The Role of Geology in the Construction of the Lake Dorothy Hydroelectric Project

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REGIONAL CHARACTERIZATION OF BEDROCK

- Landforms Shaped by Pleistocene Glaciation
- Ice Carved Valleys, Often With Deep Lakes
- Rock Generally Hard and Competent
Predominant Bedrock at Project

Composite of:
- Granodiorite,
- Quartz Diorite (tonalite)
- and related plutonic (deep intrusive) Bedrock Types
- Strong Gneissic Characteristics

Characterized as:
- Very Strong
- Competent
- Metamorphosed
- Wavy
- Alternating Dark & Light Bands
Lake Dorothy Project Data

- **Capacity**: 14.3 MW
- **Average annual energy**: 75 GW hours
- **Cost**: $70 million
- **Lake Dorothy elevation**: 2,423’
- **Lake Dorothy tap**: 143’ below surface
  - **Tunnel**: 900’ long
  - **Outlet pipe**: 48” diameter
- **Bart Lake elevation**: 1,009’
- **Bart Lake dam**: 34’ high
- **Penstock length**: 8,249’
  - **Diameter**: 60”
- **Powerhouse**: 50’ x 60’ x 50’
- **Transmission line**: 3.5 miles at 138 kV

Permission began August 1995.
Construction began May 2006.
Access by Water
Powerhouse Site
Upper sites by Helicopter
Construct 8,000 ft. of Access Road to Reach Bart Lake
Road to Bart Lake
Top Slope Slides Became a Growing Problem
Abandon Higher Heading and Drop Alignment
Begin Second Heading
From Bart Lake

rrial view of the roadway from about Station 98 to about Station 106. 10/20/2007
Completed Road
The Cat 375 worked to clear a talus slide above the road in the area of Station 84. 5/16/2008
Bart Lake Dam

- 36-foot-high rockfill structure with an impervious core
- No site exploration
- Basis of Design: Visual observations that when lake level drops to elevation 985 ft, no outflow is seen from the lake.
- Therefore; Bedrock is “just below the debris pile”
The debris dam at Bart Lake, 9/17/2007
Steeply Dipping Side Walls

Bart Lake
Site Inaccessible

Landing Pad
Field Survey of Bart Lake Dam Site 10/13/2007
No Bedrock Found
Near Vertical Rock Face

Talus Slope

Material

End of 2007 Construction Session
Dashed line indicates proposed dam axis
Bedrock much deeper than expected – change design
An aerial view of the near vertical rock along the right abutment.
First attempt to drill for bedrock

4/26/2008
Rockfill Dam Designs

- Concrete Core Wall
- Sheetpile Wall with Concrete Plinth
- Asphalt Core Wall
- Upstream Asphalt Face
- Upstream Concrete Face
- Concrete Face with Upstream Bituminous Geo-Membrane Seepage Blanket
Two 24-Diameter Low Level Outlet Pipes Encased in Concrete
Toe Plinth

Low Level Outlet Works

Dewatering Pipes
Arrive on Site May 12, 2009 – Surprise!
Overlay Geo-Membrane with 18-in of 3/4-minus material
Mats overlapped 18 inches

Propane torch
Construction of concrete face panels
Grouted Riprap on downstream face
Time to start filling Bart Lake
Reservoir Elevation 985 feet
Elevation 995 Ft.
Elevation 1000 ft
8/19/2009
3.8 cfs
6.4 cfs

10-2-2009 at 1008.6'
Dye tests were inclusive
Diver inspection looking for signs of leakage in reservoir.  8/29/2009
Drilling left abutment for seepage joints

5.2 cfs
Owner Directed to Develop Seepage Remediation Plan
2010 Upstream Blanket Extension
Installation of Bentomat Membrane almost complete

And Fill Reservoir
No Change in Seepage

6.9 cfs

7-30-2010 at 1008.2'
After Another Year of Operation

- Seepage remains constant at given elevation
- Very little turbidity seen on monitoring pans
- Keep 5-foot drawdown (Elev. 1004)
- Real time readings for the 5 piezometers
- Check daily (weather permitting)
Geologic Issues

- Rapidly changing rock quality made blasting very difficult
- Dip of bedrock resulted in slope stability problems
- Foundation conditions at Bart Lake resulted seven different dam designs
- Added two years to construction
At the Beginning of Each Project
The Question is Often Asked:

How much exploration is enough?

Does the benefit of the exploration out weigh the cost and the potential delay of the project?
We grow too soon old,
and too late smart