The Walnut Grove Dam 1890 Failure: The Worst and Most Forgotten Disaster in Arizona History.

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Abstract-- California was not the only state that experienced gold fever in the mid and late 1800's. In Arizona near the town of Wickenburg, gold was discovered in 1863 and a gold rush ensued. However, by the late 1800's gold mining was not limited to prospectors manually mining with pans and sieves. Big money, from New York stockbrokers and lawyers, funded hydraulic mining to process thousands of cubic yards of river and alluvial sediments and strip it of its gold and everything else. This type of mining requires tremendous hydrodynamic force, the kind of force necessitating the damming of water. Thus, Walnut Grove Dam was envisioned to be constructed at a site approximately 20 miles northeast of Wickenburg. Managing a dam construction project from over 2,000 miles away presented many challenges. During the construction there were frequent complaints about low pay, a poor work force, and high construction and design costs – this led to there being 5 different chief engineers on the job, each serving as superintendent (one would go on to become Governor of Arizona). Walnut Grove Dam, a 110-foot-high rockfill dam with a wood and tar paper face, was completed in 1888. Less than two years later, a rain-on-snow flood event caused the dam to overtop leading to failure on February 22, 1890. The flood wave destroyed, homes, farms, mines and took with it approximately 100 lives. While the ultimate cause was overtopping, many factors led to the dam failure:

- Remote management from New York
- Frequent succession of construction superintendents
- Periods of time without construction oversite
- Spillway under-designed (i.e. limited capacity) to save money
- Poor overall design due to the view it was a temporary dam
- Limited understanding of hydrology in the area

I. Introduction

In 1862 Pauline Weaver found gold along the Colorado River and town of La Paz was founded. This started a rush of gold fever to the area. One year later, in 1863 Arizona became a state and there were two were two additional gold finds in the Hassayampa valley – the Vulture Mine south of what is today Wickenburg and Rich Hill to the north. The Vulture Mine was built by the man who discovered the gold in that area, Henry Wickenburg. They decided to name the town after him and Wickenburg grew rapidly. By the mid 1870's the town was estimated to have 20,000 people, mostly men.

But by 1880 the west was changing. It wasn't just the lone traveler with a pan that saw his fortune in the west. New York bankers, lawyers and traders wanted to get in the action. Money from men like JP Morgan and Andrew Carnegie was put into investments in railroads and other infrastructure to increase trade and ability to travel to the west. Two such men were Wells H. Bates (a 35-yo lawyer) and DeWitt C. Bates (a 38-yo law clerk), both from New York, heard of the gold in the Hassayampa valley and purchased land and a gold mine in the area. But they did not plan to rent a donkey and head out west with pick and pan. No, they knew to really get most of the investment they needed to process tons of material, and the way to do that was using hydraulic mining. Basically, hydraulic mining is power washing huge amounts of sediment out of the riverbed into a long flume which slowed the water to allow for the gold and iron to settle out at the top of the flume. But to do this required lots two things: pressure and water. The answer to get both – a dam.

II. William P. Blake

The brothers then started the Walnut Grove Water Storage Company to attract investors. They sold most of the company to Henry Van Buren, a millionaire in New York, but the Bates brothers remained heavily involved. Step one was get somebody who knew something about dams. They hired Professor William P. Blake (see Figure 1). He had been a professor at the College of California (later Berkeley) from 1864-1867. He began work on the design and construction of the dam in 1886. He

had no engineering background or experience but was the first Chief Engineer and Superintendent. His degree was from Yale in mineralogy. For this he was paid $500 a month, a handsome salary in 1886. The real reason W. Blake had been hired was he was a nationally recognized mining consultant. Without his name attached to the project, the Bates brothers simply could not get investors.

The civil engineering experience came from W. Blake's son Frank who graduated the year they went out to build the dam. The plan was to place a 60-foot-high dam in the river. But sometimes W. Blake said the dam would be 80-feet-high. There were no plans or specifications at this point, but some construction had already been completed.

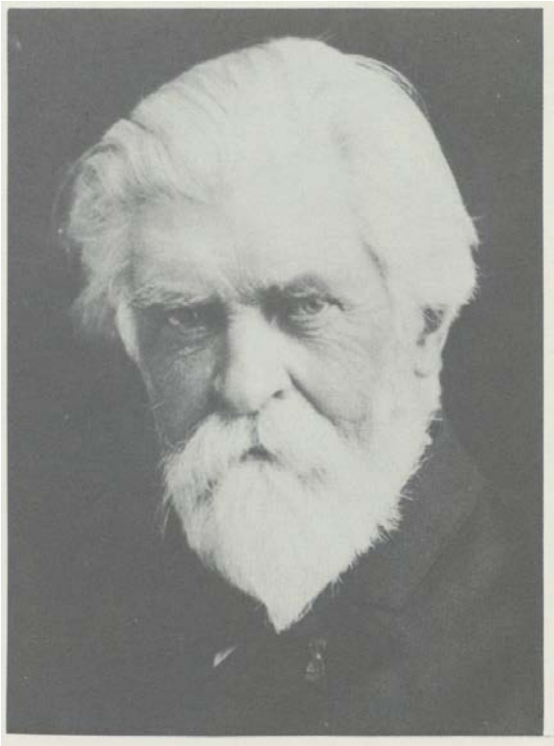

Figure 1. *Photo of William P. Blake (Dill (1987), The Walnut Grove Dam Disaster of 1890, The Journal of Arizona History).*

Christmas 1886 found W. Blake with his sons and crew working on the dam. They received a visit from the Bates brothers and Edwin Robinson. They had a good visit including a nice ham supper, but a few weeks later W. Blake was fired. Although one of W. Blake's sons, Whit, was asked to stay on as head surveyor. Robinson, a well-known San Francisco civil engineer, had reviewed the work W. Blake had done and convinced Bates that it was clearly wanting. They decided to hire Robinson to replace W. Blake as Chief Engineer and Superintendent.

III. ROTATING CHIEF ENGINEERS

Robinson had experience in dam design and construction and from him we get the first drawings and specifications, although still limited. He would use the location and tried to salvage some of the dam W. Blake has started, but design was completely new and called for a height of 110 feet instead of the 60-80 feet W. Blake specified. Ultimately, he would choose to abandon the work Blake had done. He also realized the need for larger spillway capacity and called for an auxiliary spillway. But the relationship with himself and the owners was not much better than it had been with W. Blake, and in April 1887, less than 4 months after being hired, he was fired. The exact reason is unknown, but Robinson's spillway design was considerably more expensive than the original estimate and this may have been part of the reason for dismissal.

The firing of Robinson was a crucial time for the project. The team decided to hire Walter Bates, a third Bates brother who was in his 20's. He had no engineering credentials. His only past job was that of a salesman. The decision was quickly made to scrap the auxiliary spillway in Robinson's design. Also, the superintendent of construction only lasted two weeks under Walter Bates' management. Construction on the site was hard. The contractor struggled to hire and retain workers. Walter

Bates complained of this in an article he wrote in Scribner's Magazine, "Payday sees saloon and gambling houses in full blast, and but little work is forthcoming for a week." He also wrote, perhaps prophetically, "The building of a great dam anywhere is a most difficult task, involving the best, and often the boldest, engineering skill, great administrative ability, and the most scrupulous fidelity in minute details."

During his tenure most of the dam was constructed, but he spent most of it in New York (i.e. there was no onsite oversight of the contractor). There was considerable concern related to QA/QC that was already fairly limited. Clearly at some point there was a realization of his engineering limitation because in August of 1987, he hired Luther Wagoner, a well-respected civil engineer from San Francisco. His job was mostly to design and oversee construction of the flume line that would come downstream of the dam to convey water to the mining location. He was asked to visit the main dam site once a week to provide oversight. He was critical of the dam from the beginning, in part due to lack of spillway capacity. But he would also write, "The history of the construction of the dam is one full of blunders, mainly caused by officers of the company in New York."

There was one other chief engineer right at the end of construction – James Emmett Anderson, but we know very little about him or his role. Of more interest was his assistant Alexander Oswald Brodie, who was trained in West Point. He would leave the project right before the dam was completed and came back as chief engineer in September of 1989, after the dam was complete. And he oversaw the lower dam construction and downstream flume. He also oversaw enlarging the spillway in 1889 after the first year of runoff damaged the spillway. They were expanding the spillway when the dam failed.

IV. Dam Specifications and Basin Hydrology

The dam was ultimately a 110-foot-high rockfill dam (see Figure 2) on the Hassayampa River. The Walnut Grove Dam had a top length of 400 feet (top width of 10 feet) and bottom length of 150 feet (base width of 138 feet). The reservoir area at top-of-dam was approximately 1,120 acres. This Hassayampa River drainage area at the dam site was approximately 310 mi^2. The elevation at the Walnut Grove Dam was approximately 2,900 feet; in the watershed the elevations reached nearly 8,000 feet in its Bradshaw Mountains headwaters. There was no hydrographic survey to determine how much flow the Walnut Grove Dam need to pass – the design was apparently negligent in providing adequate flood protection. The actual size of the spillway is uncertain; however, Liggett (2010) estimated the spillway to have a capacity of approximately 2,200 cfs. This flow corresponds with a flood flow frequency with recurrence period between 2-years and 5-years estimated using USGS regional regression methods (Paretti, et al., 2014).

Figure 2. *Photo of Walnut Creek Dam and Reservoir (Dill (1987), The Walnut Grove Dam Disaster of 1890, The Journal of Arizona History).*

V. Failure and Warning

Rain began to fall on February 16th, 1890 and would continue on and off leading up to February 21st. This was a long rain-on-snow event. While such a rainstorm may have been rare, large rain events were not unknown in the basin. [Liggett (2010) estimated the inflow associated with this event to be approximately 20,000 cfs. This flow corresponds with a flood flow frequency of 25-years estimated using USGS regional regression methods (Paretti, et al., 2014)]. In fact, the winter of 1889

had another large event that had caused damage at the dam, following which it was decided to enlarge the spillway. This spillway enlargement project was being completed when the 1890 rain-on-snow event began.

Onsite the sub-superintendent Brown was onsite and saw as the spillway filled. By about 3:00 in the afternoon on the 21st he decided it was important to warn the people downstream. The only person available was Dan Burke. He was hired blacksmith onsite making $6 a day. He mounted his horse and began to ride downstream to warn the public. Unfortunately, his first stop was a local pub. There he got stinking drunk and failed to warn anyone. He would argue that he didn't get drunk, but got lost and sited his witness, James Cameron, but Cameron would state that he did see Burke that night, and he was drunk. Burke would be charged with manslaughter and kept in jail for a few days to keep him from being lynched but was ultimately let go because there was no provision of law in Arizona under which he can be punished.

Back at the dam, Brown continued to watch the dam and despite full flow in the newly expanded spillway the water continued to rise. By 9 P.M. the dam began to over top, ultimately passing over 3 feet of water over the dam. The dam surprisingly withstood over three hours of over topping but a little after midnight the dam collapsed suddenly, and a wall of water headed down the canyon. Liggett (2010) estimated the peak breach flow to have a peak instantaneous flow approximately 850,000 cfs.

The first place that it hit was the camp at the lower diversion dam and flume. Brodie, the superintendent was very excited that the flume had just been completed and they had planned to begin mining by the end of the month. The flume and dam became very small bumps in the road and washed away almost instantly. Brodie was not there, but unfortunately many men were. At this spot alone, a couple of dozen bodies were found and over 14 men were missing. And while Brodie was not there, the owner's niece Mary Hanlon was, and she would try in vain to save her maid and save a hydraulic engineer by a warning that would risk her life. She would go onto marry Brodie the superintendent, who would go onto become the Governor of Arizona. The devastating wave would head downstream and take with it over 100 lives.

Figure 3. *Photo of remnant of Walnut Creek Dam after failure (Dill (1987), The Walnut Grove Dam Disaster of 1890, The Journal of Arizona History).*

VI. LAWSUITS

Lawsuits were very much part of the Walnut Grove dam history. The first was when the company was sued by William Blake over unpaid salary for the first year when he worked on the dam. He put in the lawsuit in October 1987, less than a year after they fired him. It was for $4,000 salary plus 10% interest. The case was ultimately settled out of court.

The second fight was also over money. E. N. Robinson, the second Chief Engineer, was also not paid for the four months of work and design of the dam. He threatened legal action, but ultimately gave up and likely decided after the dam failed that he was better off without the money.

Once the dam failed, fingers began to point in all directions; no one wanted to take accountability for the failure and blame was dispersed liberally. The San Francisco Chronicle ran an article on the failure on February 24., two days after the failure. The paper was run by William Randolph Hurst, who is better known for his exciting headlines rather than his journalistic integrity. Indeed it quoted Luthor Wagnor, the famous San Francisco engineer as saying about his fellow San Francisco

engineer E.N. Robinson, “Robinson, the engineer in charge, who was a worthless drunkard, was shot-gunned out of the place, and I met him a few days ago begging for money to get a meal with.”

Mr. Wagnor did not agree that he had said that and wrote, “I have never met Mr. Robinson, and I know nothing whatsoever of his habits. The original designs of the dam were made by him, and I consider them good…The most probable cause of the failure, to my mind, is the notoriously bad work done after Colonel Robinson had left and up to the time of my taking hold.” The first lawsuit that materialized to recover damages was filed by a group of 14, the most famous of the group which was Henry Wickenberg, the town’s namesake. His fields had been damaged and he asked for $7,000. The largest claim was for A.S. Foushee who had become caregiver to two girls, 15 and 18, who had lost both parents in the failure. His claim was for $50,000. It went to trial February 1891, one year after the dam failed. The first jury was deadlocked; a second jury was called and decided in favor of the Walnut Grove Company. To add insult to injury, they awarded the company their lawyer fees so those involved in the lawsuit were all forced to pay a share, except for H. Wickenberg for whom the company waived his need to pay.

The verdict was given in one sentence (which is one of the longest sentences ever written by man):

> *If you should believe from the evidence that said Board caused plans, specifications and design for the creation of a reservoir at Walnut Grove, and the erection of a dam to impound the water therein, to be prepared by a person whom they reasonably believed to be a competent engineer, and that thereafter they on behalf of the corporation entered into a contract in good faith with persons whom they reasonably believed [illegible handwritten insertion] to be competent persons for the erection of said dam in accordance with such a plan, specifications and design, and such a dam and its appurtenances were accordingly constructed, or constructed according to such plan specifications and design modified by a person whom they reasonably [illegible handwritten insertion] believed to be competent to modify same, and that such construction was under the supervision of a person selected by said Board or its president whom in the exercise of reasonable care they reasonably believed to be competent therefore, then such president and members of such Board are not liable, even though you should believe from the evidence that there was a defect in the plans, specification or design prepared for such structure, or fault in the manner of construction, unless you further believe from the evidence that such president had actual notice of such defect or default, and that such president or Board of Directors had access to and may have seen such plans and specification, or may have seen the work progressing, or may have given directions in some part of its progress provided such directions were not contrary to such plans and specifications is not sufficient to charge him or them with knowledge of such defect if any there were if you believe that the preparation of such plans specifications and design required scientific knowledge and skill, and you do not believe from the evidence that such president of Board possessed such knowledge or skill, there is no presumption that any of them did.*

There were also two lawsuits related to loans on the property. One loss claim was by a landowner next to the dam whose timber had been cut and used on the dam. The judge ruled in favor of the Walnut Grove Company on that. The other was over a loan for $350,000 that had gone into default. They sought foreclosure of the property over the loan. The company also prevailed in this case, but it would be drawn out until 1908 after several failed attempts to rebuild the dam.

Those seeking legal action against the company should have gotten a sense of the direction their lawsuits would go in the local courts by how the public responded to the failure. The owner, H. Van Buren, came with his daughter and niece back to the site on March 8, 1890. He had been at a nearby town on the night of the failure and his niece had been at one of the camps where most of the men died – she had been one of the few survivors. You might think the owner of the company would have met with a tough crowd in a town where the dam they built and managed killed over 100 of its residents but you would be wrong.

H. Van Buren did come to pay out some claims – $6,000 worth and at his hotel the local band came to play for him. The Chief Justice of Arizona James H. Wright gave a speech praising the company for their efforts and gave the Van Buren’s niece a 5.5 once gold nugget that was found during the flood recovery for her survival and help on the day of the failure.

VII. REBUILDING

Van Buren was determined to rebuild and started plans immediately to get to work. However, due to the lawsuits pending on the land, he was unable to move forward. He died in 1906 making his daughter promise on his deathbed that she would rebuild the dam. She made several attempts in her life but never was able to raise the capital to complete the dam.

Throughout the dam boom era of 1930-1970 there were several attempts to rebuild the dam, but they never came to fruition. So, the Hassayampa remains free flowing to this day.

VIII. Lessons Learned

There were many lessons learned from the failure of this dam. But a few include:

- Remote management from New York
- Frequent succession of construction superintendents
- Hiring engineers with little to no engineering or dam specific education, training or experience
- Periods of time without construction oversite
- Spillway under-designed (i.e. limited capacity) to save money
- Poor overall design due to the view it was a temporary dam
- Limited understanding of hydrology in the area
- Using trustworthy warning systems is important

IX. References

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