THE STONY CREEK WATER WARS
Glenn County - Tehama County - Colusa County , California.

Uh, what do I do if there is an EARTHQUAKE? - Collected references to the seismic vulnerability of the Federal Dams on Stony Creek

Since I am not an expert at these things I cannot tell whether the conditions described in the Black Butte abutments [see below] are nothing unusual, or instead are cause for great concern. Meanwhile, someone has gone and built a very fine upscale subdivision north of Orland between I-5 & 99W right up against the creek apparently with no or inadequate levee protection against something like a Black Butte Dam abutment failure.

And, of course, apparently parts of Elk Creek are too near Stony Gorge to be protectable.

On 10/01/2009 I filed a protest to the extension of SWRCB Ap. 18115 & related permit; following is from my Supplement, http://www.mjbarkl.com/p2.pdf :

> IV. ENVIRONMENT AND PUBLIC TRUST:
> G. SEISMIC WARNING
> Within recent years there has been broadcast and print publicity regarding the possible threats to Eugene Oregon from possible failure of U.S. Army Corps of Engineers' "Hills Creek Dam" , an earth-fill dam of the same vintage as Black Butte. These reports include comments by USACE spokesmen that reinforce the concerns, not dispel them. Black Butte Dam is built near one or more faults that have been active in relatively recent geologic time. I do not know if this is a risk for those downstream from Black Butte, but ask, if these issues have not been explored, that they be explored as a requirement for this Ap 18115 extension and, if appropriate, a seismic evacuation plan for people downstream be crafted and published.
>
> V. SETTLEMENT TERMS:
> B. Settlement Terms/Mitigations
> 14. That USA develop a seismic event evacuation plan for locations downstream from Black Butte, should it prove warranted by further examination.

Since filing that protest, other reports, studies, etc. have come to my attention. This is a growing compilation of them:

SWRCB APPLICATION A026378 City of Santa Clara Case Index - Stony Gorge Power Plant
File Category 7 FERC LICENSES AND REPORTS VOL. 1 OF 1
Folder 2, Item ?

- 10??81 Stony Gorge and East Park Powerplants, Orland Project - California, An Appraisal Report on Adding Hydroelectric Powerplants at Stony Gorge and East Park Dams, 10/1981, Unted States Department of Interior, Bureau of Reclamation

> - Part II. Setting
> - - p. 6, Dam Safety, "The Reclamation Safety of Dams Act of 1978, Public Law 95-578 [following the Teton Dam failure, assume not a coincidence], established criteria for determining the safety of existing dams. A dam must be able to:
> (1) Safely pass the inflow design flood developed according to advanced hydrologic standards, and
> (2) withstand the maximum credible earthquake (MCE) determined for the area.
>
> Stony Gorge Dam could fail during an inflow design flood. Alternative modifications being considered for the dam would provide for overtopping or for construction of a gated spillway either in the right abutment or in natural ground at the north end of the dam.
>
> East Park would withstand an inflow design flood, but some overtopping would occur. This spillway has the potential for failure when the existing spillway design capacity is exceeded. Modifications to East Park spillway

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may be required; however, they would not affect a powerplant located at the dam.

The results of seismotectonic studies made to define the maximum credible earthquake for the Stony Gorge and east Park Dam sites are [p. 7] covered [later]. Although stability evaluations have not been made for either dam or for East Park spillway, it is believed that all three structures could be seriously threatened by the occurrence of an MCE. To determine the ability of these structures to withstand an MCE, a dynamic analysis will be performed during the design phase of project modifications.

As a result of safety evaluations made in June 1980, it was recommended for both Stony Gorge and East Park Dams that:
(1) Evaluations be made of the stability of each structure during dynamic loading conditions produced by the MCE, and
(2) provisions be made to ensure that each structure can safely pass the inflow design flood."

- - The Area
- - - Climate
- - - p. 7, Geology, "Stony Gorge...Unstable rock or soil conditions are not apparent in the dam foundation or upstream or downstream from the dam."

An east-west trending fault dipping 50 degrees northeast crosses the dam foundation on the right side of the channel. The fault belongs to a group of east-west 'cross-faults' which displace Cretaceous and Jurassic age marine sediments throughout the eastern foothills of the Coast Ranges. The cross faults do not displace Quaternary age deposits and so are considered inactive...." [p. 9] "East Park Dam blocks a narrow, steep-walled gorge which has been eroded into an extremely hard, massive conglomerate. The foundation conglomerate extends over 300 feet upstream from the dam but grades abruptly to interbedded claystone and siltstone immediately downstream from the dam. Both the conglomerate and interbedded claystone and siltstone dip 35 degrees to the east. Unstable rock or soil conditions are not apparent near the dam.

Claystone and, to a lesser extent, siltstone slake or break down when exposed to air, but remain hard and relatively unfractured if continuously submerged [water? soil? rock?]. Air slaking usually causes intense fracturing of outcrop surfaces to a depth of 0.1 to 0.4 foot. Conglomerate is unaffected by air slaking.

East Park Powerplant would be founded on interbedded claystone and siltstone. The power outlet-works tunnel would be almost entirely in massive conglomerate. A small amount of unconsolidated slopewash may be encountered near the tunnel's outlet portal."

- - - Seismicity; "Stony Gorge and East Park Dams are located in an area of low to moderate seismic activity. Seismic events occurring within a 35-mile radius of the dams since 1903 range from 1 to 4.9 in magnitude (M), with the most common at magnitude 3.

Seismotectonic studies for the Stony Gorge and East Park Dam sites were made in 1981. Maximum credible earthquakes within 20 miles of the two dams have been assigned to the Willows Fault and the Franciscan block. More distanct active faults which have produced or are capable of [p. 10] producing events of magnitudes large enough to affect the dams are the San Andreas Fault, the Maacama-Lake Mountain fault zone, the Battle Creek Fault, and the Sierra Foothills fault zone. The estimated maximum credible earthquakes and corresponding epicentral distances for the causative structures which may possibly affect the dams are:

Causative structure	MCE (M)	Epiccentral distance from dam: Stony Gorge (mi)	Epiccentral distance from dam: East Park (mi)	Focal depth (mi)
Franciscan block	6.0	5	3	6
Willows Fault	6.0	20	20	6

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Battle Creek Fault	6.9	35	45	6
Maacama-Lake Mountain fault zone	7.2	40	40	6
Sierra Foothills Fault zone	6.5	50	50	6
San Andreas Fault	8.5	70	65	6

[1906 was estimated to be an 8.3 or 8.0 or 7.8 depending on who is quoted ; the San Francisco Marina and the Nimitz Freeway were both approximately 60 miles from the 6.9 or 7.1 Loma Prieta Quake. Yes, it depends on the soils under the structure (or the dam abutments), etc.]

Folder 2, Item ?

- 102081 Before the Federal Energy Regulatory Commission, Application for License for Project No. 3193, The Stony Gorge Hydroelectric Project By the City of Santa Clara, California, Prepared by: Resource Management International, Inc. Sacramento, California and Sverdrup & Parcel and Associates, Inc., San Francisco, California; on cover, SCH "81011202"

- Exhibit F - General Design Drawings [2 different title pages?]
- - - Appendix F-1, Stony Gorge Dam Regional and Site Area Geology; ESA Glenn Reservoir Complex report & "1980 draft report on site geology for the Stony Gorge Dam spillway modification study by the U.S. Bureau of Reclamation." [similar to E.1.A]

- - - - Faults and Joints, "Stony Gorge Dam is about four miles east of the Stony Creek fault and Coast Range thrust which runs north-south along the east side of the Coast Range. Several shears and a foundation fault are in the vicinity of the Stony Gorge Dam. The majority of shears and the fault are tight, clean, occaionally slickensided fractures with little or no gouge. Shears range in length from 10 to over 325 feet; the fault is over 1,000 feet long. Apparent bedding offset on the various shears ranges from a few inches to 3 to 4 feet; the main failt shows apparent lateral offset of bedding of approximately 124 feet. This fault trends east-west and is steeply northeast-dipping. The fault was mapped during excavation of the Stony Gorge Dam key trench in the 1920's. It intersects the dam axis between buttresses 33 and 34.

A few open joints are present downstream of the outlet structure between buttresses 35 and 37, in the floor and right slope of the 'outlet channel'. The most obvious joint strikes N. 77° E., dips 27° SW out of the right slope, is 21 feet long, and is open 1 inch to 0.2 foot. The joint separates a large sliver of conglomerate from the main rock mass. Other open joints are not visible but are assumed to underlie conglomerate in the 'outlet channel' floor as the conglomerate produces a hollow sound locally when struck by a rock hammer.

The channel downstream of the outlet structure was apparently excavated in massive conglomerate by drilling and blasting as evidenced by several remnants of old vertical shotholes (bootlegs) in the channel floor. The blasting either [p. F-1.3] caused existing joints to open or created new, open fractures in the rock. These open joints are now manifested as the southwest dipping joint and the 'hollow' floor of the 'outlet channel' as described above."

- - - - Groundwater, "There is no evidence of extensive amounts of groundwater in the vicinity of the proposed Stony Gorge Hydroelectric Project. The bedrock foundation of the dam and power plant is relatively impermiable [sic], and there have been no instances of seepage under the dam."

- - - - Landslide Hazards, "The proposed project is in an area that is gently sloping and slightly irregular. There should be no landslide hazards from cut slopes. Excavation for the powerhouse foundation and tailrace will require the normal slope stability protection.

- - - - Seismic Potential, "Stony Gorge Dam is in an area of low to moderate seismicity. Recorded earthquakes

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within a 40-mile radius of the dam range in magnitude between 1 and 4.8, with the most common at magnitude 3. Earthquake epicenters within the region do not show a significant alignment or association with known faults. The Stony Creek fault has experienced the most recent movement of all faults in the region, this being between 30,000 and 130,000 years. A list of seismic events that may affect the Stony Gorge Project are shown in Table F-1A [same as Black Butte F-1A]

- - - - Foundation Conditions

- - - - TABLE F-1A PROBABLE SEISMIC EVENTS FOR STONY GORGE HYDROELECTRIC PROJECT (same as Black Butte table)

File Category 20 TRANSCRIPTS AND EXHIBITS VOL. 1 OF 1
Folder 4, Item 3, Exh. 11

- - Exh. 11 Application 26379 - Before the Federal Engergy Regulatory Commission Application for License for Project No. 3190 - the Black Butte Hydroelectric Project by the City of Santa Clara, California Prepared by: Resource Management International, Inc. Sacramento, California and Sverdrup & Parcel and Associates, Inc., San Francisco, California 09/1981

- - 7. List of Literature [some of the relevant ones] , p. E-63
- - - 2. Earth Science Associates. *Seismic and Fault Activity Study: Proposed Glenn Reservoir Complex*. Prepared for California Department of Water Resources. January 1980, Palo Alto, California
- - - 9. U.S. Army Corps of Engineers. *Foundation Report, Black Butte Lake, Stony Creek, California*, Sacramento District. September 16, 1963

- Appendix F-1 - Black Butte Dam Regional and Site Area Geology, based on 1980 Earth Sciences Associates' 'Seismic and Fault Activity Study for the Proposed Glenn Reservoir Complex' & USACE "foundation report on the construction of Black Butte Dam." "The Red Bluff gravels, composed largely of boulders, cobbles, and pebbles in a matrix of sandy clay, occur as a narrow, uplifted belt along the edge of the foothills. The formation is typically a dark red color and is commonly designated the redlands. Its occurrence in the project area is confined to the lower end of the outlet and diversion channels and in road cuts of the relocated Newville Road." "There are at least two faults within the project area and two more are present a short distance upstream. The most significant of these local faults is known as [p. F-1.3] the Black Butte fault, and it occurs at the western margin of the buttes about one mile upstream from the dam where the vertical displacement is in the order of 2500 feet. The Tehama formation on the west has been dropped down to form the floor of the Main and North Fork channels of Stony Creek. The other three faults are probably branches of this main fault and all have minor displacement. The surface expression of one is evident where it cuts the north rim of the valley three-quarters of a mile upstream from the dam. Two more local faults are present in the right abutment, one cutting the existing outlet tunnel at Sta. 8+00 and the other cutting the tunnel at Sta. 13+00. Both trend north and dip east at high angles. These are normal faults in which the east blocks have been dropped in relation to the west blocks. Although they have displacements of less than 50 feet, their effects on the rock have been detrimental. A shear zone on either side of these faults contains fractured rock which weathers upon exposure and consequently loses its initial bearing capacity. Unstable rock conditions resulting directly and indirectly from faulting which were encountered during construction of the dam necessitated major changes by the Corps of Engineers in the stilling basin, diversion channel, and downstream tunnel portal during construction of Black Butte Dam [sic, syntax]. In the outlet tunnel from Sta. 7+50 to Sta. 9+35 an almost continuous zone of shearing was penetrated.

Two major joint systems, trending almost normal [?] to each other, are present in the basalt at the dam site and are particularly noticeable in the right abutment. They also extend into the mudstone of the right abutment to a lesser degree. The more prominent of the two has a strike of N40°-55°W and dips vertically. The second joint system is almost as persistent as the first and strikes N40°-60°E. It also has a vertical dip. A third joint set, of lesser prominence, has a gentle eastward dip and was probably horizontal prior to the tilting of the flow. The result of these joint systems is the formation of roughly rectangular joint blocks whose dimensions average 15 to 20 feet. [p. F-1.4] Fracturing has affected all the rocks of the dam site area, except possibly the Tehama

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formation, which probably reacts to stresses more as a soil than rock. These fractures are the result of shrinkage during cooling of the basalt. Many zones exist in which the fracture filling has been removed by weathering, leaving loose and frequently open fractures. The zones of open fractures are closely associated with major joints or fault zones or else occur in discontinuous surface areas where the weathering agents have penetrated downward into the rock. These surface zones are generally restricted to areas covered by overburden. Fracturing in the mudstone and sandstone is associated with jointing and is generally confined to a narrow zone adjacent to major joint planes. However, in some areas of the right abutment, particularly the upstream tunnel portal area and the tunnel from Sta. 10+30 to Sta. 11+00, extensive fracture zones are present in which open fractures are closely spaced and their surfaces heavily stained with iron oxide and manganese dioxide....The basalt which occurs on the abutments of Black Butte Dam is quite susceptible to weathering, especially where water is able to penetrate the rock [including from the reservoir?]. When weathered, the basalt frequently decomposes completely to a greenish-gray or buff clay. In the presence of oxygen the clay oxidizes to a red or reddish-brown. The joint system which has broken the Basalt into elongated, rectangular joint blocks provides the agents of weathering with a fairly regular system of entry channels from which the rock can be attacked and decomposed. Typically the basalt joint blocks have been weathered on four sides, and where low-angle joints divide the blocks into vertical sections, the [page F-1.5] blocks are completely isolated by weathered zones. Weathering of the basalt adjacent to joint surfaces has produced seams of clay from four inches to two feet or more in thickness.

The end result of the combined jointing and weathering is the existence of large, somewhat rounded basalt blocks or boulders isolated from one another by clay and decomposing rock. The inability of the clay to support these large boulders makes for very unstable conditions on cut slopes. During the construction of Black Butte Dam this condition was extremely severe in the outlet channel, irrigation diversion channel, right abutment core trench, and to a lesser extent affected the rock in the spillway, left abutment core trench, and outlet works intake channel. It is expected that similar unstable conditions will be encountered during construction of the Black Butte Hydroelectric Project....

Ground Water: Prior to completion of the dam in 1963, the ground water table corresponded with the water level of Stony Creek under the valley section of the main dam embankment, and, except for an isolated area in the left abutment, showed a gradual rise above streambed of 25 to 35 feet in the abutments. This indicates that the rock which forms the abutments is fairly pervious. In general water levels in the downstream portions of the abutments are slightly higher and are somewhat erratic. The basalt occurs at a lower elevation here and, being less pervious that the other formations, possibly acts as a cut-off allowing water percolation only in facture zones. During tunnel driving a small amount of seepage was present, usually along contacts, but presented no dewatering problem. The water in the abutment had poor recharge, draining quickly as it was tapped, and the tunnel seemed to encounter less ground water as driving progressed from upstream to downstream. A small amount of water seepage was encountered [p. F-1.6] also in excavations for the control tower, transition section and irrigation diversion channel conduit section. Seepage was very minor and was handled easily by air-driven sump pumps. There have been no seepage problems through the abutments or under the dam since the reservoir was filled. No abnormal groundwater levels are expected to be encountered during construction of the proposed project as long as the penstock tunnel is constructed during the season of low reservoir pool.

Landslide Hazards: As noted previously, an unstable condition may occur on cut slopes in the basalt formations. A slide occurred during construction of the downstream tunnel portal in 1960. The high clay content in some of the soils of the area could also lead to conditions of slope failure unless preventive measures are taken.

Seismic Potential: Black Butte Dam is in an area of low to moderate seismicity. Recorded earthquakes within a 40-mile radius of the dam range in magnitude between 1 and 4.8, with the most common at magnitude 3. Earthquake epicenters within the region do not show a significant alignment or association with known faults. The Stony Creek fault has experience the most recent movement of all faults in the region, this being between 30,000 and 130,000 years....

Foundation Conditions: The existing outlet tunnel was constructed from the upstream end to the downstream end and was driven progressively through Chico shale and conglomerate of the Black Butte formation to the fault,

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and then through mudstone and the lower portion of the basalt. The tunneling operation was difficult due to the fractured nature of the rock. Preparation of the surface before placement of the tunnel lining was also difficult because the [p. F-1.7] rock weathered after exposure, especially on the floor where vehicle traffic and water caused erosion...."

TABLE F-1A
PROBABLE SEISMIC EVENTS
FOR
BLACK BUTTE HYDROELECTRIC PROJECT

Earthquake Source	Distance from Project	Most Recent Displacement	Maximum Credible Earthquake	Maximum Probable Earthquake
Stony Creek fault	12 mi.	30,000-130,000 yr.	6.5	4.0 (4)
Willows fault	14 mi.	Historic (1972)(?)	6.0	5.0 (4)
Battle Creek fault	9 mi.	150,000 yr.	6.9	5.5 (1,4)
Maacama fault	52 mi.	Holocene	7.2	5.2 (1,3)
Foothills fault system	48 mi.	Historic (1975)	6.5	5.7 (2)
San Andreas fault	80 mi.	Historic (1906)	8.5	8.3 (2)

1. Mark & Bonilla, 1977
2. DWR, 1979
3. Toppazada and Cramer, 1978
4. Earth Sciences Associates 1980

[Still looking for:]

2. Earth Science Associates. *Seismic and Fault Activity Study: Proposed Glenn Reservoir Complex*. Prepared for California Department of Water Resources. January 1980, Palo Alto, California
9. U.S. Army Corps of Engineers. *Foundation Report*, *Black Butte Lake, Stony Creek, California*, Sacramento District. September 16, 1963

"1980 draft report on site geology for the Stony Gorge Dam spillway modification study by the U.S. Bureau of Reclamation."

SWRCB Ap. 26379, 05/1981 Black Butte Hydroelectric Project, Initial Study, City of Santa Clara, Prepared by Resource Mangement International, Inc.;
- [I had seen it elsewhere and it didn't register, so I'm quoting it from this report:]
- - 5. Proposed Project; "...No releases have ever been made over the dam's spillway." [so it has never been tested?]

SWRCB APPLICATION A027750 City of Santa Clara Case Index - Highline Canal Power Plant
File Category 7 FERC Licenses & Reports VOL. 1 OF 1
folder 2 Item 1:

- 042883 Before the Federal Energy Regulatory Commission, Application for License for Minor Project, the High Line Canal Hydroelectric Project, a Competing Application Submitted by the City of Santa Clara;

- Exhibit E, Environmental Report
- - I. Description of Environmental Setting
- - - A. Description of Locale

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> - - - - 1. Topography and Geology, "soft Tertiary and Quaternary continental deposits. The hills are generally smooth and have moderate to steep slopes with the exception of a prominent protruding butte extending from the Black Butte dam site upstream (West) one mile and southward about five miles. The butte is formed by a resistant caprock of basalt which protects the softer underlying formations.

[Which is older, Stony or the cap? How did Stony Creek cut through that cap? or are the two caps on either side from independent flows? of the same height [782' north, 808' and 883' south]?, or did the flow cover the channel backing up the stream but subsurface flows undercut & collapsed the mid-section? and if undercut once....?]

Some other sources on the web:

http://www.stormingmedia.us/cat/sub/subcat46-76.html
Black Butte Lake, Stony Creek, California Geologic and Seismologic Investigation JAN 86 Authors: William E. Hancock; Lawrence V. Mann; CORPS OF ENGINEERS SEATTLE WA SEATTLE DISTRICT

http://www.stormingmedia.us/cat/sub/subcat101-25.html
Repair, Evaluation, Maintenance, and Rehabilitation Research Program. Geotechnical Aspects of Rock Erosion in Emergency Spillway Channels. Report 4. Geologic and Hydrodynamic Controls on the Mechanics of Knickpoint Migration DEC 89 Authors: James H. May; ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS GEOTECHNICAL LAB
During the last decade, occurrences of emergency spillway discharges at Soil Conservation Service, Corps of Engineers, and private reservoirs have increased and, in certain circumstances, resulted in erosional damages to the spillways. Rapid headward erosion in unlined emergency spillways at Corps of Engineers reservoirs including Grapevine, Saylorville, and Black Butte caused the Corps to take a serious look at the available methods used to predict erosion damage in unlined emergency ...

http://www.stormingmedia.us/cat/sub/subcat46-100.html
In Situ Seismic Investigation of Black Butte Dam DEC 1982
Authors: Jose L. Llopis; Ronald E. Wahl; ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS GEOTECHNICAL LAB
Surface refraction, surface vibratory, downhole, and crosshole seismic tests were conducted. Compression-, shear-, and Rayleigh-wave (P-,S-, R- wave) velocities as a function of depth were determined for the dam and underlying foundation materials. Results of the investigation indicated that P- wave velocities in the dam's core exhibited values of 2150, 5050, and 3050 fps with increasing depth. The random-fill section indicated velocities of 1825 and 32225 fps. The foundation materials ...

[are there multiple Black Butte Dams?]

http://www.cwclaw.com/attorneys/attorneyBio.aspx?name=WilliamNorman
William H.G. Norman, litigation partner with Cooper, White & Cooper LLP.
Successfully defended the project engineer on professional negligence claims arising out of construction of the Black Butte Dam.

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Return to Stony Creek Water Wars.

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