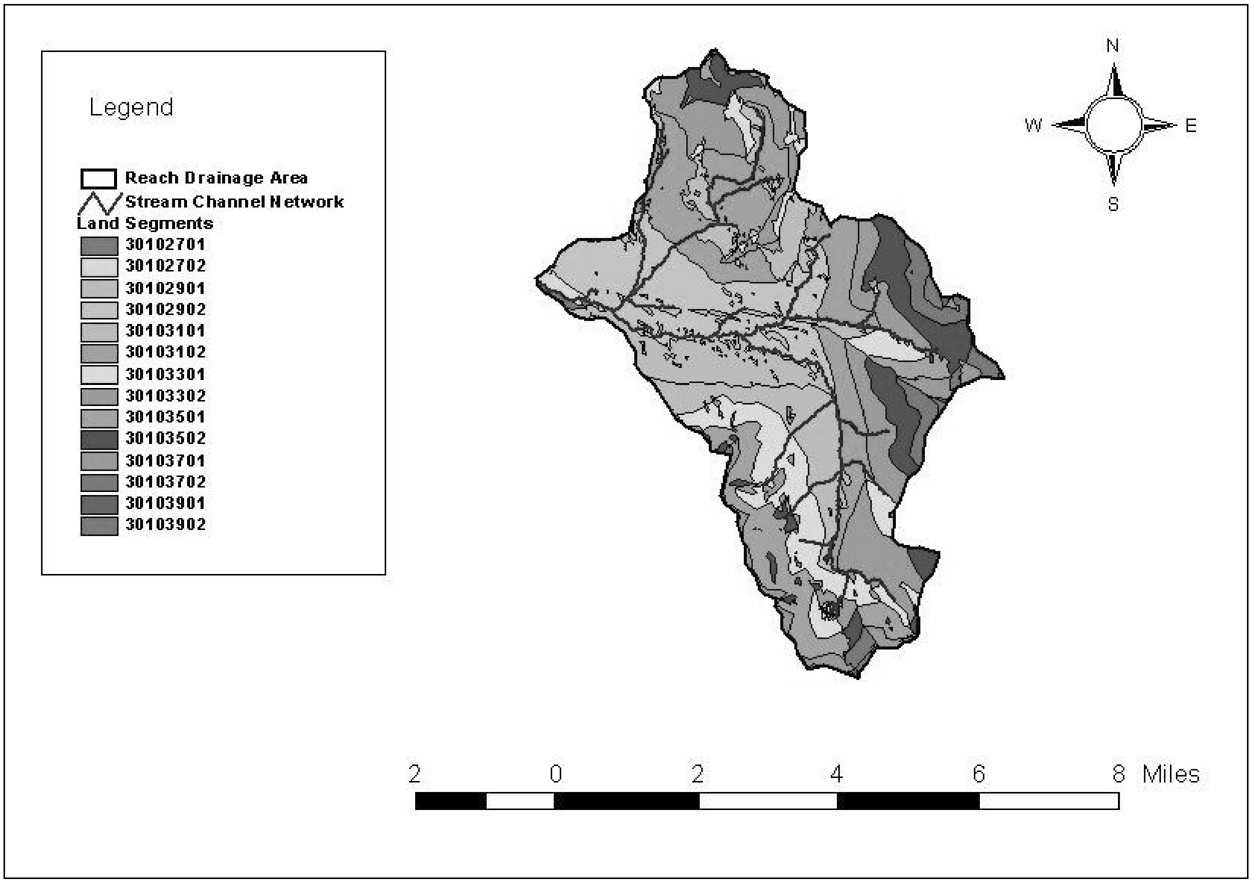


Figure 4-2. Dana Fork Tuolumne River land segments

HY-52 cont.

The model requires continuous hourly meteorological input timeseries and produces comprehensive hourly output timeseries for many variables including soil moisture, snowpack, evapotranspiration, runoff from the land surface, and reservoir inflows. HFAM results can be viewed in the HFAM interface or exported as hourly or daily data files for use in other programs. HFAM creates XML output files readable by Microsoft Word and Excel.

4.2 Meteorological Database

The Tuolumne watershed model includes a historical meteorological database of hourly precipitation, temperature, evaporation, solar radiation and wind speed for period of 10/1/1930 to 9/30/2008. Precipitation and evaporation are used to calculate rainfall and runoff on the land surfaces and in the channel reaches and reservoirs. Temperature, solar radiation and wind speed data are needed for simulation of snowpack heat exchange and melt on the land segments.

Figure 1-1 shows the California Data Exchange Center (CDEC) station identifier and location of each meteorological station used by the Tuolumne HFAM model. Table 4-1 lists the meteorological stations used by the Tuolumne HFAM model and indicates which of the meteorological data types are available at each station (precipitation, temperature, wind, solar radiation, and evaporation).

Table 4-1. Tuolumne meteorological stations

Station ID	Name	Precip	Temp	Evap	Solar	Wind
MID	Modesto Roof	✓				
MOR	Modesto Reservoir	✓				
HTH	Hetch Hetchy Reservoir	✓	✓	✓		
BKM	Buck Meadows	✓	✓		✓	✓
TMM	Tuolumne Meadows	✓	✓			
TUM	Tuolumne Meadows	✓	✓			
PDS	Paradise Meadows		✓			
HRS	Horse Meadow		✓			
SLI	Slide Canyon		✓			
CHV	Cherry Valley Dam	✓	✓			
MCN	Moccasin	✓	✓			
GNL	Gianelli Meadow		✓			

Table 4-2 lists station elevations and the long-term average daily temperature range (daily maximum temperature minus daily minimum temperature) of each of the temperature stations. The daily temperature range at stations in mountainous terrain is affected by upslope movement of warm air during the day and by cold air drainage into valleys at night. The topography at each station determines these air movements. The daily temperature range in the Tuolumne watershed decreases with elevation at all locations except TUM/TMM. TUM/TMM has a large temperature range and is unique due to cool air pooling (Lundquist 2008).

HY-52 cont.

Table 4-2. Tuolumne temperature stations

Station	Elevation (ft.)	Start of Records	Daily Temperature Range (deg F)
BKM	3200	1989	27.5
PDS	7650	1989	25.1
HRS	8400	1987	23.5
GNL	8400	1998	21.1
TUM/TMM[1]	8600	1992	32.3[2]
SLI	9200	1985	24.6
MCN	938	1950	31.4
CHV	4764	1950	26.1
HTH	3858	1930	26.0

Notes:

1. Temperature records at TUM (8600 ft) begin in 1998. These TUM records were extended for the period 1992 to 1998 using records taken at TMM (9200 ft).
2. The TUM station records from 1998 to 2008 have an average daily range of 32.8 deg. F. The TUM station records from 1992 to 1998 have an average daily range of 31.4 deg F.

Data records are not available for the entire historical data period (1930 to 2008) for all the meteorological stations, as shown in Table 4-2. The real-time stations (BKM, TUM/TMM, PDS, HRS, GNL and SLI) that record and transmit data in real-time did not begin recording data until 1985 or later. Hydrocomp extended the records back in time by estimating meteorological conditions prior to the period of real-time records based on the data recorded at nearby stations with long periods of record (historical stations), adjusted according to the difference in long-term average temperature between the real-time station and the historical station. Data sources and extension is discussed in detail in Appendix E.

A maximum/minimum temperature adjustment method was developed to extend real-time temperatures by adjusting data from the historical stations using the difference between long-term minimum daily temperature and long-term maximum daily temperature at the real-time and historical stations (this adjustment method is described further in Appendix E). This adjustment method does not bias the daily temperature range and was used to estimate the revised extended data period at all the real-time stations.

4.3 Modeling System Calibration

Modeling system calibration in the Upper Tuolumne, a large and geographically complex watershed, requires:

- Analysis of watershed topography, soils, vegetation and forest cover to define watershed elements (land segments, reaches).
- Analysis of historic meteorological data including locations of stations, estimating missing and invalid measurement from correlations among stations, and analysis of atmospheric lapse rates.
- Analysis of stream gage and reservoir release records
- Model parameters adjustments at multiple sites to reduce for modeled and recorded streamflow differences, and for improved representation of snow course snowpack water content. HY-52 cont.
- Analysis of model algorithms.

Although differences between model results and watershed measurements are deemed ‘model error’ and more descriptive term is ‘modeling system error’ where the modeling system includes the data series employed and the level of detail for watershed elements defined in the model.

The Tuolumne HFAM model was first developed by Hydrocomp in 1998 and has been used to support hydrologic forecasting for TID. Model calibration is an on-going activity, as more data are collected and new data stations are added. The model was re-calibrated in 2007, when the model was upgraded from HFAM 1.1 to HFAM II (Hydrocomp, 2007).

For the modeling of the Tuolumne climate change scenarios, the HFAM model parameter SNOWCF was changed from the value used for TID operational model (1.05 - 1.08) to 1.0 for all land segments so that temperature increases in the climate change scenarios would not change total precipitation depths.[4] The precipitation factor (ratio between precipitation at the gage and at the land surface) for each land segment was increased to compensate for the SNOWCF parameter change to maintain the same total precipitation on each land segment.

In addition, the Tuolumne HFAM model calibration was refined using the previously unavailable Hetch Hetchy estimated inflow records and the USGS gage on the Grand Canyon of the

[4] Precipitation falling as snow is not captured by gages as effectively as rainfall. The SNOWCF (snow correction factor) increases the precipitation depth for recorded snowfall events.

Tuolumne.[5] Biases between observed and HFAM-simulated streamflow were present prior to the recalibration, particularly for SFPUC reservoirs. The model was recalibrated based on available estimated reservoir inflows and gaged streamflow data for water years 1975 through 2008.

Steps taken to improve modeling system calibration for the Upper Tuolumne are described for watershed elements, the hydrometeorological data base, and for model structure, algorithms and parameters.

4.3.1 Watershed Elements

Upper Tuolumne watershed structural elements are land segments and stream reaches. Hydrologic processes in land segments, e. g. infiltration, evapotranspiration, snow accumulation and melt, provide runoff to streams. Stream reaches collect runoff and route flows downstream.

In the Upper Tuolumne HFAM application areas within land segments have similar elevation, soils or exposed rock, topography, aspect and vegetal cover. Land segments are non-contiguous. Approximately 32,000 GIS defined areas were combined into more than 900 land segments.

Increasing the number of land segments in the Upper Tuolumne application is possible, for example by reducing the elevation interval or by increasing the number of aspect categories used but this would not significantly improve the model calibration for inflows to O'Shaughnessey, Cherry Valley or Don Pedro. The level of watershed element detail that is needed or helpful for improved calibration is linked to basin scale; in a 2 sq. mi. watershed 100 land segments might be helpful, but in a 2000 sq. mi. watershed 100,000 land segments would be cumbersome, delaying calibration model runs without improving model accuracy. Increasing the number of stream reaches can be equally ineffective for improving model calibration. HY-52 cont.

Assignments of meteorological data to land segments in the Upper Tuolumne were changed during calibration based on model results. In mountainous watersheds, the distance from a gage to a land segment and elevation/exposure differences affects these assignments.

4.3.2 Meteorological Data Base

Each land segment requires hourly precipitation, temperature, potential evapotranspiration, wind and solar radiation. These data are rarely observed within a land segment and must be estimated or scaled to account for gage location to land segment differences, particularly for elevation and aspect differences (Appendix E).

Missing and incomplete records at gaged locations in the Tuolumne are filled using both program routines and human judgment. Outliers or erroneous data are located and replaced by human judgment. Data transmitted from real-time sensors at snow course sites are often erroneous and extended periods of missing data are common at these sites. Missing or erroneous data at CHV, HTH and MCN are uncommon.

[5] USGS Site 11274790, Tuolumne in the Grand Canyon of the Tuolumne above Hetch Hetchy, installed in October 2006.

Hydrometeorological data records at the real-time snow course sites were extended back in time from 1974 to 1985 or later (Appendix E). Data from gaged sites were scaled as necessary to represent conditions at the land segments. Precipitation is scaled using isohyetal mapping. Wind is scaled as a function of elevation. Potential evapotranspiration are assumed constant with elevation.

Air temperatures in land segments are calculated using lapse rates, and affect the temperature dependent snowfall vs. rainfall assignments. Temperatures are important for snowpack heat exchange and snowmelt timing. Analyses attempted to estimate lapse rates continuously throughout the Upper Tuolumne from concurrently available hourly temperature, wind, and precipitation data series. These analyses were inconclusive due to limited concurrent historic data and station to station lapse rates based on long-term daily maximum and minimum temperature records were used (Table E-4, Appendix E).

Temperature is strongly dependent on elevation and often declines with increasing elevation at a ‘lapse rate’ of -2 to -6 degrees F. per thousand feet. Lapse rates are dynamic, cold air draining from mountain slopes into valleys may create temperature inversions. In the Tuolumne historic hourly temperatures are not available at CHV or HTH. Typical diurnal temperature cycles, with daily minimum temperatures at 4 to 6 a.m. and daily maximum temperatures at 2 to 4 p.m., are used to estimate hourly temperatures from daily maximum and minimum temperatures. These typical diurnal cycles are often not present during storms. Wind and heat releases by condensing water vapor during storms affect lapse rates. HY-52 cont.

Direct calculation of lapse rates from concurrent records at the real-time stations (PDS, HRS, SLI and TUM/TMM) was erratic and unrealistic due to distances between station locations and relatively small elevation differences between stations.

Much of the improvement in the calibration was due to corrections to the meteorological data. In addition, model calibration for the Tuolumne tributaries improved when extended temperature records were revised using the maximum/minimum temperature adjustment method as discussed in Section 4.2.

4.3.3 Model Algorithms and Parameters

The algorithms that calculate snow accumulation and melt and surficial hydrologic processes in the HFAM model were first developed at Stanford and have evolved over many years based on thousands of applications but algorithm updates are made when observed data warrants. One algorithm update was made during this project to attenuate liquid water outflow from snowpacks. Streamflow data showing the diurnal variability of flows during snowmelt were collected in the Upper Tuolumne for Raffery, Parker Pass and Gaylor basins (Lundquist and Dettinger, 2005). These are small basins, 6 to 10 sq. mi. in area, tributary to Tuolumne Reach 3000 (Figure 4-1). The Lundquist and Dettinger data for the time difference between maximum snowmelt rates, usually about 2 p.m., and the peak basin outflow measured during snowmelt indicated that liquid water releases from snowpacks were attenuated more than previously modeled in HFAM. The algorithm update delayed peak liquid water outflow timing by several hours.

Data collected at the recently installed streamgage at Tuolumne Grand Canyon (USGS 11274790, 301 sq. mi.) supported this algorithm change, although as drainage areas increase snowpack water outflow timing may not be separated from other flow attenuation processes; e. g. flow routing in reaches and flow through ponds and lakes.

The timing of peak flows measured during snowmelt is also dependent on where snow is melting in a watershed. Figure 4-3 shows snow water equivalent in the Tuolumne above the Tuolumne Grand Canyon gage on May 1, 2008. Modeled peak flow timing May 1st was 7:30 p.m. in Reach 3000 and 8 p.m. in Reach 3085 (Tuolumne Grand Canyon). Snowmelt runoff observed at Reach 3085 on May 1st was primarily coming from the northern watershed areas tributary to Puite, Matterhorn and Register Creeks rather than from land tributary to Reach 3000. Peak snowmelt timing would have minimal secondary effects on model results for climate change but the algorithm update does more closely follow snowpack processes.

HY-52 cont.

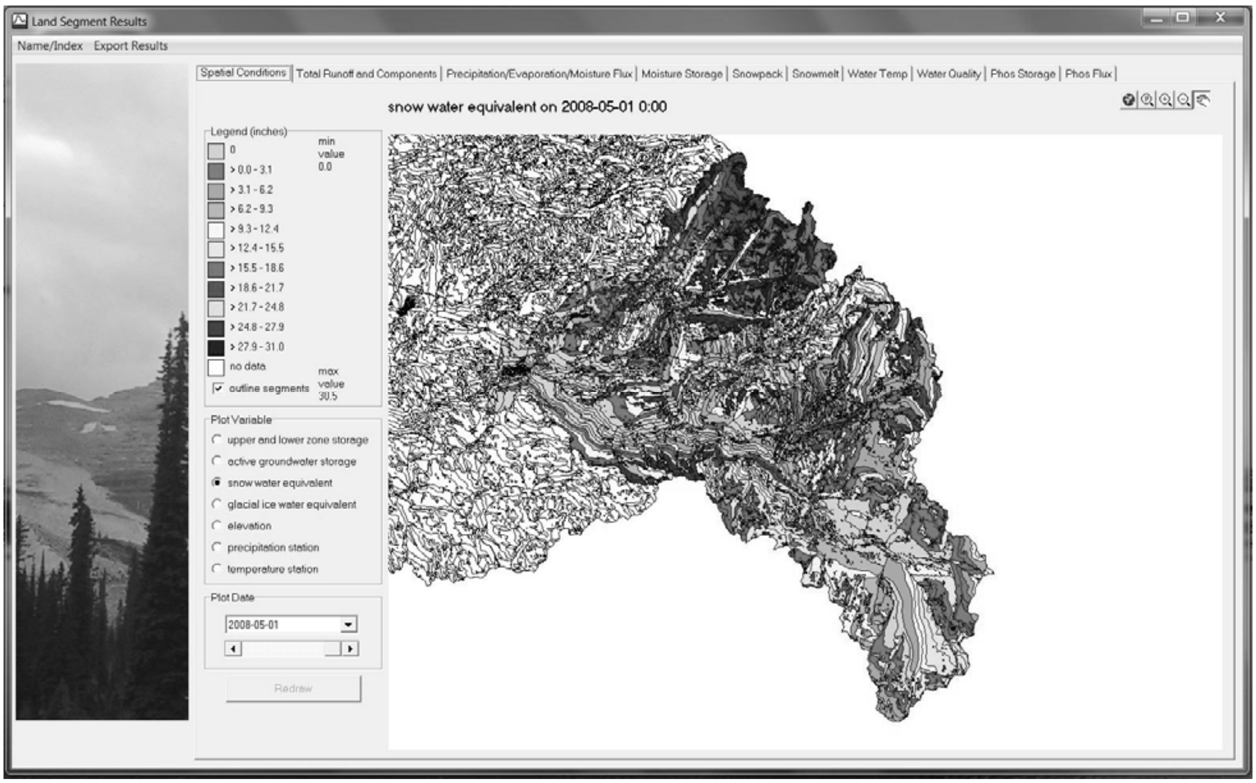


Figure 4-3. Modeled Snowpack Water Equivalent above Tuolumne Grand Canyon, May 1st, 2008

Model parameters represent the diverse characteristics of the Upper Tuolumne. Watershed land at elevations below 6500 ft. is covered by forests, shrubs and grass. Soils are granite derived silt and sand with relatively high infiltration rates and soil moisture holding capacities. Watershed lands above 6500 ft. are exposed granite with near zero infiltration rates and moisture holding capacities or valley meadows with substantial infiltration rates and soil moisture holding capacities. Lakes and ponds are found in high elevation valleys. Lakes, ponds and perched aquifers in meadows in high elevation valleys provide base or groundwater flows for streams even where exposed granite predominates.

Model parameter changes in calibration affected surface runoff, interflow and groundwater flowpath assignments (HFAM parameters INFILT, INTFW, and AGWRC), and snow accumulation, net heat exchange and melt (HFAM parameters TSNOW, NEGHTE, HSHADE and FSHADE). HFAM parameters are defined in the HFAM II Reference and User's Manual (Hydrocomp, 2011).

Model parameter calibration for snow accumulation and melt and for surficial hydrologic processes, especially for inflows to O'Shaughnessey, Eleanor and Cherry Valley reservoirs, was significantly refined because reservoir inflow estimates for these sites were provided for 1974 through 2008 by SFPUC. Appendix B shows simulated reservoir inflows and newly calculated reservoir inflow estimates for O'Shaughnessey and Don Pedro for water years 1974 through 2008.

4.3.4 Calibration Results

Figure 4-4 shows a summary of the calibration results for the Clavey River, the South Fork Tuolumne River and for La Grange, as seen in the HFAM interface. The calibration results summary includes a plot of simulated and observed monthly flows, a bar chart of simulated and observed long-term average monthly flows, the total simulated and observed flow volumes and the percent difference in these volumes over the period of record within water years 1975 to 2008. HY-52 cont.

Figure 4-5 shows simulated inflows to O'Shaughnessey dam in water year 2002 (a sample normal year[6]) compared to calculated natural inflows, as seen in the HFAM interface.

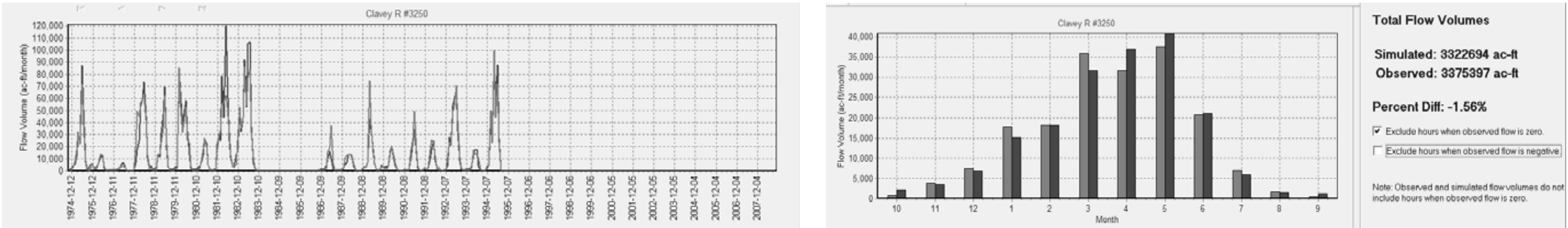
Figure 4-6 shows an example of the calibration results in water year 2002, an average snow year, as seen in the HFAM interface. Observed snow water equivalent at the Horse Meadows (HRS) real-time data observation site at 8400 feet elevation is compared to simulated snow water equivalent on a land segment that represents the Horse Meadows location. The zero observed data point on May 21st is incorrect and is a bad data point.

Annual hydrographs from October 1974 through September 2008 are given in Appendix B.

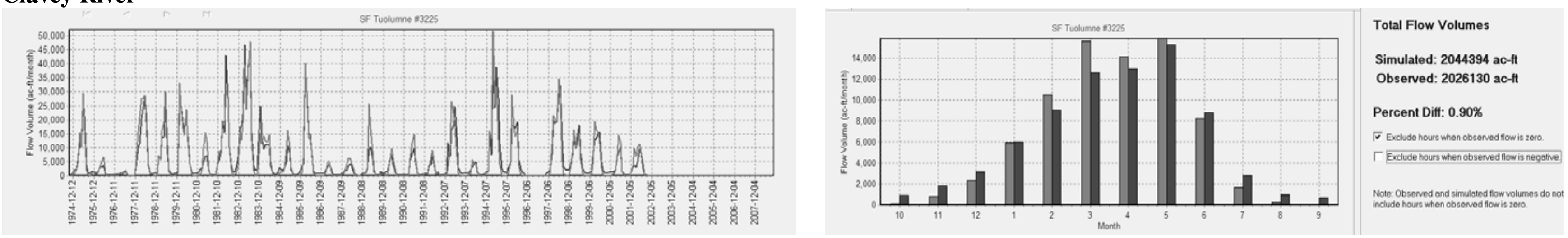
The USGS installed a new streamflow gage on the Tuolumne in the Grand Canyon of the Tuolumne above Hetch Hetchy (11274790) at 3,830 feet with a drainage area of 301 square miles. Data records began 10/21/2006 and will be useful for on-going calibration of the model.

[6] See footnote 2 for description of water year classification system.

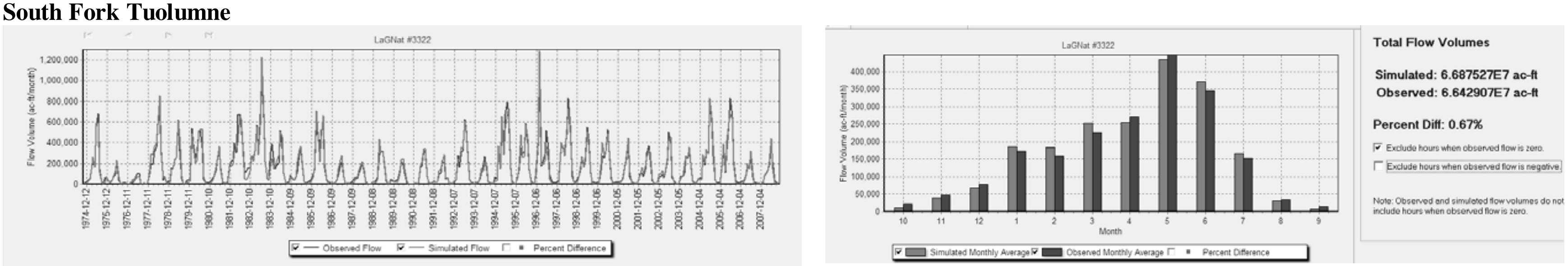
Attachment A



Clavey River



South Fork Tuolumne



La Grange

Figure 4-4. Calibration results for the Clavey River, the South Fork of the Tuolumne River and the Tuolumne River at New Don Pedro Reservoir

O-TRT-DREKMEIER Cont.

HY-52 cont.

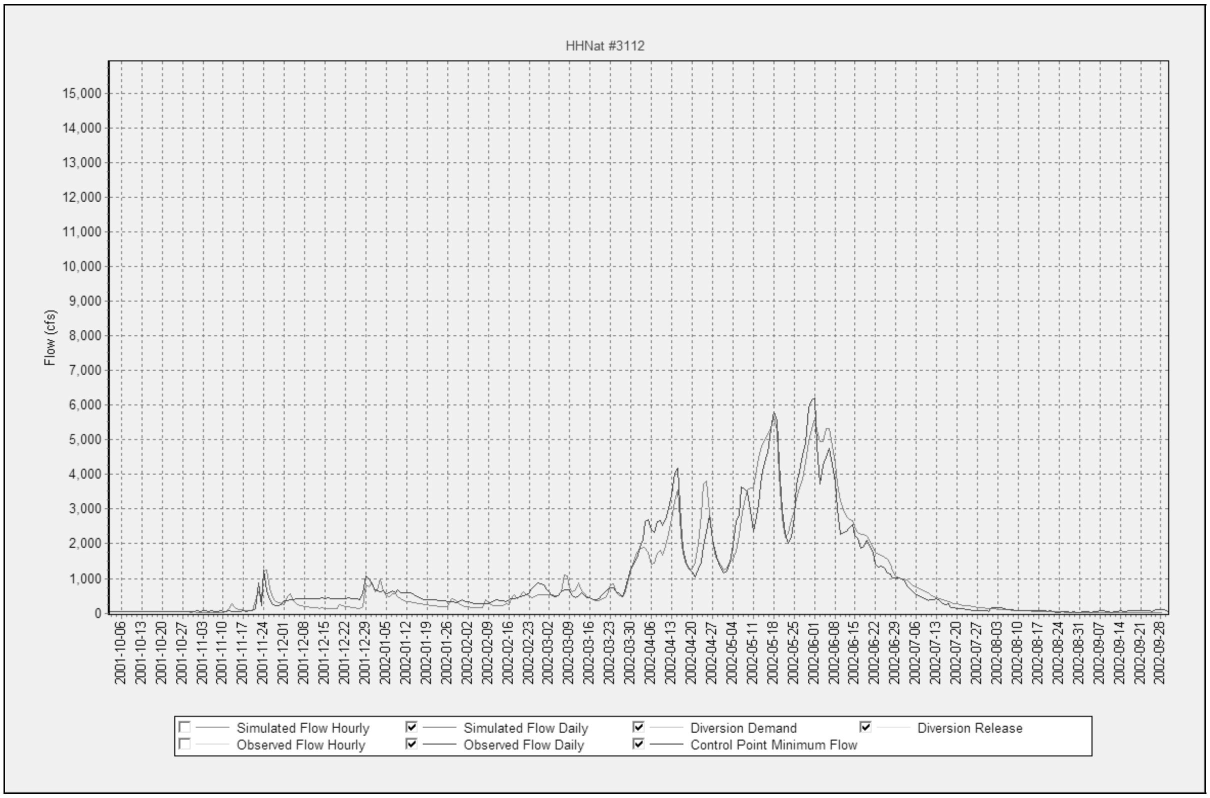


Figure 4-5. O'Shaughnessey simulated and observed natural inflow, 2002 (normal year)

HY-52 cont.

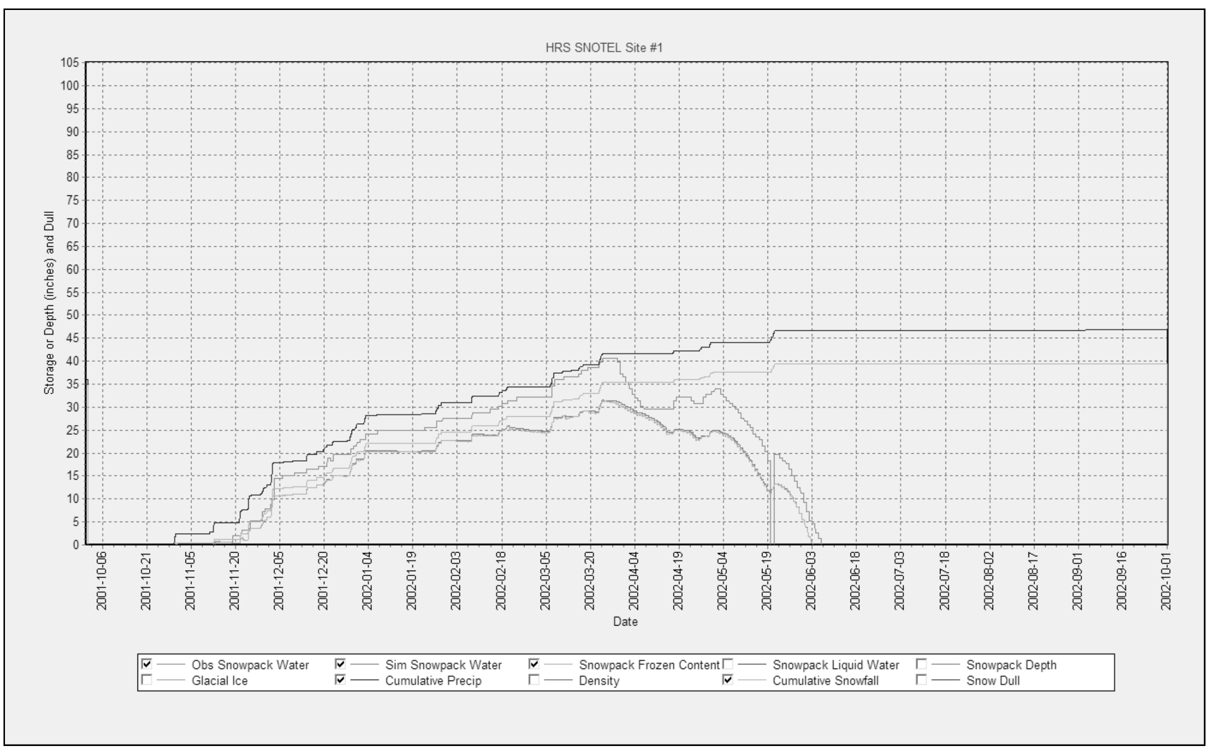


Figure 4-6. Simulated and observed snow water equivalent at 8400 ft., HRS, 2002

5. Constructing Current Conditions and Climate Change Scenarios Weather Inputs

5.1 Historical Trends and Current Climate

Climate is represented in the Tuolumne HFAM model as input timeseries of precipitation, temperature, wind, solar radiation, and evaporation. Climate change scenarios were developed to represent the range of plausible future conditions in the Upper Tuolumne River watershed. The input timeseries for the climate change scenarios were built based on trends and statistics seen in historical meteorological data.

This section summarizes the analysis of historical data. Specific details on the historical data and the analysis are available in Appendix E. Temperature was the only data series found to have consistent historic trends, as in detail in Appendix E and summarized below.

Hourly precipitation, temperature, wind, solar radiation, and evaporation data were compiled for the period of 1930 to 2008 into a 79-year Tuolumne historical meteorological database. These data include records collected at the stations for the period of record and extended records estimated from data recorded at historical stations using the maximum/minimum temperature adjustment method, as discussed in Appendix E.

HY-52 cont.

The historical meteorological database for the Tuolumne watershed was found to have long-term temperature trends, but no trends were detected in precipitation, wind, solar radiation or evaporation. A meteorological database was needed for the climate change study that represents the current climate condition without the long-term trends, so that eventually reservoir yield could be computed and storage needs assessed using traditional analysis (see Section 2). A static meteorological database was created from the historical database, with adjustments to the historical temperature from 1960 to 2008 to remove the long-term temperature trends.

Methods used to adjust the historic temperatures to static conditions are in Appendix E. This static meteorological database was used as the current climate condition of 2010 in this analysis.

5.1.1 Precipitation Trends

Figure 5-1 shows the total annual precipitation at Hetch Hetchy (HTH) for the historical data period and the long-term historical annual precipitation trend. The historical annual precipitation trend line is relatively flat and does not indicate any long-term trend in precipitation.

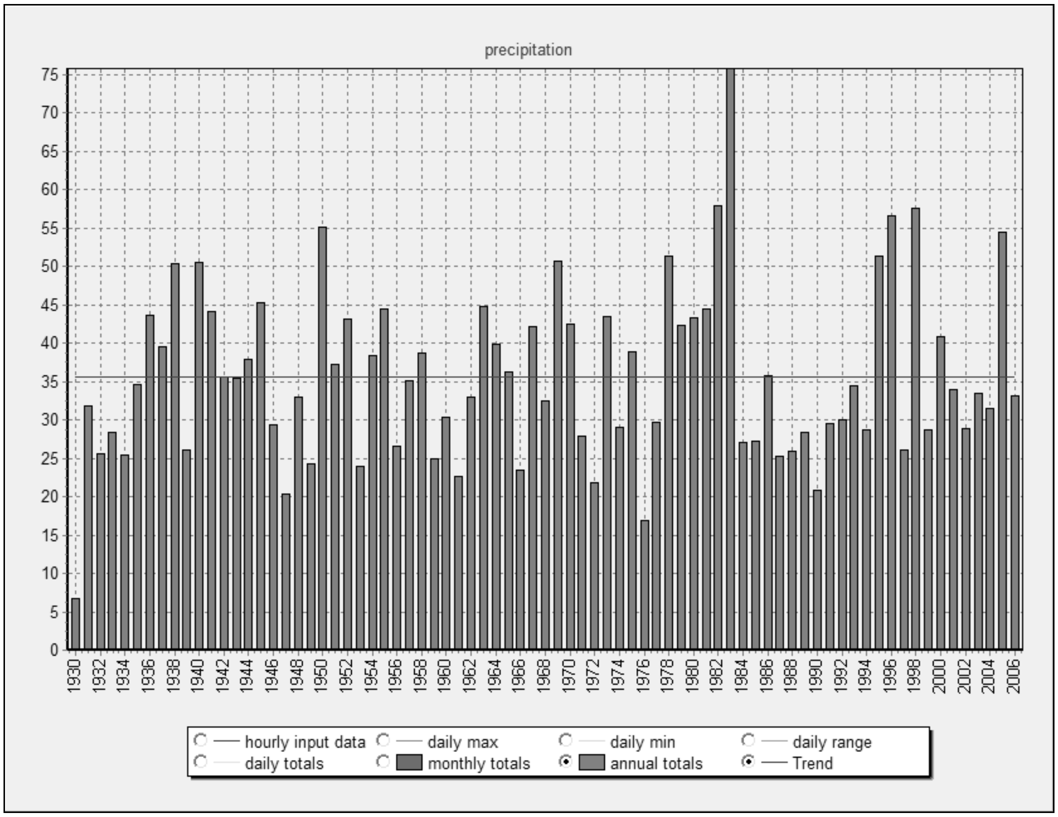


Figure 5-1. HTH historical annual precipitation and trend (plot generated by HFAM)

HY-52 cont.

5.1.2 Temperature Trends

Analysis of historical data from the Tuolumne stations shows overall trends toward increasing temperatures. The details of these trends are complex, but in summary the trends are:

1) Average daily temperatures have increased over the full 79-year period 1930 to 2008, but increases are not consistent over the 79-year period.
2) There are no apparent trends in average daily temperatures from about 1930 to 1960.
3) From about 1960 to the present average daily temperatures at Hetch-Hetchy (HTH) and Cherry Valley (CHV) increase, but the increase is due to an increase in daily minimum temperatures. Daily maximum temperatures show no significant trend.
4) Temperature records at Moccasin at 938 ft. elevation do not show preferential increases in daily minimum temperatures relative to daily average or daily maximum temperatures.

These results correspond to the findings of other climatic studies in the region. Daily minimum temperatures in the Sierras have generally increased since 1900, with most of the increase occurring before 1930 and since 1960 (Behnke, R. 2011). Daily minimum winter temperatures in the Sierras increased over 1.5^{o}C (2.7^{o}F) between 1950 and 1999, while winter average daily maximum temperatures increased over 0.8^{o}C (1.4^{o}F) (Bonfils et al. 2008). Increasing minimum daily temperatures have also been noted at other stations in the Sierra Nevada (John Shaake, pers. comm. December 2009). While temperature has increased in the region overall, there is spatial variability in observed temperatures changes related to elevation and hillslope aspect at individual monitoring stations (Behnke R. 2011, Lundquist and Cayan 2007).

There is a correlation between climate in the Upper Tuolumne River basin and the Pacific Decadal Oscillation that is presented in Appendix E. However, accounting for this correlation has no significant impact on the observed temperature trends and therefore can be ignored in creating the static meteorological database for 2010 current conditions.

The increasing daily minimum temperature trends from 1960 to the present happened when the gage locations and instrumentation at Hetch Hetchy and Cherry Valley were stable (as discussed further in Appendix C.2). Tables of historic temperature trends at Tuolumne river stations are provided in Appendix E.

5.1.3 Solar Radiation Trends

Solar radiation data for the analysis period 1974 to 2008 were calculated from theoretical clear sky solar radiation and percent sunshine estimated from sky cover descriptions at Cherry Valley and Moccasin. The calculated data were compared to short record solar radiation observations at Buck Meadows (BKM) and at high elevation stations in the Tuolumne (TUM, DAN, and TES), (Appendix E). The calculated solar radiation data series show no significant trends.

HY-52 cont.

5.1.4 Wind Speed Trends

Wind speeds for the analysis period 1974 to 2008 were from the National Centers for Environmental Prediction-National Center for Atmospheric Research (NCEP-NCAR) Reanalysis data set (Kalnay et al. 1996) and from limited observations at Buck Meadows (BKM). These data show no significant trends (Appendix E).

5.1.5 Evaporation Trends

Evaporation data were only recorded at Hetch Hetchy (HTH) for part of the historical data period. Evaporation data before and after the period of data collection are set to the monthly long-term averages with a diurnal pattern. These data have no significant trend.

5.2 Weather Inputs for Climate Change Scenarios

A simple and commonly-used method of developing meteorological timeseries to represent climate change scenarios is the “delta method”. The method was developed in the early days of climate change assessments but is still widely used today. In the delta method, a future timeseries is generated from an historical timeseries representing present-day climate by adding or multiplying it by an adjustment factor equally across all seasons and diurnally to represent future climate. One consequence of this assumption is that the future frequency and magnitude of extreme weather events are the same as they are in present-day climate. Another is that this approach assumes change will occur equally at all times of the year. The method assumes that changes in climates are only relevant at coarse scales, and that relationships between variables are maintained towards the future. While these assumptions might hold true in a number of cases, they could be wrong, particularly in highly heterogeneous landscapes where topographic conditions cause considerable variations over relatively small distances. Nevertheless, the relative simplicity of the delta method approach makes it appropriate for this first sensitivity analysis.

A delta-adjusted future meteorological database was generated from the 2010 current condition static meteorological database to represent each of the future climate conditions listed in Table 3-1. The precipitation for each future climate condition was applied as a multiplication factor to each precipitation record in the static meteorological database. The temperature increase for each future climate condition is stated as average temperature increases instead of increases to minimum and maximum temperatures. Since the historical temperature records in the Tuolumne at Hetch Hetchy and Cherry Valley show that minimum daily temperatures have increased much more than maximum daily temperatures, this tendency is assumed to continue, becoming gradually more moderate. The method of modeling the relative changes in the minimum and maximum temperatures is discussed in Appendix E.

HY-52 cont.

6. Analysis of Hydrologic Response

This section presents the simulated hydrologic response for the period 1975 to 2008 for the climate change scenarios.

Section 6.1 provides results for the 2010 static current condition which uses the de-trended meteorological inputs discussed in Section 5.1. Sections 6.2 to 6.5 compare the 2010 static current condition simulated hydrology to the simulated hydrology for each constructed climate change scenario.

6.1 Effects of Historical Trends

The historical meteorological database was found to have long-term historical trend for minimum and average daily temperature. The observed minimum daily temperature increases over the 1960 to 2008 period at both the Hetch Hetchy (HTH) and Cherry Valley (CHV) gages. A "static meteorological database" was created (as described in Section 5.1) by adjusting the historical temperature data to remove trends using the methods discussed in Appendix E.

HY-52 cont.

Table 6-1 lists the mean daily temperatures at Hetch Hetchy and Cherry Valley calculated from the historical and static meteorological database for the 34-year period, water years 1975 to 2008.

Table 6-1. Mean daily temperature in historical and static meteorological database

Station	Historical Meteorological Database (deg F)	Static Meteorological Database (deg F)	Difference (deg F)
Hetch Hetchy	54.19	55.07	+ 0.88
Cherry Valley	53.36	54.34	+ 0.98

The static meteorological database represents the current climate condition and was used to simulate the current hydrological conditions (year 2010). The higher temperatures in the static meteorological database resulted in increased simulated watershed evapotranspiration and decreased simulated total runoff in the 2010 current condition compared to the historical condition. Table 6-2 lists the percent change in simulated total runoff and total watershed actual evapotranspiration at O'Shaughnessy and Don Pedro dams.

Table 6-2. Change in current hydrological conditions from historical condition

Location	Hydrological Characteristic	Current Climate Condition[1] (% change from historical)
O'Shaughnessy	total runoff	- 0.5 %
O'Shaughnessy	actual evapotranspiration	+ 1.9 %
Don Pedro	total runoff	- 0.9 %
Don Pedro	actual evapotranspiration	+ 1.8 %

[1]The current climate condition (year 2010) was simulated using the static meteorological database.

The adjustments made to historical temperature to remove trends and create a static temperature record are constant from 1930 to 1960, and decrease linearly from 1960 to 2008 (Table E.7). The resulting change in simulated streamflow and actual evapotranspiration are also greater in the early record and become smaller after 1960, disappearing entirely by 2008.

6.2 Runoff Timing and Volume

The future hydrological conditions were simulated with HFAM using the future meteorological database which represents each of the future climate conditions (climate change scenario at a future climate date). The results of these simulations were compared with 2010 current climate simulated hydrologic conditions to analyze the potential hydrological effects of climate change at 2040, 2070 and 2100.

Appendix A provides comparisons of the change in simulated runoff, actual evapotranspiration and snow water equivalent for each future climate condition compared to the current condition.

The effect of temperature increase can be assessed by comparing the results of climate change scenarios 1A (low temperature increase with no precipitation change), 2A (moderate temperature increase with no precipitation change) and 3A (high temperature increase with no precipitation change). The effect of precipitation change can be assessed by comparing the results of climate change scenarios 2A (moderate temperature increase with no precipitation change), 2B (moderate temperature increase with precipitation decrease) and 2C (moderate temperature increase with precipitation increase) or by comparing 3A (high temperature increase with no precipitation change) with 3B (high temperature increase with precipitation decrease).

HY-52 cont.

Table 6-3 summarizes the percentage change in median runoff volume at O'Shaughnessy and Don Pedro Dam for each future climate condition. The percentage changes in simulated runoff for each future climate condition are given in comparison with the current climate condition based on the 2010 current conditions meteorological database. Simulated runoff volumes based on the 2010 current conditions meteorological database are approximately one percent lower than the runoff simulated with the historical meteorological database (Table 6-2).

Climate change scenarios cause changes in monthly runoff timing that can be seen in the plots of simulated average monthly runoff for the current and future climate conditions, shown in Section A.1.3. Under climate change scenario 2A in 2100 at O'Shaughnessy, the May through August runoff would decrease by 45% from the current condition (31% of current condition annual runoff), the September through April runoff would increase by 81% (26% of annual runoff), and 5% of the annual runoff would be lost to additional evapotranspiration.

Table 6-3. Change in median runoff volume for future climate conditions

Climate Change Scenario		O'Shaughnessy Runoff (% change from 2010)			Don Pedro Runoff (%change from 2010)		
		2040	2070	2100	2040	2070	2100
1A	low temperature increase no precipitation change	-0.7%	-1.5%	-2.6%	-1.1%	-2.4%	-3.6%
2A	moderate temperature increase no precipitation change	-1.2%	-2.9%	-5.4%	-1.8%	-4.0%	-6.4%
2B	moderate temperature increase precipitation decrease	-7.6%	-15.8%	-24.7%	-9.5%	-19.1%	-28.7%
2C	moderate temperature increase precipitation increase	1.4%	2.2%	2.4%	1.1%	2.0%	2.8%
3A	high temperature increase no precipitation change	-2.1%	-5.6%	-10.2%	-3.0%	-6.5%	-10.1%
3B	high temperature increase precipitation decrease	-8.6%	-18.6%	-29.4%	-10.7%	-21.6%	-32.3%

These results illustrate that runoff is a residual. The long term water balance in the watershed is: HY-52 cont.

$$\text{Precipitation} - \text{Actual Evapotranspiration} = \text{Total Runoff} \qquad \text{(E.6)}$$

The effect of the climate change scenarios on actual ET was greater than initially anticipated. With warming, snow disappears earlier in the spring and so there is a longer snow free season. For that reason, there is an increase in actual ET in a warmer climate. At higher elevation, in 2010 conditions, soil moisture in valleys (e.g. Tuolumne Meadows) allows increased ET in a warmer climate; soil moisture is not completely depleted when snow returns. This explains the reduction in runoff above Hetch Hetchy in scenarios 1A, 2A and 3A.

The potential ET was kept constant in the model due to uncertainty in changes in land cover conditions in the future. A refinement of the model would be to make educated assumptions on land cover conditions and associated change potential ET in a warmer climate.

6.2.1 Actual Evapotranspiration

The watershed water balance equation (E.6) can be restated as:

$$\text{Actual Evapotranspiration} = \text{Precipitation} - \text{Total Runoff} \qquad \text{(E.7)}$$

As climate change increases temperatures, rainfall replaces snow in the fall and winter and reduced snowpacks melt earlier in the spring. Evapotranspiration increases in the fall and winter and begins earlier in the spring. Model algorithms follow a basic hierarchy; at low soil moisture water that reaches the land surface usually infiltrates into the soil profile and is later evaporated or transpired. Algorithms reduce infiltration and allow more runoff as soil moisture storage increases.

Evapotranspiration changes in the climate change scenarios are straightforward in principle but are complex in detail. In the Tuolumne, granite outcrops are common above 6500 ft. These outcrops have very low moisture storage capacity compared to soils at lower elevations. At lower elevations with higher forest density and more grasses, brush and shrubs, evapotranspiration will decrease as soil moistures are depleted in summer.

In climate change scenarios 1A, 2A and 3A, there is an increase in evapotranspiration and a decrease in simulated long-term runoff with no change in precipitation. In climate change scenario 2C, there is an increase in evapotranspiration and in simulated long-term runoff so the runoff increase is less than the increase in precipitation.

Section A.2 of Appendix A shows figures of simulated actual evapotranspiration for the future climate conditions compared to the current condition.

Figure 6-1 shows an example of simulated daily actual evapotranspiration on the watershed above O'Shaughnessy Dam in water year 1994, a sample dry year. The simulated daily actual evapotranspiration for the current climate condition is plotted in red; the simulated daily actual evapotranspiration for the future climate condition in year 2100 of climate scenario 2A (moderate temperature increases with no precipitation change) is plotted in blue. Figure 6-1 shows a consistent increase in evapotranspiration in 2100 from October through May compared to current evapotranspiration. HY-52 cont.

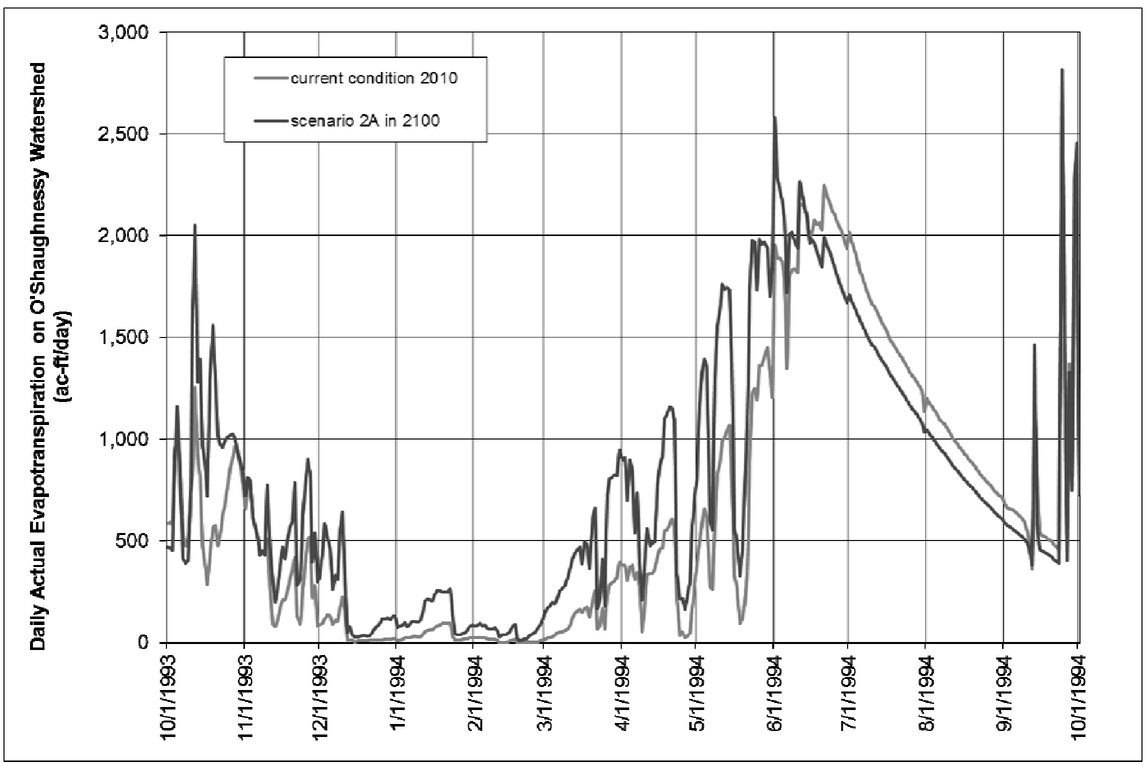


Figure 6-1. Simulated watershed actual evapotranspiration above O'Shaughnessy for current climate condition (red) and scenario 2A in 2100 (blue), water year 1994

Increasing temperatures due to climate change and reduced soil moisture will very likely, over time, alter forest extent and density. Forests may expand at higher elevations and decline at lower elevations. This could change evapotranspiration and require adjustments to the calibrated land segment parameters. Changes in total water yield from Tuolumne due to forest migration may be limited, however, if the total forest extent does not change.

6.2.2 Low and High Runoff Years

The results provided above in are valid for median runoff (exceeded in 50 percent of all water years). Simulated changes in median annual runoff do not fully describe how runoff would be affected during high runoff or drought years. When firm yield from reservoirs is evaluated, low runoff years are critical.

Table 6-4 summarizes the modeling results in terms of the change in simulated 5 (extremely wet), 50 (the median value as shown in Table 6-3) and 95 (extremely dry) percent exceedance annual runoff for two climate change scenarios (2A moderate temperature increases with no precipitation and 3B high temperature increases with precipitation decreases).

HY-52 cont.

Table 6-4. Change in runoff volume for future climate conditions at 5%, 50%, and 95% exceedance level

Climate Change Scenario		Exceed Prob	O'Shaughnessy Runoff (% change from 2010)			Don Pedro Runoff (% change from 2010)		
			2040	2070	2100	2040	2070	2100
2A	moderate temperature increase no precipitation change	5%	-0.6%	-1.4%	-2.4%	-1.1%	-2.6%	-3.7%
2A	moderate temperature increase no precipitation change	50%	-1.2%	-2.9%	-5.4%	-1.8%	-4.0%	-6.4%
2A	moderate temperature increase no precipitation change	95%	-3.4%	-8.8%	-15.1%	-4.2%	-9.8%	-16.1%
3B	high temperature increase precipitation decrease	5%	-7.1%	-14.3%	-21.8%	-8.7%	-16.7%	-24.3%
3B	high temperature increase precipitation decrease	50%	-8.6%	-18.6%	-29.4%	-10.7%	-21.6%	-32.3%
3B	high temperature increase precipitation decrease	95%	-14.7%	-30.9%	-46.5%	-16.6%	-33.3%	-48.1%

Appendix A provides figures showing simulated runoff, actual evapotranspiration and maximum snow accumulation exceeded in 5, 50, and 95 percent of all water years for climate change scenario 2A. Simulated runoff exceeded in 5, 50, and 95 percent of all water years is also provided for climate change scenario 3B, the scenario which results in the greatest reduction in simulated runoff. These figures show the non-linear effects of climate change on runoff in low and high runoff years and illustrate that soil moisture and evapotranspiration have precedence over runoff in droughts.

Runoff in drought years is a relatively small percentage of precipitation and is very sensitive to changes in precipitation. This non-linear sensitivity is found in response to climate change scenarios too: Runoff reductions, as a percentage of current runoff, are greatest in drought years.

The non-linearity of the response to climate change is also reflected in the difference between the mean (average) change in runoff and the median (exceeded in 50 percent of all water years) change. The percent reduction in mean runoff is consistently less than the percent reductions in median runoff. Table 6-5 summarizes these changes for climate change scenarios 2A and 2B.

Table 6-5. Change in median and mean runoff for climate change scenarios 2A and 2B

Climate Change Scenario		Hydrological Characteristic	O'Shaughnessy (% change from 2010)			Don Pedro (% change from 2010)		
			2040	2070	2100	2040	2070	2100
2A	moderate temperature no precipitation change	precipitation	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		median runoff	-1.2%	-2.9%	-5.4%	-1.8%	-4.0%	-6.4%
		mean runoff	-1.2%	-2.9%	-5.1%	-1.8%	-3.9%	-5.9%
2B	moderate temperature precipitation decrease	precipitation	-5.0%	-10.0%	-15.0%	-5.0%	-10.0%	-15.0%
		median runoff	-7.6%	-15.8%	-24.7%	-9.5%	-19.1%	-28.7%
		mean runoff	-7.6%	-15.5%	-23.5%	-9.1%	-17.8%	-26.3%

HY-52
cont.

6.3 Snow Accumulation, Areal Extent, and Snowmelt Timing

Simulated total watershed runoff and actual evapotranspiration are dependent on snow accumulation. Table 6-6 summarizes the percentage change in median annual maximum snow water equivalent on the watersheds above O'Shaughnessy and Don Pedro dams for all future climate conditions. Section A.3 of Appendix A shows figures of simulated annual maximum watershed snow water equivalent for each future climate condition compared to the current climate condition (year 2010). Appendix D provides additional details on the change in snow accumulation and snow melt due to the future climate conditions.

Figure 6-2 shows simulated watershed snowpack above O'Shaughnessy Dam in water year 1994. The simulated watershed snowpack for the current climate condition is plotted in red; the simulated watershed snowpack for the future climate condition in year 2100 of climate change scenario 2A (moderate temperature increase with no precipitation change) is plotted in blue. Figure 6-3 shows the simulated natural inflow to O'Shaughnessy Dam over the same period for the same climate conditions. It can be seen the inflows are accelerated. Precipitation events that fell mainly as snow under the 2010 current condition instead trigger rain events under the future climate scenarios which increase wintertime peak inflows. Meanwhile, snowmelt is accelerated due to warmer temperatures and less spatial snow coverage (shallower snowpack melts faster and need less energy to reach isothermal conditions to generate melt and the resulting runoff).

Table 6-6. Change in median annual maximum snow water equivalent for future climate conditions

Climate Change Scenario		O'Shaughnessy Snow (% change from 2010)			Don Pedro Snow (%change from 2010)		
		2040	2070	2100	2040	2070	2100
1A	low temperature increase no precipitation change	-1.6%	-11.4%	-21.7%	-11.9%	-26.6%	-38.8%
2A	moderate temperature increase no precipitation change	-4.3%	-24.5%	-43.8%	-20.8%	-41.6%	-59.8%
2B	moderate temperature increase precipitation decrease	-10.3%	-33.4%	-54.8%	-25.9%	-49.5%	-67.6%
2C	moderate temperature increase precipitation increase	-2.0%	-20.8%	-38.3%	-18.8%	-38.4%	-56.6%
3A	High temperature increase no precipitation change	-15.5%	-45.8%	-73.5%	-33.6%	-60.8%	-81.4%
3B	High temperature increase precipitation decrease	-20.6%	-53.6%	-79.5%	-38.2%	-66.2%	-85.6%

The simulated snow areal extent is also reduced for the future climate conditions. Figure 6-4 shows a spatial plot of the simulated snow water equivalent in the Tuolumne watershed on April 1, 1992 for the current climate condition displayed in the HFAM interface. April 1st is used as a reference point of peak annual snowpack accumulation. Figure 6-5 shows the same plot of simulated snow water equivalent for the future climate condition in year 2100 of climate change scenario 2A (moderate temperature increases with no precipitation change). Figure 6-6 shows the same plot of simulated snow water equivalent for the future climate condition in year 2100 of climate change scenario 2B (moderate temperature increases with precipitation decrease). Note that the color legend is different in each plot as it corresponds to an increasingly smaller range of snow water equivalent depth. HY-52 cont.

O-TRT-DREKMEIER Cont.

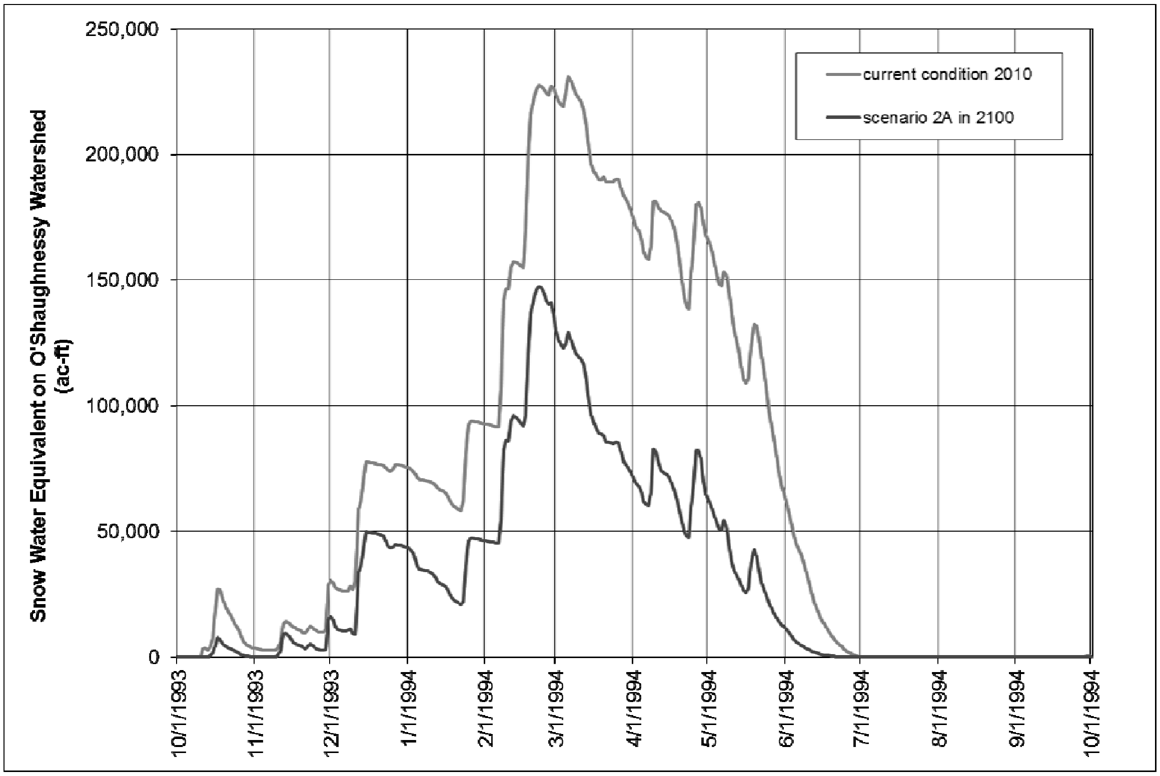


Figure 6-2. Simulated watershed snowpack above O'Shaughnessy Dam for current climate condition (red) and scenario 2A in 2100 (blue), water year 1994.

HY-52 cont.

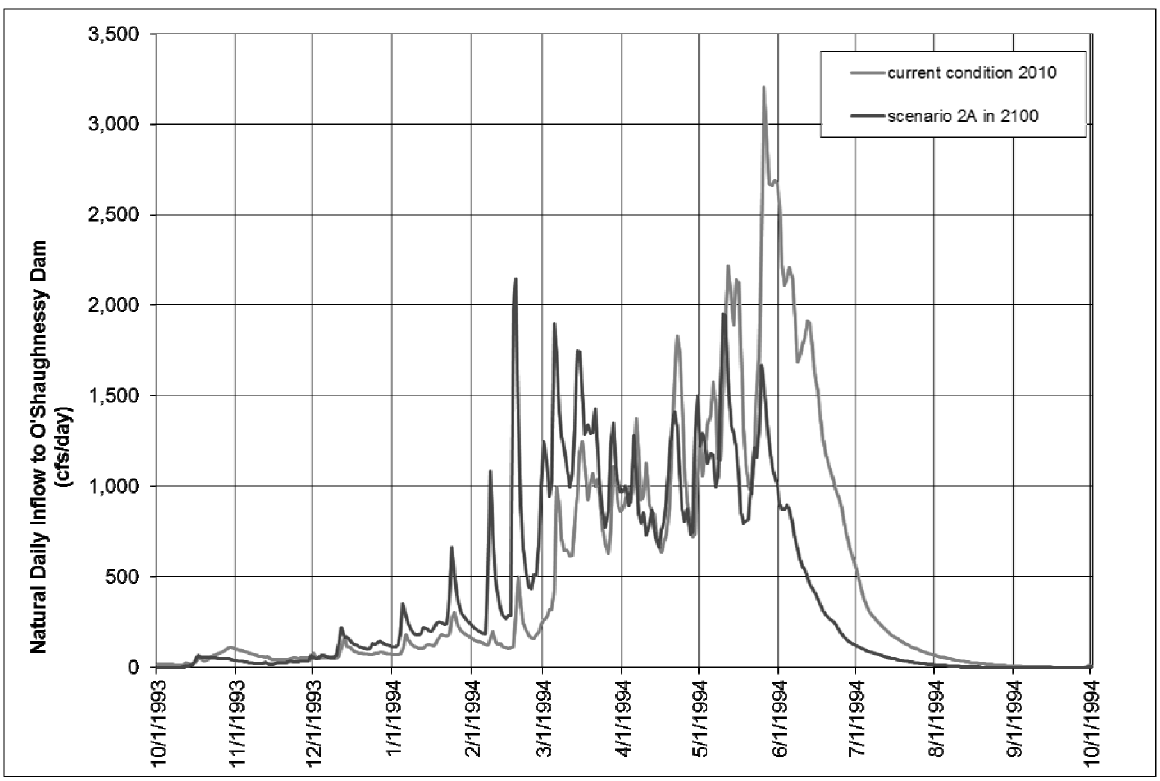


Figure 6-3. Simulated natural inflow to O'Shaughnessy Dam for current climate condition (red) and scenario 2A in 2100 (blue), water year 1994

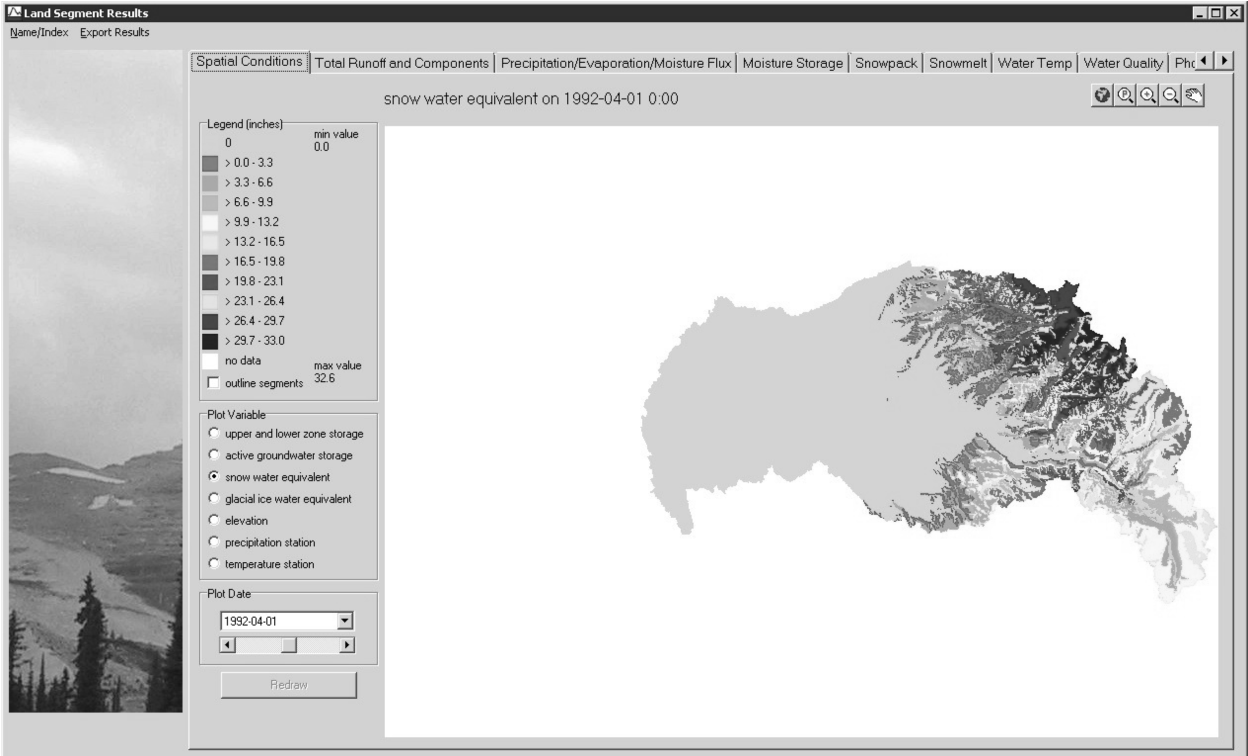


Figure 6-4. Simulated snow water equivalent on 4/1/1992 for current climate condition

HY-52 cont.

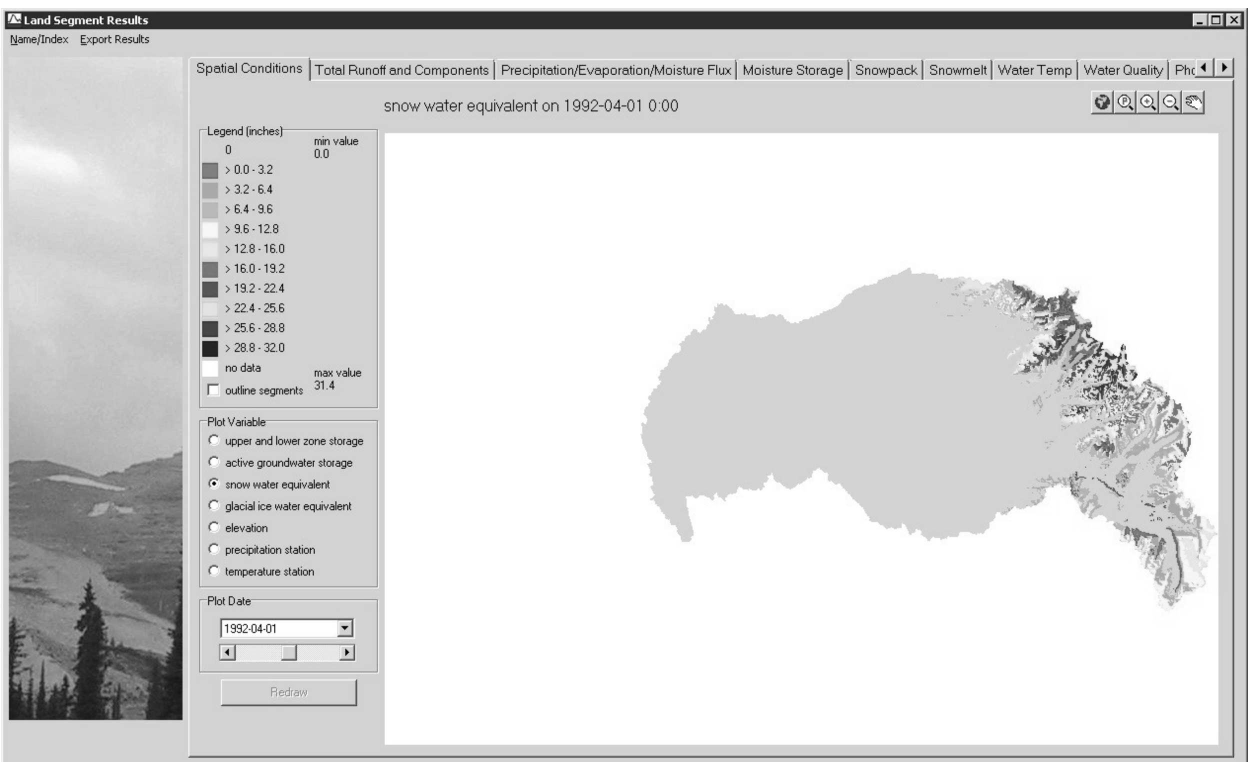


Figure 6-5. Simulated snow water equivalent on 4/1/1992 for scenario 2A in 2100

O-TRT-DREKMEIER Cont.

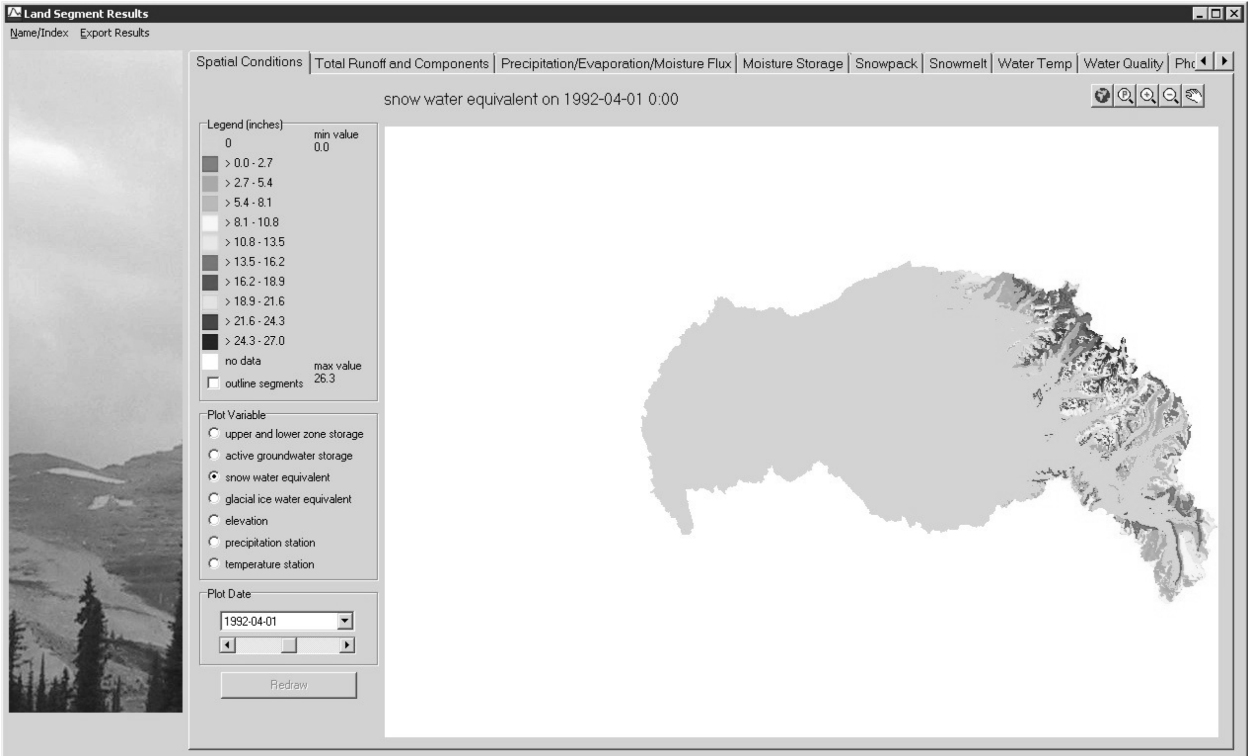


Figure 6-6. Simulated snow water equivalent on 4/1/1992 for scenario 2B in 2100

HY-52 cont.

Figure 6-7 shows the simulated snow water equivalent in the watershed above O'Shaughnessy Dam for water years 1987 to 1995. The simulated snow water equivalent for the current climate condition is plotted in red; the simulated snow water equivalent for the future climate condition in year 2100 of climate change scenario 2A (moderate temperature increases with no precipitation change) is plotted in blue. The reduction in snowpack in the watershed above O'Shaughnessy Dam and the increased actual evapotranspiration that occurs with earlier spring melt result in a 5.6% reduction in simulated flow at O'Shaughnessy Dam over water years 1987 to 1995 compared to the current condition. Simulated flows at Don Pedro Dam are reduced by 6.5% over the same period.

Figure 6-8 shows the simulated snow water equivalent on two land segments with SW aspect at different elevations in the Tuolumne watershed for water year 1992. Snow water equivalent for the land segment at 10,000 feet shown as a solid line; snow water equivalent for the land segment at 7,000 feet is shown as a solid line. The simulated snow water equivalent for the current climate condition is plotted in red; the simulated snow water equivalent for the future climate condition in year 2100 of climate change scenario 2A (moderate temperature increases with no precipitation change) is plotted in blue.

O-TRT-DREKMEIER Cont.

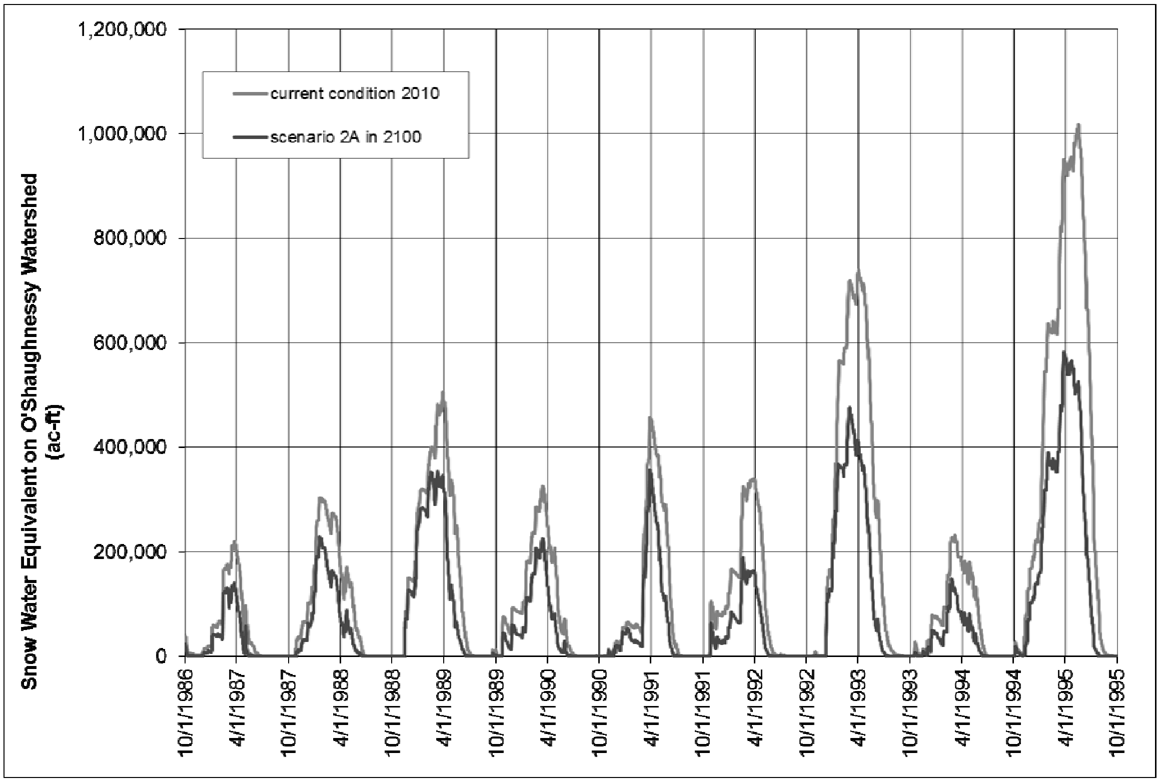


Figure 6-7. Simulated watershed snow water equivalent above O'Shaughnessy Dam for current climate condition (red) and scenario 2A in 2100 (blue), water years 1987 to 1995

HY-52 cont.

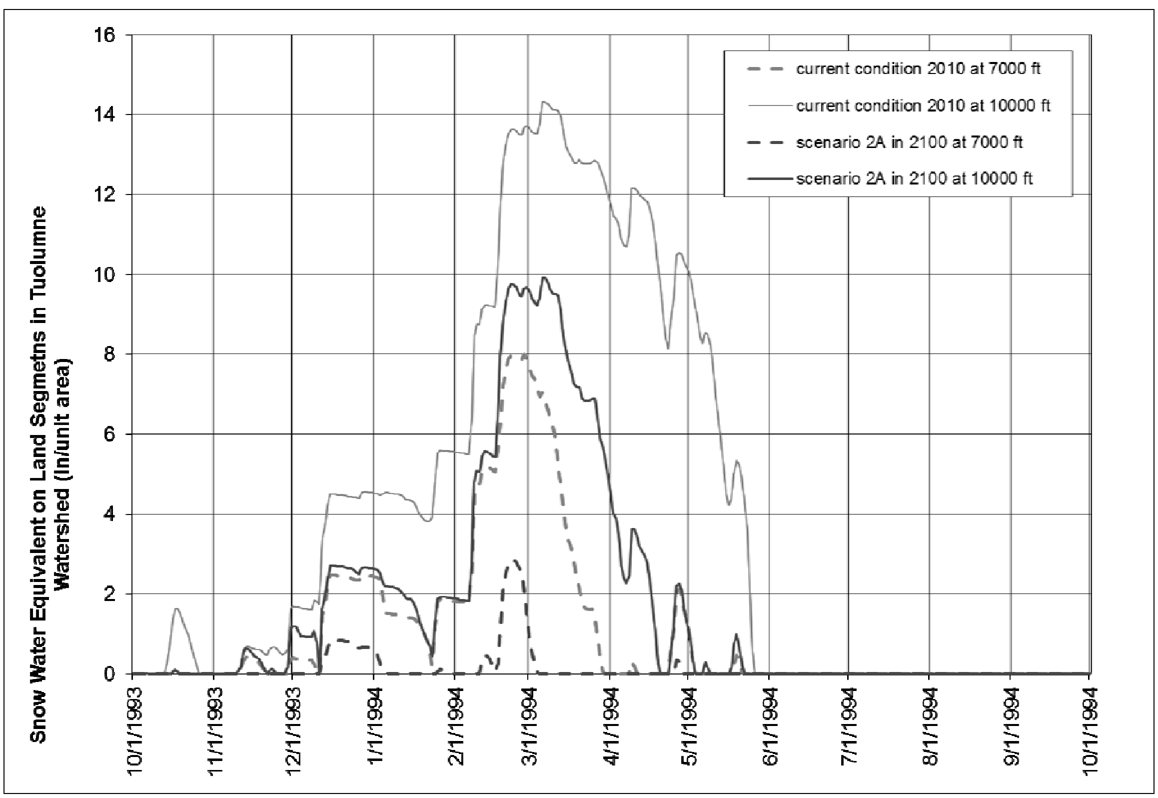


Figure 6-8. Simulated watershed snow water equivalent on land segments at 10000 ft (solid) and 7000 ft (dashed) ft for current climate condition (red) and scenario 2A in 2100 (blue), water year 1992

6.4 Physical Processes, Snowmelt Runoff and Actual Evapotranspiration

Under future climate conditions, winter snow decreases and melts earlier in the spring, resulting in an increase in actual evapotranspiration and a decrease in watershed runoff. Runoff reductions are greater in years with less than normal precipitation. Actual evapotranspiration in all water years is key for runoff reductions.

Actual evapotranspiration (AET) is dependent both on soil moisture, decreasing as soil moisture is depleted, and on snow cover. AET decreases as soil moisture is depleted. In years when there is a large snowpack and in years when cool spring temperatures delay snowmelt, actual evapotranspiration is reduced.

The relative influence of soil moisture and snowpack on actual evapotranspiration losses depends on soil moisture storage and on elevation. The watershed above O'Shaughnessy Dam has more exposed granite and higher elevations, so its actual evapotranspiration is more dependent on snowpack than soil moisture. Lower elevations have less snow and deeper soils so actual evapotranspiration is more dependent on soil moisture.

To illustrate the relationship between actual evapotranspiration, snowpack and soil moisture for the O'Shaughnessy watershed, simulation results are shown for water year 1995, a year with a large snowpack and late spring melt, and for water year 1994, a year with a low snowpack and early spring melt. HY-52 cont.

Figure 6-9 shows simulated cumulative actual evapotranspiration for the O'Shaughnessy watershed for each year of the 34-year meteorological database for the future climate condition in year 2100 of climate change scenario 2A. The red line shows the simulated actual evapotranspiration for water year 1995, a sample wet year. The blue line shows the results for water year 1994, a sample dry year.

The simulated 1995 runoff to O'Shaughnessy Dam for the future climate condition in year 2100 of climate change scenario 2A was 1,378,000 acre-feet. Simulated actual evapotranspiration was 258,000 acre-feet, approximately 19 percent of runoff. In comparison, the simulated 1994 runoff for the same future climate condition was 299,000 acre-feet and simulated actual evapotranspiration was 283,000 acre-feet, approximately 95 percent of runoff.

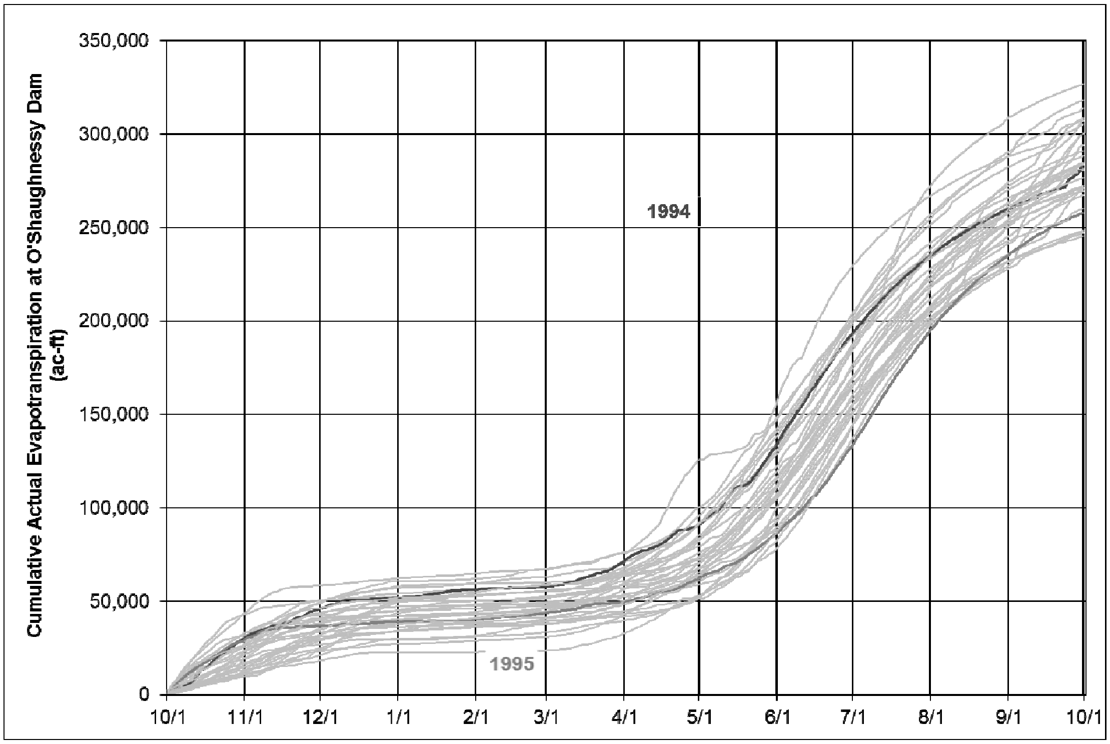


Figure 6-9. Simulated watershed cumulative actual evapotranspiration above O'Shaughnessy Dam for scenario 2A in 2100, water year 1995 in red and water year 1994 in blue.

HY-52 cont.

Figure 6-10 shows the simulated watershed snow water equivalent above O'Shaughnessy Dam for each year of the 34-year meteorological database for the future climate condition in year 2100 of climate change scenario 2A. The red line shows the simulated snow water equivalent for water year 1995. The blue line shows the simulated snow water equivalent for water year 1994.

Figure 6-11 shows the same information for soil moisture. The much larger snowpack in 1995 increases soil moisture in April and May, 1995, compared to April and May, 1994. This increase in soil moisture is not proportional to the difference in snowpack between 1995 and 1994. Soil moisture storage is limited by soil moisture storage capacity.

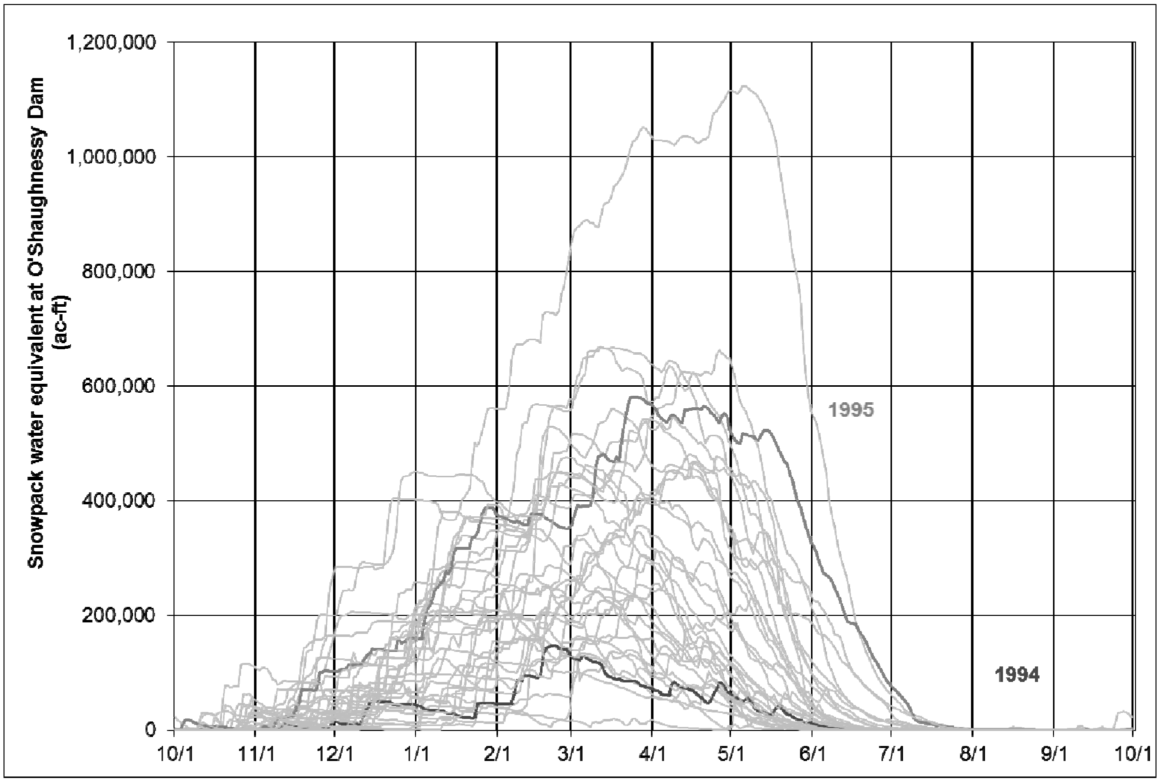


Figure 6-10. Simulated watershed snow water equivalent above O'Shaughnessy Dam for scenario 2A in 2100, water year 1995 in red and water year 1994 in blue.

HY-52 cont.

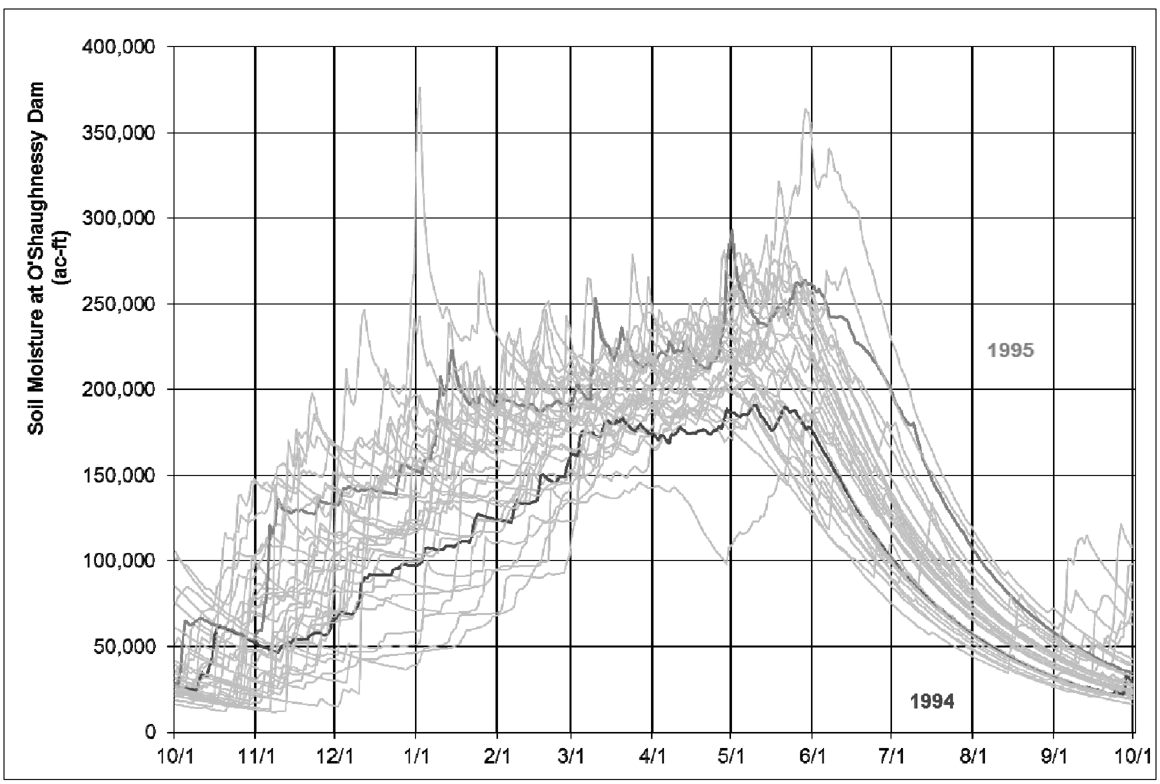


Figure 6-11. Simulated watershed soil moisture above O'Shaughnessy Dam for scenario 2A in 2100, water year 1995 in red and water year 1994 in blue.

6.5 Soil Moisture

HFAM II calculates the hydrologically active moisture storage, the storage that is depleted during the summer and refills in the late spring in most years. Simulated soil moisture storage volumes do not include water in deep alluvium that is not accessible to transpiration or evaporation.

Figure 6-12 shows the simulated watershed soil moisture above O'Shaughnessy Dam for the current climate condition (red) and the future climate condition in year 2100 of climate change scenario 2A (blue) for water year 1995, a year with a large snowpack and late spring melt.

In contrast, Figure 6-13 shows the same results for water year 1994, a year with a low snowpack and early spring melt.

Soil moisture changes under future climate conditions are more noticeable in years with above average precipitation, but reduced soil moistures in summer are found in all years. The amount of change in soil moisture under the future climate condition in year 2100 of climate change scenario 2A would affect all types of vegetation.

HY-52
cont.

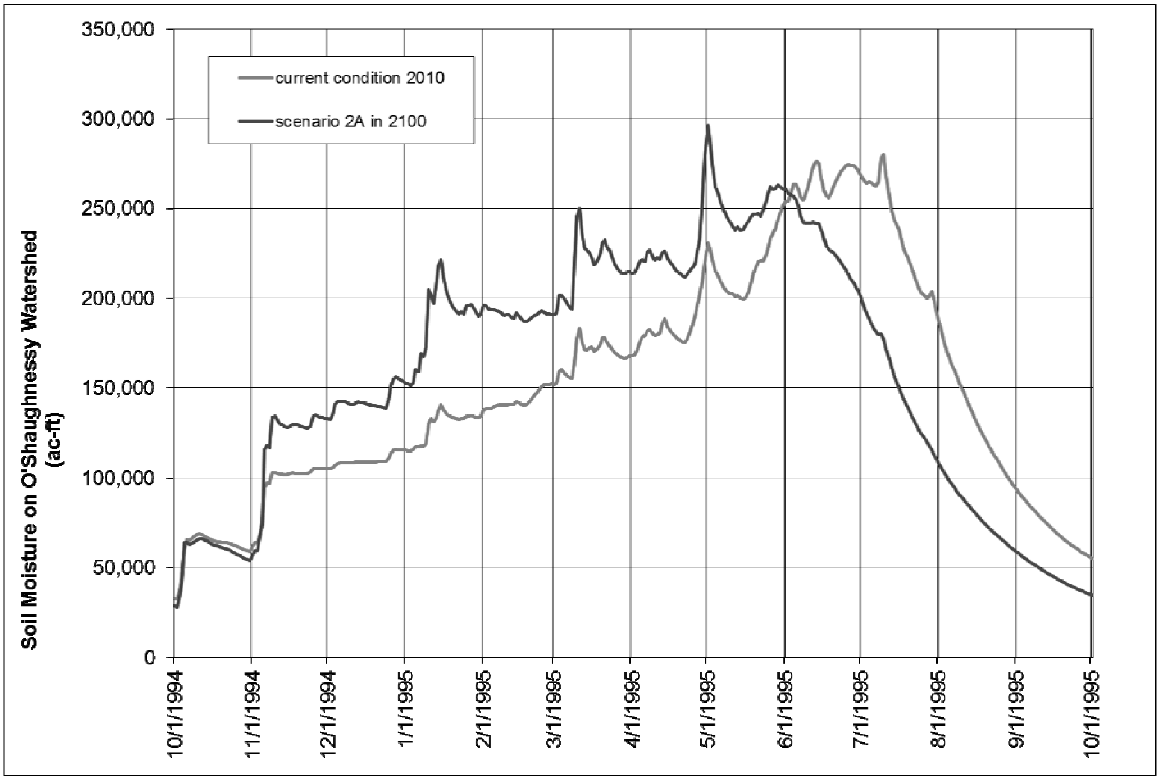


Figure 6-12. Simulated watershed soil moisture above O'Shaughnessy Dam for current climate condition (red) and scenario 2A in 2100 (blue), water year 1995

HY-52 cont.

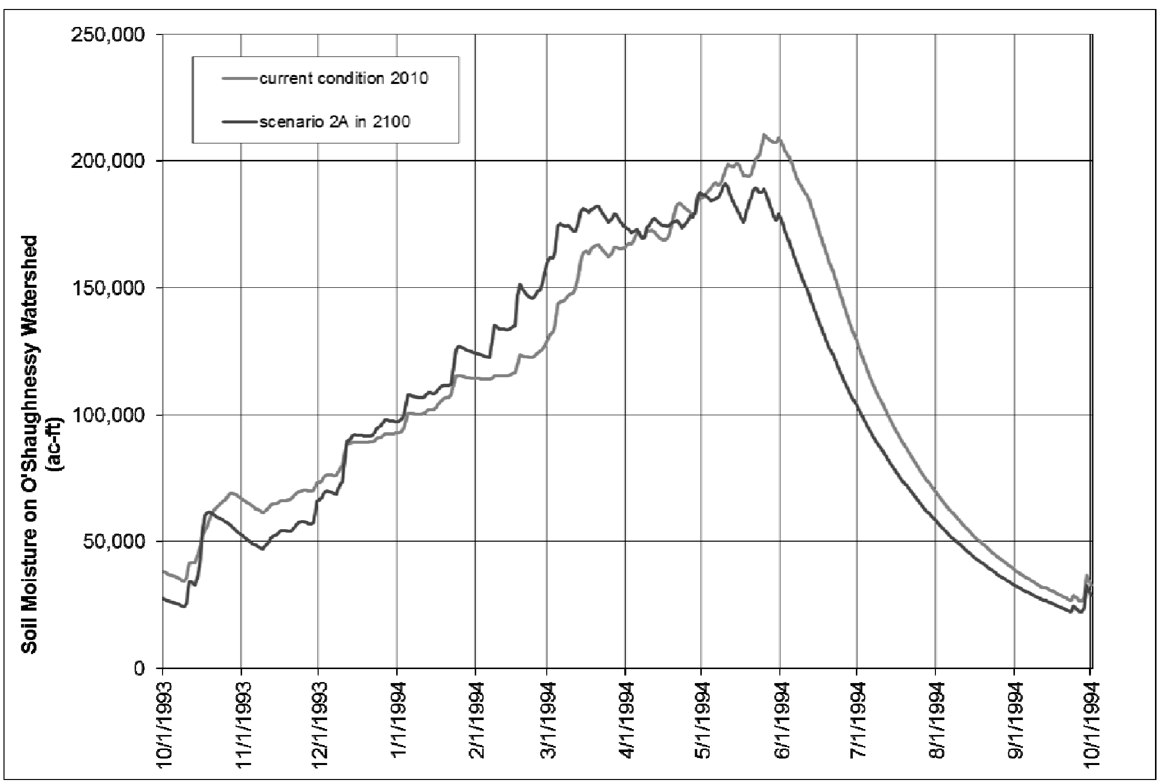


Figure 6-13. Simulated watershed soil moisture above O'Shaughnessy Dam for current climate condition (red) and scenario 2A in 2100 (blue), water year 1994

O-TRT-DREKMEIER Cont.

7. Conclusions

7.1 Tuolumne Climate Change Modeling Methods

Minimum daily temperature increases in the Sierra Nevada are known to be sensitive to climate change but the historical trends of increasing minimum daily temperatures and reduced daily temperature range found at Hetch Hetchy and Cherry Valley from 1960 to the present were unexpected. A method was developed to create the average temperature increases in the climate change scenarios consistent with historical trends in daily minimum temperatures while retaining a reasonable daily range in temperatures.

The modeling results of the climate change scenarios are internally consistent and are generally within the range of conditions found in the historical meteorological records. For example, model runs for the 2A climate change scenario in 2100 have a 46.5 degrees F average temperature at Hetch Hetchy, 6.2 degrees F higher than the average current January temperature (40.3 degrees F), but equal to the average current March temperature at Hetch Hetchy. The HFAM model uses detailed soils, vegetation, and topographic information and these data together with meteorological timeseries to create the model results.

Assumptions and limitations in this study include: HY-52 cont.

- Observed data are not sufficient to document the physical processes responsible for the increasing minimum daily temperatures at Hetch Hetchy and Cherry Valley; water vapor and cloud cover changes may have occurred. Changes in gage locations, instrumentation and shading at Hetch Hetchy as described in Appendix C-2 are likely to have had effects, but similar increasing daily minimum temperatures are present at Cherry Valley without known instrumentation changes, and minimum daily temperature increases begin in 1960 at Hetch Hetchy before instrumentation changes occurred. Increasing daily minimum temperatures have been observed elsewhere in the Sierra Nevada. (John Schaake, pers. Comm., Behnke, R. 2011, Bonfils et al. 2008)

- Existing vegetation distributions were assumed unchanged and calibrated land segment parameters for current conditions were used without adjustments to model the future climate conditions in 2040, 2070, and 2100. This assumption might be refined by further analysis.

- Historical meteorological temperature and precipitation were assumed to retain their current characteristics, e.g., temperatures retain observed seasonal patterns and storms are no more or less frequent in the future climate conditions. Historical solar radiation, potential evapotranspiration and wind speed were assumed unchanged in the future climate conditions.

- The climate change scenarios have broad ranges for projected future temperatures and precipitation.

O-TRT-DREKMEIER Cont.

- The effects of climate change on Tuolumne River flood frequency were not established by this analysis because the frequency and magnitude of large storms in the future climate change scenarios are uncertain.

As additional data are collected in the Tuolumne, and as more detailed GCM results become available, it will be possible to refine the future climate and watershed runoff projections.

7.2 Tuolumne Climate Change Modeling Results

Climate change in the Tuolumne River affects snow accumulation and melt, soil moisture and forests, and reservoir inflows, and potentially the water supplies available for all purposes. Table 7-1 summarizes the modeling results in terms of the change in simulated median annual runoff at O'Shaughnessy and Don Pedro dams for the climate change scenarios at the future climate dates.

HY-52 cont.

Table 7-1. Change in median runoff volume for future climate conditions

Climate Change Scenario		**O'Shaughnessy Runoff (% change from 2010)**			**Don Pedro Runoff (%change from 2010)**		
		2040	**2070**	**2100**	**2040**	**2070**	**2100**
1A	low temperature increase no precipitation change	-0.7%	-1.5%	-2.6%	-1.1%	-2.4%	-3.6%
2A	moderate temperature increase no precipitation change	-1.2%	-2.9%	-5.4%	-1.8%	-4.0%	-6.4%
2B	moderate temperature increase precipitation decrease	-7.6%	-15.8%	-24.7%	-9.5%	-19.1%	-28.7%
2C	moderate temperature increase precipitation increase	1.4%	2.2%	2.4%	1.1%	2.0%	2.8%
3A	high temperature increase no precipitation change	-2.1%	-5.6%	-10.2%	-3.0%	-6.5%	-10.1%
3B	high temperature increase precipitation decrease	-8.6%	-18.6%	-29.4%	-10.7%	-21.6%	-32.3%

Note: The same results are shown in Table 6-3.

Simulated changes in median annual runoff do not fully describe how water supplies would be affected. When firm yield from reservoirs is evaluated, low runoff years are critical. Climate change effects are exacerbated in low runoff years. Table 7-2 summarizes the modeling results in terms of the change in simulated 5 (dry), 50 (the median runoff shown in Table 7-1) and 95% percent exceedance annual runoff for two climate change scenarios (2A moderate temperature increases with no precipitation and 3B high temperature increases with precipitation decreases).

Table 7-2. Change in runoff volume for future climate conditions at 5%, 50%, and 95% exceedance level

Climate Change Scenario		Exceed Prob	O'Shaughnessy Runoff (% change from 2010)			Don Pedro Runoff (% change from 2010)		
			2040	2070	2100	2040	2070	2100
2A	moderate temperature increase no precipitation change	5%	-0.6%	-1.4%	-2.4%	-1.1%	-2.6%	-3.7%
2A	moderate temperature increase no precipitation change	50%	-1.2%	-2.9%	-5.4%	-1.8%	-4.0%	-6.4%
2A	moderate temperature increase no precipitation change	95%	-3.4%	-8.8%	-15.1%	-4.2%	-9.8%	-16.1%
3B	high temperature increase precipitation decrease	5%	-7.1%	-14.3%	-21.8%	-8.7%	-16.7%	-24.3%
3B	high temperature increase precipitation decrease	50%	-8.6%	-18.6%	-29.4%	-10.7%	-21.6%	-32.3%
3B	high temperature increase precipitation decrease	95%	-14.7%	-30.9%	-46.5%	-16.6%	-33.3%	-48.1%

Note: The same results are shown in Table 6-4.

HY-52 cont.

Runoff timing within the water year changes under the future climate conditions. Figure 7-1 shows the average monthly median runoff volume at O'Shaughnessy for the current climate and at the 2040, 2070 and 2100 future climate dates for two climate change scenarios, 2A moderate temperature increases with no precipitation and 2B moderate temperature increases with precipitation decreases. Under climate change scenario 2A in 2100 at O'Shaughnessy, the May through August runoff would decrease by 45% from the current condition (31% of current condition annual runoff), the September through April runoff would increase by 81% (26% of annual runoff), and 5% of the annual runoff would be lost to additional evapotranspiration. Reservoir operations would need to be revised to manage increased runoff in November through April, and decreased runoff in May for most climate change scenarios, and in June and July for all climate change scenarios.

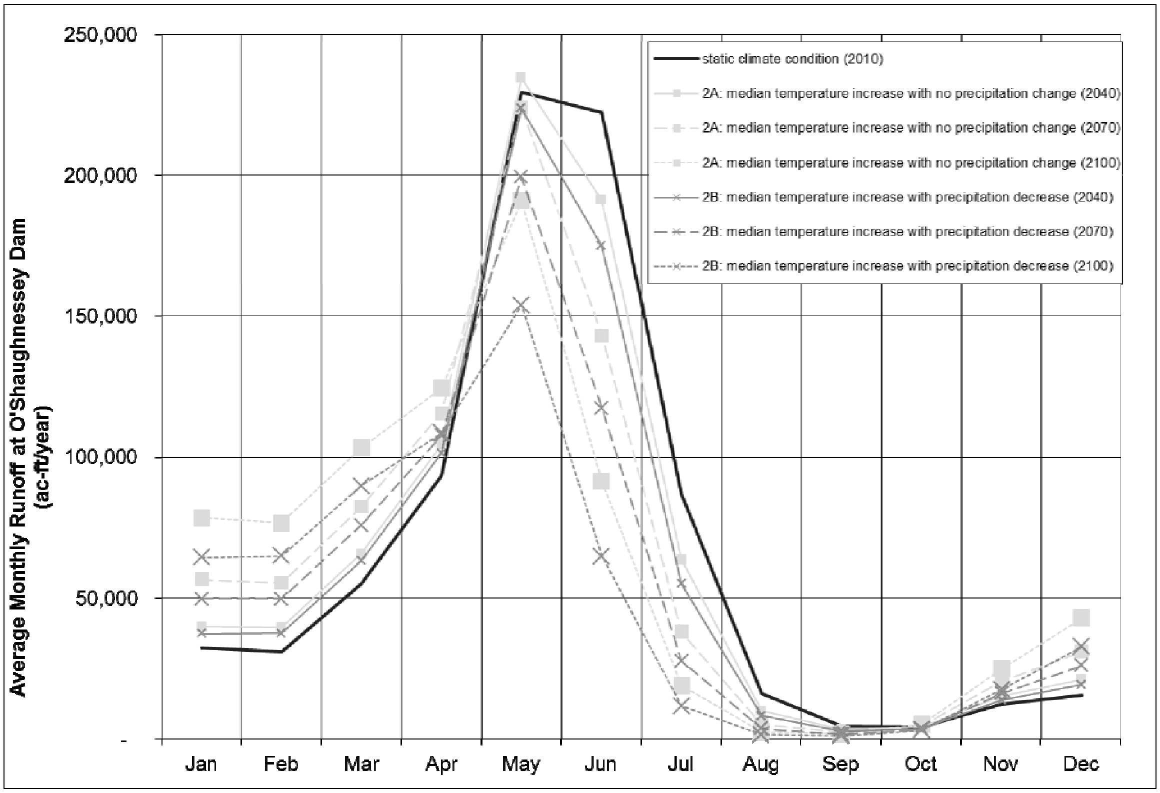


Figure 7-1. Average monthly runoff at O'Shaughnessy Dam for moderate temperature increase and precipitation change scenarios at future climate dates

HY-52
cont.

The simulated change in future hydrologic conditions based on the climate change scenarios results in a significantly altered snow and runoff regime in the watershed. Snow accumulation is reduced and snow melts earlier in the spring. Fall and early winter runoff increases and late spring and summer runoff decreases.

The reliability of projected changes in reservoir inflows for the climate change scenarios is good because the model is physically-based and has been calibrated over a 34-year period to accurately represent hydrologic conditions in the Tuolumne watershed during a range of temperature and precipitation conditions. The temperature and precipitation timeseries used for the climate change scenarios are within the range of temperatures experienced in the Tuolumne during the calibration period. For example, a climate change scenario may have higher temperatures than experienced in the same period historically but similar temperatures would have been observed at other times in the calibration period.

Reduced snow accumulation and a resulting shift of runoff from the spring to the winter runoff in the Tuolumne were expected due to the temperature increases of the climate change scenarios. In addition, the climate change scenario results showed that:

- Climate change effects are most exacerbated in low runoff years because of increased evapotranspiration results, particularly when expressed as a percent of runoff. This result is important for reservoir 'firm yield' analysis. This study created daily reservoir inflow data during the 34-year analysis period (water years 1974 to 2008) for all climate change scenarios which can be used for subsequent operations studies by TID and SFPUC.

- Soil moisture reductions in summer would be very significant by 2070 and 2100. The predicted reduction in summer soil moistures would be expected to change vegetation distribution within the watershed. The potential changes in vegetation might cause a secondary change in the hydrologic response of some land segments but this effect was not modeled in this study.

- The future climate condition in year 2040 of climate change scenario 3B (moderate temperature increases with precipitation decrease) results in reductions in median runoff of -8.6% at O'Shaughnessy Dam and -10.7% at Don Pedro Dam, so relatively large reductions in runoff may take place in 30 years if both temperature rise and precipitation decrease occur.

- The future climate condition in year 2040 of climate change scenario 2A (moderate temperature increase and no precipitation change) results in insignificant runoff reductions of 0.6% at O'Shaughnessy Dam and 1.1% at Don Pedro Dam. The 2A results in terms of runoff and timing changes are small compared to the year-to-year variation that is currently experienced.

HY-52
cont.

8. References

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HY-52 cont.

O-TRT-DREKMEIER Cont.

APPENDIX A

HY-52 cont.

Future Climate Condition Simulation Results

Attachment A

O-TRT-DREKMEIER Cont.

APPENDIX A

Future Climate Condition Simulation Results

A.1 Changes in Simulated Runoff Timing and Volume

A.1.1 Simulated Annual Runoff Comparisons

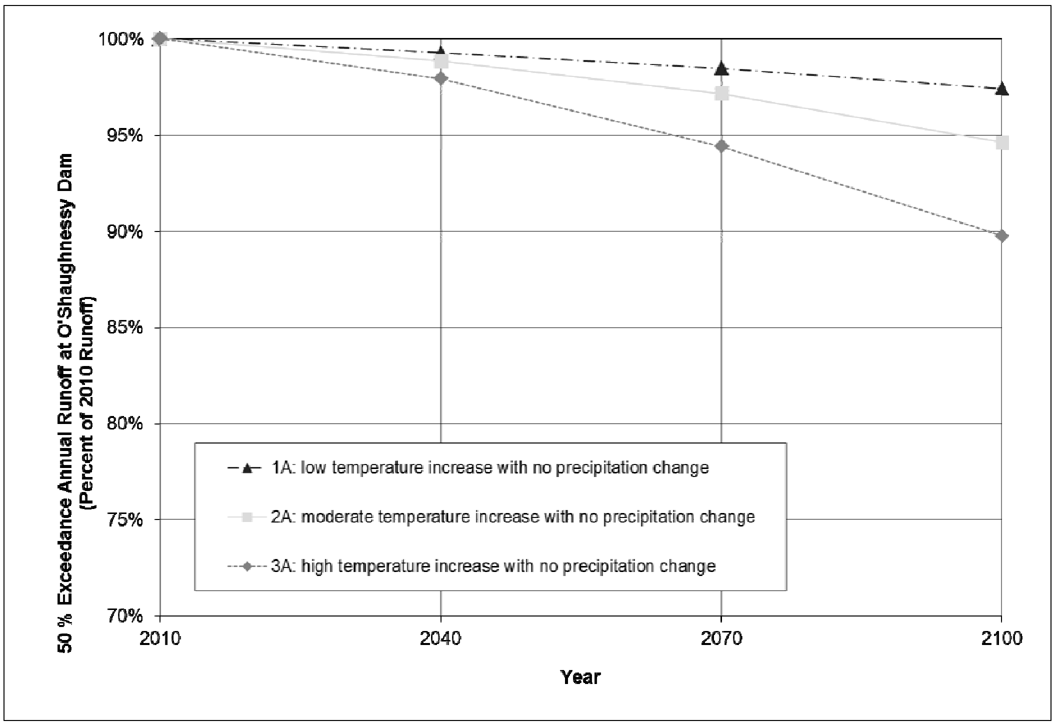


Figure A-1. Annual runoff at O'Shaughnessy Dam for temperature change scenarios

HY-52 cont.

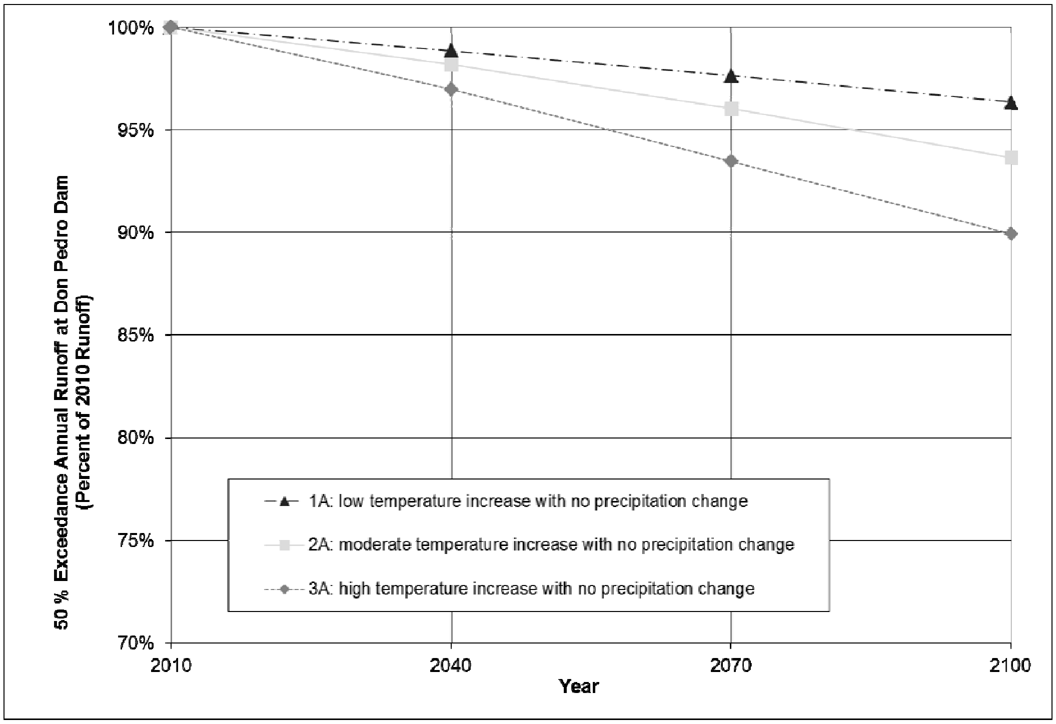


Figure A-2. Annual runoff at Don Pedro Dam for temperature change scenarios

HY-52 cont.

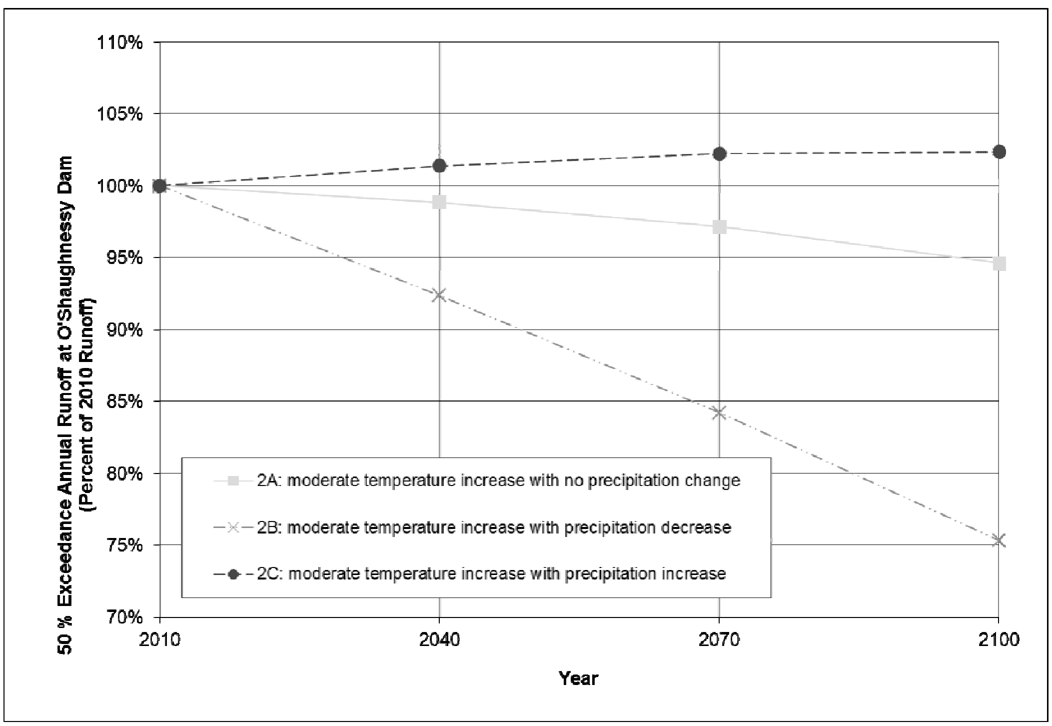


Figure A-3. Annual runoff at O'Shaughnessy Dam for moderate temperature increase and precipitation change scenarios

O-TRT-DREKMEIER Cont.

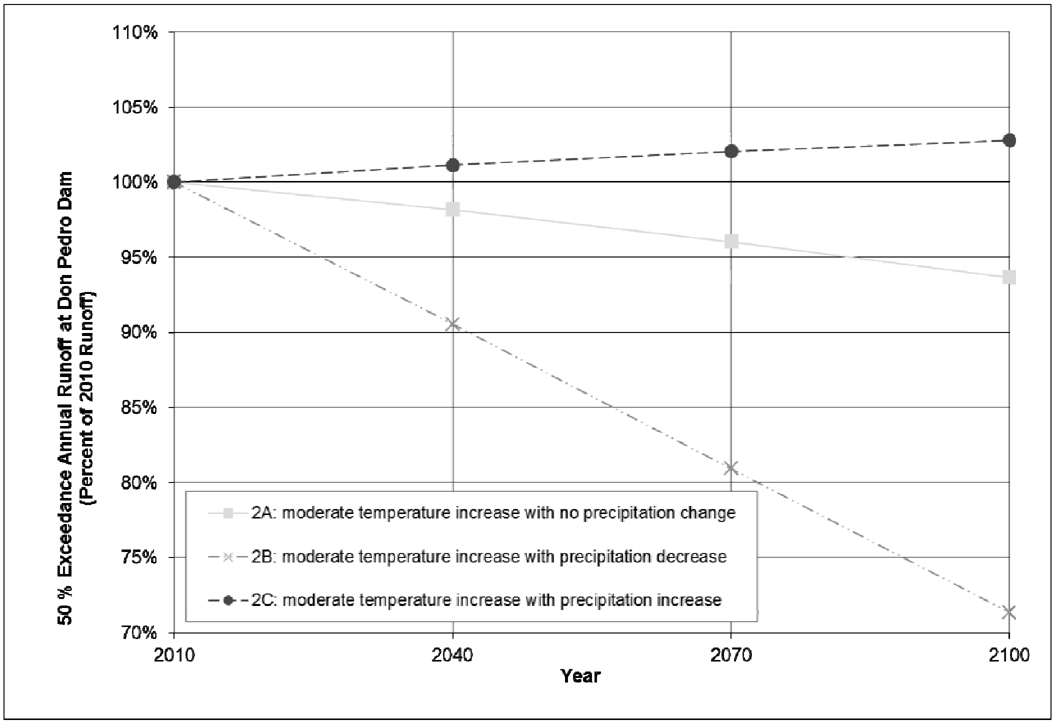


Figure A-4. Annual runoff at Don Pedro Dam for moderate temperature increase and precipitation change scenarios

HY-52 cont.

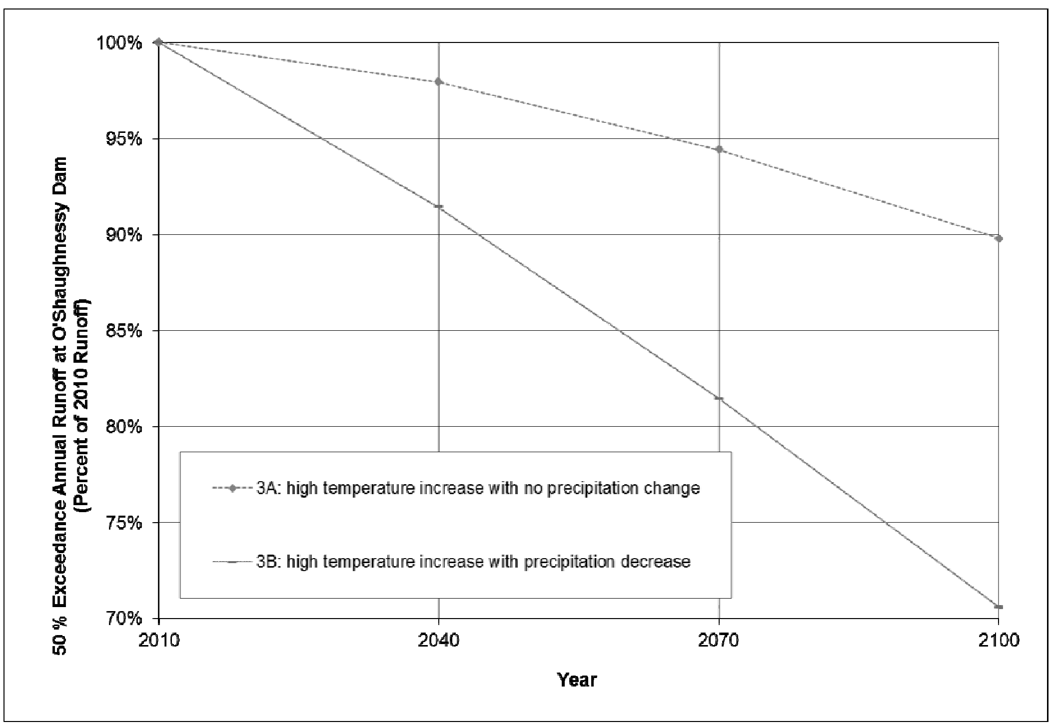


Figure A-5. Annual runoff at O'Shaughnessy Dam for high temperature increase and precipitation change scenarios

O-TRT-DREKMEIER Cont.

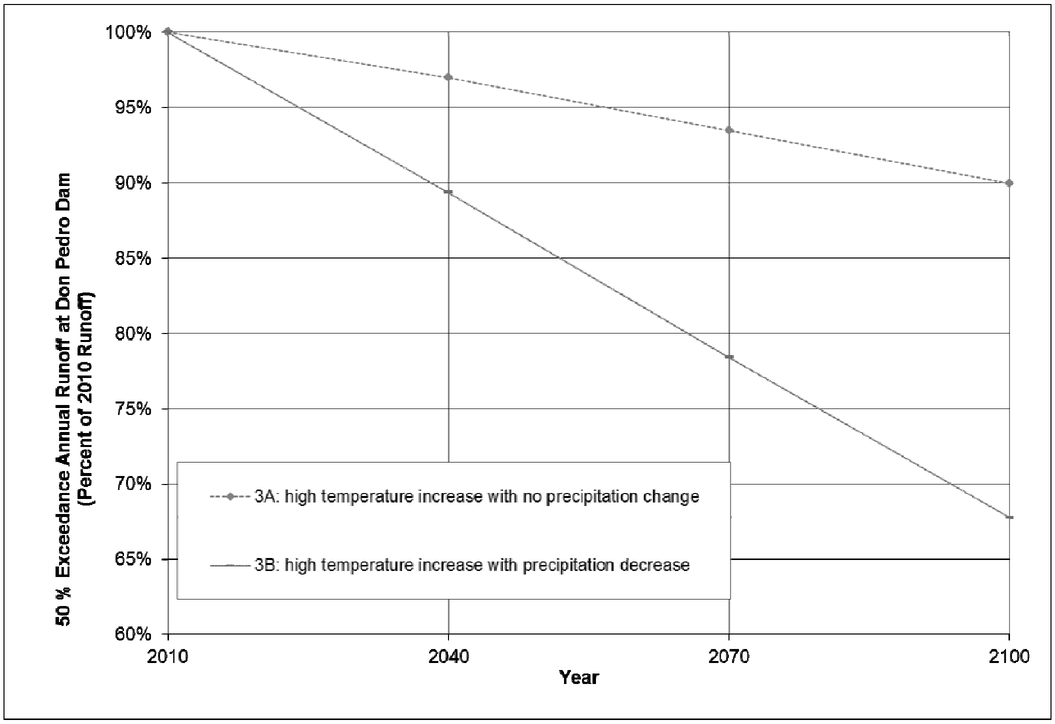


Figure A-6. Annual runoff at Don Pedro Dam for high temperature increase and precipitation change scenarios

HY-52 cont.

A.1.2 Simulated Annual Runoff in Low and High Runoff Years

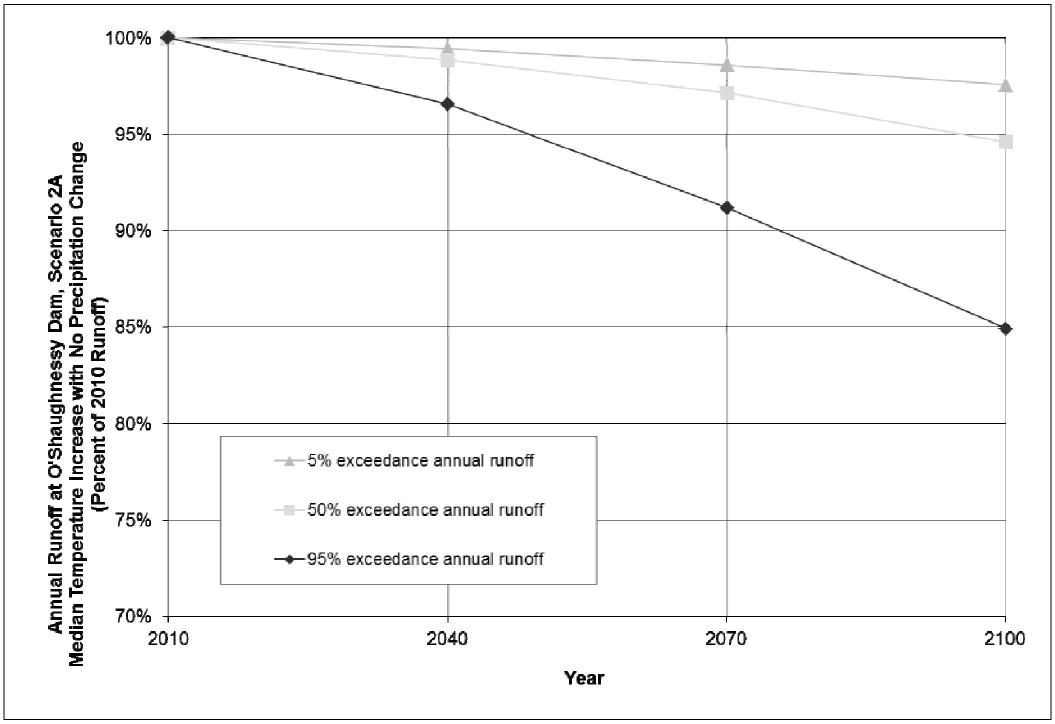


Figure A-7. Annual runoff at O'Shaughnessy Dam for scenario 2A (moderate temperature increase with no precipitation change) for 5%, 50% and 95% exceedance

HY-52 cont.

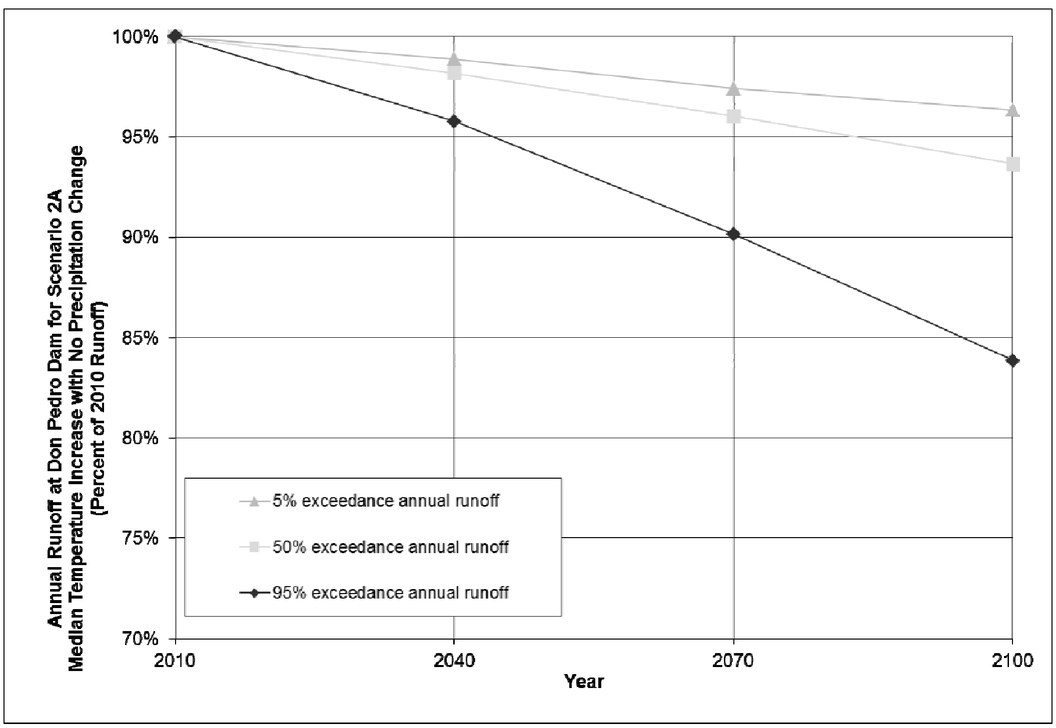


Figure A-8. Annual runoff at Don Pedro Dam for scenario 2A (moderate temperature increase with no precipitation change) for 5%, 50% and 95% exceedance

O-TRT-DREKMEIER Cont.

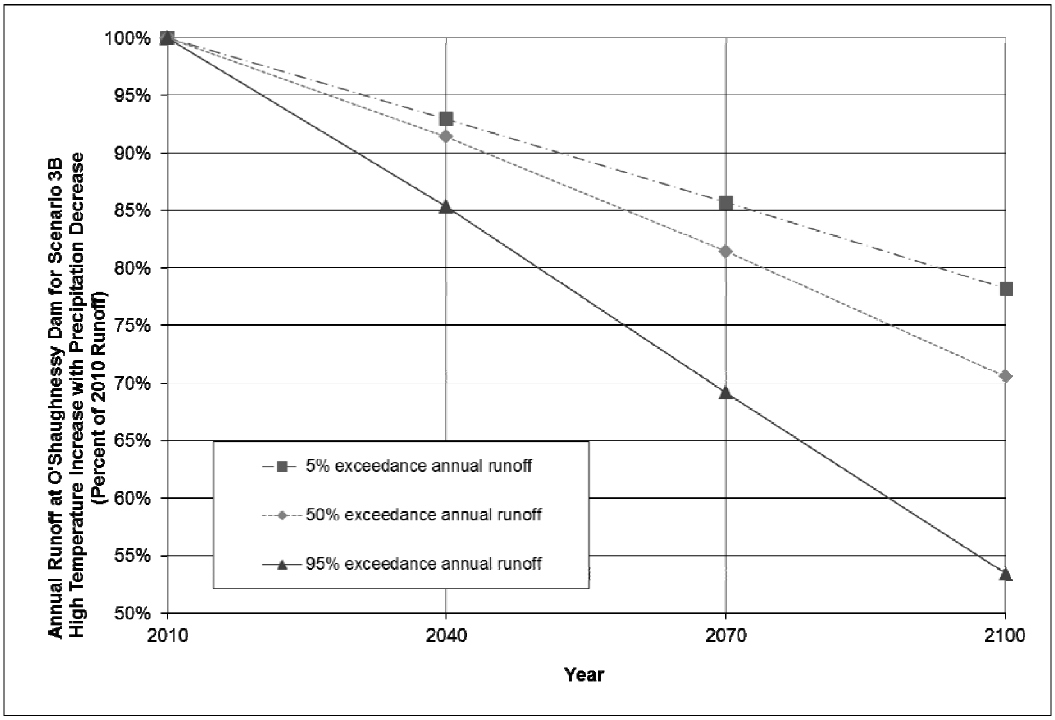


Figure A-9. Annual runoff at O'Shaughnessy Dam for scenario 3B (high temperature increase with precipitation decrease) for 5%, 50% and 95% exceedance

HY-52 cont.

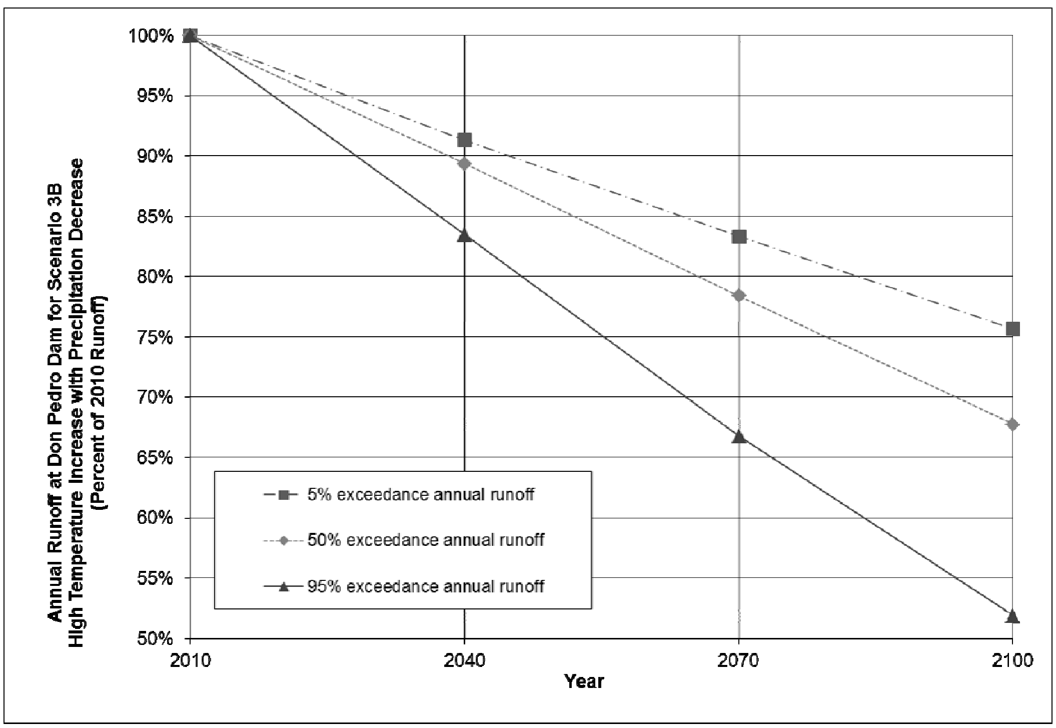


Figure A-10. Annual runoff at Don Pedro Dam for scenario 3B (high temperature increase with precipitation decrease) for 5%, 50% and 95% exceedance

O-TRT-DREKMEIER Cont.

A.1.3 Monthly Runoff Timing Comparisons

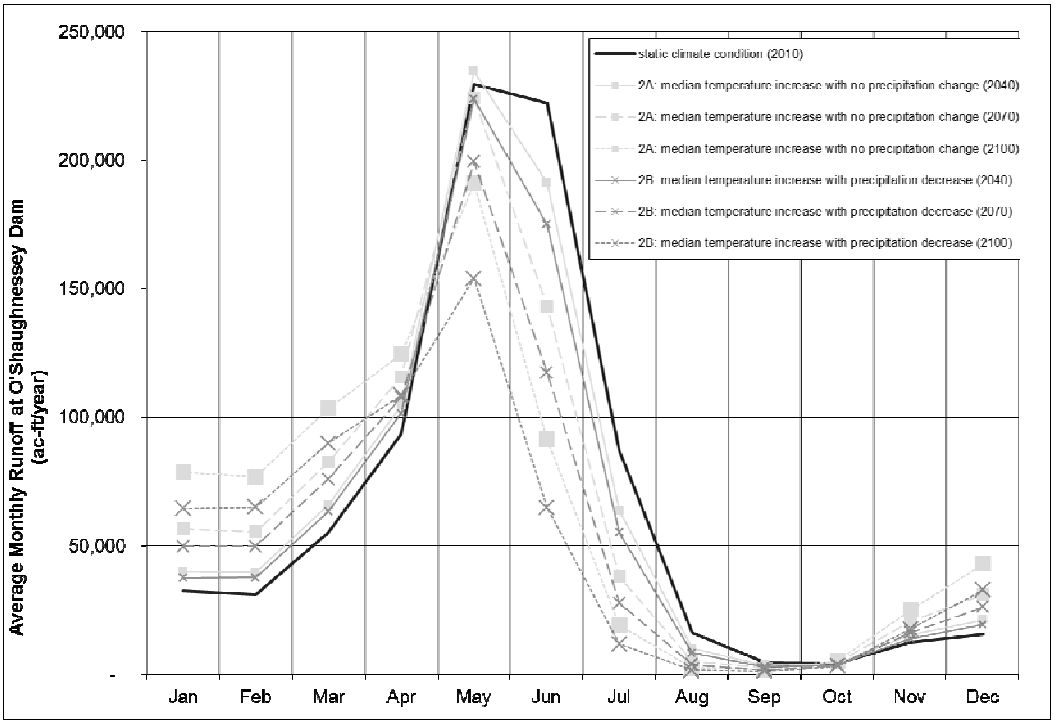


Figure A-11. Average monthly runoff at O'Shaughnessy Dam for moderate temperature increase and precipitation change scenarios at future climate dates

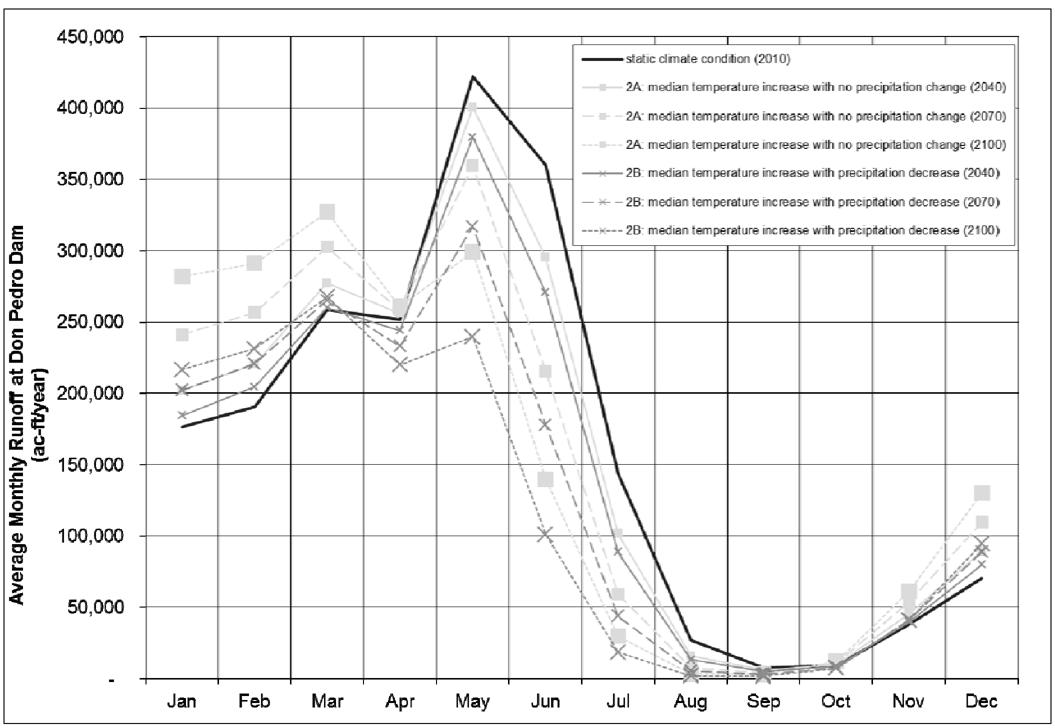


Figure A-12. Average monthly runoff at Don Pedro Dam for moderate temperature increase and precipitation change scenarios at future climate dates

HY-52 cont.

O-TRT-
DREKMEIER
Cont.

A.1.4 Drought Period Comparison

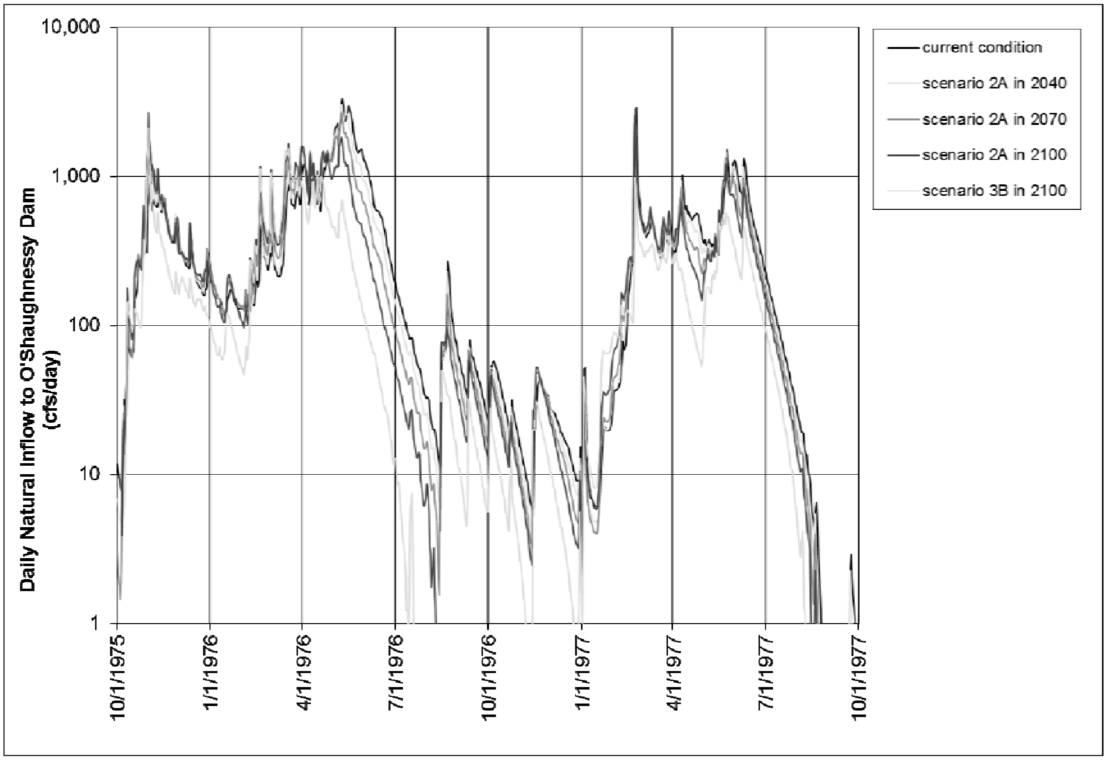


Figure A-13. Daily natural inflow to O'Shaughnessy Dam, water years 1976 and 1977 on log scale

HY-52
cont.

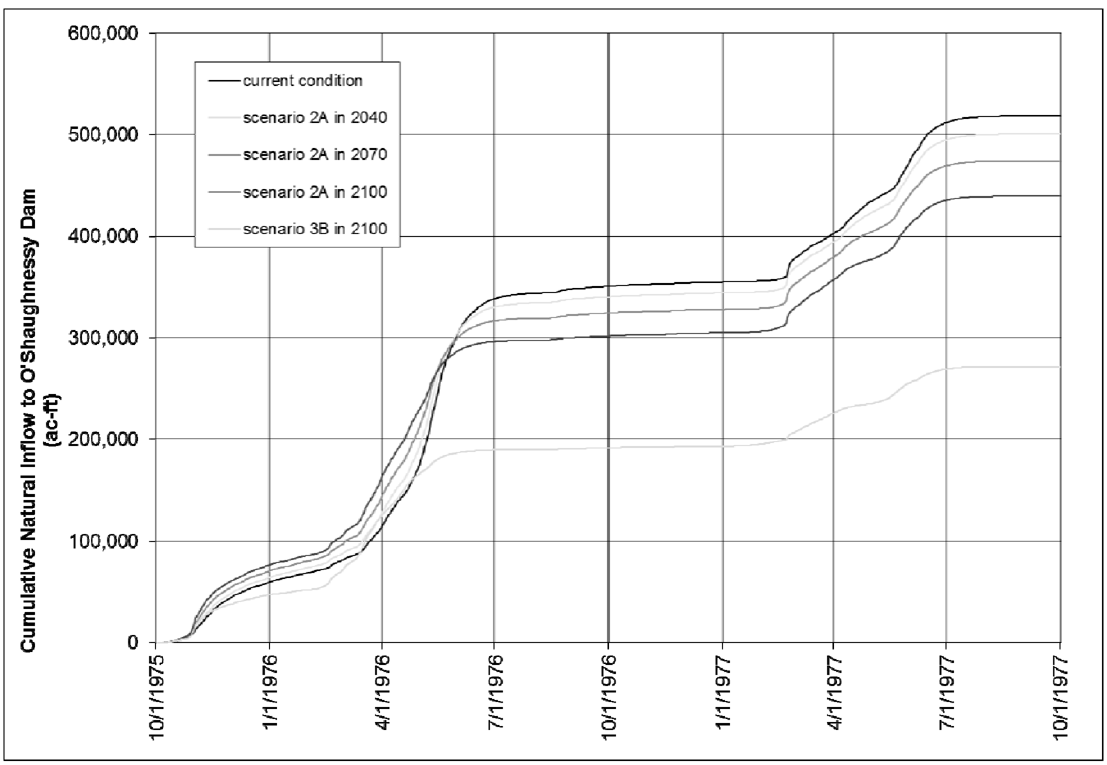


Figure A-14. Cumulative natural inflow to O'Shaughnessy Dam, water years 1976 and 1977

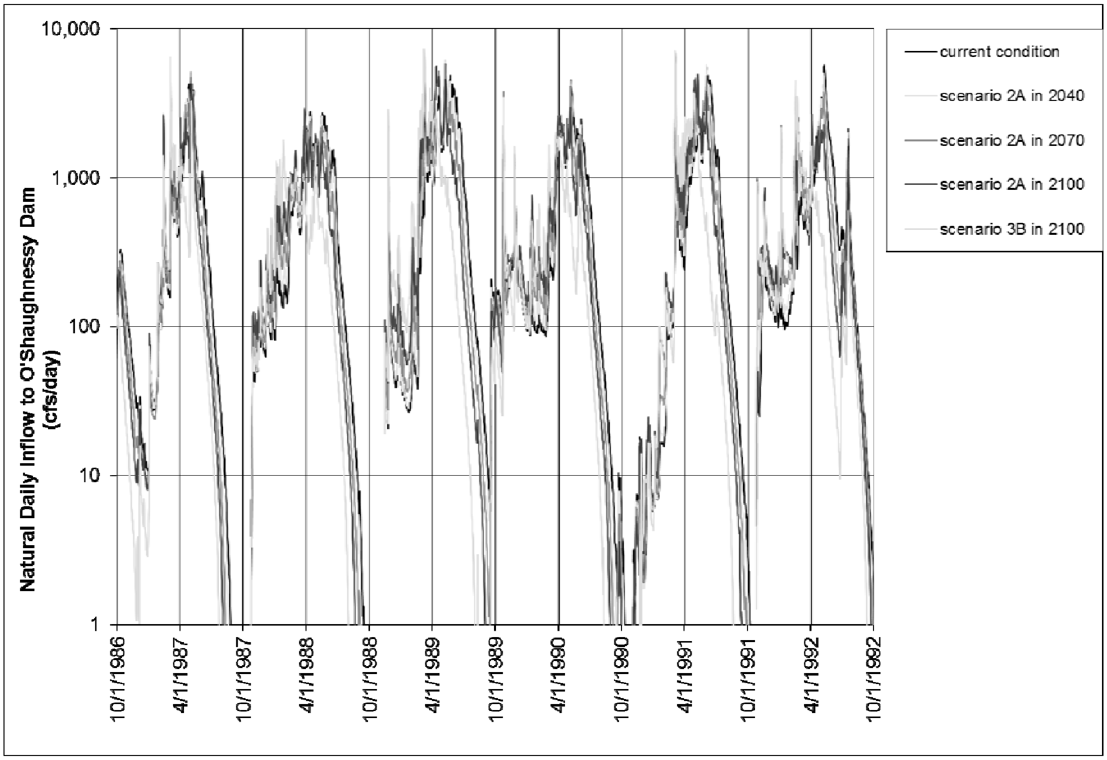


Figure A-15. Daily natural inflow to O'Shaughnessy Dam, water years 1987 to 1992 on log scale

HY-52 cont.

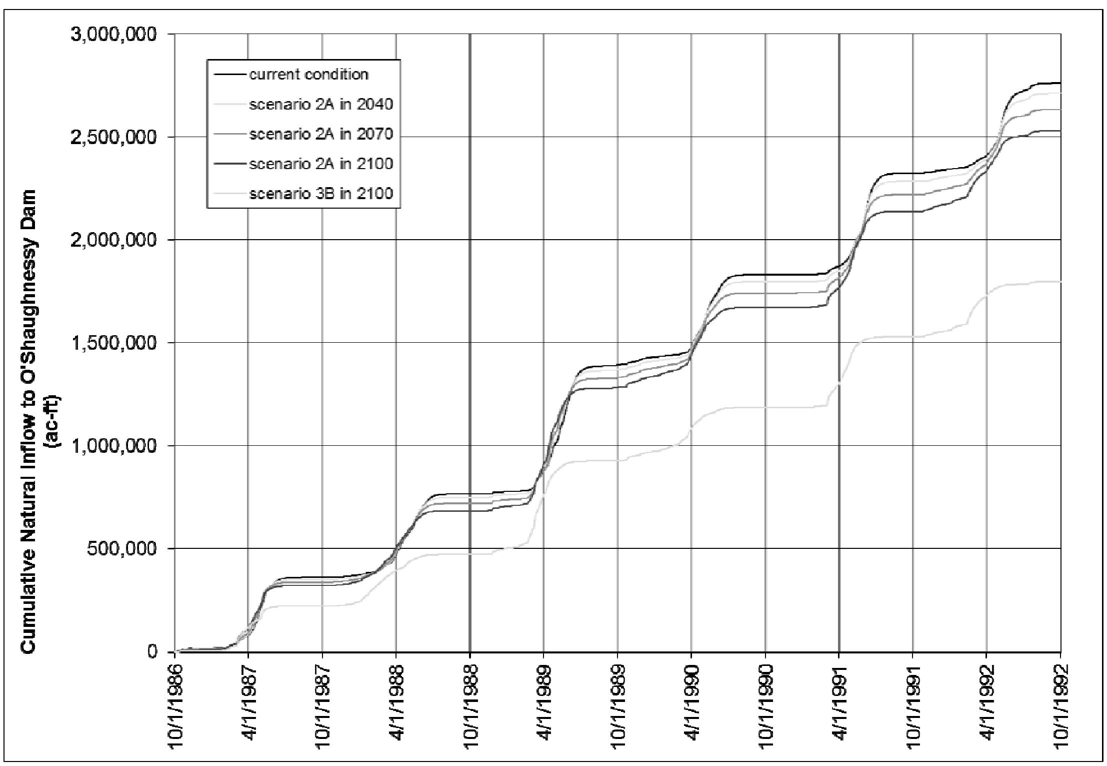


Figure A-16. Cumulative natural inflow to O'Shaughnessy Dam, water years 1987 to 1992

A.2 Changes in Simulated Actual Evapotranspiration

A.2.1 Simulated Annual Actual Evapotranspiration Comparisons

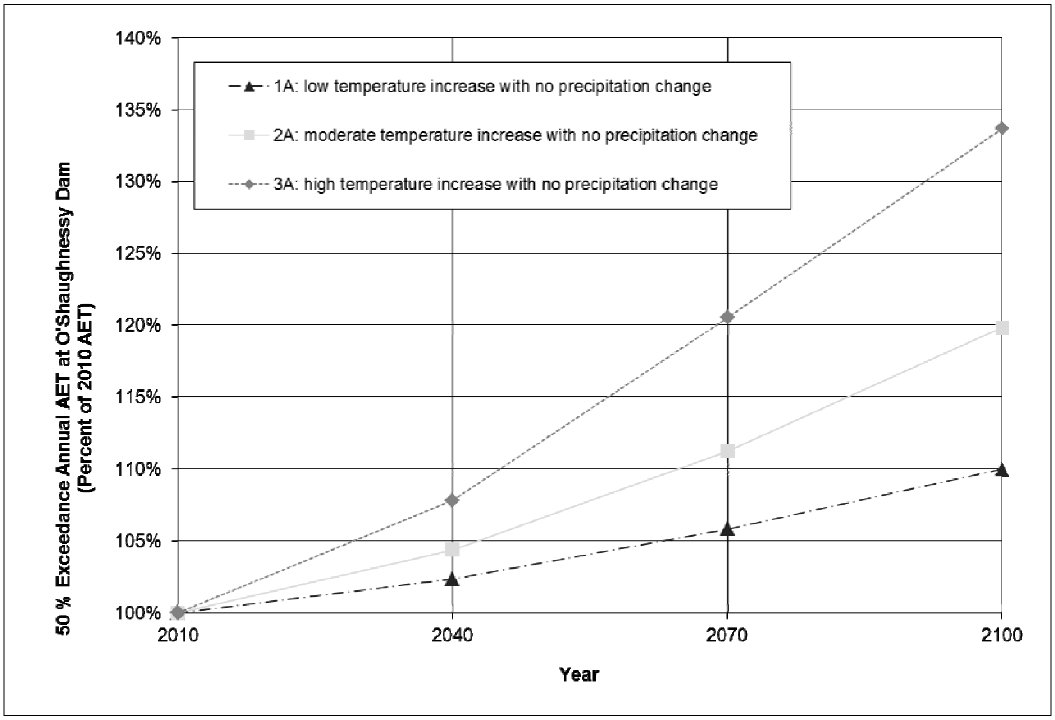


Figure A-17. Annual AET at O'Shaughnessy Dam for temperature change scenarios

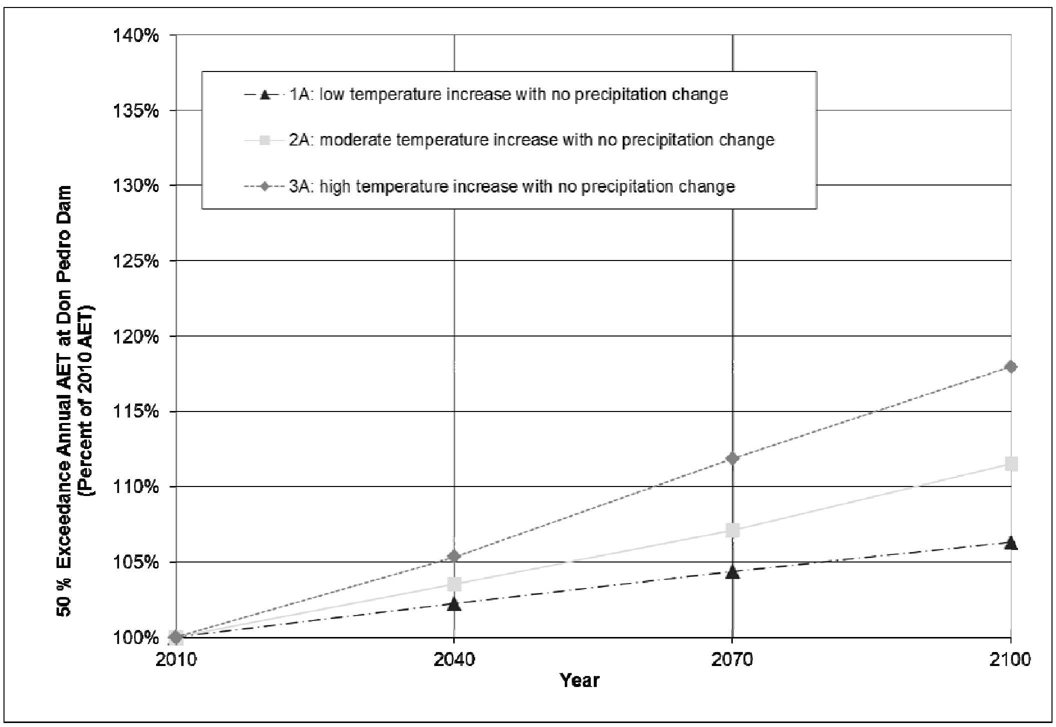


Figure A-18. Annual AET at Don Pedro Dam for temperature change scenarios

HY-52 cont.

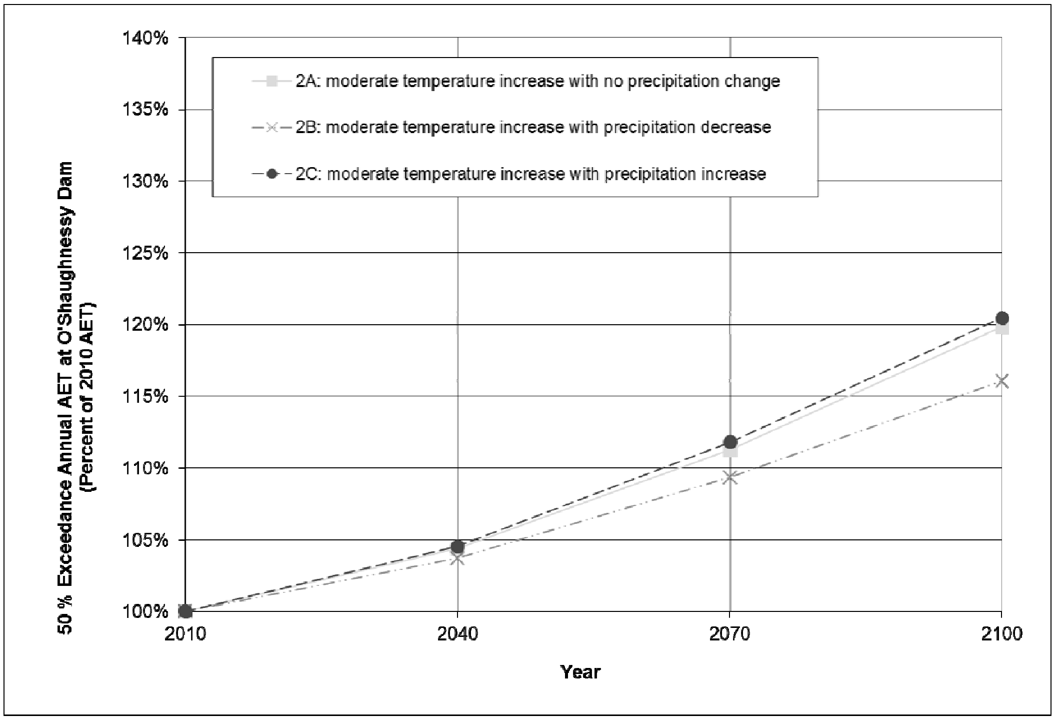


Figure A-19. Annual AET at O'Shaughnessy Dam for moderate temperature increase and precipitation change scenarios

HY-52 cont.

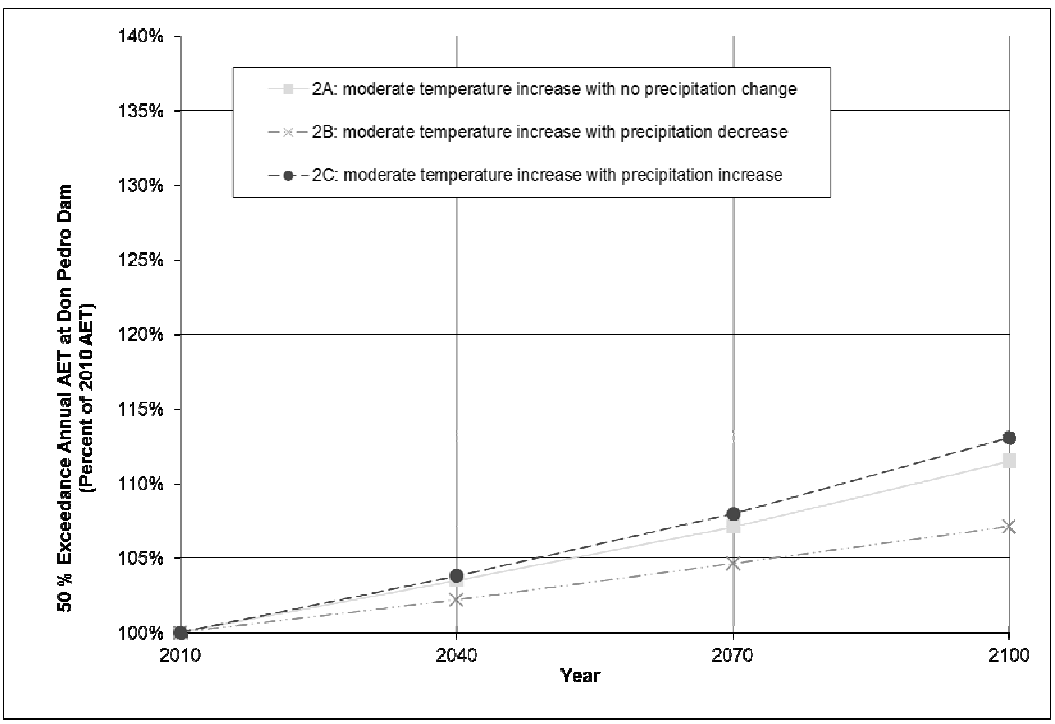


Figure A-20. Annual AET at Don Pedro Dam for moderate temperature increase and precipitation change scenarios

O-TRT-DREKMEIER Cont.

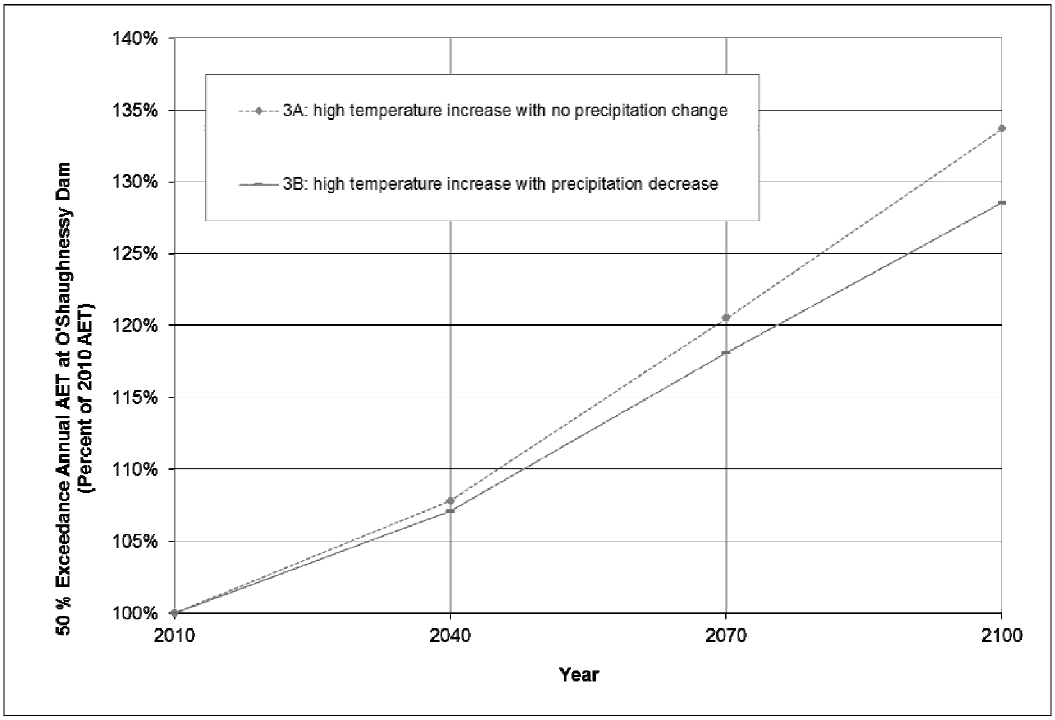
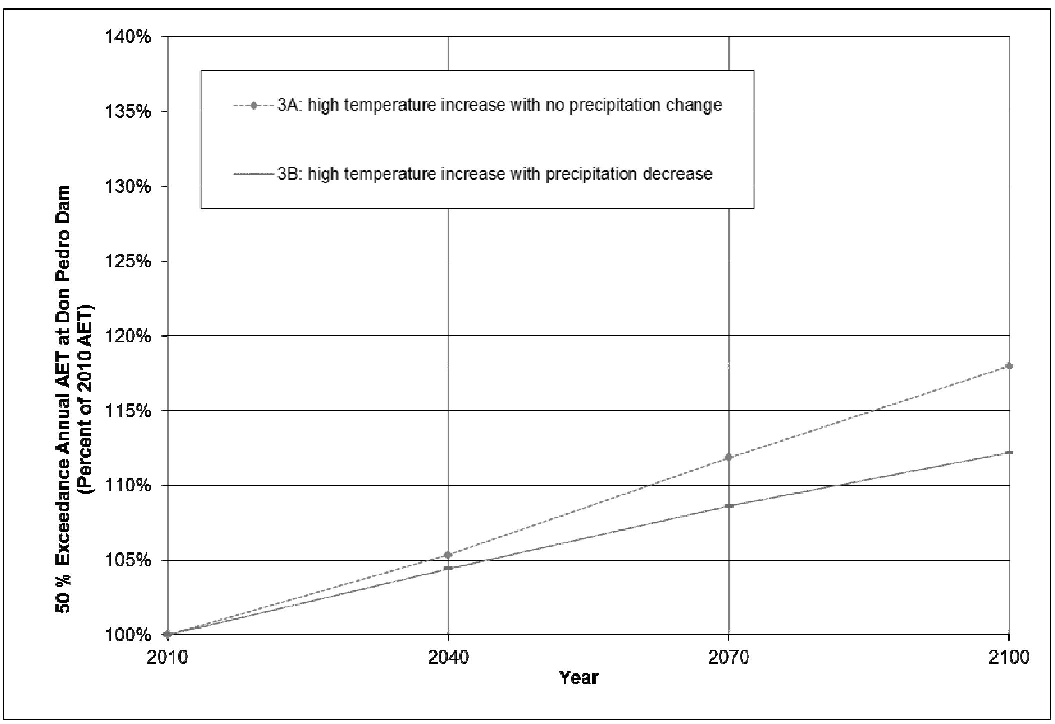


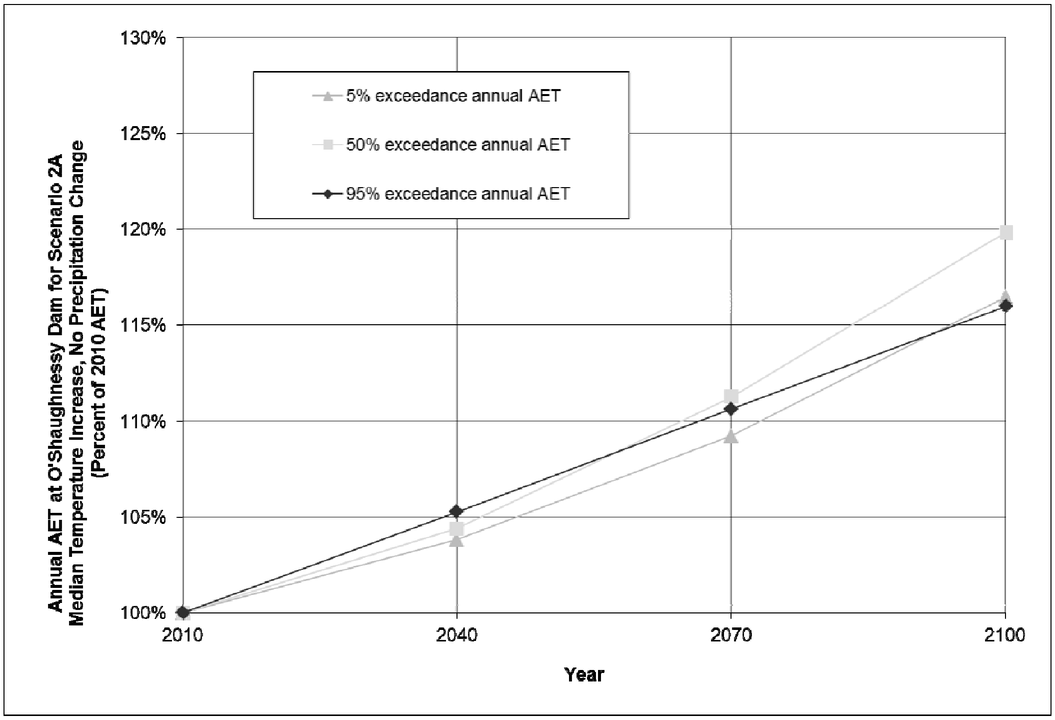
Figure A-21. Annual AET at O'Shaughnessy Dam for high temperature increase and precipitation change scenarios

HY-52 cont.



FigureA-22. Annual AET at Don Pedro Dam for high temperature increase and precipitation change scenarios

A.2.2 Simulated Annual Actual Evapotranspiration in Low and High Runoff Years



HY-52 cont.

Figure A-23. Annual AET at O'Shaughnessy Dam for scenario 2A (moderate temperature increase with no precipitation change) for 5%, 50% and 95% exceedance

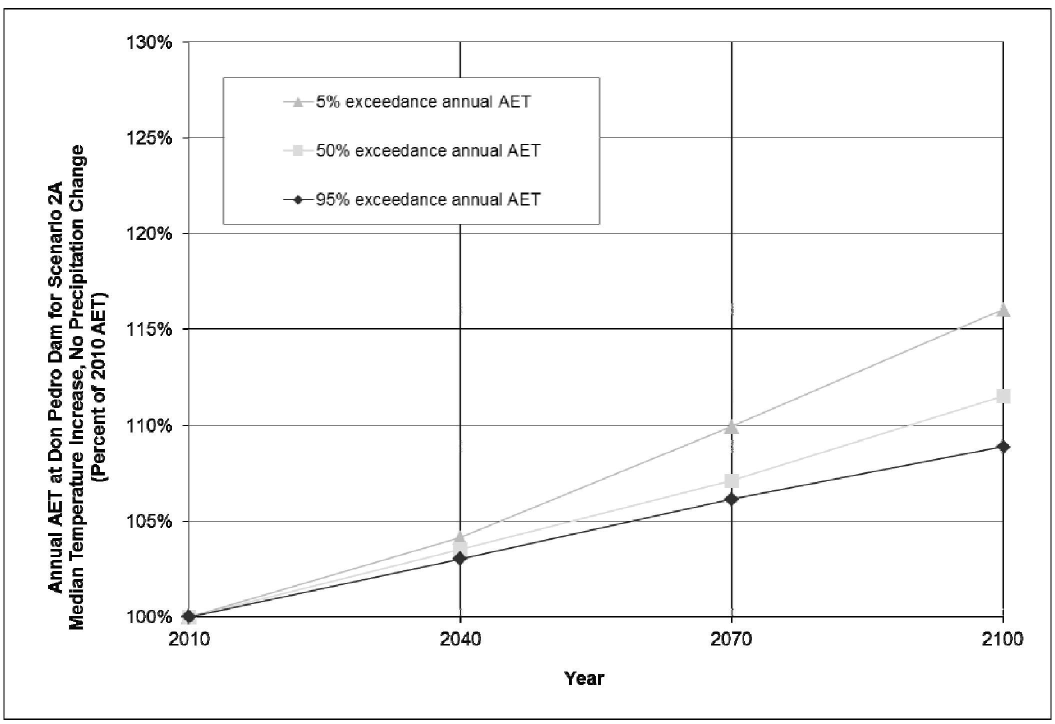


Figure A-24. Annual AET at Don Pedro Dam for scenario 2A (moderate temperature increase with no precipitation change) for 5%, 50% and 95% exceedance

O-TRT-DREKMEIER Cont.

A.3 Changes in Simulated Snow Water Equivalent

A.3.1 Simulated Annual Maximum Snow Water Equivalent Comparisons

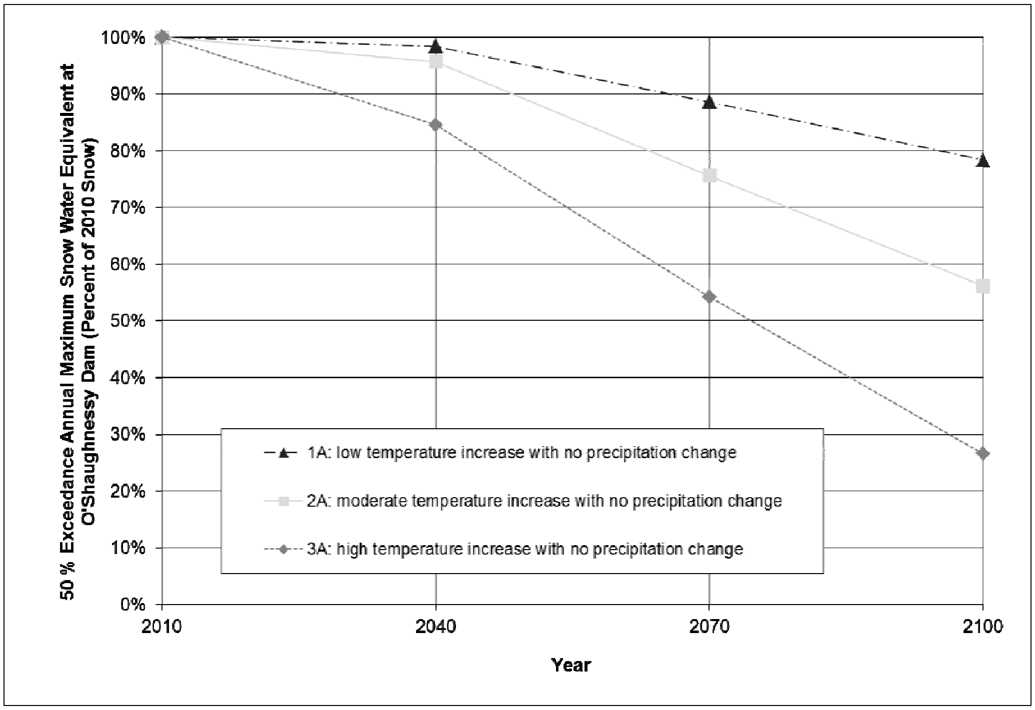


Figure A-25. Annual maximum snow water equivalent at O'Shaughnessy Dam for temperature change scenarios

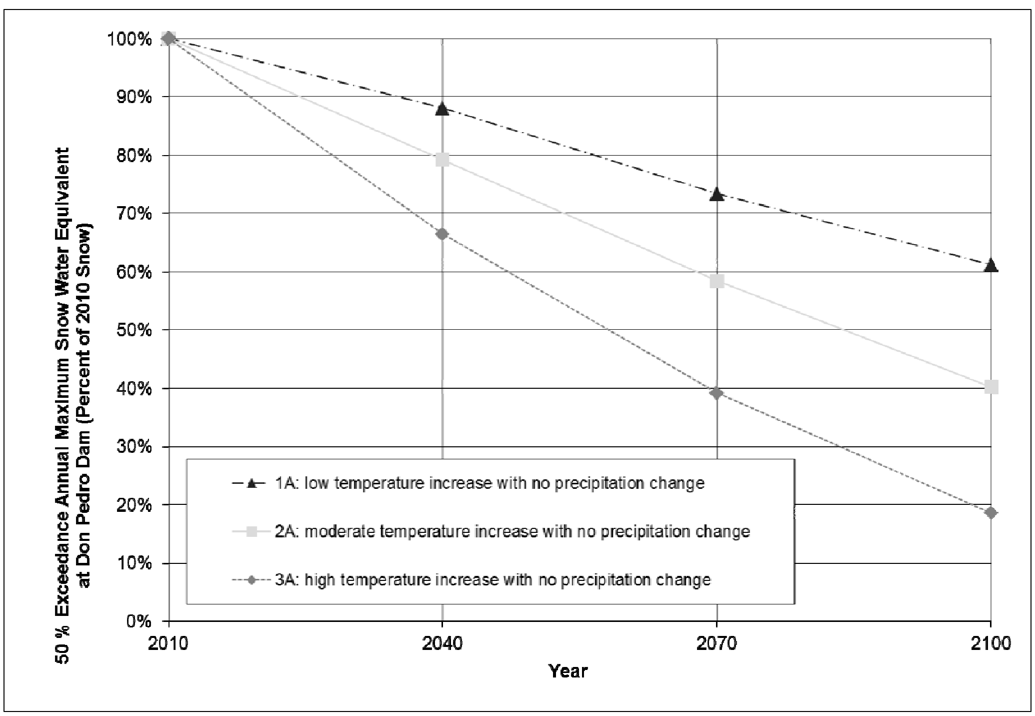


Figure A-26. Annual maximum snow water equivalent at Don Pedro Dam for temperature change scenarios

HY-52 cont.

O-TRT-DREKMEIER Cont.

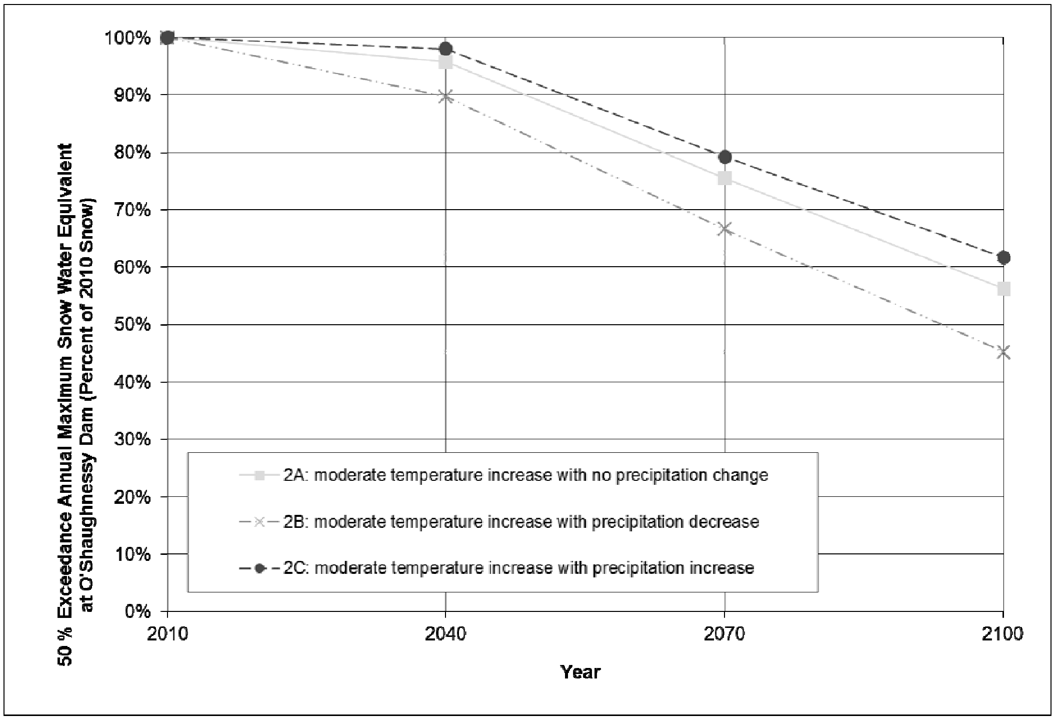


Figure A-27. Annual maximum snow water equivalent at O'Shaughnessy Dam for moderate temperature increase and precipitation change scenarios

HY-52 cont.

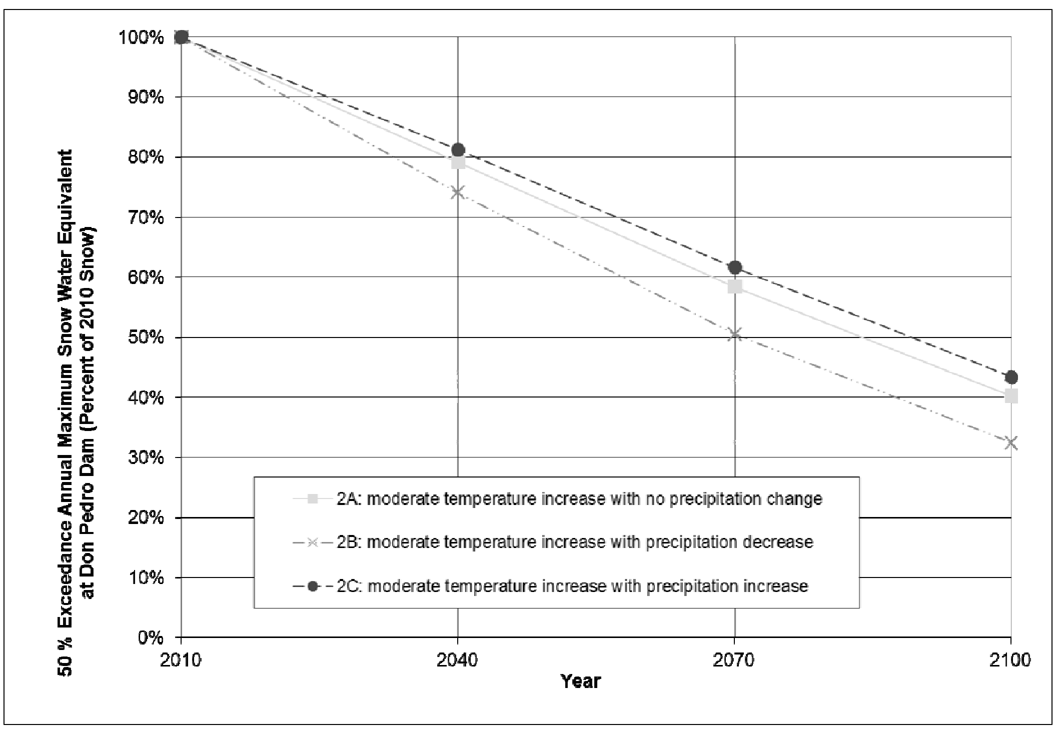


Figure A-28. Annual maximum snow water equivalent at Don Pedro Dam for moderate temperature increase and precipitation change scenarios

O-TRT-DREKMEIER Cont.

A.2.2 Simulated Annual Maximum Snow Water Equivalent in Low and High Runoff Years

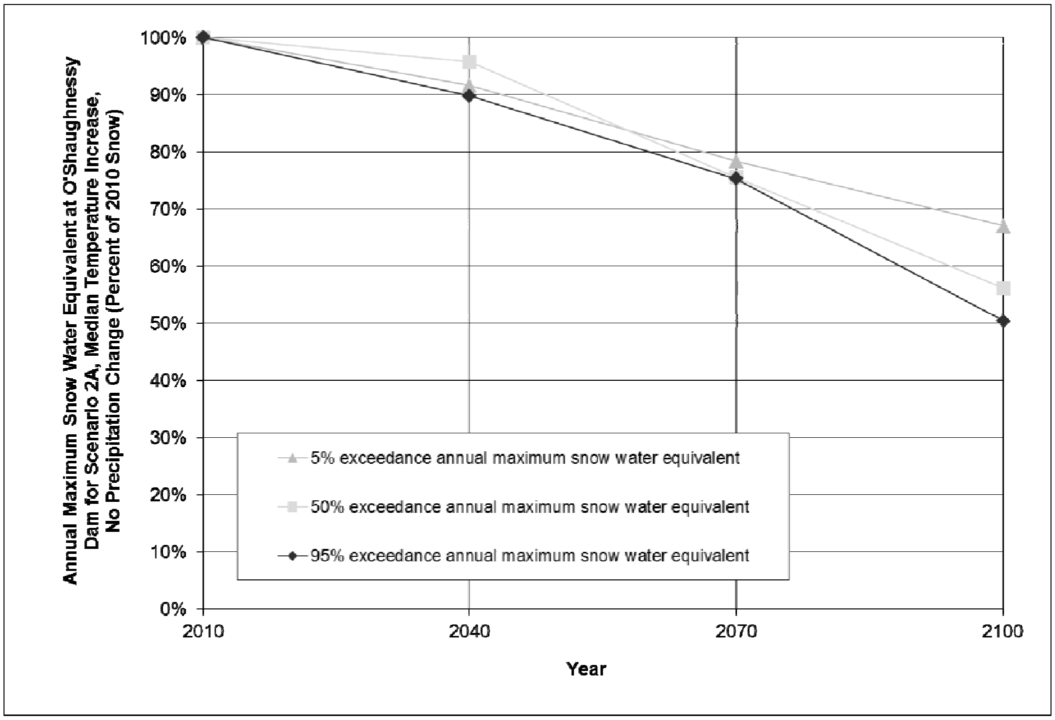


Figure A-29. Annual maximum snow water equivalent at O'Shaughnessy Dam for scenario 2A (moderate temperature increase with no precipitation change) for 5%, 50% and 95% exceedance

HY-52 cont.

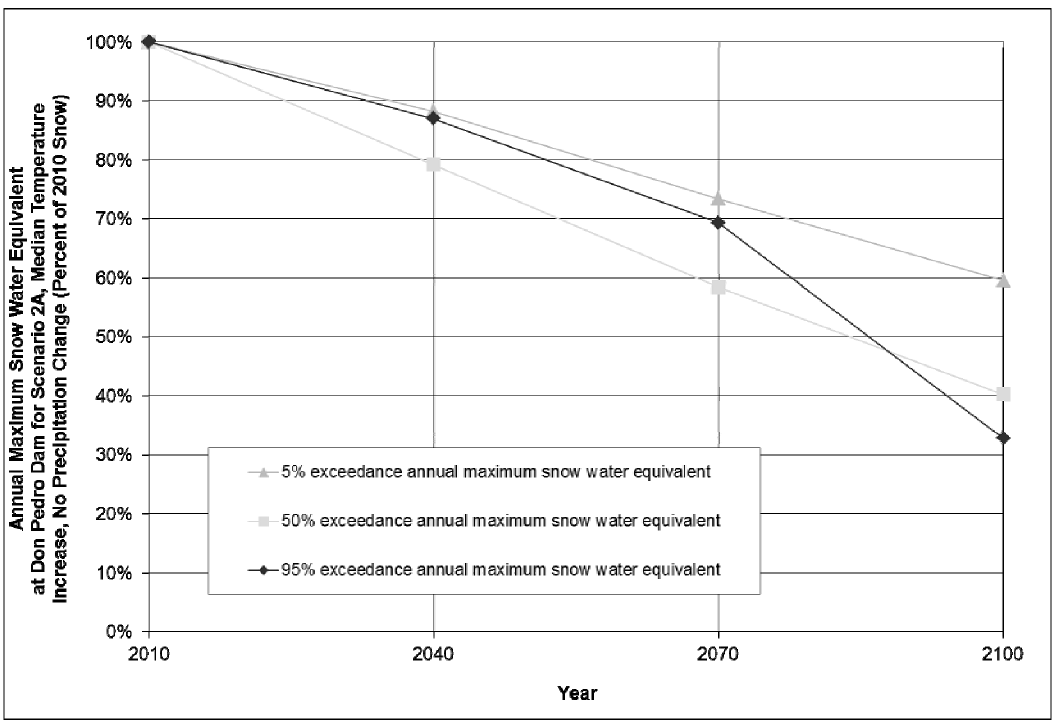


Figure A-30. Annual maximum snow water equivalent at Don Pedro Dam for scenario 2A (moderate temperature increase with no precipitation change) for 5%, 50% and 95% exceedance

APPENDIX B

HY-52 cont.

Calibration Results

APPENDIX B

Calibration Results

This appendix provides daily hydrographs of HFAM simulated and estimated actual natural inflow to Hetch Hetchy and Don Pedro reservoirs for each year in the calibration period, water years 1975 to 2008.

Hetch Hetchy flows are plotted with a maximum Y-axis of 20,000 cfs. Flows higher than 20,000 cfs only occurred during the January 1997 storm; HFAM simulated daily average peak flow during this storm is 44,788 cfs and estimated actual peak flow is 37,685 cfs.

La Grange flows are plotted with a minimum Y-axis of 0 cfs and a maximum Y-axis of 40,000 cfs. Flows higher than 40,000 cfs occurred during the January 1997 storm; HFAM simulated average daily peak flow during this storm is 107,212 and estimated actual peak flow is 117,706 cfs. The estimated natural inflows to Don Pedro reservoir include negative values due to the method of calculation and are needed for correct inflow volumes however negative inflows would not actually occur. HY-52 cont.

O-TRT-DREKMEIER Cont.

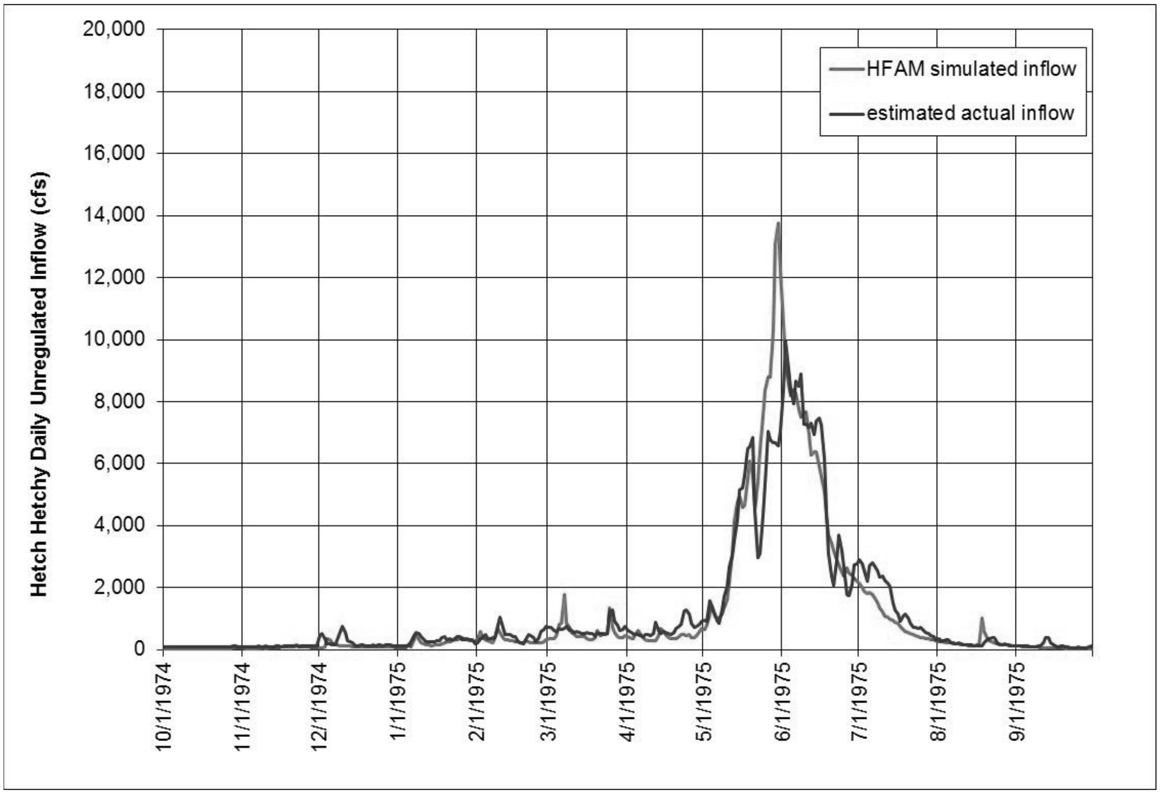


Figure B.1a Hetch Hetchy Daily Unregulated Inflow, water year 1975

HY-52 cont.

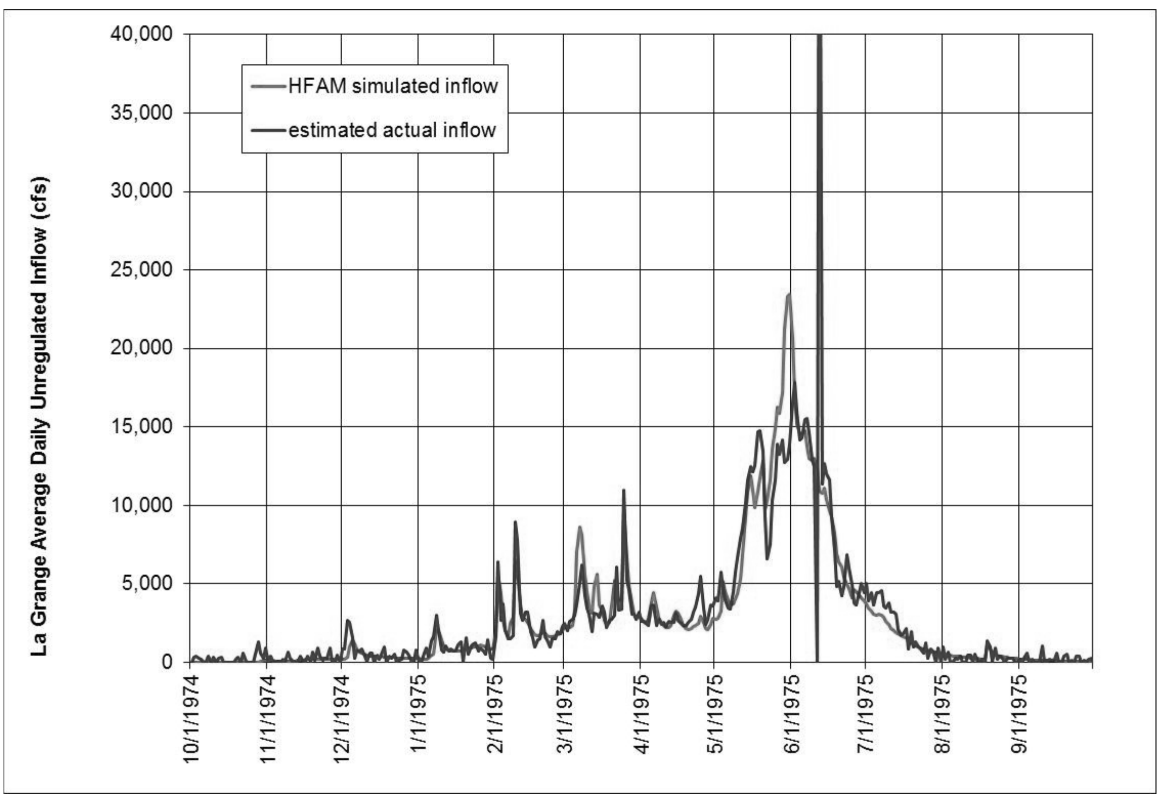


Figure B.1b La Grange Daily Unregulated Inflow, water year 1975

O-TRT-
DREKMEIER
Cont.

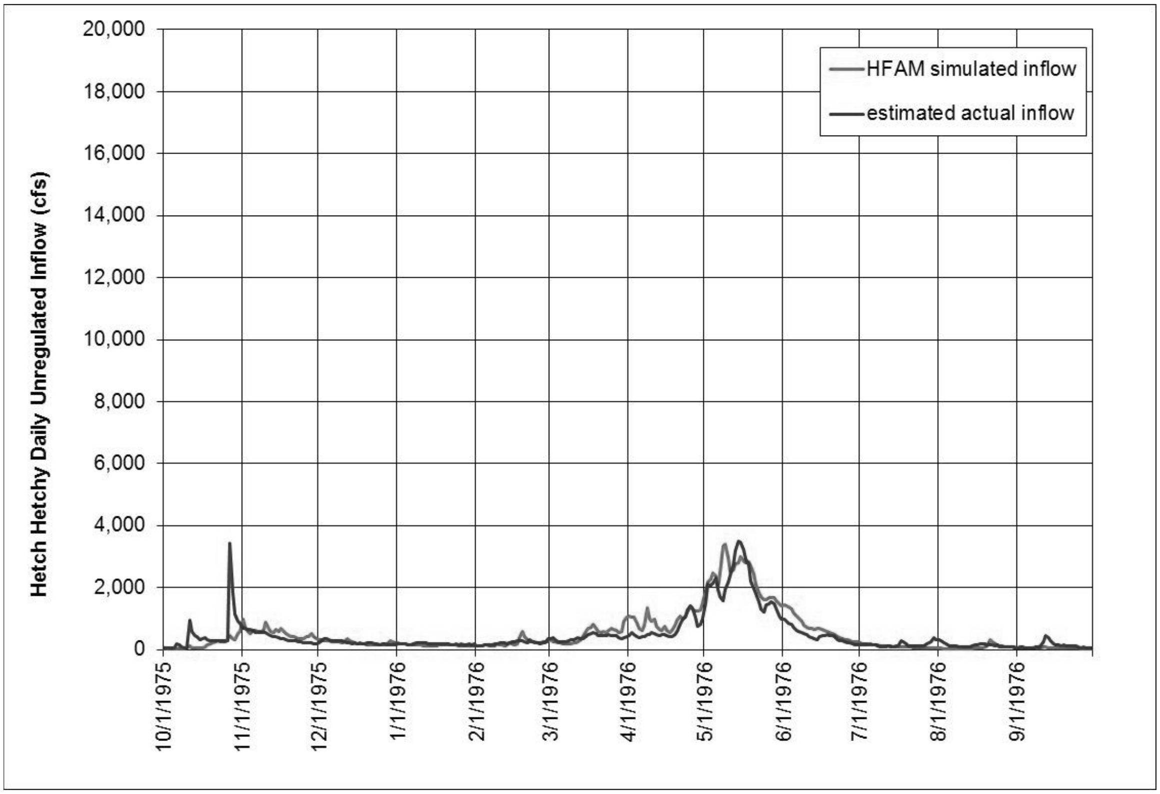


Figure B.2a Hetch Hetchy Daily Unregulated Inflow, water year 1976

HY-52
cont.

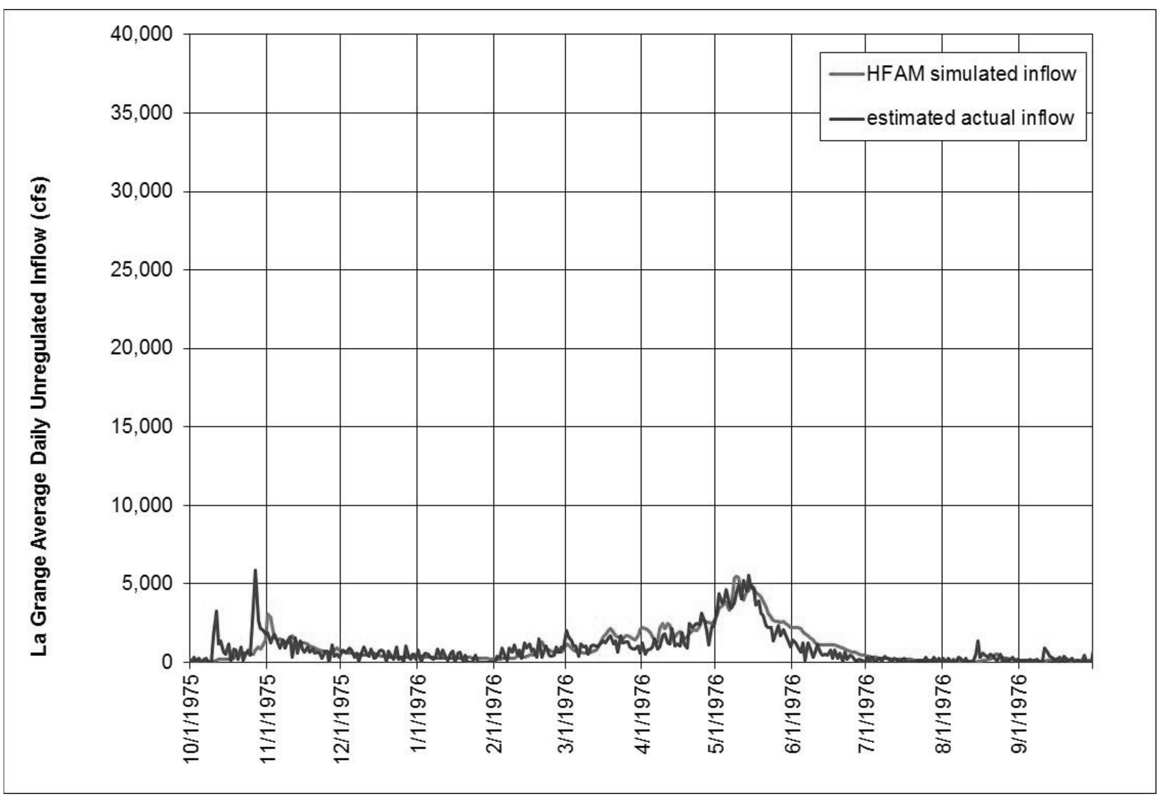


Figure B.2b La Grange Daily Unregulated Inflow, water year 1976

O-TRT-DREKMEIER Cont.

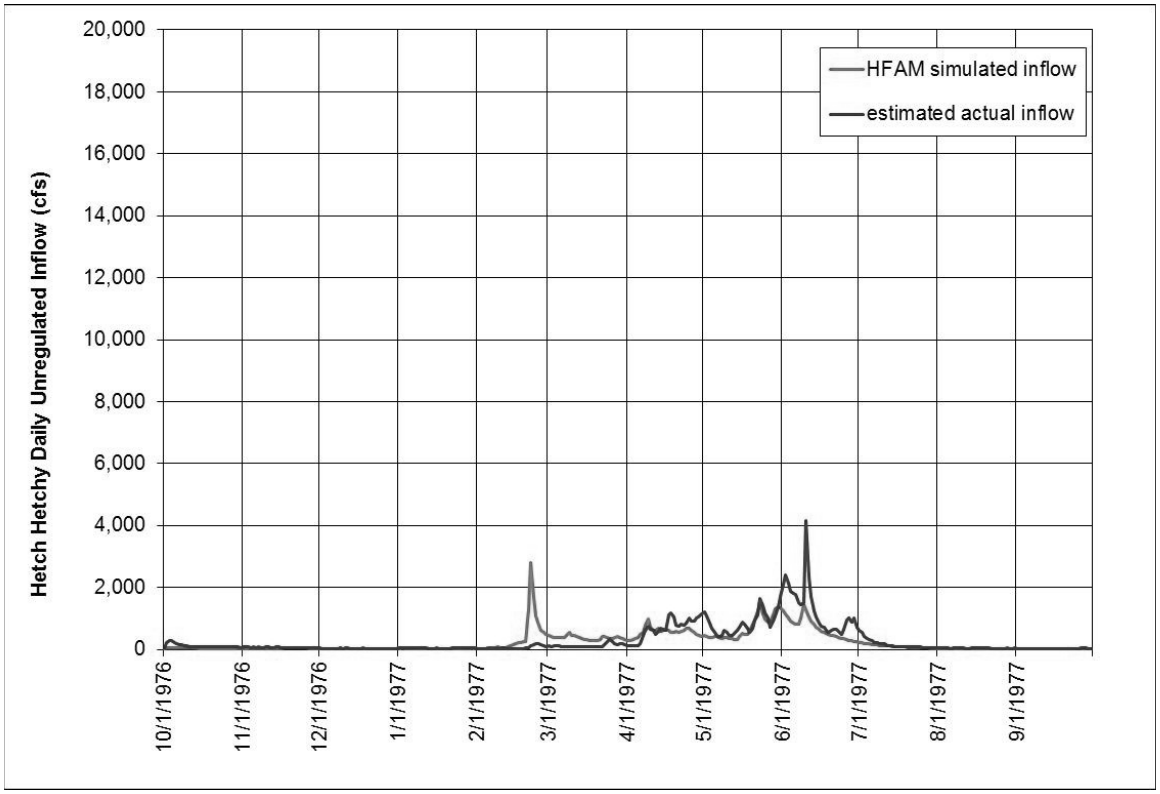


Figure B.3a Hetch Hetchy Daily Unregulated Inflow, water year 1977

HY-52 cont.

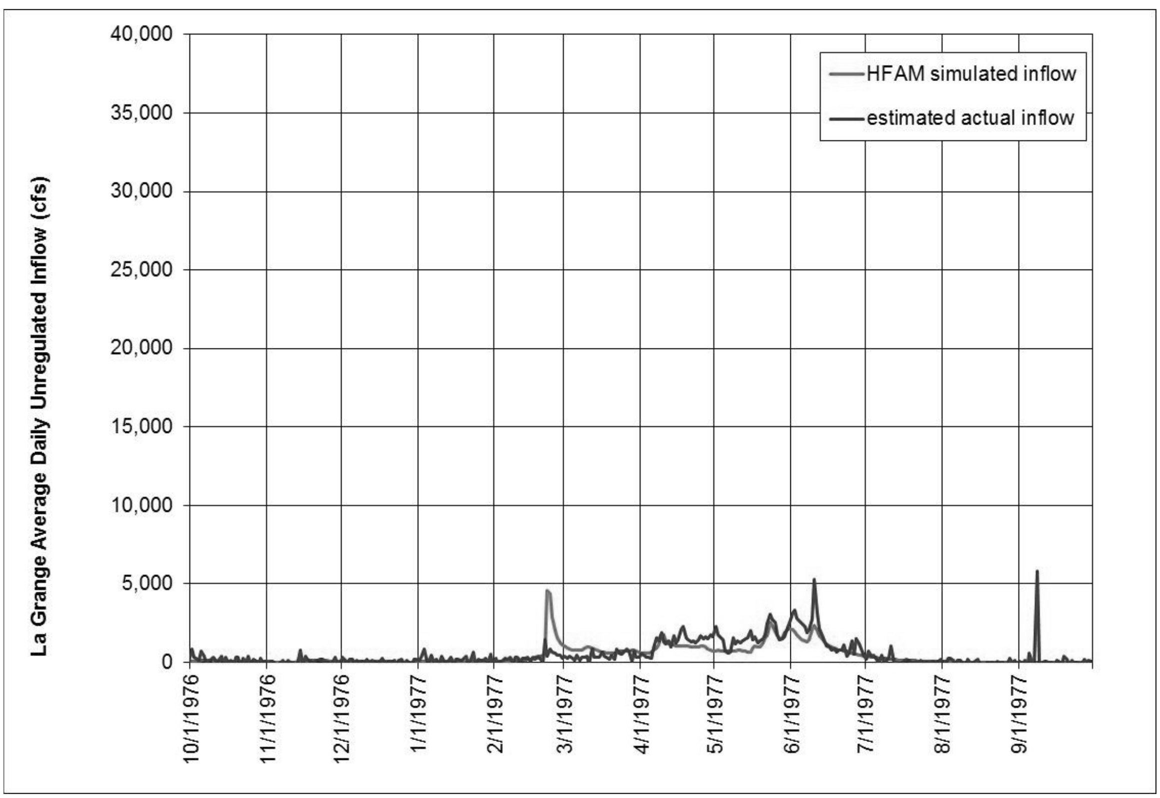


Figure B.3b La Grange Daily Unregulated Inflow, water year 1977

O-TRT-DREKMEIER Cont.

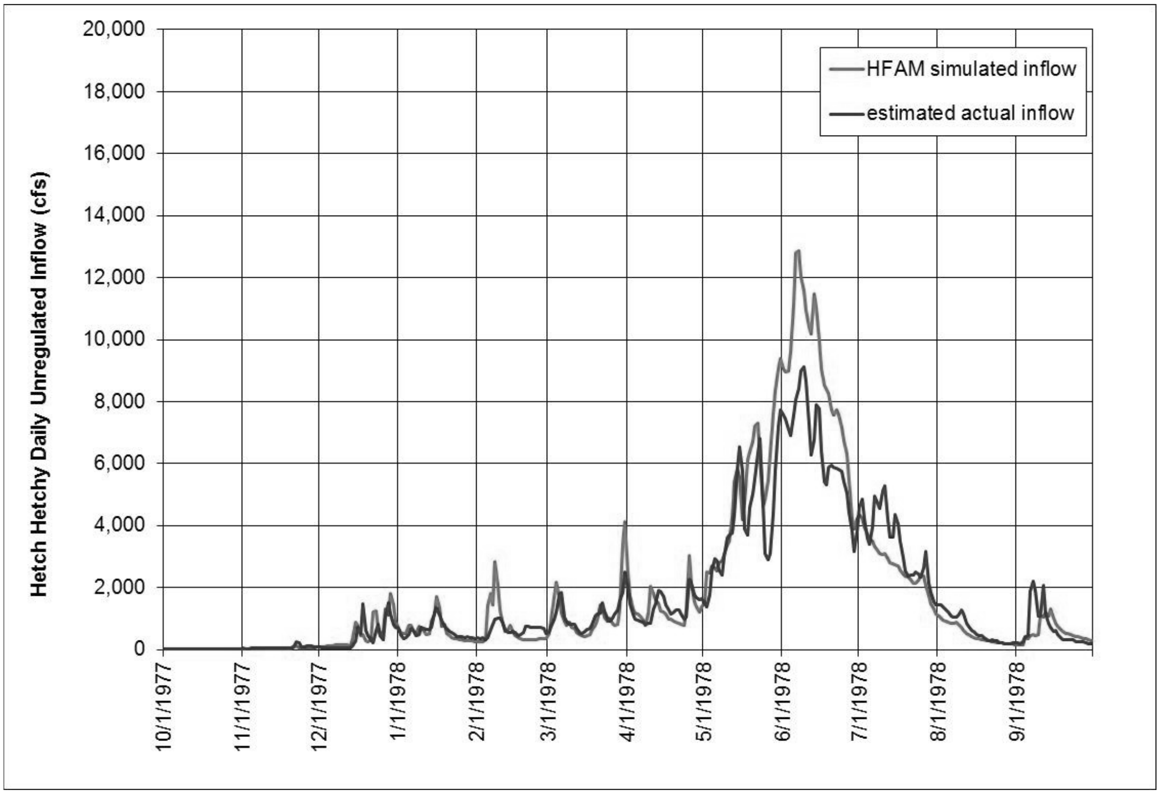


Figure B.4a Hetch Hetchy Daily Unregulated Inflow, water year 1978

HY-52 cont.

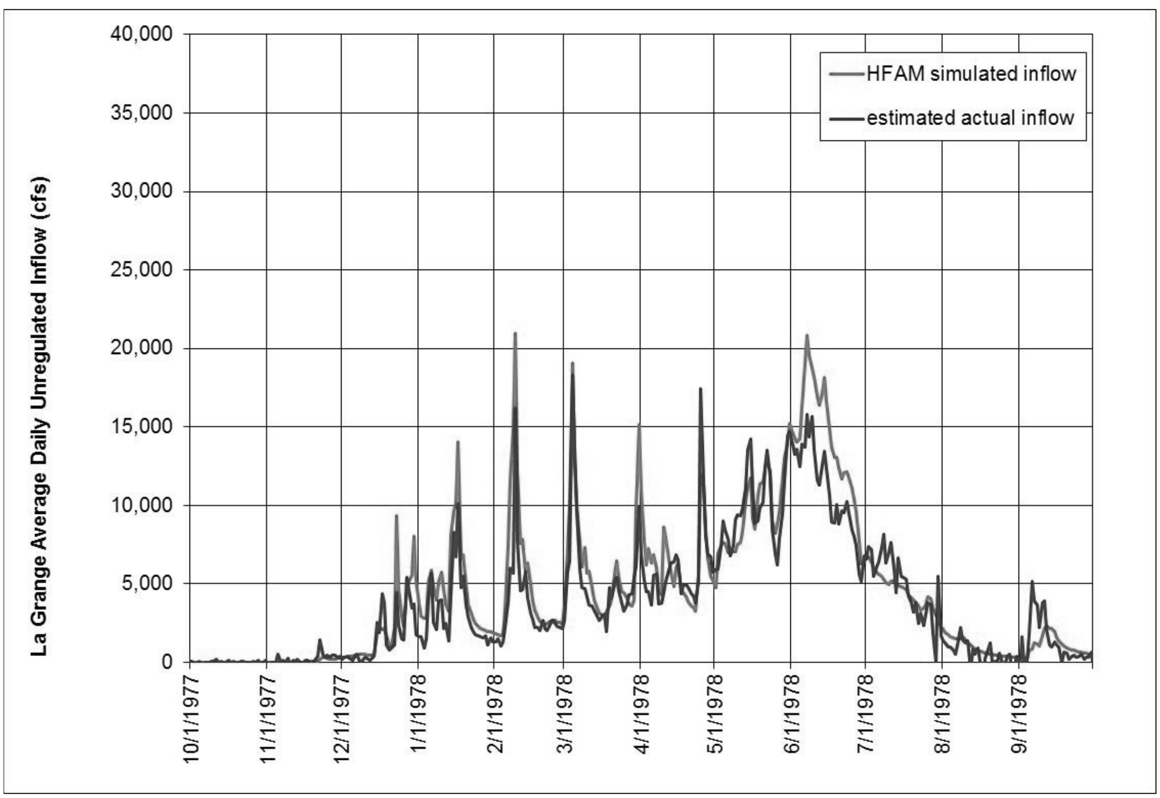


Figure B.4b La Grange Daily Unregulated Inflow, water year 1978

O-TRT-DREKMEIER Cont.

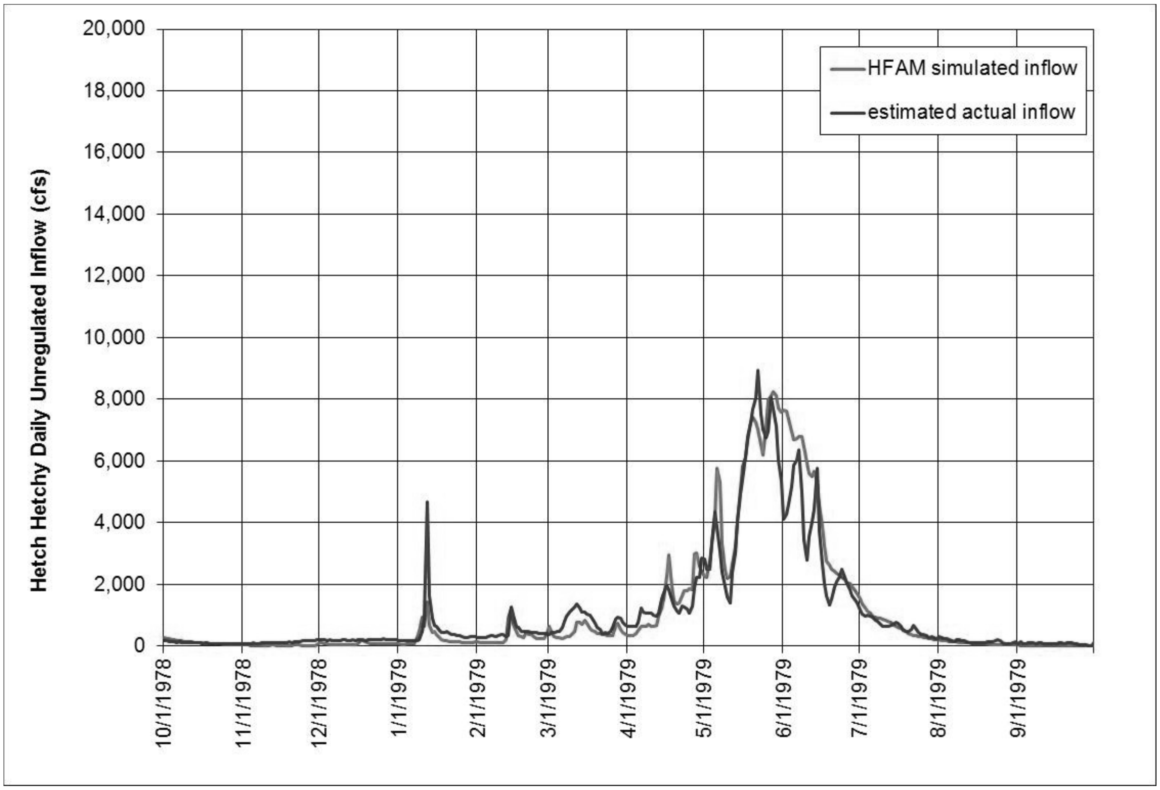


Figure B.5a Hetch Hetchy Daily Unregulated Inflow, water year 1979

HY-52 cont.

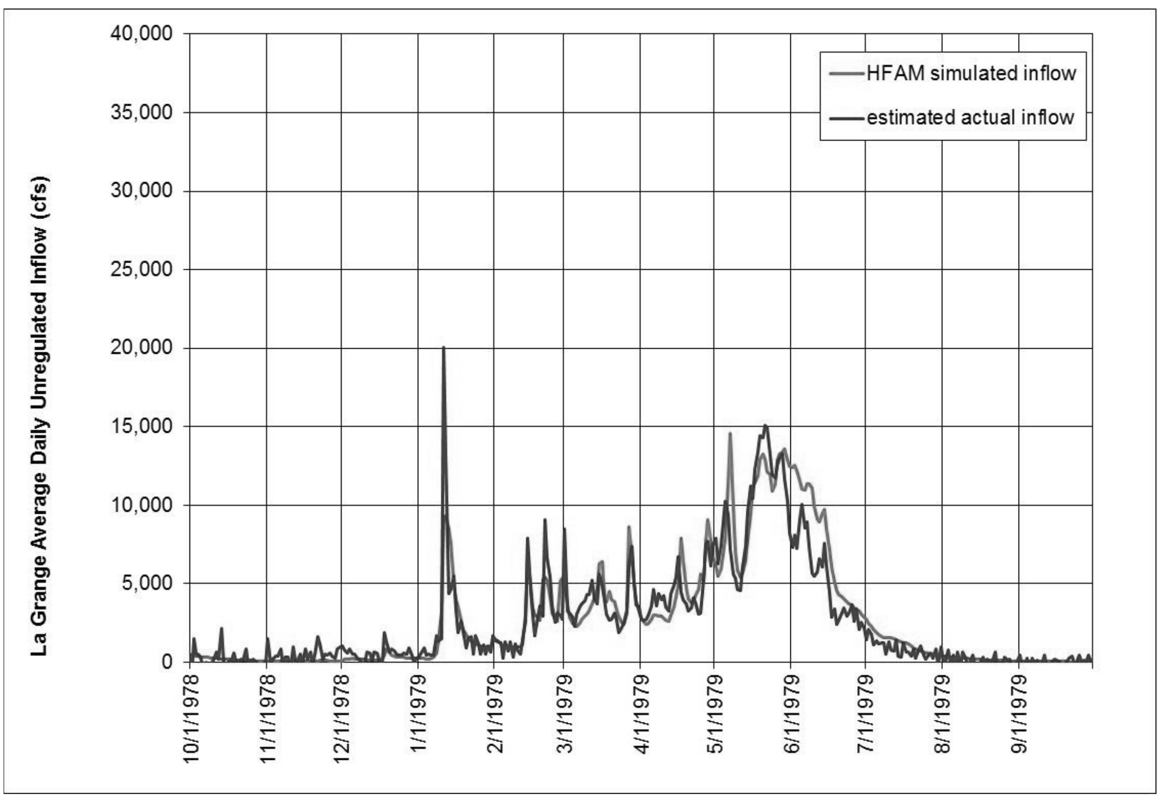


Figure B.5b La Grange Daily Unregulated Inflow, water year 1979

O-TRT-DREKMEIER Cont.

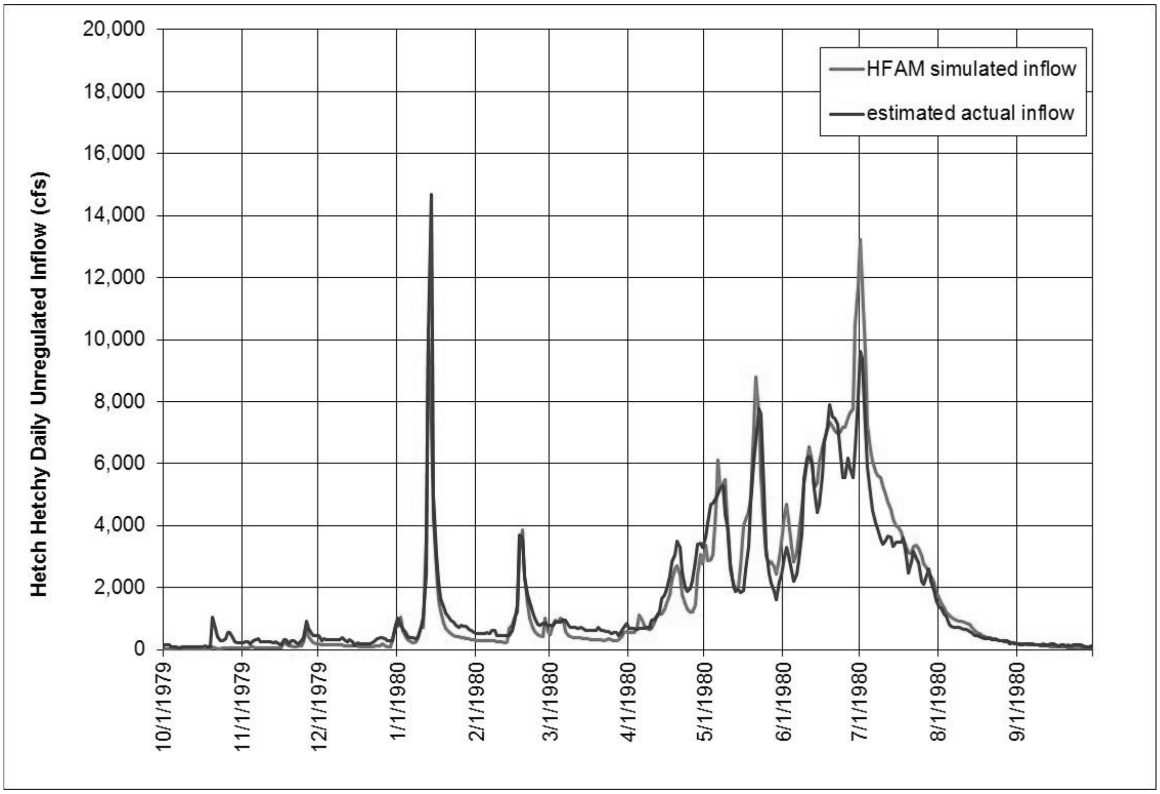


Figure B.6a Hetch Hetchy Daily Unregulated Inflow, water year 1980

HY-52 cont.

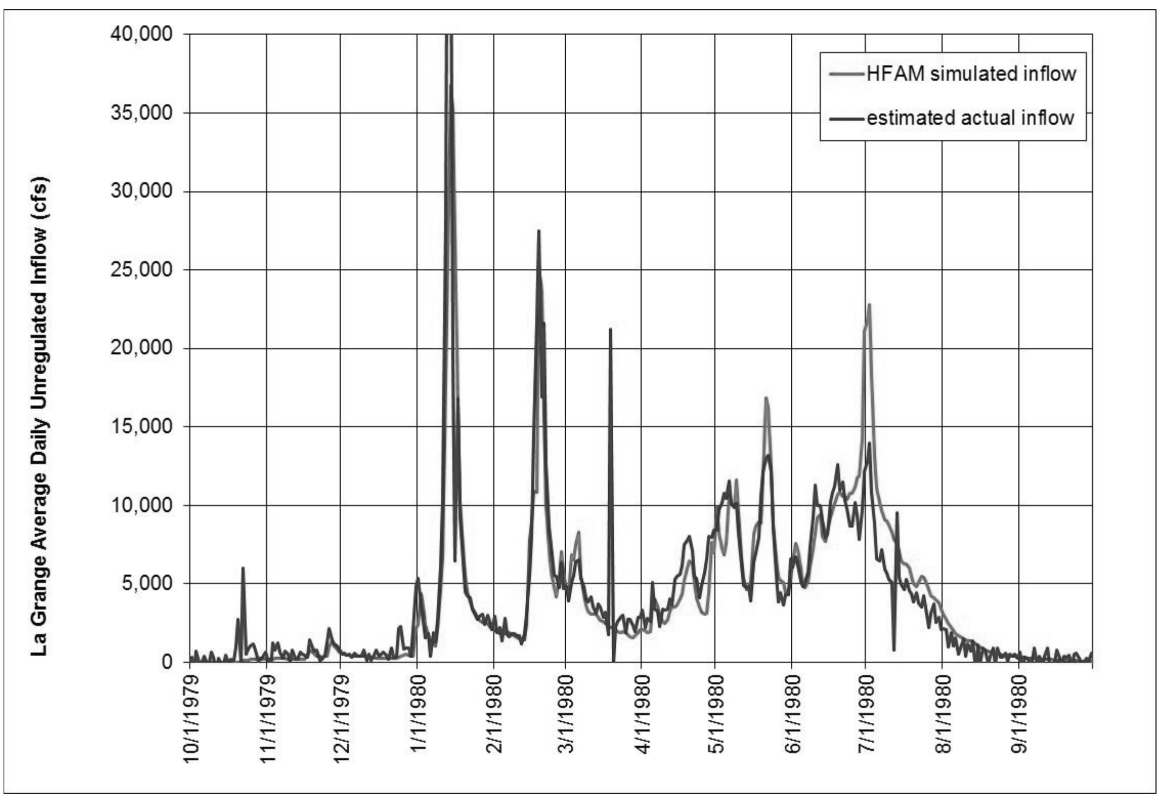


Figure B.6b La Grange Daily Unregulated Inflow, water year 1980

O-TRT-DREKMEIER Cont.

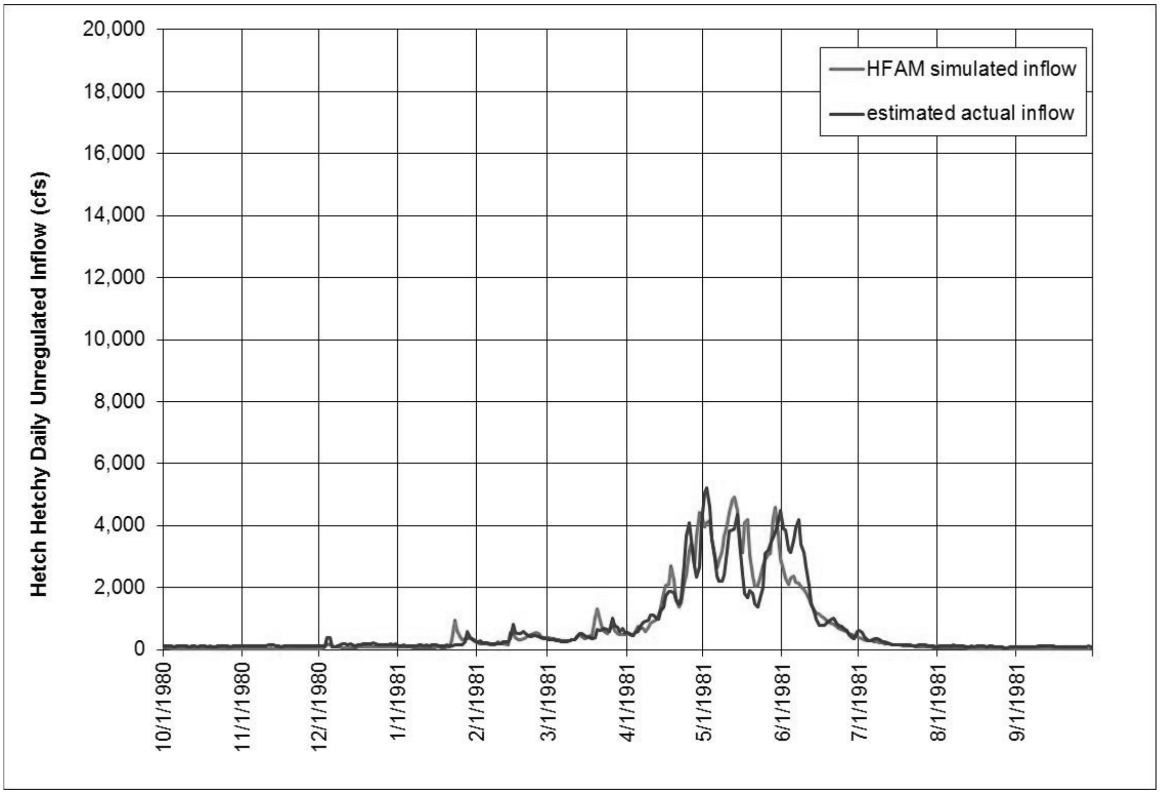


Figure B.7a Hetch Hetchy Daily Unregulated Inflow, water year 1981

HY-52 cont.

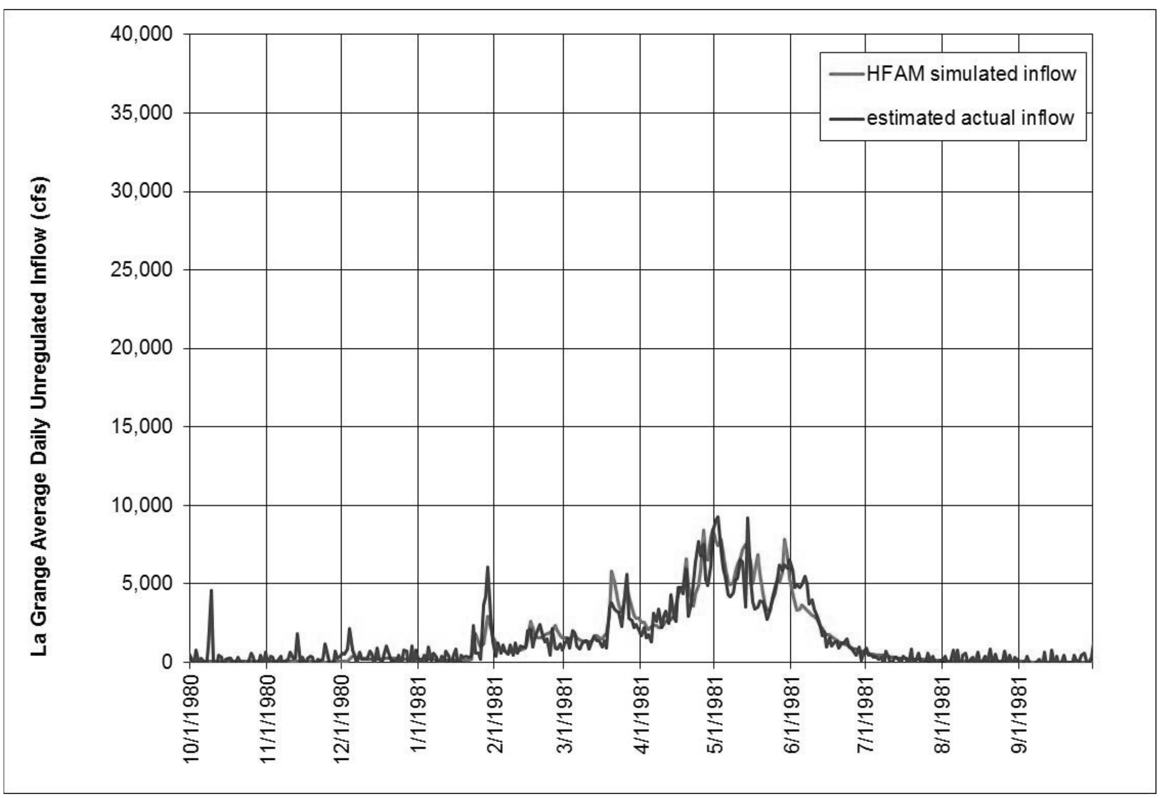


Figure B.7b La Grange Daily Unregulated Inflow, water year 1981

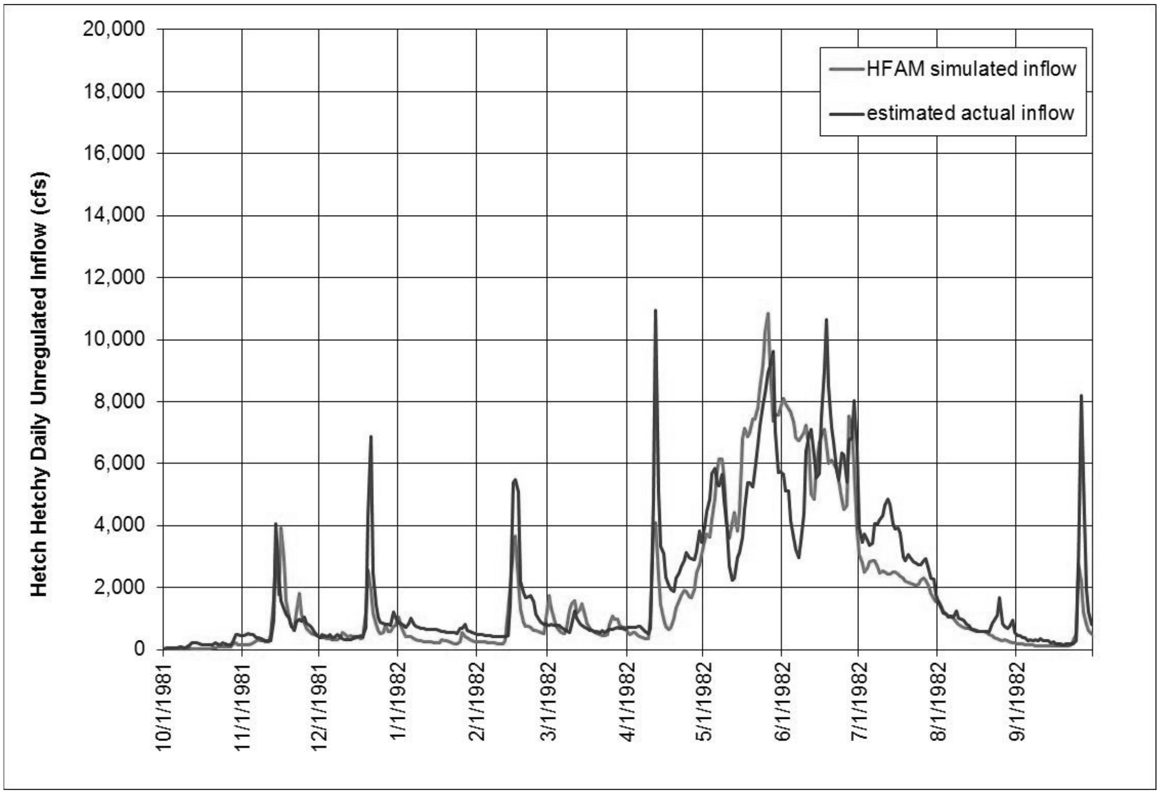


Figure B.8a Hetch Hetchy Daily Unregulated Inflow, water year 1982

HY-52 cont.

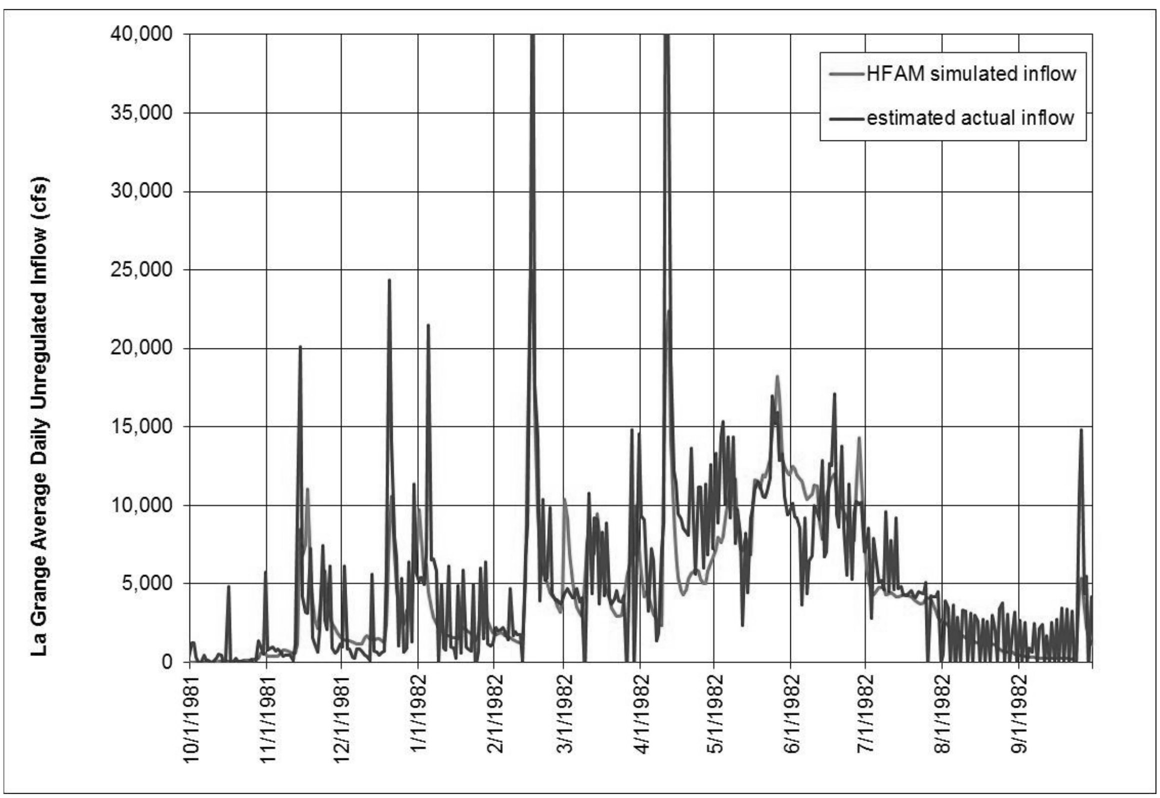


Figure B.8b La Grange Daily Unregulated Inflow, water year 1982

O-TRT-DREKMEIER Cont.

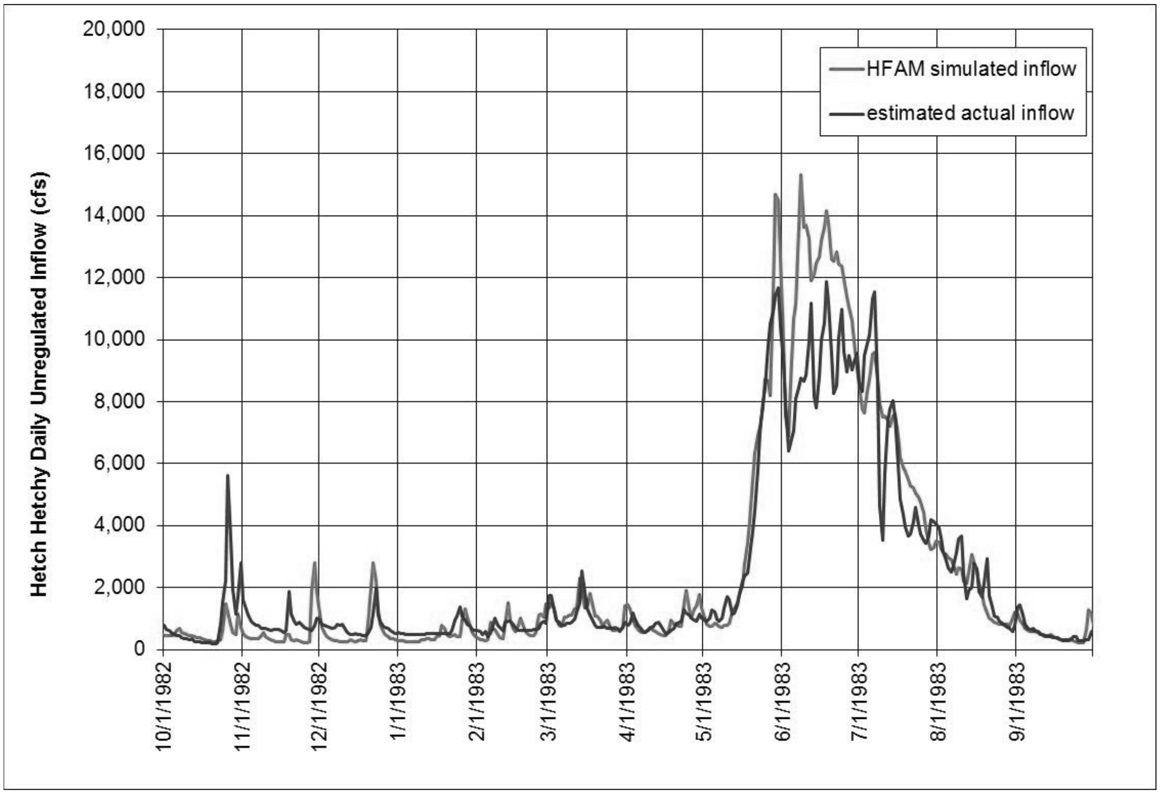


Figure B.9a Hetch Hetchy Daily Unregulated Inflow, water year 1983

HY-52 cont.

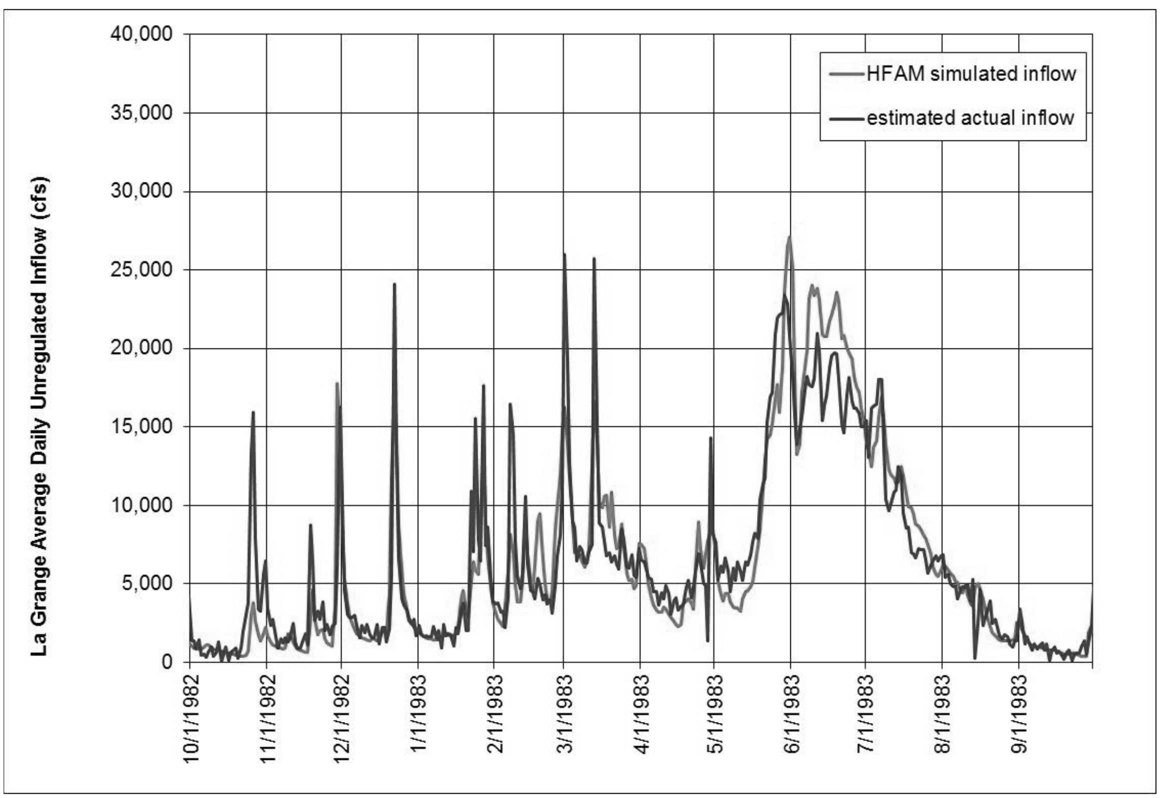


Figure B.9b La Grange Daily Unregulated Inflow, water year 1983

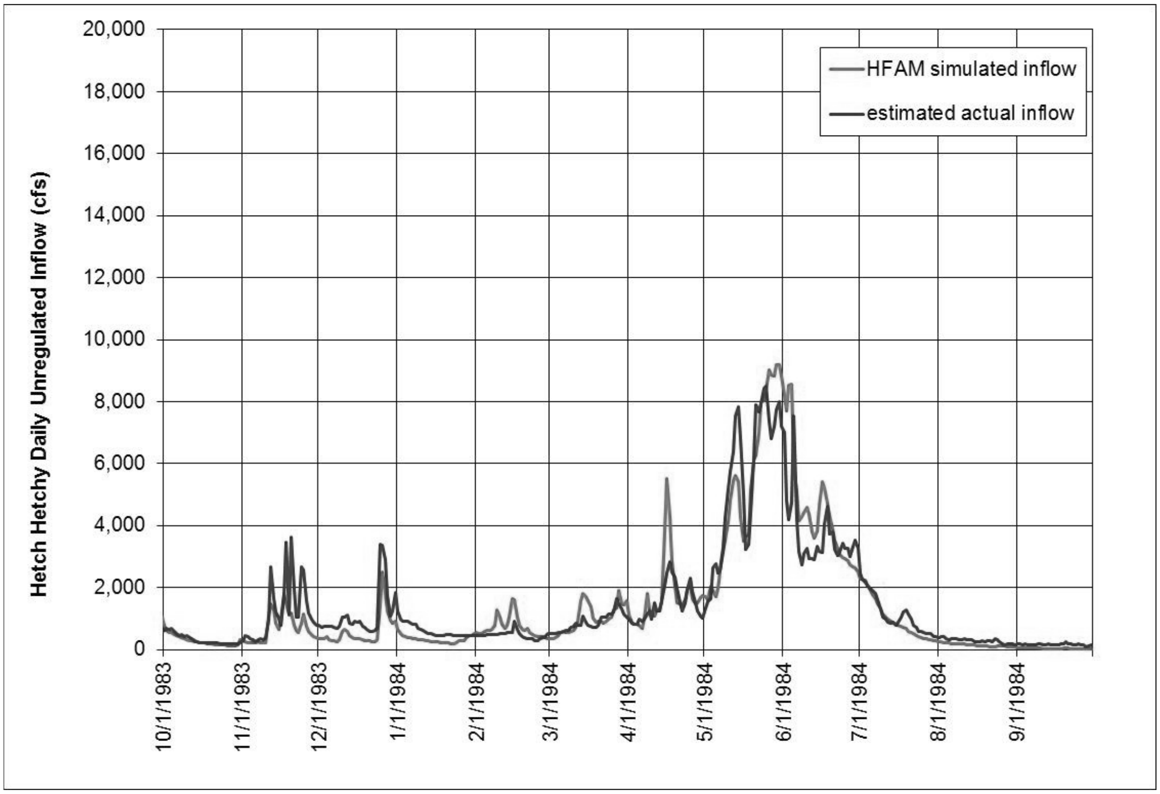


Figure B.10a Hetch Hetchy Daily Unregulated Inflow, water year 1984

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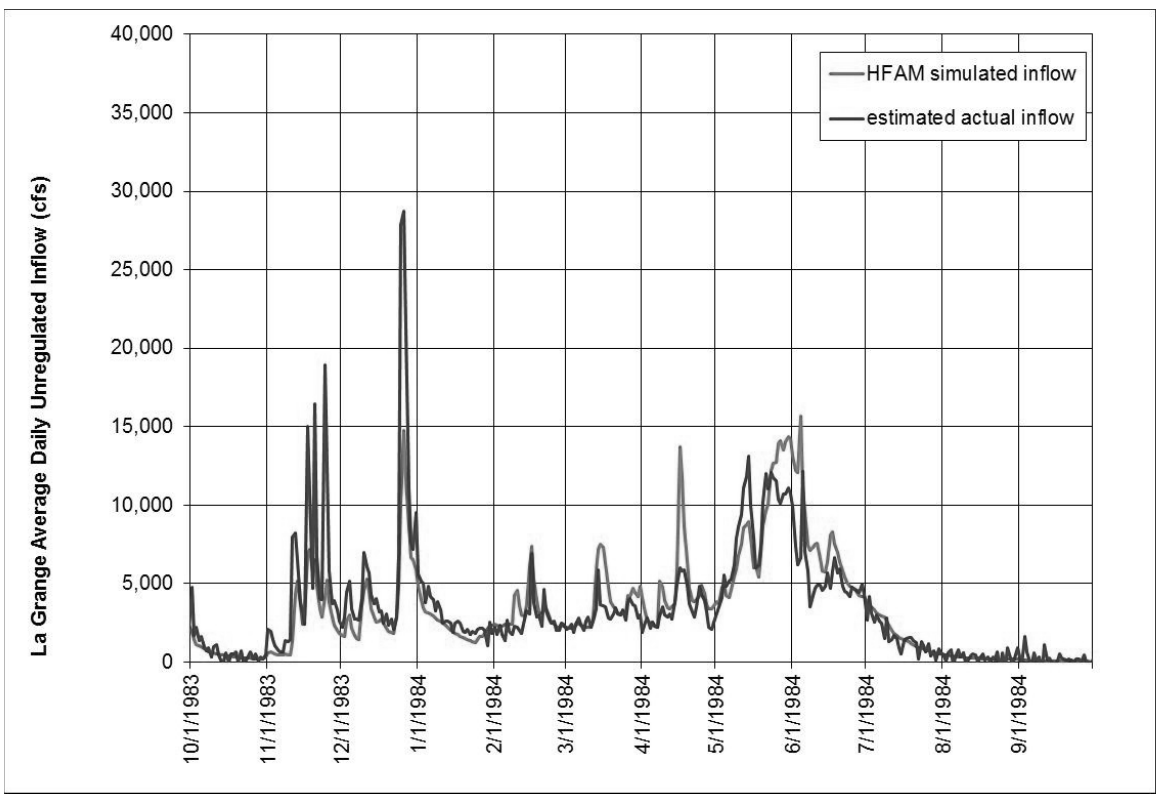

Figure B.10b La Grange Daily Unregulated Inflow, water year 1984

O-TRT-DREKMEIER Cont.

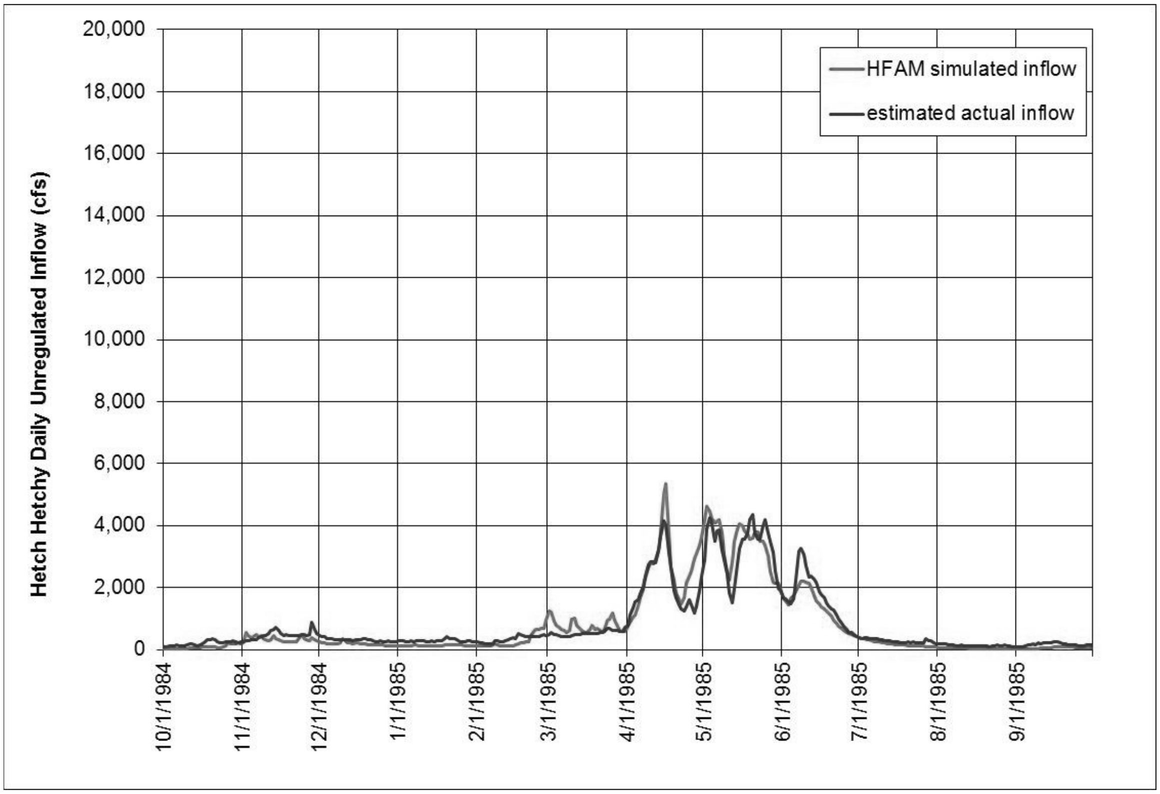

Figure B.11a Hetch Hetchy Daily Unregulated Inflow, water year 1985

HY-52 cont.

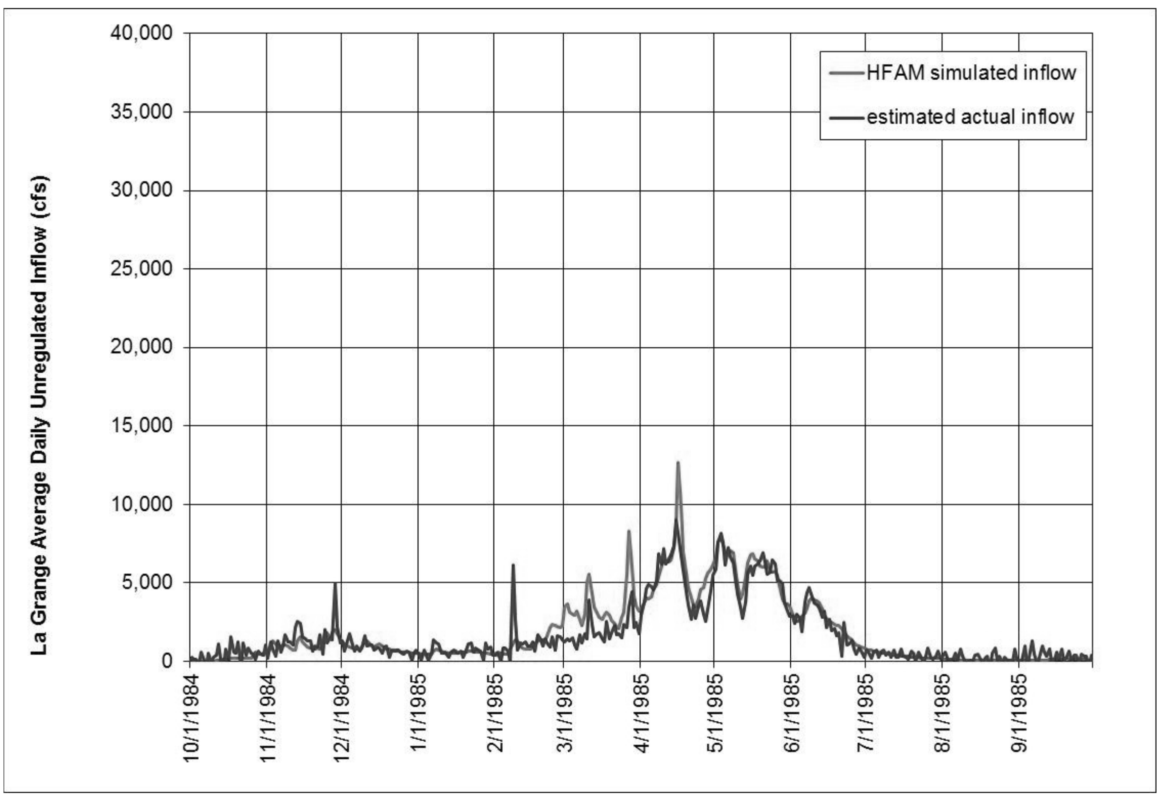

Figure B.11b La Grange Daily Unregulated Inflow, water year 1985

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Cont.

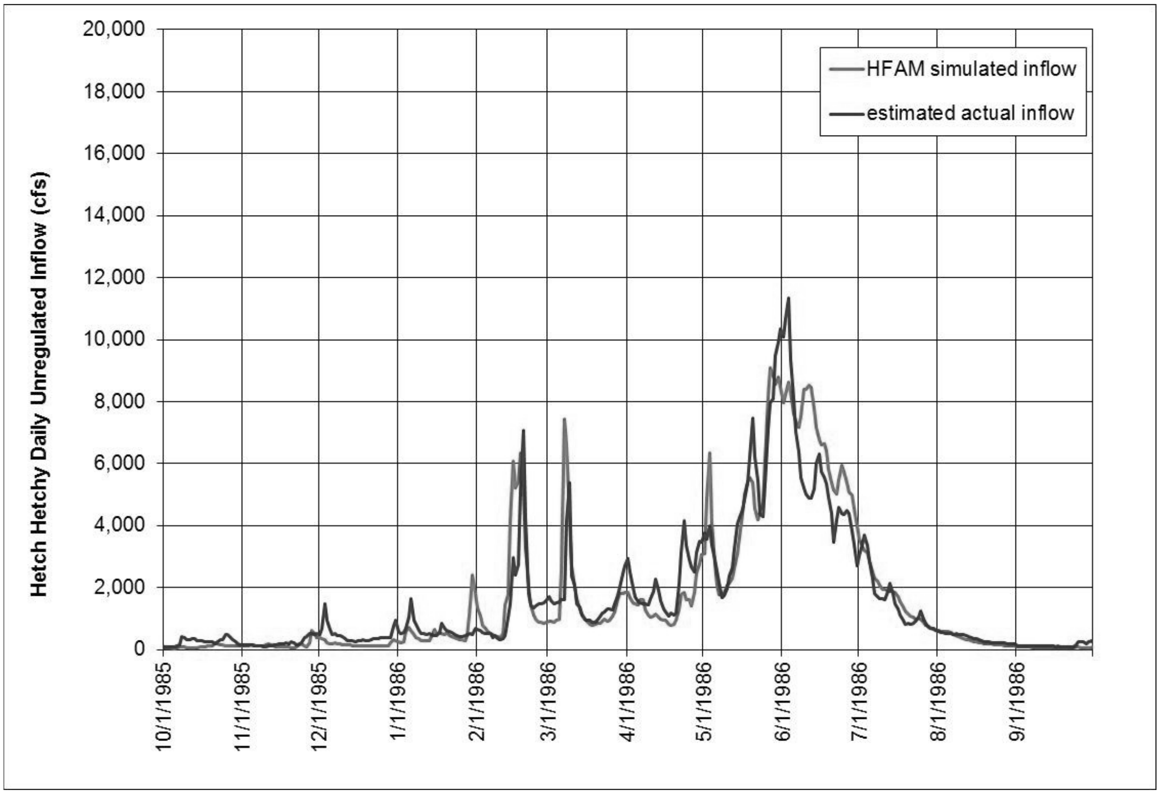

Figure B.12a Hetch Hetchy Daily Unregulated Inflow, water year 1986

HY-52
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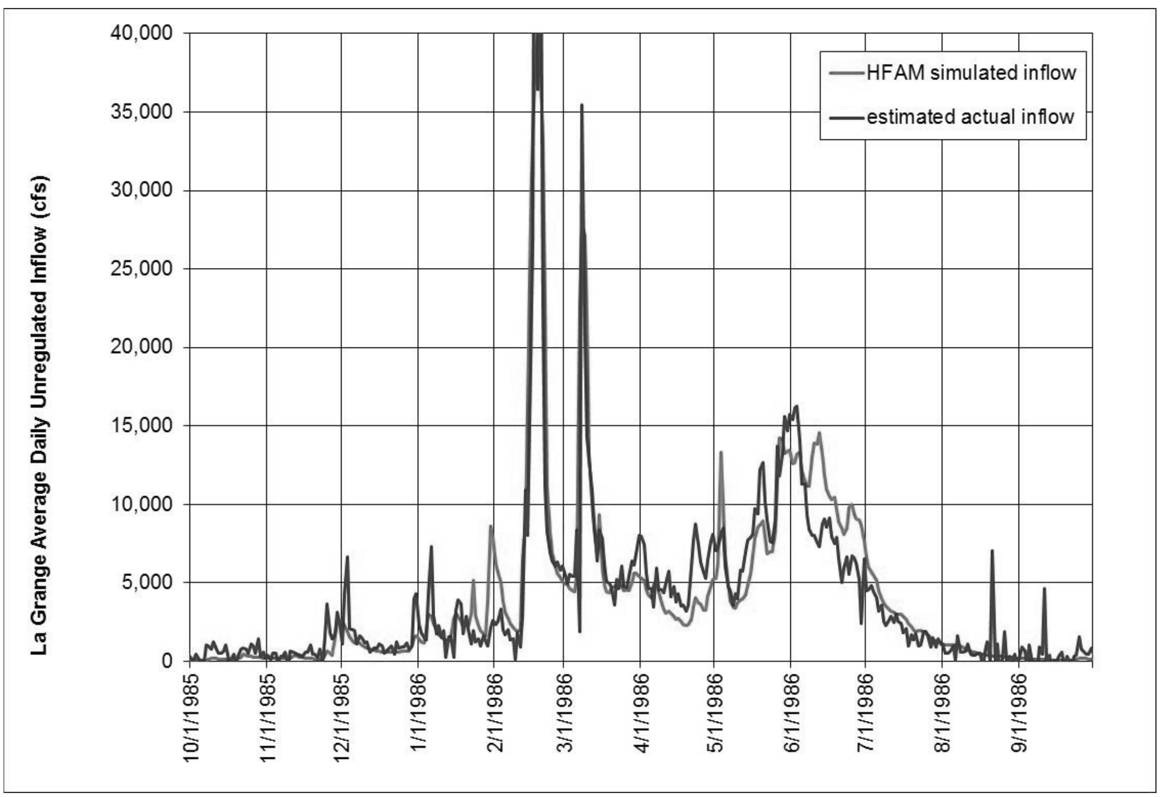

Figure B.12b La Grange Daily Unregulated Inflow, water year 1986

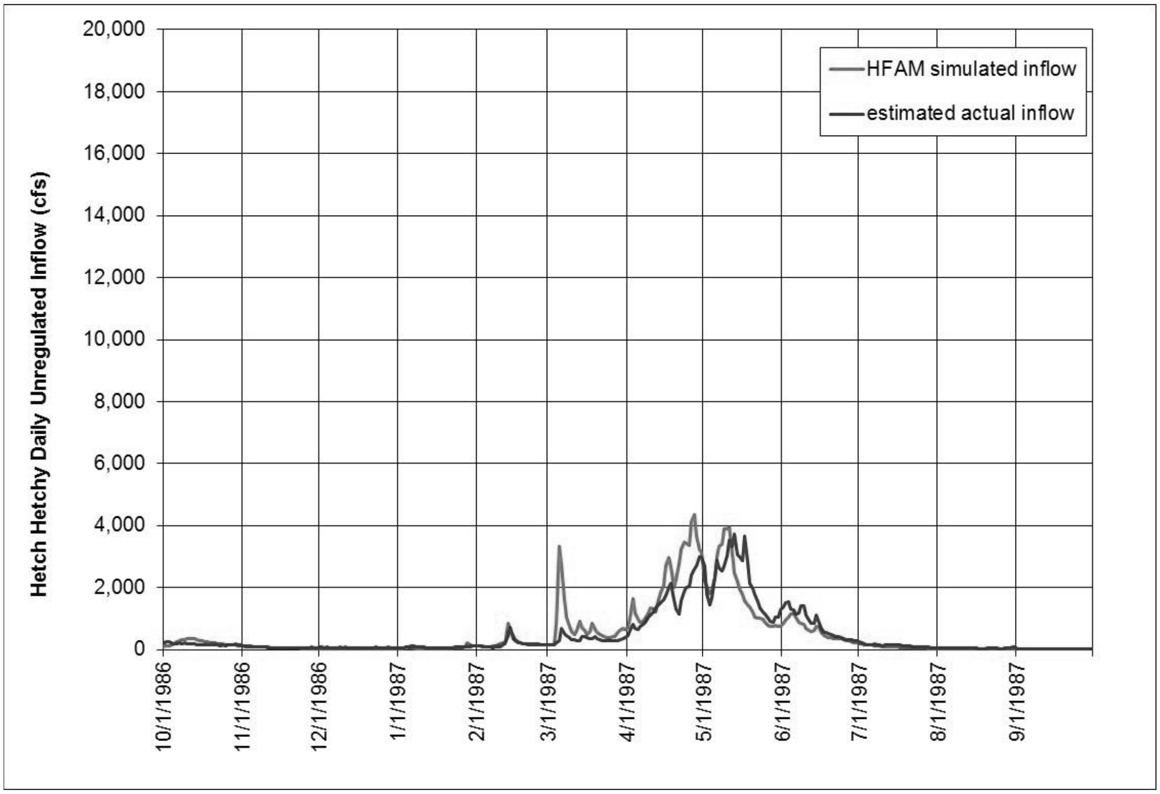

Figure B.13a Hetch Hetchy Daily Unregulated Inflow, water year 1987

HY-52
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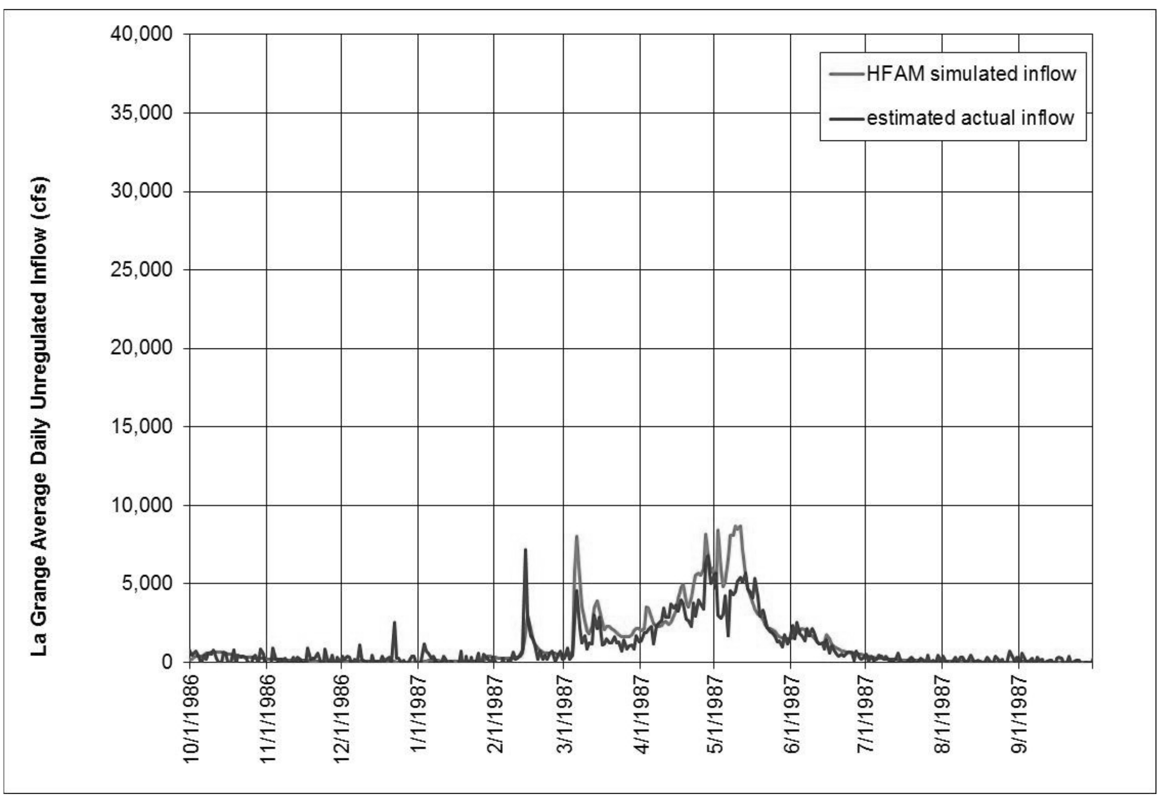

Figure B.13b La Grange Daily Unregulated Inflow, water year 1987

Attachment A

O-TRT-DREKMEIER Cont.

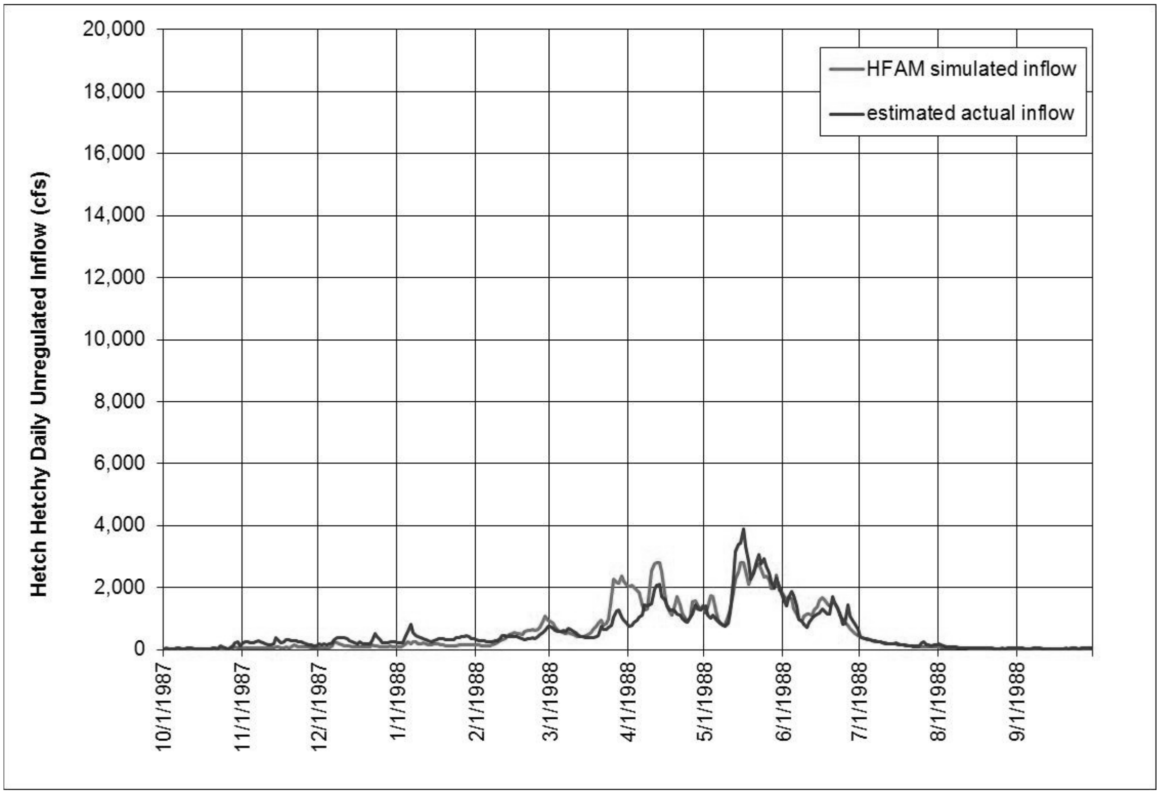

Figure B.14a Hetch Hetchy Daily Unregulated Inflow, water year 1988

HY-52 cont.

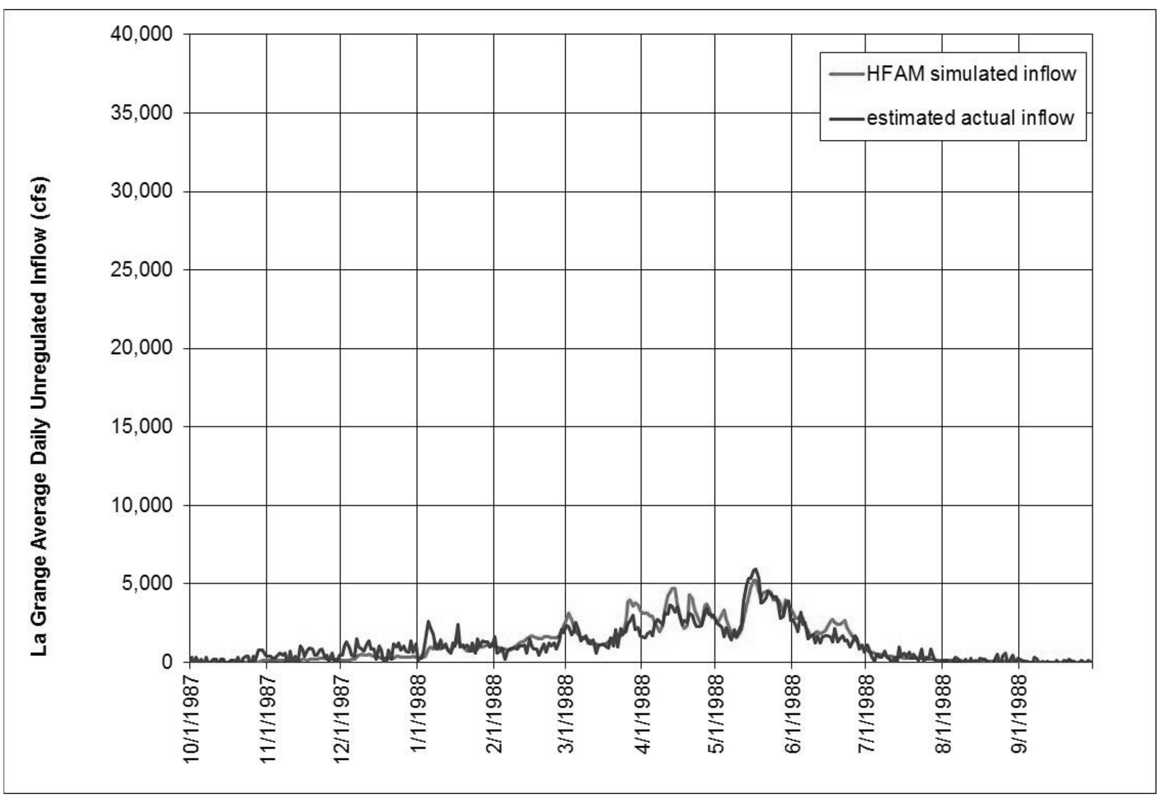

Figure B.14b La Grange Daily Unregulated Inflow, water year 1988

Attachment A

O-TRT-DREKMEIER Cont.

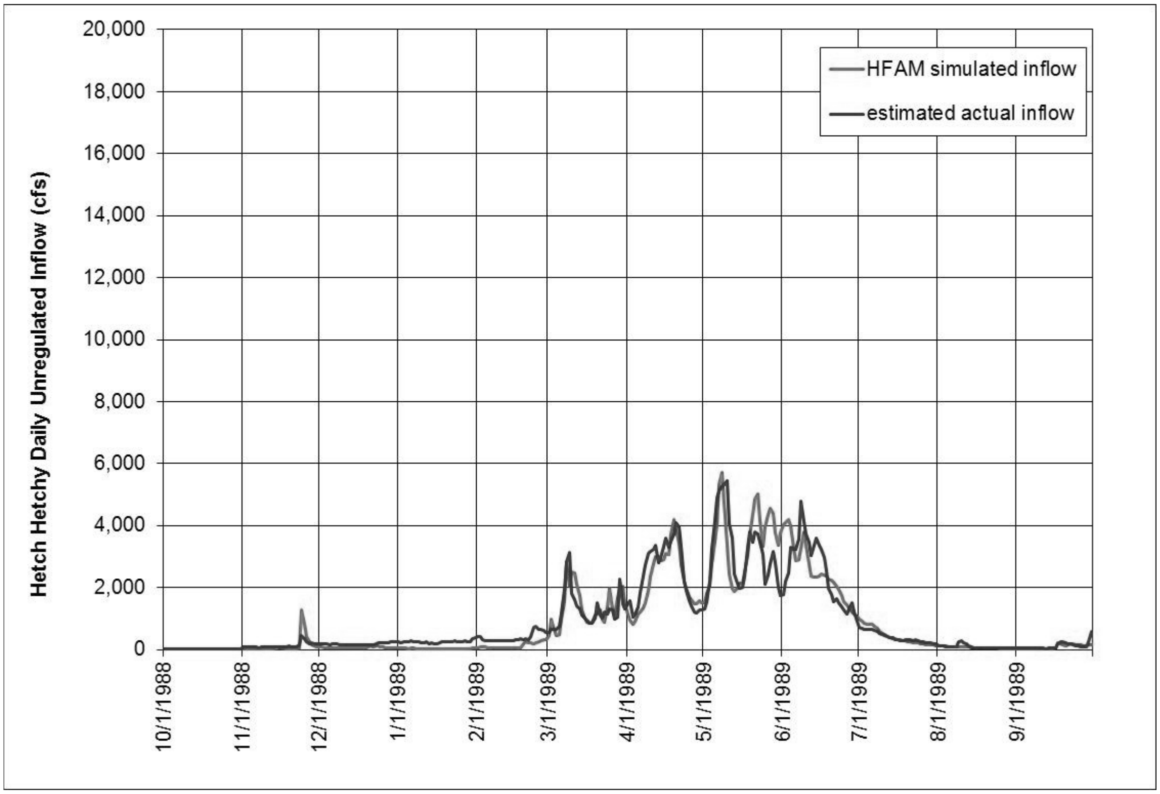

Figure B.15a Hetch Hetchy Daily Unregulated Inflow, water year 1989

HY-52 cont.

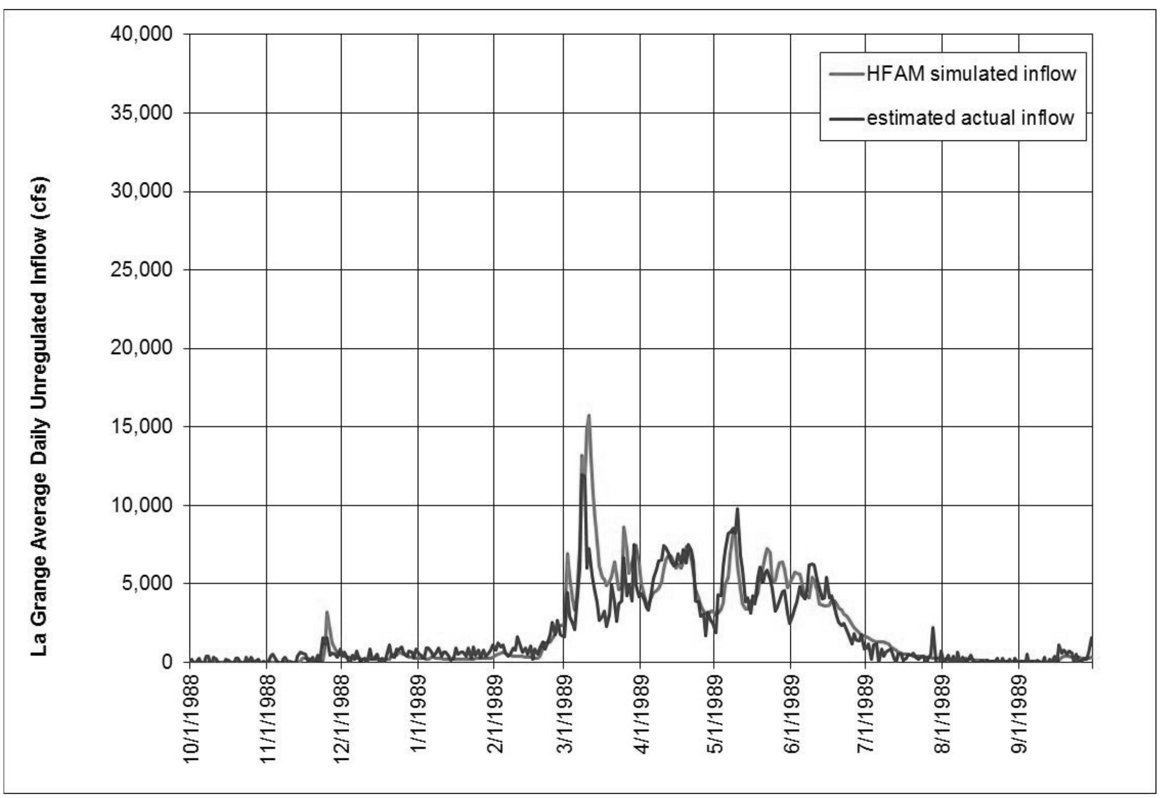

Figure B.15b La Grange Daily Unregulated Inflow, water year 1989

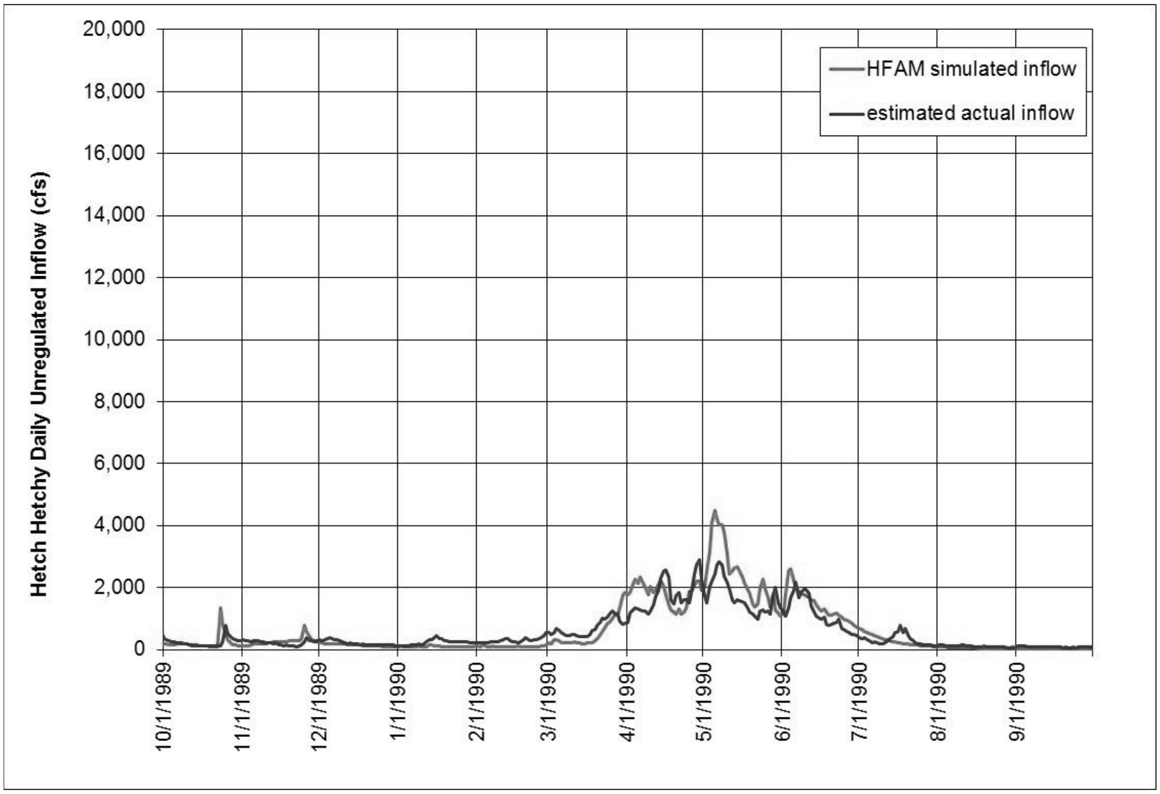

Figure B.16a Hetch Hetchy Daily Unregulated Inflow, water year 1990

HY-52 cont.

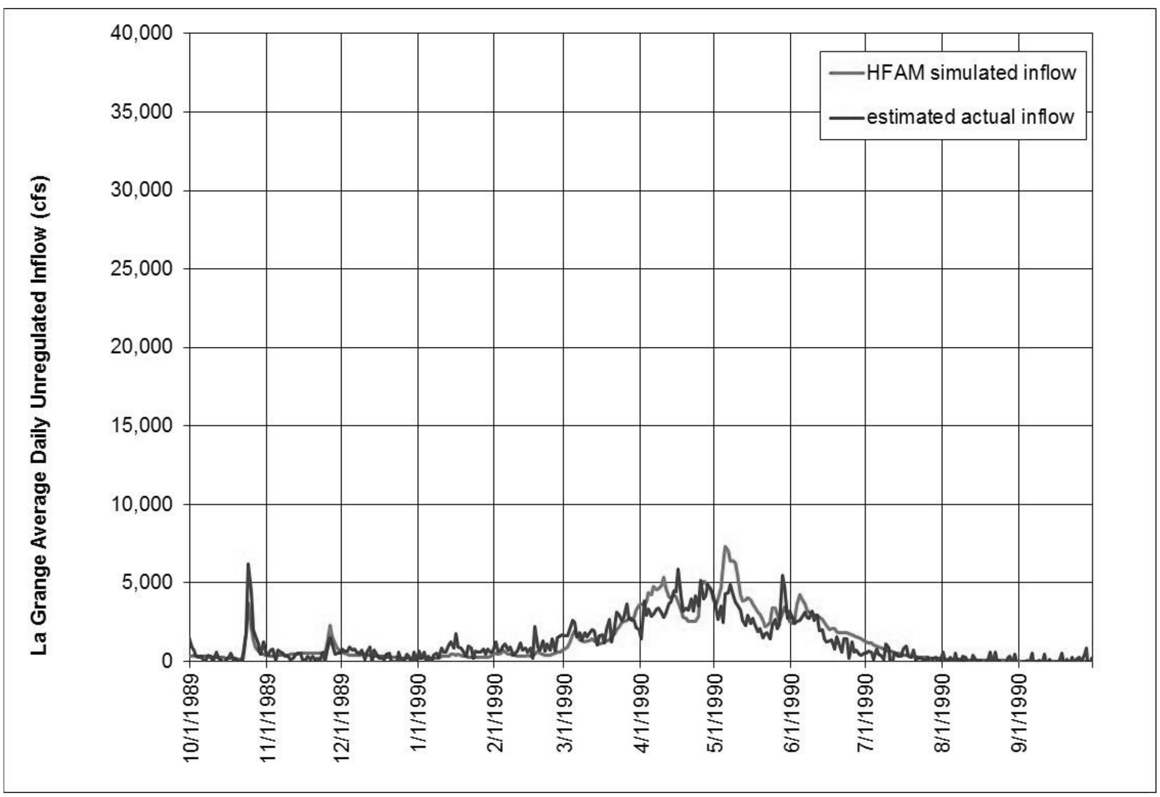

Figure B.16b La Grange Daily Unregulated Inflow, water year 1990

Attachment A

O-TRT-DREKMEIER Cont.

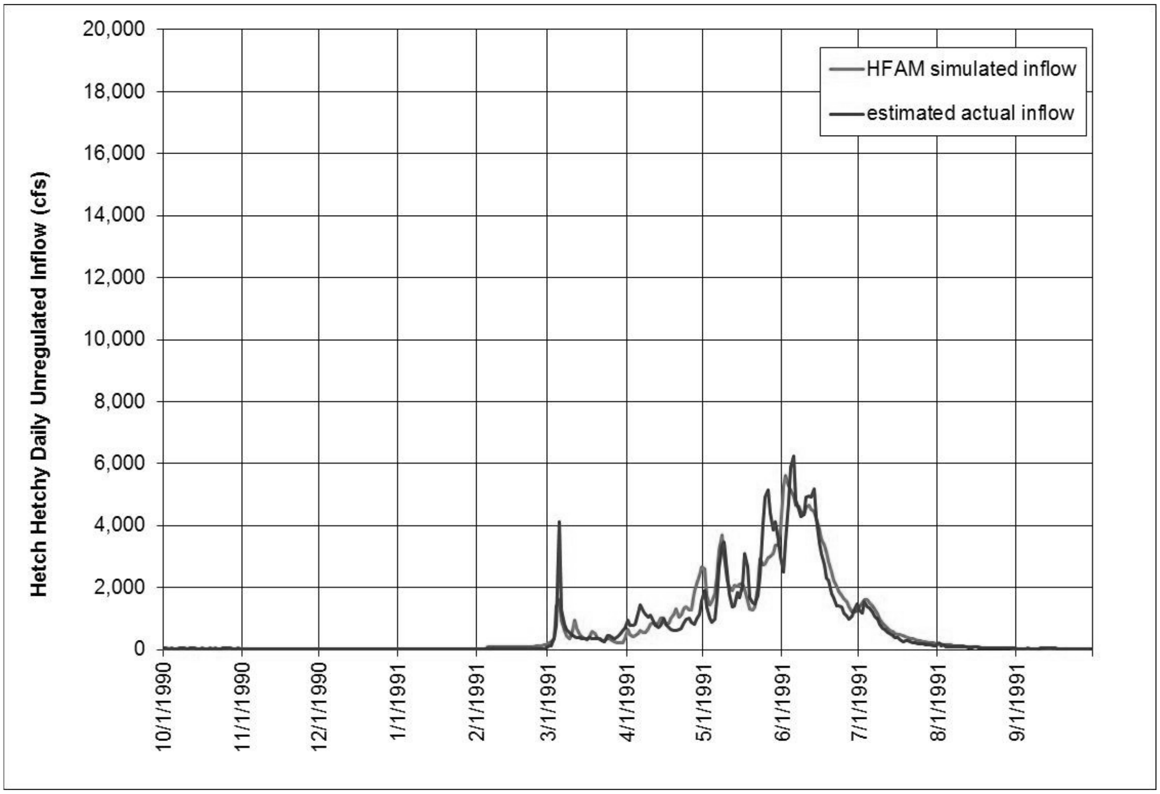

Figure B.17a Hetch Hetchy Daily Unregulated Inflow, water year 1991

HY-52 cont.

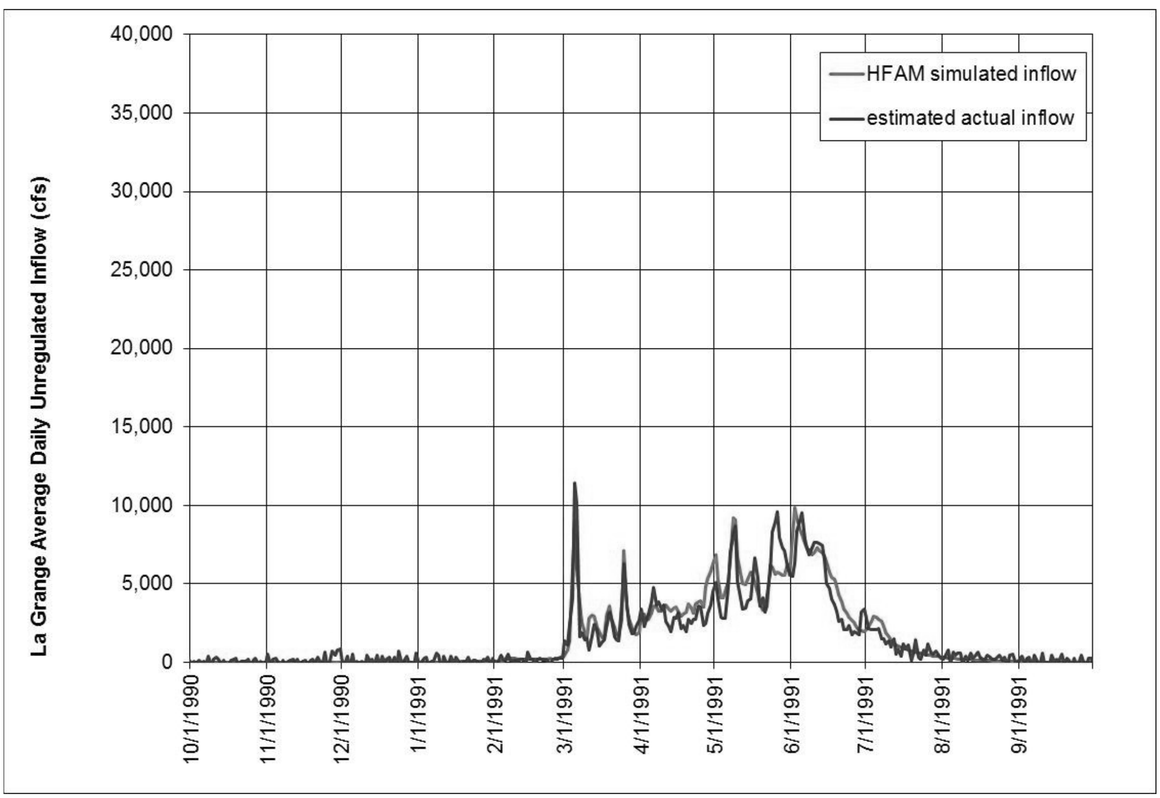

Figure B.17b La Grange Daily Unregulated Inflow, water year 1991

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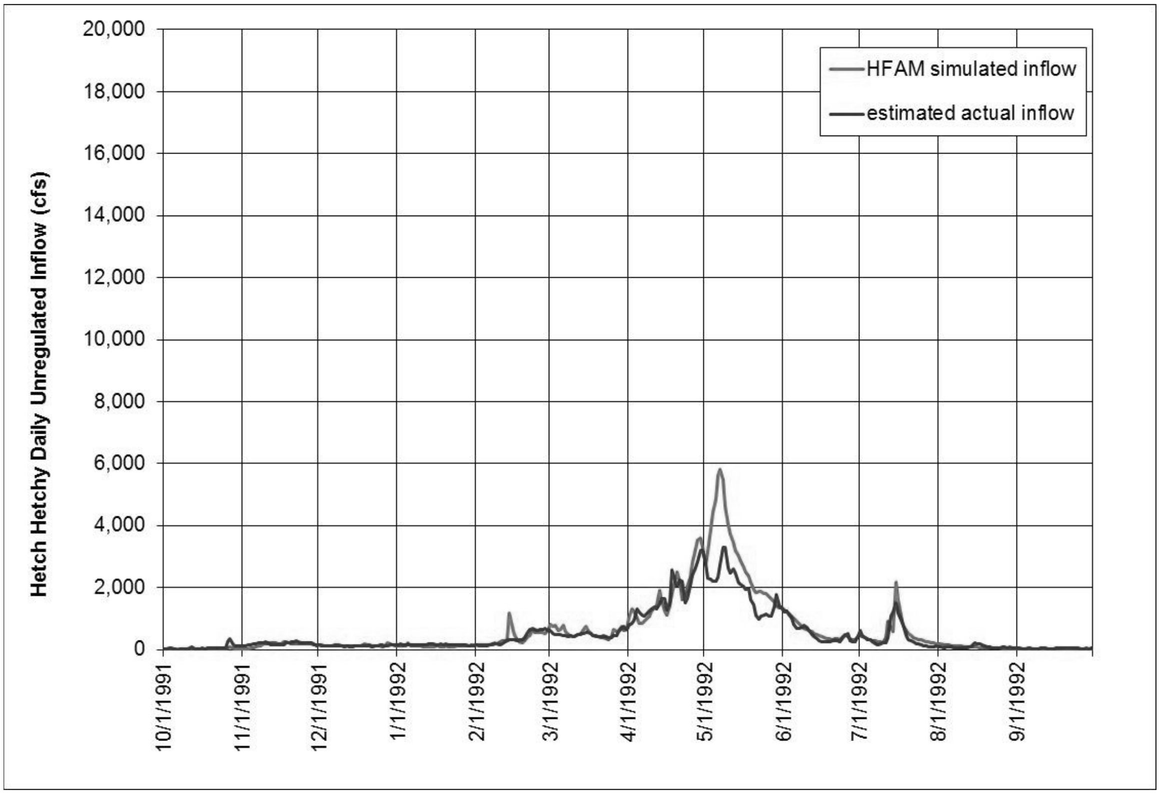

Figure B.18a Hetch Hetchy Daily Unregulated Inflow, water year 1992

HY-52 cont.

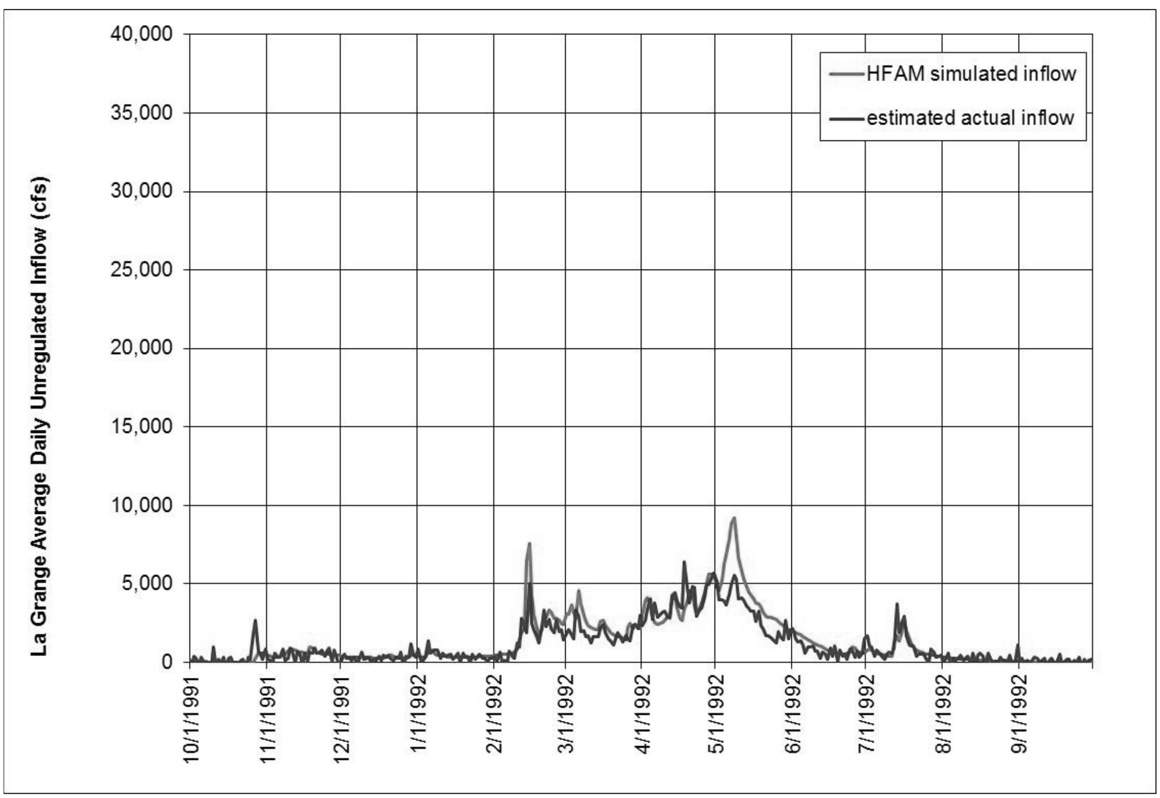

Figure B.18b La Grange Daily Unregulated Inflow, water year 1992

O-TRT-DREKMEIER Cont.

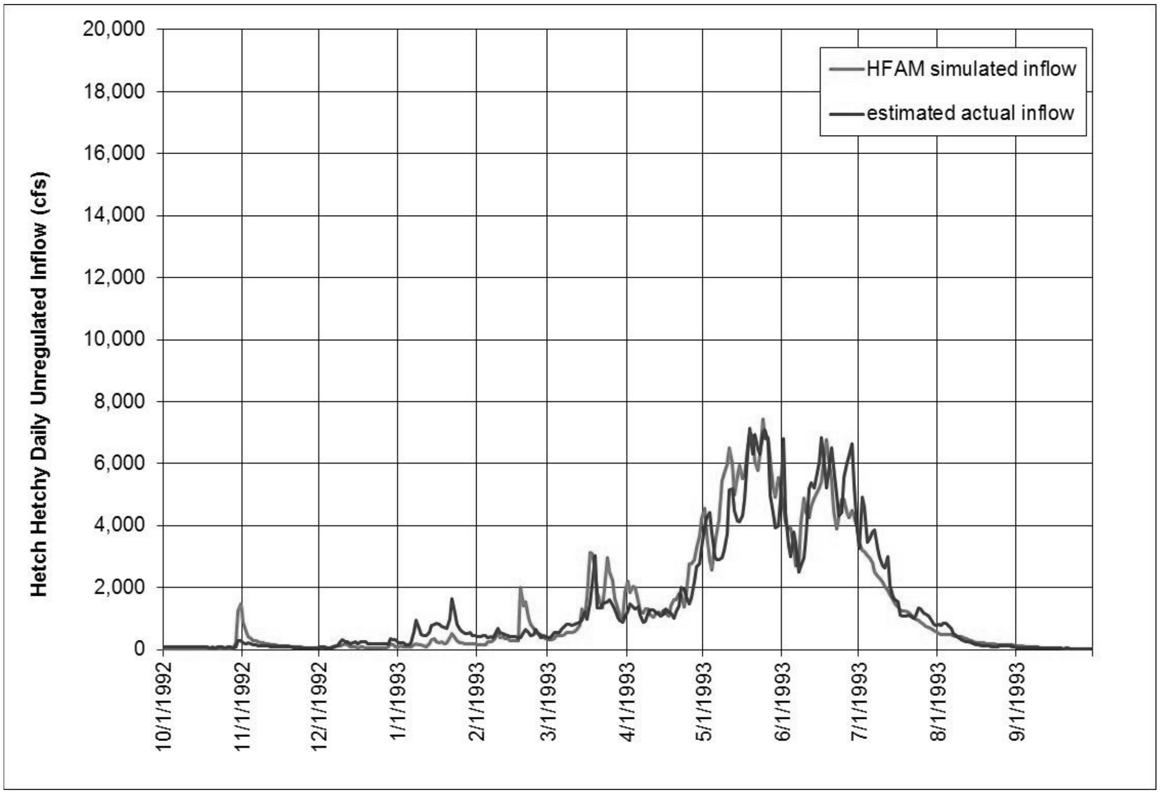

Figure B.19a Hetch Hetchy Daily Unregulated Inflow, water year 1993

HY-52 cont.

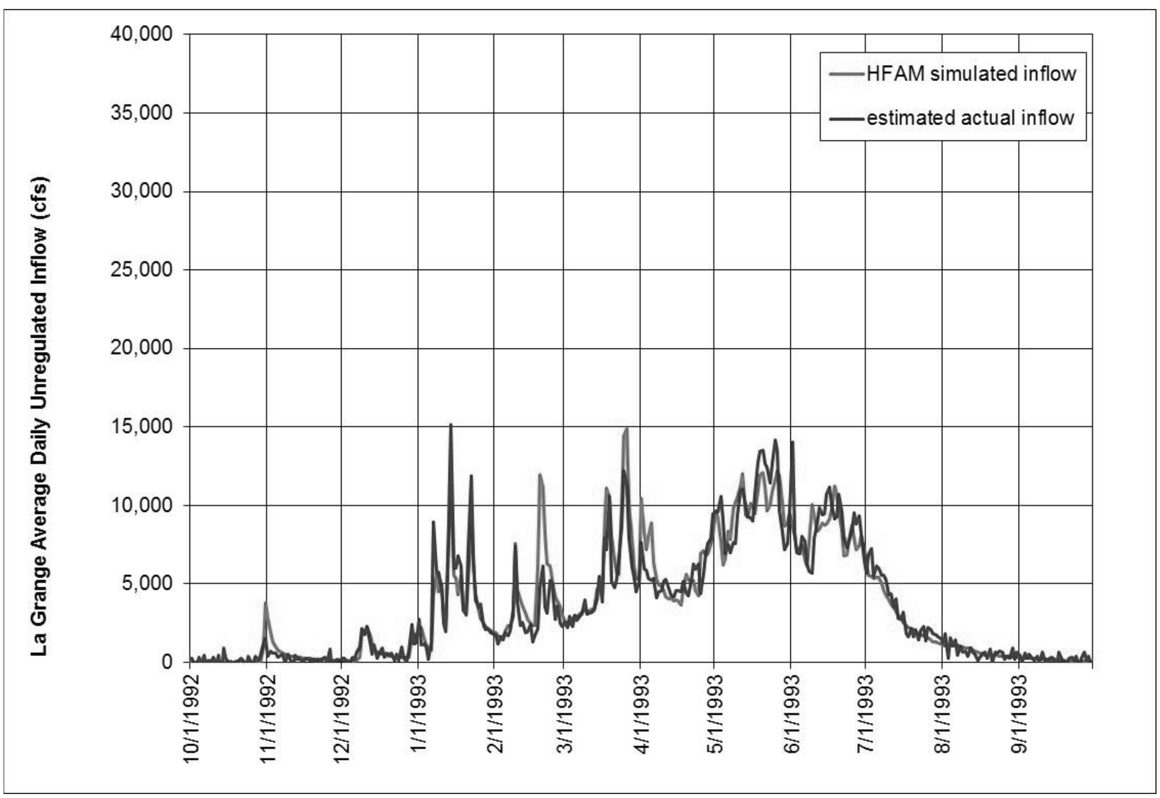

Figure B.19b La Grange Daily Unregulated Inflow, water year 1993

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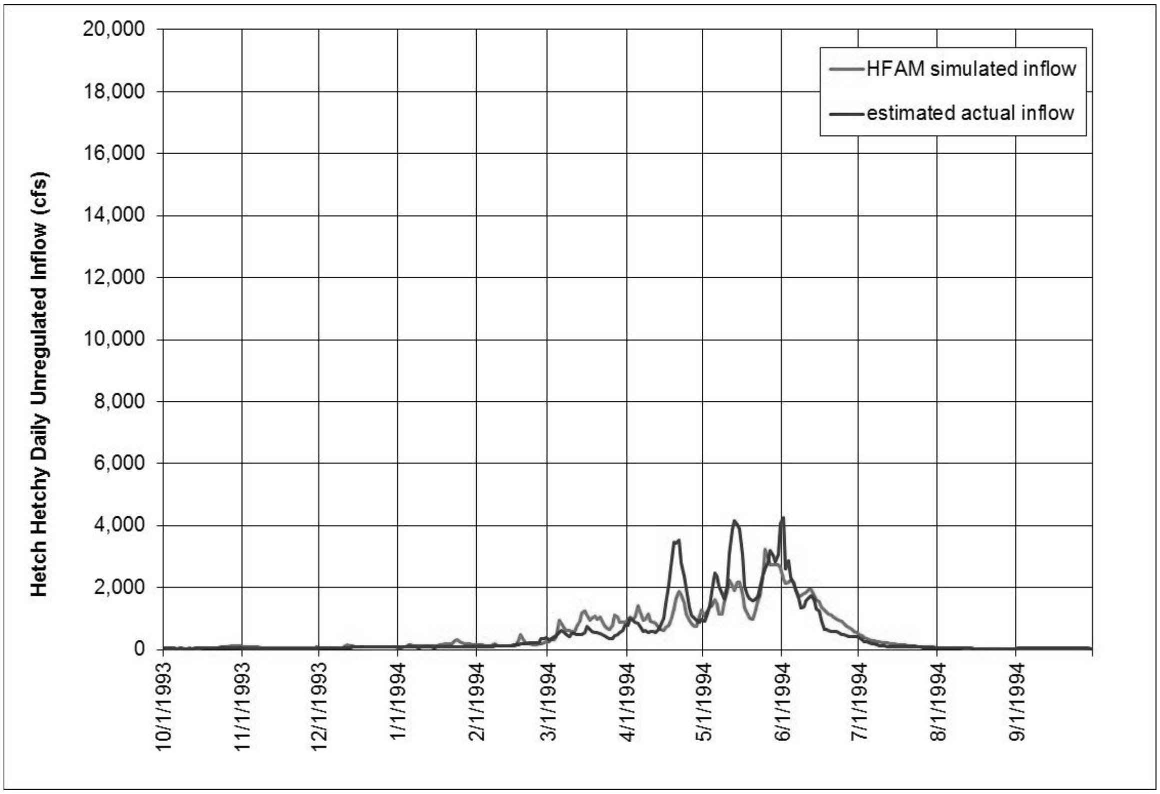

Figure B.20a Hetch Hetchy Daily Unregulated Inflow, water year 1994

HY-52 cont.

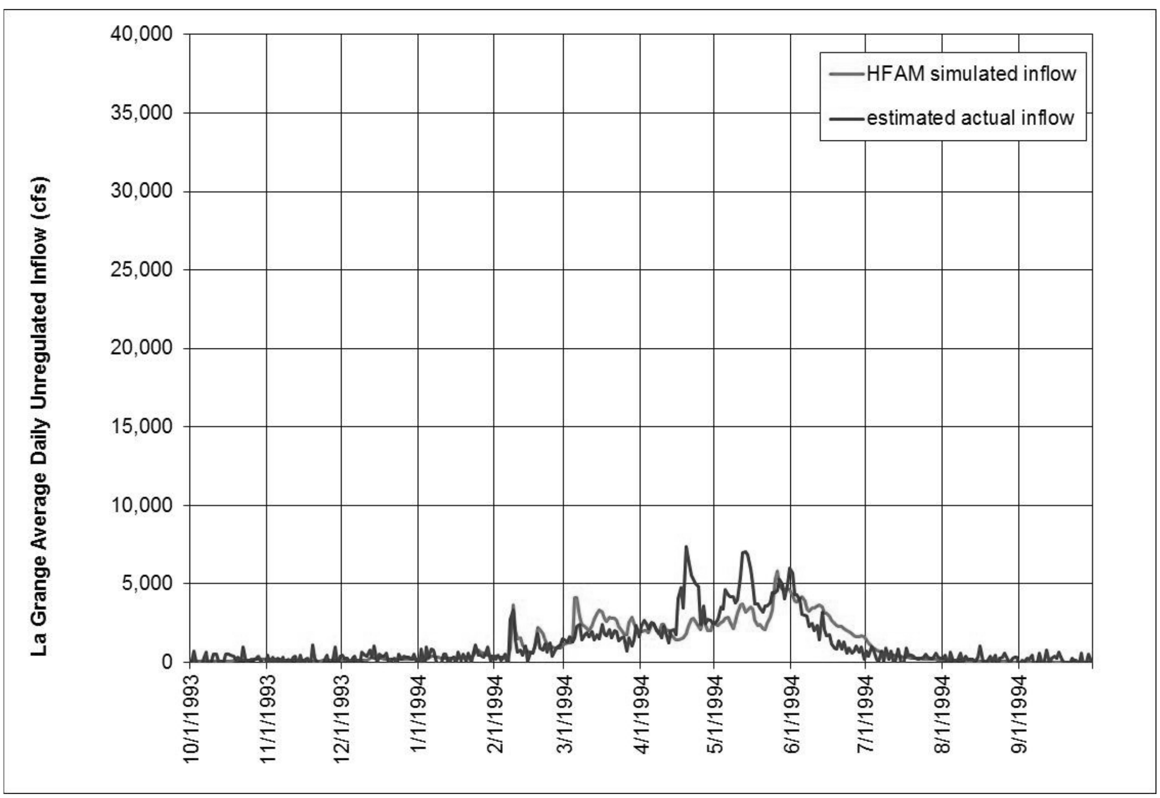

Figure B.20b La Grange Daily Unregulated Inflow, water year 1994

O-TRT-DREKMEIER Cont.

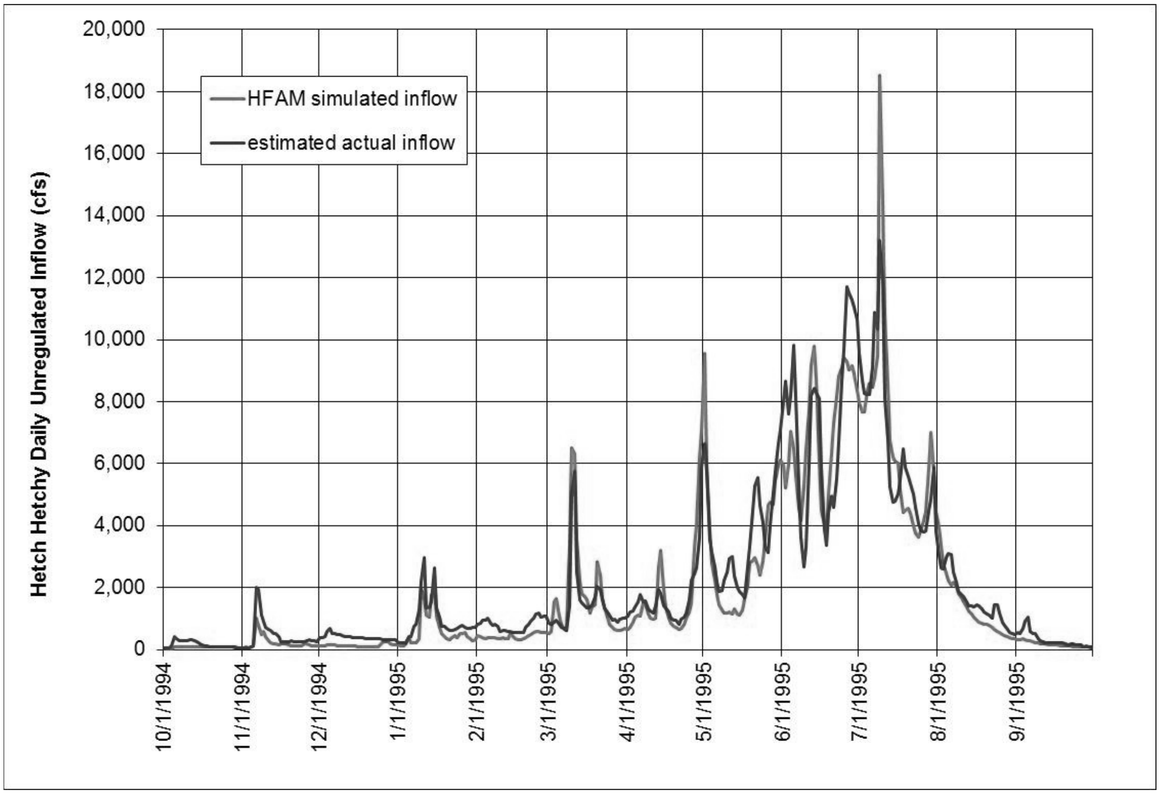

Figure B.21a Hetch Hetchy Daily Unregulated Inflow, water year 1995

HY-52 cont.

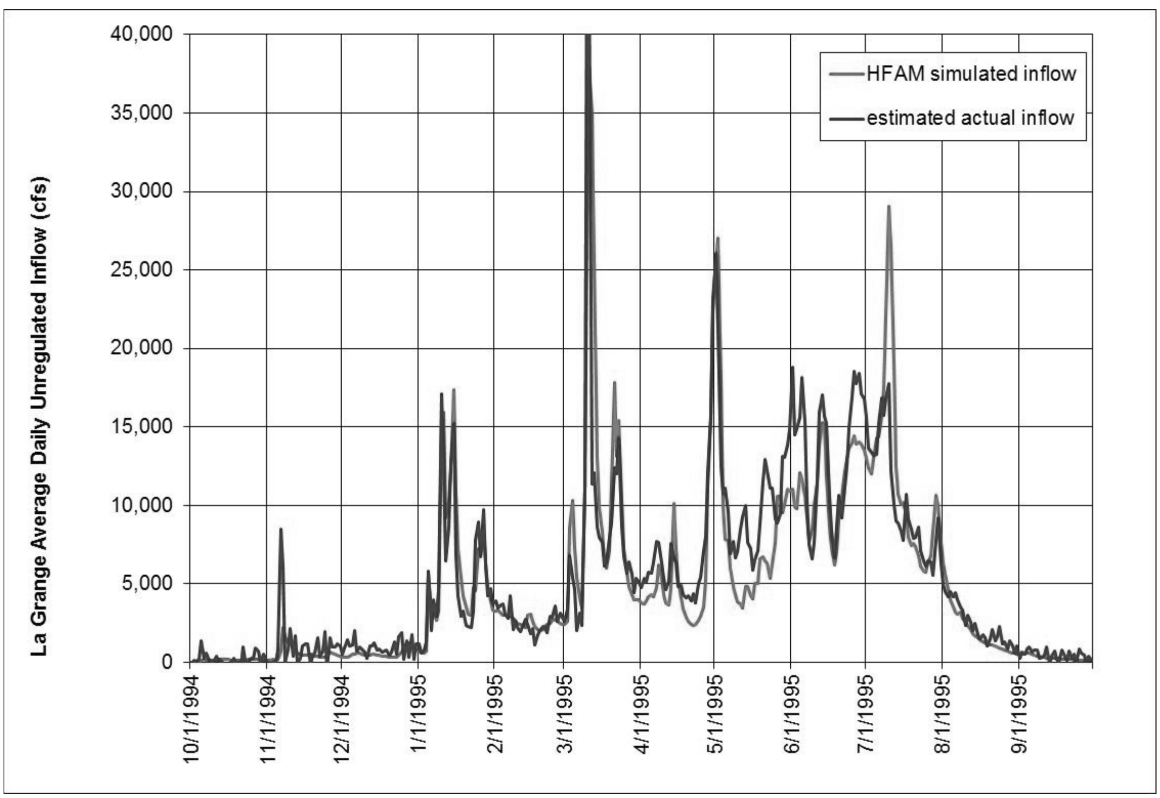

Figure B.21b La Grange Daily Unregulated Inflow, water year 1995

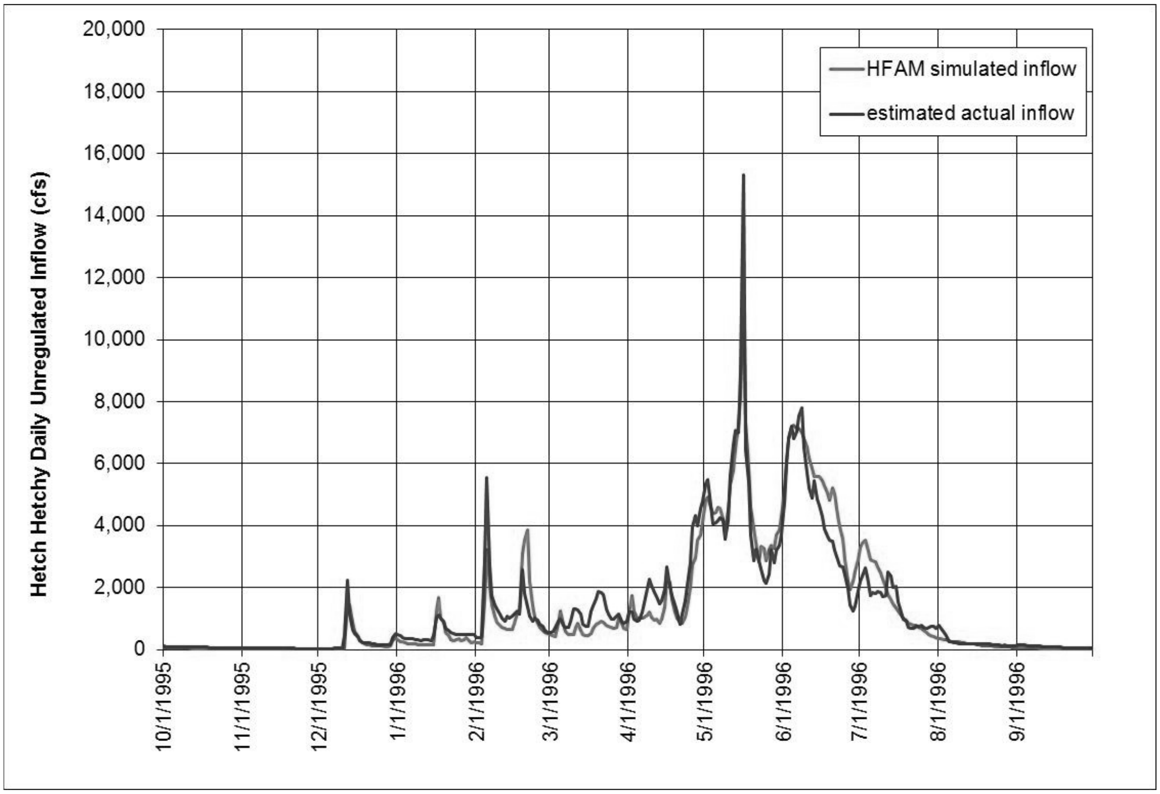

Figure B.22a Hetch Hetchy Daily Unregulated Inflow, water year 1996

HY-52 cont.

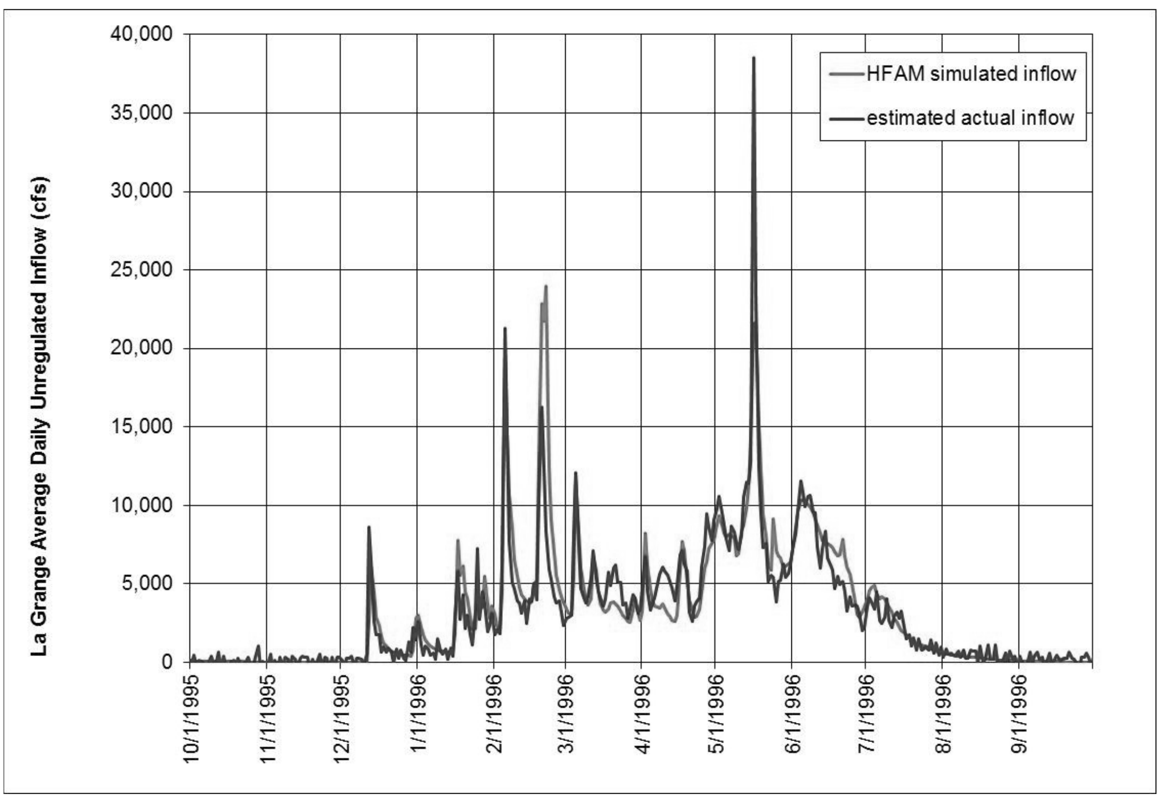

Figure B.22b La Grange Daily Unregulated Inflow, water year 1996

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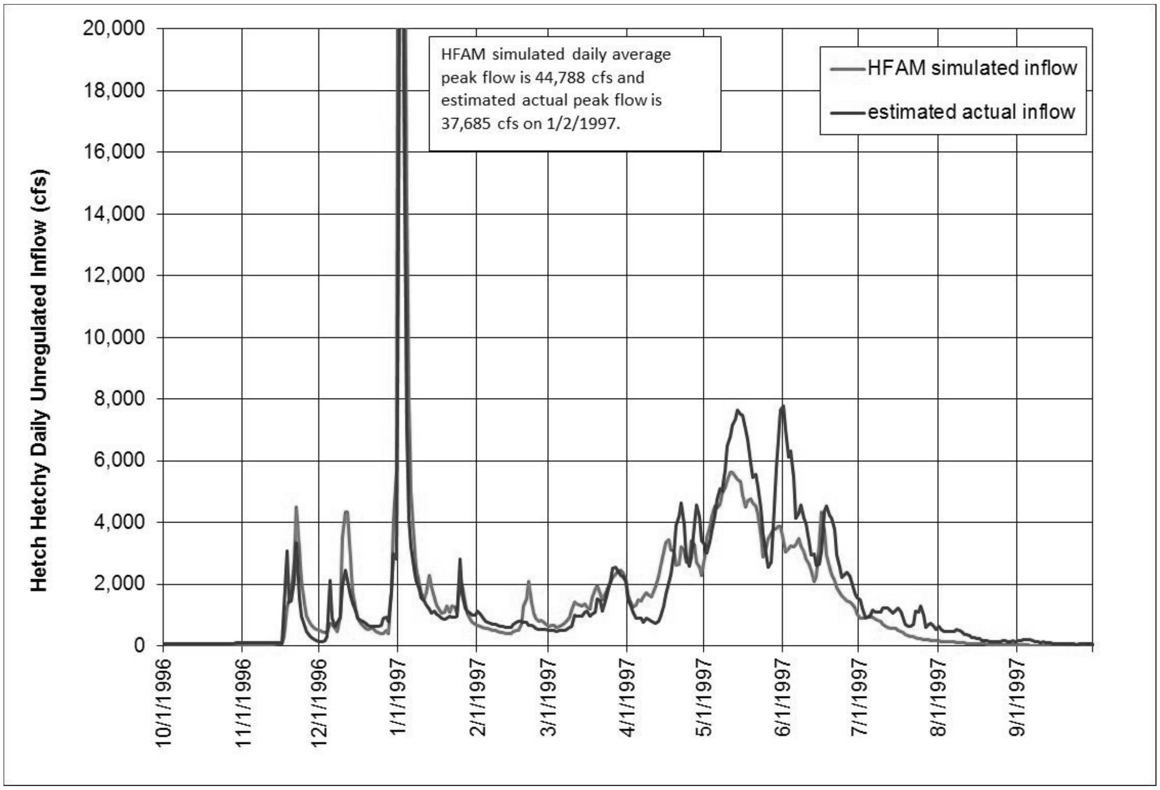

Figure B.23a Hetch Hetchy Daily Unregulated Inflow, water year 1997

HY-52
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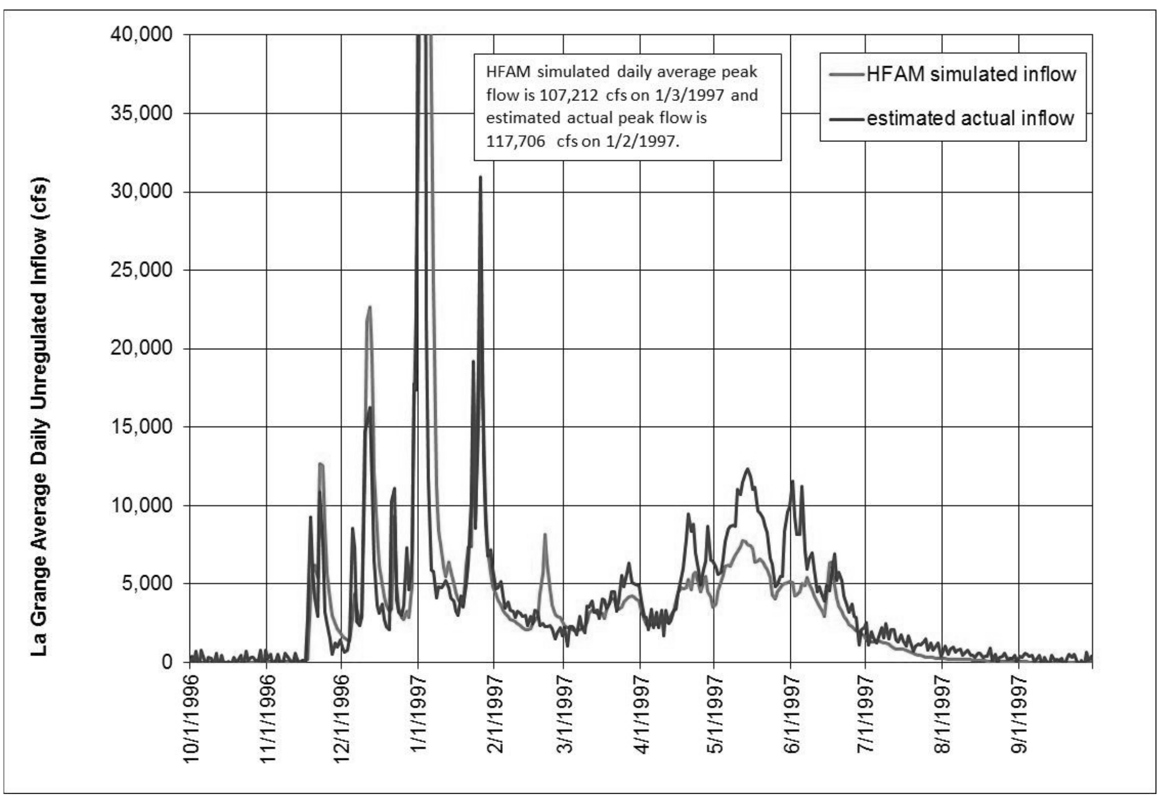

Figure B.23b La Grange Daily Unregulated Inflow, water year 1997

O-TRT-DREKMEIER Cont.

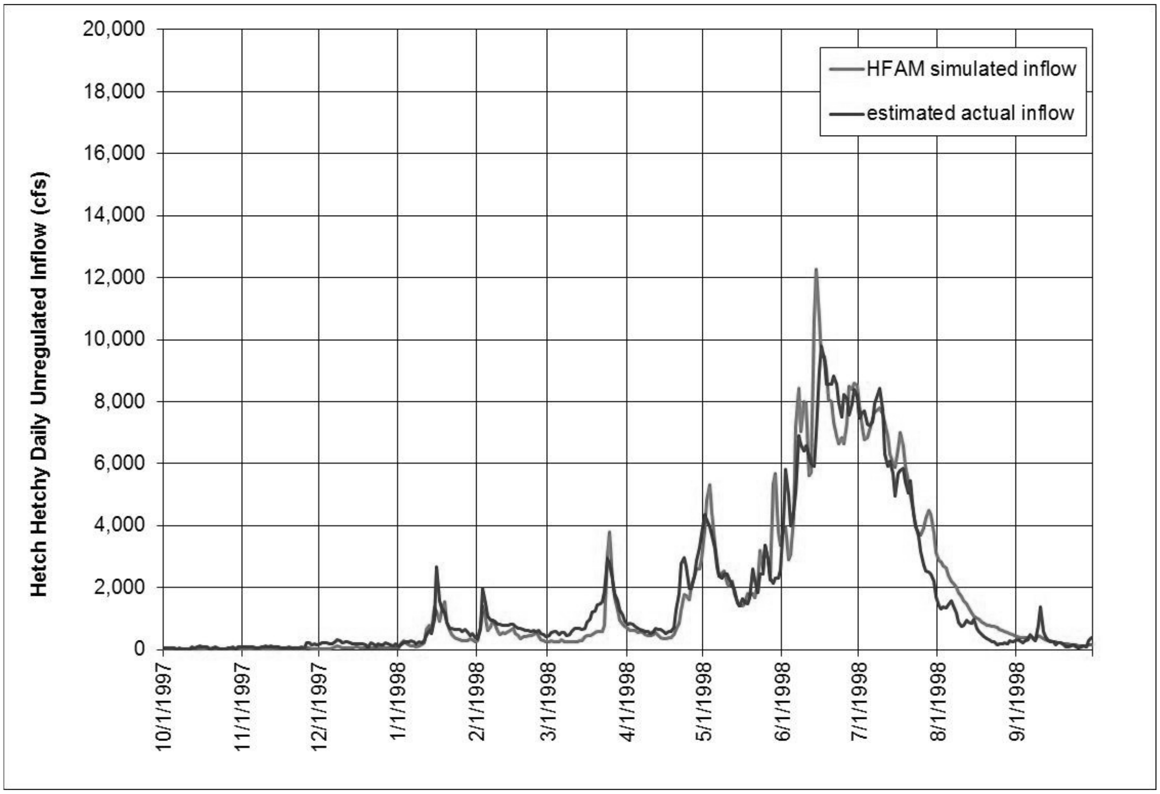

Figure B.24a Hetch Hetchy Daily Unregulated Inflow, water year 1998

HY-52 cont.

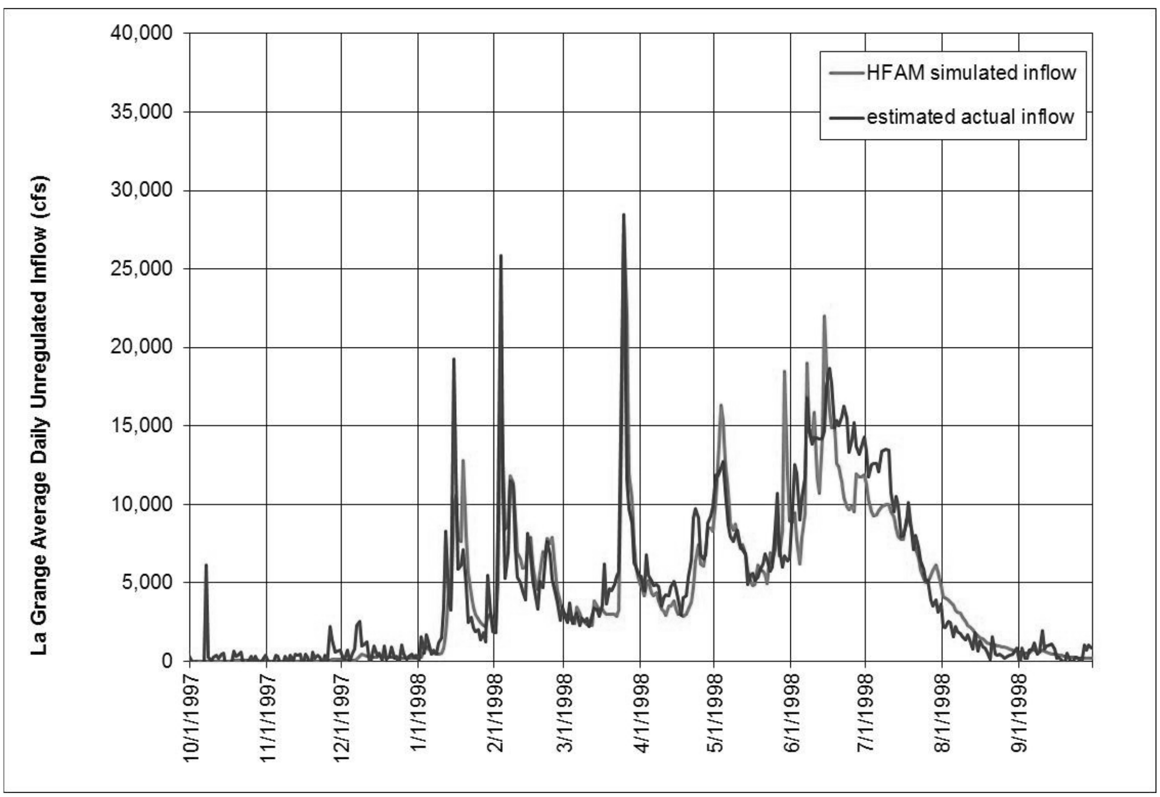

Figure B.24b La Grange Daily Unregulated Inflow, water year 1998

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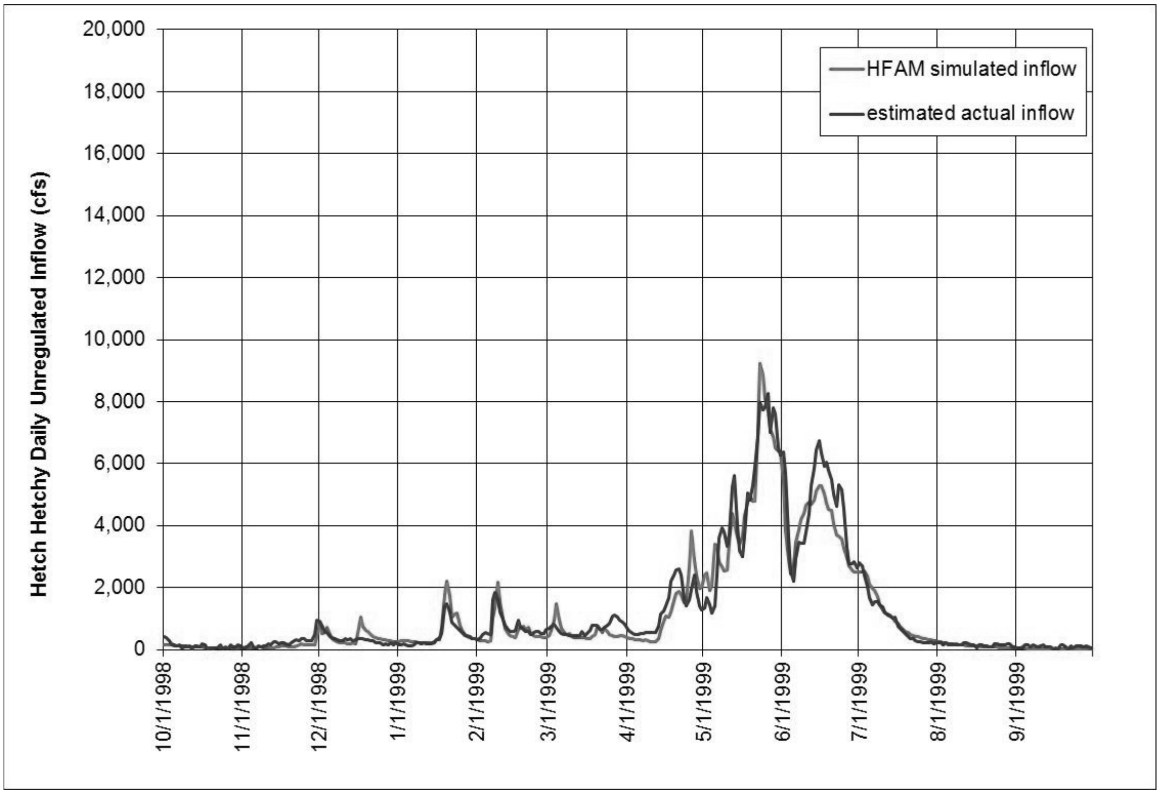


Figure B.25a Hetch Hetchy Daily Unregulated Inflow, water year 1999

HY-52 cont.

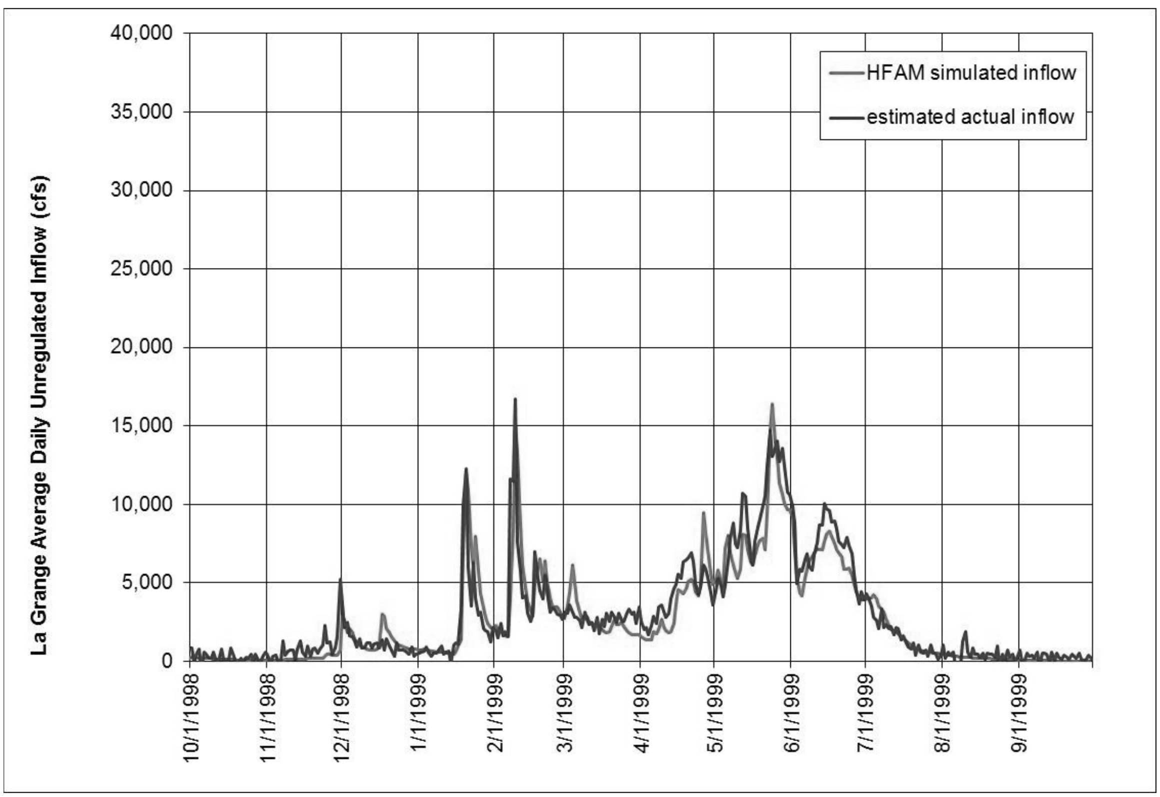


Figure B.25b La Grange Daily Unregulated Inflow, water year 1999

O-TRT-DREKMEIER Cont.

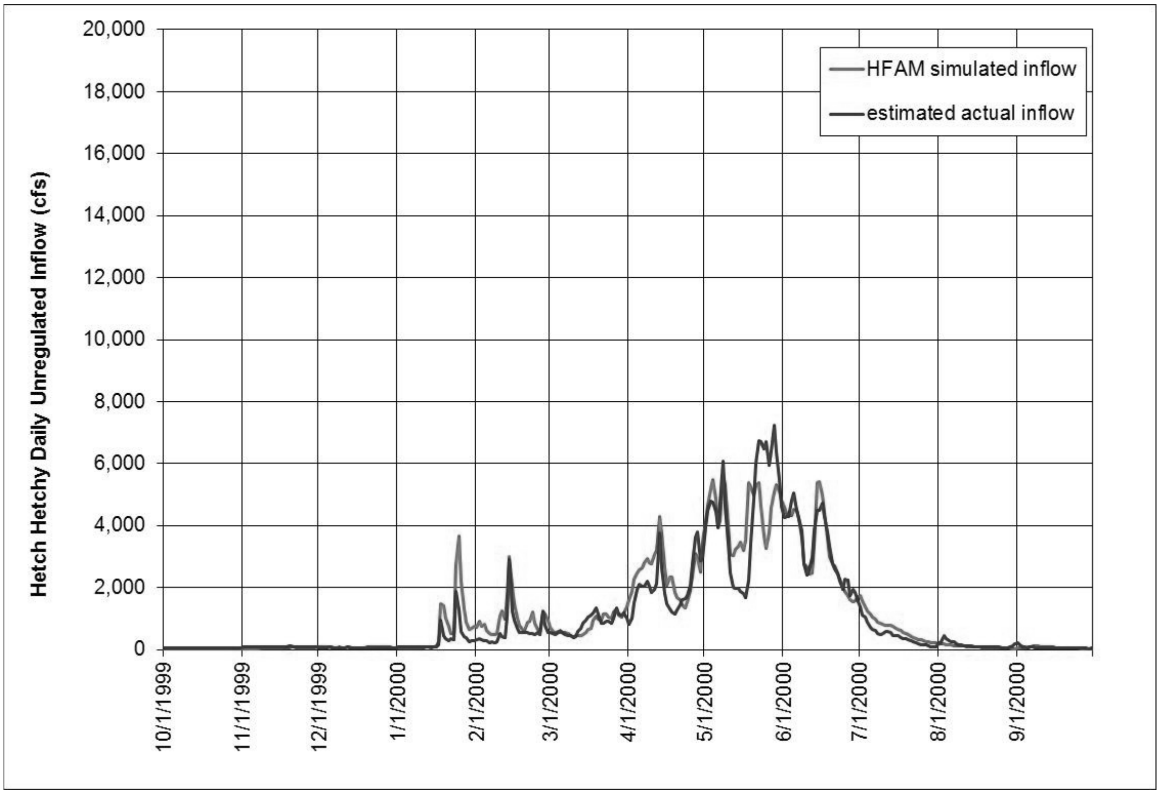


Figure B.26a Hetch Hetchy Daily Unregulated Inflow, water year 2000

HY-52 cont.

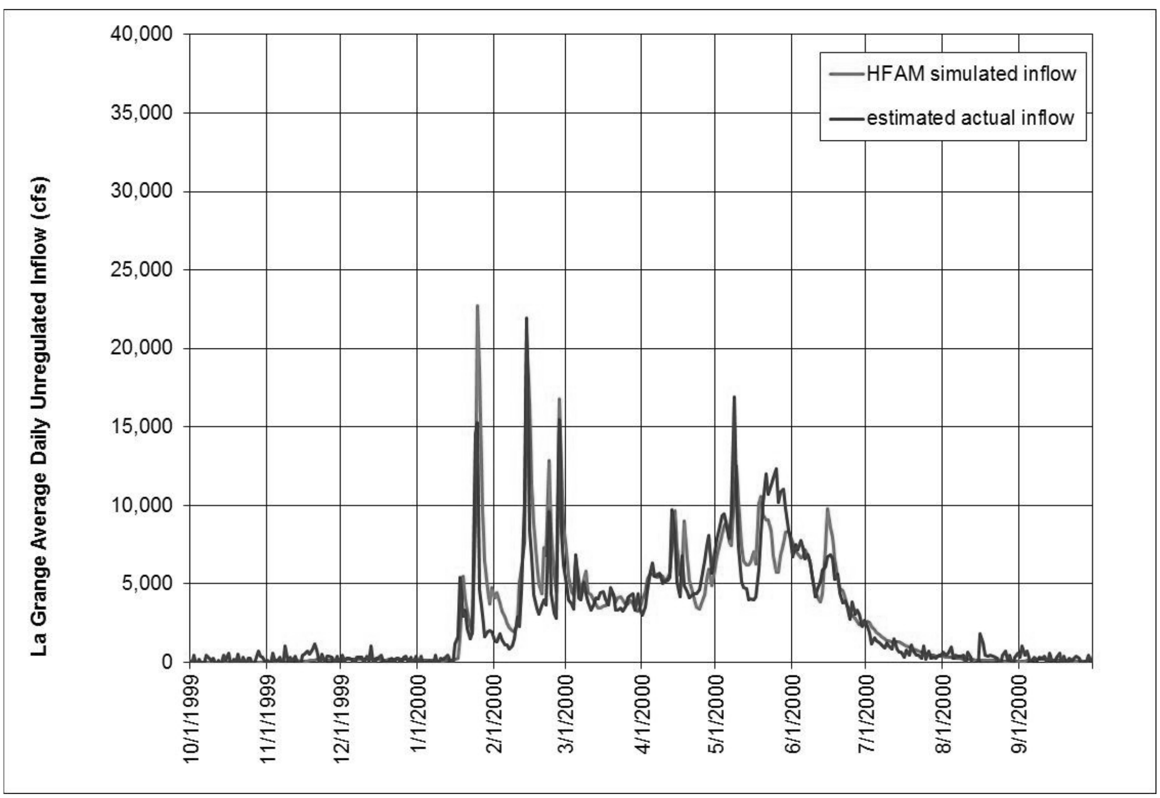


Figure B.26b La Grange Daily Unregulated Inflow, water year 2000

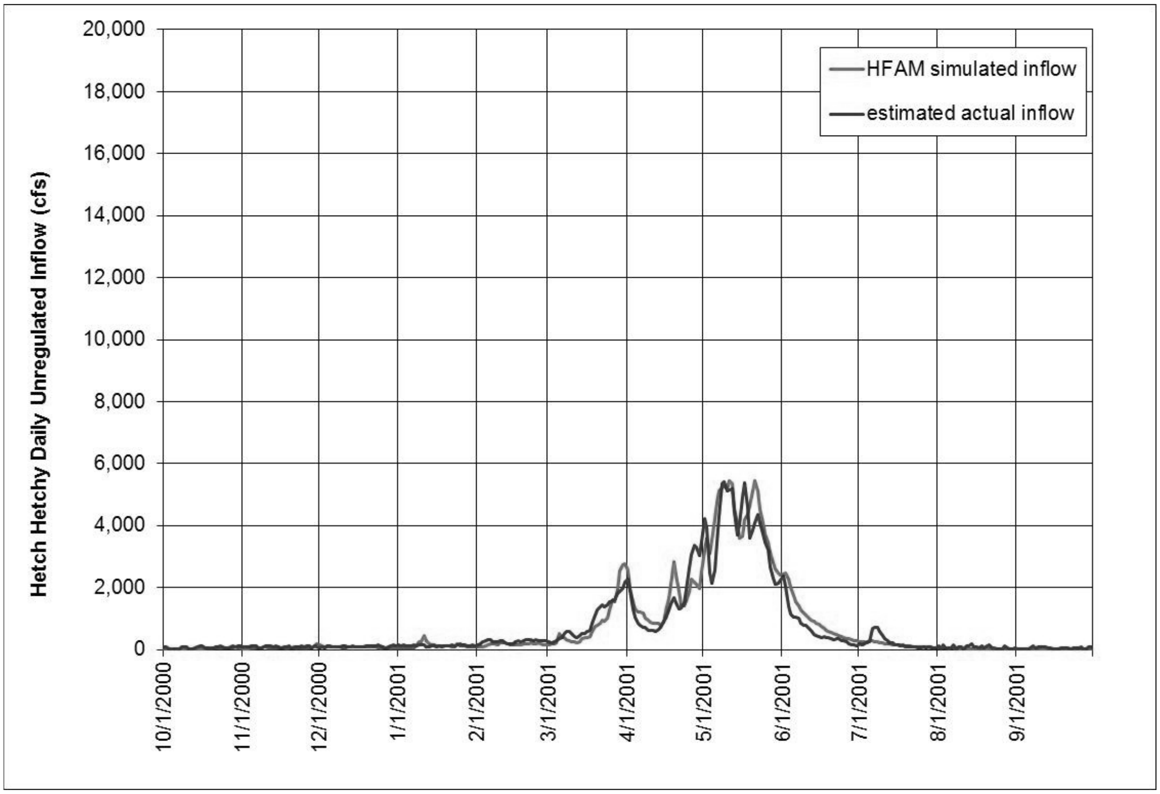


Figure B.27a Hetch Hetchy Daily Unregulated Inflow, water year 2001

HY-52 cont.

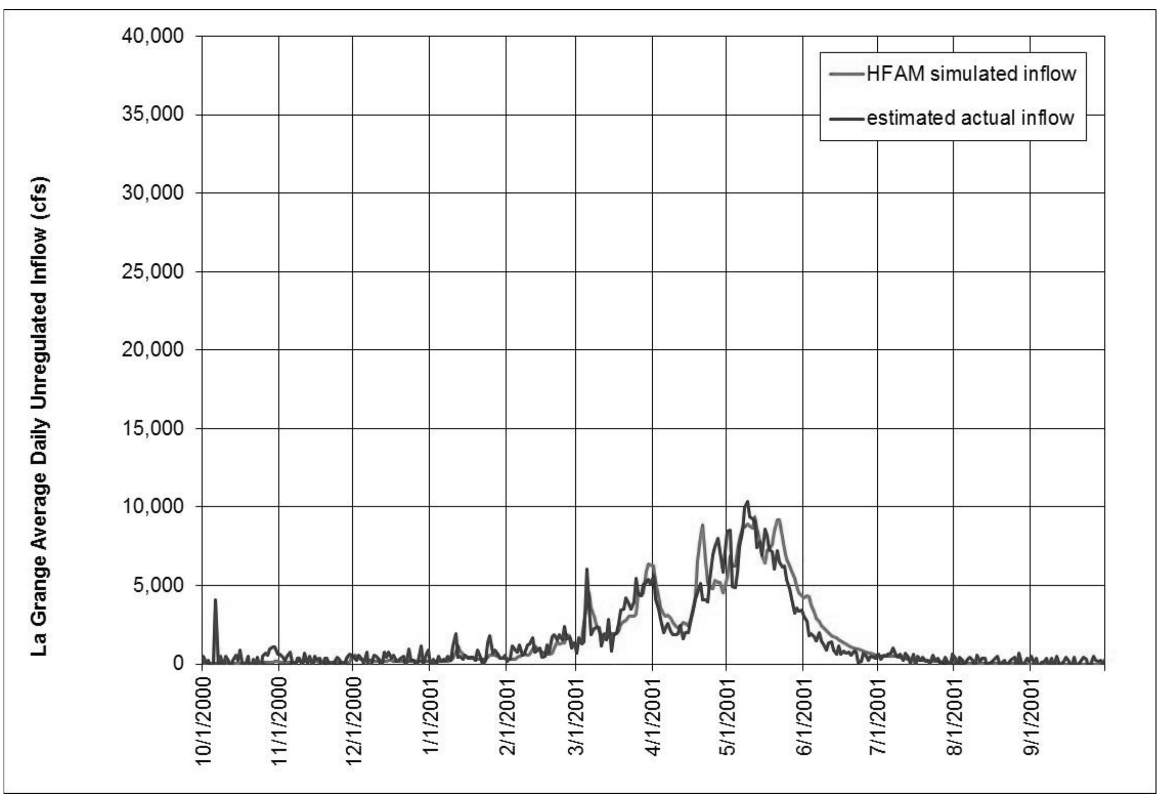


Figure B.27b La Grange Daily Unregulated Inflow, water year 2001

O-TRT-DREKMEIER Cont.

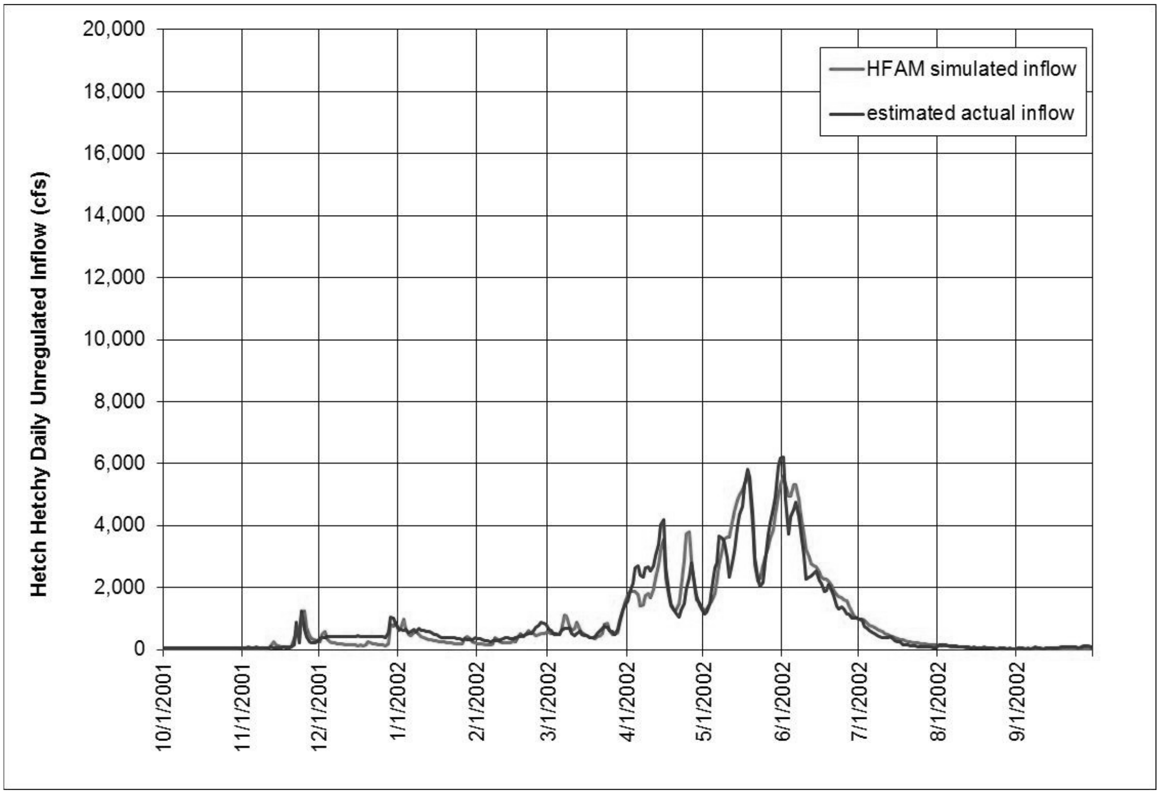


Figure B.28a Hetch Hetchy Daily Unregulated Inflow, water year 2002

HY-52 cont.

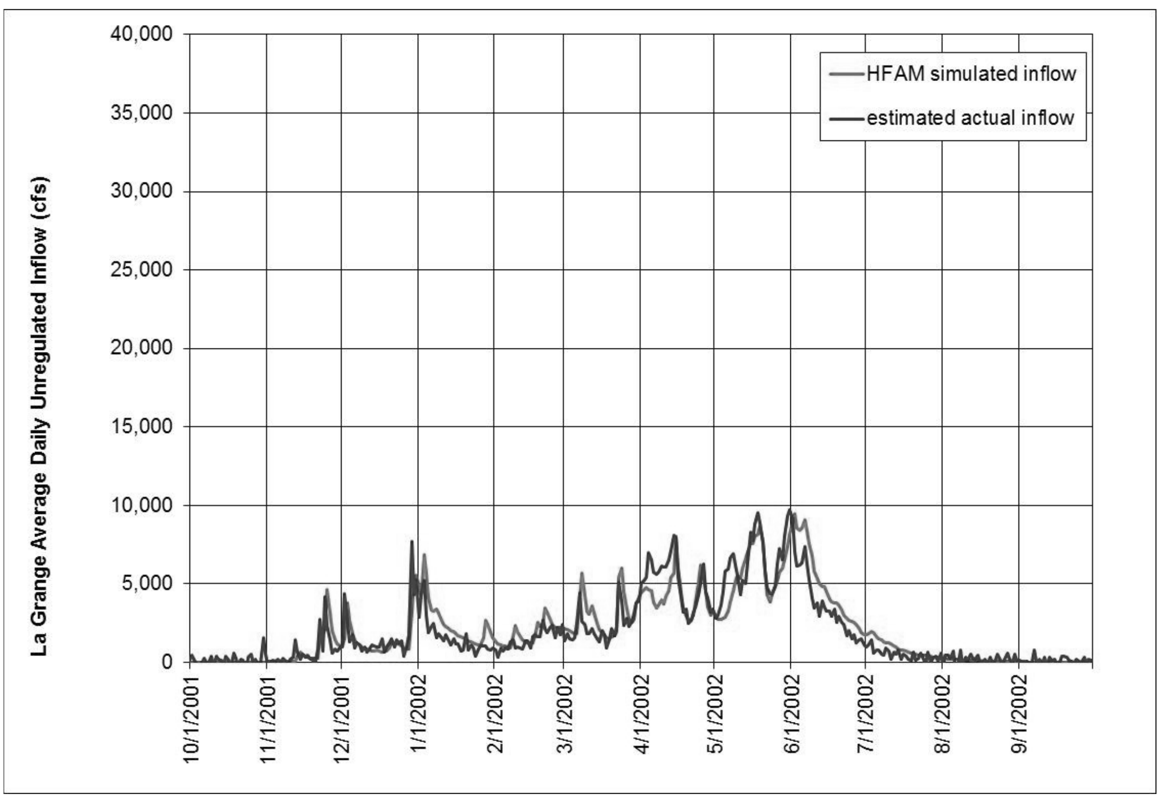


Figure B.28b La Grange Daily Unregulated Inflow, water year 2002

O-TRT-DREKMEIER Cont.

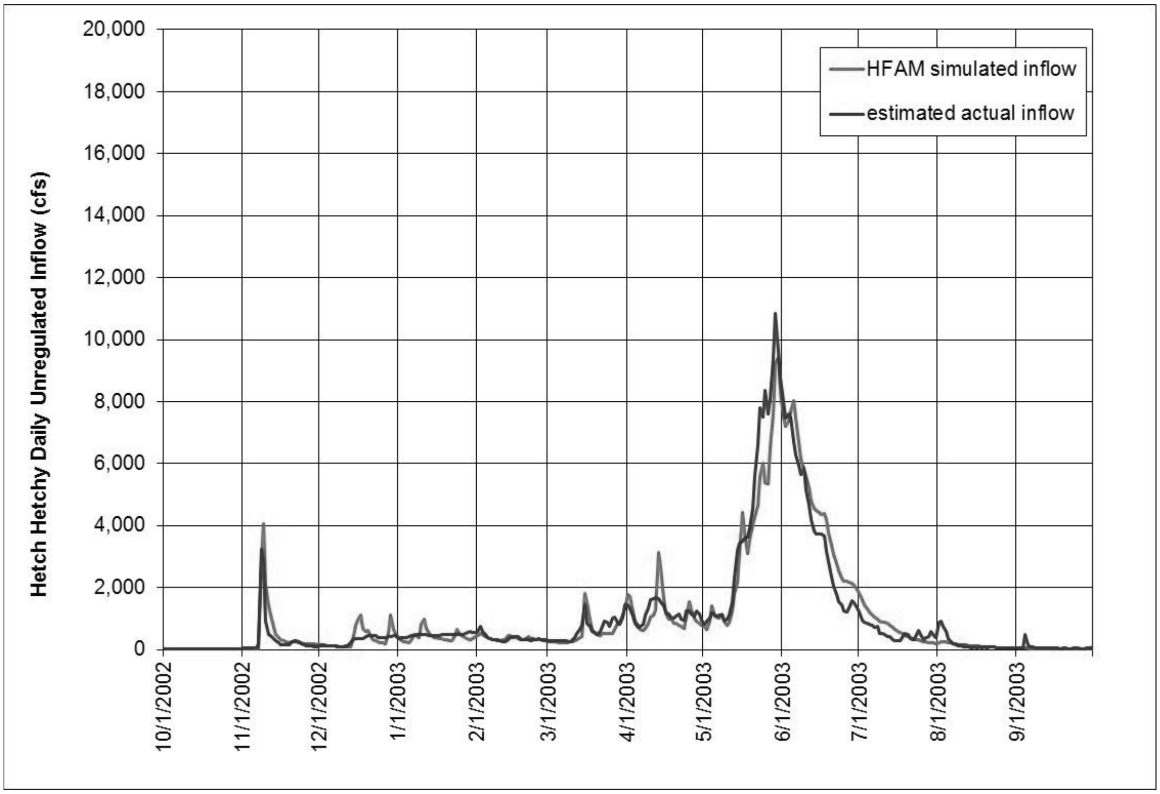


Figure B.29a Hetch Hetchy Daily Unregulated Inflow, water year 2003

HY-52 cont.

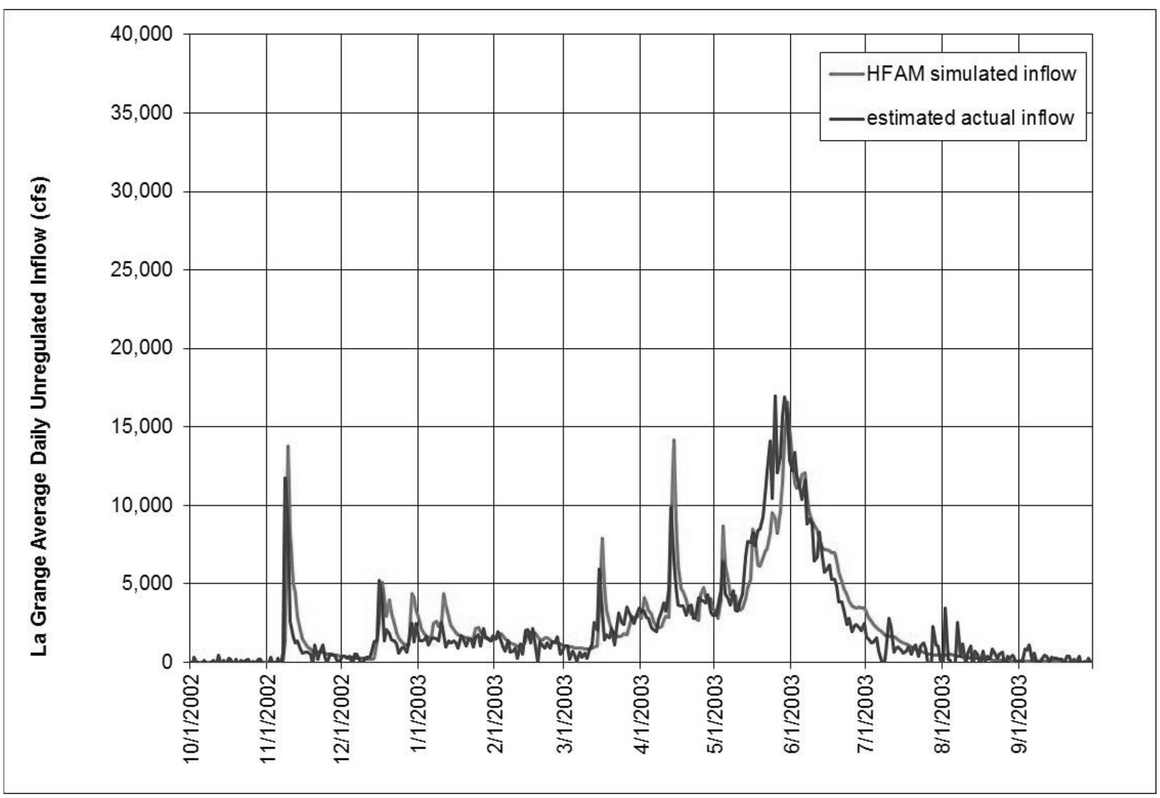


Figure B.29b La Grange Daily Unregulated Inflow, water year 2003

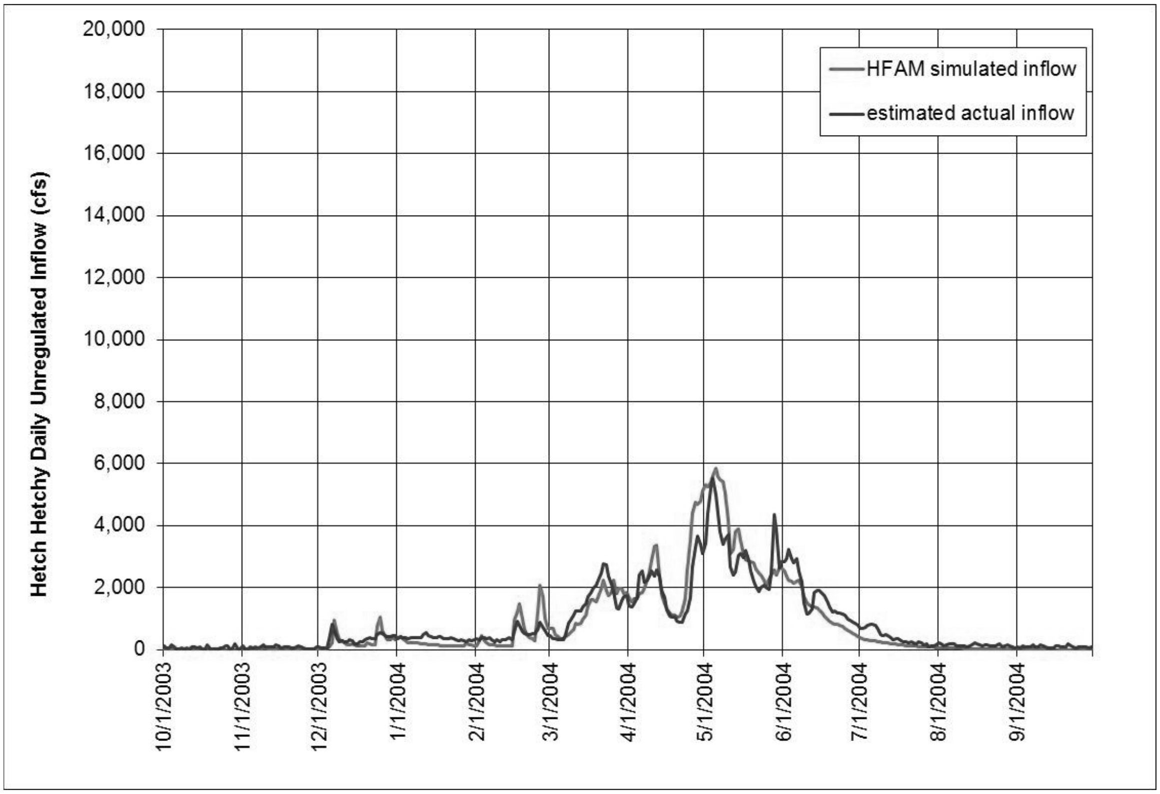


Figure B.30a Hetch Hetchy Daily Unregulated Inflow, water year 2004

HY-52 cont.

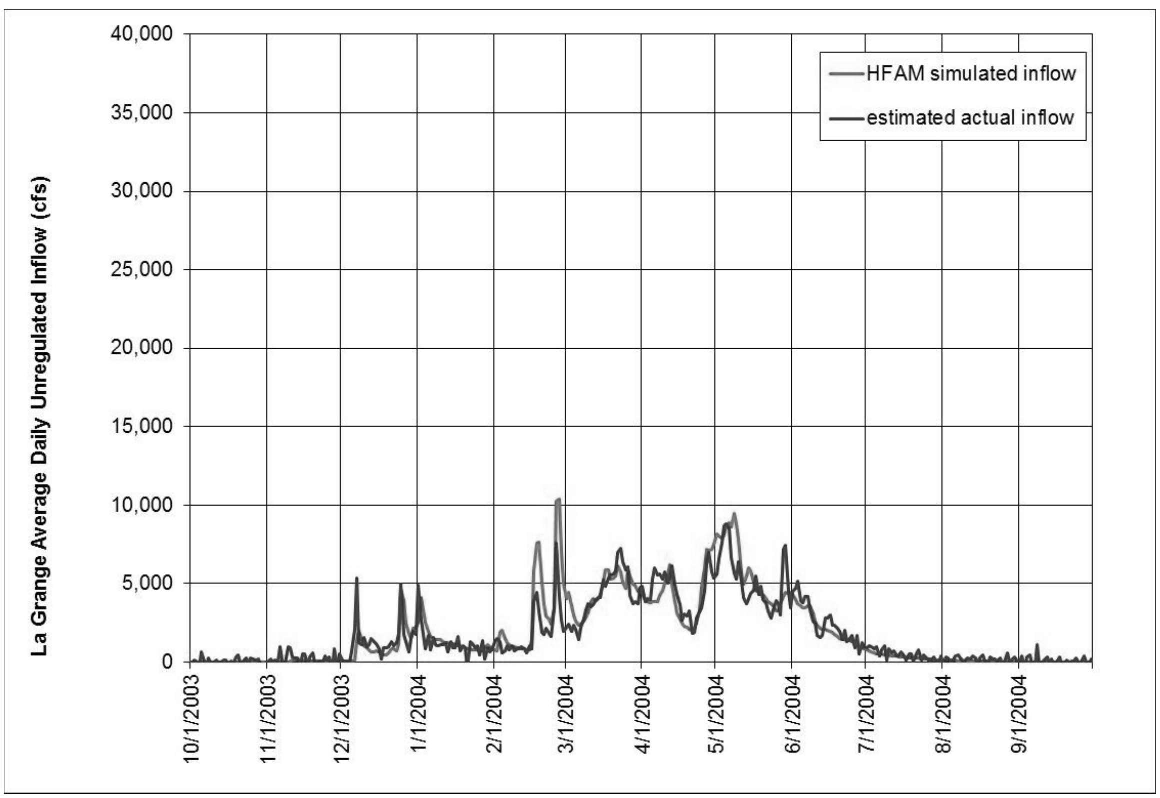


Figure B.30b La Grange Daily Unregulated Inflow, water year 2004

O-TRT-DREKMEIER Cont.

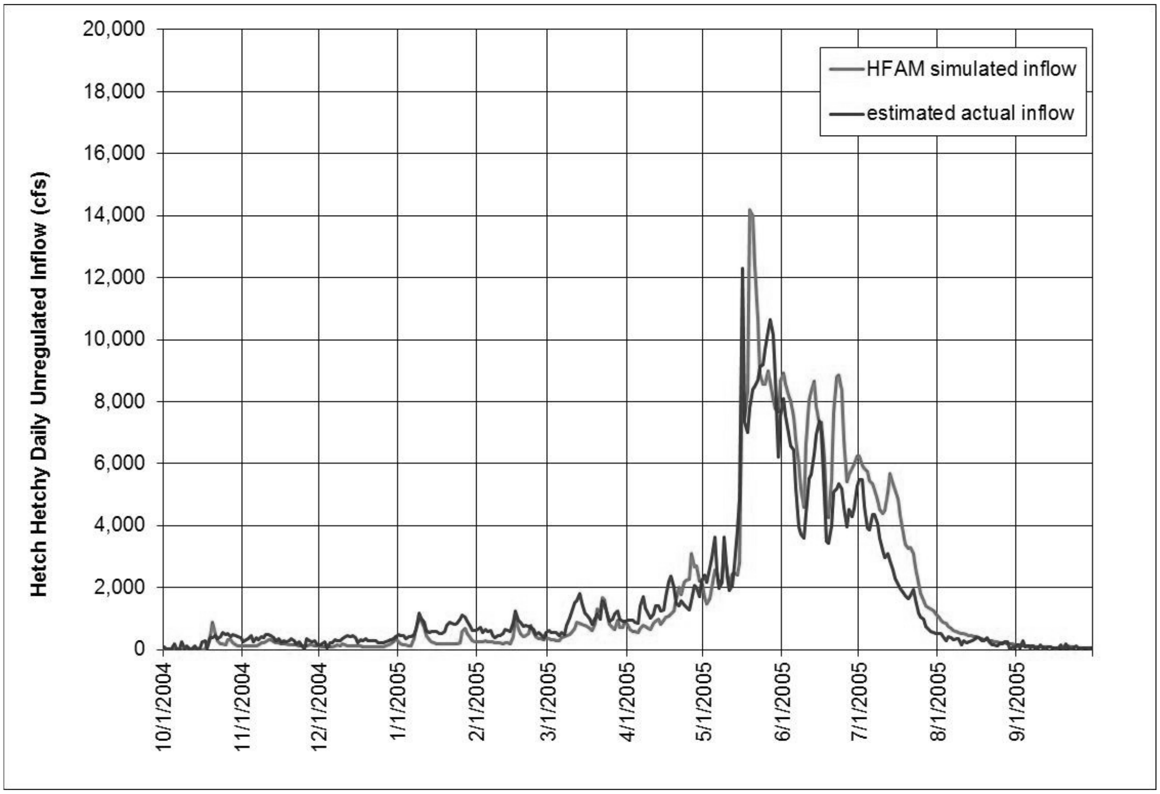


Figure B.31a Hetch Hetchy Daily Unregulated Inflow, water year 2005

HY-52 cont.

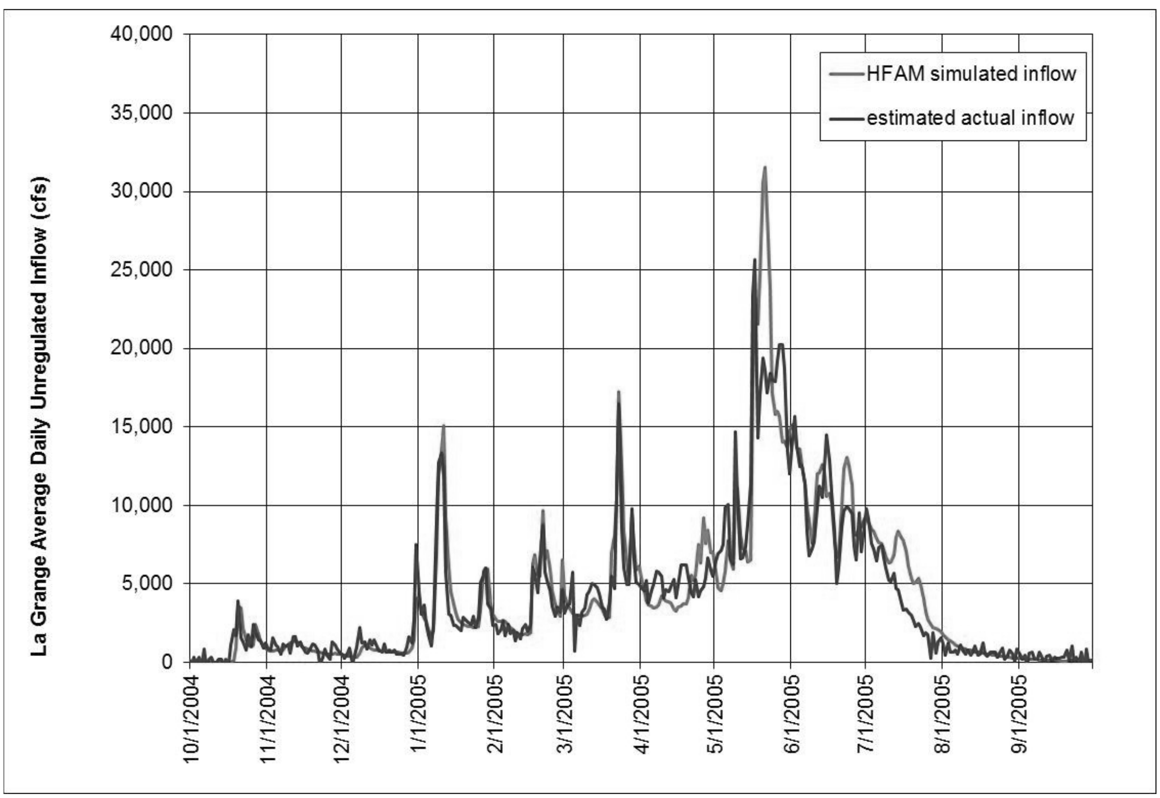


Figure B.31b La Grange Daily Unregulated Inflow, water year 2005

O-TRT-DREKMEIER Cont.

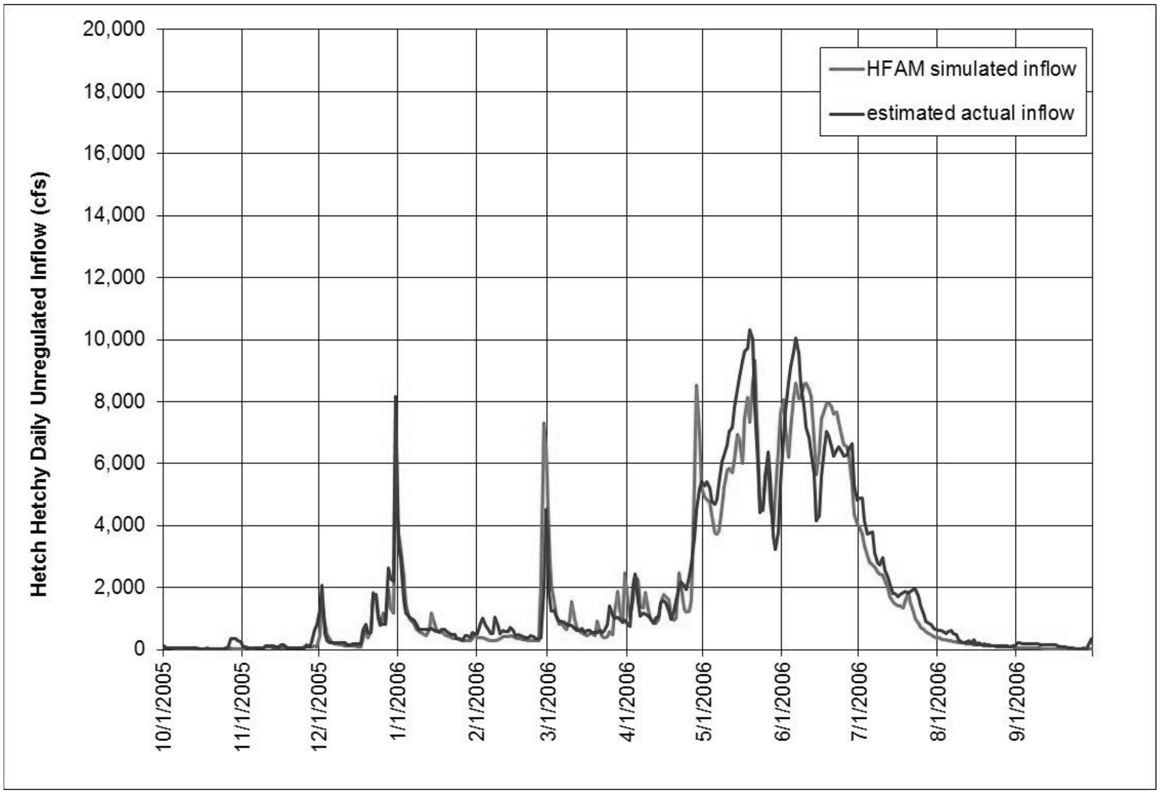


Figure B.32a Hetch Hetchy Daily Unregulated Inflow, water year 2006

HY-52 cont.

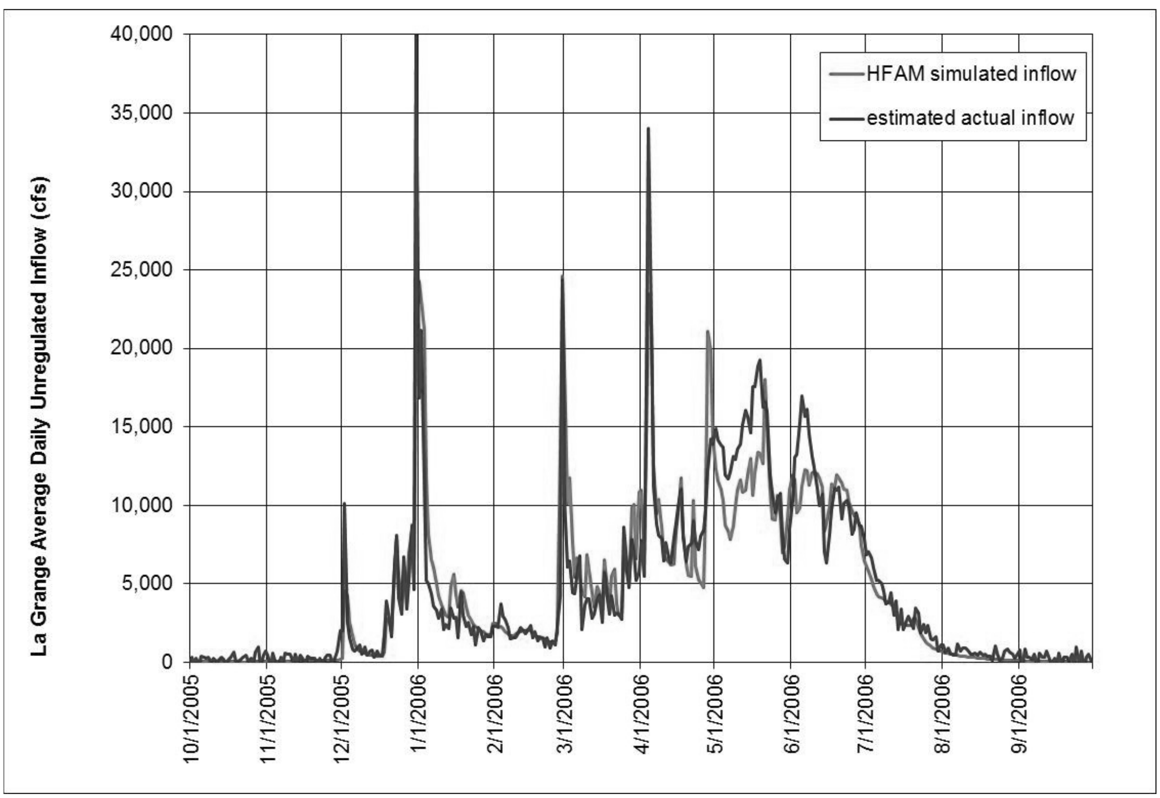


Figure B.32b La Grange Daily Unregulated Inflow, water year 2006

O-TRT-DREKMEIER Cont.

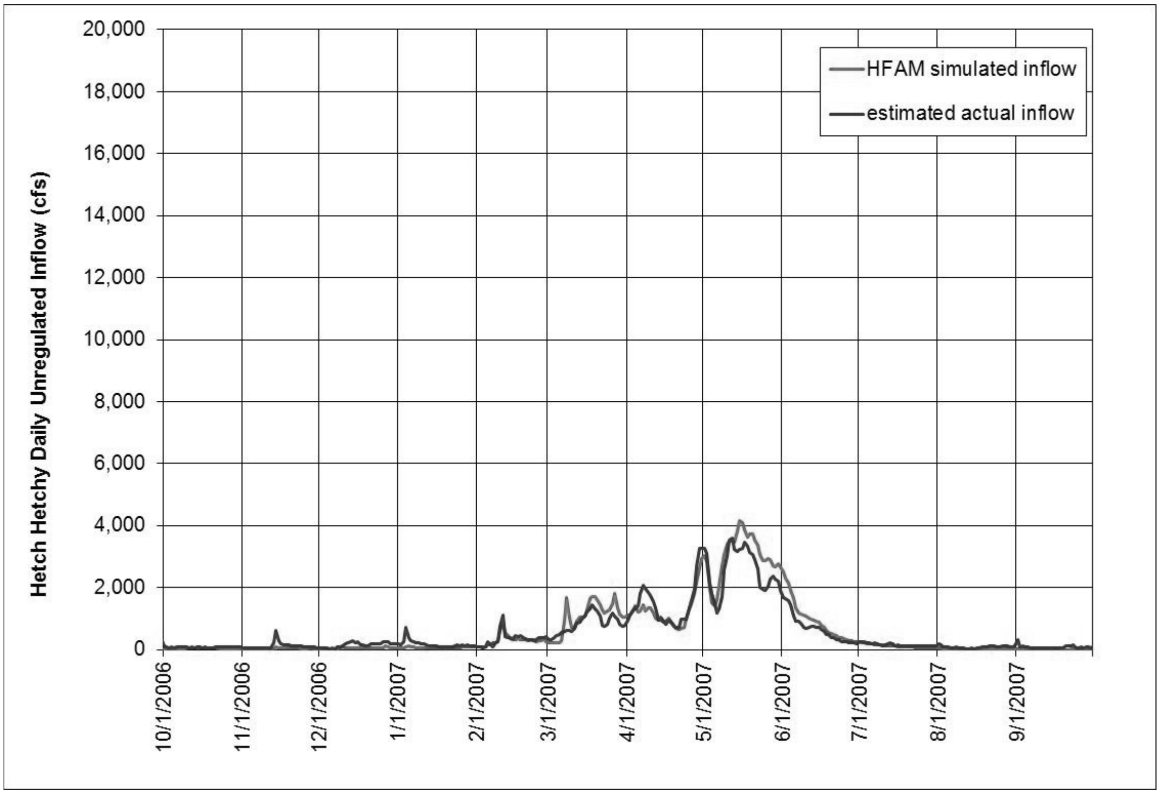


Figure B.33a Hetch Hetchy Daily Unregulated Inflow, water year 2007

HY-52 cont.

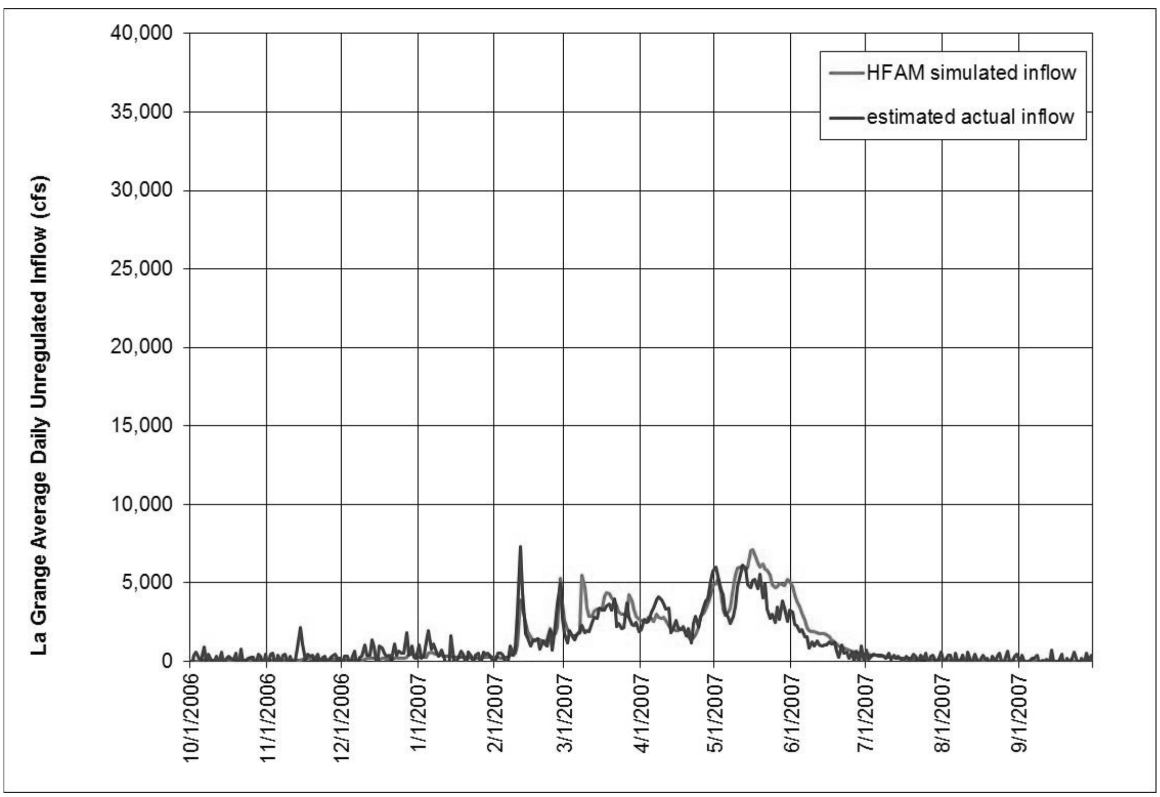


Figure B.33b La Grange Daily Unregulated Inflow, water year 2007

O-TRT-DREKMEIER Cont.

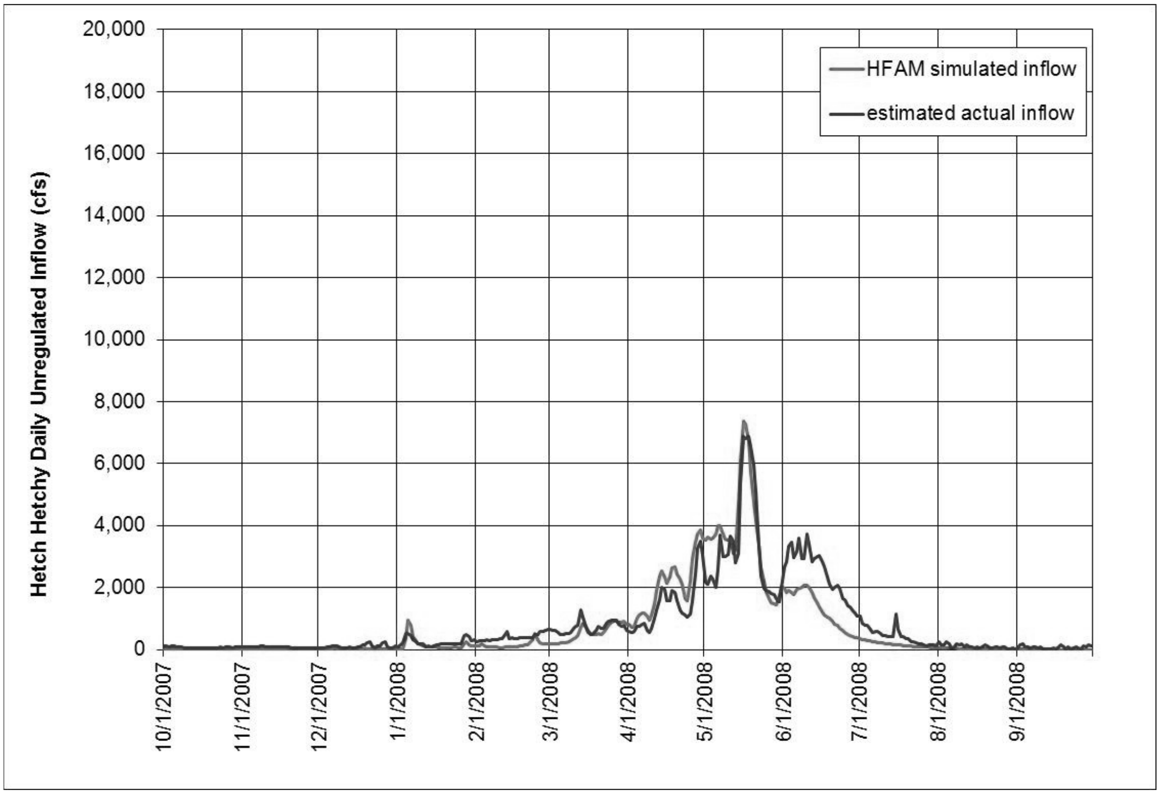


Figure B.34a Hetch Hetchy Daily Unregulated Inflow, water year 2008

HY-52 cont.

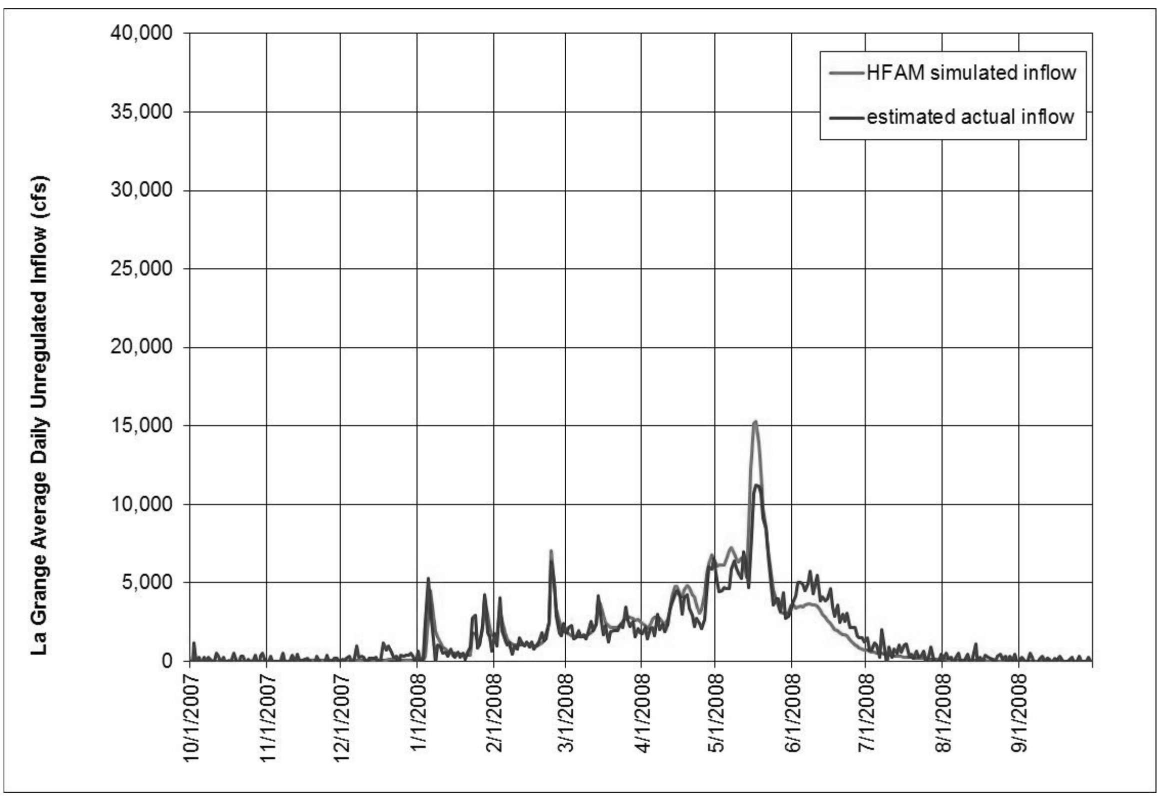


Figure B.34b La Grange Daily Unregulated Inflow, water year 2008

APPENDIX C

HY-52 cont.

Long Term Meteorological Records at Hetch Hetchy and Cherry Valley

O-TRT-DREKMEIER Cont.

APPENDIX C

Long Term Meteorological Records at Hetch Hetchy and Cherry Valley

C.1 NOAA Substation History and Data Base Notes

A NOAA Substation History, published in 1958, shows installation of maximum-minimum temperature gages and a storage rain gage in 1910. No significant changes in location of the gages are listed from 1910 to 1958.The instruments appear to have remained in place to the present, except for the changes noted by Bruce McGurk.

In 1942, a recording rain gage was added at Hetch Hetchy. When the Tuolumne River modeling database was first established in 1998, hourly data were obtained from NCDC for Hetch Hetchy from 1948 to 1996. Overall, the hourly data were only 91 percent complete and the storage rain gage data were more reliable.

When only daily total precipitation data are available, patterns of hourly precipitation distributions for similar daily total precipitation are used. An hourly distribution, randomly selected from a collection of distributions, is used to create hourly data for the day. Hourly distributions are seasonally dependent.

HY-52 cont.

The NOAA Substation History in 1958 includes the Cherry Valley station, installed in October 1955, and states that the instruments are "on the ground, well shaded by surrounding trees".

C.2 Summary of notes and photographs provided by Bruce McGurk, Operations Manager & Hydrologist, Hetch Hetchy Water & Power - Moccasin in May 2009

The Hetch Hetchy station (HTH) has been at the same site since 1930. The glass maximum and minimum thermometers and standard 8 inch NWS manual brass rain gauge were serviced about 8 am, 7 days per week through 9/13/86 by Hetch Hetchy Water and Power (HHWP) watershed keepers. A retired watershed keeper, who spent 6 months at O'Shaughnessy when he joined HHWP in 1975, described the station as it was in 1975 in a recent phone conversation. His description matches what is there now, with one important change. The thermometers were then in the cotton-belt shelter across the road, about 25 ft. from the rain gauge (Photo 1).

O-TRT-DREKMEIER Cont.

HY-52 cont.

Photo 1. Hetch Hetchy rain gauge and road

The temperature shelter now is on the north side of a cluster of live oak trees, and the shelter is now on the north side rather than the south side of a 12 ft. wide blacktop road. The shelter is about 10 ft. from the road and has shading during a lot of the day, as it did prior to 1986; the view east is occluded by a deciduous and a conifer, and the view west is also mostly shaded but might get late afternoon sunshine in summer.

The rain gauge is on the south side of a 6 ft. patch of evergreen shrubs (Photo 2), the road and conifers to the east, and is fairly open to the west and south. The gauge has no windscreen, which is the normal setup for a NOAA gauge.

HY-52 cont.

Photo 2. Hetch Hetchy rain gauge and evergreen shrubs

The manual rain gauge and the cotton belt shelter have not moved, but on 9/13/1986, a Fisher-Porter 8 inch recording gauge was installed next to the manual can and a new temperature system was installed that was far from optimal. NOAA decided at that time to change from glass thermometers (breakage issues, mercury, etc.) to electronic systems through their system, and installed a thermistor network sensor. NOAA also changed to a naturally aspirated sensor shelter and abandoned the cotton-belt shelter at that time. The new temperature shelter was apparently fastened to the railing of the watershed keeper's house for several years – in February 2006 (Photo 3) you can just see the white blob in front of the blue truck on a railing below the porch roof. Last year it was put on a pole 10 ft. away in the yard, and that is a better site. Being next to the building and only about 3 ft. off the ground was not the NOAA standard. However, there is still a lot of shade there, especially afternoon in the summer, but there is an oak that sheds its leaves and probably leaves the shelter exposed to the sun in the winter time.

HY-52 cont.

Photo 3. Hetch Hetchy temperature gauge

The climate station near Cherry Dam (CHV) has had less change. It is behind the bunkhouse that was built in the 1950's when Cherry Dam was built (see Photo 4). I tracked the station back to 1975, and it is still using the same gage and glass thermometers, and has been consistently serviced by watershed keepers. I do not believe it is an official NOAA site, so it never got the automatic rain gauge or the electronic thermistor setup. The shelter and temperature sensors are shown in Photo 5. A paved parking area is closer than optimal and the access road is near as well.

The Hetch Hetchy and Cherry climate stations may have had vegetation and shading changes over this long time period. I have not researched photos of the Hetch Hetchy site back when the road was a train

Photo 4. Cherry Valley climate station

HY-52 cont.

Photo 5. Cherry Valley shelter and temperature sensors

APPENDIX D

HY-52 cont.

Snow Accumulation and Melt with Climate Change

Attachment A

O-TRT-DREKMEIER Cont.

APPENDIX D

Snow Accumulation and Melt with Climate Change

The Tuolumne River watershed's range in elevation and its diverse topography, soils, forests and vegetation is amenable to large-scale snow accumulation and melt process analysis, rather than small-scale analysis that might be done on an experimental watershed. The observed runoff at gages comes from multiple land segments. These land segments are at different elevations, and will have different aspect and shading from solar radiation. Snowpack water yield on a given day may occur only in a limited elevation range.

Real-time stations with snow pillow measurements of snow water equivalent do allow process analysis and comparisons between historic conditions and climate change scenarios. In the following figures, simulated Slide Canyon (SLI) snowpack conditions are compared to historic snow measurements for water year 1992. Slide Canyon is at 9200 feet elevation. Figure D-1 shows Slide Canyon observed and simulated snow water equivalent and liquid water in water year 1992. Figure D-2 shows the same model results for late March, April and May of water year 1992. HY-52 cont.

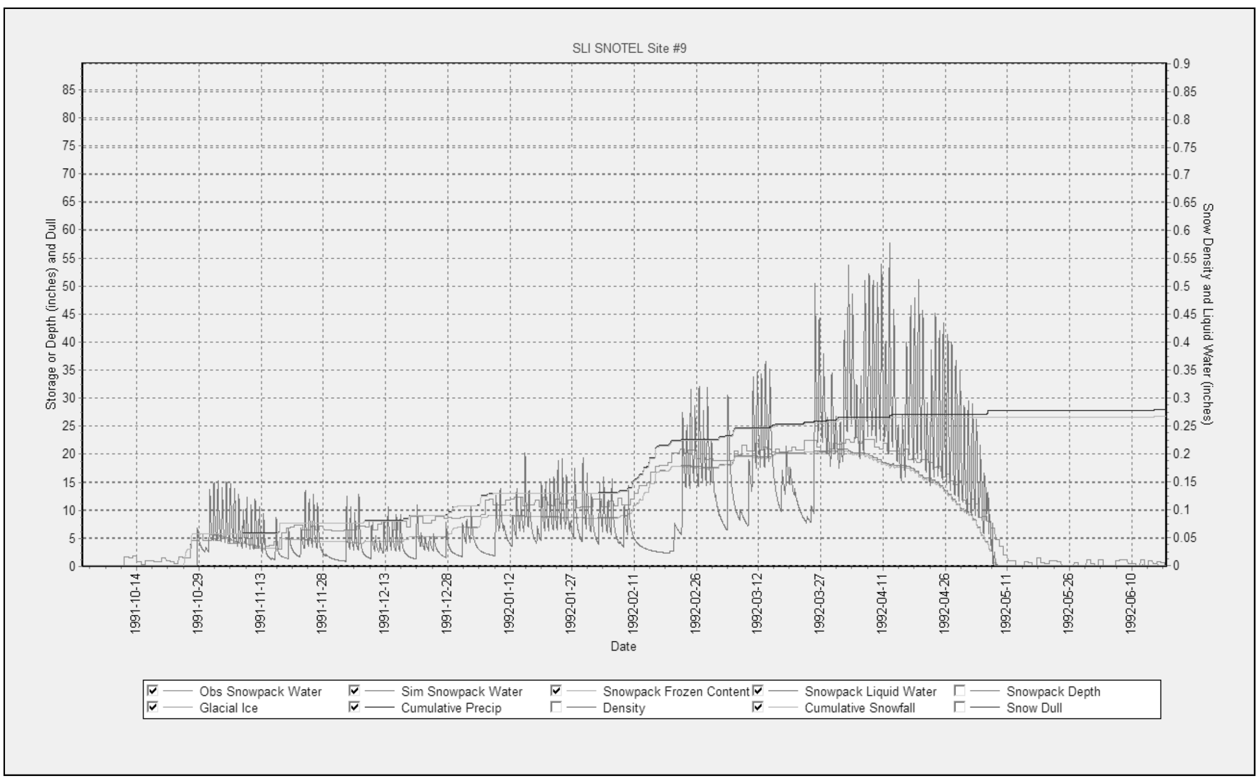


Figure D-1. Slide Canyon observed (pink) and simulated snow water equivalent (red) and liquid water content of the snowpack (blue), water year 1992

O-TRT-DREKMEIER Cont.

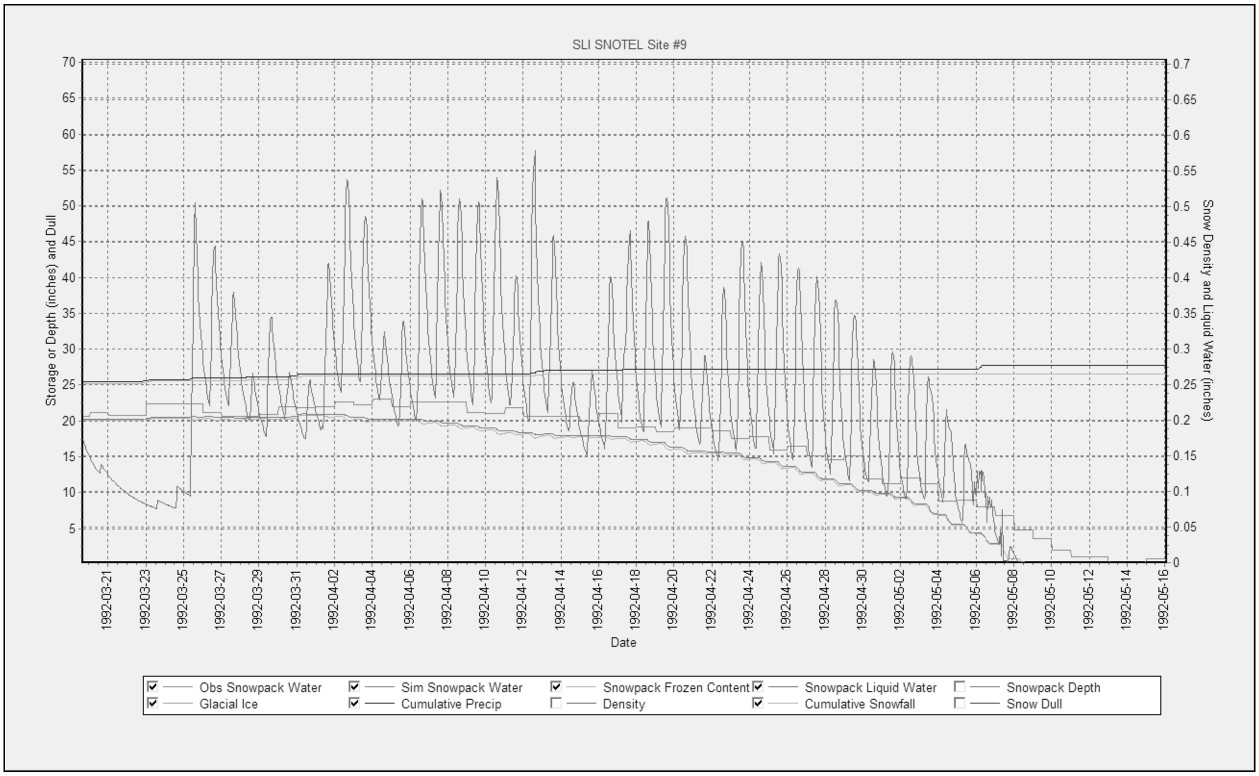


Figure D-2. Slide Canyon observed (pink) and simulated snow water equivalent (red) and liquid water content of the snowpack (blue), March to May, water year 1992.

HY-52 cont.

For each of the climate change scenarios, hourly temperature adjustments were made based on the expected average daily temperature increase and the corresponding change in the maximum and minimum daily temperatures. The simulated snowpack depth is reduced due to these higher temperatures.

Figure D-3 shows Slide Canyon observed historic and simulated climate change scenario 2A in 2100 snow water equivalent and liquid water content in the snowpack. For climate change scenario 2A in 2100 (moderate temperature increase of 3.4 degrees C/6.12 degrees F with no change in precipitation), less snow accumulates than under current conditions because some precipitation that historically fell as snow was simulated as rainfall. Simulated snow depth reaches only 10 inches water equivalent compared to 21 inches water equivalent for historic conditions. The simulated climate change scenario 2A in 2100 results are based on water year 1992 meteorological conditions with the temperature adjustments for climate change scenario 2A in 2100.

HY-52 cont.

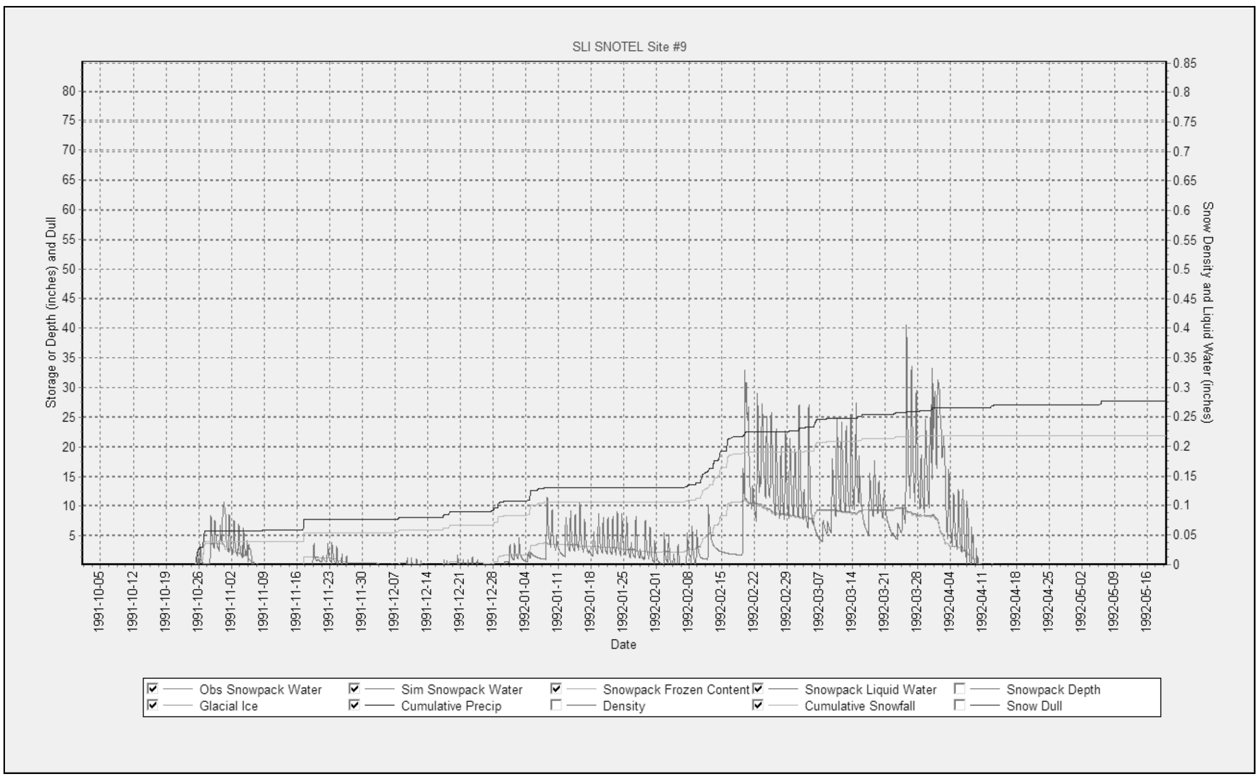


Figure D-3. Slide Canyon observed (pink) and scenario 2A in 2100 snow water equivalent (red) and liquid water content (blue) of the snowpack, water year 1992

O-TRT-DREKMEIER Cont.

Figure D-4 shows details of the snowpack melt out for climate change scenario 2A in 2100. The period of significant melt under the future climate conditions, April 1st to 10th, did not experience significant melt out historically – the historic 'obs snowpack water' in Figure D-4 show only minor melt in March and early April.

The snowpack melts out by April 10, 1992 for climate change scenario 2A in 2100, compared to May 8, 1992 for historic conditions.

HY-52 cont.

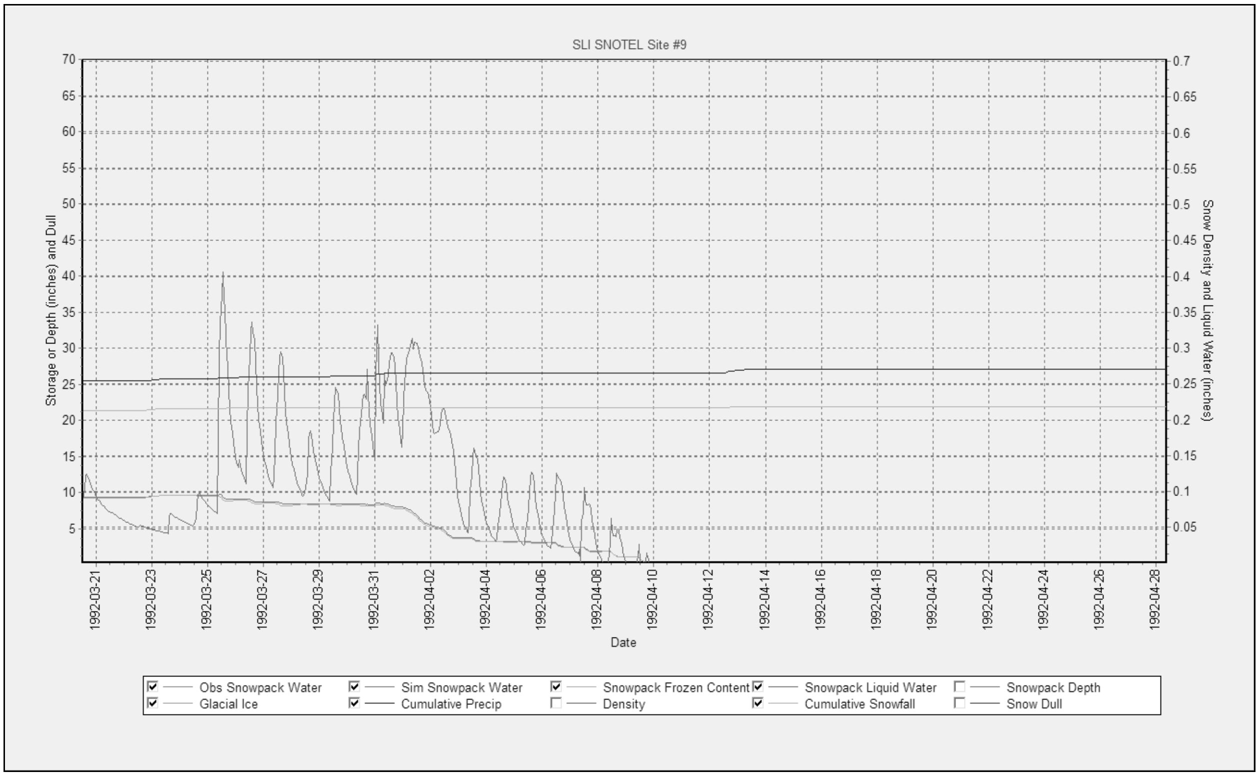


Figure D-4. Details of the Slide Canyon snowpack melt out for scenario 2A in 2100

Figure D-5 shows Slide Canyon simulated historic snowpack albedo, air temperature and solar radiation, solar radiation, negative heat, snow melt and snow yield (water leaving the snowpack) in water year 1992. Figure D-6 shows the same information during only the melt out period of water year 1992.

During the fall and winter with historic conditions, there is little or no water yield from the snowpack. Negative heat builds during the night whenever the snowpack cools below 0 degrees C. The snow must warm to 0 degrees C before melt can occur. Figure D-5 shows that melt does occur in fall and winter, but melt that enters liquid water storage will often re-freeze at night when the net heat exchange between the atmosphere and the snowpack becomes negative and the snowpack cools.

In Figure D-6, it can be seen that warmer night time temperatures reduce or prevent the increase of negative heat during the night time and the snowpack remains at 0 degrees C. The liquid water holding capacity of the snowpack is exceeded, melt occurs, and water leaves the snowpack.

HY-52 cont.

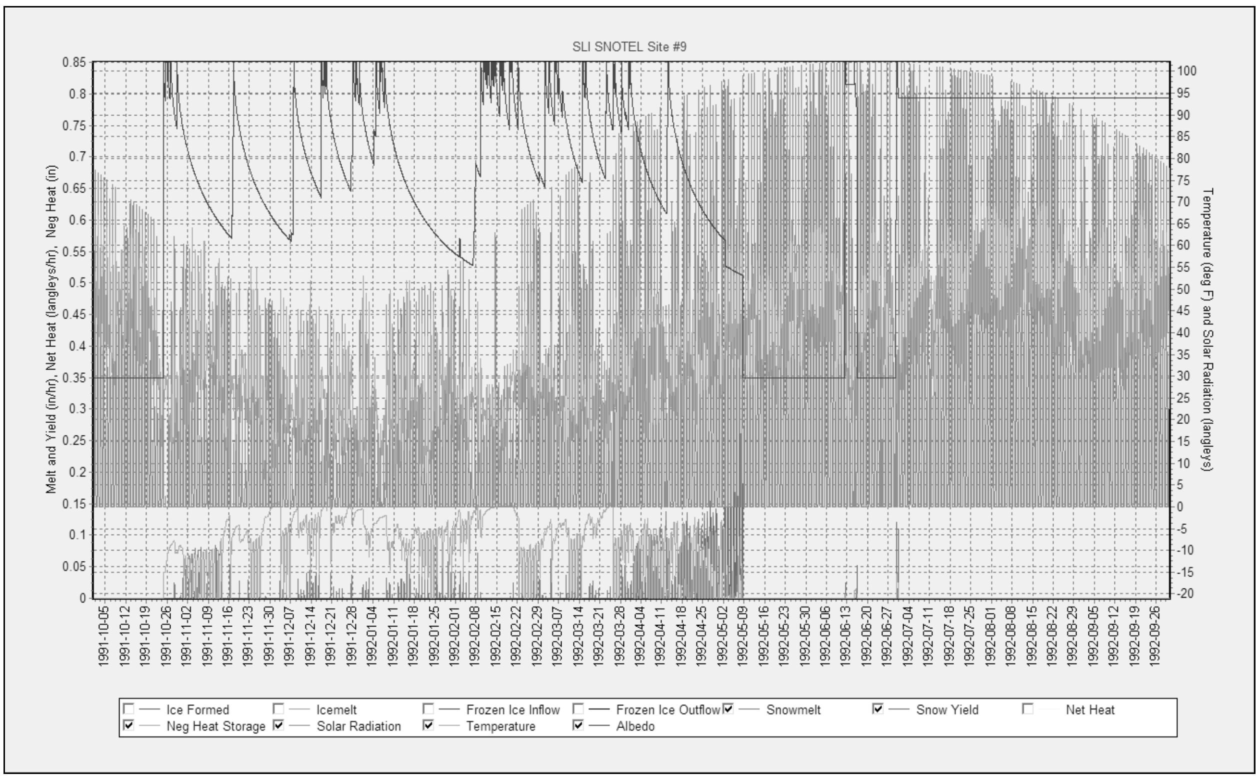
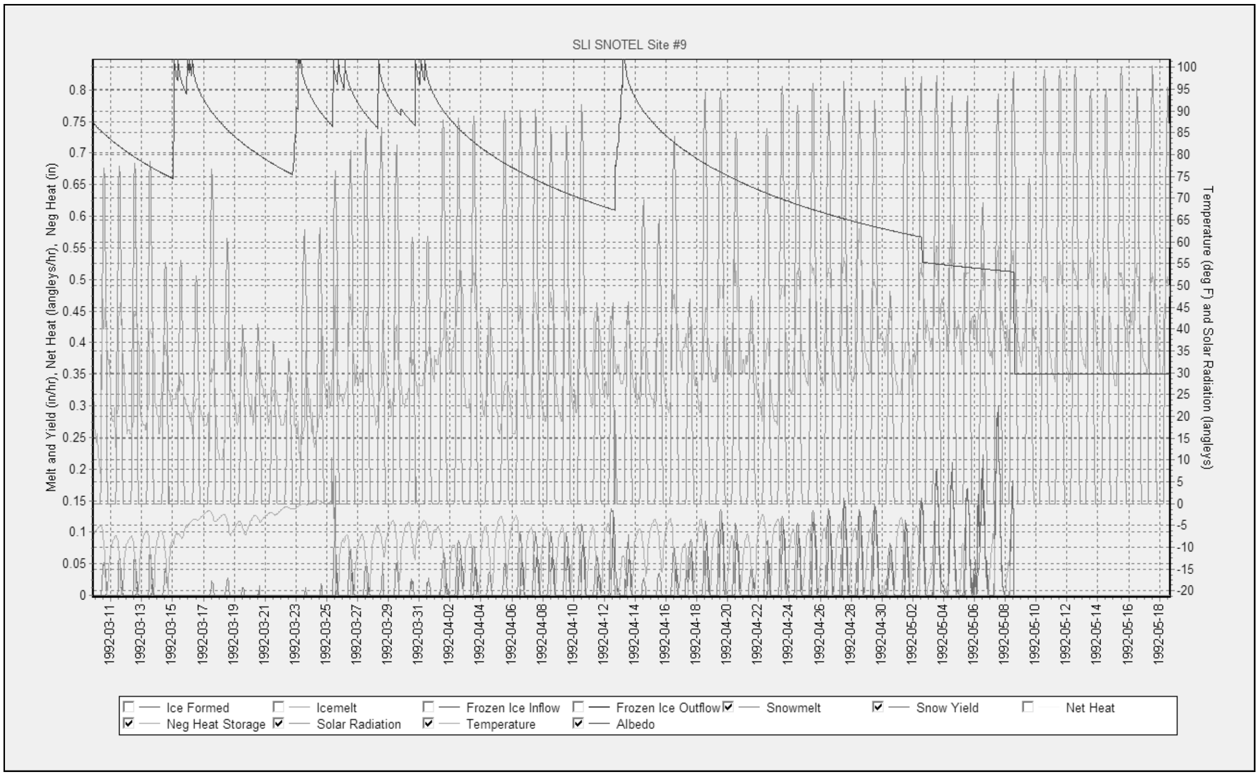


Figure D-5. Slide Canyon simulated historic snowpack albedo, air temperature, solar radiation, negative heat, snow melt and snow yield, water year 1992



HY-52 cont.

Figure D-6. Slide Canyon simulated historic snowpack albedo, air temperature, solar radiation, negative heat, snow melt and snow yield, May and June of water year 1992

Figure D-7 shows Slide Canyon simulated snowpack albedo, air temperature, solar radiation, negative heat, snow melt and snow yield for climate change scenario 2A in 2100 based on adjusted meteorological data from water year 1992. With higher temperatures, snowpack does not build until late December. Negative heat in Figure D-7 is much less consistent than the historical conditions shown in D-5. Figure D-8 shows the melt out of the snowpack. As in Figure D-6, warmer night time temperatures in Figure D-8 tend to reduce or prevent night time negative heat and the snowpack remains at 0 degrees C. The liquid water holding capacity of the snowpack is exceeded and water leaves the snowpack. In Figure D-8 for climate change scenario 2A in 2100, melt out ends by April 10, 1992 compared to May 8, 1992 for the historical conditions shown in Figure D-6.

With climate change and warmer temperatures and earlier spring melt, physical processes appear to cause melt out to be more episodic. Negative heat appears more likely to interrupt melt when the Slide Canyon snowpack begins melting in March.

HY-52 cont.

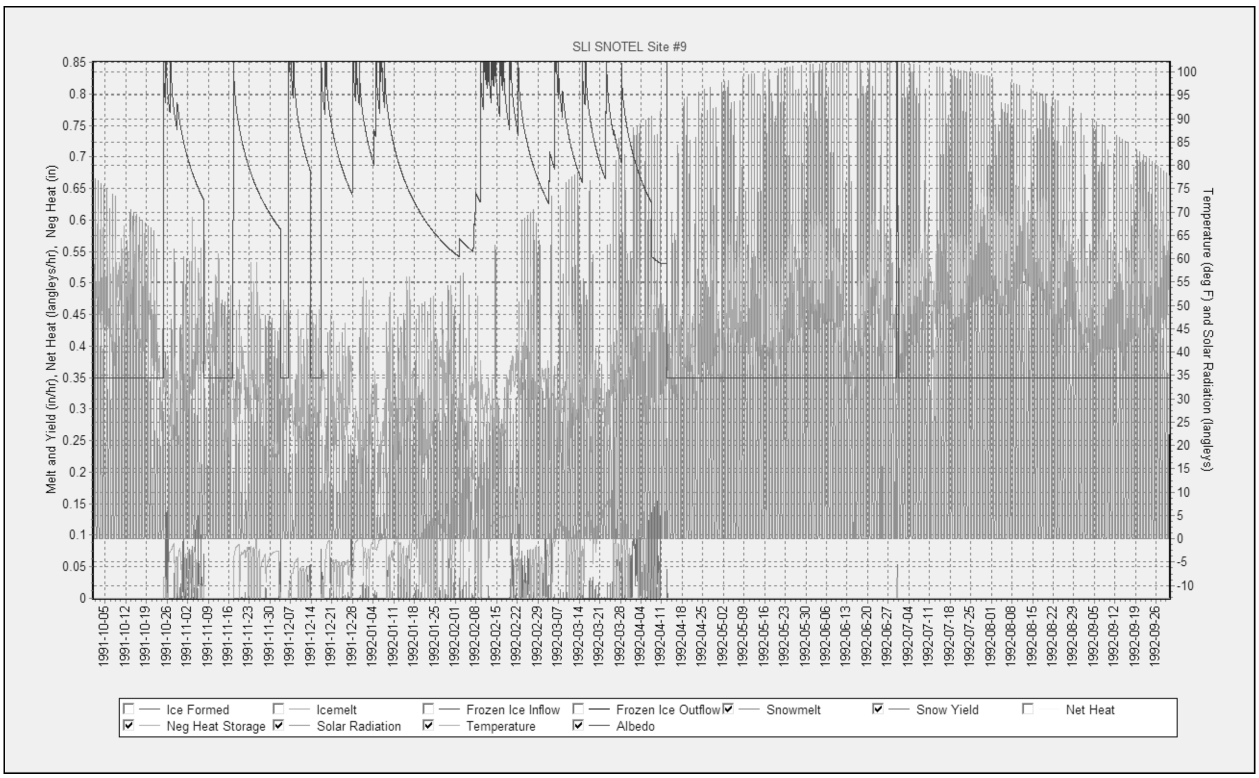


Figure D-7. Slide Canyon simulated snowpack albedo, air temperature, solar radiation, negative heat, snow melt and snow yield for scenario 2A in 2100, water year 1992

O-TRT-DREKMEIER Cont.

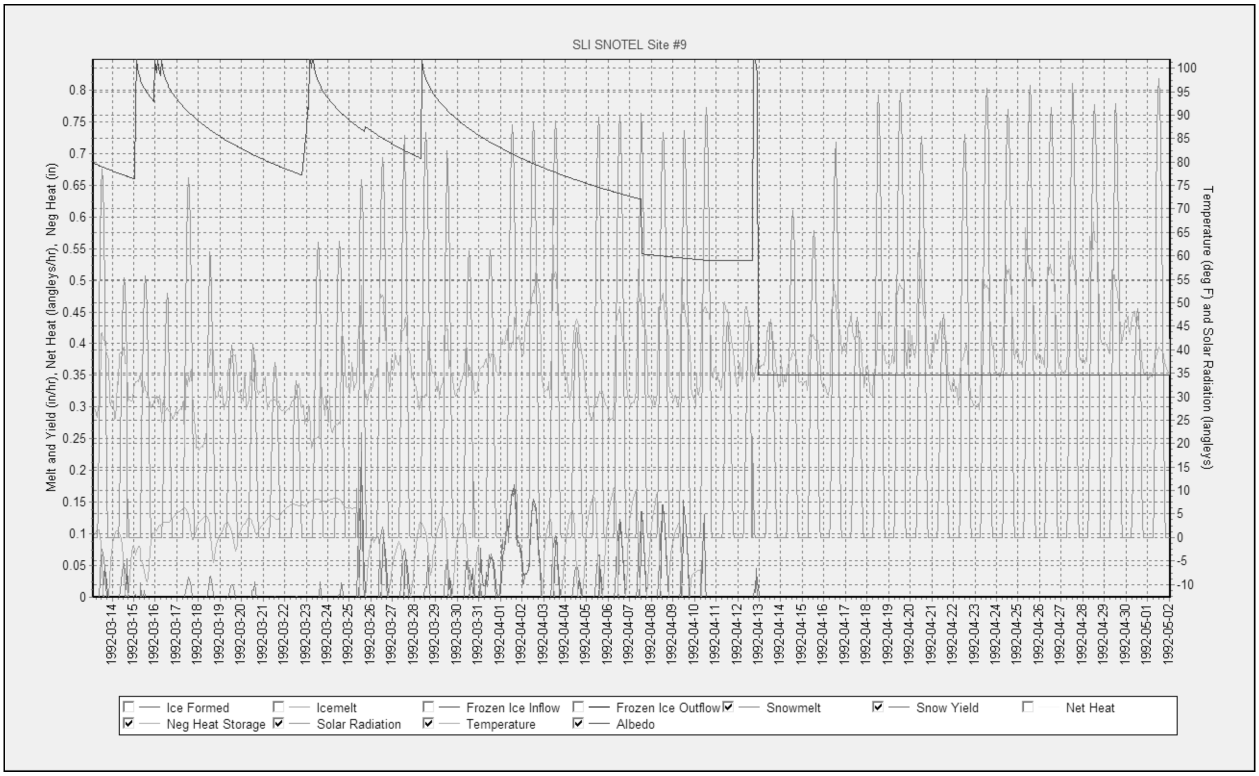


Figure D-8. Slide Canyon simulated snowpack albedo, air temperature, solar radiation, negative heat, snow melt and snow yield for scenario 2A in 2100, May and June of water year 1992

HY-52 cont.

APPENDIX E

HY-52 cont.

Tuolumne Meteorological Data

APPENDIX E

Tuolumne Meteorological Data

HFAM requires hourly input data for precipitation, temperature, evaporation, wind speed and solar radiation.

For the current project, the HFAM meteorological database for the Tuolumne watershed was improved by correcting obvious errors in the data and updating the database to Sept 30, 2008. The current database includes data for all stations for water years 1931-2008. Data sources and adjustments are described in detail in section E.1.

In addition to the historic database, a static database was created for water years 1931-2008 which represents the climatic conditions in 2010, as described in section E.2.

Future climate scenarios are developed from the 2010 current conditions static database. The method for addressing the different trends in minimum and maximum temperatures is described in section E.3. HY-52 cont.

It is important to distinguish between climate change and climate variability when predicting future meteorological conditions. A short analysis of historical temperature data and climate variability is presented in section E.4.

E.1 Tuolumne Meteorological Data Sources

E.1.1 Precipitation Data

Table E.1 summarizes the station names and data sources for Tuolumne hourly precipitation data compiled for the HFAM meteorological database.

Table E.1 Precipitation data in HFAM database

HFAM PRECIPITATION DATA						
HFAM Station #	**CODE**	**Station Name**	**Station Elev. (ft)**	**Station for Estimation of Earlier Record**	**Extended Data Starts**	**Extended Data Ends**
218	HTH	Hetch Hetchy	3858	(none)		
220	BKM	Buck Meadows	3200	Groveland 2	1930	June 1999
235	TUM	Tuolumne Meadows	8600	HTH	1930	Sept. 1997
260	CHV	Cherry Valley Dam	4764	HTH	1930	approx. 1955
265	MCN	Moccasin	938	HTH	1930	approx. 1950

O-TRT-DREKMEIER Cont.

E.1.2 Temperature Data

Table E.2 summarizes the station names and data sources for Tuolumne hourly temperature data compiled for the HFAM meteorological database.

Table E.2 Temperature data in HFAM database

HFAM TEMPERATURE DATA							
HFAM Station #	**CODE**	**Station Name**	**Station Elev. (ft)**	**Observation Interval**	**Station for Estimation of Earlier Record**	**Extended Data Starts**	**Extended Data Ends**
218	HTH	Hetch Hetchy	3858	Daily	none		
265	MCN	Moccasin	938	Daily	none		
260	CHV	Cherry Valley Dam	4764	Daily	HTH	Oct. 1930	Dec. 1952
230	PDS	Paradise Meadow	7650	Hourly	CHV	Oct. 1930	Sept. 1991
235	TUM	Tuolumne Meadows	8600	Hourly	HTH	Oct. 1930	Oct. 1992
220	BKM	Buck Meadows	3200	Hourly	CHV	Oct. 1930	Sept. 1991
245	HRS	Horse Meadow	8400	Hourly	CHV	Oct. 1930	April 1988
255	SLI	Slide Canyon	9200	Hourly	CHV	Oct. 1930	Oct. 1990

HY-52 cont.

Estimation of Hourly Temperature Data

Temperature data are recorded and published in two observation intervals, either daily maximum and minimum temperatures or hourly temperatures. Daily stations are Cherry Valley Dam, Hetch Hetchy, and Moccasin. These records are available for a longer period than the hourly records and are more complete.

To disaggregate daily temperatures to hourly values required by HFAM, the daily maximum is assigned to 4 PM and the daily minimum is assigned to 4 AM. Temperatures at other hours are calculated using a symmetrical diurnal variation between maximum and minimum temperatures.

Hourly temperature records acquired from telemetry stations operated by the US Forest Service and the California Dept. of Water Resources are listed in Table E.3.

Table E.3 Real-time stations in the Tuolumne watershed

ID	**Name**	**Latitude**	**Longitude**	**Elevation (ft)**	**Operator**
BKM	BUCK MEADOWS	120.10	37.823	3200	US Forest Service
HRS	HORSE MEADOW	119.66	38.158	8400	CA Dept of Water Resources
PDS	PARADISE MEADOW	119.67	38.047	7650	CA Dept of Water Resources
SLI	SLIDE CANYON	119.43	38.092	9200	CA Dept of Water Resources
TUM	TUOLUMNE MEADOWS	119.35	37.873	8600	CA Dept of Water Resources

O-TRT-DREKMEIER Cont.

Some of these stations were installed in the 1980's but data are less reliable in the early years. Hourly data in the HFAM database begin the month after the end of extended (i.e. estimated from long-term stations) data, as indicated in the last column of Table E.2.

For years prior to the start of hourly telemetry records, data are estimated from nearby stations. HFAM's Horse Meadow, Buck Meadows, Paradise Meadow, and Slide Canyon temperature records are estimated from Cherry Valley Dam temperatures. Tuolumne Meadows temperatures are estimated from Hetch Hetchy. Estimated temperature is a function of lapse rates and the difference between elevations of the stations:

Estimated Temperature = Temperature at Nearby Station + (Lapse Rate * Elevation Difference)

Temperature lapse rates are given in Table E.4. Lapse rates were calculated from concurrent record at the two stations and were re-calculated for the current study. Hence the current HFAM database has been revised for the early (extended) data period.

Table E.4 Lapse Rates for estimation of early records in the HFAM database (deg F/1000ft)

HY-52 cont.

	Record Based on Cherry Valley Data				Record Based on Hetch Hetchy Data
Month	PDS-CHV	SLI-CHV	HRS-CHV	BKM-CHV	TUM -HTH
JAN	4.30	3.68	4.58	1.19	3.55
FEB	4.46	4.01	4.91	0.98	3.88
MAR	4.54	4.18	5.10	1.03	3.94
APR	4.82	4.28	5.14	0.93	3.92
MAY	5.01	4.41	5.38	1.74	3.78
JUN	4.81	4.48	5.18	1.14	3.62
JUL	5.00	4.60	5.19	0.51	3.81
AUG	5.26	4.63	5.35	0.00	3.99
SEP	4.91	4.55	5.16	0.00	4.24
OCT	4.87	3.98	4.95	0.00	3.86
NOV	4.42	3.97	4.70	0.00	3.65
DEC	4.29	3.63	4.48	0.56	3.38
MEAN	**4.72**	**4.20**	**5.01**	**0.67**	**3.80**

E.1.3 Evaporation Data

The evaporation data station is Hetch Hetchy (HFAM station HTH 218). For years when no evaporation data are available, average values are adequate. It was not necessary to revise the evaporation data for the current study.

E.1.4 Wind Data

The wind data in prior versions of the HFAM database were measured at Buck Meadows. In the current database, wind data are based on NCEP-NCAR Reanalysis (Kalnay et al. 1996) 700 millibar wind data for Yosemite (latitude 37.5 N, longitude 120 W).

O-TRT-DREKMEIER Cont.

For the period October 2005 to September 2008, reanalysis wind data were not available. For those years, HFAM's wind data are a function of surface wind measurements at Buck Meadows modified to increase consistency with the reanalysis data.

During the final calibration, selected periods of wind data were modified to improve simulation of spring snowmelt.

The current database retains the station name Buck Meadows. A summary of data sources is shown in Table E.5.

Table E.5 Sources of wind data in the current HFAM database

HFAM Wind Data for Station ID BKM 220	Start Date	End Date
Monthly average for years 1948 to 2008	1/1/1930	12/31/1947
Reanalysis wind data, scaled by 1/7	1/1/1948	9/30/2005
A function of hourly Buck Meadows wind, based on a correlation between reanalysis data and Buck Meadows data	10/1/2005	9/30/2008

Reanalysis Wind Data

HY-52 cont.

The NCEP-NCAR Reanalysis Project provides simulated historical meteorological data, including upper atmosphere wind speeds.[7] The website states that "reanalysis datasets are created by assimilating ("inputting") climate observations using the same climate model throughout the entire reanalysis period in order to reduce the effects of modeling changes on climate statistics. Observations are from many different sources including ships, satellites, ground stations, RAOBS, and radar." Reanalysis wind data were provided to Hydrocomp for the period 1948-2005.

The format of the reanalysis data is a pair of velocities for each day, which are components of velocity on the north-south coordinate and the east-west coordinate. The N-S (or zonal) velocity is called Vwind and the E-W (or meridianal) component is called Uwind.

Zonal Components	Value (+ or -)	Direction
Vwind	+	towards North (southerly wind)
Vwind	-	towards South (northerly wind)

Meridianal Components	Value (+ or -)	Direction
Uwind	+	towards East (westerly wind)
Uwind	-	towards West (easterly wind)

[7] Reanalysis data are provided by the NOAA-ESRL Physical Sciences Division, Boulder Colorado from their Web site at http://www.esrl.noaa.gov/psd/

To create a data series for HFAM, the resultant magnitude of the wind speed was calculated from Uwind and Vwind. The wind direction information is not used in HFAM. The units were converted to miles per hour and the time step was converted from daily to hourly assuming the same wind speed for all hours in each day.

HFAM requires data for wind speeds at the land surface. The upper-atmosphere (700 millibar) reanalysis wind speeds were divided by seven to estimate wind speed at the land surface. It is not necessary to define this scaling factor precisely because HFAM parameters are adjusted during model calibration.

Correlation between Buck Meadows Surface Wind and Reanalysis Data

Prior versions of the HFAM database included wind speeds measured at the Buck Meadows weather station. The reanalysis data differ statistically from surface measurements of wind. The surface measurements are much less variable than the reanalysis wind data. To increase the consistency of the HFAM database Buck Meadows wind data for October 2005 – September 2008 was modified:

- For Buck Meadows wind speeds less than 1.5 MPH, the HFAM wind is 0.2 MPH
- For Buck Meadows wind speeds between 1.5 and 3.4, the HFAM wind was computed as: **HFAM wind = $0.8104x^2 - 1.3762x + 0.4681$** (where x is wind speed at Buck Meadows) HY-52 cont.
- For Buck Meadows wind speeds greater than 3.7, the HFAM wind was computed as **HFAM wind = $0.6x + 3.7$** (where x is wind speed at Buck Meadows)

These modifications to the wind data improved the simulation of snowmelt for 2005-2008.

Wind Data Modifications for the Final Calibration

Adjustments to wind were made in 1980, 1985, 1988, 1993, 1995, 1997, 2005 and 2008. Adjustments were for periods of two to four weeks during April, May or June and wind velocities were typically scaled by 0.5 to 2 during these periods.

E.1.5 Solar Radiation Data

The solar radiation data in prior versions of the HFAM database are data from the weather station at Buck Meadows. In the current database, solar radiation data for water years 1975-2008 were estimated from theoretical maximum solar radiation at the land surface and sky cover descriptions at Cherry Valley Dam and Moccasin. This method improved the model calibration because it is more consistent from year to year. The solar radiation data prior to 1975 are the original HFAM data scaled by a factor of 1.07 to increase consistency and remove trends.

The current database retains the station name Buck Meadows. A summary of data sources is shown in Table E.6

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Cont.

Table E.6 Sources of solar radiation data in the current HFAM database

HFAM Solar Radiation Data for Station ID BKM 220	Start Date	End Date
Prior HFAM data scaled by 1.07	1/1/1930	9/30/1974
Cherry Valley Dam and Moccasin Sky cover description,	10/1/1974	9/30/2008
and theoretical clear sky solar radiation		

Theoretical Clear Sky Solar Radiation

Maximum (clear sky) solar radiation at the land surface was obtained from an Excel spreadsheet application called ***solrad.xls (version 1.2)*** developed by Greg Pelletier of the Washington State Department of Ecology, Olympia, WA. Solar radiation was calculated for the latitude and longitude coordinates of Buck Meadows and an elevation of 1000 m. The *solrad.xls* spreadsheet provided hourly values of solar radiation for one year. Figure E.1 shows the seasonal variation of solar radiation at noon.

HY-52
cont.

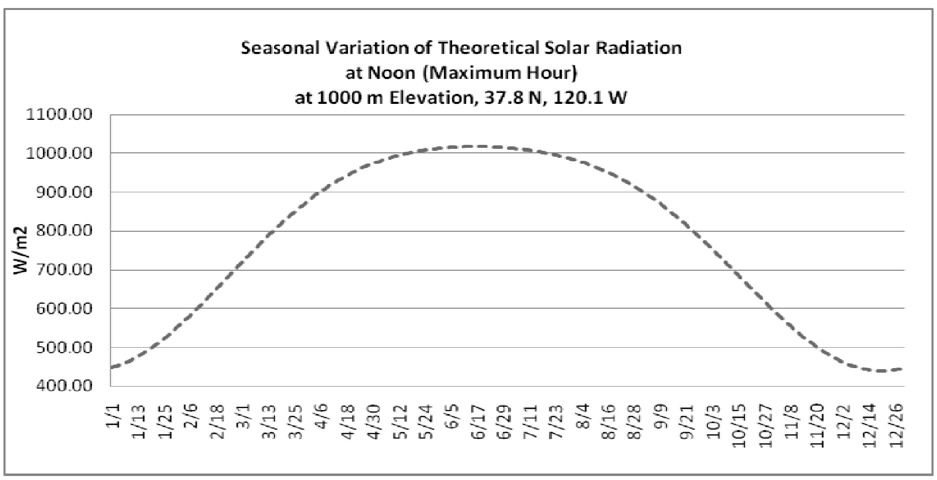

Figure E.1 Seasonal variation of solar radiation at noon

The HFAM data series of solar radiation was estimated by multiplying clear sky solar radiation by percent possible sunshine:

Solar Radiation = Theoretical Clear Sky Solar Radiation (hourly) * % Possible Sunshine (daily)

Percent possible sunshine was estimated from sky cover descriptions. For the study period, water years 1975-2008, the most useful data available are sky cover descriptions at Cherry Valley Dam and Moccasin. By comparing a short record (Oct 2006 to April 2007) of solar radiation measurements at Buck Meadow (BKM), as well as the average of measurements at Tuolumne Meadows (TUM), Dana Meadows (DAN) and Tioga Entrance Station (TES) correlations between sky cover and percent possible sunshine were developed, shown in Table E.7.

O-TRT-DREKMEIER Cont.

Table E.7 Daily sky cover descriptions and corresponding values of percent possible sunshine

Sky Cover Description	% Possible Sunshine
Rain or Snow	40
Cloudy	50
Fog or Smoke	90
Part Cloudy	90
Clear	100

Figure E.2 shows the comparison of percent possible sunshine based on solar radiation measured at weather stations with percent possible sunshine estimated from sky cover descriptions, for October 2006 to January 2007.

HY-52 cont.

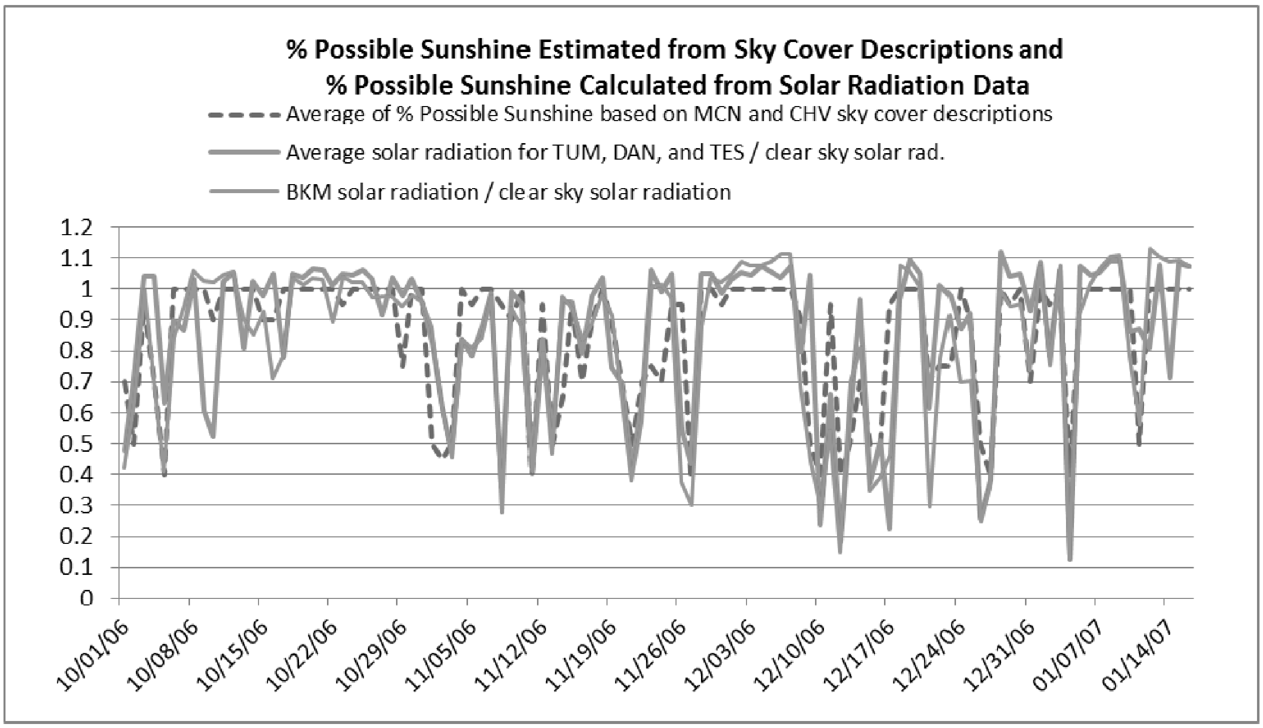

Figure E.2 Percent possible sunshine estimated from solar radiation data

O-TRT-DREKMEIER Cont.

E.2 Trends in Historic Meteorological Database and HFAM Static Data

Hydrocomp evaluated trends in historical temperature data using the revised database which includes data added for recent years and corrections made to erroneous temperature data.

Trends in the current solar and wind data were also calculated. As shown in Figures E.3 and E.4, the final wind and solar data do not have significant long-term trends over the water years 1931-2008

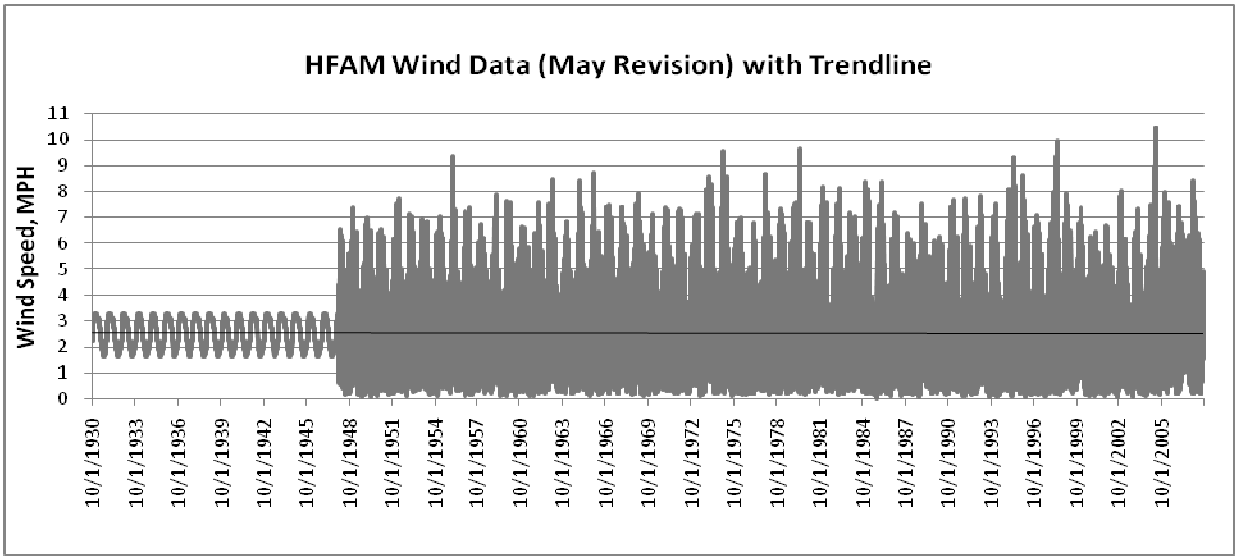

Figure E.3 Trends in wind data for 1931-2008

HY-52 cont.

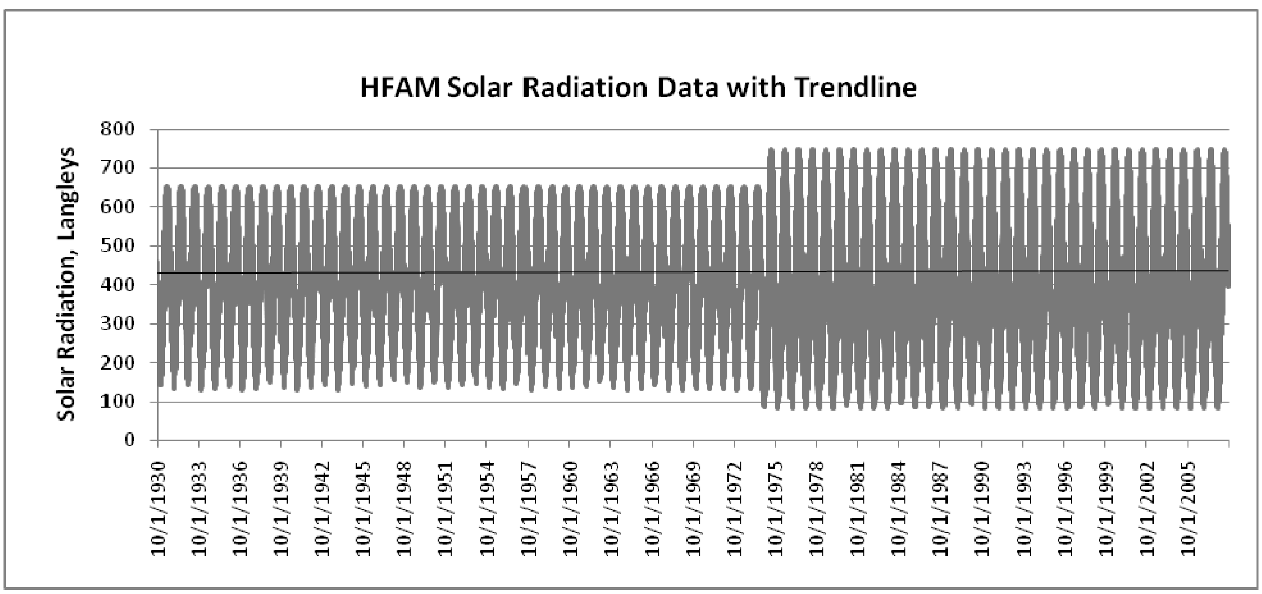

Figure E.4 Trends in solar radiation data for 1931-2008

Trends in Temperature Data

Trends in the HFAM temperature data were quantified from linear regression equations calculated by MS Excel. The average annual temperature change for the long-term records for Cherry Valley Dam, Hetch Hetchy and Moccasin are given in Table E.8 for the 34-year climate change study period, water years 1975-2008.

Table E.8 Average annual change in temperature over the 34-year period 1975-2008 (deg F/year)

	CHV	HTH	MCN
Daily Maximums	0.0756	0.0703	0.0926
Daily Minimums	0.1118	0.1285	0.0262

The annual rates in Table E.8 multiplied by 34 give temperature change over the 34-year climate change study period (1975-2008), as shown in Table E.9. Average daily temperature changes in HFAM are equivalent to the average of the change in daily maximum and daily minimum temperature because HFAM uses a constant symmetrical pattern to disaggregate daily maximum and minimum temperatures to hourly temperatures.

HY-52
cont.

Table E.9 Change in temperature based on trend for 1975-2008 (deg F)

	CHV	HTH	MCN
Daily Maximums	2.57	2.39	3.15
Daily Minimums	3.79	4.37	0.89
Average	3.18	3.38	2.02

Trends were also calculated for the 49-year period 1960-2008 because preliminary analysis indicated that 1960 was the beginning of the warming trend. A longer record may give more reliable information. The 49-year trends are shown in Table E.10.

Table E.10 Average annual change in temperature over the 49-year period water year 1960-2008 (deg F/year)

	CHV	HTH	MCN
Daily Maximums	0.0103	0.0175	0.1052
Daily Minimums	0.1138	0.1031	0.0268

Multiplying the annual rates in Table E.10 which were calculated over the 49-year period by 34 gives another estimate of the temperature change over the 34-year climate change study period (1975-2008), shown in Table E.11. Moccasin trends are similar for both 34-year and 49-year calculations. However, Cherry Valley Dam and Hetch Hetchy temperature changes are larger for the 34-year records than the 49-year record, especially for maximum temperatures.

Table E.11 Change in temperature based on trend for 1960-2008 (deg F)

	CHV	HTH	MCN
Daily Maximums	0.35	0.60	3.58
Daily Minimums	3.87	3.51	0.91
Average	2.11	2.05	2.24

Trends were also calculated for the hourly telemetry stations. These shorter records are more subject to short-term weather fluctuations. Table E.12 shows the trends calculated for these stations.

HY-52 cont.

Table E.12 Trends for telemetry stations with hourly temperature data average annual change for analysis period (deg F/year)

Station	Trend Analysis Starts	# of years	Change in Daily Average Temperature	Change in Daily Maximum Temperature	Change in Daily Minimum Temperature
Horse Meadow	Oct 1989	19	0.23 deg F/year	0.23 deg F/year	0.20 deg F/year
Paradise Meadow	OCT. 1991	17	0.16 deg F/year	0.15 deg F/year	0.15 deg F/year
Tuolumne Meadows	Oct. 1993	15	0.19 deg F/year	0.25 deg F/year	0.13 deg F/year
Buck Meadows	Oct. 1991	17	0.07 deg F/year	0.11 deg F/year	0.07 deg F/year
Slide Canyon	Oct. 1990	18	0.12 deg F/year	0.14 deg F/year	0.08 deg F/year

Corrections to Historic Temperature Data to Develop Static Records

The steps followed to develop static temperatures are:

1) Generate static temperature records for the long-term daily maximum and minimum temperatures stations: Cherry Valley Dam, Hetch Hetchy, and Moccasin
2) Confirm that there are no trends in the static data for the period 1930-2008 for Cherry Valley Dam, Hetch Hetchy, and Moccasin
3) Extend the short records for hourly telemetry station by applying lapse rates to the static temperature data.
4) Confirm that there are no trends in the static data for hourly telemetry stations for the period 1930-2008

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Static Temperatures Records for the Daily Max-Min Temperatures Stations: Cherry Valley Dam, Hetch Hetchy, and Moccasin

Daily maximum-minimum temperature records are disaggregated to hourly data for the HFAM database using the same hourly pattern each day. Minimum temperatures are assigned to 4 AM and maximums are assigned to 4 PM. Because the diurnal pattern never varies, the historical record's mean, maximum and minimum temperatures can be modified by adding hourly temperature increments.

For example, to create a static temperature record for Moccasin, hourly temperature increments in Figure E.5 were added to the historical Moccasin record. The increment to the daily minimum temperature is 0.91 deg F and the increment to the daily maximum temperature is 3.58 deg F; the average daily increment is 2.4 deg F. These increments were determined by trend analysis for the period 1960-2008 (see Table E.11).

HY-52
cont.

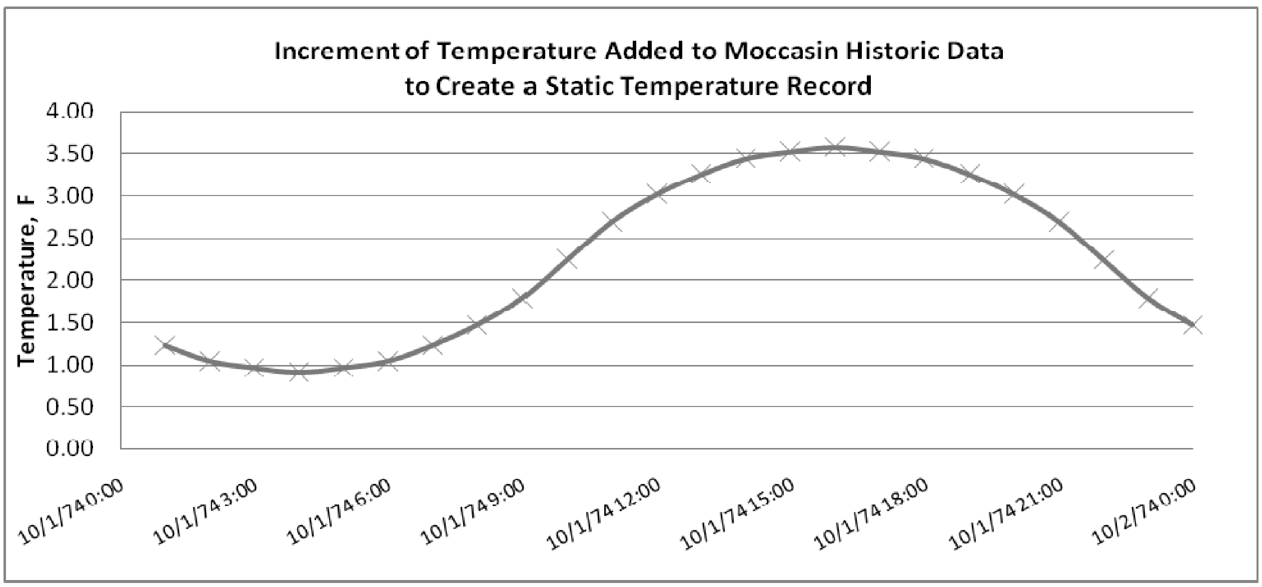


Figure E.5 Increments of temperature added to Moccasin historic data to create a static record

O-TRT-DREKMEIER Cont.

Warming trends for minimum temperatures at Cherry Valley Dam and Hetch Hetchy are greater than the trend in daily maximum temperatures. Only minimum temperatures trends were incorporated in static temperature data. Figure E.6 shows the adjustments used to generate static temperature records for the long-term stations and Table E.13 illustrates the pattern of adjustments for Cherry Valley Dam and Hetch Hetchy.

Table E.13 Cherry Valley Dam, Hetch Hetchy, and Moccasin temperature change applied to the 34 years 1975-2008 to create static record

	CHV	HTH	MCN
Daily Maximums	0	0	3.58
Daily Minimums	3.87	3.51	0.91
Average	1.93	1.76	2.24

HY-52 cont.

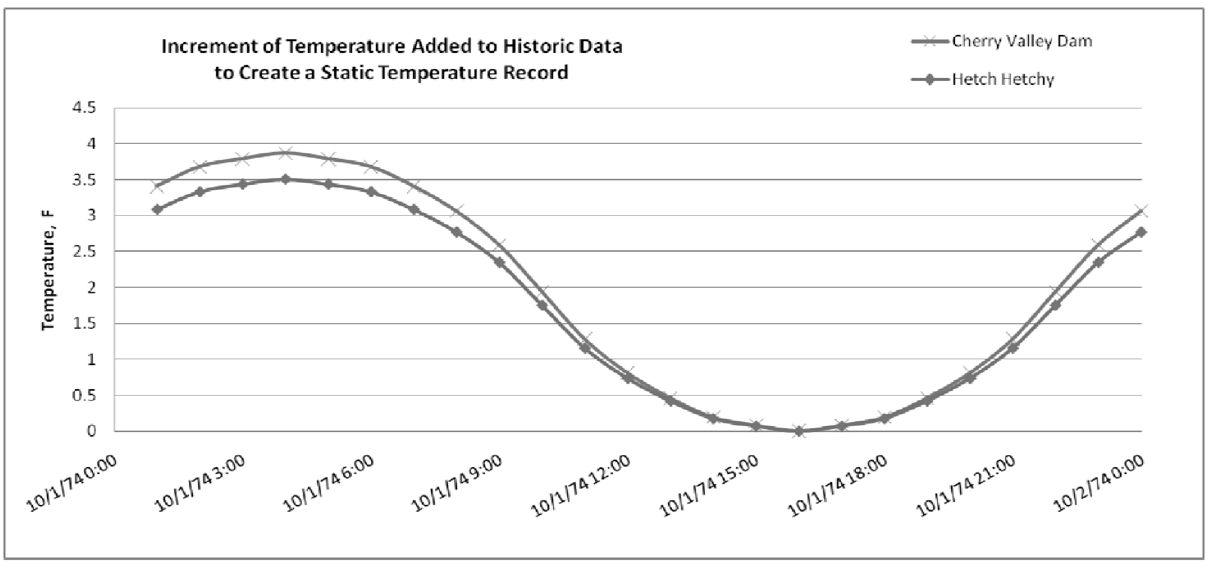


Figure E.6 Increments of temperature added to Cherry Valley and Hetch Hetchy historic data to create a static record

The static adjustments to Moccasin, Hetch Hetchy and Cherry Valley temperatures shown in Figures E.5 and E.6 were decreased linearly for water years 1975-2008. The static temperature is calculated with the following equation using scaling factors illustrated in Figure E.7:

Static Temperature = Historic Temperature + (Static Adjustment * Scaling Factor)

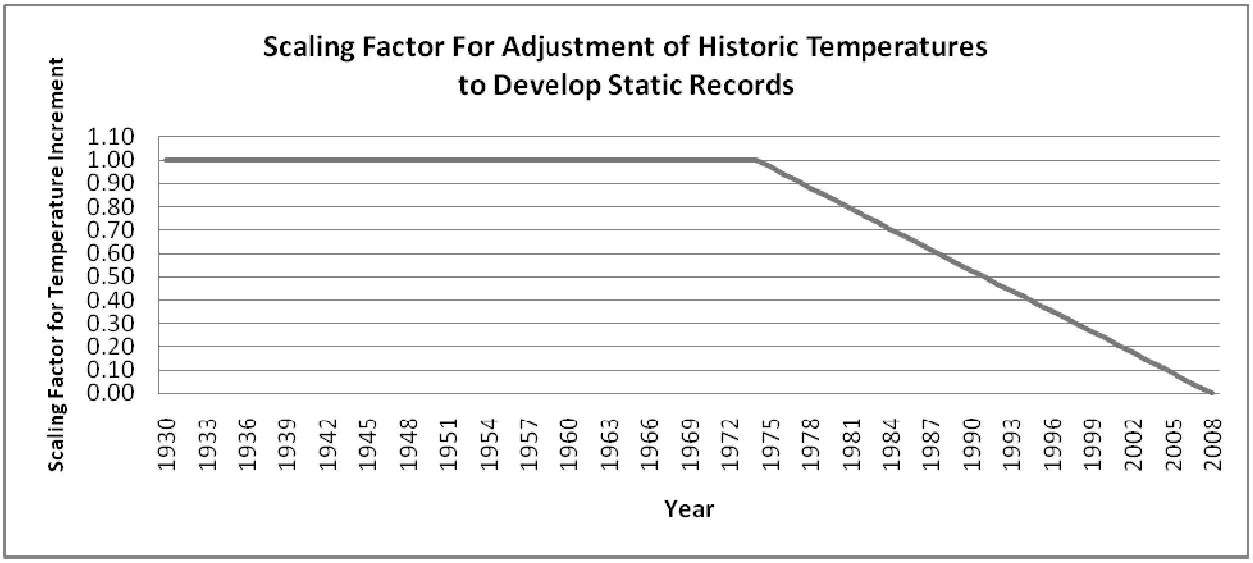


Figure E.7 Scaling factors for static temperature records

HY-52 cont.

Figures E.8 and E.9 are examples of the scaled static temperature increments for Moccasin. The scaling factor for 10/1/1980 is 0.82 and the factor for 10/1/2000 is 0.24.

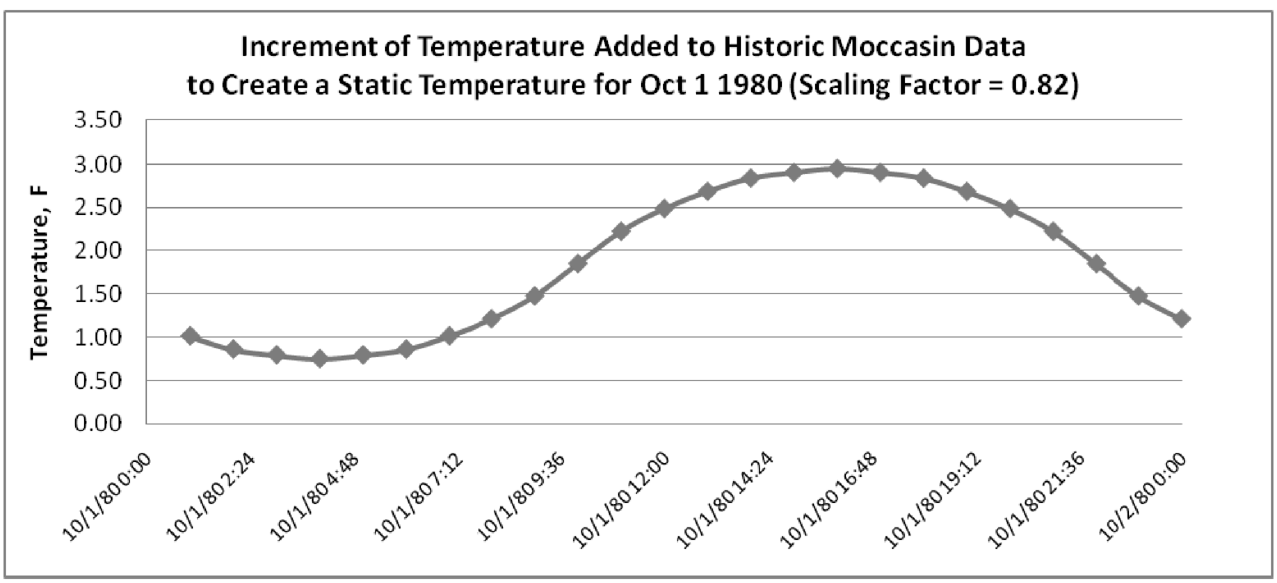


Figure E.8 Scaled static temperature increments for Moccasin, 1980

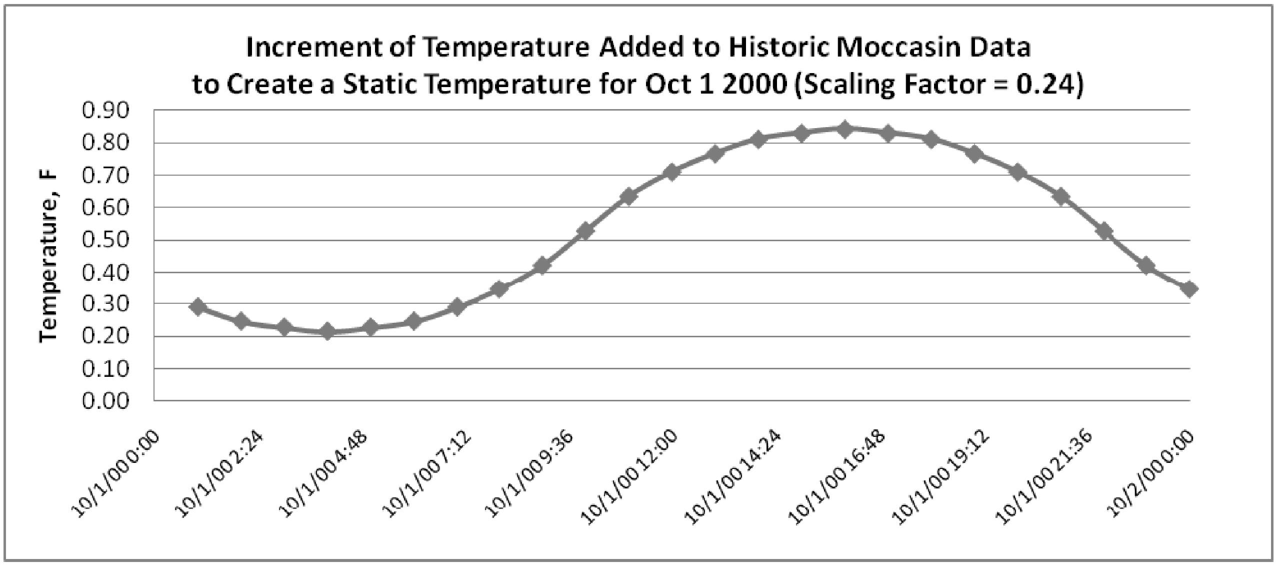


Figure E.9 Scaled static temperature increments for Moccasin, 2000

HY-52 cont.

Static Temperatures Records for the Hourly Telemetry Temperatures Stations: Horse Meadow, Tuolumne Meadows, Paradise Meadow, Buck Meadows and Slide Canyon

Warming trends were calculated for the hourly temperature stations. However, there is less certainty in trends because the records are shorter.

The HFAM database contains estimated data for years prior to the start of hourly telemetry records. HFAM's Horse Meadow, Buck Meadows, Paradise Meadow, and Slide Canyon temperature records are estimated from Cherry Valley Dam temperatures. The HFAM historical data were estimated by applying lapse rate adjustments from Cherry Valley Dam to the telemetry stations. To create the static HFAM data, the same lapse rate adjustments were applied to the static Cherry Valley temperature record. Trend analysis of the resulting records for the period 1930-2008 is acceptable.

Tuolumne Meadows (TUM) is the only hourly record extended with Hetch Hetchy (HTH) temperature data. Lapse rate adjustment of the static Hetch Hetchy temperature to Tuolumne Meadows did not remove trends in temperature data. A different method was used to create a static record for TUM:

1. Adjust the historic TUM data for November 1, 1992- September 30 2008 by +2.9 degrees F multiplied by scaling factor. The scaling factor decreases linearly from 1.0 to 0.0.
2. Extend the TUM record based on HTH data. Both static adjustments and lapse rate adjustments were made. The lapse rate adjustments are the same as were used for the HFAM historic database. The static temperature adjustments are a diurnal pattern shown in Figure E.10. No scaling factor is used.

O-TRT-DREKMEIER Cont.

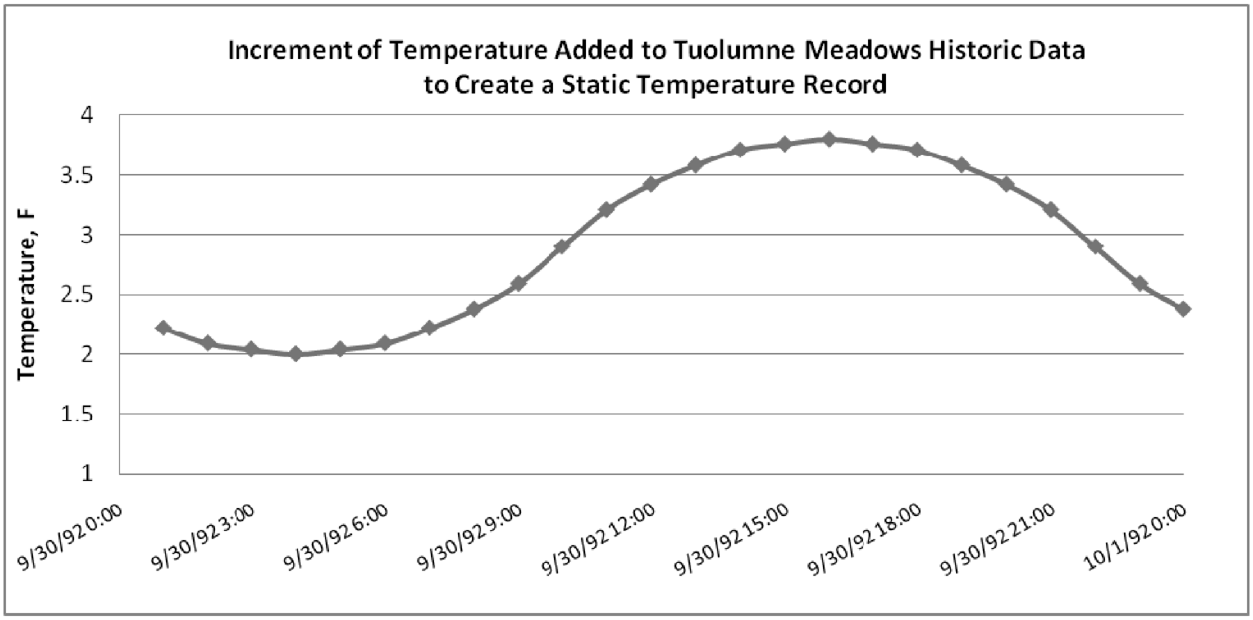


Figure E.10 Static temperature increments for Tuolumne Meadows

HY-52 cont.

Trends in HFAM Static Temperature Data

The HFAM static temperature records were checked to ensure that trends are small. Table E.14 summarizes the trends in daily maximum, minimum and average temperature by the HFAM temperature stations for the 78 years 1930-2008. All changes are less than 2 degrees F. Trends in daily average temperature are all less than 1.1 degrees F over 78 years.

Table E.14 Trends in HFAM Static Temperature Records
Changes in Temperature over 79 years, 1930-2008 (deg F)

Stations With Daily Observations					
	CHV	**HTH**	**MCN**		
Daily Maximums	-1.16	-1.34	0.22		
Daily Minimums	0.07	1.29	-0.21		
Daily Average	**-0.49**	**-0.01**	**0.04**		
Stations With Hourly Observations					
	BKM	**HRS**	**PDS**	**SLI**	**TUM**
Daily Maximums	1.45	-0.19	0.01	0.30	0.39
Daily Minimums	-1.66	-0.84	-0.52	-0.27	0.39
Daily Average	**-1.03**	**-0.99**	**-0.92**	**-1.09**	**-0.13**

E.3 Development of future temperature timeseries

A delta-adjusted future meteorological database was generated from the static meteorological database to represent each of the future climate conditions listed in Table 3-1. The delta method consists of adjusting existing timeseries by a given factor or factors to develop a new set of timeseries (Bader et al. 2008).

Predicted temperature changes are given as average temperature increases in Table 3-1. The historical temperature records in the Tuolumne at Hetch Hetchy and Cherry Valley show that minimum daily temperatures have increased much more than maximum daily temperatures. This tendency is assumed to continue, with the daily temperature cycle becoming gradually more moderate.

Hydrocomp developed a method to calculate the increases to daily minimum and daily maximum temperatures, given a specified increase to daily average temperatures. Figure E.11 shows the relationship used to determine the daily minimum and daily maximum temperature increases from the average daily temperatures increase in degrees F. Use of this relationship when calculating the hourly temperature increase ensures that the daily range in temperature (i.e. the daily maximum minus the daily minimum temperature) remains within reason for all climate change scenarios.

HY-52 cont.

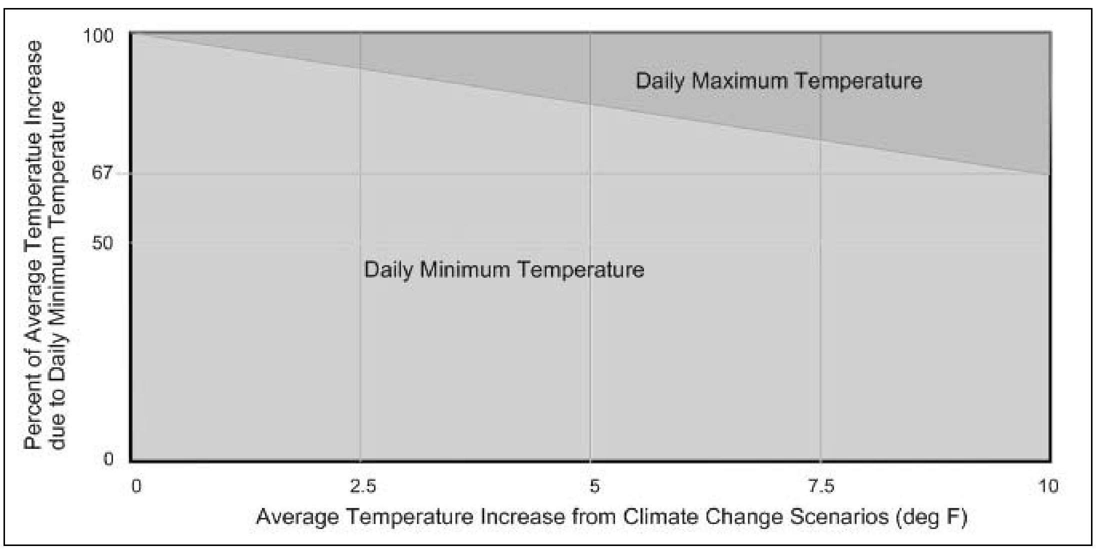
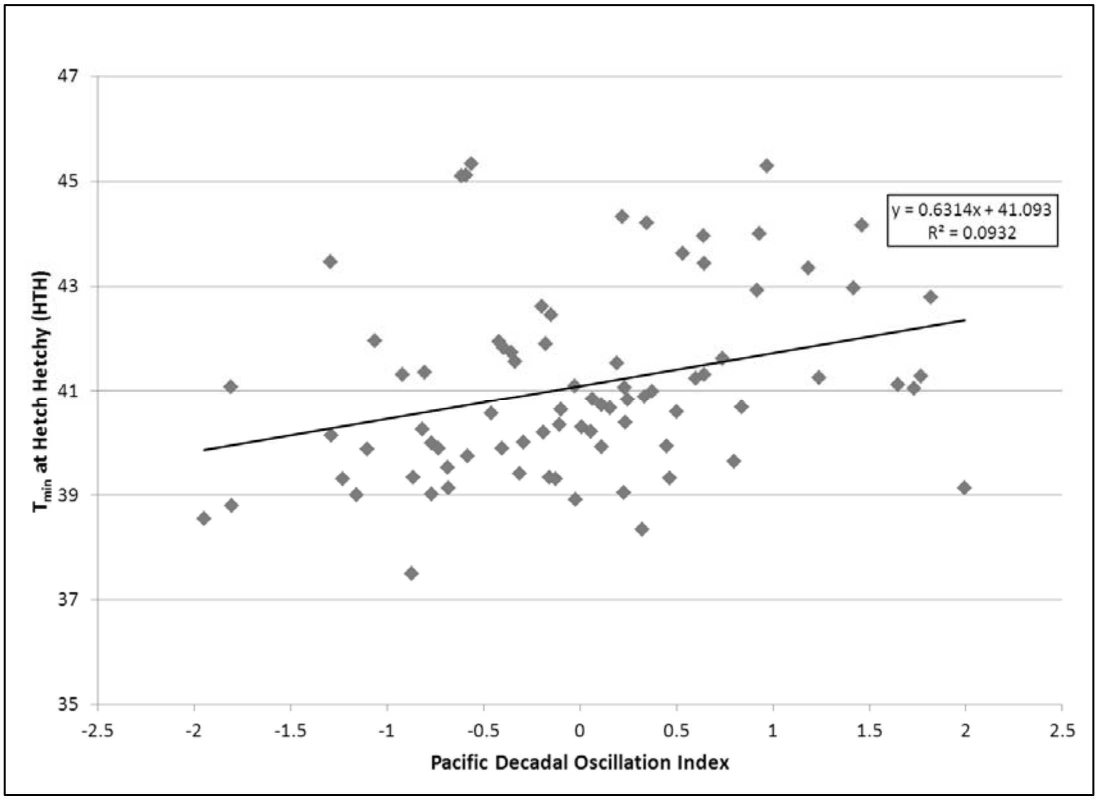


Figure E.11. Percentage of average temperature increase due to daily minimum and daily maximum temperature increases

E.4 Climate variability and trends in temperature data

The potential climate change scenarios were developed based on statistical analysis of historical meteorological data. It is important to distinguish between climate change and climate variability in such an analysis. Weather in the Sierras is driven by climate patterns over the Pacific Ocean, which are affected by El Niño/Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) (Mantua N. 2002). The overall warming trend in the Western United States between 1950 and 1999 is smaller when the PDO is accounted for (Bonfils et al. 2008).

The impact of the PDO on weather in the Upper Tuolumne Basin was studied by correlating the Pacific Decadal Oscillation Index (PDOI) with the daily minimum and maximum temperatures (T_{min} and T_{max}) at Hetch Hetchy Dam from 1930-2009 and at Cherry Valley Dam from 1953-2010. There is a small correlation between the PDOI and T_{min} that is seen at both sites when data are averaged monthly, seasonally, or annually. There is no consistent relationship between the PDOI and T_{max}). Figure E.12 shows the correlation between the annual average value of T_{min} and the PDOI at Hetch Hetchy.



HY-52 cont.

Figure E.12. Correlation between PDOI and annual average Tmin at HTH

The annual average daily minimum temperature at Hetch Hetchy with the PDOI correlation removed is presented in Figure E.13. The timeseries that excludes the PDO is slightly different than the raw timeseries, and the warming trend after 1960 is not significantly altered. The raw timeseries is used to develop inputs for the HFAM model so that the input includes all climate variability.

O-TRT-DREKMEIER Cont.

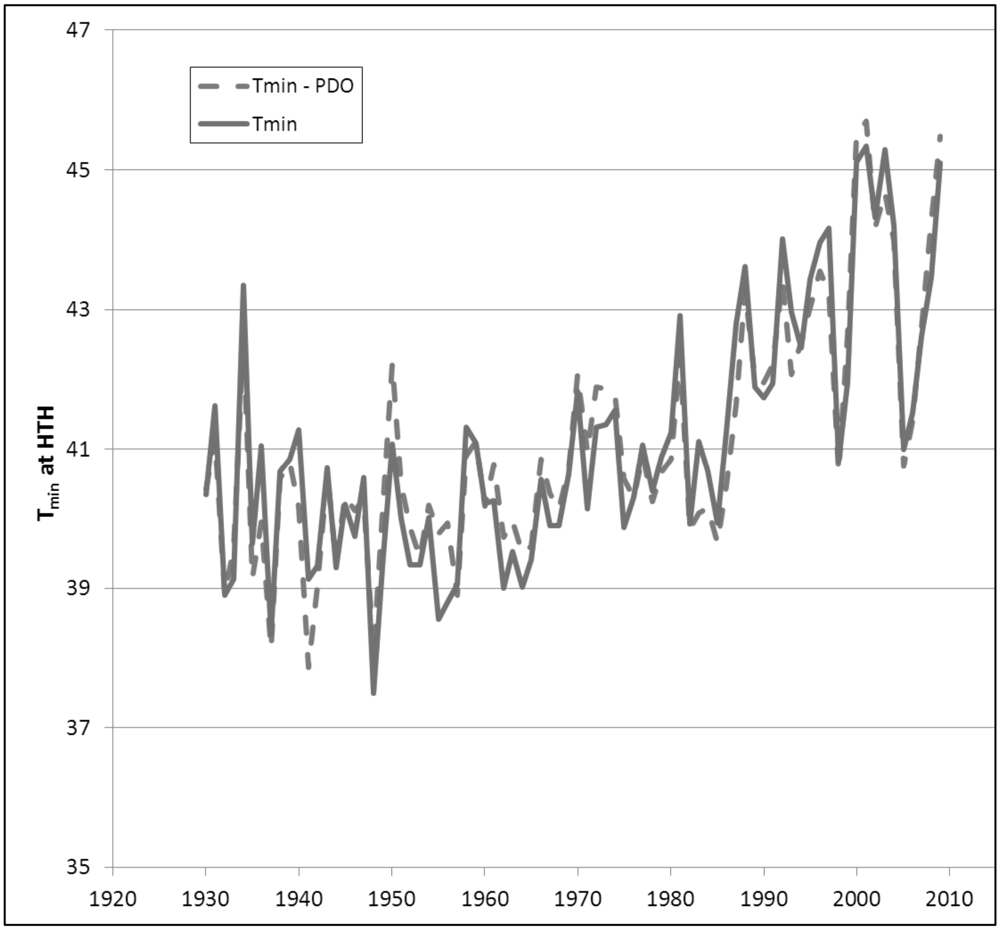


Figure E.13. Annual average Tmin without the PDOI correlation

There was no significant relationship found between Tmin and Tmax and the ENSO index.

HY-52 cont.

1985

Stipulation for Amendment of
Rights-of-Way for
Canyon Power Project
Approved by
Secretary of the Interior
on May 26, 1961
to fulfill the conditions
set forth in Provision 6 of
said Amended Permit

Pursuant to the Act of December 19, 1913 (38 Stat. 242), and in consideration of relocation and installation of its facilities and the granting to it by the United States of amended rights-of-way applied for, the City and County of San Francisco, a municipal corporation of the State of California, on May 23, 1961 stipulated and agreed and did bind itself, its successors and assigns to the terms, conditions and obligations set forth in the amended rights-of-way approved May 26, 1961 and amendments or modifications subsequent thereto. HY-52 cont.

Condition number 6 of said amended rights-of-way provided, among other things, that the interim stream flow releases would be subject to a study for a recommended flow schedule. The study, with recommendations, was completed August 23, 1976. Following the City's objections to certain aspects of the study's recommendations, the City now hereby agrees, amends and/or supplements said rights-of-way and binds itself, its successors and assigns, to each of the following terms, conditions, and obligations, consisting of six provisions, including the water release schedule set forth on Exhibit A:

1. That the minimum amount of water released from Hetch Hetchy Reservoir to the Tuolumne River at O'Shaughnessy Dam be in accordance with the schedule attached hereto as Exhibit A.

2. That the allowable rate of change in the magnitude of water releases from Hetch Hetchy Reservoir to the river at O'Shaughnessy Dam be changed from the present stipulation of "... not more than double nor less than one-half the previous release over a one-hour period ..." to "not more than double nor less than one-half the previous release over a four-hour period except when the previous release is 200 cfs or less, in which case the rate of change shall not exceed 50 cfs over a four-hour period."

3. That, insofar as the storage capacity at Hetch Hetch Reservoir and emergency situations allow, releases to the Tuolumne River shall be managed to prevent sudden or short-term high magnitude releases or spills at O'Shaughnessy Dam. HY-52 cont.

4. That the San Francisco Public Utilities Commission provide the appropriate field offices of the U.S. Forest Service, the National Park Service, the U.S. Fish and Wildlife Service, and the California Department of Fish and Game with periodic reports of releases from Hetch Hetchy Reservoir to the Tuolumne River at O'Shaughnessy Dam. The reports should (1) be furnished on a monthly basis by the 10th workday of the month following that reported on, (2) indicate the magnitude of the release at any given time during the report period, and (3) contain an explanation of any circumstances preventing compliance with the schedule of minimum reservoir releases specified in Recommendation No. 1.

5. That the San Francisco Public Utilities Commission notify the appropriate field office of the U.S. Forest Service, the National Park Service, the U.S. Fish and Wildlife Service, and the California Department of Fish and Game at least 7 days in advance of any anticipated noncompliance with the schedule of minimum reservoir releases specified in Recommendation No. 1.

6. That the foregoing conditions are imposed for the Tuolumne River from O'Shaughnessy Dam to Early Intake with respect to the existing Hetch Hetchy facilities and capacities along the Tuolumne River. San Francisco agrees that any proposed expansion, alteration, or other modification of the water and power supply facilities which could alter flows along that stretch of river will be subject to review by the Department of the Interior for the purpose of determining what change, if any, should be made in the flow release schedule stipulated in Condition 1. San Francisco further agrees that it will provide to the Department of the Interior advance information concerning any such proposed projects and will assist

the Department of the Interior in making its review by undertaking as part of San Francisco's environmental review a study of any such project's impact on fish, wildlife, recreational, and aesthetic values due to changes in river flow. The plan of study will be formulated in coordination with the U.S. Fish and Wildlife Service, National Park Service, U.S. Forest Service and the California Department of Fish and Game, and approved by the Department of the Interior, to insure that all aspects of the proposed projects that could impact river flow are adequately investigated. At the conclusion of the study and based upon such study, the U.S. Fish and Wildlife Service will recommend to the Secretary of the Interior such changes in the flow releases schedule as may be necessary to protect fish, wildlife, recreational, and aesthetic values. Such recommendations, shall become part of these conditions, unless San Francisco, within 30 days from receipt of notice of the recommendations, shall file with the Secretary of the Interior, its objections thereto. In such event, at its request, San Francisco shall be afforded a hearing regarding these objections before a special hearing officer who will render proposed findings of fact. The Secretary, after considering the proposed findings of fact and the record, shall determine what additional flows, if any, shall be required over those specified above.

HY-52 cont.

The City further agrees that said conditions, and release schedule, are hereby made a part of and included in said rights-of-way and its stipulations.

Attachment B

O-TRT-DREKMEIER cont.

IN WITNESS WHEREOF, the said City and County of San Francisco has caused this instrument to be executed in the City of San Francisco, California, this 13th day of December, 1984.

General Manager of Public Utilities Commission, City and County of San Francisco

Subscribed and sworn to before me this 13th day of December, 1984

FORM APPROVED:

Thomas M. Berliner

City Attorney
City and County of San Francisco

DATE: 12/14/84

Romaine A. Boldridge

Secretary, Public Utilities Com.
City and County of San Francisco

DATE: December 13, 1984

2528p

Assistant Secretary for Fish and Wildlife and Parks

JAN 31 1985

DATE:

HY-52 cont.

Attachment B

_xhibit A

That the minimum amounts of water to be released from Hetch Hetchy Reservoir to the Tuolumne River at O'Shaughnessy Dam shall be in accordance with the following schedules:

	Minimum Release Schedules (cfs)			Cumulative Precip. (inches)/runoff (acre-feet)		
	A	B	C	A Equal to or greater than:	B Less than Col. A but equal to or greater than:	C Less than Col. B:
anuary	50	40	35	8.8	6.1	---
ebruary	60	50	35	14.0	9.5	---
arch	60	50	35	18.6	14.2	---
pril	75	65	35	23.0	18.0	---
ay	100	80	50	26.6	19.5	---
une	125	110	75	28.5	21.3	---
uly	125	110	75	575,000	390,000	---
ugust	125	110	75	640,000	400,000	---
eptember 1-15	100	80	75	---	---	---
eptember 16-30	80	65	50	---	---	---
ctober	60	50	35	---	---	---
ovember	60	50	35	---	---	---
ecember	50	40	35	---	---	---
inimum amount of ater (acre-feet)	59,235	50,019	35,215			
requency (percent)1/	60	32	8			

etermination of applicable schedule (A, B or C) is to be made on the first of each month during January through ugust. Determinations for January through June are to be based on cumulative precipitation at Hetch Hetchy ince October 1 of the preceding year. Determinations for July and August are to be made based on calculated umulative runoff into Hetch Hetchy since October 1 of the preceding year. The release schedule which is in ffect on August 1 of each year shall remain in effect until the following January.

1/ The frequency of each schedule is based on precipitation and runoff data which have been collected over the past 50 years at Hetch Hetchy. During the first three months Schedule B is adjusted to be in effect an average of 25% of the time and Schedule C 15% of the time.

HY-52 cont.

O-TRT-DREKMEIER cont.

INTERIM AGREEMENT

BETWEEN CITY AND COUNTY OF SAN FRANCISCO, CALIFORNIA TROUT, FRIENDS OF THE RIVER, SIERRA CLUB, AND TUOLUMNE RIVER PRESERVATION TRUST REGARDING FISHERIES STUDIES TO DETERMINE THE EFFECT OF THE KIRKWOOD POWERHOUSE, INCLUDING THE ADDITION TO THE KIRKWOOD POWERHOUSE ON THE FISHERIES RESOURCES OF THE TUOLUMNE RIVER FROM O'SHAUGHNESSY DAM TO EARLY INTAKE.

1. The parties to this agreement are the City and County of San Francisco ("City") acting through its Public Utilities Commission ("Commission"), California Trout, Friends of the River, Sierra Club, and Tuolumne River Preservation Trust (referred to collectively as either "Interested Parties" or "The Trust, Etc."). HY-52 cont.

2. The purpose of this interim agreement, in part, is to provide sufficient time for the Commission and the Department of the Interior ("D.O.I.") to enact a formal agreement concerning additional fisheries studies to be conducted by the Commission as well as implementation of increased flows should they be mandated by the fisheries studies. The parties anticipate that this interim agreement will be superseded to the extent that the terms hereof are substantively included in the agreement to be formulated between the Commission and D.O.I. To the extent that terms and conditions contained herein are not substantively set forth in the agreement between the Commission and D.O.I., said terms and conditions herein shall remain in effect. This

agreement shall remain in full force and effect until such time as it is terminated by mutual consent of the parties hereto.

3. Once the City has received concurrence from the D.O.I. and other state or federal agencies who have not yet completed their review of the project known as Kirkwood Powerhouse Unit Number 3 ("Kirkwood Addition") within a time acceptable to the Commission, the City shall then proceed immediately to arrange for appropriate fisheries studies to make a determination as to what effect, if any, the Kirkwood Powerhouse Project and the Kirkwood Addition would have or have had on fisheries operations between O'Shaughnessy Dam and Early Intake. The studies will include information compiled since 1967. The studies shall be conducted over a four year period; the consequent reports and analyses shall be published by December, 1989. This deadline shall be extended in the event that the consultants conducting said studies have determined that because of climatic or other environmental conditions, the results of said studies would result in inaccurate or inconclusive data.

HY-52 cont.

4. If, as a result of the foregoing fisheries studies, the consultants conducting the studies can preliminarily determine on or after December 31, 1986 that flows in the upper region of the Tuolumne River between O'Shaughnessy Dam and Early Intake should be increased, the City will increase its annual releases as set forth in Exhibit A to the document known as "Stipulation for Amendment of Rights-of-Way for Canyon Power Project Approved by Secretary of the Interior on May 26, 1961 to fulfill the

conditions set forth in Provision 6 of said Amended Permit", dated January 31, 1985, agreed to with the D.O.I.

Under Schedule "A" to include the following:

1. Anytime the draft through the Canyon Tunnel exceeds 920 CFS the fish release at O'Shaughnessy Dam will be increased an additional 64 CFS.
2. On July 1st 15,000 acre-feet will be available to mitigate any deficiency in the existing fish release shown to be required as a result of the fisheries studies, as provided for in paragraph 3, above.

Under Schedule "B" to include the following:

1. Anytime the draft through the Canyon Tunnel exceeds 920 CFS the fish release at O'Shaughnessy Dam will be increased an additional 64 CFS.
2. On July 1st 6,500 acre-feet will be available to mitigate any deficiency in the existing fish releases shown to be required as a result of the fisheries studies, as provided for in paragraph 3, above.

Under Schedule "C" to include the following:

1. On July 1st if the water storage behind O'Shaughnessy Dam is at or above 210,000 acre-feet, (the highest storage reached in 1976) 4.400 acre-feet will be available to mitigate any deficiency in the existing-fish releases shown to be required as a result of the fisheries studies, as provided for in paragraph 3, above.

HY-52 cont.

It is understood and agreed that water releases made by the City at Hetch Hetchy for fisheries purposes shall remain in the Tuolumne River between O'Shaughnessy Dam and New Don Pedro Reservoir, and the timing of these releases will be such as to coincide with the documented causes for the decrease in fisheries in the affected stretch of the river. By way of example, if fish population have declined because of warm water conditions, the releases shall be made during the summer months. The extent of these releases shall be determined by consultation between the City, Commission staff, appropriate state and federal agencies, as well as The Trust, Etc..

HY-52 cont.

5. The four year study(s) to be conducted shall be those requested by the California Department of Fish and Game, the United States Fish and Wildlife Service, and/or the United States Parks Service. It is anticipated that the types of studies the Commission will be responsible for conducting will include fish population, habitat preference and IFIM studies. The studies will be conducted by the California Department of Fish and Game, the United States Fish and Wildlife Service, or private consultants jointly selected by the City, the Commission and the above state and federal agencies, in consultation with The Trust, Etc. The population and preference studies will be conducted over the next four years, or longer if necessary, as provided for in paragraph 3, above. The IFIM study, analysis and report will be concluded by the end of the fourth year, or as extended if necessary, as provided for in paragraph 3, above. The purpose of

delaying the IFIM study toward the end of the fourth year is to allow the techniques associated with the study to reach a more refined level, thereby producing more accurate quantifications. Should the above studies not produce the results anticipated, other necessary studies may be undertaken.

6. In the event that the results and analysis of all studies dictate an increase to the present flow regime, such an increase shall be implemented up to the limits set forth in paragraph 4 above, except that necessary spring spill-flows shall not be subject to these limitations or cause a reduction in the minimum flows found necessary in other seasons.

7. It is specifically understood that the ultimate agreement encompassing the above shall be between the City and the D.O.I.. The Trust, Etc. shall function as interested parties who shall have standing to enforce the terms and conditions of said agreement.

HY-52 cont.

8. Upon execution of this agreement, The Trust, Etc. shall each withdraw their opposition to the Kirkwood Addition and request all other parties with whom it has been in contact urging or proposing opposition to the Kirkwood Powerhouse, to withdraw their opposition also. The Trust, Etc. shall each send written request to all said parties with copies to be forwarded to the City. Further, The Trust, Etc. will each make personal contact with all such parties requesting their withdrawal of opposition to this project. Furthermore, The Trust, Etc. will not seek through direct or indirect means to subvert the purpose of the

Kirkwood Addition as both an operational and economic resource for the City, as contemplated by this agreement. Additionally, should a party not to this agreement challenge the Kirkwood Addition, The Trust, Etc. shall not take a position adverse to the City, whether before state or federal agencies, legislative branches, or the judicial system.

IN WITNESS WHEREOF, City and Interested Parties have executed this Agreement in quadruplicate as of November 4, 1985.

CITY AND COUNTY OF SAN FRANCISCO, a municipal corporation

APPROVED:

RUDOLF NOTHENBERG
General Manager
Public Utilities Commission

Authorized by
PUBLIC UTILITIES COMMISSION

Resolution No. _______

Adopted: _______

Attest: _______

THEODORE CHUNG
Acting General Manager
Hetch Hetchy Water and Power

HY-52 cont.

APPROVED AS TO FORM:

GEORGE AGNOST, City Attorney

By

GEORGE E. KRUEGER
Utilities General Counsel

ROMAINE BOLDRIDGE
Secretary

CALIFORNIA TROUT

FRIENDS OF THE RIVER

TUOLUMNE RIVER PRESERVATION TRUST

SIERRA CLUB

ANTONIO ROSSMANN
Attorney for California Trout, Friends of the River and Tuolumne River Preservation Trust

Kirkwood Addition as both an operational and economic resource for the City, as contemplated by this agreement. Additionally, should a party not to this agreement challenge the Kirkwood Addition, The Trust, Etc. shall not take a position adverse to the City, whether before state or federal agencies, legislative branches, or the judicial system.

IN WITNESS WHEREOF, City and Interested Parties have executed this Agreement in quadruplicate as of November 4, 1985.

CITY AND COUNTY OF SAN FRANCISCO, a municipal corporation

APPROVED:

RUDOLF NOTHENBERG
General Manager
Public Utilities Commission

THEODORE CHUNG
Acting General Manager
Hetch Hetchy Water and Power

Authorized by
PUBLIC UTILITIES COMMISSION

Resolution No. ______

Adopted: ______

Attest: ______

ROMAINE BOLDRIDGE
Secretary

CALIFORNIA TROUT

FRIENDS OF THE RIVER

SIERRA CLUB

APPROVED AS TO FORM:

GEORGE AGNOST, City Attorney

By ______
GEORGE E. KRUEGER
Utilities General Counsel

TUOLUMNE RIVER PRESERVATION TRUST

ANTONIO ROSSMANN
Attorney for California Trout, Friends of the River and Tuolumne River Preservation Trust

HY-52 cont.

Attachment D

O-TRT-DREKMEIER cont.

United States Department of the Interior

OFFICE OF THE SOLICITOR
WASHINGTON, D.C. 20240

RECORD COPY
NO 12653 4
INFORMATION COPY
MO Y/N
ISSUED TO DATE
THIS COPY MAY BE DISCARDED

Memorandum

To: Director, National Park Service

From: Assistant Solicitor, Parks and Recreation

Subject: Yosemite National Park-Kirkwood Power House Agreement

Enclosed is a copy of:

> MODIFICATION FOR KIRKWOOD POWERHOUSE UNIT NO. 3 TO STIPULATION FOR AMENDMENT OF RIGHTS-OF-WAY FOR CANYON POWER PROJECT APPROVED BY SECRETARY OF THE INTERIOR ON MAY 26, 1961 TO FULFILL THE CONDITIONS SET FORTH IN PROVISION 6 OF SAID AMENDED PERMIT.

HY-52 cont.

Please retain the original (which had previously been sent to Dave Jervis of your office) in your permanent records for the Park and the Hetch-Hetchy Project.

David A. Watts

Attachment

cc:
Western Regional Director, FNP]
Superintendent, Yosemite]
Director, Bureau of Reclamation]
Assistant Secretary, FW]w/attachment
San Francisco Field Solicitor]
Tom Berliner, San Francisco City Attorney

MODIFICATION FOR KIRKWOOD POWERHOUSE UNIT NO. 3 TO STIPULATION FOR AMENDMENT OF RIGHTS-OF-WAY FOR CANYON POWER PROJECT APPROVED BY SECRETARY OF THE INTERIOR ON MAY 26, 1961 TO FULFILL THE CONDITIONS SET FORTH IN PROVISION 6 OF SAID AMENDED PERMIT

Pursuant to the Act of December 19, 1913 (38 Stat. 242), and in consideration of relocation and installation of its facilities and the granting to it by the United States of amended rights-of-way applied for, the City and County of San Francisco ("City"), a municipal corporation of the State of California, on May 23, 1961 stipulated and agreed and did bind itself, its successors and assigns to the terms, conditions and obligations set forth in the amended rights-of-way approved May 26, 1961 and amendments or modifications subsequent thereto.

HY-52 cont.

Condition number 6 of said amended rights-of-way provided, among other things, that the interim stream flow releases would be subject to a study for a recommended flow schedule.

On December 13, 1984, the City, acting through the General Manager of its Public Utilities Commission, executed a further stipulation to fulfill the conditions set forth in condition number 6 and bound itself, its successors and assigns, to the terms, conditions and obligations, consisting of six provisions, including a water release schedule set forth on Exhibit A, contained therein. Condition number 6 of this Stipulation provided, in part, that the City agreed that any proposed expansion, alteration, or other modification of the water and power supply facilities which could alter flow along the stretch of river in issue would be subject to review by the Department of the Interior ("Department") for the purpose of determining what change, if any, should be made in the agreed upon flow release schedule. This Stipulation was approved by the Department on January 31, 1985. (hereinafter "1985 Stipulation")

By letter of July 3, 1985, the City, acting through the General Manager, San Francisco Water Department, requested the Department's review and concurrence with a proposal to add a third generator to the Kirkwood Powerhouse on the Tuolumne River in accordance with condition number 6 of the 1985 Stipulation.

HY-52 cont.

Following discussions with the Department, the City now hereby agrees to supplement and amend said 1985 Stipulation, to provide for additional protection of fishery resources and to provide variability in the water releases resulting from spring runoff to the extent practicable so as to enhance park resources and visitor enjoyment, and to bind itself, its successors and assigns, to each of the following terms, conditions, and obligations, consisting of 8 provisions, as follows:

1. At the direction of the Department, the U.S. Fish and Wildlife Service, or the City, shall conduct studies to make a determination as to what effect, if any, the Kirkwood Powerhouse Project and the Kirkwood Addition would have or have had on habitat for and populations of resident fish species, between

O'Shaugnessy Dam and Early Intake. The studies will include information compiled since 1967. The studies will be conducted over a four-year period; the consequent reports and analyses shall be published by December, 1992. This deadline shall be extended in the event that the U.S. Fish and Wildlife Service determines that because of climatic or other environmental conditions, the results of said studies would result in inaccurate or inconclusive data.

2. If, as a result of the foregoing studies, the U.S. Fish and Wildlife Service preliminarily determines on or after December 31, 1986, that flows in the upper region of the Tuolumne River between O'Shaugnessy Dam and Early Intake should be increased, the City will adjust its minimum releases as set forth in Exhibit A to the document known as "Stipulation for Amendment of Rights-Of-Way for Canyon Power Project Approved by Secretary of the Interior on May 26, 1961 to Fulfill the Conditions Set Forth in Provision 6 of Said Amended Permit", as dated January 31, 1985, (also referred to herein as the "1985 Stipulation") in the following manner.

HY-52 cont.

Under Schedule "A" to include the following:

a. Anytime the draft through the Canyon Tunnel exceeds 920 CFS the flow release schedule at O'Shaughnessy Dam will be increased an additional 64 CFS.

b. At any time after May 1st, 15,000 acre-feet will be available to mitigate any deficiency in the existing flow release schedule shown to be required as a result of the studies, as provided for in paragraph 1, above.

c. Increases to the March through July portion of the flow release schedule in addition to those specified in paragraphs "a" and "b" above necessary to protect habitat for or populations of resident fish species in any year the draft through the Canyon Tunnel exceeds 920 CFS.

HY-52 cont.

Under Schedule "B" to include the following:

a. Anytime the draft through the Canyon Tunnel exceeds 920 CFS the flow release schedule at O'Shaughnessy Dam will be increased an additional 64 CFS.

b. At anytime after May 1st 6,500 acre-feet will be available to mitigate any deficiency in the existing flow release schedule shown to be required as a result of the studies, as provided for in paragraph 1, above.

c. Increases to the March through July portion of the flow release schedule in addition to those specified in paragraphs "a" and "b" above necessary to protect habitat for or population of resident fish species in any year the draft through the Canyon Tunnel exceeds 920 CFS.

Under Schedule "C" to include the following:

a. On July 1st if the water storage behind O'Shaughnessy Dam is at or above 210,000 acre-feet (the highest storage reached in 1976), 4,400 acre-feet will be available to mitigate any deficiency in the existing flow release schedule shown to be required as a result of the studies, as provided for in paragraph 1, above.

b. Additional increases to the March through July portion of the flow releases schedule necessary to protect habitat for or populations of resident fish species in any year the draft through the Canyon Tunnel exceeds 920 CFS. HY-52 cont.

It is understood and agreed that water releases made by the City at Hetch Hetchy provided herein shall remain in the Tuolumne River between O'Shaughnessy Dam and New Don Pedro Reservoir, and the timing of these releases will be such as to coincide with the documented causes for the decrease in the habitat for or populations of resident fish species in the affected stretch of the river. The extent of these releases shall be determined by the U.S. Fish and Wildlife Service, in consultation with the City, Commission staff, appropriate state and federal agencies, and interested members of the public.

3. The four-year study(s) to be conducted shall be as determined by the U.S. Fish and Wildlife Service, in consultation with the California Department of Fish and Game, the U.S. Forest Service and the National Park Service. It is anticipated that the types of fisheries studies to be conducted will include fish population, habitat preference, and IFIM studies. The studies will be conducted by the U.S. Fish and Wildlife Service; the California Department of Fish and Game; or, a private consultant selected by the U.S. Fish and Wildlife Service in consultation with the City, the Commission, and the above state and federal agencies, and with interested members of the public. The U.S. Fish and Wildlife Service shall have the right to undertake these studies itself should it elect to do so. If so directed, the City shall conduct these studies through a private consultant selected by the U.S. Fish and Wildlife Service in consultation with the City, the Commission and the above state and federal agencies, and with interested members of the public. The population and preference studies will be conducted over the next four years, or longer if necessary, as provided for in paragraph 1, above. The IFIM study, analysis and report will be concluded by the end of the fourth year, or as extended if necessary, as provided for in paragraph 1, above. The purpose of delaying the IFIM study toward the end of the fourth year is to allow the techniques associated with the study to reach a more refined level, thereby producing more accurate quantifications. Should the above studies not produce the results anticipated, other necessary studies may be undertaken.

HY-52
cont.

4. In the event that the results and analysis of all studies dictate an increase to the present flow regime as determined by the U.S. Fish and Wildlife Service, such an increase shall be implemented by the City, without right to any appeal, administrative hearing or further review, up to the limits set forth in paragraph 2 above, except that any changes to the spring portion of the flow release schedule specified in paragraph 2, Schedules A and B, subpart "c" and Schedule C, subpart "b" shall be afforded such review as provided for in paragraph 5 of this Modification.

HY-52 cont.

5. Both the City and the Department specifically recognize and agree that the issue of changes in the flow release schedule will be studied by the U.S. Fish and Wildlife Service or its designee consistent with the terms of this Modification. In the event that the U.S. Fish and Wildlife Service shall determine that changes to the March through July portion of the flow release schedule specified in paragraph 2, Schedules A and B, subpart "c" and Schedule C, subpart "b" may be necessary based upon these studies, it will recommend to the Secretary of the Interior such changes in the flow release schedule as may be necessary to protect the habitat for or population of resident fish species during the March through July portion of the flow release schedule. Such recommendations shall become part of these provisions, unless the City, within thirty (30) days from receipt of notice of the recommendations, shall file with the Secretary of the Interior, its objections thereto. In such event, at its

request, the City shall be afforded a hearing regarding these objections before a special hearing officer who will render proposed findings of fact. The Secretary, after considering the proposed findings of fact and the record, shall determine what additional flows, if any, shall be required.

6. The City agrees to fund the studies determined to be appropriate by the U.S. Fish and Wildlife Service under the terms of this Modification at a cost not to exceed $200,000, unless otherwise mutually agreed by the parties hereto.

HY-52 cont.

7. In an attempt to enhance park resources and visitor enjoyment, each year within ten days of the completion of the City's March 1 snow survey, the Superintendent of Yosemite National Park ("Superintendent") and the General Manager of the Hetch Hetchy project ("General Manager") shall meet, together with a representative of the U.S. Fish and Wildlife Service.

At the outset of the meeting, the General Manager shall explain whether the City's operating criteria for the Hetch Hetchy project indicate that the year will be a normal water year (as defined by a "Schedule A" year pursuant to the Flow Release Schedule set forth in the 1985 Stipulation), that is, a year when the snow survey indicates that the reservoir will fill and spill by July 1.

If such operating criteria indicate that the year will be a normal water year (Schedule A), the above-named persons shall make best efforts to develop a framework for the timing and quantity of releases from Hetch Hetchy Reservoir that will enhance the variability of flows and consider other measures to simulate to the extent possible the natural conditions of the Tuolumne River, and to the extent that such variability and other measures will not affect the City's operating and water requirements.

HY-52 cont.

If the General Manager, at any time, determines that climatic or other conditions require a departure from said framework or Schedules to meet the City's operating and water requirements, the General Manager will convene another meeting of the above-named persons in order to review whatever adjustments to the framework may be necessary. Provided, however, the City will not exceed 920 CFS through the Canyon Tunnel in a non-normal (Schedule B or C) year.

After ten years of operating pursuant to these procedures, the parties, based upon their experiences during this time period, shall meet and attempt to develop supplemental criteria to be incorporated, as an amendment to this Modification, that will establish variances in the release regime sought by the National Park Service, subject to the limits of the City's operating and water requirements and the fisheries requirements as discussed above. This ten year period may be extended for such additional periods as the parties may deem necessary.

No action shall be taken pursuant to this section which will adversely affect the fishery resource protections set forth elsewhere in this Modification.

HY-52 cont.

8. It is further agreed that this Modification is solely concerned with the operations of a third generator at the Kirkwood Powerhouse within the Hetch Hetchy Water and Power System as it is presently configured and that the provisions of other Raker Act Stipulations, including condition 6 of the 1985 Stipulation, remain in effect in accordance with their terms and amendments thereto.

IN WITNESS WHEREOF, the City and County of San Francisco has caused this instrument to be executed in the City of San Francisco, California, this 10 day of March. 1987.

General Manager of Public Utilities Commission, City and County of San Francisco
SUBSCRIBED AND SWORN to before me this 10th day of March, 1987.

Secretary, Public Utilities Commission, City and County of San Francisco

HY-52 cont.

FORM APPROVED:

DATE: March 10, 1987

Utilities General Counsel
City and County of San Francisco

DATE: March 10, 1987

Assistant Secretary for Fish and Wildlife and Parks (Sgd) P. Daniel Smith

DATE: MARCH 11, 1987

INSTREAM FLOW REQUIREMENTS FOR RAINBOW AND BROWN TROUT IN THE TUOLUMNE RIVER BETWEEN O'SHAUGHNESSY DAM AND EARLY INTAKE

Prepared by
Michael E. Aceituno
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HY-52 cont.

July 1992

INSTREAM FLOW REQUIREMENTS FOR RAINBOW AND BROWN TROUT IN THE TUOLUMNE RIVER BETWEEN O'SHAUGHNESSY DAM AND EARLY INTAKE

ABSTRACT

In 1988, the U.S. Fish and Wildlife Service's Instream Flow Incremental Methodology (IFIM) was applied to the Tuolumne River below Hetch Hetchy Reservoir. The purpose was to determine the instream flow needs for rainbow trout (*Onchorhynchus mykiss*) and brown trout (*Salmo trutta*) inhabiting the reach of the Tuolumne River affected by the Hetch Hetchy Water and Power Project, owned and operated by the City and County of San Francisco. A streamflow versus habitat relationship was determined using the physical habitat simulation (PHABSIM) model and is based on the rivers stage-discharge relationship established for three calibration flows measured as releases below O'Shaughnessy Dam. Annual instream flow requirements are discussed for the juvenile and adult life stages of rainbow and brown trout within the affected reach of the Tuolumne River. An annual fishery allocation of between 59,207 acre-feet and 75,363 acre-feet is recommended, based on the findings of the instream flow study.

HY-52 cont.

INSTREAM FLOW REQUIREMENTS FOR
RAINBOW AND BROWN TROUT IN THE TUOLUMNE RIVER
BETWEEN O'SHAUGHNESSY DAM AND EARLY INTAKE

ACKNOWLEDGEMENTS

This investigation was funded through monies provided by the City and County of San Francisco in an agreement with the U.S. Fish and Wildlife Service. Mr. Leo Bauer was the primary contact throughout the investigation. Many others also contributed to the completion of this study. Fish and Wildlife personnel Phil North (field crew leader), Roger Guinee, Mike Sullivan, Nadime Kanim, Phil Harrison, Melony McFarland, and Rich Williams all provided assistance during various tasks of the project.

HY-52 cont.

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Attachment E

O-TRT-DREKMEIER cont.

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HY-52 cont.

Attachment E

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INSTREAM FLOW REQUIREMENTS FOR RAINBOW AND BROWN TROUT IN THE TUOLUMNE RIVER BETWEEN O'SHAUGHNESSY DAM AND EARLY INTAKE

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APPENDIX C: Estimated weighted usable area of habitat for rainbow trout and brown trout in the Tuolumne River between Hetch Hetchy Reservoir and Early Intake.

APPENDIX D: Water temperature records for the months of June through October during water years 1988 through 1991 for the Tuolumne River above Early Intake.

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INSTREAM FLOW REQUIREMENTS FOR
RAINBOW AND BROWN TROUT IN THE TUOLUMNE RIVER
BETWEEN O'SHAUGHNESSY DAM AND EARLY INTAKE

INTRODUCTION

The Hetch Hetchy water and power system, an integrated system of water supply and hydroelectric facilities, was constructed by the City and County of San Francisco under terms of easements issued by the United States Department of the Interior pursuant to legislation enacted by the U. S. Congress in 1913 (the Raker Act, 38 Stat. 242).

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Staged construction of project facilities within the Hetch Hetchy system has taken place since 1913. First, O'Shaughnessy Dam was built at the lower end of Hetch Hetchy Valley in Yosemite National Park. Storage in Hetch Hetchy Reservoir, formed behind the dam, began in April 1923. A diversion dam and tunnel entrance (known as Early Intake) was also constructed 12.1 river miles downstream in the Stanislaus National Forest. From 1925 to 1967, water released from Hetch Hetchy Reservoir was diverted from the river at Early Intake and transported, by tunnel, 20 miles to a powerhouse on Moccasin Creek, a tributary to the Tuolumne River further downstream. At Moccasin Creek, Hetch Hetchy water enters the Hetch Hetchy Aqueduct and is conveyed 120 miles to San Francisco.

Subsequently, the Canyon Power Project was constructed as part of the Hetch Hetchy System, and was completed in 1967. Its principle features include a diversion facility at O'Shaughnessy Dam, a 12 mile conveyance tunnel along the north canyon wall of the Tuolumne River, and the Robert C. Kirkwood powerhouse, constructed just upstream of the Early Intake diversion. This project was approved by the Secretary of the Interior on April 27, 1961 provided that "[t]he interests of sport fishery and recreation can be protected by requiring continuing releases of water from O'Shaughnessy Dam to maintain the Tuolumne as a **live** [emphasis added] stream between the dam and Early Intake." Included within this approval were stipulations for: 1) minimum instream flows between O'Shaughnessy Dam and Early Intake; and 2) a two year study to determine the adequacy of the prescribed minimum instream flows for the resident fishery, recreational use, and aesthetics.

HY-52 cont.

In August 1967 the U. S. Fish and Wildlife Service completed a report describing the interagency study conducted pursuant to the Secretary's 1961 approval and presented a recommended release schedule to protect the fishery, recreational use, and aesthetic value of the affected reach of the Tuolumne River. Negotiations subsequent to completion of the fishery and recreation study resulted in instream flow schedules providing 59,235 acre-feet, 49,994 acre-feet, or 35,197 acre-feet of water for fishery flows, depending on rainfall and reservoir storage within the Hetch Hetchy basin.

In 1985 the City and County of San Francisco was granted approval by the Secretary of the Interior to install a third generator at the Kirkwood powerhouse. This approval was predicated on an agreement between San

Francisco, California Trout, Friends of the River, the Sierra Club, and the Tuolumne River Preservation Trust, which provided additional river flows of 15,000 acre-feet, 6,500 acre-feet, or 4,400 acre-feet, to mitigate any deficiencies in the existing fishery flow releases. This agreement also included an additional 4 year study to document flow needs and habitat affects.

In 1987 the City and County and the Department of the Interior reached agreement regarding a study to be completed to determine the affect of operation of the new generator on the Tuolumne River fishery resources between O'Shaughnessy Dam and the diversion dam at Early Intake. This study is generally called the Hetch Hetchy Fishery Investigation and includes four major elements. These are: 1) a detailed instream flow analysis, using the Service's instream flow incremental methodology (IFIM); 2) development of habitat suitability curves for rainbow and brown trout within the affected reach of the Tuolumne River; 3) a population survey of adult and juvenile rainbow and brown trout within the affected reach; and, 4) a review of existing temperature data and development of a temperature model for the affected reach.

HY-52 cont.

This report describes results of efforts undertaken by Service personnel under study element 1 of the Hetch Hetchy Fishery Investigation and provides recommendations regarding instream flows to be released from O'Shaughnessy Dam to protect the fishery resource.

DESCRIPTION OF STUDY AREA

General Setting

The Tuolumne River originates at an elevation of 13,000 feet above mean sea level on the western slope of the southern Sierra Nevada mountains of California. It flows approximately 185 miles in a westerly direction, eventually joining the San Joaquin River and flowing into the Pacific Ocean (Figure 1). Of glacial origin the Tuolumne flows westerly across the Tuolumne meadows area of Yosemite National Park, over the falls and cascades of the "Grand Canyon of the Tuolumne" and into the 8 mile long Hetch Hetchy Valley. Since O'Shaughnessy Dam was completed in 1923, Hetch Hetchy Valley has been submerged below Hetch Hetchy Reservoir. Below O'Shaughnessy Dam the river drops from pool to pool over cascades, riffles, and pocket waters until it reaches Poopenaut Valley. Leaving Poopenaut Valley the Tuolumne River flows through an extremely deep gorge characterized by sheer granite walls 1,000 feet tall. Exiting the gorge area, the river passes through Mather Pool, over Preston falls, and courses through Preston Meadow and on into Indian Meadow. Below Indian Meadow and before the River reaches the confluence of Cherry Creek it encounters the Early Intake diversion dam where, prior to 1967, much of the river flow was diverted into a tunnel where it begins the 140 mile journey to San Francisco. Below Early Intake, the Tuolumne continues westerly into Don Pedro Reservoir below which it finally leaves the Sierra Nevada and

HY-52 cont.

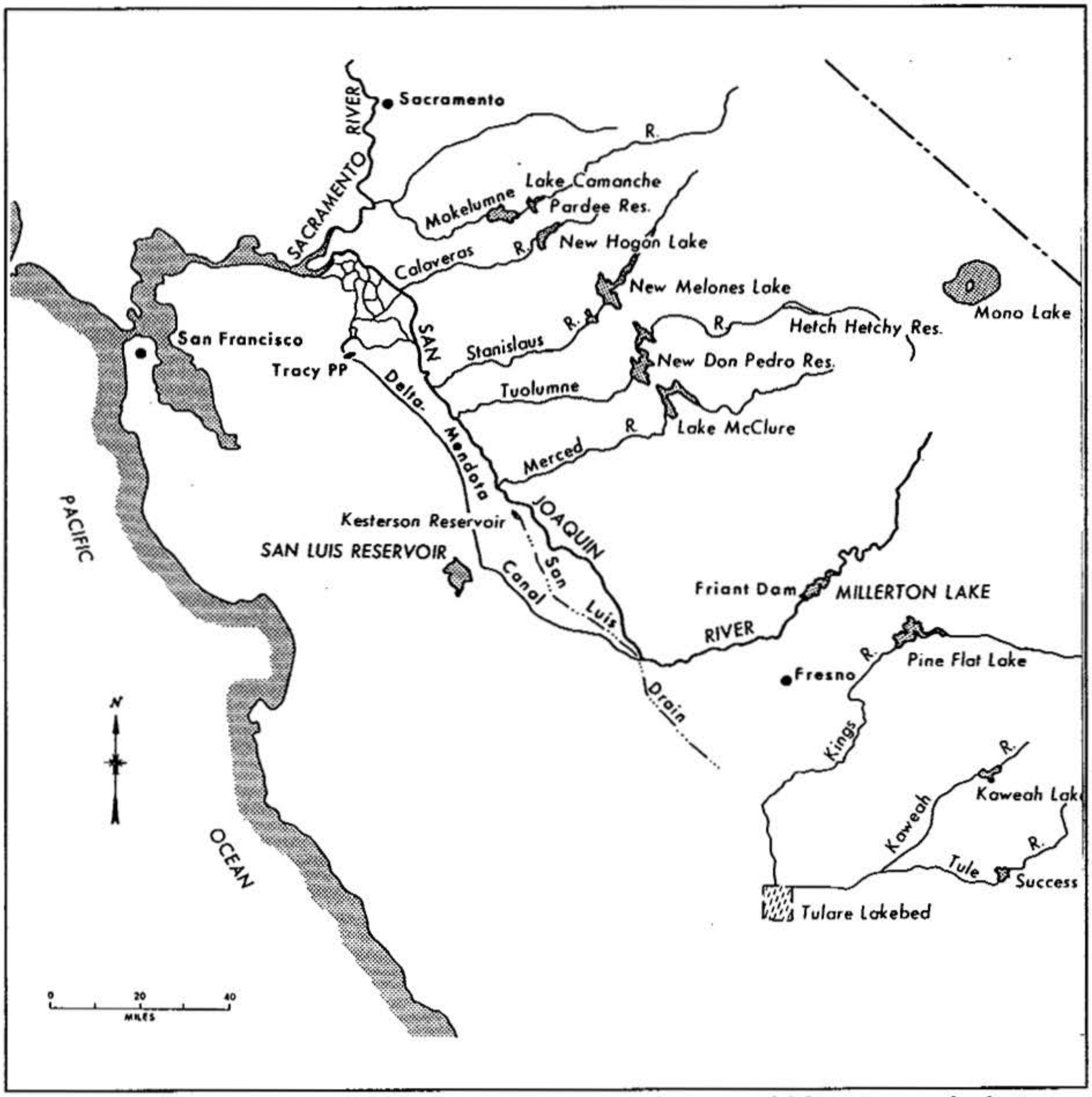


Figure 1. General location of the Tuolumne River, California, and the Hetch Hetchy Fishery Investigation Study Area.

its foothills, crosses the eastern floor of the San Joaquin Valley and ultimately flows into the San Joaquin River near the town of Modesto, California. Eventually, the waters of the Tuolumne River flow into the Sacramento-San Joaquin River Delta, through the San Pablo Bay-San Francisco

HY-52 cont.

Bay complex and into the Pacific Ocean, passing beneath San Francisco's famous Golden Gate.

HY-52 cont.

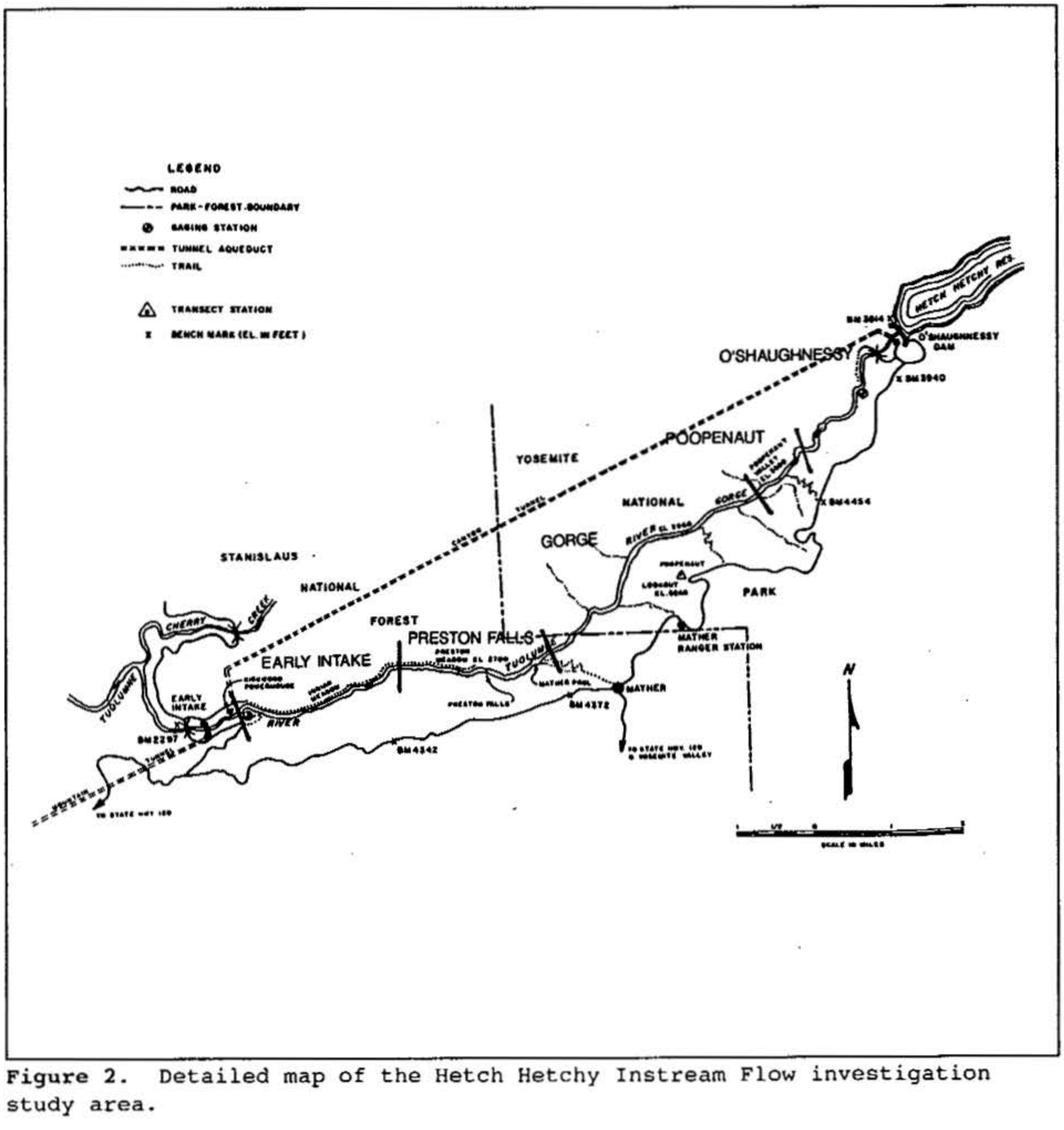


Figure 2. Detailed map of the Hetch Hetchy Instream Flow investigation study area.

The study reach for this investigation begins at O'Shaughnessy Dam, at an elevation of 3,814 feet above mean sea level, in the northwestern corner of Yosemite National Park, and extends to Early Intake 12.1 miles downstream at an elevation of 2,297 feet above mean sea level. About half the study reach falls within the National Park, the other half falls within the Stanislaus National Forest. Between O'Shaughnessy Dam and Early Intake, 12.1 miles of trout habitat is available in the Tuolumne River. Within the study reach no tributaries enter the Tuolumne, although there are a number both above and below the area. A detailed map of the study reach is provided in Figure 2.

HY-52
cont.

Hydrology

Historical flow records for the Tuolumne River exist only for the years 1911 through 1916. These records were taken at the lower Hetch Hetchy Valley and are illustrated in Figure 3.

Since storage began in Hetch Hetchy Reservoir in April 1923, Tuolumne River flows below O'Shaughnessy Dam have been controlled by the City and County of San Francisco through operation of the Hetch Hetchy Water and Power Project. Until 1967 water was released from Hetch Hetchy Reservoir at O'Shaughnessy Dam into the Tuolumne River. It was diverted 12.1 miles downstream at Early Intake into the Hetch Hetchy Aqueduct. For the most part flow patterns seemed to remain as they had been prior to 1923 expect that the magnitude of high flows was significantly reduced (Figure 4). Flow reductions, however, were

Attachment E

O-TRT-DREKMEIER cont.

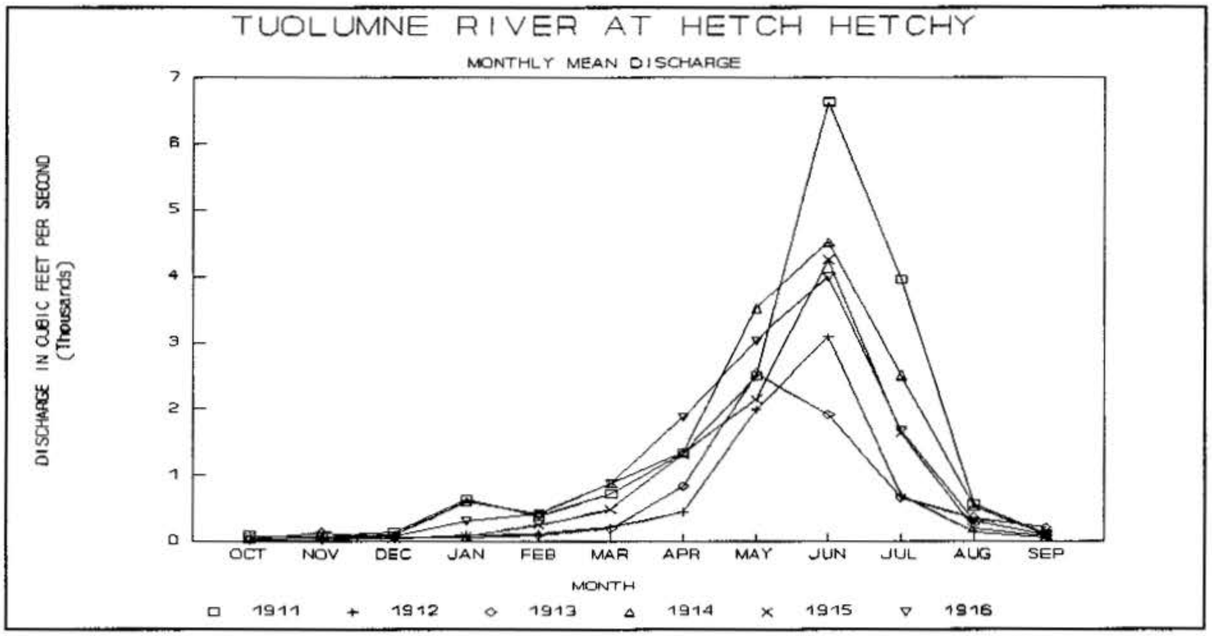


Figure 3. Monthly mean Tuolumne River flows at the old Hetch Hetchy cabin site and near the future O'Shaughnessy Dam site for the years 1911 through 1916.

HY-52 cont.

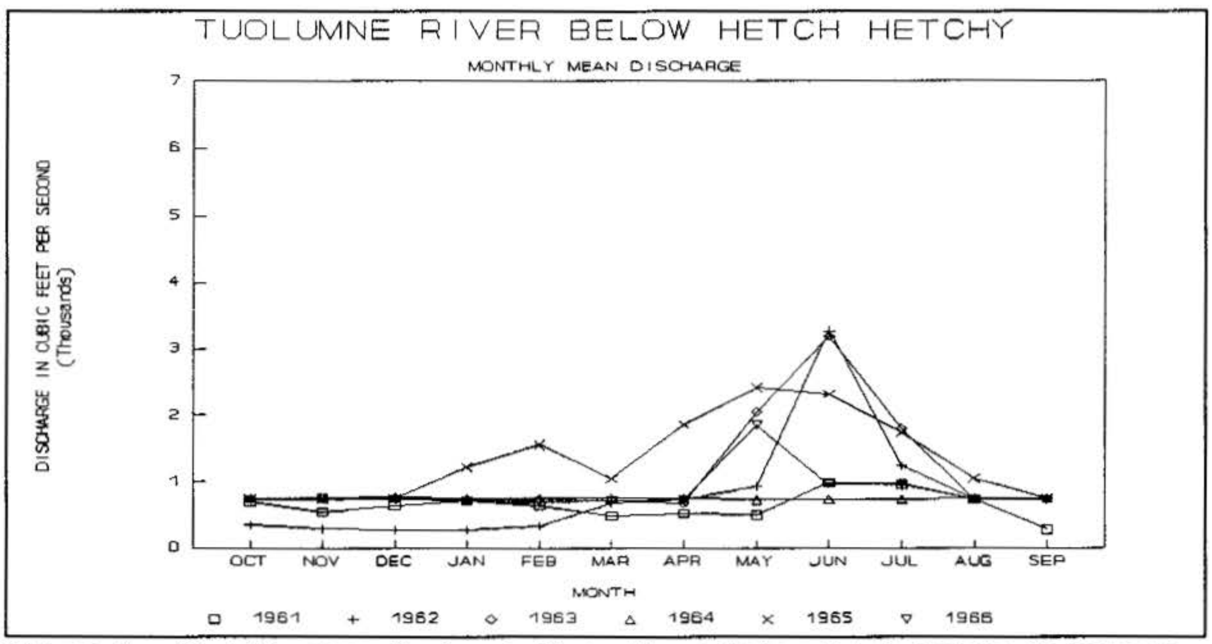


Figure 4. Monthly mean Tuolumne River flows below Hetch Hetchy Reservoir for the water years 1961 through 1966.

most significant during the spring and summer months.

O-TRT-DREKMEIER cont.

Through an agreement between the City and County of San Francisco, the Department of the Interior, the Department of Agriculture, and the State of California between 39,597 acre-feet and 74,207 acre-feet of water is currently

Table I. The minimum amounts of water to be released from Hetch Hetchy Reservoir to the Tuolumne River at O'Shaughnessy Dam by water year schedule along with additional "mitigation" water provided under agreement in 1985.

	Minimum Monthly Release Schedule (CFS)			Cumm. Precip.(in.) or runoff (AF)		
Month	A	B	C	A >	B >	C
January	50	40	35	8.8	6.1	
February	60	50	35	14.0	9.5	
March	60	50	35	18.6	14.2	
April	75	65	35	23.0	18.0	
May	100	80	50	26.6	19.5	
June	125	110	75	28.5	21.3	
July	125	110	75	575,000	390,000	
August	125	110	75	640,000	400,000	
September 1-15	100	80	75	---	---	
September 16-30	80	65	50	---	---	
October	60	50	35	---	---	
November	60	50	35	---	---	
December	50	40	35	---	---	
MINIMUM RELEASE (AF)	59,207	49,994	35,197			
Added "mitigation" release for water year (AF)	15,000	6,500	4,400			
TOTAL ANNUAL FISHERY ALLOCATION (AF)	74,207	56,494	39,597			

HY-52 cont.

available to protect the fishery resources between O'Shaughnessy Dam and Early Intake. The actual annual volume of water is based on cumulative rainfall from January through June and on reservoir storage criteria for the months of July and August. The current annual water allocation schedules for fishery flows into the Tuolumne River below O'Shaughnessy Dam, along with rainfall and storage criteria, are provided in Table I.

Additional mitigation water has also been provided since 1985 and varies with water year flow schedule. This mitigation water is used to increase instream flows, as necessary, and is provided according to schedules provided by the Fish and Wildlife Service.

HY-52 cont.

Mean monthly Tuolumne River flows below O'Shaughnessy Dam for the past twenty years are illustrated in Figure 5.

Fishery Resources

The fishery resources of the Tuolumne River are significant. Rainbow trout (*Onchorhynchus mykiss*) and brown trout (*Salmo trutta*) inhabit the reach of the river between Hetch Hetchy Reservoir and Early Intake. In 1976 the Service estimated that the 12.1 mile reach of the Tuolumne River between O'Shaughnessy Dam and Early Intake supported about 8,000 wild rainbow and brown trout 6.5 inches in length or larger (USFWS, 1976). More recently, population estimates

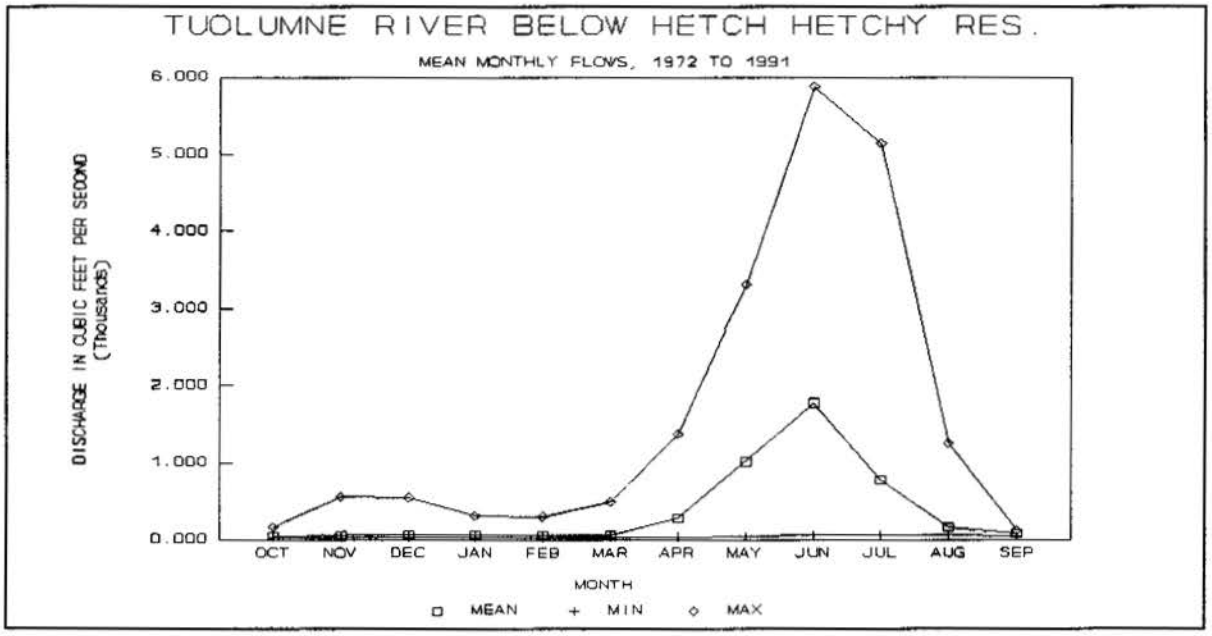


Figure 5. Monthly discharges (streamflow) for the Tuolumne River, measured just below O'Shaughnessy Dam for the years 1972 through 1991.

HY-52 cont.

conducted as part of the Hetch Hetchy Fishery Investigation have estimated approximately 7,000 adult trout for the study reach (USFWS 1990). Other fish species are also found within the study reach and include California roach (*Hesperoleucus symmetricus*), sculpin (*Cottus* spp.), and suckers (*Catostomidae* spp.).

At one time the Tuolumne River supported annual runs of chinook salmon numbering upward of 100,000 or more. Many of these fish are believed to have migrated upstream into the study area as far as Preston Falls, about half way between O'Shaughnessy Dam and Early Intake.

Steelhead trout were also thought to occur within the Tuolumne River and may, in fact, have migrated well past Preston Falls and Hetch Hetchy Meadow, currently submerged below Hetch Hetchy Reservoir, in Yosemite National Park.

The existence of anadromous fishes within the study area was eliminated following construction of LaGrange Dam in 1915. This dam is located on the Tuolumne River near the town of LaGrange, California.

Rainbow trout and brown trout are the target species for this study. All lifestages (spawning, fry, juvenile, and adults) have been observed within the study reach. Table II is a lifestage periodicity chart for trout in the Tuolumne River between O'Shaughnessy Dam and Early Intake. HY-52 cont.

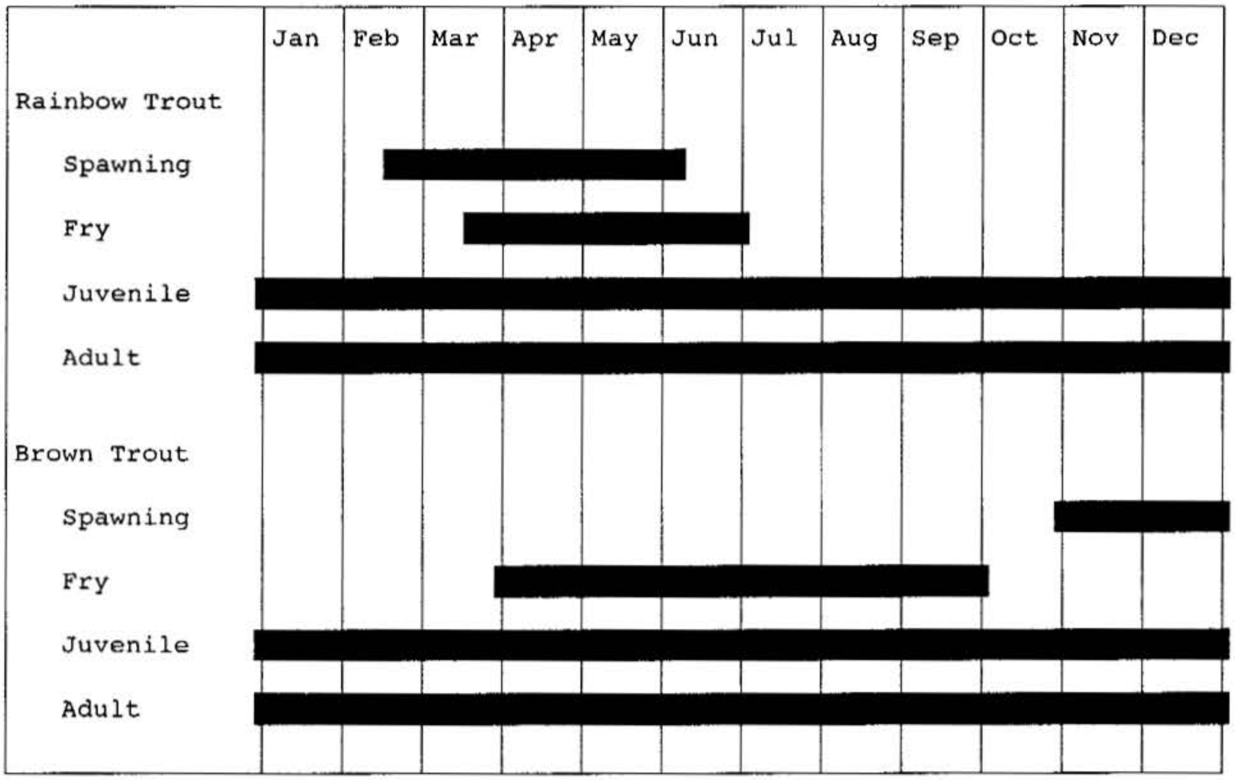
IFIM Study Sites

The Tuolumne River between O'Shaughnessy Dam and Early Intake was first surveyed by air and then on foot (except for that reach between Poopenaut Valley and Mather Pool). The study reach was subsequently divided into 5 river sections. These sections were determined based on general stream channel configuration, aquatic habitat types, overall gradient, and fish population assemblage and are identified as: 1) the Early Intake reach ; 2) the Preston Falls reach; 3) the Gorge reach; 4) the Poopenaut Valley reach; and, 5) the O'Shaughnessy reach.

Attachment E

O-TRT-DREKMEIER
cont.

Table II. life stage periodicity chart for rainbow trout and brown trout inhabiting the Tuolumne River between O'Shaughnessy Dam and Early Intake.



HY-52
cont.

During the spring of 1988 aquatic habitat mapping was completed for the entire study reach. Twelve habitat types were described. These are: deep pools, shallow pools, pocket water, cascades, cascade/deep pool, cascade/pocket water, chutes, riffles, runs, glides, side channels, and backwaters.

Complete descriptions of the 5 river sections, measured lengths and areas of each habitat type within these sections, along with habitat maps are provided in Appendix A.

Of the 12 habitat types identified and mapped we found that 6 (deep pools, shallow pools, pocket water, run, riffle, and cascade/pocket water) made up 93.9 percent of the total habitat available between O'Shaughnessy Dam and Early Intake. Steep gradient, high velocity cascade and chute habitats, and a combination of cascade/deep pool habitats made up 4.6 percent of the remaining habitat area, while low gradient glides, side channel, and backwater habitats were found to amount to only 1.5 percent of the total available habitat within the study area. Therefore, we decided that stream hydraulic data (velocities and depths) along with substrate and cover data necessary to describe the physical habitat available at various flows would be gathered mainly within the 6 main habitat types for use in the instream flow evaluation. A total of 29 transects were eventually selected. HY-52 cont.

METHODS

The Service's Instream Flow Incremental Methodology (IFIM) (Bovee and Milhouse 1978; Milhouse et al. 1981; Bovee 1982) was used for this evaluation. The IFIM was developed to facilitate water resource development, evaluation, and effective stream management. Basically, the methodology uses a computer-based physical habitat simulation model (PHABSIM) to combine stream hydraulic and physical parameters with fish habitat requirements. The product of the PHABSIM allows investigators to relate changes in streamflow to physical habitat availability. Important components of this technique are the development of a calibrated hydraulic stream model and knowledge of the suitability of specific habitat conditions (i.e., water depths, velocity, and substrate or cover) for individual fish species and life stages.

Field Techniques

Transects were placed within each study site so as to provide a representation of the predominant habitats found within that reach. Permanent markers (pins) were placed at the ends of each transect and a benchmark established as reference points within each study site. For each transect, water velocities, depths, and substrate were measured and recorded at vertical points distributed across the wetted width of the river for each of three "calibration" flows. Generally, the distance between each measuring point was kept constant. As needed, however, additional measuring points were added at gradient breaks in bottom profile or where significant changes in water velocities or substrate were observed. A rule of thumb was established that no more than 10 percent of the total measured streamflow for any one transect would occur within any given "cell" (i.e., the area between vertical measuring points). As a result, the number of vertical points across each transect where measurements were recorded varied from transect to transect depending on stream hydrology and streambed morphology. Generally, the number ranged between 20 and 30 per transect.

HY-52
cont.

Water depths and velocities were measured at each transect for three release flows from O'Shaughnessy Dam. These "calibration" flows were 250 cubic feet per second (cfs), 125 cfs, and 25 cfs. Water velocity and depth data collected for each calibration flow was subsequently used to establish the water surface elevation (stage) versus streamflow (discharge) relationship and to calibrate the hydraulic simulation incorporated within the physical habitat simulation program. The measured flow for each transect was calculated using standard techniques. In calibrating the model, measured discharges at the Hetch Hetchy stream gage was used as the mean discharge for each study site.

HY-52 cont.

Mean water column velocities were measured at 0.6 of the total depth (measured from the water surface) for water depths less than or equal to 2.5 feet. At depths greater than 2.5 feet but less than or equal to 5.0 feet, velocities were measured at 0.2 and 0.8 of the total water depth. For water depths greater than 5.0 feet, velocities were measured at 0.2, 0.6 and 0.8 of the total water depth. Water velocity measurements were made with either a Price AA or Gurley water velocity meter. In extremely slow velocity areas, with water depths of less than 1 foot, a Pygmy water velocity meter was used. Mean water column velocities were calculated using standard formulas.

Water depths were measured to the nearest 0.1 foot with a top-setting wading rod in areas less than 8 feet deep. For depths greater than 8 feet a raft mounted sounding reel system with a cable and 15-pound sounding weight was used.

Substrate composition and fish cover were assessed in each observation cell. An observation cell is defined as having a width equal to the horizontal distance between midpoints of adjacent vertical measuring points and a length

Table III. Substrate composition categories used in the Hetch Hetchy instream flow study, 1988.

Code	Substrate Type	Size Range (mm)
1	Organic Debris	---
2	Mud/Soft Clay	---
3	Silt	<.062
4	Sand	.062 - 2
5	Course Sand	2 - 4
6	Small Gravel	4 - 25
7	Medium Gravel	25 - 50
8	Large Gravel	50 - 75
9	Small Cobble	75 - 150
10	Medium Cobble	150 - 225
11	Large Cobble	225 - 300
12	Small Boulder	300 - 600
13	Medium Boulder	600 - 2000
14	Large Boulder	> 2000
15	Bedrock	---

HY-52 cont.

upstream and downstream to a point representing the "transition" point to the next habitat type. Substrate composition was described using a modified Brusven index system. Substrate categories and their respective codes are listed in Table III. An index was used, composed of a 6-digit substrate descripter based on dominant and subdominant substrate types and percent embeddedness of the substrate. It is coded as xXyY.%E (where xX = dominant substrate, yY = subdominant substrate, %E = percent embeddedness).

Table IV. Cover categories used in the Hetch Hetchy instream flow study, 1988.

Object Cover	Overhead Cover	Cover Quality
0 = None	0 = None	0 = None
1 = Objects < 6 inches	1 = Instream Overhead (undercut banks, rootwads, logs, etc.)	1 = Poor (<25%)
2 = Objects 6 to 12 inches	2 = Overhanging Overhead (within 18" of waters surface)	2 = Fair (25-50%)
3 = Objects > 12 inches	3 = Instream & Overhanging (both code 1 and 2)	3 = Good (50-75%)
------	-------	4 = Excellent (75-100%)

HY-52 cont.

Cover was described using a three-digit code. The first digit of the code defines the size of the largest object(s) seen within the observation cell. The second digit defines any overhead cover which provides protection from predators, sunlight, etc., within the observation cell. The third digit, which follows a decimal, describes the quality of the cover as poor, fair, good, or excellent. Cover codes and descriptions are listed in Table IV. The cover index is coded as XY.Z (where X = object cover, Y = overhead cover, and Z = cover quality).

If no overhead cover was present in the observation cell, the linear distance to the nearest overhead cover was estimated to the nearest foot.

General information recorded for each field day included sampling date and time, river reach and site, estimated stream discharge, air and water temperature, name of observer and recorder, observation method, water visibility, weather conditions, total length of study area and equipment used.

Water depth, velocity, and substrate suitability criteria used in this investigation were determined through field measurements of habitat use by rainbow and brown trout adults (both spawning and non-spawning), fry, and juveniles within the study reach of the Tuolumne River. These data were collected between October 20, 1987 and June 14, 1990. Results of the habitat criteria development phase of this study are described in the 1990 Progress Report on the Hetch Hetchy Fishery Investigation (USFWS 1991). Habitat suitability indexes used in the Hetch Hetchy IFIM are provided in Appendix B.

HY-52
cont.

Data Analysis

Field data gathered was initially transcribed from the field data forms into microcomputer database files using dBASE II (Ashton-Tate, dBASE II, IBM PC-DOS, Version 2.43). These files were checked for errors and corrected where necessary. They then became the "raw" database files from which all subsequent data analyses were conducted. The edited dBASE files where then transcribed to LOTUS 1-2-3 spreadsheets (1-2-3, release 2.01, LOTUS Development Corp.) for further analysis, including mean column water velocity calculations and conversion of substrate and cover codes to appropriate index values. These data were then formatted to input data decks needed for the hydraulic simulation (IFG4) program by using FLOSORT, a program developed by Andrew Hamilton of the Service's Lewiston Suboffice, Lewiston, California. All files were checked for accuracy using the RCKI4 microcomputer program provided by the Service's National Ecology Research Center, Aquatic Systems Modeling Section (NERC).

Individual input data decks were built for each flow and study site using the 3 sets of water surface elevations and velocity data collected during the calibration flows.

HY-52 cont.

The product of the physical habitat simulation (PHABSIM) is an index of the habitat potential for each study site, called the weighted usable area (WUA). For each study site and each computation flow the WUA is equal to the suitability index for the combined characteristics measured (water velocity, water depth, and substrate or cover) and the total surface area represented by that study site. The WUA is unique to the streamflow, the transect, and the target species and life stage to which it applies. The term "weighted" refers to the influence of the habitat suitability criteria applied to the physical habitat simulation and is provided as a separate input data set.

The fish habitat versus streamflow relationship determined through the physical habitat simulation model is expressed in terms of square feet of weighted usable area of habitat per 1,000 linear feet of stream. Since the study sections on the Tuolumne River are not the same length, the total weighted usable habitat area for each study section (represented by a study site) was calculated. The study section totals were than combined for a total estimate of weighted usable area of habitat for the entire 12 mile study reach between O'Shaughnessy Dam and Early Intake.

RESULTS

During 1988 data describing the water surface elevations at each transect, water velocity across the transect, substrate, and cover were collected at each of the 29 transects during 3 "calibration" flows, measured as releases from O'Shaughnessy Dam. The calibration flows were 250 cubic feet per second (cfs), 125 cfs, and 25 cfs. These data were used to calibrate the hydraulic simulation portion of the PHABSIM model. Table V summarizes dates and flow conditions during transect data collection. HY-52 cont.

The streamflow versus total weighted usable area of habitat relationship for rainbow trout and brown trout in the Tuolumne River between Hetch Hetchy Reservoir and Early Intake are illustrated in Figures 6 and 7, respectively.

The weighted usable area estimates used to generate these figures are provided in Appendix C.

Attachment E

O-TRT-DREKMEIER cont.

Table V. Dates and Stream discharges during transect data collection for the Hetch Hetchy Instream FLow Investigation.

Reach	Number Transects	Date(s) Data Gathered	Discharge at O'Shaughnessy Dam
1. Early Intake	6	July 21-22	250
		Sept. 13-15	125
		Oct. 13	25
2. Preston Falls	7	July 21	250
		Sept. 15	125
		Oct. 13	25
3. Gorge	0	inaccessible, no data gathered	
4. Poopenaut	4	July 20	250
		Sept. 14	125
		Oct. 12	25
5. O'Shaughnessy	12	July 18-19	250
		Sept. 12-13	125
		Oct. 11-12	25

HY-52 cont.

DISCUSSION

Developing a flow recommendation for the Tuolumne River between Hetch Hetchy Reservoir and Early Intake is a difficult task. It is important to balance the habitat needs for the target species and life stages. These needs include not only the availability of physical habitat but also adequate water quality to provide for survival and growth. The model developed for this study resulted in the estimated total weighted usable area of habitat for rainbow and brown trout within the Tuolumne River study reach as shown in Figures 6

Attachment E

O-TRT-DREKMEIER cont.

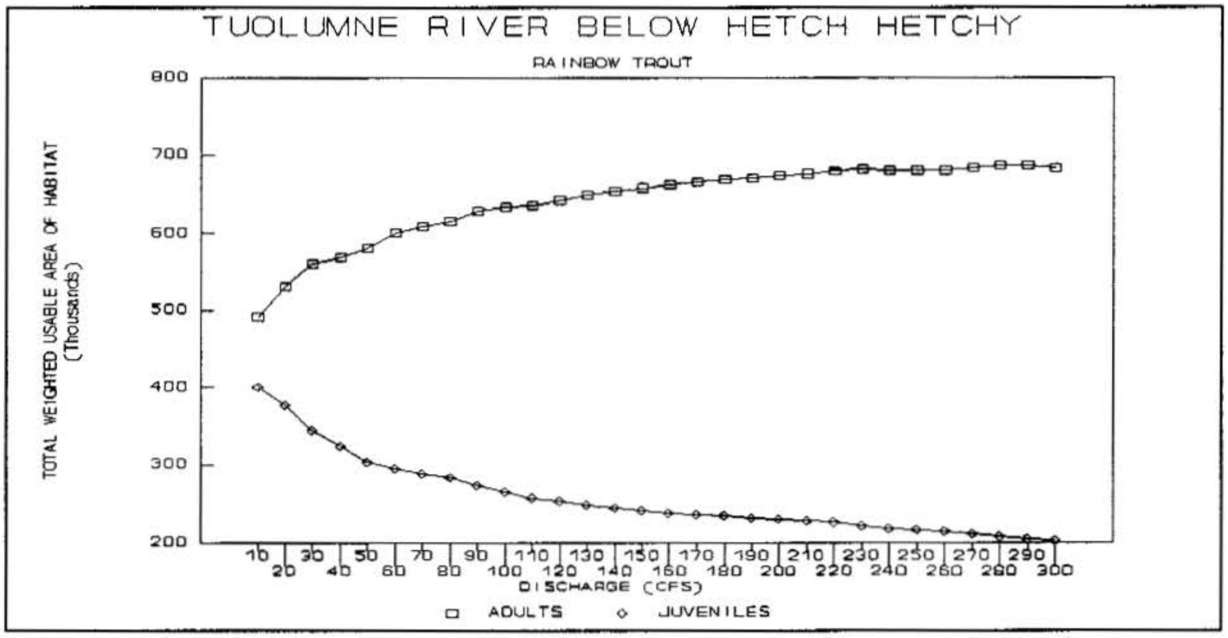


Figure 6. Weighted usable area versus streamflow relationship for rainbow trout in the Tuolumne River, between Hetch Hetchy Reservoir and Early Intake.

HY-52 cont.

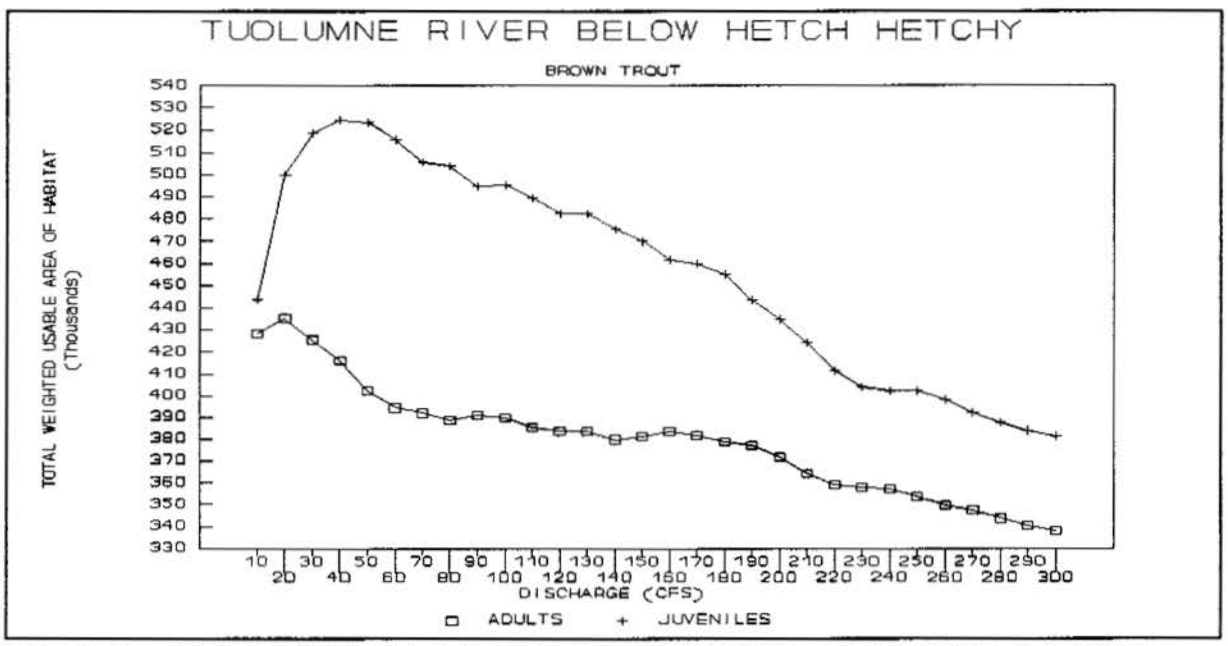


Figure 7. Weighted usable area versus streamflow relationship for brown trout in the Tuolumne river between Hetch Hetchy Reservoir and Early Intake.

and 7. Considering the overall percentage of the maximum predicted amount of available habitat, flows as low as 80 cfs would provide at least 90 percent of the maximum predicted area of adult trout habitat within the study reach. Flows as low as 20 to 30 cfs would provide at least 90 percent of the maximum habitat area predicted for juvenile rainbow and brown trout.

However, caution should be used and the availability of physical habitat alone should not be used to establish flow needs. An examination of the water temperature records gathered by the U.S. Geological Survey within the study reach since August 1987 suggests that this may be the most critical habitat parameter influencing the trout population below Hetch Hetchy Reservoir. Water temperature records for the years 1988 through 1991 are discussed in the 1990 Annual Report for the Hetch Hetchy Fishery Investigation (USFWS, 1991) and are also provided in Appendix D.

HY-52 cont.

Generally, rainbow and brown trout can survive water temperatures between 0^{o} and 28^{o} C, although the optimal range for growth is between 13^{o} and 21^{o} C, and the best range for egg incubation is between 8^{o} and 15^{o} C (Moyle 1976, Bovee 1978).

The data illustrated in Appendix D indicate that the months of June and July are typically those months where high water temperatures (i.e. > 21^{o} C) occur, except when river flows exceed about 125 cfs. In addition, by reviewing the

Attachment E

O-TRT-DREKMEIER cont.

winter water temperature data it is evident that water temperatures during the months of November and March may be low enough to limit development of brown trout eggs which are incubating in the river gravel during this time.

While water temperatures generally increase between O'Shaughnessy Dam and Early Intake during the summer months, they can decrease during the winter months. This is due to the warming or cooling effect of the ambient air temperature during these months.

Therefore, a balance between optimizing the availability of physical habitat for rainbow and brown trout, and providing suitable water temperatures for growth and development has been taken into account when conceiving the recommended instream flow schedules which follow.

HY-52 cont.

RECOMMENDED FLOW SCHEDULES

Based on the results of this instream flow study, and considering the importance of water temperature to the survival, growth, development and condition of rainbow and brown trout inhabiting the river, an annual instream flow allocation of 59,207 acre-feet to 75,363 acre-feet is recommended for the Tuolumne River below Hetch Hetchy Reservoir. Recommended annual flow schedules are provided in Table VI.

Table VI. Annual instream flow schedule recommended for the maintenance of rainbow and brown trout within the Tuolumne River Between O'Shaughnessy Dam and Early Intake.

		Minimum Instream Flow Schedules					
		A		B		C	
Month	Days	cfs	Ac-Ft	cfs	Ac-Ft	cfs	Ac-Ft
January	31	85	5,227	70	4,304	50	3,074
February	28	85	4,721	70	3,888	60	3,332
March	31	85	5,227	70	4,304	60	3,689
April	30	100	5,951	70	4,165	75	4,463
May	31	100	6,149	70	4,304	100	6,149
June	30	125	7,438	125	7,438	125	7,438
July	31	150	9,223	135	8,301	125	7,686
August	31	150	9,223	135	8,301	125	7,686
September 1-15	15	125	3,719	100	2,975	100	2,975
September 16-30	15	100	2,975	70	2,083	80	2,380
October	31	85	5,227	70	4,304	60	3,689
November	30	85	5,058	70	4,165	60	3,570
December	31	85	5,227	70	4,304	50	3,074

HY-52 cont.

Three schedules are maintained because of the uncertainty of sustaining appropriate water temperatures, during the summer and winter months under the recommended flows. Rainfall and water storage criteria, currently being used to determine the instream flow schedule for the Tuolumne below Hetch Hetchy, should also be maintained. Water temperature records should continue to be collected, both near Hetch Hetchy and above Early Intake, to verify that appropriate levels can be maintained to support a healthy trout population within the Tuolumne River below Hetch Hetchy Reservoir.

It is recommended that these schedules be applied beginning in water year 1993 and that a period of validation follow. During the validation period water temperature data, currently being gathered just below O'Shaughnessy Dam and above Early Intake, should continue to be recorded and that these data be reviewed annually. This would document the adequacy of recommended schedules in meeting river water temperatures necessary to improve trout growth and development. Periodic trout population surveys should also be continued to develop estimates of total adult population size and to monitor condition of the fish.

HY-52
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HY-52 cont.

APPENDIX

HY-52 cont.

HY-52
cont.

APPENDIX A: Description of Hetch Hetchy IFIM study sections, distribution of habitat types and habitat maps of the Tuolumne River between O'Shaughnessy Dam and Early Intake.

HY-52 cont.

HY-52
cont.

Attachment E

O-TRT-DREKMEIER cont.

STUDY SECTIONS

SECTION 1 - EARLY INTAKE.

This reach extends from Kirkwood Powerhouse (0.5 river mile upstream from Early Intake) to Lower Preston Falls a distance of 2.5 river miles. It is moderately steep, as the 12 mile study reach goes, with a gradient of 1.8%. The stream bed is composed primarily of boulders 2 to 6 feet in diameter. Nearly half of this reach is pocket water (45%). The next most common habitat type is deep pool at 26% of the length of the study section. Deep pools in this section are located where bedrock ridges extend into the stream causing scour holes. Nineteen percent of the section is cascade/pocket water, this is located just above the powerhouse where larger boulders have fallen into the channel. The other habitat types represented here are shallow pool (3%), run (4%), a single 302 foot side channel (2%), and chute and backwater both less than 1%.

SECTION 2 - PRESTON FALLS.

This section is from Lower Preston Falls to the Mather Pool, a distance of 2 river miles.In this section the most abundant habitat type changes from pocket water to deep pool. Deep pool makes up 66% of the study section. Shallow pool habitat is 9% of the section length for a total of 75% of this section as pool habitat. The pools here have a different character from the rest of the study reach, they are mostly long pools with fine sand substrate. Many trees have fallen in from the eroding banks providing abundant woody debris (however we haven't found any fish specifically associated with this wood). The rest of the length of this section is spread among the other habitat types. Pocket water 9%, cascade/pocket water 2%, cascade/deep pool 2%, cascade 5%, chute 1%, riffle 1%, run 3%, and side channel 2%. the overall gradient, 1.5% is similar to section 1 but much of this area is composed of two relatively flat meadows.

HY-52 cont.

SECTION 3 - GORGE

From Mather Pool to the lower end of Poopenaut Valley this study section is 4.3 river miles long. Above Mather Pool the canyon walls become almost vertical and are close together. This section is the longest, 4.3 miles, and steepest, 2.2% gradient. The stream bed which is almost always adjacent to the sheer canyon walls is choked with boulders. Pocket water and cascade/pocket water make up almost half of the length, 23% and 24% respectively. Deep pool intersperses these boulder areas with 44% of the length. Shallow pool, riffle and run compose 1, 3 and 3% of the length. These last three types are primarily in the lowest 1.5 miles of the study section.

SECTION 4 - POOPENAUT VALLEY

O-TRT-DREKMEIER cont.

This section extends from the lower end of Poopenaut Valley to the upper end of Poopenaut Meadow at a pool called "big pool". The reach is 0.9 river miles long. Poopenaut Meadow is the largest meadow in the study reach. A wide grass covered bench extends on either side of the river with a dense thicket of willows along the bank. The stream bed is all sand. The gentle gradient of the section, 0.8% slope, is reflected in that 70% of the length is classified as run or glide (62% and 8% respectively). At bedrock outcrops deep pools (22% of the length) are scoured out. Shallow pools make up 7% of the length and riffles 1%.

SECTION 5 - O'SHAUGHNESSY

Section 5 extends from the upper end of Poopenaut Meadow to O'Shaughnessy Dam, 2.7 river miles.The section below the dam is in a relatively wide valley. The valley floor is mostly bedrock with pockets of alluvium. The gradient of this section in 1.2%. Sixty percent of the section length is deep pools, 14% shallow pool and the rest spread between the other habitat types. Six percent is pocket water, 3% cascade/pocket water, 4% cascade/deep pool, cascade 6%, chute 1%, riffle 5%, side channel <1%, backwater 1%.

HY-52 cont.

O-TRT-DREKMEIER cont.

Table A-1. Lengths and areas of each habitat type in study section 1, Early Intake to Lower Preston Falls (2.5 miles).

Habitat Type	Distance(ft)	Percent of Total	Area(Acres)	Percent of Total
Deep Pool	3355	26	4.87	28
Shallow Pool	436	3	0.66	4
Pocket Water	5943	45	7.81	46
Cascade/Pocket Water	2423	19	2.77	16
Cascade/Deep Pool	0	0	0	0
Cascade	0	0	0	0
Chute	4	<1	0.01	<1
Riffle	0	0	0	0
Run	557	4	0.78	5
Glide	0	0	0	0
Side Channel	302	2	0.19	1
Backwater	78	<1	0.05	0

HY-52 cont.

Table A-2. Lengths and areas of each habitat type in study section 2, Lower Preston Falls to Mather Pool.

Habitat Type	Distance(ft)	Percent of Total	Area(acres)	Percent of Total
Deep Pool	8109	66	18.42	74
Shallow Pool	1052	9	2.90	12
Pocket Water	1092	9	1.30	5
Cascade/Pocket Water	374	2	0.41	2
Cascade/Deep Pool	283	2	0.31	1
Cascade	560	5	0.54	2
Chute	73	1	0.07	<1
Riffle	174	1	0.15	1
Run	427	3	0.59	2
Glide	0	0	0	0
Side Channel	200	2	0.07	<1
Backwater	0	0	0	0

O-TRT-DREKMEIER cont.

Table A-3. Lengths and areas of each habitat type in study area 3, Mather Pool to the lower end of Poopenaut Valley.

Habitat Type	Distance(ft)	Percent of Total	Area(acres)	Percent of Total
Deep Pool	9780	44	17.39	53
Shallow Pool	171	1	0.22	1
Pocket Water	5088	23	5.15	16
Cascade/Pocket Water	5379	24	8.09	25
Cascade/Deep Pool	0	0	0	0
Cascade	406	2	0.35	1
Chute	0	0	0	0
Riffle	687	3	0.44	1
Run	777	3	0.85	3
Glide	0	0	0	0
Side Channel	0	0	0	0
Backwater	0	0	0	0

Table A-4. Lengths and areas of habitat types in study section 4, lower end of Poopenaut Meadow to Study Reach Mile 9.7 "Big Pool".

HY-52 cont.

Habitat Type	Distance(ft) Total	Percent of	Area(acres) Total	Percent of
Deep Pool	886	22	3.19	46
Shallow Pool	278	7	0.53	7
Pocket Water	0	0	0	0
Cascade/Pocket Water	0	0	0	0
Cascade/Deep Pool	0	0	0	0
Cascade	0	0	0	0
Chute	0	0	0	0
Riffle	33	1	0.05	1
Run	2498	62	2.78	40
Glide	331	8	0.42	6
Side Channel	0	0	0	0
Backwater	0	0	0	0

O-TRT-DREKMEIER cont.

Table A-5. Lengths and areas of habitat types in study section 5, upper end of Poopenaut Meadow to O'Shaughnessy Dam.

Habitat Type	Distance(ft)	Percent of Total	Area(acres)	Percent of Total
Deep Pool	10803	60	16.11	70
Shallow Pool	2489	14	2.56	11
Pocket Water	1159	6	1.24	5
Cascade/Pocket Water	480	3	0.74	3
Cascade/Deep Pool	676	4	0.40	2
Cascade	1056	6	0.95	4
Chute	133	1	0.07	<1
Riffle	917	5	0.65	3
Run	0	0	0	0
Glide	0	0	0	0
Side Channel	42	<1	0.08	<1
Backwater	94	1	0.09	<1

Table A-6. Length in feet of each habitat type contained within each study section and the total study area.

Section / Habitat Type	1	2	3	4	5	Total	Percent
Deep Pool	3355	8109	9780	886	10803	32933	51
Shallow Pool	436	1052	171	278	2489	4426	7
Pocket Water	5943	1092	5088	0	1159	13282	13
Cscde/Pckt Water	2423	374	5379	0	480	8656	13
Cscde/Deep Pool	0	283	0	0	676	959	1
Cascade	0	560	406	0	1056	2022	3
Chute	4	73	0	0	133	210	<1
Riffle	0	174	687	33	917	1811	3
Run	557	427	777	2498	0	4259	7
Glide	0	0	0	331	0	331	<1
Side Channel	302	200	0	0	42	544	<1
Backwater	78	0	0	0	94	172	<1
Total	13098	12344	21588	4026	17849	68902	100

HY-52 cont.

Table A-7. A comparison of lengths and areas of each habitat type within the total study reach, between Kirkwood Powerhouse and O'Shaughnessy Dam.

Habitat	Length(ft)	Percent	Area(acres)	Percent
Deep Pool	32933	51	59.98	67
Shallow Pool	2489	7	6.87	8
Pocket Water	13282	13	1.24	1
Cscde/Pckt Water	8656	13	12.01	13
Cscde/Deep Pool	959	1	0.71	1
Cascade	2022	3	1.84	2
Chute	210	<1 (.3)	0.15	<1 (.2)
Riffle	1811	3	1.29	1
Run	4259	7	5.00	6
Glide	331	<1 (.5)	0.42	<1 (.5)
Side Channel	544	<1 (.8)	0.34	<1 (.4)
Backwater	172	<1 (.3)	0.14	<1 (.2)
Total	67668*	100	89.99	100

*The sum of the lengths may be longer than the study reach length because some habitat types overlap in the river channel.

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Attachment E

O-TRT-DREKMEIER
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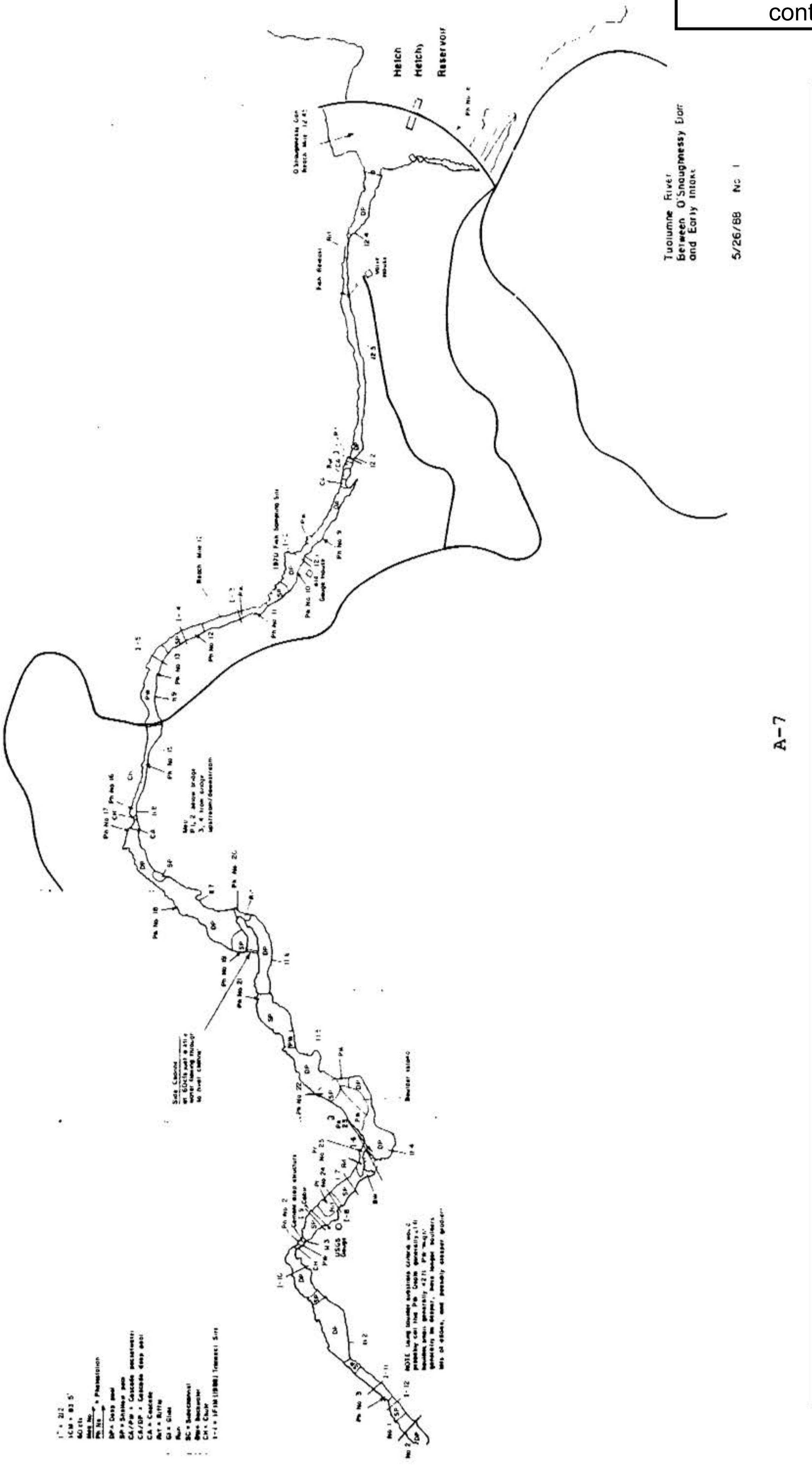

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Attachment E

O-TRT-DREKMEIER
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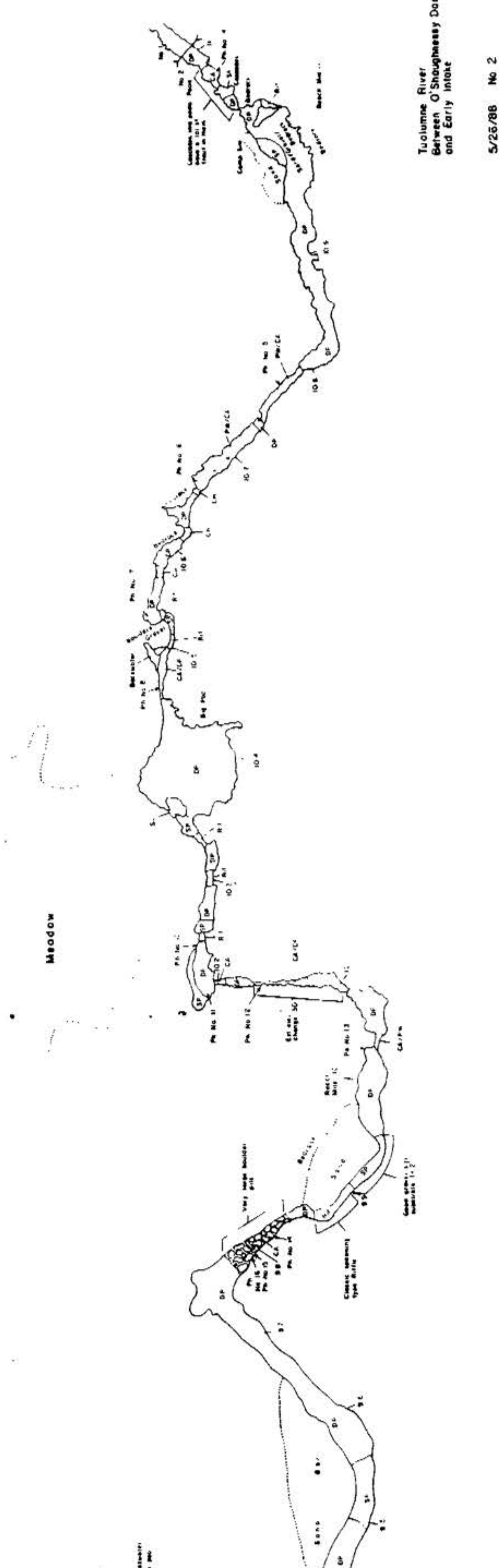

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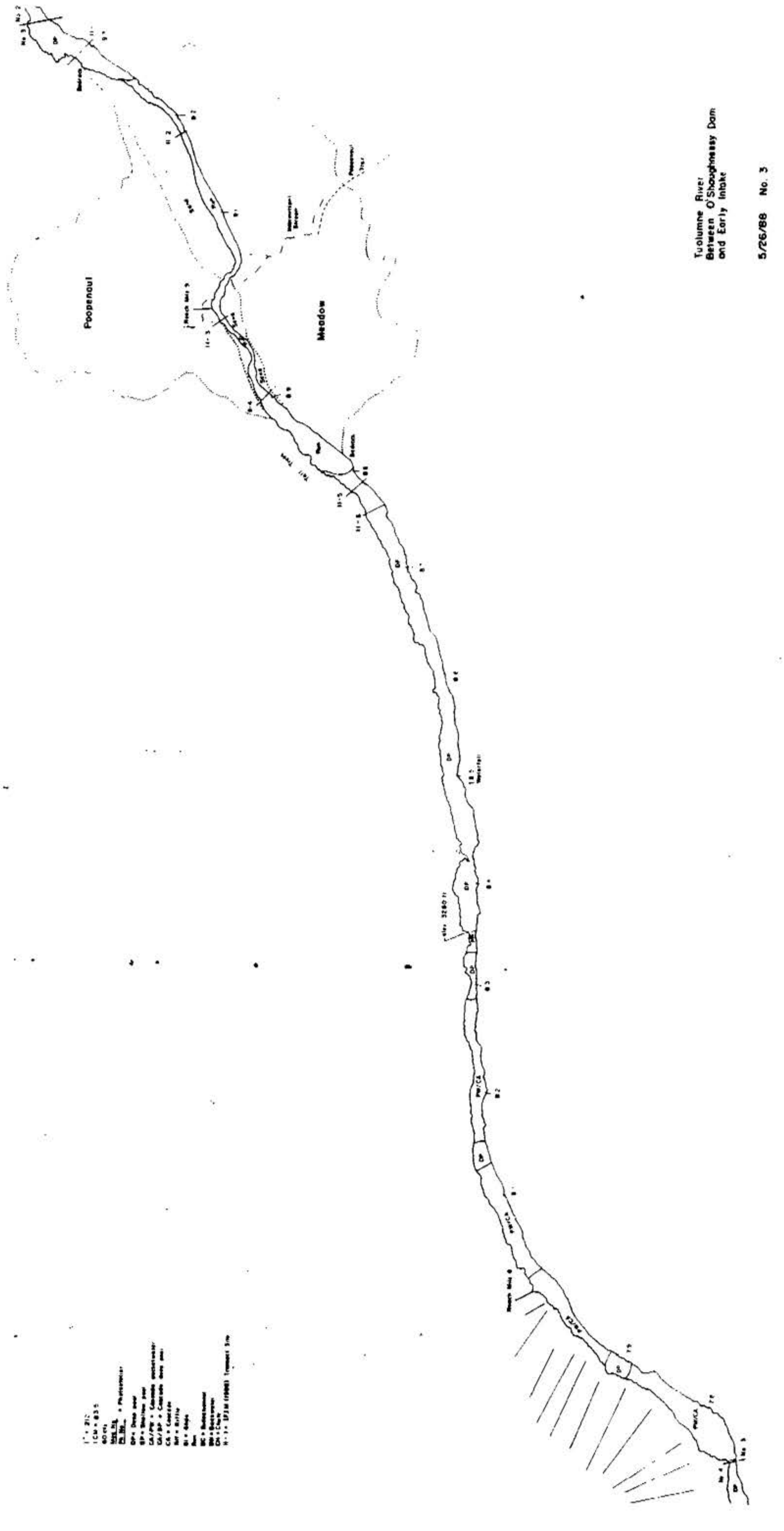
Attachment E

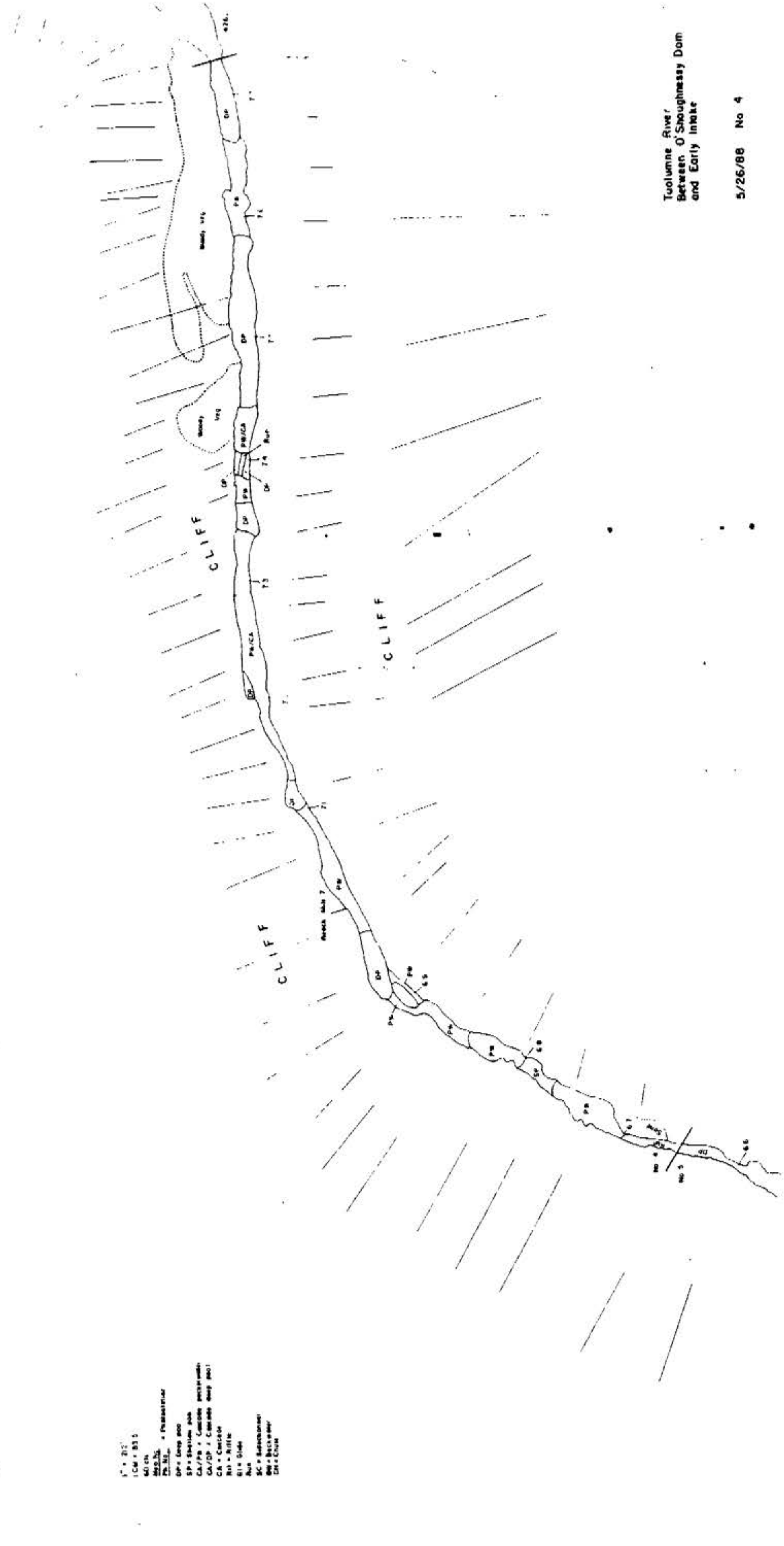
O-TRT-DREKMEIER
cont.



HY-52
cont.

Attachment E

O-TRT-DREKMEIER
cont.



HY-52
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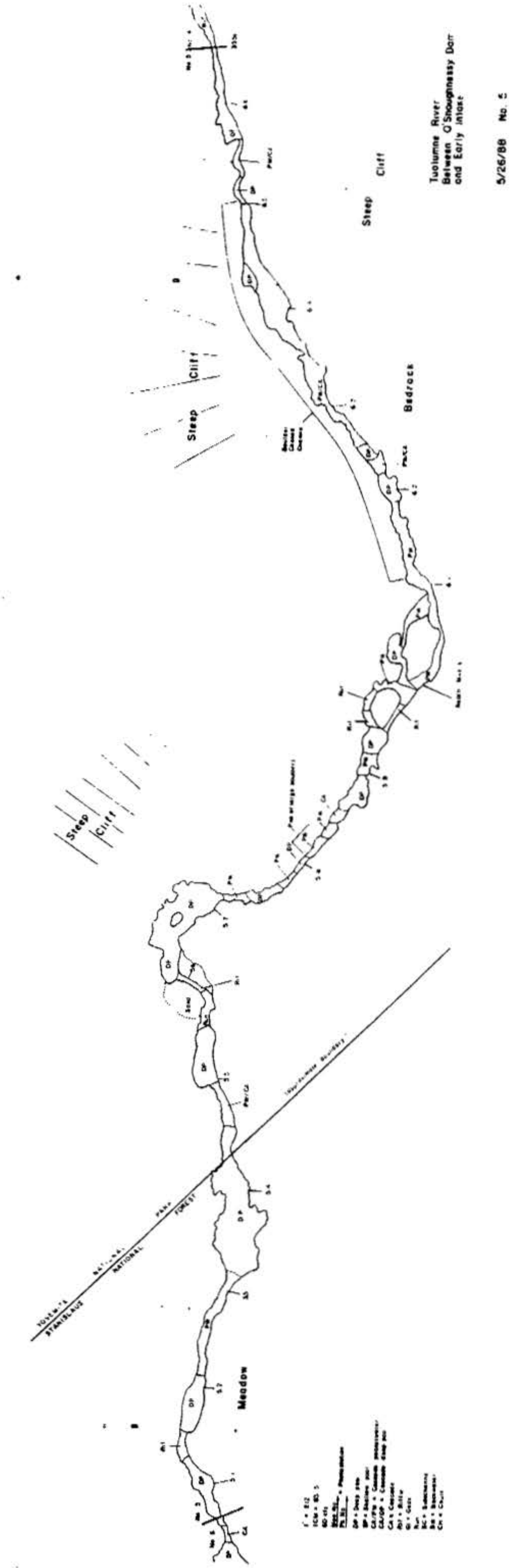
Attachment E

O-TRT-DREKMEIER
cont.



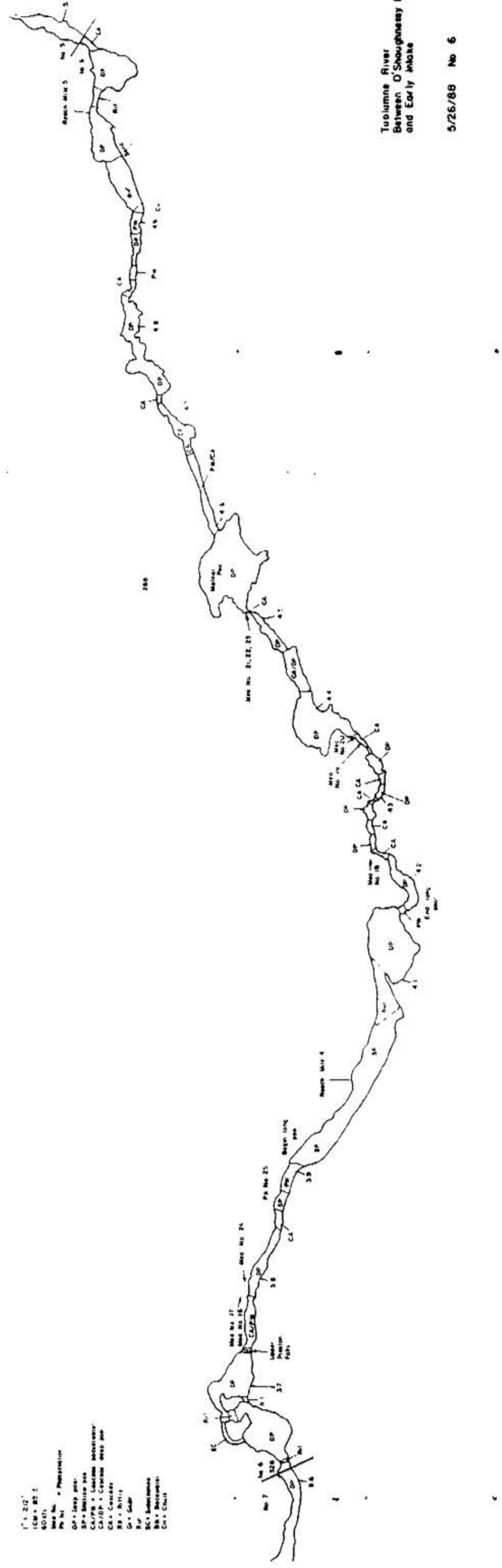
HY-52
cont.

A-11

Attachment E

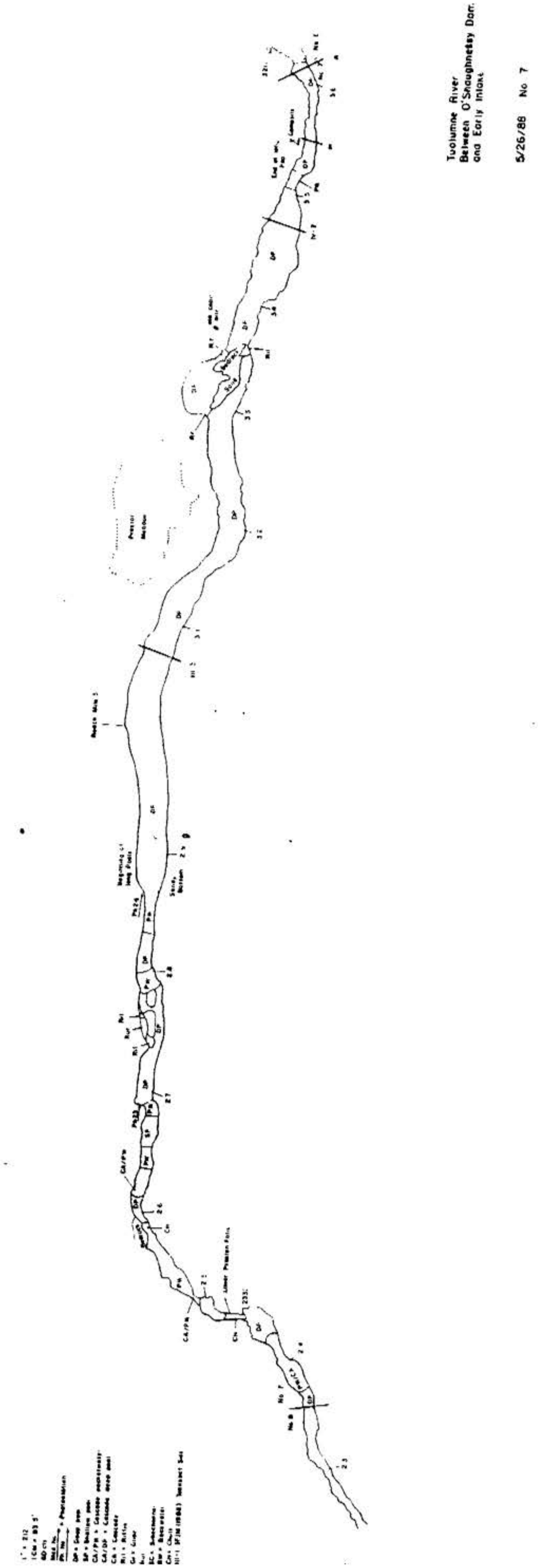
O-TRT-DREKMEIER
cont.

HY-52
cont.



Attachment E

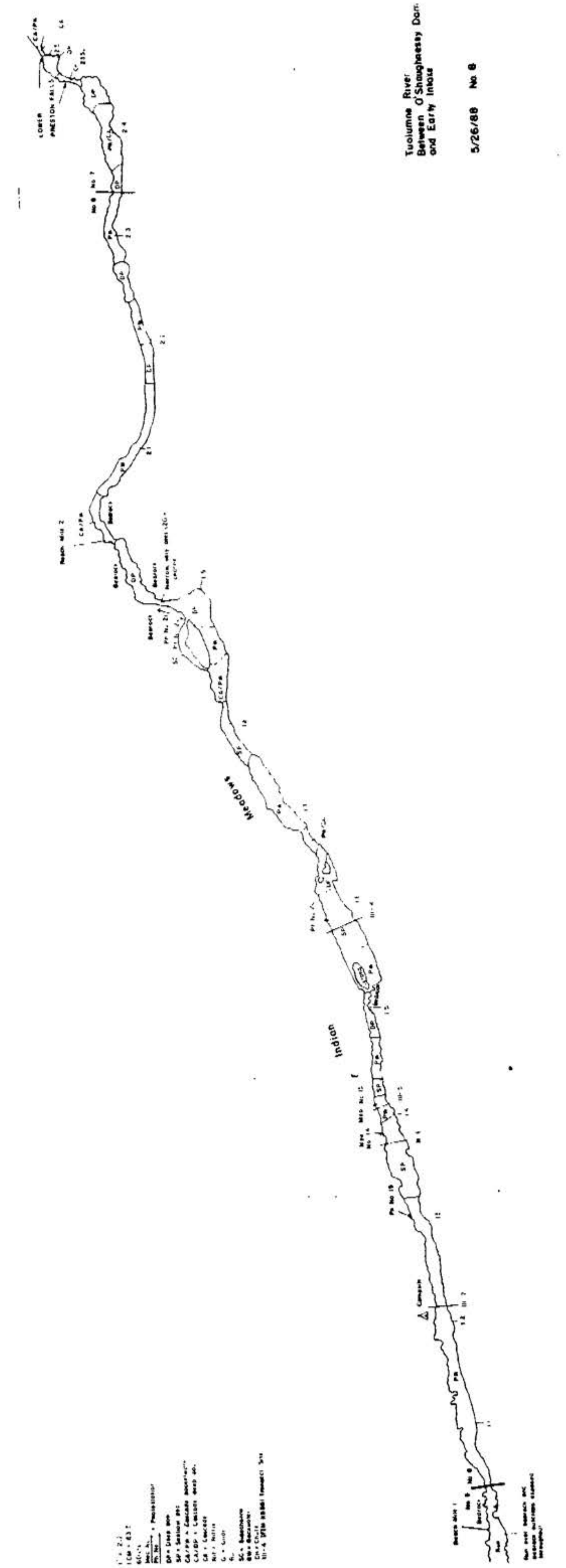
O-TRT-DREKMEIER
cont.



HY-52
cont.

Attachment E

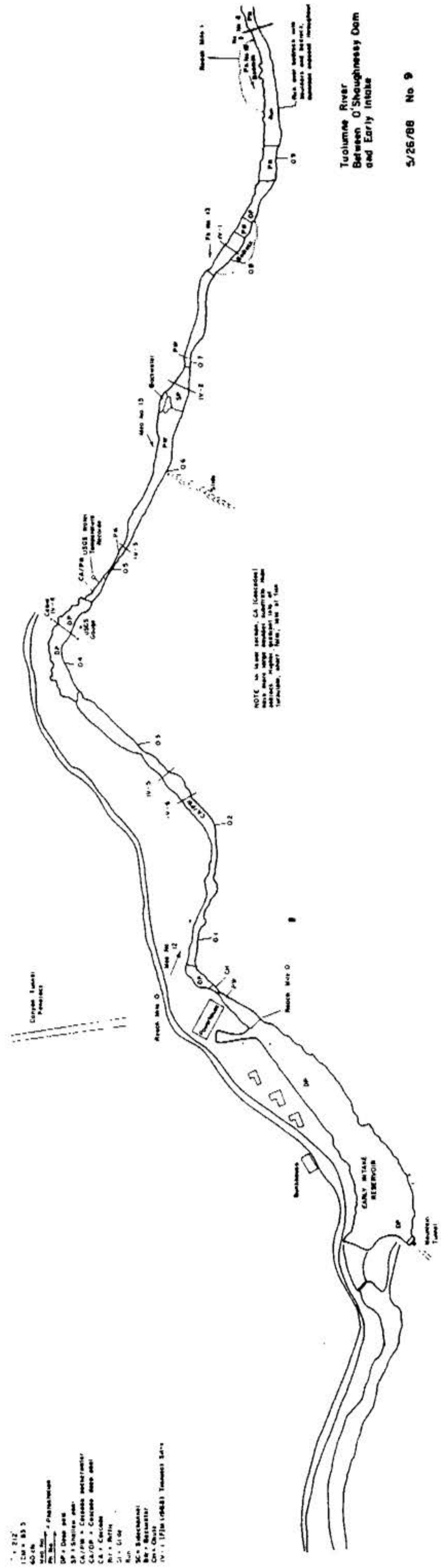
O-TRT-DREKMEIER
cont.



HY-52
cont.

Attachment E

O-TRT-DREKMEIER
cont.



HY-52
cont.

HY-52 cont.

Attachment E

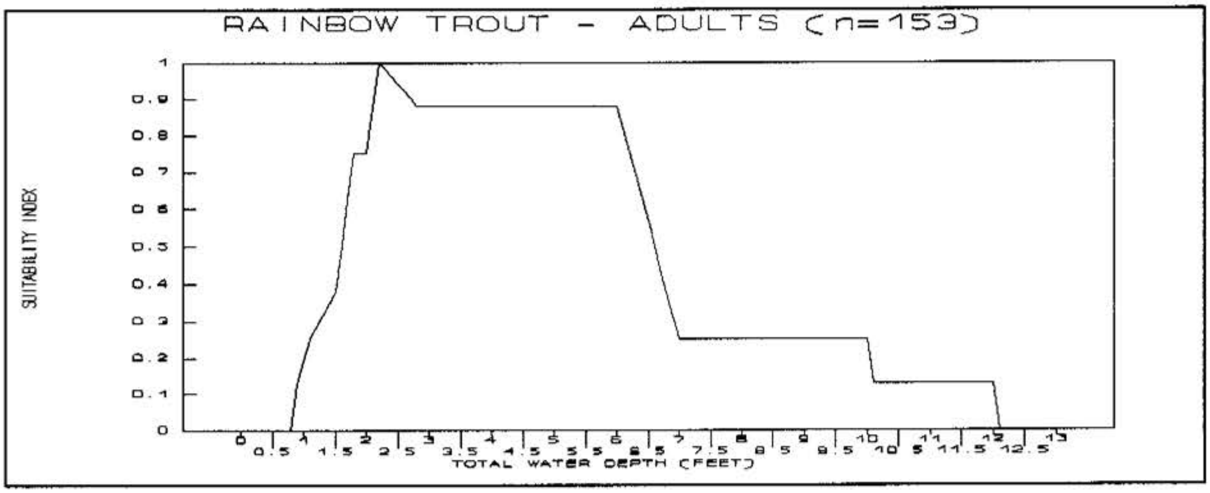
O-TRT-DREKMEIER cont.

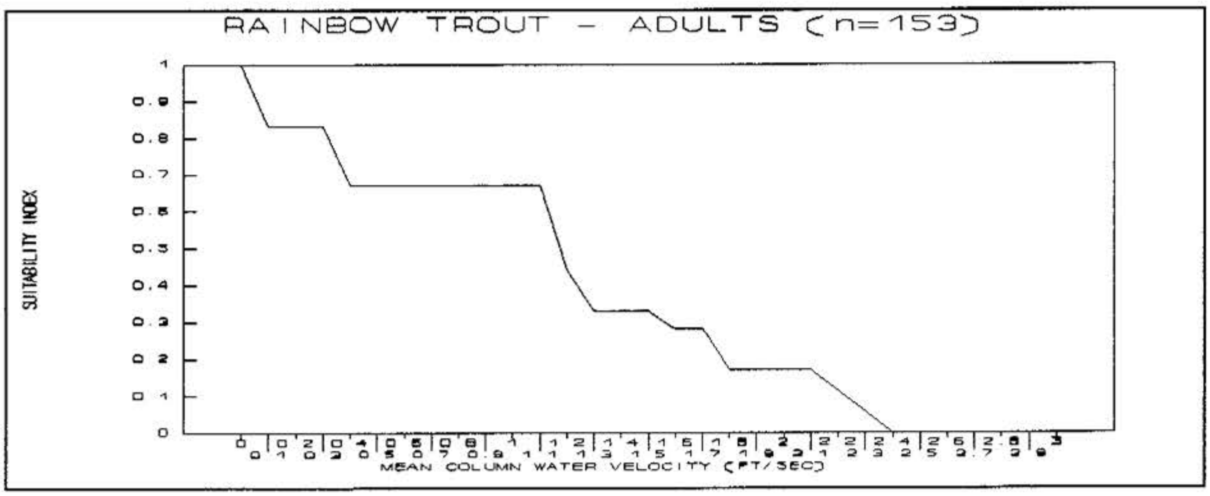
APPENDIX B: Habitat Suitability Indexes for Rainbow Trout and Brown Trout inhabiting the Tuolumne River between O'Shaughnessy Dam and Early Intake.

HY-52 cont.

HY-52
cont.

O-TRT-DREKMEIER
cont.





HY-52
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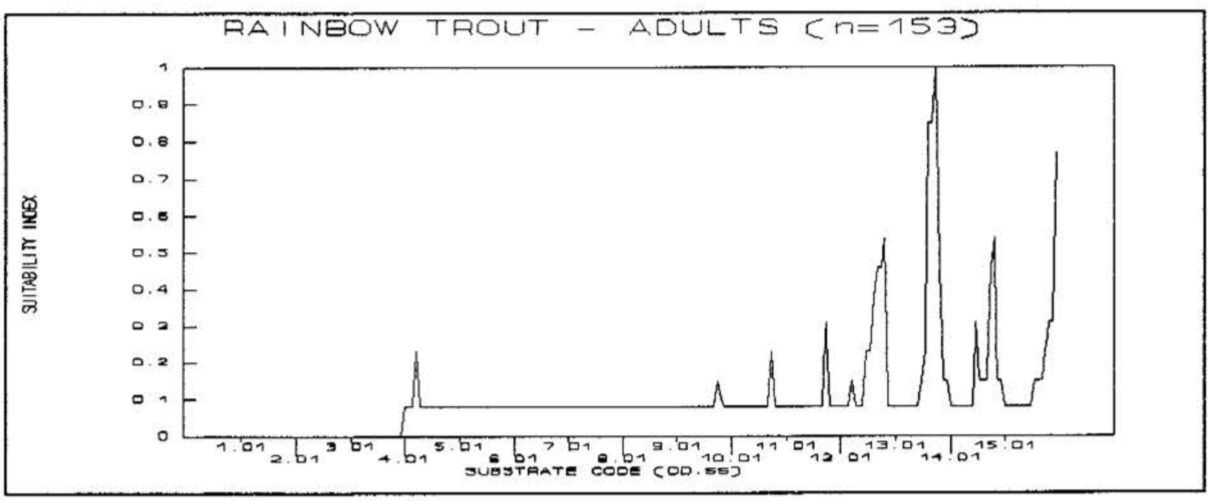
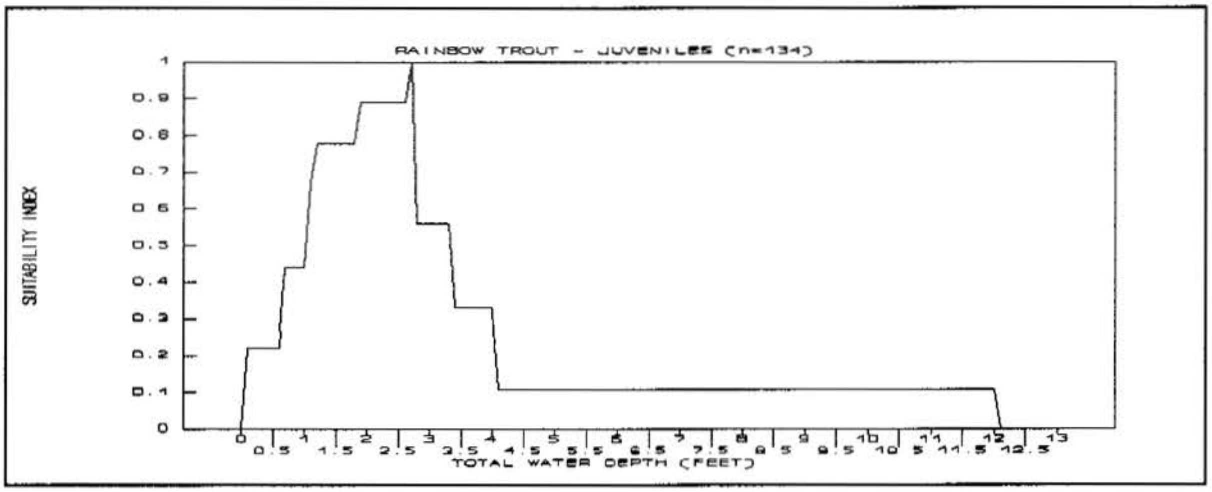
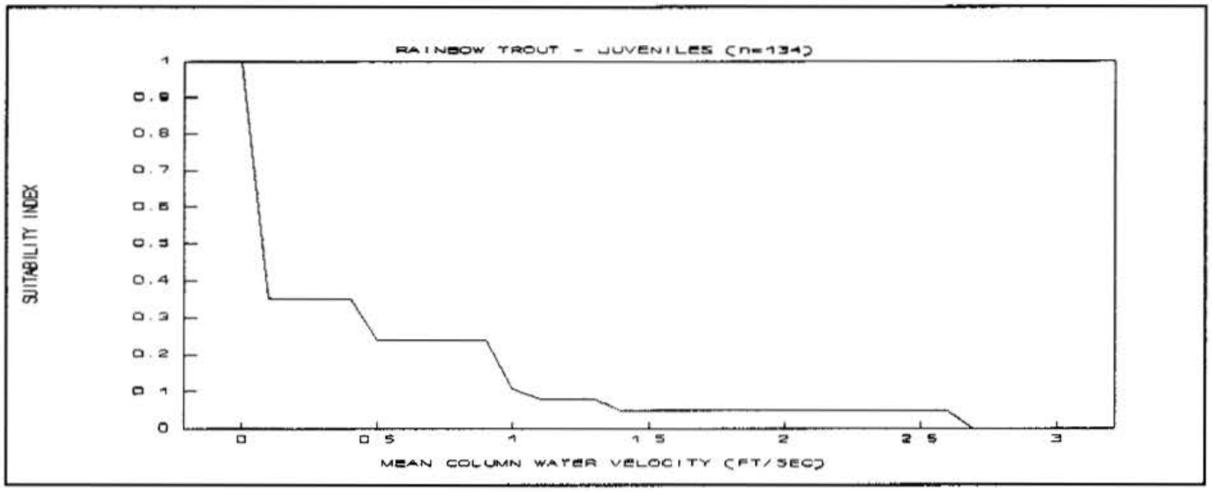
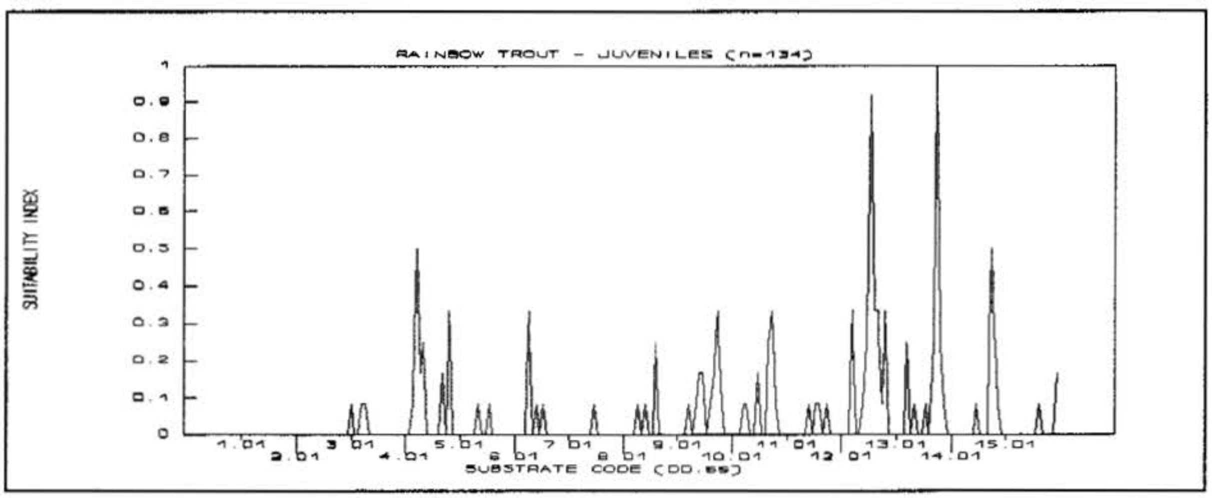


O-TRT-DREKMEIER
cont.



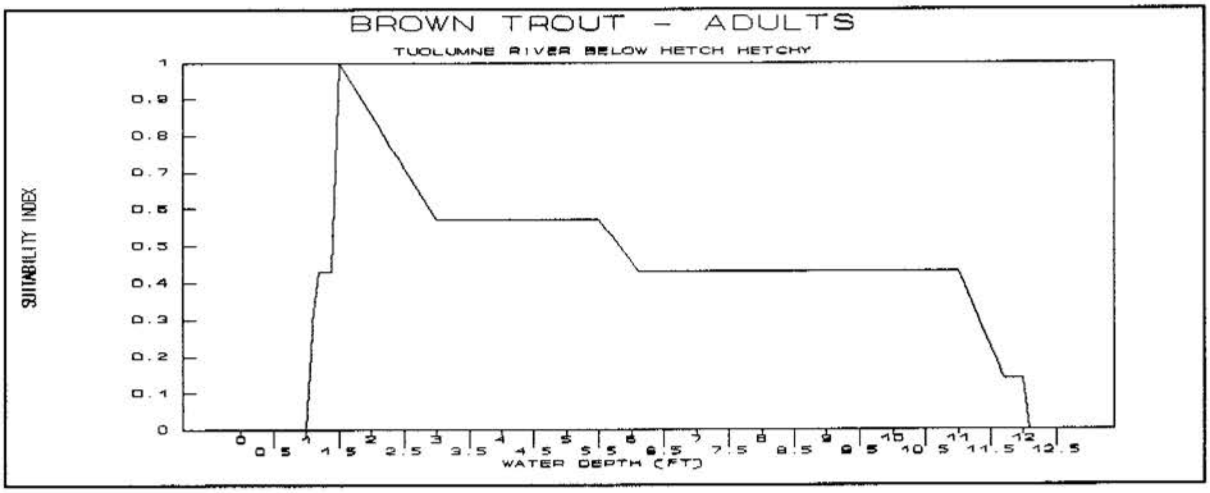




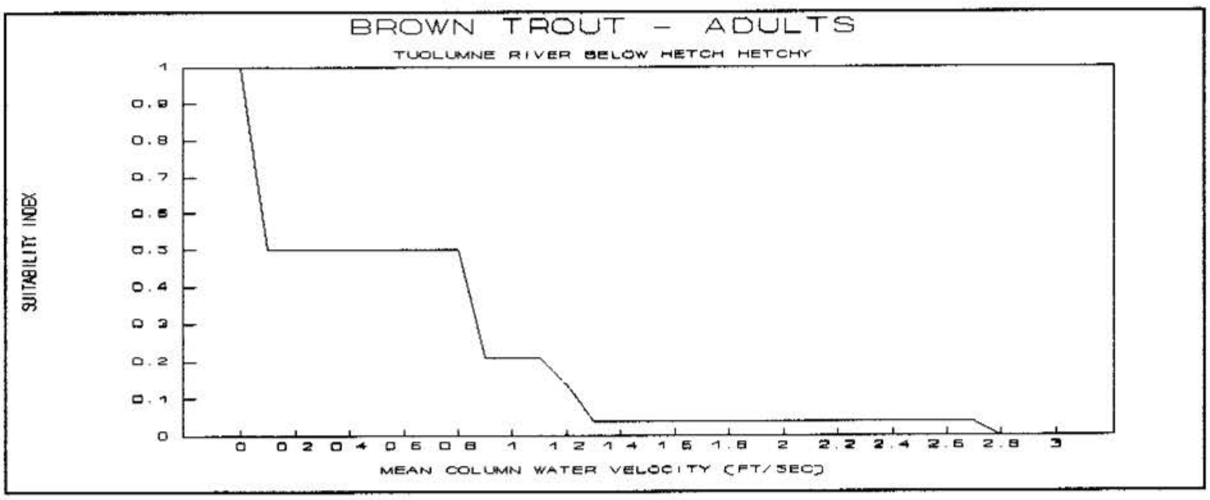
HY-52
cont.

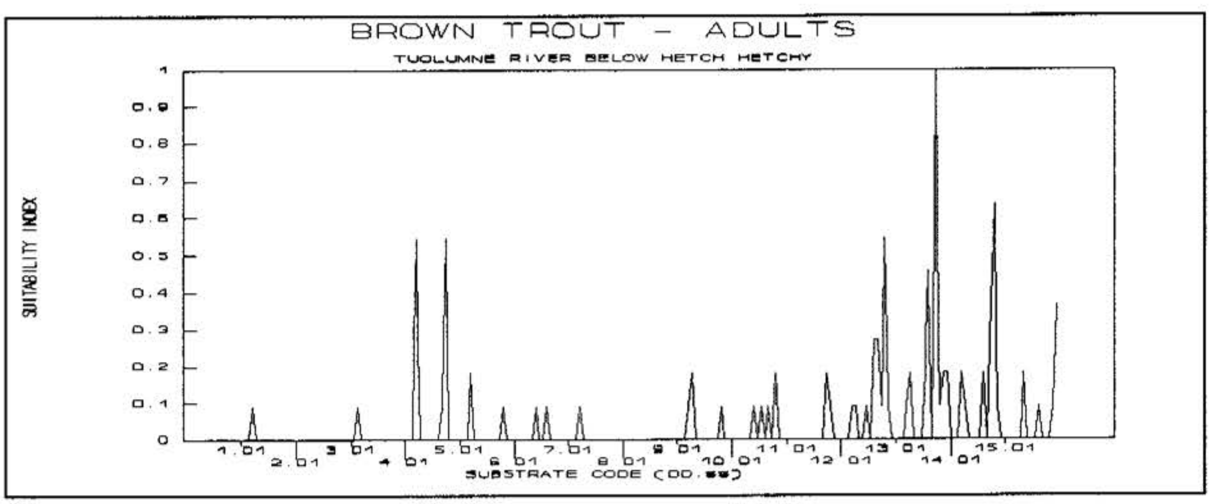
Attachment E

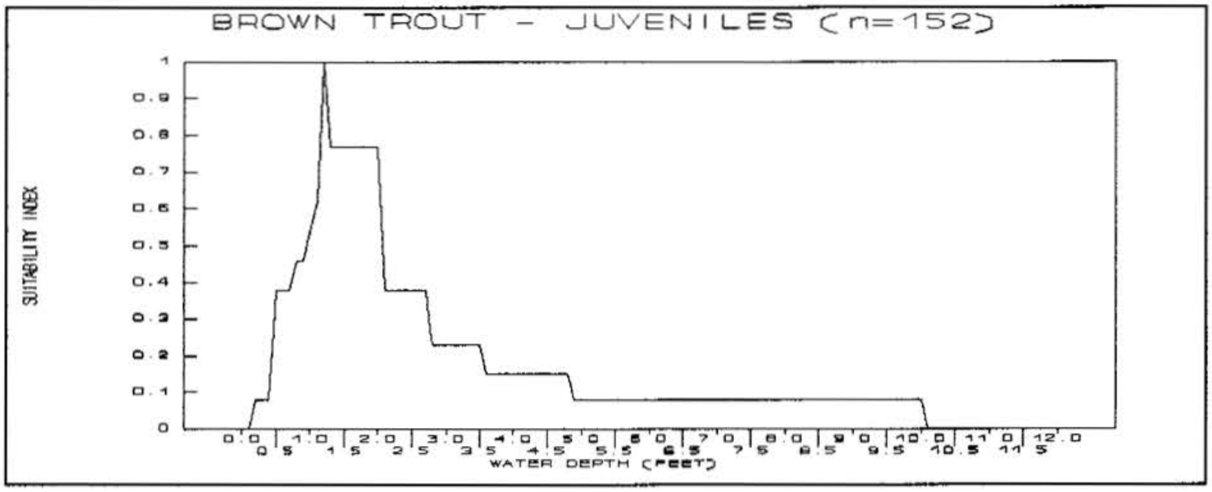
O-TRT-DREKMEIER cont.

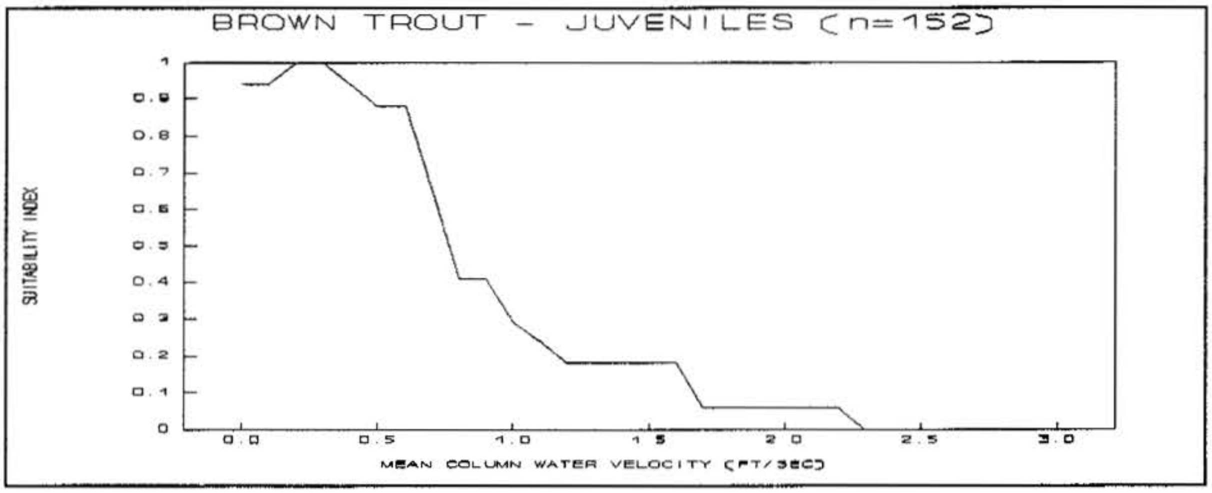


HY-52 cont.

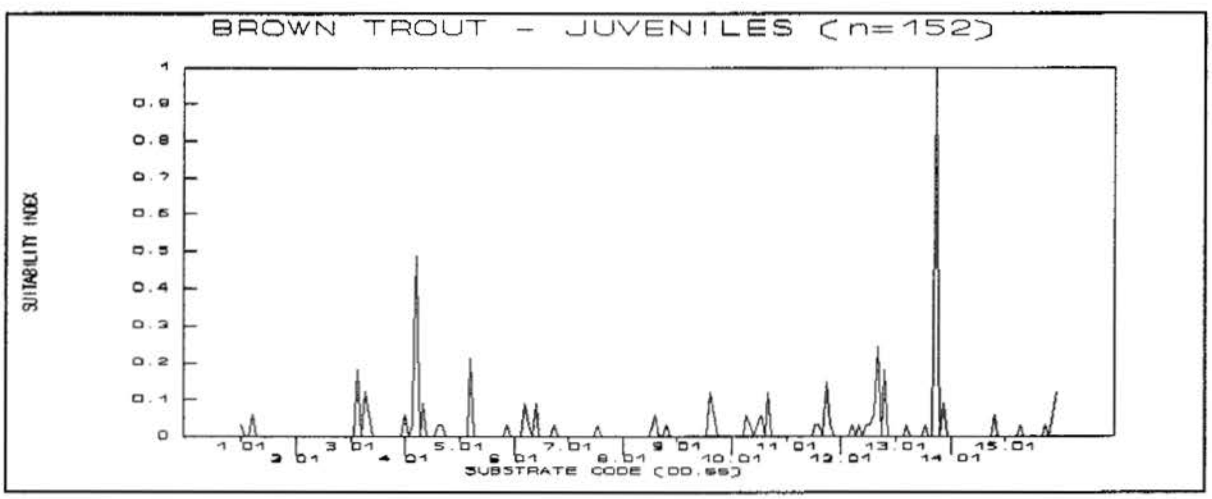





BROWN TROUT - JUVENILES (n=152)
SUITABILITY INDEX
WATER DEPTH (FEET)


BROWN TROUT - JUVENILES (n=152)
SUITABILITY INDEX
MEAN COLUMN WATER VELOCITY (FT/SEC)

HY-52 cont.


BROWN TROUT - JUVENILES (n=152)
SUITABILITY INDEX
SUBSTRATE CODE (DD.SS)

HETCH HETCHY TROUT HABITAT USE OBSERVATIONS
OCTOBER 20, 1987 THROUGH JUNE 14, 1990
FREQUENCY DISTRIBUTIONS (FQ) & SUITABILITY INDEX (SI)

WATER DEPTH

	RAINBOW TROUT						BROWN TROUT					
	Adults			Juveniles			Adults			Juveniles		
INTERVAL	#	FQ	SI	#	FQ	SI	#	FQ	SI	#	FQ	SI
0	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
0.1	0	0.00	0.00	2	0.22	0.22	0	0.00	0.00	0	0.00	0.00
0.2	0	0.00	0.00	0	0.00	0.22	0	0.00	0.00	1	0.08	0.08
0.3	0	0.00	0.00	0	0.00	0.22	0	0.00	0.00	1	0.08	0.08
0.4	0	0.00	0.00	0	0.00	0.22	0	0.00	0.00	0	0.00	0.08
0.5	0	0.00	0.00	1	0.11	0.22	0	0.00	0.00	5	0.38	0.38
0.6	0	0.00	0.00	1	0.11	0.22	0	0.00	0.00	4	0.31	0.38
0.7	0	0.00	0.00	4	0.44	0.44	0	0.00	0.00	3	0.23	0.38
0.8	0	0.00	0.00	3	0.33	0.44	0	0.00	0.00	6	0.46	0.46
0.9	1	0.13	0.13	2	0.22	0.44	0	0.00	0.00	1	0.08	0.46
1	0	0.00	0.19	4	0.44	0.44	0	0.00	0.00	7	0.54	0.54
1.1	2	0.25	0.25	6	0.67	0.67	2	0.29	0.29	8	0.62	0.62
1.2	1	0.13	0.28	7	0.78	0.78	3	0.43	0.43	13	1.00	1.00
1.3	1	0.13	0.32	1	0.11	0.78	2	0.29	0.43	8	0.62	0.77
1.4	0	0.00	0.35	6	0.67	0.78	3	0.43	0.43	7	0.54	0.77
1.5	3	0.38	0.38	7	0.78	0.78	7	1.00	1.00	8	0.62	0.77
1.6	2	0.25	0.50	5	0.56	0.78	2	0.29	0.97	8	0.62	0.77
1.7	1	0.13	0.63	7	0.78	0.78	1	0.14	0.94	4	0.31	0.77
1.8	6	0.75	0.75	3	0.33	0.78	2	0.29	0.92	3	0.23	0.77
1.9	3	0.38	0.75	8	0.89	0.89	3	0.43	0.89	6	0.46	0.77
2	6	0.75	0.75	2	0.22	0.89	6	0.86	0.86	10	0.77	0.77
2.1	1	0.13	0.88	4	0.44	0.89	2	0.29	0.83	5	0.38	0.38
2.2	8	1.00	1.00	3	0.33	0.89	2	0.29	0.80	3	0.23	0.38
2.3	5	0.63	0.98	5	0.56	0.89	0	0.00	0.77	2	0.15	0.38
2.4	2	0.25	0.96	4	0.44	0.89	0	0.00	0.74	5	0.38	0.38
2.5	4	0.50	0.94	5	0.56	0.89	5	0.71	0.71	4	0.31	0.38
2.6	3	0.38	0.92	2	0.22	0.89	3	0.43	0.68	2	0.15	0.38
2.7	4	0.50	0.90	9	1.00	1.00	1	0.14	0.65	5	0.38	0.38
2.8	7	0.88	0.88	3	0.33	0.56	0	0.00	0.63	3	0.23	0.23
2.9	4	0.50	0.88	3	0.33	0.56	2	0.29	0.60	2	0.15	0.23
3	5	0.63	0.88	2	0.22	0.56	4	0.57	0.57	3	0.23	0.23
3.1	2	0.25	0.88	0	0.00	0.56	2	0.29	0.57	0	0.00	0.23
3.2	6	0.75	0.88	4	0.44	0.56	0	0.00	0.57	1	0.08	0.23
3.3	3	0.38	0.88	5	0.56	0.56	1	0.14	0.57	0	0.00	0.23
3.4	4	0.50	0.88	1	0.11	0.33	0	0.00	0.57	1	0.08	0.23
3.5	2	0.25	0.88	1	0.11	0.33	2	0.29	0.57	3	0.23	0.23
3.6	3	0.38	0.88	1	0.11	0.33	0	0.00	0.57	0	0.00	0.15
3.7	3	0.38	0.88	0	0.00	0.33	0	0.00	0.57	0	0.00	0.15
3.8	1	0.13	0.88	1	0.11	0.33	1	0.14	0.57	1	0.08	0.15
3.9	3	0.38	0.88	2	0.22	0.33	3	0.43	0.57	2	0.15	0.15
4	4	0.50	0.88	3	0.33	0.33	1	0.14	0.57	0	0.00	0.15

HY-52 cont.

4.1	2	0.25	0.88	0	0.00	0.11	0	0.00	0.57	0	0.00	0.15
4.2	2	0.25	0.88	1	0.11	0.11	3	0.43	0.57	1	0.08	0.15
4.3	3	0.38	0.88	0	0.00	0.11	2	0.29	0.57	0	0.00	0.15
4.4	3	0.38	0.88	0	0.00	0.11	1	0.14	0.57	0	0.00	0.15
4.5	4	0.50	0.88	0	0.00	0.11	0	0.00	0.57	0	0.00	0.15
4.6	2	0.25	0.88	1	0.11	0.11	0	0.00	0.57	0	0.00	0.15
4.7	0	0.00	0.88	0	0.00	0.11	0	0.00	0.57	0	0.00	0.15
4.8	7	0.88	0.88	1	0.11	0.11	1	0.14	0.57	2	0.15	0.15
4.9	1	0.13	0.88	0	0.00	0.11	0	0.00	0.57	0	0.00	0.08
5	1	0.13	0.88	1	0.11	0.11	0	0.00	0.57	1	0.08	0.08
5.1				0	0.00	0.11	0	0.00	0.57	0	0.00	0.08
5.2	1	0.13	0.88	0	0.00	0.11	0	0.00	0.57	0	0.00	0.08
5.3	1	0.13	0.88	0	0.00	0.11	0	0.00	0.57	0	0.00	0.08
5.4	0	0.00	0.88	0	0.00	0.11	0	0.00	0.57	0	0.00	0.08
5.5	2	0.25	0.88	0	0.00	0.11	4	0.57	0.57	1	0.08	0.08
5.6	0	0.00	0.88	0	0.00	0.11	0	0.00	0.55	0	0.00	0.08
5.7	0	0.00	0.88	0	0.00	0.11	1	0.14	0.52	0	0.00	0.08
5.8	0	0.00	0.88	0	0.00	0.11	0	0.00	0.50	0	0.00	0.08
5.9	1	0.13	0.88	0	0.00	0.11	0	0.00	0.48	0	0.00	0.08
6	7	0.88	0.88	0	0.00	0.11	2	0.29	0.45	0	0.00	0.08
6.1	0	0.00	0.82	0	0.00	0.11	3	0.43	0.43	0	0.00	0.08
6.2	0	0.00	0.75	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
6.3	0	0.00	0.69	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
6.4	0	0.00	0.63	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
6.5	1	0.13	0.57	1	0.11	0.11	3	0.43	0.43	0	0.00	0.08
6.6	0	0.00	0.50	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
6.7	0	0.00	0.44	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
6.8	1	0.13	0.38	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
6.9	1	0.13	0.31	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
7	2	0.25	0.25	0	0.00	0.11	1	0.14	0.43	1	0.08	0.08
7.1	1	0.13	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
7.2	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
7.3	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
7.4	0	0.00	0.25	0	0.00	0.11	2	0.29	0.43	0	0.00	0.08
7.5	0	0.00	0.25	0	0.00	0.11	3	0.43	0.43	0	0.00	0.08
7.6	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
7.7	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
7.8	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
7.9	1	0.13	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
8	1	0.13	0.25	0	0.00	0.11	1	0.14	0.43	0	0.00	0.08
8.1	1	0.13	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
8.2	0	0.00	0.25	0	0.00	0.11	2	0.29	0.43	0	0.00	0.08
8.3	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
8.4	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
8.5	0	0.00	0.25	1	0.11	0.11	1	0.14	0.43	0	0.00	0.08
8.6	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
8.7	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
8.8	1	0.13	0.25	0	0.00	0.11	1	0.14	0.43	0	0.00	0.08
8.9	0	0.00	0.25	0	0.00	0.11	2	0.29	0.43	0	0.00	0.08
9	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08

HY-52
cont.

9.1	1	0.13	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
9.2	1	0.13	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
9.3	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
9.4	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
9.5	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
9.6	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
9.7	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
9.8	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
9.9	0	0.00	0.25	0	0.00	0.11	0	0.00	0.43	0	0.00	0.08
10	2	0.25	0.25	0	0.00	0.11	3	0.43	0.43	1	0.08	0.08
10.1	0	0.00	0.13	0	0.00	0.11	0	0.00	0.43	0	0.00	0.00
10.2	0	0.00	0.13	0	0.00	0.11	0	0.00	0.43	0	0.00	0.00
10.3	0	0.00	0.13	0	0.00	0.11	0	0.00	0.43	0	0.00	0.00
10.4	0	0.00	0.13	0	0.00	0.11	0	0.00	0.43	0	0.00	0.00
10.5	0	0.00	0.13	0	0.00	0.11	0	0.00	0.43	0	0.00	0.00
10.6	0	0.00	0.13	0	0.00	0.11	0	0.00	0.43	0	0.00	0.00
10.7	0	0.00	0.13	0	0.00	0.11	0	0.00	0.43	0	0.00	0.00
10.8	0	0.00	0.13	0	0.00	0.11	0	0.00	0.43	0	0.00	0.00
10.9	0	0.00	0.13	0	0.00	0.11	0	0.00	0.43	0	0.00	0.00
11	0	0.00	0.13	0	0.00	0.11	3	0.43	0.43	0	0.00	0.00
11.1	0	0.00	0.13	0	0.00	0.11	0	0.00	0.39	0	0.00	0.00
11.2	0	0.00	0.13	0	0.00	0.11	0	0.00	0.35	0	0.00	0.00
11.3	0	0.00	0.13	0	0.00	0.11	0	0.00	0.31	0	0.00	0.00
11.4	0	0.00	0.13	0	0.00	0.11	0	0.00	0.27	0	0.00	0.00
11.5	0	0.00	0.13	0	0.00	0.11	0	0.00	0.23	0	0.00	0.00
11.6	0	0.00	0.13	0	0.00	0.11	0	0.00	0.18	0	0.00	0.00
11.7	0	0.00	0.13	0	0.00	0.11	1	0.14	0.14	0	0.00	0.00
11.8	0	0.00	0.13	0	0.00	0.11	0	0.00	0.14	0	0.00	0.00
11.9	0	0.00	0.13	0	0.00	0.11	0	0.00	0.14	0	0.00	0.00
12	1	0.13	0.13	1	0.11	0.11	1	0.14	0.14	0	0.00	0.00
12.1	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0		
12.2	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0		
12.3	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0		
12.4	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0		
12.5	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00	0		
12.6	0	0.00	0.00	0	0.00	0.00	0	0.00		0		
12.7	0	0.00	0.00	0	0.00	0.00	0	0.00		0		
12.8	0	0.00	0.00	0	0.00	0.00	0	0.00		0		
12.9	0	0.00	0.00	0	0.00	0.00	0	0.00		0		
13	0	0.00	0.00	0	0.00	0.00	0	0.00		0		

HY-52
cont.

HETCH HETCHY TROUT HABITAT USE OBSERVATIONS
OCTOBER 20, 1987 THROUGH JUNE 14, 1990
FREQUENCY DISTRIBUTIONS (FQ) & SUITABILITY INDEX (SI)

MEAN COLUMN WATER VELOCITY

	RAINBOW TROUT							BROWN TROUT					
	Adults				Juveniles			Adults			Juveniles		
INTERVAL	#	FQ	SI		#	FQ	SI	#	FQ	SI	#	FQ	SI
0	18	1.00	1.00		37	1.00	1.00	28	1.00	1.00	16	0.94	0.94
0.1	6	0.33	0.83	3	10	0.27	0.35	6	0.21	0.50	12	0.71	0.94
0.2	12	0.67	0.83	8	13	0.35	0.35	8	0.29	0.50	17	1.00	1.00
0.3	15	0.83	0.83	0	12	0.32	0.35	3	0.11	0.50	17	1.00	1.00
0.4	11	0.61	0.67	0	13	0.35	0.35	6	0.21	0.50	16	0.94	0.94
0.5	8	0.44	0.67	0	9	0.24	0.24	7	0.25	0.50	12	0.71	0.88
0.6	11	0.61	0.67	0	8	0.22	0.24	5	0.18	0.50	15	0.88	0.88
0.7	9	0.50	0.67	0	2	0.05	0.24	6	0.21	0.50	11	0.65	0.65
0.8	6	0.33	0.67	0	5	0.14	0.24	14	0.50	0.50	5	0.29	0.41
0.9	4	0.22	0.67	0	9	0.24	0.24	3	0.11	0.21	7	0.41	0.41
1	8	0.44	0.67	0	4	0.11	0.11	0	0.00	0.21	5	0.29	0.29
1.1	12	0.67	0.67	0	3	0.08	0.08	6	0.21	0.21	4	0.24	0.24
1.2	8	0.44	0.44	0	3	0.08	0.08	4	0.14	0.14	1	0.06	0.18
1.3	6	0.33	0.33	0	0	0.00	0.08	0	0.00	0.04	3	0.18	0.18
1.4	2	0.11	0.33	0	2	0.05	0.05	1	0.04	0.04	3	0.18	0.18
1.5	6	0.33	0.33	3	1	0.03	0.05	0	0.00	0.04	1	0.06	0.18
1.6	1	0.06	0.28	0	0	0.00	0.05	0	0.00	0.04	3	0.18	0.18
1.7	5	0.28	0.28	0	1	0.03	0.05	1	0.04	0.04	0	0.00	0.06
1.8	0	0.00	0.17	9	0	0.00	0.05	0	0.00	0.04	1	0.06	0.06
1.9	0	0.00	0.17	6	0	0.00	0.05	1	0.04	0.04	1	0.06	0.06
2	1	0.06	0.17	0	0	0.00	0.05	0	0.00	0.04	0	0.00	0.06
2.1	3	0.17	0.17	0	0	0.00	0.05	0	0.00	0.04	1	0.06	0.06
2.2	0	0.00	0.12	0	0	0.00	0.05	0	0.00	0.04	1	0.06	0.06
2.3	1	0.06	0.06	8	1	0.03	0.05	0	0.00	0.04	0	0.00	0.00
2.4	0	0.00	0.00	0	0	0.00	0.05	0	0.00	0.04	0	0.00	0.00
2.5	0	0.00	0.00	0	0	0.00	0.05	1	0.04	0.04	0	0.00	0.00
2.6	0	0.00	0.00	0	1	0.03	0.05	1	0.04	0.04	0	0.00	0.00
2.7	0	0.00	0.00	0	0	0.00	0.00	0	0.00	0.04	0	0.00	0.00
2.8	0	0.00	0.00	0	0	0.00	0.00	0	0.00	0.00	0	0.00	0.00
2.9	0	0.00	0.00	0	0	0.00	0.00	0	0.00		0	0.00	0.00
3	0	0.00	0.00	0	0	0.00	0.00	0	0.00		0	0.00	0.00

HY-52 cont.

HETCH HETCHY TROUT HABITAT USE OBSERVATIONS
OCTOBER 20, 1987 THROUGH JUNE 14, 1990
FREQUENCY DISTRIBUTIONS (FQ) & SUITABILITY INDEX (SI)

SUBSTRATE CATEGORY

	RAINBOW TROUT						BROWN TROUT					
	Adults			Juveniles			Adults			Juveniles		
CATEGORY	#	FQ	SI	#	FQ	SI	#	FQ	SI	#	FQ	SI
1.01	0	0.00	0.00	0	0.00		0	0.00		1	0.03	
1.02	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
1.03	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
1.04	0	0.00	0.00	0	0.00		1	0.09		2	0.06	
1.05	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
1.06	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
1.07	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
1.08	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
1.09	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
1.10	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
1.11	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
1.12	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
1.13	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
1.14	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
1.15	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.01	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.02	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.03	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.04	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.05	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.06	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.07	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.08	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.09	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.10	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.11	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.12	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.13	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.14	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
2.15	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
3.01	0	0.00	0.00	1	0.08		0	0.00		0	0.00	
3.02	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
3.03	0	0.00	0.00	0	0.00		1	0.09		6	0.18	
3.04	0	0.00	0.00	1	0.08		0	0.00		0	0.00	
3.05	0	0.00	0.00	1	0.08		0	0.00		4	0.12	
3.06	0	0.00	0.00	0	0.00		0	0.00		2	0.06	
3.07	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
3.08	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
3.09	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
3.10	0	0.00	0.00	0	0.00		0	0.00		0	0.00	
3.11	0	0.00	0.00	0	0.00		0	0.00		0	0.00	

HY-52 cont.

3.12	0 0.00	0.00	0 0.00	0 0.00	0 0.00
3.13	0 0.00	0.00	0 0.00	0 0.00	0 0.00
3.14	0 0.00	0.00	0 0.00	0 0.00	0 0.00
3.15	0 0.00	0.00	0 0.00	0 0.00	0 0.00
4.01	1 0.08	0.08	0 0.00	0 0.00	2 0.06
4.02	0 0.00	0.08	0 0.00	0 0.00	0 0.00
4.03	0 0.00	0.08	1 0.08	0 0.00	1 0.03
4.04	3 0.23	0.23	6 0.50	6 0.55	6 0.48
4.05	0 0.00	0.08	2 0.17	0 0.00	0 0.00
			3 0.25	0 0.00	3 0.09
4.07	0 0.00	0.08	0 0.00	0 0.00	0 0.00
4.08	0 0.00	0.08	0 0.00	0 0.00	0 0.00
4.09	0 0.00	0.08	0 0.00	0 0.00	0 0.00
4.10	1 0.08	0.08	0 0.00	0 0.00	1 0.03
4.11	1 0.08	0.08	2 0.17	1 0.09	1 0.03
4.12	1 0.08	0.08	0 0.00	6 0.55	0 0.00
4.13	0 0.00	0.08	4 0.33	0 0.00	0 0.00
4.14	0 0.00	0.08	0 0.00	0 0.00	0 0.00
4.15	0 0.00	0.08	0 0.00	0 0.00	0 0.00
5.01	0 0.00	0.08	0 0.00	0 0.00	0 0.00
5.02	0 0.00	0.08	0 0.00	0 0.00	0 0.00
5.03	0 0.00	0.08	0 0.00	0 0.00	0 0.00
5.04	0 0.00	0.08	0 0.00	2 0.18	7 0.21
5.05	0 0.00	0.08	0 0.00	0 0.00	0 0.00
5.06	1 0.08	0.08	1 0.08	0 0.00	0 0.00
5.07	0 0.00	0.08	0 0.00	0 0.00	0 0.00
5.08	0 0.00	0.08	0 0.00	0 0.00	0 0.00
5.09	0 0.00	0.08	1 0.08	0 0.00	0 0.00
5.10	0 0.00	0.08	0 0.00	0 0.00	0 0.00
5.11	0 0.00	0.08	0 0.00	0 0.00	0 0.00
5.12	0 0.00	0.08	0 0.00	0 0.00	0 0.00
5.13	0 0.00	0.08	0 0.00	1 0.09	0 0.00
5.14	0 0.00	0.08	0 0.00	0 0.00	1 0.03
5.15	0 0.00	0.08	0 0.00	0 0.00	0 0.00
6.01	0 0.00	0.08	0 0.00	0 0.00	0 0.00
6.02	0 0.00	0.08	0 0.00	0 0.00	0 0.00
6.03	0 0.00	0.08	0 0.00	0 0.00	0 0.00
6.04	0 0.00	0.08	0 0.00	0 0.00	3 0.09
6.05	0 0.00	0.08	4 0.33	0 0.00	1 0.03
6.06	0 0.00	0.08	0 0.00	0 0.00	0 0.00
6.07	1 0.08	0.08	1 0.08	1 0.09	3 0.09
6.08	0 0.00	0.08	0 0.00	0 0.00	0 0.00
6.09	0 0.00	0.08	1 0.08	0 0.00	0 0.00
6.10	0 0.00	0.08	0 0.00	1 0.09	0 0.00
6.11	0 0.00	0.08	0 0.00	0 0.00	0 0.00
6.12	1 0.08	0.08	0 0.00	0 0.00	1 0.03
6.13	0 0.00	0.08	0 0.00	0 0.00	0 0.00
6.14	1 0.08	0.08	0 0.00	0 0.00	0 0.00
6.15	1 0.08	0.08	0 0.00	0 0.00	0 0.00
7.01	0 0.00	0.08	0 0.00	0 0.00	0 0.00

HY-52 cont.

7.02	0	0.00	0.08	0	0.00	0	0.00	0	0.00
7.03	0	0.00	0.08	0	0.00	0	0.00	0	0.00
7.04	0	0.00	0.08	0	0.00	1	0.09	0	0.00
7.05	0	0.00	0.08	0	0.00	0	0.00	0	0.00
7.06	0	0.00	0.08	0	0.00	0	0.00	0	0.00
7.07	0	0.00	0.08	0	0.00	0	0.00	0	0.00
7.08	0	0.00	0.08	1	0.08	0	0.00	0	0.00
7.09	0	0.00	0.08	0	0.00	0	0.00	1	0.03
7.10	0	0.00	0.08	0	0.00	0	0.00	0	0.00
7.11	0	0.00	0.08	0	0.00	0	0.00	0	0.00
7.12	0	0.00	0.08	0	0.00	0	0.00	0	0.00
7.13	0	0.00	0.08	0	0.00	0	0.00	0	0.00
7.14	0	0.00	0.08	0	0.00	0	0.00	0	0.00
7.15	0	0.00	0.08	0	0.00	0	0.00	0	0.00
8.01	0	0.00	0.08	0	0.00	0	0.00	0	0.00
8.02	0	0.00	0.08	0	0.00	0	0.00	0	0.00
8.03	0	0.00	0.08	0	0.00	0	0.00	0	0.00
8.04	0	0.00	0.08	0	0.00	0	0.00	0	0.00
8.05	0	0.00	0.08	1	0.08	0	0.00	0	0.00
8.06	0	0.00	0.08	0	0.00	0	0.00	0	0.00
8.07	0	0.00	0.08	1	0.08	0	0.00	0	0.00
8.08	0	0.00	0.08	0	0.00	0	0.00	0	0.00
8.09	0	0.00	0.08	0	0.00	0	0.00	1	0.03
8.10	0	0.00	0.08	3	0.25	0	0.00	2	0.06
8.11	0	0.00	0.08	0	0.00	0	0.00	0	0.00
8.12	0	0.00	0.08	0	0.00	0	0.00	0	0.00
8.13	0	0.00	0.08	0	0.00	0	0.00	1	0.03
8.14	0	0.00	0.08	0	0.00	0	0.00	0	0.00
8.15	0	0.00	0.08	0	0.00	0	0.00	0	0.00
9.01	0	0.00	0.08	0	0.00	0	0.00	0	0.00
9.02	0	0.00	0.08	0	0.00	0	0.00	0	0.00
9.03	0	0.00	0.08	0	0.00	0	0.00	0	0.00
9.04	0	0.00	0.08	1	0.08	1	0.09	0	0.00
9.05	0	0.00	0.08	0	0.00	2	0.18	0	0.00
9.06	0	0.00	0.08	1	0.08	0	0.00	0	0.00
9.07	0	0.00	0.08	2	0.17	0	0.00	0	0.00
9.08	0	0.00	0.08	2	0.17	0	0.00	0	0.00
9.09	0	0.00	0.08	0	0.00	0	0.00	0	0.00
9.10	1	0.08	0.08	1	0.08	0	0.00	4	0.12
9.11	1	0.08	0.08	2	0.17	0	0.00	2	0.06
9.12	2	0.15	0.15	4	0.33	0	0.00	0	0.00
9.13	1	0.08	0.10	1	0.08	1	0.09	0	0.00
9.14	1	0.08	0.08	0	0.00	0	0.00	0	0.00
9.15	1	0.08	0.08	0	0.00	0	0.00	0	0.00
10.01	0	0.00	0.08	0	0.00	0	0.00	0	0.00
10.02	0	0.00	0.08	0	0.00	0	0.00	0	0.00
10.03	0	0.00	0.08	0	0.00	0	0.00	0	0.00
10.04	0	0.00	0.08	1	0.08	0	0.00	0	0.00
10.05	0	0.00	0.08	1	0.08	0	0.00	2	0.06
10.06	1	0.08	0.08	0	0.00	0	0.00	1	0.03

HY-52 cont.

10.07	0	0.00	0.08	0	0.00	1	0.09	0	0.00	
10.08	0	0.00	0.08	2	0.17	0	0.00	1	0.03	
10.09	0	0.00	0.08	0	0.00	1	0.09	2	0.06	
10.10	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
10.11	1	0.08	0.08	3	0.25	1	0.09	4	0.12	
10.12	3	0.23	0.23	4	0.33	0	0.00	0	0.00	
10.13	0	0.00	0.08	1	0.08	2	0.18	0	0.00	
10.14	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
10.15	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
11.01	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
11.02	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
11.03	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
11.04	1	0.08	0.08	0	0.00	0	0.00	0	0.00	
11.05	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
11.06	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
11.07	1	0.08	0.08	1	0.08	0	0.00	0	0.00	
11.08	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
11.09	0	0.00	0.08	1	0.08	0	0.00	1	0.03	
11.10	0	0.00	0.08	1	0.08	0	0.00	1	0.03	HY-52 cont.
11.11	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
11.12	4	0.31	0.31	1	0.08	2	0.18	5	0.15	
11.13	1	0.08	0.08	0	0.00	1	0.09	1	0.03	
11.14	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
11.15	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
12.01	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
12.02	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
12.03	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
12.04	2	0.15	0.15	4	0.33	1	0.09	1	0.03	
12.05	0	0.00	0.08	0	0.00	1	0.09	0	0.00	
12.06	0	0.00	0.08	0	0.00	0	0.00	1	0.03	
12.07	0	0.00	0.08	1	0.08	0	0.00	0	0.00	
12.08	3	0.23	0.23	3	0.25	1	0.09	1	0.03	
12.09	1	0.08	0.23	1	0.92	0	0.00	1	0.03	
12.10	5	0.38	0.38	4	0.33	3	0.27	2	0.06	
12.11	6	0.46	0.46	4	0.33	3	0.27	8	0.24	
12.12	1	0.08	0.46	1	0.08	1	0.09	0	0.00	
12.13	7	0.54	0.54	4	0.33	6	0.55	6	0.18	
12.14	1	0.08	0.08	0	0.00	1	0.09	0	0.00	
12.15	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
13.01	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
13.02	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
13.03	0	0.00	0.08	0	0.00	0	0.00	0	0.00	
13.04	1	0.08	0.08	3	0.25	1	0.09	1	0.03	
13.05	0	0.00	0.08	0	0.00	2	0.18	0	0.00	
13.06	1	0.08	0.08	1	0.08	0	0.00	0	0.00	
13.07	1	0.08	0.08	0	0.00	0	0.00	0	0.00	
13.08	2	0.15	0.15	0	0.00	0	0.00	0	0.00	
13.09	3	0.23	0.23	1	0.08	2	0.18	1	0.03	
13.10	11	0.85	0.85	0	0.00	5	0.45	0	0.00	
13.11	2	0.15	0.85	2	0.17	0	0.00	0	0.00	

13.12	13	1.00	1	2	1.00	1	1.00	3	1.00
13.13	6	0.46	0.46	3	0.25	1	0.09	0	0.00
13.14	2	0.15	0.15	1	0.08	2	0.18	3	0.09
13.15	2	0.15	0.15	0	0.00	2	0.18	0	0.00
14.01	0	0.00	0.08	0	0.00	0	0.00	0	0.00
14.02	0	0.00	0.08	0	0.00	0	0.00	0	0.00
14.03	0	0.00	0.08	0	0.00	0	0.00	0	0.00
14.04	1	0.08	0.08	0	0.00	2	0.18	0	0.00
14.05	1	0.08	0.08	0	0.00	1	0.09	0	0.00
14.06	0	0.00	0.08	0	0.00	0	0.00	0	0.00
14.07	0	0.00	0.08	0	0.00	0	0.00	0	0.00
14.08	4	0.31	0.31	1	0.08	0	0.00	0	0.00
14.09	2	0.15	0.15	0	0.00	0	0.00	0	0.00
14.10	2	0.15	0.15	0	0.00	2	0.18	0	0.00
14.11	0	0.00	0.15	0	0.00	0	0.00	0	0.00
14.12	6	0.46	0.46	6	0.50	4	0.36	0	0.00
14.13	7	0.54	0.54	3	0.25	7	0.64	2	0.06
14.14	2	0.15	0.15	1	0.08	1	0.09	0	0.00
14.15	2	0.15	0.15	0	0.00	0	0.00	0	0.00
15.01	0	0.00	0.08	0	0.00	0	0.00	0	0.00
15.02	0	0.00	0.08	0	0.00	0	0.00	0	0.00
15.03	0	0.00	0.08	0	0.00	0	0.00	0	0.00
15.04	0	0.00	0.08	0	0.00	0	0.00	0	0.00
15.05	0	0.00	0.08	0	0.00	0	0.00	1	0.03
15.06	1	0.08	0.08	0	0.00	2	0.18	0	0.00
15.07	0	0.00	0.08	0	0.00	0	0.00	0	0.00
15.08	0	0.00	0.08	0	0.00	0	0.00	0	0.00
15.09	2	0.15	0.15	0	0.00	0	0.00	0	0.00
15.10	2	0.15	0.15	1	0.08	1	0.09	0	0.00
15.11	0	0.00	0.15	0	0.00	0	0.00	0	0.00
15.12	3	0.23	0.23	0	0.00	0	0.00	1	0.03
15.13	4	0.31	0.31	0	0.00	0	0.00	0	0.00
15.14	3	0.23	0.31	0	0.00	1	0.09	2	0.06
15.15	10	0.77	0.77	2	0.17	4	0.36	4	0.12

HY-52 cont.

HY-52
cont.

APPENDIX C: Estimated weighted usable area of habitat for rainbow trout and brown trout in the Tuolumne River between Hetch Hetchy Reservoir and Early Intake.

HY-52
cont.

HY-52
cont.

Attachment E

O-TRT-DREKMEIER cont.

WEIGHTED USABLE AREA PER 1000 LINEAR FEET OF STREAM FOR FOUR STUDY SITES IN THE TUOLUMNE RIVER ALONG WITH THE ESTIMABED TOTAL COMBINED WEIGHTED USABLE AREA OF HABITAT FOR RAINBOW AND BROWN TROUT IN THE REACH BETWEEN O'SHAUGHNESSY DAM AND EARLY INTAKE.

TOTAL AREA

	DISCHARGE	EARLY INTAKE	INDIAN MEADOW	O'SHAUGHNESSY LOWER	O'SHAUGHNESSY UPPER	COMBINED TOTAL
1	10	46,614	70,696	51,600	55,780	1,596,619
2	20	53,086	78,738	54,887	59,166	1,741,760
3	30	58,654	83,161	56,856	61,965	1,843,058
4	40	62,847	88,397	58,534	64,356	1,935,244
5	50	66,295	92,172	60,106	65,992	2,006,579
6	60	69,190	95,584	61,112	67,217	2,064,347
7	70	72,076	97,356	62,145	68,349	2,111,121
8	80	74,271	98,432	63,044	69,402	2,147,377
9	90	76,047	99,682	64,307	70,324	2,183,924
10	100	77,140	100,821	65,041	71,099	2,210,075
11	110	78,407	101,561	66,237	71,733	2,237,330
12	120	79,159	102,198	66,652	72,294	2,253,893
13	130	79,724	102,704	67,042	72,744	2,267,355
14	140	80,138	103,183	67,437	73,171	2,279,545
15	150	80,521	103,866	67,825	73,657	2,293,251
16	160	82,406	104,577	68,239	74,036	2,316,040
17	170	84,305	105,259	68,818	74,399	2,339,905
18	180	84,593	105,915	69,881	74,763	2,357,212
19	190	84,863	106,417	70,533	75,137	2,370,259
20	200	85,173	106,884	71,167	75,497	2,383,068
21	210	85,671	107,100	71,850	76,773	2,403,131
22	220	85,976	107,233	72,450	77,051	2,412,876
23	230	86,274	107,361	73,036	77,513	2,423,889
24	240	86,564	107,486	74,564	77,997	2,442,464
25	250	86,859	107,607	75,167	78,446	2,453,453
26	260	87,181	107,711	75,729	78,766	2,463,140
27	270	87,544	107,810	76,254	79,005	2,472,134
28	280	87,838	107,906	76,731	79,240	2,480,254
29	290	88,068	108,068	77,137	79,471	2,487,807
30	300	88,294	108,299	77,538	79,673	2,495,478

HY-52 cont.

RAINBOW TROUT

	DISCHARGE	EARLY INTAKE ADULT	EARLY INTAKE JUVENILE	INDIAN MEADOW ADULT	INDIAN MEADOW JUVENILE	LOWER O'SHAUGHNESSY ADULT	LOWER O'SHAUGHNESSY JUVENILE	UPPER O'SHAUGHNESSY ADULT	UPPER O'SHAUGHNESSY JUVENILE	COMBINED ADULT
1	10	24,817	13,926	14,075	18,908	12,280	12,519	18,430	11,758	490,590
2	20	24,996	10,703	16,233	17,629	14,182	13,935	19,837	11,018	531,660
3	30	24,957	9,118	17,847	15,177	15,883	13,583	20,498	10,370	560,381
4	40	23,732	8,471	19,423	14,684	16,576	12,291	20,666	10,042	569,449
5	50	23,296	8,081	20,947	14,725	16,869	10,203	21,017	9,732	581,460
6	60	23,873	7,864	22,224	14,785	17,352	9,582	21,441	9,384	600,436
7	70	23,857	7,787	23,225	14,493	17,857	9,240	21,225	9,128	608,985
8	80	23,922	7,767	23,995	14,641	17,936	8,914	21,328	8,792	615,737
9	90	24,502	7,531	24,911	14,647	18,325	8,493	21,334	8,123	628,375
10	100	24,606	7,420	25,663	14,369	18,836	8,170	20,848	7,709	634,024
11	110	24,799	7,270	26,276	14,209	19,243	7,975	19,920	7,219	635,009
12	120	24,992	7,130	26,969	14,227	19,398	7,922	19,934	6,776	641,989
13	130	25,179	7,084	27,533	14,197	19,473	7,845	20,078	6,430	648,501
14	140	25,516	7,169	28,017	14,072	19,549	7,735	20,049	6,039	654,085
15	150	25,788	7,164	28,513	13,887	19,585	7,556	19,868	5,990	657,818
16	160	25,917	7,152	29,043	13,772	19,655	7,306	19,794	5,977	661,974
17	170	25,938	7,212	29,658	13,602	19,713	7,137	19,675	5,911	665,540
18	180	25,889	7,352	30,212	13,441	19,691	7,009	19,694	5,909	668,725
19	190	25,894	7,193	30,552	13,128	19,698	7,010	19,641	5,859	670,550
20	200	25,994	7,092	30,819	12,937	19,699	7,041	19,693	5,865	673,295
21	210	26,192	7,015	30,992	12,738	19,636	6,986	19,822	5,885	676,179
22	220	26,336	7,046	31,213	12,468	19,623	6,888	19,958	5,919	679,474
23	230	26,425	7,059	31,320	12,114	19,635	6,748	20,062	5,896	681,650
24	240	26,396	7,110	31,185	11,752	19,709	6,540	19,994	5,880	680,651
25	250	26,503	7,227	31,054	11,498	19,680	6,441	19,966	5,870	680,039
26	260	26,788	7,306	30,938	11,159	19,617	6,340	19,978	5,887	680,720
27	270	27,177	7,303	30,909	10,687	19,557	6,260	20,099	5,913	683,485
28	280	27,482	7,281	30,863	10,195	19,522	6,216	20,263	5,932	686,155
29	290	27,639	7,252	30,741	9,795	19,528	6,193	20,300	5,960	686,714
30	300	27,692	7,267	30,528	9,495	19,481	6,158	20,088	5,974	683,651

HY-52 cont.

Attachment E

O-TRT-DREKMEIER cont.

BROWN TROUT

	DISCHARGE	EARLY INTAKE		INDIAN MEADOW		LOWER O'SHAUGHNESSY		UPPER O'SHAUGHNESSY		COMBINED
		ADULT	JUVENILE	ADULT	JUVENILE	ADULT	JUVENILE	ADULT	JUVENILE	ADULT
1	10	16,397	12,818	12,322	23,923	12,412	14,451	18,589	12,033	428,222
2	20	14,204	13,459	13,159	28,911	14,720	15,869	18,281	13,239	435,452
3	30	12,614	14,105	13,379	31,240	15,371	15,656	17,451	13,424	425,323
4	40	11,666	13,822	13,783	33,483	15,353	15,431	16,785	12,805	416,440
5	50	11,804	13,553	13,687	33,407	13,876	15,635	16,445	12,748	402,303
6	60	11,742	13,699	13,629	33,278	13,164	15,110	16,245	12,319	394,320
7	70	11,729	13,886	14,120	32,858	12,827	14,164	15,908	12,181	392,012
8	80	11,883	14,176	14,317	33,194	12,651	13,425	15,397	12,184	388,811
9	90	12,103	14,378	14,819	33,289	12,320	12,637	15,464	11,558	391,304
10	100	11,968	14,480	15,165	33,467	12,251	12,502	15,167	11,569	389,738
11	110	12,037	14,248	15,110	33,225	12,128	12,498	14,702	11,211	385,170
12	120	12,240	14,435	15,317	32,530	11,916	12,238	14,395	10,967	383,664
13	130	12,370	14,530	15,490	32,312	11,845	12,291	14,209	10,988	383,562
14	140	12,462	14,600	15,406	31,434	11,747	11,980	13,824	11,079	379,781
15	150	12,585	15,033	15,894	30,373	11,504	11,517	13,738	11,375	381,049
16	160	12,632	15,099	16,516	29,440	11,235	11,112	13,790	11,431	383,594
17	170	12,654	15,269	16,691	28,798	10,998	10,798	13,630	11,856	381,704
18	180	12,644	15,773	16,844	28,072	10,722	10,521	13,448	11,744	378,977
19	190	12,685	15,741	16,967	27,288	10,445	10,349	13,336	11,101	376,940
20	200	12,474	15,389	16,925	26,483	10,136	10,350	13,187	10,936	371,705
21	210	12,246	14,951	16,708	25,536	9,782	10,280	12,955	10,771	364,226
22	220	12,313	14,702	16,483	24,447	9,476	9,897	12,771	10,603	359,339
23	230	12,477	14,806	16,035	23,720	9,352	9,528	12,899	10,542	357,560
24	240	12,948	14,996	15,503	23,278	9,275	9,437	12,997	10,625	357,342
25	250	13,077	14,976	14,931	22,849	9,194	9,598	12,950	10,792	353,521
26	260	13,030	14,672	14,440	22,243	9,182	9,705	12,888	10,937	349,511
27	270	13,044	14,696	14,197	21,231	9,092	9,596	12,890	11,092	347,356
28	280	13,037	14,722	13,760	20,299	8,981	9,550	12,878	11,280	343,562
29	290	13,070	14,511	13,433	19,501	8,867	9,566	12,829	11,589	340,395
30	300	13,141	14,218	13,162	18,998	8,805	9,621	12,783	11,803	338,269

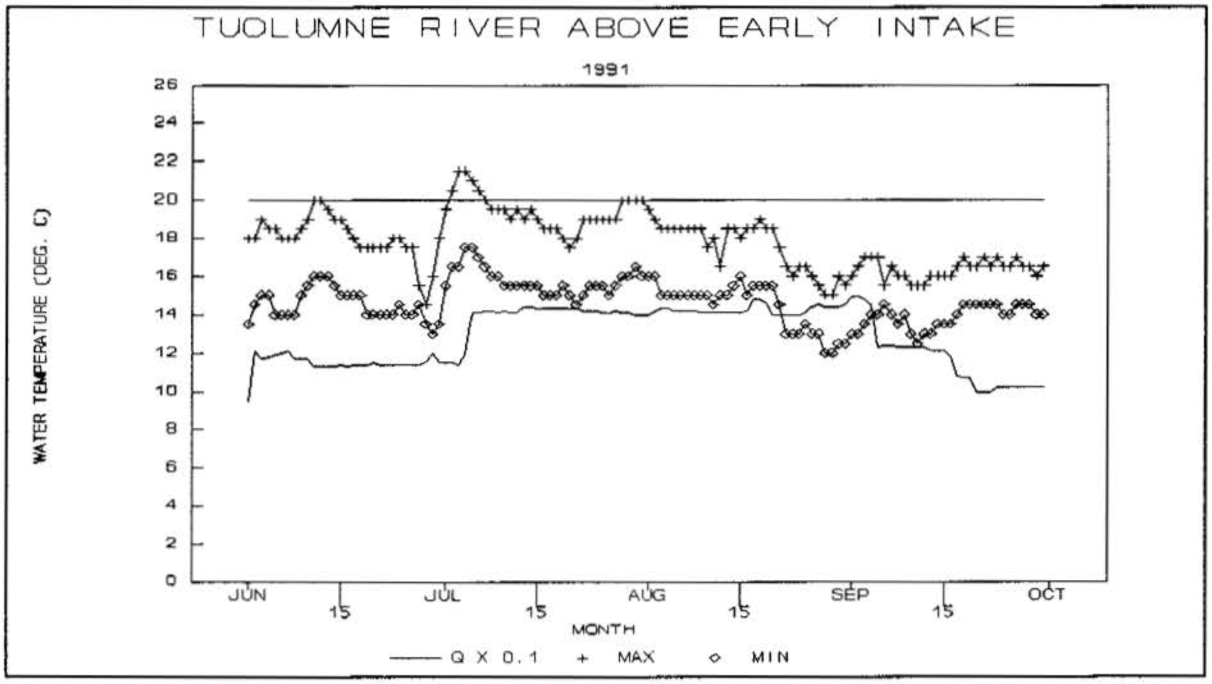
HY-52 cont.

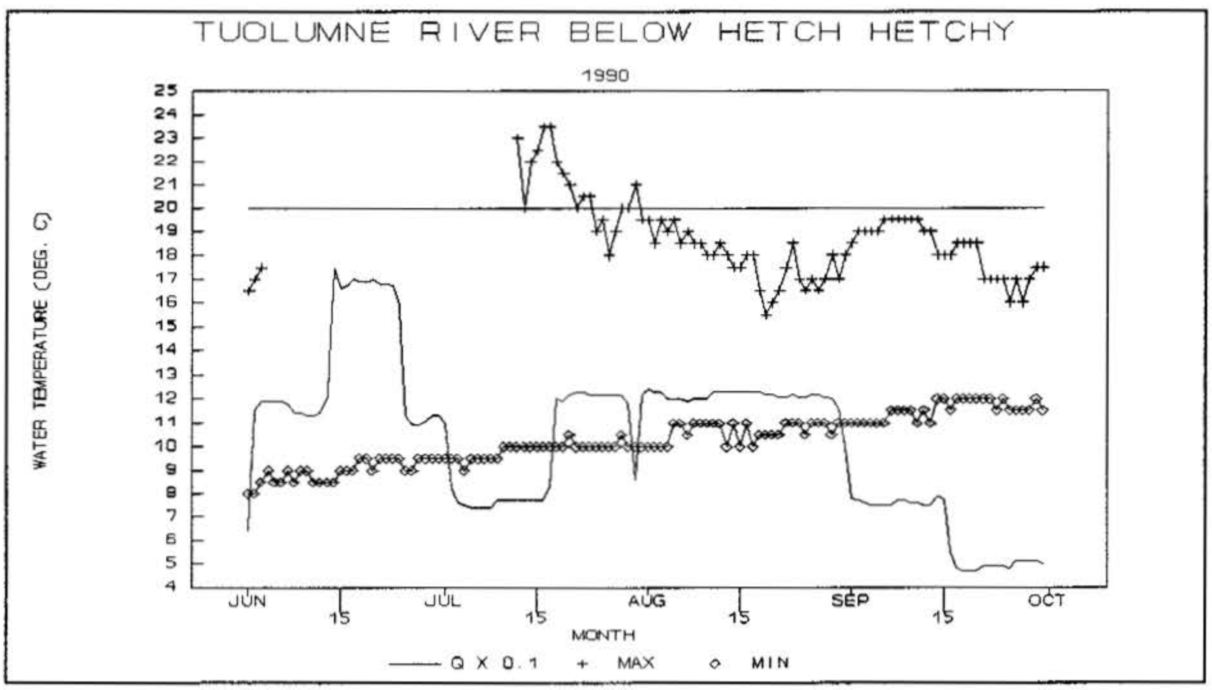
HY-52
cont.

APPENDIX D: Water temperature records for the months of June through October during water years 1988 through 1991 for the Tuolumne River above Early Intake.

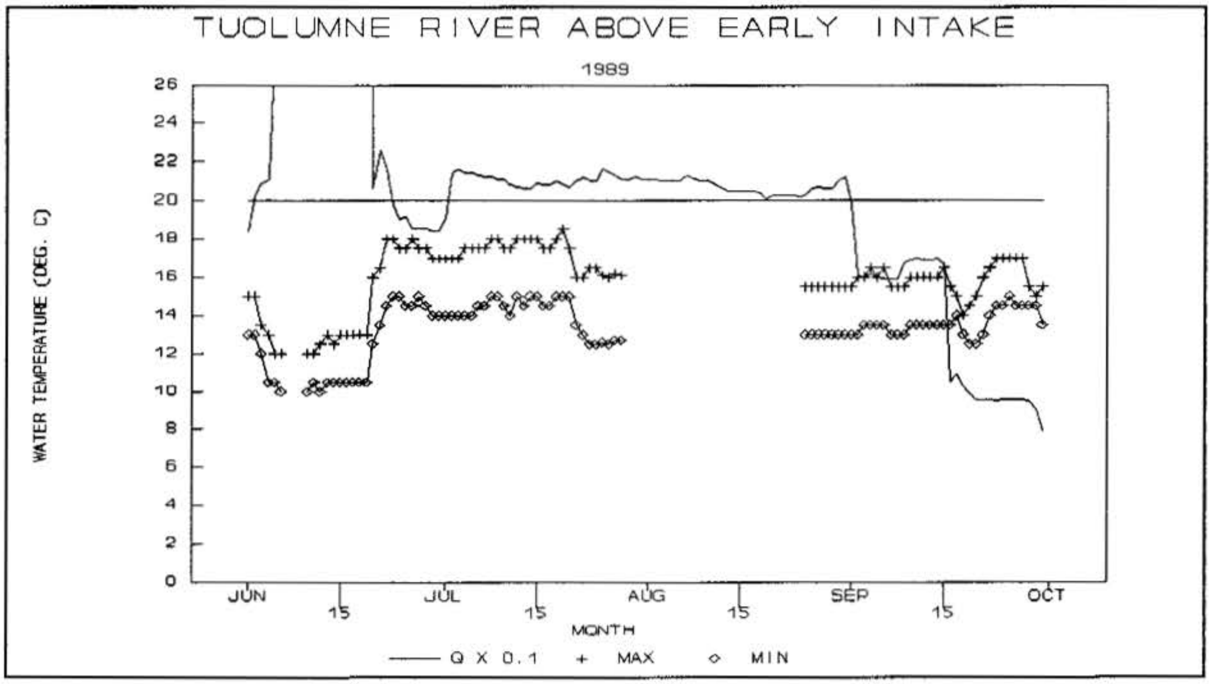
HY-52
cont.

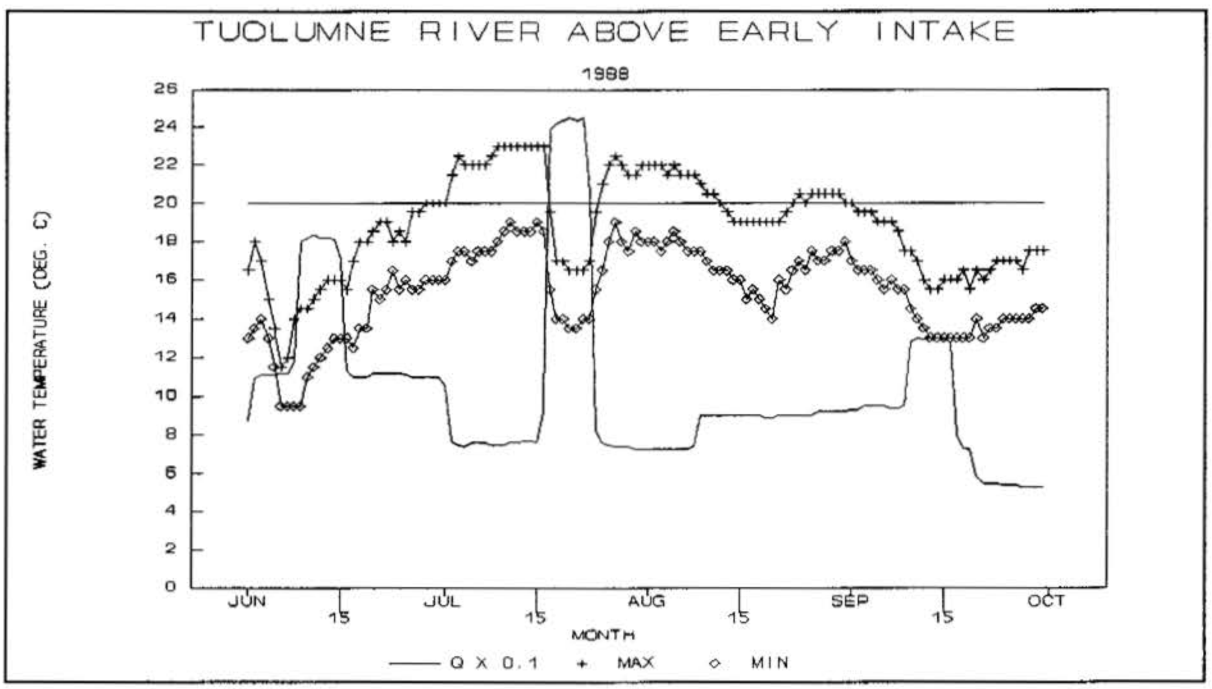
HY-52
cont.


TUOLUMNE RIVER ABOVE EARLY INTAKE
1991
WATER TEMPERATURE (DEG. C)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
JUN
15
JUL
15
AUG
15
SEP
15
OCT
MONTH
Q X 0.1
+ MAX
◇ MIN

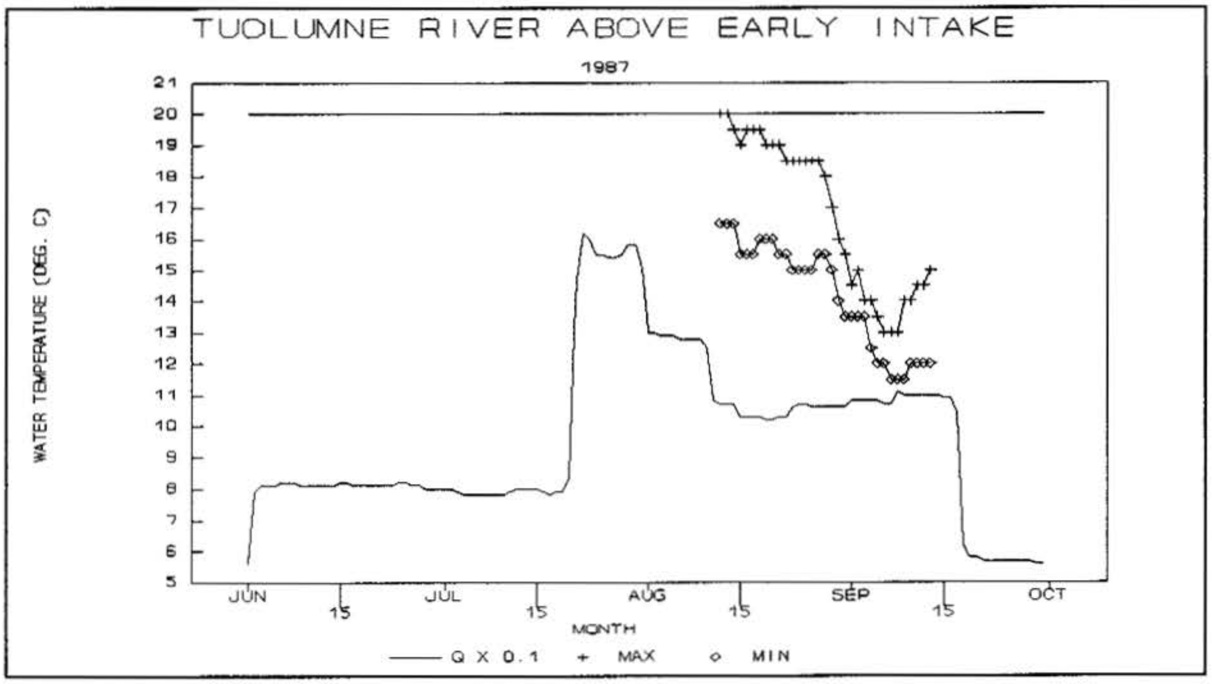

TUOLUMNE RIVER BELOW HETCH HETCHY
1990
WATER TEMPERATURE (DEG. C)
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
JUN
15
JUL
15
AUG
15
SEP
15
OCT
MONTH
Q X 0.1
+ MAX
◇ MIN

HY-52 cont.


TUOLUMNE RIVER ABOVE EARLY INTAKE
1989
WATER TEMPERATURE (DEG. C)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
JUN
15
JUL
15
AUG
15
SEP
15
OCT
MONTH
Q X 0.1
+ MAX
◇ MIN


TUOLUMNE RIVER ABOVE EARLY INTAKE
1988
WATER TEMPERATURE (DEG. C)
26
24
22
20
18
16
14
12
10
8
6
4
2
0
JUN
15
JUL
15
AUG
15
SEP
15
OCT
MONTH
Q X 0.1
+ MAX
◇ MIN

HY-52
cont.


TUOLUMNE RIVER ABOVE EARLY INTAKE
1987
WATER TEMPERATURE (DEG. C)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
JUN
15
JUL
15
AUG
15
SEP
15
OCT
MONTH
Q X 0.1
MAX
MIN

HY-52
cont.

HY-52
cont.

Instream Flow Schedule for the Tuolumnne River between O'Shaughnessy Dam and Early Intake under the 1985 agreement (table from WSIP PEIR).

TABLE 5.3.1-2
SCHEDULE OF AVERAGE DAILY MINIMUM REQUIRED RELEASES TO SUPPORT FISHERIES BELOW O'SHAUGHNESSY DAM

Month	Year Type A		Year Type B		Year Type C
	Release	Criteria[a,b]	Release	Criteria[a,b]	Release
January	50 cfs	8.80 inches	40 cfs	6.10 inches	35 cfs
February	60 cfs	14.00 inches	50 cfs	9.50 inches	35 cfs
March	60 cfs	18.60 inches	50 cfs	14.20 inches	35 cfs
April	75 cfs	23.00 inches	65 cfs	18.00 inches	35 cfs
May	100 cfs	26.60 inches	80 cfs	19.50 inches	50 cfs
June	125 cfs	28.45 inches	110 cfs	21.25 inches	75 cfs
July	125 cfs	575,000 acre-feet	110 cfs	390,000 acre-feet	75 cfs
August	125 cfs	640,000 acre-feet	110 cfs	400,000 acre-feet	75 cfs
September 1–14	100 cfs		80 cfs		75 cfs
September 15–30	80 cfs		65 cfs		50 cfs
October	60 cfs		50 cfs		35 cfs
November	60 cfs		50 cfs		35 cfs
December	50 cfs		40 cfs		35 cfs

HY-52 cont.

Recommended Instream Flow Schedule from *Instream Flow Requirements for Rainbow and Brown Trout in the Tuolumne River Between O'Shaughnessy Dam and Early Intake*, Michael Aceituno for the U.S. Fish and Wildlife Service, Draft, 1992.

HETCH HETCHY IFIM ROUGH DRAFT 07/17/92 10:00am

Table VI. Annual instream flow schedule recommended for the maintenance of rainbow and brown trout within the Tuolumne River Between O'Shaughnessy Dam and Early Intake.

Minimum Instream Flow Schedules

Month	Days	A cfs	A Ac-Ft	B cfs	B Ac-Ft	C cfs	C Ac-Ft
January	31	85	5,227	70	4,304	50	3,074
February	28	85	4,721	70	3,888	60	3,332
March	31	85	5,227	70	4,304	60	3,689
April	30	100	5,951	70	4,165	75	4,463
May	31	100	6,149	70	4,304	100	6,149
June	30	125	7,438	125	7,438	125	7,438
July	31	150	9,223	135	8,301	125	7,686
August	31	150	9,223	135	8,301	125	7,686
September 1-15	15	125	3,719	100	2,975	100	2,975
September 16-30	15	100	2,975	70	2,083	80	2,380
October	31	85	5,227	70	4,304	60	3,689
November	30	85	5,058	70	4,165	60	3,570
December	31	85	5,227	70	4,304	50	3,074

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OTHER OFFICES

ANCHORAGE, AK
NEVADA CITY, CA
SACRAMENTO, CA
HOUSTON, TX

March 20, 2006

Matthew J. Hogan
Acting Assistant Secretary for Fish and Wildlife and Parks
U.S. Department of Interior
1849 C Street, N.W.
Washington, D.C. 20240

Susan Leal, General Manager
San Francisco Public Utilities Commission
1155 Market St., 11th floor
San Francisco CA, 94103

HY-52 cont.

Re: Hetch Hetchy System: Kirkwood Powerhouse

Dear Assistant Secretary Hogan and General Manager Leal:

The Tuolumne River Preservation Trust respectfully provides notice of apparent violations of the "Modification for Kirkwood Powerhouse Unit No. 3 to Stipulation for Amendment of Rights-of-Way for Canyon Power Project Approved by Secretary of the Interior on May 26, 1961 to Fulfill the Conditions Set Forth in Provision 6 of Said Amended Permit" (March 10, 1987) (1987 Stipulation, Attachment 1). We request that you respond specifically to the facts that apparently show that the City and the Interior Department have not complied with these conditions. We further request a meeting to discuss your responses and corrective actions for these apparent violations.

On May 23, 1961 the Interior Department granted the City an amended right-of-way across National Park and National Forest lands for the Canyon Power Project, a facility in the Hetch Hetchy System. Among other things, this permit establishes a minimum flow release from O'Shaughnessy Dam. On January 31, 1985, the City and Interior Department entered into a Stipulation (Attachment 2) that requires a study of the impacts on fish, wildlife, recreational and aesthetic value, as a condition of any modification (including expansion) of the City's Hetch Hetchy System that may affect the flow of the Tuolumne between O'Shaughnessy and Early Intake. The 1985 Stipulation further provides that the purpose of the study is to determine what change, if any, should be made to the flow release schedule. It reserves the Interior Department's authority to require such change after consideration of any objection.

On November 4, 1985, the City entered into an Interim Agreement (Attachment 3) with the Conservation Groups, confirming this obligation with respect to the third generating unit of Kirkwood Powerhouse. The Interim Agreement also granted the groups standing to enforce the conditions of a subsequent agreement between the City and the Interior Department relating to a fisheries study.

On March 10, 1987, the City and Interior Department entered into the 1987 Stipulation. Paragraph 1 requires the City, or the U.S. Fish and Wildlife Service (FWS), to undertake a study "...to determine what, if any effect, the Kirkwood Powerhouse and Kirkwood Addition would have or have had on the habitat for and populations of resident fish species, between O'Shaughnessy Dam and Early Intake...." The condition requires the study to be completed by December 1992, subject to extension only if the FWS determines that the study is inconclusive or inaccurate as a result of climactic or other environmental conditions. Paragraph 2 specifies adjustments to the minimum flow releases, if the FWS determines that flow in the Tuolumne River "...should be increased." Paragraph 3 provides the methods and procedures for the fisheries study, including consultation with interested members of the public. Paragraph 4 requires implementation of the flow release schedule set forth in paragraph 2, without right of appeal except for the March-July period. Paragraph 5 establishes a procedure for appeal of any recommended change in flow schedule during that period. Paragraph 6 establishes a funding obligation for the City. Paragraph 7 provides for continued operation pursuant to the City's operating criteria for a decade, after which the parties will meet and confer to develop supplemental criteria.

HY-52 cont.

Many of the conditions of the 1987 Stipulation have not been timely met. The study required by Paragraph 1 has not been published. Based on inquiries to the City, FWS, and National Park Service, we believe that a draft study dated July 20, 1992 has not been revised or otherwise completed, and that the FWS did not make a determination that the data used for the study was inconclusive or inaccurate, the sole basis for any extension of the December 1992 deadline. The minimum flow release schedule has not been adjusted as provided in paragraphs 2, 4-5, since the study, which is the basis for such adjustment, has not been completed. The City and Interior Department have not consulted with the Conservation Groups on the conduct of the study since July 1992, as provided in paragraph 3. To the best of our knowledge, they have not conferred regarding adoption of supplemental operating criteria in 1997 or thereafter as provided in paragraph 7. They have not included the Conservation Groups in any related consultation regarding such criteria.

We request that the City and Interior Department, within 30 days, provide any documents material to the performance of these conditions of the 1987 Stipulation. We make this request under the City's Sunshine Ordinance, San Francisco Administrative Code section

67.1 *et seq.*, and the Freedom of Information Act, 5 U.S.C. section 552, respectively, as well as the Interim Agreement with the Conservation Groups. We request that you negotiate a resolution of these concerns, including consideration of an interim flow schedule pending the completion of a fishery study.

Please contact me at 415-693-3000 ext. 103 if you have any questions.

Respectfully submitted,

Richard Roos-Collins
Julie Gantenbein
NATURAL HERITAGE INSTITUTE
Counsel for TUOLUMNE RIVER PRESERVATION TRUST

HY-52 cont.

Holly D. Gordon
ENVIRONMENTAL LAW CLINIC, STANFORD LAW SCHOOL
Co-counsel for TUOLUMNE RIVER PRESERVATION TRUST

Cc: Ryan Broddrick
Director, California Department of Fish and Game

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HY-52
cont.

O-RHH-ROSEKRANS

RESTORE HETCH HETCHY
YOSEMITE NATIONAL PARK

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June 11, 2013

Sarah B. Jones, Acting Environmental Review Officer
Regional Groundwater Storage and Recovery Project
San Francisco Planning Department
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San Francisco, CA 94103

RE: Restore Hetch Hetchy comments on Regional Groundwater Storage and Recovery Project

Dear Ms. Jones:

Restore Hetch Hetchy appreciates the opportunity to comment on Case No: 2008.1396E – the Regional Groundwater Storage and Recovery Project (Project). GC-1 As currently proposed, we believe the proposed project does not adequately address groundwater opportunities within San Francisco's service territory and fails to bring San Francisco and its customers into compliance with federal law. GC-2

San Francisco currently lags behind most of the state in diversifying its water supply and is overly reliant on imported water. While all California water agencies face challenges in droughts, San Francisco's concerns are particularly acute due to its status as a junior (to the Turlock and Modesto Irrigation Districts) water rights holder on the Tuolumne River. Increases in local storage will help to provide a water supply buffer in drought years while also helping to protect customers from a potentially catastrophic conveyance outage. GC-1

We congratulate San Francisco for its work in the South Westside Basin. We view this as a storage project, to be filled on an in-lieu basis by providing surface supplies to users who formerly relied on groundwater. By developing a cooperative project with Partner Agencies, San Francisco is developing a model groundwater storage project that will provide additional supply when it is needed most. GC-2 The additional 7.2 million gallons per day will be a valuable asset. We are also pleased that the monitoring program appears well designed. GC-2 We do believe, however, that San Francisco and its partners should be more aggressive and creative in increasing groundwater recharge. AL-1

O-RHH-ROSEKRANS cont.

We are disappointed, however, that the groundwater production in the (north) Westside Basin will not be similarly operated. If groundwater supplies in the Westside Basin are to be pumped on every year, less water will accumulate in the aquifer and the Project will not be able to provide additional supply in drought years. We have heard anecdotally that it may not be feasible to operate the Westside Basin as a storage reservoir for two reasons: (1) that seawater intrusion may occur, and (2) that Lake Merced levels may be affected. We have not, however, seen any evidence in the EIR to support these anecdotes and we are not convinced that the Westside Basin could not be and should not be operated as a storage reservoir. The project neither has yet to identify the actual storage capacity of the Westside nor has identified ideas for substantive groundwater recharge. We ask the SFPUC to pursue the potential for such operation of the Westside aquifer as, were it possible, it would improve reliability for all SFPUC wholesale and retail customers. GC-1

More importantly, these programs encompass only a small portion of the SFPUC's service territory and many of San Francisco's customers have not maintained the local supplies that were once available. Local groundwater programs should be pursued as they improve reliability through diversity and can provide additional supplies in dry years. Moreover, retaining local supplies is mandated by the plain language of the Raker Act that authorized construction of facilities that make it possible to divert Tuolumne River supplies to the Bay Area.

HY-51

> **<u>Section 9(h) of the Raker Act reads:</u>**
> That the said grantee shall not divert beyond the limits of the San Joaquin Valley and more of the waters from the Tuolumne watershed than, together with the waters which it now has or may hereafter acquire, shall be necessary for its beneficial use for domestic and other municipal purposes.

It is apparent that some of San Francisco's customers are in violation of this provision of the Raker Act. For example, two of San Francisco's wholesale customers have stipulated in their 2010 Urban Water Management Plans that they have ceased to maintain their groundwater supplies:

> **<u>From Palo Alto's Urban Water Management Plan (2010):</u>**
> "A 1950 engineering report noted, "the capricious alternation of well waters and the SFWD water . . . has made satisfactory service to the average consumer practically impossible." However, groundwater production increased in the 1950s, leading to lower groundwater tables and water quality concerns. In 1962, a survey of water softening costs to City customers determined that <u>the City should purchase 100% of its water supply needs from the SFWD</u>. A 20-year contract was signed with San Francisco, and the City's wells were placed in a standby condition. The SFWD later became known as the SFPUC. Since 1962 (except for some very short periods) the City's entire supply of potable water has come from the SFPUC."

GC-1

O-RHH-ROSEKRANS cont.

<u>From Hayward's Urban Water Management Plan (2010):</u>
"Water service is provided by the City of Hayward for residential, commercial, industrial, governmental, and fire suppression uses. Originally, wells were used to supply Hayward with water. During the 1940s and 1950s, the well water was supplemented by water purchased from San Francisco's Hetch Hetchy system, owned and operated by the San Francisco Public Utilities Commission (SFPUC). In 1962, Hayward entered into an agreement with the SFPUC to purchase all Hayward water from the SFPUC. Hayward constructed over 20 miles of aqueduct in order to deliver Hetch Hetchy water and <u>ceased providing well water in 1963."</u>

GC-1 Cont.

The Southwest Basin Project is a positive step forward, but literally only a drop in the bucket. To effectively meet customer needs, keep up with other communities throughout California and comply with federal law, San Francisco and its customers must go much further. The city and its wholesale customers must pursue extensive additional regional groundwater projects throughout the service territory to recoup the local water supply that was available a century ago.

AL-1

Thanks you for the opportunity to comment on the Regional Groundwater Storage and Recovery Project.

GC-1

Sincerely,

Spreck Rosekrans
Director of Policy

O-CGC-MADDOW

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June 11, 2013

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Acting Environmental Review Officer
San Francisco Planning Department
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San Francisco, CA 94103

Re: **Comments by California Golf Club on SFPUC'S Regional Groundwater Storage and Recovery Project Draft Environmental Impact Report**

Dear Ms. Jones:

This law firm has been engaged as special counsel by the California Golf Club (Club) regarding the Draft Environmental Impact Report (DEIR) for the SFPUC's proposed Regional Groundwater Storage and Recovery Project (Project). On behalf of the Club, we hereby present comments in response to your April 10, 2013 Public Notice of Availability of the DEIR, and your May 28, 2013 Public Notice of Extension of Comment Period for the DEIR. GC-1

The Club is located in South San Francisco, where it has been in continuous operation since 1924. Unlike a number of other private golf clubs located in San Francisco and San Mateo Counties, this Club did not purchase the property upon which it is located from either the Spring Valley Water Company or from the City and County of San Francisco, and it is not subject to any deed reservation or other restriction on its use of groundwater which in any way limits its ability to exercise the rights and privileges of an overlying owner. Those rights make up an important element of the real property interests held by the Club, and although it hopes that it will never need to utilize them, the Club is aware that it has available to it a wide range of legal and equitable remedies if actions of another entity or person results in intrusion upon or interference with the rights it enjoys. HY-9

It is with that background of facts and the fundamentals of California law (and the California Constitution) that the Club has asked us to assist it in reviewing the DEIR for the proposed Project. In doing so, we have not sought the assistance of groundwater hydrologists or engineers to critique or interpret the data and analyses contained in the DEIR. Instead, we have focused on the narrative analysis, which clearly and unambiguously demonstrates that the proposed Project, if fully implemented, will have a significant adverse impact on the Club – an impact which we believe will deprive the Club of the ability to continue to enjoy and benefit from the reasonable use of the groundwater to which it is legally entitled in order to operate its golf course. The nature and extent of the proposed Project's adverse impacts on the Club and its ability to use its water rights appear to have potential to constitute the type of diminution of an interest in real property that may be characterized as a compensable "taking" for which redress is available under applicable constitutional and legal doctrines and procedures. HY-9 Cont.

This Club is not just any golf course. According to the Golf Club Atlas, which is widely considered the definitive international authority on golf course architecture, this Club is one of the top five in California, a golf-rich state in terms of the number of premium quality courses. HY-15 In addition to its unique architecture, the golf course is differentiated from all other Bay Area courses in that it utilizes fine fescue grasses in its playing and practice surfaces. Among other things, that means that the source and quality of the water used for Club irrigation is particularly important in terms of being able to reliably control the time and duration of irrigation cycles and especially in regard to avoiding any irrigation water constituent – especially nitrates – that are potentially dangerous to the grasses used by the Club. HY-15, HY-34

In 2007 and 2008, the Club went through an extensive renovation. Millions of dollars were spent on changes to the course layout, replacement of all drainage, and substantial soil amendments, in order to make it possible to replace the previously used poa anna grasses with a bent grass/fescue mix in fairways, and native fescues in the rough. By their very nature, the new grasses use less water, and the renovation also meant that the amount of irrigated acreage was actually reduced. In conjunction with this renovation work, the Club's irrigation system was modernized and improved in terms of efficiency and the precision with which water is applied to the course. Since the renovation, the Club's annual irrigation water volume has been reduced by 11% to 16% when compared to pre-project levels. As will be discussed further in a subsequent part of this letter, the mitigation measures contained in the DEIR that call for improved irrigation efficiency and modification of irrigation operations would not be applicable for the Club because such measures have already been fully analyzed, designed, and constructed, and placed in operation. HY-15

The DEIR estimates that the proposed Project, if approved and implemented, would result in a 41% decrease in the productive capacity of the Club's main well, and a 78% decrease in the capacity of its secondary well. Such dramatic reduction of the Club's ability to irrigate could create an existential threat to the Club, which has worked extremely hard for 9 decades to be a good steward of the land and water resources which the Club owns, and a good neighbor in the community in which it is located. The Club believes that the groundwater rights that it owns and exercises are superior to the rights of the proponents of the proposed Project who are now seeking to extract water from beneath the Club's property. The Club's right to use of that water on its overlying land is clearly paramount to the right of any of the proposed Project's proponents, who want to extract that water for an appropriative use. HY-9 The Club understands and acknowledges the Project objective with regard to regional water supplies, but accomplishment GC-2 of any such objective must be done with full recognition of and respect for the rights of property owners who will be adversely impacted by the Project and who should be "made whole" by the proponents of the proposed Project. GC-2 Cont.

The DEIR estimates that the proposed Project, if implemented, would reduce the 12-hour production capacity of the Club's wells from 2.2 acre-feet to 1.1 acre-feet – a 50% reduction in the Club's ability to obtain the water it needs to irrigate in peak periods, and the DEIR also estimates that the reduced production capacity would be about 40% short of the Club's irrigation demand. All irrigation systems have to cope with peak demand periods, but the estimated adverse impact to the Club's ability to irrigate in protracted hot spells would be extremely damaging to the long-standing land uses for which these rights are the foundation. Interference with normal irrigation patterns of as little as three days can be devastating to the type of turf used at the Club. HY-15

The DEIR also estimates that by the end of the "design drought" selected by the proponents, static and pumping water levels will be well below the tops of the screens at the Club's wells. The Club's main well is an excellent and productive well, but since it was constructed, to the Club's knowledge it has never faced circumstances in which water levels were drawn down to levels below the tops of the screens. Although the DEIR mentions the possibility of damage to a well that faces such a drawdown, there is no discussion of the nature, magnitude, or potential consequences of such risk, or of what the proponents of the proposed Project would do to avoid or counteract such risks.

Since the renovation of the Club and the introduction of fine fescue grasses into the turf on playing and practice surfaces, water quality has been a particular concern of the Club. The irrigation water constituent that is of primary concern in this regard is nitrate. The DEIR notes the presence of nitrates generally in the groundwater in the South San Francisco area, perhaps as a result of historic agricultural activities in the area, and suggests the possibility that water at deeper levels in the aquifer will be lower in nitrates. The Club is aware that there has been a short-term test of "in-lieu recharge" in some portions of the groundwater basin; however, the Club is also aware that at no time has there ever been anything like the proposed full-scale operation that the proposed Project would represent. In addition to not being able to predict with certainty what the impacts of the proposed Project would be on groundwater quantities, pumping capacities, and the water rights of legal users of water from the Basin, the Club is deeply concerned that implementation of the proposed Project might have the potential to mobilize or redistribute nitrates in the Basin, or to otherwise adversely impact water quality. None of the proposed mitigation measures appear to address the potential for adverse water quality impacts. HY-34

With regard to the short-term in-lieu recharge test that was conducted by the proponents of the proposed Project, the Club is concerned about whether the conclusions drawn from that test are sufficiently certain to support the leap from a short-term pilot program to full-scale Basin-wide implementation. Based upon the materials in the DEIR, the Club cannot tell if the test results were conclusive with regard to the ability of the aquifer to in fact recharge at the rates PD-18 and volumes necessary to support the proposed Project. The Club understands that there is a high degree of certainty with regard to the "take" portion of operations under the proposed Project, but does not understand if there is a similar degree of certainty with regard to the "put" portion. Accordingly, the Club suggests that a more prudent approach to implementation of the proposed Project might be phased implementation, beginning with those portions of the proposed Project that would be located in areas where the most information now exists and where the risk to pumpers like the Club might be minimized. As more data becomes available about water quality and quantity issues and adverse consequences for other pumpers, it would appear to be good public policy for the proponents of the proposed Project to have some "off-ramps" or "adaptive management" milestones so that the Project could be tailored to adjust to new or unexpected consequences.

PD-18
Cont.

PD-24

The Club has looked carefully at the nine types of mitigation contained in the DEIR, and cannot take much comfort from them. To reiterate, the Club has the legal right to use the groundwater that underlies its property for reasonable and beneficial use, and it has been doing so continuously for about 90 years. It has made significant and expensive changes to its lands and its irrigation system so as to improve the efficiency with which it uses water, and to reduce its water use. The DEIR clearly states that proposed Project has the potential to severely impact the Club's water production capacity. None of the mitigation measures listed in the DEIR, either individually or collectively, can quantitatively or qualitatively match the dramatic and potentially devastating impact that the proposed Project will have on the Club. An above-ground 20,000 gallon tank cannot mitigate the loss of 40% of peak-period pumping capacity. Lowering or changing pumps in Club wells cannot be expected to solve the reduction in pumping capacity if the water levels in the aquifer have been degraded to the degree estimated in the DEIR. Implementation of a temporary replacement water supply as suggested in the DEIR conjures up visions of "invasion pipe" or fire hoses being strung across the Club's property. In comparison to the nature and magnitude of the proposed Project's adverse impact, no one or combination of the mitigation measures appears to make the Club whole.

HY-9

HY-15

The Club looks forward to your responses to the comments raised in this letter, and to the forthcoming hearings on the Final EIR and on approval of the Project.

GC-1

Very truly yours,

Robert B. Maddow

Robert B. Maddow

cc: Glenn Smickley, General Manager, California Golf Club
Timothy Johnston (SF Planning Department), via e-mail

O-CLMP-QUICK

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June 11, 2013

VIA E-MAIL

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Re: San Francisco Public Utilities Commission Regional Groundwater Storage and Recovery Project Draft EIR, San Francisco Planning Department File No. 2008.1396E

Dear Ms. Jones and Mr. Johnston:

Morgan Lewis hereby submits the comments of our client, Cypress Lawn Memorial Park ("Cypress Lawn"), on the Draft Environmental Impact Report ("DEIR") for the San Francisco Public Utilities Commission (the "SFPUC") Regional Groundwater Storage and Recovery project (the "GSR Project"). Pursuant to Ms. Jones' e-mail of May 21, 2013, the San Francisco Planning Department and the SFPUC have agreed to accept and respond to comments from Cypress Lawn submitted on or before June 11, 2013. GC-1

This letter is organized as follows: GC-3

- Section I comments on the DEIR's failure to adequately describe and analyze physical and legal impacts of the GSR Project on existing water rights.
- Section II describes general deficiencies in the DEIR's analysis, including in the Project Description and Project Setting.
- Section III includes comments on inadequacies in the DEIR's resource analyses.

O-CLMP-QUICK cont

- Section IV explains why Alternative 3B, with the incorporation of revised Mitigation Measure M-HY-6, is a superior alternative to the GSR Project, as proposed. GC-3 Cont.

These comments are supplemented by the comments of David Abbott and Jenny Cherney, Senior Hydrologists with Daniel B. Stephens & Associates ("DBS&A"). Together, Mr. Abbott and Ms. Cherney have combined experience of over 44 years in groundwater analysis and management. DBS&A's comments are attached as **Exhibit A** and fully incorporated herein by this reference. GC-1

Cypress Lawn requests a copy of the Response to Comments when that document is issued.[1] GC-6

I. INTRODUCTION

Cypress Lawn, established in 1892, is both a historically important cemetery and an important provider of cemetery and funeral services for today's San Francisco Bay Area community.[2] As with the other cemeteries in Colma, Cypress Lawn's approximately 209 acres[3] of historically significant grounds are irrigated entirely with groundwater from the underlying south Westside Groundwater Basin ("SWG Basin" or the "Aquifer"), the same Aquifer proposed to be used for the GSR Project. Cypress Lawn's planned expansion of an additional five acres will also be irrigated with groundwater from the Aquifer. One of Cypress Lawn's wells, described in the DEIR as "well #3" is within 1.5 miles of proposed GSR Project wells at Sites 7, 8, 9, 10, and 11 (and well 17 (Alternative)). Thus, in addition to the general risks to the underlying aquifer posed by the GSR Project, Cypress Lawn's well is at risk and within the potential cones of depression that may result from simultaneous operation of up to five GSR Project wells (and in addition, potentially an alternative well). The general risks to the aquifer posed by the GSR Project, and the specific risks posed by the proximity of five GSR Project wells, have potentially significant impacts on Cypress Lawn's ability to continue to use its existing irrigation infrastructure and maintain its landscaping (including historically significant landscaping). The GSR Project poses risks of significant impacts to the aesthetic and historic resources of Cypress Lawn's and other cemeteries. HY-21 OV-1 AE-6 CR-2

Most fundamentally, however, the DEIR fails to address the GSR Project's incompatibility with the established legal hierarchy of California groundwater rights, an incompatibility flowing from the GSR Project's projected reduction in the net volume of water available to overlying groundwater users during dry, or "take," years. This failure is linked to a critical inadequacy in the significance criteria used to determine the GSR Project's impact on the underlying aquifer. HY-9 As a result of these deficiencies, the mitigation measures proposed fail to adequately address the significant impacts of the GSR Project on existing, overlying irrigators such as Cypress Lawn. HY-15

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1 DEIR, p. 2-13.

2 Town of Colma General Plan, pp. 5.08.9, 5.08.14-15.

3 The East and West Gardens are approximately 175 acres and the Hillside Gardens are approximately 34 acres.

O-CLMP-QUICK cont

All of these inadequacies in the DEIR must be corrected, and feasible and effective mitigation measures incorporated, in order for the GSR Project to comply with CEQA's fundamental mandates that the public and decision makers be adequately and accurately informed, and the environment afforded all feasible and effective protections.[4]

GC-3

A. **The GSR Project Would Unlawfully Interfere With Cypress Lawn's Paramount Overlying Groundwater Rights.**

Although the comments in this letter focus primarily on compliance with the California Environmental Quality Act ("CEQA"),[5] the DEIR raises fundamental legal compliance issues that, while they stem from changes in the physical environment, go beyond CEQA. Specifically, the GSR Project appears to have been formulated with an explicable disregard for (or perhaps non-recognition of) basic California groundwater rights law.

The GSR Project design does not take account of the paramount position of overlying groundwater rights (vis-à-vis parties that store surface waters in an aquifer). The DEIR does not acknowledge that the SFPUC does not have a right (under California water rights law) to interfere with the paramount groundwater rights of overlying landowners such as Cypress Lawn.[6] As explained further below, such interference with the overlying rights of Cypress Lawn and other owners of land above the southern part of the SWG Basin is unlawful under established water rights law. If the GSR Project would cause such interference, SFPUC could be liable for the inverse condemnation of overlying groundwater rights.

HY-9

Under California groundwater rights law, there are two types of legal entitlements to extract and use groundwater. The first such entitlement is "overlying" groundwater rights, which provide that landowners whose property overlies a groundwater aquifer have a right to the reasonable and beneficial use of waters in such aquifer on their overlying land.[7] The second such entitlement is "appropriative" groundwater rights, which provide for the right of non-overlying parties to

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4 *Vineyard Area Citizens for Responsible Growth v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 428, citing Public Resources Code § 21061; *In re Bay-Delta Programmatic Envt'l Impact Report Coordinated Proceedings* (2008) 43 Cal.4th 1143, 1162.

5 Public Resources Code, § 21000, *et seq.*

6 Chapter 16 is completely silent with respect to overlying groundwater rights. The only references to water rights throughout the entire DEIR are the definition of the term "water rights" and a discussion of the No Project Alternative that refers solely to the water rights of the City and County of San Francisco. *See* DEIR, pp. TOC xxi, 7-3.

7 *See, e.g., City of Barstow v. Mojave Water Agency* (2000) 23 Cal.4th 1224, 1240; *California Water Service Company v. Sidebotham* (1964) 224 Cal.App.3d 715, 725; *City of Pasadena v. City of Alhambra* (1949) 33 Cal.2d 908, 925.

deliver groundwater for uses on lands that do not overlie the aquifer that is the source of the groundwater.[8]

With respect to the proposed GSR Project, Cypress Lawn (and the other cemeteries and golf courses whose lands overlie the Westside Groundwater Basin) extract and use the groundwater in the Westside Groundwater Basin pursuant to "overlying" groundwater rights. In contrast, the Partner Agencies that extract and use the groundwater in the Westside Groundwater Basin do so pursuant to "appropriative" groundwater rights; the SFPUC's groundwater extraction and use through the proposed GSR Project would also be undertaken pursuant to "appropriative" groundwater rights.

The distinction between "overlying" and "appropriative" groundwater rights is of great importance in connection with the GSR Project because, under well established California law, "overlying" groundwater rights are superior to "appropriative" groundwater rights.[9] That is, when there is not adequate groundwater in an aquifer to meet the needs of both overlyers and appropriators, the appropriators must cease their pumping to avoid interference with overlyers paramount groundwater rights, and the failure of appropriators to do so constitutes an invasion of overlyers' property interest in the groundwater underneath its lands. Or put another way, it is illegal for an appropriative groundwater user to conduct pumping activities that reduce the groundwater available to overlyers.

HY-9 Cont.

> Overlying rights take priority over the needs of appropriators. The cumulative needs of all overlying owners must be satisfied before an appropriator may take any water surplus to the needs of the overlying owners.[10]

Notwithstanding that the superiority of overlying groundwater rights vis-à-vis appropriative groundwater rights is black letter California law, the GSR Project by its very design proposes that the SFPUC engage in groundwater pumping activities that are anticipated in drought/take years to have "significant and unavoidable" adverse impacts on the Westside Groundwater Basin waters available for use by overlyers such as Cypress Lawn.[11] As such, the GSR Project appears

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[8] *Wright v. Goleta Water District* (1985) 174 Cal.App.3d 74, 83-88; *City of Los Angeles v. City of San Fernando* (1975) 14 Cal.3d 199, 282.

[9] See *City of Barstow*, *supra*, 23 Cal.4th at pp. 1241-1242; See *City of Pasadena*, *supra*, 33 Cal.2d at p. 926.

[10] Scott S. Slater, California Water Law and Policy (LexisNexis 2009) Chapter 9, §902(3).

[11] *See* GSR Project DEIR, p. 5.16-91. The DEIR acknowledges that the GSR Project would have a "significant impact relative to well interference at Cypress Lawn Memorial Park" because "groundwater levels due to Project pumping at the end of the design drought are estimated to be approximately 95 to 98 feet lower than under modeled existing conditions" and because "the estimated groundwater levels with Project pumping at the end of the design drought would likely dewater a substantial portion of the well screen of Cypress Lawn Memorial Park's well #3."

O-CLMP-QUICK cont

to be premised on SFPUC groundwater pumping activities that are inherently unlawful and violative of the paramount overlying rights of Cypress Lawn (and other overlyers). HY-9 Cont.

Section 1094.5 of the California Code of Civil Procedure provides for the issuance of a writ to set aside agency approvals and enjoin agency actions when such approvals or actions constitute an "abuse of discretion." CCP Section 1094.5 further provides that abuse of discretion is established if the respondent agency "has not proceeded in a manner required by law." Cases brought pursuant to CCP Section 1094.5 have confirmed that a landowner's property interest in its water supply involves a "fundamental vested right" so that reviewing courts should afford little or no deference to agency determinations.[12] For the reasons noted above, in the case of the proposed GSR Project, the SFPUC would be engaging in groundwater pumping activities in a manner disallowed by law, and as such any approvals to engage in these lawful activities would therefore constitute an "abuse of discretion." CCP Section 1095.4 provides a means to address this abuse of discretion that is independent of (and in additional to) to other CEQA compliance concerns addressed in this letter. HY-9

Beyond the remedy of a writ pursuant to CCP Section 1094.5, overlying groundwater rights holder such as Cypress Lawn can also bring a "quiet title" action against the SFPUC in connection with their paramount property interests in the waters under their land. The SFPUC's unlawful appropriation of overlying groundwater can also provide the basis for an "inverse condemnation" claim in which the SFPUC would be liable to Cypress Lawn and other overlying landowners for damages resulting from reduced groundwater availability.

Section 5.16.2 of the GSR Project DEIR is titled "Regulatory Framework." It is here, in Section 5.16.2 that one would have expected some recognition and discussion of California groundwater law, to evaluate the extent to which California law permits the SFPUC to lawfully undertake the groundwater pumping proposed in the GSR Project. Yet remarkably, Section 5.16.2 of the DEIR does not contain any mention whatsoever of California groundwater law, and is limited only to discussion of water quality regulation. The DEIR's omission of any analysis of applicable groundwater law is startling, as the viability of the GSR Project hinges on whether or not the SFPUC has the right to conduct the groundwater pumping proposed. HY-9

Moreover, concerns regarding GSR Project interference with overlying groundwater rights were specifically noted in comment letters submitted to the SFPUC in response to the EIR Notice of Preparation ("NOP") in 2009.[13] The SFPUC appears to have disregarded these concerns. HY-9

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[12] *See, e.g., Gallegos v. California State Board of Forestry* (1978) 76 Cal. App.3d 945, 950.

[13] *See* Letter from Robert Maddow to Bill Wycko, dated July 28, 2009, p. 2; *see also* Attachment to Letter from Colma City Manager Laura Allen to Bill Wycko, dated July 28, 2009, ¶¶2-3.

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The NOP comment letter submitted to the SFPUC on behalf of the Green Hills Country Club, Lake Merced Country Club, Olympic Club and San Francisco Golf Club stated:

> As overlying property owners, the Clubs each have the legal right to pump that amount of water reasonably needed for their use for irrigation of their property, and their rights are protected against injury by California law...Protection of Existing Water Rights - The EIR needs to address protection of existing overlying rights...In all aquifer storage and recovery projects, and particularly in the case of an in lieu project such as this, there is always the possibility that the ratio of 'stored' to future extracted water is not actually or even close to 1:1...This issue is fraught with the potential for dispute, as many groundwater users experienced in the long fight over the Santa Maria Basin.

The NOP comment letter submitted by the Town of Colma stated:

HY-9 Cont.

> What rights to the overlying municipalities, including the Town of Colma, and the residents and property owners within such municipalities have to the use of groundwater in the South West Groundwater Basin (SWGB)? Under California law, an overlying landowner has the right to the reasonable use of groundwater located in an underlying basin, subject to the reasonable use by other overlying landowners...If the project has an adverse effect on the Town of Colma, its residents and property owners to use the groundwater in the SWGB, what provisions, if any, does the City of San Francisco...plan to take to avoid or minimize such adverse effects? Does the City of San Francisco plan to design the project in a way that avoids or minimizes such effects, and if so, how? If not, does the City of San Francisco plan to provide compensation to those whose rights have been lost or reduced?

The DEIR must be revised to address the legal hierarchy of groundwater rights identified in the 2009 comment letters on the NOP and summarized in this letter. The GSR Project will likely need to be modified to avoid interference with the superior groundwater rights of overlying owners.

II. The DEIR's Project Description And Description Of The Project Setting Are Inadequate.

A. The Project Description Is Inaccurate And Inconsistent With The Resource Analyses.

PD-16

The GSR Project has been described as in "in lieu" groundwater banking project. As described in the DEIR, the SFPUC would enter into agreements with "Partner Agencies" that currently

O-CLMP-QUICK cont

pump and distribute water from the Westside Groundwater Basin. Under these agreements, in wet (or "put") periods the Partner Agencies would agree to "forgo" their groundwater pumping and the SFPUC would agree to deliver replacement water (or "in lieu" water) to the Partner Agencies. The forgone pumping by the Partner Agencies would enable additional groundwater to remain in the aquifer (that would otherwise have been pumped), which the SFPUC could then later use in dry (or "take") periods. To implement the GSR Project, the SFPUC would maintain something called the "SFPUC Storage Account" to quantify the amount of "forgone" pumping by Partner Agencies (during wet/put periods) and thereby determine the amount of water available in the Westside Groundwater Basin for the SFPUC to pump (during dry/take periods).

Chapter 3 of the DEIR, the Project Description, asserts that the amount of groundwater pumped by the SFPUC in "take/dry" periods would be limited to the amount water "forgone" by the Partner agencies.[14] Under the theory underpinning the DEIR's Project Description, limiting SFPUC groundwater pumping in dry/take periods to the amount of additional water actually stored in the aquifer during wet/put periods (as a result of forgone pumping by the Partner Agencies) would ensure that the GSR Project pumping would not reduce the groundwater table anymore than would otherwise occur under existing conditions if the Partner Agencies had not forgone their pumping. Such drawdown of the groundwater table would not occur because, as suggested in the DEIR and in the April 2012 Fugro Memo, SFPUC would not extract water from the aquifer when there is not a "positive balance" in the SFPUC Storage account. PD-16 Cont.

The remaining portions of the DEIR, however, reveal that the SFPUC is well aware that the *actual* operation of the GSR Project's Storage Account will differ greatly from the *theoretical* model presented in the project description, and in fact will result in significant and repeated drawdown of the groundwater table during dry/take periods.[15] These other portions of the DEIR indicate, during dry/take periods, SFPUC pumping of the Westside Groundwater Basin will not in fact be limited to the additional water stored in the aquifer due to forgone pumping by Partner Agencies. Thus, the GSR Project described on Page 3.1.41 of the DEIR and in the April 2012

[14] *See, e.g.*, DEIR, p. 3.1-141 ["Project wells would only be pumped in Take Periods if there is a positive balance in the SFPUC Storage Account"]; *see also* App. H7 to DEIR, *SFPUC Regional Groundwater Storage and Recovery Project: South West Basin Third Party Well Survey and Well Interference Analysis* (April 2012) ("April 2012 Fugro Memo"), p, 2, 25 ["The GSR Project would only extract groundwater up to the amount that has been stored in the SFPUC Storage Account"].

[15] *See, e.g.*, DEIR, pp. 5.16-86, 5.16-91 [acknowledging significant drawdown of the Aquifer at the end of the design drought]; *see also* April 2012 Fugro Memo, pp. 25-26 ["The analytical calculations indicate that the proposed GSR Project would cause cemetery well static water levels to be from 95 to 116 lower than would occur without the project at the end of the Design Drought"].

Appendix C to the April 2012 Fugro Memo includes four figures (Figures C-11, C-12, C--13 and C-14) that confirm that, during dry/take period, the GSR Project is expected to cause the groundwater table where the Cypress Lawn well is located to drop as much as 120 feet below the level the groundwater table would be if the GSR Project was not implemented.

O-CLMP-QUICK cont

Fugro Memo does not appear to be consistent with the GSR Project described in other portions of the DEIR.

If the GSR Project groundwater pumping by the SFPUC was in fact equal to or less than the amount of actual additional groundwater banked in the aquifer due to forgone pumping by the Partner Agencies, then it would follow that the operation of the GSR Project (even in dry/take periods) should not result in any lowering of the groundwater table below levels that would have otherwise occurred had the GSR Project not been implemented. The fact that the DEIR predicts such a significant lowering of the groundwater table indicates that, contrary to the theoretical project descriptions, actual SFPUC pumping during dry/take periods will in fact not be limited to the amount of actual additional groundwater banked in the aquifer due to forgone pumping by the Partner Agencies. Rather, this lowering of the groundwater table indicates that as part of the GSR Project the SFPUC intends to pump amounts of groundwater in excess of the amount of water banked due to the forgone pumping.[16]

When the proposed actual operation of the GSR Project Storage Account is understood, it becomes evident that the "Positive Balance" referred to in the DEIR is simply "paper water." Given the limited storage capacity of the Westside aquifer, the fact that the Partner Agencies may have forgone pumping for multiple years does not mean that the amount of forgone pumping equates to the amount of actual additional water stored/banked in the Westside aquifer. The GSR Project treat these two amounts as if they were one and the same, when in fact they are not - because once the aquifer is filled to capacity it cannot store additional water regardless of whether the Partner Agencies continue to forgo pumping. As such, much of the "Positive Balance" (upon which the SFPUC determines how much it can pump in dry/take periods) is illusory from a hydrologic standpoint, a balance that exists on paper but not in the Aquifer.

PD-16 Cont.

As DBS&A's comments explain, the illusory/paper water aspects of this "Positive Balance" constitute a fundamental flaw in the GSR Project Storage Accounting methodology.

The proposed operation of the GSR Project Storage Account is not based so much on the premise of a "Positive Balance" as it is on the premise of "Borrowing/Payback." That is, during dry/take periods, the SFPUC will significantly drawdown the Westside aquifer by pumping amounts that are in excess of the additional water added to the aquifer as a result of the Partner Agencies' forgone pumping. However, as part of the GSR Project, the SFPUC proposes over the long run to "payback" the groundwater it borrowed (via substantial drawdown of the groundwater table) through forgone pumping by Partner Agencies in subsequent wet/put periods, which over time should allow the groundwater table to eventually rebound.

[16] *See* **Exhibit B** to this letter, "Modified Diagram of GSR Project," attached hereto and incorporated herein by this reference, showing drawdown below stored amount.

O-CLMP-QUICK cont

This "borrowing/payback" model is reflected in other portions of the DEIR and its technical appendices. For example, the April 2012 Fugro Memo states: "During the majority of years (68 to 83%) while the project is in place there will be a net benefit (i.e. higher groundwater levels and higher groundwater pumping capacities) to third party wells from the proposed GSR Project."[17] However, the converse implication of this acknowledgement is that, for 17 to 32% of the years the GSR Project operates, there will be a net injury to third party wells from the proposed GSR Project (i.e, lower groundwater levels and lower groundwater pumping capacities). The net benefit years correspond to the wet/put periods while the net injury years result to the dry/take periods. PD-16 Cont.

Yet even this analysis of "net benefit" is largely illusory, at least in terms of Cypress Lawn. Cypress Lawn relies primarily on a single groundwater well that is at a fixed depth, and Cypress Lawn's cemetery irrigation needs remain constant. Cypress Lawn would not engage in superfluous additional groundwater pumping and irrigation simply because additional water in the Westside aquifer was available. So there is really no benefit (net or otherwise), other than reduced pumping costs, to Cypress Lawn in having the groundwater level in Westside aquifer rebound/rise above its well intake. However, during those "17 to 32%" net injury years when the GSR Project may cause the groundwater table to fall below the intake screen of its current well, the harm to Cypress Lawn will be severe. Without a supply of water for irrigation, grass, plants and trees on Cypress Lawn's cemetery grounds could wither and die in the course of a single season. The eventual long-term rebound of the groundwater table would do nothing to offset this damage – that is, the net benefit years would not mitigate the intensive damage Cypress Lawn (and presumably other overlying irrigators) would suffer during the net injury years. HY-15

14 Cal. Code of Regulations (the regulations adopted for implementation of CEQA, the "Guideline") Section 15124 requires that an EIR must include an accurate, stable and consistent description of the proposed project.[18] Because the GSR Project DEIR at times claims that SFPUC groundwater pumping will be limited only to the amount water banked in the Westside Groundwater Basin through forgone pumping by Partner Agencies, yet at other times evidences that such pumping will occasionally be in excess of the amount of water banked in the Aquifer through such forgone pumping, the project description in the GSR Project DEIR does not meet the accuracy, stability or consistency requirements of CEQA Guideline Section 15124. PD-16

Beyond CEQA, there are also legal implication associated with the "borrow/payback" approach that underlies the operation of the GSR Project Storage Account. As explained above, under HY-9

[17] *See, e.g.*, App. H7 to DEIR, p. 26.

[18] See *County of Inyo v. City of Los Angele*s (1977) 71 Cal.App.3d 185, 197; *San Joaquin Raptor Rescue Center v. County of Merced* (2007) 149 Cal.App.4th 645, 655; *Communities for a Better Environment v. City of Richmond* (2010) 184 Cal.App.4th 70, 80.

California law the groundwater rights of overlying landowners (such as Cypress Lawn) are superior and paramount to the groundwater rights of appropriators. Under the "borrow/payback" scenario proposed pursuant to the GSR Project Storage Account, the SFPUC would "borrow" the groundwater by exercising its "appropriative" groundwater rights at the expense of the "overlying" groundwater rights of Cypress Lawn and others. The exercise of appropriative groundwater rights in this manner is violative of California groundwater law, and for the reasons noted above could expose the SFPUC to quiet title and inverse condemnation claims and abuse of discretion actions pursuant to CCP Section 1094.5. HY-9 Cont.

The DEIR's Project Description must be revised to answer fundamental questions regarding the GSR Project's potential reliance on native groundwater (to the determinant of overlying owners with superior groundwater rights).

B. **The Description Of The Project Setting Is Inadequate.**

CEQA Guideline Section15125 provides that an EIR include a description of the existing environment in the vicinity of the proposed project, and this description of the environmental setting should be sufficient to allow the project's significant impacts "to be considered in the full environmental context. The accurate description of hydrologic condition of an aquifer is essential for an EIR that involves the extraction of groundwater.[19] CEQA Guideline Section 15126 provides that an EIR's discussion of a project's environmental effects should include relevant specifics of the area affected, the resources that will be involved, and the physical changes to such resources that will result. HY-2

1. **The DEIR fails to accurately and consistently explain the relationship between the North and South Westside Groundwater Basins.**

The DEIR provides inconsistent environmental setting descriptions and impact analysis of the hydrological relationship between what is referred to as the "North" Westside Groundwater Basin and what is referred to as the "South" Westside Groundwater Basin. According to the "Project Location" section of the DEIR's Executive Summary, the HY-1

> The proposed Project would be located in Northern San Mateo overlying the southern portion of the Westside Groundwater Basin.... For purposes of discussion in this EIR, the Westside Groundwater Basin has been administratively divided at the San Francisco-San Mateo County line. Although this is **not a**

[19] *Cadiz Land Company v. Rail Cycle* (2000) 83 Cal.App.4th 74, 94.

O-CLMP-QUICK cont

> **physical boundary**, there are differences in conditions between the northern and the southern portion of the Basin.[20]

The DEIR then states (in the next section) that the GSR Project "proposes to increase water supply reliability during the dry year or in emergencies, by increasing water storage in the South Westside Groundwater Basin during wet and normal years for subsequent recapture during dry years."[21] However, the section concerning water supply impacts states:

> There is **no** geologic feature that restricts groundwater flow between the northern and southern parts of the [Westside] groundwater basin. However, groundwater development in the two parts of the Basin are different from each other, as groundwater has been more heavily developed as a water supply in the South Westside Groundwater Basin.[22]

HY-1 Cont.

These inconsistent descriptions are confusing. After noting in Section 1.4.1 and 5.16.1.3 of the DEIR that there is not physically boundary or geological feature separating the North (or "northern portion) and South (or "southern portion") of the Westside Groundwater Basin, other parts of the DEIR then go on to describe and analyze the North Westside Groundwater Basin and the South Groundwater Basin as if they were in fact hydrologically distinct. The DEIR suggests that there are two basins that would be affected in very different ways by the GSR Project.[23]

Because the DEIR provides little or no information that explains the underlying hydrologic connection (or perhaps the lack thereof) between the North (or "northern portion) and South (or "southern portion") of the Westside Groundwater Basin, it is not possible to coherently evaluate the adequacy of the DEIR's analysis of GSR Project impacts on the North and South Westside-Groundwater Basins. If there in fact is no physical boundary or geological feature separating the North and South Groundwater Basins, it is unclear why the drop in the water table or the intrusion of seawater into one portion of the Westside Groundwater Basin would not have impacts through the entire basin. Without a discussion of the hydrological relationship between the North and South Basins, much of the DEIR groundwater impact analysis that follows is impossible for readers to follow.

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[20] DEIR, p. 1-8, emphasis added.

[21] *Ibid.*

[22] *Id.* at p. 5.16-6, emphasis added.

[23] For instance, the remainder of the impact analysis in Section 5.16.1.3 includes separate analysis of GSR Project impacts on groundwater levels and potential seawater intrusion in the North Westside Groundwater Basin and the South Groundwater Basin, concluding that these project impacts would be quite different in the North and South Basins.

O-CLMP-QUICK cont

In failing to explain the hydrologic relationship between the North and South Westside Groundwater Basins, the GSR Project DEIR has not satisfied either the environmental setting description requirements of CEQA Guideline Section 15125 or the environmental effects analysis requirements of CEQA Guideline Section 15126. HY-1 Cont.

2. **The DEIR Fails to Quantify System Losses and Confirm That 100% of Deferred Pumping Results In Storage of Actual Groundwater "Deposits" That Can Be "Withdrawn" in Take Periods.**

The DEIR does not identify or explain the estimated amount of "system losses" that were considered when determining the calculations for Storage Account deposits and withdrawals.[24] System losses, through seepage, outflow, evapotranspiration, maintenance of wells, et cetera, must be accurately estimated and factored into the calculations in order to accurately determine the amount of "deposited" in lieu deferred pumping that can be claimed later as groundwater available for GSR Project "withdrawal." For example, of the 20,000 af of supplemental surface water delivered to Partner Agencies during the In-Lieu Recharge Demonstration Study, how much has the deferred pumping from Partner Agency wells resulted in measurable, verifiable levels of Aquifer recharge? Can SFPUC confirm that <u>all</u> of the 20,000 af in the Storage Account is actually stored and held in the Aquifer and that none has been lost? HY-43

The analysis concerning potential seawater intrusion states that, under Project conditions, the amount of "flux" or outflow to the ocean would increase by 17 af per month (afm) in the northern end of the basin and that the entire Westside Groundwater Basin will discharge 3 afm more groundwater than under existing conditions.[25] The analysis does not report, however, what those existing conditions are. How much of the groundwater in the basin currently flows to the ocean or the Bay or is otherwise lost? The DEIR fails to provide a clear answer to this basic question.

Table 5.16-2 reports the annual groundwater budget for the Westside Groundwater Basin – this table estimates that the basin loses more water than it gains through inflow.[26] The DEIR does not answer the implicated question: would the rate of outflow increase with the GSR Project's deferred pumping regime? HY-45

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[24] *See* DEIR, p. 5.16-181 [reference to memo addressing mitigation measure to account for "system losses," with no other mention of system losses in the DEIR]; *see also* SFPUC 2013a [memo re mitigation measure to account for "system losses" which does not provide any information concerning the estimated quantity of system losses].

[25] DEIR, pp. 5.16-111 – 5.16-112.

[26] *See id.* at p. 5.16-26. The DEIR explains that the "predicted overall negative change" is "largely" the product of a modeled drought that is longer than any experienced in the historical record. *Ibid.* It does not explain the basis for this modeled drought, its likelihood of occurring, or whether the negative change is a realistic assessment of the groundwater budget.

O-CLMP-QUICK cont

The analysis of Impact HY-14 purports to address groundwater depletion.[27] This analysis acknowledges "leakage" from the Aquifer, but does not accurately predict the increased amount of loss that will occur during Put Periods. Instead, it includes a mitigation measure that will establish "accounting rules that will account for losses from the Basin due to leakage."[28] This analysis must be done now, before the GSR Project is approved, so that conditions of approval can be established that will limit groundwater pumping by the SFPUC and Partner Agencies.

HY-48

3. The DEIR Fails To Adequately Explain Vertical Stratification of Sediments, Contaminants and Water Quality in Different Elevations of the Westside Groundwater Basin.

The DEIR analyzes of chloride, nitrates and volatile organic compound (VOC) contamination in the Westside Groundwater Basin, both in terms of existing conditions (environmental setting per CEQA Guideline Section 15125) and the GSR Project's impacts (per CEQA Guideline Section 15126). The DEIR's analysis of these water quality issues treats groundwater chlorine, nitrate and VOC concentrations as if they were uniform vertically throughout the aquifer. This assumption of such uniformity is not warranted, as there can be significant variations in contaminate concentrations throughout the vertical strata of the groundwater column, and these concentrations can be significantly impacts by the rising and the failing of groundwater levels within an aquifer.

HY-35

The DEIR acknowledges that nitrates, tetracholoroethylene (PCE) and tricholoroethylene (TCE) (among other contaminants) have been detected in groundwater samples.[29] Yet, as groundwater levels rise towards the surface (which is expected under the GSR Project during wet years), such rising groundwater levels may have a tendency to mobilize nitrate, PCE and TCE contaminants into the aquifer.

The vertical stratification can also occur with solids/sediments in the groundwater column. That is, high concentration of dissolved solids tend to settle at higher concentrations in lower strata of the water column of groundwater aquifers, such that groundwater extraction wells located in these deeper strata are likely to pump water with more dissolved contaminants.

In failing to address the issue of vertical stratification of contaminations and sediments in the water column of the Westside Groundwater Basins, the GSR Project DEIR has not satisfied either the environmental setting description requirements of CEQA Guideline Section 15125 or the environmental effects analysis requirements of CEQA Guideline Section 15126.

[27] DEIR, pp. 5.16-142 – 5.16-146.

[28] *Id.* at p. 5.16-146.

[29] DEIR, pp. 5.16-28 – 5.16-29.

O-CLMP-QUICK cont

C. **The DEIR Is Overly Technical and Voluminous and Inadequate As An Informational Document.**

In addition, the DEIR, taken as a whole, is overly technical, voluminous, and is not presented in a manner that can be easily understood by the lay public.[30] For all of these reasons, the DEIR fails to satisfy CEQA's informational requirements.[31] GC-3

III. **Inadequacies In The DEIR's Resources Analyses**

A. **The DEIR's Analysis of Impacts to Water Supply, Subsidence and Water Quality Fails to Satisfy CEQA's Requirements.**

1. **Inadequate Analysis of Impacts to Water Supply and Insufficient Mitigation for Impacts to Existing Irrigators.**

The DEIR Uses an Incorrect Significance Criterion: the DEIR modifies the significance criterion found in Appendix G to the CEQA Guidelines so as to eliminate the consideration of the GSR Project's impacts to the Aquifer. Appendix G's significance criterion states that an impact to water supply is significant if it would: HY-8

> b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)[.][32]

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[30] For example, the GSR Project well naming conventions used in the DEIR (Project well "Site __") and the technical appendices ("CUP-__") are different, making it difficult to follow the analysis. The data in the EIR must be presented in a manner calculated to inform the public and those not involved in the EIR preparation process. The DEIR and the appendices must be revised so that the GSR Project wells are consistently identified in all documents.

[31] *See* CEQA Guidelines §§ 15140 ["EIRs shall be written in plain language and may use appropriate graphics so that decision makers and the public can rapidly understand the documents"], 15141 ["The text of draft EIRs should normally be less than 150 pages and for proposals of unusual scope or complexity should normally be less than 300 pages"], emphasis added; *see also Bakersfield Citizens for Local Control v. City of Bakersfield* (2004) 124 Cal.App.4th 1184, 1197 ["An EIR must include detail sufficient to enable those who did not participate in its preparation to understand and to consider meaningfully the issues raised by the proposed project"], *quoting Association of Irritated Residents v. County of Madera* (2003) 107 Cal.App.4th 1383, 1391.

[32] *See* Appendix G to CEQA Guidelines § IX(b). Appendix G provides sample questions and is intended to be used by a lead agency in conducting an initial study to determine whether a project may have a significant effect on the environment. (Guidelines § 15063, subds.(a) & (f); *See also Madera Oversight Coalition, Inc. v. County of Madera*

O-CLMP-QUICK cont

The DEIR modifies this criterion so that it only considers whether the GSR Project would:

> Deplete groundwater supplies in a manner that would result in a lowering of the local groundwater to a level where the production rate of preexisting nearby wells would drop to a level that would not support existing or planned land uses.

This change results in a criterion that completely disregards the GSR Project's potential to "deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level." The omitted portion of the standard Appendix G language is the very heart of this criterion, the portion of the criterion that the DEIR included is just an example of one of the types of impacts that can occur when a project causes "a net deficit in aquifer volume" or "a lowering of the local groundwater table level." By eliminating the heart of the standard significance criterion, the DEIR in effect games the analysis so that it does not have to consider a reduction in the aquifer's volume – clearly a physical change in the environment – as a significant impact of the GSR Project.

HY-8 Cont.

The DEIR's modified significance criterion for impacts to groundwater differs markedly from the significance criterion identified in the WSIP PEIR:

> The CCSF has not formally adopted significance standards for impacts related to groundwater, but generally considers that <u>implementation of the proposed program would have a significant groundwater impact if it were to</u>:
>
> <u>Substantially deplete groundwater supplies</u> or <u>interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level</u> (e.g., the production rate of preexisting nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted)....[33]

Unlike the criterion identified in the DEIR, the criterion in the PEIR closely follows Appendix G's significance criterion. The DEIR does not explain this discrepancy, nor does it explain why the DEIR's preparers appear to have purposefully modified the criterion in order to disregard a GSR Project impact that would cause "a net deficit in aquifer volume or a lowering of the local groundwater table level." The DEIR's exclusion of this important consideration is conspicuous.

(2011) 199 Cal.App.4th 48, 94, fn. 24 (*Madera Oversight*).) The initial study is then used by the lead agency in deciding whether to prepare an EIR. (Guidelines § 15063, subd. (c).)

[33] WSIP PEIR, pp. 4.5-20, 5.5.4-1, 5.6-22, emphasis added.

O-CLMP-QUICK cont

In addition, the analysis only considers the effects of the GSR Project to be significant if primary, active and secondary wells together cannot supply estimated peak demand.[34] But many irrigators do not operate multiple wells simultaneously. Thus, the effect should be considered significant if the irrigators well(s), as the currently are used, cannot continue satisfy peak demand (among other criteria for significance, such as drawdown below existing conditions). HY-20

Well interference is only considered significant if GW levels fall "substantially" below well screens as a result of the GSR Project.[35] But any drop below the top of well screens caused by the Project should be considered significant. HY-11

The DEIR's analysis of impacts to irrigators is superficial and incomplete: The DEIR acknowledges that the GSR Project may have significant adverse impacts on overlying irrigators (such as Cypress Lawn) who currently rely on water pumped from the SWG Basin.[36] For example, the DEIR acknowledges that the GSR Project pumping, at the end of the design drought, "would likely dewater a substantial portion of the well screens of Cypress Lawn Memorial Park's well #3, which could add to the estimated reductions in well yield."[37] However, it does not go far enough in identifying the range of severity of those impacts. For example, it fails to define or fully describe the extent of potential "interference" with existing irrigators that the GSR Project may cause. Five GSR Project wells are proposed to surround the Cypress Lawn property, all within 1.5 miles of Cypress Lawn's wells – wells at Sites 7, 8, 9, 10, and 11 all have the potential to cumulatively contribute to localized (cone of depression) and generalized impacts to Cypress Lawn's source of groundwater. If selected, Site 17 (Alternative) also has the potential to contribute to the impacts of the surrounding GSR Project wells.[38] HY-21

Green lawns and other irrigated landscapes are critically important to both cemeteries and golf courses. For cemeteries, the well-kept appearance of the grounds is an important source of comfort to the bereaved. Those who choose to bury their loved ones at a cemetery do so with the expectation that the grounds will be well-maintained in perpetuity. Cypress Lawn takes this solemn responsibility very seriously. The GSR Project's potential to interfere with the cemeteries' beneficial use of groundwater threatens to undermine the ongoing viability of these land uses. These are not merely economic or social impacts – reductions or loss of the LU-5

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[34] DEIR, p. 5.17-84.

[35] *Id.* at pp. 5.17-84 - 5.16-85.

[36] *See* , *e.g.*, *id.* at p. 5.16-73 ["If well interference were great enough, irrigation water currently supplied by existing irrigation wells could be decreased to the extent that existing irrigation uses, such as for turf at cemeteries and golf clubs, would not be fully supported."].

[37] *Id.* at p. 5.16-91.

[38] Notably, the existing Partner Agency wells are nowhere near the cemeteries' wells. Thus, the GSR Project proposes to tap into a section of the Aquifer that previously has only been used by the existing irrigators.

O-CLMP-QUICK cont

cemeteries' critically important groundwater supplies could cause a form of blight or urban decay that the DEIR must also consider.

The importance of a well-watered and manicured lawn for golf courses is obvious. The DEIR fails to fully disclose the ramifications of the GSR Project's potential to interfere with the critical water supply of numerous golf courses. LU-5 Cont.

The DEIR also completely ignores the issue of increased pumping costs when Aquifer is drawn down during drought years. It also does not address the damage to existing wells that could occur if Aquifer water levels are depressed below the screened intervals of the well casings. HY-7

The DEIR does not explain the Project's affects on the sustainable yield of the Aquifer: During dry years (take periods), the proposed GSR Project will involve pumping 7.23 mgd from the southern part of the Westside Groundwater Basin ("SWG Basin" or the "Aquifer"); the Partner Agencies will pump 6.90 mgd.[39] These pumping rates, which total 14.13 mgd, are more than double the rates under existing conditions – the rates will far exceed the estimated 1.14 mgd rate of pumping by the golf club and cemetery overlying irrigators.[40] While the DEIR acknowledges that GSR Project pumping will interfere with the production capacity of existing irrigators' wells, it does not acknowledge or address the extent of that interference. HY-42

Further, while the DEIR states that project pumping can proceed at a rate of 7.23 mgd during take periods, the WSIP PEIR stated that project pumping could not exceed 6.0 mgd during take periods.[41] The DEIR fails to identify and explain the discrepancy and the basis for substantially increasing the rate of groundwater pumping. PD-23

The DEIR does not address the "safe yield" of the Aquifer. This glaring omission must be corrected in a revised DEIR. Without an analysis of the quantity of water that can be withdrawn annually in a sustainable manner, the lead agency cannot analyze the GSR Project's impacts to groundwater quantity in general and to the existing irrigators in particular. HY-42

The DEIR does not restrict Partner Agency and SFPUC pumping: The DEIR describes a proposed requirement for Partner Agencies to reduce their pumping during wet put periods; but HY-48

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[39] DEIR, pp. 5.1-9 – 5.1-10 [Table 5.1-2]. The DEIR fails to explain why the pumping rates of Partner Agencies would increase from the baseline rate of 6.84 mgd to 6.90 mgd during so-called hold years. This increase seems inconsistent with the concept of maintaining the status quo during hold years and would tend to draw down the Aquifer more rapidly than existing conditions. Further, it is not clear that the Partner Agencies have the legal right to increase their rate of extraction.

[40] *Ibid.*

[41] WSIP PEIR, p. 3-39 ["This additional volume of water available (storage) [61,000 af] would equate to an additional 6 mgd of delivery yield during drought years (average over 8.5-year design drought)"].

O-CLMP-QUICK cont

this appears to be an assumption, subject to agreement between the SFPUC and the Partner Agencies, not a requirement.[42] In order to protect existing irrigators and prevent overdraft of the Aquifer, the GSR Project must include a requirement that the SFPUC and the Partner Agencies monitor and report all pumping from the Aquifer during put periods (so the amount of water identified as stored in the Aquifer is accurate) and that pumping during dry periods be restricted so that the Aquifer is not drawn down below existing baseline levels. The DEIR must be revised to include this requirement, and must describe the methods that will be employed to monitor and control pumping by Partner Agencies. HY-48 Cont.

To give Existing Irrigators a voice in how the GSR Project is operated, and to provide procedural safeguards that will help ensure that GSR Project operations do not unduly impact existing irrigators, the Operating Committee should include at least one position for a representative of the existing irrigators. The existing irrigators can develop their own process for selecting their Operating Committee representative. HY-18

The DEIR fails to consider the impacts of unrestricted GSR Project and Partner Agency drawdown in the event of a drought that is more severe and/or more prolonged than the 8.5 year "design drought": The DEIR only considers the GSR Project's adverse impacts in the event of a modeled 8.5 year "design drought."[43] It fails to consider the adverse impacts that the GSR Project would have in the event of a drought that lasted longer than the modeled 8.5 year period. PD-21

The DEIR also does not define the types of "emergency" that would allow indefinite and unlimited pumping. This term must be defined and the DEIR must include objectively defined limits for emergency pumping. PD-22

The analysis of the effects of climate change (e.g., how warmer temperatures and changing precipitation patterns may change the drought cycle) on GSR Project is conspicuously absent from the DEIR chapter concerning hydrology. Instead, the DEIR appears to assume that the drought cycles and precipitation patterns that occurred over the past 47 years will simply be repeated. Yet it is common knowledge now, after intensive research over the past decade (and longer), that climate change will impact all of California's water resources.[44] State and federal agencies have developed many tools for evaluating projects in light of climate change.[45] The OV-3

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[42] DEIR, p. 3-4; *see also id.* at pp. 3-138 – 3-139 ["The Partner Agencies would agree to limit pumping from their existing wells and any new wells to the designated quantities totaling 6.9 mgd over a five-year averaging period"].

[43] *See* DEIR, p. 5.16-83.

[44] *See* DWR pamphlet, Climate Change in California (2007), available at: http://www.water.ca.gov/climatechange/docs/062807factsheet.pdf.

[45] *See, e.g.*, Climate Change Handbook (DWR and U.S. EPA, 2011), available at: http://www.water.ca.gov/climatechange/CCHandbook.cfm; *see also* Evaluating Projects, Resource Management

DEIR must be revised to consider this important issue, which implicates the assumptions upon which the GSR Project is based.

The WSIP PEIR provides a generalized analysis of the effects of climate change: it acknowledged that it was relying on limited information concerning the effects of climate change for its analysis.[46] Further, the WSIP PEIR analysis of the impacts of climate change focused on the change in precipitation in the Sierra Nevada, but it did not address increased temperatures in the Bay Area, and the resulting increased evaporation and potential changes to Bay Area water demands.[47] Even if the WSIP PEIR adequately addresses climate change effects on the GSR Project (which it did not), the DEIR failed to incorporate any discussion of this issue by reference.[48] OV-3 Cont.

Mitigation Measure M-HY-6 is Inadequate: The DEIR identifies and discuss a number of feasible mitigation measures that could reduce the adverse impacts on Cypress Lawn and other overlying irrigators to a less than significant level, including: reduce GSR Project pumping in affected areas; redistribute GSR Project pumping; modify irrigation operations to increase efficiency; lower the pump in irrigation wells or replace irrigation wells; and secure a replacement water source for irrigators (such as above ground storage tanks).[49] Although these mitigation measures are "identified" and "discussed" they were not incorporated into the Project and no provisions were made for their funding and implementation. Despite identifying numerous feasible mitigation measures, the DEIR found the adverse impacts "significant and unavoidable with mitigation." HY-15

Strategies, and IRWM Plan Benefits with Climate Change (DWR and U.S. EPA, 2011), available at: http://www.water.ca.gov/climatechange/docs/Section%206%20Evaluating%20Projects-Final.pdf.

[46] PEIR, 5.7-92 ["[O]ther than the general trends listed above, there is no clear scientific consensus on exactly how global warming will quantitatively affect California water supplies, and current models of California water systems generally do not reflect the potential effects of global warming. The Hetch Hetchy/Local Simulation Model (HH/LSM) used in the PEIR for the water supply and system operations analysis remains the best available tool for assessing the impacts of the WSIP.... Nevertheless, staff performed an <u>initial</u> evaluation of the effect on the regional water system of a 1.5-degree Celsius (°C) temperature rise between 2000 and 2025 (SFPUC, 2006a)"], emphasis added"].

[47] *See* PEIR, pp. 5.7-92 – 5.7-96; *see also id.* at p. 14.11-2 – 14.11-33 [Master Response to comments, providing supplemental analysis regarding climate change effects]. When dismissing the effects of climate change on the Peninsula, the WSIP PEIR erroneously states that "SFPUC operational practices during drought events would remain the same, regardless of whether the WSIP is implemented." *Id.* at p. 14.11-29.

[48] The DEIR does not refer to this discussion or provide the reader with the required "road map" that would enable the reader to understand how the DEIR may rely upon this information. (*See Vineyard Area Citizens for Responsible Growth v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 443 ["When an EIR uses tiering or incorporation, it must give the reader a better road map to the information it intends to convey"], citing CEQA Guidelines §§ 15150, 15153.

[49] DEIR, pp. 5.16-93 – 5.16-100.

Given that the DEIR itself has identified mitigation measures that (collectively) would reduce the impacts on overlying irrigators to a "less than significant" level, and that there is no evidence showing that these measures are infeasible, there is no support for the DEIR's determination that such significant impacts are "unavoidable." Indeed, reduced GSR Project pumping alone would be effective in avoiding the interference impacts to existing irrigators. Thus, the DEIR must identify Impact HY-6 as less than significant with mitigation. HY-15 Cont.

In addition to the CEQA mitigation deficiencies noted above, the DEIR hydrology mitigation analysis is deficient for the following additional reasons:

- Mitigation Measure M-HY-6 focuses on mitigating impacts on land uses and completely ignores the potentially significant impacts to the groundwater rights of existing irrigators; HY-9
- The measure lacks a commitment to avoid or reduce the impacts to less than significant levels; HY-15
- The measure lacks credible criteria for the determination of whether the GSR Project is causing a decrease in production from existing groundwater wells; and
- The measure fails to describe the process by which the SFPUC and/or the San Francisco Planning Department's Environmental Review Officer ("ERO") will determine whether the GSR Project is causing a decrease in production from existing groundwater wells, and fails to describe a process for a party to challenge a determination that causation is not established. HY-15

As drafted, Mitigation Measure M-HY-6 allows only a determination of such causation (which would trigger mitigation) through groundwater well monitoring conducted by SFPUC as opposed to monitoring conducted by the parties impacted. Cypress Lawn has redrafted Mitigation Measure M-HY-6 to correct the above deficiencies, as well as address many other problems with the measure. We submit the revised measure, attached hereto as Appendix 2 and incorporated herein by this reference, for lead agency and the SFPUC's consideration.[50]

2. Failure to Acknowledge and Address the Adverse Impacts to Pipelines and Structures from Subsidence.

Much of the SWB Basin is comprised of the Colma Formation, not the Merced Formation that was assumed in the analysis. What is the compressibility of the Colma Formation and how does HY-23

[50] *See* **Exhibit C** to this letter, Proposed Revisions to MM CLEAN and **Exhibit D** to this letter, Proposed Revisions to MM REDLINE, both of which are attached hereto and incorporated herein by this reference.

O-CLMP-QUICK cont

this compare to the Merced Formation? If the Colma Formation is even slightly more susceptible to compression then even the levels of drawdown assumed in the analysis could cause subsidence exceeding the 6 inch threshold of significance. The DEIR's assumptions concerning the susceptibility for subsidence may be unreasonable and inaccurate. HY-23 Cont.

The DEIR's conclusion that subsidence of less than 6 inches would not cause damage to structures and pipelines is not supported by substantial evidence.[51] The cited e-mail includes only the conclusory statement: "According to SFPUC's Engineering Management Bureau water pipelines can withstand subsidence of up to 6 inches."[52] This unsupported opinion does not constitute "substantial evidence" and does not serve the important function of informing the public and decision makers about the basis for this opinion. The cited reference *Soil Mechanics*, by Lambe and Whitman has not been made available for public review, and the information from the book concerning subsidence has not been summarized or otherwise provided so that the threshold of 6 inches can be verified. Without supporting substantial evidence, the DEIR cannot rule out the possibility that subsidence of less than 6 inches can cause damage to pipelines and structures. HY-25

The analysis does not address the impacts of elastic subsidence. Elastic or temporary subsidence "results in cycles of very small amounts of compression and expansion that occur normally in response to alternating periods of groundwater drawdown and recovery."[53] The flexing and movements caused by elastic subsidence can cause damage, even if the total movements are less than 6 inches. HY-23

3. Inadequate Analysis of Water Quality Impacts.

a. Inadequate Analysis of Seawater Intrusion

The DEIR's analysis of the risk of seawater intrusion is perfunctory, incomplete, and unsupported. HY-27

The 2008 WSIP PEIR, in Chapter 5.6, included separate analysis of seawater intrusion impacts in the North and South Westside Groundwater Basin. According to the 2008 WSIP PEIR, because the North Basin is "in direct connection with the ocean", seawater intrusion was a potentially significant impact (but rendered less than significant due to groundwater monitoring which would provide early detection). The 2008 WSIP PEIR concluded that "seawater intrusion

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[51] DEIR, p. 5.16-104, citing Lambe and Whitman 1969; SFPUC 2013d. The DEIR appears to be referring to inelastic (permanent) subsidence rather than elastic (temporary) subsidence, although this is not explained. Even small amounts of elastic subsidence may have impacts not experienced with inelastic subsidence.

[52] SFPUC 2013d.

[53] *See* DEIR for the East Bay Municipal Utility District Bayside Groundwater Project, pp. 3.1-54.

into the [South Basin] has not yet been detected...attributed to Merced Foundation." On this basis, without any further study or evidence, the WSIP PEIR concluded that the risk of seawater intrusion in the South Basin would be less than significant. HY-27 Cont.

Notably, the WSIP PEIR's analysis of seawater intrusion did not consider the effects of sea level rise caused by climate change.[54] HY-31

The GSR Project DEIR acknowledges the prospect of potential seawater intrusion into the South Westside Groundwater Basin, noting this basin's proximity to and hydrologic connection to the saline waters of both San Francisco Bay and the Pacific Ocean. The analysis in Chapter 5.16 explains the dynamics of higher elevation seawater spilling into a lower elevation aquifer, noting:

> Seawater intrusion occurs when the freshwater groundwater gradient declines toward the ocean or bay and the resulting seawater intrusion along the base of the aquifer is termed a 'saltwater wedge'....The extent of seawater intrusion into a freshwater aquifer is affected by the relative difference between water levels in the ocean or bay and the freshwater aquifer with which it is in hydraulic connection.[55]

HY-27

The DEIR presents these dynamics visually in Figure 5.16-9 (titled *Seawater Intrusion Schematic*).[56] After explaining the gravity-based characteristics of a saltwater wedge, the DEIR then goes on to determine that the prospect for the GSR Project to cause seawater intrusion into the South Westside Groundwater basin did not appear all that likely and therefore could be considered a "less than significant" impact for CEQA purpose. Because the DEIR characterized seawater intrusion into the South Westside Groundwater Basin as a less than significant impact it did not require identification and implementation of mitigation measures to address this impact.

The DEIR's significance determination in this regard was grounded on a comparison of surrounding San Francisco Bay and Pacific Ocean sea water levels to the "**average** groundwater levels" in the South Westside Groundwater predicted to result from the operations of the GSR Project.[57] By basing its seawater intrusion analysis on the anticipated "average" groundwater HY-30

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55 DEIR, p. 5.16-106.

56 *Id.* at p. 5.16-107.

57 *Id.* at pp. 5.16-109 and 5.16-110 ["**Average** groundwater levels were used because **short term** movement of the seawater interface towards lands during periods of low groundwater can be **offset** by movement of seawater interface towards the ocean during periods of high groundwater law...Seawater intrusion is not likely to occur due to **seasonal fluctuation** of groundwater levels, because **seasonal fluctuations** are **temporary**, and seasonal decrease may be **compensated** for by seasonal increases"], emphasis added.

O-CLMP-QUICK cont

level of the South Westside Groundwater Basin during the GSR Project operational period, the DEIR was able to avoid altogether analysis of seawater intrusion impacts during those "Design Drought" periods (which the DEIR acknowledges could last as long as 8 years) when the South Westside Groundwater Basis level is expected to drop precipitously more than 100 feet below the "average" groundwater level during the entire life of the project. The drawdown during these protracted Design Drought periods will lower the South Westside Groundwater Basin level to below the levels of surrounding seawater thereby creating conditions that would likely result in seawater intrusion.[58]

By grounding its seawater intrusion analysis on "average" GSR Project groundwater levels, the DEIR was able to gloss over and mask the seawater intrusion impacts during those design drought years/periods when the project will dramatically lower the groundwater table.[59] Moreover, the DEIR's attempt to characterize such drawdown periods as "short-term" and mere "seasonal fluctuations" is contradicted by the remainder of the DEIR which acknowledges that design drought periods could last as long as 8 years. An 8-year period in which a saltwater wedge is continuously spilling into the South Westside Groundwater Basin cannot be credibly described as a mere "temporary short-term seasonal fluctuation." Furthermore, there is no hydrological support for the DEIR's claim that an 8-year period of continuous seawater intrusion into the aquifer will somehow be "compensated" for in later years when the groundwater level is expected to rise. Once the South Westside Groundwater Basin is damaged and degraded by high salinity levels, a subsequent period of higher groundwater levels and groundwater flow back may push back the saltwater wedge contaminating the aquifer but it would not "undo" or "offset" the damage and degradation already done to the Aquifer's water quality from the previous seawater intrusion.

HY-30 Cont.

DBS&A's comments questions to propriety of using the "average" groundwater level methodology to assess seawater intrusion impacts. This approach is fundamentally flawed and not scientifically credible.

DBS&A's comments concerning this issue confirm that, instead of relying on "average" anticipated groundwater levels, the scientifically credible approach would have been for the DEIR to analyze the impacts to seawater intrusion/salinity impacts related to the anticipated periods of drought when the groundwater table in the South Westside Groundwater Basin will be drawn down substantially below the surrounding sea level. The DEIR must be revised so that

[58] The DEIR does not even attempt to analyze the potential for seawater intrusion if a drought lasts longer than the modeled design drought period or if water levels in the Aquifer at the end of such a protracted drought decline to below modeled conditions.

[59] The DEIR's analysis of the GSR Project's contribution to cumulative seawater intrusion impacts suffers from the same fundamental flaw of only considering average water levels. *See* DEIR, p. 5.16-156.

O-CLMP-QUICK cont

the potentially significant impacts associated with seawater intrusion are fully analyzed and mitigated. HY-30 Cont.

b. Inadequate Analysis of Risk of Mobilizing Contaminants In Soils Overlying the Basin Through Raising the Aquifer's Water Table.

The DEIR glosses over potential adverse water quality impacts that may be caused by the GSR Project's substantial changes to the water table.[60] The analysis concerning Impact HY-12 is inadequate because it focuses solely on water quality impacts to GSR Project drinking water and ignores the water quality impacts to existing irrigators who currently do not treat their pumped groundwater. In other words, the DEIR looks only at the quality of the water it extracts from the SWG Basin for its use as drinking water and neglects to analyze the potential impacts to the basin from substantially fluctuating water levels.[61] The DEIR must be revised to analyze and mitigate the water quality impacts to the Aquifer as a whole, with particular attention to adverse water quality impacts to existing irrigators. HY-39

The analysis of Impact HY-12 is also insufficient for several other reasons. First, it does not provide any factual basis for the assumption that contamination is limited to the top 50 feet below ground surface (bgs).[62] It is quite possible that contamination may be present below 50 feet or even 70 feet bgs. Accordingly, it is also possible that raising groundwater levels to levels lower than 70 feet bgs could mobilize contamination. The DEIR must address these possibilities and the implications for raising the water table to levels that could potentially mobilize deeper areas of soil and/or water contamination. HY-36

Second, the analysis considers only known contamination sites within close proximity to GSR Project wells and Partner Agency wells.[63] In other words, it seems to only be concerned with mobilizing contaminants into the groundwater that will impact SFPUC and Partner Agency drinking water supplies (while ignoring potential water quality impacts to the Aquifer in general and to others who rely on the Aquifer). This is inappropriate. Instead, the DEIR must consider known soil and groundwater contamination sites in all areas overlying the Aquifer, in order to HY-40

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[60] This is another example of the SFPUC ignoring a pertinent comment concerning the NOP for the DEIR. *See* Letter from Robert Maddow to Bill Wycko, dated July 28, 2009, p. 3.

[61] *Id.* at p. 5.16-135 – 5.16-136.

[62] DEIR, p. 5.16-130.

[63] *See* DEIR, p. 5.16-129 [description of Groundwater Protection Zones], 5.16-132 – 5.16-139 [impact analysis focusing exclusively on PCA's around GSR Project and Partner Agency Wells]. The DEIR reports that a Preliminary DWSAP report has not been prepared for the proposed alternate site at Site 17 (Alternate). This alternate site is located in very close proximity to Cypress Lawn. We request that a Preliminary DWSAP be prepared for this alternate site.

O-CLMP-QUICK cont

assess water quality impacts to all Aquifer users, including existing irrigators.[64] Any of these contamination sites could potentially be a source of contamination that could be mobilized into the Aquifer through raised water table levels that result from the GSR Project's program of in lieu recharge. HY-40 Cont.

Third, the DEIR considers that "time-averaged" water levels in the Aquifer, rather than the lower water levels during take periods to conclude that the "the downward movement of contaminated groundwater from the shallow water-bearing zone would generally be less than under existing conditions."[65] This is yet another example of using "average" water levels to minimize the possibility of impacts. To be conservative, the DEIR must be revised to address the increased downward gradient that would occur when water levels are reduced below existing conditions (especially at the end of design drought periods, when water levels would be substantially below existing conditions). HY-37

The WSIP PEIR is completely silent with respect to these questions

The analysis of Impact HY-12 must be substantially revised to consider the risk of mobilizing contaminants throughout the area overlying the Aquifer. This risk must be eliminated or minimized through enforceable mitigation that will protect all of the Aquifer's users. HY-39

c. Improper Dismissal of Impacts to Drinking Water Quality.

The primary source (approximately 85%) of domestic water provided by the SFPUC comes from Hetch Hetchy Reservoir in Yosemite National Park on the Tuolumne River. The drinking water from this source is of exceptional purity and quality. According to the SFPUC website, a unique feature of the SFPUC water supply is that "the drinking water provided is among the purest in the world." The SFPUC website also notes that the drinking water from Hetch Hetchy Reservoir is often such high quality that it does not need to be filtered. HY-38

A recent newspaper article also confirmed the high quality and purity of SFPUC primary water supply. This article stated that drinking water in San Francisco "is some of the crispest water found on the planet" and reported that "San Franciscans are probably unaware that they have some of the freshest tap water in the world."[66]

Pursuant to the proposed GSR Project, during dry/drought periods, the SFPUC proposes to augment its drinking water from Hetch Hetchy Reservoir with drinking water supplies from the

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[64] *See, e.g.*, DEIR, pp. 5.17-6 – 5.17-12 [Table 5.17-1, listing known contamination sites].

[65] *See id.* at p. 5.16-131.

[66] *See* Golden Gate Express magazine, *Tap Water Remains Best Choice for SF* (May 12, 2013), available at: http://www.goldengatexpress.org/2013/05/12/tap-water-sf/.

O-CLMP-QUICK cont

Westside Groundwater Basin. As such, pursuant to the GSR Project, Bay Area customers that now drink Hetch Hetchy water will increasingly be drinking water from a much more urban and much less pristine source.

The GSR Project's switch from Hetch Hetchy water to Westside aquifer water as a drinking water supply may have adverse taste/odor impacts on SPFUC water customers.

The DEIR fails to furnish information and analysis concerning the GSR Project's proposal to substitute the exceptionally pristine Hetch Hetchy drinking water supply with drinking water pumped from the less pristine Westside groundwater aquifer. That is, the DEIR does not describe the particular purity and taste/odor attributes of traditional SFPUC drinking water (the current environmental setting/baseline conditions) and then compare such attributes with the Westside groundwater that would be supplied as a substitute drinking water supply pursuant to the GSR Project. HY-38 Cont.

Although the GSR Project DEIR did not address water quality considerations other than water quality violations of federal and state law, other CEQA EIRs have analyzed the comparative taste attributes of groundwater and surface water drinking water supplies. For example, in December 2011 the City of Roseville prepared a DEIR for its Aquifer Storage and Recovery Program. That DEIR notes the potential for "customer sensitivity to switching between surface water and groundwater" and continues: "Even though the groundwater delivered to the customers meets all applicable drinking water standards, during the [pilot] test the City received complaints regarding the water's taste and odor, referred to as aesthetic qualities in this EIR."[67] The DEIR then explains:

> "Groundwater is typically harder than surface water because, as water moves through soil and rocks, it dissolves small amounts of naturally occurring minerals such as calcium and magnesium and carries them into the groundwater aquifer. Hard water does not pose a health risk but can be aesthetically unpleasing due to the mineral buildup or spotting on plumbing fixtures, shower doors, dishes and glasses. It can also have undesirable odor and taste..."[68]

The DEIR determined that "water customers may perceive a decrease in the aesthetic water qualities of potable water during ASR [Aquifer Storage and Recovery] recovery operations when compared with surface water."[69] AE-7

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[67] City of Roseville Aquifer Storage and Recovery Program DEIR, p. 2-10, available at: http://www.roseville.ca.us/eu/water_utility/aquifer_storage_n_recovery.asp.

[68] *Id.* at p. 4-24.

[69] *Id.* at p. 4-26.

O-CLMP-QUICK cont

The inclusion of information and analysis in the GSR Project DEIR concerning the comparative taste/odor attributes (as drinking water supplies) of Hetch Hetchy Reservoir water and Westside Groundwater Basin water is consistent with CEQA requirements relating not only to water quality but also aesthetics. Section 21001(b) of the CEQA statute confirms that it is the state's policy to protect and preserve "aesthetic, natural, scenic, and historic environmental qualities." Similarly, Public Resources Code Section 21060.5 and CEQA Guideline Section 15350 include resources of "aesthetic significance" in the definition of the term "environment." AE-7 Cont.

B. The Analysis of Impacts to Utilities and Service Systems Fails to Consider Impacts to Existing Irrigators.

At the outset of the Chapter 12 of the DEIR, there is a brief discussion concerning the criteria considered for determining whether the GSR Project would cause significant impacts to utilities and service systems.[70] This discussion improperly eliminates a critical significance criterion based on a conclusory and unsupported statement that "[us]e of the groundwater during construction and operations is so small that it would have a negligible effect on the ability of the Project to supply water and would not have any effect on existing water supply sources."[71] The discussion does not quantify the amount of water that would be used during construction, so there is no evidentiary basis for concluding that construction-period water demand would have only a negligible effect. Further, the discussion does not address the operational demand for native (non-banked) groundwater resources. If the GSR Project will draw down the Aquifer during take periods to levels below existing conditions, and thereby interfere with the overlying rights of the existing irrigators, then this chapter of the DEIR must be revised to determine whether the GSR Project would require new or expanded water supply resources or entitlements. UT-1

The analysis of operational impacts to wastewater systems does not specify the current and projected volume of wastewater the treatment plants handle,[72] so it is impossible to confirm that the volume of wastewater that would be produced by the GSR Project's wells will exceed the treatment plants' capacity. The DEIR must be revised to address this issue. UT-2

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[70] DEIR, p. 5.12-7 – 5.12-8 [eliminating criteria that would require the DEIR to evaluate whether the GSR Project would "Have insufficient water supply available to serve the Project from existing entitlements and resources, or require new or expanded water supply resources or entitlements"].

[71] DEIR, p. 5.12-8.

[72] *Id.* at p. 5.12-19 [stating that the treatment plants are "currently functioning at below their permitted capacity," but not identifying the amount of capacity that remains or addressing any competing future demands for that capacity].

O-CLMP-QUICK cont

C. **The DEIR Uses an Overly Narrow Visual Study Area and Fails to Analyze Reasonably Foreseeable, Significant Impacts of the GSR Project.**

As described above, a reasonably foreseeable consequence of the GSR Project is that during dry, take periods, the net volume of water available for use by overlying irrigators will be reduced. Further, the DEIR as currently written fails to incorporate feasible, effective and binding mitigation measures that would prevent this significant impact or the related significant impact of existing overlying irrigators experiencing interruptions or reductions in irrigation supplies. HY-15

The aesthetic impacts of such interruptions or reductions in irrigation supplies on the visual character of the cemeteries would be swiftly felt and significant. The significance of these impacts would be heightened because the DEIR includes cemetery visitors in the category of "[*s*]*ensitive viewers.*" As "sensitive viewers" cemetery visitors have "a strong stake or interest in the quality of the landscape and have a greater level of concern towards changes that degrade or detract from the visual character of an area."[73]

In this context, and given the acknowledged dominance of cemetery landscapes within Colma,[74] the DEIR's aesthetics analysis is patently inadequate, as it completely fails to analyze the aesthetic effects of such reasonably foreseeable irrigation reductions and/or interruptions on cemeteries, including Cypress Lawn. The DEIR defines the visual study area analyzed as consisting solely of each "facility" (i.e., GSR Project well and related infrastructure). This overly narrow definition is clearly inadequate. While interruptions or reductions in groundwater supplies for overlying irrigators may not be the intended purpose of the GSR Project, they are clearly reasonably foreseeable consequences of the Project. CEQA requires that EIRs analyze both direct and indirect impacts of projects.[75] AE-6

Turf landscapes are particularly sensitive to even brief interruptions in irrigation. Particularly in light of Mitigation Measure M-HY-6's failure to include objective criteria for determining whether an interruption or reduction in an overlying irrigator's supplies is attributable to the GSR Project, and the lack of a clear commitment to preventing any such interruption or reduction,

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[73] DEIR, p. 5.3-2.

[74] "Colma is a community dominated by cemeteries surrounding a commercial core. ... The aesthetic component of the community's character is largely a function of the cemeteries and associated open space and landscaping. Well-groomed lawns, rolling hills, manicured landscaping and natural vegetation, quiet scenic areas for meditation, and tranquil paths for strolling are common and essential features of Colma's memorial park uses." DEIR, p. 5.3-4 - 3.4-5.

[75] Guidelines § 15126.2 (a). Indirect effects are defined as "a physical change in the environment which is not immediately related to the project, but which is caused indirectly by the project." Guidelines 15064 (d) (2). Effects of a project that must be analyzed in an EIR include "[i]ndirect or secondary effects which are caused by the project and are later in time or farther removed in distance, but are still reasonably foreseeable." Guidelines § 15358 (a) (2). *See El Dorado Union High School District v. City of Placerville* (1983) 144 Cal.App.3d 123, 133.

there is a reasonably foreseeable probability that overlying irrigators of cemeteries, including Cypress Lawn, will experience interruptions and reductions in irrigation supplies, leading to significant impacts to Colma's visual quality, and significant impacts on sensitive viewers. The DEIR must be revised to include an analysis of the GSR Project's direct and indirect aesthetic impacts on cemetery uses, including an analysis of cumulative aesthetic impacts across a visual study that is not overly narrowly defined, so that it captures all reasonably foreseeable effects of the GSR Project, including the aesthetic impacts that could result from interference with the existing irrigators groundwater wells. AE-6 Cont.

D. **The DEIR Fails To Analyze the GSR Project's Reasonably Foreseeable Significant Impact on Historic Resources, Including Cypress Lawn, A National-Register Eligible Historic District.**

Similar and related to the failure of the DEIR to properly define the visual study area in order to capture the full range of the GSR Project's aesthetic impacts, the DEIR also fails to analyze the Project's impacts on the integrity of historically significant cemetery landscapes, such as Cypress Lawn, and other cemeteries in Colma with historic resource values.

The DEIR describes the historic significance of Colma's cemeteries, and in particular that of Cypress Lawn, which is both a historically significant example of the "memorial park" style of cemetery, with "[l]awns as the main natural feature," and also includes among Colma's cemeteries "the greatest concentration of San Francisco's elite."[76] The DEIR also documents that Cypress Lawn and other cemeteries in Colma are eligible for inclusion on the National Register.[77] CR-2

The DEIR does not acknowledge, however, that Cypress Lawn's historic importance is inextricably linked to its lawn-dominated, irrigated landscape. As identified in the Historical Resources Element of the General Plan of the Town of Colma, Cypress Lawn is eligible for listing on the National Register as a historic district with distinctive design features, representing an "Elite Garden Cemetery, Memorial Park," not just an isolated landmark or building.[78] Cypress Lawn, as described in the Historical Resources Element, combines on its east side "one of the last rural grand cemeteries built in the west. ... In the 19th century rural cemeteries were considered pleasure gardens and not just a place for the dead" with, on its "west side ... the design period of memorial parks."[79] Clearly, Cypress Lawn's ability to maintain the turf-

[76] DEIR, pp. 5.5-15 – 5.5-16.

[77] DEIR, p. 5.5-29.

[78] Town of Colma General Plan, p. 5.08.14. The Historic Resources Element of the Town of Colma's General Plan is attached hereto as **Exhibit E** and incorporated herein by this reference.

[79] *Id.*, p. 5.8.15.

dominated landscape that comprises the historically significant setting for the 21 separately identified resources in this historic district is critical to preventing significant impacts to these historic resources. And yet, as with the aesthetics analysis, the DEIR narrowly confines it analysis to the impacts of isolated GSR Project facilities. The reasonably foreseeable impacts of an interruption or reduction in Cypress Lawn's groundwater supplies for overlying irrigation on Cypress Lawn's significance as a historical district must be analyzed in the DEIR.[80] In particular, the effects of irrigation interruptions and/or reductions on Cypress Lawn's significance as a historical resource with distinctive design features representing a 19th century rural garden cemetery and memorial park must be analyzed pursuant to Guidelines Section 15064.5. CR-2 Cont.

The DEIR must also be revised to analyze the impact of subsidence, discussed *supra*, on the historic resource value of structures at Cypress Lawn and other cemeteries in Colma. HY-23

E. **The Conclusion of No Significant Greenhouse Gas Impacts Form GSR Project Operation Is Not Supported By Substantial Evidence.**

The DEIR's description of "[i]ndirect operation-related [greenhouse gas, or GHG] emissions includ[ing] the use of electricity for operation of Project" facilities does not include the increased electricity needed to operate overlying irrigators' wells due to the lowering of the groundwater level caused by the GSR Project.[81] This despite the fact that Mitigation Measure M-HY-6 expressly contemplates that pumps in the wells of existing irrigators may be lowered as a "mitigation action."[82] The DEIR must be revised to include this additional electricity demand directly resulting from operation of the GSR Project. GG-1

In addition, the following statement appears to assert that the SFPUC has a dedicated electricity transmission system to serve all of the GSR Project facilities: GG-2

> Furthermore, the electricity required to supply the new well facilities would be supplied by the SFPUC Power Enterprise from facilities at Hetch Hetchy. Generation of this electricity does not cause GHG emissions because the power is generated by hydroelectric facilities.[83]

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[80] Guidelines § 15126.2 (a). Indirect effects are defined as "a physical change in the environment which is not immediately related to the project, but which is caused indirectly by the project." Guidelines 15064 (d) (2). Effects of a project that must be analyzed in an EIR include "[i]ndirect or secondary effects which are caused by the project and are later in time or farther removed in distance, but are still reasonably foreseeable." Guidelines § 15358 (a) (2). *See El Dorado Union High School District v. City of Placerville* (1983) 144 Cal.App.3d 123, 133.
[81] DEIR, p. 5.9-10.
[82] DEIR, p. 5-16-96.
[83] DEIR, p. 5.9-10.

However, nowhere does the DEIR analyze the construction of this dedicated transmission system to supply electricity to the GSR Project wells. A diagram of the SFPUC Power Enterprise facilities available at the SFPUC website states that "Hetch Hetchy energy enters the electricity grid at the Newark Substation."[84] Thus, it appears that the GSR Project facilities will draw from the existing transmission system, and therefore the electricity supplying the GSR Project (as well as the electricity necessary to supply increased pumping by overlying irrigators impacted by the Project) will come from sources including those that create GHG emissions. The DEIR must be revised to quantify these emissions. GG-2 Cont.

IV. Alternative 3B, While Still Problematic, is Superior to the Proposed GSR Project.

Alternative 3B is superior to the proposed GSR Project because it would reduce localized impacts to existing irrigators and it would result in reduced depletion of the Aquifer during take years.[85] While Alternative 3B would not satisfy the stated project objective of increasing the dry-year and emergency pumping capacity of the SGW Basin by 7.2 mgd, this objective is unduly narrow, is inconsistent with the WSIP PEIR analysis, and may conflict with the overlying water rights of existing irrigators.[86]

Even Alternative 3B would be legally infeasible, however, because it would draw down the Aquifer to below levels that would occur without the GSR Project, thereby unlawfully interfering with superior water rights. If Mitigation Measure M-HY-6 is revised to more effectively protect the superior water rights of existing irrigators and prevent well interference, then Alternative 3B could become a feasible alternative. AL-2

Alternative 3A is also superior to the proposed GSR Project because it could reduce localized impacts to existing irrigators. However, the DEIR has not determined the extent to which redistributed pumping of 7.2 mgd could reduce these localized impacts. Further, this alternative, like the proposed GSR Project, would tend to draw down the Aquifer substantially below levels projected to occur without the GSR Project. It therefore would also conflict with existing irrigators' superior water rights and would interfere with their wells.

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[84] http://sfwater.org/modules/showdocument.aspx?documentid=3152, a copy of this diagram is attached hereto as **Exhibit F** and incorporated by this reference.

[85] *See* DEIR, pp. 7-30 – 7-31.

[86] As stated previously, the WSIP anticipated that groundwater pumping capacity of the GSR Project would be approximately 6.0 mgd during take years. *See* WSIP PEIR, p. 3-39. The DEIR does not explain how this capacity could have been substantially increased to 7.2 mgd. If this project objective was consistent with the WSIP PEIR estimate of 6.0 mgd pumping capacity, then Alternative 3B would fully meet all project objectives.

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V. CONCLUSION

For all of the reasons set forth above, the DEIR is inadequate under CEQA and must be substantially revised. Given the critical and pervasive conceptual, definitional and analytical defects in the document, and the scope of the revisions necessary, it is likely that recirculation will be warranted as well pursuant to Public Resources Code Section 21092.1 and Guidelines Section 15088.5. GC-3

Sincerely,

Deborah E. Quick

cc: Mr. Kenneth Varner
Barry H. Epstein, Esq.

EXHIBIT A

Exhibit A

O-CLMP-QUICK cont

June 11, 2013

Sarah B. Jones, Acting Environmental Review Officer
Timothy Johnston, Lead Planner
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103-2479

Re: Comments Regarding the Draft Environmental Impact Report for the Regional Groundwater Storage and Recovery Project

Dear Ms. Jones and Mr. Johnston:

Daniel B. Stephens & Associates, Inc. (DBS&A) is pleased to provide our comments regarding the subject draft environmental impact report (DEIR) on the behalf of Cypress Lawn Memorial Park (Cypress Lawn). GC-1

Summary

As further explained below, the Regional Groundwater Storage and Recovery Project (GSR Project) DEIR prepared by the San Francisco Public Utilities Commission (SFPUC) is incomplete in several areas. For example, the DEIR lacks: HY-2

- A fundamental physical characterization of the Westside Basin, including the definition of basin characteristics that would allow an accurate and verifiable analysis of the potential for salt water intrusion along the bayside of the aquifer, regional and localized subsidence impacts caused by planned water level drawdowns during take years, and potential interference with third-party wells.
- A full description of baseline conditions for the Westside Basin—necessary baseline potentiometric or water table maps for the Westside Basin are missing. HY-2
- Water quality parameters, typically used to evaluate salt water intrusion. HY-27
- Verifiable projections for the groundwater model used to determine GSR Project impacts. OV-4
- A clear description of the Storage Accounting methods used to evaluate when the SFPUC can remove water in storage (take periods)—instead, take periods are summarily projected to reduce water level elevations below historical conditions and result in unavoidable impacts to many of the irrigators' wells, including those owned and operated by Cypress Lawn. PD-16
- A clear roadmap of mitigation measures to address significant impacts to the irrigators once trigger mechanisms are observed, especially if the irrigators' wells fail either in quantity or quality. HY-15

Daniel B. Stephens & Associates, Inc.
490 Grand Avenue, Suite 110 510-444-1256
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Project Description

The following information concerning the proposed GSR Project was derived in its entirety from the DEIR, including its appendices and referenced documents. The proposed GSR Project would be located in San Mateo County and is sponsored by the SFPUC in coordination with its partner agencies, which include the cities of Daly City and San Bruno, and the California Water Service Company (Cal Water) in its South San Francisco service area (collectively referred to as Partner Agencies). The GSR Project includes operation of groundwater well facilities at 16 different locations in Daly City, Colma, South San Francisco, San Bruno, Millbrae, and in unincorporated San Mateo County.

The SFPUC is proposing a project to increase water supply reliability during dry years and in emergencies by increasing water storage in the South Westside Groundwater Basin during wet and normal years for subsequent recapture during dry years. The proposed GSR Project consists of the construction and operation of 16 new production wells and water treatment facilities to recover the stored groundwater. Each facility would include the construction of a groundwater production well and associated fenced enclosure or treatment building, distribution pipelines to connect the well to the existing regional water system or to the local distribution system, and overhead or underground utility connections. Most well facilities would provide disinfection and additional treatment (i.e., pH adjustment, fluoridation, and/or iron/manganese removal). In addition, the proposed GSR Project includes upgrades to the Westlake Pump Station to serve three new well facilities, including new fluoride, chlorine, and ammonia chemical storage tanks, replaced or upgraded chemical metering pumps, a resized transformer, and up to three new booster pumps to deliver the additional water into the Daly City distribution system, all of which would be located within the existing pump station building. PD-26

The Partner Agencies currently supply potable water to their retail customers through a combination of groundwater from the South Westside Groundwater Basin and purchase of SFPUC surface water. The GSR Project would provide supplemental SFPUC surface water to the Partner Agencies during normal and wet years. During normal and wet years, the Partner Agencies would reduce their groundwater pumping by a comparable amount to increase the amount of groundwater in storage through natural recharge during these periods; this is referred to as in-lieu recharge. During normal and wet years, the volume of groundwater in the South Westside Groundwater Basin would increase due to natural recharge and reduced groundwater pumping by the Partner Agencies. During dry years, the Partner Agencies and the SFPUC would pump the stored groundwater using 16 new facilities. This new dry-year water supply would be blended with water from the regional water system, and would thereby increase the available water supply to all regional water system customers. An Operating Agreement among the SFPUC and this Partner Agencies would guide overall groundwater management and surface water deliveries associated with the proposed Project.

According to the DEIR, there have been water level declines due to pumping beginning in the 1950s and 1960s that stabilized in the 1970s in the Daly City, South San Francisco, and Northern

San Bruno areas. The pumping and associated water level declines resulted in 75,000 acre-feet (af) of vacated water storage. During normal and wet years, when water would be stored in the groundwater basin (put periods), the SFPUC could require the Partner Agencies to accept delivery of up to 5.52 million gallons per day (mgd) (16.9 acre-feet per day [afd]) of regional water system water in lieu of pumping a like amount of groundwater from their existing facilities. As a result of the in-lieu deliveries, up to 60,500 af of groundwater storage or put credits could accrue to the SFPUC storage account during an 8.5-year accounting period. During shortages of SFPUC system water due to drought, emergencies, or scheduled maintenance, the Partner Agencies would return to pumping from their existing wells. In addition, the SFPUC and the Partner Agencies would pump groundwater using the new wells installed by the SFPUC as part of the proposed Project (take periods) and deduct the volumes from the SFPUC storage account, at a maximum annual volume of 8,100 af withdrawn at an average rate of 7.2 mgd (22.1 afd) for up to 8.5 years. The SFPUC would not direct pumping during these take periods unless a positive balance exists in the SFPUC storage account. When the SFPUC storage account is full, defined as 60,500 af, but there is no shortage requiring the SFPUC to pump groundwater from Project wells (hold periods), pumping could not exceed 7.6 mgd (23.3 afd) in any year of the 5-year averaging period under the terms of the proposed Operating Agreement. PD-26 cont.

The DEIR found that implementation of the proposed GSR Project would lead to significant unavoidable construction-related land use, noise, and aesthetics impacts, and potential operations-related existing irrigators' well interference impacts. The GSR Project well facilities and sites contain no known hazardous materials as defined under Section 35962.5 of the Government Code. GC-1

Questions and Comments Related to Identified Impacts

The following questions and comments are related to Identified Project Operational Impacts and Operational Cumulative Impacts.

Impact HY-6: Project operation would decrease the production rate of existing nearby irrigation wells due to localized groundwater drawdown within the Westside Groundwater Basin such that existing or planned land use(s) may not be fully supported. HY-15

Item 1 – What is the definition of "Significant Well Interference" and why are GSR Project water levels at the end of take periods so deep?

Please clarify the definition of "significant well interference." Well interference can result from overlapping cones of depression from multiply wells (both from project wells and more than one non-project well) and interception of a barrier or recharge boundaries. This well interference will increase pumping water level depths resulting in deeper pumping water levels and increased pumping costs, and will potentially accelerate premature wear of existing irrigators' wells.

During the take periods, the water levels in the vicinity of the GSR Project wells and non-project wells will be significantly below existing and historical elevations. This will impact non-project HY-15 wells and discharges and may also shorten the lifespan of the wells, even though, according to the DEIR, only banked water is pumped. Please explain why water levels would be drawn down so low at the end of take periods, reconciling the seemingly inconsistent GSR Project restriction of only using banked water. The DEIR should describe and analyze multiple well interferences and barrier boundary impacts. HY-15 cont.

Item 2 – How will barrier boundaries along the southwest and northeast basin perimeters impact the DEIR estimates of well interference, both for the Partner Agencies' wells and those of the irrigators?

Pumping interference was based on estimates (using the Theis method) that do not recognize the potential for the cone of depression encountering a barrier boundary (impermeable sides of the aquifer). While the DEIR acknowledges that the Theis method used to predict drawdowns does not account for recharge, it asserts that the approach provides a conservative estimate. The approach is not conservative, however, because the DEIR does not acknowledge that when the cone of depression encounters such a barrier boundary, the drawdown accelerates and essentially doubles, producing larger drawdowns and deeper pumping water levels. The closer the well is to a barrier boundary, the sooner the cone of depression encounters it, which results in greater drawdowns during pumping, lower specific capacities, and ultimately lower pumping rates. HY-22

Thus, the use of the Theis method for determining pumping interference is inappropriate for a relatively small and narrow aquifer with multiple barrier boundaries, as it tends to underestimate the interference caused by GSR Project pumping.

Item 3 – Why are the locations of the GSR Project wells so close to the location of the Partner Agencies' wells?

We note that the location of the proposed GSR Project wells are aligned along the central axis of the South Westside Basin and are parallel to the alignment of the wells of existing irrigators. We also note that the GSR Project wells are located in areas in which Partner Agencies' wells are not located. Is there any significance to this parallel arrangement? How were the locations for the GSR Project wells selected? Was interference with existing irrigators' wells a factor in selecting the location of GSR Project wells? Will the recharge that occurs due to foregone pumping by Partner Agencies' wells spread evenly across the basin, allowing equivalent pumping at the GSR Project wells? PD-4

Item 4 – Can SFPUC use Partner Agencies' wells for GSR Project pumping rather than build new ones? Has this been evaluated?

It appears that the GSR Project includes installation of production wells that could ultimately be used by some of the Partner Agencies rather than their existing wells. We understand that both the Partner Agencies' wells and the GSR Project wells will be pumped at the same time during take periods. It is unclear whether the Partner Agencies' wells will be eventually replaced by the GSR Project wells, which may even be pumped during put periods while the Partner Agencies' wells remain idle. How would this impact the projected water elevation declines? PD-11

Item 5 – Please clarify the significant level of impacts caused by interference between multi-wells pumping?

Existing irrigation wells are wells owned and operated by parties other than the Project Partner Agencies, including Cypress Lawn. During take periods (dry periods), pumping at GSR Project wells could cause groundwater levels to decline below levels that are predicted under modeled existing conditions (i.e., levels predicted to occur without operation of the Project under existing conditions considering the historic range of hydrologic and rainfall conditions). The GSR Project will deepen groundwater levels in the Westside Groundwater Basin near existing irrigation wells, resulting in unavoidable adverse effects from well interference. This interference will cause deeper water levels and irrigation water currently supplied by existing irrigation wells could be decreased to the extent that existing irrigation uses would not be fully supported. The quality of turf grass at cemeteries and golf clubs is an important and vital component of the attractiveness of these facilities and hence the long-term economic viability of these land uses. Insufficient irrigation water would result in a deterioration of existing turf grass and landscaping, affecting operating conditions at both golf clubs and cemeteries. HY-15 LU-5

Pumping at a well causes groundwater levels to decline in the area around the well. The area of groundwater level decline is known as the cone of depression. Well interference occurs when a well's cone of depression comes into contact with or overlaps the cone of depression from another well (see Figure 5.16-7 [Well Interference Schematic]) (Driscoll, 1986).

Table 5.16-11 of the DEIR shows the projected static and pumping water levels at the end of the design drought at the existing irrigators' wells, when the greatest groundwater level decreases would be expected to occur. The proposed Projects are projected to decrease water level depths at Cypress Lawn Wells 3 and 4 by 95 and 98 feet, respectively. Table 3 in Appendix H7 indicates that the top of the screen in Well 4 is 330 feet and the pumping water level is only 8 feet higher, at 322 feet. Not only would the water table drop below the top of the screen, but a significant portion of the screen would be dry under this scenario. Lowering the water level below the top of the screen will result in cascading water, which will entrain air and promote cavitation of the pump and premature wear of the pump and well. The wear of the pump will result in lower pumping rates and increased costs for operation, including more frequent pump replacements. Premature clogging and wear of the well may occur with the water and air mixture caused by cascading water and by pump cavitation. Deeper pumping water levels will change the operating splash zone between the static water level and the pumping water level and may impact water quality and well longevity. HY-11

Item 6 – Please provide estimates of the reduction in discharge capacity that will occur at the Cypress Lawn wells?

The DEIR states that "Project pumping and resulting groundwater level decreases at the end of the design drought are projected to affect the pump discharge rates of existing irrigators' wells as shown in Table 5.16-12 (Estimated Pump Discharge Rate at the End of the Design Drought)." No information related to reduction in discharge capacity is provided that relates to the Cypress HY-21

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Lawn wells, but based on the decrease of water level depths of approximately 90 feet of screen at Well 4, it can be assumed that reduction in discharge capacity of this well would be significant. Please quantify the reduction in discharge rates with increased drawdowns (lower specific capacity), the increased energy required to operate pumps under these circumstances, the estimated reduction in pump life, and the impacts to well longevity, water quality, and local aquifer stability.

HY-21 cont.

Item 7 – The alternate scenario considered in the DEIR increases drawdowns in the Colma and South San Francisco Area. Will the SFPUC replace the Cypress Lawn wells if water level elevations are significantly lower? Will SFPUC replace the pumps because of premature wear due to cascading water or because of, other unknown or unanticipated impacts?

To evaluate the well interference impacts of operating at the three alternate well sites, the DEIR analysis assumed that 16 wells would be operated, including Sites 17 (Alternate), 18 (Alternate), and 19 (Alternate). The DEIR states that the alternate well configuration would reduce drawdowns in the Daly City and San Bruno areas and increase drawdowns in the Colma and South San Francisco area (Fugro, 2012a). Using the alternate well sites, including one on the corner of the Cypress Lawn's property, the SFPUC has acknowledged that drawdown in the wells will be even greater than the 95 and 98 feet presented in Table 5.16-11 of the DEIR. The impact to the Cypress Lawn wells will be even greater than the significant impacts already predicted. A drawdown of 95 or 98 feet will leave nearly half of the screen interval in Cypress Lawn Well 4 above the water table. As the SFPUC has already acknowledged, this not only reduces the production capability of the well, but accelerates well degradation and the need for repairs and/or replacement. In light of these issues and should the need arise, one or more of the following mitigation measures may need to be conducted by SFPUC to correct damages to the Cypress Lawn wells: replace the well, deepen the well, lower the pumps, replace the pumps, conduct well rehabilitation, and treat water quality changes due to the GSR Project.

HY-11

Item 8 – Can well interference impacts caused by the GSR Project be avoided or reduced to less-than-significant levels if the GSR Project wells are at other locations or at reduced well yields?

The planned mitigation measure M-HY-6 requires a monitoring program at the existing irrigators' wells to provide data to determine if the performance standard is being met and proposes requiring analysis of monitoring data twice a year during take periods (i.e., when Project wells are regularly pumping) to determine whether or not reduced pumping capacities at existing irrigation wells are found to occur as a result of the Project. This requires extensive cooperation between irrigators and the SFPUC that includes access to property and records that is not currently required.

Although SFPUC is planning on collecting the information, that data collection will require extensive efforts and cost by the irrigators. Who will pay for that? How can it be assured that this will not interfere with current uses? Water levels should be collected at least every month (even weekly, daily or continuously) rather than twice per year to evaluate dynamic water level changes. The results of monitoring should be reported regularly to the existing irrigators, as well

HY-12

as to the SFPUC, the San Francisco Planning Department's Environmental Review Officer (ERO), and Partner Agencies. This monitoring program frequency should continue for at least two GSR Project operating cycles of 8.5 years, or 17 years, to build up a reliable, meaningful and significant baseline dataset that can be used to predict future responses. Data should be evaluated monthly during take periods to alert SFPUC, the ERO, Partner Agencies and existing irrigators of any unanticipated water level trends and corresponding model predictions that could significantly impact the outcome of the GSR Project. During the course of the GSR Project, if sufficient data are collected to demonstrate the predicted responses from the model then the baseline years could be shortened. HY-12 cont.

Item 9 – The performance Standard is based on existing or planned land use – Planned use is planned by whom? How does this use need to be formulated and documented?

The DEIR Performance Standard indicates that the SFPUC will ensure that the production capacity at existing irrigators' wells is equivalent to the existing production capacity of the wells or is sufficient to meet existing and planned peak irrigation demand at the land use, whichever is greater, provided that the loss of capacity at the existing irrigators' wells is reasonably expected to have been caused by the GSR Project. HY-10

The DEIR should account for currently unknown changes to the land uses supported by the existing irrigators' wells. As it stands, the DEIR only protects the uses that are known now, but the existing irrigators have the right to use groundwater to support their beneficial uses going forward, and the GSR Project must be tailored to account for this right and not interfere with it. HY-9

One currently unknown factor that will affect future uses is the change that will come with climate change. We know that climate change will have an impact on water availability and demand, but how severe that impact will be in the region is not known with certainty. How will climate change impact peak irrigation demand for existing and planned peak irrigation demand? How are those impacts accounted for in the analysis of what is an existing or planned use? HY-19

Item 10 – What is the method for determining whether loss of pumping capacity at an existing irrigation well(s) is due to the GSR Project?

According to the DEIR:

> Any loss in production capacity of an existing irrigation well(s) is assumed to be caused by the Project if: 1) it is temporally correlated with the onset of increased GSR Project pumping; 2) it occurs in an area predicted in this DEIR to be affected by well interference; 3) static groundwater levels have dropped; 4) pumping groundwater levels have not dropped more than static groundwater levels (if pumping groundwater levels drop more than static groundwater levels it could indicate the drop in production capacity is due to increased well inefficiency and not due to the Project); or 5) no other obvious reason exists for the drop in production capacity. If another reason is identified, it will be based on the written professional opinion of a certified hydrogeologist or professional engineer with expertise in groundwater hydrology that will be submitted to the ERO, or designee, for review and concurrence. The ERO may require the SFPUC to hire an independent expert to advise the ERO.

HY-15

This assumes that the model is good and reflects current conditions. However, the model is based on a hypothetical precipitation history, not reality. There are no comparisons of the model predictions for existing conditions and the actual current conditions (i.e., water levels) presented in the DEIR. It is assumed that well inefficiencies would have occurred without the GSR Project; however, as the DEIR pointed out, an exposed screen can lead to accelerated deterioration of the well and resulting well inefficiency. Well efficiency can be accelerated with (1) deeper water levels that reduce the saturated thickness of the aquifer promoting greater screen entrance velocities to maintain the desired discharges, (2) cascading water, and (3) other changes to the dynamics of well. HY-15 cont.

Item 11 – The ultimate decision as to whether increased well inefficiency is the result of the GSR Project should be made by a neutral, disinterested party, not the SFPUC.

The ultimate determination as to whether increased well inefficiency from well interference is the result of the GSR Project is placed in the hands of the SFPUC, not an independent entity. In the event that a conflict arises, the SFPUC would be both in the position of being one of the parties to the conflict and the decision maker, an unfair position relative to any of the irrigators. The requirement that the loss of capacity must be caused by the GSR Project places an immense burden on the existing irrigators to prove that failures are the result of the SFPUC's activities, which are predicted to have a significant impact on water levels and well capacity. This will lead to an ongoing need for costly legal and technical assistance that is not currently required in order to make that showing. Instead, the SFPUC should provide all of its well monitoring data and reports to the existing irrigators, and the determination regarding whether the GSR Project is interfering with existing irrigators' wells should be made by a neutral, disinterested party. HY-17

Impact HY-7: Project operation would not result in substantial land subsidence due to decreased groundwater levels in the Westside Groundwater Basin where the historical low water levels are exceeded.

Item 12 – Has land subsidence been fully evaluated for the Westside Basin?

Land subsidence and the associated negative effects are a serious potential impact in most groundwater basins that pump groundwater. Subsidence impacts can be localized around a well or more regional in nature. Impacts can disrupt ground surface elevations and affect major, costly, and vital infrastructure, including roads, aqueducts, pipelines, subsurface and surface utilities, buildings and house foundations, etc. In general, subsidence occurs when water levels decline, which results in removal of groundwater stored in fine-grained sediments in the units that overlie the saturated zone. The sediments become more consolidated (compacted), disrupting ground surface elevations and eliminating pore space that can be resaturated. The amount of subsidence is related to the total thickness of fine-grained sediments exposed. Hence, the thicker the fine-grained sediments in an area of a groundwater basin, the more likely that significant subsidence will occur. HY-23

GSR Project over-pumping the groundwater basin resulting in 100 or 200 feet of drawdown with significant fine-grained sediments will only increase the odds that subsidence will occur. There

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may be a time-lag of years between when pumping occurs and subsidence is first observed. The state of California is replete with examples of subsidence and its negative impacts (Antelope Valley, Santa Clara Valley, Central Valley, etc.). The best way to avoid these significant subsidence impacts is to prevent subsidence in the first place by restricting pumping so that water levels do not decline below current average levels. Once subsidence occurs there may be few engineering platforms to resolve the impacts. HY-23 cont.

<u>*Item 13 – Why wasn't a subsidence silt/clay isopach/thickness map included in the DEIR?*</u>

The amount of subsidence depends largely upon the amount of dewatered fine-grained sediments. A regional isopach map that shows the percent clay and fine-grained sediments would be used to evaluate potential regional subsidence. We recognize that the potential maximum drawdown and associated exposed fine-grained sediments will be located near the project and irrigator wells. However, other areas of the Westside Groundwater Basin (particularly the bayside area) may observe potentially greater subsidence impacts because of the larger thickness of fine-grained sediments. HY-26

Without a regional isopach map that depicts the percent of clay and fine-grained sediments that the DEIR's analysis based its subsidence estimates on, it is not possible to confirm whether the predicted levels of subsidence are reasonably accurate.

Lambe and Whitman (1969) state that the amount of settlement a structure can tolerate, or the allowable settlement or permissible settlement, depends on many factors including the type, size, location, and intended use of the structure, and the pattern, rate, cause, and source of settlement. They point out that there is a wide disparity of observed results and views as to allowable subsidence or settlements and that this illustrates the difficulty in establishing an allowable level of subsidence or settlement. According to Lambe and Whitman (1969) masonry, framed structures, structural mats and smokestacks can be damaged by subsidence or settlement of as little as 1 to 3 inches. The DEIR presented estimates of subsidence resulting from GSR Project operations for three locations that range between 1 and 3.4 inches, within the range that Lambe and Whitman indicate could be problematic for various structures. How will this subsidence be mitigated? HY-25

Impact HY-8: Project operation would not result in seawater intrusion due to decreased groundwater levels in the Westside Groundwater Basin.

<u>*Item 14 – Please provide additional analysis and information on water quality parameters as it relates to seawater intrusion and agricultural use?*</u>

The evaluation of water quality parameters is not discussed thoroughly in the DEIR. Elevated total dissolved solids (TDS) concentrations above background can provide information on the location of the freshwater/salt water interface and any impending impacts. Kirker Chapman and Associates (1972) used chloride-bicarbonate ratios to evaluate whether seawater intrusion had occurred in the basin. The water quality discussion in the DEIR focused on drinking water standards; there was no discussion on irrigation water quality requirements. Because irrigation HY-27 water will not be treated or mixed with surface water before being applied to lawns and landscaped areas, it is critically important that the DEIR evaluate the risk of seawater intrusion into the aquifer. HY-27 cont.

Item 15 – Why did the DEIR not include an analysis of current and projected changes in salinity? Why was modeling of water quality not included in this analysis? Will future analysis include analysis of actual and modeled water quality impacts? If there is unforeseen seawater intrusion, how will it be mitigated?

A standard measurement or evaluation of seawater intrusion includes an evaluation of water quality, including but not limited to chloride and TDS concentrations of the groundwater to a standard that is considered to be representative of seawater intrusion. Different studies have used varying concentrations of chloride as an indicator of seawater intrusion. It appears that the DEIR is using the secondary maximum contaminant level (MCL) for chloride (250 milligrams per liter [mg/L]). HY-27

The DEIR analysis related to the potential impact of seawater intrusion does not include analysis based on water quality, but is based solely on measurements and modeling of water level changes near the coastline. The Westside Basin is bounded at least in part on the west by the Pacific Ocean and on the east by the San Francisco Bay. Seawater intrusion is a very real and important threat to water quality in the Project area. The description and characterization of the southwest side of the basin (south and west of Lake Merced) was poorly described in relationship to the potential seawater intrusion. The bayside portion is poorly defined and described.

Item 16 – How does the location and shape of the fresh-salt water interface vary during basin operations?

"When an aquifer contains an underlying layer of saline water and is pumped by a well penetrating only the upper fresh water portion of the aquifer, a local rise of the interface below the well occurs; this is referred to as up-coning" (Todd, 1980). The description of the position of the toe of the freshwater/salt water interface, rather than water level elevation changes, is needed in order to understand and address up-coning issues. HY-28

Up-coning was not addressed in the DEIR. This gap in the analysis should be corrected. HY-28

Item 17 – Why was the average water level used (DEIR, page 5.16-109, 4th paragraph) to evaluate the movement of the fresh-salt water interface rather than the worst-case scenario?

The average water level change predicted from the model does not provide the maximum potential impact from the proposed GSR Project. The maximum drawdown or minimum water level elevation near the coastline and the duration of this low water level would be more appropriate measures to evaluate the impacts for the project. Water levels that are below sea level and near the coast would produce significant inland movement of the freshwater/salt water interface and potential up-coning impacts resulting from GSR Project well pumping. HY-30

O-CLMP-QUICK cont

Impact HY-12: Project operation would not cause a violation of water quality standards due to mobilization of contaminants in groundwater from changing groundwater levels in the Westside Groundwater Basin.

Item 18 – Is water stratified as the GSR Project draws down the aquifer water level?

In general, the water quality for many aquifers is naturally stratified, resulting in the increase of TDS concentration with depth. In addition, anthropogenic industrial, urban, and domestic activities have resulted in impacts by volatile organic compounds and nitrates to the shallow aquifers.

HY-35

The DEIR did not fully discuss water quality stratification of the underlying aquifers, potential remobilization of existing contaminants by increasing the water table, or lowering the water table that could result in salt water intrusion. Nested wells have been installed in selected areas of the groundwater basin near proposed GSR Project wells. Are there other areas in which nested wells should be installed to evaluate existing contaminant plumes or to evaluate the freshwater/salt water interface?

Item 19 – Will up-coning result in the increase of TDS concentrations in the lower portions of the Westside Basin aquifer? How will increases in TDS concentrations is if it occurs in non-GSR Project wells be mitigated?

Up-coning can result in contaminating the deeper parts of the aquifer tapped by existing irrigator wells with additional salts, resulting in greater TDS concentrations. Because of the dynamic operation for the groundwater basin by SFPUC, water quality should be analyzed and evaluated annually from non-GSR Project wells. Water quality parameters that should be monitored annually including major cations (magnesium, calcium, sodium, and potassium), major anions (sulfate, chloride, and bicarbonate), minor ions (iron, manganese, fluoride, nitrogen species, and boron), and physical properties (total alkalinity, pH, total hardness, electrical conductivity, TDS, turbidity, color, and odor, and MBAS).

HY-28

Item 20 – Will the general public accept the water quality changes that result from drinking water that is a blend of Hetch Hetchy surface water and Westside Basin groundwater? Will the switch to groundwater affect water conveyance infrastructure or inside household fixtures?

Typically, groundwater has greater TDS concentrations than surface water. The higher TDS concentrations in groundwater result from the close and long-term contact to aquifer materials. The DEIR does not disclose or address the difference in drinking water quality that the SFPUC will provide as a consequence of the GSR Project, or its implications to water distribution infrastructure and to customers.

AE-7

Item 21 – How will potential water quality degradation impact the irrigators? How will that degradation be mitigated? What happens if and when contaminated water is used to irrigate and surficial soils and associated storm water are impacted by the contamination?

The DEIR states that the operation of the Project could violate water quality standards or waste discharge requirements if the groundwater pumped as part of the Project, after proposed treatment and/or blending would not meet drinking water standards. The DEIR discusses that although there is known contamination within the Westside Basin, the treatment of water used by the SFPUC and Partner Agencies to serve to the public will result in minimal degradation of water quality. There are a number of other known water users in the Project area, including the irrigators, who will not have the same benefit. The DEIR must analyze and mitigate the impacts to water quality that will be felt by those who use the aquifer and do not treat the water they pump. HY-39

Impact HY-13: Project operation would not result in degradation of drinking water quality or groundwater quality relative to constituents for which standards do not exist.

See comments and questions discussed above under Impact HY-12. HY-35

Impact HY-14: Project operation may have a substantial adverse effect on groundwater depletion in the Westside Groundwater Basin over the very long term.

Item 22 – Why is the Basin Safe Yield not discussed in the DEIR? Why would the short-term and long-term projected water levels change if the Project and Partner Agencies did not exceed the basin Safe Yield?

Kirker Chapman (1972) reports an annual safe yield of about 2,050 million gallons, or 6,300 af. Section 1.4.4 Project Operations states "Under the Project, the SFPUC and Partner Agencies would operate the 16 new well facilities with an annual average pumping capacity of 7.2 million gallons per day (equivalent to 8,100 acre-feet [af] per year) to provide a supplemental dry-year water supply. During dry-year conditions, Partner Agencies would also pump from their own existing wells up to annual average rates consistent with the pumping limitations expressed in the proposed Operating Agreement between the SFPUC and the Partner Agencies, as explained later in this section." This would imply that the GSR Project plans to pump about 8,100 acre-feet per year (afy) during take periods in addition to a 0.06 mgd increase in pumping by the Partner Agencies from 6.84 mgd to 6.90 mgd—hence, the significant drop in water levels. HY-42

The DEIR must be revised to address the basin's safe yield and discuss how the GSR Project and Partner Agencies' pumping relates to that yield.

Impact C-HY-2: Operation of the proposed Project would result in a cumulatively considerable contribution to cumulative impacts related to well interference.

See comments and questions discussed above under Impact HY-6. HY-15

Impact C-HY-3: Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to subsidence. HY-23

See comments and questions discussed above under Impact HY-7

Impact C-HY-4: Operation of the proposed Project would not have a cumulatively considerable contribution to seawater intrusion. HY-29

See comments and questions discussed above under Impact HY-8.

Impact C-HY-6: Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to water quality standards. HY-35

See comments and questions discussed above under Impact HY-12.

Impact C-HY-7: Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to water quality degradation. HY-35

See comments and questions discussed above under Impact HY-12.

Impact C-HY-8: Operation of the proposed Project would have a cumulatively considerable contribution to a cumulative impact related to groundwater depletion effect. HY-49

See comments and questions discussed above under Impact HY-14.

Questions and Comments Related to Other Issues

The following questions and comments are general in nature.

Item 23 –What will the redistribution of pumpage throughout the basin be locally and regionally? HY-46

The DEIR placed significant discussion on the local impacts to water level drawdowns to non-project wells but what are the more regional impacts to water levels? Given the quantity and timing of the take period, the redistribution of pumpage would significantly lower the regional water table elevations, affecting all groundwater pumpers in the Westside Basin.

Item 24 – The SFPUC acknowledges significant adverse impacts.

The DEIR and associated appendices describe the regional hydrogeologic system of the Westside Basin. The potential impacts have been acknowledged but are poorly understood and described. For example, salt water intrusion, subsidence, well interference, and contaminant redistribution and remobilization have been described in general terms, but the discussion presented in the DEIR lacks details on monitoring and mitigation measures. HY-15 HY-53

Item 25 – North Westside Basin and South Westside Basin are discussed inconsistently.

There appears to be a hydrological boundary (groundwater divide) between the North Westside and South Westside Basins, but this was not clearly discussed in the DEIR. We realize that discussion of the entire groundwater basin is needed to put the GSR Project into context. However, once the groundwater divide between the North Westside and South Westside Basins is defined, the South Westside Basin can be discussed separately. There is a significant amount of emphasis and discussion on the North Westside Basin, while most of the GSR Project operations and impacts are in the South Westside Basin. For example, the DEIR has a lengthy discussion on salt water intrusion in the North Westside Basin and significantly less discussion on the potential for bayside salt water intrusion; this may be because the freshwater/salt water interface on the Pacific Ocean side is much better defined than on the bayside of the Westside Groundwater Basin. That, however, is not a valid reason for failing to include the appropriate level of information and analysis with respect to the South Westside Basin. HY-1

Item 26 – Is the accounting system appropriate and sufficient for ensuring that the aquifers in the Westside Basin are not depleted and that current and planned water uses remain viable? Will the groundwater monitoring program be sufficient to identify years that should be take periods? HY-48

The water level and pumpage monitoring data are keys to the success of the GSR Project, as well as for the protection of existing irrigators. Biannual water level monitoring is insufficient to predict short-term impacts. Water level data should be collected on a monthly (even weekly, daily or continuous) basis and should include both non-pumping and pumping water levels. Water level and pumpage data should be collected using standard protocols developed for the GSR Project. Pumpage data should be collected weekly and include both volumes of water pumped from the wells and elapsed time of pumping. In addition, the volume of surface water used in lieu of groundwater will need to be recorded on a regular basis. The shorter the monitoring intervals, the more meaningful and useful they will be to predict future impacts. Water level trends and pumpage volumes should be analyzed on a monthly basis during take periods to determine if any of the mitigation measures are triggered. The monitoring data and reports should be provided to all interested stakeholders, including the Partner Agencies and existing irrigators. PD-12 Operating periods have been defined as 8.5 years, but we believe that the appropriate operating period is twice that, or 17 years, to build up a reliable, meaningful, and significant baseline dataset that can be used to predict future responses. PD-12 During the course of the GSR Project, if sufficient data are collected to demonstrate the predicted responses from the model then the baseline years could be shortened. PD-12

Item 27 – Is there a possible loss of water as rejected recharge? How is the SFPUC going to perform their accounting of water stored during take periods? Will it reflect actual water increases or will it only reflect reductions in pumping levels? How will it account for water lost to the ocean or leaving the areas of recharge? PD-16

The SFPUC plans to provide surface water to the Partner Agencies in lieu of the Partner Agencies' pumping groundwater from their wells. During put periods (i.e., years with reduced pumpage by Partner Agencies) the GSR Project counts on natural groundwater recharge to restore water levels in the groundwater basin. This really involves the SFPUC "borrowing" (appropriating) water during dry take periods that are well in excess of what was banked via the "forgone" pumping, and then (over time) paying this "borrowed water" back during wet or normal put periods. Yet, during this "payback" period when the groundwater table has plummeted, irrigators, including Cypress Lawn and other overlying landowners, are left with excessive drawdowns of the groundwater in the Westside Basin and all of the impacts on current and planned operations associated with the reduced water elevations. PD-16 cont.

Item 28 – Will the water accounting method for the Partners Agencies be clear and concise and provide the necessary information for the Storage Account?

Forgone pumpage must be clearly documented on a regular and consistent basis. Unclear or incomplete records will only need to be rectified by estimating from other methods. If needed, who will retrofit the Partner Agencies' and existing irrigators' wells to allow reliable water level measurements and pumpage volumes? PD-16

Item 29 – Is there sufficient availability of precipitation for the groundwater recharge that is assumed during the Put Periods?

The DEIR reports that there is an average of 22 inches per year of rainfall over the Westside Basin, which is 45 square miles, or an average of 52,800 afy of rainfall. The DEIR assumes that 8,000 afy will be banked during put periods, or 15 percent of the total rainfall. Is this recharge sufficient for the GSR Project to be water budget neutral? PD-17

Item 30 – Should GSR Project wells be screened and sealed based on the hydrogeology at each of their individual locations?

The DEIR indicates that all Project wells will be sealed at 50 feet bgs. The hydrogeology of the individual wells is likely to vary significantly as indicated in the DEIR, and the well construction including screening intervals and wells seals should be based on the hydrogeology and conditions at each well location. PD-20

Item 31 – Why does the DEIR not include additional cross sections that are perpendicular to the single one included in the DEIR to better depict the geology? Is the single cross section an accurate depiction of the variability that is present in the Westside Basin?

The DEIR includes one cross section that runs the length of the Westside Basin. The Westside basin covers an extensive area and includes several faults that are significant hydrologic barriers. Cross sections perpendicular to the axial cross section will demonstrate the subsurface barrier boundaries along the northeast and southwest sides of the South Westside Basin. HY-2

Item 32 – Why were water levels not included on the cross section?

The DEIR discusses the water level variability across the Westside Basin and between the various aquifers. It would be very useful to see how measured water levels do in fact vary across the basin and between the aquifers. HY-2

Item 33 – What is the basis for the model layers? What is the basis for increased elevation in layers 2 and 3 under Lake Merced? How does this layer depiction impact modeling results?

A critical feature of the Westside Basin Groundwater Flow Model is the layering used in the model. Figure 10.1-3 overlays the Westside Basin Groundwater Flow Model structure on the single cross section of regional geology included in the DEIR. The model layers appear to be inconsistent with the regional geology that is presented. The lack of transparent and consistent information precludes careful review by the interested public. OV-4

Item 34 – What was the basis for developing subareas or model parameter zones? Would additional perpendicular cross sections help support the basis for the subareas? How do the parameters used for the distinct subareas impact the modeling results?

Each model layer in the Westside Basin Groundwater Model was divided into subareas (also referred to as parameter zones) within which aquifer parameters are assumed to be uniform. Choosing the parameters used in the model is a very important decision and has large impacts on the predictions and validity of the model. OV-4

Item 35 – How does uncertainty and lack of data impact the model results, particularly with respect to water level elevation predictions under the different scenarios?

The model subareas with the highest root-mean-square-error (RMSE) are the Colma and San Bruno subareas. The DEIR attributes this to historical water level measurement limitations, model scaling, and uncertainty in vertical hydraulic conductivity and vertical hydraulic gradients. The DEIR should acknowledge the level of uncertainty and its implications for the analysis, and should take a conservative approach at estimating impacts predicted by the model. OV-5

Item 36 – How do the modeled "existing conditions" compare to historic and current measured water levels? How do the potentiometric surfaces compare and how do the individual well records compare to modeled results?

A model is only as useful as the information that is used to construct it. The DEIR did not present actual historical and/or current water level data or rainfall data or show comparisons with actual data and the modeling results. The only hydrographs and potentiometric surfaces that are presented in the DEIR are those based on modeling using a hypothetical rainfall history. Even for the model scenario for "existing conditions", the use of the hypothetical rainfall history makes it difficult to evaluate how accurate the modeling analysis is without being able to compare it to real conditions. OV-5

Item 37 – Was a sensitivity analysis conducted? How sensitive are the modeling results to variations in the model layer configuration, the parameters used, the boundary conditions, the initial conditions, hypothetical rainfall scenario, production rates, time frame for recovering waters during the take period, and distribution of Project sites?

No modeling sensitivity analysis, which is a standard procedure in groundwater model development, was presented in the DEIR for the Westside Basin Groundwater Flow Model. The OV-5

Exhibit A

O-CLMP-QUICK cont

DEIR should be revised to report the results of a sensitivity analysis and the analysis itself should be reported in a technical appendix. OV-5 cont.

Item 38 – How well did the Westside Basin Groundwater Model results compare with measured current conditions? Are actual historical potentiometric surfaces similar to modeled potentiometric surfaces for existing conditions?

No model validation of modeled water level conditions to actual water level conditions was presented in the DEIR, as required by best practices. OV-5

Conclusion

This document provides DBS&A's comments on the DEIR based on our evaluation at this point in time. DBS&A had a limited time to review these voluminous materials. Due to these time constraints, DBS&A may have additional comments upon further evaluation of the DEIR and related materials and may supplement the comments and questions presented here. GC-1

Sincerely,

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Exhibit A

O-CLMP-QUICK
cont

Soil Mechanics

T. William Lambe • Robert V. Whitman

Massachusetts Institute of Technology

HY-26

1969

John Wiley & Sons, Inc.

New York London Sydney Toronto

Exhibit A

O-CLMP-QUICK cont

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Exhibit A

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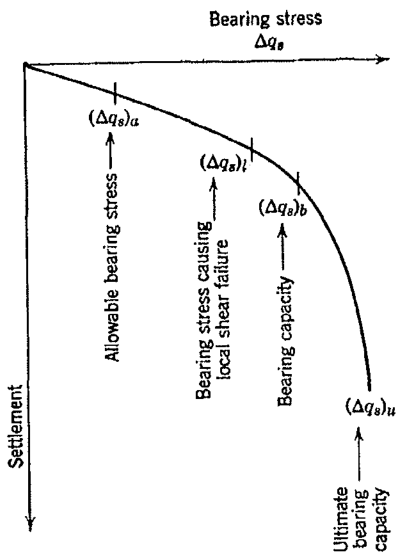


Fig. 14.5 Relationship between bearing stresses and bearing capacities.

2. Determination of the bearing capacity and the actual factor of safety under the expected load.
3. Estimation of the settlement and comparison with the permissible settlement.

In the foregoing discussion, the terms "bearing capacity" and "bearing stress" have been used in several different senses. The meaning of each of the various terms is summarized below and in Fig. 14.5.

Bearing stress Δq_s. This is the stress actually applied to the soil. In an actual foundation Δq_s must be no greater than the:

Allowable bearing stress $(\Delta q_s)_a$. The allowable bearing stress is selected after consideration of safety against instability, permissible settlement, and economy. Often $(\Delta q_s)_a$ is obtained by dividing a safety factor F into the:

Bearing capacity $(\Delta q_s)_b$. The bearing stress at which settlements begin to become very large and unpredictable because of a shear failure is the bearing capacity. Usually, $(\Delta q_s)_b$ is taken equal to the:

Bearing stress causing local shear failure $(\Delta q_s)_l$. This is the bearing stress at which the first major nonlinearity appears in the stress-settlement curve. In some carefully analyzed problems $(\Delta q_s)_b$ may exceed $(\Delta q_s)_l$. However, in any case $(\Delta q_s)_b$ must not exceed the:

Ultimate bearing capacity $(\Delta q_s)_u$. The ultimate bearing capacity is the bearing stress which causes a sudden catastrophic settlement of the foundation.

There are many problems in which $(\Delta q_s)_a$ must be less than $(\Delta q_s)_b$, owing to limitations upon settlement.

14.2 ALLOWABLE SETTLEMENT

Settlement can be important, even though no rupture is imminent, for three reasons: appearance of the structure; utility of the structure; and damage to the structure.

Settlement can detract from the appearance of a building by causing cracks in exterior masonry walls and/or the interior plaster walls. It can also cause a structure to tilt enough for the tilt to be detected by the human eye.

HY-26 cont.

Settlement can interfere with the function of a structure in a number of ways, e.g., cranes and other such equipment may not operate correctly; pumps, compressors, etc., may get out of line; and tracking units such as radar become inaccurate.

Settlement can cause a structure to fail structurally and collapse even though the factor of safety against a shear failure in the foundation is high.

Some of the various types of settlement are illustrated in Fig. 14.6. Figure 14.6*a* shows *uniform settlement*. A building with a very rigid structural mat undergoes uniform settlement. Figure 14.6*b* shows a uniform *tilt*, where the entire structure rotates. Figure 14.6*c* shows a very common situation of *nonuniform settlement*,

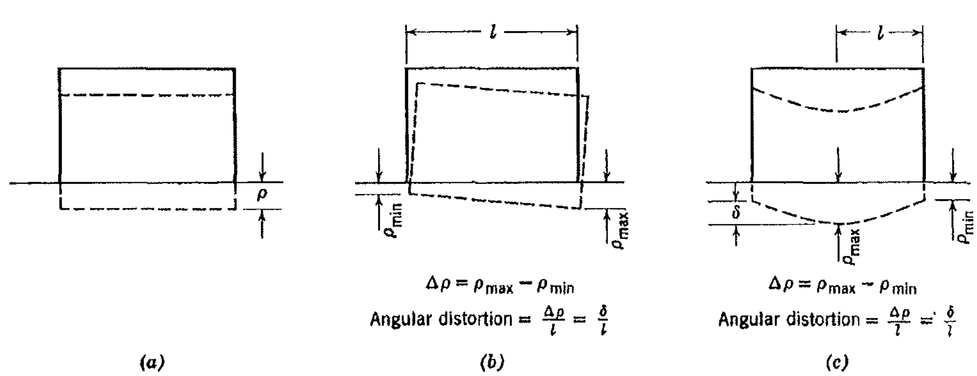


Fig. 14.6 Types of settlement. (*a*) Uniform settlement. (*b*) Tilt. (*c*) Nonuniform settlement.

Exhibit A

O-CLMP-QUICK cont

Table 14.1 Allowable Settlement

Type of Movement	Limiting Factor	Maximum Settlement
Total settlement	Drainage	6–12 in.
	Access	12–24 in.
	Probability of nonuniform settlement:	
	Masonry walled structure	1–2 in.
	Framed structures	2–4 in.
	Smokestacks, silos, mats	3–12 in.
Tilting	Stability against overturning	Depends on height and width
	Tilting of smokestacks, towers	$0.004l$
	Rolling of trucks, etc.	$0.01l$
	Stacking of goods	$0.01l$
	Machine operation-cotton loom	$0.003l$
	Machine operation-turbogenerator	$0.0002l$
	Crane rails	$0.003l$
	Drainage of floors	$0.01–0.02l$
Differential movement	High continuous brick walls	$0.0005–0.001l$
	One-story brick mill building, wall cracking	$0.001–0.002l$
	Plaster cracking (gypsum)	$0.001l$
	Reinforced-concrete building frame	$0.0025–0.004l$
	Reinforced-concrete building curtain walls	$0.003l$
	Steel frame, continuous	$0.002l$
	Simple steel frame	$0.005l$

From Sowers, 1962.
Note. l = distance between adjacent columns that settle different amounts, or between any two points that settle differently. Higher values are for regular settlements and more tolerant structures. Lower values are for irregular settlements and critical structures.

HY-26 cont.

"dishing." Nonuniform settlement can result from: (*a*) uniform stress acting upon a homogeneous soil; or (*b*) nonuniform bearing stress; or (*c*) nonhomogeneous subsoil conditions.

As shown in Fig. 14.6, ρ_{max} denotes the maximum settlement and ρ_{min} denotes the minimum settlement. The differential settlement $\Delta\rho$ between two points is the larger settlement minus the smaller. Differential settlement is also characterized by *angular distortion* δ/l, which is the differential settlement between two points divided by the horizontal distance between them.

The amount of settlement a structure can tolerate—the *allowable settlement* or *permissible settlement*—depends on many factors including the type, size, location, and intended use of the structure, and the pattern, rate, cause, and source of settlement. Table 14.1 gives one indication of allowable settlements. It might seem that the engineer designing a foundation would have the permissible settlement specified for him by the engineer who designed the structure. However, this is seldom the case and the foundation engineer frequently finds himself "in the middle" between the structural engineer who wants no settlement and the client who wants an economical foundation. Thus a foundation engineer must understand allowable settlements.

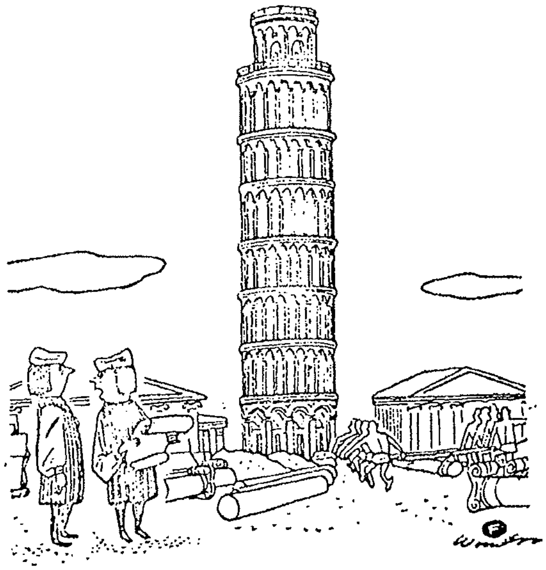
In the following paragraphs some of the salient aspects of allowable settlement are discussed and illustrated. The last portion of this section presents general guides for estimating the allowable settlement for a particular situation.

Total Settlement

Generally the magnitude of total settlement is not a critical factor but primarily a question of convenience. If the total settlement of a structure exceeds 6 to 12 in. there can be trouble with pipes (for gas, water, or sewage) connected to the structure. Connections can, however, be designed for structure settlement. Figure 1.3 shows a classic example of a building that has undergone large settlements and yet remained in service. However,

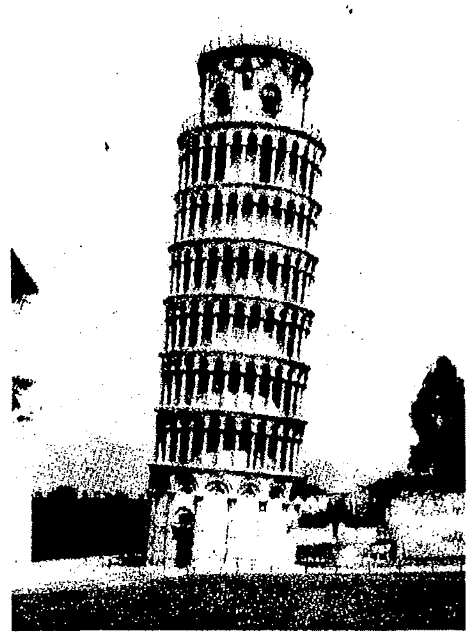
Exhibit A

O-CLMP-QUICK
cont

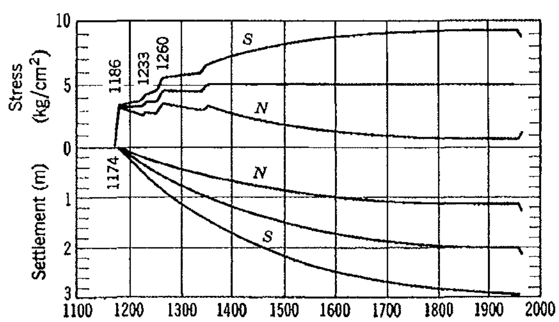


"I skimped a little on the foundation, but no one will ever know it!"

(*a*)



(*b*)



(*c*)

Fig. 14.7 The Leaning Tower of Pisa. (*a*) From 1964 ASCE Settlement Conference. (*b*) and (*c*) From Terracina, 1962.

there are situations where large total settlements can cause serious problems; e.g., a tank on soft clay near a waterfront can settle below water level.

Tilt

The classic case of tilt is the Leaning Tower of Pisa (Fig. 14.7). As can be seen from the time-settlement curve, the north side of the tower has settled a little over 1 m, whereas the south side has settled nearly 3 m, giving a differential settlement of 1.8 m. The tilt causes the bearing stress to increase on the south side of the tower, thus aggravating the situation. This much tilt in a tall building represents a potentially unstable, dangerous situation. Engineers are now studying methods to prevent further tilt (Terracina, 1962).

Nonuniform Settlement

HY-26 cont.

The allowable angular distortion in buildings has been studied by theoretical analyses, by tests on large models of structural frames, and by field observations. Figure 14.8 gives a compilation of results from such studies. An extreme case is precision tracking radars where a tilt as small as $\delta/l = 1/50{,}000$ can destroy the usefulness of the radar system.

A steel tank for the storage of fluids is a particularly interesting structure. Most of the load is from the stored fluid, and owing to the flexibility of the tank's bottom the bearing stress has a uniform distribution. The flexilibity also means that tanks can tolerate large differential settlements without damage, and owners of such tanks are seldom concerned by their appearance. Yet there is amazing disagreement among engineers, builders, and owners as to the allowable settlement of such tanks. A survey of this subject by Aldrich and Goldberg (unpublished) has revealed the following facts:

1. Tanks have settled more than 60 in. and remained in service.
2. Tanks have failed structurally as the result of settlements as small as 7 in.
3. Allowable settlements commonly used for the design of tank foundations vary from 1 to 18 in.

The wide disparity of observed results and views as to allowable settlements illustrates vividly the difficulty faced by a soil engineer in establishing an allowable settlement. Although Table 14.1 and Fig. 14.8 give good

Exhibit A

O-CLMP-QUICK cont

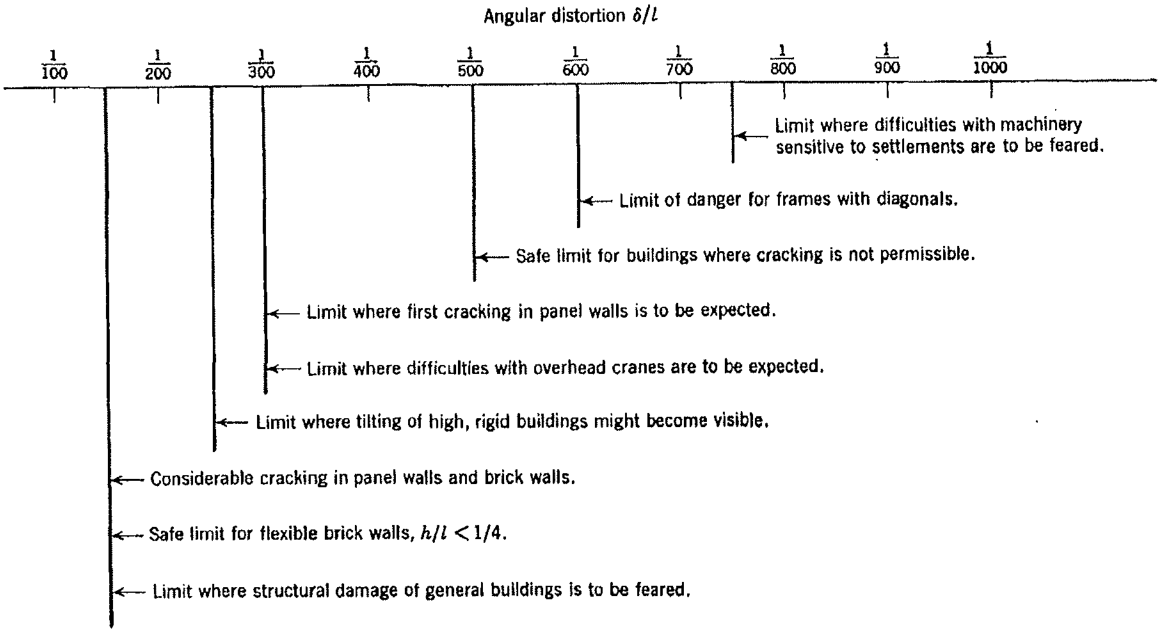


Fig. 14.8 Limiting angular distortions (From Bjerrum, 1963a).

HY-26 cont.

general guidance that will suffice for routine jobs, each large project must receive additional careful study.

Relation of Total and Differential Settlement

As stated previously, it usually is the differential settlement (rather than the total settlement) that is of concern in the designing of a foundation. On the other hand, it is much more difficult to estimate differential settlement than it is to estimate the maximum settlement. This is because the magnitude of differential settlement is affected greatly by the nonhomogeneity of natural soil deposits, and also by the ability of structures to bridge over soft spots in the foundation. On a very important job, it usually is worthwhile to make a very detailed study of the subsoil to locate stronger and weaker zones, and to investigate comprehensively the relation between foundation movements and forces in the structures. On a less important job, it may suffice to use an empirical relationship between total settlement and differential settlement, and to state the design criterion in terms of an allowable total settlement.

Figure 14.9 presents results from actual buildings resting on granular soils. Part (*a*) gives observed values of angular distortion δ/l versus maximum differential settlement. Whereas δ/l is determined by the differential settlement between adjacent columns, the maximum differential settlement may well be between two columns which are far apart. The curve drawn on the figure gives the average for the observed points. Part (*b*) shows the relationship between maximum differential settlement and maximum settlement. The line drawn as an upper envelope indicates that the maximum differential settlement can be equal to the maximum settlement; i.e., there may well be one column which has almost no settlement. Generally, the maximum differential settlement is less than the maximum settlement.[2]

The use of these relationships is illustrated in Example 14.1. From the nature of the building a permissible δ/l is chosen. Then the curves are used to find first the maximum differential settlement and then the maximum permissible total settlement. The settlement as predicted by the methods discussed in Sections 14.8 through 14.10 should then be less than this allowable settlement. An allowable total settlement of 1 in. is a typical specification for commercial buildings.

▶ Example 14.1

Given. A one-story reinforced concrete building with brick curtain walls.

Find. Allowable total settlement which will ensure no cracking of the brick walls.

Solution. From Fig. 14.8, maximum $\delta/l = 1/500 = 0.002$. Table 14.1 would give 0.003. Use $\delta/l = 0.002$.

From Fig. 14.9*a*, maximum allowable differential settlement is 2.5 cm.

From Fig. 14.9*b*, using the upper bound, the allowable total settlement is also 2.5 cm or 1 in. ◀

[2] Maximum differential settlement greater than maximum total settlement can result when one portion of the structure heaves while another settles. This situation is not uncommon in tanks on sand.

Exhibit A

O-CLMP-QUICK cont

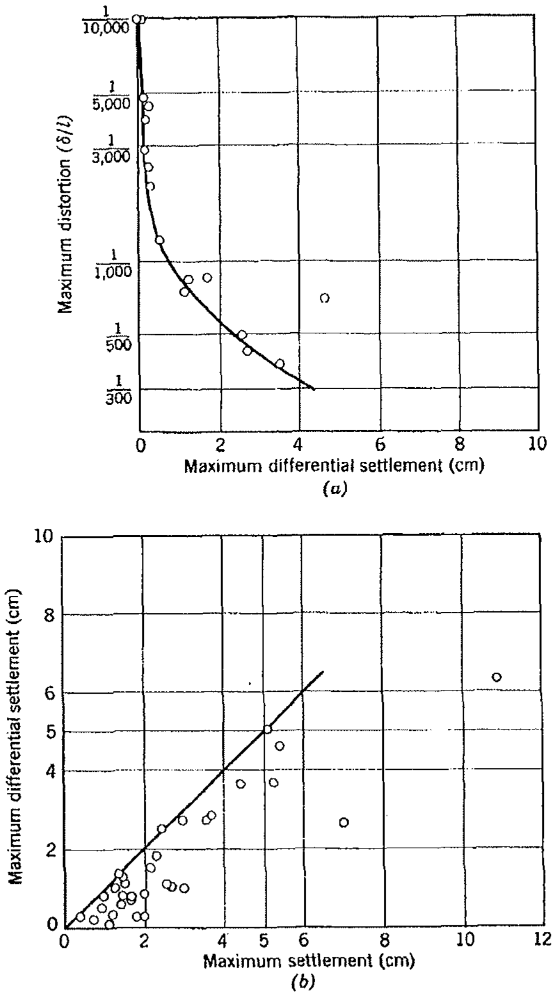


Fig. 14.9 Settlement of structures on sand (From Bjerrum, 1963a and 1963b).

14.3 ULTIMATE BEARING CAPACITY OF STRIP FOOTINGS

As a first step in our study of methods for establishing the bearing capacity of foundations, we shall study the ultimate bearing capacity $(\Delta q_s)_u$ of a footing which is very long compared to its width. This type of footing occurs under retaining walls and under building walls. Methods have been developed for predicting the ultimate bearing capacity of such footings. Subsequent sections will discuss how the theoretical results are modified by judgment and experience to account for the effects of local shear failure and for different shapes of footings.

A typical strip footing is depicted in Fig. 14.10. Because the footing is very long in comparison to its width, the problem is one of plane strain; i.e., the problem is two-dimensional. There are several reasons why the footing is generally located below ground surface rather than at the very surface: (*a*) to avoid having to raise the first-floor level well above ground surface; (*b*) to permit removal of the surface layer of organic soil; (*c*) to gain the additional bearing capacity that comes from partial embedment (see later portions of this section); and (*d*) to place the footing below the zone of soil which experiences volume changes because of frost action or other seasonal effects. In Boston, for example, the building code requires that exterior footings be 4 ft or deeper below ground surface.

For purposes of analysis, the actual situation shown in Fig. 14.10*a* is usually replaced by the situation shown in Fig. 14.10*b*: the soil above the base of the footing is replaced by a uniform surcharge of intensity $q_s = \gamma d$, where

γ = the unit weight of the soil
d = the depth of the base of the footing below ground surface

The effect of the weight of the soil above the footing base is thus taken into consideration, but the shear resistance of this soil is neglected. The accuracy of this approximation will be discussed later in this section.

HY-26 cont.

Solution Based on Rankine Wedges

We shall begin with an analysis which is much too approximate for practical use, but which illustrates in a simple way the factors that must be considered in a more accurate analysis. It is assumed that the failure zone is made up of two separate wedges, as shown in Fig. 14.11: a Rankine active wedge I, which is pushed downward and outward, and a Rankine passive wedge II, which is pushed outward and upward. There are corresponding patterns of motion on the other side of the center line.

The analysis begins with consideration of wedge II. Using Eq. 13.9, we can write an expression for the maximum thrust P (i.e., passive thrust) which can be applied to this wedge along the vertical face IJ (note $N_\phi = K_p$). Equation 14.1 includes the resistance resulting from friction and surcharge. This thrust P is also the maximum thrust available to hold the active wedge I in equilibrium under the application of the loading Q_{ult}/B. The value of this loading may therefore be found by using Eq. 13.7 for the active thrust.

Equation 14.3 may be written in the form[3]

$$\frac{Q_{ult}}{B} = (\Delta q_s)_u = \frac{\gamma B}{2} N_\gamma + q_s N_q \qquad (14.4)$$

where N_γ and N_q are dimensionless factors that depend only on the friction angle of the soil. Based on this

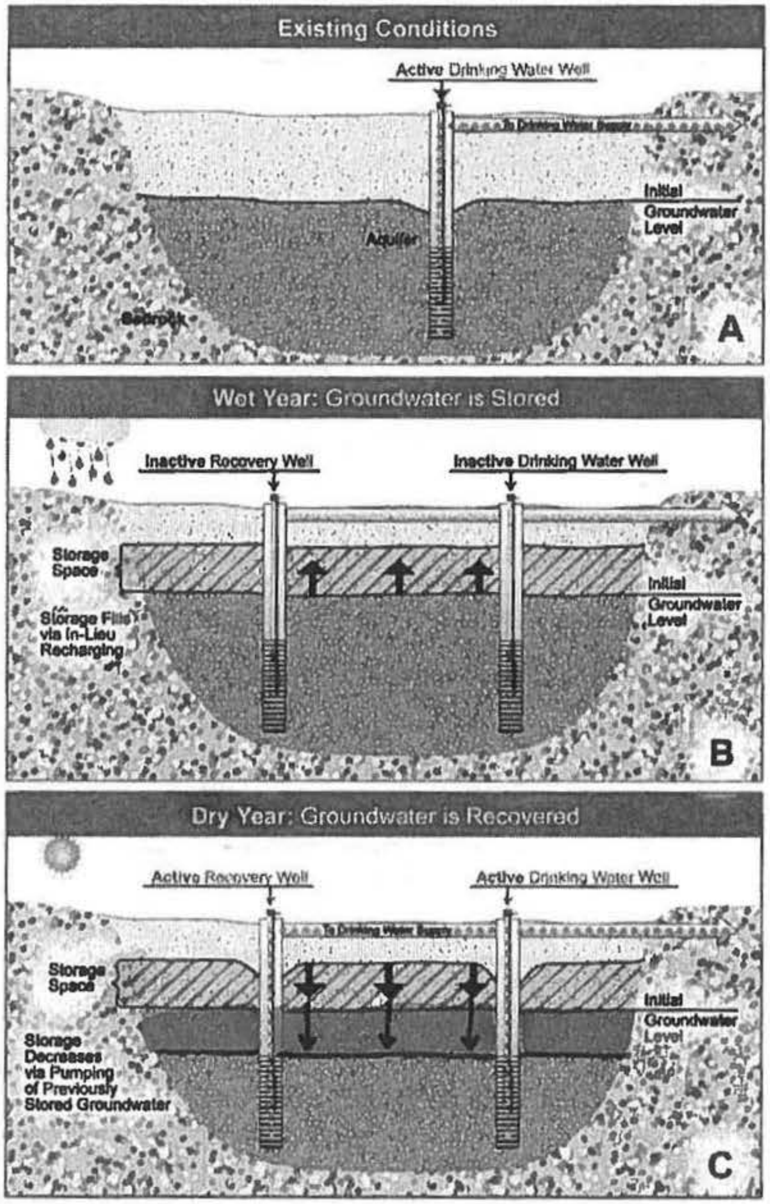
[3] The reason for writing $\gamma B/2$ is purely historical; i.e., this is the way it was first written.

EXHIBIT B

Exhibit B

O-CLMP-QUICK
cont

PD-16



= Pumping beyond stored amount

Figure (A) reflects the existing groundwater conditions, showing available storage space above the aquifer. In (B) the upward arrows represent the filling of the storage space with groundwater during wet years; in (C) the downward arrows represent the decline in stored water during dry years. The "Drinking Water Wells" represent the existing wells operated by the Cities of San Bruno and Daly City and California Water Service Company. The "Recovery Wells" represent the new wells that are proposed as part of the Project.

Groundwater Storage and Recovery Schematic Diagram

Regional Groundwater Storage and Recovery Project

Figure 3-1

EXHIBIT C

Exhibit C

O-CLMP-QUICK cont

Cypress Lawn Memorial Park's

Proposed Changes to Mitigation Measure M-HY-6, as Presented in DEIR

(modified from text at pp. 5.16-93 through 5.16-98 of DEIR)

Mitigation Approach

SFPUC commits to implementing mitigation actions to ensure the Project does not materially interfere with the groundwater supplies, irrigation well operation and maintenance costs, or the overlying water rights of the owners of irrigation wells that could be significantly impacted by Project operations.

As provided below, Mitigation Measure M-HY-6 (Ensure Project Operation Does Not Materially Interfere with Irrigators' Wells and Overlying Water Rights) establishes a performance standard to ensure that well interference impacts caused by the Project would be avoided or reduced to *less-than-significant* levels. The mitigation measure also requires a Monitoring and Reporting Program to provide reliable and timely data to determine if the performance standard is being met. The measure requires monthly collection of data at Project wells and irrigators' wells during Take Years (i.e., years when Project Wells are pumping), collection of data over the first three months during Put Years (i.e., years when water is being injected into the aquifer for storage), and advanced notice to third-party well owners, and annual monitoring, during Hold Years (i.e., when Project water is neither injected nor withdrawn from the aquifer). The measure also requires the analysis and reporting of monitoring data on a quarterly basis during Take Years, on a semi-annual basis during Put Years, and on an annual basis during Hold Years. The periodic analysis and reporting of data will allow the SFPUC and third-party irrigation well owners to determine whether or not reduced pumping capacities or higher pumping costs during Take Years, pressurization/overflow during Put Years, or other adverse impacts at irrigation wells are found to occur as a result of the Project. HY-16

Mitigation actions that the SFPUC must implement if the Project significantly impacts irrigation wells would vary depending on site-specific conditions at the irrigators' wells, agreements with irrigators, and a determination, subject to peer review, that the impacts to irrigation wells or the water rights of irrigation well owners are caused by Project operations. Therefore, the list of mitigation actions includes actions both at the irrigators' wells and at the Project wells. Each action item may be suitable to address impacts on an irrigator's well, either alone or in combination with one or more of the other mitigation actions. Each of the mitigation actions, or a combination of mitigation actions, may be feasible and effective in particular circumstances. However, not every one of the mitigation actions alone are anticipated to be feasible and effective at reducing impacts to *less-than-significant* levels in all circumstances, because the irrigation systems, wells, and parcels where the irrigators' wells are located are all different and may experience a range of impacts due to Project-caused well interference. Either one or a combination of the mitigation actions identified in Mitigation Measure M-HY-6 is anticipated to reduce impacts to a *less-than-significant* level. All feasible mitigation actions shall be implemented to reduce impacts to less than significant levels for all irrigators' wells. HY-16 cont.

Mitigation actions #1, Redistribute GSR pumping, and #2, Reduce GSR pumping: SFPUC would reduce the rate of groundwater level decline in an affected area by redistributing Project pumping to other areas or by reducing or ceasing Project pumping. Redistribution of GSR pumping would not be undertaken where the resulting groundwater levels would then decline more than predicted to be caused by the Project by modeling. Therefore, redistribution likely would be effective at reducing well interference impacts at irrigators' wells, but only if some GSR wells are determined to be capable of producing more water with less drawdown than predicted (SFPUC 2012a, 2012c). Reduction or cessation of GSR pumping likely would be effective at reducing well interference impacts at irrigators' wells to *less-than-significant* impacts, but would reduce the benefits of the Project; therefore, if an alternate measure can be developed and implemented, with the agreement of the owner(s) of impacted irrigators' well(s), that also mitigates the impact to *less-than-significant* levels, then this measure would be implemented on an interim basis. HY-15

Mitigation actions #3, Improve irrigation efficiency, and #4, Modify irrigation operations: SFPUC would install or completely fund measures such as more-efficient sprinkler heads or soil-moisture sensors and would modify operations, for example, through the use of longer irrigation cycles or revised scheduling of irrigation to respond to evapotranspiration data. These actions, which would be subject to the agreement and permission of the owner(s) of impacted irrigators' well(s), likely would not result in substantial reductions in water use at irrigators' wells. Effectiveness of the actions would vary depending on the design of the impacted irrigation system, and would not be expected to be feasible and effective in all cases. (SFPUC 2012c) HY-15

Mitigation actions #5, Lower pump in irrigation well, and #6, Lower and change pump in irrigation well: SFPUC would lower the well pump to accommodate groundwater level fluctuations induced by Project pumping that exceed historic levels, or lower and replace the well pump using a more suitable pump for the conditions that are encountered in order to meet demands, or completely fund these actions. SFPUC would also compensate owners of such wells for any incremental increase in pumping costs associated with deeper well pumps. These actions, which would be subject to the agreement and permission of the owner(s) of impacted irrigators' well(s), likely would mitigate impacts if the irrigation well capacity were moderately less than the performance standard due to Project pumping. Effectiveness of the actions would vary depending on the design of the irrigation well and type of pump used. The actions would also be dependent upon the irrigation well being deep enough to accommodate lowering of the pump. For this reason, these actions would not necessarily be feasible and effective in all cases. (SFPUC 2012c) HY-15

Mitigation action #7, Add storage capacity for irrigation supply: SFPUC would add storage; for example, an above-ground tank of 20,000 gallons, which could be up to 20 feet in height. This action, which would be subject to the agreement and permission of the owner(s) of impacted irrigators' well(s), would also require landscaping around any storage tank(s) to reduce any aesthetic impacts. SFPUC would also be required to acquire any necessary permits and mitigate any other secondary impacts that this mitigation action may cause. Increased storage HY-15 capacity may provide the ability to meet peak flow rates that would otherwise be less than the performance standard, in that irrigators could store the additional water in the tank to use during the period of peak demand. It appears likely that each of the third-party irrigators could feasibly place a tank on their property, provided they agree to this form of mitigation and SFPUC provides compensation for the use of land necessary for the storage tank(s) and the establishment and maintenance of landscaping required for each tank. However, increased storage may not be sufficient to meet the performance standard if the reduced well capacity due to the Project is large. (SFPUC 2012c) HY-15 cont.

Mitigation action #8, Replace irrigation well: SFPUC would replace impacted irrigators' well(s), would remove above-ground pumping equipment for any replaced well(s) and cap such wells, and would compensate owners of such wells for any incremental increase in pumping costs. Possible environmental impacts that may result from the installation of replacement irrigation wells would be the same as those expected for construction of Project wells; therefore all mitigation measures to be applied for the construction of Project wells will also be applied to the construction of replacement irrigation wells. This mitigation action, which would be subject to the agreement and permission of the owner(s) of impacted irrigators' well(s), likely would be effective at any of the affected land uses, because the replacement well could be constructed deep enough at each of the cemeteries or golf clubs to operate under the new conditions and thereby meet peak irrigation demand. This mitigation action, likely would be feasible from the standpoint that each of the existing irrigators' well sites appear to have available area in which a replacement well could be installed, and groundwater resources are deep enough in the area of each irrigator to drill deeper wells (SFPUC2012d). SFPUC may need to obtain well permits from the San Mateo County Department of Environmental Health or City of Daly City, depending on the location of the replacement well. The County's and Daly City's well ordinances provide that granting of a well permit is dependent upon the well meeting the health, safety, and welfare of its citizens. Because wells that would be installed under Mitigation action #6 would replace existing and currently operational irrigation wells, it is expected that the required well permits would be issued by the County and Daly City. HY-15

Mitigation action #9, Replace irrigation water source: SFPUC would provide a new temporary source of water only until another mitigation action could be implemented. Water could be provided via temporary aboveground pipes from Partner Agency or SFPUC supply from distribution or transmission pipelines close to the location where additional irrigation supplies are needed. This action, which would be subject to the agreement and permission of the owner(s) of impacted irrigators' well(s), would not be implemented on a permanent basis. HY-15

Mitigation action #10, Compensate irrigation well owner(s) for increased pumping costs and/or decreased pumping capacity: If mitigation actions #1 through 9 are not effective in reducing impacts to irrigators' well(s) to less-than-significant levels, or SFPUC and the owner(s) of irrigation well(s) cannot reach an agreement regarding mitigation actions to implement to reduce Project impacts to irrigation wells, SFPUC would compensate the well owner in proportion to the reduction in pumping capacity of any well(s) below the performance standard and for any increased irrigation well operation and maintenance costs. SFPUC will make a reasonable good faith effort to negotiate the amount of such compensation with each affected HY-7 irrigators' well owner, and will offer to subject any disagreements concerning this amount to mediation or to resolution by the San Mateo Superior Court. HY-7 cont.

Mitigation actions 1 and 2 of Mitigation Measure M-HY-6 (Ensure Project Operation Does Not Materially Interfere with Irrigators' Wells and Overlying Water Rights) could fully mitigate the Project's impacts to irrigators' wells, but these mitigation actions would reduce the benefits of the Project. While SFPUC can implement mitigation actions 1 and 2 unilaterally, without requiring any agreements with the owners of the irrigators' wells, implementing mitigation actions 3 through 10 would depend upon reaching agreements with each of the irrigation well owners. With participation in the Monitoring and Reporting Program and concurrence to allow implementation of the mitigation actions by all owners of affected irrigators' wells, the Project benefits would be fully realized while well interference impacts would be less than significant with mitigation. Impact HY-6 with implementation of Mitigation Measure H-HY-6 is deemed to be *less than significant with mitigation*.

HY-14

Mitigation Measure M-HY-6: Ensure Project Operation Does Not Materially Interfere with Irrigators' Wells and Overlying Water Rights

This mitigation measure is organized into five sections, as follows:

- Performance standard,
- Mitigation Actions to be Undertaken to Meet the Performance Standard,
- Method for Determining Whether Loss of Pumping Capacity at an Irrigator's Well Is Due to the Project,
- Irrigator Well Monitoring and Reporting Program, and
- Definitions of terms

Performance Standard: The SFPUC will ensure that: (1) the production capacity at irrigators' wells is equivalent to the existing production capacity of the wells and is sufficient to meet existing and planned peak irrigation demand at the land use, (2) the Project does not increase the costs of operating and maintaining irrigators' wells, (3) the Project does not materially interfere with the well owners' overlying water rights, and (4) Project pumping does not cause a water level decline of five feet or more below existing baseline conditions at an irrigator's well.

HY-16

A violation of any of the prongs of the above performance standard (1 through 4) would trigger SFPUC mitigation obligations, provided that the violation is reasonably determined, based on verifiable data, to have been caused by the Project. Methods for determining causation are described below. When the Project is determined to have caused the violation, the SFPUC will implement the mitigation actions described below, or a combination thereof, to avoid or reduce Project effects.

In order to implement one or more of the mitigation actions, it is necessary to, and the SFPUC shall, (1) conduct monitoring at irrigators' wells to determine whether the performance standard is being met, (2) analyze and periodically report the data collected through well monitoring, and (3) consult with the owner(s) of impacted irrigation wells to reach agreement(s) concerning appropriate mitigation. The Monitoring and Reporting Program is described in detail below. HY-16 cont.

Mitigation Actions to be Undertaken to Meet the Performance Standard: The SFPUC shall, in cooperation with the existing irrigators, implement mitigation actions when the performance standard in this mitigation measure is violated. The following mitigation actions, alone or in combination, will avoid or reduce Project impacts, depending on the circumstance: HY-16

1. *Redistribute GSR pumping.* Reduce the rate of groundwater level decline in the affected area by redistributing Project pumping to other areas; however, in no case would redistribution be undertaken where the resulting groundwater levels would then decline more than predicted Project modeling. The periodic analyses of data from the Monitoring and Reporting Program would continue while this action is undertaken. The action would cease when the data analysis demonstrates that the performance standard is met without continued redistribution of GSR pumping. HY-15

2. *Reduce GSR pumping.* Reduce the rate of groundwater level decline through a reduction in Project pumping (including a cessation in Project pumping at wells in the vicinity of impacted irrigation wells). The periodic analyses of data from the Monitoring and Reporting Program would continue while this action is undertaken. The action would cease when the data analysis demonstrates that the performance standard is met without continued reduction of GSR pumping.

3. *Improve irrigation efficiency.* Reduce applied water demand through irrigation efficiency measures. For example, sprinkler nozzles can be replaced with more efficient models, sprinklers can be added to achieve more evenly distributed irrigation, and installation of soil-moisture sensors can aid in irrigation scheduling. HY-15

4. *Modify irrigation operations.* Modify irrigators' wells operations to accommodate reduced well capacity. For example, use longer irrigation cycles to meet the same irrigation demand or use evapotranspiration data to modify *irrigation scheduling.*

5. *Lower pump in irrigation well.* Lower pump in irrigator's well to accommodate water level fluctuations induced by Project pumping that exceed historic levels. SFPUC would compensate the well owner for any increased pumping and maintenance costs. HY-15

6. *Replace and lower pump in irrigation well.* Replace pump in irrigator's well and set pump to a lower depth to accommodate new head conditions because of

lowered water levels induced by Project pumping. SFPUC would compensate the well owner for any increased pumping and maintenance costs. HY-15 cont.

7. *Add storage capacity for irrigation supply.* Under certain conditions, add storage (e.g., an above-ground tank with suitable shielding landscaping) to offset reduced well capacity caused by Project pumping. The availability of storage capacity (or of increased capacity) can provide an ability to meet peak flow rates that are otherwise reduced by lowered water levels. SFPUC would obtain any necessary permits. HY-15

8. *Replace irrigation well.* Replace an existing irrigation well with a new well which may be designed with different screen intervals or depth. The new irrigation well could therefore access additional groundwater resources at new depths in the aquifer. Subject to owner agreement, the replacement irrigation well would be subject to the Monitoring and Reporting Program and, if significantly impacted, to these mitigation measures. HY-15

9. *Replace irrigation water source.* In the event that the preceding options cannot be implemented without causing an interruption in the irrigation supply, provide a temporary replacement water supply source from the regional water system or Partner Agency distribution system via temporary aboveground pipes close to the location where additional irrigation supplies are needed until another mitigation option(s) is implemented. HY-15

10. *Compensate existing irrigation well owner(s) for reduced pumping capacity and/or increased pumping costs.* In the event that SFPUC cannot reach an agreement with the owner(s) of significantly impacted irrigation wells concerning implementation of the preceding options, the SFPUC shall compensate such owners in proportion to the reduction in well pumping capacity below the performance standard and shall compensate the well owner for any increase in pumping operation and maintenance costs caused by Project operations. HY-7

Methods for Determining Whether Loss of Pumping Capacity or Increased Pumping Costs at an Irrigators' Well(s) Is Due to the Project. Any loss in production capacity of an irrigators' well(s), increased pumping costs at such wells, interference with overlying water rights, or well water level drawdown of five (5) feet or more is assumed to be caused by the Project if: 1) it is temporally correlated with the onset of increased Project pumping; 2) it occurs in an area predicted to be affected by well interference; 3) static groundwater levels have dropped; 4) pumping groundwater levels have not dropped more than static groundwater levels (if pumping groundwater levels drop more than static groundwater levels it could indicate the drop in production capacity is due to increased well inefficiency and not due to the Project); or 5) no other obvious and substantiated reason exists for the these effects. If another reason for these effects is identified by the SFPUC, another agency, or by a third-party (such as an owner of an irrigation well or an owner's agent), it will be based on the written professional opinion of a certified hydrogeologist or professional engineer with expertise in groundwater hydrology that HY-13 will be submitted to the San Francisco Planning Department's Environmental Review Officer (ERO), or designee, the SFPUC, and the affected irrigation well owner for review and concurrence. The ERO may require the SFPUC to hire an independent expert to advise the ERO.

To support this determination, the SFPUC will develop and share with irrigation well owners at least the following information:

- *Item 1. It is temporally correlated with the onset of increased Project pumping.* The SFPUC will develop a graph that shows the pumping of Project and Partner Agency wells within 1.5 miles of the irrigator's well over time, compared to the production capacity of the irrigator's well over the same period.

- *Item 2. It occurs in an area predicted to be affected by well interference.* The SFPUC will calculate the cone of depression, using a methodology agreed upon in consultation with existing irrigation well owners, at Project and Partner Agency wells within 1.5 miles of the irrigators' well(s), as well as at the irrigators' well(s).

HY-13 cont.

- *Items 3 and 4. Static water levels have dropped and pumping water levels have not dropped more than static water levels.* The SFPUC will develop a graph showing the difference between static and pumping water levels at the irrigators' well(s) over time.

- *Item 5. Another substantiated reason exists for the drop in production capacity.* If the SFPUC concludes, based on verifiable evidence, that the drop in production capacity of the irrigators' well(s) is caused by factors other than the Project – and the owner of the irrigators' well(s) disagrees – then the SFPUC will have a certified hydrogeologist or professional engineer with expertise in groundwater hydrology prepare documentation regarding the reasons for the drop in production capacity and submit this documentation to the owner of the irrigators' well(s) for an opportunity for peer review. This documentation shall also be submitted to the San Francisco Planning Department's ERO, or designee. The ERO may require the SFPUC to hire an independent expert to advise the ERO.

Irrigators' well owners shall be afforded at least 30 days to review and comment on the information identified in Items 1 through 5, above, as well as the underlying data and analysis on which the SFPUC is relying, prior to any determination of causation.

After reviewing any comments submitted by owner(s) of an irrigators' well affected by the Project, the SFPUC and ERO may determine that the Project does not cause a loss in production capacity of an irrigators' well(s). Within 30 days of receiving written notice of such a determination, the owner of the potentially affected irrigation well may submit a written objection to the determination. If no timely objections are received, the determination is considered final and conclusive. If the SFPUC and ERO maintain the conclusion of no Project impact after considering any timely objection(s), the verifiable

HY-17

evidence on which this determination is based (including a response to all written comments and, if requested, the underlying data and analysis on which the SFPUC is relying) shall be provided to the owner(s) of the irrigation well(s) at issue within 30 days of the receipt of the written comments or the date the determination is made, whichever is earlier. Any dispute concerning the determination may be resolved through mediation or legal action.

Alternatively, the owner(s) of any irrigators' well may submit to the SFPUC and ERO substantiated information showing that Project operations have caused violations of the above performance standard. SFPUC would have the opportunity to review and comment on the information provided by irrigation well owner(s) prior to any determination of causation by the ERO.

HY-17 cont.

In addition, the following Monitoring and Reporting Program will assist the SFPUC and ERO in obtaining the data necessary to support the determination of causation for any groundwater level decreases at an irrigator's well.

Irrigation Well Monitoring and Reporting Program. The SFPUC will monitor and report short- and long-term changes in groundwater conditions and operations at irrigators' wells. This Irrigator Well Monitoring and Reporting Program applies to existing well owners who choose to participate in the program. The terms for participating in the Monitoring and Reporting Program shall be established through negotiations between SFPUC and irrigation well owners, with input from the ERO. Any disagreements concerning the terms for participation will be resolved through mediation. Participation in this monitoring program is not mandatory, but would aid in the SFPUC's effective implementation of mitigation actions at the affected well.

HY-12

At least 18 months prior to the commencement of pumping of Project wells, the SFPUC shall contact existing irrigators with information about the Monitoring and Reporting Program. To participate in the program, existing irrigators will complete a registration form and enter into a mutually acceptable agreement with the SFPUC.

Prior to issuance of construction permits, the SFPUC shall prepare the Monitoring and Reporting Program and shall submit the Program to the ERO for review and approval. The Program shall provide detailed methodology for monitoring background and Project-induced groundwater levels, water quality, and flow.

HY-17

The monitoring program will include the installation of a flow meter to allow for daily well production volumes to be recorded and a groundwater level transducer/data logger (a device for automatically detecting and recording groundwater levels) for measuring groundwater levels. Baseline monitoring of flow meter data and groundwater level data in the irrigators' well(s) will be collected and reported to participating well owners for at least one year prior to pumping the Project wells. In addition to baseline monitoring of well production and groundwater levels, pumping tests will be conducted prior to commencement of pumping Project wells to collect baseline data on pump and well performance and report that data to well owners. The pumping tests will collect data on

HY-12

well capacity and drawdown, well specific capacity, pump efficiency and head-capacity characteristics, sand content, and selected water quality parameters. HY-12 cont.

The SFPUC shall also collect any existing information and data available regarding the irrigators' well(s) from the well owners, including any estimates or measurements of historical, existing, and planned land and water use (e.g., driller's logs, water level data, pumping records, acres irrigated) to provide information upon which to evaluate the performance of the irrigators' wells over time, to establish baseline operating conditions, and to determine Project impacts on planned water use. When there is an opportunity to open an irrigators' well (such as when a pump is removed by a well owner), the SFPUC may seek to conduct video log surveys in wells to determine the condition of the well structure. The monitoring effort will continue through the life of the Project, unless canceled by the well owner as part of the well owner's decision to remove itself from the Monitoring and Reporting Program. Continued participation in this monitoring program is assumed to be necessary for the mitigation actions to be effectively implemented by the SFPUC. Periodic re-testing of a well may occur as prompted by the need to evaluate performance throughout the life of the Project. If there is uncertainty or disagreement about whether the Project is responsible for a loss in production capacity at an irrigators' well, the SFPUC shall undertake more frequent monitoring and/or testing, shall timely provide the well owner with all data, reports, and information collected concerning well production capacity, and provide an opportunity for peer review and comment, to help resolve the disagreement. HY-12

Data from the water level transducers/data loggers and flow meters shall be recorded daily during the first year. Following the first year of data collection, the frequency may be modified (e.g., as prompted by a need to evaluate pump and/or well performance to determine effects of the Project), but in no case data collection and recording take place less frequently than once per month. HY-12

The SFPUC shall provide participants with 14-day advance notice for the site visit(s) that would be scheduled within a 48-hour window.

Data shall be analyzed and reported to irrigation well owners on a quarterly bases each year during Take Periods when Project wells are pumping regularly. HY-17 The first data analysis period shall end March 31st when production capacity can be compared to peak demand prior to the peak demand period. The second data analysis period shall end June 30th, when pumping is underway during the beginning of the irrigation season. The third data analysis period shall end September 30th, when groundwater levels will likely be lowest at the end of the peak irrigation season. The fourth and final data analysis period shall end December 31, when and production capacity of the well would be at its lowest. HY-12

The SFPUC's certified hydrogeologist or professional engineer with expertise in groundwater hydrology shall compile, analyze, and report the collected data for each quarter to irrigation well owners. HY-17 The quarterly well monitoring reports shall be furnished by April 30th, July 31st, October 31st and January 31st for the four data analysis periods. In Put Years, the SFPUC shall monitor the irrigators' wells for HY-12 pressurization and/or overflow for the first three months of injection and report analyzed data to irrigation well owners no later than July 31st. In Hold Years, data shall be analyzed once per year for the data collected through October with analysis and reporting to irrigation well owners completed by January 15th. HY-12 cont.

Voluntary monitoring of all irrigators' wells would be required during the period that is the longer of: (i) 17 years (or, twice the 8.5 year cycle analyzed in this DEIR); or (2) the period including the first 5 Take Years of the Project from the initiation of Project operation. After this initial period of monitoring, the SFCUP and the ERO, in consultation with irrigation well owners, shall jointly evaluate the effectiveness of the Monitoring and Reporting Program and determine if data collection, monitoring and reporting frequencies and other procedures should be revised or eliminated. HY-6

Definition of Terms

Existing or planned land use. All existing and planned land uses served by irrigators' wells are related to turf irrigation. The only planned known (future) land uses are the potential expansion of the Holy Cross Cemetery to include up to an additional 30 acres of irrigated turf and the planned expansion of the Cypress Lawn Memorial Park to include an additional approximately 39 acres of irrigated turf. OV-1

Existing baseline conditions. Existing baseline conditions is the verified seasonal pre-Project water levels at an irrigator's well, measured over a one-year period. HY-12

Existing well capacity. Existing well capacity is the production capacity of the existing irrigator's well during the 12-month monitoring period prior to operation of the Project. The well capacity will be determined, and confirmed by irrigation well owners, through the Monitoring and Reporting Program described herein. HY-15

Peak irrigation demand. Peak irrigation demand is defined either as the actual peak irrigation demand determined from well production records obtained by the Monitoring and Reporting Program described herein or as identified in Table M-HY-6 (developed from Table 5.16-14 [Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought] of the EIR), whichever is agreed to by the parties.

Production capacity. Production capacity of a well is the quantity of water that can be produced by a well in a 12-hour period. Production capacity will be calculated based on daily production, as measured by the flow meter, divided by pumping duration, as measured by the flow meter, multiplied by 12 hours. HY-12

Irrigators' wells. The existing and replacement wells that support the following existing and planned land uses are the only wells that meet the definition of "irrigators' wells" for the purposes of this mitigation measure: Lake Merced Golf Club, Woodlawn Memorial Park, Italian Cemetery, Eternal Home Cemetery, Olivet Memorial Park, Home of Peace Cemetery, Cypress Lawn Memorial Park, Holy Cross Cemetery and the California Golf Club. Existing wells are those wells that are in operation prior to the approval of the HY-15

Project. Replacement wells are those wells that may replace existing wells (due to Project interference or for some other reason). HY-15 cont.

Impact Conclusion: Less Than Significant with Mitigation

DB2/ 24163919.2

EXHIBIT D

Exhibit D

O-CLMP-QUICK cont

Cypress Lawn Memorial Park's

Proposed Changes to Mitigation Measure M-HY-6, as Presented in DEIR

(modified from text at pp. 5.16-93 through 5.16-98 of DEIR)

Mitigation Approach

SFPUC commits to implementing mitigation actions to ensure the Project does not materially interfere with the groundwater supplies, irrigation well operation and maintenance costs, or the overlying water rights of the owners of irrigation wells that could be significantly impacted by Project operations.

As provided below, Mitigation Measure M-HY-6 (Ensure [~~Existing~~]**Project Operation Does Not Materially Interfere with** Irrigators' Wells [~~Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation~~]**and Overlying Water Rights**) establishes a performance standard to ensure that well interference impacts caused by the Project would be avoided or reduced to *less-than-significant* levels. The mitigation measure also requires a Monitoring **and Reporting** Program[~~ at the existing irrigators' wells~~] to provide reliable and timely data to determine if the performance standard is being met[~~ and~~]**. The measure** requires [~~the analysis of monitoring data twice a year~~]**monthly collection of data at Project wells and irrigators' wells** during Take Years (i.e.**, years** when Project Wells are [~~regularly~~]pumping)**, collection of data over the first three months during Put Years (i.e., years when water is being injected into the aquifer for storage), and advanced notice to third-party well owners, and annual monitoring, during Hold Years (i.e., when Project water is neither injected nor withdrawn from the aquifer). The measure also requires the analysis and reporting of monitoring data on a quarterly basis during Take Years, on a semi-annual basis during Put Years, and on an annual basis during Hold Years. The periodic analysis and reporting of data will allow the SFPUC and third-party irrigation well owners** to determine whether or not reduced pumping capacities **or higher pumping costs during Take Years, pressurization/overflow during Put Years, or other adverse impacts** at[~~ existing~~] irrigation wells are found to occur as a result of the Project. HY-16

[~~If the results of the Monitoring Program and biannual analyses during Take Years indicate that well interference impacts of the Project would cause the performance standard to be exceeded, then a list of example mitigation actions are provided that would maintain an uninterrupted supply of groundwater to the affected land use. Mitigation actions that may need to be implemented~~]**Mitigation actions that the SFPUC must implement if the Project significantly impacts irrigation wells** would vary depending on [~~sitespecific~~]**site-specific** conditions at the [~~existing~~]irrigators' wells**, agreements with irrigators,** and a determination[~~ of the extent of the decrease in pumping capacity that is occurring due to Project operations and, therefore~~]**, subject to peer review, that the impacts to irrigation wells or the water rights of irrigation well owners are caused by Project operations. Therefore**, the list of mitigation actions includes actions both at the [~~existing~~]irrigators' wells and[~~ also~~] at the Project wells. Each action item may be suitable to address impacts on an[existing] irrigator's well, either alone or in combination with one or more of the other mitigation actions. Each of the mitigation actions, or a combination of mitigation actions, may be feasible and effective in particular circumstances. However, not every one of the mitigation actions alone are anticipated to be feasible and effective at reducing impacts to *less-than-significant* levels in all circumstances, because the irrigation systems, wells, and parcels where the[existing] irrigators' wells are located are all different and may experience a range of impacts due to Project-caused well interference. Either one or a combination of the mitigation actions identified in Mitigation Measure M-HY-6 is anticipated to reduce impacts to a *less-than-significant* level. **All feasible mitigation actions shall be implemented to reduce impacts to less than significant levels for all irrigators' wells.** HY-16 cont.

Mitigation actions #1, [~~Improve irrigation efficiency, and #2, Modify irrigation operations,~~ ~~would install measures such as more-efficient sprinkler heads or soil-moisture sensors and would modify operations, for example, through the use of longer irrigation cycles or revised scheduling of irrigation to respond to evapotranspiration data. These actions would tend to mitigate impacts if the irrigation well capacity were only slightly less than the performance standard due to Project pumping. Effectiveness of the actions would vary depending on the design of the existing irrigation system, and would not be expected to be feasible and effective in all cases. (SFPUC 2012c)~~**][~~Mitigation actions #3,~~]Redistribute GSR pumping, and #[~~4,~~]2, Reduce GSR pumping[~~,~~]: SFPUC** would reduce the rate of groundwater level decline in an affected area by redistributing Project pumping to other areas or by reducing **or ceasing** Project pumping. Redistribution of GSR pumping would not be undertaken where the resulting groundwater levels would then decline more than [~~what was originally~~]predicted to be caused by the Project by modeling[~~, therefore~~]**. Therefore**, redistribution **likely** would be effective at reducing well interference impacts at [~~existing irrigation~~]**irrigators'** wells**, but** only if some GSR wells are determined to be capable of producing more water with less drawdown than [~~originally~~]predicted (SFPUC 2012a, 2012c). Reduction **or cessation** of GSR pumping **likely** would be effective at reducing well interference impacts at [~~existing irrigation~~]**irrigators'** wells to *less-than-significant* impacts, but [~~this would be an interim measure, implemented until such time as~~]**would reduce the benefits of the Project; therefore, if** an alternate measure can be **developed and** implemented**, with the agreement of the owner(s) of impacted irrigators' well(s),** that also mitigates the impact to *less-than-significant* levels**, then this measure would be implemented on an interim basis**. HY-15 HY-15

Mitigation actions #3, Improve irrigation efficiency, and #4, Modify irrigation operations: SFPUC would install or completely fund measures such as more-efficient sprinkler heads or soil-moisture sensors and would modify operations, for example, through the use of longer irrigation cycles or revised scheduling of irrigation to respond to evapotranspiration data. These actions, which would be subject to the agreement and permission of the owner(s) of impacted irrigators' well(s), likely would not result in substantial reductions in water use at irrigators' wells. Effectiveness of the actions would vary depending on the design of the impacted irrigation system, and would not be expected to be feasible and effective in all cases. (SFPUC 2012c) HY-15

Mitigation actions #5, Lower pump in irrigation well, and #6, Lower and change pump in irrigation well[~~,~~]**: SFPUC** would lower the well pump to accommodate groundwater level fluctuations induced by Project pumping that exceed historic levels, or lower and replace the well pump using a more suitable pump for the conditions that are encountered in order to meet demands[~~. These actions~~]**, or completely fund these actions. SFPUC would also compensate owners of such wells for any incremental increase in pumping costs associated with deeper well pumps. These actions, which would be subject to the agreement and permission of the owner(s) of impacted irrigators' well(s), likely** would mitigate impacts if the irrigation well capacity were moderately less than the performance standard due to Project pumping. Effectiveness of the actions would vary depending on the design of the [~~existing~~]irrigation well and type of pump used. The actions would also be dependent upon the[~~ existing~~] irrigation well being deep enough to accommodate lowering of the pump. For this reason, these actions would not necessarily be feasible and effective in all cases. (SFPUC 2012c) HY-15

Mitigation action #7, Add storage capacity for irrigation supply[~~,~~]**: SFPUC** would add storage; for example, an above-ground tank of 20,000 gallons, which could be up to 20 feet in height. **This action, which would be subject to the agreement and permission of the owner(s) of impacted irrigators' well(s), would also require landscaping around any storage tank(s) to reduce any aesthetic impacts. SFPUC would also be required to acquire any necessary permits and mitigate any other secondary impacts that this mitigation action may cause.** Increased storage capacity may provide the ability to meet peak flow rates that would otherwise be less than the performance standard, in that irrigators could store the additional water in the tank to use during the period of peak demand. It appears likely that each of the [~~existing~~]**third-party** irrigators could feasibly place a tank on their property, [~~however~~]**provided they agree to this form of mitigation and SFPUC provides compensation for the use of land necessary for the storage tank(s) and the establishment and maintenance of landscaping required for each tank. However**, increased storage may not be sufficient to meet the performance standard if the reduced well capacity due to the Project is large. (SFPUC 2012c) HY-15

Mitigation action #8, Replace irrigation well[~~,~~]**: SFPUC would replace impacted irrigators' well(s), would remove above-ground pumping equipment for any replaced well(s) and cap such wells, and would compensate owners of such wells for any incremental increase in pumping costs. Possible environmental impacts that may result from the installation of replacement irrigation wells would be the same as those expected for construction of Project wells; therefore all mitigation measures to be applied for the construction of Project wells will also be applied to the construction of replacement irrigation wells. This mitigation action, which would be subject to the agreement and permission of the owner(s) of impacted irrigators' well(s), likely** would be effective at any of the affected land uses, because the replacement well could be constructed deep enough at each of the cemeteries or golf clubs to operate under the new conditions and thereby meet peak irrigation demand. This mitigation action**, likely** would be feasible from the standpoint that each of the existing irrigators' well sites [~~has~~]**appear to have** available [~~areas~~]**area** in which a replacement well could be installed, and groundwater resources are deep enough in the area of each irrigator to drill deeper wells (SFPUC2012d). [~~Well permits would~~]**SFPUC may** need to [~~be obtained~~]**obtain well permits** from the San Mateo County Department of Environmental Health HY-15 or City of Daly City, depending on the location of the replacement well. The County's and Daly City's well ordinances provide that granting of a well permit is dependent upon the well meeting the health, safety, and welfare of its citizens. Because wells that would be installed under Mitigation action #6 would replace existing and currently operational irrigation wells, it is expected that the required well permits would be issued by the County and Daly City. HY-15 cont.

Mitigation action #9, Replace irrigation water source[~~,~~]**: SFPUC** would provide a new temporary source of water only until another mitigation action could be implemented. Water [~~would~~]**could** be provided via temporary aboveground pipes from Partner Agency or SFPUC supply from distribution or transmission pipelines close to the location where additional irrigation supplies are needed. This action**, which would be subject to the agreement and permission of the owner(s) of impacted irrigators' well(s),** would not be implemented on a permanent basis. HY-15

Mitigation action #10, Compensate irrigation well owner(s) for increased pumping costs and/or decreased pumping capacity: If mitigation actions #1 through 9 are not effective in reducing impacts to irrigators' well(s) to less-than-significant levels, or SFPUC and the owner(s) of irrigation well(s) cannot reach an agreement regarding mitigation actions to implement to reduce Project impacts to irrigation wells, SFPUC would compensate the well owner in proportion to the reduction in pumping capacity of any well(s) below the performance standard and for any increased irrigation well operation and maintenance costs. SFPUC will make a reasonable good faith effort to negotiate the amount of such compensation with each affected irrigators' well owner, and will offer to subject any disagreements concerning this amount to mediation or to resolution by the San Mateo Superior Court. HY-7

[~~Implementation~~]**Mitigation actions 1 and 2** of Mitigation Measure M-HY-6 (Ensure [~~Existing Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation) would depend upon the willingness of the well owner to participate in the monitoring program and to allow the SFPUC to install a replacement well or take other corrective action as mutually determined necessary to address the impacts from the Project and meet the performance standard. Therefore, while Mitigation Measure MHY-6 could reduce the impacts of well interference to a level where existing and planned land uses would continue to be fully supported, its implementation cannot be assured at this time. Nevertheless, with participation in the monitoring program~~]**Project Operation Does Not Materially Interfere with Irrigators' Wells and Overlying Water Rights) could fully mitigate the Project's impacts to irrigators' wells, but these mitigation actions would reduce the benefits of the Project. While SFPUC can implement mitigation actions 1 and 2 unilaterally, without requiring any agreements with the owners of the irrigators' wells, implementing mitigation actions 3 through 10 would depend upon reaching agreements with each of the irrigation well owners. With participation in the Monitoring and Reporting Program** and concurrence to allow implementation of the mitigation actions by all **owners of** affected [~~existing irrigation well owners, the~~]**irrigators' wells, the Project benefits would be fully realized while** well interference impacts would be less than significant with mitigation.[~~ However, because such assurance cannot be attained prior to Project approval,~~] Impact HY-6 with implementation of HY-14

Mitigation Measure H-HY-6 is deemed [at this time]to be ***less than*** *significant [and potentially unavoidable]with mitigation.*

Mitigation Measure M-HY-6: Ensure [Existing]Project Operation Does Not Materially Interfere with Irrigators' Wells [Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation]and Overlying Water Rights

This mitigation measure is organized into five sections, as follows:

HY-14 cont.

- Performance standard,
- Mitigation Actions to be Undertaken to Meet the Performance Standard,
- Method for Determining Whether Loss of Pumping Capacity at an[Existing] Irrigator's Well Is Due to the Project,
- [Existing]Irrigator Well Monitoring **and Reporting** Program, and
- Definitions of terms

Performance Standard: The SFPUC will ensure that**: (1)** the production capacity at[existing] irrigators' wells is equivalent to the existing production capacity of the wells [or]**and** is sufficient to meet existing and planned peak irrigation demand at the land use, [whichever is less, provided that the loss of capacity at the existing irrigators' wells is reasonably expected]**(2) the Project does not increase the costs of operating and maintaining irrigators' wells, (3) the Project does not materially interfere with the well owners' overlying water rights, and (4) Project pumping does not cause a water level decline of five feet or more below existing baseline conditions at an irrigator's well.**

A violation of any of the prongs of the above performance standard (1 through 4) would trigger SFPUC mitigation obligations, provided that the violation is reasonably determined, based on verifiable data, to have been caused by the Project.[If the production capacity at an existing irrigator's well is shown to drop below this performance standard due to the Project, measures to avoid or reduce Project contributions to the loss of capacity or measures to meet irrigation needs will be implemented by the SFPUC. The SFPUC will implement these measures] **Methods for determining causation are described below. When the Project is determined to have caused the violation, the SFPUC will implement the mitigation actions described below**, or a combination thereof, [so that water supply provided to the land use by the existing irrigators' well(s) is not interrupted. The method for determining whether the loss of pumping capacity is attributable to the Project is described in detail below]**to avoid or reduce Project effects**. HY-16

In order to implement one or more of the mitigation actions, it is necessary to, and the SFPUC shall, **(1)** conduct monitoring at [existing]irrigators' wells to determine whether the performance standard is being met[. The monitoring program], **(2) analyze and periodically report the data collected through well monitoring, and (3) consult with the owner(s) of impacted irrigation wells to reach agreement(s) concerning appropriate mitigation. The Monitoring and Reporting Program** is described in detail below. HY-16 cont.

Mitigation Actions to be Undertaken to Meet the Performance Standard: The SFPUC shall, in cooperation with the existing irrigators, implement **mitigation** actions [to meet]**when** the performance standard in this mitigation measure [when the production capacity of an existing irrigator's well drops below the performance standard]**is violated**. The following mitigation actions[are examples of the type of actions that], alone or in combination, will avoid or reduce Project impacts, depending on the circumstance: HY-16

[1. *Improve irrigation efficiency.* Seek ways to reduce applied water demand through irrigation efficiency measures. For example, sprinkler nozzles can be replaced with more efficient models, sprinklers can be added to achieve more evenly distributed irrigation, and installation of soil-moisture sensors can aid in irrigation scheduling.] HY-15

[2. *Modify irrigation operations.* Seek ways to modify operations to accommodate reduced well capacity. For example, use longer irrigation cycles to meet the same irrigation demand or use evapotranspiration data to modify irrigation scheduling.]

1. *Redistribute GSR pumping.* [Seek to reduce]**Reduce** the rate of groundwater level decline in the affected area by redistributing Project pumping to other areas; however, in no case would redistribution be undertaken where the resulting groundwater levels would then decline more than [what was originally]predicted [to be caused by the]Project [by]modeling. The [bi-annual]**periodic** analyses of data from the Monitoring **and Reporting** Program would continue while this action is undertaken. The action would cease when the data analysis [shows]**demonstrates** that the performance standard is met without continued redistribution of GSR pumping. HY-15

2. *Reduce GSR pumping.* [Seek to reduce]**Reduce** the rate of groundwater level decline through a reduction in Project pumping (including a cessation in Project pumping at wells in the vicinity of [existing]**impacted** irrigation wells). The [bi-annual]**periodic** analyses of data from the Monitoring **and Reporting** Program would continue while this action is undertaken. The action would cease when the data analysis [shows]**demonstrates** that the performance standard is met without continued reduction of GSR pumping.

3. ***Improve irrigation efficiency.* Reduce applied water demand through irrigation efficiency measures. For example, sprinkler nozzles can be replaced with more efficient models, sprinklers can be added to achieve more evenly distributed irrigation, and installation of soil-moisture sensors can aid in irrigation scheduling.** HY-15

4. ***Modify irrigation operations.* Modify irrigators' wells operations to accommodate reduced well capacity. For example, use longer irrigation cycles to meet the same irrigation demand or use evapotranspiration data to modify *irrigation scheduling.*** HY-15 cont.

5. *Lower pump in irrigation well.* [~~A~~]**Lower** pump [~~may be lowered~~]**in irrigator's well** to accommodate water level fluctuations induced by Project pumping that exceed historic levels. **SFPUC would compensate the well owner for any increased pumping and maintenance costs.**

6. *[~~Lower~~]**Replace** and [~~change~~]**lower** pump in irrigation well.* [~~A~~]**Replace** pump [~~may be replaced~~]**in irrigator's well** and set **pump** to a lower depth to accommodate new head conditions because of lowered water levels induced by Project pumping. **SFPUC would compensate the well owner for any increased pumping and maintenance costs.** HY-15

7. *Add storage capacity for irrigation supply.* Under certain conditions, **add** storage[~~-may be added~~] (e.g., an above-ground tank **with suitable shielding landscaping**) to offset reduced well capacity caused by Project pumping. The availability of storage capacity (or of increased capacity) can provide an ability to meet peak flow rates that are otherwise reduced by lowered water levels**. SFPUC would obtain any necessary permits**. HY-15

8. *Replace irrigation well.* [~~An~~]**Replace an** existing irrigation well [~~may be replaced~~]with a new well which may be designed with different screen intervals or depth. The new irrigation well could therefore access additional groundwater resources at new depths in the aquifer. **Subject to owner agreement, the replacement irrigation well would be subject to the Monitoring and Reporting Program and, if significantly impacted, to these mitigation measures.** HY-15

9. *Replace irrigation water source.* In the event that the preceding options cannot be implemented without causing an interruption in the irrigation supply, **provide** a temporary replacement water supply source [~~would be provided~~]from the regional water system or Partner Agency distribution system via temporary aboveground pipes close to the location where additional irrigation supplies are needed until another mitigation option(s) is implemented. HY-15

10. ***Compensate existing irrigation well owner(s) for reduced pumping capacity and/or increased pumping costs.* In the event that SFPUC cannot reach an agreement with the owner(s) of significantly impacted irrigation wells concerning implementation of the preceding options, the SFPUC shall compensate such owners in proportion to the reduction in well pumping capacity below the performance standard and shall compensate the well owner for any increase in pumping operation and maintenance costs caused by Project operations.** HY-7

[~~Method~~]Methods for Determining Whether Loss of Pumping Capacity or Increased Pumping Costs at an [~~Existing Irrigation~~]Irrigators' Well(s) Is Due to the Project. Any loss in production capacity of an [~~existing irrigation well(s)~~]**irrigators' well(s), increased pumping costs at such wells, interference with overlying water rights, or well water level drawdown of five (5) feet or more** is assumed to be caused by the Project if: 1) it is temporally correlated with the onset of increased Project pumping; 2) it occurs in an area predicted [~~in this EIR~~]to be affected by well interference; 3) static groundwater levels have dropped; 4) pumping groundwater levels have not dropped more than static groundwater levels (if pumping groundwater levels drop more than static groundwater levels it could indicate the drop in production capacity is due to increased well inefficiency and not due to the Project); or 5) no other obvious **and substantiated** reason exists for the [~~drop in production capacity~~]**these effects.** If another reason **for these effects** is identified **by the SFPUC, another agency, or by a third-party (such as an owner of an irrigation well or an owner's agent)**, it will be based on the written professional opinion of a certified hydrogeologist or professional engineer with expertise in groundwater hydrology that will be submitted to the San Francisco Planning Department's Environmental Review Officer (ERO), or designee, **the SFPUC, and the affected irrigation well owner** for review and concurrence. The ERO may require the SFPUC to hire an independent expert to advise the ERO. HY-13

To support this determination, the SFPUC will develop **and share with irrigation well owners** at least the following information:

- *Item 1. It is temporally correlated with the onset of increased Project pumping.* The SFPUC will develop a graph that shows the pumping of Project and Partner Agency wells within 1.5 miles of the[~~ existing~~] irrigator's well over time, compared to the production capacity of the [~~existing~~]irrigator's well over the same period.

- *Item 2. It occurs in an area predicted to be affected by well interference.* The SFPUC will calculate the cone of depression, using [~~the same~~]**a** methodology [~~as used in evaluating the impact in the EIR~~]**agreed upon in consultation with existing irrigation well owners**, at Project and Partner Agency wells within 1.5 miles of the [~~existing irrigator's~~]**irrigators'** well**(s)**, as well as at the [~~existing irrigator's~~]**irrigators'** well**(s)**.

- *Items 3 and 4. Static water levels have dropped and pumping water levels have not dropped more than static water levels.* The SFPUC will develop a graph showing the difference between static and pumping water levels at the [~~existing irrigator's~~]**irrigators'** well**(s)** over time.

- *Item 5. Another* ***substantiated*** *reason exists for the drop in production capacity.* If the SFPUC [~~believes~~]**concludes, based on verifiable evidence,** that the drop in production capacity of the [~~existing irrigation~~]**irrigators'** well(s) is caused by factors other than the Project – and the owner of the [~~existing irrigation~~]**irrigators'** well(s) disagrees – then the SFPUC will have a certified hydrogeologist or professional engineer with expertise in groundwater hydrology prepare documentation regarding the reasons for the drop in production capacity and submit this documentation to the **owner of the irrigators' well(s) for an opportunity for peer review. This documentation shall also be submitted to the** San Francisco Planning Department's ERO, or designee[~~, with a copy to the existing well owner~~]. The ERO may require the SFPUC to hire an independent expert to advise the ERO.

HY-13 cont.

Irrigators' well owners shall be afforded at least 30 days to review and comment on the information identified in Items 1 through 5, above, as well as the underlying data and analysis on which the SFPUC is relying, prior to any determination of causation.

After reviewing any comments submitted by owner(s) of an irrigators' well affected by the Project, the SFPUC and ERO may determine that the Project does not cause a loss in production capacity of an irrigators' well(s). Within 30 days of receiving written notice of such a determination, the owner of the potentially affected irrigation well may submit a written objection to the determination. If no timely objections are received, the determination is considered final and conclusive. If the SFPUC and ERO maintain the conclusion of no Project impact after considering any timely objection(s), the verifiable evidence on which this determination is based (including a response to all written comments and, if requested, the underlying data and analysis on which the SFPUC is relying) shall be provided to the owner(s) of the irrigation well(s) at issue within 30 days of the receipt of the written comments or the date the determination is made, whichever is earlier. Any dispute concerning the determination may be resolved through mediation or legal action.

HY-17

Alternatively, the owner(s) of any irrigators' well may submit to the SFPUC and ERO substantiated information showing that Project operations have caused violations of the above performance standard. SFPUC would have the opportunity to review and comment on the information provided by irrigation well owner(s) prior to any determination of causation by the ERO.

In addition, the following Monitoring **and Reporting** Program will assist the SFPUC **and ERO** in obtaining the data necessary to support the determination of [~~probable cause~~]**causation** for any groundwater level decreases at an [~~existing~~]irrigator's well.

[~~Existing~~]Irrigation Well Monitoring and Reporting Program. The SFPUC will monitor **and report** short- and long-term changes in groundwater conditions and operations at [~~existing~~]irrigators' wells. This [~~Existing~~]Irrigator Well Monitoring **and Reporting** Program applies to existing well owners who choose to participate in the program. **The terms for participating in the Monitoring and Reporting Program shall be established through negotiations between SFPUC and irrigation well owners, with input from the ERO. Any disagreements concerning the terms for participation will be resolved through mediation.** Participation in this monitoring program is [~~assumed to be necessary for the~~]**not mandatory, but would aid in the**

HY-12

SFPUC's effective implementation of mitigation actions[~~ to be effectively implemented by the SFPUC~~] at the affected well. HY-12 cont.

At least 18 months prior to the commencement of pumping of Project wells, the SFPUC shall contact existing irrigators with information about the [~~monitoring program~~]**Monitoring and Reporting Program**. To participate in the program, existing irrigators will complete a registration form and [~~an~~]**enter into a mutually acceptable** agreement with the SFPUC.

Prior to issuance of construction permits, the SFPUC shall prepare the Monitoring and Reporting Program and shall submit the Program to the ERO for review and approval. The Program shall provide detailed methodology for monitoring background and Project-induced groundwater levels, water quality, and flow. HY-17

The monitoring program will include the installation of a flow meter to allow for daily well production volumes to be recorded and a groundwater level transducer/data logger (a device for automatically detecting and recording groundwater levels) for measuring groundwater levels. Baseline monitoring of flow meter data and groundwater level data in the[~~ existing~~] irrigators' well[~~ will occur among willing participants~~]**(s) will be collected and reported to participating well owners** for at least one year prior to pumping the Project wells. In addition to baseline monitoring of well production and groundwater levels, pumping tests will be conducted prior to commencement of pumping Project wells to collect baseline data on pump and well performance **and report that data to well owners**. The pumping tests will collect data on well capacity and drawdown, well specific capacity, pump efficiency and head-capacity characteristics, sand content, and selected water quality parameters. HY-12

The SFPUC shall also collect any existing information and data available regarding the [~~existing irrigator's~~]**irrigators'** well**(s)** from the well [~~owner~~]**owners**, including any estimates or measurements of historical, existing, and planned land and water use (e.g., driller's logs, water level data, pumping records, acres irrigated) to provide information upon which to evaluate the performance of the [~~existing irrigator's well~~]**irrigators' wells** over time[~~ and~~]**,** to establish baseline operating conditions**, and to determine Project impacts on planned water use**. When there is an opportunity to open an [~~existing irrigator's~~]**irrigators'** well (such as when a pump is removed by a well owner), the SFPUC may seek to conduct video log surveys in wells to determine the condition of the well structure. The monitoring effort will continue through the life of the Project, unless canceled by the well owner as part of the well owner's decision to remove itself from the [~~monitoring program~~]**Monitoring and Reporting Program**. Continued participation in this monitoring program is assumed to be necessary for the mitigation actions to be effectively implemented by the SFPUC[~~ at the affected well~~]. Periodic re-testing of a well may occur as prompted by the need to evaluate performance throughout the life of the Project. If there is uncertainty or disagreement about whether the Project is responsible for a loss in production capacity at an [~~existing irrigator's~~]**irrigators'** well, the SFPUC shall undertake more frequent monitoring and/or testing**, shall timely provide the well owner with all data, reports, and information collected concerning well production** HY-12

capacity, and provide an opportunity for peer review and comment, to help resolve the disagreement. HY-12 cont.

Data from the water level transducers/data loggers and flow meters shall be recorded daily during the first year. Following the first year of data collection, the frequency may be modified (e.g., as prompted by a need to evaluate pump and/or well performance to determine effects of the Project)**, but in no case data collection and recording take place less frequently than once per month**.

The SFPUC shall provide participants with 14-day advance notice for the site visit(s) that would be scheduled within a 48-hour window. HY-12

Data shall be analyzed [~~two times~~]**and reported to irrigation well owners on a quarterly bases** each year during Take Periods when Project wells are pumping regularly. HY-17 The first data analysis period shall end [~~April 30th~~]**March 31st** when production capacity can be compared to peak demand prior to the peak demand period. The second data [~~collection~~]**analysis** period shall end [~~October 30th~~]**June 30th, when pumping is underway during the beginning of the irrigation season. The third data analysis period shall end September 30th,** when groundwater levels will likely be lowest at the end of the peak irrigation season**. The fourth and final data analysis period shall end December 31, when** and production capacity of the well would be at its lowest. HY-12

The[~~ data shall be compiled and analyzed by~~] SFPUC's certified hydrogeologist or professional engineer with expertise in groundwater hydrology [~~by June~~]**shall compile, analyze, and report the collected data for each quarter to irrigation well owners.** HY-17 **The quarterly well monitoring reports shall be furnished by April** 30th**, July 31st, October 31st** and January [~~15th~~]**31st** for the [~~two data analysis periods. The data collected from each existing irrigator's well shall also be shared with the well owner upon request. In Project Put and Hold Periods~~]**four data analysis periods. In Put Years, the SFPUC shall monitor the irrigators' wells for pressurization and/or overflow for the first three months of injection and report analyzed data to irrigation well owners no later than July 31st. In Hold Years**, data shall be analyzed once per year for the data collected through October with analysis **and reporting to irrigation well owners** completed by January 15th. HY-12

Voluntary monitoring of all irrigators' wells would be required during the period that is the longer of: (i) 17 years (or, twice the 8.5 year cycle analyzed in this DEIR); or (2) the period including the first 5 Take Years of the Project from the initiation of Project operation. After this initial period of monitoring, the SFCUP and the ERO, in consultation with irrigation well owners, shall jointly evaluate the effectiveness of the Monitoring and Reporting Program and determine if data collection, monitoring and reporting frequencies and other procedures should be revised or eliminated. HY-6

Definition of Terms OV-1

Existing or planned land use. All existing and planned land uses served by[existing] irrigators' wells are related to turf irrigation. The only planned known (future) land [use is]**uses are** the potential expansion of the Holy Cross Cemetery to include up to an additional 30 acres of irrigated turf **and the planned expansion of the Cypress Lawn Memorial Park to include an additional approximately 39 acres of irrigated turf**. OV-1 cont.

Existing baseline conditions. Existing baseline conditions is the verified seasonal pre-Project water levels at an irrigator's well, measured over a one-year period. HY-12

Existing well capacity. Existing well capacity is the production capacity of the existing irrigator's well during the 12-month monitoring period prior to operation of the Project. The well capacity will be determined[by]**, and confirmed by irrigation well owners, through** the Monitoring **and Reporting** Program described herein. HY-15

Peak irrigation demand. Peak irrigation demand is defined either as the actual peak irrigation demand determined from well production records obtained by the Monitoring **and Reporting** Program described herein or as identified in Table M-HY-6 (developed from Table 5.16-14 [Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought] of the EIR), whichever is agreed to by the parties.

Production capacity. Production capacity of a well is the quantity of water that can be produced by a well in a 12-hour period. Production capacity will be calculated based on daily production, as measured by the flow meter, divided by pumping duration, as measured by the flow meter, multiplied by 12 hours. HY-12

[Existing irrigators]**Irrigators'** wells. The existing **and replacement** wells that support the following **existing and planned** land uses are the only wells that meet the definition of [existing]**"**irrigators' wells**"** for the purposes of this mitigation measure: Lake Merced Golf Club, Woodlawn Memorial Park, Italian Cemetery, Eternal Home Cemetery, Olivet Memorial Park, Home of Peace Cemetery, Cypress Lawn Memorial Park, Holy Cross Cemetery and the California Golf Club. Existing wells are those wells that are in operation prior to the approval of the Project. **Replacement wells are those wells that may replace existing wells (due to Project interference or for some other reason).** HY-15

Impact Conclusion: ***Less Than*** *Significant [and Unavoidable]with Mitigation*

Exhibit D

O-CLMP-QUICK
cont

Document comparison by Workshare Compare on Tuesday, June 11, 2013 12:52:59 PM

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Document 2 ID	interwovenSite://MCW2/DB2/24163919/2
Description	#24163919v2<DB2> - Cypress Lawn: Proposed_Revisions_to_SFPUC_MM
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Legend:	
Insertion	
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Moved cell	
Split/Merged cell	
Padding cell	

Statistics:	
	Count
Insertions	171
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Moved to	0
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Format changed	0
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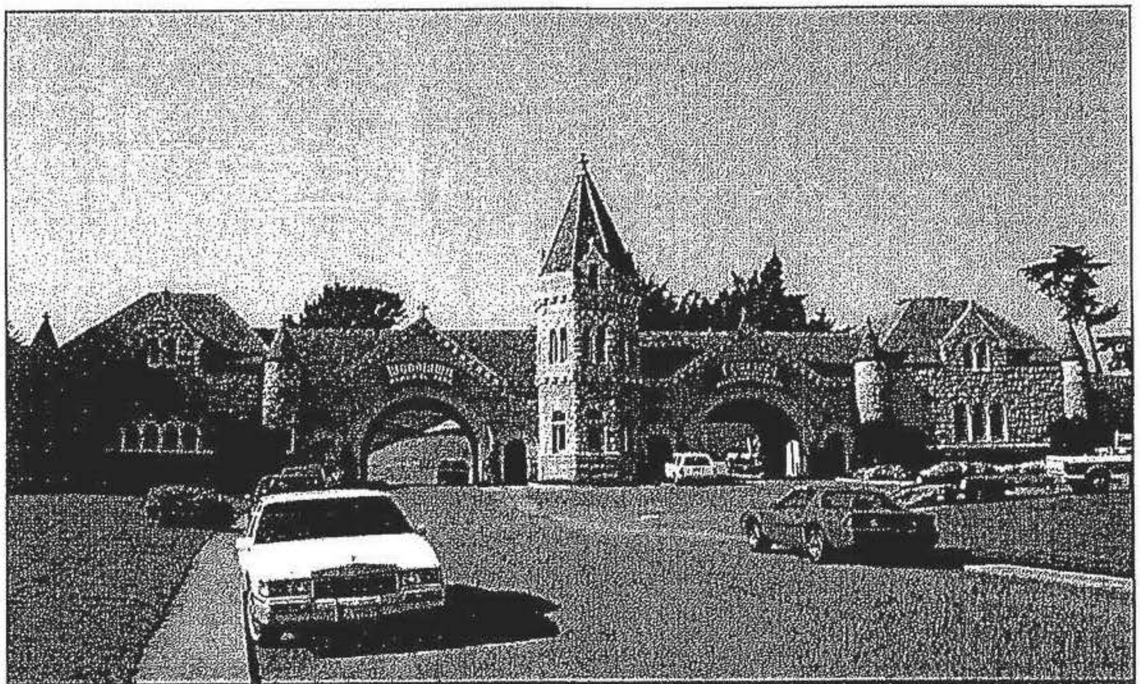
EXHIBIT E

Exhibit E

O-CLMP-QUICK cont



WOODLAWN GATEHOUSE ENTRY, 1904, Woodlawn Memorial Park. The Gatehouse is said to have the highest artistic value of any like building in Colma or possibly the State.

CR-2

HISTORICAL RESOURCES ELEMENT

5.08.000 INTRODUCTION

5.08.010 PURPOSE

The Town of Colma has a unique history among California cities. Although it haw been an important center, at various times, for agriculture and floriculture, it is truly unique because of its cemeteries that incorporated as a town in 1924 and now comprise nearly three-quarters of the land area within the Town limits. Buildings, monuments and residences associated with the cemeteries are among the most prominent historical resources in Town. The purpose of this Historical Resources Element is to identify historic sites and buildings in Colma and to set forth programs for their protection.

5.08.020 AUTHORIZATION

The California Government Code allows the development of optional General Plan Elements. The Code, Section 65303(J), permits the inclusion of an Historical Resources Element for the identification, establishment, and protection of sites and structures of architectural, historical, archaeological and cultural significance, including significant trees, hedgerows and other plant materials.

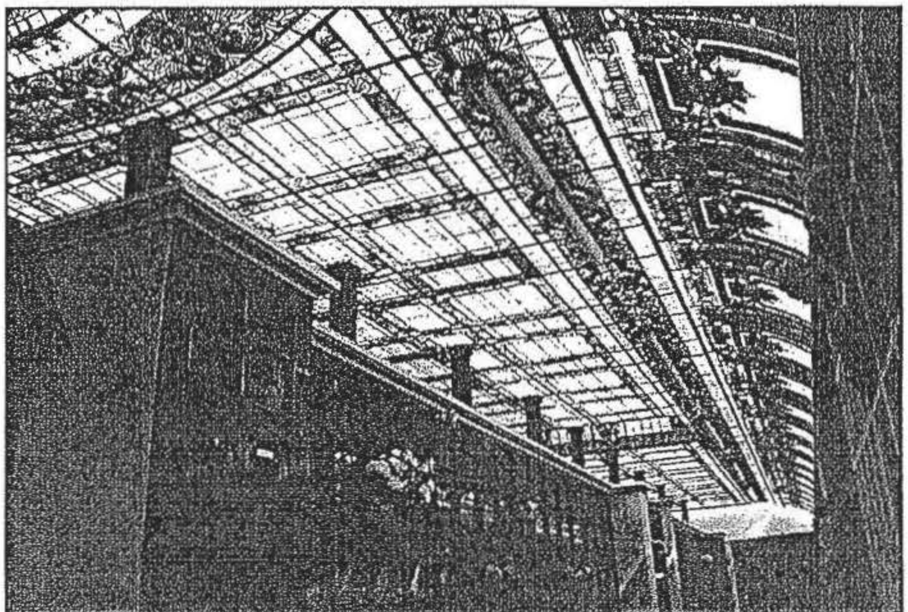
5.08.030 RELATIONSHIP TO OTHER PLAN ELEMENTS

The Historical Resources Element is related to all of the other General Plan Elements. The Town's historic buildings, sites and districts can be affected by encroaching land uses, by natural hazards such as earthquakes, and by roads and transit facilities. The most extensive existing and established land use in Colma are the memorial parks and associated uses. The Land Use Element addresses compatibility between memorial parks and proposed future development. The Open Space Element recognizes dedicated cemetery lands as permanently unavailable for urban development. The Housing Element works within the framework set by the Land Use and Open Space Elements. The Safety Element strives to protect against natural hazards.

Exhibit E

O-CLMP-QUICK cont

CR-2 cont.



COMMUNITY MAUSOLEUM, 1916, 1924, Cypress Lawn Memorial Park. The entire ceiling of the Mausoleum is comprised of stained glass.

5.08.040 PAST PRESERVATION EFFORTS

Recognizing its uniqueness the Town of Colma commissioned an historic resources inventory in December 1992. The Colma Historic Resources Inventory identifies and describes numerous buildings and sites having significance of local, State and National importance. A small sample of the Town's notable historic resources includes Cypress Lawn Memorial Park which is a virtual museum of architecture and art, being one of the last grand rural cemeteries built in the west. The Cypress Lawn Community Mausoleum covers four and one-half acres and represents one of the finest collections of stained glass in the United States with work by Tiffany, Connick and Lamb. Cypress Lawn has established a program to restore all of the stained glass window and ceiling panels. A restoration studio and technical staff are located at 1791 Old Mission Road.

The Holy Cross Gateway/Lodge is one of only a few examples of the Richardson Romanesque architectural style in San Mateo County and is the oldest remaining building ensemble of Colma's first cemetery; Woodlawn's Gatehouse is considered to possess the highest artistic value of any like architectural feature in Colma or possibly in the State of California. Other historic commercial or residential buildings include: Molloy's, the Town's oldest commercial establishment in continuous operation since 1883; L. Bocci Monuments Shop which was established in 1904 and is still in operation; and, the Ottoboni residence at 417 F Street where Colma's floriculture industry began. All of the Town's historic resources are summarized in Section 5.08.100.

MOLLOY'S, 1883. The oldest commercial establishment in continuous operation.

Grass roots interest in Historic Preservation by Town residents resulted in the formation of a Chartered Historic Association several years ago. The Colma Historical Association has begun a museum with collections of relics and information from the past. The Association will play a key role in the Town's historic preservation efforts.

The Town recently acquired the Old Colma Railroad Station, built in 1881, which was threatened to be demolished; by the construction of the Bay Area Rapid Transit (BART) facilities. The Station, formerly known a the School House Station, played a key role in the development of Northern San Mateo County as it was where farmers and teamsters stopped on their way to San Francisco; where the area's first school was built and around which businesses were established. The Station's architectural style is rare in the Bay Area and is one of the last surviving examples of early station houses. The Station will be restored for the Colma Historical Association to house its offices and museum.

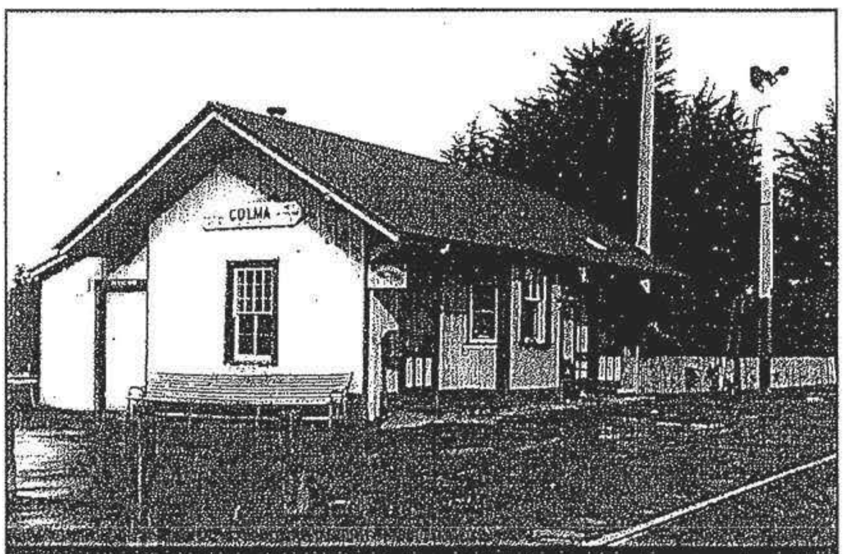
The Town has attempted to preserve its open space and park-like greenbelt character by adopting certain development constraints. One regulation requires a 30 foot landscape setback from El Camino Real and another requires a 15 foot setback from Colma Creek. A Tree Ordinance preserves and protects trees in the Town, some of which are well over 100 years old. The Land Use Element requires that buildings on the El Camino Real corridor utilize a Spanish Eclectic architectural style incorporating tile roofs, wrought iron, stucco exterior and colors complementary to the Colma Town Hall building built in 1937.

5.08.050 FUTURE HISTORIC PRESERVATION

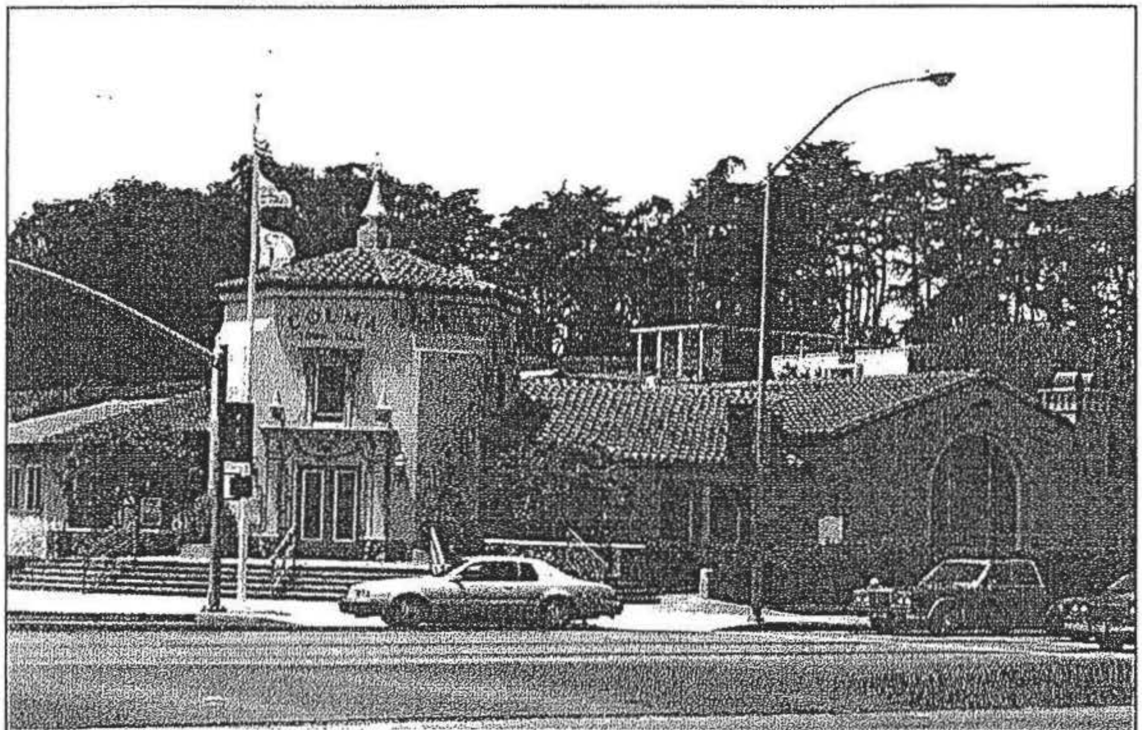
In the interest of preserving Colma's historic resources the Town must look for ways to both promote and protect their historic resources. Numerous historic buildings have been lost to the pressures of development. The Town must find ways in its day-to-day operation to prevent other historic resources from being lost. Three such efforts are described below.

5.08.051 <u>Historic Resource Registration</u>
One of the basic steps that should be taken to protect historical resources is for the Town of Colma to formally adopt a list of historical resources and to seek their inclusion on national and state registers subject to the consent of the property owners. Procedures for nomination to national and state registers are described in Section 5.08.140.

CR-2
cont.



OLD COLMA TRAIN STATION, 1881. One of the last surviving examples of early station houses.



COLMA CITY HALL, 1936-1940: Colma's City Hall is a symbol of the community.

CR-2 cont.

5.08.052 Historic Route and Signage

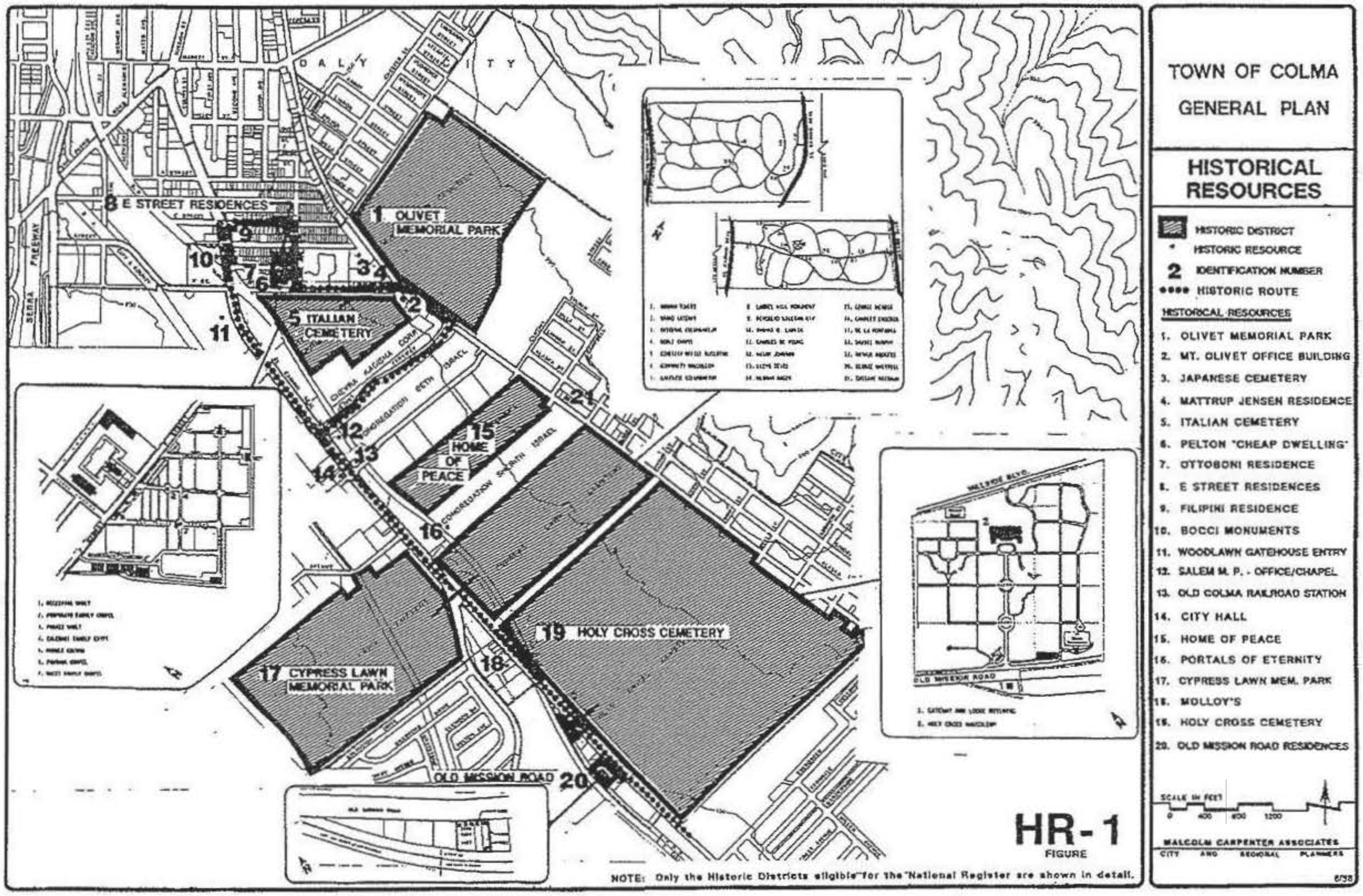
In an effort to preserve the Town's historic resources the public should be informed and educated about Colma's historic buildings, monuments, mausoleums and sites. One way to do this is to establish an easy to follow historic route leading motorists and pedestrians past some of Colma's key historical sites. Knowledge about the Town's historic resources will increase the public's appreciation and support for historic preservation efforts. An informed public will build a constituency which is necessary to promote and ensure a successful Historic Preservation Program.

The historic route diagrammed on Figure HR-1 identifies 20 properties with a variety of historic resources including seven historic districts, numerous residences from different eras, several offices and commercial establishments, cemetery buildings, mausoleums and the Colma Town Hall. The historic route map and a short description of the sites should be prepared in brochure form and made available at City Hall, the Colma Historical Association offices, local libraries and schools, the future Town Community Center, and at relevant Town events. Special signs with a distinctive color and lettering should be installed to facilitate and inform the public about the Historic Route.

5.08.053 Historic Commons

Only a few of Colma's historic residences remain. Many were lost during expansion of the commercial areas. To ensure that none of the remaining buildings are lost, the Town should establish protected historic districts or seek a site where threatened historic buildings can be relocated and restored for residential, office or commercial use. If a relocation site is found it should be developed and promoted as an Historic Commons. Depending on the use of these buildings and their location, the Historic Commons could be included on the Historic Route described above or showcased at community events to illustrate different restoration techniques.

Exhibit E



CR-2
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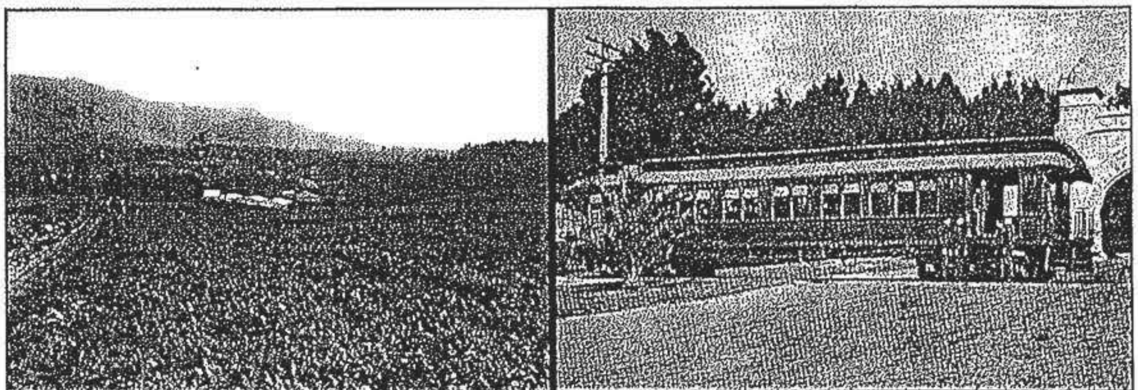
O-CLMP-QUICK
cont

Exhibit E

O-CLMP-QUICK cont



Early Colma (shown in 1929, left) was a tranquil farming community. Southern Pacific Railroad's funeral car, "El Descanso," (right) at Cypress Lawn photographed during the 1890's.

CR-2 cont.

5.08.100 HISTORIC RESOURCES

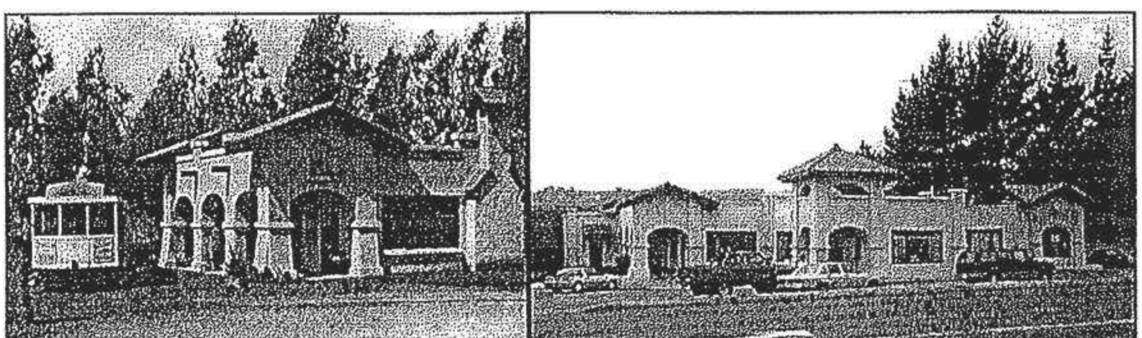
5.08.110 HISTORIC OVERVIEW OF COLMA

In the 1850's a large area in northern San Mateo County was called Colma. This early district extended from the San Francisco County line to parts of today's Daly City and South San Francisco and from San Bruno Mountain to Pacifica. Immigrant settlers started farming in the area in the mid-1850's growing potatoes, vegetables and grain for the San Francisco market. Later floricultural, hog ranches, and dairies were significant business in the area.

In the late 1880's several cemeteries purchased land in the Colma area as an outcome to their mounting concerns about a movement in San Francisco to stop burials within the City. These early cemeteries include:

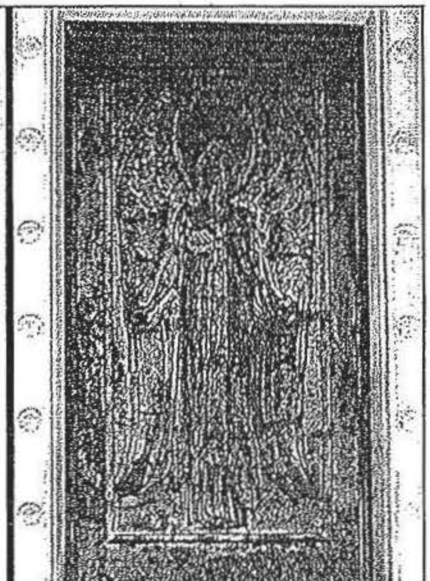
- Holy Cross, 1887
- Cypress Lawn, 1892
- Hills of Eternity, 1889
- Mount Olivet, 1896
- Home of Peace, 1889
- Italian Cemetery, 1899
- Salem Memorial Park, 1891

The first internment in the Colma area was in 1887 at Holy Cross Cemetery. The pace of cemetery development accelerated when the City of San Francisco, in 1901, passed an ordinance prohibiting burials in the city. The cemeteries which were established in Colma during this period include: Japanese Cemetery,



MOUNT OLIVET CEMETERY OFFICE AND STREETCAR LINE, 1896 (circa 1910, left, recent photo, right). Now used as an office building. The former cemetery office entrance was at the southeast tower. The arcade served as the boarding area for the electric railway. The building included a kitchen to entertain undertakers.

CR-2 cont.



CHARLES CROCKER MAUSOLEUM, 1895-98 (left), Cypress Lawn Memorial Park. The sculpted bronze doors of the Mausoleum are one of the earliest works of Robert I. Aiken, one of only a few Californians to become a major American sculptor. The hovering angel, with closed eyes, holding a single flower, is called "The Gate of Silence."

DE LA MONTANYA MAUSOLEUM, 1909, Cypress Lawn Memorial Park (right). The Mausoleum with its Spanish Gothic three-stage towers is one of the more elaborate mausoleums at Cypress Lawn.

1901; Eternal Home Cemetery, 1901; Serbian Cemetery, 1901; Greenlawn, 1903; and Woodlawn, 1904.

During the period when the cemeteries were being evacuated from San Francisco, a group of cemeteries in the Colma area organized themselves as the Associated Cemeteries. The Associated Cemeteries realized that the only way to avoid recurring eviction and other stringent regulations and controls was to incorporate themselves. So the Town of Lawndale (renamed Colma in 1941) was incorporated on August 5, 1924 through the efforts of the Associated Cemeteries. When the San Francisco Board of Supervisors, in 1937, voted to evacuate all of the cemeteries within their city limits, additional cemetery growth and development occurred in Colma.

Cemeteries which relocated brought historically significant monuments, mausoleums, and the remains of California's pioneers and prominent figures to the Town of Colma. Many of the monuments and mausoleums that are found in local cemeteries are outstanding examples of the stonecutters' art such as the ornate Italian Renaissance Fugaze family vault and the granite Fontana Chapel found at the Italian Cemetery. People are also attracted to Colma to visit the gravesite of famous persons, such as Wyatt Earp, or to enjoy a walk through time to see the sites of California's famous and not so famous citizens who contributed to the making of the State.

Exhibit E

O-CLMP-QUICK cont

THOMAS O. LARKIN MONUMENT, 1859, Cypress Lawn Memorial Park (top). The monument was moved to Colma from San Francisco. Thomas Larkin was California's first and last American Consul to Mexican California.

MATTRUP JENSEN'S RESIDENCE, 1930 (bottom). Mattrup Jensen, who is considered the "Father of Colma", designed and built this house.

cont.

CR-2 cont.

The presence of cemeteries brought stonecutters, gardeners, florists, morticians and laborers to the area. Their work and crafts have contributed to the aesthetics of the Town. Agriculture and flower nurseries also had a presence in the Town. Evidence of these later uses still remain. However land clearing has resulted in the removal of almost all of the farmstead buildings.

Numerous individuals were key in the development of Colma. One notable individual was Mattrup Jensen, a trained engineer and landscape architect who as the superintendent of the Mount Olivet Cemetery completely redesigned the cemetery grounds. He is considered the "Father of Colma" and was Colma's fir mayor. Mattrup Jensen's home on F Street is eligible for listing on the National Register as a landmark representing his accomplishments in the community both as a civic leader and a businessman.

5.08.120 HISTORIC RESOURCES -- SITES AND DISTRICTS

Colma has a number of individual buildings and sites which are historically significant. There are also several concentrations of buildings, monuments and structures which are better identified as historic districts. Table HR-1 (following pages) comprises the official list of historic resources in the Town of Colma. These are mapped on Figure HR-1. The criteria for determining whether an historic resource merits national, state or local recognition are discussed in Section 5.08.130.

Exhibit E

O-CLMP-QUICK
cont

TABLE HR-1: Colma Historical Resources

1st of 2 TABLES

	LOCATION	STREET ADDRESS	NAT'L REG STATUS	DESIGNATION	SIGNIFICANCE
	Filipini Residence	7701 Mission Street	5S1	HR	Arch
	E Street Historic District	464 E Street 466 E Street 467 E Street 469 E Street 471 E Street	5S1 5S1 5S1 5S1 5S1	HR/C HR/C HR/C HR/C HR/C	Arch Arch Arch Arch Arch
	Woodlawn Entry	1000 El Camino Real	3S	L	Arch
	Salem Memorial Park Office/Chapel	1171 El Camino Real	5S1	HR	Arch
	City Hall	1198 El Camino Real	3S	L	Arch/Hist
	Home of Peace Historic District	1299 El Camino Real	5S1	HR(5)	Arch/Hist
	Hills of Eternity	1301 El Camino Real	5S1	HR	Arch
	Cypress Lawn Historic District	1370 El Camino Real	3S	L(21)	Arch/Hist
	Ottoboni Residence	417 F Street	3S	L	Arch/Hist
	Pelton "Cheap Building"	437 F Street	5S2	HR	Arch
	Italian Cemetery Historic District	540 F Street	3S	L(7)	Arch/Hist

TABLE CONTINUED NEXT PAGE

L = Landmark HR = Historic Resource C = Building Contributing to a Historic District.
(5) Indicates the number of individual resources associated with this property.
A "3S" means the property may be eligible for the National Register

CR-2
cont.

Exhibit E

O-CLMP-QUICK cont

TABLE HR-1: Colma Historical Resources

2nd of 2 TABLES	LOCATION	STREET ADDRESS	NAT'L REG STATUS	DESIGNATION	SIGNIFICANCE
	Mattrup Jensen Residence	649 F Street	3S	L	Hist
	Japanese Cemtery	1300 Hillside Blvd	7	L	Hist
	Olivet Office	1500 Hillside Blvd	3S	L	Arch/Hist
	Olivet Memorial Park Historic District	1601 Hillside Blvd	4S8	HR(3)	Arch/Hist
	Pet's Rest Office	1905 Hillside Blvd	5S1	HR	Arch
	Old Mission Road Historic District (Lagomarsino Farm)	1431 Mission Road	3S	HR/C	Arch/Hist
		1433 Mission Road	3S	HR/C	Arch/Hist
		1439 Mission Road	3S	HR/C	Arch/Hist
		1445 Mission Road	3S	HR/C	Arch/Hist
		1451 Mission Road	3S	HR/C	Arch/Hist
		1457 Mission Road	3S	HR/C	Arch/Hist
	Holy Cross Historical District	1595 Mission Road	3S; 4	HR(2)	Arch/Hist
	Molloy's	1655 Mission Road	3S	L	Hist
	Bocci Monuments	7778 Mission Street	3S	L	Hist
	Old Colma Railroad Station	480 Serramonte Blvd (temporary location)	3S	L	Arch/Hist

L = Landmark HR = Historic Resource C = Building Contributing to a Historic District.
(5) Indicates the number of individual resources associated with this property.
A "3S" means the property may be eligible for the National Register

CR-2 cont.

O-CLMP-QUICK cont

5.08.121 Sites and Districts Eligible for National Register

Buildings eligible for National Register listing are shown below:

PLACE	ADDRESS	DATE	STYLE	SIGNIFCANCE*
Woodlawn Office	1000 El Camino Real	1904	Romanesque	C(a), (c)
City Hall	1198 El Camino Real	1937	Spanish Eclectic	A, C(c)
Ottoboni House	417 F Street	1904	Craftsman	A, B
Mattrup Jensen House	649 F Street	1903	Vernacular	A, B
Olivet Office	1500 Hillside Blvd	1896	Mission Revival	A, C(c)
Molloy's	1655 Mission Road	1872	Vernacular	A
Bocci Monuments	7778 Mission Street	1934	Vernacular	A, B
Colma RR Station	480 Serramonte Blvd (Temporary Location)	1881	RR Depot	A, C(a)

* National Register Significance Criteria:
A = Representative of Events of Broad Pattern of History
B = Associated with Important Persons
C = Architectural Significance
(a) Significant Type, Period, or Method of Construction
(b) Work of a Master

CR-2 cont.

Four proposed historic districts eligible for National Register listing are shown below:

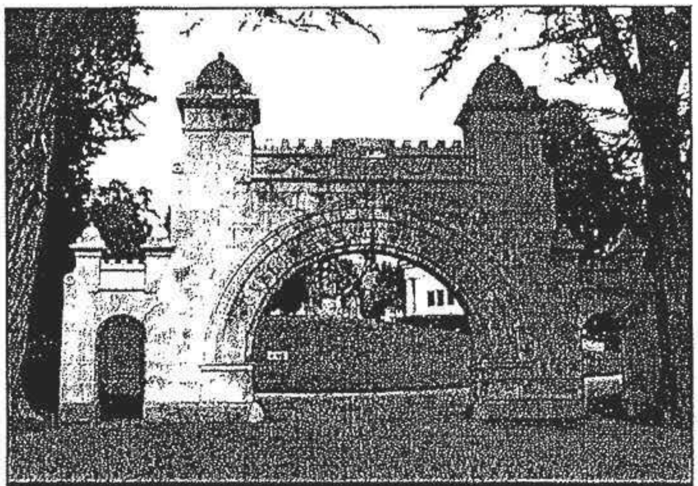
PLACE	ADDRESS	DATE	STYLE
Cypress Lawn	1370 El Camino Real	1892	Elite Garden Cemetery, Memorial Park; 21 resources
Italian Cemetery	540 F Street	1899	Traditional European Cemetery; 7 resources
Old Mission Road	1431-1457 Mission Road	1908-1918	Neoclassical Houses; 6 resources
Holy Cross Cemetery	1595 Mission Road	1886	Rural Cemetery; 2 resources

Exhibit E

O-CLMP-QUICK cont

5.08.121.1 Cypress Lawn Historic District

Cypress Lawn comprises a museum, visually chronicling the American cemetery movement from the end of the 19th century to the present. The older an smaller section of Cypress Lawn, on the east side of El Camino Real, is considered one of the last grand rural garden cemeteries built in the west. Many ornate monuments and family crypts are evident. In the 19th century rural cemeteries were considered pleasure gardens and not just a place for the dead. The west side of Cypress Lawn represents the cemetery design period of memorial parks. It has an open appearance due primarily to the predominance of memorial tablets that are flush to the ground.



GRANITE ARCHWAY, 1892, Cypress Lawn Memorial Park. Cypress Lawn's grand archway is setback from El Camino Real and has become the symbol of Cypress Lawn.

The original 1892 granite archway and the 1893 Columbarium at Cypress Lawn are among the earliest examples of Mission style architecture to be found. Many of the monuments and mausoleums were designed by prominent architects of the time.

More of California's pioneers and prominent figures are buried ate Cypress Lawn than anywhere else. Some familiar names include Andrew Jackson Pope; Senator George Hearst; Claus Spreckles; James C. Flood; Lillie Hitchcock Coit; Gertrude Atherton; Col. Charles Crocker; Charles DeYoung and William Ralston. The twenty-one resources identified for inclusion in this Historic District are shown on Figure HR-1.

CR-2 cont.

5.08.121.2 Italian Cemetery Historic District

Italian Cemetery is a traditional European cemetery and a showcase of old world stonecutter's art. Most of the historic chapels and mausoleums and funerary art are the products of ethnic Italians living in the area. The cemetery has continued to maintain its old world quality and characteristics. Street trees bordering the cemetery have been pruned using traditional methods found in the Italian cemeteries in Florence and Genoa. Its gardens follow the same geometric layout as a traditional European cemetery. At the time of its establishment the Italian Cemetery in Colma was the only Italian cemetery in the United States. The seven resources identified for inclusion in this Historic District are shown on Figure HR-1.

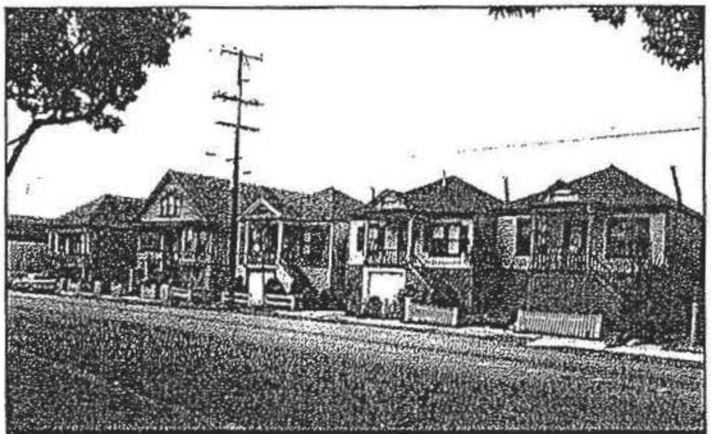
FUGAZI FAMILY MAUSOLEUM, 1916, Italian Cemetery. The mausoleum is an important visual terminus of one of the principal streets of the cemetery.

Exhibit E

O-CLMP-QUICK
cont

5.08.121.3 Old Mission Road (Lagomarsino Farm) Historic District

Old Mission Road has six Neoclassical houses which were built for Frank Lagomarsino between 1908 and 1918. These buildings are the single largest group of early 20th century residences in Colma, and are one of the last remaining examples of the family farmsteads that occupied most of Colma in the early 1900's. These six buildings are shown on Figure HR-1.



LAGOMARSINO VEGETABLE FARMSTEAD, 1906-1918. The six neo-Classical residences are all that remains of Colma's last and largest farmstead.

5.08.121.4 Holy Cross Historic District

Holy Cross Catholic Cemetery, 1886, was the first established cemetery in Colma. It is Colma's oldest and largest cemetery. The Roman Catholic Church purchased the original 176 acres after the church's attempts to purchase new cemetery land in San Francisco failed. The first official burials at Holy Cross were in June 1887. The cemetery may be eligible to the National Register for its design, buildings, mausoleums and monuments as well as the people who are buried there. Some of the prominent names are: Governor Downey, A. P. Giannini, and Senators J. Phelan and J. Fair.

The Holy Cross Mausoleum was designed by John McQuarrie in 1921. The Mausoleum originally covered four acres and had 15,000 crypts, it now occupies nine acres and has approximately 40,000 crypts. In the Mausoleum's rotunda are crypts for the Church's archbishops of San Francisco. Archbishop Joseph Alemany's remains lie here. Alemany played an important role in the development of California's religious community, education of children, and secular life.

CR-2
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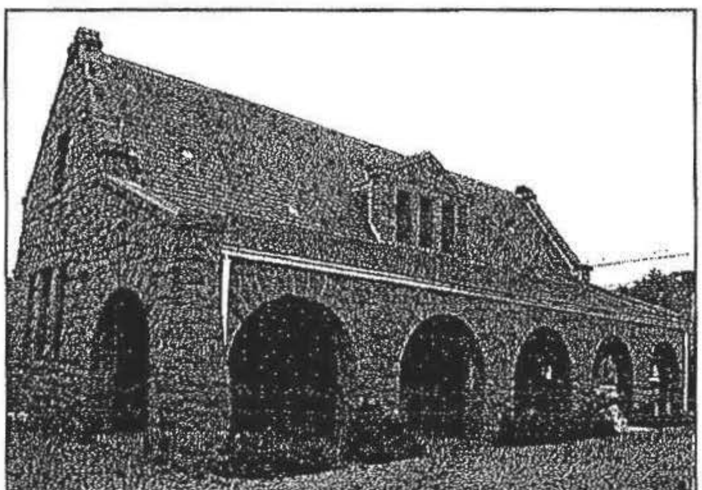


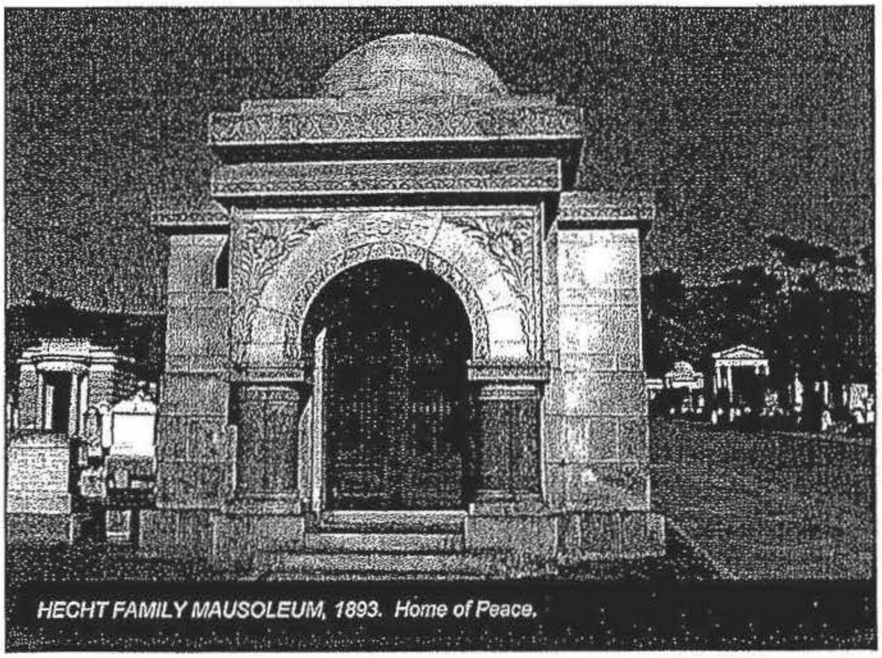
GATEWAY AND LODGE BUILDING, 1920, HOLY CROSS CEMETERY. The masonry railroad depot and office building is also known as McMahon or Cemetery Station. There are only a few examples of the Richardson Romanesque architectural-style in San Mateo County.

The remains of other notable figures in the Mausoleum include Faxon Atherton (prosperous land owner, gold rush merchant, and namesake of the Town of Atherton); Angelo Rossi (San Francisco's twenty-eighth mayor) and Michael Geraldi (former owner of the Grotto at Fisherman's Wharf). There are numerous family mausoleums and monuments and cemetery buildings which contribute to the beauty of this rural cemetery.

Trains stopped at Holy Cross' McMahon or Cemetery Station which is also known as the Gateway and Lodge Building. This stone masonry railroad depot and office building is the oldest remaining building ensemble of Holy Cross. These two resources are shown on Figure HR-1.

Exhibit E

O-CLMP-QUICK cont

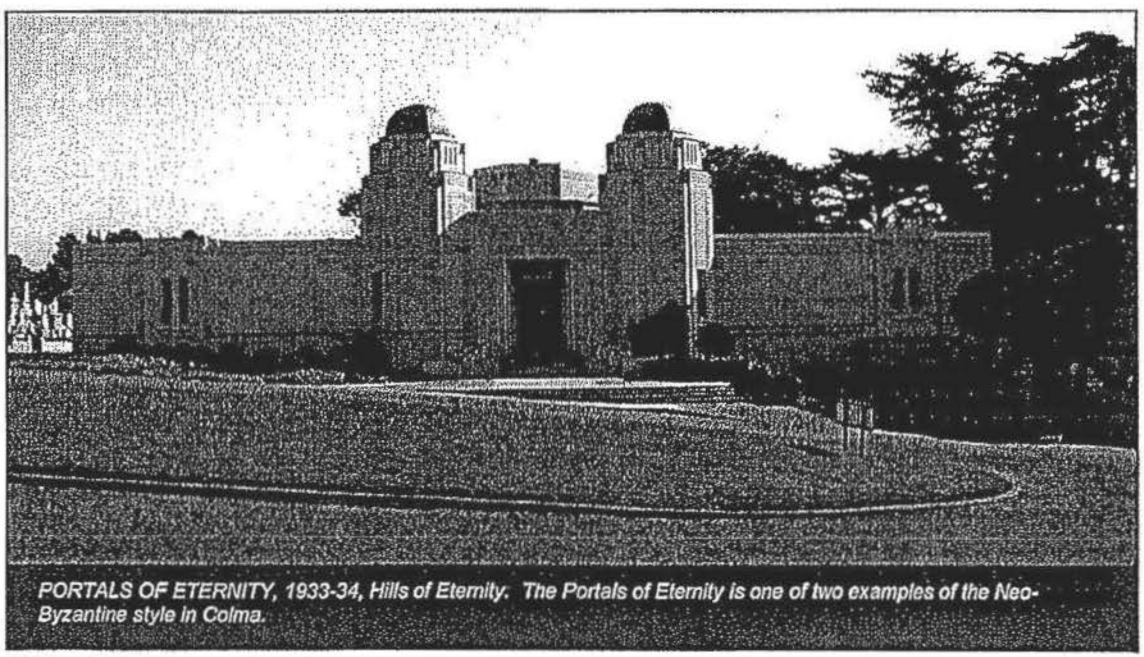


HECHT FAMILY MAUSOLEUM, 1893. Home of Peace.

CR-2 cont.

5.08.122 Other Considerations for Nomination to the National Register

The Home of Peace Cemetery and Hills of Eternity Memorial Park may be eligible for listing on the National Register as Historic Districts for their landscape architecture, cemetery design and the people buried there who contributed to California history. Some of these significant individuals and families are: Levi Strauss, Zellerbach, Fleishhacer and Sutro. Additional research needs to be conducted before National Register eligibility can be determined.



PORTALS OF ETERNITY, 1933-34, Hills of Eternity. The Portals of Eternity is one of two examples of the Neo-Byzantine style in Colma.

O-CLMP-QUICK
cont

5.08.123 Sites and Districts Worthy of State and Local Listing

All of the sites and districts eligible for National Register listing also qualify for State and local listing. Some sites and districts which do not qualify for National Register listing also qualify for State and local listing. Some sites and districts which do not qualify for National Register listing may still offer State and local interest. These are identified below:

PLACE	ADDRESS	DESIGNATION	SIGNIFCANCE*
Filipini Residence	7701 Mission Street	HR/C	Arch
E Street Historic District (Ottoboni Residences)	464 E Street 466 E Street 467-469 E Street 471 E Street	HR/C HR/C HR/C HR/C	Arch Arch Arch Arch
Salem Memorial Park Office/Chapel	1171 El Camino Real	HR	Arch
Home of Peace Historic District	1299 El Camino Real	HR (5)	Arch/Hist
Hills of Eternity	1301 El Camino Real	HR	Arch
Pelton "Cheap Dwelling"	437 F Street	HR	Arch
Japanese Cemetery	1300 Hillside Boulevard	L	Hist
Olivet Historic District	1601 Hillside Boulevard	HR (3)	Arch/Hist
Pet's Rest Cemetery Office	1905 Hillside Boulevard	HR	Arch/Hist

Designation: L = Landmark
HR = Historic Resource
(2) = Indicates the number of individual resources associated with this property

CR-2
cont.

5.08.124 The Town of Colma as an Historic Landmark

Consideration should be given to listing the whole Town of Colma as a State Historical Landmark. Colma is the only incorporated necropolis and the cemeteries contain information about the area, the state, the United States, and key figures from the gold rush through the present.

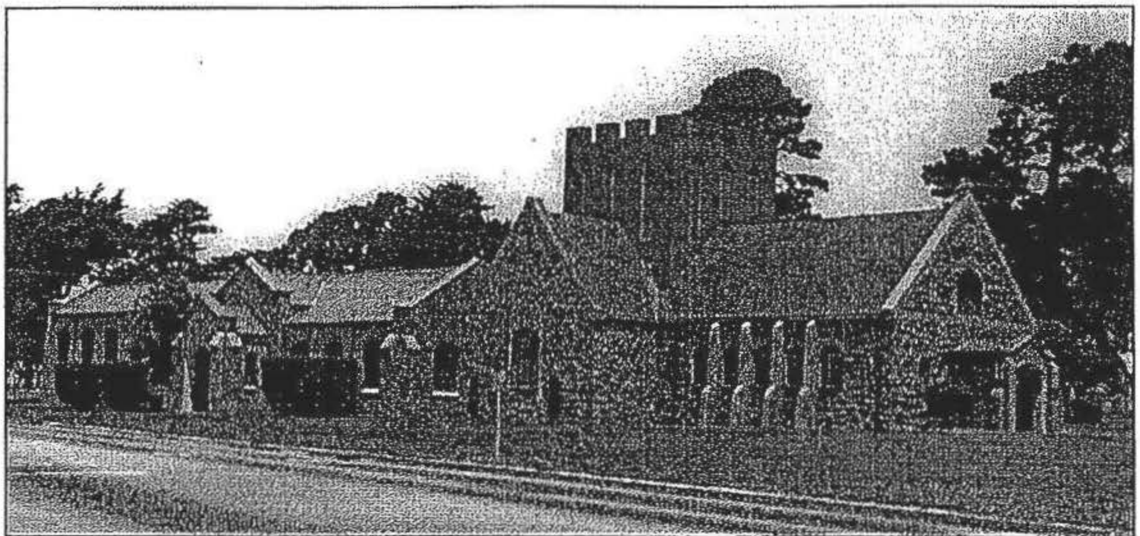
5.08.130 DETERMINING HISTORICAL SIGNIFICANCE

The basic criteria for evaluating historic properties includes the criteria established for the National Register of Historic Places and the criteria established for California's selection of historic property. These are described in Sections 5.08.131 and 5.08.132. The Town will use these criteria when applying for National or State designation. Both State and Federal evaluation methodology was used in Colma's 1992 Historic Resources Inventory. The Town may adopt its own criteria for the designation of local historic resource. Generally speaking the difference between historical properties of National, State and local significance are:

a) National significance are those properties which give an understanding of the country's history;

b) Statewide significance are those properties which give an understanding of the history of the State.

c) Local significance are those properties which have retained their historic appearance and are associated with people, events, trends, architecture and places key to the general history of the local community.



RECEIVING CHAPEL/COLUMBARIUM, 1896, Olivet Memorial Park

CR-2
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5.08.131 National Register Criteria
The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:

A. That are associated with events that have made a significant contribution to the broad patterns of our history; or

B. That are associated with the lives of persons significant in our past; or

C. That embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. That have yielded, or may be likely to yield, information important to prehistory or history.

5.08.132 California Code Criteria
California's Health and Safety Code, Part 10, Chapter 2, Section 37626 provides the mandatory criteria for the selection of historic properties eligible for use of its Historical Rehabilitation Financing Program under the Marks Historical Rehabilitation Act. These criteria are:

A. Its character, interest or value as part of the local, regional, state or national history, heritage or culture;

B. Its location as a site of significant historic events;

C. Its identification with a person or persons who significantly contributed to the local, regional, state or national culture or history;

D. Its exemplification of the cultural, economic, social, ethnic or historic heritage of the locale;

E. Its portrayal of the environment of a group of people in an era of history characterized by distinctive architectural style;

F. Its embodiment of distinguishing characteristics of an architectural type or specimen;

G. Its identification as the work of an architect or master builder whose works have influenced the development of a locale;

H. Its embodiment of distinguishing characteristics of an architectural type or specimen;

I. Where its structures display a building type, design or indigenous building form;

J. Where its structures display outstanding examples of original architectural integrity, structurally or stylistically or both;

K. Where its structures or places act as focal or pivotal points in the character or visual quality of an area;

L. Historical and culturally significant grounds, gardens and objects;

M. Its relationship to other designated landmarks, historic resources or historic districts if its preservation is essential to the integrity of the landmarks, historic resources or historic districts.

5.08.140 FEDERAL, STATE, AND LOCAL REGULATIONS

The following sections describe the various regulations currently available to the Town of Colma to protect historic resources. Table HR-2 summarizes the opportunities and implications of each of these programs.

5.08.141 Federal

5.08.141.1 National Register of Historic Places

The National Register of Historic Places is the nation's official inventory of buildings, structures, objects, sites and districts worthy of preservation. The purpose of the National Register is to "Ensure that property significant in national, state and local history are considered in the planning of federal undertakings, and to encourage historic preservation initiated by state and local governments and the private sector". Historic resources must satisfy the National Register criteria for evaluation described in Section 5.08.131. An application with photos, maps, and a letter of permission from the property owner is submitted to the State Historic Preservation

L. BOCCI & SONS, 1934. Bocci & Sons, a stonecarver ship, is the oldest cemetery related business in continuous operation.

Officer. The State Historic Preservation Officer (SHPO) will evaluate the resource and application and, if appropriate, propose it or nomination to the National Register. The Keeper of the National Register in Washington, D.C. will make the final approval for designation to the National Register.

CR-2 cont.

5.08.141.2 Federal Income Tax Credit

Listing on the National Register or eligibility to the National Register makes the historic resource eligible for federal tax benefits. The Tax Reform Act of 1986 created a tax incentive for the rehabilitation of historic buildings that are income producing properties. Under the Act owners of historic buildings can take a 20 percent income tax credit on the cost of rehabilitating their building. The property must, however, be an income producing or depreciable property and must be rehabilitated according to the Secretary of Interior's Standards for Rehabilitation. See Appendix C for more information.

5.08.141.3 Conservation Easements (Facade Easements)

The Federal Revenue Code provides for a federal tax deduction for charitable contributions of all or partial interests of historically important areas or buildings. A facade easement, for example, means that an owner has agreed to preserve the building facade in return for lower property taxes and income tax deductions. The law recognizes that the dedication of conservation restrictions on the property results in a decline of fair market value.

Exhibit E

O-CLMP-QUICK cont

5.08.141.4 National Historic Preservation Act
The National Historic Preservation Act was established in 1966. The Act is the nation's most important historic preservation law. It expanded the National Register of Historic Places, and required each governor to appoint a State Historic Preservation Officer (SHPO), offered matching funds to states to set up preservation offices and established grant programs for state-guided historic surveys in local communities. The Act requires the Federal Government, Section 106, to protect historic properties under its ownership or control. Section 106 offers protection of National Register eligible properties from adverse effects from any federal action, including projects utilizing federal funds. Per this section the Federal Government may not destroy or allow destruction of a property eligible for National Register listing unless mitigation is offered. All federal projects must take into account the effects of their actions on historic properties.

5.08.142 State
The Office of Historic Preservation (OHP) within the California Department of Parks and Recreation administers both state and federal preservation programs. The state programs which the OHP oversees include the California Historical Landmarks and California Points of Historical Interest, and a new program called The California Register of Historical Resources.

A historic resource listed on either the National Register, and/or on the State Register or which is a California Historical Landmark or a Point of Historical Interest will be eligible for the programs discussed in Sections 5.08.142.4 through 5.08.142.8.

5.08.142.1 California Historical Landmarks Program
The California Historical Landmarks program is for buildings, objects, sites and structures of statewide significance. The application to OHP must be accompanied with a letter of permission from the property owner, photographs (historic and current); and certification from a preservation officer of the American Institute of Architects that the property is of statewide significance. Once listed as a landmark the site is eligible for an official bronze landmark plaque and a highway directional sign from CalTrans.

5.08.142.2 California Points of Historical Interest Program
The California Points of Historical Interest program is for properties of county-wide and regional importance. Applications sent to OHP must be signed by the chief elected government official, and must be accompanied by a letter of support from the local historical society. Once listed as a Point of Historical Interest the site is eligible for a small enamel directional sign from CalTrans.

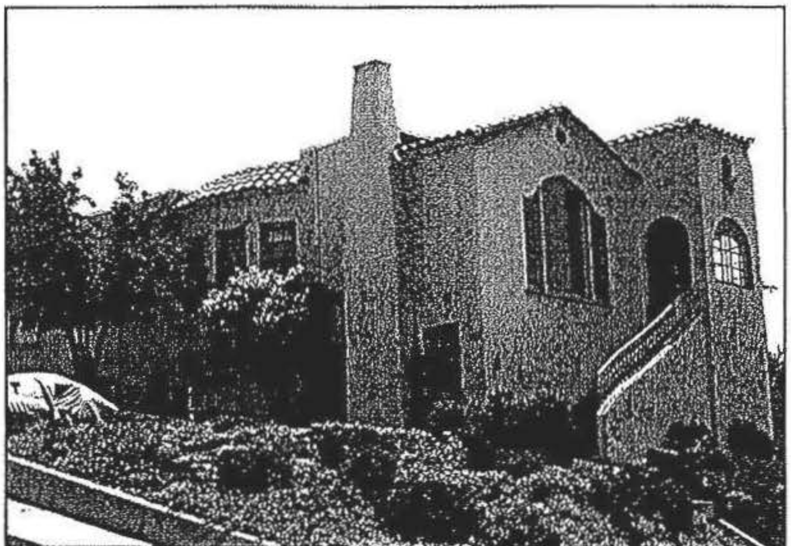
5.08.142.3 California Register of Historical Resources
The California Register of Historical Resource is a new State program which maintains a comprehensive list of all approved Federal, State and local historic resources. The California Register was created September 25, 1992 through Assembly Bill 2881. Most existing California Historical Landmarks, Points of Historical Interest, and properties on the National Register are automatically placed on the California Register's list. Colma's Historic Resources, Table HR-1, could be nominated to the California Register after its adoption by the Town.

5.08.142.4 State Historical Building Code
The State Historical Building Code, Section 18950 et. seq., of the State Code allows a more sensitive approach to restoring structures that were built prior to the development of modern construction techniques and the implementation of current building codes. The State Historical Building Code (SHBC) is an alternative building regulation which can be used for the rehabilitation, preservation, restoration, or relocation of Federal, State or locally designated historic buildings or structures.

The SHBC allows greater flexibility in enforcement of today's code requirements for older buildings but it does not waive standards, it simply provides alternative methods to be utilized to achieve reasonable levels of safety. Building Officials must allow the State Historical Building Code to be applied to the rehabilitation of all locally adopted and State or Federally registered historic resources. The Uniform Building Code (UBC) regulation, or the alternative Historical Building Code regulations, or any combination thereof can be used to

CR-2 cont.

permit repairs, alterations, and additions to the historical buildings or structures.



JOSEPH FILIPINI RESIDENCE, 1934. This home is one of the best examples of the Spanish Eclectic architectural style in Colma.

5.08.142.5 Mills Act
The Mills Act, as amended, is a state law which provides a property tax reduction to the owner of a designated historic property when the owner enters into a preservation contract with the local government agreeing to restore the property if necessary, maintain its historic character and use it in a manner compatible with its historic character. The preservation contract is valid for a 10-year period during which time the owner is entitled to a reduced property tax under Revenue and Taxation Code Section 439.

CR-2
cont.

5.08.142.6 Marks Historical Rehabilitation Act
The Marks Historical Rehabilitation Act provides cities with the authority to issue tax exempt revenue bonds for the purpose of financing historical rehabilitation of buildings having local, state or national significance. It is applicable to situations where the subject property is capable of generating revenues through visitor fees or other means.

5.08.142.7 California Environmental Quality Act (CEQA)
Historic resources are reviewed by the local governments as part of the CEQA environmental review process. Assembly Bill 2881 amended CEQA to facilitate the identification and definition of historic resources and establish that "locally significant resources" are presumed to be significant if the property can be or has been shown to be culturally or historically significant.

(PRC Section 21084.1). Since significant impacts under CEQA include the demolition or destructive alteration of architectural or historical resources, procedures for environmental review should routinely consider impacts on historic resources.

5.08.142.8 California Park and Recreation Facilities Act
Under the historic preservation component of the 1984 California Park and Recreation Facilities Act, publicly owned buildings, listed on the National Register, are eligible for restoration funds from the State. Restoration funds may be granted by the State whenever voters approve another bond.

5.08.143 Local

5.08.143.1 Historic Resources Inventory
The Town of Colma had a Historic Resources Inventory prepared by the San Mateo County Historical Association and the San Mateo County Resource Advisory Board in consultation with Kent Seavey in December 1992. The Inventory identifies twenty properties with a total of sixty-one historic resources including seven proposed Historic Districts. The Inventory identified nine individual properties and four Historic Districts that may be eligible for the National Register. It also contains other resources that may qualify as State Historical Landmarks or Points of Historical Interest or local historic resources, landmarks or districts. These resources are included on Table HR-1.

Exhibit E

O-CLMP-QUICK cont

TABLE HR-2
COLMA HISTORICAL PRESERVATION
IMPLICATIONS OF PROGRAMS & REGULATIONS

SECTION + PROGRAM OR REGULATION	OPPORTUNITY	IMPLICATION	REMARKS
5.08.141 Federal Regulations & Programs			
5.08.141.1 National Register of Historic Places	1. Use of **State Historic Building Code** which is a more flexible alternative to the UBC. This Code could save owners money when repairing or rehabilitating historic properties. 2. Tax Reform Act of 1986. Provides for a 20% **federal income investment tax** credit for rehabilitation projects of historic buildings. This applies only to income producing depreciable properties. 3. **Preservation easement** provides a tax deduction for a dedicated conservation easement. The easement must be donated to a qualified organization such as state, federal or municipal governments or non-profit organization. The value of the facade easement will be tax deductible because donations to a non-profit are tax deductible. The tax deduction can be spread out over a six year period if the value of the deduction exceeds the value of his/her income. An easement conveyance agreement must be drawn up between the property owner and the qualified organization. The recipient organization should require proof of title by the donating party and an appraisal should determine the value of the building and value of the easement. In the agreement the owner agrees to preserve the historic building into perpetuity in return for certain tax benefits. An income tax deduction is allowed for facade easements on buildings listed on the National Register. The presence of an enforceful restriction limits the increase in assessed valuation which correspondingly limits the amount of property taxes that can be levied. Facade easements have their highest dollar value and their highest tax benefit in areas where the pressure for demolition is great and the property values are higher. When the restriction is place on the property it will have the effect of limiting the use of the property and thereby lower the property's value; however, buildings located in areas which do not have a high property value will not experience as great a tax benefit. If there is not a qualified organization in our area the Calif. Preservation Foundation, a state-wide non-profit preservation group, has an easement program to receive donations.	**2. Federal Income Investment Tax Credit** • Rehabilitation projects accomplished with federal assistance must be reviewed by the Office of Historic Preservation (OHP) and must generally use the Secretary of Interior's Standards for Rehabilitation projects. The plans for rehabilitation must be reviewed by the SHPO and the National Park Service. Even if a building is not on the National. Register, many of these requirements may apply if the bldg. is considered eligible for listing. Actual listing on the N.R. does not increase the owners' responsibility under the law. The Secretary of Interior's standards have more requirements but to off-set this the State Historical Building Code can be used to bring down costs. • Rehabilitation of income-producing buildings with a National Register designation qualifies for a 20% federal income investment tax credit; however, all work must be done in conformance with the Secretary of the Interior's Standards for Rehabilitation. (See Section 5.02.412 for more details) 3. A **conservation easement** (i.e. façade easement) placed on a historic building means that the owner agrees to preserve the façade into perpetuity. (See Section 5.02.413)	2. **Funding** is limited, federal tax credits are the most generally available financial assistance

CR-2 cont.

O-CLMP-QUICK cont

TABLE HR-2
COLMA HISTORICAL PRESERVATION
IMPLICATIONS OF PROGRAMS & REGULATIONS

SECTION + PROGRAM OR REGULATION	OPPORTUNITY	IMPLICATION	REMARKS
5.08.141.1 National Register of Historic Places (continued)	4. **National Register designation** is an honor, indicating that the site is worthy of preservation.	4. National Register Designation: • **Local ordinances**, design review may be imposed on properties listed on the National Register. (These only occur if the local government has passed ordinances and regulations for historic preservation). • The **demolition or significant alteration** of a National Register property damaged by a national disaster (i.e., flood, earthquake) may be subject to review by the SHPO. (Section 5028 of PRC). Generally, if only minor alterations are required the SHPO will not get involved. However, if major reconstruction is required or if federal funds are used then SHPO will evaluate each project. In a state of emergency all buildings using federal funds are evaluated by SHPO. For major projects with historic buildings SHPO will review the architectural plans.	4. A National Register listing does not mean that federal, state or local governments assume any property rights of the building or site.
	5. A property which is on the National Register (NR) list is automatically included on the **California Register of Historic Resources.** 6. Properties on the National Register must be considered in the planning of **"federal undertakings"** where federal funds are involved (i.e. CDBG, or highway projects, etc.). While the consideration won't provide complete protection from federal actions, it does mean that the project will have to work with the Calif. OHP to eliminate, minimize or otherwise take into account the federal undertaking's effect on the historic property.	**Procedures to apply** for Nat'l Reg. listing: • complete application forms. provided by OHP • following Bulletin 16A's guidelines • obtain written consent from property owner • for historic districts follow SHRC policies prior to submitting application • submit completed forms, photographs and maps to OHP for review • OHP will review application if the application is not complete or additional info. is needed it will be returned for more work • OHP notifies applicant, property owner and city of SHRC meeting date. (1 every 3 months) • if approved by SHRC the application goes to SHPO for nomination to National Register. • The Keeper of the National Register in Washington D.C. will make the final determination in 2-4 months.	
	7. Major projects impacting a National Register property may be subject to **CEQA.**	7. A National Register (NR) designation of a property involving a **CEQA** project would indicate the property's significance and the need to consider the project's impact on the historic property. (Depending on one's point of view this is either an opportunity or a constraint).	7. If a property is not subject to **CEQA**, to local preservation ordinances or other environmental regulations the property owner is free to make changes to the property (but if the property is significantly altered it could be removed from the National Register).
	8. Properties on the National Register may obtain a property tax reduction through the **Mills Act** by the property owner and city entering into a preservation agreement. (Refer to Section 5.02.425)	8. Property owners of buildings on the Nat'l Register can enter into a preservation contract with the city through the **Mills Act**. The preservation contract requires certain conditions which are described in Section 5.02.425.	

CR-2 cont.

TABLE HR-2
COLMA HISTORICAL PRESERVATION
IMPLICATIONS OF PROGRAMS & REGULATIONS

SECTION + PROGRAM OR REGULATION	OPPORTUNITY	IMPLICATION	REMARKS
5.08.141.2 Federal Income Tax Credit	1. Twenty percent of **federal income investment tax** credit for rehabilitation of historic buildings (income producing properties only). (Tax Reform Act of 1986).	1. Applies only to income producing, depreciable properties. 2. Must be rehabilitated per the Secretary of Interior's standards for rehabilitation, Appendix C. 3. **Application Procedure**: • obtain application from OIIP or Nan. Park Service • verify building historical significance describe architectural project and work scope • OHP will evaluate the project.	
5.08.141.3 Conservation Elements	1. Federal tax deduction and property tax deductions are available with a Conservation Easement on a historic resource. (See Section 5.02.411, Item 3)	1. Dedicated **conservation easement** placed on building, i.e., facade easement. Owner agrees to preserve the historic buildings' facade into perpetuity.	
5.08.141.4 National Historic Preservation Act	1. Federal Historic Preservation Act which established State Historic preservation Officers (SHPO) for each State, expanded the National Register, provides funding to States for historic preservation, and requires all projects with federal funding and all federal projects to consider in advance their project's impact on any historic resource eligible for the National Register.	1. Projects with federal funding must document how historic properties eligible to the National. Register may be impacted and how these impacts will be mitigated. A federal project cannot after or destroy a property eligible for listing on the National Register 2. May require CEQA review if a major project could impact a National Register property.	
5.08.142 State Regulations and Programs 5.08.142.1 California Historical Landmarks Program	1. The site is eligible for an official bronze landmark **plaque** and a **highway directional sign** from CalTrans. 2. Property can use the **California Historic Building Code** which is more flexible than UBC. (See Section 5.02.424) 3. Rehabilitation of **historic public buildings** can use **preservation funding** under the Historic Preservation Component of the California Park and Recreation Facilities Act of 1984. 4. Can use **federal investment tax credit**. (See Section 5.02.412)	1. **Application Procedure:** • obtain application and criteria from OHP • compile documents of historic significance (i.e., it's the first, last, only or most significant type in the region, state) and arch. supplement form must be completed by AIA and other information about the building's historical significance • letter by property owner approving placement of plaque on property • OHP will review application and documents and if complete schedule for review by SHRC. 3. **Preservation funding** for publicly-owned buildings is only available when California voters approve a Bond.	

CR-2 cont.

Exhibit E

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TABLE HR-2 COLMA HISTORICAL PRESERVATION IMPLICATIONS OF PROGRAMS & REGULATIONS			
SECTION + PROGRAM OR REGULATION	**OPPORTUNITY**	**IMPLICATION**	**REMARKS**
5.08.142.1 California Historical Landmarks Program (continued)	5. Can use the **Mills Act** which provides a reduction of property tax. (See Section 5.02.425) 6. **CEQA** review is required of buildings eligible for National Register and also for those on a Local Inventory orpart of a collection of locally significant buildings. (See Section 5.02.427)		
5.08.142.2 California Points of Historical Interest Program	1. The site is eligible for a **small enamel directional sign** from CalTrans. 2. Limited protection through environmental review under **CEQA**. (See Section 5.02.427) 3. **Mills Act** is available for property tax reductions. (See Section 5.02.425) 4. Property can use **State Historic Building Code** (SHBC) which is more flexible than UBC. (See Section 5.02.424)	1. **Application Procedure:** • obtain application and criteria from OHP • compile documentation: maps, description, statement of significance, letter of support, bibliography • obtain letter of support from chief elected government official • application reviewed by OHP and sent to State Historic Resource Commission (SHBC) for action.	
5.08.142.3 California Register of Historic Resources	1. A comprehensive list of California's historic resources which can be used as a **guide** by state and local agencies, private groups and citizens to identity the state's historic resources. 2. The Register will be used to indicate which properties are to be considered during the **CEQA** environmental review process and thereby require protection, to the extent prudent and feasible, from substantial adverse change. 3. To identity historic resources for state and local **planning** purposes.	2. Simply because a property is not listed on the California Register does not mean that it is not a historical resource and not subject to **CEQA** environmental review.	1. The California Register automatically includes properties listed on the National Register, properties designated as a California Historical Landmark and a Point of Historical Interest. Other historic resources that may be included are: locally designated historic resources, historic resources contributing to a historic district, and historic resources identified in an inventory.
5.08.142.4 State Historical Building Code	1. **The State Historical Building Code** (SHBC) is a more flexible code than UBC and therefore may result in a more affordable rehabilitation of historic properties. The SHBC provides an alternative method while achieving reasonable levels of safety.	1. Local Building Department oversees project using State Historic Building Commission (SHBC)	

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Exhibit E

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CR-2 cont.

TABLE HR-2
COLMA HISTORICAL PRESERVATION
IMPLICATIONS OF PROGRAMS & REGULATIONS

SECTION + PROGRAM OR REGULATION	OPPORTUNITY	IMPLICATION	REMARKS
5.08.142.5 Mills Act	1. A **property tax reduction** is made available when the owner enters into a preservation contract with a local government using the **Mills Act** and agreeing to: a) restore the property if necessary; b) maintain the property's historic character; and c) use the property in a manner compatible with its historic character. The benefits are often minimal during the first few years; however as the value of the property climbs a significant property tax savings may be experienced.	1. **Conditions of the preservation contract** are that it: a) is valid fore 10 year period; b) remains valid even upon resale of the property; c) must be professionally drawn up between the historic property owner and the city; d) is monitor by the City for compliance with the provisions of the contract until ft expires. 2. The county tax assessor must adjust the **assessed value** of the property downward to reflect the restrictions imposed on the property. (Revenue & Taxation Code Section 439) 3. When entering into a **Mills Act contract** the Town's Building Official will specify if the building requires restoration then or anytime during the contract period. 4. To **withdraw** from the Mills Act contract the property the owner will have to pay a 12% penalty on his/her savings from the property tax deduction.	
5.08.142.6 Marks Historical Rehabilitation Act	1. The city has the authority to issue tax exempt revenue **bonds** for the purpose of financing historical rehabilitation of buildings with local state or national significance.	1. The **Marks Bond Act** program has rarely been used in California seemingly because of the requirement that developers may make no more than ten million dollars on capital expenditures. Cities are rarely willing to spend the time and money involved in issuing bonds for this small amount; however, if several major historic projects are undertaken in a jurisdiction at one time, the collective costs and expenses may total an amount high enough to justify staff time and fees to issue bonds, then the Marks Act may prove to be a useful and desirable tool. 2. The Marks Act would only be applicable to situations where the property will generate revenues.	
5.08.142.7 California Environmental Quality Act (CEQA)	1. Some level of protection for historic resources is offered by the need for **CEQA** review by the local agency. 2. All locally significant resources, meeting those properties on an officially designated list, and recognized as historically significant by the local government pursuant to a local ordinance or resolution are considered **significant**. Substantial adverse change in the significance of an historic resource is a **significant effect on the environment.**	1. Additional layers of planning and environmental review are required if **CEQA** is required. 2. The lead agency must prepare an initial study to determine if the project may result in substantial adverse change. If substantial adverse change will occur, then **CEQA** mitigation measures must be prepared. If the CEQA mitigation measures won't avoid a substantial adverse change, then an EIR must be prepared.	1. Discretionary projects requiring **CEQA** review cannot use categorical exemptions if a substantial adverse change in the significance of a historic resource might occur. A "substantial adverse change" is defined as "demolition, destruction, relocation, or alteration activities which would entail historical significance". **CEQA** does not apply to ministerial actions which may impact the historic resource; for example, if the project complies with UBC or SHBC and doesn't require discretionary permit.

TABLE HR-2 COLMA HISTORICAL PRESERVATION IMPLICATIONS OF PROGRAMS & REGULATIONS			
SECTION + PROGRAM OR REGULATION	**OPPORTUNITY**	**IMPLICATION**	**REMARKS**
5.08.142.7 California Environmental Quality Act (CEQA) (continued)		3. After a **natural disaster** (i.e., flood, earthquake, fire) a local agency can only demolish or destroy those historic structures which are an "imminent threat." Otherwise a local agency must notify and consult with the SHPO if there are damaged historic resources which may require demolition, destruction, or significant alteration. In most cases action taken after a natural disaster for which a state emergency has been declared are statutorily exempt from CEQA. However, actions in the aftermath of disaster which might adversely affect historic resources are subject to statewide governing considerations of historic resources. No structure listed on the National Register, California Register, or local register that is damaged in a natural disaster can be destroyed, demolished or significantly altered unless: a) the structure represents an imminent threat to the public for bodily harm or damage to adjacent property, or b) the action is approved by the State Historical Preservation Office.	
5.08.142.8 California Park and Recreation Facilities Act	1. Restoration **funds for publicly owned buildings** listed on the National Register are eligible from the state when available.	1. These funds are not always available. They are only available whenever a bond is approved by the voters of the State. 2. The source of funds is from the federal government therefore the rehabilitation project must follow the Secretary of Interior's Guidelines or the State Historical Building Code.	
5.08.143 Local Regulations and Programs 5.08.143.1 Historic Resources Inventory	1. Historic Resource Inventory identifies historic resources and districts in the Town of Colma. The approved official list of Historic Resources in the Town of Colma, Table HR - 1, should be sent for inclusion on the California Register per Section 5.02.423. 2. The Historic Resource Inventory should be **updated** following City Council Action. 3. A copy of the approved local Historic Resources list Table HR - 1 should be sent to the State Office of Historic Preservation, the California Register of Historical Resources, San Mateo County Planning Department, San Mateo County Historical Resources Advisory Board, and San Mateo County Historical Association.		

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Exhibit E

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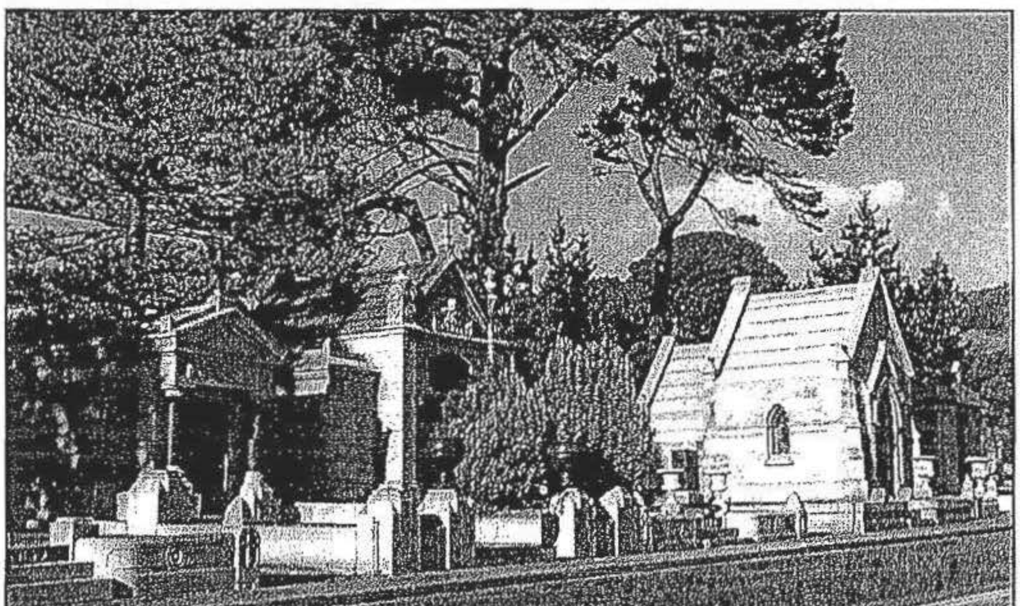
5.08.200 HISTORIC RESOURCES POLICIES & IMPLEMENTATION MEASURES

The Historical Resources Element is designed to link the Town's past with the present by establishing goals and policies to preserve, protect, and enhance the Town's historic resources.

5.08.210 HISTRORIC RESOURCE PROTECTIONS			
REFERENCE NUMBER	**POLICY**	**IMPLEMENTATION MEASURE**	**CROSS REFERENCES WITH OTHER GENERAL PLAN ELEMENTS**
5.08.211	Colma should encourage the rehabilitation and continued use or reuse of designated historic buildings or sites whenever planning or building permits are involved.	The City Planner will make recommendations consistent with this policy to the City Council.	
5.08.212	Important historic resources should be protected through designation by the Town of Colma.	The City Planner will make recommendations consistent with this policy to the City Council.	
5.08.213	State and/or Federal recognition of selected historic resources should be sought by applying for designation as a California Historical Landmark, or a California Point of Historical Interest, and/or inclusion in the National Register of Historic Places. Nomination to the California Register of Historical Resources should be made for qualifying public buildings and whenever private property owners concur.	The City Planner will facilitate applications for qualifying public buildings, and assist property owners who want to apply for historical designation for their buildings.	



Family crypts in the Holy Cross Historic District

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5.08.220 HISTORIC RESOURCE PROTECTIONS			
REFERENCE NUMBER	POLICY	IMPLEMENTATION MEASURE	CROSS REFERENCES WITH OTHER GENERAL PLAN ELEMENTS
5.08.221	A Historic Preservation Ordinance, and Historic District Resource "HR" Combining Zone should be used to identify historic resources. Protection of historic resources should be provided by use of the design review procedure.	The City Planner will make recommendations consistent with this policy to the City Council.	
5.08.222	The Colma Historical Association should be consulted whenever a proposed development project involves a designated historic resource in Colma.	The City Planner will contact the Colma Historical Association and solicit input whenever a proposed development project involves a designated historic resource.	
5.08.223	Colma should use the nationally established, Rehabilitation Standards and Guidelines for the Restoration and Rehabilitation of Historic Structures (See Appendix C).	The City Planner and Building Department will make recommendations consistent with this policy to the City Council.	
5.08.224	Colma should use the California State Historical Building Code (SHBC) for designated buildings to encourage historic rehabilitation.	The City Planner and Building Department will make recommendations consistent with this policy to the City Council.	
5.08.225	An Historic Resources Inventory should be maintained, including keeping a current list of all local, state, and federally designated historical landmarks, points of historical interest, historic resources and historic districts in Colma.	The City Planner will maintain an Historic Resources Inventory and make it available for public inspection.	
5.08.226	The Town should utilize its Design Review procedure for review of development in historic districts and adjacent to designated historic landmarks.	The City Planner will make recommendations consistent with this policy to the City Council for new development projects.	

5.08.230 INCREASE PUBLIC AWARENESS			
REFERENCE NUMBER	POLICY	IMPLEMENTATION MEASURE	CROSS REFERENCES WITH OTHER GENERAL PLAN ELEMENTS
5.08.231	The Town should provide information to the public concerning the location of historic resources and their value to the community, State and Nation.	The City Planner will maintain an Historic Resources Inventory and make it available for public inspection. Historical essays will continue to be published in the Town's newsletter.	
5.08.232	The Town should support the Colma Historical Association in their efforts to expand historical knowledge about Colma.	The Town will pursue establishment of an historical park and museum for Colma.	Open Space/ Conservation 5.04.391
5.08.233	Colma should maintain communication with the State Office of Historic Preservation, California Register of Historical Resources and San Mateo County Planning Department to disseminate information about historical resources in Colma.	The City Planner, City Manager and City Council will take actions consistent with this policy.	

Exhibit E

O-CLMP-QUICK cont

5.08.300 HISTORIC PRESERVATION IMPLEMENTATION PROGRAMS OR ACTIONS

Proposed programs or actions that can be utilized to implement the Historical Resources Element are described below. The status of the program is noted in parentheses after the title of each program. Existing programs which the Town can use without action by the City Council are discussed in Section 5.08.140, and their opportunities and implications are summarized on Table HR-2.

5.08.301 Historic Preservation Ordinance and Historic Resource Combining Zone (New)
The City Council will adopt an Historic Preservation Ordinance and a Historic Resource "HR" Combining Zone for the identification of the Town's historic resources. The Ordinance should establish evaluation criteria for the designation of historic resources and districts, definitions, and use of the Secretary of Interior's Standards for Rehabilitation. The "HR" Zone will be applied as an overlay to the Town's regular land use designations to identify historic resources to be protected. Protection will be afforded by the existing design review procedure.

5.08.302 Historic Evaluation Criteria (New)
The Town Planning Department will work with the Colma Historical Association to draft criteria for use in evaluating historic properties for eligibility as Local Historic Landmarks or Historic Districts. The criteria shall be based on the established criteria for the National Register and California Criteria, Section 5.08.131 and 5.08.132, so that the local resources are qualified to benefit from Federal and State Historic Preservation Programs and funding.

5.08.303 Local Historic Landmarks and Districts (New)
The City Council will adopt the Historic Resource Inventory (see Table HR-1) as the Town's official list of local landmarks and historic districts. The Planning Department shall maintain the Inventory and update it when appropriate. Any newly proposed addition to the inventory will e evaluated using the set of criteria created by the Planning staff and Colma Historical Association (See Section 5.08.302).

5.08.304 Historic Preservation Advisory Board (New)
The Town will designate the Colma Historical Association to participate in the preparation of Colma's Historic Preservation Ordinance and Historic Resource ("HR") Combining Zone, to work with the Planning staff to establish the criteria and procedures for designating historic landmarks and districts, and to operate as a review and advisory body on historic resources.

5.08.305 Standards and Guidelines for Rehabilitation of Historic Buildings (New)
The Town will adopt the Secretary of Interior's (revised 1990) Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings as the Town's administrative Design Review Guidelines for any proposed exterior changes to a designated landmark, historic resource or contributing building to a historic district that might offset the character of the designated historic property. Income producing properties on the National Register are eligible for the National Register which work within these standards may obtain a twenty percent tax credit for the cost of rehabilitation.

CR-2 cont.

5.08.306 Mills Act (New)
The City Council will support the Mills Act to provide owners of historic resources with an incentive to maintain the historic character of their property.

5.08.307 Marks Historical Rehabilitation Act
The City Council will consider implementing this Act, when the potential for revenue generation exists, by issuing tax-exempt revenue bonds for the purpose of financing rehabilitation of historic buildings having local, State or National significance.

5.08.308 California Register of Historical Resources Nomination (New)
The City Council will authorize staff to send the adopted list of local historic landmarks and historic districts, Table HR-1, to the California Register of Historical Resources for nomination to their list of Historic Resources.

5.08.309 Historic Route and Signs (New)
The City Council will designate a historic route through Town and consider installing signs to direct visitors along the historic route.

NOBLE CHAPEL, 1892-93, Cypress Lawn Memorial Park. This Victorian Gothic Chapel and Crematory was named after Hamden Noble, the founder of the cemetery.

CR-2
cont.

5.08.310 Town of Colma - State Historic Landmark (New)

The City Council will consider steps necessary to apply for the Town to become a State Historical Landmark.

5.08.311 Historic Residential Buildings Preservation (New)

The City Council will seek out property where buildings that are threatened by development may be relocated to create a residential compound or mixed use retail/office/residential village or commons.

5.08.312 Historic Resources Information Sheet (New)

The Town Planning Department with assistance from the Colma Historical Association will prepare an Historic Resources Information Fact Sheet that identifies different federal and state programs, and tax incentives available to the property owner of designated historic properties.

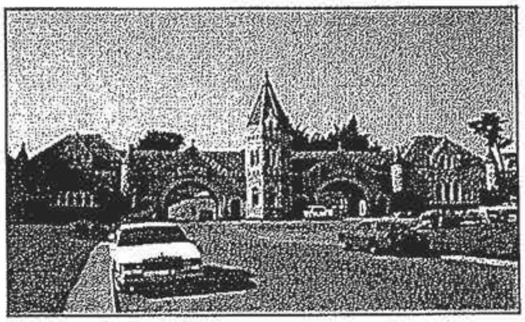
Exhibit E

O-CLMP-QUICK cont

5.08.400 HISTORICAL RESOURCES ELEMENT APPENDIX A

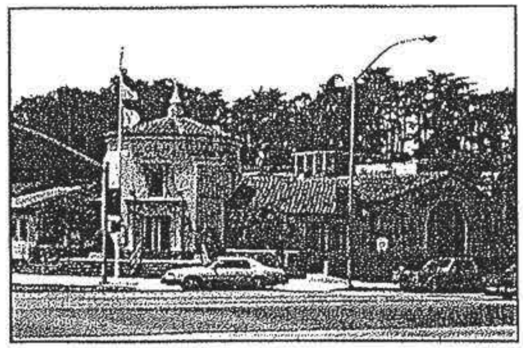
The following is a summary of the documentation compiled during the 1992 Colma Historic Resources Inventory. The full inventory is on file at Colma Town Hall. Definitions of "landmark," "historic resource" and "criteria" used in the following descriptions are found at the end of Appendix A.

5.08.410 SITES ELIGIBLE FOR NATIONAL REGISTER



A. Woodlawn Gatehouse Entry
1000 El Camino Real
Rating: National Register
- Landmark
- Criteria: C (a)(c)

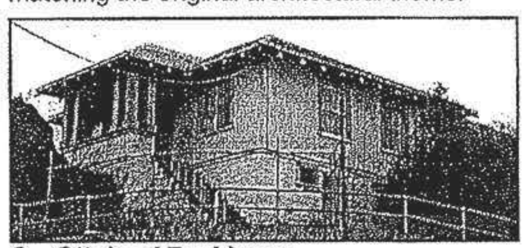
The 1904 Woodlawn office and entry building possesses the highest artistic value of any like architectural feature in Colma and perhaps, the State. Designed by San Francisco architect Thomas Patterson Ross, it successfully combines stylistic elements of the late Gothic Revival with those of H. H. Richardson into an impressive expression of the stonecutter's craft. Its employment of structural concrete as a framework was an early use of new building technology. The *Park and Cemetery Magazine*, July 1915, noted that "Nothing adds more to the dignity and impressiveness of a park or cemetery with an artistic entrance". Cemetery entrances, be they simple or ornate, break the continuity of the surrounding neighborhood and, "announce a special room dedicated to the departed". The Woodlawn gateway provides security by regulating visitation and preserves the sanctity and physical integrity of the cemetery.



B. City Hall
1198 El Camino Real
Rating: National Register
- Landmark
- Criteria: A, C (c)

The Spanish Eclectic style of architecture for Colma's Town Hall was selected by Mattrup Jensen, Colma's first mayor and the Superintendent of Mount Olivet Memorial Park. Mattrup Jensen was impressed with the beauty of the Town Hall in Ross, California, designed by John White in 1928. Jensen made sketches of the building and had them incorporated into the final design of Colma's Town Hall by the architectural firm of Resing and McGinness of San Francisco. While the Town Hall was not constructed until 1937 it is symbolic of the Town's struggle to gain its own identity and for the cemeteries to gain control of their properties through incorporation of the Town in 1924. An addtion to the Town Hall was completed in 1986 matching the original architectural theme.

CR-2 cont.



C. Ottoboni Residence
417 F Street
Rating: National Register
- Landmark
- Criteria: A, B

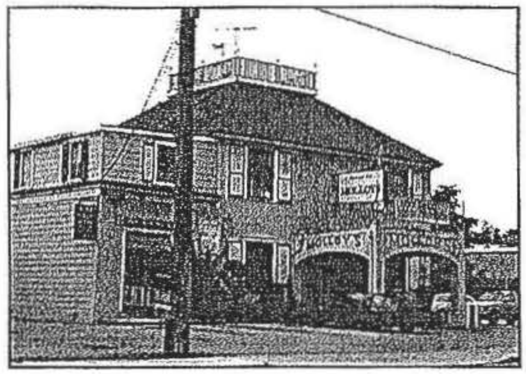
The Ottoboni Family residence was the original office of the family's Pioneer Nursery. The Ottoboni family is attributed with initiating the flower industry in the region. The Ottoboni family home is significant as the originating point for a major local industry, floriculture, and for the contributions to the community over time by family members. The residence is a craftsman style building. The house is sited next to a group of buildings that were moved to the site in the 1960s onto what was once the flower beds of Colma's first nursery, Ottoboni's Pioneer Nursery.

D. Mattrup Jensen Residence
649 F Street
Rating: National Register
- Landmark
- Criteria: A, C (c)

Mattrup Jensen, the father of modern Colma and first mayor, designed and built his home on F Street. He later remodeled the house based on examples of antebellum residences he had seen while on vacation in the south. Through Jensen's leadership, in 1923 the Associated Cemeteries joined together to incorporate the Town. Jensen's house is the best resource representative of his many accomplishments within the community as a businessman and civic leader.

E. Mount Olivet Cemetery Office and Streetcar Line
1500 Hillside Boulevard
Rating: National Register
- Landmark
- Criteria: A, C (c)

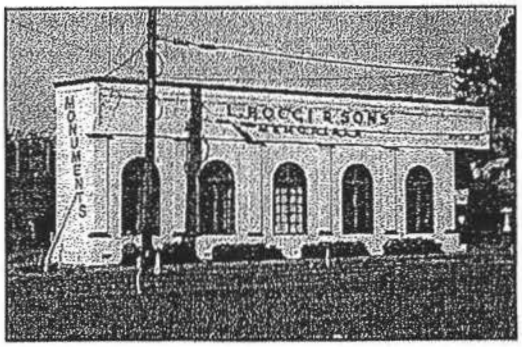
This building best represents the contributions of the Abbey Land and Improvement Company to the development of Colma. The company established Mount Olivet Memorial Park, the fifth cemetery to be built in Colma and constructed a streetcar line along F Street to their office and cemetery from the main electric railway at El Camino Real. The Mount Olivet local line, as it was known, was in operation until 1926. The Mission Revival Style office was designed by the corporation's vice president, San Francisco architect William H. Crim. The square tower at the southeast corner of the building marks the original entry to the Mount Olivet Cemetery office. In spite of some changes to the building's windows the building retains its original character.



F. Molloy's (Historically known as Brooksville Hotel)
1655 Old Mission Road
Rating: National Register
- Landmark
- Criteria: A

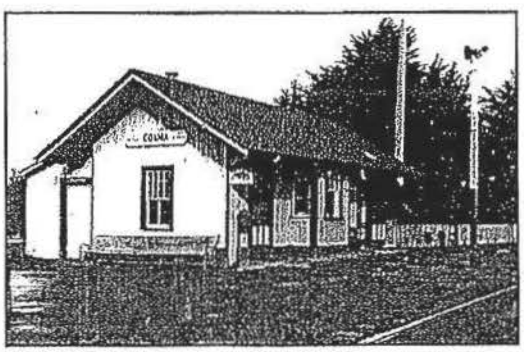
In 1883 the Brooksville Hotel was opened to house the workers who were about to build a succession of cemeteries in the area. It is the oldest commercial establishment in continuous operation in Colma. The Brooks family left in 1912 but retained ownership of the hostelry which became a popular speakeasy during prohibition. In 1929 Frank Molloy purchased the Hotel and named it Molloy's Springs. Molloy's became the social center of Colma. The hotel and bar are still operating in the historic commercial complex beside Old Mission Road.

CR-2 cont.



G. L. Bocci & Sons Monuments
7778 Mission Street
Rating: National Register
- Landmark
- Criteria: A, B

Leopold Bocci, a professional stone carver, established the first monument shop in Colma in 1904. In approximately 1937 a local contractor, Joseph Ragni, built the new office facade for Bocci and his sons. This building represents the oldest cemetery related industry in continuous operation in Colma Donald Bocci, Leopold's grandson, continues to operate the shop as a family business with two of his daughters.



H. Old Colma (School House) Railroad Station
480 Serramonte Boulevard (Temporary Pending Relocation)
Rating: National Register
- Landmark
- Criteria A, C (c)

The Old Colma Railroad Station built in 1881, and recently relocated to El Camino Real and Serramonte Boulevard, may be eligible for listing on the National Register. The Station was originally called the School House Station. Its architectural style is rare and is considered a relic from Colma's gardening era. The School House Station, which was located at the juncture of El Camino Real and San Pedro Avenue, was the center of the larger northern San Mateo County area historically known as Colma. Early businesses clustered along these intersecting streets. This was where the farmers and teamsters stopped enroute to San Francisco; the location of the area's first school, and later a post office. According to the San Mateo County Gazette in November 1882 the School House Station was "decidedly the most important stopping place between the town of San Mateo and the city of San Francisco" and is ". . . the most valuable garden ground in the State . . . ".

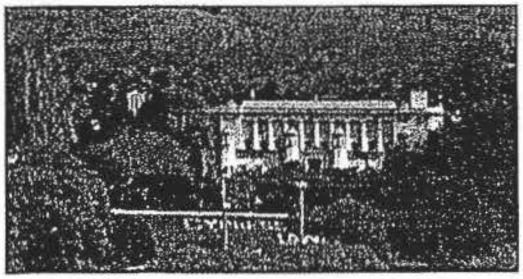
Before the station was moved it was evaluated by the State Office of Historic Planning and the Keeper of the Register as being eligible for the National Register. Since the station was relocated its original National Register Ranking of 2S2 may no longer be valid. However, it shouldn't affect the ranking significantly because the station is still on El Camino Real at a major intersection, it is only a mile south of its original location and it will be sited on the site in a fashion which is similar to its original situation.

CR-2 cont.

Exhibit E

O-CLMP-QUICK
cont

5.08.420 HISTORIC DISTRICTS ELIGIBLE FOR NATIONAL REGISTER



A. Cypress Lawn Historic District
1370 El Camino Real
Rating: National Register Historic District with 21 Resources

The Cypress Lawn Historic District is described in Section 2.211 of the Historical Resources Element. The twenty-one historic resources are identified below:

1. Norman Towers
Pair of monumental stone towers, forty feet high, at the Hillside Boulevard entrance.

2. Grand Gateway
1892 granite archway set back from El Camino Real. The archway, designed by Barnett McDougal & Son of San Francisco, is one of the earliest examples of Mission Revival-style architecture found anywhere.

3. Original Columbarium
1893 two-story rock-faced granite columbarium designed by architects Edward Heatherton and Thomas P. Ross for the exclusive use of cremated remains. This building is one of the earliest examples of Mission style architecture and is one of the first columbariums designed in the West.

4. Noble Chapel
A small English-style Victorian Gothic chapel designed by architect Thomas P. Ross in 1894. It continues to be used for religious services and contains the cemetery's receiving vault and two modern crematoria.

5. Cemetery Office Building
1918 administration/office building on the west side of El Camino Real was designed by architect Bernard J. S. Cahill. The columned building has a red tile roof which gives the feeling of old California Spanish Architecture.

6. Community Mausoleum:
1921 Roman Renaissance mausoleum designed by Bernard J. S. Cahill. The building received international recognition for its architectural and artistic excellence. The stained and art glass ceiling of the complex, which covers about four and one-half acres, represents one of the finest collections of stained glass in the United States. Buried here are William C. Ralston, Elizabeth Fry Ralston, K. W. Koo and George Fox.

7. Lakeside Columbarium
1927 concrete columbarium by architect Bernard J. S. Cahill. The unfinished columbarium is both the largest and the last of its type in the United States. Gertrude Atherton and Paul I. Fagan are buried here.

CR-2
cont.

8. Laurel Hill Monument
The three acre grassy mound is the final resting place for over 35,000 San Francisco pioneers. Two monuments can be found here. A life size bronze statue of a pioneer family mounted on a round granite plinth with a granite wall behind it. A giant obelisk by Vladimir Oslou, has a sculpture of Father Time on its backside commemorating the burial place of California's pioneers.

9. Reverend William Kip
Kip was the first Episcopal bishop of California. A tall granite Celtic Cross by Ernest Coxhead marks the Reverend Kip's burial place.

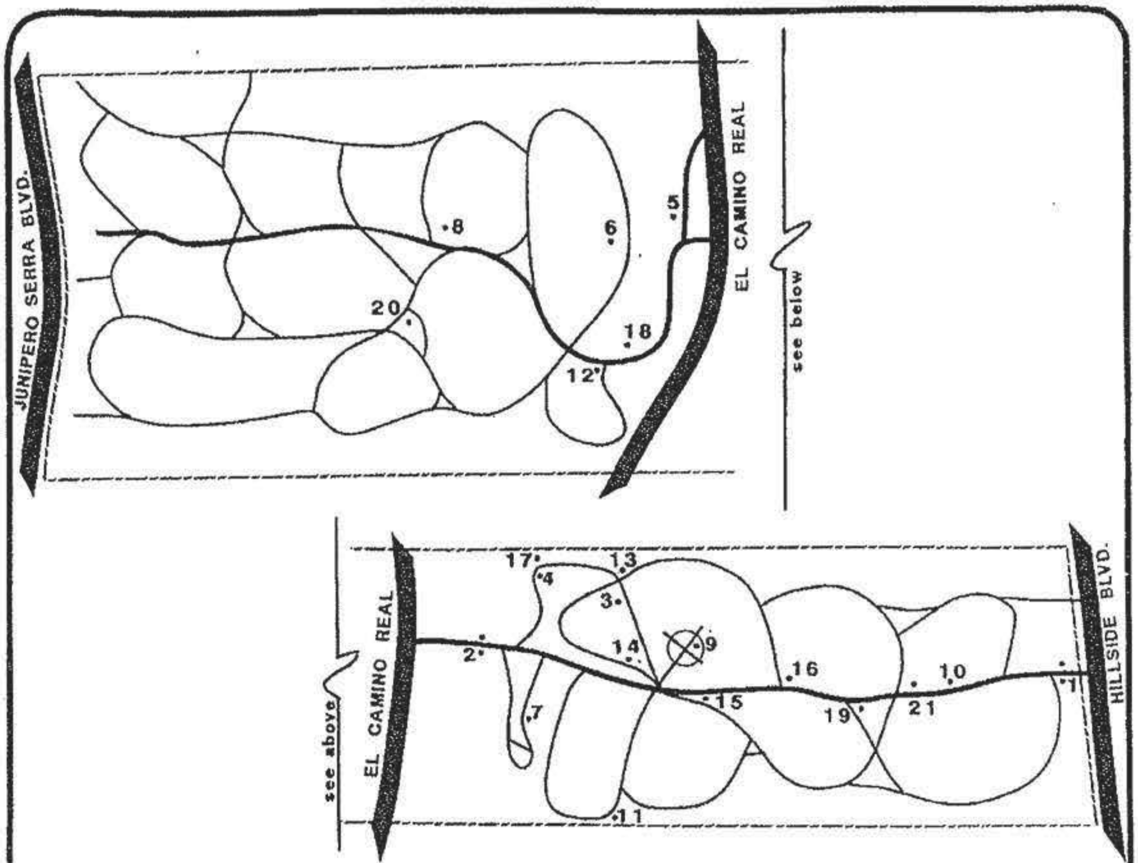
10. Thomas Oliver Larkin
Larkin's kneeling angel gazing at sculpted cameo sitting atop his tomb.

11. Charles de Young:
A life size bronze statue of Charles de Young marks his final resting place which was transferred here from San Francisco's Odd Fellow Cemetery.

Exhibit E

O-CLMP-QUICK cont

CR-2 cont.



1. NORMAN TOWERS
2. GRAND GATEWAY
3. ORIGINAL COLUMBARIUM
4. NOBLE CHAPEL
5. CEMETERY OFFICE BUILDING
6. COMMUNITY MAUSOLEUM
7. LAKESIDE COLUMBARIUM
8. LAUREL HILL MONUMENT
9. REVEREND WILLIAM KIP
10. THOMAS O. LARKIN
11. CHARLES DE YOUNG
12. HIRAM JOHNSON
13. LLOYD TEVIS
14. HERMAN NAGER
15. GEORGE HEARST
16. CHARLES CROCKER
17. DE LA MONTANYA
18. DANIEL MURPHY
19. ARTHUR RODGERS
20. GEORGE WHITTELL
21. GUSTAVE NIEBAUM

CYPRESS LAWN HISTORIC DISTRICT

------ HISTORIC DISTRICT

•2 HISTORIC RESOURCE

HR-2
FIGURE

8/98

12. Hiram W. Johnson
A former California Governor (1910-1916) and U. S. Senator (1917-1945). A white marble sarcophagus of a Depression Modern design is topped by an eagle over a shield with stripes and stars.

13. Lloyd Tevis
The Tevis Memorial tomb was designed by John G. Howard (1912) and is one of his best works. A massive winged bronze angel dominates the circular niche.

14. Herman Nager
A white marble mausoleum (1917) designed by J. S. Cahill as a Greek temple using the Doric order. This temple may have been inspired by the Temple of Poseidon in Paestum, Italy.

15. George Hearst
This family mausoleum with sixteen columns of granite was designed like a Greek temple using the Ionic order. The temple was designed by architect Albert C. Schweinfurth in 1896.

16. Charles F. Crocker
A granite Roman Renaissance style mausoleum set on a stone foundation was designed by A. Page Brown in 1894-98. The entry doors, by Robert I. Aiken, are of a sculpted bronze hovering angel.

17. De la Montanya
A mausoleum designed by J. S. Cahill in 1819-1909. It is one of the more elaborate mausoleums at the cemetery and it once had a Tiffany window.

18. Daniel T. Murphy
A spired family mausoleum with a green bronze roof is like a French Gothic chapel. The mausoleum has unique stained glass.

19. Arthur Rodgers
An Egyptian style tomb with three giant sphinxes at the entrance, and a
winged Egyptian sun-disc on the cornice above the entrance. The interior floor is tile with traditional Egyptian designs.

20. George Whittell & Nicholas Luning
The mausoleum design has an Egyptian influence and is flanked by two sphinxes on the exterior which are of Greek origin.

21. Gustave Niebaum
A handsome granite mausoleum set on a stone foundation. It apparently is very similar and yet has distinct differences to the 1890 Carrie Getty mausoleum in Chicago designed by Louis Sullivan. The Niebaum mausoleum may have been designed by L. Sullivan or is a take-off of the Getty mausoleum. The tomb was moved to Colma from Laurel Hill Cemetery.

The boundary of the Cypress Lawn Historic District is Holy Cross Cemetery and South San Francisco city line on the south; Hillside Boulevard on the east; Junipero Serra Boulevard on the west; and Hills of Eternity Cemetery and numerous commercial properties on the north. The cemetery is composed of two large rectangular tracts that are bisected by El Camino Real and Colma Creek. Refer to Figure 2.

CR-2 cont.

B. Italian Cemetery Historic District
540 F Street
Rating: National Register Historic District with 7 Resources

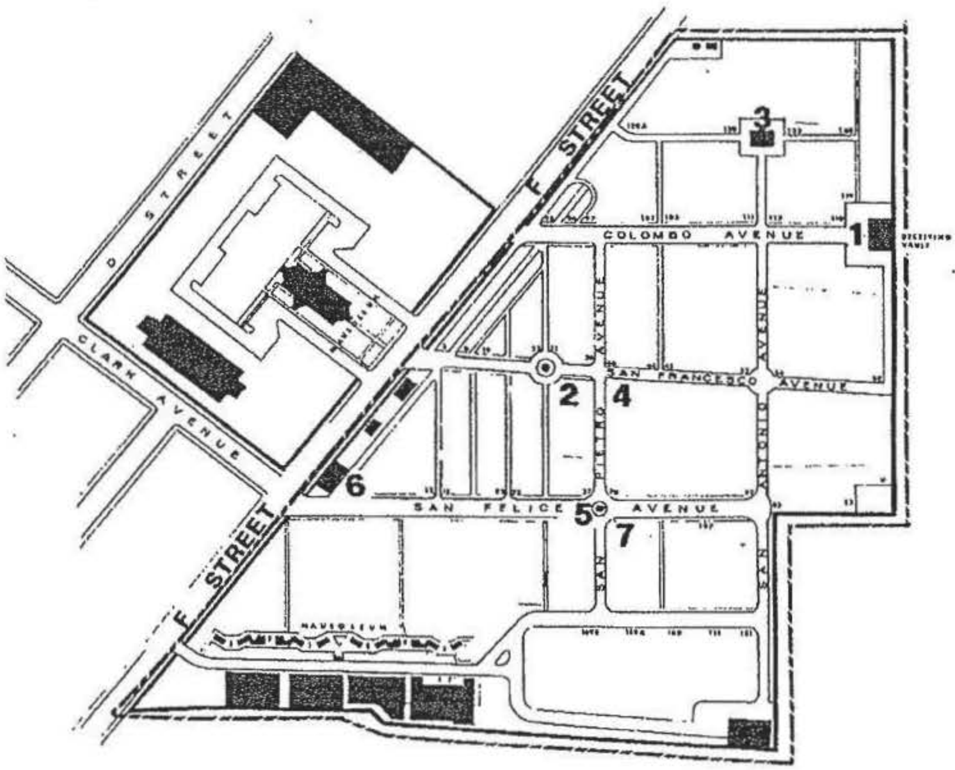
The Italian Cemetery Historic District is described in Section 2.212 of the Historical Resources Element. The seven individual historic resources are identified below as:

1. Receiving Vault
This receiving vault designed by John Porporato in 1900 is the oldest structure in the cemetery. The interior walls are covered with a veneer of Carrara marble and the exterior is fashioned with brick and concrete. Stained glass windows occur throughout the building.

2. Porporato Family Chapel
This concrete family chapel was designed by John Porporato in 1908 and was crafted by Valerio Fontana. It was one of the first private chapels in the cemetery.

Exhibit E

O-CLMP-QUICK cont



1. RECEIVING VAULT
2. PORPORATO FAMILY CHAPEL
3. FUGAZI VAULT
4. CALEGARI FAMILY CRYPT
5. MARBLE COLUMN
6. FONTANA CHAPEL
7. BOCCI FAMILY CHAPEL

ITALIAN CEMETERY HISTORIC DISTRICT

- - - - HISTORIC DISTRICT

2 HISTORIC RESOURCE

HR-3
FIGURE

8/98

CR-2 cont.

3. Fugazi Vault
This vault is the largest and most majestic family vault in the cemetery. John Fugazi, known as Pappa Fugazi, was Northern California's most prominent Italian banker of the time. This ornate Italian Renaissance family vault with columns and pilasters was designed by architect Italo Zanolini. Over the entry is a bronze bust of Fugazi.

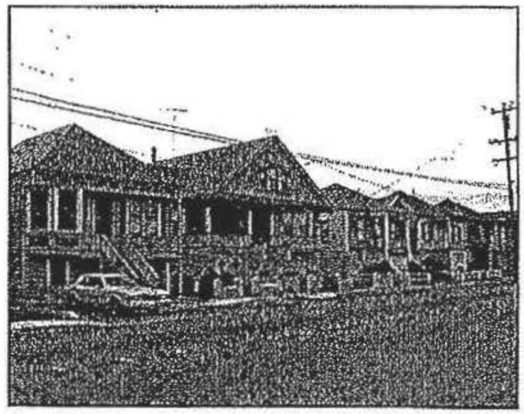
4. Calegari Family Crypt
This marble family crypt, 1905, has a full bust of Francesco Calegari atop a shaft which rises from a rectangular base. The workmanship of the stonecutters is very artistic and typical of the marble carvings throughout the cemetery.

5. Marble Column
This Carrara marble column is surmounted with a symbolic figure of grief standing on a pedestal. The column is a superb example of the stonecutter's art. The statue was carved in Genoa, Italy in 1872. It originally adorned the Brittan family mausoleum in San Francisco's Masonic Cemetery. It was brought to the Italian Cemetery in 1936 with the help of L. Bocci & Sons.

6. Fontana Chapel
This granite chapel was erected by Elio Fontana, the son of Valerino Fontana. Valerino Fontana was an established and important stonecutter in Colma.

7. Bocci Family Chapel
The chapel's black granite door surround is capped with a marble statue of Jesus. Leopoldo Bocci established the first stonecutting business in Colma. Bocci and Fontana created most of the funerary art at the Italian Cemetery.

The boundary of the Italian Cemetery Historical District is: F Street on the north; El Camino Real on the west; Eternal Home Cemetery on the south, and several private parcels on the east (Refer to Figure 3). The cemetery has an irregular shape, the newest section on the north side of F Street is not included in the historic district.



C. Old Mission Road Historic District 1431, 1433, 1439, 1445, 1451, 1457 Mission Road

Rating: National Register - Historic District with six contributing buildings

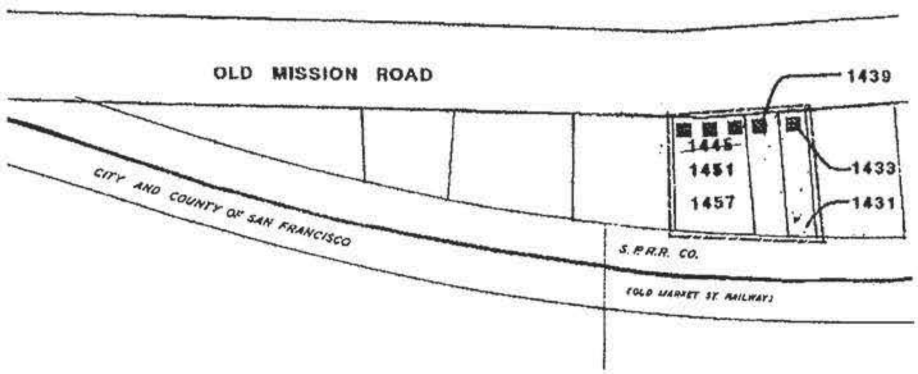
The Old Mission Road Historic District is also discussed in Section 2.213 of the Historic Resources Element. These six Neo-Classical houses were built for Frank Lagomarsino and are Colma's single largest collection of residences built between 1908 and 1918. These houses are Colma' s most intact example of family farmstead. Frank Lagomarsino built his family farmhouse (1439) in 1917. His son's house (1431) and four rental units (1433, 1445, 1451, 1457) were built in 1918. While the original farm buildings were demolished in the 1980s and the farmland has been developed for commercial use, the six rowhouses retain much of their integrity from when they were constructed by L. Ferreios' New Era Construction Company. Four of the houses were built from the same set of plans prepared by L. Ferreios. Three of the houses continue to be owned by Lagormarsino family members (1431, 1433, 1439).

The boundary of the Old Mission Road Historic District is: Old Mission Road on the east; the Southern Pacific Railroad right-of-way on the west; and a privately owned commercial property on the north and south (Refer to Figure 4). The district is comprised of three separate parcels; one parcel has three residences and another parcel has two residences.

CR-2 cont.

Exhibit E

O-CLMP-QUICK
cont



CR-2
cont.

OLD MISSION ROAD HISTORIC DISTRICT

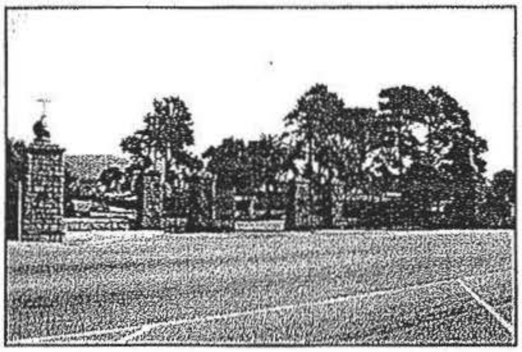
- - - HISTORIC DISTRICT

■ HISTORIC RESOURCE

HR-4
FIGURE

8/98

O-CLMP-QUICK
cont



D. Holy Cross Historic District
1595 Mission Road
Rating: National Register Historic District with 2 Resources

The Holy Cross Historic District is described in Section 2.214 of the Historical Resources Element. The two historic resources are described below:

1. Holy Cross' Gateway and Lodge Building
The Gateway and Lodge Building, also known as McMahon Station was designed by Frank T. Shea and William D. Shea in 1902. It is the oldest remaining building ensemble of Colma's first cemetery. The building functioned as both an office and a station for funeral parties and visitors. The Lodge is a good example of the Richardson Romanesque architectural style with its rock-faced ashlar masonry articulated by arcaded walls. It represents a functional adaptation of Richardson's popular railway depot design for the needs of the cemetery. It is one of very few examples of the style found in San Mateo County, the most notable of which is Stanford University.

2. Holy Cross Mausoleum
The Holy Cross Mausoleum was designed by John McQuarrie in 1921, and was dedicated by Archbishop Edward Hanne. The mausoleum original covered a four acre area and contains 14,000 crypts, it now covers over nine acres. The mausoleum contains the remains of numerous prosperous California figures such as Faxon Atherton, Angelo Rossi, and Michael Geraldo. The sepulcher of Archbishop Joseph Sadoc Alemany is located in the central apse of the Holy Cross mausoleum which is reserved for the burial of archbishops of San Francisco.

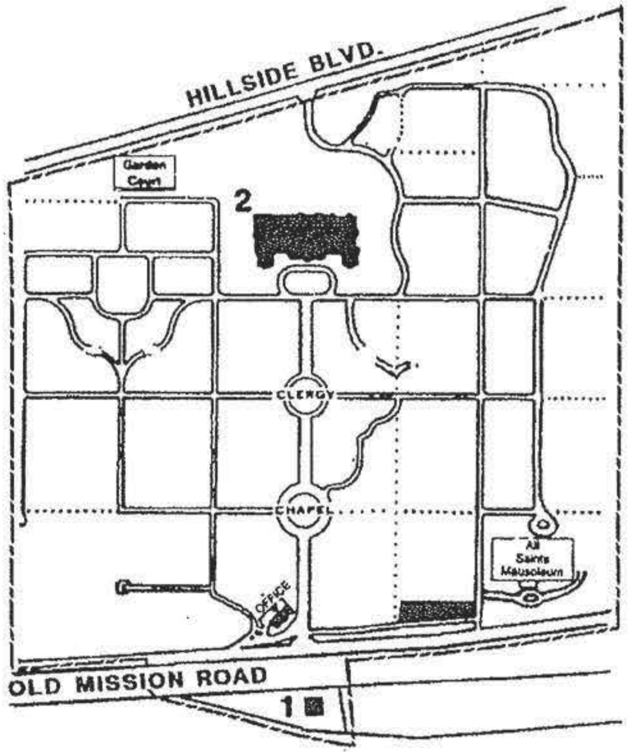
Alemany played an important role in the development of California's religious community, education of the children, and secular life. He profoundly shaped the conscience of California's Catholics and was the first and last Catalan who brought the best of his province's heritage to his adopted country. Alemany died and was buried in 1888 in Vich, Spain, his birthplace. However in 1965 the remains of Joseph Sadoc Alemany were transferred to the sepulcher in Holy Cross Cemetery. He was a naturalized American citizen and while his influence permeated Northern California's education and social institutions, his final resting place is at Holy Cross Cemetery.

The boundary of the Holy Cross Historic District is Cypress Lawn Memorial Park on the north, city limit line and the City of South San Francisco on the south, Hillside Boulevard on the east and Old Mission Road on the west. The district also includes a triangular parcel on the west side of Old Mission Road bound by Old Mission Road on the north and east, Southern Pacific Railroad right-of-way on the west and a private parcel on the south. Refer to Figure 5.

CR-2
cont.

Exhibit E

O-CLMP-QUICK cont



1. GATEWAY AND LODGE BUILDING
2. HOLY CROSS MAUSOLEUM

HOLY CROSS HISTORIC DISTRICT

HISTORIC DISTRICT

2 ■ HISTORIC RESOURCE

HR-5
FIGURE

8/98

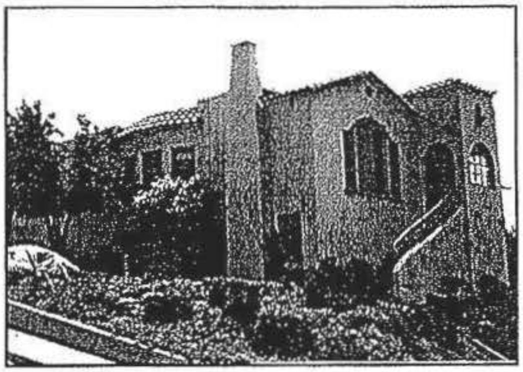
CR-2 cont.

Exhibit E

O-CLMP-QUICK cont

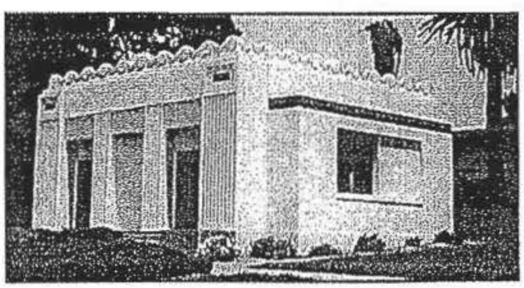
CR-2 cont.

5.08.430 POTENTIAL STATE AND LOCAL HISTORIC RESOURCES



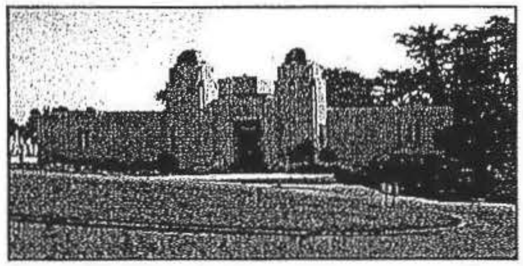
A. Filipini Residence
7701 Mission Street
Rating: Historic Resource

The Joseph Filipini house is the best remaining example of the Spanish Eclectic style of architecture in Colma. Very few residences were constructed in Colma between the time it was incorporated in 1924 and the end of World War II. The Filipini house was constructed in 1934 by Anthony Pianca. Pianca is one of the few early contractors identified with the development of Colma. The home probably derives its Mediterranean character more from the Italian-American makeup of the community than from any conscious effort to express a specific building style.



B. Salem Memorial Park Office/Chapel
1171 El Camino Real
Rating: Historic Resource

The Salem Memorial Park/Office Chapel is an interesting example of divergent historical forms incorporated in a composition reflecting the architectural fashion of the building's own design period, the 1903, as well as the malleability of a modern construction material, concrete. The rectangular forms and decorative banding are Neo-Babylonian while the symmetrical use of pilasters draws from Roman sources. In combination they make a successful Moderne design, at once reflective and contemporary.



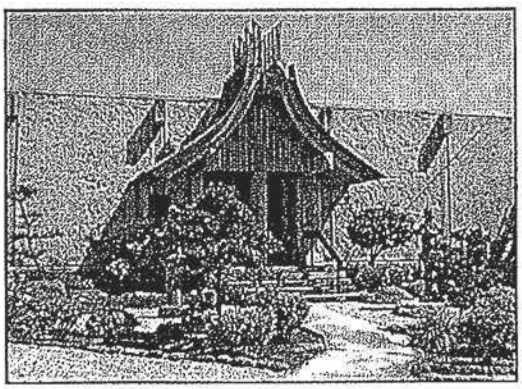
C. Hills of Eternity
1301 El Camino Real
Rating: Historic Resource

Near the El Camino Real entrance is the Portals of Eternity Mausoleum which is on a grass slope with mature trees to the southwest that create a natural backdrop for the building. It is one of two examples in Colma of Neo-Byzantine style buildings reflecting the near eastern architectural sources for the Jewish monumental design. There is also a marked reference to the Moderne style with horizontal and vertical grooves and lines and the chevron moldings that characterize the compound entry. The building was designed by the San Francisco architectural firm of Samuel Hyman and Abraham Appleton. The Hyman and Appleton office has done most, if not all, of the additions over time and are responsible for the building's continuity of design.

D. Pelton "Cheap Dwelling"
437 F Street
Rating: Historic Resource

This house is one of San Francisco architect John Pelton's design for "Cheap Dwellings" published in the *San Francisco Evening Bulletin* between 1880 and 1883. The building was moved to its current location in the 1960s from the

Alemany Street area of San Francisco during the construction of Highway 280. The building is a relatively intact example of the Cheap Dwellings designed by John Pelton. The plans for these dwellings were published by the newspaper because the editors had the idea to publish inexpensive, hence "cheap," plans to make housing affordable. While 437 F Street is a relocated building it still functions in its intended role as affordable housing and is one of the few remaining examples of the style to survive. It should be treated as a historic resource because of its role in the broader patterns of residential development in the San Francisco Bay Area.



E. Japanese Cemetery
1300 Hillside Boulevard
Rating: Landmark

The cemetery is small and unique for its absence of trees and lawn and its crowded monuments. Upon entering the main gate visitors pass through a traditional Japanese garden. The cemetery is for all Japanese regardless of fame or fortune. Japanese who were buried in Laurel Cemetery in San Francisco were reburied in Colma's Japanese Cemetery. A granite monument marks the graves of hundreds of Japanese who were removed from San Francisco's Laurel Hill Cemetery in 1940.

The graves of three Japanese sailors from the Ship Kanrin Maru, who died in San Francisco in 1860, were moved to Colma from Laurel Cemetery. In front of these graves is a circle and a marker referred to as ireito (comfort all souls) which symbolizes the center of the cemetery. These gravestones were paid for by the Emperor of Japan. A towering obelisk stands in tribute to George Shima (Kinji Ushijima) who produced the bulk of California's potatoes and gained the title "Potato King". Another person who influenced California's Agricultural history is Keisaburo Koda who became known as "California's Rice King." He was the only American grower of sweet rice, an ancient ceremonial rice, and was the first to sow rice seeds by airplane. He demonstrated that rice could be grown on a commercial scale. There is a monument to the "Unknown Soldiers" which recognizes the Japanese-Americans who fought as part of the United States Armed Forces in World War II. The Cemetery's most traditional family tomb contains the remains of three generations of the Hagiwara family. Makoto Hagiwara came to San Francisco in 1890 and built the Japanese Tea Graden in Golden Gate Park.

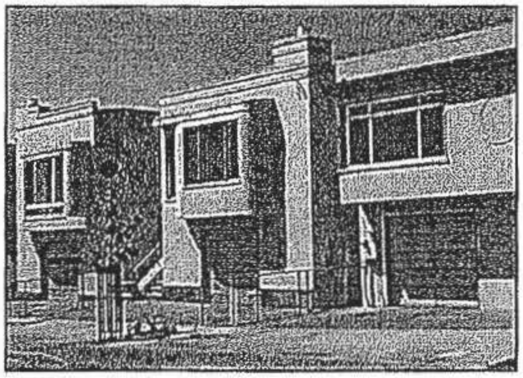
F. Pet's Rest Cemetery Office
1905 Hillside Boulevard
Rating: Historic Resource

This house is one of the few remaining examples of post-1906 earthquake residential buildings in Colma. Following the earthquake the Colma area became a center for resettlement for refugees from the San Francisco disaster. The residential building type that resulted from this rapid population influx was typically a one or two and one-half story and gabled building with a rectangular plan. The facades of the homes were characterized by recessed central entries, flanked by single or double angled bays. Many of these new buildings had raised basements requiring tall, straight or side approach stairways to reach the front doors. Earl Taylor, Assistant Manager of Cypress Lawn Cemetery, bought his home in 1947 to establish Pet's Rest Cemetery, the only pet cemetery in Colma.

CR-2
cont.

5.08.440 POTENTIAL STATE AND LOCAL HISTORIC DISTRICTS

Historic Districts should be formed when more than one historic resource occurs on a parcel.



A. E. Street Historic District (Ottoboni Residential Buildings) 464, 466, 467-469, 471 E Street
Rating: Historic District
4 Resources

These four residential buildings on E Street, which is only one block long, are Spanish Eclectic and Moderne in style. The Spanish Eclectic houses at 464 and 466 E Street were constructed in 1924. The other homes of the Moderne design were moved to the site in the 1960's from the Alemany Street area of San Francisco during the construction of State Highway 280. Most of the Eclectic buildings in Colma were relocated from locations outside of Colma to their present site by owner Raymond Ottoboni after World War II. While these buildings were not originally built in Colma, so many of San Francisco's row houses were relocated in Colma in the 1960's that they need to be discussed. Their significance is in their number and distribution giving the erroneous sense that they were part of the chronological growth of the Town when, in fact, them came over a very short period of time as the result of a specific event.

B. Home of Peace Historic District 1229 El Camino Real
Rating: Historic District
5 Resources

Home of Peace Cemetery is the oldest and largest Jewish cemetery in the west. While there are many similarities between the funerary practices with Jewish faith and those of other religions represented in Colma, there are also differences. Above ground interment has been a Jewish practice since the ancient times. The style of both monuments and mausoleums at Home of Peace tend to draw their inspiration from early near eastern architectural forms rather than those typically associated with funerary design. Home of Peace is a resting place for many Jews prominent in the settlement and upbuilding of California and the west. The cemetery has a park-like landscape with lawns and mature stands of trees as well as prominently featured palms. There are many handsome granite mausoleums from the 19th and early 20th centuries as well as beautifully carved monuments and headstones. The design of many of the family mausoleums with their square or cross axial base capped with rounded domes reflect building forms of the ancient near east. Of particular note is the Emanu-El Memorial of Mae and Benjamin Swig with its large tiled dome reminiscent of Constantinople's Hagia Sophia.

The five identified historic resources include:

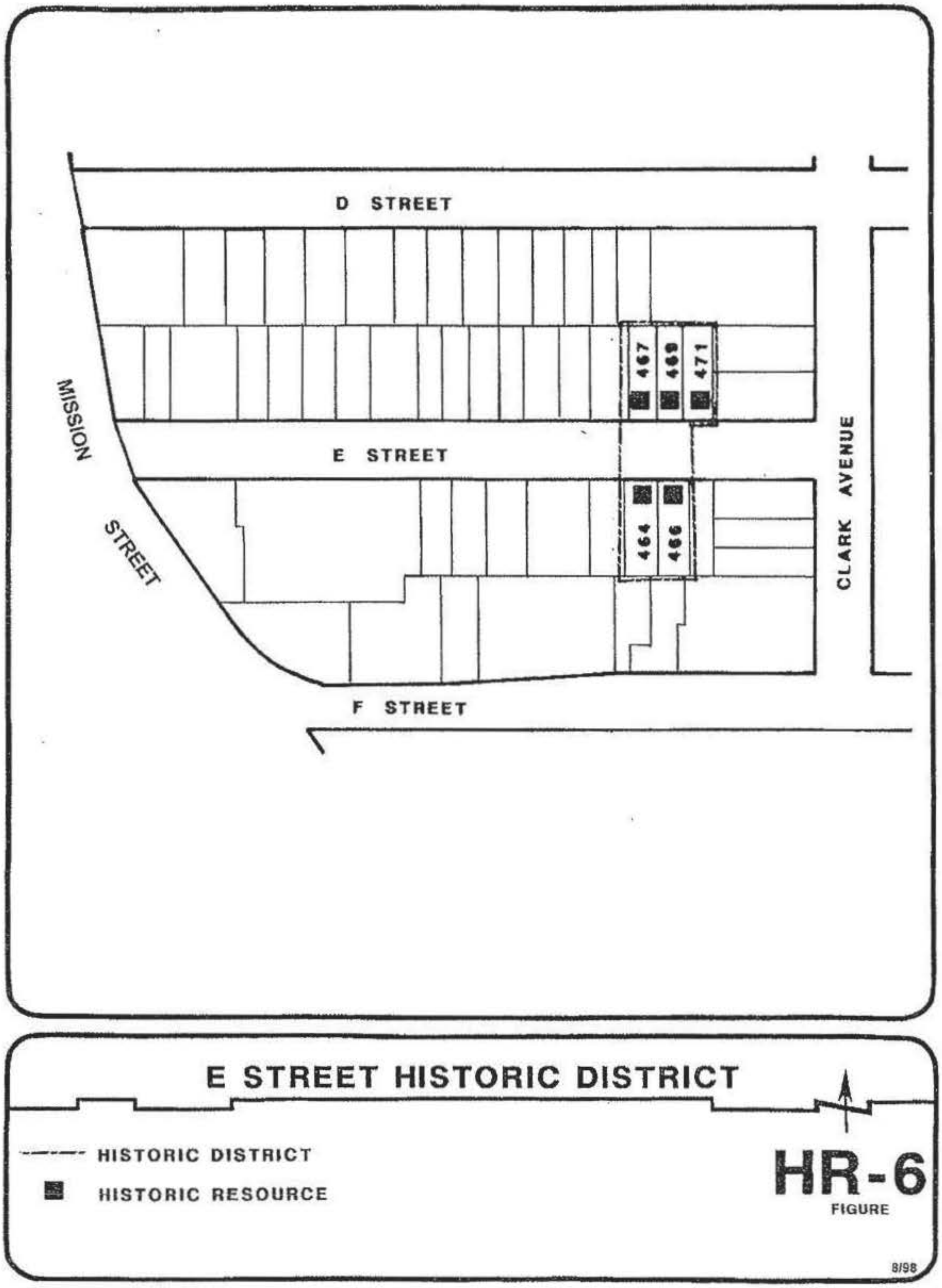
a) Mae and Benjamin Swig's Memorial Chapel (with mausoleum and columbarium;

b) Carved granite family mausoleum (Hetch family);

CR-2 cont.

Exhibit E

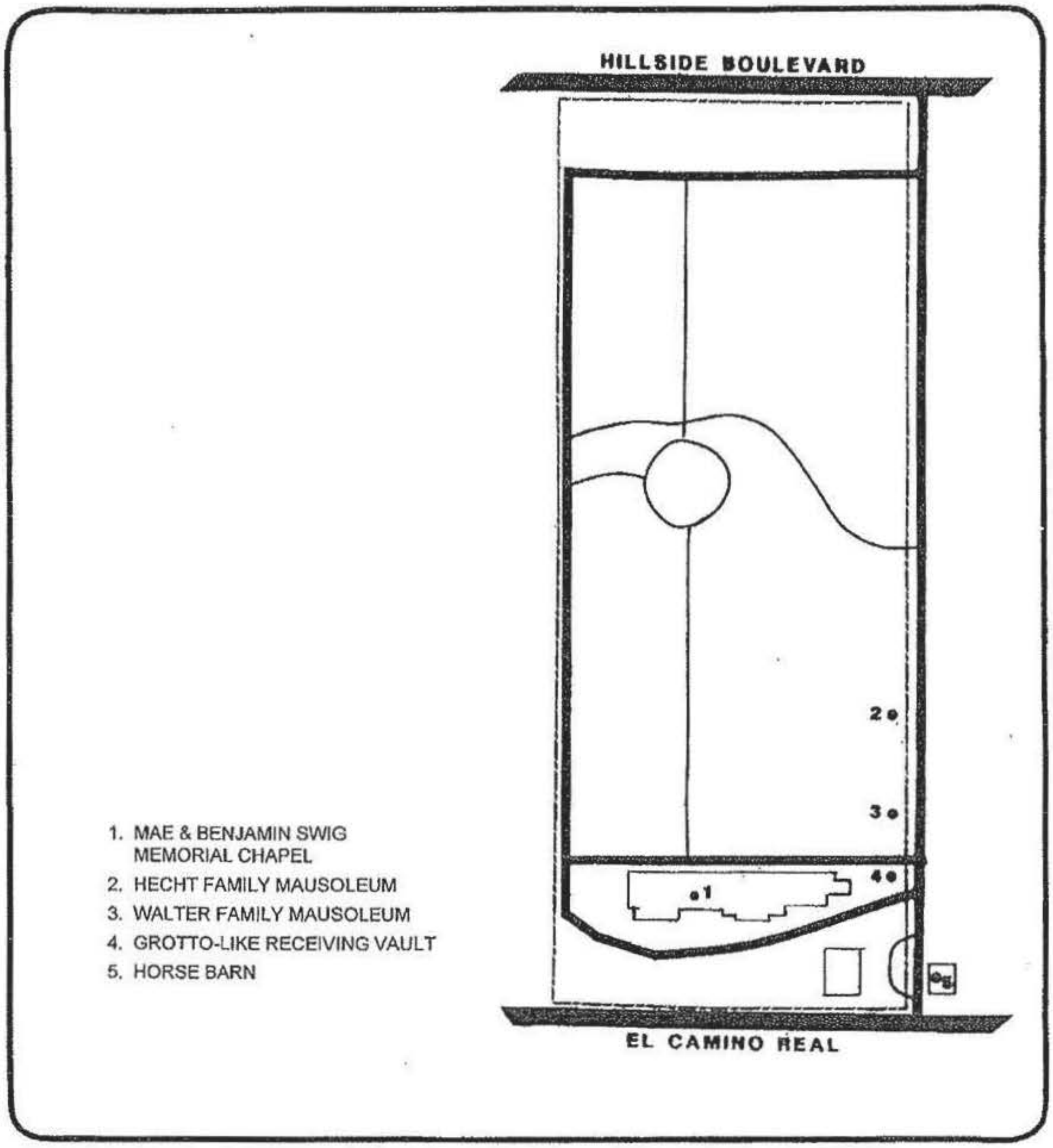
O-CLMP-QUICK
cont



CR-2
cont.

Exhibit E

O-CLMP-QUICK
cont



HOME OF PEACE HISTORIC DISTRICT

------ HISTORIC DISTRICT

• 3 HISTORIC RESOURCE

HR-7
FIGURE

8/98

CR-2
cont.

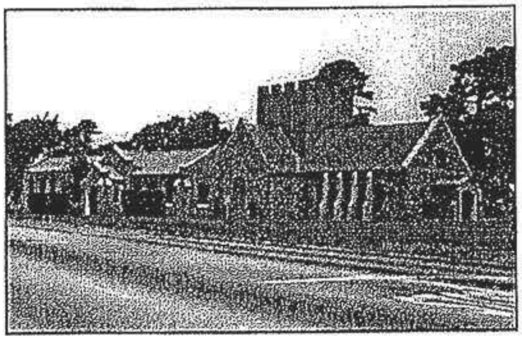
Exhibit E

O-CLMP-QUICK cont

c) Greek temple family mausoleum (Walter family);

d) Recessed grotto-like receiving vault;

e) Wooden horse barn (1889).



C. Olivet Historic District
1601 Hillside Boulevard
Rating: Historic District
3 Resources

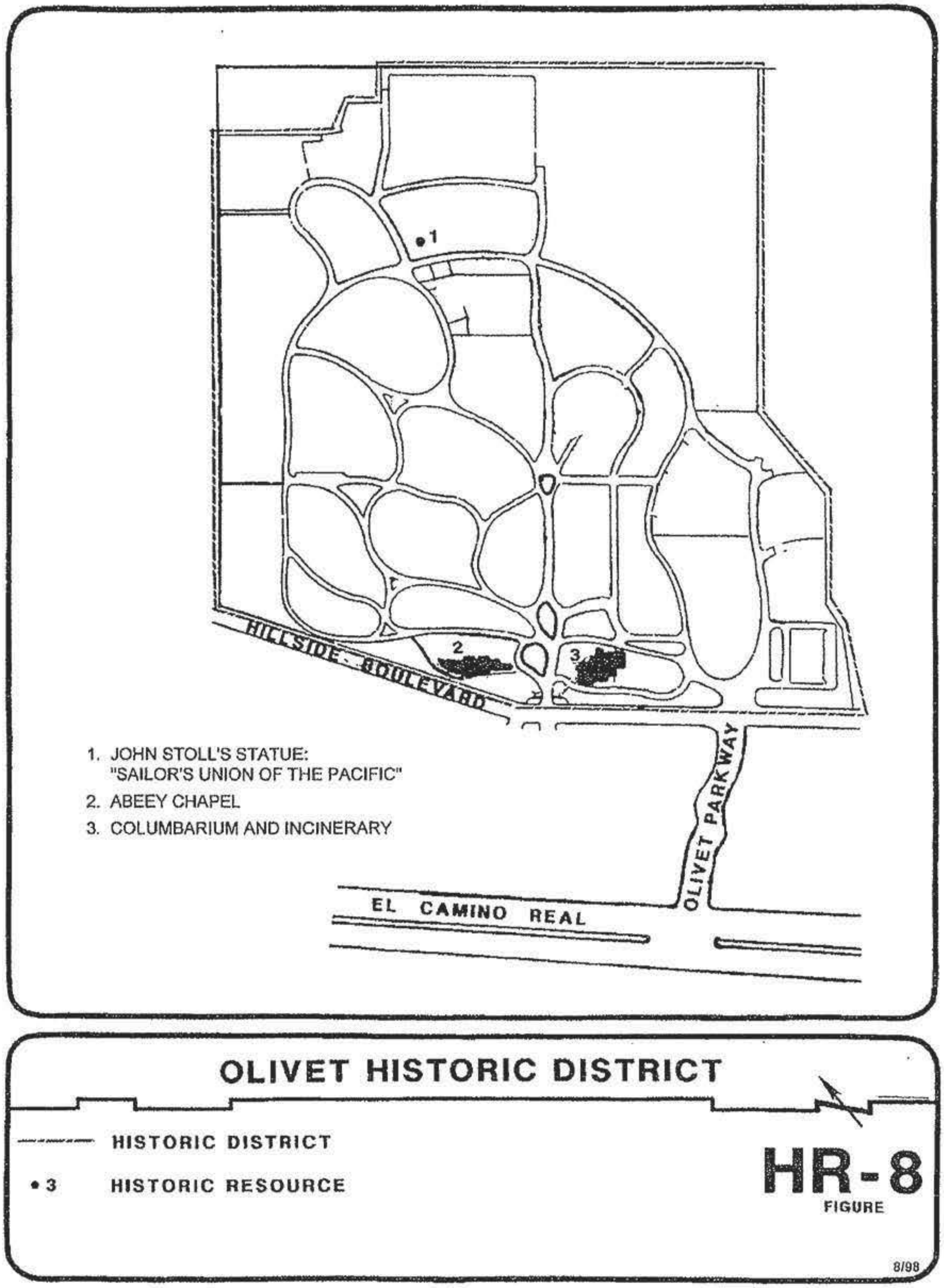
Olivet Memorial Park was originally known as Mount Olivet Cemetery. The cemetery evolved during its first seven years without an organized plan until 1904 when Mattrrup Jensen became Superintendent and completely redesigned the grounds. The cemetery derives its significance as a model modern cemetery; Jensen made Olivet "an outdoor cathedral" the interment of the dead. In the older portions of the cemetery there are stone and concrete crypts, mausoleums and examples of Victorian funerary statuary. Of particular interest are the sections reserved for persons related by vocation or interest. Most of these areas are marked by an appropriate monument such as John Stoll's monolithic black granite statue of a helmsman in the "Sailor's Union of the Pacific" plot.

In 1908 Mattrup Jensen began to design modern crematories and in 1912 perfected a retort for cremation which became a standard for the trade. In 1915 his ideas were incorporated in the design of the new columbarium and incinerary prepared by architect William Crim, Jr.. The late English Gothic Revival style Abbey Chapel of 1896 and the 1915 revival style Columbarium were both designed by William Crim Jr. These two buildings still retain much of their original design integrity in spite of addition to both over time. Buried in the Columbarium are the remains of Ishi, 1916, a California Yahi Indian who is believed to be the last surviving member of his tribe.

CR-2 cont.

Exhibit E

O-CLMP-QUICK cont



CR-2 cont.

5.08.450 CATEGORIES AND DEFINITIONS FOR HISTORIC PROPERTIES*

Landmark (Highest Importance): The first, last, only or most significant of a type in a region, over fifty years old, possessing integrity of original location and intangible elements of feeling and association. A site or structure no longer standing may possess significance if the person or event associated with the structure was of transcendent importance to the community's history and the association consequential. Every effort should be made to retain the original exterior appearance of the landmark, including its immediate setting and, on an advisory basis, to encourage uses which would maintain the interior, in its original configuration.

Historic Resource: (Major Importance) A Historic Resource is a structure, site or feature which is representative of a historic period or building type but is not of Landmark quality. Modifications of the feature, including change of use, additions, etc., are acceptable as long as the resource retains the essential elements which make it historically valuable.

Historic Districts: A geographically definable area with a significant concentration of buildings, structures, sites, spaces, or objects unified by past events, physical development, design, setting, materials, workmanship, sense of cohesiveness or related historical and aesthetic associations.

Within a Historic District, the following designations would apply:

A Contributing Building, site, structure, or object that adds to the historic architectural qualities, historic associations or archeological values for which a district is significant because:

(a) it was present during the period of significance, and possesses historic integrity reflecting its character at that time, or is capable of yielding important information about the period, or

(b) it in independently meets the Landmark of Historic Resource criteria.

* From *Colma Historic Inventory*, 1992.

A Non-contributing Building, (Contextual Importance) site, structure, or object does not add to the architectural qualities, historic associations, or archaeological values for which a property is significant because:

(a) it was not present during the period of significance,

(b) due to alteration, disturbances, additions, or other changes, it no longer possesses historic integrity reflecting its character at that time or is incapable of yielding important information about the period, or

(c) it does not independently meet Landmark or Historic Resource criteria.

5.08.460 DEFINITIONS OF NATIONAL REGISTER CRITERIA*

A = Representative of Events of Broad Pattern of History

B = Associated with Important Persons

C = Architectural Significance:
- (a) Significant Type, Period, or Method of Construction
- (b) Work of a Master
- (c) High Artistic Values

CR-2 cont.

Exhibit E

O-CLMP-QUICK cont

5.08.500 HISTORICAL RESOURCES ELEMENT APPENDIX B

5.08.510 ADDITIONAL READING MATERIALS ON COLMA'S HISTORY

1) Chandler, Samuel; Gateway to the Peninsula: A History of Daly City, Daly City, California: City of Daly City, 1973.

2) Cloud, Roy; History of San Mateo County, Vol. 1 & 2; Chicago: S. T. Clarke Publishing Co., 1928.

3) Gudde, Erwin; California Place Names; University of California Press, Berkeley, California, 1960.

4) San Mateo County Historical Association & Advisory Board; Kent Seavey, Historic Resources Inventory, Colma, California, December 1992.

5) Stanger, Frank; History of San Mateo County; San Mateo, California: San Mateo Times, 1938.

6) Svanevik, Michael; and Burgett, Shirley - City of Souls; San Francisco's Necropolis at Colma, Custom and Limited Editions, San Francisco, California 1995.

7) Svanevik, Michael; and Burgett, Shirley - Pillars of the Past - A Guide to Cypress Lawn Memorial Park, Colma, California; Custom and Limited Editions, San Francisco, California 1992.

CR-2 cont.

5.08.700 HISTORIC RESOURCES ELEMENT APPENDIX C

5.08.710 SECRETARY OF THE INTERIOR'S STANDARDS FOR REHABILITATION AND GUIDELINES FOR REHABILITATING HISTORIC BUILDINGS

1. A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.

2. The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a historic property shall be avoided.

3. Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken.

4. Most properties change over time; those changes have acquired historic significance in their own right shall be retained and preserved.

5. Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a historic property shall be preserved.

6. Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.

7. Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.

8. Significant archaeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.

9. New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property and its environment. The new work shall be differentiated from the old to protect the historic integrity of the property and shall be compatible with the massing, size, scale, and architectural details to protect the historic integrity of the property and shall be compatible with the massing, size, scale, and architectural details to protect the historic integrity of the property and its environment.

CR-2 cont.

10. New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

Exhibit E

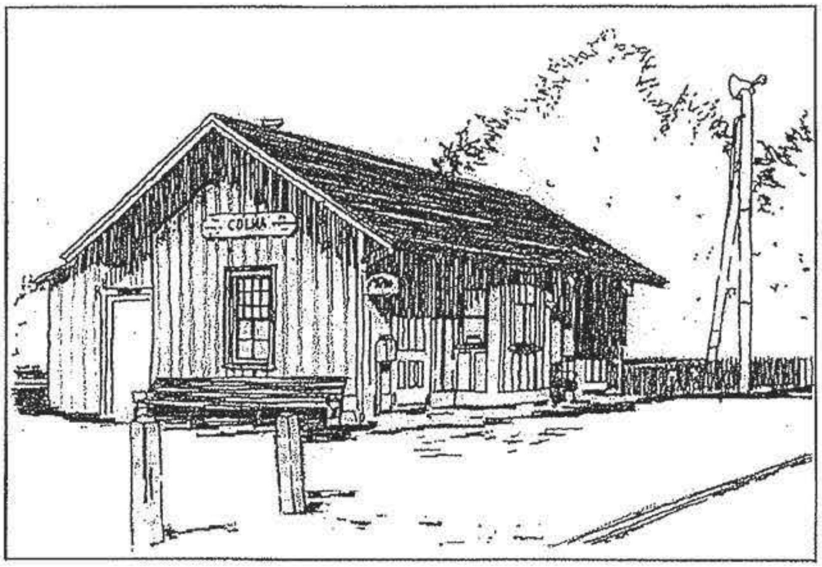
O-CLMP-QUICK
cont

CR-2
cont.

Exhibit E

O-CLMP-QUICK cont

HISTORICAL RESOURCES ELEMENT



CR-2 cont.

TABLE OF CONTENTS

Exhibit E

O-CLMP-QUICK cont

FIGURES

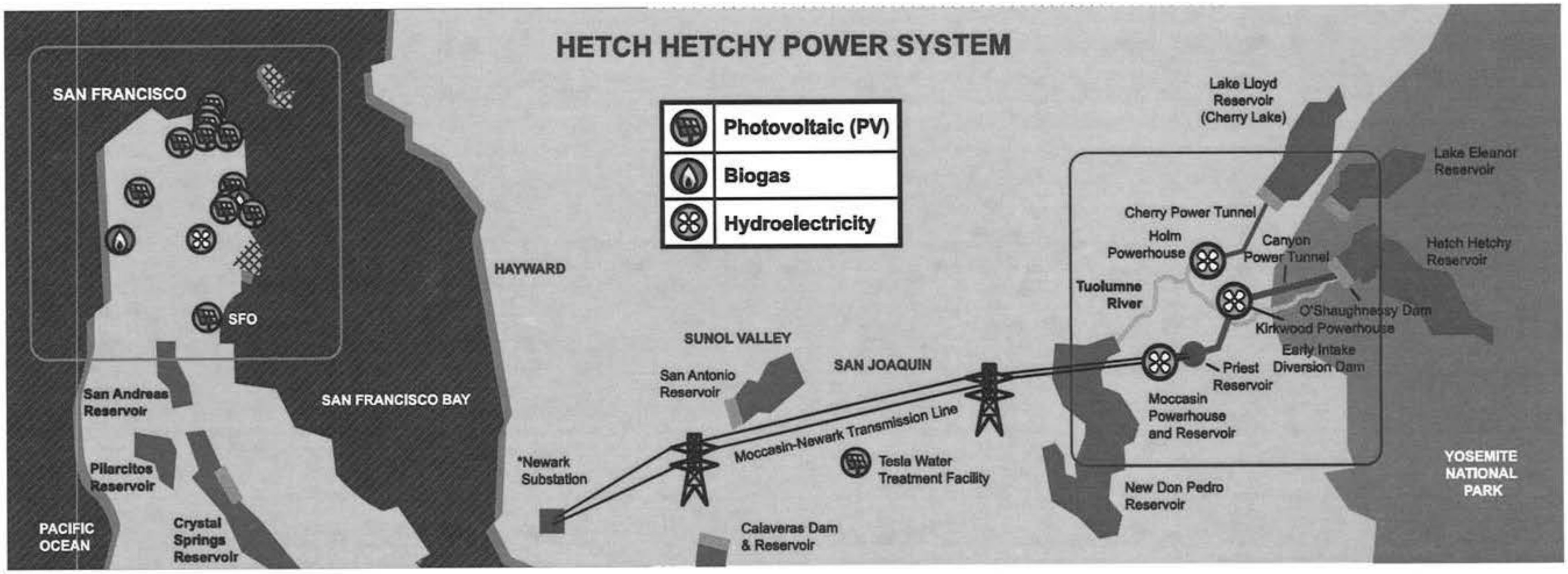
CR-2 cont.

TABLES

APPENDICES

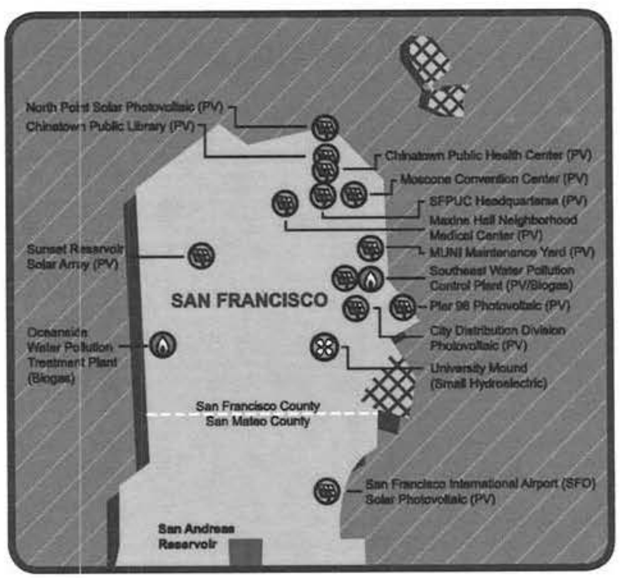
EXHIBIT F

Exhibit F



*Hetch Hetchy energy enters the electricity grid at the Newark Substation.

The San Francisco Public Utilities Commission is the exclusive power provider on Treasure Island and in the parts of the Hunter's Point Shipyard.



HYDROELECTRIC GENERATION	Approximate Hydroelectric Capacity: 405 mW			
Powerhouse	**Date On line**	**Unit 1**	**Unit 2**	**Unit 3**
Moccasin Powerhouse	1969	55 mW	55 mW	0 mW
Holm Powerhouse	1960	90.1 mW	0 mW	90.1 mW
Kirkwood Powerhouse	1967	39.5 mW	39.5 mW	36.5 mW

SMALL HYDROELECTRIC GENERATION	Total Small Hydroelectric Capacity: 3.1 mW		
Project	**Date On line**	**Location**	**Output**
University Mound Reservoir	2013	University Mound Reservoir	240 KW
Moccasin Low Head Unit	1987	Moccasin Powerhouse	2.9 mW

BIOGAS GENERATION	Total Biogas Capacity: 3 mW		
Project	**Date On line**	**Location**	**Output**
Oceanside Water Pollution Treatment Plant	1993	3500 Great Highway	1.1 mW
Southeast Water Pollution Treatment Plant	2002	750 Phelps St.	1.9 mW

PHOTOVOLTAIC (PV) GENERATION	Total Solar Capacity: 7.4 mW		
Project	**Date On line**	**Location**	**Output**
Moscone Convention Center	Mar 15, 2004	747 Howard St.	676 kW
Southeast Water Pollution Control Plant	Oct 6, 2005	750 Phelps St.	255 kW
Pier 96	Jan 2, 2007	Pier 96	245 kW
Maxine Hall Neighborhood Medical Center	Dec 4, 2007	1301 Pierce St.	32 kW
North Point	Dec 27, 2007	111 Bay St.	241 kW
City Distribution Division	Dec 27, 2007	1990 Newcomb Ave.	134 kW
Chinatown Public Library	Jan 8, 2008	1135 Powell St.	10 kW
San Francisco International Airport (SFO)	Mar 12, 2008	Terminal 3	456 kW
Sunset Reservoir	Nov, 2010	Ortega & 28th Ave.	5 MW
MUNI Maintenance Yard	Oct, 2011	1095 Indiana St.	106 kW
Chinatown Public Health Center	Nov, 2011	1490 Mason St.	24.5 kW
Tesla Water Treatment Facility	Mar, 2012	Tesla	32 kW
SFPUC Headquarters	Jun, 2012	525 Golden Gate	164 kW

O-CLMP-QUICK cont

I-KING

RECEIVED

MAY 07 2013

CITY & COUNTY OF S.F.
PLANNING DEPARTMENT
M.E.A.

Christopher King
15 Mateo Ave #10
Millbrae, CA 94030

4/26/2013

Sarah B. Jones
Acting Environmental Review Officer
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

Dear Ms. Jones:

I am writing to comment on case no. 2008.1396E, "Regional Groundwater Storage and Recovery Project." I noticed that in the document "2008.1396E_DEIR1 (April 2013 DRAFT Environmental Impact Report Volume 1 of 3), figure 3-37 (Site 16, Millbrae Corporation Yard), labels the properties at 9 Mateo Avenue and 15 Mateo Avenue as "Convalescent Hospital". These are actually residential properties: 9 Mateo Avenue is a multi-family apartment building, and 15 Mateo Avenue is a condominium building. PD-3

Sincerely,

Christopher King

I-ROBERT

RECEIVED

MAY 07 2013

CITY & COUNTY OF S.F.
PLANNING DEPARTMENT
MEA

May 2, 2013

Sarah B. Jones
Acting Environmental Review Officer
San Francisco Planning Department
1650 Mission Street
Suite 400
San Francisco,
CA 94103

Attn: Sarah B. Jones, Kelley Capone, Tim Johnston, and the San Francisco Planning Department

Good day to all of you,

I am writing in regards to the recent information sent out dated April 10, 2013, for Case No. 2008.1396E, Project Title: Regional Groundwater Storage and Recovery Project. GC-1

After review, it seems the recent information provided describes a project without specific need nor specific implementation, by an agency owned by the city and county of San Francisco, focusing on communities outside of San Francisco. PD-1 Yes, according to the website http://www.sanbrunowater.ca.gov/watersources.html Welcome to Water Conservation page, approximately 50% of the drinking water in San Bruno comes from the San Francisco Public Utilities Commission. Yet also, the reservoir at Crystal Springs, closer to San Bruno than San Francisco, is a valuable link in this chain already visibly available. This was observed after many enjoyable walks of pride near this beautiful and efficient reservoir, which showed how fortunate the area already is to have such a great source for water use. Yet we receive this information about these alternate vague sources, and are apparently supposed to welcome this, even when the paperwork states "the proposed project would lead to significant unavoidable construction-related land use character, noise, and aesthetics impacts, and potentially, operations-related well interference impacts." GC-2

One of the proposed sites is outside the window from where I write this message to you. Unless you live near one of these proposed sites as well, and are ok with another city deciding land use near your home without possible good reason, perhaps this helps explain why it is difficult to readily accept this project. LU-4

Although we may disagree on this matter, I hope you have heard these comments with an open mind, and thank you for your time. GC-1

Sincerely,

Robert in San Bruno

I-LAWRENCE (1)

From: Jones, Sarah
To: Johnston, Timothy
Cc: Smith, Steve
Subject: FW: Regional Groundwater Storage & Recovery draft EIR, comment
Date: Tuesday, May 28, 2013 9:04:07 AM

Sarah Bernstein Jones
Acting Environmental Review Officer
Acting Director of Environmental Planning

Planning Department│City and County of San Francisco
1650 Mission Street, Suite 400, San Francisco, CA 94103
Direct: 415-575-9034│Fax: 415-558-6409
Email: sarah.b.jones@sfgov.org
Web: www.sfplanning.org

From: Steve Lawrence [mailto:splawrence@sbcglobal.net]
Sent: Sunday, May 26, 2013 5:34 PM
To: Sinclair, Amy; sarah.jones@sfgov.org
Subject: Regional Groundwater Storage & Recovery draft EIR, comment

Please accept these comments to the Draft EIR for Regional Groundwater Storage & Recovery:
(Amy, please forward this to the right email if it is not properly addressed; thank you.) GC-1

1. Will the Westside Aquifer be overdrawn? Assume planned withdrawals for 7.5 years during a design drought, as well as groundwater extraction as planned in local project SF Groundwater; at the end of 7.5 years, will the aquifer be overdrawn?* HY-44

2. Assume as in 1; will there be ground subsidence?* HY-23 Will Lake Merced be depleted or unacceptably low?* HY-32

3. When the planned quantity of water is stored in the aquifer, will any land now dry become wet such that it cannot be used as it has been? HY-54

4. With the groundwater table as high as it will be when the aquifer is "full" with stored 60,500 acre feet of water, is it likely that this water, or some of it, will be extracted, openly or surreptitiously, by landowners, either as a source of cheap(er) water or because land is now swampy or wet? HY-54

5. There is some outflow of groundwater to the ocean. Especially near Lake Merced (to the ocean side), will the project cause outflow to increase, and if so, will greater outflow accelerate the creation of a pathway for ocean water (at highest tides and westerly storm conditions) to enter into Lake Merced? HY-32

Steve Lawrence

*Footnotes are for my use.
Reference Table 5.16-2; my guess is this is for an average year; my further guess is that estimates are to some level of accuracy, which I do not see (e.g. standard deviation of __ AF).

There is discussion of subsidence beginning on 5.16-27. 5.16 is in volume 2.
Lake Merced: a discussion begins 5.16-30.

I-LAWRENCE (2)

From: Jones, Sarah
Sent: Thursday, June 13, 2013 1:26 PM
To: Johnston, Timothy
Subject: Fwd: Comment for Regional Groundwater Storage & Recovery

Sent from my iPhone

Begin forwarded message:

> **From:** Steve Lawrence <splawrence@sbcglobal.net>
> **Date:** June 13, 2013, 3:13:34 PM EDT
> **To:** <sarah.jones@sfgov.org>
> **Cc:** Steve Ritchie <sritchie@sfwater.org>
> **Subject: Comment for Regional Groundwater Storage & Recovery**
>
> Please add this Comment:
>
> At his June 11 presentation concerning projects that will affect Lake Merced, Mr. Ritchie, and the Commission, declined to address how pumping 7.2 mgd from the Westside aquifer during drought years (7.5 years per the design) will affect Lake Merced, except to say it "would suffer along with the rest of us."
>
> It is possible, even likely, that when pumping occurs the Lake level drops. Mr. Ritchie's presentation did not deny the connection between Lake and aquifer. (I believe that is new).
>
> HY-32
>
> Given the long, intense interest of citizens in the Lake, it is very possible that people rise up in protest when their Lake is sucked dry.
>
> Should San Francisco invest $100 million in a project that may suck the Lake dry?
>
> GC-2
>
> Is there an alternative?
>
> Yes: desalination. A plant could be built that would be activated during drought. In that regard, new technology shows promise of replacing reverse osmosis, the current tech, which consumes much electricity. Graphene-based membranes may more efficiently separate salt from sea water.
>
> Please consider the desalination option, and weigh the environmental negatives of GSR, including its effect on Lake Merced, against those of desal.
>
> AL-1

This e-mail has been scanned for viruses by MessageLabs.

Attachment RTC-B

Draft EIR Public Hearing Transcripts and Memorandum

Table RTC-B-1
Comments in the Draft EIR Public Hearing Transcripts and Memorandum

Comment Code	Full Name	Topic Code
PH-SSF-Lapuyade	Thomas Lapuyade	GC-1, Unrelated to Adequacy of the Draft EIR
PH-SSF-Drekmeier	Peter Drekmeier	GC-1, Unrelated to Adequacy of the Draft EIR
		HY-50, Diversions from the Tuolumne River
		HY-51, Raker Act
PH-PC-Commissioner Antonini	Michael J. Antonini	GC-3, Adequacy of the Draft EIR
		AL-1, Additional Alternatives to the Proposed Project
PH-HPC-Hasz	Karl Hasz	GC-1, Unrelated to Adequacy of the Draft EIR
		CR-4, Addition of Interpretive Signage at the Golden Gate National Cemetery
		CR-5, Visual Simulation to Demonstrate the Feasibility of Mitigation Measure M-CR-5a

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SAN FRANCISCO PLANNING DEPARTMENT

WATER SYSTEM IMPROVEMENT PROGRAM
REGIONAL GROUNDWATER STORAGE AND RECOVERY PROJECT
PUBLIC HEARING ON THE DRAFT ENVIRONMENTAL IMPACT REPORT

---oOo---

TUESDAY, MAY 14, 2013

SOUTH SAN FRANCISCO, CALIFORNIA

REPORTED BY: KATY LEONARD
Certified Shorthand Reporter
License Number 11599

LEONARD REPORTING SERVICES, INC.

(415) 312-9040

A P P E A R A N C E S

Presenter:

TIMOTHY JOHNSTON, Environmental Planner

SAN FRANCISCO PLANNING DEPARTMENT

(415) 575-9035

(415) 558-6409 (Fax)

timothy.johnston@sfgov.org

Also present:

GREG BARTOW, CHg, CEG, Groundwater Program Manager

SAN FRANCISCO WATER POWER SEWER

(415) 934-5724

---oOo---

♀

A T T A C H M E N T S

San Francisco Planning Department DEIR Meeting Agenda, 1 page

San Francisco Planning Department Public Notice Availability of Draft Environmental Impact Report, 3 pages

---oOo---

P R O C E E D I N G S

MAY 14, 2013 7:01 P.M.

PUBLIC HEARING

MR. JOHNSTON: So, this portion begins the Public Hearing. This is a hearing to receive your comments on the Draft EIR.

This is not a hearing to consider whether or not to approve the project, but rather before the project is even considered for approval, State law, the California Environmental Quality Act, requires that we first prepare a Draft Environmental Impact Report, and so -- which is what we've done. It was released for review on April 10th. The end of the public review period is May 28th at 5:00 p.m.

And so, during this 45-day review period, we're hoping to get comments from the public, from other public agencies on the adequacy and accuracy of the information contained in the Draft EIR.

You can view the EIR online. We've also made it available at a number of locations in the project area. You can see there (Indicating), if you want to review a paper copy.

We still have a plenty of paper copies at the San Francisco Planning Department, if you need one.

Let's see. Then we have, again, an overview of the Environmental Review schedule. Right now we're

SSF - Public Hearing cont

in the -- towards the end of the comment period. We have hearings this week, Tuesday and Thursday.

At the end the comment period, we gather all the comments, we analyze all the comments, and then we decide whether or not we need to make any changes to the Draft EIR.

We also provide draft responses to the comments we receive during the public comment period. And so, there would be a follow-up report to this one that we call a "Responses to Comments" document. We expect that to be released later this year.

So, although we won't be responding to your comments tonight, later this year you'll be able to review a follow-up report that will have responses to your comments.

And then with that, we return to the Planning Commission to seek certification of the Final EIR, which we also expect to happen towards the end of the year.

Okay. And then, so, now we're ready to start the Public Hearing where we hear from you folks.

So, can I see how many -- okay. We've got two

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speakers.

Does anybody else wish to speak tonight?

If so, we would appreciate a speaker card from you.

PH-Lapuyade

So, just two folks.

All right. Thomas?

GC-1

SSF - Public Hearing cont

PH-Lapuyade

MR. LAPUYADE: Yes.

MR. JOHNSTON: Could you come up to the microphone?

MR. LAPUYADE: Actually, I filled it out just in the event I wanted to say something. That was a safety net --

MR. JOHNSTON: Okay.

MR. LAPUYADE: -- so you wouldn't put a muzzle on me.

MR. JOHNSTON: Okay, Mr. Lapuyade.

MR. LAPUYADE: Very good. Yes.

GC-1 Cont.

MR. JOHNSTON: And then, Peter Drekmeir?

PH-Drekmeier

MR. DREKMEIR: Good evening. I'm Peter Drekmeir. I'm with the Tuolumne River Trust, and I actually just have a few questions.

I just got back from vacation so I wasn't able to read the whole EIR, but I skimmed it, and I couldn't immediately find any details on potential impacts to the Tuolumne River from providing a 5.4 mgd during wet and

HY-50

normal years.

Is that included in the EIR in terms of the Tuolumne River?

MR. JOHNSTON: It is. And then, I can -- we can chat a little bit after the hearing, but right now we're just here to receive comments on the adequacy and accuracy.

MR. DREKMEIR: Right.

MR. JOHNSTON: So, if you're not prepared to comment tonight, you can still comment --

MR. DREKMEIR: I'll still submit written comments, but yeah, if you could direct me to that section, I'd appreciate it.

MR. JOHNSTON: Sure.

GC-1

MR. DREKMEIR: And then, kind of an obscure question, but the Raker Act, which granted the SFPUC the right to build and operate the Hetch Hetchy system, prevents them from selling Tuolumne River water to private companies, and I'm wondering if there was an analysis of whether this would put Cal Water over its entitlement, because right now the thought is that the 15 percent of SFPUC water that is provided to Cal Water comes from the local reservoirs, Calaveras and Crystal Springs. And I'm wondering if this additional Tuolumne water might jeopardize that arrangement.

So, it's a question that you don't need to answer, but it's something to look into.

HY-51

And is there a time set for the hearing on Thursday in San Francisco?

MR. JOHNSTON: I think we're the second item of the regular calendar, so it will be towards the beginning. The hearing starts at 12:30.

MR. DREKMEIR: Okay. Thank you very much.

GC-1

MR. JOHNSTON: All right. So, if there's no one else here that's come to offer comments on the Draft EIR, we can wrap it up.

And so, my contact information is here. If you have any questions about the Environmental Review process, please feel free to contact me. I have business cards at the table back there.

If you have questions about the project proposal, you can contact Kelley Capone, and her contact information is there at the PUC.

And again, even if you weren't able to comment tonight, you still have a chance. Whether we receive your comments verbally tonight or subsequently in writing by the deadline of 5:00 p.m. on Tuesday, May 28th, they're equally valid -- whether we receive them in writing or in person.

So, you can send them by mail, by fax, by

E-mail. You can deliver them in person, if you like.

And that's it. That's all for tonight. Thanks for coming.

(Whereupon at 7:06 p.m. the
Public Hearing was closed.)

---oOo---

STATE OF CALIFORNIA) SS.

I, KATY LEONARD, CSR No. 11599, in and for the State of California, do hereby certify:

That the foregoing is a true, correct, and complete transcript of the Public Hearing made this date.

I further certify:

That I am not interested in the events of this action.

WITNESS MY HAND this 24th day of May, 2013.

KATY LEONARD
Certified Shorthand Reporter

♀

---oOo---

SAN FRANCISCO PLANNING COMMISSION

WATER SYSTEM IMPROVEMENT PROGRAM

REGIONAL GROUNDWATER STORAGE AND RECOVERY PROJECT

PUBLIC HEARING ON THE DRAFT ENVIRONMENT IMPACT REPORT

---oOo---

THURSDAY, MAY 16, 2013

SAN FRANCISCO, CALIFORNIA

REPORTED BY: S. MICHELLE LUJAN
Certified Shorthand Reporter
License Number 12248

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A P P E A R A N C E S

COMMISSIONERS PRESENT:

RODNEY FONG, Commission President
KATHRIN MOORE, Commissioner
HIASHI SUGAYA, Commissioner
RICH HILLIS, Commissioner
MICHAEL J. ANTONINI, Commissioner
GWYNETH BORDEN, Commissioner

STAFF IN ATTENDANCE:

JOHN RAHAIM, Planning Director
SCOTT SANCHEZ, Zoning Administrator
TIMOTHY JOHNSTON, Environmental Planner

---oOo---

A T T A C H M E N T S

San Francisco Planning Commission "Notice of Meeting & Calendar," 8 pages

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P R O C E E D I N G S

MAY 16, 2013 1:06 P.M.

Planning Commission-Public Hearing cont.

PUBLIC HEARING

COMMISSIONER FONG: Is there any public comment?

(No response)

COMMISSIONER FONG: Okay. I see none.

Public comment's closed.

COMMISSIONER COMMENTS

COMMISSIONER FONG: Commissioner Antonini.

PH-Commissioner Antonini

COMMISSIONER ANTONINI: Thank you.

I read the draft report and I think it's extremely well done. Just a couple of comments on the entire picture.

GC-3

And I guess we've been talking for a long time about an average daily demand, 285 gallons. And the way you were making your formula work is there's a certain amount of supply that comes from various sources. And some of it is conservation and some of it is, as you point out here, potentially, I think, 7. -- I forget the

AL-1

number -- 7.6 gallons per day that could be augmented from stored water.

Is that number correct?

MR. JOHNSTON: 7.2.

Planning Commission-Public Hearing cont.

COMMISSIONER ANTONINI: 7.2.

And I think this is extremely good. And I would like to see addressed looking at the ability to store even more and cut down on the amount you're planning for conservation.

As you know, San Francisco's consumption of water is the lowest per capita of anywhere in your region and probably one of the lowest in the United States, and I think we can't be expected to be much lower. And a lot of our public lands are a little dry-looking and kind of under-water sometimes.

And I think we should emphasize the possibility of increasing, if possible, the amount that would be from a stored water (Inaudible) within San Francisco in the lands you're talking about here, which is south of San Francisco, and also in the East Bay. That should be addressed whether there's a capability of storing even more than the 7.2 million gallons per day in the available aquifer space that exists.

AL-1 Cont.

I know that the aquifer exists mostly in the southern part of the region, because it can be allowed

to go below sea level because it's safe. In the northern part of the region, you don't want to do that because there's a chance of ocean intrusion.

And I just wonder how much more capacity there could be. That's my question for -- for the response is this: Is there a capacity to store even more?

And then I also read with favorable -- the alternative 2b, which would be one that utilizes more pumping from the southern-most stations with deference to Lake Merced, which has been constantly a problem, keeping it high enough.

AL-1 Cont.

And the fear would be that pumping from the northern-most stations might put further strains on the lake level. And certainly I would say that's something to look at in terms of choosing the options that are the most advantageous.

But those were my main comments in regards to the report. Thank you.

COMMISSIONER FONG: Commissioners, any further comment?

(No response)

COMMISSIONER FONG: All right. Thank you.

(Whereupon at 1:11 p.m. the Public Hearing and Commissioner Comments were concluded.)

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STATE OF CALIFORNIA) SS.

I, S. MICHELLE LUJAN, CSR No. 12248, in and for the State of California, do hereby certify:

That the foregoing is a true, correct, and complete transcript of the Public Hearing made this date.

I further certify:

That I am not interested in the events of this action.

WITNESS MY HAND this 24th day of May, 2013.

S. MICHELLE LUJAN
Certified Shorthand Reporter

♀

PH-HPC-Hasz

SAN FRANCISCO
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Ms. Sarah B. Jones
Environmental Review Officer
San Francisco Planning Department
1650 Mission Street, 4th Floor
San Francisco, CA 94103

Dear Ms. Jones,

On May 15, 2013, the Historic Preservation Commission (HPC) held a public hearing and took public comment on the Draft Environmental Impact Report (DEIR) for the SFPUC's proposed Regional Groundwater Storage and Recovery Project (2008.1396E). After discussion, the HPC arrived at the question and comment below: GC-1

- The HPC asked whether the SFPUC might want to consider adding interpretive signage on historical resources at the well sites proposed at the Golden Gate National Cemetery. CR-4

- The HPC suggested that a requirement for a diagram or visual simulation be required as part of Mitigation Measure M-CR-5a (Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 14), in order to demonstrate the feasibility of this measure for reducing potential impacts on historical resources at the Golden Gate National Cemetery to less-than-significant levels. CR-5

The HPC appreciates the opportunity to participate in review of this environmental document. GC-1

Sincerely,

Karl Hasz, President
Historic Preservation Commission