US Army Corps
of Engineers
Los Angeles District

Los Angeles County
Department of Public Works

ARROYO SECO WATERSHED ECOSYSTEM RESTORATION STUDY LOS ANGELES COUNTY, CALIFORNIA





FEASIBILITY SCOPING MEETING DOCUMENTATION (FINAL)

AUGUST 2011

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ECOSYSTEM RESTORATION STUDY
LOS ANGELES COUNTY, CALIFORNIA

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(FINAL)

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AUGUST 2011

COVER SHEET

Feasibility Scoping Meeting Documentation (Final)

Arroyo Seco Watershed Ecosystem Restoration Study
Los Angeles County, California

The responsible lead Federal agency for this study is the U.S. Army Corps of Engineers (Corps), Los Angeles District. The non-Federal sponsor for this study is the Los Angeles County Department of Public Works, California. This report provides documentation of the initial steps of the plan formulation process carried out to develop the watershed plan for the study area.

Abstract: This Feasibility Scoping Meeting Documentation presents an inventory of existing conditions and a forecast of future without-project conditions within the Arroyo Seco study area. The study area is an approximate 11-mile reach of the lower Arroyo Seco located in central Los Angeles County. The study area extends from the Angeles National Forest border through the unincorporated area of Altadena, and cities of La Cañada Flintridge, Pasadena, South Pasadena, and Los Angeles, to approximately 0.5 miles from the confluence with the Los Angeles River.

The primary purpose of the Arroyo Seco Watershed Ecosystem Restoration Study is to identify whether there is a Federal interest in providing solutions to a variety of water and land-related issues in the watershed, including ecosystem degradation, flooding, and poor water quality along the lower Arroyo Seco.

This study is not anticipated to culminate in a decision document to Congress recommending authorization of a Federal project. It will identify candidate "spin-off" feasibility studies that may be carried out to perform detailed analysis of alternatives for selection of a recommended project for each follow-on study. The product of each study effort would serve as a decision document, which is necessary for any project seeking Congressional authorization and implementation with Federal participation.

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SUMMARY

This interim document has been prepared to summarize (1) the findings, results, and data collected for historic and existing conditions in the study area, and to forecast future without-project conditions, pertaining to physical and biological resources, cultural resources, socioeconomics, and recreation; (2) problems, opportunities, objectives, and constraints for the study area; and (3) formulation of preliminary alternative plans.

The purpose of the Arroyo Seco Watershed Ecosystem Restoration Study is to evaluate opportunities for restoring ecosystem function along the 11-mile reach of the Arroyo Seco, which extends from the Angeles National Forest border to approximately 0.5 miles from its confluence with the Los Angeles River.

The objectives of this study are to provide an overview and analysis of Arroyo Seco's water-related resources. Available data was collected and reviewed, and problems and issues were identified. Using this information, candidate "spin-off" projects will be conceptualized and evaluated at a survey level to identify those projects that are most likely to effectively provide ecosystem restoration benefits and that could be implemented to contribute to the overall restoration of the ecological function of the watershed. Each spin-off study will be recommended for feasibility-level study that would develop recommended ecosystem restoration plans.

Without-Project Conditions

The Arroyo Seco watershed is currently suffering from a variety of water resource and related land resource problems. Most of these are related to widespread changes, natural and human-induced, in the watershed. Development and changes in land use in the watershed have drastically altered the natural character of the Arroyo Seco, changing the hydrological regime of the river (shift from permeable landscape to largely impermeable), fragmenting open space, disrupting habitat, reducing water quality, and reducing groundwater recharge opportunities.

The Arroyo Seco is located in one of the most densely populated parts of the country. Two of the most significant alterations to the Arroyo Seco include the construction of Devil's Gate Dam and the channelization of the lower Arroyo Seco. The Arroyo Seco is crossed and bounded by multiple-lane freeways. Parking areas and hardscape are now found in the former floodplain of the stream.

Without significant human efforts to restore the watershed conditions in the Arroyo Seco are likely to worsen. Increasing population will put greater development pressure on the watershed, and opportunities that may now exist to reconnect fragmented habitat types may be lost over time. Human uses of the watershed will increase and further affect both sensitive and general habitat types. Increasing population will increase pressure to develop and divert water supplies that currently provide a small amount of flow through the stream. If remaining habitat continues to be taken over by invasive species and severed from other remaining patches of open space, wildlife and plant species will continue to disappear from this region.

Preliminary Measures and Alternatives

This report lists preliminary alternative measures that address the problems and opportunities identified through the planning process. Measures were organized by broad categories such as: habitat restoration, flood and erosion control, recreation, water quality and conservation, and non-structural measures. Measures carried forward will be combined, in various configurations, to form a preliminary set of alternative plans. These preliminary plans were developed to encompass the broadest range of potential alternatives and intended to be subjected to a more rigorous evaluation. Preliminary plans included developing fish passage and access; floodplain reconnection; invasive plant eradication; reestablishment of native vegetation; wetland restoration; and passive recreation opportunities.

Feasibility Study Documentation Process

Future interim documents that will be released during the course of this feasibility study will include a report summarizing alternatives formulation and evaluation, and identification of the candidate spin-off studies. More detailed analysis to include engineering modeling, habitat assessment and modeling, economic analysis, and impact assessment will be completed for each spin-off project carried forward. The product of each study effort would serve as a decision document, which is necessary for any project seeking Congressional authorization and implementation with Federal participation. In addition, each spin-off project would include the appropriate National Environmental Policy Act and California Environmental Quality Act documentation and compliance to all pertinent laws, regulations, and Executive Orders prior to any construction work being completed.

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Note to reader: An asterisk (*) in the sections, as shown on the Table of Contents, refer to sections that are required for compliance with the National Environmental Policy Act.

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1.0 STUDY INFORMATION

1.1 STUDY AUTHORITY

This report was prepared as an interim response to the Senate Resolution approved on June 25, 1969, which reads as follows:

> *"Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby requested to review the report of the Chief of Engineers on the Los Angeles and San Gabriel Rivers and Ballona Creek, California, published as House Document Numbered 838, Seventy-sixth Congress, and other pertinent reports, with a view to determining whether any modifications contained herein are advisable at the present time, in the resources in the Los Angeles County Drainage Area."*

1.2 PURPOSE AND SCOPE

The Arroyo Seco Watershed Ecosystem Restoration Study is being conducted by the U.S. Army Corps of Engineers (Corps), Los Angeles District, in coordination with the non-Federal sponsor, Los Angeles County Department of Public Works (LACDPW), California. The study covers the 11-mile reach of the Arroyo Seco that extends from the Angeles National Forest (ANF) border to the Corps' Los Angeles River Ecosystem Restoration Feasibility Study (hereinafter LA River Study) limits, approximately 0.5 miles from its confluence with the Los Angeles River.

The primary purpose of the study is to identify whether there is a Federal interest in identifying solutions to a variety of water and land-related issues in the watershed, including ecosystem degradation, flooding, and poor water quality along the lower Arroyo Seco. This study will present findings from the assessment of without-project conditions, develop and evaluate stand-alone measures, and later, groups of measures developed as alternative plans.

The ecosystem restoration study will identify up to six candidate "spin-off" studies that can be pursued under specific Corps project authorization programs tailored for the size and complexity of each potential project. The product of each study effort would serve as a decision document, which is necessary for any project seeking Congressional authorization and implementation with Federal participation. Each spin-off project carried forward identified in this watershed study would provide the appropriate National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) documentation, including compliance with all laws and regulations such as the Clean Air Act (CAA), Clean Water Act (CWA), Endangered Species Act (ESA), Migratory Bird Treaty Act (MBTA), and Executive Orders (EO) prior to any construction work being completed.

This Feasibility Scoping Meeting (FSM) document has been prepared to summarize (1) the findings, results and data collected for historic and existing conditions in the study area, and to forecast future without-project conditions, pertaining to physical and biological resources, cultural resources, socioeconomics, and recreation; (2) identified problems, opportunities,

objectives, and constraints for the study area; and (3) formulation of preliminary alternative plans. Technical appendices are provided under a separate cover.

1.3 LOCATION OF THE STUDY AREA

The study area encompasses the lower portion of the Arroyo Seco that extends approximately 11 miles from the ANF border to approximately 0.5 miles from its confluence with the Los Angeles River (Figure 1.1). The downstream boundaries of the study area correspond to the limits of another ongoing Corps feasibility study effort, the LA River Study.

The study area is located in central Los Angeles County and lies within the cities of Los Angeles, South Pasadena, Pasadena, La Cañada Flintridge, as well as the unincorporated area of Altadena (Figure 1.2). Approximately 14.1 percent of the study area lies within the unincorporated area of Los Angeles County; 24.9 percent within La Cañada Flintridge; 32.0 percent within Pasadena; 3.3 percent within South Pasadena; and 25.7 percent within Los Angeles.

In August 26, 2009, the Station Fire started in the ANF approximately four miles north of La Cañada Flintridge along the Angeles Crest Highway (SR-2). The fire was the largest fire in the recorded history of the ANF (est. 1892) and the 10th largest fire in California since 1933 (Inciweb 2009). The fire burned a total of 161,189 acres, 96 percent of which was on National Forest Service lands. The fire impacted five of the LACDPW's dams and reservoirs, one of which is the Devil's Gate Dam. The fire burned almost the entire watershed of the Devil's Gate Dam (Arroyo Seco Canyon) (LACDPW 2010a). The Station Fire is further discussed in **Chapter 3, Existing and Future-Without Project Conditions**.

1.4 WATERSHED RESOURCES TRENDS

The Arroyo Seco watershed has historically played a significant role in the ecology of the Los Angeles Basin because of its diverse habitat features and as a major tributary to the Los Angeles River. The Arroyo's 22-mile length encompasses a mosaic of the habitat types found in this region. The Arroyo Seco once provided a corridor for wildlife to pass from the lower watershed (here as including and downstream of Hahamongna Basin) to the upper watershed (defined here as being above Hahamongna Basin) in the San Gabriel Mountains. It was also a conduit that would bring cool, clean water necessary to sustain some native fish species, from the upper elevations to the lower basin. Intermittent floods would bring fresh sediment deposits from the highly erodible upper watershed, which would be deposited in the alluvial basin at Hahamongna (see), then slowly make its way downstream, providing spawning gravel for anadromous fish and helping to maintain cool water temperatures. The riparian habitat provided an overstory of riparian plant species including alder, willow, and sycamore trees, and a dense understory of wetland and streamside vegetation. This vegetation and the associated stream and floodplain provided significant habitat for some of the west coast's landmark species, including steelhead trout, the arroyo toad, and the western willow flycatcher.

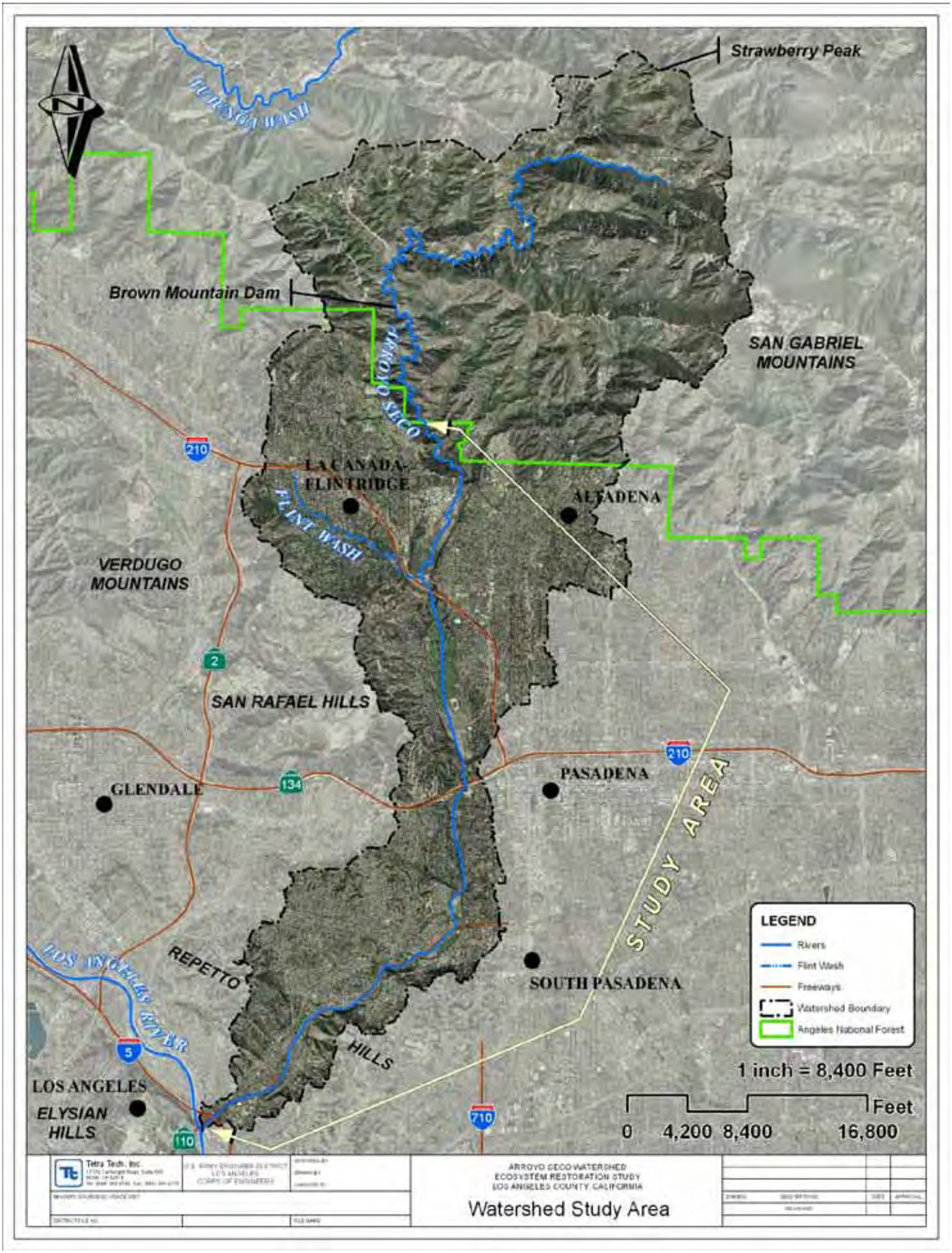

Figure 1.1 Arroyo Seco Watershed

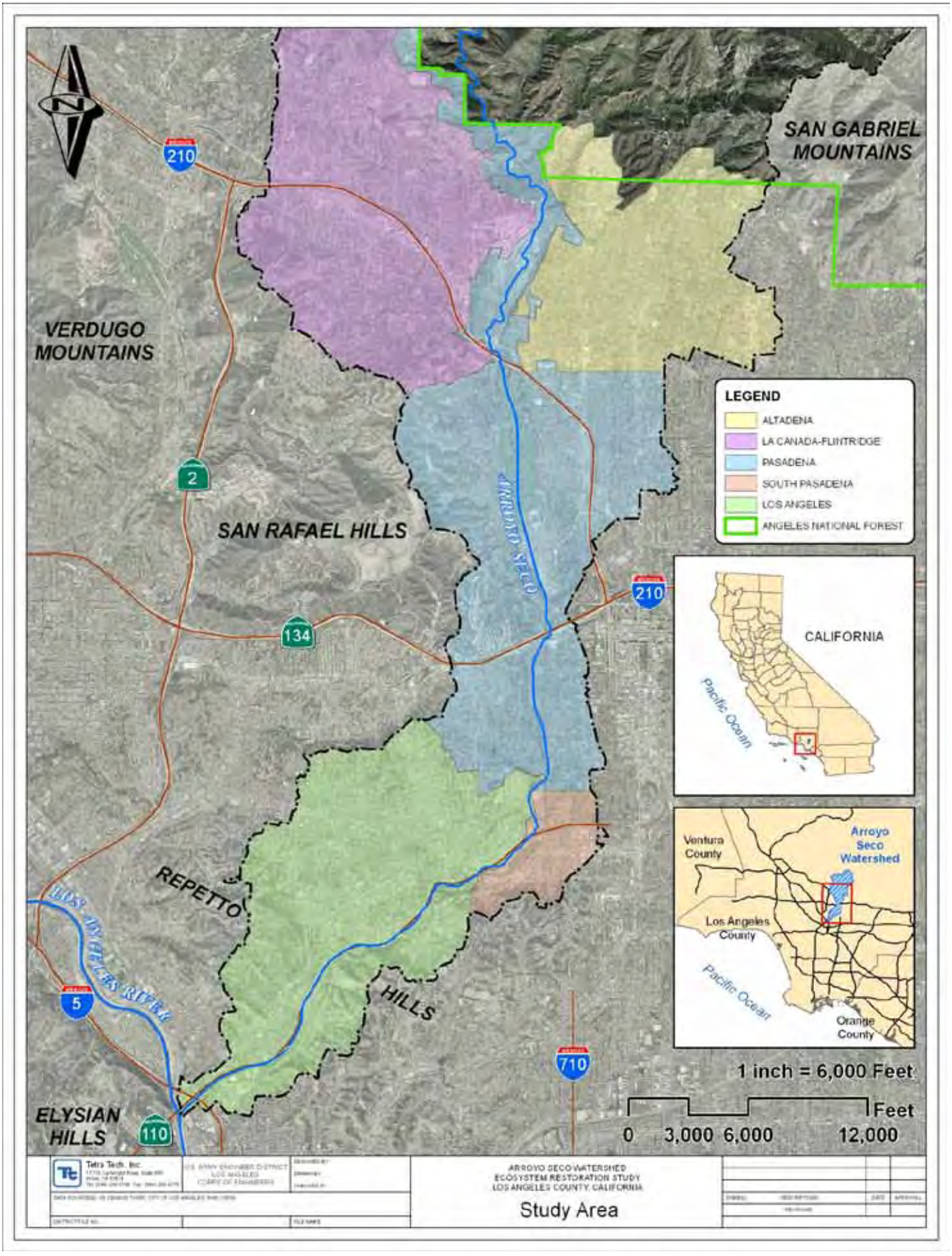

Figure 1.2 Study Area

During the last 150 years the lower and middle watershed have been extensively developed and urbanized. The Arroyo Seco is now located in one of the most densely populated parts of the country. Two of the most significant alterations to the Arroyo Seco include the construction of Devil's Gate Dam and the channelization of the lower Arroyo Seco. The Arroyo Seco is crossed and bounded by multiple-lane freeways. Parking areas and hardscape are now found in the former floodplain of the stream.

Despite these changes, many of the habitat types and important functions the Arroyo Seco once provided are still apparent, attesting to the resiliency of this ecosystem. Riparian vegetation is still found in the lower watershed, although it is limited to a small area below Devil's Gate Dam and the narrow channel above Hahamongna. Sediment is still brought down from the upper watershed, but is largely contained behind the Devil's Gate Dam. Water still flows from the upper watershed to the Los Angeles River, but is warm and polluted by urban runoff. Landmark species may still be found in the habitats in and around the Arroyo Seco, although their habitats are fragmented and disturbed by human activity and invasive species.

1.4.1 Water Development in the Arroyo Seco

Water was the attraction that brought the first settlers and succeeding generations to the Arroyo Seco. While the Spaniards dubbed the watershed Arroyo Seco or "dry streambed," the Tongva or Gabrielino Native Americans referred to the region between the Los Angeles and San Gabriel Rivers as Hahamongna meaning "the land of flowing waters, fruitful valley". These early human inhabitants settled on bluffs overlooking the stream that linked the San Gabriel Mountains to the Los Angeles River (NET-ASF 2002a; Brick 2010).

1.4.1.1 The Mission and Rancho Eras

Settlers entering the region followed the Tongva practice of locating near the Arroyo Seco or near the flowing springs. The San Gabriel Mission, established in 1771, was in part sited to take advantage of the water resources. Significant sources of water for the Mission were the springs and artesian wells created by conditions around the Raymond Fault. The combination of substantial runoff from nearby high mountains, large alluvial volumes to absorb the flood flows and a natural underground dyke that forced groundwater to the surface resulted in perennial springs and artesian wells. Water was hauled by hand from rivers, streams, and from ditches, known as zanjas. The Spanish and Mexican settlers of the early 1800s tapped these rising waters for purposes such as operating a mill, a sawmill, and a tannery in addition to domestic uses (NET-ASF 2002a; Brick 2010).

In 1819, Joseph Chapman, the first Anglo settler in southern California, found lumber to build the old Plaza church and much of the early pueblo of Los Angeles in what he referred to as "Church Canyon," later known as Millard Canyon, a tributary to the Arroyo Seco (Brick 2003). Here, Chapman established the first sawmill on the west coast, indicating the forested nature of the mountains at that time (NET-ASF 2002a). Because the natural rainfall was insufficient to maintain agricultural crops year-round, settlers soon discovered how to tap the springs that provided the perennial flows of the Arroyo Seco. The first orchards, subdivisions, and settlements were made possible by piping water from the numerous springs along this water table

or by driving horizontal tunnels back into the hills to tap the waters held in the immense bed of gravel that fed the aquifer beneath (NET-ASF 2002a; Brick 2003).

1.4.1.2 The Agricultural Period

1846 marked the beginning of the American occupation of California. The Gold Rush, which began in 1848, brought some 300,000 people in California from the rest of the United States and abroad. From this time until California gained statehood in 1850, many Americans from other parts of the country immigrated to California. The surge in population eventually led to a policy of subdividing the Mexican land grants, which further led to the development of towns and intensification of agriculture and ranching to meet the needs of the settlers (NET-ASF 2002a). In 1863, the Los Angeles Water Company was formed (NET-ASF 2002a). The Arroyo Seco provided a major water supply for the growing city of Los Angeles (Brick 2003). In 1870, the Buena Vista Reservoir was built in the hills of Elysian Park immediately west of the confluence of the Arroyo Seco and the Los Angeles River. The reservoir was expanded in the 1880s and other facilities were constructed to tap the river for a rapidly growing population (NET-ASF 2002a).

Around the same time, Benjamin Eaton, who had moved to the Rancho San Pasqual a few years before, experimented with growing grapes without irrigation, something that had never been done before in southern California. Eaton's grapes flourished, and soon the regional demand for grapes and wine increased. However, Eaton realizing the limitations of dry farming in 1867, Eaton helped the owners of the ranch build "Wilson's Ditch," the first attempt to export water from Devil's Gate in the Arroyo Seco to the mesa lands of their rancho (NET-ASF 2002a; Brick 2003). This success led to the eventual immigration of a group of settlers from Indiana in the 1870s. The demands created by these settlers lead to Eaton's development of a water system to serve the colony. The Indiana Colony incorporated the San Gabriel Valley Orange Grove Association, whose main task came to be the development of an adequate water system. When the association sunsetted after 10 years, three land and water companies assumed responsibilities for developing Pasadena and its water system: the Pasadena Land and Water Company (west of Fair Oaks); the Lake Vineyard Land and Water Company (east of Fair Oaks); and the North Pasadena Land and Water Company (2,000 acres of north Pasadena between Lake Avenue and the Arroyo Seco) (NET-ASF 2002a; Brick 2010).

As pumping increased to meet the needs of a growing population, groundwater levels continued to drop. By 1908, 141 wells were in operation in the Pasadena area. In 1914, Pasadena began a spreading program in the Arroyo Seco and along the foothills to replenish the Raymond Basin by percolating storm runoff through gravel beds (NET-ASF 2002a; Brick 2010). The program was discontinued in 1924 in the midst of a drought. The spreading was later revived and now is a major factor in replenishing the Raymond Basin (NET-ASF 2002a).

1.4.1.3 Urban/Suburban Period

Los Angeles grew to be one of the largest cities in the United States in size and population largely due to its tight hold on water supplies. In 1899, the Arroyo Seco communities of Highland Park and Garvanza voted to annex to Los Angeles for this reason. The community of Arroyo Seco followed within a few years. Later, when the river supply proved insufficient,

communities such as Eagle Rock were forced to annex to Los Angeles to obtain the imported supplies from the Owens Valley. When the Metropolitan Water District was formed (in 1928) to bring the Colorado River to southern California's coastal plain, the pressures of annexation to Los Angeles ceased (NET-ASF 2002a; Brick 2010).

Nearly every portion of the lower Arroyo Seco is heavily developed and some of the Los Angeles region's densest neighborhoods can be found in the southern portion of the Arroyo Seco in the City of Los Angeles. The Arroyo Seco has been channelized, dammed, and obstructed at multiple locations. The west coast's first freeway, the Arroyo Seco Parkway (Photo 1.1) (HABS/HAER 2010), was built in the Arroyo Seco floodplain directly adjacent to the channel and has been a critical transportation link between the San Gabriel Valley and downtown Los Angeles since 1940. Also known as the Pasadena Freeway, the Arroyo Seco Parkway was designated as a National Scenic Byway by the Federal Highway Administration in 2002, from Glenarm Street in Pasadena to US 101 (Figure 1.3) (NSBP 2010).

1.4.2 Current Trends

The natural and cultural histories of the Arroyo Seco watershed are closely intertwined as the landscape shaped human settlement and the management of the land by people altered the environment. These natural and human-induced modifications have resulted in impairments to the flows of water, sediment, and habitat in the watershed.

The Arroyo Seco represents an outstanding opportunity for the region to demonstrate a collaborative, multi-purpose approach to the management of vital natural resources. For more than 100 years, the great natural beauty of the Arroyo Seco and its proximity to a large urban population has inspired efforts to protect and preserve it. A great deal of public and political support has been expressed for restoration within the watershed, as evidenced by the number of community-scale restoration plans that have been proposed by various stakeholders. Concerned citizens, non-profit organizations, and others have partnered with local, state, and Federal governments for the development of watershed-wide studies (see Section 1.5) and implementation of projects. Recent studies have focused on water quality within the watershed, groundwater recharge in the Raymond Basin, flooding damages, recreational opportunities, and loss of fish and wildlife habitat.

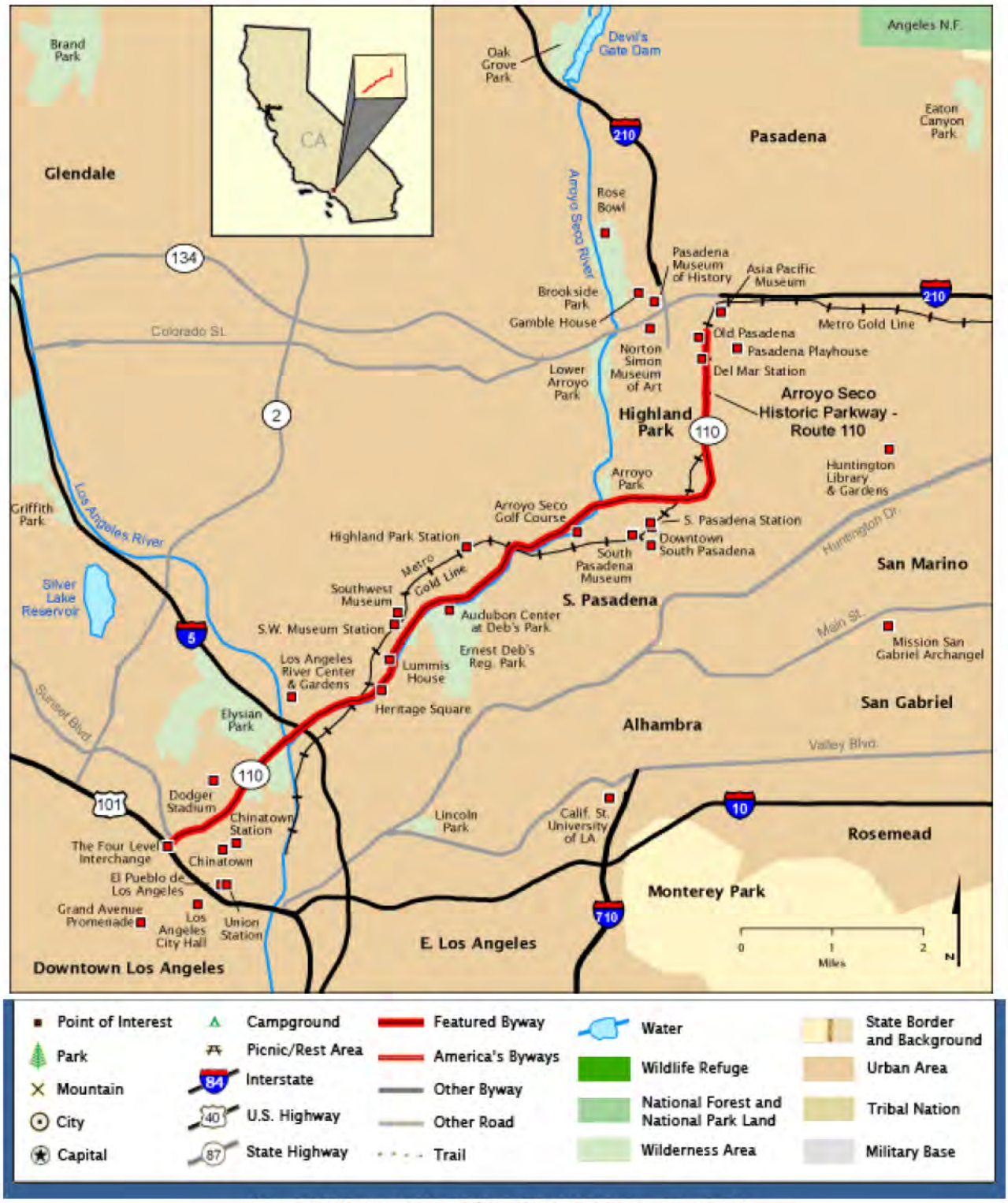

Figure 1.3 Arroyo Seco Parkway Scenic Byway - Route 110

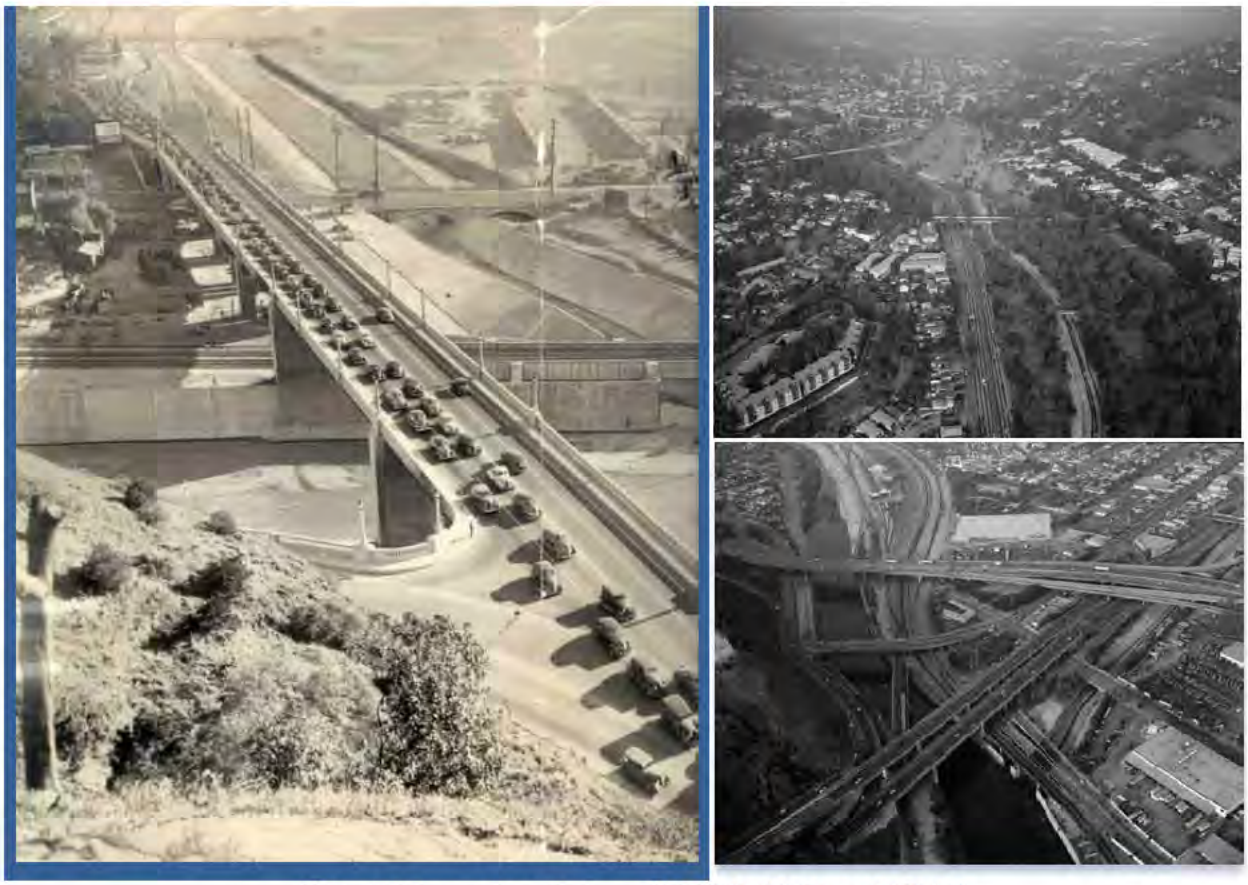

Photo 1.1 Arroyo Seco Parkway (1941) (Left); Present (Right)

Without significant human efforts to restore the watershed, conditions in the Arroyo Seco are likely to worsen. Increasing population will put greater development pressure on the watershed, and opportunities that may now exist to reconnect fragmented habitat types may be lost over time. Human uses of the watershed will increase and further affect both sensitive and general habitat types. Increasing population will increase pressure to develop and divert water supplies that currently provide a small amount of flow through the stream. If remaining habitat continues to be taken over by invasive species and severed from other remaining patches of open space, wildlife and plant species will continue to disappear from this region.

1.5 WATERSHED-WIDE PLANNING AND REGIONAL COLLABORATION

In recent years, citizens, neighborhood groups, and governmental agencies have collaborated to better manage the Arroyo Seco watershed. The Arroyo Seco Foundation (ASF) was founded by Charles Lummis more than 100 years ago to promote the preservation and promotion of the Arroyo Seco. ASF advocates an integrated approach to watershed and flood risk management, water conservation, habitat enhancement, and expansion of recreational opportunities. The activities of the ASF enable local residents and businesses to become directly involved in the restoration of the Arroyo Seco and in the recreational and environmental opportunities available. ASF has contributed to a number of regional and watershed planning efforts in the watershed, as described in this section of the report.

In 2000, ASF and North East Trees (NET) initiated the Arroyo Seco Watershed Restoration Program. Two organizations were established as a part of this program to coordinate the efforts of various agencies, organizations, and individuals working to promote better watershed management. The first, the Council of Arroyo Seco Agencies (CASA), brings together the major governmental entities that have management, planning, or regulatory responsibility in the Arroyo Seco. The second, the Council of Arroyo Seco Organization (CASO), provides a forum for neighborhood and community-based organizations as well as environmental groups to discuss issues and programs in the watershed. As a result of these efforts, NET and ASF released the Arroyo Seco Watershed Restoration Feasibility Study in 2002. That study identified general strategies and project concepts that could be developed and implemented to meet watershed objectives for water quality, water conservation, flood damage reduction, habitat restoration and recreation. Watershed strategies identified in the study included best management practices applicable to the control and water quality of storm water, decreasing watershed area covered by impervious surfaces, and general approaches to habitat restoration. Candidate project areas for habitat restoration were also identified based on compatibility with existing land uses, hydrologic setting, and flood control requirements. Preliminary costs and construction durations were also prepared to compare candidate projects identified in the watershed.

As a follow-up to the ASF/NET Arroyo Seco Watershed Restoration Feasibility Study, NET published the Arroyo Seco Watershed Management and Restoration Plan in 2006. The report provided additional consideration of habitat restoration approaches and strategies for improving water quality of Arroyo Seco and its tributaries, including recommendations for water quality monitoring, site development and drainage practices, and opportunities for habitat restoration along the arroyo channel, tributaries and adjacent areas.

Between 2003 and 2005, the City of Pasadena developed and adopted three plans that govern management of Pasadena parks along the Arroyo Seco: the Lower Arroyo Master Plan, the Central Arroyo Master Plan, and the Hahamongna Watershed Master Plan. These plans attempt to balance many different objectives, including recreational access, water supply, habitat preservation and other uses.

In 2004, the California Department of Transportation (CalTrans) developed the Arroyo Seco Parkway Corridor Management Plan. The management plan was designed to be a flexible “living document” that specifies actions, procedures, controls, operational practices, and strategies to preserve, restore, and maintain the scenic, historic, recreational, archeological, and natural qualities within the viewshed of the historic Arroyo Seco Parkway, a Scenic Byway, as well as continue to address key issues, such as roadway safety, mobility, tourism development, and economic ~~development.In~~development. In 2006, the County of Los Angeles prepared the Greater Los Angeles County Integrated Regional Water Management Plan (IRWMP) to provide a process for submitting and considering projects that compete for state grant funds under state Proposition 50. The IRWMP presented basic information regarding possible solutions, the costs and benefits, quantified goals and objectives for water supply, water quality, habitat conditions, recreation and infrastructure in the Los Angeles region. The IRWMP proposed integration of multiple water management strategies in projects to improve water supply, water quality, and open space. More than 1,500 projects and project concepts have been submitted by various agencies and stakeholders and are listed in the plan’s project database. Area steering committees

select projects for implementation based on their evaluations and stakeholder input, with overall guidance provided by a leadership committee. The Arroyo Seco watershed was one of several watersheds in the planning region that is included in the plan.

In 2007, the Central Arroyo Stream Restoration Program was developed by the ASF in partnership with the City of Pasadena. The program aimed to improve stream habitat and water quality within the central Arroyo Seco in Pasadena. It was developed to build on previous watershed and water quality planning efforts such as the City of Pasadena's master plans for parks. This program, completed in 2008, has improved stream conditions and water quality in the Arroyo Seco by providing suitable vegetative cover, parking lot and trail improvements, and trash capture devices. The arroyo chub, a native fish that had been eliminated from the arroyo by previous flood control measures, was re-introduced to the stream as part of the program.

In 2007, the Arroyo Seco Watershed Sustainability Campaign (ASWSC) was developed by the ASF in partnership with stakeholders in the CASO. This is a targeted program to improve the reliability and management of local water resources in the watershed.

The planning studies described above have been reviewed during the preparation of this document, and suitable information on existing conditions, historic trends, ecosystem problems and potential restoration approaches and projects have been included in this report, where these types of information were found to be appropriate and consistent with the objectives of this study.

1.6 HISTORY OF CORPS INVESTIGATION

In response to the study authority, the Corps, Los Angeles District, completed the reconnaissance study for this project: *Arroyo Seco Watershed, Los Angeles County, CA, Section 905(b) Analysis* (Corps 2005). The reconnaissance report established Federal interest in proceeding to the execution of this study to investigate the opportunities for the development of a watershed management plan that effectively balances the need for sustainable economic development with protection of watershed natural resources. The reconnaissance phase effort also included the development of a feasibility-level Project Management Plan (PMP) and the execution of a Feasibility Cost Sharing Agreement (FCSA) between the Corps and the LACDPW in 2005, which initiated the second phase of the study process, the feasibility phase.

Following the completion of the initial draft PMP, the Los Angeles District worked with the local sponsor, in conjunction with CASA, to revise the original scope of work to focus the study on ecosystem restoration within the watershed by identifying the most effective candidate locations for individual environmental restoration projects within the watershed. Based on the results of this study, individual sites and preliminary plans that are determined to provide the most cost-effective opportunities for ecosystem restoration that are compatible with each other will be recommended for future feasibility-level study, with the study of each site completed as a separate project-specific feasibility study and decision document. In addition, it has been determined that the study will address the portion of the watershed downstream of Angeles National Forest, as described in Section 1.3. This area is an urbanized watershed with significant need for ecosystem restoration, and spin-off projects could be implemented under cost share

agreements with non-federal sponsors that do not have the authority or interest in addressing ecosystem restoration on federal lands.

As part of this feasibility study effort, the Corps initiated an Environmental Evaluation (EE) in 2007. The EE, which was completed in 2008, presented a general inventory and assessment of the environmental conditions within the study area. The EE provided a description and discussion of nine potential environmental restoration sites within the watershed. Collectively, these sites have been chosen to represent the range of conditions found within the lower watershed. A great deal of public and political support has been expressed for restoration within the lower watershed, as evidenced by the number of community-scale restoration plans that have been proposed by various stakeholders. These sites have the greatest potential for non-Federal sponsor support and participation in site-specific cost-shared feasibility studies. The EE also included a qualitative description of site-specific problems and ecosystem restoration opportunities based on the assessment of existing and expected future without-project conditions. These alternative sites, which are further described in **Chapter 4, Alternatives**, include the following locations:

§ Site 1 – Hahamongna Area
§ Site 2 – Flint Wash
§ Site 3 – 210 Freeway near Oak Grove Drive
§ Site 4 – Brookside Area
§ Site 5 – Lower Arroyo Seco Park
§ Site 6 – South Pasadena Island
§ Site 7 – Arroyo Seco through Los Angeles
§ Site 8 – Sycamore Grove Park
§ Site 9 – Rainbow Canyon

This study includes a review of the Corps 2008 EE as well as inclusion of more detailed information from additional sources and data collected as part of this study to adequately describe baseline conditions for comparison of alternative plan outputs and impacts.

1.7 PRIOR STUDIES AND REPORTS

Various studies have been conducted pertaining to water and related land resources within the Arroyo Seco watershed. These studies have examined themes including development trends, environmental resources, water supply, groundwater recharge, flooding and erosion, geology, cultural resources, history, and recreation. The following is not intended to be a comprehensive list of previous reports, but to provide a sample of the types of studies that have been completed within the study area.

1.7.1 Corps of Engineers

Los Angeles and San Gabriel River Watershed Feasibility Study (July 2001). U.S. Army Corps of Engineers, Los Angeles District.

Arroyo Seco Watershed, Los Angeles County, CA Section 905(b) (WRDA 86) Analysis (November 2002). U.S. Army Corps of Engineers, Los Angeles District.

Programmatic Environmental Impact Report/Programmatic Environmental Impact Statement for the Los Angeles River Revitalization Master Plan (April 2007). Prepared by Tetra Tech, Inc. for the City of Los Angeles and the U.S. Army Corps of Engineers, Los Angeles District.

Environmental Evaluation, Arroyo Seco Watershed Study, Los Angeles County, California (September 2008). Prepared by Tetra Tech, Inc. for the U.S. Army Corps of Engineers, Los Angeles District.

1.7.2 Other Agencies

Wetlands of the Los Angeles River Watershed: Profiles and Restoration Opportunities (January 2000). California Coastal Conservancy.

Ernest E. Debs Regional Park Framework Plan (May 2000). Prepared by Envicom Corporation for the City of Los Angeles Department of Recreation and Parks.

Arroyo Seco Master Plan Master Environmental Impact Report (May 2002). City of Pasadena Department of Planning and Development.

Arroyo Seco Watershed Restoration Feasibility Study (May 2002). Prepared by North East Trees and Arroyo Seco Foundation for the California Coastal Conservancy.

Hahamongna Watershed Park Master Plan (September 2003). City of Pasadena.

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1.8 PLANNING PROCESS AND REPORT ORGANIZATION

The planning process consists of six major steps:

(1) Specification of water and related land resources problems and opportunities.

(2) Inventory, forecast, and analysis of water and related land resources conditions within the study area.

(3) Formulation of alternative plans.

(4) Evaluation of the effects of the alternative plans.

(5) Comparison of the alternative plans.

(6) Selection of the recommended plan based upon the comparison of the alternative plans.

Chapters of the report relate to the planning process as follows. **Chapter 2 Need for and Objectives of Action** covers the first step in the planning process. **Chapter 3, Existing and Future-Without Project Conditions** provides the results of the second step of the planning process, including descriptions of the existing conditions and trends for resources and environmental conditions in the study area. **Chapter 4, Alternatives**, provides the preliminary results for step 3, plan formulation, including individual management measures that have been identified as possible elements of plan alternatives, and initial combinations of measures to form alternatives for evaluation in subsequent steps of the planning process. As previously discussed, this watershed study will identify candidate spin-off studies that can be pursued under specific Corps authorizations. If carried forward, each individual project study would provide the appropriate NEPA and CEQA documentation and compliance with all pertinent laws, regulations and EOs prior to project implementation. Detailed evaluation of the effects of alternative plans, plan comparison and selection for the individual projects, along with documentation of impacts and mitigation measures, will be addressed in each of the individual project study reports.

2.0 NEED FOR AND OBJECTIVES OF ACTION

This chapter presents the results of the first step of the planning process, the specification of water and related land resources problems and opportunities in the study area. The chapter concludes with the establishment of planning objectives and planning constraints which are the basis for the formulation of alternative plans.

2.1 WATERSHED PLANNING OBJECTIVES

The objectives of the watershed study are to provide an overview and analysis of Arroyo Seco's water-related resources, and to develop actions that can be implemented to address identified problems in a watershed context that are also acceptable to the public and institutions with interests in the watershed. Based on the existing conditions within the watershed, problems and issues are identified, and plan alternatives are developed to address these watershed issues. Plan alternatives may identify individual projects that could be developed in detail through project-specific feasibility studies. The watershed plan may also formulate, assess and recommend structural and non-structural measures and programs that can be implemented by local entities with the authority and jurisdiction to implement these actions that provide water resources benefits in the watershed in a cost-effective and acceptable manner.

The purpose of utilizing a watershed-based approach is to consider all factors related to a particular system so that water resources activities carried out in the watershed are complementary and do not result in competing demands for resources or unacceptable effects on other resource considerations. These considerations will be used to identify potential spin-off projects that can be implemented individually, but that can work together to improve ecological functions and provide habitats across the watershed. Although this effort will not result in a decision document for an individual project, it relies on the steps of the Civil Works Program's planning process, including review of existing information, consultation with involved agencies, problem identification and description, conceptualization of alternatives that address the identified problems, and comparison of the outputs and costs of the alternatives for achieving the overall objective of watershed improvement. As this report addresses issues and resources in the Arroyo Seco watershed, it seeks to facilitate a balance between urban uses and watershed protection.

2.2 NATIONAL OBJECTIVES

The national or Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to National Economic Development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation.

The Corps has added a second national objective for ecosystem restoration in response to legislation and administration policy. The Corps' objective is to contribute to National Ecosystem Restoration (NER) through increasing the net quality and/or quantity of desired

ecosystem resources. NER measurements are based upon changes in ecological resource quality as a function of improvement in habitat quality or quantity and expressed quantitatively in physical units or indexes (not monetary units).

This watershed study will include formulation of multi-purpose alternative plans that could produce both NER and NED outputs. However, the range of plans identified in this study will be at a conceptual level and will not involve the more detailed analysis necessary to arrive at a recommendation for a selected plan for a specific Federal project for implementation. The watershed study effort is not anticipated to culminate in a decision document to Congress recommending authorization of a single Federal project. Rather, it will identify spin-off feasibility studies for candidate projects that can be implemented within the study area that can be pursued under specific Corps authorization to conduct project-specific studies. The study may also identify actions and policies to be implemented by other agencies with interests and jurisdiction within the watershed to address watershed issues.

2.3 STAKEHOLDERS' CONCERNS

Input has been received through coordination with the non-Federal sponsors, various agencies, and stakeholders during the course of the reconnaissance study and during the development of the EE. Additional concerns may be identified in future coordination with other stakeholders, agencies, resource experts, and the public through public workshops and meetings. A discussion of stakeholder involvement and consultation is presented in **Chapter 6, Coordination and Consultation**.

Descriptions of the prevalent concerns have been summarized below, in no particular order:

- Restore aquatic habitats.
- Restore the natural hydrological functions of the watershed.
- Restore the Arroyo Seco stream and tributaries by reducing channelization (e.g. widening and lengthening of streams). The stream lengthening concept would add length back into the channel to allow water velocities to drop, lessening the erosion potential.
- Reduce volume and velocity of stormwater runoff.
- Restore connection to remnant floodplain system or create inset floodplain to allow for periodic inundation while providing the required level of public safety and flood hazard mitigation.
- Better manage, optimize, and conserve water resources while improving water quality.
- Improve the quality of surface water for aquatic habitat and human contact.
- Restore the quality and quantity of groundwater recharge to the Raymond Aquifer.
- Develop groundwater management strategy for optimal use of local water resources.
- Reduce dependence on imported water for water supply.
- Restore a more natural sediment transport regime.
- Restore, protect, and augment habitat quality, quantity, and connectivity.
- Restore and protect missing linkages between fragmented habitats.
- Integrate fire management into native vegetation zones.
- Restore, protect, and augment terrestrial species habitat in existing open space of foothills and floodplains.

- Enhance and strengthen the urban interface zone.
- Improve recreational opportunities and enhance open space.
- Improve connectivity and public access from the ANF to the coastal shore.
- Protect and interpret natural, community, cultural, and historic resources.
- Integrate natural resources management with recreational needs.
- Protect existing open space while augmenting open space network.
- Improve visual quality of the landscape.
- Mediate conflicts between recreation users and conservation interests.

2.4 PROBLEMS AND OPPORTUNITIES

During the process of stakeholder coordination a number of issues were brought to light. These include concerns regarding diminished water quality, overall watershed conditions, diminished habitat quality, recreational opportunities, and invasive species infestation. This section describes these concerns as problems and opportunities that can be addressed through changes to water resource management and related land resource management. Based on the assessment of existing and expected future without-project conditions inventoried in **Chapter 3**, the following problems and opportunities within the Arroyo Seco study area were identified.

2.4.1 Problems

Problems within the study area are interrelated and are principally related to aquatic ecosystem degradation caused by poor water quality, disturbed, fragmented and displaced habitats, and altered hydrology of the watershed. Other problems in the Arroyo Seco watershed also include demand for water supply and limited recreation opportunities associated with the arroyo and its tributaries. These problems are summarized below.

- *Fragmented Riparian Habitat.* The river channel in the study area has lost the originally undisturbed nature of the riparian habitat at most locations. Alteration of the riparian conditions has resulted in fragmented, diminished or eradicated fish and wildlife habitat, and has resulted in water quality impacts that have diminished ecosystem function. For example, in the Hahamongna Watershed Park (HWP), the stream spreads over the floodplain in a braided pattern, as would be expected in a bedload-dominated alluvial system, but current land use does not provide a riparian vegetation border along the braided stream margin. Thus, the water is exposed to direct sunlight and is subject to heating, thereby reducing aquatic habitat quality for native species and contributing to harmful algal blooms. In other reaches, the riparian habitat has been replaced by an open culvert. Reference riparian habitats within the watershed are found along Arroyo Seco upstream of the JPL Bridge and along the natural stream channel immediately downstream of Devil's Gate Dam.

- *Devil's Gate Dam barrier to fish passage.* Devil's Gate Dam is a permanent structure that does not accommodate fish passage to the upper watershed, isolating and fragmenting fish habitat and reducing the reach available for fish to search for refuge and food sources.

- *Disturbance of the Hydrologic Regime.* The Arroyo Seco watershed has experienced a variety of human-induced changes to watershed hydrology, which have caused a significant decline in environmental resources. Development and changes in land use in the watershed

have drastically altered the natural character of the Arroyo Seco, changing the hydrological regime of the river, including large scale increases in impermeable surfaces in the watershed, resulting in more rapid runoff, increased peak flows associated with storm events, and shorter durations of peak flows. In addition, concrete lined channels have eliminated most hydraulic connection of the stream with the surrounding environment, greatly reducing recharge of groundwater and bank storage, which also contributes to higher peak flows and more limited peak flow durations. Hydraulic isolation and infilling of floodplain wetlands decreases residence time of water in the drainage basin and decreases water quality by eliminating wetland functions that reduce nutrient concentrations, remove pathogenic organisms, and filter out suspended solids.

§ *Reduced Groundwater Recharge.* Natural groundwater recharge in the watershed has been dramatically reduced due to development and installation of impervious surfaces such as roadways, parking areas, and buildings. Many areas of the floodplain are no longer accessible for overbank flows, thus reducing the opportunity for groundwater recharge. In addition to the reduced recharge effects on water quality and watershed hydrology mentioned above, reduced recharge results in reduced volumes of water available for incidental benefits such as public water supplies.

§ *Groundwater Contamination.* Liquid wastes from materials used at the JPL, located on the northwestern edge of the study area, were disposed of into seepage pits in the 1940s and 1950s. Since then, contaminants such as perchlorate and volatile organic compounds have been found in groundwater beneath the JPL and in areas adjacent to the facility. Leakages from old or impaired septic systems in the La Cañada Flintridge area are also a potential source of groundwater contamination in the Arroyo Seco watershed. *Invasive Species Infestation.* Giant reed *(Arundo donax)* poses the greatest threat to riparian habitat of any invasive species present. This species can result in reduced base flow volumes, lowered groundwater tables, impassable stream channels, and replacement of high-quality scrub and riparian woodland habitat with monocultural stands offering little habitat value, and dispersion of the species through the lower portions of the Arroyo Seco. In addition, other invasive species that displace native plants and degrade habitat include tree of heaven (*Ailanthus altissima*), fan palm (*Washingtonia robustus*), pampas grass (*Cortaderia selloana*), and jubata grass (*Cortaderia jubata*).

§ *Poor Water Quality.* Below the ANF, water quality of the Arroyo Seco is impacted by horse corrals and golf courses that contribute nutrients from manure, fertilizers, and pesticides. In addition, the development and installation of impervious surfaces has resulted in increased runoff from roads, commercial areas, industry, and residential neighborhoods that contain trash and a mixture of contaminants. Water quality data has been collected by Pasadena Water and Power and is available for specific storm events from 2006 – 2008 (ASF 2008c). The information available indicates fairly consistent results over the three-year, 17-sample record. Bacteria and high water temperatures appear to be the most significant issues in the study area.

§ *Channelized Stream Bottom.* The stream bottom has been altered to convey large volumes of water quickly downstream during high-flow events. This has been accomplished by

removing any impediments within the channel, including root wads, woody debris, and boulders, and disconnection from the floodplain. The stream bottom is covered with concrete throughout the majority of the Arroyo Seco downstream of the Devil's Gate Dam. The stream bottom retains none of its original functions or values except to convey water from the upper watershed. Aquatic conditions are typified by the stream running over a smooth concrete floor with few riffles or pools, no cover for aquatic wildlife, and no riparian vegetation. For example, little, if any, natural habitat occurs within the central reach of the Arroyo Seco (i.e., Brookside Golf Course). In addition to the stream being channelized, the riparian habitat that formerly bordered it has been replaced by a manicured golf course.

- *Uncertainty regarding flood risk management.* A recent LACDPW study indicated that even after the rehabilitation of the Devil's Gate Dam in 1998, portions of the downstream concrete channel may be under capacity due to increased runoff into the channel. In addition, the engineered channel is aging and requires ongoing maintenance and repair operations. As indicated in a 2001 (MWH) hydraulic study, isolated areas along the Arroyo Seco channel have less than the 100-year flood capacity. More areas are affected by the Capital Storm[1] Flood, the majority of which are open space or developed park areas adjacent to the Arroyo Seco channel. Detailed hydraulic modeling of the existing channel and floodplain is required to determine flood hazard areas more accurately. More detailed information will be presented when the Hydraulic Appendix is completed. Revised flood risk information will be used in the assessment of alternative plans, including the constraint that the restoration features do not increase flood damage risk within the watershed.

- *Limited Flood Storage at Devil's Gate Dam.* Even with a program carried out by LACDPW for regular sediment removal over the years, sediment accumulation in the basin has gradually reduced the active storage capacity of the reservoir. With the rehabilitation of the dam and the lowering of the spillway (by 13.5 feet) in 1998, the active storage capacity of Devil's Gate Dam was reduced to 1,424 acre-feet (ac-ft), and the dam has reached the LACDPW minimum flood safety capacity at elevation 1,040.5 feet. Any additional sediment entering the dam will need to be removed or moved above the 1040.5-foot elevation to maintain the required flood control volume in the HWP. Additional sediment and debris may move into the storage area behind the dam due to the impacts of the Station Fire of 2009 that affected upstream areas within the Angeles National Forest. Therefore, any potential restoration features will have to accommodate the need for sediment and debris removal operations needed to maintain the flood damage reduction provided by the dam.

[1] 170-year return period at the Devil's Gate Dam and about a 450-year return period at the Los Angeles River (MWH 2001).

Photo 2.1 Devil's Gate Dam

- *Fragmented Open Spaces.* Though it may appear that the Arroyo Seco watershed has a large amount of public open space, the area is similar to the rest of park-poor Los Angeles. Because the park space is concentrated in a narrow strip along the Arroyo Seco, it is some distance from most residential areas and not evenly distributed geographically throughout the watershed. Open spaces in the urban and suburban areas are fragmented and are generally not linked by trails or habitat corridors. The uppermost area of the watershed has vast open space due to being in the ANF. In the middle, the San Rafael and Verdugo Hills still contain open space habitat. Lower in the watershed, Mt. Washington, Montecito, and Monterey Hills mapping indicate that habitat patches exist, but are fragmented and their viability of habitat for healthy populations of wildlife is limited (NTHP 2004) . As the region's population has grown, demand on open space has increased. Over time, more open space was developed for residential neighborhoods, severing habitat corridors that allowed wildlife movement through the foothills.

2.4.2 Opportunities

Based upon information obtained in the without-project assessment and understanding of stakeholders' concerns, opportunities were identified. In addition, opportunities for restoration identified in the IWRMP and ASF and NET studies were also considered. Opportunities are desirable conditions that can be accomplished by management actions or policies. These are summarized below.

- Opportunities for large-scale ecosystem restoration exist within the study area. Specific opportunities may include:
  - Opportunities exist to link existing habitat fragments along the Arroyo Seco and tributaries by restoring the integrity of natural communities/ecosystems and providing a wildlife corridor between the Los Angeles River and the upper watershed. During low flows, water could primarily be confined to the main channel, where a restored riparian

canopy would help to ensure cooler water temperatures for aquatic species and provide habitat for neo-tropical migrant bird species.

- Opportunities exist to provide for fish passage over or around the Devil's Gate Dam, through the HWP, and into the upper watershed within the study area. This action would be most effective as part of an overall ecosystem restoration plan that would improve the quality of habitats that would become accessible and not as an isolated action.

- Opportunities exist to eradicate invasive species and restore native species that would create higher quality wildlife habitat and increase water availability to support habitat and native vegetation species.

- The opportunity exists to replace the rock revetment in Flint Wash (under the I-210, also known as the Foothill Freeway) with bio-engineered protection or engineered protection features with less habitat impact.

Photo 2.2 Flint Wash under the I-210

- The opportunity exists to stabilize the channel bank with bio-engineering methods. Use of willow wattles, willow and alder stakes, and other bioengineering methods, in combination with use of rock, could help to stabilize the bank, restore the riparian habitat, and contribute to increased habitat quality over time. Specific locations where this approach may be taken will be identified through evaluation of hydrologic and hydraulic data and geotechnical conditions along the channel.

- The opportunity exists to create one or more alternative stream channel(s) outside the current Arroyo Seco alignment on the west side of the Brookside Golf Course. The alternative stream could have an unlined stream bottom and be planted to create riparian habitat. A diversion structure at the upstream end of the site would send low flows through the alternative stream in a fashion similar to the alternative stream channel located in the Lower Arroyo Seco Park further downstream. The current concrete channel could remain in-place in its present form to convey high velocity flood flows safely through the site.

- The opportunity exists for removal of the concrete flood control channel along Arroyo Seco and restoration of the stream habitat throughout the study area. Woody debris and rock grade controls and possible channel realignment could be used to reduce flood flow velocities to a level that would enable sustainable channel vegetation and limit potential erosion in the reach. In order to replace the flood conveyance capacity lost to the restored stream bottom, the stream would need to be enlarged to account for the lowered stream velocities. This could be accomplished using offset floodplain bench levels. The

benches would also provide for more natural transition of habitat types from wet stream bottom to the drier upper banks. (Using this approach, restoration efforts could be focused on the stream bottom and lowest benches of the stream.) This would only be feasible after a thorough assessment of the required flow capacity that would be needed to provide the existing level of flood damage reduction after removing channel armoring.

- The opportunity exists to lengthen and enhance the existing low-flow diversion channels within the Lower Arroyo Seco Park. Mature riparian vegetation exists in the low-flow diversion channels, and could be augmented by revegetating and restoring flow from a diversion point on Arroyo Seco upstream of the existing low-flow diversion channels. New channels could be designed and constructed to carry water further to the south of the current entry point to the Arroyo Seco.

Photo 2.3 Low-Flow Diversion Channel

- The opportunity exists for partial restoration of a narrow strip of riparian habitat in the lower Arroyo Seco if concrete were removed from part of the channel bottom. This would be best achieved by exposing the original stream bottom and establishing a strip of riparian vegetation on either side of the stream bottom.

- The opportunity exists to develop a basin-wide sediment management plan to protect and improve the health of the watershed. The plan should investigate measures for sediment erosion control that will provide opportunities for restoration of upland/hillslope native communities. Of special importance would be addressing sediment that are a result of the Station Fire (Fall 2009), which burned much of the upper watershed and destabilized surface soils. These sediments are being deposited primarily in the Hahamongna alluvial plain and having significant effects on riparian communities, in some places completely burying them. Because sediment has been captured behind the Devil's Gate Dam for decades, the lower Arroyo Seco is sediment impoverished, with resulting effects on habitat quality. Therefore, the opportunity exists to enhance habitat in the lower Arroyo Seco by implementing a well-planned gravel augmentation program to help move sediments from behind the dam to areas downstream.

- The opportunity exists to formulate a project that addresses multiple purposes by providing storage for local runoff in a manner which facilitates groundwater recharge and helps support habitat restoration throughout the study area. As part of this effort, groundwater contaminant sources, including nonpoint source pollution, should be identified and evaluated throughout

the watershed. The necessary treatment required for surface waters should be identified prior to recharge into the groundwater basin to prevent further degradation of the aquifer.

§ The opportunity exists to identify treatment alternatives, including treatment wetlands, to improve the water quality of stormwater runoff and reduce nonpoint source pollution throughout the watershed. As part of this effort, monitoring and control plans for pollution minimization should be developed.

§ The opportunity exists to identify where flooding problems exist and where flood risk management mechanisms need to be put in place. This would be supported by the ~~the~~ hydrologic, hydraulic, and sediment transport analysis for the watershed being carried out for this study.

§ The opportunity exists to provide recreational resources in conjunction with any Federal project implemented for ecosystem restoration purposes. There is a potential for developing a comprehensive recreation plan and trail system for the watershed. The plan should also develop habitat opportunities that provide links with existing recreational and open spaces. The recreation plan should expand upon and improve existing trail systems. In addition, limited low-density recreational opportunities may be provided adjacent to restored habitat areas. Maintaining open space (recreation facilities) adjacent to restoration sites could help promote successful restoration as it minimizes the stress on habitat and wildlife associated with more intensive land use in adjacent areas. In general, facilities would likely consist of trails and interpretative signage.

2.5 PLANNING CRITERIA

2.5.1 Criteria for Evaluation of Alternatives

The planning process considers a number of factors in evaluating and comparing alternative plans to select recommended actions to address the water resources issues considered in the study. The following planning criteria are considered in the evaluation of plan alternatives, including the technical, institutional, financial, social, management and ecological aspects of the proposed actions. These criteria include:

- Completeness: Will the desired results be obtained? Does the plan include all of the necessary parts and actions to produce the desired results?
- Effectiveness: Does the plan meet the objectives identified in the study?
- Efficiency: Does the project minimize costs and is it cost-effective?
- Acceptability: Is the project acceptable and compatible with existing laws and policies?

In addition to these planning criteria, the U.S. Army Corps of Engineers has implemented a number of initiatives that govern the execution of studies and decision-making, and these are described in the following sections.

2.5.2 Environmental Operating Principles

The Corps has reaffirmed its commitment to environmental stewardship by formalizing a set of "Environmental Operating Principles" applicable to all its decision-making and programs. These principles foster unity of purpose on environmental issues, reflect a new tone and direction for dialogue on environmental matters, and ensure that employees consider conservation, environmental preservation, and restoration in all Corps activities. By implementing these principles, the Corps will continue its efforts to develop the scientific, economic, and sociological measures to judge the effects of its projects on the environment and to seek better ways of achieving environmentally sustainable solutions. The principles are described in Engineering Circular 1105-2-404, Planning Civil Work Projects under the Environmental Operating Principles (Corps 2003).

- *Achieve Environmental Sustainability*. An environment maintained in a healthy, diverse, and sustainable condition is necessary to support life.

- *Consider Environmental Consequences*. Recognize the interdependence of life and the physical environment. Proactively consider environmental consequences of Corps programs and act accordingly in all appropriate circumstances.

- *Seek Balance and Synergy*. Seek balance and synergy among human development activities and natural systems by designing economic and environmental solutions that support and reinforce one another.

- *Accept Responsibility*. Continue to accept corporate responsibility and accountability under the law for activities and decisions under our control that affect human health and welfare and the continued viability of natural systems.

- *Mitigate Effects*. Seek ways and means to assess and mitigate cumulative effects to the environment; bring systems approaches to the full life cycle of our processes and work.

- *Understand the Environment*. Build and share an integrated scientific, economic, and social knowledge base that supports a greater understanding of the environment and effects of our work.

- *Respect Other Views*. Respect views of individuals and groups interested in Corps activities; actively listen and learn from their perspective in the search to find innovative win-win solutions to the nation's problems, solutions that also protect and enhance the environment.

2.5.3 12 Actions for Change

On August 2006, the Corps released the "12 Actions for Change," a set of actions that the Corps will focus on to transform its priorities, processes, and planning. These 12 Actions were developed from the exhaustive analysis by the Corps into the performance of the Greater New Orleans Hurricane Protection System during hurricanes Katrina and Rita, and from other internal and external examination of the Corps in the recent past (Corps 2006). The 12 Actions fall within

three overarching themes: effectively implementing a comprehensive systems approach, communication, and reliable public service professionalism.

2.6 PLANNING OBJECTIVES AND CONSTRAINTS

Planning objectives and constraints provide a framework for the development of alternative plans. Alternative plans are evaluated based upon the degree to which they address the planning objectives and could take advantage of identified opportunities while remaining within the limitations imposed by the identified constraints. The evaluation and screening process is further discussed in **Chapter 4, Alternatives**.

2.6.1 Planning Objectives

The water and related land resource problems and opportunities identified in this study are stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired positive changes in the without-project conditions. The planning objectives are specified as follows:

- Reduce further degradation of the ecosystem caused by the natural and human-induced changes to the watershed by restoring water related habitats of Arroyo Seco and tributaries, addressing water quality impairments that limit ecological functions, and re-establishing hydrologic conditions in the watershed that support general ecosystem health within the study area.

- Provide ecosystem restoration by restoring high-value habitat, removing impediments to fish passage, and eradicating invasive species.

- Prevent further degradation and improve water quality (both surface and groundwater) by reducing stream temperatures, reducing non-point sources of pollution, and avoiding actions that would mobilize or result in exposure to groundwater contaminants.

- Improve riparian habitats by restoring sustainable vegetation within the study area, more natural habitat types, and re-establish flow and substrate conditions that support aquatic habitats and ecological functions.

- Maintain reduction of flood damage and life and property loss through control of bank erosion, reduction of sediment deposition, and improvements to flow capacity within the ~~channel.Increase~~channel. Increase opportunities for water conservation by improving recharge potential and addressing groundwater contamination issues.

- Design restoration features that provide incidental benefits by helping to mitigate or avoid flood damages through control of bank erosion, and improvements to flow capacity within the channel.

- Improve recreation opportunities by identifying a balance of open space, recreational trails, and habitat areas.

§ Improve the riverfront aesthetic quality of the Arroyo Seco by providing greenway experiences to the community while still allowing for sustainable habitat conditions for wildlife.

§ Restore connectivity of habitats to re-establish a wildlife corridor between the lower and upper Arroyo Seco.

2.6.2 Planning Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. The planning constraints identified in this study are as follows:

§ *Availability of Water.* A principal constraint on any ecosystem restoration project is the limited availability of water to support establishment and maintenance of healthy riparian habitats. Water could be considered a constraint primarily during the initial periods of vegetation establishment. Depending on the seasonal availability of water and the areal extent and volumes of surface water present ~~duringf~~during upstream low flows, establishment of riparian vegetation may initially require irrigation. This could be accomplished by construction of temporary irrigation features and/or use of mobile irrigation services. Once established, riparian vegetation is expected to be largely self-sustaining from the groundwater table as evidenced by various stands of cottonwoods and willows within the study area.

§ *Maintenance of Floodway Capacity.* Restoration of riparian habitat cannot be done in such a way that it would substantially reduce the hydraulic capacity of the Arroyo Seco or its tributary washes to convey or store damaging flood flows.

§ *Maintenance of Devil's Gate Dam Flood Storage Capacity.* Restoration of riparian habitat in the flood pool cannot be done in such a way that it interferes with operations needed for sediment removal to maintain the minimum flood safety capacity.

§ *Proximity of Recreation to Restoration.* Projects must be formulated in such a way as to avoid impacts from existing and planned recreational facilities to the ecological function and flood damage reduction provided by the channel and its tributaries.

§ *Endangered Species.* Under the ESA and the MBTA, any potential project must not jeopardize the continued existence of threatened or endangered species or to destroy or adversely modify their habitat. Furthermore, ecosystem restoration projects are likely to attract and enhance habitats for endangered or threatened species. Projects should be sited so that their habitation by those species does not reduce the ability to provide required flood damage reduction and do not impede maintenance of the channels.

§ *Hazardous and Toxic Waste (HTW) Sites.* Associated hazardous and toxic waste issues would be avoided whenever practicable. If HTW is identified, avoidance, response actions and responsibilities of the non-Federal interest will have to be identified.

- *Local Acceptability.* The project must have strong public support and must be acceptable to local residents and consistent with local land use, transportation and resource management plans.

- *Real Estate Costs.* The study area is located in a heavily developed area where real estate costs can significantly affect project costs. Since right-of-way costs may vary considerably with location in the study area, real estate costs represent a constraint on the location and dimensions of areas where potential alternatives could be implemented.

3.0 EXISTING AND FUTURE-WITHOUT PROJECT CONDITIONS

This chapter describes the existing natural and human environment of the area potentially affected by the project alternatives. Baseline data are provided for the study area. Changes in the environment and related resources over time are considered to project future conditions that will be used to evaluate the outputs of the plan alternatives over the period of evaluation.

3.1 ENVIRONMENTAL SETTING OF THE STUDY AREA

The Arroyo Seco watershed, a sub-watershed of the Los Angeles River watershed, spans from mountainous headwaters through a mix of natural and urban lowlands where it converges with the Los Angeles River. A total of 47 square miles drains into the Arroyo Seco watershed (ASF 2010), approximately two-thirds of which are from the San Gabriel Mountains within the ANF. In August 26, 2009, the Station Fire started in the ANF, approximately four miles north of La Cañada Flintridge, along the Angeles Crest Highway (SR-2). The fire was the largest fire in the recorded history of the ANF (est. 1892) and the 10th largest fire in California since 1933 (Inciweb 2009). The fire burned a total of 161,189 acres, 96 percent of which was on National Forest Service lands. The fire impacted five of the LACDPW's dams and reservoirs, one of which is the Devil's Gate Dam. The fire burned almost the entire watershed of the Devil's Gate Dam (Arroyo Seco Canyon) (LACDPW 2010a).

Water flow in the Arroyo Seco study area is interrupted, diverted, and channelized throughout its 11-mile length. Under past natural conditions, the Arroyo Seco flowed through a deeply incised canyon through the San Gabriel Mountains until emptying into areas of open alluvium and incised channels through the remainder of its course to its confluence with the Los Angeles River. Devil's Gate Dam restricts and controls water flow in Arroyo Seco. Below Devil's Gate Dam, Arroyo Seco is mostly channelized with a stream bottom constructed of impervious materials. This reach is bordered by parks, golf courses, residential areas, and other urban environments. Various urban landmarks are found within the area, including the City of Pasadena, City of La Cañada Flintridge, City of South Pasadena, City of Los Angeles, NASA JPL, Rose Bowl, Colorado Street Bridge, SR-110, Ventura Freeway (SR-134) and I-210.

The topography surrounding the Arroyo Seco is diverse and dominated by the San Gabriel Valley to the south, Elysian/Repetto Hills to the east, San Rafael Hills to the west, and San Gabriel Mountains to the north (City of Pasadena 2002a) (see Figure 1.1). Complex geology responsible for this topography is characterized by a mix of layered sedimentary bedrock units that include older massive granitic basement rock, older alluvial fan deposits, young alluvium, colluviums (Ludington et al. 2007), and man-made artificial fill. Numerous tectonic faults traverse the watershed and include the Raymond Fault, Eagle Rock Fault, and the Sierra Madre Fault Zone (NET-ASF 2002a) with a high potential for tectonic activity.

Nine tributaries to Arroyo Seco are found downstream of Devil's Gate Dam; Montana Street Drain, Linda Vista Tributary, Seco Street Drain, Linda Vista Avenue Drain, Annandale Country Club Drainage, Laguna Road Storm Drain, Arroyo Seco North Branch, and Avenue 50 Storm Drain (City of Pasadena 2002a). The extensive impervious surfaces and the steep mountain

stream channels found in the upper reaches forces runoff to quickly move through the watershed, accentuating the tendency of the flows to rise and fall rapidly. Flow during the dry season, from May to October, consists primarily of base flow from groundwater and nuisance urban runoff. During the wet season from November to April, flows increase from the addition of storm runoff (City of Pasadena 2002a). Water quality is highly degraded by the surrounding urban environment; trash, bacteria, metals, and various chemicals all move into the Arroyo Seco through storm drains. The Arroyo Seco has little capacity to remove these toxins due to its lack of the complex biological processes that are present in natural-bottomed streams with intact assemblages of animals, plants, and algae (NET 2006).

Historically, the Arroyo Seco watershed supported a diverse mosaic of vegetation communities and wildlife. The upper mountainous reaches were mostly dominated by chaparral with patches of mixed hardwood and conifer woodlands and corridors of riparian vegetation (NET 2006). Downstream, dry foothill areas supported a matrix of coastal sage scrub and chaparral interspersed with patches of oak and walnut woodlands in cool areas with moist soils. Riparian habitat bordered the stream course and marshes and lagunas were present around the natural springs (NET 2006). Grasslands composed of perennial bunchgrasses, annual grasses and herbs most likely occupied large areas of the valley lowlands (ASF 2010). Many rare or extirpated wildlife species were once found in this rich ecosystem, including grizzly bears, mountain lions, and wolves. Other species now listed under the Endangered Species Act such as native anadromous fish, arroyo toads, red-legged frogs, and California gnatcatchers were also prevalent. Over the last 200 years, these natural conditions were extensively modified by humans through the setting of fires, establishment of settlements, agriculture, and eventually urbanization.

3.2 PHYSICAL LAND RESOURCES

This section describes the physical conditions of the study area, including topography, geology, soils, and seismicity.

3.2.1 Topography

The Arroyo Seco watershed is located near the northwestern edge of the San Gabriel Valley, north and northeast of the Elysian/Repetto Hills, east of the San Rafael Hills, and south of the San Gabriel Mountains. The watershed drains 47 square miles, approximately two-thirds of which are in the San Gabriel Mountains within the ANF. The mountains are relatively steep with 67 percent of the landscape at slopes over 60 percent. The headwaters of the Arroyo Seco originate at Strawberry Peak (elevation 6,164 feet) in the San Gabriel Mountains. From the headwaters the creek runs 22 miles downstream (of which, 12 miles are in the ANF) through a deeply incised channel to its terminus at the Los Angeles River (elevation 320 feet) near downtown Los Angeles. The Arroyo Seco watershed is a sub-watershed of the Los Angeles River watershed.

Since the late 1800s, a number of hydromodification projects aimed at water supply and flood control have been constructed within the Arroyo Seco watershed, which subsequently shaped the topographic and geologic features of the watershed by altering natural geomorphological riparian processes. Two key projects are the Brown Mountain Dam, located seven miles below the headwaters of the Arroyo Seco, and the Devil's Gate Dam, five miles downstream of the Brown

Mountain Dam. Below Devil's Gate Dam, the Arroyo Seco becomes a mostly concrete/channelized urban stream bordered by parks, golf courses, parking lots, residential areas, the Rose Bowl, industrial areas, and the SR-110.

3.2.2 Geology

Portions of the San Gabriel Valley area of the Los Angeles Basin are underlain by a thick (several thousand feet) sequence of Tertiary age sedimentary rocks overlying crystalline basement rocks. As represented in a geologic map database compiled by the U.S. Geological Survey (USGS) (Ludington et al. 2007), the Arroyo Seco watershed consists of the following major crystalline bedrock units (): a mixed strata of gneissic metamorphic and granitic intrusive igneous rocks mapped as "gneiss and granite"; dioritic intrusive igneous rocks mapped as "quartz monzonite"; granitic intrusive igneous rocks mapped as "granodiorite"; and sedimentary rocks mapped as "sandstone".

The Arroyo Seco is characterized by layered sedimentary bedrock units classified as the Topanga Formation; older massive granitic basement rock termed Quartz Diorite; older alluvial fan deposits on the flanks of the Arroyo Seco; young alluvium and colluvium in the Arroyo Seco channel; and man-made artificial fill. Topanga Formation bedrock (Miocene-age) generally consists of sandstone and conglomerate that are typically hard to very hard and very suitable for foundation support. Quartz Diorite is a crystalline granitic basement formation composed of massive to slightly foliated diorite that may be fresh in man-made cuts slopes, but is often highly weathered in surface exposures. Older alluvial fans (terrace deposits) consist of consolidated cemented sand, silt, and gravelly sand. Alluvium overlying the bedrock in the channel consists of a gravel-coarse sand mixture with minor silt and finer sand, which in turn is overlain by artificial (man-made) fill consisting of similar materials. Artificial fill at the site is associated mainly with previous concrete channel construction (backfill and spoil).

3.2.3 Local Faults and Liquefaction

Numerous earthquake faults traverse the region (). The Raymond (or Raymond Hill) Fault, roughly in the center of the study area, is the nearest designated Alquist-Priolo Earthquake Fault Zone (APEFZ)[2]. This fault is a reverse, left-slip, 12 miles in length, and extends through the southern portion of South Pasadena. One potentially active fault, Eagle Rock Fault, projects into the lower portion of the watershed on a northwest-southeast trend at Loma Road. It is believed to be a northeast dipping thrust fault (movement would be up on the north side).

The City of Pasadena has designated a fault hazard management zone for the Eagle Rock Fault, which means that geological studies are required for determining the potential for fault rupture before development occurs within the zone. The Sierra Madre Fault Zone crosses the Arroyo Seco at the JPL Bridge. This segment represents the easternmost part of this fault zone. The

[2] The APEFZ Act was passed in 1972 in order to identify hazard areas along active faults, (fault zones) that should be avoided when planning areas of human occupancy. This California state law was chiefly influenced by the devastating impacts of the 1971 San Fernando Earthquake. The Alquist-Priolo Zones Special Studies Act defines "active" faults as those that have experienced surface displacement, or movement during the last 11,000 years. Faults classified as potentially active moved during the last 2 million years. Faults that have not moved within the last 2 million years are considered inactive.

Sierra Madre fault segment is not part of an APEFZ, but is considered active/potentially active by the Los Angeles County Seismic Safety Element.

Various maps delineate potential liquefaction potential in the Arroyo Seco area. The Los Angeles County Seismic Safety Element shows liquefaction potential in the Arroyo Seco area. Seismic Hazard Zone Reports (CDC 1998a; 1998b) prepared by the California Department of Conservation focused on defining areas as potentially liquefiable with historical depth to groundwater of less than 40 feet. Maps developed from these reports show that shallow groundwater exists in the Arroyo Seco area. The study concluded that younger alluvium within the area where groundwater historically has been less than 40 feet from the surface are included in a liquefaction zone. It is important to note that liquefaction zone maps identify areas where the potential for liquefaction is relatively high (). However, they do not predict the amount of direction of liquefaction-related ground displacements, or the amount of damage to facilities that may result from liquefaction. These factors must be evaluated on a site-specific basis to assess the potential for ground failure at any given project site.

3.2.4 Future Without-Project Conditions

Under the future without-project conditions, the existing topography would remain relatively unchanged. Landforms would remain approximately the same, although large-scale flood events may continue to change the floodplain. Areas within the Arroyo Seco channel that are currently subject to erosion are expected to continue to erode at current rates. Soil that is currently barren of vegetation would continue to be easily eroded, contributing to continuing problems with flooding and sediment deposition downstream.

The Station Fire burned approximately 99 percent (13,376 acres) of the Arroyo Seco watershed (ANF lands) (BAER 2009). Geomorphic erosion rates are high, perpetuating shallow coarse soils, especially with pulse erosion following fire as a natural long-term process in this mountain region (BAER 2009). Eroded soil, by gravity or water, provides the materials for damaging debris flows and stream bulking. Cover is critical for soil stabilization and is lacking throughout most of the fire area. Given the slope characteristics and active hillslope processes, extremely little in the way of land treatments can be done to moderate hazards[3], even if funding were unlimited (BAER 2009). Approximately 64 percent and 11 percent of the Arroyo Seco watershed have been classified with moderate to high classes, respectively, of soil burn severity. In addition, 35 percent and 38 percent of the Arroyo Seco watershed have been given an erosion hazard rating of high and very high, respectively.

The BAER (2009) study also estimated first-year hillslope sediment productions for a range of storm events. Approximately 165,000 tons of sediment from the Arroyo Seco watershed is generated by a single 2-year event; a 10-year event could generate approximately 540,000 tons of sediment. Without any treatments to stabilize the soil in the burned area, off-site effects of soil erosion downstream will occur. Sediment-laden runoff and stream water has much greater erosive power than clean water in the stream system. This constitutes potential adverse effects to

[3] Moderate to high classes have evidence of severe soil heating in isolated patches.

facilities (roads, building, reservoirs), water quality deterioration for sensitive species and human use, and risk to human life and property from potential flooding, mudslides, and debris flows.

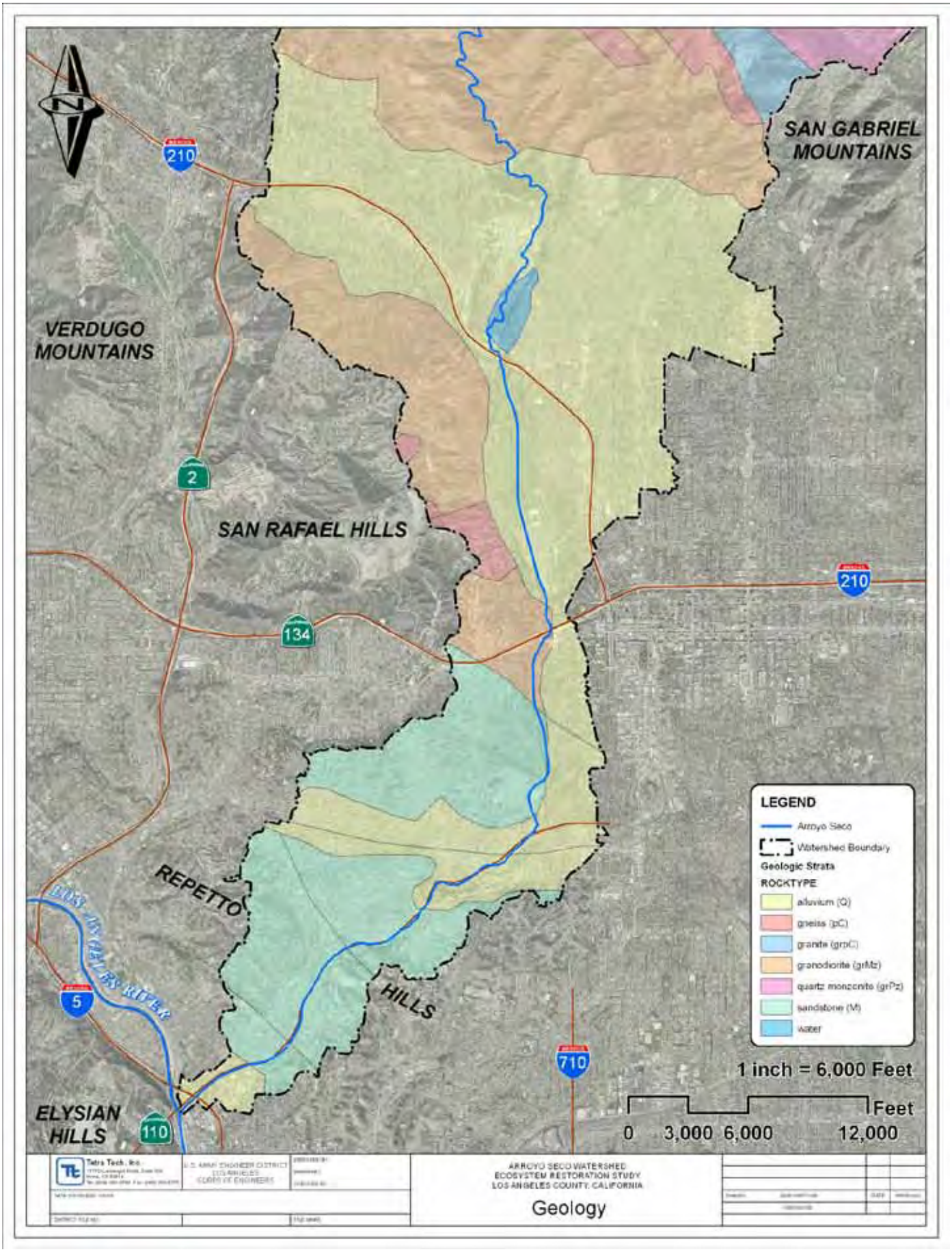

Figure 3.1 Geology

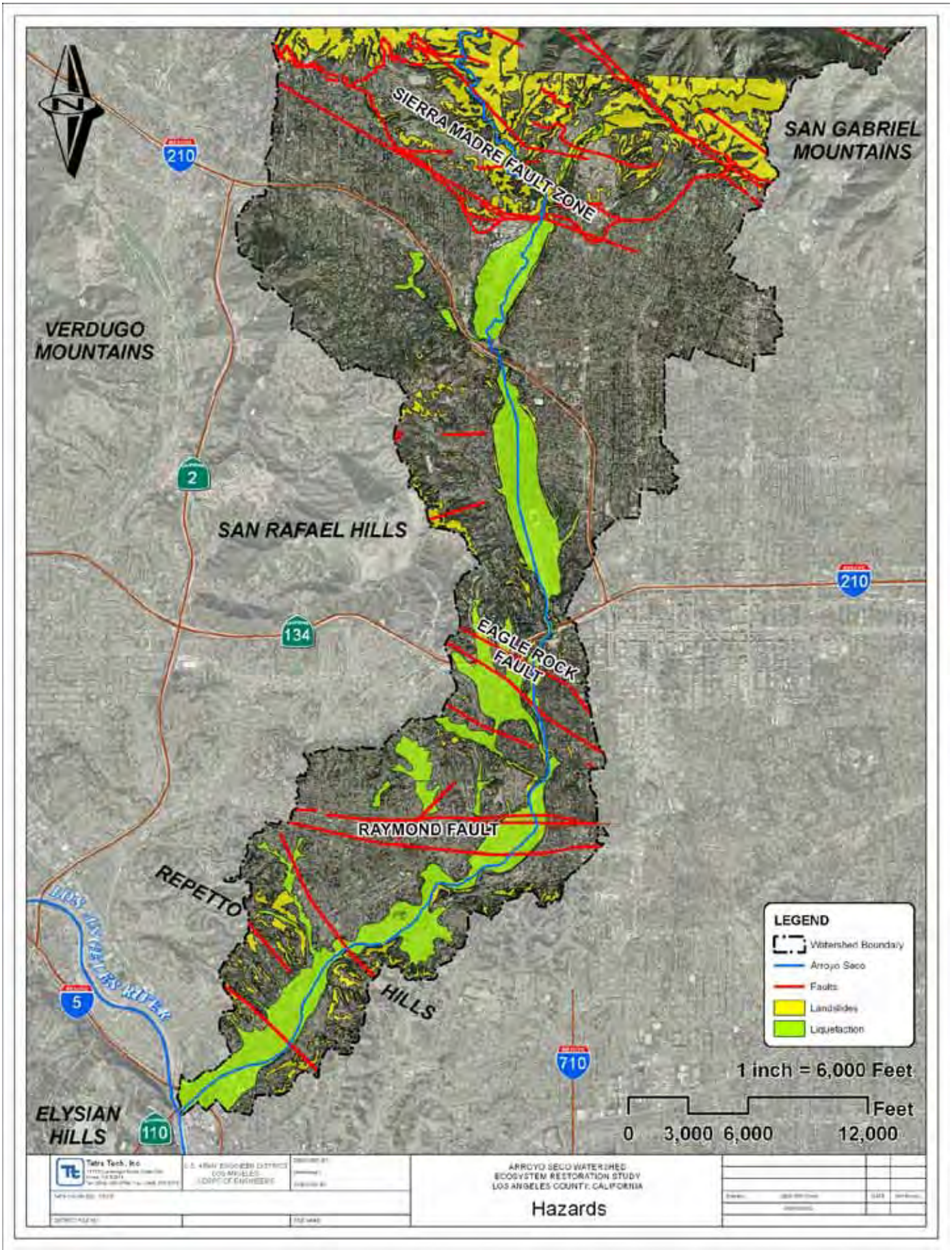

Figure 3.2 Hazards

Photo 3.1 Hahamongna Basin immediately upstream of the Devil's Gate Dam (2010)

3.3 LAND USE

This section describes existing land uses in and around the study area and applicable policies and regulations for Los Angeles County and the cities of Los Angeles, South Pasadena, Pasadena and La Cañada Flintridge, as well as the unincorporated area of Altadena.

3.3.1 Land Use Patterns

The study area vicinity is characterized by a mix of land uses, including open space and recreation, residential, public (i.e. schools, government facilities), and commercial uses. The development in the region consists primarily of residential uses of varying densities, with commercial and industrial uses located along the major transportation corridors, interspersed with open space and recreational lands. The land uses within the study area and vicinity are shown on Figure 3.3.

The existing and future land uses are defined by the each jurisdiction (city) in the study area through their general plan and zoning ordinances. Examples of general land use designations are listed below with example uses that the designations may encompass:

- Open Space: Environmentally sensitive habitat, wildlife refuge/preserve, river, stream or floodplain, coastal bluff, vacant urban land.
- Recreation: State, county, city parks or beach, recreation facility, cultural center, golf course, campground.
- Residential: Single and Multi-family residential, condominium and apartment, mobile homes, hillside management area.
- Commercial: Retail uses, professional offices, business parks.
- Industrial: Manufacturing activities, warehouse and storage, utilities, substations,
- Public Facilities: Major facilities built and maintained for public use such as civic buildings, airports, military installations, hospitals, water, and sewer facilities.

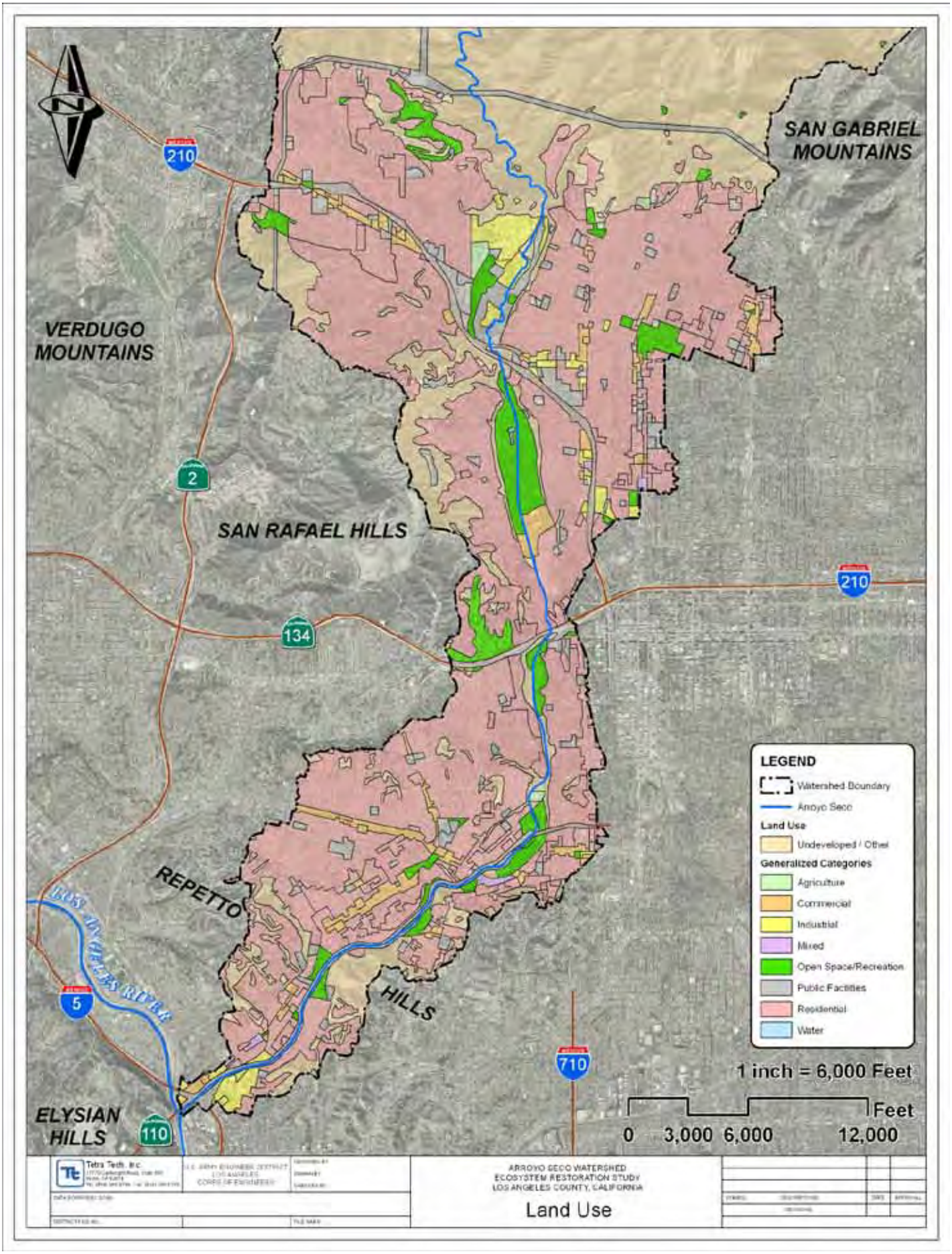

Figure 3.3 Land Use

3.3.2 Regulatory Setting

Regulatory requirements for land use decisions in the Arroyo Seco watershed are addressed at the local level. The LACDPW has jurisdiction over the Arroyo Seco channel. Local regulation is found in various land use plans and policy documents. Land use controls that are specific to each site are discussed under separate headings.

3.3.2.1 City of Pasadena

Five of the nine identified sites are within the City of Pasadena including Site 1, a portion of Site 2, Site 3, Site 4, and Site 5. These sites are subject to the land use goals, objectives, and requirements of the City of Pasadena General Plan (2004) and the Pasadena Municipal Code (2009), as well as more site specific regulations.

Site 1, a portion of Site 2, Site 4, and Site 5 are designated as Open Space in the Pasadena General Plan. Open Space is defined by the Pasadena General Plan as follows: "This category is for a variety of active and passive public recreational facilities and for City-owned open space facilities. This includes natural open spaces and areas which have been designated as environmentally and ecologically significant. This category applies to land which is publicly owned, though in some instances public access may be restricted. Most importantly, this designation only applies to lands owned by the City." Objective 9, Open Space Preservation and Acquisition, of the General Plan identifies the Arroyo Seco for preservation. Specifically, Policy 9.2 states "continue and complete comprehensive planning for, and implementation of plans for the Arroyo Seco, including restoration of the natural area of the Lower Arroyo (Seco) and the development of the Hahamongna Watershed Park Plan."

The four sites designated as Open Space in the General Plan are zoned as Open Space (OS) in the Pasadena Municipal Code. According to the Pasadena Municipal Code, the Open Space zoning classification is applied to sites with open space, parks, and recreational facilities of a landscaped, open character having a minimum contiguous site area of two acres. The Open Space District is consistent with and implements the Open Space land use designation of the General Plan. The goals stated in the Land Use Element of the City of Pasadena's General Plan include the preservation of open space areas.

The Arroyo Seco Public Lands Ordinance (Pasadena Municipal Code, Chapter 3, Section 32) identifies the uses, activities, facilities and structures permitted on the public lands of the Arroyo Seco, including the Lower Arroyo Seco Park site. This site is within the Natural Preservation sub-area established by this ordinance. Permitted uses in this sub-area include low intensity recreational activities within defined activity areas and new structures as required for utility operations, park maintenance and protection of plant and animal communities. All existing uses are allowed to remain but are not allowed to expand.

The Arroyo Seco Public Lands Ordinance also identifies special regulations for Natural Preservation Areas. These regulations limit planting and plant removal activities; the use of fertilizers, pesticides and herbicides; pollutants and wastes; excavation and fill activities; animal hunting and/or trapping; the paving of trails and roads; and the use of motor vehicles. The

ordinance expressly states that: "Except for threat to privately owned lands, structures or public safety, nothing in this chapter shall preclude modification of the flood control channel to restore all or part of the natural stream in the Lower Arroyo Seco." Future proposed restoration activities should be consistent with this ordinance.

3.3.2.2 City of La Cañada Flintridge

A portion of Site 2 is located within the City of La Cañada Flintridge and is subject to the land use goals, objectives, and requirements of the City of La Cañada Flintridge General Plan (1980) and Municipal Code (2009).

3.3.2.3 City of South Pasadena

One of the nine identified sites, Site 6, is partially within the South Pasadena city limits. This site is subject to the land use goals, objectives, and requirements of the City of South Pasadena General Plan (1998) and the City of South Pasadena Municipal Code (2010). The City of South Pasadena General Plan's Land Use Element identified eight Focus Areas for special attention. This designation is intended to define development potential more specific than the underlying land use designation. The Island Site is located within the Arroyo (Seco) Annexation Focus Area, and is designated as Open Space.

3.3.2.4 City of Los Angeles

Four of the nine identified sites are within the City of Los Angeles including Sites 6, 7, 8, and 9. These sites are subject to the land use goals, objectives, and requirements of the City of Los Angeles General Plan (Envicom 1995) and the Los Angeles Municipal Code (2010b). The City of Los Angeles General Plan Land Use Element is divided into 35 community planning areas. The four sites are located within the Northeast Los Angeles Community Plan area. Land use consistency with existing regulations is discussed for each site in detail below.

3.3.2.5 County of Los Angeles

The LACDPW holds an easement granting the County the right to construct and maintain Devil's Gate Dam, its spillway, bypasses, tunnels, and other support facilities as may be necessary for the construction and maintenance of a reservoir capable of impounding the waters of the Arroyo Seco for purposes of storage and control, and to control such waters as may be necessary in the prevention of damage by flood (City of Pasadena 2003b). Downstream of the dam, the LACDPW holds an easement for the Arroyo Seco channel and maintains a 25-foot easement on either side of the channel. Any river channel modification measures that would impact the configuration of the channel would need to be coordinated with the LACDPW to fully evaluate compatibility with existing uses of the channel for flood conveyance. Adjacent to Site 1 is the unincorporated area of Altadena and is subject to the land use goals and policies established in the County's General Plan and the Altadena Community Plan.

3.3.3 Future Without-Project Conditions

In general, land uses in the study area under the future without-project condition would be similar to existing conditions. The study area vicinity is primarily built-out and as such, no substantial changes in the surrounding land use that would affect the Arroyo Seco are anticipated.

3.4 WATER RESOURCES

This section describes the Arroyo Seco surface and groundwater resources in the study area.

3.4.1 Surface Water

The Arroyo Seco is a 22-mile long tributary of the Los Angeles River draining an area of 47 square miles. The Arroyo Seco begins in the San Gabriel Mountains within the ANF and proceeds through Pasadena, South Pasadena, and northeast Los Angeles to join the Los Angeles River near Elysian Park. The upper watershed is in the front range of the San Gabriel Mountains, also referred to as the Sierra Madre Mountains, immediately north of Pasadena, northwest of Altadena and northeast of La Cañada Flintridge. Thirty-two square miles (67 percent) of the watershed is steep, erosion-prone terrain that drains into Devil's Gate Dam and the HWP. The highest point of the watershed is 6,164 feet at Strawberry Peak. Flint Wash drains the northwest corner of the watershed through several canyons and La Cañada Flintridge, entering the Arroyo Seco at Devil's Gate Dam (NET 2006; NET-ASF 2002b).

The Arroyo Seco channel in the study area below the San Gabriel Mountains is characterized by four major reaches:

§ Hahamongna/Devil's Gate basin (1.5 miles in length) at the foot of the mountains: Arroyo Seco is a natural channel in the Devil's Gate Dam flood pool.

§ Central Arroyo Seco (2.5 miles in length, which includes Brookside Park and the Rose Bowl): From the Devil's Gate Dam, the Arroyo Seco flows through a short natural canyon and is contained primarily in a trapezoidal concrete channel extending from the golf course to north of Seco Street. South of Seco Street, the Arroyo Seco transitions to a rectangular concrete channel, extending 750 feet south to the natural drainage channel passing under the Holly Street and the SR-134 bridges before continuing to the next reach.

§ Pasadena's Lower Arroyo Seco (1.5 miles in length): This reach extends from the Colorado Street Bridge to the South Pasadena boundary just south of the SR-110 Bridge. At the Colorado Street Bridge, the natural Arroyo Seco drainage channel flows over a spillway back into the concrete channel. The channel is located in a narrow, highly urbanized canyon.

§ South Pasadena/Los Angeles Arroyo Seco (5.5 miles in length): The Arroyo Seco channel is concrete-lined and located in a narrow, highly urbanized canyon to the confluence with the Los Angeles River.

The Devil's Gate Dam currently has an active storage volume of 1,424 acre-feet (ac-ft) at an elevation of 1,040.5 feet. According to the LACDPW, the minimum capacity for flood safety is 1,400 ac-ft (or two debris events); therefore, the minimum capacity has been reached and any additional sediment entering the dam will need to be removed or moved to above the 1040.5-foot elevation (City of Pasadena 2003b).

There are nine major tributaries to Arroyo Seco downstream of the dam: Montana Street Drain, Linda Vista Tributary, Seco Street Drain, Linda Vista Avenue Drain, Annandale Country Club Drainage, Laguna Road Storm Drain, Arroyo Seco North Branch (also known as Project 5202) (downstream of Avenue 64 and Avenue 52), and Avenue 50 Storm Drain. Over 20 bridges cross the Arroyo Seco in the highly urbanized section downstream of Devil's Gate Dam (City of Pasadena 2002a).

3.4.1.1 Historic Flooding

Since 1860, nine major flood events have occurred along the Arroyo Seco, which led to the development of the Los Angeles River and Arroyo Seco stormwater drainage systems. Overflow channel flooding over the past century has caused loss of life and severe damage to structures and infrastructure. The Arroyo Seco has a long history of flooding from winter storms including:

- In 1861, severe flooding occurred along the Arroyo Seco.
- In 1884, the most destructive flood recorded in Los Angeles County.
- In 1889, Arroyo Seco experienced severe flooding.
- In 1914, a devastating flood occurred in Los Angeles County, primarily the result of floodwaters originating in the San Gabriel Mountains. The flood caused over $10 million in property damage, destroyed 10 bridges, 30 homes, and claimed many lives. Peak flows at the USGS Gage 11098000 were recorded at 5,800 cfs.
- In 1916, a flood recorded peak flows at 3,150 cfs occurred on January 17.
- In 1934, flooding of La Cañada and La Crescenta occurred resulting in 49 deaths and causing $6.1 million in damages.
- In 1938, flooding damaged the SR-2. The USGS gage station recorded a maximum peak flow of 8,620 cfs on March 2.
- In 1943, a flood damaged portions of the Arroyo Seco flood control channel.
- In 1969, a peak flow of 8,540 cfs was recorded on January 25 during heavy rains falling on saturated soil conditions.

Photo 3.2 Flooding along Arroyo Seco (in Highland Park 1912 - top left; 1913 - top right; at Sycamore Grove 1938 - right)

As a result of the 1914 flood, the LACDPW (formerly the Los Angeles County Flood Control District) was formed with a mandate to provide flood protection. The LACDPW initiated construction of multiple dams in the San Gabriel Mountains with the Devil's Gate Dam being the first. The dam was completed in 1920 at the narrowest section of the Arroyo Seco, at the confluence of Arroyo Seco and Flint Wash, near the location of the I-210 Bridge. The dam was developed with the dual purposes of providing flood risk management and water recharge to the Raymond Basin aquifer. The LACDPW holds an easement granting the District the right to construct and maintain the dam and related facilities, including the storage capacity. The project originally was developed to collect flood runoff from the drainage area upstream, store it temporarily, and release it so as not to exceed the downstream channel capacity. Due to

sedimentation, the dam no longer has sufficient storage capacity to significantly affect the magnitude of peak flood flows and the outlet gates and tunnels are now operated to maximize sediment pass-through the dam and minimize sediment accumulation in the dam basin.

3.4.1.2 Hydrology

A large portion of the Arroyo Seco watershed downstream of the San Gabriel Mountains has been urbanized and is now substantially impervious. Due to the high amount of impervious surfaces within the watershed, rainwater quickly makes its way to the storm drains and the Arroyo Seco. In addition, any rainfall in the headwaters makes its way to the Arroyo Seco quickly because of the steep mountainous stream channels in the upper watershed. Additional factors such as wildfires, denuding the slopes of vegetation in the upper watershed that would otherwise slow down the rainfall's journey to the stream, can also increase the speed at which water reaches the Arroyo Seco. The flows in the Arroyo Seco vary greatly over the course of the year. During the dry season, May to October, the streamflow consists of rising groundwater and nuisance[4] urban runoff, and runoff from local and tropical storms is possible (though unlikely) during that time of year. During the wet season, November to April, the river maintains the same baseflow components in addition to runoff from storm events.

In order to determine the discharges in the Arroyo Seco, HEC-FFA (Hydrologic Engineering Center-Flood Frequency Analysis) and HEC-HMS (Hydrologic Modeling System) models were developed for the watershed. The flood frequency analysis was used to develop both low-flow estimates and flood frequency relationships. The results of the flood frequency analysis were then used in the calibration of the HEC-HMS model. The HEC-HMS model was used to develop ranges of discharges for locations along the Arroyo Seco from the headwaters in the San Gabriel Mountains to the confluence with the Los Angeles River. The **Draft F3 Hydrology Appendix** presents the flood frequency analysis and the development and result of the HEC-HMS modeling.

The flood frequency analysis used the data from the USGS Gage 11098000. The gage has a nearly continuous period-of-record since 1914. The flood frequency analysis was conducted using Bulletin 17B methodology using the HEC-FFA software. lists the resulting expected probability peak discharges for the flood frequency analysis for the USGS gage. The flood frequency analysis resulted in an exceedance probability curve with mean of 2.7, a standard deviation of 0.60, and an adopted skew of -0.30.

In addition to the flood frequency analysis, a low-flow analysis was performed on the gage. The results indicate that flow at the gage exceeds 0.5 cfs an average of 78 percent of the year, 1 cfs an average of 64 percent of the year, and 5 cfs an average of 27 percent of the year. The seven-day 2-year (50 percent exceedance probability) flow rate was 0.2 cfs and the seven-day 10-year (10 percent exceedance probability) flow rate, which is normally an indicator of low-flow conditions during a drought, is zero. An analysis of the Los Angeles County Gage below the Devil's Gate Dam was not conducted. First, the operation of the dam has been changed a number of times

[4] Nuisance urban runoff is flow derived from non-rainfall related sources, such as excess landscape watering and drainage, property and auto washing, pool maintenance flushing, and construction dewatering.

over the period of record. Second, data from 1988 on is currently under review by the LACDPW. These factors would render any statistical analysis unreliable.

Table 3.1 Peak Flows in the Arroyo Seco Watershed

LOCATION (CONCENTRATION POINT)	DRAINAGE AREA (sq mi)	DISCHARGE (cfs) FOR RETURN PERIOD (EXCEEDANCE PROBABILITY)						
		2-year (0.50)	5-year (0.20)	10-year (0.10)	25-year (0.04)	50-year (0.02)	100-year (0.01)	500-year (0.002)
USGS Gage #11098000 (BP3)	16.0	586 (570)	1,750 (1,750)	3,030 (3,030)	5,180 (5,200)	7,560 (7,580)	10,300 (10,300)	18,900 (18,900)
Explorer Rd JPL – U/S end of Devil's Gate Dam (J88)	23.2	837	2,480	4,180	7,080	10,200	13,900	24,400
Devil's Gate Dam (J78)	31.6	1,030 (1,100)	2,500 (2,500)	4,280 (4,300)	7,390 (7,400)	11,400 (11,500)	17,300 (17,000)	36,000 (36,000)
Seco St (J73)	36.8	678	1,520	2,270	5,600	8,450	11,200	17,000
Arbor St – South of Colorado Blvd (BP2)	37.5	791	1,720	2,550	5,680	8,580	11,800	17,800
San Pascual Ave - Hermosa St (BP1)	39.4	1,060	2,240	3,260	5,860	8,910	13,200	20,000
49th Ave (J68)	44.5	2,110	3,910	5,430	7,720	10,400	17,800	26,600
Confluence of Arroyo Seco and Los Angeles River (Outlet1)	46.2	2,430	4,430	6,120	8,670	11,400	19,200	28,800
Discharges shown in parentheses were developed from the flood frequency analysis using HEC-FFA.								

A HEC-HMS model of the Arroyo Seco watershed was developed to compute the 2- to 500-year (0.5 to 0.002 exceedance probability) peak flows along the Arroyo Seco channel and serve as baseline model for alternative analysis. The major elements in the rainfall-runoff model include the rainfall data, watershed delineation, and parameterization and calibration. The rainfall data was developed from two National Weather Service precipitation gages located within the Arroyo Seco watershed. The watershed was delineated into 22 sub-watersheds based on 10-meter USGS Digital Elevation Model (DEM) data. The Devil's Gate Dam was modeled using dam operations, stage storage curves, and stage discharge curves provided by the LACDPW. The model was calibrated to the USGS Gage 11098000, the Devils Gate Dam inflow gage, and previous HEC-1 modeling of the confluence of the Los Angeles River.

The discharges computed by the HEC-HMS model are shown in above. shows the locations of the discharges in the study area. It should be noted that the results presented above do not take into account the effects of the 2009 Station Fire, which impacted a large portion of the upper watershed. The response of burnt slopes may affect the discharges from large events for a number of years to come.

3.4.1.3 Hydraulics

The LACDPW developed a HEC-RAS model of the Arroyo Seco from the Devil's Gate Dam outlet to its confluence with the Los Angeles River. The model was developed using available as-built drawings for the channel as well as latest survey data. The HEC-RAS model consists of

channel cross-sections with no overbank modeling. The model is not geo-referenced. Bridge crossings were not modeled since all are above the channel wall, and are free spans with no piers or obstructions in the channel. shows the range of channel velocities for Arroyo Seco below the Devil's Gate Dam for the 10-year (10 percent exceedance probability) event listed in . No modeling for the Arroyo Seco is available upstream of the Devil's Gate Dam.

A review of the Federal Emergency Management Agency (FEMA) Digital Flood Insurance Rate Maps (DFIRM) designate the Arroyo Seco floodplain as either Zone D or Zone X. Zone D is defined as areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted for areas designated as Zone D. Zone X is defined as areas determined to be outside the 500-year (0.002 exceedance probability) floodplain. The 100-year (0.01 exceedance probability) floodplains were not mapped by FEMA.

3.4.2 Groundwater

The primary source of groundwater in the Arroyo Seco watershed is the Raymond Basin, which underlies the majority of the watershed north of the Raymond Fault (located near the Pasadena/South Pasadena city border). Below the Raymond Fault in South Pasadena and northeast Los Angeles, the Arroyo Seco has a limited underground flow towards the Los Angeles River.

The upper two-thirds of the Arroyo Seco watershed flows over the Raymond Basin; the lower one-third continues over a small stretch (approximately 0.6 miles) of the San Gabriel Valley Basin, a 3-mile stretch over the San Fernando Valley Groundwater Basin, and then meets the Coastal Plan of Los Angeles Basin before its terminus at the Los Angeles River .

The Raymond Basin encompasses 40.9 square miles and is located in the northwest part of the San Gabriel Valley, in eastern Los Angeles County, and was considered a part of the San Gabriel Valley Groundwater Basin (DWR 2004). The Raymond Basin is bounded by the San Gabriel Mountains on the north and the San Rafael Hills on the southwest. The west boundary is delineated by a drainage divide at Pickens Canyon Wash and the southeast boundary is the Raymond Fault. Overall, the basin slopes to the south, with an elevation of 1,500 feet at the toe of the San Gabriel Mountains to 500 to 700 feet at the Raymond Fault. Groundwater levels on the north side of Raymond Fault are 200 to 300 feet higher than on the south side of the fault (Brick 2003). Groundwater recharge of the Raymond Basin results from the infiltration of streamflow, penetration of rain falling on alluvial surfaces, and returns from irrigation water. The Arroyo Seco contributes approximately one-third of the natural replenishment of the aquifer (North East Trees et al. 2001). In addition to natural replenishment, a number of spreading grounds are located in the basin including the City of Pasadena's spreading grounds in the HWP above Devil's Gate Dam. The estimated maximum annual capacity of these spreading grounds is about 41,000 ac-ft with an average capture of about 6,000 ac-ft per year over the last 45 years (NET 2002b).

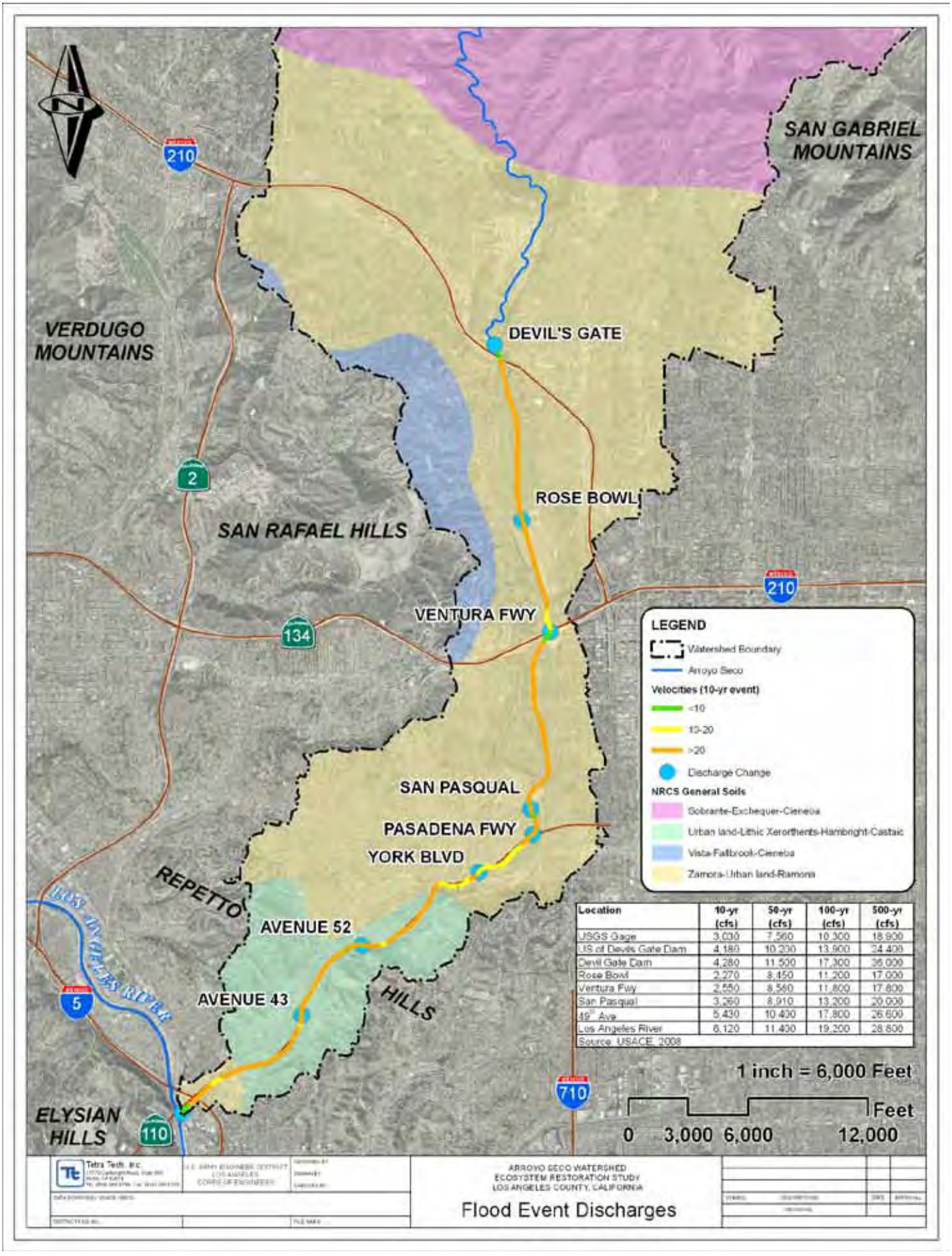

Figure 3.4 Flood Event Discharges

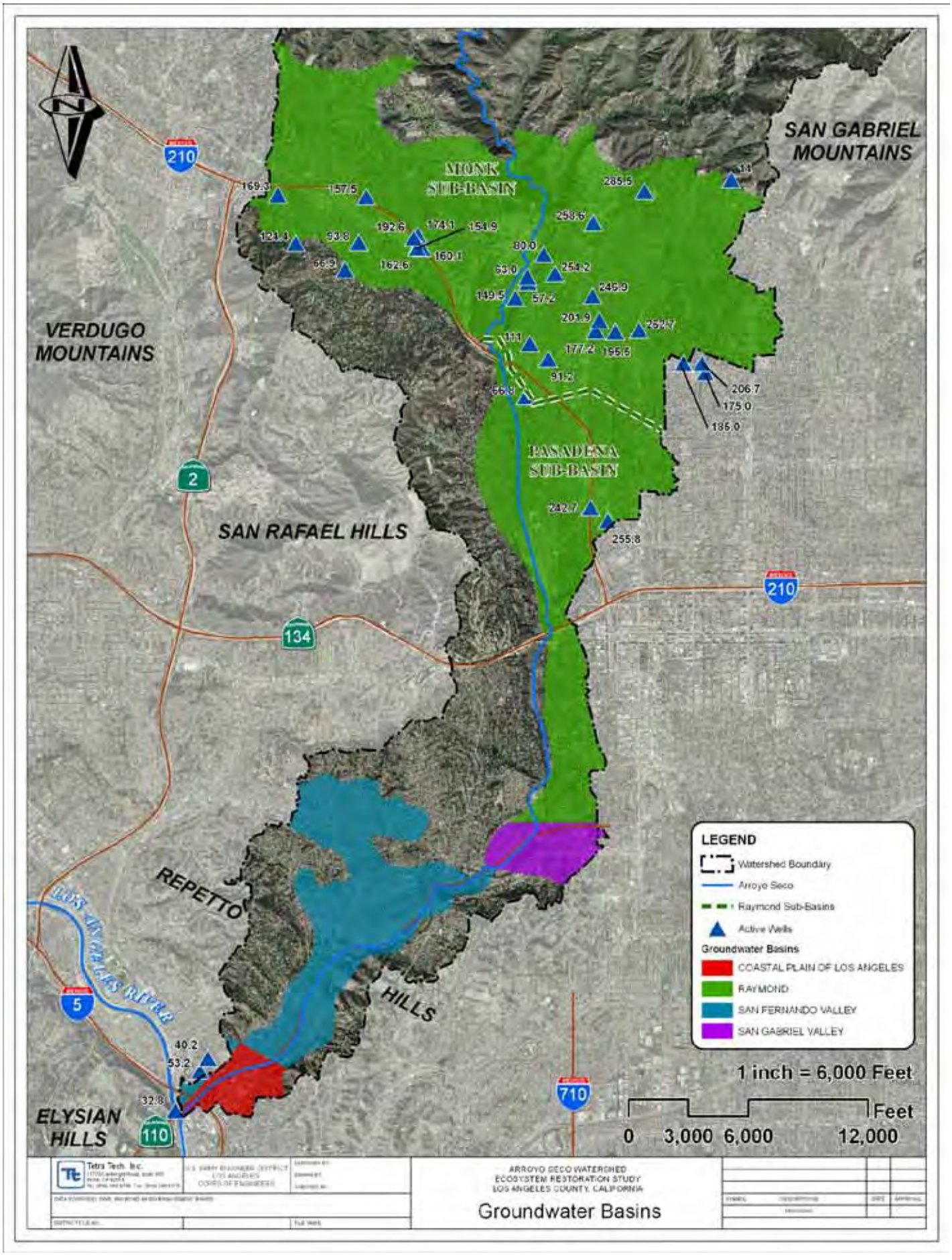

Figure 3.5 Groundwater Basins

The San Gabriel Valley Groundwater Basin encompasses 255 square miles and is bounded on the north by the Raymond Fault and consolidated basement rocks of the San Gabriel Mountains. The Repetto, Merced, and Puente Hills bound the basin on the south and west, and the Chino and San Jose Faults form the eastern boundary (DWR 1966). The Rio Hondo and San Gabriel drainages have their headwaters in the San Gabriel Mountains, then surface water flows southwest across the San Gabriel Valley and exit through the Whittier Narrows, a gap between the Merced and Puente Hills.

The San Fernando Valley Groundwater Basin encompasses 226 square miles and includes the water-bearing sediments beneath the San Fernando Valley, Tujunga Valley, Browns Canyon, and the alluvial areas surrounding the Verdugo Mountains near La Crescenta and Eagle Rock (DWR 2003). The basin is bounded on the north and northwest by the Santa Susana Mountains, on the north and northeast by the San Gabriel Mountains, on the east by the San Rafael Hills, on the south by the Santa Monica Mountains and Chalk Hills, and on the west by the Simi Hills. The valley is drained by the Los Angeles River and its tributaries.

The Coastal Plain of Los Angeles Basin encompasses 142 square miles and is bounded on the north by the Ballona Escarpment, to the east by the Newport-Inglewood fault zone, and to the south and west by the Pacific Ocean and consolidated rocks of the Palos Verdes Hills (DWR 2003). The surface of the subbasin is crossed in the south by the Los Angeles River through the Dominguez Gap, and the San Gabriel River through the Alamitos Gap, both of which then flow into San Pedro Bay.

3.4.3 Water Rights/Supply

The California Department of Water Resources (DWR) defines the Arroyo Seco as a *Fully Allocated Stream*, meaning that there is no more water to be distributed. Water rights in the Arroyo Seco watershed are clearly defined and carefully regulated. Water rights in the Raymond Basin were divided by a judicial decree in 1944 that established a safe yield for the basin. lists the water rights allocation for the Raymond Basin. The Raymond Basin Management Board, composed of representatives of the water rights holders, manages pumping and is overseen by a judge. The California DWR measures streamflow and pumping (NET 2002b).

The Raymond Basin provides a large portion of the domestic water supply to the cities of La Cañada Flintridge, Pasadena, Sierra Madre, Alhambra, and Arcadia, with Pasadena and Arcadia having rights to over 60 percent of the total basin allocation. The sixteen allocated producers operate more than 50 wells annually in the basin with various wells yielding up to several thousand gallons per minute. The Metropolitan Water District's (MWD) Upper Feeder serves treated imported water to six producers in the basin, including the City of Pasadena and five agencies of the Foothill Municipal Water District. The MWD water supplements the local groundwater supply and accounts for more than 60 percent of the water supply use in the area. In Pasadena, groundwater extraction accounts for 49 percent of the city's domestic water supply (NET 2002b; Brick 2003).

Table 3.2 Raymond Basin Water Rights Allocation			
AGENCY	**DECREED RIGHT (ac-ft)**		**MAXIMUM STORAGE ALLOCATION (ac-ft)**
Alhambra, City of	1,031	3.37%	3,600
Arcadia, City of	5,644	18.33%	17,000
California-American Water Company	2,299	7.51%	6,900
East Pasadena Water Company	515	1.68%	1,600
H.E. Huntington Library & Art Gallery	372	1.21%	1,200
Linneloa Irrigation Water District	516	1.69%	1,600
La Cañada Irrigation District	100	0.33%	2,300
Las Flores Water Company	249	0.81%	900
Lincoln Avenue Water Company	567	1.85%	2,200
Pasadena Cemetery Association	91	0.30%	300
Pasadena, City of	12,807	41.83%	38,500
Rubio Cañada Land & Water Association	1,221	3.99%	3,700
San Gabriel County Water District	1,091	3.56%	3,300
Sierra Madre, City of	1,764	5.76%	5,300
Sunny Slope Water Company	1,558	5.09%	4,700
Valley Water Company	797	2.60%	3,400
TOTAL	**30,622**		**96,500**

In addition to the groundwater use in the Raymond Basin, several water users divert streamflow from the Arroyo Seco or nearby springs including:

§ The City of Pasadena has the right to divert up to 25 cfs from the Arroyo Seco, including diversions from Millard Creek, for use in the spreading grounds above Devil's Gate Dam. Pasadena receives an 80 percent credit for water recharged to the basin. Currently, the spreading capacity can only handle an 18 cfs diversion (Geoscience 2004).

§ The Arroyo Seco Golf Course in South Pasadena has taken an unmetered diversion from the Arroyo Seco stream since 1955 to irrigate approximately 30 acres of the golf course (Takara 2008; NET-ASF 2002a).

§ The Yosemite Waters Company taps a spring at Avenue 54 for its drinking water supply.

§ Near the confluence at 451 N. San Fernando Road in Los Angeles, the Angelica Healthcare Services Group, a linen supplier, is pumping groundwater. This is outside of the Raymond Basin and not subject to the allocation agreement discussed above (NET 2002b).

§ Previously, the small amount of water being produced by the abandoned Devil's Gate percolation tunnels was used for irrigation at the Brookside Golf Course in Pasadena. This was discontinued around 1998. Currently, a feasibility study is being conducted to determine the viability of renewing irrigation with tunnel water (Takara 2008).

3.4.4 Water Quality

3.4.4.1 Surface Water Quality

Water quality in the Arroyo Seco watershed is degraded in several significant ways. The greatest influence on in-stream water quality conditions within Arroyo Seco is the location of human activities within the watershed. The upper two-thirds of the Arroyo Seco watershed lies within the boundaries of the ANF; hydrologic functions, water quality, and the natural ecosystem in this area is relatively pristine due to conservation/preservation efforts enacted by national forest designation (limited anthropogenic activities). However, with steep slopes and forest/brush fires caused by arson with far less frequent natural cycles of fire, debris flows and high concentrations of fine sediment loadings have impaired the creek's water quality.

Further down the watershed to the south, pollutant loadings from horse corrals and golf courses contribute unnaturally high loadings of nutrients from manure and synthetic fertilizers. Water quality impairments of concern within the lower reaches of the watershed include increased temperatures, non-point source pollution, trash, coliforms, and algal blooms (ASF 2008c). Unlike the upper reaches of the creek, the lower Arroyo Seco is channelized, disconnected from the floodplain, and void of natural habitat that can aid in the cooling of instream temperatures, stabilization of channel banks, and filtration of natural and anthropogenic sources of pollutants.

The Hahamongna Basin, a subwatershed of the Arroyo Seco, is a Superfund site due to the presence of volatile organic chemicals and perchlorate. The source of these contaminants originates from the NASA-funded JPL upgradient of the site. These contaminants were improperly disposed of in seepage pits by JPL and the U.S. Army (owned and operated from 1945 to 1957) and were not detected until just recently (20 years ago). The contaminants are being addressed by Federal, state, and local actions (USEPA 2010d). For more information on the JPL Superfund site, see Section 3.10 under Hazardous Waste and Materials in this report.

Nitrates from past agricultural practices and septic tank systems are a significant factor in some parts of the watershed. Street runoff from throughout the watershed pollutes the Arroyo Seco stream with trash and contaminants, and the Los Angeles Regional Water Quality Control Board (LARWQCB) has detected unacceptable levels of coliform from animal waste.

A. Beneficial Uses of the Arroyo Seco Watershed

Water quality throughout California is protected by the State Water Resources Control Board's Water Quality Objectives designated to protect Beneficial Uses. Beneficial Uses determine the degree of water quality protection needed to support current and future human and wildlife utilization. The LARWQCB Region 4 has designated Beneficial Uses for the Arroyo Seco including:

§ Municipal (MUN). Water used for military, municipal, individual water systems, and may include drinking water.

- Industrial Process Supply (PROC). Uses of water for industrial activities that depend primarily on water quality.
- Industrial Service Supply (IND). Water supply for industrial uses that do not depend on water quality.
- Ground Water Recharge (GWR). Natural or artificial Ground Water Recharge for future extraction, to balance natural hydrologic processes, and to maintain navigable channels.
- Recreational Contact 1 (REC1). Recreational Contact 1 is protective of activities where body with water contact or possible ingestion may occur. Examples of these activities include: wading, swimming, diving, surfing, white water rafting, etc.
- Recreational Contact 2 (REC2). Recreational Contact 2 is protective of activities near water, but not occurring in water. Examples of these activities include: picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool exploration, etc.
- Warmwater Habitat (WARM). Water used for the support of warm water ecosystems for the preservation and maintenance of aquatic habitat and wildlife species (flora and fauna).
- Coldwater Habitat (COLD). Uses of water that support cold water ecosystems for the preservation and maintenance of aquatic habitat and wildlife species (flora and fauna).
- Wildlife Habitat (WILD.) Waters that support wildlife habitats that may include, but are not limited to, the preservation and enhancement of vegetation and prey species used by waterfowl and other wildlife.
- Rare, Threatened or Endangered Species (RARE). Habitat types that are necessary for the survival and livelihood of plant and animal species listed by the state/Federally as rare, threatened, or endangered.
- Wetlands (WET). Water used for the support of wetland ecosystems and habitat for the preservation of species of flora and fauna. WET beneficial uses also include flood and erosion control, natural treatment of impaired water quality, and stream bank restoration.

B. Impaired Waters 303(d) listings

As required under Section 303(d) of the Federal Clean Water Act (CWA), states, territories, and tribes are required to identify and prioritize impaired water bodies for the future development of Total Maximum Daily Loads (TMDLs) within their boundaries. Impaired water bodies in California are defined as water bodies that consistently do not meet Water Quality Objectives, and do not protect designated Beneficial Uses. The law requires that jurisdictions responsible for 303(d)-listed waters develop a TMDL. A TMDL quantifies the amount of pollutant that a water body can receive and still safely meet established Water Quality Objectives and ensure protection of designated Beneficial Uses.

As required under the CWA, baseline water quality monitoring assessments conducted by watershed stakeholders and the state have characterized two reaches of the Arroyo Seco as impaired and consequently 303(d) listed. The U.S. Environmental Protection Agency (EPA) 303(d)-listed water bodies and impairments that contribute pollutant loadings to the Arroyo Seco are as follows: Arroyo Seco Reach 1 (downstream Devil's Gate Dam) and Reach 2 (W. Holly Avenue to Devil's Gate). Both reaches () are listed for trash and pathogens. A description of these impairments follows:

- Trash. Trash is conveyed into water bodies via urban run-off from improper land use management activities. Trash contributes to the degradation of habitat, flora and fauna species, and coastal resources downstream.

- Pathogens. Coliform bacteria is categorized by the EPA as a "pathogen" and is conveyed into watersheds via urban runoff and readily propagates in degraded in-stream habitat conditions. Coliforms can cause illnesses in recreational water contact (swimming, kayaking, surfing, etc.).

C. Total Maximum Daily Loads

The law requires that jurisdictions responsible for 303(d) listed waters develop a TMDL in order to set numeric limits on the amount of pollutant that a water body can receive and still safely meet established Water Quality Objectives and ensure protection of Designated Uses. A Trash TMDL was established for the Los Angeles River watershed and tributaries (including Reaches 1 and 2 of Arroyo Seco) in 2002 and then updated in 2008. The objective of the Los Angeles River Trash TMDL is to reduce trash loadings to zero by September 2016. Numeric targets were established for the TMDL by calculating baseline trash loadings. From this baseline, compliance checkpoints were set up to gage waste load allocation reductions. Reductions will continue incrementally until the September 2016 zero trash target.

A pathogen TMDL is still under development and was originally anticipated for September 30, 2009. Currently, a 2008 state water boards TMDL listing is being developed for the pathogen TMDL, which is expected to be released by summer 2010.

D. Water Quality Monitoring Programs and Studies within the Watershed

Several entities concerned with the health of the Arroyo Seco watershed have been conducting water quality monitoring activities to better establish baseline conditions and to assess the source of water quality impairments.

Arroyo Seco Watershed Management and Restoration Plan

The study, led by the NET in conjunction with the California State Water Resources Control Board and local partners, improved knowledge on current conditions within the Arroyo Seco watershed through more in-depth technical analysis, as well as developed water quality and habitat models to target key project areas. The water quality analyses involved the assessment of Arroyo Seco water quality; the identification of key sources of nonpoint source pollution; and the identification of BMPs to mitigate these pollution sources (NET 2006).

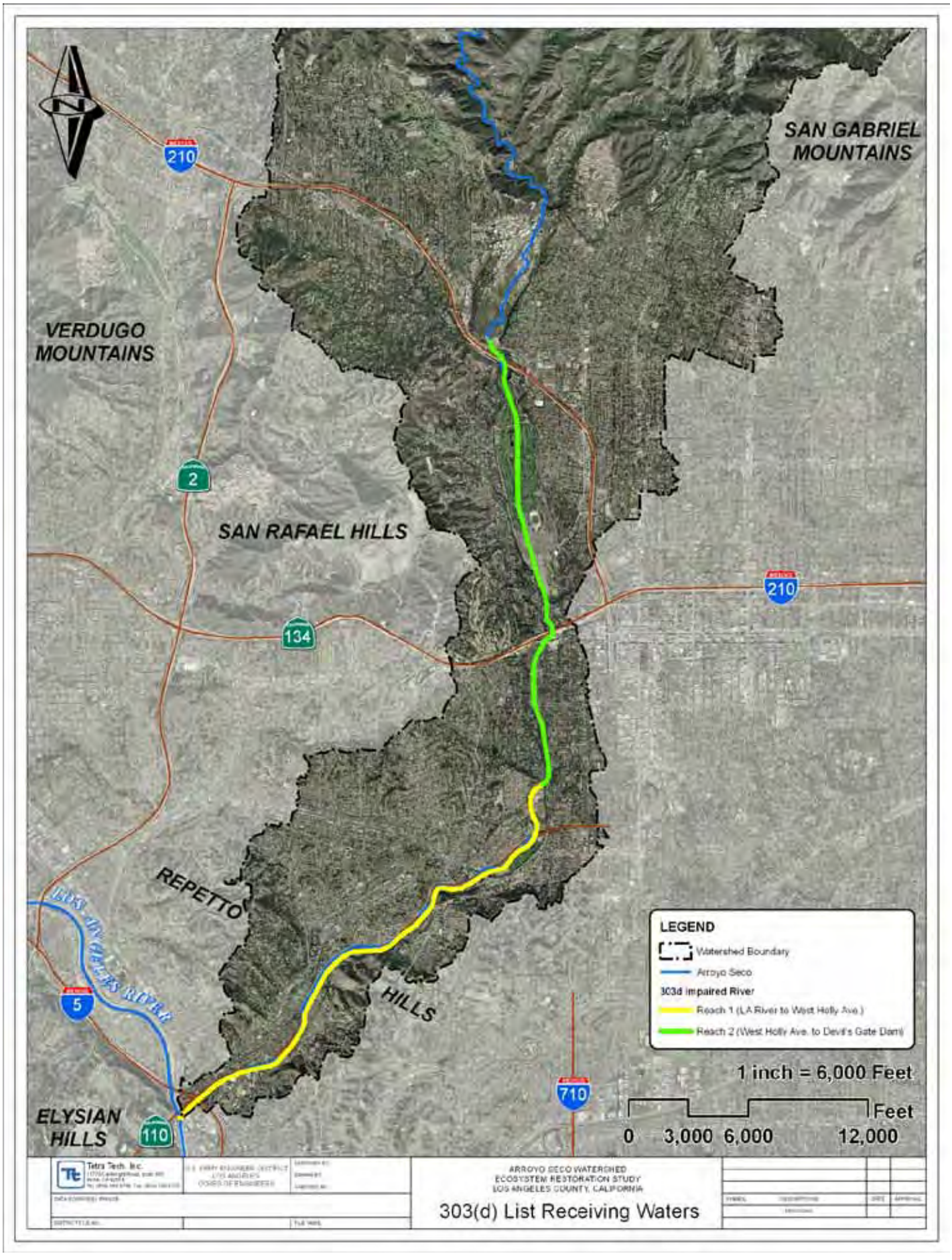

Figure 3.6 303(d) List Receiving Waters

During the study, the NET launched an aggressive data collection campaign, which yielded seven sources of water quality monitoring data collected from past water quality monitoring programs/efforts and studies. Sources collected included water quality data from the following: LARWQCB, County of Los Angeles, City of Los Angeles, City of Pasadena, Southern California Coastal Watershed Research Project, JPL, and Friends of the Los Angeles River. Data from these agencies was sampled from 1976 to 2004, covered at least six different sampling points within the watershed, included over 225 analytes, and consisted of at least 1,950 discrete samples (NET 2006).

Results from the water quality analysis of existing data indicated that elevated bacteria levels within the Arroyo Seco watershed were the most persistent and problematic water quality impairments. Bacteria levels far exceeded the LARWQCB's water quality objectives and did not support, or meet the beneficial uses designated for the watershed (NET 2006). Other impairments found in the analysis included chloride, the metals copper, lead, aluminum, and zinc, and the pesticides diazinon and nitrite. The study noted that though sampling events indicated that these impairments exceeded LARWQCB's water quality objectives, additional baseline data was needed to better establish an understanding of the extent of contamination from these constituents within the watershed (NET 2006).

Arroyo Seco Foundation

The ASF conducted water quality monitoring from 2006 to 2008 with a majority of water quality collection occurring from June 2007 to June 2008. The objectives of the monitoring program was to collect water quality data that could characterize seasonal, annual, and long-term changes in the watershed water quality and resources, to detect point and non-point sources of pollution, to educate the public about the Arroyo Seco and its riparian corridor, and to develop community awareness and stewardship for the watershed and its resources. The latter objective involving education and stewardship was accomplished by recruiting and training volunteer citizens for water quality collection and assessment.

Water quality parameters collected by the program included: pH, water temperature, air temperature, dissolved oxygen, nitrate, phosphate, copper, and bacteria. The following sites were monitored by the program from 2006 to 2008:

- Confluence. The site is located where the Arroyo Seco joins the Los Angeles River near downtown Los Angeles.
- North Branch. A major tributary, which flows through Sycamore Grove Park in northeast Los Angeles.
- Golf Course. The Arroyo Seco Golf Course in South Pasadena.
- San Rafael. The creek coming from Johnson Lake in Pasadena entering the Arroyo Seco a bit north of the South Pasadena city line.
- Restoration (BFI). The low-flow streams in Pasadena's Lower Arroyo Seco.
- Seco Street. A stormdrain system that drains much of Northwest Pasadena and enters the Arroyo Seco near Brookside Park just south of the Rose Bowl.
- Flint Canyon. A tributary, which drains La Cañada Flintridge and meets the Arroyo just north and to the west of Devil's Gate Dam in Hahamongna.
- Altadena Drain. A storm drain outlet from Altadena near the top of the Hahamongna basin.

§ El Prieto. The canyon near the Forest Service homes above the mouth of the Arroyo Seco and JPL.

Water Quality Monitoring Results: June 2007 to June 2008

Available data for analysis from the sample period (June 2007 to June 2008) includes pH, NO3-N (Nitrate-Nitrogen), turbidity, total coliform, and E.coli (Escherichia coliform). Following is a discussion of bacteriological project sample results, and a review of pH, turbidity, and NO3-N data results.

The ASF collected E.coli and total coliform data for the duration of the program. Though bacteria are usually not harmful to humans and wildlife, large concentrations are often correlated with human and animal viral pathogens. Bacteria can be introduced into surface water from wildlife, septic system failures, and improper land use management of domesticated animals (ungulates, dogs, cats etc.).

Total coliform levels at the program's samples sites were relatively low to moderate concentrations, ranging from >200 to >2500 MPN CFU (Most Probable Number per Colony Forming Unit).

The LARWQCB does not have a water quality objective established for total coliform levels, but has established fecal coliform water quality objectives. E.coli is categorized as fecal coliform and can be used to analyze the presence of fecal coliform in surface water. The LARWQCB's water quality objectives for fecal coliform state that samples shall not exceed 400 MPN/CFU for 10 percent of samples taken during a given month. (If only one sample is taken during the month then that sample is used). illustrates the percentage of E.coli sample exceedances in the 13-month sample period.

Table 3.3 ASF 2007 – 2008 E.coli Sample Exceedance Data

SAMPLE SITE	NO. OF SAMPLES	EXCEEDANCE
Confluence	13	15%
North Branch	12	8%
Golf Course	13	0%
San Rafael	13	15%
BFI	12	0%
Slime Side	11	9%
Seco St Drain	12	8%
Flint	13	31%
Altadena Drain	11	9%
Millard Canyon	9	0%
El Prieto	13	0%

The LARWQCB's Basin Plan water quality objectives state that the pH (hydrogen ion activity of water) of inland surface waters shall not be depressed below 6.5, or elevated above 8.5 as a result of waste discharges. In addition, in-stream ambient pH levels shall not be changed by more than 0.5 units from natural conditions as a result of waste discharge. High (basic >7) or low (acidic

<7) levels of pH can have serious and negative impacts the health of plants and aquatic animals. As presented in , sites within the Arroyo Seco had three exceedances during three separate sample events in the course of the monitoring program. Additional information not provided (instrument resolution) was not factored in as a margin of error for this report.

Table 3.4 ASF 2007 – 2008 pH Monitoring Data

SAMPLE SITE	2007							2008						# EXCEEDANCE
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Confluence	8.22	8.06	8.45	8.72	8.3	8.1	8.15	7.58	7.94	8.03	8.29	7.99	8.27	1
North Branch	7.95	7.92	8.14	8.2	8.12	8.02	8.05	7.67	7.75	7.98	8.1	8.01	8.08	0
Golf Course	8.04	8.01	8.05	8.21	8.16	8.15	8.13	8.04	7.9	7.94	8.12	8.05	8.13	0
San Rafael	8.06	7.92	8.23	8.27	8.47	8.27	8.39	8.39	8.26	8.36	8.14	8.14	8.28	0
BFI	7.88	7.58	8.02	8.1	8.07	7.98	7.95	7.58	7.92	8.12	8.1	8.01	7.98	0
Slime Side			8.04	8.17	8.05	7.99	8.02	7.46	7.68	7.93	8.03	7.85	7.85	0
Seco St Drain		8.34	8.1	8.1	8.19	8.12	8.12	8.06	7.5	8.08	8.17	8.09	8.51	1
Flint	7.97	7.96	7.78	7.94	8.1	7.96	8.05	7.95	7.76	8	7.92	7.89	8.03	0
Altadena Drain			8.49	8.06	8.41	8.35	8.43	8.32	7.8	8.33	8.41	8.38	8.52	1
Millard Canyon					7.82	7.93	7.98	7.56	7.54	7.82	7.84	7.91	7.73	0
El Prieto		7.87	7.9	7.8	8.04	7.78	7.98	8.02	8.06	8.12	8.21	8.18	8.17	0

The LARWQCB's Basin Plan water quality objectives state that inland surface water with natural turbidity levels between 0 and 50 NTU (nephelometric turbidity units) shall not have increases greater than 20 percent; inland surface waters with natural turbidity levels over 50 NTU shall not have increases greater than 10 percent. High in-stream turbidity levels can cause increased water temperatures, smother eggs of aquatic species, and limit light in the water body for the growth of aquatic plants. As seen in , sites within the Arroyo Seco had relatively low turbidity levels during the course of the monitoring program. An analysis of exceedances for turbidity during the program's monitoring period was not performed for this data because natural background turbidity for the system has not been identified. Additional information not provided (instrument resolution) was not factored in as a margin of error for this report.

The LARWQCB's Basin Plan water quality objectives states that inland surface waters shall not exceed NO3-N (Nitrate-Nitrogen) levels by 10 mg/L. Nitrogen levels are an indicator of leaky septic systems, fertilizers, and animal manure. High levels of nitrogen cause excessive algal blooms and subsequent anoxic conditions within a water body. Site on the Arroyo Seco () did not exceed the LARWQCB's NO3-N water quality objectives on any sample event.

Table 3.5 ASF 2007 – 2008 Turbidity Monitoring Data													
SAMPLE SITE	2007							2008					
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Confluence	1.4	2.7	0.8	2.2	1.9	0.5	0.9	5.65	3.2	2	0.31	0.27	1.73
North Branch	0.6	0.7	0.4	0.9	0.7	0.35	0.4	5.9	5.15	0.48	0.29	0.37	0.42
Golf Course	2.4	3.7	0.8	4.2	1.4	4	1.65	2	2.6	1.3	0.66	1.05	2.72
San Rafael	5.9	7.2	1.7	7.4	2.7	2.5	1.35	0.55	1.2	0.63	1.8	2.51	16.5
BFI	1.8		0.6	1.1	2	0.3	0.45	5.65	0.25	0.88	1.01	1.15	0.7
Slime Side			1	1.9	1	2.5	1.1	5.9	5.55	2.5	0.65	0.53	0.88
Seco St Drain		1	1.3	17E	1	0.7	0.7	1.5	11.8*	1.75	0.5	0.32	4.38
Flint	1	0.9	1.4	1.35	1.6	0.8	1.2	1.4	9.9*	2.2	1.47	0.55	1.12
Altadena Drain			1.3	4.5	2.9	0.5	0.55	2.4	2.8	0.53	1.04	1.17	0.87
Millard Canyon					0.55	0.15	0.2	0.4	0.25	0.32	0.21	0.31	0.2
El Prieto		0.1	0.2	0.5	0.4	0.2	0.25	0.25	0.45	0.22	0.39	0.14	0.19

Table 3.6 ASF 2007 – 2008 NO3-N Monitoring Data													
SAMPLE SITE	2007							2008					
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Confluence	3.5	3.09	3.78	3.53	3.91	4	4.4	1.35	3.3	4.13	3.93	3.37	4
North Branch	8.2	7.82	6.68	6.99	7.6	7.62	8.65	1.37	4.67	9.15	9.06	8.63	8.61
Golf Course	2.8	3.03	2.77	2.65	2.43	2.45	3.03	3.1	3.19	2.9	3.8	2.45	2.88
San Rafael	0.7	1.24	0.92	0.83	0.7	1.3	1.48	1.69	2.18	2.18	1.48	1.21	0.67
BFI	3.2		2.25	2.61	2.63	2.76	2.92	1.21	1.19	2.81	4.09	2.63	2.58
Slime Side			2.97	3.19	3.08	3.46	3.24	1.24	3.19	3.03	4.56	3.03	3.24
Seco St Drain		3.89	9.07	7.51	8.7	8.38	8.99	9.35	4.36	9.24	7.48	8.9	1.53
Flint	2.5	2.87	2.14	2.11	1.17	2.72	1.89	4.49	3.17	1.3	5.08	1.75	2.43
Altadena Drain			0.74	11.46	3.66	0.9	1.39	3.57	2.31	1.87	0.92	3.21	1.17
Millard Canyon					1.98	1.71	1.26	1.98	1.39	0.81	1.35	1.15	1.24
El Prieto		0.25	0.18	0.22	0.25	0.22	0.4	1.35	0.52	0.07	0.09	0.11	0.22

3.4.4.2 Groundwater Quality

Groundwater quality in the Raymond Basin is generally good to fair in most areas with the exception of the Superfund site near JPL. Groundwater concentrations of total dissolved solids (TDS) typically range from 350 to 700 mg/L in the central and southern portions of the Pasadena Monk Hill subareas. In the Santa Anita subarea, concentrations of TDS range from below 300 mg/L near the mountains of the Sierra Madre to above 300 mg/L further south (MWD 2007). Groundwater quality samples are collected from active production wells within the Raymond Basin in accordance with California Department of Health Services (DHS) requirements, as specified in Title 22 of the California Code of Regulations. No basin-wide monitoring program has been established. The primary contaminants of concern in the Raymond Basin include:

nitrate, perchlorate, and volatile organic compounds (VOCs), specifically chlorinated solvents perchloroethylene (PCE) and trichloroethylene (TCE) (MWD 2007).

A number of wells throughout the basin have been impaired by nitrate, a result of historical agricultural practices and septic tank effluent (). Most of the higher concentrations of nitrate are found in the shallower portions of the Raymond Basin. Nitrate concentrations are highest in the shallow areas below former agricultural areas in Monk Hill and in the southeastern portion of the Pasadena unit. Twelve wells have had nitrate concentrations above the maximum contaminant levels of 10 mg/L (MWD 2007).

Table 3.7 Water Quality in Public Supply Wells

CONSTITUENT GROUP[1]	NUMBER OF WELLS SAMPLED[2]	NUMBER OF WELLS WITH CONCENTRATION ABOVE MCL[3]
Inorganics-Primary	66	9
Radiological	55	8
Nitrates	78	23
Pesticides	57	0
VOCs and SVOCs	60	19
Inorganics-Secondary	66	9

[1]A description of these constituent groups can be found in California's Groundwater- Bulletin 118 by DWR (2003).
[2]Represent distinct number of wells sampled as required under DHS Title 22 program from 1994 through 2000.
[3]Each well confirmed with a concentration above an MCL was confirmed with a second detection above an MCL. This does not indicate the type of water quality that is delivered to the consumer, but the characteristics of contamination in the groundwater basin.

In the 1940s and 1950s, liquid wastes from materials used at the JPL were disposed of into seepage pits, a practice common at that time. While these disposal practices were discontinued by the early 1960s, some chemicals, such as perchlorate and volatile organic compounds, have been found in groundwater beneath the facility and in areas adjacent to JPL, to the east and southeast. Due to the presence of elevated levels of contaminants during routing well monitoring in the late 80s, the JPL site was characterized as a Superfund site in 1992. The EPA's Superfund program is used to identify, investigate, and clean up uncontrolled or abandoned hazardous waste sites throughout the United States (USEPA 2010d). Cleanup of VOCs and perchlorate have been ongoing and are being addressed by Federal, state, and local entities. For more information on Superfund sites within the Arroyo Seco watershed, see Section 3.10, Hazardous Waste and Materials. PCE and TCE have been detected above the maximum contaminant level (MCL) for TCE and PCE in seven wells in Monk Hill, southeastern Pasadena and in Santa Anita. Treatment for PCE and TCE is online in Monk Hill. Seven wells within the Monk Hill and Pasadena subareas along the Arroyo Seco are currently inactive because of perchlorate (MWD 2007).

Groundwater in this basin is typically high in calcium bicarbonate. The average total dissolved solids content in the Pasadena portion of the basin is about 400 mg/L, with a high of 600 mg/L (PWP 2000). The Electrical Conductivity of groundwater ranges from 436 to 895 mhos/cm (PWP 2000). Data for 70 public supply wells indicate an average TDS content of 346 mg/L with a range from 138 to 780 mg/L.

Monitoring efforts in the basin, including responsible agencies, parameters, number of wells, and the frequency of measurements are illustrated in the following table () (DWR 2004):

Table 3.8 Active Groundwater Monitoring Data Collection		
AGENCY	**PARAMETER**	**NUMBER OF WELLS/MEASUREMENT FREQUENCY**
Department of Water Resources	Groundwater Levels	88 /annually
Water Resources USGS	Quality	
Department of Health Services	Title 22	70/Annually

A. Groundwater Beneficial Uses

Groundwater quality is under the jurisdiction of the LARWQCB Region 4. The LARWQB has designated Beneficial Uses for the Raymond Groundwater Basin including:

§ Municipal (MUN). Water used for military, municipal, individual water systems, and may include drinking water.

§ Industrial Service Supply (IND). Water supply for industrial uses that do not depend on water quality.

§ Industrial Process Supply (PROC). Uses of water for industrial activities that depend primarily on water quality.

§ Agricultural (AGR). Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

B. Groundwater Impairments

Fluoride content occasionally exceeds recommended levels of 1.6 mg/L near the San Gabriel Mountain front (maximum of 3.1 mg/L; average of 1.0 mg/L; [DWR 1978]). High nitrate concentrations are found in water from some wells near Pasadena (RBMB 1999). Volatile organic compounds are detected in wells near Arroyo Seco (RBMB 1999). Radiation is occasionally detected near the San Gabriel Mountains (DWR 1978). A Superfund site exists near the JPL because of perchlorate contamination (RBMB 1999).

3.4.5 Future Without-Project Conditions

Under the future without-project conditions, habitat and stream degradation in the Arroyo Seco would continue as a result of increased flows from impervious areas from urban development. Paved areas allow less infiltration and create greater runoff delivered at higher velocities and less sediment. This rapid-flowing “sediment-hungry” water will have the tendency to pick up sediment as it moves downstream resulting in higher rates of erosion of the creek bed and banks. In addition, the Arroyo Seco channel would be maintained at the existing capacity and localized flooding would continue to occur.

With the projected population growth in the region, water quality (surface and groundwater) in the watershed is expected to continue to decline primarily due to increased anthropogenic sources of pollution. Population growth will also create higher demands for water use in the region and further degrade the basin's ability to naturally recharge groundwater.

The Arroyo Seco watershed would be subject to varying hydrologic and hydraulic conditions with the increased potential for natural catastrophic wildfires in the upper reaches. As discussed in Section 3.6, Global Climate Change, the projected increase in average temperatures and changes in rainfall patterns could increase the risk of wildfires in the area. The response of burnt slopes and their effect on large event discharges is currently under investigation by the BAER Team. Results from recent post-fire assessment (2009 Station Fire) are presented in Section 3.3 (under Land Use).

3.5 AIR QUALITY

This section presents the current air quality conditions in the Arroyo Seco study area and the applicable regulatory framework.

3.5.1 Setting

The primary factors that determine air quality in a particular area include the types of pollutants released to the atmosphere, the locations of air pollutant sources, and the amounts of pollutants emitted. Important contributing factors are meteorological and topographical conditions. Atmospheric conditions such as wind speed, wind direction, and air temperature gradients interact with the physical features of the landscape to determine the movement and dispersal of air pollutants.

The Arroyo Seco watershed lies within the boundaries of the South Coast Air Basin (SCAB), which is managed by the South Coast Air Quality Management District (SCAQMD). The SCAB, which covers an area of approximately 6,745 square miles, is bounded by the Pacific Ocean to the west and the San Gabriel, San Bernardino, and San Jacinto Mountains to the north and east, and encompasses all of Orange County and Riverside County, Los Angeles County except for Antelope Valley, and the non-desert portion of San Bernardino County.

3.5.2 Regional Climate

The SCAB is primarily a coastal plain with interconnected valleys and low hills progressing into high mountain ranges on the perimeter. The region is located within a semi-permanent high-pressure system that lies off the coast. As a result, the weather is mild, tempered by a daytime sea breeze and a nighttime land breeze. This mild climate is infrequently interrupted by periods of extremely hot weather, winter storms, and Santa Ana winds. Rainfall in the SCAB mainly occurs from November through April, with rainfall totals being highly variable from year to year.

The SCAB has a low average wind speed of 4 miles per hour (mph). Because of the low average wind speed, air contaminants in the SCAB do not readily disperse. On spring and summer days, most pollution is moved out of the SCAB through mountain passes or is lifted by the warm vertical currents produced by the heating of the mountain slopes. From late summer through the

winter months, lower wind speeds and the earlier appearance of offshore breezes combine to trap pollution in the SCAB. Strong, dry, north or northeasterly winds, known as Santa Ana winds, occur during the fall and winter months, dispersing air contaminants. These conditions tend to last for several days at a time.

The SCAB experiences a persistent temperature inversion as a result of the Pacific High, a large subtropical high pressure system, which holds air contaminants relatively near the ground. Under normal atmospheric conditions, temperature decreases with altitude. During an inversion condition, temperature increases with altitude. As the air pollutants rise in the atmosphere they reach an altitude where the ambient temperature exceeds the temperature of the pollutants. This causes the pollutants to sink back to the Earth's surface. This phenomenon acts to trap and concentrate air pollutants near the surface. In summer, the longer daylight hours and bright sunshine combine to cause a reaction between hydrocarbons and oxides of nitrogen to form ozone. In winter, the greatest pollution problems are carbon monoxide and nitrogen oxides, which are trapped and concentrated by the inversion layer.

Periodically, the SCAB experiences an intermittent weather condition known as El Niño-Southern Oscillation (ENSO) and its counterpart La Niña. During El Niño years, the SCAB experiences warmer air and ocean temperatures, and higher than normal precipitation. ENSO occurs in the tropical Pacific Ocean on an average of every 5 years, but varies from 3 to 7 years. The driving factor in ENSO conditions is warmer-than-normal ocean surface temperatures in the tropical Pacific, which causes the reversal, or in milder years the slowing or stopping of circulation patterns between Asia and the Americas. This change in circulation patterns shifts the "normal" pattern of rising warm wet air and rainfall from Southeast Asia to South and North America. La Niña is the counterpart to El Nino and usually has an opposite effect on weather patterns. La Niña brings dry weather to the SCAB and the southwest and southeastern States, usually prevailing strongest from November to January (CDFG 2010a).

3.5.3 Regional Air Quality

Regulation of air pollution is achieved through both Federal and state ambient air quality standards and emission limits for individual sources of air pollutants. As required by the Federal Clean Air Act, the EPA has identified criteria pollutants and has established national ambient air quality standards (NAAQS) to protect public health and welfare. The NAAQS are defined as the maximum acceptable concentration that may be reached, but not exceeded more than once per year. The EPA has established the NAAQS for ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (PM_{10}, $PM_{2.5}$), and lead. These pollutants are called "criteria" pollutants because standards have been established for each of them to meet specific public health and welfare criteria.

In comparison to Federal standards, California has adopted more stringent ambient air quality standards (i.e. California Ambient Air Quality Standards [CAAQS]) for most of the criteria air pollutants. presents the Federal and state ambient air quality standards and provides a brief description of the related health effects and principal sources for each pollutant.

Table 3.9 Ambient Air Quality Standards for Criteria Pollutants

POLLUTANT	AVERAGING TIME	STANDARD		HEALTH EFFECTS	POLLUTANT CHARACTERISTICS AND MAJOR SOURCES
		STATE	FEDERAL		
Ozone (O_3)	1 Hour 8 Hour	0.090 ppm 0.070 ppm	– 0.075 ppm	Short term exposures to high concentrations can irritate eyes and lungs. Long-term exposure may cause permanent damage to lung tissue.	Ozone is a secondary pollutant that is formed in the atmosphere through reactions between reactive organic gases (ROGs) and nitrogen oxides (NOx) in the presence of sunlight. Major sources of ROGs and NOx include combustion processes (including motor vehicle engines) and evaporative solvents, paints and fuels.
Carbon Monoxide (CO)	1 Hour 8 Hour	20 ppm 9.0 ppm	35 ppm 9 ppm	Classified as a chemical asphyxiant, CO interferes with the transfer of fresh oxygen to the blood and deprives sensitive tissues of oxygen. Exposure to high CO concentrations can cause headaches, dizziness, fatigue, unconsciousness, and even death.	CO is an odorless, colorless gas that is formed by incomplete combustion of fuels. The primarily source of CO is the internal combustion engine, primarily gasoline-powered motor vehicles.
Nitrogen Dioxide (NO_2)	1 Hour Annual	0.18 ppm 0.030 ppm	– 0.053 ppm	Irritating to eyes and respiratory tract.	NO2 is a reddish brown gas that is a by-product of combustion. Motor vehicles and industrial operations are the main sources of NO2.
Sulfur Dioxide (SO_2)	1 Hour 3 Hour 24 Hour Annual	0.25 ppm – 0.04 ppm –	– 0.5 ppm 0.14 ppm 0.03 ppm	Irritates upper respiratory tract; injurious to lung tissue. Can yellow the leaves of plants, destructive to marble, iron, and steel. Limits visibility and reduces sunlight.	SO2 is a colorless acid gas with a strong odor. Fuel combustion, chemical plants, sulfur recovery plants, and metal processing are the main sources of this pollutant.
Respirable Particulate Matter (PM10)	24 Hour Annual	50 $\mu g/m^3$ 20 $\mu g/m^3$	150 $\mu g/m^3$ 50 $\mu g/m^3$	May irritate eyes and respiratory tract, decreases in lung capacity, cancer and	Solid or liquid particles in the atmosphere. Sources include dust and fume-producing industrial and agricultural

Table 3.9 Ambient Air Quality Standards for Criteria Pollutants					
POLLUTANT	AVERAGING TIME	STANDARD		HEALTH EFFECTS	POLLUTANT CHARACTERISTICS AND MAJOR SOURCES
		STATE	FEDERAL		
				increased mortality. Produces haze and limits visibility.	operations, combustion, atmospheric photochemical reactions, and natural activities (e.g., wind-raised dust and ocean sprays).
Fine Particulate Matter (PM2.5)	24 Hour Annual	– 12 µg/m^3	35 µg/m^3 15.0 µg/m^3	Increases respiratory disease, lung damage, cancer, and premature death. Reduces visibility and results in surface soiling.	Solid or liquid particles in the atmosphere. Major sources include fuel combustion in motor vehicles, equipment, and industrial sources; residential and agricultural burning. PM2.5 may also be formed from photochemical reactions of other pollutants, including NOx, SO2, and organics.
Lead (Pb)	Monthly Quarterly	1.5 µg/m3 –	– 1.5 µg/m3	Disturbs the nervous system, kidney function, immune system, reproductive and developmental systems, and the cardio vascular system.	Present source: lead smelters, battery manufacturing & recycling facilities. Past source: combustion of leaded gasoline.
Source: CARB 2010a; USEPA 2010b.					

Responsibility for attaining and maintaining ambient air-quality standards in California is divided between the California Air Resources Board (CARB) and regional air-pollution control or air-quality management districts. Areas of control for the regional districts are set by the CARB, which divides the state into air basins, based largely on topography that facilitates or limits airflow across or within county boundaries.

3.5.4 Existing Air Quality

The CARB coordinates and oversees state and Federal air pollution control programs in California; oversees activities of local air quality management agencies; and maintains air quality monitoring stations throughout the State in conjunction with the EPA and local air districts. The Arroyo Seco watershed is located in Source Receptor Area 8. Annual ambient air quality monitoring is conducted at one location (Pasadena ARB #70088) in the vicinity of the study area. This monitoring station monitored CO, NO_2, O_3, and $PM_{2.5}$. below presents the result from this monitoring station for the years of 2006 through 2008.

Table 3.10 Ambient Air Quality within the Arroyo Seco Watershed (Source Receptor Area 8)							
POLLUTANT	AVERAGING TIME	MAXIMUM CONCENTRATION BY YEAR			NUMBER OF DAYS STATE/FEDERAL STANDARDS EXCEEDED		
		2006	**2007**	**2008**	**2006**	**2007**	**2008**
Ozone	1-hour (ppm)	.151	.149	0.122	25s 5F	13s 3F	16s 0F
	8-hour (ppm)	.117	.100	0.100	24 s 7F	21s 11F	26s 16F
Carbon Monoxide	1-hour (ppm)	4	3	3	-	-	-
	8-hour (ppm)	2.8	2.3	2.1	-	-	-
Nitrogen Dioxide	1-hour (ppm)	.12	.09	.11	-	-	-
	24-Hour (ppm)	.06	-	-	-	-	-
PM2.5	24-hour ($\mu g/m^3$)	45.9	68.9	66	1(0.9)F	3(2.8)F	2(1.7)F
Particulate TSP	24-hour ($\mu g/m^3$)	123	123	108	-	-	-
Sulfate	24-hour ($\mu g/m^3$)	28.7	22.4	14.1	1(1.7)s	0s	0s
Source: AQMD 2006; 2007; 2008. S - State Standards F - Federal Standards							

The existing levels of criteria pollutants in the study area summarized above in shows regular exceedances of state and Federal standards for O_3 for the 2006, 2007, and 2008 sampling years. $PM_{2.5}$ had a low number of Federal exceedances in the 2006, 2007, and 2008 and sulfate had one exceedance in the 2006 sampling year.

Overall air quality has improved considerably throughout the SCAB since 1990. In that year, the peak ozone concentration at the Pasadena monitoring station was 0.26 ppm and the state ozone standard was exceeded 118 times. In 2000, the peak reading at that same station was 0.16 ppm and the state standard was exceeded 19 times. These improvements have occurred despite extensive population growth in the SCAB during the past decade.

Data collected at monitoring stations are used by the CARB to classify air basins as "attainment" or "nonattainment" with respect to each pollutant and to monitor progress in attaining air quality standards. identifies the attainment status for the criteria pollutants in the SCAB.

Table 3.11 Attainment Status of Criteria Pollutants		
POLLUTANT	STATE[1]	FEDERAL
Ozone	Nonattainment	Severe 17 Nonattainment
$PM_{2.5}$	Nonattainment	Nonattainment
PM_{10}	Nonattainment	Serious Nonattainment[2]
Carbon Monoxide	Attainment	Unclassified/Attainment[2]
Nitrogen Dioxide	Attainment	Unclassified/Attainment
Sulfur Dioxide	Attainment	Attainment
Sulfates	Attainment	Not Available
Lead	Attainment	Attainment
[1]2006 State Area Designations [2]2008 National Area Designations Source: CARB 2006; USEPA 2010c.		

3.5.5 Future Without-Project Conditions

Under future without-project conditions, population growth in the cities surrounding the study area would likely increase vehicle trips, identified as the main air pollution source in the region. The cities are implementing traffic reduction measures and programs to encourage alternate transportation and researching clean fuel alternatives. Local and regional planning agencies are also focusing on land use planning to reduce travel needs. These efforts would reduce future air emissions; however, it is not expected that air quality would substantially change from existing conditions.

3.6 GLOBAL CLIMATE CHANGE

This section presents a discussion of global climate change and regulatory setting for global climate change, particularly with regard to the generation of "greenhouse gases."

3.6.1 Greenhouse Gas Emissions

Greenhouse gases are compounds in the atmosphere that absorb infrared radiation and re-radiate a portion of that back toward the earth's surface, thus trapping heat and warming the earth's atmosphere. The most important naturally occurring greenhouse gas (GHG) compounds are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone, and water vapor. CO_2, CH_4, and N_2O are produced naturally by respiration and other physiological processes of plants, animals, and microorganisms; by decomposition of organic matter; by volcanic and geothermal activity; by naturally occurring wildfires; and by natural chemical reactions in soil and water. Ozone is not released directly by natural sources, but forms during complex chemical reactions in the atmosphere among organic compounds and nitrogen oxides in the presence of ultraviolet radiation. While water vapor is a strong greenhouse gas, its concentration in the atmosphere is primarily a result of, not a cause of, changes in surface and lower atmospheric temperature conditions.

Although naturally present in the atmosphere, concentrations of CO_2, CH_4, and N_2O also are affected by emissions from industrial processes, transportation technology, urban development, agricultural practices, and other human activity. The Intergovernmental Panel on Climate Change (IPCC) estimates the following changes in global atmospheric concentrations of the most important greenhouse gases (IPCC 2001; 2007):

- Atmospheric concentrations of CO_2 have risen from a pre-industrial background of 280 ppm by volume (ppm) to 379 ppm in 2005.
- Atmospheric concentrations of CH_4 have risen from a pre-industrial background of about 0.70 ppm to 1.774 ppm in 2005.
- Atmospheric concentrations of N_2O have risen from a pre-industrial background of 0.270 ppm to 0.319 ppm in 2005.

The IPCC has concluded that these changes in atmospheric composition are almost entirely the result of human activity, not the result of changes in natural processes that produce or remove these gases (IPCC 2007).

CO_2, CH_4, and N_2O have atmospheric residence times ranging from about a decade to more than a century. Several other important GHG compounds with long atmospheric residence times are produced almost entirely by various industrial processes; these include sulfur hexafluoride (SF_6) and a wide range of fluorinated hydrocarbons (HFCs). Fluorinated compounds typically have atmospheric residence times ranging from a few decades to thousands of years.

The overall global warming potential of GHG emissions is typically presented in terms of carbon dioxide equivalents (CO_2e), using equivalency factors developed by the IPCC. The IPCC has published sets of CO_2e factors as part of its periodic climate change assessment reports issued in 1995, 2001, and 2007. The latest IPCC data assign global warming potential multipliers of 1 to CO_2, 25 to CH_4, and 298 to N_2O (IPCC 2007). The global warming potential multiplier for SF_6 is 22,800; global warming potential multipliers for HFCs vary widely according to the specific compound.

California began efforts to address GHG issues at a state level in 1988, when the California Energy Commission was directed to develop a statewide inventory of GHG emission sources. The California Climate Action Registry was established in 2000 to allow companies and government agencies to voluntarily record their GHG emissions in a database, in anticipation of possible future regulations that might allow credit for early GHG emission reductions. In 2002, Assembly Bill 1493 directed CARB to develop regulations to reduce GHG emissions from vehicles sold in California. In 2005, Governor Arnold Schwarzenegger issued EO S-3-05, which sets the following target dates for reducing statewide GHG emissions:

§ Reduce GHG emissions to 2000 levels by 2010.

§ Reduce GHG emissions to 1990 levels by 2020.

§ Reduce GHG emissions to 80 percent below 1990 levels by 2050.

In 2006, Senate Bill 1368 created GHG performance standards for new long-term financial investments in base-load electricity generation facilities serving California customers. Also in 2006, California passed the California Global Warming Solutions Act of 2006 (Assembly Bill 32); California Health and Safety Code Division 25.5, Sections 38500, et seq.), which requires CARB to design and implement regulations, emission limits, and other measures to reduce statewide GHG emissions to 1990 levels by 2020.

Assembly Bill 32 established the following timetable for specific CARB actions:

§ Publish a list of discrete early-action GHG emission reduction measures by June 30, 2007.

§ Establish a statewide GHG emissions cap for 2020 (equivalent to the 1990 emissions level) by January 1, 2008.

§ Adopt mandatory reporting rules for significant sources of GHG by January 1, 2008.

§ Adopt a scoping plan by January 1, 2009, indicating how GHG emission reductions will be achieved from significant GHG sources via regulations, market-based compliance mechanisms, and other actions, including identification of a de minimus threshold for GHG emissions, below which emission reduction requirements would not apply.

§ Adopt regulations by January 1, 2011, to achieve the maximum technologically feasible and cost-effective reductions in GHG, including provisions for using both market-based and alternative compliance mechanisms.

§ Establish January 1, 2012, as the date by which all regulations adopted prior to January 1, 2010 are to become operative (enforceable).

CARB (2007a) has estimated that the 1990 level of GHG emissions in California was 470.7 million tons CO_2e. By comparison, the estimated 2004 level of GHG emissions in California was 529 million tons CO_2e. CARB (2008a) estimated that without implementation of programs to reduce GHG emissions, statewide GHG emissions in 2020 would be about 596 million tons CO_2e. The goals of the California Global Warming Solutions Act of 2006 are to halt the growth in annual GHG emissions and to reduce GHG emissions to the 1990 level by 2020. Achieving the 2020 goal would represent an 11 percent reduction in statewide GHG emissions from 2004 levels and a 21 percent reduction from projected 2020 "business as usual" emission levels. Based on the GHG inventory for 2004 (CARB 2007b), the major sources of GHG emissions in California are presented in .

Table 3.12 Greenhouse Gas Emissions by Sector in 2004

SECTOR	TOTAL EMISSIONS ($MMTCO_2e$)	PERCENT OF TOTAL GROSS EMISSIONS
Agriculture	27.9	6
Commercial	12.8	3
Electricity Generation	119.8	25
In-State	*58.5*	*12*
Imports	*61.3*	*13*
Forestry (excluding sinks)	0.2	<1
Industrial	96.2	20
Cement	*9.8*	*2*
Landfills	*5.6*	*1*
Petroleum Refining	*34.9*	*7*
Residential	29.1	6
Transportation	182.4	38
Source: CARB 2007		

In 2007, CARB adopted regulations requiring mandatory reporting of GHG emissions from the following categories of stationary emission sources:

§ Cement manufacturing plants.
§ Electric generating plants, retail providers, and power marketers.
§ Cogeneration facilities.

§ Petroleum refineries, hydrogen plants, and combustion from oil and gas production.
§ General stationary source fuel combustion.

The GHG reporting requirements (CARB 2008b) establish a de minimis threshold of 25,000 metric tons (27,558 tons) per year of CO_2 emissions for industrial facilities other than power generation and cogeneration facilities. The de minimis emissions threshold for power generation and cogeneration facilities is 2,500 metric tons (2,756 tons) per year of CO_2. The regulation exempts power generation and cogeneration facilities with a capacity of less than one megawatt, backup and emergency generators, portable equipment, primary and secondary schools, and most hospitals. GHG emissions from vehicle fleets also are excluded from the reporting requirements, but the regulation provides for voluntary reporting of those emissions. Non-exempt facilities with annual CO_2 emissions below the relevant de minimis thresholds are not required to report their annual GHG emissions. Depending on type and size of facility, GHG emissions must be reported either annually or every third year.

3.6.2 Climate Change

Climate change is a shift in the average weather patterns observed on earth, which can be measured by such variables as temperature, wind patterns, storms, and precipitation (SCWA 2008).

Scientific research to date indicates that observed climate change is most likely a result of increased emission of GHGs associated with human activity (IPCC 2007). In California, the transportation sector is the largest emitter of GHGs (accounting for 40.7 percent of the total GHG emissions in the state in 2004), followed by electricity generation (California Energy Commission 2006). If California were a country, it would rank between the 12th and 16th largest emitters of CO_2 in the world. California produced 492 million gross metric tons of CO_2 equivalents1 in 2004 (California Energy Commission 2006).

3.6.2.1 Potential Changes and Effects from Climate Change

The many effects of GHG emissions are still being researched and are not fully known, but are expected to include increased temperatures, which could reduce snowpack, which in most areas is a primary source of fresh water. Climate change is expected to exacerbate air quality problems and adversely affect human health by increasing heat stress and related deaths; increase the incidence of infectious diseases, asthma and respiratory health problems; cause sea level rise threatening urban and natural coastal areas; cause variations in natural plant communities affecting wildlife; and cause variations in crop quality and yields. Climate change is also expected to result in more extreme weather events and heavier precipitation events that can lead to flooding as well as more extended drought periods.

A. Water Resources

Water supply can be described in terms of indices such as precipitation, snow pack, and runoff. Analysis of data and weather records are studied to determine the trend and the variability in the indices (e.g., precipitation and runoff), which affect water availability.

Most precipitation events in California occur between October and April more specifically, in terms of amount of precipitation occurring from November through March. An analysis by the U.S. National Weather Service (USNWS) using data from 1931 through 2005 indicates a long-term trend of increasing annual precipitation (i.e., increase of up to 1.5 inches per decade) in California, especially in northern California (USNWS 2008). A second investigation completed by the California DWR indicated a statistically significant increasing trend in total precipitation in northern and central California since the late 1960s (DWR 2006). An investigation by Bardini et al. (2001) showed a trend of potentially decreasing annual precipitation in California; however, this result is probably related to the specific subset of data that the Bardini study relied upon, wherein extremes at the beginning or end of time series data can substantially impact the identified trend (DWR 2006). Rainfall data from November through March of 1930 through 1997 indicated significant increases in California rainfall (Mote 2005).

There is also evidence that the amount of precipitation that occurs on an annual basis is becoming more variable (i.e., periods of both high and low rainfall are becoming more common). Specifically, a study performed by DWR (2006) indicates that present day variability in annual precipitation is about 75 percent greater than that of the early 20th century. As stated above, precipitation across California appears to have increased over the past century, and individual water years have become more variable in terms of the amount of precipitation that occurs. It follows, therefore, that similar trends would be observed for runoff. Annual runoff (i.e., runoff measured from October 1 through September 30) and peak runoff (i.e., typically measured for individual storm events) include flows derived from precipitation events, snowmelt, and river base flow. However, most of the water mass present during a peak runoff event is typically derived from concurrent precipitation and/or snowmelt.

A DWR study by DWR (2006) compares pre- and post-1955 annual average water year unimpaired runoff[5] for 24 watersheds across northern, central, and southern California. The study indicates an annual increase in runoff of up to 27 percent for 21 of the 24 watersheds, with an overall average increase of 9 percent. However for summer months the runoff from April to July is decreasing.

B. Flooding and Sea Level Rise

As discussed above, it is anticipated that climate change will have a substantial effect on the timing and magnitude of snowfall, rainfall, and snowmelt events in California. Large annual variations in winter rainfall and runoff, which are normal in California, create uncertainty surrounding potential increase in flooding as a result of climate change.

According to a report by DWR (2006), the mean sea level at the Golden Gate Bridge has risen by at least 8 inches since 1900. This is in line with a report by the IPCC (2007), which indicates average increases of 3.9 to 7.9 inches globally during the last century. The observed sea level rise likely results from a combination of factors, including melting of polar and terrestrial ice and snow, and thermal expansion of ocean water as the earth's temperature increased (IPCC, 2007).

[5] Unimpaired runoff refers to the runoff that occurs within a river above major regulation impoundments such as major dams.

Efforts have been made to predict the amount of sea level rise that would likely occur in the future under various worldwide GHG emissions scenarios. Results from a recent IPCC report indicated that global sea level could increase by an estimated 7 to 23 inches by 2099, or about 0.6 to 3.8 inches per 10 years (IPCC 2007). There is some disagreement and uncertainty in regards to sea level rise projections (Munk 2002); however, the IPCC (2007) study represents what is probably the most highly regarded and accepted study.

C. California Wildlife

Rising temperatures, increase in punctuated storm events, prolonged droughts, and sea level rise will likely change the makeup of entire ecosystems, increasing adaptation pressures that would shift wildlife distributions and in some cases, increase the frequency of local extinctions (Moser et al. 2009; Midgly et al. 2010). While some species adapted to arid environments may increase their ranges or densities or both, species closely tied to the dwindling natural water resources in southern California may be particularly at risk. Stream systems supporting aquatic species such as salmonids would be degraded by loss of cold-water habitat and reduced stream flows for spawning, incubation, and rearing. Furthermore, increased scouring of stream channels by surges of storm runoff would damage eggs and egg laying habitat (Battin et al. 2007). Amphibians may also be directly impacted by these changes, although secondary effects related to climate change such as increases in infectious diseases and increased input of pollutants and sediments through storm runoff may have the greatest impacts (Davidson et al. 2001; Carey and Alexander 2003). Other wildlife such as bird species that rely on remnant patches of riparian habitat in southern California may also be at risk from climate change. Shifts in timing and rate of migration (summarized by Marra et al. 2005), habitat loss, increased frequency of punctuated storm events (Preston et al. 2008), loss of prey base, and shifts in plant species regimes (Kerns et al. 2009) are all predicted to occur and would negatively impact local populations. In many cases, the severely degraded riparian habitat currently present in southern California has already led to some riparian bird populations to be depressed or even threatened, making them increasingly susceptible to future environmental changes brought upon by climate change.

Climate change, at a regional level, could contribute to more frequent and intense El Niño events, triggering a number of large-scale environmental changes. Warmer waters drive toxic algae blooms in bays and estuaries and depress offshore ocean productivity, affecting wildlife throughout the food web. The frequency of environmental catastrophes such as those caused by the 1997-98 and 2009-2010 El Niño events would be expected to increase. During those events, primary production precipitously declined along the Pacific Coast, causing large die-offs of primary and secondary consumers. In inland areas, the frequency and intensity of droughts and wildfires increased, substantially altering upland vegetation. Subsequent heavy rains triggered extensive erosion in the burned areas, which removed topsoil from the upper reaches of local watersheds. Powerful storm runoff events moved high sediment loads downstream where they scoured and buried riparian vegetation and physically altered floodplains, fundamentally impacting local ecosystems.

The heavily altered natural environment of the Arroyo Seco and its geographic location within an arid, water-stressed biome, make it particularly susceptible to future impacts from climate

change. These impacts would undoubtedly stress local wildlife populations, and in particular, further impact sensitive species already susceptible to environmental shifts and stochastic events.

3.6.3 Future Without-Project Conditions

The potential for disruption of rainfall and weather pattern, and increased wildfire risks associated with global climate change could have future adverse affects on the Arroyo Seco watershed under the future without-project conditions. Changes in weather and rainfall patterns could alter the flow of the creek and runoff patterns, as well as increase the chance for extreme flooding and droughts and increase the risk of wildfires. This could exacerbate existing problems such as channel instability, degraded water quality, loss of fish and wildlife habitat, and flood damage. The loss of habitat quality and diversity could increase fuel loading, which increases the potential for natural catastrophic wildfires.

3.7 NOISE

The following discussion provides background information on noise terminology and describes the existing environment in terms of sensitive receptors, existing noise levels, and regulatory requirements.

3.7.1 Noise Measurement

Noise is usually defined as unwanted sound. It consists of any sound that may produce physiological or psychological damage and/or interfere with communication, work, rest, recreation, and sleep. To the human ear, sound has two significant characteristics: pitch and loudness. Pitch is generally an annoyance, while loudness can affect our ability to hear.

Sound, traveling in the form of waves from a source, exerts a sound pressure level (referred to as sound level), which is measured in decibels (dB), with zero dB corresponding roughly to the threshold of human hearing, and 120 to 140 dB corresponding to the threshold of pain. A frequency-dependent adjustment, referred to as "A-weighting," is applied to correspond to the human ear's decreased sensitivity to low and extremely high frequencies. This frequency weighting is expressed in A-weighted decibels (dBA).

3.7.1.1 Noise Exposure and Community Noise

An individual's "noise exposure" is a measure of noise over a period of time. A "noise level" is a measure of noise at a given instant in time. "Community noise" (also known as environmental noise) varies continuously over a period of time depending on the contributing sound sources within the environment. Community noise is primarily the product of many distant noise sources, which constitute a relatively stable background noise exposure, with the individual contributors unidentifiable. The background noise level changes throughout a typical 24-hour period, but does so gradually, corresponding to addition and subtraction of distant noise sources such as traffic and atmospheric conditions. The addition of short duration single-event noise sources (e.g., aircraft flyovers, motor vehicles, sirens) also contributes to variation. These successive additions of sound to the community noise vary the noise level from instant to instant, requiring the

measurement of noise exposure over a period of time. The most frequently used noise descriptors are summarized below:

§ L_{eq}: The equivalent sound level is used to describe noise over a specified period of time, in terms of a single numerical value. The L_{eq} is the constant sound level which would contain the same acoustic energy as the varying sound level, during the same time period (i.e., the average noise exposure level for the given time period).

§ L_{max}: The instantaneous maximum noise level measured during the measurement period of interest.

§ L_{dn}: Day-Night Average Sound Level, or the energy average of the A-weighted sound levels occurring during a 24-hour period, and which accounts for the greater sensitivity of most people to nighttime noise by weighting noise levels at night ("penalizing" nighttime noises). Noise between 10:00 PM and 7:00 PM is weighted (penalized) by adding 10 dBA to take into account the greater annoyance of nighttime noises. It should be noted that the L_{dn} is sometimes referred to as the DNL.

§ *CNEL*: Similar to the L_{dn}, the Community Noise Equivalent Level (CNEL) adds a 5-dBA *penalty* for the evening hours between 7:00 PM and 10:00 PM.

3.7.1.2 Effects of Noise on People

Excessive noise can pose a serious public health problem and is one of the most widespread environmental pollutants affecting communities. The effects of noise on people can be placed into three categories:

§ Subjective effects of annoyance, nuisance, dissatisfaction.
§ Interference with activities such as speech, sleep, learning.
§ Physiological effects such as hearing loss or sudden startling.

Environmental noise typically produces effects in the first two categories. Workers at industrial plants often experience noise in the last category. There is no completely satisfactory way to measure the subjective effects of noise, or the corresponding reactions of annoyance and dissatisfaction. A wide variation exists in the individual thresholds of annoyance, and different tolerances to noise tend to develop based on an individual's past experiences with noise. lists disturbances from excessive noise that range from minor sleep annoyance to potential hearing loss. Sensitive receptors to noise, such as children or the elderly, are at particularly high risk of being affected by excessive noise levels. Zero dB or dBA should not be construed as the absence of sound. Instead, it is the generally accepted threshold of best human hearing. Sound pressure levels in negative decibel ranges are inaudible to humans. On the other extreme, the decibel scale can go higher than shown in the table. For example, gun shots, explosions, and rocket engines can reach 140 dBA or higher at close range.

Table 3.13 Sources and Effects of Common Noise Levels			
DECIBELS	EFFECTS	OBSERVATION	SOURCE
130	Hearing Loss	Pain Threshold	Hard Rock Band
120		Deafening	Thunder
110			Jet Take-Off
100			Loud Auto Horn at 10 feet
90		Very Loud	Noisy City Street
85			
80			School Cafeteria
75			
70	Physiological Effects	Loud	Vacuum Cleaner at 10 Feet
65			
60	Interference with Speech		Normal Speech at 3 Feet
55			
50	Sleep Interruption	Moderately Loud	Average Office Dishwasher in Next Room
45			
40	Sleep Disturbance		Soft Radio Music Quiet Residential Area
35			
30		Faint	Interior of Average Residence
20			Average Whisper at 6 Feet
10			Rustle of Leaves in Wind
5		Very Faint	Human Breathing
0		Audibility Threshold	
Source: Los Angeles County 2008a			

3.7.2 Existing Noise Environment in the Study Area

The predominant noise source within the Arroyo Seco watershed is transportation, including railroad, airport, and motor vehicle sources. Traffic volume, average speed, vehicular fleet mix (i.e. combination of automobiles, motorcycles, buses, and trucks), roadway steepness, distance, and characteristics of the pathway between generator and receptor, and weather all influence the level of noise near roadways. For example, as the roadway traffic volume, speed, proportion of fleet mix represented by trucks, and roadway grade increase, so do the composite noise levels at the locations affected by the traffic noise (City of Los Angeles 2006). However, as the roadway volume increases beyond a certain point, congestion increases, in turn causing reduced traffic speeds, which would, to some extent, offset noise from the traffic volume increase (City of Los Angeles 2006).

The Arroyo Seco travels under and along several major freeways and main traffic arteries as it snakes its way through the cities of Pasadena, South Pasadena, La Cañada Flintridge, and Los Angeles to its final destination and terminus at the Los Angeles River. From the headwaters the first major freeway undercrossing is at the Devil's Gate Dam at the I-210. From the I-210, the creek travels south until it underpasses the SR-134 near the junction of the I-210. Downstream of the SR-134, the Arroyo Seco travels downstream two miles until it meets the SR-110 where it runs parallel for several miles until it meets the Los Angeles River at the junction of the SR-110 and I-5. Arroyo Seco is bordered and crosses under several main traffic arteries including: Ventura Street, Foothill Boulevard, Rose Bowl Boulevard, Colorado Boulevard, Pasadena Avenue, Orange Grove Boulevard, Bridewell Street, Marmion Way and Griffith Avenue. The Burbank Glendale Pasadena Airport, located approximately 10 miles west of the Arroyo Seco,

and the Metrolink and Amtrak railway near the confluence of the Arroyo Seco and the Los Angeles River and upstream along Colorado Boulevard also contributes to the existing noise levels in the area.

3.7.3 Sensitive Receptors within the Study Area

Human response to noise varies considerably from one individual to another. Effects of noise at various levels can include interference with sleep, concentration, and communication, and can cause physiological and psychological stress and hearing loss. Given these effects, some land uses are considered more sensitive to ambient noise levels than others. In general, residences, schools, hotels, hospitals, and nursing homes are considered to be the most sensitive to noise. Places such as churches, libraries, and cemeteries, where people tend to pray, study, and/or contemplate are also sensitive to noise. Commercial and industrial uses are considered the least noise-sensitive.

Several areas adjacent to and within the Arroyo Seco watershed have been set aside for recreational purposes including two golf courses, 11 parks, the Rose Bowl sports arena, bike paths, playgrounds, and hiking trails. Development surrounding the Arroyo Seco is predominantly residential and commercial development. In addition, sensitive uses located within 1 mile from the Arroyo Seco boundaries include over 50 schools, 30 places of worship, 25 motels/hotels, and 10 medical facilities/hospitals.

3.7.4 Future Without-Project Conditions

Much of the study area vicinity is either built-out or set aside as permanent open space; therefore, substantial new development, which could generate sources of noise within the study area, is unlikely. However, ambient noise levels may increase over time as a result of population growth, which could generate higher noise levels associated with traffic increases and greater open space use.

Any future developments involving demolition and construction activities that are undertaken in the study area would be temporary and not change the long-term ambient noise environment. Proponents of any future development would be responsible for addressing potential project-specific and cumulative noise impacts and for implementing needed mitigation measures consistent with state and local guidelines and regulations.

3.8 BIOLOGICAL RESOURCES

Vegetation and wildlife in the Arroyo Seco watershed have been fundamentally altered from their state prior to European settlement. Pressures from agriculture (beginning in the mid-1800's) that later transitioned to pressures from urbanization, have been primarily responsible in shaping the biological environment present today. The diverse topography and geology of the Arroyo Seco watershed originally hosted many habitat types ranging from chaparral, oak woodlands, and grasslands in upland areas, to riparian, wetland, and open water habitats in low lying areas such as canyons and floodplains (NET 2006). Early agriculture and subsequent land conversion, water diversion, and flood control reduced the quantity and quality of upland habitat and altered natural stream flows. The construction of homes, roads, industrial parks, and urban parks converted most

of the remaining natural habitat and accentuated the need for flood protection for these new urban environments. This need resulted in the Arroyo Seco being realigned, channelized, and concrete lined through most of the watershed. Today, with the exception of a few fragmented patches of degraded natural habitat, the only area that has retained a substantial amount of natural habitat features is found above the Devil's Gate Dam.

In spite of past land uses and alterations, the Arroyo Seco watershed still provides natural habitat features and hosts native plant and wildlife species. The HWP and Lower Arroyo Park protect substantial areas of open space adjacent to the Arroyo Seco, as do a number of parks in the Los Angeles and South Pasadena reaches of the river (NET 2006). However, even these protected areas have been degraded. Native vegetation has been reduced and fragmented, and exotic plants and trees are predominant. Less surface water is available to both plants and animals due to development of the watershed, groundwater extraction, and the channelization of the natural streams. Roads and other manmade structures cut off wildlife corridors, separating attractive natural areas in the south from wildlife in the north.

Many species formerly found in the Arroyo Seco have been extirpated or largely eliminated from the area. Included are grizzly bear, all native fish including the southern steelhead, and many smaller animals such as the arroyo toad, California red-legged frog, coast horned lizard, California gnatcatcher, and yellow-billed cuckoo (NET-ASF 2002a). Despite these losses, many native species still inhabit the watershed, both in the natural northern portions and in the urbanized southern reach. In the forested upper reaches, many large and/or rare species remain. Mountain lions, California spotted owls, and rainbow trout (of uncertain origin; see CDFG 2007) are still found in the foothills and mountains. Downstream, smaller animals including many native birds still frequent areas where native habitat remains, while others animals, such as coyotes, crows, and ravens, are well established in the urban/natural interface.

3.8.1 Studies to Date

Ecological features of the study area have been documented in numerous reports. Some of the most significant are as follows:

- Survey of Lower Arroyo Seco from just above the JPL Downstream to the San Rafael Road Bridge with Particular Reference to Native Freshwater Fishes (Swift 2001).

- Arroyo Seco Watershed Restoration Feasibility Study (2002).

- Memorandum; Restoration of Brookside Park/Arroyo Seco Aquatic Habitat Areas with Particular Reference to Arroyo Chub and Possibly other Native Fishes (Entrix 2008).

Additional documentation of biological resources occurred during preparation of master plans for the lower, central, and Hahamongna reaches of Arroyo Seco (City of Pasadena 2003a, 2003b, 2003c).

Baseline conditions were field-truthed by Tetra Tech biologists on two occasions. The first field visit occurred in September 2007, and was intended as a reconnaissance level survey to assess general ecological conditions. During this survey, habitat communities were defined and possible

restoration measures were outlined. The second visit occurred on February 10-11, 2010, and was intended to more fully document existing conditions and restoration potential at the various sites, with the exception of Rainbow Wash, which was fully assessed during the first survey. The descriptions of existing conditions and preliminary assessment below are based on published data and direct observations made during the field surveys.

3.8.2 Vegetation

Historically, the Arroyo Seco watershed supported a diverse mosaic of vegetation communities. The steep, upper mountainous reaches were blanketed by shrub-dominated chaparral interspersed with tracts of mixed hardwood and conifer woodlands which were divided by drainages hosting riparian habitat (Stephenson and Calcarone 1999). The foothills found further downstream were dominated by a matrix of fire-adapted, shrub-dominated vegetation communities such as coastal sage scrub and chaparral, which were likely found on dry, south-facing slopes that had the most direct sunlight (NET 2006). On shadier slopes and canyon floors, patches of oak and walnut woodlands thrived while the wet drainage areas sustained corridors of riparian habitat. In some foothill areas, springs flowed abundantly, maintaining marshes and lagunas (NET 2006; ASF 2010). Below the steep-sided canyon where the Arroyo Seco flowed into the floodplain, vegetation communities associated with alluvial fans and disturbance likely dominated the alluvial terraces created by past flood events. Grasslands composed of perennial bunchgrasses, annual grasses, and herbs likely occupied large areas of the valley lowlands.

Many of the naturally occurring vegetation communities have been degraded in quality and greatly reduced in extent. Where native habitats once were, urban environments are now present. Exotic plant species including invasives and ornamentals are common throughout the watershed, particularly along the stream bottom in the remaining areas not covered by hard artificial surfaces. The various urban parks, housing developments, industrial and commercial complexes, and alterations to the stream channel have disturbed or eliminated most naturally occurring habitat, facilitating the establishment of the invasive plant species that are now common throughout the watershed. Extensive summer fires followed by punctuated winter storms (i.e. El Niño events during 1997-1998 and 2009-2010) (USGS 2010), have combined to further alter the vegetation communities and topography of the watershed. Recent attempts to restore native habitats, however, have been successful on a small scale (i.e. the La Loma Bridge Rehabilitation Replacement Project and the Central Arroyo Stream Restoration Program).

Vegetation patterns in the Arroyo Seco watershed reflect a mix of upland, riparian, landscape, and altered or ruderal types. Five native vegetation communities are found in the watershed and include coast live oak forest and woodland, southern willow scrub, coastal scrub, riversidian alluvial fan sage scrub, mulefat scrub, and southern sycamore-alder riverine woodland (CDFG 2003; City of Pasadena 2003a, 2003b, 2003c; also see Holland 1986; Sawyer and Keeler-Wolf 2000; CGAP 2010) (). Other non-native habitat types, or distinct areas defined by non-native vegetation features, are also found in the watershed. These include streambed, landscaped vegetation, and ruderal land.

Each vegetation community and habitat type is discussed following . Numerical coding indicates a California terrestrial natural community recognized by the California Natural Diversity

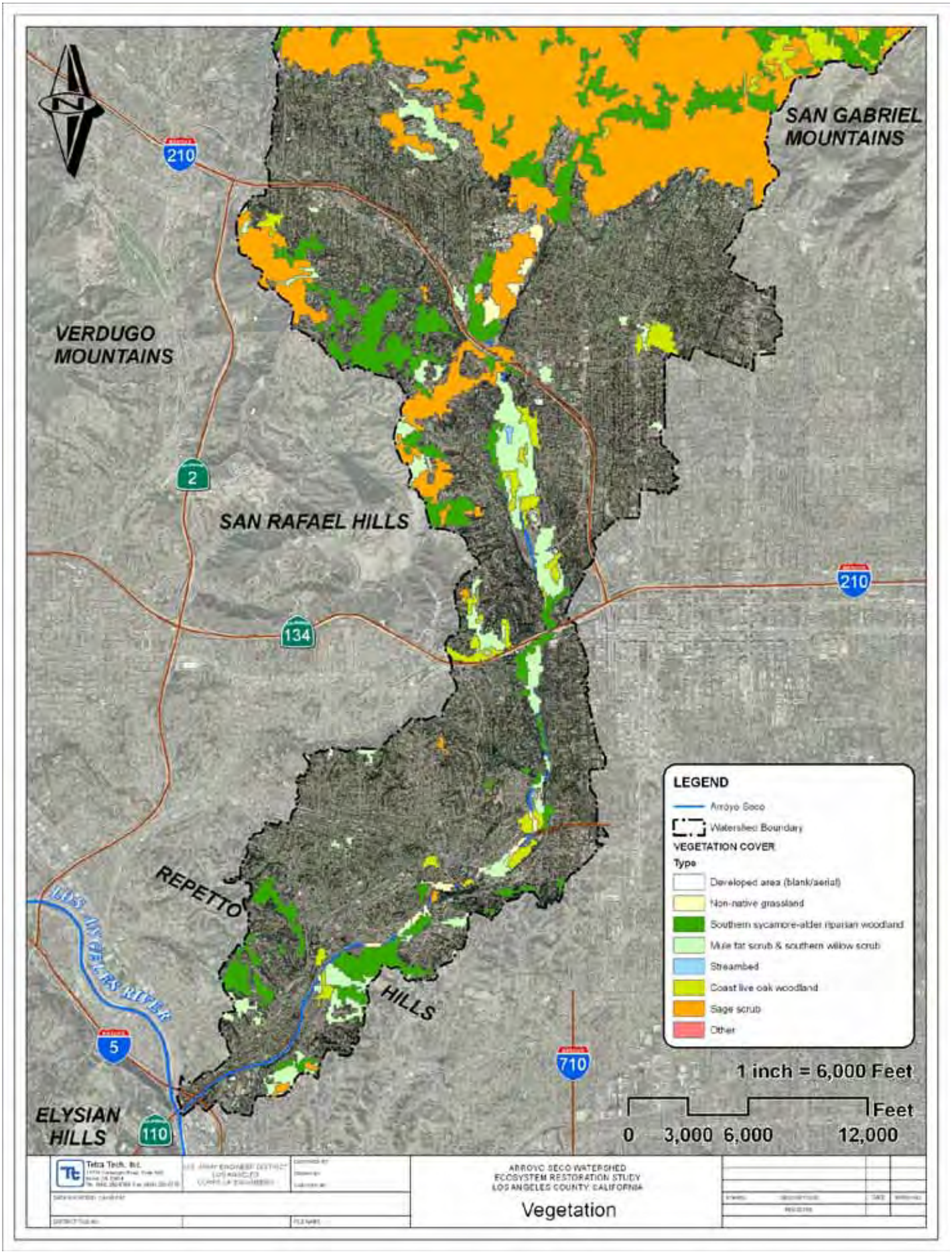

Figure 3.7 Vegetation

Database (CNDDB); an asterisk next to a numeric code denotes special communities that are either known to be rare or are of high priority for conservation by the California Department of Fish and Game (CDFG).

*3.8.2.1 Riversidian alluvial fan sage scrub (*32.005.02)*

Riversidian alluvial fan sage scrub is only found on alluvial fan terraces along the Arroyo Seco floodplain north of Devil's Gate Dam and along the western edges of most of the spreading basins in the HWP (the spreading basins are largely situated upon what was originally Riversidian alluvial fan sage scrub) (City of Pasadena 2003a, 2003b, 2003c; Calflora 2010). Riversidian alluvial fan sage scrub has been created and maintained during past flood events when water flow deposited sediments into the HWP flood basin. Today, only remnants of this vegetation community remain in the watershed (City of Pasadena 2003a, 2003b, 2003c). Historically, before the construction of Devil's Gate Dam, alluvial fan terraces spread across most of what is now parkland, and gradually merged with upland areas hosting coast live oak forest and woodland or coast scrub. Riversidian alluvial fan sage scrub is considered a sensitive habitat by the CDFG (2003, 2009). Riversidian alluvial fan sage scrub is a dry-adapted vegetation community with both coarse and fine soils that are slow to release stored moisture (CDFG 2003; CGAP 2009; Sawyer and Keeler-Wolf 2000). Low shrubs are common and form a canopy ranging from continuous to intermittent. The ground layer is often variable but usually dominated by grasses and forbs ().

Photo 3.3 Riversidian alluvial fan sage scrub in Hahamongna

Dominant species in riversidian alluvial fan sage scrub include scalebroom (*Lepidospartum squamatum*), California sagebrush (*Artemisia californica*), California buckwheat (*Eriogonum fasciculatum* var. *foliolosum*), black sage (*Salvia mellifera*), white sage (*Salvia apiana*), brome grasses (*Bromus* spp.), western sycamore (*Platanus racemosa*), Fremont cottonwood (*Populus fremontii*), southern California black walnut (*Juglans californica*), brittlebush (*Encelia farinosa*), chaparral yucca (*Yucca whipplei*), hairy yerba santa (*Eriodictyon crassifolium*), laurel sumac (*Malosma laurina*), lemonadeberry (*Rhus integrifolia*), Mexican elderberry (*Sambucus nigra*), mulefat (*Baccharis salicifolia*), Pacific poison oak (*Toxicodendron diversilobum*), prickly pear (*Opuntia* spp.), deerweed (*Lotus scoparius*), and four-wing saltbush (*Atriplex canescens*) (City of Pasadena 2003a, 2003b, 2003c). This terrestrial natural community comprises approximately 17.2 acres (1.72 percent of the basin) (City of Pasadena 2002a).

3.8.2.2 Coastal scrub (Venturan coastal sage scrub 32.190.00 and Riversidian sage scrub 32.005.00)

Two bio-geographically distinct vegetation communities overlap in the Arroyo Seco watershed; Venturan coastal sage scrub and Riversidian sage scrub, forming a hybrid zone with characteristics of both communities (Westman 1983; O'Leary 1990; Sawyer and Keeler-Wolf 2000; CDFG 2003; CGAP 2009). Because these areas are not distinctly one community, their shared super-alliance, “coastal scrub”, will be used for this discussion. Coastal scrub is therefore not a true terrestrial natural community recognized by CNDDB; however, because it is composed of two terrestrial natural communities, it will be treated as such.

Coastal scrub is found on slopes and sidewalls of the Arroyo Seco watershed in areas devoid of urban influences. It commonly forms indistinct borders with coast live oak forest and woodland and areas of ruderal land and developed areas (City of Pasadena 2003a, 2003b, 2003c).

Coastal scrub is a mixture of fire-adapted, woody chaparral species, and drought-deciduous sage scrub species. It is often found on dry, rocky, steep, south-facing slopes and ridges with shallow or poorly differentiated soils (City of Pasadena 2003a, 2003b, 2003c). It may also be located on clay-rich soils that are slow to release stored water. Generally, shrubs in coastal scrub are moderate in height and form a continuous or intermittent canopy over a sparse ground layer.

Dominant species in this habitat include California sagebrush, chamise (*Adenostoma fasciculatum*), California buckwheat, black sage, white sage, laurel sumac, lemonade berry, sugar bush, deerweed, chaparral yucca, bush monkeyflower (*Mimulus aurantiacus*), hoaryleaf ceanothus (*Ceanothus crassifolius*), scrub oak (*Quercus berberidifolia*), Pacific poison oak, holly-leaf cherry (*Prunus ilicifolia* ssp. *ilicifolia*), southern California walnut, brittlebush, Mexican elderberry, toyon (*Heteromeles arbutifolia*), and exotics such as Brazilian pepper (*Schinus terebinthifolius*) and Peruvian pepper (*S. molle*) (City of Pasadena 2003a, 2003b, 2003c). This terrestrial natural community comprises approximately 148.9 acres (14.85 percent of the basin) (City of Pasadena 2002a).

Photo 3.4 Coastal Scrub in Arroyo Seco upstream of JPL Bridge

*3.8.2.3 Southern willow scrub (*61.208.00)*

Southern willow scrub dominates the central riparian corridor of the Arroyo Seco in the HWP between Devil's Gate Dam and the Metropolitan Water District property, and downstream of the dam near the SR-134 and the Colorado Street Bridge where the riparian corridor maintains a natural state (City of Pasadena 2003a, 2003b, 2003c). Upstream of the dam, southern willow scrub merges with coast live oak forest and woodland and ruderal land, while downstream of the dam, it merges with coastal scrub, coast live oak forest and woodland, ruderal land, and the landscaped vegetation of adjacent residents.

Southern willow scrub is composed of dense, broadleafed, winter-deciduous riparian thickets dominated by several willow species including red willow (*Salix laevigata*), arroyo willow (*S. lasiolepis*), and sandbar willow (*S. interior*) with scattered emergent Fremont cottonwood and western sycamore (CDFG 2003; CGAP 2009; Sawyer and Keeler-Wolf 2000). Other plant species common to this community include mulefat and invasive species such as giant cane (*Arundo donax*), tobacco tree (*Nicotiana glauca*), and castor bean (*Ricinus communis*). Ornamental species such as eucalyptus (*Eucalyptus* spp.), date palm (*Phoenix canariensis*), fan palm (*Washingtonia robusta*), and various pines (*Pinus* spp.) are also often present. Most stands of southern willow scrub are too dense to allow much understory development (). Soils in this community are loose sandy or fine gravelly alluvium deposited near stream channels during

flood flows. This early seral type requires repeated flooding to prevent succession to southern cottonwood-sycamore riverine forest. Southern willow scrub is considered a sensitive habitat by CDFG (CDFG 2003; 2009), and with mulefat scrub, is one of the two terrestrial natural communities in the Arroyo Seco watershed that are composed of vegetation that typifies jurisdictional wetland habitats (USDA 2010). This terrestrial natural community comprises approximately 40.84 acres (4.07 percent of the basin) (City of Pasadena 2002a).

Photo 3.5 Southern willow scrub at confluence with Flint Wash

*3.8.2.4 Southern sycamore - alder riverine woodland (*61.312.00)*

Southern sycamore - alder riverine woodland is very limited in its distribution within Arroyo Seco watershed. Currently, it is only found bordering the natural stream channel just south of Devil's Gate Dam and the I-210, continuing downstream to the Brookside Golf Course (City of Pasadena 2003a, 2003b, 2003c) (). In this limited area, surface flows that run past the dam help sustain the hydrologic regime needed by western sycamore trees. Southern sycamore - alder riverine woodland favors areas of very rocky stream bottoms that are subject to seasonal high-intensity flooding. White alder (*Alnus rhombifolia*) increases in abundance on streams with more perennial flows, unlike western sycamores, which prefer more ephemeral or intermittent stream conditions (City of Pasadena 2003a, 2003b, 2003c). Because the Arroyo Seco maintains ephemeral characteristics, western sycamores solely dominate this vegetation community. Southern sycamore-alder riverine woodland is considered a sensitive habitat by the CDFG (2003, 2009).

Stands of southern sycamore-alder riverine woodland form open canopy forests interspersed with shrubby thickets of evergreen and deciduous shrubs. Species of vines and brambles such as Pacific poison oak, California blackberry (*Rubus ursinus*), and Himalayan blackberry (*Rubus discolor*) may dominate the understory layer (City of Pasadena 2003a, 2003b, 2003c). Other associated species often include arroyo willow, black willow (*Salix gooddingii*), red willow, California laurel (*Umbellularia californica*), coast live oak (*Quercus agrifolia*), Fremont cottonwood, mulefat, Mexican elderberry, ash (*Fraxinus* spp.), bigleaf maple (*Acer macrophyllum*), mugwort (*Artemisia douglasiana*), stinging nettle (*Urtica dioica* ssp. *holosericea*), wild oats (*Avena* spp.), brome grasses (*Bromus* spp.), and smilo grass (*Piptatherum miliaceum*) (CDFG 2003; CGAP 2009; Sawyer and Keeler-Wolf 2000). This terrestrial natural community comprises approximately 5.47 acres (0.55 percent of the basin) (City of Pasadena 2002a).

Photo 3.6 Southern sycamore-alder riverine woodland downstream of Devil's Gate Dam

3.8.2.5 Mulefat scrub (63.510.00)

Mulefat scrub often forms a monoculture, dominated only by mulefat (). It is found in areas of intermittent stream channels with a fairly coarse substrate and moderately deep surface water (CDFG 2003; CGAP 2009; Sawyer and Keeler-Wolf 2000). This early seral community is maintained by disturbance from frequent flooding, whereas without this feature, most patches would succeed to cottonwood or sycamore dominated riparian forests or woodlands (CDFG 2003; CGAP 2009; Sawyer and Keeler-Wolf 2000). Like mulefat, other species present in this vegetation community are the first to colonize disturbed areas. Commonly associated species

include arroyo willow, narrow-leaved willow (*Salix exigua*), Mexican elderberry, and various sedges (*Carex* spp.). Some invasive species found in association with mulefat scrub include giant cane, castor bean, poison hemlock (*Conium maculatum*), stinging nettle, and cocklebur (*Xanthium strumarium*).

Photo 3.7 Mulefat scrub at edge of Hahamongna Reach

Within the Arroyo Seco watershed, mulefat scrub is found bordering the riparian corridor of the stream channel in the HWP, extending from the toe of the Devil's Gate Dam upstream to near Johnson Field (City of Pasadena 2003a, 2003b, 2003c). The distribution of mulefat scrub downstream of Devil's Gate Dam is restricted only to areas with natural stream substrate that receives frequent disturbance by flooding. Although large flood events (i.e. those of 1998 and 2010) increase available habitat for mulefat scrub, the impoundment behind the Devil's Gate Dam prevents most species in this community from invading this area (City of Pasadena 2003a, 2003b, 2003c). Along with southern willow scrub, mulefat scrub is one of the two terrestrial natural communities in the Arroyo Seco watershed that is composed of vegetation that typifies true wetland habitats (USDA 2010).This terrestrial natural community comprises approximately 20.58 acres (2.05 percent of the basin) (City of Pasadena 2002a).

*3.8.2.6 Coast live oak forest and woodland (*71.060.00)*

Coast live oak forest and woodland is associated with upland areas on slopes that are often very steep or on raised stream banks and terraces (CDFG 2003; CGAP 2009; Sawyer and Keeler-Wolf 2000). Coast live oak may be the sole or dominant tree in the canopy. These oaks reach heights over 100 feet and form a mostly open to continuous canopy (). Shrubs can be occasional or common in the understory and the terrestrial surface layer can range from being devoid of vegetation to being covered with various grasses. Many understory shrub species can be found in coast live oak forest and woodlands. This includes black sage, California blackberry, California laurel, California coffeeberry (*Rhamnus californica*), California sagebrush, chamise, laurel

sumac, Pacific poison oak, scrub oak, toyon, Mexican elderberry, bigleaf maple, box elder (*Acer negundo*), hairy ceanothus (*Ceanothus oliganthus*), Engelmann oak (*Quercus engelmannii*), bush monkey flower, and various currant and gooseberry species (*Ribes* sp.) (City of Pasadena 2003a, 2003b, 2003c; Calflora 2010). The herbaceous layer component is often continuous and dominated by ripgut brome (*Bromus diandrus*) and other introduced species such as common chickweed (*Stellaria media*).

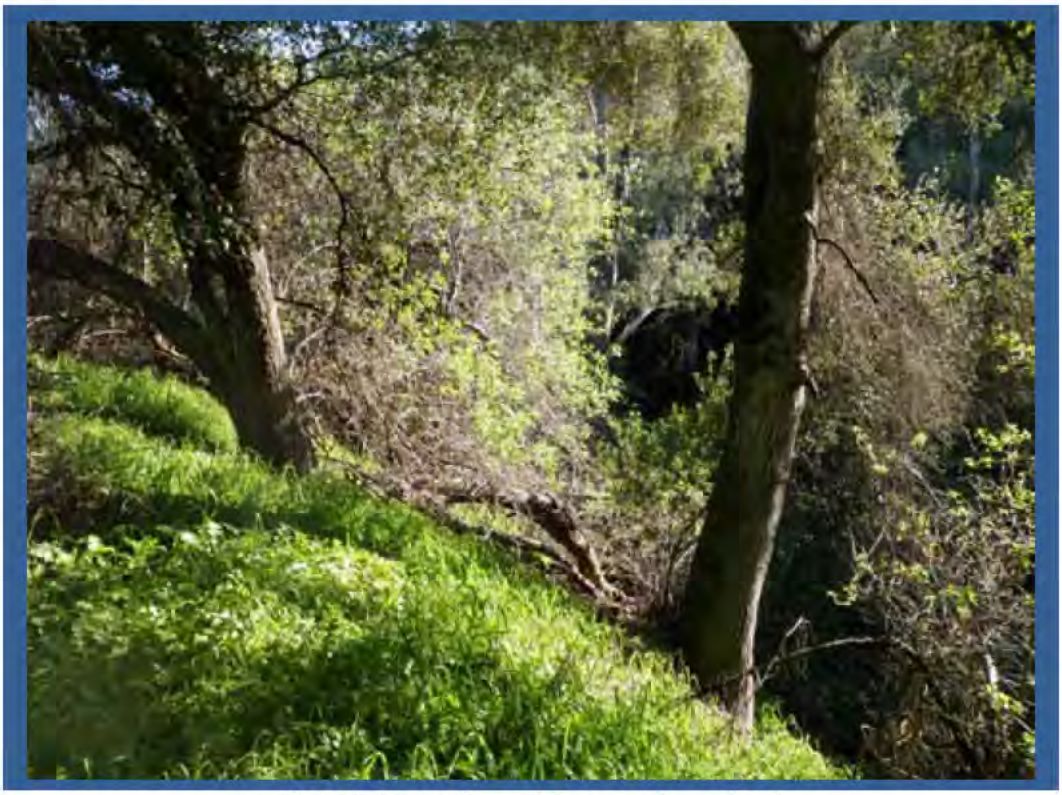

Photo 3.8 Coast live oak forest and woodland

In southern California, coast live oak forest and woodland is typically located on north-facing slopes and shaded ravines, however, its distribution and prevalence tends to differ between the HWP and the downstream areas of the watershed (City of Pasadena 2003a, 2003b, 2003c). In the HWP, it occurs on mostly level alluvial fan terraces on the west boundary, and on drier, west- and south-facing slopes on the east boundary. Downstream of the Devil's Gate Dam, coast live oak forest and woodland distribution is remnant and patchy, and only associated with side-slopes along the west and east boundaries. Coast live oak forest and woodland intergrades with southern willow scrub, mulefat scrub, and the ruderal land in the HWP, and downstream with sage scrub and ruderal land (City of Pasadena 2003a, 2003b, 2003c). Currently, the overall distribution of coast live oak forest and woodland in the watershed only represents a fraction of this formerly widespread community. However, the Oak Grove area located on the west side of the HWP, and portions of the MWD property, still host good quality patches. Coast live oak forest and woodland is considered a sensitive habitat by CDFG (CDFG 2003; 2009). This terrestrial natural community comprises approximately 47.3 acres (4.72 percent of the basin) (City of Pasadena 2002a).

3.8.2.7 Streambed

Streambed is not a true terrestrial natural community, but instead is a habitat type, or distinct area defined by a collection of vegetation features that do not fit within the CNDDB-accepted classification system (CDFG 2003). Streambed is found in the active stream channel where ongoing disturbance by annual flooding and scouring from seasonal rainfall runoff and sediment deposition occurs at least annually (). The only area within the Arroyo Seco watershed where streambed is found is the alluvial plain upstream of Devil's Gate Dam. Flooding events such as those that occur during El Niño rains (i.e., during 1998 and 2010), maintain disturbed alluvial substrate that hosts riparian and stream bottom habitat.

Photo 3.9 Streambed

Streambed maintains a patchy distribution in the main channel and because of the high frequency of disturbance; it is in a near constant state of primary succession and hosts few plants (City of Pasadena 2003a, 2003b, 2003c). Examples of streambed vegetation may include dominant or less abundant plant species found in southern willow scrub, riversidian alluvial fan sage scrub, mulefat scrub, and Southern sycamore-alder riverine woodland. In addition to species common to these terrestrial natural communities, other species are present in areas of streambed and include sedges, rushes (*Juncus* spp.), cattails (*Typha* spp.), spikerushes (*Eleocharis* spp.), bulrushes (*Scirpus* spp.), willow weed (*Polygonum lapathifolium*), and willow herbs (*Epilobium* spp.) (City of Pasadena 2003a, 2003b, 2003c). This habitat type comprises approximately 8.1 acres (0.81 percent of the basin) (City of Pasadena 2002a).

3.8.2.8 Landscaped Vegetation

Landscaped vegetation is largely composed of cultivated ornamental or horticultural plants that have been planted because of their aesthetic appeal (City of Pasadena 2003a, 2003b, 2003c). Landscaped vegetation is found in urban environments such as near buildings, roads, parking areas, or within developed parkland and percolation ponds. Many of the plant species that comprise landscaped vegetation are drought-tolerant xerophytes that require little or no irrigation for their survival (City of Pasadena 2003a, 2003b, 2003c). Occasionally, landscaped vegetation escapes from its intended setting and becomes established in the wild. Landscaped vegetation is common in the watershed particularly in areas downstream of Devil's Gate Dam.

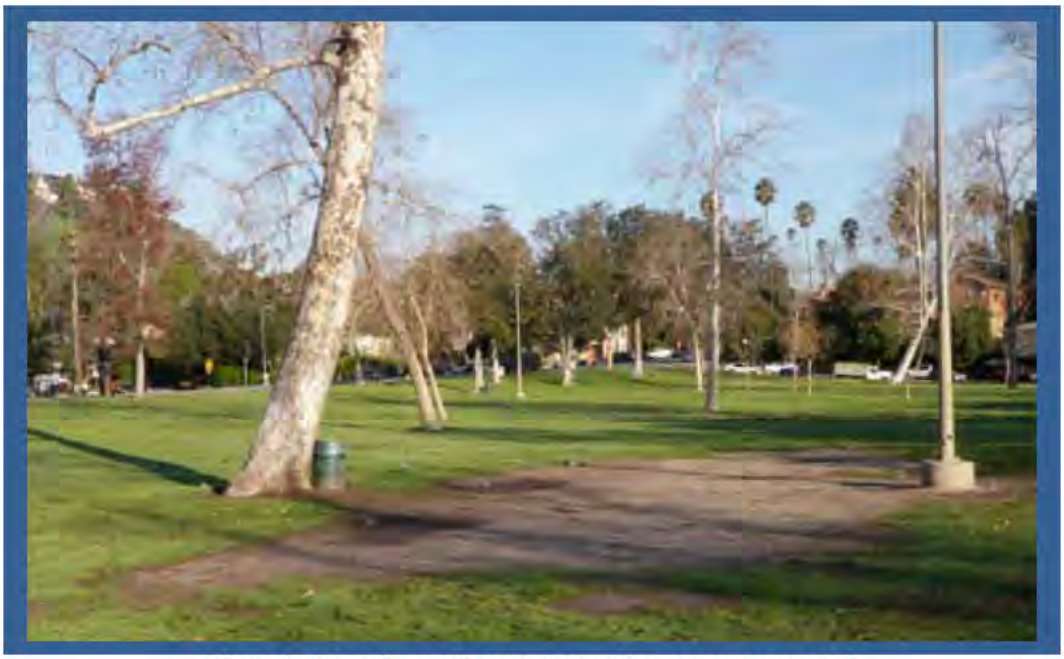

Photo 3.10 Landscaped vegetation at Sycamore Grove Park

The numbers and types of plant species associated with landscaped vegetation are numerous; however, the most common species include eucalyptus, pines, oaks, acacias (*Acacia* sp.), western sycamore, fig (*Ficus* sp.), common olive (*Olea europaea*), cherry (*Prunus* sp.), pepper trees, maples, ash, junipers (*Juniperus* sp.), cypress (Cupressaceae), oleander (*Nerium* sp.), palms, periwinkle (*Vinca* sp.), English ivy (*Hedera helix*), tree of heaven (*Ailanthus altissima*), agaves (*Agave* sp.), and many others (City of Pasadena 2003a, 2003b, 2003c; Clarke et al. 2007). Some native plant species such as western sycamore and coast live oak are associated to landscape vegetation due to urban development incorporating these desirable plants into their landscaping, or by planting these species directly. This habitat type comprises approximately 307.7 acres (30.69 percent of the basin) (City of Pasadena 2002a).

3.8.2.9 Ruderal Land

Ruderal lands are areas that have been substantially altered by human disturbance, causing them to be dominated by invasive non-native vegetation. These areas are found throughout the Arroyo Seco watershed but are most extensive in the southernmost reach. Ruderal lands are maintained by frequent disturbances such as grading, clearing, burning, or flooding which prevent most native plants from establishing. Ruderal lands occur on virtually any aspect or slope available in the watershed () (City of Pasadena 2003a, 2003b, 2003c). High frequency of disturbance in these areas prevents most plants from becoming established; however, hardy herbaceous invasives such as prickly Russian thistle (*Salsola tragus*) and cocklebur are both present. This non-native habitat comprises approximately 119.6 acres (11.93 percent of the basin) (City of Pasadena 2002a).

Photo 3.11 Ruderal land

3.8.2.10 Wetlands

The riparian habitat that would have normally existed in the Arroyo Seco prior to channelization likely would have contained streambed and southern sycamore-alder riverine woodland (described above). Some of the area within these habitat types likely would have contained soils, vegetation, and/or hydrological features normally associated with wetlands falling under the jurisdiction of the Corps. Although a jurisdictional delineation has not been performed for wetlands throughout the study area, it appears that most wetlands occur as relatively isolated pockets or in remnant stream channels.

The most extensive wetlands are found above Devil's Gate Dam, where a matrix of permanent and seasonal wetland is found in such habitat types as riparian woodland, emergent marsh wetland, and at the edges of the stream channels. Much of the area above the dam is mapped by the National Wetlands Inventory (NWI) as freshwater emergent wetland, and some is mapped as riparian habitat (USFWS 2010b). Freshwater emergent marsh in this area is dominated by cattails, rushes, sedges, and spikerushes.

The channel below the dam is also mapped as riparian habitat by the NWI. However, most of the channel is confined in an open culvert, with the only viable riparian habitat located in a non-culverted stretch immediately below the dam, and in a similar stretch approximately one mile downstream. Most areas mapped as "riparian" would likely be delineated as other Waters of the U.S., rather than as wetlands.

3.8.2.11 Non-native Invasive Plant Species

The study area contains numerous invasive plant species, which out-compete native riparian species, thereby limiting native species diversity and reducing habitat and food for native wildlife.

Although numerous exotic and invasive plant species are found in the study area, most have not formed significant communities. However, giant reed *(Arundo donax),* which is an aggressive invasive species, has been identified in the HWP, below Devil's Gate Dam, and in Flint Wash (Tetra Tech 2010). Giant reed is able to reproduce quickly, sprouts from plant parts that may wash downstream, and can withstand drought and flooding. These characteristics allow giant reed to out-compete native plant species for land and food resources, thus establishing thick, concentrated stands.

Other non-native and invasive plant species are listed under the Ruderal Vegetation section above.

3.8.2.12 Site Specific Habitat Conditions

A. Site 1 – Hahamongna Area

Habitat in the HWP is a diverse matrix of riversidian alluvial fan sage scrub, coastal scrub, southern willow scrub, mulefat scrub, coast live oak forest and woodland, streambed, and limited emergent wetland. The wide alluvial plain upstream of Devil's Gate Dam is very dynamic and its topographical features can change significantly during high flow events. Therefore, much of the vegetation in the active floodplain is young, although some mature riparian vegetation, aquatic emergent habitat along the active stream channel, and seasonal wetland habitat have been identified. Permanent wetland habitat appears along the main channel and where stormwater outfalls provide a permanent water source. The site appears to receive extensive use by humans.

B. Site 2 – Flint Wash

Flint Wash is a small stream that originates in the hills southwest of Devil's Gate Dam and enters Arroyo Seco just upstream of the dam. Although the watershed above and around the wash has been significantly developed and altered, the stream bottom and bank remain relatively free of hardscape features (rock revetment or concrete faces, culverts, etc.), except in the middle of the reach beneath the I-210, where the banks are lined with rock revetment and very little natural vegetation occurs. The habitat of this reach is a spatially confined mix of southern sycamore - alder riverine woodland, coast live oak forest and woodland, streambed, and numerous invasive plant species and escaped ornamentals, which have degraded the natural quality of the area.

Stream bottom conditions show an appropriate mix of sand, gravel, and cobble, and would likely support benthic invertebrates. There is extensive canopy cover, and overhanging vegetation provides cover for aquatic species as well as songbird habitat. Stream temperatures are assumed to be cooler and more constant than other areas in the watershed due to groundwater inflow as well as extensive shading from overhead vegetation.

Although the stream is at the bottom of a steep canyon and has little or no floodplain in most cases, it does not appear to be incising and the overall habitat conditions are good. Habitat complexity could be increased by adding wood and strategically placed rock in the stream.

C. Site 3 – 210 Freeway near Oak Grove Drive

A small area of riparian habitat dominated by southern willow scrub is found beneath the I-210, where outfall from small water production tunnels is released from under the dam. The constant source of water has allowed for a small yet very healthy area of riparian habitat to establish. This area is especially important as it creates a corridor from the Arroyo Seco channel to the uplands on the east side of the stream. Restored habitat in this area would be of most benefit to the southwestern willow flycatcher, the yellow-bellied chat, and the least Bell's vireo. The reach of Arroyo Seco directly beneath and just downstream of the I-210 contains some of the only natural stream bottom found downstream of Devil's Gate Dam. The topographical features of the stream bottom appear to have been altered, likely during construction of the I-210 overpass or Devil's Gate Dam. Habitat in this reach supports sparse riparian vegetation and small patches of streamside wetland composed of southern willow scrub, southern sycamore-alder riverine woodland, coast live oak forest and woodland, and numerous invasive plant species and escaped ornamentals, which have degraded the natural quality of the area. The surrounding upland area also hosts patches of coastal scrub.

D. Site 4 – Brookside Area

The Brookside Area contains almost no natural habitat and is dominated by landscaped vegetation and ruderal land. The Arroyo Seco through this section consists of a large trapezoidal concrete-lined channel. As briefly viewed, it is apparent that there is little natural vegetation in this area. Conditions in the stream are likely influenced by fertilizer runoff from the golf course, exposure of the stream to direct sunlight and corresponding water temperature increases, and lack of habitat complexity.

E. Site 5 – Lower Arroyo Seco Park

The main Arroyo Seco channel at this location is completely armored in a rectangular concrete channel. However, habitat value is added by low-flow streams on either side of the channel. Both of these streams offer very good habitat for migratory songbirds as well as good habitat for aquatic species such as frogs and snakes. Habitat types in this area are mostly coast live oak forest and woodland, southern willow scrub, mule fat scrub, and streambed. Restoration of riparian habitat in this area would likely be of most benefit to the southwestern willow flycatcher, the least Bell's vireo, and the yellow-breasted chat. This area also serves as a park, and is regularly visited by walkers and bicyclists.

F. Site 6 – South Pasadena Island

South Pasadena Island (the Island) is a narrow, undeveloped area situated between the Arroyo Seco Golf Course and the SR-110. The area supports an annual grassland and coast live oak forest and woodland plant community and is situated above the bankfull elevation of the Arroyo Seco channel. It is not clear what type of plant community(s) this area supported prior to human disturbance, but based on the existing conditions it is assumed that if restored, it could support a native grassland-oak woodland community. However, this assumption is made purely from observation of the existing vegetation community; research regarding soil types and aspect may indicate that this site is more appropriate for a coastal scrub and oak woodland matrix.

G. Site 7 – Arroyo Seco through Los Angeles

The overriding problem in this stretch is the absence of natural habitat. Virtually the entire area has been channelized or developed or consists only of steep canyon walls that provide suitable habitat for very few species. However, Ernest E. Debs Regional Park (Debs Park) contains significant stands of California black walnut (*Juglans californica*), a native tree designated very threatened by the CDFG.

H. Site 8 – Sycamore Grove Park

Sycamore Grove Park is a landscaped area consisting of a large lawn, playground, and parking area. It appears to have once supported southern sycamore-alder riverine woodland, based on the size of the western sycamore trees in the park and the way that they are configured across the park. It may be possible to restore this type of habitat to the park, or to restore riparian or marsh habitat. The original stream bottom has been filled and flows have been diverted into a culvert that runs under the park and directly into the Arroyo Seco channel. Sycamore Grove Park offers ample opportunity to combine recreation, water quality and habitat benefits, and environmental education.

I. Site 9 – Rainbow Canyon

Rainbow Canyon Park is undeveloped woodland located on a hillside in a developed residential neighborhood. A small, remnant stream bottom located on one side of the park appears to have formerly channeled water from higher in the watershed. Any runoff from higher in the watershed is now confined to an underground culvert. The stream bottom courses through a coastal live oak/bay laurel woodland, while habitat in the balance of the park is a matrix of annual grassland and woodland. Rainbow Canyon is completely surrounded by developed areas and is not connected to any other natural areas. The area appears to be well cared for and maintained and is a prime location for small, community-based restoration projects. Although historic accounts of the natural ecosystem are not available, it can be assumed that restorations such as creating amphibian ponds in the stream bottom (assuming flow can be restored), restoring butterfly habitat by planting milkweed, oxeye daisy, lavender, and butterfly bush, or restoring songbird habitat, would help restore natural function to the area. There is also space to restore California bunch grasses that will stay green throughout most of the drought season and provide habitat for small mammals and insects.

3.8.3 Fish and Wildlife Resources

The mixed habitats found in the Arroyo Seco watershed represent a remnant of the rich biotic community that was once dominant within the Los Angeles basin. However, despite the disturbed nature of the landscape and limited connectivity throughout the watershed, many wildlife species can still be found in the area. Because the least amount of urbanization is present above Devil's Gate Dam in the HWP, it hosts the most natural assemblage of wildlife habitat in the watershed. Species that are most commonly found in the watershed are discussed below.

Mammals common throughout the watershed include coyote (*Canis latrans*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), striped skunk (*Mephitis mephitis*), California ground squirrel (*Spermophilus beecheyi*), Botta's pocket gopher (*Thomomys bottae*), and Audubon cottontail (*Sylvilagus audubonii*). Non-native species such as feral cats and dogs are also common (City of Pasadena 2005). Evidence observed in the HWP suggests that dusky-footed woodrat (*Neotoma fuscipes*), gray fox (*Urocyon cinereoargenteus*), red fox (*Vulpes vulpes*), mule deer (*Odocoileus hemionus californicus*), cougar (*Puma concolor*) (ASF 2008a), and bobcat (*Lynx rufus*) utilize the upper watershed. Bat species are also present, using many habitats in the watershed for roosting, breeding, or foraging.

Over 180 native bird species have been documented in the Arroyo Seco watershed for breeding, wintering, or are residents (Pasadena Audubon Society 2005). Common residents include red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), great blue heron (*Ardea herodias*), great egret (*Ardea alba*), mourning dove (*Zenaida macroura*), Anna's hummingbird (*Calypte anna*), Allen's hummingbird (*Selasphorus sasin*), cliff swallow (*Petrochelidon pyrrhonota*), northern flicker (*Colaptes auratus*), Say's phoebe (*Sayornis saya*), black phoebe (*Sayornis nigricans*), western scrub-jay (*Aphelocoma californica*), American crow (*Corvus brachyrhynchos*), chestnut-backed chickadee (*Poecile rufescens*), American robin (*Turdus migratorius*), northern mockingbird (*Mimus polyglottos*), California towhee (*Pipilo crissalis*), common yellowthroat (*Geothlypis trichas*), spotted towhee (*Pipilo maculatus*), song sparrow (*Melospiza melodia*), Brewer's blackbird (*Euphagus cyanocephalus*), and house finch (*Carpodacus mexicanus*). During the wet season when standing water is present, the watershed also attracts waterfowl and shorebirds. Dryer, more upland habitats host a diversity of passerine species such as western wood pewee (*Contopus sordidulus*), Hutton's vireo (*Vireo huttoni*), wrentit (*Chamaea fasciata*), oak titmouse (*Baeolophus inornatus*), bushtit (*Psaltriparus minimus*), house wren (*Troglodytes aedon*), ruby-crowned kinglet (*Regulus calendula*), California thrasher (*Toxostoma redivivum*), Townsend's warbler (*Dendroica townsendi*), yellow warbler (*Dendroica petechia*), and white-crowned sparrow (*Zonotrichia leucophrys*). Woodland habitat hosts red-shouldered hawk (*Buteo lineatus*), Cooper's hawk (*Accipiter cooperii*), sharp-shinned hawk (*Accipiter striatus*), California quail (*Callipepla californica*), band-tailed pigeon (*Columba fasciata*), great-horned owl (*Bubo virginianus*), acorn woodpecker (*Melanerpes formicivorus*), downy woodpecker (*Picoides pubescens*), and pacific-slope flycatcher (*Empidonax difficilis*).

Various native amphibians and reptiles are found in the Arroyo Seco watershed. Two amphibians common to the area are the California toad (*Bufo boreas halophilus*) and Pacific treefrog (*Hyla regilla*). Reptiles are most common in upland areas and include western fence lizard (*Sceleporous occidentalis biseriatus*), side-blotched lizard (*Uta stansburiana*), coastal western whiptail (*Cnemidophorus tigris multiscutatus*), San Diego alligator lizard (*Elgaria multicarinatus webbi*), California striped racer (Masticophis *lateralis lateralis*), San Diego gopher snake (*Pitouphis melanoleucus annectens*), California red-sided gartersnake (*Thamnophis sirtalis infernalis*), and southern Pacific rattlesnake (*Crotalus viridis helleri*) (CRA 2007). Two-striped gartersnake (*Thamnophis hammondii*) is one of the few species associated to wetter areas.

Rainbow trout (*Oncorhynchus mykiss*) and arroyo chub (*Gila orcutti*) are the only native fish that are present in the Arroyo Seco watershed (ASF 2008b and Entrix 2008). A few rainbow trout were observed near the JPL Bridge in the HWP (Swift 2001; City of Pasadena 2003a; CDFG 2007); however, it is not know if this population is persistent or whether these fish are from native or introduced stock. Arroyo chub, a southern California endemic that has been extirpated from most of its native range, was reintroduced to the Arroyo Seco below Devil's Gate Dam on August 25, 2008 (ASF 2008b and Entrix 2008). As of summer 2009, this small population has apparently continued to persist (ASF 2009). Overall, habitat that could support native fish species is very limited because of the lack of connectivity from dam obstructions, reduced flows, and the mostly channelized structure of the stream bottom in the downstream reach. However, the various restoration efforts have begun to improve habitat for fish in the Arroyo Seco. The only other fish species known to be currently present in the watershed is mosquitofish (*Gambusia affinis*); a non-native from the eastern United States. A population of mosquitofish was observed in a standing pool located between the SR-134 and Colorado Boulevard (Swift 2001).

3.8.4 Species of Special Concern

The following discussions and summarize the listing status, habitat requirements, distributions, and likelihood of occurrence for each Federally or state listed species of special concern potentially occurring in the Arroyo Seco watershed study area. These species were identified using U.S. Fish and Wildlife Service (USFWS) – Threatened and Endangered Species System (USFWS 2010c) and CDFG – CNDDB (CDFG 2010). California Native Plant Society (CNPS) rare plant data was also used to describe the status of plant species of special concern. Because anadromous fish were historically present in the Arroyo Seco, National Oceanic and Atmospheric Administration – National Marine Fisheries Service (NOAA 2010) was also consulted. Species demographics were obtained from USFWS, National Oceanic and Atmospheric Administration (NOAA), NatureServe, primary literature, and from field survey data whenever available.

Many species of special concern have been listed by USFWS (138 species) and CDFG (66 species) as potentially occurring in Los Angeles County (A complete list is available in **Appendix A**). Of these, seven have been assessed as historically occurring and currently or potentially preset in the study area. Potential for occurrence is based on availability of suitable habitat, direct observations during field visits by Tetra Tech biologists, and whenever available, field observation data from other entities. Included species of special concern are seven USFWS

listed species; five endangered and two threatened, and four CDFG listed species, all of which are listed as endangered. In addition, the two USFWS listed plant species potentially occurring in the study area have also been listed by CNPS as rare (1B.1). Each of these species of special concern is listed in and discussed below.

Table 3.14 Special Status Species Potentially Occurring in the Study Area

COMMON NAME (*Scientific Name*)	FEDERAL STATUS	CA STATE STATUS	CNPS STATUS	POTENTIAL FOR OCCURRENCE
Plants				
Nevin's barberry (*Berberis nevinii*)	Endangered	Endangered	1B.1	Present
Slender-horned spineflower (*Dodecahema leptoceras*)	Endangered	Endangered	1B.1	Unlikely
Amphibians				
Arroyo toad (*Bufo californicus*)	Endangered	None	NA	Possible
California red-legged frog (*Rana aurora draytonii*)	Threatened	None	NA	Unlikely
Birds				
Coastal California gnatcatcher (*Polioptila californica californica*)	Threatened	None	NA	Unlikely
Least Bell's vireo (*Vireo bellii pusillus*)	Endangered	Endangered	NA	Possible
Southwestern willow flycatcher (*Empidonax traillii extimus*)	Endangered	Endangered	NA	Possible

Some species of special concern that historically occurred in the study area have been extirpated, and habitat features required to support these species have been severely degraded or altogether eliminated from the system. The historic range of southern steelhead (*Oncorhynchus mykiss irideus*), Santa Ana sucker (*Catostomus santaanae*), and Santa Ana speckled dace (*Rhinichthys osculus* ssp.) includes the Arroyo Seco watershed (CDFG 2007). These species have not been documented in the study area since before the 1970s (City of Pasadena 2002a). The absence of these fishes is the result of natural stream features being restricted to only two reaches of the Arroyo Seco: the reach located upstream of Devil's Gate Dam, and the reach located between the SR-134 and Colorado Boulevard (City of Pasadena 2002a). The rest of the stream channel is concrete-lined with no fish passage structures, preventing it from supporting these fish. Although southern steelhead are currently extinct in the Arroyo Seco, they remain very important as an indicator species for the entire watershed, and any effort to reestablish a population would result in the necessary reestablishment of natural habitat that would support other species of special concern.

3.8.4.1 Nevin's barberry (Berberis nevinii) – (USFWS endangered, CDFG endangered, CNPS 1B.1)

Nevin's barberry occurs in sandy or gravelly places between 800 and 2,700 feet in elevation, on steep north-facing slopes or on low gradient, south-facing washes (Boyd 1987; CPC 2010). Associated plant communities are alluvial scrub, riverine scrub or woodland, coastal sage scrub, chaparral, and/or oak woodland (USFWS 2007a; Calflora 2010; NatureServe 2010). Individuals have been documented mainly in wetlands, but have also been identified in non-wetland areas

under natural conditions (Smith and Berg 1988; CNPS 2001; USFWS 2007a; Calflora 2010). Nevin's barberry is known from the lower Arroyo Seco, 0.5 miles north of the Rose Bowl near the corner of Arroyo and Washington Streets; however, this population may not be native (USFWS 2007a; Calflora 2010). Although rare in nature, this species has become readily available and somewhat common in the nursery trade (KBC and MLF 2005; USFWS 2007a).

3.8.4.2 Slender-horned spineflower (Dodecahema leptoceras) – (USFWS endangered, CDFG endangered, CNPS 1B.1)

The slender-horned spineflower was listed as endangered under the ESA in September 1987. No critical habitat has been designated for this species. This species occurs just below 2,200 feet in elevation on old sandy benches or floodplain terraces containing alluvial fan scrub (Munz 1959; USFWS 1987; Calflora 2010; NatureServe 2010). Extinctions of slender-horned spineflower have been documented in the region; Rubio Canyon, which is adjacent to the Arroyo Seco watershed, is known to have hosted a population in the past (NET-ASF 2002a). Surveys performed within some portions of the watershed did not identify the specific habitat characteristics necessary to support this species (Wood and Wells 1996; NET-ASF 2002a). However, the close proximity of the Arroyo Seco watershed to at least one known extinct population and the lack of targeted surveys covering the entire project area leave some potential for slender-horned spineflower to occur.

3.8.4.3 Arroyo toad (Bufo californicus) – (USFWS endangered)

The arroyo toad was listed as endangered under the ESA in December 1994. Critical habitat for the species was designated on 7 February 2001, a final rule published on 4 April 2005, and revised as a proposed rule on 13 October 2009. Critical habitat for this species does not include the Arroyo Seco study area (USFWS 2009). The arroyo toad prefers riparian habitats with sandy stream bottoms and cottonwood, sycamore, and willow trees (USFWS 2009; NatureServe 2010) near upland habitats associated with loose sandy soils for burrowing. Preferred stream features include adjacent shallow pools where toads can sit in the water while partially exposed (SDNHM 2010). Breeding occurs in open sandy and gravelly streams (USFWS 2009; NatureServe 2010). Population declines have been primarily due to habitat loss, hydrologic alteration, and human activity in stream bottoms (USFWS 2009; NatureServe 2010).

Habitat that would support the arroyo toad occurs in the Arroyo Seco watershed throughout the HWP and immediately downstream of the Devil's Gate Dam. The occurrence of arroyo toads in the Arroyo Seco watershed and the designation of Federal critical habitat, however, have both been debated. Six miles of the Arroyo Seco extending from the top of Devil's Gate reservoir into the San Gabriel mountains was initially designated as critical habitat (USFWS 2001), but has since been excluded for "…economic reasons (see Application of Section 3(5)(A) and 4(a)(3) and Exclusions Under Section 4(b)(2) of the Act)." (USFWS 2005a, 2009) leaving no designated critical habitat in the watershed. During the same time, the City of Pasadena performed a focused biological protocol survey in the Arroyo Seco watershed which found no sign of arroyo toads (City of Pasadena 2002b), although additional surveys are required to legally establish presence/absence (USFWS 1999) and more have been scheduled (City of Pasadena 2003b). Furthermore, the original critical habitat designation (USFWS 2001) stated that "arroyo toads

have recently been documented (in the last 5 years) in each of these drainages (including Subunit 7c that encompasses 6 miles of the Arroyo Seco from the Long Canyon confluence downstream to the upper end of Devil's Gate Reservoir)…" suggesting that they are known to be present in the watershed. The nearest confirmed occurrence of the arroyo toad was in 1991 at Mill Creek, a tributary of Big Tujunga Creek, less than 10 miles northeast of the Arroyo Seco (CDFG 2010).

3.8.4.4 California red-legged frog (Rana aurora draytonii) – (USFWS threatened)

The California red-legged frog was listed under the ESA as threatened in May 1996. Critical habitat was designated for this species in March 2003 and was revised in October 2009, with a final rule issued on March 17, 2010. Under the final rule, critical habitat occurs in Los Angeles County, but does not include the Arroyo Seco study area (USFWS 2010a, 2010b).

The California red-legged frog is California's largest native frog. This species usually occurs in or near quiet permanent water of streams, marshes, ponds, and lakes (Stebbins 2003; USFWS 2010a; NatureServe 2010) typically 2.3 feet deep, in habitats characterized by dense, shrubby riparian vegetation (Hayes and Jennings 1988). Individuals may range far from water along riparian corridors and in damp thickets and forests. The California red-legged frog is generally found near water but often disperses to upland habitat after rains (Stebbins 2003).

Factors contributing to local declines include wetland destruction and degradation/fragmentation, urbanization, residential development, reservoir construction, stream channelization, livestock grazing of riparian vegetation, off-road vehicle activity, drought, overharvesting, exotic fishes (bass, mosquitofish, etc.) and bullfrogs (USFWS 2010a; NatureServe 2010). However, habitat characteristics and good leaping ability may render the California red-legged frog less vulnerable to bullfrog predation than other native species (USFWS 2010a; NatureServe 2010). Conversion of habitat to more permanent ponds is a major threat, as this allows breeding waters to be invaded by non-native predators (USFWS 2010a).

Preferred habitat features of the California red-legged frog do exist in or adjacent to the Arroyo Seco watershed; the highest quality habitat is found in the HWP and immediately downstream of the Devil's Gate Dam. However, no occurrences are known from the area. The nearest confirmed occurrence was in 1995 at Ritter Ranch, 9 miles west of Palmdale, California (CDFG 2010).

3.8.4.5 Coastal California gnatcatcher (Polioptila californica californica) – (USFWS threatened)

The coastal California gnatcatcher was listed under the ESA as endangered in October 2000 and critical habitat was designated for this species in October 2000 and in December 2007. This species is found in association with coastal sage scrub habitat below 2,500 feet in elevation (USFWS 2007b). Several distinctive sub-associations between coastal California gnatcatchers and coastal sage scrub community exist, especially those dominated by California sagebrush (Atwood 1992) growing along dry coastal slopes, washes, and mesas; and areas dominated by low-growing plants (USFWS 2007b; NatureServe 2010). Coastal California gnatcatchers generally avoid crossing even small areas of unsuitable habitat (Atwood 1992).

The historic range of coastal California gnatcatchers extended across the coastal counties of Ventura, Los Angeles, Orange, San Diego, San Bernardino, and Riverside (USFWS 2007b). They still occur in these locations, with the exception of Ventura and San Bernardino Counties (USFWS 2007b; NatureServe 2010). Occurrences near the Arroyo Seco watershed include a sighting in 1991 in the Verdugo Mountain Park, approximately 12 miles east-southeast of the Arroyo Seco (CDFG 2010), and one dispersing juvenile that was observed along the central Arroyo Seco in 2001 (City of Pasadena 2001).

3.8.4.6 Least Bell's vireo (Vireo bellii pusillus) – (USFWS endangered, CDFG endangered)

The least Bell's vireo was listed as endangered under the ESA in May 1986. Critical habitat for the species was designated in 1994. The least Bell's vireo is a spring and summer breeding resident in the area, migrating south for fall and winter (USFWS 1994; NatureServe 2010). They primarily inhabit riparian woodlands, scrublands, and thickets for breeding. Population declines are due to urban and agricultural development, habitat alteration, and brood parasitism by the brown-headed cowbird (*Molothrus ater*) (USFWS 1994; NatureServe 2010). Rangewide, brown-headed cowbird control (trapping and nest monitoring) has resulted in a nearly 10-fold population expansion of least Bell's vireos over the last decade (NatureServe 2010). Limited habitat features for the least Bell's vireo do exist in and adjacent to the Arroyo Seco watershed (CDFG 2010). Therefore, it is possible that least Bell's vireos may use the watershed; however, no occurrences have been documented despite past targeted survey efforts (City of Pasadena 2001).

3.8.4.7 Southwestern willow flycatcher (Empidonax traillii extimus) – (USFWS endangered, CDFG endangered)

The southwestern willow flycatcher was listed as endangered under the ESA in February 1995. Critical habitat for the species was designated in 2005. The southwestern willow flycatcher is a late spring and summer breeding resident that migrates south for fall and winter (USFWS 2005b; NatureServe 2010). It inhabits riparian woodlands and thickets, associated with the presence of surface water and/or very moist soil conditions and understory vegetation (USFWS 2005b; NatureServe 2010) and in areas with riparian habitat where willow, cottonwoods, and stinging nettles are dense. Population declines are due to urban and agricultural development, hydrologic and habitat alteration of rivers and streams, and brood parasitism by brown-headed cowbirds (USFWS 2005b; NatureServe 2010). Preferred habitat features of the southwestern willow flycatcher do exist in and adjacent to the Arroyo Seco watershed.

Historically, southwestern willow flycatchers nested throughout California wherever willow thickets or other riparian habitat were found. Current nesting is known only from a few mountain meadows in the Sierra Nevada and several rivers in Trinity, Inyo, Kern, Santa Barbara, Los Angeles, and San Diego Counties (USFWS 2005b; NatureServe 2010). Although southwestern willow flycatchers have not been recently documented in the Arroyo Seco watershed (City of Pasadena 2001), this species has been observed along other rivers in Los Angeles County (Thelander et al. 1994; CDFG 2010).

3.8.5 Non-Native/Invasive Animal Species

Several species of introduced fish and wildlife species are found in the study area. These include mosquito fish, house sparrows *(Passer domesticus)*, European starlings *(Sturnus vulgaris)*, feral dogs *(Canis lupus familiaris)*, feral cats *(Felis catus)*, Asian clam *(Corbicula fluminea)*, bullfrog *(Rana catesbeiana)*, rats *(Rattus rattus)*, and eastern fox squirrel *(Sciurus carolinensis)*. Some of these species have competitive advantages over their native counterparts or prey species that may allow them to have serious effects on populations of native songbirds, frogs, and invertebrates.

3.8.6 Future Without-Project Conditions

Human activities and development have severely fragmented and degraded habitats throughout the Arroyo Seco watershed. Without significant human efforts to restore the stream, riparian areas, and upland areas, conditions are likely to worsen. Increasing population will put greater development pressure on the watershed and opportunities that may now exist to reconnect, expand, or restore fragmented habitat types may be lost over time. Human uses of the watershed will increase and further affect sensitive and general habitat types. Increasing population will also increase pressure to develop and divert water supplies that currently provide at least a small amount of flow through the stream. Invasive species, most of which have a competitive advantage over native species, will continue to spread. In particular, giant cane would be expected to further establish itself and will likely become one of the dominant species in the non-channelized stream bottom without active containment in the short term and restoration of functional conditions in the long term.

Species that have been extirpated from Arroyo Seco, including steelhead trout and arroyo chub, are unlikely to return on their own without restoration of stream bottom functions, upstream passage, and watershed processes. A small population of arroyo chub that has been reintroduced to Arroyo Seco may persist with active management. Other listed or sensitive species are also unlikely to recolonize the study area without restoration, due to fragmented or heavily disturbed habitat conditions.

3.9 CULTURAL RESOURCES

Cultural resources include prehistoric archeological sites, historic-period archeological sites, historic structures, and consist of artifacts, structures, and facilities made by people in the past. Prehistoric archeological sites are places that contain the materials remains of activities carried out by the native population of the area (Native Americans) prior to the arrival of Europeans in southern California. Artifacts found in prehistoric sites include flaked stone tools such as projectile points, knives, scrapers, and drills; ground stone tools such as manos, metates, mortars, and pestles for grinding seeds and nuts; and bone tools, such as awls. Prehistoric sites and features include hearths, bedrock mortars, rockshelters, rock art, and burials.

Historic-period archeological sites are places that contain the material remains of activities carried out by people during the period when written records were produced after the arrival of Europeans. Historic archeological materials usually consist of refuse, such as bottles, cans, and food waste, deposited near structure foundations. Archeological investigation of historic period sites is usually supplemented by historic research using written records. Historic structures

include houses, commercial structures, industrial facilities, other structures, and facilities more than 50 years old.

3.9.1 Methods

In order to characterize the existing environment of cultural resources within the Arroyo Seco watershed, the following studies were conducted: cultural resources records search through the California Historical Resources Information System, South Central Coastal Information Center (CHRIS-SCCIC) at California State University, Fullerton (half-mile radius on either side of the Arroyo Seco); a Sacred Lands File Search through the California Native American Heritage Commission (NAHC) in Sacramento; and consultation with Native American tribes and individuals listed by NAHC as having affiliation with the Arroyo Seco watershed area. The records search results are incorporated into the discussion below. As of July 8, 2008, no information has been received from the NAHC; any information received from NAHC will be incorporated into future planning documents for future ecosystem restoration projects. Pertinent sections of the Arroyo Seco Master Plan Environmental Impact Report (EIR) were reviewed (City of Pasadena 2002a). The cultural records search through CHRIS-SCCIC included an examination of historic topographic maps (Pasadena, CA USGS 1896 and 1900), California Points of Historical Interest, California Historical Landmarks, the California Register, the National Register, the California State Historic Resources Inventory, and the City of Los Angeles Historic-Cultural Monument listings.

3.9.2 Alternative Sites Considered

3.9.2.1 Site 1 – Hahamongna Area

Only two cultural resources studies have been conducted within the Site 1. Compass Rose Archeological, Inc. conducted a pedestrian archeological survey for a deteriorated Southern California Edison power pole replacement (Romani 2002). Their survey area was a 0.25-acre area located at the northernmost tip of the site immediately east of the JPL boundary. No cultural resources were recorded during the survey. Next, Myra Frank and Associates conducted a survey evaluation of the Oak Grove Drive over Arroyo Seco Bridge (Feldman and Greenwood 2003) located in the southern end of Site 1. This study was part of a CalTrans historic bridge survey update (Myra Frank and Associates 2004). The Oak Grove Drive over Arroyo Seco Bridge was recommended as not eligible for the National Register of Historic Places or California Register of Historic resources. The majority of the Hahamongna Area has not been surveyed by archaeologists for cultural resources.

Built in 1920, Devil's Gate Dam is the only recorded cultural resource within Site 1. This dam is under the jurisdiction of the LACDPW. It has not been documented (i.e., Historic American Engineering Record) or evaluated for the National Register or California Register.

3.9.2.2 Site 2 – Flint Wash

Parts of Site 2 have been previously surveyed by archaeologists. These investigations include the Oak Grove Drive over Arroyo Seco Bridge (Myra Frank and Associates 2004) mentioned above, two CalTrans surveys associated with Interstate 210 (Barbara 2001; Smith 2000), and a

windshield survey conducted by McKenna *et al.* for sanitary sewer improvements in La Canada-Flintridge (McKenna 2000). No cultural resources have been recorded within Site 2.

3.9.2.3 Site 3 – 210 Freeway near Oak Grove Drive

The eastern half of Site 3 has been surveyed by an archaeologist. In 1973 C. William Clewlow, Jr., conducted a survey for a proposed Pasadena helipad site. No cultural resources were identified or recorded during this survey. Cultural resources located within Site 3 include the Oak Grove Bridge over Arroyo Seco (P-187693) and the northern extension of the Arroyo Seco channel (P-186859). As mentioned previously, the Oak Grove Bridge over Arroyo Seco is not eligible for listing in the National Register or California Register. The Arroyo Seco channel has been determined eligible for the National Register and California Register (Dolan et al. 2005). Therefore, the Arroyo Seco channel is considered a historic property. The Los Angeles County is currently conducting a Historic American Engineering Record (HAER) documentation for the Arroyo Seco channel between Devil's Gate Dam and the Los Angeles River as mitigation for improvements to the Arroyo Seco channel which required a Section 404 Permit from the Corps, Los Angeles District Regulatory Division.

3.9.2.4 Site 4 – Brookside Area

One survey has been conducted within Site 4. In 2001, archeologists from LSA Associates, Inc. conducted a records search and survey for a cellular phone tower located just north of the Rose Bowl (Duke 2001). No cultural resources were identified within the area of potential effect for this project. There have been no other archeological surveys within the Brookside Area.

Site 4 is immediately adjacent to the Rose Bowl stadium located at 991 Rosemont Avenue. The Rose Bowl is a National Historic Landmark and listed in the National Register (NR# 87000755) and the California Register. The Rose Bowl was constructed in 1924 and has made a significant contribution to the broad patterns of the Nation's history; it continues to host the most well-known post-season college football game.

Site 4 is within the Arroyo Seco Cultural Landscape. Recently, Pasadena Heritage nominated the Arroyo Seco Cultural Landscape for listing in the National Register. The Arroyo Seco Cultural Landscape includes several contributing and non-contributing buildings, structures, and sites including: Devil's Gate Dam; Brookside Golf Club; the Rose Bowl; Jackie Robinson Baseball Stadium; Fannie Morrison Horticultural Center Buildings (Kidspace); Brookside Park Amphitheater; La Casita del Arroyo; stone retaining walls throughout the Arroyo Seco; original circulation elements (i.e., roads and pathways throughout the Arroyo Seco); all historic bridges over and throughout the Arroyo Seco including the Colorado Street Bridge and La Loma Bridge — both listed in the National Register —, the San Rafael Bridge, and the Holly Street Bridge; the view of the San Gabriel Mountains from inside the Rose Bowl; and the aerial view of the Rose Bowl rim.

The Brookside Golf Course is located within Site 4. The Brookside Golf Course opened in 1928, and it is one of the oldest courses in Los Angeles County. It was designed by prominent golf course architects William Bell and Desmond Muirfield. The Brookside Golf Course is listed as a

contributing site to the Pasadena Arroyo Parks and Recreation District, which is eligible for listing in the National Register and California Register.

The Arroyo Seco channel is located within Site 4 and has been recommended as eligible for listing in the National Register and California Register.

Finally, the Prospect Historic District, a National Register-listed historic district, is located along the eastern edge of the Arroyo Seco east of Rosemont Avenue and Site 4. Prehistoric archeological site CA-LAN-26 was also recorded in the Brookside Area. Also referred to as Walker's Sheldon Reservoir Site, site CA-LAN-26 contained two cremations, 56 human burials, and associated grave goods and prehistoric resources (City of Pasadena 2007a). The mapped location of this site was likely developed before the advent of the National Historic Preservation Act of 1966. However, the hill slopes in the area still have the potential to contain similar buried prehistoric artifacts.

3.9.2.5 Site 5 – Lower Arroyo Seco Park

Four cultural resources surveys have been conducted within the boundaries of Site 5. In 2001, LSA Associates, Inc. conducted a survey for a cell tower site and did not identify any cultural resources (Duke 2001). In 2006, Robert Wlodarski conducted a survey for a telecommunications site and did not identify any cultural resources. In 2007, PAR Environmental Services, Inc., conducted a cultural resources survey and evaluation of structures on the Unites States Army Reserve 63D Regional Readiness Command Facility. Four buildings were recommended as eligible for listing in the National Register. No prehistoric or historic archeological sites were identified. In 2007, McKenna *et al.* conducted a cultural resources inventory for the Lower Arroyo Seco trail and trailhead improvements (McKenna 2007). McKenna did not identify any prehistoric archeological resources but noted that there is potential for buried prehistoric cultural resources.

In 2005, the Lower Arroyo Seco Historic District (NR# 04000331) was listed on the National Register. It includes the area roughly between Arroyo Boulevard, W. California Boulevard, and La Loma Boulevard. It includes Lower Arroyo Seco Park. Constructed between 1909 and 1918, the Lower Arroyo Seco Park is a Cultural Heritage Landmark and has been designated and protected since 1977. In 1982, the City of Pasadena passed the Arroyo Seco Ordinance which restricts land use within the park. Other historic properties located within or immediately adjacent to the Site 5 Lower Arroyo Park include the Colorado Street Bridge (1913), Mayberry and Parker Bridge (1914), Arroyo Seco Channel (1934-1948), La Loma Bridge (1914), and La Casita del Arroyo (1932), and the Arroyo Seco Cultural Landscape. Lower Arroyo Seco Park is also a contributing element to the Arroyo Seco Cultural Landscape. Finally, Lower Arroyo Seco Park contains rock walls, steps, and other park features which were constructed by Works Progress Administration (WPA) programs in the 1930s (McKenna et al. 2007).

3.9.2.6 Site 6 – South Pasadena Island

This area was surveyed by Historic Resources Group in 2001 in support of the City of Los Angeles' determination of eligibility for the Arroyo Seco Park Historic District. The Arroyo Seco Park Historic District is comprised of a series of contiguous parks along the Arroyo Seco

extending from Pascual Avenue south to Pasadena Avenue (Johnson 2000). The Arroyo Seco Park Historic District is recommended as eligible for the National Register. LSA Associates, Inc. conducted two surveys for telecommunication facilities in 2003 and 2004, respectively; no cultural resources were identified. In 2007, Historic Resource Associates conducted a cultural resources study of the Royal Street Communications facility in the southwestern end of Arroyo Seco Park.

Historic properties within the Site 6 include the Arroyo Seco Park Historic District, the Pasadena Arroyo Parks and Recreation District, the Arroyo Seco Cultural Landscape, the SR-110, and the Arroyo Seco channel. The bridges on York Boulevard and SR-110 and the Arroyo Seco are likely historic.

One prehistoric archeological site is located in the South Pasadena Island area: site 19-003057. This is a Native American human burial site. It was discovered in 2002 by construction workers while excavating for a new pipeline in the park (Fulton 2004).

3.9.2.7 Site 7 – Arroyo Seco through Los Angeles

Several cultural resources investigations have included sections of Site 7. These include surveys for new telecommunications sites (McLean 1998), CalTrans bridge surveys (Snyder 1986), and a pipeline project (Peak and Associates 1992). The majority of Site 7 is the channelized Arroyo Seco channel.

Historic properties within Site 7 include the Arroyo Seco channel and the SR-110, and 26th Avenue Overcrossing. Also, the California Point of Historic Interest No. LAN-027, Heritage Square, is located immediately east of the Arroyo Seco channel. Established in the late 1960s, Heritage Square is comprised of houses and a railroad station, which was designated as Historical-Cultural Monuments of the City of Los Angeles; these structures were relocated to Heritage Square. Finally, Site 7 includes the City of Los Angeles Historic-Cultural Monument No. 339: the Santa Fe Arroyo Seco Railroad Bridge located at Avenue 61 and the SR-110.

3.9.2.8 Site 8 – Sycamore Grove Park

Sycamore Grove Park is a contributing element to the Arroyo Seco Park Historic District (1927-1940), which Historic Resource Associates recommended as eligible for the National Register in 2001 (LA6385). Sycamore Grove Park is also within the Highland Park Historic District and is a contributing feature to the City's Highland Park Historic Preservation Overlay Zone. Sycamore Grove Park is depicted on the 1896 and 1900 Pasadena, CA USGS topographic maps.

3.9.2.9 Site 9 – Rainbow Canyon

This site is a small canyon located north of the Arroyo Seco near the confluence of the Los Angeles River. Rainbow Canyon is adjacent to residential areas and it contains a series of storm drains to contain runoff. The cultural resources records search through SCCIC did not include this area because it is outside of the half-mile radius used for this analysis.

3.9.3 Future Without-Project Conditions

The study area is primarily built out or preserved as open space/recreation. Therefore, areas of identified cultural resources are largely protected from new development and would not be expected to change from existing conditions under the future without-project conditions. If construction/grading activities were to occur within the vicinity of a cultural resource, disturbance and/or damage to the resource could occur. Excavation or other ground disturbing activities from possible future projects could potentially disturb cultural resources in the vicinity However, if any projects are approved and implemented, project proponents would be required to identify and protect cultural resources within the study area.

3.10 HAZARDOUS MATERIALS AND WASTES

Tetra Tech conducted a preliminary Hazardous and Toxic Waste and Materials (HTWM) investigation of the Arroyo Seco study area to determine if there is any current and/or historical contamination from activities in the study area that could potentially adversely influence the implementation of any future planned restoration projects. The preliminary assessment was primarily based on a review of relevant environmental databases maintained by Federal and state regulatory agencies. However, in addition to the database review, the assessment included a preliminary review of the 2002 Arroyo Seco Master Plan EIR (City of Pasadena 2002).

3.10.1 Database Search

As a primary basis for the preliminary investigation, Tetra Tech requested a search of available environmental databases regarding the Arroyo Seco study area, which was performed by Environmental Data Resources, Inc. (EDR 2007). The EDR database search included lists compiled by the EPA and the State of California for sites within or in proximity to the Arroyo Seco study area that have had recent or historical unauthorized releases of hazardous materials or hazardous waste, or may store and use hazardous materials, or be generators and/or transporters of hazardous wastes. The search boundary for the EDR database search included ¼-mile on each side of the Arroyo Seco channel, and the portion of the Flint Wash channel under study.

The following government databases relevant to this study were included in the EDR search in accordance with ASTM Standard E 1527-05 search distances:

§ *Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)*. This is a nationwide database of sites identified by EPA as abandoned, inactive, or uncontrolled hazardous waste sites that may require cleanup.

§ *National Priorities List (NPL)*. This is a database maintained by EPA under the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA). Those CERCLIS sites that contain the greatest potential risk to human health and the environment become part of the NPL.

§ *Resource Conservation and Recovery Information System (RCRIS)*. In this database, EPA maintains information on those sites across the Country that may generate, transport, store,

treat, and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA).

§ *Emergency Response Notification System (ERNS)*. This database is maintained by EPA that covers reported unauthorized releases of oil and hazardous substances.

§ *FIFRA/TSCA Tracking System (FTTS)*. These are recent cases tracked by EPA that involve pesticide enforcement actions and compliance activities related to the Federal Insecticide, Fungicide, and Rodenticide Act, the Toxic Substance Control Act, and the Emergency Planning and Community Right-to-Know Act.

§ *ENVIROSTOR*. The California Department of Toxic Substance Control (DTSC) manages information on this list of known hazardous waste sites that are present throughout California. This list is California's equivalent of EPA's CERCLIS. On this DTSC list, priority sites planned for cleanup; to be paid either by the state or by potentially responsible parties.

§ *Waste Discharge System (WDS)*. This is a list of waste discharge systems (including stormwater) maintained and monitored by the State Water Resources Control Board (SWRCB).

§ *Leaking Underground Storage Tanks (LUST)*. Information is maintained at the SWRCB on reported leaking underground storage tank incidents. The information is typically collected quarterly by regional offices of the SWRCB.

§ *Solid Waste Facility / Landfill (SWF/LF)*. The California Integrated Waste Management Board (IWMB) maintains a list of, and information on solid waste facilities and landfills (SWF/LF) in the state. Data maintained include location, type and age of landfill, if it is a permitted facility, and the status of its permit.

§ *Waste Management Unit Database System / Solid Waste Activity Tracking (WMUDS/SWAT)*. This is a database tracking system used by the SWRCB to inventory and track waste management units in the state.

§ *CAL Voluntary Cleanup Program (VCP)*. These are sites listed by DTSC that have confirmed or unconfirmed releases where a project proponent has requested the state to oversee investigation and/or cleanup activities at the proponent's expense.

§ *CORTESE*. This database is maintained by California EPA and includes drinking water wells with contamination, hazardous substance sites selected for remedial action, sites with known releases of contamination, and solid wastes disposal facilities with known migration.

3.10.2 Initial Sites of Interest Identified from the EDR Database Search Report

An overview of the database search report was conducted to identify any initial sites of interest reported within the databases listed above that may possibly adversely affect the Arroyo Seco study area and thus warrant closer review of the information provided in the EDR report. This

overview yielded 52 initial sites of interest reported in the 12 above-listed databases, as summarized in and shown on .

Table 3.15 Summary of HTWM Initial Sites of Interest in the Study Area

DATABASE	INITIAL SITES OF INTEREST
National Priority List (NPL; also known as Superfund)	1
Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS)	1
Resource Conservation and Recovery Act – Information – Large Quantity Generators (RCRAInfo - LQG).	3
Emergency Response Notification System (ERNS)	5
FIFRA/TSCA Tracking System (FTTS)	2
Solid Waste Facilities/Landfills (SW/LF)	3
California Water Resources Control Board – Waste Discharge System (WDS)	4
Waste Management Unit Database System (WMUDS)	4
California Hazardous Waste and Substances Sites (CORTESE)	17
Leaking Underground Storage Tank Information System (LUST)	5
California Voluntary Cleanup Program (VCP)	3
ENVIROSTOR	4
TOTAL	52

Source: EDR 2007

3.10.3 Additional HTWM Information about the Arroyo Seco Study Area from the Arroyo Seco Master Plan EIR

As reported in the 2002 Arroyo Seco Master Plan EIR (City of Pasadena 2002a), activities involving the generation, storage, and management of, as well as remediation actions regarding hazardous wastes and materials in several locations within the study area have been ongoing. Brief discussions of relevant activities and actions in the study area reported in the Master Plan EIR are presented below. Updated information from the preliminary review of the EDR Report is added to the discussions where applicable. The proximity of these activities to the nine alternative project sites in the Arroyo Seco study area under consideration in this feasibility study is indicated, as appropriate.

It bears mentioning that further investigation of the information regarding sites in the study area provided in the Master Plan EIR, as well as the sites of interest identified from the EDR Report discussed previously, may be necessary to bring the information up to date in order to complete the evaluation of potential HTWM effects on future planned restoration projects in the Arroyo Seco study area.

As discussed in the Master Plan EIR, the JPL is located adjacent to the northwestern portion of Site 1. The JPL site has been identified as a CERCLA site (also known as Superfund), and has been listed since 1992 on the NPL. The JPL contains approximately 150 buildings and other structures on about 176 acres of land. The northeastern portion is used for project support, testing, and storage; the southwestern portion is used for administrative, laboratory, and project functions. During its operational history, various chemicals and chemical waste materials were

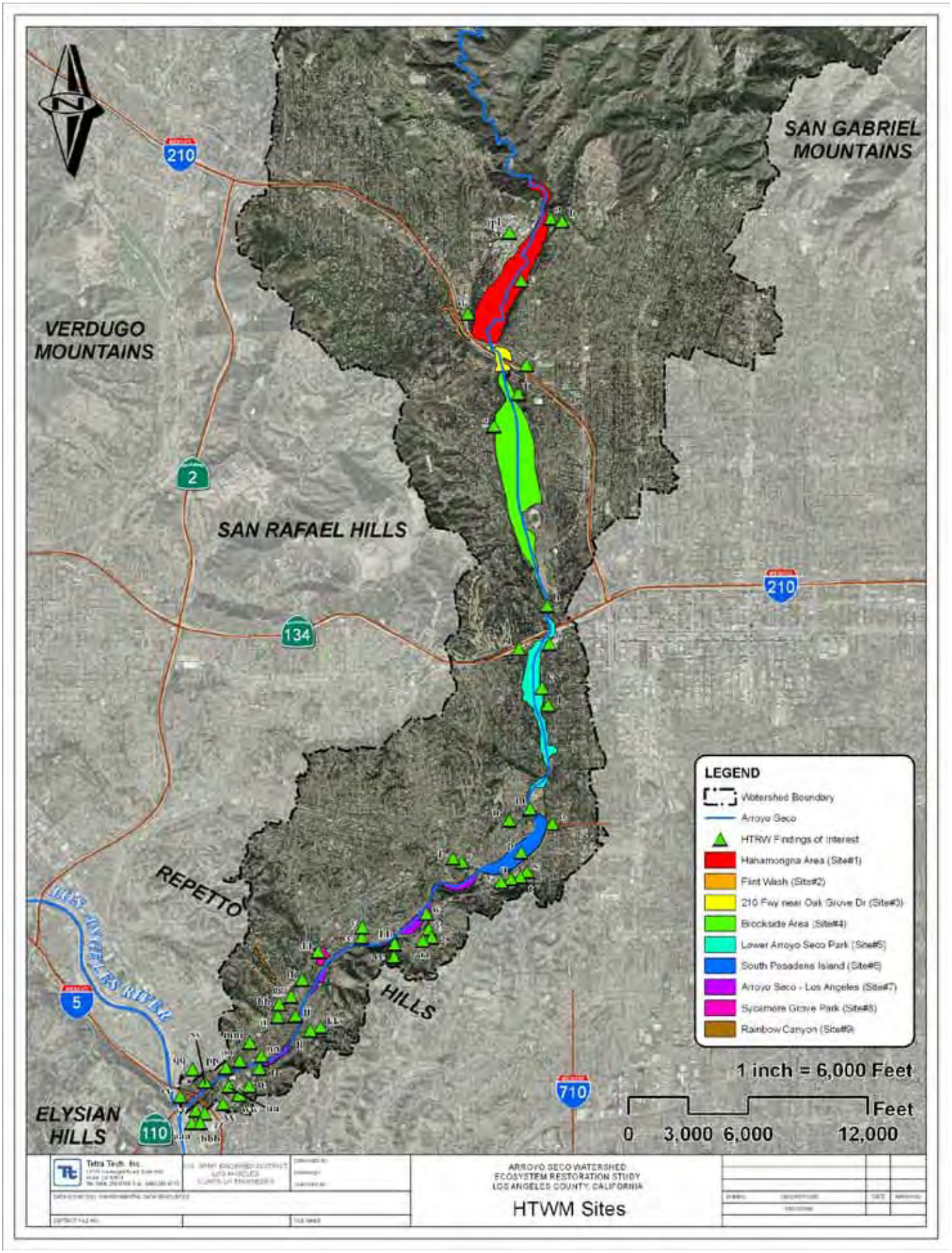

Figure 3.8 HTWM Sites

generated at the site, including solvents, solid and liquid rocket propellants, and laboratory wastes. In the 1940s and 1950s, many buildings at the JPL maintained seepage pits to dispose of liquid and solid wastes collected from drains and sinks within the buildings. The pits were designed to allow liquid wastes to seep into the surrounding soil. The results of a remedial soil and groundwater investigation conducted by the California EPA in 1990 revealed the presence of VOCs in the soil and groundwater at the site in levels exceeding Federal and state drinking water standards at depths up to 200 feet below ground surface (bgs).Subsequent site investigations identified a VOC plume beneath approximately 45 acres in the central portion of the site, ranging from about 50 feet bgs to the water table (approximately 200 bgs). In response to a request by the EPA, the JPL initiated a long-term quarterly groundwater monitoring program plan in August 1996. Additionally, soil vapor extraction methods were planned to remediate the contaminated soil on site. Since the inception of the quarterly monitoring plan, several substances have been detected in concentrations above their respective state or Federal regulatory limits, including carbon tetrachloride, trichloroethene (TCE), tetrachloroethene (PCE), perchlorate, 1,2-DCA, 1,4-dioxane, total chromium, hexavalent chromium, and dead (metals). A groundwater treatment facility, located in the northeast portion of the HWP, treats contaminated groundwater pumped from three wells.

According to the Master Plan EIR, the JPL is also a permitted hazardous waste generator and solid waste disposal facility. It has 19 registered underground storage tanks (USTs) ranging in capacity from 1,000 gallons to 20,000 gallons. There are two LUST locations within the JPL facility; discovered during tank closures in 1990 and 1995, respectively. These unauthorized releases of petroleum hydrocarbons (gasoline and diesel) were confined to soil and are not a factor in assessing groundwater quality. In the HWP, adjacent to the northwest portion of Site 1, existing restrooms near the Equestrian Staging Area are connected to three septic tanks. Also, because park restroom and maintenance structures were constructed in the 1950s, it is reasonable to assume that asbestos-containing building materials (ACMs) were used during original construction activities, and surfaces may have been treated with lead-based paint (LBP).

Both the Master Plan EIR and the EDR Report do not indicate the presence of any activities involving generation, use, or storage of hazardous wastes and materials in proximity to Site 2. However, in the EDR Report, the presence of a leaking underground storage tank (LUST) is reported in the database search in proximity to Site 3.

With regard to Site 4, it was reported in the Master Plan EIR that the Brookside golf course maintenance facility had two 1,000-gallon USTs containing diesel and unleaded fuel, respectively. The Rose Bowl Aquatic Center and the Rosemont Pavilion maintain supplies that are listed in their hazardous material inventories on file with the Pasadena Fire Department. No unauthorized releases of hazardous materials are reported for these facilities. Due to the age of construction of the Rose Bowl Stadium and associated restrooms and maintenance structures (prior to 1978-1979 when asbestos and lead regulations limited the use of ACM and LBP), it is anticipated that asbestos-containing building materials were used during original construction activities, and surfaces may have been treated with LBP. The EDR Report identified sites of interest in proximity to Site 4 (see).

According to the Master Plan EIR, there were no reported USTs, ASTs, or reportable quantities of hazardous materials used, stored, or generated in the parks and public areas in proximity to Site 5, Site 6, and the upper portion of Site 7. However, because the construction of public restrooms and maintenance structures located in the park areas along this section of the Arroyo Seco occurred prior to 1978-1979, it is reasonable to assume asbestos-containing building materials were used during original construction activities, and surfaces may have been treated with LBP. Also, it is apparent in , which are based on the EDR Report, that there are a number of findings in proximity to Sites 5, 6, 7, 8, and 9 that have in the past or are currently being tracked by regulatory agencies.

3.10.4 Future Without-Project Conditions

The baseline conditions regarding the use of hazardous wastes and materials and the generation, storage, and disposal of hazardous wastes and materials in the study area will likely continue as at present into the foreseeable future. Regarding the sites of interest in proximity to the Arroyo Seco study area identified from the EDR Report and the other sites discussed in the Arroyo Seco Master Plan EIR, there is the potential for current and historical contamination at these sites to adversely affect human activities in the study area, with or without the implementation of any Federal project.

3.11 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

This section describes demographics and the local economy in Los Angeles County and the cities of Los Angeles, South Pasadena, Pasadena, and La Cañada Flintridge, including the unincorporated area of Altadena. Economic parameters discussed include population, ethnicity, housing, employers, employment, and income. Details regarding socioeconomics are provided in the Economic Appendix.

This section also presents a discussion of environmental justice in the study area in accordance with EO 12898 and the protection of children from environmental health risks in accordance with EO 13045.

3.11.1 General Setting

The Arroyo Seco passes through a variety of neighborhoods, with a great diversity of income, race, and ethnicity. Many of these neighborhoods have traditionally been under-served by parks and other public amenities. Median home values range from $150,000 to $500,000. Racially, some areas have over 70 percent Caucasian population, while others have roughly a 50/50 mix of Hispanic and Caucasian. A concentration of African-American population occurs in the northeast portion of the watershed, and the Asian population has grown to be about the same proportion of the total study area population (about 12 percent) as the African-American population. No age group dominates any part of the watershed.

Arroyo Seco is one of the earliest settled parts of the Los Angeles region, and contains many cultural and historic sites and historic districts. The Arroyo Seco was the center for the Arts and Crafts movement on the West Coast. The movement started in the United Kingdom between the late 1850s and early 1860s and is characterized by a disregard for industrialization, with

followers of the movement building their own houses out of as many natural materials as possible and handcrafting as much of their environment as possible. By the late 1890s, the movement had worked its way over to America, having significant influence on the Arroyo culture throughout the first two decades of the 20th Century. The movement gave rise to thriving enterprises, including furniture design and manufacturing, home plans and kits, ceramics, glasswork, metalwork, and textiles. The area is known worldwide for its concentration of historic arts and crafts resources, and many early craftsman structures. Also, the historic Route 66 runs through the watershed, which with its gateway of sycamores was for years considered the "Gateway to Los Angeles."

3.11.2 Demographic Characteristics

Information on population, race, housing, income, and employment in the study area are based on data for 2001 and 2010. The Census 2000 Tracts and portions of the cities of La Canada-Flintridge, Pasadena, South Pasadena, and Los Angeles, as well as the unincorporated area of Los Angeles County that are within or overlap with the Arroyo Seco watershed are illustrated on

3.11.2.1 Population

The population of Los Angeles County is over 10 million, which is highest among all the counties in the United States. Population estimates over the past decade for the five primary areas within the Arroyo Seco watershed are listed in . Population increased by 11.7 percent for Pasadena; 3.1 percent for La Cañada Flintridge; 4.8 percent for South Pasadena; 9.2 percent for Los Angeles; and 8.8 percent for Los Angeles County (). The population within the county is projected to increase by 24.2 percent over the next 40 years.

Table 3.16 Population Estimates (2001 – 2010)

LOCATION	2001	2002	2003	2004	2005
Pasadena	135,587	138,904	142,214	143,797	145,314
La Cañada Flintridge	20,621	20,956	21,214	21,387	21,479
Altadena	NA[1]	NA	NA	NA	NA
South Pasadena	24,676	25,011	25,276	25,481	25,634
City of Los Angeles	3,748,362	2,810,154	3,864,381	3,906,603	3,934,714
County of Los Angeles	9,656,730	9,816,492	9,961,407	10,077,865	10,163,097
	2006	**2007**	**2008**	**2009**	**2010**
Pasadena	146,327	146,452	147,293	149,540	151,576
La Cañada Flintridge	21,340	21,233	21,155	21,139	21,261
Altadena	NA	NA	43,887	NA	NA
South Pasadena	25,708	25,678	25,644	25,737	25,881
City of Los Angeles	3,980,422	3,996,070	4,022,450	4,050,727	4,094,764
County of Los Angeles	10,233,263	10,275,914	10,301,658	10,365,053	10,441,080

[1] Estimates were unavailable.

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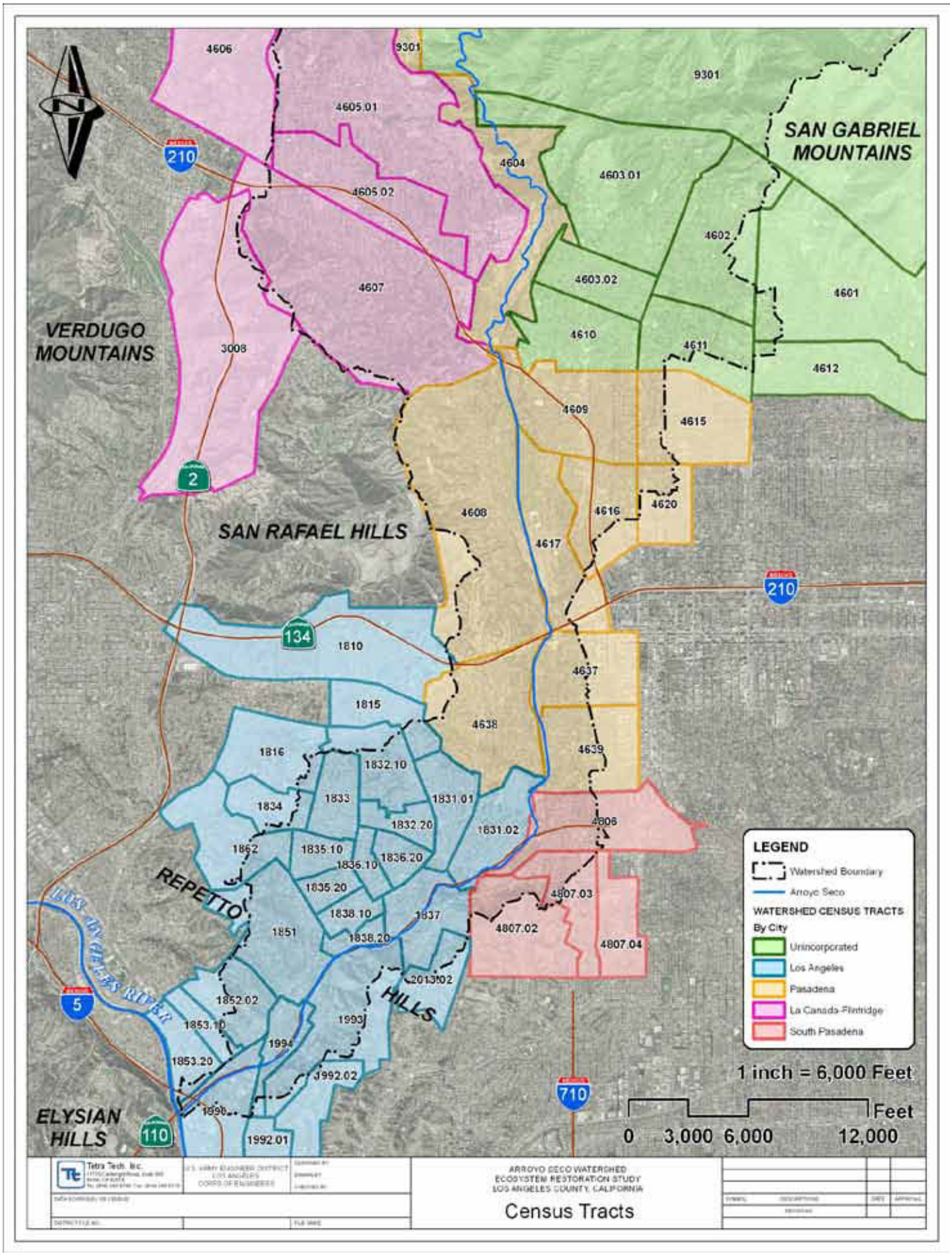

Figure 3.9 Census Tracts

Table 3.17 Historical Population Change and Density					
LOCATION	2001	2010	CHANGE (%)	AREA (sq. mi.)	POPULATION DENSITY (sq. mi.)
Pasadena	135,587	151,576	11.79	23.2	6,533
La Cañada Flintridge	20,621	21,261	3.10	8.65	2,457
Altadena	NA [1]	43,887	NA	8.70	5,044
South Pasadena	24,676	25,881	4.88	3.44	7,523
City of Los Angeles	3,748,362	4,094,764	9.24	498.3	8,217
County of Los Angeles	9,656,730	10,514,663	8.88	4,752	2,212
Source: U.S. Census					

3.11.2.2 Ethnicity

The study area population includes a wide variety of ethnic groups as displayed in . For all the areas, the predominant ethnicity is Caucasian, which ranges from a low of 47.9 percent (Los Angeles) to a high of 71.4 percent (La Cañada Flintridge). The second largest ethnic group from all of the areas is Hispanic/Latino of any race, these estimates range from a low of 19.7 percent for South Pasadena to a high of 46.5 percent for Los Angeles. The third largest ethnic group from all areas is those with some percent of some other race. All of the areas in the table below ranked individuals from some other race as the third most populace group except for South Pasadena, which ranks Asians as the third most populace group and Altadena, which ranks Blacks and African Americans as the third most populace group.

Table 3.18 Ethnicity Composition				
AREA	**PERCENT (%)**			
	CAUCASIAN	**HISPANIC LATINO OF ANY RACE**	**BLACK AND AFRICAN AMERICAN**	**AMERICAN INDIAN AND ALASKA NATIVE**
Pasadena	58.7	33.5	11.5	0.4
La Cañada Flintridge	71.4	Sampling Cases Too Small	0.0	0.20
Altadena	57.3	25.4	27.5	0.2
South Pasadena	58.3	19.7	3.1	0.0
Los Angeles	46.9	46.5	11.2	0.8
Los Angeles County	48.7	44.6	9.8	0.8
State of California	59.5	32.4	6.7	1.0
AREA	**ASIAN**	**NATIVE HAWAIAN AND PACIFIC ISLANDER**	**SOME OTHER RACE**	**TWO OR MORE RACES**
Pasadena	11.7	0.1	14.2	3.3
La Cañada Flintridge	25.4	0.0	0.7	2.3
Altadena	3.9	0.1	7.5	3.5
South Pasadena	28.4	0.0	5.7	4.5
Los Angeles	10	0.2	25.7	5.2
Los Angeles County	11.9	0.3	23.5	4.9
State of California	10.9	0.3	16.8	4.7

3.11.2.3 Housing

Los Angeles County is expected to experience continued, although slow, population growth throughout the next 50 years, with corresponding increases in demand for housing. Land available for development in the study area is limited as the cities approach full "build-out". shows the housing units for cities within the study area as well as for the Los Angeles County and the state of California.

Table 3.19 Housing Units

LOCATION	TOTAL HOUSING UNITS	OCCUPIED	VACANT
Pasadena	56,535	52,376	4,159
La Cañada Flintridge	7,133	6,900	233
Altadena	15,340	14,754	588
South Pasadena	10,927	10,583	344
City of Los Angeles	1,337,706	1,275,412	62,294
County of Los Angeles	3,270,909	3,133,774	137,135
State of California	12,214,549	11,502,870	711,679
Source: Housing data based on U.S. Census Bureau, adjusted from the April Decennial Census of Population for 2000			

3.11.2.4 Employers

Los Angeles County offers a wide range of jobs in various employment categories. The main private sector employment type is retail followed by health care and social assistance, and management and administrative support. The cities within the study area also offer a large and diverse number of employers to support the large population living in the study area. The overall employment within the Pasadena region includes 84,000 highly technical jobs, sales, managerial, and clerical jobs. Some of the companies or institutions located within Pasadena include the JPL, California Institute of Technology, Huntington Memorial Hospital, Bank of America, Kaiser Permanente, Pasadena Unified School District, Pasadena City College, Countrywide Credit Industries, City of Pasadena, SBC, and the Ralph M. Parson Company. For La Cañada Flintridge, top businesses are in the food sector including grocery stores, fast food and regular restaurants. Rated second is the apparel industry, while rated third is other retail which includes footwear, jewelry and accessories, furniture, and photo equipment. South Pasadena's five largest private employers are Alert Communications, Bristol Farms, Abbot Labs, Vons, and Orchard Supply. The top employers for the City of Los Angeles are Kaiser Permanente, Ralph's Grocery Company, Target, University of Southern California (private), Tenet Health Care Corporation, and Bank of America.

3.11.2.5 Employment and Income

Due to the recent recession and slow economic recovery, the City of Los Angeles has a high rate of unemployment as noted in . The city's unemployment rate of 13 percent for January 2010 is slightly higher than Los Angeles County's unemployment rate (12 percent) and the state of California's unemployment rate (12 percent).

Table 3.20 Labor Force Data				
AREA NAME	LABOR FORCE	EMPLOYMENT	UNEMPLOYMENT	
			Number	Rate (%)
Los Angeles	1,909,300	1,656,700	252,600	13.2
Los Angeles County	4,869,400	4,285,100	584,300	12.0
California	18,195,800	15,989,300	2,206,600	12.1
Source: EDD 2010				

Also, the City of Los Angeles has a slightly lower level of median household income, family income, and per capita income relative to Los Angeles County and the state of California (). La Cañada Flintridge, Altadena, South Pasadena, and Pasadena have higher median household income, median family income, and per capita income, respectively. In addition, the percentage of the population below the poverty level in the City of Los Angeles (22 percent) is substantially higher than that for Los Angeles County (17 percent), the state of California (14 percent), and Pasadena (13 percent). The population below the poverty level is drastically reduced for La Cañada Flintridge, Altadena, and South Pasadena, which are more affluent.

Table 3.21 Income Data					
AREA	MEDIAN HOUSEHOLD INCOME	MEDIAN FAMILY INCOME	MEDIAN PER CAPITA INCOME	PERCENTAGE OF FAMILIES BELOW POVERTY LINE	PERCENTAGE OF INDIVIDUALS BELOW POVERTY LINE
Pasadena	64,184	78,600	39,190	10.5	13.6
La Cañada Flintridge	140,474	157,511	71,221	2.1	2.9
Altadena	86,384	93,277	37,880	5.5	8.1
South Pasadena	80,582	97,437	49,691	4.5	5.6
Los Angeles	36,687	39,942	20,671	18.3	22.1
Los Angeles County	42,189	46,452	20,683	14.4	17.9
California	47,493	53,025	22,711	10.6	14.4

3.11.3 Environmental Justice

In 1994, the President of the United States issued EO 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*. The objective of this EO include developing Federal agency implementation strategies, identifying minority and low-income populations where proposed Federal actions could have disproportionately high and adverse human health and environmental effects, and encouraging the participation of minority and low-income populations in the NEPA process.

The Council on Environmental Quality (CEQ) identifies minority groups as American Indian or Alaskan Native, Asian or Pacific Islander, Black not of Hispanic origin, and Hispanic (CEQ 1997). It defines a minority population as any group of minorities that exceed 50 percent of the existing population where a minority group comprises a meaningfully greater percentage of the local population than in the general population. As shown on above, the adjacent communities of the Arroyo Seco watershed are overwhelmingly Caucasian, with a sizeable Latino population.

None of the local communities, the county, or the state has a minority population that exceeds 50 percent.

The CEQ guidelines do not specifically define low income populations, but some agencies have developed thresholds for environmental justice impacts analysis. Disadvantaged communities are defined in California Guidelines as those communities with an annual median household income less than 80 percent of the statewide annual median household income (California Water Code § 79505.5(a)). Using 2000 Census data, the statewide annual median household income for disadvantaged communities is $37,994. In comparison, in 2000 the annual median household income for Los Angeles County was $42,189, about 11 percent lower than the statewide annual median household income of $47,493. Similarly, the annual median household income for the communities within the Arroyo Seco watershed is higher than the statewide annual median household income, with the exception of the City of Los Angeles, which is about 23 percent lower.

3.11.4 Future Without-Project Conditions

Under the future without project conditions, socioeconomic trends, including employment, industry, and income, in the cities within the Arroyo Seco watershed are not expected to change substantially relative to past years. Population in Los Angeles County is estimated to increase to approximately 12.3 million in 2035 (SCAG 2008). Population growth would increase spending in the region and increase housing demands. Employment and income in the region would adjust to overall economic conditions, but the long-term socioeconomic character of the region is not expected to change. Minority and low-income populations in the vicinity of the study area would also remain similar to existing conditions and environmental justice is not expected to change under the future without-project condition.

3.12 TRANSPORTATION

Transportation within Los Angeles County is a complex system of roads, highways, public transit, freight railroads, airports, seaport, and intermodal terminals. Local streets, arterial streets, freeways, and carpool lanes allow access to private autos, carpool vehicles, private and public buses, and trucks. The freeway and highway system is the primary means of regional transportation for people and goods, allowing direct access to places of employment and commerce. This section discusses the transportation system that exists within the study area.

3.12.1 Interstate Highways

There are four primary routes of travel in the vicinity of the Arroyo Seco. The SR-2 runs northeast/southwest, and crosses the northern portion of the watershed; the I-210 generally runs east/west, crosses the Arroyo Seco north of the Brookside Golf Course, just south of the HWP; SR-134 runs east/west and crosses the Arroyo Seco north of the Colorado Boulevard Bridge; and the historic SR-110, scenic Highway, runs north/south along the south end of the Arroyo Seco ().

3.12.2 Local Roadways

The primary local roadways that provide access to the Arroyo Seco study area are described below. Traffic volumes for these roadway segments in the vicinity of the study area are shown on .

- Immediate access to the upper portion of the watershed (HWP) is provided via Oak Grove Drive and Foothill Boulevard on the west and Windsor Avenue on the east.
- Immediate access to the central portion of the watershed is provided via Rosemont Avenue, West Washington Drive, Rose Bowl Drive, Seco Street, Pasadena Avenue, Orange Grove Avenue, Grand Avenue
- Arroyo Boulevard, Salvia Canyon Road, and Parkview Avenue.
- Immediate access to the lower portion of the watershed is provided via Arroyo Boulevard, Monterey Road, Avenue 60, Via Marisol, Griffin Avenue.

Table 3.22 Traffic Volume Summary

PRIMARY STREET	CROSS STREET/LIMITS	CITY	COUNT DATE	TOTAL (ADT)[1]
Oak Grove Drive	JPL to Foothill	La Cañada Flintridge	2009	8,866
	Foothill to Berkshire Place	La Cañada Flintridge	2009	11,709
Foothill Boulevard	Daleridge to Oak Grove	La Cañada Flintridge	2009	8,425
Windsor Avenue	Woodbury Road	Altadena	2008	12,482
Rosemont Avenue	Orange Grove Boulevard	Pasadena	2004	16,011
W. Washington Drive	N. Arroyo Boulevard	Pasadena	2000	4,014
Rose Bowl Drive	N/A	Pasadena	N/A	N/A
Seco Street	N/A	Pasadena	N/A	N/A
Pasadena Avenue	Arroyo Drive	South Pasadena	2001	20,000
	Mission Street	South Pasadena	2001	6,600
Orange Grove Avenue	Magnolia Street	South Pasadena	2001	11,300
Grand Avenue	SR-110	South Pasadena	2001	3,000
Monterey Road	Via Marisol	Los Angeles	2009	11,743
Avenue 60	SR-110	Los Angeles	2009	13,333
Via Marisol	Monterey Road	Los Angeles	2009	7,115
Griffin Avenue	Mission Road	Los Angeles	2009	7,138

[1]Total volume are bi-directional average daily traffic (ADT)
Source: City of La Cañada Flintridge 2009a; City of Pasadena 2009b; City of South Pasadena 2001; City of Los Angeles 2010a; LADPW 2010.

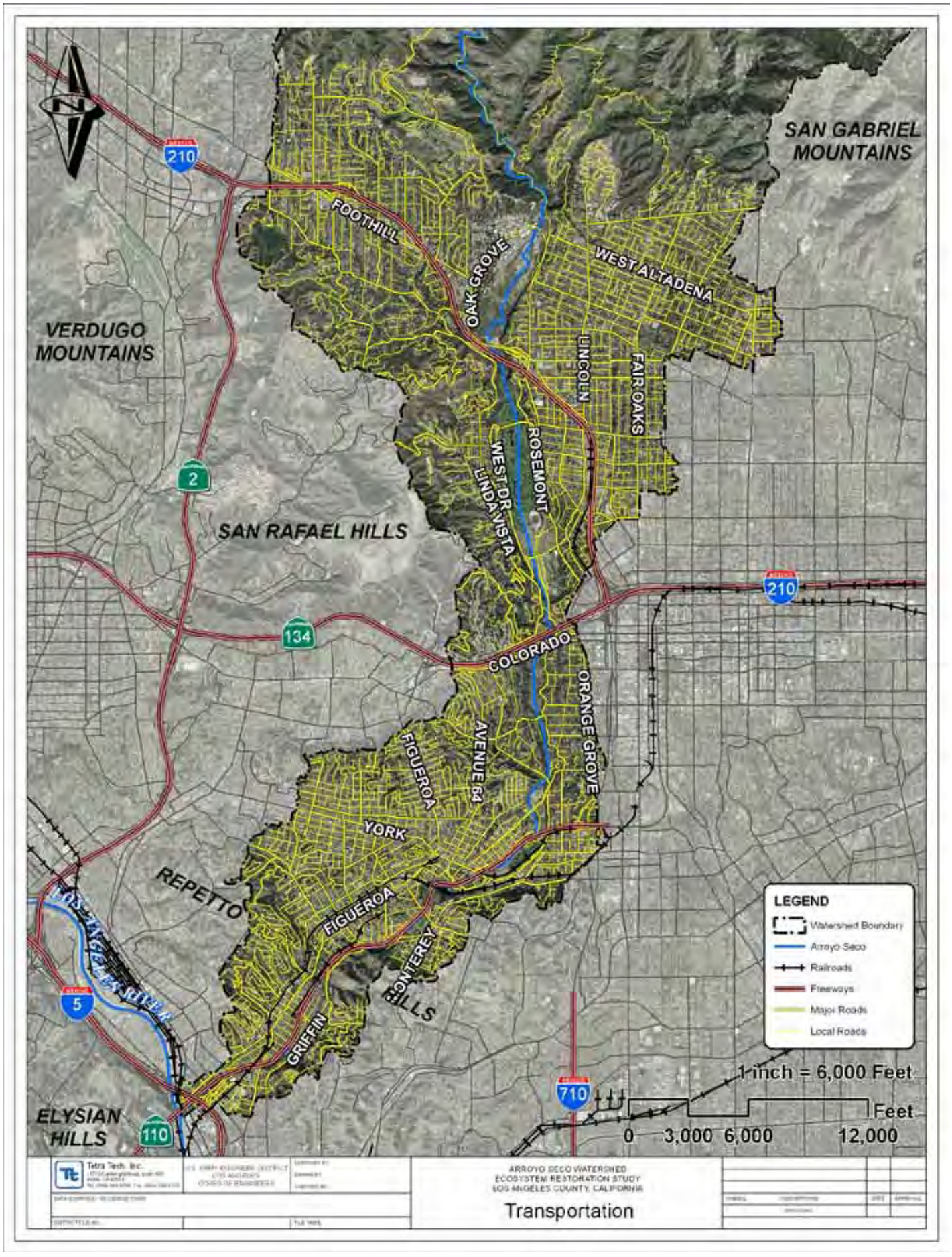

Figure 3.10 Transportation

3.12.3 Local Public Transit Services

The Arroyo Seco study area is served directly by public bus lines operated by the Los Angeles County Metropolitan Transportation Authority (MTA), the Pasadena Area Rapid Transit Service (ARTS), and the South of Pasadena Gold Link shuttle buses.

3.12.4 Future Without-Project Conditions

Under the without-project conditions, increased traffic on area roadways is expected as population in the region grows. The southern California region is the most congested metropolitan area in the country (SCAG 2008). Based on SCAG's analysis, average daily Vehicle Miles of Travel (VMT) are expected to grow from 219 million miles in 2008 to 260 million miles per day in 2035 (SCAG 2008). This change constitutes a 19 percent increase over this period. Over the past 20 years, traffic delays have nearly tripled in the region (SCAG 2008). Reasons for delay and congestion vary and include merging, weaving, accidents, weather, special events, and lane closures, among others. It estimated that there would be substantially higher average Vehicle Hours Traveled (VHT) in delay by 2035. The total daily VHT in delay are expected to grow from 7.9 million person-hours in 2008 to 10.2 million person-hours in 2035 (SCAG 2008). This constitutes a 29 percent increase from conditions in 2008.

3.13 UTILITIES AND INFRASTRUCTURE

This section identifies the utilities and infrastructure found within the Arroyo Seco corridor. Utilities addressed in this document include those services provided to residents and commercial businesses within the County of Los Angeles and the cities of Los Angeles, Pasadena, South Pasadena, and La Cañada Flintridge, including electricity, natural gas, telecommunications, sewer and septic systems, water supply, treatment or distribution facilities, and sanitation services. The following paragraphs describe the availability of utilities for the Arroyo Seco watershed and general vicinity.

3.13.1 Power and Telecommunications

Power in the Arroyo Seco watershed and general vicinity is provided by three major suppliers. Southern California Edison (SCE) serves 13 million customers over 50,000 square miles of Southern California including unincorporated areas of Los Angeles County in the Arroyo Seco watershed. The Los Angeles Department of Water and Power (LADWP) serves the City of Los Angeles and portions of Owens Valley serving over 3.9 million customers. The Pasadena Water and Power (PWP) provides power to approximately 94,000 customers in the City of Pasadena and nearby communities. Power is produced for these customers using power generated from coal, natural gas, nuclear fuel, large hydroelectric plants, and renewable sources.

Telecommunications utilities include telephone, television, and Internet. Corporations providing telecommunication services within the area include SBC, Verizon, Time Warner, Comcast, DirecTV, Dish, Adelphia, Qwest, and Earthlink.

3.13.2 Natural Gas

Natural gas is provided to customers in the Greater Los Angeles Region by Southern California Gas Company (SoCalGas), an affiliate of Sempra Energy. SoCalGas provides gas to residential, commercial, and industrial markets of Los Angeles, through a series of transportation, exchange, and storage facilities (CPUC 2006). SoCalGas' existing gas supply portfolio is regionally diverse and includes supplies from California sources (onshore and offshore), southwestern U.S. supply sources (the Permian, Anadarko, and San Juan Basins), the Rocky Mountains, and Canada (CPUC, 2006). Most natural gas used in California comes from out-of-state basins. In 2003, 42 percent of natural gas came from the southwest, 26 percent came from Canada, 14 percent from the Rocky Mountains, and only 18 percent from basins within California (CPUC 2006). The California Public Utilities Commission (CPUC) and the Federal Energy Regulatory Commission both regulate SoCalGas operations.

Underground Service Alert (also known as USA or Dig Alert) is a nonprofit organization supported by utility firms that provides specific information on the location of underground utilities to contractors on request, prior to construction.

3.13.3 Water and Water Supply

Water is provided by a number of entities in the area. The two primary suppliers in the Arroyo Seco watershed are LADWP and PWP. In addition, a number of smaller water districts provide water in the area. The majority of the water supplied is imported into the area by the MWD of southern California and sold to the individual suppliers with local groundwater making up the remainder of the water supply.

3.13.4 Wastewater and Solid Waste

The City of Los Angeles' Bureau of Sanitation and Los Angeles County Sanitation District (LACSD) provides services for the Arroyo Seco watershed, including the wastewater program and solid resources program. The LACSD operates a wastewater treatment plant in La Cañada in the watershed. No solid waste facilities were found in the Arroyo Seco corridor.

3.13.5 Storm Drains

Over the past century, the streams and rivers draining the greater Los Angeles area have been steadily converted into a system of concrete flood control channels. As the area around the small ditches and gullies that formerly fed the rivers and streams were urbanized, these too were channelized and in some case covered completely. Today, runoff from storms in the region is collected, sent to storm drains, and eventually to the Pacific Ocean. The Arroyo Seco channel is the primary flood control channel serving the study area and is fed by numerous storm drains as it flows from the toe of the San Gabriel Mountains to its confluence with the Los Angeles River ().

3.13.6 Alternatives Sites Considered

The following generally describes the availability of utilities for the study area and general vicinity. Natural gas is provided to the cities adjacent to the Arroyo Seco study area by SoCalGas, an affiliate of Sempra Energy. The SCE provides electrical services via overhead transmission lines. In general, other utility services such as water supply, sewer, and solid waste are provided by the cities within its city boundaries.

3.13.6.1 Site 1 – Hahamongna Area

§ Overhead power lines in the HWP area include SCE and the PWP Department. In some cases, the power poles are also utilized by Verizon and local cable companies. There are also communication lines installed underground starting at Devil's Gate Dam traveling along the east side of Oak Grove Drive to the JPL campus.

§ A 12-inch high-pressure natural gas line owned by the SoCalGas is buried from three to eight feet deep and traverses the basin underground from Kent Street to Foothill Boulevard. The City of Pasadena owns and operates three wells in the park. The JPL has set up a series of monitoring test wells throughout the basin, on its campus, and in the western residential areas of Altadena to track contaminants in the groundwater. The three water lines, a 12-, 16-, and 30-inch lines, owned by the City of Pasadena run along the east side of the basin.

§ The Oak Grove Drive sewer main runs near the site. In addition to the sewer main, a number of small local sewer lines connections serve park facilities. A small number of park facilities, restrooms located in the interior of the park (600 to 1,800 feet from the Oak Grove Line) use septic systems. The current HWP Master Plan (City of Pasadena 2003b) calls for replacing all septic systems located within the HWP.

§ There are 23 identified storm drains entering the HWP. The storm drains primarily originate in the residential neighborhoods of Altadena and La Cañada Flintridge and from the JPL grounds. There are no industrial-zoned areas draining into the basin.

3.13.6.2 Site 4 – Brookside Area

§ A network of water mains covers most of the flat terrain in the area to service the many recreation facilities in the reach. Water line crossings are located on each of the road crossings of Arroyo Seco.

§ A network of sewer lines serve the northern area west of the Arroyo Seco channel where most of the structures associated with the Rose Bowl are located. There are no known sewers lines in the golf course other than the line that feeds the Clubhouse. All sewers lead to the County outfall in South Pasadena.

§ Eleven storm drains serving the area residential streets connect to the Arroyo Seco channel. In addition, the roadways and parking lots within the reach drain directly into the channel.

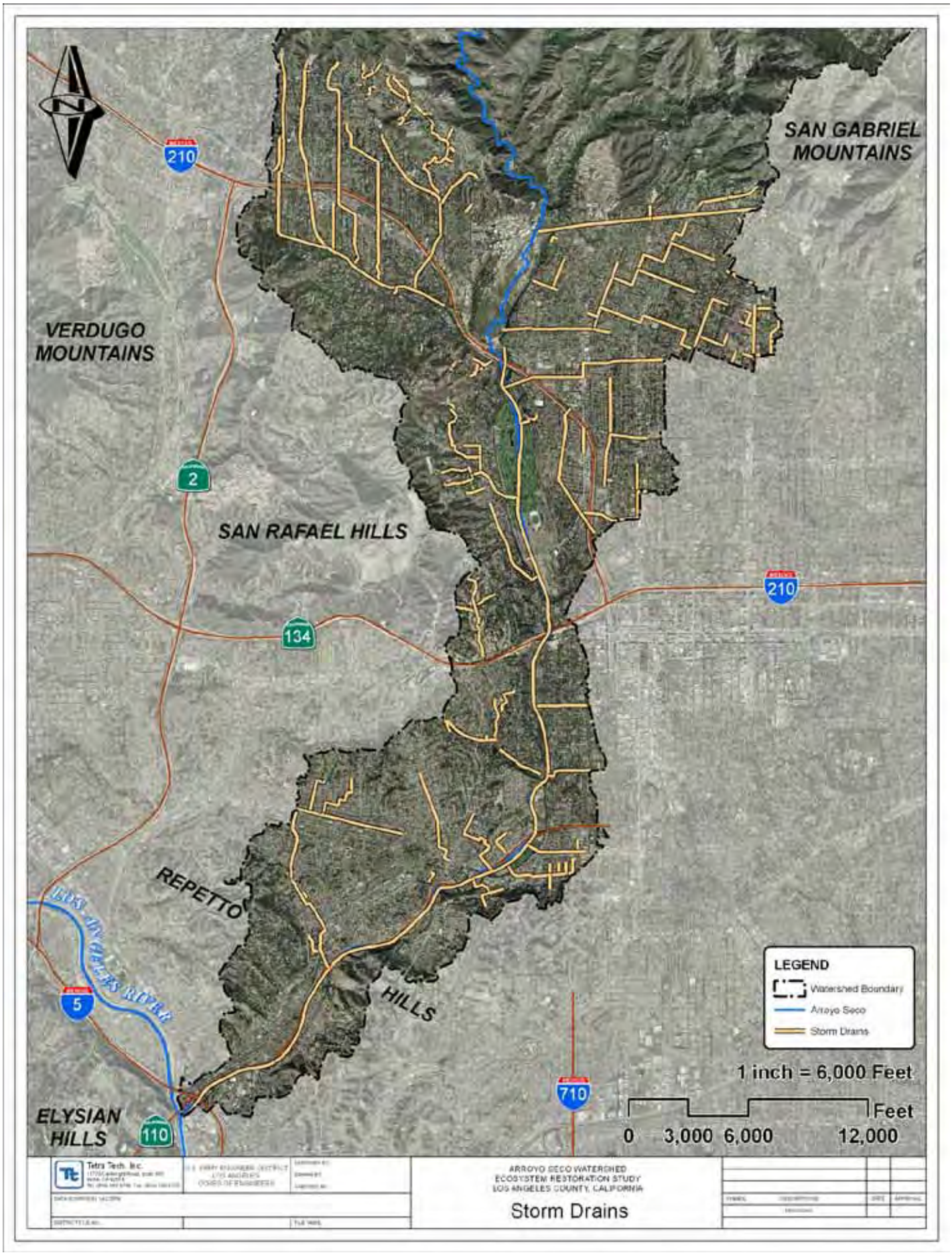

Figure 3.11 Storm Drains

3.13.6.3 Site 5 – Lower Arroyo Seco Park

§ A system of underground power lines provide power to the various park facilities from the overhead power lines running along the Arroyo Boulevard.

§ A municipal water main exists along Arroyo Boulevard on the easterly edge of the Lower Arroyo Seco Park site and two lateral water mains cross the Arroyo Seco on the south side of the La Loma Road Bridge. The water source or water service for landscaping, recreational facilities, and fire suppression in the Lower Arroyo Seco Park is provided via a water main along the Arroyo Boulevard.

§ The sewer mains serving the San Rafael area of West Pasadena cross the Arroyo Seco channel on the La Loma Road and San Rafael Avenue Bridges to connect to the eastside mains. There are three sewage lift stations in the site. The Casting Club building with kitchenette and public restrooms has a pump station adjacent to the building as does the restroom building in the Memorial Grove area. The Busch Gardens residential area has a pump station on the floor of the Arroyo Seco, south of the homes. Each lift station pumps the sewage up to the sewer main above.

§ Eleven storm drains located on the slopes of the canyon discharge into the Arroyo Seco. In addition, most of the large areas within the Lower Arroyo Seco Park have short area drains to allow surface runoff to flow directly into the flood-control channel including three inlets on the west side of the channel and four inlets on the east side. The Busch Gardens residential area has a small underground storm drain system that discharges directly into the flood channel.

3.13.6.4 Site 6 – South Pasadena Island

§ A network of sewer lines serves the residential area northwest west of the Arroyo Seco channel. There are no known sewers lines within the site except a line crossing at San Pasqual Bridge.

§ Eleven storm drains serving the area residential streets and the SR-110 connect to the Arroyo Seco channel throughout this site.

3.13.6.5 Site 7 – Arroyo Seco through Los Angeles

§ Overhead power lines observed through aerial interpretation were found at South Avenue 57, crossing the SR-110 and the Arroyo Seco channel. A tower is located near the north bank of the channel.

§ A network of sewer lines serves areas to the west and north of the Arroyo Seco throughout the entire reach of Site 7, with many lines paralleling the river or the nearby the SR-110. At several locations, sewer lines cross the river: at Pasadena Avenue near the southern end of the site; at South Avenue 52, which services a small community on the south side of the channel, at Via Marisol, and at Marmion Way.

§ Thirty-six main lines, as classified by the City of Los Angeles in their stormwater conduit data, discharge to the Arroyo Seco channel. Sixteen smaller connector storm drains also connect to the channel within the site. Main lines tend to be larger systems draining large developed areas on either side of the channel, while connector drains service smaller areas directly abutting the channel.

3.13.6.6 Site 8 – Sycamore Grove Park

§ A network of sewer lines serves the residential areas surrounding Sycamore Grove Park, under both Figueroa Street and S. Avenue 49. One sewer line parallels the SR-110, running under the southeast edge of the park.

§ A storm drain serving the area residential area north by northwest runs directly under the park, under the SR-110 discharging directly into the Arroyo Seco channel.

3.13.6.7 Site 9 – Rainbow Canyon

§ A network of sewer lines serves residential areas on both sides of Rainbow Canyon. They connect at the downhill end of the canyon, outside the site location. No lines run within the site itself.

§ Two storm drains service the area surrounding Rainbow Canyon. One drains Rainbow Avenue and discharges directly into the canyon about half way up the site. A second starts in the lower quarter of the site, running along the northeast edge, then following W. Avenue 45 outside the site.

3.13.7 Future Without-Project Conditions

Population growth under the future without-project conditions would increase demands for public services and utilities in the region. In the study area, public services and utilities would remain relatively the same as existing conditions. Emergency repairs would be implemented as needed to protect existing utilities in place. Existing flood risk management structures are expected to be maintained to protect the area from flood damages.

3.14 AESTHETICS

This section describes the visual landscape in the study area, views from the study area, and views of the study area from surrounding sites.

3.14.1 General Project Setting

Most of the Arroyo Seco is channelized for flood control purposes below Devil's Gate Dam to the confluence with the Los Angeles River. Below the Devil's Gate Dam, much of the native riparian vegetation has been removed or has been substantially disturbed during flood control and urban development activities. This segment of the Arroyo Seco is bordered by parks, golf courses, parking lots, residential areas, the Rose Bowl, limited industrial areas, and the SR-110. Most of the remaining stream and riparian habitats are located above the dam.

Significant manmade features along the Arroyo Seco include the SR-110, which has recently been Federally-designated as a scenic byway; the Devil's Gate Dam, located at the base of the HWP; and the JPL, located where the Arroyo Seco emerges from the ANF.

Please refer to Section 3.2, Physical Land Resources, Section 3.3, Land Use, and Section 3.4, Water Resources, for other details on the physical conditions that influence the visual and aesthetic character of the study area. Site-specific information is presented in the following paragraphs.

3.14.2 Alternatives Sites Considered

3.14.2.1 Site 1 – Hahamongna Area

Located on the south-facing slopes of the San Gabriel Mountains, the basin floor consists of a broad sediment plain of erosional deposits that have accumulated behind the Devil's Gate Dam between the walls of the Arroyo Seco canyon. The park gently slopes from an upstream to downstream with steep wall around its perimeter. Past excavation and mining activities as well as erosion have contributed to irregularities in the park's terrain characterized by shallow ridgecrests and alluvial fan slopes, interspersed with fairly level ground. Vegetation in the central portion of the site consists of a mix of primarily riparian scrub habitats and nonnative grasslands. The site also appears to be disturbed by off-road vehicular traffic, off-road bicycles, and by the presence of dogs and feral cats. Nighttime lighting in this area is primarily associated with outdoor lighting for the structures around the perimeter of the site as well as street lighting. Some glare is generated by light reflecting off the JPL buildings and sunlight reflected by car windshields in the surface parking area.

Photo 3.12 Hahamongna Area looking East

Views of Site 1 are available primarily from the surrounding roadways, residences, and the JPL. Views of the north/northeastern portion of the site consist of a large surface parking lot. Spreading grounds are adjacent to the parking lot and extend south along the eastern portion of the site until roughly West Kent Street. Views of the south/southwestern portion of the site consist of somewhat patchy vegetated areas, sedimentary materials, small water-filled

depressions and partially-excavated areas in front of the Devil's Gate Dam. A series of sparsely-vegetated trails and meandering stream courses dominate views of the central portion of the site.

Due to the size of Site 1 and its position below the level of surrounding development, views through the site are unobstructed. Views of the San Gabriel Mountains are available looking in a northerly direction from the site. Views of the San Raphael Hills are available looking in a southeasterly direction from Site 1. The JPL structures are notable features in the visual landscape looking north/northwest through the site. As the Devil's Gate Dam is located down slope and farther below street level with intervening trees and shrubs, views are limited especially from surrounding uses to the north and east.

3.14.2.2 Site 2 – Flint Wash

Flint Wash is an unimproved channel that drains to the southwest corner of the HWP. Flint Wash joins Arroyo Seco immediately upstream of the Devil's Gate Dam. Though the watershed above and around the wash has been significantly developed and altered, this portion of the stream bottom and bank remain relatively free of hardscape features (rock revetment or concrete faces, culverts, etc.), except in the middle of the reach. The I-210 is the most significant manmade feature visible in the site area. This segment of the Arroyo Seco is lined with low-density residences and a country club. A public multi-purpose trail is located upslope along the northern flank of the stream bottom. Nighttime lighting in this area is primarily associated with the I-210.

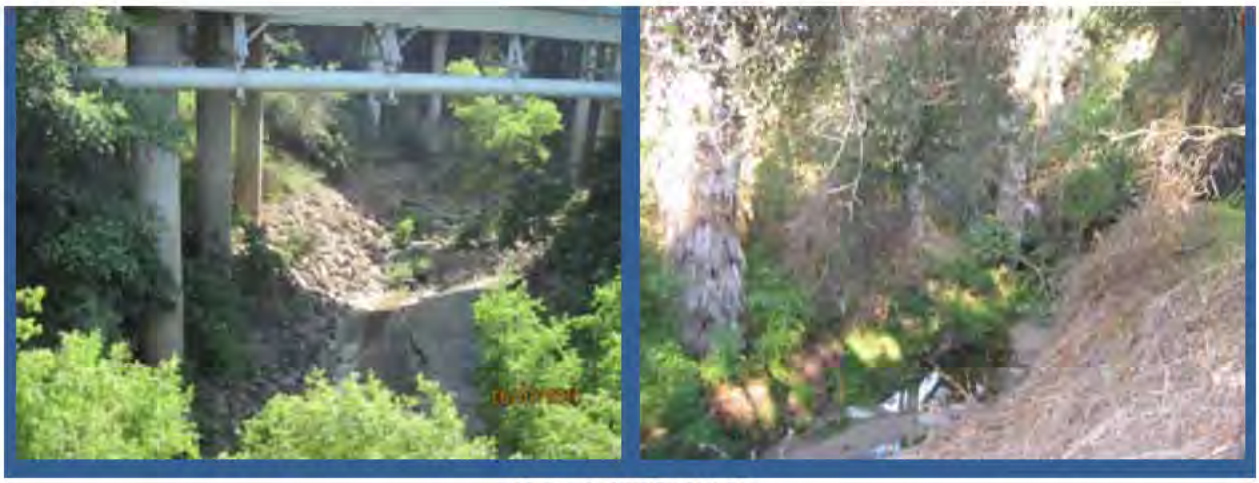

Photo 3.13 Flint Wash

Views of Site 2 are primarily available from the surrounding residences, the country club, the freeway overpass and bridge, as well as users along the multi-purpose trail. Views from more distant uses to and through the site are obstructed by existing development, vegetation in and around the wash, and its location substantially below street level. Additionally, public views are further constrained as much of the surrounding property is privately-owned.

3.14.2.3 Site 3 – 210 Freeway near Oak Grove Drive

This short segment of the stream is naturalized. The visual setting of this segment of the Arroyo Seco is characterized by the surrounding park area including public trails and by the I-210

underpass. Views of the site are primarily available from the freeway overpass, as well as users along the trail. Views from more distant uses to and through the site are obstructed by existing development, vegetation in and around the wash, and its location substantially below street level. Nighttime lighting in this area is primarily associated with the I-210.

Photo 3.14 Site 3 - Arroyo Seco downstream of Devil's Gate Dam near I-210

3.14.2.4 Site 4 – Brookside Area

The visual setting of Site 4 is characterized by existing recreational structures including the Rose Bowl, Brookside Golf Course, Rosemont Pavilion, Rose Bowl Aquatic Center, and associated parking areas. Additionally, the streets adjacent to the Brookside Golf Course and the Rose Bowl operate as a multi-purpose recreation loop as well as the main vehicular circulation pattern three miles in length. At either end, as the central Arroyo Seco narrows, the park landscape transitions to a natural setting. This segment of the stream is fully channelized.

The visual setting of the site is characterized by the linear concrete channel running through the center of the Brookside Golf Course as well as between the Rose Bowl and associated surface parking lots. Views of the site are available primarily from the adjacent recreational uses. Little, if any, natural habitat occurs in this area. In addition to the stream being channelized, the riparian habitat that formerly bordered it has been replaced by a manicured golf course. Nighttime lighting in this area is primarily associated with outdoor lighting for the structures around the perimeter of the site as well as street lighting. There is also some glare generated by sunlight being deflected off of car windshields in the surface parking areas.

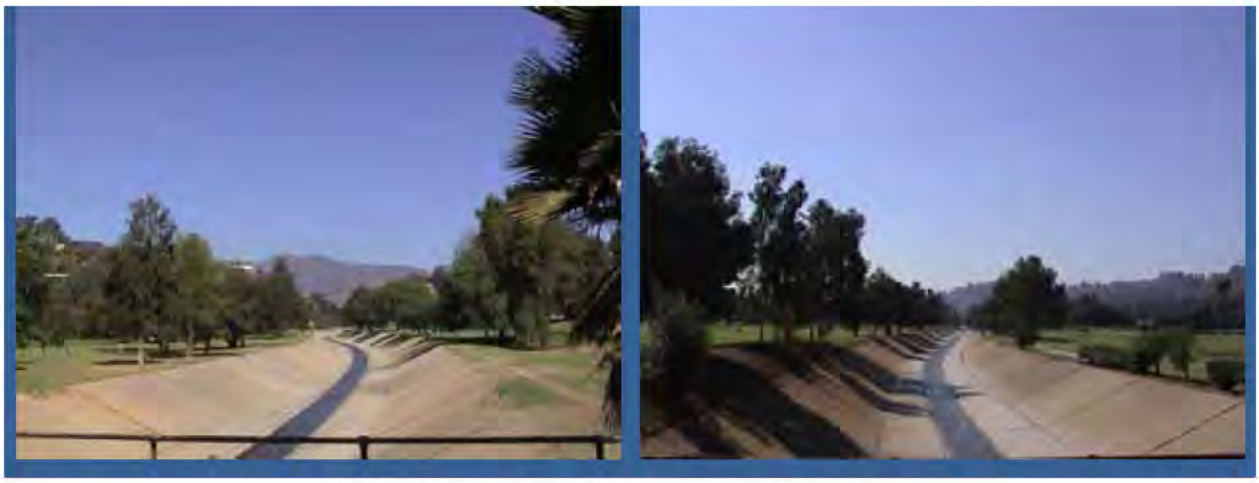

Photo 3.15 Arroyo Seco through Brookside Golf Course

3.14.2.5 Site 5 – Lower Arroyo Seco Park

The visual setting of Site 5 is characterized by the concrete channelized section of the Arroyo Seco, recreation facilities, and associated parking areas, which ultimately transition into the landscape and natural vegetation on the surrounding hillslopes. Major manmade features in the site area include the Colorado Street Bridge near the SR-134 to the north, the San Pascual Stables to the south, and various residential streets and properties that abut the publicly owned banks to the east and west. The Arroyo Seco is very narrow in this reach and the stream channel is bounded on either side by the low-flow channels. These low-flow alternative streams have well-established riparian habitat associated with them.

Views of the site are primarily available from the freeway overpass, as well as users along the trail. Views from more distant uses to and through the site are obstructed by existing development, vegetation in and around the wash, and its location substantially below street level.

Nighttime lighting in this area is primarily associated with outdoor lighting for the structures around the perimeter of the site as well as street lighting.

Photo 3.16 Lower Arroyo Seco Park (Colorado Street Bridge Upstream - Left; Downstream - Right)

3.14.2.6 Site 6 – South Pasadena Island

The roughly tear-drop shaped Site 6 is currently undeveloped and vegetation is dominated by invasive plant species. No streamside vegetation exists at the site and all species are upland species. The stream bottom is dominated by the concrete-covered overflow channel in this area. The area has been significantly disturbed by human practices such as off-road vehicle use and illegal camping.

Photo 3.17 South Pasadena Island

The visual setting for the site consists of the SR-110 to the northwest and the Arroyo Seco Golf Course to the southeast. The concrete channel runs the length of the site to the east. Residential uses located within the Highland Park community of Los Angeles line the SR-110 across from the Island.

Views of the site are available from the surrounding uses and include motorists traveling on the SR-110, patrons of the golf course, and residents of the multi-family units located west across the SR-110. These views are characterized by fairly dense non-native vegetation, dirt trails and litter from illegal dumping. Nighttime lighting in this area is primarily associated with the SR-110.

3.14.2.7 Site 7 – Arroyo Seco through Los Angeles

Site 7 is fully channelized and tightly constrained by development on one side and a steep canyon wall on the other. There is no habitat value either within the channel or on the banks above the channel.

The visual setting for the site consists of the concrete channel and limited views of significant features in the project area including the SR-110, Debs Park, Heritage Square, and surrounding urban development. Views of the channel are largely limited due to its location substantially below the level of surrounding development and configuration of the surrounding uses. Nighttime lighting in this area is primarily associated with outdoor lighting for the structures around the perimeter of the site as well as street lighting.

Photo 3.18 Arroyo Seco Channel through Los Angeles

3.14.2.8 Site 8 – Sycamore Grove Park

Site 8 is a landscaped area consisting of a large lawn, some sycamore trees, a playground, and parking area. The original stream bottom has been filled and flows have been diverted into a storm drain that runs under the park and directly into the Arroyo Seco channel. The visual setting of the Site 8 is situated along the SR-110 west of Debs Park. Offsite views of the Sycamore Grove Park site are available from the surrounding roadways, including the SR-110 to the east and residential uses. Nighttime lighting in this area is primarily associated with outdoor lighting for the residential structures around the perimeter of the site as well as street lighting.

Photo 3.19 Sycamore Grove Park

3.14.2.9 Site 9 – Rainbow Canyon

Rainbow Canyon is a small canyon tributary located on a small strip of hillside land situated between residential uses. The visual setting of Site 9 is characterized by a well-cared for and maintained, undeveloped hillside woodland area with significant portions of the natural stream bottom still remaining. Views of the riparian habitat include coastal live oak/bay laurel woodland and a matrix of annual grassland and woodland as well as another small, remnant stream bottom.

Offsite views of the site are available primarily from the surrounding residential uses. Views from more distant uses to and through the site are obstructed by existing development, vegetation in and around the wash, and its location within a canyon. Additionally, public views are further constrained as much of the surrounding property is privately-owned.

Nighttime lighting in this area is primarily associated with outdoor lighting for the residential structures around the perimeter of the site.

Photo 3.20 Rainbow Canyon

3.14.3 Future Without-Project Conditions

The visual setting of the study area would not likely change substantially from existing conditions under the future without-project conditions. The land designated for development in the vicinity is largely built out, while the undeveloped spaces are preserved as open space/recreation. Under the future without-project conditions, a continued decline in habitat within the study area would likely occur resulting in a decline in visual resource quality.

3.15 RECREATION

This section describes existing recreational resources in the vicinity of the study area.

3.15.1 Introduction

The Arroyo Seco watershed includes a mix of urban and open space resources. Significant natural open space areas in the watershed above the SR-134 include the ANF to the north, which is comprised of the San Gabriel Mountains, and the San Rafael Hills to the west of the corridor. This portion of the watershed also includes numerous park and recreational facilities including the HWP and Central Arroyo Park which contains the Rose Bowl, Brookside Golf Course, and extensive additional recreational amenities ().

Below the SR-134, recreational opportunities in the watershed are characterized by a series of parks lining both sides of the Arroyo Seco. Larger open space areas in this section of the watershed include the Debs Park and portions of Mount Washington, the Monterey Hills, and the Montecito Hills. Parks and open spaces in the watershed are interwoven with local and regional trails.

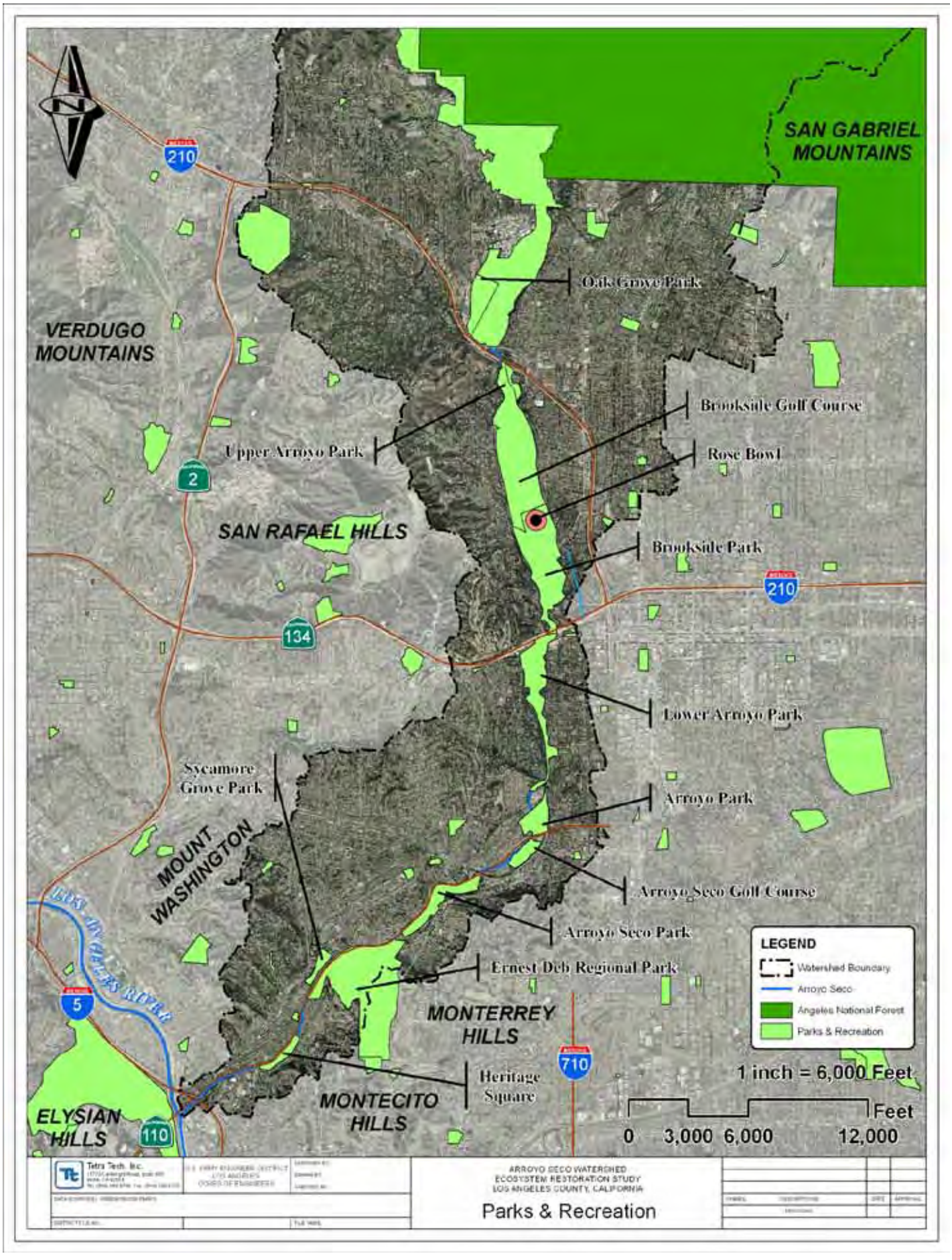

Figure 3.12 Parks and Recreation

The watershed lies partially within multiple local jurisdictions including the cities of Los Angeles, South Pasadena, Pasadena, and La Cañada Flintridge, including the unincorporated area of Altadena. These respective jurisdictions are responsible for providing and maintaining a variety of parks and recreation facilities providing the public with a wide variety of recreational opportunities.

3.15.2 Alternatives Sites Considered

3.15.2.1 Site 1 – Hahamongna Area

The following paragraphs describe the recreational facilities as identified in the HWP Master Plan (City of Pasadena 2003b).

Oak Grove Park has two activity levels on an upper and a lower terrace separated by a steep slope. The upper terrace is adjacent to the internal roadway from the west entry at Foothill Boulevard south to the Flint Wash. The upper terrace is primarily devoted to individual picnic facilities under mature oak trees. The equestrian staging area is open to the general public by permit only. The staging area provides access to nearby trails, parking for cars and horse trailers, and a restroom. The lower terrace is situated along the base of the western slope of the basin and extends to the group picnic areas south of the existing play field. The lower terrace includes facilities for passive and active recreation; the facilities include group picnicking, a play field, restrooms, and disc golf course.

There is a small amphitheater at the base of the slope near the group picnic area adjacent to the play field. Oak Grove Field is used for baseball, large group activities for Tom Sawyer Camp, and special events such as the recent statewide Police Activities Games. The field is also used as a staging area for major disasters in coordination with the U.S. Forest Service and Los Angeles County Fire Department. There is an 18-hole disc golf course which is located on both the north and south ends of the lower terrace. Recreation facilities on the eastside of the park are limited to Johnson Field.

There are six trailhead connections to the HWP that link the area with regional and local trails including: the Gabrielino Trail, Arroyo Seco Trail, Gould Canyon Trail, Flint Wash Trail, Altadena Crest Trail, and the Mountain View Trail. These trails are characterized as follows:

§ *Gabrielino Trail.* This regional trail begins at the intersection of Windsor Avenue and Ventura Street and connects northward to the trail system in the ANF. The trail within HWP follows the east boundary of the park north of Ventura Street. The trail is designated by the U.S. Forest Service as a multi-use trail for equestrians, hikers, and bicyclists.

§ *Arroyo Seco Trail.* Linking all three sections of the Arroyo Seco is the Arroyo Seco Trail. The Arroyo Seco Trail is a series of parallel trails on both sides of the Arroyo Seco. Typically the east and west trails merge in the transition from one section of the Arroyo Seco to the next. Within each section of the Arroyo Seco, the trails are given local names. The Arroyo Seco Trail is part of the Rim of the Valley Trail Corridor. To the west through La Cañada-Flintridge, the Arroyo Seco Trail follows trails that are part of the Los Angeles County riding and hiking trails systems. The trail continues south from the HWP through

Central Arroyo Park via the east tunnel of the Devil's Gate Dam. Connections north to the Pacific Crest Trail in the ANF can be made using the Gabrielino Trail. The Arroyo Seco Trail within the HWP is currently restricted for equestrian and hiking use only.

§ *Gould Canyon Trail.* This trail connects the La Cañada trails system through an access tunnel under Foothill Boulevard to the West Rim Trail.

§ *Flint Wash Trail*. The Flint Wash trailhead is located in the southwest corner of the HWP, starting at the confluence of Flint Wash and the HWP flood basin. The trail follows Flint Wash under the I-210, connecting to the La Cañada trail system. This trail is part of the Rim of the Valley Trail.

Equestrians and hikers use a combination of trails and maintenance roads within the HWP. All of these trails can be considered as part of the Arroyo Seco Trail. Internal to the park, trails exist along portions of the upper slope of the basin. The West Rim Trail leads north from the Flint Wash trailhead connection to the Equestrian Staging Area. Segments of the maintenance roads along the bottoms of the slopes serve as trails. Trail connections running east-west in the HWP are established on an ad hoc basis during the dry summer months. There is no east-west connection at Devil's Gate Dam due to the removal of the Flint Wash Bridge. No permanent all-weather east-west trails exist in the HWP.

§ *Altadena Crest Trail / Mountain View Trail.* The interrupted Altadena Crest Trail runs across the foothills above the community of Altadena between Eaton Canyon and the HWP. Local trail access to the community is provided at the end of Altadena Drive and at the parking lot at the intersection of Windsor and Ventura. These trailhead connections lead to the Altadena Crest Trail and the Mountain View Trail.

3.15.2.2 Site 2 – Flint Wash

The Flint Wash trailhead is located in the southwest corner of the HWP, starting at the confluence of Flint Wash and the HWP flood basin. The trail follows Flint Wash under the I-210, connecting to the La Cañada trail system. This trail is part of the Rim of the Valley Trail.

3.15.2.3 Site 3 – 210 Freeway near Oak Grove Drive

This segment of the stream is located to the north of the Brookside Golf Course. After crossing Seco Street and passing through Areas F and K of the Rose Bowl area, the Arroyo Seco Trail splits. The western segment follows the outer edge of West Avenue Drive north to Washington Avenue, and then the toe of the slope to the beginning of the concrete flood channel, just north of the golf course below Devil's Gate Dam. The trail crosses the stream and connects with the eastern trail and continues north along the eastern slope into the HWP via a tunnel under the I-210 and Oak Grove Drive.

3.15.2.4 Site 4 – Brookside Area

The Brookside site runs through the Brookside Golf Course in Central Arroyo Park. The park is characterized by existing recreational structures including the Rose Bowl and Brookside Park.

Brookside Park currently features a number of active recreation facilities including the Rose Bowl Aquatics Center, Jackie Robinson Baseball Stadium, two softball fields, and five tennis courts. An unused horseshoe pit and a few remaining pieces of a large, heavy timber play structure are left over from earlier park developments. The park also features the Rosemont Pavilion, group picnic facilities, and other park- related elements. Additionally, the streets adjacent to the Brookside Golf Course and the Rose Bowl operate as a multi-purpose recreation loop. The following paragraphs contain information about existing recreational resources as described in the Central Arroyo Master Plan.

The recreation trails in the Central Arroyo Park are part of a regional hiking and equestrian trail system. There is also a network of local pedestrian pathways connecting to adjacent neighborhoods. Along the east and west sides of the central Arroyo Seco are trails for hikers and equestrians that merge at the northern and southern ends of the Central Arroyo Park. Locally, these trails are known as the Arroyo Seco Trail; as part of the regional trail system they are identified as a component of the Rim of the Valley Trail. The Rim of the Valley Trail, when complete, will circle the San Fernando Valley, linking the Arroyo Seco to the Santa Monica Mountains.

From the Lower Arroyo Park, traveling north, the Arroyo Seco Trail is a single path located on the shoulder of South Arroyo Boulevard, adjacent to the flood control channel. After crossing Seco Street and passing through Areas F and K of the Rose Bowl area, the trail splits. The western segment follows the outer edge of West Avenue Drive north to Washington Avenue, and then the toe of the slope to the beginning of the concrete flood channel, just north of the golf course below Devil's Gate Dam. The trail crosses the stream and connects with the eastern trail and continues north along the eastern slope into the HWP via a tunnel under the I-210 and Oak Grove Drive.

3.15.2.5 Site 5 – Lower Arroyo Seco Park

From the Lower Arroyo Seco Park, one can travel the Arroyo Seco Trail through the Central Arroyo Park and into the HWP and the ANF. The Arroyo Seco Trail through South Pasadena connects to the Debs Park and could potentially connect to the Los Angeles River. These regional hiking and equestrian trails and the local pedestrian pathways make up the network of trails in the Lower Arroyo Seco Park. These trails also form part of the Rim of the Valley regional trail system.

The northern pedestrian/equestrian entrance to the east side of the lower Arroyo Seco from the pathway along the natural reach of the channel in the central Arroyo Seco is via an unimproved slope beneath the Parker-Mayberry Bridge, a maintenance bridge located under the Colorado Street Bridge. An unimproved trail also provides pedestrian access to the west side of the northern end of the Lower Arroyo Seco Park from the Parker Mayberry Bridge. An unimproved maintenance road enters the Lower Arroyo Seco Park from San Pascual Road at the southern end of the Lower Arroyo Seco. This maintenance access requires entering and passing through the private San Pascual stables in South Pasadena to reach Pasadena's section of the Lower Arroyo Seco.

Hikers, joggers, and walkers regularly use the pathways and trails in the Lower Arroyo Seco Park. Many pedestrians in the area access the Lower Arroyo Seco by way of the central parking area, usually driving to the Arroyo Seco as a destination for such activity. However, others enter the area on the connecting trails to the north and south or from the Rim Trail on the eastern edge. The Rim Trail parallels Arroyo Boulevard on the top of the bank at the east side of the Lower Arroyo Seco. Current conditions along this long-time trail vary throughout its length. In some areas it exists as a defined path along the road and in other areas it is overgrown and ill-defined.

Most equestrians enter the Lower Arroyo Seco Park from the south entrance at the private San Pascual Stables or from the Central Arroyo Park to the north, originating from the HWP area where long distance trail riding, extending into the ANF, is concentrated. Public horse rentals are not available at the San Pascual Stables or anywhere in the Arroyo Seco. Equestrians currently use Lower Arroyo Seco Park trails on both the west and east sides of the flood control channel. Trail connections from the south are adequate for horses on both sides of the channel, but wider and more accessible on the east side. Existing conditions on the west side near the Colorado Street Bridge provide limited connection to the Central Arroyo Seco and are generally not favorable for equestrians. It is difficult for horses to pass on the steep and narrow pathway leading up to the Parker-Mayberry Bridge from the south. In addition, the private property lines to the north follow the stream, forcing riders to cross the stream, which maybe unsafe during winter conditions. Equestrian rest areas in the Lower Arroyo Seco Park are limited, poorly maintained, and marginally used. Hitching posts are located amidst overgrown vegetation outside the abandoned restroom.

Eleven pedestrian access points connect the Lower Arroyo Seco with adjacent residential neighborhoods. Nine of these access points lead from the Rim Trail and the surrounding eastside residential area into the Lower Arroyo Seco. The trails from these easterly access points are typically stone-edged with similarly edged stairs and walls. The trails are in varying states of disrepair. Topography and private property limit the potential for pedestrian access points on the west side. There is only one deteriorated trail, located just south of the La Loma Road Bridge that crosses private property. A final pedestrian access is located near the San Pascual Stables in the City of South Pasadena. In the southern archery range area on the west side, the main trail more or less follows the alignment of the flood control maintenance road and parallels the flood control channel to the South Pasadena city limits. Similarly, on the east side the main trail also parallels the flood-control channel with a slight jog around the Camel's Hump. Trail sections narrow considerably on both sides of the flood control channel in the vicinity of the Camel's Hump. There are three locations for pedestrians to cross from one side of the Arroyo Seco to the other at the channel elevation: A pedestrian bridge just south of the Colorado Street Bridge, the maintenance bridge crossing at the central entrance/parking area (near the Roving Archers building), and another pedestrian bridge south of the Laguna Road/San Rafael Avenue Bridge crossing and just north of the San Pascual Stables.

Currently, bicycle use is not allowed within the Lower Arroyo Seco, pursuant to the restrictions of the Arroyo Seco Public Lands Ordinance. However, unauthorized recreational bicycle use occurs. Arroyo Boulevard is a heavily used, signed Class III bicycle route and part of the Kenneth Newell Bikeway that runs from Los Angeles through South Pasadena and Pasadena to

Altadena. This bikeway is the only bicycle route in the Lower Arroyo Seco area officially designated by the City of Pasadena Bicycle Master Plan (adopted in November 2000).

3.15.2.6 Site 6 – South Pasadena Island

The South Pasadena Island is located in the City of Los Angeles, between the SR-110 and the South Pasadena city limits. There is no direct access to the Island. Located just southwest of the Island is the three-acre Arroyo Seco South Pasadena Woodland and Wildlife Park along the southern bank of the Arroyo Seco, near the intersection of York Boulevard and the SR-110. The park features rarely seen native California walnut trees. Two small bioswales are planted with native grasses and allow stormwater to infiltrate into the soil instead of flowing into the concrete-lined Arroyo Seco, adjacent to the park. A lookout point near the center of the site offers views of Mount Washington, the historic York Boulevard Bridge, the Verdugo Mountains, and the San Gabriel Mountains in the distance. Educational material about native habitat and wildlife, natural sciences, the history of the site, and an overview of the Arroyo Seco watershed is incorporated into trailside displays, a kiosk, and plant identification markers throughout the site.

3.15.2.7 Site 7 – Arroyo Seco through Los Angeles

Located in this segment of Arroyo Seco is the Debs Park, one of only five regional facilities owned and operated by the City of Los Angeles. Debs Park is also home to the multi-million dollar Audubon Nature and Science Center. The Center provides environmental educational programs for the 50,000 school children who live within two miles of the park. Two additional regional parks, Elysian Park and Griffith Park, are in the northeast Los Angeles area and all three are located along the Los Angeles River system to the Arroyo Seco. Nearby is privately owned open space on Mount Washington.

From Arroyo Seco Park on the boundary of South Pasadena and Los Angeles, walkers can cross Marmion Way and walk along the path near the Gold Line tracks that hugs the hillside down to and through Debs Park. Another nice walk is to take the concrete bike path in the bottom of the Arroyo Seco stream from Arroyo Seco Park to the Montecito Park Community Center near Heritage Square and the Lummis House.

The Arroyo Seco bike path is a short path leading along the Arroyo Seco river basin in Los Angeles, from the Montecito Heights Recreation Area through the gap between the Debs Park and Sycamore Park in the Highland Park district, paralleling the SR-110, and ending at Arroyo Seco Park in South Pasadena. The southwest portion of the path runs along the high ground overlooking Arroyo Seco through chain-link fencing, and the northeast portion of the path runs on the concrete slabs that make up the banks of the drainage basin. For safety reasons, if rain is predicted, the paths in the river rights-of-way are closed; that is, the gates to the lower sections are padlocked. Both the upper and lower portions of the path are scantily traveled, with much of the traffic being pedestrians walking their dogs or jogging.

3.15.2.8 Site 8 – Sycamore Grove Park

The Sycamore Grove Park is created as a public park in 1905. The park features the Sousa-Hiner Bandshell, named after local resident Dr. Edwin M. Hiner, and his friend John Philip Sousa who

performed here. Barbecue pits, children's play area, picnic tables, and lighted tennis courts are some of the amenities that this park offers.

3.15.2.9 Site 9 – Rainbow Canyon

The Rainbow Canyon Park encompasses the site. This 0.21-acre park is owned and operated by the Santa Monica Mountains Conservancy.

3.15.3 Future Without-Project Conditions

As previously discussed, the population in Los Angeles County is expected to increase by approximately 2.8 million by 2035. It is expected that regional use of the recreational facilities in the Arroyo Seco watershed will increase in the future, resulting in more wear on existing trails and amenities. Limited and fragmented open space and recreational opportunities in the lower portions of the watershed would remain the same.

3.16 PUBLIC HEALTH AND SAFETY

Included in this section are water-related safety, wildfire safety, and vector-borne diseases. The study area for these conditions includes the Arroyo Seco corridor between the south boundary of the ANF and the Los Angeles River, and includes the nine potential alternative restoration sites. A discussion of hazardous and toxic wastes and materials in the study area is provided in Section 3.10.

3.16.1 Water-Related Safety

For the majority of the study area, the proximity of the Arroyo Seco to urban land uses and the ready-access to the waterway makes the risk of river-related accidents a potential safety concern. The majority of the Arroyo Seco right-of-way in the study area has been re-constructed in the past to provide a hard-surfaced channel to contain and manage the intermittent flood waters that can accompany storm events. During dry periods, the channel typically contains low volumes and heights of water. However, during periodic storm events, the channel rapidly fills with storm water runoff, conveying large volumes of fast-moving runoff water to the Los Angeles River, which conveys it on to the Pacific Ocean. During and following these storm events, when water levels and flow velocities in the Arroyo Seco channel rise quickly, the risks of accidental death and injuries increase to individuals venturing too close to the river.

The County of Los Angeles Fire Department has special Swiftwater Rescue teams that respond to emergencies along the Arroyo Seco and other waterways in the county during and following storm events. These teams are strategically co-located in selected fire stations to be able to rapidly respond to such emergencies. These rescue teams are staffed by specially trained and equipped fire fighters and lifeguards, who augment the Department's basic Urban Search and Rescue and Lifeguard staff. Depending on the particular circumstances and location of emergencies, Swiftwater Rescue personnel have access to the Department's helicopters, as well as ground vehicles, to provide rescue services to all waterways comprising the Los Angeles River system within the Department's jurisdiction, including the Arroyo Seco.

3.16.2 Wildfire Safety

The devastating Station Fire in the ANF, which burned over 250 square miles (160,577 acres) of forested land in the San Gabriel Mountains to the north and northwest of the Arroyo Seco study area during August – October 2009, brought into sharp focus the potential risks to people and property that such wildfires represent to the Arroyo Seco study area and surrounding region. In addition to the immediate threat from the fire itself, additional risks to public safety and health can ensue from potential flooding, mudslides, and debris flows caused by the fire's removal of soil-holding vegetation and ground cover.

The structures destroyed on forest service lands by the Station Fire, created a mixture of ash, building materials (asbestos, fiberglass, etc), household supplies, gas, oil, and other chemicals that have been combined to form toxic ash that can be liberated through strong winds as dust or heavy rains as toxic effluent affecting water quality. While the ash is a visible reminder of the pollution currently impacting the region, the fine particles, which are invisible to the naked eye, cause more concern. These particles bypass the body's natural defense system and lodge into the lungs, causing irritation and decreased lung function over time.

While most of Los Angeles County and municipalities surrounding the Arroyo Seco study area are urbanized, much of the Arroyo Seco watershed contains or is adjacent to hills and mountains that include areas of undeveloped land supporting a variety of vegetation types, including shrubs, stands of trees, and forested upland areas with brushy understory. Because many of these areas are un-maintained open space, considerable ground fuel (e.g., dry leaves, woody debris, snags, limbs and tree fall) has accumulated in some areas.

Because of their proximity to these unmanaged areas of vegetation and stands of trees, all nine of the alternative restoration sites being considered in this study have some vulnerability to wildfires with associated risks to public safety. Those alternative sites most at risk from such dangers include the four sites upstream of SR-134 (Sites 1, 2, 3, and 4), which have the San Gabriel Mountains to the north and the San Rafael Hills to the west. However, the hilly terrain in the El Sereno and Lincoln Heights portions of the study area between South Pasadena and south to the confluence of the Arroyo Seco and Los Angeles River has resulted in large lot development, which includes considerable undeveloped wooded as well as large planted areas. This would tend to increase the risk of wildfires for the four alternative sites in this portion of the study area (Sites 6, 7, 8, and 9).

Protection from and response to wildfires in the Arroyo Seco study area and vicinity is handled by a collaborative effort involving Federal, state, and local levels of government. The Natural Resource Conservation Service (NRCS) manages the Emergency Watershed Protection (EWP) Program, which offers financial and technical support to communities, homeowners, farmers, and ranchers in southern California to assist with post-wildfire restoration efforts. The California Department of Forestry and Fire Protection (CAL FIRE) develops, compiles, and maintains a plethora of information about wildfires in the state that it makes available through its website. Much of the information is in the form of GIS mapping, under the Fire and Resource Assessment Program (FRAP).

On the FRAP *Fire Hazard Severity Zone Map* (CAL FIRE 2007) (), the upper portion of the Arroyo Seco study area that is within the ANF (close to Site 1), is designated as the Federal Responsibility Area (FRA). A small area to the northeast of Site 1 is designated as the State Responsibility Area (SRA). The remainder of the Arroyo Seco study area is designated as Local Responsibility Area (LRA), which relies on the Los Angeles County and local municipalities (e.g., La Cañada-Flintridge, Pasadena) to handle wildfire prevention and response. As shown , the FRA and SRA to the northern portion and the LRA to the northern and western portions of the study area are designated as "Very High Risk of Wildfires," based on parameters such as availability of fuels, terrain, and local weather.

The Los Angeles County Fire Department has established the Coordinated Agency Recovery Effort (CARE) to assist residents affected in wildfire-damaged areas. This service focuses on providing resources for flood and mudflow protection following wildfires.

In July 2007, CAL FIRE, the Governor's Office of Emergency Services, the Los Angeles County Fire Department, and several regional councils teamed up to form the California Fire Alliance. The mission of the Alliance is to facilitate interagency and public collaboration in protecting the quality of life threatened by wildfire in southern California. A main focus of the Alliance is to promote and support the development of local Community Wildfire Protection Plans (CWPP).

The fire stations serving the Arroyo Seco study area and vicinity are listed below ().

Table 3.23 Fire Stations Serving the Arroyo Seco Study Area and Vicinity

FIRE JURISDICTION	ADDRESS	MUNICIPALITIES/ LOCATIONS SERVED
LA County Station #1 – Battalion 3	1108 N. Eastern Ave., Los Angeles, CA 90063	Unincorporated Los Angeles
LA County Station #11 – Battalion 4	2521 N. El Molino Ave., Altadena, CA 91001	Altadena
LA County Station #12 – Battalion 4	2760 N. Lincoln Ave., Altadena, CA 91001	Altadena
LA County Station # 19 – Battalion 4	1729 W. Foothill Blvd., La Cañada Flintridge, CA 91011	La Cañada Flintridge
LA County Station # 82 – Battalion 4	352 N. Foothill Blvd., La Cañada Flintridge, CA 91011	La Cañada Flintridge
LA County Station #66 – Battalion 4	2764 E. Eaton Canyon Dr., Pasadena, CA 91107	Pasadena
Pasadena Station # 31	135 S. Fair Oaks Ave., Pasadena, CA 91105	Pasadena
Pasadena Station # 32	2424 E. Villa St., Pasadena, CA 91107	Pasadena
Pasadena Station # 33	515 N. Lake Ave., Pasadena, CA 91101	Pasadena
Pasadena Station # 34	1360 E. Del Mar Blvd., Pasadena, CA 91106	Pasadena
Pasadena Station # 36	1140 N. Fair Oaks Ave., Pasadena, CA 91103	Pasadena
Pasadena Station # 37	3430 E. Foothill Blvd., Pasadena, CA 91107	Pasadena
Pasadena Station # 38	1150 Linda Vista, Pasadena, CA 91103	Pasadena
Pasadena Station # 39	50 Avenue 64, Pasadena, CA 91105	Pasadena

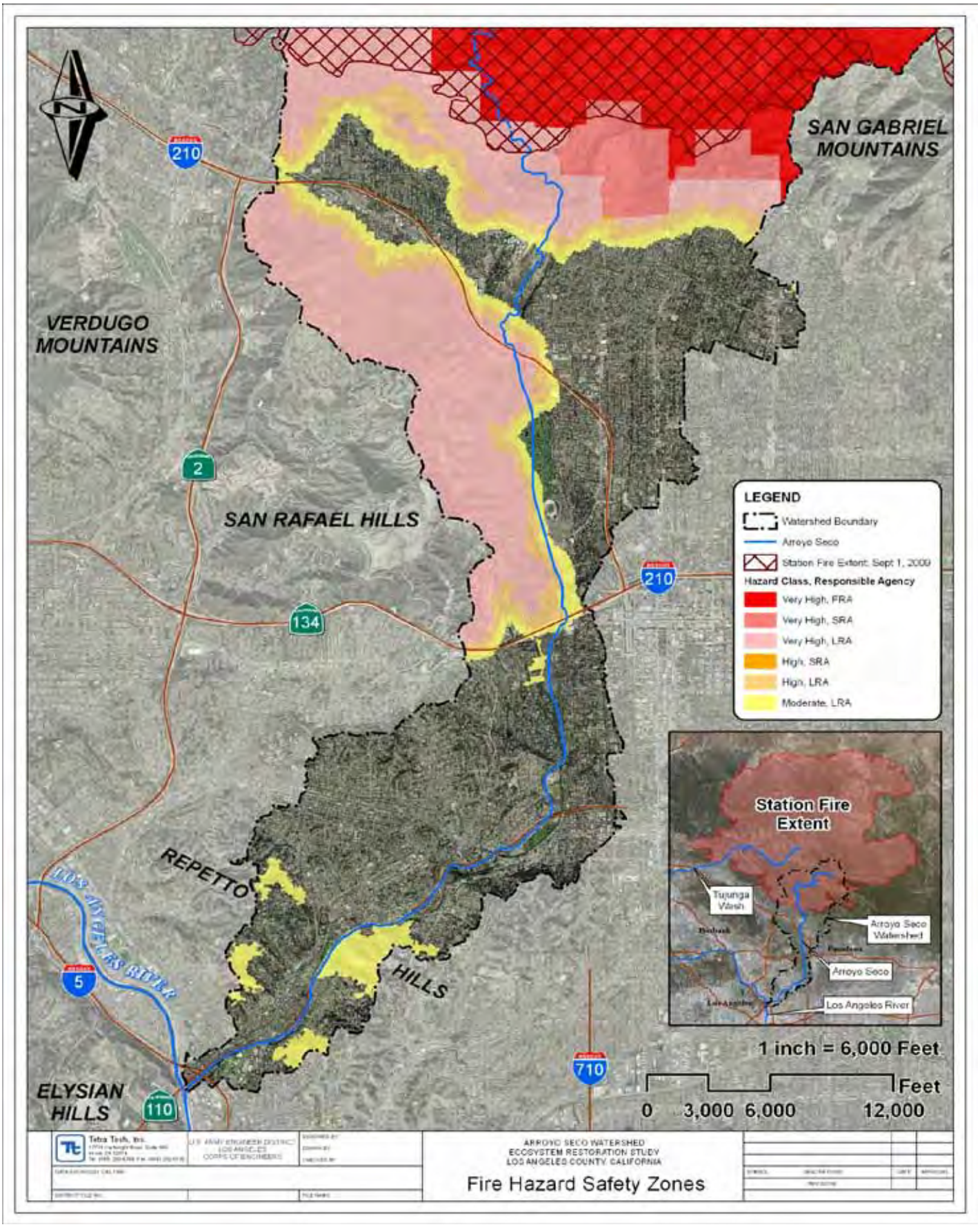

Figure 3.13 Fire Hazard Severity Zones

3.16.3 Vector-Borne Diseases

The presence of standing water that occurs seasonally in the study area provides possible breeding grounds for mosquitoes, which poses a potential public health risk from the spread of infectious diseases. The County of Los Angeles Department of Health Services has an aggressive and comprehensive vector-borne disease control program in place that includes mosquito control. The City of Pasadena Public Health Department also has its own vector-mosquito control program that is separate from the county's program. The two jurisdictions cooperate in their programs. The City of La Cañada Flintridge is presently included in the county's program, but is considering changing to become under Pasadena's program. The City of Los Angeles is under the County's vector-mosquito control program. The City of South Pasadena's vector-mosquito control is overseen by the San Gabriel Valley Mosquito and Vector Control District.

3.16.4 Future Without-Project Conditions

3.16.4.1 Water-Related Safety

The baseline conditions regarding the risk to public safety in the study area in those areas that are in close proximity to the hard-surfaced channel sections of the Arroyo Seco would continue as at present into the foreseeable future under the without-project conditions. Similarly, the risk to public safety in the study area from potential wildfires would continue under the without-project conditions. The potential for additional areas of seasonal or perennial standing water to develop within the Arroyo Seco study area and the opportunity for mosquito breeding grounds, and the associated health risk from vector-borne disease would continue as at present into the foreseeable future. The planning and design of future opportunities for public use and access of the study area would need to take into account potential increased risk to public health, and the County of Los Angeles Health Department and City of Pasadena Health Department, and other agencies overseeing those mosquito-vector control programs that involve the study area (e.g., San Gabriel Valley Mosquito and Vector Control District) would need to be consulted.

The Station Fire resulted in both emission increases and decreases that affect air quality conditions. In the short term, the windblown particulate emissions within the Station Fire's perimeter could potentially increase due to the fine ash particulate and the reduction in cover. There will also be increased emissions from the activities conducted for rehabilitation. These increases within the ANF will be temporary and will abate over time as the natural ground cover is restored, and may also be partially offset due to use restrictions and reduced recreational activities in the burn area for a period of time.

3.17 SUSTAINABILITY

3.17.1 Introduction

Sustainability can be broadly defined as "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs". This definition takes into account that there are three "spheres" comprising sustainability (environmental, economic, and social) that need to be considered when developing and evaluating projects and management

systems. The three spheres of sustainability are described in . For the Corps, applying the goals inherent in this definition to the development and implementation of Corps-led and Corps-co-sponsored projects involves approaching the planning, design, construction, and operation phases of these projects with the intention of sustaining natural resources, protecting the environment, achieving economic viability, and promoting a high quality of life.

With the passing of the Water Resources Development Act (WRDA) in 2007, Congress directed the Corps (and other Federal agencies such as the Bureau of Reclamation) to put environmental protection and restoration first when planning water resources projects. This emphasis complements the sustainability approach taken by the Corps in developing and implementing water resources and ecosystem restoration projects such as those being considered in this integrated document. Moreover, sustainability as a practice for the Corps has become increasingly important as rising population continues to place greater pressure on land development and competition for natural resources and land use, especially in and near urban areas such as the Arroyo Seco watershed.

In the following paragraphs the three spheres of sustainability (environmental, economic, and social) are discussed with respect to the baseline opportunities afforded by the alternative sites being considered in achieving the inherent goals of sustainability (sustaining natural resources, protecting environment, achieving economic viability, and promoting high quality of life).

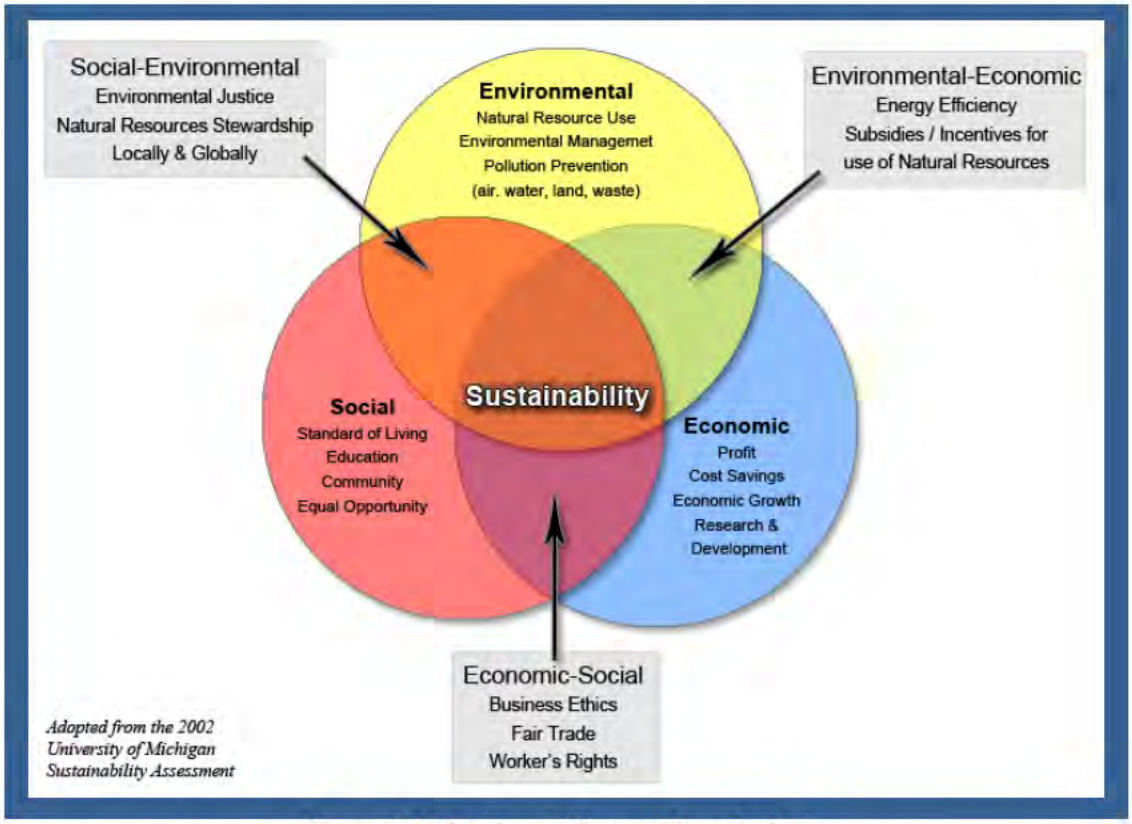

Figure 3.14 The Three Spheres of Sustainability

3.17.2 Environmental Sustainability

Under ideal environmental sustainability conditions an ecosystem would maintain functionality and biodiversity over time. Characteristics of this ideal ecosystem would include a steady (equilibrium) state, the ability to recover from disturbance (resilience), and evolving plant communities (succession). Because the landscape within and around the study area has been altered, ideal ecosystem function as described above does not exist, and achieving it may be no longer possible. However, the premise going forward is that with intervention, some of the critical ecosystem functions at many of the alternative restoration sites can be maintained, enhanced, or even to some extent restored. In all cases, it is assumed that an adaptive management program can be developed and implemented that will help support environmental sustainability. The baseline conditions with respect to functionality and biodiversity vary among the nine alternative sites in the study area.

3.17.3 Economic Sustainability

Similar to environmental sustainability, which is based on the ability of an ecosystem to maintain functionality over time, economic sustainability involves creating economic value (in terms of capital and monetary exchanges) from implementing restoration projects in the study area that would also be sustainable over time. For the alternative sites being considered, striving for economic sustainability may involve developing programs and activities that generate revenue for the maintenance and upgrade of facilities. Also, more indirectly, it may involve the development of amenities such as restaurants and lodging in or near the watershed as a result of the interest generated in activities afforded at the project sites. However, developing these types of income amenities would need to be accomplished without exploiting and/or sacrificing environmental protection and restoration. Therefore, in the planning, design, construction, and operation phases, the usage and potential waste of resources in the generation of economic activity would be accounted for, and the use of green technology and materials and renewable resources maximized.

3.17.4 Social Sustainability

Social sustainability is based on the concept that sustainable ecosystem restoration projects in the Arroyo Seco study area that maintain and enhance healthy natural environment and involve the development of sustainable (and revenue-generating) on-site and area activities would also result in ongoing high quality of life for area residents. It is also based on the above definition of sustainability whereby future generations should have the same or greater access to these quality of life benefits as the current generation. This concept encompasses human rights and environmental justice. Social sustainability applies not only to the provision of recreational and other social amenities but also to the protection of environmentally sensitive areas in the study area. Future generations deserve the opportunity to have a high quality experience with the natural areas of the watershed while perpetuating our collective responsibility of environmental stewardship. Finally, a healthy ecosystem that treats all people fairly with access to high quality amenities (both built and natural) is the best assurance of sustaining a vibrant economic system.

3.17.5 Future Without-Project Conditions

Historical and ongoing human activities and development continue to adversely affect the Arroyo Seco study area. If potential future projects in the Arroyo Seco study area such as those being considered in this integrated document are not implemented (proposed action), the baseline sustainability conditions are likely to worsen. With this scenario, opportunities that may now exist to reconnect fragmented habitats, protect sensitive areas, ensure water flow in the Arroyo Seco channel, and provide potentially self-supporting quality-of-life experiences for area residents may become lost over time.

4.0 ALTERNATIVES

This chapter describes the initial formulation, evaluation, and screening of management measures that address the planning objectives. It also describes the formulation of a preliminary array of plans that will be further refined and analyzed in the subsequent planning steps. The alternative plans formulated in this watershed study will be developed at a survey level of detail, as directed in Engineering Circular (EC) 1105-2-411. Project alternatives are formulated to provide different approaches to achieving the study objectives based on combinations of management measures identified as potentially feasible and effective actions that can be implemented as plan components. Plan alternatives are then compared based on the planning criteria described in Section 2.5.1.

Management measures are specific types of actions that have been developed to address the study objectives. For example, one of the main issues in the lower watershed is lack of natural stream bottom where the original stream channel has been engineered as a hardened structure. This issue would be addressed by measures that improve riparian habitat by restoring ecologically functional substrate conditions. Direct measures to attain this objective may include full or partial removal of hardscape within the stream bottom, combined with addition of woody debris, grade control structures, or boulders.

Measures that have been developed to achieve one objective may provide incidental benefits that help to attain other objectives. For example, riparian forest species that are planted to provide shade for the stream and cover for wildlife will also contribute to stream bottom complexity by generating woody debris that supports understory vegetation and provides additional habitat.

4.1 PLAN FORMULATION RATIONALE

Plan formulation is the process by which measures are evaluated for their effectiveness and compatibility, and measures are combined to form alternative solutions to a problem. These alternatives are compared and the rationale is developed for plan selection and recommendation for implementation.

Plan formulation during this study process needs to meet multiple objectives. Alternatives need to be prepared in such a way as to satisfy both the requirements of the Corps' planning process and the needs of the local sponsor and stakeholders. Based on input from the local sponsor and stakeholders during the revision of the PMP, it was determined that this study will use a watershed approach to formulating and providing a preliminary comparison of candidate restoration projects for the available restoration sites identified in the Environmental Evaluation. The management measures identified that provide ecosystem restoration and ancillary benefits for water supply and conservation, recreation and flood damage reduction are used to develop preliminary alternatives. The preliminary alternatives will then be evaluated with respect to their applicability and feasibility for each of candidate restoration sites. Tentative plans identified for each site will then be evaluated for possible conflicts and competing demands for resources in the watershed to determine the candidate projects recommended for the spin-off studies that would select plans and serve as the decision documents for the individual projects.

4.2 Potential Restoration Sites

The Arroyo Seco offers a rare opportunity for a very significant restoration project. Its function as a tributary to the Los Angeles River would make restoration beneficial far beyond the limits of the watershed. Much of the land is under public ownership, and many of the organizations that manage these lands, including the cities of Los Angeles, La Canada/Flintridge, Pasadena, and South Pasadena, have indicated a willingness to commit as active partners in restoration. There is a great deal of public and political support for naturalizing the stream, evidence of this being found in the number of community-scale restoration plans that have been proposed by non-profit groups such as the ASF. Historical, cultural, biological, and hydrological features of the watershed have been extensively documented in reports including the Arroyo Seco Master Plan (City of Pasadena 1997) and the Arroyo Seco Watershed Hydrology Study (Los Angeles County 2001). All of these features increase the likelihood that a cost-effective, integrated watershed restoration plan can be implemented.

As discussed in Section 1.6, History of Investigation, a variety of sites within the watershed have been identified for management actions in the 2008 Corps EE. Collectively, these sites have been chosen to represent the range of conditions found within the lower watershed. Proposed management actions are not designed to restore the watershed to pre-settlement conditions. Rather, they are designed to restore the natural functions that were once widespread within the watershed, and to address the overall reduction in habitat quality and water quality that is apparent throughout the lower watershed. Some of these management actions are relatively small in the context of the overall watershed, but if implemented would demonstrate the potential for improvement of water and habitat quality throughout the watershed. Other measures are more extensive and would result in fundamental changes in the way parts of the watershed are managed. These measures include eradicating invasive species and restoring native vegetation, partial or complete removal of the concrete lining of the stream, restoring fish passage around Devil's Gate Dam, wetland restoration, floodplain reconnection, removal of revetments, creation of side channels, and conversion of turf to wetlands or swales.

In general, restoring these sites would encompass the range of conditions and features that existed at the Arroyo Seco in the past. These include the following:

- Riparian habitat.
- Tributary habitat providing access to higher points in the watershed.
- Water quality that can support native species.
- A large alluvial floodplain that offers wildlife habitat *and* flood attenuation *and* recreation *and* sediment control *and* groundwater recharge.
- Enhanced listed species habitat.

These sites, shown on through and are described below, are located in and adjacent to the Arroyo Seco with the exception of Site 9, Rainbow Canyon, which is located along a tributary drainage near its confluence with the arroyo. Site-specific alternative plans will be developed

from the preliminary plans identified in this watershed study to address a multi-purpose project in each of the potential alternative site.

4.2.1 Site 1 – Hahamongna Area

The roughly 208-acre Hahamongna Area site is located within the 1,300-acre HWP[6] in the northwestern portion of the City of Pasadena (). This site is approximately 1,300 feet wide and encompasses approximately 10,400-foot segment of the Arroyo Seco. The Hahamongna Area site is located primarily within the City of Pasadena. The JPL is located along the northwestern border of the site; extensive low-density residential neighborhoods are located to the east of the site; the Devil's Gate Dam is to the southeast of the site; and the I-210 borders the southwestern edge of the site. The Arroyo Seco and the area of the lower HWP are dominated by the operations of the Devil's Gate Dam. Much of Site 1 lies within the ephemeral stream floodplain and area of the reservoir created by the dam. Habitats in Site 1 are a diverse matrix of riversidian sage scrub (xeric scrub on steep slopes), coastal scrub, southern willow scrub, mulefat scrub, coast live oak forest and woodland, streambed, and limited emergent wetland.

4.2.2 Site 2 – Flint Wash

The Flint Wash site is approximately seven acres located partially within the City of La Cañada Flintridge and partially within the City of Pasadena (). The stream within this site is approximately 3,200 feet long and runs west-east along Berskshire Avenue until it intercepts the I-210 where it turns north and runs alongside the freeway. This site is approximately 110 feet wide. Flint Wash is an unimproved channel that drains to the southwest corner of the HWP. Flint Wash joins Arroyo Seco immediately upstream of the Devil's Gate Dam. Habitat through this reach is a spatially confined mix of southern sycamore-alder riverine woodland, coast live oak forest and woodland, streambed, and numerous invasive plant species and escaped ornamentals, which have degraded the natural quality of the area.

4.2.3 Site 3 – 210 Freeway near Oak Grove Drive

This 21-acre segment of the Arroyo Seco is located downstream of the Devil's Gate Dam to north of the Brookside Golf Course in the City of Pasadena (). This site is approximately 600 feet wide and encompasses an approximate 1,520-foot segment of the Arroyo Seco. A small, healthy area of riparian habitat dominated by southern willow scrub is found beneath the I-210, where outfall from small water production tunnels is released from under the dam. Current habitat consists of a mix of southern willow scrub, southern sycamore-alder riverine woodland, coast live oak forest and woodland, and numerous invasive plant species and escaped ornamentals, which have degraded the natural quality of the area.

[6] This 1300-acre park in the Arroyo Seco extends from the Devil's Gate Dam north into the San Gabriel Mountains. HWP is bounded on the south by the Devil's Gate Dam area and Oak Grove Drive. Oak Grove Drive and the JPL bound HWP to the west in the City of La Cañada-Flintridge. To the east, HWP is bounded by the residential neighborhoods of Pasadena and Altadena. City of Pasadena operates recharge basins on the east side of the Arroyo Seco. Facilities include: an athletic field; 24-hole Frisbee golf course; and an extensive network of bridle, bicycle, and hiking trails; a dog park; numerous picnic areas and barbecue pits; restrooms; and drinking fountains.

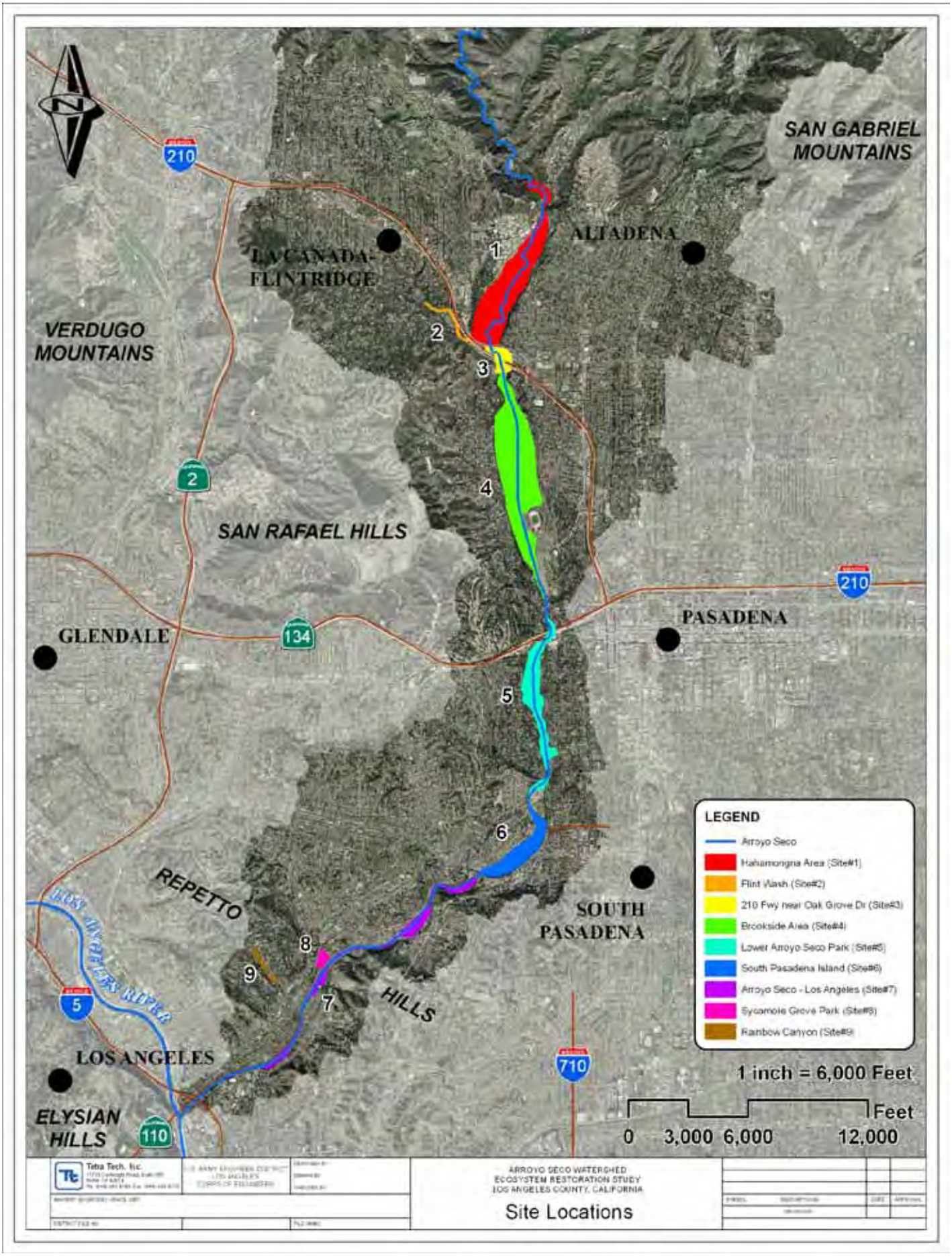

Figure 4.1 Potential Alternative Sites

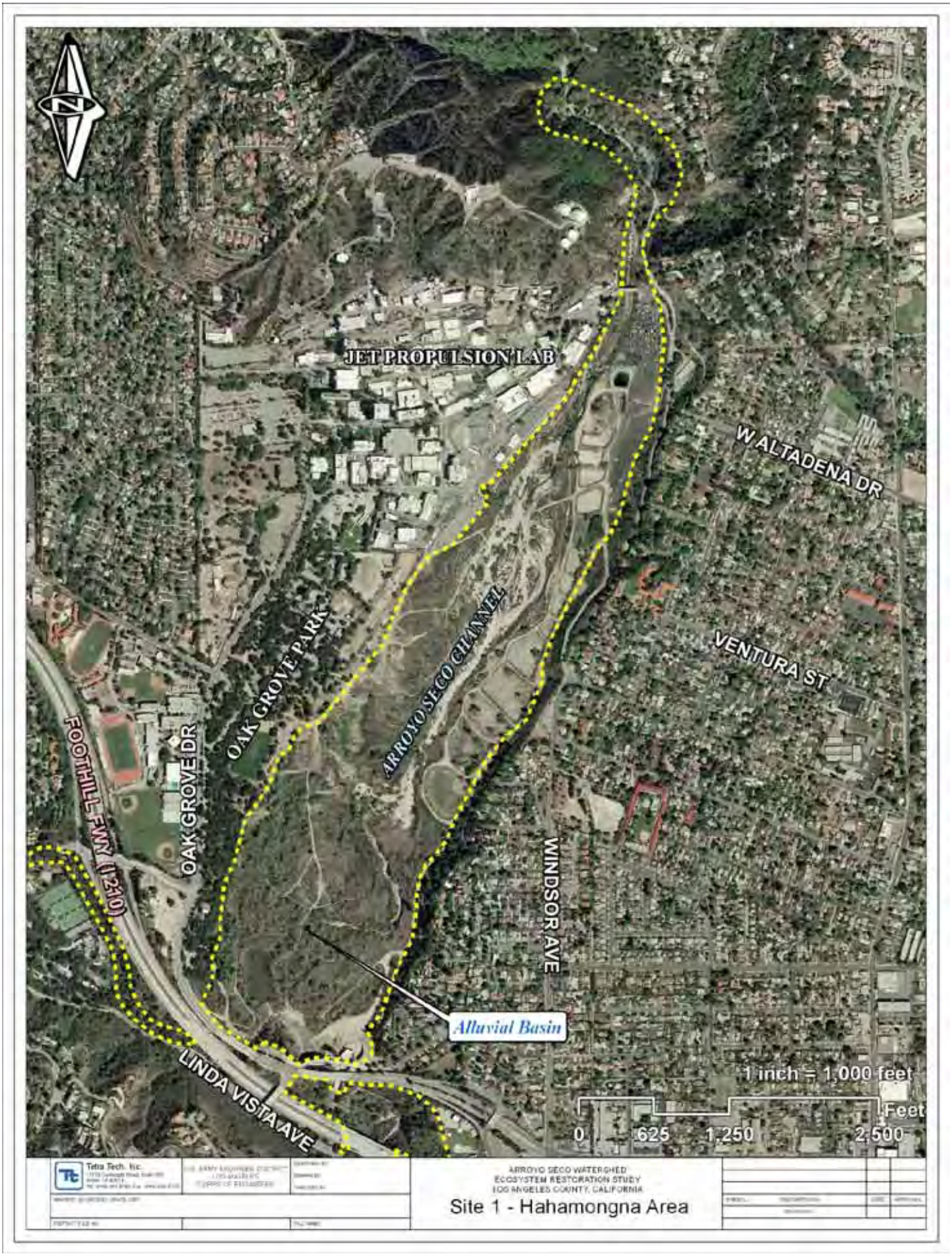

Figure 4.2 Site 1 – Hahamongna Area

Figure 4.3 Site 2 – Flint Wash

4.2.4 Site 4 – Brookside Area

The Brookside Area is a roughly 276-acre site located between the north end of the Brookside Golf Course and Holly Street in the City of Pasadena (). This north-south segment of the Arroyo Seco is approximately 2.3 miles long. This site is approximately 1,800 feet wide. The stream bisects the Brookside Golf Course, located generally between Linda Vista Avenue to the west and Rosemont Avenue to the east. This segment of the stream also passes by the Rose Bowl and associated surface parking lots. This site contains almost no natural habitat and is dominated by landscaped vegetation and ruderal land. The Arroyo Seco through this section consists of a large trapezoidal concrete-lined channel.

4.2.5 Site 5 – Lower Arroyo Seco Park

The Lower Arroyo Seco Park site is roughly 106 acres located within the Lower Arroyo Park in the City of Pasadena (). The channel through this reach is approximately two miles in length and is bounded by Holly Street to the north, the South Pasadena city limits at San Pascual Stables to the south, and various residential streets and properties that abut the publicly owned Arroyo Seco banks to the east and west. The Lower Arroyo Seco Park site is approximately 6,500 feet wide. The main Arroyo Seco channel at this location is completely armored in a rectangular concrete channel. However, habitat value is added by low-flow streams located on either side of the channel and limited coast live oak forest and woodland, southern willow scrub, mule fat scrub, and streambed.

4.2.6 Site 6 – South Pasadena Island

The South Pasadena Island (the Island) site is roughly 69 acres located in the northern portion of the City of Los Angeles along its border with the City of South Pasadena (). The site is bounded by the Arroyo Seco Parkway (also known as Pasadena Freeway [SR-110]) to the northwest and the Arroyo Seco channel to the southeast forming the isolated Island. The Arroyo Seco Golf Course is located southeast of this site. This site also includes an alternative stream course and trail connection along the east side of the Arroyo Seco from San Pasqual Avenue to the south end of the golf course. The channel, which runs the length of the Island to the east, is approximately 5,000 feet long within the site. The Island site is approximately 750 feet wide. The area supports annual grassland and a coast live oak forest and woodland vegetation community, and is situated above the bankfull elevation of the Arroyo Seco channel.

4.2.7 Site 7 – Arroyo Seco through Los Angeles

The Arroyo Seco through Los Angeles site runs parallel to the east of the SR-110 roughly between York Boulevard and the I-5 (). This approximately 76-acre site encompasses an approximately 3.4-mile segment of the Arroyo Seco and lies entirely within the City of Los Angeles. This site is approximately 150 feet wide. Virtually the entire area has been channelized or developed, or consists only of steep canyon walls that provide suitable habitat for very few species.

Figure 4.4 Site 3 – 210 Freeway near Oak Grove Drive

Figure 4.5 Site 4 – Brookside Area

Figure 4.6 Site 5 – Lower Arroyo Seco Park

Figure 4.7 Site 6 – South Pasadena Island

4.2.8 Site 8 – Sycamore Grove Park

The Sycamore Grove Park site is approximately 800 feet long and 400 feet wide. This 8-acre site is located in northeast Los Angeles and situated west of the SR-110 (). This site encompasses Sycamore Grove Park and is bounded by South Avenue 49 to the northeast, the SR-110 to the east, medium density residential uses to the south, and North Figueroa Street to the west. Sycamore Grove Park is a landscaped area consisting of a large lawn, playground, and parking area. The North Branch tributary is contained within a storm drain beneath Sycamore Grove Park.

4.2.9 Site 9 – Rainbow Canyon

Rainbow Canyon is a Santa Monica Mountains Conservancy Park located on the southeast side of Mount Washington in the City of Los Angeles. The approximately 5.8-acre Rainbow Canyon site is generally between West Avenue 44 and Rainbow Avenue/West Avenue 45, northwest of Glenalbyn Drive (). A storm drain underlies this approximately 0.3-mile long site. The Rainbow Canyon site is approximately 125 feet wide. Rainbow Canyon is undeveloped woodland located on a hillside in a developed residential neighborhood.

4.3 MANAGEMENT MEASURES AND PRELIMINARY PLANS

4.3.1 Potential Management Measures

As the first step in the formulation of alternative plans, a list of potential measures has been developed. These measures are then evaluated for their ability to solve the problem, based on consideration their engineering requirements, environmental impacts and effectiveness. Some of these measures may be implemented as stand-alone features capable of meeting some of the study objectives, but none of them, on their own, would provide a comprehensive solution of the problems identified earlier. None of the individual measures are capable of maximizing the potential for ecosystem restoration, while providing incidental benefits for flood risk management, water quality, water supply or recreation within the study area. Thus, the plan formulation effort focuses on *combinations* of individual measures as the means by which to achieve the study objectives. Management measures were screened based on the following considerations:

§ Measures that have little or no potential for meeting study objectives, or those that are unsupported by non-Federal sponsorship have been eliminated from further consideration in plan formulation.

§ Measures that conflict with the planning constraints are eliminated from consideration, or are considered in limited situations where the constraints are not violated.

§ The remaining measures are then assembled into various combinations to create a series of preliminary plans that adequately address the study goals and objectives.

Figure 4.8 Site 7 – Arroyo Seco through Los Angeles

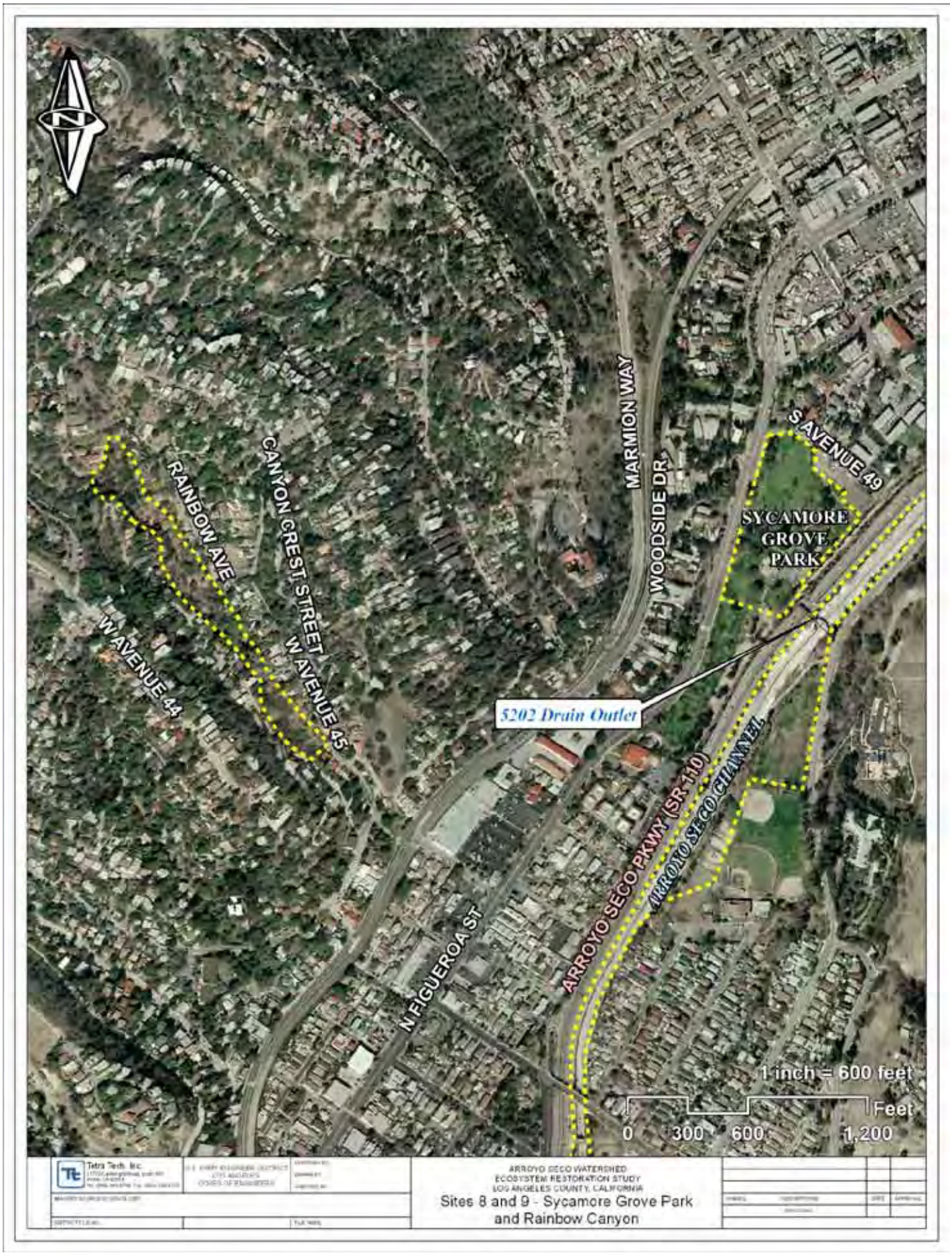

Figure 4.9 Sites 8 and 9 – Sycamore Grove Park and Rainbow Canyon

The following presents the list of management measures that have been developed for this study. These measures consist of structural measures and non-structural measures including watershed management activities or policies. As additional plan formulation is carried out during this study, additional measures may be identified that could be considered as components of plan alternatives, depending on their contribution to study objectives and ability to meet the planning constraints.

4.3.1.1 Structural Measures

These measures are grouped in four main categories: habitat restoration, flood damage reduction and erosion control, water quality and conservation (for habitat restoration), and recreation.

A. Habitat Restoration

§ In-channel vegetation. Existing channel can be used to preserve existing riparian vegetation and reestablish riparian vegetation.

§ Riparian-fringe vegetation. These habitats typically experience less frequent inundation. Linkage of these habitats to others within the stream corridor would provide additional habitat diversity and quality and would provide a corridor between stream and upland habitats.

§ In-stream habitat improvement. Habitat enhancement features such as erratic clusters of boulders and woody debris, pool and riffles systems, and partially submerged vegetation would be utilized in areas with natural stream bottom.

§ Exotic/invasive species eradication. Replacing invasive species with native species would create better quality wildlife habitat, promote water quality benefits, and enhance conveyance. Invasive species eradication must be accompanied by measures to ensure that conditions that would promote their regrowth are addressed.

§ Low-flow channel modification. Reconfiguring existing low-flow channels would distribute water quality and habitat benefits across a larger portion of the floodplain and riparian habitat.

§ Flow modification. Drainage flow modification to distribute flows over a wider area thereby supporting more habitats.

§ Fish ladder or fish passage devices. This would address the need for fish passage over otherwise inaccessible in-stream barriers. This includes provisions for fish passage over or around the dam, through HWP and into the upper watershed and into tributaries in the lower reach.

§ Wetland restoration. Wetlands would be reestablished at appropriate locations given appropriate hydrologic, topographic, and soil conditions.

§ Terracing. Creating terraces above the existing channel invert and below the existing top-of-bank offers opportunities for habitat restoration by reestablishing a connection to the floodplain and creating additional riparian and wetland habitat.

§ Create islands. Modifying existing stream bottom to create islands of riparian habitat at elevations that would be affected by frequent floods would create additional habitat value and diversity.

§ Open water. Restoring naturally occurring seasonal pools or channel reaches with open water would support restoration of riparian habitat and benefit migratory waterfowl.

§ Side channel diversions. Excavate one or more side channel(s) parallel to the current Arroyo Seco alignment. The side channels would have an unlined bed and bank and vegetation would be planted to create riparian habitat.

§ Concrete removal. This consists of the (complete or partial) removal of the concrete lining of the stream channel and restoration of the riparian habitat. Restoring the channelized lower reaches of Arroyo Seco is not possible without at least partial concrete removal.

§ Stream daylighting. This refers to the practice of bringing buried or culverted streams back to the surface.

§ Sediment redistribution. Redistributing sediment that is currently trapped behind Devil's Gate Dam would be used to enhance stream bottom conditions and provide habitat for a benthic community as well as improved habitat for pelagic species and also to support riparian vegetation.

B. Incidental Flood and Erosion Control

§ Stream lengthening. Adding meanders (i.e. add length back) to the system decreases the gradient and reduces flow velocities and erosion potential.

§ Bank stabilization. Bank protection and/or grade stabilization may be used at selected locations to prevent destruction of existing or future riparian habitats. This could be accomplished by re-contouring banks into stable slopes utilizing bioengineering methods and through limited placement of stone slope protection.

§ Modification of existing channel banks. Reducing the angle of existing banks would create a wider and more natural channel profile, thereby increasing vegetative access to existing water sources and increasing flood storage capacity. Regrading the channel banks would allow revegetation on the new slopes, which cannot occur under existing conditions due to the presence of concrete facing along the existing banks. This measure could be applied in a

variety of ways where sufficient right-of-way is available or could be acquired to accommodate bank alteration.

§ Drop structures/weirs. Placement of semi-permanent structures with associated weirs in the channel to aid in channel flow stabilization during low-flow conditions and creation of seasonal pools. Weirs usually have a level crest with elevation high enough to intercept a large percentage of the flow during low-flow conditions but that are not high enough to impede conveyance of flood waters.

§ Grade control stabilizers. Boulders and wood grade controls and possible channel realignment could be used to reduce flood flow velocities that would support sustainable channel vegetation, capture sediment, and limit erosion that would endanger newly restored channel reaches. The structures could span the entire width of the riverbed and have sufficient toe down to survive the anticipated scour resulting from a full range \and magnitude of flood events.

C. Recreation

§ Recreational corridor. Incorporation of trails and other low-impact recreational features in conjunction with other restoration management measures.

§ Access points. Access points with connections to streets and sidewalks, and signage may be considered to increase recreational use consistent with ecosystem restoration objectives.

D. Water Quality and Water Conservation

§ Stormwater best management practices (BMPs). Stormwater control measures are designed to mitigate the changes to both the quantity and quality of stormwater runoff caused by urbanization. Practices to achieve these goals include green infrastructure and low-impact development.

§ Stormwater treatment wetlands. Constructed wetlands could be utilized to improve water quality by settling, adsorption and transformation of pollutants, and water filtration.

§ Retention/infiltration basins. This would utilize retention (wet) basins to reduce the total volume of flows and allow infiltration and groundwater recharge.

§ Riparian buffers. Riparian buffers, defined here as the entirety of aquatic, wetland, and riparian forest habitat within the stream's channel and floodplain, can reduce runoff rates by increasing flow complexity and travel time to the stream, increasing the opportunity for water quality treatment by pollutant uptake, degradation, absorption, and transformation.

4.3.1.2 Non-Structural Measures

These measures focus on preserving open space, protecting natural systems, and incorporating existing landscape features such as wetlands and stream corridors into a site plan to manage stormwater at its source.

§ Stormwater-sensitive site planning and design. A major objective for this measure is to avoid encroachment upon, disturbance of, and alteration to those natural features which provide valuable stormwater functions (floodplains, wetlands, natural flow pathways/drainage ways) or with stormwater impact sensitivity (steep slopes, historic and natural resources, adjoining properties, etc.) wherever practicable.

§ Watershed education plan. This measure would involve the preparation of a document containing information, coursework, curricula, resources, and teaching plans to provide educa~~SFloo~~tors with the necessary support to teach students the same information.

§ Streetsweeping. Increased street sweeping along with higher density of trash barrels and Arroyo Seco-specific signage, standardized throughout the watershed in areas of high use could reduce non-point pollution at the source.

§ Citizen monitoring program. This program would generate information critical to monitoring the effectiveness of the measures proposed in this watershed study.

§ Local government ordinances and policies. City policies and ordinances can play a large role in either promoting or discouraging programs designed at improving watershed health.

§ Reduce area of impervious surface. Reducing impervious street areas performs valuable stormwater functions including increased infiltration, decreased stormwater runoff volume, increased stormwater time of concentration, improved water quality by decreased pollutant loading of streams, and decreased concentration and energy of stormwater. This can be accomplished by minimizing pavement using alternative roadway layouts, restricting on-street parking, minimizing cul-de-sac radii, and using permeable pavers.

§ Disconnection from storm sewers. Minimize stormwater volume by disconnecting impervious roads and driveways and directing runoff to grassed swales and/or bioretention areas to infiltrate.

§ Acquisition of key parcels for habitat protection and restoration, as well as water quality improvements. Work with non-profit land trusts and private owners to secure conservation easements or purchase of parcels of land throughout the watershed that are important to either improving water quality or restoring habitat.

4.3.2 Management Measures Screening Process

Selection of practicable measures is based on assessments of (1) the effectiveness and/or applicability of a measure in meeting study objectives and constraints and (2) the measure's potential environmental, economic, and social effects.

The screening process focused on the effectiveness of the various management measures thus far developed. Table 4.1 displays the results of the qualitative ratings developed, which is based on how each measure meets the stated objectives and how it is affected by the constraints (i.e. yes or no function – measures effective in meeting specific objectives or constraints are shown with a bullet; those not effective are left blank). This screening process results in the refinement of measures by eliminating those that were (1) inappropriate for Federal participation or unsupported by non-Federal sponsorship, (2) had little to no potential for meeting the study objectives, or (3) were less productive compared to other, more efficient measures.

Table 4.1 Preliminary Measures, Objectives, and Constraints Screening Matrix

MEASURES	OBJECTIVES									CONSTRAINTS							
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
STRUCTURAL																	
HABITAT RESTORATION																	
In-channel vegetation	●	●	●	●				●	●	●	●			●		●	
Riparian-fringe vegetation	●	●	●	●				●	●	●				●		●	
In-stream habitat improvement	●	●		●		●	●	●	●	●				●		●	
Exotic/invasive species removal	●	●		●	●		●	●	●	●	●			●		●	
Low-flow channel modification		●		●	●		●	●	●	●	●			●		●	
Flow modification		●	●	●		●			●	●	●			●		●	●
Fish ladder or fish passage device		●							●	●				●		●	●
Wetland restoration	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	
Terracing	●	●		●			●		●	●			●	●		●	●
Create islands		●		●			●	●		●				●		●	
Open water		●					●	●		●				●		●	
Alternative stream bottom	●	●		●	●				●	●	●		●			●	●
Concrete removal		●	●			●		●	●		●					●	●
Stream daylighting	●	●	●			●		●	●							●	●
Sediment redistribution	●	●	●	●					●	●	●	●		●	●	●	
FLOOD AND EROSION CONTROL																	
Stream lengthening	●	●		●	●	●	●	●			●		●	●	●	●	●
Bank stabilization	●	●	●	●	●			●						●	●	●	●
Modification of existing channel banks	●	●	●				●	●	●						●	●	●
Drop structures/weirs	●	●			●									●	●	●	●
Grade control stabilizers	●	●	●		●									●	●	●	●
RECREATION																	
Recreational corridor							●	●	●				●		●	●	●
WATER QUALITY AND CONSERVATION																	
Stormwater BMPs	●	●	●		●	●									●	●	

Table 4.1 Preliminary Measures, Objectives, and Constraints Screening Matrix

MEASURES	OBJECTIVES									CONSTRAINTS							
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Stormwater treatment wetlands	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	
Retention/infiltration basins	●	●	●	●	●	●			●	●	●				●	●	●
Riparian Buffers	●	●	●	●	●			●	●	●			●	●		●	●
NONSTRUCTURAL																	
Stormwater-sensitive site planning and design	●	●	●	●	●	●		●		●	●			●	●	●	
Watershed education plan	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
Non-point source public awareness	●	●	●		●	●									●	●	
Streetsweeping	●	●	●					●								●	
Citizen monitoring program		●			●	●									●	●	
Local government ordinances and policies	●	●		●	●	●	●	●	●	●	●	●			●	●	
Reduce street imperviousness	●	●	●		●	●										●	
Disconnection from storm sewers	●	●	●	●	●										●	●	
Acquisition of key parcels for habitat restoration	●	●		●		●		●	●	●	●		●	●		●	
Public education/outreach	●	●	●	●	●	●	●	●		●	●	●	●		●	●	

Objectives:

A. Reduce further degradation of the ecosystem caused by the natural and human-induced changes to the watershed by improving habitat, water quality, flood storage capacity, and general ecosystem health within the study area.
B. Develop opportunities for ecosystem restoration by providing high-value habitat, removing impediments to fish passage, eradicating invasive species, and providing habitat corridors and habitat linkages that currently do not exist.
C. Prevent further degradation and improve water quality (both surface and groundwater) by reducing stream temperatures, reducing non-point sources of pollution, and establishing treatment recommendations for groundwater contaminants.
D. Improve riparian habitats by restoring sustainable vegetation within the study area, more natural habitat types, and advantageous flow and substrate conditions.
E. Maintain reduction of flood damage and life and property loss through control of bank erosion, reduction of sediment deposition, and improvements to flow capacity within the channel.
F. Increase opportunities for water conservation by improving recharge potential and addressing groundwater contamination issues.
G. Improve recreation opportunities by identifying a balance of open space, recreational trails, and habitat areas.
H. Improve the riverfront aesthetic quality of the Arroyo Seco by providing healthier and more enjoyable greenway experiences to the community while still allowing for sustainable habitat conditions for wildlife.
I. Restore wildlife corridor between the lower and upper Arroyo Seco.

Constraints:

J. Availability of water.
K. Maintenance of floodway capacity.
L. Maintenance of Devil's Gate Dam flood storage capacity.
M. Proximity of recreation to restoration.
N. Endangered species.
O. Hazardous and toxic waste sites.
P. Local acceptability
Q. Real estate costs.

4.3.3 Preliminary Plans

Measures that are carried forward will be considered for inclusion in the preliminary set of alternative plans that are formulated to address the goals and objectives established for the study. These preliminary plans will refined and evaluated following the procedures outlined in the Planning Guidance Notebook (ER 1105-2-100) and the Engineering Circular on Watershed Plans (EC 1105-2-411). Different combinations of management measures will be selected based on appropriate site selection characteristics and physical parameters. Management measures that do not meet the criteria or that are not compatible with other measures included in the plan alternatives will be eliminated from further consideration.

The preliminary alternatives were developed to group management measures that address related objectives within the Arroyo Seco study area while addressing constraints and also considering incidental benefits for water quality improvement, recreation, and water supply conservation and management.

4.3.3.1 Preliminary Plans Eliminated from Further Consideration

The Corps will not develop single-purpose flood risk management alternatives for this study. As the study reach is protected to the 100-year event in most areas, a single-purpose flood risk management alternative would not be justified. The Corps will not develop single-purpose water quality improvement, water supply, or recreation alternatives. These would not meet Federal or local objectives for the study area, and would be duplicative with planning efforts and projects that are already being implemented by local agencies with jurisdiction and resources to address these issues.

While watershed feasibility studies include non-structural measures including policies and regulatory approaches to improving water resources conditions within a watershed, plan alternatives based on water management strategies and other non-structural measures that could not be implemented as part of a spin-off project are not considered in subsequent plan formulation in this study.

4.3.3.2 Preliminary Plans for Further Consideration

The potential ecosystem restoration measures identified above were organized into alternatives. These alternatives address general areas of emphasis for the restoration objectives within the watershed. Each alternative contains a set of management measures to address the resource problems in the study area. During the detailed evaluation of plan alternatives, alternatives may be combined where they are compatible and the combined plan provides a more effective response to the study objectives. The preliminary plan alternatives and combinations of the preliminary alternatives will be considered for the potential restoration sites that have been identified in the watershed (see Section 4.2) to develop a combination matrix that would allow plan alternatives to be identified for the restoration areas that results in the best integrated watershed approach for achieving the planning objectives.

In subsequent phases of the feasibility study, the alternatives will also be subjected to a cost/benefit analysis once the specific measures for each alternative or combined alternatives for

the restoration sites have been determined. The following preliminary alternative plans have been developed from the initial list of measures presented above.

A. Alternative 1: No Action Alternative

Under this alternative, the Corps would take no action to restore any ecosystem functions or values within the Arroyo Seco study area. The No Action Alternative is the basis for comparison with all other alternatives, as it represents a condition, both current and future, under which none of the plan alternatives are implemented. Trends in environmental and resource conditions would continue through the period of analysis. Because the study area is intensely urbanized, significant additional development is not anticipated to occur, and population of the region is expected to remain relatively stable. Processes that contribute to ecosystem degradation such as growth and propagation of invasive species would continue in the future, and fragmented habitats and wildlife areas would remain isolated from each other. In addition, the existing hardened channel and flood control structures would remain in place, and operation and maintenance activities would continue as currently administered.

By comparing the No Action Alternative to each formulated alternative, one may assess the advantages and disadvantages of the study alternatives in relation to current and future "without-project" conditions. All alternatives are evaluated against the No Action Alternative to determine the benefits and risks associated with each of the proposed alternatives.

B. Alternative 2: Fish Passage, Rearing, and Forage

Fish passage and access barriers include dams, culverts, and perched streams. Fish rearing impediments include lack of complexity, cover, and water quality, and forage impediments occur from lack of organic input. The range of project measures to address these issues, located primarily at Site 1, Site 3, and Sites 4 through 7 (described in Section 4.2), may involve:

§ Construction or maintenance of fish ladder/passage systems.

§ Reconnection of the main channel to small tributaries by building up the stream bottom or creating a step pool sequence into perched streams.

§ Reestablishing riparian forest at the stream's edge to provide organic input, shade, and occasional large wood input.

§ Implementing stormwater management BMPs at select locations to minimize stream velocities, reduce sedimentation and turbidity, and enhance water quality.

In-channel restoration projects target stretches of stream that lack habitat and complexity. Measures may involve:

§ Removing non-native species and planting native riparian vegetation.

§ Bank stabilization.

- Adding channel complexity through narrowing and the creation of meanders.
- Adding large woody debris and pools and creating more edge habitat by creating islands or woody debris jams.
- De-armoring and widening the stream stretches which are armored and incised.
- Redirecting or realigning flows to restore water into historic side channels.
- Redistributing sediment throughout the lower system to allow for formation of benthic communities and in-stream vegetation.
- Altering flow patterns to ensure that water of adequate quality and quantity is available when fish and bird species are most likely to be in the system.
- Installing fish-passable drop structures and weirs to stabilize low flows and create scour pools for dry season habitat and cover.
- Lengthening the stream by allowing or creating meanders to form. This would reduce flow velocities and diversify habitat conditions.

The possible benefits of projects of this type include: providing rearing habitat refuge and possible spawning for native fish, reducing water temperatures, reducing flood depths, increasing channel complexity, and improving wildlife habitat.

C. Alternative 3: Floodplain Reconnection

This alternative would be implemented mostly below Devil's Gate Dam, since the stream and floodplain are well-connected above the dam. Floodplain connection measures may involve:

- Diversion of small amounts of water from Arroyo Seco into previously established side channels.
- Raising the stream bottom by allowing sediment to pass beyond the dam, and installing grade control structures to capture sediment.
- Native riparian plantings.
- Excavation of off-stream channels or backwaters; clearing out sediment and removing non-native plant species, to restore historic side channels and/or create new habitat.
- Creating terraces above the existing channel invert to the top of bank and revegetating with native plant species.
- Restoring wetlands in the floodplains to enhance off-channel habitat and to allow for greater dry-season water availability in the main channel.

§ Stream daylighting. Some tributaries enter the main channel through culverts. Restoring surface flow in these tributaries would create a direct connection to the floodplain.

§ Modifying bank angles to allow for greater flood storage capacity as well as better conditions for establishment of riparian buffers.

It should be noted that some of these measures may require real estate acquisition/relocation.

D. Alternative 4: Invasive Plant Eradication/Revegetation

Replacing non-native vegetation with native vegetation reestablishes the structural and vegetative diversity that was once present, while controlling erosion and reducing sediment deposition. This alternative would be implemented primarily in Sites 1, 2, and 3 (described in Section 4.2) since these have the greatest infestation of non-native plant species. The native vegetation provides cover, nesting, foraging and dispersal opportunities for birds and small mammals. Additionally, maturing native vegetation can reduce solar exposure in the stream channel, and provide detritus and future large woody debris, thereby restoring and enhancing habitat for the fish species found in the stream. The range of measures may involve the following:

§ In-channel vegetation installation.

§ Flow modification to favor native species over non-native species.

§ Sediment redistribution to enhance substrate conditions for revegetation.

§ Invasive non-native species removal.

§ Establishment of riparian-fringe vegetation and riparian buffers.

E. Alternative 5: Wetland Restoration and Enhancement

This alternative would be appropriate in areas where wetlands have been filled or have been disconnected from channels. This is likely the case at most sites, but particularly those sites where the stream bottom has been armored. Wetland enhancement projects would involve improving the diversity and complexity of wetland habitats and would provide water quality improvement, groundwater recharge, sediment trapping and flood storage, and fish and wildlife habitat enhancement. Depending on whether the wetland is accessible to fish, the benefits to fish may be indirect by providing water quality improvements and other functions (habitat quality), rather than directly usable habitat quantity for fish. The range of measures may involve the following:

§ Flow modification. Occasionally allowing larger flows into the lower system would help support off-channel wetland habitat.

- Low-flow channel modification. Off-channel wetlands would be enhanced by diverting more water from the main channel to the low-flow channels found at several locations in the lower reach.

- Install stormwater treatment wetlands, which would enhance habitat quality in the floodplain and water quality downstream of the wetland.

- Install retention basins, which would have similar benefits as stormwater treatment wetlands and would also reduce habitat degradation in the stream bottom associated with high runoff velocities.

- Install recreational and educational features such as interpretive signs and boardwalks at wetland areas.

4.3.3.3 Conclusion from the Preliminary Screening

The preliminary alternatives described above demonstrate that there is a full range of possibilities for ecosystem restoration in the Arroyo Seco study area. In the subsequent phase of the feasibility study (i.e. preceding the Alternative Review Conference [ARC] – F4 Milestone), a revised and expanded array of alternatives will be developed and analyzed. Different combinations of the restoration measures and/or alternatives will be investigated based on appropriate characteristics and physical parameters of potential alternative sites.

More detailed engineering, design, cost estimating, incremental evaluation, analysis of potential project impacts, and the development of preliminary cost-effectiveness analysis will be conducted during the ARC. The resulting information will be used to make plan formulation decisions on the potential removal of alternative plans from further consideration or progression into a final array of alternative plans, carried forward as spin-off projects that are subject to further refinement and analysis.

5.0 STUDY COMPLETION

After the completion of the Feasibility Scoping Meeting (FSM), the Vertical Team will compile comments and provide direction through a Policy Guidance Memorandum (PGM). The PGM will inform the study team on study-specific actions to be taken in revising and correcting the study materials provided in this report, and for completion of subsequent steps of the study process. Based on the PGM, the Planning Guidance Notebook, and the Engineering Circular on Watershed Plans, the study team will then complete the formulation of alternatives, and compare the alternatives based on the cost-effectiveness and incremental cost analysis of alternative plan costs and outputs, and the planning criteria described in Section 2.5.

The information generated through the assessment and comparison of alternatives described above will be used to recommend project-specific feasibility studies to be carried forward for feasibility level of detail analyses through individual follow-on studies. A draft report will be prepared to document the completion and findings of the plan formulation process, and the draft report will be subject to a District Quality Control review, followed by an Agency Technical Review (ATR). The ATR will be performed by a review team with members having appropriate experience and expertise from other Corps districts. ATR comments will be entered into DRChecks, and responses will also be provided by the study team. The ATR review comments will then be back-checked by the reviewers and closed out by the Study Manager. The revised draft document will then be provided to the Vertical Team for review and comment. Once Vertical Team approval has been provided, the final document will be provided to the Chief of Planning at HQUSACE for distribution to Congress for information purposes, in compliance with the procedures documented in the Engineering Circular on Watershed Plans (EC 1105-2-411).

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6.0 COORDINATION AND CONSULTATION

The Corps will continue its coordination with the following agencies and stakeholders during the completion of this watershed study document and spin-off implementation projects.

- City of Los Angeles
- City of South Pasadena
- City of Pasadena
- City of La Cañada Flintridge
- Los Angeles County
- Arroyo Seco Foundation
- Council of Arroyo Seco Agencies
- Council of Arroyo Seco Organization
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. Environmental Protection Agency
- California Department of Fish and Game
- California Department of Transportation
- State Water Resources Control Board, Los Angeles Regional Board

Full compliance with state and Federal regulations by spin-off implementation projects in the Arroyo Seco study area will require subsequent environmental investigations and consultation with the appropriate agencies and public stakeholders. Specific consultation that is needed with local, state, and Federal agencies will be identified as the planning and design of spin-off projects proceeds.

6.1 Stakeholders Coordination

An integral part of the planning process was soliciting feedback and comments from the public and agencies. A meeting was held at the LACDPW Headquarters on May 27, 2010. The Corps gave a presentation on the status of the Arroyo Seco Watershed Ecosystem Restoration Study to the CASA members. The presentation included the following: study schedule, technical reports/appendices, in-kind products, preliminary planning objectives and constraints, development of measures, and preliminary alternative sites. Questions from the CASA members were addressed throughout the presentation. Following the presentation, the CASA members were asked to provide their input into the planning process, screening of measures, and alternative site development. In response to the Corps' request, the CASA members provided their input on June 3, 2010. The questions and comments provided by the CASA members are presented in Table 6.1.

Table 6.1 Stakeholders Questions and Comments

COMMENTS	AGENCY
OBJECTIVES	
Revise "E" to "Reduce urban flood damages and life and property loss"	Raymond Basin
Add an "Economic Feasibility" criteria with a cost benefit ratio of at least 1	Raymond Basin
A is overly broad and implies that natural changes to the watershed are necessarily degrading to the ecosystem	Los Angeles and San Gabriel Rivers Watershed Council (LASGRWC)

Table 6.1 Stakeholders Questions and Comments	
COMMENTS	**AGENCY**
Objective D overlaps with A. Eliminate Objective D. Revise it to: "Reduce further degradation of the ecosystem"	LASGRWC / LACDPW
G should be changed to "Improve opportunities for passive and active recreation"	LASGRWC
Enhance wildlife corridor and its connectivity	City of Pasadena
CONSTRAINTS	
Add "no impacts to the Flood Control District's ability to perform it Flood Risk Management and Water Conservation missions"	Raymond Basin
Add "no impacts to the existing flood control and water conservation facilities and structures"	Raymond Basin
Add "no impacts to the current and future operation and maintenance activities relative to the Devil's gate Dam, the Devil's Gate Reservoir, and the Arroyo Seco Spreading Grounds"	Raymond Basin
Add "no impacts to the implementation of future flood risk management and water conservation projects"	Raymond Basin
L should be framed to make it clear that pathways for walking, biking, riding, and bird watching are just as important as active recreation opportunities	LASGRWC
M should be expanded to include California Species of Special Concern and threatened species	LASGRWC
Revise "Endangered Species" to Sensitive, Threatened and/or Endangered Species"	Pasadena
Add "Implementation Costs" as a constraint	LACDPW
MEASURES	
Provide a narrative section explaining the purpose of the measures (Structural and Non-Structural)	Raymond Basin
Provide a definition of each measure	Raymond Basin
Add a "Water Conservation Measure" and a "Groundwater Recharge" under this new added measure	Raymond Basin
Under REC, expand to 1. Passive Recreation Corridor and 2. Active Recreation	LASGRWC
Under WAQ, I would add "disconnection from storm sewers with infiltration to groundwater	LASGRWC
Under Potential Nonstructural measures: Explain how storm sewer disconnection is solely a nonstructural measure; "Reduce street imperviousness" should be changed to "reduce impervious surfaces"; "Acquisition of key parcels for habitat restoration" should be augmented to "Acquire key parcels for habitat protection and restoration, and water quality improvement." Natural landscapes improve and protect water quality	LASGRWC
Add Water Conservation as a measure and move Retention/Infiltration Basins from Water Quality to Water Conservation	LACDPW
Under Flood and Erosion Control, add "Maintain Flood Capacity" and "Enhance Capacity" as measures	LACDPW
ALTERNATIVE SITES	
Site 1: Pasadena Water Department needs to comment about the headworks not being included; If this plan is focused on ecosystem restoration, why are not all the natural/plant community areas included, as they are in some of the other sites.	City of Pasadena
Site 2: Why are not areas such as Berkshire Creek and some of the other natural slopes on the west side of the basin included?	City of Pasadena
Site 4: Why are not all of the natural plant/community areas, above the floor of the golf course on both the east and west side of the canyon included, as	City of Pasadena

Table 6.1 Stakeholders Questions and Comments	
COMMENTS	**AGENCY**
they are in site 3?	
Site 5: Needs to include Laguna Canyon as well as the southern portion of the City of Pasadena.	City of Pasadena
Site 6: Should include connectivity with the City of Pasadena, particularly the stretch on the west side of the channel that connects to the northern tip of site 6 with the City of Pasadena's Lower Arroyo.	City of Pasadena

The above questions and comments will be further analyzed and addressed in the next phase of the planning process, i.e. the ARC (F4 Milestone), to determine their eligibility in satisfying the requirements of the Corps' planning process.

Additional progress briefing will be scheduled during the course of this study. These briefings will serve as informal workshops where the non-Federal sponsor and stakeholders and representatives from other agencies receive status reports from the Corps team. These meeting will also be useful in achieving consensus on study methodologies and dissemination of study findings.

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7.0 LIST OF PREPARERS

The following individuals were primarily responsible for the preparation of this report.

Table 7.1 List of Preparers

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9.0 ACRONYMS AND ABBREVIATIONS*

ac-ft	acre-feet
ACM	asbestos-containing building material
ADT	average daily traffic
AGR	agricultural
APEFZ	Alquist-Priolo Earthquake Fault Zone
AQMD	Air Quality Management District
ARB	Air Resources Board
ARC	Alternative Review Conference
ARTS	Pasadena Area Rapid Transit Service
ASF	Arroyo Seco Foundation
ASTM	American Society for Testing and Materials
BFI	Browning Ferris Industries
bgs	below ground surface
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAAQS	California Ambient Air Quality Standards
CAL FIRE	California State Department of Forestry and Fire Protection
CalTrans	California Department of Transportation
CARB	California Air Resources Board
CARE	Coordinated Agency Recovery Effort
CASA	Council of Arroyo Seco Agencies
CASO	Council of Arroyo Seco Organization
CDFG	California Department of Fish and Game
CEQ	Council of Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH_4	methane
CHRIS-SCCIC	California Historical Resources Information System, South Central Coastal Information Center
CNDDB	California Natural Diversity Database
CNEL	Community Noise Equivalent Level
CNPS	California Native Plant Society
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
COLD	cold freshwater habitat
Corps	United States Army Corps of Engineers
CPUC	California Public Utilities Commission
CWA	Clean Water Act

CWPP	Community Wildfire Protection Plans
dB	decibels
dBA	A-weighted decibels
DEM	Digital Elevation Model
DHS	California Department of Health Services
DTSC	California Department of Toxic Substances Control
DWR	California Department of Water Resources
EA	environmental assessment
EDR	Environmental Database Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EO	Executive Order
EPA	See USEPA
ERNS	Emergency Response Notification System
ESA	Endangered Species Act
EWP	Emergency Watershed Protection
FCSA	Feasibility Cost Sharing Agreement
FFA	Flood Frequency Analysis
FONSI	Finding of No Significant Impact
FRA	Federal Responsibility Area
FRAP	Fire and Resource Assessment Program
FSM	Feasibility Scoping Meeting
FTTS	FIFRA/TSCA Tracking System
GHG	greenhouse gases
GIS	Geographic Information System
GWR	groundwater recharge
HAER	Historic American Engineering Record
HEC	Hydrologic Engineering Center
HFC	fluorinated hydrocarbons
HMS	Hydrologic Modeling System
HTW	Hazardous and Toxic Waste
HTWM	Hazardous and Toxic Waste Materials
HWP	Hahamongna Watershed Park
IND	industrial service supply
IPCC	Intergovernmental Panel on Climate Change
IRWMP	Integrated Regional Water Management Plan
IS	initial study
JPL	Jet Propulsion Laboratory

LACDPW	Los Angeles County Department of Public Works
LACSD	Los Angeles County Sanitation District
LADWP	Los Angeles Department of Water and Power
LARWQCB	Los Angeles Regional Water Quality Control Board
LBP	lead-based paint
Ldn	Day-Night Average Sound Level
LEDPA	Least Environmentally Damaging Practicable Alternative
Leq	equivalent sound level
Lmax	maximum noise level
LRA	Local Responsibility Area
LUST	Leaking Underground Storage Tank
µg	microgram
m^3	cubic meters
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level
mg/L	milligrams per liter
mph	miles per hour
MTA	Metropolitan Transportation Authority
MUN	municipal and domestic supply
MWD	Metropolitan Water District
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NAHC	Native American Heritage Commission
NASA	National Aeronautics and Space Administration
NED	National Economic Development
NEPA	National Environmental Policy Act of 1969
NER	National Ecosystem Restoration
NESHAP	National Emission Standards for Hazardous Air Pollutants
NET	North East Trees
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NOx	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRCS	Natural Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
O_3	ozone
OS	Open Space

Pb	lead
PCE	perchloroethylene / tetrachloroethene
PM_{10}	respirable particulate matter
$PM_{2.5}$	fine particulate matter
PMP	Project Management Plan
ppm	parts per million
PROC	industrial process supply
PWP	Pasadena Water and Power
RARE	rare, threatened, or endangered species
RBMB	Raymond Basin Management Board
RCRA	Resource Conservation and Recovery Act
RCRIS	Resource Conservation and Recovery Information System
REC1	contact water recreation
REC2	non-contact water recreation
ROG	reactive organic gases
RWQCB	Regional Water Quality Control Board
SCAB	South Coast Air Basin
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
SF_6	sulfur hexafluoride
SIP	State Implementation Plan
SO_2	sulfur dioxide
SoCalGas	Southern California Gas Company
sq mi	square miles
SR	State Route
SRA	State Responsibility Area
SWAT	Solid Waste Activity Tracking
SWF/LF	Solid Waste Facilities/Landfills
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TCE	trichloroethylene / trichloroethene
TDS	total dissolved solids
TMDL	total maximum daily load
USA	Underground Service Alert
USACE	See Corps
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
USNWS	United States National Weather Service
UST	underground storage tank

VCP	Voluntary Cleanup Program
VHT	Vehicle Hours Traveled
VMT	Vehicle Miles of Travel
VOC	volatile organic compound
WARM	warm freshwater habitat
WDS	Waste Discharge System
WET	wetland habitat
WILD	wildlife habitat
WMUDS	Waste Management Unit Database System
WRDA	Water Resources Development Act

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10.0 INDEX*

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