April 30th, 2018 Earthquakes and the Stability of the Dam Prepared

1. Background

· The Cleveland Hills fault caused the 1976 earthquake which shook the area around the Dam and resulted in some minor damage in the Oroville. It is not reported as having a significant effect on the Dam structure or function.
· On 9-29-13 the Sacramento Bee reported that a 2010 FERC inspection recommended a reinspection of the dam focused on new information for an earthquake safety assessment evaluation. The then head of the DWR Division of Dam Safety, David Gutierrez, said that he would not recommend the additional recommended evaluation because it would be a waste of money. We do not know whether this evaluation was ever done.
· There are documents in the FERC files covering evaluations of earthquake risks relating to the Oroville Dam. We found the 2005, 2010 and 2014 DWR 12 D reports to FERC but the language is hard to follow. We have not had the time to get an appraisal of these reports from a forensic engineer.
· This year, when the lake rose above the level of the green spots and the point at which the original spillway broke last year, water started to flow though the new spillway. The DWR attributed this to the heavy rain, but the leak is continuing, 10 days after the rain stopped. There have been reports of minor earthquakes in he last 12 months. The DWR attributed the tremors to blasting. Blasting and excavation last year are possible contributory causes of the leaks.

2. What we do and do not know

· There is little public knowledge of any earthquake risk assessment at Oroville, one of the largest earth dams in the world. We have no idea whether the Oroville Dam could stand up to a major earthquake. We have little confidence that proper studies, including a probabilistic analysis, have been made, or that any action indicated has been seriously considered.
· It is standard practice to assess earthquake risks among all hazards associated with a dam. This assessment involves a characterization of
o the energy, movements and shaking an earthquake could release,
o the ability of the dam to withstand such conditions,
o and 50-foot acoustic grids to 3D map faults near and under the dam.
· We know that the proper assessment of the effects of earthquakes on a large earth dam requires bore holes and/or instrumentation under the surface of the dam and that there is no such instrumentation on the Oroville Dam.

There is apparently a Seismic Monitoring Station at the Dam monitored by the UC Berkeley Seismic Monitoring Station. Our contacts in the UC Berkeley Engineering Department do not know about this station and it has never been mentioned, to our knowledge, in Oroville over the past 20 years. We are told that it is likely to be analog and not useful for measuring stresses in the dam itself. We do not know whether it is still functioning or like the piezometers has been abandoned.

· The IFT in their report refers to problems with the 'Probable Failure Mode Analysis' (PMFA) in a DWR report. Additionally, there is no indication that a probabilistic analysis that explicitly identifies and incorporates uncertainty as part of the PMFA work. This means that a long list of assumptions that cannot be examined are buried in the analysis. Professional engineers tell us that this is very troubling.

· Experts tell us that water pressure near a lake that has recently been filled, as Lake Oroville was in early April, can cause rock to shift which can lead to a minor earthquake. This, in combination with the pressure of the water on the dam and last year's excavations, may contribute to the seepage.

· We know that, beside water coming through the Dam at the green spots and now, quite possibly, under the spillway where the old one broke, there are leaking tunnels through the Dam, at least one with no useful purpose. Intuitively, tunnels, particularly tunnels with water falling off the roof, suggest an increase in the risk of damage from an earthquake. We do not know why the tunnels without any use are not filled in.

· The earthquake risk is not confined to the risk of earthquakes near the Oroville Dam. An earthquake that broke any of the upstream dams might, depending on the lake level and concurrent rainfall, cause a catastrophic failure of the Oroville Dam or catastrophic flooding downstream if the Oroville Dam structure was able to handle the increased inflow that might, in theory at least, rise for a while to over 400,000 cf/s if the uppermost dam failed causing failures in the lower dams. We have no idea of the possibility or likelihood of such an event and wonder whether this scenario has ever been studied

3. Conclusions

· As with other aspects of what is wrong with the Dam, we do not know whether the Dam can withstand a major earthquake nor whether earthquakes have contributed to the seepage and we are unsure whether anyone knows (including DWR and FERC).

· As part of an overall independent forensic assessment of all aspects of the Dam, the risks posed by earthquakes should be studied by an independent seismic team led by a PhD with no connections to DWR and who resides out

of state. The first step should be to gather all available data and records and go through them with an eye for using them to focus the next steps.

· Any existing PMFA studies should be re-done in a probabilistic fashion so that we can understand what assumptions were made, the degree of uncertainty in the evaluation parameters and where more information is needed.

· Any study should also include the earthquake risks posed by the upstream dams. A failure in one of them at the wrong time could cause a catastrophe at Oroville