**CALMAC Study ID CPU0035.01**
**Volume 3 of 15**
**Appendix B**

# Embedded Energy in Water Studies
# Study 1: Statewide and Regional Water-Energy Relationship

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**Prepared for the**
**California Public Utilities Commission**
**Energy Division**

**Managed by**
**California Institute for Energy and Environment**

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# Appendix B Hydrologic Region Profiles

## B.1 Hydrologic Region Profile: North Coast (NC)

### *B.1.1 Summary*

The North Coast Hydrologic Region is in the northwestern corner of California and includes redwood forests, inland mountain valleys, and the arid Modoc Plateau. Heavy rainfall in the coastal mountain ranges makes the North Coast region the most water-abundant area of California, producing about 41 percent of the state's total natural runoff. As a result of the abundant rainfall, the average annual runoff for the rivers of this region is about 29 million acre-feet per year, which is the largest volume compared to all other hydrologic regions of California.

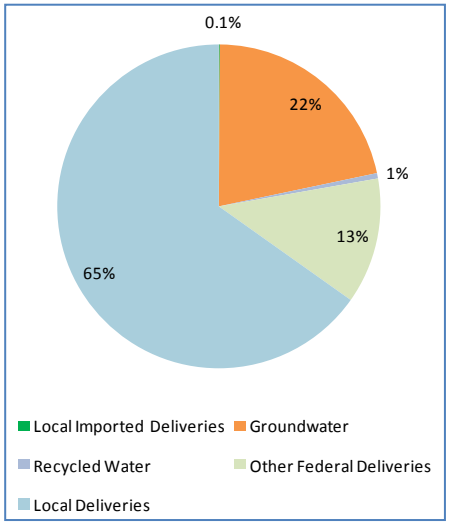
See Table 1 for additional information on the North Coast Hydrologic Region.

**Table 1 - North Coast Hydrologic Region Profile**

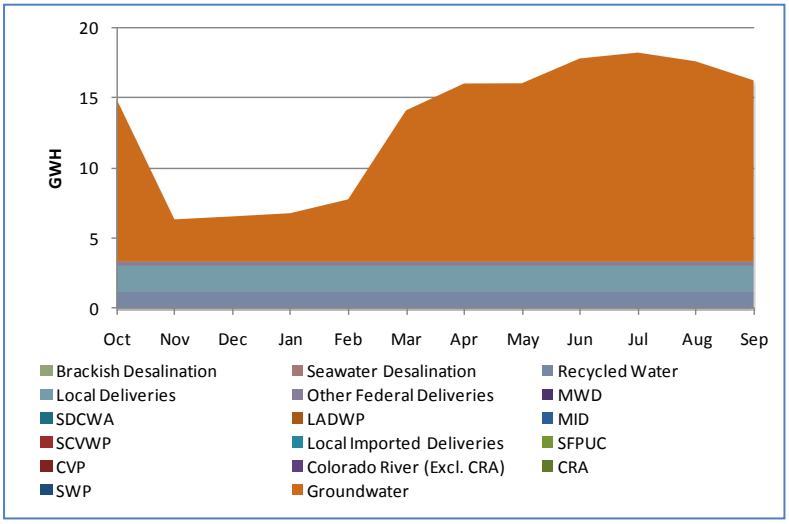
| | | | |
|---|---|---|---|
| **Size** | 19,476 square miles (12.3% of State) | | |
| **Population (2000)** | 644,000 | | |
| **Projected Population (2030)** | 895,150 | **Percent Growth** | 39% |
| **Reservoir Storage Capacity** | 3,780 TAF | | |
| **Average Annual Precipitation** | 50.6 inches | | |
| **Land Use** | Forest and rangeland represent about 98 percent of this region's land area. The agricultural trend in the past decade has been one of land consolidation and the conversion of prime agricultural land to urban growth. This trend is a result of low crop values, the lack of additional inexpensive surface water, and the ability to use only the most economically developable groundwater. | | |
| **Water Supply** | Many of the smaller communities and rural areas in the North Coast region are generally supplied by small local surface water and groundwater systems. Larger water supply projects in this region include the USBR's Klamath Project, the U. S. Army Corps of Engineers' Russian River Project (Lake Mendocino and Lake Sonoma), and the Humboldt Bay Municipal Water District's Ruth Reservoir, which serves coastal communities from Eureka to McKinleyville. | | |
| **Water Use** | In the year 2000, a "normal" water year, agriculture accounts for about 83 percent of the region's water use, while urban use is about 17 percent. | | |
| | Urban | 126.9 TAF | |
| | Agricultural | 640.7 TAF | |
| | Total | 767.6 TAF | |

### *B.1.2 North Coast 2010 Water Supply and Energy Profile:*

Total Supply: 3,251 TAF




Total Energy Consumption: 159 GWh




## B.2 Hydrologic Region Profile: San Francisco Bay (SF)

### *B.2.1 Summary*

The San Francisco Bay Hydrologic Region, which occupies parts of nine counties, extends from southern Santa Clara County north to Tomales Bay in Marin County, and inland to the confluence of the Sacramento and San Joaquin rivers near Collinsville. The climate within the region varies significantly from west to east. Coastal areas are typically cool and often foggy, and inland valleys are warmer with a Mediterranean-like climate.

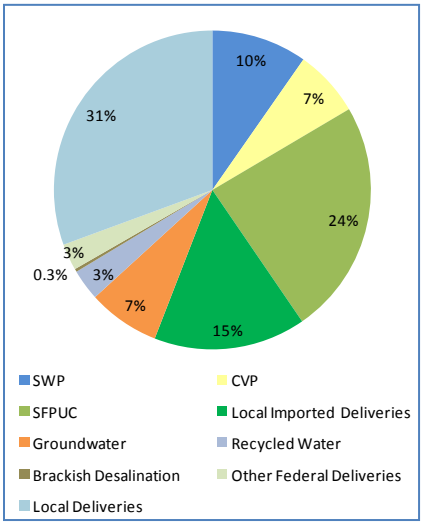
See Table 2 for additional information on the San Francisco Bay Hydrologic Region.

**Table 2 – San Francisco Bay Hydrologic Region Profile**

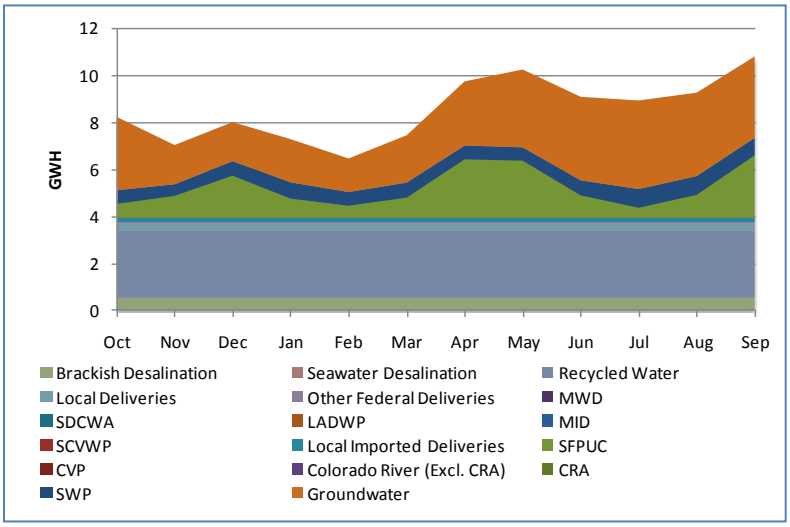
| | | | |
|---|---|---|---|
| **Size** | 4,506 square feet (2.85 of State) | | |
| **Population (2000)** | 6,105,650 | | |
| **Projected Population (2030)** | 7,857,360 | **Percent Growth** | 29% |
| **Reservoir Storage Capacity** | 746 TAF | | |
| **Average Annual Precipitation** | 25.4 inches | | |
| **Land Use** | Portions of the region are highly urbanized and include the San Francisco, Oakland, and San Jose metropolitan areas. Agricultural acreage occurs mostly in the north and northeast in Napa, Marin, Sonoma, and Solano counties. Santa Clara and Alameda counties also have significant agricultural acreage at the edge of the urban development. | | |
| **Water Supply** | In the early 1900s, local water agencies developed significant imported water supplies from the Mokelumne and Tuolumne rivers to meet the anticipated demands. At the same time, local reservoirs and watersheds were being developed to capture surface supplies, to recharge the groundwater basins, and to act as terminal reservoirs for the larger projects. Recycled water is also used in a full spectrum of applications including landscape irrigation, industrial cooling, agricultural needs, and as supply to wetlands. Currently, nearly 50-million gallons per day of recycled water is produced in the bay region. | | |
| **Water Use** | In the year 2000, a "normal" water year, agriculture accounts for about 10% percent of the region's water use, while urban use is about 90% percent. | | |
| | Urban | 1,011.8 TAF | |
| | Agricultural | 109.7 TAF | |
| | Total | 1,121.5 TAF | |

### *B.2.2 San Francisco Bay 2010 Water Supply and Energy Profile:*

Total Supply: 1,277 TAF




Total Energy Consumption: 103 GWh




## B.3 Hydrologic Region Profile: Central Coast (CC)

### *B.3.1 Summary*

The Central Coast Hydrologic Region extends from southern San Mateo County in the north to Santa Barbara County in the south. The region includes all of Santa Cruz, Monterey, San Benito, San Luis Obispo and Santa Barbara counties and parts of San Mateo, Santa Clara, and Ventura counties. Many attributes define the Central Coast region including: the topography, many microclimates, the variety of agricultural products, and the picturesque coastline, Valleys and communities that drive a thriving tourism economy.

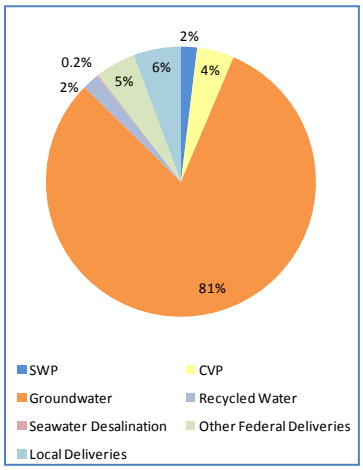
See Table 3 for additional information on the Central Coast Hydrologic Region.

**Table 3 – Central Coast Hydrologic Region Profile**

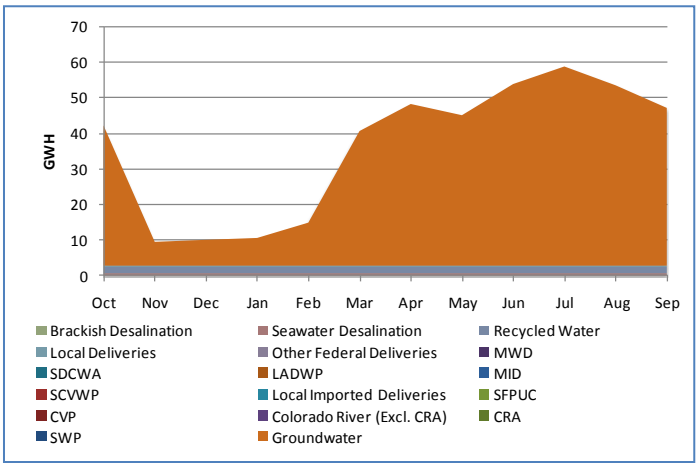
| | | | |
|---|---|---|---|
| **Size** | 11,326 square miles (7.1% of the state) | | |
| **Population (2000)** | 1,459,205 | | |
| **Projected Population (2030)** | 1,890,390 | **Percent Growth** | 30% |
| **Reservoir Storage Capacity** | 1,227 TAF | | |
| **Average Annual Precipitation** | 18.7 inches | | |
| **Land Use** | The busy topography of the Central Coast Region and distance from California's major population centers have resulted in a landscape that is primarily pastoral and agricultural. Agriculture in the Central Coast region can be divided into two distinct categories. One is irrigated vegetable and specialty crops grown on coastal terraces and valleys and in some inland valleys; and the other category is range pasture and dry-farmed grain in the inland valleys. | | |
| **Water Supply** | Groundwater is the primary source of water in the region, accounting for roughly 75 percent of the annual supply in 2000. Local and some imported surface water supplies make up the rest of the available water for this region. A significant amount of groundwater recharge is provided by the Pajaro, Salinas, and Carmel rivers, and by the Arroyo Seco, which flows into the Salinas river. | | |
| **Water Use** | In the year 2000, a "normal" water year, agriculture accounts for about 77% percent of the region's water use, while urban use is about 23% percent. | | |
| | Urban | 221.0 TAF | |
| | Agricultural | 746.2 TAF | |
| | Total | 967.2 TAF | |

## *B.3.2 Central Coast 2010 Water Supply and Energy Profile:*

Total Supply: 1,219 TAF




Total Energy Consumption: 435 GWh



## B.4 Hydrologic Region Profile: South Coast (SC)

### *B.4.1 Summary*

The South Coast Hydrologic Region comprises the southwest portion of the state and is California's most urbanized and populous region. The topography includes a series of nearly flat coastal plains and valleys, many broad but gentle interior valleys, and several mountain ranges of low and moderate elevation. The region has a mild, dry subtropical climate where summers are virtually rainless, except in the mountains where late summer thunderstorms sometimes occur.

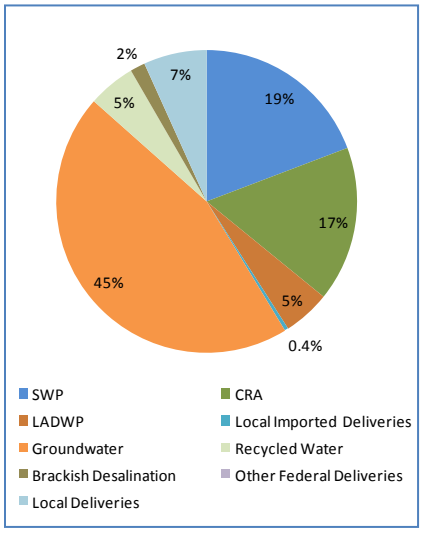
See Table 4 for additional information on the South Coast Hydrologic Region.

**Table 4 – South Coast Hydrologic Region Profile**

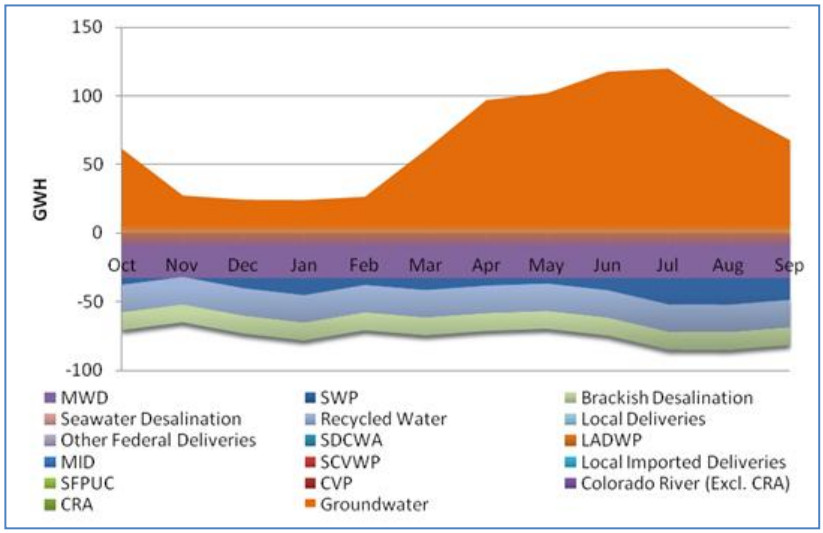
| | | | |
|---|---|---|---|
| **Size** | 10,925 square miles (6.9% of State) | | |
| **Population (2000)** | 18,223,425 | | |
| **Projected Population (2030)** | 23,827,075 | **Percent Growth** | 24% |
| **Reservoir Storage Capacity** | 3,059 TAF | | |
| **Average Annual Precipitation** | 17.6 inches | | |
| **Land Use** | The expansion of new single- and multi-family homes, commercial services, businesses, and highway systems into the warmer sections of the region continues onto lands that were historically pastoral, if not agricultural. Although pockets of open space and agricultural uses still exist, the urban area now extends southward from Ventura County to the international border with Mexico and eastward from the coast to beyond Riverside and San Bernardino. Irrigated agriculture now occupies only one-seventh as much land as urban uses. | | |
| **Water Supply** | The region has developed a diverse mix of both local and imported water supply sources. Local water resources development over the last 15 years has included water recycling, groundwater storage and conjunctive use, conservation, brackish water desalination, water transfer and storage, and infrastructure enhancements to complement imported water supplies. The region imports water through the State Water Project (SWP), the Colorado River Aqueduct (CRA), and the Los Angeles Aqueduct (LAA). This diverse mix of sources provides flexibility in managing supplies and resources in wet and dry years. | | |
| **Water Use** | In the year 2000, a "normal" water year, agriculture accounts for about 17% percent of the region's water use, while urban use is about 83% percent. | | |
| | Urban | 3,860.4 TAF | |
| | Agricultural | 795.9 TAF | |
| | Total | 4656.3 TAF | |

### *B.4.2 South Coast 2010 Water Supply and Energy Profile:*

Total Supply: 5,408 TAF




Total Energy Consumption: 822 GWh




Note: the negative area is due to energy production in the region

## B.5 Hydrologic Region Profile: Sacramento River (SR)

### *B.5.1 Summary*

The Sacramento River Hydrologic Region includes the entire drainage area of the state's largest river and its tributaries, extending from the Oregon border downstream to the Sacramento – San Joaquin Delta. The Sacramento Valley with its alluvial soils, abundant water and moderate climate, is one of the richest agricultural regions on earth. These same physical attributes also make it an incredibly productive ecosystem that supports more than 250 species of fish and wildlife.

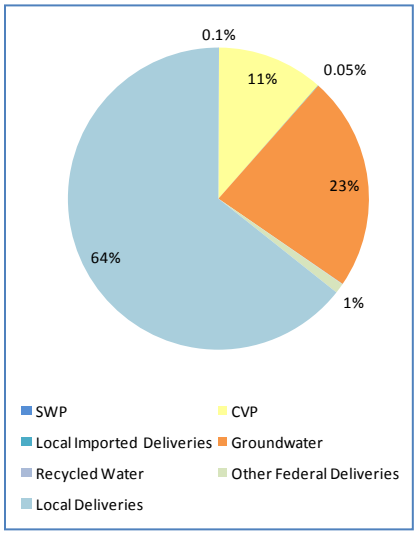
See Table 5 below for additional information on the Sacramento River Hydrologic Region.

**Table 5 – Sacramento River Hydrologic Region Profile**

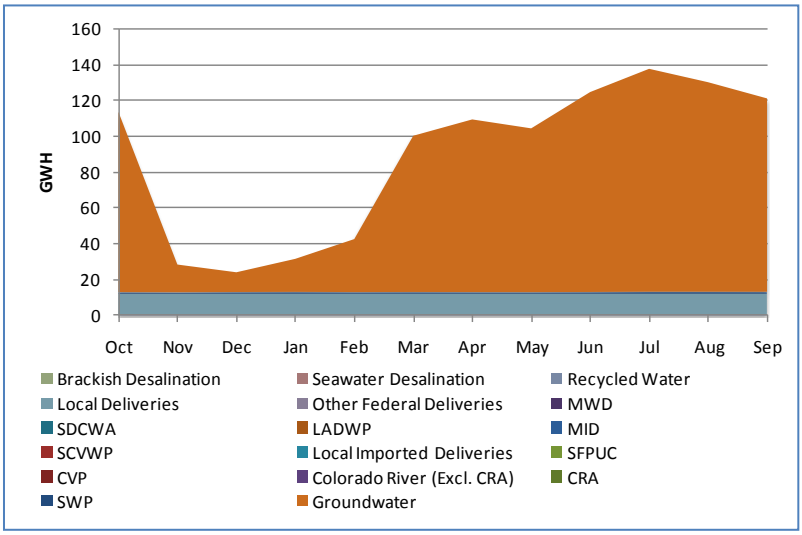
| | | | |
|---|---|---|---|
| **Size** | 27,246 square miles (17.2% of State) | | |
| **Population (2000)** | 2,593,110 | | |
| **Projected Population (2030)** | 4,569,490 | **Percent Growth** | 76% |
| **Reservoir Storage Capacity** | 16,146 TAF | | |
| **Average Annual Precipitation** | 36.7 | | |
| **Land Use** | Agriculture is the region's largest industry, contributing a wide variety of crops including rice, grain, tomatoes, field crops, fruits and nuts. A substantial number of acres of rangeland in this region are also used for livestock management. During the past 130 years, more than 95 percent of the valley's historic riparian forests have been converted to other land uses. | | |
| **Water Supply** | Because of the weather patterns that produce a high level of precipitation in the region, major water supplies from the region are provided through the development of reservoirs and from direct groundwater pumping, which historically has recharged through the winter months. Although a few of the larger cities in the region, such as Sacramento, divert most of their water from the larger rivers, the principal source of water for most of the urban and rural communities throughout this region is groundwater. | | |
| **Water Use** | In the year 2000, a "normal" water year, agriculture accounts for about 91% percent of the region's water use, while urban use is about 9% percent. | | |
| | Urban | 756.2 TAF | |
| | Agricultural | 7,343.3 TAF | |
| | Total | 8,099.5 TAF | |

## *B.5.2 Sacramento River 2010 Water Supply and Energy Profile:*

Total Supply: 21,545 TAF




Total Energy Consumption: 1,068 GWh



## B.6 Hydrologic Region Profile: San Joaquin River (SR)

### *B.6.1 Summary*

The San Joaquin River hydrologic region is in the heart of California and includes the northern portion of the San Joaquin Valley. It is bordered on the east by the Sierra Nevada and on the west by the coastal mountains of the Diablo Range. Because the San Joaquin Valley is isolated by mountains from the marine effects of coastal California, the maximum average daily temperature in the valley reaches a high of 101 degrees during late July, although the northern part of this hydrologic region does benefit from Delta breezes during the hot summer periods.

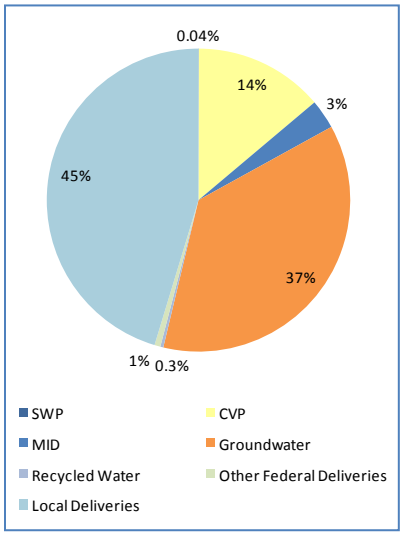
See Table 6 below for additional information on the San Joaquin River Hydrologic Region.

**Table 6 – San Joaquin River Hydrologic Region Profile**

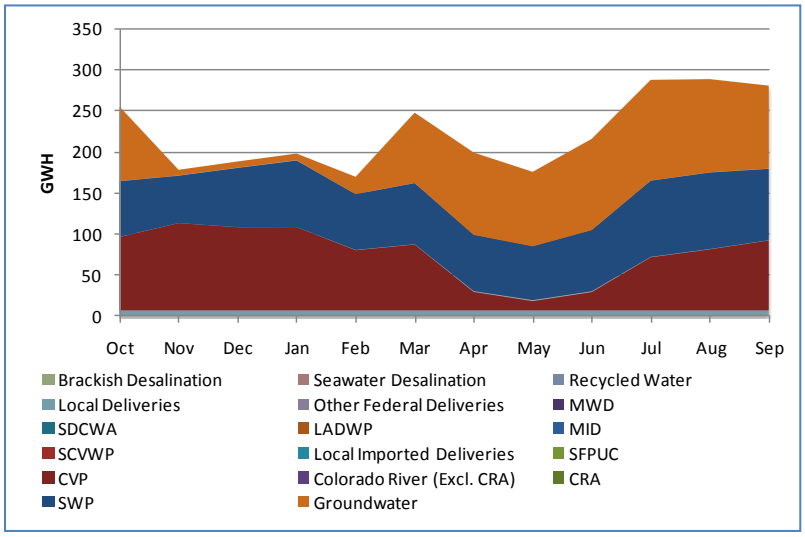
| | | | | |
|---|---|---|---|---|
| **Size** | 15,214 square miles (9.6% of State) | | | |
| **Population (2000)** | 1,751,010 | | | |
| **Projected Population (2030)** | 3,385,885 | | **Percent Growth** | 93% |
| **Reservoir Storage Capacity** | 11,477 TAF | | | |
| **Average Annual Precipitation** | 26.3 inches | | | |
| **Land Use** | The valley portion of the San Joaquin River region consists primarily of highly productive farmland and the rapidly growing urban areas of Stockton, Tracy, Modesto, Manteca, and Merced. Agriculture is the major economic and land use activity in the San Joaquin River region. The Valley has roughly 2 million acres of irrigated cropland and an annual agricultural output valued at more than $ 4.9 billion. | | | |
| **Water Supply** | The primary sources of surface water in the San Joaquin River region are the rivers that drain the western slope of the Sierra Nevada. These include the San Joaquin River and its major tributaries, the Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Cosumnes rivers. Most of the surface water in the upper San Joaquin River is stored and diverted at Friant Dam, and is then conveyed north through the Madera Canal and south through the Friant-Kern Canal. | | | |
| **Water Use** | In the year 2000, a “normal” water year, agriculture accounts for about 94% percent of the region’s water use, while urban use is about 6% percent. | | | |
| | Urban | 374.1 TAF | | |
| | Agricultural | 5655.9 TAF | | |
| | Total | 6,030.0 TAF | | |

### *1.1.1 San Joaquin River 2010 Water Supply and Energy Profile:*

Total Supply: 10,448 TAF




Total Energy Consumption: 2,682 GWh




## 1.2 Hydrologic Region Profile: Tulare Lake (TL)

### *1.2.1 Summary*

The Tulare Lake Hydrologic Region is in the southern end of the San Joaquin Valley. This region includes all of Tulare and Kings Counties and large portions of Fresno and Kern counties. The valley is broad and flat, and is surrounded by the Diablo and Coast Ranges to the west, the Sierra Nevada to the east, and the Tehachapi Mountains to the south. The valley portion of the region is hot and dry in summer with long, sunny days and cooler nights. Winters are wet and often blanketed with dense fog.

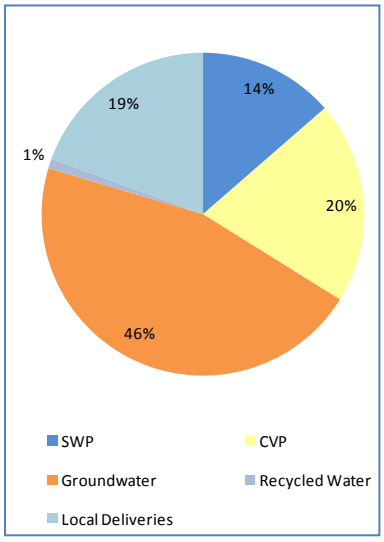
See Table 7 below for additional information on the Tulare Lake Hydrologic Region.

**Table 7 – Tulare Lake Hydrologic Region Profile**

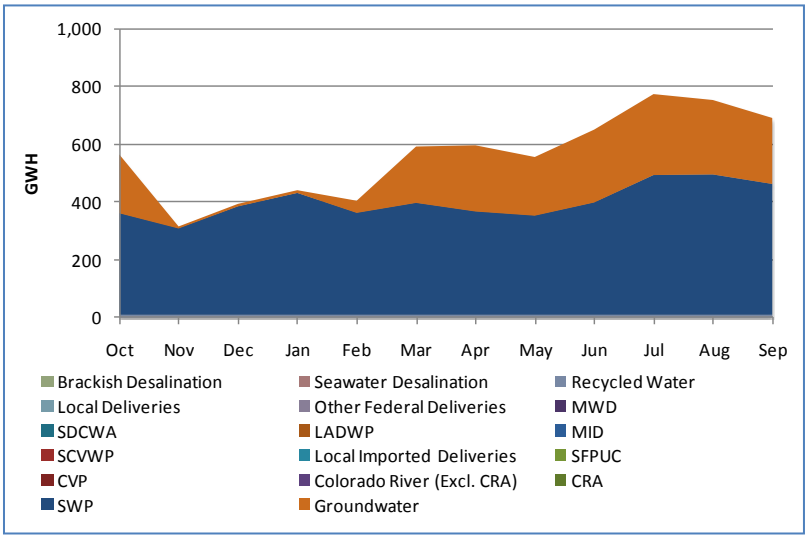
| | | | |
|---|---|---|---|
| **Size** | 17,033 square miles (10.7% of State) | | |
| **Population (2000)** | 1,884,675 | | |
| **Projected Population (2030)** | 3,121,625 | **Percent Growth** | 66% |
| **Reservoir Storage Capacity** | 2,046 TAF | | |
| **Average Annual Precipitation** | 15.2 inches | | |
| **Land Use** | The State and federal government agencies own about 30 percent of the land in the region, including about 1.7 million acres of national forest, 0.8 million acres of national parks and recreation areas, and 1 million acres of land managed by the U.S. Bureau of Land Management. Privately owned land totals about 7.4 million acres. Irrigated agriculture accounts for more than 3 million acres of the private land, while urban areas take up over 350,000 acres. Other agricultural lands and areas with native vegetation represent an additional 1.4 million acres in the region. | | |
| **Water Supply** | The region receives most of its surface water runoff from four main rivers that flow out of the Sierra Nevada, which are the Kings, Kaweah, Tule, and Kern rivers. Major water conveyance facilities in the region include the California Aqueduct, the Friant-Kern Canal, and the Cross Valley Canal. Water diversions from the San Joaquin River at Friant Dam are also a significant supply source for all uses in the Tulare Lake region. | | |
| **Water Use** | In the year 2000, a "normal" water year, agriculture accounts for about 97% percent of the region's water use, while urban use is about 3% percent. | | |
| | Urban | 236.1 TAF | |
| | Agricultural | 8,104.8 TAF | |
| | Total | 8340.9 TAF | |

### *B.6.2 Tulare Lake 2010 Water Supply and Energy Profile:*

Total Supply: 11,258 TAF




Total Energy Consumption: 6,736 GWh



## B.7 Hydrologic Region Profile: North Lahontan (NL)

### *B.7.1 Summary*

The North Lahontan Hydrologic Region forms part of the western edge of the Great Basin, a large landlocked area that includes most of Nevada and northern Utah. The crest of the Sierra Nevada forms much of the western boundary of this region. All surface water in the region drains eastward toward Nevada. The regions climate is characterized by dry summers, with the occasional thunderstorm and snowy winters. The snowpack from the eastern slopes of the Sierra Nevada melts in the late spring and summer to become the primary source of surface water supplies for much of northern Nevada.

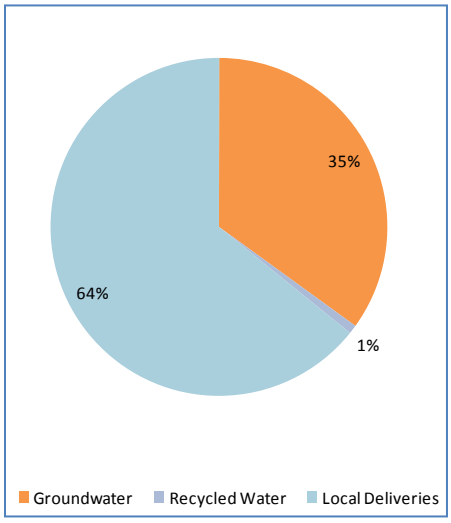
See Table 8 below for additional information on the North Lahontan Hydrologic Region.

**Table 8 – North Lahontan Hydrologic Region Profile**

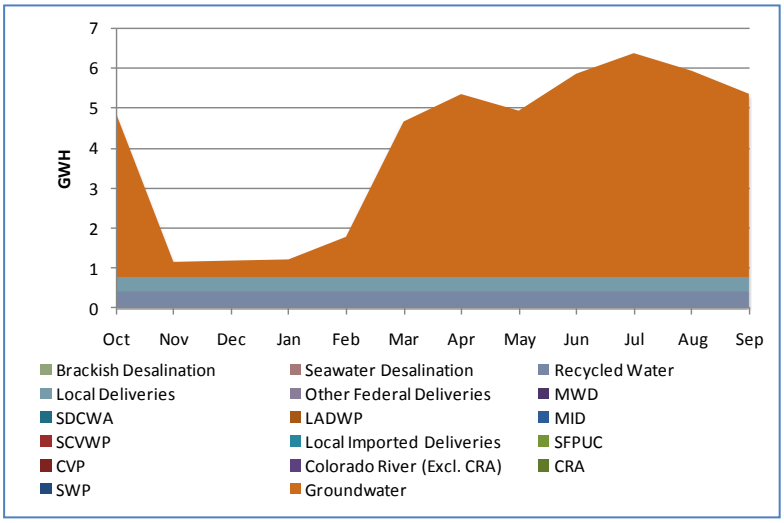
| | | | |
|---|---|---|---|
| **Size** | 6,122 square miles (3.9% of the state) | | |
| **Population (2000)** | 99,035 | | |
| **Projected Population (2030)** | 130,800 | **Percent Growth** | 32% |
| **Reservoir Storage Capacity** | 1,181 TAF | | |
| **Average Annual Precipitation** | 23.1 inches | | |
| **Land Use** | Much of the region is either national forest or lands under the jurisdiction of the Bureau of Land Management. Cattle-ranching is the principal agricultural activity with pasture and alfalfa being the dominant irrigated crops. Although growing seasons vary considerably each year, the mountain valleys where most crops are grown are usually frost free from late May to mid-September or about 120 days. | | |
| **Water Supply** | The largest rivers in the region and their average regulated runoff at the Nevada state line are the Truckee River with 540,000 acre-feet; the Carson River, 335,000 acre-feet; and the Walker River, 300,000 acre-feet. The Susan River is the only major river in the northern half of the region and its annual discharge at Susanville averages 60,000 acre-feet. The Truckee, Carson, and Walker rivers are largely governed by existing federal court water right decrees. On the California side, most locally developed water supplies are from groundwater or small surface water diversions, with storage provided by outlet dams constructed on natural lakes. | | |
| **Water Use** | In the year 2000, a "normal" water year, agriculture accounts for about 94% percent of the region's water use, while urban use is about 6% percent. | | |
| | Urban | 24.8 TAF | |
| | Agricultural | 400.1 TAF | |
| | Total | 424.9 TAF | |

### *B.7.2 North Lahontan 2010 Water Supply and Energy Profile:*

Total Supply: 691 TAF




Total Energy Consumption: 49 GWh




## 1.3 Hydrologic Region Profile: South Lahontan (SL)

### *1.3.1 Summary*

The South Lahontan Hydrologic Region contains the Eastern Sierra and the Mojave Desert and includes both the highest point (Mount Whitney) and lowest point (Death Valley) in the lower 48 states. The northern half of the region includes Mono Lake, Owens Valley, Panamint Valley, Death Valley, and the Amargosa River Valley. The climate of the South Lahontan region is generally arid.

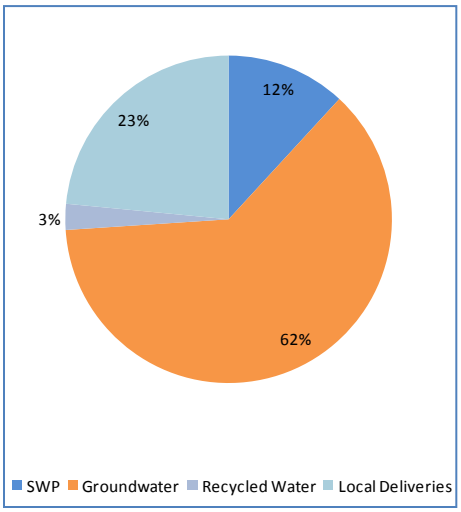
See Table 9**Error! Reference source not found.** below for additional information on the South Lahontan Hydrologic Region.

**Table 9 – South Lahontan Hydrologic Region Profile**

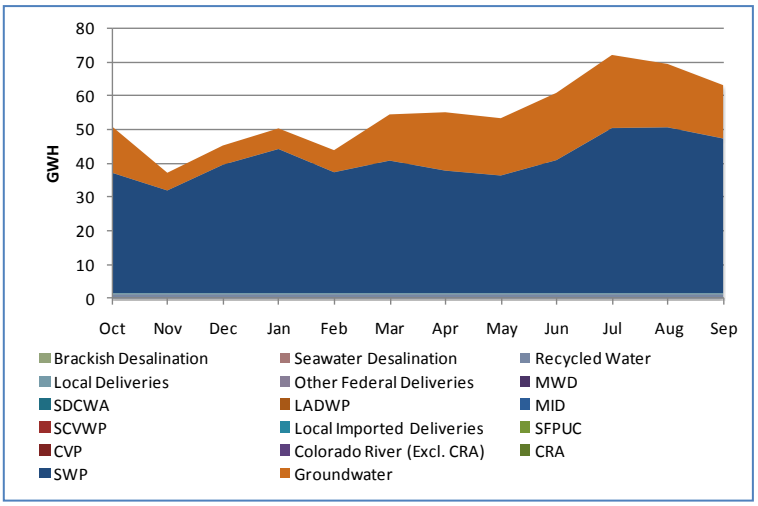
| | | | |
|---|---|---|---|
| **Size** | 26,732 square miles (16.9% of State) | | |
| **Population (2000)** | 721,490 | | |
| **Projected Population (2030)** | 1,266,375 | **Percent Growth** | 76% |
| **Reservoir Storage Capacity** | 459 TAF | | |
| **Average Annual Precipitation** | 7.8 inches | | |
| **Land Use** | The region supports a variety of urban and agricultural uses, including a moderate amount of agricultural acreage and several growing cities. Much of the land in the region remains undeveloped and is under protected or managed status for recreational, scenic, environmental, or military purposes. | | |
| **Water Supply** | The Los Angeles Aqueduct is the region's major water development feature. In 1913, the initial 223-mile-long aqueduct was completed by the Los Angeles Department of Water and Power (LADWP) and began transporting water from Owens Valley to the city of Los Angeles. Since then the aqueduct has been extended 115 miles and a second 137-mile pipeline was completed. There are eight small reservoirs in the Los Angeles Aqueduct system with a combined storage capacity of about 323,000 acre-feet. | | |
| **Water Use** | In the year 2000, a "normal" water year, agriculture accounts for about 63% percent of the region's water use, while urban use is about 37% percent. | | |
| | Urban | 178.8 TAF | |
| | Agricultural | 310.4 TAF | |
| | Total | 489.2 TAF | |

### *B.7.3 South Lahontan 2010 Water Supply and Energy Profile:*

Total Supply: 730 TAF




Total Energy Consumption: 657 GWh



## B.8 Hydrologic Region Profile: Colorado River (CR)

### *B.8.1 Summary*

The Colorado River Hydrologic Region is in the southeastern corner of California. The region includes all of Imperial County, about the eastern one-fourth of San Diego County, the eastern two-thirds of Riverside County, and the southeastern one-third of San Bernardino County. It has a variety of arid desert terrain that includes many bowl-shaped valleys, broad alluvial fans, sandy washes, and hills and mountains. Nearly the entire Colorado River region has a subtropical desert climate with hot summers and generally mild winters.

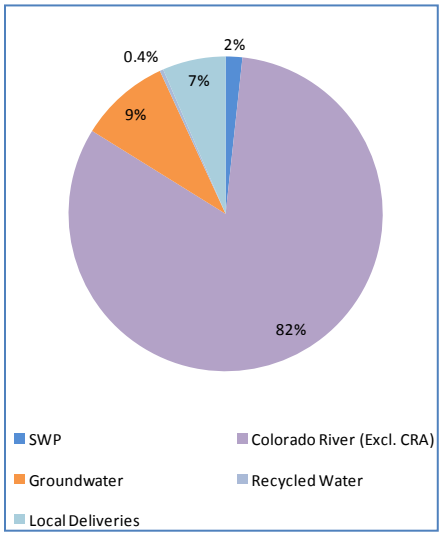
See Table 10 below for additional information on the Colorado River Hydrologic Region.

**Table 10 – Colorado River Hydrologic Region Profile**

| | | | |
|---|---|---|---|
| **Size** | 19,962 square miles (12.6% of State) | | |
| **Population (2000)** | 606,535 | | |
| **Projected Population (2030)** | 1,166,550 | **Percent Growth** | 92% |
| **Reservoir Storage Capacity** | 620 TAF | | |
| **Average Annual Precipitation** | 5.7 inches | | |
| **Land Use** | The region is a land of unequalled agricultural bounty with a growing urban sector, and large expanses of open, wild terrain. Famous parks in the region include Joshua Tree National Park, the Mojave National Scenic Preserve, Anza-Borrego Desert State Park, and the Salton Sea and the Picacho state recreation areas. There are also several areas set aside for preservation or other land management purposes, including national recreation and wilderness areas, wildlife refuges, Indian tribal reservations and U.S. Navy facilities. | | |
| **Water Supply** | About 85 percent of the region's urban and agricultural water supply comes from surface water deliveries from the Colorado River. Water from the river is delivered into the region through the All-American and Coachella canals, local diversions, and the Colorado River Aqueduct by means of an exchange for State Water Project (SWP) water. The remaining water is provided by local surface water and groundwater. The Colorado River is an interstate and international river whose use is apportioned among the seven Colorado River Basin states and Mexico by a complex body of statutes, decrees, and court decisions known collectively as the "Law of the River" | | |
| **Water Use** | In the year 2000, a "normal" water year, agriculture accounts for about 90% percent of the region's water use, while urban use is about 10% percent. | | |
| | Urban | 420.6 TAF | |
| | Agricultural | 3,831.6 TAF | |
| | Total | 4,252.2 TAF | |

## *B.8.2 Colorado River 2010 Water Supply and Energy Profile:*

Total Supply: 4,697 TAF




Total Energy Consumption: 2,025 GWh