

CALIFORNIA'S
GROUNDWATER

2025

UPDATE

HIGHLIGHTS

Groundwater: The Foundation of California's Resilience

This publication,
California's Groundwater: Bulletin 118 – Update 2025 Highlights,
has a companion detailed statewide report.

Both the statewide report and the companion summary
can be accessed on the Department of Water Resources'
[California's Groundwater webpage](#).



*A publication of
the California Department of Water Resources*

California's Groundwater: Bulletin 118 – Update 2025 Highlights

March 2026

State of California
The Natural Resources Agency
Department of Water Resources

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CalGW Update 2025 Products

California's Groundwater: Bulletin 118 – Update 2025 (CalGW Update 2025) is the most up-to-date compendium of statewide data and information on the occurrence, nature, use, and conditions of California's groundwater resources and management. CalGW Update 2025 continues the series of earlier DWR publications, building on past progress and knowledge. It synthesizes the latest data to address knowledge gaps and focuses on statewide groundwater management and planning efforts, including drought planning and response.

CalGW Update 2025 consists of a highlights (this document), a detailed statewide report, and a series of appendices. It can be accessed on the [California's Groundwater website](#), with supporting data available on the [CNRA Open Data website](#).

The update is complemented by [CalGW Live](#), an interactive website that delivers near-real-time access to groundwater-related data, and by [California's Groundwater: Semi-Annual Updates](#), which are released twice each year to bridge gaps between the comprehensive CalGW Updates.

Highlights (English and Spanish): A stand-alone summary document describing the value, current state, and challenges of groundwater conditions and management in California, including findings and recommendations to advance sustainable groundwater management.

Statewide Report (Chapters 1 to 7): A detailed report on the current state of knowledge of groundwater resources including information on the location, basin characteristics, water use, management, climate change vulnerability, monitoring, and conditions of the state's groundwater. It includes "Groundwater at a Glance," a hydrologic region-based summary of key groundwater-related topics.

Appendices A to J: A series of appendices that provide additional details supporting the content of the various chapters of the *Statewide Report*, including methods and assumptions, selected data, citations, and references.

Message from the Director



Although much work remains to fully protect and manage California's groundwater, our efforts to understand this vital resource have finally begun to reflect its immeasurable value to the state. The report that follows, *California's Groundwater: Bulletin 118 – Update 2025 (CalGW Update 2025)*, represents the most comprehensive collection of information yet assembled about a resource that meets 30% to 60% of the water needs of the people, businesses, and farms of California every year and helps sustain vital ecosystems.

California's underground aquifers are as formative to the state's natural infrastructure as Mount Shasta or Yosemite Valley. Though hidden from view, these geologic formations function as ably as any human-designed infrastructure and are capable of holding far more water than all of California's surface reservoirs combined. No resource helps the state cope with drought better than groundwater. In a changing climate, its value only grows. The most extreme atmospheric rivers will become more so, and dry spells will be longer and more severe. Groundwater basins offer massive capacity to buffer water supplies against weather whiplash, but they are more than a safety net. When sustainably managed, these basins are a cornerstone of climate resilience, enabling the capture of excess stormwater during floods, supporting biodiversity, and helping stabilize water supplies across hydrologic extremes.

One of our biggest challenges is to halt the billions of dollars of damage that comes from groundwater overdraft, such as failed wells; deteriorated water quality; environmental harm; and irreversible land subsidence that impacts bridges, levees, roads, and canals. Bringing groundwater basins into sustainable conditions will require substantial economic adjustments and changes in historical groundwater use and considerations in regions where users have pumped too much groundwater for too long. But to avoid or delay this reckoning would inflict even greater pain on future generations. The time to act is now.

Ten years into the implementation of the Sustainable Groundwater Management Act (SGMA), local groundwater agencies are shifting gears from planning to project implementation. Recent legislation, including SB 659 (2023) and SB 72 (2025), highlights the growing role of groundwater and recharge in California's water future. These bills set statewide priorities for water supply, storage, and recharge and direct their integration into the California Water Plan Update 2028 and beyond.

Local agencies must work together to capture and store water when it is available, expand conjunctive use programs, transition to less water intensive land use, and fallow farmland to reduce demand where necessary. State agencies will continue to support local efforts toward sustainable groundwater management. The California Department of Water Resources stands ready to help local water districts establish water-sharing arrangements and water bank accounting methods and to assist in the development of locally managed canals, pipes,

and wells necessary to convey water to prime recharge locations. The California Department of Conservation, through its Multi-Benefit Land Repurposing Program, stands ready to help communities chart an economic future in which irrigated agriculture plays a smaller but more sustainable role. As part of SGMA implementation and the State's broader commitment to sustainable groundwater stewardship, state agencies will continue to support local agencies in improving groundwater science, making data more accessible and timely, and building the capacity needed to enable informed decisions that strengthen water supply reliability and drought resilience, and protect communities over the long term.

CalGW Update 2025 captures a decade of SGMA implementation progress, describes the challenges of the next 10 years, sets forth a more complete set of facts about groundwater conditions than ever assembled, and connects groundwater to all aspects of water resources. This report marks a five-year milestone since the previous *Bulletin 118*, and the next one is planned for 2035. In the meantime, DWR's compendium of groundwater data will continue to deepen and expand, and all of it is available to everyone at any time through the interactive website [CalGW Live](#) and the [California's Groundwater: Semi-Annual Updates](#). I invite you to explore this wealth of information and learn more about the incredible natural infrastructure that makes California's prosperity possible.

A handwritten signature in black ink, appearing to read "Karla A. Mendez". The signature is fluid and cursive, with a prominent initial "K" and "M".

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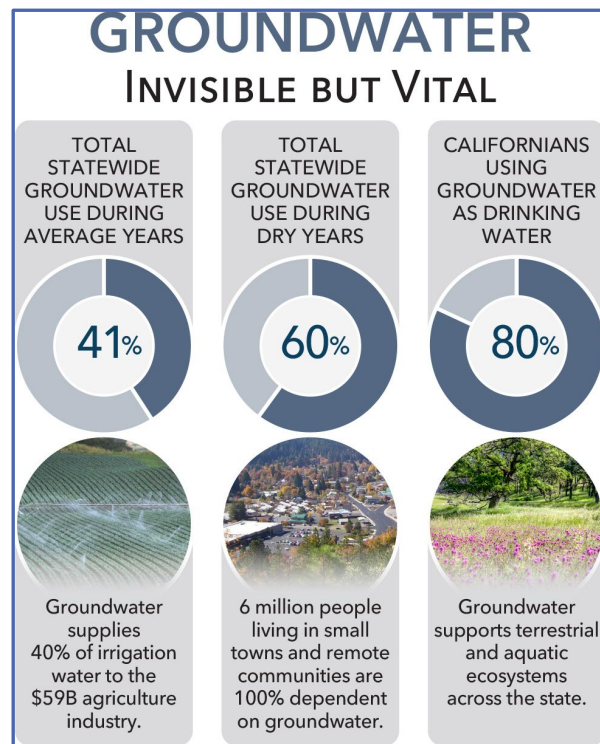
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Executive Summary

Groundwater is the foundation of California’s water resilience, delivering a vast and indispensable water supply to sustain large and small communities, irrigated agriculture, rural groundwater users, Tribal cultural and religious practices, and the environment and natural ecosystems. It accounts for about 41% of the state’s total water supply during average years and almost 60% during dry years.

Approximately 32 million Californians, or 82% of the state’s population, rely on groundwater for drinking or household uses. This includes about 8.5 million people in small- to mid-sized towns who are 100% reliant on groundwater for their drinking water supply. Groundwater supplies about 40% of the water used to irrigate California’s farmland, which supports a \$59 billion agricultural industry. This share can increase to 60% during drought years (California Department of Food and Agriculture, 2024). Agriculture is a significant sector of California’s economy, employing more than 880,000 people (Hooker et al. 2024). Beyond meeting human and agricultural needs, groundwater is vital for sustaining groundwater-dependent ecosystems. It contributes to the baseflow of rivers and

Figure H-1 Groundwater is the Lifeblood of California



streams, which not only provides important water supply benefits, but also helps maintain the water levels of wetlands and supports critical habitat for many aquatic and riparian species.

Groundwater also plays a vital role in protecting water quality. As it moves through soil and geologic layers, it undergoes natural filtration that can reduce contaminants and improve overall water quality. In coastal areas, maintaining healthy groundwater levels can help prevent seawater intrusion and protect the quality of drinking and irrigation supplies.

Unlike surface reservoirs that fluctuate with seasonal weather and runoff, groundwater aquifers offer a more stable and consistent supply – even during prolonged droughts and extreme water scarcity. Beyond acting as a buffer in dry times and sustaining biodiversity, groundwater enables Californians to bridge flood management and long-term water security through innovative approaches like using floodwaters for managed aquifer recharge (Flood-MAR), reducing flood risks while increasing groundwater storage. Additionally,

interconnected infrastructure presents a powerful opportunity to enhance resilience. As a versatile and largely invisible resource, groundwater is uniquely positioned to help Californians respond effectively to both shortages and surpluses – quietly meeting demand during dry periods and offering abundant storage during wet periods.

California now stands at a pivotal moment in water management, where emerging challenges and transformative opportunities intersect. Climate change continues to disrupt historical water supply patterns, intensifying droughts and flood events, reducing snowpack, and increasing reliance on groundwater – particularly during dry years. This has amplified long-standing issues such as overdraft and land subsidence, threatening the physical integrity and delivery capability of water infrastructure and also the long-term sustainability of the resource itself. One clear example is the State Water Project (SWP), which is projected to experience a significant reduction in delivery capability over the next 20 years due to climate change if no adaptive action is taken. If land subsidence in the San Joaquin Valley continues unabated, its combined effects with climate change could reduce SWP deliveries by as much as 87% during that same timeframe. This connection between surface water and groundwater underscores how climate change and overreliance on groundwater are straining both surface and groundwater systems and highlighting the urgent need for integrated, statewide water management.

Groundwater's ability to support safe and affordable water for cities and communities, power the economy, sustain agriculture, and preserve ecosystems underscores why its protection and sustainable use must be at the heart of California's climate adaptation strategy. Sustainable groundwater management is not merely a legal mandate or a policy obligation; it is a shared commitment for all Californians and a foundational pillar of the state's strategy to address future water challenges.

In the 10 years since the enactment of the Sustainable Groundwater Management Act (SGMA) in 2014, significant progress has been made. SGMA has laid a strong foundation for sustainable groundwater management, driven by the leadership of groundwater sustainability agencies (GSAs) and other local agencies, and supported by vital technical guidance and nearly \$1 billion in State financial support for local planning, implementation, and state operations. These collective efforts have meaningfully advanced the state toward sustainability, though substantial challenges still lie ahead.

California's future water security and resilience depend on an urgent, focused, and coordinated approach – one that aligns local, regional, and state efforts around shared priorities. In this context, groundwater provides a vital source of stability and adaptability. However, decades of over-pumping have caused significant and lasting damage. Restoring groundwater resources to sustainable and healthy conditions will require difficult economic decisions and changes in historical groundwater use and considerations, particularly in areas that have long depended on unsustainable pumping. Delaying these necessary actions would lead to even greater consequences for future generations. We must accelerate the

momentum toward full and committed implementation of SGMA – with more urgency, focus, and coordination than ever before. Key priorities to implement this focused and coordinated approach include:

1. **Building climate resilience** by holistically managing interconnected groundwater and surface water, natural and built infrastructures, basin and non-basin areas, and ecosystems.
2. **Managing groundwater demand and land use**, including through strategies such as land repurposing, groundwater accounting, and water markets, to achieve sustainable extraction levels and improve overall water efficiency.
3. **Aligning land use planning with water supply availability** to ensure that future development is multi-benefit and land use does not exhaust available water resources.
4. **Minimizing or avoiding subsidence** through targeted recharge and sustainable pumping practices, before further, irreversible damage to aquifer capacity and infrastructure limits resource availability and increases infrastructure failure risk.
5. **Maximizing groundwater recharge**, especially during high-flow periods, to replenish groundwater storage and strengthen drought resilience.
6. **Understanding and managing natural and built infrastructures** to support integrated, basin-wide, and regional solutions.

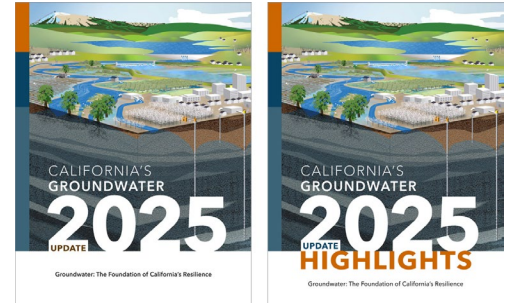
Looking ahead, the future of California’s water resilience lies in proactive groundwater stewardship, which depends on integrated planning of land and water use, building community-level support, and developing flexible, data-informed strategies to ensure sustainable use of our aquifers. To advance these priorities, a set of recommendations and actions is presented in Section V, with the goal of leveraging current opportunities and preparing for an increasingly uncertain water future. These actions support and align with broader statewide efforts identified in the Water Resilience Portfolio and California’s Water Supply Strategy, and inform other statewide planning efforts, including future updates to the California Water Plan. Together, they represent not only technical solutions but also a cultural shift toward groundwater stewardship, reframing groundwater basins as *natural infrastructure* essential to California’s long-term resilience, prosperity, and ecological health amidst rising reliance on groundwater. Beneath our feet lies not only a vast reservoir, but also a powerful opportunity to rethink how we connect land, water, infrastructure, and climate resilience in a changing world.

I. Introduction

Groundwater management in California is undergoing a profound transformation. It is the foundation of California’s water resilience and is at the forefront of the state’s strategy to navigate increasingly volatile water conditions. To support this transition, *California’s Groundwater: Bulletin 118 – Update 2025* (CalGW Update 2025) serves as the most up-to-date and comprehensive compendium of statewide data and information on the occurrence, nature, uses, management, climate change vulnerability, monitoring, and conditions of

California’s groundwater resources. Building on the legacy of Bulletin 118 and past California Water Plans, CalGW Update 2025 synthesizes recent data – available up to December 2023 – and closes key knowledge gaps to inform more effective statewide groundwater planning and decision-making.

CalGW Update 2025 consists of this **Highlights** document and a detailed **statewide report**, supported by a series of appendices. While it builds on the foundation of previous CalGW updates, the 2025 edition expands the scope and depth of the report, with new and enhanced areas of focus, including:



- Expanded data and information in basin and non-basin areas.
- Enhanced basin characterization information using new airborne electromagnetic (AEM) surveys, and subsurface data.
- Analysis of data from groundwater sustainability plans (GSPs), alternatives to GSPs (Alternatives), and annual reports.
- New insights on groundwater recharge.
- Expanded groundwater quality content using State Water Resources Control Board (State Water Board) data.
- Summary of SGMA implementation across the state.

CalGW updates are part of a comprehensive suite of resources designed to support understanding and management of the state’s groundwater. CalGW serves as a foundational reference, but it is strengthened by continually updated tools and documents that provide timely data, trends, and decision-support for sustainable groundwater management. These resources are integral to the development and refinement of each CalGW update and include:

- **CalGW Live:** An interactive, user-friendly online platform that provides access to current groundwater data, trends, and analysis. It offers real-time insights (updated daily as new information is available) into regional and statewide groundwater conditions, incorporating advanced data such as satellite-based Interferometric Synthetic Aperture Radar (InSAR) land subsidence mapping and information from DWR’s voluntary dry well database.
- **CalGW Semi-Annual Updates:** Released twice annually, these [documents](#) provide timely information on groundwater conditions, including water level trends and storage estimates. In addition to physical conditions, the reports also provide insight into the status of SGMA implementation and highlight emerging issues and trends in groundwater management.
- **SGMA Portal:** A centralized platform that offers essential tools and datasets for informed groundwater management, helping local agencies and interested parties meet SGMA requirements.

Together, these dynamic resources provide frequent, up-to-date insights into groundwater conditions, while the periodic CalGW updates offer a comprehensive, long-term record of groundwater trends across California. The purpose of CalGW is threefold:

- (1) Inform local agencies, practitioners, decision-makers, and the public about the state of groundwater in California.
- (2) Provide an updated inventory and analysis of groundwater conditions, use, and management.
- (3) Chart a path forward with recommendations and actions for sustainable groundwater management in the face of climate change and recurring floods and drought.

CalGW Update 2025 also fulfills the State's statutory obligation under California Water Code Section 12924, which was recently amended to require DWR to publish comprehensive groundwater reports, from every 5 years to every 10 years, specifically in years ending in "5." This shift allows CalGW to focus on providing a robust archive of long-term trends, while DWR's ongoing updates and tools ensure that local agencies, interested parties, and the public have access to more frequent, timely information to inform groundwater management decisions between 10-year updates. In addition to addressing the 515 alluvial groundwater basins, CalGW Update 2025 also enhances understanding of groundwater in non-basin areas where many domestic wells are located and which are particularly vulnerable to drought-related declines in groundwater levels and storage.

II. Decade of Progress Under SGMA

The enactment of SGMA in 2014 marked a historic turning point in California's water management. For the first time, the State established a comprehensive, long-term framework to manage groundwater sustainably – recognizing its foundational role in California's water future. As climate change, land use pressures, and increasing water demands strain traditional supply systems, SGMA has laid the groundwork for a more resilient, locally led, and science-informed approach to groundwater stewardship. Over the past decade, SGMA has catalyzed a shift from reactive extraction toward proactive planning, integrating sustainability into local decision-making while safeguarding drinking water, ecosystems, and agricultural viability. This section outlines how the SGMA mandate has been implemented, the transformative progress made in the first 10 years, and the path forward as California builds a more equitable and climate-adapted groundwater future.

A. The SGMA Mandate

SGMA is the cornerstone of the State's efforts to bring groundwater basins into balance and ensure a more secure water future. DWR designated 94 of California's 515 groundwater basins as high- and medium-priority; the remaining basins are designated either low- or very low-priority. SGMA mandates that all high- and medium-priority groundwater basins achieve sustainability by 2042, providing a framework for consideration of beneficial uses of

groundwater and informing local agencies' management of extraction and recharge to avoid locally defined impacts. SGMA fundamentally changed the future course of California's water management by creating a regulatory framework for groundwater including the "...management and use of groundwater in a manner that can be maintained during the (50 year) planning and implementation horizon without causing undesirable results." The six undesirable results (Figure H-2) identified in SGMA serve as performance metrics to track progress toward achieving groundwater sustainability.

Figure H-2 Six Undesirable Results Defined in SGMA



SGMA was founded on the premise that groundwater is best managed at the local level. It established a new governance structure for managing California's groundwater resources at the local level by authorizing the establishment of local public agencies, called groundwater sustainability agencies (GSAs). The high- and medium-priority groundwater basins were required to form GSAs while the formation of GSAs in low- and very-low-priority basins is encouraged, though not required under SGMA. GSAs and local agencies are the primary drivers of SGMA implementation and innovation across the state's groundwater basins.

DWR also plays a pivotal role in implementing SGMA by providing technical, planning, and financial assistance, as well as guidance and oversight for GSPs. The State Water Board complements this work by serving as a regulatory backstop, stepping in to manage groundwater basins if local agencies are unable or unwilling to meet SGMA requirements. Together with the State Water Board's Safe and Affordable Funding for Equity and Resilience (SAFER) program, SGMA has also contributed to protecting domestic wells and improving drinking water reliability across vulnerable communities.

B. Ten Years of Progress

In its first decade, SGMA has driven transformative progress in groundwater management across California as summarized in Figure H-3. Over 250 GSAs have been established, tasked with developing and implementing GSPs to bring groundwater basins into balance. All high- and medium-priority basins that are required to comply with SGMA have submitted an adopted GSP or Alternative; in addition, nine low- and very-low priority basins have also voluntarily adopted a GSP. On February 27, 2025, DWR completed the evaluation and

approved a GSP or Alternative for all high- and medium- priority basins, except for seven high-priority basins that were found to be non-compliant with SGMA requirements, whose managers are working to resolve deficiencies with the State Water Board.

SGMA has spurred plans for over 1,500 local projects and management actions; the creation of sophisticated models, tools, accounting platforms, and analytical frameworks; and the monitoring of nearly 9,000 wells statewide, with a growing number of those collecting real-time data. Quantified benefits were reported for about 50% of the water supply management projects and management actions. The total reported benefit amounts to 2.9 maf/year, including approximately 1.3 maf/year from water supply augmentation and about 1.1 maf/year from recharge and conjunctive use. Successful implementation of the projects and management actions defined in GSPs and alternatives to GSPs requires sustained funding. While DWR has provided \$500 million in grant funding over the last 10 years (about \$140 million for planning and \$360 million for project implementation), the State cannot cover the full cost of SGMA implementation. Therefore, GSAs must find ways to self-fund their ongoing efforts, including project implementation, administration, community engagement, and monitoring.

SGMA has also fostered cross-disciplinary studies and innovations, including watershed-scale assessments that connect land use, water availability, and long-term resilience. Additionally, SGMA has enabled the collection of large volumes of groundwater-related data, groundwater basin characterization studies, and water budget analyses, providing a deeper understanding of groundwater as “natural infrastructure,” its flow patterns, and the opportunities offered by interconnectedness with surface water systems. State and local investments have further enhanced the ability to replenish aquifers and strengthen long-term water resilience. Efforts to maximize recharge must go hand-in-hand with demand management and land use planning that considers the water supply nexus, ensuring future development does not undermine sustainability goals. To support this integration, SGMA has also mandated stronger coordination and consultation between water management agencies and land use planning entities.

Over the past decade, which included two severe drought periods, SGMA has laid the foundation for a more equitable and sustainable approach to groundwater management across the state.

GSAs have already begun implementing innovative strategies to reduce groundwater pumping and overdraft, including local recharge initiatives and demand management programs. While challenging, these approaches are laying the groundwork for sustainable groundwater management, but achieving sustainability will require even tougher decisions about significant land repurposing that demand careful planning, collaboration and equitable consideration of all beneficial uses and users. In parallel, infrastructure improvements such as the development of groundwater recharge basins have helped reduce the rate of land subsidence in some areas and mitigate risks in others. Through this work, SGMA has also emerged as a key tool for climate adaptation, helping ensure California’s water management strategies remain flexible and resilient in the face of growing climate variability.

Figure H-3 SGMA Implementation in Action



Figure H-3 Note: taf = thousand acre-feet; maf = million acre-feet.

Statewide, the 10-year comparison of groundwater levels from fall 2014 to fall 2024 shows that water levels rose five feet or more in 41% of wells, remained similar (change within +/- 5 feet) to 2014 levels in 39%, and declined by five feet or more in 20% of wells. This marks the first time that groundwater levels have shown more increases than decreases in 10-year fall comparisons, as reported in CalGW Semi-Annual Updates. These improvements align with the first decade of SGMA and likely reflect both recent wetter precipitation patterns and SGMA management efforts. This progress underscores the opportunity to further integrate

infrastructure, such as the Delta Conveyance Project, to enhance water supply, enable more frequent high-flow diversions, and support conjunctive use and recharge strategies across basins.

Public awareness of groundwater's importance has also grown significantly, helping to foster proactive and collaborative management. Local agencies and GSAs are now planning for long-term drought resilience – not only to support agriculture and ecosystems but to ensure water security for communities statewide. Importantly, the November 2024 passage of a \$10 billion natural resources bond, Proposition 4, has secured new funding to build on the momentum of SGMA's first decade, ensuring continued support for GSP implementation and further advancing California's progress toward groundwater sustainability.

Over the past decade, SGMA has recognized and addressed the need for equity in groundwater management, particularly for California's frontline communities that have historically faced the greatest vulnerabilities. Progress includes greater representation of disadvantaged communities (DACs) in local planning processes and increased access to technical and financial assistance. DWR has worked to elevate community voices – particularly those impacted by dry wells, water quality issues, and limited access to safe drinking water – through tools like the Office of Environmental Health Hazard Assessment's Human Right to Water Framework and the DWR's DAC Engagement Pilot Projects. Strengthening this focus, Senate Bill 552 directs DWR to maintain and update the Water Shortage Vulnerability Score and Tool to identify and prioritize at-risk small water systems and rural communities. These efforts reflect a deepening commitment to ensure groundwater sustainability reaches all Californians, especially the most vulnerable. Looking ahead, SGMA's continued success will depend on deepening partnerships, accelerating implementation, and reinforcing the principle of stewardship, where groundwater is treated not merely as a resource to be used, but as a shared asset to be sustained for generations to come.

C. Local Agencies Are Key to Success

Local water management agencies across California have made extraordinary efforts over the past decade, making progress under SGMA possible. Since SGMA's enactment in 2014, these agencies have risen to the challenge, forming over 250 GSAs tasked with managing the state's critically important groundwater resources. Rooted in the principle that groundwater is best managed at the local level, GSAs have worked tirelessly to assess conditions, engage communities, and develop and adopt GSPs tailored to the unique conditions and needs of their basins.

The GSPs and alternatives to GSPs serve as the foundation for long-term sustainability, guiding local actions to address overdraft, protect water quality, reduce pumping by reducing demand, reduce land subsidence, and promote groundwater recharge. GSAs and local agencies have launched hundreds of projects and management actions, from infrastructure investments and demand reduction programs to recharge basins and monitoring networks, often incorporating climate adaptation strategies suited to local conditions. Counties have

also played a vital role, particularly in areas without established GSAs, by integrating groundwater considerations into land use planning and serving as backstops in governance.

Groundwater sustainability must be achieved by 2040 for critically overdrafted basins, and by 2042 for all other high- and medium-priority basins. To meet this goal, the next decade will demand even greater commitment to integrated planning for multi-benefit projects, collaboration, innovation, and climate-informed planning. The window for effective action is narrowing – if we are to secure reliable and resilient groundwater supplies for future generations, we must act now with urgency and resolve. As SGMA implementation shifts from planning to implementation focused on measurable outcomes and results, the continued leadership and institutional knowledge of local agencies will be critical. Sustained engagement and leadership transitions within GSAs must be carefully managed to ensure momentum is not lost as local leaders change over time. With sustained support from DWR, the State Water Board, and other local and State agencies, it is these local actors – GSAs and their partners and interested parties – who will remain the key drivers of California’s sustainable groundwater future.

III. Groundwater Management in Transition: Challenges and Opportunities

Groundwater management in California stands at a pivotal moment of transition. The passage of SGMA marked a turning point in how groundwater is managed, and the path forward is shaped by both unprecedented challenges and emerging opportunities. While management continues to evolve in response to SGMA, new realities – such as the need to co-manage periods of flood and drought – are pushing groundwater and other managers to innovate and expand their actions.

As climate extremes intensify and surface water becomes less reliable, shifts in land use and water demand are accelerating, and communities, agriculture, and ecosystems are relying more heavily on groundwater for survival. This growing reliance and pumping bring mounting risks: declining groundwater levels, land subsidence, dry wells, degraded water quality, seawater intrusion, depletions of interconnected surface water, and the impairment of groundwater-dependent ecosystems. Yet amid these pressures, California’s vast underground storage potential, innovative flood management and recharge strategies, and integrated planning efforts offer a promising path forward. The following sections examine key drivers of this transition, highlighting the complex interplay of challenges and opportunities that define California’s groundwater management landscape – and revealing how thoughtful, coordinated action can turn today’s pressures into tomorrow’s resilience.

A. Rising Groundwater Reliance Amid Climatic Extremes

Over the past two decades, California has experienced substantial shifts in land use, water demand, state and federal project operations, and water allocation strategies, compounded by the challenges of a changing climate, prolonged droughts, and extreme weather events.

These converging factors have dramatically reshaped how, when, and where groundwater is used across the state. Rapid development and land use changes, accompanying a population projected to reach about 41 million by 2050 (California Department of Finance 2024), have altered spatial patterns of water use across the state, as development expands into areas with varying levels of groundwater availability. At the same time, agricultural practices, driven by markets, have shifted toward more water-intensive crops, further straining available supplies despite water use efficiency practices. These pressures are compounded by climate change, which is not only increasing the evaporative demand of crops but also other evaporative demands (from soils, surface waters, and other vegetation). These changes are also expected to reduce the state's surface water supply by up to 10% by 2040 (California Natural Resources Agency 2022). As a result, major infrastructure systems are facing declining reliability. The State Water Project (SWP), for example, is projected to experience a 23% reduction in delivery capability over the next 20 years due solely to climate change (Department of Water Resources 2024). With the availability of surface water becoming less predictable, groundwater has increasingly become a critical source to meet urban, agricultural, and rural needs, particularly during droughts and prolonged dry periods.

California's highly variable climate plays a major role in shaping groundwater use patterns from year to year, as shown in the statewide water use data presented in Figure H-4 for years 2002 to 2021. During the recent wet water years of 2011, 2017, and 2019, total statewide groundwater use was about 31% of total water use. In contrast, during the critically dry water years of 2014, 2015, and 2021, total groundwater use was respectively approximately 53%, 58%, and 51% of total water use. These patterns highlight a growing dependence on groundwater overall as surface water supplies become less reliable in increasingly extreme dry years (Figure H-4). Reliance on groundwater increased significantly during the drought years 2012-2016 and 2020-2021. This increased reliance on groundwater during dry periods has exacerbated already troubling consequences, including overdraft, land subsidence, dry wells, declining groundwater quality and environmental impacts.

The statewide water use data beyond 2021 is in development at the time of publication of this report. However, water use data from 2021 to 2023 for basins managed under GSPs, alternatives to GSPs, and adjudicated areas are available from annual reports submitted to DWR by GSAs and local agencies as part of SGMA implementation. These reports represent a new and critical data source that will continue to inform sustainable groundwater management into the future. As shown on the rightmost edge of Figure H-4, during the dry years of 2021 and 2022, groundwater accounted for as much as 64% of the total water use in these SGMA basins.

Figure H-4 Percentage of Water Use by Source: Historical Statewide Data (2002–2021) and Annual Reports Data (2021–2023)

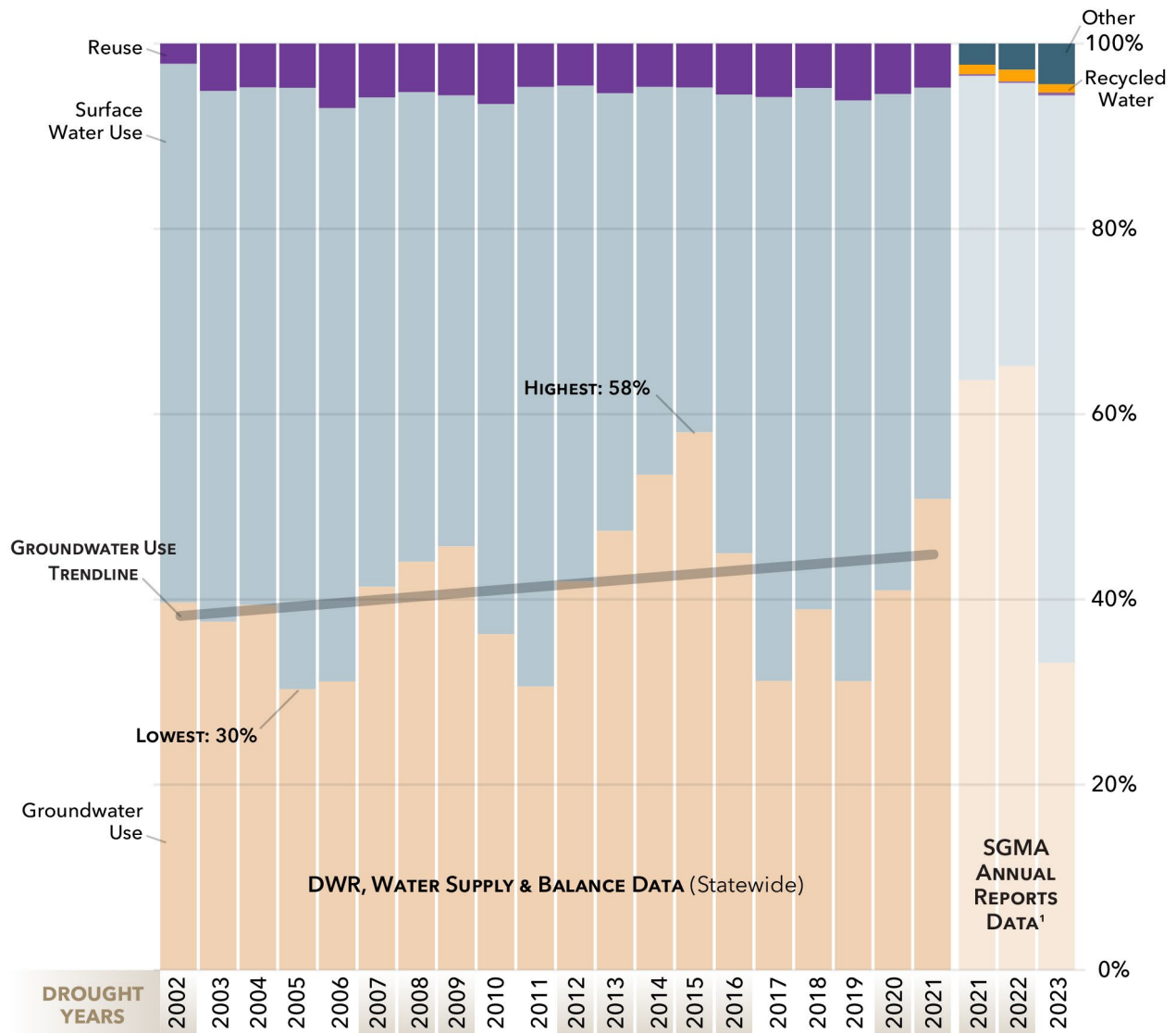


Figure H-4 Note:

1. SGMA Annual Reports Data sourced from annual reports submitted for basins managed under groundwater sustainability plans (GSPs), alternatives to GSPs, and adjudicated areas. The number of basins submitting annual reports varies by year: 94 basins in 2021, 98 in 2022, and 100 in 2023.

These recent patterns reflect a broader statewide trend that is projected to intensify in the coming decades under climate change. The California Water Plan Update 2023 assessed the risks climate change poses to water supply through 2070. The results underscore a growing dependence on groundwater across the state’s major hydrologic regions due to climate change. Most probable projections indicate a 2%-9% increase in groundwater reliance, with the San Joaquin region facing the highest rise at 9%. When climate uncertainty is factored in, groundwater dependency could surge by as much as 11% in the Sacramento River region, 32% in the San Joaquin region, and 6% in the Tulare Lake Region, potentially exacerbating

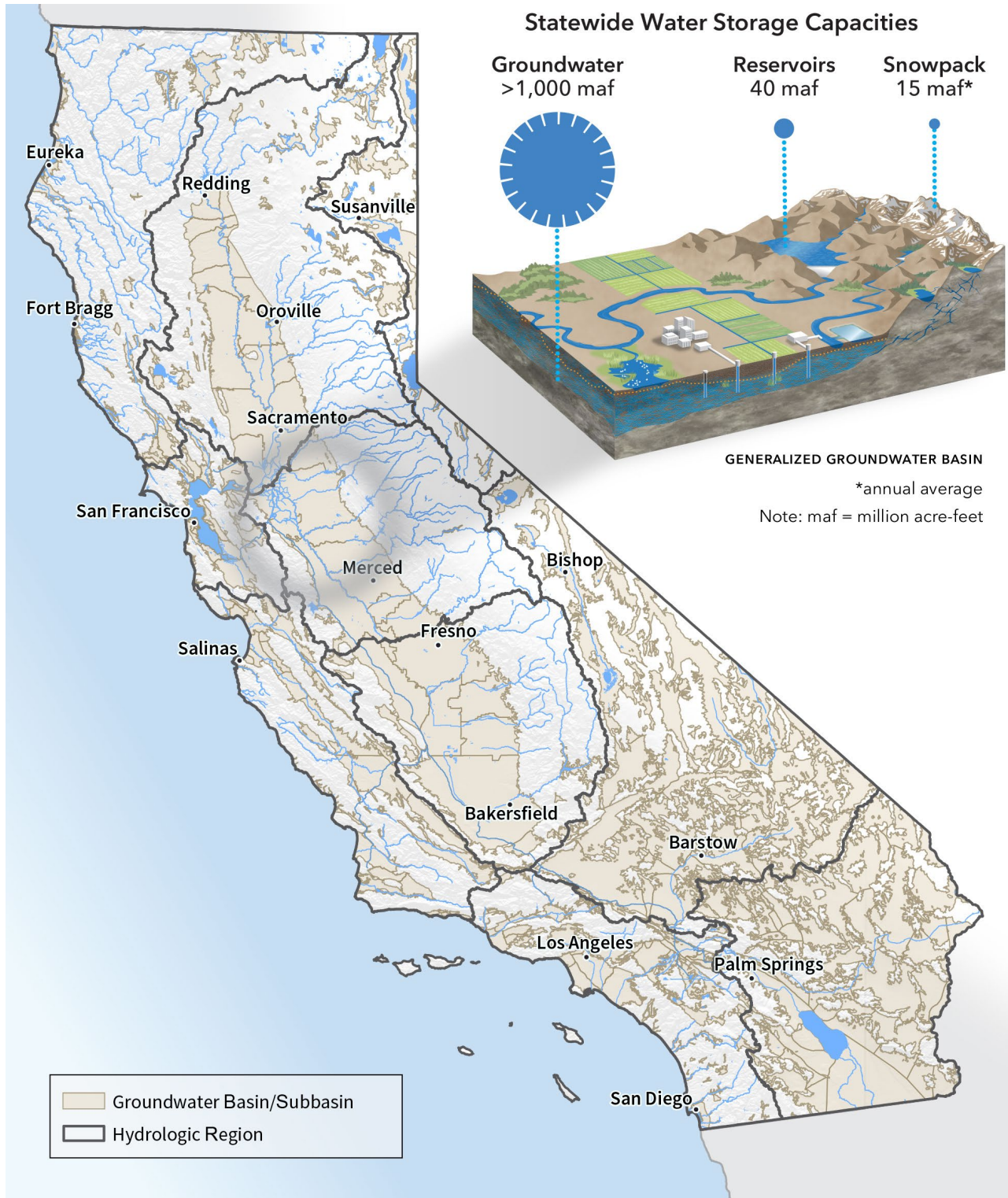
significant storage depletion without drastic demand management actions or new water supplies.

The historic and projected rise in groundwater dependence amid climatic extremes underscores a critical inflection point for California. The results are clear: Over-reliance without sustainable management has led to serious consequences for communities, aquifer and ecosystem health, water quality, and infrastructure. Sustainable management will require a shift toward proactive stewardship, strategic planning, and coordinated implementation of projects and management actions at all levels. Recognizing the urgency and acting decisively will determine whether this growing reliance on groundwater becomes a vulnerability – or a foundation for resilience.

B. A Vast Reservoir Beneath Our Feet

While surface water reservoirs visibly reflect signs of abundance or scarcity, the true measure of California's water health lies underground in the 515 groundwater basins. The state's vast groundwater storage capacity, estimated at more than 1,000 million acre-feet (maf), far surpasses the combined water supply storage capacity of all surface reservoirs, which is only about 40 maf (California Department of Water Resources 2026) (Figure H-5). Although physical limitations, poor water quality, and economic constraints may reduce the usability of this vast groundwater storage, its sheer size underscores its importance and potential to provide long-term water security. Building on this potential, emerging technologies such as advanced water treatment, improved monitoring, and recharge innovations are further enhancing the ability to utilize additional groundwater. Regardless of its vast size and potential, ensuring sustainable use remains essential to protecting this critical resource for future generations.

Figure H-5 California's Groundwater Basins



The promise of this underground reservoir is undermined by historical unsustainable use. Decades of over-extraction have severely depleted aquifers, with some regions facing groundwater levels that will take decades of careful management to recover. This historical chronic groundwater depletion becomes more concerning because climate change has fundamentally disrupted California's water cycle. The 2001-2022 period marked the driest 22-year span in at least 1,200 years, surpassing even the megadrought of the late 1500s. This new reality of hotter, drier conditions threatens to reduce the state's overall water supply by up to 10% by 2040.

Chronic groundwater depletion has also led to significant land subsidence in parts of California. Between 2019 and 2023, about 4,000 square miles experienced subsidence of more than 0.5 feet with approximately 113 square miles exhibiting subsidence of 3 to 4 feet. In earlier periods between 2010 and 2018, which included the 2012-2016 severe drought, the city of Corcoran recorded a cumulative subsidence of 6.0 feet. This gradual sinking of land, caused by the compaction of overdrafted aquifer systems, has resulted in severe and lasting damage to land surface uses and critical water infrastructure, including canals, levees, and pipelines that are essential for protecting our communities and conveying water throughout the state. The consequences of this subsidence are costly and difficult, if not impossible, to reverse, compounding the challenges of delivering water efficiently and reliably. Focused and coordinated action is needed as soon as possible, to avoid or minimize further damage to aquifer capacity and infrastructure. To support GSAs in addressing these challenges, DWR released subsidence best management practices in 2025, and will continue to assist local agencies in their efforts to minimize or avoid subsidence. As climate change accelerates and groundwater demand increases, the risks of further subsidence and damage to water infrastructure become even more urgent to address through sustainable groundwater management.

Recognizing this urgency, California took a significant step in 2023 by formally designating aquifers as "natural infrastructure" through Senate Bill 122. This legislative milestone acknowledges the critical role aquifers play in climate adaptation and unlocks new public funding to support recharge projects and storage enhancement. This policy shift lays the foundation for a more strategic and integrated approach to groundwater management – one that treats aquifers as vital assets requiring long-term stewardship.

As California manages groundwater for water resilience, understanding aquifers as critical, natural, long-lived assets that store, filter, and convey water is essential. Treating basins as natural infrastructure opens the door to more strategic investments in their health and function. Key to this shift are efforts such as DWR's Groundwater Basin Characterization Program, as well as local hydrogeologic analysis and modeling efforts. These efforts integrate hydrologic, geologic, and land use data to assess the subsurface conditions and how water moves through different regions of the aquifer system. These efforts provide the foundation for making informed decisions about recharge potential, storage optimization, and sustainability planning at both regional and statewide scales.

Significant progress has been made through the deployment of Airborne Electromagnetic (AEM) surveys and subsurface data compilation, which offer high-resolution, three-dimensional imaging of aquifer structure. DWR has completed 16,000 miles of AEM surveys across 95 groundwater basins and digitized over 15,000 well completion reports that enable a more refined understanding of the aquifers as “natural infrastructure,” including where water can be stored, how deep aquifers extend, and where recharge would be most effective. This data is instrumental in identifying subsurface “preferential pathways” and “storage sweet spots” for optimized managed aquifer recharge (MAR) efforts.

In parallel, DWR’s Aquifer Recharge Potential Mapping initiative, within the Groundwater Basin Characterization Program, is helping to identify the most suitable lands for recharge based on soil permeability, slope, and geologic conditions. By combining this spatial information with groundwater level trends, water availability forecasts, and infrastructure assessments, the state can prioritize areas where recharge yields the greatest benefit, especially in vulnerable, overdrafted basins. This approach transforms groundwater planning from reactive recovery to proactive stewardship, aligning closely with California’s broader climate adaptation and water resilience goals.

Ultimately, leveraging groundwater basins as natural infrastructure – supported by cutting-edge science and modern mapping tools – provides California with a powerful opportunity. By optimizing this invisible reservoir, the state can expand its effective water storage capacity, buffer against droughts, reduce flood risks, and support sustainable agriculture and development in the face of an uncertain climate future.

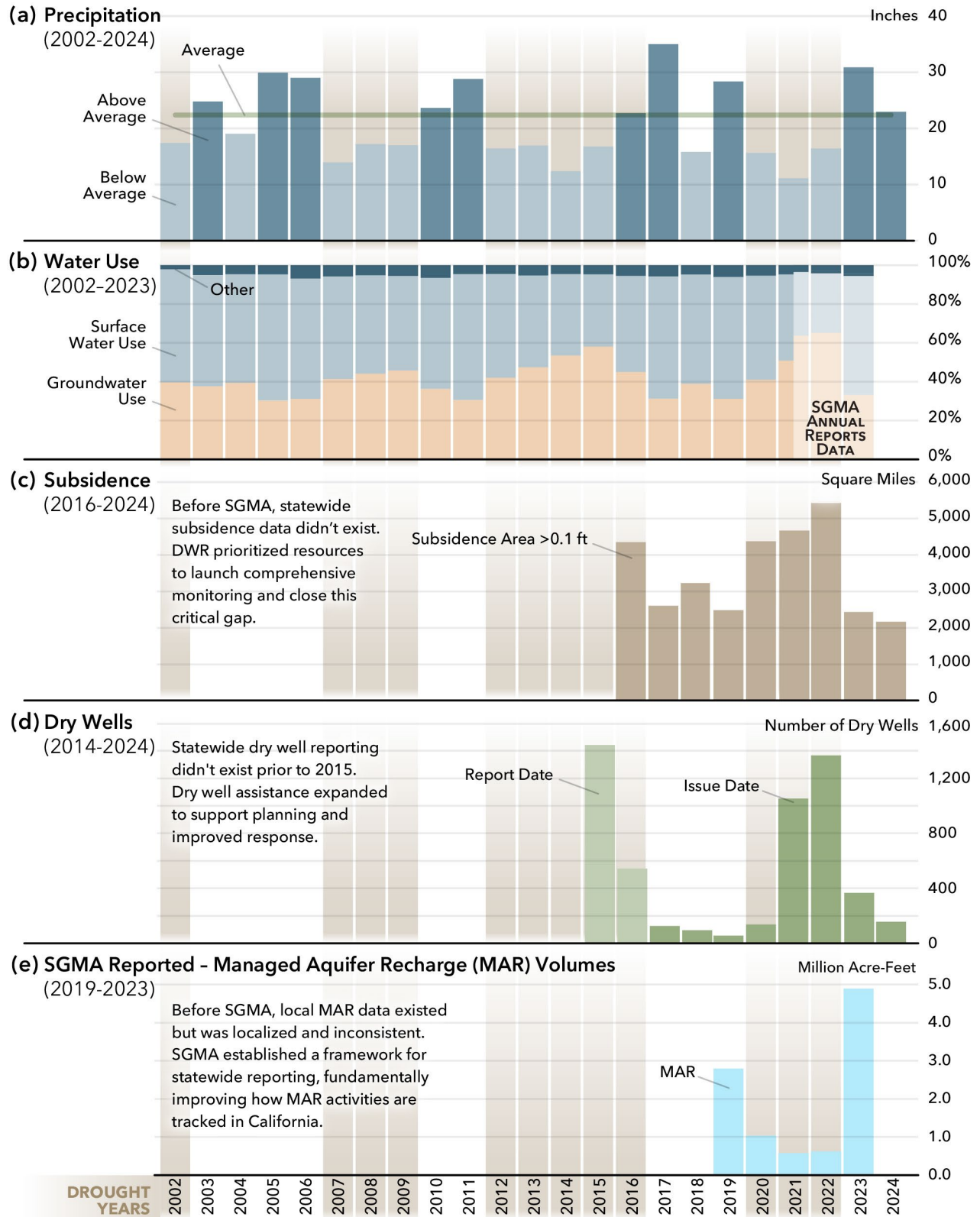
C. Need for Integration and Transformation

Amid these diverse and complex water resilience challenges lies a profound opportunity: Groundwater is not an isolated resource. It is an essential foundation that connects every part of California’s water system, including natural and built infrastructure, as illustrated in Figure H-6. It shows how changes in precipitation, water use, and recharge – combined with drought-driven stressors like land subsidence and dry wells – are deeply interconnected, underscoring the need for integrated data and coordinated groundwater management. The time series data presented in Figure H-6 varies across different aspects of groundwater management. Although data collection efforts have been ongoing for years, they were often distributed and siloed across regions. It was not until the enactment of SGMA in 2014 that the State was able to organize and compile comprehensive data across key elements of groundwater management. This transformation has been made possible through the work of local groundwater agencies, which are primarily responsible for collecting and reporting groundwater data as part of SGMA requirements.

Historical precipitation data, as shown in part (a) of Figure H-6, is a key driver in this system; when rainfall is plentiful, surface water supplies increase, reducing the need to pump groundwater and increasing the water available for recharge. However, during dry years, groundwater use rises significantly, as shown in part (b) of Figure H-6, leading to decreased

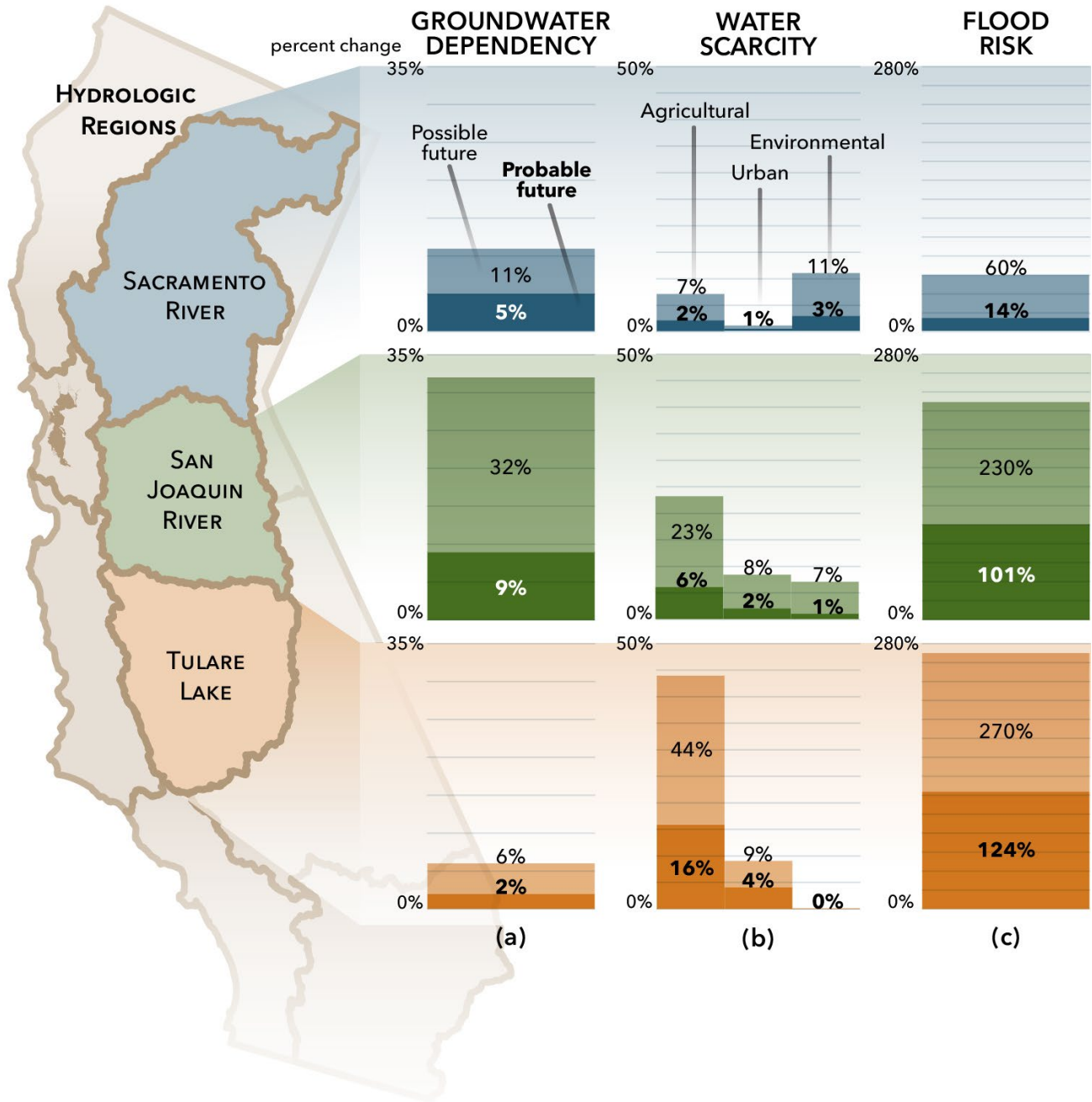
groundwater levels and increased land subsidence (part (c)) and a surge in reported dry wells (part (d)). These systemic relationships are especially evident during prolonged droughts (e.g., 2012-2016, 2020-2022), when strain on aquifers gradually intensifies, leading to increased areas of land subsidence and a growing number of dry wells. At the same time, precipitation runoff during wet years (e.g., 2023) provides high-flow events that create vital opportunities for managed aquifer recharge, helping to restore depleted groundwater levels.

Figure H-6 Interconnectedness of Groundwater with Water Supply, Groundwater Use, Land Subsidence, Dry Wells, and Recharge



This interconnectedness is further reinforced by the California Water Plan Update 2023 future scenario analysis (Figure H-7), which modeled long-term climate impacts on water systems through 2070 in the Central Valley. The analysis projected a significant increase in groundwater dependency (Figure H-7a) – up to 32% in the San Joaquin, 11% in the Sacramento, and 6% in the Tulare Lake hydrologic regions under climate uncertainty. Simultaneously, unmet water demands (Figure H-7b) could rise by as much as 44% in agriculture in the Tulare Lake region and 8% in urban sectors in San Joaquin hydrologic region. Perhaps most striking, the study found that flood flows (Figure H-7c) could increase by up to 270% in the Tulare Lake region and 230% in the San Joaquin region due to intensified winter runoff and earlier snowmelt. These projections underscore the deep interdependence of drought, flood, and groundwater dynamics and the need for integrated water management that accounts for the dynamic relationship between climate, water use, and groundwater sustainability.

Figure H-7 Future Scenarios of Groundwater Dependency, Water Scarcity, and Flood Risk (Water Plan Update 2023)



DWR Alignment and Integration

Groundwater management and CalGW Updates are closely aligned and connected with DWR’s broader framework of integrated water management and multi-benefit planning. This includes other major DWR interconnected initiatives such as the California Water Plan, Watershed Resilience Program, Central Valley Flood Protection Plan, Delta Conveyance Project, and extreme weather preparedness. By connecting these efforts, the State capitalizes

on emerging opportunities and advances its broader goals of climate resilience and water security.

The California Water Plan and the Watershed Resilience Program promote the holistic management of all water resources, recognizing groundwater as essential to long-term reliability, drought resilience, and sustainable supply. These efforts, along with SGMA and CalGW updates, are closely aligned, with information and data from each informing and strengthening one another to support coordinated planning and implementation. Watershed networks that emerge from the Watershed Resilience Program can serve as a productive forum for developing and implementing multi-benefit projects that integrate surface water and groundwater. CalGW updates and their supporting suite of resources provide foundational technical information on groundwater conditions, which informs both statewide policy and local management. This information also supports initiatives such as Senate Bill 659 (2023), which directs DWR to incorporate actionable groundwater recharge strategies into the California Water Plan, starting with the 2028 update and continuing in subsequent updates.

The Central Valley Flood Protection Plan supports multi-benefit flood risk reduction strategies, such as reconnecting floodplains and harnessing high flows for managed aquifer recharge, which directly bolster groundwater sustainability. The Delta Conveyance Project would improve the reliability and timing of surface water deliveries, enabling more effective conjunctive use and providing greater operational flexibility to divert water for supply and groundwater recharge when conditions allow. By aligning and integrating groundwater management strategies with improved forecasting, proactive planning, and the dual challenges of drought and flood, the state can shift from reactive crisis management to maximizing the opportunities presented by extreme weather.

The unpredictability of extreme weather and swings between wet periods and dry periods – known as “weather whiplash” – offers challenges as well as opportunities for integrated water management. A significant multi-year drought from 2020-2022 was followed by one of the wettest years on record. In early 2023, California experienced a record-breaking sequence of 19 atmospheric rivers, delivering 192%, 237%, and 300% of normal snowpack respectively in the northern, central, and southern Sierra. Although the resulting floods were not nearly enough to replenish deeply stressed aquifers, they also provided opportunities. In 2023, for example, regulatory streamlining, State support, and significant local action enabled approximately 4.9 maf of managed aquifer recharge statewide, with 83% (4.1 maf) occurring in the water-stressed San Joaquin Valley. These outcomes highlight the value of turning flood events into strategic moments for bolstering long-term water resilience.

To better capitalize on these episodic high-flow events, California is advancing forecast-informed reservoir operations for managed aquifer recharge (FIRO-MAR). This emerging approach uses improved precipitation forecasting to anticipate storm inflows and create reservoir space in advance, allowing the strategic release of water to recharge aquifers while preserving flood protection capacity. When combined with expanded recharge infrastructure

and aquifer capacity mapping, FIRO-MAR can optimize both flood risk reduction and groundwater storage enhancement, bridging the gap between drought resilience and flood response. To make these strategies work, local agencies need access to timely data and decision-support tools that align with state-level planning efforts.

As part of DWR's technical assistance to local public agencies responsible for flood management, the public, and the diverters interested in using floodwaters for managed aquifer recharge, DWR has developed the Flood-MAR Dashboard. The Dashboard provides access to information on hydrologic and hydraulic conditions and allows flood management agencies to indicate when local flood conditions may exist within their jurisdiction to allow diversions that help reduce flood risk and provide groundwater recharge under Water Code Section 1242.1 or other directives.

D. Groundwater Monitoring and Forecasting

Building on these interconnected resource strategies, the next frontier in resilience lies in groundwater forecasting – an essential counterpart to surface water forecasting. Groundwater forecasting involves predicting future groundwater availability, recharge rates, and aquifer conditions over short- and long-term periods. This prediction relies on integrating hydrologic models, historical data, and real-time monitoring to anticipate changes in groundwater storage, flow, and quality. Forecasting also integrates with emerging groundwater accounting efforts across the state by tracking inflows, outflows, and storage changes to ensure sustainable use and improve transparency for water users.

Groundwater forecasting would enable water managers to prepare for fluctuations in demand and supply caused by extreme weather and climatic events, seasonal variability, and long-term climate change. Key components include monitoring aquifer levels, analyzing recharge rates from precipitation and managed aquifer recharge projects, and assessing land-use changes that both affect and are influenced by groundwater availability. Forecasting these conditions and providing timely information to water managers will help them better manage groundwater extraction, avoid over-pumping, ensure sustainable use while protecting ecosystems and meeting urban and agricultural water needs, and be better prepared to respond to extreme and climatic weather events. By identifying at-risk areas early, groundwater forecasting can also help anticipate and prepare for potential dry-well occurrences, particularly in vulnerable communities that depend heavily on groundwater, enabling targeted mitigation strategies and support for domestic well users during times of shortage.

California is making progress and becoming better positioned to forecast groundwater conditions and impacts by enhancing statewide monitoring network coverage and data collection frequency and making this information easily accessible through online platforms such as CalGW Live and California Natural Resources Agency (CNRA) Open Data website. These systems can integrate data from about 9,000 monitored wells across the state, including telemetered, real-time monitoring wells providing hourly updates on groundwater

levels. To move toward robust forecasting, the State is expanding its monitoring network, investing in advanced modeling tools, and enhancing data-sharing platforms. As those investments continue, groundwater forecasting can become more impactful to water managers. For example, expanding the tracking and monitoring of initiatives like Flood-MAR can offer valuable insights on recharge potential, while advancing satellite data and remote sensing technologies such as InSAR can enable tracking of subsidence and aquifer depletion in real time. Pairing groundwater forecasting with groundwater accounting will create a more transparent and proactive groundwater management system, allowing for better tracking of water budgets, encouraging equitable allocation, and providing early warning tools to protect vulnerable users from shortages. By combining these tools with machine learning and predictive analytics, California can develop dynamic groundwater forecasts akin to surface water forecasting systems such as DWR's Bulletin 120, which provides seasonal surface water supply forecasts, and the California-Nevada River Forecast Center, which provides hydrologic, river and flood forecast data. This approach would enable proactive decision-making, improve drought and flood preparedness, and enhance the long-term sustainability of groundwater resources.

By pairing recharge innovations like forecast-informed reservoir operations (FIRO) with groundwater forecasting and decision-support tools, California is moving toward a more proactive, data-driven groundwater management system. This shift recognizes that aquifers are not passive reserves, but dynamic, natural infrastructure that must be managed with foresight, flexibility, and coordination to ensure long-term resilience. The continued evolution of these tools and strategies will ensure that groundwater remains a foundational stabilizing resource as climate volatility intensifies.

E. Groundwater Management in a Changing Climate

Climate change is reshaping the foundation of California's water resilience, with increasingly erratic weather patterns disrupting the historical balance of supply and demand. The very hydrologic systems that once sustained California's urban centers, agricultural economy, and ecosystems are now under mounting stress. Reduced snowpack, shifting precipitation timing and intensity, increased evaporation, and more frequent extreme events like atmospheric rivers and megadroughts compound the strain on already overdrawn groundwater basins.

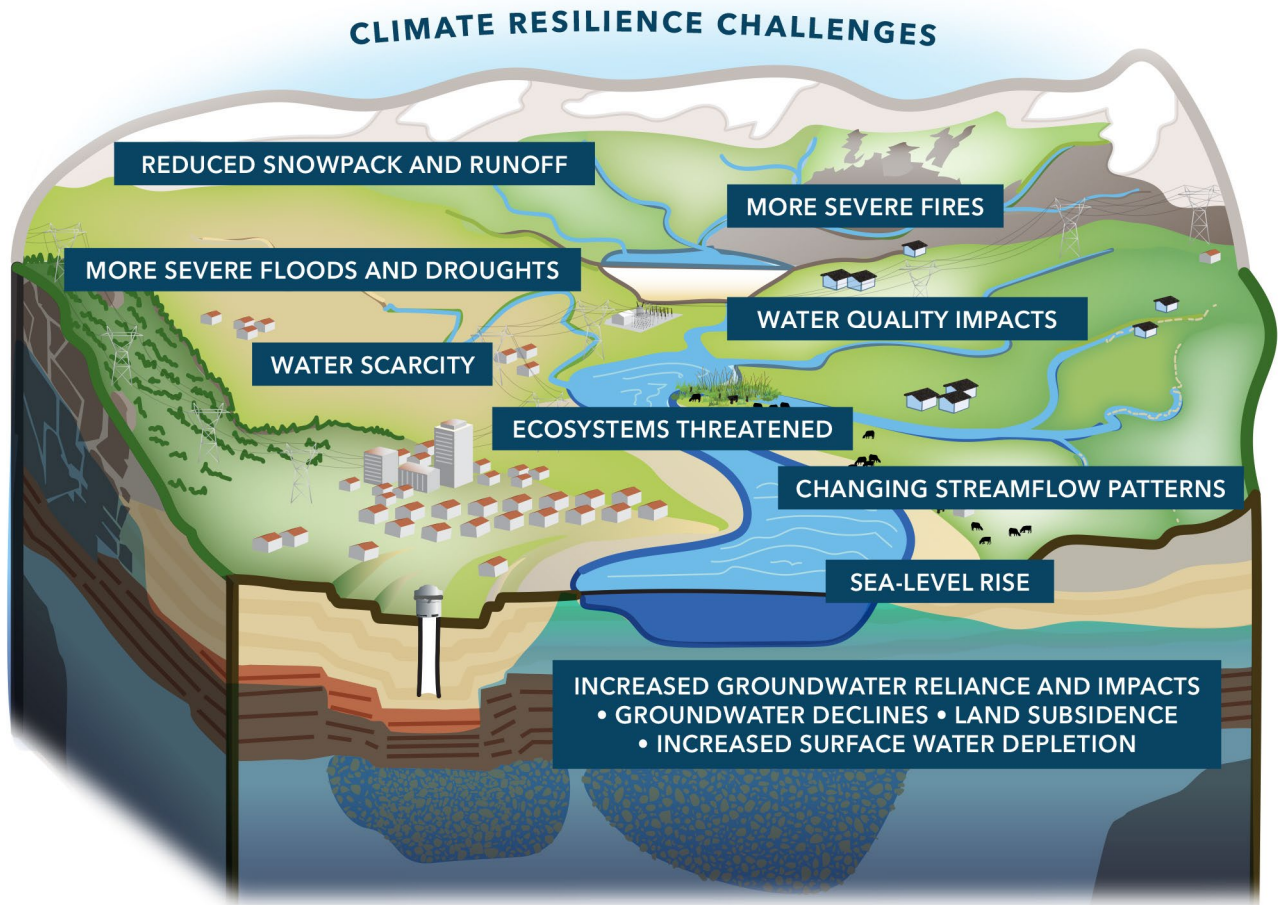
In addition to amplification of climatic and hydrologic extremes, one of the most consequential climate trends impacting California is aridification – the long-term shift toward a hotter, drier climate. Southern and inland regions are already experiencing reduced precipitation and snowpack, elevated evaporation rates, and rising irrigation demands. These factors are diminishing the recharge potential of aquifers and intensifying groundwater dependence across both rural and urban areas.

The effects of aridification extend beyond California's borders. The Colorado River, which supplies approximately 4.4 maf of water annually to California, has experienced a 20% decline in flow since 2000 due to climate change. A U.S. Geological Survey study projects this flow

could drop by as much as 31% by 2050 (Milly and Dunne 2020). This will place tremendous strain on regions like the Imperial Valley, which produces 80% of the nation’s winter vegetables and heavily depends on this shrinking supply. As climate-induced aridification accelerates across the American West, these changes are not theoretical – they are already here, transforming the state’s water landscape in complex and costly ways.

California’s vulnerability is underscored by projections that warn of a potential 10% decline in the state’s overall water supply by 2040, including reduced supply availability from the Colorado River. This shortfall forces policymakers, local water managers, and communities to rethink traditional water strategies and develop integrated, climate-informed solutions. With surface water growing less reliable, groundwater is increasingly becoming the frontline defense, which puts greater pressure on a resource that is both essential and already overburdened.

Figure H-8 Climate Change Challenges



The nature of this challenge is compounded by two distinct but interconnected forces: thermodynamic and dynamic climate changes. Thermodynamic changes, directly driven by rising global temperatures, intensify evaporation, increase evapotranspiration, and raise atmospheric moisture capacity, which in turn amplifies the intensity of storms and droughts. In California, this has translated into more severe and prolonged droughts, heightened irrigation demand, and more intense atmospheric river events. These atmospheric rivers, while capable of delivering substantial rainfall in short bursts, often lead to surface runoff rather than effective groundwater recharge, especially in landscapes altered by urbanization or hardened by drought.

Dynamic climate changes, on the other hand, stem from shifting wind and weather patterns in the atmosphere, which affect when, where, and how much it rains or how hot it gets. These changes have contributed to rapid shifts between dry and wet extremes, such as those experienced between the 2020-2022 drought and the record-setting snow and rainfall events of early 2023. Observations over the past four decades show an increase in atmospheric conditions that favor atmospheric rivers, potentially reducing the frequency of moderate storms while increasing the extremes. This unpredictability complicates long-term water management and places added stress on infrastructure designed for more stable, seasonal flows.

Compounding these climatic shifts is a rise in climatic water deficits – a condition where evaporative demand exceeds available water supply. As temperatures warm, soils dry out faster and vegetation draws more moisture, reducing the amount of water that can percolate into aquifers. This deficit is especially pronounced in California’s arid and semi-arid regions, where even small reductions in precipitation or slight increases in temperature can result in significant losses in recharge potential. Modeling results show that under a scenario – where average precipitation remains unchanged but temperatures rise by 3°C with a 21% increase in extreme precipitation intensity – California may face 6-9% increases in average annual climatic water deficit, with some regions like the Sierra Nevada and North Coast experiencing even higher increases. In a drier scenario – where both temperatures rise and average precipitation decreases – climatic water deficits climb even further, intensifying water stress across both human and ecological systems.

The following sections examine several key dimensions of how climate change is reshaping California’s groundwater landscape, highlighting critical elements such as land-use changes, groundwater recharge, land subsidence, the unique vulnerabilities of non-basin areas, and the increasing need for equity, inclusion, and partnerships. Together, these interconnected factors underscore the complexity of the state’s groundwater resilience challenges and inform the adaptation strategies needed for a hotter, drier future.

Land Use Changes

The relationship between land use, water use, and climate change in California is complex, reflecting how land management practices contribute to climate change and are, in turn,

shaped by its impacts. Intensifying climate stressors, such as severe droughts and wildfires, are driving significant shifts in land use across the state. During the last several decades, farmers have progressively adapted their cropping practices, shifting to high-value perennial crops like fruits and nuts, which offer better economic returns than less profitable annual crops. These changes optimize economic returns but increase vulnerability to future climate challenges.

Over the long term, land use changes profoundly influence the exposure and sensitivity of surface water and groundwater systems to climate impacts. As surface water supplies become less reliable and crop water demands rise due to higher temperatures, the availability and protection of groundwater reserves during dry years are critical to avoiding significant agricultural economic losses (Medellín-Azuara et al. 2018). However, achieving this resilience will require significant investment in land use transitions, such as repurposing irrigated farmland to less water-intensive uses, enhancing recharge areas, and implementing multi-benefit strategies that balance agricultural production, ecosystem health, and water sustainability.

Climate change also underscores the urgent need to align land use decisions with groundwater management. In many regions, land use planning remains disconnected from local water supply realities. Development often proceeds without fully accounting for the long-term capacity of aquifers to support additional demand. This misalignment contributes to chronic over-pumping, declining groundwater levels, and lasting impacts on water reliability. To ensure sustainable groundwater management, especially as droughts become more frequent and severe, land use planning must be grounded in a clear understanding of the sustainable yield of local groundwater resources.

Addressing the challenges associated with land use changes also necessitates integrating climate adaptation tools, such as demand management strategies, with sustainable land and water management practices. For instance, water-efficient irrigation and crop diversification, including applying compost to rangelands, can improve soil organic matter and water retention, simultaneously mitigating emissions and enhancing drought resilience (Silver et al. 2018). Policymakers and land managers must carefully balance urban development, agricultural demands, and conservation efforts to bolster resilience against the growing impacts of climate change.

Groundwater Recharge

Groundwater recharge is a vital component of California's long-term water resilience, providing a critical buffer against drought and sustaining both agricultural and urban water supplies. However, climate change is significantly disrupting the natural recharge processes that sustain the state's aquifers. Modeling studies show that under warming-only scenarios with increased extreme precipitation intensity, natural recharge could decline by up to 10% across much of the Sierra Nevada and coastal regions. In drier future scenarios, reductions exceeding 30% are projected in parts of the Sacramento and San Joaquin valleys – regions

already heavily dependent on groundwater. While wetter scenarios may offer increased recharge, they also heighten flood risks and present operational challenges due to infrastructure constraints.

The implications of declining recharge extend far beyond simple water availability. Reduced infiltration increases the risk of seawater intrusion in coastal aquifers, threatening both water quality and supply security. In arid and semi-arid regions, limited precipitation and high evaporation rates further increase vulnerability to groundwater scarcity. Meanwhile, snowmelt-dominated regions face disruptions in seasonal recharge patterns due to earlier and faster snowmelt. The convergence of these factors underscores the growing urgency to actively manage aquifer replenishment, particularly during wet years, through strategies such as FIRO-MAR and expanded recharge infrastructure. Without proactive intervention, reduced recharge will deepen reliance on already stressed groundwater reserves, escalating the risk of long-term aquifer depletion and compounding the state's broader climate adaptation challenges.

Land Subsidence

Land subsidence is a critical and growing dimension of California's climate adaptation challenge, particularly in the San Joaquin Valley where groundwater overdraft is most acute. Increasing reliance on groundwater, especially during prolonged droughts, has led to the compaction of underlying aquifers and the sinking of land across wide areas. According to a 2015 report by the National Aeronautics and Space Administration's (NASA's) Jet Propulsion Laboratory (JPL), land near the city of Corcoran in California's Tulare Basin sank approximately 13 inches over an eight-month period in 2014. This subsidence was primarily attributed to excessive groundwater pumping during a period of severe drought. Such deformation reduces the capacity and efficiency of major canals in the region. It also compromises public safety and agricultural productivity by increasing flood risk and damaging roads, levees, and pipelines. In particular, levee damage caused by subsidence reduces the ability to safely convey floodwaters, increasing flood risk for communities that rely on this infrastructure for protection. Additionally, by altering the natural topography and historical floodplains, subsidence can shift flood patterns – causing areas that previously remained dry to become vulnerable to inundation.

A 2025 addendum (California Department of Water Resources 2025) to the State Water Project (SWP) *Delivery Capability Report* concluded that land subsidence caused by continued over-pumping has already reduced annual water delivery capability by 3%. The addendum analyzed additional potential changes to future deliveries due to damage to major SWP canals tied to groundwater pumping and oil and gas production. If no further infrastructure preservation and impact avoidance action is taken, the combined effects of continued subsidence and climate change could slash SWP deliveries by up to 87% by 2043. As the SWP provides water to 27 million Californians and supports 750,000 acres of farmland, the consequences would be far-reaching. The addendum highlights not only the damage

subsidence has already inflicted on key delivery infrastructure, but also the urgency of eliminating overdraft and repairing degraded canals to preserve future supply reliability.

In response to these threats, California is prioritizing land subsidence in its broader climate resilience framework to ensure California's groundwater systems remain secure, and the infrastructure built upon them remains functional in the face of an increasingly uncertain climate future. DWR, which operates the SWP, is implementing preventive and corrective actions to protect the California Aqueduct from subsidence damage.

Non-basin Areas

Climate change is significantly altering hydrology in non-basin areas that lie outside the 515 designated groundwater basins and include mountainous regions such as the Sierra Nevada, Klamath Mountains, Cascades, and Coast Ranges. Although they account for only about 7% of the state's groundwater production, non-basin areas are vital as headwaters for snowpack, snowmelt, springs, and surface runoff that sustain major water systems like the State Water Project and Central Valley Project. Additionally, many people living in these remote and rural areas also rely heavily on groundwater as their primary source of drinking water, making them particularly vulnerable to groundwater depletion, dry wells, and water quality issues.

These high-elevation regions are experiencing some of the most profound climate-driven hydrologic changes in the state. Rising temperatures are shifting precipitation from snow to rain and accelerating snowmelt, reducing groundwater recharge and shortening water availability during critical dry months. Snowmelt, which historically supplied about one-third of California's water, is projected to fall to two-thirds of historical levels by 2050 and potentially as low as one-third by 2100. Earlier runoff also increases flood risk, as reservoirs may not be positioned to store this early inflow. Worsening wildfire conditions, fueled by a warming climate, further compromise non-basin hydrology. Uncontrolled, high-intensity wildfires – not prescribed burns – can create hydrophobic soils that reduce infiltration, elevate erosion, and release pollutants, harming both surface and groundwater quality. Changes to vegetation and soil properties following wildfires disrupt natural recharge patterns, adding to regional vulnerability.

Despite these risks, non-basin areas harbor critical ecosystems that act as natural groundwater infrastructure. Meadows, in particular, function like sponges – absorbing snowmelt and gradually releasing water through the dry season, supporting baseflows, regulating stream temperatures, and improving downstream water quality. Restoration of meadows is essential to climate resilience. Through California's 30x30 initiative, over 17,000 acres were restored from 2020–2023, including key sites like Osa Meadow, West Walker River, and Childs Meadow. These projects improve groundwater recharge, stabilize stream temperatures, reduce sediment, and enhance ecological health.

Equity, Inclusion, Tribal Engagement, and Partnerships

While equity, inclusion, and partnership between policymakers, water practitioners, the State, California Tribes, and historically marginalized communities have long been essential for sustainable water management, climate change adds new urgency to advancing these efforts. These are no longer peripheral goals but central pillars of California's journey toward water resilience, as sustainable solutions must incorporate the voices and needs of those who have long faced systemic disadvantages in water access and management.

In California, numerous rural and disadvantaged communities face mounting physical and social vulnerabilities in securing safe and reliable water supply – challenges that are being intensified by climate change. Physically, many of these frontline communities – defined as those that experience the “first and worst” of environmental consequences – rely 100% on groundwater from shallow domestic wells, leaving them acutely exposed to declining groundwater levels during droughts, prolonged dry spells, and increasing over-extraction. As climate change accelerates the frequency and severity of these extremes, the risk of dry wells and disrupted water access grows ever more urgent.

Social vulnerabilities compound these risks. Limited financial capacity, language barriers, and insufficient political representation reduce the ability of these communities to prepare for, respond to, or recover from water shortages. This convergence of environmental and social stressors not only exposes deep inequities but also underscores the State's obligation to uphold the human right to water under Water Code Section 106.3 – to install policy measures that work towards all Californians having access to safe, clean, and affordable drinking water. In recognition of this, Senate Bill 552 (2021) requires counties to develop Drought Resilience Plans for small water systems and domestic wells, supported by tools such as DWR's Water Shortage Vulnerability Explorer Tool. These resources aim to identify at-risk communities and guide targeted, equity-centered interventions that build resilience where it is most needed.

DWR has administered millions of dollars in funding specifically to benefit underserved and underrepresented communities, through grants that support the development and implementation of GSPs. Technical assistance and engagement tools have been provided to enhance local capacity, particularly in regions where groundwater is the sole source of supply. DWR-funded projects have included groundwater recharge infrastructure, well rehabilitation, drought resilience planning, and nitrate mitigation. In agricultural regions like the San Joaquin Valley, where land retirement linked to groundwater sustainability may significantly impact employment and local economies, the State is assessing co-benefit strategies and economic transition programs to reduce unintended social consequences.

California has also taken measurable steps to integrate Tribal communities into sustainable groundwater planning, with full recognition of their sovereign status, including data sovereignty, and deep stewardship traditions. Tribes are self-governing nations with distinct cultural, legal, and ecological relationships to water. DWR hosted an active SGMA Tribal Advisory Group from 2015 through 2023 to provide a regular forum for Tribal engagement

in groundwater policy development and outreach and engagement opportunities. In 2021, DWR launched the Underrepresented Communities, California Tribes, and Small Farmers Groundwater Technical Assistance Program to assess groundwater-related risks and needs. In 2022, a \$15 million funding agreement was executed to directly support Tribal water supply projects, demonstrating government-to-government collaboration. DWR expedited a water transfer agreement in 2024 with the Santa Rosa Rancheria Tachi Yokut Tribe to meet urgent water supply needs north of the Tulare Lake area.

By grounding these efforts in both scientific assessment and community engagement, California's groundwater programs aim to operationalize equity through direct investment, decision-making inclusion, and transparent performance tracking. Tools such as the State Water Board's Human Right to Water Portal and DWR's Water Shortage Vulnerability Scoring and Tool provide data-driven frameworks for prioritizing support where it is most urgently needed. These efforts, aligned with the California Water Plan Update 2023 and CalGW Update 2025 themes, underscore the importance of inclusive governance, interagency coordination, and ongoing technical support to ensure that sustainable groundwater management benefits all Californians.

F. California's Whole-System Approach

Intensifying drought, erratic weather patterns, declining recharge, land subsidence, changing land and water use, and wildfires are disrupting the delicate balance between groundwater supply and demand. Consequently, groundwater cannot be viewed as a static reserve but must be managed as a dynamic system vulnerable to both gradual depletion and acute disruption. The implications for land subsidence, water quality, and long-term sustainability are profound. Preparing for these changes requires a shift from reactive crisis management to proactive, climate-adaptive groundwater stewardship grounded in better data, flexible infrastructure, and integrated planning that connects water, land, ecosystems, and communities. With innovations like Flood-MAR, California is beginning to align its flood and drought strategies through an integrated lens. Such practices convert climate extremes from threats into opportunities for resilience.

Ultimately, California's path forward will depend on a coordinated, whole-system approach that bridges science, planning, data, equity, and innovation. Adaptive water management must consider the entire landscape, from mountain meadows and non-basin areas to the vast Central Valley aquifers and California coastline. Investments in meadow restoration, recharge infrastructure, climate-resilient agriculture, and land-use alignment are no longer optional – they are essential. Climate change has shaken the foundation of the state's water resilience. Now, it is up to California to respond with equally transformative action.

Taken together, these insights and realizations about California's groundwater affirm a powerful reality: The state's long-term water security and resilience rest on how thoughtfully and proactively it stewards its vast groundwater resources and vulnerable natural groundwater infrastructure. In an era marked by increasing climate variability, where historic

droughts and record-breaking floods can occur within just a few years, groundwater unifies and offers both stability and flexibility. It is a vital, dynamic asset that can help California thrive amid uncertainty. To manage this resource effectively, we must begin with a clear understanding of its current state and trends.

To manage this resource effectively, strong coordination among local, state, tribal, and federal partners is essential. A whole-system approach – one that connects water, land, ecosystems, and communities across regional and watershed boundaries – requires collaborative governance, shared investment, and aligned priorities across all levels of government. This integrated framework ensures that groundwater management actions are scalable, equitable, and climate-informed. Only through this kind of sustained partnership can California build the adaptive capacity needed to steward its groundwater resources and secure long-term water resilience for future generations.

IV. The State of Groundwater in California

This section presents the state of groundwater in California in terms of monitoring coverage, resource conditions, water use patterns, and management activities – highlighting key trends and regional differences across both basin and non-basin areas. Understanding these current conditions and long-term trends is essential to effectively addressing the state’s groundwater challenges and leveraging opportunities for sustainable management.

California’s groundwater occurs in a variety of geologic settings across the state, within basin and non-basin areas. The state’s 515 defined groundwater basins provide approximately 93% of the total groundwater used in the state, while the non-basin areas provide the remaining 7%. *CalGW Update 2025 Highlights* (this document) provides a concise summary of the State’s groundwater conditions and management, along with key findings and recommendations to support future management and protection of groundwater, while the *CalGW Update 2025* statewide report provides detailed information on the statewide and regional groundwater conditions and management activities, including the distinct conditions in non-basin areas and California’s 10 hydrologic regions (Figure H-9).

Figure H-9: Hydrologic Regions, Basin Areas, and Non-Basin Areas



A. Groundwater Occurrence

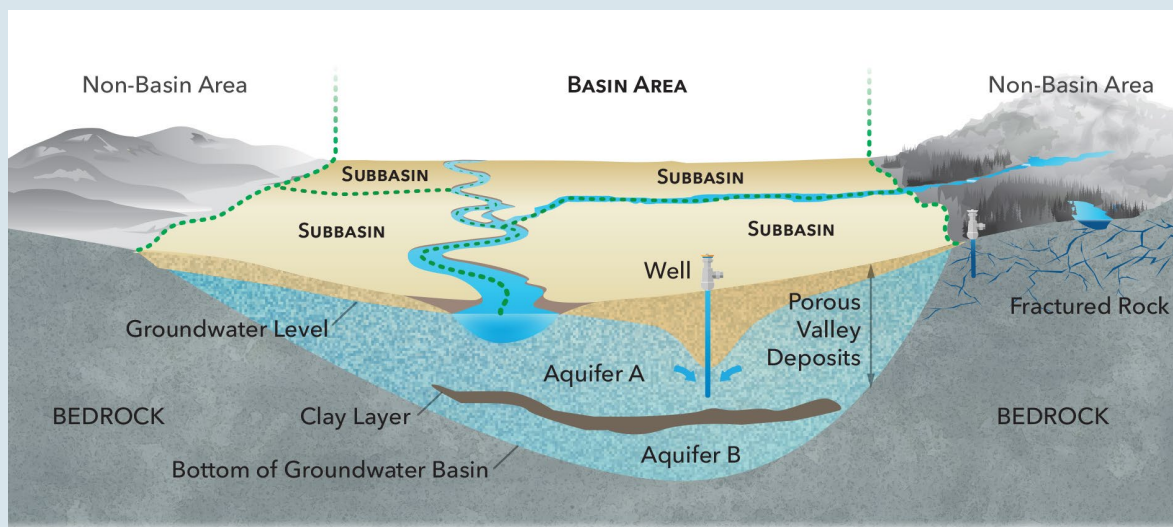
1. Groundwater Basins

The concept of a groundwater basin was first introduced around the turn of the 20th century at a time when California's population and agricultural industry were rapidly expanding and becoming more reliant on groundwater. In the state's groundwater basin areas, groundwater occurs in aquifers or stacked series of aquifers comprised of porous and permeable sediment and can yield significant quantities of groundwater to wells and springs (Figure H-10). Over the next half-century, the understanding of, and reliance on, groundwater basins in California increased, leading to the release of the first official list of groundwater basins in 1952 (California Department of Public Works 1952). Since then, DWR, working with other local, State, and federal agencies, has periodically updated the definitions, boundaries, and locations of California's groundwater basins in various updates of CalGW. Currently, there are 515 groundwater basins identified in California, which encompass almost 40 million acres, or more than 40% of the state's total land area. Approximately 82% of the state's population, and 97% of the state's agricultural lands, are in these groundwater basins.

What is a groundwater basin?

A groundwater basin is an "... aquifer or stacked series of aquifers with reasonably well-defined boundaries in a lateral direction, based on features that significantly impede groundwater flow, and a definable bottom . . ." - Title 23, Division 2, Chapter 1.5, Subchapter 1, Article 2, Section 341(g)(1) of the California Code of Regulations.

Figure H-10 Groundwater Basin and Aquifers



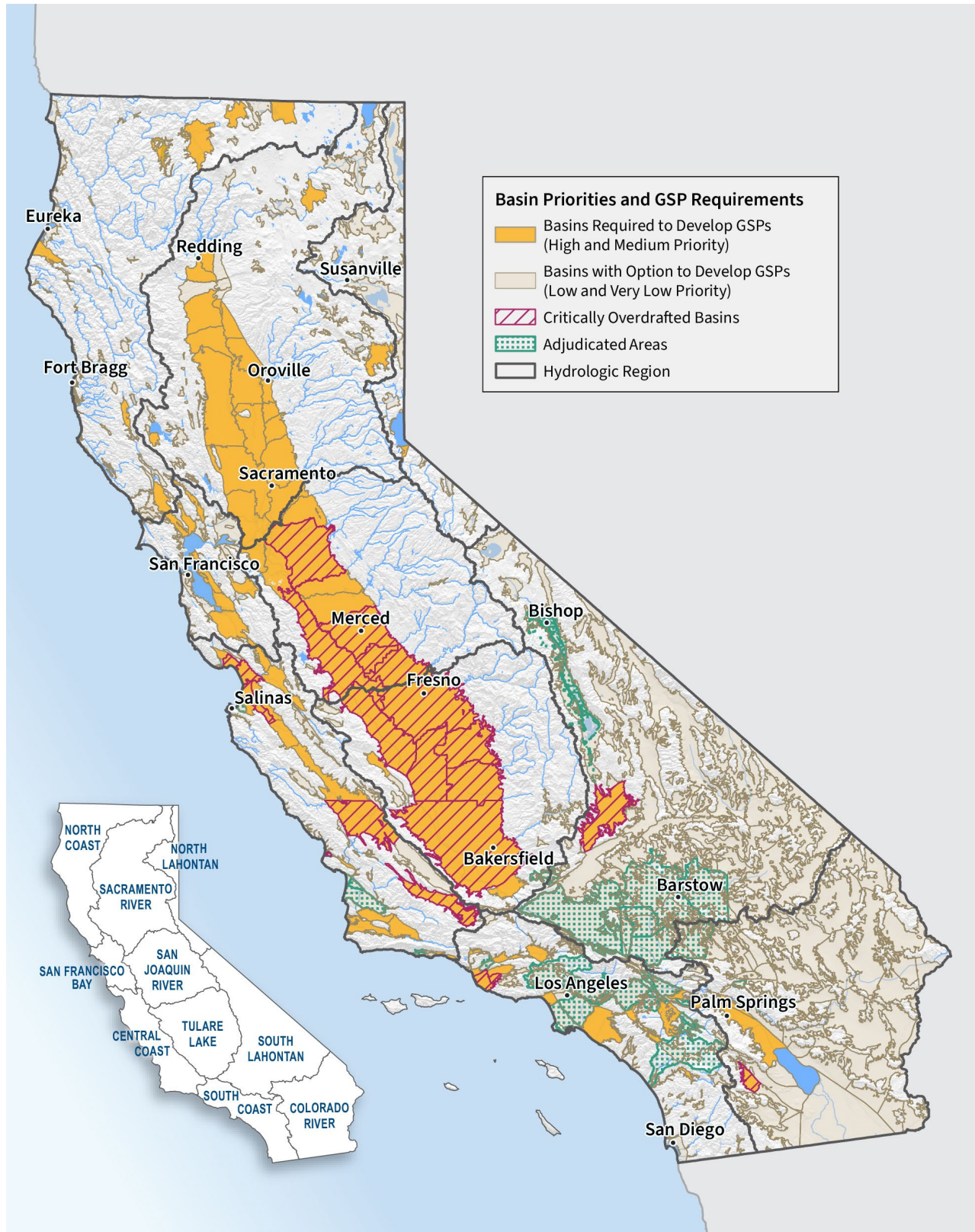
2. Groundwater Basin Prioritization

California's 515 groundwater basins are prioritized into one of four categories: high, medium, low, or very-low priority. Basin prioritization is a technical process that utilizes the best available data and information and considers several factors (e.g., current and projected population, number of wells, irrigated acreage, amount of groundwater used, degree of reliance on groundwater, and documented adverse impacts) to assign a priority. Ninety-four basins and subbasins were identified as medium- or high-priority; these basins are required to form GSAs and develop GSPs (or Alternative GSPs) in compliance with SGMA. The low- and very-low-priority basins are encouraged to form GSAs and develop GSPs, update existing groundwater management plans, or coordinate with others to develop a new groundwater management plan in accordance with Water Code Section 10750 et seq. (Figure H-11). The state's 30 adjudicated areas, mostly in Southern California, are not subject to SGMA requirements other than annual reporting and have existing court-mandated governance and oversight in place.

Key findings regarding the prioritized groundwater basins are:

- The 94 high- and medium- priority basins and adjudicated areas account for approximately 95% (20 million acre-feet) of the statewide total groundwater pumping of about 21 million acre-feet.
- Of the 94 high- and medium-priority basins, 21 are classified as basins subject to critical conditions of overdraft. Two of the critically overdrafted basins are also adjudicated basins.
- The 21 basins that are subject to critical conditions of overdraft cover almost one-fifth of the total groundwater basin area in the state and account for close to two-thirds of total groundwater pumping in the state in a typical year.

Figure H-11 Basin Priorities and GSP Requirements



3. Groundwater in Non-basin Areas

California's non-basin areas are defined as any area outside of a defined groundwater basin or subbasin and consist of impermeable granitic, metamorphic, volcanic, or sedimentary rocks, where groundwater is found in fractures or other voids. Non-basin areas are an integral part of the natural groundwater infrastructure. These areas are typically found in the mountains and foothills upgradient of, or adjacent to, groundwater basins and include many of California's national parks, forests, and other wildland areas. Forests are identified as an asset to help California's water systems adapt to climate change in more beneficial and durable ways than traditional human engineering. Upper watersheds, in general, are recognized as natural assets that are viable locations for multi-benefit water projects and large-scale habitat restoration efforts, which can build community and economic resilience. The enhanced characterization of the non-basin areas is explained in greater detail in the *Statewide Report*.

Key findings regarding California's non-basin areas are:

- Approximately 60% (62 million acres) of California's total land area is in non-basin areas. While the majority (53%) of domestic wells in California are in these areas, total groundwater extraction from all uses in non-basin areas accounted for about 7% (1.1 million acre-feet) of the state's average annual groundwater extraction during the three-year period from 2019-2021.
- Approximately 7.2 million people, 18% of the state's population, live in non-basin areas. Notably around 58% of California's disadvantaged and severely disadvantaged communities are also located in non-basin areas. (U.S. Census Bureau 2021).
- Many residents in non-basin areas rely on private groundwater wells as their primary source of water. In non-basin areas, 90% of wells are domestic wells, which are generally more vulnerable to water shortages during dry periods compared to those served by larger public water systems. Additionally, 68% of small water suppliers and self-supplied communities in the state, which are also at a higher risk of drought and water shortage vulnerability, are in non-basin areas.
- California has approximately 30 million acres of managed national parks, forests, and other wildland areas, 88% of which are in non-basin areas.

B. Groundwater Use

Groundwater is a vital part of California's water portfolio, providing about 40% of the state's total water supply during average years and nearly 60% in dry years (Figure H-1 above). Groundwater also supports ecosystems and perennial streams and provides substantial supplies to the state's wetlands.

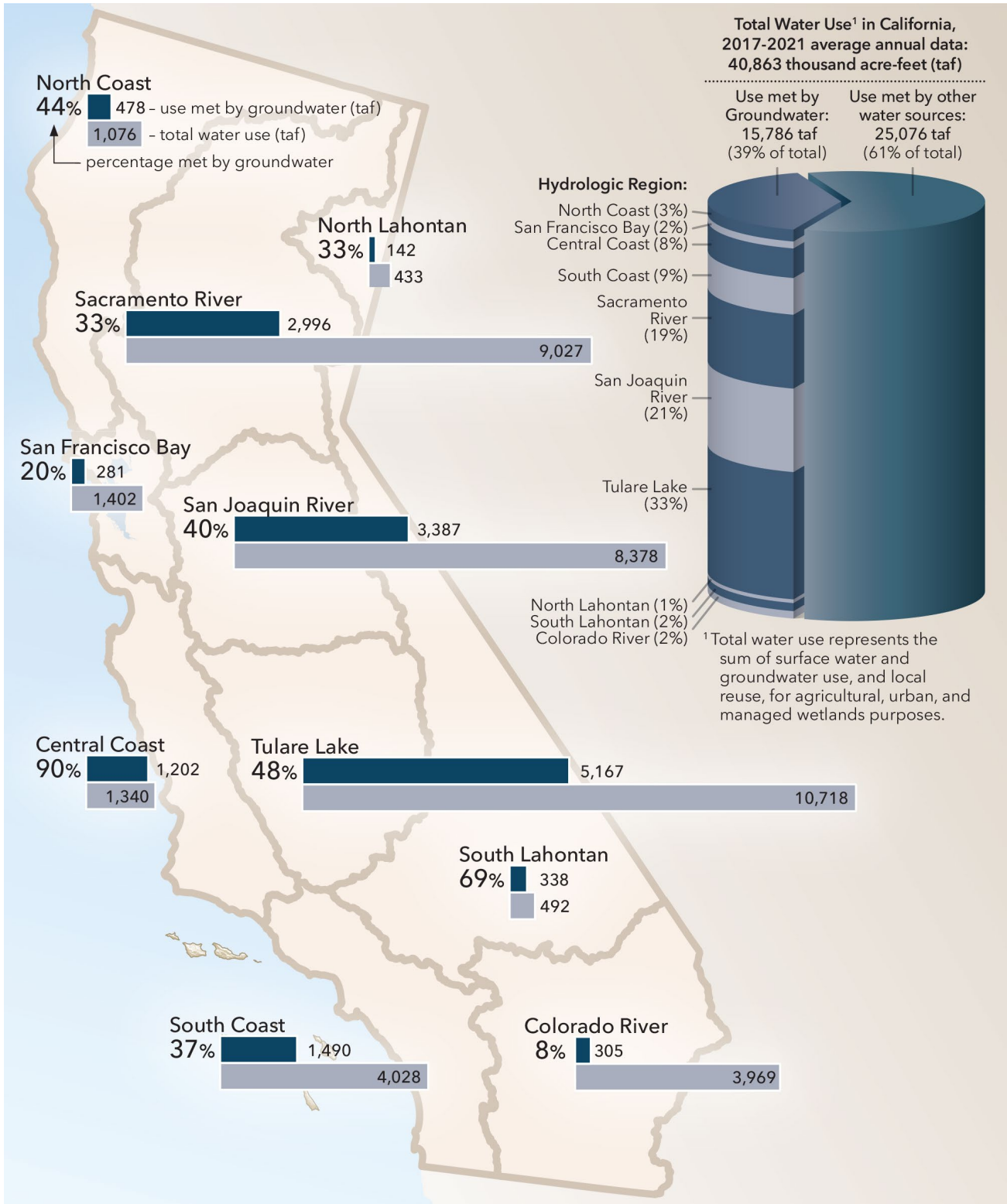
The distribution of groundwater use across the state's 10 hydrologic regions, which include both basin and non-basin areas, is highly variable (Figure H-12). Groundwater provides as

little as 8% of the Colorado River Hydrologic Region's water supply and as much as 90% of the Central Coast Hydrologic Region's water supply.

Key findings related to groundwater use in California are:

- Approximately 32.3 million Californians (82% of the state's population of 39.5 million) use groundwater for drinking water or other household uses. About 8.5 million Californians, mostly in small- to moderate-sized towns and cities, rely entirely on groundwater for their drinking water supplies.
- On average (2002-2021), 79% of the total groundwater use in the state each year is used for agricultural purposes, 19% for urban, and 2% for managed wetlands.
- Groundwater acts as a drought buffer and climate change adaptation strategy for California. It provided 58% of the total water supply to meet agricultural, urban, and managed wetland demands in 2015 at the height of the 2012-2016 drought, whereas the 2017-2021 average contribution from groundwater to the total water supply was 39%.
- During the 2017-2021 period, in the Tulare Lake Hydrologic Region, groundwater provided an average of 45% of the total managed wetlands water supply for the region.
- California currently estimates much of its groundwater use through land-use-based methods, including crop evapotranspiration, crop acreage, and known surface water deliveries. In 2021, an estimated 18.7 maf of groundwater extraction in medium and high priority basins was reported through GSP and Alternative annual reports. Of this total, 23.4% was directly measured using meters or electricity demand, and 76.6% was estimated indirectly. Increasing the use of direct measurement methods offers a valuable opportunity to improve accuracy, reduce uncertainty, and support more effective and sustainable groundwater management.

Figure H-12 Water Use by Hydrologic Region



C. Groundwater Monitoring

Monitoring is the backbone of sustainable groundwater management; without robust and timely data, effective decision-making is greatly hindered. Monitoring provides the data and insights necessary to assess basin conditions, detect potential problems, and respond to evolving challenges. In California, monitoring efforts span a wide array of groundwater components, including water levels, water quality, land subsidence, and seawater intrusion. The following sections describe the status of monitoring across these key components, underscoring their role in tracking progress toward groundwater sustainability under SGMA. It should be noted that while some indicators, such as groundwater elevations and subsidence, can be directly measured, others, including changes in groundwater storage and stream depletion, cannot be directly observed. These more complex indicators are quantified through numerical hydrologic models and integrated water budget analyses, both of which still require extensive data to produce meaningful and reliable insights.

1. Groundwater Level Monitoring

The collection and reporting of groundwater level data and the identification of seasonal and long-term trends are fundamental to assessing and sustaining California's groundwater resources. For decades, groundwater level monitoring efforts were limited and highly dispersed across the state. Legislatively mandated statewide programs aimed at groundwater monitoring began with the establishment of the California Statewide Groundwater Elevation Monitoring Program (CASGEM) in 2009 under Senate Bill X7-6. The SGMA, enacted in 2014, further mandated it as a key element of the development and implementation of GSPs. These legislative efforts have led to significant advancements in groundwater monitoring and data management across the state, as shown in Figure H-13.

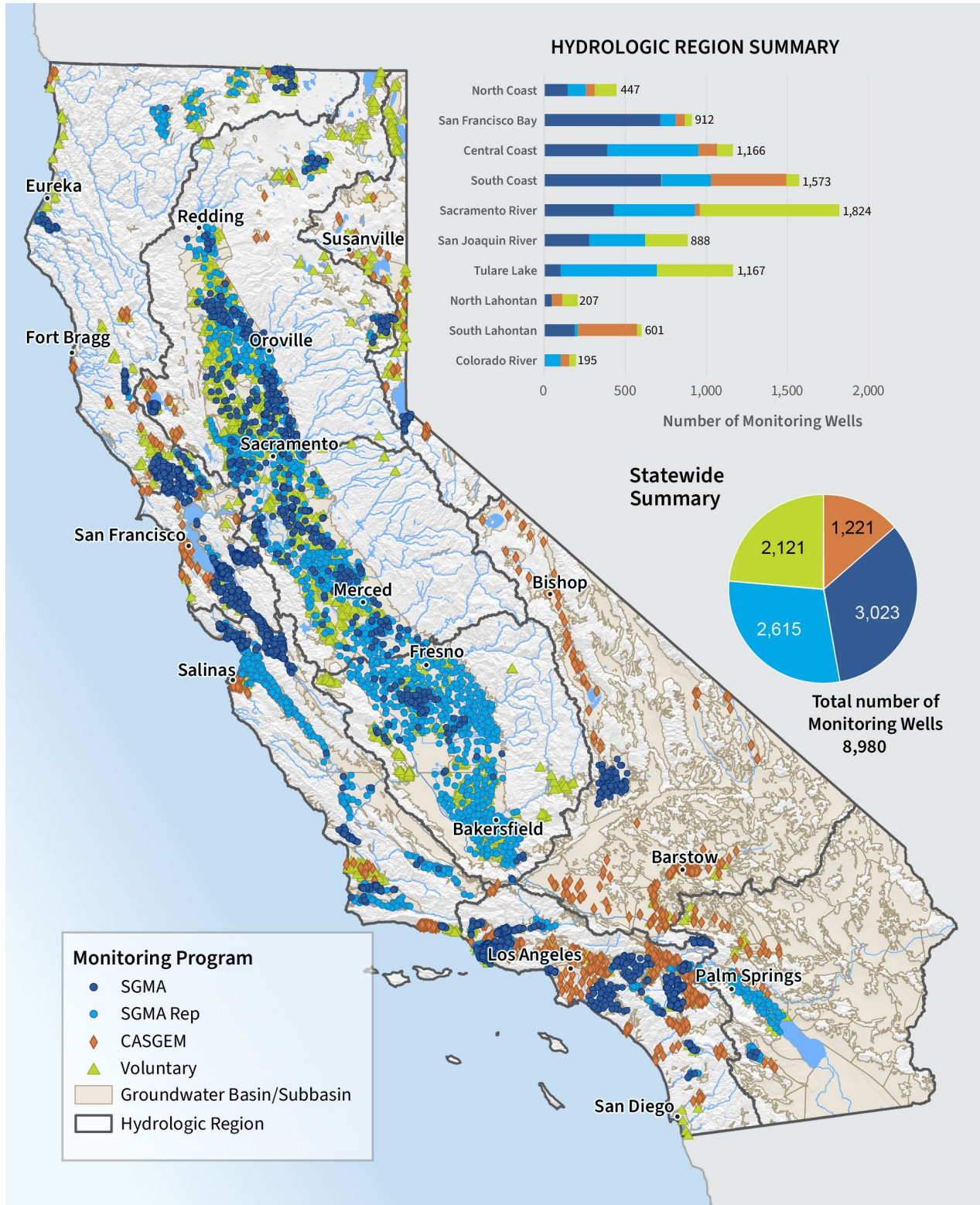
Key findings related to groundwater level monitoring are:

- Between 2019 and 2024, a total of 8,980 active groundwater level monitoring wells were recorded statewide, including 8,789 wells within groundwater basins and 191 wells in non-basin areas.
- The statewide monitoring network now includes 5,571 SGMA wells, of which 2,615 are designated as representative wells – those wells selected by local agencies to represent basin conditions being monitored under SGMA implementation. Additionally, 1,239 wells are part of the CASGEM program, and the remaining 2,298 wells come from other groundwater programs or voluntary submissions. This represents a shift from the CalGW Update 2020, prior to the development of GSPs, when most monitoring wells were classified under the CASGEM program.
- Groundwater monitoring efforts have steadily increased from Water Year (WY) 2019 to WY 2023, with semi-annual measurement remaining the most common frequency. In WY 2024, 29% of groundwater level measurements were submitted within 30 days of collection, up from 14% just six years ago in 2019. Additionally, continuous real-time

telemetered data, operated by DWR in coordination with the U.S. Geological Survey, was collected in 219 wells (2.5%) in WY 2024.

- Of the 8,980 monitoring wells, 1,175 (13%) have unknown or incomplete well construction information. Only 623 wells extend deeper than 1,000 feet, which limits the ability to assess conditions in deeper aquifers. On the other hand, 2,716 wells are shallower than 200 feet, limiting assessments of groundwater-dependent ecosystems, domestic well vulnerabilities, and interconnected surface water systems.

Figure H-1 Groundwater Level Monitoring Wells by Monitoring Program (Water Years 2019–2024)



2. Groundwater Quality Monitoring

Groundwater quality monitoring is essential for detecting and evaluating chemical concentrations in groundwater, assessing potential contamination risks, ensuring water safety for various uses, and supporting sustainable groundwater management by identifying trends and emerging water quality concerns. Groundwater quality monitoring is performed for many reasons and at thousands of locations throughout California.

The State Water Board and its Regional Water Quality Control Boards have the primary responsibility for monitoring and regulating groundwater quality in the state. They operate various programs to detect, evaluate, and remediate groundwater contamination. Groundwater quality monitoring data collected by the Water Boards are stored in the Groundwater Ambient Monitoring Assessment (GAMA) Geographic Information System (GIS) database, the largest groundwater quality monitoring repository in California. GAMA includes groundwater quality data from numerous regulatory and non-regulatory programs across the state, including DWR data from the Water Data Library. The U.S. Geological Survey and other federal agencies, as well as DWR, have separate groundwater quality databases. Local agency water quality monitoring networks and protocols also vary from one agency to another.

Through its Staff Report determinations and consultation meetings, DWR has encouraged GSAs to collaborate and coordinate with the appropriate groundwater users, water quality regulatory agencies, and existing programs in their basins to understand and develop a process for determining if groundwater management and extraction have the potential to cause or is causing degraded water quality. Figure H-14 shows the statewide distribution of groundwater quality monitoring wells in the local monitoring network module of GSPs and alternatives to GSPs.

Figure H-14 Groundwater Quality Monitoring Wells Available in the Monitoring Network Module for GSPs and Alternatives

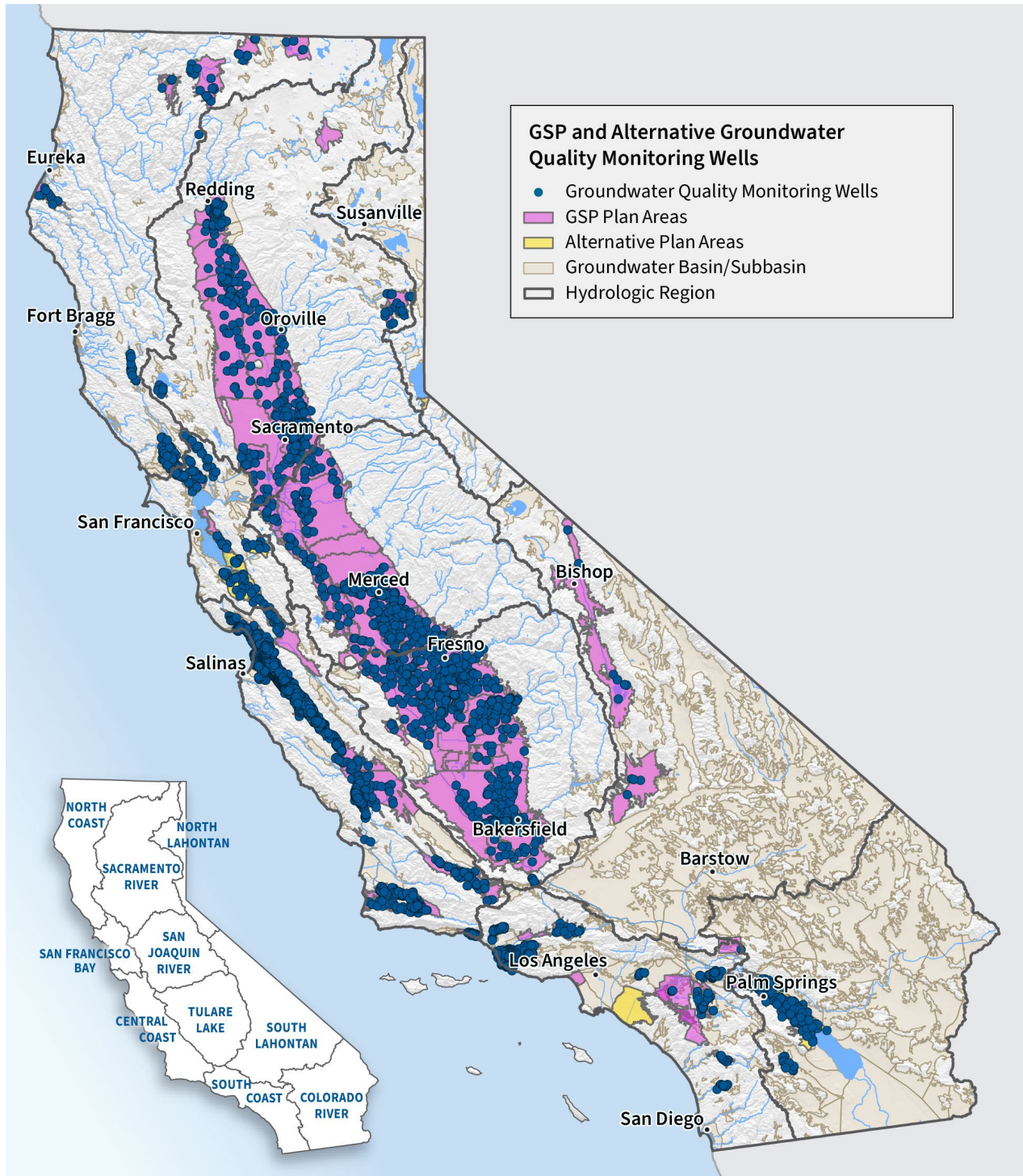


Figure H-14 Note: Monitoring wells for the GSP Monitoring Network Module as of July 2024, which includes some alternatives to GSPs (Alternatives). Some networks were provided to DWR directly as part of outreach in August 2024.

Key findings regarding groundwater quality monitoring are:

- The GAMA dataset includes 33,922 wells used in the groundwater quality analysis for CalGW Update 2025 – a 21% increase compared to CalGW Update 2020.
- Of these wells, 82% are located within groundwater basin areas, while the remaining 18% are in non-basin areas.

3. Land Subsidence Monitoring

Land subsidence is the gradual settling or sudden sinking of the Earth's surface, most commonly caused by the compaction of fine-grained sediments, such as clay, as groundwater, oil, and gas are withdrawn, reducing pore pressure and leading to the loss of support for the overlying materials. Subsidence monitoring has been conducted sporadically since the 1950s in select locations across the state. Due to advances in technology, such as satellite imagery and remote sensing, land subsidence monitoring coverage has expanded significantly since the 1990s. During this time, satellite-based remote sensing using InSAR emerged as a key method for detecting ground surface deformation. In 2019, DWR began providing public access to monthly statewide InSAR-based land subsidence data. Repeated light detection and ranging (LiDAR) is also employed to measure changes in the ground surface elevations. Figure H-15 displays the distribution of Global Positioning System (GPS) stations, InSAR data coverage, borehole extensometers, and regional subsidence networks. A more comprehensive description of subsidence networks is provided in the *Statewide Report*.

Key findings related to subsidence monitoring are:

- Since the 2020 CalGW Update, the frequency of publicly available InSAR data has increased, with updates now released on a quarterly basis.
- In 2023, DWR began enhancing California's subsidence monitoring network by installing Continuous GPS (CGPS) stations in groundwater basins; eight are currently installed and operational, with additional installations planned to improve real-time tracking of ground surface displacement. In addition, data from CGPS stations maintained by others are made available in DWR's SGMA Data Viewer.
- While subsidence monitoring frequency has improved through the availability of telemetered data from extensometer sites, and CGPS stations, as well as statewide monthly InSAR data, groundwater levels are only collected semi-annually and reported after 30 days of collection for most monitoring sites, which is insufficient to support adaptive subsidence management.

Figure H-15 Distribution of Continuous GPS Stations, Borehole Extensometers, InSAR Data Coverage, and Selected Regional Subsidence Networks

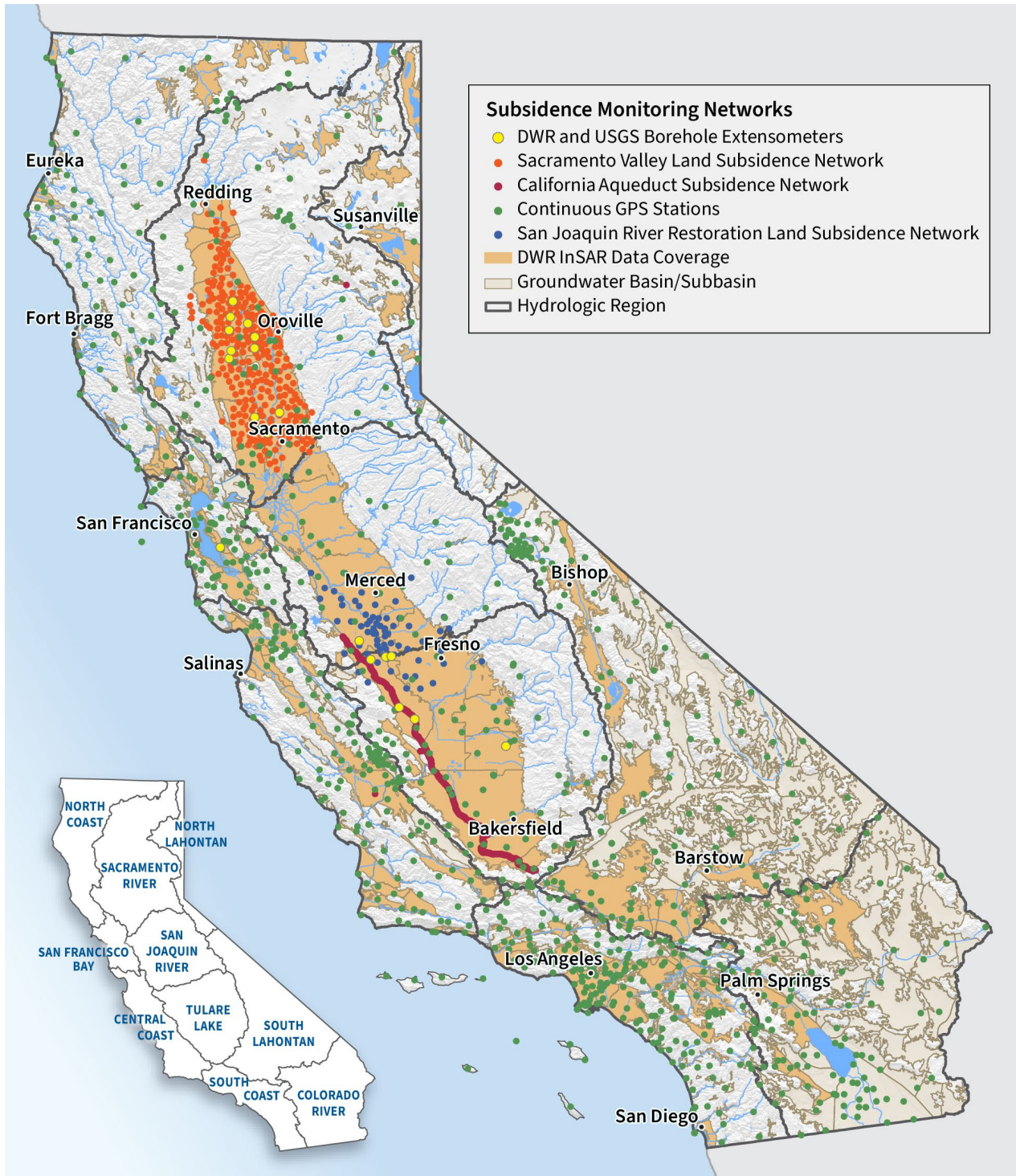


Figure H-15 Note: GPS = global positioning system, InSAR = interferometric synthetic aperture radar.

4. Seawater Intrusion Monitoring

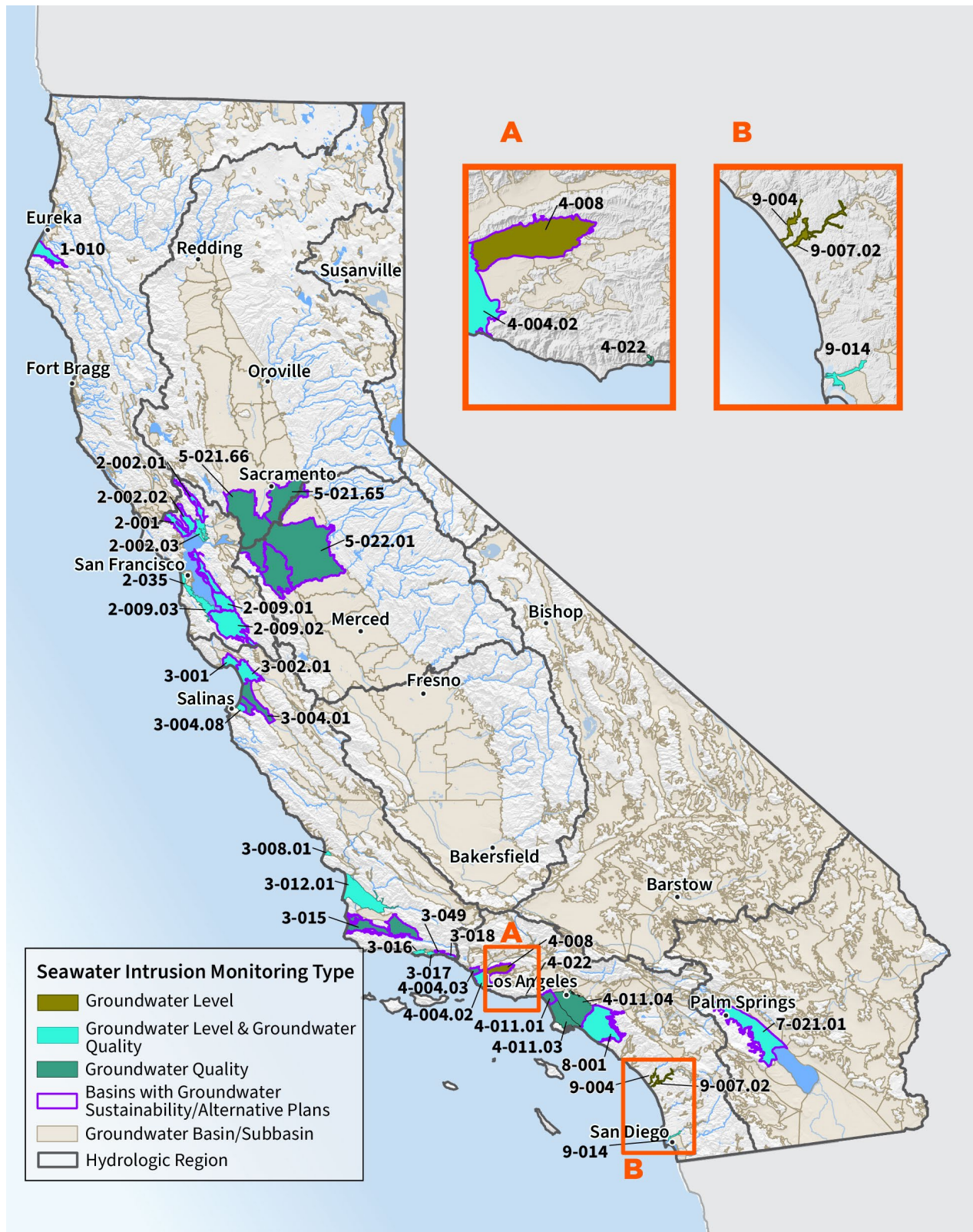
Seawater intrusion refers to the shoreward and inland migration of the seawater front, also referred to as the saline front, which is the natural interface between fresh groundwater and seawater within an aquifer. This inland migration of seawater can be driven by both natural processes and anthropogenic (human-caused) activities that impact the hydraulic gradient of coastal aquifers. As fresh groundwater storage within these coastal aquifers decreases, seawater can migrate landward, potentially compromising the quality and reliability of fresh groundwater supplies in the affected coastal communities.

Water quality constituents that are commonly used to monitor seawater intrusion include total dissolved solids (TDS) and chloride, as their concentrations differ significantly between freshwater and seawater, making seawater intrusion clearly detectable in groundwater samples. DWR compiled available data on seawater intrusion monitoring in coastal basins (Figure H-16), which highlights significant data gaps in seawater intrusion monitoring across several coastal groundwater basins, particularly in areas with low population density, impaired aquifers, or limited reliance on groundwater. These gaps hinder effective management and forecasting of potential impacts to water quality and beneficial uses. Routine monitoring through a dedicated seawater intrusion well network is essential to support local water managers and protect coastal groundwater resources from degradation.

Key findings related to seawater intrusion monitoring are:

- The large disparity of concentrations of TDS and chloride between freshwater and seawater makes groundwater quality analysis a functional method to determine the occurrence, extent, and timing of seawater intrusion.
- Monitoring for seawater intrusion has occurred in 36 coastal basins since 2011. Groundwater quality has been analyzed to monitor seawater intrusion in 33 (92%) of those basins.
- DWR's recent compilation reveals significant data gaps in seawater intrusion monitoring across some coastal groundwater basins, underscoring the need for routine monitoring to support informed water management and protect against water quality degradation.

Figure H-16 Groundwater Basins with Seawater Intrusion Monitoring



D. Groundwater Conditions by Sustainability Indicators of SGMA

The state of groundwater conditions as of December 2024 is summarized below through the lens of SGMA's six sustainability indicators, incorporating both recent observations and long-term trends. These six sustainability indicators are: (1) lowering of groundwater levels; (2) changes in groundwater storage; (3) degraded water quality; (4) land subsidence; (5) seawater intrusion; and (6) surface water depletion. Indicators such as groundwater levels, water quality, land subsidence, and seawater intrusion are supported by expansive monitoring networks, while changes in groundwater storage and depletions of interconnected surface water (ISW) generally rely on modeling and indirect estimation.

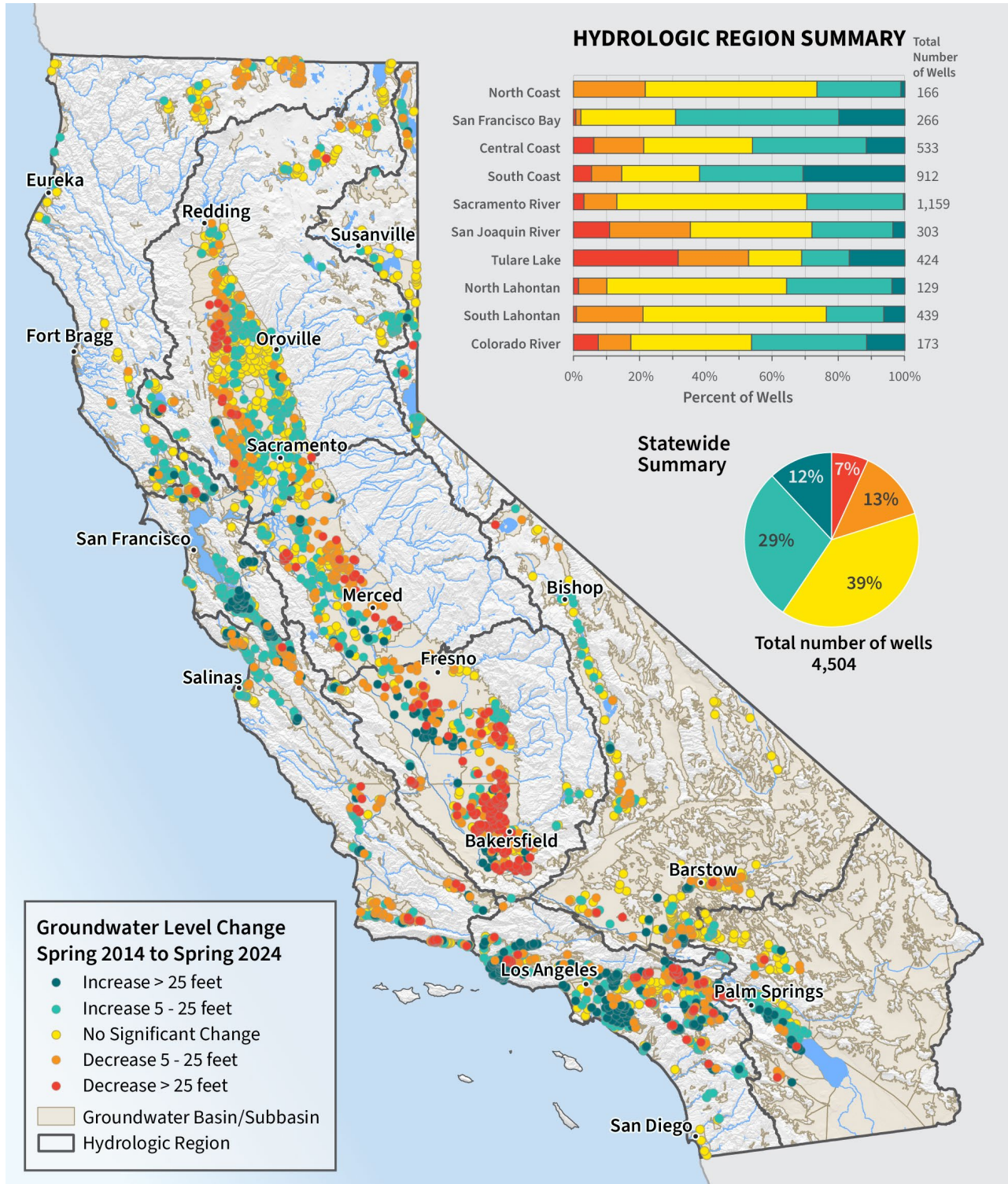
1. Lowering of Groundwater Levels

As discussed in the previous section, groundwater levels are measured from a wide range of wells across the state. These measurements include data collected directly by DWR as well as data reported to DWR by CASGEM Monitoring Entities, GSAs, and other local agencies. Changes in groundwater levels reflect variations in groundwater storage over time and are influenced by multiple factors, including pumping volumes and precipitation patterns.

Key findings related to the lowering of groundwater levels are:

- A trend analysis of the groundwater elevations data for the 10-year period from 2014 to 2024 indicates that approximately 41% of wells statewide demonstrated an increasing trend of 5 feet or more, with approximately 20% a neutral trend (change less than +/- 5 feet), and approximately 39% a decreasing trend of more than 5 feet. (Figure H-17)
- A trend analysis of the groundwater elevation data for the 20-year period from 2004 through 2024 indicates that approximately 51% of wells statewide demonstrated a decreasing trend in groundwater elevations, with approximately 41% a neutral trend, and approximately 8% an increasing trend.
- During the drought in California from 2020 to 2022, reduced precipitation resulted in high groundwater demand due to low surface water availability. When comparing fall 2022 groundwater levels to average statewide conditions, 60% of wells were below average.
- Following a wet year in 2023, with flooding in the southern Central Valley, and a normal year in 2024, reduced groundwater demand allowed for increased recharge, with 42% of spring 2024 groundwater levels statewide classified as above normal.
- Despite increased groundwater levels following a wet 2023 and a normal 2024, with 42% of spring 2024 groundwater levels above normal from the prior year, overall levels remain below pre-2020-2022 drought conditions, with 26% of wells statewide showing a five-year decline.

Figure H-17 Ten-Year Changes in Groundwater Levels (Spring 2014 to Spring 2024)



2. Changes in Groundwater Storage

Groundwater storage in California has been in decline in various parts of the state, with the most prominent decline occurring in the Central Valley. Long-term estimates for changes in groundwater storage in the Central Valley are available for three methods (Figure H-18), as described in the *Statewide Report*. All methods show a net decrease in groundwater storage over the respective geographic areas and time frames they cover: approximately 21 maf between 2006 and 2024 using the DWR Groundwater Level Method, 26 maf between 2006 and 2021 using the DWR C2VSim-FG model, and 54 maf between 2006 and 2023 using the NASA Gravity and Climate Experiment (GRACE) data. Variance in the estimated change in groundwater storage is attributed to the differences in the estimation methods and the area covered by these estimates. Although these estimates differ, the trend of decreasing groundwater storage is consistent and significant with all methods. During the 19 years from 2006 to 2024, there were 10 drought years, which led to increased demand for groundwater and subsequent declines in groundwater storage, while non-drought years saw only limited increases in groundwater levels.

An examination of the post-SGMA period suggests that groundwater storage trends may be stabilizing or even slightly positive, as indicated by the results from DWR's Groundwater Level and NASA's satellite-based GRACE methods. These patterns highlight the significant impact that hydrologic conditions and pumping behavior have on basin recovery. The very wet conditions of 2023 in the San Joaquin Valley, combined with the widespread availability of surface water, led to a substantial reduction in groundwater pumping. When surface supplies are abundant and regional pumping decreases, measurable gains in groundwater storage can be achieved, underscoring the importance of managing conjunctive use to support long-term sustainability.

Figure H-18 Estimated Cumulative Change in Groundwater Storage Using DWR Groundwater Level Method, DWR C2VSim-FG, and NASA GRACE Program Data (in Thousand Acre-Feet)

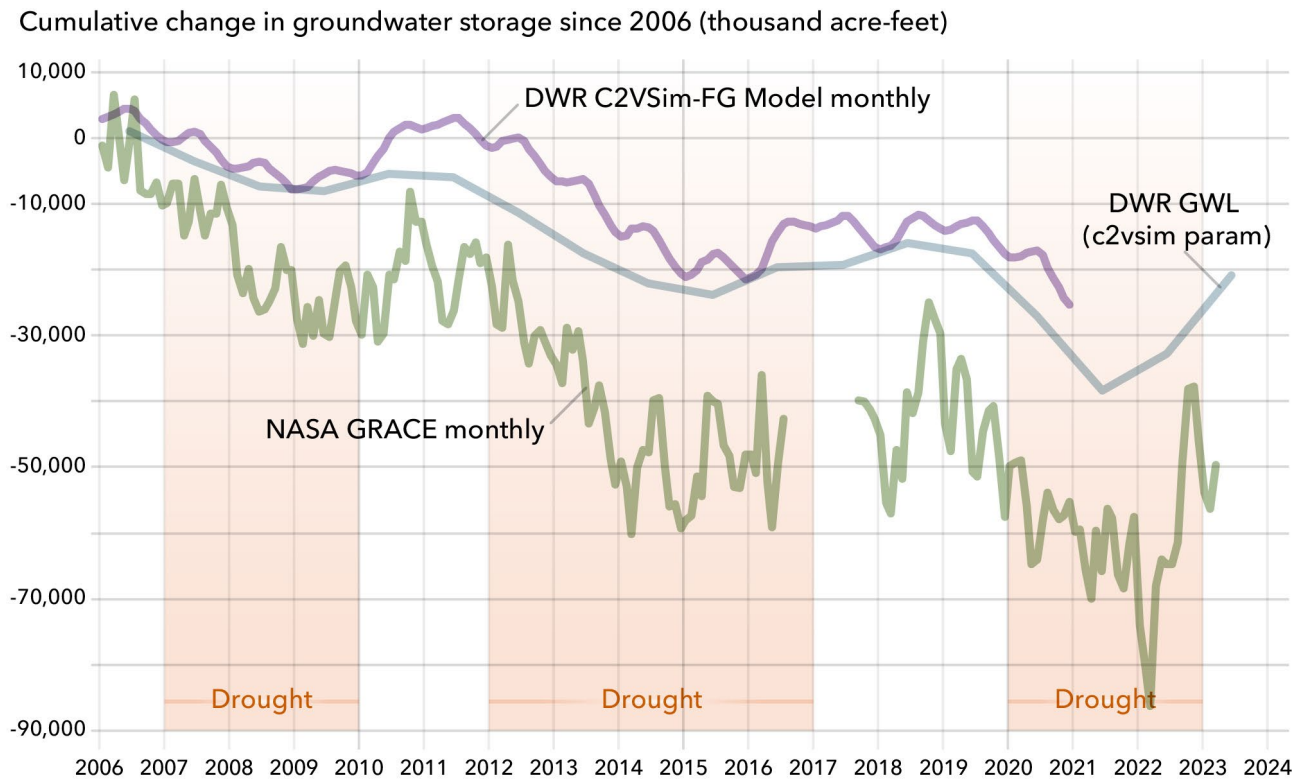


Figure H-18 Notes: GRACE and C2VSim-FG methods show cumulative data for a monthly timestep analysis. DWR GWL (c2vsim param) method shows cumulative data for an annual timestep, based on a spring-to-spring analysis. Estimates provided for geographic areas covered by the analyses, as defined in Chapter 6.

Trends in Annual Groundwater Storage Changes (WY 2019-2023)

Annual change estimates from SGMA-required reports offer important insights into recent groundwater storage trends across the Central Valley. These reports, submitted by GSAs, were required beginning in 2020 for critically overdrafted basins (starting with WY 2019 data) and in 2022 for the remaining basins (starting with WY 2021 data). The estimates provided in these annual reports were prepared using a variety of methods, including groundwater level analysis developed by local agencies, numerical models such as C2VSim-FG or other models, and combinations of these or other approaches. The key patterns observed from SGMA annual reports in three major hydrologic regions during WYs 2019-2023 are summarized below, along with estimates from two of the other methods described above.

Sacramento River Hydrologic Region

Groundwater storage in this region fluctuated over the period, with modest gains in WY 2019 followed by significant declines during the 2020-2022 drought years (Figure H-19). A rebound was observed in WY 2023. The SGMA annual report data suggest an overall net loss by 2023, consistent with estimates from other methods described above.

Figure H-19 Cumulative Change in Groundwater Storage for the Sacramento River Hydrologic Region Using Various Methods (in Thousand Acre-Feet)

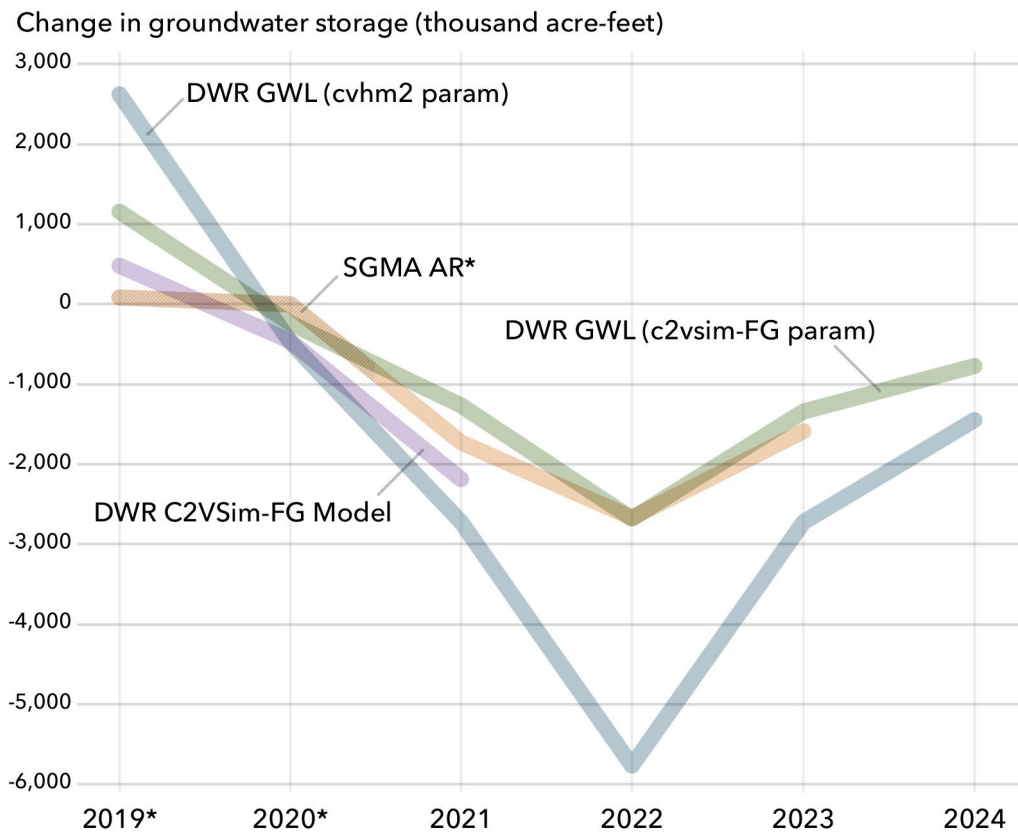


Figure H-19 Notes: SGMA annual reports and C2VSim-FG methods show water year estimates; DWR GWL methods show spring-spring annual estimates. SGMA annual report estimates for WY 2019 and WY 2020 reflect partial data, covering groundwater storage data for the North Yuba and South Yuba subbasins only.

San Joaquin River Hydrologic Region:

This region showed sharp declines in groundwater storage between WYs 2020 and 2022, especially during the driest years (Figure H-20). Despite some recovery in WY 2023, cumulative storage remained in deficit. SGMA data broadly align with other model-based estimates, reinforcing the severity of depletion during drought.

Figure H-20 Cumulative Change in Groundwater Storage for the San Joaquin River Hydrologic Region Using Various Methods (in Thousand Acre-Feet)

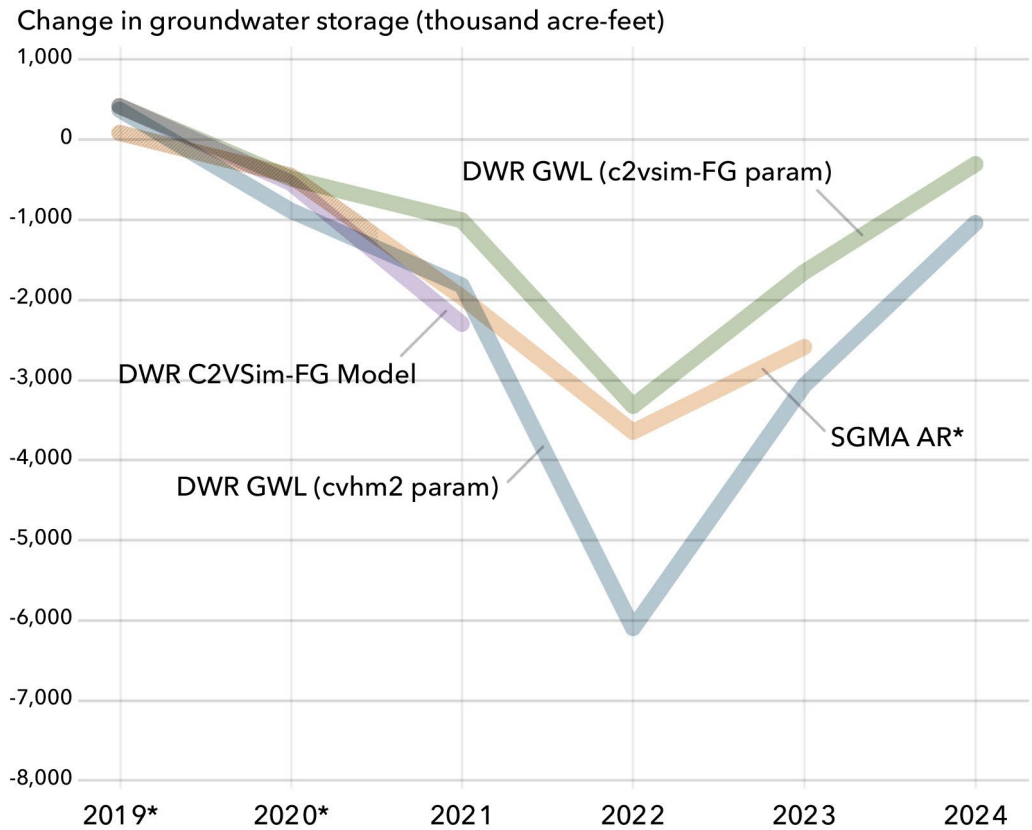


Figure H-20 Notes: SGMA annual reports and C2VSim-FG methods show water year estimates; DWR GWL methods show spring-spring annual estimates. SGMA annual report estimates for WY 2019 and WY 2020 reflect partial data, covering groundwater storage data for critically overdrafted basins only.

Tulare Lake Hydrologic Region:

Among the three regions, Tulare Lake exhibited the most pronounced fluctuations in groundwater storage. While WY 2019 saw a notable storage gain, the following three years brought steep storage losses, particularly in WYs 2021 and 2022 (Figure H-21). A substantial rebound occurred in WY 2023, but cumulative deficits remained significant. Variations in results among estimation methods highlight the region’s complex hydrogeology and sensitivity to drought-recovery cycles.

Figure H-21 Cumulative Change in Groundwater Storage for the Tulare Lake Hydrologic Region Using Various Methods (in Thousand Acre-Feet)

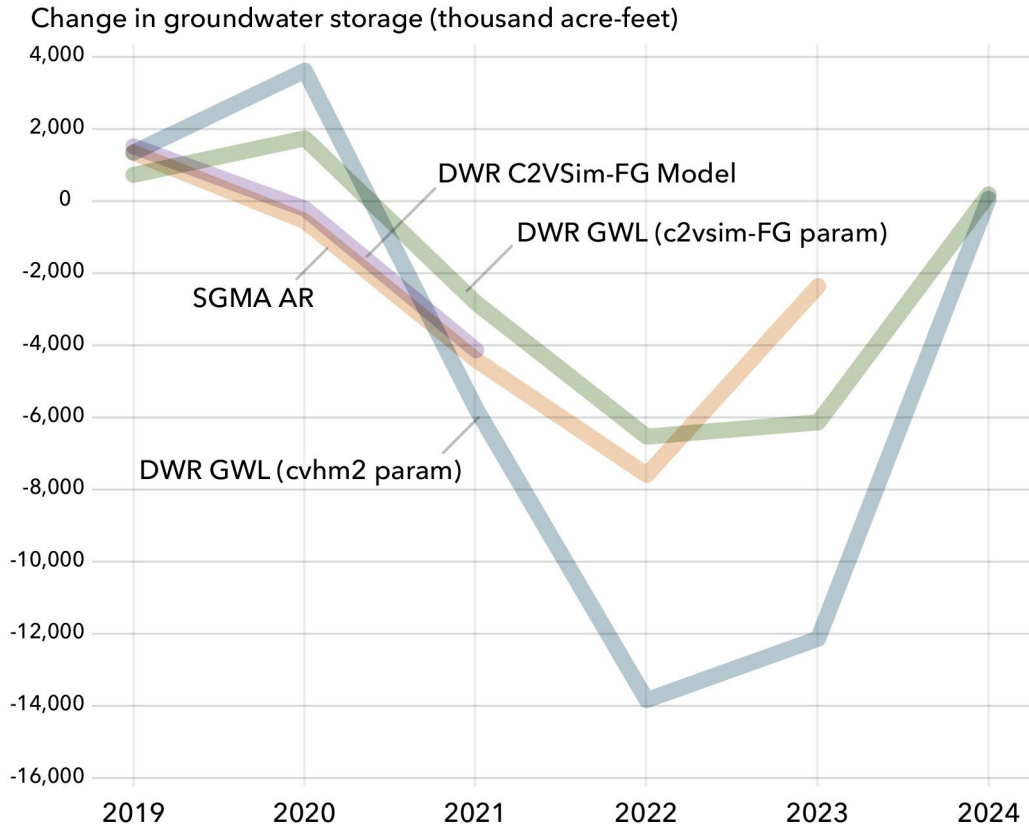


Figure H-21 Note: SGMA annual reports and C2VSim-FG methods show water year estimates; DWR GWL methods show spring-spring annual estimates.

These trends underscore the importance of robust annual reporting and multi-method comparisons to support adaptive management under SGMA. Figures accompanying this summary provide visual comparisons of annual changes across all methods.

Key findings related to changes in groundwater storage are:

- From 2006 through 2024, there was an average annual reduction of 900 thousand acre-feet (taf) to 2,100 taf in the Central Valley, with almost 50% of the reduction occurring in the Tulare Lake Hydrologic Region.
- Central Valley groundwater storage has experienced significant fluctuations in recent years, reflecting the impacts of drought and subsequent partial recovery. From WY 2019 to WY 2024, groundwater storage initially increased, followed by substantial

declines during the drought years of 2020-2022, with some recovery observed in WY 2023 and WY 2024.

3. Degraded Water Quality

Groundwater quality varies greatly in California’s groundwater basins because of a broad range of natural and anthropogenic influences. According to the State Water Board’s 2024 *Annual Compliance Report*, there are 385 public water systems that had one or more violations of a maximum contaminant level (MCL) or a treatment technique (TT) outlined in the Safe Drinking Water Act.

Groundwater quality information available from the State Water Board GAMA Program’s groundwater information system was used to summarize raw groundwater quality conditions in California, as presented below. Data from water quality monitoring stations were queried from October 2013 through September 2023. Statewide results are presented in Figure H-22 with reference to the MCL or secondary MCL (SMCL) for eight common constituents of concern selected based on known toxicity. They are: 1,2,3-trichloropropane (1,2,3-TCP), nitrate as nitrogen (NO₃N), arsenic (As), uranium (U), hexavalent chromium (Cr(VI) or Cr6), total dissolved solids (TDS), perfluorooctanoic acid (PFOA), and perfluorooctane sulfonate (PFOS).

Figure H-22 Statewide Water Quality Summaries for Eight Constituents of Concern

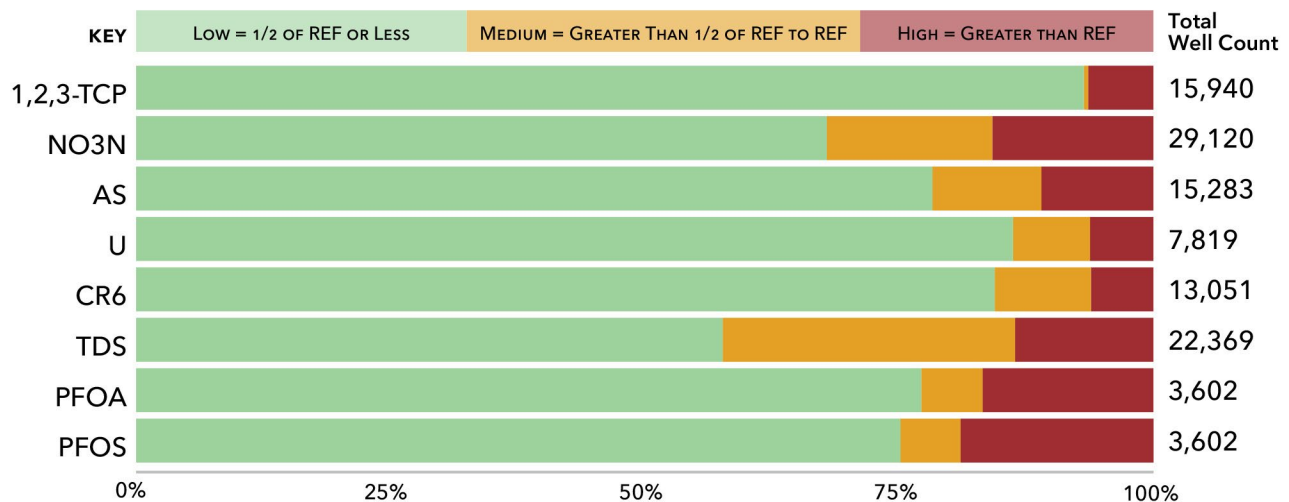


Figure H-22 Note: Reference concentration (REF) refers to Maximum Contaminant Levels (MCLs), Secondary MCLs, and Notification Levels, defined by the USEPA or State Water Resources Control Board.

Key findings based on 10-year groundwater quality monitoring data from water years 2014 to 2023:

- Wells with 1,2,3-TCP concentrations above the MCL were identified in all hydrologic regions. The greatest percentage of wells above the MCL was in the Tulare Lake, San Joaquin River, and South Coast hydrologic regions.

- Wells with nitrate as nitrogen concentrations above the MCL were identified in all hydrologic regions. The greatest percentage of wells above the MCL was in the Tulare Lake, San Joaquin River, Central Coast, and South Coast hydrologic regions.
- Wells with arsenic concentrations above the MCL were identified in all hydrologic regions. The greatest percentage of wells above the MCL was in the South Lahontan, North Lahontan, and San Joaquin River hydrologic regions.
- Wells with uranium concentrations above the MCL were identified in all hydrologic regions except the North Coast and San Francisco Bay. The greatest percentage of wells above the MCL was in the North Lahontan, San Joaquin River, and South Lahontan hydrologic regions.
- Wells with total dissolved solids (TDS) concentrations above the SMCL were identified in all hydrologic regions. The greatest percentage of wells above the SMCL was in the Central Coast, South Coast, and San Francisco Bay hydrologic regions.
- Wells with hexavalent chromium concentrations above the MCL were identified in all hydrologic regions. The greatest percentage of wells above the MCL was in the Colorado River, Sacramento River, Central Coast, and South Lahontan hydrologic regions.
- Wells with perfluorooctanoic acid concentrations above the notification level (NL) were identified in all hydrologic regions except the Colorado River. The greatest percentage of wells above NL was in the South Coast, Sacramento River, and Central Coast hydrologic regions.
- Wells with perfluorooctane sulfonate concentrations above the NL were identified in all hydrologic regions except the Colorado River. The greatest percentage of wells above the NL was in the South Coast, San Francisco Bay, and Sacramento River hydrologic regions.
- No PFOA or PFOS data were available for non-basin areas in the Colorado River hydrologic region.
- Nitrate, total dissolved solids (TDS), and arsenic were the most commonly reported constituents in GSPs and alternatives to GSPs, with exceedances more frequent in SGMA-regulated basins, particularly in the Tulare Lake hydrologic region, highlighting the importance of locally tailored water quality monitoring to support sustainable groundwater management.

4. Land Subsidence

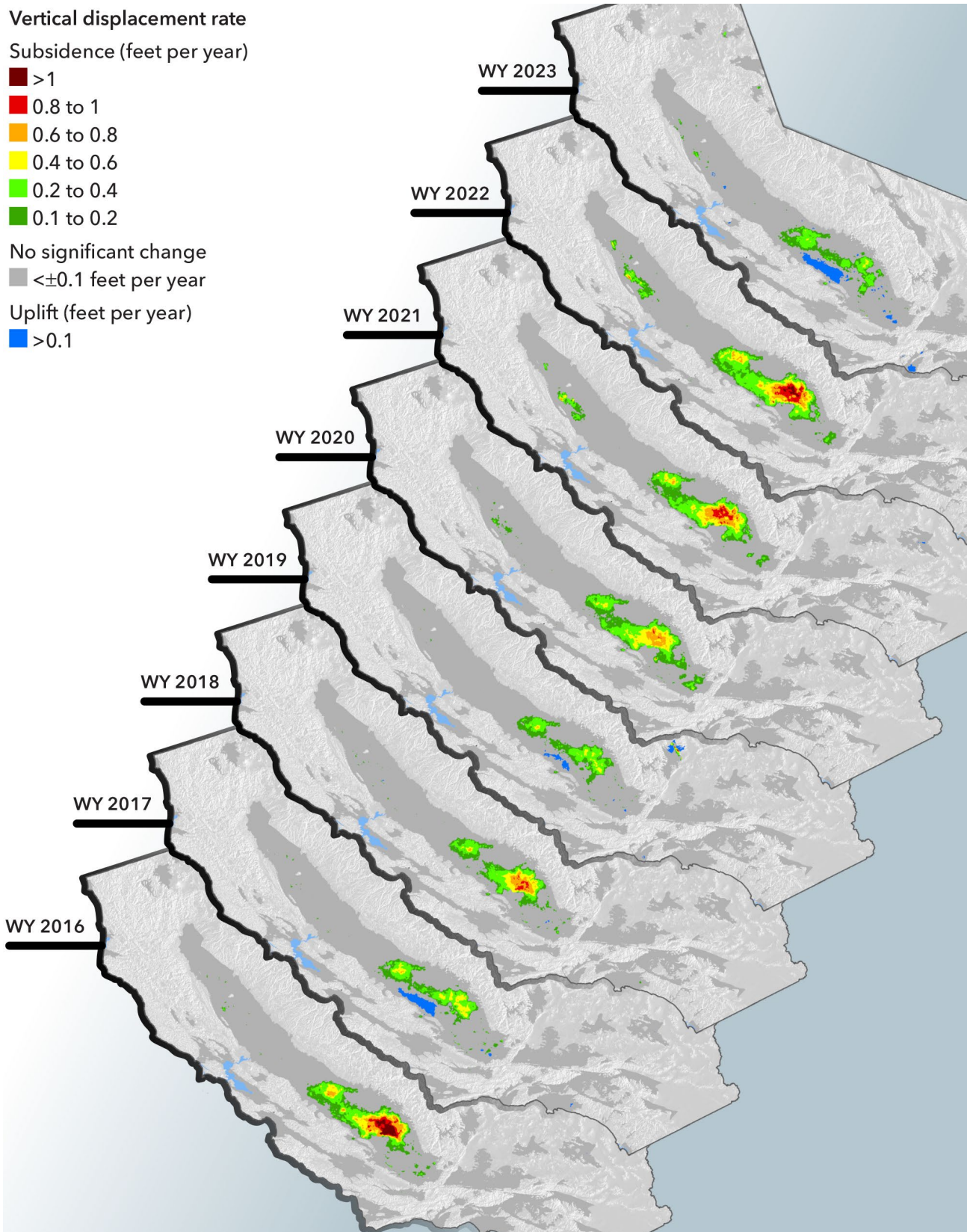
Land subsidence caused by excessive groundwater pumping has historically occurred and continues to occur in portions of the Central Valley and several smaller basins throughout California. Portions of the Central Valley have been experiencing land subsidence at differing rates since the 1920s. Some areas are estimated to have subsided as much as 28 feet (Faunt et al. 2016).

Figure H-23 shows InSAR data of annual subsidence rates for WY 2016 through WY 2023. This time span represents a period of five below-average (dry/drought) years and three above-average (wet) years. WY 2016 was the last year of the 2012-2016 drought, a period in which roughly 90% of California experienced severe drought conditions.

Key findings regarding land subsidence conditions are:

- During the recent five years (WY2019 to 2023), about 4,000 square miles in the state exhibited land subsidence exceeding 0.5 feet, with a majority of that subsidence, particularly subsidence greater than two feet, occurring in the Tulare Lake hydrologic region. The maximum land subsidence in the state remained less than 4 feet, but about 113 square miles of area exhibited land subsidence of more than 3 feet.
- Uplift exceeding 0.5 feet was observed across 29 square miles of the Indian Wells Valley subbasin, resulting from the magnitude 6.4 and 7.1 Ridgecrest earthquakes in July 2019.
- Areas of active land subsidence between 0.5 foot and two feet were observed in the Sacramento River, San Joaquin River, and Tulare Lake hydrologic regions.
- Reduced surface water availability during the 2020-2022 drought led to increased groundwater pumping, resulting in increased subsidence rates, greater than 1 foot per year, in parts of the Central Valley.
- Annualized surface displacement maps highlight that subsidence intensifies during dry years due to increased groundwater pumping and lessens in wet years with recharge. Despite recent improvements, over 50% of wells in the San Joaquin River and Tulare Lake hydrologic regions remained below normal in Spring 2024, indicating groundwater levels have not fully recovered and subsidence risk persists.
- A rapid recovery of groundwater level in the aquifer substantially above the point where subsidence would occur in fine-grained units (i.e. critical head) can provide the best chance at minimizing ongoing subsidence. For additional information, see Appendix I of CalGW Update 2025 and DWR's Subsidence Best Management Practice released in 2026.

Figure H-23 Annual InSAR Land Subsidence Data (Water Years 2016–2023)



5. Seawater Intrusion

Seawater intrusion is the process of the natural seawater-freshwater interface migrating toward a groundwater basin because of changes in the hydraulic gradient in the basin that can be caused by groundwater extraction. California has 98 groundwater basins adjacent to the ocean, a bay, or a delta where fresh groundwater interacts with seawater. This interaction of fresh groundwater with seawater typically creates a saltwater wedge due to differences in density between the two water types. Seawater intrusion results in higher TDS levels and corresponding negative water quality impacts.

DWR reviewed available literature and data for coastal groundwater basins to identify basins that have or had experienced seawater intrusion, are susceptible to seawater intrusion, and have projects or management actions to mitigate seawater intrusion. The recent status of seawater intrusion for each reviewed coastal basin is shown in Figure H-24 to H-25.

Figure H-24 Status of Seawater Intrusion in Groundwater Basins

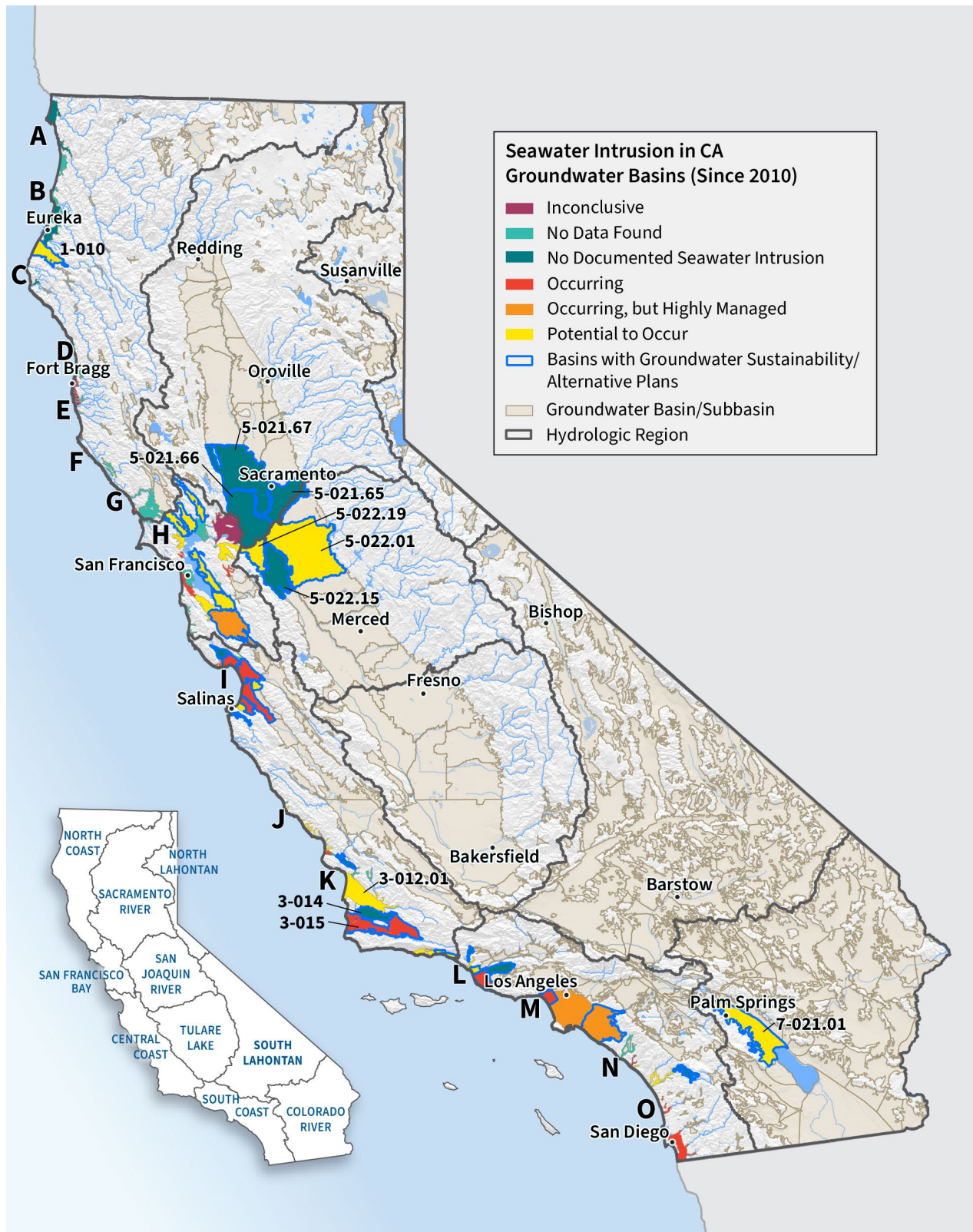
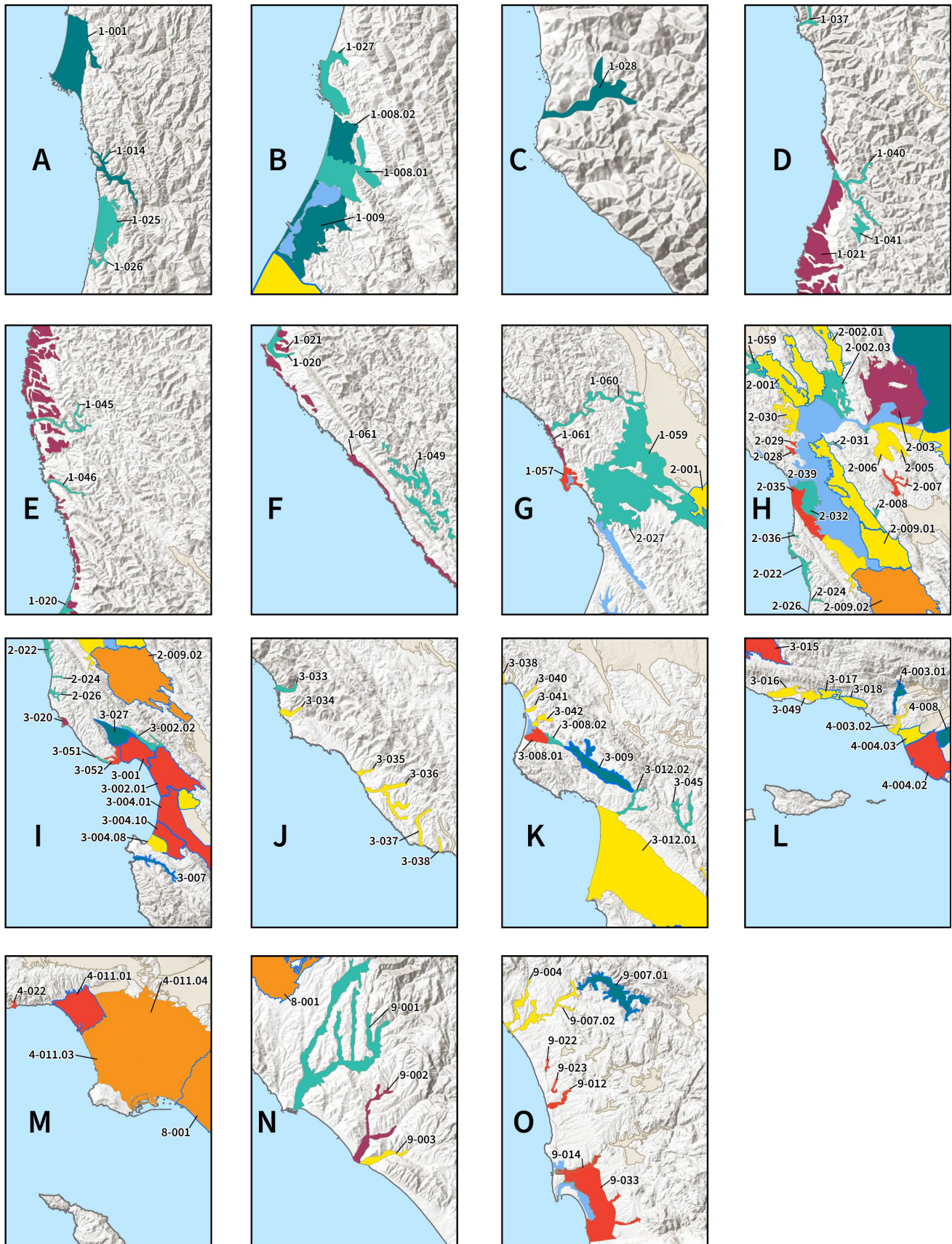


Figure H-25 Status of Seawater Intrusion in Basins (Detailed Insets)



Key findings regarding seawater intrusion are:

- Of the 98 coastal groundwater basins evaluated, data indicate that 57 have historically experienced actual or potential seawater intrusion, affecting eight of the 10 hydrologic regions.
- Recent occurrence (since 2010) of seawater intrusion has been observed in 24 basins, with 33 additional basins identified as having the potential for seawater intrusion because these basins have historically been impacted.
- To protect against seawater intrusion, water managers can implement projects or management actions that aim to keep fresh groundwater levels above the locally appropriate protective threshold.

6. Depletion of Interconnected Surface Water

California is crisscrossed by numerous rivers, streams, and creeks that carry runoff from precipitation and agricultural return flows. The majority of these streams are hydraulically connected to the underlying groundwater aquifers. Aquifers can either gain water from or lose water to surface water bodies depending on the hydraulic gradient between the surface water and groundwater systems.

The interaction between groundwater and surface water and the effects of groundwater extraction on interconnected surface water (ISW) vary greatly in California's groundwater basins. Estimating the depletion of ISW caused by groundwater extraction requires information on several factors, most notably the volumes, timing, location and depth of pumping, as well as the subsurface hydrogeologic characteristics. As GSPs are implemented and updated over time, more data and insights on depletion of ISW are expected to emerge.

As of 2024, very few agencies reported information on ISW depletion caused by groundwater pumping, with most identifying this as a data gap and establishing further efforts to improve understanding. The limited data submitted to DWR are still being evaluated along with the methods used to determine the depletions caused by groundwater use. As more agencies begin to better understand and estimate the location, quantity, and timing of depletions, DWR will be better positioned to assess and report these conditions in future Bulletin 118 updates.

Understanding and managing depletions of ISW remains particularly complex due to limited data availability and the challenges of characterizing dynamic surface water-groundwater interactions. To support local agencies in addressing this sustainability indicator under SGMA, DWR developed a three-part technical paper series to guide water managers in identifying, quantifying, and evaluating ISW depletions caused by groundwater use.

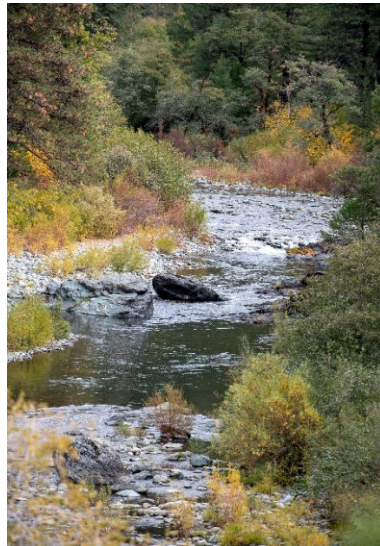
- **Paper 1** - *Depletions of Interconnected Surface Water: An Introduction* outlines foundational concepts, including how to identify ISW and define depletion due to groundwater pumping.

- **Paper 2** - *Techniques for Estimating Depletion of Interconnected Surface Water Caused by Groundwater Use* details data requirements, analysis methods, and a general process for conducting depletion analyses using numerical groundwater models.
- **Paper 3** - *Examples for Estimating Interconnected Surface Water Depletion Caused by Groundwater Use* presents two case studies using model simulations to evaluate ISW depletion in basins with both long and short groundwater response times.

Together, these papers provide critical tools to help groundwater sustainability agencies develop technically sound management strategies aligned with SGMA's requirements. DWR is expected to publish a guidance document for managing ISW depletion in the near future.

Key findings related to evaluating ISW depletion due to pumping are:

- As of 2024, very few agencies reported the quantity, location, and timing of ISW depletions caused by groundwater pumping. Most agencies identified this as a data gap and committed to future efforts to improve understanding.
- Geologic and hydrologic data are important for analyzing ISW depletion under SGMA. Identifying interconnected surface water bodies and estimating the volume and timing of depletion support more effective coordination of surface water and groundwater management, particularly where such coordination is needed to protect beneficial uses and users. Producing these estimates depends on reliable supporting data, including information on pumping and aquifer properties.



V. Moving Forward to Resilience through Sustainable Groundwater Management

Groundwater conditions across California are highly diverse, shaped by each region's distinct water sources, hydrology, geologic characteristics, ecosystems, climate stressors, and community composition and needs. As a result, approaches to implementing SGMA vary widely. Some basins benefit from decades of experience in groundwater management, while others are in the early stages of building capacity and will require additional financial, technical, facilitation, and educational support. This diversity underscores that a uniform, statewide strategy is not practical. Instead, long-term groundwater sustainability depends on locally tailored GSPs, robust monitoring, and carefully designed projects and management actions that reflect the unique realities of each basin.

At the same time, sustainable groundwater management cannot succeed through basin-level actions alone. Many of California's groundwater challenges are deeply interconnected, crossing jurisdictional lines, hydrogeologic systems, and resource disciplines. Climate extremes, land subsidence, floodwaters, and water trading do not stop at basin boundaries. Effectively addressing these challenges requires integrated, cross-basin, watershed-scale and regional solutions that make full use of both natural and built infrastructure. The state's conveyance systems, surface reservoirs, aquifers, recharge basins, flood infrastructure, forecasting platforms, and modeling tools all offer opportunities to coordinate actions across multiple basins and sectors.

Local leadership and decision-making will always remain central to groundwater sustainability, but they must be matched with a broader systems perspective. Narrow, siloed approaches that overlook the value of regional coordination and statewide infrastructure may miss opportunities to maximize benefits and build long-term resilience. A unified, integrated approach – rooted in local knowledge but connected at the regional, watershed and state scale – is essential to meeting the moment and securing a resilient water future for all Californians.

Amid the pressing need to align local action with broader systems thinking, DWR plays a dual role, serving both as a regulatory authority and a supportive steward of sustainable groundwater management. DWR provides oversight to ensure local agencies meet SGMA's requirements, while also offering critical guidance, funding, and technical assistance to empower local and regional success. This balanced role allows DWR to uphold statewide standards while nurturing the innovation, collaboration, and capacity-building essential for long-term groundwater resilience.

DWR has defined its mission as "to sustainably manage the water resources of California, in cooperation with other agencies, to benefit the state's people and protect, restore, and enhance the natural and human environments." CalGW Update 2025 and its accompanying documents and tools represent a pivotal step towards achieving both the State's and DWR's mission to secure a sustainable water future. This update builds on the State's robust

administrative and legislative framework including SGMA, the Human Right to Water Act, California's Water Supply Strategy, the Water Resilience Portfolio, and the DWR Strategic Plan, as well as decades of planning and collaborative efforts to achieve water resilience and sustainability. More importantly, the State's initiatives build upon decades of foundational work carried out by local agencies, whose expertise, projects, and management actions in relation to groundwater management have set the stage for broader state-level strategies.

A. Recent Legislative Directives Shaping California's Groundwater Future

The pathway to sustainable groundwater management in California is now being significantly shaped by two recent water laws that establish clear directives for the state's water future. Senate Bill 659 (2023) and Senate Bill 72 (2025) represent a pivotal evolution of how California approaches water management, supply development, groundwater recharge, and the integration of local and statewide planning efforts. Together, these bills create a comprehensive framework that elevates groundwater recharge as a key strategy while establishing ambitious supply augmentation targets that will define natural and built infrastructure priorities for decades to come.

In addition, these bills redefine California's water planning paradigm, moving the state from voluntary planning to mandatory performance tracking, from isolated basin management to integrated statewide coordination, and from treating groundwater as a backup supply to recognizing it as the state's largest storage reservoir and a cornerstone of climate resilience.

1. Senate Bill 659: Elevating Groundwater Recharge as a Strategic Priority

Senate Bill (SB) 659 places groundwater recharge at the forefront of the state's water resilience strategy and requires that future California Water Plans include actionable recommendations to develop additional groundwater recharge opportunities that increase the recharge of the state's groundwater basins. This law recognizes that in an era of increasing climate variability and hydrologic extremes, the ability to capture, store, and bank water during wet periods is essential to building drought resilience and achieving long-term sustainability.

The law's influence on groundwater management is far-reaching. It accelerates the development and expansion of recharge infrastructure, incentivizes innovative recharge techniques including agricultural land repurposing and floodwater capture, and strengthens the connection between surface water operations and groundwater storage. SB 659 explicitly defines the full spectrum of recharge methods, signaling that California must pursue recharge through every viable pathway. It requires estimation of recharge volumes and mapping of suitable recharge locations, transforming recharge from an opportunistic practice to a systematically planned and measured strategy.

SB 659 also emphasizes the need for coordinated, multi-benefit recharge projects that not only replenish aquifers but also address land subsidence, support ecosystem health, and enhance water quality. This multi-benefit approach aligns seamlessly with SGMA's sustainability goals while expanding the scope of what recharge projects can accomplish.

2. Senate Bill 72: Establishing Ambitious Supply Augmentation Targets with Groundwater at the Core

Senate Bill 72 establishes an ambitious statewide target for California to develop 9 million acre-feet of additional water supply, water conservation, or water storage capacity to be achieved by 2040. This unprecedented benchmark represents a fundamental recognition that California's water security depends on a diversified portfolio that maximizes both above-ground and below-ground storage capabilities. Meeting this goal without groundwater storage at the core would be impossible both financially and physically.

SB 72 transforms how the state conceptualizes water storage infrastructure. Rather than viewing storage through a narrow lens of dams and reservoirs, the legislation encourages an integrated approach where aquifer storage, managed aquifer recharge, and groundwater banking are recognized as essential components of California's storage portfolio. This acknowledges the unique advantages of groundwater storage: minimal evaporative losses, distributed storage capacity across regions, natural water quality improvements, and the ability to leverage existing infrastructure with relatively lower capital costs.

SB 72 also accelerates investments in recharge infrastructure, incentivizes the development of regional groundwater banking programs, and creates opportunities for conjunctive use projects that optimize the combined operation of surface and groundwater systems. The 9 million acre-feet target drives innovation in storage technologies and techniques, from on-farm recharge and distributed stormwater capture to large-scale flood-managed aquifer recharge (Flood-MAR) projects. Local agencies implementing SGMA are now positioned to contribute directly to meeting this state goal through projects that simultaneously address basin sustainability and expand storage capacity.

SB 72 also establishes rigorous reporting requirements. Building on previous California Water Plan updates that described water conditions and suggested strategies, SB 72 requires the state to set measurable goals, track actual progress toward achieving them, analyze costs and benefits of different strategies, and report results to the Legislature every two years. This accountability framework transforms water management from a local practice to a tracked contribution to statewide water security. SB 72's explicit requirement to include more community voices—Tribes, environmental justice groups, disadvantaged communities—in planning processes creates new engagement obligations for groundwater managers, ensuring that storage and recharge investments serve the needs of all Californians, not just those with established water rights or financial resources.

The synergy between SB 72's storage target and CalGW Update 2025 is profound. Achieving 9 million acre-feet of additional water requires comprehensive understanding of groundwater basin capacities, water quality, recharge potential, geologic suitability, and sustainability constraints—all information that flows from GSP implementation and SGMO program activities including basin characterization and local assistance. The California Water Plan must now synthesize information from GSPs, climate projections, and infrastructure inventories to guide strategic storage investments. CalGW Update 2025, along with its companion documents, tools, and data platforms, provides the groundwater-specific analysis and data infrastructure

needed to inform these decisions, ensuring that groundwater storage projects are sited appropriately, designed effectively, and operated sustainably.

3. Integration of CalGW with California Water Plan: A New Dimension of Coordinated Planning

The combined directives of SB 659 and SB 72 redefine the relationship between groundwater management and statewide water planning. The California Water Plan now serves as the integrative nexus where local SGMA implementation, regional water supply planning, statewide planning, climate adaptation strategies, and legislative requirements converge. For California's groundwater community specifically, this means that GSP development, recharge project planning, and basin management decisions must now align with statewide storage targets, recharge goals, and biennial reporting requirements—ending decades of groundwater planning occurring largely in isolation from state-level water strategy.

This integration offers several benefits. First, it ensures that billions of dollars in state investments—whether for recharge projects, storage development, or SGMA implementation support—are strategically aligned with both local needs and statewide priorities. Second, it enables systematic evaluation of how local actions collectively contribute to state goals, identifying opportunities for regional coordination and highlighting areas where additional support is needed. Third, it creates transparency and accountability, allowing the Legislature and public to understand progress toward sustainability and storage goals.

For local agencies implementing SGMA, this integration provides both opportunities and responsibilities. GSPs become not just local planning documents but foundational inputs to statewide strategy. Local recharge projects and storage investments, when aggregated and analyzed through the California Water Plan, inform state policy, guide funding priorities, and shape infrastructure development programs. Conversely, state-level planning provides local agencies with regional context, comparative data, and coordination opportunities that enhance the effectiveness of local actions. Local agencies now have clear visibility into how their work contributes to statewide goals, enabling them to articulate the broader significance of local projects when seeking funding, permits, or community support. The explicit connection between SGMA implementation and SB 72's storage targets provides new justification for groundwater investments that might otherwise be viewed as purely local concerns.

CalGW Update 2025 and its companion tools and data platforms are designed to facilitate this integration. By summarizing key information and establishing standardized reporting protocols and integrated data platforms, CalGW Update 2025 enables information flow between local GSP implementation and statewide water planning. This integration is not merely administrative; it is strategic, ensuring that California's approach to groundwater sustainability is connected to its broader vision for water resilience, climate adaptation, and equitable resource management rather than treated as a separate, subordinate groundwater planning process.

B. Themes of CalGW Update 2025

The CalGW Update 2025 introduces four themes for advancing sustainable groundwater management, grounded in the findings of this report, which highlight the most significant pressures on California's natural and built groundwater infrastructure and the strategies and tools needed to address them. The themes align with California's vision, policies, and priorities for climate resilience, equity, and water security.

The first theme, "Maximizing Groundwater Infrastructure for Climate Adaptation and Resiliency," emphasizes the vision to maximize the potential of groundwater infrastructure to mitigate the impacts of a changing climate and extreme weather by understanding and investing in it. This theme directly operationalizes SB 659's charge to develop additional groundwater recharge opportunities and supports SB 72's ambitious storage targets by optimizing California's largest natural storage reservoir—its aquifers.

The second theme, "Accelerating Momentum for Sustainability," calls for a continued commitment to SGMA implementation to secure long-term sustainability. This theme ensures that the momentum of SGMA implementation enables the rapid expansion of recharge and storage infrastructure required by SB 659 and SB 72, with progress systematically tracked through the California Water Plan's reporting requirements.

The third theme, "Strengthening Connections for Equity," highlights the necessity of incorporating diverse voices, especially those from frontline and underrepresented communities, into water management decisions. This theme aligns with SB 72's requirement to expand community participation in water planning, ensuring that groundwater investments documented in the California Water Plan serve all Californians equitably.

Finally, the fourth theme, "Enhancing Groundwater Data, Tools, and Analysis for Decision Support," underscores the need for cutting-edge data and technologies, as well as long-term, systematic water level measurements that will enable accurate evaluation of resource changes, trend forecasting, real-time science-based decision-making, and monitoring of the effectiveness of groundwater management. This theme provides the technical foundation for meeting SB 659's requirements to estimate recharge volumes and map suitable locations, SB 72's comprehensive data collection directives, and the California Water Plan's biennial reporting obligations to the Legislature.

These four themes, discussed below in detail, reflect the depth of California's commitment to sustainable water management and serve as the foundation for the State's success in addressing water scarcity and hydrologic variability. As climate challenges intensify, CalGW Update 2025 builds on the groundwork laid by other efforts included in DWR's California Water Plan, the Central Valley Flood Protection Plan, the Water Resilience Portfolio, the California's Water Supply Strategy, and other policy roadmaps. Together, these efforts provide a forward-thinking blueprint for addressing water management challenges and highlighting sustainable groundwater management as a cornerstone of California's water resilience and equity efforts.

Theme 1: Maximizing Groundwater Infrastructure for Climate Adaptation and Resiliency

Over the next two decades, fully harnessing California's groundwater basins, aquifers, and recharge infrastructure will be essential for advancing climate adaptation, strengthening long-term resilience, and enhancing preparedness for extreme weather and climatic events. Foundational components of California's natural and built infrastructure, groundwater basins play a crucial role in supporting communities, ecosystems, and the economy while providing a vital buffer against droughts and reducing dependence on surface water. Understanding and optimizing California's groundwater systems, together with sustainable watershed and land management practices and strategic investments in conveyance infrastructure, will help the State enhance groundwater recharge efforts and water supply reliability, capture high flows during heavy rainfall to reduce flood risks, and support biodiversity.

Strategic investments, both financial and non-financial, aimed at stabilizing, preserving, and maximizing groundwater resources are necessary to sustain these benefits. Policy incentives and regulatory flexibility to foster innovation and implement nature-based solutions will be indispensable for safeguarding groundwater supplies, improving water quality, and expanding the adaptive capacity of California's water systems. By prioritizing groundwater natural infrastructure in climate resiliency strategies, California can achieve a more robust and sustainable water management system that meets the needs of both current and future generations.

Theme 2: Accelerating Momentum for Sustainability

With just over 15 years remaining to achieve sustainability, accelerating progress toward sustainable groundwater management is crucial for California's water future. While the State provides the regulatory framework, guidance, and technical, planning, and financial assistance, local agencies are at the forefront of funding and implementing SGMA.

Local agencies need to persist in their efforts in the SGMA implementation phase, intensifying actions to carry out their GSPs, projects, and management actions. By expanding its support, the State can enable local agencies to implement more effective groundwater management strategies, address current challenges, enhance recharge efforts, and reduce over-extraction. This partnership between the State and local agencies is essential for accelerating momentum and achieving SGMA's sustainability goals, ultimately securing California's groundwater resources for future generations.

Theme 3: Strengthening Connections for Equity

People and communities across the state depend on safe, clean groundwater for their daily needs, but many are underserved and among the first to experience the impacts of declining groundwater levels and degraded water quality. Through the enactment of California Water Code Section 106.3 in 2013, California was the first state in the nation to legislatively recognize that "every human being has the right to safe, clean, affordable, and accessible water..." Building on this foundational commitment, the State must continue to strengthen engagement, communication, and outreach efforts to work toward equity in groundwater

management and outcomes for communities. Ensuring that various communities – including frontline and vulnerable communities and Tribes – are involved in all aspects of groundwater management decisions allows valuable input from these water users to be leveraged. By fostering collaborative and inclusive connections, the State empowers local agencies, community leaders, and decision-makers to work together not only to protect groundwater, a critical resource, but also ensure its long-term resilience for all who depend on it.

Essential resources like CalGW, along with companion and complementary platforms such as DWR's Dry Well Susceptibility and Water Shortage Vulnerability Tools, provide critical insights and help bridge the information gaps faced by historically underrepresented communities. Identifying and addressing these data gaps promotes equity in information access, ultimately leading to more equitable groundwater management practices and solutions. By utilizing these resources, the State can leverage local knowledge and data to better inform agency partners and engage communities. These actions affirm that all voices should be valued and considered in the pursuit of sustainable groundwater management and water equity.

Theme 4: Enhancing Groundwater Data, Tools, and Analysis for Decision Support

Effective groundwater management requires both high-frequency and long-term groundwater data, as well as advanced analytical forecasting capabilities, similar to those used in the surface water arena, to support real-time, informed decision-making. The State is committed to strengthening these capabilities by improving data collection, reporting, tool development, and analysis in partnership with local and federal agencies. Reports such as CalGW Updates and CalGW Semi-Annual Updates, along with data-driven platforms like the SGMA Data Viewer and California's Groundwater Live, will serve as central repositories for comprehensive, statewide groundwater data, facilitating real-time operational insights.

By making this information accessible through the CNRA Open Data website, the State aims to empower water managers and decision-makers with the tools necessary for data-driven solutions in sustainable groundwater management and extreme weather preparedness. Enhanced data availability, frequency, and quality will ensure effective groundwater management, addressing current challenges and advancing sustainable practices statewide.

C. Recommendations of CalGW Update 2025

This section presents a set of recommendations and supporting actions aimed at addressing California's groundwater challenges while seizing opportunities to strengthen the state's ability to navigate an increasingly uncertain water future. Beyond technical solutions, these recommendations reflect a broader cultural shift toward groundwater stewardship – recognizing aquifers as vital natural infrastructure essential to California's long-term resilience, economic stability, and environmental health amid growing groundwater dependence.

These recommendations are based upon past and current groundwater conditions and findings and include:

(1) **Continuing and Updated Recommendations** that were originally published in *CalGW Update 2020*, presented here either in their original form or with modifications (shown in *blue font*) to incorporate updated information and needs based on recent findings; and

(2) **New Recommendations** developed based on groundwater conditions and findings through 2025 to further strengthen efforts to better characterize, evaluate, and sustainably manage California’s groundwater resources.

The recommendations and actions (Tables H-2 through H-5) are organized by the four categories that correspond to the four themes of *CalGW Update 2025*. These themes reflect the most significant pressures on California’s natural and built groundwater infrastructure and the strategies and tools needed to address them (Table H-1).

Table H-1 CalGW 2025 Themes and Recommendations at a Glance

Themes	Recommendation Topics
<i>Maximizing Groundwater Infrastructure for Climate Adaptation and Resiliency</i> <i>(Theme 1)</i>	<ul style="list-style-type: none"> • Basin Characterization • Investments and Funding • Non-Financial Incentives • Innovation and New Technology • Climate Change
<i>Accelerating Momentum for Sustainability</i> <i>(Theme 2)</i>	<ul style="list-style-type: none"> • Oversight, Support, and Stewardship • Multi-Benefit Projects • Water Markets and Transfers • Groundwater Sustainability Agency (GSA) Capacity Building
<i>Strengthening Connections for Equity</i> <i>(Theme 3)</i>	<ul style="list-style-type: none"> • Engagement • Coordination • Groundwater Education
<i>Enhancing Data, Tools, and Analysis for Decision Support</i> <i>(Theme 4)</i>	<ul style="list-style-type: none"> • Data Collection • Sustainable Groundwater Management (SGMA) Portal • Methods, Standards, Tools

These recommendations will be implemented in partnership with local, State, and federal agencies, Tribes, nongovernmental organizations (NGOs), and other interested parties and will support related actions identified in the Water Resilience Portfolio and California's Water Supply Strategy, and inform other statewide planning efforts, including future updates to the California Water Plan. Implementation of these recommendations will require time, effort, and funding, and the pace of implementation will depend on the availability of needed resources, technical and institutional feasibility, and competing priorities. Given these constraints, successful implementation will require close collaboration between State and local agencies to prioritize recommendations that provide the greatest benefit to groundwater sustainability and to design streamlined approaches that reduce costs, minimize administrative complexity,

and avoid duplicative requirements. Appendix A of CalGW Update 2025 provides a status description for each continuing and updated recommendation.

Table H-2 Maximizing Groundwater Infrastructure for Climate Adaptation and Resiliency Recommendations

<p>Recommendation 1 (Basin Characterization)</p>	<p>Build upon the California's Groundwater (Bulletin 118) legacy by collaborating with local agencies on the application of new technology and tools for geologic and hydrogeologic characterization of groundwater basins and water budgets to inform long-term planning for sustainability under average, dry, <i>wet, and extreme</i> conditions.</p>
<p>Action 1.1</p>	<p>Work with applicable State agencies to improve knowledge and understanding of California’s groundwater basins by enhancing basin characterizations with the latest data and information, including climate change data to improve groundwater management</p>
<p>Action 1.2</p>	<p><i>Develop aquifer recharge potential maps across the state through a standardized process to help identify optimal areas for enhanced recharge and critical connections in aquifer systems to enable local governments to maximize opportunities for managed aquifer recharge consistent with long term planning.</i></p>
<p>Action 1.3 (new)</p>	<p><i>Work with local, state, and federal agencies to improve the understanding and delineation of various components of groundwater basin hydrogeologic conceptual models such as extent of water-bearing units, distribution of geologic materials/texture, base of freshwater, bottom of basin and depth to basement, and amount of brackish water available.</i></p>
<p>Action 1.4 (new)</p>	<p><i>Develop and maintain a centralized database of measured aquifer flow parameters to improve data accessibility, support consistent groundwater flow model development, enhance tools for estimating aquifer parameters, and facilitate the integration of large datasets into models describing aquifer characteristics and parameters.</i></p>
<p>Action 1.5 (new)</p>	<p><i>Enhance the understanding of land subsidence, interconnected surface water (ISW), and seawater intrusion by advancing monitoring efforts and by developing and refining state-stewarded maps and models that define water-bearing units, ISW extents, natural groundwater recharge pathways, subsidence potential, seawater intrusion extent, the base of freshwater, and the bottom of groundwater basins to support sustainable groundwater management.</i></p>

Action 1.6	Expand airborne and ground-based electromagnetic and related geophysical surveys to collect data of subsurface hydrogeologic characteristics of aquifer systems statewide, develop methods to incorporate geophysical data in groundwater models, and provide training to local agencies on use of geophysical data in local models.
Recommendation 2 (Investment and Funding)	Secure sustained funding to support sustainable groundwater management projects and management actions that will improve water resiliency.
Action 2.1	Secure sustained funding for programs supporting sustainable groundwater management, including technical assistance, data collection and dissemination, groundwater sustainability plan (GSP) evaluation, guidance documents, hydrogeologic investigations, models and tools development, outreach and education, and capacity building.
Recommendation 3 (Innovation and New Technology)	Promote innovation and new technology adoption in sustainable groundwater management.
Action 3.1	Continue to enhance and update the CalGW Live website with the latest information on groundwater data, the best available science, drought conditions, and new technologies to support innovations in sustainable and resilient groundwater management
Action 3.2	Provide incentives to promote adoption and use of new approaches and technologies in groundwater, such as flood-managed aquifer recharge (Flood-MAR) and remote sensing (e.g., Interferometric Synthetic Aperture Radar (InSAR), airborne electromagnetic and other geophysical surveying.
Recommendation 4 (Non-Financial Incentives)	Work with the Legislature and government agency executives to create and provide non-financial incentives (e.g., streamlined permitting) for activities that support sustainable groundwater management.
Action 4.1	Incentivize groundwater sustainability agencies (GSAs) and grant applicants to consider statewide priorities in formulating inter-regional projects for sustainable groundwater management.
Action 4.2	Incentivize groundwater sustainability agencies (GSAs) and grant applicants to undertake projects that directly improve the human right to water and reduce drought risks for underrepresented communities, Tribes, and rural communities.
Recommendation 5 (Climate Change) - new	<i>Leverage statewide climate change analyses to improve understanding and preparedness for meeting the groundwater challenges and opportunities under a hotter, drier climate with more extreme conditions.</i>

<p>Action 5.1 (new)</p>	<p><i>Enhance the ability to distinguish and attribute observed changes in groundwater conditions to climate change – relative to California’s natural climatic variability, land use change, and groundwater management practices – through supporting long-term groundwater data collection programs to enable more informed, effective, and adaptive decision-making.</i></p>
<p>Action 5.2 (new)</p>	<p><i>Improve understanding of groundwater vulnerability to climate change by coordinating with local, state, federal, and academic partners to assess how shifting precipitation patterns, rising temperatures, and intensifying climate hazards – such as extreme drought, wildfire, and sea level rise – affect groundwater reliance, recharge potential, and water quality in basin and non-basin areas. Apply this information to inform basin-scale water budgets, management strategies, and climate resilience planning.</i></p>
<p>Action 5.3 (new)</p>	<p><i>Advance groundwater adaptation by supporting multi-benefit, climate-ready recharge strategies – such as flood managed aquifer recharge (Flood-MAR), forecast-informed reservoir operations for managed aquifer recharge (FIRO-MAR), Flood Diversion and Recharge Enhancement (FDRE), stormwater capture, and recycled water use – while identifying and addressing conveyance needs and integrating real-time climate signals into operational groundwater forecasting to enhance recharge efficiency, drought preparedness, and long-term sustainability.</i></p>
<p>Action 5.4 (new)</p>	<p><i>Evaluate the need to update best management practices, technical guidance, and planning tools to incorporate climate change projections, analytical methods for assessing groundwater vulnerability, and approaches to support the design and implementation of adaptation strategies that improve groundwater resilience and sustainability.</i></p>

Table H-3 Accelerating Momentum for Sustainability Recommendations

<p>Recommendation 6 (Oversight, Support, and Stewardship)</p>	<p>Continue the implementation of the Sustainable Groundwater Management Act (SGMA) by effectively performing regulatory oversight, monitoring progress towards achieving sustainability goals, and supporting <i>and stewarding</i> the adaptive management of groundwater to achieve sustainability within regulatory timeframes.</p>
<p>Action 6.1</p>	<p>Support the implementation of projects and management actions identified in the groundwater sustainability plans (GSPs), and <i>track and</i> report on statewide sustainability performance measures <i>and statewide progress towards achieving sustainability by 2040/2042.</i></p>
<p>Action 6.2</p>	<p>Ensure local agencies are tracking and reporting on sustainability performance measures, <i>as well as the implementation of projects and management actions (PMAs) in SGMA Portal's PMA module</i> and assist local agencies <i>in their stewardship role</i> to manage groundwater basins adaptively and collaboratively.</p>
<p>Action 6.3</p>	<p>Ensure ongoing, consistent, and timely evaluation and review of groundwater sustainability plans (GSPs), annual reports, and alternatives to GSPs and their updates to assess the likelihood of achieving sustainability, <i>with particular attention to identifying and addressing irreversible and highly impactful undesirable results – such as those that may be associated with land subsidence and seawater intrusion – that require immediate action, as state intervention is mandated by law if local agencies fail to respond.</i></p>
<p>Recommendation 7 (Multi-Benefit Projects)</p>	<p>Promote and support groundwater projects that achieve multiple benefits to reduce statewide overdraft, replenish groundwater basins, reduce drought and flood risks, <i>minimize or avoid subsidence</i>, and secure ecosystem benefits.</p>
<p>Action 7.1</p>	<p>Collaborate with State, federal, Tribal, local, and regional agencies to support and provide financial and non-financial incentives for a comprehensive approach to local and <i>watershed-based</i> regional groundwater recharge and storage projects that would achieve multiple benefits.</p>
<p>Action 7.2</p>	<p>Promote streamlining and acceleration of managed aquifer recharge, <i>flood-managed aquifer recharge (Flood-MAR), forecast-informed reservoir operations for managed aquifer recharge (FIRO-MAR), Flood Diversion and Recharge Enhancement (FDRE)</i>, and groundwater banking permitting processes to <i>overcome recharge project implementation</i></p>

	<i>challenges and barriers and continue to support local agencies in maximizing all opportunities for long-term proactive drought management strategies.</i>
Action 7.3	Encourage climate-ready multi-benefit projects – such as groundwater recharge using recycled and reused water, <i>stormwater capture, and flood-managed aquifer recharge (Flood-MAR) and identify opportunities and needs for critical conveyance improvements and expansion</i> – to increase water supply reliability, offset statewide water demand, <i>and support data collection to evaluate benefits to the groundwater system.</i>
Action 7.4	Work with local agencies, under-represented communities, domestic users, and Tribes in basins and non-basin areas to identify and understand their use of and reliance on groundwater and historical impacts from droughts to reduce risks and better prepare for future droughts, in particular, through the development of the drinking water well principles and strategies to anticipate and proactively address drought impacts.
<i>Action 7.5 (new)</i>	<i>Encourage and support local implementation of demand management and land repurposing strategies to reduce groundwater pumping and minimize or avoid subsidence and other undesirable results.</i>
<i>Action 7.6 (new)</i>	<i>Assist local agencies in determining when water is available in local waterways for recharge without harming downstream users or the environment, and in understanding the requirements of Water Code Section 1242.1 for diverting floodwater for recharge without a water right.</i>
Recommendation 8 (Water Markets and Transfers)	Foster and strengthen local and regional water markets and streamline water transfers to optimize the economic value of groundwater while providing protection for the environment and communities.
Action 8.1	Streamline <i>responsible</i> groundwater substitution and water transfer permitting and approval processes by allowing consolidated basin-level environmental reviews to facilitate water market transactions <i>with due considerations to the potential impacts to interconnected surface water depletions, third parties, and all other beneficial users and uses of groundwater.</i>
Action 8.2	Facilitate the efficient, fair, and equitable development and implementation of water markets by creating an adaptable standardized framework for market structure, governance, and operations.

Action 8.3	Continue to <i>create support efforts aimed at establishing</i> a voluntary statewide water transfer database and support efforts to develop a groundwater accounting platform.
Recommendation 9 (GSA Capacity Building)	Continue and enhance the local assistance program and build capacity within agencies to maintain momentum toward sustainability.
Action 9.1	Continue local assistance, in the form of training, technical support, and financial grants to groundwater sustainability agencies (GSAs), other groundwater management entities, underrepresented communities, and Tribes, in both basin and non-basin areas, to gradually build capacity to manage groundwater and reduce drought risks, including advancing guidance on drinking water well-related drought impacts.
Action 9.2	Identify groundwater basins where water budgets and management practices have not been established and provide technical assistance and financial incentives to establish basin-wide water budgets for average years and dry years under historical and climate change conditions. <i>As resources allow, expand these efforts to include low- and very-low priority basins, working toward a comprehensive understanding of water budgets throughout the state.</i>
Action 9.3	Encourage and support local agencies to utilize existing local authority to effectively manage groundwater in low- and very-low-priority basins and non-basin areas.

Table H-4 Strengthening Connections for Equity Recommendations

Recommendation 10 (Engagement)	Engage with a comprehensive range of interested parties, including underrepresented communities, to communicate the value of groundwater and listen to the issues, challenges, and needs of the interested parties, and <i>improve the collective understanding of local conditions.</i>
Action 10.1	Continue to engage with local agencies and underrepresented communities through groundwater basin points-of-contact and regional coordinators to identify and understand local needs and priorities, tools needed, opportunities for grants and loans, and obstacles to data sharing.
Action 10.2	Publish an annual report summarizing the status and accomplishments of the sustainable groundwater management program, its benefits, and progress toward achieving statewide sustainability.
<i>Action 10.3 (new)</i>	<i>Increase groundwater monitoring and facilitate the establishment of locally led Community Monitoring Networks for groundwater dependent communities and neighborhoods within both basin and non-basin areas.</i>
Recommendation 11 (Coordination)	Communicate and collaborate <i>across-sectors</i> with local agencies, counties, Tribes, and non-governmental organizations on finding synergistic solutions and <i>size opportunities to emerging challenges</i> problems.
Action 11.1	Increase coordination among various local and regional water resource planning efforts, including Sustainable Groundwater Management Act (SGMA), integrated regional water management <i>and watershed resilience planning</i> , agricultural and urban water management, and <i>flood</i> management to maximize the effectiveness of individual efforts and foster synergistic collaborations for multi-benefit and multi-partner projects.
Action 11.2	Provide State incentives to local water management agencies and counties to coordinate with Tribes, underrepresented communities, and other agencies for taking actions to ensure the long-term sustainability of groundwater supply and human right to water, including the advancement of funding to support the implementation of strategies to address drinking water well and drought impacts.

Action 11.3	Increase communication, collaboration, and coordination between land use planning, <i>well permitting agencies</i> and groundwater sustainability agencies (GSAs) to link land use development and water management and protect the interests of all beneficial users and uses of groundwater in California.
Action 11.4 (new)	<i>Continue coordination with relevant entities to stay abreast of the best available information for baseline recharge estimates, such as the National Aeronautics and Space Administration's (NASA's) Jet Propulsion Laboratory's Gravity Recovery and Climate Experiment (GRACE) program and the United States Geological Survey (USGS) data and studies, and support new research in this field.</i>
Recommendation 12 (Groundwater Education)	Build groundwater education program for local agencies, elected officials, students, well owners, underrepresented communities, and general population to garner support for sustainable groundwater management programs and projects.
Action 12.1	Collaborate with non-governmental organizations and other agencies to distribute existing groundwater educational material more broadly and develop targeted educational materials that can be used to brief local agency board members, county supervisors, and local elected officials.
Action 12.2	Work with the California Department of Education, appropriate education institutions, the Groundwater Resources Association, groundwater sustainability agencies (GSA), Tribes, and other key interested parties to develop groundwater related educational materials for use in K-12 classrooms, colleges, and universities to instill the value and importance of groundwater and sustainability. <i>Coordinate with DWR's overall goals for student education on water resources and climate resilience.</i>
Action 12.3	Develop groundwater educational material in English, Spanish, Hmong, and other languages representing large population groups in California to communicate the value of groundwater and importance of sustainability. Continue public awareness efforts and support local agencies in promoting consistent and effective messaging that water conservation also saves groundwater.
Action 12.4	Work with educational institutions to develop multi-disciplinary programs to attract talent and promote diversity and leadership in groundwater professions to support building capacity at State and local levels.

Table H-5 Enhancing Data, Tools, and Analysis for Decision Support Recommendations

Recommendation 13 (Data Collection)	Strengthen and support long-term groundwater data collection programs at state, local, and regional levels and enable statewide sustainable groundwater management and drought response.
Action 13.1	Continue to collect groundwater data in high- and medium-priority basins and expand existing data collection programs (California Statewide Groundwater Elevation Monitoring Program) in low- and very-low-priority basins and non-basin areas <i>while integrating these data collection efforts under a unified California's Groundwater Monitoring program, ensuring consistent data standards, broader coverage, and improved accessibility for decision-making.</i>
Action 13.2	Enhance existing groundwater level data collection programs by expanding spatial coverage, <i>promoting and supporting the installation of telemetered, near-real-time monitoring data,</i> and increasing the frequency of groundwater level measurements to quarterly, monthly, or more frequently to improve understanding of the seasonal variations and enable real-time decision-making.
Action 13.3	Collect and compile agricultural, urban, and environmental water use data, <i>with land use attributes and water source information by basin and non-basin area,</i> to expand data coverage and improve data accuracy for statewide water accounting and inform sustainable water management.
Action 13.4	Coordinate with the State Water Resources Control Board and other agencies on the collection of statewide groundwater quality and seawater intrusion monitoring data.
Action 13.5	Enhance and expand data collection necessary to be able to monitor the groundwater and surface water interaction in both basin and non-basin areas by augmenting stream gage monitoring networks (consistent with <i>California's Stream Gage Improvement Program (CaSIP) Senate Bill 19</i>), compiling groundwater pumping data, <i>and increasing groundwater level monitoring in the vicinity of streams establishing dedicated shallow monitoring well networks specifically designed for interconnected surface water (ISW) assessment, with wells installed within 50 to 300 feet of surface water bodies.</i>

Action 13.6	Coordinate with State and local agencies, Tribes, and environmental interest groups to improve data collection, mapping, and understanding of groundwater dependent ecosystems and their vulnerabilities to climate change
Action 13.7	Enhance the state's subsidence monitoring network, in collaboration with local, State, and federal agencies, by increasing the frequency of satellite-based Interferometric Synthetic Aperture Radar (InSAR) data collection and increasing the number of ground-based continuous global positioning systems and extensometers to monitor existing subsidence locations and detect new occurrences specifically near critical water infrastructure.
Action 13.8	Improve the reporting of subsurface data by requiring geophysical logs to be submitted with well completion reports, <i>digitize wells logs and locations</i> , and work with local agencies to reduce the number of existing monitoring wells with missing or incorrect well construction and depth information.
Action 13.9	Enhance and enrich the State's voluntary <i>Household Water Supply Shortage Dry Well</i> Reporting System, to minimize under-reporting of data, errors, and omissions, through outreach and local assistance to underrepresented communities, domestic users, and Tribes.
Action 13.10	Expand data collection and synthesis programs and conduct groundwater investigation studies to develop a better understanding of non-basin areas, including contribution of snowpack and streams to groundwater recharge from non-basin areas and associated climate change and drought impacts.
<i>Action 13.11 (new)</i>	<i>Encourage and support local agencies to improve identification, characterization, and status tracking of active groundwater production wells as well as expand metering where feasible for more accurate groundwater extraction estimates.</i>
<i>Action 13.12 (new)</i>	<i>Develop methods to consistently evaluate the reliability of methods used by groundwater sustainability agencies (GSAs) to calculate changes in groundwater storage to strengthen the accuracy of regional and statewide water accounting.</i>
<i>Action 13.13 (new)</i>	<i>Enhance statewide groundwater monitoring in areas identified as having high physical or social vulnerability by expanding data collection networks, improving spatial and temporal coverage, integrating community monitoring efforts, and prioritizing underserved and at-risk communities, which are often the most vulnerable to climate change, to support equitable and informed groundwater management.</i>

Recommendation 14 (SGMA Portal)	Enhance Sustainable Groundwater Management Act (SGMA) reporting systems and align them with the Open and Transparent Water Data Act (Assembly Bill 1755) to make groundwater data easily accessible, useful, timely, and transparent to support short-term and long-term planning for sustainable groundwater management.
Action 14.1	Continue and enhance the State’s groundwater databases to handle the new groundwater basin data submitted by groundwater sustainability agencies) GSAs <i>for areas covered by groundwater sustainability plans (GSPs), alternatives to GSPs, adjudicated areas</i> , and other local agencies and establish a high level of data quality by incorporating necessary quality assurance procedures.
<i>Action 14.2</i> <i>(new)</i>	<i>Develop and implement a standardized and automated data reporting format for all parties – regardless of whether they are reporting under groundwater sustainability plans (GSPs), alternatives to GSPs, or adjudicated areas – for all reported data types, including, but not limited to, water quality, recharge data, water source, and water use sector.</i>
Recommendation 15 (Methods, Standards, and Tools)	Develop and enhance analysis methods, standards, and modeling tools to support decision making for sustainable groundwater management.
Action 15.1	Incorporate new groundwater basin data, including groundwater <i>accounting</i> and basin water budgets, submitted by groundwater sustainability agencies (GSAs) and other local agencies, to inform and update how statewide water balance information is synthesized and reported in the California Water Plan Updates and the Water Resilience Portfolio.
Action 15.2	Update the California Well Standards and provide training to local enforcing agencies in administering the updated standards.
Action 15.3	Continue to support and enhance DWR's Integrated Water Flow Model (IWFM), the California Central Valley <i>Surface Water-Groundwater</i> Simulation Model (C2VSim) <i>and potentially other applications like</i> the Sacramento Valley Simulation Model (SVSim) based on user feedback. <i>Work with agencies in the Central Valley to better understand how local information and needs can inform future model application updates.</i>

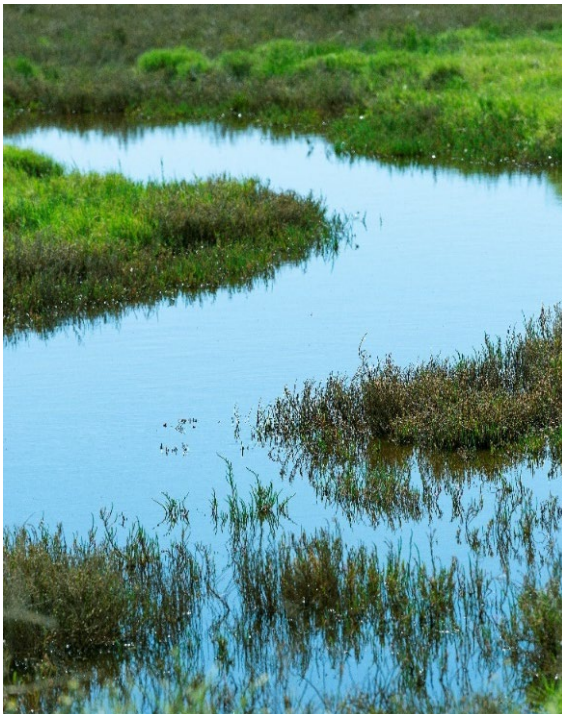
<p>Action 15.4 (new)</p>	<p><i>Work with local agencies to establish standards and consistent methods – aligned with existing Best Management Practices for the Sustainable Management of Groundwater, DWR’s Handbook for Water Budget Development, and available groundwater accounting platforms – for developing and reporting water budget data to facilitate scaling and aggregation for water accounting at various spatial scales. Provide technical assistance on water accounting through the development and refinement of data, tools, and technical guidance.</i></p>
<p>Action 15.5 (new)</p>	<p><i>Develop standardized methods to estimate changes in groundwater storage across the state, and coordinate with local, State, and federal agencies to update total, usable, and available basin storage capacity estimates – beginning with the Central Valley and expanding to all priority groundwater basins.</i></p>

VI. Shared Stewardship, Shared Future

Implementing the recommendations and actions set forth in CalGW Updates 2020 and 2025 will require sustained stewardship, strategic investment, coordinated oversight, and collaboration across all levels of government in California. While some actions are already underway or can be realized in the near term, others – equally vital – will take time, as progress continues in SGMA implementation, data innovation, forecast-informed planning and operations, and long-term infrastructure planning. CalGW Update 2025 provides a clear path to monitor and guide this progress.

Shared stewardship means recognizing that the path to groundwater sustainability is not the responsibility of any one entity. Local, regional, State, and federal water managers must work together to bridge efforts within and across basins, align priorities, and close critical data and capacity gaps. Realizing sustainable groundwater management will depend on strong partnerships among State and federal agencies, GSAs, Tribes, NGOs, and other regional water entities who each bring vital knowledge, resources, and leadership to the table.

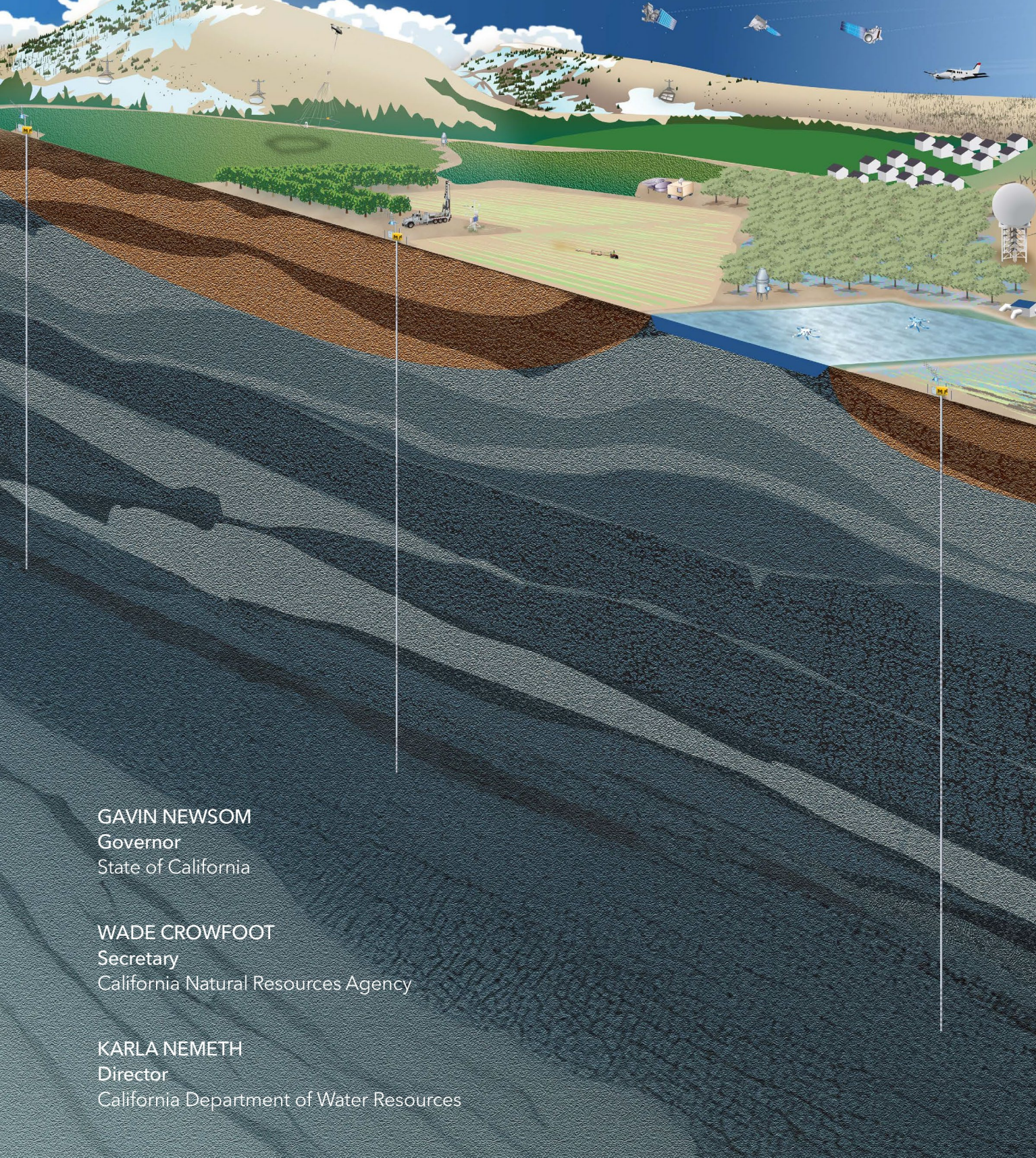
A successful path forward must also embrace climate adaptation – recognizing the growing variability in precipitation and recharge – and pursue integrated, multi-benefit strategies that align groundwater management with broader water resilience goals. With shared commitment and resources, aligned strategies, and a renewed focus on equity and innovation, California is well-positioned to transform challenges into opportunity – ensuring that the promise of sustainable groundwater is not only envisioned, but achieved, for generations to come.



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