Wells Earthquake Dam Inspection February 21, 2008

On February 21, 2008, an earthquake occurred approximately 6 miles east-northeast (ENE) of Wells, Nevada, with an initial reported strength of M6.3 Richter (at 11 miles ESE). Later downgraded to M6.0, the ground movement was sufficient to drop unreinforced masonry building facades, collapse roofs and cause general home and household damage. Residents in Wells reported that it was difficult or impossible to stand during the quake. Infrastructure damage was initially suspected with respect to utilities, pipelines, and bridges.

The NEVSTERR program was run to estimate potential ground motions at local dams with the earthquake coordinates provided by the USGS. The results are summarized below. Of the affected dams, Wells Wastewater Ponds (J-188) suffered the highest potential lateral accelerations as they were closest to the epicenter. Although the release of partially treated municipal effluent could have significant environmental effects, especially in a low winter stream flow condition in the Humboldt River, the embankments are classified as “low” hazard meaning the priority assigned to its inspection was similarly low. As of this date, the status of the Wells Wastewater Ponds is assumed to be “OK” as no reports of spilled effluent were made. City of Wells experienced accelerations between 0.15g and 0.31g according to NEVSTERR.

Several aftershocks were associated with the strong earthquake but two in particular stand out. One was reported by USGS immediately (5 minutes) following on the initial quake to the NNE of Wells and much closer (only 1 mile). This was reported as M4.5 but produced much stronger accelerations at local dams to the north and comparable to the initial shock within the City of Wells, itself, being on the order of 0.1g to 0.22g. A second aftershock occurred at about 3:00 pm to about 5 miles SSE of wells with a reported strength of M4.6. This one also produced stronger motions at some of the local dams than the initial shock with shaking in Wells on the order of 0.07g to 0.17g

Quake	Time	Epicenter		Direction and distance
Magnitude	(PST)	Latitude	Longitude	from Wells
6	6:16am	41.0767	-114.7523	6 miles ENE
4.5	6:21am	41.1237	-114.9614	1 mile NNE
4.6	3:57pm	41.0529	-114.9233	5 miles SSE

NEVSTERR calculated ground acceleration range in gravities (g) for each site (anticipated to +1 std dev)

City of Wells	Bishop Creek	Wells Effluent	Angel Lake	Egbert Dam	Welcome Dam	Jaynes Res.
0.15 to 0.31	0.123 to 0.249	0.144 to 0.293	0.091 to 0.18	0.091 to 0.179	0.098 to 0.196	0.098 to 0.192
0.10 to 0.22	0.231 to 0.479	0.237 to 0.481	<0.05	<0.05	0.143 to 0.283	0.138 to 0.272
0.07 to 0.17	<0.05	0.237 to 0.481	0.144 to 0.231	<0.05	0.143 to 0.283	0.138 to 0.272

The only "high" hazard dam to be significantly affected was Bishop Creek Dam (NV00050), a previously damaged irrigation reservoir with significant structural and hydrologic deficiencies which is currently under Order by the State Engineer to remain drained until it can be either removed or repaired. Bishop Creek Dam was modeled to have local lateral acceleration of approximately 0.123g and potentially up to 0.249g as a result of the initial shock and as high as 0.479g in the first aftershock. A lateral acceleration of up to 0.2g is generally considered to not pose a threat to well-constructed and designed earth embankments but some localized damage to appurtenant structures or landslides are possible. Liquefaction of very prone soils is also possible. Bishop Creek Dam was further hampered by an inoperable outlet that was partially open and somewhat obstructed by rocks that had fallen off the right abutment. The main concern was that the abutment may have experienced enough shaking to release a significant amount of debris, further obstructing the outlet and causing an unintentional impoundment of water in the reservoir. Impoundment of water in this instance is not desirable as the dam previously failed through the upstream cementitious liner causing a large erosion hole on the downstream face. Any significant amount of water (which the snowpack in the basin was likely to generate) impounded would likely cause a complete rupture and loss of the impoundment, potentially causing loss of life at downstream ranches. Mr. Uhlig was called at the Ranch but was not immediately available. Ms. Uhlig, who answered the phone, was able to convey a message to her husband and related that the shaking at the ranch was significant and prevented her from being able to stand with her less than trustworthy knees and caused unsecured items on the walls and shelves to crash down about her. She also stated she was uncomfortable with sending her husband up there as it was very dangerous "last time," referring to the previous rupture of the embankment. When Mr. Uhlig was able to return my call a few minutes later, he was requested to visit the dam. He related that he would not be able to approach the dam until some of the heavy snow accumulation had an opportunity to melt off in a few months. He did, however, offer

to contact a local trapper who was working the canyon to ask him to approach the dam on his snowmobile.

The remainder of the dams that experienced significant lateral acceleration were all low-head small dams, although Angel Lake Dam (NV00128) –misidentified as XJ-329 in the report- is perched above a steep narrow canyon in the alpine zone resulting in a "significant" hazard classification. This resulted in an inspection priority list topped by Bishop Creek Dam, followed by Angel Lake Dam and summed up with the remaining identified structures, as possible. Spring Dam (the actual XJ-329) was never built, although another old dam is at the site.

A phone query was made to the local office of the U.S.F.S., owner of Angel Lake Dam to inspect it at their earliest convenience. Their office in Wells was in significant disarray but they committed to visiting the dam as soon as practical. Making an inspection of Angel Lake Dam is complicated by its location and the heavy snow accumulation this winter. The road to the dam is unlikely to open before June in a normal year and may be even further delayed this year.

Rick Martin at Nevada Department of Emergency Management (DEM) was notified of the State Engineer's concerns at Bishop Creek Dam and a request was made that if any aircraft were in the area to please make an over flight of the dam (and any others on the report) to make a preliminary estimate of any damage such that further action, if necessary, could be planned. DEM made inquiries that resulted in a National Guard aircraft being deployed from the Stead Air Operations Center to make an over flight. Due to the weather and distance involved, a helicopter was not initially considered to be a practical alternative. However, the final decision was to send an OH-58 Kiowa helicopter to the site. This resulted in the ability to carry a trained observer and the author was offered the opportunity to visit the dam sites in person.

The author was picked up from Carson City airport at approximately 1:00 pm on Thursday February 21 by officers* Brandon Hose and Jeff Buckboom. The flight was direct to Winnemucca to refuel and thence direct to Bishop Creek Dam. Enroute, several smaller known and unknown dams were spotted and photographed until the earthquake zone was approached. A fly-by of Egbert Dams indicated that Egbert Dam (J-97) and an older upstream dam appeared to

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* Unfortunately, I did not jot down the rank of the pilots and my civilian memory cannot seem to dredge them up.

be standing with no apparent damage. A landing was not afforded due to the fuel situation.

Next, at about 4:00 pm two passes were made at Bishop Creek Dam. The reservoir was as low as possible (nearly empty), given the partially obstructed outlet, and water was flowing from the downstream invert of the outlet conduit. The damaged area of the embankment was covered by snow and a slight amount of earth from the upper part of the scarp, not enough to indicate a slope failure had occurred and possibly only due to temperature cycling since the last snowfall.

No water was observed issuing from the scarp area and no unusual melting of the accumulated snow. Surprisingly, the right abutment area did not appear to have shifted at all. No new debris was on the surface of the ice over the impoundment, no areas of damaged ice other than typical stress-cracks and the outlet could be clearly observed as being “typical” with a very small area of clear water before it indicating it was flowing as well as usual. Again, due to the fuel situation and the lack of a safe nearby landing zone, no landing was made at the dam.

A nearly direct flight was then made back to Elko with a small perturbation of the route to allow a quick observation of Welcome and Jaynes Dams. Neither dam appeared to have been disturbed by the ground motion in any way.

Angel Lake Dam was not visited due to the fuel situation and its alpine location. Cloud cover on the North Ruby Range in the vicinity of Angel Lake made an over flight very hazardous and the decision was made by the author to allow U.S.F.S. to make an inspection as previously agreed. Similarly, Wells Wastewater Ponds were not visited as personnel with City of Wells are anticipated to inspect the dam along with a PDA (Preliminary Damage Assessment) team from DEM, if any damage was reported.

Landing at Elko was made at about 5:00 pm and, after refueling, the light conditions and weather made return to station unwise and I was released for the day at 5:30 pm. On Friday, I returned to the airport at 7:00 am and the weather cleared sufficient to return to station at about 9:00 am. The return flight was uneventful with a reciprocal refueling at Winnemucca, resulting in my arrival in the office at about 1:00 pm.

In summary, many of the dams identified by NEVSTERR as having suffered significant acceleration were visited and experienced no noticeable damage from an aerial survey. It is likely that the cold temperatures prevented saturation of the embankments at depth from the precipitation and what saturation did occur was frozen solid, lending some stability. Each of these dams should be visited on the ground as soon as practical to verify their condition and look for developing conditions that may have not been expressed during the over flights. Follow-up must be made with City of Wells and U.S.F.S. to ensure their dams were inspected and their condition. The expenditure of resources to make this survey has paid off in the ability to ease the minds of the affected public, de-prioritize these dams from the emergency relief effort and concentrate further efforts on other areas.

Respectfully submitted,

Michel J. Anderson, P.E., Staff Engineer III
February 26, 2008