State Of California
SEISMIC SAFETY COMMISSION
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Report on the Significance of Changes in the San Francisco Public Utilities Commission's Water System Improvement Program (WSIP) With respect to Public Health And Safety

April 17, 2006

The Legislature enacted and the Governor signed into law AB 1823 (Chapter 841, 2002) "Wholesale Regional Water System Security and Reliability Act". Under the act, the Seismic Safety Commission (SSC) is required to "submit written comments with regard to the significance of any changes with respect to public health and safety" within 90 days of receiving notice of changes to the scope or schedule of the previously proposed (2002) SFPUC Capital Improvement Program (CIP). Such notice was received January 23, 2006. The purpose of this report is to fulfill that obligation.

The SFPUC's water transmission system serves 27 wholesale customers in addition to delivering water to the San Francisco City Distribution Department's retail system. Together these 28 retail distribution systems (including San Francisco) serve approximately 2.4 million users. In 2002, the seismic upgrade component of the CIP was comprised of a collection of projects intended to limit the loss of service to the SFPUC's wholesale customers following major earthquakes. The SFPUC staff has indicated that the 2002 program was prepared and evaluated in an intuitive manner, without the benefit of specific seismic performance objectives, quantitative analysis of alternatives, or a completion schedule that allowed for a programmatic environmental impact review (EIR).

The newly adopted 2005 program, now named the Water System Improvement Program (WSIP), differs in a number of important ways: 1) The SFPUC established new Levels Of Service Goals; 2) they analyzed the alternatives to optimize the sequence of projects and their effects on the expected delivery of water after major earthquakes; and 3) they incorporated a schedule that accommodates a programmatic EIR. Appendix A lists the planned seismic safety projects and their schedule changes from the 2002 program to the 2005 program including nine key projects that were identified in the above state law.

It must be pointed out that it is still very early in the deployment of the WSIP. Many projects are still under study, environmental reviews are in early stages, and, apart from the early projects, plans for final design and construction are not completed. SFPUC staff has been very responsive to SSC questions and provided detailed responses where information was available. The primary limitations to this review include the limited amount of detailed design information about projects in the new program and the fact that the changes in both the Levels of Service (LOS) Goals after major earthquakes and the details of some of the individual projects are so substantial that the two generations of projects are difficult to compare directly.

It is important to note that the proposed WSIP applies only to the wholesale trunk line of the water supply system, not the post-earthquake supply of water to the 2.4 million retail consumers served by a combination of the SFPUC system together with the 27 wholesale water companies of the Bay Area

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Water Supply & Conservation Agency (BAWSCA). The following quote from the SFPUC's March 8, 2006 *WSIP Notice Of Changes To Water System Improvement Program* is illustrative:

> "….the efforts being made by the SFPUC to improve the reliability of the system after a seismic event relate … to the delivery of water only up to the turnouts to the 28 wholesale customers. The reliability of the water supply to individual customers (served by those wholesalers) after an event is very much dependent on the plans and upgrades being implemented by the various wholesalers."

As part of its review, the Seismic Safety Commission examined SFPUC's project summaries and strategies, those of other similar organizations, and other relevant literature. In addition, Commissioners and staff drew upon personal expertise in conducting and reviewing major projects. Appendix B has a partial list of sources of information used during this review.

FINDINGS:

The Commission finds the following:

1. **The changes in methodology and scope of the proposed program between 2002 and 2005 should result in a more robust system that will increase the ultimate seismic resistance of the facilities to a degree that makes the 2005 program the preferable one from a public health & safety standpoint.** When completed, the probability of meeting the wholesale water delivery Levels of Service (LOS) goals for the retail agencies should be greater (i.e. the risk lower) than the probability of meeting the new LOS goals under the original 2002 plan.

2. **The establishment of Levels of Service (LOS) Goals in 2005 is a distinct improvement over the original proposal.** In fact, because there were no clear LOS seismic criteria in the 2002 plan, it is difficult to quantify the improvements that were anticipated by that plan, let alone compare it in a meaningful way with the 2005 plan.

   The new LOS Goals for seismic reliability are as follows:

   - Deliver minimum system demand (winter month demand) within 24 hours after a major earthquake. Minimum winter month demand is estimated at 215 million gallons per day (MGD) in 2030.
   - Deliver minimum system demand equally to three regions within the service area to the extent possible. These regions include: 1) the East and South Bay Area, 2) the Peninsula, and 3) City of San Francisco. At least 70 percent of the turnouts within each region should receive flow to achieve minimum month demand for the region. Estimated 2030 minimum month demands for the three regions noted above are 96 MGD, 37 MGD, and 82 MGD respectively.
   - Restore facilities to meet average demand within 30 days after a major earthquake.
   - Design facilities to meet the established seismic upgrade criteria. Various levels of hardening will be required for different components of the system, depending upon site-specific conditions and system functions.

3. **The SFPUC is planning to adopt new "General Seismic Requirements for the Design of New Facilities and Evaluation and Upgrade of Existing Facilities" that appear to meet or exceed the standard of practice for such programs.** These general requirements will be incorporated in detailed design criteria adopted for each project forming the program. The Commission reviewed draft requirements that include compliance with American Lifelines Alliance's 2005 *Seismic Guidelines for Water Pipelines* and the 2006 *International Building Code* where applicable. The SFPUC also plans to use state-of-the-art methods to periodically evaluate changes to the seismic vulnerability of the water system during the course of construction.

4. **The current plan also includes an increase in risk due to delays in the schedule of completion of several key improvements compared to the 2002 plan.** SFPUC characterizes the schedule as having up to approximately a three-year delay in the interim portion of the program, but some delays are later reversed by accelerated construction schedules so that the final program completion is expected to be sooner than was anticipated in the 2002 plan. The interim delay increases the chance that an earthquake will occur before a portion of the upgrade is complete, but the final completion of the entire program occurs earlier in the 2005 plan schedule than it did in the 2002 plan schedule.

   Any delay in completion of the system increases the risk of a loss of function if an earthquake happens during the delay. The USGS estimates that the probability that a major earthquake would strike the region during the time that the project was delayed is approximately one to two percent for each year of delay. Depending on the progress of environmental impact studies, the detailed engineering design activities, and/or the construction itself, the schedules might be further delayed, even from the 2005 plan.

   The overall level of increased risk from these individual changes is not easily quantified. The schedule has slipped in part because some facilities have been redesigned to result in a more robust final product. In other words, to compare the two plans is to compare apples to oranges. Building a less capable system for which portions would come on line one to three years earlier would clearly not result in a reduction in overall risk through the life of the improvements.

FUTURE CONSIDERATIONS:

While the 2005 WSIP plan appears to be much more desirable in terms of post-earthquake public health and safety than the 2002 CIP plan, there are several issues that will need to be considered by SFPUC to ensure that the WSIP plan meets both the overall LOS Goals that SFPUC has adopted and its proposed schedule of completion by 2014. A complex upgrade program with interrelated projects like this can be delayed or sidetracked entirely by problems that arise as engineering planning and construction proceed. A number of specific elements of the plan should be reviewed carefully as the individual projects proceed through detailed planning and into construction. The following issues were identified in the course of the Seismic Safety Commission's review:

1. A public information and outreach effort on the part of SFPUC and the retail water service providers is required so that the retail customers understand that a successful response to a large earthquake by the SFPUC water system could still result in up to 30% of the regional turnouts being out of service for up to a month, based on the SFPUC's new Levels of Service goals. Furthermore, which turnouts will not be in service cannot be predicted ahead of time. Therefore, widespread recognition of, and planning for, the expected performance of the water system after the earthquake will help make the entire community safer and better prepared.

2. Active participation by the SFPUC's newly created Seismic Safety Task Force, and other experts as needed, to evaluate critical, seismic-related design decisions should be encouraged. Those decisions have a substantial effect on the future performance of the system, and thus on the future risk to the health and safety of the water users around the Bay. If necessary the Task Force should be expanded so that experts from the appropriate fields of earthquake science and engineering can review all major seismic design decisions, to assure that the current state of the practice in earthquake-resistant design has been incorporated into each element of the water delivery system.

3. Use of a large hypothetical earthquake on each of the three major faults crossed by the water delivery system has been helpful in modeling the regional impacts of earthquakes to the system overall, and in identifying the primary projects and sites that need to be upgraded as a part of the WSIP. However, the effects of those particular earthquakes do not constitute a typical seismic hazard standard for design purposes. Individual facilities in the system will require site-specific analyses to identify their engineering design requirements. We understand the design phase will incorporate appropriate site-specific seismic criteria. The results of these analyses could change some of the conclusions about levels of risk that were drawn in the WSIP report.

4. The ability of pipelines and other components of water transmission systems to withstand the impacts of earthquakes is the subject of a number of active engineering research programs today. Important information comes both from laboratory testing of pipelines and facilities, and from observations of the performance of existing water systems during recent and future earthquakes in other parts of the world. The engineering design effort will want to make use of the most up-to-date knowledge and understanding of this topic, because many parts of the upgraded water delivery system being proposed in WSIP must not fail in future Bay Area earthquakes, if the Levels of Service criteria are to be met.

5. The SFPUC should proceed as quickly as feasible with its Programmatic Environmental Impact Report for the proposed WSIP program, followed in short order by individual project EIRs. Because the program consists of a number of phased construction projects, the schedule for the EIR approvals is critical to meeting the deadlines in the WSIP plan. The environmental review process could lead to additional delays, which would increase the health and safety risk of the public in a future earthquake.

6. The SFPUC should continue to work with the retail providers to facilitate completion of comparable programs for risk reduction in the distribution systems that carry water from the SFPUC regional water transmission system to the 2.4 million users. Public health and safety ultimately depends on delivery of the water to the end users as quickly as possible after earthquakes. Delivery of adequate quantities of water by the SFPUC regional water system to the retail water distribution systems' turnouts is a necessary, but not a sufficient condition to assure that water actually reaches the end users. Emergency response and recovery plans should include provisions to accommodate the potential that direct supplies of potable water will not be available at all connections to the SFPUC regional water transmission system. The entire delivery system, from Hetch Hetchy to the local faucets, must operate in the hours and days after major earthquakes if public health and safety are to be protected.

Appendix A

Water System Improvement Program
Seismic Reliability Projects and Schedule Comparisons

The San Francisco Public Utilities Commission is undertaking a $4.3 billion Water System Improvement Program to enhance the Hetch Hetchy water transmission system with an anticipated 2014 completion of seismic projects. The table below summarizes the seismic reliability projects and compares schedules between the 2002 program and the 2005 changes.

WSIP Seismic Reliability Projects	Program Dates		
New Irvington Tunnel	Aug 2009	Sep 2013	1
Crystal Springs to San Andreas Reservoir Transmission Upgrade	Jul 2011	Apr 2014	2
Bay Division Pipeline Reliability Upgrade	Feb 2013	Jan 2014	8
Seismic Upgrade of Bay Division Pipelines 3&4	Aug 2010	Oct 2012	4
Alameda Siphon Upgrade	**	Apr 2011	5
New Crystal Springs Tunnel	May 2009	Oct 2010	6
Bay Division Pipelines 3&4 Crossover/Isolation Valves	N/A	Sep 2008	7
Crystal Springs No.2 Replacement	Nov 2015	Apr 2012	
San Andreas No.3 Pipeline Installation	Nov 2014	Jun 2011	
Calaveras Dam Projects	May 2009	Jun 2012	9
Capuchino Valve Lot Improvements	Mar 2016	Jul 2009	
Baden & San Pedro Valve Lot	N/A	Oct 2011	
Sunset Reservoir – North Basin	Oct 2014	May 2009	
Harry Tracy Water Treatment Plant Short Term Improvements	Nov 2012	Sep 2010	
Harry Tracy Water Treatment Plant Long Term Improvements	Mar 2016	Apr 2014	
Pipeline Repair & Readiness	Sep 2004	Mar 2007	
Standby Power Facilities	Nov 2013	Dec 2010	
Slip line of Bay Division Pipelines 3 & 4*	N/A	Mar 2008	
Bay Division Pipelines 1 and 2 Repairs***	Jan 2013	N/A	3

* An assessment of pipelines is included, and the construction or rehabilitation process will be determined later.
** The Alameda Siphon Upgrade is now a separate project that was previously combined with the New Irvington Tunnel.
***The SFPUC removed this project from the Water System Improvement Program since it is not required to achieve the new Levels of Service Goals. Refer to the Bay Division Pipeline Reliability Upgrade Project.

Appendix B

List of Publications Received/Reviewed

American Lifelines Alliance, 2005, *Seismic Guidelines for Water Pipelines*, (CSSC library copy).

American Society of Civil Engineers, 2003, *Seismic Evaluation of Existing Buildings* ASCE/SEI-31-03. (CSSC library copy).

Bay Area Water Supply & Conservation Agency, 2006, Letter to Mr. Lawrence Klein, Chair, California Seismic safety Commission re: San Francisco Public Utilities Commission Response to AB 1823 Requirements for Notice of Change to water System Improvement Program, dated February 23, 2006.

Department of Health Services, 2006, (Final Draft) Response to Notice of Adopted Changes to the San Francisco Public Utilities Commission (SFPUC) Capital Improvement Program (CIP)/Water Supply Improvement Program. (Received March 20, 2006).

Division of Safety of Dams, *Guidelines for Use of the Consequence-Hazard Matrix and Selection of Ground Motion Parameters*, CA Department of Water Resources, Fraser and Howard, October 4, 2002.

Federal Emergency Management Agency, 2002, Second Edition, *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*, FEMA 154/March 2002. (CSSC library copy)

Multidisciplinary Center for Earthquake Engineering Research, 1999, *Seismic Reliability Assessment of Critical Facilities: A Handbook, Supporting Documentation, and Model Code Provisions*, Technical Report MCEER-99-0008. (Received March 27, 2006).

Nisar, A., Honegger, D., Ameri, A., Summers, P., Hitchcock, C., Liu, A., Louie, H., Bachhuber, J. ,2004, *Mitigation of Fault Rupture Hazard to Water Mains of a Major Metropolitan in the San Francisco Bay Area*, 13th World Conference on Earthquake Engineering Vancouver, B.C. Canada, August 2004.

O'Rourke, T.D., Wang, Y., Shi, P. 2004, *Advances in Lifeline Earthquake Engineering*, in 13th World Conference on Earthquake Engineering Vancouver, B.C. Canada, August 2004.

O'Rourke, T.D., Wang, Y., and P. Shi, 2004, *Final Draft Report: Seismic Wave Effects on Bay Division Pipelines*, (Received March 16, 2006).

Parsons CH2M HILL, 2005, *Water System Improvement Program Assessment Report*, Prepared for the San Francisco Public Utilities Commission. (Received November 2005)

Ruskin, I., 2006, Letter to CSSC Chairman Lawrence Klein regarding timing of completion of CSSC AB 1823 report (March 16, 2006).

San Francisco Public Utilities Commission, 2003, *Emergency Response and Recovery Plan* Sections 7.1 through 7.4.2 (Received March 24, 2006)

San Francisco Public Utilities Commission, 2006, *AB1823: Notice of Changes to Water System Improvement Program*, (Received January 23, 2006).

San Francisco Public Utilities Commission, 2006, *AB1823: Notice of Changes to Water System Improvement Program* (March 8, 2006, with clarifications requested by CSSC).

San Francisco Public Utilities Commission, 2006, *General Seismic Requirements for the Design of New Facilities and Evaluation and Upgrade of Existing Facilities* (Received April 3, 2006).

San Francisco Public Utilities Commission, 2002, *Capital Improvement Program Proposal Documents* May 28, 2002. (CSSC library copy).

United States Army Corps of Engineers, 1991, *Seismic Evaluation and Rehabilitation for Buildings,* TI 809-05. (Received March 16, 2006).

Meetings With SFPUC and CSSC Ad Hoc Committee or Staff

October 26, 2005: Initial briefing with SFPUC staff and seismic task force members.

November 10, 2005: CSSC hearing with SFPUC staff providing an introduction about the WSIP

November 29, 2005: SFPUC hearing to adopt changes to the WSIP

February 21, 2006: CSSC Ad Hoc Committee met with SFPUC staff to discuss SFPUC's response to the CSSC's Feb. 14, 2006 letter.

March 28, 2006: CSSC Ad Hoc Committee met with SFPUC staff to discuss CSSC requests for additional information described in CSSC's March 27, 2006 letter.