THE CASE FOR REMOVING MATILIJA DAM

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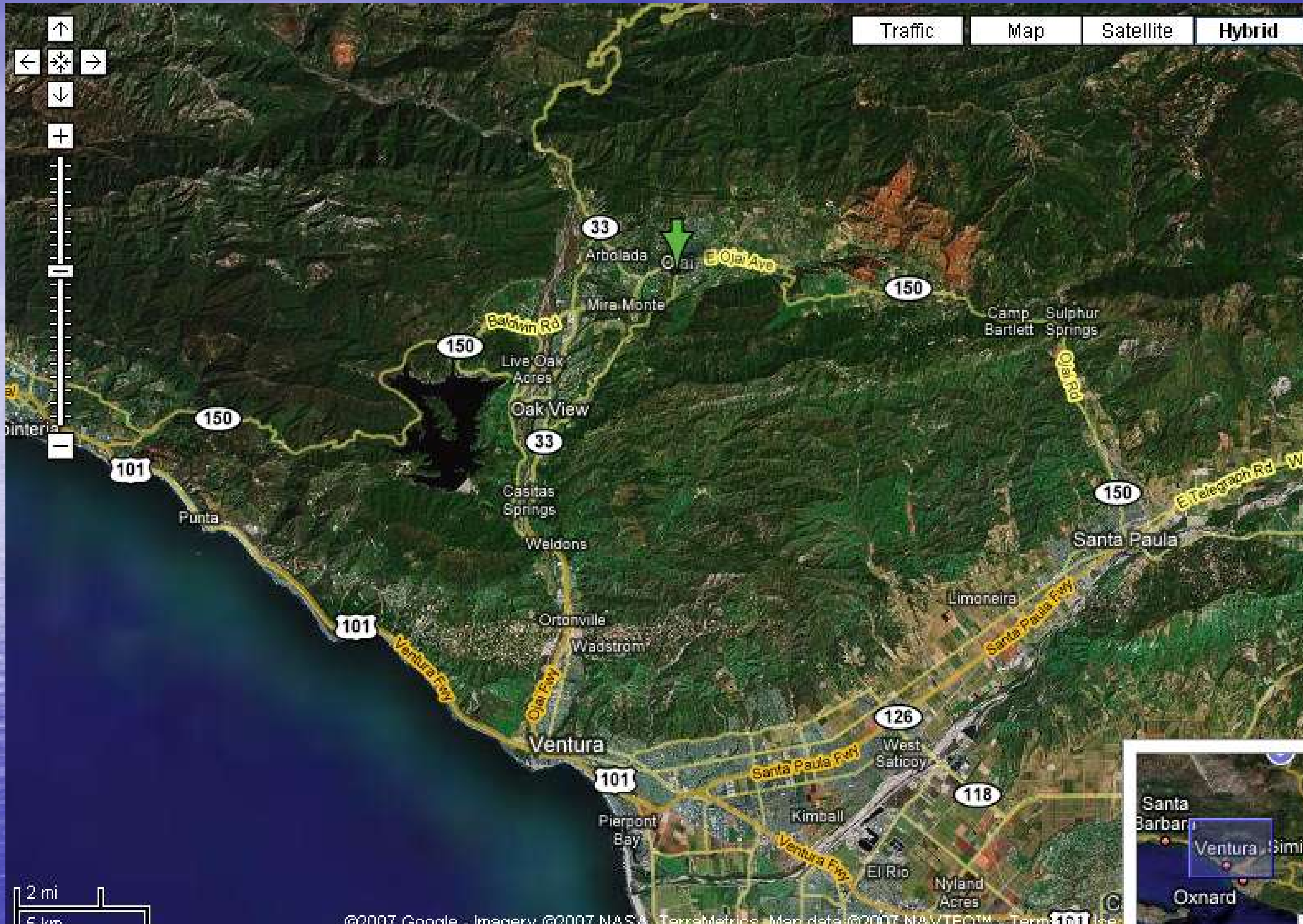
Traffic
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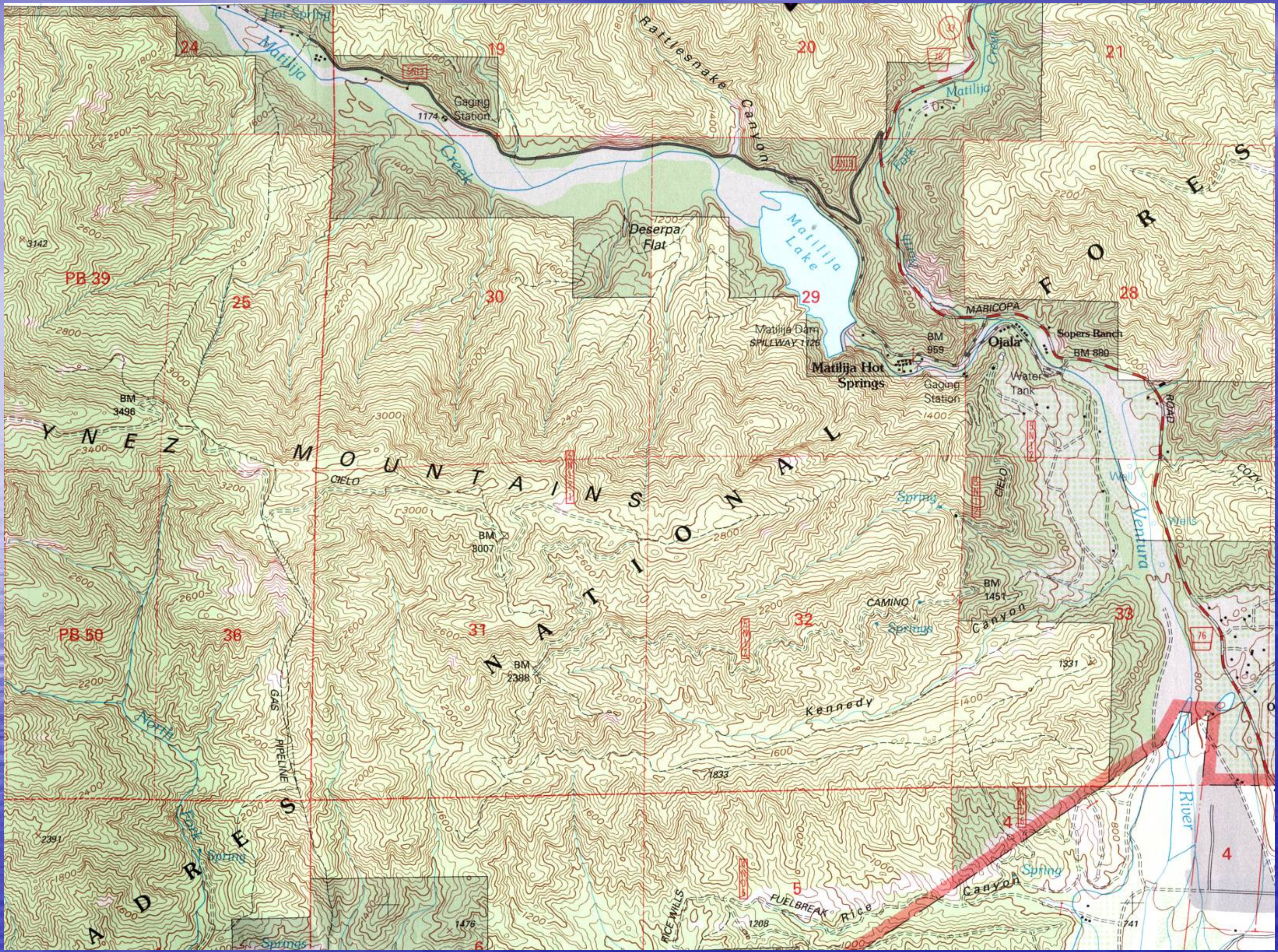
Matilija Creek
Gaging Station
Rattlesnake Canyon
Matilija Lake
Deserpa Flat
Matilija Dam
SPILLWAY 1126
Matilija Hot Springs
MABICOPA
Ojala
Sopers Ranch
Water Tank
Gaging Station
YNEZ MOUNTAINS
NATIONAL FOREST
SANTA
ADRES
GAS PIPELINE
CIELO
CAMINO
Spring
Springs
Kennedy Canyon
Canyon
Ventura River
FUELBREAK
Rice Canyon
RICE WILLS
North Fork
PB 39
PB 50
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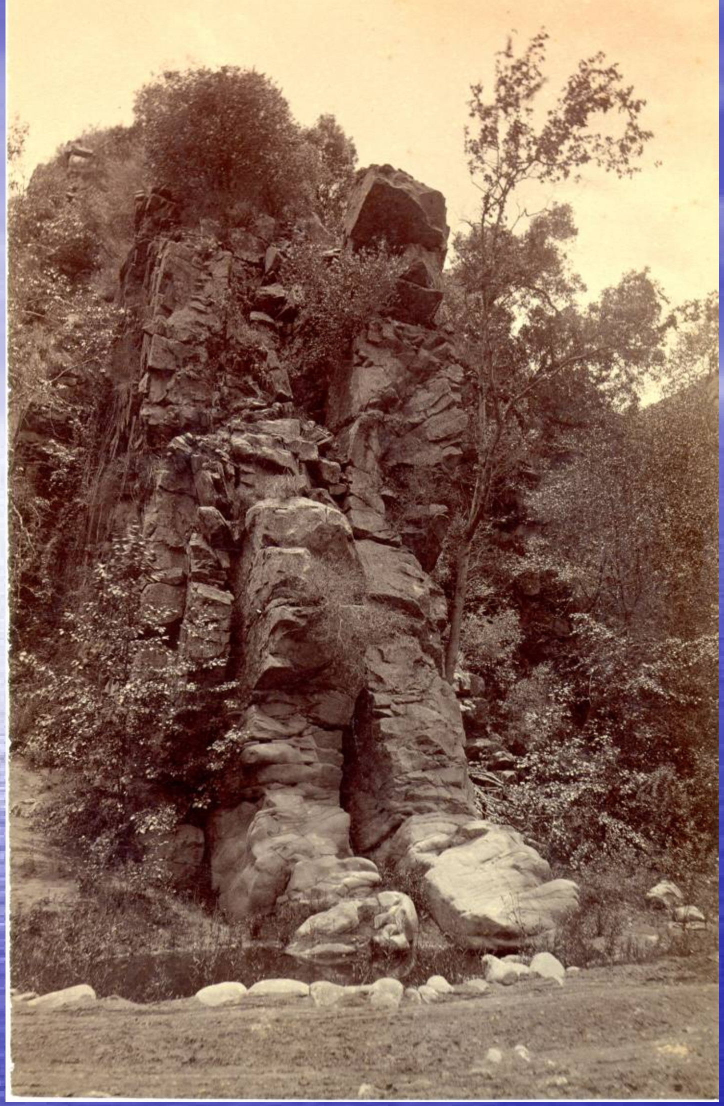
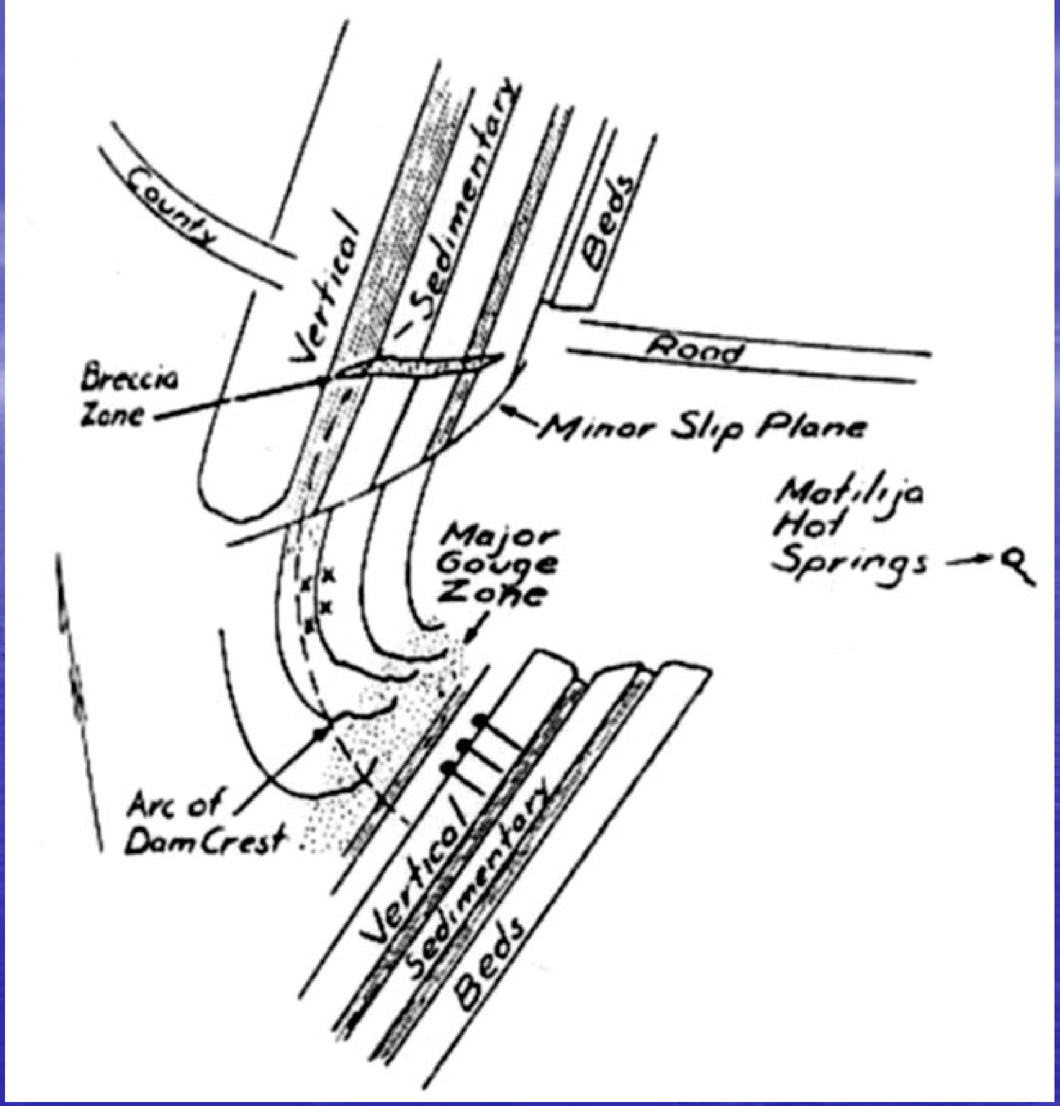
- **Geologic map of the Matilija Quadrangle (Dibblee, 1987) .The dam was founded on the Eocene age Matilija sandstone**

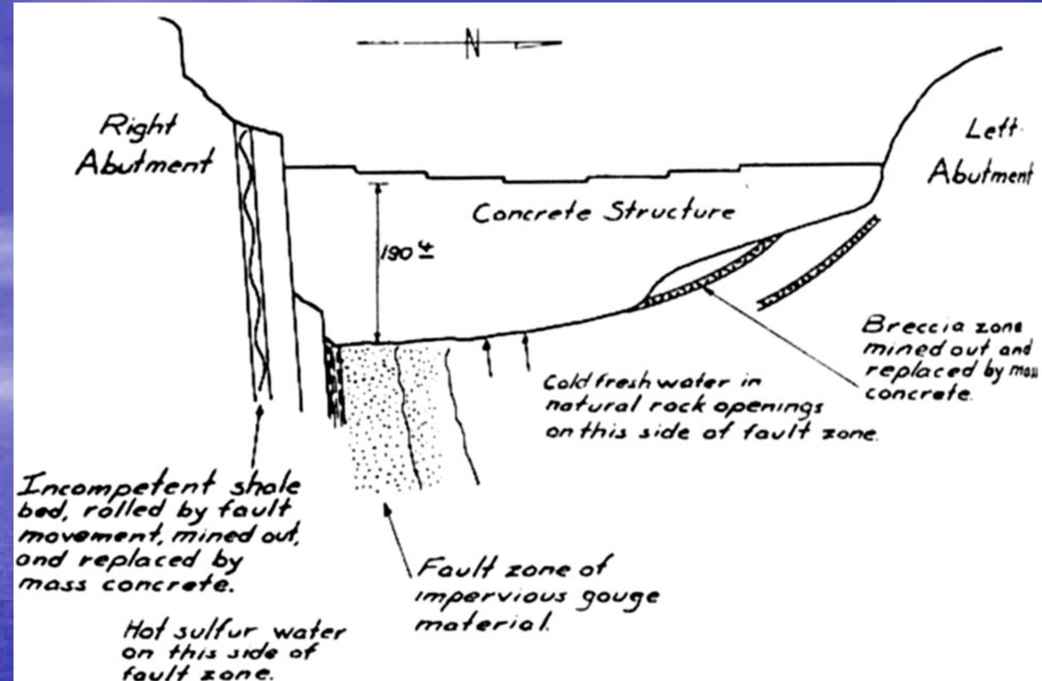


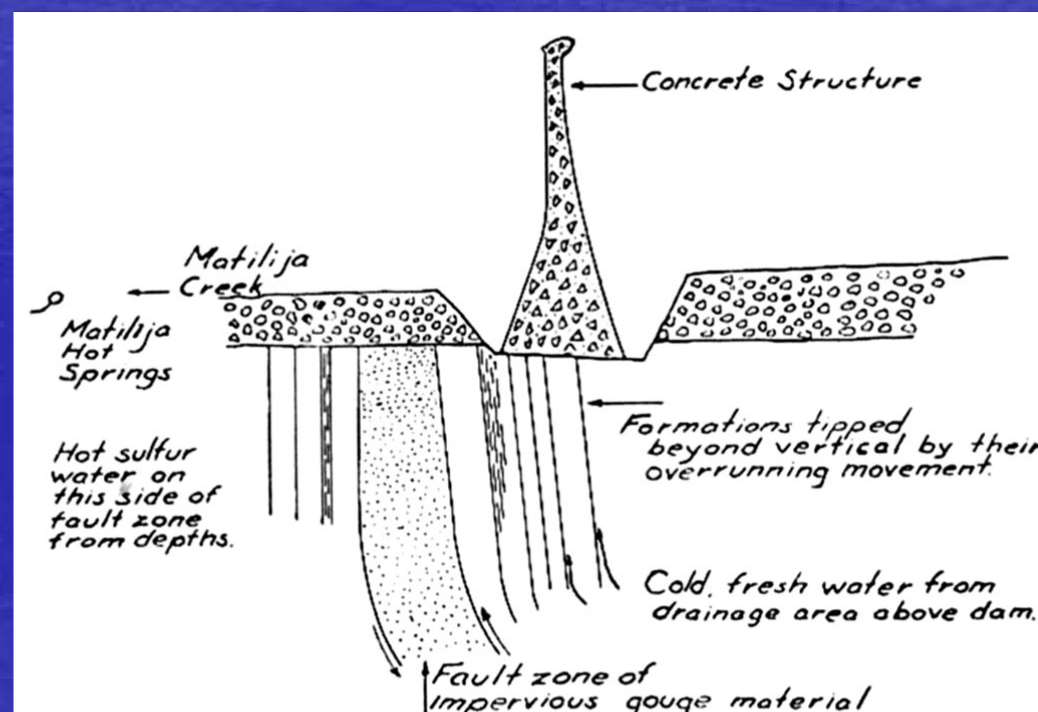


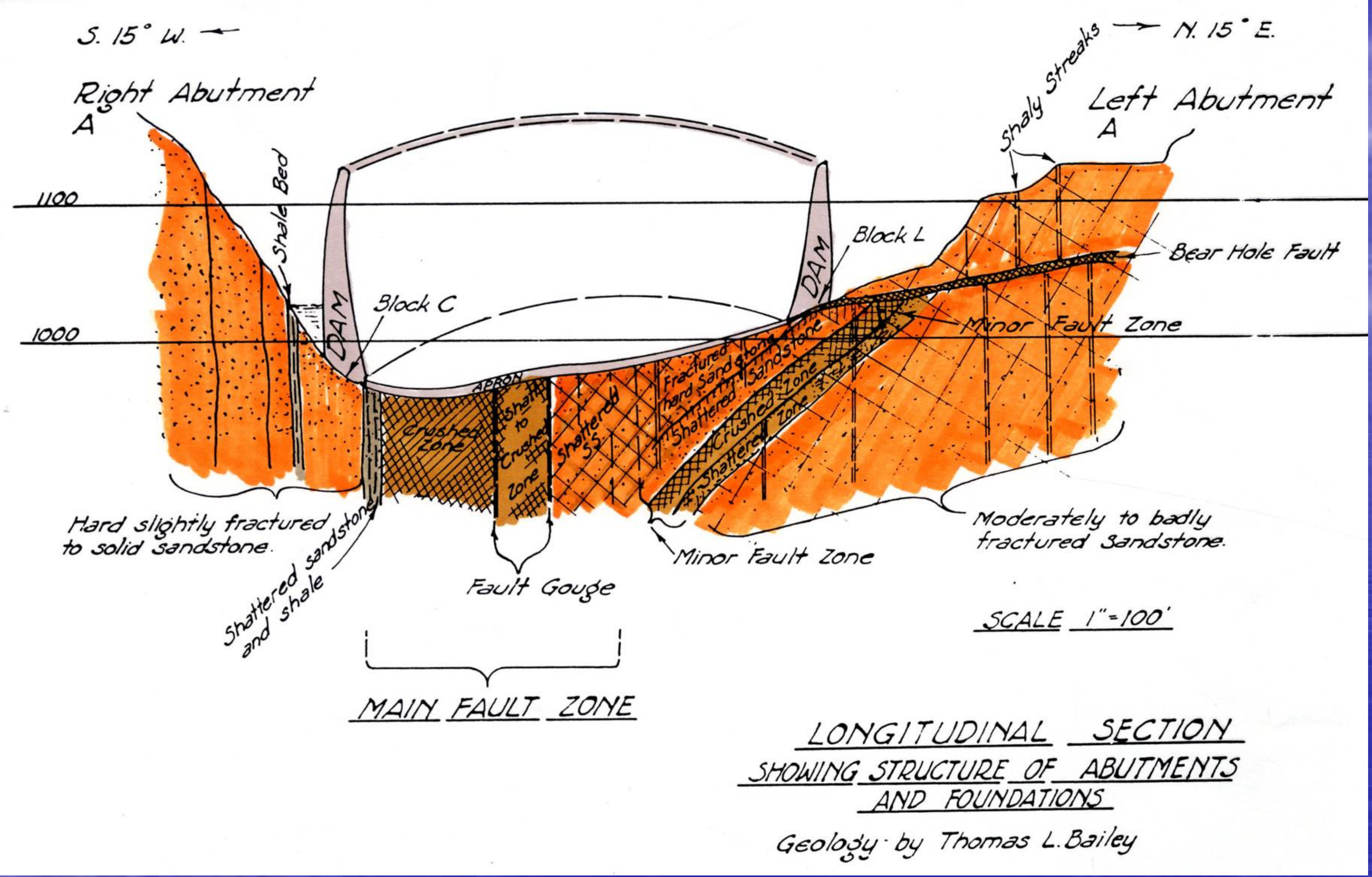
- **Soon after construction began, the contractor's geologist discovered a fault in a tightly folded anticline. The fault offsets slightly dissimilar geology on either abutment and the drag folds suggest an offset of ~100 ft. The fault zone is about 150 ft wide.**

Foundation Problems

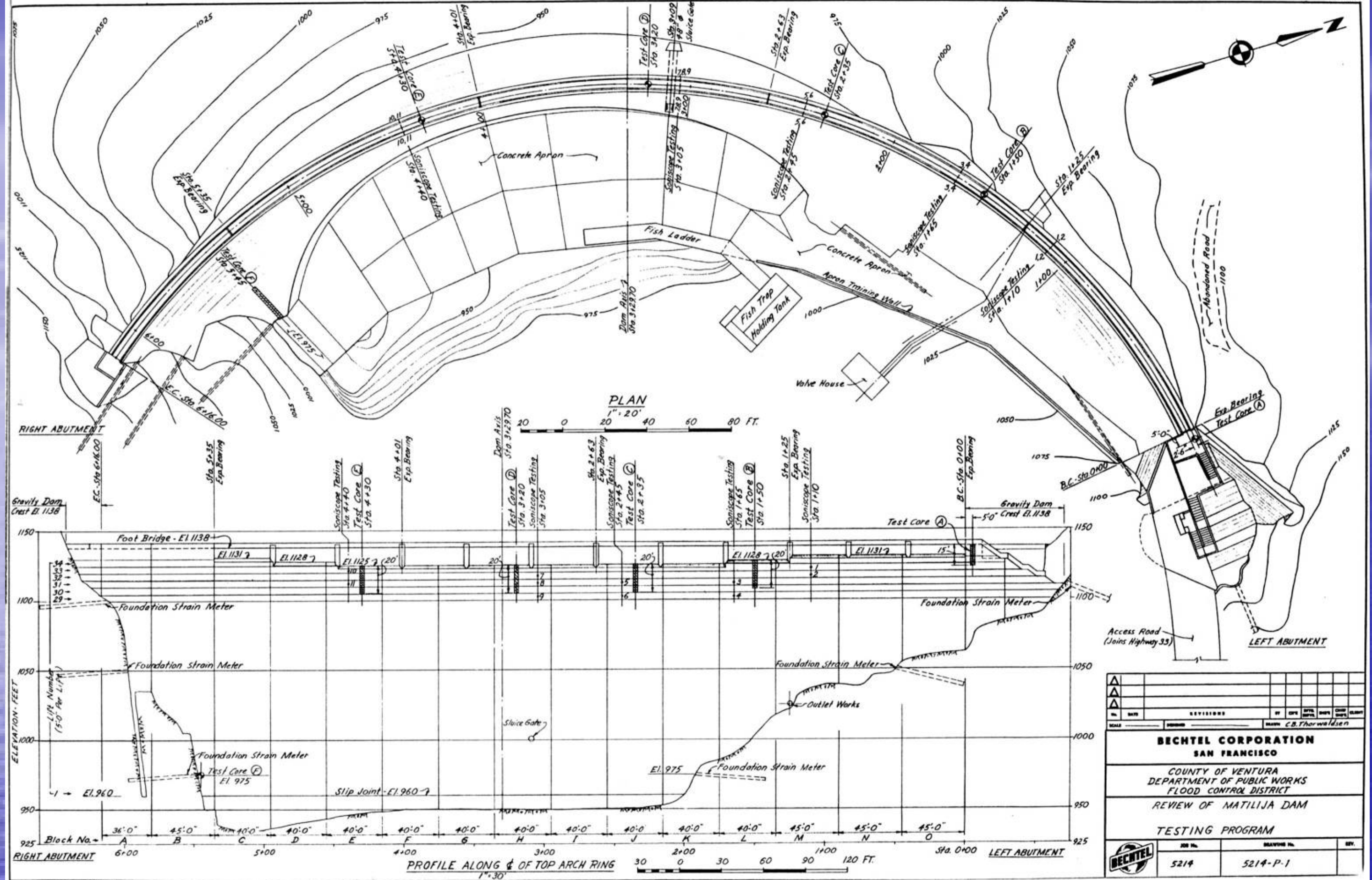
- Special foundation treatment was required for a fault in the southwest abutment
- Prof. Charles Berkey brought in as a consultant, as well as many others



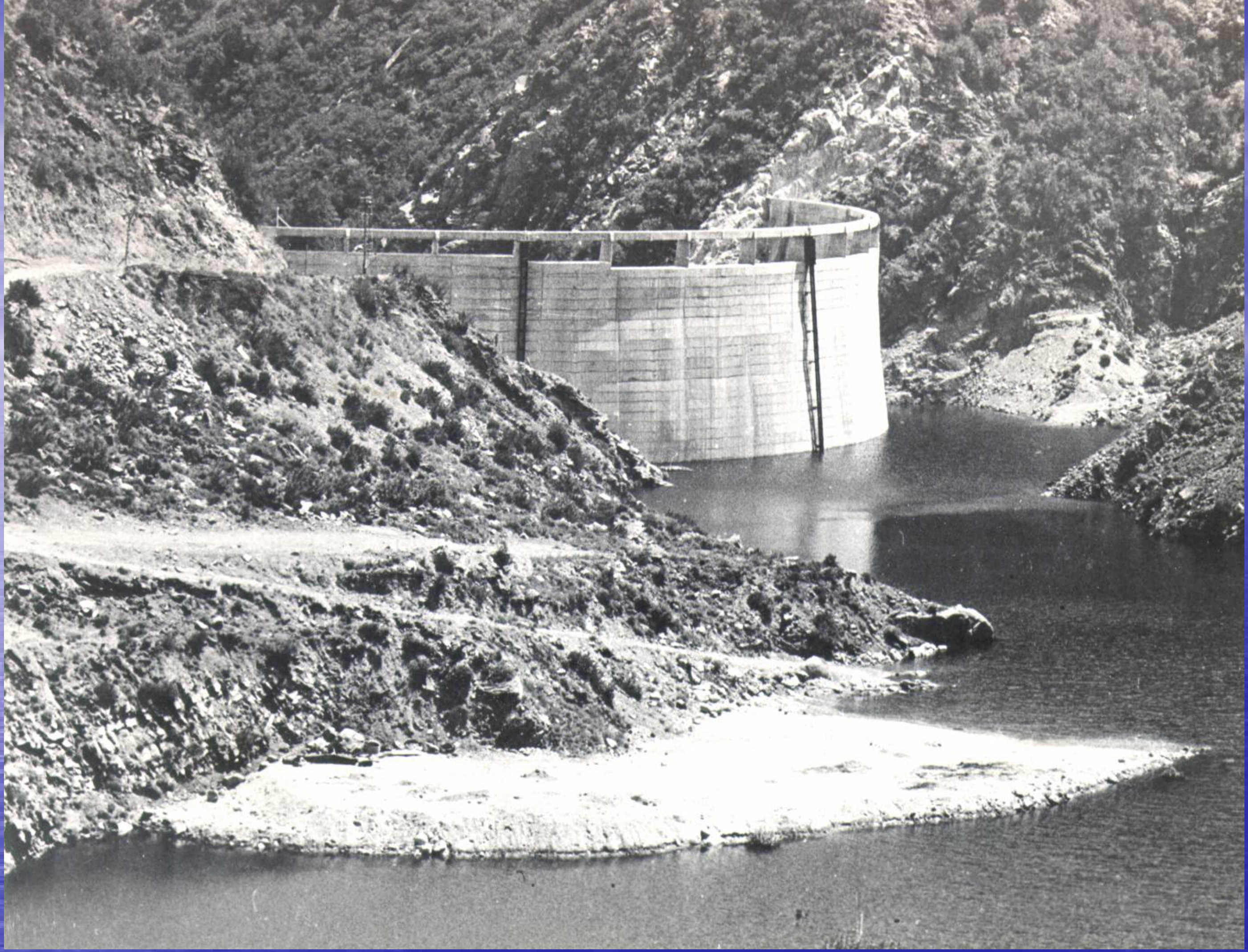




- **The dam's right abutment was moved so it could be placed on sandstone between two seams of shale, shown here. The "main fault zone" passing beneath the dam's right side is about 150 ft wide.**



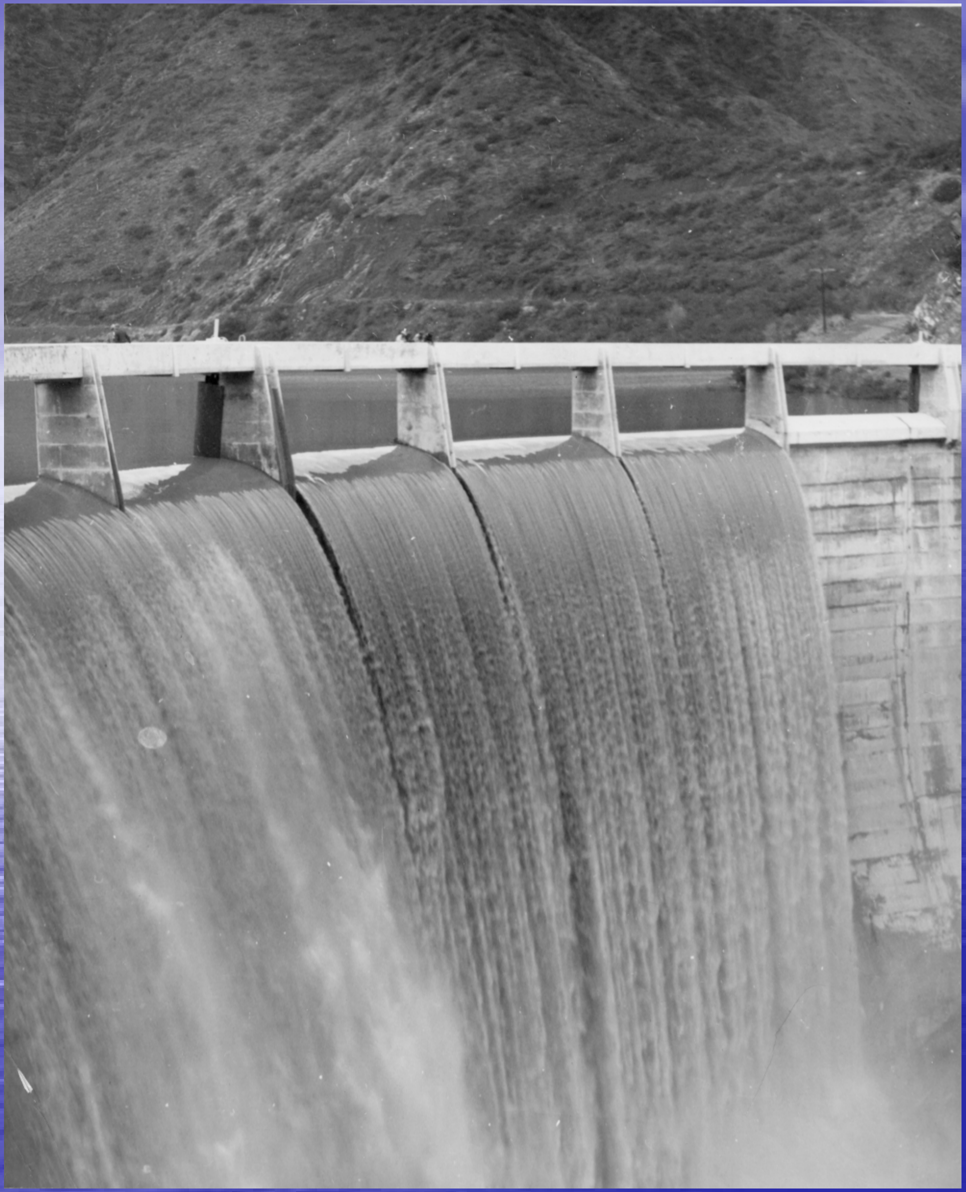
- Matilija Dam was designed as a 190-ft high constant angle arch dam with a crest 620 ft long. It was designed by the Donald R. Warren Co. of Los Angeles in 1946.
- Because of opaline quartz in volcanic andesites exposed in the Santa Ynez Range, the construction specifications called for Type II low alkali cement <0.6 % Na_2O). The coarse aggregate was brought by rail from Irwindale, over 100 miles away.

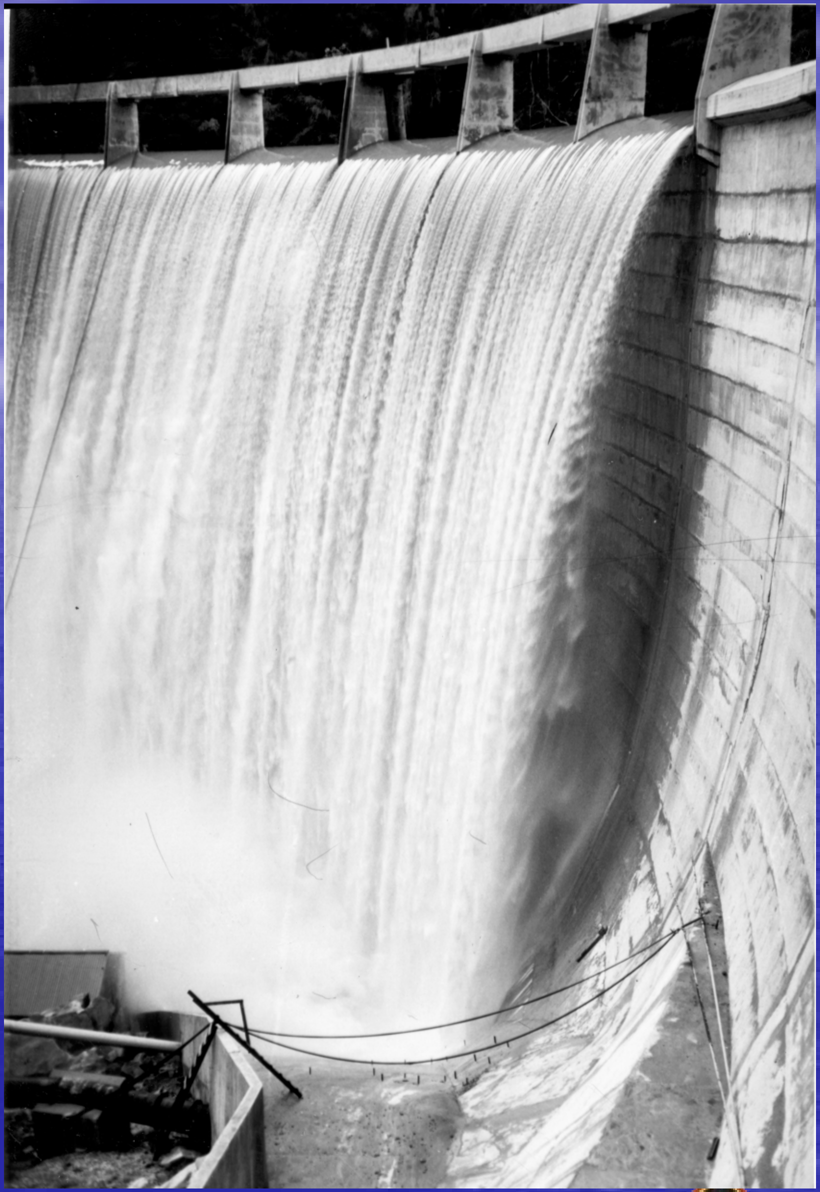


- Unfortunately, the contractor obtained his sand aggregate from a nearby source at Saticoy, along the lower Santa Clara River, near Ventura, which contained chalcedonic chert and glassy andesites, which are very reactive.

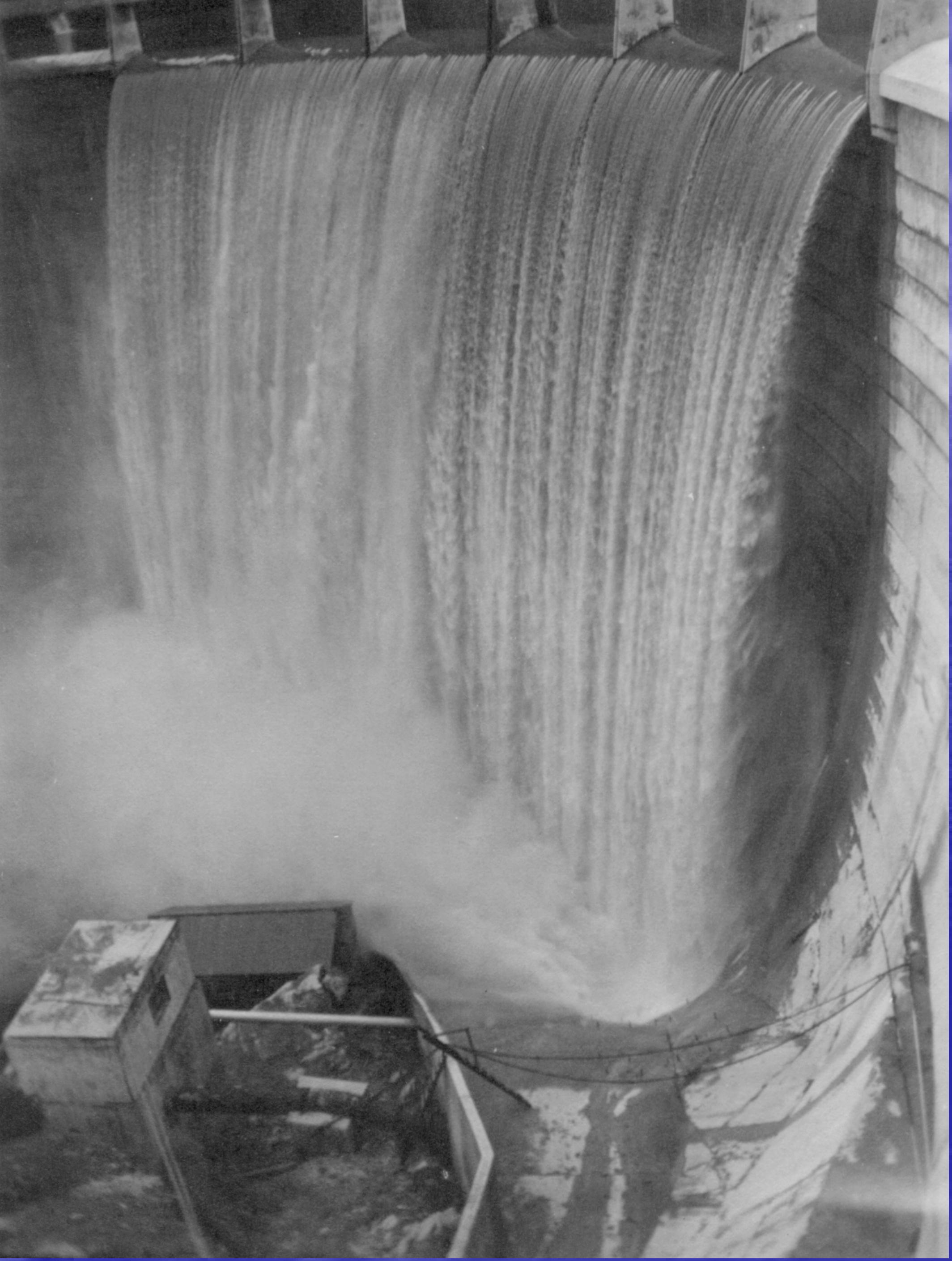
- **The tributary reservoir area was 55 square miles, within Matilija Creek. The maximum storage was 7000 ac-ft in Jan 1952 and the minimum storage 1848 ac-ft, in Nov 1961.**

- Because of contactor construction claims, the dam was not officially brought into operation until 1949. It first spilled during the intense storms of January 1952, shown here.





Initial spillage in 1952. Note people standing on 8-foot wide walkway for scale. The design capacity was 60,000 cfs



Spill Problems

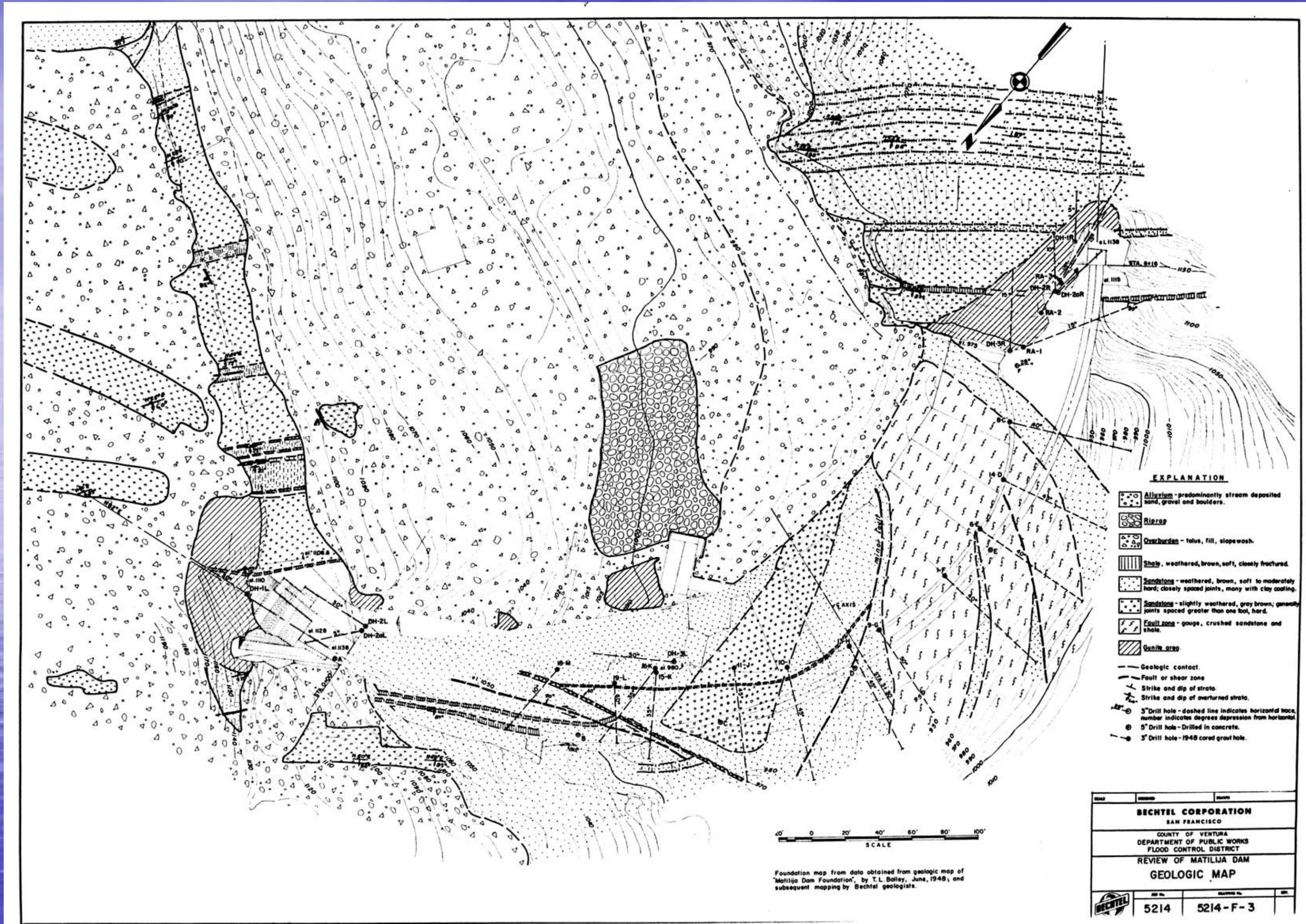
- The only obvious operational problem experienced by the dam during its first decade of service was severe erosion, caused by deflection of spillage on the left side of the spillway, shown here.

- Postcard view of Matilija Reservoir at full stage, with 7000 ac-ft of water, before siltation became noticeable.

- As the dam got older, the water district started noticing staining and unusual deterioration of the dam’s concrete.

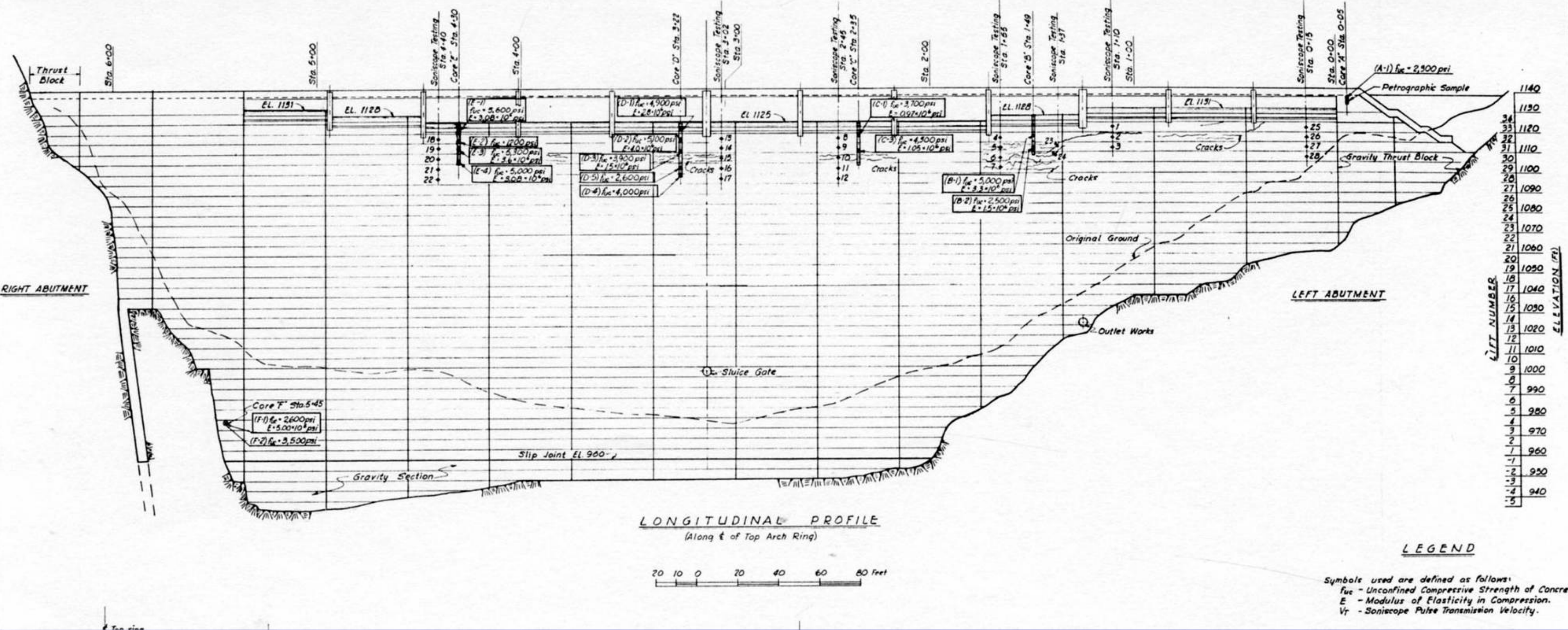
Alkali-Aggregate reaction

- In 1964 the water district retained Bechtel to evaluate excessive cracking problems in the dam's concrete. The cracking was most severe in the upper 40 feet.

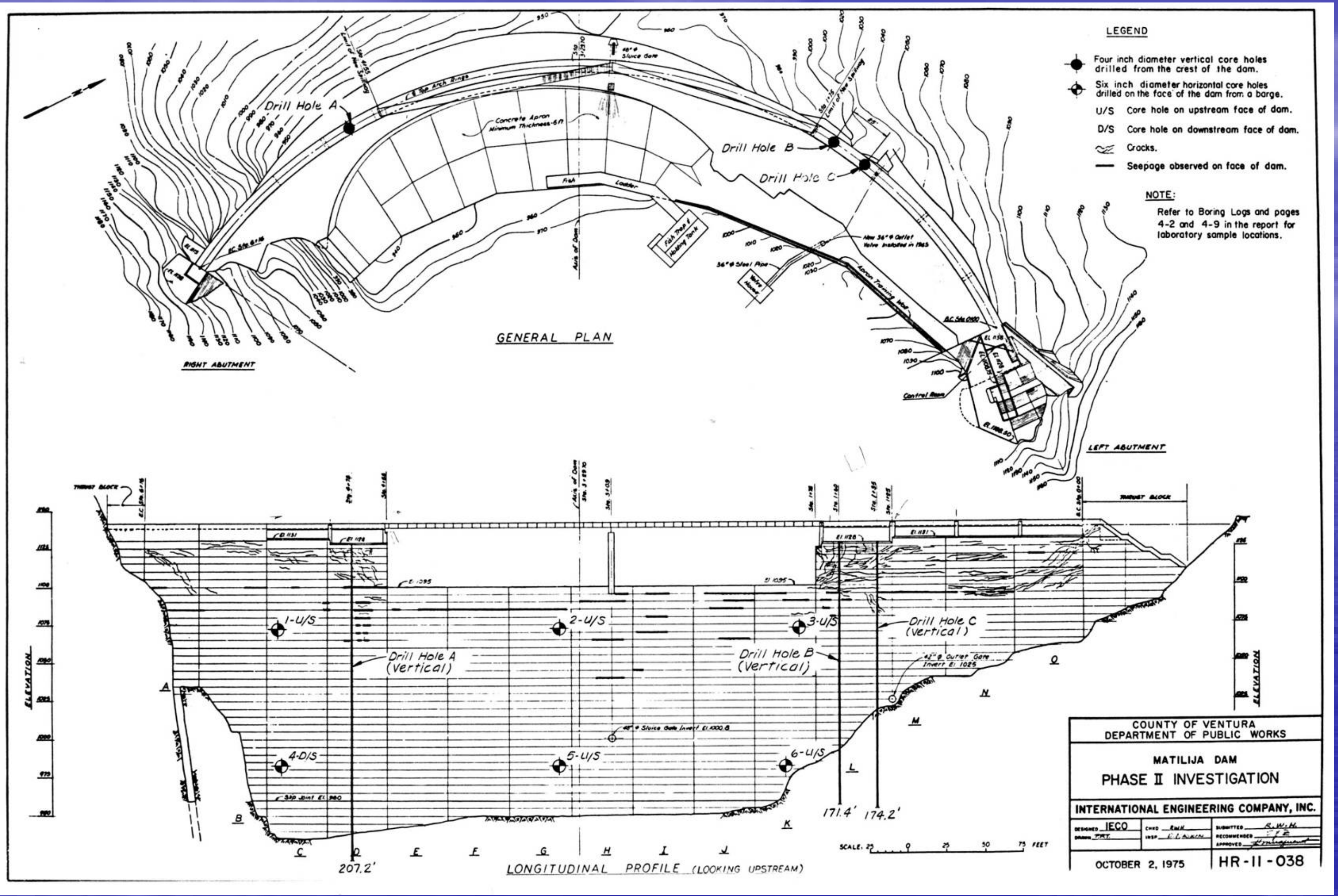


- **Bechtel performed a new round of studies characterizing the dam site geology, shown here.**

- The alkali aggregate reaction was caused by inclusion of glassy andesite and chalcedonic chert in the fine aggregate fraction.
- Cores from the dam showed concrete strength had deteriorated to between 1,200 and 2,600 psi; while the original tests at time of construction were 4,500 to 5,000 psi.
- The precise mechanism was not ascertained until the mid 1970s; that being a chemical reaction between opaline quartz and the cement paste

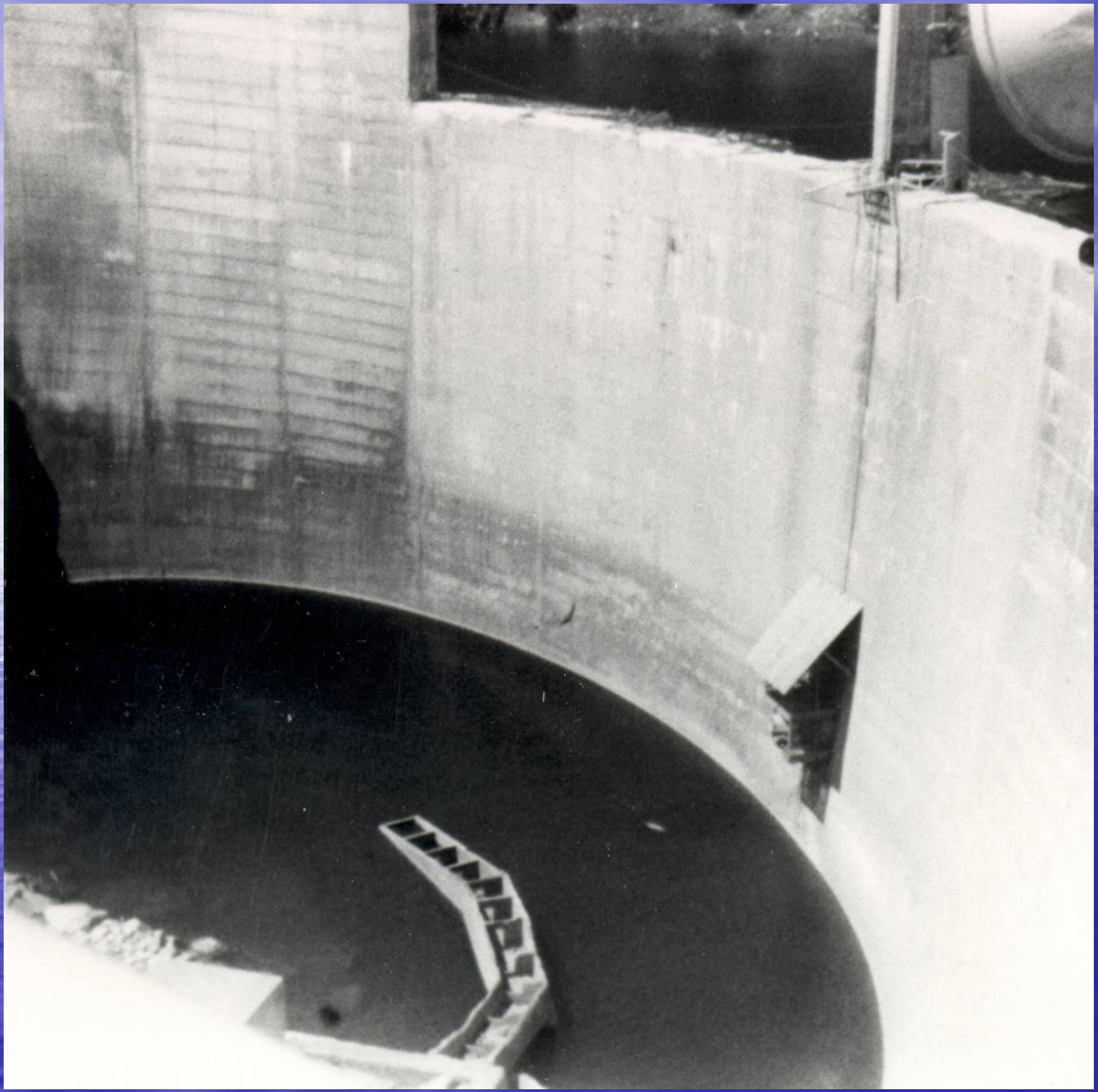


- **Bechtel performed a series of structural analyses using the lower strength of the deteriorated interior of the dam's arch**
- **These structural analyses concluded that lower than normally accepted factor of safety existed.**
- **This work was reviewed by CA DSOD**



- **Bechtel recommended lowering the dam crest by 40 feet. This reduced the reservoir storage by 540 ac-ft. Later, the catwalk was also removed.**

- After the Bechtel study in 1964-65 the dam was lowered in three notches, 40 feet deep and 280 ft wide. This reduced storage by 2,633 ac-ft. Bechtel performed a follow up study in 1975, followed by IECO in 1977-78.



Fish Ladder

- A fish ladder was added by the County in 1956 to enamble steelhead trout trying to reach their ancient spawning grounds along Matilija Creek.

- **With a tributary watershed area of 55 square miles, the reservoir filled at an average rate of about $85{,}000^3$ yds per year between 1947-64.**
- **The floods of Jan-Feb 1969 followed fires in the upper watershed. These storms brought 1,067 ac-ft of sediment into the reservoir, reducing its capacity to just 34% of the original design in just 22 years.**

MATILIJA SLATED FOR REMOVAL

- By 2000, the reservoir was essentially full, with just 400 ac-ft of storage left. Matilija Creek used to support steelhead trout, migrating up Ventura River from Pacific Ocean
- Current plans call for its removal, after studies by USBR, USGS and USCOE are concluded

- **NASA image of the almost-filled Matilija Reservoir, as it appeared in 2005**

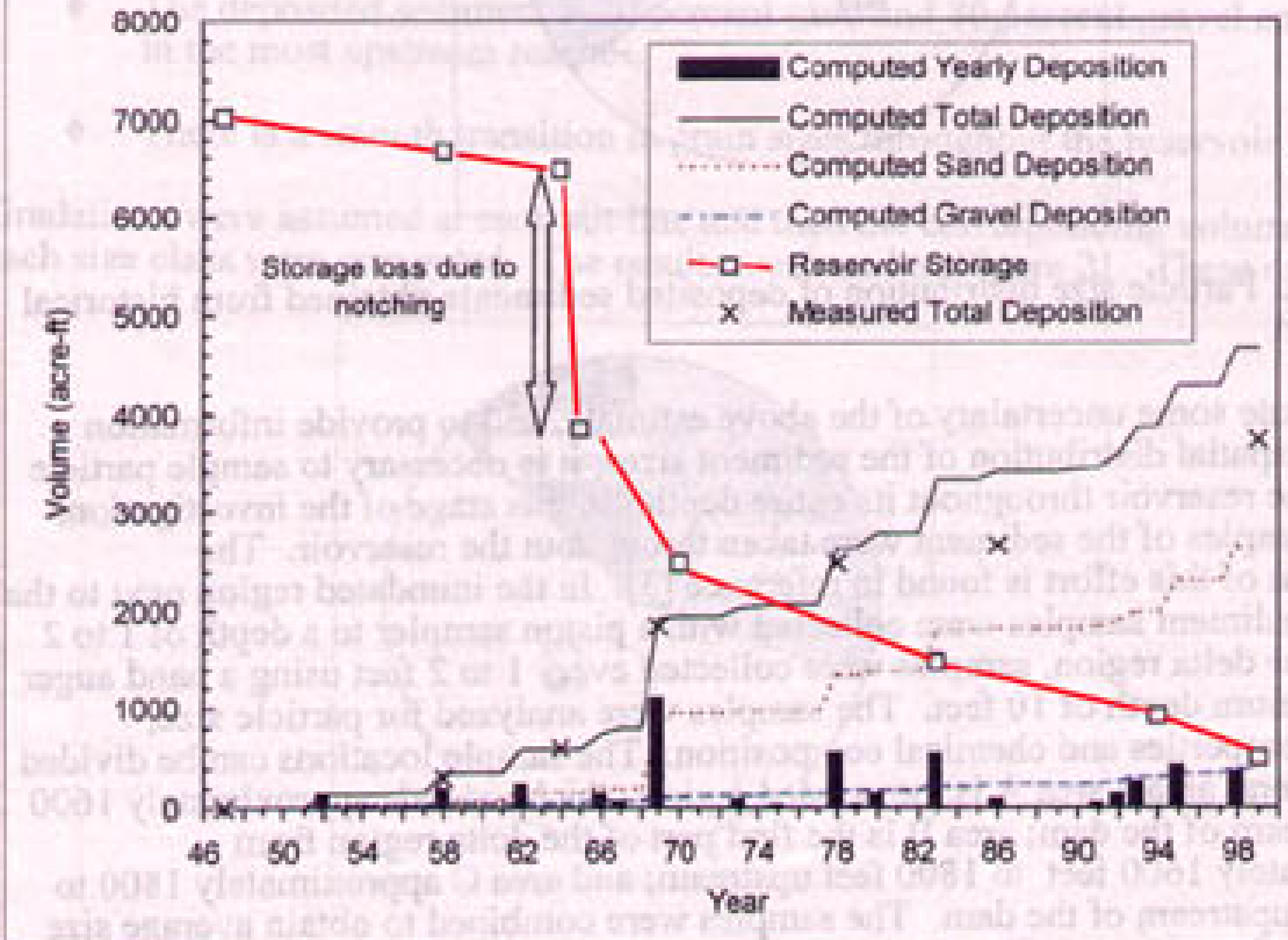


Figure 18. Simulation of reservoir deposition using sediment rating curve.

Understanding Sedimentation

- Sediment Trap Efficiency = qty deposited / qty sediment inflow.
  - Factors: fall velocity, reservoir size / shape, flow rate through reservoir.
- Sedimentation rates are difficult to estimate.
- Constructing a dam will usually increase sediment load upstream.
- Predictions for storage capacity that will be lost to sedimentation are often very optimistic!
- Smaller reservoirs usually lose storage capacity faster than larger reservoirs.

Methods Commonly Employed to Reclaim Storage Capacity

- Dredging
- Sediment flushing through sluice gates (under modest head)
- Low head sediment sluicing during low flows/low storage periods
- Mecahnical excavation and offsite storage, in embankments

Dredging

- Short-term, expensive
- U.S.A. Corps of Engineers in Western Pennsylvania
  - $2.3M to remove 1% of 14.8M yd3 from flood control dam.
- What to do with sediment?
  - Sell as aggregate
  - Example: 10M tons of coal from Safe Harbor Dam on Susquehanna River.

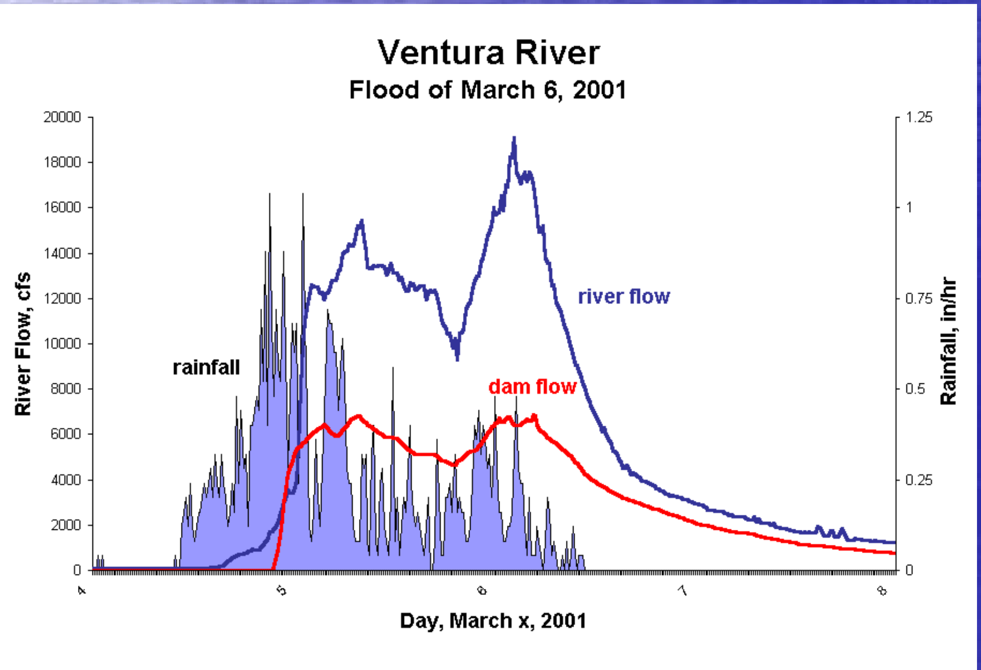
Sediment Flushing

- Flush sediment through outlet works.
- Factors:
  - low reservoir level (vary to promote slumping)
  - river-like conditions
  - shape of reservoir
  - timing/ balance of water and power demands
  - enough water to transport sediment
  - annual runoff large vs. reservoir size
  - sediment mobility
  - ability to fill dam after flushing?

Sediment Management in Los Angeles County

- Los Angeles County removes 25 to 50 million yds^3 of accumulated sediment each year, mostly from 93 detention basins in the Santa Monica and San Gabriel Mountains

No meaningful storage



- The dam spilled up to 6,000 cfs on March 6, 2001, shown here.
- The precipitation and flow hydrograph comparisons for this storm are presented at left.

Present Situation

- The dam has been under evaluation for the past decade and was slated for removal back in 2000, by the Corps of Engineers
- Some of the sediment is slated to be transferred to an **off-channel disposal site**, with the rest to be **stabilized in place**.
- The **$130 million price tag** has been a nagging problem in getting the project underway, and in November 2006 the Corps' budget rescinded dam removals for the time being in wake of the flood control infrastructure losses incurred by Hurricane Katrina.
- Nonetheless, Matilija Dam is a high priority for removal because it is unsafe, it no longer provide its intended water storage functions, and it blocks access to excellent spawning and rearing habitat for steelhead trout (*Oncorhynchus mykiss*), formerly abundant, but increasingly rare in the region.