Seismic Hazard Evaluation of the Midland and West Tracy Faults Near Byron, CA, for Water Infrastructure Projects

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The Sacramento-San Joaquin Delta levees, which direct the flow of fresh water from the Central Valley toward SF Bay and protect the Delta islands from flooding, are vulnerable to damage and collapse from strong ground shaking during an earthquake. Seismic hazard studies for state and municipal water infrastructure have identified the Midland and West Tracy faults as the closest sources of large earthquakes to the Delta levees. The Midland fault (MF) has been mapped in the subsurface for a total of about 62 km from the latitude of Byron north to the town of Dixon, and it originated as a west-down normal fault bounding the eastern margin of the early Tertiary Rio Vista basin. The southern 30 km of the MF has been reactivated as a west-up reverse or reverse-oblique fault since late Neogene time and is at least partially responsible for Quaternary uplift of the Montezuma Hills near Rio Vista. Long-term average separation rate on the southern MF from structural relief on the base of late Neogene continental deposits is about 0.04–0.07 mm/yr, and the fault is interpreted to be capable of generating M6.5 earthquakes. The blind West Tracy fault (WTF) underlies the southwestern Delta region approximately between Byron and Tracy, and it passes beneath intake structures for the California Aqueduct. A recent seismic reflection survey conducted by the California Department of Water Resources near Byron images the WTF as a moderately SW-dipping reverse fault beneath a NE-vergent fault propagation fold. Geotechnical investigations by the US Bureau of Reclamation several kilometers on strike to the south have documented monoclinal folding of a buried late Quaternary stratigraphic marker, indicating youthful and recurrent activity. A distinctive NW-trending geomorphic lineament near Byron associated with the WTF is interpreted to be a fold scarp, a zone of localized surface uplift and NE-ward tilting above the fault tip that is active when the fold grows incrementally during a moderate to large earthquake. The WTF has a long-term average slip rate of about 0.2–0.3 mm/yr, and it is interpreted to be capable of generating M6.75 earthquakes. Larger earthquakes are possible if the MF and WTF rupture together in a single event; however, differences in slip rate and geometry between the two faults suggest that this may not be a very likely scenario.

Biography: Dr. Jeffrey Unruh is President of Lettis Consultants International, Inc., and a Certified Engineering Geologist with over 30 years of experience in neotectonics, structural geology and seismic hazard evaluation. Dr. Unruh has managed many large, multidisciplinary investigations for dams, LNG facilities, nuclear power plants, and military installations. Recent projects include seismic hazard analysis for design of the Sites dam and reservoir in northern California, and neotectonic studies for nuclear facilities in Idaho and western Wyoming. Dr. Unruh currently is the manager and technical lead on a project to develop a probabilistic subsidence forecast model for the Department of Water Resources. The model will be used to inform long-term planning and analyses of potential investments needed to address the effects of historic land subsidence, and to ensure a suitable level of engineering performance of the California Aqueduct. In addition to his professional consulting work, Dr. Unruh is an active member of the scientific and research community. He held a courtesy position as a Research Geologist at the University of California, Davis, from 1996 to 2015, and is a Geological Society of America Fellow. Dr. Unruh currently is adjunct faculty at Diablo Valley College in Pleasant Hill, where he teaches a class on the geology of California.