Planning Level Wetland Delineation and Geospatial Characterization of San Diego Creek Watershed, Orange County, California

Completed by

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Executive Summary

A planning level delineation of aquatic resources was performed within the San Diego Creek Watershed, Orange County, California. A planning level delineation is defined here as the identification of areas that meet the jurisdictional requirements under Section 404 of the Clean Water Act (Section 404), but is done at watershed scale and covers regulated water bodies (including aquatic resources regulated under the California Department of Fish and Game 1600 Code) at a high level of accuracy, but it is not specific to any one site. Thus, a planning level wetland delineation does not replace the need for a jurisdictional wetland delineation from the Corps of Engineers (COE) permitting program.

The modification of standard delineation sampling protocols and the development of ratings for Section 404 Regulatory purpose for the riparian vegetation map units allowed for a watershed scale delineation. The sampling protocols outlined in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and 33 CFR 328 were modified for use at the watershed scale. To delineate at this scale we mapped geomorphic surfaces in the riparian zones that represent several different return intervals, which were later interpreted for frequency requirements under Section 404. Individual vegetation units were sampled at 65 sites to develop a characterization of the wetland indicators for both wetlands and WoUS. Wetland decisions were determined by combining the field data for wetland criteria for each separate vegetation map unit with the distribution patterns of vegetation units within the geomorphic surfaces. By combining the wetland indicators with flood frequency information obtained from the geomorphic surface map, we made jurisdictional decisions with regards to “Waters of the United States (WoUS), including wetlands” across the entire watershed.

The vegetation units in the riparian areas were then rated for their probability of meeting the criteria as either wetland or non-wetland WoUS. These ratings resolved the issue that some vegetation units had repeatable characteristics that always meet the criteria of WoUS including wetlands, and others were so ecologically diverse that they were able to occur in various landscape positions. By combining field sampling and observations with distribution patterns analyzed within the GIS database, probabilities ratings intended for regulatory purposes (Section 404 of CWA) were developed to accommodate all variations. Six categories of wetland ratings were assigned to each of the riparian vegetation units with ratings ranging from always regulated to very low probability of being regulated to upland or not regulated. An addition rating was assigned for those areas that have been set aside for wetland mitigation purposes.

We delineated a total of 917 hectares (2266 acres) of WoUS including wetlands in the riparian areas and 570 kilometers (354 miles) of ephemeral and intermittent streams as non-wetland WoUS on the watershed.

1. Introduction

1.1 Background

The U.S. Army Corps of Engineers, Los Angeles District (LA District) in cooperation with other Federal, State of California, and private interests recently funded an effort to map the aquatic resources within the San Diego Creek watershed, Orange County, California. This effort began by using vegetation coverages obtained from Orange County. By combining these preliminary data layers with onsite mapping efforts for hydrogeomorphic surfaces and field sampling, we were able to develop a large scale wetland delineation for the watershed. Our report provides support to the LA District and other sponsors on wetland locations and their regulatory status that will be useful for the large scale future assessment of impacts to wetlands in the watershed. Specifically, it provides information necessary to identify and characterize regulated waters of the United States (WoUS) including wetlands, in the context of Section 404 permit review. In addition, this planning level delineation of aquatic resources provides a comprehensive mapping of aquatic resources regulated under California Department of Fish and Game's 1600 program. This planning level delineation also supports in part the concurrent landscape level functional assessment for the watershed.[1]

1.2 Objectives

The objectives of the study were to:

1. Conduct a planning level identification of aquatic resources within the boundaries of San Diego Creek watershed as provided by the LA District through the interpretation of orthophoto quadrangles and stereoscopic aerial photography.

2. Verify jurisdictional status and location of identified aquatic resources using sampling and global positioning system (GPS) techniques at a representative numbers of field locations.

3. Produce a planning level map of aquatic resources that includes jurisdictional WoUS (including wetlands) for an ArcINFO and ArcView based geographical information system (GIS).

4. Develop a GIS based database of riparian ecosystem and watershed characteristics.

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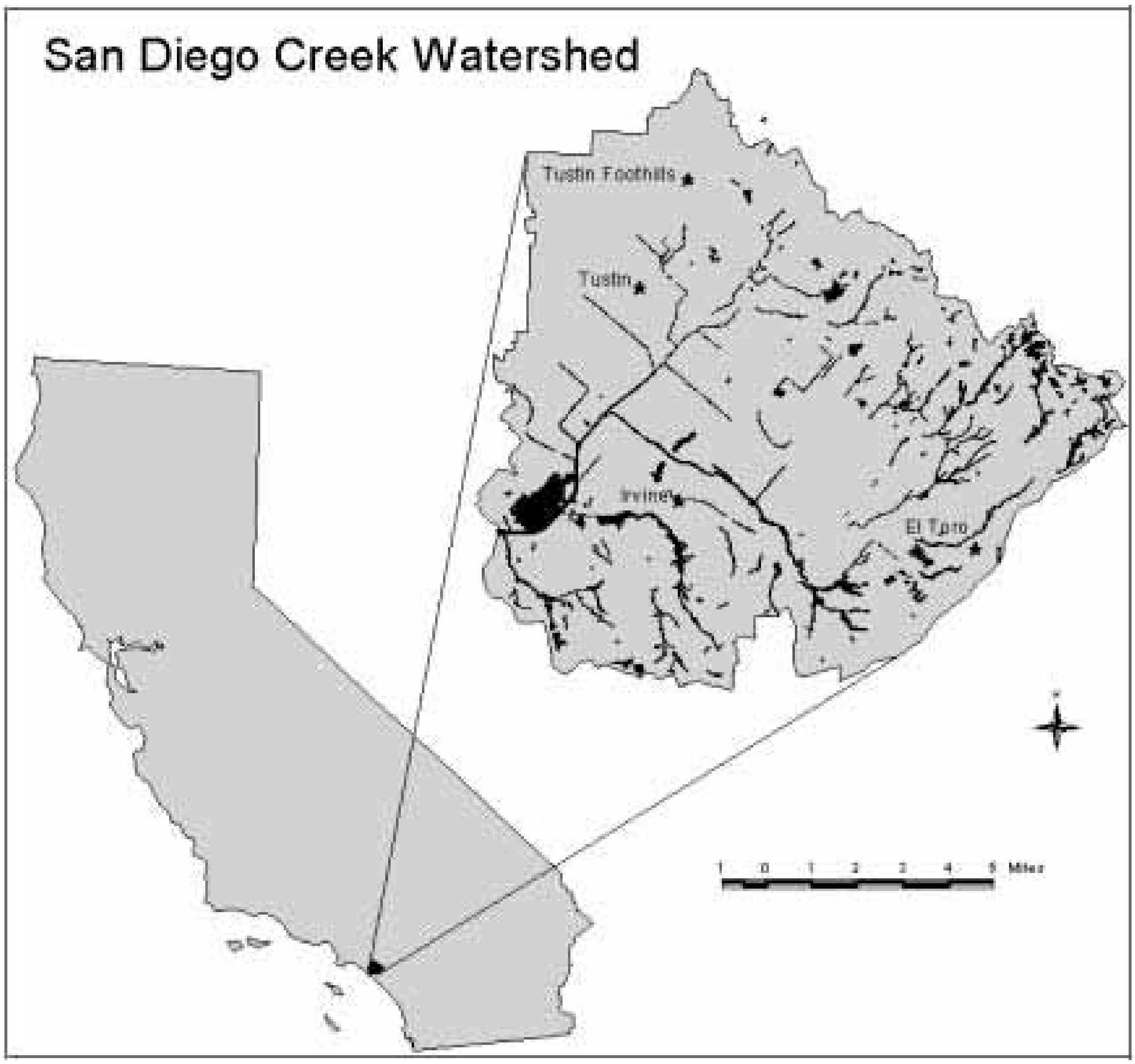
[1] Aquatic resources delineated in this study are intended to include those regulated under Section 404 of CWA and CDFG's 1600 program. The term aquatic resource is used to be inclusive of these regulated resources.

5. Provide aquatic resources occurrence data, characterization and digital coverages to support a concurrent Landscape level functional assessment within the watershed.

2. Study Area

San Diego Creek watershed encompasses ca. 30,744 hectares (75,968 acres) approximately 76 kilometers (47 miles) south of County of Los Angeles in Orange County, CA. San Diego Creek watershed includes communities such as City of Irvine, City of Lake Forest, City of Laguna Hills, and City of Newport Beach. The watershed is bounded by Route 1 on the south, the crest of the foothills at Loma Ridge Road to the north, the Tustin Ranch Road to the west, and the El Toro Road to the east (Figure 1).

Figure 1. Study Area Site and Location Map



Elevations range from sea level at the mouth to 1929 meters (6,327 ft) in the northern areas of the watershed. Terrain includes rugged mountains, steep-walled canyons and gently sloping floodplains. The southern portion of the watershed is located on a marine terrace, or mesa, on the coastal plain that rises gradually from the Pacific Ocean. The western section changes from a relatively flat valley to foothills with deeply incised canyons. The eastern part of the watershed is made up of coastal foothills and canyons with moderate to steep slopes.

The major vegetation types include chaparral, coastal sage scrub, grassland, and riparian vegetation.

2.1 Climate

The regional climate in the San Diego Creek watershed is classified as Mediterranean, which is characterized by warm, dry summers, and mild, wet winters. Precipitation averages approximately 30.48 cm (12 in) per year and is associated with low intensity storms in the winter and spring. Frosts are light and infrequent, with the growing season ranging from 345 to 360 days. The average annual temperature is about 63 degrees Fahrenheit. The average daily high is 71 degrees, and the low 53 degrees F (11.66 C). The major influences on the regional climate are the Eastern Pacific High, a strong persistent anticyclone, and the moderating effects of the cool Pacific Ocean (USACE 1998).

During summer, the Eastern Pacific High block storm systems originating in the Gulf of Alaska and produces a temperature inversion that traps air pollutants near the earth's surface, resulting in poor air quality throughout the Los Angeles basin. Cool marine air condenses into fog and stratus clouds below the inversion layer during the evening but dissipates the following morning as the land heats up. Onshore airflows, associated with low-pressure systems over the inland desert, are the norm. Precipitation associated with tropical air masses during the summer is generally infrequent and unsubstantial.

During winter, polar storm systems begin to pass through the area as the Eastern Pacific High weakens and shifts south. Most regional precipitation occurs during this period. Excessive rainfall can occur when the jet stream maintains a position over southern California and carries multiple storms across the region. Major flooding events for this region typically occur December to March and have been documented for the following years during the 20th century: 1910, 1916, 1937, 1938, 1943, 1969, 1978, 1980, 1983, 1995 and 1998. A strong northeastern wind is prevalent in the fall and winter, referred to as Santa Ana's, can ventilate the Los Angeles basin, preventing the buildup of air pollutants.

2.2 Regional Geology

The San Diego Creek watershed lies on the western slopes of the Santa Ana Mountains, which are part of the Peninsular Ranges which extends from the tip of Baja California northward to the Palo Verdes peninsula and Catalina Island. The geology of the region is dominated by alternating periods of subsidence and deposition, mass wasting and sediment deposition. The majority of the eastern parts of the watershed are composed of igneous and sedimentary rocks of Jurassic age and younger. The western portions of the watershed are Tertiary in age from the foothills to the Pacific Ocean. The geologic assemblages found here are marine and non-marine sandstones, limestones, siltstones, shales, and conglomerates.

2.3 Soils

The U.S. Department of Agriculture study divides Orange County for soil classification and surveys into the following major types: an area of terraces and rolling foothills extending to the Santa Ana Mountains and the alluvial flood plains (USDA-SCS 1978). The soils of primary interest for this study are those developed in riparian areas and active flood plains. The majority of these flood plain soils are classified as Entisols and are poorly developed. The USDA soil survey (1978) describes the soils along the streambeds as: somewhat excessively drained to poorly drained, nearly level to moderately sloping soils on alluvial fans and flood plains and in basins of the coastal plains. Flood plain soils are young in age and are mainly composed of silt loam and silty clay loam alluvial deposits. In terrace locations in the flood plain where fine silts and organic material have accumulated for years, the soils have developed horizons within the soil profile.

The lower to middle reaches of the watersheds are dominated by the Riverwash (RM) landform type. This flood plain soil unit is composed of soil that has developed on alluvium and is moderately well drained to excessively drained. In the upper reaches of the watersheds, another land type, Stony land (SvE) is commonly associated with smaller reach bottoms. This map unit is dominated by stones, rocks, or boulders located on the soil surface. This unit is generally associated with the first and second order streams that have intermittent flowing water.

Outside of the flood plains are a variety of soil associations that are used to describe alluvial fans, slopes of both fine and cobbly materials, and other sandstone, shale, metavolcanic, and sedimentary formations.

2.4 Topography

Elevations within the watershed range from just over 1929 meters (6,327 ft) in the east to nearly sea level in the west. The uplands to the east are cut by southwesterly trending canyons that open onto alluvial fans, which broadening on to an alluvial plain. Along drainages on the alluvial plain are a series of fluvial terraces composed of coarse channel deposits. The alluvial plain thins to the west as marine deposits that are partially covered by younger alluvial fan deposits appear. The foothills to the south have approximately half of the elevation as the uplands to the east and are about cut by northwesterly trending canyons that open onto alluvial fans. These fans broaden as well onto the terraced alluvial plain.

2.5 Subwatersheds

Local watersheds drain to the west or southwest. The major subwatersheds were subdivided into uplands, plains, and foothills. The larger upland subwatersheds include Hicks Canyon, Limestone Canyon, Middle Borrego Canyon Wash, Peters Canyon Wash, Santa Ana Santa Fe Channel, Serrano Creek and Upper Borrego Canyon Wash, which drain predominately to the southwest. The elongate plain subwatersheds include Barranca Channel Lane Channel, El Modena Irvine Channel, Laguna Hills, Lower Borrego Canyon Wash, Middle San Diego Creek, Tustin US Marine Air Station Center and Tustin US Marine Air Station North that have been artificially channelized. The foothill subwatersheds include El Moro Canyon, Middle San Diego Creek Laguna Reservoir, Sand Canyon, Upper Newport Bay San Diego Creek, Upper San Diego Creek and Wood Canyon that drain predominately north/northwest. These subwatersheds drain at some point into San Diego Creek.

2.6 Vegetation Communities

The diversity of vegetation in the study area is dependant upon the amount of human development that has occurred. Riparian woodlands and forests occur along most portions of the streams courses that remain in a less disturbed condition. The slopes and mesas lying above or upslope of the riparian corridors, that are not farmed or developed, are vegetated with either coastal sage scrub or chaparral communities. The coastal sage community is the dominant vegetation type found west of the watershed in the foothills. With increasing elevation, chaparral communities replace coastal sage. Coastal sage scrub is restricted to xeric, south facing slopes. Oak woodlands and forest become common in the upper reaches of the watershed on north-facing slopes and along drainages.

The riparian vegetation is one of the most dynamic vegetation communities within the watershed. The dramatic changes in vegetation patterns over short time scales are a result of periodic cycles of destruction and regrowth from flooding events and human disturbance. As a result of these disturbances, the ability of riparian vegetation to have "pure stands" or "climax" vegetation is limited in these dynamic environments. The natural events caused by periodic flooding can quickly change the distribution and species composition and reset the disturbance-recovery cycle. Additionally, land development within parts of some watersheds has modified the potential of the natural vegetation to reestablish itself after flooding events. These disturbances have modified watercourse directions, changed silt loads, and have allowed areas to maintain water for longer periods of time than previous occur. Impacts from water being discharged from parking lots and other developed areas have allowed for more disturbed willow forests and ponds to occur. Finally, most of the major native riparian vegetation areas in the lower watershed have been eliminated and replaced by concrete lined flood control structures.

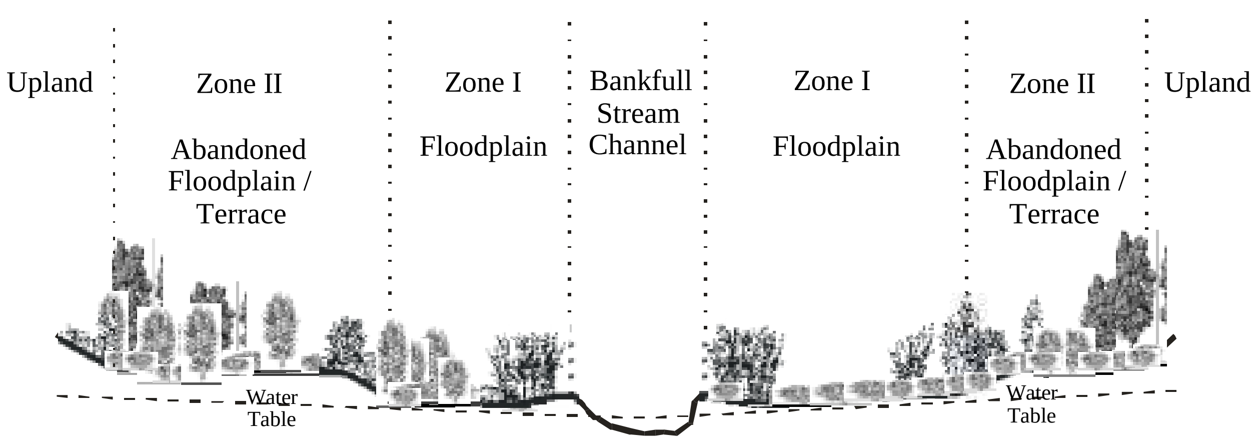
2.7 Streams and Riparian Ecosystems

San Diego Creek watershed encompasses five major and numerous smaller subwatersheds. The larger subwatersheds are drained by the Barranca, Borrego, Serrano, San Diego, and Sand Canyon creeks. Smaller subwatersheds are drained by streams originating in the foothills immediately adjacent to the coastal plain.

Streams on the base fall into several of the Rosgen (1996) stream classes. Some intermittent and 1st order streams fall into the "A3-4" stream type, which is characterized as steep, entrenched, cascading step/pool streams often in sand and gravel or bedrock and boulder dominated channels. More typically intermittent and 1st order streams fall into the lower gradient (2-4% slopes) "B4" or "B5" stream type with sand and gravel substrates. Second and 3rd order streams are typically of the "C3-4" stream type with slopes <2% and cobble, gravel, or sandy substrates. Fourth, 5th, and 6th order streams are of the braided channel "D3-5" stream types with slopes <2 %.

Associated with the higher order streams are riparian ecosystems. Based on the work of Richards (1982); Harris (1987); Kovalchik and Chitwood (1990); Gregory et al. (1991); Malanson (1995); and Goodwin et al. (1997), riparian ecosystems were defined as the relatively narrow ecotones that exist between the bankfull channel of alluvial streams and adjacent upland habitat. The riparian ecosystem consists of two distinct parts or zones, although either may be absent under certain circumstances, i.e. in narrow canyons. The first zone is that portion of riparian ecosystems flooded by surface water from the stream channel at least every five to ten years. Throughout this report we refer to this part of the riparian ecosystem as active floodplain or Riparian Zone 1 (Figure 2).

Figure 2. Cross-section depicting hydrogeomorphic floodplain surfaces.



The second zone of the riparian ecosystem consists of abandoned floodplains and terraces formed by fluvial processes operating under different climatic or hydrologic regimes. Under current climatic and hydrologic conditions, these areas are flooded episodically during larger magnitude events (Dunn and Leopold 1978). This part of the riparian ecosystem is referred to as terrace or Riparian Zone II (Figure 2).

3. Definitions

3.1 Riparian Ecosystems

Riparian areas typically border rivers and streams. These riparian areas are particularly important because they link and integrate across landscapes by serving as corridors through which water, materials, and organisms move. In arid regions they are also critical to maintaining regional biodiversity because they provide habitat for a disproportionately large number of species in spite of their limited aerial extent. Riparian areas typically include a zone of frequent flooding (bank full), that is regulated under existing federal and state law, as well as a less frequently flooded transition zone between these areas and adjacent uplands (active floodplain to floodplain terrace). These transition zones vary in regulated statute from WoUS (including wetlands) to uplands even though they contribute greatly to the habitat, hydrologic, and biogeochemical functions performed by riparian areas. In this delineation and characterization we identify and discuss all these units because they constitute the "functional" riparian ecosystem, and that this functional riparian ecosystem should be identified, assessed, and managed as a unit.

3.2 Waters of the United States

Waters of the United States (WoUS) are regulated under Section 404 of the Clean Water Act (CWA). The areas delineated as WoUS in this study met the requirements outlined in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987), subsequent guidance from the Office of the Chief of Engineers (1992; 1995), and 33 CFR 329.11(a)(1-7). These areas include the following, "…1) all waters that are currently used, or were in the past, for interstate or foreign commerce, including all waters that are subject to the ebb or flow of the tide; 2) all interstate waters including interstate wetlands; 3) all other waters such as intrastate lakes, rivers, streams, (including intermittent streams), mud flats, sandbars, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds; 4) all impoundments of waters otherwise defined as waters of the United States; 5) tributaries of waters identified in numbers 1-4 above; 6) the territorial seas; and 7) wetlands adjacent to waters listed in 1-6 above". All surface waters within the base boundary were considered WoUS including streams, intermittent streams, ponds, lakes, and reservoirs.

3.3 Ordinary High Water Mark

The jurisdictional limits of streams are defined by using the "ordinary high water mark" (OHW). The OHW is defined at 33 CFR 328.3(e) as "... that line on the shore established by fluctuations of water and indicated by physical characteristics such as clear, natural lines impressed on the bank, shelving, changes in the character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding area". Additionally, seasonal wetlands, as described in the Corps of Engineers Wetland Delineation Manual, are where "... water in a depression (is) ... sufficiently persistent to exhibit an ordinary high-water mark or the presence of wetland characteristics."

The regulated waters delineated in this study are ephemeral and intermittent streams, riverine, isolated wetland depressions, and coastal salt marshes. The isolated depressions, coastal marshes, and parts of the riverine system were determined to be wetlands because they met the three parameter criteria. The ephemeral and intermittent streams and some portions of the perennial streams were treated as WoUS.

3.4 Wetlands

Wetlands are one of six special aquatic sites included under WoUS. Wetlands are defined as "... areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR 328.3(b)). The methodology for delineating the boundaries of jurisdictional wetlands, using hydrologic, hydrophytic vegetation and hydric soil criteria, is outlined in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987).

Despite the fact that “wetlands” are technically WoUS, throughout this report we will follow the common convention of distinguishing between wetlands and WoUS. The term “wetland” will refer to WoUS that are regulated by virtue of the fact that they meet the hydrologic, hydrophytic vegetation, and hydric soils criteria outlined in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987). The term WoUS will refer to those waters regulated under the CWA that may not meet the three criteria used to distinguish wetlands.

4 METHODS

4.1 Delineation of Aquatic Resources

Aquatic resources were identified using a high precision planning-level delineation approach that adjusts the sampling methods outlined in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and 33 CFR 328 and applies them at a watershed scale. This delineation approach allows for the identification of different types of regulated wetlands and WoUS over a large area. While the approach provides a high quality map of jurisdictional wetlands and WoUS, suitable for use in project planning, it does not serve as a substitute for the on-site jurisdictional delineation that is normally conducted as part of Section 404 permit review process.

4.2 Initial Identification of Aquatic Resources

Aquatic resources were initially identified by interpretation of existing vegetation spatial databases (maps). These initial maps were supplied by Orange County, CA, Natural Resources Office (developed by Paul Cylinder of Jones and Stokes, pers. com. 1999). It was determined that these maps had several limiting issues, 1) they had numerous rectification problems, 2) they lacked enough detail to produce acceptable wetland maps, and 3) the spatial extent of the map units was too large to be used for our purposes. To develop the wetland delineation map units we used a combination of resources and techniques.

We delineated map units using true color aerial photographs at a scale of 1:4800. These aerial photographs were color copied and used to delineate riparian vegetation in the field with a minimum mapping unit size of about one quarter of an acre. Each riparian vegetation unit was labeled using the modified Holland (1986) classification for CA vegetation. These delineated aerial photographs were later digitized in the laboratory using ArcINFO software. Other landscape features useful for digitizing and rectification were contours (at 1:24,000 at a scale of 10 foot contour interval), vegetation community/land, hydrology, soil, and major roads that were obtained from Orange County GIS center in ArcINFO format. The mapping base data consisted of scanned aerial photographs at a resolution of 6 inches per pixel as well as USGS 2 meter quarter orthoquadrangles. These images were used as a backdrop for digitizing the delineated riparian vegetation units. A list of the riparian vegetation communities and other map unit types, the codes used to designate them, and other information is provided in Appendix 1.

These same sources of information were used to develop a GIS coverage of the hydrogeomorphic surfaces within the riparian ecosystem. Three types of surfaces were identified including the bank full channel, the active floodplain (Zone 1), and terraces (Zone 2). In addition to the delineating of vegetation units on the copied aerials, the hydrogeomorphic surfaces were mapped in the field using the same copies. Likewise, the hydrogeomorphic surface polygons were digitized on screen using the orthophoto quadrangle along with GIS coverage as a base map. This resulted in spatial database with two attribute fields, one for riparian vegetation (hereafter referred to as the riparian vegetation base map) and the other of geomorphic surfaces within the riparian ecosystem.

The first order streams were digitized by stereoscoping the locations on the aerial photographs and then digitizing the coverage by using the rectified orthophoto quadrangle as a background. The first order streams, identified on the coverages in this report as red lines, are typically 15 feet or less wide. These single line features were not associated with other hydrogeomorphic surfaces. In several instances, second and third order streams were also identified as a single red line due to their narrow width and lack of other hydrogeomorphic surfaces. Typically, these single lined second and third order stream channels resulted from human influences that caused down cutting in the channel.

4.3 Field Verification

We sampled 65 sites in the field to verify the regulatory status (Section 404) of riparian vegetation communities identified on the riparian vegetation base map (Appendix 6; data sheets will go here). Representative sites were selected using a stratified random approach with subwatersheds and riparian vegetation communities serving as the stratification criteria. At each sample point the wetland boundary was established using GPS equipment and the information necessary to complete a routine wetland delineation was collected. In addition, physical and biological information was collected to help classify and characterize vegetation communities and riparian reaches and providing information for the functional assessment. This information included: geomorphic surface (channel, active floodplain, and terrace), soil texture, plant species and abundance by stratum, adjacent land use/land cover, and cultural alterations.

The data collected during field sampling was summarized to provide a description of the geomorphology, hydrology, soils, and vegetation of various vegetation community types. This was used to modify the riparian vegetation/wetlands and geomorphic surface base maps.

Any boundaries that needed to be corrected were redrawn later in the laboratory using a stereoscope. The map is developed as an iterative process that combines both field and laboratory efforts. Sample data sheets may be obtained from U.S. Army Corps of Engineers, Los Angeles District upon request.

4.4 Analysis of Field Verification Data

Data collected during the field verification was summarized and analyzed to characterize the common riparian vegetation types in terms of riparian vegetation species and environmental variables. Canonical Correspondence Analysis (CCA) (ter Braak 1988) was used to determine the relationship between species density values and environmental variable values in the 48 sample points at San Diego Creek watershed. CCA is a direct gradient analysis technique that relies on the assumption of unimodal relationships between species and environmental variables. CCA, like other ordination techniques, is used to construct a multidimensional graph whereby each axis represents some environmental descriptor. Within this graph, those species occurring in clusters generally occur in similar habitats, whereas species found relatively far from each other occur in differing habitats. The environmental descriptor associated with each axis can be interpreted by examining the environmental variables that extend roughly parallel to the axis. The length of the arrow for each variable is an indicator of the strength of the relationship between that variable and the axis. Therefore, the greater the length of the arrow, the greater the relationship between the species, the environmental variable and the axis. To determine which components explain the greatest proportion of variance in the data, stepwise, forward selection of environmental variables was employed. Environmental variables examined in this study were primarily descriptors of the vegetation and soil characteristics at the site (Table 1). Finally, Monte Carlo permutation analysis was performed on the ordination axes to determine their significance (Manly 1990). In addition, descriptive statistics were performed on the values for select environmental variables.

Table 1. Environmental variables collected at San Diego Creek Watershed

Vegetation Variables	**Soil Variables**
% Cover – coarse woody debris	% Silt
% Cover – trees	% Sand
% Cover - shrubs	% Gravel
% Cover – herbs	Gravel Size (cm)
% Cover - exotics	% Cobble
% Cover - litter	Cobble Size (cm)
Species Richness	
PI Value	

4.5 Final Map of Wetlands and Waters of the United States

The final map for WoUS, including wetlands, was developed by assigning probability ratings for regulatory purpose to the riparian vegetation/ hydrogeomophic base map. These designations were made based on the results of the field verification sampling, and by evaluating the hydrology for each geomorphic surface, and its vegetation type. These designations were further evaluated using GIS software to compare their spatial distribution patterns with those of other types (e.g. watersheds, human disturbance and geomorphic surfaces).

The bank full, active flood plain, and first order ephemeral streams were found to be mostly WoUS, and therefore regulated. The wetland status of vegetation types occurring in terrace geomorphic surfaces and along some of the first order streams varied depending on a number of factors and therefore could be placed in one of several Section 404 jurisdictional wetlands categories. Because of the variation in site conditions and lack of fidelity of certain riparian vegetation types for similar site conditions in the terrace and first order stream positions, probability ratings were adopted to determine the likelihood that wetlands or WoUS occurring in both the floodplain and non-floodplain areas. Each riparian vegetation type within the three geomorphic surfaces (hereafter referred to as floodplain riparian vegetation) was assigned a rating of 1-6. The ratings are explained in Table 2. The non-riparian wetland vegetation (hereafter referred to as non-floodplain riparian vegetation) associated with first order streams and outlier positions were assigned a similar but separate rating as shown in Table 2. This allowed for distinguishing the different hydrologic regimes associated with each major ecological setting. The Ratings assigned to both the floodplain and non–floodplain riparian vegetation ratings are compared and shown in Appendix 2. In addition to these wetland ratings, another category called water resources (WR) was applied to those areas requiring further legal investigation and decisions from the local Corps District. This category of units goes beyond the scope of this study and includes water bodies like sewage lagoons and water retention basins.

Table 2. Wetland/WoUS Ratings assigned to riparian and non-riparian floodplain vegetation types.

Rating	Description
1	Types meet the criteria for a wetland or WoUS 100% of the time
2	Types meet the criteria for a wetland or WoUS 67-98% of the time
3	Types meet the criteria for a wetland or WoUS 33-66% of the time.
4	Types meet the criteria for a wetland or WoUS 2-32% of the time (primarily uplands)
5	Types meet the criteria for a wetland or WoUS <2% of the time (primarily uplands)
6	Unregulated upland
7	Mitigation
WR	Water Resource (contact local Corps District for jurisdiction interpretation)

Section 404 jurisdictional designations were assigned to each polygon, intermittent, and ephemeral stream reaches as follows. The bank full channel geomorphic surface meets the criteria for a jurisdictional wetland if it is vegetated because the hydrology criteria has been met "in most years or [with a] greater than 50 percent probability." It also met the hydrology criteria, which allows the soils to be considered hydric as a result of long periods of flooding or ponding. However, when hydrophytic vegetation is lacking, the polygon qualifies as a WoUS based on the presence of a bed and bank or OHW. Unlike the bank full channel geomorphic surface, the active floodplain geomorphic surface is characterized by a recurrence interval of 10 years or less, and consequently, may not meet the hydrologic criteria required for a jurisdictional wetland (Section 404). But because of the frequency of flooding events, it is then considered a non-wetland WoUS regardless of the hydrophytic nature of the vegetation or the status of the hydric soils. Included within the active flood plain are occasional adjacent wetlands that met the criteria for a jurisdictional wetland. Also occasional tributary channels bisecting the active flood plain and the terrace generally met the criteria as a WoUS. Terraces had several types of regulated units, the lateral tributary, adjacent wetlands, and areas that receive over bank flooding or groundwater influence enough to develop wetland features. Adjacent wetlands that meet all three criteria were usually located in the linear paleo channels. In the upper most reaches of the watershed, the 1st and 2nd order streams, and some 3rd order streams were identified as WoUS based on the location of the OHW, i.e. bed and bank. Riparian vegetation associated with these locations were assigned a probability rating for non-floodplain riparian vegetation. These non-flood plain riparian wetlands also include isolated wetlands scattered throughout the watershed that are not associated with flood plain areas.

5. Results and Discussion

5.1 Description of Vegetation Community Types

Thirty-two of the 88 vegetation types within the coverages provided by Orange County were identified as potential vegetation units containing WoUS, including wetlands, and sampled. These 32 subset types were contained within 14 major vegetation units within the Holland classification. These 14 major types were identified as those vegetation units most likely to occur within the riparian corridor. Of these 14 types, eight of them had a sample size large enough to allow for limited descriptive statistical analysis. The mean for seven environmental variables and four of the most frequently associated species are presented in Table 3. The types Fresh Water Marsh (6.4), Riparian Sycamore Woodland (7.4), Riparian Southern Willow Forest (7.6), and Riparian Black Willow Forest (7.7) had soils with a high percentage of silt content. These three units also had a higher probability rating for being regulated, which corresponds to soils with the ability to hold water longer with higher silt content. The Riparian Sycamore Woodland had a lower rating for being regulated probably due to having soils that were greater than 60 percent content of sand. A higher percentage of sand content is expected for Sycamore woodlands since it is typically located in depositional areas in the terrace.

The two wettest community types were Fresh Water Marsh and Riparian Southern Willow Forest. The Prevalence Index (PI), a weighted average calculation using the wetland indicator status by species and their cover estimate, was 1.35 and 1.91 respectively. The driest three units were the Flood Plain Sage (2.6), Riparian Herb (7.1) and the Riparian Sycamore Woodland. These were 4.4, 3.28, and 4.95 respectively. The Flood Plain Sage type was dominated by soils with a high gravel to cobble content and positioned on less active flooding surface within the terrace. The Sycamore Woodland typically was situated in a position that infrequently floods. The riparian herb type tended to be areas that had previously been under some agricultural modification and reverting to dry uplands dominated by weedy herbaceous species.

The most challenging type of vegetation to associate with a specific soil variable was Riparian Mulefat (7.3). This type, dominated by *Baccharis salicifolia*, was scattered in the low flow, active, and flood plain terrace geomorphic surfaces. This species of Mulefat has a Facultative Wet (FACW) indicator (Reed 1988). This species appears to be responding to several variables including moist soils. We found this species frequently in the active flood plain on sandy terraces. In addition, it occurs on the flood plain terrace in areas with sand to gravel textured soils. Since the ecological amplitude of this species is so broad, regardless of its apparent preference for the active flood plain position, we assigned a probability rating of 3 (33-66 percent probability of being a regulated wetland) to this group in the terrace position.

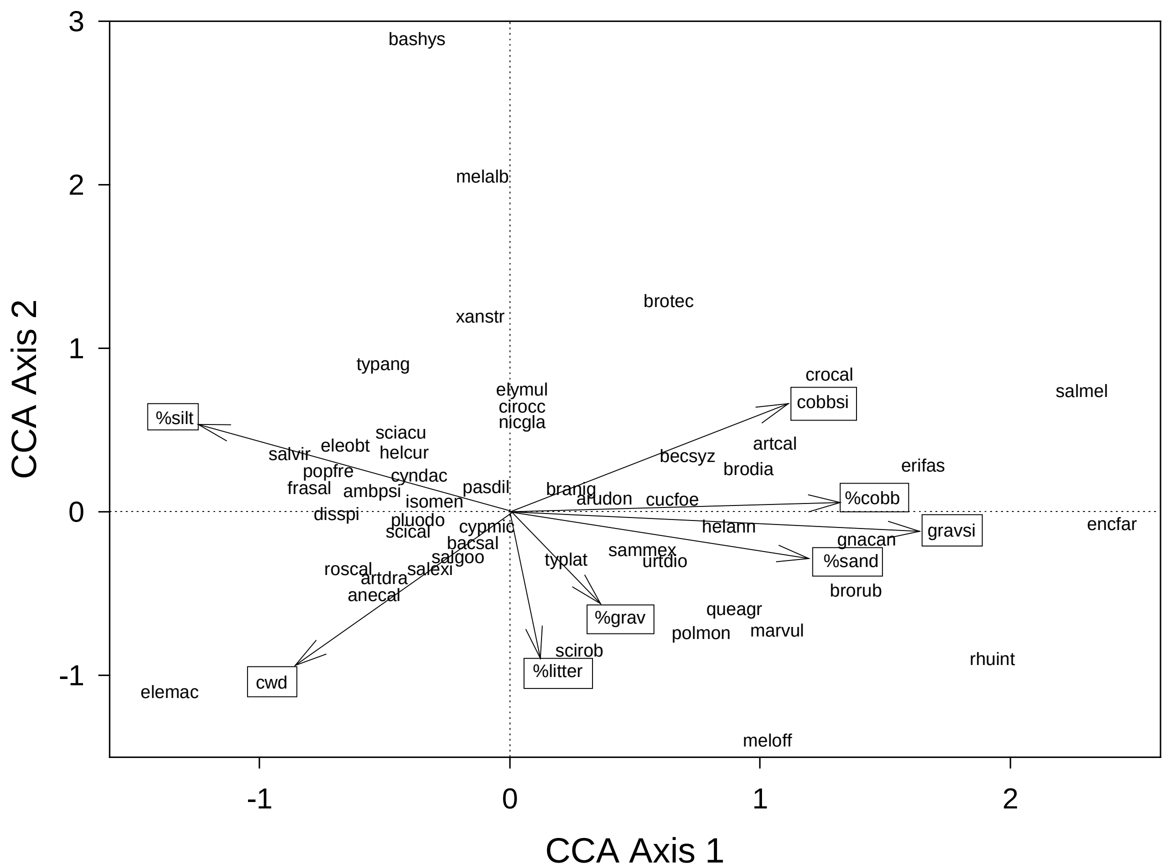
Table 3. Dominant riparian vegetation species and range of variable values for common riparian vegetation .

Type	Associates	% Cover	% Exotics	Spp. Rich.	% Silt	% Sand	% Gravel	% Cobble	PI Value
2.6 N=3	***Opuntia phraecantha, Salvia mellifera, Eriogonum fasiculatum***	66	39.5	8	15	80	1	4	4.4
6.4 N=4	***Scirpus californicus, Typha latifolia, Eleocharia macrostachya***	100	23.3	5.5	22.5	56.3	0	0	1.35
7.1 N=4	***Conium maculatum, Cressa truxillensis, Artemisia dranunculus***	62	56.8	4	15	62.5	0	1.2	3.28
7.2 N=6	***Salix lasiolepis, Baccharia salicifolia,***	91.6	21.2	7.5	16.7	66.7	0	5	2.44
7.3 N=8	***Baccharis salicifolia, Baccharis piluraris, Artemisia californica***	91.4	5.5	5.5	13	78.8	0	0	2.59
7.4 N=2	***Plantus racemosa, Avena fatua, Sambucus mexicanus***	70	70	4	20	60	0	0	4.95
7.6 N=7	***Salix lasiolepis, Scirpus microcephalus, Juncus dubius,***	92.3	6.3	6.6	23.6	40.7	9.3	1.4	1.91
7.7 N=5	***Salix goodingii, Baccharis salicifolia, Heterotheca grandiflora***	87.4	21.6	7.4	24	60	0	0	2.42

5.2 Analysis of Field Verification Data

Initially, to decrease the influence of rare species, only those species that maintained a relative density of 0.1% were retained in the ordination (55 of the original 88 species were retained). All remaining species data were log transformed. Subsequent to these modifications, Canonical Correspondence Analysis (CCA) suggested that soil texture was the primary factor determining species composition at San Diego Creek (Figure 3). Indeed, species that occur on fine textured soils (i.e. *Anemopsis californica, Distichilis spicata*, and *Scirpus acutus*) were found on the left side of the first axis, while species occurring on coarse textured soils (i.e. *Erigonum fasciclatus, Sambucus mexicana*, and *Salvia mellifera*) were found on the right side of the first axis. Finally, Monte Carlo permutation analysis showed that all canonical axes were significant ($p > 0.05$).

Figure 3. CCA ordination of select environmental variables using plant species occurrence frequencies.



5.3 Hydrology

Two main types of hydrologic flow characterized the flood plain wetlands: (1) flood flow over open flood plains, and (2) precipitation combined with over bank flooding into topography. Field indicators for these two hydrology sources were assessed in the field for making jurisdictional decisions at various locations. Surface runoff and groundwater supplies water to riverbeds throughout most of the year and provides for a perennial source of water. During some storms, the amount of water throughout various parts of the flood plain increases dramatically. We estimated that the bank full and active flood plains geomorphic surface fill with water during storms that occur at intervals of less than 10 years. The remainder of the flood plain is estimated to flood at various stages depending upon the storm severity until in certain events all of the flood plain is full. In larger events, greater than 10 years, the WoUS and wetland primary hydrology indicators of drift and silt material is scattered across some or all of the flood plain. These indicators are not reliable for assessing jurisdictional wetland occurrence since they can be remnants of an infrequent but large event that scattered these indicators across most of the flood plain. Because of this issue, we relied on bed and bank features and geomorphic surfaces combined with certain vegetation units as field indicators for meeting regulatory criteria.

Over bank flooding and local precipitation provides the hydrology for isolated paleo channels and other depressional sites in the flood plains. For those seasonally wet areas in the flood plain that have less than a 50 percent likelihood of having ponded or saturated soils in the upper part for at least 17 days (5 percent of the 345 to 360 day growing season in the coastal and foot hill regions) and do not meet the hydrology requirements for a jurisdictional wetlands (Section 404) were considered regulated because they met the definition of non-wetland WoUS with an ordinary high water mark. Most of the paleo channels located in the terrace geomorphic surface don't hold water for long periods of time. But some of the paleo channels are supplied water from tributaries entering the flood plain. These larger and slightly depressed zones are typically covered by *Salix lasiolepis* (Southern Arroyo Willow; vegetation type 7.6) vegetation type which can hold water for longer periods. The soils in these depressional sites typically have higher silt content so consequently they can pond water for extended periods. These observations and the analysis of soil textures in CCA (Figure 3) support the Ratings assigned to several of the vegetation types associated with these flood plain settings.

5.4 Soils

The USDA Soil Conservation Service (1978) listed several miscellaneous land types as hydric and seven map units as non-hydric with hydric inclusions in the 1978 survey of Orange County, CA (SCS 1973). The miscellaneous land types are river wash (Rm) and pits (Pt). The Rm and Pt soil landscape features are hydric because of hydric soil criteria 3 and 4 (NRCS 1996; Environmental

Laboratory, 1987) as those soils or areas are ponded or flooded for at least seven days every other year during the growing season. Of the seven soil units classified as non hydric with hydric inclusions, 3 had hydric components based on flooding frequency and durations and meet criterion 3 and 4 (frequency of ponding and flooding).

The floodplain is mostly dominated by one miscellaneous land type. The Rm map unit is located in intermittent stream channels and in floodplains. In our study area this soil was usually located on the terrace where the flood return interval is 10-100 years. Occurring with this are map units Sobobo, Corralitos, and Metz. These 3 map units are not hydric but can frequently occur along streams and flood plains and met the flooding criteria.

Only those soils with redoximorphic features could be classified as hydric soils. In the field it was not possible to determine which of the soils, mapped as hydric by definition of criteria 3 and 4 for ponding and flooding, qualified as hydric because drift and rack was scattered across the entire flood plain from a recent flood event. Using field indicators for hydric soils was useful for soil map units in certain parts of the terrace in the flood plain. At eight sample locations, redoximorphic features were observed within the top 30 cm (12 inches) of the soil. These features are similar to those described by the USDA-NRCS as Indicator F3- Depleted Matrix (NCRS 1996).

5.5 Delineation Results: Aquatic Resources (including Waters of the United States)

Aquatic resources including wetland and WoUS areas within San Diego Creek Watershed totaled 917 ha (2266 ac) and there were 570 km (354 miles) of intermittent streams identified within the watershed. Table 4 shows how the regulated areas correspond to the geomorphic surfaces and other parts of the watersheds. The jurisdictional ratings (Section 404) for each geomorphic surface and all riparian vegetation types occurring in them are provide in Appendices 3, 4, 5. The aquatic resource vegetation types, geomorphic surfaces, and jurisdictional rating coverages are shown in Appendix 7.

The wetland ratings for 32 subset riparian vegetation units gave the following results for each geomorphic surface. Within the bank full and active floodplain channel there was a combination of 22 riparian vegetation types and unvegetated watercourse that were considered jurisdictional (Rating 1). Of the 22 types that were located in these two geomorphic surfaces, there were 15 wetland units and 7 WoUS.

There were 279 ha (690 ac) of vegetation types that were considered jurisdictional within the bank full and active flood areas (Appendices 4 and 5). Of these regulated wetland vegetation types, there was only a slight overlap of the larger and more abundant types. Of those units in this category, 3 units were in

Table 4. Regulated decisions for each floodplain and non-floodplain riparian units in the wetland GIS coverage.		
Geomorphic Surfaces and Ratings	**Number of Vegetation types**	**Hectares and km**
Bankfull channel (Rating 1)	17	196 ha (484 ac)
Active flood plain (Rating 1)	17	83 ha (206 ac)
Terrace		
Rating 1	4	35 ha (87 ac)
Rating 2	3	37 ha (92 ac)
Rating 3	4	6.5 ha (16 ac)
Rating 4	1	3.6 ha (9 ac)
Rating 5	3	30 ha (74 ac)
Rating 6	8	24 ha (59 ac)
Rating 7 (Mitigation Sites)	17	109 ha (269 ac)
Non-Floodplain Riparian		
Rating 1	6	272 ha (673 ac)
Rating 2	1	8.5 ha (21 ac)
Rating 3	3	37 ha (92 ac)
Rating 4	2	11 ha (28 ac)
Rating 5	2	28 ha (69 ac)
Rating 6	5	153 ha (377 ac)
Rating 7 (Mitigation Sites)	7	59 ha (146 ac)
Intermittent Streams (Rating 1)		570 km (354 miles)
Water Resources (WR)	12	157 ha (389 ac)
Total of regulated wetlands and WoUS		**917 ha and 570 km (2266 ac and 354 miles)**

the bank full and 4 in the active flood plain. The most frequent and largest units are listed in Table 5.

Of the 21 riparian vegetation types located in the terrace geomorphic surface, most had either a low probability of being a regulated wetland under Section 404 or were uplands (Appendix 3). However, these low probability polygons may have a high probability of being regulated under CDFG's 1600 program. The largest and or most frequent vegetation units in the tertiary were Southern Black Willow, Southern Willow Scrub, Mulefat, and Riparian Herb. There were 80 ha (198 ac) of riparian vegetation considered to be wetlands (Rating of 1, 2 and 3). Additionally there were 85 ha (210 ac) of vegetation types within the riparian corridor considered of lower probability to be a wetland or uplands (Ratings 4, 5, and 6).

Table 5. Largest and most frequent riparian vegetation types in the bank full and active flood plain.			
Type	**Location**	**Frequency**	**Size (ha)**
Perennial rivers and stream	bank full	2	63 (156 ac)
Flood control channels	bank full	71	24 (59 ac)
Southern willow scrub	bank full	12	12 (30 ac)
Southern Arroyo Willow	active flood plain	17	18 (44 ac)
Mulefat	active flood plain	53	13 (33 ac)
Black Willow	active flood plain	18	11 (28 ac)
Southern Willow Scrub	active flood plain	37	15 (37 ac)

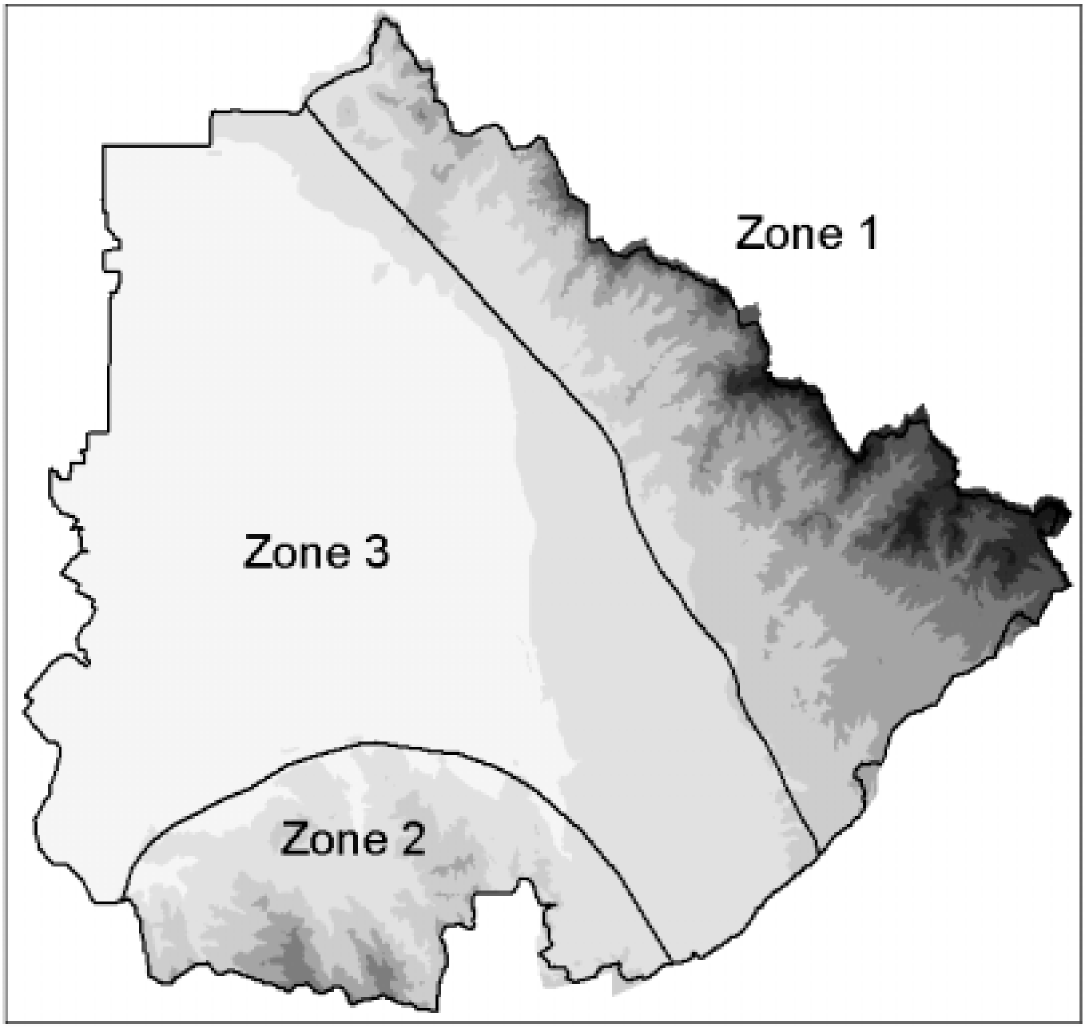
There were 570 km (354 miles) of ephemeral and intermittent stream channels identified as WoUS. These areas were mostly first and second order streams and located higher in the watersheds. The location of these stream channels resulted from some being partially identified on the vegetation type map and the remaining being identified form our stereoscoping efforts.

5.6 Distribution patterns of riparian vegetation types

Several distribution patterns of the riparian vegetation types were observed within the three major topographic relief zones within the study area. These general distribution patterns are shown in Figure 4. Examples of various vegetation units are shown (Table 6) along with brief comments. Codes for riparian vegetation community types are provided in Appendix 1.

Wetland vegetation distribution patterns within the San Diego Creek watershed are driven by two major features in Figure 4. These are human development and major landforms associated with topographic positions. Riparian vegetation units in Zone 1 (mountainous) reaches of the watershed are less impacted from human development than those in lower reaches. In the higher elevations of the watersheds the riparian vegetation types are associated with rocky to gravelly channel substrates. Upland chaparral vegetation types are common in these reaches since the ephemeral and intermittent stream channel areas are dry most of the time. Most of these vegetation types are dominated by upland species except for Southern Willow Scrub (7.2), which does have hydrophytic species. In contrast, the lower elevations of the watersheds in both Zones 2 and 3 where there is an increase in hydrology, flood plain terraces, and culturally influenced hydrology regimes, the number of wetland type vegetation units increases. The disturbance types such as Flood Control Channels (14.4) and Southern Arroyo Willow riparian forest (7.2) are located in areas below discharge points for storm water from human developments or in association of agricultural field and urban

Figure 4. Topographic relief of San Diego Creek watershed DEM. The major topographic zones are delineated.



development. Generally, most of the larger and wetter wetland areas are located in the lower parts of the watersheds where human influences are prevalent. Watersheds such as Borrego, Sand Canyon, and San Diego Creek have frequent occurrences of these wetland vegetation units. Plant species compositions in these types are mostly wetland plants except those associated with the Riparian Herb (7.1) unit. The Sycamore woodlands that are located in parts of Zone 2 and 3 are located in dry upland terraces with very little wetland features. The conversions of Sycamore woodlands to pastures are common here.

In most of the watershed, one of the several types of Willow units is the dominant vegetation type found on the terraces. These types are located mostly along the edges of the active flood plain or on the terrace. At some locations the level of introduced species are lower and the site is less disturbed, but overall it appears

Table 6. Major Vegetation Distribution Patterns by Zones.		
Zones	**Major Landform**	**Units and Comments**
Zone 1	Mountainous	Coastal Live Oak (8.1), Southern Coast Live Oak (7.5), intermittent channels (12.1), Southern Willow Scrub (7.2); most areas were first or second order streams with poor development of flood plain terraces
Zone 2	Coastal Foothills	Southern Arroyo Willow (7.6), intermittent channels (12.1), Southern Black Willow (7.7), Sycamore Woodlands (7.4), Southern Willow Scrub (7.2); development of some flood plain terraces; mixed active flood plains with flood plain terraces
Zone 3	Central Flats	Fresh Water Marsh (6.4), Riparian Herb (7.1), Southern Willow Scrub (7.2), Southern Arroyo Willow (7.6), perennial rivers and stream (13.1), and flood control channels (13.4); highly modified for agricultural and urban development purpose

that the Willow communities have been able to either adapt or respond to all the human modification. Along some of the sections of Barranca and San Diego Creek where there are concrete lined channels for flood control structures, Willow communities have been able to maintain themselves without a flood palin terrace. Some of these areas in the lower reaches have been designated mitigation sites. In many of the mitigation sites, he occurrence of hydrophytic species tends to drop off and most of the soils are considered non hydric.

The fresh water marsh type is dominated by man-made features. Most of these wetland types have occurrences of Tule (*Scirpus californicus*), Cattail (*Typha latifolia*), and Spike Rush (*Eleocharis macrostachya*). Each of these species are indicators of disturbances and reflect the altered wetland conditions they are located in. Most of the features associated with this type are settling ponds, abandoned barrow pits, and margins of man made reservoirs located throughout the watershed.

The most dramatic impact to wetlands and flood plain riparian systems has been the agricultural and human developments that occurred within the watershed. In Zone 3, most of the historical flood plains and wetlands have been eliminated and replaced with concrete line channels. This elimination of flood plains terraces in these reaches limited our mapping of wetlands to the top of the control channel. Any wetland vegetation within the channel was not mapped since we could not determine the hydrogeomorphic surfaces. However in the lower most reaches of San Diego Creek where the control channel is broad enough to allow for some similar development of flood plain terraces within the channel, we separated out both the vegetation and recently developed terraces.

Mitigation sites and the constructed wetlands associated with flood control channels were mapped separately. A database for these types was built with consultation with current and former LA District employees. Using location data supplied in addition to those encountered in the field, 17 mitigation sites were mapped. Many of these sites were mapped by using GPS technology in the field because they were hard to distinguish from the adjacent upland vegetation types.

In general, the riparian vegetation within the flood plain and terrace at San Diego Creek watershed are associated with modified flood control channels or human developed features. Due to modifications in the watershed for enhanced runoff, flood control and agricultural usage, the flood plain terraces have been greatly reduced in their ability to act as a functional part of the flood plain. Historically, more of the terrace may have been considered wetlands (under Section 404 criteria), than has been currently determined. Vegetation types such as Mulefat (7.3) are typically common within the active flood plain and parts of the terrace in this part of southern California. Within San Diego Creek watershed, these occurrence have been reduced in frequency as a result of modifications in the flood plains.

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Appendix 1 Holland Vegetation codes used in the study and their common names

Holland Vegetation Codes	Common Name
20600	Floodplain Sage Scrub
30100	Coastal Sage-Chaparral Scrub Ecotone
40100	Annual Grassland
40600	Ruderal
50300	Freshwater Seep
50400	Freshwater Swale
60100	Southern Coastal Salt Marsh
60400	Coastal Freshwater Marsh
70100	Riparian Herb
70200	Southern Willow Scrub
70300	Mulfat Scrub
70400	Southern Sycamore Riparian Woodland
70500	Southern Coast Live Oak Riparian Forest
70600	Southern Arroyo Willow Forest
70700	Southern Black Willow Forest
70800	Southern Cottonwood-Willow Riparian Forest
71000	Canyon Live Oak Ravine Forest
71200	Salix Exiqua
71300	Eucalytus
80100	Coast Live Oak Woodland
120100	Open Water
120200	Fluctuating Shorelines
120300	Spreading Grounds and Detention Basins
130100	Perennial Rivers and Streams
130200	Intermittent Streams and Creeks
130300	Ephemeral Drainages and Washes
130400	Flood Control Channels
140300	Vineyards and Orchards
150100	Urban
150500	Parks and Ornamental Plantings
160100	Cleared or Graded Areas

Appendix 2: Ratings for non-floodplain and floodplain riparian vegetation

Common Name	Floodplain Riparian Rating	Non Floodplain Riparian Rating
Floodplain Sage Scrub	5	0*
Coastal Sage-Chaparral Scrub Ecotone	6	0
Annual Grassland	6	6
Ruderal	6	0
Coastal Freshwater Marsh	1	1
Riparian Herb	5	5
Southern Willow Scrub	2	3
Mulfat Scrub	3	4
Southern Sycamore Riparian Woodland	4	5
Southern Coast Live Oak Riparian Forest	6	6
Southern Arroyo Willow Forest	2	3
Southern Black Willow Forest	2	2
Canyon Live Oak Ravine Forest	6	0
Eucalytus	6	0
Coast Live Oak Woodland	5	6
Spreading Grounds and Detention Basins	1	3
Perennial Rivers and Streams	1	0
Flood Control Channels	1	1
Urban	6	0
Cleared or Graded Areas	6	6
Parks and Ornamental Plantings	0	6
Ephemeral Drainages and Washes	0	1
Intermittent Streams and Creeks	0	1
Open Water	0	1
Freshwater Seep	0	1

* O refers to the type does not occur in the category.

Appendix 3: Frequency and area of riparian vegetation community types on the terrace geomorphic surface

Wetland Rating	Riparian Vegetation Community Type	Frequency	Acres	Hectares
Rating 1	Coastal Freshwater Marsh	1	1.2692	0.51
	Perennial Rivers and Streams	3	56.7886	22.98
	Flood Control Channels	12	26.6032	10.76
	Coastal Freshwater Marsh	7	2.2635	0.9
Rating 2	Southern Willow Scrub	29	38.5478	15.58
	Southern Arroyo Willow Forest	8	12.545	5.07
	Southern Black Willow Forest	18	40.7599	16.49
Rating 3	Mulfat Scrub	20	16.4488	6.66
Rating 4	Southern Sycamore Riparian Woodland	15	9.4163	3.8
Rating 5	Coast Live Oak Woodland	5	1.5999	0.65
	Riparian Herb	30	72.3529	29.29
	Coast Live Oak Woodland	1	0.1361	0.06
Rating 6	Urban	1	0.9911	0.4
	Cleared or Graded Areas	2	1.205	0.49
	Coastal Sage-Chaparral Scrub Ecotone	2	0.9414	0.39
	Annual Grassland	6	9.8033	3.97
	Ruderal	3	17.2425	6.98
	Southern Coast Live Oak Riparian Forest	7	8.2587	3.34
	Canyon Live Oak Ravine Forest	2	0.4643	0.19
	Eucalytus	5	19.9909	8.1
Rating 7	Ruderal	4	35.1037	14.21
	Southern Willow Scrub	1	4.4181	1.79
	Mulfat Scrub	6	20.3312	8.23
	Southern Black Willow Forest	1	1.6518	0.67
	Southern Cottonwood-Willow Riparian Forest	3	3.2914	1.34

Appendix 4: Frequency and area of riparian vegetation community types on the bankfull channel geomorphic surface

Riparian Vegetation Community Type	Frequency	Acres	Hectares
Ruderal	1	0.2299	0.09
Freshwater Seep	1	0.652	0.26
Coastal Freshwater Marsh	15	16.5139	6.68
Riparian Herb	5	12.5904	5.09
Southern Willow Scrub	12	30.1279	12.19
Mulfat Scrub	15	13.1189	5.31
Southern Sycamore Riparian Woodland	1	0.5022	0.2
Southern Coast Live Oak Riparian Forest	1	0.122	0.05
Southern Arroyo Willow Forest	8	12.837	5.2
Southern Black Willow Forest	4	3.6726	1.49
Salix Exiqua	2	0.486	0.2
Open Water	6	70.9993	28.73
Spreading Grounds and Detention Basins	19	47.8925	19.38
Perennial Rivers and Streams	2	156.0371	63.15
Intermittent Streams and Creeks	5	17.8039	7.22
Ephemeral Drainages and Washes	29	40.9987	16.61
Flood Control Channels	71	59.3962	24.05

Appendix 5: Frequency and area of floodplain riparian vegetation by type.

Riparian Vegetation Community Type	Frequency	Acres	Hectares
Annual Grassland	3	0.3553	0.14
Freshwater Swale	1	0.1211	0.05
Southern Coastal Salt Marsh	1	0.1585	0.06
Coastal Freshwater Marsh	10	14.2624	5.76
Riparian Herb	23	25.852	10.46
Southern Willow Scrub	37	37.2691	15.08
Mulfat Scrub	53	33.3938	13.53
Southern Sycamore Riparian Woodland	1	0.081	0.03
Southern Coast Live Oak Riparian Forest	2	10.0571	4.07
Southern Arroyo Willow Forest	17	43.7073	17.67
Southern Black Willow Forest	18	27.6604	11.18
Salix exiqua	2	0.9609	0.39
Coast Live Oak Woodland	1	0.3117	0.13
Fluctuating Shorelines	2	5.0742	2.05
Perennial Rivers and Streams	1	0.3418	0.14
Ephemeral Drainages and Washes	8	5.0458	2.04
Flood Control Channels	7	1.7836	0.73

Appendix 6: Frequency and area of the non-riparian vegetation by type.

Wetland Rating	Non-Floodplain Riparian Vegetation Community Type	Frequency	Acres	Hectarcs
Rating 1	Open Water	79	313.3475	126.79
	Intermittent Streams and Creeks	3	14.7207	5.96
	Ephemeral Drainages and Washes	3	14.6919	5.94
	Flood Control Channels	23	103.722	41.95
	Freshwater Seep	1	0.1245	0.05
	Coastal Freshwater Marsh	20	226.1819	91.53
Rating 2	Southern Black Willow Forest	10	21.0564	8.52
Rating 3	Spreading Grounds and Detention Basins	11	44.4873	18.01
	Southern Willow Scrub	21	32.6286	13.19
	Southern Arroyo Willow Forest	6	14.699	5.94
Rating 4	Mulefat Scrub	23	28.0243	11.33
	Salix exiqua	1	0.3883	0.16
Rating 5	Riparian Herb	11	19.0108	7.69
	Southern Sycamore Riparian Woodland	15	50.2677	20.35
Rating 6	Parks and Ornamental Plantings	2	1.7967	0.73
	Cleared or Graded Areas	1	0.2709	0.11
	Annual Grassland	2	9.1273	3.69
	Southern Coast Live Oak Riparian Forest	26	111.7326	45.23
	Coast Live Oak Woodland	52	254.4062	102.95
Rating 7	Vineyards and Orchards	1	16.9202	6.85
	Annual Grassland	3	24.7272	10
	Coastal Freshwater Marsh	3	45.5409	18.43
	Riparian Herb	4	4.3041	1.74
	Southern Sycamore Riparian Woodland	1	5.9052	2.39
	Southern Black Willow Forest	1	40.684	16.46
	Southern Cottonwood-Willow Riparian Forest	5	8.0042	3.24

Appendix 7. Aquatic Resources Delineation Figures.

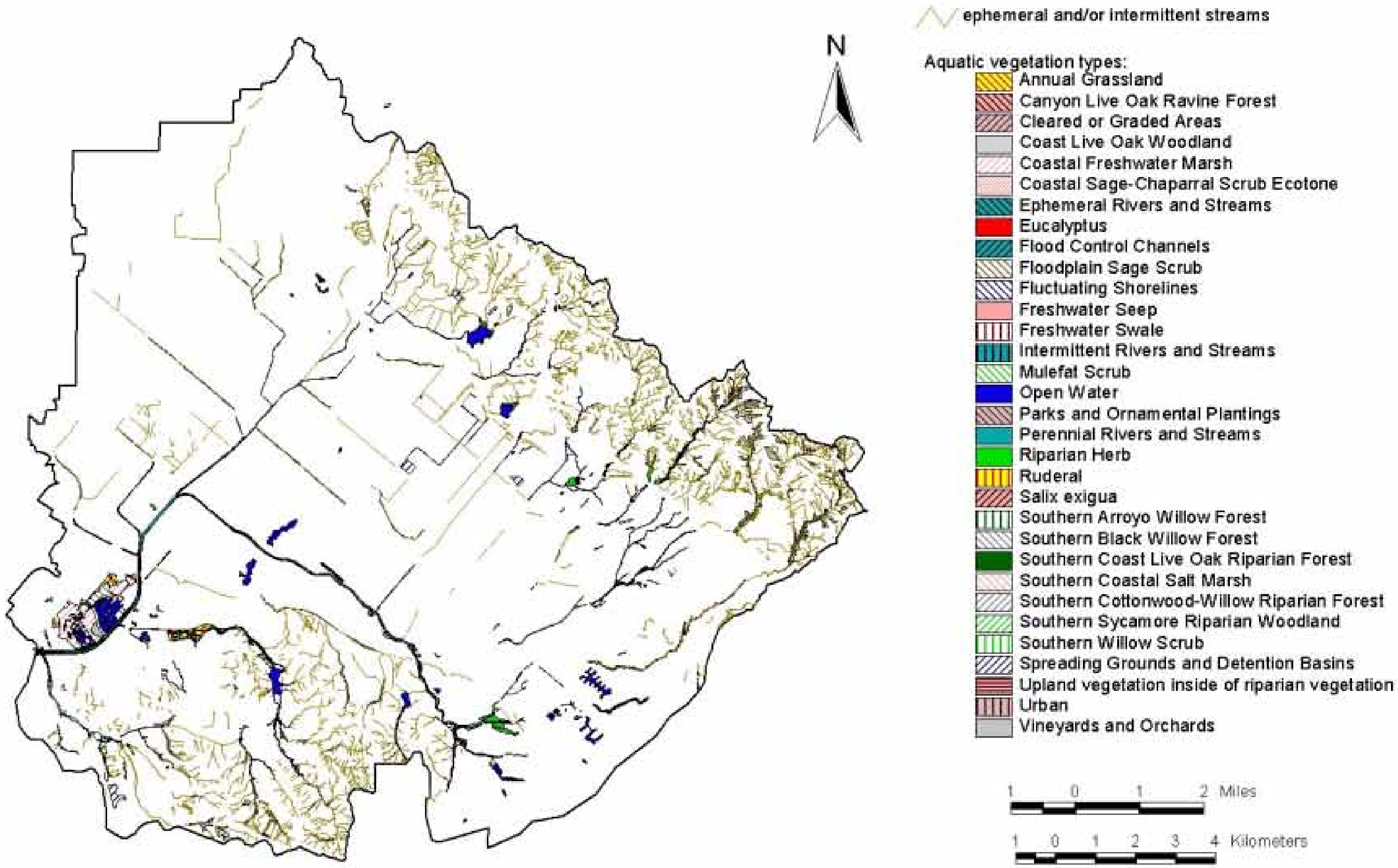


Figure 1. Vegetation types for the San Diego Creek Watershed

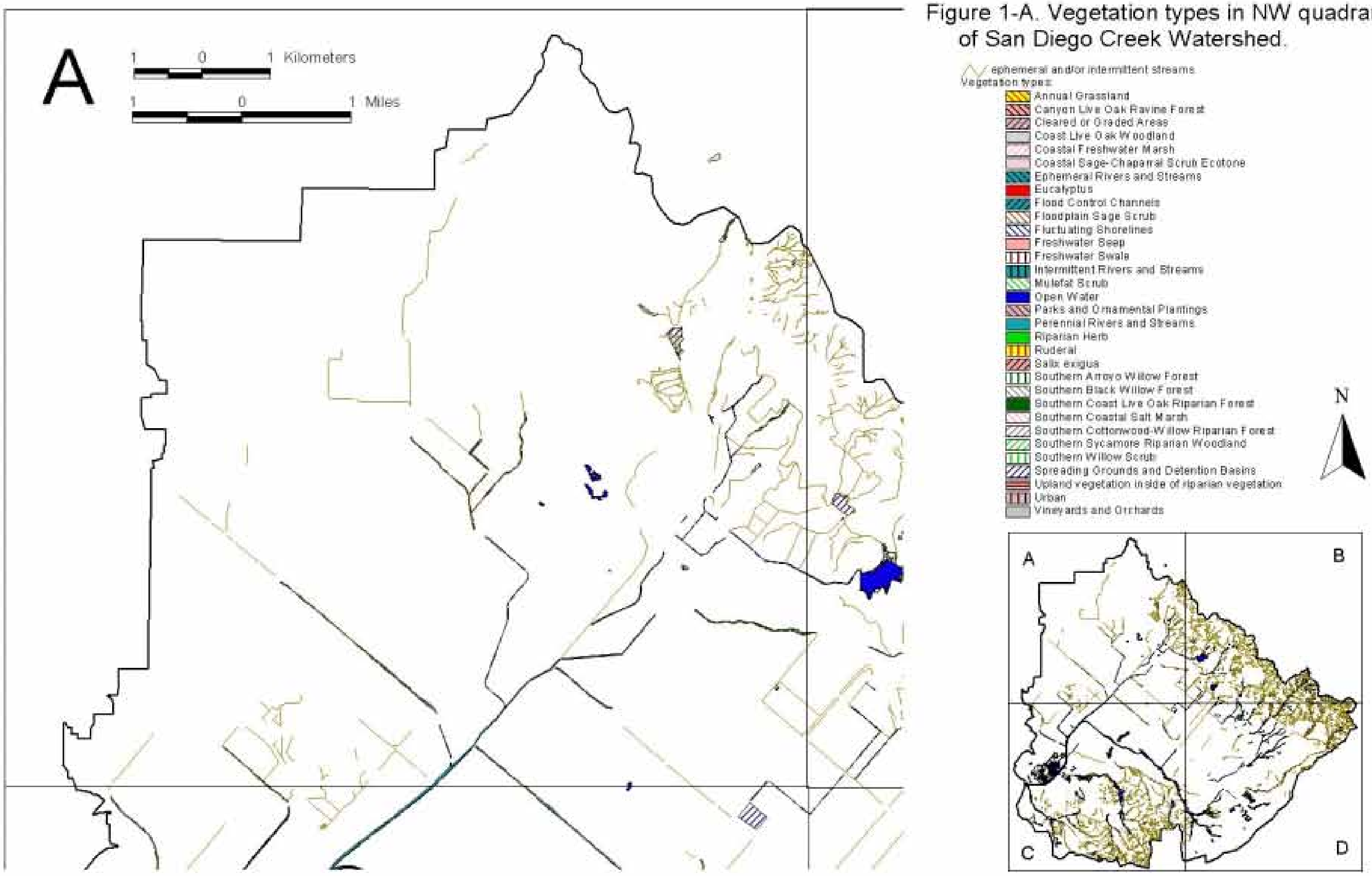
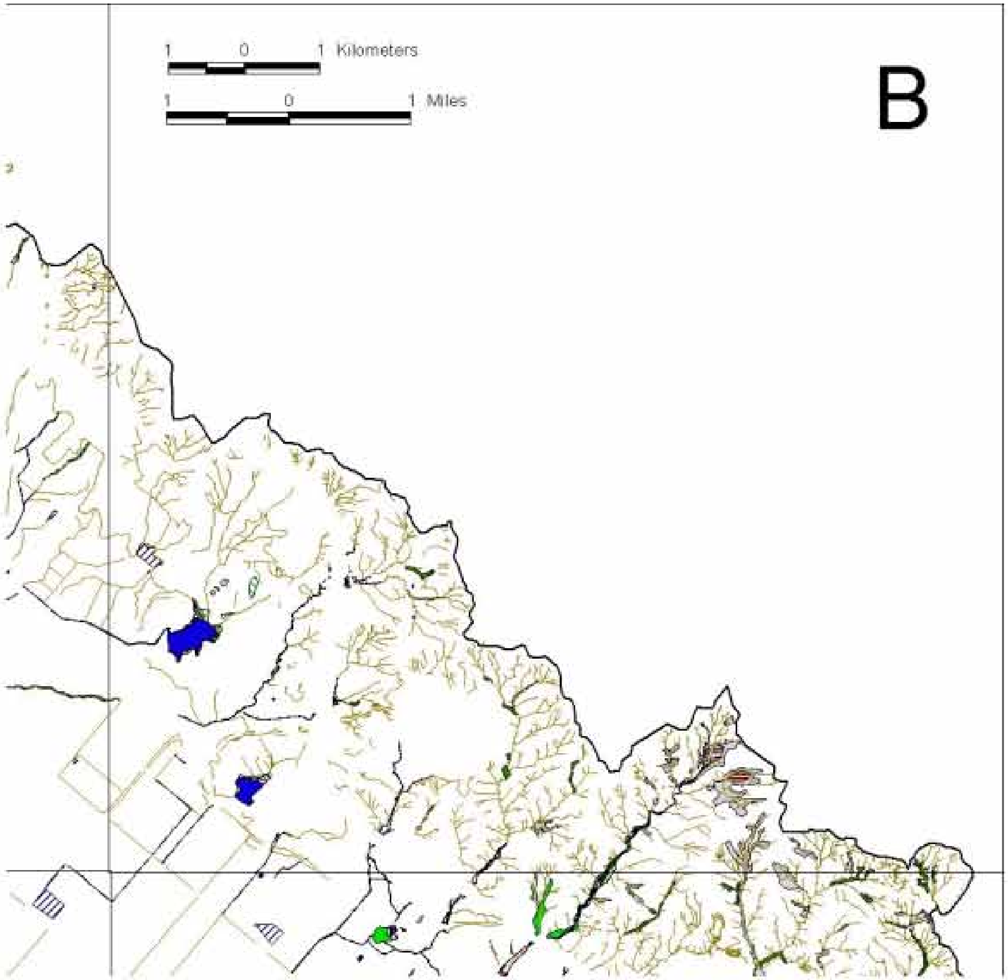


Figure 1-A. Vegetation types in NW quadrant of San Diego Creek Watershed.

Figure 1-B. Vegetation types in NE quadrant of San Diego Creek Watershed.



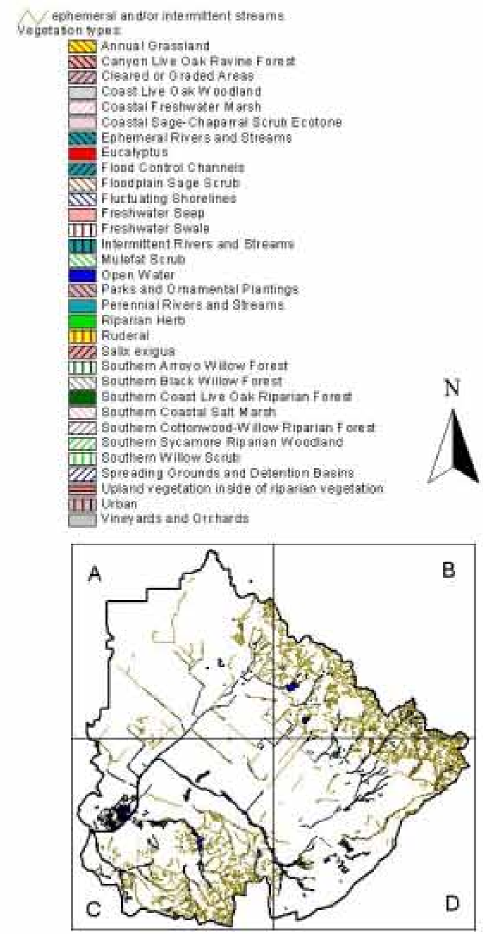


Figure 1-C. Vegetation types in SW quadrant of San Diego Creek Watershed.

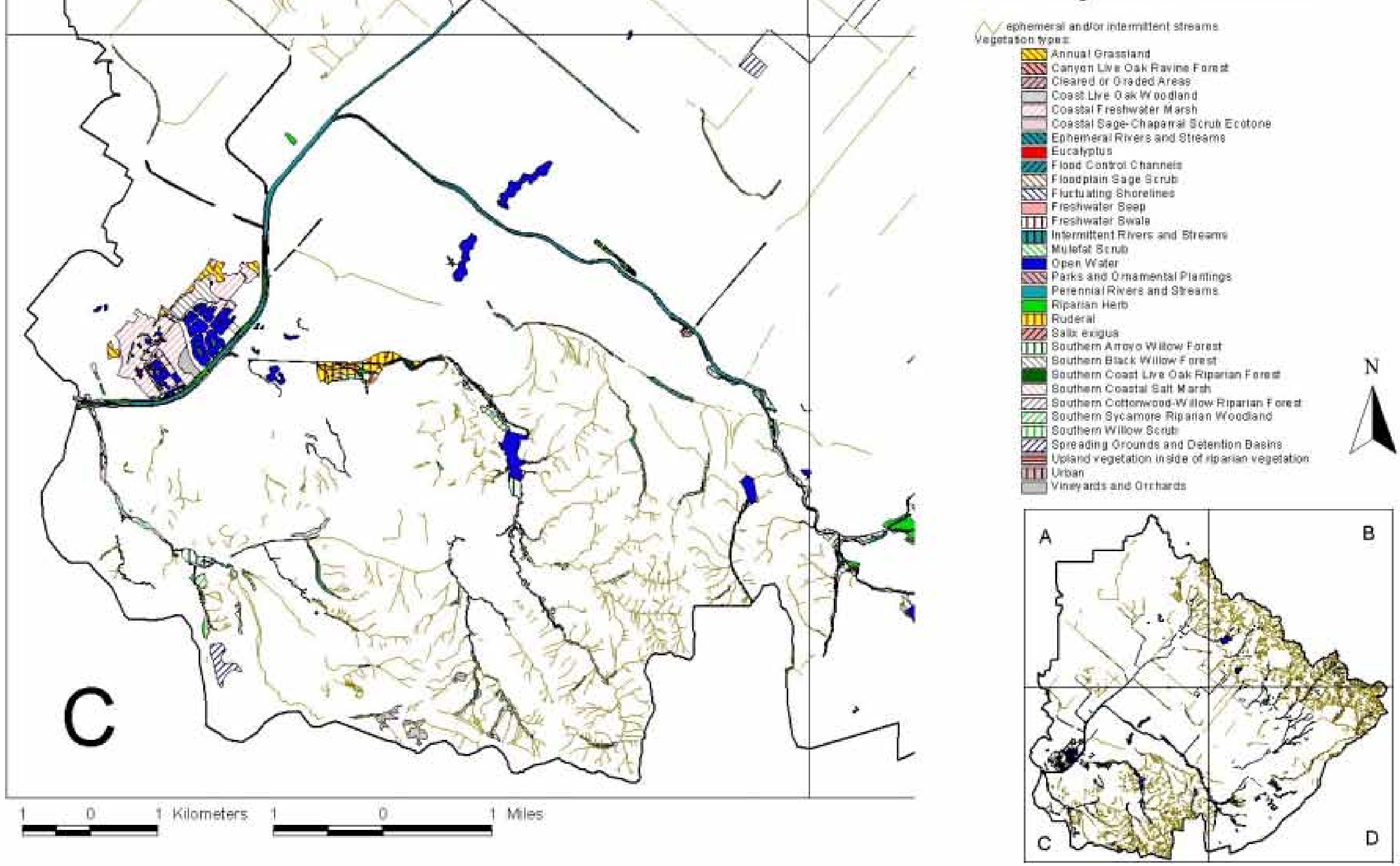
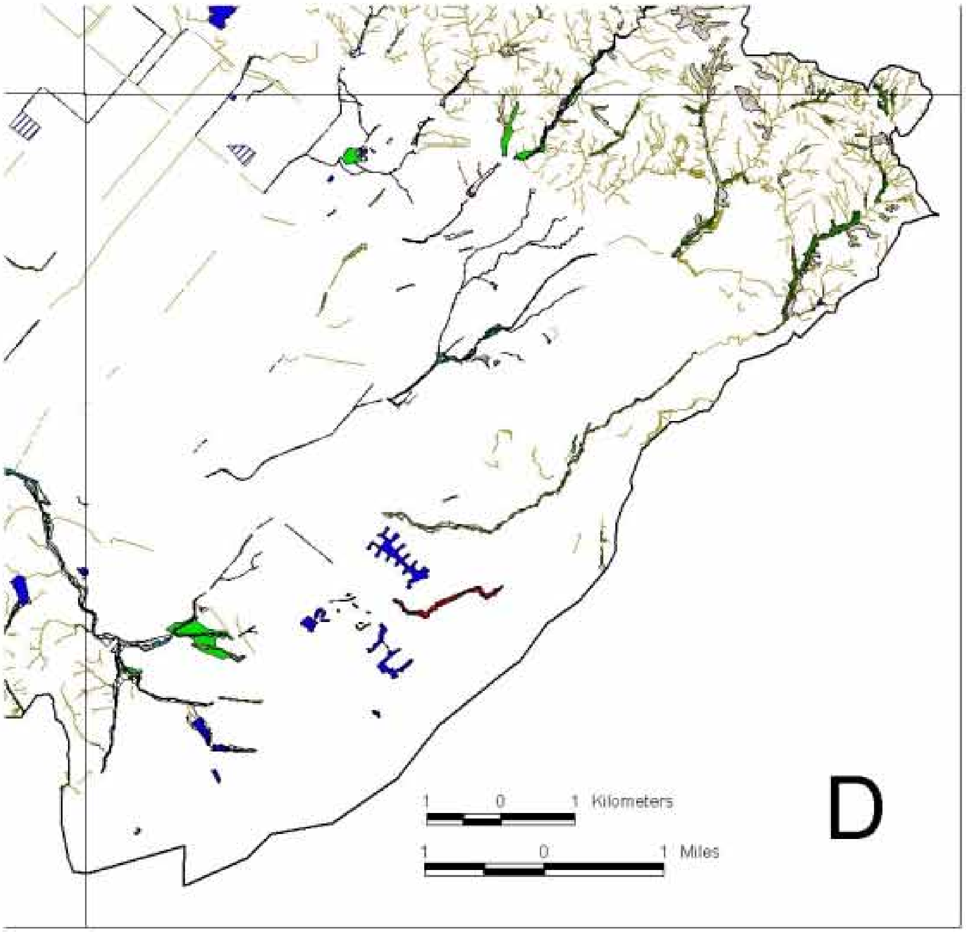
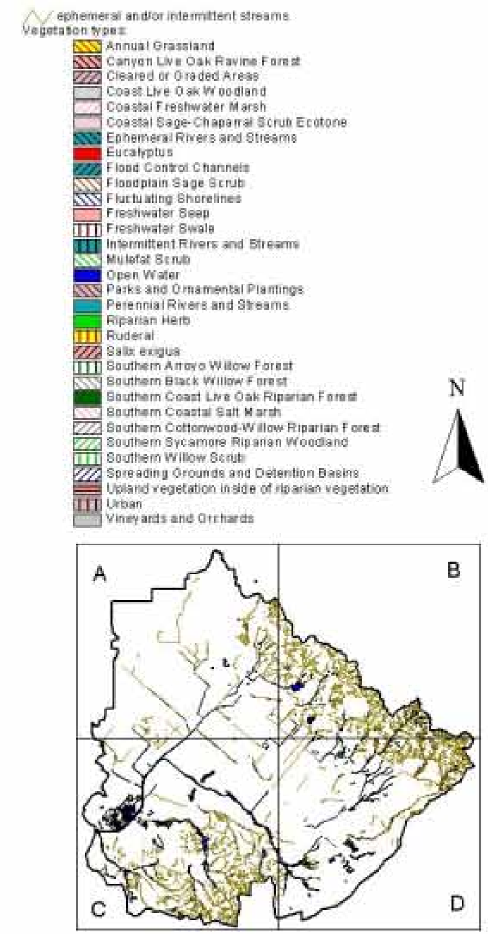


Figure 1-D. Vegetation types in SE quadrant of San Diego Creek Watershed.





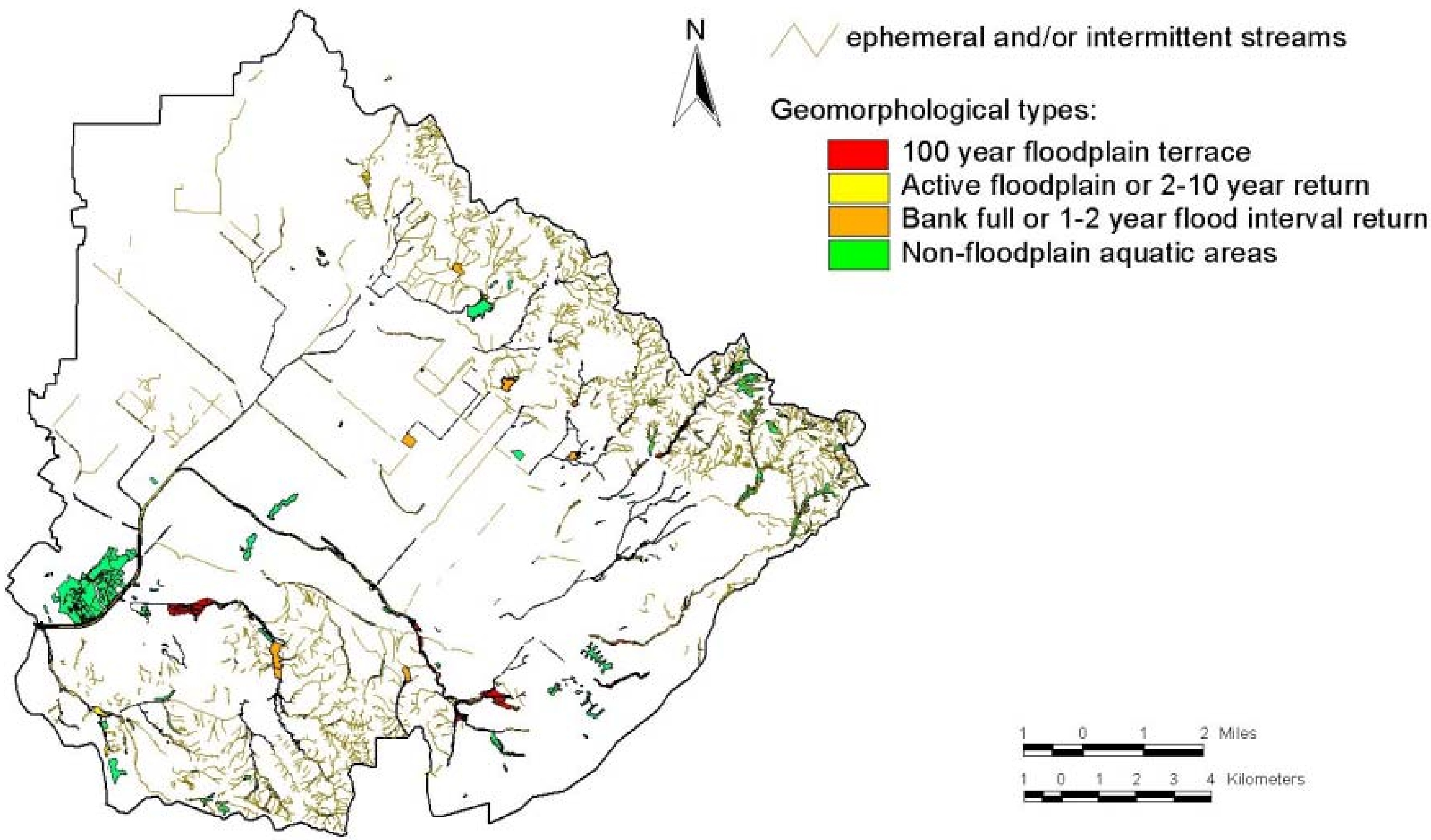


Figure 2. Geomorphology types for the San Diego Creek Watershed

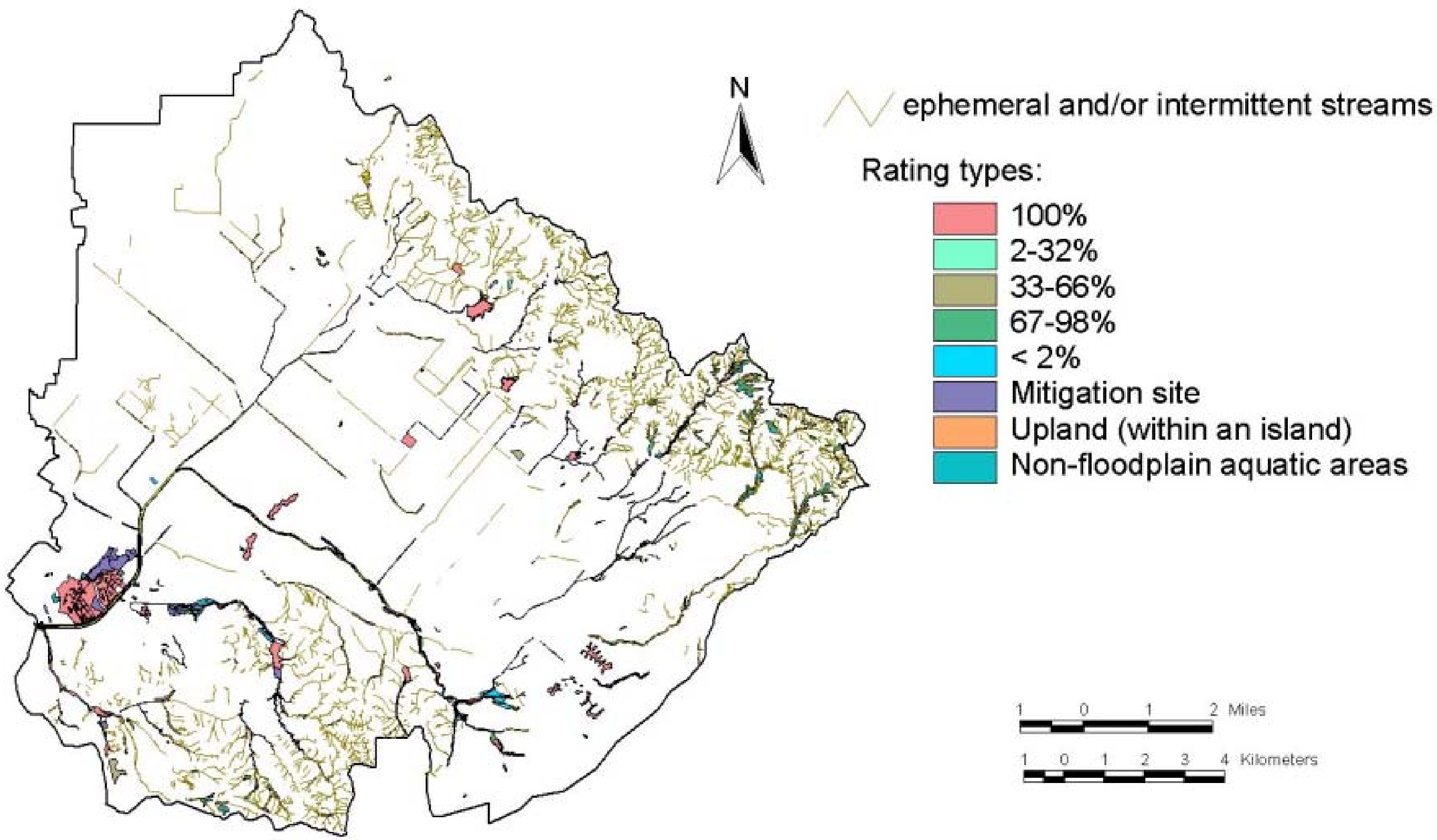


Figure 3. Rating types for the San Diego Creek Watershed