California's Groundwater Update 2013:
A Compilation of Enhanced Content for California Water Plan Update 2013

Groundwater Webinars 1 and 2
April 23 and April 24, 2015

Abdul Khan, Supervising Water Resources Engineer
&
Dan McManus, Supervising Engineering Geologist

California Department of Water Resources

Presentation will follow content outline shown in agenda

Quotes from Two DWR Directors: Past and Present

- In 1957, DWR Director Harvey O. Banks stated: "Groundwater looms very large in the total water picture in California and the formation and implementation of plans to meet our needs for water in the future. We are seriously lacking in the data and information necessary for planned utilization of groundwater."

- DWR Director Mark Cowin stated: "Today, it is all the more apparent that we need to change the trajectory in terms of our ability to understand groundwater and take bold actions to manage it sustainably."

Current Effort: Modest but groundbreaking

The Groundwater Team

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- Robb Whitaker
- Kate Williams
- Betty Yee
- Matt Zidar
- Joe Zilles

- > 60 Members
- Ag./Urban/Env Interests
- State/Federal/Regional/Local Agencies

Chronology of Groundwater Content in Previous Water Plans

CWP UPDATE	CHRONOLOGY OF GROUNDWATER CONTENT IN THE CALIFORNIA WATER PLAN
1957	• Groundwater is discussed primarily in terms of additional storage capacity and water supply.
1970	• Discussed what is required to locally manage groundwater basins, including potential new regulations.
1974	• Discussed groundwater policy to limit development. • Described groundwater basin by region. • Provided map of San Joaquin Valley aquifer levels in wet and dry periods.
1983	•
1987	• • •
1993	• •
1998	• •
2005	• Introduced groundwater-related resource management strategies.
2009	• Expanded discussion of groundwater-related resource management strategies: ○ Conjunctive management and groundwater storage. ○ Groundwater and aquifer remediation. ○ Recycled Municipal Water. ○ Recharge Area Protection. • Recommended expanded groundwater content for future CWP updates.

- Lack of Comprehensive Groundwater Contents in Previous Water Plans
- Groundwater Update 2013 Expands Groundwater Contents Significantly

California's Groundwater Update 2013
Three Main Goals

1. Improve statewide and regional understanding of groundwater conditions and management.

2. Identify data gaps and groundwater management challenges.

3. Develop recommendations to improve groundwater management in California.

California's Groundwater Update 2013

Report Organization

- Findings, Data Gaps, and Recommendations
- Chapter 1 – Introduction, Scope, and Future Directions
- Chapter 2 – Statewide Update
- Chapter 3 – North Coast
- Chapter 4 – San Francisco Bay
- Chapter 5 – Central Coast
- Chapter 6 – South Coast
- Chapter 7 – Sacramento River
- Chapter 8 – San Joaquin River
- Chapter 9 – Tulare Lake
- Chapter 10 – North Lahontan
- Chapter 11 – South Lahontan
- Chapter 12 – Colorado River

California's Groundwater Update 2013

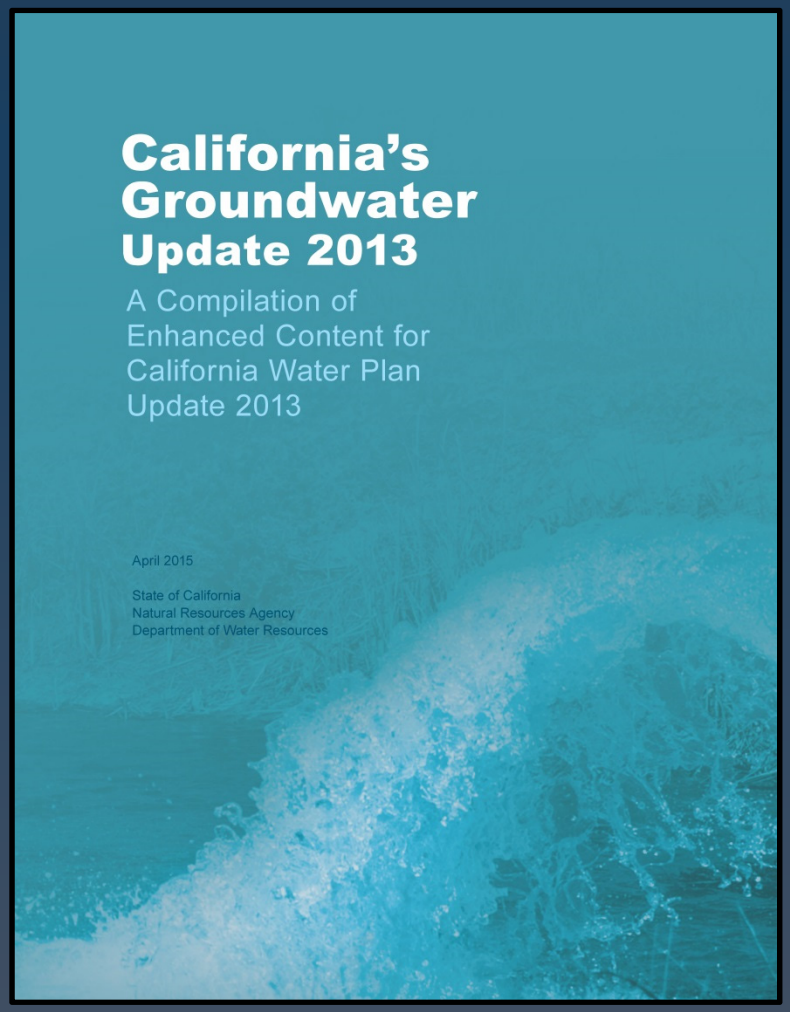
Report Organization

Technical Appendices

- Appendix A – Methods and Assumptions
- Appendix B – CASGEM Basin Prioritization
- Appendix C – Groundwater Use Data
- Appendix D – Conjunctive Management Survey Results
- Appendix E – Change in Storage Data
- Appendix F – Land Subsidence

California's Groundwater Update 2013
A Comprehensive Report

1. Introduction
2. Findings, Data Gaps, and Recommendations
3. Groundwater Supply and Development
   - Alluvial Aquifers
   - Fractured-Rock Aquifers
   - Well Infrastructure
   - CASGEM Basin Prioritization
4. Groundwater Supply
   - Average Annual Groundwater Supply
   - Change in Annual Groundwater Supply
5. Groundwater Monitoring Efforts
   - Groundwater Level Monitoring
   - Groundwater Quality Monitoring
   - Land Subsidence Monitoring



California's Groundwater Update 2013
A Comprehensive Report

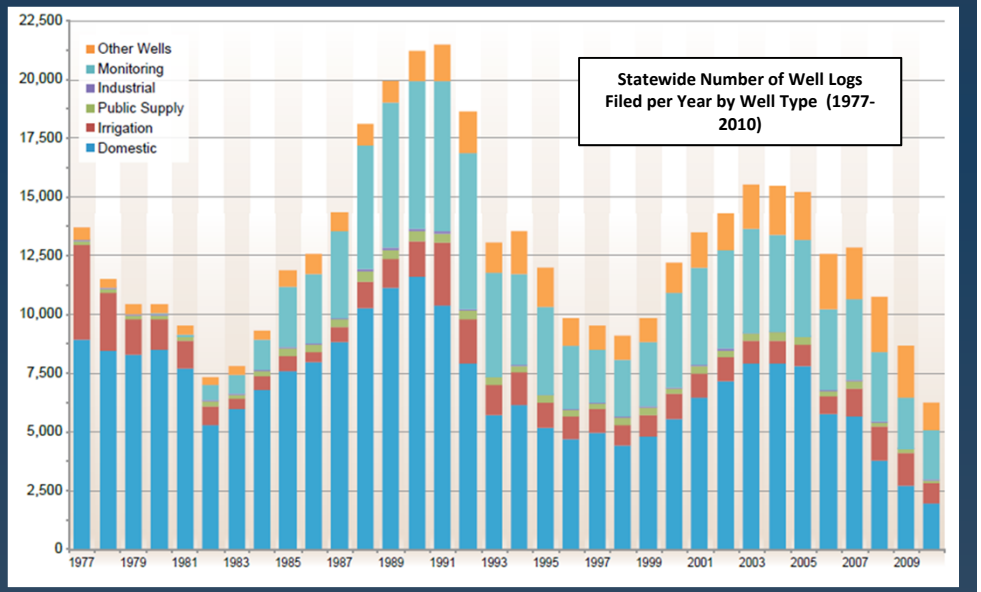
5. Aquifer Conditions
   - Groundwater Occurrence and Movement
   - Depth to Groundwater
   - Groundwater Elevations
   - Groundwater Level Trends
   - Change in Groundwater in Storage
   - Groundwater Quality
   - Land Subsidence
6. Groundwater Management
   - GWMP Inventory
   - GWMP Assessment
   - Groundwater Ordinances
   - Special Act District
   - Court Adjudications
   - Other Groundwater Management Planning Efforts
7. Conjunctive Management Inventory
   - Conjunctive Management Inventory Results
8. References

Statewide Groundwater Contents: Overview

- Findings, Data Gaps, and Recommendations
- Chapter 1 – Introduction, Scope, and Future Directions
- Chapter 2 – Statewide Update

California's Groundwater Update 2013
Findings: Well Infrastructure/Distribution

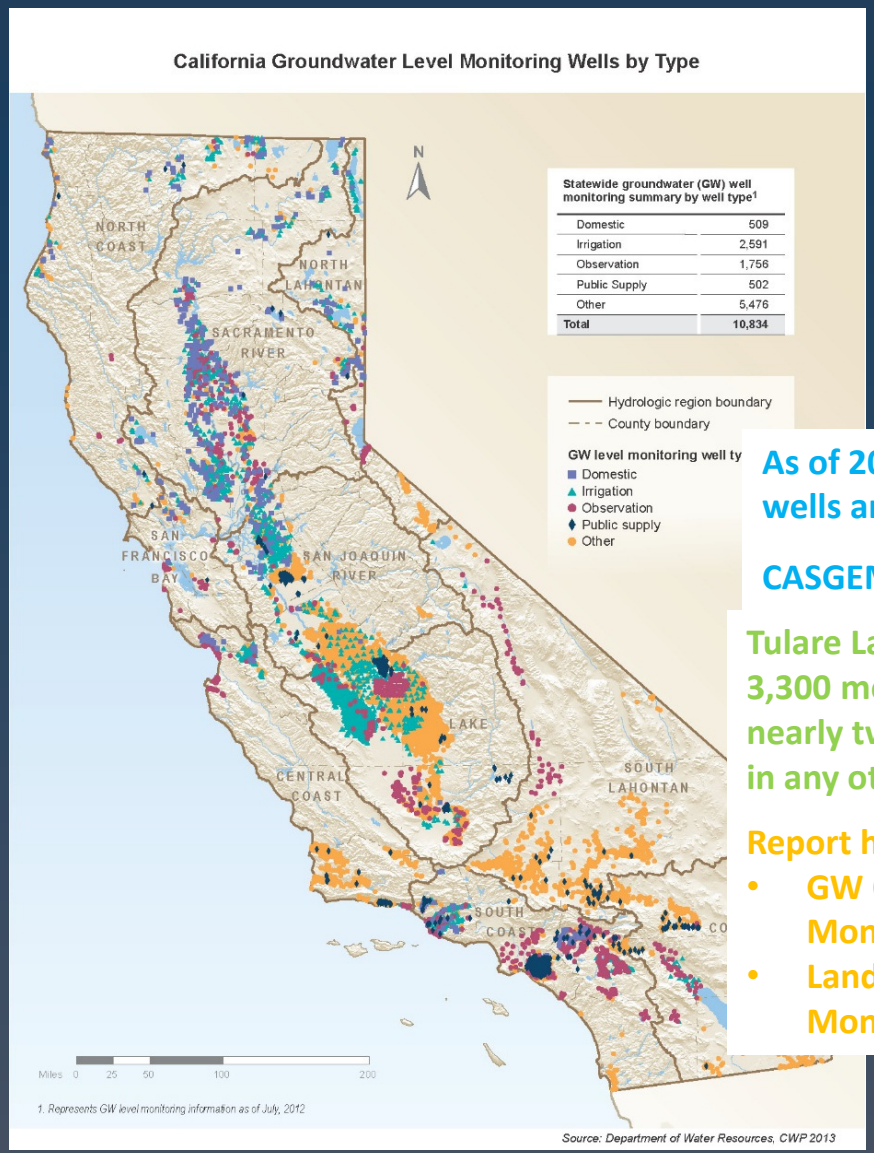
- Wells completed between 1977 and 2010:
  - Total number: **432,500**
  - Low of **4,100** wells in North Lahontan HR
  - High of **108,300** wells in Sacramento River HR

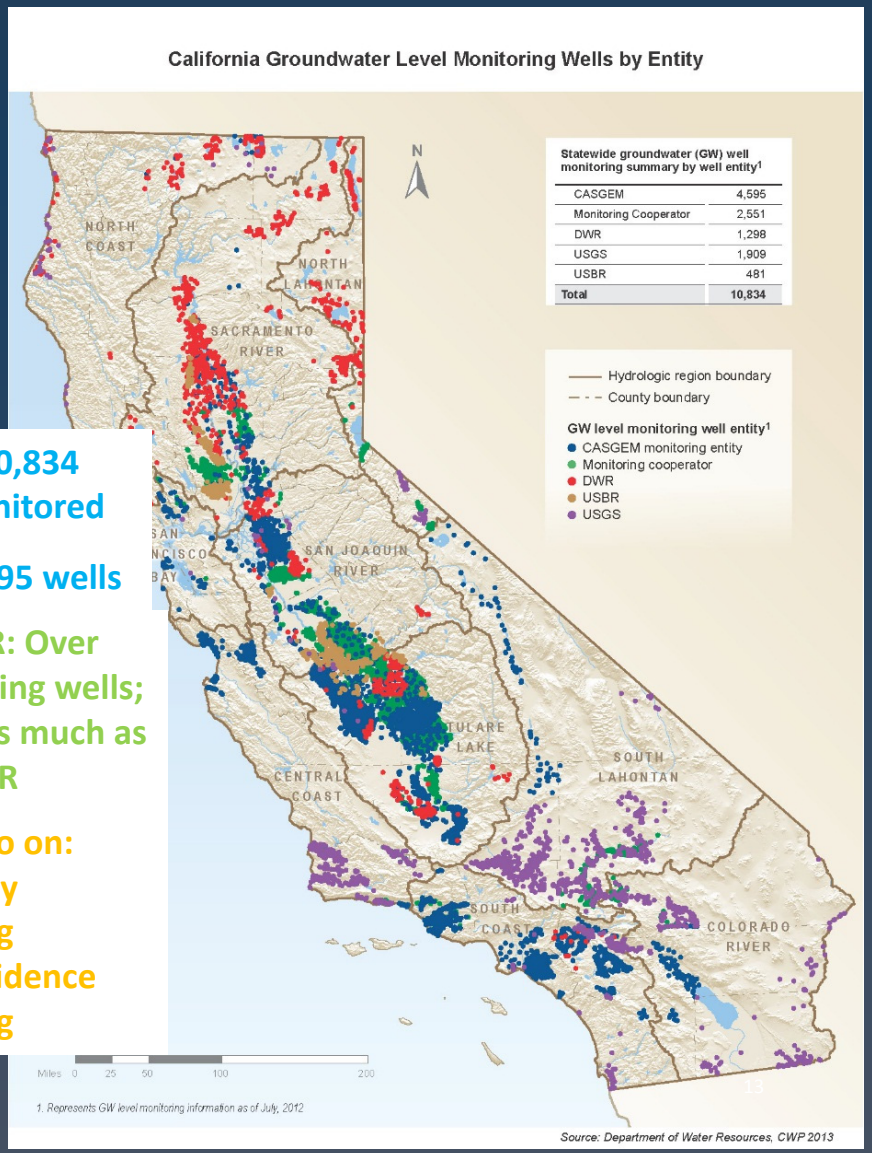


Statewide Number of Well Logs, by Hydrologic Region and Well Type (1977-2010)							
Hydrologic Region	Total Number of Well Logs by Well Use						Total Well Records
	Domestic	Irrigation	Public Supply	Industrial	Monitoring	Other	
North Coast	24,710	1,899	689	150	6,155	1,352	34,955
San Francisco Bay	8,951	2,594	356	154	41,487	9,399	62,941
Central Coast	17,137	3,849	501	80	4,880	4,480	30,927
South Coast	10,414	4,067	1,029	260	15,935	5,444	37,149
Sacramento River	78,260	6,781	1,628	368	16,514	4,795	108,346
San Joaquin River	47,789	7,280	1,461	225	11,031	5,661	73,447
Tulare Lake	28,466	12,786	1,581	181	3,211	8,097	54,322
North Lahontan	3,064	319	68	40	366	212	4,069
South Lahontan	7,394	521	1,292	196	2,329	1,380	13,112
Colorado River	8,096	1,430	472	85	2,292	826	13,201
Total CA Well Logs:	**234,281**	**41,526**	**9,077**	**1,739**	**104,200**	**41,646**	**432,469**

- Min: 6,000 Wells in 2010
- Max: > 20,000 Wells in 1990 and 1991
- Avg: 12,000 Wells

California's Groundwater Update 2013
Findings: Monitoring Well Information





As of 2012, 10,834 wells are monitored

CASGEM: 4,595 wells

Tulare Lake HR: Over 3,300 monitoring wells; nearly twice as much as in any other HR

Report has info on:

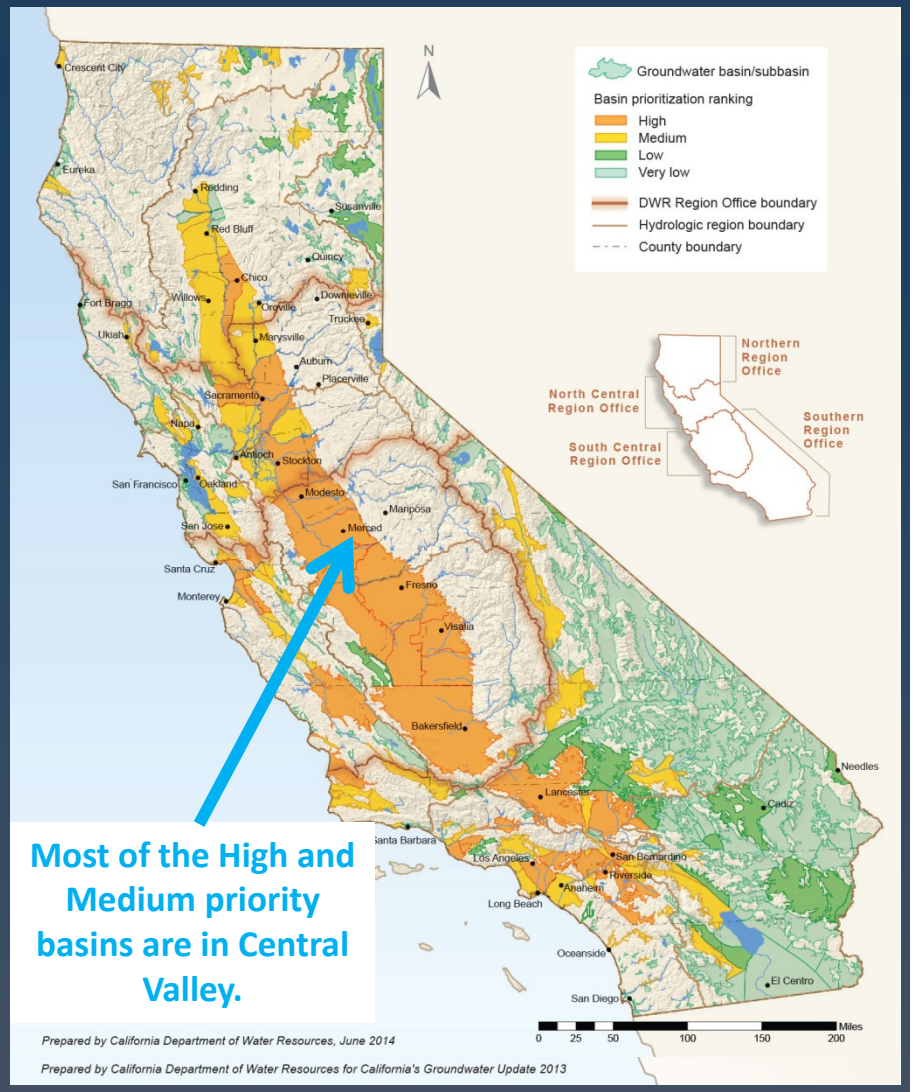
- **GW Quality Monitoring**
- **Land Subsidence Monitoring**

California's Groundwater Update 2013
Findings: Basin Prioritization

- 515 alluvial basins/subbasins underlying 61,900 square miles
- **127 high & medium priority basins** account for:
  - **96% of average annual GW supply**
  - **88% of 2010 population** overlying basin area
  - Required to address SGMA

BASIN RANKING	BASIN COUNT	PERCENT OF TOTAL FOR STATE	
		GW USE	POPULATION
High	43	69%	47%
Medium	84	27%	41%
Low	27	3%	1%
Very Low	361	1%	11%
Totals	515	100%	100%

Basin Prioritization Results – June 2, 2014



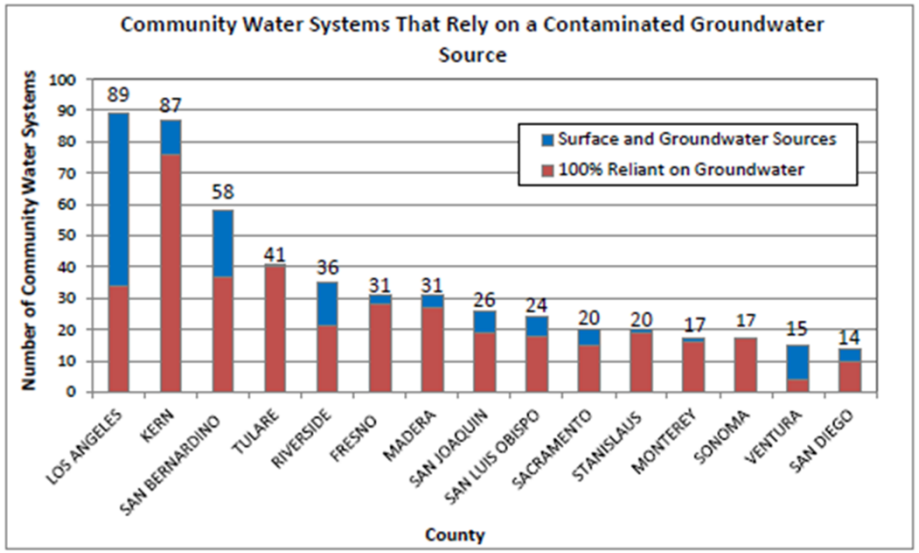
Most of the High and Medium priority basins are in Central Valley.

California's Groundwater Update 2013
Findings: Groundwater Quality

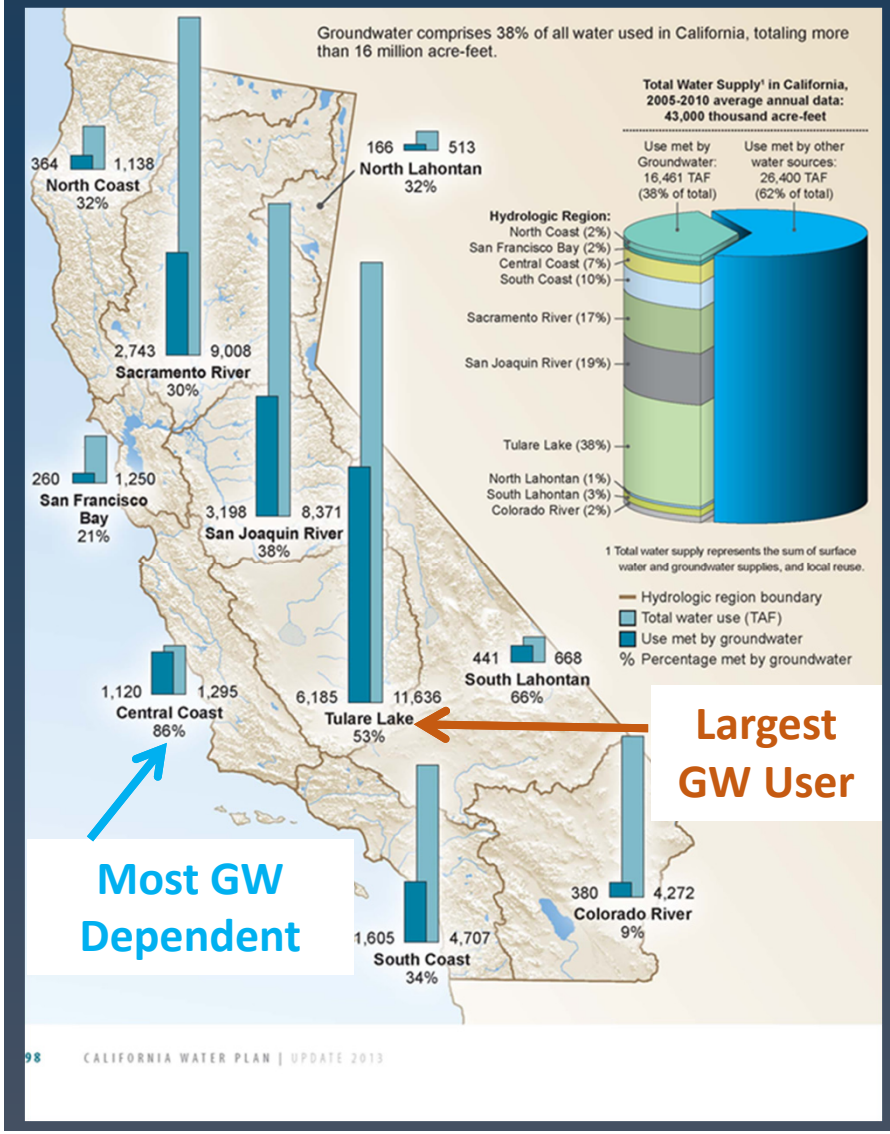
- Groundwater Quality
  - Information compiled by Regional Water Quality Control Boards
  - Table of Data Sources
  - Quality at Community Drinking Water Wells
  - GAMA Priority Basin Project
  - Groundwater Quality at Domestic Wells
  - Groundwater Quality Protection
    - Protection Strategy
    - Salt and Nutrient Management Plans
  - DWR WDL Water Quality Data

Key Findings:

- **2,584 community water systems rely on groundwater as a primary source of drinking water.**
- **1,659 groundwater wells used by 680 community water systems are contaminated by a principal chemical contaminant.**



California's Groundwater Update 2013
Findings: Groundwater Supply Data



2005-2010 **Average Annual Total Supply**

- **43 maf (43,000 taf)**

2005-2010 **Average Annual GW Supply**

- **16.5 maf (38% of total supply)**

➢ **GW Meets 39% of Total Agricultural Use**

➢ GW Meets 41% of Total Urban Use

Average Annual Groundwater Use and Percent of Total Supply Met by Groundwater, by Hydrologic Region and by Type of Use (2005-2010)

Hydrologic Region	Agriculture Use Met by Groundwater		Urban Use Met by Groundwater		Managed Wetlands Use Met by Groundwater		Total Water Use Met by Groundwater	
	taf	%	taf	%	taf	%	taf	%
North Coast	301.3	41%	60.3	41%	2.5	1%	364.0	32%
San Francisco	76.1	74%	183.5	16%	0.0	0%	259.5	21%
Central Coast	906.1	91%	213.3	71%	0.0	0%	1,119.5	86%
South Coast	385.4	54%	1,219.6	31%	0.0	0%	1,605.0	34%
Sacramento River	2,294.2	30%	428.6	47%	20.1	4%	2,742.9	30%
San Joaquin	2,591.8	36%	415.9	58%	190.7	38%	3,198.4	38%
Tulare Lake	5,551.8	51%	604.0	82%	28.9	37%	6,184.8	53%
North Lahontan	118.4	27%	37.1	84%	10.7	48%	166.2	32%
South Lahontan	270.6	72%	170.3	58%	0.0	0%	440.9	66%
Colorado River	50.1	1%	329.7	53%	0.0	0%	379.7	9%
2005-2010 annual average California total:	12,545.7	39%	3,662.2	41%	252.9	18%	16,460.8	38%

Notes:

1. taf = thousand acre-feet
2. Percent use is the percent of the total water supply that is met by groundwater, by type of use
3. 2005-10 Precipitation equals 96% of the 30-yr average for California
4. Total Water Use = Groundwater + Surface Water + Reuse

California's Groundwater Update 2013
Findings: Groundwater Supply Trend

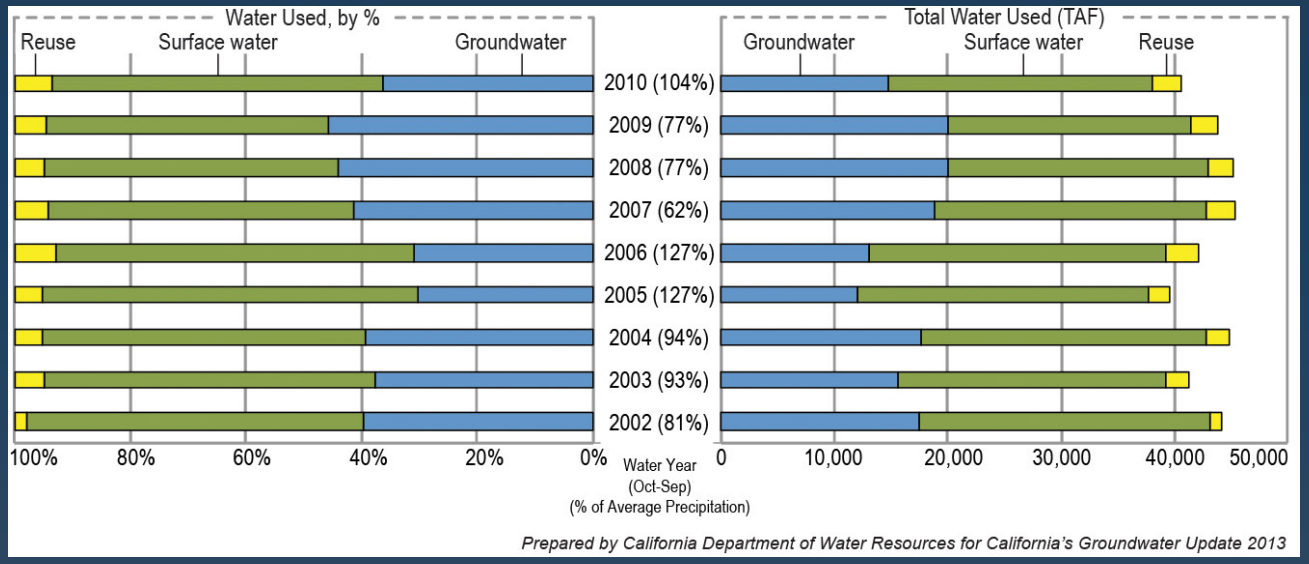
2002-2010 DATA

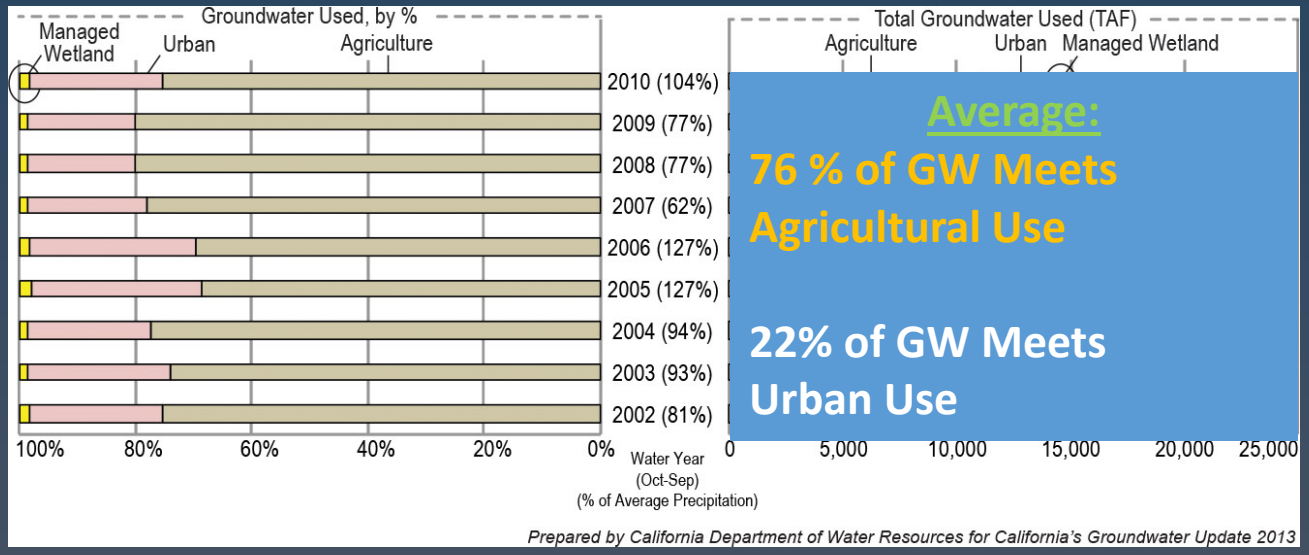
Total Supply

- High of 45.5 maf
  - 2007 (62%)
- Low of 39.7 maf
  - 2005 (127%)

Groundwater Supply

- **High of 20.1 maf**
  - 2009 (77%)
  - **46% of total supply**
- **Low of 12 maf**
  - 2005 (127%)
  - 30% of total supply



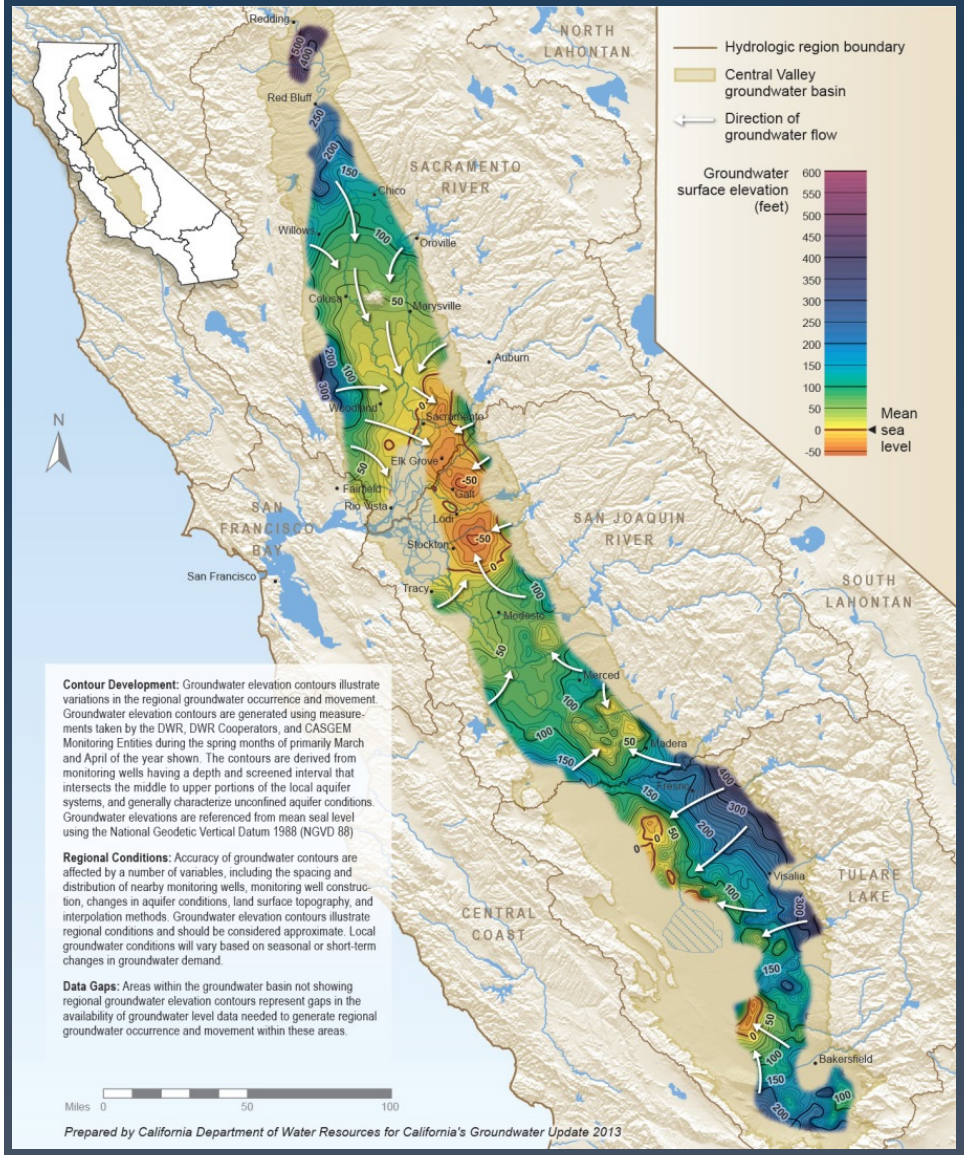


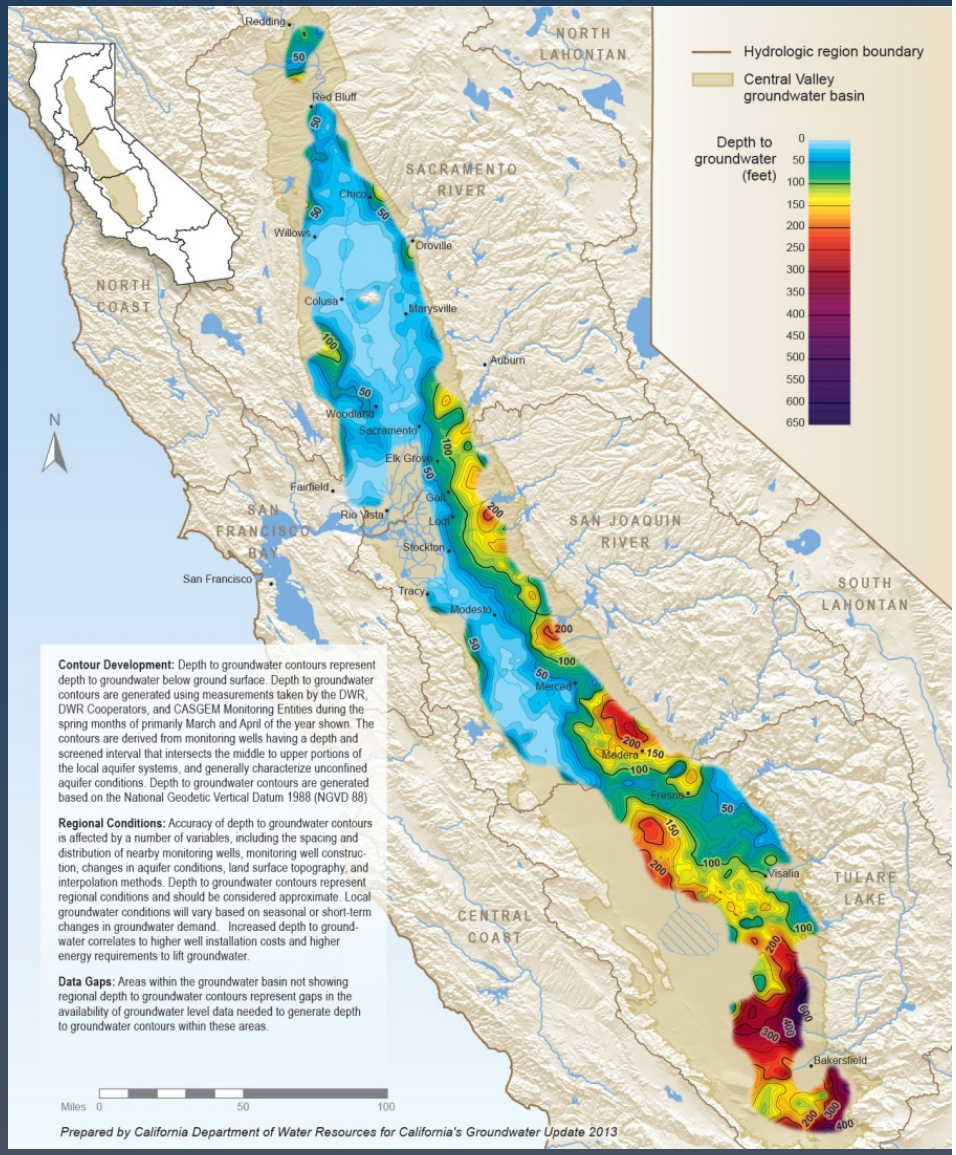
Average:

76 % of GW Meets Agricultural Use

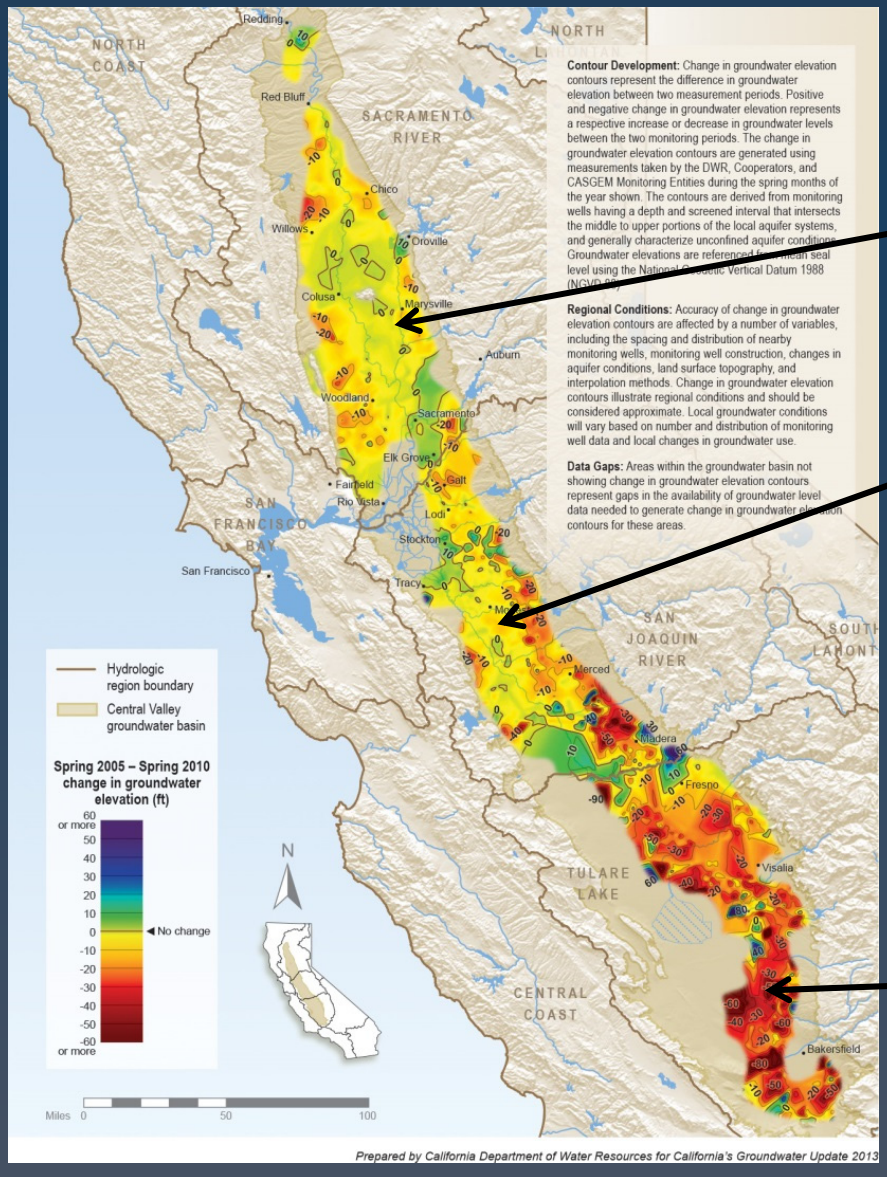
22% of GW Meets Urban Use

California's Groundwater Update 2013 Findings:
Aquifer Conditions: Spring 2010 GW Contours





California's Groundwater Update 2013 Findings:
Aquifer Conditions: 2005-2010: **Δ GW Storage**

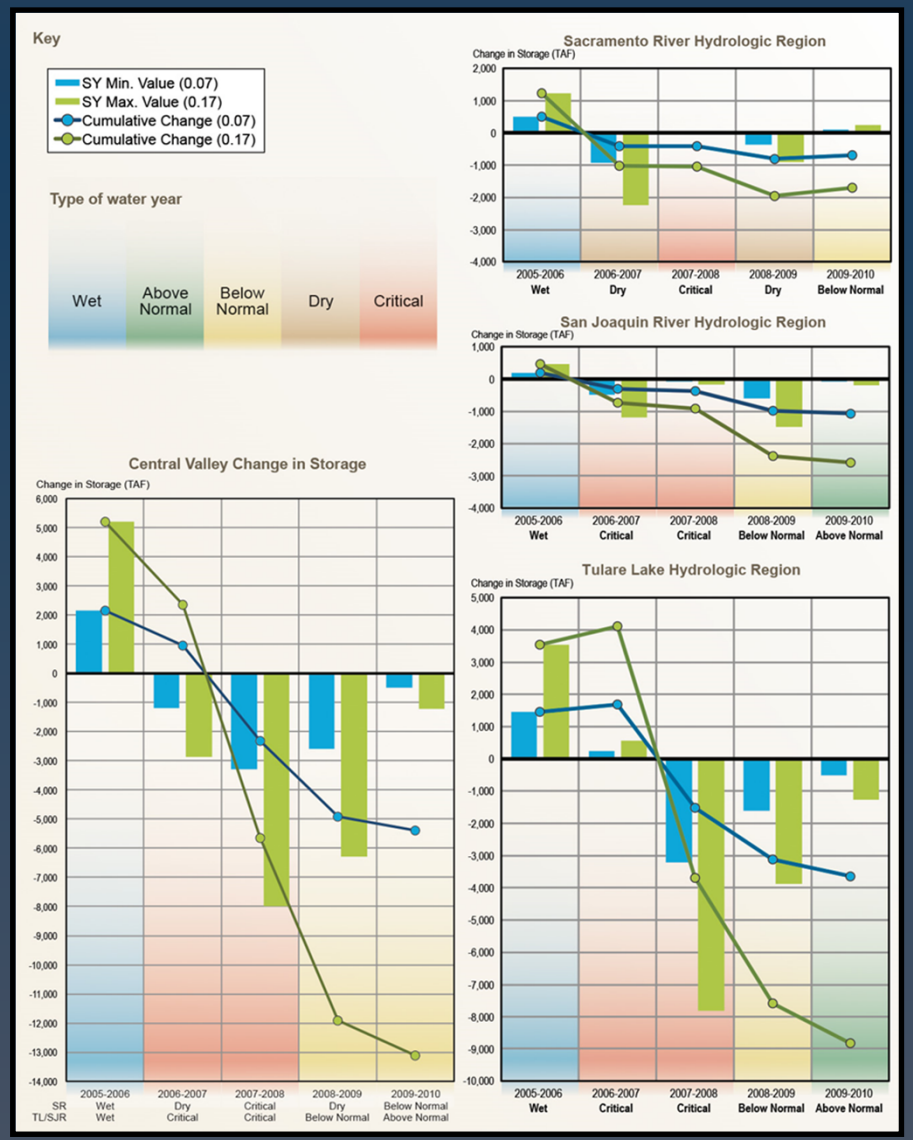


Sacramento Valley GW Storage Reduction: 0.8 to 1.8 maf

San Joaquin Valley GW Storage Reduction: 1.1 to 2.6 maf

Tulare Lake GW Storage Reduction: 3.6 to 8.8 maf

California's Groundwater Update 2013 Findings:
Aquifer Conditions: 2005-2010 **Δ GW Storage**



- **Developed GIS Change in Storage Tool**
- **Change in Groundwater in Storage for the *Central Valley***
  - **Total GW Storage Decline:**
    - **5.4 to 13.1 maf**
  - **Avg. Annual GW Storage Decline:**
    - **1.1 maf to 2.6 maf per year**

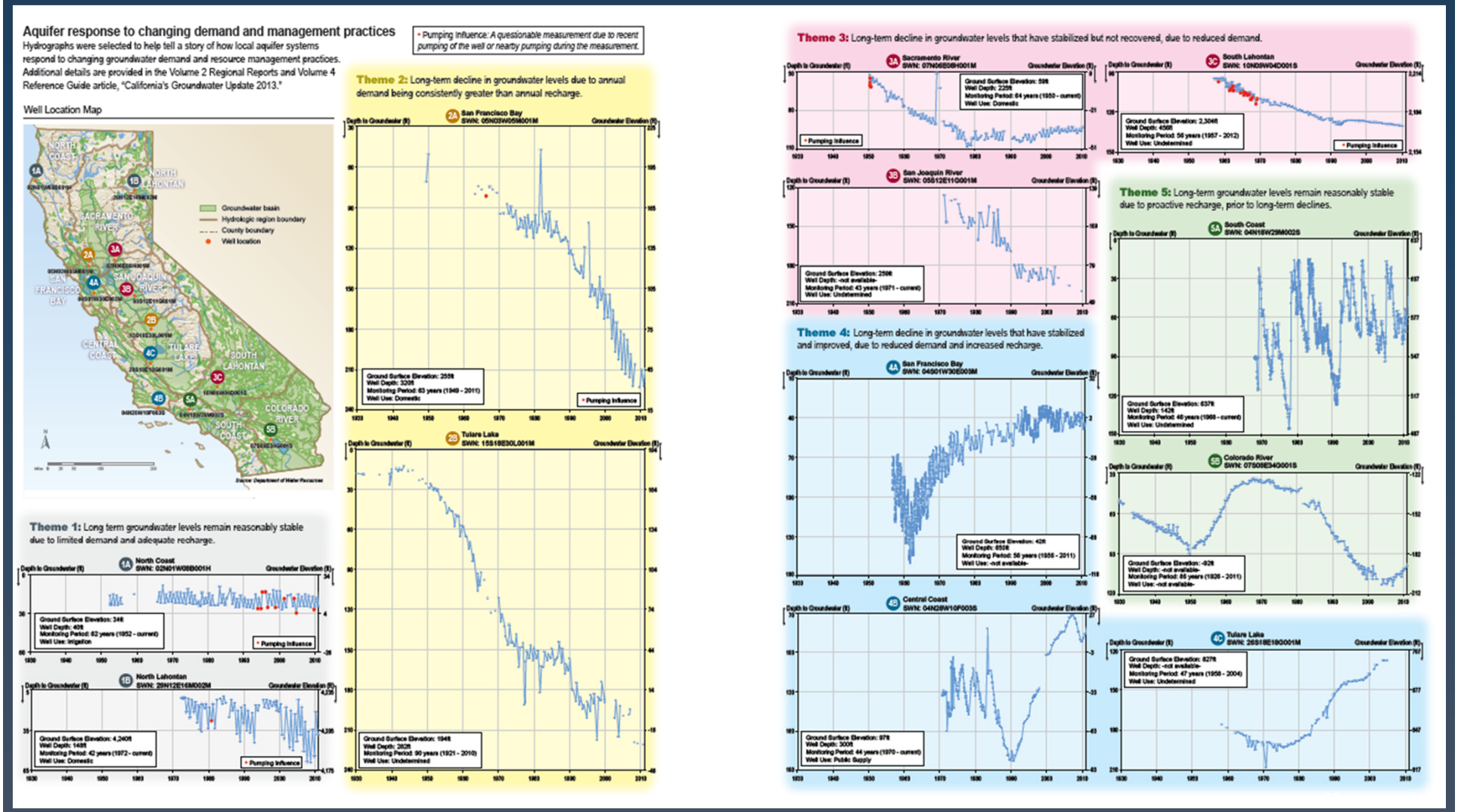
Change in Elevations and Groundwater in Storage for California's Central Valley (Spring 2005 – Spring 2010)			
Period Spring/Spring	Average change in groundwater elevation (ft)	Estimated Change in Storage in taf	
		Assuming Specific Yield = 0.07	Assuming Specific Yield = 0.17
2005-2006	3.6	2,148	5,218
2006-2007	-2.0	-1,179	-2,863
2007-2008	-5.5	-3,288	-7,984
2008-2009	-4.3	-2,584	-6,276
2009-2010	-0.8	-497	-1,209
Total (2005-2010)	-9.0	-5,400	-13,114

Notes:
1. taf = thousand acre feet
2. ft = feet
3. GW elevation and change in storage is estimates are calculated within reporting area only
4. Reporting Area (Acres): 8,588,247
5. Non-Reporting Area (Acres): 4,232,587

Long-term Groundwater Level Trends
Tell-a-Story Hydrographs: Five Themes

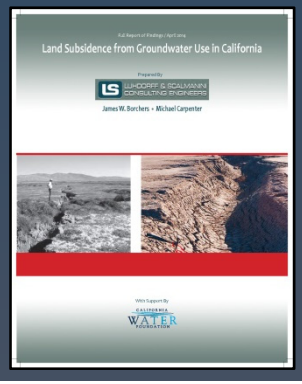
- **Theme 1. Long term groundwater levels remain reasonably stable because of limited demand and adequate recharge.**
- **Theme 2. Long-term decline in groundwater levels because of annual demand being consistently greater than annual recharge.**
- **Theme 3. Long-term decline in groundwater levels that have stabilized because of reduced demand, but have not recovered.**
- **Theme 4. Long-term decline in groundwater levels that have stabilized and improved, because of reduced demand and increased recharge.**
- **Theme 5. Long-term groundwater levels remain reasonably stable because of implementing managed recharge activities prior to long-term declines.**

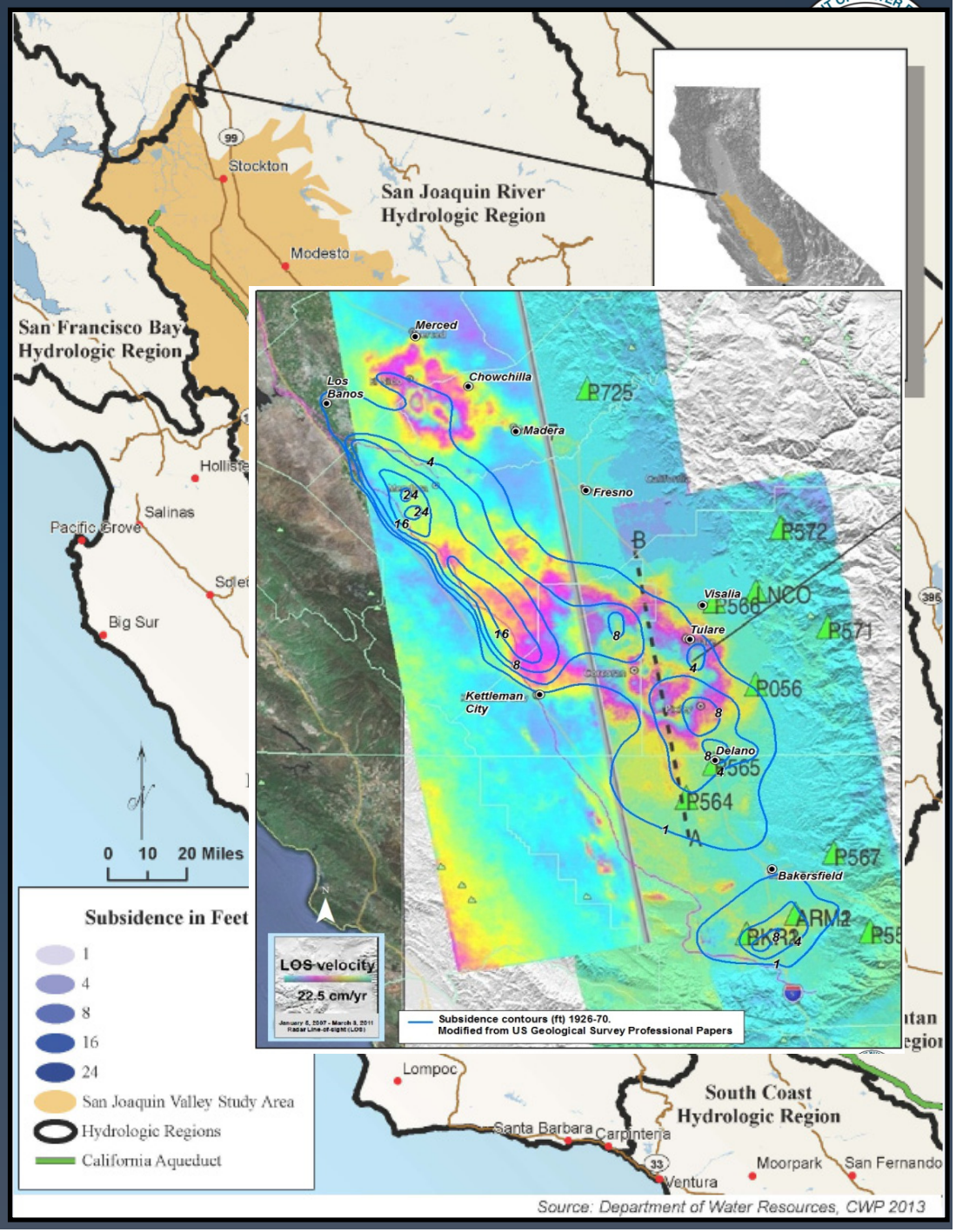
Long-term Groundwater Level Trends
Tell-a-Story Hydrographs: Themes 1 to 5



California's Groundwater Update 2013 Findings: Land Subsidence

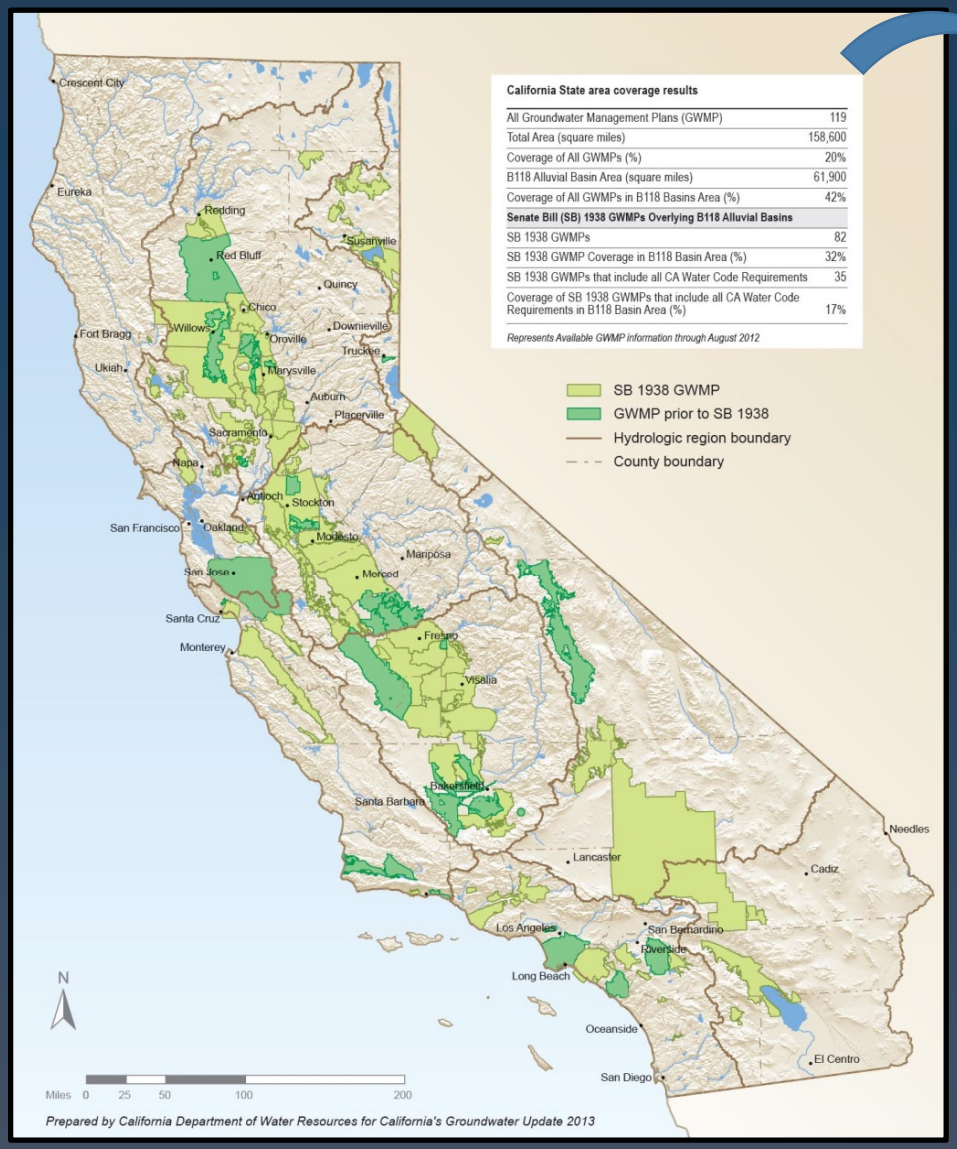
- **Between 1926 and 1970 there was more than 24 feet of land subsidence in some areas (Ireland, 1984)**
- **Recent studies show renewed land subsidence (USGS) rates as high as 1 foot per year.**
- **Appendix F references the 2014 LSCE & CWF subsidence report and 2014 DWR Report on Subsidence Potential**





Source: Department of Water Resources, CWP 2013

California's Groundwater Update 2013 Findings: Groundwater Management Inventory



California State area coverage results

All Groundwater Management Plans (GWMP)	119
Total Area (square miles)	158,600
Coverage of All GWMPs (%)	20%
B118 Alluvial Basin Area (square miles)	61,900
Coverage of All GWMPs in B118 Basins Area (%)	42%
Senate Bill (SB) 1938 GWMPs Overlying B118 Alluvial Basins	
SB 1938 GWMPs	82
SB 1938 GWMP Coverage in B118 Basin Area (%)	32%
SB 1938 GWMPs that include all CA Water Code Requirements	35
Coverage of SB 1938 GWMPs that include all CA Water Code Requirements in B118 Basin Area (%)	17%

Represents Available GWMP information through August 2012

California State area coverage results

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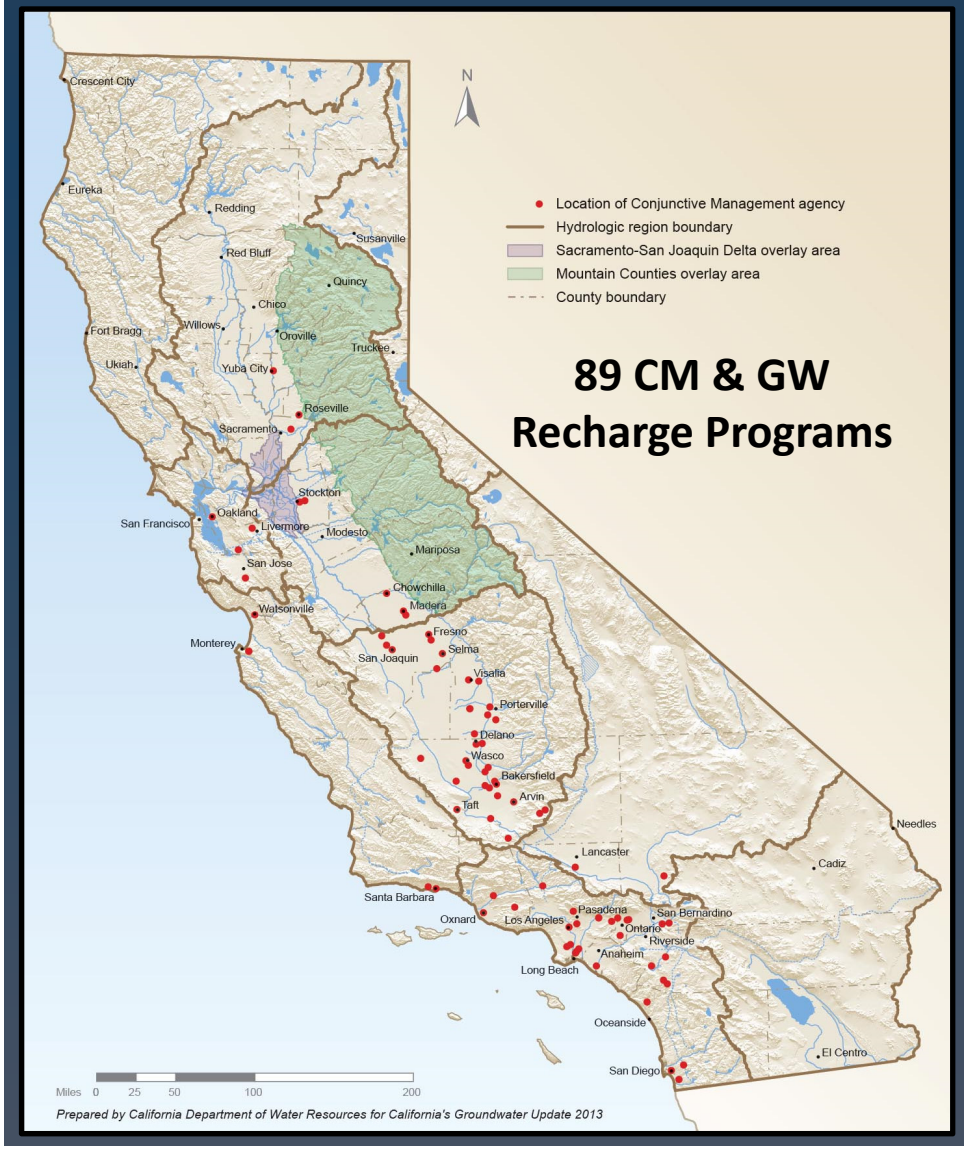
Coverage of SB 1938 GWMPs that include all CA Water Code Requirements in B118 Basin Area (%)	17%

Represents Available GWMP information through August 2012

SB 1938 GWMP
GWMP prior to SB 1938
Hydrologic region boundary
County boundary

California's Groundwater Update 2013 Findings: *Conjunctive Management Inventory*



- **Location of project**
- **Year project was developed**
- **Capital costs**
- **Annual operating cost**
- **Administrator/operator**
- **Capacity in units of acre-feet**
- **Source of water received**
- **Put and take capacity**
- **Type of project**
- **Program goals and objectives**
- **Constraints on development of program**

Table of 89 survey responses will be included as Appendix D

California's Groundwater Update 2013 Findings: *Conjunctive Management Survey*

Figure 2-25 Number of Conjunctive Management Projects Developed per Decade in California

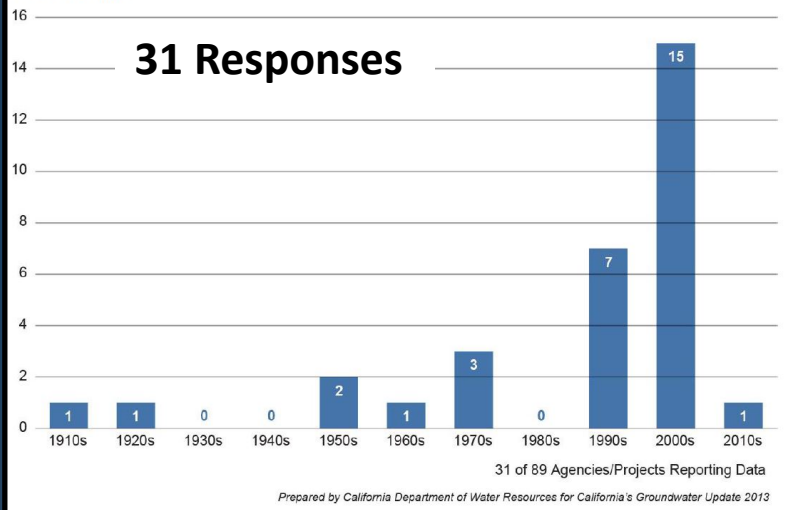


Figure 2-26 Sources of Water Used for Conjunctive Management Programs in California

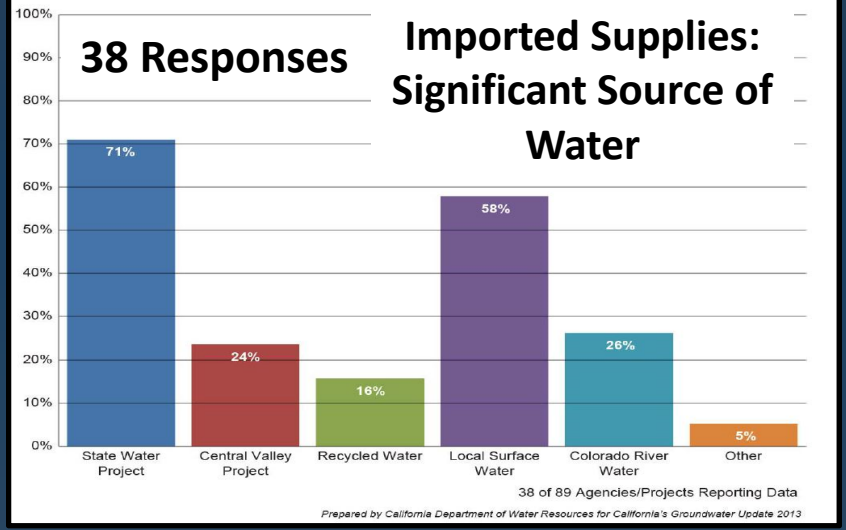


Figure 2-27 Method Used for Groundwater Recharge in a Conjunctive Management Program

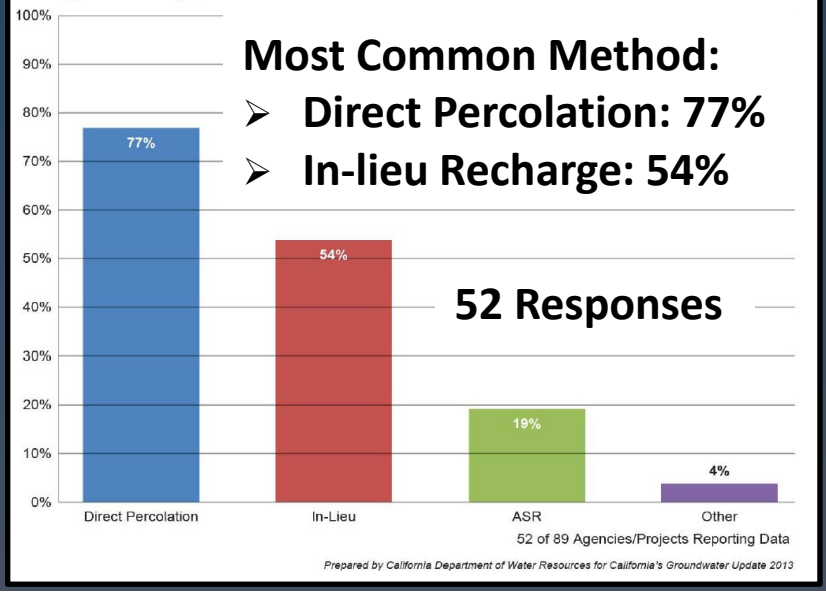
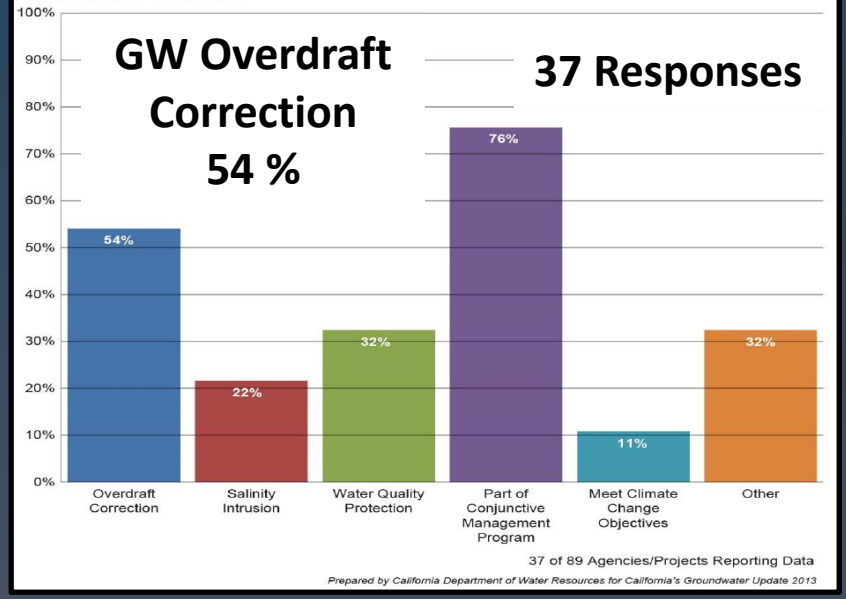


Figure 2-28 Reported Goals and Objectives for Conjunctive Management Programs in California



California's Groundwater Update 2013
Recommendations

1. Promote public education about groundwater.
2. Improve collaboration, coordination, and alignment among agencies.
3. Develop a statewide groundwater management planning Web site to promote easy access to groundwater information.
4. Improve essential data to enable sustainable groundwater management by expanding and funding the CASGEM Program.
5. Improve understanding of California's high- and medium- priority groundwater basins by conducting groundwater basin assessments.
6. Develop a groundwater sustainability plan evaluation and implementation process.
7. Advance sustainable groundwater management within the framework of integrated water management.
8. Review and assist local agencies in developing improved analytical tools to assess conjunctive management and groundwater management strategies.
9. Increase local and regional groundwater recharge and storage.

California's Groundwater Update 2013 DWR Director Mark Cowin (from Foreword):

- "Answering fundamental questions regarding how groundwater supply and demand relate to basin sustainability requires commitment to regular, consistent, and comprehensive data collection, reporting, and assessment."

- "Groundwater data collection and information exchange, which enhance education and understanding, comprise a critical first step toward improving the reliability of groundwater resources, restoring key ecosystem functions, and establishing the resiliency needed to preserve California's groundwater resources for future generations."

California's Groundwater Update 2013

California's Groundwater Update 2013

California's Groundwater Update 2013: A Compilation of Enhanced Content for California Water Plan Update 2013 compiles and analyzes readily-available groundwater information to characterize California's groundwater basins, aquifers, and well infrastructure.

Although previous California Water Plan Updates had included groundwater-related resource management strategies, feedback from advisory committees and other stakeholder groups highlighted the lack of hydrologic region-specific groundwater information in the California Water Plan.

The Update expands and enhances baseline groundwater information on a regional scale, identifies challenges associated with sustainable groundwater management and helps guide implementation of diverse resource management strategies. Statewide and regional findings, data gaps and recommendations to improve groundwater management also are included.

The report is organized into the following components:

California's Groundwater Update

- Front Cover
- Director's Foreword
- Front Matter and Table of Contents
- Statewide Findings, Data Gaps and Recommendations
- Introduction, Scope and Future Directions (Chapter 1)
- Statewide Groundwater Update (Chapter 2)
- Back Cover

Hydrologic Region Groundwater Update

- North Coast Hydrologic Region (Chapter 3)
- San Francisco Bay Hydrologic Region(Chapter 4)
- Central Coast Hydrologic Region (Chapter 5)
- South Coast Hydrologic Region (Chapter 6)
- Sacramento River Hydrologic Region (Chapter 7)
- San Joaquin River Hydrologic Region (Chapter 8)
- Tulare Lake Hydrologic Region (Chapter 9)
- North Lahontan Hydrologic Region (Chapter 10)
- South Lahontan Hydrologic Region (Chapter 11)
- Colorado River Hydrologic Region(Chapter 12)

Appendices:

- Front Cover
- Appendix A: Methods and Assumptions
- Appendix B: California Statewide Groundwater Elevation Monitoring (CASGEM) Basin Prioritization
- Appendix C: Groundwater Use Data
- Appendix D: Conjunctive Management Survey
- Appendix E: Change in Groundwater in Storage
- Appendix F: Land Subsidence
- Back Cover

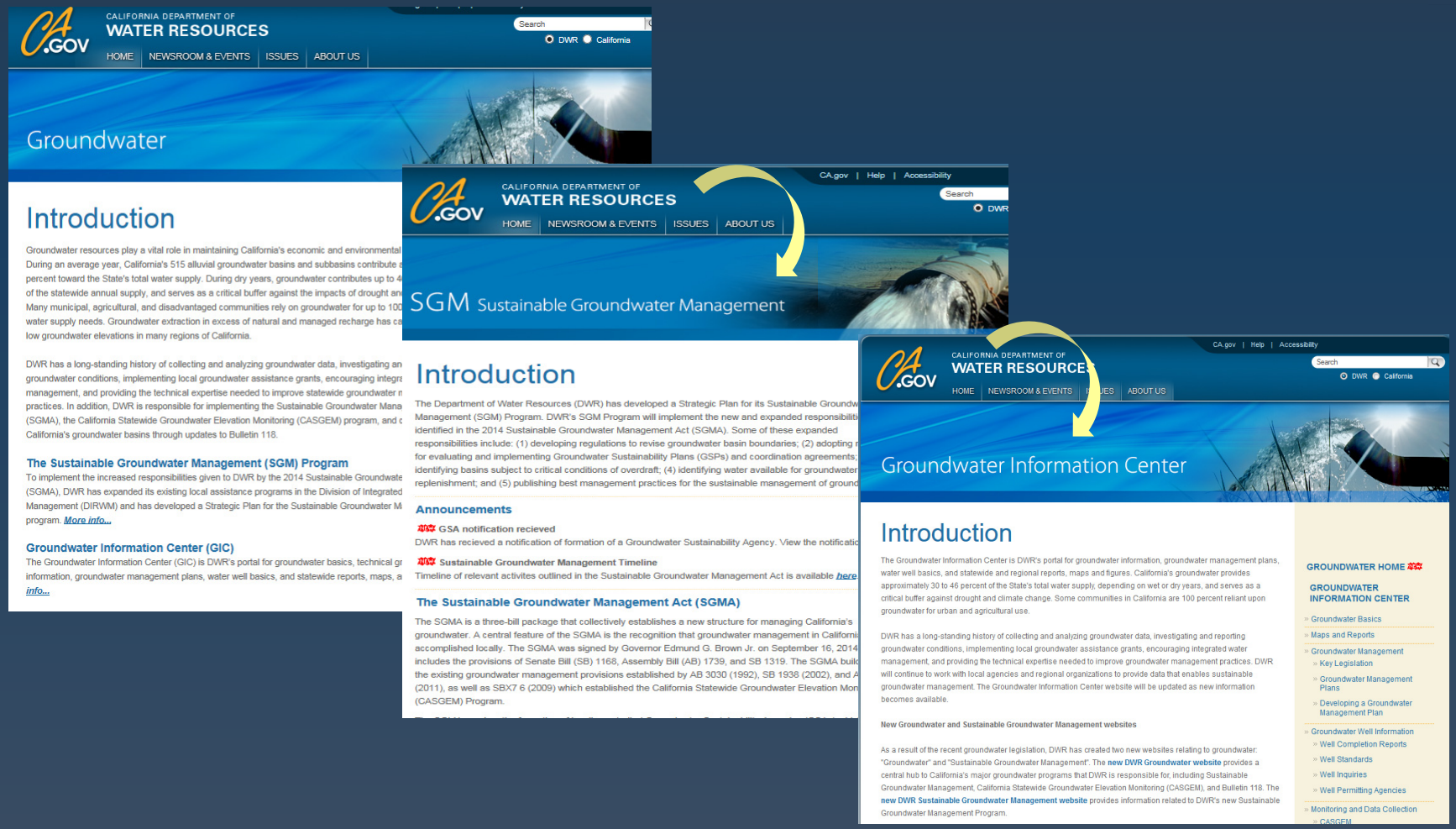
Finding Contents:

Available online at
http://www.waterplan.water.ca.gov/topics/groundwater/index.cfm

If you would like to be notified of a new release, you can subscribe to **California Water Plan eNews** weekly newsletter at:
https://listserv.state.ca.gov/wa.exe?SUBED1=DWR_CWP_eNews&A=1

CALIFORNIA
WATER PLAN eNEWS

Groundwater Information: Ongoing



State: http://www.water.ca.gov/cagroundwater/

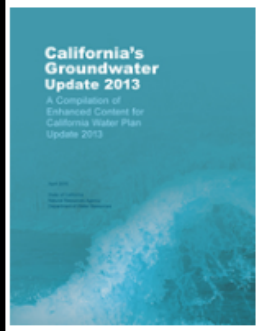
DWR: http://www.water.ca.gov/groundwater/

SWRCB: http://www.waterboards.ca.gov/water_issues/programs/gmp/

California's Groundwater Update 2013 Future Webinars

- 1st Hydrologic Region Webinar: May, 2015
- 2nd Hydrologic Region Webinar: July, 2015
- Technical Appendices Webinar: August, 2015

California's Groundwater Update 2013



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