

MAY 2018

BRIEFING FOR POLITICIANS ON THE REASONS WHY THERE MUST BE A COMPREHENSIVE INDEPENDENT FORENSIC ASSESSMENT OF THE OROVILLE DAM

In April and May, the FRRRA was asked to prepare a briefing for politicians on why an independent investigation of the Oroville Dam is necessary.

The downstream communities cannot be expected to trust the DWR's assertions given their assurances before the spillway incident and their unwillingness or inability to provide convincing documentation of studies assessing the continuing areas of risk.

The Independent Forensic Team's (IFT) February report indicated that there are problems in other parts of the dam and that the root causes of the spillway incident, failures in design, construction, maintenance and operation, apply to the whole dam not just the spillway.

Until there is some certainty about the risks the downstream communities, particularly Oroville, are facing, there will be limited development and the area will be blighted.

This briefing was sent to Senator Feinstein's office and supported the case made to her by Supervisor Bill Connelly that an independent assessment of the Dam is needed. Senator Feinstein had this inserted into the 2019 Federal Budget. Congressman LaMalfa has assured the FRRRA that he strongly supports this request. Reconciliation between the Senate and House versions of the budget will be completed in September. If this clause gets omitted from the final version, it will likely be because of lobbying by the DWR who have shown little interest in learning the truth.

At the end of this report there are links to a number of significant documents:

Professor Bea published a report on the 'Root Causes of the Spillway Failure' This report can be accessed here: <https://tinyurl.com/ycxjlj7l>.

Additional references can be found here: <https://tinyurl.com/y9q5wcrk>

Numbered references in the report

1. ITF report <https://tinyurl.com/y7wymwx5>
2. FERC's April 11th letter to the Director of the DWR with attachments <https://tinyurl.com/yb2hnft2>
3. CCRM report on the DWR management and organization <https://tinyurl.com/ycxijl7l>
4. DWR report on the Green Spots <https://tinyurl.com/ybd8rb6n>
Bea report on the Green Spots. <https://tinyurl.com/ychxrjrt>

The "Whys" and "Whats" that a comprehensive, independent Analysis and Report of the Lake Oroville Dam installation and operations should encompass

A thorough independent inspection and review of the dam and all project related facilities and related operating and maintenance manuals, records and procedures is essential. Further, there should be independent inspection and analysis of all agency procedures and practices that underlie and drive DWR's culture and organizational governance and accountability practices. All of this should be carried out by recognized, professional experts in the various disciplines having no connection whatsoever to DWR, the State Water Contractors or either's consultants.

As a model, the inspection and review could follow the in-depth review and analysis conducted of PG&E following the 2012 gas pipeline explosion and fire in San Bruno. There, the scope extended well beyond the physical equipment, records and reports and extended to the way the company does business and its procedures and practices and organization culture that drove its business approach that could have led to the costly and tragic incident. The result was revolutionary in the way PG&E now conducts its gas pipeline business. The DWR review should be no less independent, aggressive, or thorough than PG&E's.

Also, the expert consultants should not be required to rely on responses prepared by DWR "publicists" or ex-employee "experts" that has so much been the source of responses to public inquiry and even many of the Independent Forensic Report questions that analyzed the aftermath of the Emergency and "normal" Spillway structures last February that resulted in the largest evacuation ever west of the Mississippi River and damages in the BILLIONS. On the contrary the independent experts must have unfettered access to the raw data and the professionally signed notes and reports of the responsible DWR employees.

After realizing that much of the Spillways incident was related to design and or construction flaws and ineptitude, neglected maintenance procedures, and ignored warnings by outside experts, to name a few, it is hard to imagine that all of these errors, omissions and inadequacies were or are confined to those facilities that have failed to date. What about the dam structure itself and all the other appurtenances of the entire project that is the linchpin of so much of the state's economy.

Moreover this was only the latest in "headline " incidents associated with the Project facilities over just the last decade, including, to name some that achieved major notoriety: the major fire in the Thermelito Afterbay Powerhouse, the river valve accident that resulted in severe injuries to several employees and an OSHA citation of significance, and finally the engineering miscalculations that were bungled resulting in less than expected performance improvement and in the cases of some units, actual major damage causing a long unplanned outage.

Obviously, there is a systemic and serious underlying culture that continues to produce catastrophic or near catastrophic consequences without any apparent accountability or even a lessons learned review. Only a comprehensive, independent look at the facilities data and operating processes can hope to rectify such an ingrained culture of one of the largest and most powerful bureaucracies in the State.

The result should be a comprehensive report with detailed recommendations as to the Project 2100's Mission and Goals, especially as regards public safety, any restructuring, practices or procedure amendments, including operations and maintenance manuals, training and "corporate" cultural modifications and processes that require accountability and consequences for anything less than perfect performance. Nothing should be off the table even the potential of removing the project from DWR responsibility.

WHAT IS WRONG WITH THE DAM?
WHY IS A COMPREHENSIVE INDEPENDENT FORENSIC STUDY NECESSARY?
WHAT NEEDS TO BE INSPECTED?
Feather River Recovery Alliance
April 23 2018

WHAT IS WRONG WITH THE DAM?

1. We do not know what is wrong with the Dam and we are unsure whether anyone does (including DWR and FERC).

The information provided by DWR includes little factual information that would allow us to learn. The facts that are provided are not supported by an analysis signed by the professional engineer in responsible charge of the dam as required by California Water Code Section 6025.6. Given our experience, particularly of the broken spillway and the comments relating to the evacuation, it is difficult for us to believe the statements made by DWR.

Here is a list of the reasons that the DWR has given for the problems with the roller compacted concrete events in the last year:

1. The RCC is temporary and will be replaced this year.
2. The RCC is porous and permeable- water seeps through it.
3. Three of the concrete slabs may have to be repaired or replaced due to contractor error in curing the RCC.
4. The RCC does not have a smooth surface due to the type of concrete that it is made from.
5. The seepage through the RCC in the spillway is an expected result of rainwater seepage through the RCC from the adjacent hillside.

It should be noted that point 5 refers to water that is leaking through the new spillway at the point where the old spillway broke when the lake rose to that level. Professional engineers have suggested other possible causes for this leak and foresee continued uncertainty about the real cause.

Similar lists of unconvincing and unsubstantiated excuses can be compiled for other problems as is clear from the DWR's comments in the references cited. The standard practice of having a Professional Engineer sign to confirm that facts and opinions are supported by evidence is not one followed by the DWR.

We are unaware of any instrumentation installed within the dam to confirm/refute assumptions made with respect to the design and operation of the dam. Installing instruments to provide 'real time' feedback is currently the standard practice. This illustrates the lack of understanding of 'best practices' and opportunities to confirm/refute basic assumptions that can mean the difference between life and death.

Ignorance about what is wrong with the Dam which appears to be shared by everyone else, including the DWR, is the most important reason for the request for an independent forensic assessment of all aspects of the Dam and its ancillaries.

An independent investigation will uncover knowable problems with the Dam. In future all DWR reports on serious concerns must be signed by a competent engineer so that our knowledge of the state of the Dam is constantly updated, as required by the California Water Code.

2. The dangers presented by the Dam are not assessed systematically

Unlike the incomplete and partial assessments performed to date, there should be a comprehensive assessment that starts with an inventory and understanding of the basic design and operational assumptions for the dam. Feedback on the validity of these assumptions (such as the assumption of the emergency spillway being founded on 'sound' bedrock, when in fact it was founded on highly erodible weathered bedrock) would then be the basis for further inquiry. Areas where assumptions are confirmed by system operation would receive a lower level of scrutiny than those assumptions with no measurement metrics or operational confirmation.

Aspects of the dam that are high-consequence and high-uncertainty should be the primary initial areas of investigation. Once there is a comprehensive list of assumptions, they can be compared to the available data. From this comparison it will be possible to provide a list of areas with high impact and high vulnerability. There is no evidence that the DWR takes this type of approach, so there are constant surprises.

3. The regulators have not acted independently of the DWR, the operator of the Dam

The Department of Dam Safety is part of the DWR. That speaks for itself.

FERC appears to have been captured by the DWR. In 2005, the Friends of the River petitioned FERC requesting FERC to order DWR to armor the emergency spillway which had seemed likely to be put to use in 1997 in circumstances more dangerous than those in 2017. FERC asked DWR whether there was a problem. DWR opposed the petition telling FERC, ignoring the original design assumptions, that the rock under the hillside at the emergency spillway was solid bedrock. Based on this, FERC did not order further study of the emergency spillway. The February 2017 collapse proved that the rock was incompetent and highly erodible. Friends of the River were right. The practice of FERC relying on the DWR's informal opinions must end. There are signs that it is ending but FERC has not yet ordered an independent forensic assessment of all the risks of the Dam which is the main request of a petition being circulated which already has 6,000 signatures.

At the Assembly hearing on the Dam in April 2017, the Director of the DWR proudly stated that the regulators were 'embedded in the operation' so that the new spillway could be built quickly. Embedding regulators in an operation that they are supposed to be regulating abnegates their responsibility and results in no one being responsible, which is now the situation with every problem that emerges.

4. The interests of the State Water Contractors (SWC) and the supply of water at the lowest cost takes precedence over safety and the long-term viability of the State Water System

The SWC are not the owners of the Dam but the costs associated with the Dam and its repairs are paid by them. Just as the DWR has captured FERC, the SWC appear to have captured the DWR.

We do not know why necessary repairs and or renovation have not been undertaken, for instance:

- to the main spillway before it broke despite the significant cracks
- to the spillway gates, which have been decrepit for years and malfunctioned or were not fully functional during the 1997 crisis and again in 2017
- to the Hyatt power house which has not operated efficiently or to its capacity for decades
- to the Thermolito power house which burnt down in mysterious circumstances 3 years ago and is still not operating
- to the River Tunnel on which the main valve has limited operation.

It is not unreasonable to surmise that the repairs are left undone because the short-term interests of the SWC take precedence over the long-term future of the State Water System and safety.

The SWC has a strong lobbying program in Sacramento. The SWC benefit from the Dam without the responsibilities of ownership. The local communities are exposed to the risks of Dam failure without any influence over its operation. In these circumstances, a strong independent regulator is vital.

5. The reservoir and Dam are not operated in accordance with modern practices and information now available, for instance modern weather forecasts.

The operating rule book was prepared by the Corps of Engineers in the 1950s. DWR manages the lake level in accordance with this rule book with exceptions being approved by FERC. Folsom Dam is now operated using modern methods. Oroville Dam should also be.

WHY IS A COMPREHENSIVE INDEPENDENT FORENSIC STUDY NECESSARY?

1. Limitations of the IFT's Report

The Independent Forensic Team (IFT) study acknowledges that it had a limited scope of evaluation. A full independent review of the design, operation, and management of dams (both physical assets and human and organizational factors) is essential. To date, no indication from FERC or DWR that this essential review is underway or even being seriously considered.

Section 2 – Scope and Methodology of the Investigation

2.0 SCOPE AND METHODOLOGY OF THE INVESTIGATION

2.1 Focus and Limitations of the Investigation

The IFT's efforts were focused on the Oroville Dam service spillway chute and the emergency spillway, both of which suffered damage in the February 2017 incident. The IFT did not delve into issues related to the embankment dam, the service spillway headgate structure, or any other components of the Oroville facility. As the IFT reviewed the FERC-mandated Part 12D inspection reports and other documents, it noted that there have been some issues of concern raised related to the embankment dam and the service spillway headgate structure, but those issues are beyond the scope of the IFT's mission.

The IFT considered the emergency management of the incident only to the degree that it affected the activation of the emergency spillway. Detailed review of the emergency management process was again beyond the scope of the IFT's mission.

Figure 1: Excerpt from January IFT report (page 3) noting the limited review of IFT.

2. Challenging 'best practices'

The Independent Forensic Team (IFT) study identifies a suite of 'lessons still to be learned.' To date, no efforts to address this comment have been shared with the public from either FERC or DWR. This critically important comment must be addressed in a transparent fashion to provide those hundreds of thousands of residents living and businesses operating downstream of these high-hazard structures some understanding of the risk of dam breach and inundation they are exposed to.

Some of these general lessons are self-evident, and have been noted by others previous to the IFT's investigation of this incident. The question is whether dam owners, regulators, and other dam safety professionals will recognize that many of these lessons are actually *still to be learned*. Although the practice of dam safety has certainly improved since the 1970s, the fact that this incident happened to the owner of the tallest dam in the United States, under regulation of a federal

Summary

agency, with repeated evaluation by reputable outside consultants, in a state with a leading dam safety regulatory program, is a wake-up call for everyone involved in dam safety. Challenging current assumptions on what constitutes "best practice" in our industry is overdue.

Figure 2: IFT's finding that dam safety is not mature, many lessons are still to be learned, and current assumptions of 'best practice' must be challenged.

3. DWR's Inadequate Plan to FERC to address IFT Recommendations

Early indicators of DWR's comprehension and 'way forward' to the IFT recommendations is clearly showing a lack of responsiveness. FERC required DWR to submit a plan on how to address and incorporate the IFT recommendations. The submittals fell far short, as noted by FERC. The IFT noted that DWR as an organization was "insular" (IFT, page S-3; 68). There has been no indication that DWR has overcome this organizational obstacle (being insular) in order to access the suite of capabilities it needs in order to be fully responsive to the IFT recommendations (predominantly the human and organizational factors).

These appear to be appropriate initial steps and efforts. Your letter also states that DWR "will provide a multi-year plan and schedule to implement DSP improvements and associated organizational changes in August 2018." We are requesting more clarity on how your multi-year plan addresses the DWR-specific findings and recommendations of the forensic report. The forensics report identifies a number of industry-wide and DWR-specific findings and recommendations. Section 7.2

of the forensic report summarizes the DWR-specific findings (“lessons”) and recommendations. We have included these items in the Enclosure. Each one of these findings and recommendations must be specifically addressed by DWR. Within 60 days of this letter, submit a plan and schedule to address the findings and recommendations of the forensic report that are contained in the Enclosure. If you have any questions regarding this letter, please contact me at 202-502-6314.

Figure 3: FERC note that DWR did not comply with the original FERC request to provide an implementation plan for the IFT recommendations as originally requested.

WHAT NEEDS TO BE INSPECTED BY AN INDEPENDENT FORENSIC TEAM?

1. The Spillway and Emergency Spillway

The Independent Forensic Team (IFT) study (1) provides an independent assessment of the spillway systems. FERC's letter to DWR dated April 11th 2018 (2) sets out the recommendations arising from the IFT study to which DWR should respond.

Based on history and a report on the DWR (3), it seems unlikely that the DWR has the ability to comply with these recommendations comprehensively on a timely basis. An independent forensic team should be assigned to work alongside them so that these recommendations are satisfactorily addressed.

2. The Spillway Gates

These are known to be unreliable, old and decrepit. They have a series of extensive cracks in the housing structure that are far outside acceptable design conditions. Being outside the design conditions would warrant an IMMEDIATE shutdown and replacement within the Nuclear and Aviation Industries. To date, neither DWR nor FERC have recognized this condition and is an excellent illustration of the IFT's finding of 'physical factors not being recognized and properly addressed.'

There were many opportunities to intervene and prevent the incident, but the overall system of interconnected factors operated in a way that these opportunities were missed. Numerous human, organizational, and industry factors led to the physical factors not being recognized and properly addressed, and to the decision-making during the incident. The following are some of the key factors which are specific to DWR:

- The dam safety culture and program within DWR, although maturing rapidly and on the right path, was still relatively immature at the time of the incident and has been too reliant on regulators and the regulatory process.

Figure 4: IFT highlighting that physical indicators were missed and not properly addressed.

3. Seepage and the Green Spots

The DWR published a paper on seepage and the green spots (4) in response to a paper by Professor Bea (5). The DWR gives little technical detail and asserts conclusions, the other report provides technical material that leads to uncertain conclusions. We know that the original piezometers have failed and have not been replaced. The lack of this instrumentation prevents anyone (including DWR and FERC) from ascertaining if seepage conditions are within the expected range or trending towards failure.

4. The River Tunnel and the other tunnels through the dam

There is less independent information about the dangers of the tunnels than about the seepage but we know that the main River Tunnel valve is not working properly with releases limited to 1,000 cfs. We are told that water leaks into the tunnels from their roofs by people who have worked on the Dam. We need to have an independent assessment of the risks they represent.

5. The Hyatt Power Plant

The Hyatt Power plant is operating well below its design capacity. One or two turbines are not functioning – one has been under repair for three years. This is mainly an economic concern but when turbines are down the amount of water that can be released through the Hyatt plant is reduced. Currently we are told that 14,000 cfs can be released through the Hyatt plant 3,000 cfs less than the flow when all the turbines are in operation.

The lack of the capacity to release significant amounts of water from a low-level limits the flexibility of lake management. When Folsom Dam was renovated, a low-level release tunnel was installed.

The condition of the 50-year old Hyatt plant and its robustness should be studied by an independent of the Thermalito Power Plant which was destroyed by fire 3 years ago and has not yet been rebuilt.

6. The ancillary dams

The DWR has recently submitted assessment to FERC dealing with the several ancillary dams associated with the Oroville Dam under their management. Details of these reports were redacted. An Independent forensic engineer should review these reports and make recommendations for further studies is necessary.

EARTHQUAKES AND THE STABILITY OF THE DAM

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 may be documents in the FERC files relating to evaluations of earthquake risks but we have not been able to find anything in the time we have had available and, given the tendency for anything to do with dam safety to be redacted as was the link we found, they may not be available to the public. We understand that earthquake safety inspections are supposed to be done every five years and maybe they were.
- 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 through 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 the last few weeks, which the DWR attributed to blasting.

2. What we do and do not know

- We have no idea whether the Oroville Dam could stand up to a major earthquake and have not found any studies of this. We have no confidence that proper studies have been made nor that any action indicated has been seriously considered.
- It is standard practice for earthquake risks among all hazards associated with a dam to get the most attention and the most rigorous assessment. This assessment involves a characterization of the energy, movements and shaking an earthquake could release and the ability of the dam to withstand such conditions. This being the case it is surprising that there is so little public knowledge of any earthquake risk assessment at Oroville, one of the largest earth dams in the world.
- We know that the proper assessment of the effects of earthquakes on a large earth dam requires 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 have no knowledge of this 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 refer 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, may contribute to seepage.
- 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 far as we know, the DWR has not provided analyses signed by professional engineers about the earthquake risk any more than they have on other risks.
- The risks posed by earthquakes should be studied as part of any inspection by an independent forensic team. 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 the assumptions, the degree of uncertainty in the evaluation parameters and what more information I needed can be understood.
- Any study should also include the earthquake risks posed by the upstream dams.

Footnotes

Professor Bea published a report on the ‘Root Causes of the Spillway Failure’ This report can be accessed here: <https://tinyurl.com/ycxjlj7l>.

Additional references can be found here: <https://tinyurl.com/y9q5wcrk>

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