What if we could start over: Large landscape-scale 2D hydrodynamic modeling of Sacramento Valley "What If" scenarios

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Goals of Project

- To produce an extremely “rapid” 2D hydrodynamic model for the Sacramento Valley to be used as a planning tool for floodplain management
- To calibrate and validate the 2D model
- To model existing floodplain inundation conditions in the Sacramento Valley
- To use the model to test a variety of “big picture” floodplain management scenarios – “What if we could start over...?”
- To apply the model to a range of issues in the Sacramento Valley

Overview of Project

- Phase 1 - Existing conditions model
- Phase 2 - Develop up to 5 flood & ecosystem management scenarios to simulate with the JFLOW model
- Develop potential scenarios with team members
- Conceptual design elements to consider:
  - Flood bypasses
  - Levee setbacks
  - Ring levees
  - Flood attenuation basins
- Identify appropriate hydrology; i.e., 2- & 200-yr.
- Analysis techniques; e.g., EAH.
- Prepare draft and final technical memorandum summarizing scenarios for subsequent modeling

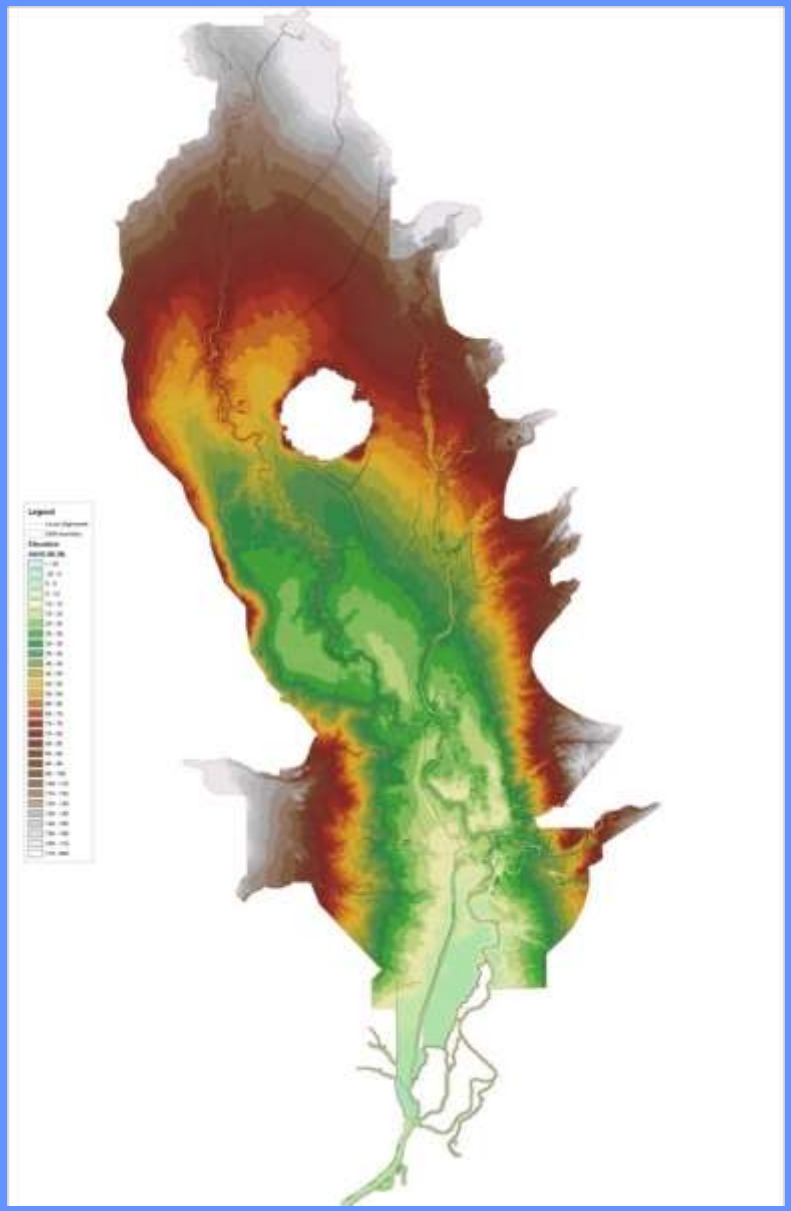
Model Platform and Limitations

- Jflow+
  - Solves 2D Shallow Water Equations
  - Finite volume method with gridded mesh
  - GPU based for high performance (100 million cells)
  - Outputs: depth and velocity maps, profiles, time series
- Boundary conditions
  - Multiple inflows and gridded sources
  - Weir outflow, no level boundary condition
  - No hydraulic structures (locally increase roughness)
- Model uncertainty
  - Largely dependent on time step and grid resolution
  - Deep, narrow channels with very shallow bed slopes

Phase 1 – Existing Conditions Model

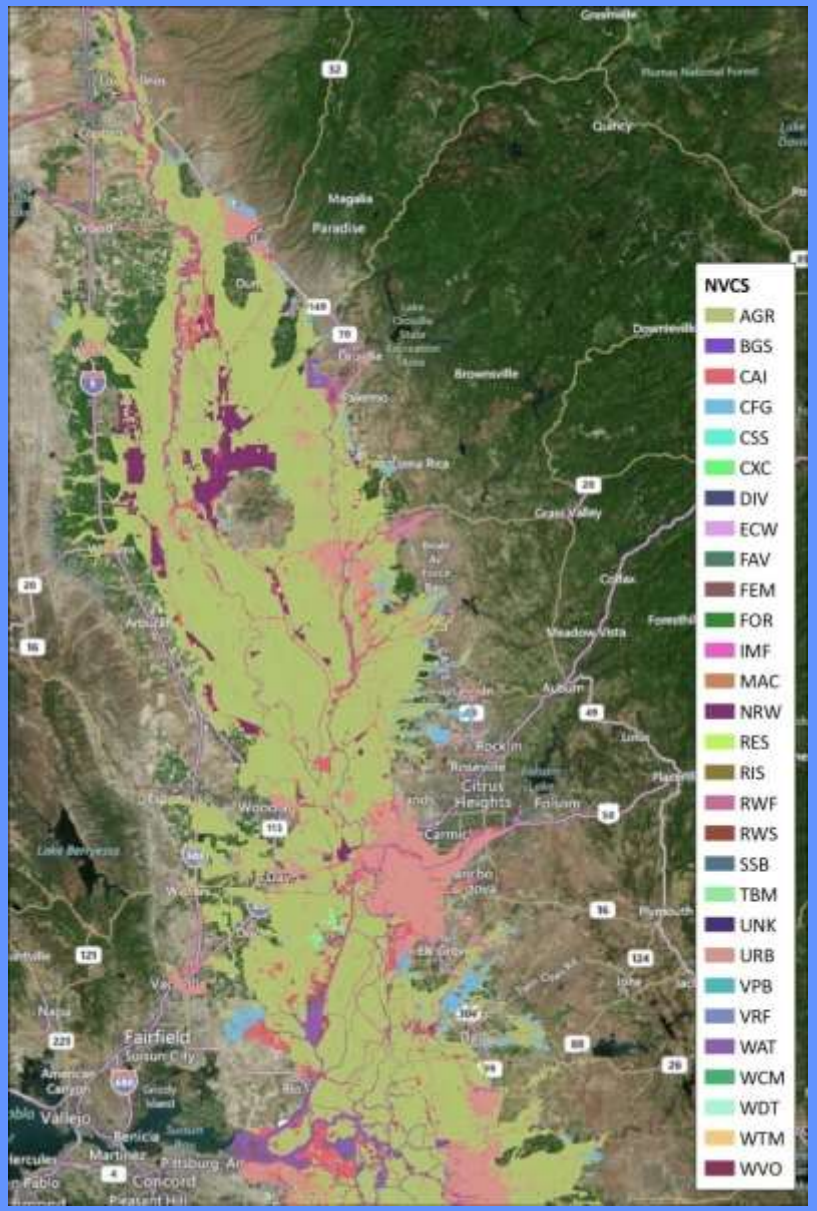
Sacramento Valley Surface Model

- CVFED LiDAR and bathymetry (3990 mi^2)
- Levee alignments (fixed data gaps)
- Setback levees (Feather River, Shanghai, Star Bend, Bear River)
- Cache Slough Complex bathymetry
- Bed condition (gauge based WSP upstream of Verona)



Central Valley Riparian Mapping

- CSUS vegetation mapping
- Other local hydraulic models and studies (Feather River CMP, USACE, Yolo Bypass)
- Primary parameter for calibration

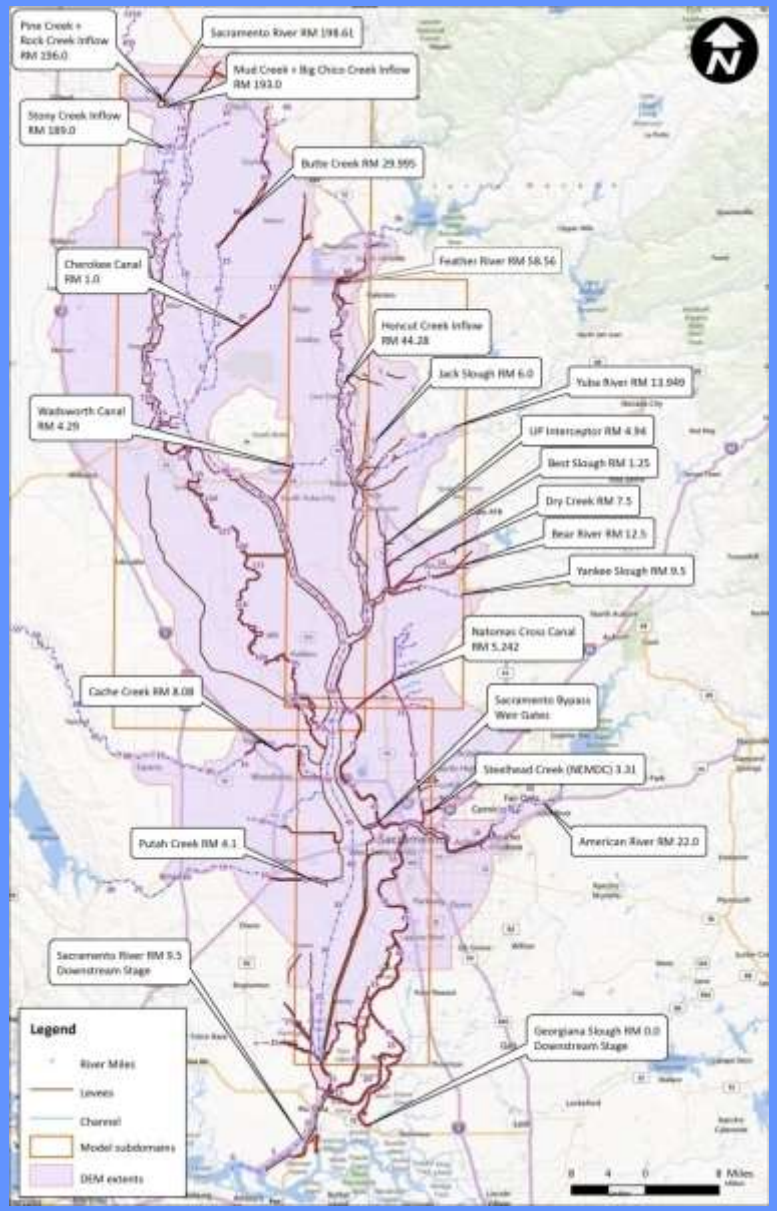


Model Calibration / Validation

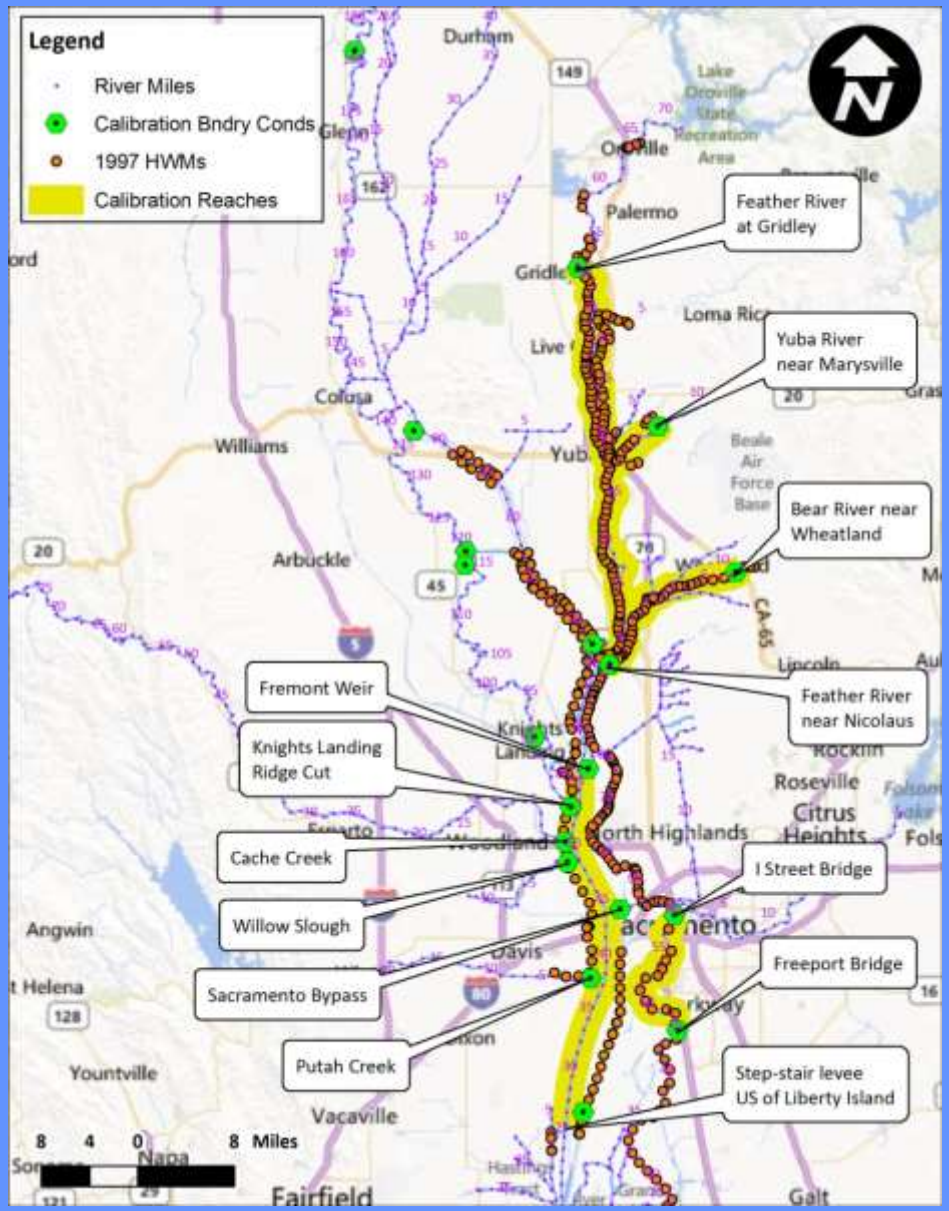
- Flood events: 1997 and 2006
- Data sources:
  - Gauge TMs from Wood Rodgers/CH2MHill
  - SBFCA Feather River reconstructed flows
  - USACE Yolo Bypass reconstructed flows
  - CVFED HEC-RAS models
  - High water marks (HWMs)
- Topography adjusted to reflect the conditions at the time of events (e.g., setback levees)

Design Boundary Conditions

- Comp Study hydrology:
  - 2- through 200-year
  - 21 upstream inflows

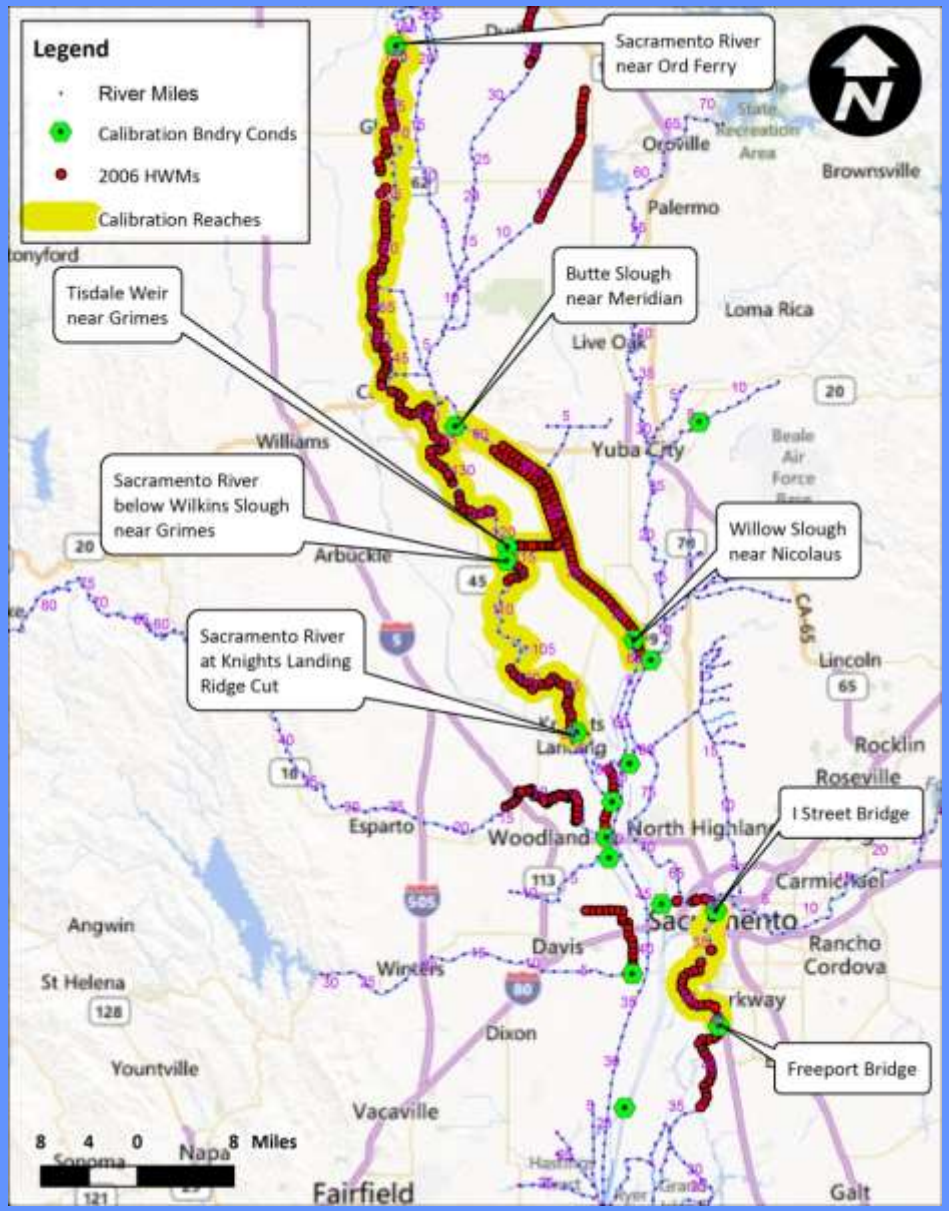


1997 Calibration / Validation



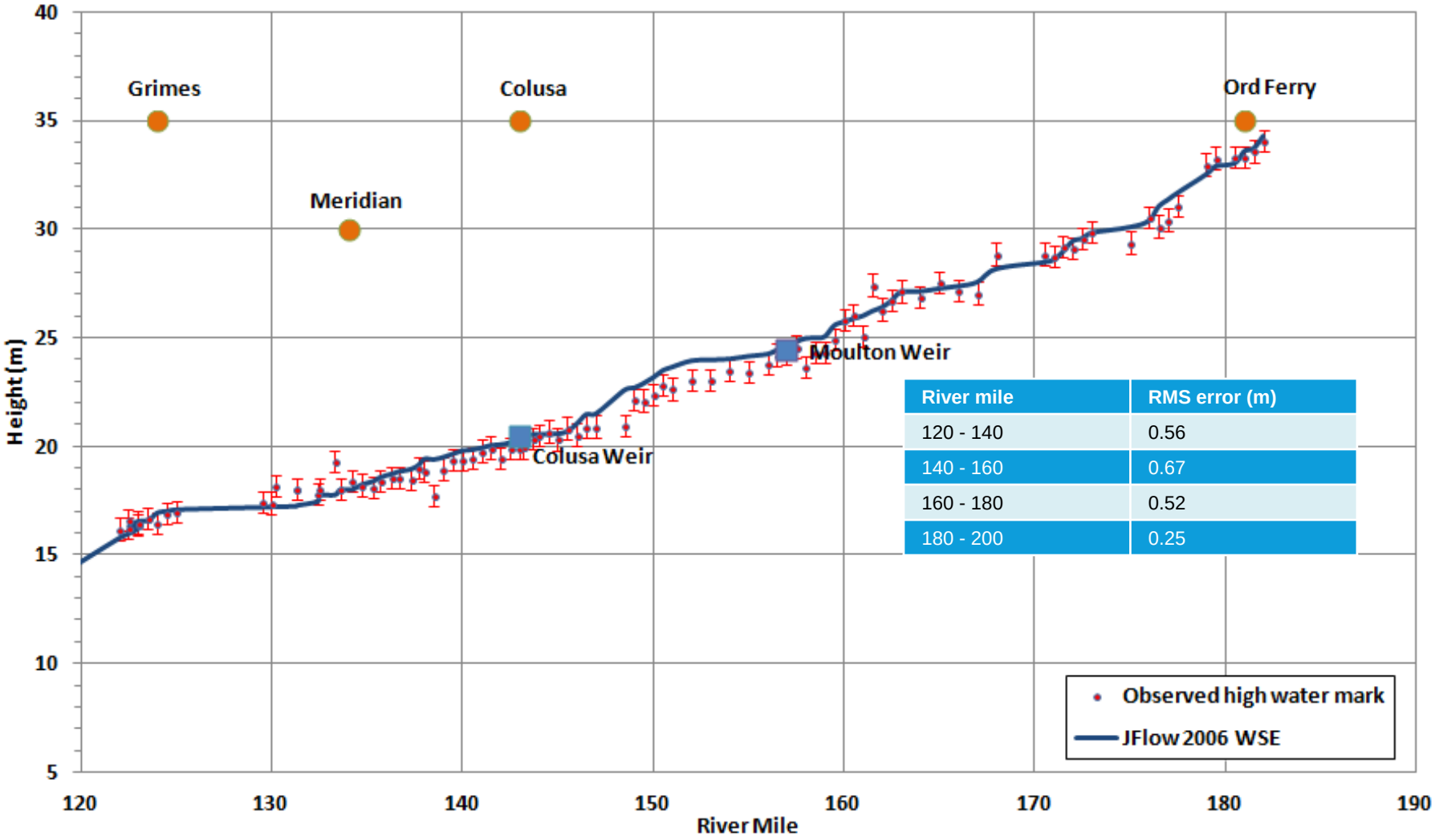
- Calibration:
  - Feather River and tributaries
  - Yolo Bypass
  - Lower Sacramento River
- Validation:
  - Combined Lower Sacramento River and Yolo Bypass

2006 Calibration / Validation



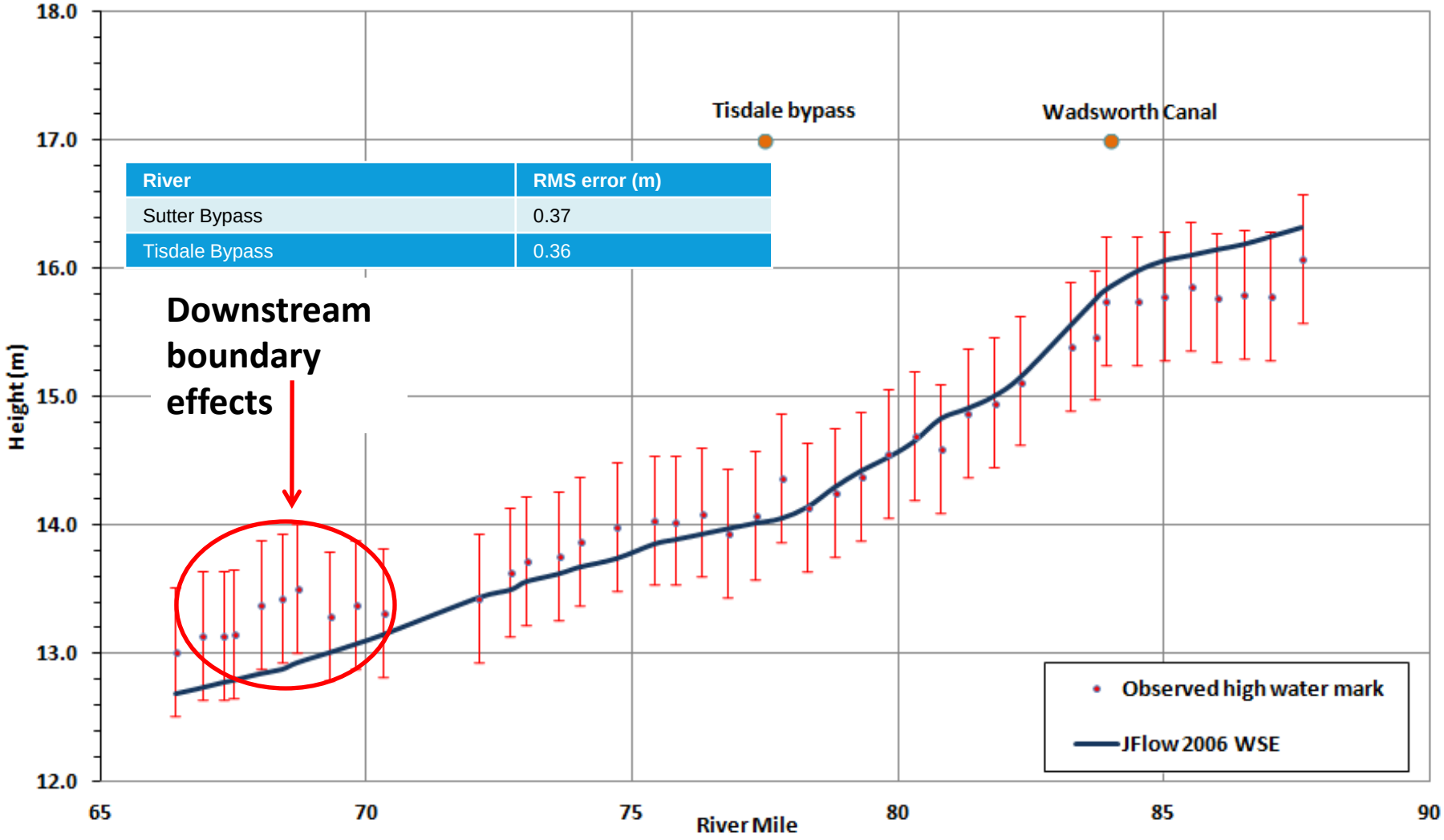
- Calibration:
  - Upper Sacramento River
  - Sutter Bypass and Tisdale Bypass
- Validation:
  - Lower Sacramento River

Upper Sacramento – 2006 Calibration



River mile	RMS error (m)
120 - 140	0.56
140 - 160	0.67
160 - 180	0.52
180 - 200	0.25

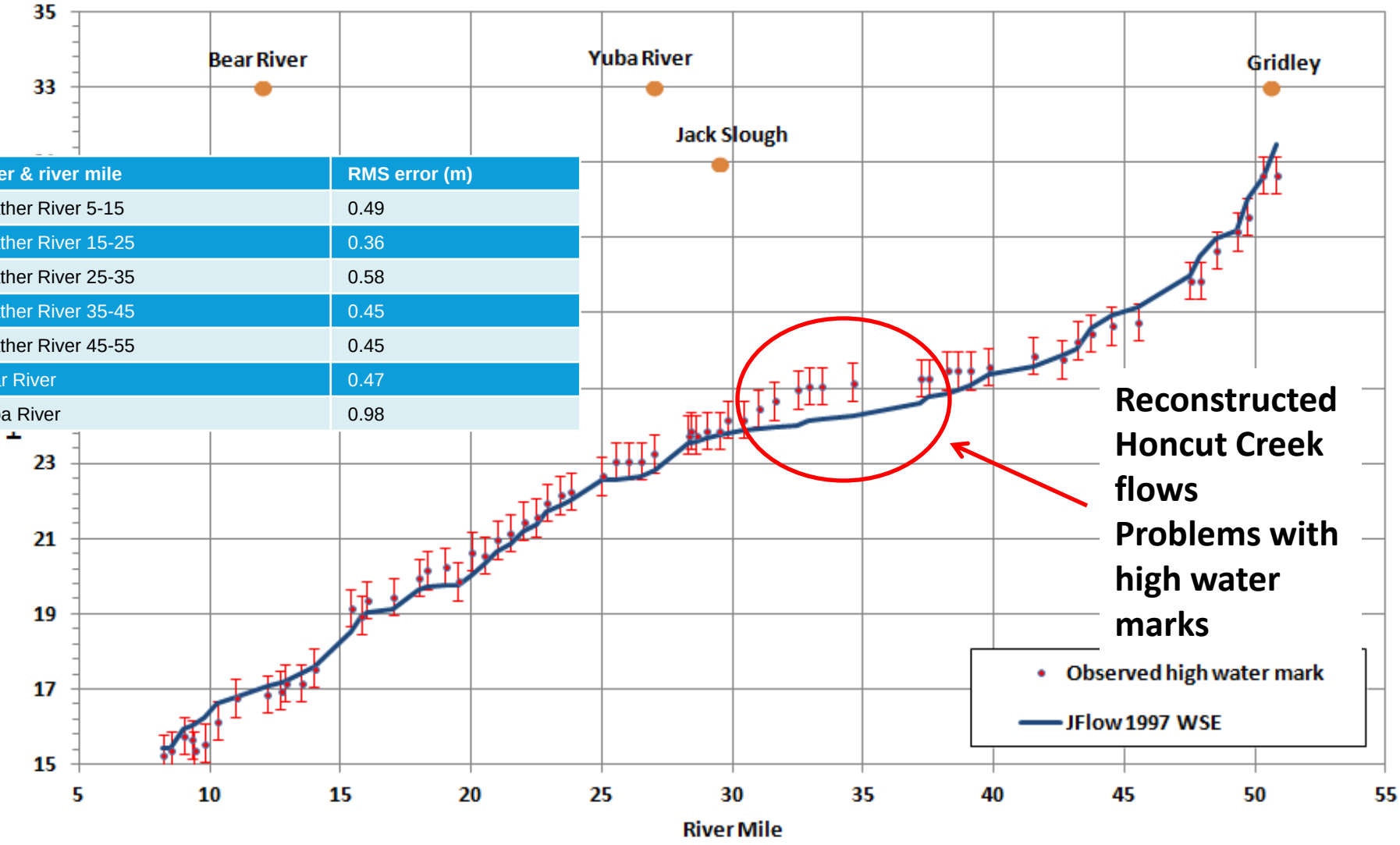
Sutter Bypass – 2006 Calibration



River	RMS error (m)
Sutter Bypass	0.37
Tisdale Bypass	0.36

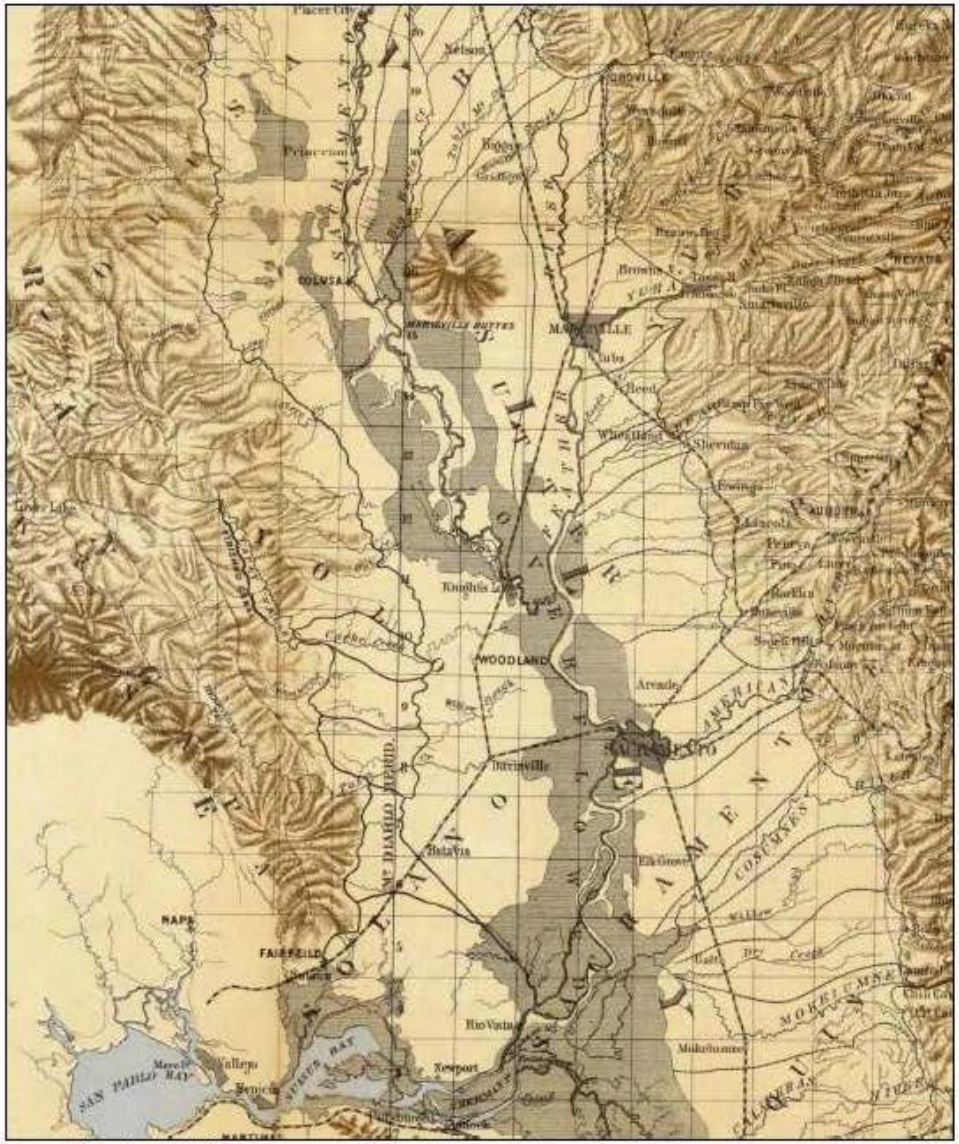
Feather River – 1997 Calibration

River & river mile	RMS error (m)
Feather River 5-15	0.49
Feather River 15-25	0.36
Feather River 25-35	0.58
Feather River 35-45	0.45
Feather River 45-55	0.45
Bear River	0.47
Yuba River	0.98



Phase 2 – Development and Simulation of Scenarios

Historic Observed Floodplains

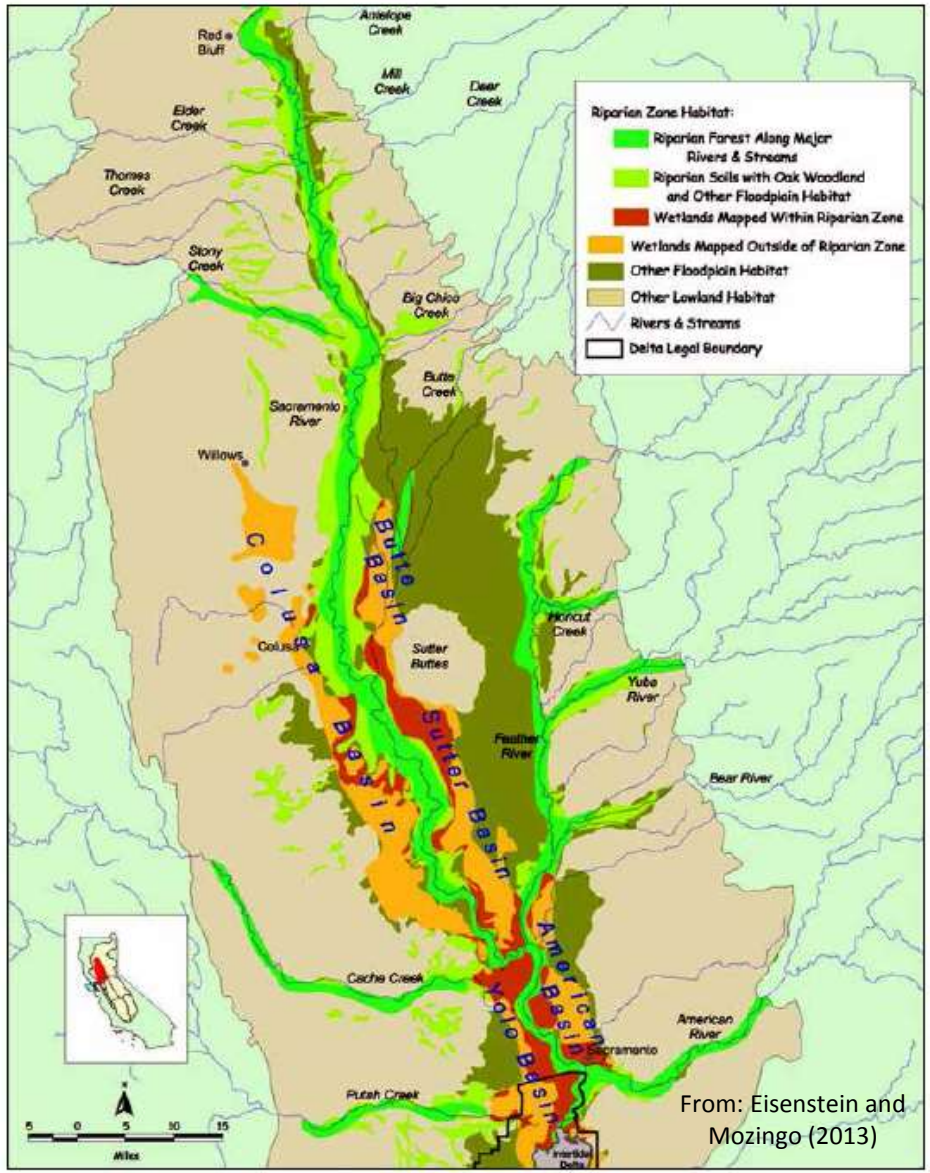


Source: Alexander et al., 1874

Figure 2-1. Extent of "Overflowed Lands" (Tule Marshes) (Shaded Area) in the Sacramento Valley in 1873

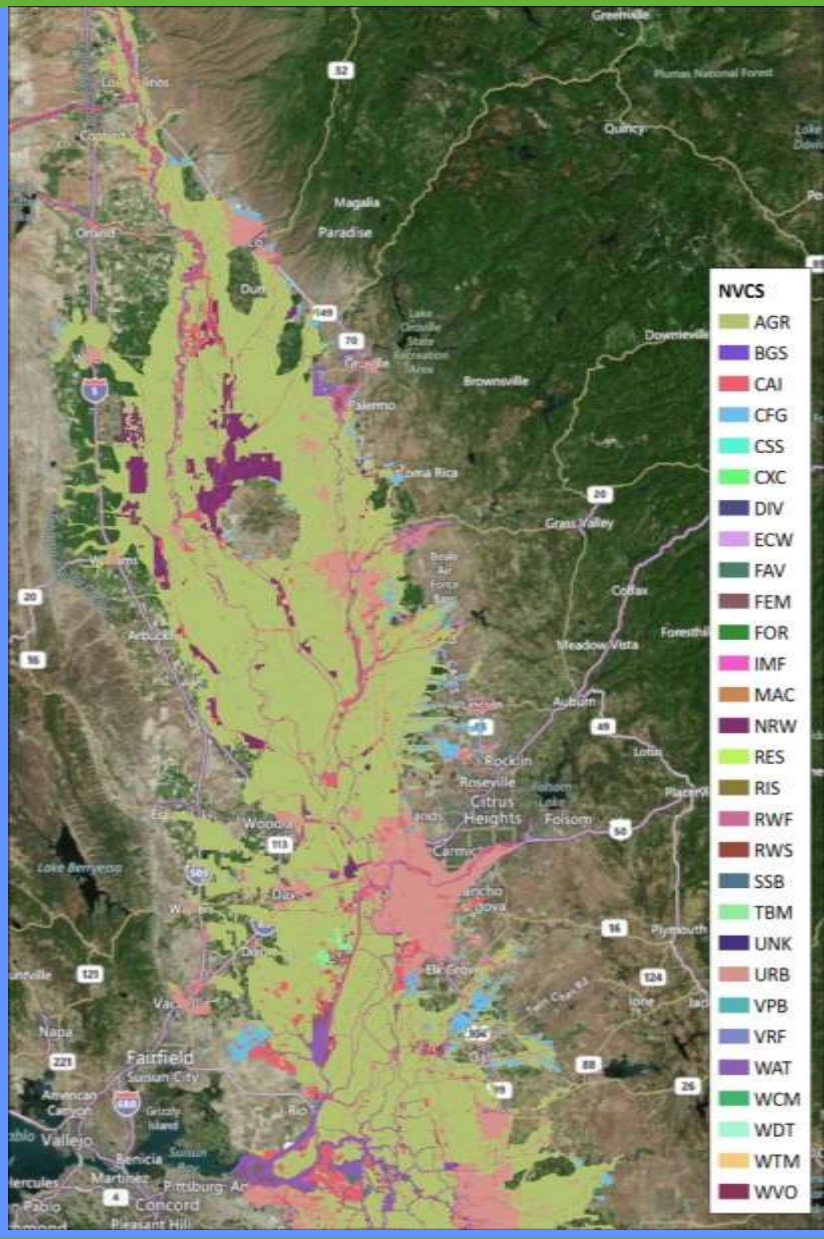
Fig. 89.—Sketch map of Sacramento Valley and Delta, California.

Historic and Existing Vegetation

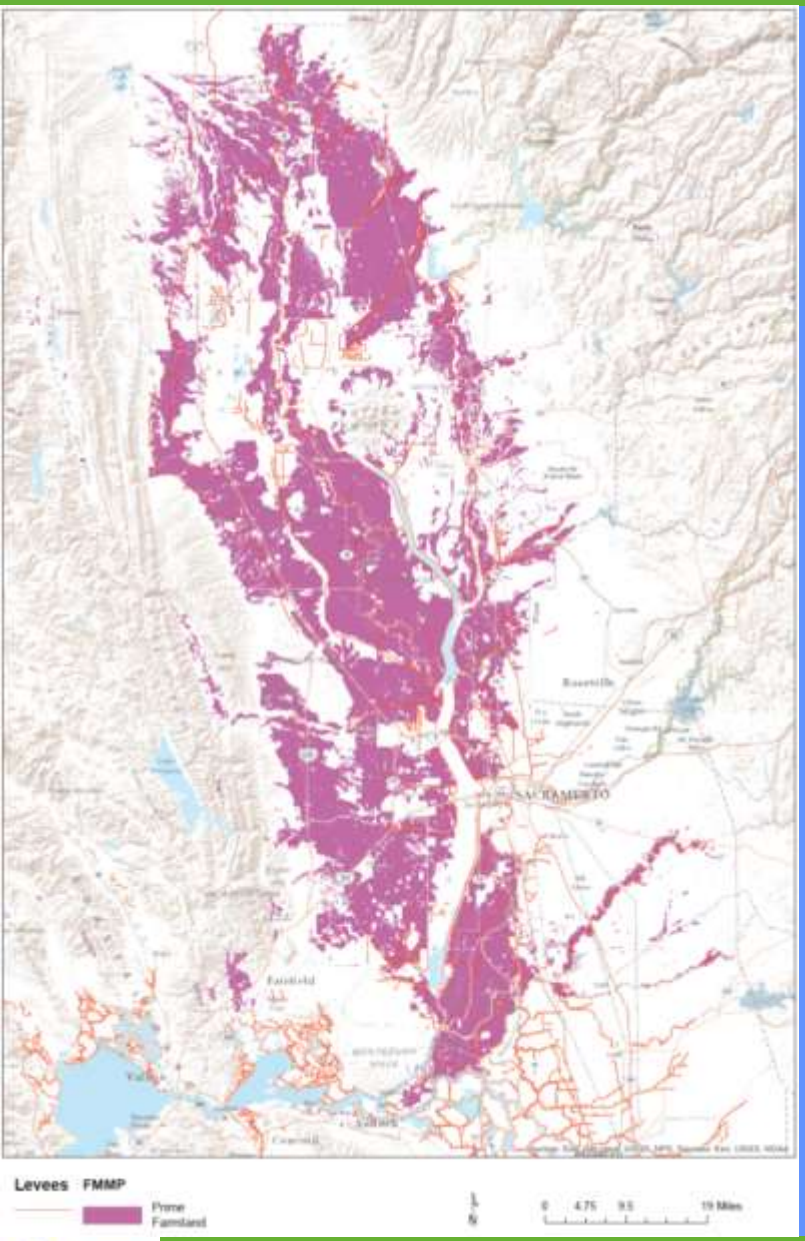


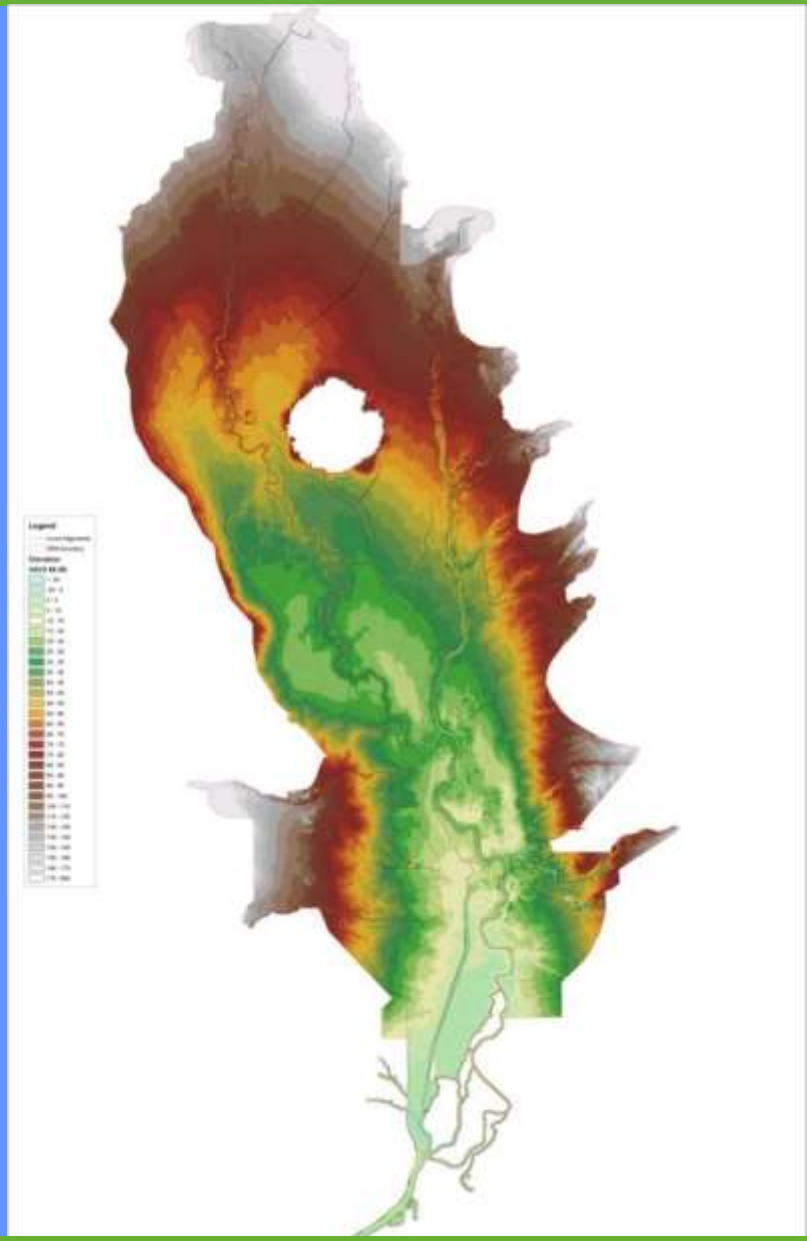
From: Eisenstein and Mozingo (2013)

Figure 5. Historical Sacramento Valley floodplain habitats. Courtesy of The Bay Institute (1998), *Sierra to the Sea*.



Prime Farmland and CVFED LiDAR Topography





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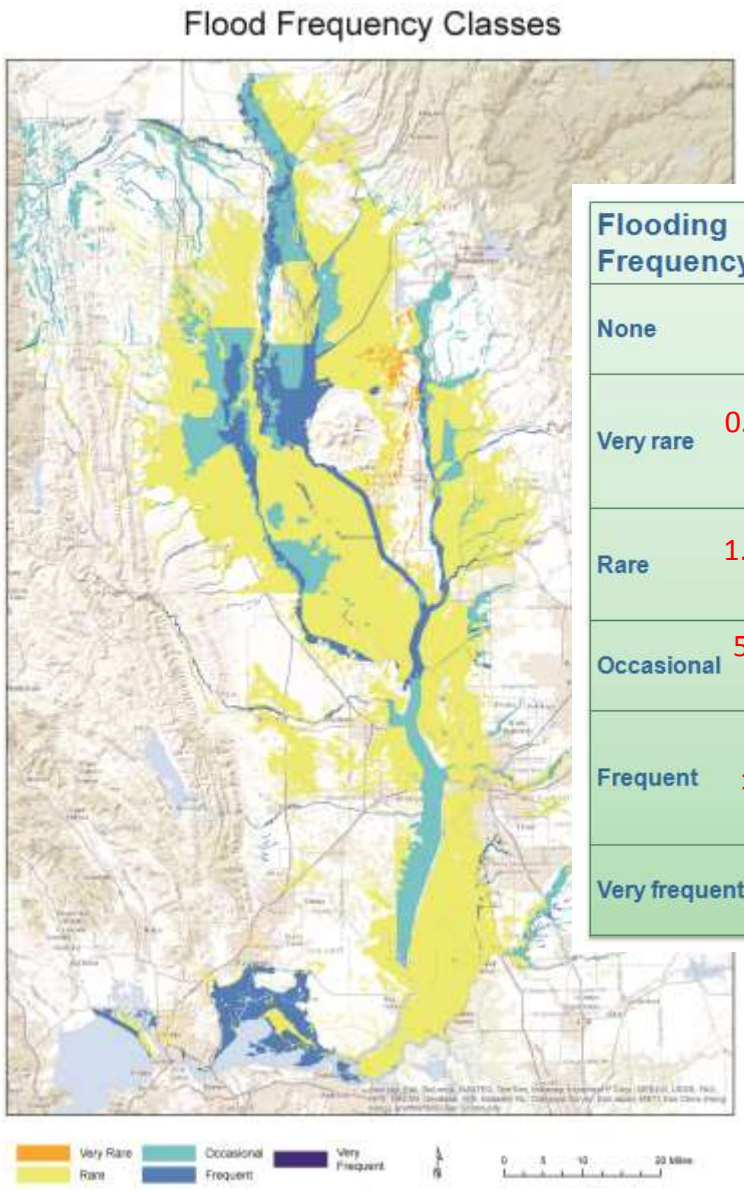
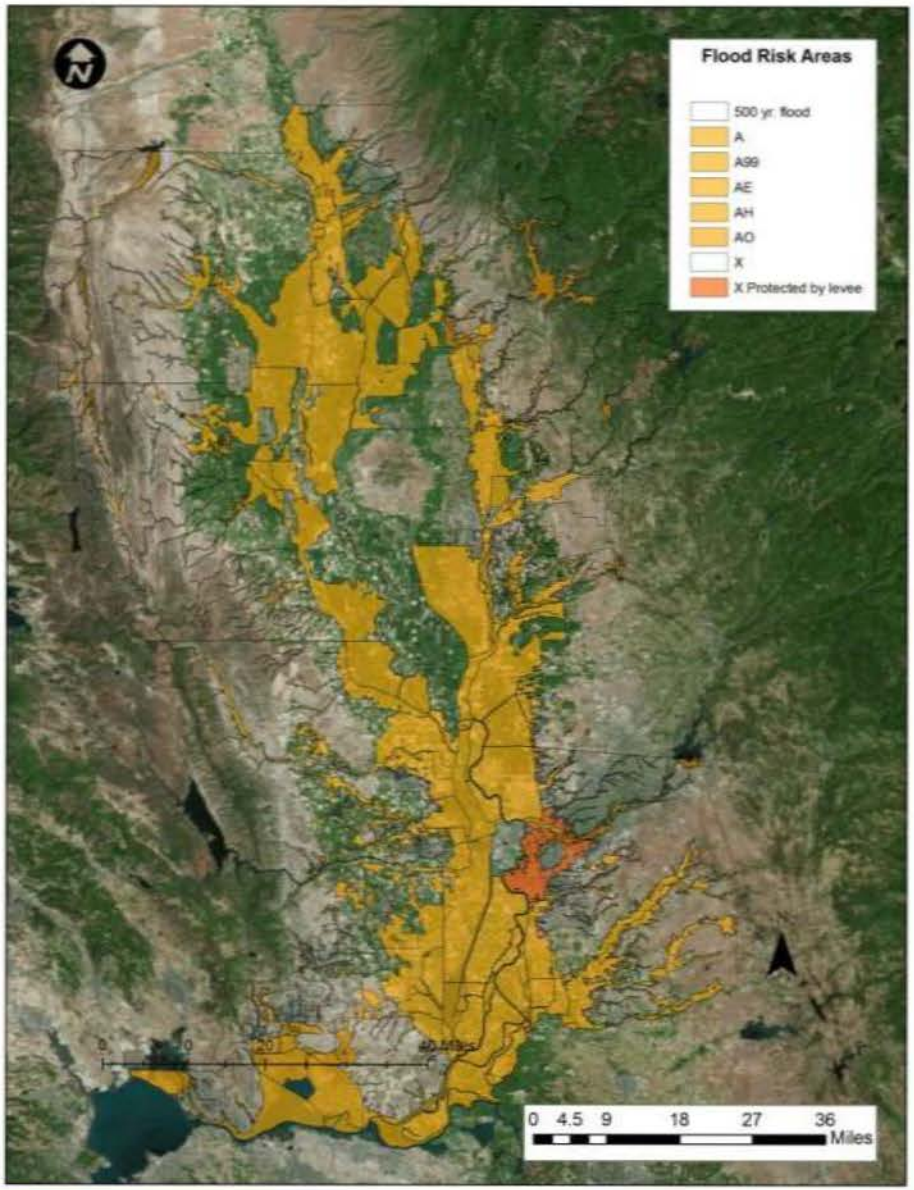
JFlow Model of the Sacramento Valley

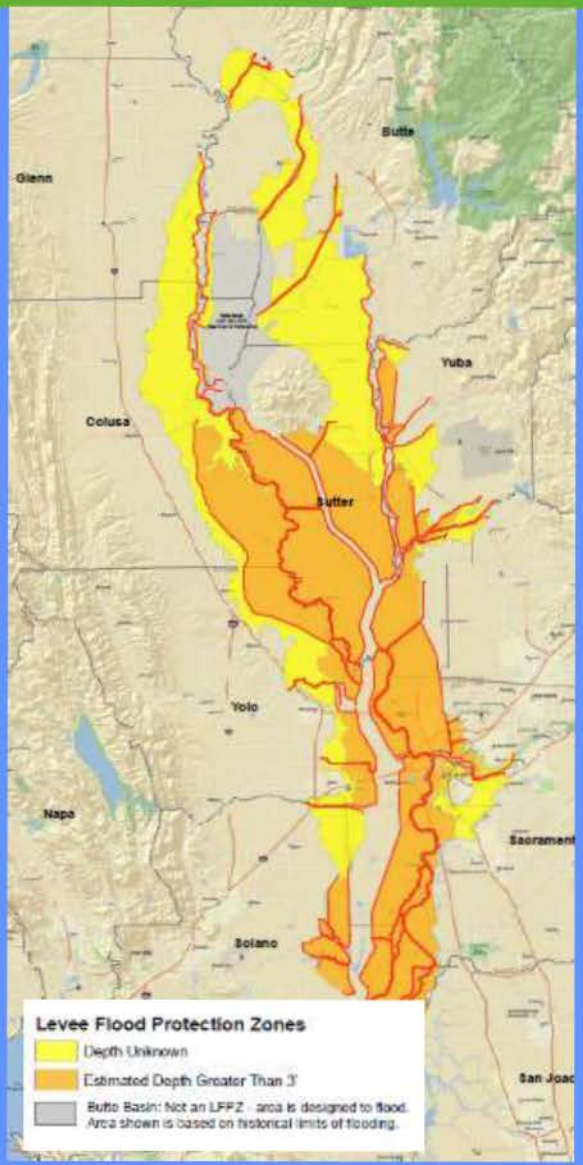
Flood-Prone Soils-Based Floodplains



Flooding Frequency Class		Definition
None		No reasonable possibility of flooding; one chance out of 500 of flooding in any year or less than 1 time in 500 years.
Very rare	0.2% - 1.0% AEP	Flooding is very unlikely but is possible under extremely unusual weather conditions; less than 1 percent chance of flooding in any year or less than 1 time in 100 years but more than 1 time in 500 years.
Rare	1.0% - 5.0% AEP	Flooding is unlikely but is possible under unusual weather conditions; 1 to 5 percent chance of flooding in any year or nearly 1 to 5 times in 100 years
Occasional	5.0% - 50% AEP	Flooding is expected infrequently under usual weather conditions; 5 to 50 percent chance of flooding in any year or 5 to 50 times in 100 years.
Frequent	>50% AEP	Flooding is likely to occur often under usual weather conditions; more than a 50 percent chance of flooding in any year (i.e., 50 times in 100 years), but less than a 50 percent chance of flooding in all months in any year.
Very frequent	>50% MEP	Flooding is likely to occur very often under usual weather conditions; more than a 50 percent chance of flooding in all months of any year.

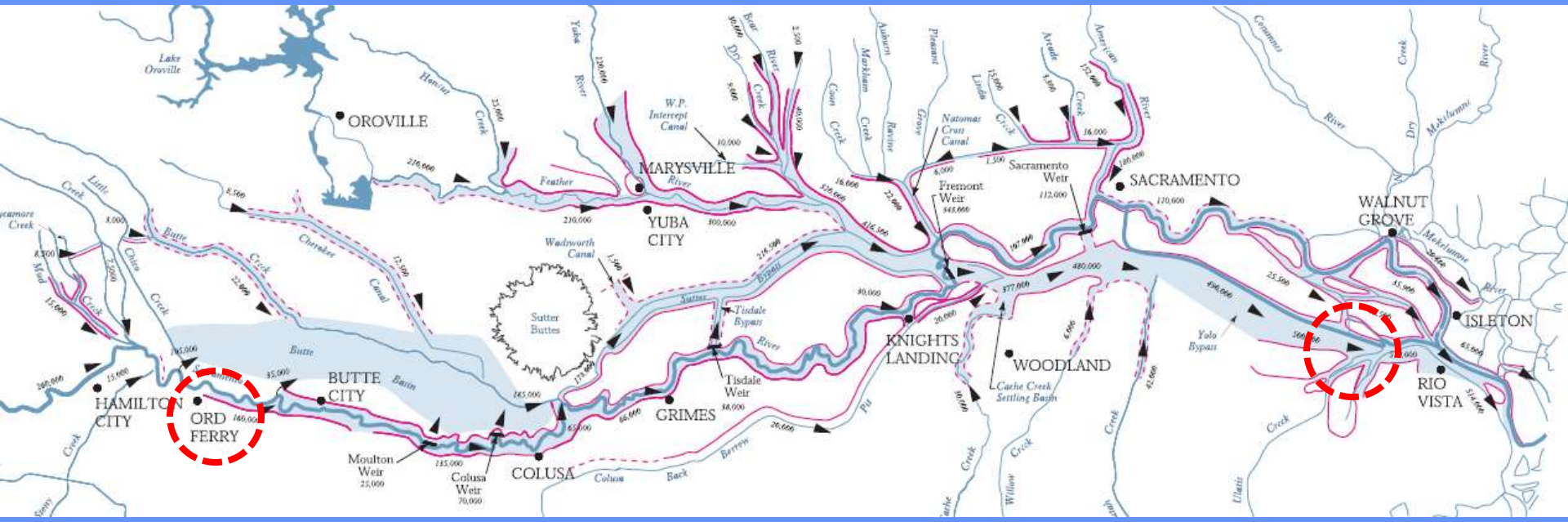
FEMA Flood Zones and DWR LFPZ





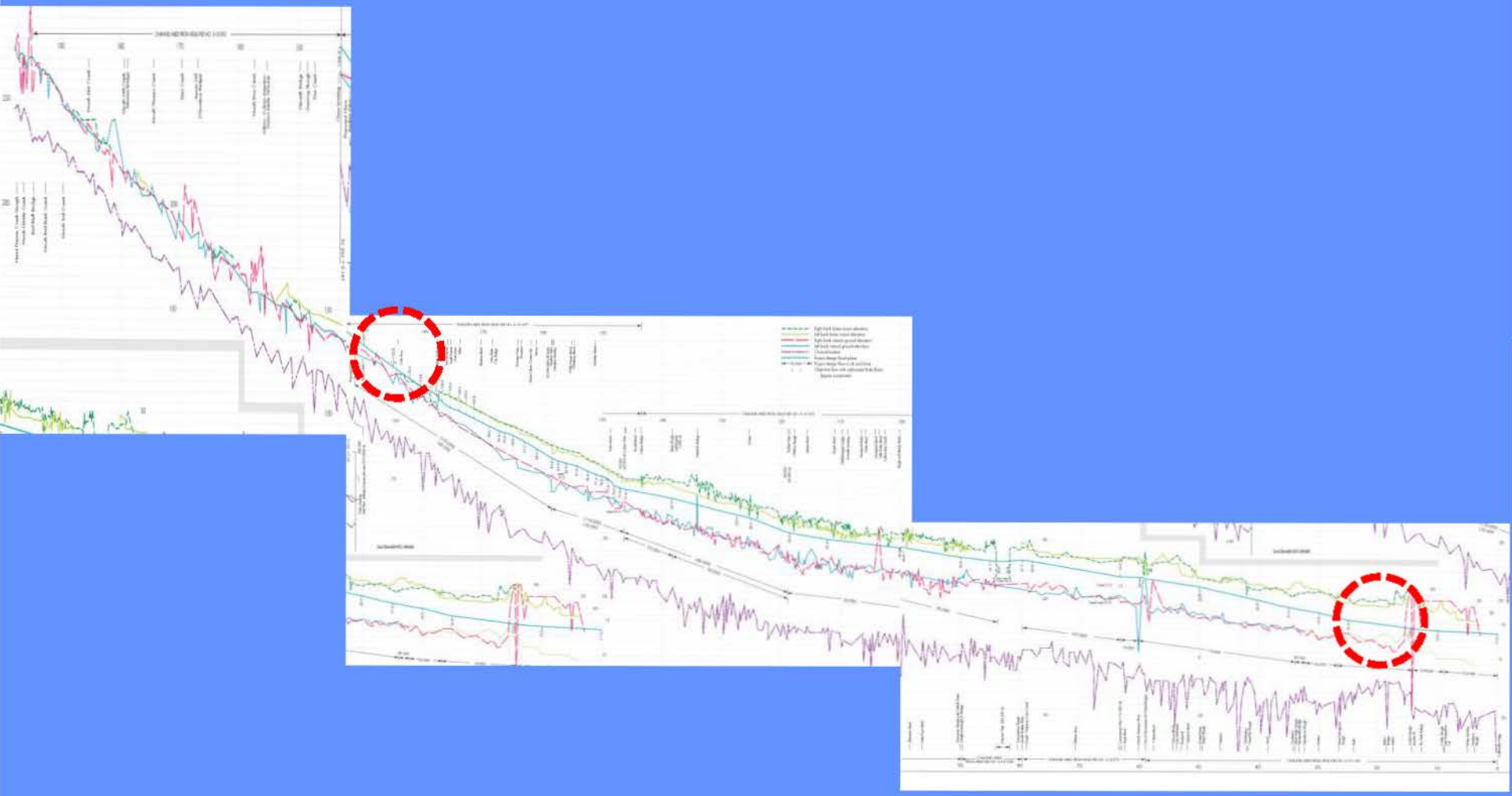
http://www.water.ca.gov/floodmgmt/lrafmo/fmb/fes/levee_protection_zones/LFPZ_maps.cfm

Reach of Interest

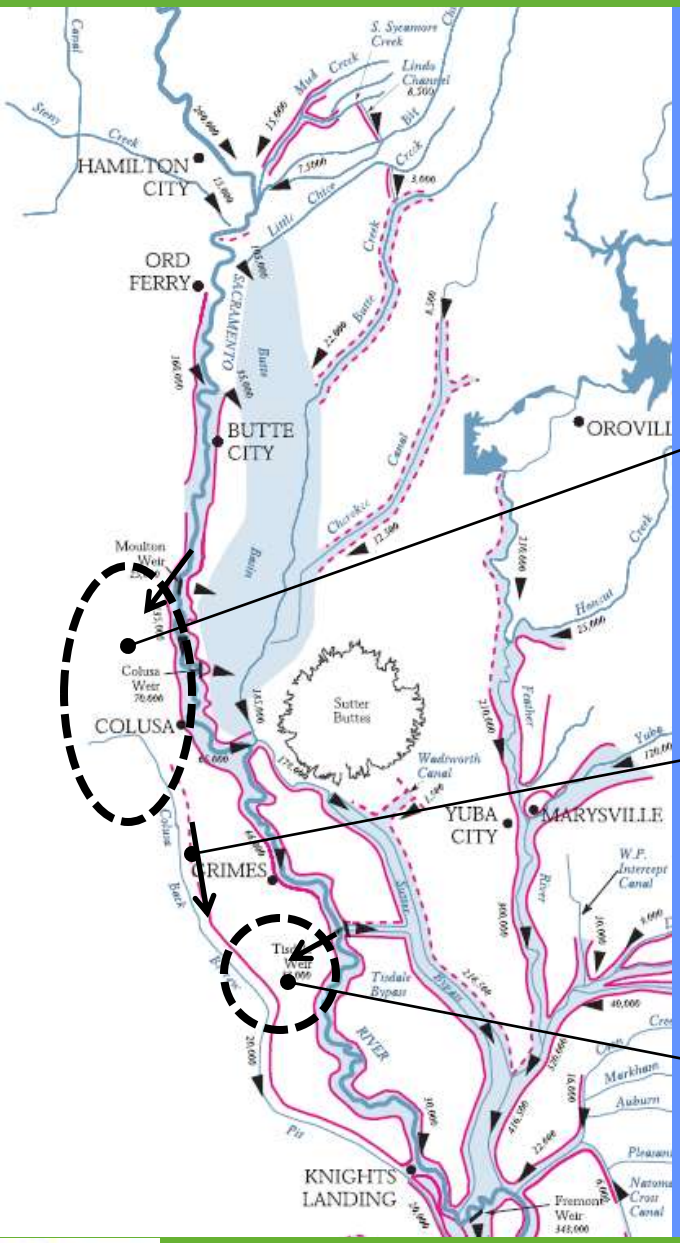


Attenuate ⟶ Bypass ⟶ Convey

Reach of Interest



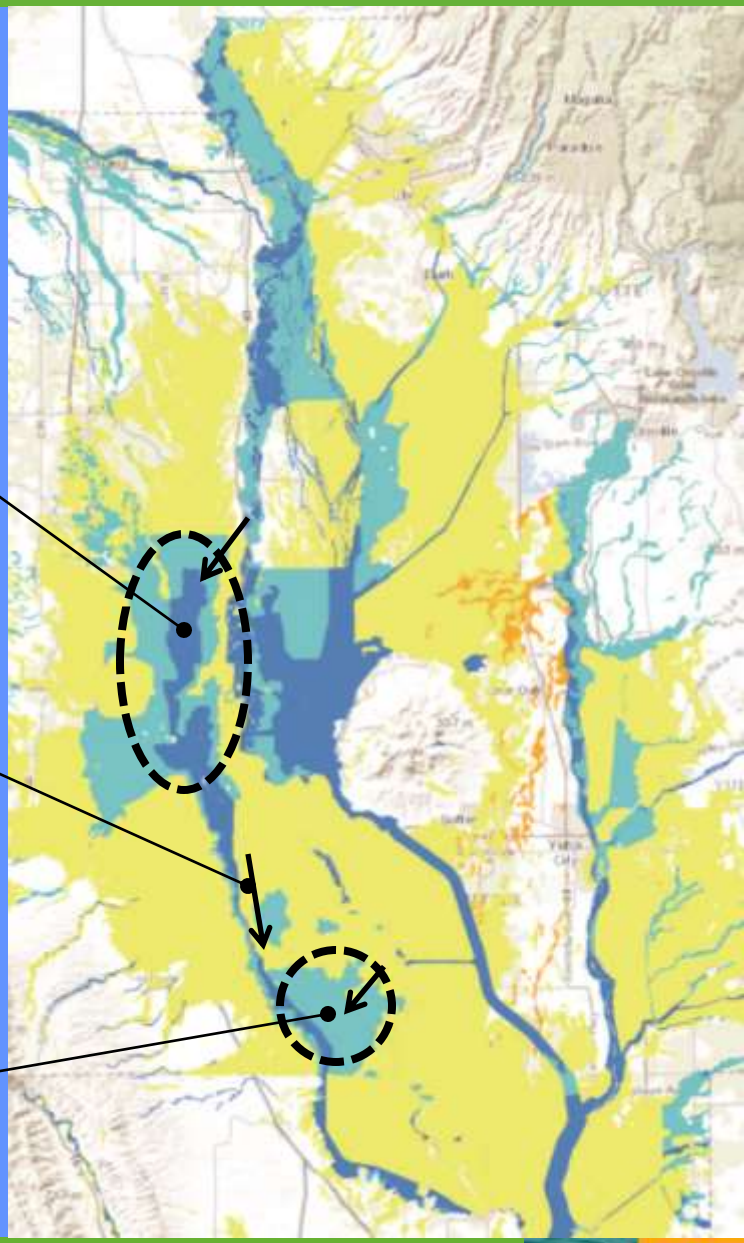
Potential Floodplain Management Scenarios



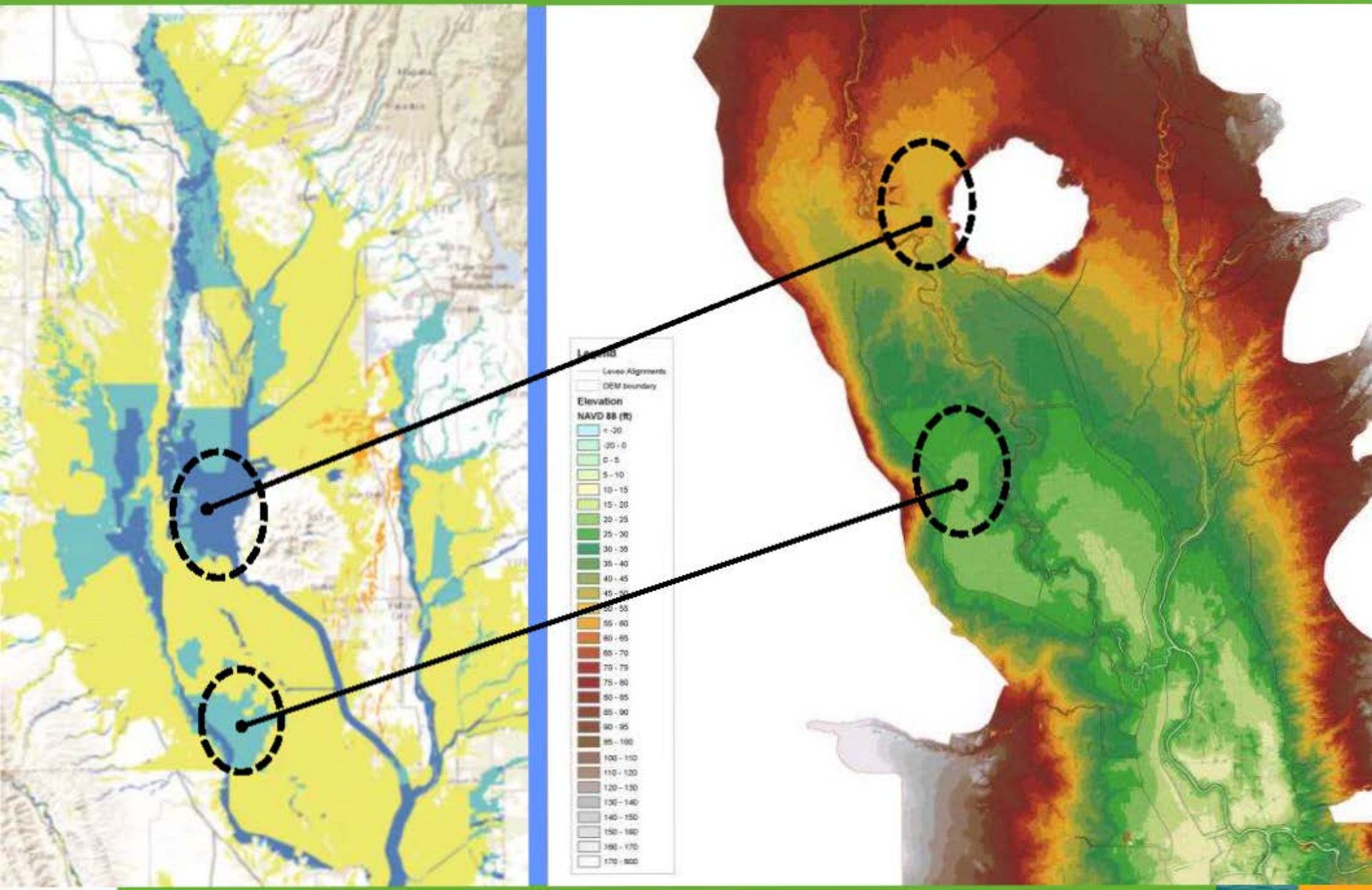
Create high-flow bypass upstream of Colusa towards Colusa Back Borrow Pit.

Expand Colusa Back Borrow Pit as new bypass/attenuation basin.

Create flood attenuation basin in topographic lows south of Grimes.



Potential Floodplain Management Scenarios



JFlow Model of the Sacramento Valley

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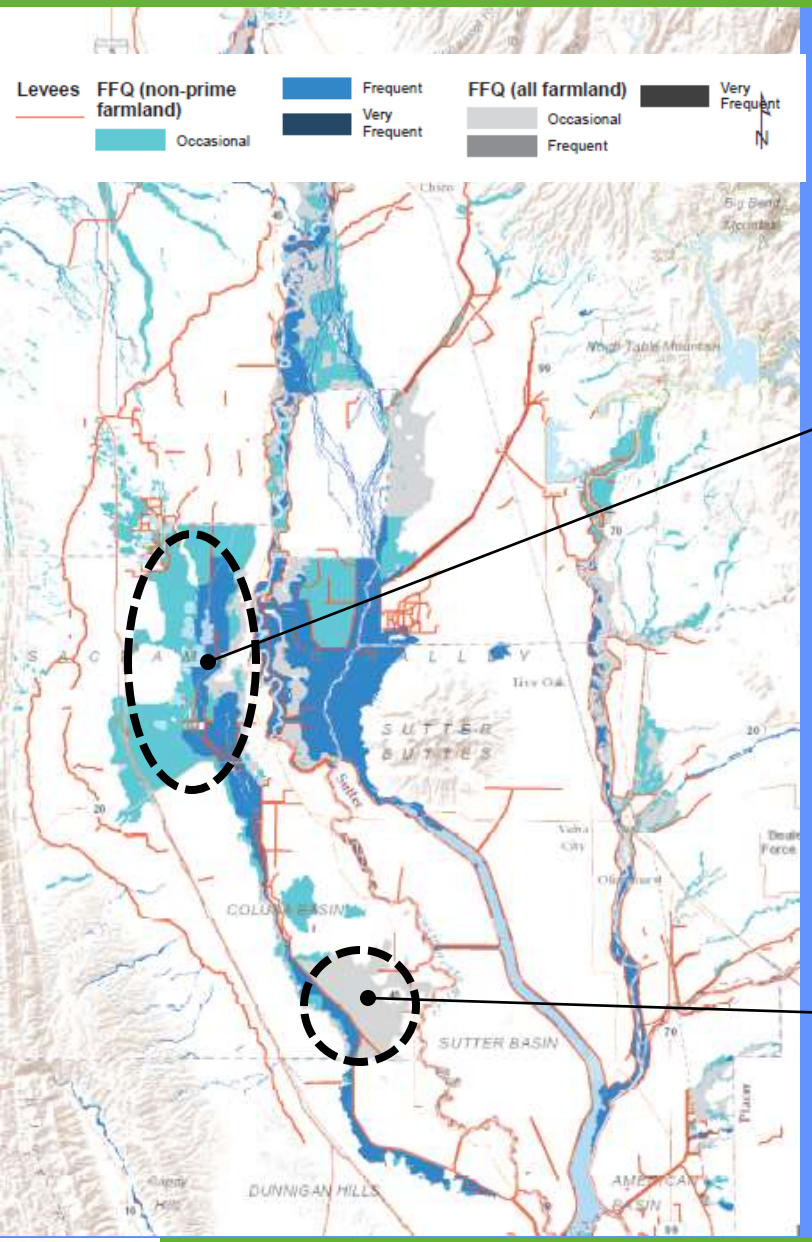
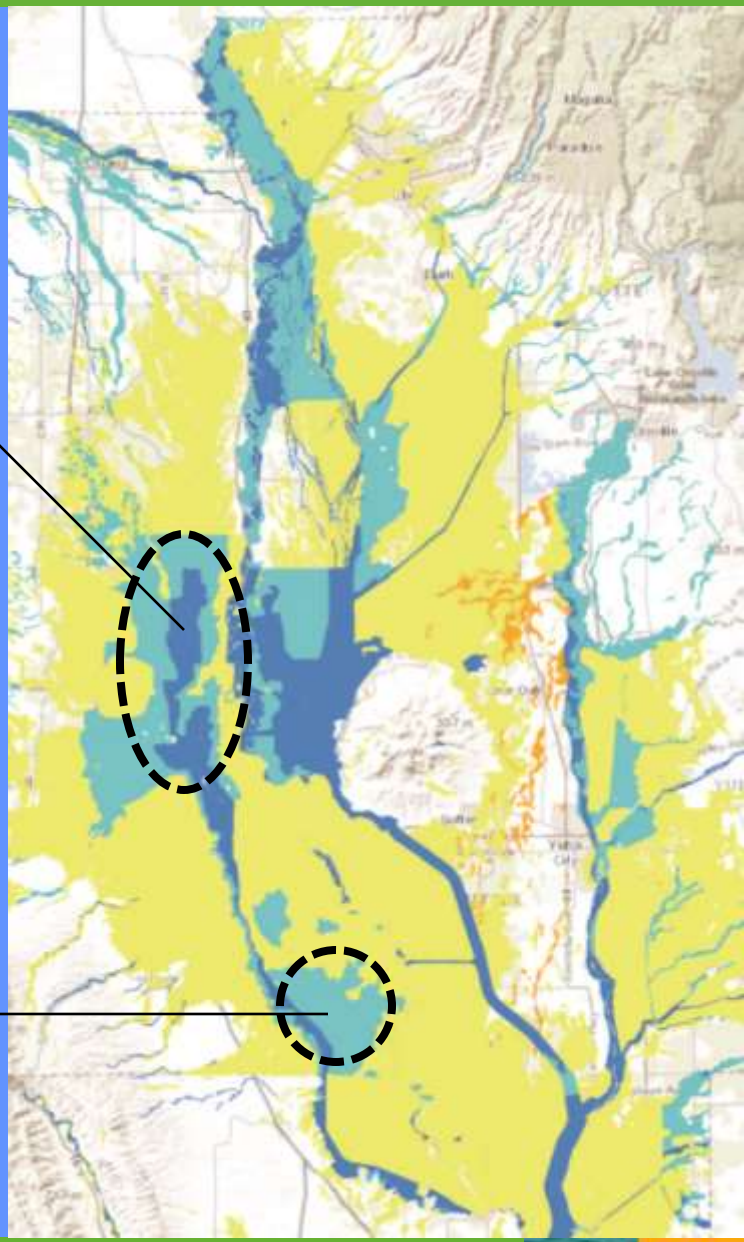
FloodSAFE CALIFORNIA

Potential Floodplain Management Scenarios

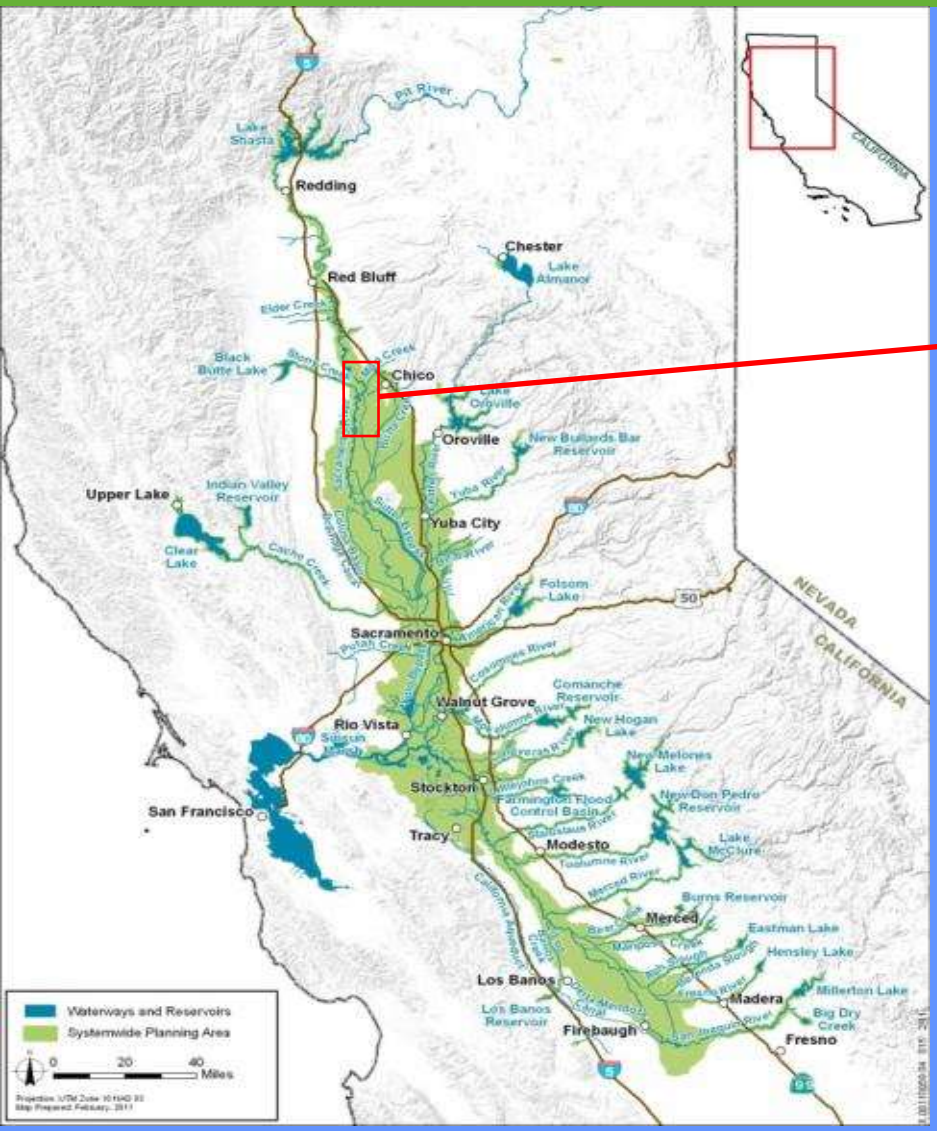


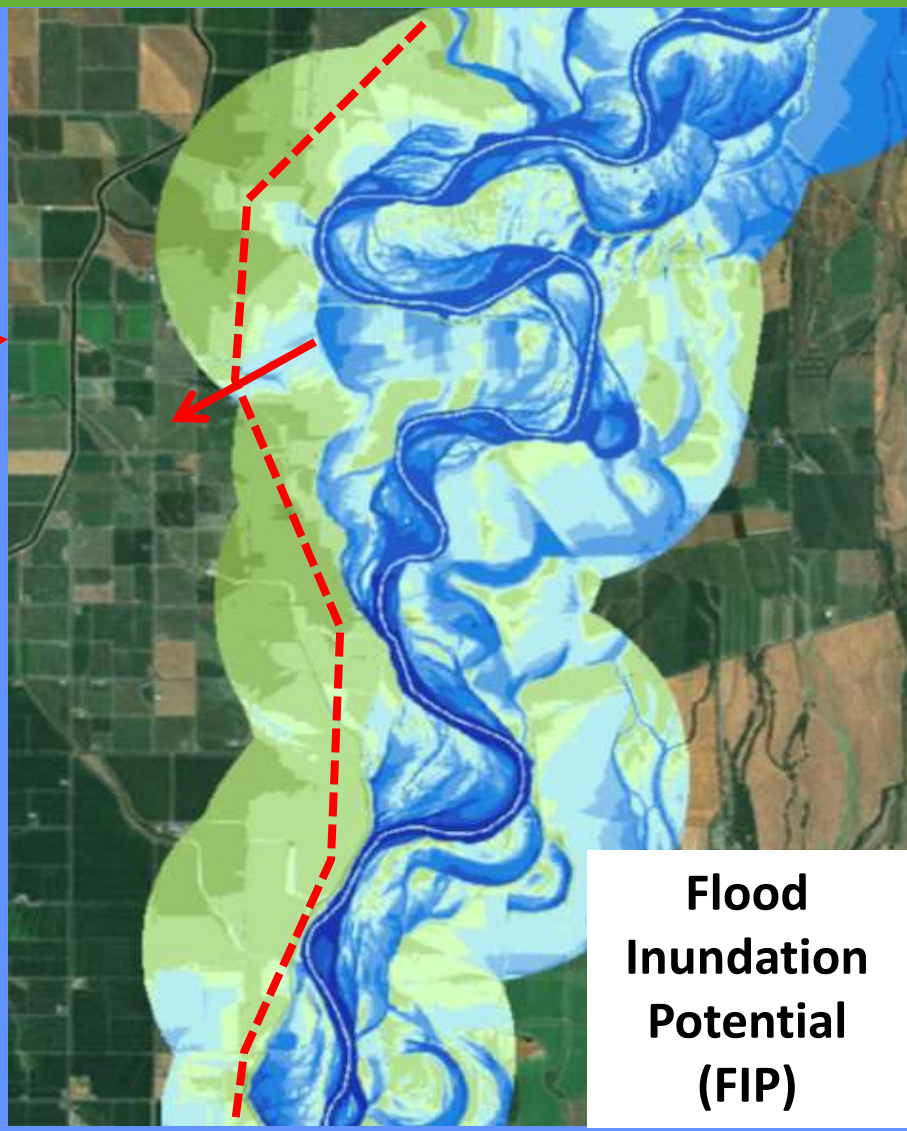
Flood-prone soils not within prime agricultural lands.

Flood-prone soils within prime agricultural lands.



River Corridor Management Actions

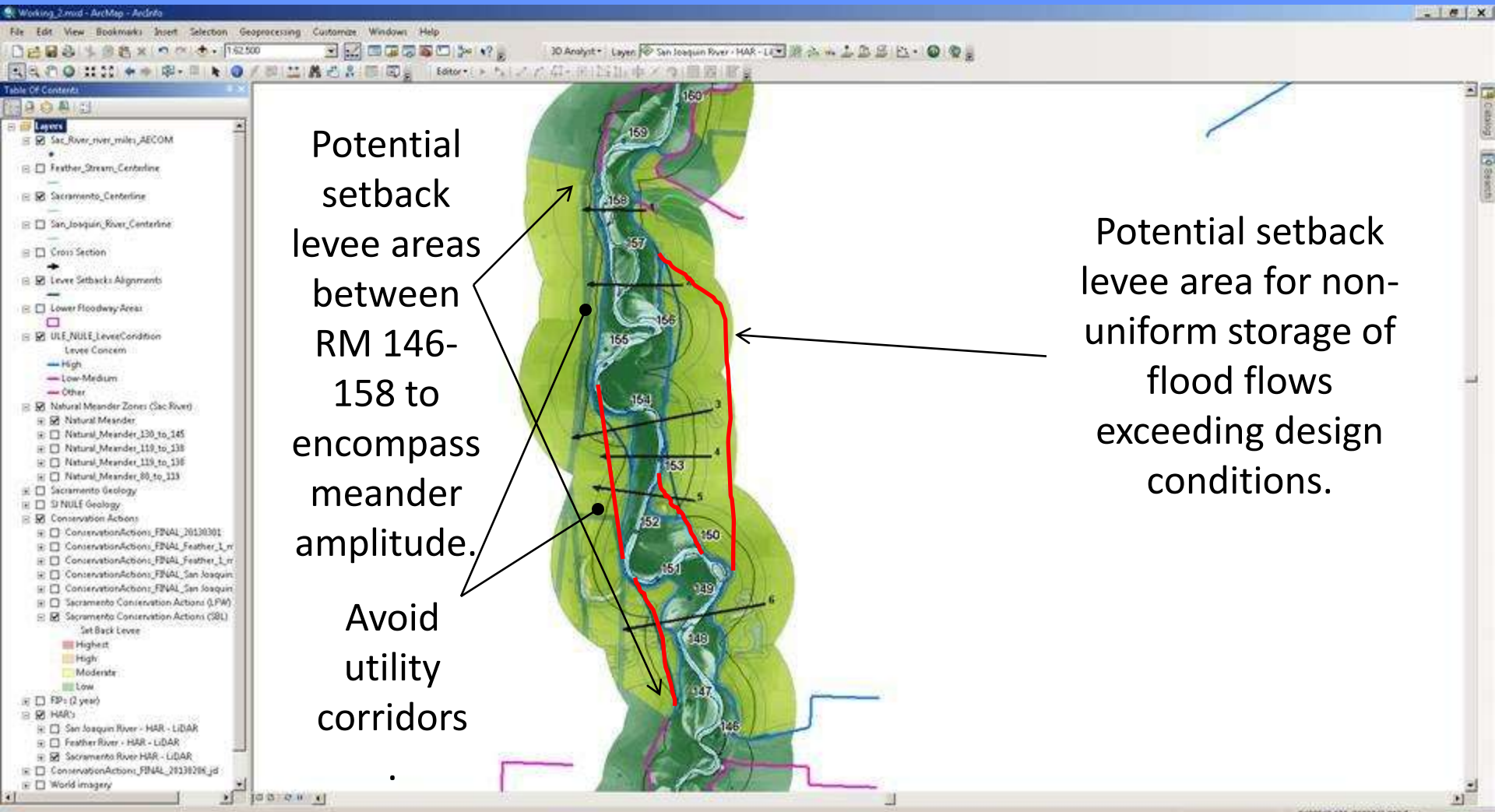




Flood Inundation Potential (FIP)

Use FIP data to quickly to identify overflows and establish potential setback levee alignments on high ground relative to flood profiles to minimize levee heights, where possible, and costs.

FROA Phase 2 - Sacramento River RM 146-160
March 2008 LIDAR FIP – Setback Levees



Animations

JFLOW Support of CVFPP Goals

- Improve Flood Risk Management
- Promote Ecosystem Functions
- Improve Operations & Maintenance
- Improve Institutional Support
- Promote Multi-Benefit Projects

Thank You For Listening!

- Very special thanks to many people:
  - Funders: DWR FESSRO and Resources Legacy Fund
  - cbec and JBA team
  - TAC: Ray McDowell, Stacy Cepello, Kristin Brainerd, Joe Countryman, Joe Bartlett, John Cain, Mark Tompkins, Pete Ghelfi, Renee Henery, Steve Greco, Lester Snow
  - Friendly advice: Todd Bernardy, Mary Jiminez, Tim Washburn, Ted Frink, Craig Williams, Stefan Lorenzato.
  - Any other people I forgot, I apologize!