

Fact Sheet - B.F. Sisk Dam

Safety of Dams Modification Project

March 2019



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B.F. Sisk Dam (formerly called San Luis Dam) has undergone detailed analysis of its safety in the event of a severe earthquake, and it was found to potentially be vulnerable and to present excessive risk to the public living downstream. A Corrective Action Study to identify means to reduce the risk and to select the preferred alternative has been finalized in March 2019. This fact sheet provides information about the analysis and planned actions.

Background Information

B.F. Sisk Dam is a 382-foot-high zoned compacted earthfill embankment located on the west side of California's Central Valley approximately 12 miles west of Los Banos, California. The

dam is over 3 -1/2 miles long and impounds San Luis Reservoir, which has a total capacity of over 2 million acre-feet.

The dam was built between 1963 and 1967 to provide supplemental irrigation water storage for the Federal Central Valley Project, and municipal and industrial water for the California State Water Project. Water is lifted into the reservoir for storage by the Gianelli Pumping – Generating Plant from the California Aqueduct and from the Delta-Mendota Canal via O’Neill Forebay. B.F. Sisk Dam is owned by the Bureau of Reclamation and operated by the California Department of Water Resources (DWR). Reservoir storage space is allotted 55% State and 45% Federal under the San Luis Act for Joint-use Facilities (Agreement No. 14-06-200-9755).

Geologic Investigations

The dam and reservoir are located in an area of high potential for severe earthquake loading from identified active faults, primarily the Ortigalita Fault that crosses the reservoir from north to south. The dam’s foundation may be divided into three main sections, the abutments, the south side of the valley (SVS), and the north side of the valley (NVS), each with different geology and different issues. The abutments are formed by soft sedimentary bedrock called the Panoche formation. However, some of the rock is covered by clayey material called “slopewash” which, as the name suggests, is soil particles washed down the slope and deposited by rain water. This material is much weaker than the bedrock, and it is of concern for deformation of the dam under strong earthquake loading. In the NVS, the foundation is primarily sandy material deposited by flowing streams, referred to as “alluvium.” The foundation of the SVS has predominantly clayey soil material that was deposited under still water in lakes or wetlands that existed in earlier geologic times. In parts of the SVS, the alluvium and lake deposits are several hundred feet thick.

In the early 1980s, Reclamation conducted an extensive investigation of the seismic safety of B.F. Sisk Dam. This included drilling to sample the soils and test their density in place, laboratory testing of the samples, and geophysical tests. The general conclusion of the analyses was that some of the less-dense soils could undergo liquefaction in a major earthquake. Liquefaction results in a major reduction of soil strength, and the sand may even flow like a liquid. It can occur in loose, saturated sand shaken by a strong earthquake. At that time, it was concluded that liquefaction would not be sufficiently widespread to cause the dam to be unstable. Using the simpler methods available at the time, the amount of predicted deformation that would occur under severe shaking would be small, and the conclusion was that the dam had no safety deficiencies.

By 2005, the state of the art in seismic analysis of dams had advanced significantly and additional dam-safety investigations were begun. These included a reevaluation of the Ortigalita Fault, new understanding of the behavior of soil materials (including clay and embankment fill) under earthquake loading, and new computer-based analysis methods for predicting the behavior of the dam under various loadings. Even now (2019), the state of the art in Corrective Action Study (CAS) analysis does not allow a precise calculation of the amount of settlement that would occur, and there remains a significant amount of uncertainty in the results.

Corrective Action Study

Because of the risk to the downstream public, Reclamation conducted a Corrective Action Study (CAS) and is now working on the final design of modifications to reduce the risk of B.F. Sisk dam. The CAS included:

- additional geologic field investigations, and detailed analysis of potential for liquefaction or loss of strength in the foundation soils,
- identifying several possible design alternatives for modifying the embankment (or otherwise reducing the risk to the public), and development of the designs to "feasibility level"
- engineering analyses and risk analyses of the proposed alternatives, and cost estimates for them
- selection of the preferred alternative, considering the cost and the effectiveness of each alternative,

Seismic Potential Failure Modes

Seismic deformation and stability analyses were performed in the CAS for the three typical sections of the dam described above (abutments, NVS, and SVS). For each section, there are two possible seismic failure modes: 1) Settlement of the embankment due to earthquake shaking great enough that the dam crest falls below the reservoir surface, allowing reservoir water to flow over it and erode a breach of the dam, and 2) Cracks in the embankment caused by an earthquake, which could allow reservoir water to flow through the crack, causing erosion that ultimately develops into a breach.

Analysis of Risk

In an effort to balance public safety and costs for modifying dams, Reclamation uses a risk-informed approach to making dam-safety decisions. The analysis of risk includes the probability of a severe earthquake, the likelihood of dam failure if the earthquake were to occur, and the consequences of dam failure. Decisions about what should be done are then based on Reclamation's Public Protection Guidelines. Reclamation and California DWR have conducted a series of probabilistic risk analyses (PRA) that use the results of the seismic deformation analysis and soil testing described above. A PRA consists of detailed study of the chain of events that would have to occur for the dam to fail and of how likely each event is to occur. Although failure was determined to be very unlikely in any particular year, the consequences could be quite severe. As a result, the risk the B.F. Sisk Dam poses to the public living downstream does not meet the Public Protection Guidelines so corrective action is justified. The risk is not, however, so large that the guidelines mandate expedited action, such as limiting the amount of storage in San Luis Reservoir.

Reclamation was the lead for the Corrective Action Study. However, the California DWR was an active participant at all stages of the program. Reclamation and DWR agreed to split the costs of the CAS with approximately 45% of the funding from the Federal government and 55% from the State of California. This division was based on the cost-sharing agreement between DWR

and Reclamation for the construction of the Joint Use Facilities. The cost of the CAS was \$14.6 Million.

Final Design

The final design stage is nearing completion. The preferred alternative is a series of earthfill berms designed to buttress the downstream slope of the dam, with some requiring excavation to replace seismically weak foundation soils with much stronger compacted embankment material. The crest of the dam will be raised up to 12 feet to provide additional freeboard, but not to allow additional storage. The crest raise and other portions of the embankment will be equipped with new filters to halt the progression of any internal erosion that begins due to an earthquake or during normal operation. Products of the final-design phase include additional geologic investigation and lab studies to better classifying material properties, refine earlier results, detailed, up-to-date engineering and risk analyses of the preferred alternative, and construction drawings and specifications. Environmental Impact Statement / Environmental Impact Report (EIS/EIR) is being prepared and scheduled to be finalized by the end of the year 2019. There will also be environmental documentation for obtaining construction permits, and a Modification Report sent to the federal Office of Management and Budget and to Congress. Congressional acceptance of the Modification Report allows funding for construction. (In accordance with public law, the construction contract cannot be awarded until congressional approval of the Modification Report.)

It is estimated that, upon completion, Final Design will cost \$18 Million. Similar to the CAS, the cost is to be shared 45 percent by the Federal government and 55 percent by the State of California.

Funding and the Reclamation Safety of Dams Act

Reclamation will fund its portion of the project by means of the Reclamation Safety of Dams Act. The State of California will fund its portion of the project separately. Some of the provisions of the Reclamation Safety of Dams Act are as follows:

- The Secretary of the Interior is responsible for determining the need for risk reduction actions and selection of the actions to be implemented
- Modifications are not to address reasonable and normal maintenance
- The cost of the modifications funded by the Act must be reimbursed. If the need for modification is due to a change in hydrologic, seismic, or the state-of-the-art conditions, the Act currently limits reimbursement to 15 percent of the total cost
- Reclamation must notify the project water beneficiaries of the need for risk reduction and explain the administrative and legal requirements
- Reclamation must provide opportunities for project beneficiaries to participate in development of plans for risk reduction actions

Water Contractor Participation

During the process of developing and implementing a preferred risk-reduction action, water contractors are invited to participate in the process and to share thoughts and ideas for cost-effective means of achieving the required risk reduction. Project update briefings are provided to a combined State Water Project (SWP) water customer and CVP water customer forum at approximately six month intervals. These briefings are provided at Reclamation's Cottage Way Sacramento Office or DWR's downtown (9th and O St) facility. Conference call-in numbers are provided to interested SWP/CVP water customer officials. The briefings include current and projected activities as well as financial information.