

What's Your Drought Vulnerability? (Surviving the Drought of 2012-2014)



Jay Jasperse, P.E.

Chief Engineer

Sonoma County Water Agency

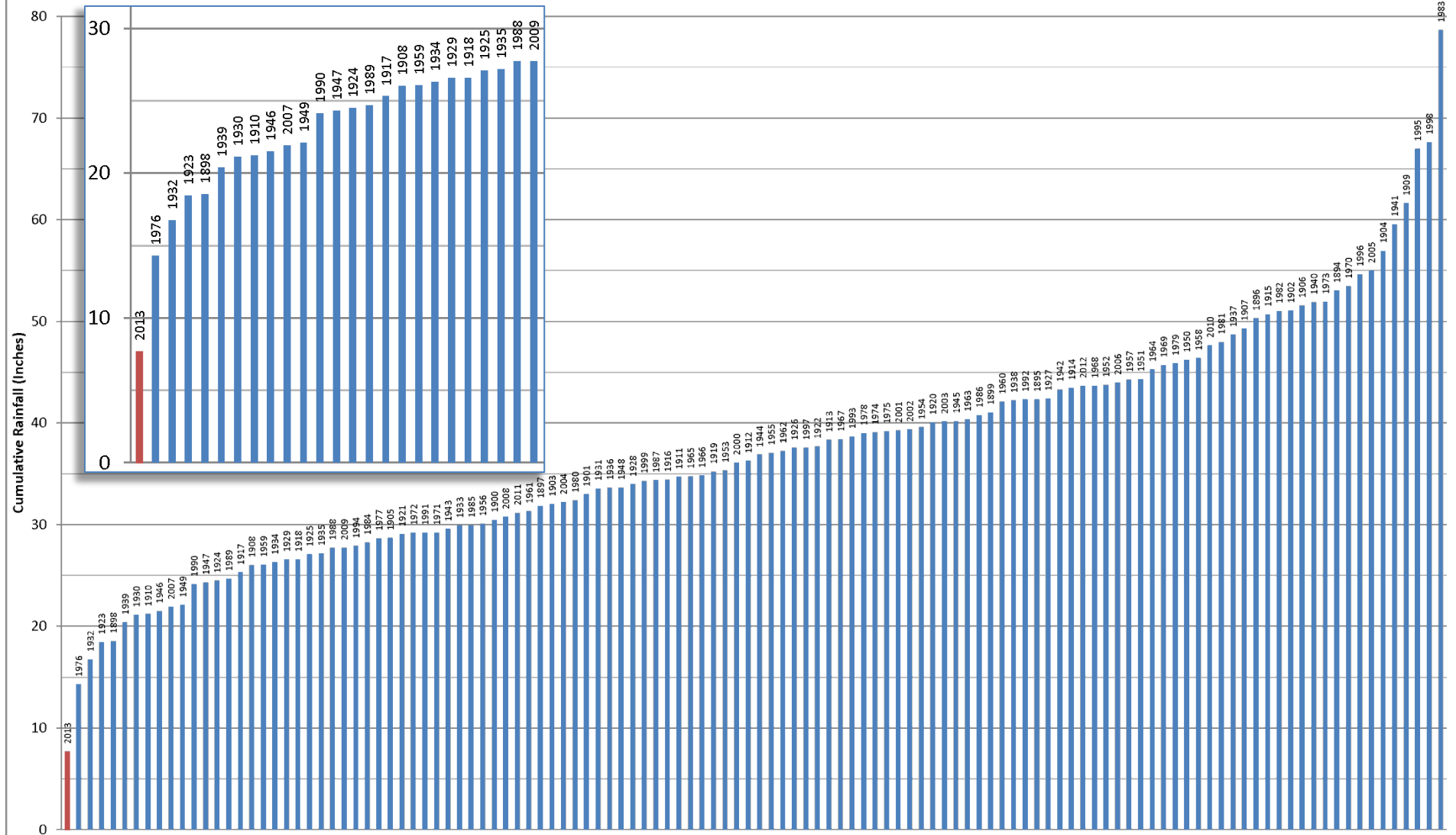
February 21, 2014



Historical Ukiah Precipitation

120 Year Record

Ukiah Cumulative Rainfall Through December 31 (Calendar Year) 1894-2013



2013 Rainfall vs. Tree Ring Analysis

RUSSIAN RIVER VALLEY PRECIPITATION AND STREAMFLOW RECONSTRUCTED FROM BLUE OAK TREE RINGS

Daniel Griffin¹, Connie A. Woodhouse¹, and David W. Stahle²

¹UCAR Institute of Environment and Natural Resources, University of Arizona
²Department of Geosciences, University of Arizona

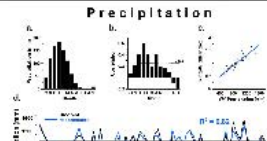


Quercus douglasii

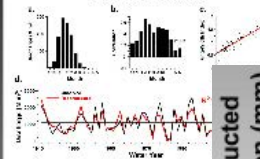


In the Russian River there is 2000 km² of forest south of San Francisco (Golden Gate). Some of the heavily regulated surface water in the Russian River Valley include a successful wine production industry, more than 100 people in (Weedwood, Sonoma, and Marin Counties), and a number of historically managed oak groves. Like in the Chinese cotton production, which in recent years, through over-irrigation, has led to a decline in water quality and water imported from the neighboring Red River Basin has been problematic for the Russian County Water Agency, where required to maintain minimum flows for the dry season almost run. As stakeholders and water managers continue to put for sustainability into the mid-21st Century, an investigation of the Russian River Valley, an otherwise irrigated, forested, water source to support 300,000 people. The investigation targeted Mt. Diablo, a long-standing water source, and recently developed at California State University, Stanislaus in the Russian River Valley. The investigation, through a partnership, used well-established methods of dendrochronology, and tree-ring analysis, with a statistical analysis of precipitation and streamflow in the Russian River valley, as a preliminary assessment on coverage of the long-lived trees on chronologies from the north coast region (Bear Valley and Mt. Diablo). The study was conducted with water year precipitation measured from stations at Ukiah and Santa Rosa (see inset), and also with the most recent annual mean of natural flow on the Russian River at Healdsburg (see inset).

The link between tree-ring growth and precipitation is not linear, and is a function of the regional climate. The regional climate is characterized by a Mediterranean climate, with winter precipitation and summer drought. The regional climate is characterized by a Mediterranean climate, with winter precipitation and summer drought. The regional climate is characterized by a Mediterranean climate, with winter precipitation and summer drought.

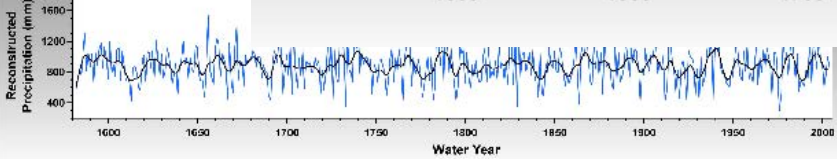
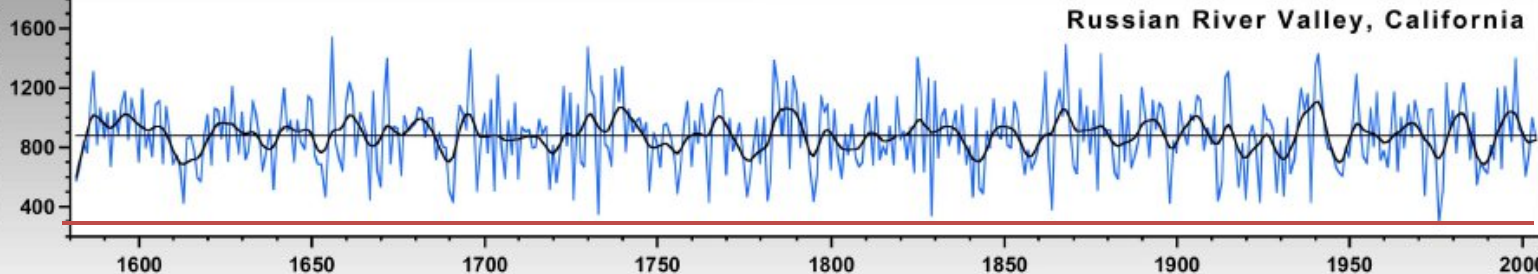


Streamflow



In other words, instead of wet and dry years, there are wet and dry years. In other words, instead of wet and dry years, there are wet and dry years. In other words, instead of wet and dry years, there are wet and dry years.

Reconstructed Precipitation (mm)

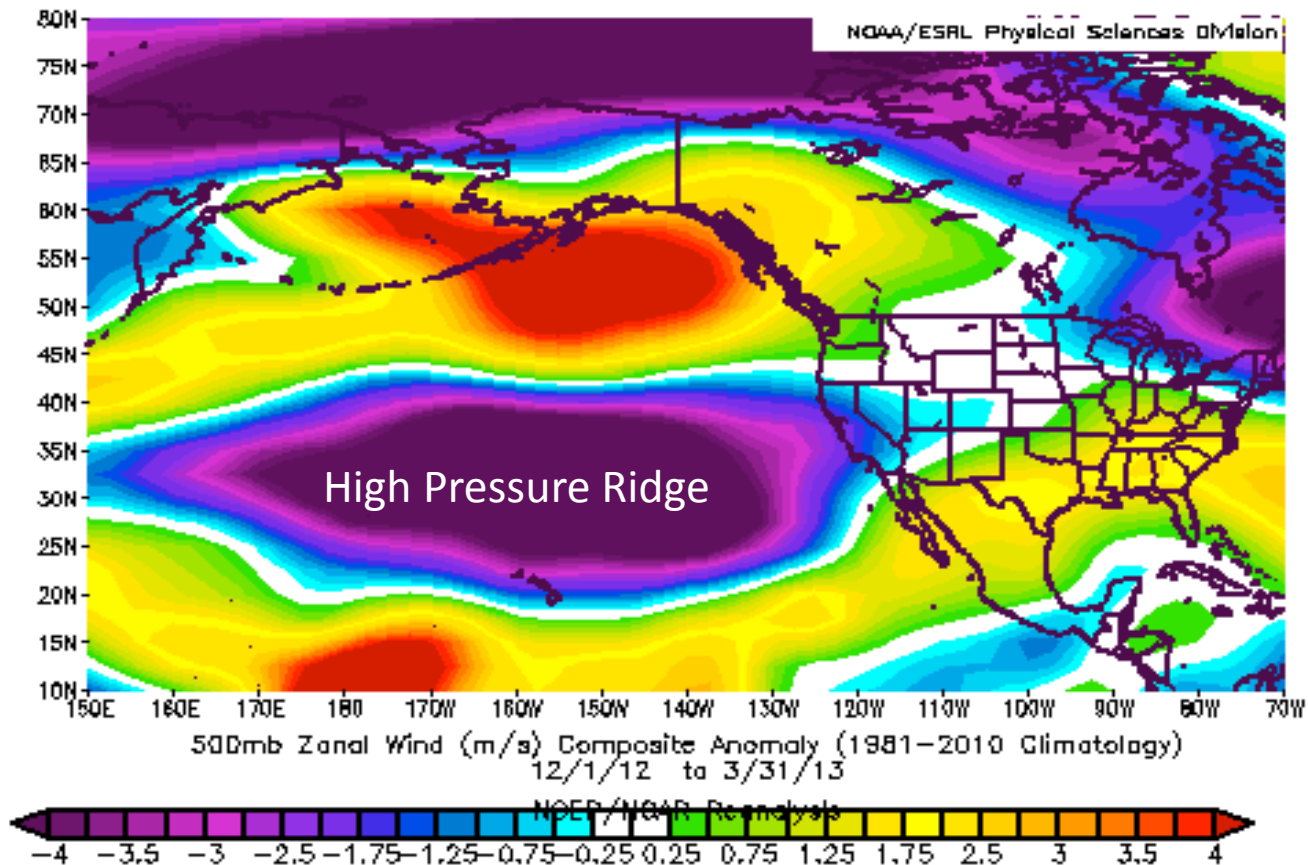


According to reconstructed precipitation study by University of Arizona:

Rainfall in last calendar year (red line) would be a historical low over past 400+ years

The Culprit!

Eastern Pacific High Pressure Ridge



Droughts Are Unlike Other Natural Disasters ...

- Droughts slowly creep into a region - unnoticed by most at first - and end abruptly
- The impacts are felt unequally depending on location & circumstances
- No one knows when the drought will be over until its over - Will it be next month or ten years from now?

Communities Have Different Drought Vulnerabilities

Depends on Location & Circumstances

- Surface Water - 2 Reservoirs, 2 Stories
- Groundwater - Areas of groundwater depletion & other areas generally stable groundwater conditions - at least for now!

No Agency Manages Entire Water Supply

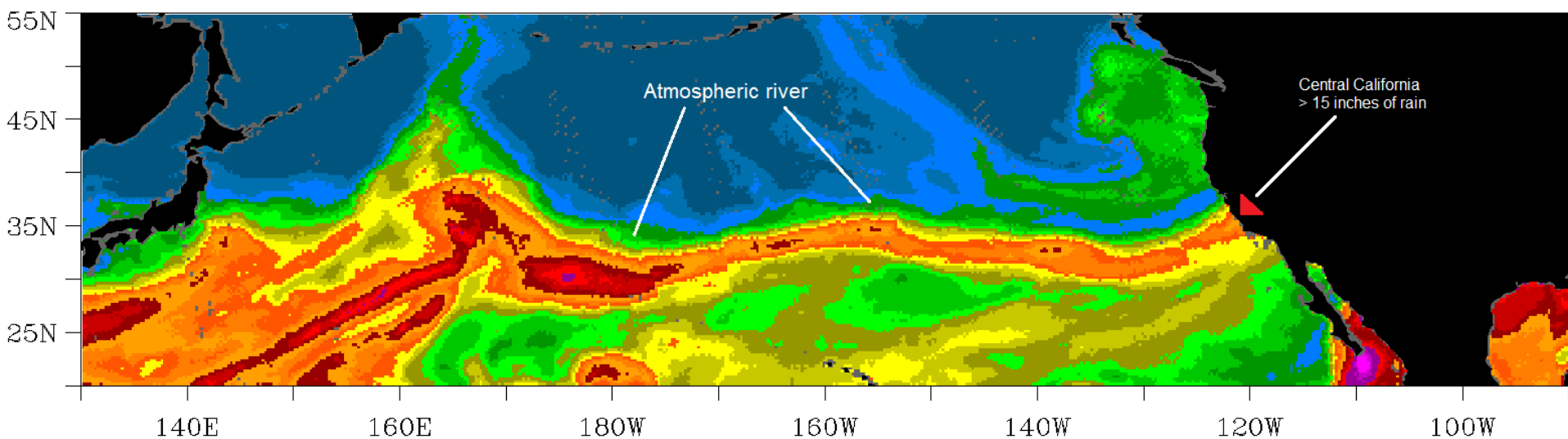
- Different approaches by Cities/Water Districts
- Rural residential & agriculture not part of developed water systems

Impacts People, Agriculture & Fish

- Pain felt by all



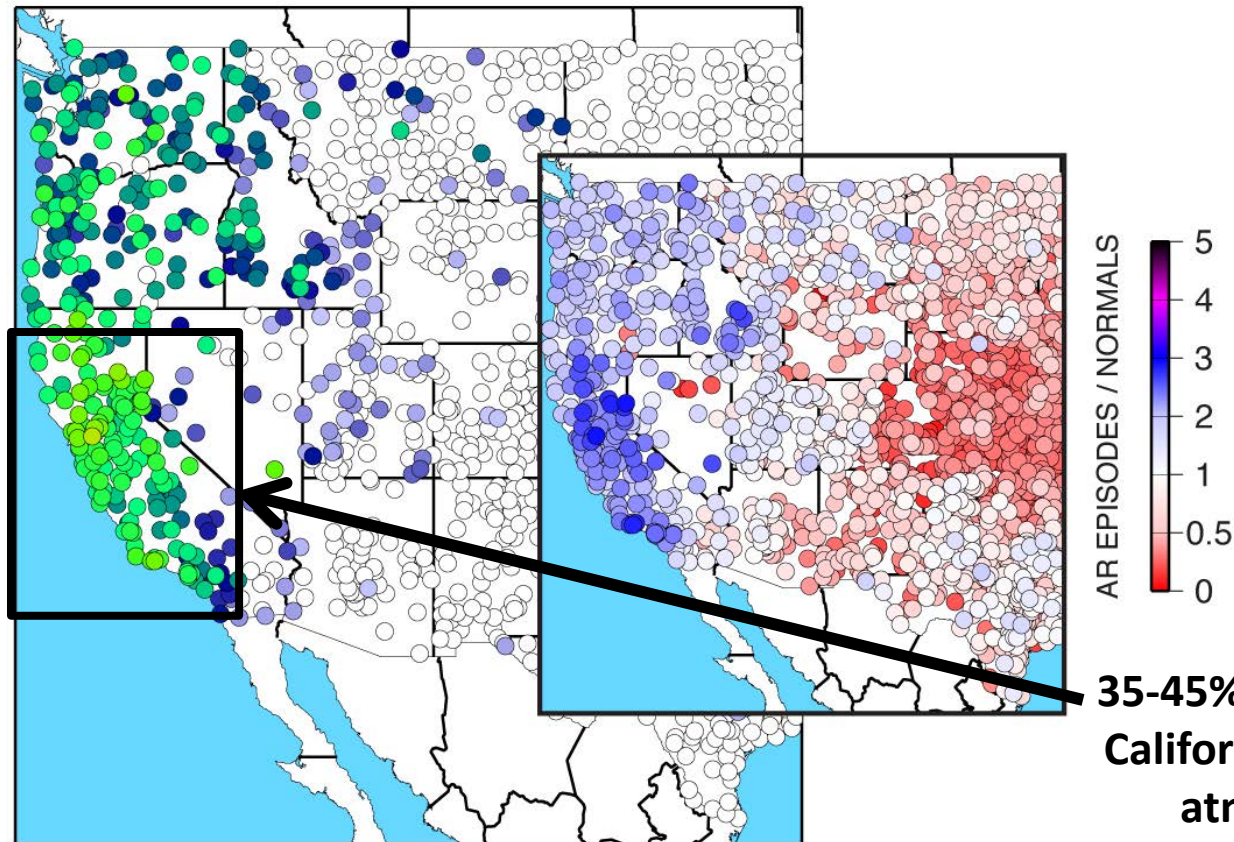
Is There Hope? Atmospheric Rivers: Drought Busters & Flood Producers



**A fire hose from the equator!
(It's hit or miss)**

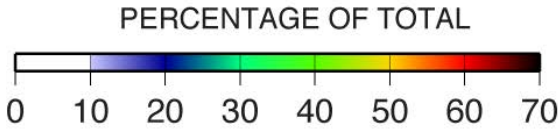
Atmospheric Rivers: A Major Factor in California Weather

CONTRIBUTIONS OF ALL AR EPISODES (days 0 to +1)
TO TOTAL PRECIPITATION, WY 1998-2008



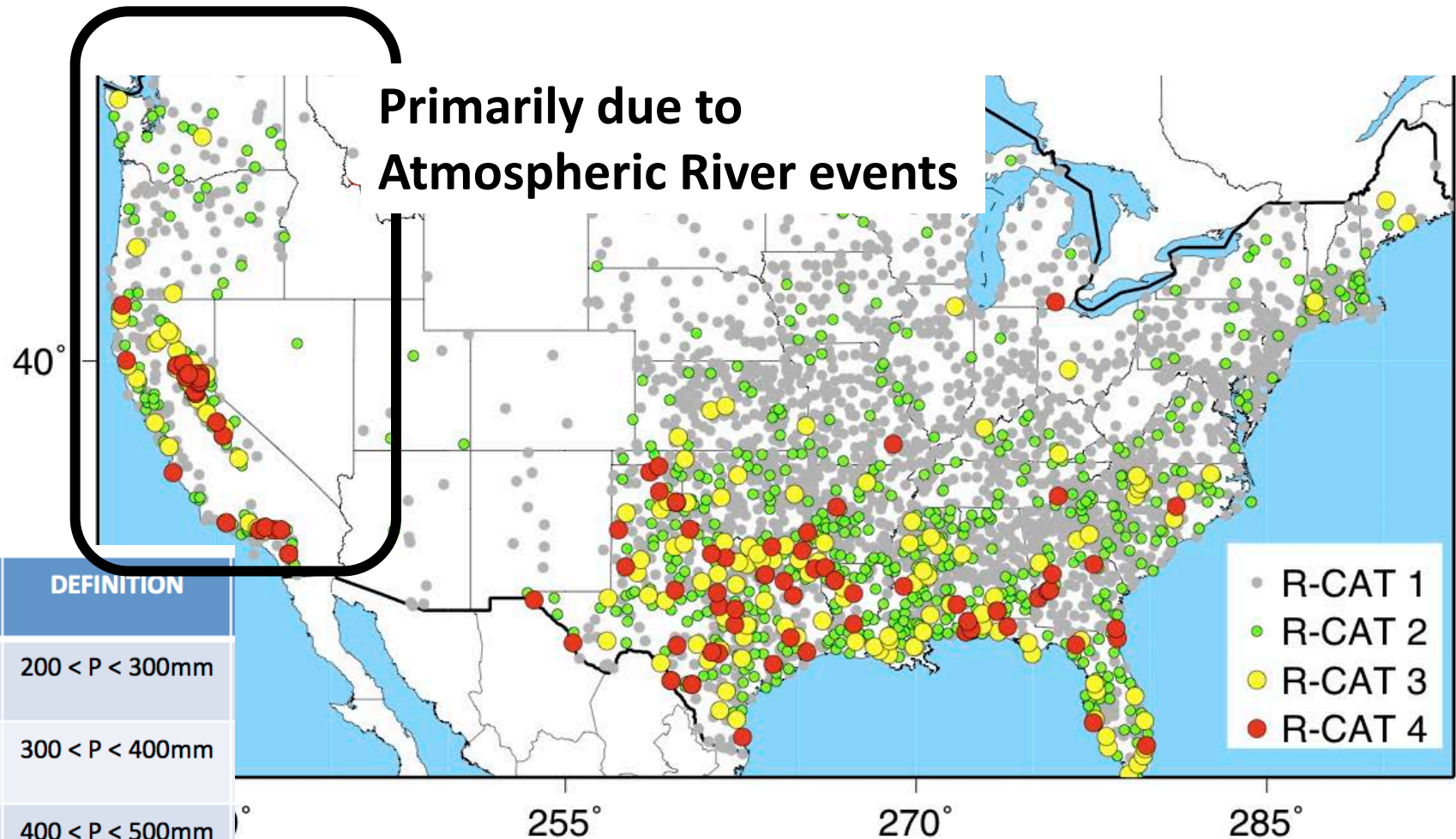
An average AR transports the equivalent of 7.5 times the average discharge of the Mississippi River, or ~10 M acre feet/day

35-45% of annual precipitation in California fell in association with atmospheric river events



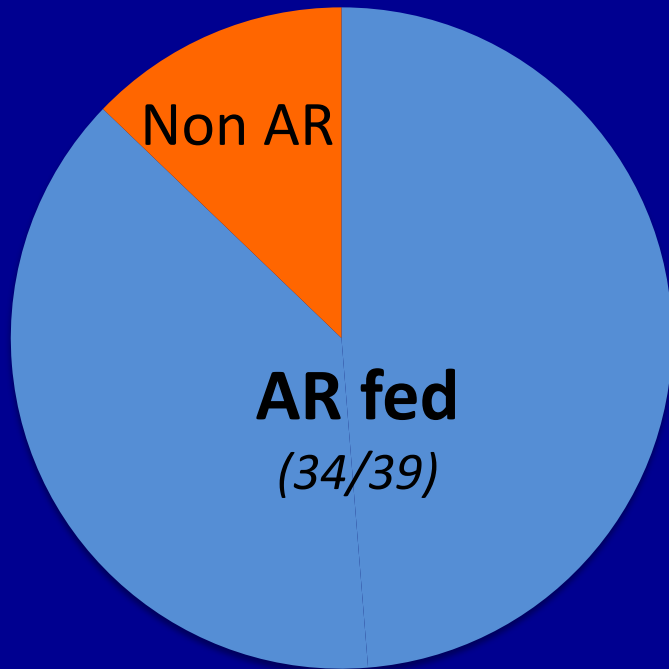
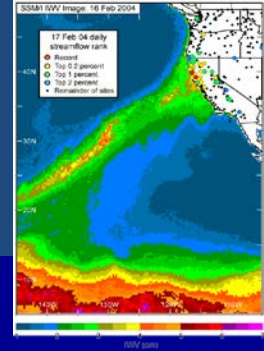
Atmospheric Rivers, Floods and the Water Resources of California
by Mike Dettinger, Marty Ralph, Tapash Das, Paul Neiman, Dan Cayan
Water, 2011

LARGEST 3-DAY PRECIPITATION TOTALS 1950-2008



Ralph, F.M., and Dettinger, M.D., Historical and national perspectives on extreme west-coast precipitation associated with atmospheric rivers during December 2010: Bulletin of the American Meteorological Society, (in press, Nov 2011)

ARs & Russian River floods



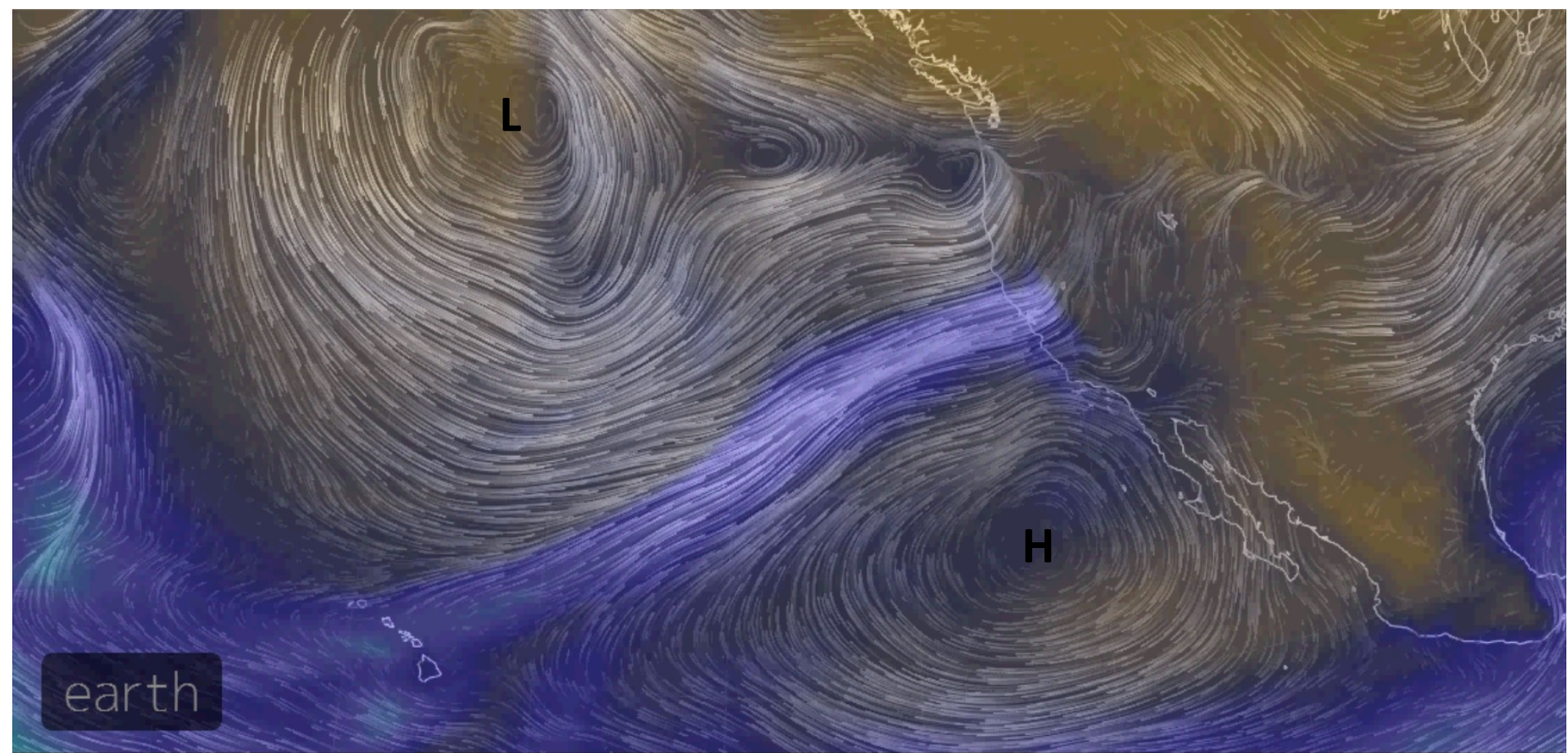
- ALL 7 major floods of Russian River since 1997 have been atmospheric rivers (Ralph et al, GRL, 2006)

On a longer time scale, among all 39 “declared” floods of the Russian River (39 cases with > 50,000 cfs) from 1948-2011...

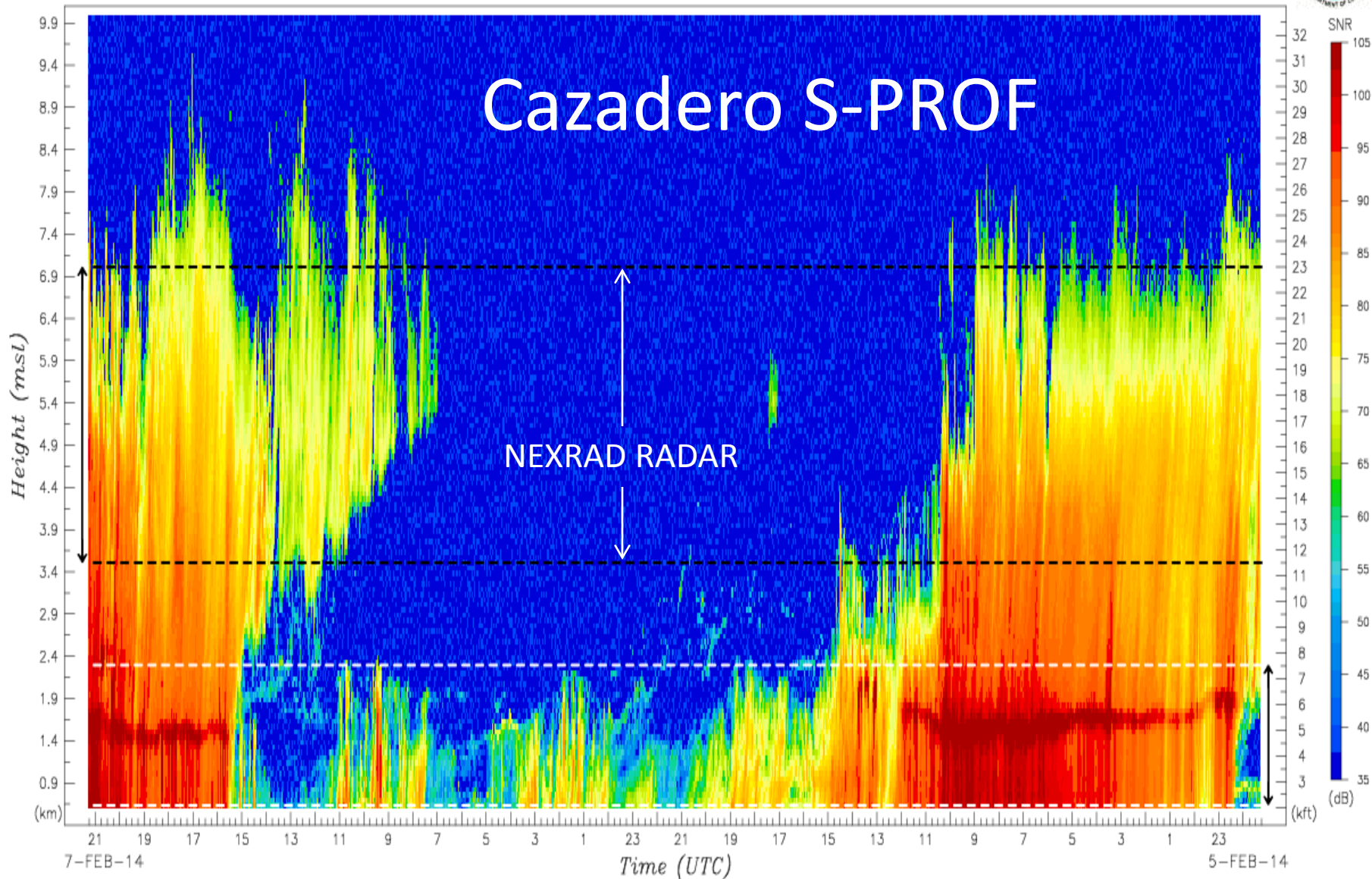
87% were caused by ARs

~45% Rainfall in Sonoma Co. Due to Atm. Rivers

February 8, 2014 Atmospheric River – (A Moderate Atm. River)



ESRL Physical Sciences Division
S-band Precipitation Profiling Radar



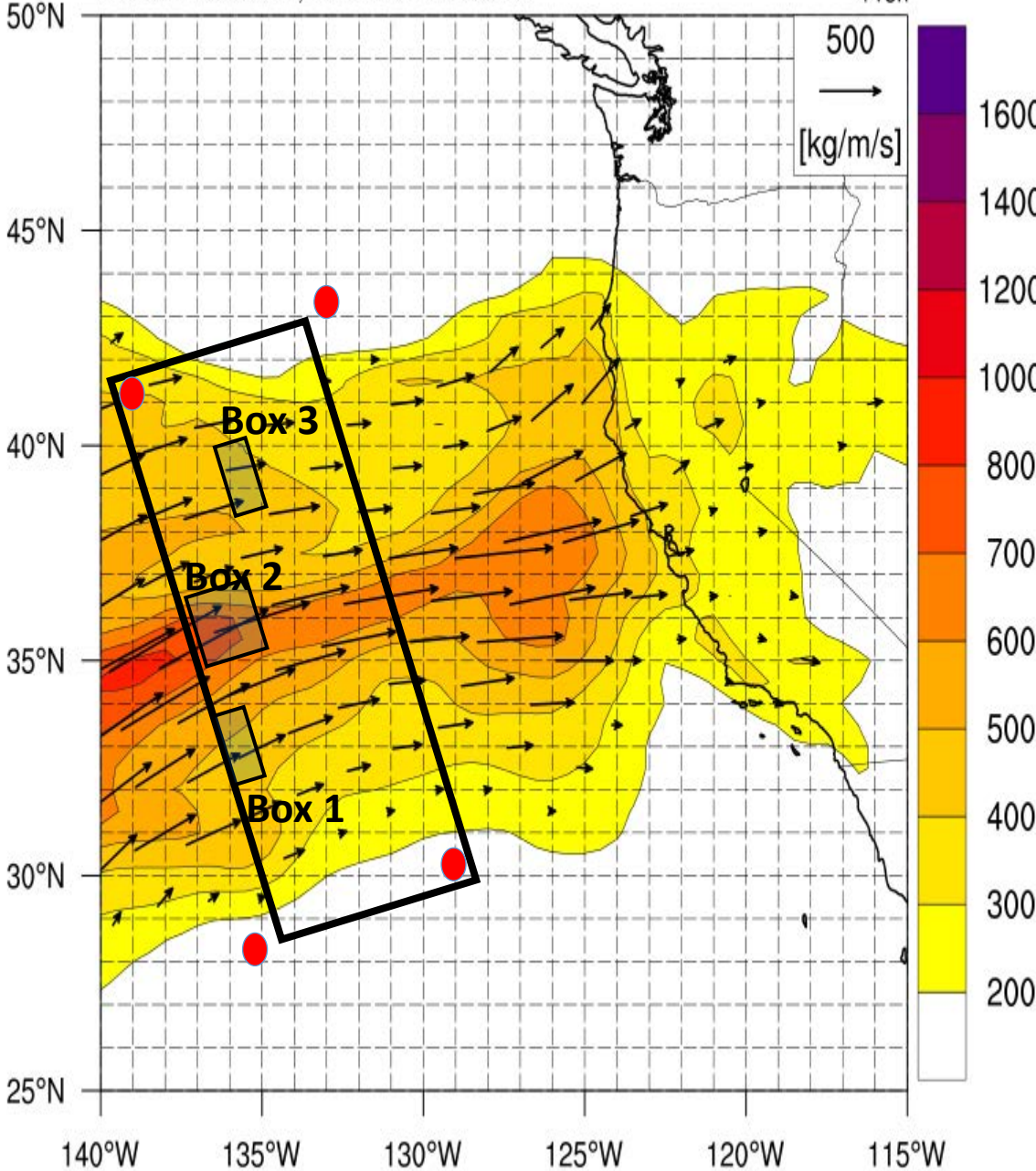
Cazadero, CA (CZC)
38.61 N, 123.22 W, 475 m

--- KMUX NEXRAD 0.5 degree elevation (black)
--- KPIX C-band 0.0 degree elevation (white)

NCEP GFS IVT and Vector

Init: 6Z Fri 02/07/14; Verif: 21Z Fri 02/07/14

+15h



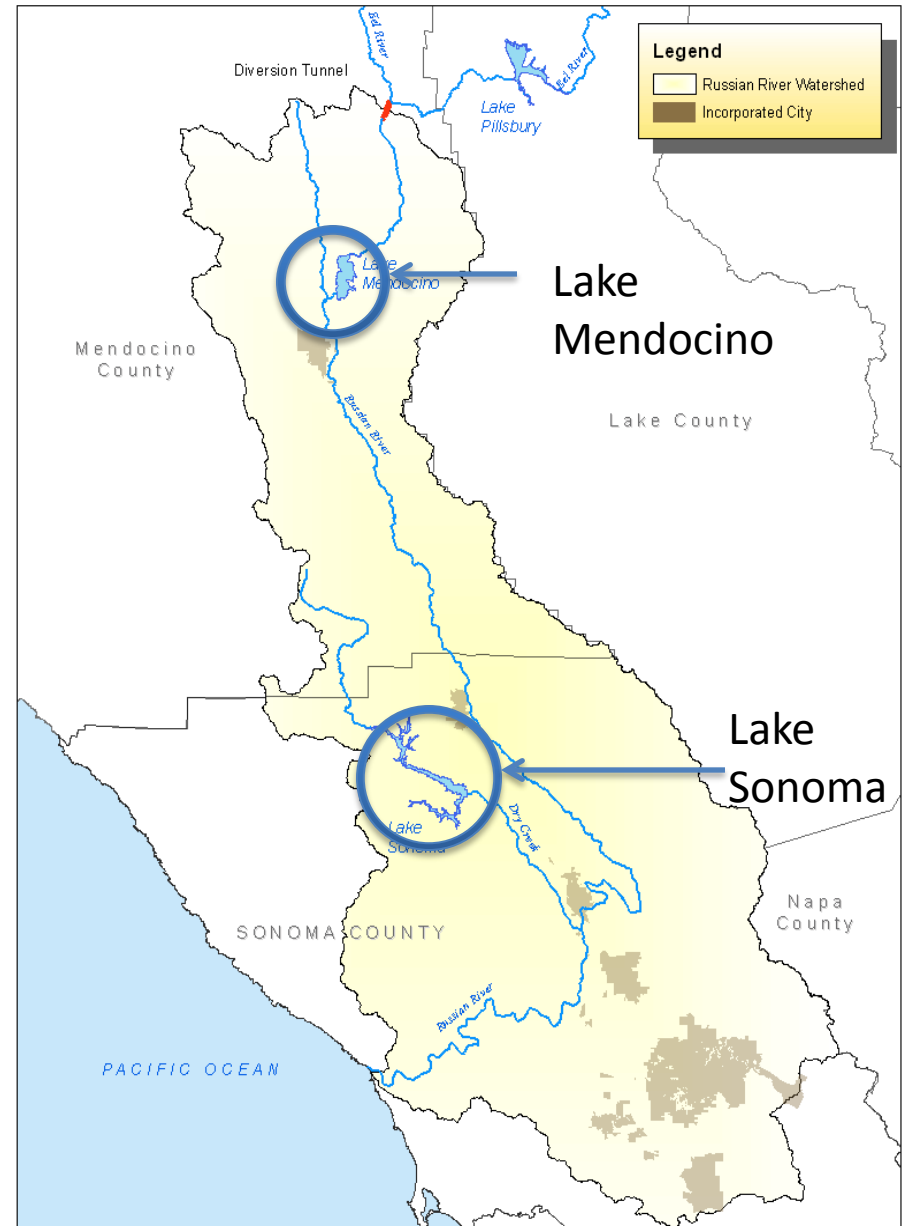
Atmospheric River Research – Hurricane Hunters



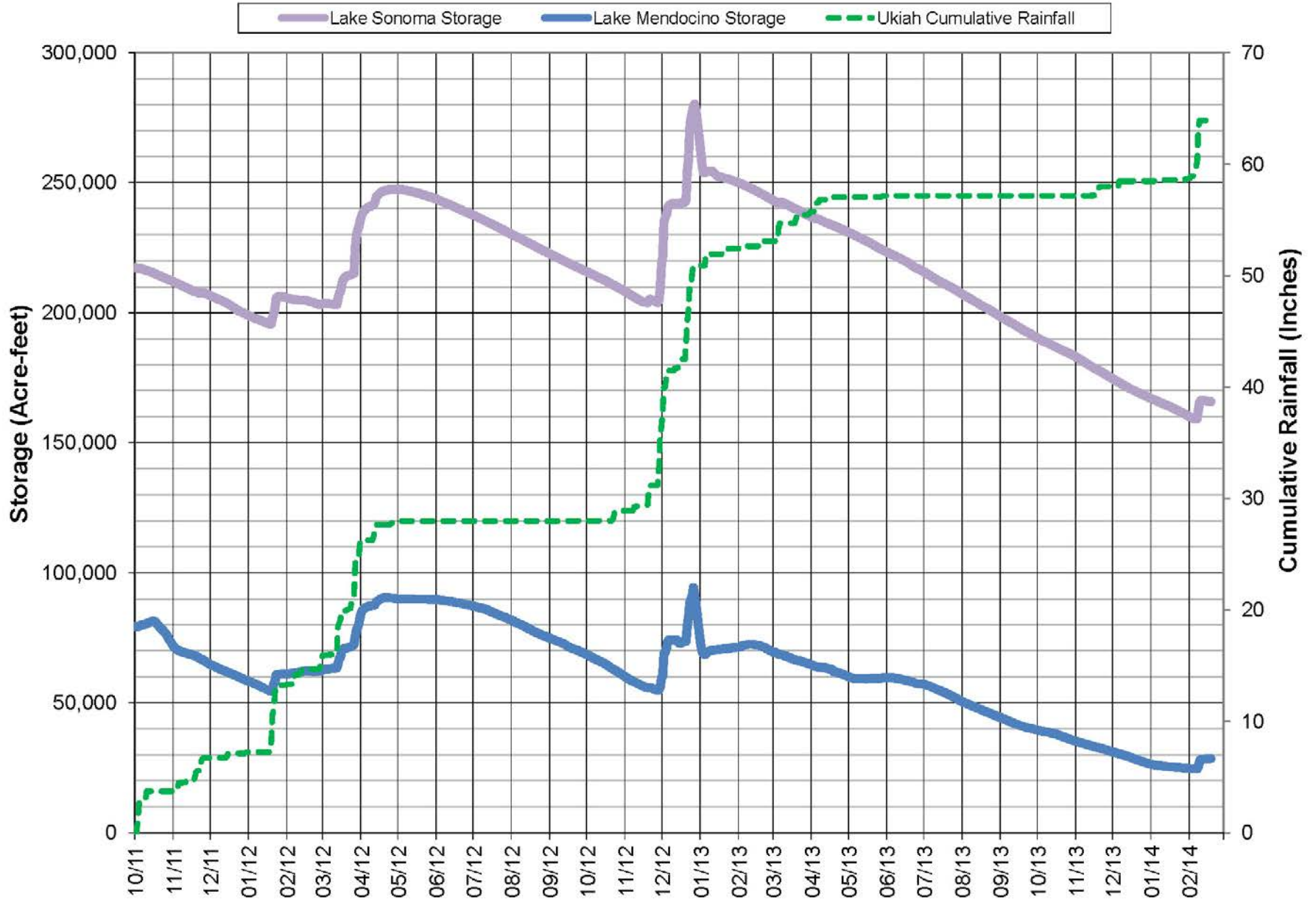
Drought Impacts: Russian River Water Supply Facilities - A Tale of 2 Reservoirs



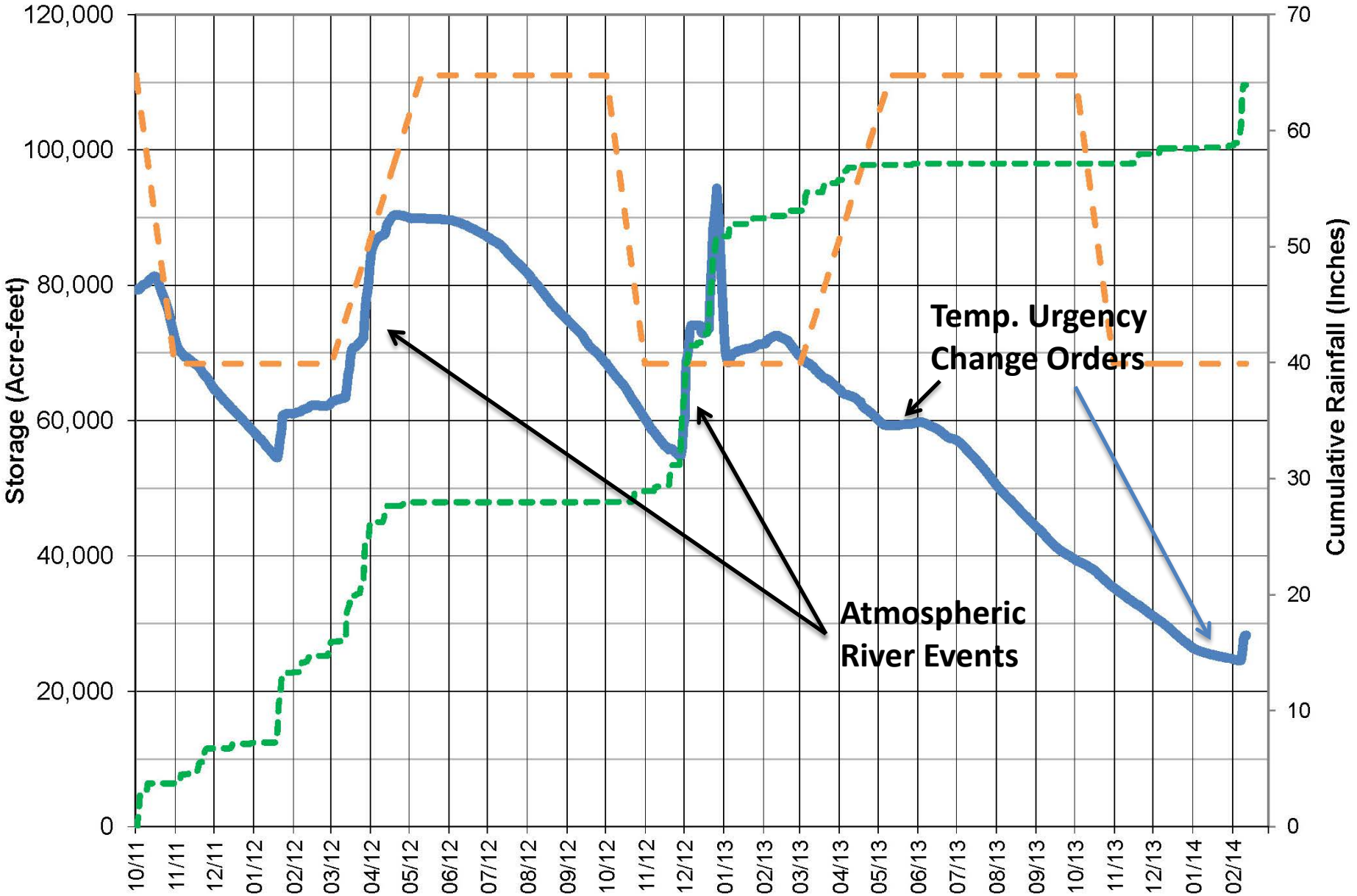
Lake Mendocino Dec. 2013



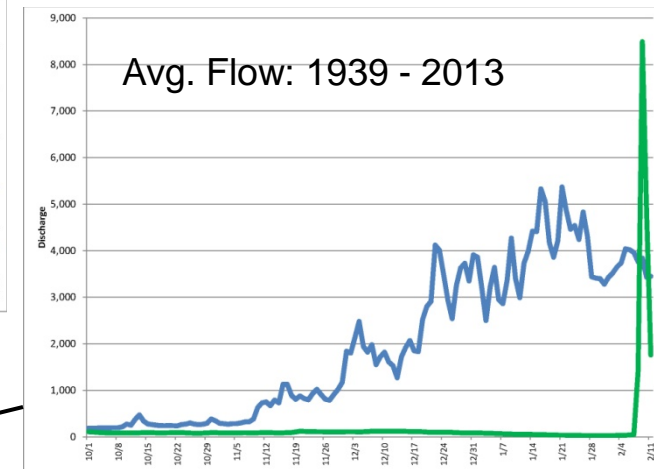
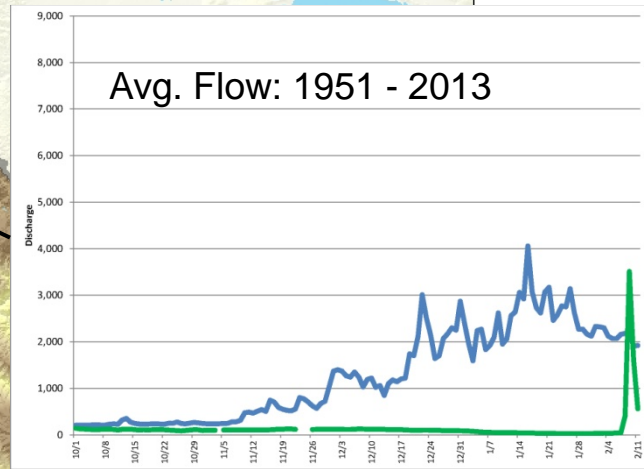
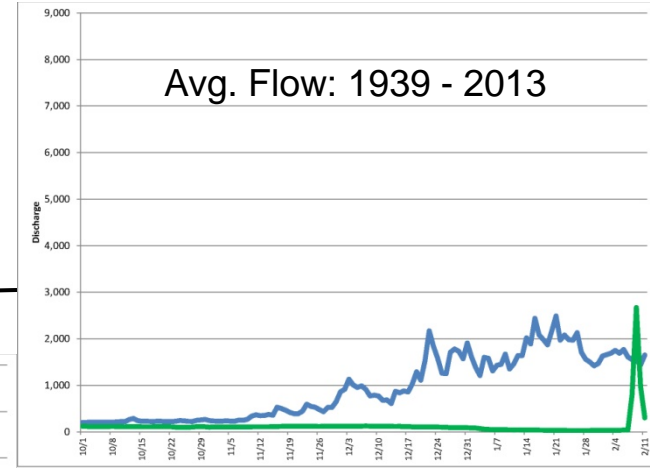
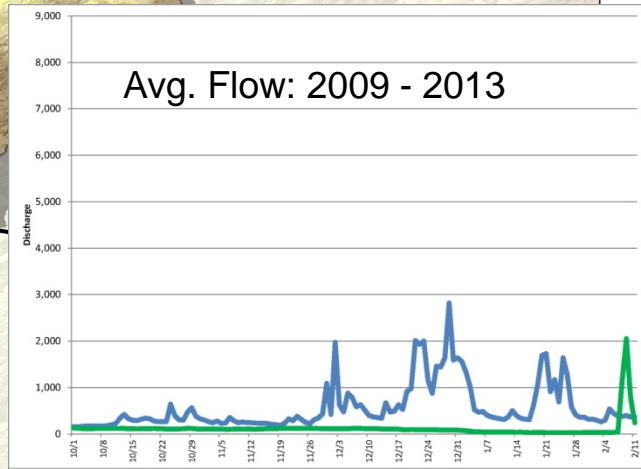
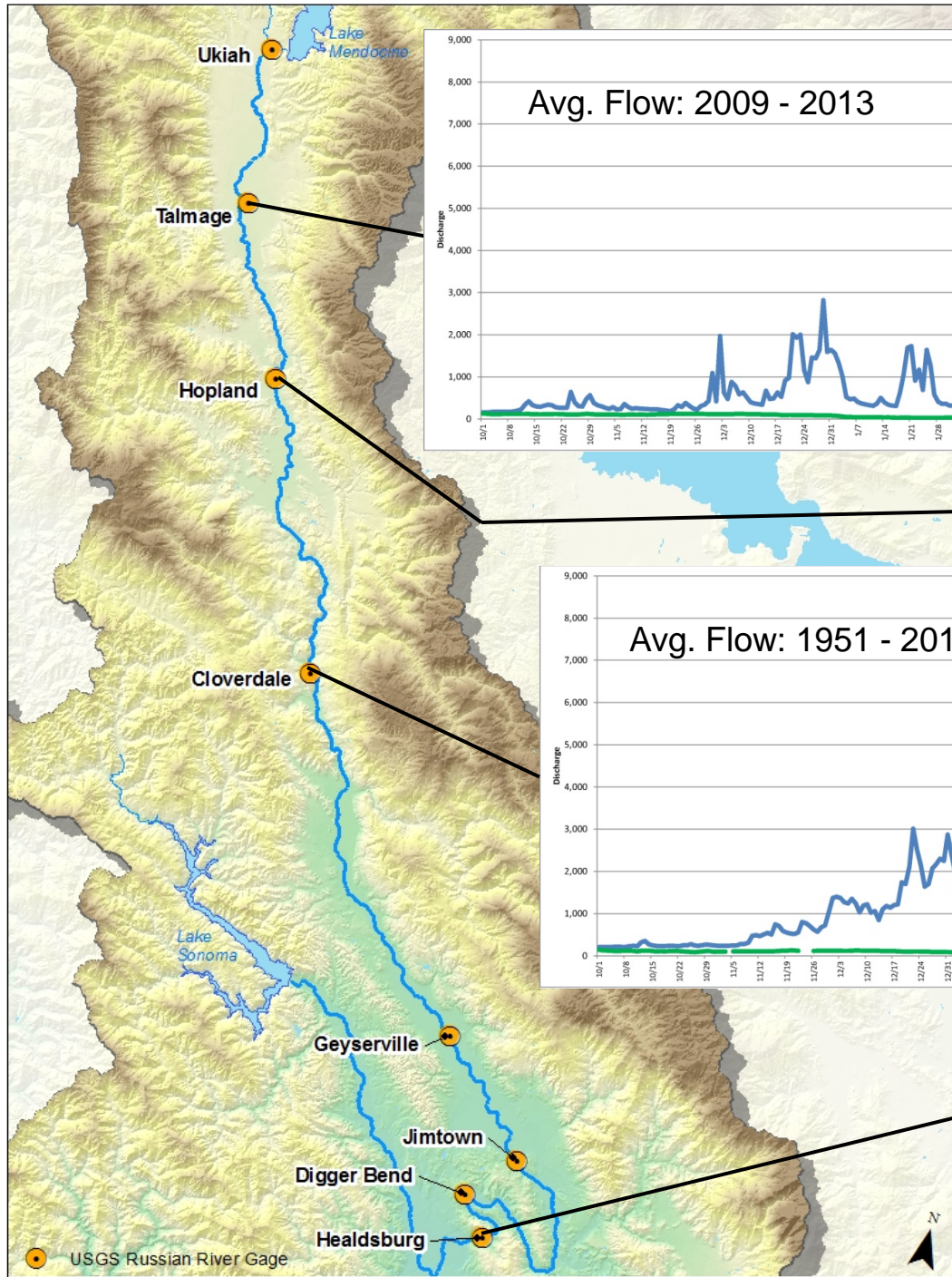
Lake Sonoma and Lake Mendocino Storage Water Years 2012 - 2014



Lake Mendocino Water Years 2012 - 2014

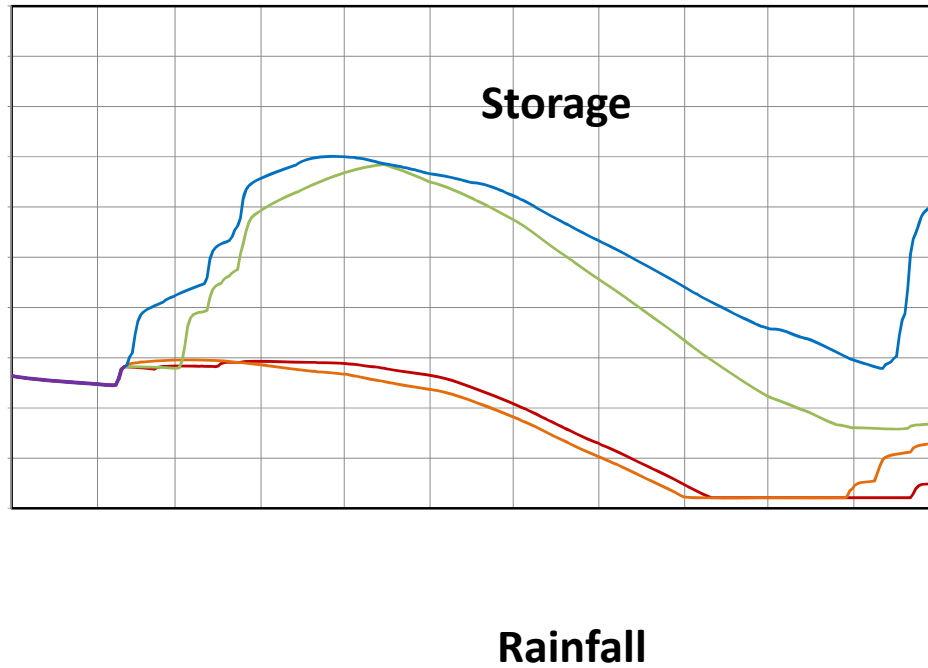


Upper Russian River Unprecedented Low Flows



■ Average Discharge 10/1 – 2/11
■ Actual WY2014 Discharge 10/1 – 2/11

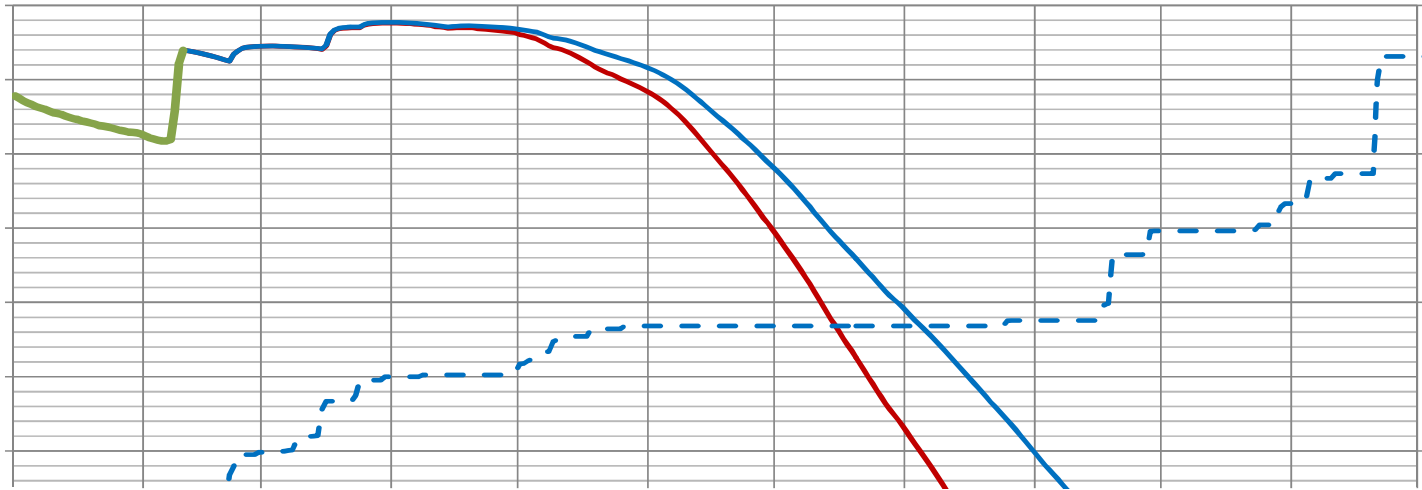
Lake Mendocino Forecasted Storage Scenarios With Dry Year Hydrology



➤ Assumptions:

- Minimum flows - consistent with D1610 and Biological Opinion
- Hydrologic Index - current TUCP Lake Mendocino storage
- Dry year system losses
- PVP Releases - predicted based on current conditions

Lake Mendocino Storage Forecast With Reduced Upper River Water Use



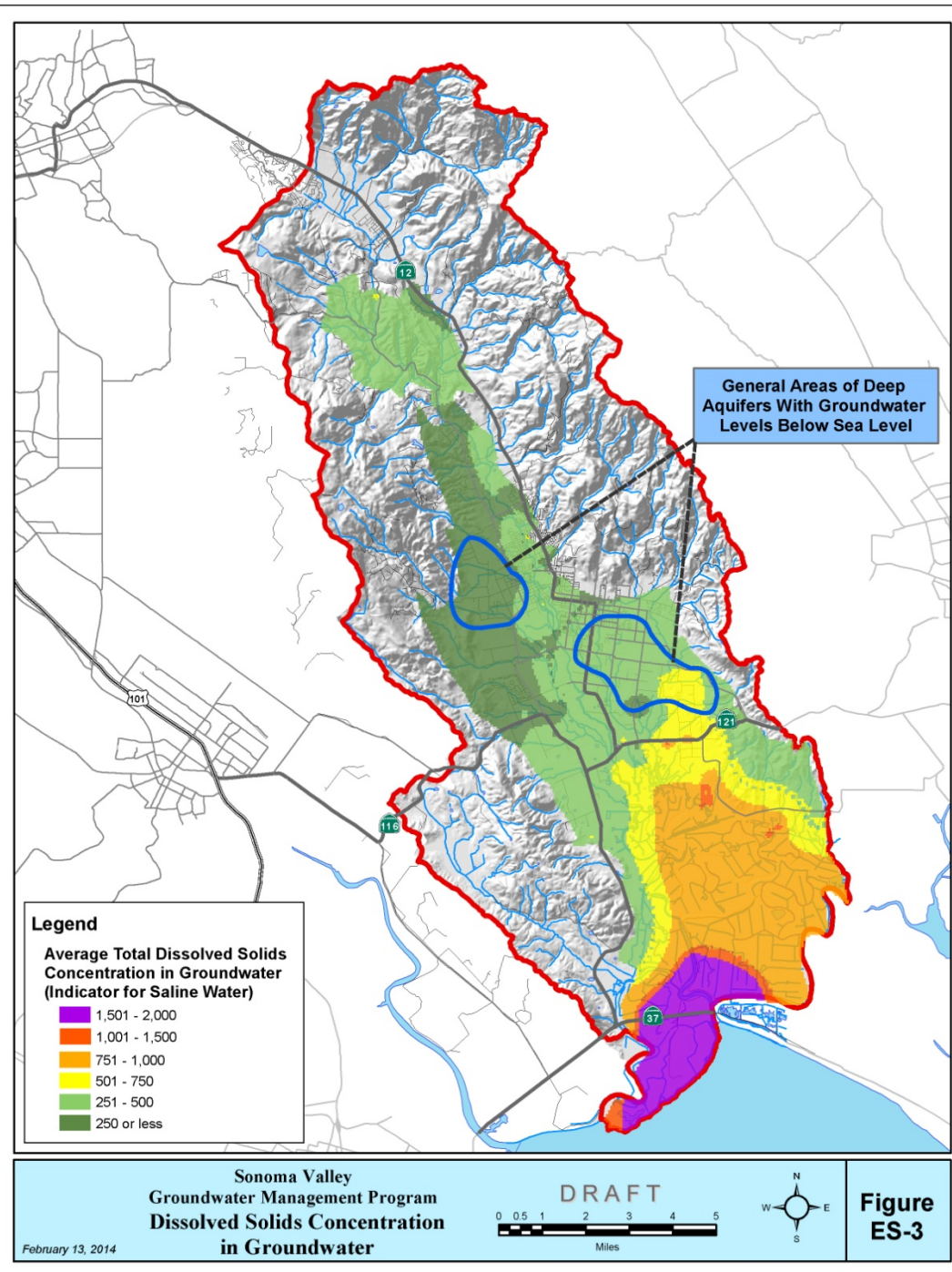
— Precipitation - 2014

1977

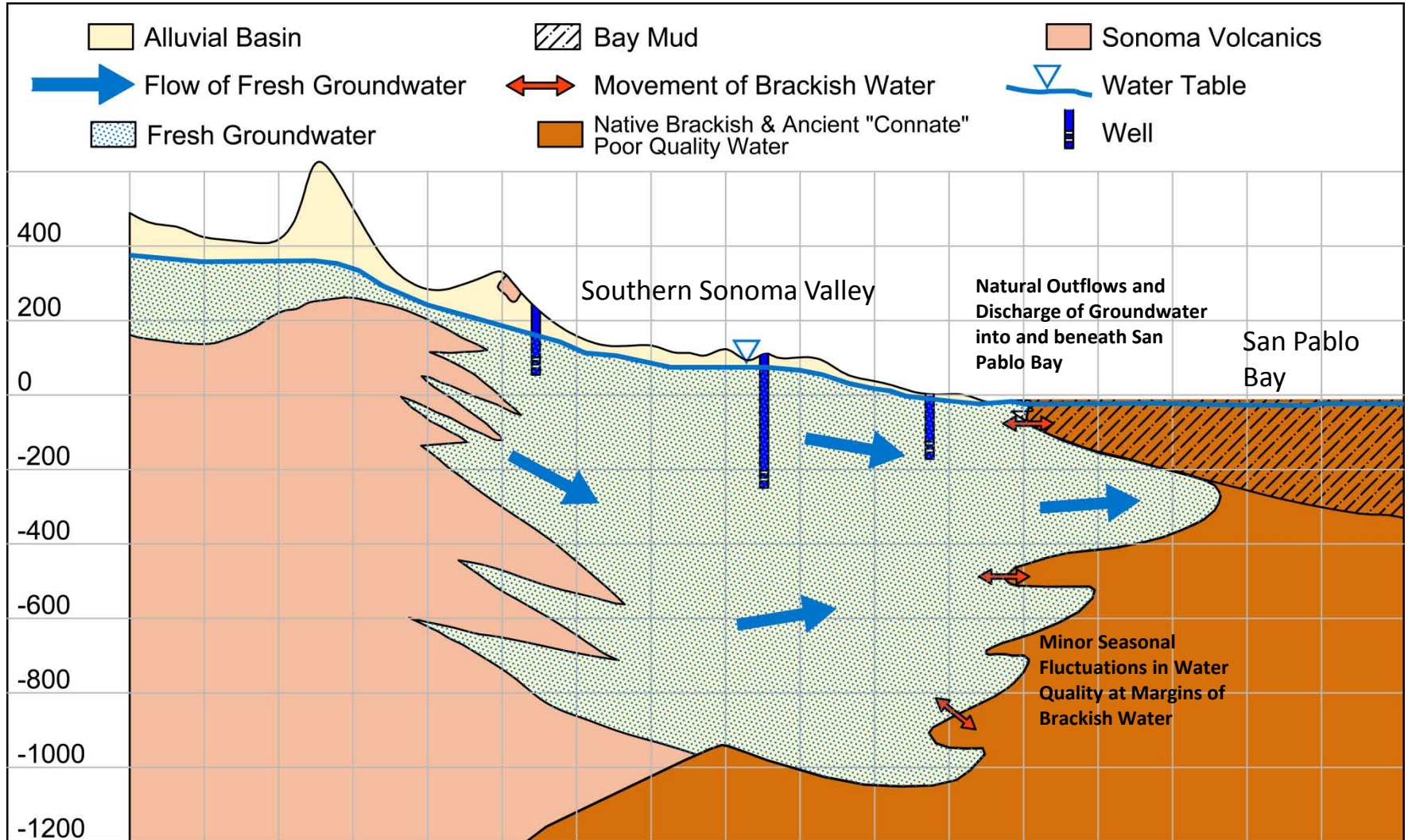
Drought Impacts to Groundwater

Areas of concern include:

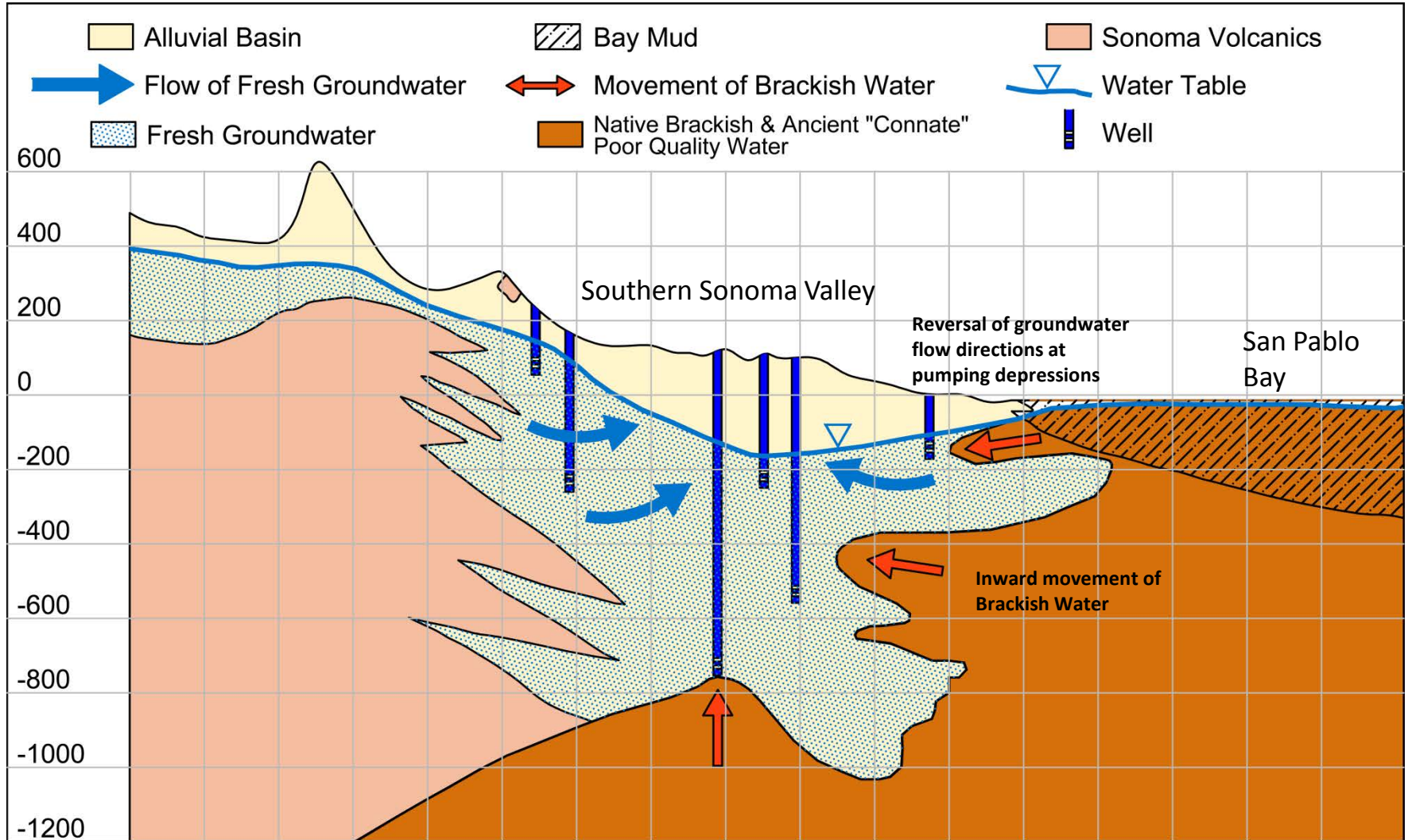
- Sonoma Valley
- Petaluma Valley & southwest Sonoma County
- Alexander Valley?
- Coastal basins
- Others?



1950: Shallow Groundwater Levels Prior to Extensive Pumping



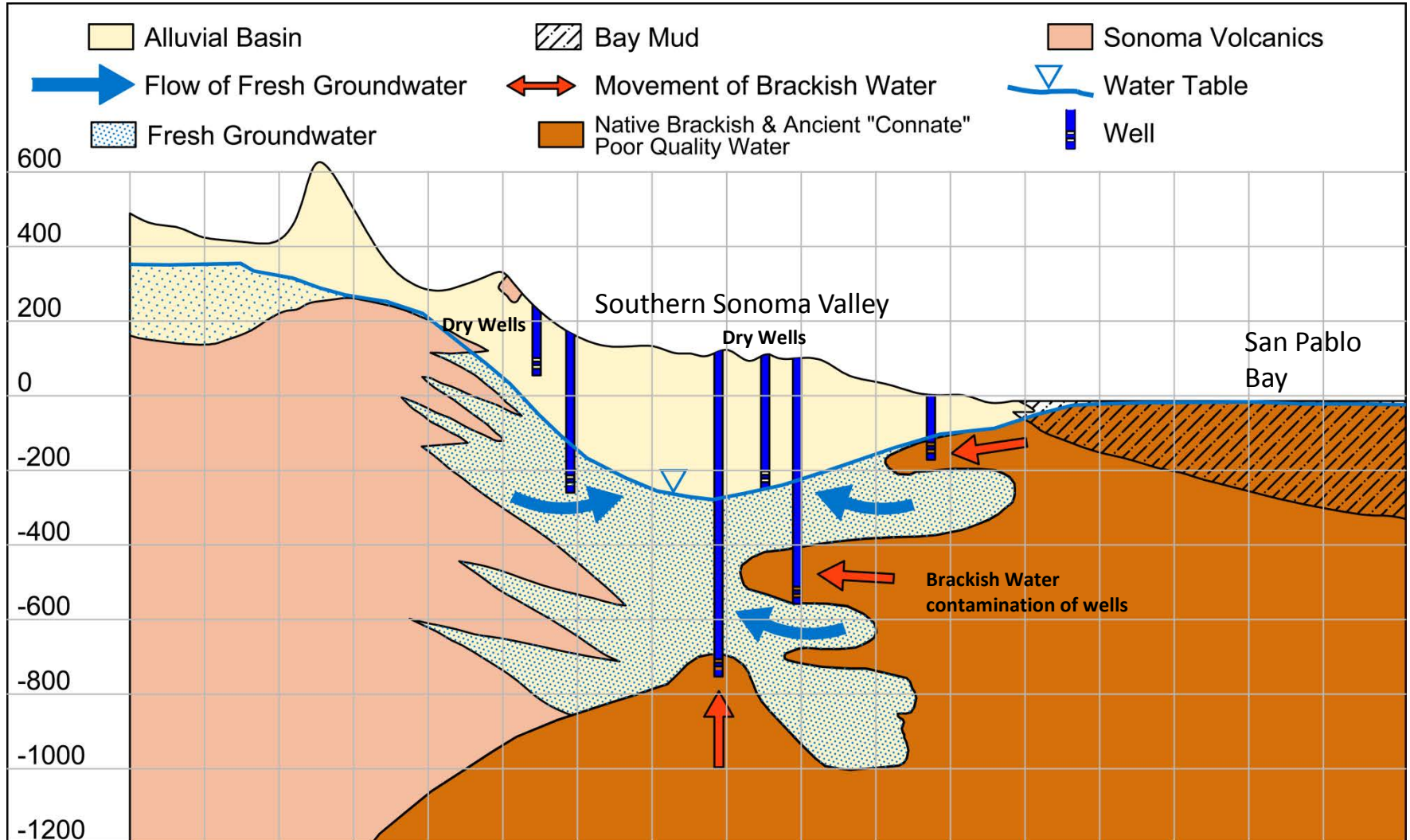
Today: Groundwater Levels Lowered over 100 Feet in Southern Sonoma



Future Continued Depletion of Groundwater?

- * Dry Wells

- * Brackish Water Contamination of Wells



What Does the Future Look Like?

- Non-Stationarity: The past is not likely a predictor of the future
- SCWA and USGS partnership assess range of possibilities by looking at multiple scenarios



USGS-SCWA Climate Change Study

➤ Downscale 4 future climate change scenarios

- Spatially - 270 m
- Temporally - 1 day timestep

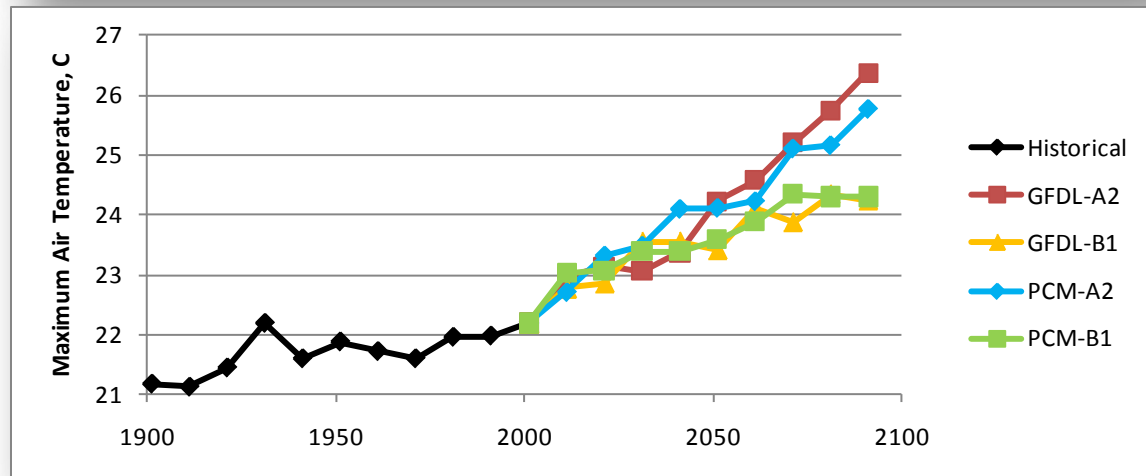
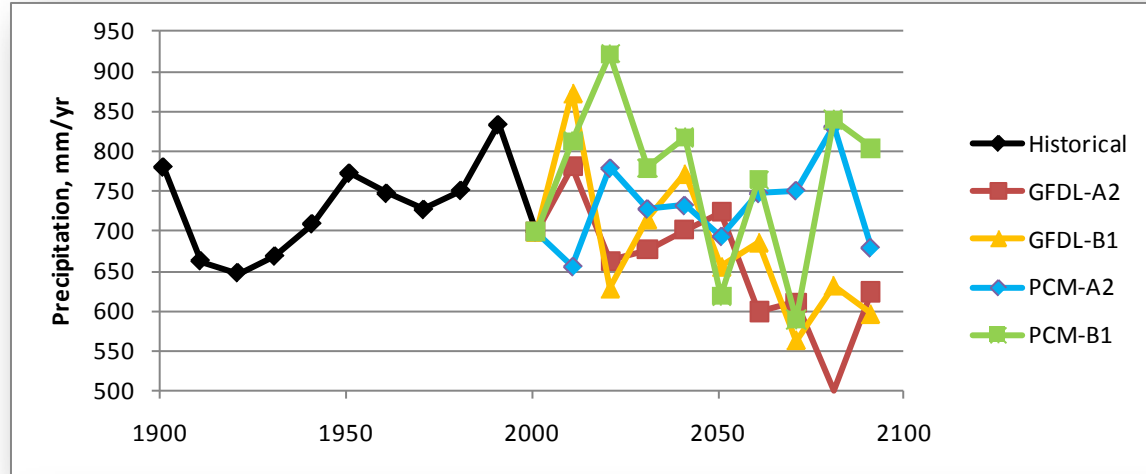
➤ 2 Global Climate Models

1. Parallel Climate Model
2. NOAA GFDL

➤ 2 Emission Scenarios

1. A2 - medium high emissions
2. B1 - low emissions

➤ Updating to 18 scenarios



Anticipated Climate Change Impacts

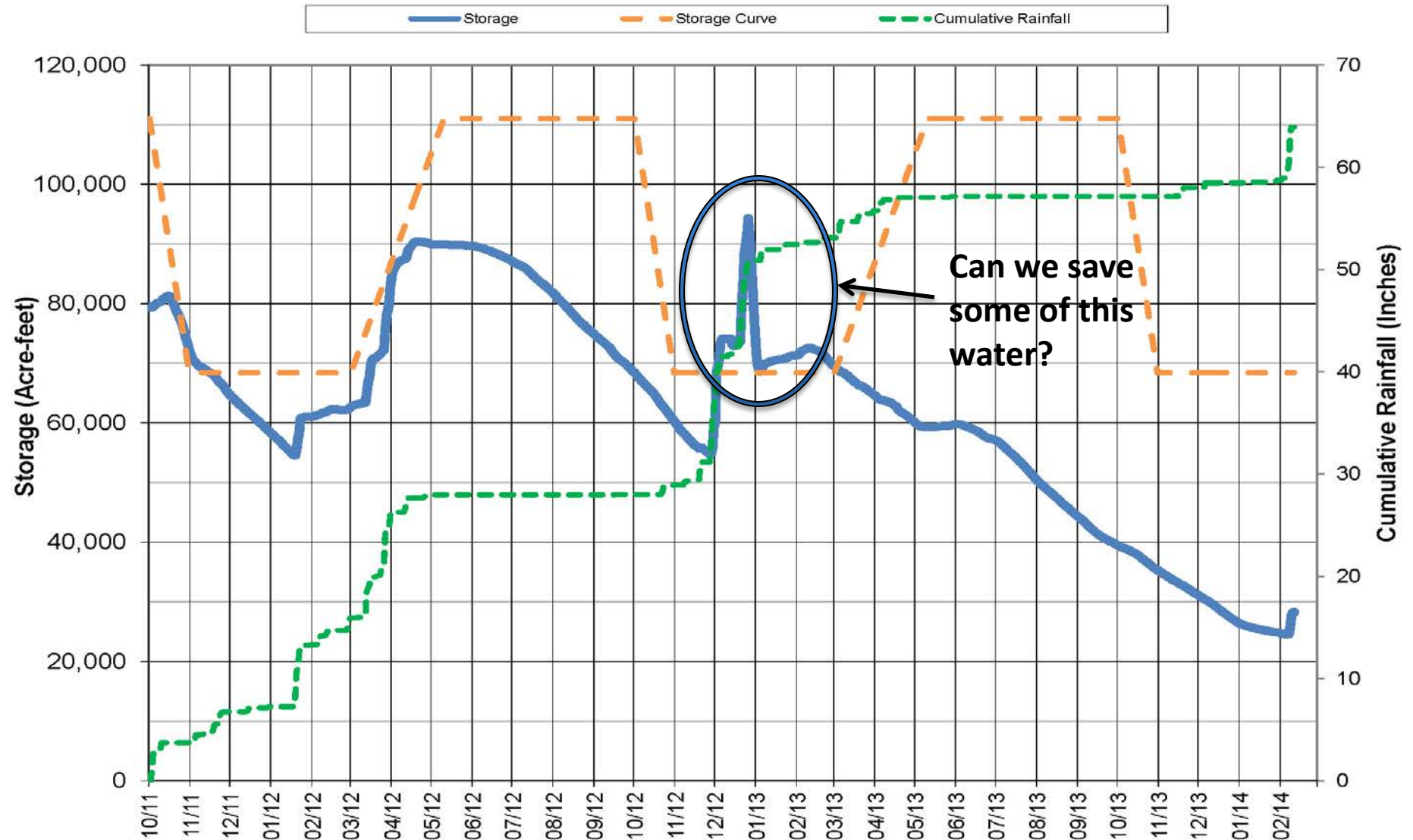
- Increased temperature = Increased water demand (Human, Agricultural, Environmental) - Even in wet years
- Drier soils mean lower groundwater recharge
- Increased variability - Droughts & floods will be more extreme
- Even “wet” years likely to exhibit compressed winters
- Sea-level rise impact to infrastructure & saline intrusion
- Increased wildfire threat: Water quality & flood impacts

How Can We Improve Our Drought Resiliency?

- Improve scientific understanding of weather & climate variability AND then relate to how we use/manage water
- Use forecasts in coordinated reservoir operations
- Pursue integrated water resource management
- Overcome fragmentation of water management
 - Need to work together by coordinating programs & collaborating

Reservoir Operations to Improve Resiliency

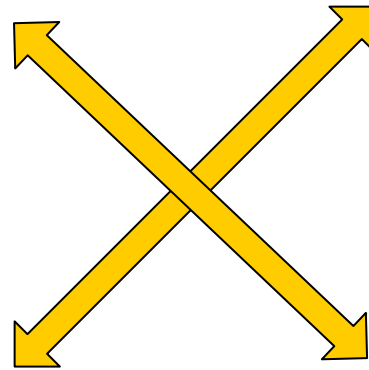
Lake Mendocino Water Years 2012 - 2014



Weather Forecast Coordinated Reservoir Reoperations

- Dynamic tension between flood control & water supply reservoir operations
- Change of Corps operations manual difficult - approval of Congress. Cannot reduce dam safety.
- Will require other federal agencies including NOAA (National Weather Service & River Forecast Center)
- SCWA is working to fund Corps & NOAA to conduct assessment for Lk. Mendocino

Integrated Water Management: 4 Ways to Meet Water Supply Demands



Examples of SCWA Integrated Water Management Programs

- **Conservation & water efficiency**
- **Recycled water use to offset groundwater & surface water**
- **Stormwater recharge of groundwater basins**
- **Recharge of groundwater basins using winter Russian River water**

Groundwater Plays Import Role in Building Resiliency

Overarching Goal: Proactive
Management of Surface
Water & Groundwater
Resources to Promote
Reliability for All Users

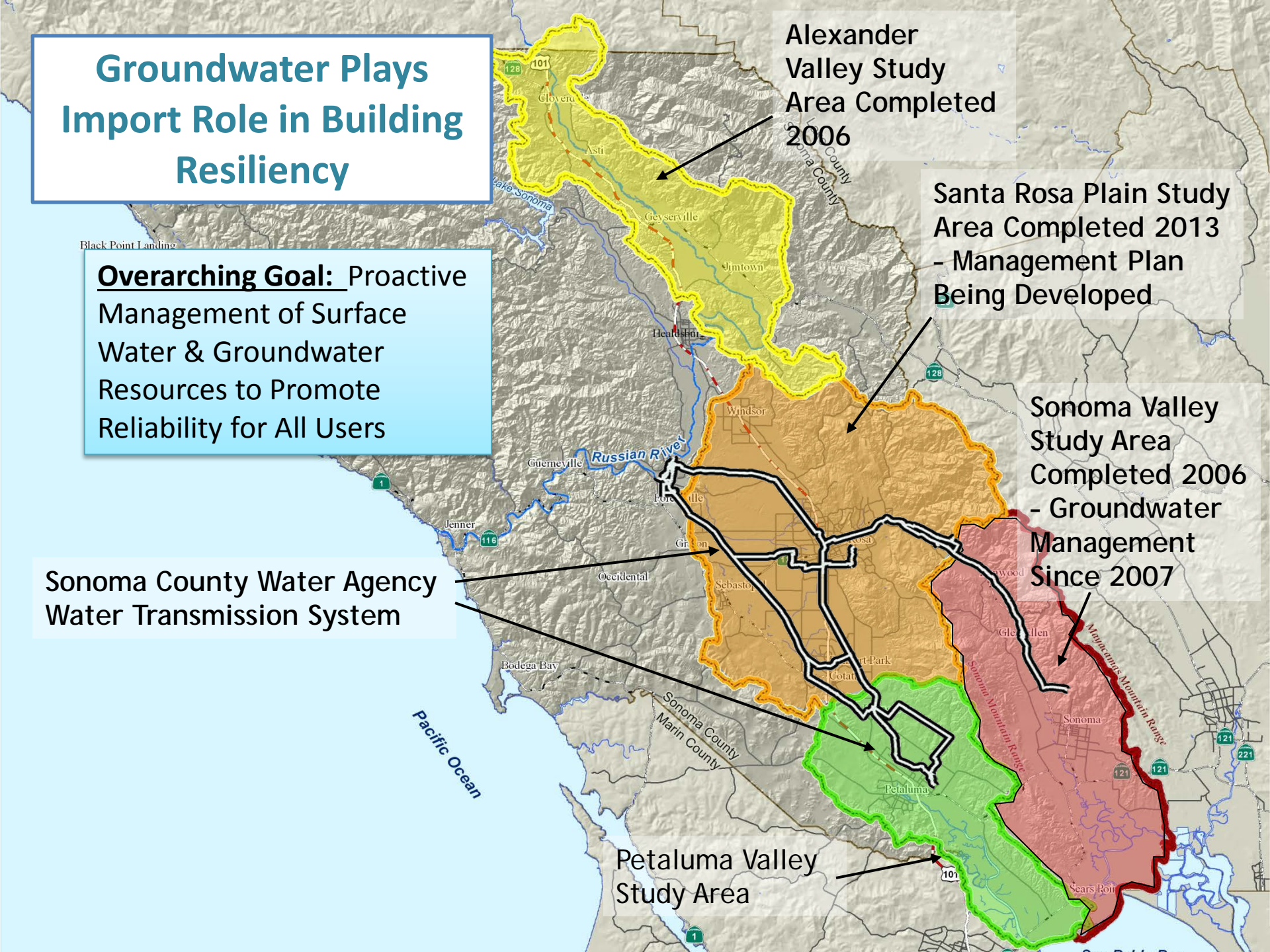
Sonoma County Water Agency
Water Transmission System

Alexander
Valley Study
Area Completed
2006

Santa Rosa Plain Study
Area Completed 2013
- Management Plan
Being Developed

Sonoma Valley
Study Area
Completed 2006
- Groundwater
Management
Since 2007

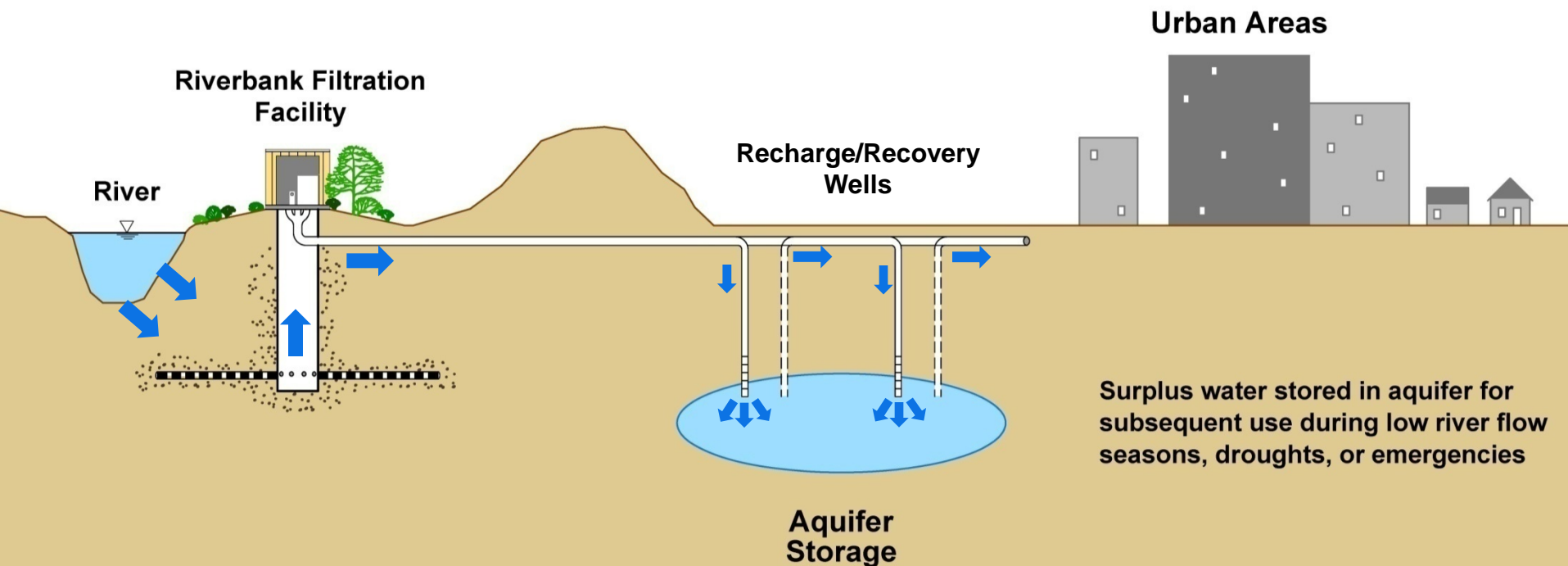
Petaluma Valley
Study Area



Conceptual Groundwater Banking Schematic

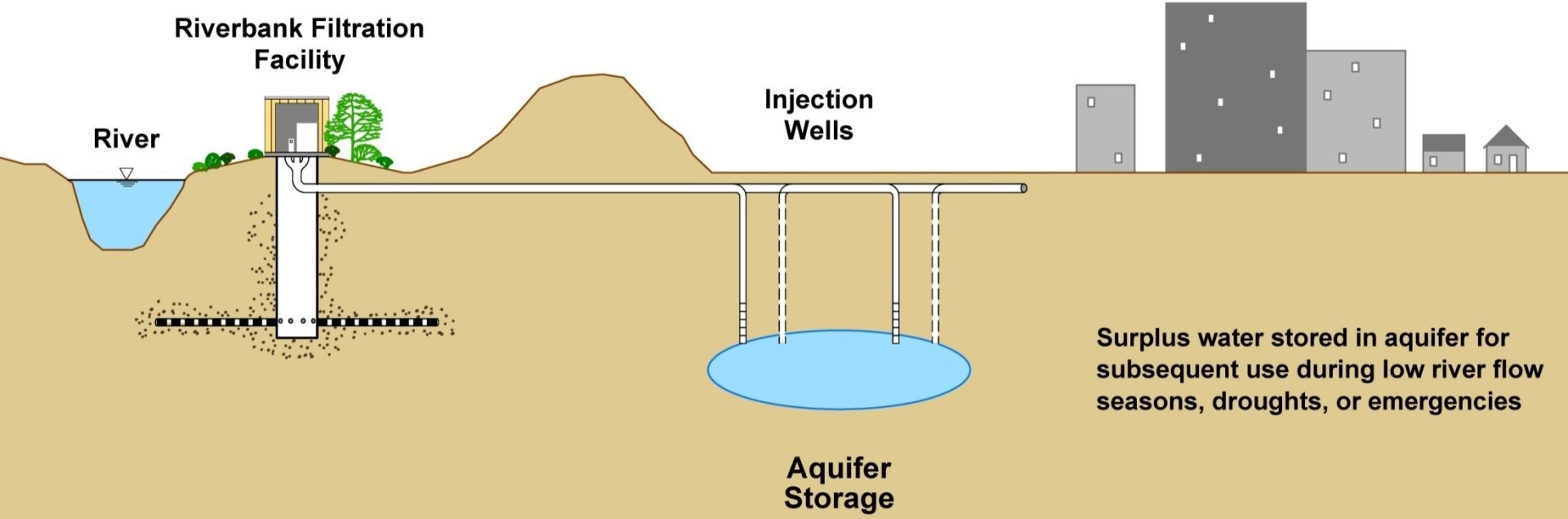
Aquifer Storage and Recovery

- Proceeding with Aquifer Storage and Recovery Concepts
- Geochemical compatibility assessment
 - Groundwater quality sampling and geochemical modeling
- Developing Work Plans for Pilot-Scale Demonstration Project(s)
- Explore funding options



Wet Year - 2011

High River Flow Conditions



Urban Areas

Riverbank Filtration Facility

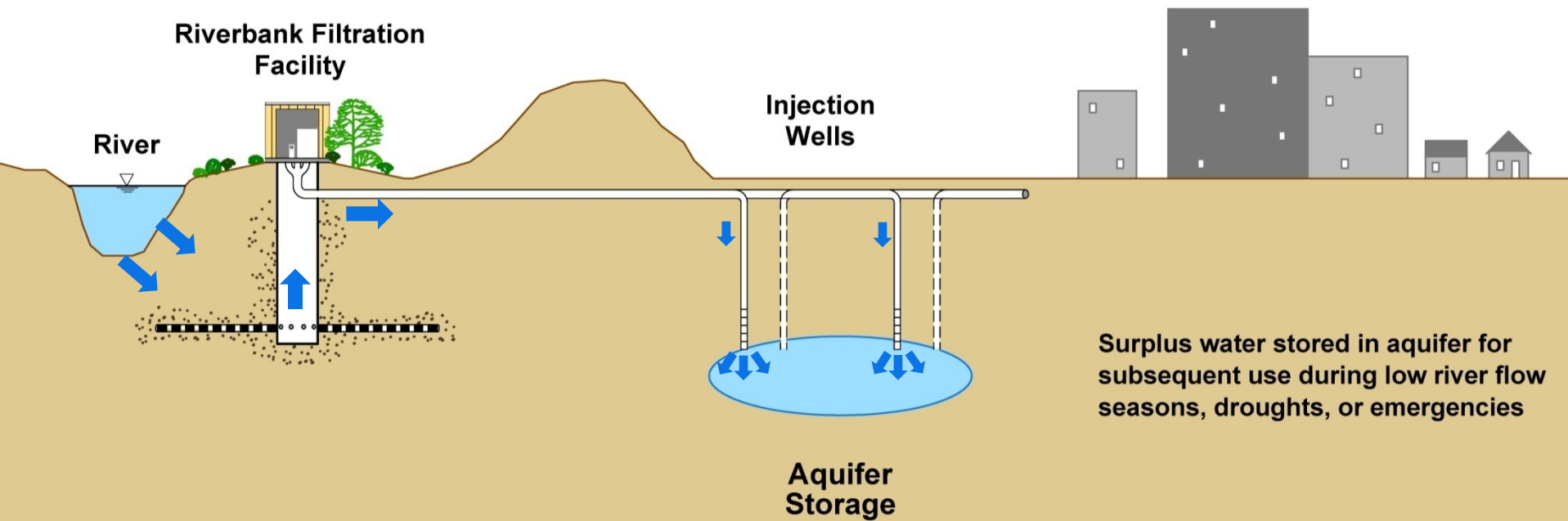
River

Injection Wells

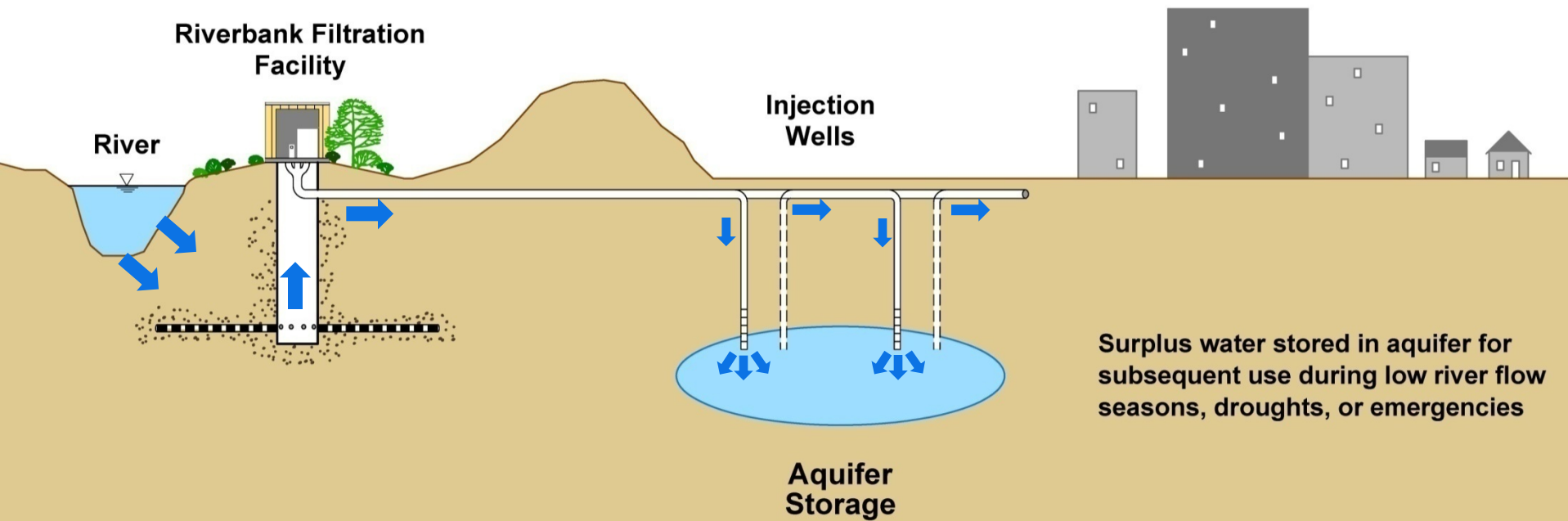
Surplus water stored in aquifer for subsequent use during low river flow seasons, droughts, or emergencies

Aquifer Storage

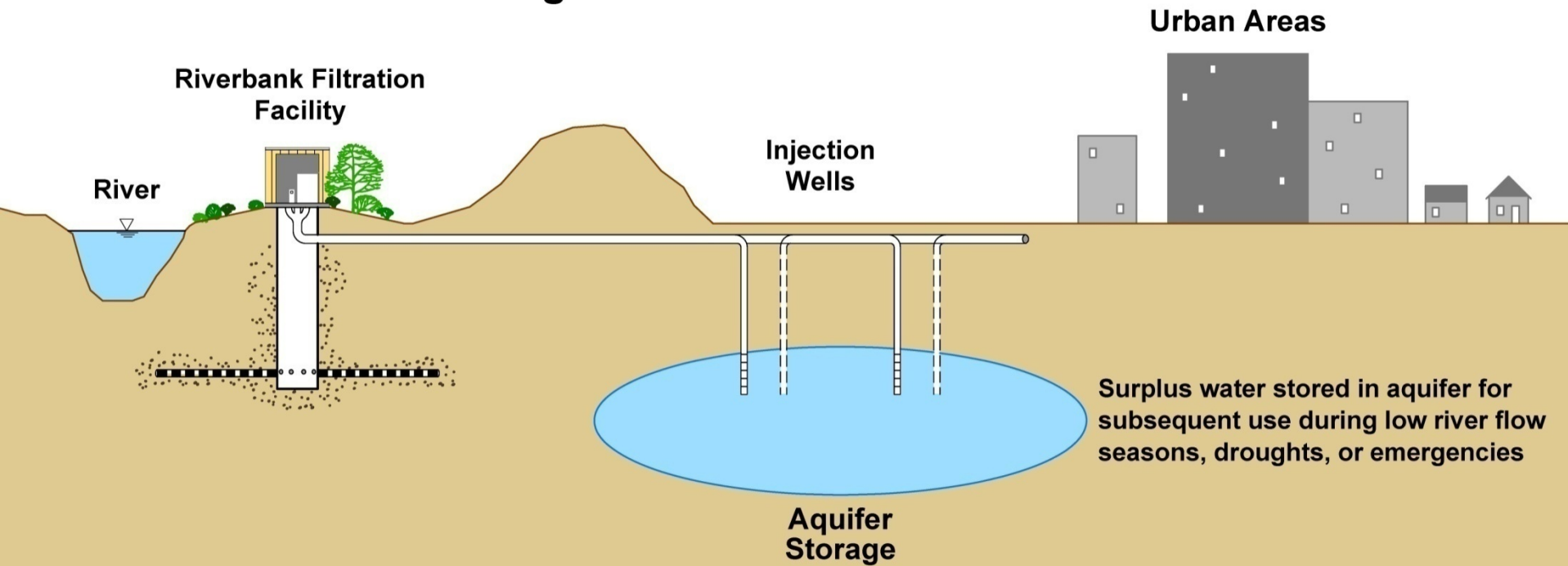
High River Flow Conditions



High River Flow Conditions

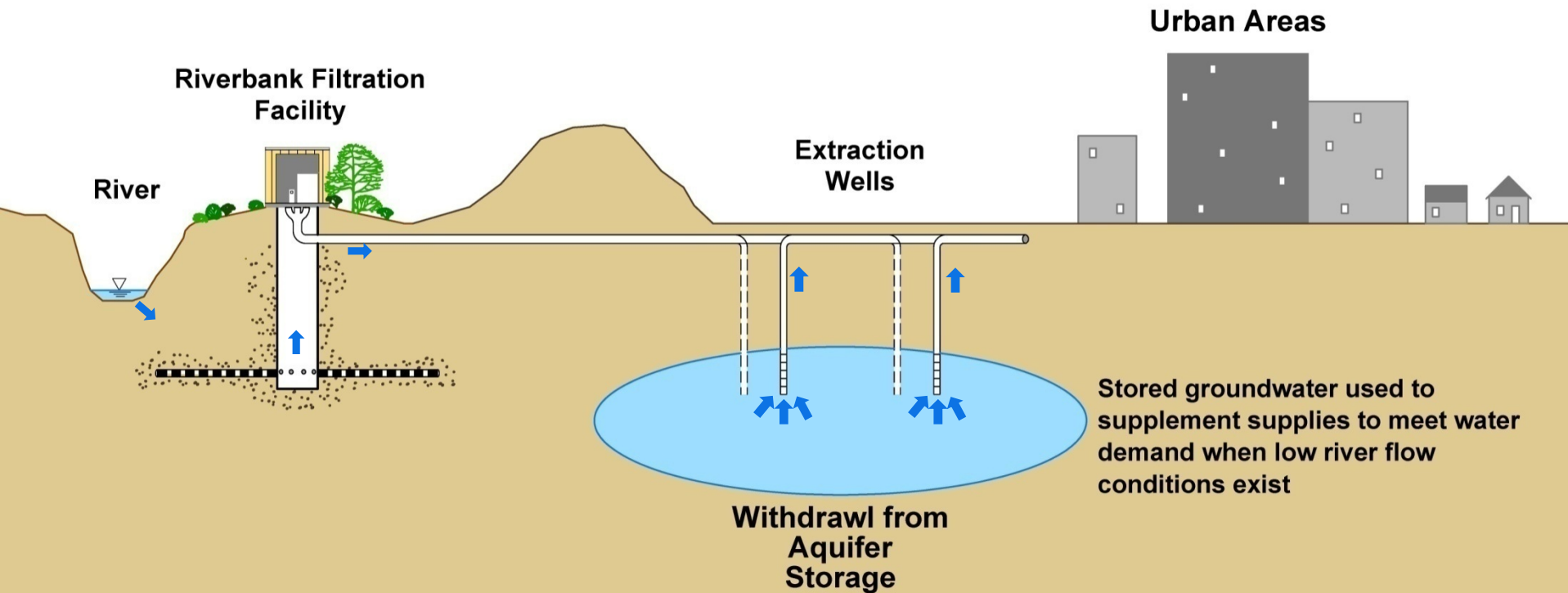


High River Flow Conditions

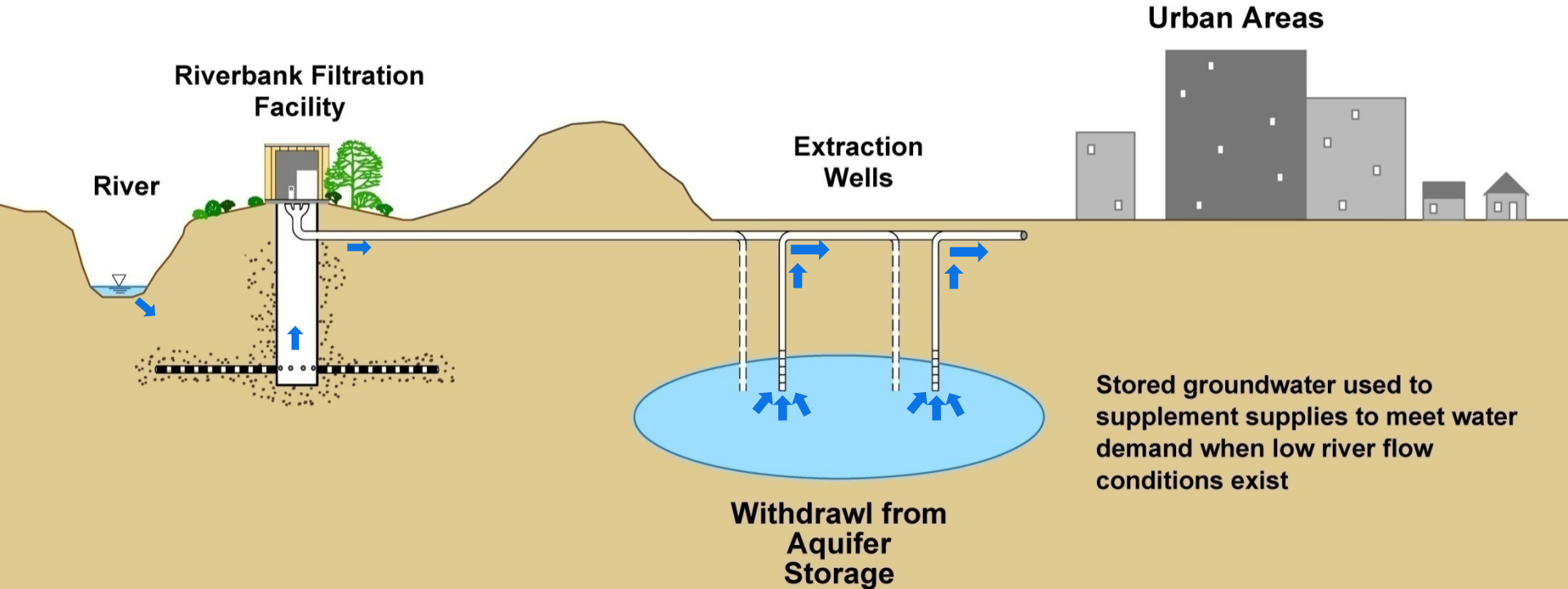


Dry Year - 2013

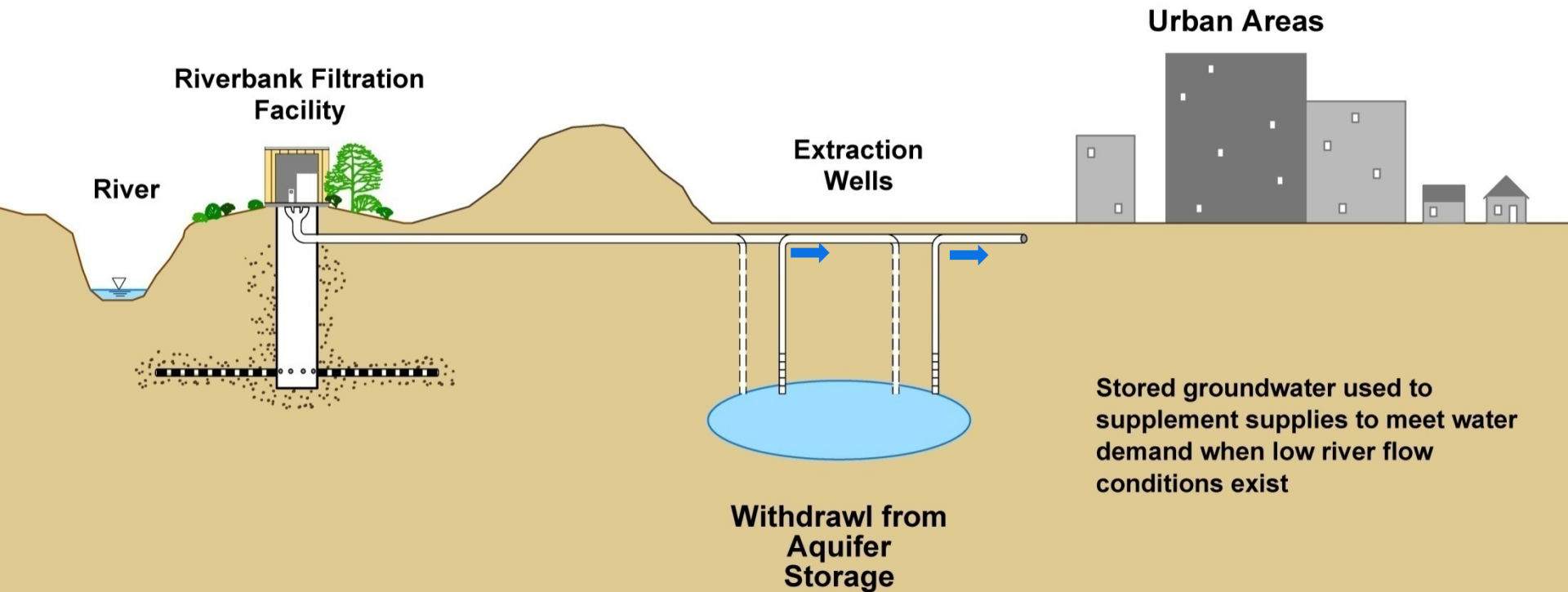
Low River Flow Conditions



Low River Flow Conditions



Low River Flow Conditions



River

Riverbank Filtration Facility

Extraction Wells

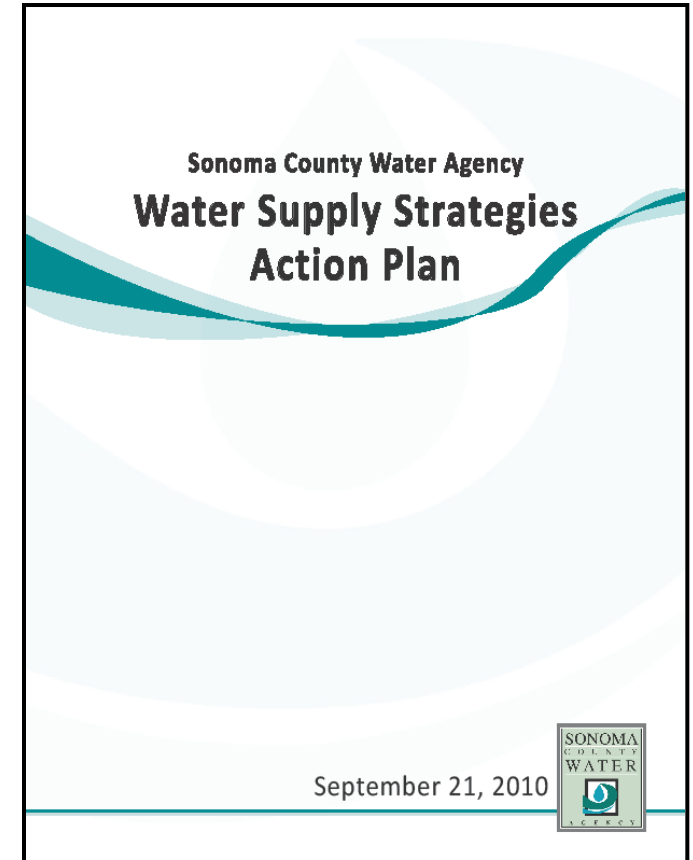
Urban Areas

Withdrawal from Aquifer Storage

Stored groundwater used to supplement supplies to meet water demand when low river flow conditions exist

SCWA Water Supply Strategy Action Plan

- Framework for integrated water management
- Plan adopted September 2010
- Dozens of meetings, hundreds of comments
- 16 months outreach
- Updated 2011 & 2013



Final Thoughts ...

- **No one knows when this drought will be over – but it will likely end abruptly**
- **Drought vulnerability varies depending on your circumstances**
- **Deal with crisis but need to be strategic & proactive to build long-term water supply resiliency:**
 - **Use latest science & technology**
 - **Integrated water resource management**
- **Partnerships are key - Many rural areas & agriculture are encouraged to organize to build programs that will improve water supply resiliency**