The Final Phase of San Clemente Dam – Removal and Stream Restoration

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Outline

- Project Location and History
- Project Overview
- Geology
- Final Design Elements
- Final Construction Phases
- Dam Removal(s)
- Instrumentation and Monitoring
- Questions
Project Location

[Map of California highlighting project location]
History of San Clemente Dam

- Constructed between 1920 & 1921 by PIC
- Owned and operated by California American Water
- Built for drinking water storage for Monterey Peninsula
- Fish ladder added later
History of San Clemente Dam

- Built in V-notch canyon below confluence of San Clemente Creek and Carmel River
- Concrete arch dam
  - 106 feet high
  - 300 foot width
  - 1425 acre-feet – now 70 acre-feet
  - Over 2.5 million cubic yards of sediment
Project Overview
Project Overview

- 1990’s CDWR – DSOD issued safety order
- Potential failure during MCE (7.0M Tularcitos fault) or PMF
- 2006 released a draft EIS
- EIR Alternatives:
  - Dam Strengthening ($50M)
  - Dam Removal
- 2008 CAW – preferred removal of the dam. Benefits: fish access, sediment replenishment, removal of hazard
- Previous investigations by URS, MWH, Woodward-Clyde and Kleinfelder
  - URS provided an indicative design
Project Overview – Key Stakeholders

- $83M cost
- Funding: California American Water
- California Department of Fish & Wildlife
- California Natural Resources Agency
- California Wildlife Conservation Board
- California State Coastal Conservancy
- National Marine Fisheries Service – NOAA
- Resources Legacy Fund
- The Nature Conservancy
- United States Fish & Wildlife Service
Project Overview – Project Team/Schedule

- **Granite Construction** – General Contractor
- **Kleinfelder** – Engineer of Record (EOR) and lead Civil/Geotechnical designer
- **Tetra Tech** – H/H modeler, Channel Restoration design
- **Rana Creek, Habitat Restoration Oversight**
- **AECOM** – Owners Engineer
- **WSC** – Construction Mgr.

**2013 Season:**
Geotechnical Investigation, initial diversion structures, overall design

**2014 Season:**
Reroute Cut, Diversion Dike, Sediment Stockpile, design/construct

**2015 Season:**
Stabilized Sediment Slope, dam removal, CFR channel design/construct
Regional Geology

Jennings 2010
2015 Final Design Elements

Combined Flow Reach

Upper Carmel River Reach

Habitat Restoration

Dam Demo Plan

Stabilized Sediment Slope
Diversion Dike (DD) Design
Stabilized Sediment Slope (SSS) Design
Combined Flow Reach (CFR) Design
CFR Design – Step Pool Plan
CFR Design - Step Pool Elevation
2015 Final Construction Elements

- Construct Combined Flow Reach
- Restore San Clemente Creek
- Reroute Rock Sill
- Grade Upper Carmel River Reach
- Complete Stabilized Sediment Slope
- Top off Sediment Stockpile
- Remove Dam and Slide Debris
- Remove Diversion Pipe and Cutoff
- Final Reservoir Drain
Construction – Christmas Slide/pipe repair

Dec. 2014 landslide; Mar. 2015 debris removal and pipe repair

June 2015 right abutment and diversion pipe
Construction – Reservoir Dewatering
Construction - Diversion Dike (DD)

October 2014 view NE

October 2015 view SW
Construction – Reroute Channel Rock Sill
Construction – Reroute Channel Rock Sill
Construction – SSS foundation mapping

Toe of SSS

Transition beneath SSS
Construction – Geologic Strip Mapping
Potential for catastrophic landsliding and stream blockage
Evaluation – Catastrophic Landslide Risk

Geologic Map of Combined Flow Reach.

Section 2
Evaluation – Catastrophic Landslide Risk

- Failure of CFR valley ways leading to stream blockage due to runout.

- Evaluation Methodology:
  - Inputs:
    - Geologic data (borehole, strip mapping, GSI, RMR)
    - Scour Analysis (1000 flood event WSE, Erodibility Index K)
    - Slope Stability ($K_h = 0.2$ (1/2 of pga))
Evaluation – Catastrophic Landslide Risk

Geomechanical Model, Section 2

Pseudostatic Analysis, Section 2
(De) construction – dam removal

Upstream Ramp and use Pneumatic hammer

Recycle rebar, bury concrete in SSS

Sigh.....No Explosives
(De) construction – DSOD Concerns

Left Abutment Rockfall

Right Abutment Stability
Boulders for CFR Pools - Material Testing

“Drop Test” at various quarries to measure durability. Eventually used mostly concretions from two quarries in Livermore valley.
Construction – CFR pool construction

Step Pool sequence

Field Supervision
Instrumentation installation and monitoring

- Slope inclinometers (SI) along former reservoir rim and top of engineered embankments
- Time Domain Reflectometers (TDR):
  - Deformation at depth
  - No magnitude
- Reflective Survey Monuments:
  - All over slope
  - Measured biannually
- Vibrating Wire Piezometers
- Instrumentation data collection
Instrumentation installation and monitoring

TDR for Reroute, Left Slope  
Slope Inclinometer for SSS
Removal of 1883 Old Carmel River Dam
Sleepy Hollow Ford Bridge Construction
Path Forward – 5 year monitoring period

- Slope stability and erosion reconnaissance
- Instrumentation measurements (Slope Inclinometer, VWP, TDR and surface settlement markers)
- Additional monitoring via Triggering Events
  - 4.0M EQ w/in 50 miles
  - 10yr flood event (>3,600 cfs)
- Habitat die-off/ replacement
- Win-win for everyone
  - Dam removal for safety
  - Restore ecological balance
- Turnover to BLM
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QUESTIONS?