

Forecast Informed Reservoir Operations

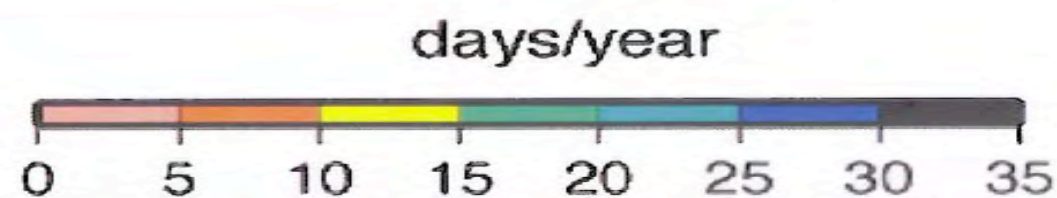
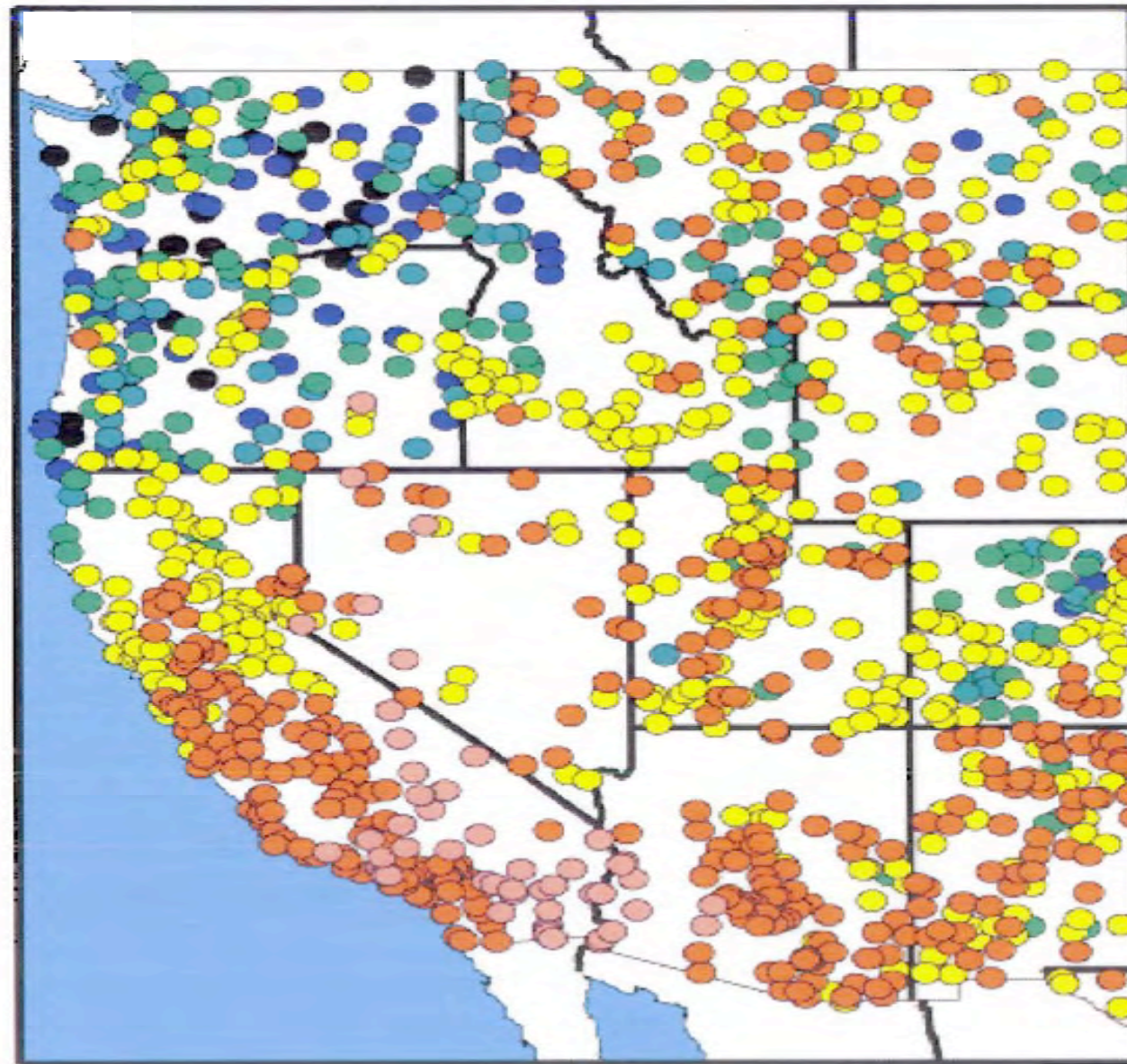
California Water Commission Briefing, May 19, 2021



John Leahigh, SWP Water Operations Executive Manager
Division of Operations & Maintenance

Storms and California Water Supply

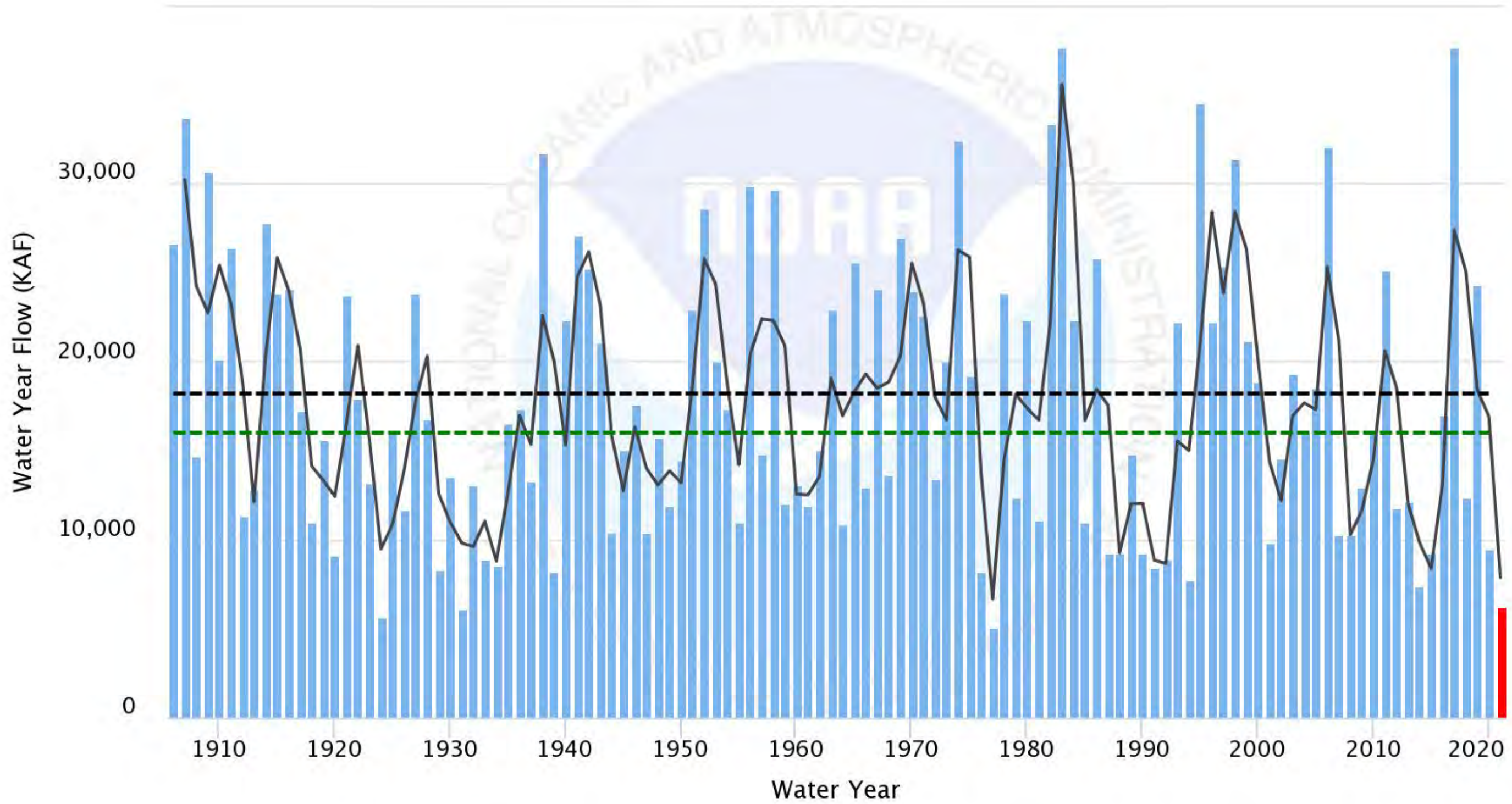
c) AVERAGE NUMBER OF DAYS/YR TO OBTAIN HALF OF TOTAL PRECIPITATION, WY 1951-2008



Just a few storms each year are the core of California's water supplies

Dettinger et al, 2011

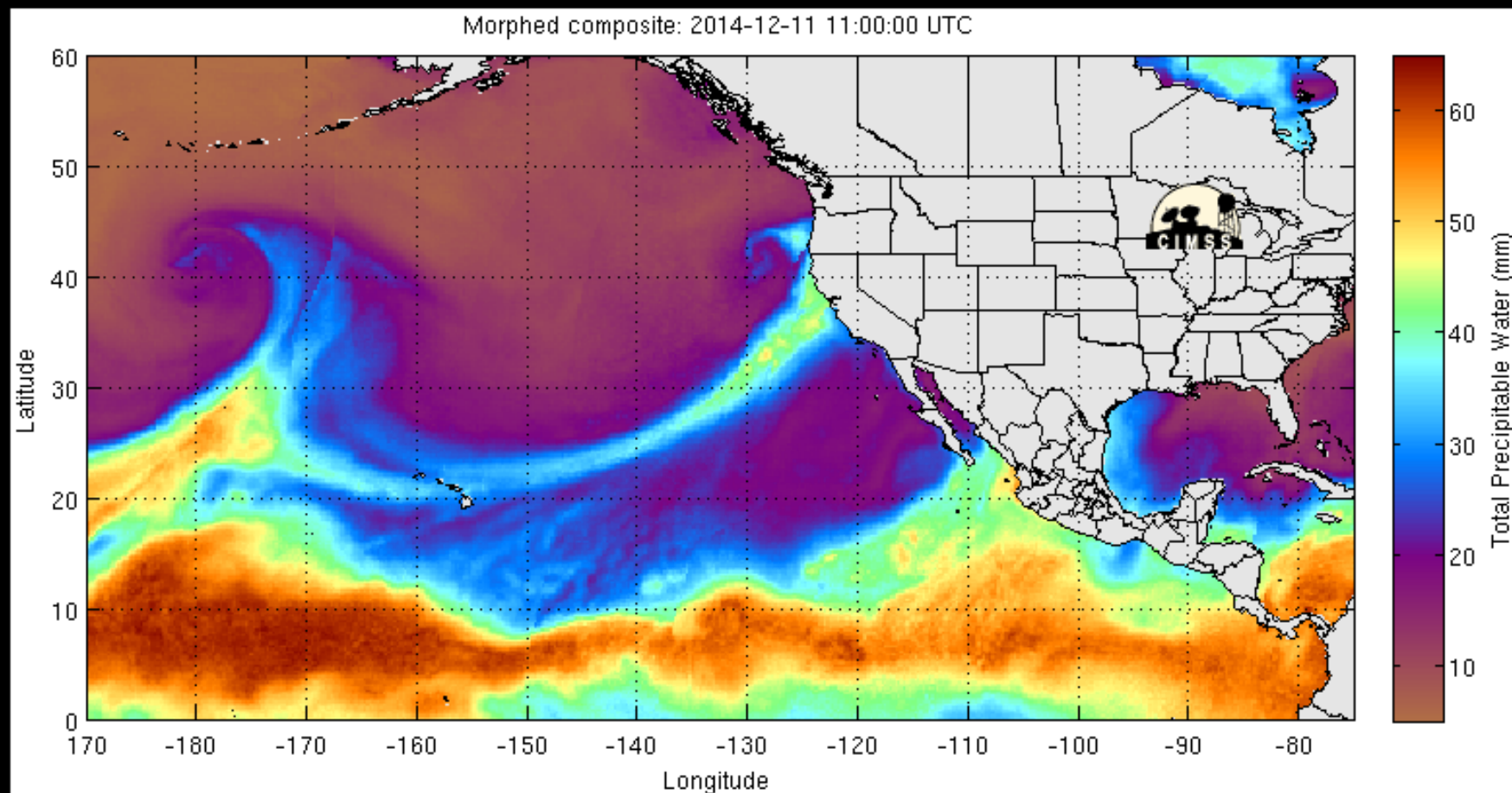
Water Year Historical Flow for SACC0



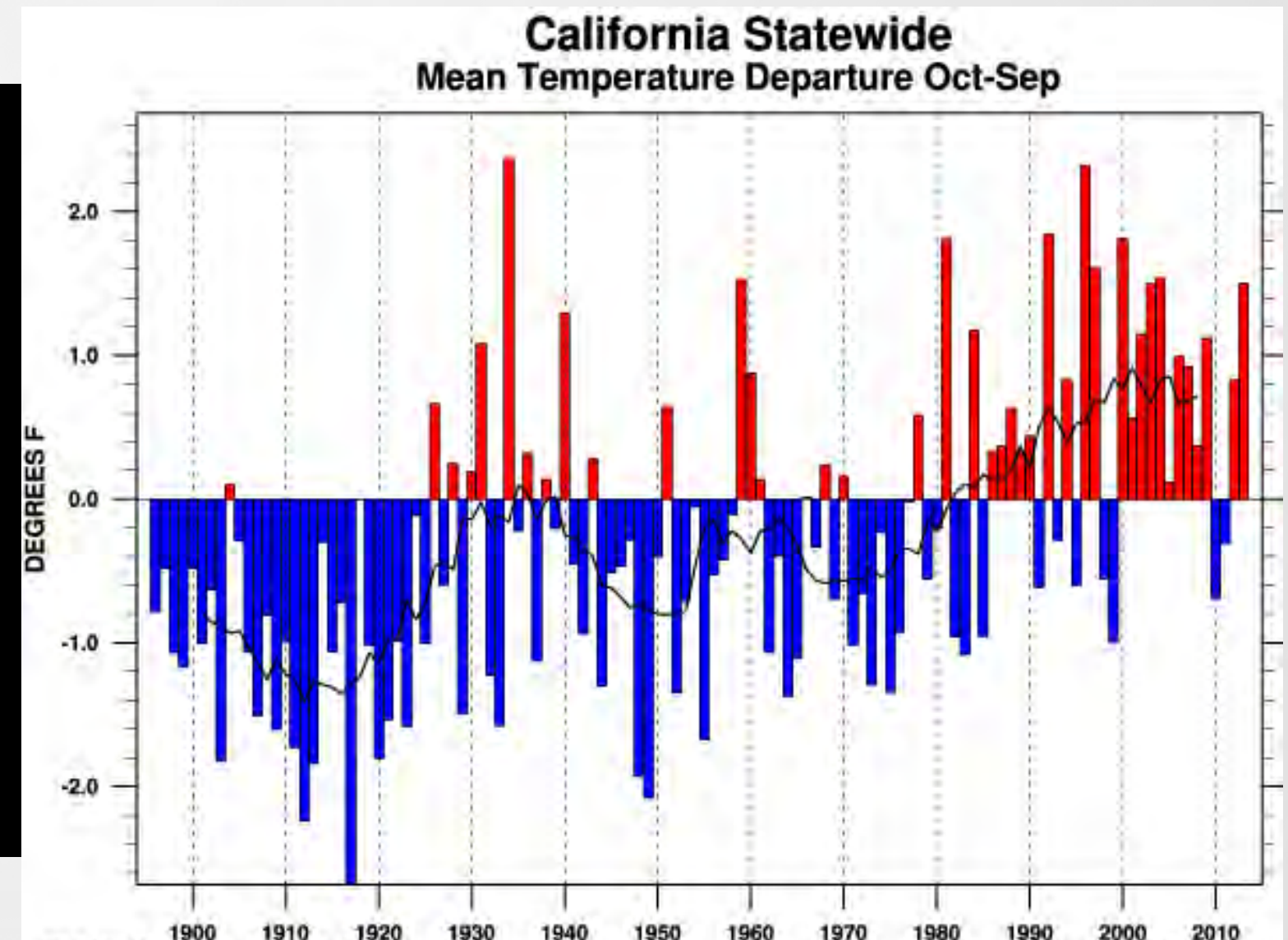
● Annual Flow — 2-Year Mean - - Volume Median (16000 kaf) - - Volume Mean (18200 kaf)

Changing Climate is Increasing Challenges to Water Management

Increasing precipitation extremes



Increasing temperatures



Adaptation to a Changing Climate

- Current water management and flood risk analyses depend on historical estimates and statistics of hydrology
- Water management infrastructure and policy decisions will likely be tested against climate variability and change not experienced in the past 100⁵ years.

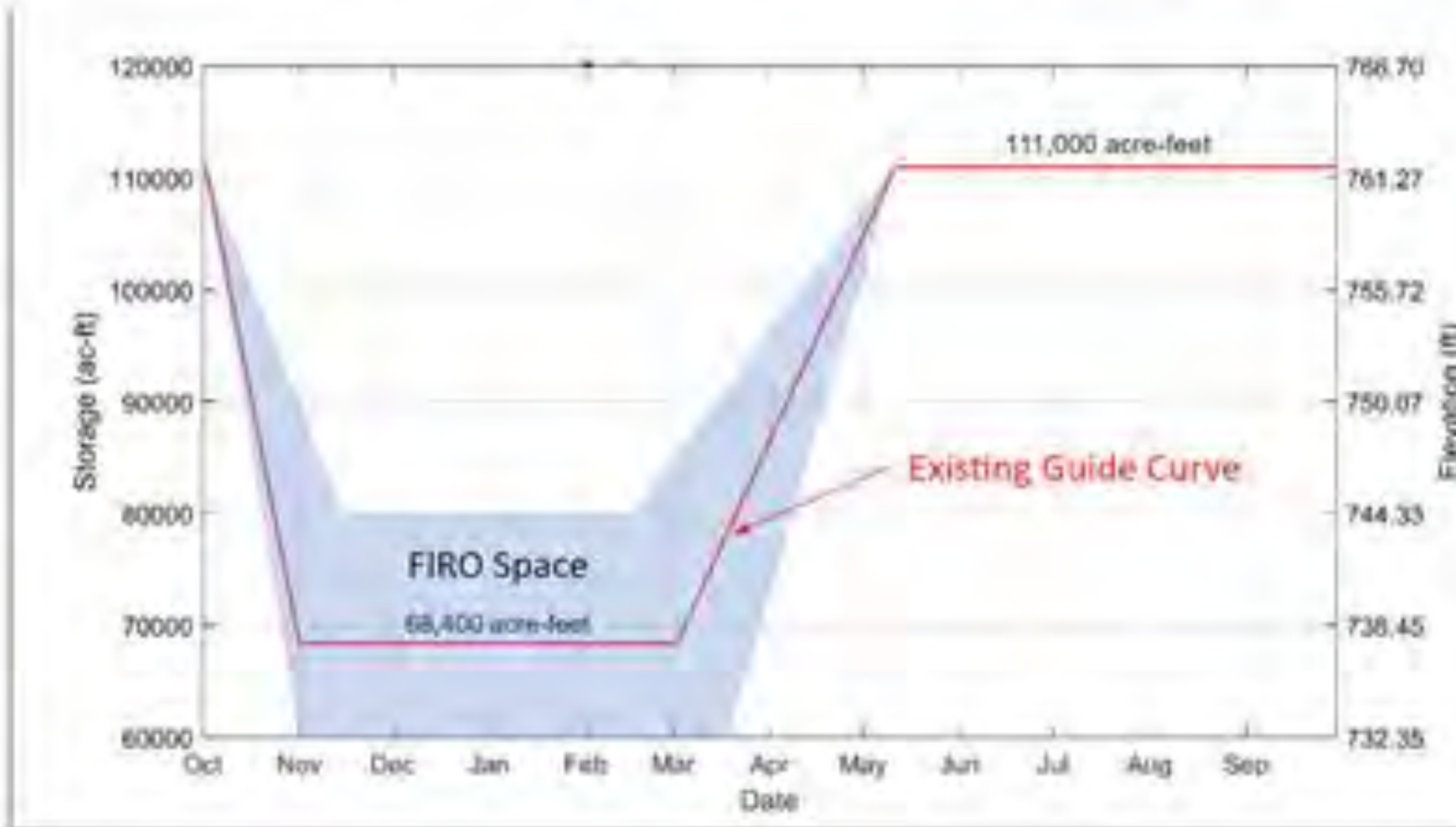


Better Utilization of Advances in Forecasting

- If the forecast shows a large event approaching, reservoir releases can be made gradually in advance of peak inflow to attenuate peak outflow downstream, yielding greater flood control benefits.
- Conversely, in the spring, if no storms are forecast, water can be stored, yielding water supply reliability benefits.
- “Software” changes can potentially improve the performance of existing infrastructure



FIRO Space for Lake Mendocino



Key Attributes

- Does not redefine the flood control space
- Allows for forecast informed release decisions within the space
- Can extend into both the flood control and water conservation space

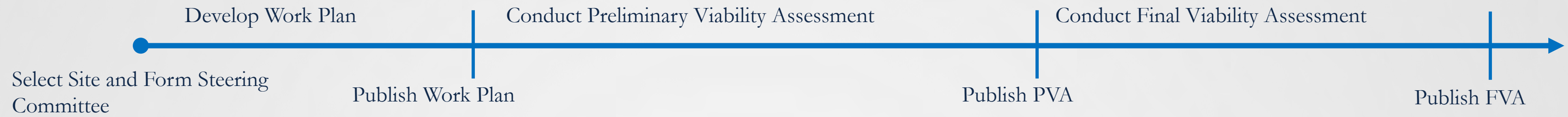


FIRO Project Comparison

Attribute	Lake Mendocino	Prado Dam	New Bullards Bar	Oroville Dam
Drainage Area	105 mi ²	2,230 mi ²	489 mi ²	3,950 mi ²
Elevation Range	637-4,480'	470-11,500'	2,000-8,450'	900-10,457'
Avg Inflow	265 KAF/yr	159 KAF/yr	1,270 KAF/yr	4,460 KAF/yr
Snowpack	Non factor	Minor factor	Significant factor	Significant factor
Gross Pool	116.5 KAF	174 KAF	966 KAF	3538 KAF
Max Flood Control	48.1 KAF	174 KAF	170 KAF	750 KAF
Hydro-electric	3.1 MW	None	315 MW	819 MW
DS Constraints	Most events	Next few years only	Largest events	Largest events
Construction	No	Yes	Yes	No
Environmental	Fisheries	Birds/habitat	Fisheries	Fisheries



FIRO Viability Assessments – Current Status and Timeline



Lake Mendocino



Prado Dam



New Bullards Bar & Oroville Dams



Howard Hanson Dam

* Ongoing discussions to add additional reservoirs



Yuba-Feather

Forecast-Informed Reservoir Operations

Collaborative Effort

- Department of Water Resources
- Yuba Water Agency
- UCSD / Scripps Institute
- USACE
 - Research and Development
 - Water Operations
- National Weather Service
- National Marine Fishery Service
- Sonoma Water Agency

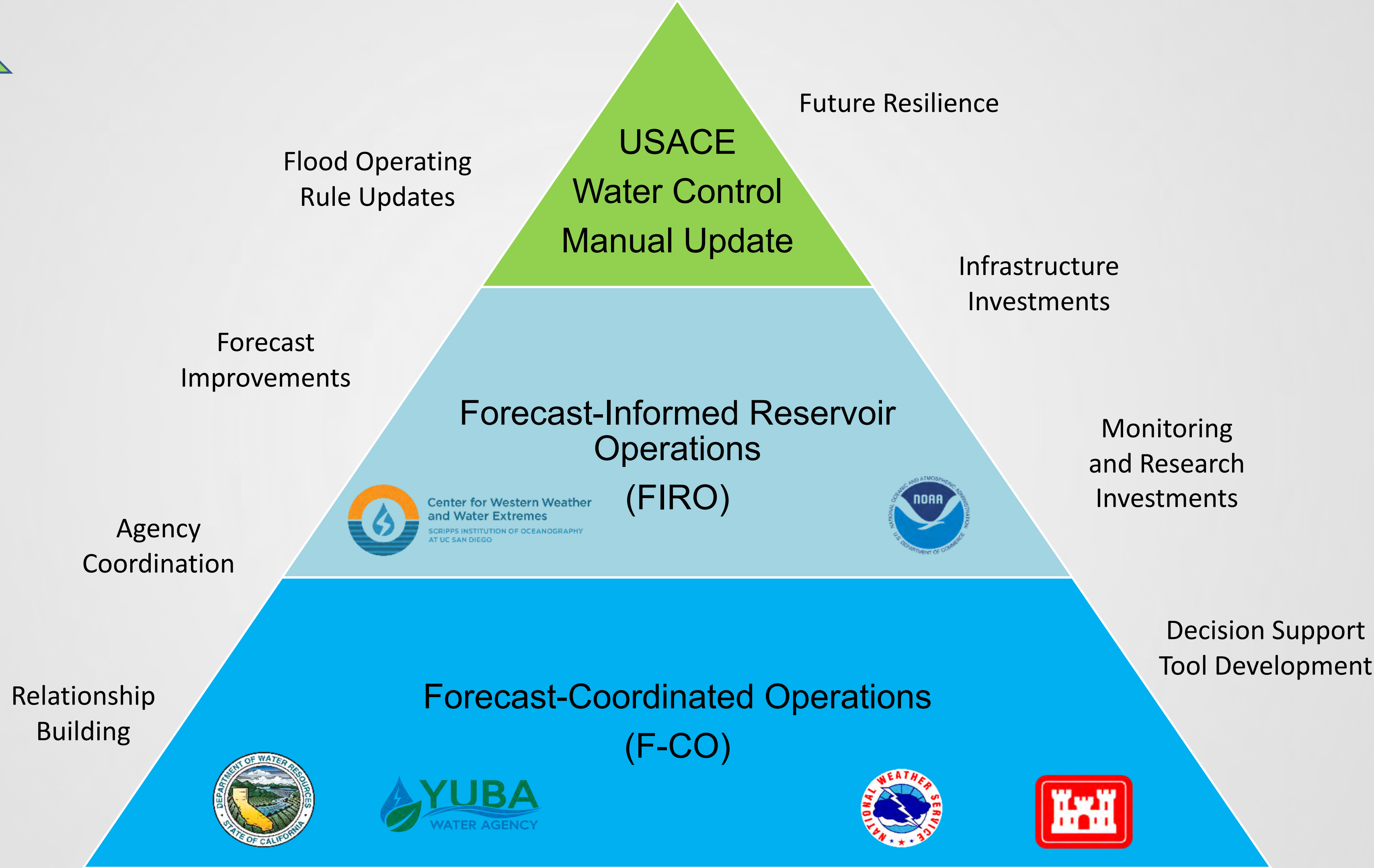
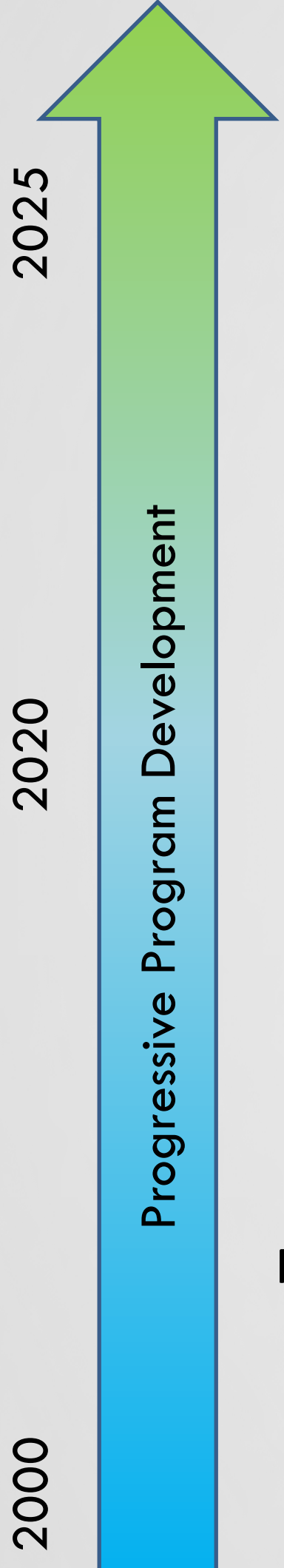
Project Partners



Yuba-Feather FIRO Initiative

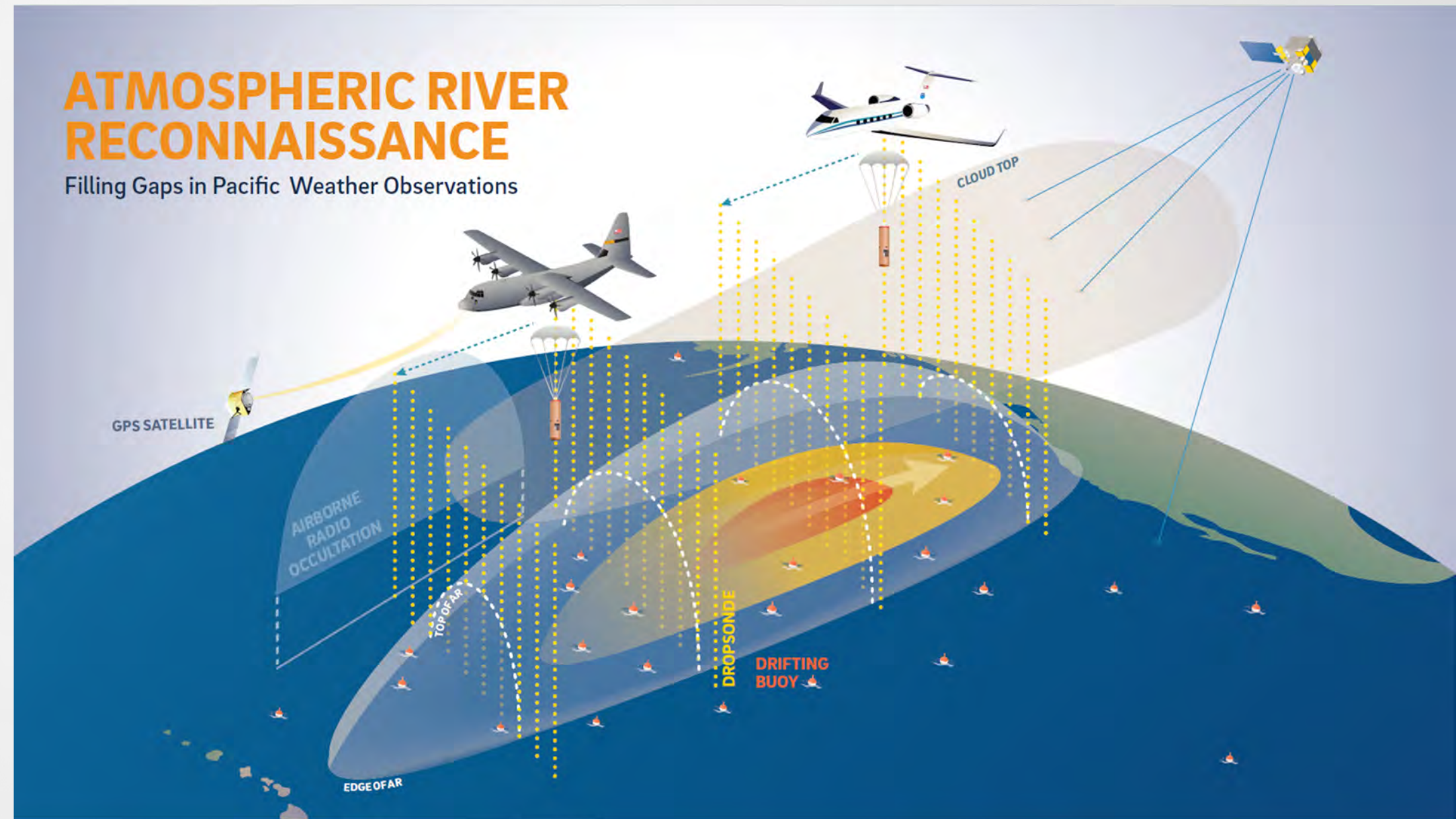
- Builds upon existing Forecast Coordinated Operations Program
- Initiate research investigations to improve forecasting
- Develop and conduct viability assessments for formal operations rule changes
- Expected to provide:
 - ✓ Flood risk reduction
 - ✓ Water supply savings
- Informing development of Water Control Manual updates
 - ✓ Current Water Control Manuals are dated to the early 1970s





Atmospheric River Research Investments

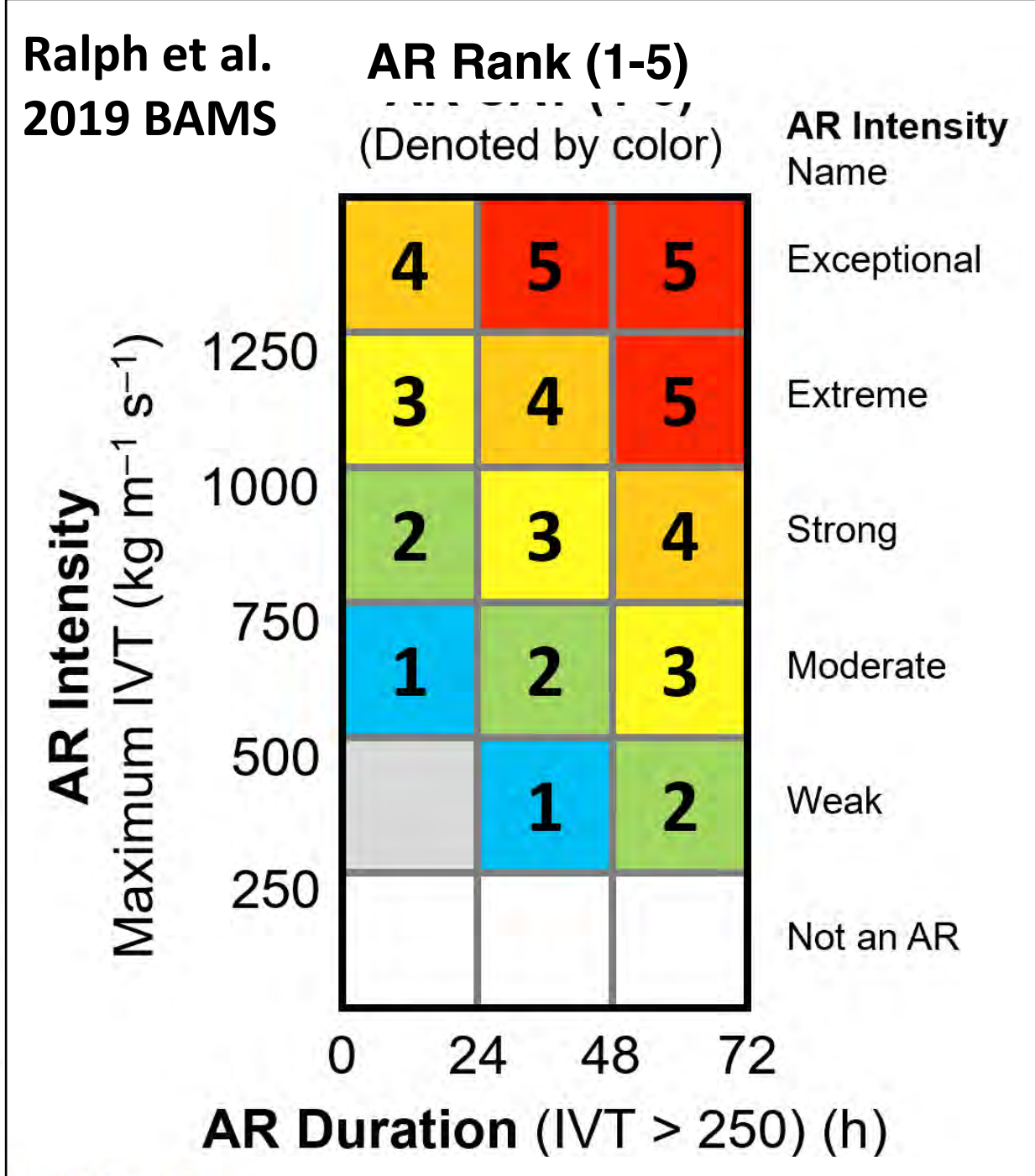
- Ocean Reconnaissance
 - C-130 Hurricane Hunter
 - Northeast Pacific Buoy Observations
- Land-Based Monitoring Installations
 - Weather Balloon
 - Snow Level Vertically Pointing Radar
 - Surface Meteorology Stations
 - Soil Moisture Instrumentation



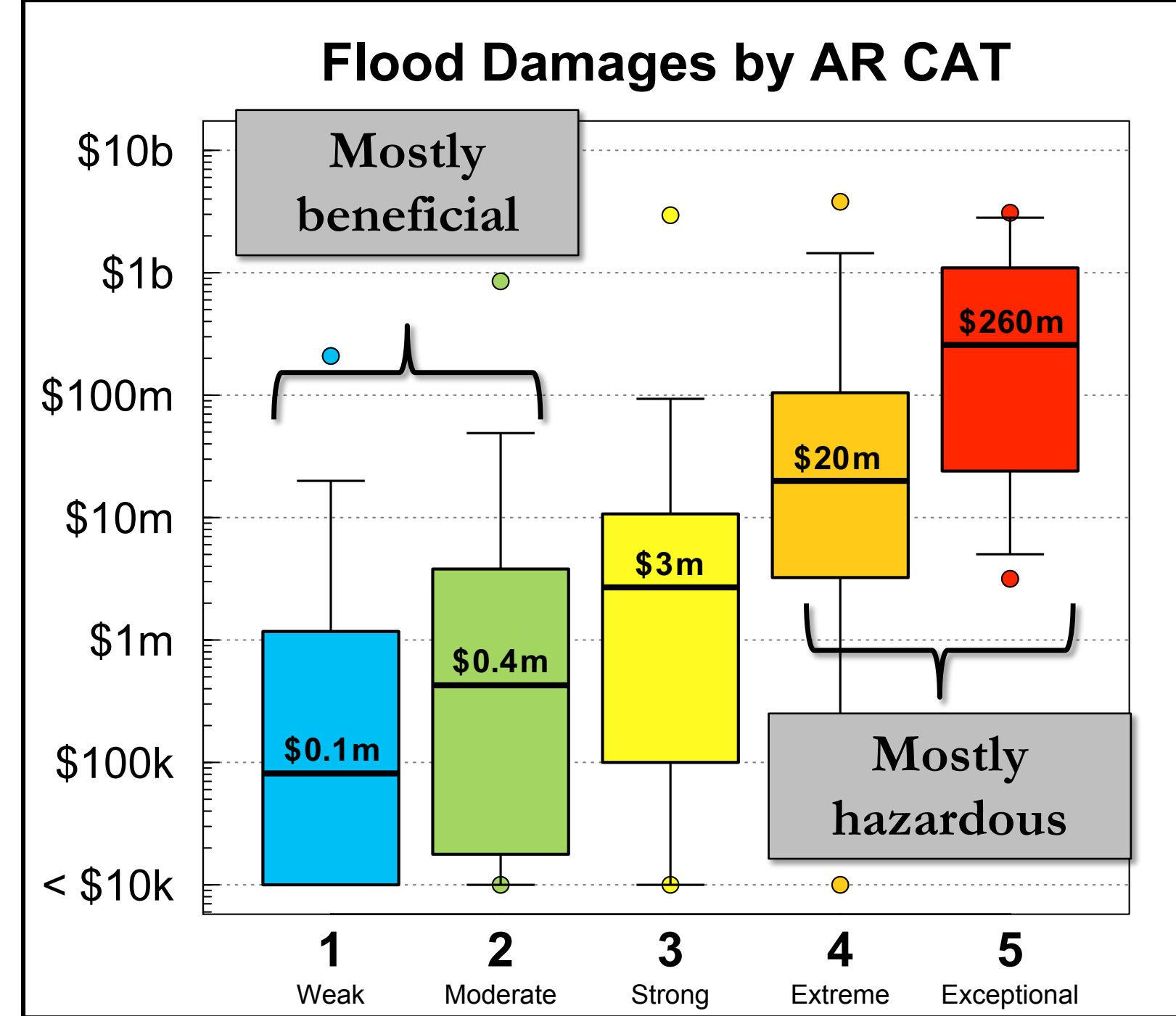
Atmospheric Rivers Rating Scale – Ralph et al. (2019)

Strength measured in IVT – Integrated Vapor Transport

IVT is like “CFS in the sky” - Like a terrestrial river, but instead a river in the sky – a river of water vapor pushed along by the wind



- AR 5 – Primarily hazardous
- AR 4 – Mostly hazardous, also beneficial
- AR 3 – Balance of beneficial and hazardous
- AR 2 – Mostly beneficial, also hazardous
- AR 1 – Primarily beneficial

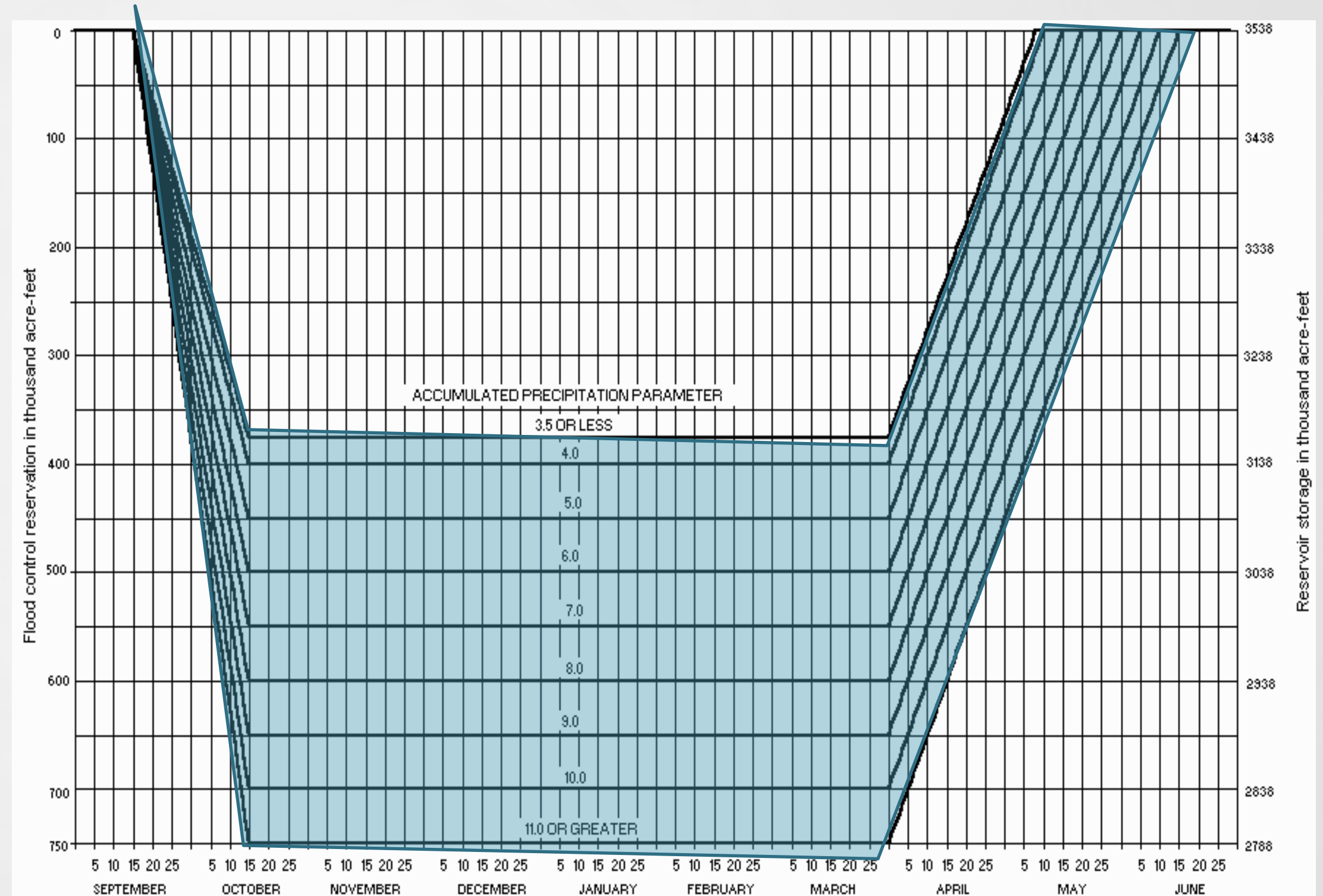


Corringham et al. 2019, Science Advances

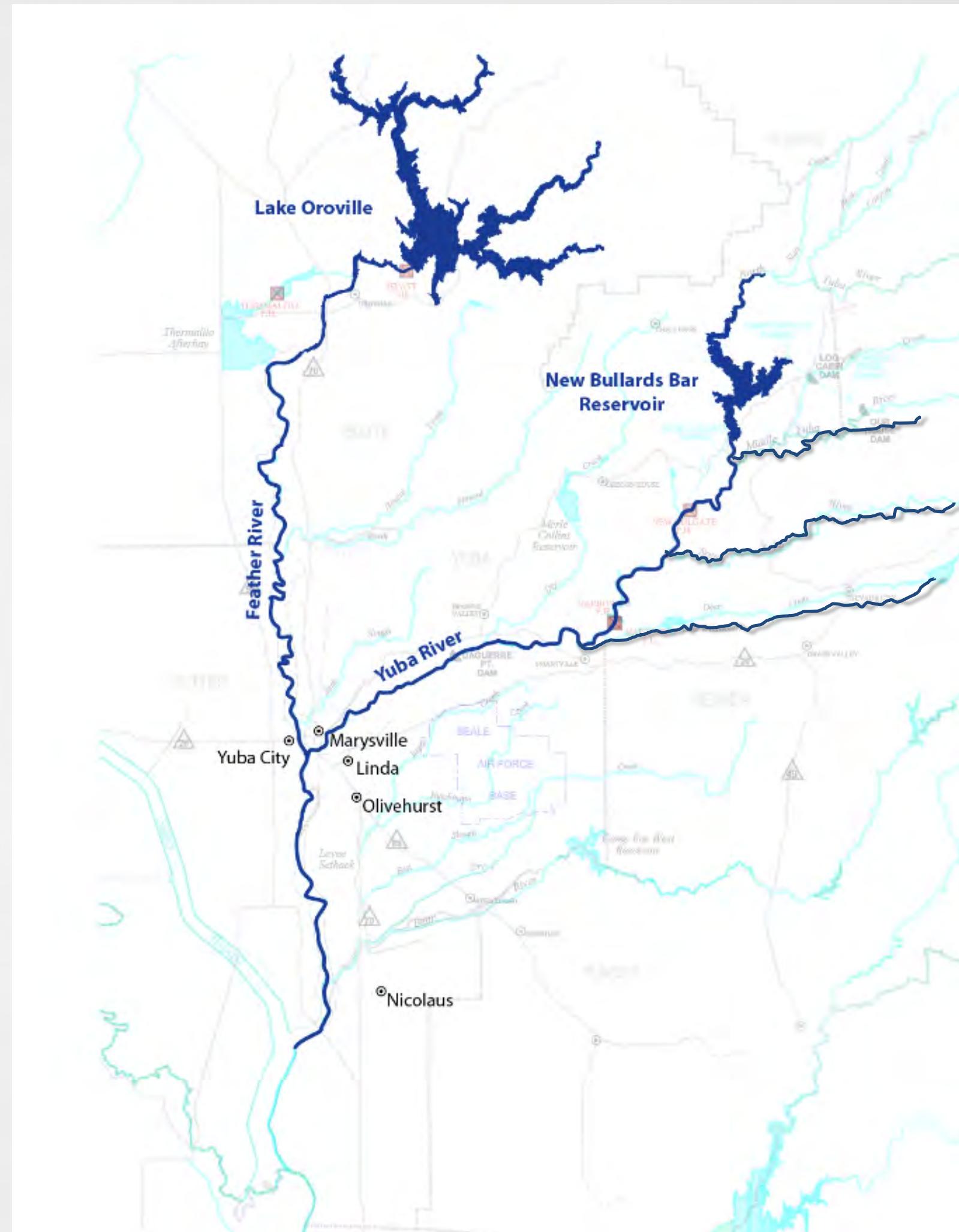


Oroville 1970 USACE Flood Control Diagram

- Required vacant flood pool varies from 375,000 AF and 750,000 AF
- Top of Conservation (TOC) set by prior precipitation measured by a “wetness index”
- Pursue more sophisticated approach to more effectively allocate “FIRO space”



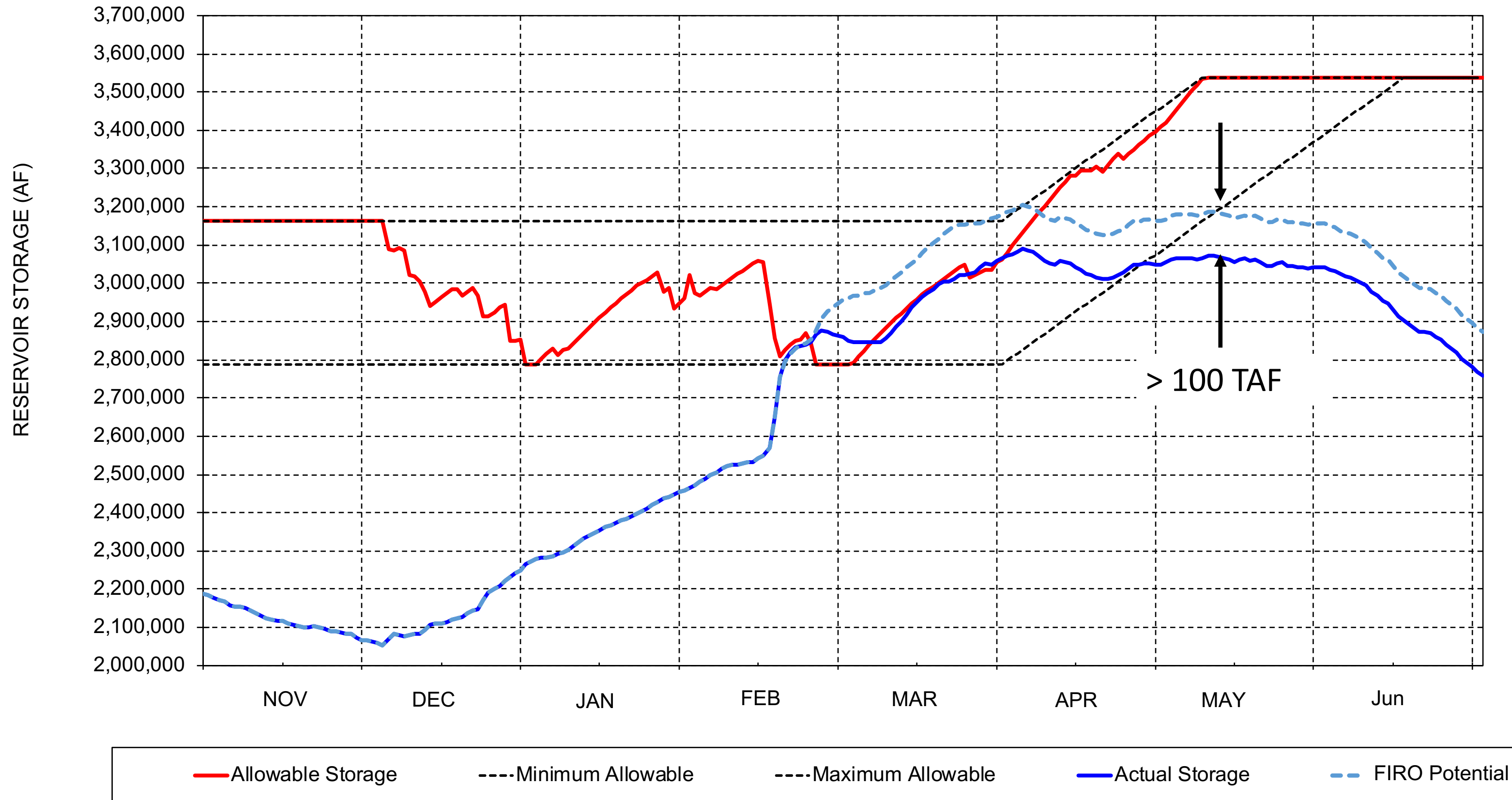
- Common downstream control points on the lower Yuba-Feather system
- Moderate releases in advance of a forecasted storm can avoid higher releases later during the storm
- Potentially providing decrease frequency of higher flows on the downstream levee system



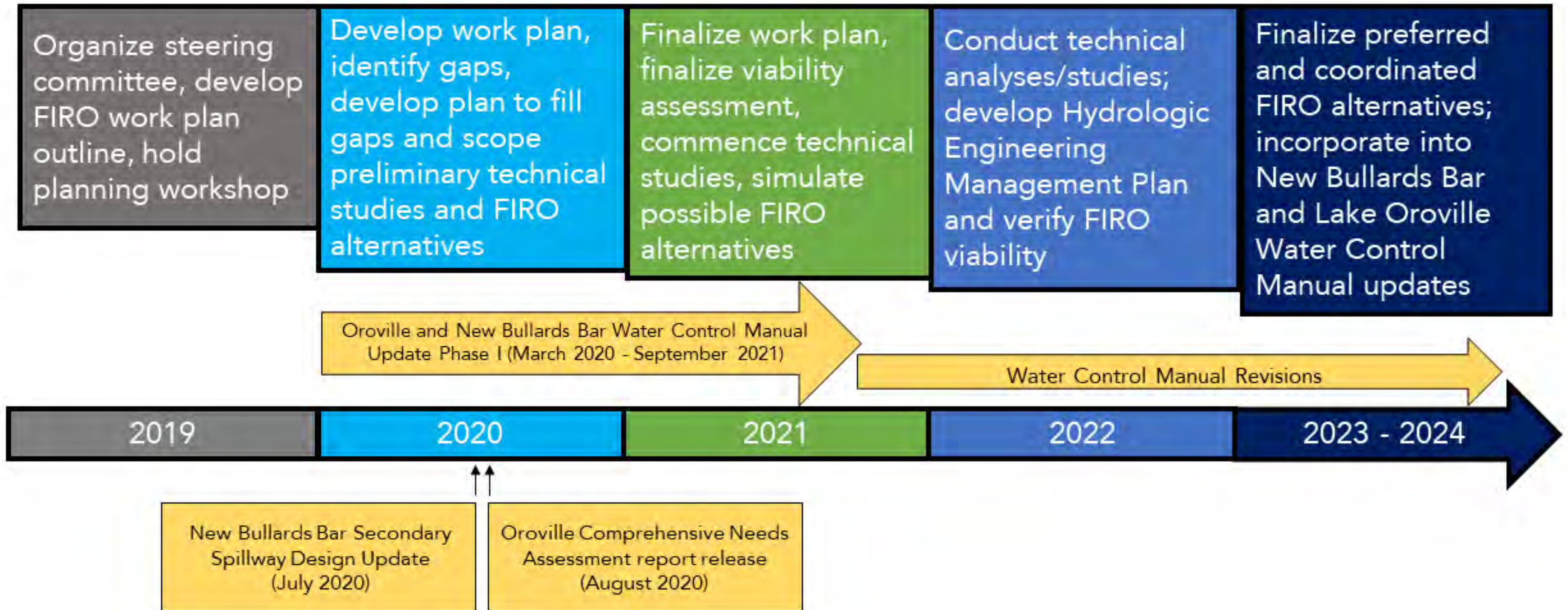
Potential Water Supply Reliability Improvements

Lake Oroville WY 2004 Hypothetical Example

CAPACITY: 3,537,577 ACRE-FEET



Y-F FIRO/WCM Update Schedule



FIRO Outcomes

- Updated flood rules through a resilient update of the USACE Water Control Manual
- Continuous investments to improve forecasting capabilities

