Rehabilitating a Historic Dam with Seepage Issues over a Complex Geologic Foundation

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Introduction

➢ Case History – Rehabilitation of 107 year old embankment dam
➢ Historical evaluations
➢ Site Geology
➢ Recent Dam Safety Actions
➢ Design
➢ Construction
Site Location

COLORADO

FAIRPLAY

HARTSEL

CHEESMAN RESERVOIR

ANTERO DAM PROJECT LOCATION
Site History

- Constructed between 1908-1909
- 45 feet tall – 4,200 ft long
- Hydraulic fill core, shells placed with horse carts
- No cutoff
- Designed to store 80,000 AC-FT – restricted to 20,000
- Pool of record 1912, 25 feet of water – “The toe of dam came alive”
Since 1950s, various restrictions between gage height 16 to 18.5 feet

1984 Spillway lowered and stability berm added
  - Soft berm foundation – gravel encapsulated in filter fabric

Gage 18 current SEO restricted pool
  - Denver Water self restricted gage 16
Geologic Setting

- Complex sedimentary and volcanic
  - Intensely weathered and fractured
- Fine grained embankment
- Alluvial material below entire embankment
Antero Formation

- **Volcanic**
  - Ash Fall
  - Ash Flow
  - Lahar

- Incorporates other rock materials (BIM Rock)

- **Matrix low density**

- Could be easily mistaken for sedimentary units
  - Claystone
  - Appearance of cemented sands
  - Sandstone
Site Conditions 2011
Recent Dam Safety action (2009-present)

- Comprehensive review of existing data
- PFMA/QRA
  - Internal erosion through alluvium and shallow bedrock (volcanic)
- Multiphase multi-season construction schedule
General Design Concept
Phase I

- B-P supported Trench
- Excavated two feet into sedimentary, five feet into volcanic
- Backfilled with ASTM C33 fine aggregate
Phase I
Phase I - Issues

- Increase of Phreatic surface
- B-P slurry not degrading
- Filter material too fine grained for adequate slurry flow
- Added hyperchlorite
- Filter sand less permeable than foundation
Phase II – General Concept
Phase II - Issues

- Fat clay within toe drain excavation
  - Unable to adequately dewater
  - Cracks develop adjacent to shored excavation
  - Excavated and backfilled with filter sand
Phase II – Toe Drain
Phase II – Blanket Drain
Phase II – Chimney Drain and Earth Fill
Phase II – Finished Product
Phase III – General Concept
Phase III – Barrier Wall Excavation
Phase III – Barrier Wall Excavation
Phase III – Barrier Wall Excavation
Phase III – Backfill Mixing
Phase III – Backfill Placement
Phase III - Finished
Dam Safety improved
- Preliminary seepage reduction greater than anticipated – gage 15
- Expect the unexpected
- All phases of construction under budget
- Total construction cost about 10,186,000
Any Questions
Historical Borrow Excavation
Antero Investigations 1964-1997

LEFT SIDE OF DAM

BOREHOLE 1964

RIGHT SIDE OF DAM