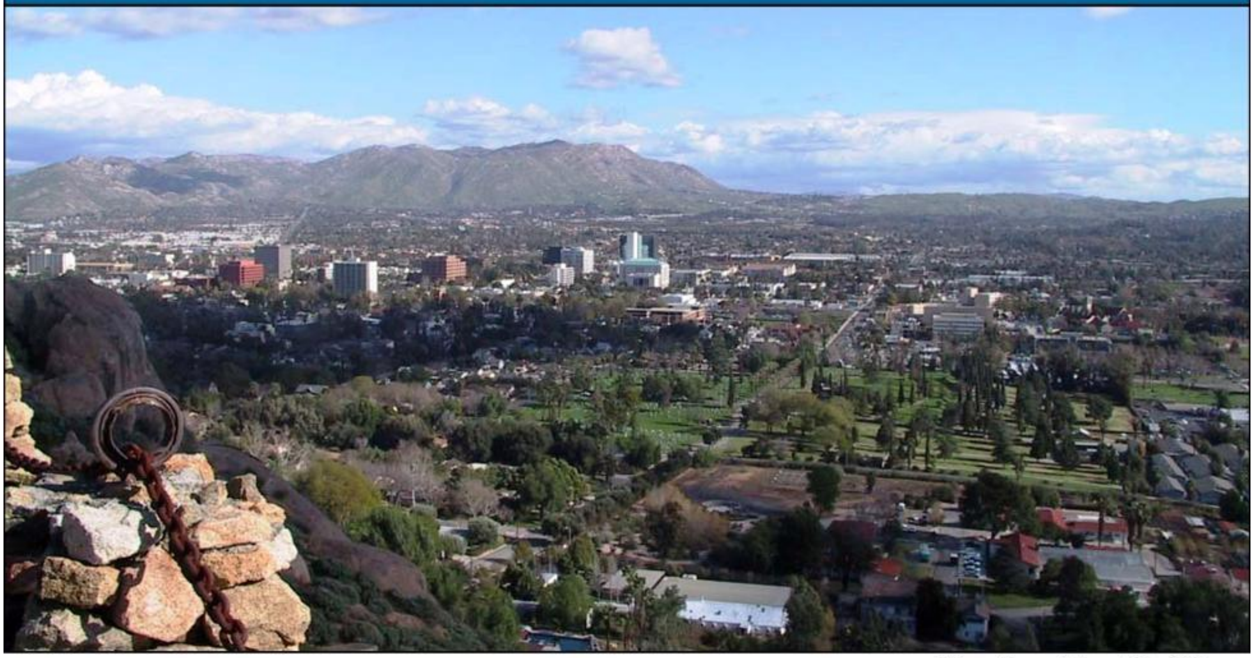
3.0 Watershed Setting



View from Mount Rubidoux
City of Riverside

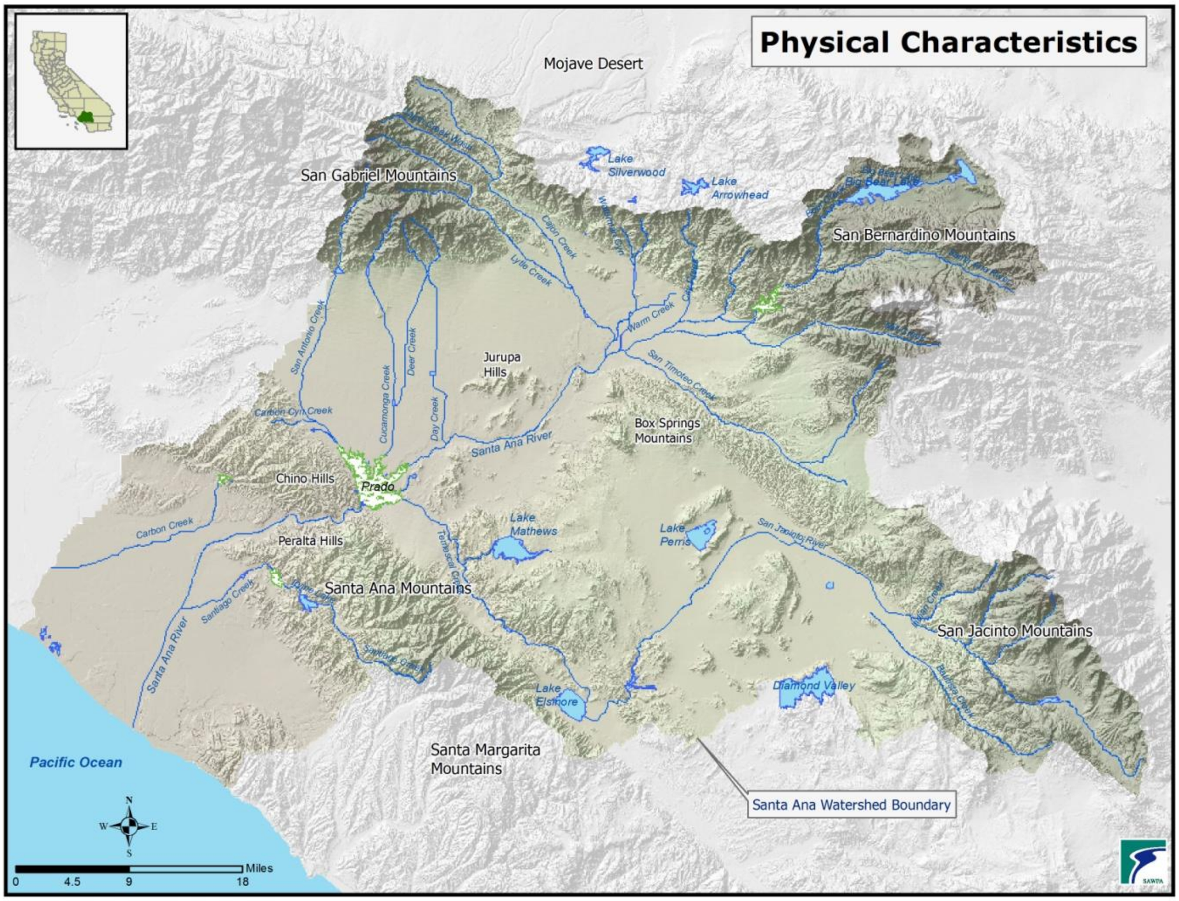
Physical Setting

Dunne and Leopold (1978) define a watershed as an area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel.

The Santa Ana River (SAR) Watershed, depicted in **Figure 3-1**, drains a 2,650 square-mile area. The watershed is home to over 6 million people and includes the major population centers of parts of Orange, Riverside, and San Bernardino Counties, as well as a sliver of Los Angeles County.

The Santa Ana River flows over 100 miles and drains the largest coastal stream system in Southern California. It discharges into the Pacific Ocean at the City of Huntington Beach. The total length of the SAR and its major tributaries is about 700 miles.

Figure 3-1 Santa Ana Integrated Regional Water Management Region



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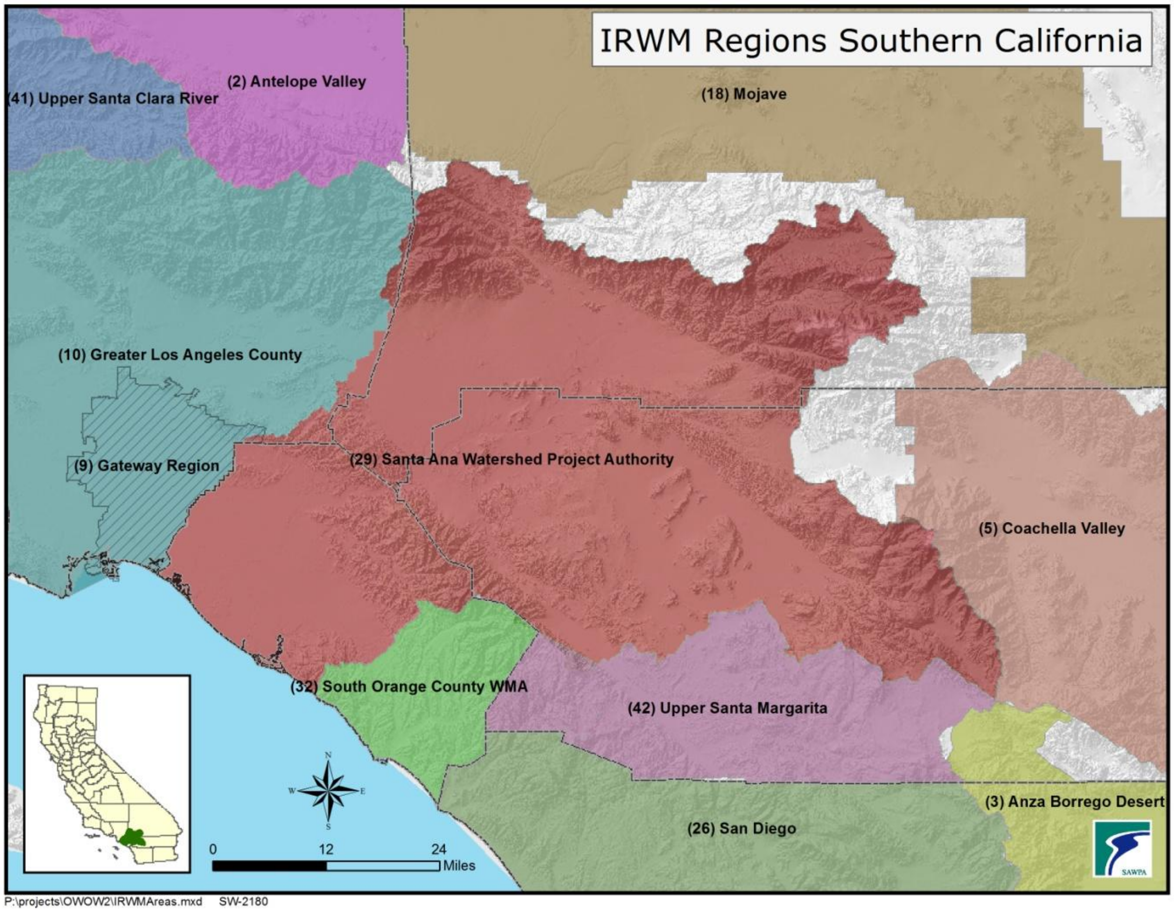
The watershed boundaries nearly match the boundaries of the Santa Ana Regional Water Quality Control Board, an organization with whom the Santa Ana Watershed Project Authority (SAWPA) has worked closely with for many years. In addition, its boundaries match the Integrated Regional Water Management (IRWM) region and the recognized Santa Ana Funding Area, as defined by the Proposition 84 IRWM program. Although there are many sub-watershed planning efforts, One Water One Watershed 2.0 (OWOW) attempts to bring all these efforts, as well as all different jurisdictions in the watershed, into a single watershed-wide vision. Over the years, SAWPA has participated in the development of sub-regional IRWM plans, with the understanding that such plans would be complementary to OWOW.

In addition, SAWPA proactively seeks meeting with neighboring regions, shown in **Figure 3-2** to share and stay abreast of critical issues, ongoing efforts, and opportunities for collaboration in the region.

Figure 3-2 Santa Ana IRWM Neighboring Regions

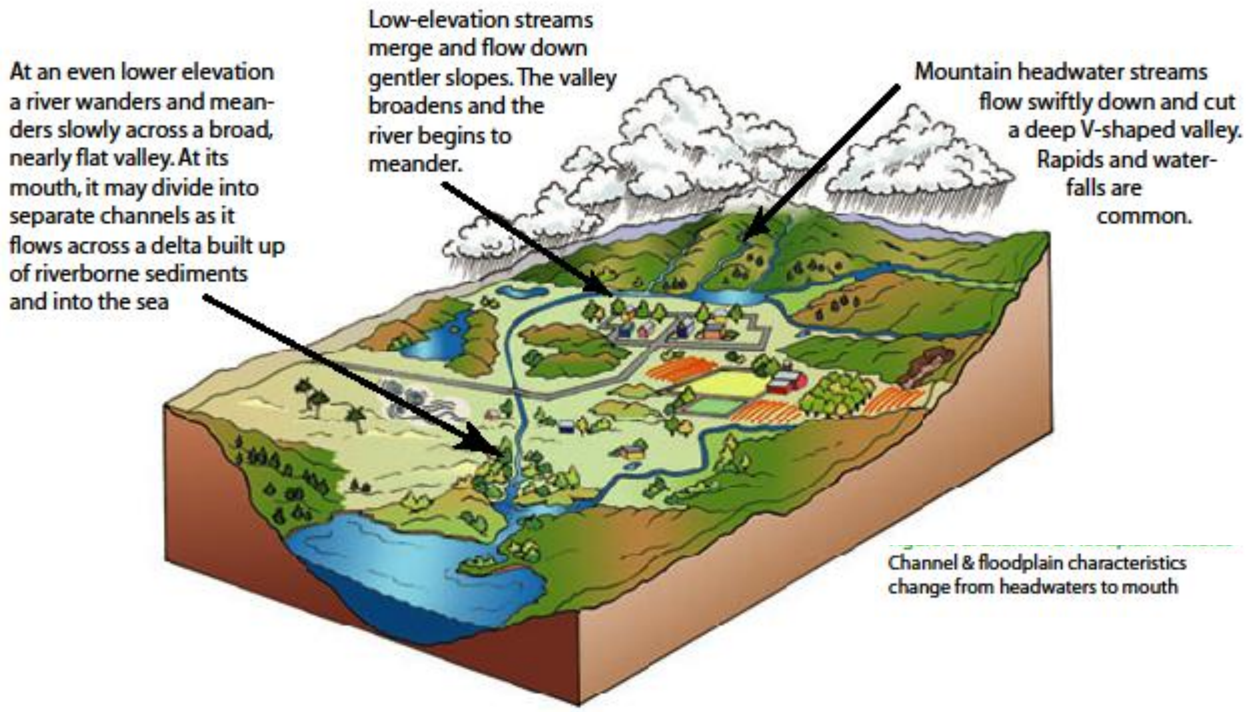


A more detailed write up on regional collaboration is included in **Chapter 2 Governance, Outreach and Integration.**

Hydrology, and Geomorphologic Features of the Watershed

Much of the movement of materials, energy, and organisms associated with the channel environment and adjoining upland environment depend on the movement of water within the Watershed. To the extent that this movement is altered, so does the potential exist for the system to become "dysfunctional" for species that depend on it. That is, alteration of water movement via damming or channelization can reduce ecosystem functionality. Refer to **Figure 3-3** for an illustration of water and sediment transport throughout a watershed.

Figure 3-3 Water and Sediment Transport through the Watershed



Today, only 20% of the SAR is a concrete channel, the majority being near the mouth of the river. Discharge from publicly owned treatment works (POTWs) have changed natural surface flows and provides base flow in many parts of the Santa Ana River's drainage network. This treated wastewater has altered the natural system by providing year-round river flow. As populations have increased, urban runoff and wastewater flows have increased. Between 1970 and 2000, the total average volume rose from less than 50,000 to over 146,000 acre-feet per year (AFY), as measured at the Prado Dam. Base flow is expected to rise to 370,000 AFY by 2025, a projected increase of 153 percent since 1990.

The geologic and hydrologic features of the watershed or geomorphology – the study of the classification, description, nature, origin, and development of present landforms and their relationships to underlying structures – and of the history of geologic changes as recorded by these surface features includes the following features. The upper watershed or headwaters, including the highest point in the drainage system, is delineated by the east-west ridgeline of the San Gabriel and San Bernardino Mountains. Over this ridgeline lies the Mojave Desert, which is part of the Lahontan Basin. This upper "erosion" zone of the watershed has the highest gradient, highest erosion level of new sediment to the system, and fastest stormwater runoff. As flows consist mainly of snowmelt and storm runoff from the undeveloped land in the San Bernardino National Forest, water quality tends to be high, with low concentrations of total dissolved solids (TDS), nitrates, and other pollutants. In this zone, the SAR channel is confined in its lateral movement, contained by the slope of the high, mountainous terrain. Within the upper watershed, the SAR and its tributaries travel around large boulders and over sand and gravel bars punctuated by pools and riffles reaching depths of about six feet.

In addition to the SAR, several other important watersheds make up the Santa Ana River basin. The Newport Bay sub-watershed encompasses an area of approximately 154 square miles. The sub-watershed is bounded to the north by the Santiago Hills (Loma Ridge) and to the south by the San Joaquin Hills. The Tustin Plain, a broad alluvial valley, occupies the major portion of this watershed. The Newport Bay sub-watershed is within the United States Geological Survey (USGS) hydrologic unit no. 18070204. The Newport Bay sub-watershed is composed of the San Diego Creek sub-watershed, with an area of 119 square miles, which is the largest system draining into Upper Newport Bay. The Santa Ana-Delhi Channel drains 17 square miles and Big Canyon Wash drains 2 square miles. The remaining 16 square miles are divided among several small sub-watersheds that discharge into lower Newport Bay.

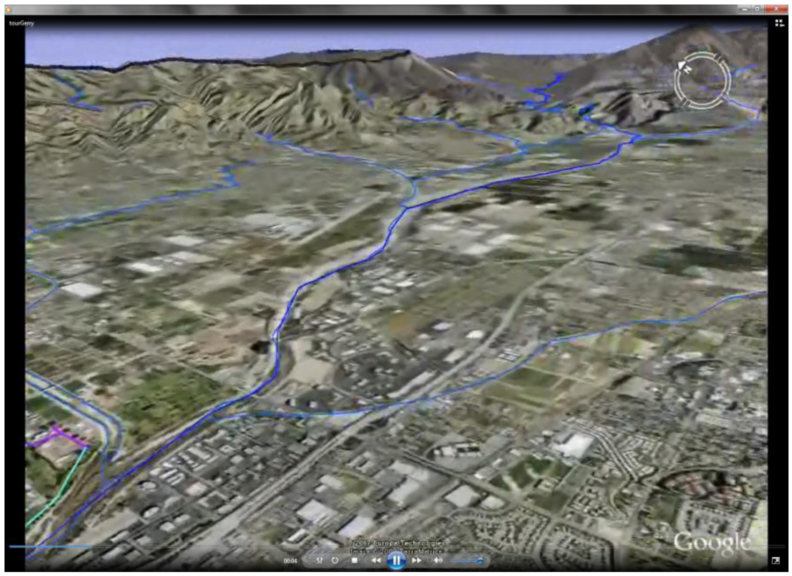
Two other important watersheds in the Santa Ana region include the Anaheim-Bay Huntington Harbor (AB-HH) and Lower San Gabriel River/Coyote Creek. The AB-HH watershed encompasses an area of 81 square miles. The main surface water systems that provide drainage in this watershed are the Bolsa Chica Channel that provides drainage to the Anaheim Bay-Huntington Harbor Complex; and the East Garden Grove-Wintersburg Channel that carries flow to Bolsa Bay and ultimately to Huntington Harbor. The Coyote Creek Watershed encompasses an area of 85 square miles within the Santa Ana region. This watershed is located in the northernmost portion of the County of Orange. This watershed straddles the Los Angeles and Orange County border in its upper reaches and then continues through Orange County until it discharges into the San Gabriel River in Long Beach.

Sedimentary and crystalline materials from the upper watershed move down slope through a process fed by storm pulses; therefore, sediment does not move at a continuous speed. River flow from Seven Oaks Dam to the City of San Bernardino consists mainly of storm flows, flows from the Lower San Timoteo Creek, and groundwater that is rising due to local geological features. From the City of San Bernardino to the City of Riverside, the river flows perennially and much of the reach is operated as a flood control facility. The principal tributary streams in the upper Watershed originate in the San Bernardino and San Gabriel Mountains. These tributaries include San Timoteo, Reche, Mill, Plunge, City, East Twin, Waterman Canyon, Devil Canyon, Cajon Creeks, and University Wash from the San Bernardino Mountains; and Lone Pine, Lytle, Day, Cucamonga, Chino, and San Antonio Creeks from the San Gabriel Mountains.

From the City of Riverside to the recharge basins below Imperial Highway, river flow in Orange County consists of highly treated POTW effluent, urban runoff, irrigation runoff water, imported water applied for groundwater recharge, and groundwater forced to the surface by underground barriers (SAWPA, March 2004). Near Corona, the SAR cuts through the Santa Ana Mountains and the Peralta-Chino Hills, which together form the northern end of the Peninsular Ranges in Southern California. The SAR then flows down onto the Orange County coastal plain where the channel lessens in gradient, the valley floor is reached, and the soft features of the channel where sediment has deposited are more prevalent. Floodplains are strewn with boulders and characterized by sand and gravel washes. Within this valley floor, the transport and depositional processes are less confined by higher terrain as water, dissolved material and sediment move toward the sea. Over time, aquatic and terrestrial wildlife have adapted to this dynamic process and channel form. However, rapid urbanization has artificially increased the rate of sedimentation and loss of habitat in this part of the watershed, negatively affecting water quality and wildlife habitat.

A visual "fly-through" of the Santa Ana Watershed is available here: http://www.youtube.com/watch?v=HXDQCXKP6lM

Figure 3-4 Watershed Flythrough



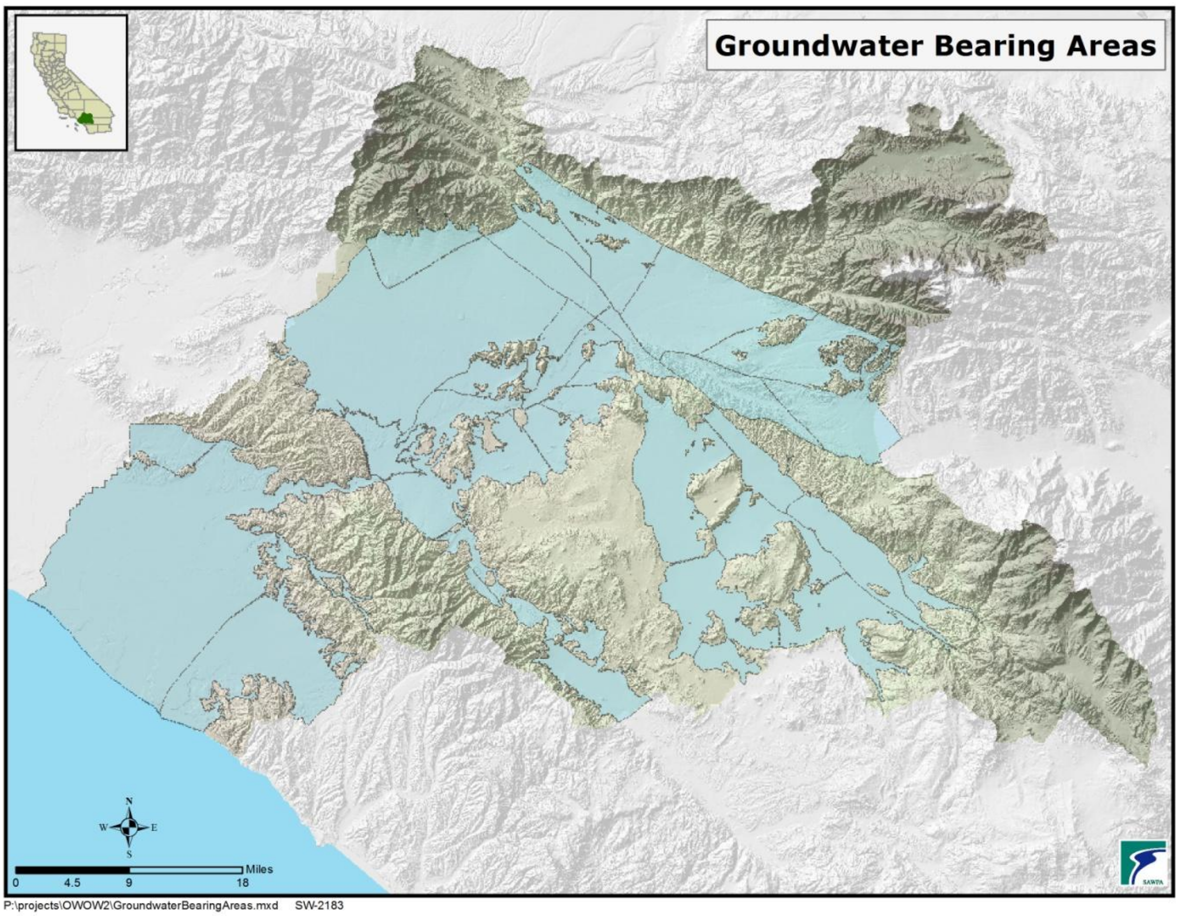
In the southern portion of the watershed, the regional boundary divides the Santa Margarita River drainage area, which is not part of the watershed, from that of the San Jacinto River. The San Jacinto River, which is part of the Watershed, starts in the San Jacinto Mountains, runs westerly through Canyon Lake and normally ends in Lake Elsinore. In wet years, the San Jacinto River will overflow the lake and connect with the SAR through the Temescal Wash. Flood flows from the San Jacinto River produce a broad, shallow wetlands area called Mystic Lake.

The Orange County coastal plain is composed of alluvium derived from the mountains. Upstream from the Santa Ana Canyon lay Prado Dam and Prado Wetlands; SAR flows are passed through the Prado Wetlands to improve water quality and remove nitrates before being used for Orange County Groundwater Basin recharge. Santiago Creek, the only major tributary to the lower SAR, joins the SAR in the City of Santa Ana. The lower limit of both the groundwater recharge area and the SAR's ordinary flows is 17th Street in the City of Santa Ana. Prior to channelization of the lower part of the SAR, the channel used to meander slowly across broad flood plains. Currently, the SAR is a concrete channel from 17th Street in the City of Santa Ana to Adams Avenue in Huntington Beach. The riverbed is ordinarily dry from 17th Street in the City of Santa Ana to the Victoria Street Bridge. The Greenville-Banning Channel, which carries stormwater discharge and urban runoff, is channelized to the Victoria Street Bridge where it joins the SAR. Discharge from the Greenville-Banning Channel combines with tidal flow from the Pacific Ocean and the SAR is wet from the Victoria Street Bridge to the mouth of the SAR.

Groundwater

Groundwater in the watershed is highly controlled by the geology of the area, in both the configuration of bedrock and by the extensive faulting. Most groundwater basins are unconfined, much like a bowl full of sand that has water poured in halfway, see **Figure 3-5**. However, the variable depth to bedrock, and the presence of faults cause pressure zones where water flows towards (or to) the ground surface. In general, groundwater flows the same direction as surface waters from the mountains in the east/north to the Pacific Ocean in the west. There are about 40 groundwater basins in the watershed (depending on how they are defined and boundaries are drawn); many are inter-related. Some of the largest groundwater basins include the Chino Basin (Chino/Ontario/Fontana area), the Orange County Basin, the Bunker Hill Basin (San Bernardino), the San Timoteo Basin (Yucaipa/Banning/Beaumont area), and the San Jacinto/Hemet Basins.

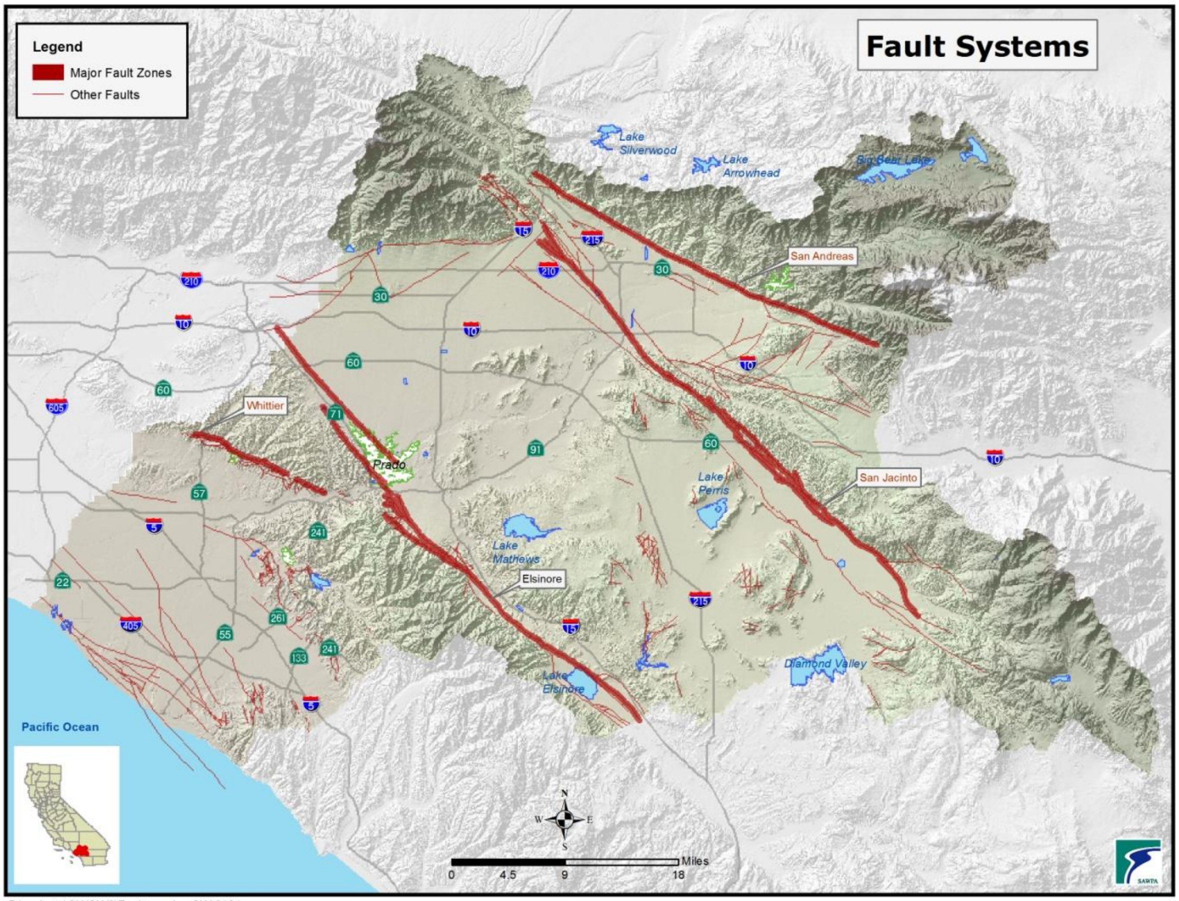
Figure 3-5 Groundwater Basins



Four primary faults transverse the watershed, with other minor faults either branching off of, or running parallel to, the major faults **(Figure 3-6)**. Within the upper watershed, the San Andreas Fault divides the San Bernardino Mountains from the San Gabriel Mountains and branches off into the San Jacinto Fault near San Bernardino. Known as Southern California's most active fault, the San Jacinto Fault affects groundwater in the San Jacinto River and the SAR, forcing groundwater to the surface at the Bunker Hill

Dike. Toward the central watershed, the Elsinore-Whittier Fault passes under the Prado Dam from the northwest to the southeast. Toward the coast, the Newport-Inglewood Fault enters the region from the Los Angeles area and passes offshore near Newport Beach.

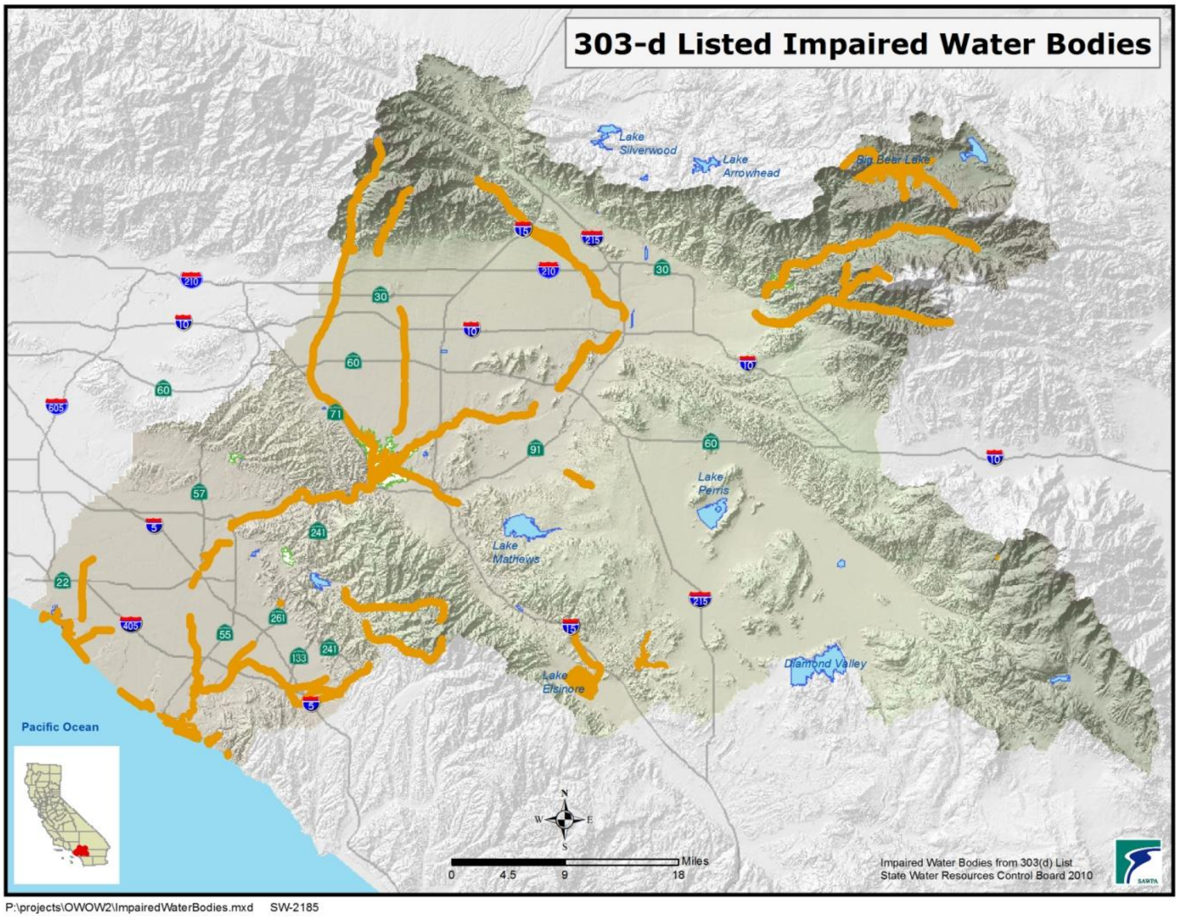
Figure 3-6 Fault Systems



Water Quality

Fortunately, water quality in the SAR has improved in recent years due to technological developments and water quality planning. Most of the native fishes of the Watershed are adapted to clear, unpolluted water that can support food resources and provide the various habitat conditions necessary to complete their respective life cycles. While fish kills, due to the spill of toxic substances into streams, are dramatic examples of the effects of pollution, these instances are acute, or short-term, rather than chronic. More insidious, however, are the chronic effects on aquatic resources of non-lethal forms of pollution that decrease growth, inhibit reproduction, or impair movement. Chronic elevated water temperatures or high sediment loads are an example of this type of pollution, even though toxic chemicals are not involved. Other examples include elevated but non-toxic levels of ammonia, increases in salinity, and low levels of dissolved oxygen (DO). Because most of the remaining native freshwater fishes live, at some time, in treated wastewater, the issue of chronic, low-level pollution is of great concern, although the quality of wastewater has increased markedly in past years. Impaired water bodies can be seen in **Figure 3-7**.

Figure 3-7 Impaired Waterbodies

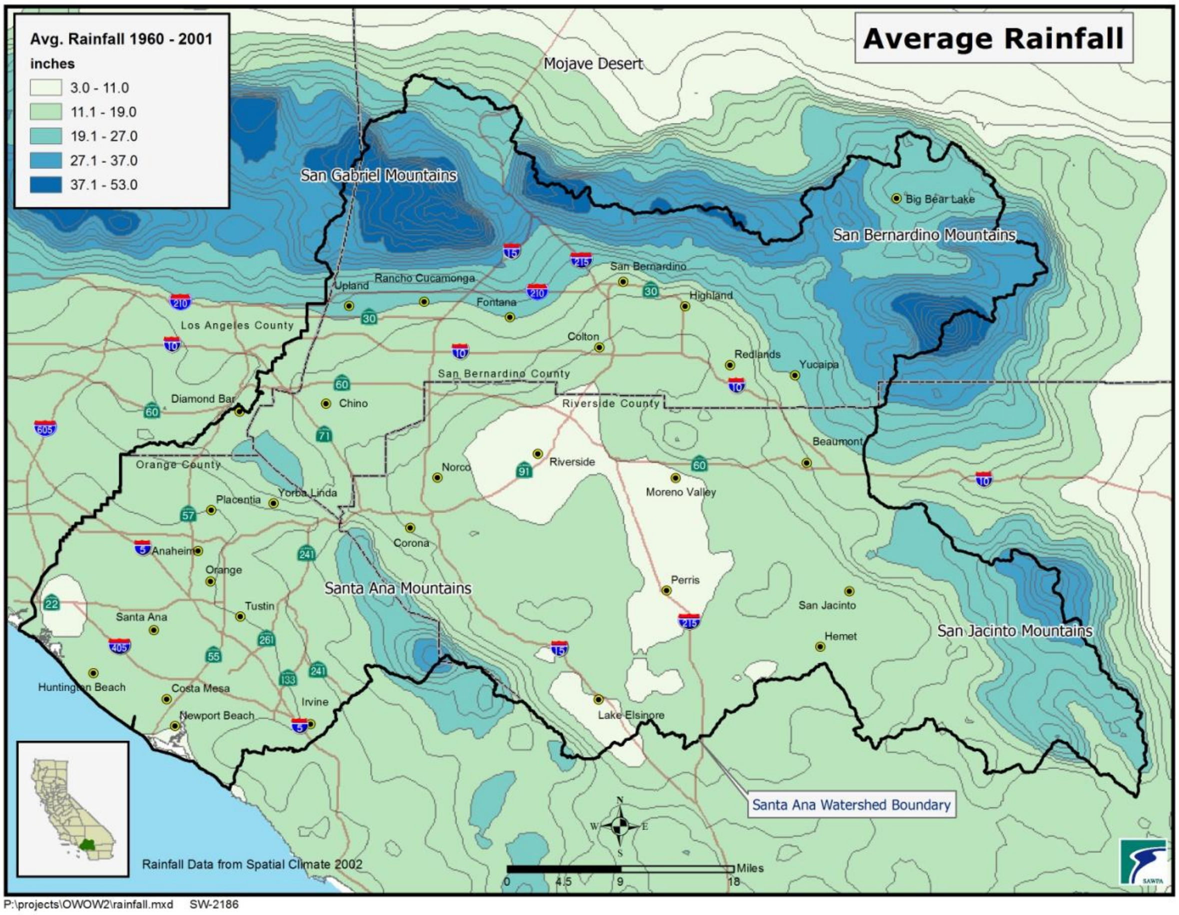


A more detailed write up on water quality issues in the Santa Ana Watershed is included in **Chapter 5.5 Beneficial Use Assurance**.

Climate

The climate of the Watershed is considered Mediterranean with hot, dry summers, and cooler, wetter winters. Average annual precipitation ranges from 12 inches per year in the coastal plain to 18 inches per year in the inland alluvial valleys, reaching 40 inches or more per year in the San Bernardino Mountains (**Figure 3-8**). Most of the precipitation occurs between November and March in the form of rain with variable amounts of snow in the higher mountains of the Watershed. The climatological cycle of the region results in high surface water flows in the spring and early summer period, followed by typically low flows during the dry season. Winter and spring floods generated by precipitation in the high mountains are not uncommon. Similarly, during the dry season, severe thunderstorms in the high mountains periodically have generated torrential floods in local streams.

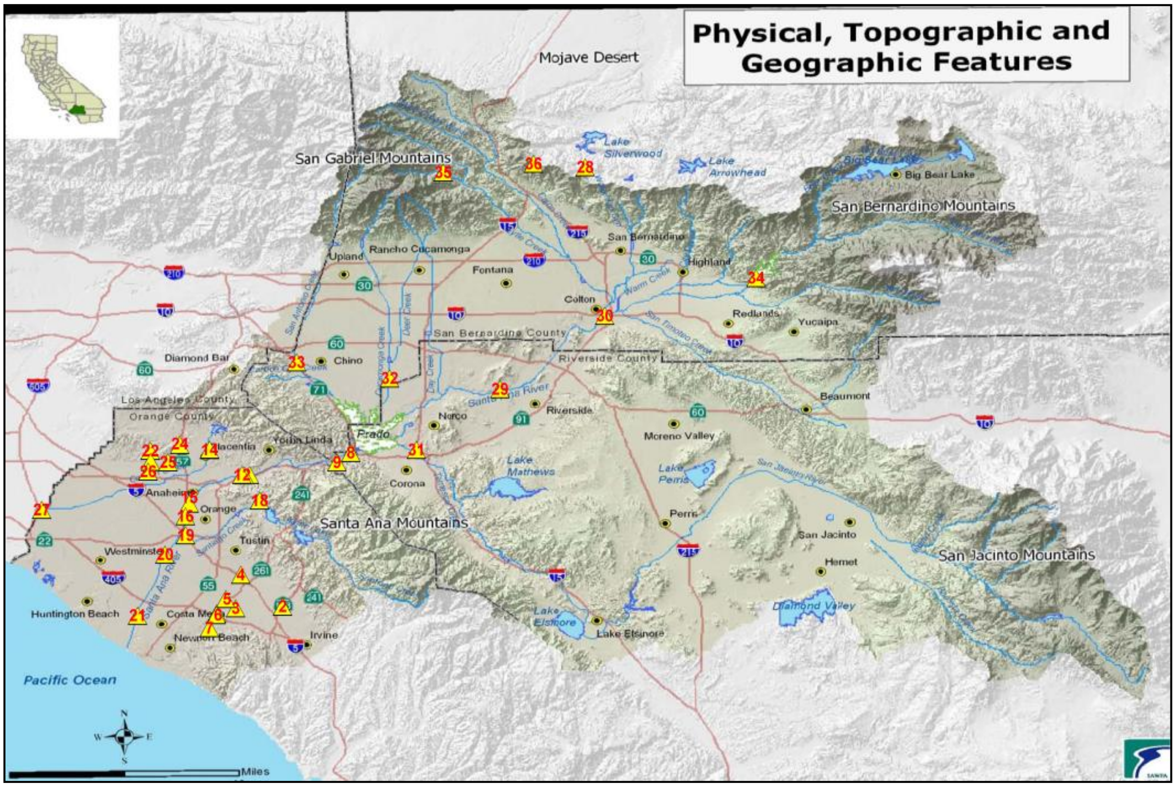
Figure 3-8 Average Rainfall



Climate Impacts

Climate change-related impacts already have taken place in California, and are having an effect within the watershed. According to the Department of Water Resources (DWR), historic hydrologic patterns can no longer be relied upon to forecast the water future. As such, the reliability of the system of imported water that provides significant supply to the region has been lessened. Precipitation and associated runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management, and ecosystem functions. The average early snowpack in the Sierra Nevada has decreased by about ten percent during the last century, representing a loss of 1.5 million AF of snowpack storage. During the same period, the sea level rose seven inches along California's coast. The state's temperature also has risen 1 degree Fahrenheit. Most of the increased temperature readings are at night and during the winter season, with higher elevations showing the greatest increase. Rainfall has become increasingly variable, with Southern California experiencing both its driest and wettest years on record within the past decade.

Figure 3-9 Climate Model Monitoring Locations



A more detailed write up on the impacts of Climate Change in the Santa Ana Watershed is included in **Chapter 5.13 Energy and Environmental Impact Response**.

Habitat and Native Species

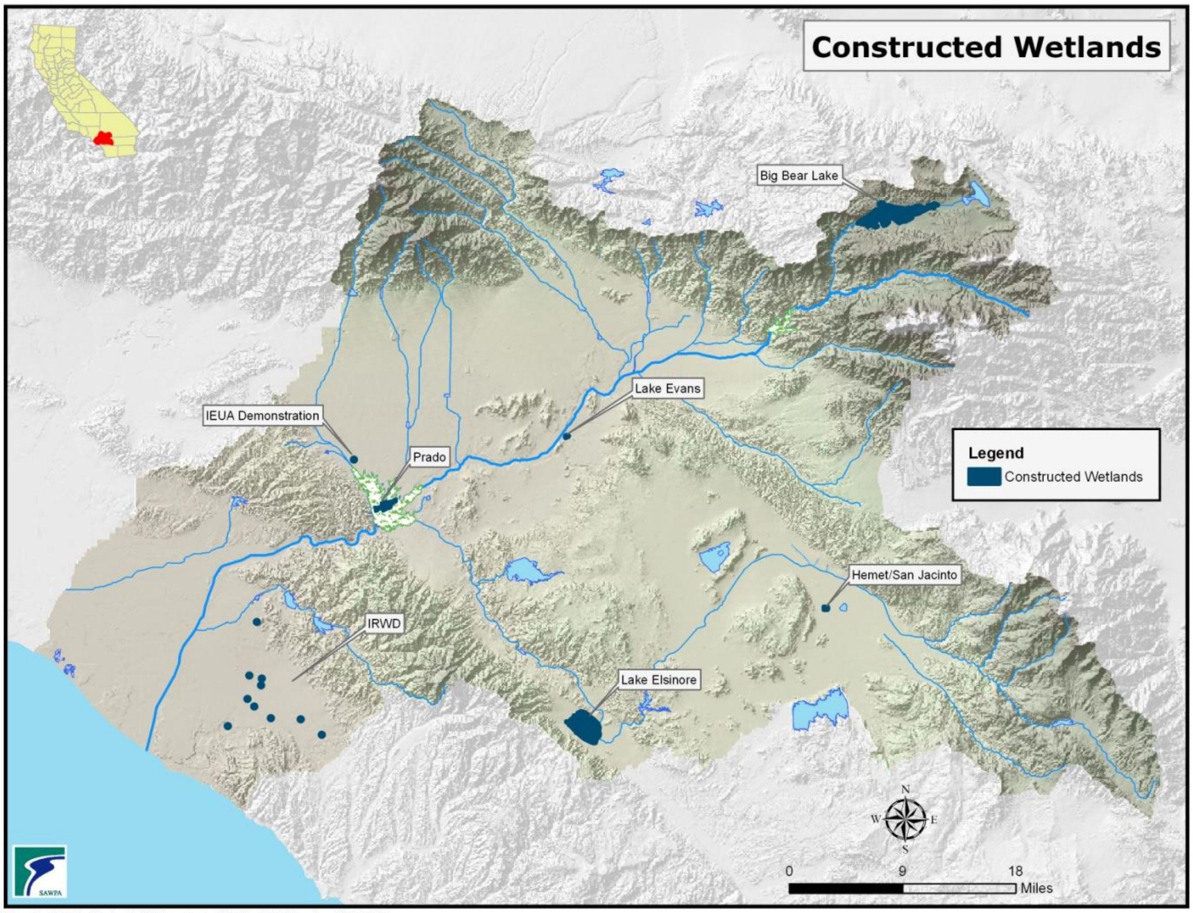
Habitat

OWOW attempts to catalog the locations of many water-oriented habitats within the watershed. While there are several types of habitat within the watershed boundary that are not directly water-oriented (e.g., chaparral, pine forest, oak woodland, grassland), the primary focus is on water-oriented habitat types (e.g., alluvial fans, riparian woodland, emergent wetlands, vernal pools, lakes, streams, estuaries, tidelands, open ocean). These water-oriented habitats tend to show up on maps as the "corridors" that connect the larger, non-water-oriented habitats. Water-oriented habitats locations that are candidates for protection or enhancement are of particular interest.

Wetlands

Constructed wetlands have a wide range of benefits, including surface water protection . Constructed wetlands designed to treat secondary effluent will directly affect the reclaimed water supply. If water produced from the wetlands is of suitable quality to be recharged into groundwater aquifers, diminishing groundwater resources can be supplemented, or in some areas, reclaimed water can be recharged as part of a groundwater remediation program. Located along the Pacific Flyway, the critical migratory corridor connecting Alaska and Canada to Latin America, Southern California wetlands provide vital habitat for migratory waterfowl. Opportunities for wildlife enhancement were considered in the construction/preservation of many of the following wetlands with environmental features that increase habitat diversity and wildlife productivity.

Figure 3-10 Constructed Wetlands



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Impacts to the Natural System

As noted by Moyle (2002), most of California's inland waterways today bear little resemblance to the streams and lakes encountered by the first European explorers and settlers. In the watershed, this observation is certainly true as flood control and channelization activities have left portions of streams channelized and concrete-lined where once riparian forests grew along a meandering stream. Fortunately, today only 20% of the SAR is concrete-lined. Dam construction and flood control activities were not the only factors influencing the watershed in ways that adversely impact habitat critical for aquatic resources. The following factors have also played a role:

- Stream channel alteration
- Draining of streams and lakes, especially adjacent wetlands

- Livestock grazing and the impact on aquatic and riparian vegetation, sedimentation, and water pollution
- Historical logging practices
- Bark Beetle infestation
- Mining, particularly in-stream aggregate mining
- Watershed changes resulting in cumulative affects to aquatic resources

A more detailed write up on issues relating to natural systems in the Santa Ana Watershed are included in **Chapter 5.9 Natural Resources Stewardship**.

Forest

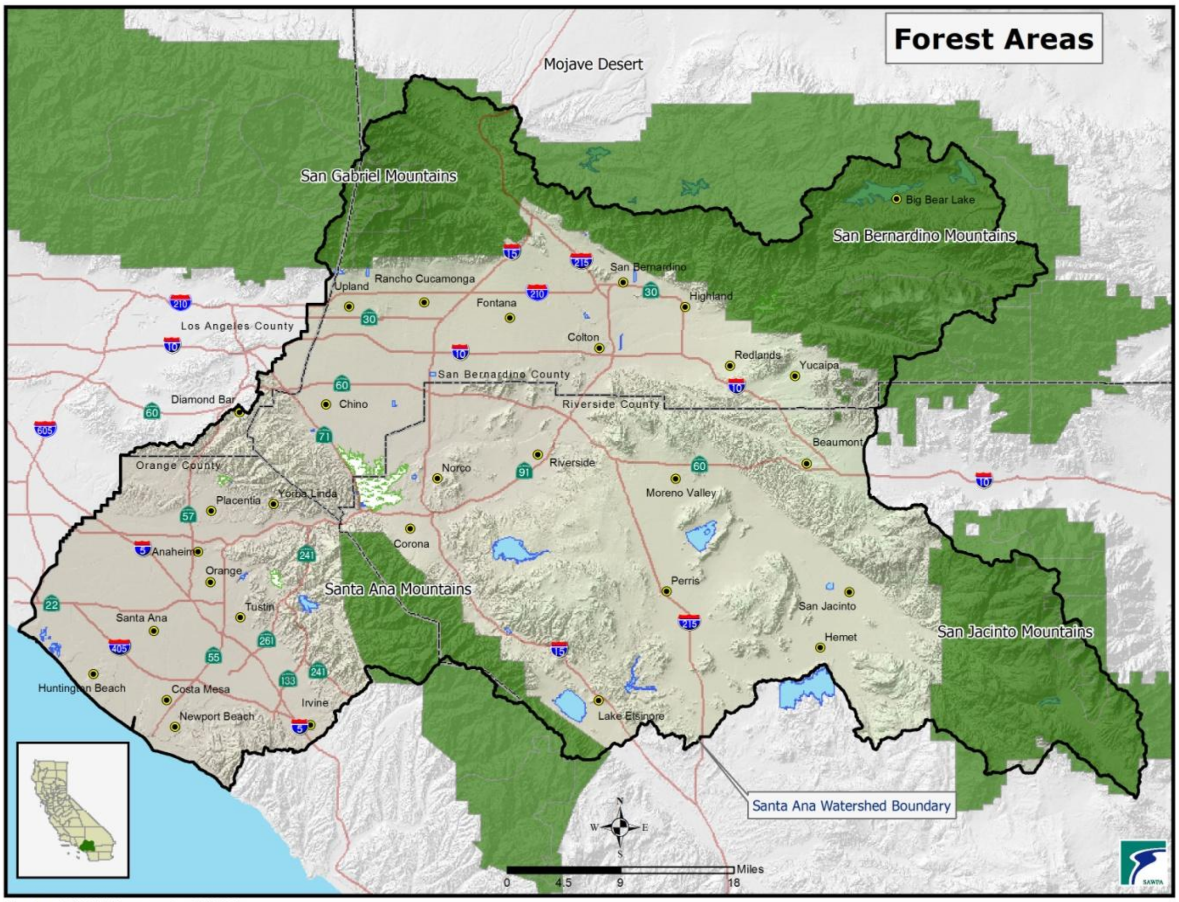
As home to the headwaters of the Santa Ana River, the San Bernardino and Cleveland national forests encompass approximately 29% of the Santa Ana watershed's land mass. These forest areas also receive 90% of annual precipitation. Runoff on that land directly affects the amount and quality of water received downstream**.** If there are too many trees, the water supply is reduced by their thirst and the amount of fire fuel is increased resulting in more intense fires which are more difficult to control and have a greater potential for incurring loss of property or life. Meadows, which act as nature's sponge retaining water for groundwater recharge, can dry up due to natural and manmade channelization prohibiting the potential benefit of this resource. Restoration of impaired meadows could restore their beneficial function. The benefit of chaparral has mixed perception, having good benefits for erosion control and water dispersion contrasted by negativity when viewed as excessive fire fuel, therefore a clear method of management has been elusive.

There are two forests under the management of the U.S. Forest Service within the Santa Ana River Watershed; San Bernardino National Forest and Cleveland National Forest. The combined area of these forests is approximately 1.1 million acres. The U.S. Forest Service is challenged with managing this vast area while striving to address the multiple goals of conserving habitat for sensitive and endangered species, hazardous fuels reduction and the restoration of meadows. However, their resources have been limited to proactive measures aimed at protecting urbanized areas in and adjacent to national forest land leaving a substantial quantity of land vulnerable to overgrowth and increased fire risks and intensity.

Fire is an ongoing risk faced by the U.S. Forest Service due to man's encroachment into forested areas as evidenced by the nearly 2,300 special use permits issued each year by the U.S. Forest Service. The variables in weather such as drought seasons and wind also contribute to fire risk. The combinations of variables that contribute to fire risk make predictions and planning for fire events problematic. Hard lessons were learned after the forests experienced devastating fires in the early 2000's and the aftermath of those fires directly impacted the quality of water downstream of the burn areas and it took between three and five years to recover.

A partnership is being pursed among downstream groundwater management agencies, flood control and water conservation districts, water supply agencies, resource agencies and the U.S. Forest Service to find amicable projects that can be executed in specific areas within the forest that will have a direct effect in preserving the quality and quantity of water resources from the source or headwaters, contributing to the overall health of the watershed. Evidence of a quantitative cost/benefit analysis is being sought to validate investment in projects that when implemented will help the U.S. Forest Service to keep the forest healthy which will in turn promote a gain in both the quantity and quality of available water resources.

Figure 3-11 Forested Areas in the Santa Ana River Watershed



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A more detailed discussion relating to the partnership between water agencies and the U.S. Forest Service are included in **Chapter 5.12 Government Alliance**.

Native Riparian Species

Fish

The SAR historically provided habitat for eight species of native fish (species have multiple forms). Only four native non-game freshwater fishes are currently found in non-estuarine waters: arroyo chub, Santa Ana Speckled Dace, Santa Ana Sucker, and Threespine Stickleback. All of these remaining fishes have limited distributions and face possible extirpation. As previously mentioned, the Santa Ana Sucker is listed by the Federal government as a “threatened” species pursuant to the Endangered Species Act. Currently, the Western Brook Lamprey, Steelhead, and Unarmored Threespine Stickleback are known to be extirpated from the watershed. The Pacific Lamprey has been observed once in the past 47 years and it likely is extirpated as well. Introduced forms of the rainbow trout have been extensively stocked in the watershed for sport fishing for over 100 years, and it is unknown if any genetically pure rainbow trout stocks endemic to the watershed remain. The partially Armored Threespine Stickleback was widely planted in the watershed for mosquito control in the early 1900s and is now found out of its natural historical range, e.g., Big Bear Lake. In contrast, at least 33 fishes have been introduced into the watershed and are currently present. New species can be expected to be found at any time due to inter-basin water transfers, ship ballast water hitchhikers, bait bucket introductions, and hobbyists disposing of unwanted fishes. Many of the introduced fishes are widespread, while a few are restricted to specific locations or habitats. Of the current inventory of introduced fishes, most were introduced by government agencies to serve as a food resource, for insect control, for sport fishing, or to serve as forage for sport fishes. A smaller number of fish have become established after arriving inadvertently via inter-basin water transfers or in ships’ ballast water. For a detailed discussion of the introduction of fishes to California, the reader is directed to Dill and Cordone (1997). Additional information about introductions of fishes to Southern California is presented by Swift *et al*. (1993). Supplemental records can be found in Moyle (2002).

The Santa Ana sucker is a federally listed fish native to the Santa Ana River

Amphibians

During the last 50 years, population growth and urban development in Southern California has displaced many amphibian species, and encroached upon much of former amphibian habitat. Several species are thought to be extinct, and many others have fragmented populations, which are at risk of extirpation. Amphibians especially are sensitive to environmental changes that alter the hydrology, ecology, and geology of a region because they have evolved, highly specialized adaptations that have allowed them to exist in these relatively arid regions. Introduced species also have been a major contributor to the decline in amphibian populations in Southern California. These non-native species increase competition for food sources, as well as prey upon many of the native amphibians.

Reptiles

The California Department of Fish and Wildlife (CDFW) considers the Southwestern Pond Turtle (*Clemmys marmorata*) a species of “special concern”. Recent reports on *C. marmorata* in Southern California indicates that a few viable populations remain in the regions (see also Brattstrom 1988).

Approximately six to eight viable populations of the turtle remain south of the Santa Clara River system in California. Droughts have exacerbated the negative effects of habitat alteration accumulated over many years over much of this region from changes in land and water use, and abusive grazing practices. In particular, most western pond turtle populations examined in this region appear to show an age structure increasingly biased towards adults, indicating little or no recruitment is taking place. Recent surveys indicate that the southwestern pond turtle also is seriously threatened throughout most of its range outside of California.

Birds

Riparian ecosystems harbor the highest number of bird species in the arid and semi-arid parts of the southwestern United States. Riparian habitat provides productive breeding grounds and offers vital over-wintering and migration stop-over areas for migrating birds. Loss and degradation of riparian habitat have negatively impacted bird populations throughout the watershed. Other factors affecting bird populations are brood parasitism by the brown-headed cowbird, and disruption of natural hydrological regimes from dams and levees.

Least Bell's Vireo, a federally listed bird species

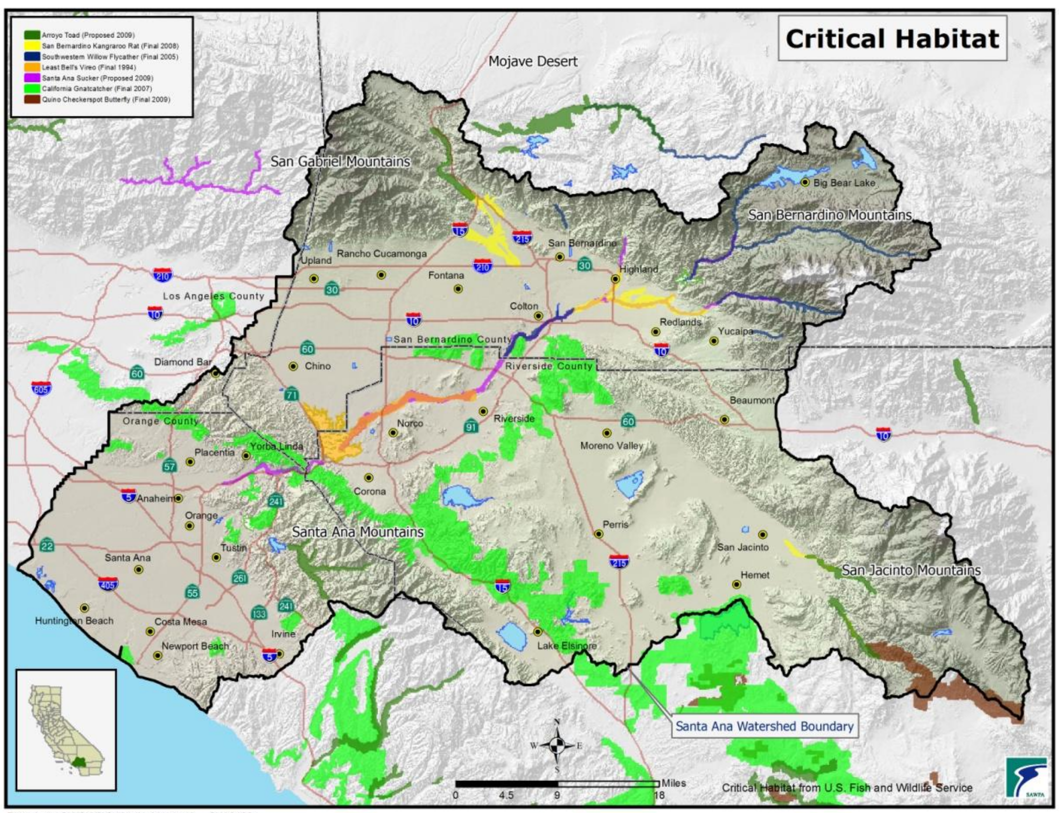
The Federally endangered Least Bell's Vireo has experienced recent population growth within the watershed due to aggressive management activities within Prado Basin and on adjacent lands. Within the basin, the population rose from 19 nesting pairs in 1986 to 123 nesting pairs in 1993. By the end of 1996, the count stood at 195 nesting pairs. This stunning recovery is due to the provision of a high quality habitat for the bird species, in part, due to invasive species removal, a project in place to control populations of the predatory cowbird, and efforts on the part of the U.S. Fish and Wildlife Service (USFWS) , Orange County Water District (OCWD), a number of Resource Conservation Districts (RCDs), and others.

The Federally endangered southwestern willow flycatcher also is affected by cowbird brood parasitism. The implementation of cowbird management programs in addition to preservation and restoration of riparian deciduous shrub habitat is needed to reduce current populations. The bald eagle, listed by the USFWS as endangered in 1978 has experienced population growth over the past two decades. The bald eagle could be considered a USFWS success story: reclassified as "threatened" in 1995 and first proposed for delisting in 2000. Delisting of a species is the USFWS's ultimate goal and only happens when specific recovery goals have been met for a species. Unfortunately, delisting is an infrequent occurrence. In the case of the bald eagle, delisting has been delayed while the USFWS determines how the species would be managed once it is no longer classified as threatened.

Special Status Species

Second only to Hawaii, the State of California is home to the highest number of endangered species in the United States. As defined within the Federal Endangered Species Act of 1973, an endangered species is any animal or plant listed by regulation as being in danger of extinction throughout all or a significant portion of its geographical range. A threatened species is any animal or plant that is likely to become endangered within the foreseeable future throughout all or a significant portion of its geographical range. Federal law prohibits the “take” of any individuals or habitat of federally listed species without a special permit. In addition to federal laws, the State of California has its own California Endangered Species Act, with a separate listing of species and separate laws governing take of listed species. Enforcement of the Federal Endangered Species Act is administered by the USFWS and the National Marine Fisheries Service, while the CDFW enforces the California Endangered Species Act.

Figure 3-12 Critical Habitat within the Watershed



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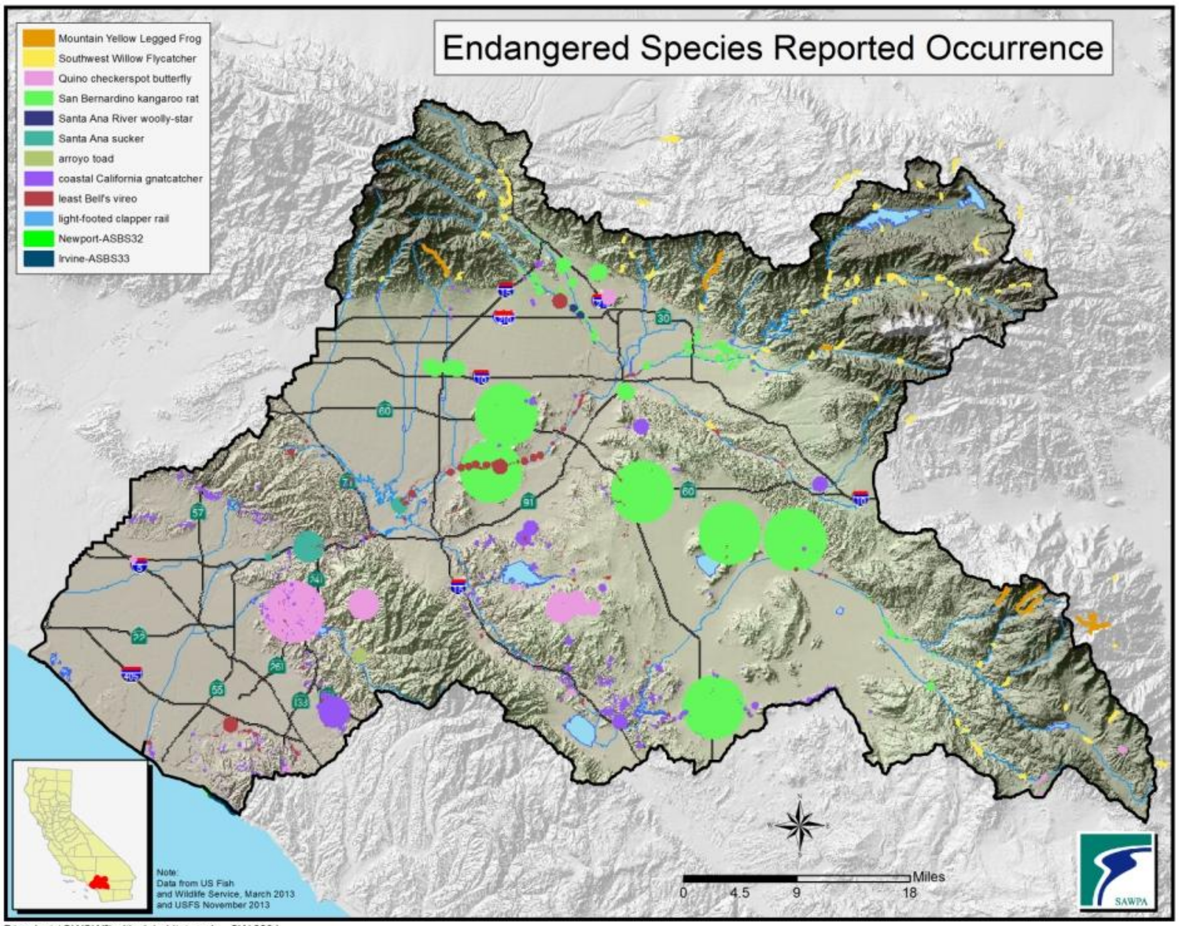
The varied geography and natural features of the Watershed provide habitat for a number of Federally and/or state-listed species. As OWOW 2.0 focuses on the resources in and around the SAR, listed species of concern herein are those that occupy aquatic, wetland, riparian, or riparian adjacent areas. Of these, two are plants – the Santa Ana River Woolly Star (*Eriastrum densifolium*) and the slender-horned spine flower (*Dodecahema leptoceras*); one fish – the Santa Ana River Sucker (*Catostomus santaanae*); one amphibian – the Arroyo Toad (*Bufo californicus*); three birds – the Least Bell’s Vireo (*Vireo bellii pusillus*), the Southwestern Willow Flycatcher (*Empidonax traillii*), and the Bald Eagle (*Haliaeetus leucocephalus*);

two mammals – the San Bernardino Kangaroo Rat (*Dipodomys merriami parvus*) and Stephen's Kangaroo Rat (*Dipodomys panamintinus*); and one insect – the Delhi Sands Flower-loving Fly (*Rhaphiomidas terminatus abdominalis*). Any project or policy recommended by the Santa Ana IWP will need to assess potential impacts to listed species, and incorporate measures to avoid impacts to these species.

Figure 3-13 Endangered Species Reported Occurrence



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Factors Affecting Native Species

Introduced Species

The 33 species of introduced fishes greatly outnumber the four remaining native fish species. The number of species, *per se*, is not the problem but, rather, the impact that introduced fishes and other aquatic organisms, have on the native fishes of the watershed. Introduced fishes have dramatically changed the composition of the watershed's fish community and now act as a deterrent to the restoration and enhancement of the native fishes that remain. The manner in which introduced fishes can affect the aquatic resources of the watershed are:

- Competition between native and introduced fishes for food and space
- Predation by introduced species on native fishes
- Habitat interference by introduced fishes that change habitat characteristics
- Introduction of diseases that may infect native fish or other aquatic animals
- Hybridization between closely related species

Exploitation

Over-exploitation of rainbow trout/steelhead, primarily by angling, was a major factor in driving the native populations to low levels, and perhaps to extinction. Over-fishing, in turn, led to the stocking of hatchery fish and the introduction of various exotic species as angling alternatives to the native trout. The intensity of over-exploitation is illustrated by a report in the July 17, 1892 edition of the *Citrograph*, a Redlands newspaper, which reported that three boys fishing in Bear Creek, a tributary to the SAR in San Bernardino County, had caught 592 trout in three hours. Similar reports are common in the historical press.

It was not until 1872 that the California Legislature banned the use of nets, weirs, baskets, traps, explosives, and poisons as acceptable means of harvesting trout. Unfortunately, there was no one to enforce this statute, nor was there any limit on the number of fish that could be harvested by legal means. The over-exploitation of trout became such a problem in the watershed that in 1894, San Bernardino County, on its own authority, finally took action and limited the number of trout a person could catch to 50 per day. The State of California did not take similar action until 1905, when the harvest was limited to 50 trout per day and 25 total pounds. By then, the native stocks already had become depleted in the watershed.

Each of the aforementioned factors has acted in concert over a long period of time to reduce the native fish community of the Watershed to that which remains today. OWOW 2.0 recognizes that history cannot be undone and the aquatic community cannot be restored to its pre-settlement condition; however, a conservation strategy can be implemented that will ensure the long-term viability of the watershed's aquatic communities.

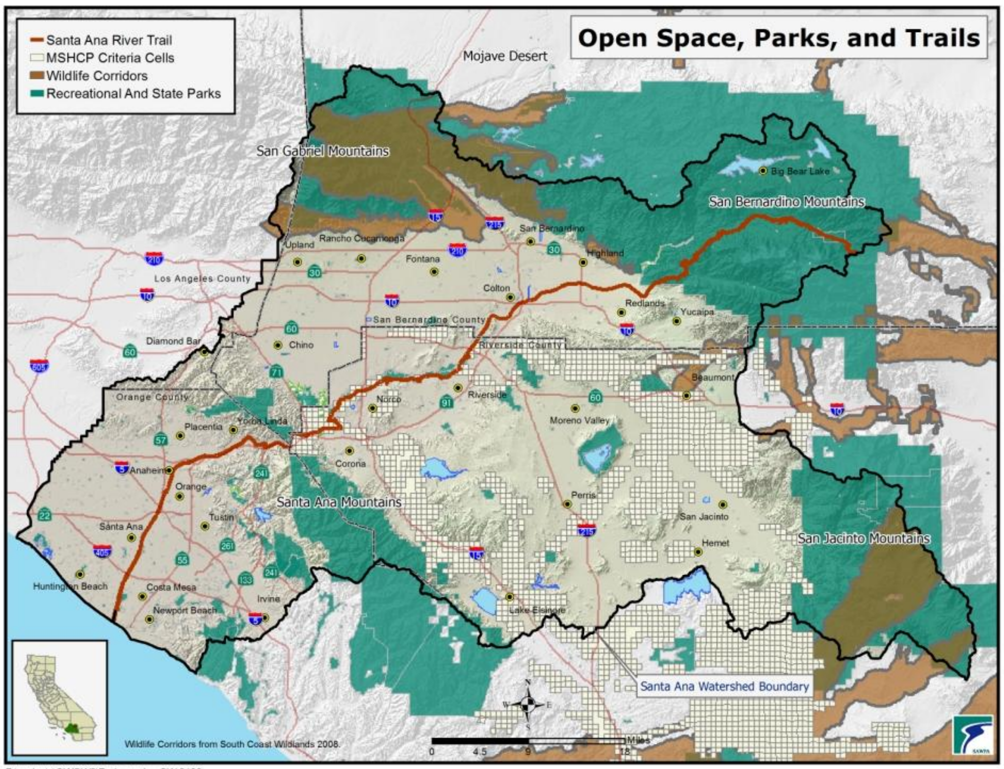
Open Space and Recreation

The Santa Ana River Watershed is a stunning location with a wide variety of scenery and natural resources. It is a unique location, situated between the desert, mountains, and the sea. The watershed combines a complex arrangement of terrain, climates, and habitats that extend from the San Bernardino Mountains down to the Pacific Ocean.

Taking advantage of the watershed's beautiful landscape, the Santa Ana River Trail, highlighted in **Figure 3-14** links open space areas throughout the Watershed. Building the SART has been a highly successful collaborative effort and should be used as a model for other recreation projects in the future. The

SART's achievements only could have been accomplished through a variety of partnerships, combining the expertise and resources of multiple counties, cities and other groups.

Figure 3-14 Recreational Opportunities within the Santa Ana River Watershed



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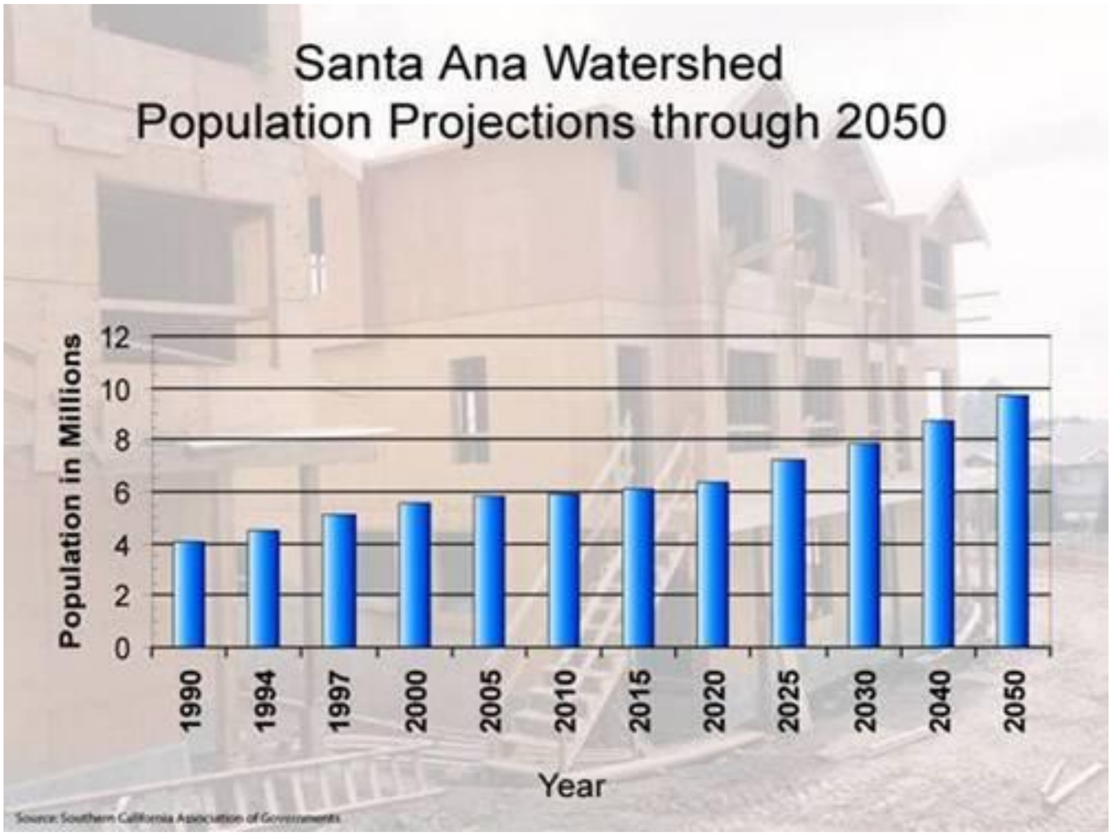
A more detailed write up on issues relating to recreational opportunities in the Santa Ana Watershed are included in **Chapter 5.9 Natural Resources Stewardship**.

Watershed Demographics

Population and Population Projections

The Santa Ana River Watershed has experienced significant population growth in recent years and is expected to continue growing at a considerable pace over the next 40 years. According to the U.S. Census Bureau, the watershed had a population of 5.9 million in 2010 and is expected to reach 9.9 million by 2050, or an average annual growth rate of 1.3 percent (**Figure 3-15**). The recent recession most likely will slow this growth rate substantially. Although recent Southern California Association of Governments (SCAG) reports show that the Santa Ana Watershed will continue to grow and reach long–term population estimates, the timeline is uncertain. Until the issues of higher unemployment and high-foreclosure rates within the region are resolved, population growth rates will be slowed.

Figure 3-15 Population Projections



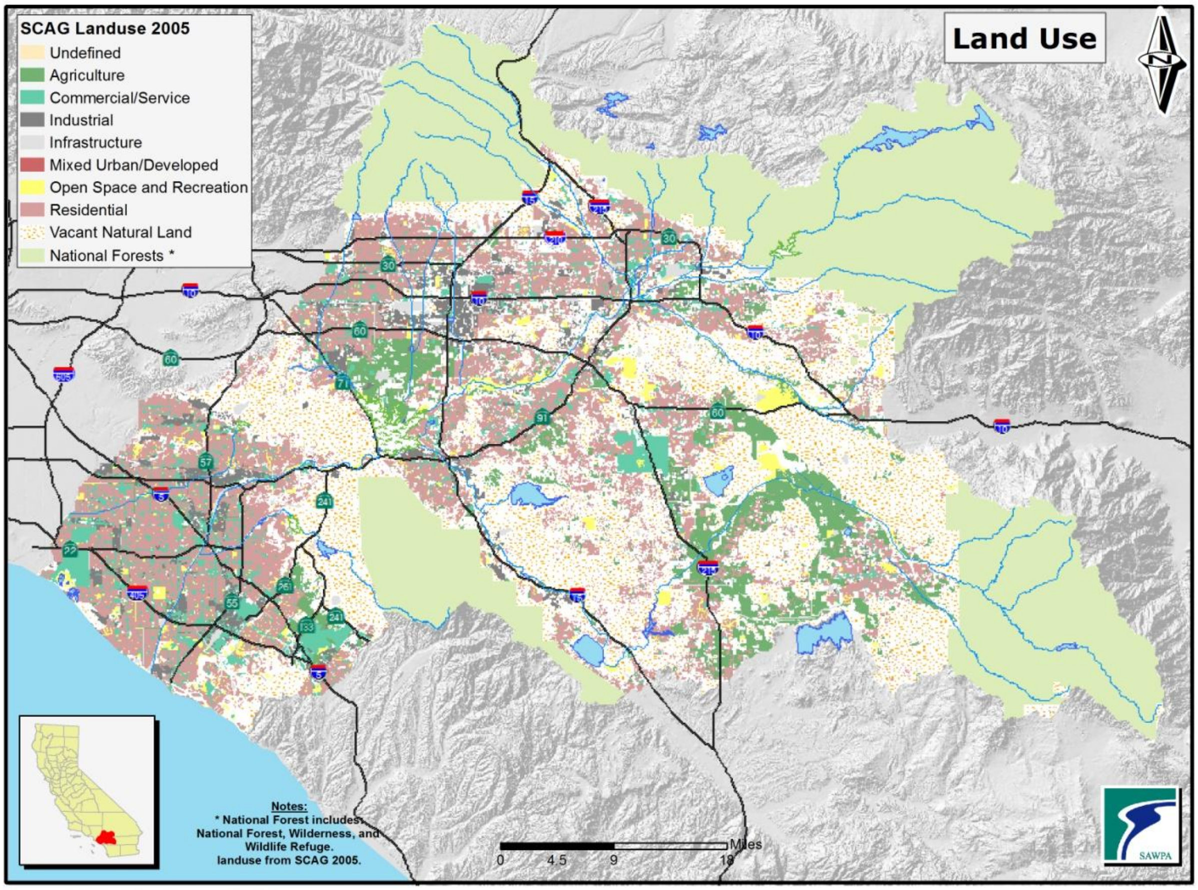
Demographic estimates for the watershed indicate that much of future population growth will take place in Riverside and San Bernardino counties, as Orange County is fairly built out. According to the U.S. Census Bureau, Riverside County grew by 37.5% between 2000 and 2010 (or an annual average of 3.6%), compared to 9.1% for the state of California as a whole (an average of less than 1% per year). Population growth will continue at an average of 1.9% per year through 2035, according to Riverside County Center for Demographic Research.

Similarly, San Bernardino County grew by 18.0% in the same period (or 1.8% per year), or almost twice the state rate. In contrast, Orange County grew by 6.3% in the same period, below the State average. Population growth will exacerbate some of the issues previously described for the watershed if no action is taken. In particular, population growth could result in more habitat fragmentation, increased impervious surfaces, modification of natural hydrology, increased water demand, and increased waste generation. The types of multi-benefit and multi-jurisdictional or watershed-wide projects promoted by the OWOW plans could help reverse this trend.

Land Use

The watershed is substantially urbanized; about 32 percent of the land use is residential, commercial, or industrial. Agricultural land, once accounting for virtually all of the use of the watershed during the days of the ranchos, now accounts for a mere ten percent. Instead of a scattered population of indigenous peoples, the watershed now supports over 5 million people. **Figure 3-16** presents a breakdown of the major land use categories of the watershed obtained from the SCAG 2005 land use dataset.

Figure 3-16 Land Use



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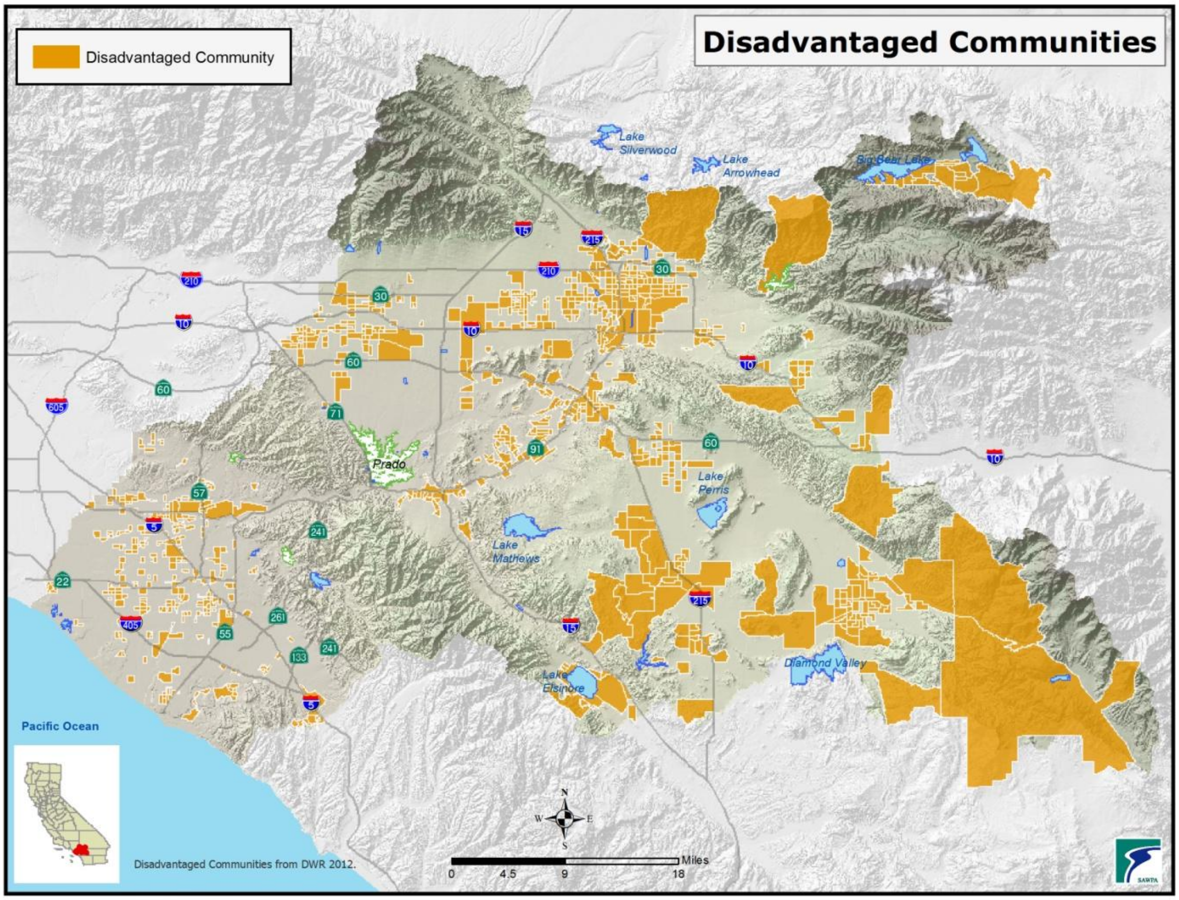
A more detailed write up on issues relating to land use planning in the Santa Ana Watershed are included in **Chapter 5.7 Land Use and Water Planning**.

Disadvantaged Communities

The SAR Watershed contains one of the fastest growing regions in California and also some of the State's poorest residents. In 2000, the per capita income of portions of the Inland Empire was about 25% below the state average (Schreiber, 2003). **Figure 3-17** depicts watershed income in the SAR Watershed by census tract, based on 2007 incomes as collected by the Claritas division of Nielson Company in 2008. This disparity in income is exacerbated by the recent economic downturn which has had a detrimental effect on the region in general and specifically impacted laborers in disadvantaged communities with limited job skills.

Figure 3-17 Disadvantaged Communities in the Santa Ana River Watershed



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A more detailed write up on issues relating to disadvantaged and tribal communities in the Santa Ana Watershed are included in **Chapter 5.9 Natural Resources Stewardship**.

Water Infrastructure Systems

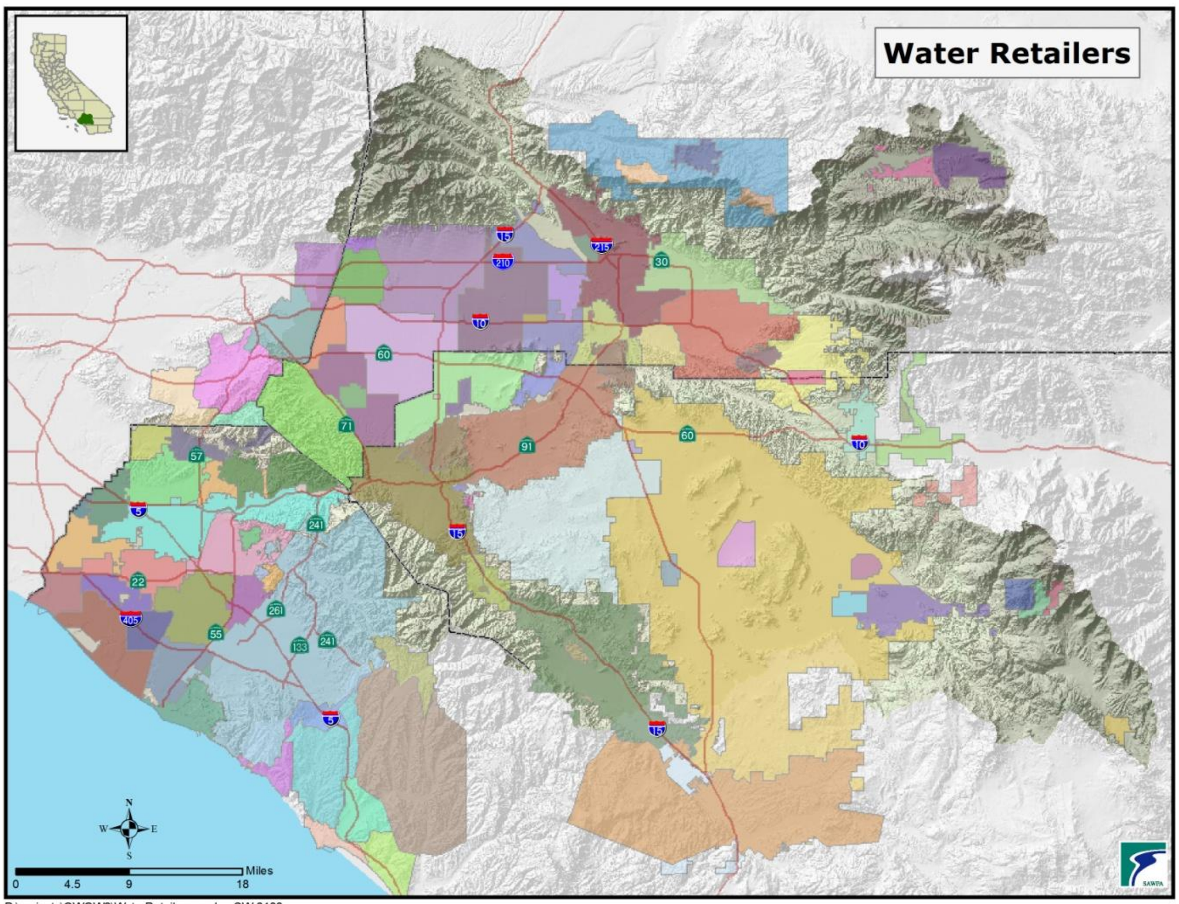
In order to suggest ways to improve water reliability for the future, the existing water infrastructure system must be considered as the foundation to build upon. Particularly in this watershed, when we describe water infrastructure, we are describing not just the large-scale systems, services, and facilities that are necessary to support the collection, storage, treatment and delivery of water to customers in the region, but also many other systems, service and facilities, such as trails, parks, and land use that may use or have a nexus with water. In addition, since water demands and supplies are interrelated to a variety of other natural and man-made support systems, several different maps are included in this chapter to fully convey the opportunities to coordinate among infrastructure systems, as well as land use for the development of multi-beneficial integrated projects.

The importance of an effective water-related infrastructure system cannot be understated. Evaluations of the infrastructure in the watershed were conducted by the American Society of Civil Engineers in 2010 as conveyed in two separate infrastructure report cards, one for the San Bernardino and Riverside

Counties and one for the Orange County. These infrastructure report cards evaluated the condition, capacity, operations and security as criteria for assigning grades to the systems. In the San Bernardino and Riverside counties, the most populated and developed areas of the counties lie within the western portions (Inland Empire) and within the SAR Region.

In review of the water-related infrastructure grades for the Inland Empire, room for improvement clearly exists, particularly as this area struggles to maintain and provide water-related infrastructure for two counties, as reflected in **Figure 3-18**, which shows the various water retail service areas within the SAR region.

Figure 3-18 Water Retail Service Areas in the Santa Ana River Watershed



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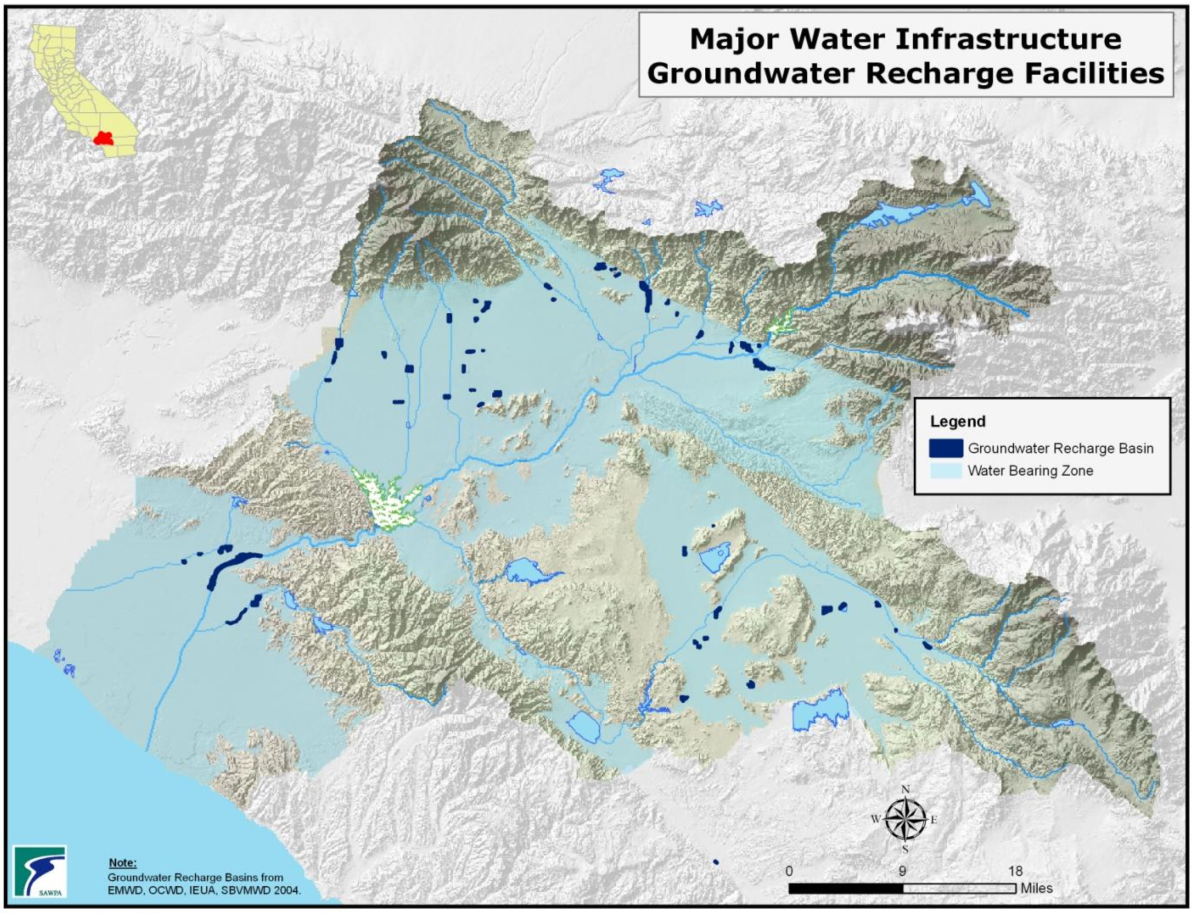
In Orange County, the strains of an increasingly built-out area with a population base of 2,846,289 (2000 census), the second most populous county in the State of California, have resulted in both surface quality and groundwater recharge concerns to meet the needs in this area. New infrastructure is required to clean up urban runoff, increase groundwater recharge, treat increasing wastewater flows for recycled use, and expand capture of upper watershed flows to recharge the groundwater supply. **Figure 3-19** displays groundwater recharge facilities within the Santa Ana River Watershed.

Figure 3-19 Groundwater Recharge Facilities in the Santa Ana River Watershed (overlying GW basins)



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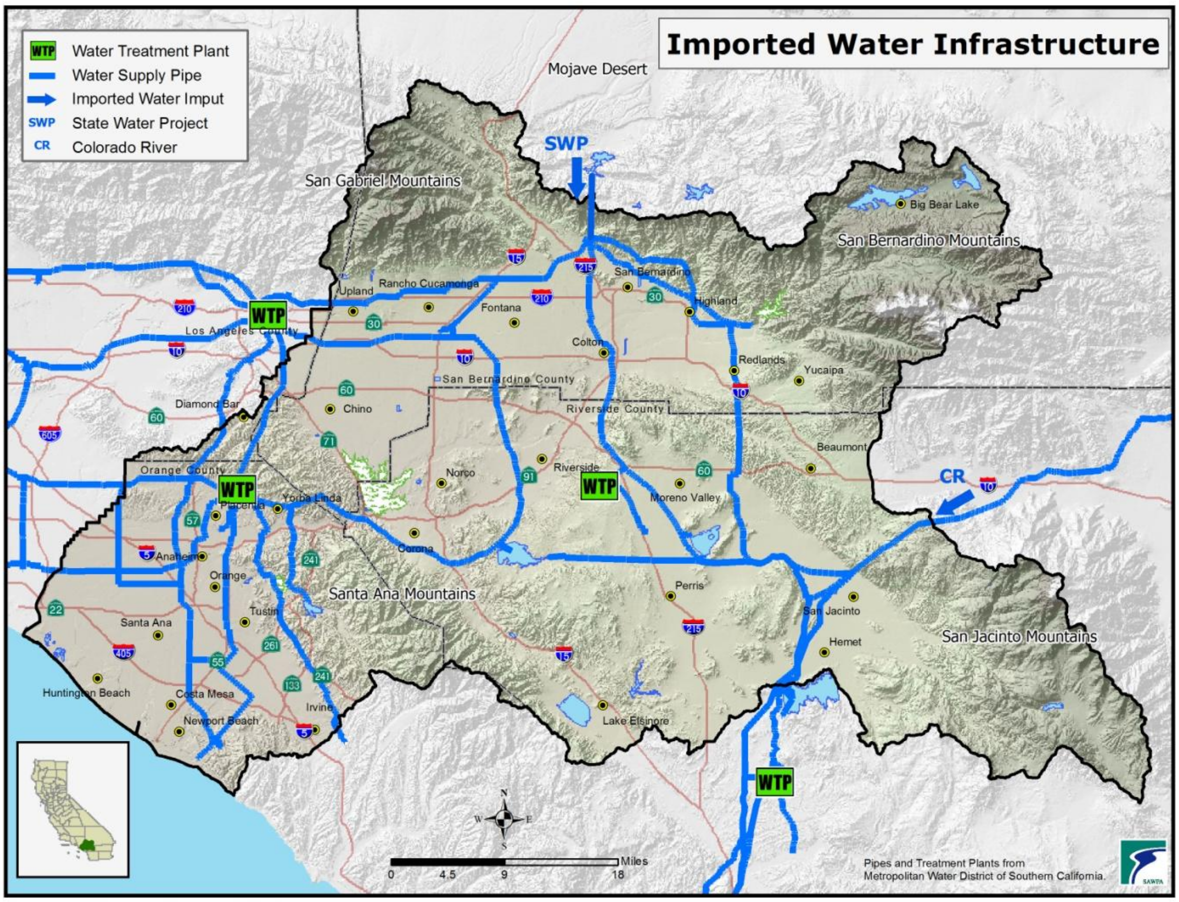
To best understand the water-related infrastructure in the Watershed, some sense of the water development history of the region is appropriate. Prior to the Mission and Rancho periods of the 1800s, the primary land use in the Watershed consisted of grazing cattle and horses. With the advent of Mormon settlements, agricultural lands began to be developed, utilizing the readily available surface springs as a dependable source of irrigation water. As more and more settlers arrived and communities sprang up demanding more water supplies, issue of water rights arose along with competition for the best diversion points. Gradually, a system of water rights was established and shares in a water supply became marketable commodities. As agricultural activity continued to increase in the inland areas of the Watershed, more and more infrastructure was needed to provide the necessary water. First windmills, then motors, and finally, deep well turbines were installed. Gradually over time with increasing urbanization, the dominant land use of the region, agriculture, was subsumed by residential, commercial and industrial areas to serve a burgeoning population drawn to the semi-arid warm climate of this region (see Year 1933-2000 Land Use Transition Maps).

In the late 1920s, to assure adequate water supplies for the population growth of Southern California and following the lead of the City of Los Angeles in its construction of the LA Aqueduct in the early 1910s, efforts commenced to raise money to import water from other places. Metropolitan Water

District (MWD) built and still operates the Colorado River Aqueduct, which each year imports millions of AF of water westward across the Mojave Desert and into the SAR Region. After SWP facilities were extended into the region in the early 1970s, State Water Contractors received deliveries from northern California's Bay Delta region to constructed pipelines to deliver imported water to serve the rapidly growing water demands of the region. Connections were established for the SAR Region by four State Water Contractors: MWD, Valley District, San Gorgonio Pass Water Agency (SGPWA), and the San Gabriel Valley Municipal Water District as shown in **Figure 3-20**.

Figure 3-20 Imported Water Infrastructure in the Santa Ana River Watershed



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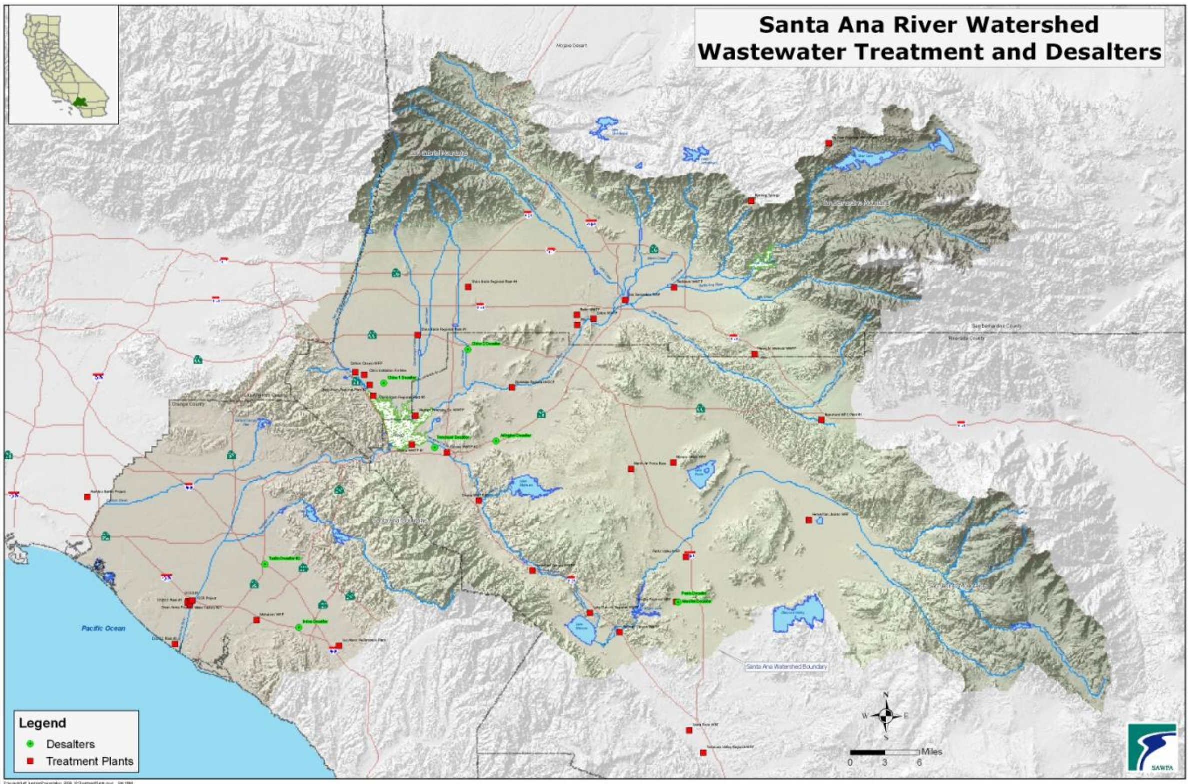
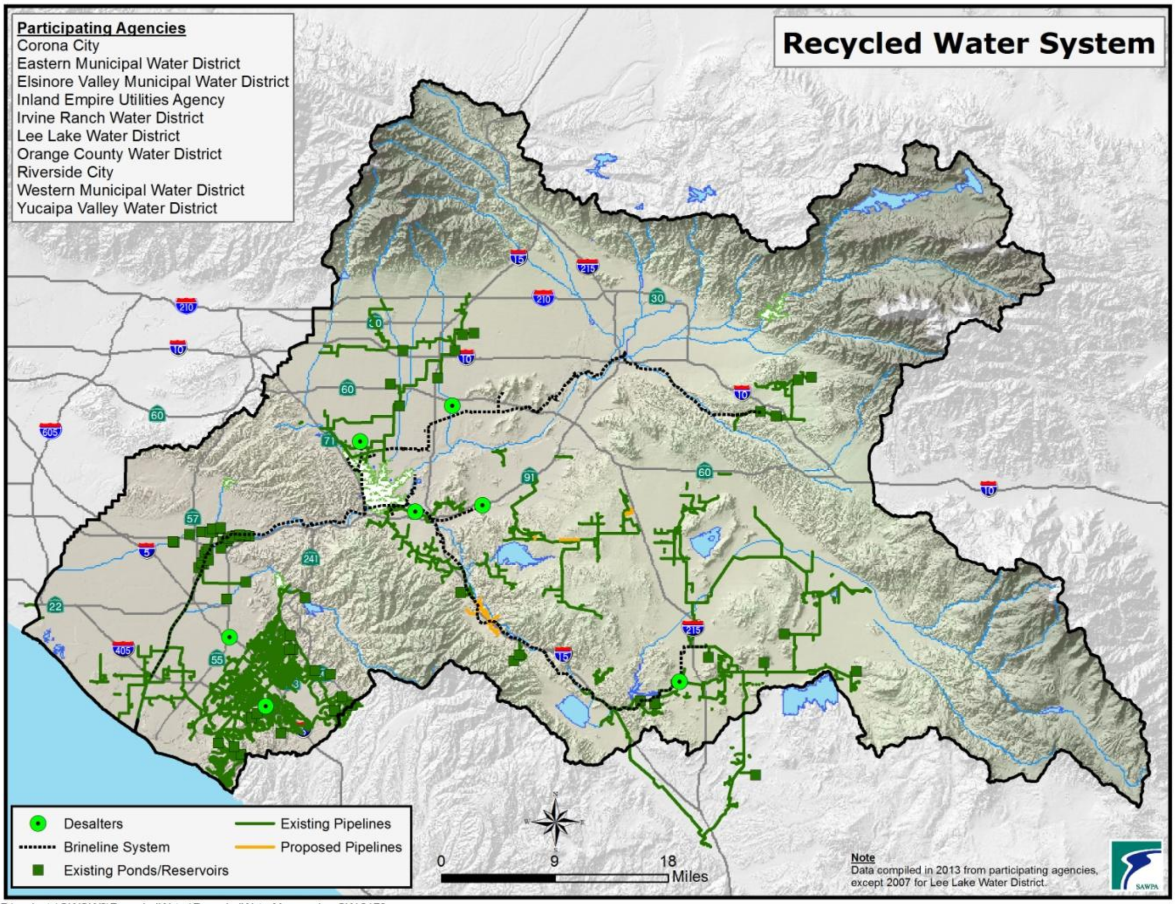
After use of available local and imported water by urban populations, wastewater treatment infrastructure collects and treats the effluent at locations, shown in **Figure 3-21**, but with the majority located near the SAR due to their proximity to a discharge location.

Figure 3-21 Wastewater Treatment Facilities in the Santa Ana River Watershed



Gradually over time, the once perennial flows of the SAR, which often dwindled to a near trickle during the summer months in the late 1800s, were replaced with predominantly steady and reliable, tertiary-treated discharge flows that could be captured downstream for reuse and recharge by downstream entities. Major infrastructure developed to support water reuse is shown in **Figure 3-22**.

Figure 3-22 Major Recycled Water Infrastructure in the Santa Ana River Watershed



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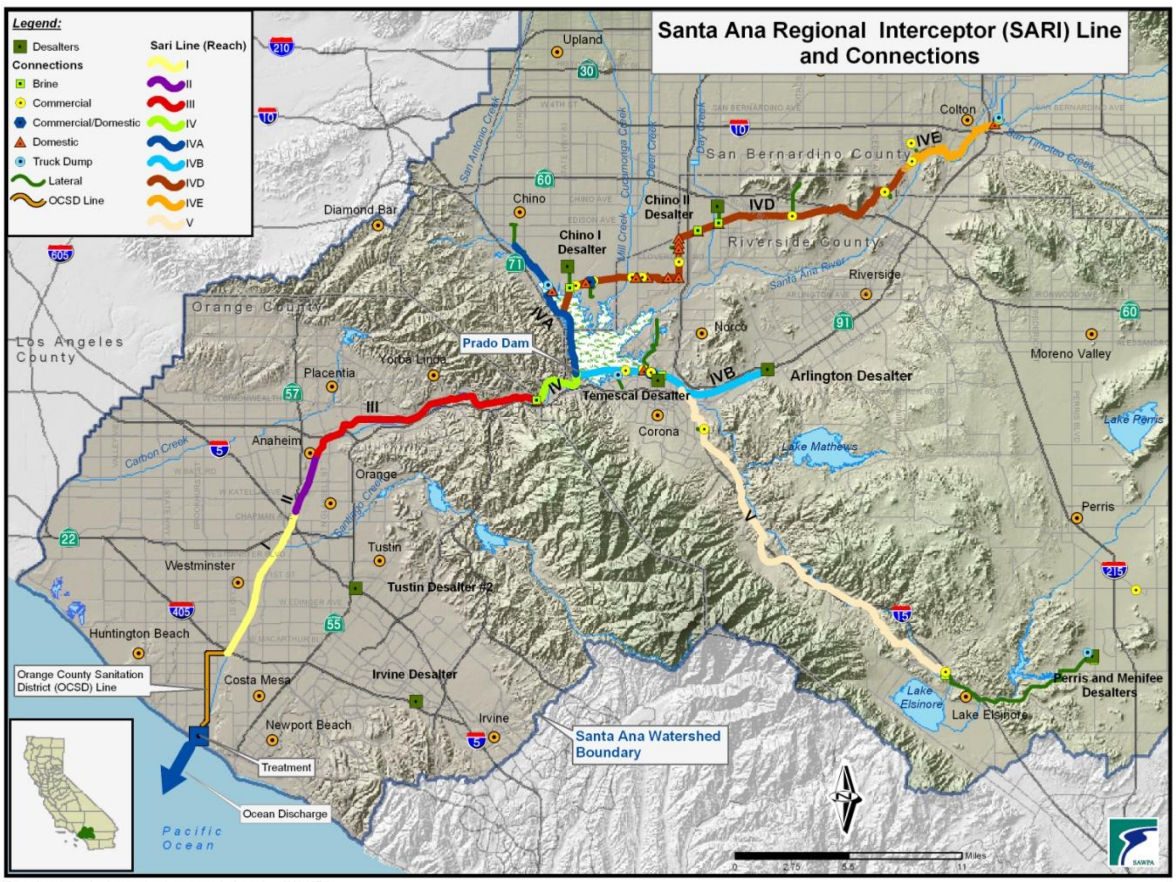
A more detailed write up on issues relating to water supply and demand relating to water resources in the Santa Ana Watershed are included in **Chapter 5.4 Water Resource Optimization**.

Salt Management

One of the most predominant concerns arising from the heavy use of the watershed for past agricultural practices, and now from the imported water and use of water, is the buildup of salts. Almost a century of agricultural and industrial use has resulted in salts and other constituents of concern infiltrating many aquifers and streams within the watershed. As the watershed continues to grow, cities encroach ever closer in proximity to dairies and other agricultural operations. To counter this added stress to the stream and groundwater supplies, producers have developed advanced methods of reducing potential conflicts. Technologically advanced wastewater control infrastructure has been rigorously employed, and negative impacts from agricultural runoff continue to be minimized. Nevertheless, the existing salts and contaminants present in the watershed from past practices still need to be removed, as improving water quality is inextricably linked to improving water supplies and implementing a comprehensive groundwater storage program.

As part of the solution to the TDS issues within the Watershed, SAWPA constructed approximately 93 miles of the 16- inch to 84-inch Inland Empire Brine Line to convey non reclaimable high saline brine out of the Watershed, as shown in **Figure 3-23**. These brine flows are collected throughout the upper Watershed and sent to Orange County Sanitation District (OCSD) wastewater treatment facilities before final discharge to the ocean. SAWPA owns capacity rights in Brine Line downstream of Prado Dam, and owns the brine line pipeline upstream of Prado Dam. With projected future growth, both developmentally and economically, the watershed's reliance on this 100-mile long pipeline will continue to be a critical factor in the overall plan to minimize future drought impacts, achieve the desired salt balance, and improve the quality of the water resources in the upper SAR Basin. Therefore, maintaining the integrity of the brine line and optimizing its future use are of utmost importance.

Figure 3-23 Inland Empire Brine Line and Connections



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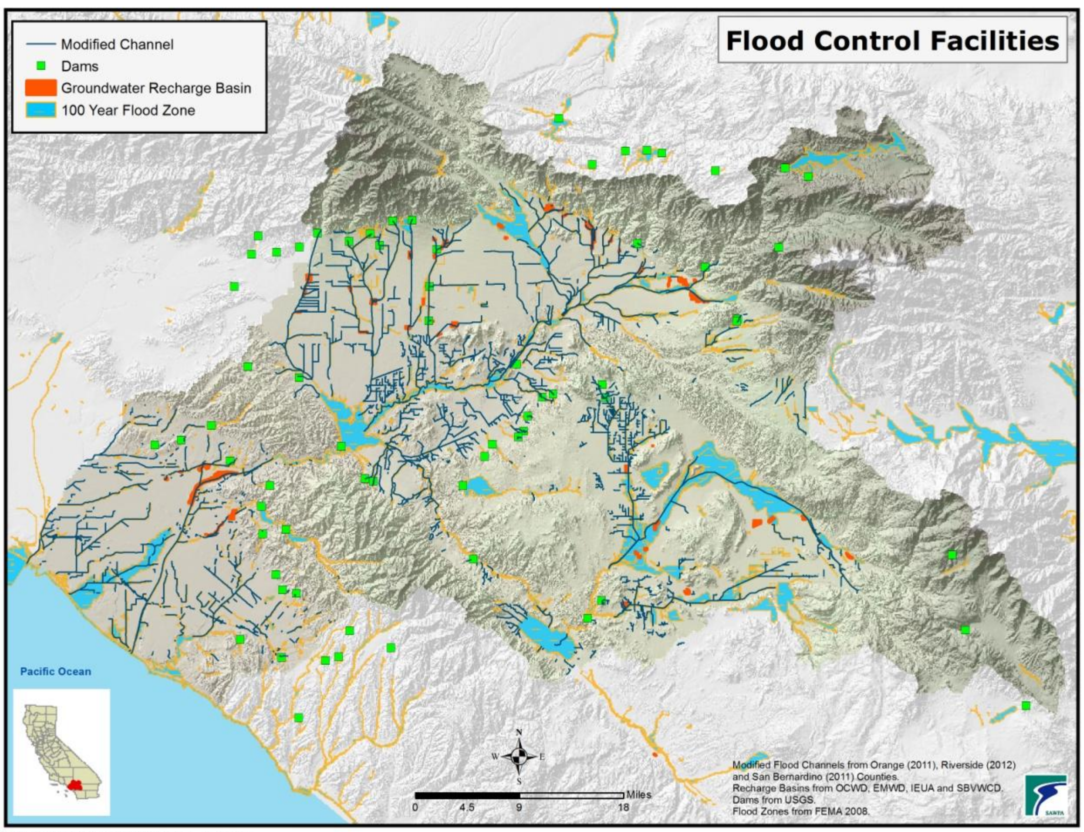
Flood Control

Flood control in the Santa Ana River has been the focus of U.S. Army Corps of Engineers projects starting with the authorization of Prado Dam in 1936. The dam was completed in 1941. Levees were constructed in Riverside in 1955.

Prado Dam was built primarily for downstream flood protection, and 92 percent of the watershed lies above it. More recently, the dam also has become a vital component of the water supply management program in the region, and has allowed the creation of ecologically important habitat areas behind the dam. Prado Dam was originally designed to provide protection against flooding in a 200-year event but as the watershed urbanized, the protection had decreased to a 70-year event with the downstream channel only having capacity for a 50-year event. To address these deficiencies the Army Corps of Engineers (Corps) initiated study of the Santa Ana River Main Stem Project (SARP) in 1964. Construction of the SARP was initiated in 1989.

The SARP is located along a 75-mile reach of the Santa Ana River in Orange, Riverside and San Bernardino Counties. The project's objective is to provide the developed and developing areas in the watershed with approximately 100-year flood protection through the end of the project life.

Figure 3-24 Built Flood Control Systems and 100-Year Flood Zones in the Santa Ana River Watershed



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A more detailed write up on issues relating to stormwater and flood risks in the Santa Ana River Watershed are included in **Chapter 5.8 Stormwater: Resource and Risk Management.**

Conservation and Reducing Dependence on Delta Supply Regionally

With pressures on available local groundwater and imported water supplies in the watershed increasing due to continuing drought conditions, increasing population, climate change impacts and mandated cutbacks in imported water, particularly from the Bay Delta, collaborative and integrated water resource planning is critical for a sustainable future. A study by the Pacific Institute, "Waste Not, Want Not: The Potential for Urban Water Conservation in California," concludes that Water Use Efficiency (WUE) is the most cost-effective way to maximize diminishing water supplies, which makes it one of the most important components for diversifying the region's water portfolio in the coming years.

Over the past decade, significant WUE measures have been implemented by Southern California water agencies. These programs include the large-scale replacement of old inefficient water fixtures and the upgrade of building and plumbing codes in the state requiring low-flow toilets and showerheads in all new development. It is anticipated that these types of regulatory mandates will continue to be enhanced as emerging technologies become available. Through these programs, the amount of water imported into much of Southern California has remained fairly constant, sufficiently meeting demands despite significant development and population increases. However, with the water supply outlook continuing to worsen, WUE will be a critical resource management strategy that this region will need to embrace.

With implementation of expanded water use efficiency practices as well as other integrated local water resource development, the OWOW 2.0 Plan will help reduce dependence on Delta supply regionally. A more detailed write up on issues relating to water conservation and water use efficiency practice that are proposed for the Santa Ana River Watershed are included in **Chapter 5.6 Water Use Efficiency**

Future

As we in the watershed move forward with an eye on sustainability, future water infrastructure improvements will be key to achieving a sustainable balance. Keeping these systems, on which we depend so completely, in a good state of repair, is not a luxury, but prudent self-interest. Without a continued and reliable flow of infrastructure services, the viability of the region, as defined by our quality of life and economic well being, is put at risk. It is up to us now to assure that adequate infrastructure is in place to meet the needs of the region for tomorrow.