



**San Francisco Public Utilities  
Commission**

# **Calaveras Dam Replacement Project**

## **Third Party Due-Diligence Review Investigations and Design of the Left Abutment**

**Presented By:**

**Steve Verigin**

**Senior Vice President, GEI Consultants**



# DUE-DILIGENCE REVIEW

## Issue

**Unforeseen geologic conditions (ancient landslides) were revealed during the excavation for the Left Abutment of Calaveras Dam that resulted in significant increases in the project construction cost and schedule.**



# DUE-DILIGENCE REVIEW

## Review Mission

To evaluate the Design Team's services with respect to site exploration and foundation characterization of the Left Abutment relative to standard practice in the industry for a major dam project in California.



# KEY QUESTIONS

- **Were geologic/geotechnical investigations planned and implemented prudently in accordance with standard practice in the industry?**
- **Were reasonable/sufficient geotechnical data obtained?**
- **Were data properly evaluated and in accordance with standard practice?**
- **Were analyses done properly?**
- **Was senior oversight and QA/QC performed on the data collection, geologic interpretation and analyses?**
- **Were conclusions and recommendations prudent and within standard practice in the industry?**



# GEI REVIEW TEAM

- **Project Manager: Alberto Pujol, PE, GE**
  - 34 Years Industry Experience
- **Senior Geologist: Jeffrey Brown, PG, CEG**
  - 33 Years Industry Experience
- **Senior Reviewer: Steve Verigin, PE, GE**
  - 35 Years Industry Experience (including Chief of the California Division of Safety of Dams and President of the Association of State Dam Safety Officials)



# SCOPE OF WORK

- **Site visit to view Left Abutment**
- **Review of agency guidelines, site geologic literature, and aerial photographs**
- **Review of rock samples from exploratory borings**
- **Review of relevant project documents including QA/QC policies and documentation**
- **Interview with Design Team members**



# APPROACH TO REVIEW

- Review focused on the Left Abutment
- Reviewed and assessed the Design Team's rationale through investigation and design of Left Abutment
- Conducted document review to gain an understanding of subsurface conditions as expressed on boring logs and in reports



# RESULTS OF REVIEW

- **Agency guidelines indicate that scope and methods of subsurface exploration should vary with the nature and complexity of the site geology, and dam size and importance**
- **For the CDRP an extensive amount of subsurface data was generated:**
  - **77 exploratory borings**
  - **Over 10,300 linear feet of exploratory borings**
- **Pre-construction exploration program was consistent with agency guidelines for design of major dams in California**





# RESULTS OF REVIEW

## Rock Core Review

- Rock samples reviewed to evaluate appropriateness and consistency of core descriptions in logs
- Descriptions on logs found to be representative of rock core viewed
- Log detail found to be consistent with that typically produced by experienced field personnel on significant projects



# RESULTS OF REVIEW

## Engineering Documents

- Design Team was methodical and thorough in efforts to characterize subsurface materials
- Design Team's interpretation of the subsurface conditions was consistent with assembled data
- Strength parameters and methods of Left Abutment slope stability analysis were reasonable and appropriate



# ASSEMBLED DATA - SURFACE

- **Site was known and altered by prior work**
- **Lack of previously-mapped landslides**
- **Rock slope appeared stable at steep angle**
- **Surface outcrops appeared to be in place rock (did not display the chaotic appearance typical of landslide mass)**
- **Bedding orientations appeared consistent**
  - **Summary: No surface indications of landslide**



# ASSEMBLED DATA - SUBSURFACE

- Rock pieces in core samples fit back together rather than being disjointed
- Absence of weak claystone or shale layers
- Basal slide surface was not identified
- Deep weathering reasonably attributed to disturbance caused by faulting, folding and shaking
  - Summary: No compelling subsurface evidence in support of landslide



# INTERPRETATION OF LEFT ABUTMENT CONDITIONS

**Rock mass in Left Abutment was:**

- **Interpreted to be a fractured and highly weathered, but intact, rock mass**
- **Characterized as retaining its internal structure**



# RESULTS OF REVIEW

## Quality Assurance/Quality Control

- QA/QC documents dictate comprehensive quality control of field data, analyses and reporting
- Design Team adhered to the provisions of their QA/QC policies
- QA/QC provisions match industry standards



# RESPONSE TO QUESTIONS

Questions	Answers
1. Investigations planned/implemented prudently?	Yes
2. Reasonable/sufficient geotechnical data obtained?	Yes
3. Data properly evaluated in accordance with standard practice?	Yes
4. Analysis done properly?	Yes
5. Senior oversight and QA/QC performed?	Yes
6. Conclusion and recommendations prudent and within standard practice?	Yes



# RESPONSE TO QUESTIONS

- 1) Were geologic/geotechnical investigations planned and implemented prudently and in accordance with standard practice in the industry?  
***YES – Despite access and schedule challenges, Design Team developed reasonable workarounds and conducted explorations without compromising their field data objectives.***





# RESPONSE TO QUESTIONS

2) Were reasonable/sufficient geotechnical data obtained?

***YES – Design Team’s investigation used common methods of data recovery that are standard for this type of project and prevailing ground and topographic conditions. Number and depth of explorations were appropriate for a major dam project.***



# RESPONSE TO QUESTIONS

3) Were data properly evaluated and in accordance with standard practice?

***YES – Design Team appeared thorough in review and evaluation of available data to form the basis for their site characterization. Their “no-landslide” interpretation for the Left Abutment was consistent with a comprehensive body of geologic and geotechnical data.***



# RESPONSE TO QUESTIONS

4) Were analyses done properly?

***YES – Based on Design Team’s interpretations of site conditions, their analyses and design of the Left Abutment used procedures that are broadly accepted by the dam design community.***



# RESPONSE TO QUESTIONS

5) Was proper senior oversight and QA/QC performed on the data collection, geologic interpretation and analyses?

*YES – QA/QC policies were detailed in project work plans and QA/QC documentation was provided for GEI’s review. A rigorous and comprehensive peer review process was in-place throughout the Design Team’s investigation.*



# RESPONSE TO QUESTIONS

6) Were conclusions and recommendations prudent and within standard practice in the industry?

***YES – Considering the Design Team’s interpretations of subsurface conditions in the Left Abutment, their design of the Left Abutment and methods for foundation preparation appear appropriate, prudent and within standard practice in the industry.***



# REVIEW CONCLUSIONS

- **The subsurface characterization of the Left Abutment was very difficult given:**
  - the complex and disturbed geologic conditions resulting from faulting, folding and seismic activity on an adjacent active fault
  - the disturbance from past dam construction
  - limited access for exploration equipment
- **Design Team's work conformed to standard practice in the industry for major dams in California**



# QUESTIONS