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California Groundwater Conditions Update – Spring 2021

California's drought and groundwater

California, as well as the entire Western United States, is facing a significant drought in the wake of one the driest periods ever recorded. Most of the state is in an Extreme or Exceptional Drought status. As summer began, the West had already experienced record heatwaves that further depleted water supplies.

In terms of statewide precipitation, water year 2021 was the second driest year on record (1896 to 2021) and is exacerbated by a dry 2020 water year. Recorded rainfall and snowfall this past winter in the northern Sierra are drier than they were in 2014-15 at the height of the previous drought, and the past two years are the second driest two-year period behind only 1976-77. Furthermore, statewide precipitation was well below normal during three of the last five water years and seven of the last ten water years. The precipitation information provided in **Figure 1** summarizes the annual statewide precipitation variability for the last 50 years from 1971 to present, although local conditions are variable.

Figure 1 shows that California's climate is highly variable with dry periods interspersed with wet years. Precipitation drives the hydrologic system in California, but it's the snowpack, reservoirs, and groundwater basins that provide the State's water storage (**Figure 2**). During dry periods, groundwater is California's largest source of stored water used to supply the State.

Groundwater basins act as a buffer between wet and dry periods, balancing out the variability in annual snowpack and reservoir storage by providing additional storage capacity in wet years and additional supply in dry years.

About 85 percent of Californians depend on groundwater for some portion of their water supply. Some communities rely entirely on groundwater for drinking water, and it is a critical resource for many farmers, urban areas, and ecosystems across the State. Snowpack and reservoir storage contribute a large percentage to the State's water supply (DWR Current Conditions); however, in dry years groundwater provides up to 60 percent of California's water supply and serves as a critical buffer against the impacts of drought and climate change. Other important factors enhancing California's water supply portfolio include conservation, desalination, and water reuse.

The State's increased reliance on groundwater during these recent dry years is reflected in the lowering of groundwater levels, as described in this report.

By the numbers

Changes in groundwater levels, especially when considering groundwater level declines during drought, can indicate potential vulnerabilities to groundwater wells and the environment. Groundwater level data also serves as a proxy for groundwater storage and provide valuable information on seasonal fluctuations, long-term changes, and trends in groundwater storage.

Groundwater levels are measured in a variety of groundwater wells located throughout the state. The data are collected by the Department of Water Resources (DWR) and also reported to DWR by California Statewide Groundwater Elevation Monitoring (CASGEM) Entities, Groundwater Sustainability Agencies implementing the Sustainable Groundwater Management Act (SGMA), local agencies, and private well owners.

This report uses maps to depict how groundwater levels have changed over time using two different analytical methods. One method, **groundwater level change maps**, show the change in groundwater levels between two different springtime measurements. The second method uses **trend analysis of water levels** for wells having at least 10 annual springtime measurements over a 20-year period to illustrate the statistical magnitude and direction of groundwater level change (a well's water level increasing or decreasing trend over time). Spring groundwater level data are an important indicator of groundwater conditions because spring generally corresponds to both the pre-irrigation season and the peak groundwater levels in a water year.

The groundwater level change maps (**Figures 3** - **6**) compare the spring 2021 groundwater level values to the values from spring 2020, 2018, 2016, and 2011 (one, three, five, and ten-year comparisons). The groundwater level change maps display groundwater level increases and decreases in wells and summarize data by hydrologic region. **Table 1** shows a breakdown of the information shown in the groundwater level change maps.

The one-year change map (**Figure 3**) shows more declines than increases in groundwater levels. Measurements from approximately 31 percent of measured wells show more than five feet of decline in groundwater level, and only six percent show more than five feet of increase in water levels. More wells indicate decreasing groundwater levels in the Sacramento River Region than in the Water Year 2020 one-year comparison (2020 Seasonal Groundwater Report).

The three-year change map (**Figure 4)** also shows more declines than increases in groundwater levels, with declining water levels greater than five feet in approximately 30 percent of the measured wells and 15 percent showing an increase of at least five feet in water levels. In the South Coast Hydrologic Region, forty-seven percent of groundwater measurements show an increase in groundwater levels greater than five feet, likely attributed to well established water management projects and actions.

The five-year change map (**Figure 5**) spans three years of above average precipitation, resulting in 26 percent of wells showing increases in water levels greater than five feet suggesting that Statewide, groundwater levels have rebounded since the height of the 2012 – 2016 drought. The five-year change data shows the highest percentage of wells with increasing water levels for all four reported change-year comparisons in this report.

Conversely, the 10-year change map (**Figure 6**) shows 62 percent of well measurements with greater than five feet of decrease in groundwater levels. This illustrates how some groundwater basins have not fully recovered to pre 2012-2016 drought conditions, specifically in the Central Valley.

Figure 7 shows the trend of change, which is the magnitude of decreasing or increasing groundwater levels over the most recent 20 years. The percent changes observed from Water Year 2001 to Water Year 2021 are summarized in **Table 2**. This period includes droughts from 2001 to 2002, 2007 to 2009, 2012 to 2016, and the current drought spanning years 2020 and 2021. During this 20-year period of stressed water resources and subsequent increased reliance on groundwater, water levels in more than 55 percent of statewide wells demonstrate a decreasing trend and in just over five percent demonstrate an increasing trend.

There are several clusters of wells with steep groundwater level declines across the state during the most recent 20-year period. These declining groundwater level trends were more pronounced in the southern Central Valley, although the north end of the valley shows a continued decrease of groundwater levels of up to 2.5 feet per year. Areas of steep decline include the western edge of the Sacramento Valley in the Sacramento River Hydrologic Region, the southeastern part of the San Joaquin Valley in the San Joaquin River Hydrologic Region, and most groundwater basins within the Tulare Lake Hydrologic Region. Moderate groundwater level declines are found in the North Coast, North Lahontan, South Coast, and South Lahontan Hydrologic Regions. There are notable increases in groundwater levels in the basins in the southeastern portion of the Sacramento Valley. The Central Coast and Colorado River Hydrologic Regions show the highest overall percentage of wells with groundwater level increases; however, relatively few wells were analyzed in these regions. The San Francisco Bay Hydrologic Region has the most stable groundwater levels of all regions.

Closing thoughts

Although the wet 2017 and 2019 Water Years resulted in higher amounts of runoff, reservoir storage, and increased groundwater levels in some locations (**Figure 5**), spring 2021 groundwater measurements show lower overall groundwater levels than the previous year (**Figure 3)**. Furthermore, groundwater levels in many regions of California have not fully recovered to conditions preceding the 2012-2016 drought as shown in the 10-year and 20-year change maps (**Figures 6 and 7**).

Groundwater level data show us that water levels throughout the state can respond differently to precipitation at both the regional and local levels. California's groundwater supply depends on the complex interaction of water recharge and management; including precipitation, the use of surface and recycled water supplies (in place of groundwater supplies), and groundwater pumping. At present, even during above normal and wet years of 2016, 2018 and 2019, the data show that groundwater levels continue to decline. This raises the question, is the state in a groundwater drought?

Extended dry periods typically require the reliance on groundwater while diminishing the amount of water entering the groundwater system. Thus, exacerbating groundwater declines, forcing the hydrologic system out of its historical balance, which decreases the groundwater system's ability to buffer the state's water supply.

Climate change is contributing to more frequent and severe droughts in California which has and will continue to have an impact on groundwater levels and groundwater storage due to

reduced natural groundwater recharge rates and increased reliance on groundwater. If unmanaged, this can lead to negative impacts.

Balancing the State's water supply, and planning for the variable and changing climate is imperative to the State's water reliance. A necessary component of this is a balanced groundwater system and is the goal of California's new groundwater regulatory framework under the Sustainable Groundwater Water Management Act (SGMA). Continued commitment and investment in sustainable groundwater management will improve the ability of state and local Groundwater Sustainability Agencies (GSA) to effectively manage droughts when a lack of precipitation and shortage of available surface water supplies result in a greater reliance on groundwater. To assist water managers and the public with accessing and visualizing up-to-date groundwater information, DWR has developed several web-based tools, the most recent of which is California's Groundwater Live website, an interactive application that allows users to explore, analyze, and visualize the latest groundwater data and information for California.

SGMA is a climate change adaptation strategy with the goal to help prepare for longer, hotter, and more severe droughts by balancing groundwater use and recharge. A foundational tenet of SGMA is the local management of groundwater resources which enables a powerful and collaborative framework for interested parties to be involved with groundwater management within their region. DWR encourages you to reach out to your county and local GSA, attend public GSA meetings, and provide input on the sustainable management of your groundwater resource.

Additional groundwater level data and information about current conditions can be found on DWR's Data and Tools Site, California Drought, and SGMA Program webpages.

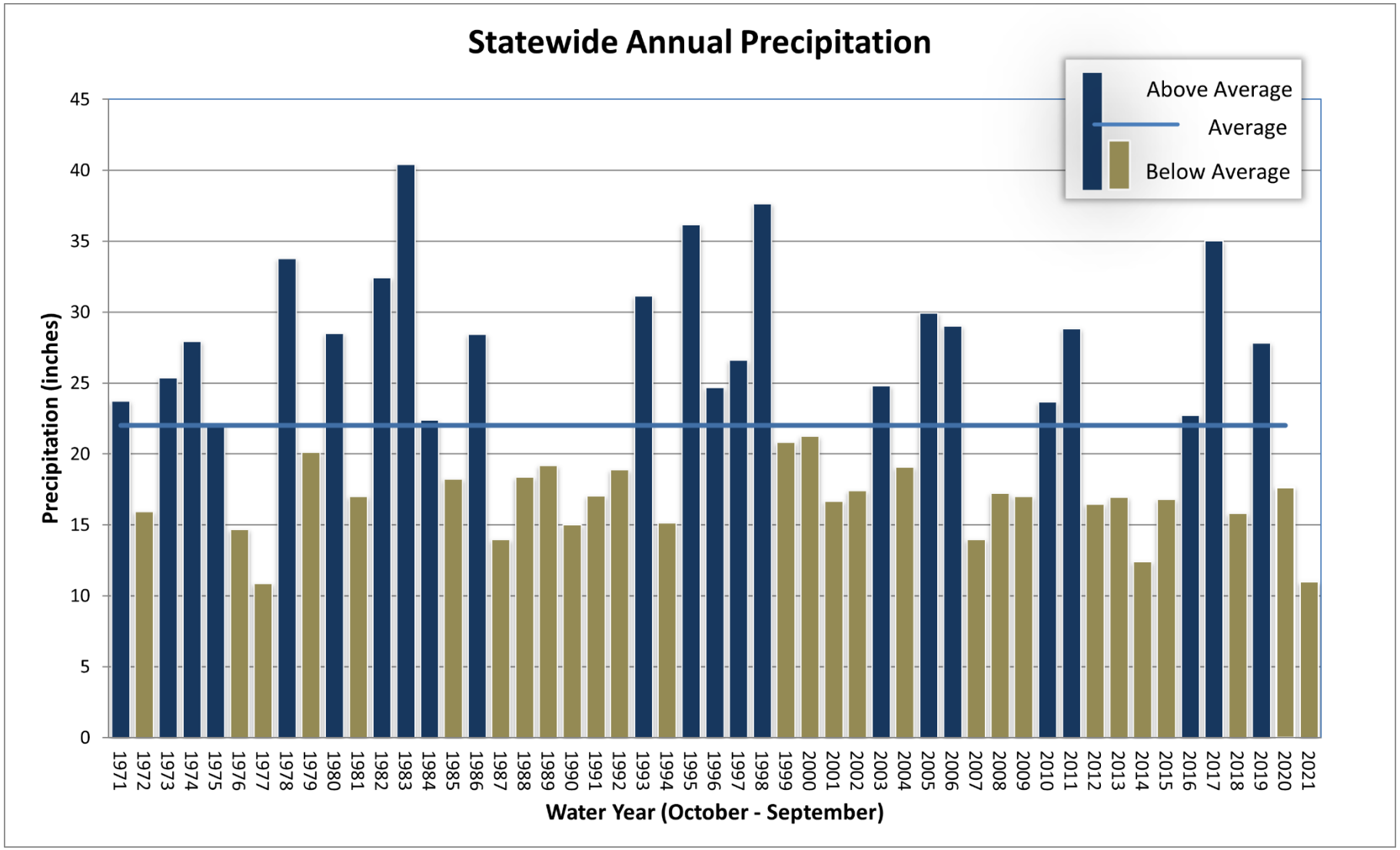

Figure 1: Statewide Annual Precipitation, NOAA National Centers for Environmental Information, (Climate at Glance: U.S. Time Series, Precipitation). 2021 Water Year Data uses projected totals based off mean precipitation levels from September 1896 to 2020 means.

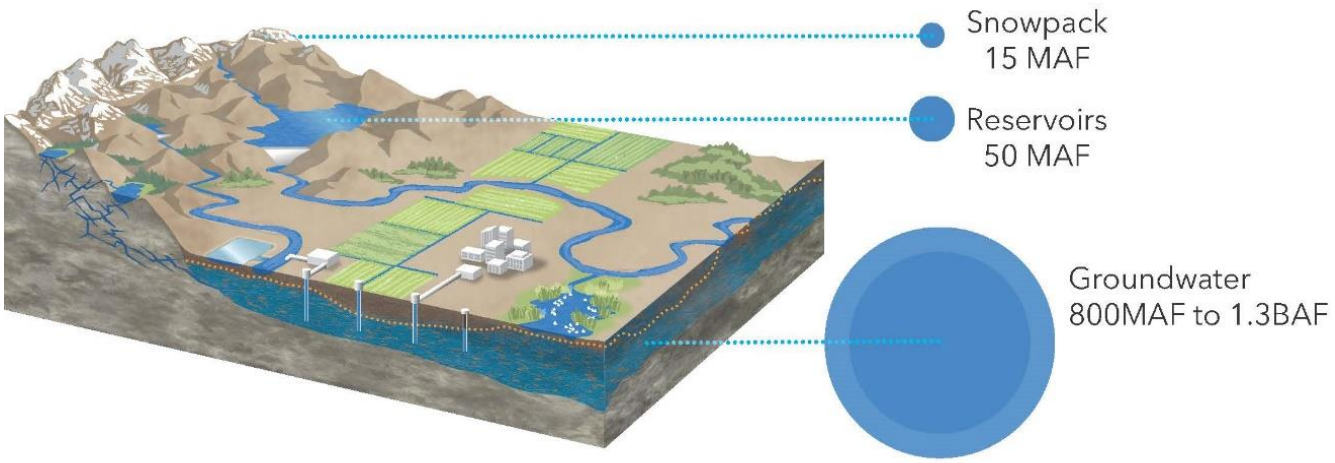

Figure 2: Relative Storage Volumes in Snowpack, Reservoirs, and Groundwater Aquifers.

Table 1: Statistical Summary of Groundwater Level Change Maps (**Figures 3-6**)

Period	Total Well Count	Decrease > 25 ft	Decrease 5 to 25 ft	Change +/- 5 ft	Increase 5 to 25 ft	Increase >25 ft
1-Year Change: 2021 levels compared to 2020 levels	5,185	4.7%	26.5%	62.8%	5.0%	1.1%
3-Year Change: 2021 levels compared to 2018 levels	5,006	4.2%	25.6%	55.0%	12.0%	3.2%
5-Year Change: 2021 levels compared to 2016 levels	4,918	3.3%	19.1%	50.9%	21.2%	5.4%
10-Year Change: 2021 levels compared to 2011 levels	3,133	20.4%	41.6%	30.7%	5.2%	2.1%

Table 2: Statistical Summary of Groundwater Level Trend Map (**Figure 7**)

Period	Total Well Count	Decrease > 2.5 ft	Decrease 0.01 - 2.5 ft	Change +/- .01 ft	Increase 0.01 - 2.5 ft	Increase > 2.5 ft
20-Year Trend: 2001 to 2021	4,342	16.7%	41.2%	36.0%	5.6%	0.6%

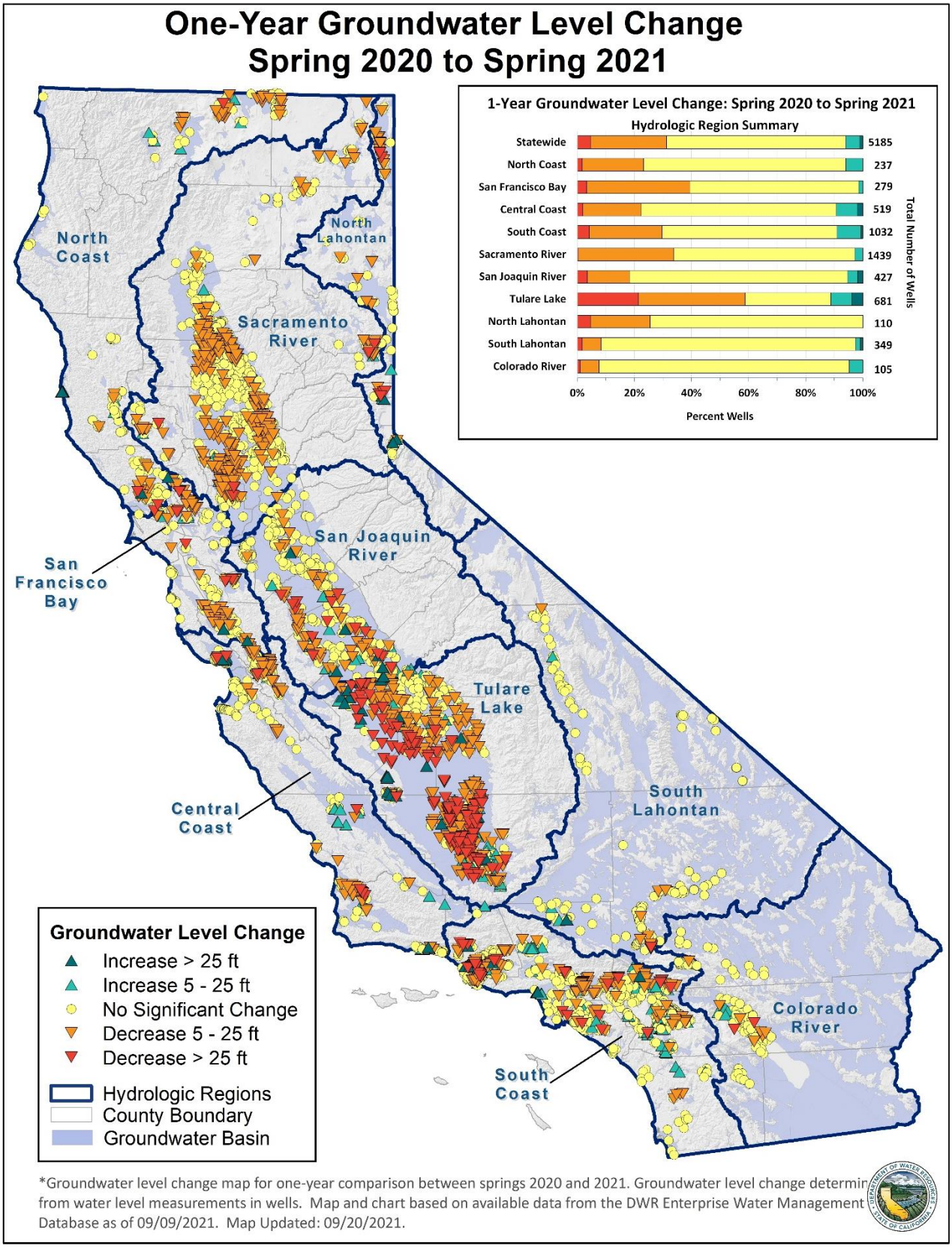

Figure 3: Statewide and Hydrologic Region groundwater level change map for one-year period between 2020 and 2021. See **Table 1** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 09/09/2021.

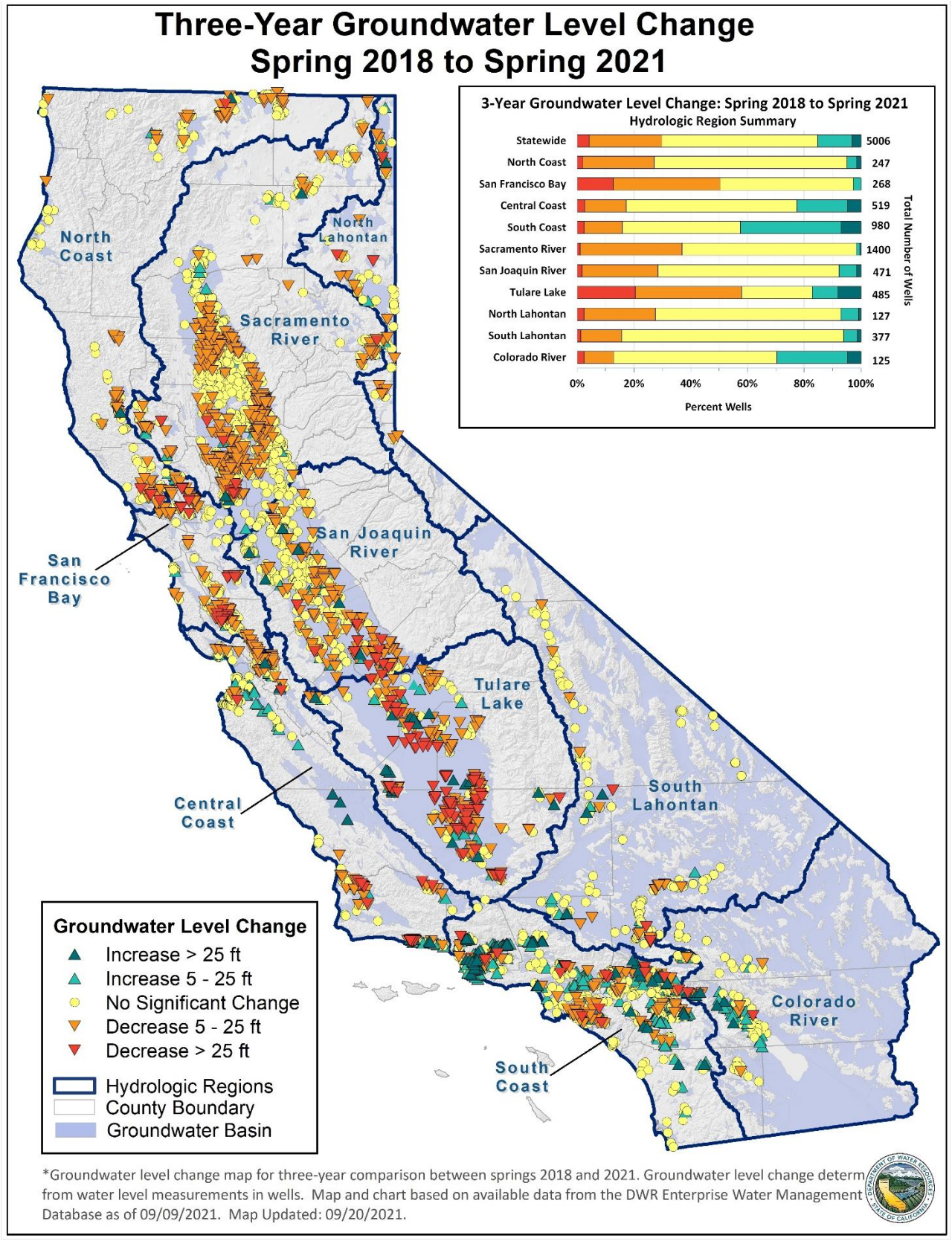

Figure 4: Statewide and Hydrologic Region groundwater level change map for three-year period between 2018 and 2021. See **Table 1** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 09/09/2021.

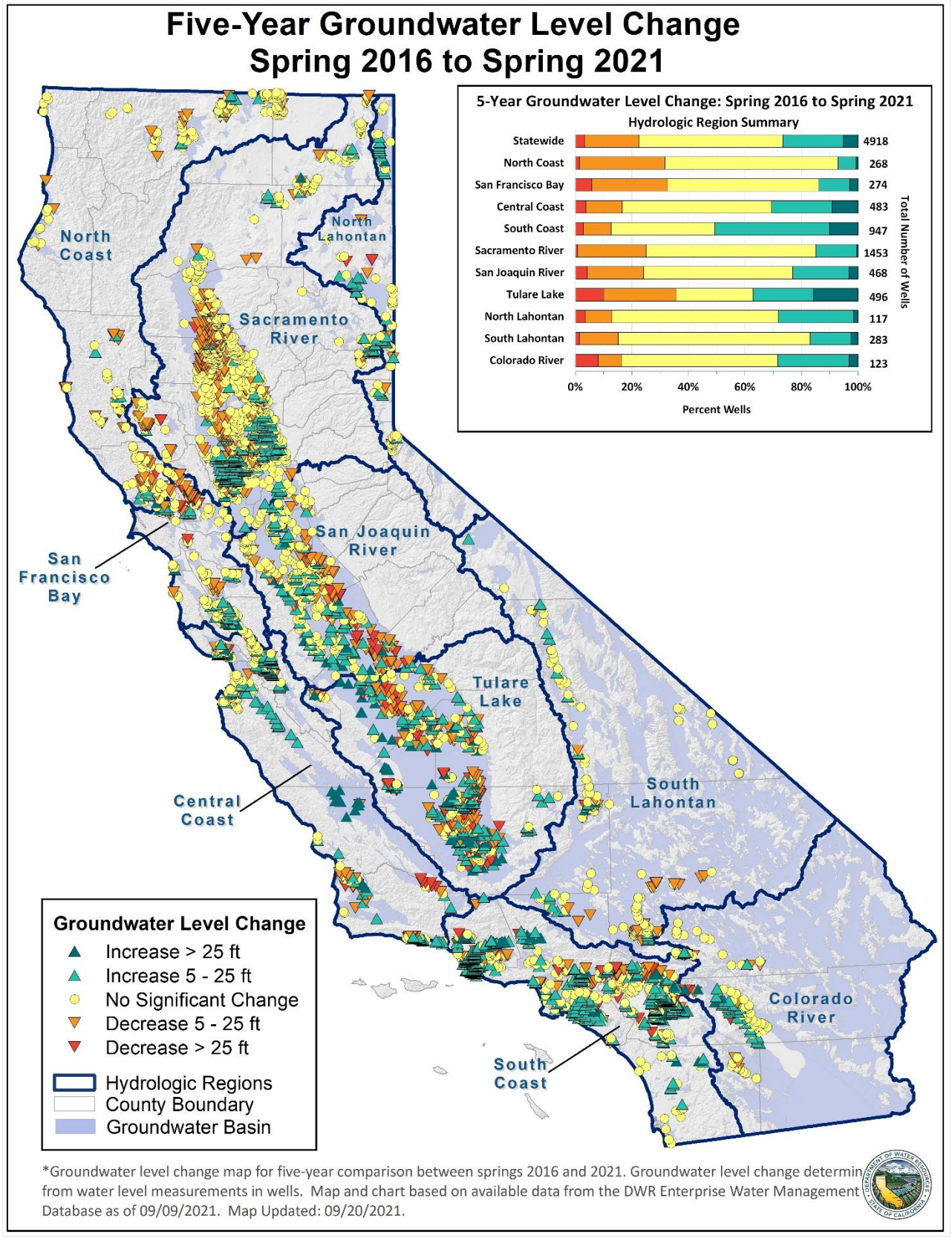

Figure 5: Statewide and Hydrologic Region groundwater level change map for five-year period between 2016 and 2021. See **Table 1** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 09/09/2021.

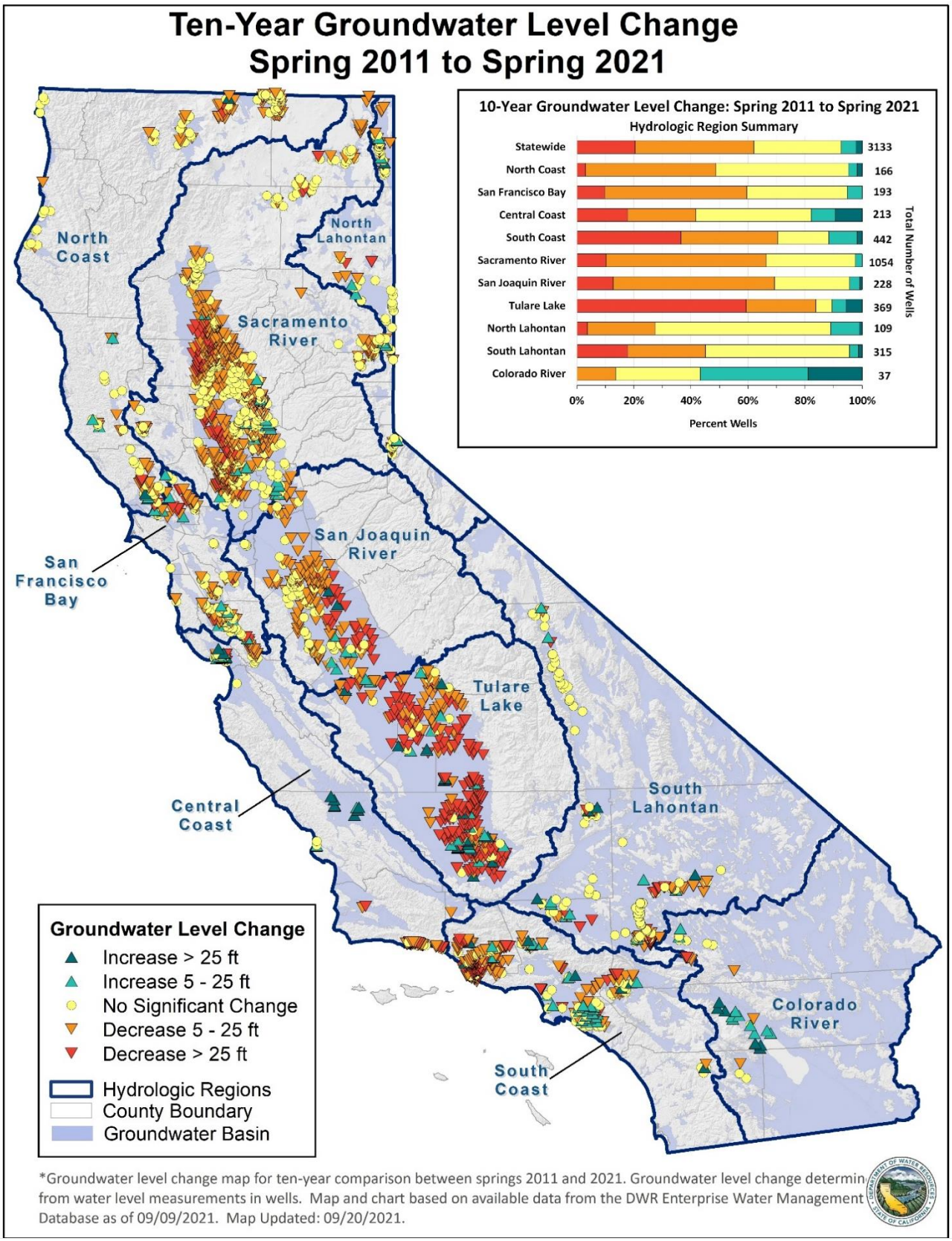

Figure 6: Statewide and Hydrologic Region groundwater level change map for 10-year period between 2011 and 2021. See **Table 1** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 09/09/2021.

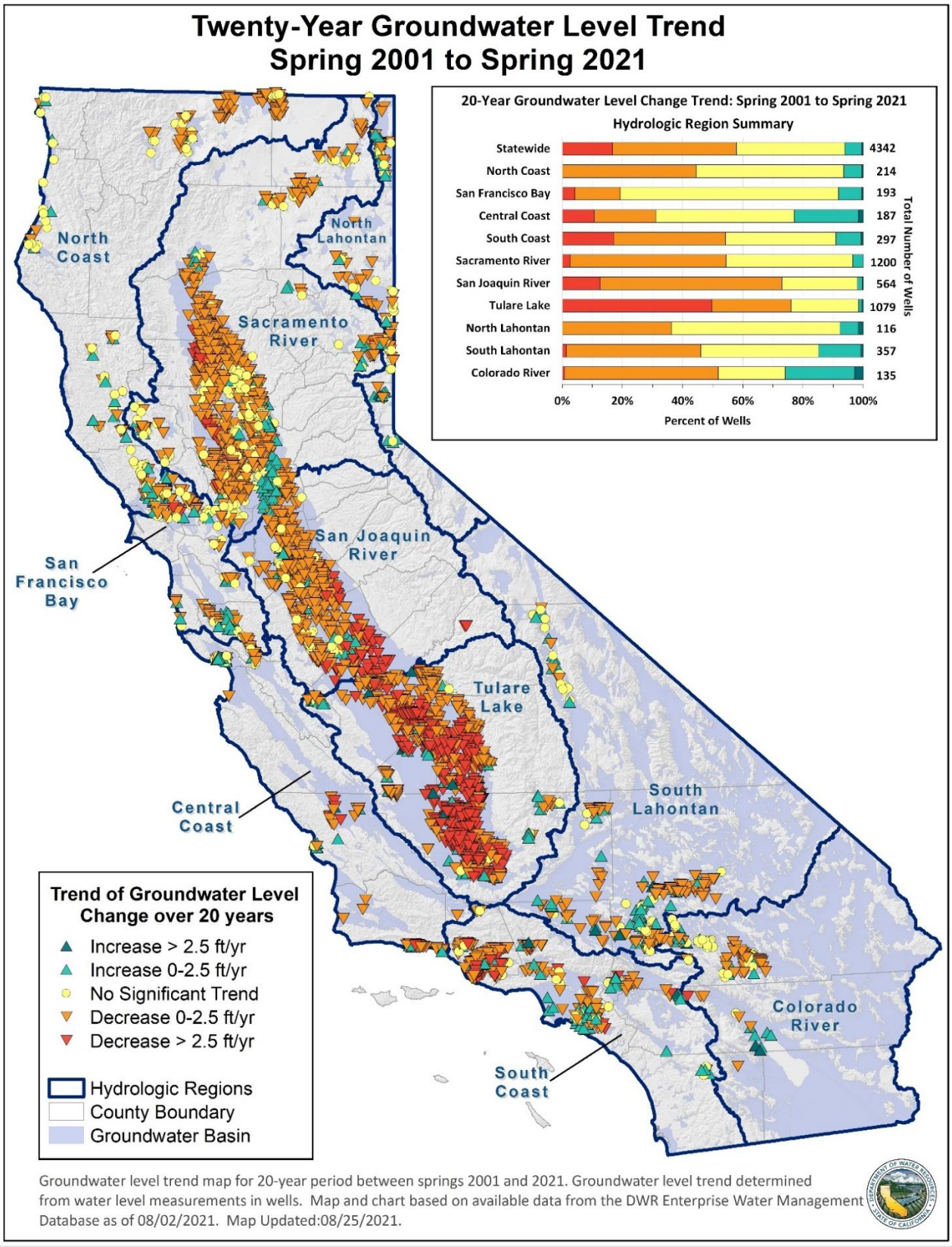

Figure 7: Statewide and Hydrologic Region groundwater level trend analysis map for Water Years 2001-2021. See **Table 2** for specific groundwater level statistics. Map and charts based on available data from the DWR Water Data Library as of 08/02/2021.