Sonoma County
Hazard Mitigation Plan

APPENDIX D: CLIMATE CHANGE

APRIL 2017

Sonoma County Permit and Resource Management Department
2550 Ventura Avenue
Santa Rosa, CA 95403

Sonoma County Fire and Emergency Services Department
2300 County Center Drive, Suite B220
Santa Rosa, CA 95403

Adopted by Resolution No. 17-0168
of the Sonoma County Board of Supervisors
April 25, 2017

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1. DROUGHT HAZARD

Hazard Description

A drought is a deficiency in precipitation over an extended period, usually a season or more, resulting in a water shortage causing adverse impacts on vegetation, animals, or people. A hydrological drought usually occurs following periods of extended precipitation shortfalls that impact water supply (i.e., stream flow, reservoir and lake levels, ground water), potentially resulting in significant societal impacts. An agricultural drought occurs when precipitation shortages result in soil water deficits and, reduced ground water or reservoir levels needed for irrigation, and other agricultural production.

Drought severity is dependent not only on the duration, intensity, and geographical extent of a specific drought episode but also on the demands made by human activities and vegetation on a region's water supplies. Human factors, such as water demand and water management, can exacerbate the impact that drought has on a region. For instance, water use may exceed the available water reserves and water replenishment rates causing water supplies to dwindle faster and stream and groundwater levels water levels to recede.

Unlike the other hazards discussed here, droughts are not a sudden onset hazard, but rather develop over an extensive period of time. Although droughts are sometimes characterized as an emergencies, they differ from typical emergency events. Most natural disaster, such as, floods or forest fires, occur relatively rapidly and afford little time for preparing for a disaster response; it is often not obvious or easy to quantify when a drought begins and ends. Multiple dry years generally pass prior to development of drought conditions. Similarly, multiple wet years generally pass prior to their alleviation. If drought conditions extend over a number of years, the direct and indirect economic impacts can be significant. High temperatures, high winds, and low humidity can worsen drought conditions and make areas more susceptible to wildland fires.

Drought is not localized, but occurs simultaneously across the region, and may extend statewide or across a larger expanse. While the drought may exist across a broad region, the impacts of the drought are locally unique, based on local and regional water supply systems, soil conditions, and the typical climate and vegetation land covering. This Appendix analyses and discusses the County's potential vulnerability to drought and sets forth a number of actions that can be taken to help reduce the vulnerability to and impacts from droughts.

Hazard History

California has experienced significant droughts in 1912-13, 1918-20, 1923-24, 1929-34, 1947-50, 1959-61, 1976-77, 1987-92, 2008-10 and 2013-16. Droughts exceeding three years are relatively rare in Northern California, the source of much of the state's water supply. The 1929-1934 drought established the criteria commonly used in designing storage capacity and

yield for large Northern California reservoirs. The driest single year in California's measured hydrologic history is 1977. The more recent drought events are summarized below.

1976-77 Drought

The drought of 1976-77 was the worst in the state's recent history due to the driest (1977) and fourth driest (1976) years on record. Statewide, California's average annual rainfall is 200,000,000 acre-feet. In 1977, precipitation totalled only 90,000,000 acre-feet, or 45 percent of average. This drought left California with dangerously low reservoir and ground water levels. Forty seven of the state's 58 counties declared emergencies. Economic losses totalled $2.4 billion. In Sonoma County, the Russian River saw only 6 percent of its normal runoff in 1977. The reduction of flow from this water source significantly impacted communities throughout Sonoma, Marin and Mendocino counties. The Board of Directors for the Sonoma County Water Agency proclaimed an emergency for the Russian River Water Supply in February 1976 and the Board of Supervisors proclaimed the Local Emergency in July 1976. The response required implementation of Water conservation measures and construction of emergency wells to augment supplies.

1987-1992 Drought

From 1987 to 1992, California experienced a serious drought due to low precipitation and run-off levels. The hardest-hit region was the central coast, roughly from San Jose to Ventura. 1987 to 1990 was the driest period on record in the central coast and central Sierra Nevada. In 1988, 45 California counties experienced water shortages that adversely affected about 30 percent of the state's population, much of the dry-farmed agriculture, and over 40 percent of the irrigated agriculture. Fish and wildlife resources suffered, recreational use of lakes and rivers decreased, forestry losses and fires increased, and hydroelectric power production decreased.

2007-2009 Drought

The 2007-2009 State drought brought issues of unsustainable groundwater use to the fore and inflamed debates over the Delta Water Project, a large initiative to accommodate the movement of water to Southern California. As a result, legislators passed a package of reforms to require local groundwater monitoring, increase urban water conservation targets, and plan for the Delta's future.

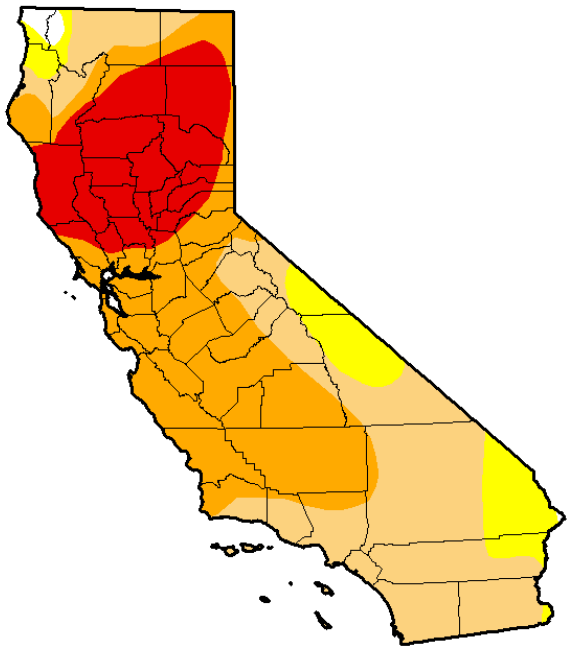
Rainfall levels statewide for the 2008-2009 water year were 24 percent below average as of the February 1, 2009 measurement; and the second snow pack survey of the 2009 winter season indicated that snow pack water content was 39 percent below normal. As of February 23, 2009, storage in the state's reservoir system was at a historic low. Low water levels in the state's reservoir system had significantly reduced the ability to generate hydropower. State Water Project water allocations were reduced to 15 percent of requested deliveries, matching 1991 as the lowest water allocation year in State Water Project history. Central Valley Project water allocations for agricultural users have also been reduced to zero.

The lack of water forced California farmers to abandon or leave unplanted more than 100,000 acres of agricultural land. California farmers provide nearly half of the fresh fruits, nuts and vegetables consumed by Americans, and the crop losses caused by the drought increased food prices, further adversely affecting families and economies throughout California. Agricultural

revenue losses exceeded $300 million, with a total economic loss of nearly $3 billion in 2009. These income and job losses adversely impacted entire communities and diverse sectors of the economy, including the housing market and commercial business.

In Sonoma County, abnormally dry to extreme drought conditions occurred from April 2007 to January 2012. At the height of drought severity in 2009, Lake Sonoma was 74 percent full, with about 182,000 acre feet of water, a decrease from 210,000 acre feet in 2008. Lake Mendocino was 38 percent full in 2009. After two dry years, and only 7.28 inches of rain – compared to 15.5 inches in 2008 – the area was listed by the U.S. Drought Monitor as in a "D-2" or "severe drought" condition (Figure App E-1).

Figure App E-1: CA Drought Snapshot February 3, 2009



U.S. Drought Monitor

California

February 3, 2009

(Released Thursday, Feb. 5, 2009)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.77	99.23	89.43	54.70	19.01	0.00
Last Week 1/27/2009	1.23	98.77	88.21	48.90	15.94	0.00
3 Months Ago 11/4/2008	0.00	100.00	90.51	40.37	0.00	0.00
Start of Calendar Year 12/30/2008	1.69	98.31	88.21	43.02	2.77	0.00
Start of Water Year 9/30/2008	0.04	99.96	95.90	55.23	2.05	0.00
One Year Ago 2/5/2008	18.23	81.77	36.63	14.06	0.00	0.00

Intensity:

D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Eric Luebehusen
U.S. Department of Agriculture

http://droughtmonitor.unl.edu/

2012-2016 Drought

California experienced prolonged dry conditions from 2012-2016 and is currently in its fifth year of severe drought. Seven of the nine years since 2007 (when the 2007-09 drought began) have been dry. California also experienced record-high temperatures during this time, intensifying drought impacts to mountain snowpack and stream flow. 2014 and 2015 were, respectively, the warmest and second-warmest years in 121 years of statewide average temperature records. 2014 was also the third driest year on record. At the end of 2014, the state reservoirs were on the average at 41 percent of their capacity. On January 17, 2014 California State Governor, Jerry Brown, proclaimed a drought state of emergency and directed state officials to take all necessary actions to prepare for drought conditions. The lack of winter rain and snowfall

resulted in severe impacts to municipal and well water supplies, agriculture (plants and livestock) and firefighting capabilities.

In Sonoma County, "Abnormally Dry" to "Exceptional Drought" conditions (see Figure App E-1) occurred from January 2010 to May 2016. The Board of Supervisors proclaimed a local emergency due to drought conditions on February 25, 2014. That proclamation covered the entire Sonoma County Operational Area, including all nine cities and special districts and was continued until March 1, 2016. This proclamation was in response to an intensification of the state's ongoing drought in 2014, and was guided by mandatory State emergency conservation regulations issued to all water providers in California.

Figure App E-2: CA Drought Snapshot July 29, 2014

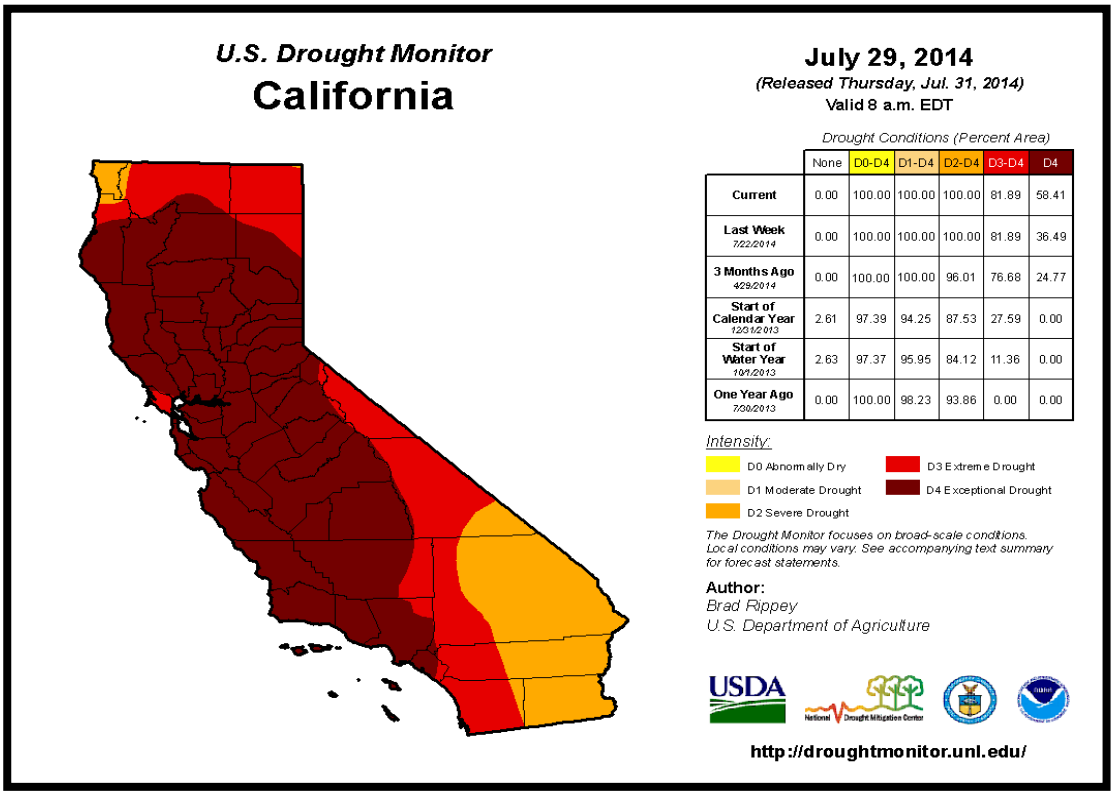
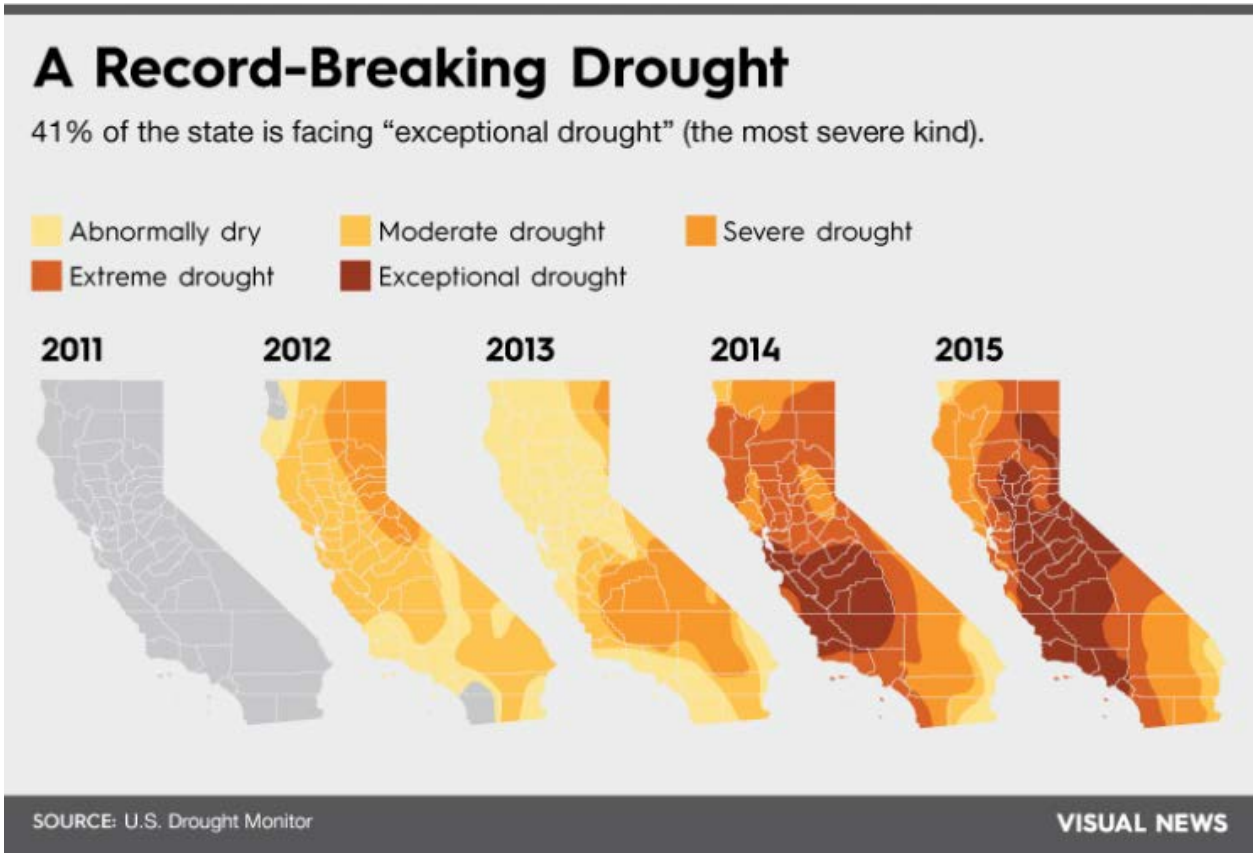


Figure App E-3: California Drought Trends 2011-2015



Future Potential

In urban areas, drought conditions can cause a decrease in available water supplies, which may lead to increases in water rates or restrictions in water use. Drought conditions harden the ground, which can lead to increased flooding when rains return because the soil cannot easily absorb water. Prolonged drought can also create increased levels of wildfire risk, with prolonged conflagrations fuelled by excessively dry vegetation. Droughts can also result in adverse economic impacts because water is integral for producing goods and providing services.

During times of drought, vegetation is visibly dry, stream and river flows decline, water levels in lakes and reservoirs fall, and the depth to water in wells increases. As drought persists, longer-term impacts can emerge, such as land subsidence, seawater intrusion, and ecosystem damage, especially cold water fisheries. Unlike the immediate impacts of drought, however, long-term impacts are more complex and may be costly to manage in the future.

Table App E-1: US Drought Monitor Classification Scheme

Category Description	Possible Impacts
D0 Abnormally dry	Slower growth of crops and pastures compared to normal activities.
D1 Moderate drought	Some damage to crops and pastures. Streams, reservoirs, or wells low. Some water shortages may be developing or imminent.
D2 Severe drought	Likely crop and pasture losses. Water shortages are common, leading to restrictions.
D3 Extreme drought	Major crop and pasture losses. Widespread water shortages.
D4 Exceptional drought	Exceptional and widespread crop and pasture losses. Emergency shortages develop.

Source: US Drought Monitor 2016

Short-Term Drought Impacts

During drought, declines in surface water flows can be detrimental to agricultural and municipal water supplies, hydropower production, navigation, recreation, and habitat for aquatic and riparian species. Several California Water Science Center stream gages have recently recorded stream flows that are below all-time record lows for specific days of the year. Annual runoff, which is calculated from this streamflow data, is an important source of water.

Unlike the effects of a drought on stream flows, groundwater levels in wells may not reflect a shortage of rainfall for a year or more after a drought begins. Despite reduced availability, reliance upon groundwater often increases during drought through increased groundwater pumping to meet water demands. If water is pumped at a faster rate than an aquifer is recharged by precipitation or other sources, groundwater water levels can drop, resulting in decreased water availability, poor groundwater quality, and land subsidence.

Long-Term Drought Impacts

Excessive groundwater pumping and aquifer depletion can result in compaction of aquifer material which can result in permanent loss of aquifer storage, land subsidence, and

infrastructure damage. In areas near the bay and ocean groundwater pumping can cause seawater intrusion into the freshwater aquifer system. Seawater intrusion compromises groundwater quality and can be a costly problem to manage.

Water allocations for river, wetland, and fish and wildlife habitat can be reduced or stopped altogether during severe drought. A key consideration and priority is maintaining sufficient river flows to aid the recovery of endangered and threatened salmon and steelhead.

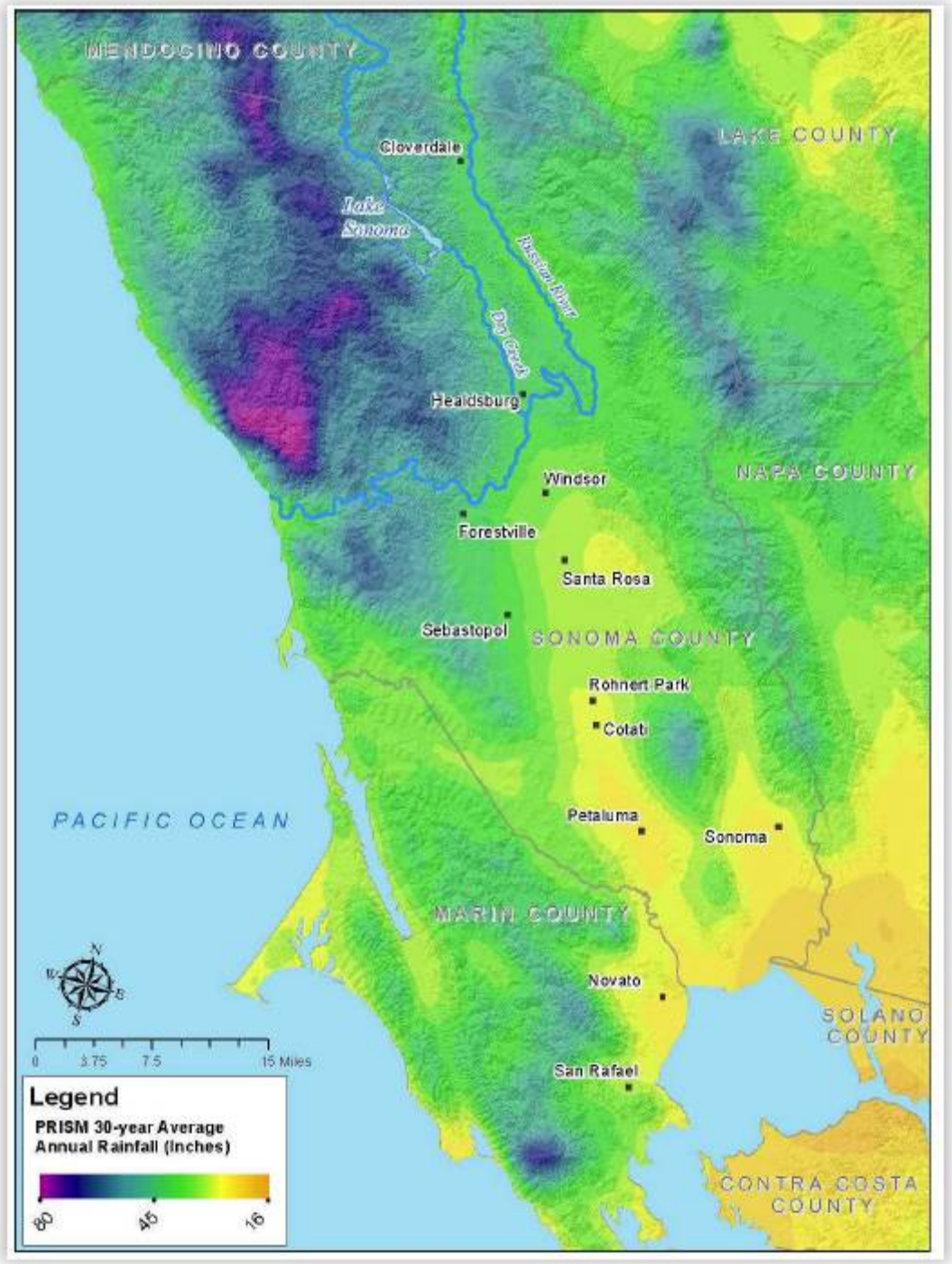
Physical Factors Affecting Drought and Water Availability

The California Water Science Center monitors the immediate impacts of drought on water availability and water quality through streamflow, surface water, and groundwater monitoring and data collection. Long-term local data collection is needed to assess the effects of climate variability on water sources, to monitor the effects of regional aquifer development, and to obtain data sufficient for analysis of surface water and groundwater-level trends.

The climate in the County influences water demands, primarily outdoor water use, and the amount of surface water supplies. In the Russian River Watershed, approximately 93 percent of the annual precipitation normally falls during the wet season, October to May, with a large percentage of the rainfall typically occurring during three or four major winter storms. These major storms often come in the form of an atmospheric river, the horizontal transport of large amounts of water vapor through the atmosphere along a narrow corridor. Although brief, atmospheric rivers can produce 30 to50 percent of the regions annual precipitation in a matter of a few days.

The quantity of rainfall in the county increases with elevation, with the greatest precipitation occurring over the highest ridges. The valleys, where the majority of the water users are located, receive considerably less rainfall with some areas averaging just over 20 inches of precipitation annually. Figure App E-4 shows the variation in average annual rainfall across the County.

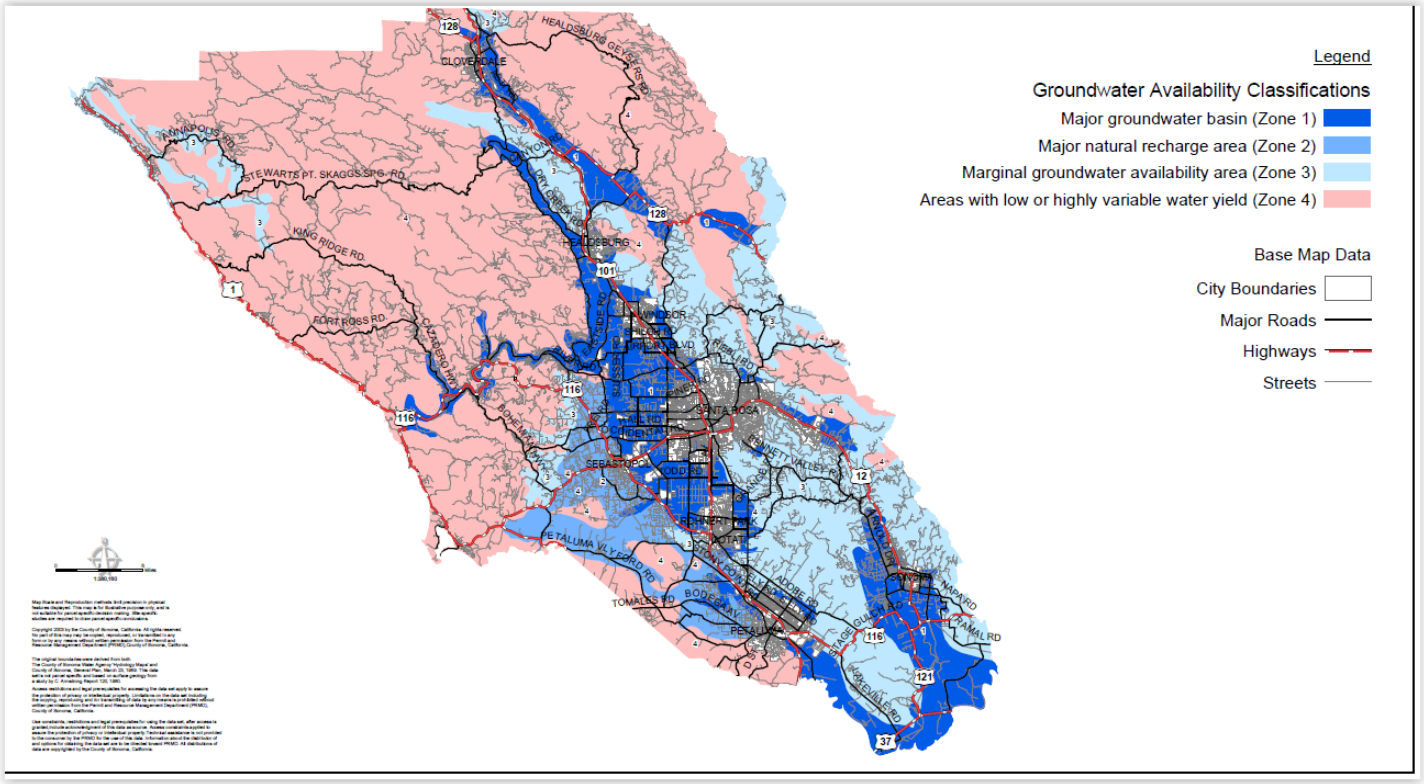
Figure App E-4: Regional Average Precipitation Rates



Groundwater storage capacity varies throughout the County and is dependent on variations across the underlying geology and its water storage capacity. Many of the Coastal hills and mountain ranges are underlain by fractured bedrock and lask alluvial deposits that readily store water. Figure App E-5 shows the four areas of groundwater availability in the County. Water is generally less abundant in marginal Groundwater Availability Areas 3 and 4. However, even in

major groundwater basins (Area 1) groundwater availability and impacts from groundwater pumping are more pronounced during times of drought.

Figure App E-5: Groundwater Availability in Sonoma County



Climate Change Impacts on Water Resources

As a result of climate change, Sonoma County can expect to experience hotter, drier weather with longer summers causing more frequent and more severe droughts. *Climate Ready Sonoma County: Climate Hazards and Vulnerabilities* by the North Bay Climate Adaptation Initiative looks at the risks and uncertainties involved with climate readiness. Although models disagree about whether Sonoma County precipitation levels will decrease or increase as a result of climate change, the projected warmer temperatures are expected to increase the rate of evaporation from bodies of water, further decreasing the amount of available water. However, all scenario models indicate more variable precipitation, with unusual amounts of rain occurring at unusual times, contributing to increased drought. With longer periods of time when soils are drier and less runoff into reservoirs, drought conditions reduce local water supply, stress regional supplies and limit the availability of statewide water sources.

More variable precipitation from climate change may also contribute to bigger and more frequent floods.

Rising sea levels will lead to more frequent flooding of homes and infrastructure. Coastal communities in Sonoma County will face flooding with bigger waves, storm surges, and wave run-up, increasing erosion.

Scientific studies have identified the following trends resulting from climate changes:

- A reduction of the Sierra Nevada snowpack, an important source of urban, agricultural and environmental water.
- Weather patterns becoming more variable, causing more frequent severe winter and spring flooding and longer, drier droughts.
- In the past century, sea levels has risen over one-half foot at the Golden Gate. It is projected continued sea level rises will threaten many coastal communities.
- Rising water temperatures and changes in runoff patterns or decreased stream flows may adversely impact salmon and other aquatic species.
- Additional Severe to Extremely Severe Droughts over the next 10-20 years.

Exposure and Vulnerability

Sonoma County has two principal sources of water for residential, commercial, industrial and agricultural use: the Russian River and groundwater. Additional water sources include diversions from small streams and springs and numerous reservoirs. According to the 2010 Census, approximately 460,000 people live in Sonoma County. Of this amount, about 66 percent live in cities served by public water systems. There are about 150,000 people living in the county's unincorporated areas. The majority of the population living in the unincorporated rural areas are outside urban service areas and are dependent on individual onsite wells or small scale shared water supply systems.

In California drought impacts are felt first by those most dependent on or affected by annual rainfall – agencies fighting forest fires, ranchers engaged in dry land grazing, rural residents relying on wells in low-yield rock formations, or small water systems lacking a reliable water source.

Agriculture

In addition to residential, commercial and industrial needs, the County's agricultural industry relies on a steady source and supply of water. Sonoma County's agricultural industry is a strong economic sector, producing 888 million dollars of goods in 2014. Table App E-2 shows the estimated land area of crops. Local agriculture industry produces over almost 90 million dollars' worth of livestock each year. The agricultural industry's dependency upon water for production and processing makes it vulnerable to drought conditions.

Table App E-2: Estimated Land Area of Agricultural Uses in Sonoma County, 2014

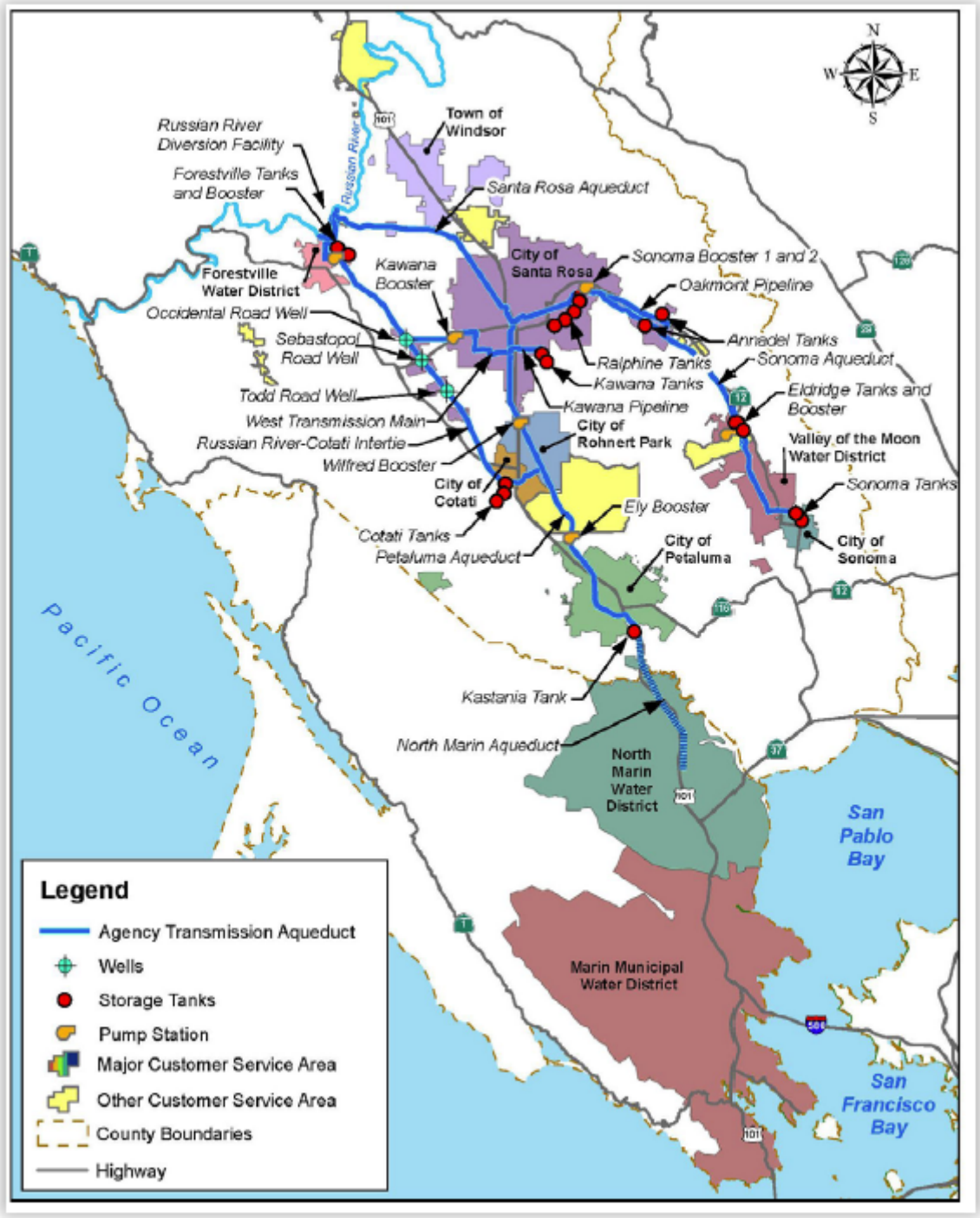
Crop Class	Sum of acres
Vineyard	63,120
Intensively Managed Hayfield	16,403
Orchard or Grove	3,729
Irrigated Pasture	3,424
Vineyard Replant	1,237
Annual Cropland	1,226
Perennial Agriculture	199
Nursery or Ornamental Horticultural Area	75
Grand Total	**89,414**

For example, the 2014 Sonoma County Crop Report indicated that, field crops saw significant damage due to drought. Many of the crops produced one third of their normal yield; volunteer hay yield was 37 percent of the five-year average and grain oats produced just 33 percent. Pasture and Rangeland were severely impacted, with yields of 38 percent and 26 percent of normal. The United States Department of Agriculture declares a disaster for any county which is shown in severe drought on the U S Drought Monitor for eight consecutive weeks. During 2014, the United States Department of Agriculture designated most counties in the state as primary natural disaster areas due to damages and losses caused by severe drought. Sonoma County was included in this designation

Sonoma County Water Agency Water Storage and Transmission System

The Russian River provides most of the Sonoma County Water Agency's water supply to the urbanized areas of Sonoma County and northern Marin County. The extensive system of water supply infrastructure (reservoirs, groundwater basins, and interregional conveyance facilities) operated by the Water Agency generally mitigates the effects of short-term dry periods for most water users.

Figure App E-6: Russian River Watershed and the Water Agency's water supply system



The Russian River watershed drains an area of 1,485 square miles that includes much of Sonoma and Mendocino counties. The watershed collects water from rainfall, groundwater seepage, reservoir releases, and Eel River diversions. The two major reservoirs regulating flow on the Russian River are Lake Mendocino (Coyote Valley Dam) and Lake Sonoma (Warm Springs Dam). The United States Army Corps of Engineers manages flood control operations

flood management releases from both reservoirs. The Water Agency has the right to manage and control releases from the water supply pools of both reservoirs. The State Water Resources Control Board sets minimum stream flow requirements on the Russian River and Dry Creek.

Lake Pillsbury and the Potter Valley Project (PVP)

PG&E's Potter Valley Project (PVP) consists of a diversion tunnel to transfer water from the Eel River into the Russian River watershed. Water is stored in Lake Pillsbury on the Eel River in Mendocino County then released 12 miles downstream to Cape Horn Dam and flows through a diversion tunnel to the Potter Valley powerhouse in the Russian River watershed. The water is discharged from the powerhouse into a canal from which the Potter Valley Irrigation District diverts water. It then flows into the East Fork of the Russian River to Lake Mendocino. PVP diversions are regulated by a license issued to PG&E by Federal Energy Regulatory Commission and serves multiple purposes, including power generation, Potter Valley agricultural irrigation, and minimum instream flow requirements in the East Fork of the Russian River.

Lake Mendocino and Coyote Valley Dam

The Coyote Valley Dam impounds water on the East Fork of the Russian River in Mendocino County, forming Lake Mendocino. Lake Mendocino captures water from two sources: (1) runoff from a drainage area of about 105 square miles and (2) Eel River water diverted by PG&E's PVP. Natural drainage and stream flow (as opposed to reservoir releases) contribute the majority of the Russian River flow downstream of Coyote Valley Dam and above Dry Creek during the rainy season (November through April). During the drier months of May through October, water released from Lake Mendocino accounts for most of the water in the Russian River upstream of Dry Creek.

The Water Agency and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFC&WCID) have water right permits authorizing storage up to the design capacity of 122,500 acre-feet per year (ac-ft/yr) in the reservoir. The water supply pool capacity of Lake Mendocino is currently 68,400 ac-ft. The Water Agency controls releases from the water supply pool in Lake Mendocino. However, the Corps manages flood control releases when the water level exceeds the top of the water supply pool elevation. The Corps allows the Water Agency to encroach into the flood pool in the spring so that the summer water supply pool can be increased to 111,000 ac-ft.

Lake Sonoma and Warm Springs Dam

The Warm Springs Dam impounds water on Dry creek in Sonoma County forming Lake Sonoma. Runoff from a drainage area of about 130 square miles flows into Lake Sonoma. Lake Sonoma has a design capacity of 381,000 ac-ft at the spillway crest and a design water supply pool capacity of 245,000 ac-ft.

The Water Agency controls water supply releases from Lake Sonoma and the USACE manages flood control releases. Natural drainage and stream flow (as opposed to reservoir releases) contribute the majority of the Dry Creek flow downstream of Warm Springs Dam during the rainy season (November through April). During the dry season (May through October), reservoir releases contribute the majority of the flow in Dry Creek.

Reservoir discharges supply flow along with other flows from runoff and tributaries to meet minimum instream flow requirements and municipal, residential, and commercial demands in the lower Russian River area.

In Sonoma County, major users of Russian River water include the cities of Cloverdale and Healdsburg; numerous individual diverters along the main stem of the Russian River and Dry Creek; and the Sonoma County Water Agency. The Water Agency diverts water from the Russian River near Forestville and conveys the water via its transmission system (including diversion facilities, treatment facilities, aqueducts, pipelines, water storage tanks, and booster pump stations) to its customers.

Small Water System Vulnerability

About 72 Small Water Systems (defined as having between 5 to 14 service connections) supply water to a wide variety of users in Sonoma County, including campgrounds, small commercial establishments, mobile home parks, isolated rural residences and subdivisions, and small unincorporated communities. Permitting, inspecting and monitoring are conducted through County Department of Health Services, Division of Environmental Health. The vulnerability of these systems vary depending on their location, water supply, and available storage and demand.

Private Well Vulnerability

Private Wells are most vulnerable in groundwater basins where limited recharge and excessive withdrawals lead to a decline in the groundwater levels. Groundwater availability and aquifer conditions vary widely in the county but shallow wells and wells in upland areas may be particularly vulnerable. Private Wells considered most vulnerable to drought are located in the marginal groundwater Areas 3 and 4 shown on Figure AppE-5, though groundwater levels can be adversely affected in major groundwater basins (Area 1)

Plans

The California Water Plan Update 2013

Required by the California Water Code Section 10005(a), the California Water Plan (Water Plan) is the strategic plan for managing and developing water resources statewide for current and future generations. It provides a collaborative planning framework for elected officials, agencies, tribes, water and resource managers, businesses, academia, stakeholders, and the public to develop findings and recommendations and make informed decisions for California's water future.

Climate Action Plan 2020 and Beyond

Climate Action 2020 and Beyond builds on prior commitments to reduce Greenhouse Gas (GHG) emissions through a community-wide climate action plan (CAP) for all communities in Sonoma County. The regional framework creates an efficient and consistent approach to address climate change but allows local governments to adopt locally appropriate measures to reduce GHG emissions. It provides information about local climate hazards and makes recommendations to Sonoma County communities can do to prepare for GHG related issues.

Climate Ready Sonoma County: Climate Hazards and Vulnerabilities (2015)

Climate resilience, or climate readiness, is critical for Sonoma County. The report “Climate Ready Sonoma County: Climate Hazards and Vulnerabilities” looks at the risks Sonoma County faces due to climate change, and identifies threats for which we need to increase preparedness.

The report explores the potential impacts of climate change on various sectors, including people and social systems, built infrastructure, and natural and working lands by examining trends in weather patterns, sea level rise, and flood plains. The hazards identified in the report are not new, there are processes in place to manage these risks such as severe storms, floods, droughts, heat waves, and fires, but it is important to continue investing in the resiliency of the community as the intensity and frequency of these events change.

Sonoma County General Plan 2020: Water Resources Element

The broad purpose of the Sonoma County General Plan is to set forth policies which will guide decisions on future growth, development, and conservation of natural resources. The Land Use Element, Water Resources Element and the Public Facilities Element all set forth policies seeking to maintain adequate water supplies.

2015 Urban Water Management Plan

The Urban Water Management Plan (UWMP), adopted on June 21, 2016, addresses the Sonoma County Water Agency water transmission system and includes a description of the water supply sources, historical and projected water use, and a comparison of water supply to water demands during normal, single-dry, and multiple-dry years. The Water Agency provides wholesale water, principally from the Russian River, to eight water contractors, other water transmission system customers, and the Marin Municipal Water District (MMWD).

The Sonoma County Water Agency's extensive system of water supply infrastructure consisting of its reservoirs, groundwater basins, and inter-regional conveyance facilities help mitigate the effect of short-term dry periods for most water users in its service area. The Water Agency is involved with different regional programs and partnerships to provide help and information for consumption reduction.

As the main water supply entity for 2/3 of the county population, Section 7 of the Plan describes the Water Agency's planning for responding to water shortages including stages of action, prohibitions, penalties, consumption reduction methods, mechanisms for determining actual reductions in use, revenue and expenditure impacts, a shortage contingency resolution, plans for catastrophic events, and the estimated multiple dry-year minimum water supply.
As a water wholesaler, the Water Agency does not have the ability to impose use restrictions or other requirements directly on end users of water in the event of a shortage; such actions must be taken by the Water Agency's Customers. The Agency's Agreement for Water Supply describes the manner in which the Water Agency is to allocate water to its customers in the event of a water supply shortage, and describes the manner in which the Water Agency is to allocate water to its customers in the event of a temporary impairment of the capacity of some or all of the Water Agency's transmission system.

Table App E-3: Allocations to regular customers in the event of a 50% cutback in the Agency's Russian River Water Supply

Regular Customers	Allocation, ac-ft/yr
Cotati	689
Petaluma	6,129
Rohnert Park	2,906
Sonoma	1,253
Windsor (From Transmission System)	315
North Marin Water District (MMWD)	4,751
Santa Rosa	16,787
Valley of the Moon Water District	2,147
Other Water Agency Customers	946
Sub-Total	35,922
Marin Municipal Water District	712
Russian river Customers (includes Windsor direct diversions)	3,166
Total	39,800

Table App E-4 compares the total water supply available in multiple dry years with projected total water use over the next 25 years. According to the Department of Water Resources analysis, there is adequate water supply during multiple dry years (three years in a row) to meet demands through 2040.

Table App E-4: Multiple dry year supply and demand comparison in acre-feet

		2015	2020	2025	2030	2035	2040
First Year	Supply Totals	42,254	66,260	70,309	73,011	75,117	75,998
	Demand Totals	42,254	66,260	70,309	73,011	75,117	75,998
	Difference	0	0	0	0	0	0
Second Year	Supply Totals	42,254	66,260	70,309	73,011	75,117	75,998
	Demand Totals	42,254	66,260	70,309	73,011	75,117	75,998
	Difference	0	0	0	0	0	0
Third Year	Supply Totals	42,254	66,260	70,309	73,011	75,117	75,998
	Demand Totals	42,254	66,260	70,309	73,011	75,117	75,998
	Difference	0	0	0	0	0	0

Legislation

The California Water Conservation Act of 2009

In an effort to emphasize and increase water use efficiency, the State Legislature has directed urban retail water suppliers to reduce urban per-capita water use by 20 percent by the year 2020. This legislation, the Water Conservation Act of 2009 was enacted as part of a five-bill package aimed at improving the reliability of California's water supply and restoring the ecological health of the Delta.

Sustainable Groundwater Management Act

The Sustainable Groundwater Management Act (SGMA) of 2014, gives local agencies (cities, counties and water districts) the powers needed to sustainably manage groundwater over the long-term, and requires Groundwater Sustainability Plans (GSPs) be developed for medium- and high-priority groundwater basins. In Sonoma County, three of the county's 14 basins and sub-basins are currently designated as medium-priority: Santa Rosa Plain, Sonoma Valley and Petaluma. Sustainable yield is defined as the amount of groundwater that can be withdrawn annually without chronically lowering groundwater levels, causing seawater intrusion, degrading water quality, causing land subsidence or depleting interconnected surface water (for example, creeks, streams and rivers) in a manner that causes significant and adverse impacts.

Codes and Regulations

Water Efficient Landscape Ordinance

Chapter 7D3 of the County Code sets forth requirements for water efficient landscaping. The Water Efficient Landscape Ordinance (WELO) was adopted by the Board of Supervisors on December 15, 2009, and went into effect on January 15, 2010. The ordinance requires a landscape plan check for certain projects, as described in the ordinance. An amendment to Chapter 7D3 was adopted by the Board of Supervisors on November 17, 2015, updating the WELO in accordance with the Department of Water Resources regulations to reduce water consumption and waste in landscape irrigation.

California Building Codes

- *CALGreen:* The California Green Building Standards Code (CALGreen Code) is Part 11 of the California Building Standards Code and is the first statewide "green" building code in the US. CalGreen includes building related water conservation measures.
- As of January 1, 2014, Sections 1101.1 through 1101.8 of the California Civil Code require that all non-complaint plumbing fixtures within a single-family dwelling be replaced with compliant, water-conserving plumbing fixtures as a condition of final inspection of all permits issued for alterations and improvements.
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Case Study: 2012-2016 Drought – Sonoma County Response

An overview of the 2012-2016 Drought in Sonoma County can be found in the Hazard History of this Appendix. The following is a summary of the actions the County took to mitigate the impacts of the most recent drought.

Sonoma County Regulations

Sonoma County's water suppliers made significant progress on water reductions. The County's eight urban suppliers and the North Marin Water District (which also purchases water from the Sonoma County Water Agency) cut usage by a combined 25 percent in 2014.

Table App E-5: Water Reduction Tiers for Sonoma County Providers

Supplier Name	June 2015 Residential per-capita usage	Conservation Standard	Monthly Savings, June 2015	Cumulative Savings from June 2015 to February 2016
Healdsburg, City of	101.0	24%	30%	30%
North Marin Water Dist.	112.8	24%	29%	29%
Petaluma, City of	77.1	16%	27%	27%
Rohnert Park, City of	65.3	16%	16%	16%
Santa Rosa, City of	79.9	16%	12%	12%
Sonoma, City of	112.6	28%	32%	32%
Sweetwater Springs Water Dist.	71.4	16%	29%	29%
Valley of the Moon Water Dist.	74.5	20%	23%	23%
Windsor, Town of	86.6	16%	28%	28%
Total	86.8	20%	25%	25%

(Note: Sebastopol and Cloverdale do not have conservation standards and their water savings are not reported to the State.)

Partnership Incentive and Education Programs

Cities and water districts in the region developed localized programs, incentives and rebates to support their customers in achieving these reduction goals. This approach of providing support and education has proved to be effective across the region. In addition to the individual efforts, six cities, three water districts, and the Water Agency provided funding to join forces in providing region wide outreach and education though the Sonoma-Marin Water Savings Partnership (Partnership). Members included the Cities of Cotati, Petaluma, Rohnert Park, Santa Rosa, and Sonoma; the Town of Windsor; Marin Municipal, North Marin, and Valley of the Moon water districts; and the Water Agency. With support from the Partnership, water suppliers administered a variety of rebate and outreach programs to reduce water use, including:

- Rebates for removing grass or improving the efficiency of irrigation systems. Over 507,222 square feet of lawn have been removed and 215 landscapes were upgraded.
- Rebates for reusing greywater for landscaping. 11 permitted greywater systems were installed in homes to reuse water from bathroom sinks, shows, tubs and laundry for irrigating landscapes.
- Water use surveys to analyze water use and provide recommendations for water savings. 4,410 home evaluations were completed.
- Rebates for capturing rainwater and reusing it for landscaping.
- Rebate for installing recirculating hot water pumps.
- Rebates for high-efficiency washing machines. 2,379 rebates for washing machines that use 60% less water than older models and save energy from heating and wringing less water during the cycle.

- Rebates for high-efficiency toilet rebates. 3,540 rebates were issues to residents for replacing their old, inefficient toilets with new high-efficiency, low-flow toilets. 941 rebates were issued to businesses for installing high-efficiency toilets and urinals.
- Rebates for sustained monthly water savings. Through the sustained reduction programs local business save 5,355,996 gallons of water per year.
- Free leak detection kits and water conservation hardware and supplies.
- Field studies, garden tours, school performances, water education curriculum, and rainwater harvesting classes. (The metrics for each program are from the FY 2013/2014 Annual Report. The FY 2014/2015 metrics will be available by the end of the 2015 calendar year.)
- Through the Russian River Drought Relief Program residents of a number of smaller districts, including those supervised by the Department of Transportation and Public Works, as well as private well users in the County who live inside the Russian River Watershed were also eligible for high-efficiency toilet retrofits. With support from the North Coast Resource Partnership additional Prop 84 funds were available to prolong the Upper River Drought Relief Program in Sonoma County and provide grant funds for many Partnership members in the North Coast region.

While the water districts and the Russian River program offer high-efficiency toilet retrofits for many Sonoma County residents, there is still a large unmet need within the unincorporated sections of the County. Many households on well water throughout the unincorporated areas would greatly benefit from these retrofits. The Russian River program has proven to be successful and can serve as a model for expansion of direct installation of high-efficiency toilets. County and Water Agency staff will research the possibility of expanding the direct install program to the areas of the County that are not currently served by an existing program. This work will include researching grant opportunities to fund administration of the program. Staff estimates that demand in those currently uncovered areas would total approximately 5,500 retrofits and cost $2,000,000.

Public Outreach

The Water Agency, in collaboration with the Partnership and the North Bay Water Sustainability Coalition, a newly formed business-agriculture coalition formed to promote drought and conservation awareness, successfully held a drought drive up and community drought discussion in Sonoma Valley in July, 2015. Approximately 400 drought tool kits were distributed at the drive up, which included a shower bucket filled with a shower head designed to release less water, a faucet aerator that mixes air with water to reduce its flow, a toilet tank leak detector, and literature about reducing water in other areas around the house.

Business Coalition Launches

In July 2015, the North Bay Water Sustainability Coalition officially launched in Santa Rosa. The purpose of the Coalition is to increase and support ongoing drought public outreach efforts by the Partnership and to keep the business and agricultural sector involved with drought discussions.

Legislation

County Energy and Sustainability Programs are working directly with residential and business customers on water use reduction measures: (a) the financing provided through Property

Assessed Clean Energy (PACE) assessments, including the Sonoma County Energy Independence Program product, have facilitated over 69 improvement projects; (b) the Pay-As-You-Save program operated for the Town of Windsor has saved over 7,569,860 gallons, or 23 acre feet of water; and (c) the Green Business Program projects over 3 million gallons of water saved as a result of the certification process. Electric fan crop frost protection equipment, replacing irrigation methods, has been added as an eligible improvement for PACE financing.

Sonoma County Responds – Planning and Conservation

The Permit and Resource Management Department (PRMD) actively implements low water usage solutions in its permitting and planning processes.

Through the Water Efficient Landscape Ordinance, PRMD mandates landscape water budgets - irrigation design and scheduling - for most new or rehabilitated commercial, industrial, and residential uses requiring a building permit, grading permit, or design review. Most of the agency's discretionary approvals include a water conservation condition mandating submittal of a Water Conservation Plan before building permit issuance to ensure all feasible measures are taken to reduce water demand and enhance water resource recovery. Rainwater capture and gray water systems are important components in this program.

PRMD also enforces Low Impact Development – vegetated roofs, rain gardens, bioswales, etc. – through grading permits to encourage groundwater recharge and improve water quality. The agency is implementing a $1M grant with local non-profits in the Sonoma and Petaluma Valleys to improve water quality and conservation through education programs such as "Slow it; spread it; sink it."

In the Sonoma Valley and Santa Rosa Plain, voluntary Groundwater Management Plans are in place to encourage the sustainable use of groundwater. These collaborative plans put the County in an excellent position for implementation of the Sustainable Groundwater Management Act, which will require plans to sustainably manage major basins to be in place by 2022.

The Riparian Corridor Ordinance has been enacted to protect streams for water and biotic resource purposes. Well Water Construction Standards will improve well technology and further protect surface and ground water resource. Implementation of the Sustainable Groundwater Management Act, will allow the County to participate in sustainable groundwater management on a long term basis.

Mitigation Programs and Activities

Sonoma Marin Saving Water Partnership

Sonoma-Marin Saving Water Partnership was formed in 2010 and represents 11 water utilities in Sonoma and Marin counties who have joined together to provide a regional approach to water use efficiency. The utilities are the Cities of Santa Rosa, Rohnert Park, Petaluma, Sonoma, Cotati; North Marin, Valley of the Moon and Marin Municipal Water Districts, Town of Windsor, California American Water, and Sonoma County Water Agency. Each of these utilities implement water conservation programs that help reduce water use.

Sanitation Water Efficiency Rebate Program

The Sonoma County Water Agency's Sanitation Water Efficiency Rebate Program was established to help residents save water, save money, and reduce wastewater flows to local wastewater treatment plant, within the County sanitation service areas.

Russian River Drought Relief Program

The Russian River Drought Relief Program includes two opportunities for eligible customers to reduce their water use in participating service areas: 1) High-Efficiency Fixture Direct-Install Program and 2) Turf Replacement Rebate Program.

USDA Farm Service Agency Disaster Relief

The USDA Farm Service Agency (FSA) provides economic assistance for agricultural losses, resulting from drought, floods, fires, and a host of other natural catastrophes. In order to provide access to the assistance programs available through the FSA the amount of losses experienced by farmers and ranchers in the county must be determined.

2. PROJECTED SEA LEVEL RISE

Rising sea levels increase the risk of coastal flooding, storm surge inundation, bluff and coastal erosion and shoreline retreat, and wetland loss. There is a growing concern that sea-level rise resulting from climate change will exacerbate flooding and inundation risks in coastal areas, including permanently inundating some areas. Three different sea-level rise scenarios for the year 2100 are discussed below.

A 2008 assessment of sea-Level rise prepared by the California Energy Commission's Public Interest Energy Research (PIER) Climate Change Research Program, and a 2009 assessment prepared by the Pacific Institute project, states that under medium to medium-high levels of greenhouse gas emissions, the mean sea level along the California Coast will rise from 1.0 to 1.4 meters (3.3 to 4.7 feet) by year 2100. In its report, "The Impacts of Sea-Level Rise on the California Coast", the Pacific Institute makes the following findings regarding this rise in sea level if no adaptation actions are taken:

- Many people will have increased vulnerability to inundation and flooding,
- Some critical infrastructure will be at increased risk of inundation,
- Wetlands and natural ecosystems will be destroyed, degraded, or altered,
- Coastal erosion will be accelerated.

The report further states that scientists forecast that sea level rise will continue for centuries, even if we stop emitting greenhouse gases immediately; and as a result, coastal areas will be subject to increasing risk of inundation and erosion. They conclude that adaptation strategies must be evaluated, tested, and implemented if the risks of damage or injury resulting from sea level rise identified in the report are to be reduced or avoided; and they recommend practices and policies for federal, state, and local governments to address sea level rise.

The San Francisco Bay Conservation and Development Commission (BCDC) indicates that, according to greenhouse gas emissions scenarios published by the Intergovernmental Panel on

Climate Change and the consensus of California's leading climate scientists, the Bay could rise 11 to 18 inches by 2050 and 23 to 55 inches by 2100. The areas of the county that may be inundated along San Pablo Bay are shown in Figure 8.14. The BCDC report indicates that 27 miles of existing roads and rail are vulnerable to sea level rise in Sonoma County.

The National Research Council's report "Sea Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future" provides the most up-to-date science and guidance on sea level rise. The report found that much of the land on the coast south of Cape Mendocino is sinking at an average rate of about 1 mm (.04 inches) per year. For that reason, relative sea level south of Cape Mendocino has been rising. The report projects that sea level along the California coast south of Cape Mendocino, which includes the Sonoma County Coast, will rise 4 to 30 cm (2 inches to 1 foot) by 2030 relative to 2000, 12 to 61 cm (5 inches to 2 feet) by 2050, and up to 42 to 167 cm (17 to 66 inches) by 2100 if high greenhouse gas emissions continue.

It is important to acknowledge that the coastal hazard area may extend beyond the simple delineated boundary of the projected sea level rise. For instance, a rise in sea level could also result in more parcels being subject to tsunamis. Climate change may also result in greater wave height and increased coastal erosion. If a large storm event, such as a 100-year storm, occurs on a high tide, the reach of inundation and erosion could extend much further than a six-foot rise in the average sea level. The 2009 Pacific Institute Report *The Impacts of Sea-Level Rise on the California Coast* contains a series of maps for the entire California Coast which demonstrate the extent of the areas at risk from flooding and erosion as a result of sea level rise during a 100-year storm event by year 2100. The maps show the current coastal base flood (approximate 100-year flood event), the sea level rise scenario (coastal base flood + 1.4 meters), and the landward limit of the erosion high hazard zone.

The areas subject to sea level rise are depicted in Figures 8-13 to 8-15. The same areas are designated in the Sonoma County Coastal Plan which guides and restricts development along the coast.

Sonoma County Planning staff examined the digital data from the Pacific Institute Report and used it to prepare enlarged maps of eleven coastal subareas (Coastal Plan Figures C-PS-3a-k). The preliminary sea level rise maps were then compared to the public roads, public facilities, and private commercial properties and facilities of the Sonoma County Coast potentially flooded or inundated by the maximum projected sea level rise for the year 2100 and the 100-year storm event. Table App E-6 below shows a preliminary list of the roads, State facilities, and County facilities affected. (This Table is also included in the Sonoma County Local Coastal Plan as Table: C-PS-1a).

Table App E-6: Roads, State Facilities, and County Facilities on the Sonoma County Coast Potentially Flooded as a Result of Sea Level Rise and the 100-Year Flood by Year 2100

Coastal Subarea	Highways and Roads	State Facilities	County Facilities
The Sea Ranch North (1)	• State Highway 1		• Gualala Point County Park • Sea Ranch Access Trails: • Walk-on Beach Access
The Sea Ranch South (2)			• Sea Ranch Access Trails: • Shell Beach • Stengel Beach • Pebble Beach • Black Point Beach
Salt Point (4)		• Salt Point State Park • Fisk Mill Cove • Gerstle Cove • Horseshoe Cove • Horseshoe Point • Salt Point • Stump Beach	
Timber Cove/Fort Ross (5)	• State Highway 1	• Fort Ross State Historic Park • Kohlmer Gulch • Sandy Cove • Windermere Point	• Stillwater Cove Regional Park • Stillwater Cove & Boat Launch • Stillwater Cove Expansion: Pocket Cove • Bluff Trail – Ocean Cove to Stillwater Cove
High Cliffs/Muniz-Jenner (6)	• State Hwy 1 • State Hwy 116 • County roads: • Burke Ave • Pacific Ave • Willig Drive	• Sonoma Coast State Park • North Jenner Beach • Jenner Beach • Russian Gulch • Jenner River Access • Russian River Access: State Hwy 1 Bridge to Sawmill Gulch	
Duncans Mills (7)	• State Hwy 1 • State Hwy 116 • County roads: • B Street • Freezeout Rd. • Main Street • Moscow Road • Steelhead Blvd	• Sonoma Coast State Park • Duncans Mills River Access • Rancho del Paradiso - Freezeout River Access • Steelhead Blvd. River Access • Willow Creek - Freezeout Access	

Pacific View / Willow Creek (8)	• State Hwy 1 • County roads: • Emery Road • Willow Creek • Wrights Beach Rd	• Sonoma Coast State Park • Arched Rock • Blind Beach • Duncans Cove, Point, & Landing • Goat Rock Beach • Mann Beach • Monte Rio - Willow Creek Trail • No Name Beach • North Portuguese Beach • Penny Island • Portuguese Beach • Willow Creek Campground Russian River Access • Wrights Beach	
State Beach / Bodega Bay (9)	• State Hwy 1 • County roads: • Bay Flat Road • Bean Avenue • Brooke Road • Churchill Street • Doran Beach Rd.	• Bodega Dunes Campground • Sonoma Coast State Park • Salmon Creek Beach	• Doran Regional Park • Mason's Marina: onshore facilities • Spud Point Marina: onshore facilities
Valley Ford (10)	• State Hwy 1 • County roads: • John's Street • Middle Road • School Street (Main Street) • Valley Ford – Estero Road • Valley Ford - Freestone Road • Valley Ford Road		• Gold Ridge Soil Conservation District Office