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

Jay Jasperse, P.E.

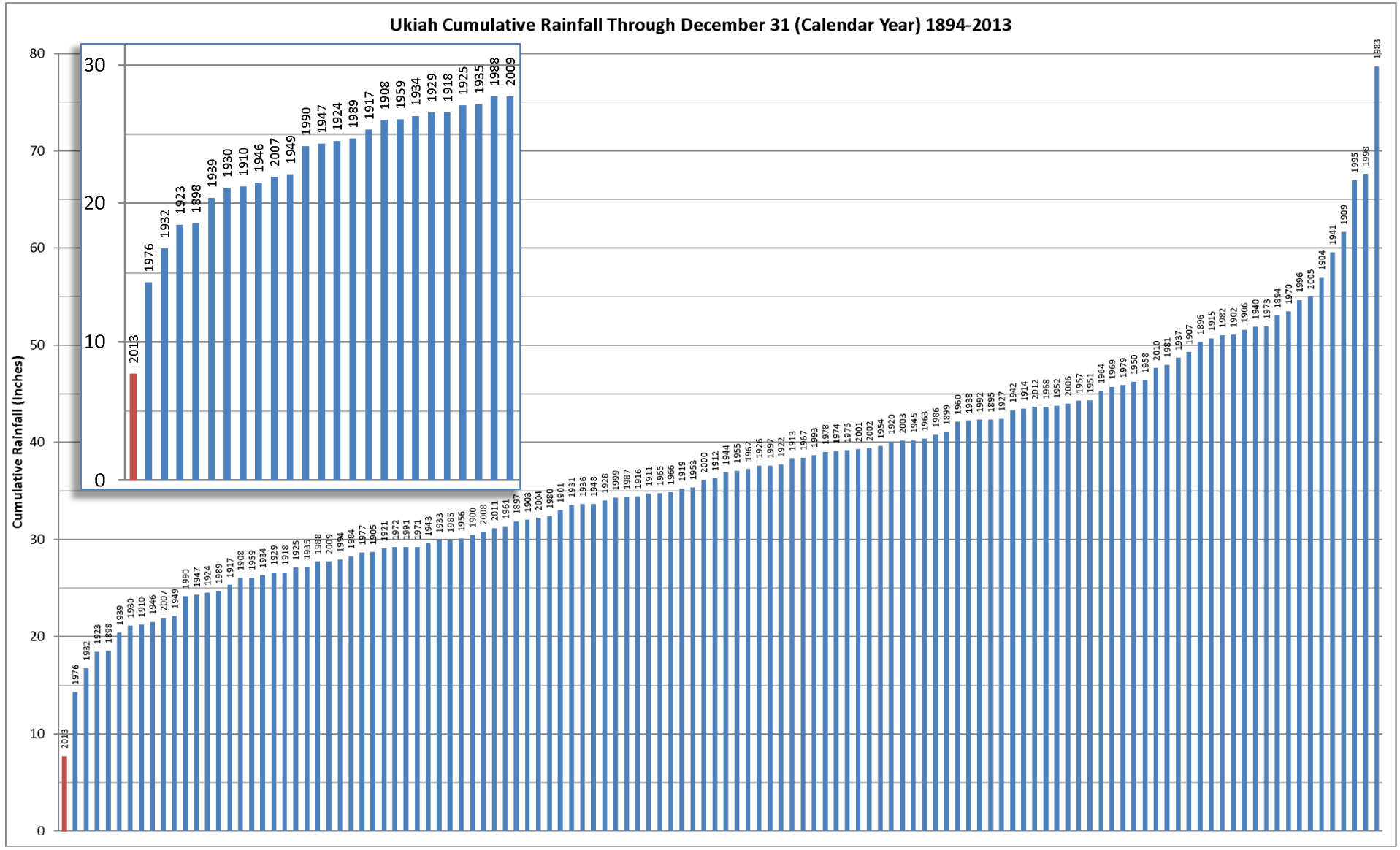
Chief Engineer

Sonoma County Water Agency

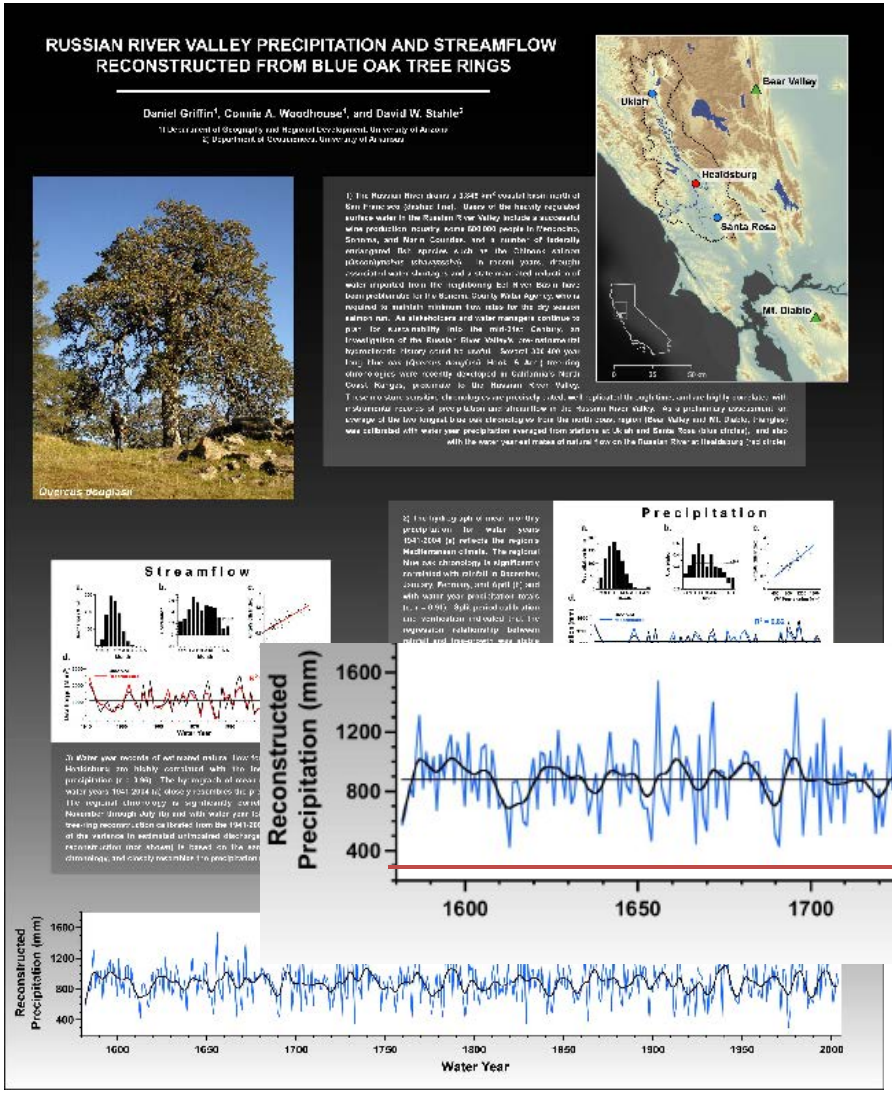
February 21, 2014

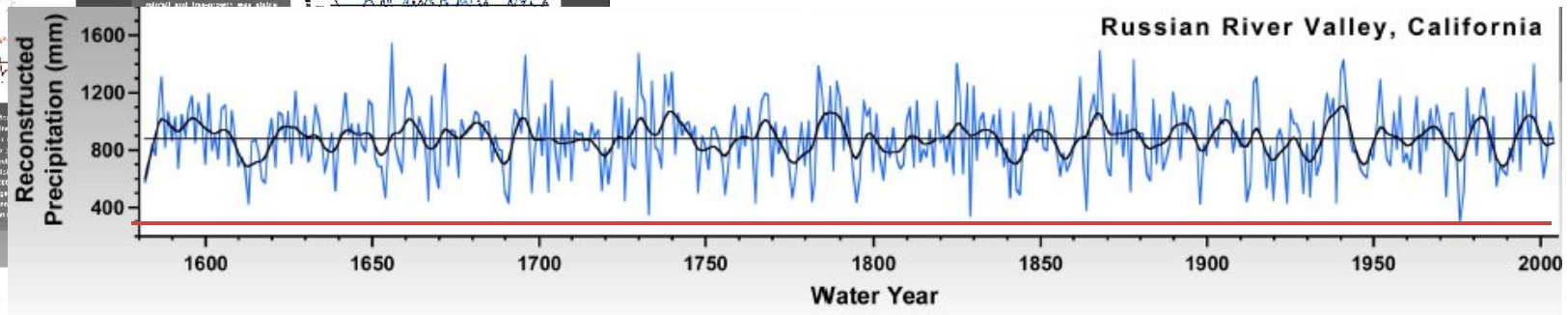
SONOMA COUNTY WATER AGENCY

Historical Ukiah Precipitation
120 Year Record



2013 Rainfall vs. Tree Ring Analysis

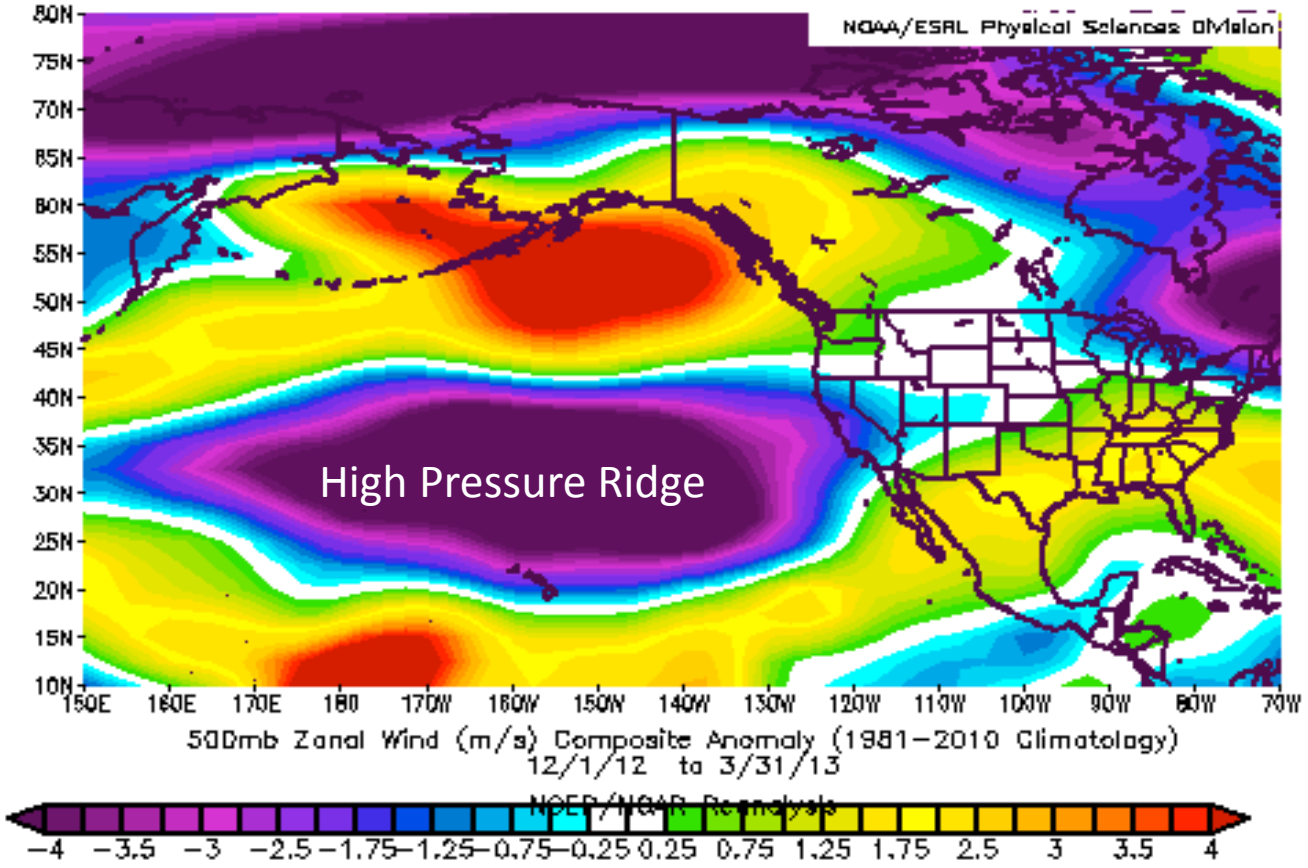




According to reconstructed precipitation study by University of Arizona:

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!**

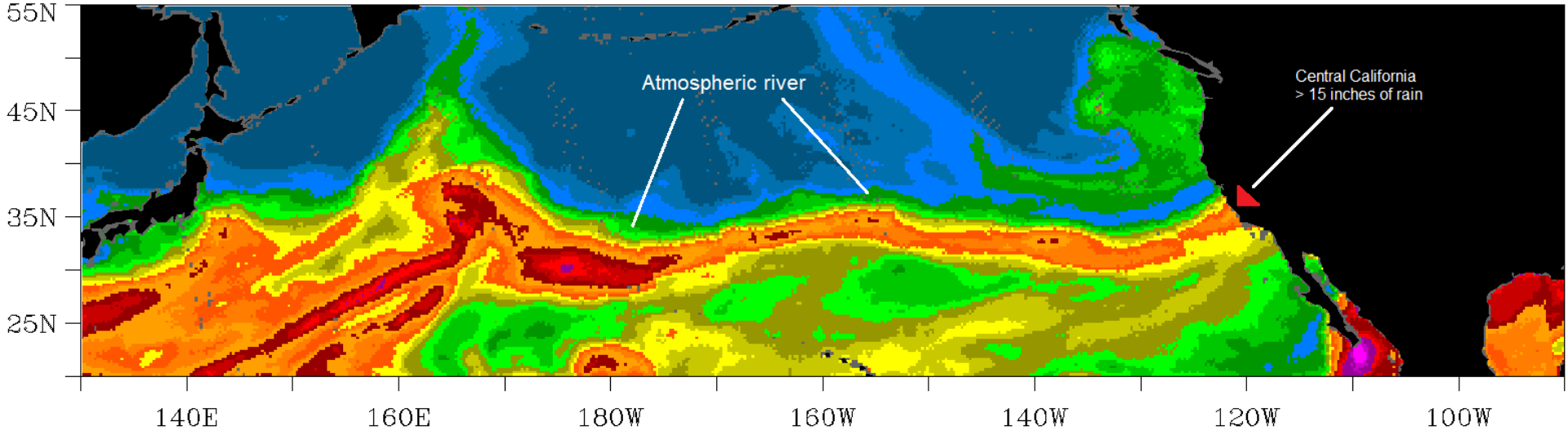
No Agency Manages Entire Water Supply

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

Impacts People, Agriculture & Fish

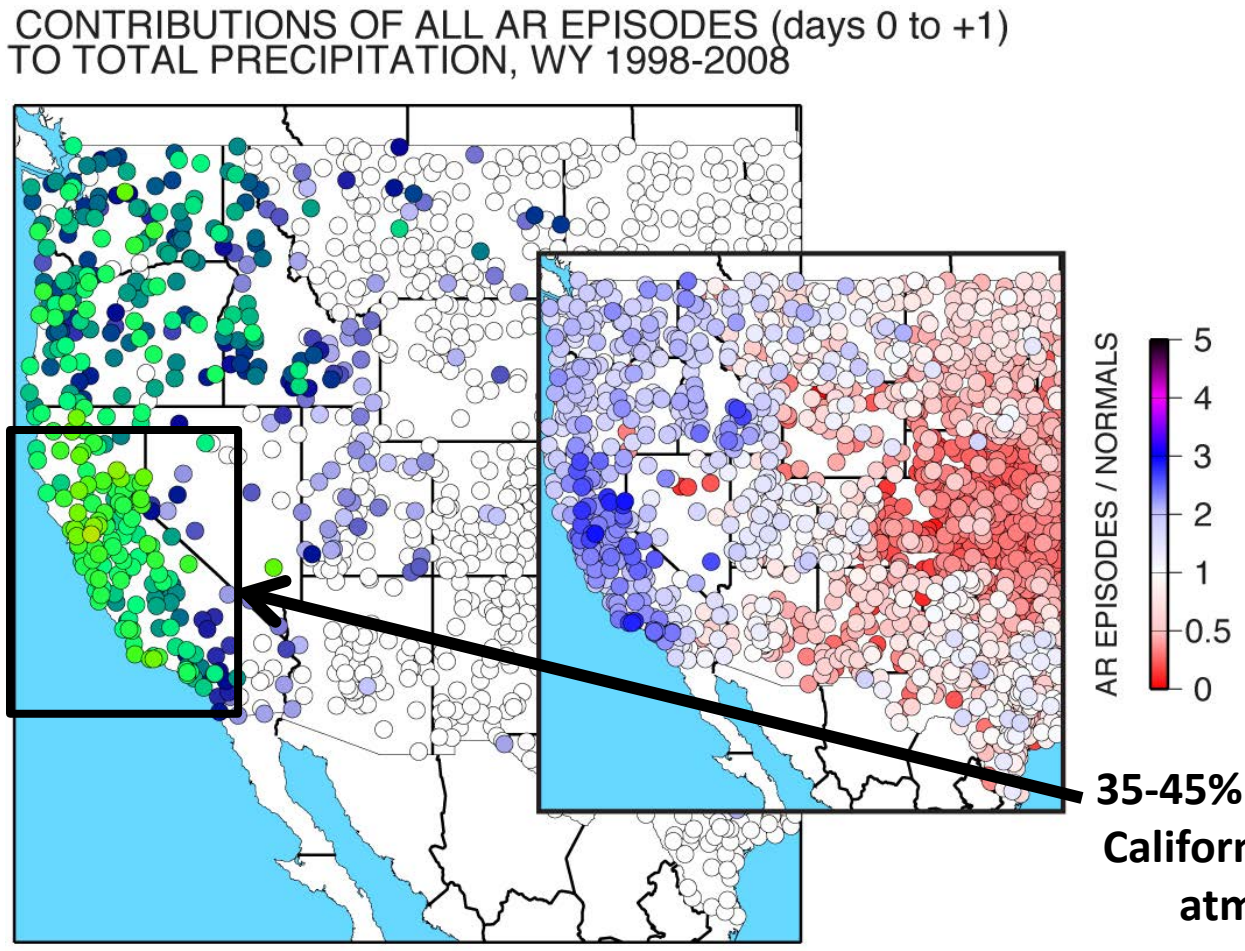
- **Pain felt by all**

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

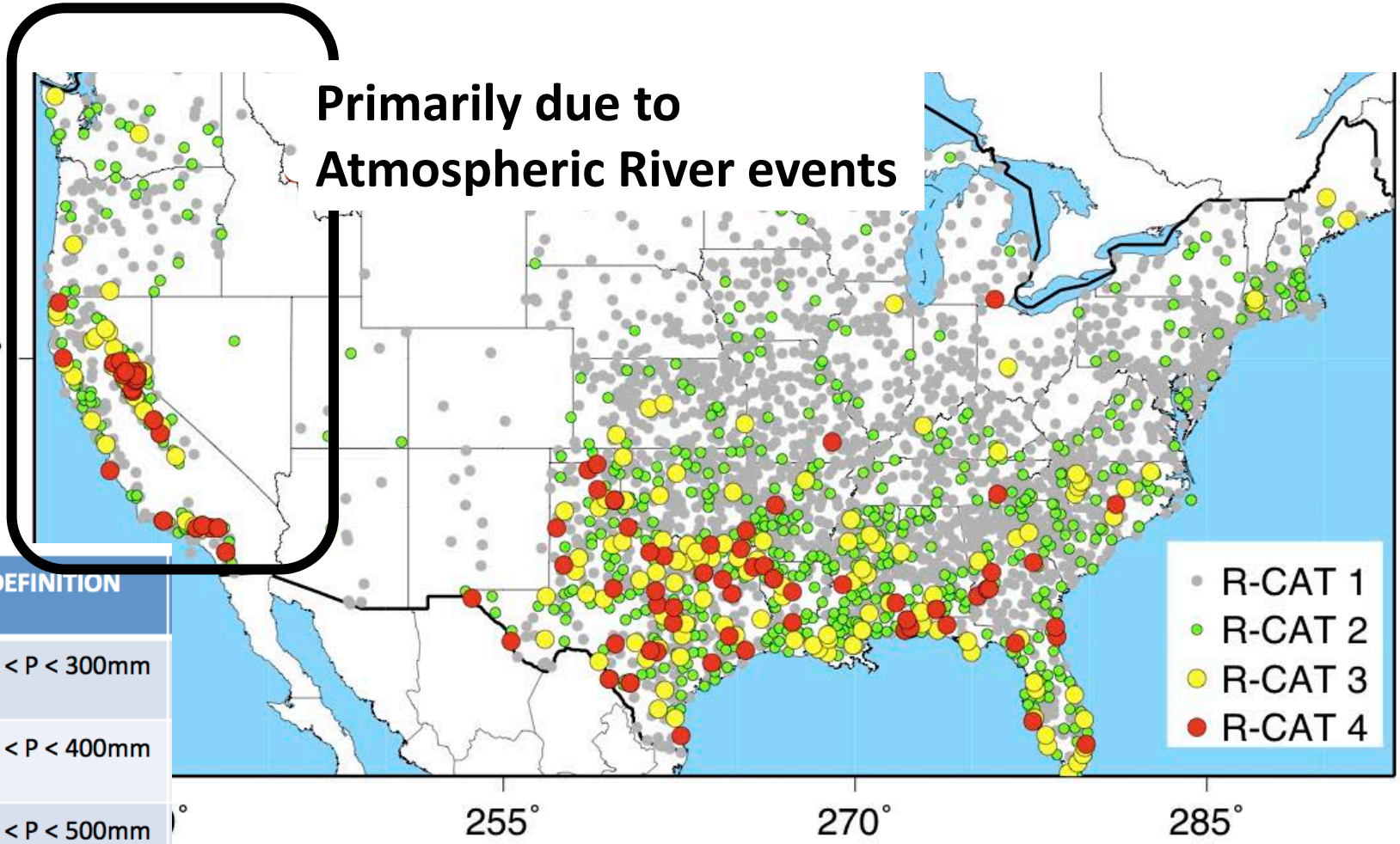


An average AR transports the equivalent of 7.5 times the average discharge of the Mississippi River, or ~10 M acre feet/day

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

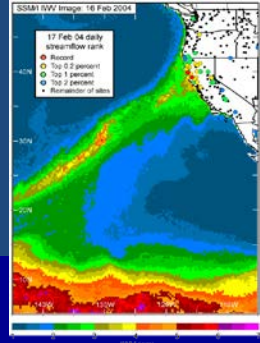
LARGEST 3-DAY PRECIPITATION TOTALS 1950-2008

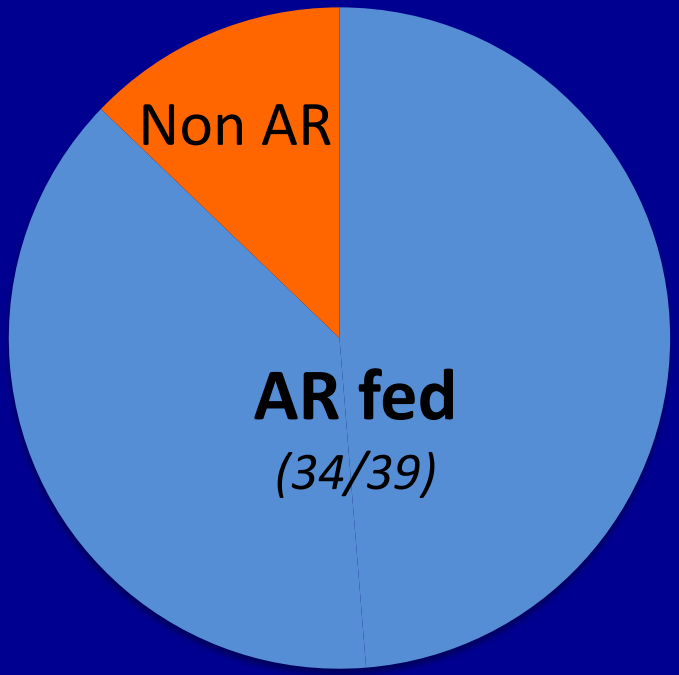


R-CAT	DEFINITION
1	200 < P < 300mm
2	300 < P < 400mm
3	400 < P < 500mm
4	P > 500mm

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

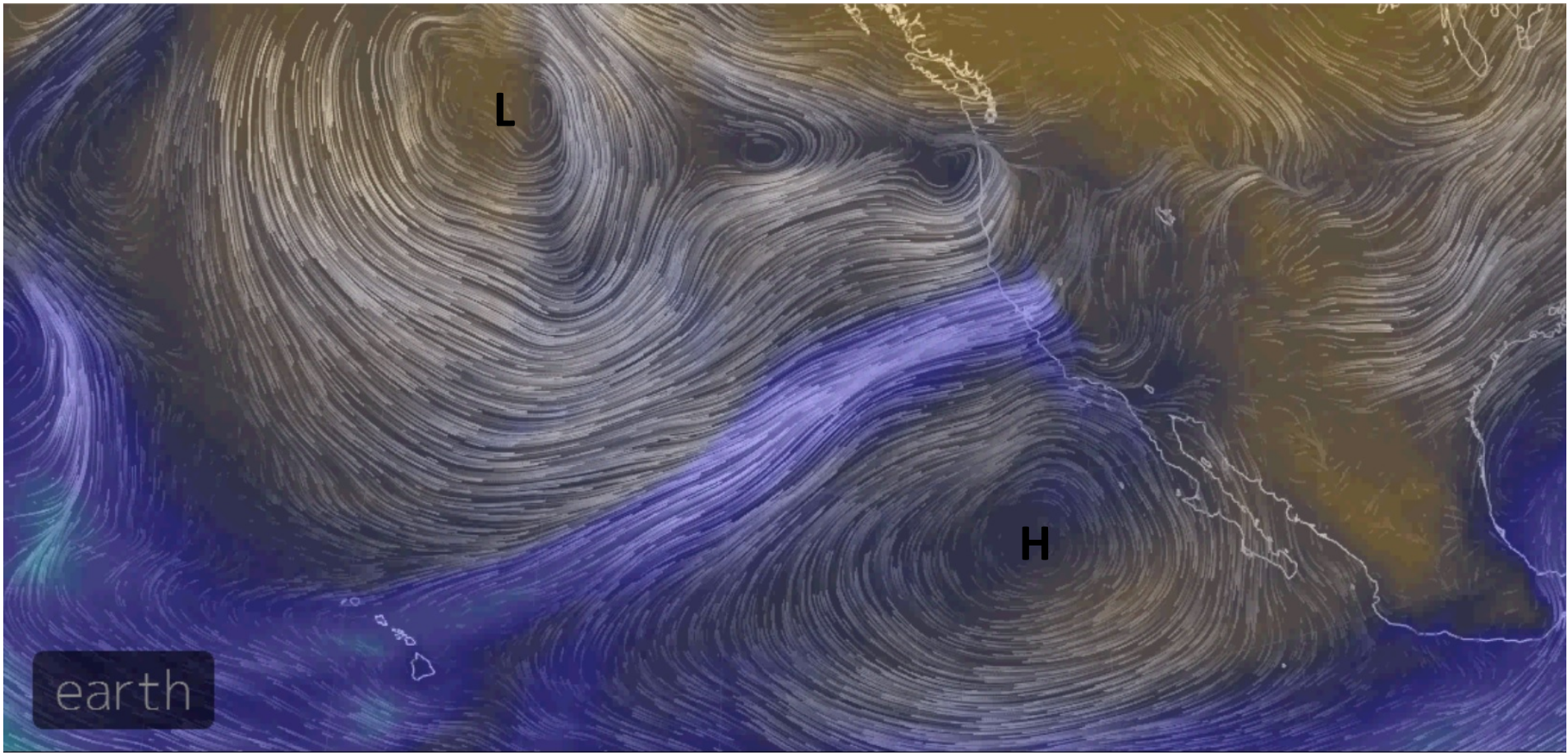
USGS science for a changing world

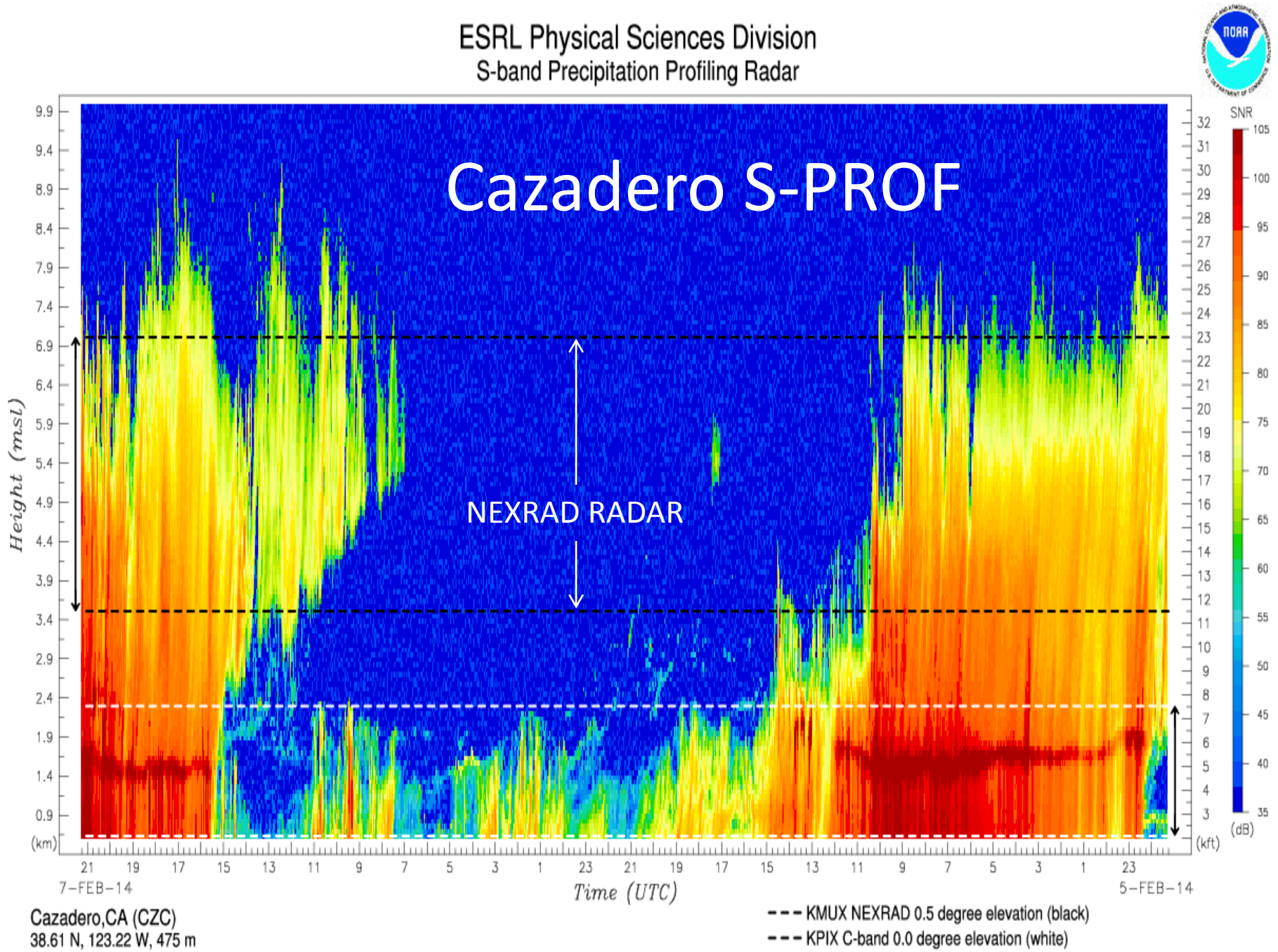
Southwest Climate Science Center

CNAP California-Nevada Climate Applications Program

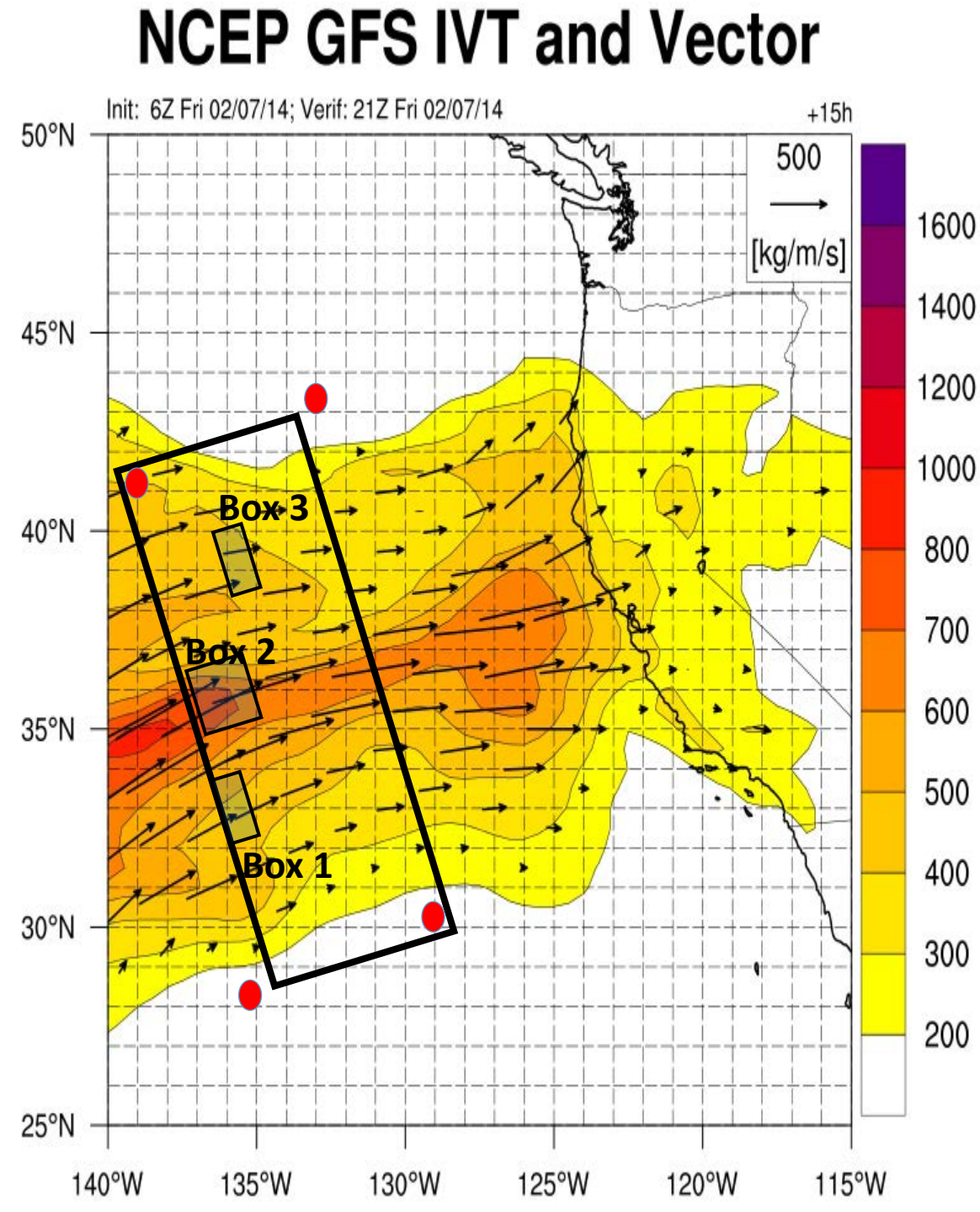
Ralph et al., GRL, 2006

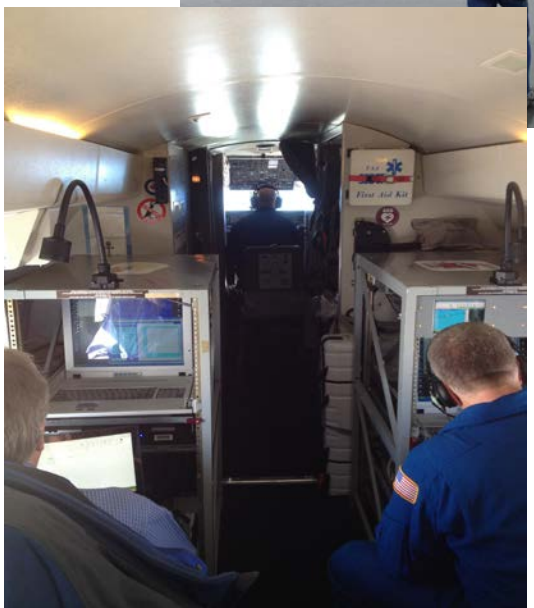
February 8, 2014 Atmospheric River – (A Moderate Atm. River)




ESRL Physical Sciences Division
S-band Precipitation Profiling Radar
Cazadero S-PROF
NEXRAD RADAR
Height (msl)
(km)
(kft)
Time (UTC)
7-FEB-14
5-FEB-14
SNR
(dB)
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)

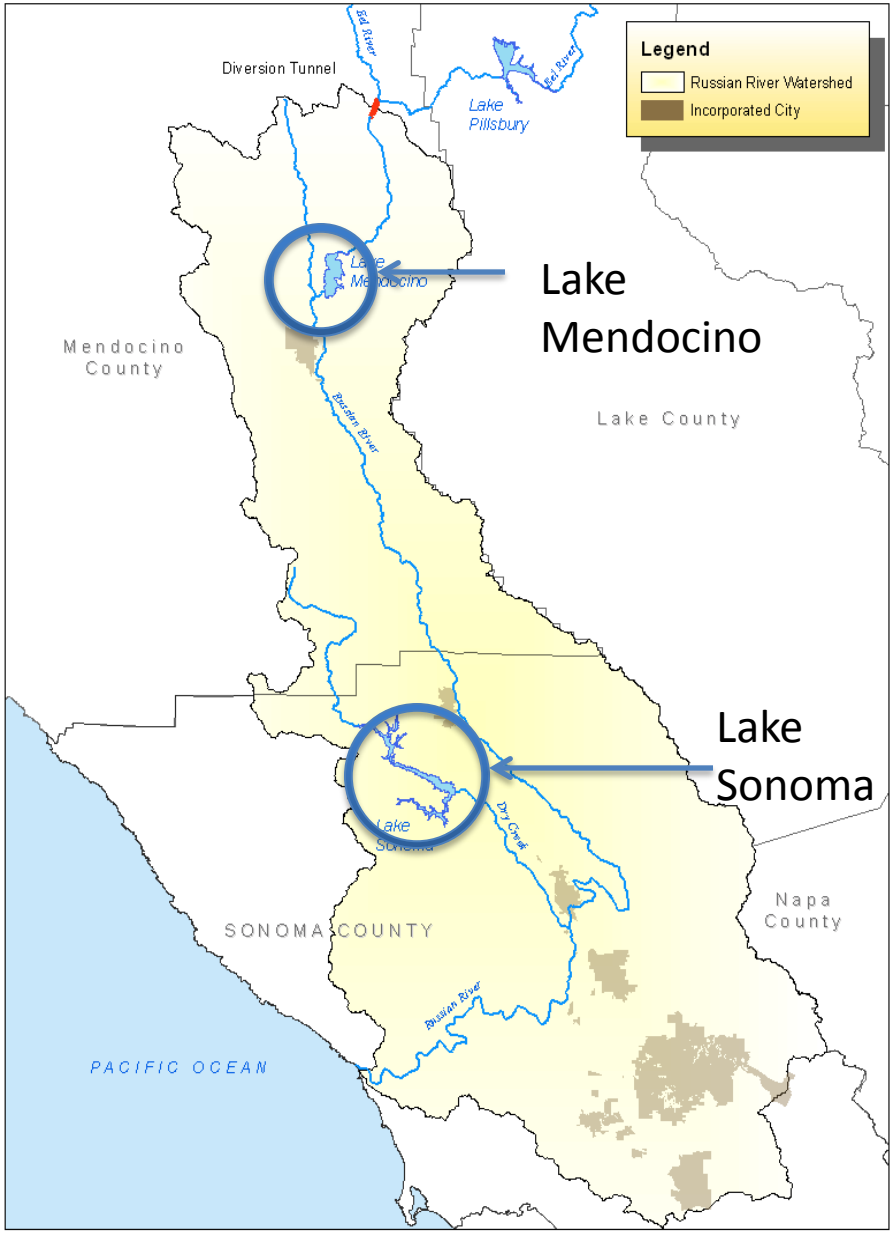
Atmospheric River Research – Hurricane Hunters



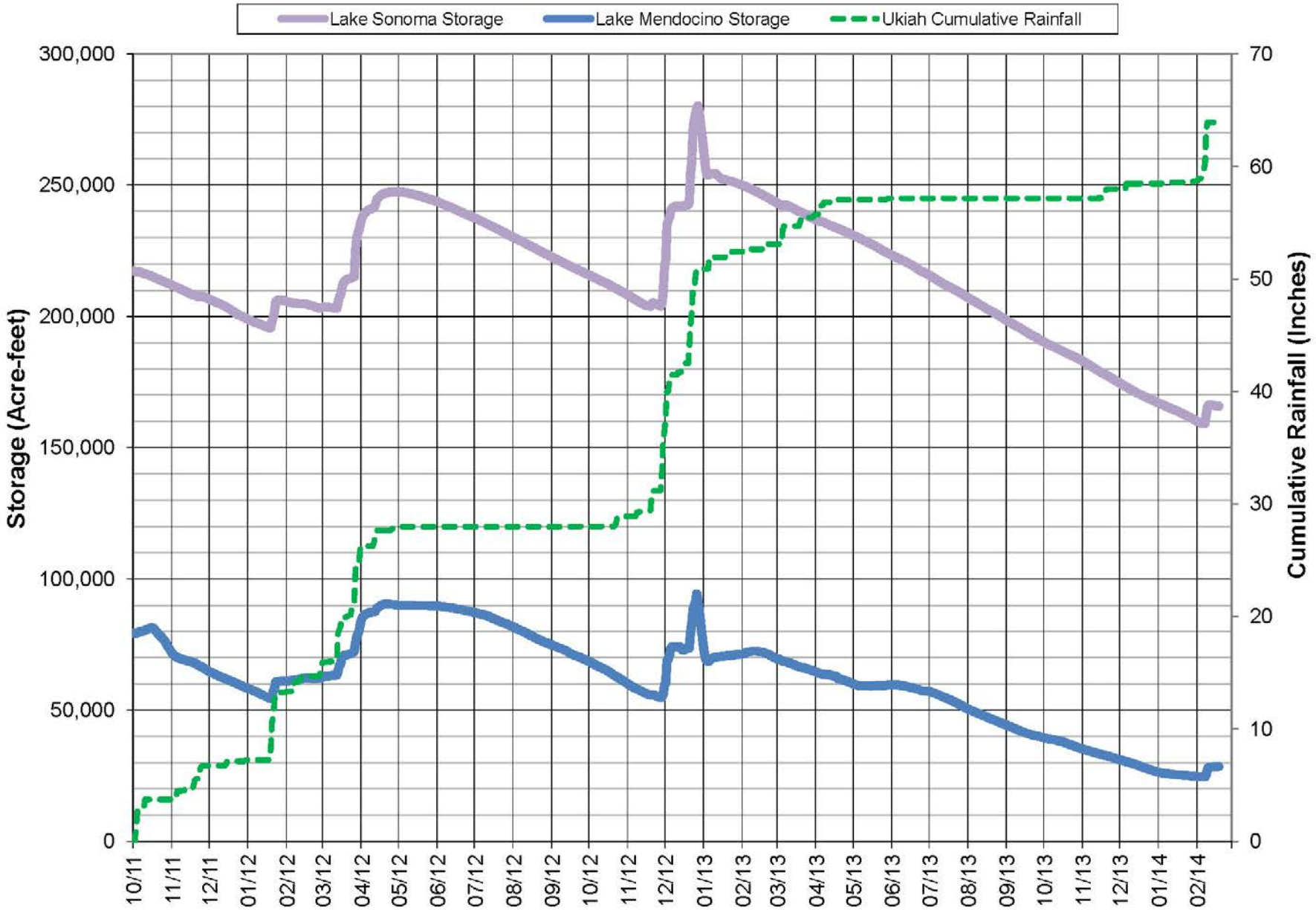


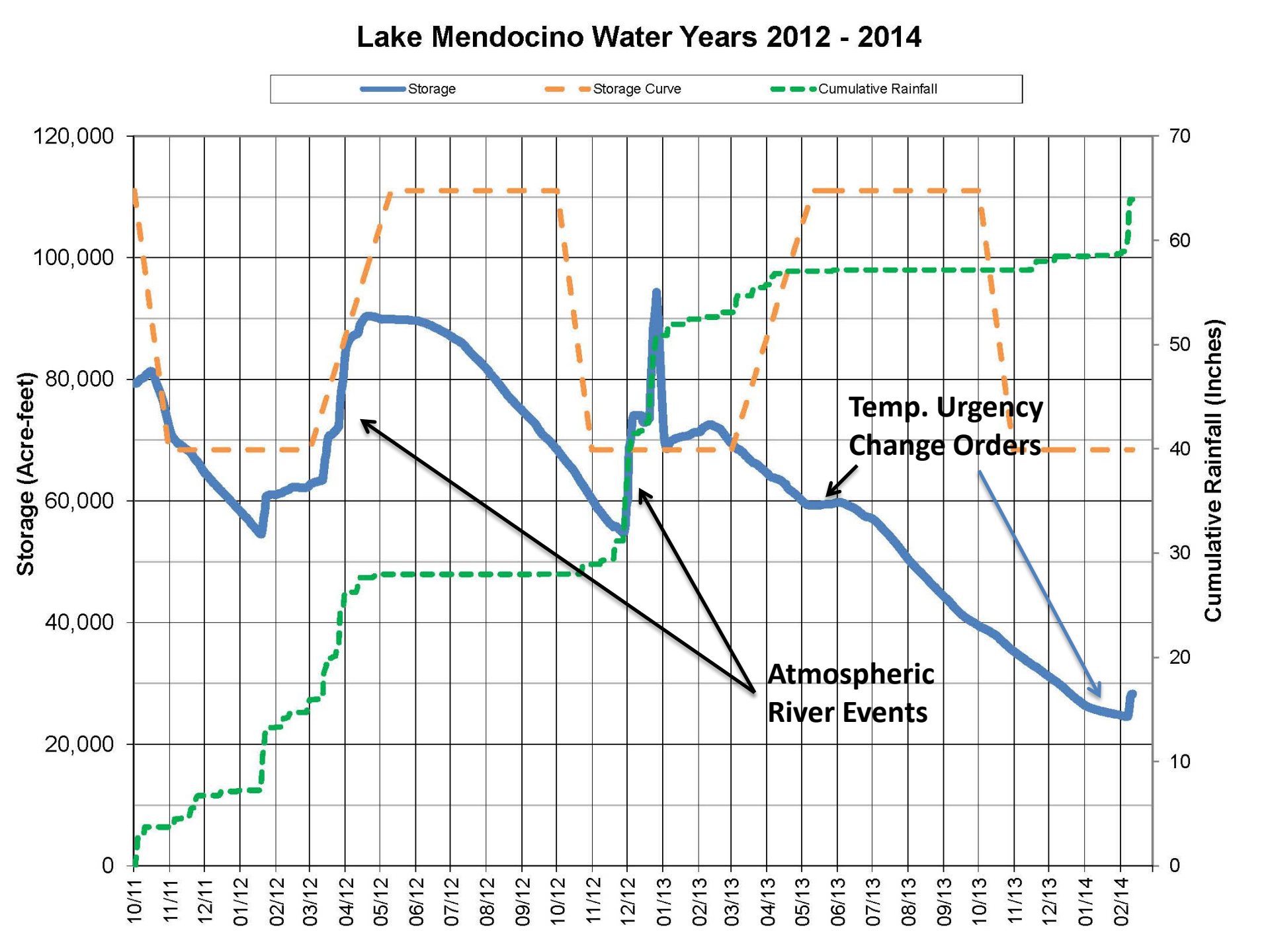
Drought Impacts: Russian River Water Supply Facilities – A Tale of 2 Reservoirs

Lake Mendocino Dec. 2013



Lake Sonoma and Lake Mendocino Storage
Water Years 2012 - 2014




Lake Mendocino Water Years 2012 - 2014
Storage
Storage Curve
Cumulative Rainfall
Storage (Acre-feet)
Cumulative Rainfall (Inches)
120,000
100,000
80,000
60,000
40,000
20,000
0
70
60
50
40
30
20
10
0
10/11
11/11
12/11
01/12
02/12
03/12
04/12
05/12
06/12
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03/13
04/13
05/13
06/13
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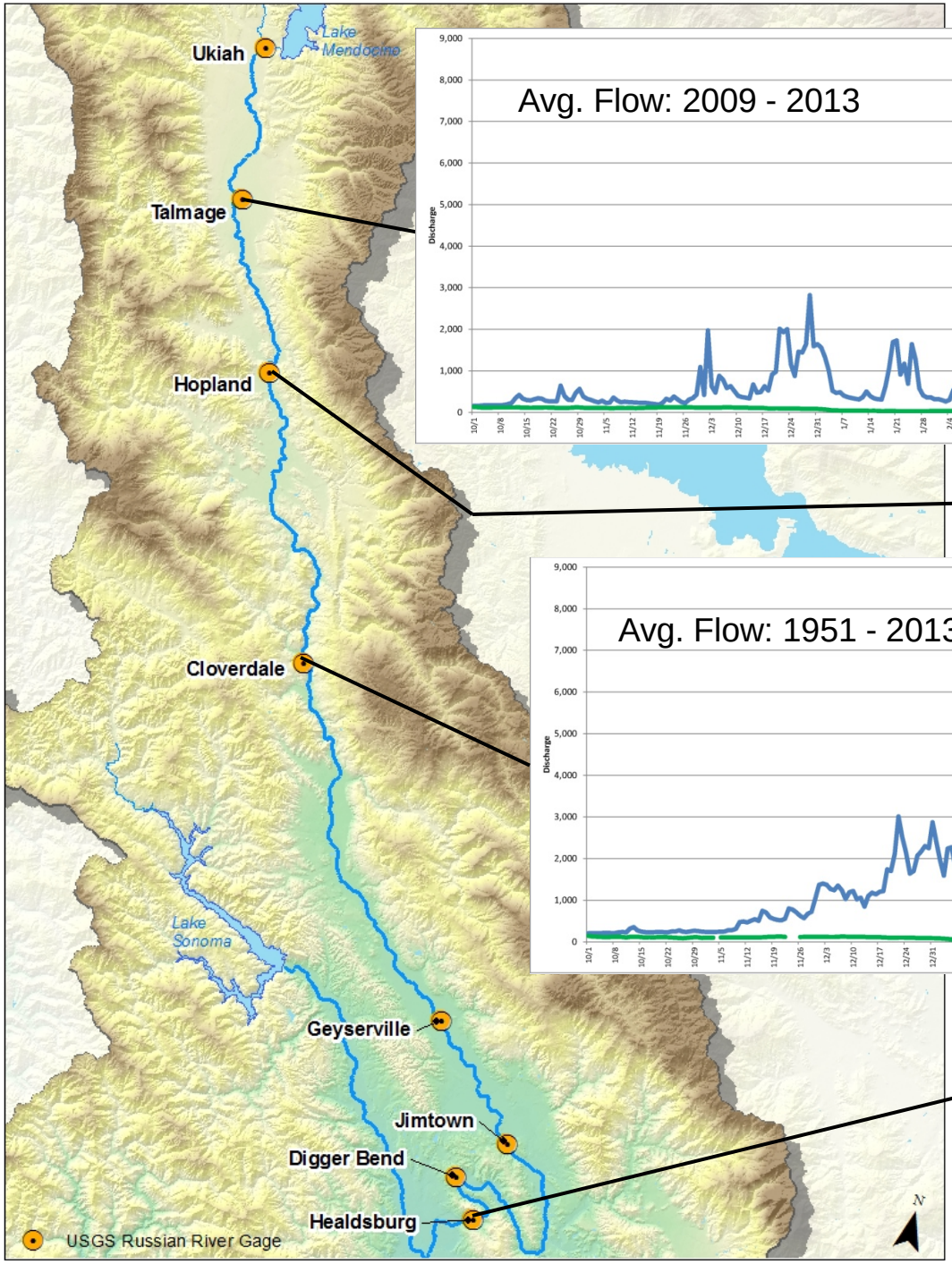
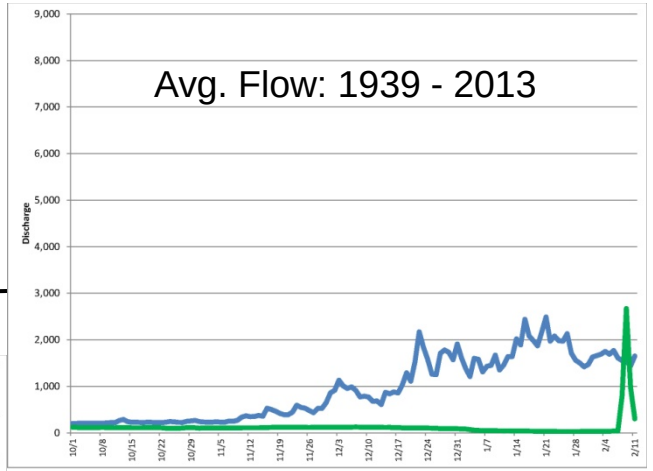
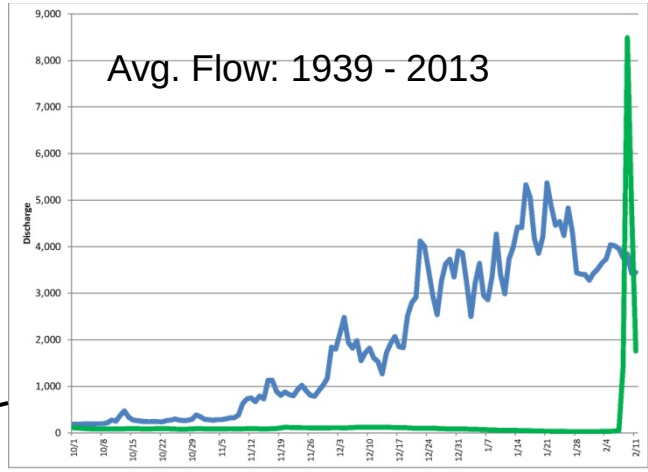
01/14
02/14
Temp. Urgency Change Orders
Atmospheric River Events

Upper Russian River
Unprecedented Low Flows



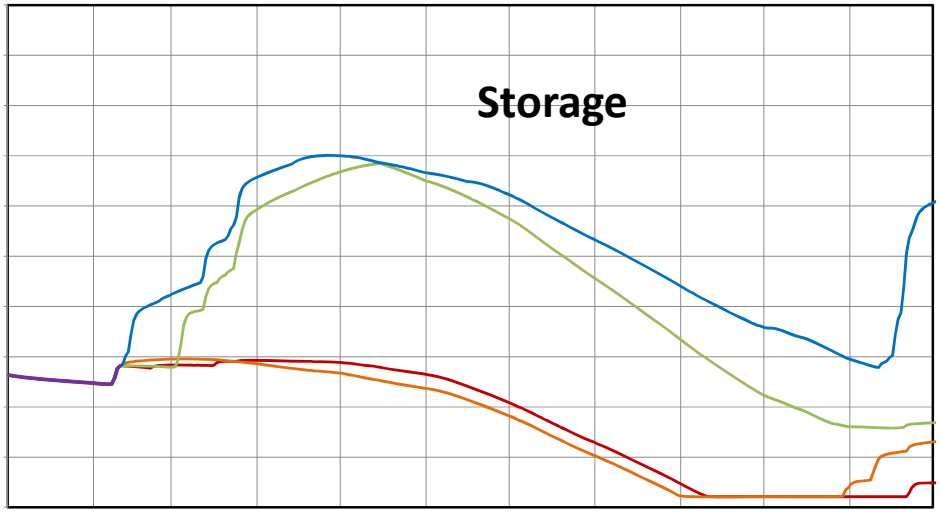




Average Discharge 10/1 – 2/11

Actual WY2014 Discharge 10/1 – 2/11

Lake Mendocino Forecasted Storage Scenarios With Dry Year Hydrology



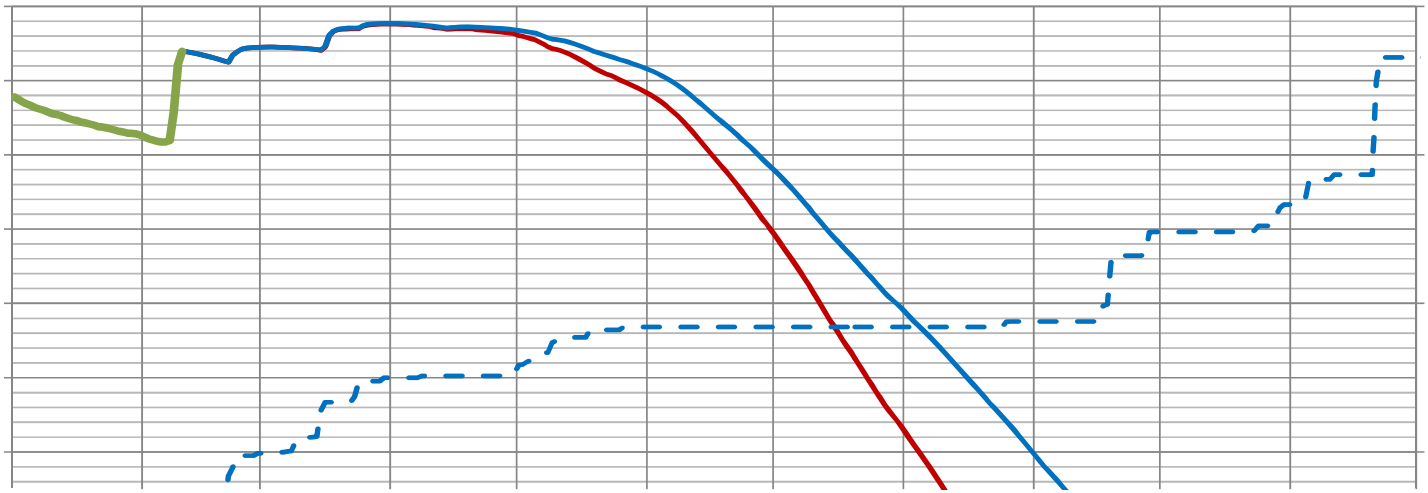
Rainfall

➢**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**

logy Current (2014)

Lake Mendocino Storage Forecast With Reduced Upper River Water Use



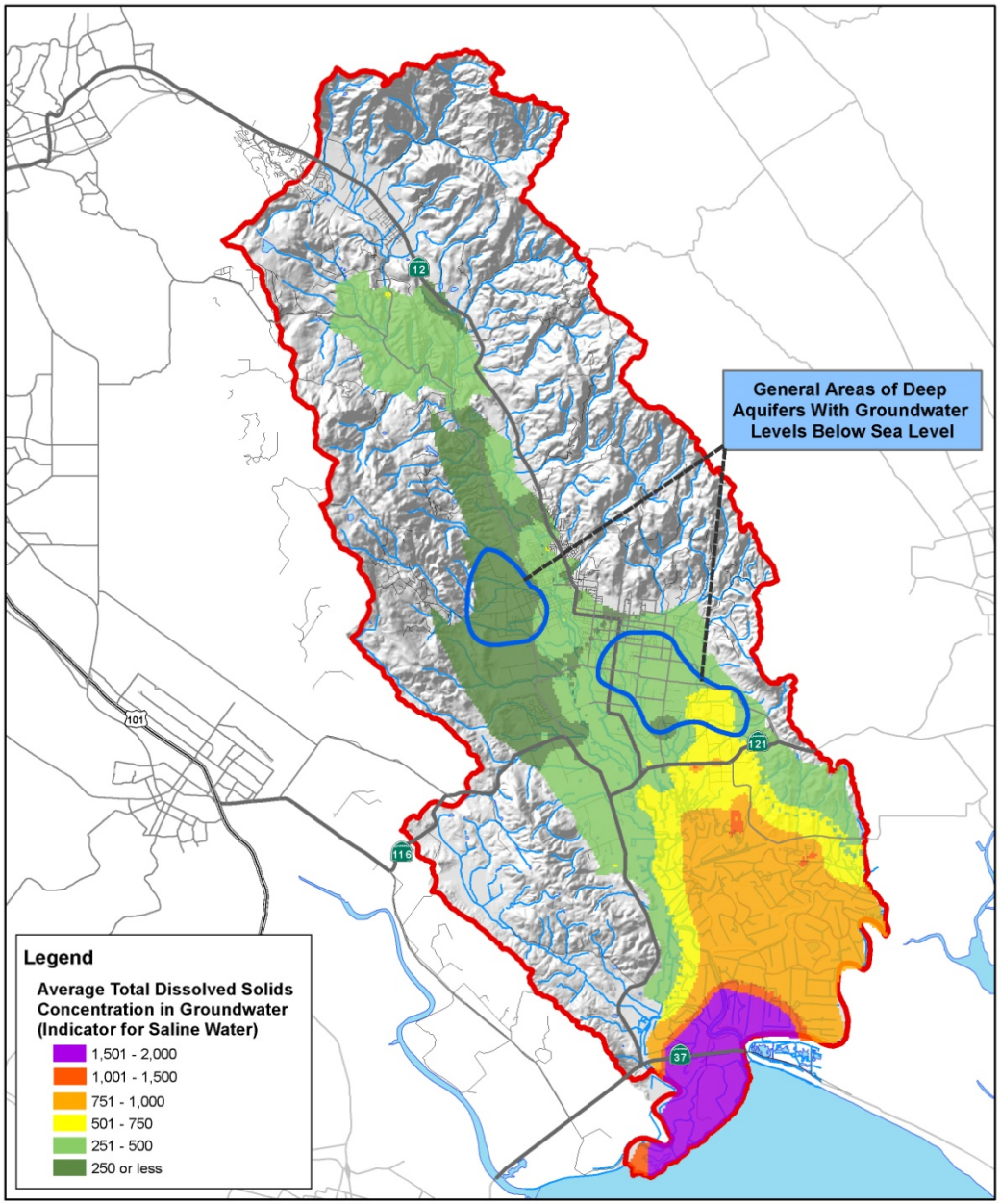
1977

Precipitation - 2014

Drought Impacts to Groundwater

Areas of concern include:

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



Sonoma Valley
Groundwater Management Program
Dissolved Solids Concentration in Groundwater

February 13, 2014

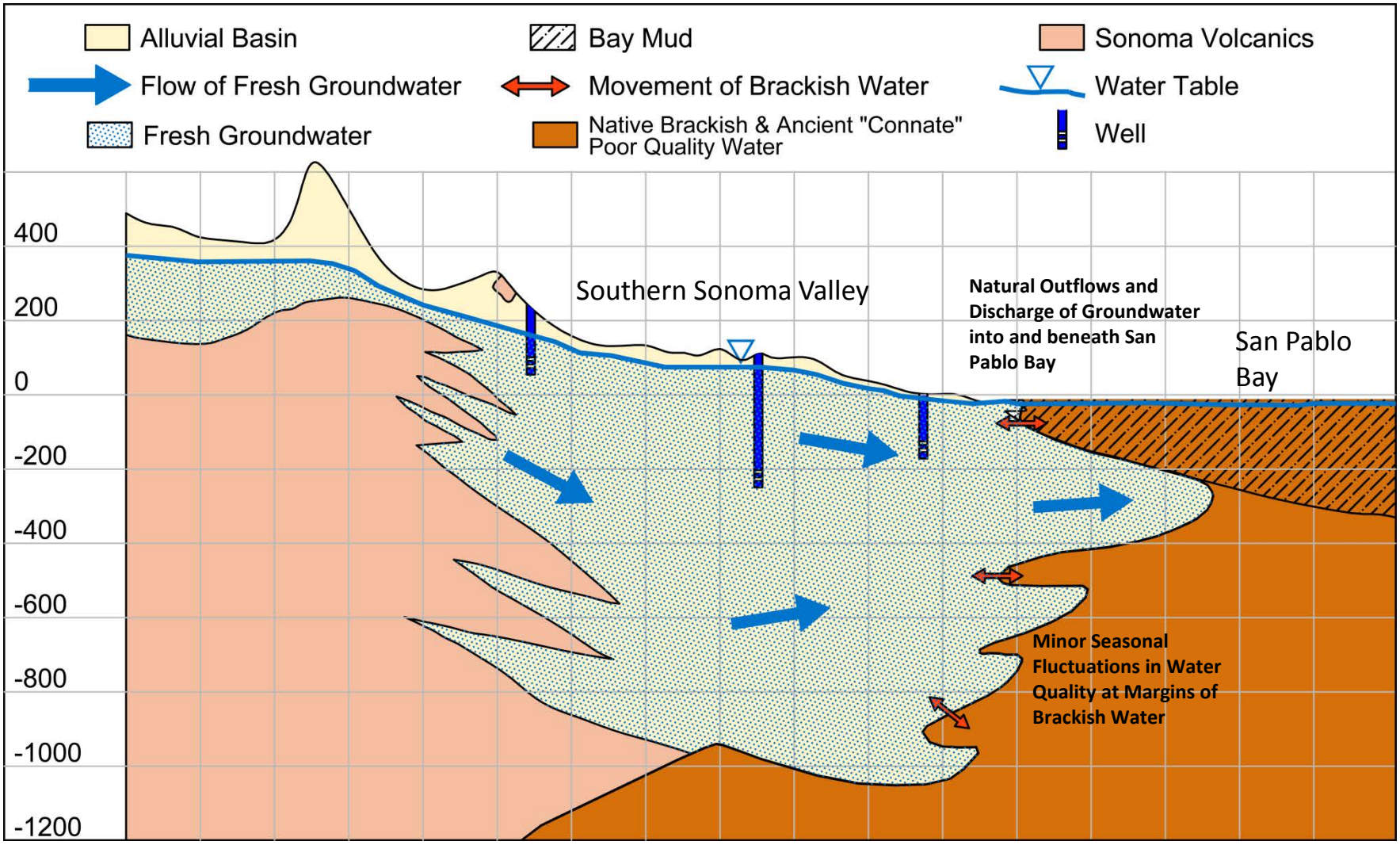
DRAFT

0 0.5 1 2 3 4 5
Miles

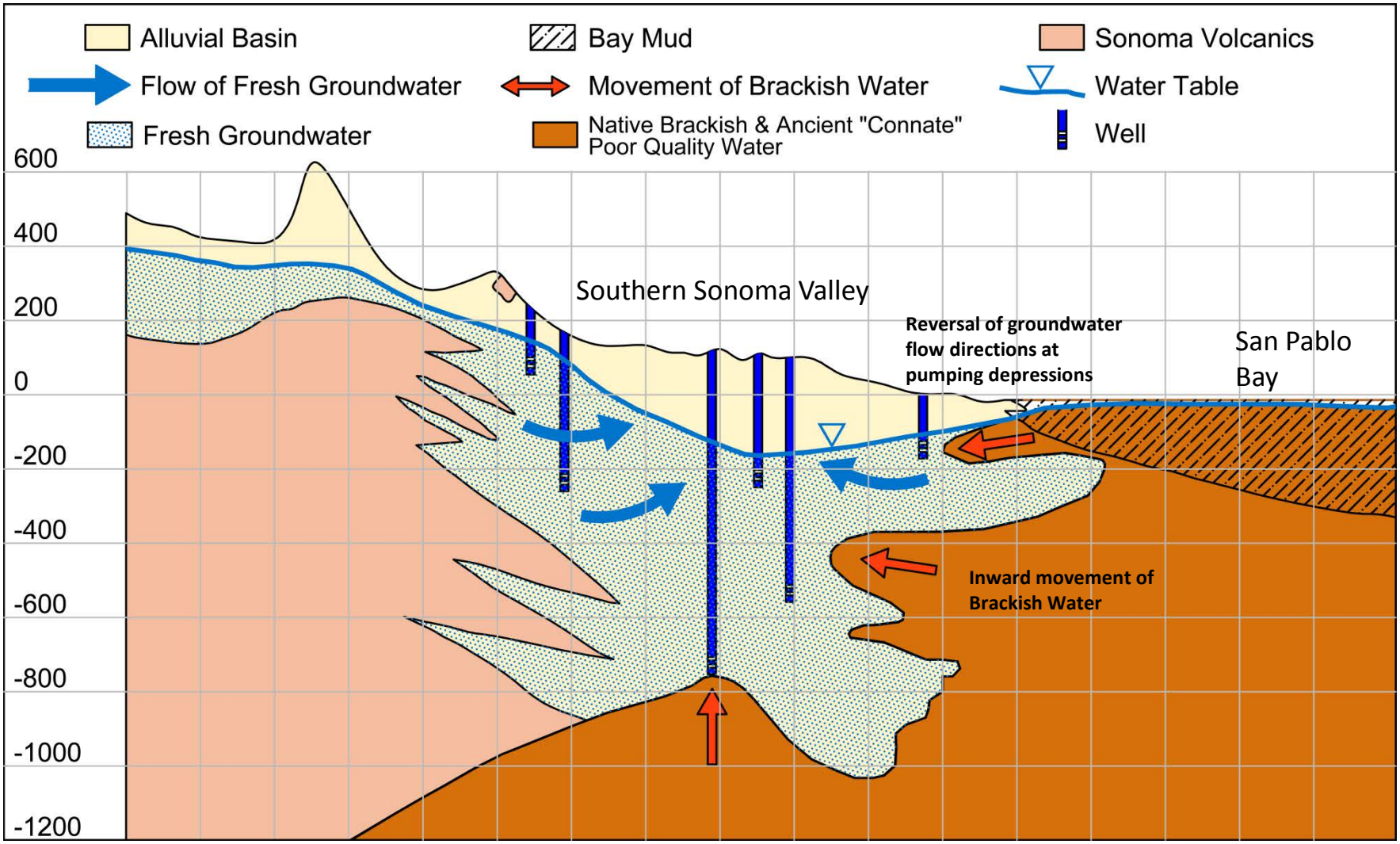
N
W E
S

Figure ES-3

1950: Shallow Groundwater Levels Prior to Extensive Pumping

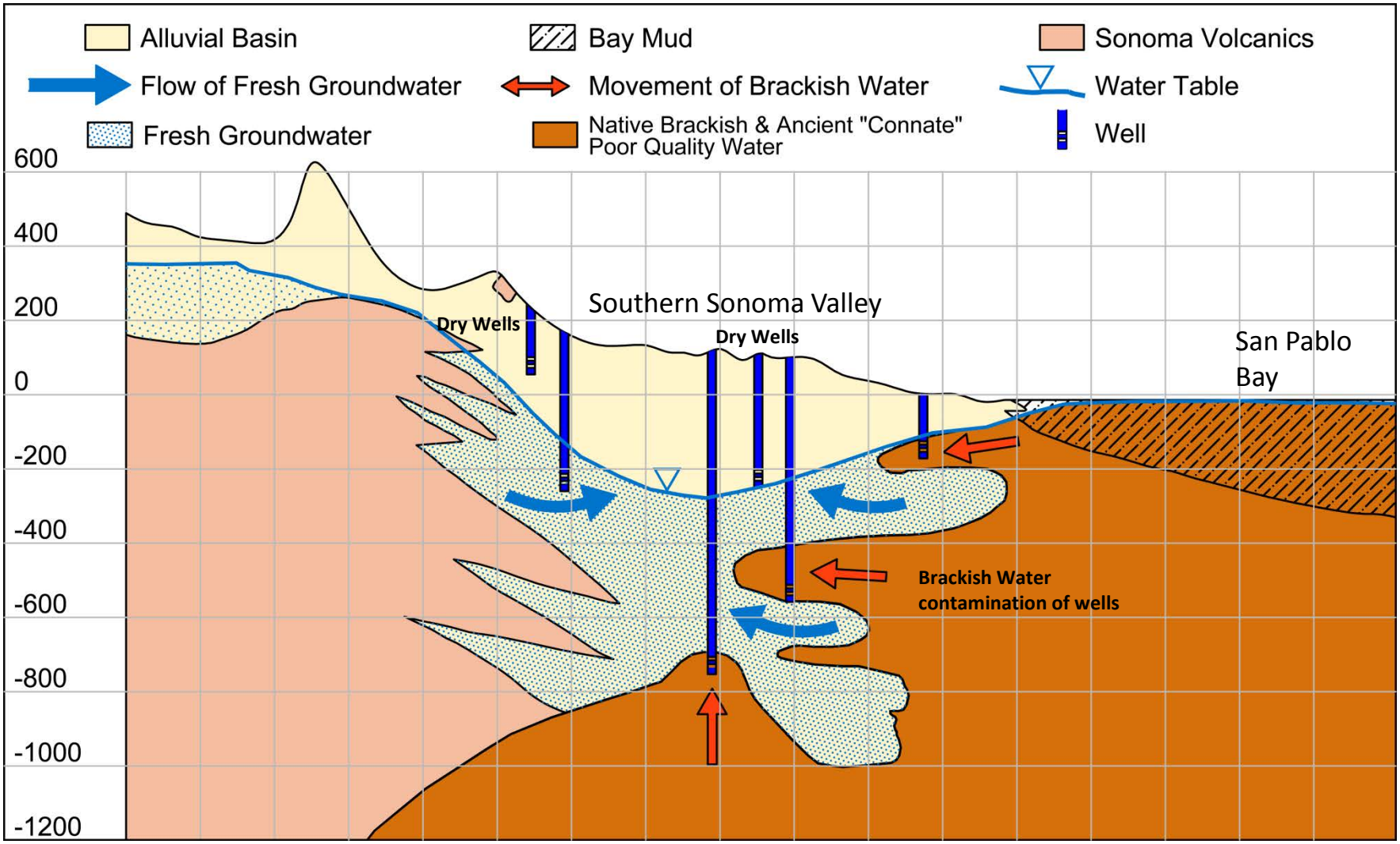


Today: Groundwater Levels Lowered over 100 Feet in Southern Sonoma



Future Continued Depletion of Groundwater?

* Dry Wells
* Brackish Water Contamination of Wells

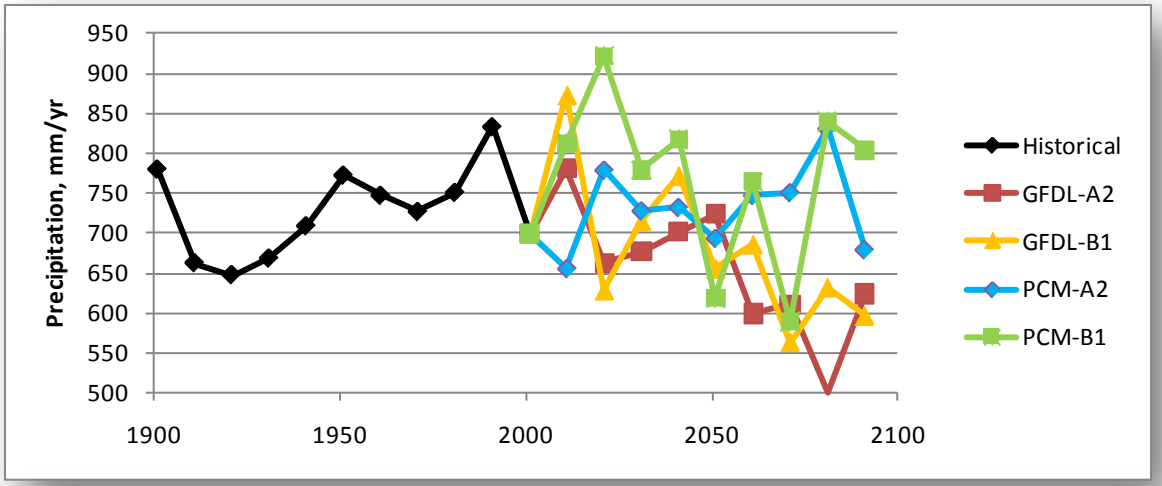


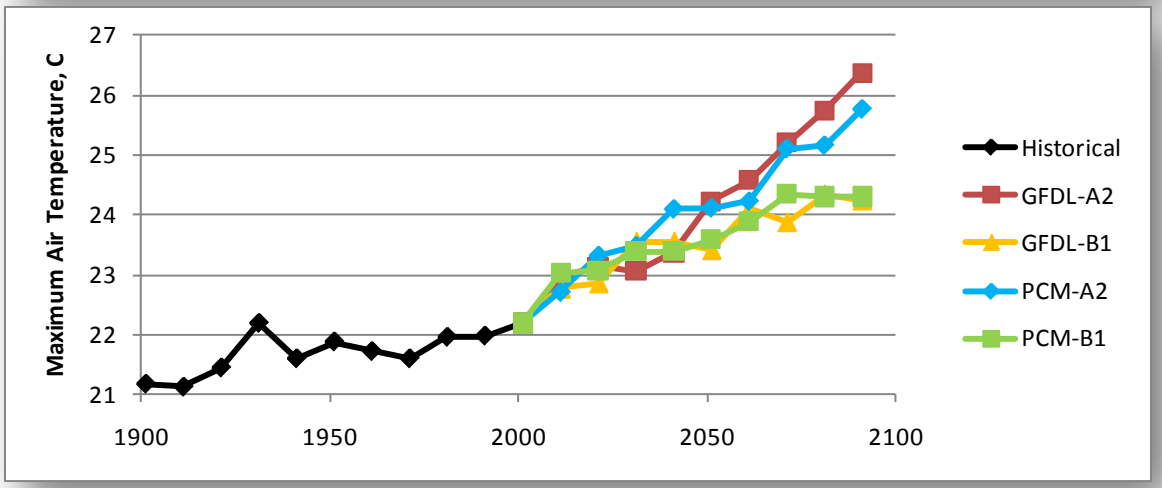
What Does the Future Look Like?

- **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





USGS science for a changing world

SONOMA COUNTY WATER AGENCY

Anticipated Climate Change Impacts

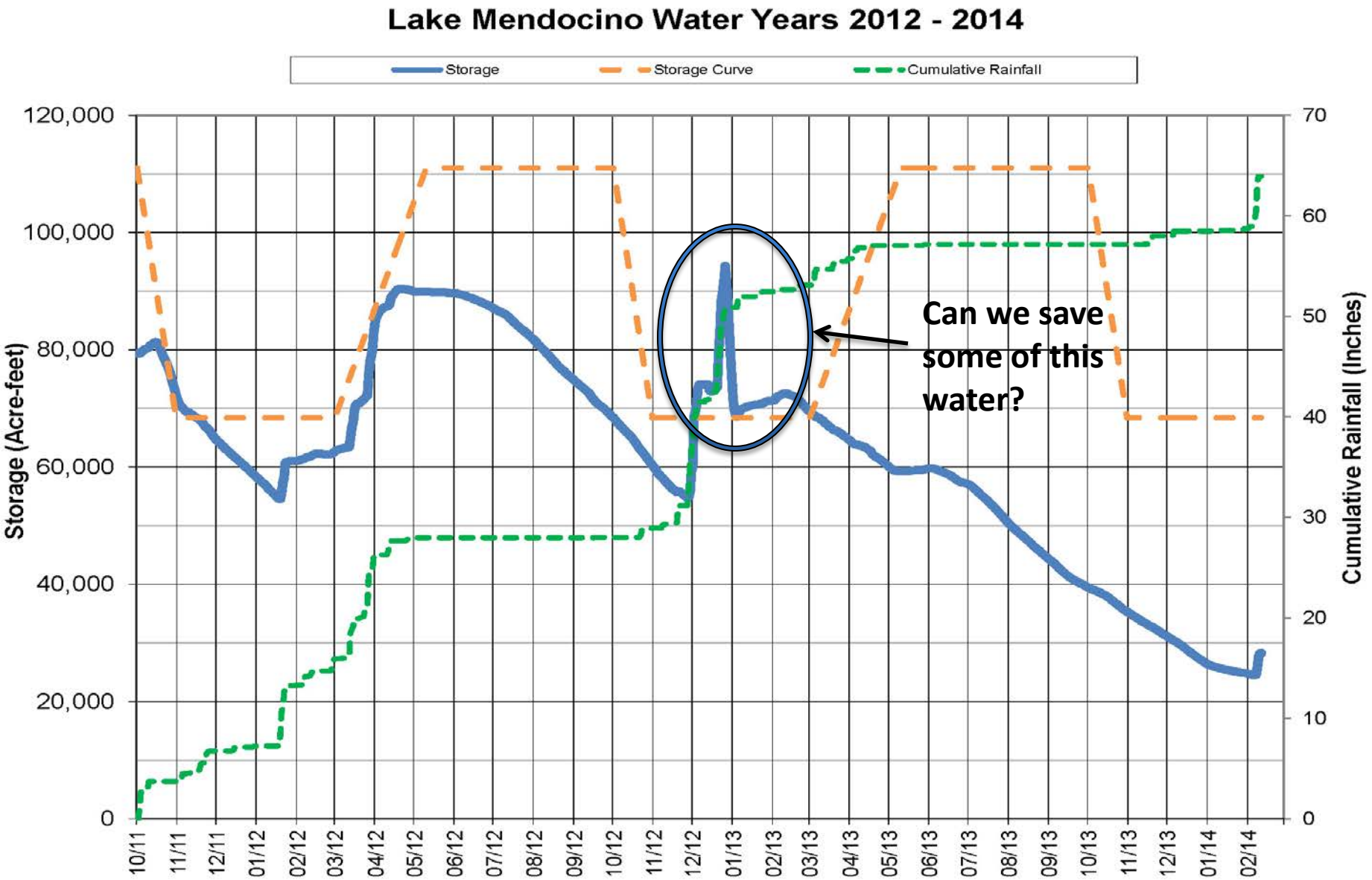
- Increased temperature = Increased water demand (Human, Agricultural, Environmental) - Even in wet years
- Drier soils mean lower groundwater recharge
- Increased variability – Droughts & floods will be more extreme
- Even “wet” years likely to exhibit compressed winters
- Sea-level rise impact to infrastructure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

SONOMA COUNTY WATER AGENCY

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



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

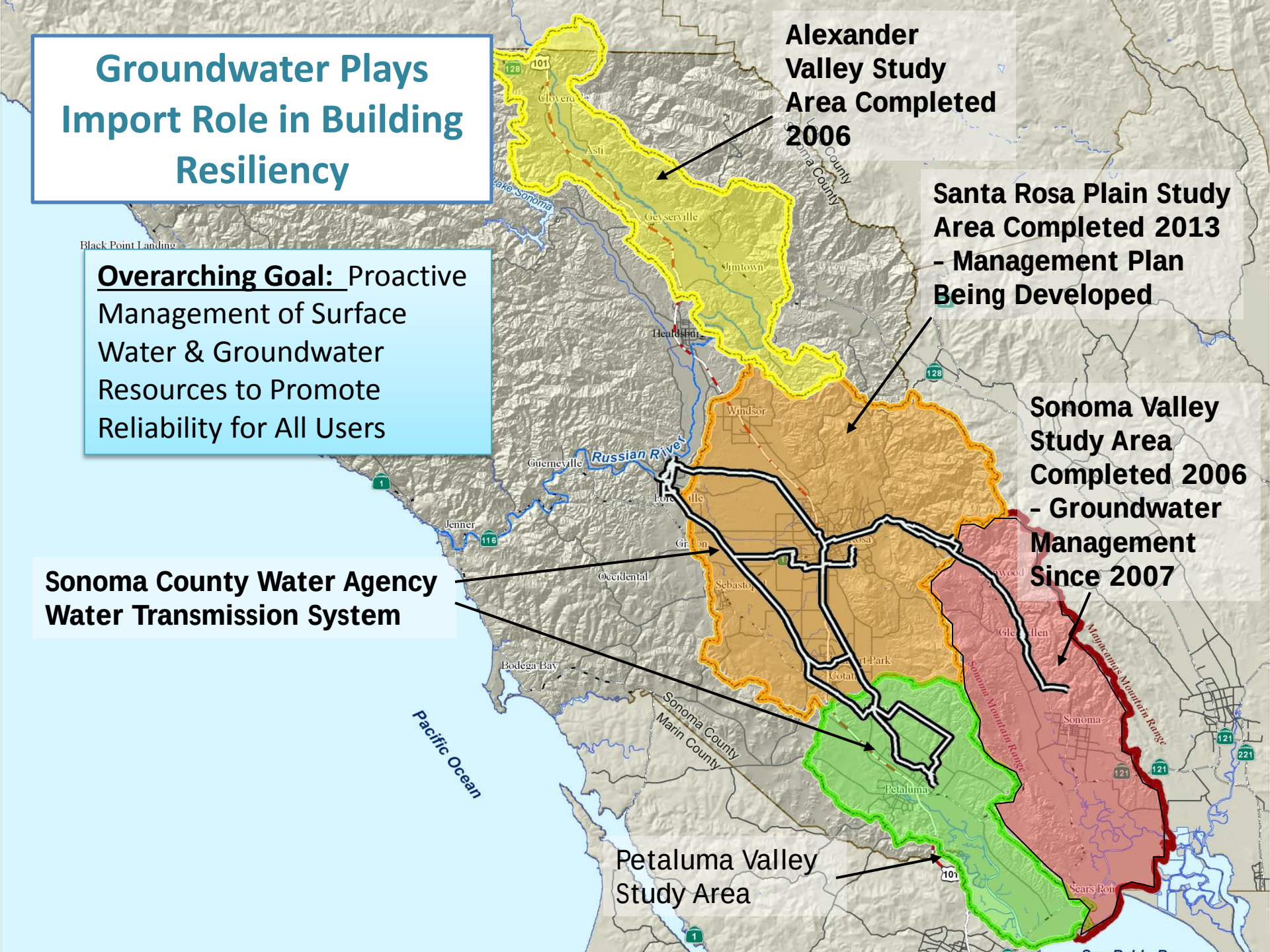
Integrated Water Management:
4 Ways to Meet Water Supply Demands

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

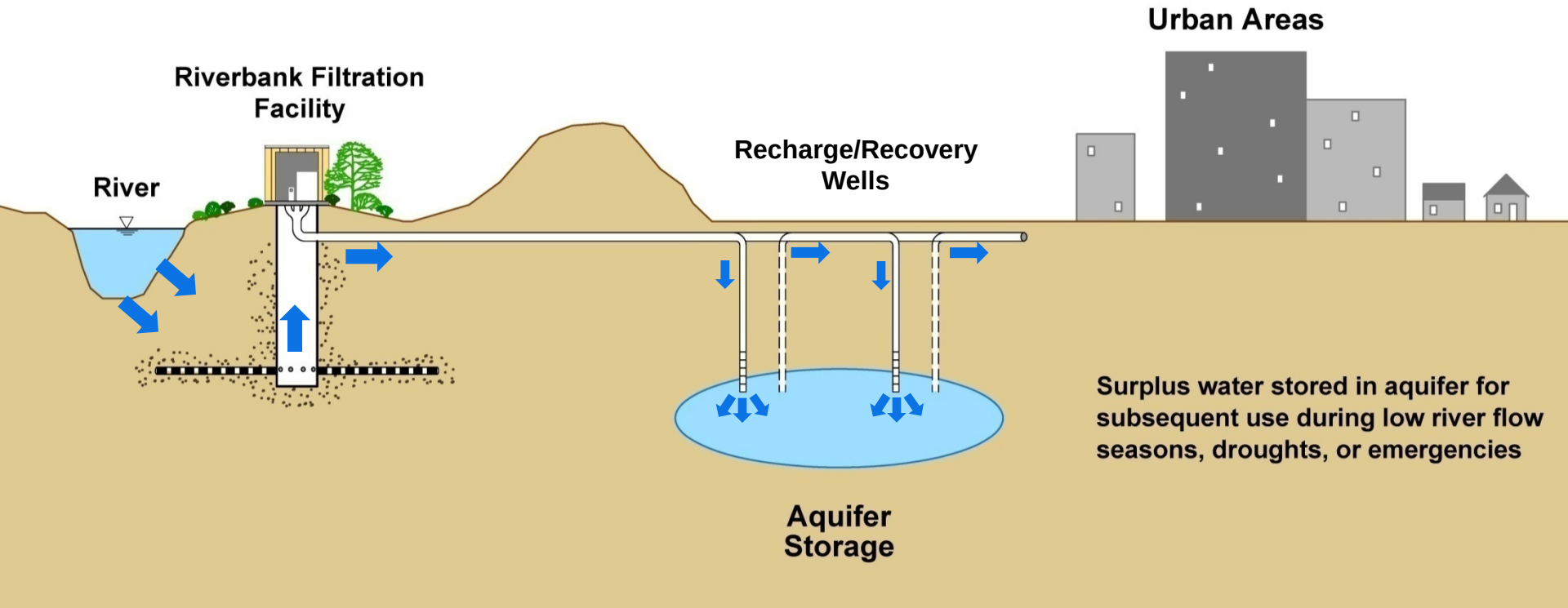
Groundwater Plays Import Role in Building Resiliency

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

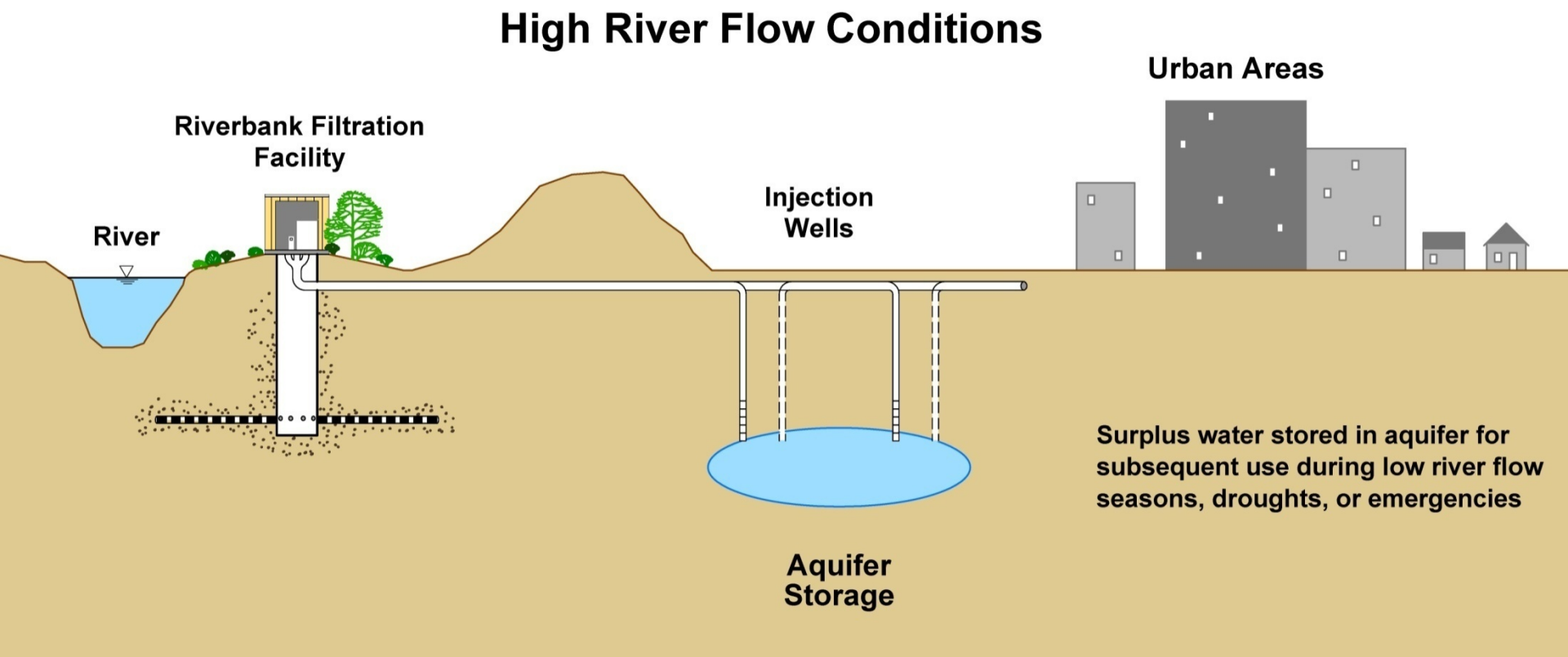


Conceptual Groundwater Banking Schematic
Aquifer Storage and Recovery

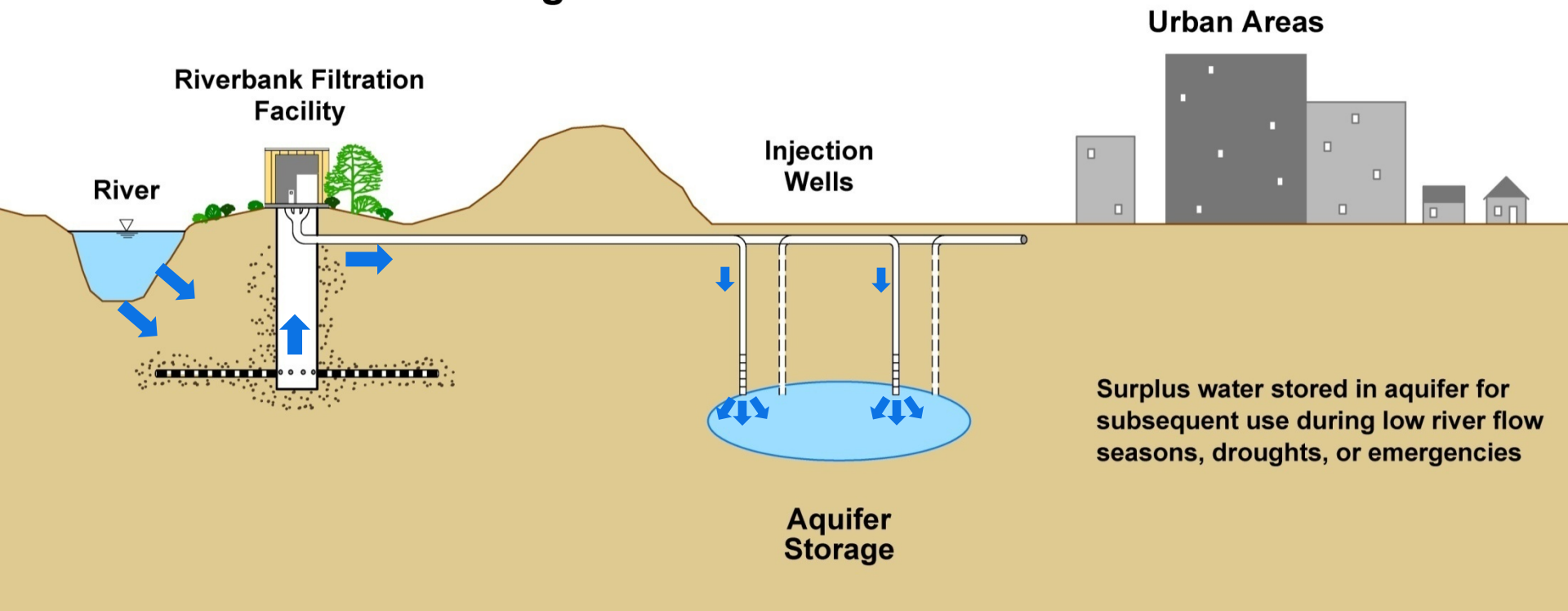
- Proceeding with Aquifer Storage and Recovery Concepts
- Geochemical compatibility assessment
  - Groundwater quality sampling and geochemical modeling
- Developing Work Plans for Pilot-Scale Demonstration Project(s)
- Explore funding options



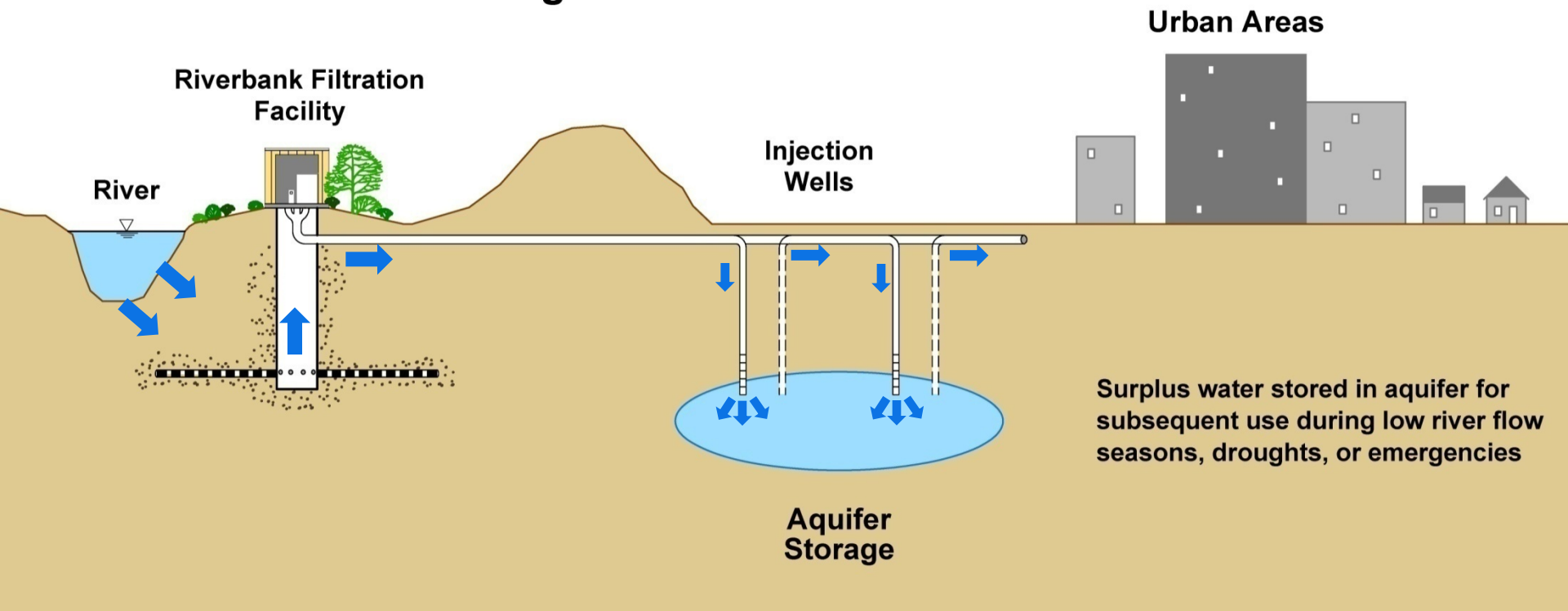
Wet Year - 2011



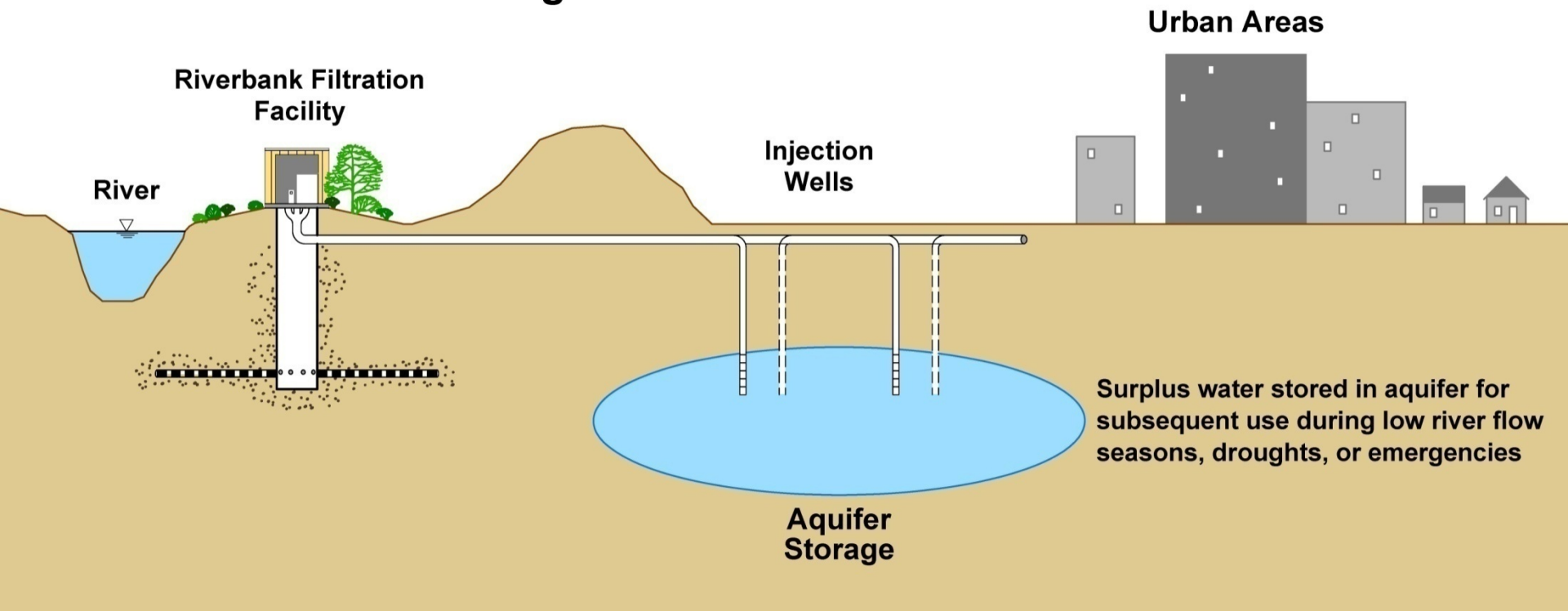
High River Flow Conditions



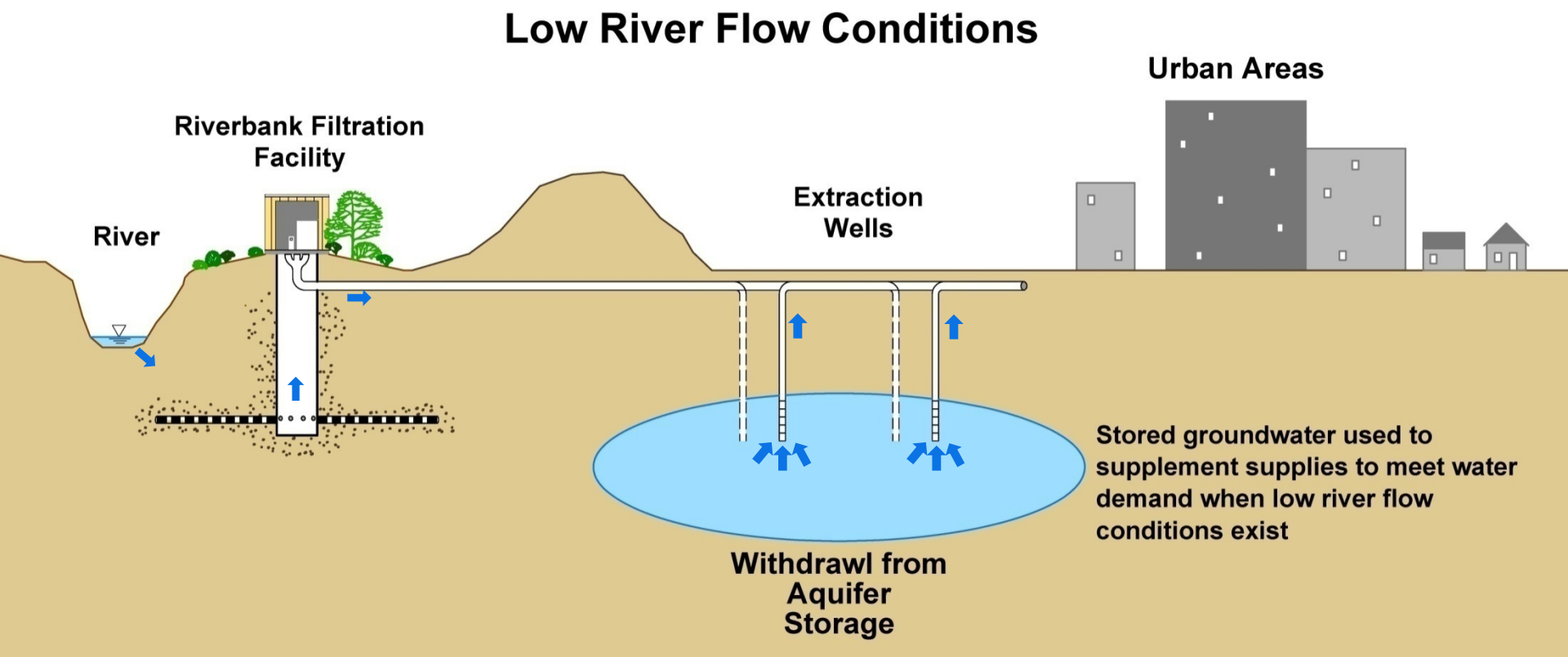
High River Flow Conditions



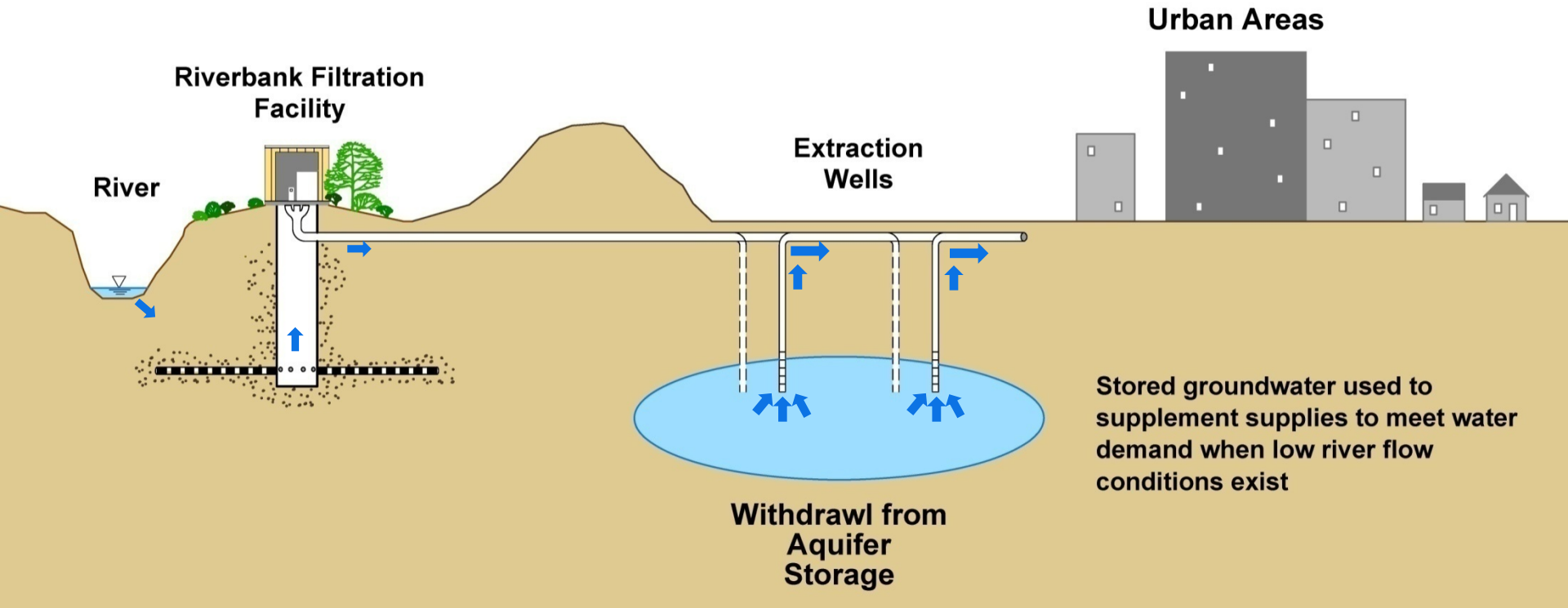
High River Flow Conditions



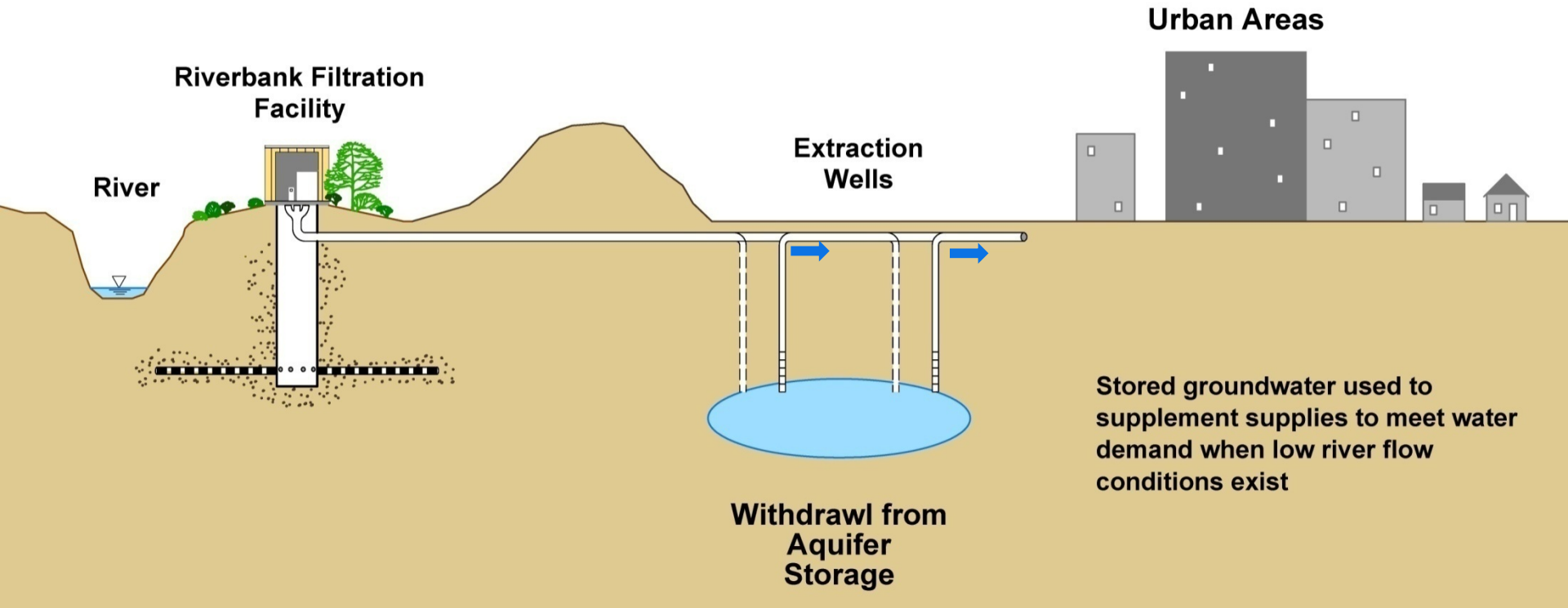
Dry Year - 2013



Low River Flow Conditions

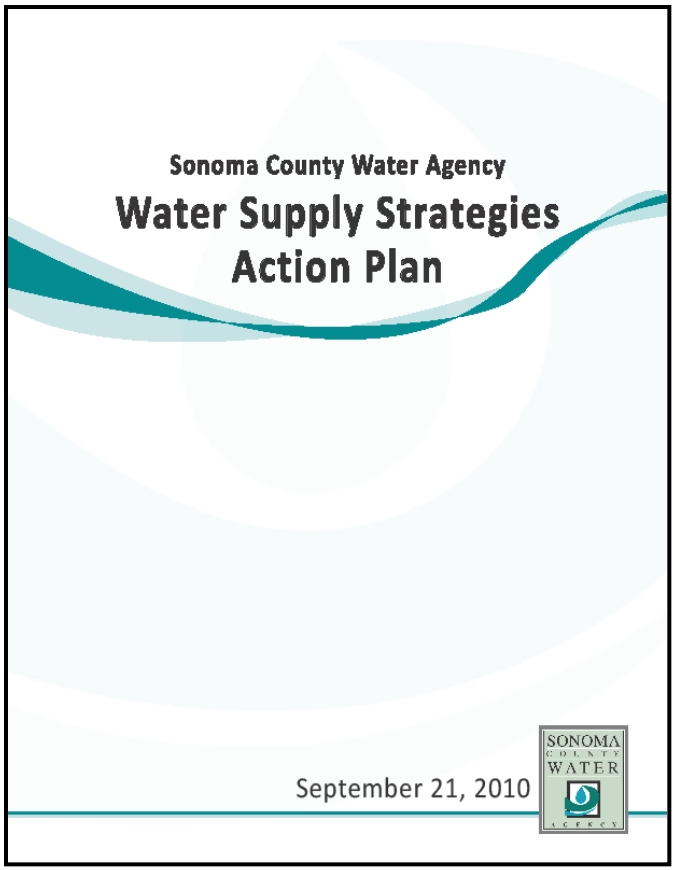


Low River Flow Conditions



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