CHAPTER 4.0
EXISTING CONDITIONS

4.1 WATERSHED EXISTING CONDITIONS

Although the sub-basins in the San Juan Creek Watershed and the western portion of the San Mateo Creek Watershed are hydrologically and biologically connected, each major sub-basin has somewhat unique or distinctive attributes. Therefore two scales of analysis are used in this EIS, the watershed-scale and the sub-basin scale. To assist the reader to understand the existing conditions at the watershed-scale and sub-basin scale and the relationships between the two, this EIS examines both scales depending on the topic being discussed.

4.1.1 PHYSICAL PROCESSES AND CONDITIONS

4.1.1.1 Overview of San Juan Creek Watershed

The San Juan Creek Watershed is located in southern Orange County. The watershed encompasses a drainage area of approximately 176 square miles and extends from the Cleveland National Forest in the Santa Ana Mountains to the Pacific Ocean at Doheny State Beach near Dana Point Harbor. The upstream tributaries of the San Juan Creek Watershed flow out of steep canyons and widen into several alluvial floodplains. As depicted in Figure 4.1.1-1, the major streams in the San Juan Creek Watershed include San Juan Creek, Bell Canyon Creek, Cañada Chiquita, Cañada Gobernadora, Verdugo Canyon Creek, Oso Creek, Trabuco Creek, and Lucas Canyon Creek. Elevations range from over 5,800 feet above sea level at Santiago Peak to sea level at the mouth of San Juan Creek (USACE, 1999).

The San Juan Creek Watershed is bound on the north by the San Diego Creek, Aliso Creek, and Salt Creek Watersheds, and on the south by the San Mateo Creek Watershed. The Lake Elsinore Watershed, which is a tributary of the Santa Ana River Watershed, is adjacent to the eastern edge of the San Juan Creek Watershed.

The lower portion of the watershed is mostly urbanized with a mix of commercial, industrial, and residential land uses. The northwestern portion is dominated by mostly suburban neighborhoods, and the eastern portion is mostly open space with pockets of residential, agricultural, mineral extraction, and commercial business parks. The major transportation routes that cross the watershed include: I-5, State Highway 1, State Highway 73, State Route 74 (Ortega Highway), State Route 241, Marguerite Parkway, Oso Parkway, Santa Margarita Parkway, Crown Valley Parkway, and Camino Capistrano. Numerous bridges have been constructed along these and other routes at crossings of the major and minor tributaries within the watershed.

Many hydraulic structures have been constructed along San Juan Creek and its tributaries. Detention basins have been constructed for the primary purpose of flood control. Drop structures have been constructed to provide grade control, primarily to protect transportation infrastructure (bridges, roads, and utilities). Additionally, segments of the Creek have been converted to concrete channel for bank protection and flood conveyance. Major hydraulic structures contained in the San Juan Creek Watershed area are listed in Table 4.1.1-1.

TABLE 4.1.1-1
MAJOR HYDRAULIC STRUCTURES IN SAN JUAN CREEK WATERSHED

Water Course	Description	Location
Detention Structures		
Oso Creek	Galivan Detention Basin Off-line detention basin	Along Cabot Road just north of Crown Valley Parkway
Drop Structures		
San Juan Creek	Grade control structure to protect access road	Caspers Regional Park at access road near main entrance
San Juan Creek	Grade control structure to stabilize stream bed	Approximately 500 feet downstream of Caspers Regional Park access road
Trabuco Creek	Grade control structure to protect Rancho Viejo, I-5, Camino Capistrano Bridges	Below Rancho Viejo Road
Trabuco Creek	Grade control structure to protect Metrolink railroad bridge	Near Camino Capistrano just upstream of the Oso Creek/Trabuco Creek confluence
Trabuco Creek	Series of small (1-3 feet) drop structures for grade control	From San Juan Creek confluence to upstream of Del Obispo Road
Oso Creek	Rip-rap energy dissipater	At terminus of rectangular concrete box channel
Channel Modifications		
San Juan Creek	Trapezoidal soft-bottomed channel with concrete side slopes	From ocean outfall to I-5
San Juan Creek	Gabion side slope protection	Within Caspers Regional Park
Trabuco Creek	Rectangular concrete box channel	Beneath Rancho Viejo, I-5 Camino Capistrano Creek crossings
Trabuco Creek	Trapezoidal soft-bottomed channel with concrete side slopes	From San Juan Creek confluence to just upstream of Del Obispo Road
Oso Creek	Trapezoidal soft-bottomed channel with rip-rap sides slopes	From just upstream of the Camino Capistrano Road crossing to just upstream of Crown Valley Parkway
Oso Creek	Rectangular concrete box channel	From just upstream of Crown Valley Parkway to just downstream of Rancho Capistrano property
Source: U.S. Army Corps of Engineers, 2002		

4.1.1.2 Overview of San Mateo Creek Watershed

The San Mateo Creek Watershed is located in the southern portion of Orange County, the northern portion of San Diego County, and the western portion of Riverside County. The watershed is bound on the north and west by the San Juan Creek Watershed, to the south by the San Onofre Creek Watershed, and to the northeast by the Lake Elsinore Watershed. San Mateo Creek flows 22 miles from its headwaters in the Cleveland National Forest to the ocean just south of the City of San Clemente. The total watershed is approximately 139 square miles and lies mostly in currently undeveloped areas of the Cleveland National Forest, the northern portion of MCB Camp Pendleton, and ranch lands in southern Orange County. Major named streams in the San Mateo Creek Watershed include Cristianitos Creek, Gabino Creek, La Paz Creek, Talega Creek, Cold Spring Creek, and Devil Canyon Creek (Figure 4.1.1-1). The SAMP Study Area includes only the portion of the San Mateo Creek drainage within Orange County (approximately 17 percent of the watershed). Elevations range from approximately 3,340 feet above sea level in the mountains of the Cleveland National Forest to sea level at the mouth of

San Mateo Creek. No flood control structures or sediment basins are located within the San Mateo Creek Watershed within the Study Area. Land use is mostly cattle grazing with limited tree crop production and one industrial use–the Northrop Grumman Space Technology TRW Capistrano Test Site.

4.1.1.3 Geology, Geomorphology, and Terrains

Regional Geology

The San Juan Creek and San Mateo Creek Watersheds are located on the western slopes of the Santa Ana Mountains, which are part of the Peninsular Ranges that extend from the tip of Baja California northward to the Palos Verdes peninsula and Santa Catalina Island. The geology of the region is complex and has been dominated by alternating periods of depression and uplift, mass wasting, and sediment deposition. Figure 4.1.1-2 shows the surficial geology of the SAMP Study Area. Within the watersheds, the Santa Ana Mountains are composed of igneous, metavolcanic, and metasedimentary rocks of Jurassic age and younger. The exposed rocks in the mountainous areas are slightly metamorphosed volcanics, which have been intruded by granitic rocks of Cretaceous age, principally granites, gabbros, and tonalites. Overlying these rocks are several thousand stratigraphic feet of younger sandstones, siltstones, and conglomerates of upper Cretaceous age, composed largely of material eroded from the older igneous and metavolcanic rocks now underlying the Santa Ana Mountains.

Younger sedimentary rocks comprise the bedrock between the Santa Ana Mountains, their foothills, and the Pacific Ocean. Most of the SAMP Study Area is underlain by these marine and non-marine sandstones, limestones, siltstones, mudstones, shales, and conglomerates, many of which weather, erode, and/or hold groundwater in characteristic ways. Overlying them are Quaternary stream terrace deposits and Holocene stream channel deposits.

During the past two million years or longer, at least three processes that fundamentally affect structure and process along the major stream channels have affected the two watersheds:

- Continuing uplift, typically 400 feet or more, which has left at least four major stream terrace levels along the major streams.
- Down cutting of the main canyons to sea levels, which have fluctuated widely during the global glaciations.[1] The flat valley floors were deposited as the sea level rose, leaving often-sharp slope breaks at the base of the existing hillsides and tributary valleys. These materials are geologically young, soft, and prone to incision under certain conditions.
- Soils formed under climates both warmer/colder and drier/wetter than at present, which led to development of hardpans that have been eroded to form mesas. These hardpan mesas have minimal infiltration and presently channel flows into headwater streams.

Seismicity

There are several Quaternary faults in the SAMP Study Area. The most significant is the Newport-Inglewood-Rose Canyon fault, which is found about six miles offshore of the mouth of San Juan Creek. This fault parallels the coastline. Two fault zones are located north and east of San Juan Capistrano: the Cristianitos fault and the Mission Viejo fault. The Cristianitos fault

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[1] As recently as 18,000 years ago, the sea level was about 380 feet lower, and the shoreline was several miles further west than at present. San Juan, Chiquita, Gobernadora, San Mateo, and Cristianitos Creeks (among others) flowed in valleys 60 to 120 feet lower than at present.

parallels Oso Creek in a northwest-southeast direction, crosses San Juan Creek about four miles east of San Juan Capistrano, and passes into the Pacific Ocean in San Clemente, about seven miles down coast of the mouth of San Juan Creek. The Mission Viejo fault zone is parallel to the Cristianitos fault zone, crosses San Juan Creek about nine miles east of San Juan Capistrano, then passes offshore into the Pacific Ocean below San Mateo Point in San Diego County. The Newport-Inglewood-Rose Canyon fault is known to be active; the Cristianitos fault is thought by some to be active.

The earliest recorded earthquake event in the project area occurred near San Juan Capistrano in 1812, and almost demolished the nearby mission. The Point Loma Earthquake of 1862, with a calculated magnitude of 6.5, was located 60 to 65 miles from the SAMP Study Area. The Long Beach Earthquake of 1933 was located about 20 miles northwest of the SAMP Study Area and had a magnitude of 6.3. A magnitude 5.5 event occurred in 1938 within Upper Trabuco Canyon, about 20 miles northwest of San Juan Capistrano. A maximum credible event of 7.1 on the Newport-Inglewood-Rose Canyon fault would produce a peak bedrock site acceleration of 0.39 g at San Juan Capistrano.

Terrains

Terrain designations are largely based on soils, geology, and topography, as these provide many of the fundamental factors that influence the hydrology and geomorphology characteristic of each terrain. Bedrock is the raw material from which soils are weathered, and, as such, it determines the size and types of particles that will comprise the soil. The resistance of different kinds of bedrock to weathering and erosion also controls the topography of the landscape within a given terrain and, therefore, influences the hydrology of the watersheds and morphology of the drainage networks. Watershed hydrology is also strongly influenced by the climatic patterns typical of southern California.

There are three major geomorphic terrains found within the San Juan Creek and San Mateo Creek Watersheds: (a) sandy and silty-sandy, (b) clayey, and (c) crystalline. These terrains are manifested primarily as roughly north-south oriented bands of different soil types.[2] Figure 4.1.1-3 shows landscape-scale terrains and shallow substrate erodibility. The soils and bedrock that comprise the western portions of the San Juan Creek Watershed (i.e., Oso Creek, Arroyo Trabuco, and the lower third of San Juan Creek) contain a high percentage of clays in the soils. The soils typical of the clayey terrain include the Alo and Bosanko clays on upland slopes and the Sorrento and Mocho loams in floodplain areas. In contrast, the middle portion of the San Juan basin, (i.e., Cañada Chiquita, Bell Canyon, and the middle reaches of San Juan Creek) is a region characterized by silty-sandy substrate that features the Cieneba, Anaheim, and Soper loams on the hill slopes and the Metz and San Emigdio loams on the floodplains. The upstream portions the San Juan Creek Watershed, which comprise the headwaters of San Juan Creek, Lucas Canyon Creek, Bell Creek, and Trabuco Creek, may be characterized as a "crystalline" terrain because the bedrock underlying this mountainous region is composed of igneous and metamorphic rocks. Here, slopes are covered by the Friant, Exchequer, and Cieneba soils, while stream valleys contain deposits of rock and cobbley sand. The upland slopes east of both Chiquita and Gobernadora Canyons are unique in that they contain somewhat of a hybrid terrain. Although underlain by deep sandy substrates, these areas are locally overlain by between two and six feet of exhumed hardpan.

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[2] The different bands of terrain types should be considered as general trends; not every stream is comprised of a single terrain, and inclusions of other soil types occur within each terrain.

Runoff Patterns of Specific Terrains

Runoff patterns typical of each terrain are affected by basin slope, configuration of the drainage network, land use/vegetation, and, perhaps, most importantly the underlying terrain type. Although all three terrains exhibit fairly rapid runoff, undisturbed sandy slopes contribute less runoff than clayey ones because it is easier for water to infiltrate into the coarser substrate. Runoff in crystalline terrains tends to be rapid and is highly influenced by the presence and density of coverage of impervious areas of rock outcrop that typify the terrain. As a result, the volume of runoff generated by the same amount and intensity of rainfall in a sandy watershed is generally lower than that generated in a clayey or crystalline watershed. When comparing clayey and crystalline terrains, the former seals and becomes impervious upon saturation, while the latter allows for some infiltration through shallow sands that overlay bedrock. Therefore, runoff in clayey terrains is generally more rapid than in crystalline terrains, not withstanding site-specific differences such as slope and land cover/vegetation.

Expected runoff patterns based on terrains should be distinguished from estimated runoff potential based on soil hydrogroups. Although both provide valid, and typically congruent information, the effect of terrains predominates at low to moderate return interval events (i.e., 2-, 5-, and 10-year events), while the effect of soil hydrogroups predominate at larger return-interval events (e.g., 25-, 50-, and 100-year events).

During low to moderate storm events terrains influence the likelihood and extent of channel migration, avulsion, or incision. However, during extreme storm events, the influence of terrains is minimal and runoff is more strongly influenced by soil hydrogroup. For example, a Type C soil in a sandy terrain would produce less runoff during a 5-year event than a Type C soil in a clayey terrain. However, during a larger storm event, runoff from both terrains would be comparable (assuming similar vegetation, slope, and land use).

Channel Characteristics of Specific Terrains

Sandy and silt-sandy terrains are generally able to infiltrate larger volumes of water than are clayey and crystalline terrains. As a result (a) sandy terrains play a vital role in groundwater recharge, (b) undisturbed sandy terrains are typified by lower runoff rates than clayey or crystalline terrains, (c) stream valleys in undisturbed sandy terrains tend to have wide floodplains and are often channel-less, (d) flows tend to persist longer after storms or further into the summer within sandy watersheds, and (e) there is a greater contrast between runoff conditions in undeveloped and urbanized watersheds in sandy terrains than in clayey or crystalline terrains.

Crystalline terrains are typified by narrow, well-defined stream valleys nestled between steep mountainous slopes. Unlike sandy streams that are susceptible to incision, streams in crystalline areas often flow over bedrock and have stable grades. The topography, soils, and hydrography of the crystalline geomorphic terrain are all inherently controlled and influenced by the underlying bedrock.

In southern California, clayey terrains are also typified by more gentle topography than sandy or crystalline areas. Ridges tend to be lower and broader because the underlying bedrock is often more easily eroded. Clayey terrains also feature streams with fairly well-defined channels that have evolved to handle the higher runoff rates associated with clayey slopes. Clayey terrains are generally less susceptible to many of the environmental problems that plague sandier soils (such as enhanced sediment loading, incision, and headcutting), although specific sites may exhibit different characteristics (e.g., Borrego Wash and Serrano Creek in Orange County which are clay soils and do exhibit erosion).

Of the three terrains present in the San Juan Creek Watershed, streams in sandy terrains are the most vulnerable to channel incision or channel widening associated with land use changes. The two main risks associated with development within sandy terrains are dramatically increased peak discharge and channel incision accompanied by headward erosion. To a certain extent, the two are inherently linked, and both result from the unique erosion and runoff properties of sandy watersheds. Studies have shown and as depicted on Figure 4.1.1-4, urbanization in sandy watersheds can result in a proportionately greater increase in storm peaks and associated alteration of downstream channel morphology than in more clayey watersheds.[3] Sandy terrains are often typified (under undisturbed conditions) by the presence of poorly defined channels along grassy, vegetated valley floors. Increased flood peaks due to urbanization can not only cause channel incision along grassy swales, but channel incision itself further serves to increase flood peaks through enhanced conveyance. The result is an amplified cycle of erosion and down cutting that destroys floodplain interaction, increases sediment yields, and the tendency for flooding downstream, and significantly alters habitat.

4.1.1.4 <u>Historic Context</u>

Physical and biological conditions in the watersheds have been affected over time by both natural and anthropogenic forces. Early historical accounts of lower San Juan Creek suggest near-perennial flow, with a freshwater lagoon near the mouth and a “green valley full of willows, alders and live oak, and other trees not known to us” (c.f., Friar Crespi in 1769). Natural events that have helped shaped the current conditions in the watershed include wet and dry cycles, flooding, and fires. Anthropogenic effects include changes in patterns of water use, urban development, mining, grazing, and agriculture. The spatial and temporal effect of key historical events is based on not only the scale of the event, but the timing relative to other events. Investigating these patterns can be valuable for understanding natural processes and for long-range planning of future land use changes.

<u>Natural Processes</u>

The geology, topography, and climate of the coastal watersheds of southern California make them unique among the watersheds in the United States. The Transverse and Peninsular Ranges are intensely sheared and steep due to ongoing uplift and tectonic activity. In addition, these ranges are located close to the coast, resulting in steeper, shorter watersheds than those found in most other portions of the country.

The Mediterranean climate in southern California is characterized by brief, intense storms between November and March. It is not unusual for a majority of the annual precipitation to fall during a few storms proximate to each other. The higher elevation portions of the watershed (typically the headwater areas) typically receive significantly greater precipitation, due to orographic effects. In addition, rainfall patterns are subject to extreme variations from year to year and longer term wet and dry cycles. The combination of steep, short watersheds; brief intense storms; and extreme temporal variability in rainfall result in “flashy” systems where stream discharge can vary by several orders of magnitude over very short periods of time.

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[3] Differences in the susceptibility of streams in the three terrains to increased runoff are most pronounced for moderate runoff events (e.g., 10- to 25-year events). During extreme runoff events, streams in all three terrains are susceptible to channel incision and headcutting.

Wet and Dry Cycles

Wet and dry cycles, typically lasting up to 15 to 20 years, are characteristic of southern California. The region presently appears to be emerging from a wetter than normal cycle of years beginning in 1993. Previously, five consecutive years of sub-normal rainfall and runoff occurred in 1987 through 1991.

Prior droughts of recent note include the brief, “hard” droughts of 1946 to 1951 and 1976 to 1977. Previous notable wet periods of the recent past were observed in 1937 to 1944, 1978 to 1983, and 2004/2005. An unusually protracted sequence of generally dry years began in 1945 and continued through 1977.[4] During this period, rainfall was approximately 25 percent below the average for the prior 70 years. Both recharge and (especially) sediment transport were diminished to even greater degrees. Although wet years did occur during this period, dry conditions were sufficiently persistent to lower groundwater levels and contract the extent of riparian corridors. In many areas, landslide activity was much less than during strings of wet years. Throughout Chiquita and Gobernadora Canyons, many of the channel segments that may have cut across debris aprons formed by the 1938 floods and subsequent wet years may have refilled during this period. At a broader regional scale, the 33 years of below-average rainfall, recharge, and sediment entrainment coincided with the post-World War II period of especially intensive hydrologic data collection, resulting in underestimates of hydrologic activity. Most of the hydrologic design studies performed in southern Orange County were based on data collected between 1960 through 1985, when rainfall, recharge, and sediment yields were below longer-term norms. Therefore, they may not account for variations in flow and sediment associated with long-term climate trends.

Floods

Major, flood-related disturbance of the channel and riparian systems may be expected with mean recurrences of 10 to 20 years. Large floods occurred in coastal southern California in 1907, 1916, 1937, 1938, 1969, 1978, 1983, 1993, 1995, and 1998. Historical accounts of the 1916 flood indicate that San Juan Creek extended fully across the valley downstream from the San Juan Capistrano Mission and what is now I-5. Peak runoff values were estimated to be in the range of 104 to 151 cubic feet per second per square mile (cfs/sq.mi.) for Aliso, Trabuco, San Juan, and San Onofre creeks, and 234 cfs/sq.mi. for Laguna Creek in the City of Laguna Beach in a more clay-rich watershed.[5] No data are available for either flood from San Mateo Creek or its major tributaries. The February 1969 peak flows were long-duration events, which eventually generated peak flows of 22,400 cfs at the La Novia gauging station in the City of San Juan Capistrano, the highest reported prior to general urbanization in the watershed. The January and March 1995 events led to peaks of 15,200 cfs and 25,600 cfs, respectively, the latter being the largest flow recorded on San Juan Creek. Five distinct major crests were observed in February 1998, with a peak flow of 17,000 cfs.

Watershed-Scale Fires

Historic fire data indicates that large wildland fires have occurred frequently in the SAMP Study Area. Since the 1940s, the California Department of Forestry and Fire Protection and later the Orange County Fire Authority (OCFA) have documented all wildland fire events for the entire

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[4] Inman and Jenkins have classified the time period between 1948 and 1977 as a relatively dry cycle and the period of October 1977 to the present as a relatively wet cycle.

[5] Substantially higher peaks were observed February 6, 1937, in the Aliso (230 cfs/sq.mi.) and Trabuco (255 cfs/sq.mi.) Watersheds during what were described as a minor regional storm; San Juan Creek conveyed 80 cfs/sq.mi. during the 1937 storm.

county. Figure 4.1.1-5 depicts the recorded wildland fires history for the SAMP Study Area for years 1911 to 2002. Most of these fire events were of human origin, associated with roadways, arson, and other human-related activities. Exceptions include the Santiago Canyon Fire of 1998, where multiple lighting strikes caused this fire. The 1958 Wiegard Fire is the largest fire to date within the SAMP Study Area. The most recent fires are the Antonio and Avery fires of 2002. Most, but not all, of the SAMP Study Area lands have experienced a wildfire one or more times in the past 50 years. The fire history of the SAMP Study Area is such that some areas of the SAMP Study Area have burned multiple times (for example, Talega and Gabino Sub-basins). Some areas within the SAMP Study Area have no recorded burns (for example Trampas Sub-basin).

The primary hydrologic effects of the fires are sharp increases in sediment yields and often aggradations in the channel downstream. It should be noted that not all areas falling within a mapped fire periphery have actually been burnt. Generally, north-facing slopes and riparian corridors are much less likely to burn, and other areas may be affected only by a rapidly moving (and less destructive) ground fire. Pockets of soil and vegetation have survived for many decades (or perhaps centuries) without high-intensity burning occurring throughout the two watersheds.

Fires can result in shifts or changes in the vegetation community. Coastal sage scrub is generally considered to be relatively resilient to disturbance. However, frequent or intense fires may result in temporary to long-term increases in grassland species. In extreme instances, frequent or intense fires may result in a type-conversion from sage scrub to grassland. Such a conversion may decrease infiltration and increase runoff and erosion into streams that drain the burned sub-basins.

The combination of fire, followed by high rainfall runoff shortly thereafter, can be one of the most significant sequences of events that shape the riparian corridors. This series of events can result in mobilization of large sediment stores that significantly alter the geometry and elevation of downstream channels. Much of the eastern San Juan Creek Watershed was last burned in 1959. The combination of this fire and the subsequent 1969 floods (described above) may have resulted in considerable deposition within the channels and floodplains, which have subsequently incised for many years.

Grazing

Non-native plant invasions associated with European settlement in the 1700s and 1800s (Froke 1993) led to vegetation type conversions on Rancho Mission Viejo lands, and only active management approaches will allow managers to restore and maintain lands in a condition that approximates those historical circumstances that are most beneficial to native plant and animal species of concern (Allen et al. 2000; Bartolome and Gemmill 1981; Heady 1988; Stylinski and Allen 1999; Whelan 1989; White 1967). Much of the land currently designated as reserved open space has undergone nearly complete conversion to non-native annual grasslands, either from perennial grasslands and forblands, or from coastal sage scrub. The causes of this type conversion are many and complex (Allen et al. 2000; Klopatek et al. 1979; Minnich and Dezzani 1998; Pavlik et al. 1993; Zedler et al. 1983), and include past grazing practices. Regardless of the mechanism of the conversion, strategies must be developed to maintain diverse, interdigitated grasslands and open stands of coastal sage scrub.

An often-cited review article by Fleischner (1993) concluded that livestock grazing, especially in the arid west, is virtually exclusively deleterious to environmental health and should be terminated in nearly all circumstances. Brussard et al. (1994) challenged that conclusion, warning that the premise was faulty, and, importantly, that Fleischner's treatment of the issue was biased in its presentation of both standing literature and then current knowledge. Certainly, there are many examples that show that grassland ecosystems that are overgrazed, especially during periods of stress from drought, can be negatively impacted and that overgrazed grasslands frequently manifest reduced biomass and native plant species diversity. However, at lowest levels, grazing can have inconsequential, or immeasurable, effects on native plant and animal species diversity. At low but consequential levels, grazing can be selective, serving to reduce biomass and the likelihood of devastating wildfire, and selecting against undesired non-native plants that may compete with desired native species. It has become clear that grazing is a necessary component of conservation strategies that target native plant and animal species where atmospheric nitrogen deposition is creating a fertilizer load on coastal California grasslands (Cione et al. 2002; Padgett and Allen 1999; Padgett et al. 1999; Weiss 1999). Many conservation planning efforts have incorporated livestock grazing as a tool to assist managers in meeting explicit species diversity goals or other productivity-related targets (Wallis Devries and Raemakers 2001; Kimball and Schiffman 2003; Soderstrom 1999; Harrison et al. 2003).

According to Menke (1996), herbivory and fire are natural and necessary processes which remove litter, recycle nutrients, stimulate tillering, and reduce seed banks of competitive annual plants. Recognition that grazing is important to the evolved ecology of grasslands is not however, as Edwards (1992) notes, license to use it indiscriminately; nor is understanding that grazing is not always needed license to eliminate it in advance of analyzing site-specific needs.

4.1.1.5 Hydrology: San Juan Creek Watershed

Drainage Network

Hydrologically, the San Juan Creek Watershed can be organized into three regions: (1) the western portion of the watershed with the highly developed Oso Creek Sub-basin and the moderately developed Trabuco Creek Sub-basin; (2) the relatively undeveloped sub-basins of the central San Juan Creek Watershed (i.e., Cañada Chiquita, Cañada Gobernadora, Bell Canyon, Lucas Canyon, Trampas Canyon, and Verdugo Canyon); and (3) the steeper eastern headwater canyons. The drainage density of the entire watershed is 10 mi/sq.mi. This value is somewhat low compared to other published data which suggest average drainage densities for various geomorphic settings, including southern California, of between 20 to 30 mi/sq.mi. Geologic, soil, and basin configuration issues may all contribute to this lower than expected drainage density value. In the San Juan Creek Watershed, many tributary valleys are comprised of sandy terrains and, as such, include swales that do not have a clearly defined channel form (i.e., channel-less swales). Omitting these swales from the calculated surface drainage network also reduces the drainage density of San Juan Creek Watershed.

Infiltration

The infiltration rate, or the amount of water that enters the soil pores over a given length of time, is largely determined by rainfall intensity, substrate type, land cover, timing of inter-storm events, and the antecedent moisture conditions. As the soil's storage capacity fills, the infiltration rate decreases. If the rate of rainfall exceeds the infiltration capacity of the soil, the excess water either ponds on the surface or travels down slope as surface runoff. A portion of the water that infiltrates may reach a restrictive layer and move as interflow (or lateral subsurface flow), eventually discharging to the adjacent stream.

Infiltration was estimated using the U.S. Department of Agriculture hydrologic soil group classification. This standard classification is based upon estimated runoff potential based upon soil properties that influence runoff. Soils are classified into hydrologic soil groups A, B, C, or D, depending upon infiltration rates measured when the soils are thoroughly wet. A-type soils have the highest infiltration rates and type D soils have the lowest infiltration potential. In general, Type A soils contain a higher proportion of coarser textures (sand and gravel) and/or have a deeper soil profile. These conditions result in good drainage with higher rates of water transmission into the subsurface. Type D soils are likely to contain a less permeable restricting clay layer, or are shallow, resulting in slower rates of water transmission into the subsurface. Conditions for type B and C soils are intermediate to type A and D soils. The distribution of hydrologic soil groups in the San Juan Creek Watershed is shown in Figure 4.1.1-6.

Overall, infiltration in the San Juan Creek Watershed is relatively low because of the prominence of poorly infiltrating soils (e.g., 79.8 percent of the watershed in underlain by soil types C or D) and the significant proportion of development in the San Juan Creek Watershed. However, there are significant pockets of the watershed, particularly in the central watershed, which have more permeable soils and offer better potential infiltration. Following the methods described in the Orange County Hydrology Manual, Soil Conservation Service runoff curve numbers were assigned throughout the watershed. The Soil Conservation Service curve numbers were used in the hydrologic model of the watershed to translate rainfall depths to runoff quantities, accounting for the hydrologic losses associated with the local soil types, land use, vegetation, and infiltration processes.

Figure 4.1.1-7 and Table 4.1.1-2 show the distribution of Soil Conservation Service runoff curve numbers for the San Juan Creek Watershed. Assigned runoff curve numbers range from 30 to 97, with an area-averaged curve number of 80.5 for the entire watershed. The majority of the watershed (91 percent) was characterized by higher curve numbers between 70 and 97. For modeling purposes, higher curve numbers result in a greater proportion of rainfall becoming surface runoff (i.e., less infiltration). The highly developed western watershed and the northern portion of Cañada Gobernadora have the highest runoff curve numbers. Lower curve numbers occur mostly along riparian corridors and alluvial valley floors. Arroyo Trabuco, Wagon Wheel Canyon, Cañada Gobernadora, Bell Canyon, Lucas Canyon, Verdugo Canyon, and the Central San Juan catchments all contain zones of lower curve numbers along their valley bottoms.

Storm Event Runoff

When the infiltration capacity of soil is exceeded, additional water flows as runoff. Runoff can occur as overland sheet flow, tributary flow, or channelized flow. Similar to infiltration, runoff patterns are affected by basin size and slope, configuration of the drainage network, land cover, and the underlying terrain type. Within the SAMP Study Area, there are three general terrains: (1) sand and sandy-silty terrains that favor the infiltration of storm water and produce proportionately less surface runoff, (2) clayey terrains that are characterized by very high surface runoff rates, with little contribution to groundwater, and (3) crystalline terrains that have high runoff rates during large storms and are typified by rock outcrops and other impervious surfaces (Figure 4.1.1-3).

TABLE 4.1.1-2
SAN JUAN CREEK WATERSHED PHYSICAL CHARACTERISTICS

Sub-Watershed Region	Area (sq. mi.)	Area as % of Upstream Watershed Area	Length (mi)	Elevation (ft.)		Percentage Area with Hydrologic Soil Group				Area-Averaged Curve Number (AMC II)[a]	Impervious Area (%) of Total Sub-basin
				Max.	Min.	A	B	C	D		
Lucas Canyon	7.17	14.31%	7.99	3,022	430	3.62	0.17	48.57	47.64	78.60	0.20
Verdugo Canyon	4.80	6.21%	6.02	2,487	358	8.30	1.25	61.81	28.63	74.80	0.05
Bell Canyon	5.12		5.47	4,485	1,178	1.94	0.00	9.15	88.91	82.30	0.00
	9.10		6.86	3,061	584	3.41	2.95	43.29	50.34	78.80	7.44
	6.35		8.86	2,405	358	8.12	5.64	45.83	40.41	74.00	0.02
Area Averages	20.57	28.42%				4.50	3.05	35.58	56.87	78.20	3.30
Cañada Gobernadora	2.99		3.17	1,237	656	3.43	35.25	54.36	6.96	79.50	29.84
	2.93		4.31	1,050	390	7.37	27.82	60.71	4.11	76.50	12.05
Wagon Wheel Canyon	1.77		3.49	1,063	390	0.69	30.59	62.96	5.76	74.50	1.77
	3.40		4.01	797	230	4.40	19.89	38.90	36.81	79.40	0.26
Area Averages	11.08	11.58%				4.33	27.83	52.67	15.16	77.88	11.59
Cañada Chiquita	4.58		5.59	1,168	358	0.00	36.55	41.89	21.56	77.70	0.35
	4.66		3.82	656	154	3.27	14.95	31.65	50.13	79.20	1.72
Area Averages	9.24	8.80%				1.65	25.65	36.73	35.98	78.49	1.04
Central San Juan Catchments	7.42	8.77%	4.48	892	230	6.07	12.08	52.62	29.24	75.90	3.14
Entire Watershed	175.97	100.00 %				4.74	15.42	27.80	52.04	80.50	21.84

a. normal antecedent moisture conditions

Source: PWA, 2000

The 2-year, 10-year, and 100-year storm events were analyzed using the HEC-1 model for the San Juan Creek Watershed. Peak flows computed for four locations in the San Juan Creek Watershed are summarized in Table 4.1.1-3.

TABLE 4.1.1-3
SAN JUAN CREEK WATERSHED SUMMARY OF PEAK FLOWS (CFS)

Watershed Location	2-Year Event		10-Year Event		100-Year Event	
	cfs	cfs/sq.mi.	cfs	cfs/sq.mi.	cfs	cfs/sq.mi.
Oso Creek, upstream of Trabuco Creek	1,490	92	4,650	286	6,180	380
Lower Trabuco Creek, upstream of San Juan Creek	2,560	47	10,600	194	20,040	366
San Juan Creek, upstream of Horno Creek	2,940	27	18,280	167	44,120	403
San Juan Creek at Pacific Ocean	5,170	29	29,820	169	67,820	385

cfs: cubic feet per second
cfs/sq.mi.: cubic feet per second per square mile

Source: PWA HEC-1 Analysis, 2000

Total runoff volumes and runoff per unit area for San Juan Creek at the Pacific Ocean are shown in Table 4.1.1-4 for the 2-year, 10-year, and 100-year events. Runoff volume per unit area is generally higher for the overall San Juan Creek Watershed than it is for the individual sub-basins because the individual sub-basins of the central watershed are generally undeveloped. Increased runoff from the more developed western portions of the watershed increases the overall watershed-averaged runoff volumes (Table 4.1.1-4).

TABLE 4.1.1-4
SAN JUAN CREEK WATERSHED AT THE PACIFIC OCEAN
STORM EVENT RUNOFF VOLUMES

Event	Total Runoff Volume (acre-feet)	Runoff Volume per Unit Area (acre-feet/square mile)
2-Year	6,410	36
10-Year	31,040	176
100-Year	70,800	402

Source: PWA HEC-1 Analysis, 2000

Peak flows and runoff volumes per unit area are fairly similar for the sub-basins within each watershed. Within the San Juan Creek Watershed, runoff volumes per unit area are lowest for the Chiquita, Gobernadora, and central San Juan Creek Sub-basins, which have the sandiest terrains and the highest infiltration rates (i.e., highest relative proportion of Type A and Type B soils). Gobernadora has slightly higher peak flows per unit area than would be expected, given the inherent properties of the sub-basin; this likely results from (1) the upstream development, which acts to increase volume and decrease time of concentration; and (2) from the hardpan layer which covers much of the upslope areas in the sub-basin. Hydrologic and sediment transport conditions in these individual sub-basins are described in further detail in this chapter.

4.1.1.6 Hydrology: San Mateo Creek Watershed

Drainage Network

The 133.2-square-mile San Mateo Creek Watershed has two principal drainage systems that join in the lower stream valley approximately 2.7 miles upstream of the ocean. The focus area of the SAMP analysis is the western portion of the watershed north of the main stem of San Mateo Creek. The sub-basins of interest include La Paz, Gabino, Cristianitos, Blind, and Talega Canyons upstream of the Cristianitos and San Mateo Creek confluence. Approximately 17 percent of the total runoff in the San Mateo Creek basin emanates from these tributaries.

The predicted drainage density for the San Mateo Creek Watershed is 8 mi/sq.mi. Since the ERDC/Cold Regions Research Laboratory (CRRL) study mapped only the portion of the San Mateo Creek Watershed within the SAMP Study Area, complete calibration of the basin channel mapping was not possible. However, the predicted channel networks and drainage densities for the northwestern portion of the watershed (within the area mapped by ERDC/CRRL) have comparable accuracy to those in the San Juan Creek Watershed.

Infiltration

Overall, infiltration in the San Mateo Creek Watershed is relatively low due to the prominence of poorly infiltrating soils (e.g., 89.8 percent of the watershed is underlain by soil types C or D). However, there are pockets of the San Mateo Creek Watershed, particularly in the upper western watershed, which do have more permeable soils and offer higher infiltration. Figure 4.1.1-8 shows the distribution of hydrologic soil groups for the San Mateo Creek Watershed. Using the Orange County Hydrology Manual methods, Soil Conservation Service runoff curve numbers were assigned to synthesize the effect of soil type, land use, vegetation, and infiltration processes and offer an integrated overall “hydrologic loss” rate. Figure 4.1.1-9 and Table 4.1.1-5 display the distribution of Soil Conservation Service runoff curve numbers for the San Mateo Creek Watershed.

Assigned runoff curve numbers range from 31 to 97, with an area-averaged curve number of 78.7 for the whole watershed. The majority of the watershed (93 percent) was characterized by higher curve numbers between 70 and 97. Higher curve numbers result in a greater proportion of rainfall becoming surface runoff. The lower valley zones and riparian corridors along Cristianitos, Gabino, La Paz, and Talega canyons, as well as some reaches along the main San Mateo Creek upstream, include several areas of lower curve numbers.

TABLE 4.1.1-5
SAN MATEO CREEK WATERSHED PHYSICAL CHARACTERISTICS

Sub-Watershed Region	**Area (sq.mi.)**	**Length (mi)**	**Elevation (ft)**		**Percentage Area with Hydrologic Soil Group**				**Area-Averaged Curve Number (AMC II)**	**Impervious Area (%)**
			max	**min**	**A**	**B**	**C**	**D**		
La Paz Canyon	7.25	6.8	2,497	436	6.70	1.72	43.77	47.81	77.0	0.03
Upper Gabino Canyon	5.03	5.82	1,923	436	5.59	7.68	55.72	31.02	74.9	0.00
Lower Gabino Canyon with Blind Canyon	3.28	4.02	1,050	282	3.46	2.54	33.99	60.00	78.4	1.67
Upper Cristianitos Canyon	3.67	3.69	1,007	282	0.63	12.86	43.86	42.66	77.2	< 1.00
Talega Canyon	8.38	10.08	2,438	177	2.91	2.63	18.83	75.63	79.2	0.55
Entire Watershed	133.28	28.81	3,412	0	1.92	8.29	49.31	40.48	78.7	3.917
Source: PWA HEC-1 Analysis, 2000										

Storm Event Runoff

The 2-year, 10-year, and 100-year storm events were analyzed using the HEC-1 model of the San Mateo Creek Watershed. Peak flows for four locations in the watershed are summarized in Table 4.1.1-6.

TABLE 4.1.1-6
SAN MATEO CREEK WATERSHED SUMMARY OF PEAK FLOWS (cfs)

Watershed Location	2-Year Event		10-Year Event		100-Year Event	
	(cfs)	(cfs/mi.2)	(cfs)	(cfs/mi.2)	(cfs)	(cfs/mi.2)
Cristianitos Creek at Talega Canyon	740	27	5,220	189	11,800	427
San Mateo Creek at Nickel/Tenaja Canyons	2,980	37	16,990	211	39,440	489
San Mateo Creek downstream of Cristianitos Creek	3,200	25	19,100	148	47,070	366
San Mateo Creek at Pacific Ocean	3,200	24	19,160	144	47,530	357
Source: PWA HEC-1 Analysis, 2001						

Total runoff volumes and runoff per unit area for San Mateo Creek at the Pacific Ocean are shown in Table 4.1.1-7 below for the three modeled events. The individual sub-basins of the western portion of the San Mateo Creek Watershed have generally higher infiltration conditions and less runoff per unit area than the overall San Mateo Creek Watershed rates. It should be noted that for the 10-year and 100-year events, runoff volume per unit area for the relatively undeveloped San Mateo Creek Watershed is comparable to the more developed San Juan Creek Watershed to the north. However, peak discharge per unit area for the San Mateo Sub-basins is generally higher than for the San Juan Creek Sub-basins due to differences in terrain and slope between the two watersheds. In comparing runoff and discharge between the San Mateo sub-basins, the absolute discharges are highest for the Gabino Sub-basin due to its large area. However, discharge per unit area is slightly higher for the Cristianitos and La Paz Sub-basins primarily due to their shape and predominance of poorly infiltrating soils.

TABLE 4.1.1-7
SAN MATEO CREEK WATERSHED AT THE PACIFIC OCEAN
STORM EVENT RUNOFF VOLUMES

Event	**Total Runoff**Error! Bookmark not defined. **Volume (acre-feet)**	Runoff Volume per Unit Area (acre-feet/square mile)
2-Year	4,550	34
10-Year	24,970	187
100-Year	59,100	443
Source: PWA HEC-1 Analysis, 2000		

Low-Flow Conditions

The potential effect of urbanization on low-flow conditions was investigated by analyzing the Oso Creek Sub-basin as an example of what could potentially happen in other parts of the San Juan Creek or San Mateo Creek Watersheds if similar urbanization was to occur. The results of the trend analysis conducted for Oso Creek show that annual minimum stream flows and mean summer flows consistently increased over time as the basin progressively developed. The effect of upstream development on dry season flows is currently observable in the northern portion of the Cañada Gobernadora Sub-basin, where the Coto de Caza development has increased the magnitude and persistence of low flows to the central Cañada Gobernadora Watershed. The effect of increased urbanization on low-flow conditions varies based on the underlying terrains. In general, the sandy terrains of the central San Juan Creek Watershed is more susceptible to increased low flow associated with urbanization. In contrast, crystalline terrains found in the eastern San Juan Creek Watershed and portions of the San Mateo Creek Watershed have intrinsically low infiltration rates. Therefore, the proportionate increase in low flow associated with urbanization in these areas may be less than in the sandy portions of the SAMP Study Area.

4.1.1.7 Sediment Processes

Sediment Yield

Sediment yield is the result of all of the erosive processes that take place in a watershed. Hill slope sediment yield consists of the process of sheet wash, rilling, and gullying, which are responsible for producing much of the sediment that is delivered to a stream on an average annual basis (excluding large episodic events). Sediment transport capacity is the ability of any given stream to transport the sediment yield from a watershed. Once the infiltration capacity in a contributing catchment is exceeded, water flows downhill and typically erodes and transports sediment with the water flow. Minor irregularities in the surface of hill slopes (either natural or human induced) can cause flow to coalesce. This localized concentration of flow increases shear stress and can result in rilling (i.e., tiny incisions or channels in the hill slope). As rills deepen and coalesce, they form gullies, which over time can supply significant amounts of sediment to the receiving water courses.

Rates of erosion in coastal southern California are among the highest in the world, and in the semi-arid environment of southern California, more sediment is typically shed from upland slopes than can be transported by stream networks. Floodplains and stream valleys, therefore, serve as areas of sediment deposition and temporary storage. Erosion rates tend to increase with both the seasonality of rainfall and the tendency toward relatively large, infrequent storms. Hill slopes are episodically subjected to fire and channels tend to periodically incise into their valley floors, processes that may generate most of the sediment yielded by some watersheds.

Hill slope sediment yield contributes sediment supply to streams, which in turn affects the geometry of the channel and the substrate properties in the stream. The nature and volume of the sediment generated form the contributing watershed as well as the ability for this sediment to be transported to the stream, influences whether streams have a sand bed, gravel bed, or cobble bed.

Many factors affect sediment yield. Among the most significant are geology, topography, rainfall, vegetation, multi-year wet and dry climatic cycles, fires, floods, landslides, and land use. Of these factors, fires, floods, and landslides are all episodic events that interact with the geology, topography, vegetation, and land use to affect the volume and timing of sediment delivery in the SAMP Study Area.

Sediment yields for the San Juan Creek and San Mateo Creek Watersheds were estimated from existing data on measured sediment discharge in San Juan Creek and other creeks in the region, estimates of upland sediment yield rates in southern California, and the application of the USACE, Los Angeles District debris method and the Modified Universal Soil Loss Equation (MUSLE).

Using measurements of stream flow and suspended sediment discharge, as well as estimates of bedload sediment discharge based on the modified Einstein method, Kroll and Porterfield (1969) estimated that long-term total sediment discharge for the San Juan Creek drainage basin between 1931 and 1968 was approximately 1,230 tons per square mile per year (tons/sq.mi./yr.). This value is believed to underestimate total sediment yield from the watershed because: (a) it is an estimate of the sediment that is actually transported by the streams rather than the total amount of sediment provided to them; and (b) the data from which long-term sediment yields were extrapolated were collected during two years that did not experience significant floods. Because most sediment is moved during extreme events, such as relatively large floods, this last point is key.

Taylor (1981) developed a catchment sediment yield model based on data from 36 water conservation reservoirs, flood control reservoirs, and debris basins throughout southern California. Taylor's denudation rates, expressed as base sediment yield rates, for the sub-watersheds in the San Juan Creek and San Mateo Creek drainages are shown in Table 4.1.1-8 and Table 4.1.1-9 respectively. Computed denudation rates are highest in the mountainous crystalline areas, where projected sediment yields are almost 6,000 tons/sq.mi./yr. In the foothills, projected base sediment yield rates range from approximately 2,500 to 3,100 tons/sq.mi./yr. The Base Sediment Yields and Particle Size foothill denudation rates calculated by Taylor are approximately twice the average annual sediment load for San Juan Creek estimated by Kroll (1969). This difference may be attributable to the fact that: (a) denudation rates represent the amount of material available to streams for transport rather than the amount that they are actually able to move on a regular basis; (b) as discussed previously, Kroll may have underestimated sediment transport during large storms; and (c) sediment sampling and calculation of yearly sediment budgets by Kroll do not appear to include the bedload sediment being transported.[6]

The sediment yields estimated based on the USACE, Los Angeles District and the MUSLE methods are expressed as cubic yards per square mile (cy/sq.mi.) for specific design discharge events, including the 2-year, 25-year, 50-year, 100-year, 200-year, and 500-year floods, making direct comparison with historical measured or estimated sediment yields obtained from other sources difficult. Computed sediment yields based on the USACE, Los Angeles District method were 145 tons/sq.mi. and 10,270 tons/sq.mi. for the 2-year to 100-year floods, respectively, in the San Juan Creek Watershed and 640 tons/sq.mi. and 14,840 tons/sq.mi. for the same design storms in the Arroyo Trabuco Watershed. Sediment yield estimates obtained using the MUSLE method were 71 tons/sq.mi. and 7,800 tons/sq.mi. in the San Juan Creek Watershed for the 2-year and 100-year floods, respectively, and 200 tons/sq.mi. and 8,900 tons/sq.mi. in the Arroyo Trabuco Watershed for the same design storms. Yields calculated using the MUSLE and USACE, Los Angeles District methods for the 25-year and 50-year events are within a similar range of baseline sediment yields estimated by Taylor's denudation rate formula. Table 4.1.1-10 provides a comparison of estimated sediment yields in the San Juan Creek Watershed using the techniques discussed above.

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[6] Sediment yield associated with episodic events is the most significant factor in the overall sediment budget for southern California coastal watersheds. Bedload transport accounts for a small fraction of the overall sediment movement in the watershed, and is a minor factor in shaping stream geomorphology.

TABLE 4.1.1-8
SAN JUAN CREEK WATERSHED
BASE SEDIMENT YIELDS AND PARTICLE SIZE DISTRIBUTIONS

Stream	Major Geologic (Unit[s])	Weathers to:[a]	Streambed Characteristics	Transport Characteristics	Base Sediment Yield Rate[b] (mm/year)	Base Sediment Yield Rate (tons/sq.mi./yr.)	Particle Size Distribution					Percent Bedload
							Suspended Load		Bedload			
							Clay/Silt	Sand	Sand	Gravel	Cobble	
Oso	Niguel Sandstone	clayey and sandy silt	Sand, silt, clay	supply limited	0.35	2,491	high	high	high	very low	very low	15 to 25
	Capistrano Siltstone	clayey silt, expansive clay, some sand										
Trabuco	Bedford Canyon Metamorphics	sand, silt, clay, pebbles	gravel, sand, silt, clay	transport limited	0.35	2,491	high	high	high	med	low	10 to 20
	Santiago Peak Volcanics	angular pebbles and clay										
	Sespe and Vaqueros Sandstone and Conglomerate	clay, silt, sand, gravels										
	Old channel deposits	clay, silt, sand, gravels, cobbles										
	Monterey Shale	silt and clay										
	San Onofre Breccia	silt, sand, gravels, cobbles										
	Niguel Sandstone	clayey and sandy silt										
	Capistrano Siltstone	clayey silt, expansive clay, some sand										

TABLE 4.1.1-8 (Continued)
SAN JUAN CREEK WATERSHED
BASE SEDIMENT YIELDS AND PARTICLE SIZE DISTRIBUTIONS

Stream	Major Geologic (Unit[s])	Weathers to:[a.]	Streambed Characteristics	Transport Characteristics	Base Sediment Yield Rate[b.] (mm/year)	Base Sediment Yield Rate (tons/sq.mi./yr.)	Particle Size Distribution					Percent Bedload
							Suspended Load		Bedload			
							Clay/Silt	Sand	Sand	Gravel	Cobble	
Chiquita	Sespe Sandstone and Conglomerate	clay, sand, gravels	sand, some silt	supply limited	0.41-0.45	2,918 to 3,202	high	high	high	very low	very low	5
	Santiago Sandstone, Siltstone, Claystone	clayey sand										
	San Onofre Breccia	silt, sand, gravels, cobbles										
Gobernadora	Sespe Sandstone and Conglomerate	sand, silt, clay, minor gravels	sand, silt, clay	supply limited	0.41	2,918	high	high	high	low	very low	5 to 10
	Santiago Sandstone, Siltstone, Claystone	clayey sand										
Bell	Bedford Canyon Metamorphics	sand, silt, clay, pebbles	cobbles, gravels, sand	transport limited	0.38	2,704	med	med	med	high	high	50 to 60
	Starr Fanglomerate and Sandstone	silt with pebbles and cobbles										
	Santiago Sandstone, Siltstone, Claystone	clayey sand										

TABLE 4.1.1-8 (Continued)
SAN JUAN CREEK WATERSHED
BASE SEDIMENT YIELDS AND PARTICLE SIZE DISTRIBUTIONS

Stream	Major Geologic (Unit[s])	Weathers to:[a.]	Streambed Characteristics	Transport Characteristics	Base Sediment Yield Rate[b.] (mm/year)	Base Sediment Yield Rate (tons/sq.mi./yr.)	Particle Size Distribution					Percent Bedload
							Suspended Load		Bedload			
							Clay/Silt	Sand	Sand	Gravel	Cobble	
Upper San Juan	granitic	sand or smaller with large boulders	bedrock, gravels	supply limited	0.84	5,978	low	high	med	med	high	60 to 80
	meta-sedimentary	sand, silt, clay, pebbles										
	Santiago Peak Volcanic	angular pebbles and clay										
	Trabuco Conglomerate	sand, cobbles, boulders										
	Starr Fanglomerate and Sandstone	silt with pebbles and cobbles										
Verdugo	Trabuco Conglomerate	sand, cobbles, boulders	cobbles, gravels, sand, silt	transport limited	0.44	3,131	med	high	high	med	high	50 to 60
	Starr Fanglomerate and Sandstone	silt with pebbles and cobbles										
Trampas	Shultz Ranch Sandstone	sand and silt	sand, silt, clay	supply limited			low	high	high	very low	very low	40 to 50
	Santiago Sandstone	sand and clay										
	Monterey Shale	silt and clay										
	San Onofre Breccia	silt, sand, gravels, cobbles										

TABLE 4.1.1-8 (Continued)
SAN JUAN CREEK WATERSHED
BASE SEDIMENT YIELDS AND PARTICLE SIZE DISTRIBUTIONS

Stream	Major Geologic (Unit[s])	Weathers to:[a.]	Streambed Characteristics	Transport Characteristics	Base Sediment Yield Rate[b.] (mm/year)	Base Sediment Yield Rate (tons/sq.mi./yr.)	Particle Size Distribution					Percent Bedload
							Suspended Load		Bedload			
							Clay/Silt	Sand	Sand	Gravel	Cobble	
Lucas	Trabuco Conglomerate	sand, cobbles, boulders	cobbles, gravels, sand, silt	transport limited	0.44	3,131	low	med	low	high	high	50 to 60
	Starr Fanglomerate and Sandstone	silt with pebbles and cobbles										
	Shultz Ranch Sandstone	sand and silt										

a. Gravels are 2 to 64 mm. Pebbles are a subset of larger gravels (16 to 64 mm). Cobbles are 64 to 256 mm (2.5 to 10 inches). Boulders are larger.
b. Sediment yield rates presented are based on Taylor (1981) and should be revised to reflect a more refined understanding of local conditions. Data are presented as calculated to allow replication; readers should be aware that these values should be read to no more than two significant figures.

Source: Balance Hydrologics, 2000

TABLE 4.1.1-9
SAN MATEO CREEK WATERSHED
BASE SEDIMENT YIELDS AND PARTICLE SIZE DISTRIBUTIONS WITHIN SAMP STUDY AREA

							Particle Size Distribution					
							Suspended Load		Bedload			
	Stream	**Major Geologic (Unit[s])**	**Weathers To:**	**Streambed Characteristics**	**Base Sediment Yield Rate$^{b.}$ (mm/year)**	**Base Sediment Yield Rate (tons/sq.mi./yr.)**	**Clay/Silt**	**Sand**	**Sand**	**Gravel**	**Cobble**	**Percent Bedload**
Within SAMP Study Area	Cristianitos	Santiago Sandstone, Siltstone, Claystone	clayey sand	Sand, silt, clay,	0.48	3,416	high	high	high	low	low	40 to 50
	Gabino	Williams Sandstone, Conglomerate	sand, silt, gravels	Sand, silt, gravel, cobbles	0.42	2,989	med	med	med	med	med	50 to 60
		Shultz Ranch Sandstone	sand and silt									
		Santiago Sandstone, Siltstone, Claystone	clayey sand									
	La Paz	Trabuco Conglomerate	gravels, cobbles, boulders, sand	Sand, silt, gravel, cobbles	0.42	2,989	med	med	med	med	low	50 to 70
		Williams Sandstone, Conglomerate	sand, silt, gravels									
		Shultz Ranch Sandstone	sand and silt									
		Santiago Sandstone, Siltstone, Claystone	clayey sand									

TABLE 4.1-9 (Continued)
SAN MATEO CREEK WATERSHED
BASE SEDIMENT YIELDS AND PARTICLE SIZE DISTRIBUTIONS WITHIN SAMP STUDY AREA

Stream		Major Geologic (Unit[s])	Weathers To:	Streambed Characteristics	Base Sediment Yield Rate[b.] (mm/year)	Base Sediment Yield Rate (tons/sq.mi./yr.)	Particle Size Distribution					Percent Bedload
							Suspended Load		Bedload			
							Clay/Silt	Sand	Sand	Gravel	Cobble	
Outside of SAMP Study Area	Talega	volcanics and meta-volcanics	sand, silt, clay, gravels, cobbles	n/a	0.39	2,775	high	n/a	n/a	high	n/a	20 to 40
		Williams Sandstone, Conglomerate	sand, silt, gravels									
		Santiago Sandstone, Siltstone, Claystone	clayey sand									
		Capistrano Siltstone, Sandstone	clay, silt, sand									
	Devil Canyon	Granodiorite	sand or smaller with large boulders	bedrock, gravel, sand	0.35	2,490	med	high	high	high	high	30 to 50
		volcanics and meta-volcanics	sand, silt, clay, gravels, cobbles									
	Lower San Mateo (south of confluence with Cristianitos)	mid-Miocene marine	sand, silt, clay	Sand, silt, cobble, gravel (sandiest near mouth)	0.35	2,490	high	high	low	low	very low	20 to 40
		upper Miocene marine	silt and clay									
		Pleistocene marine terrace	sand, silt, clay; minor cobbles, gravels									
	Upper San Mateo	upper Cretaceous marine	sand, silt, clay	bedrock, gravel, sand, silt	0.35	2,490	low	high	med	med	high	20 to 40
		Santiago Sandstone, Siltstone, Claystone	clayey sand									

n/a: not available

a. Taylor classified Devil Canyon and Upper San Mateo as hills not mountains which leads to an anomalously low base sediment yield. Therefore, the estimated denudation rate has been increased from 0.30 to 0.35 mm/yr.

b. Sediment yield rates presented are based on Taylor (1981) and should be revised to reflect a more refined understanding of local conditions. Data are presented as calculated to allow replication. The reader should not that these values should be read to no more than two significant figures.

Source: Baseline Hydrologics, 2000.

TABLE 4.1.1-10
COMPARISON OF SEDIMENT YIELD ESTIMATES

Watershed	County	Author	Dominant Substrate Type	Method	Time Period	Sediment Type (tons/ mi.2)	Comments
San Juan	Orange	Kroll & Porterfield	crystalline & sedimentary	rating curve applied to gauging record	1931-1968	1,230	based on measurements taken during 1967-1968
San Juan	Orange	Taylor	crystalline & sedimentary	calculated denudation rate	—	1,500 to 6,000	highest in mountainous areas, lower in foothills
San Juan	Orange	SLA	crystalline & sedimentary	LADB	—	4,350 to 6,850	indicated range is Q25 to Q50 with no burn
San Juan	Orange	SLA	crystalline & sedimentary	MUSLE	—	3,000 to 5,000	indicated range is Q25 to Q50
Arroyo Trabuco	Orange	SLA	crystalline & sedimentary	LADB	—	5,700 to 9,950	indicated range is Q25 to Q50 with no burn
Arroyo Trabuco	Orange	SLA	crystalline & sedimentary	MUSLE	—	3,000 to 5,500	indicated range is Q25 to Q50
San Diego	Orange	Orange County Public Facilities and Resources Department (OCPFRD)	crystalline & sedimentary	sampled sediment transport	1983-1998	1,800	suspended sediment only
San Diego	Orange	OCPFRD	crystalline & sedimentary	debris basin sediment removal	1983-1998	395	low trap efficiency

Source: Balance Hydrologics, 2000

For all methods, calculated sediment yields that attempt to quantify the amount of material available for stream transport exceed estimates and measurements of transported sediment loads by more than a factor of two. This may accurately reflect the condition of watersheds in an arid environment, where far more material is weathered and eroded than can typically be conveyed to and transported by local stream systems.

Mass Movements/Debris Flows (Episodic Events)

In central and southern California, up to 98 percent of the amount of sediment moved in any single decade is often mobilized during one or two intense flow events creating mass movements and debris flows. This conclusion is supported by estimates of sediment discharge in Arroyo Trabuco and in San Juan Creek near the City of San Juan Capistrano over a period from 1932 to 1968. The amount of sediment mobilized during an intense flow event is governed by available sources in the watershed, landform, and time since the last major fire. In fact, an estimated 70 percent of all sediment production in California's chaparral is triggered by fire.

Large volumes of sediment and debris produced during mass movements can dam rivers and facilitate channel migration and sediment deposition, resulting in abandoned floodplains and formation of new terraces. More typically, mass movements may impinge stream flow, resulting in localized erosion or down cutting. In many cases, it may take decades or longer for streams to cut through sediments deposited during mass movement, during which time the deposited mass of sediment and debris acts as a source of sediment to downstream areas.

Mass movements such as rotational slumps, block glides, and soil slips have been observed and mapped in different portions of the San Juan Creek and San Mateo Creek Watersheds. Residual bedrock landslide debris covers more than 3.7 square miles in the San Juan Creek Watershed. It has been estimated by PCR et al (2001) that more than one billion tons of landslide debris is ready for transit down this drainage area during a major flood event.

Landslides cover more than one-third of the Cristianitos fault zone; composite slides as large as 630 acres are also present. Although impressive in aerial extent and important from a geotechnical perspective, these large bedrock slides are likely geologically-old relict features thought to contribute less sediment to streams than do shallow failures on much steeper slopes.

West of the Cristianitos fault zone, the landscape is comprised mostly of low hills that terminate at a broad, wave cut terrace formed by marine erosion at the coast line. This area is not marked by extensive landslides because capping deposits help to protect the underlying bedrock, and stream erosion is not significantly active near the coast. Landslides in the hills between the coastal terrace and the Cristianitos fault zone are prevalent and consist mainly of bedrock failures that generally occur along the slopes of streams as discrete units or as aprons of coalescing slides. Although earth movement is common in these areas, localized slides do not contribute significantly to episodic sediment yields unless they impinge directly into the channel; rather, they contribute to baseline sediment yields.

East of the Cristianitos fault zone, landslides cover less than one percent of the area. More importantly, from the perspective of sediment yield, the area east of the fault zone has a propensity for the occurrence of mud debris flows, notably in the Trabuco and Williams Formations. During periods of extended rainfall, such as during the 1969 floods, mud debris flows emanating from the heads of steep canyons were commonplace.

In Channel Sediment Transport

Once sediment is delivered to a channel via hill slope sediment yield or mass movements, it may move downstream as bed load or suspended load. Bed load transport is the movement of coarser sediments along the channel substrate under shear force, most of which typically occurs in pulses during large storm events. Suspended load is the movement of particles (which may be finer grained) within the water column, typically during higher flow events. Mobilization of sediments stored in-channel or within the floodplain can be caused by increases in stream discharge, decreases in sediment supply, or a combination of the two. Circumstances that mobilize stored sediment may be caused by (1) land practices that alter flow or sediment delivery to streams, (2) natural responses to episodic events, or (3) ongoing adjustment to geologic changes in the valley platform. In-channel sediment transport processes affect the channel geometry and bedform. The erosion and movement of sediment within a channel can result in changes in the channel width and depth, and affect the structure of floodplain benches.

Peak sediment transport rates were calculated for each major sub-basin in the SAMP Study Area for the 2-year, 10-year, and 100-year discharge events. Peak transport rates per unit area were also calculated for each of the sub-basins. It should be noted that these rates represent estimates of the capacity for the system to transport sediment and may not describe actual sediment transport rates. Actual sediment transport is determined by both transport capacity and sediment supply.

San Juan Creek Watershed

Absolute peak sediment transport capacities for each major sub-basin during the 100-year flow event are compared in Figure 4.1.1-10. Transport rates are given at the most downstream end of each sub-basin. The Cañada Gobernadora and Bell Canyon Sub-basins had the highest absolute sediment transport rates in the San Juan Creek Watershed. This result is likely explained by the relatively large size of these two canyons (11.08 square miles and 20.57 square miles, respectively), although Cañada Gobernadora also has a relatively high transport capacity per unit area (Figure 4.1.1-10). After the Bell Canyon and Cañada Gobernadora Sub-basins, the main stem of the Central San Juan Creek Sub-basin had the next highest absolute sediment transport rate. Peak transport rates from the Lucas Canyon Sub-basin were the lowest of the San Juan Creek Watershed sub-basins.

Transport rates per unit area at the most downstream reach of each sub-basin for a 100-year flow event are shown in Figure 4.1.1-11. Since these transport rates are independent of sub-basin size, they reflect sediment shedding properties, integrating factors of channel geometry, runoff rates, and geology. The Trampas Canyon Sub-basin had the highest transport rates per unit area of any of the studied sub-basins entering San Juan Creek. The Cañada Gobernadora, Verdugo Canyon, and Lucas Canyon Sub-basins had the next highest transport capacities per unit area. Transport rates per unit area are likely highest for Trampas Canyon because of steep channel slopes at the basin mouth, transportable sediment sizes, and a small drainage area. In many ways, the Trampas Canyon Sub-basin is different from the other studied sub-basins which are larger canyon systems that occupy broader valleys. Trampas Canyon is more representative of the steeper headwater systems of the San Juan Creek Watershed where sediment yields are much higher. Conversely, sediment yields per unit area for the main San Juan Channel are the lowest.

Calculated sediment yields for the 2-year, 10-year, and 100-year storm events are shown in Figure 4.1.1-12. These results represent the potential volume of sediment delivered to the main stem of San Juan Creek from each of the tributary sub-basins during various magnitude storm events. In general, average annual measures of sediment yield (Table 4.1.1-10) are consistent with the absolute transport rates for a 2-year storm event estimated by PWA. The Bell Canyon Sub-basin exhibited the highest sediment yield to San Juan Creek. This finding is expected since Bell is the largest of the sub-basins and produced relatively high transport rates. The main stem of the Central San Juan Sub-basin and the Gobernadora, Trampas, and Lucas Canyons Sub-basins also produced relatively high yields. The Cañada Chiquita Sub-basin had the lowest yields of the San Juan Creek Watershed sub-basins (Figure 4.1.1-12). The Trampas Canyon Sub-basin has the highest yields per area. This finding is consistent with the results for transport rates described above for this steep, small tributary catchment. Of the studied canyon sub-basins, Verdugo Canyon had the highest yield per unit area.

Based on the in-channel yield results, sediment mass balances were calculated for the four modeled reaches of the main stem of San Juan Creek to assess if the reaches were erosional or depositional. Upstream sediment input to San Juan Creek (from the upper watershed above Lucas Canyon) was estimated using results from Balance Hydrologics. Although the magnitude of results varies somewhat for the two sediment transport functions, both functions indicate a general pattern of deposition in three of the four modeled reaches during large flood events. The most downstream reach was predicted to be slightly erosional during extreme flood events. The delivery of sediment from the canyon sub-basins to the main San Juan Creek channel likely plays a significant role in this depositional pattern observed in the three upstream reaches.

San Mateo Creek Watershed

In the San Mateo Creek Watershed, the Gabino Canyon Sub-basin (upstream of the Cristianitos Creek confluence) was calculated to have the highest sediment transport capacity (Figure 4.1.1-10). This absolute rate is the highest of all modeled sub-basins in the San Juan Creek and San Mateo Creek Watersheds and is similar in magnitude to rates calculated for the Gobernadora and Bell Canyons Sub-basins in the San Juan Creek Watershed. Transport rates calculated for the La Paz and Cristianitos Canyons Sub-basins are the lowest of the modeled San Mateo sub-basins and are similar to values calculated for the Lucas and Verdugo Canyons Sub-basins. The Upper Cristianitos Sub-basin (3.67 square miles) had the highest transport capacity per unit area of the three modeled San Mateo sub-basins (Figure 4.1.1-11). The Upper Cristianitos Sub-basin’s per unit area transport rate surpasses rates calculated for all other sub-basins except the Trampas Canyon Sub-basin. This rate implies that the hydrology, geology, and geomorphology of Upper Cristianitos Creek are conducive to transporting sediment. The transport capacity per unit area of the Gabino Canyon Sub-basin is intermediate between estimated rates for the La Paz and Cristianitos Canyons Sub-basins. Of the modeled sub-basins in the San Mateo Creek Watershed, the La Paz Canyon Sub-basin had the lowest transport rates per unit, only slightly higher than those for the Lucas Canyon Sub-basin.

Calculated sediment yields at the mouth of the sub-basins for the 2-year, 10-year, and 100-year storm events are shown in Figure 4.1.1-12. This figure illustrates that the Gabino Canyon Sub-basin has the highest sediment yield of the three San Mateo Creek Watershed Sub-basins. This fact is most likely due to the somewhat larger size of Gabino Canyon when compared to the Upper Cristianitos and La Paz Sub-basins. Although the Upper Cristianitos Sub-basin is half the size of the La Paz Sub-basin, its relatively high rate of sediment transport per unit area (see Figure 4.1.1-11) resulted in total sediment yields that were slightly higher than those from the La Paz Sub-basin for the 10-year and 100-year events.

In comparing yield figures or sediment rating curves for different basins, it is important to note differences between the basins in the primary factors that affect sediment yields and transport. These differences include precipitation regime, geology and soils, relief, bank and bed stability, drainage area, type of stream (i.e., alluvial or bedrock), tectonic setting, and fire and land use history of a basin. Of particular interest are subwatersheds underlain by Monterey shale, which have steeply sloping sediment rating curves. This diatomaceous, chalky rock weathers quickly and yields high quantities of sediments at all flows. Very little sand is produced from Monterey shale. In contrast, the crystalline bedrock sediment yield is highly episodic. At most flows, Monterey shale produces few sediments. However, at extremely high flows and/or after fires, it yields high quantities of sediments. In general, suspended sediment discharge in San Mateo Creek is less than in San Juan Creek for all measured flows. One factor that may contribute to the lower suspended sediment discharge in San Mateo Creek is the absence of Monterey shale in the drainage geology. Monterey shale underlies ten percent of the drainage area in San Juan Creek. Another factor contributing to the lower rate of suspended sediment transport in San Mateo Creek is its smaller drainage area size.

4.1.1.8 Water Quality

Regulatory Setting

The federal Water Pollution Control Act (also known as the Clean Water Act) was amended in 1972 to prohibit the discharge of any pollutants into waters of the United States unless the discharge is authorized by a National Pollutant Discharge Elimination System (NPDES) Permit. The Clean Water Act amendments of 1990 required NPDES permits for nonpoint source discharges including urban runoff and storm water from construction activities, municipal areas discharging to municipal separate storm sewer systems (MS4s), and certain industrial facilities. The SWRCB and nine RWQCBs administer the water quality control programs in California and issue NPDES permits. Each RWQCB is required to adopt a Water Quality Control Plan (referred to as the Basin Plan) that describes the existing water quality conditions and problems in the region, establishes beneficial uses of the surface waters and groundwaters in the region along with water quality objectives to protect those beneficial uses. The San Juan Creek and San Mateo Creek Watersheds are located within the San Diego Region and governed by the Basin Plan for the San Diego Basin. The San Diego Basin Plan is designed to preserve and enhance water quality and protect the beneficial uses of all waters in the region.

Storm water discharges from construction activities are regulated by the SWRCB under the General Permit for Storm Water Discharges Associated with Construction Activities (99-08-DWQ) (General Construction Permit). The permit regulates pollutants in storm water discharges from activities disturbing one acre or more of soil. Issuance of the permit requires preparation and implementation of a Construction Storm Water Pollution Prevention Plan (SWPPP) that outlines BMPs to control sediment and other construction material pollutants in storm water discharges from the construction site

Beginning in 1990, the County of Orange, the Orange County Flood Control District and the incorporated cities in Orange County collectively received a NPDES MS4 Permit (MS4 Permit) for storm water discharges into watersheds within the permitting jurisdiction of the San Diego RWQCB. This permit was renewed in 2002. The jurisdictional area covered by the San Diego RWQCB MS4 Permit can generally be described as the southerly portion of Orange County including the cities of Aliso Viejo, Dana Point, Laguna Beach, Lake Forest, Laguna Hills, Laguna Niguel, Laguna Woods, Mission Viejo, Rancho Santa Margarita, San Clemente, San Juan Capistrano, and the County of Orange and the County Flood Control District. Major surface water bodies within the MS4 Permit area include Cañada Gobernadora, Arroyo Trabuco, Prima Deshecha Cañada, Segunda Deshecha Cañada, the Pacific Ocean, Moro Canyon, Laguna Canyon, Aliso, English Canyon, Sulphur, Wood Canyon, Salt, San Juan, Bell Canyon, and Oso Creeks.

The MS4 Permit requires implementation of storm water management practices, control techniques, system design, and engineering methods to protect beneficial uses of receiving waters to the maximum extent practicable. Programs and activities required by the MS4 Permit are in the Orange County Drainage Area Management Plan (DAMP). The County of Orange and each city has developed a Local Implementation Plan for implementation of the Orange County DAMP program elements within their jurisdiction. The Local Implementation Plan is also known as the Jurisdictional Urban Runoff Management Plan by the San Diego RWQCB.

The MS4 Permit requires the cities/county to implement programs that minimize the short-term and long-term impacts on receiving water quality from new development and significant redevelopment. The Orange County DAMP and city/county Local Implementation Plans require applicants of new development projects to submit a Water Quality Management Plan (WQMP) for approval by the county or city prior to issuance of a grading permit. The WQMP must meet specific criteria of the MS4 Permit to minimize the effects of development on site hydrology, runoff flow rate and velocities, and pollutant loads to the maximum extent practicable. The WQMP for a new development project must incorporate a variety of post-development Best Management Practices (BMPs) that control the volume and rate of storm water runoff and reduce pollutants in storm water discharges. The four categories of BMPs that can be incorporated into a proposed project as specified in the DAMP/Local Implementation Plan are site design, routine non-structural source control, routine structural source control, and treatment BMPs. As required by the MS4 Permit, the DAMP specifies that new development must meet specific volume-based and flow-based numerical sizing criteria for treating storm water runoff.

Applicable Beneficial Uses and Water Quality Objectives

As part of the San Diego Basin Plan, the San Diego RWQCB has designated beneficial uses (pursuant to Section 303 of the Clean Water Act) for San Juan Creek and San Mateo Creek. These designated beneficial uses for the receiving waters of these watersheds are defined and listed in Table 4.1.1-11. In addition, applicable surface water quality standards established by the San Diego RWQCB and the SWRCB under the California Toxics Rule are summarized in Table 4.1.1-12. Applicable groundwater quality standards established by the San Diego RWQCB and the SWRCB are provided in Table 4.1.1-13.

Section 303(d) of the federal Clean Water Act (CWA, 33 USC 1250, et seq., at 1313 [d]), requires States to identify waters that do not meet water quality standards. States are required to compile this information in a list and submit the list to EPA for review and approval. This list is known as the Section 303(d) list of impaired waters. As part of this listing process, states are required to prioritize the impaired waters/watersheds for future establishment of total daily maximum load (TMDL) allocations for point and non-point source discharges into the impaired waters. California's most recent Section 303(d) list of impaired water bodies was approved by EPA in July 2003 and contains 509 water bodies, many listed as being impaired for multiple pollutants. For the San Juan Creek and San Mateo Creek Watersheds, the Section (303)(d) list specifies San Juan Creek as being impaired for bacteria. The San Diego RWQCB has indicated that establishment of a TMDL for this impairment is of medium priority.

TABLE 4.1.1-11
SAN DIEGO BASIN PLAN DESIGNATED BENEFICIAL USES

Description of Use	San Juan Creek Watershed	San Mateo Creek Watershed
Agricultural Supply (AGR)—Includes uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.	Yes	
Industrial Service Supply (IND)—Includes uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.	Yes	
Contact Water Recreation (REC-1)—Includes uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and SCUBA diving, surfing, white water activities, fishing, or use of natural hot springs.	Yes	
Non-Contact Water Recreation (REC-2)—Includes the uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.	Yes	Yes
Warm Freshwater Habitat (WARM)—Includes uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.	Yes	Yes
Cold Freshwater Habitat (COLD)—Includes uses of water that support cold water ecosystems including, but not limited to, preservation and enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates.	Yes	
Wildlife Habitat (WILD)—Includes uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.	Yes	Yes
Rare, Threatened, or Endangered Species (RARE)—Includes uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.	a.	Yes (lower reaches only)

a. Although the San Juan Creek Watershed supports endangered species, such as the arroyo toad, the San Diego Water Board has not designated RARE as a beneficial use for this watershed.

Source: San Diego Water Quality Control Board

TABLE 4.1.1-12
BASIN PLAN AND CALIFORNIA TOXIC RULE STANDARDS AND OBJECTIVES APPLICABLE TO SURFACE WATERS IN SAMP STUDY AREA

Constituent	Units	California Drinking Water Standards[a.]	Basin Plan Objectives[b.]	California Toxics Rule[f.] (CMC)[g.]	California Toxics Rule[f.] (CCC)[h.]
Inorganic Chemicals					
Aluminum	mg/l	1	–	–	–
Antimony	mg/l	0.006	–	–	–
Arsenic	mg/l	0.05	–	0.34	0.15
Asbestos	MFL	7	–	–	–
Barium	mg/l	1	–	–	–
Beryllium	mg/l	0.004	–	–	–
Boron	mg/l	–[c.]	0.75	–	–
Cadmium	mg/l	0.005	–	0.0043	0.0022
Chromium	mg/l	0.05	–	0.016	0.011
Chloride	mg/l	none	250	–	–
Copper	mg/l	1.3	–	0.013	0.009
Cyanide	mg/l	0.2	–	–	–
Fluoride	mg/l	2	1	–	–
Iron	mg/l	0.3	0.3	–	–
Lead	mg/l	0.015	–	0.065	0.0025
Manganese	mg/l	0.05	0.05	–	–
Mercury	mg/l	0.002	–	–	–
Nickel	mg/l	0.1	–	0.47	0.52
Nitrate+Nitrite (as N)	mg/l	10	–	–	–
Nitrite (as N)	mg/l	1	–	–	–
Selenium	mg/l	0.01	–	–	0.005
Silver	mg/l	0.05	–	0.0034	–
Sodium	%	–[c]	60	–	–
Sulfate	mg/l	250, 500	250	–	–
Thallium	mg/l	0.002	–	–	–
Zinc	mg/l	5	–	0.12	0.12
Others					
PH	pH Units	6.5-8.5	6.5-8.5	–	–
Specific Conductance	(µs)	900, 1600	–	–	–
Total dissolved solids	mg/l	500	500	–	–
Ammonia (as N)	mg/l	30	4	–	–
Fecal coliform bacteria	MPN/100m	log mean <20	–	–	–

mg/l: milligrams per liter

a. Maximum contaminant levels established by the Department of Health Services, from Title 22 of the California Code of Regulations, April 2000. Where two values are shown, they represent the “recommended” and “mandatory” values.
b. Concentrations not to be exceeded more than 10 percent of the time during any one year period.
c. No primary drinking water standards have been established for boron or sodium. At elevated concentrations, these constituents may constrain plant or crop growth.
d. Un-ionized ammonia concentrations exceeding 0.0025 mg/l can be toxic.
e. Biostimulating constituents.
f. California Toxics Rule (CTR) freshwater aquatic life criteria.
g. Criteria Maximum Concentration (CMC) equals the highest concentration to which aquatic life can be exposed for a short time period.
h. Criteria Continuous Concentration (CMC) equals the highest concentration to which aquatic life can be exposed for an extended (4 days) period of time.

Source: Balance Hydrologics, Inc., 2001

TABLE 4.1.1-13
WATER QUALITY OBJECTIVES APPLICABLE TO GROUNDWATER IN THE SAMP STUDY AREA

Constituent	Units	California Drinking Water Standards [a]	Basin Plan Objectives [b]
Inorganic Chemicals			
Aluminum	mg/l	1	–
Antimony	mg/l	0.006	–
Arsenic	mg/l	0.05	–
Asbestos	MFL	7	–
Barium	mg/l	1	–
Beryllium	mg/l	0.004	–
Boron	mg/l	– [c]	0.75
Cadmium	mg/l	0.005	–
Chromium	mg/l	0.05	–
Chloride	mg/l	none	250
Chlorine	mg/l	–	250,375,400
Copper	mg/l	1.3	–
Cyanide	mg/l	0.2	–
Fluoride	mg/l	2	–
Fluorine	mg/l	–	1.0
Iron	mg/l	0.3	0.3
Lead	mg/l	0.015	–
Manganese	mg/l	0.05	0.05
Mercury	mg/l	0.002	–
Nickel	mg/l	0.1	–
Nitrate (NO_3)	mg/l		45
Nitrate+Nitrite (as N)	mg/l	10	– [e]
Nitrite (as N)	mg/l	1	–
Selenium	mg/l	0.01	–
Silver	mg/l	0.05	–
Sodium	%	– [c]	60
Sulfate	mg/l	250, 500	250,375,500
Thallium	mg/l	0.002	–
Zinc	mg/l	5	–
Others			
Color	Color Units	15	15
Methylene Blue-Activated Substances (MBAS)	mg/l	–	0.5
Odor		3	none
PH	pH Units	6.5-8.5	–
Specific Conductance	(μs)	900, 1600	–
Total dissolved solids	mg/l	500	500,750,1200
Turbidity	NTU	5	5
Ammonia (as N)	mg/l	30[d]	–
Fecal coliform bacteria	MPN/100m	log mean <20	–

mg/l: milligrams per liter

a. Maximum contaminant levels established by the Department of health Services, from Title 22 of the California Code of Regulations, April 2000. Where two values are shown, they represent the "recommended" and "mandatory" values.

b. Concentrations not to be exceeded more than 10 percent of the time during any one year period. Where three values are shown, they represent the upper, middle, and lower San Juan Creek hydrologic sub areas.

c. No primary drinking water standards have been established for boron or sodium. At elevated concentrations, these constituents may constrain plant or crop growth.

d. Un-ionized ammonia concentrations exceeding 0.0025 mg/l can be toxic.

e. Biostimulating constituents.

Source: Balance Hydrologics, Inc., 2001 and URS, 2003

Overview of Existing Water Quality Conditions

The information presented below is based on information contained in *Baseline Biologic, Hydrologic and Geomorphic Conditions, Rancho Mission Viejo: San Juan and Upper San Mateo Watersheds* (PCR, PWA and Balance Hydrologics, Inc., May 2001). This report is included as Appendix C to this EIS. Additional discussion and quantification of water quality conditions can be obtained from the source document. The Water Quality Management Plans and technical memorandum are provided in this EIS as Appendix D.

Pollutant pathways and cycles within settings as diverse as the San Juan Creek and San Mateo Creek Watersheds can be complex. Constituents of concern in these watersheds include temperature, turbidity, nutrients (primarily nitrogen and phosphorus), metals, and pesticides (primarily diazinon and chlorpyrifos).

In general, pollutants are transported and sometimes transformed into other compounds with storm water runoff. They are either in dissolved form, particulate form, or are adsorbed to other particles in the water (clays, colloids, etc.). The availability of particulates, pH, and dissolved oxygen affect the distribution of pollutants between dissolved and bound forms. Therefore, land use characteristics that promote infiltration and slow the flow of water allowing sediments to settle or filter out are the main factors that control pollutant mobility.

Geology can also have a direct impact on specific water quality constituent concentrations. For example, the Monterey shale bedrock, which occurs in several of the San Juan Creek sub-basins, is a source of high levels of phosphate and certain metals, such as cadmium.

Terrain can influence the mobilization, loading, and cycling of pollutants. Some general water quality characteristics of the major terrains in the SAMP Study Area (Figure 4.1.1-3) are:

- **Sandy terrains.** Sandy terrains generally favor infiltration of rainfall and therefore have the potential to direct pollutants mobilized in low to moderate rainfall events into sub-surface pathways, with little or no actual biogeochemical cycling taking place in surface waters. Sequestered in sands, pollutants have the opportunity to degrade and attenuate via contact with soils and plants in the root/vadose zones before passage to groundwater or mobilization and transport to surface waters during larger storm events.

- **Silty terrains.** Silty terrains are characterized by higher runoff rates and tend to favor surface water pathways more than sandy terrains (but less than clayey terrains). Silty substrates can also be a significant source of turbidity (i.e., fine sediments). Conversely, the finer sediments derived from the silty substrates promote the transport of metals and certain pesticides in particulate form. This factor makes them less readily available in first- and second-order stream reaches, but potentially allows transport to higher order streams and subsequent deposition over long distances.

- **Clayey terrains.** Clayey terrains are characterized by very high rates of surface runoff during low and moderate storm events. Although clay soils are generally quite resistant to erosion, they can be very significant sources of turbidity during extreme rainfall events when erosion occurs and/or headcutting or incision within the streambed begins.

- **Crystalline terrains.** Crystalline terrains are common only in the uppermost reaches of the San Juan Creek and San Mateo Creek systems where development and agricultural activities are absent. Similar to clayey terrains and in contrast to sandy terrains, during low to moderate rainfall events, primary pollutant pathways will be in surface water flow, leading to the potential for rapid mobilization and transport of constituents. Unlike clayey terrains, the crystalline substrates may be relatively poor in the finer particles that cause turbidity. Like all terrain types, extreme events would likely result in the mobilization and transport of all sizes of sediments from these areas.

Existing Water Quality Data for the San Juan Creek Watershed

The County of Orange has collected a significant amount of water quality data for San Juan Creek since the 1950s.[7] Most of recent water quality monitoring data in the San Juan Creek Watershed was collected by the Orange County Public Facilities and Resources Department in the 1990s at three sampling points that allow for a generalized comparison among land use and terrain types. The sampling points were: (a) the main stem of San Juan Creek at La Novia bridge in the City of San Juan Capistrano which has a large drainage area that includes all terrain types and contains diverse land uses; (b) the main stem of San Juan Creek at Caspers Regional Park (approximately 10 miles upstream of San Juan Capistrano) which represents runoff from primarily open space coastal scrub and chaparral on crystalline terrains; and (c) the Oso Creek sample location represents mostly urban land uses on clayey terrains.

The data for the key nutrients (nitrate, ammonia, and phosphate) monitored by the County of Orange is summarized in Table 4.1.1-14. This table includes statistical summaries for the measured concentrations of these nutrients as a function of the 3-day antecedent rainfall measured at the Tustin rain gauge.[8] It is important to note that the measured nutrient concentrations, especially during dry periods, were at or below the detection limit for one or more of these constituents.

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[7] Concurrent discharge measurements were not taken at the time of sampling for much of the data, creating some limitations on its use.

[8] Rainfall data from the Tustin gauge was chosen due to the completeness of the data and the relative proximity of the gauge to the watershed. The gauge is operated by the Orange County PFRD and is located northwest of the water quality stations on San Juan and Oso Creeks. Additionally, the gauge is located at an elevation (and, thus, mean annual rainfall) similar to the monitored watersheds. It is reasonable to assume that storm patterns and relative intensities observed at Tustin will be generally representative of conditions within the San Juan, Arroyo Trabuco, and Oso Creek sub-watersheds. Additional insight could be gained with precipitation data collected, and especially stream discharge data, collected within these basins.

TABLE 4.1.1-14
SUMMARY OF WATER QUALITY DATA MEASURED BY THE ORANGE COUNTY PUBLIC FACILITIES AND RESOURCES DEPARTMENT AS FUNCTION OF ANTECEDENT RAINFALL, WY 1991 TO WY 1999

3-Day Rainfall[a]	Caspers Regional Park			La Novia			Oso Creek/Mission Viejo		
	# of Samples	Mean	Median	# of Samples	Mean	Median	# of Samples	Mean	Median
Nitrate Concentrations (mg/l NO_3 as N)									
0.00	32	0.1	0.1	43	0.3	0.2	10	0.9	1.0
0.01-0.50	10	0.2	0.1	21	0.5	0.5	23	1.2	1.3
0.51-1.00	6	0.9	0.1	15	1.2	1.2	15	1.2	1.2
1.00-1.50	1	0.7	0.7	7	1.5	1.7	15	1.4	1.3
>1.50	0	n.d.	n.d.	5	0.4	0.4	18	1.0	0.8
Ammonia Concentrations (mg/l NH_3 as N)									
0.00	31	0.1	0.1	42	0.1	0.1	10	0.9	1.0
0.01-0.50	9	0.4	0.1	20	0.1	0.1	23	1.2	1.3
0.51-1.00	5	2.5	0.5	14	0.1	0.1	15	1.2	1.2
1.00-1.50	1	0.5	0.5	7	0.3	0.6	15	1.4	1.3
>1.50	0	n.d.	n.d.	5	0.1	0.1	18	1.0	0.8
Phosphate Concentrations mg/l PO_4 as P)									
0.00	31	0.1	0.1	43	0.1	0.1	10	0.7	0.6
0.01-0.50	9	0.4	0.1	21	0.2	0.2	23	0.4	0.3
0.51-1.00	5	3.4	3.6	15	0.6	0.4	15	0.7	0.5
1.00-1.50	1	1.0	1.0	7	0.7	0.7	15	0.7	0.6
>1.50	0	n.d.	n.d.	5	0.5	0.5	18	1.0	0.5
Zinc Concentrations (Total Zn mg/l)									
0.00	11	23	22	12	28	16	10	68	63
0.01-0.50	9	77	23	17	52	20	23	61	49
0.51-1.00	7	87	100	18	48	32	15	87	92
1.00-1.50	1	38	38	7	51	43	14	135	58
>1.50	0	n.d.	n.d.	5	30	24	18	58	54

mg/l: milligrams per liter
n.d. = no data
a. Sum of three-day rainfall in inches as measured at the Orange County PFRD gauge in Tustin.

Source: Balance Hydrologics, 2000

Nitrates and Phosphates

Several observations can be made on the basis of this data.

- The data suggest that there are one or more significant sources of nitrogen loading between the Caspers and La Novia monitoring stations. It is not possible with the available data to ascertain the sources of the additional loading, but it may include factors such as the location of several nursery operations downstream of the Caspers site, development on San Juan Creek tributaries (e.g., Coto de Caza on Cañada Gobernadora), and the large amount of grassland in the sub-basins below Caspers.[9] There is insufficient reliable data to determine whether a similar situation exists with regard to phosphate loadings between the two sites.

- The monitoring results for nitrate provide strong indications that nitrate is introduced into the lower San Juan Creek system by a mechanism that generally increases proportionally with precipitation up to 1.50 inches of 3-day rainfall. The data are consistent with nitrate mobilization either through direct transport by surface storm water runoff or by the displacement of nitrate-rich groundwater into the stream system.

- The monitoring results for phosphate at the La Novia monitoring station indicate that there is a tendency to higher phosphate levels with increases in both 3-day antecedent rainfall and discharge. The apparent relationship between phosphate and rainfall/ discharge is consistent with erosion being the primary contributor of phosphorus loading. Unfortunately, insufficient samples were collected at the Caspers monitoring station to ascertain whether this observation applies to the whole watershed or only to that portion below Bell Canyon.

It is possible that channel incision can be a contributing factor to both nitrogen and phosphorus loading in the San Juan system. The link between channel incision and phosphorus loading is relatively straightforward: erosion of channel and floodplain terrace material can release significant quantities of stored phosphates. The link to nitrogen loading may be less apparent and focuses on the potential for changes to groundwater inflows to stream reaches as the channel bed degrades. Deeper groundwater is often enriched in nitrate. As a stream incises, it dewaters adjacent aquifers from progressively greater depths thereby increasing the nitrogen loading in the surface waters under base flow conditions,

The ratio of available nitrogen to available phosphorus within a water body often has an important regulating effect on the growth of aquatic plants and animals.[10] The monitoring data support the contention that these systems are generally nitrogen limited (i.e., N/P ratio < 10).[11] One notable exception is found for San Juan Creek at La Novia.

At this monitoring location, it appears that the San Juan system is nitrogen limited at both very low and very high flow rates. Intermediate flow rates correspond with the period when the nitrate

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[9] Grasslands (both native and non-native) have been shown to contribute relatively high loadings of nitrogen (N) in studies carried out in several locations. One obvious potential contributing factor is the fact that grasslands are ideal for livestock grazing with the associated potential for N mobilization from animal wastes. Additionally, grassland soils are typically roughly 4 to 5 percent N by weight, and this N is available to rainfall passing over or through these soils.

[10] Aquatic organisms, such as algae, require carbon, nitrogen, and phosphorus to fuel their basic metabolic processes. If one of these elements is present at low concentrations in the environment, it may become a limiting factor in their growth. The nitrogen/phosphorus ratio (N/P) is often used to indicate which element is limiting, with ratios below 10 indicating that nitrogen is limiting and ratios above 10 indicating that phosphorus is limiting.

[11] It should be noted that the threshold of N/P <10 is generalized from a wide range of aquatic systems. The actual level in the SAMP watersheds may vary with location, time of year and particular species being considered.

concentrations have increased (with increasing rainfall as discussed above) but phosphate levels have yet to increase significantly. Once discharge increases, with the associated general tendency to increase phosphate levels, nitrogen once again becomes the limiting nutrient. Although the overall nitrogen values in the more urbanized Oso Creek sub-Watershed are higher, phosphate levels are still high enough to lead to nitrogen limitation.

Zinc

Monitoring carried out by the Orange County Public Facilities and Resources Department in the 1990s in San Juan Creek included analysis of several metals: cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), silver (Ag), and zinc (Zn). The results are reported in this EIS (Appendix C), *Baseline Biologic, Hydrologic and Geomorphic Conditions, Rancho Mission Viejo: San Juan and Upper San Mateo Watersheds*. In waters with typical pH levels of 7 to 8, as found in San Juan Creek, metals are most likely to be found in their particulate phase. Therefore, one can assume that the more bio-available dissolved fraction would have a much lower concentration. Because metals are typically found in their particulate form and are, therefore, transported in the same manner as sediments, it is unlikely that significant metal transport would occur during dry weather, as the majority of sediment transport occurs during storm events. An initial examination of the San Juan Creek monitoring data shows that, with the notable exception of zinc, most metals are found in concentrations below the detection limit. Several observations can be made on the basis of these data:

- The data do not indicate a significant difference in zinc concentrations between the Caspers and La Novia monitoring stations. This suggests that equivalent zinc sources are found both upstream and downstream of the Caspers monitoring site. Such sources likely include galvanized metal products (e.g., steel culverts), automobile tire wear, roof drainage, and natural mineral weathering.

- Zinc mobility with rainfall. The relationship between measured zinc concentrations and 3-day antecedent rainfall suggest that zinc concentrations increase with increasing rainfall until approximately 1 inch of 3-day cumulative antecedent rainfall is reached, at which point zinc concentrations begin to decrease.

- Total zinc concentrations in water samples collected from San Juan Creek range from below the detection limit to 420 μg/L (measured at Caspers Regional Park on November 15, 1993). As a point of comparison, the monitoring results indicate that, on several occasions, zinc concentrations surpassed the 120 milligrams per liter (mg/l) criteria (for both acute and chronic levels) that have been established for priority toxic pollutants under the California Toxics Rule. In general, it is expected that the dissolved fraction of total zinc has much lower concentrations than particle-bound fractions.

Total Dissolved Solids

Sources of total dissolved solids include both natural weathering of bedrock and soils as well as anthropogenic sources from agriculture and urbanization. The data suggests that total dissolved solids concentrations in San Juan Creek increase from 200 mg/l at its upper reaches to over 1,000 mg/l in the lower reach. Given the minimal urbanization of the Watershed in the 1960s, this 500 percent increase in total dissolved solids is likely the result of: (a) inputs from sub-basins that drain highly erodible substrates such as Monterey Shale (e.g., Cañada Chiquita and Oso Creek); (b) irrigation return flows in Oso Creek, Cañada Chiquita, and Cañada Gobernadora; and (c) evaporative processes that concentrate salts in the water column throughout the length of San Juan Creek. These data suggest that high total dissolved solids are indicative of a baseline condition for the lower San Juan Watershed.

Bacteria

Frequent but spatially limited bacteria monitoring data are available for the lower reaches of San Juan Creek under a program carried out by the South East Regional Reclamation Agency. These data indicate persistently high counts of total and fecal coliform (FC) and enterococcus (EC), both at the mouth of San Juan Creek and upstream of the Latham Treatment Plant. The San Diego RWQCB water quality objective for contact recreation of 200/100 ml of fecal coliform (log mean over 30-day period) is consistently exceeded. However, the water quality objective for non-contact recreation of 2,000/100 ml of fecal coliform is generally attained at the upstream monitoring site. For calendar year 2000, the log mean fecal coliform concentration at Del Obispo Park was approximately 300/ml. The EPA guidelines for enterococcus that are cited in the San Diego Basin Plan (151/ml for infrequently used freshwater areas) was met on only roughly one-third of the samples taken over recent years at the upstream Del Obispo Park monitoring site. The log mean enterococci concentration for calendar year 2000 was approximately 540/ml.

It is important to note that both of the South East Regional Reclamation Agency monitoring sites are located at the most downstream reaches of San Juan Creek, within and below extensive urbanized areas. The sources of these bacterial contaminants cannot be ascertained with existing data.

Existing Water Quality Data for the San Mateo Creek Watershed

Comparable baseline water quality data for San Mateo Creek are limited. As a part of the GPA/ZC EIR 589, water quality monitoring was conducted by Rivertech Inc. The sampling plan, begun in early 2001, identified a comprehensive analysis of both storm event and dry weather samples to be collected from nine locations in the SAMP Study Area, including two sites within the San Mateo Creek Watershed (Cristianitos and Gabino Creeks). These data were supplemented by continuous monitoring of temperature, conductivity, dissolved oxygen, pH, and flow at four stations (including Cristianitos Creek).

4.1.1.9 Groundwater

The information presented below is based on information contained in *Baseline Biologic, Hydrologic and Geomorphic Conditions, Rancho Mission Viejo: San Juan and Upper San Mateo Watersheds*, by PCR, PWA, and Balance Hydrologics, Inc. (May 2001).

The majority of the San Juan Creek and San Mateo Creek Watersheds is underlain by semi-consolidated sandstones and alluvial and terrace sediments derived from sandstones that have the capacity to store groundwater. Several of the bedrock geologic units in the central portion of the San Juan Creek Watershed are moderately sandy and largely uncemented that provide opportunities for infiltration and groundwater storage. In this portion of the San Juan Creek Watershed, the sandy deposits in the floodplain and stream valleys are permeable and therefore, can be a major source of groundwater recharge to both local and regional aquifers. Clay portions of the San Juan Creek Watershed and areas with geologic units composed of siltstones, shales, and mudstones, contain few beds of water-bearing sandy sediments. These areas also tend to have the highest groundwater salinity because negatively charged clay particles are often coated with ions that are released into the groundwater. Weathered and fractured crystalline rocks yield moderate amounts of water sustaining springs and base flows, commonly in the more mountainous upper portions of the two watersheds and their neighboring basins. These flows support some of the more significant and continuous bands of riparian vegetation. They are typically the least mineralized and highest quality of the groundwaters in both watersheds, and their contributions to base flows are often significant in maintaining water quality in the alluvial aquifers downstream within levels suitable for aquatic habitat functions.

There are three shallow alluvial basins that sustain perennial or near-perennial stream flow in the San Juan Creek Watershed. These alluvial basins are located in Chiquita Canyon above the “Narrows,” Chiquita Canyon below the “Narrows,” and Gobernadora Canyon. These alluvial basins are all recharged primarily by ground water emanating from the adjoining bedrock aquifers. The shallow alluvial aquifers of the Gobernadora and Chiquita valleys are partially isolated from the San Juan aquifer via a “damming effect” resulting from the presence of fine-grained lake-bed deposits, which underlay their lower reaches.

At the landscape scale, most of the riparian and aquatic habitats have at least transient reliance on groundwater. The exception to this would be in Chiquita and Gobernadora Canyons, which contain some of the largest areas of sandy soils and the greatest volumes of aquifer storage. The low permeability lake-bed deposits in these canyons form sand wedges that help sustain shallow groundwater levels in the lower half mile of the Chiquita and Gobernadora Canyons. These shallow groundwater conditions are an important component of maintenance of riparian habitat in these areas. Slope wetlands in the SAMP Study Area are also sustained by groundwater. Approximately half of the slope wetlands are sustained by water emanating directly from landslides, while others may be supported by groundwater stored in the Santiago formation that is upwelling along bedrock fractures and faults. Generally, both the yields and the quality of groundwater vary considerably over the course of a season. Detailed analysis of groundwater in the SAMP Study Area is provided in the *Baseline Biologic, Hydrologic and Geomorphic Conditions, Rancho Mission Viejo: San Juan and Upper San Mateo Watersheds* (Appendix C of this EIS).