

Oroville Spillway Incident

Bill Croyle
Retired Acting Director
California Department of Water Resources



State Water Project Overview



- Largest state owned & operated water delivery system in the U.S.
- Serves 25 million Californians
- 750,000 acres of farmland
- 32 Storage Facilities
- 21 Pumping Plants
- 4 Pumping-generating Plants
- 8 Hydroelectric Plants
- 700 miles of Canals and Pipelines

Oroville Dam, Spillways and Diversion Pool



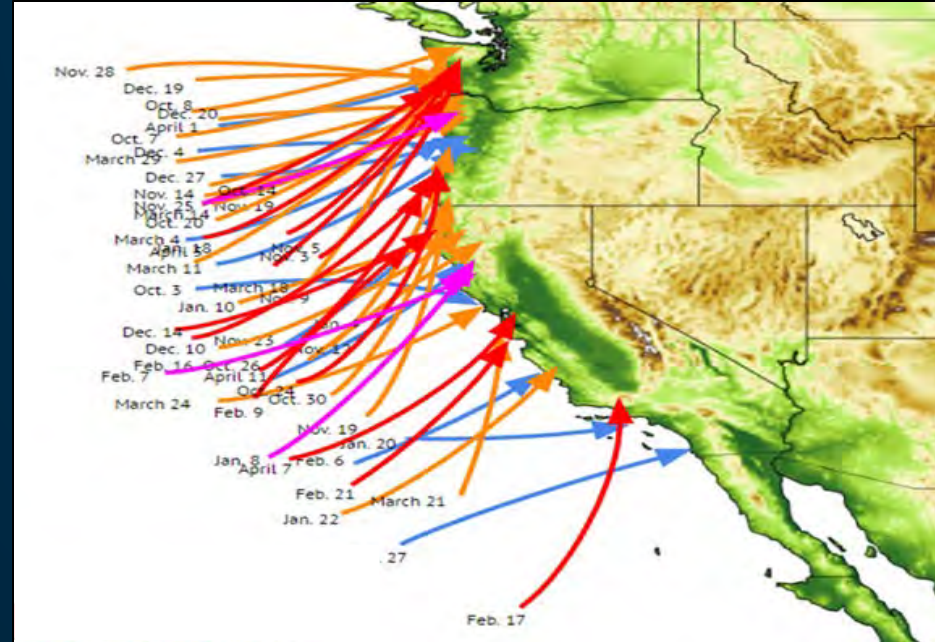
Atmospheric Rivers

*October 1, 2016 - April 12, 2017:
numerous atmospheric rivers hit
the West Coast.*

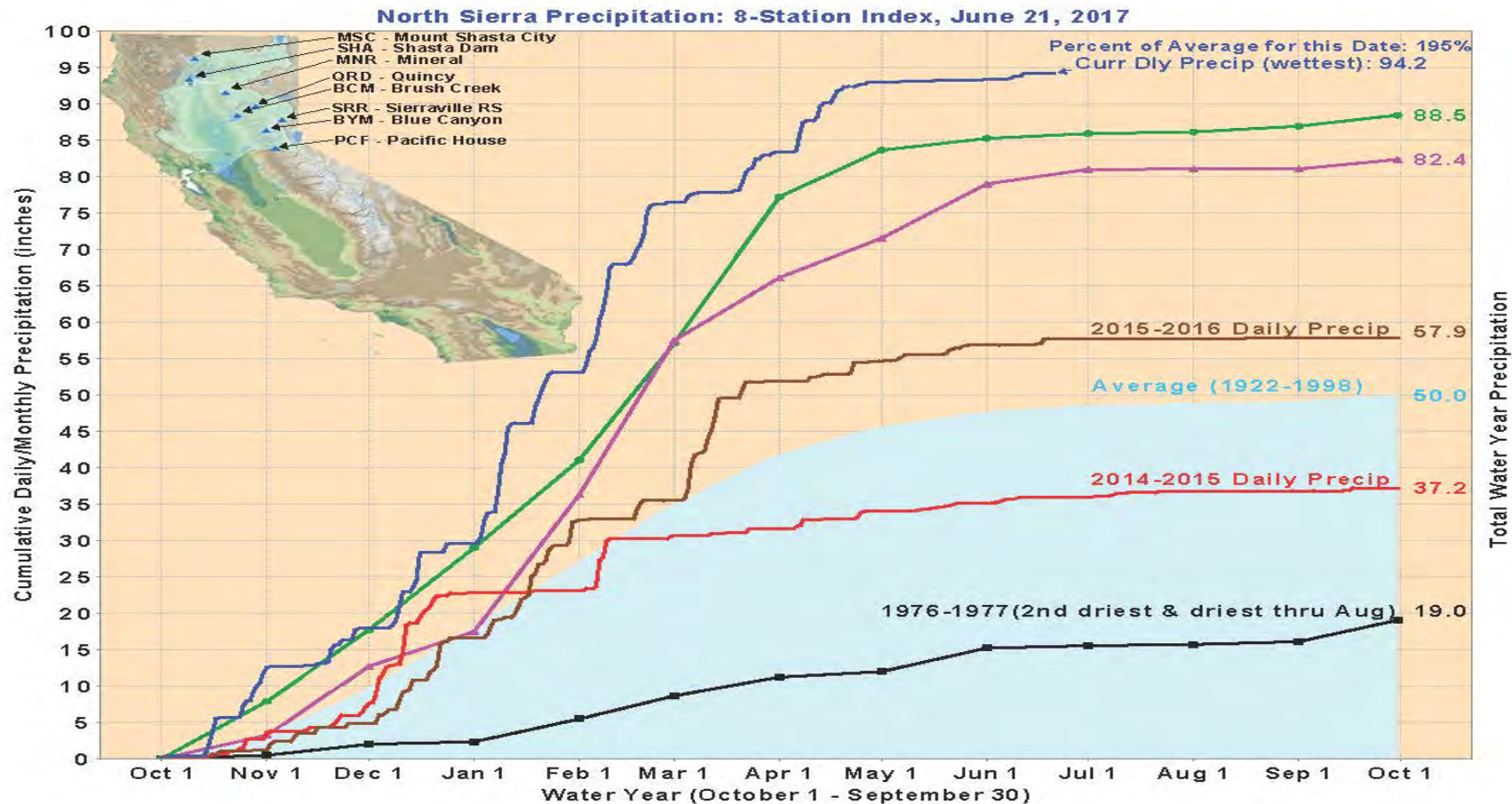
An unrelenting series of storms hit California in late 2016 and early 2017


Lake Oroville received an entire year's average runoff of 4.4 million acre feet of water in two months

More than 5 million acre feet of water was released from the lake from mid-January through the end of May




Wettest Year in Northern Sierra 8 Station Index History – 97 years



A wide-angle photograph of a large concrete dam. Water is flowing over the top of the dam, creating a white, frothy cascade. The dam is flanked by steep, forested hillsides. In the background, several tall electrical transmission towers are visible against a clear blue sky. The foreground shows the turbulent water at the base of the dam, with white foam and spray.


Monday
February 6th



Tuesday
February 7th

February 7

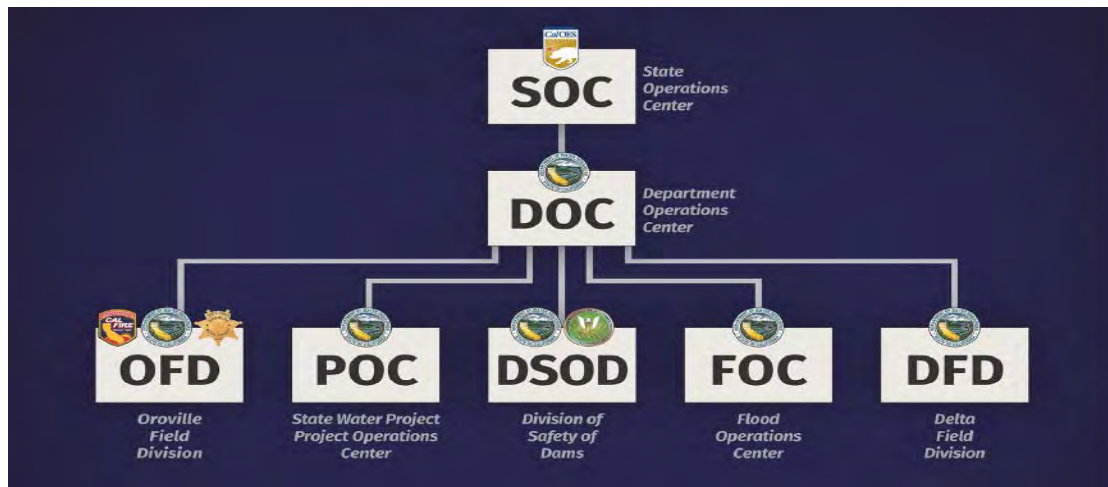
Deck and Foundation Erosion

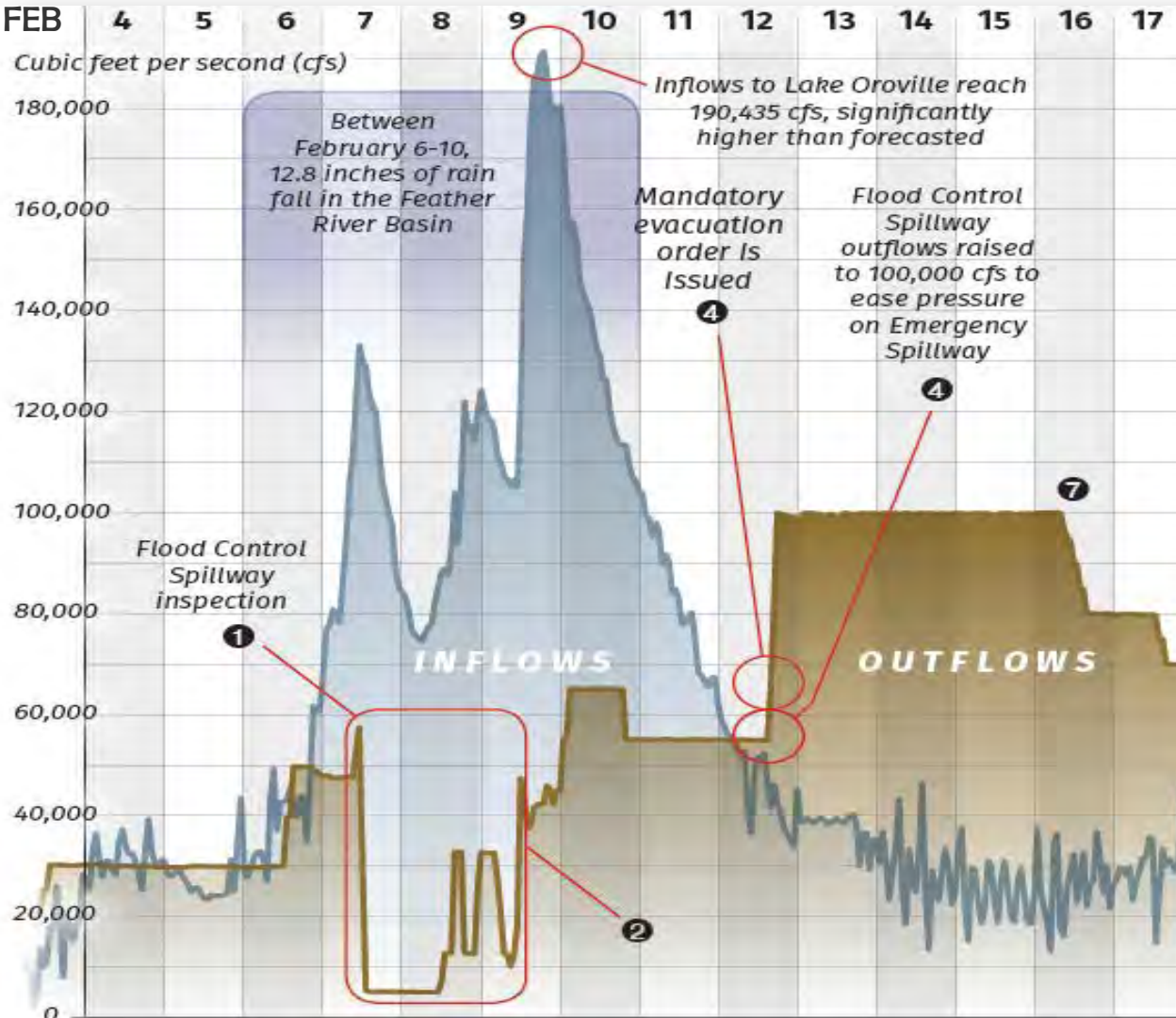


150 ft. Wide
450 ft. Long
30-45 ft. Deep



Incident Command





Forecasted Peak
Inflow: 140,000 cfs
Actual Peak: 190,000

3.5 million acre-feet
down broken spillway
in 42 days

Total of five Folsom
Lakes passed through
the spillway



February 11
Approximately 8:00 AM

**Flow Begins Over
Emergency Spillway**

**Water coming over both the
Emergency Spillway and the Flood Control Spillway morning
of February 12**





Sunday

February 12th

3:30 pm

- **Rate of Erosion
Began To Increase**
- **Moving Toward
the Emergency
S/W
at about
30 feet/hour**

Butte County Sheriff Kory Honea Ordered Evacuation February 12 Approximately 3:30 PM



Butte County Sheriff

February 12 · 🌐

This is an evacuation order.

Immediate evacuation from the low levels of Oroville and areas downstream is ordered.

A hazardous situation is developing with the Oroville Dam auxiliary spillway. Operation of the auxiliary spillway has lead to severe erosion that could lead to a failure of the structure. Failure of the auxiliary spillway structure will result in an uncontrolled release of flood waters from Lake Oroville.

In response to this developing situation, DWR is increasing water releases to 100,000 cubic feet per second.

Immediate evacuation from the low levels of Oroville and areas downstream is ordered.

This in NOT A Drill. This in NOT A Drill. This in NOT A Drill.

February 12

Approximately 4:00 PM

Flows increase to
100,000 cfs





February 14, 2017

Butte County Sheriff Kory L. Honea, Cal Fire incident commander Kevin Lawson and DWR Acting Director Bill Croyle announce that the immediate evacuation order has been reduced to an evacuation warning

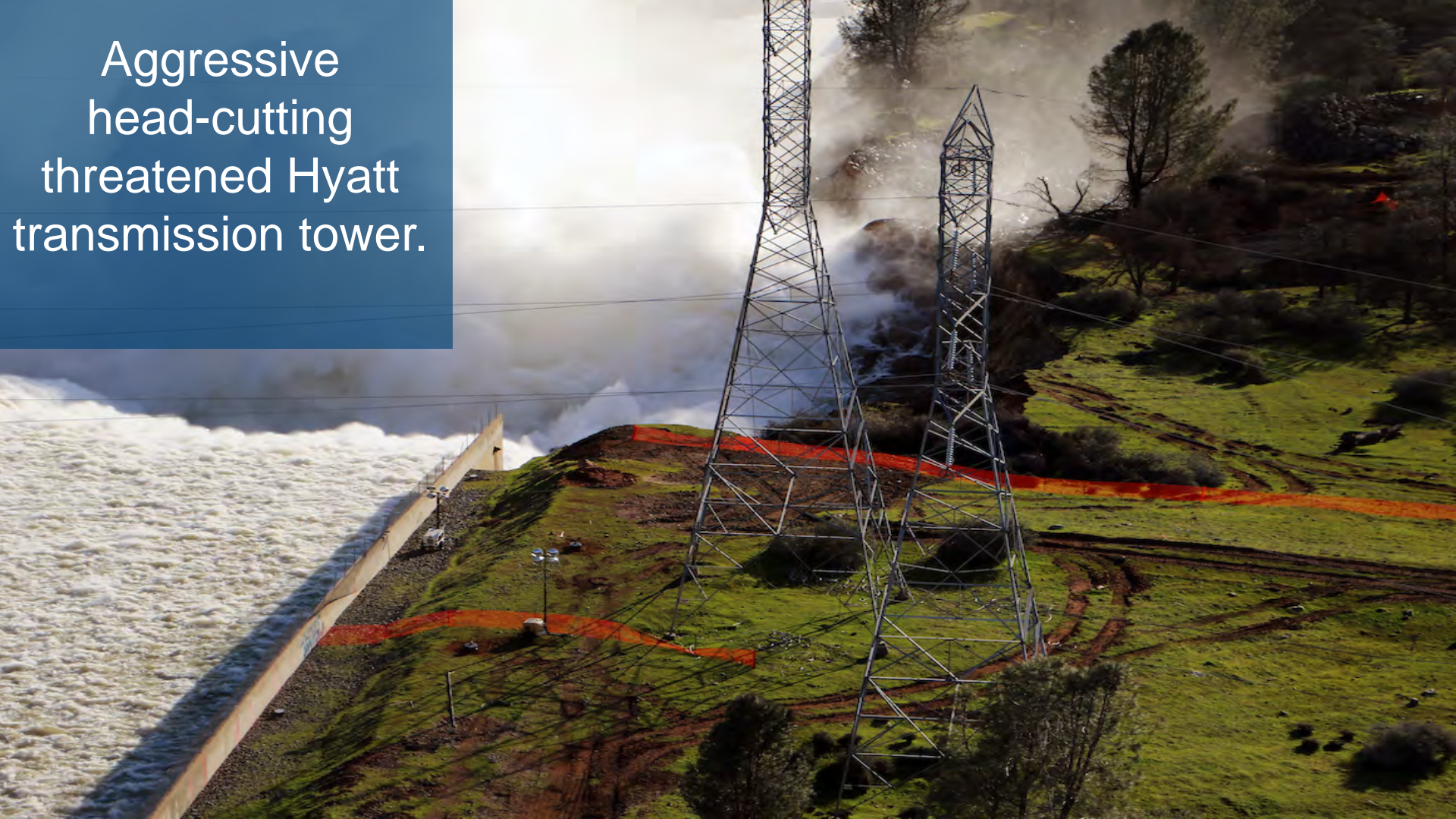
Flood Fighting at Hyatt Powerplant

Rock and concrete collected in the diversion pool, causing flood risk to Hyatt

Sandbagging, grouting, pumps, tanks, and other efforts by DWR staff and emergency response partners saved Hyatt



Aggressive
head-cutting
threatened Hyatt
transmission tower.



Monday,
February 27



Debris Dam – Diversion Pool on February 27, 2017



Over 1.9 million cubic
yards removed in
9 days
36 land and barge
based excavators
32 heavy haul trucks

Geologists begin their work



Operations ran 24/7
to get ready



State Partners

- Department of Parks & Recreation
- Department of Fish & Wildlife
- CAL FIRE
- California Conservation Corps.
- California Highway Patrol
- California National Guard
- Office of Emergency Services
- CalTrans

Local & Other Partners

- Butte County Sheriff, OES, PW
- City of Oroville, Police Dept., Fire Dept.
- Gridley-Biggs Police Department
- Oroville Hospital
- Bureau of Indian Affairs
- PG&E
- Red Cross
- Association of State Dam Safety Officials
- U.S. Society on Dams

Regulators & Oversight



Federal Energy Regulatory Commission

Dam operational license,
Inspections, input on
construction, regulator



CA Division of Safety of Dams

Operations, maintenance,
regulatory compliance,
inspections



Association of State Dam Safety Officials

Industry guidance, selection of
Independent Forensic Team



US Society on Dams

Industry guidance,
selection of Independent
Forensic Team



US Army Corps of Engineers

Response Assistance & Dam Flood Control Operations

Lake Oroville Spillways Emergency Recovery

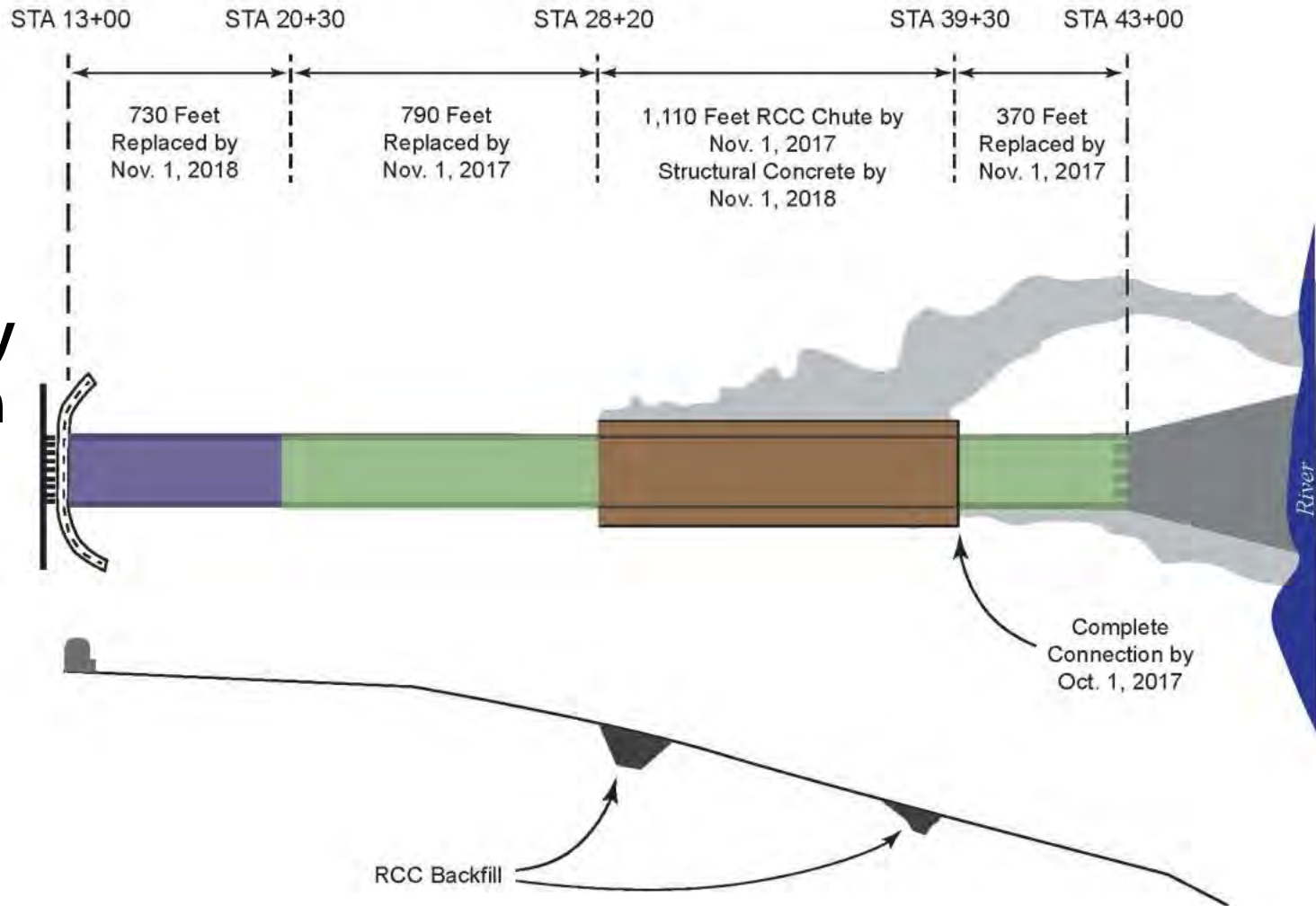
Objectives:

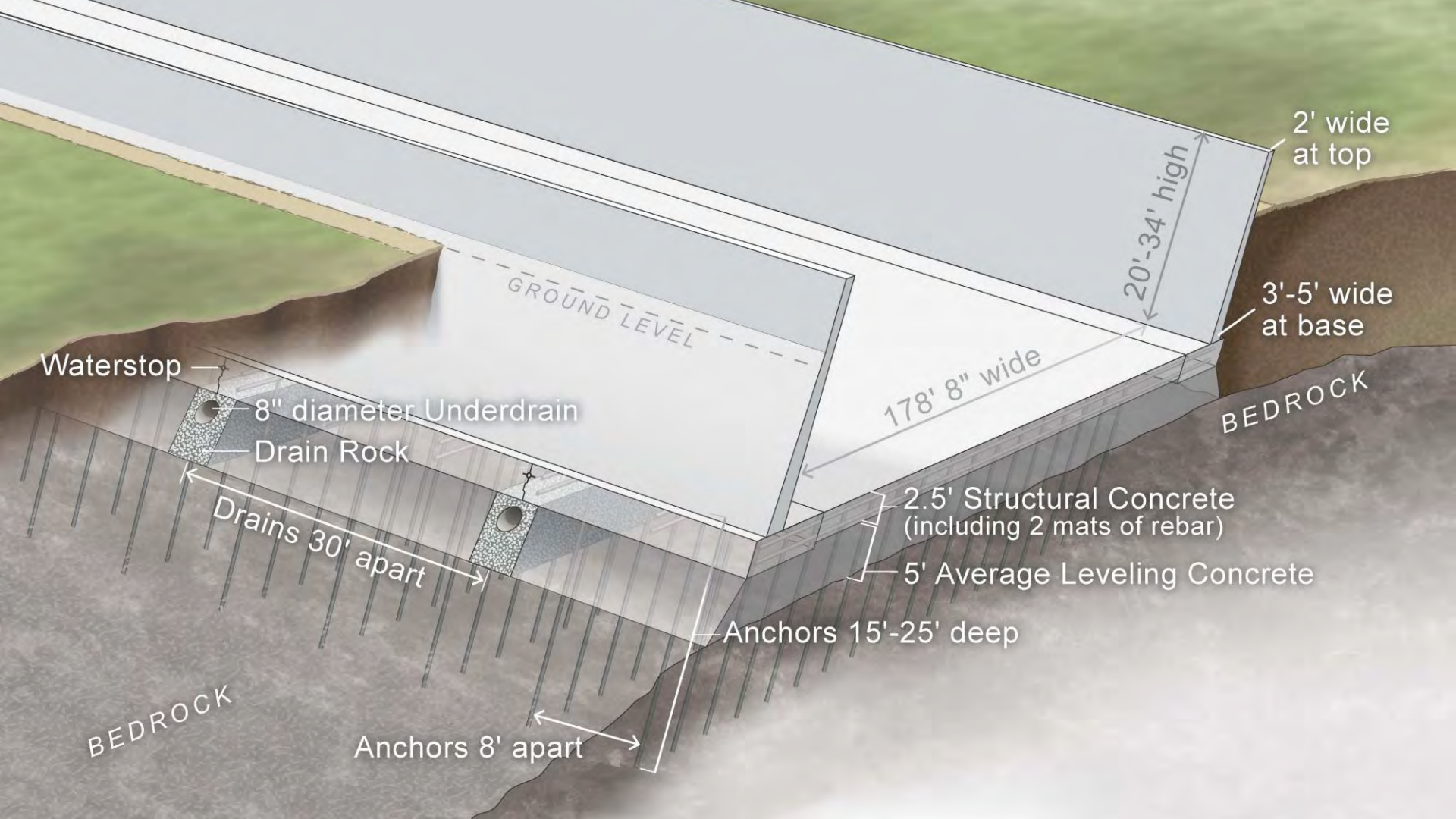
- Ensure public safety and the integrity of the Oroville Dam and associated facilities, which includes the main and emergency spillways.
- Ensure the main spillway can safely pass Feather River flood flows by November 1, 2017.
- Construct a cutoff wall to prevent uphill erosion should the emergency spillway ever need to be used again.

Key Design Milestones

- Advertised Spillways Contract – 3/31/17
 - 30% Plans and Specifications
- Awarded Spillways Contract – 4/20/17
- M.D. 6, Scour Hole Slope Stabilization – 5/9/17
- M.D. 11, 75% Plans & Specs. – 5/18/17
- M.D. 20, Final Plans & Specs. – 6/21/17
- M.D. 27, Revised Final Plans and Specs. – 7/20/17

FCO Spillway Construction Sequence





2' wide
at top

20'-34' high

3'-5' wide
at base

GROUND LEVEL

178' 8" wide

BEDROCK

Waterstop

8" diameter Underdrain

Drain Rock

Drains 30' apart

2.5' Structural Concrete
(including 2 mats of rebar)

5' Average Leveling Concrete

Anchors 15'-25' deep

BEDROCK

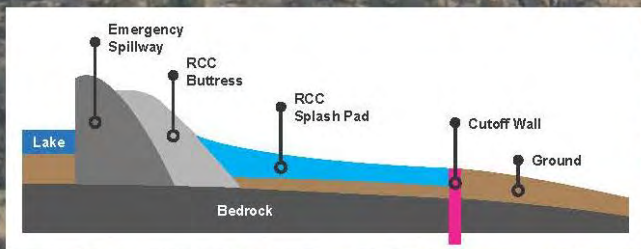
Anchors 8' apart

**Roller-Compacted
Concrete Splashpad**

**Roller-Compacted
Concrete Buttress**

**Emergency
Spillway**

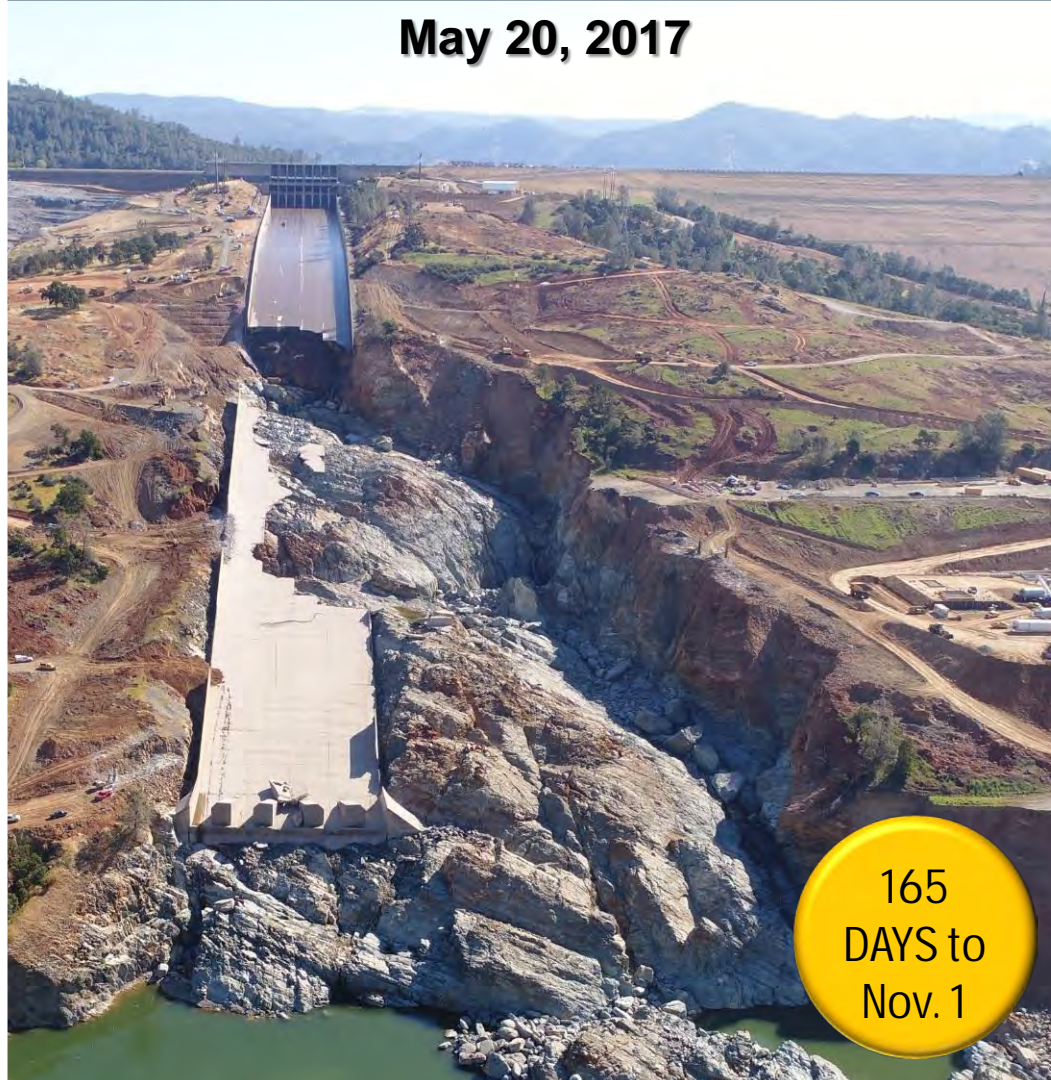
**Underground
Cut-off Wall
(Secant pile wall)
1,450 ft long
35 - 65 ft deep**



May 19, 2017



May 20, 2017



165
DAYS to
Nov. 1

Demolition



Excavation – Blasting





Blasting

1 to 2 times a
day for
weeks

Foundation Clean up



Foundation Cleanup





Leveling Concrete & Drains

55,000 feet of drain
pipes - stacked
vertically, would
stretch more than
10 miles high



Structural Concrete



Lower Chute



Main Spillway Upper Section

Structural rebar
panels

8,519,000
pounds of
reinforced steel





Main Spillway Middle Section

Building RCC
up to meet
structural
concrete

Main Spillway Middle Section

349,000 Cubic
Yards of
Roller Compacted
Concrete (RCC)

Every 5 minutes a dump
truck dropped off RCC
totaling more than 5,000
cubic yards a day





Main Spillway Lower Section

138,000 CY
Structural concrete

5.5 foot wide
sidewalk from
Sacramento to LA

Upper Chute – “The Peak”

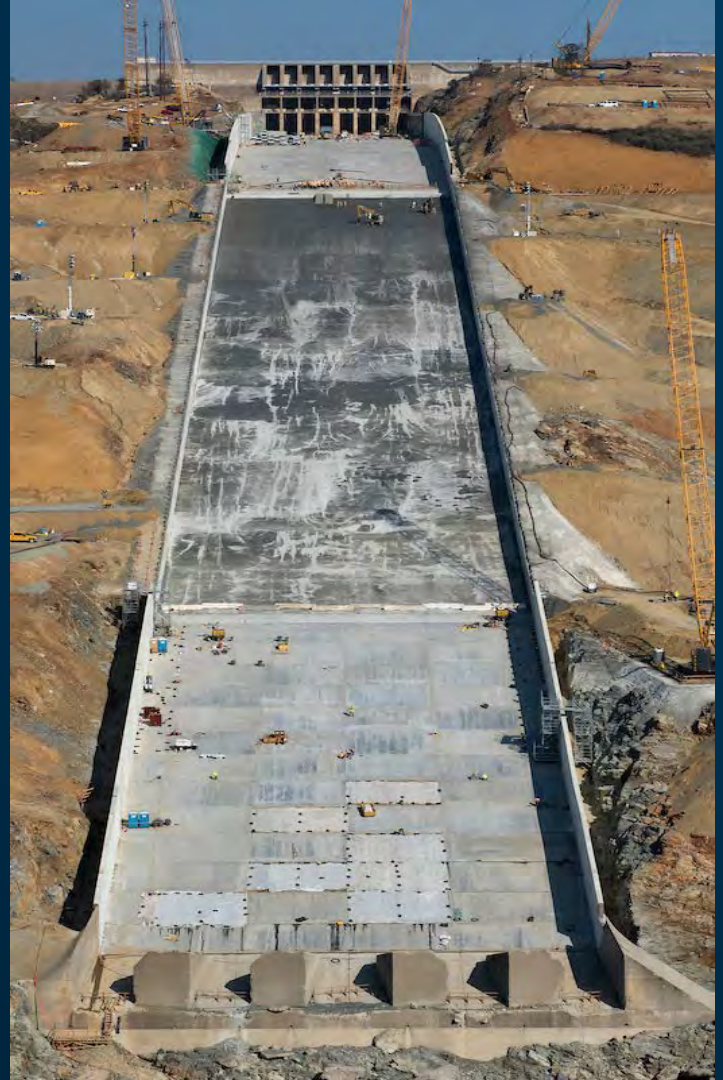


Spillways, Oroville Emergency Recovery



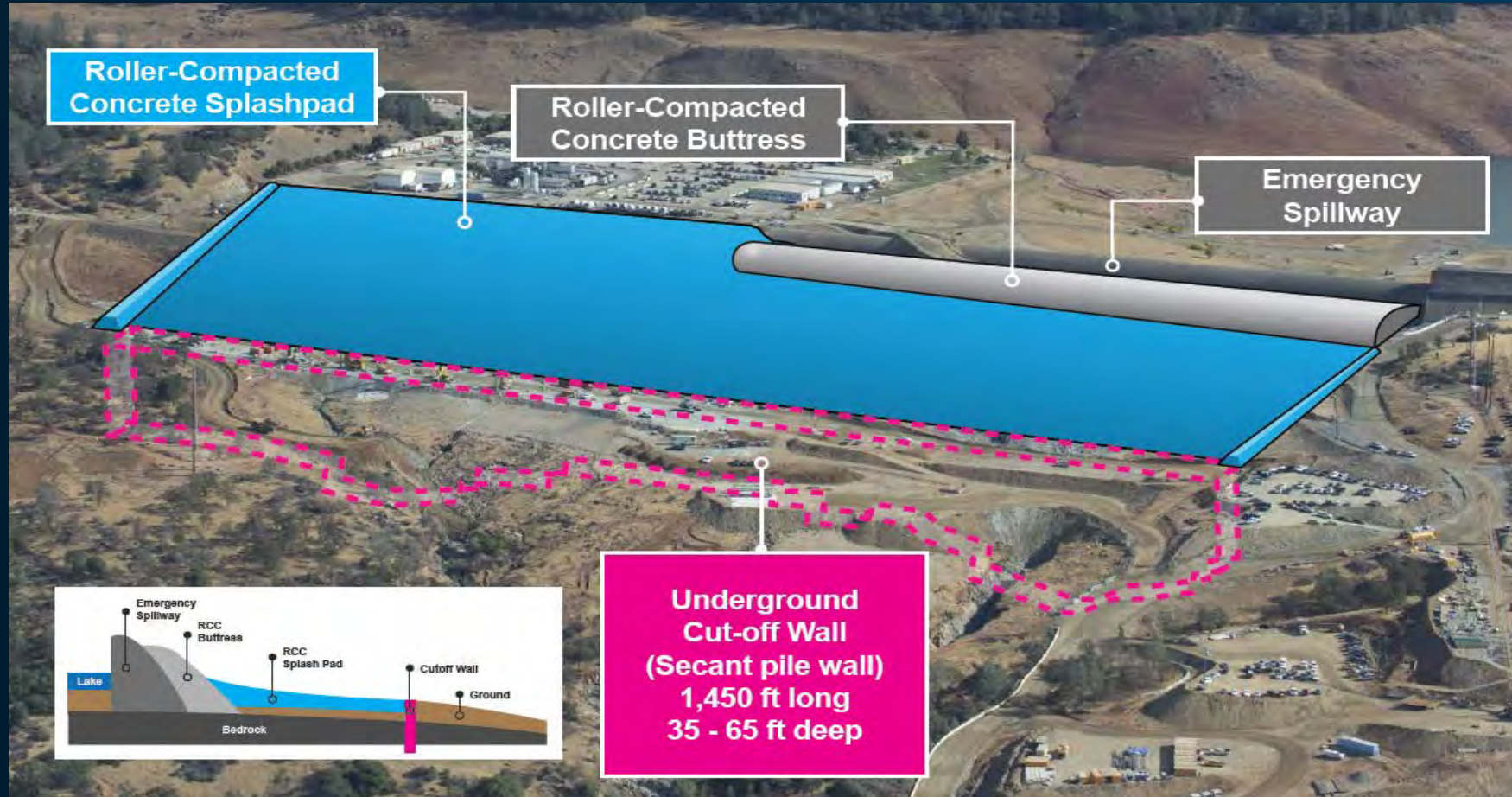
The November 1 milestone
was accomplished.

The main spillway can pass
100,000 cfs



Emergency Spillway

Buttress and Splashpad for additional integrity





Emergency Crest Cut-off Wall

Secant Pile Wall

January 3, 201



Emergency Spillway

Secant pile wall



Secant Pile Wall Working Pad and Guide Wall

Contractor's Leveling Pad design



This incident changed the critical infrastructure discussion?

- Public Safety
- Transparency
- Risks
- Collaboration
- Design and Service Life
- Time Schedules



US Army Corps
of Engineers®



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Thank You!