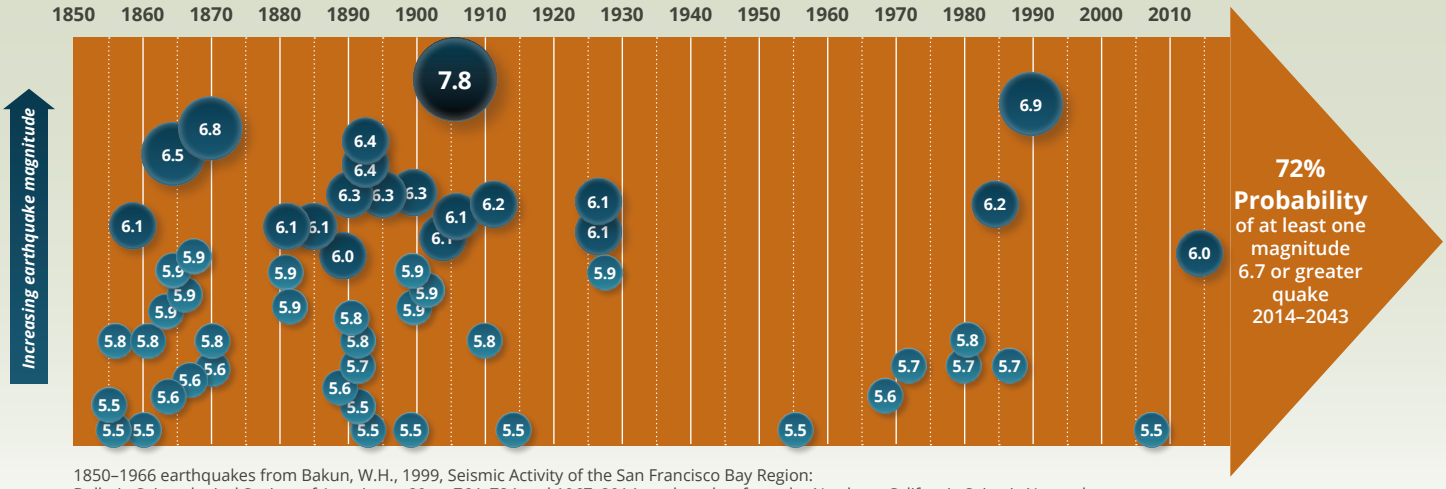
A CLOSER LOOK: DELTA CONVEYANCE AND SEISMIC RESILIENCE

The Sacramento-San Joaquin Delta is in the eastern part of the San Francisco Bay Area, one of the most seismically active areas in the United States. With many active fault systems, the U.S. Geological Survey has predicted that there is a 72 percent chance of at least one earthquake somewhere in the Bay Area region of a magnitude 6.7 or greater by 2043. The Delta itself has several active faults. The Delta Conveyance Design and Construction Authority (DCA), working at the direction of the Department of Water Resources (DWR), has developed a proposed Delta Conveyance Project designed to address this risk for all proposed facilities, advancing seismic resiliency of the State Water Project.

San Francisco Bay Region Earthquake Timeline



1850–1966 earthquakes from Bakun, W.H., 1999, Seismic Activity of the San Francisco Bay Region: Bulletin Seismological Society of America, v. 89, p. 764–784 and 1967–2014 earthquakes from the Northern California Seismic Network.

Source: USGS

Active Seismic Delta Sources

The Delta region is home to a series of fault systems known as "blind thrusts," faults that may cause some considerable ground disturbance but do not rupture at the surface during a seismic event. Known blind thrusts in the Delta include the Midland, Montezuma, Thornton Arch, West Tracy and Vernalis faults. A magnitude 6.25 to 6.75 earthquake on any of these faults would produce strong shaking in the Delta.

Liquefaction: The Delta's Seismic Risk

Liquefaction is when strong ground shaking causes the ground to lose its strength and behave more like a viscous fluid. Delta soil is prone to liquefaction in a large seismic event because of two key characteristics – shallow groundwater and loosely deposited sandy and silty alluvium from various current and historic stream channels. Moderate earthquakes of longer duration can trigger liquefaction under these circumstances. Any new Delta infrastructure must be designed with liquefaction in mind.

Delta Tunnel: Built for the Big One

Seismic reliability of the Delta Conveyance Project tunnel and all project facilities will be essential for continuing water deliveries following earthquakes. The seismic design criteria adopted for the 45-mile Delta Conveyance Project tunnel is based on what is designated as the Maximum Design Earthquake (MDE), an extreme seismic event estimated to happen once every 2,475 years on average. Using this and other criteria, Delta Conveyance Project facilities will be designed and constructed to withstand the estimated ground shaking and resulting ground loads and deformations caused by an extreme seismic event.

Interior view shows the cement segments that are designed to give a tunnel better seismic resilience than an above ground structure.

Surviving the Shakes: Built-in Tunnel Flexibility

Tunnels in general perform better during earthquakes than above ground structures such as bridges and buildings. Tunnel structures are constrained by the surrounding ground and are not subject to strong vibratory amplification compared to buildings and bridge structures which move independently of the ground during earthquakes. In addition, another benefit is that the proposed Delta Conveyance Project tunnel is located approximately 110 feet below the ground surface. The potential for tunnel damage decreases with depth since the amplitude of seismic ground motion also reduces with depth. Since the current proposed tunnel is located in excess of 110 feet below the ground surface, the tunnel lining is not expected to be impacted by liquefaction which could occur in the weaker saturated soil deposits located well above the tunnel.

Crossing the West Tracy Fault: Special Tunnel Lining

For all of the proposed alternatives, the tunnel crosses one fault, the West Tracy Fault, located at the southern end of the alignment near Byron. DCA's consulting team of engineers and geologists performed an extensive analysis of the potential displacements from this fault that could occur during a seismic event. Preliminary results indicate that a special tunnel lining would potentially be needed at the fault crossing consisting of either a more flexible lining, higher concrete strength, heavier reinforcement, use of continuous steel rods or a steel tunnel lining, or combinations thereof to mitigate for fault displacement effects.

All DCP Facilities: Designed with Earthquakes in Mind

Every proposed DCP structure – such as the intakes, tunnel shafts and discharge outlets – went through a design process to ensure seismic resiliency. The process included a review of subsurface data, an analysis based on the MDE and a design to withstand the maximum peak ground accelerations at the ground surface. The results of this process have resulted in important changes. Examples include ground improvements and embankment designs at the two proposed intakes in the northern Delta. At the southern end of DCP near the existing Bethany Reservoir, the proposed pumping facility along with other infrastructure would be sited on the most competent soils.