Water Supply and Habitat Resiliency for a Future Los Angeles River:

Site-Specific Natural Enhancement Opportunities Informed by River Flow and Watershed-Wide Action

Los Feliz to Taylor Yard

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Executive Summary

The mission of The Nature Conservancy [Conservancy] is to conserve the lands and waters on which all life depends. As the Conservancy engages with the Los Angeles region, they are investigating what it means to carry out this mission in the highly urbanized Los Angeles River ecosystem. As a starting point, it is known that the basic ecological principles of science apply to all environmental systems, regardless of their location. Therefore, the Conservancy is testing these principles by applying them in the Elysian Valley of the Los Angeles River and identifying habitat enhancement requirements, opportunities, and constraints.

As a basic principle of ecological systems, a watershed's hydrology determines the flow characteristics of its river system. These flows define what the biological characteristics of that river will be, which in turn determine what kinds of habitat enhancement projects will succeed at various locations along a river. The study of the Elysian Valley included one full year of multi-taxa biological surveys, a historical ecology investigation of the Elysian Valley, and a review of historic and existing hydrological and hydraulic conditions. Major findings of this study are:

- **Multiple Flow Scenarios = Uncertainty**: There are currently multiple visions for the flow characteristics of the Los Angeles River as a whole due to differing management priorities of the agencies and stakeholders that have governance over different aspects of this hydrologic system. Bringing the various hydrologic plans and possibilities for the watershed into a single integrated vision of system flow characteristics will allow certainty and clarity at the site level for the design of habitat projects anywhere in the River system, including the Conservancy's study area.
- **Flows Drive Biology**: The study area currently has higher flood and much higher dry weather flow rates than its historic condition. These high flow rates are supporting and encouraging non-native and invasive species. This leads to a lower level of biological diversity and resiliency than what would exist under lower flow rates, particularly during dry weather conditions.
- **Prioritize Complementary Habitats**: Enhancing and increasing the amount of perennial riparian habitat in-stream alone will not create as much biological value as identifying complementary enhancement opportunities outside of the River channel in adjacent upper terrace floodplain and upland habitats (e.g. alluvial scrub, mulefat scrub, willow scrub, oak-sycamore woodland, sage scrub, and grassland).
- **River Adjacent Land Use**: Land uses adjacent to the River and throughout the watershed are a part of the solution and part of the Los Angeles River's biological and hydrologic system. The landscaping and hydrology of these areas should be designed to provide a value-added role to the habitat functions of the Los Angeles River ecosystem.

Next steps for advancing the discussion of habitat enhancement include working with local stakeholders and agencies to find consensus on a flow condition for the River and its Watershed as a whole. In the study area itself there are six complementary project opportunities that could be implemented in the near term to advance understanding of habitat enhancement for the Los Angeles River. These smaller, localized projects can be used as pilot projects for the complicated jurisdictional and regulatory processes that all future habitat projects will have to navigate. They will provide a manageable and controlled process that will bring the necessary agencies together to identify the most effective processes for future projects throughout the Los Angeles River ecosystem.

Alternative Watershed Hydrology Scenarios

Currently, there is not a single management plan for the Los Angeles River watershed ecosystem as a whole. Based on the drivers of the jurisdictional agency involved, there are different narratives for what the hydrology of the system should be. Until consensus is forged on the most appropriate hydrologic characteristics of the system, inconsistency between stakeholders and lack of clarity for project design at the site scale will persist. A common narrative for the entirety of the Los Angeles River and its watershed is needed to enable partnership and coordinated "collective impact" for the work of all stakeholders at the project level.

Scenario 1: Existing Condition

- In-Channel Result Compared to Historic Condition: Higher Dry Weather Flows & Higher Peak Flood Flows

  The infrastructure management choices in the watershed up to this point have led to higher than historic peak flood flows from urban land uses and high levels of treated wastewater released into the River during dry weather.

  The higher flood flows have increased the infrastructure capacity required to protect against flood impacts, which constrains the integration of recreational and urban amenities into the River. This is the primary technical constraint for the strategies identified in both the Army Corps' Ecosystem Restoration Integrated Feasibility Report, and the City's River Revitalization Master Plan. Reducing these flow volumes would assist both of these efforts.

  Dry weather flows from water reclamation plant effluent prevents the River from achieving a more historic condition, which is required by some native wildlife species adapted to this semi-arid ecosystem. The year-round flows, orders of magnitude higher than would be natural, generally favor non-native species and reduce biodiversity and habitat resiliency.

Scenario 2: Stormwater Capture Focus

- In-Channel Result Compared to Historic Condition: Higher Dry Weather Flows & Higher Peak Flood Flows, But Lower Peak Flood Flows than Existing Condition

  This scenario would be achieved if the upstream water reclamation plants limited additional reuse of their effluent water, but stormwater capture was implemented at a broad scale throughout the watershed. This outcome would depend on the separate management decisions of local agencies that are largely driven by the priorities of State funding sources and regulatory programs.

  This scenario is the most consistent with the design assumptions of the Army Corps' Ecosystem Restoration Feasibility Study and the City of Los Angeles' River Revitalization Master Plan. The lower flows during wet weather would provide a greater level of protection to infrastructure in the riparian zone during rain events. The higher flows during dry weather supports a recreational experience that has water in the River year round, which is more similar to the rivers people associate with temperate climates. However, many of the native riparian species are adapted to a drier period each year, so the existing higher dry weather flows means it is not as effective at supporting native species, biodiversity, or ecological resiliency.

Scenario 3: Effluent Recycling Focus

- In-Channel Result Compared to Historic Condition: Similar, But Higher Dry Weather Flows from Urban Runoff & Higher Peak Flood Flows, But Lower Dry Weather Flows than Existing Condition due to Reduction in Wastewater Release

  This scenario would be achieved if water reclamation plants upstream did not discharge to the River and instead recycled the water for a beneficial use that reduced demand for imported water, and if stormwater capture efforts were not undertaken throughout the watershed. This outcome would depend on the separate management decisions of different local agencies that are largely driven by the priorities of State funding sources and regulatory programs.

Scenario 4: Water Supply and Habitat Resiliency

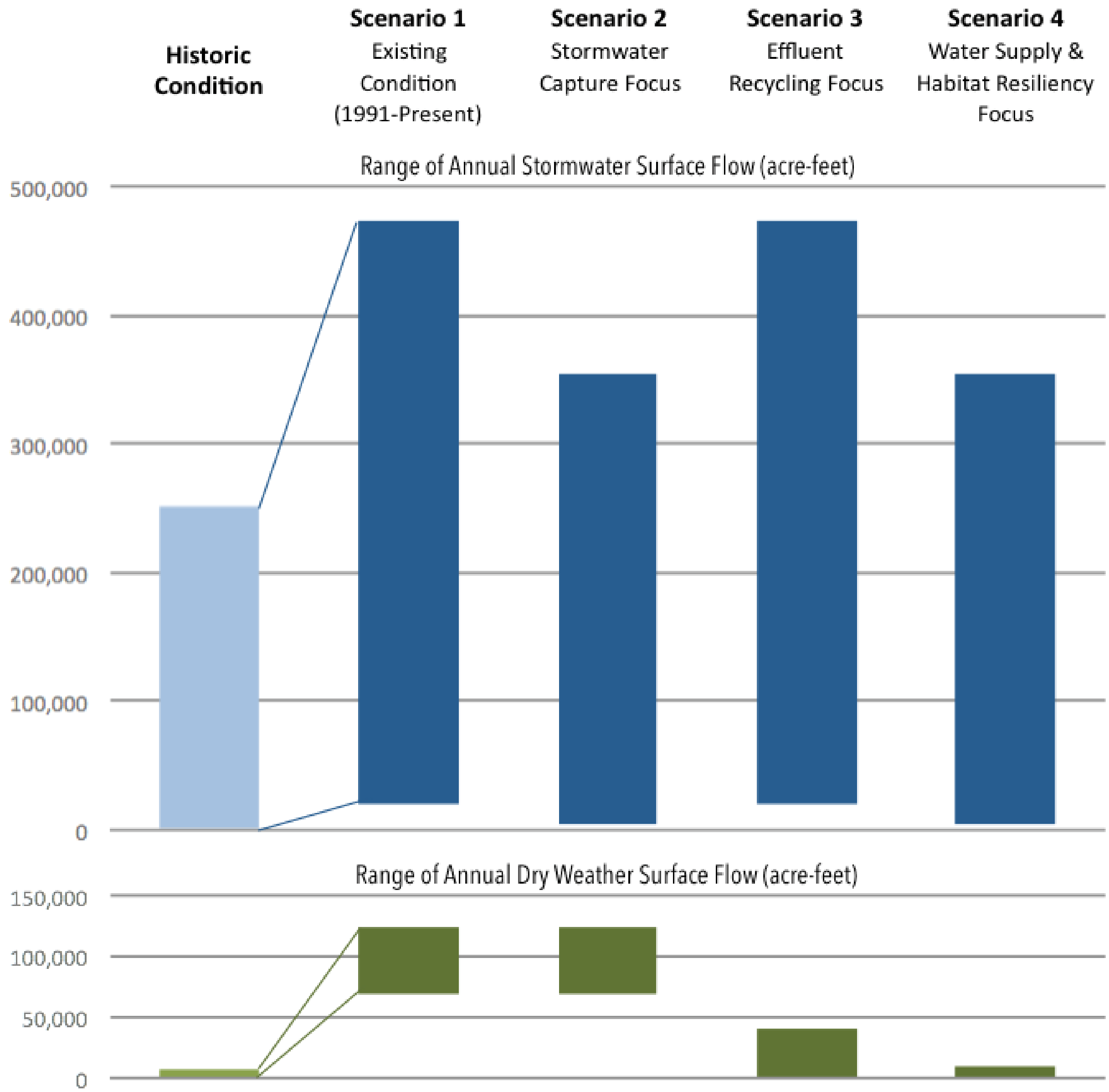
- In-Channel Result Compared to Historic Condition: Similar Dry Weather Flows & Higher Peak Flood Flows, But Lower Peak Flood Flows than Existing Condition

  This scenario would be achieved if the upstream water reclamation plants maximize recycled water, which would reduce or eliminate effluent flows to the River, **AND** stormwater capture was implemented at a large scale across the watershed. This scenario is the most responsive to ongoing Western drought conditions that necessitate reducing imported water and increasing the use and efficiency of all local water supply sources.

  This scenario most closely resembles historic hydrologic conditions in the watershed and River, and allows for the River to dry during dry weather. Therefore, it does the best job of supporting native wildlife species, with the highest level of native biodiversity and ecosystem restoration.

  In addition, the region’s habitat regulations fit this scenario best because in traditional natural science practice, the historic, predevelopment condition is what defines the higher environmental value. Modeling watershed hydrology regime management after the historic condition would enable the greatest level of alignment between all future stakeholder activities and regulatory programs.

Identifying a common flow narrative is needed as a basis for a common vision for the Los Angeles River ecosystem. This can be used to organize and unify the various missions and strategies of all the stakeholders that interact with and impact the functioning of this ecosystem. Therefore, The Nature Conservancy recommends the development of an ecosystem wide dialog among stakeholders that identifies consensus for one of the alternatives listed here, or some other single scenario that is deemed suitable by the stakeholders and jurisdictional agencies.



Notes:

1. Typical Discharge Conditions in the Elysian Valley (Above the Confluence of the Arroyo Seco) based upon DWR/ULARA Annual Reports 1928/9 to 2012/13 and Report of Referee Vol 2 (1962).
2. Dry Weather Flow Inputs in the Elysian Valley include Rising Groundwater, Water Reclamation Plants (WRPs) (Tillman, LA-Glendale, Burbank), Industrial Discharge and Urban Runoff.
3. Reductions in Dry Weather Surface Flow in Scenarios 3 and 4 assume elimination of effluent discharges from the 3 WRPs into the River and that instead the water is recycled for uses that reduce demand for imported water (e.g. Tillman WRP Groundwater Replenishment Project, GRP). Scenario 4 additionally assumes that urban runoff is captured and infiltrated outside of the channel to recharge groundwater, improve water quality and create ecologically appropriate habitat (e.g. ephemeral freshwater wetland, alluvial scrub, mulefat scrub and willow scrub) complementary to the in-channel riparian habitat.
4. In Scenarios 2 and 4, additional Stormwater Flow Capture in the San Fernando Valley assumed to be 100,000 acre-feet by 2035, per aggressive capture scenario in LADWP Stormwater Capture Master Plan (2015). Fulfills LA Water Integrated Resource Plan (IRP) and One Water LA water sustainability objectives

Figure ES-1. Range of Typical Annual Surface Flow for Stormwater and Dry Weather in the Elysian Valley for the Historic Condition and Four Watershed Hydrology Scenarios.

Elysian Valley Study Area

The Elysian Valley was chosen for this study for a number of reasons. It is at the juncture of two council districts and is the focus of a great deal of stakeholder advocacy through groups such as Friends of the Los Angeles River. It is close to a number of other open space areas that can be leveraged for habitat enhancement purposes. These areas include Griffith and Elysian Parks, California State Parks Bowtie Parcel, the Taylor Yard G2 Parcel, Los Angeles State Historic Park, and a number of pocket parks in the surrounding neighborhoods. A bike path runs through the study area, which provides the opportunity to incorporate recreational amenities and access into any pilot project.

Historically, this reach has always had detectable surface water because the water table is naturally very high, while other areas of the River, both upstream and downstream of this reach would have no surface water during dry weather. The exceptions to this perennial surface water are during periods of prolonged drought that lower the water table considerably and by the water extractions by private companies and the City that began in the late 1800s.

Today, there is surface flow in the River year-round due to treated effluent from the city's water reclamation plants and runoff from the surrounding hardscape. The current condition of constant flow combined with the 'soft bottom' of the channel has allowed for riparian vegetation to establish. This differs from other areas of the River that are fully paved, making ecosystem restoration more feasible in the near term while existing hydrologic conditions remain unchanged. The flood control channel in this part of the River is called 'soft bottom' because construction lowered the streambed elevation, penetrating the unconsolidated aquifer, which prohibited encasing the bottom with concrete.

Existing Conditions Species Occurrence

Although the Los Angeles River in the Elysian Valley is significantly different from its historic condition, there is still a great deal of ecological function in this area (Table ES-1 and Figure ES-3). The 'soft bottom', dry weather surface water flows, and relaxed vegetation clearing practices by the local agencies have allowed for a diverse community of plants and animals to survive here.

Table ES-1 Summary of Biotic Conditions (Survey Period: Oct 2014 to Sep 2015).

Plants	Reptiles & Amphibians	Birds	Insects	Mammals	Fish
•76 native species •167 total sp. •Invasive plants, like giant reed & castor bean •4 Vegetation Communities •Native willow, oak and sycamore trees	•5 natives, incl. western toad & Pacific chorus frog •7 total species •2 invasive species •Lizards, like western fence lizard use River pocket parks	•89 native species •106 total sp. •Birds use in-stream & adjacent upland habitat •Breeding documented or inferred for 33 bird species	•102 taxonomic families •Native plants are diversity hotspots •Low diversity of aquatic insects •Invasive Argentine ants •Native harvester ants	•10 native species •17 total sp, like coyote, desert cottontail, Calif. ground squirrels •5 bat sp., like Yuma myotis and big brown bat •6 non-native, like domestic mouse	•No native fish • 1992 & 2007 surveys found 5 non-native fish, like carp & mosquito fish •Lack of hydrological connections and refugia for natives

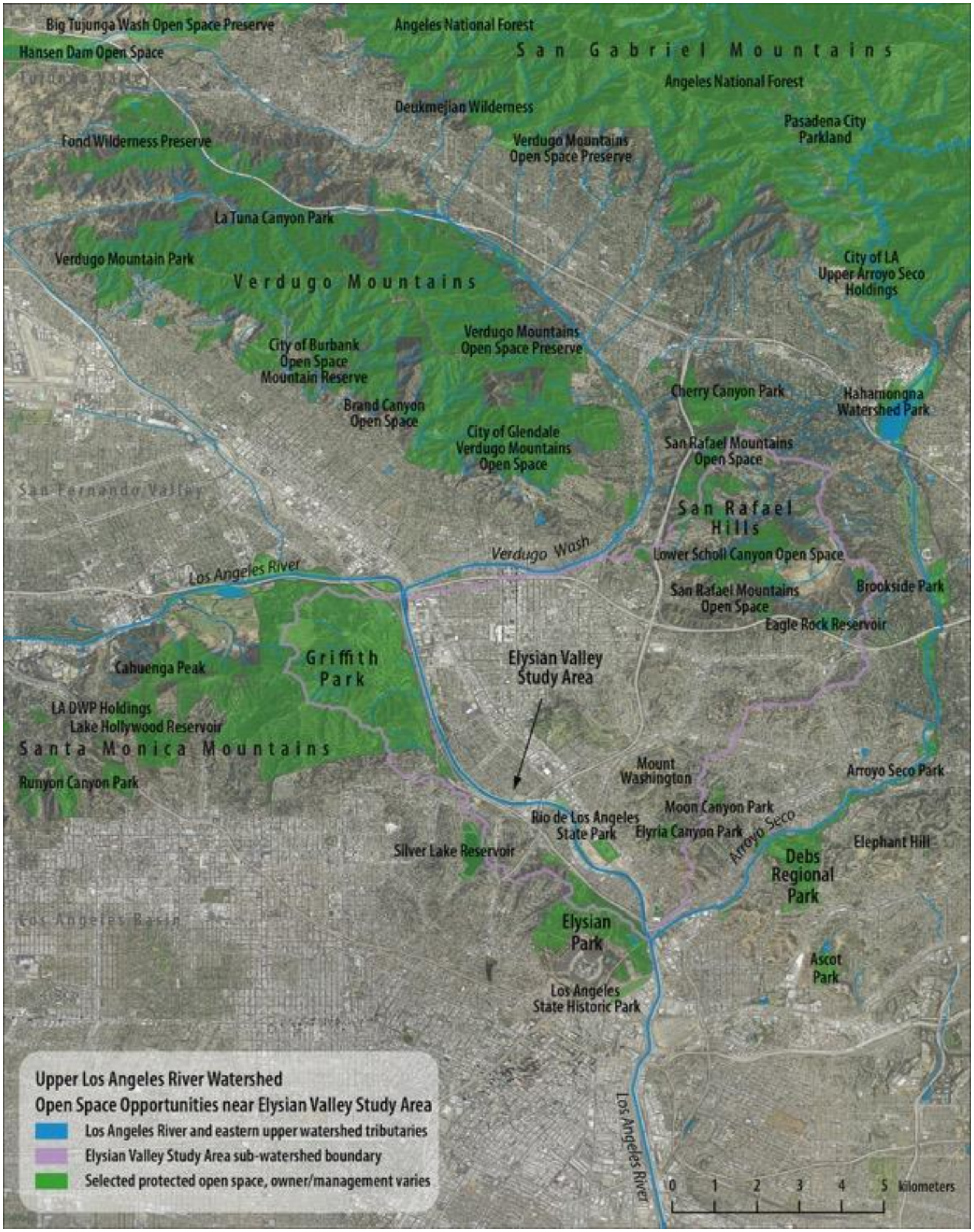


Figure ES-2 Location of the Elysian Valley Study Area in the Upper Los Angeles Watershed.

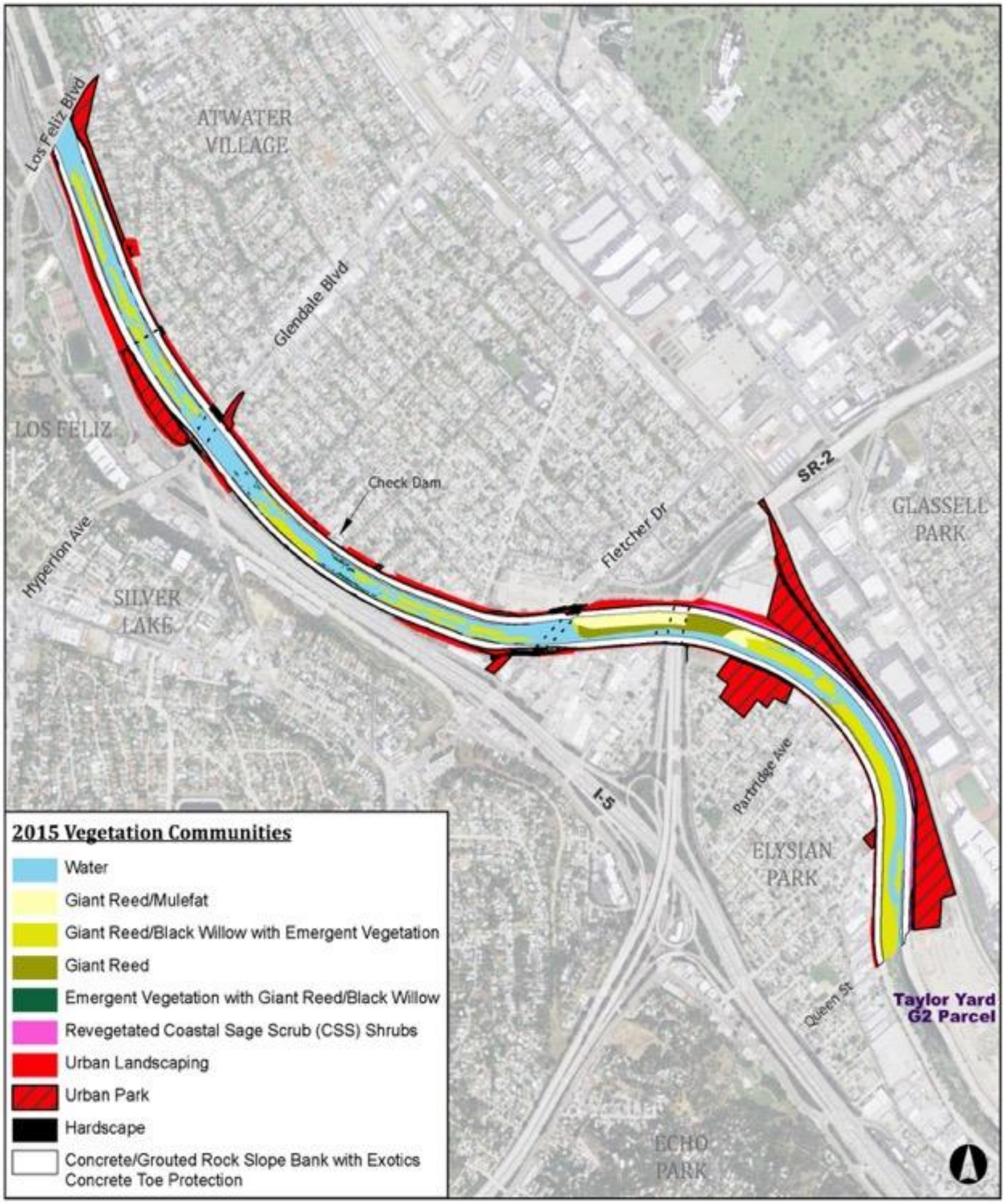


Figure ES-3 Vegetation Communities within the Study Area.

Habitat Enhancement Pilot Project Opportunities

Under current conditions, six project opportunities were identified for the study area that achieve a range of ecological benefits (Table ES-2 and Figure ES-4). These opportunities achieve maximum habitat enhancement value if implemented together, but can also be implemented separately or incrementally as circumstances allow.

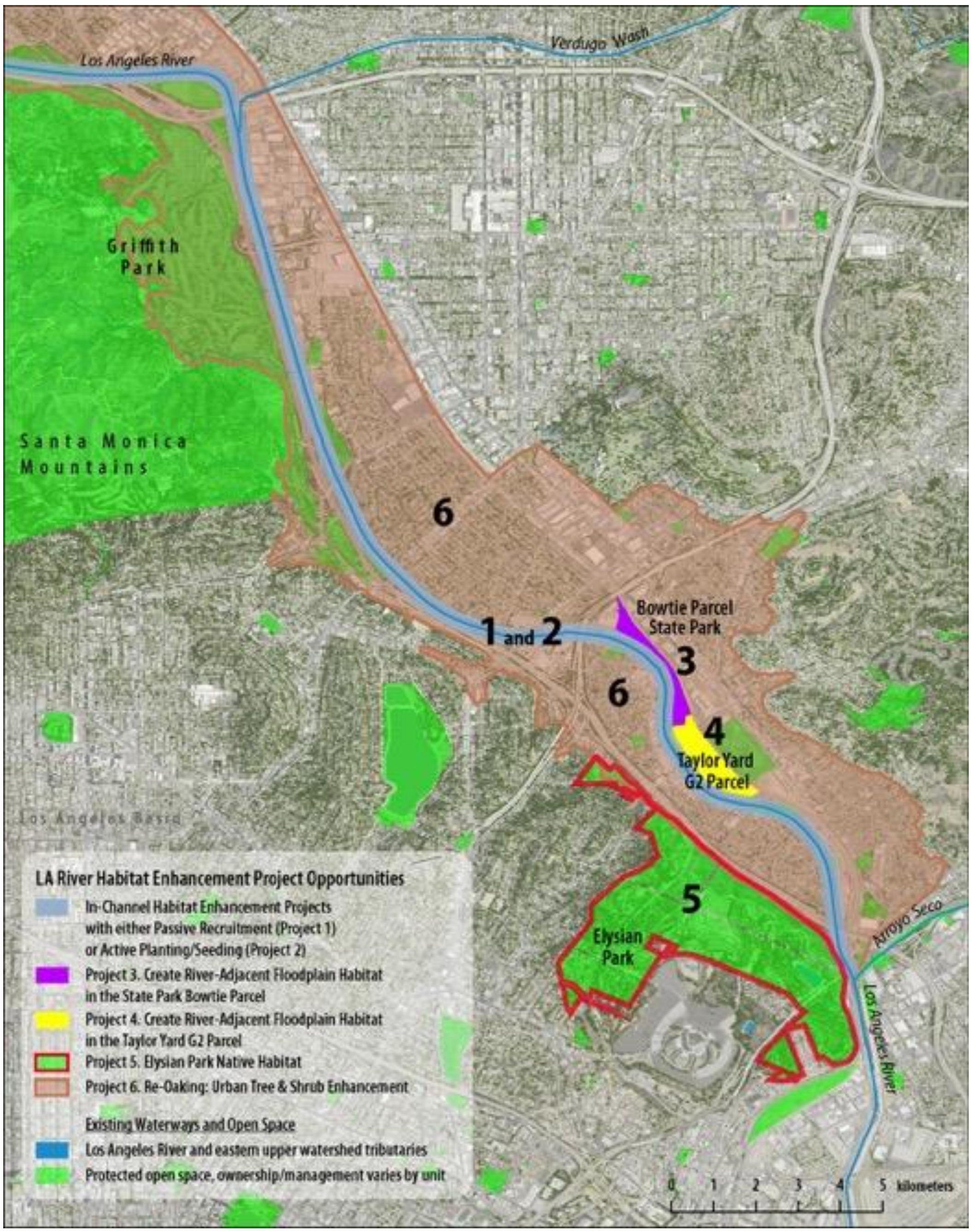


Figure ES-4 Habitat Enhancement Project Opportunities in the Elysian Valley.

Table ES-2 Habitat Enhancement Project Opportunities and expected outcomes under four different Watershed Hydrology Scenarios.

In-Channel Result Compared to Historic Condition	Watershed Hydrology Scenarios **Scenario 1** Existing Condition (1991–Present)	**Scenario 2** Stormwater Capture Focus	**Scenario 3** Effluent Recycling Focus	**Scenario 4** Water Supply & Habitat Resiliency Focus
Stormwater Flow:	Higher Peak Flood	Higher Peak Flood; But, Lower than Existing	Higher Peak Flood	Higher Peak Flood; But, Lower than Existing
Dry Weather Flow:	Higher	Higher	Similar, But Higher Due to Urban Runoff	Similar
Project Opportunities				
In-Channel				
1. In-Channel Habitat Enhancement with Passive Recruitment	5–10 years to control giant reed; passive increases over 3–5 years in quality of existing riparian habitat	Same as Scenario 1, but possibility of cleaner urban runoff inputs leading to higher quality aquatic habitat	3–5 years to control giant reed; passive increases over 3–5 years in quality of existing riparian habitat	Same as Scenario 3, but likely faster giant reed control, & reduced threat of scouring flows during plant establishment period
2. In-Channel Habitat Enhancement with Active Planting/ Seeding	5–10 years to control giant reed; increases in quality of existing riparian habitat in 1–3 years	Same as Scenario 1, but possibility of higher quality aquatic habitat; & reduced risk of scouring flows during plant establishment period from large storm	3–5 years to control giant reed; increases in quality of existing riparian habitat in 1–3 years	Same as Scenario 3, but likely faster giant reed control, & reduced threat of scouring flows during plant establishment period
Outside Channel				
3. Create River-Adjacent Floodplain Habitat in the California State Parks Bowtie Parcel	1–3 years of weed control; over 3–5 years increases in quality of adjacent in-channel riparian habitat and creation of high quality floodplain scrub habitat	Same as Scenario 1, but more funding opportunities for creating ephemeral wetland habitat on-site that also provides stormwater capture	Similar to Scenario 1	Same as Scenario 2, with higher biodiversity supported by higher quality, complementary in-stream habitat
4. Create River-Adjacent Floodplain Habitat in the Taylor Yard G2 Parcel	1–3 years of weed control; over 3–5 years increases in quality of adjacent in-channel riparian habitat and creation of high quality floodplain scrub habitat	Same as Scenario 1, but more funding opportunities for creating ephemeral wetland habitat on-site that also provides stormwater capture	Similar to Scenario 1	Same as Scenario 2, with higher biodiversity supported by higher quality, complementary in-stream habitat
5. Elysian Park Native Habitat Enhancement	Higher quality upper terrace and upland habitat, providing complementary ecosystem services and habitat for riparian wildlife in 3–5 years, & engage local community	Same as Scenario 1, but more funding opportunities related to stormwater capture projects	Same as Scenario 1	Same as Scenario 2

6. Re-Oaking: Urban Tree & Shrub Enhancement	Increase oak woodland canopy for benefit of wildlife over 1–10 years Public engagement	Same as Scenario 1, but more funding opportunities related to stormwater capture projects	Same as Scenario 1	Same as Scenario 2

Chapter 1. Introduction

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. Scientists project that by the year 2050, the world's population will reach 9 billion people. Two-thirds of that population will be city dwellers. As more people concentrate in cities, they will need access to fresh water, clean air, and natural open spaces, putting tremendous pressure on the natural resources that cities already use. The Nature Conservancy aims to address not only how these resources can be sustainably provided, but how they will be managed.

Los Angeles is a priority for urban wildlife conservation. Los Angeles is both the most populous county in the United States and a biodiversity hotspot. It is located within the California Floristic Province (Mediterranean climate region), one of only 35 in the world (Conservation International 2016). The population in the County is expected to increase from 10 million to 12 million over the next 50 years, in an already highly urbanized landscape. Despite the high level of urban development in Greater Los Angeles, ecologically significant habitat remains and faces the threats of future development, climate change, degradation of ecosystem functions and the impacts of invasive species.

The Los Angeles River has become a focus for tackling issues of ecosystem restoration, economic revitalization, open space recreation and water management. The City of Los Angeles has recognized these challenges in their comprehensive Sustainable City pLAn (2015), which includes the following goals:

- **Protect and Support Biodiversity:** Develop a city biodiversity strategy by 2017.
- **Water Conservation:** Reduce imported water purchases by 50% by 2025 and provide 50% of the water supply from local sources by 2035.
- **Los Angeles River Revitalization:** Complete 32 miles of public river access within the City of Los Angeles by 2025; and complete or initiate restoration work on 8 "reaches" identified in the Area with Restoration Benefits and Opportunities for Revitalization (ARBOR) Study by 2035.

As The Nature Conservancy [Conservancy] engages with the Los Angeles region, they are investigating what it means to conserve nature with the environmental threats of the 21st Century in the highly urbanized Los Angeles River ecosystem. As a starting point, it is known that the basic ecological principles of science apply to all environmental systems. Therefore, the Conservancy is testing the application of these principles in the Elysian Valley of the Los Angeles River by identifying habitat enhancement requirements, opportunities, and constraints.

1.1. Definition of Ecological Restoration

Ecological restoration is defined by the Society of Ecological Restoration (2004) as the "process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed." In general, the term "restoration" in an aquatic system means reversing the effects of past development to restore features of the historic watershed condition, such as replicating a past hydrologic regime or re-creating the historic riparian zone (Shabman 1996).

With respect to the Los Angeles River, attempts to stabilize and develop the historic floodplain had begun by the late 1800s.Following devastating floods in the early 1900s, there was economic incentive and public pressure to build a flood control system and channelize the River in Los Angeles County (Grumpecht 1999). Through Acts of Congress beginning in 1935 through 1958, in cooperation with the local Los Angeles County Flood Control District (LACFCD), the United States Army Corps of Engineers (Army Corps) constructed the flood control system in the County. Operation and Maintenance for the Los Angeles River is performed by Army Corps (Army Corps, 1999). Traditionally, the Army Corps mission was to promote economic prosperity through construction of dams, channels and ports. Today, ecosystem restoration is part of the Army Corps' environmental mission to restore significant ecosystem function, structure, and dynamic processes that have been degraded, damaged or destroyed. In 2013, Army Corps completed the *Los Angeles River Ecosystem Restoration Integrated Feasibility Report*, which complements and utilizes the *Los Angeles River Revitalization Master Plan* (1996), and focuses on restoration alternatives for riparian and wetland restoration in an approximately 11-mile reach from the Los Angeles City Headworks site to First Street in downtown Los Angeles.

Ecosystem Restoration Planning Objectives developed by Army Corps for the Feasibility Study include:

- Restore riparian habitat
- Establish habitat connectivity to the historic floodplain
- Restore aquatic habitat
- Restore more natural hydrologic and hydraulic processes in the alternative reach
- Provide recreation where appropriate

Additional planning objectives were identified that may be used as measurable surrogates for some of the broader objectives above:

- Decrease peak discharges
- Improve water quality
- Improve infiltration and discharge

Constraints identified by Army Corps include:

- No increase in flood risk
- Existing infrastructure (e.g. LA Department of Water and Power electrical transmission lines share the LACFCD easement right-of-way)
- Competing land use
- Water availability
- Hazardous, toxic waste (e.g. Taylor Yard soil)
- Levee regulations
- Cultural and historic sites

After evaluating 21 alternatives for the Los Angeles River Ecosystem Restoration Plan, the Los Angeles District of Army Corps selected Alternative 13 as the preferred alternative. Following the study, the City of Los Angeles requested reconsideration of Alternative 20, which was subsequently accepted and approved. Alternative 20 involves a larger ecosystem restoration area footprint (719 acres in contrast to 588 acres for Alternative 13).

The Army Corps Feasibility Study identified significant ecosystem restoration opportunities; however, because of the particular organization circumstances of Army Corps, the limits of agency jurisdiction, and their restoration program policy that requires a water “nexus” for projects (i.e. terrestrial restoration is not an Army Corps mission), the Feasibility Study was constrained from adopting a broader watershed planning perspective for defining restoration objectives.

For example, the Feasibility Study baseline design condition for dry weather flow in the River is based on existing conditions. Most of the dry weather flow in the River is from three wastewater reclamation plants (WRPs) upstream of downtown Los Angeles. Army Corps does not have jurisdiction over these watershed inputs to dry weather condition, and hence their planning process is necessarily constrained. While the Feasibility Study assumes a commitment from the local municipalities, including the City of Los Angeles, which operates two of the WRPs (LA-Glendale and Tillman), to maintain status quo discharge conditions, competing pressures for water conservation may reduce those dry weather discharges in the future. The City has set goals to drastically reduce its reliance on imported water, and the current discharges from WRPs may have a higher and better use as recycled water, thereby reducing water imports in the City. Given the anticipated effects of climate change, which are expected to increase aridity in the west, there may be both greater demand for local sources of water and reduced supply of imported water. This is an example of a watershed issue that may directly impact the valuation of Alternative 20, which is not currently considered in the planning process. If future dry weather discharges are lower than the existing condition, how might this affect the sustainability, resilience and health of riparian habitat?

It is clear that there are significant constraints to ecosystem restoration in the Los Angeles River watershed. Even as The Nature Conservancy recognizes the Army Corps’ institutional definition of “restoration,” within the field of ecological restoration, the term restoration is commonly used for returning a habitat or ecosystem to a pre-existing condition or as close to that condition as possible. Because of the project constraints identified in the Feasibility Study, most notably the need for continued flood protection and extensive development of the historic floodplain, it is not possible to recreate the historic hydrological conditions necessary for resilient and sustainable native floodplain habitat.

Conversely, “habitat enhancement” is a term that recognizes that the existing habitat differs significantly in proportion and type from the historic condition, and that by better understanding the historical ecology of the area, opportunities to replicate the historic hydrological regime in innovative ways can be identified. Habitat enhancement can occur in an existing aquatic, riparian or complementary transitional terrestrial habitat to increase the value of the ecosystem for target wildlife species (e.g. territorial riparian bird species that need a diversity of habitats, including uplands along the riparian corridor). A new floodplain habitat can be created in places it did not historically occur (i.e. in the upland terraces that are now stabilized and filled, but were historically active alluvial floodplain material).

1.2. Study Purpose and Deliverables

The purpose of this study is to investigate the historic and existing conditions of a reach of the Los Angeles River corridor in the Elysian Valley, north of downtown Los Angeles. The study identifies project opportunities to enhance the existing ecological value of the study area, and how to use these opportunities as pilot projects that can support and inform the success of other large scale revitalization efforts throughout the region, including Alternative 20 of the Army Corps *Los Angeles River Ecosystem Restoration Integrated Feasibility Report* (IFR) and the City of Los Angeles River Revitalization Master Plan.

The deliverables of this study are as follows:

1) New data sets for the biodiversity and value of the existing habitat in the Study Area for native, naturalized, non-native and migratory taxa/species.
2) Identification of habitat enhancement opportunities in the Study Area that complement and inform the design and implementation of current and future Los Angeles River revitalization projects. (e.g. ARBOR Study, LA River Master Plan, City of LA Mayoral Executive Directive No. 5).
3) Identification of four alternative watershed hydrology scenarios that result from different stakeholder and infrastructure planning processes. The presence of multiple hydrologic scenarios at the system scale reduce the certainty needed for establishing project level design parameters in areas like the Elysian Valley. The existing alternatives were identified to support a future dialog among stakeholders that could ultimately lead to a consensus as to the most advantageous one. Identifying a common vision for the hydrological system as a whole would simplify the project implementation process for all the stakeholders in the region and enable a much greater level of collaboration and "Collective Impact" for the Region's social, economic and ecological systems.

The new data sets that were collected build on the previous research and planning efforts for revitalization of the Los Angeles River in the Elysian Valley and are as follows:

- Species occurrence data for insects, avifauna, herpetofauna and mammals from a yearlong survey period (2014–2015).
- Vegetation community mapping and relevant habitat data (e.g. canopy structure, substrate) based on field surveys and imagery analysis.
- Historical ecology of the riparian zone of the Elysian Valley.
- Review of the hydraulics of the existing conditions and identification of crucial data gaps for further development of in-channel habitat restoration planning.
- Analysis of the historic hydrology and components of dry weather (non-flood) flow, which is important for understanding the appropriate in-channel baseline and target habitat restoration and enhancement conditions.
- Quantification of land cover change, low flow stream morphology and the conversion of native riparian vegetation communities following urban development and flood protection measures, including channelization of the River.

Biological and restoration ecology experts reviewed both the new data sets and existing sources of information to identify key habitat enhancement project opportunities to improve the function and value of habitat in the study area. The assessment is presented in this report as follows:

- Chapter 2: The Historical Ecology of the Los Angeles River Riparian Zone in the Elysian Valley investigates and reconstructs the historic floodplain habitat and wildlife in the late 1800s. The Historical Ecology informs the identification of ecologically appropriate habitat enhancement opportunities by describing associations between the historic floodplain vegetation communities, geomorphic features of the River, and hydrologic regimes.
- Chapter 3: Hydrology and Hydraulics, analyzes the available data for the study area influencing both dry weather and stormwater flow conditions. Data sources include data developed for the Army Corps IFR, gauge data from the Los Angeles Department of Public Works and discharge records compiled by the Upper Los Angeles River Area (ULARA) Watermaster Annual Reports.
    - Chapter 3 recognizes the uncertainty of watershed management planning, and therefore, identifies four possible watershed hydrology scenarios (i.e. alternate dry weather and peak flood flow outcomes) to guide the evaluation of habitat enhancement project opportunities. A common narrative for the entirety of the Los Angeles River and its watershed is needed in order to enable partnership and coordinated “collective impact” for the work of all stakeholders at the project level.
- Chapter 4: Biota of the Los Angeles River in the Elysian Valley, presents the results of biological surveys of current species occurrence and habitat use, conducted for one year (fall 2014 to fall 2015). Changing ecological conditions, in response to hydrologic and land use changes, are discussed for vegetation and faunal groups.
- Chapter 5: presents Habitat Enhancement Opportunities in three areas: watershed-scale hydrology planning for reduced dry weather flow to mimic historic condition; in-channel projects to enhance existing riparian and aquatic habitat by invasive plant removal with planting as needed; and, projects outside of the channel to enhance and create transitional riparian, floodplain and complementary terrestrial habitat.
- Chapter 6: Habitat Enhancement Specifications, outlines an adaptive management approach to invasive species control and enhancement of native habitat for both in-channel riparian habitat and adjacent, out of channel floodplain scrub habitat.

1.3. Study Area

The study focuses on the Elysian Valley of the Los Angeles River, from Los Feliz Blvd to the upstream edge of the Taylor Yard G2 Parcel (see Figures 1-1 and 1-2). The Elysian Valley was selected for this habitat enhancement effort in part because of the ‘soft bottom’ channel. It was not lined with concrete because of rising groundwater. The Elysian Valley is currently vegetated and provides some existing riparian habitat and recreational opportunities.

The ‘soft bottom’ substrate is primarily sand, cobble and boulders. Channel bars have formed in the channel bottom as sediment and substrate material have been reworked following high flow storm events. The establishment of vegetation on these channel bars, as well as sections of the River with lower slopes or obstructions that reduce the velocity of water (e.g. bridge supports, check dams), contribute to sediment deposition and growth of channel bars.

Figure 1-1 Regional location of study area. Green parcels are selected open space; ownership/management varies.

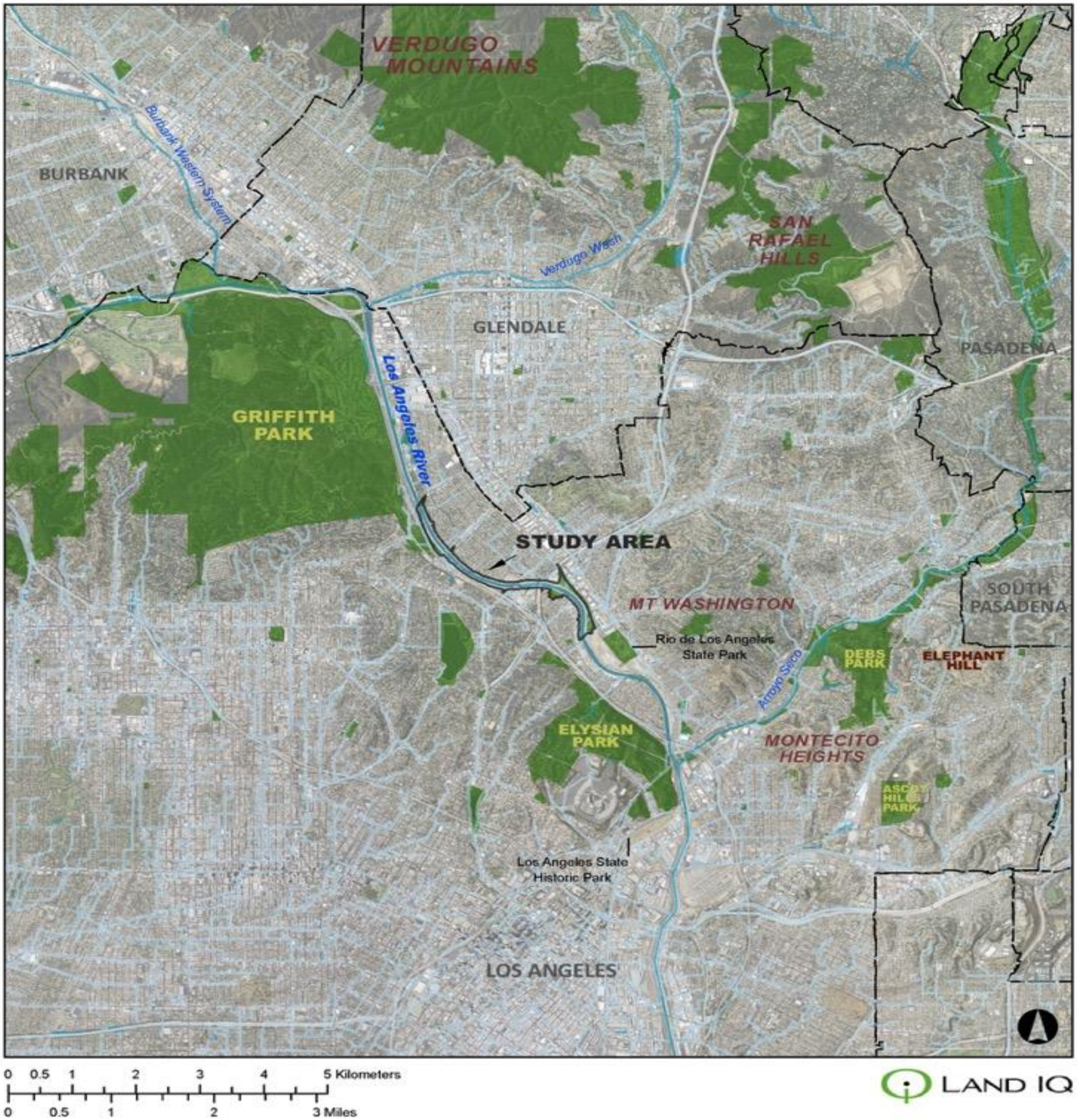


Figure 1-2 Study area extent.

Some of the trapezoidal channel, 3:1 slope bank (33.5% incline) is classified as a levee, protecting adjacent low-lying urban areas. However, USACE is currently reclassifying some of the levee structures as they have been backfilled in areas since originally constructed between 1938–1941 (e.g. some sections of the right channel bank, or southern side of the channel in the study area, along the Golden State I-5 Freeway constructed in the 1960s). The trapezoidal channel is either concrete grouted rock or concrete slab, with a variable width of concrete toe protection (for the slope bank). The crown (or the flat top of the slope bank) of the channel is either asphalt, or concrete in areas reconstructed for a bike path.

The channel slope ranges from 0.16% (Fletcher Dr. Bridge to Glendale SR-2 Freeway) to 0.56% (Glendale SR-2 Freeway to Partridge Avenue). The width of the channel at the crown (top of the slope) ranges from approximately 96 to 109 meters (315 to 358 feet). The width of the channel at the bottom of the trapezoidal slope ranges from approximately 60 to 67 meters (197 to 220 feet).

Residential, commercial and publicly owned land comprises the urban upper terrace banks outside of the flood control channel. Parks in the study area are listed in Table 1-1.

Table 1-1 Parks in the study area.

Los Feliz Blvd Park (LA City green space)	Acresite Water and Willow Gate
Yoga Park	Crystal Street Bike Park
Mini Sunnynook Park	Rattlesnake Park
Sunnynook Park	Marsh Park
Red Car River Park	Bowtie Parcel
Water with Rocks Gate Park	Elysian Valley Gateway Park

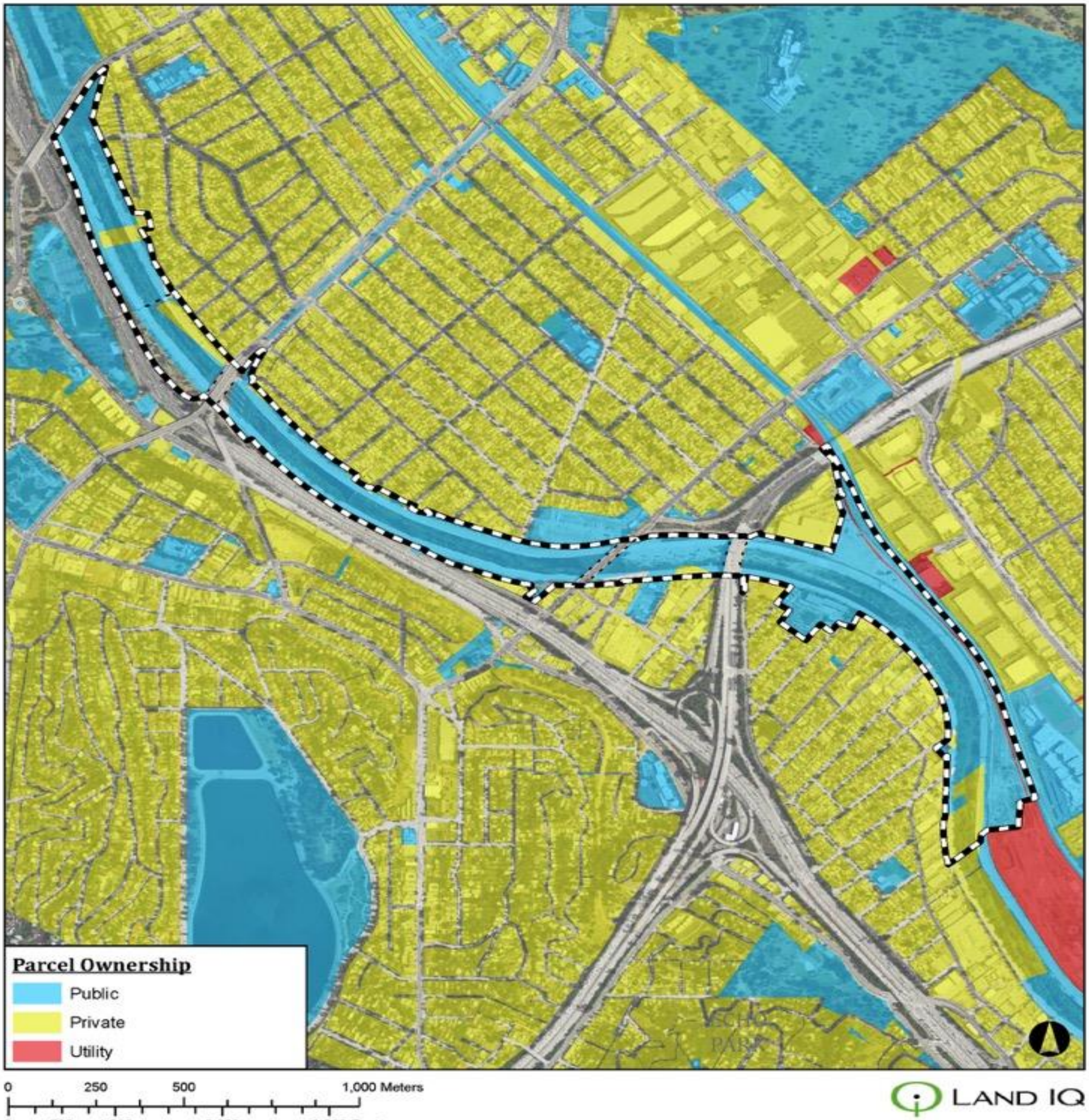
1.3.1. Political Boundaries

The study area is entirely within the City of Los Angeles; however, stormwater flow and non-flood surface flow, as well as subsurface groundwater expressed as rising groundwater in the study area, originates higher in the Los Angeles River Watershed from the San Fernando Valley, including from the cities of Burbank and Glendale.

Two Los Angeles City Council Districts intersect with the study area: District 1 (current City Councilman Gilbert Cedillo); and District 13 (current City Councilman Mitch O'Farrell). Two Los Angeles County Supervisor Districts also bisect the study area: District 1 (current Supervisor Hilda L. Soils); and District 3 (current Supervisor Sheila Kuehl).

1.3.2. Ownership and Management

One hundred four (104) parcels intersect the study area extent (see Figure 1-3). Those parcels are owned by forty-five (45) different private owners and nine (9) different public entities, which are essentially the City of Los Angeles, County of Los Angeles and the State of California (see Table 1-2). The 'soft bottom' channel bottom is owned by three (3) private and five (5) public property owners.



LAND IQ

Figure 1-3 Parcel ownership in the study area.

The Los Angeles River is managed by several agencies and organizations. The USACE and the Los Angeles County Department of Public Works (LACDPW) are responsible for maintenance of the flood control system. Within the study area, USACE is responsible for maintenance.

Table 1-2 Public owners of parcels intersecting the Study Area.

Public Property Owners	Parcels Intersecting Channel Bottom
Los Angeles City	▯
Los Angeles City/Real Estate Business Group	▯
Los Angeles City Department of Water & Power (LA DWP)	▯
LA DWP/Real Estate Business Group	▯
Los Angeles County Flood Control District (LACFCD)	▯
Los Angeles City Parks & Recreation	
State of California, Mountains, Recreation & Conservation Authority (MRCA)	
State of California, Santa Monica Mountains Conservancy (SMMC)	
State of California	

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Chapter 2. Historical Ecology of the Los Angeles River Riparian Zone in the Elysian Valley

2.1. Introduction

The Los Angeles River is emblematic of urban rivers of the twentieth century: a concrete conveyance for water, ecologically degraded, and poorly integrated into the urban landscape. From the notorious fires on the polluted Cuyahoga River in Cleveland to the near-complete channelization of the Los Angeles River, industrialization and intensified urbanization of the 1900s resulted in treatment of many rivers as part of an engineered drainage system at best and ignored at worst.

Concomitant with the ecological awareness growing out of the passage of the major U.S. environmental laws in the 1970s (Clean Water Act, Endangered Species Act, Clean Air Act), protecting and restoring rivers became a focus of civic activity and advocacy. Major river and stream restoration projects were undertaken, such as the Schuylkill River in Philadelphia, the Hudson River in New York, and many other urban streams and rivers. At the turn of the 21st century, the daylighting and re-naturalization of the Cheonggyecheon Creek in Seoul, South Korea demonstrated a global willingness to re-create waterways in even the most disturbed conditions, including those that were nearly obliterated by urban development.

Awareness of the Los Angeles River as a potential site for habitat enhancement has a long history, but one that has lagged efforts in other cities. Friends of Los Angeles River (FOLAR) was founded in 1986, but it was decades later when a master plan for revitalization came to fruition (2007) as an official effort of the City of Los Angeles. One reason for the relatively late start on river restoration includes the near-complete channelization of the River for flood protection and the urban development within the historic floodplain. Since the 1940s, virtually no remnant of the Los Angeles River has been in any condition approaching a natural state, especially given the frequent clearing of vegetation by flood control authorities from the period of channelization through the 1980s and 1990s.

Another potential reason for the late start on habitat enhancement planning is the natural hydrology of the River itself. Los Angeles has a Mediterranean-type climate, with hot, dry summers and cool, wet winters. The particular configuration of the Los Angeles basin, at the base of the substantial height of the San Gabriel Mountains, means that the Los Angeles River is naturally “flashy” in its flows, with huge variation between stormwater flow and dry weather base flow. Further, there is significant variation in the frequency and magnitude of stormwater flow during rain events within a given year and between wet and dry years. The resulting stormwater flood regimes are dangerous and particularly damaging if infrastructure is built in the floodplain. Yet, the broader floodplain of the Los Angeles River is infrequently flooded and therefore does not capture the imagination as being part of a river. This hydrology and the associated semi-arid vegetation communities are unique; therefore, are unfamiliar to the many immigrants from more mesic climates who populated Los Angeles during the boom years after World War II, and earlier following the arrival of the transcontinental railroad (Stein *et al.* 2007).

Together, these two factors—that the Los Angeles River had been confined to a narrow channel with little clue as to its former extent and habitats, and that the nature of the River itself is very different from the cultural understanding of a "river" prevailing in the United States—probably limited appreciation of the potential of the River and still stand as an impediment to ecologically appropriate planning for habitat enhancement and restoration.

The field of historical ecology provides a set of tools by which the nature of a former natural landscape can be investigated and described (Mattoni

and Longcore 1997, Egan and Howell 2001, Grossinger *et al.* 2007, Stein *et al.* 2007, Stein *et al.* 2010). This approach integrates multiple documentary sources, such as maps, textual accounts, photographs, museum records, and soil surveys, to produce a description and map of the natural features, ecological processes, and species diversity that was most likely to have been found in a location. The target period for such reconstructions is as early as is possible using the available documents, with an effort to develop an understanding of a landscape before agricultural or urban development fundamentally undermine ecosystem dynamics (Dark *et al.* 2011).

Reconstruction of historical habitats is not meant to provide a direct roadmap for future management actions. Often ecological processes are so disrupted that this is not possible. But consideration and understanding of the historical ecology of an area can inform and inspire enhancement and restoration efforts, by highlighting habitats that used to exist and are now gone, by identifying plant or animal species that might be the target of enhancement efforts and by creating a connection to and sense of place that might be used to communicate about the need for and purpose of habitat enhancement planning.

This chapter develops a description of the historical ecology of the Elysian Valley portion of the Los Angeles River. This stretch of the River is included in the 2007 Los Angeles River Revitalization Master Plan and in the U.S. Army Corps of Engineers' Los Angeles River Ecosystem Restoration Feasibility Study (2013). Both documents provide discussion of the former character of the Los Angeles River but do not contain a detailed description that might be used to inform habitat enhancement, restoration or creation design. The purpose of this chapter is to synthesize many historical data sources available about the Los Angeles River in the Elysian Valley and to characterize the distribution, dynamics, and diversity of the habitats that were found there prior to agricultural conversion in the late 1800s.

The chapter describes the methods for data search and acquisition, the archives and databases queried, and the integration of these sources in a Geographic Information System (GIS). The results of those investigations are presented by information source. Then, a section synthesizing the various data sources is offered, building from the hydrology and resulting topography and soil distribution, to predictions about the extent of various riparian-associated vegetation communities. Finally, ideas about the use of this information in developing ecologically appropriate habitat enhancement, restoration and creation plans are discussed.

2.2. Methods

Large historical ecology projects often involve multi-institution teams with multi-year timelines (Stein *et al.* 2007, Beller *et al.* 2011, Dark *et al.* 2011, Beller *et al.* 2014). The timeline and personnel available for the current project required concentration on local archives that are most likely to yield significant resources and on the available and growing digital archives that cover the topics and locations under investigation. Researchers developed and searched a set of databases and archives and then integrated the results by developing and acquiring data layers in a GIS.

Study Area

The first step of the project was to define the study area for the historical ecology study. This study area is larger than the underlying biological survey area so that some landscape context can be developed for those specific plans. The study area is defined by the extent of a subwatershed in the National Hydrography Dataset and extends roughly from the confluence of the Arroyo Seco with the Los Angeles River northward through the Elysian Valley, and just downstream from the confluence with Verdugo Wash (see Figure 2-1). The watershed contributing to this stretch of the River was included for the purpose of obtaining materials that might include information about the River.

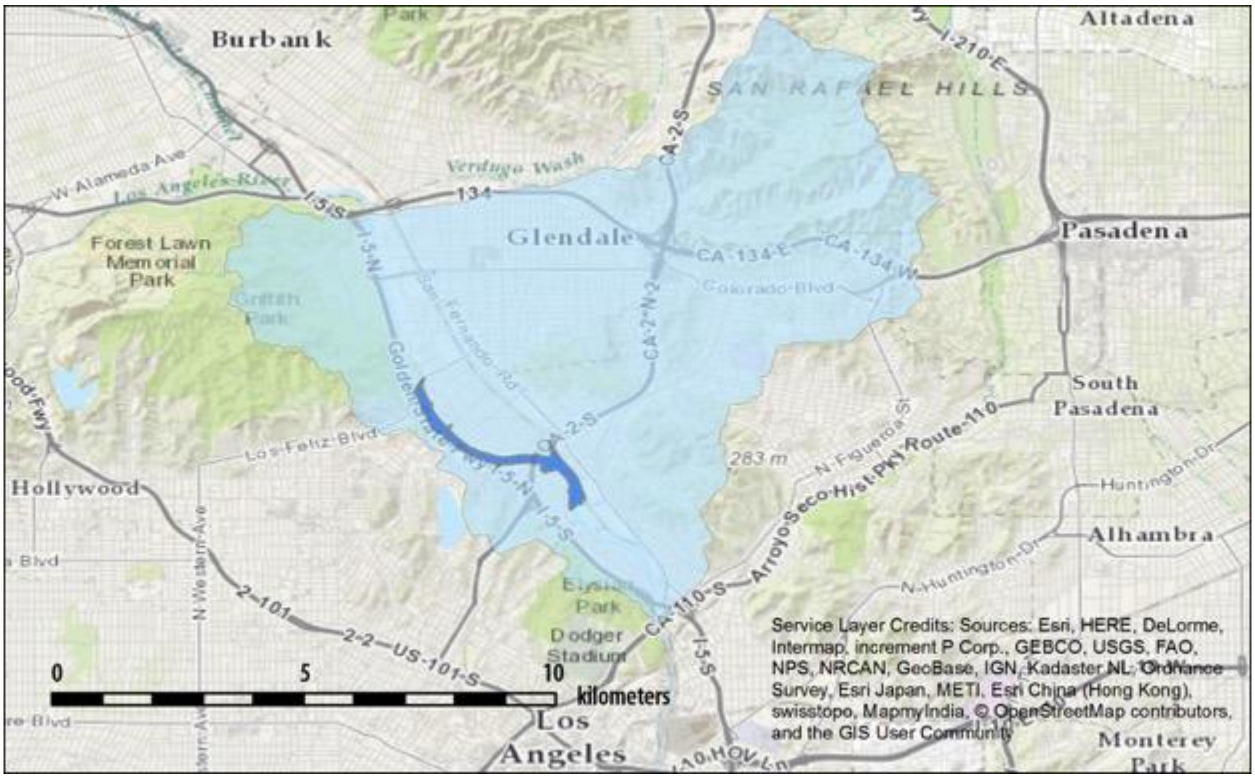


Figure 2-1 Historical ecology study area (light blue) relative to the project design area (dark blue).

Databases and Search Strategies

Georeferenced copies of the earliest U.S. Geological Survey topographic maps of the area were obtained. These maps are available online at http://historicalmaps.arcgis.com/usgs, but versions that had been georeferenced at California State University Northridge were used instead due to the high accuracy of their georeferencing. All place names on the topographic maps within the study area were then extracted and compiled as a list. Then the various archives were searched for images or maps that included these terms in the description.

The following digital databases were searched:

- USC Digital Archives
- UCLA Digital Archives
- Los Angeles Historical Society, with special attention to the archive of bridge photographs archived there by Anna Sklar
- California State University Northridge
- Huntington Library

Photographs and maps from these archives were collated and reviewed for information about the river course and vegetation within the study area. In particular, the 1897 Topographical Map of Los Angeles River by Compton and Dockweiler was acquired, georeferenced, and digitized.

The geographic finding aids at the UCLA Ben and Gladys Thomas Air Photo Archives were used to sort through all photographs taken before 1940 (coinciding with channelization) for each of the areas intersecting with the study area.

Georeferenced digital copies of the following were also obtained from the California State University Northridge: Alkali Map (1903; U.S Department of Agriculture, Bureau of Soils), Alkali Map (1905; U.S. Department of Agriculture, Bureau of Soils), Soil Map, California, Los Angeles Sheet (1916; U.S. Department of Agriculture, Bureau of Soils), Soil Map, California, Reconnaissance Survey—Central Southern Area—Western Sheet (1917; U.S. Department of Agriculture, Bureau of Soils), Plat of the Ex Mission de San Fernando finally confirmed to Eulogio de Celis (1871; W. P. Reynolds, Surveyor), survey points and notes from the General Land Office survey of Los Angeles, and a Draft Irrigation Map (1880; W. Hall, Office of the State Engineer). A set of 1928 orthogonal aerial photographs extending about halfway up the study area for review were also obtained.

Museum Records

All of the digitized herbarium records available from the state clearinghouse (Jepson Interchange) for the County of Los Angeles were obtained for plants. Because these records contain many spelling errors and the locations are not reported in a standardized manner, they were sorted manually (100,382 records) to extract those records from the study area and to exclude non-native species, leaving 15 records of native species that could be tied to this particular stretch of the Los Angeles River or nearby reaches (see Appendix A). Records were identified as being in the study area by comparing the location information with place names on current and historic maps of the area. These were updated with current nomenclature, sorted into families, and coded with the standard U.S. Fish and Wildlife Service codes for wetland indicator status.

The Western Foundation for Vertebrate Zoology provided bird nest and egg set records for a suite of riparian indicator species in Los Angeles County: Black Phoebe, Common Yellowthroat, Song Sparrow, Black-headed Grosbeak, Least (Bell's) Vireo, Yellow Warbler, House Wren, Yellow-billed

Chat, Willow Flycatcher, Western Wood-Pewee, Song Sparrow, Barn Swallow, and Cliff Swallow (See Appendix B). Region and nest condition notes were consolidated from these records as indicators of riparian vegetation.

GIS Synthesis

The spatially referenced maps and photographs were consolidated in ArcGIS 10.3. Key river features from a suite of different maps and time periods were then digitized, including the soils map for three riparian-associated soil types, the main channel of the Los Angeles River on many maps, and the land cover from the 1897 map of the Los Angeles River. Researchers also developed a database of locations for many of the orthogonal and ground-level photographs in order to compare them with the maps. Herbarium specimens were not added to the GIS because the resolution of the locations was not sufficient to represent them with the desired precision.

2.3. Results

Climate in Los Angeles at the turn of the 20th Century was a classic Mediterranean-type climate, with precipitation exceeding potential evapotranspiration from November to April, and drought conditions in place from April to November (Mesmer 1904) (Figure 2-2). Furthermore, unlike present day Los Angeles, which has increased temperatures from the urban heat island effect, late 1800s Los Angeles was subject to killing frosts between mid-November through late March and in some years through late April (Mesmer 1904). With the exception of "Hollywood" and other "well-protected" localities, citrus could not be grown because of frost (Mesmer 1904). Therefore citrus production was limited to slopes on the alluvial fans of the foothills, while other crops were grown in the lower valleys and depressed areas where frosts were more common (Nelson et al. 1919).

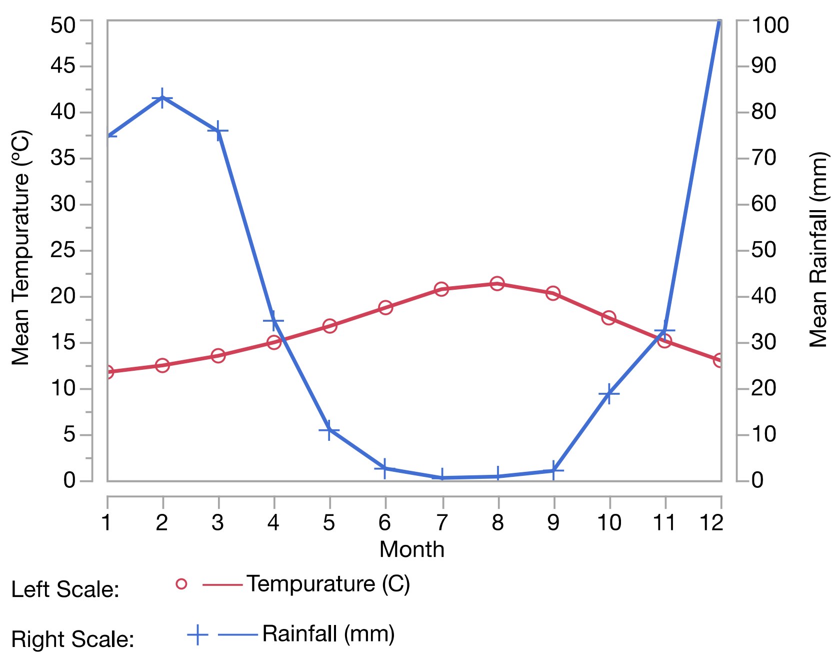


Figure 2-2 Climate diagram constructed from pre-1903 measurements of rainfall and temperature (Mesmer 1904).

This rainfall pattern resulted in a condition where all drainages to the main two rivers of the region, Los Angeles and San Gabriel, were described as "intermittent" (Nelson *et al.* 1919). Furthermore, the summer drought and significant winter rains led surveyors to remark that these two rivers experienced "very great changes in volume, becoming practically intermittent in stretches of very sandy channel during the dry season" (Nelson *et al.* 1919). The entire Los Angeles and San Gabriel River system, once out of the mountainous regions, were building up with sediment at the time of early soil surveys (Mesmer 1904, Nelson *et al.* 1919). This made the rivers subject to frequent movement during flood conditions, with associated deposition of large quantities of sediment (Nelson *et al.* 1919, Stein *et al.* 2007, Stein *et al.* 2010).

The dynamic riparian zone of the Elysian Valley is depicted as a wide channel in an 1871 map of the Los Angeles River along the northern border of the Santa Monica Mountains (then called the Providencia Mountains). The channel moves to the east as it does today and is intersected by a series of washes from the north (Tujunga Wash and others). As the River veers southward into the Elysian Valley, it follows a course quite close to the current pathway (Figure 2-3).

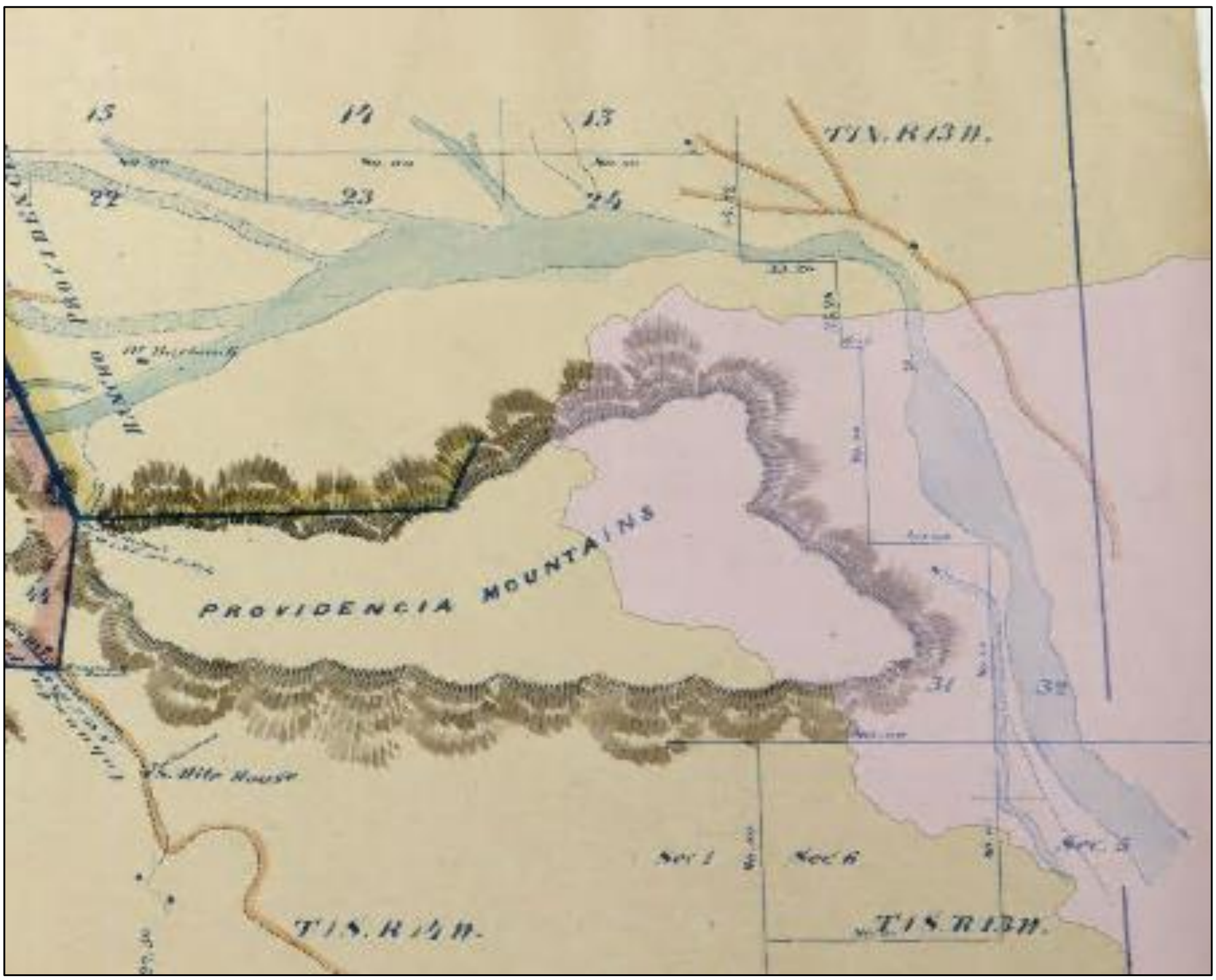


Figure 2-3 Detail of survey of San Fernando Valley extending into Elysian Valley (1871).

An irrigation map of a large portion of Los Angeles and environs is available from 1880 (Figure 2-4). Here too, the floodplain of the Los Angeles River through the Elysian Valley is visible, with the railroad line that skirts the River to the east.

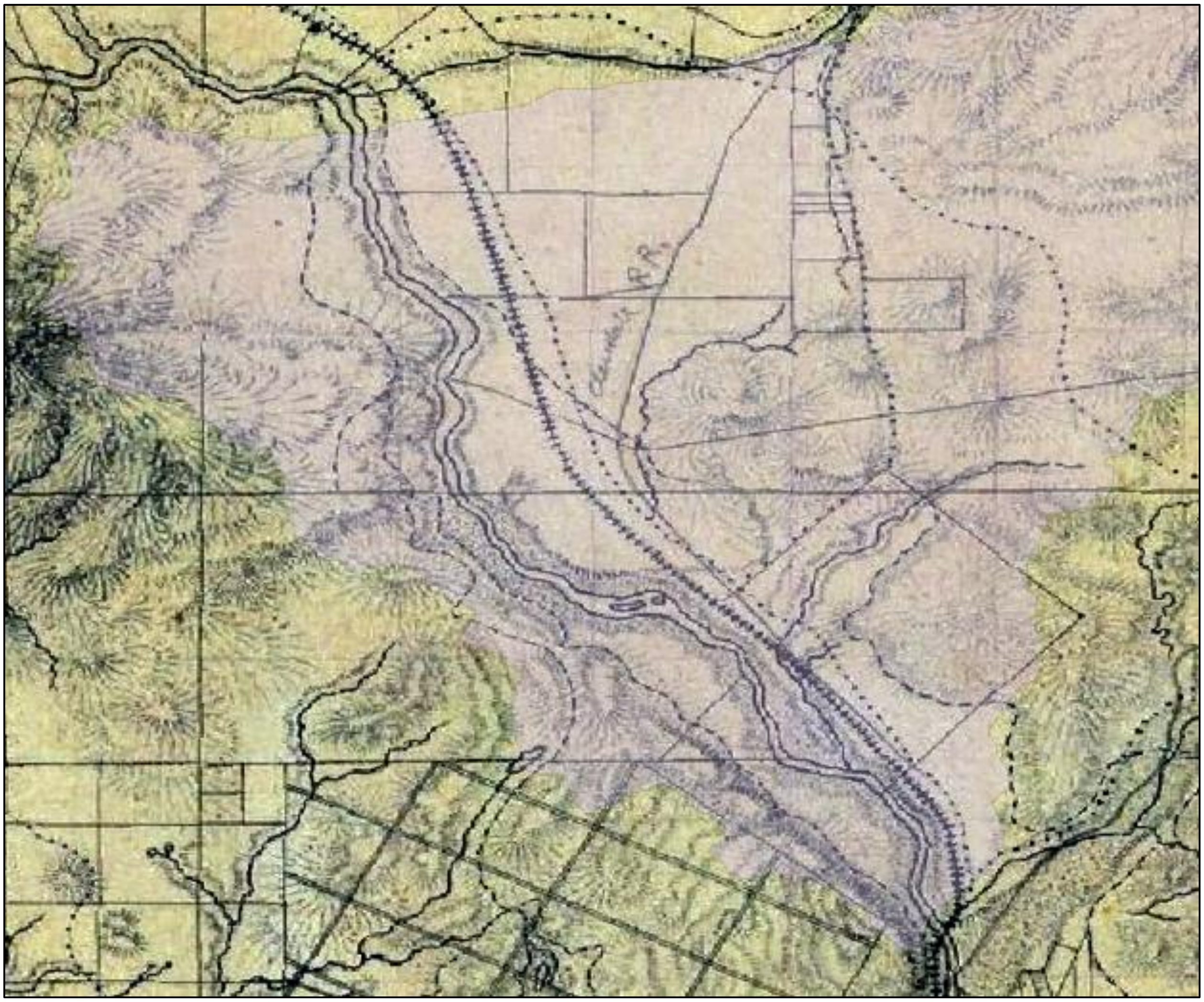


Figure 2-4 Elysian Valley from 1880 draft irrigation map by William Hall.

The most significant historical map from an ecological perspective is the Dockweiler Compton map from 1897 (Figure 2-5). The four sheets of this map provide a detailed record of the land cover and land uses from the confluence of the Arroyo Seco and the Los Angeles River upstream through the Elysian Valley and into the San Fernando Valley to the confluence with Tujunga Wash.

Figure 2-5 First section of the 1897 Compton and Dockweiler topographic map of the Los Angeles River. North is to the left.

By 1894, the rail line still demarcated the extent of urban development from the east (all major roads are east of the railroad), and the road on the west side of the valley exactly hugs the base of the Santa Monica Mountains (Figure 2-6). A few scattered structures are mapped in the valley, but no substantial infrastructure, with the exception of the road crossing at Los Feliz Boulevard, which would be the future site of the Tropico Bridge (Los Feliz Boulevard Bridge).

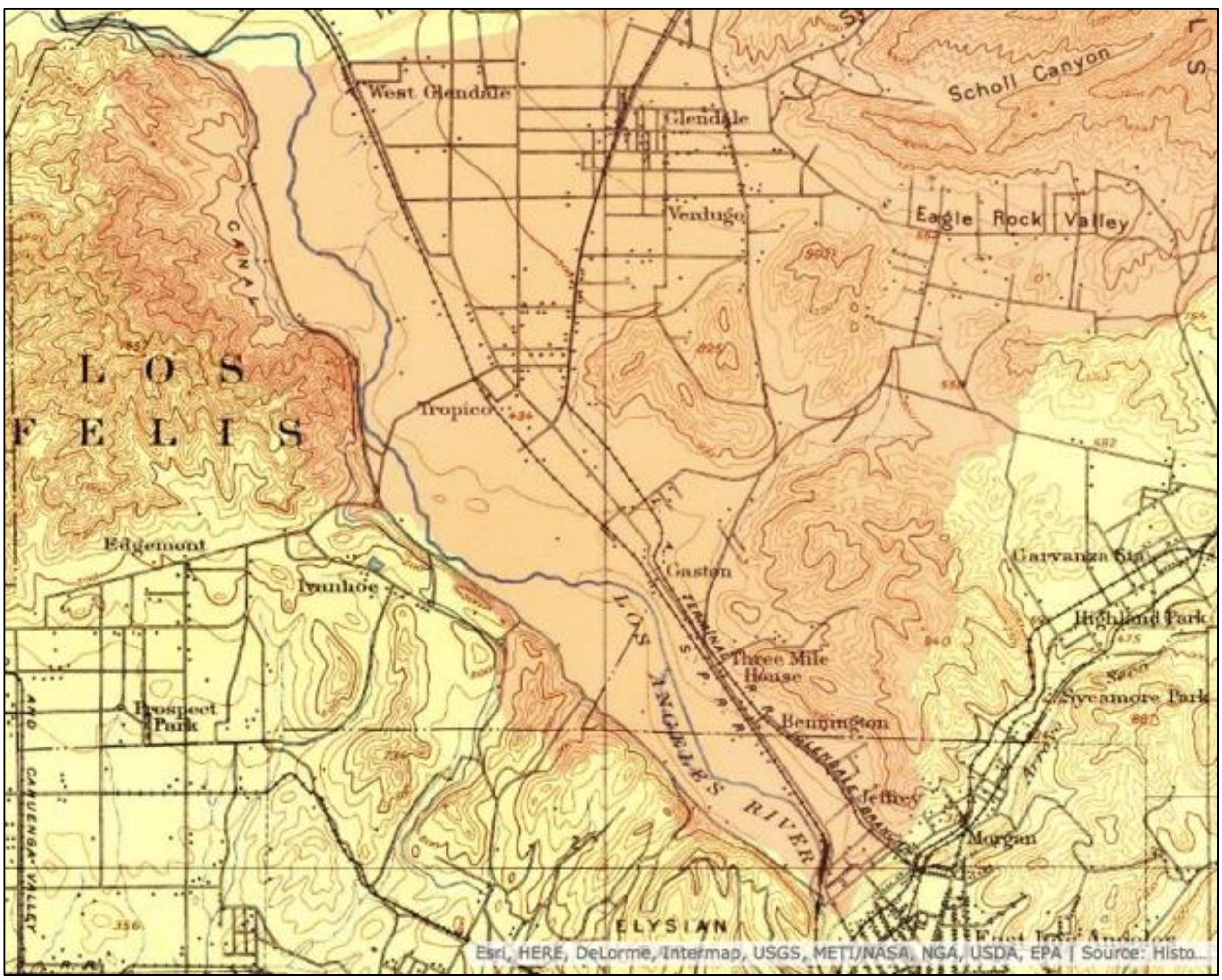


Figure 2-6 USGS topographic map (1:62,500) from 1894.

Soil Survey

Two soils maps are available from the early 1900s for the Elysian Valley. The first dates from 1903 and depicts soils on an 1897 topographic base (Figure 2-7) and the second was mapped in 1916 (Figure 2-8) and documented in a 1919 report (Nelson *et al.* 1919).

The soils associated with the modern course of the Los Angeles River in the Elysian Valley are of the Tujunga series immediately adjacent to the active river channel (Nelson *et al.* 1919). These soils are derived from granitic rocks and are accumulating through deposition. They have low organic content and may have layers of different textures in the subsurface strata (Nelson *et al.* 1919). Both Tujunga Fine Sandy Loam and Tujunga Fine Sand are found adjacent to the channel in Elysian Valley. To the east of the channel, Hanford Fine Sandy Loams are also found. These soils are recent alluvial deposits from granitic and schistose rock (Nelson *et al.* 1919). They are characteristic of recently built stream terraces and contain moderate to low organic content. They differ from the Tujunga series in their brown, as opposed to gray, color (Nelson *et al.* 1919). The final soil type associated with the River is riverwash, which is coarse sand and gravel up to a depth of six feet (Nelson *et al.* 1919). The soil was loose, porous, and had no agricultural value (Nelson *et al.* 1919). "Vines and willows gradually encroach on the stream beds" following flood events (Nelson *et al.* 1919).

Floods from the River would have extended farther out into other soil phases, in particular the Hanford Sandy Loam, which was described as "well drained but subject to overflows, which occasionally do some damage" (Nelson *et al.* 1919). These soils have a high water table when in lower, flatter areas that historically allowed for irrigation by pumping (Nelson *et al.* 1919).

Hanford Fine Sandy Loam, when occurring near streams, is described as supporting "scant to heavy growth of willow, brush, and vines" (Nelson *et al.* 1919). Where soils had accumulated alkali, the native vegetation consisting of "salt grass and other alkali-resistant plants" (Nelson *et al.* 1919). Alkali maps and generalized soil surveys indicate that the areas with harmful accumulation of alkali were extensive.

The Tujunga Fine Sand is found in low-lying areas that are subject to overflows, and was "confined to low areas along the Los Angeles River, the Rio Hondo, and the San Gabriel River. It usually borders the river banks and grades into soils of the Hanford series lying back from the streams." Water infiltrates through the soil so little alkali accumulates. The native vegetation is described as "a moderate growth of willow and vines" (Nelson *et al.* 1919).

Tujunga Fine Sandy Loam occurs in "several narrow strips along the Los Angeles River to its junction with the Arroyo Seco" (Nelson *et al.* 1919). In most instances it is intermediate between the Tujunga Fine Sand and Hanford Fine Sandy Loam on the east banks, and abuts the outcroppings of the Santa Monica Mountains on the west.

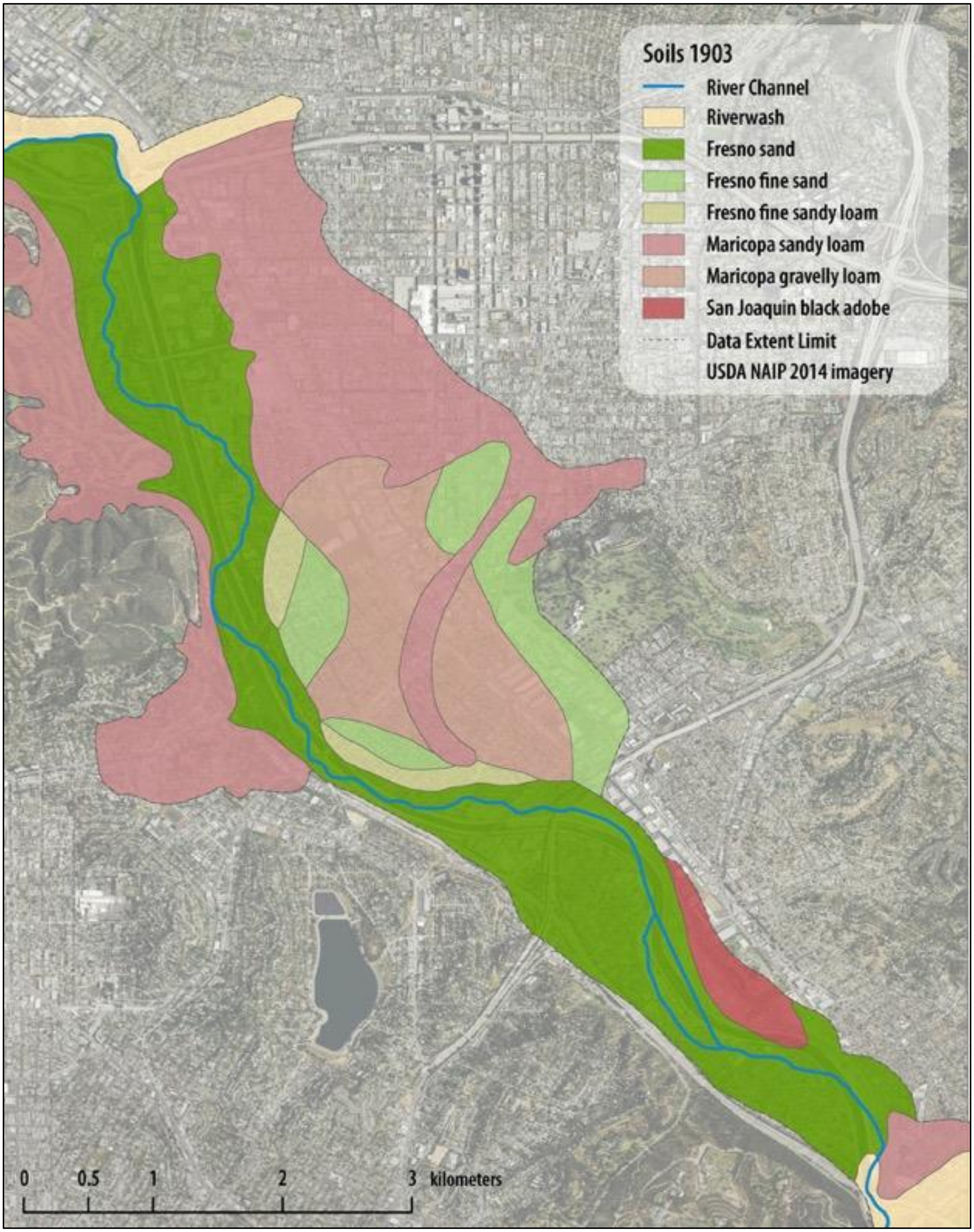


Figure 2-7 Riparian-associated soils in the Elysian Valley as mapped in 1903.

Note: Riparian-associated soils continue beyond area of focus west into the San Fernando Valley and south from the study area.

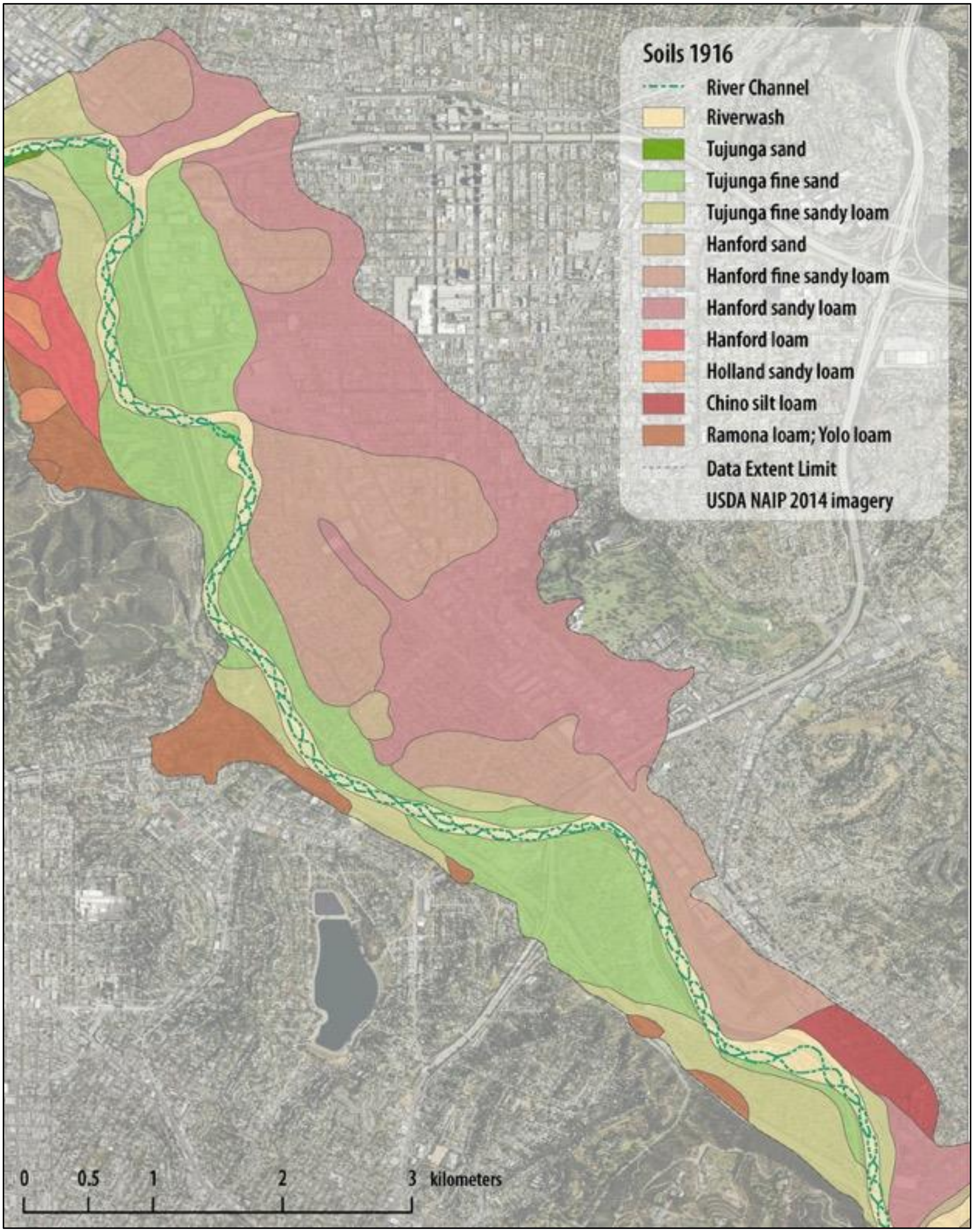
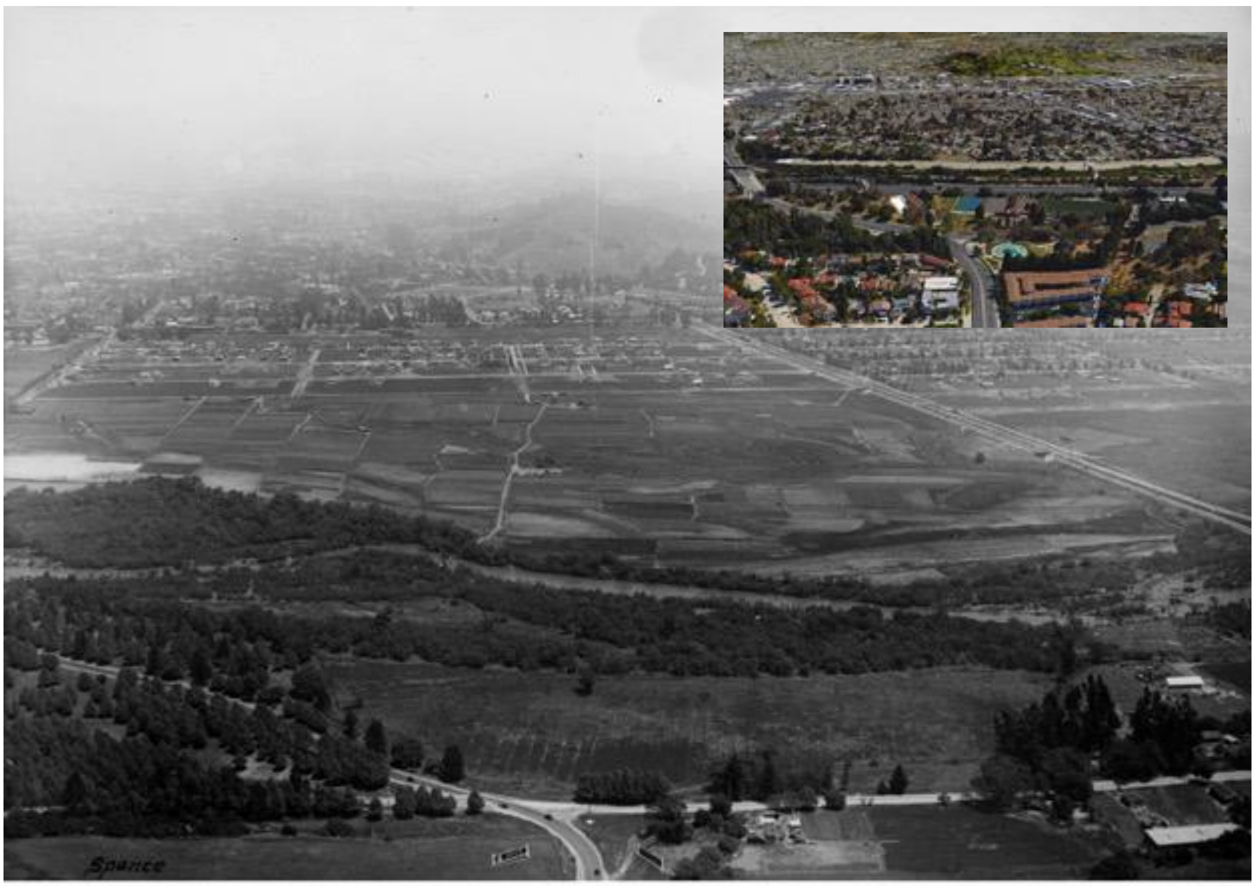


Figure 2-8 Riparian-associated soils in the Elysian Valley as mapped in 1916.

Note: Riparian-associated soils continue beyond area of focus west into the San Fernando Valley and south from the study area.

Aerial Photographs

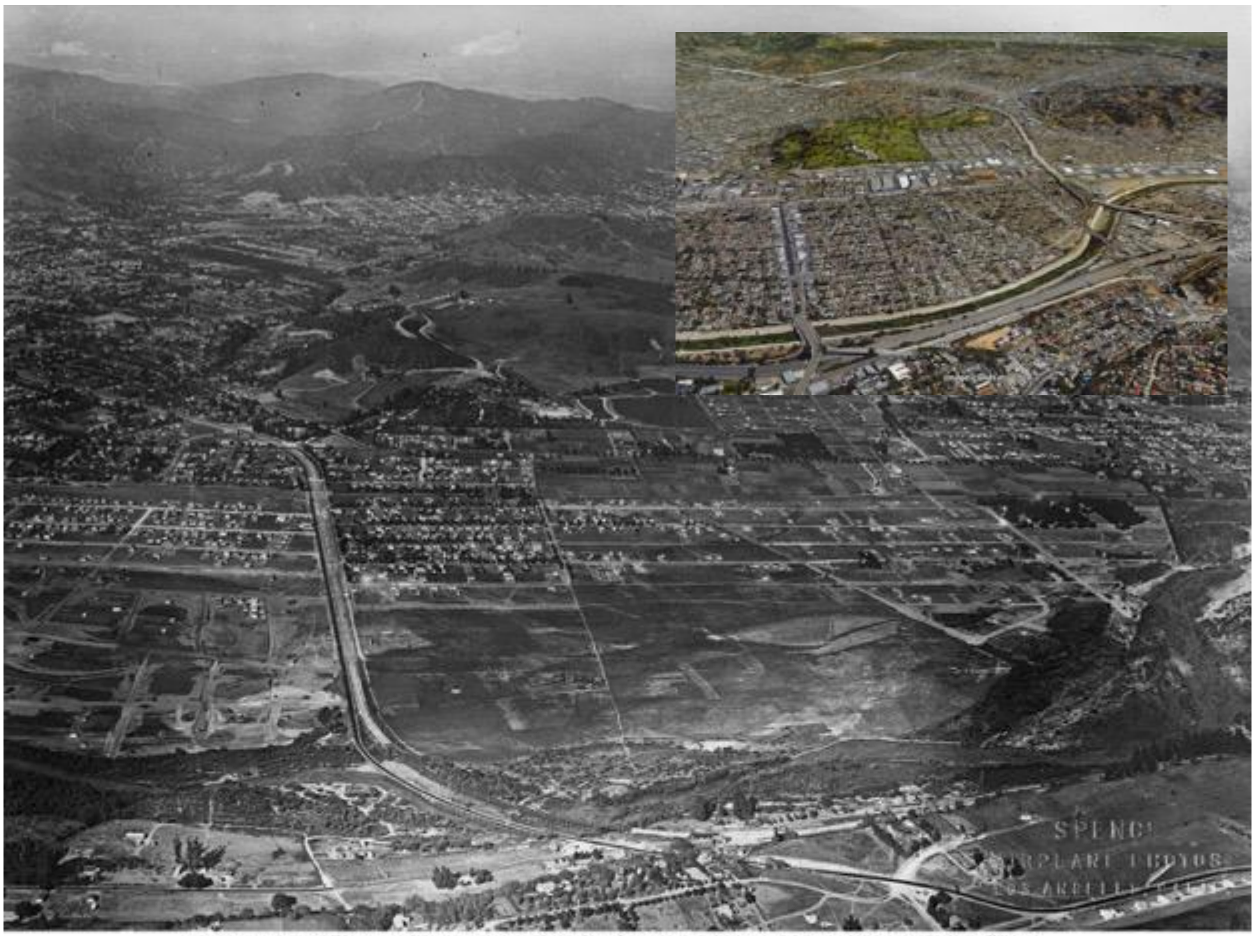
The Spence Air Photo Archive contains many oblique aerial photographs of the study area starting in the mid-1920s. These views are useful to illustrate the pre-channelization nature of the vegetation in the River floodplain in the years before 1938. They furthermore illustrate the degree to which the development of the urban street system followed natural features on the landscape. The earliest photograph shows an extensive riparian canopy, with cropland on either side, looking east toward Glendale between Glendale Boulevard on the south and Los Feliz Boulevard on the north (Figure 2-9). Some areas are low and scrubby, while others appear to be closed canopy forest and perhaps a mix of willow and some oaks.



UCLA Department of Geography, Benjamin and Gladys Thomas Air Photo Archives, Spence Air Photo Collection

Figure 2-9 Glendale at the Los Angeles River (1922). Spence Air Photo Number 2833. Inset contemporary view from Google Earth.

A second 1922 view of the River shows the Hyperion Bridge curving across the River with a wide vegetated floodplain bisected by a barren channel (Figure 2-10). At the downstream end of the view, a braided channel is visible where the River meanders eastward around Fletcher Drive. To the north of Glendale Boulevard, the streets end at present day Valleybrink Road, which corresponds with the edge of the active floodplain at that time and also with the mapped extent of the Tujunga Fine Sand associated with the riparian corridor on the soils maps.



UCLA Department of Geography, Benjamin and Gladys Thomas Air Photo Archives, Spence Air Photo Collection

Figure 2-10 **Glendale Blvd. and Los Angeles River (1922). Spence Air Photo 4806. Inset contemporary view from Google Earth.**

A broader view of the valley from 1922 (Figure 2-11) documents the extent of the riparian forest along present day Griffith Park and extending northward to the curve into the San Fernando Valley. The channel is without vegetation, while the riparian forest appears denser than downstream from the Hyperion Bridge. The forest appears to coincide with Tujunga Fine Sand soils on either side of the River.

UCLA Department of Geography, Benjamin and Gladys Thomas Air Photo Archives, Spence Air Photo Collection

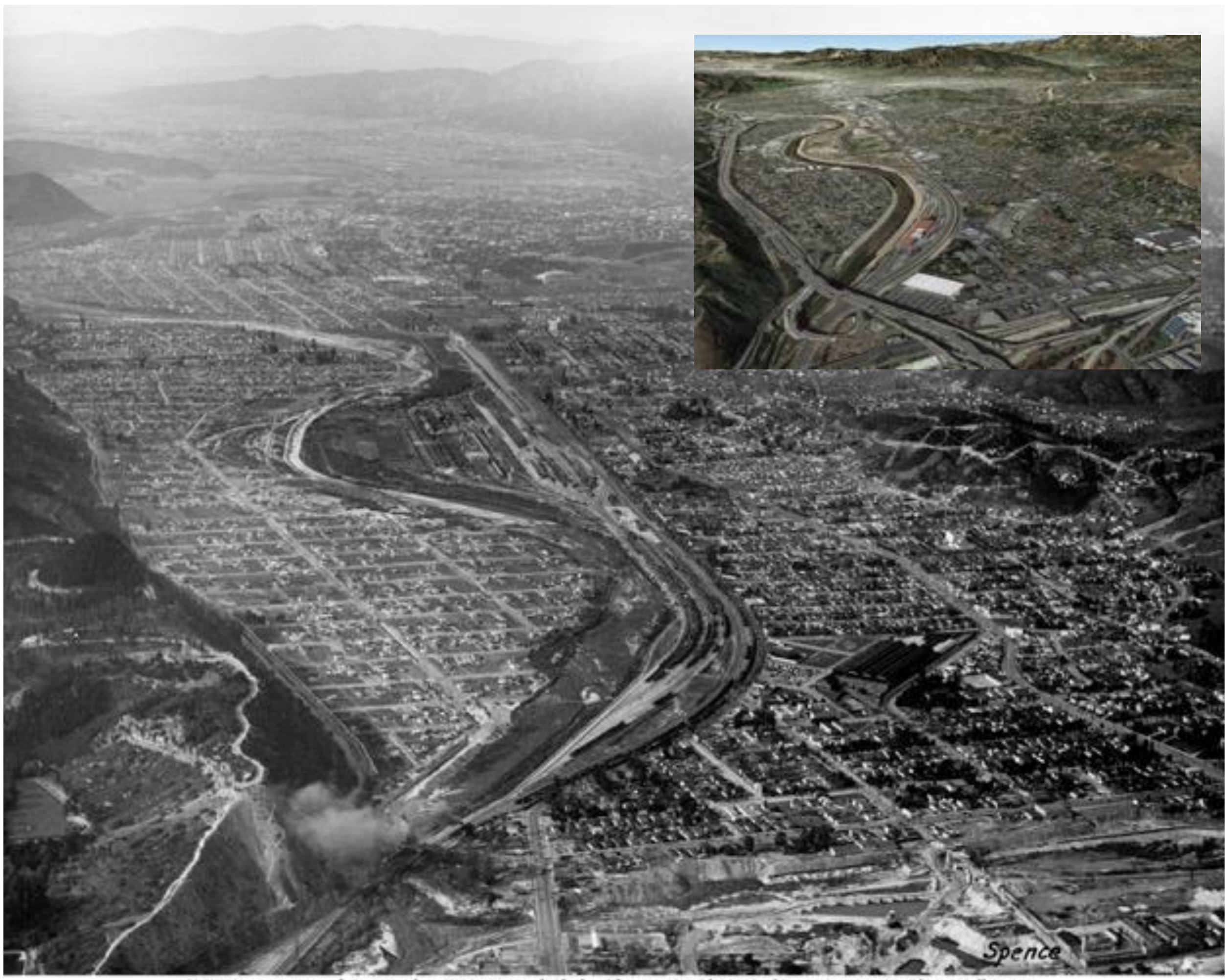
Figure 2-11 Looking up the Elysian Valley at the end of Glendale Boulevard (1922). Spence Air Photo No. 4088. Inset contemporary view from Google Earth.

At the curve of the Los Angeles River eastward at what was once called West Glendale, a close-up view of the Glendale Airport in 1923 shows some detail about the vegetation of the River (Figure 2-12). First, it shows that the River is eroding away a large embankment of the Hanford Fine Sand as it drains west out of the San Fernando Valley. The eroded slope is easily seen, with riparian scrub at its base and a road running along the top. Deposition in the form of a point bar appears to be occurring. Riparian growth is likely willows and perhaps sycamores, based on the life forms of the plants that are in view.

UCLA Department of Geography, Benjamin and Gladys Thomas Air Photo Archives, Spence Air Photo Collection

Figure 2-12 Glendale Airport (1923), with Los Angeles River in foreground. Spence Air Photo No. 5515a. Inset contemporary view from Google Earth.

Looking northward from the confluence with the Arroyo Seco in 1925 (Figure 2-13) shows the width of the active channel of the River as it is confined by the railroad to the east (which was probably built on the terrace and not in the channel). On the west side of the River, the development of the alluvial terrace with residential neighborhoods is seen, but little development is in the lower, active floodplain. Riparian vegetation appears denser at the edges of the channel and bare sandy channel is seen in places.



UCLA Department of Geography, Benjamin and Gladys Thomas Air Photo Archives, Spence Air Photo Collection

Figure 2-13 **View into the Elysian Valley from the confluence with the Arroyo Seco (1925). Spence Air Photo No. F-315. Inset contemporary view from Google Earth.**

A view of the Fletcher Street Bridge in October 1928 shows both the effect of the bridge on the channel and the absence of water during the dry season (Figure 2-14). The main channel appears recently scoured and has very little growth. No flowing or even stagnant water is visible, which is consistent with descriptions of the intermittent nature of the Los Angeles River in sandy zones. The constraining nature of the bridges and rudimentary channelization can be seen in the obvious fill needed for the road leading up to the bridge and the difference between the floodplain and adjacent terraces is clear.

UCLA Department of Geography, Benjamin and Gladys Thomas Air Photo Archives, Spence Air Photo Collection

Figure 2-14 Fletcher Street Bridge (October 13, 1928). Spence Air Photo Collection No. E-2202. Inset contemporary view from Google Earth.

Ground Level Photographs

Hundreds of photographs from digital archives were reviewed, geolocated and then used as supplementary information to describe the historic vegetation conditions. A sampling of images provides support for the description of habitat types and flow regimes that were still present in the area in the early decades of the 1900s. First, a dry channel with scrubby vegetation during the summertime is evident in many photographs (Figure 2-15).

Figure 2-15 **View across the Los Angeles River at Glendale-Hyperion Bridge in August 1927. The channel is dry and vegetation is low and scrubby. Los Angeles City Historical Society photograph F-0218. Source: Los Angeles City Archives, Public Works Collection.**

Views of the river in the wet season show visible surface flows as would be expected. The composition of the wooded riparian zones adjacent to the channel appears to be almost exclusively willows, based on the shape of the trees visible. An occasional sycamore might be present but the immediate floodplain riparian zone appears to be dominated by willows.

Second, the photographs show how the floodplain was reduced through fill, in which the adjacent terraces were extended outward into the active channel (Figure 2-16). Although this was not necessarily the case along the entire length of the Elysian Valley, in many instances the ground plain adjacent to the river appears to have been elevated along with the channelization process.

Figure 2-16 **Fill into the Los Angeles River and willow riparian forest in the floodplain in January 1928. Photograph is taken from a hillside on the west side of the river looking at the east bank south of Figueroa. Los Angeles City Historical Society F-0488. Source: Los Angeles City Archives, Public Works Collection.**

Figure 2-17 **Washout of the old trestle bridge at the Glendale-Hyperion viaduct in a photograph dated July 1927. Willow woodlands are visible upstream. Floodwaters have filled the active channel and are close to inundating the floodplain. Los Angeles City Historical Society F-0723. Source: Los Angeles City Archives, Public Works Collection.**

Bird Nest Records

Records of the following riparian bird species were found in or near the study area (See Appendix B for the source nest records):

- California Cuckoo—[Watson's Pasture]
- Western Wood Pewee—West Glendale
- Willow Flycatcher —Ivanhoe river bottom [Watson's Pasture]
- Yellow Warbler—Los Angeles River bottom, Los Feliz Valley
- Common Yellowthroat—[Watson's Pasture]
- Yellow-breasted Chat—Ivanhoe, Los Angeles River, Los Feliz river bottom, Burbank
- Song Sparrow, in riverbed near Los Angeles, [Watson's Pasture]
- Blue Grosbeak—[Watson's pasture]
- Black-headed Grosbeak—Ivanhoe, Los Angeles Riverbed near Burbank, [Watson's Pasture]
- Swainson's Thrush—Los Angeles River Bottom near Ivanhoe, [Watson's Pasture]
- Warbling Vireo—Banks of the Los Angeles River, Elysian Park, near Elysian Park
- Wilson's Warbler—Burbank

Glendale, Los Feliz, Ivanhoe, and Elysian Park are in the study area. Burbank is upstream in the San Fernando Valley. Watson's Pasture was an important collecting site for Alphonse and Antonin Jay around the first decade of the 1900s. A full text search of the Los Angeles newspaper at the time, the *Los Angeles Herald*, for the term "Watson's Pasture" yielded one item, which was a notice in the lost and found section. It reads, "Strayed from Watson's Pasture, at Fourth Street and San Fernando Road, one dark brown spotted heifer calf, eight months old" (Lundregan 1907). San Fernando Road runs north-south through the study area and currently terminates before it would intersect with Fourth Street farther south. Presumably, in 1907 San Fernando Road extended southward to intersect with Fourth Street and this location was the site of Watson's Pasture. The location may, however, have been farther south, many miles downriver. Antonin Jay published an account of his location of Yellow-billed Cuckoo nests and describes all such locations as being in the low bottomlands closer to the Pacific Ocean (Jay 1911). Watson's Pasture is therefore included as a possible analogue for habitats found along the Los Angeles River within the study area.

Almost every one of these records mentions willows as the nest site, with frequent mention of nettles (*Urtica dioica*), blackberry vines (*Rubus ursinus*), grasses, and "briars," and occasional mention of cattails (*Typha latifolia*), tule (*Schoenoplectus acutus*), alder/elder (possibly *Alnus rhombifolia*), and oaks (likely *Quercus agrifolia*).

In addition to the notes on the cards for the nest records, the breeding habitat known to be chosen by these species can lend some evidence to the types of riparian habitats available at these locations.

> **Yellow-billed Cuckoo.** This species was extirpated as a breeding species from all of Los Angeles County by the 1950s. The optimum habitat described for the species is willow-cottonwood old-growth "jungles" with a dense understory of blackberry, nettles, or wild grape (Grinnell and Miller 1944). Description of breeding habitat in Los Angeles and Orange counties are all of willow, sometimes second-growth (Schneider 1900, Jay 1911).

Western Wood-Pewee. Prefers open riparian habitat, at edges and with dead limbs present. Favors trees with open branchwork (Grinnell and Miller 1944). Was found "near Los Angeles" (Grinnell 1898).

Willow Flycatcher. Nests in thickets of willows (Grinnell and Miller 1944). Used to be "common in summer in the willow regions of the low-lands" (Grinnell 1898).

Yellow Warbler. Strongly associated with willows, in mature riparian woodlands with mixes of willow, cottonwood, alder, sycamore, oak, and aspen (Grinnell and Miller 1944). Sometimes nests in orchards and in recent decades has nested along the Los Angeles River in Los Feliz (R. Barth observation).

Common Yellowthroat. This species is associated with low, wet, dense vegetation. In California, this includes tules and cattails bordering wetlands or thickets with willow and blackberry vines (Grinnell and Miller 1944). Similar current day habitat in Los Angeles County is found at the Whittier Narrows.

Yellow-breasted Chat. Breeding of this species represents dense riparian growth, probably willows with tangles of brush in the understory, but not necessarily over damp ground (Grinnell and Miller 1944).

Song Sparrow. Prime breeding habitat is described as river bottom thickets of nettles, blackberries, and willows, in addition to freshwater and saltwater marshes (Grinnell and Miller 1944).

Blue Grosbeak. Nesting habitat would have been dense growth of riparian understory species with open areas nearby for foraging (Grinnell and Miller 1944).

Black-headed Grosbeak. Will nest in riparian woodland, shrubby oak woodland, and open coniferous forest (Grinnell and Miller 1944).

Swainson's Thrush. In southern California at low elevations, Swainson's Thrush breeds in willow-alder riparian zones (Grinnell and Miller 1944), with nearly all in Los Angeles County being found in willows (Grinnell 1898).

Warbling Vireo. This species nests in mixed willow, alder, and cottonwood growth along streams at lower altitudes (Grinnell and Miller 1944). Oaks may also be part of the habitat mix.

Wilson's Warbler. Dense thickets of shrubby growth next to water features are used for breeding. In the lowlands of California this is usually made up of riparian growth of willow, alder, dogwood, blackberry, poison oak, and ferns (Grinnell and Miller 1944).

The search for bird nest records was focused on these species, which were more-or-less found to be present, but the sheer volume of records precluded searching for indicators of other habitat types, such as oak woodlands. Therefore, absence of oak woodland indicator species does not mean that they were not also present at various locations within the study area.

Together, the presence of the nesting bird species in various locations within the study area indicates the presence of particular types of riparian vegetation. They indicate a dense "jungle" of an understory with a range of shrub-sized plant species (blackberries, nettles, poison oak) in addition to emergent wetland plants (tules and cattails) in wetter locations.

2.4. Synthesis

Synthesis of the historical datasets is presented in two parts. First is a consideration of the hydrology and resulting soil distribution in the Elysian Valley. Second is a description of the major vegetation communities of this riparian zone, building from the 1897 Compton and Dockweiler topographic map and integrating the results of other corroborating data sources.

Hydrology and Soils

A series of historical maps include depictions of the active river channel through the Elysian Valley (see Appendix C). Together they show a remarkably consistent pattern for a forty-year period ranging from 1880 through to the 1920s (Figure 2-18). Aerial photographs show that preliminary attempts at constraining the River with berms were in place by the 1920s, which is quite obvious in the straightened channel morphology on the 1928 topographic map.

Through the San Fernando Valley, the floodplain of the Los Angeles River hugs the northern boundary of the Santa Monica Mountains, with a sinuous and shifting main channel. As it passes the eastern extent of the mountains themselves, it continues for a short distance along an older alluvial terrace and then cuts to the south just before the intersection with the Verdugo Wash. At this point, most of the channel paths show a westward loop into the area now developed into the Griffith Park Golf Course, then back to the east into the area near the intersection of present day Brunswick Avenue and Chevy Chase Drive. From there, the channel curved back to the west, butting up against the base of the mountains just north of Los Feliz Boulevard. From here to the confluence with the Arroyo Seco, the historic active channel more or less followed the route of the channelized River, but had a much larger floodplain.

The soils maps provide additional detail beyond the active channel that define the area of alluvial stream terraces. In the 1903 and 1916 surveys, several soil types ranging from sand, fine sand, and fine sandy loam, show the alluvial deposits of the active channel (defined as Riverwash in one map) and raised terraces around the active channel which have to be seen as areas in which the channel has migrated in the relatively recent past. Confirmation that channels migrate within these floodplain soil types comes from the Dockweiler and Compton map, which shows marshy areas that are very clearly former channels located within the riparian-associated soil types of the floodplain.

Historical photographs, both aerial and on the ground, illustrate that the active floodplain has become reduced over time by filling operations to reduce the distance required to be spanned by bridge construction and to expand the buildable area at the grade above the River. In some instances, the configuration of the River and floodplain terraces is etched into the current landscape. For example, Valleybrink Road north of Glendale Boulevard is located quite close to the edge of the modern floodplain and an older, higher alluvial terrace. The shape of the roads in this neighborhood reflect the old edges of the Los Angeles River floodplain, even though they are now several blocks from the concrete channel.

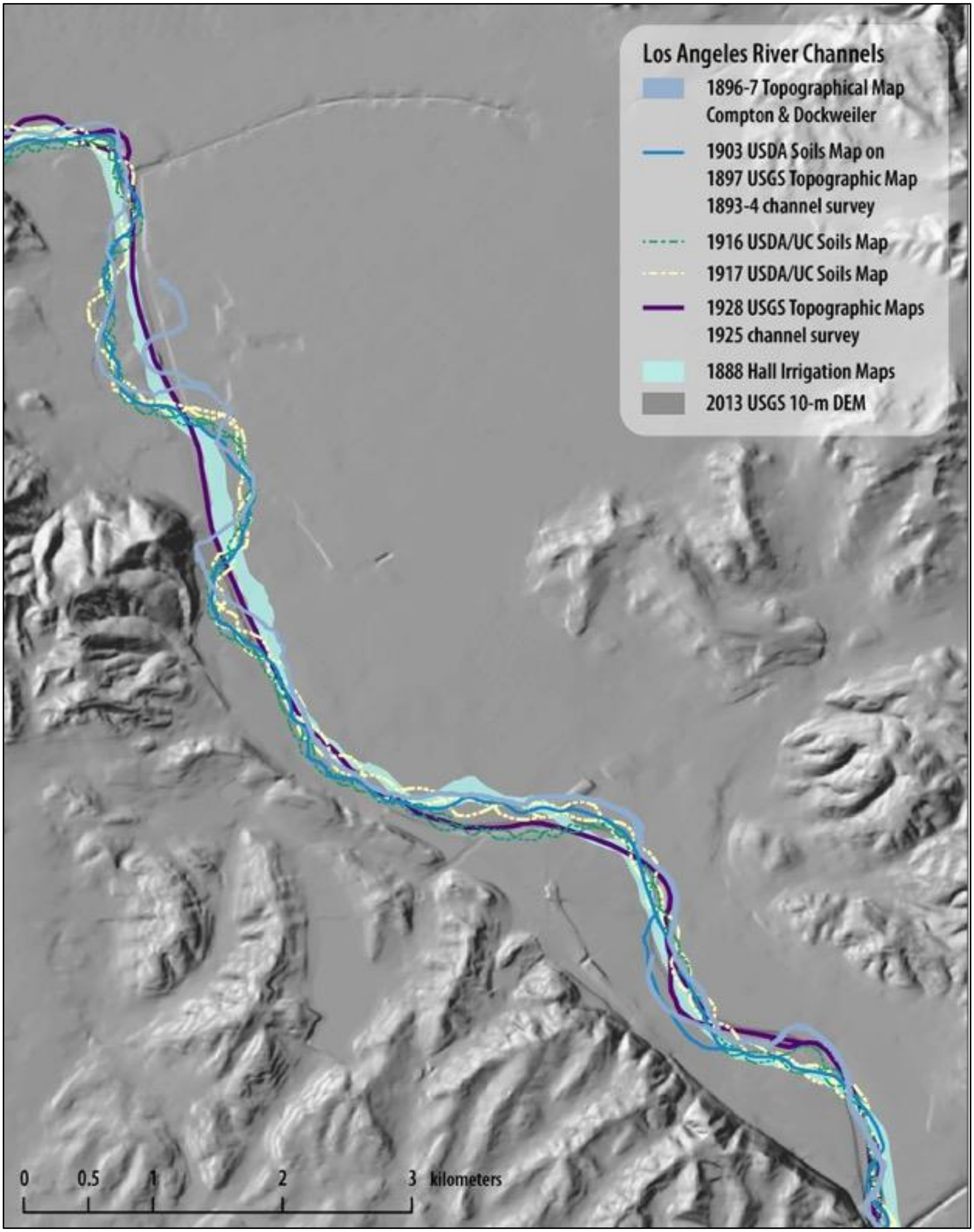


Figure 2-18 **Pre-channelization paths of the Los Angeles River in the Elysian Valley. Some paths are partial and do not represent all historical resources outside the focus area.**

Vegetation Communities

The vegetation community types in the Elysian Valley Reach of the Los Angeles River would have included several types as follows. The historic distribution of these habitats is depicted in Figure 2-19, as of the late 1800s.

River Wash with Mulefat Thickets and Alluvial Scrub
The main active channel of the River, in many locations along the Elysian Valley was likely almost entirely devoid of vegetation quite frequently. This would occur in areas where the channel scoured out the vegetation along the active channel, leaving unvegetated sand (see Figure 2-19). At other times, pioneer vegetation would have become established, such as Mulefat Thickets (*Baccharis salicifolia* Shrubland Alliance) (Sawyer *et al.* 2009) or alluvial scrub (Hanes *et al.* 1989). Alluvial scrub is classified within the Scale broom scrub Alliance (*Lepidospatrum squamatum* Shrubland Alliance) by Sawyer *et al.* (2009).

Perennial and Ephemeral Freshwater Wetlands
The Compton and Dockweiler maps unequivocally show "marshy" areas associated with past channel routes within the floodplain. Given how high the water table is in this reach of the River, these are likely to have been perennial, or near-perennial, freshwater wetlands. The presence of bird species requiring such habitats and mention of the requisite plant species (e.g., cattails, tules) in the various historical sources supports this conclusion. These wetlands could have been various classifications associated with the *Typha (angustifolia, domingensis, latifolia)* (Cattail marshes) Alliance (Sawyer *et al.* 2009).

Willow Woodlands and Shrublands
The lowlands of the Elysian Valley adjacent to the channel and in the active floodplain were dominated by willow thickets or forest. Willows are tolerant to inundation and are pioneer species of southern California riparian systems (Faber *et al.* 1989). Willows are described frequently in textual accounts of the River and visible on many photographs. Herbarium specimens from the Los Angeles River (although not all in this reach) include *Salix lasiolepis* and *Salix exigua* specimens. It is therefore likely that the most common alluvial riparian vegetation type would have been willow woodland. Specifically, the following Alliances (Sawyer *et al.* 2009):

- *Salix laevigata* Woodland (Red willow thickets)
  - Association: *Salix laevigata-Salix lasiolepsis* Willow Woodland (Red willow-Arroyo willow thickets)
- *Salix gooddingii* Woodland (Black willow thickets)
- *Salix lasiandra* (formerly *S. lucida*) Woodland (Shining willow groves)
- *Salix exigua* Shrubland (Sandbar willow thickets)

Willow Woodlands are the dominant tree group mentioned across these records and indeed historic descriptions of the region emphasize willows as being especially abundant. The vegetation was also dynamic, with "brush" growing up in years between large flood events (Los Angeles Herald 1891). During years with health flow but no large floods, the main channel would become more distinct. "The great freshets of the [flood] years referred to above and the liberal volume of water flowing in years not producing an absolute flood, have made a much wider, deeper and clearer bed for the water courses than used to be" (Los Angeles Herald 1891). Sand bars forming in the River have long caused concern among City residents: "Bars have been formed in different localities and on these have sprung up rank growths of willows which unless removed will form the nucleus of obstructions that will in flood times turn the water from its natural channel and cause overflows of the lower land on either bank of the river" (Los Angeles Herald 1875).

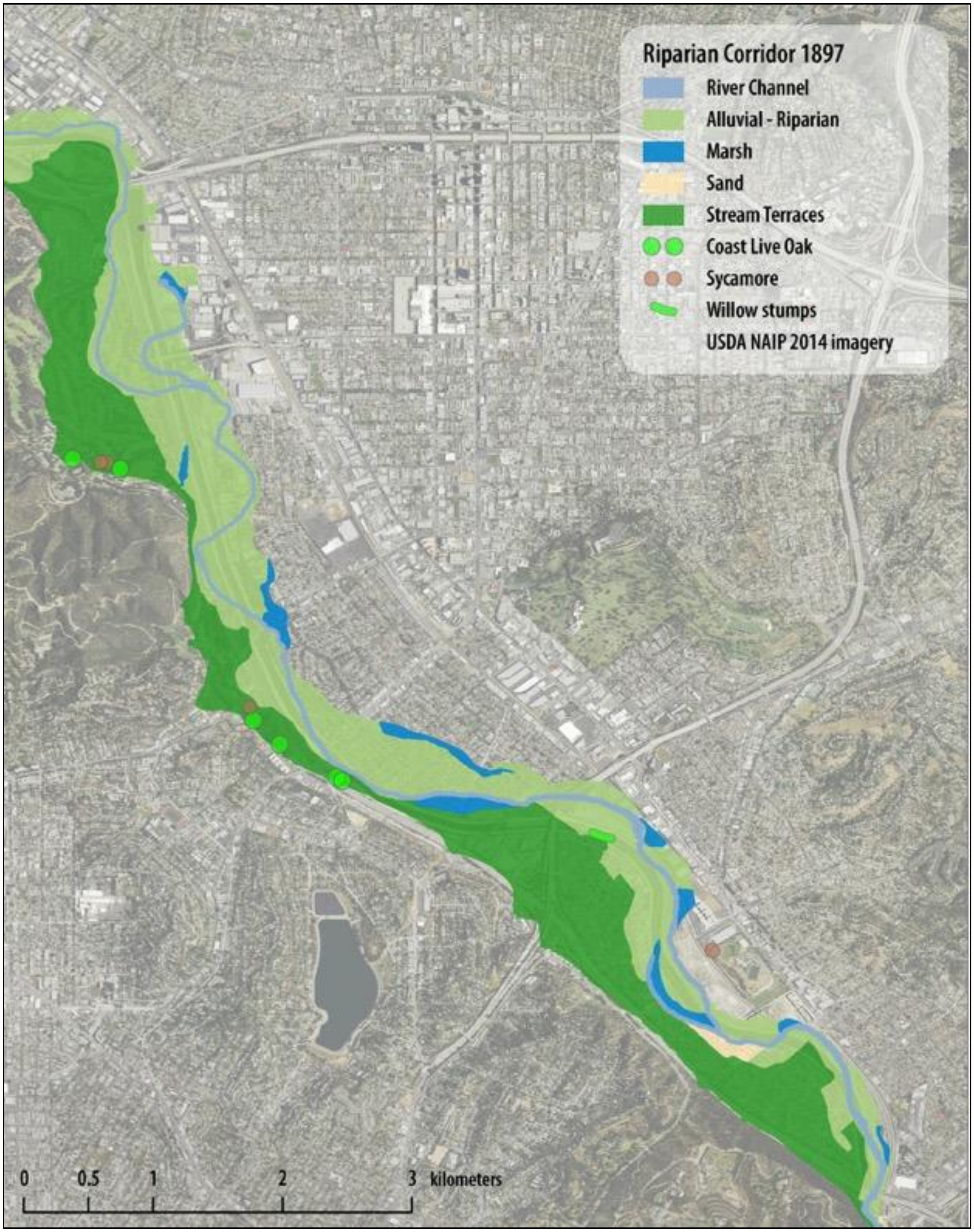


Figure 2-19 **Habitat distribution of the Elysian Valley in late 1800s, from Compton & Dockweiler survey (1897).** Note: Riparian distribution extends on either side of the study area, into the San Fernando Valley to the west and south past the Arroyo Seco.

The understory of these woodlands would have been dense, as is described in the various textual accounts, including blackberries, nettles, poison oak, grapes, and other characteristic understory species (Faber *et al.* 1989). These descriptions are similar to those of the dense understory of riparian forest described in the Whittier Narrows along the San Gabriel River (Stein *et al.* 2007).

California Sycamore - Coast Live Oak Woodland
In the upper terraces outside of the more active lower zones, a different type of riparian forest was dominant. In this zone, sycamores would be widely scattered, along with coast live oaks. Both of these species are noted as individual trees in the 1897 map. Sycamores would have extended down into the lower terraces as well, being flood tolerant (Faber *et al.* 1989). Although not confirmed through specific records, Mexican elderberry would be found in this zone as well, as indicated by similar habitats in Orange County (Bowler 1989). This vegetation would be classified as California Sycamore–Coast Live Oak Woodland (*Platanus racemosa–Quercus agrifolia* Woodland) Association in the *Platanus racemosa* Woodland Alliance (Sawyer *et al.* 2009).

Observations near downtown Los Angeles in the 1850s and 1860s described the presence of oaks and sycamores: "Sycamores and oaks were seen here and there, while the willow was evident in almost jungle profuseness, especially along river banks and along borders of lanes" (Newmark 1916). Oaks are also mentioned occasionally in association with the river in the San Fernando Valley. An 1899 silver wedding anniversary was held "under the great oak trees that border the Los Angeles River at the north entrance of the Cahuenga pass" (Los Angeles Herald 1899).

2.5. Discussion

The purpose of this historical ecology investigation is to uncover the spatial distribution of habitat types and their dynamic nature along the Los Angeles River in the Elysian Valley. It is not a template for restoration, nor is any historical ecology description (Stein *et al.* 2010), given the irreversible changes associated with the channelization of the River and urban development of the floodplain. The combination of an increased understanding of the historically present habitat types and an assessment of the current opportunities and constraints could, however, lead to an ecologically informed habitat enhancement and creation plan.

The historic floodplain of the Los Angeles River through the Elysian Valley extends far beyond the current channel area and into what are now commercial, industrial, and residential districts. It is therefore highly unlikely that flood dynamics similar to the historic conditions will ever be restored and that the flood prevention functions of the main channel must be preserved more or less in place. Assuming for the moment that the main channel will remain in place with possible changes to the channel morphology, the historical habitat types and their distributions do inspire some restoration options.

First, construction of emergent marsh habitats similar to the marshy backchannel habitats found in the historic floodplain is feasible and could serve multiple functions. Such emergent wetlands, either perennially inundated or seasonally inundated, would be ideally suited for creation where storm drains open into the main channel, allowing the wetlands to serve stormwater quality mitigation in addition to providing habitat for wetland associated species. To be maximally effective in providing habitat for sensitive species, the hydrology and plantings should be inspired by the "jungle"-like profusion of dense understory plant species. Doing so might require lowering the ground plane to be closer to the water table and re-creating a river channel bank that is pulled back from the existing concrete channel. Excavating to create floodplain wetlands outside the channel would involve removing fill that was used to constrain the channel as urbanization encroached upon it in the 1900s.

Another reason to pursue habitat creation outside of the main channel is that a more natural hydrological regime might be achieved. The main channel is currently inundated year-round by effluent from water reclamation plants (WRPs), which creates volumes of dry weather surface flows and perennial flows that are not evident in the historical record. To the contrary, bare sand and very little surface flow is seen in many of the photographs of the River in the summer and fall from the 1930s and earlier. In the future, the treated WRP effluent water may no longer be discharged into the Los Angeles River, but until that point, off-channel restoration sites might be used to create alluvial scrub, mulefat scrub and wetland habitats that have the ephemerally wetted characteristics of the historical ecology.

The development of the upper stream terraces, and even parts of the historical floodplain, for urban uses does not necessarily preclude their contribution to improved ecological functioning for the landscape. Researchers and landscape architects studying the oak savannas of the Santa Clara Valley in Northern California (Whipple *et al.* 2010) have proposed an effort to restore the density of valley oaks on the landscape that occurred historically by planting them within the urban fabric itself. This restoration of oak density is called “re-oaking” and should not only be consistent with existing land uses, it will probably increase sense of place and connection of the community to its environment. A similar project might be envisioned for the Elysian Valley.

Any of the urban communities that are found on the stream terraces above the extent of the historic floodplain might be enhanced ecologically by aggressive planting of coast live oaks and California sycamores as street trees where conditions allow. This would serve the purpose of establishing a riparian alluvial tree cover that might approach historic extent and thereby be used by a range of wildlife species characteristic of oak and sycamore woodlands. It would provide a stepping-stone for bird species that might be found in Elysian Park, Griffith Park or along the channelized Los Angeles River to move between these two areas. Importantly, it could potentially galvanize a greater public understanding of the spatial extent of the river-associated habitats and draw attention to the floodplain and channel as an interrelated system.

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Chapter 3. Hydrology and Hydraulics

3.1. Introduction

This review of available data provides a qualitative assessment of the hydrologic, hydraulic, erosion, and sedimentation effects in relation to limitations of potential habitat enhancement within the study area. The assessment is primarily based on a review of the field conditions and the data available from the U.S. Army Corps *Los Angeles River Ecosystem Restoration, Draft Integrated Feasibility Report (IFR): Feasibility Study and Environmental Impact Statement/Environmental Impact* Report, dated September 2013. Additional data from Los Angeles Department of Public Works and the Upper Los Angeles River Area (ULARA) Watermaster annual reports was analyzed, including 2006 topographic data, historic rainfall, flow and discharge records for the Los Angeles River above the confluence of the Arroyo Seco.

Army Corps Los Angeles River Ecosystem Restoration Feasibility Study

After evaluating 21 alternatives for the Los Angeles River Ecosystem Restoration Plan, the Los Angeles District of Army Corps selected Alternative 13 as the preferred alternative. Subsequent to the study, the City of Los Angeles requested reconsideration of Alternative 20, which was subsequently accepted and approved. Alternative 20 involves a larger ecosystem restoration area footprint (719 acres in contrast to 588 acres for Alternative 13). The results of the feasibility study, including descriptions of the project reaches and the final alternative, are included in the IFR.

Reaches 5, 6A and the upper portion of 6B of the Los Angeles River ARBOR (Area with Restoration Benefits and Opportunities for Revitalization) are part of the focused area for this Habitat Enhancement Study (see Figures 3-1 and 3-2). For the Army Corps feasibility study, the technical significance of ecosystem restoration in this reach is based on the importance of nodal habitat connectivity (e.g., large and small aquatic habitat patches connected via habitat corridors). Improvements along the main stem of the Los Angeles River would restore habitat connectivity and enhance both aquatic and terrestrial habitat values within other natural areas in the vicinity. By restoring additional habitat and wildlife movement pathways, nodal connections could be made to now-isolated open space areas. Vegetated corridors and flyways restored by the proposed project alternative would provide regional habitat connectivity (direct or potential) to surrounding National Forest land, including the Angeles National Forest, Santa Monica Mountains National Recreation Area, and other areas being considered for national park system (e.g., the Rim of the Valley Corridor Special Resource Study). The proposed Los Angeles River ecosystem restoration project would provide an essential backbone of physically connected habitats along a primary wildlife movement corridor/migratory pathway. This would, in turn, provide opportunities for additional connections to currently isolated or disjointed restoration and open spaces within upstream tributaries.

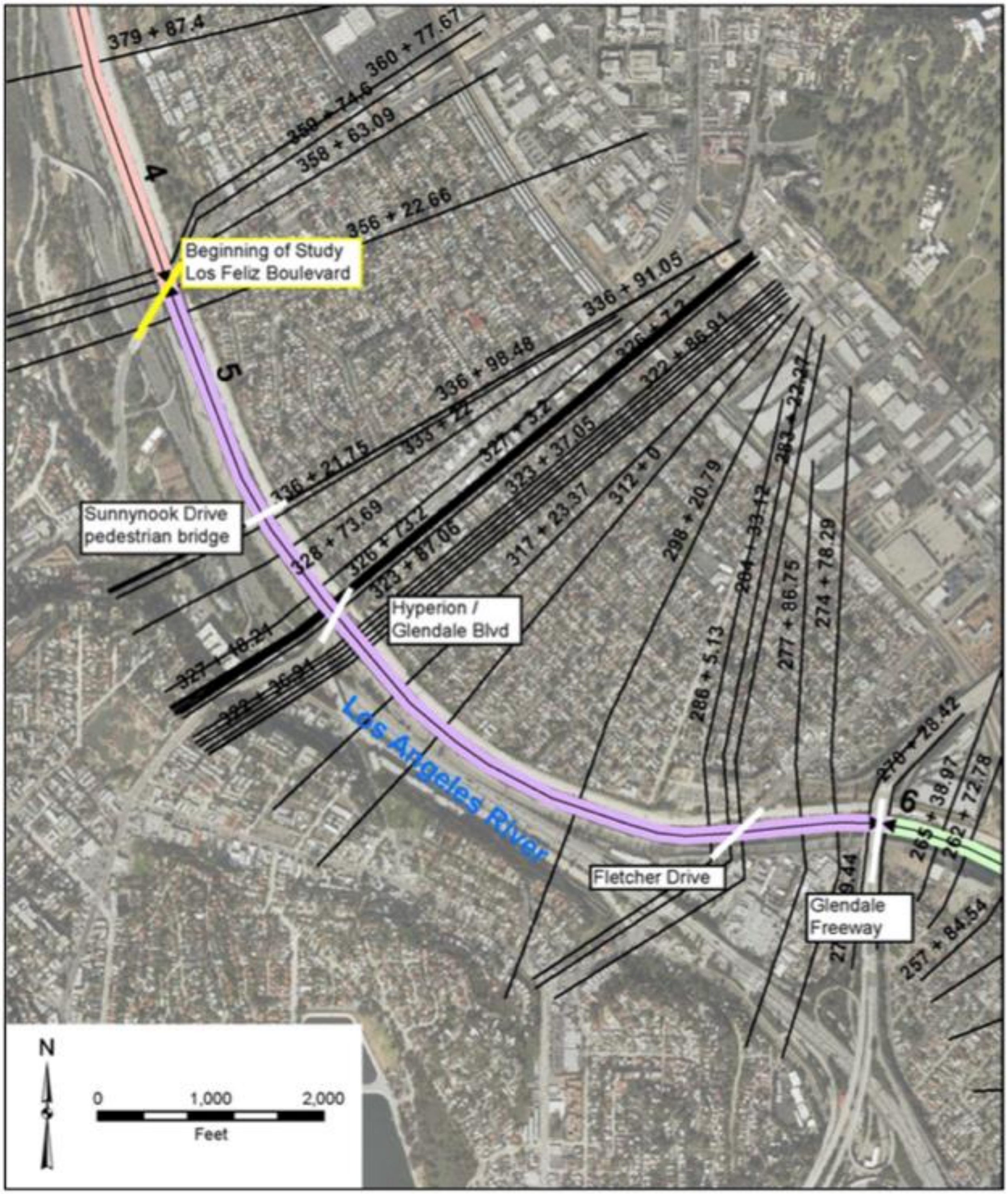


Figure 3-1 **The Habitat Enhancement Study Area includes Army Corps ARBOR Reaches 5, 6A and upper portion of 6B.**

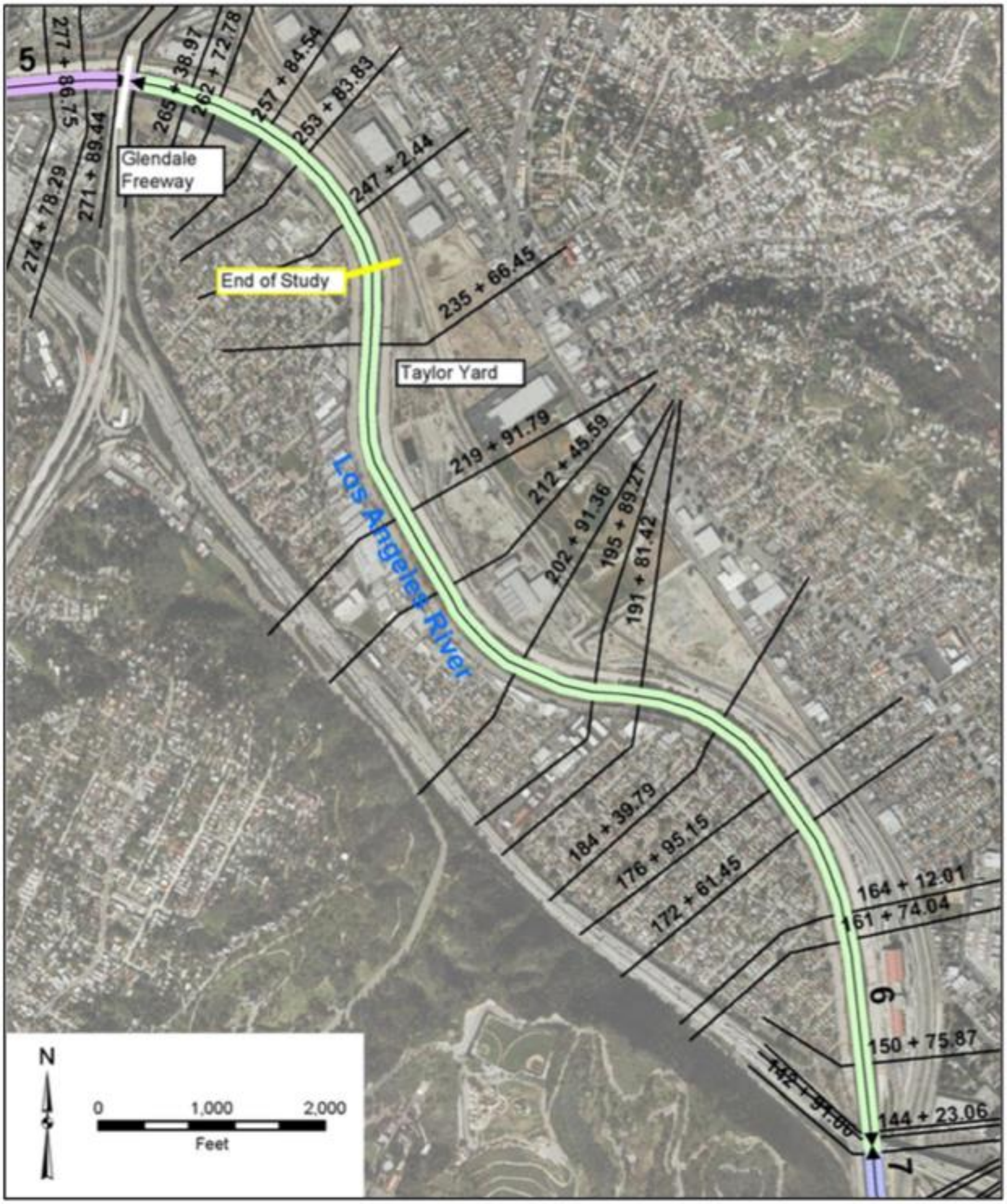


Figure 3-2 **The Habitat Enhancement Study Area includes Army Corps ARBOR Reaches 5, 6A and upper portion of 6B.**

Elysian Valley Habitat Enhancement Study Area

Implementation of Alternative 20 of the Los Angeles River Restoration Plan will take a number of years due to the phases of analysis, design, preparation of plant specifications, permitting and construction. In the near-term, this study aims to inform the selection of hydrological and hydraulic conditions that will maximize ecologically appropriate habitat and increase biodiversity in the study area. The study area extends from Los Feliz Boulevard to Taylor Yard. In relation to the IFR, the current study area includes Reach 5, Reach 6A, and the upper portion of Reach 6B (Station 358+63.09 to approximately 600 feet downstream at Station 247+02.44; see Figures 3-1 and 3-2).

The Appendix E of the IFR provides key data for this study (see Appendix D). In addition to the IFR and the related topographic and hydraulic data, WRC obtained Excel spreadsheets from Army Corps showing the typical proposed sectional changes for River restoration in the study reach (see Appendix E). Additional data from Los Angeles Department of Public Works and the Upper Los Angeles River Area (ULARA) Watermaster annual reports was analyzed, including 2006 topographic data, historic rainfall, flow and discharge records for the Los Angeles River above the confluence of the Arroyo Seco. There were no other hydrologic, hydraulic or erosion and sedimentation data available for the proposed alternatives in the study reach at the time of review.

Based on the existing data described above, limited quantitative analysis was performed to evaluate the hydraulic conditions for dry weather (e.g. non-flood) flows and habitat enhancement potential in the study area.

3.2. Review of Available Data

3.2.1. Flood Control Channel Features

The flood control channel in the study area is one component of a larger flood control system in the Los Angeles River Watershed, which is comprised of dams, infiltration basins and storm water channels. The flood control channel in the study area is approximately 100 meters wide at the crown (top) of the channel (Figures 3-3 and 3-4). The channel slope banks are trapezoidal with a 3:1 slope constructed of either concrete slab or concrete grouted rock, constructed by Army Corps at the request of the City of Los Angeles between 1938 and 1941. The toe of the slope is indicated on Figures 3-3 and 3-4, which extends several feet with concrete slab as part of the toe protection of the slope bank. In several sections due to the accumulation of sand, cobble and boulders, especially in the flatter runs of the channelized River, channel bars have built up over the toe protection and in some cases the bottom of the slope banks as well. The crowns of the channel slopes are generally asphalt access roads, which are used by pedestrians for recreation. The crown of the right bank (west-side) of the channel has been converted into a public bike path.

3.2.2. Topography

The upper terraces within the study area are generally flat, except for the Caltrans slopes below Sunnynook Park above the Golden State I-5 Freeway, and a section of slope in the Bowtie Parcel above the River channel (left bank), which has been revegetated with plants common in the Coastal Sage Scrub (CSS) vegetation community. Elevation changes from approximately 406 feet at Los Feliz Blvd to 322 feet in the channel bottom at the end of the study area (Figure 3-5).

In-channel, channel bars vary in height above the low flow water level from 0 to several feet.

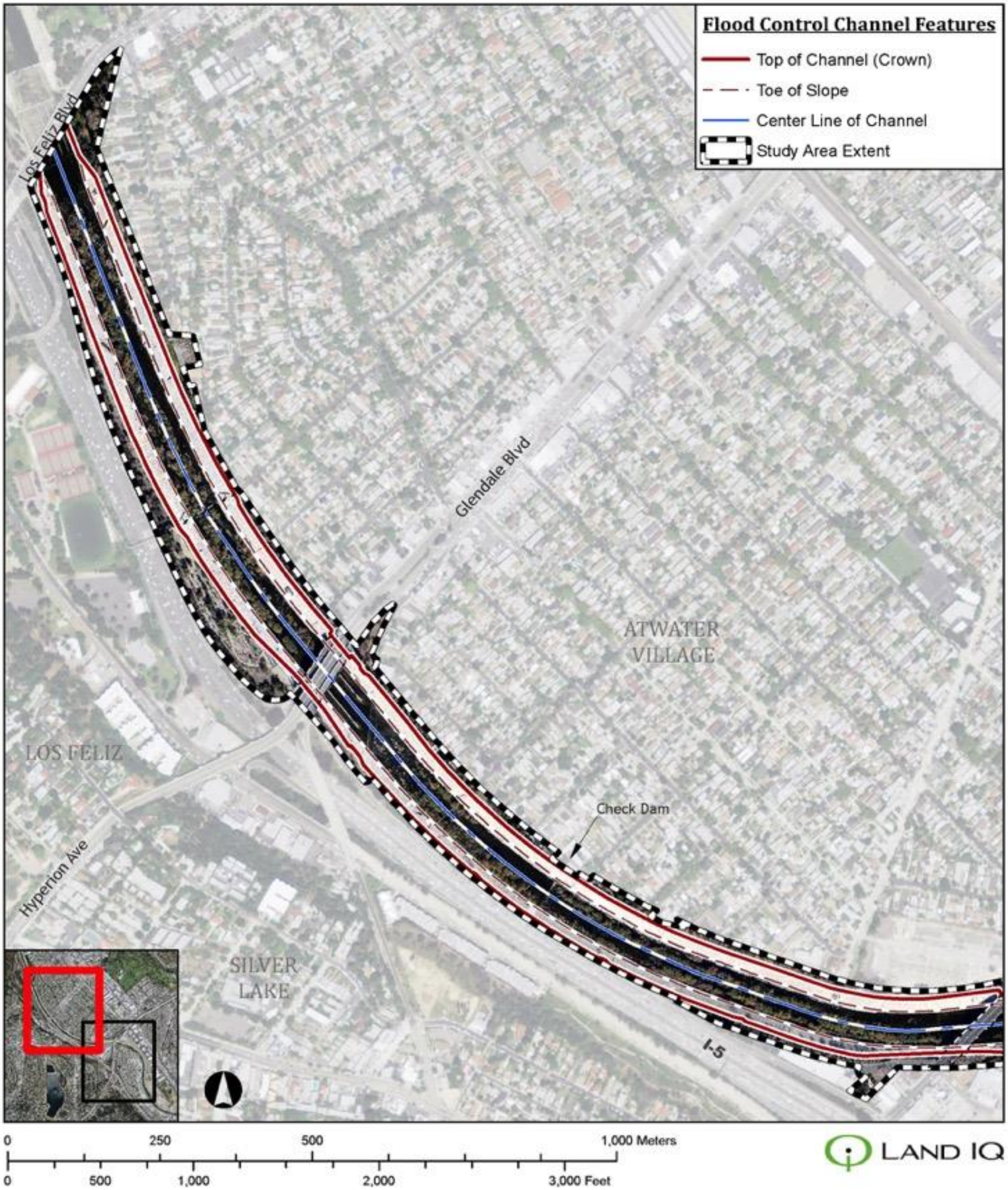


Figure 3-3 Flood control channel features of the Los Angeles River in the Elysian Valley (1 of 2).

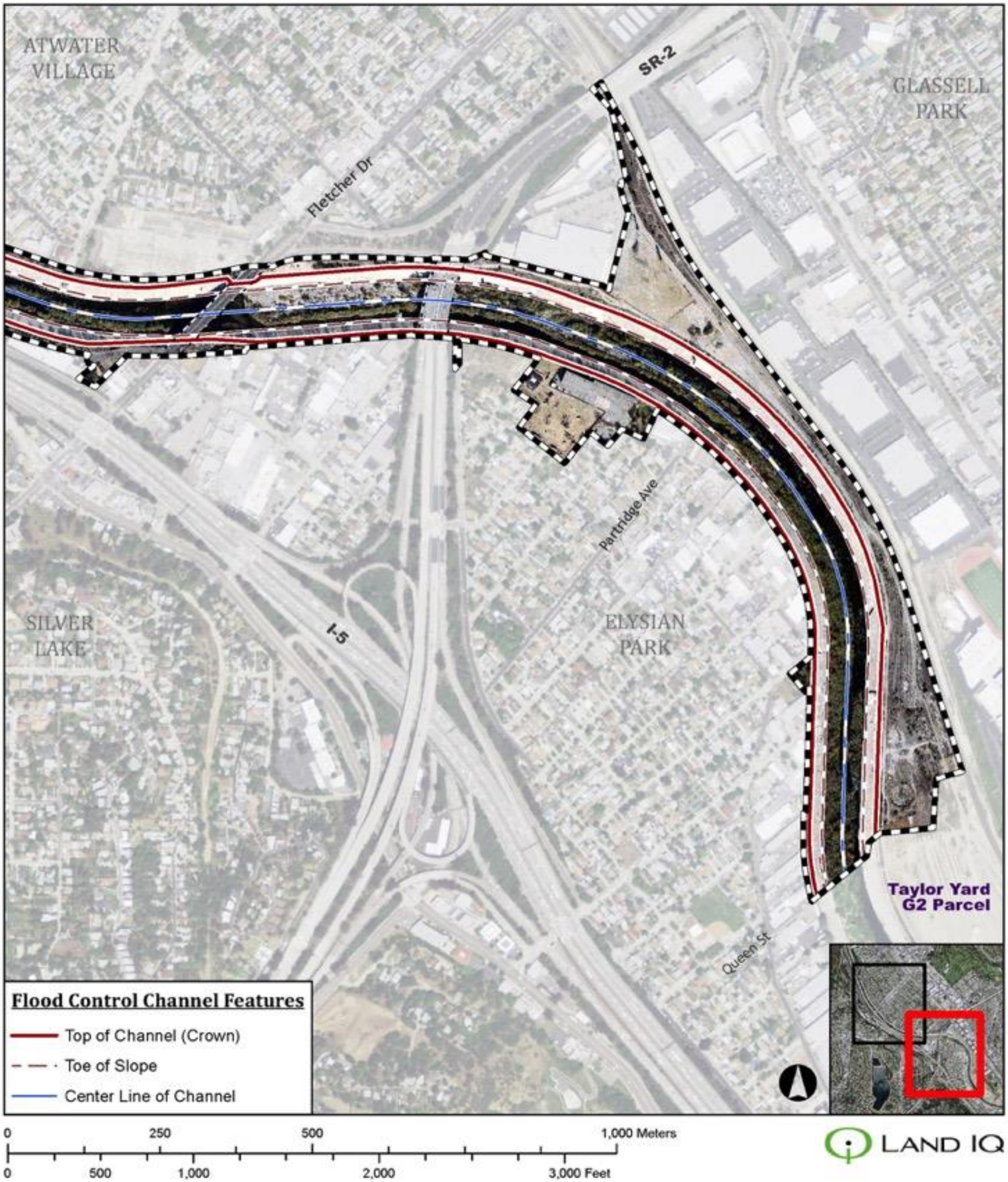


Figure 3-4 Flood control channel features of the Los Angeles River in the Elysian Valley (2 of 2).

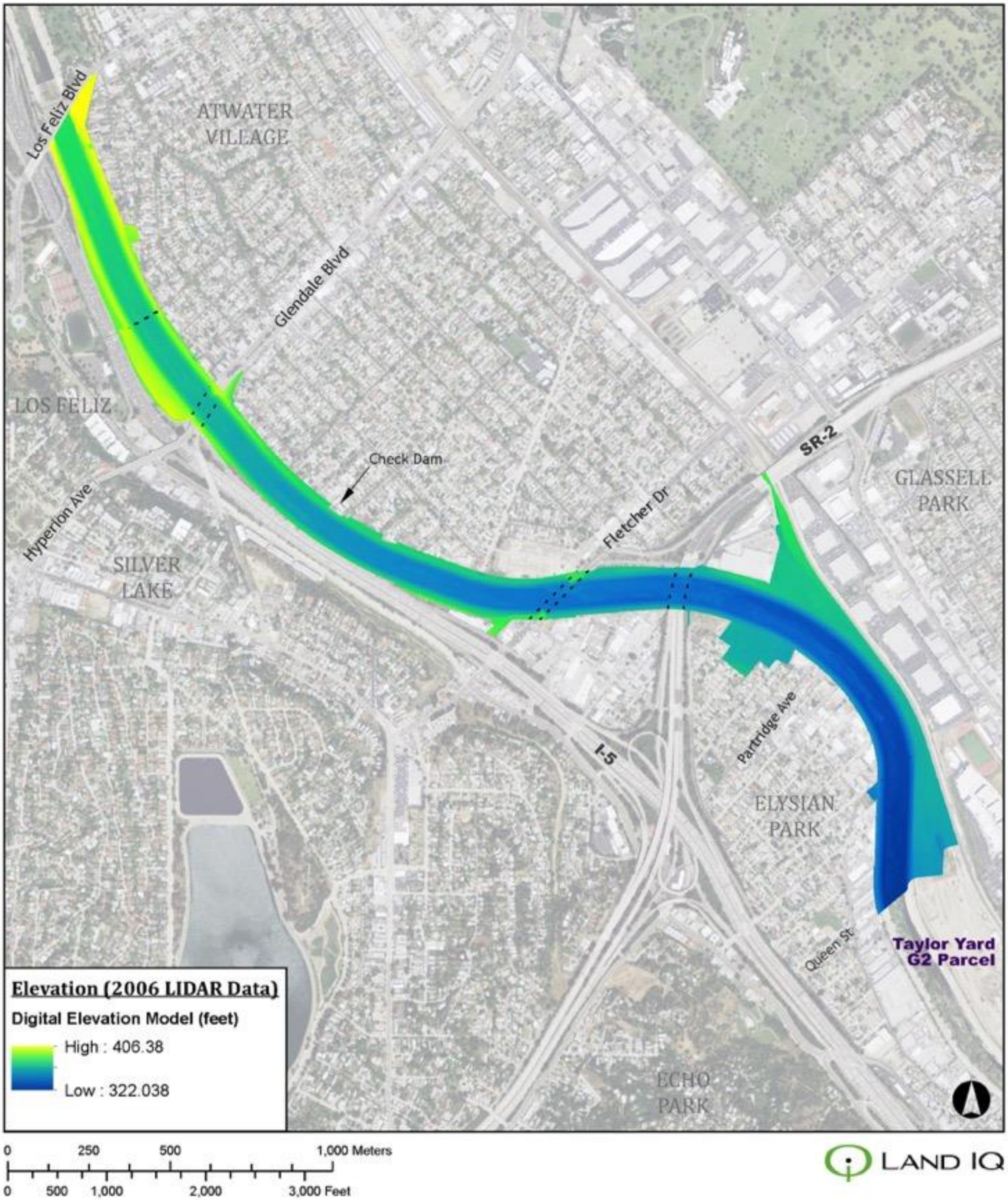


Figure 3-5 Elevation Change of the Los Angeles River in the Elysian Valley (2006 LIDAR data).

The study area includes several bridge crossings including Los Feliz Boulevard, the Sunnynook Trail, Hyperion Boulevard/Glendale Boulevard, Fletcher Drive and the Glendale Freeway (see Figures 3-1 and 3-2). Using 2006 topographic data, typical sections of the channel and overland area representing the reach are shown in Figures 3-6 to 3-9. The general channel bottom width ranges from 200 to 250 feet for 328+73.69 (near the Sunnynook Trail Crossing), 298+20.79 (between Hyperion Boulevard and Fletcher Drive), 277+86.75 (downstream of Fletcher Drive), and 247+02.44 (downstream end of Study Reach near Taylor Yard). Note that the levees exist from Station 358+63 (Los Feliz Boulevard) to Station 312+00 (midpoint between Hyperion Boulevard and Fletcher Boulevard).

Inside the channel, the existing topographic data does not display the low-flow channels or the undulating features of the River bottom (see Figure 3-10, River Station 277+86.75). The 2006 topographic data which were applied to the IFR do not provide the significant features of the River which are essential to River restoration. Although the River is confined by concrete and/or grouted rock and riprap banks, there are distinct features of the River in the reaches between the bridges noted on the February 27, 2015 field observations, as indicated below:

- From Los Feliz to upstream of Hyperion—the current perennial low-flow condition has relatively healthy water types and channel features with normal erosion and sedimentation. Channel bar islands and divided flows as well as meandering low flows are typical in the reach (see Figure 3-11).
- From Hyperion Boulevard to Fletcher Drive—the low flow has been disturbed by in-stream structures such as large pier walls and concrete drop and grade control structures (From Hyperion Boulevard to Station 298+20.79, see Figure 3-12). However, further downstream, a divided flow and channel bar habitat were observed (see Figure 3-13).
- Downstream of Fletcher Drive to Station 253+83 (downstream of Glendale Freeway)—the low-flow channel has narrowed to a straight and incised channel. The channel bars are much higher than the low flow channel in this reach, resulting in reduced vegetative cover compared with lower elevation channel bars. Invasive and non-native plants dominate the channel bars (see Figure 3-14 upstream of Glendale Freeway and Figure 3-15 below Glendale).
- Station 253+83 to the downstream end of the study reach—this short reach, as well as the Taylor Yard reach, is relatively stable with dense vegetation and mature black willows (see Figure 3-16). The Taylor Yard reach is planned to be widened as much as 600 feet for restoration (see Appendix E).

3.2.3. Landscape Features, Channel Bars and Low Flow Water Types

The landscape features of the flood control channel and the urban upper terrace are presented in Figures 3-17 and 3-18.

In-channel features, including mean channel bar height above low flow water, low flow water types and semi-vegetated versus vegetated channel bars are seen in Figures 3-19 to 3-21. Note that low flow water and channel bar substrate covers the toe of the channel slope and even the slope banks in segments, especially in the downstream end of the study area below the Fletcher Drive Bridge.

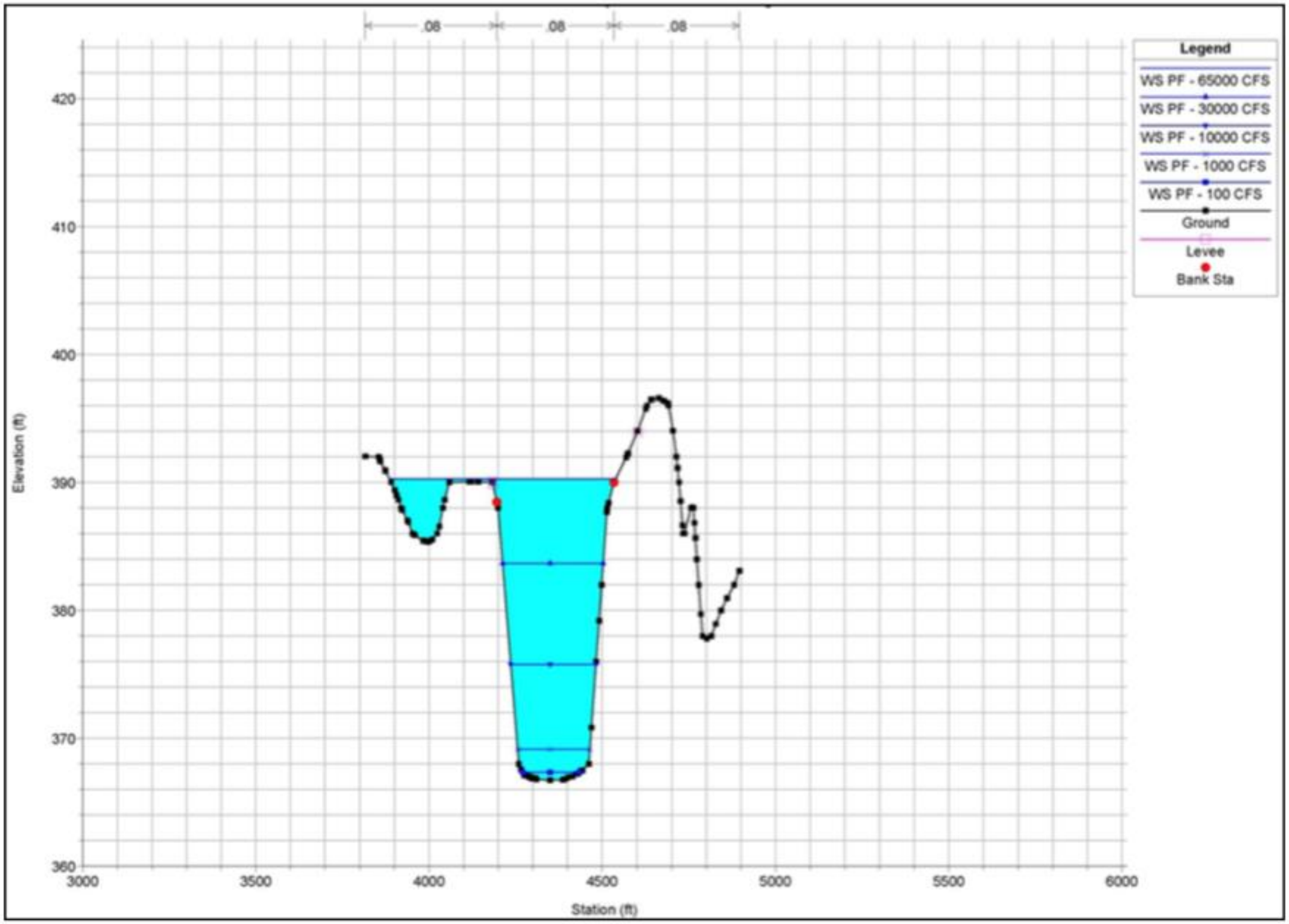


Figure 3-6 Cross Section Near Sunnynook Trail Crossing (River Station 328+73.69).

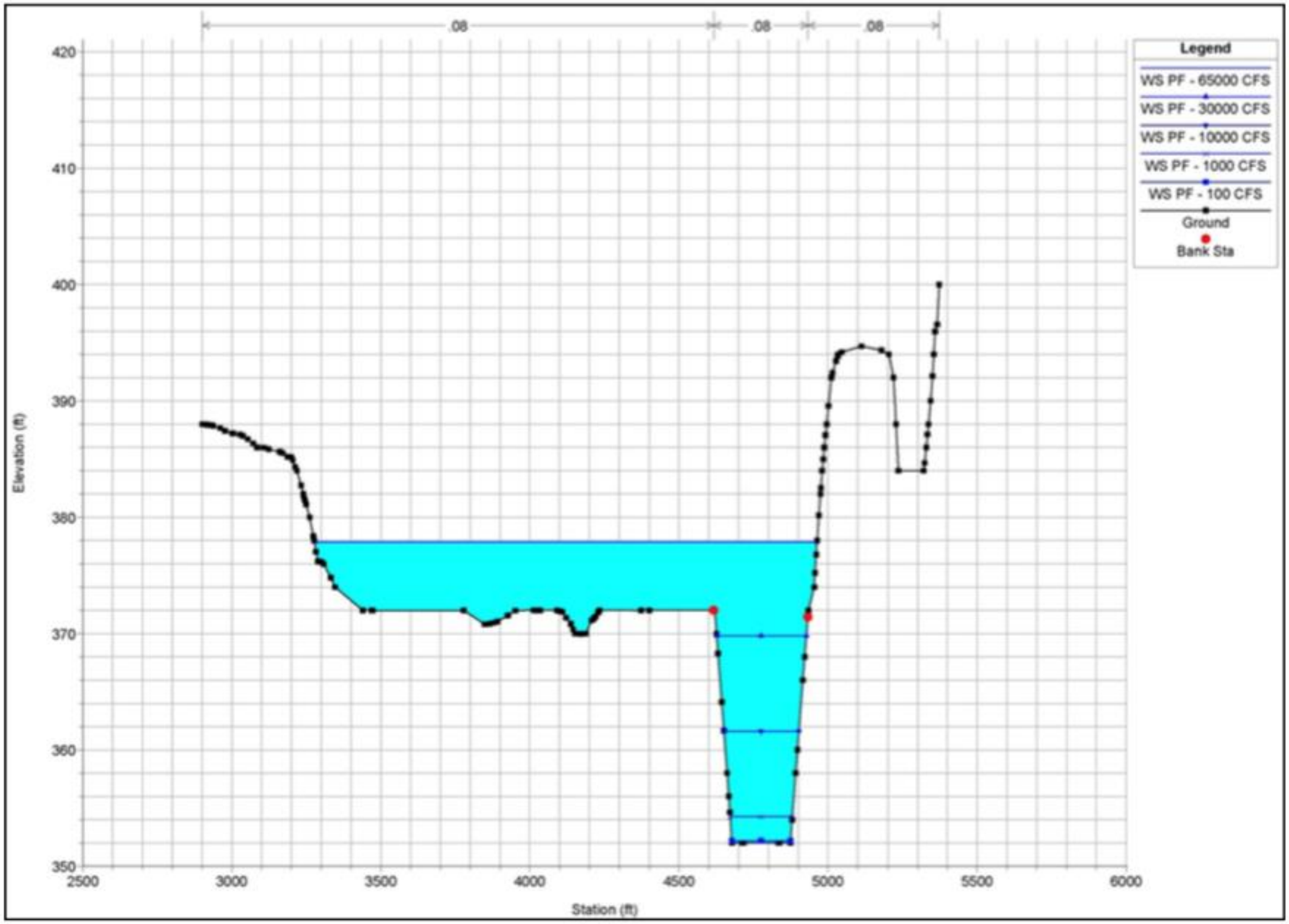


Figure 3-7 **Cross Section Downstream of Hyperion Blvd (River Station 298+20.79).**

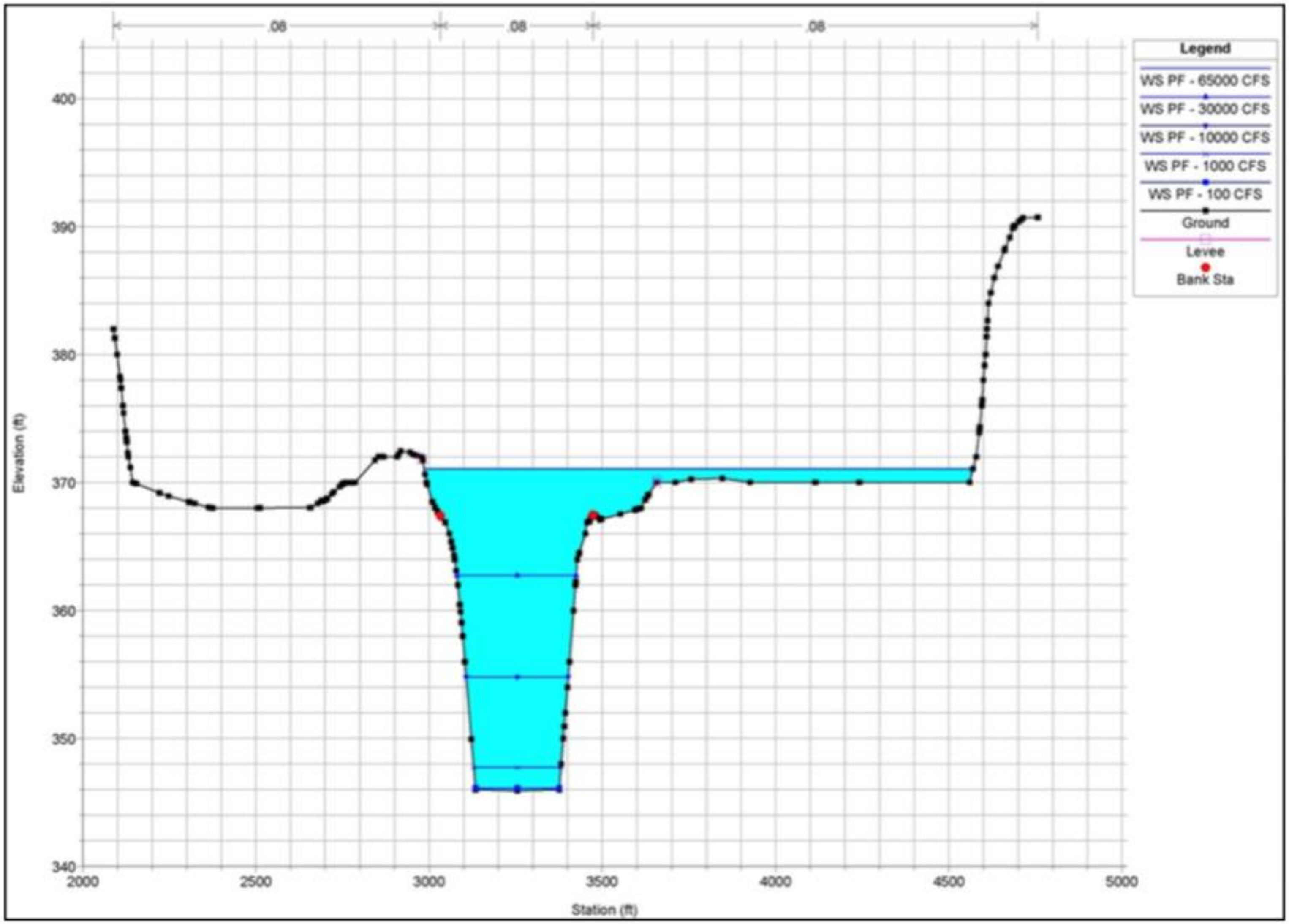


Figure 3-8 **Cross Section Downstream of Fletcher Drive (River Station 277+86.75).**

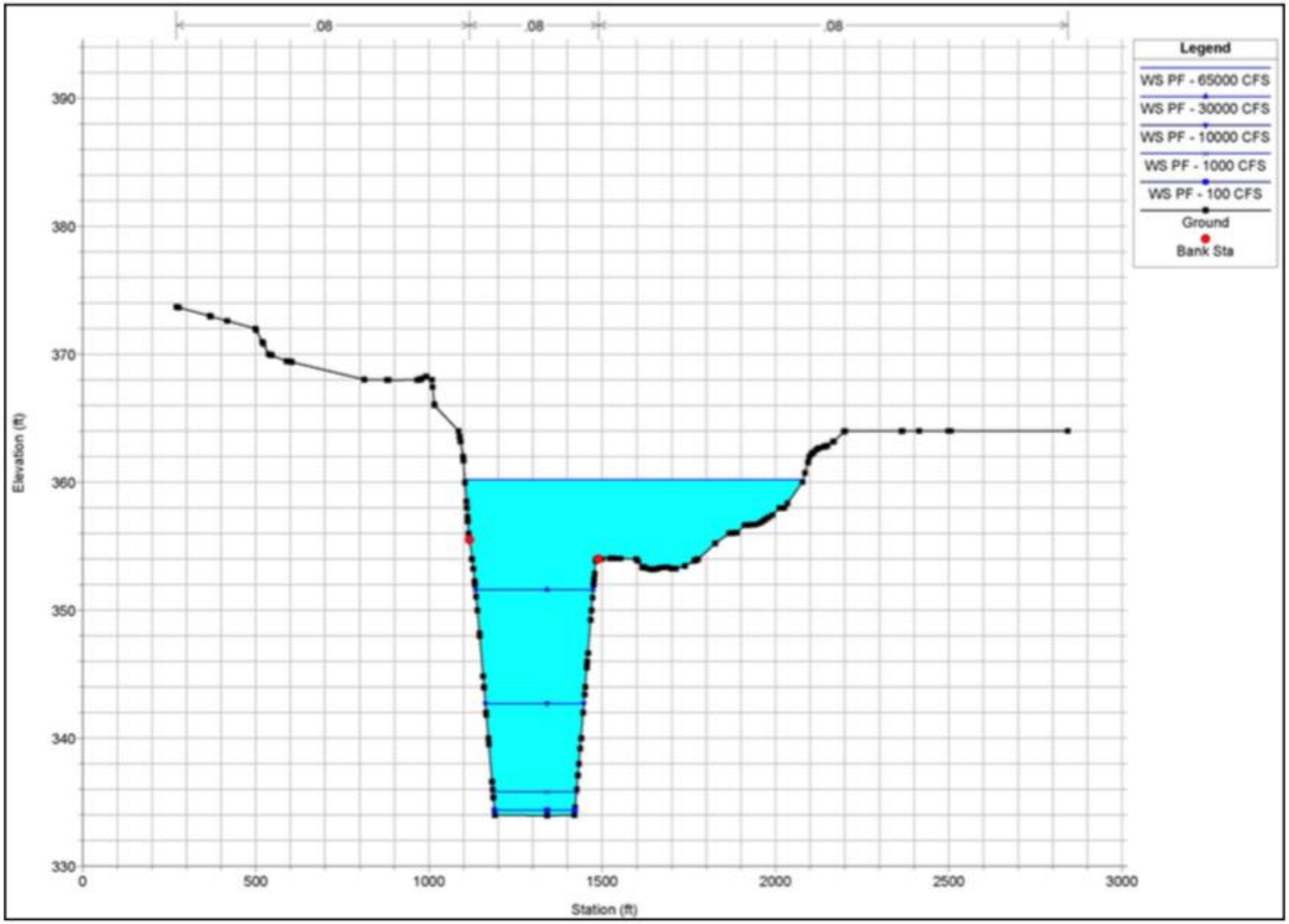


Figure 3-9 **Cross Section Near Taylor Yard (River Station 247+02.44).**

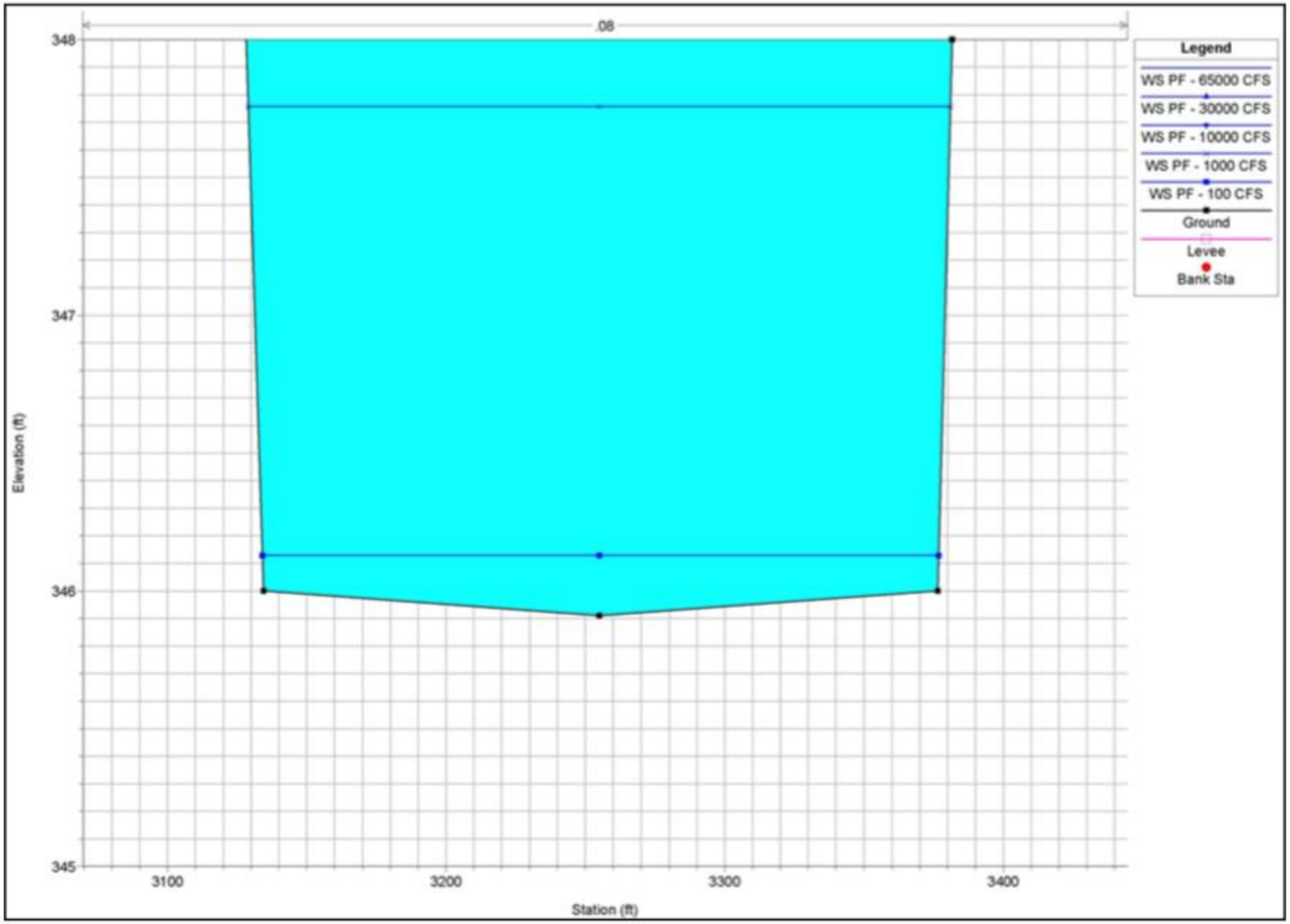


Figure 3-10 Typical Main Channel Section Without Low Flow Channel (River Station 277+86.75).

**Figure 3-11	Photo of Los Feliz Blvd to Hyperion Ave (Photo 257 taken Feb 27, 2015).**

**Figure 3-12	Photo of Hyperion Ave to River Station 298+20.79 (Photo 261 taken Feb 27, 2015).**

Figure 3-13 Photo of River Station 298+20.79 to Fletcher Dr (Photo 268 taken Feb 27, 2015).

Figure 3-14 Photo of Fletcher Dr to Glendale Freeway (Photo 276 taken Feb 27, 2015).

Figure 3-15 Photo downstream of Glendale Freeway (Photo 281 taken Feb 27, 2015).

Figure 3-16 Photo near Taylor Yard (Photo 284 taken Feb 27, 2015).

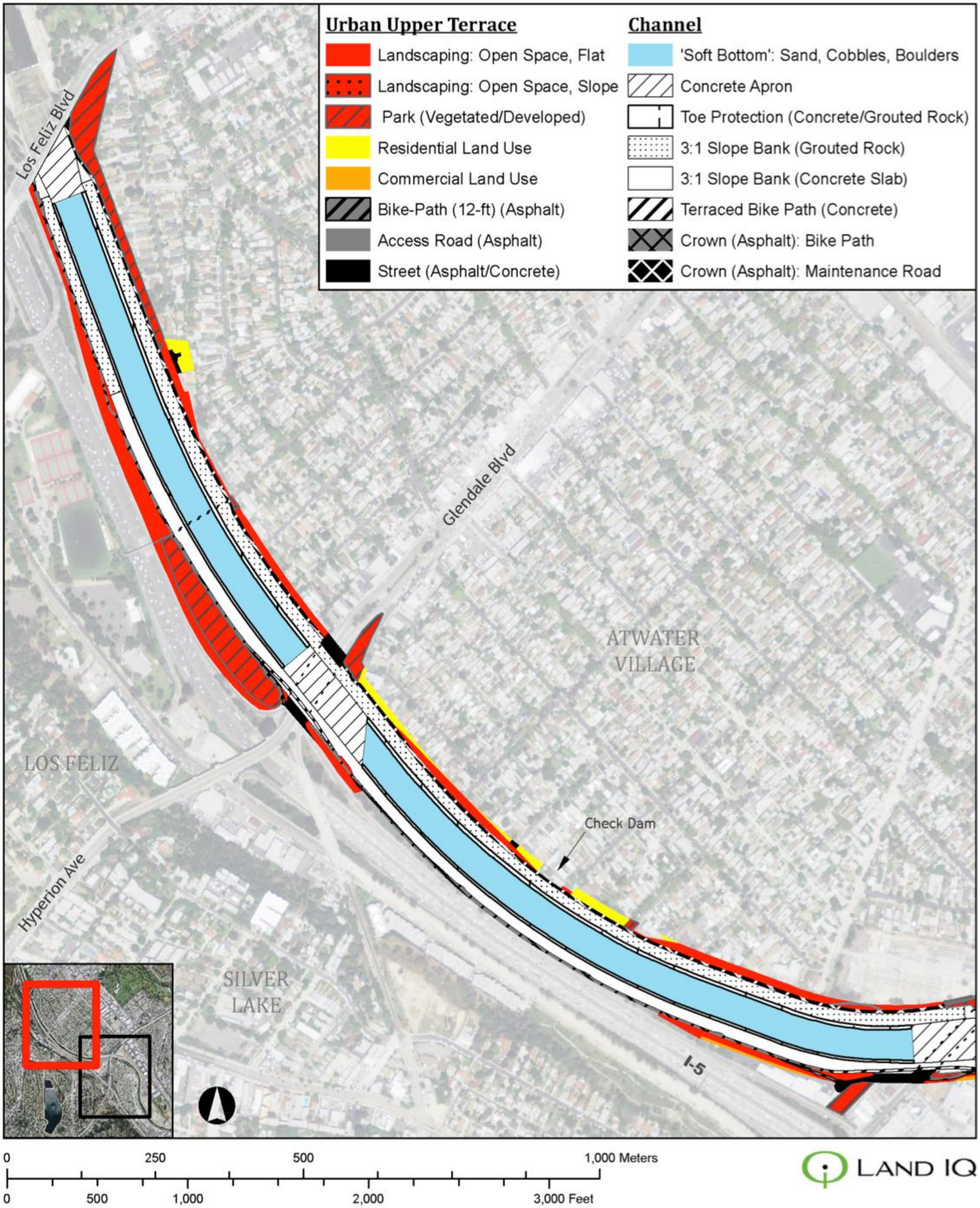


Figure 3-17 Landscape features and substrates of the Los Angeles River in the Elysian Valley (1 of 2).

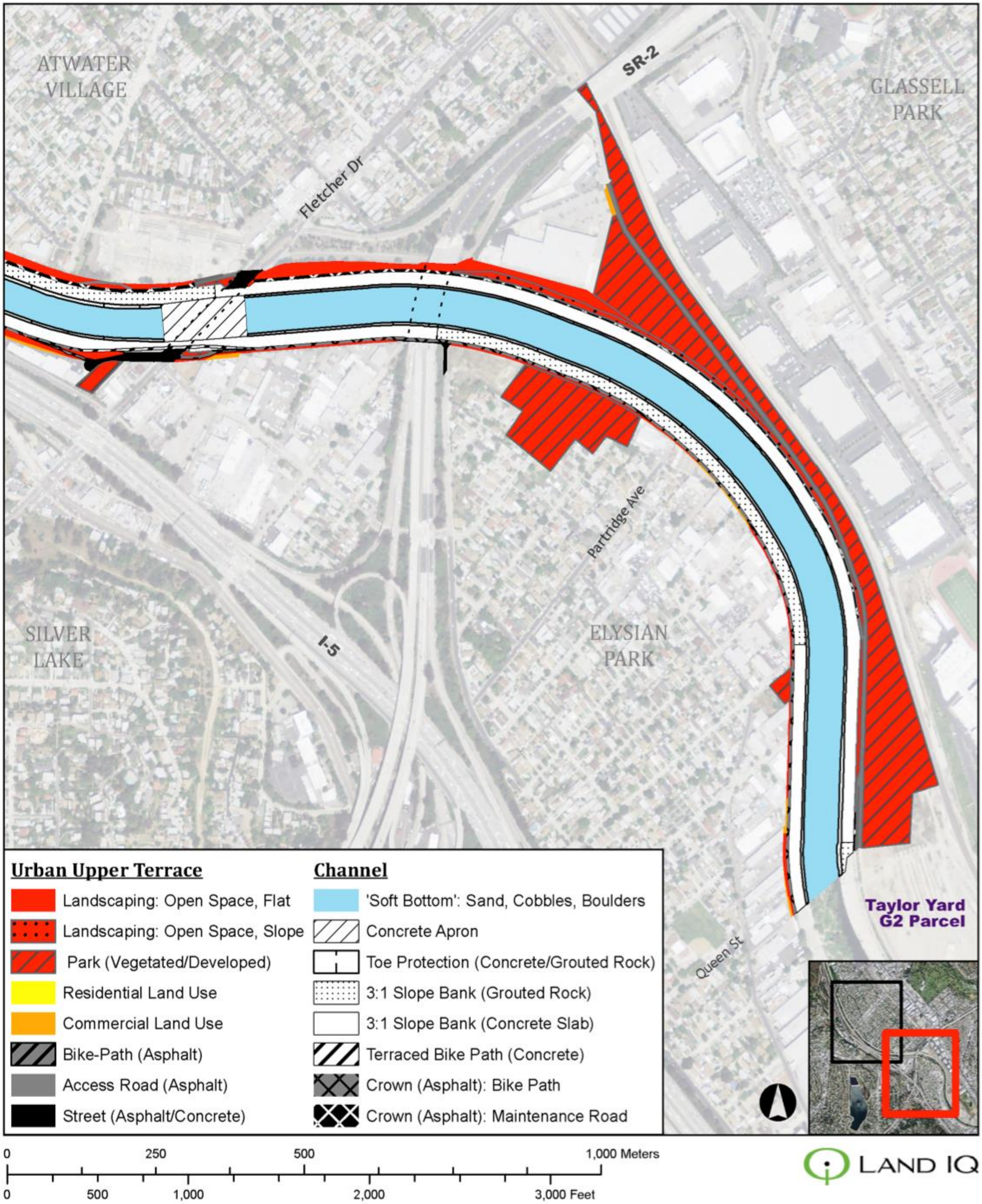


Figure 3-18 Landscape features and substrates of the Los Angeles River in the Elysian Valley (2 of 2).

Figure 3-19 Mean channel bar height above low flow Los Angeles River water in the Elysian Valley.

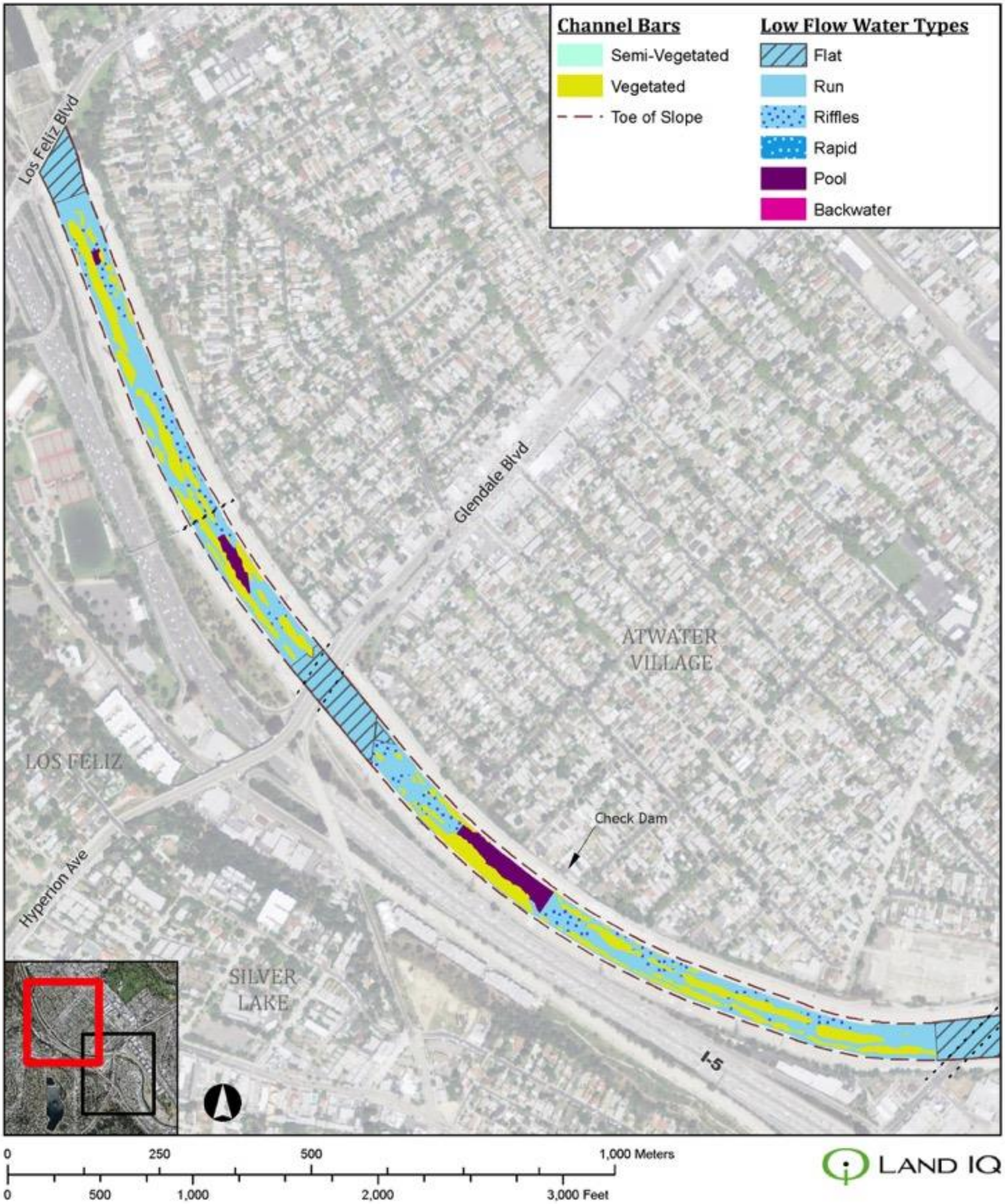


Figure 3-20 Low flow water types of the Los Angeles River in the Elysian Valley (1 of 2).

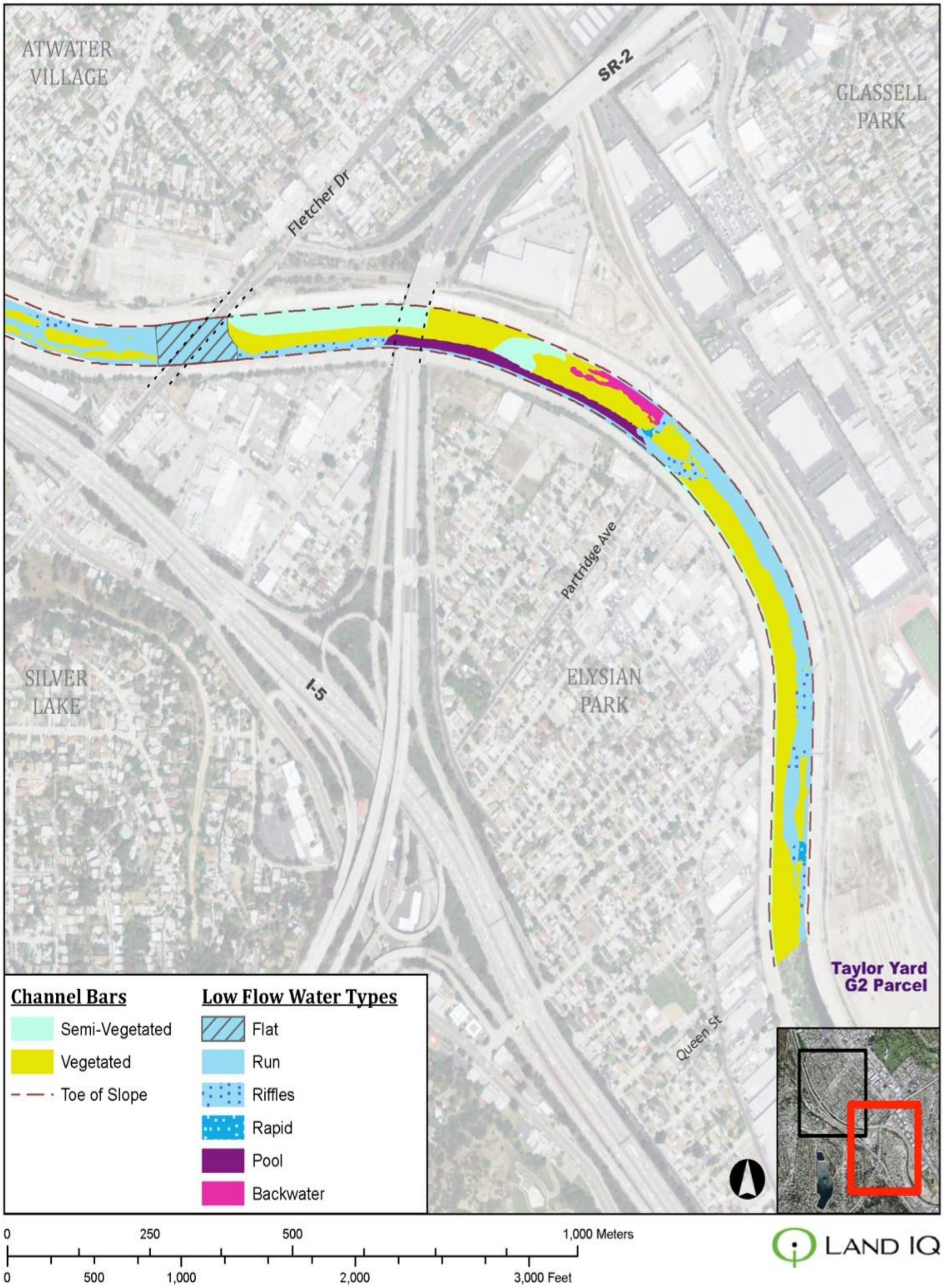


Figure 3-21 Low flow water types of the Los Angeles River in the Elysian Valley (2 of 2).

3.2.4. Rainfall Record

The long-term rainfall record (water years 1872/3 to 2014/15) from downtown Los Angeles is presented in Figure 3-22. This record is representative of rainfall trends in the study area; however, hydrology of the river channel is most influenced by rainfall that falls upstream in the Los Angeles River Watershed. Rainfall totals are often much greater in the foothills that contribute to flow in the Los Angeles River due to orographic effects on wet air masses. It should also be noted that rainfall in the watershed and flow in the River is moderated and managed by a series of flood control features, including dams. Yet, the urbanization of the Upper Los Angeles River Watershed, including the conversion of agricultural fields in the San Fernando Valley to more urban land uses since the 1960s, has increased flood hazards. This is due to a reduction in land available for rainfall infiltration and increased input of water to the Los Angeles County Flood Control System. In addition, future climatic variability may result from the impacts of a warming climate, leading to more frequent and higher intensity rainfall events in California. An example of this projection is the modeling that anticipates an increased hazard of flooding from "atmospheric rivers," which are tropical weather systems off the Pacific Ocean that are associated with major historical floods (Dettinger 2011).

The ten-year moving average is shown in Figure 3-22 to help identify decadal trends of above and below average rainfall. Periods of below average rainfall are referred to in human managed water systems as drought. Note that the past four years have been contributed to the beginning of a new drought period, compared with near or above average rainfall cumulative averages since the mid-1960s.

With respect to in-channel vegetation, the recent drought has not had an effect because dry weather flow in the River is not directly tied to watershed runoff. Instead dry weather discharge is primarily from three wastewater reclamation plants (WRPs) (Burbank, LA-Glendale and Tillman) upstream of the Elysian Valley.

3.2.5. Stormwater Discharge

Peak Annual discharges recorded in the past 17 years are presented in Figure 3-23. Stormwater discharges over 10,000 cubic-feet per second (cfs) may negatively impact establishing plants in a revegetation or habitat enhancement project of in-channel riverine habitat. For example, high water inundation or root erosion is detrimental to the health of the plants and may reduce or eliminate the restoration benefits. This depends highly on the flow hydraulic conditions as well as the river's responses to any hydraulic changes. Therefore, the high frequency of peak annual flows greater than 10,000 cfs will inform, and perhaps constrain, general habitat enhancement strategies for in-channel habitat.

Monthly and mean discharge for the same period is presented in Figure 3-24. June, July and August have the lowest recorded flows. In a very high rainfall event (e.g. March 15–16, 2003, 4.36 inches in 24-hrs, Figure 3-25D), it may take up to 48-hrs to return to baseflow.

The flood discharge table is included in Appendix D. Shown on the table is the 50-year flood design discharges (77,500 cfs for Reach 5 and 6A and 82,000 cfs for Reach 6B were used for the previous hydraulic analysis) as well as discharges for other return frequencies. The channel capacity table included in Appendix D shows that the channel is deficient for the design discharge in the study reach. This indicates possible constraints on the restoration extent, should a limitation on the allowable water surface increase be imposed.

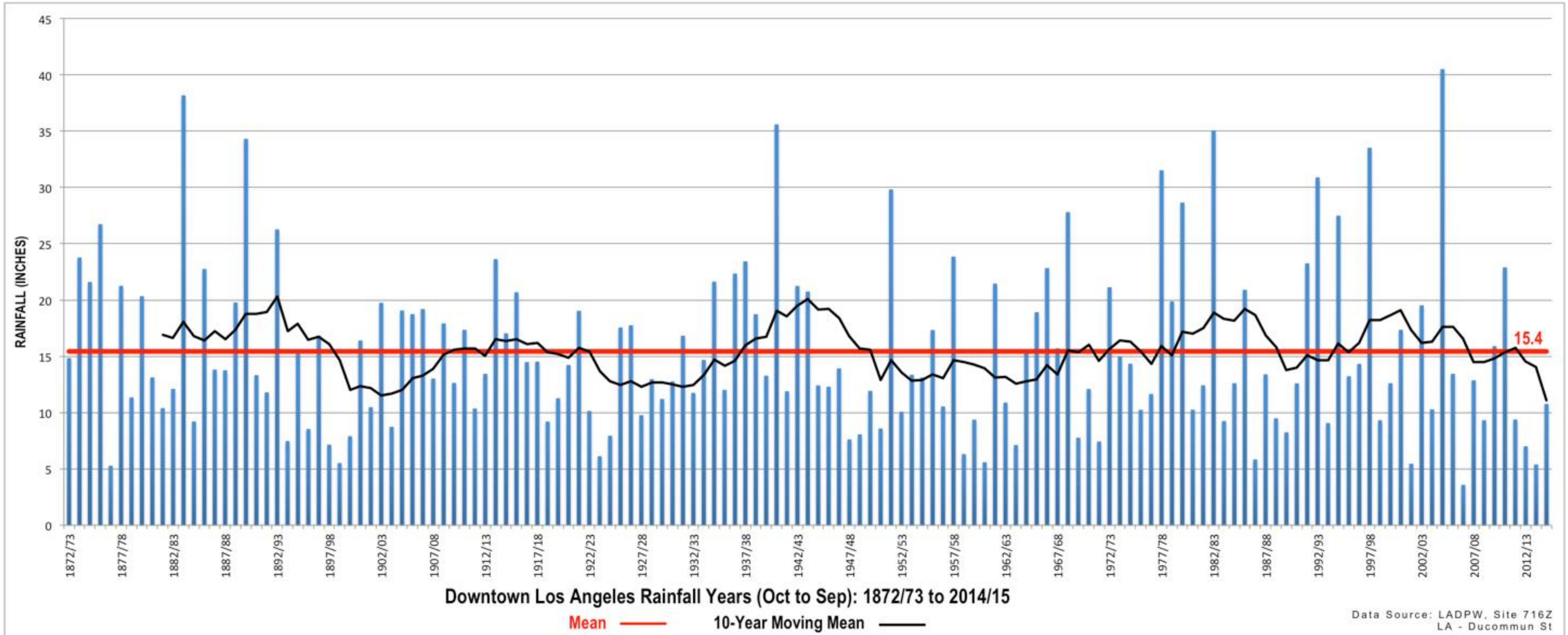


Figure 3-22 Downtown Los Angeles Long Term Rainfall Record, Water Years 1872/73 to 2014/15.

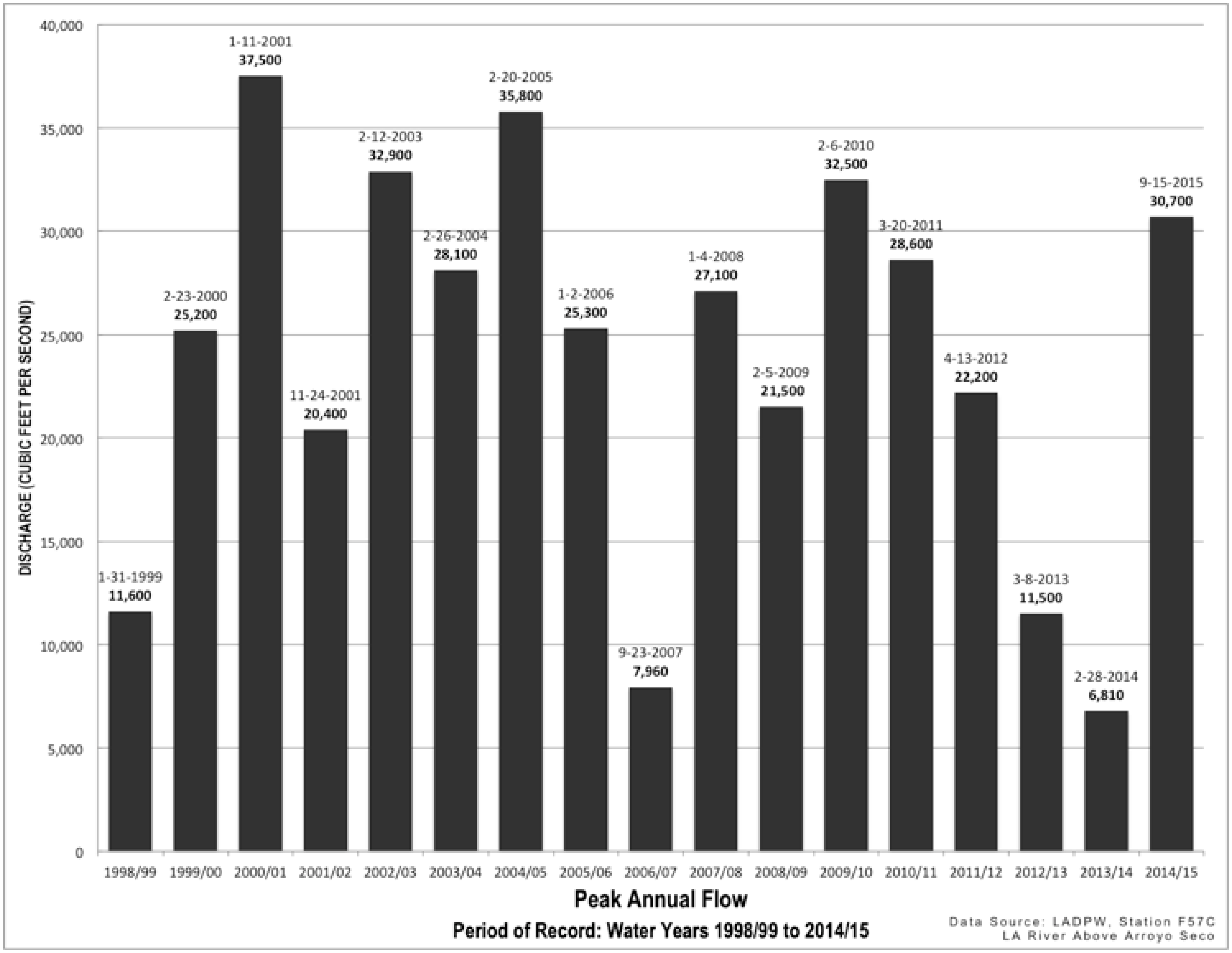


Figure 3-23 Peak Annual Flow in the Los Angeles River in the Elysian Valley, Water Years 1998/99 to 2014/15.

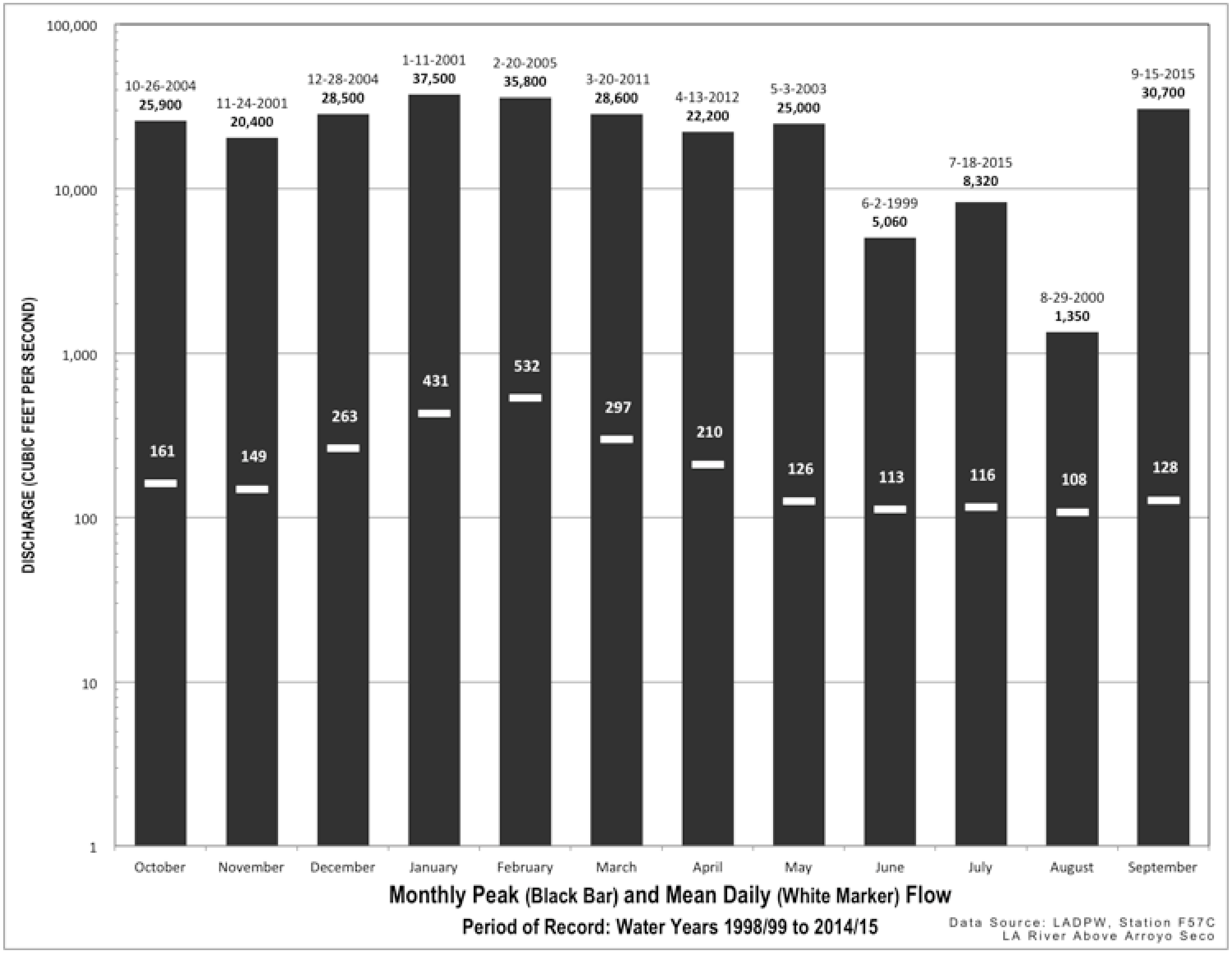
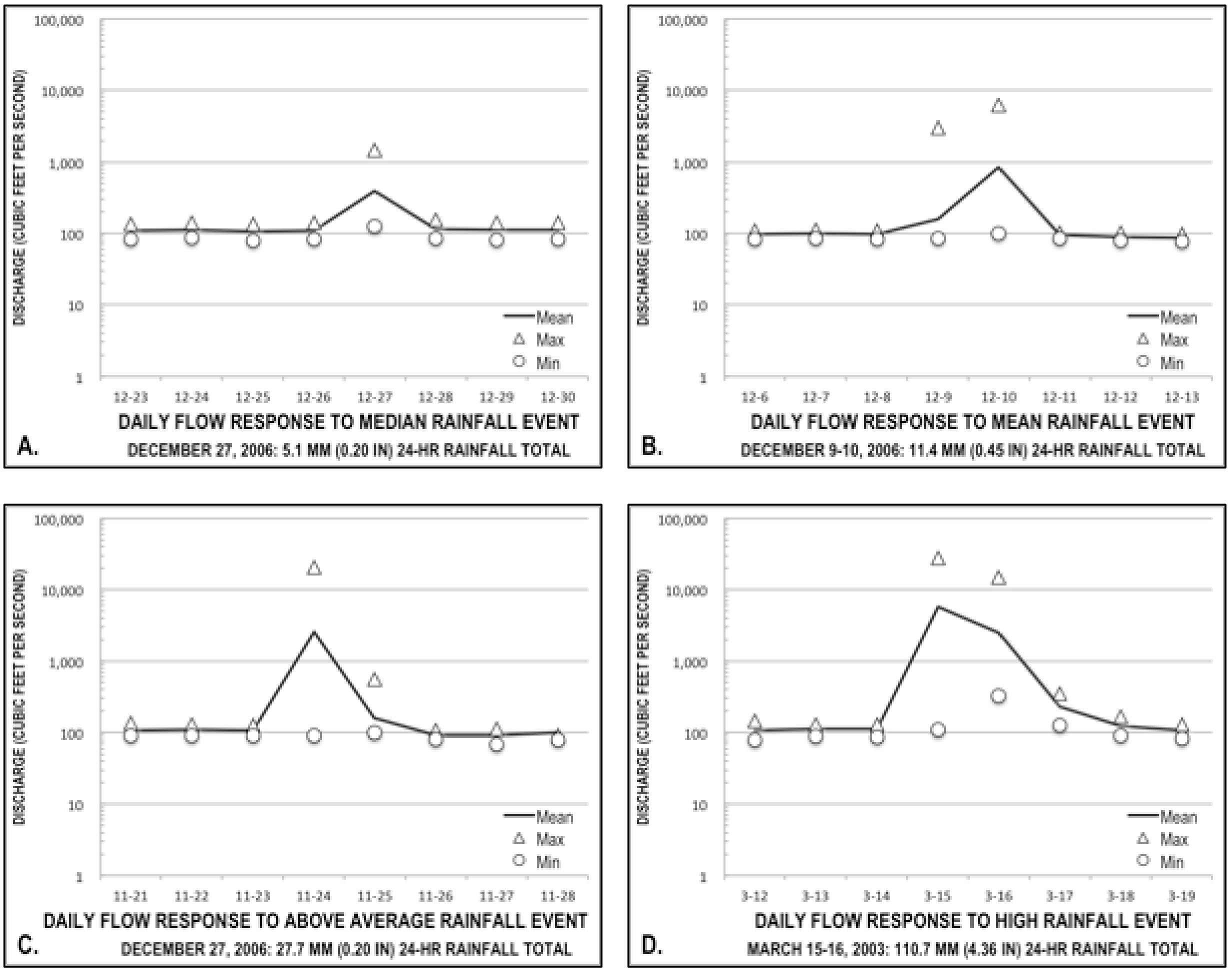


Figure 3-24 Monthly Peak and Mean Daily Flow in the Los Angeles River in the Elysian Valley, Water Years 1998/99 to 2014/15.



Data Source: LADPW, Rain Gage 716Z, LA-Ducommun St; Flow Gage F57C, LA River Above Arroyo Seco (1998/99 to 2014/15).

Figure 3-25 Dry down following rainfall events in the Los Angeles River in the Elysian Valley: (A) median, (B) mean, (C) above average and (D) high rainfall events.

3.2.6. Hydraulic Features

A HEC-RAS Model for the 2006 conditions was referenced in the IFR to identify the channel capacities and floodplain boundaries (see Appendix E). The Manning's n-values were defined as follows for the IFR:

- Scenario 1 low density: 0.045
- Scenario 2 medium density 0.060
- Scenario 3 high density 0.080

Note that the existing channel capacity is limited to 5-year flood capacity in Reach 5 and 6A (Stations 358+63 to 271+89) from Los Feliz Boulevard to Glendale Freeway. The capacity increases to 15-year flood in Reach 6A (Stations 270+28 to 262+73) and to 10-year flood in Reach 6B (Stations 257+85 to 144+23). These were based on given boundary conditions at the upstream and downstream end stations of the ARBOR Reach (Stations 692+94 and 10+31). As the results of channel deficiency, the 100-year and 500-year floodplain boundaries are beyond the channel banks (see Appendix E).

An independent evaluation by WRC for this report confirmed that the hydraulic capacity is limited to near 30,000 cfs, considering high-density vegetation and 3 feet freeboard in the levee reach. Table 3-1 shows the water depths and velocities for Station 277+86.75 (downstream of Fletcher Drive, see Figures 3-8 and 3-10) for three Manning's n-values selected in the IFR to represent a range of vegetation densities and sizes: "heavy" (n=0.08); "moderate" (n=0.06); and "minimum" (n=0.045). The bank full depth is approximately 20 feet and the water depth for a 30,000 cfs (less than 5-year flood) is 17 feet, leaving a depth to the bank of 3 feet under the high-density vegetation conditions. The channel would be able to contain a 10-year flood with freeboard or 25-year flood without freeboard under the low-density vegetation condition. For more detailed restoration design, an area targeted for restoration (such as this station) versus an area not suitable for planting (such as downstream of Hyperion Boulevard) must be evaluated using appropriate flow resistance factor representing various vegetation conditions. Based on Table 3-1, floods equal to or exceeding 30,000 cfs have a greater risk to damage established vegetation, not only due to larger inundation depths but also the erosive velocities. Based on the Los Angeles County velocity criteria (see Appendix D), 6 fps is a commonly acceptable threshold velocity prior to major riverbed movement. Note that this table was constructed to be compatible to the Manning's n-values defined in the IFR. Typically, the erosive force of an earthen channel should be evaluated using a Manning's-n of 0.025. For more conservative high water assessment, a Manning's n-value of 0.1 should also be evaluated.

3.2.7. Erosion and Sedimentation

Based on limited assessment performed for this study, in-channel restoration can be successful, given the right strategies as discussed below in Section 3.3, Hydraulic Data Findings. The sediment and flow conditions seem to support a fairly stable river morphology that is dynamic but has the ability to balance the sediment transport through the reach. Habitat degradation in reaches from Hyperion Boulevard to Station 298+20.79 and from Fletcher Drive to Station 253+83 actually caused imbalanced sediment transport and can be beneficial with the right strategies of restoration.

Table 3-1 Hydraulic Parameters (ARBOR River Station 277+86.75).

	Water Depth (ft)		
Q (cfs)	n=0.045	n=0.06	n=0.08
65,000	19.31	22.41	25.17
30,000	12.33	14.29	16.82
10,000	6.35	7.57	8.92
1,000	1.03	1.43	1.85
100	0.22	0.22	0.22

	Channel Velocity (fps)		
Q (cfs)	n=0.045	n=0.06	n=0.08
65,000	11.21	9.16	7.57
30,000	8.77	7.4	6.12
10,000	6.09	5.04	4.2
1,000	4.14	2.95	2.25
100	2.37	2.37	2.37

3.2.8. Water Quality

Both urban stormwater and dry weather urban runoff from pervious and impervious surfaces are sources of poor water quality, which frequently exceed various water quality criteria in the Los Angeles basin (SCCWRP 2007).

The Los Angeles River is listed as impaired water under the Clean Water Act for the following pollutants: ammonia, copper, cyanide, indicator bacteria, lead, benthic macroinvertebrates, nutrients (algae), oil, selenium, and trash. Total maximum daily loads (TMDLs) in the River watershed, which includes upstream of and within the study area, have been developed for bacteria, metals, nutrients, and trash pollutants. See the ARBOR Study for a summary and review of TMDL standards and additional background information. New water quality data was not collected for this study.

Currently, treated wastewater is discharged from three water reclamation plants (WRPs), which serve to dilute urban runoff in the dry weather (non-flood) flow. In the 2012/13 water year 80.9% of the non-flood surface flow was from the three water reclamation plants that contribute discharge to the channel in the study area: Burbank WRP = 10.7%; LA-Glendale WRP = 18.5%; and Tillman WRP = 51.7%. The remaining discharge was from a combination of industrial, urban runoff, and undetermined sources (including some storm water) (16.6%) and rising groundwater in the Narrows (2.5%).

The potential for decreased discharges from the WRPs due to increased recycled water use by municipalities to reduce reliance on costly and unreliable water imports into the San Fernando Valley, could have direct impacts on water quality because of the large dilution factor they currently provide.

3.2.1. Dry Weather Water Supply

The Study Area has a dry weather base flow of approximately 100 cfs (see Figure 3-26). Three wastewater reclamation plants (WRPs) (Burbank, LA-Glendale and Tillman) contribute more than 80% of the non-flood flow (see Table 3-2). In the 2012/13 water year, total discharge from the WRPs were, as follows:

- Burbank = 7,422 acre-feet (10.3 mgd, million gallons per day)
- LA-Glendale = 12,898 acre-feet (11.5 mgd)
- Tillman = 35,961 acre-feet (34.8 mgd)

Per Upper Los Angeles River Area (ULARA) Watermaster annual reports (based upon LA Department of Public Works compiled data), rising groundwater in the study area has ranged between 1 to 7 mgd, since 1928. This represents 1.6 mgd or 2.5% of non-flood flow in the 2012/13 water year. Additionally, another 1 to 11 mgd of flow is from industrial, urban runoff and unaccounted flow (including some storm water flow). The non-flood flow in the 2012/13 water year was 10.3 mgd or 16.6%.

Dry weather surface water flow, or non-flood flow, has been a median of 107 cfs since the second phase of the Tillman WRP coming online in 1991. As seen in Figure 3-26, WRPs contribute significantly to dry weather flow, beginning in 1966 with the first discharges from the Burbank WRP. Prior to 1966, discharge was a median of 3.5 cfs. And, prior to 1938 when the channel bed was excavated as part of the USACE channelization of the River, flows were even lower (median of 1.2 cfs).

Figures 3-27 and 3-28 depict the relative components of dry weather and storm flow from the 1928 to 1957 water years. In the 1930s and 1940s there were discharges of excess Owens River-Los Angeles Aqueduct River Water; however, that ceased by the early 1950s. Since 1966, WRPs have comprised the majority of dry weather flow.

Rising groundwater is persistent, although in the late 1920s and early 1930s, rising groundwater was essentially zero due to extensive groundwater pumping and extraction of subsurface water by infiltration galleries to the City of Los Angeles. The City of Los Angeles is incentivized to use all of the available surface and subsurface flows from the San Fernando Valley due to a legally recognized "pueblo water right," which is essentially a "use it or lose it" water right. The amount of water extraction by the City has varied throughout the years, and decreased precipitously in the 1980s with the discovery of contaminated groundwater from uncontrolled industrial discharges of organic compounds. Contaminated groundwater plumes are designated by the EPA as various Superfund Sites within the Valley; and, the groundwater contamination affecting the Pollock Wells is currently being remediated by the City of Los Angeles and is not a Superfund Site. The impact of groundwater pumping in the Elysian Valley should be further investigated prior to development of site specific projects to determine how groundwater pumping, either for remediation or for use by leaseholders may impact the hydrological connection of plant species that rely upon available groundwater for persistence. Research is also necessary to show how depth of groundwater may impact the appropriate habitat type selected for habitat enhancement and creation projects.

Table 3-2 Components of Dry Weather (Non-Flood) Surface Water Flow, Selected Water Years

	Annual Dry Weather (Non-Flood) Surface Water Flow in acre-feet						
Water Year	Total[1]	Rising Groundwater in Narrows[1]	Owens River Water Discharges[1]	Industrial, Irrigation Runoff & Unaccounted Flow[1,3]	Burbank WRP[1]	Los Angeles-Glendale WRP[1]	Tillman WRP[1]
Late 1800s	**1,500-7,000**[2] estimated	**1,500-7,000** (1.3-6.2 mgd) [100%]	NA	NA	NA	NA	NA
1928-29	**650** (0.58 mgd)	---	**650** (0.58 mgd) [100%]	---	NA	NA	NA
1951-52	**6,290** (5.6 mgd)	**3,110** (2.8 mgd) [49.5%]	**1,430** (1.3 mgd) [22.7%]	**1,750** (1.5 mgd) [27.8%]	NA	NA	NA
1971-72	**11,821** (10.6 mgd)	**3,602** (3.2 mgd) [30.5%]	---	**5,126** (4.6mgd) [43.3%]	**3,093** (2.8 mgd) [26.2%]	NA	NA
1982-83	**21,070** (18.8 mgd)	**3,460** (3.1 mgd) [16.4%]	---	**9,922** (8.8 mgd) [47.1%]	**4,670** (4.2 mgd) [22.2%]	**3,018** (2.7 mgd) [14.3%]	NA
1993-94	**91,083** (81.3 mgd)	**2,952** (2.6 mgd) [3.2%]	---	**7,071** (6.3 mgd) [7.8%]	**5,320** (4.8 mgd) [5.8%]	**12,576** (11.2 mgd) [13.8%]	**63,164** (56.4 mgd) [69.4%]
2004-05	**77,137** (68.9 mgd)	**6,309** (5.6 mgd) [8.2%]	---	**9,186** (8.2 mgd) [11.9%]	**8,119** (7.2 mgd) [10.5%]	**11,378** (10.1 mgd) [14.8%]	**42,145** (37.6mgd) [54.6%]
2012-13	**69,619** (62.1 mgd)	**1,754** (1.6 mgd) [2.5%]	---	**11,584** (10.3 mgd) [16.6%]	**7,422** (6.6 mgd) [10.7%]	**12,898** (11.5 mgd) [18.5%]	**35,961** (34.8 mgd) [51.7%]

1. Values from: LADPW, LA River Gage F57C, above Arroyo Seco Confluence; ULARA/DWR Water Master Annual Water Year Reports from 1968/69 to 2012/13; and Report of Referee Vol.2 1962. Values reported as million gallons per day (mgd) are annualized values, and actual daily flow from non-flood sources is variable throughout the year. WRP = Water Reclamation Plant.
2. Range based on contemporary estimates of rising groundwater.
3. Unaccounted Flow includes some storm flow.

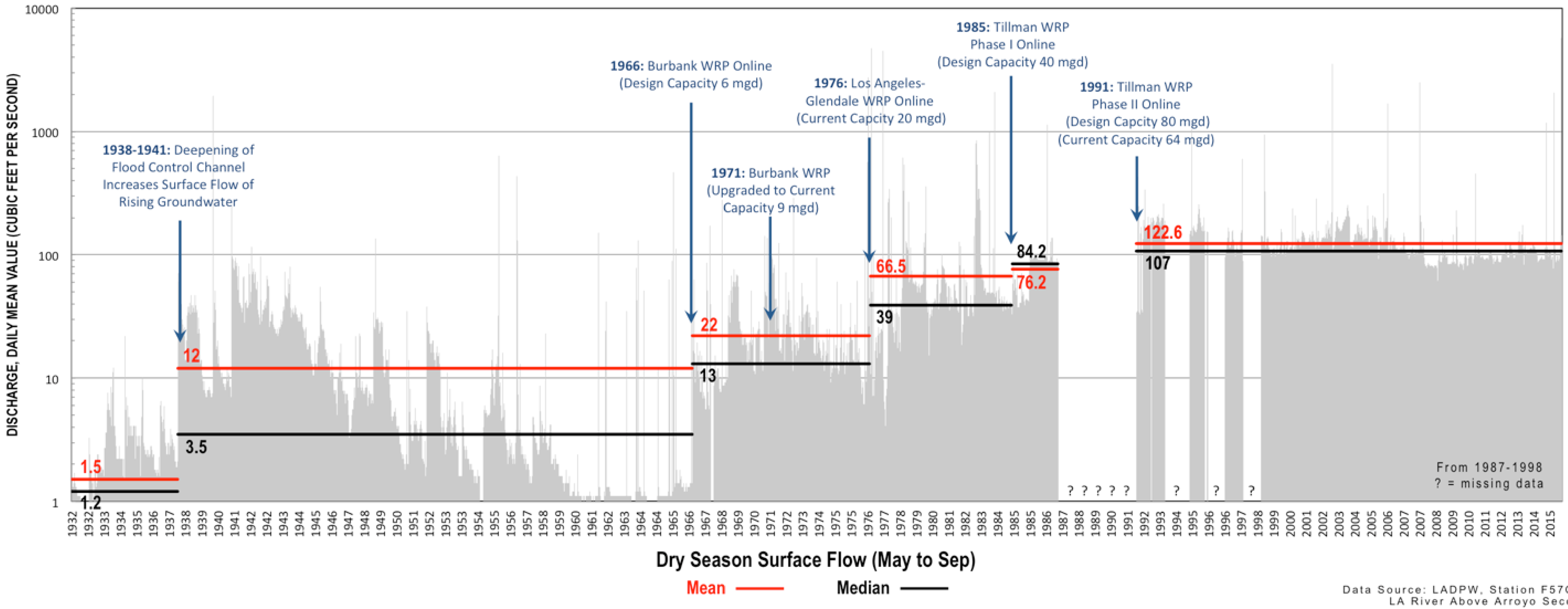


Figure 3-26 Dry Weather Flow in the Los Angeles River in the Elysian Valley, Water Years 1932/33 to 2014/15.

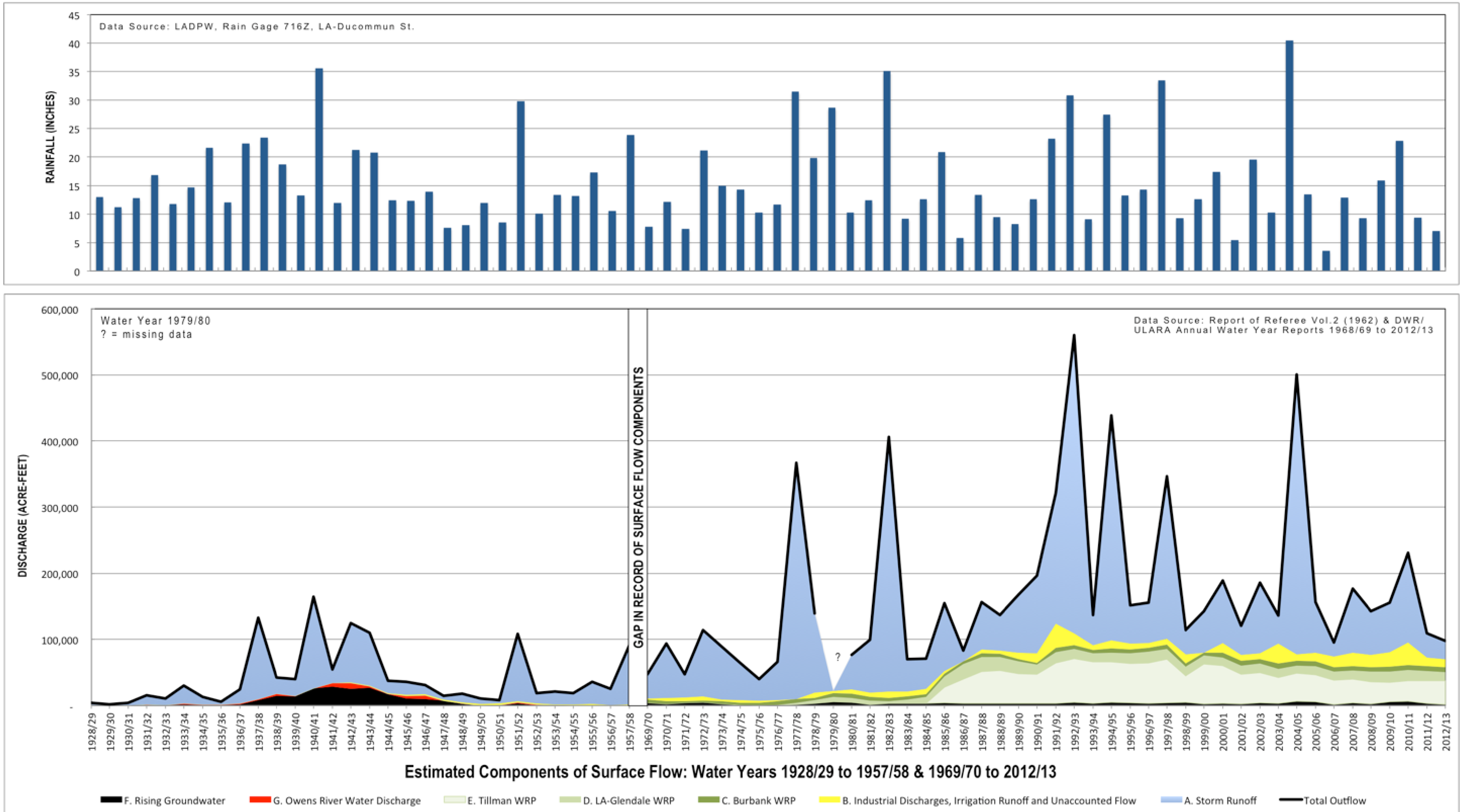


Figure 3-27 **Estimated Components of Surface Flow and Rainfall Totals: Water Years 1928/29 to 1957/58 and 1969/70 to 2012/13.**

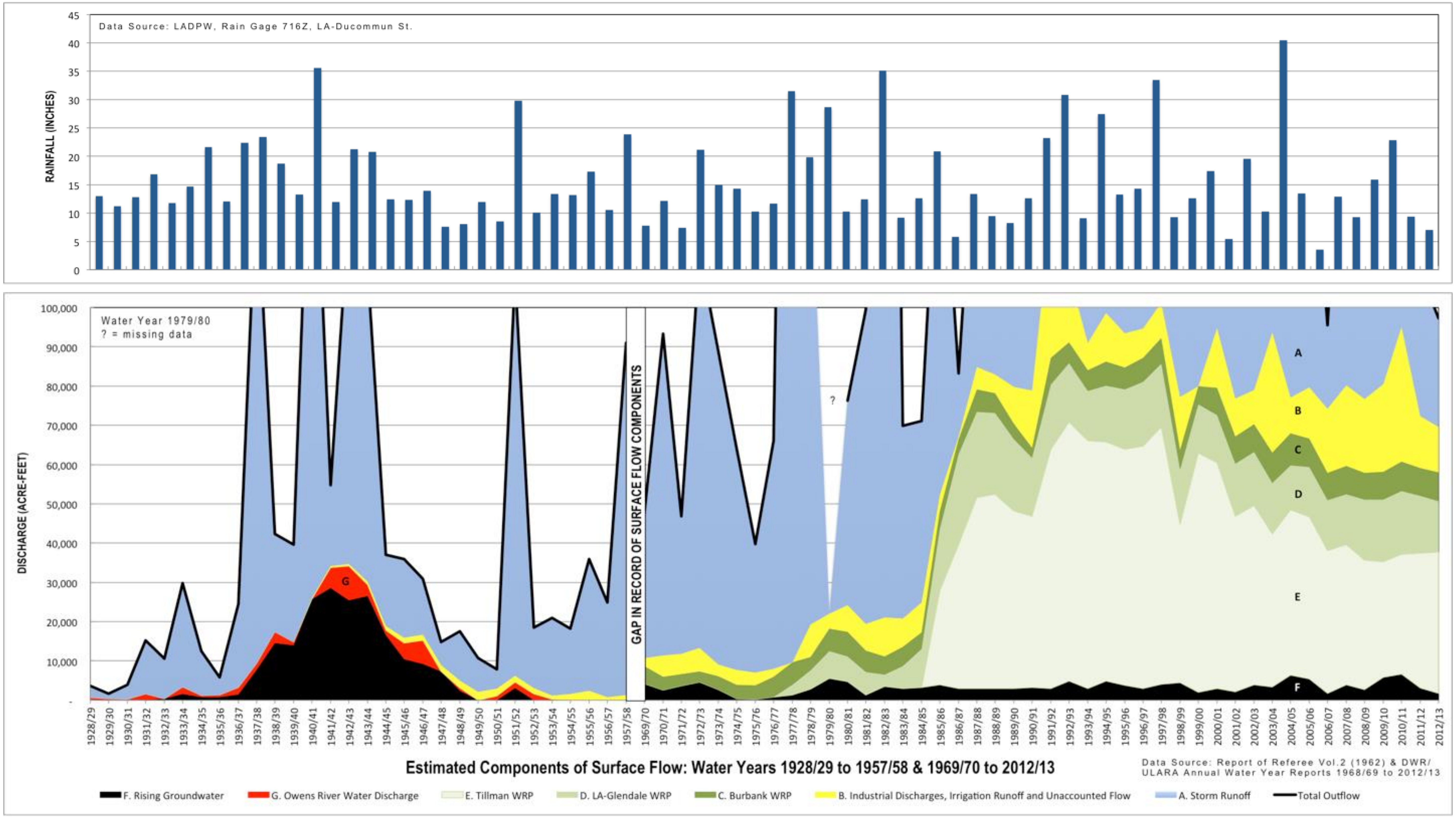


Figure 3-28 Detail of Estimated Non-Flood Surface Flow Components and Rainfall Totals: Water Years 1928/29 to 1957/58 and 1969/70 to 2012/13.

3.3. Hydraulic Data Findings

Although the Army Corps IFR contains a vast amount of information for alternative selection, it is lacking fundamental data and technical analysis to document the baseline hydraulic "project condition" in the study area.

In order to achieve in-channel habitat restoration project design and implementation, and to define a comprehensive monitoring plan, the following fundamental data are required:

- Flood control protection design criteria that are acceptable to applicable government agencies (USACE, Cities within Los Angeles County, Los Angeles County, Federal Emergency Management Agencies) and affected residences, given that most reaches are extremely deficient in confining the design flood; Alternatively, a self-mitigating design must be provided with special design features to offset the restoration impacts.
- Hydraulic model that incorporates detailed topography of the low flow condition (non-flood, dry weather), which most relates to the selection of ecologically appropriate native habitats for restoration, restoration project transplant and seed establishment, operation and maintenance.
- Baseline characteristics of low flow (e.g. width, depth, sinuosity, urban runoff inflows), channel bar stability and seepage and groundwater flows.
- Rising groundwater and subsurface hydraulics and water quality.
- Optimal flow distribution across the river in support of planting suitability and sustainability, which may be derived by acquiring a more recent LIDAR dataset with improved detection of low-lying areas within the channel and under foliage, combined with a ground truth survey.
- Clear definition of the baseline condition for in-channel vegetation to inform technical analysis, assessment of "project impact" and for performance evaluation of restoration efforts.

3.4. In-Channel Habitat Restoration Strategies

Within the existing channel bed, there is a water supply for dry weather periods, and sufficient water for a range of riparian vegetation will continue to be available from rising groundwater even if there is a reduction or cessation of discharge from water reclamation plants. Rising ground water will help sustain the moisture needed for native vegetation. Native plants may be dormant during summer seasons in response to drought stress, but should recover as soon as the flow returns or groundwater rises. For site-specific project design, further modeling will be needed to provide detailed topographic features for the river bottom.

Young plants in a restoration effort may sustain low-flow velocities for floods up to 10,000 cfs, and mature plants may survive through a two-year flood. Planning for an appropriate weather condition to avoid major storm damages is a key factor for successful establishment of new transplanted species.

Following the establishment period, as more vegetation establishes, the velocity of water flow will be reduced and the likelihood for plant survival will increase during more frequent flood events.

There are, however, several constraints, which must be considered for restoration in-channel. These include, but are not limited to:

- Ecological discontinuity by large structures such as long concrete piers and the invert control structure at Hyperion Boulevard/Glendale Boulevard.
- Insufficient flow distribution within the wide river bottom under the existing condition.
- Conflicts of the River use for recreation versus restoration.
- Proper flow distribution and water supply for the benefit of plant survival during dry weather.
- Flood capacity impacts due to increase of the vegetation density.
- Non-native plants which will reduce the flood capacity and threaten the survivability of native riparian plants.
- High velocities for floods exceeding the 10-year flood level, which may damage restored plants and species.
- Slope stabilization impacts due to the removal of concrete or riprap stones.

The existing channel reaches are not equal in terms of stream health and habitat quality. Most reaches have a common problem: The limited capacity of the stream. The flood capacity of the existing channel is insufficient to contain a typical design flood with the required freeboard (3 feet for the levee reach); therefore, in-channel restoration efforts must be planned considering all factors, including, but not limited to, the existing vegetation, the channel capacity and erosion protection.

Based on the assessment presented previously, the reach from Los Feliz Boulevard to Hyperion Boulevard including the Sunnynook Trail crossing has a healthy stream system with normal erosion and sedimentation patterns and moderate vegetation cover. This levee reach has low-lying ground outside of the channel and has exceptionally low capacity. Given the current channel design, restoration efforts are encouraged with the objectives of increasing the quality of habitats and stabilizing the riverbed against erosion by winter storms; however, higher density of vegetation is not encouraged due to flooding concerns in this reach.

The reach from Hyperion Boulevard to 1,000 feet downstream of Fletcher Drive (near Station 312+00) is a levee reach with significant disturbance to the riverbed. This area is barren and may provide the best opportunities for planting. However, plants would not survive the turbulent flow downstream of the bridge piers without some type of flow regulation. Cautious consideration may avoid wasteful restoration efforts. Restoration efforts can be emphasized in aquatic habitats with medium density, high quality plants.

Further downstream, away from the disturbed area and before Fletcher Drive, the channel is not a reach with levees, but the capacity is limited. The defined divided flows have supported the existing vegetation. Given the existing dry weather flow regime, one restoration strategy would be to discourage the deepening of the defined divided flows to allow for higher quality vegetation establishment, unless aquatic habitat is a primary objective.

From Fletcher Drive to near the end of the study reach, the low flow is confined in a straight-defined low flow channel. The low-flow channel is along the right (south) bank upstream of the Glendale Freeway and is along the left bank downstream of the freeway. As stated before, this low-flow branch has been utilized for kayaking, but maintaining flow depth and velocity for kayaking is a recreational objective that conflicts with the need for restoring a healthy river. Given the existing dry weather flow regime, one restoration strategy is to identify the geomorphology that may be beneficial to both objectives. This may involve a shallow but wide meandering channel through the elevated riverbed, providing moisture to nourish the area outside of the existing low-flow channel. Additionally, high-quality planting can be established along the low-flow channel. If this cannot be achieved, the conflicting uses must be negotiated to derive a more optimal solution for restoration.

3.5. Alternative Watershed Hydrology Scenarios

In reviewing available hydrologic and hydraulic data for the Los Angeles River in the Elysian Valley, it is recognized that there is not one single management plan for the Los Angeles River watershed ecosystem as a whole. Based on the drivers of the jurisdictional agency involved, there are different narratives for what the hydrology of the system should be. Until there is consensus on the most appropriate hydrologic characteristics of the system, there will be inconsistency between stakeholders and lack of clarity for project design at the site scale. A common narrative for the entirety of the Los Angeles River and its watershed is needed in order to enable partnership and coordinated "collective impact" for the work of all stakeholders at the project level.

Watershed hydrology is a key driver of both the type of habitat can be established and its relative ecological value (e.g. biodiversity, resiliency). Stormwater flows determine constraints on vegetation within the soft-bottom reaches of the River, both in terms of flood carrying capacity of the channel and high velocity floods that may damage in-channel restored plants and species. Dry weather hydrology and groundwater levels are critical for determining appropriate habitat restoration opportunities and design.

There are four possible systems-level watershed hydrology scenarios identified, from which the habitat enhancement project opportunities identified in Section 6 can be evaluated for the Elysian Valley project area. Figure 3-29 depicts the typical range of annual stormwater flow (top of figure in blue bars) and dry weather flow (bottom of figure in green bars) for the historic condition, and for each of the Watershed Hydrology Scenarios.

Scenario 1: Existing Condition

- In-Channel Result Compared to Historic Condition: Higher Dry Weather Flows & Higher Peak Flood Flows

  The cumulative result of infrastructure management choices in the watershed up to this point have led to higher than historic peak flood flows from urban land uses and high levels of treated wastewater released into the River during dry weather.

  The higher flood flows have increased the infrastructure capacity required to protect against flood impacts, which makes integrating recreational and urban amenities into the River highly constrained. This is the primary technical constraint for the strategies identified in both the Army Corps' IFR, and the City's River Revitalization Master Plan. Reducing these flow volumes would assist both of those efforts.

  Dry weather flows from water reclamation plant effluent prevents the River from achieving a more historic condition, which is required by some native wildlife species adapted to this semi-arid ecosystem. The year round flows generally favor non-native species and reduce biodiversity and habitat resiliency.

Scenario 2: Stormwater Capture Focus

- In-Channel Result Compared to Historic Condition: Higher Dry Weather Flows & Higher Peak Flood Flows, But Lower Peak Flood Flows than Existing Condition

  This scenario would be achieved if the upstream water reclamation plants limited additional reuse of their effluent water, but stormwater capture was implemented at a broad scale throughout the watershed. This outcome would depend on the separate management decisions of different local agencies that are largely driven by the priorities of State funding sources and regulatory programs.

  This is the scenario that is the most consistent with the design assumptions of the Army Corps' Ecosystem Restoration Feasibility Study and the City of Los Angeles' River Revitalization Master Plan. The lower flows during wet weather would provide a greater level of protection to infrastructure in the riparian zone during rain events. The higher flows during dry weather support a recreational experience that has water in the River year round, which is similar to the rivers people associate with temperate climates. However, many of the native riparian species are adapted to a drier period each year, so the existing higher dry weather flows means it is not as effective at supporting native species, biodiversity or ecological resiliency.

Scenario 3: Effluent Recycling Focus

- In-Channel Result Compared to Historic Condition: Similar, But Higher Dry Weather Flows from Urban Runoff & Higher Peak Flood Flows

  This scenario would be achieved if water reclamation plants upstream did not discharge to the River and instead recycled the water for a beneficial use that reduced demand for imported water, and if stormwater capture efforts were not undertaken throughout the watershed. This outcome would depend on the separate management decisions of different local agencies that are largely driven by the priorities of State funding sources and regulatory programs.

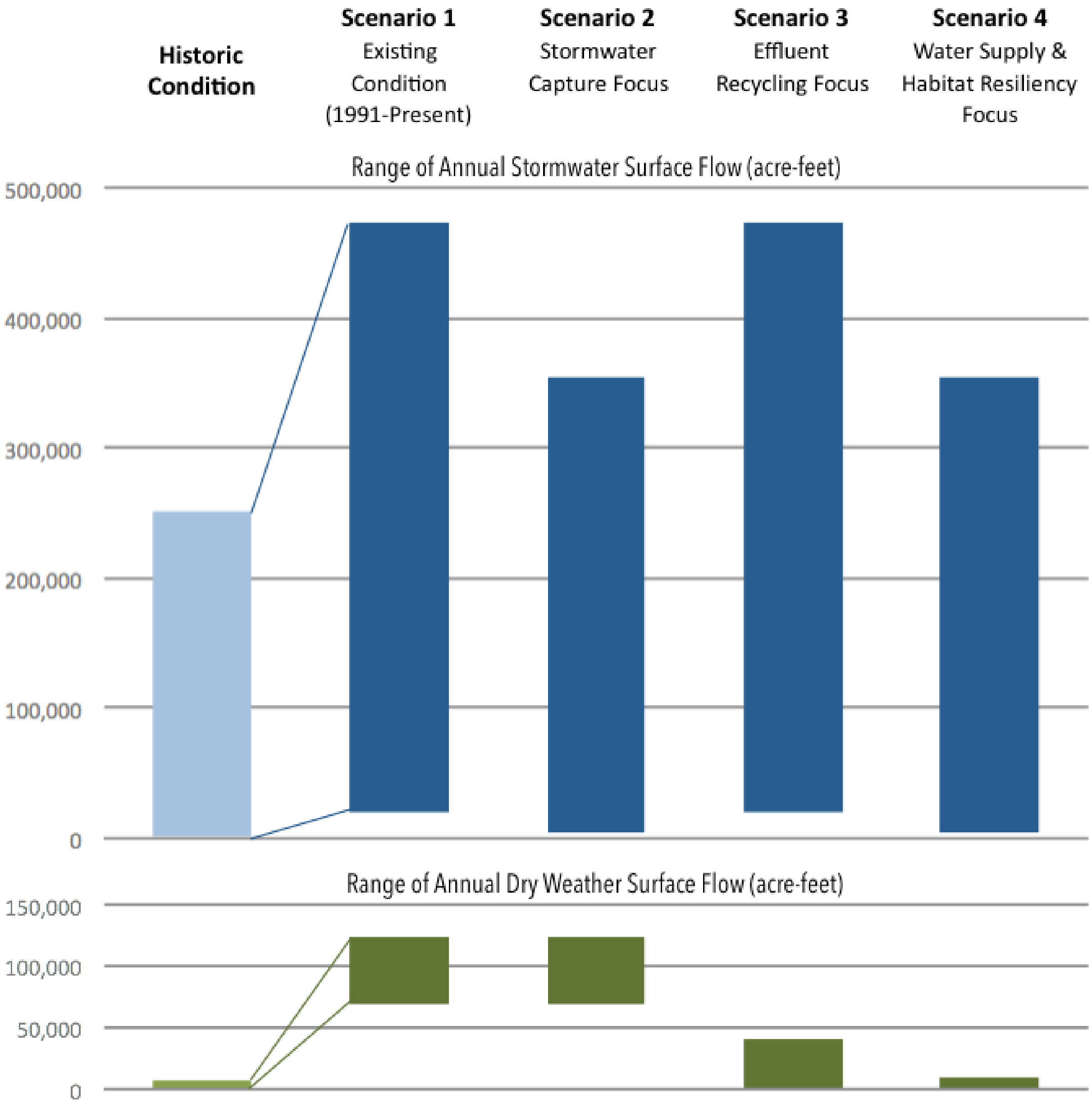
Scenario 4: Water Supply and Habitat Resiliency

- In-Channel Result Compared to Historic Condition: Similar Dry Weather Flows & Higher Peak Flood Flows, But Lower Peak Flood Flows than Existing Condition

  This scenario would be achieved if the upstream water reclamation plants maximize recycled water, which would reduce or eliminate effluent flows to the River, **AND** stormwater capture was implemented at a large scale across the watershed. This scenario is the most responsive to ongoing Western drought conditions that necessitate reducing imported water and increasing the use and efficiency of all local water supply sources.

  This scenario also most closely resembles historic hydrologic conditions in the watershed and River, and allows for the River to dry during dry weather. Therefore, it does the best job of supporting native wildlife species, the highest level of biodiversity and ecosystem restoration.

In addition, the region's habitat regulations fit this scenario best because in traditional natural science practice, the historic, predevelopment condition is what defines the higher environmental value. Modeling watershed hydrology regime management after the historic condition would enable the greatest level of alignment and streamlining between all future stakeholder activities and regulatory programs.



Notes:

1. Typical Discharge Conditions in the Elysian Valley (Above the Confluence of the Arroyo Seco) based upon DWR/ULARA Annual Reports 1928/9 to 2012/13 and Report of Referee Vol 2 (1962).
2. Dry Weather Flow Inputs in the Elysian Valley include Rising Groundwater, Water Reclamation Plants (WRPs) (Tillman, LA-Glendale, Burbank), Industrial Discharge and Urban Runoff.
3. Reductions in Dry Weather Surface Flow in Scenarios 3 and 4 assume elimination of effluent discharges from the 3 WRPs into the River and that instead the water is recycled for uses that reduce demand for imported water (e.g. Tillman WRP Groundwater Replenishment Project, GRP). Scenario 4 additionally assumes that urban runoff is captured and infiltrated outside of the channel to recharge groundwater, improve water quality and create ecologically appropriate habitat (e.g. ephemeral freshwater wetland, alluvial scrub, mulefat scrub and willow scrub) complementary to the in-channel riparian habitat.
4. In Scenarios 2 and 4, additional Stormwater Flow Capture in the San Fernando Valley assumed to be 100,000 acre-feet by 2035, per aggressive capture scenario in LADWP Stormwater Capture Master Plan (2015). Fulfills LA Water Integrated Resource Plan (IRP) and One Water LA water sustainability objectives

Figure 3-29 Range of Typical Annual Surface Flow for Stormwater and Dry Weather in the Elysian Valley for the Historic Condition and Four Watershed Hydrology Scenarios.

One example of a planned project to decrease the amount of imported water, per the Water Integrated Resources Plan (IRP) and One Water LA goals, is the Groundwater Replenishment Project (GRP) that would the divert 27 mgd of treated wastewater from Tillman WRP (same amount of current discharge to the Los Angeles River) to spreading grounds and injection wells to replenish the San Fernando Valley Groundwater Basin. This action alone would significantly reduce non-flood flows in the River to less than 30,000 acre-feet annually. The reduced low-flow condition would likely support a greater diversity of high quality in-channel habitat and likely favor native species. The current 27 mgd discharge from Tillman WRP is the current commitment by the City of Los Angeles based on outdated assumptions of "habitat value" to the River and is the design condition for the Army Corps Restoration Feasibility Study (IFR). It should also be noted that Tillman WRP could construct additional wastewater treatment capacity beyond its current design capacity, and then discharge that reclaimed water to the River, thereby maintaining or increasing the current 27 mgd flow to the River. Alternatively, the additional capacity could be used for other beneficial uses in the City, including additional groundwater replenishment or recycled water uses (e.g. irrigation, industrial water).

3.6. References

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Chapter 4. Biota of the Los Angeles River in the Elysian Valley

4.1. Introduction

The Los Angeles River, especially in its lowland reaches and historic floodplain, has been developed and urbanized. Development in the study area began in the 1800s with irrigated agriculture fed by perennial surface flows from rising groundwater in the Narrows of the Elysian Valley. Irrigation ditches were used to divert surface flows to agricultural fields outside of the active floodplain. Urban development, including commercial, industrial and residential development, increased in the early 1900s, accelerating after the opening of the Owens River-Los Angeles Aqueduct in November 1913, which provided the imported water required for expanding the City of Los Angeles. Urbanization of the floodplain necessitated channelizing storm flows, which, while infrequent from year to year, could be devastating in large storm events. The changes to the flora and fauna due to habitat loss and hydrologic changes related to urbanization and channelization for flood protection have been significant as documented in *The Biota of the Los Angeles River* (Garrett 1993) and Chapter 2, Historical Ecology. This chapter presents the results of a yearlong study of the occurrence of species and their habitat relationships for the purpose of establishing a baseline condition for future ecosystem restoration efforts and to identify opportunities for habitat enhancement.

Biological surveys were conducted in the study area (see Figure 1-2) from fall 2014 to fall 2015 to determine the current structure and composition of vegetation communities, and faunal occurrence and habitat use under the existing hydraulic flow regime. Different methodological approaches were used for each taxonomic group, but all were guided by the same goals of ecological enhancement in order to inform experimental design, sampling methods, timing, and effort.

This chapter also updates and expands upon *The Biota of the Los Angeles River*, published in 1993 by the Natural History Museum of Los Angeles. This 1993 report was a combination of reports of field surveys, a review of the museum collection, and synthesis of known accounts of the historic ecological conditions of the River.

4.1.1. Biological Study Area Segments

The study area was divided into segments in order to organize local observations during biological surveys. Segments were selected using easily identifiable landmarks in the field and changes in features of the flood control channel (Figures 4-1). See Table 4-1 for the location and physical features of each segment. Note that the least steep slope change is in Segment 5, where the location of a large sand and cobble channel bar rises a few feet above the concrete toe of the slope. The River waters are also confined in that segment and as a result, the water level flows above the toe protection, covering part of the right (west) slope bank. See Appendix F for a multi-page map book of the survey area and survey segments, with a high-resolution 2014 aerial base layer.

Figure 4-1 Biological Survey Segments in the Study Area.

Table 4-1 Biological Study Area Segments.

Segment	Start	End	Length (m)	Mean Channel Slope	Average Channel Width (m)		Area[1] (acres)			
					Toe of Slope	Crown of Channel	Channel Bottom	Slope Bank	Outside Channel	Total
1	Los Feliz Blvd	Sunnynook Bridge	652	0.52%	60	101	9.67	6.06	6.14	21.87
1A	Los Feliz Blvd Park								1.62	1.62
2	Sunnynook Bridge	Glendale-Hyperion Bridge	332	0.28%	60	101	4.88	3.35	1.86	10.09
2A	Sunnynook Park								4.15	4.15
3	Glendale-Hyperion Bridge	Check Dam between Finch St & Gracia St	527	0.46%	60	96	7.76	4.73	4.09	16.58
4	Check Dam between Finch St & Gracia St	Fletcher Dr. Bridge	759	0.40%	60	96	11.19	6.98	5.99	24.16
5	Fletcher Dr Bridge	Glendale (SR-2) Fwy Bridge	381	0.16%	67	108	6.52	3.40	2.82	12.74
6	Glendale (2) Fwy Bridge	Rapids at Partridge Ave	491	0.56%	67	108	8.39	4.72	3.55	16.66
6A	Bowtie Parcel								21.08	21.08
6B	Marsh Park								5.46	5.46
7	Rapids at Partridge Ave.	End of Bowtie Parcel at Queen St	853	0.36%	67	109	14.33	8.57	3.09	25.99

1. *Channel bottom area includes areas where dry weather flow or channel bar substrate covers the trapezoidal slope banks; conversely, there is additional slope bank area that is covered by substrate or water that is not included in the total slope bank area showed here.*

4.2. Vegetation Communities

4.2.1. Introduction

While perennial dry weather surface flow was a historic feature of the Los Angeles River in the Elysian Valley, historic flows were significantly lower and variable (estimated to be between 1–5 cfs; 1–7 mgd), both within and between years (see Chapter 3). Dry weather surface flow is supplied by rising groundwater in the Elysian Valley, which was likely variable in response to the state of the San Fernando Valley Groundwater Basin due to longer-term decadal trends in cumulative rainfall.

This lower historic dry weather flow meandered in narrow natural channels over a broader active floodplain. The position of these channels shifted in the floodplain over time during storm-driven high flow events that scoured and eroded the riparian vegetation and alluvial soils (see Chapter 2). In the Elysian Valley, tectonic faulting and uplift created the geologic masses (Santa Monica Mountain chain, including Griffith Park and Elysian Park on the southern, right bank; and Mount Washington on the northern, left bank) that both confined the alignment of the River in a relatively narrow zone, and created the perennial natural rising groundwater condition in the Glendale Narrows (Gumprecht 1999).

The native, historic riparian vegetation that occurred within the broad active floodplain of southern California is adapted to regeneration after periods of flashy, high flows that maintain the vigor of understory species. Without these periodic high flows, native riparian habitat can become less diverse floristically, as less sunlight reaches the understory through a dense canopy of trees. Examples of the range of riparian floodplain vegetation communities and adjacent, complementary upland habitat, that would have historically existed can be observed today in the Santa Clara River floodplain, and in the extensive flood basins of the Los Angeles River system (Hansen Dam Basin, Sepulveda Basin and Hahamongna Basin).

Land use changes in the watershed since the 1800s, channelization of the Los Angeles River, and the addition of dry weather discharge from urban runoff and water reclamation plants, have significantly increased both the amount of dry weather flow and the peak stormwater flow above the historic condition in the Elysian Valley (see Chapter 3). Both habitat loss and in-stream hydrological changes have created the conditions for type-conversion of the historic floodplain riparian ecosystem to a novel urban ecosystem, which is less diverse and ecologically resilient (Garrett 1993). However, by understanding the conditions that have altered the natural historic condition, new opportunities may be identified to enhance and create ecologically appropriate habitat within the contemporary urban-wildlife landscape.

This section examines the existing vegetation communities and species occurrence by field surveys and geospatial analysis, and then compares the results to reports from the 1991–92 study (Garrett 1993). Finally, using the reconstruction of the historic distribution of vegetation communities in the late 1800s (see Chapter 2) as a baseline, the type-conversion of vegetation communities and the loss of habitat to development in the historic floodplain are quantified.

4.2.2. Methods

Vegetation Field Mapping and Geospatial Analysis

The approximately 160-acre project area (see Figure 4-1) was assessed for existing conditions in terms of native vegetation, non-native vegetation, and substrate type of the river channel. Field visits occurred on February 4, 5, 11, and 12, 2015 to map the vegetation of the project area during leaf-off condition for deciduous riparian tree species (e.g. native willows). This allowed a better view of the lower and mid-canopy existing conditions. Two field visits occurred later in the growing season on July 8 and 9, 2015 during the leaf-on condition for willow species identification. Field reconnaissance consisted of observing the types of non-native and native species and estimating percent cover by homogenous vegetated units, which were later delineated in a spatial geodatabase using field observations, aerial imagery, and a 2006 LIDAR-derived elevation model (source = LARIAC 3, City of Los Angeles). During subsequent field visits, aided by review of aerial imagery, the unique vegetation polygons in the spatial geodatabase were further delineated based on the type of dominant native vegetation and the cover of non-native species, primarily giant reed (*Arundo donax*) cover. Vegetation polygons were split if native vegetation composition or non-native species cover values changed significantly.

Data collected for each vegetation polygon included estimates of native and non-native species cover, bare ground cover, and substrate type. Overall cover was estimated for the following vegetation strata: floating vegetation, emergent vegetation, herbaceous vegetation, lower canopy (shrubs/tree saplings), mid-canopy (trees/shrubs), and upper canopy (trees). The dominant species were noted for each vegetation strata. Cover for invasive non-native species was estimated for the following species: giant reed, Mexican fan palm (*Washingtonia robusta*), castor bean (*Ricinus communis*), tree-of-heaven (*Ailanthus altissima*) and poison hemlock (*Conium maculatum*). Cover class values for vegetation strata and non-native species were estimated using the following cover class categories: less than 1 percent, 1–10 percent, 11–30 percent, 31–50 percent, 51–75 percent, and greater than 75 percent. Cover class ranges were selected based on values that are highly replicable in the field when measured by different observers. This will allow for an accurate measure of change in the future from the baseline condition. Also, these cover classes are appropriate inputs for designing specifications to plan and implement habitat restoration and enhancement projects. In addition, a species list was generated along with at least one representative photo for each polygon. The geospatial database of vegetation and land cover polygons with attributed data is presented in Appendix F. Appendix G presents the species list of occurrence by vegetated polygon in the geospatial database, which correspond to the polygons and labels on the map book in Appendix F.

Photo Point Comparison of Summer 1991–92 and Summer 2015

Photo point stations established by Garrett (1993) overlap Segments 6 and 7, and continue downstream along the Taylor Yard G2 Parcel. The original slides were scanned and the color images are presented in Appendix H. Summer 2015 photos were taken at the photo points to compare the change in vegetation between 1992 to 2015; a period of 24 years.

Aerial Land Cover and Vegetation Community Change between Historic Condition and Present

In order to quantify the change in aerial cover of vegetation communities and urban land cover classes from the reconstructed historic condition (Chapter 2, Figure 2-16), historic topographic maps and aerial imagery available from the USGS Earth Explorer Geospatial Web Portal (http://earthexplorer.usgs.gov/) was reviewed. The following datasets were selected and georeferenced to the study area for further analysis:

- Los Angeles County. 2014. Color Orthogonal Imagery. Acquired in Winter 2014 by Pictometry International Corporation for the Los Angeles Regional Imagery Consortium 4 Project (LAR-IAC4). 1-Foot Resolution. Viewed on LA County GIS Viewer, Accessed January 2016. http://egis3.lacounty.gov/eGIS/gis-mapping-applications/gisviewer/.
- National Park Service (NPS). 1983a. Vertical Cartographic Color Infrared Aerial Image. Acquired on July 7, 1983. Scale 1:3,222. United States Geological Survey (USGS), National Center for Earth Resource Observations and Science (EROS), Long Term Archive (LTA), Entity ID ARL830280627217.
- NPS. 1983b. Vertical Cartographic Color Infrared Aerial Image. Acquired on July 7, 1983. Scale 1:3,222. USGS, EROS, LTA, Entity ID ARL830280627218.
- United States Air Force. 1948. Vertical Reconnaissance Black and White Aerial Image. Acquired on June 29, 1948. Scale 1:69,395. USGS, EROS, LTA, Entity ID ARB000388730035.
- United States Department of Agriculture (USDA). 2005a. National Agriculture Imagery Program (NAIP) 3-Band Color Image. 1-Meter Resolution. Acquired June 19, 2005. NAIP Entity ID N_3411863_NW_11_1_20050619_20060210.
- USDA. 2005b. NAIP 3-Band Color Image. 1-Meter Resolution. Acquired June 19, 2005. NAIP Entity ID N_3411862_NE_11_1_20050619_20060210.
- United States Geological Survey (USGS). 1928. California. (Los Angeles Co.) Glendale Quadrangle. Edition of 1928. 1:24000. Surveyed in 1925. Topography by T.H. Moncure.
- USGS. 1928. California. (Los Angeles Co.) Los Angeles Quadrangle. Edition of 1928. 1:24000. Surveyed in 1925. Topography by C.A. Ecklund.
- USGS. 1952. Vertical Cartographic Black and White Aerial Image. Acquired on July 30, 1952. Scale 1:23,600. USGS, National Center for Earth Resource Observations and Science (EROS), Long Term Archive (LTA), Entity ID AR1VP0000180081.
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- USGS. 1964a. Vertical Cartographic Black and White Aerial Image. Acquired on September 1, 1964. Scale 1:24,000. USGS, EROS, LTA, Entity ID AR1VAWW00010095.
- USGS. 1964b. Vertical Cartographic Black and White Aerial Image. Acquired on September 1, 1964. Scale 1:24,000. USGS, EROS, LTA, Entity ID AR1VAWW00040017.
- USGS. 1972. Vertical Cartographic Black and White Aerial Image. Acquired on October 25, 1972. Scale 1:30,000. USGS, EROS, LTA, Entity ID AR1VCYY00020097.
- USGS. 1994a. Hollywood Northwest 3.75-minute Black and White Digital Orthophoto Quadrangle (DOQ). Acquired on May 31, 1994. USGS, EROS, LTA, Entity ID DI00000000922116.

- USGS. 1994b. Hollywood Northeast 3.75-minute Black and White Digital Orthophoto Quadrangle (DOQ). Acquired on May 31, 1994. USGS, EROS, LTA, Entity ID DI00000000922092.

The 1928 topographic map and the aerial images were sequentially hand digitized, by date, in a geographic information system (GIS) using ESRI software. Then, the land cover units were classified and inferences were made about vegetation community identify based on the historic reconstruction, aerial photo-interpretation, and signs of development or significant soil disturbance. Finally, the digitized land cover and vegetation community geospatial layers were analyzed and mapped and graphed in a histogram to visually depict the loss of historic vegetation communities and gain in novel degraded vegetation communities over time, from the late 1800s historic condition to 2014. Field investigations were made in 2015 to verify features seen in the 2014 aerial and to help guide the interpretation of persistent structures and features in past years.

4.2.3. Results

Plant Species Richness

Across the study area, 167 total plant species were observed, including 76 native species. The frequency of species observations by vegetated mapping units is presented in Appendix G, which corresponds with the polygon labeling of the Map Book in Appendix F. Of the 167 total plant species, 76 were only observed outside of the channel in the upper terraces, including the urban parks and residential areas. In contrast, 46 total species were observed in the channel, including the channel bars, emergent vegetation, and opportunistic vegetation growing in cracks of the concrete and grouted rock channel banks. There were 45 species that were observed at least once in both the channel and outside of the channel.

Of the 76 native species observed, there were 16 annual herbs, 22 perennial herbs, 5 perennial grasses, 2 vines, 18 shrubs or succulents and 12 trees. Twenty (20) of the native species were only observed in-channel, 42 natives were only observed outside of the channel and 14 natives were observed at least once in both conditions (see Table 4-2).

Most native species observed were not abundant. The native species most commonly observed in-channel were associated with the outer fringe or perimeter of the vegetated channel bars and rock outcrops, including rough cocklebur (*Xanthium strumarium*), tule (*Schoenoplectus acutus*), northern willow herb (*Epilobium ciliatum*), duckweed (*Lemna minor*), floating water primrose (*Ludwigia peploides*), three-square bulrush (*Schoenoplectus americanus*) and watercress (*Nasturtium officinale*). Black willow (*Salix gooddingii*) forms the dominant native overstory cover in the River. While there were occasional red willow (*Salix laevigata*), Arroyo willow (*Salix lasiolepis*), Pacific willow (*Salix lasiandra*) or Fremont's cottonwood (*Populus fremontii*), the dominant native cover was black willow, with some Western sycamore (*Platanus racemosa*).

Where the vegetated cover on the channel bars was more open, lacking a mature black willow overstory or a monoculture of giant reed (*Arundo donax*) clones, mulefat (*Baccharis salicifolia*) was a common component of the mid-story.

Outside of the channel there was a higher diversity of native plants due in large part to the revegetated slope above the left bank of the channel that extends much of the length of the Bowtie Parcel. It appears that the slope was enhanced with species typical of the coastal sage scrub community, such as those listed in Table 4-2 (e.g. white sage, black sage, California sagebrush and coyote brush).

Table 4-2 Count of native plant species occurring in-channel, outside of channel and in both. Commonly encountered native species are in Bold Typeface.

IN-CHANNEL	OCCUR IN BOTH	OUTSIDE OF CHANNEL
	Annual Herb	
Spanish lotus (*Acmispon americanus*)	annual bursage (*Ambrosia acanthicarpa*)	poppy (*Eschscholzia* sp.)
fragrant flatsedge (*Cyperus odoratus*)	Canada horseweed (*Erigeron canadensis*)	common sunflower (*Helianthus annuus*)
annual phacelia (*Phacelia* sp.)	telegraph weed (*Heterotheca grandiflora*)	arroyo lupine (*Lupinus succulentus*)
vinegarweed (*Trichostema lanceolatum*)		collared annual lupine (*Lupinus truncatus*)
rough cocklebur (*Xanthium strumarium*)		aster (*Malacothrix* sp.)
		California chicory (*Rafinesquia californica*)
		rod wirelettuce (*Stephanomeria virgata*)
	Perennial Herb	
ragweed (*Ambrosia psilostachya*)	California mugwort (*Artemisia douglasiana*)	morning glory (*Calystegia macrostegia*)
bur marigold (*Bidens laevis*)	jimsonweed (*Datura wrightii*)	common bog rush (*Juncus effusus*)
Parish's spikerush (*Eleocharis parishii*)	**tule** (*Schoenoplectus acutus*)	perennail penstemon (*Penstemon* sp.)
northern willow herb (*Epilobium ciliatum*)		two-color rabbit-tobacco (*Pseudognaphalium biolettii*)
Mexican rush (*Juncus mexicanus*)		Coulter's matilija poppy (*Romneya coulteri*)
duckweed (*Lemna minor*)		bulrush (*Schoenoplectus* sp.)
floating water primrose (*Ludwigia peploides*)		chaparral nightshade (*Solanum xanti*)
watercress (*Nasturtium officinale*)		goldenrod (*Solidago velutina*)
cudweed (*Pseudognaphalium* sp.)		
three-square bulrush (*Schoenoplectus americanus*)		
Douglas' nightshade (*Solanum douglasii*)		
stinging nettle (*Urtica dioica*)		
	Perennial Grass	
---	blue wildrye (*Elymus glaucus*)	giant wild rye (*Leymus condensatus*)
		creeping wild rye (*Leymus triticoides*)
		deergrass (*Muhlenbergia rigens*)
		purple needle grass (*Stipa pulchra*)
	Shrub, Vine	
wild cucumber (*Marah macrocarpa*)	California sagebrush (*Artemisia californica*)	deerweed (*Acmispon glaber*)
	mulefat (*Baccharis salicifolia*)	coyote brush (*Baccharis pilularis*)
	California buckwheat (*Eriogonum fasciculatum*)	mountain grape (*Berberis aquifolium*)
		bush sunflower (*Encelia californica*)
		California yerba santa (*Eriodictyon californicum*)
		California coffeeberry (*Frangula californica*)
		chaparral yucca (*Hesperoyucca whipplei*)
		toyon (*Heteromeles arbutifolia*)
		bush monkey flower (*Mimulus aurantiacus*)
		coast prickly pear (*Opuntia littoralis*)
		sugarbush (*Rhus ovata*)
		fuchsia flowered gooseberry (Ribes speciosum)
		California wild rose (*Rosa californica*)
		California blackberry (*Rubus ursinus*)
		white sage (*Salvia apiana*)
		purple sage (*Salvia leucophylla*)
		black sage (*Salvia mellifera*)
	Tree	
red willow (*Salix laevigata*)	**Western sycamore** (*Platanus racemosa*)	valley oak (*Quercus lobata*)
arroyo willow (*Salix lasiolepis*)	Fremont's cottonwood (*Populus fremontii*)	California walnut (*Juglans californica*)

	black willow (*Salix gooddingii*)	**coast live oak** (*Quercus agrifolia*)
	Pacific willow (*Salix lasiandra*)	laurel sumac (*Malosma laurina*)
		holly leaf cherry (*Prunus ilicifolia*)
		blue elderberry (*Sambucus nigra* ssp. *caerulea*)

In addition, many of the pocket parks and vegetated strips along the public access trails at the top of the channel, including the bike path, have been planted with native species. Frequently seen tree species that have successfully established include Western sycamore (*Platanus racemosa*), coast live oak (*Quercus agrifolia*) and blue elderberry (*Sambucus nigra* ssp. *caerulea*). Additional native species that occur less frequently are listed in Table 4-2 and in Appendix F.

In-Channel: Dominant Species Composition and Vegetation Strata Cover of the Channel Bars

The vegetation polygons in the low-flow channelized river are comprised of five strata of vegetation:

- Upper tree canopy
- Mid-canopy (shrub/tree)
- Lower canopy (shrubs/tree saplings)
- Herbaceous, emergent
- Floating vegetation

The average cover of each vegetation strata for the vegetated channel bars is presented in Table 4-3 by survey segment. Also presented in Table 4-3 are estimates of total vegetation canopy, which includes both native and non-native vegetation (primarily giant reed), which hangs over adjacent water types in the river. The cover classes for each of the strata by vegetation polygon are mapped in Figures 4-2 to 4-8 for the entire study area. See Figure 4-1 for the location of survey segments. Tabular data of cover class mapped by geospatial polygon is presented in Appendix F.

The dominant species of the upper canopy of the vegetated channel bars is black willow (*Salix gooddingii*). Scattered individuals of Western sycamore (*Platanus racemosa*), red willow (*Salix laevigata*), shining willow (*Salix lasiandra*), and arroyo willow (*Salix lasiolepis*) are also present in the upper canopy. Cover of the upper canopy ranged from zero (no upper canopy) to 31–50 percent.

The mid-canopy layer is comprised mainly of mulefat (*Baccharis salicifolia* and younger individuals of black willow, arroyo willow, and shining willow. Cover of the mid-canopy layer ranged from 1–10 percent to 50–75 percent.

The lower canopy is comprised mainly of mulefat. Other species in the lower canopy layer include non-native species, including Mexican fan palm (*Washingtonia robusta*), giant reed, and castor bean.

The herbaceous layer consists of mainly non-native species including annual European grasses, perennial Bermuda grass (*Cynodon dactylon*), crabgrass (*Digitaria sp.*) and smilo grass (*Piptatherum miliaceum*), poison hemlock (*Conium maculatum*), and filaree (*Erodium* sp.). Native species present in the herbaceous layer include ragweed (*Ambrosia psilostachya*), mugwort (*Artemisia douglasiana*), rush (*Juncus* sp.), and rough cocklebur (*Xanthium strumarium*). Cover of the herbaceous layer ranged from zero percent to 31–50 percent cover.

Table 4-3 Channel Bar Vegetation Structure by Segment.

	1	2	3	4	5	6	7
Channel Bars (acres)	**2.49**	**1.30**	**1.52**	**2.91**	**4.41**	**5.00**	**8.29**
Cumulative Channel Bar Cover							
Upper Canopy (Tree)	45%	51%	46%	27%	4%	17%	48%
Mid Canopy (Tree/Shrub)	61%	75%	71%	44%	25%	45%	12%
Lower Canopy (Shrub)	2%	2%	10%	1%	17%	32%	30%
Herbaceous	19%	11%	10%	27%	10%	17%	29%
Emergent Vegetation	44%	51%	36%	57%	4%	18%	10%
Floating Vegetation (on edge)	1%	2%	9%	---	---	---	---
Bare Ground	<1%	1%	1%	<1%	6%	<1%	1%
Total Vegetation Canopy Over Low Flow Water Types							
Flat	0%	2%	0%	1%	0%	---	---
Run	22%	36%	23%	28%	0%	6%	17%
Riffle	29%	25%	25%	27%	23%	41%	24%
Pool	36%	25%	9%	---	13%	18%	---
Rapid	---	---	---	---	---	68%	20%
Backwater	---	---	---	---	---	45%	---

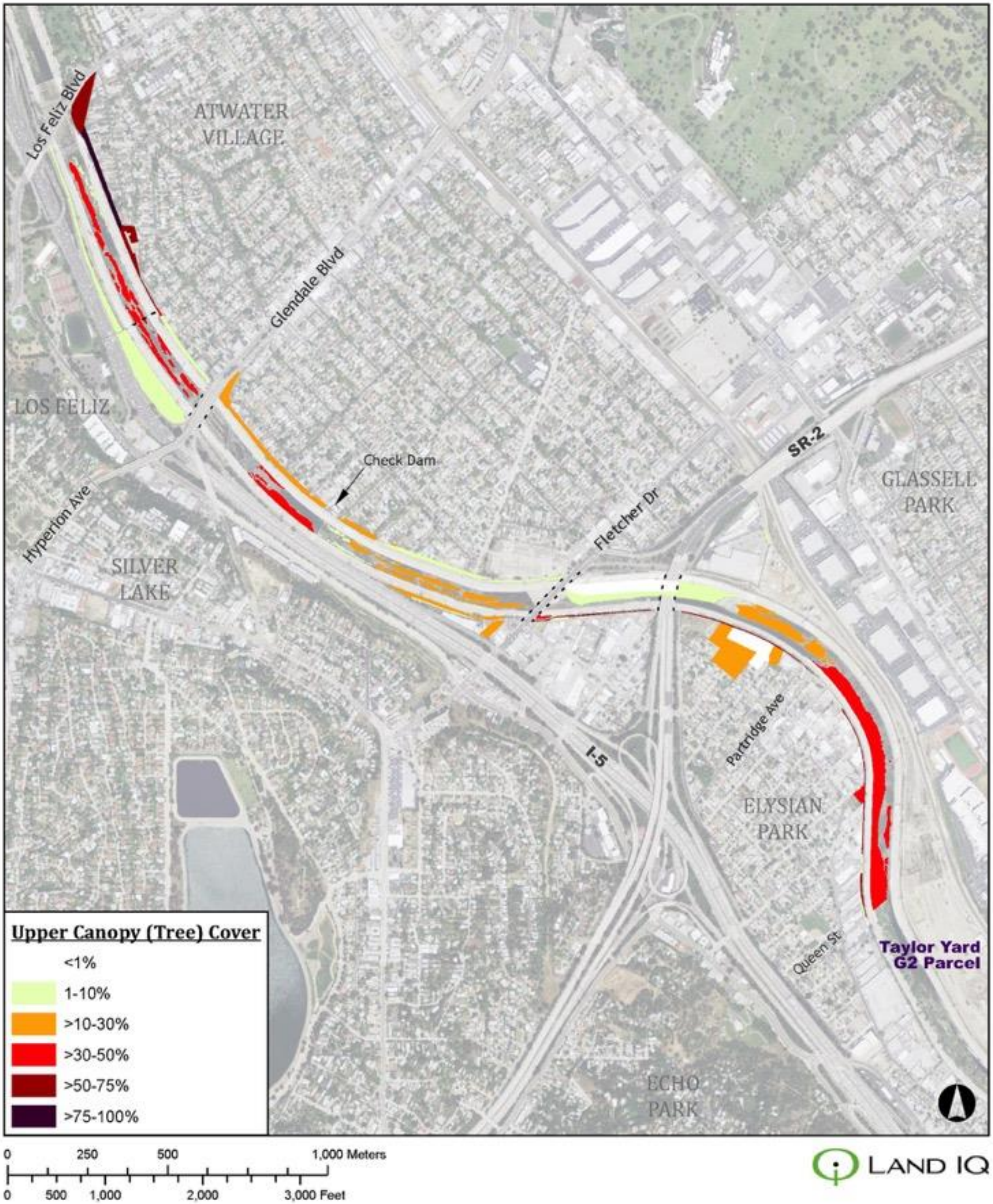


Figure 4-2 Upper canopy (tree) cover of the Los Angeles River in the Elysian Valley (Year 2015).

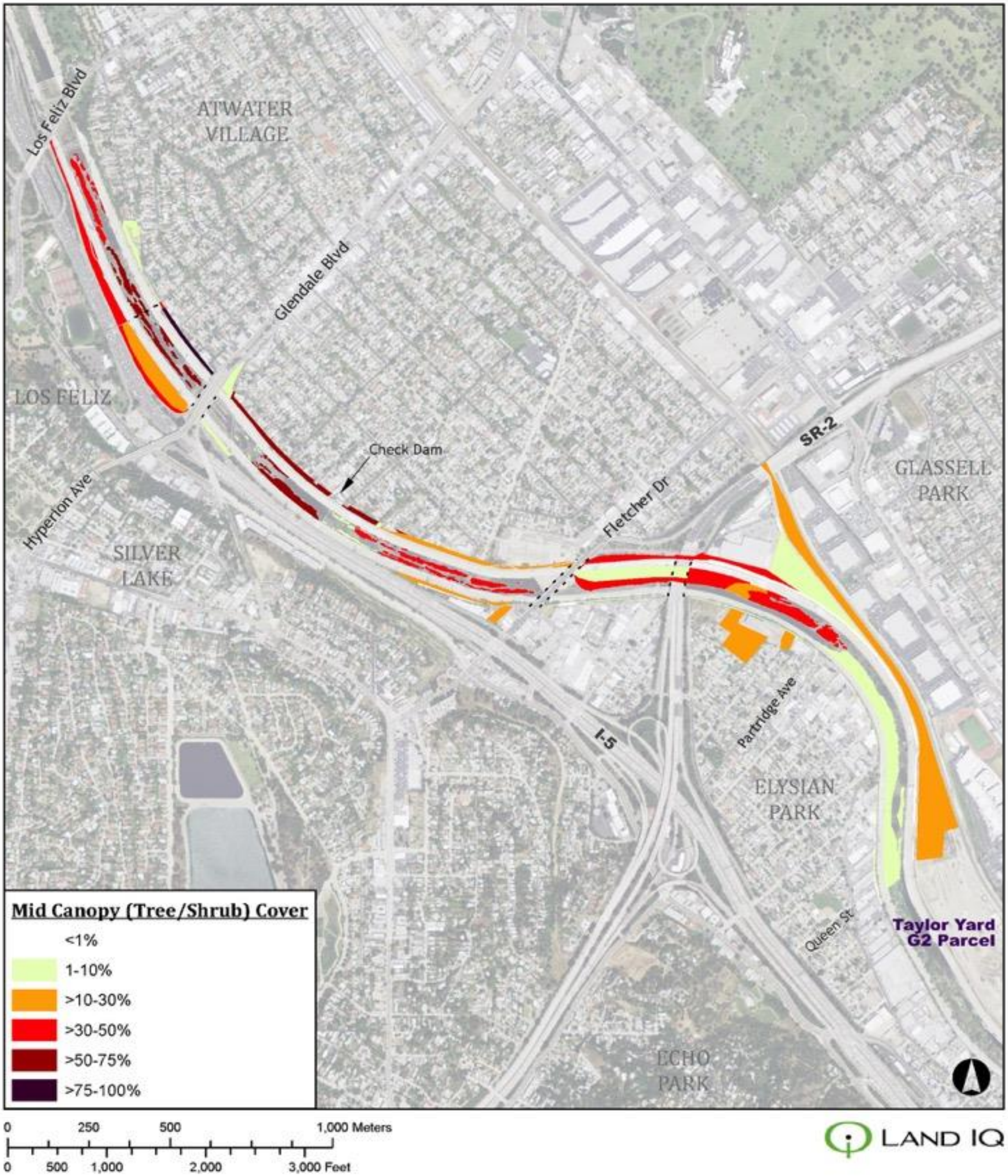


Figure 4-3 **Mid canopy (tree/shrub) cover of the Los Angeles River in the Elysian Valley (Year 2015).**

Figure 4-4 **Lower canopy (shrub) cover of the Los Angeles River in the Elysian Valley (Year 2015).**

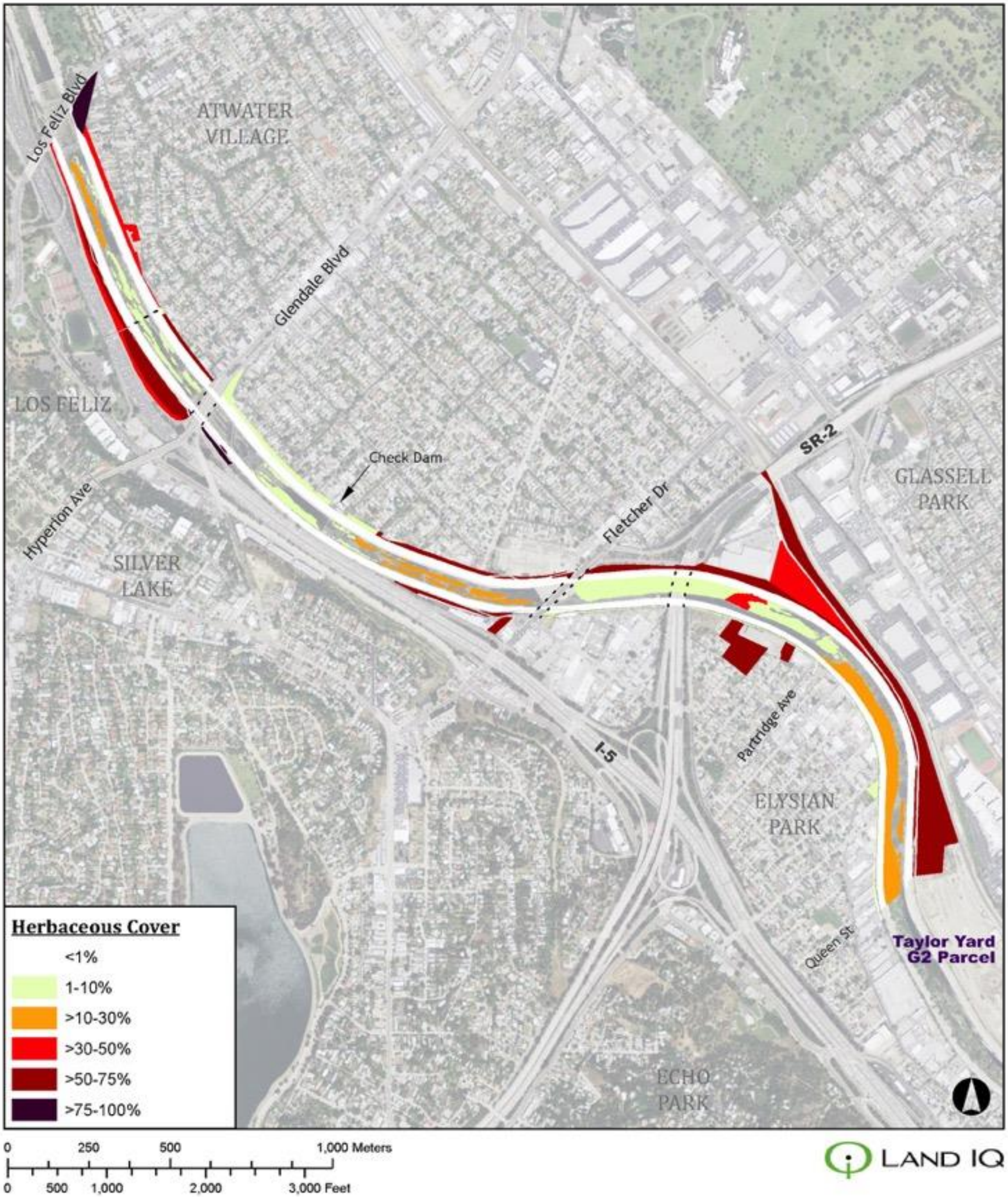


Figure 4-5 Herbaceous cover of the Los Angeles River in the Elysian Valley (Year 2015).

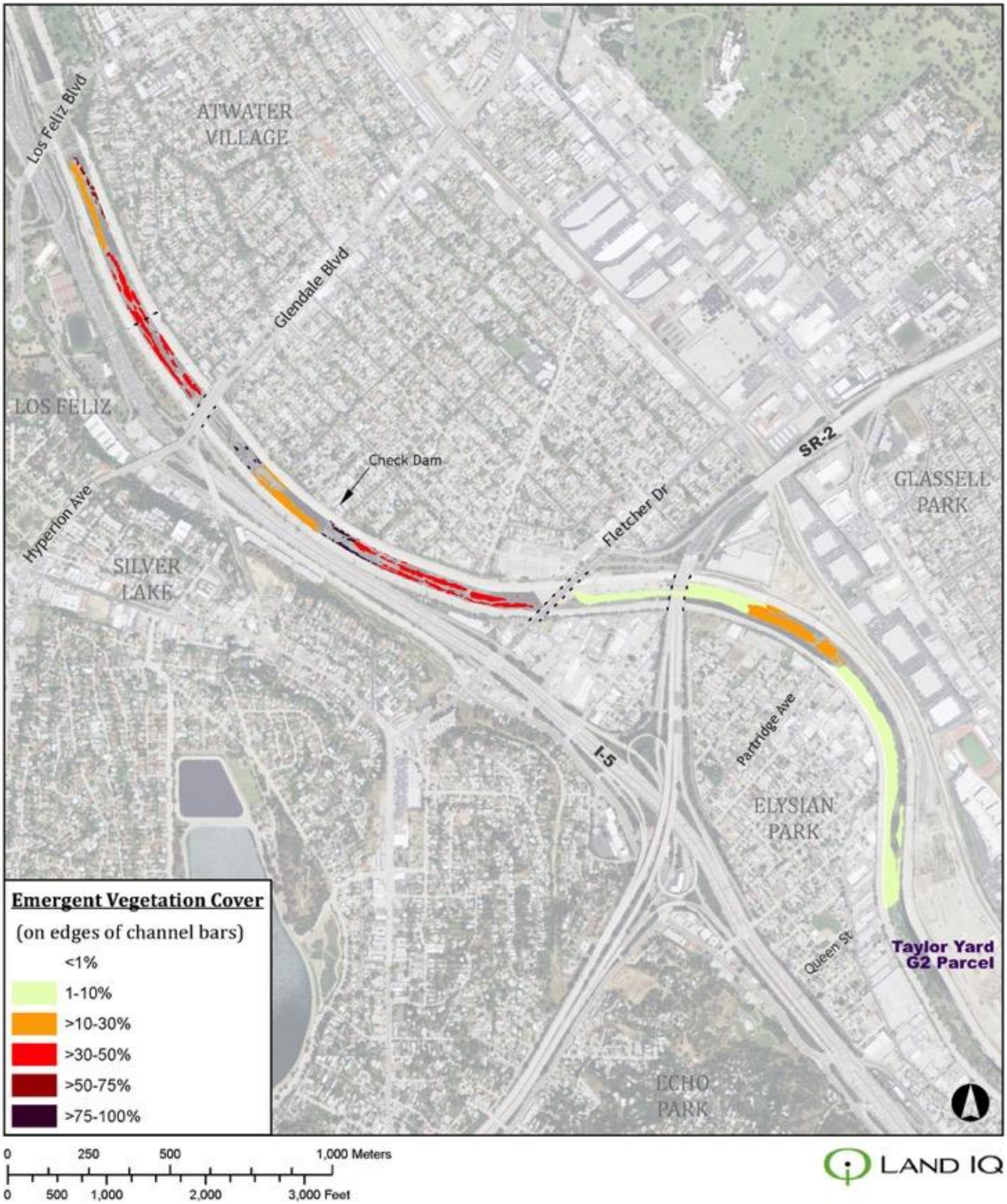


Figure 4-6 Emergent vegetation cover of the Los Angeles River in the Elysian Valley (Year 2015).

Figure 4-7 Floating vegetation cover of the Los Angeles River in the Elysian Valley (Year 2015).

Figure 4-8 Bare ground cover of the Los Angeles River in the Elysian Valley (Year 2015).

Emergent vegetation occurred mainly on the edges of vegetation islands and commonly includes cattails (*Typha* sp.), chairmaker's bulrush (*Schoenoplectus americanus*), hardstem bulrush (*Schoenoplectus acutus*), willow herb (*Epilobium ciliatum*), and floating primrose (*Ludwigia peploides*). Cover of emergent vegetation ranged from less than five percent to greater than 75 percent cover.

Floating vegetation consisted of duckweed (*Lemna minor*) and when present, cover was one percent or less.

The substrate of the channel bars is mainly comprised of sand and silt with gravels, cobbles and occasional boulders.

Vegetation Outside of the Channel

The upper terrace banks include strips of vegetation adjacent to the bike path and parks. Vegetation along the bike path included tree, shrub, and understory species. The understory consists primarily of non-native species. Native tree species that have been planted include Western sycamore, coast live oak (*Quercus agrifolia*), Fremont's cottonwood (*Populus fremontii*), blue elderberry (*Sambucus* nigra ssp. *caerulea*), and California walnut (*Juglans californica*). Native shrub species include toyon (*Heteromeles arbutifolia*), bush sunflower (*Encelia californica*), California sagebrush (*Artemisia californica*), California buckwheat (*Eriogonum fasciculatum*), and laurel sumac (*Malosma laurina*).

Non-native tree species outside the channel include tree-of-heaven, Mexican fan palm, and Brazilian peppertree (*Schinus terebinthifolius*). Other non-native species include fountain grass (*Pennisetum setacum*), veldt grass (*Ehrharta calycina*), Bermuda grass, cheeseweed (*Malva parviflora*), and annual grasses.

Turf grass is present in some of the River adjacent pocket parks like Marsh Park (water infiltration areas) and Los Feliz Blvd Park. Native vegetation planted in the parks included toyon, laurel sumac, Western sycamore, coast live oak, blue elderberry, California buckwheat, California sagebrush, bush sunflower, and California walnut. Non-native species include Washington fan palm, tree tobacco (*Nicotiana glauca*), annual grasses, fountain grass, and Russian thistle (*Salsola tragus*).

Invasive Plant Species

Invasive plant cover is a dominant and defining habitat characteristic of most of the channel bars in the low flow channel (Table 4-4, Figure 4-9). Giant reed is the most common species, forming dense groves on the larger channel bars, excluding establishment of other species, including native willows, and invading the understory of mature black willow canopies. Giant reed is ubiquitous and essentially present on all channel bars, except for some smaller newly emergent or primarily submerged cobble islands or bars (Figure 4-10).

While giant reed is confined to the mesic perennially wet channelized river, castor bean is also found in upland conditions. Castor bean is the second most common invasive plant species. Itis a prodigious seeder, and likely has established a significant seed bank in the channel bars and other upland open space it has colonized (Figure 4-11).

Mexican fan palm, like castor bean, has spread throughout the study area, including upland terraces and in-channel sandy and cobble bars and islands (Figure 4-12). Poison hemlock, ash trees and fountain grass are other common invasive species, and are reflected in the total cover values in Figure 4-9. Tabular data of invasive plant cover mapped by geospatial polygon is presented in Appendix F.

Table 4-4 Invasive Plant Cover by Segment.

	1	1A	2	2A	3	4	5	6	6A	6B	7
Channel Bars (acres)	**2.49**	NA	**1.30**	NA	**1.52**	**2.91**	**4.41**	**5.00**	NA	NA	**8.29**
Cumulative Channel Bar Cover											
All Invasive Plants	45%	NA	50%	NA	50%	75%	30%	45%	NA	NA	97%
Giant Reed	25%	NA	25%	NA	40%	50%	15%	35%	NA	NA	75%
Castor Bean	7%	NA	6%	NA	6%	16%	6%	7%	NA	NA	10%
Mexican Fan Palm	2%	NA	2%	NA	2%	1%	0.23	5%	NA	NA	3%
Tree of Heaven	2%	NA	2%	NA	2%	1%	0.00	1%	NA	NA	1%
Poison Hemlock	1%	NA	<1%	NA	2%	1%	0.05	1%	NA	NA	1%
Trapezoidal 3:1 Slope Bank (acres)	**6.06**	NA	**3.35**	NA	**4.73**	**6.98**	**3.40**	**4.72**	NA	NA	**8.57**
Cumulative Trapezoidal 3:1 Slope Bank Cover											
All Invasive Plants	1%	NA	1%	NA	1%	1%	1%	1%	NA	NA	1%
Castor Bean	<1%	NA	<1%	NA	<1%	<1%	<1%	<1%	NA	NA	<1%
Mexican Fan Palm	<1%	NA	<1%	NA	<1%	<1%	<1%	<1%	NA	NA	<1%
Fountain Grass	<1%	NA	<1%	NA	<1%	<1%	<1%	<1%	NA	NA	<1%
Outside of Channel (acres)	**6.14**	**1.62**	**1.86**	**4.15**	**4.09**	**5.99**	**2.82**	**3.55**	**21.08**	**5.46**	**3.09**
Outside of Channel Total Invasive Cover											
Urban Landscaping	4%	---	1%	1%	1%	1%	1%	1%	---	---	2%
Urban Park	2%	10%	---	1%	2%	2%	---	---	25%	---	---
Revegetated with Coastal Sage Scrub Shrubs	---	---	---	---	---	---	---	10%	10%	---	11%

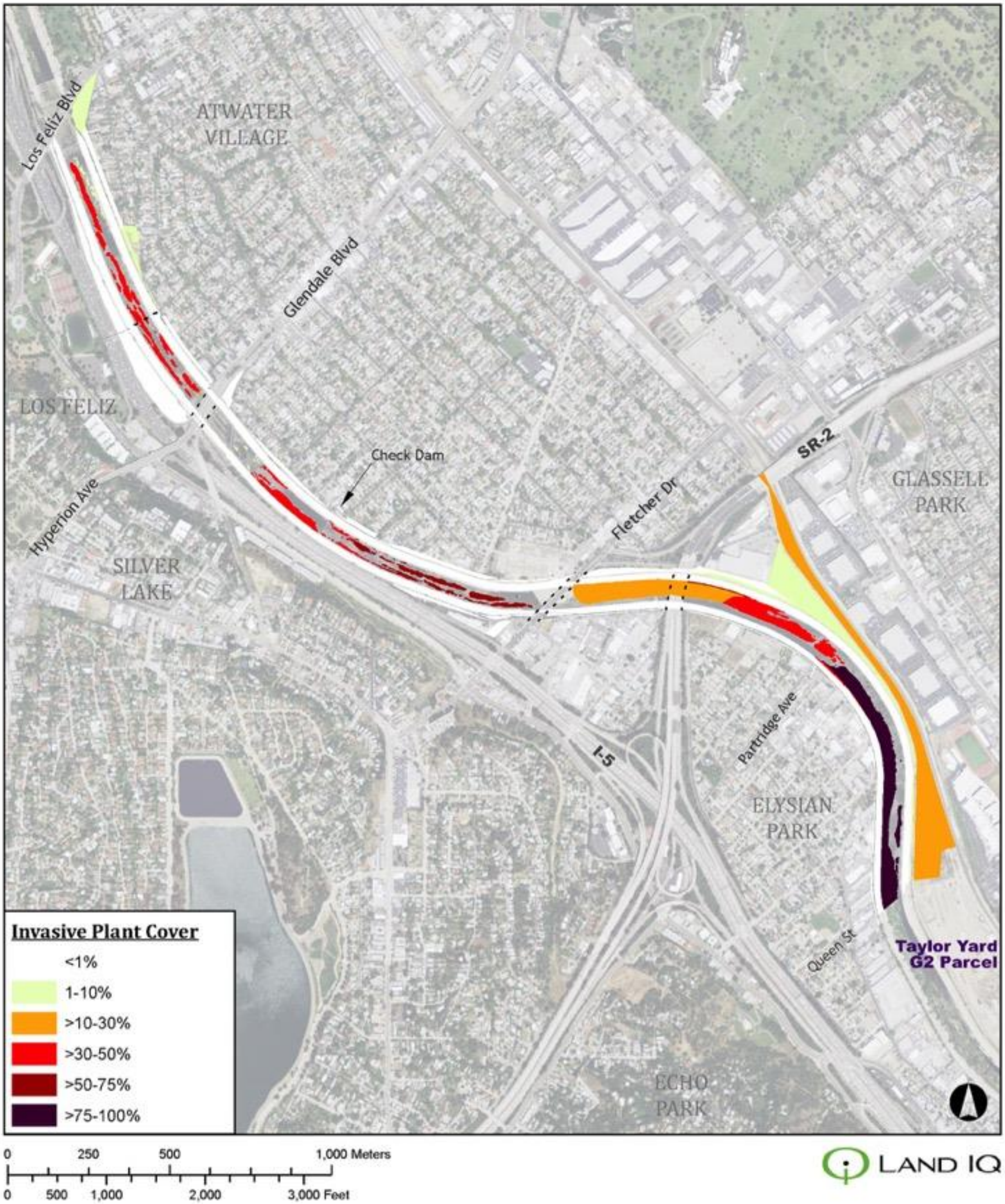


Figure 4-9 Invasive plant cover of the Los Angeles River in the Elysian Valley (Year 2015).

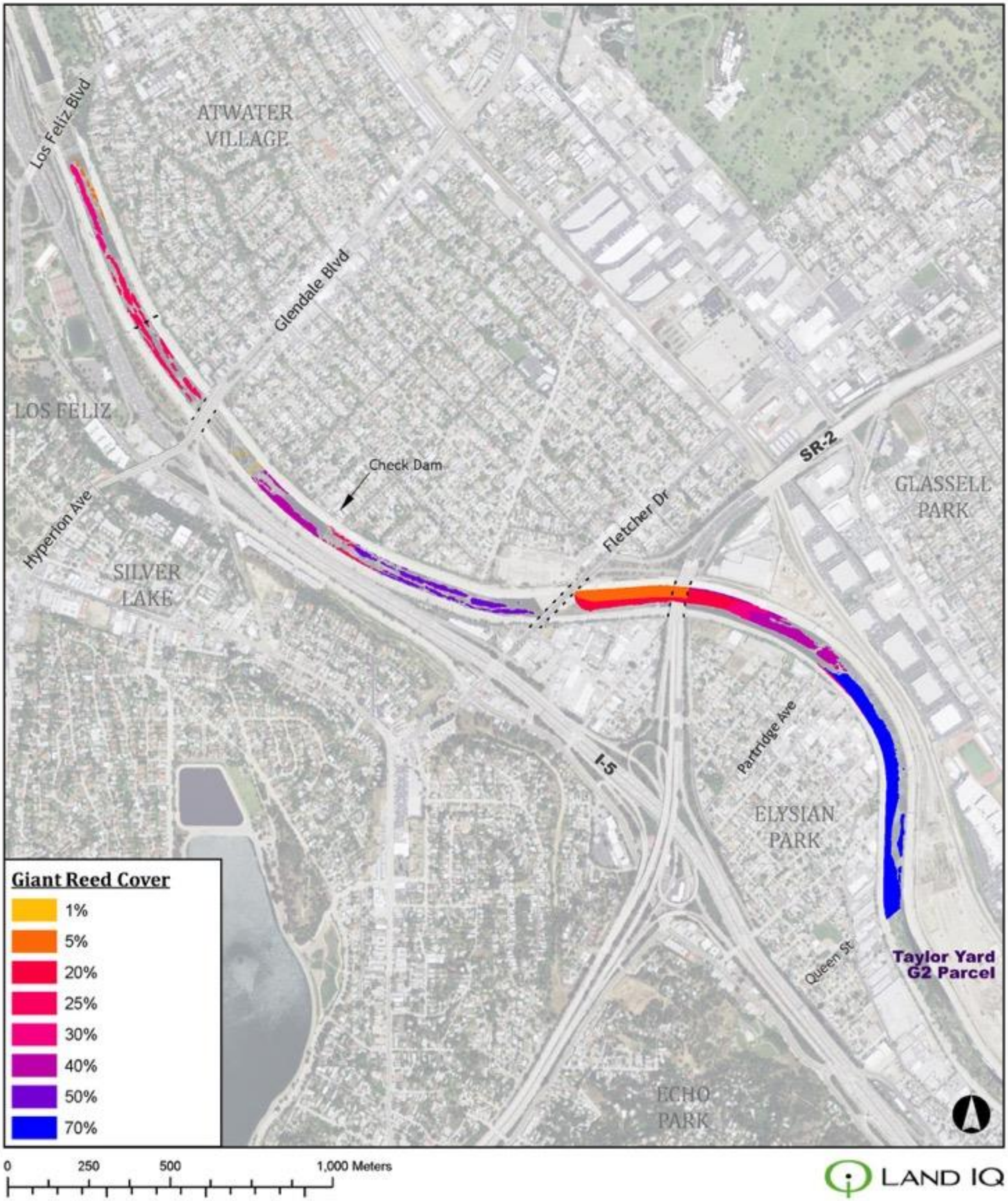


Figure 4-10 Giant reed (*Arundo donax*) cover of the Los Angeles River in the Elysian Valley (Year 2015).

Figure 4-11 Castor bean (*Ricinus communis*) cover of the Los Angeles River in the Elysian Valley (Year 2015).

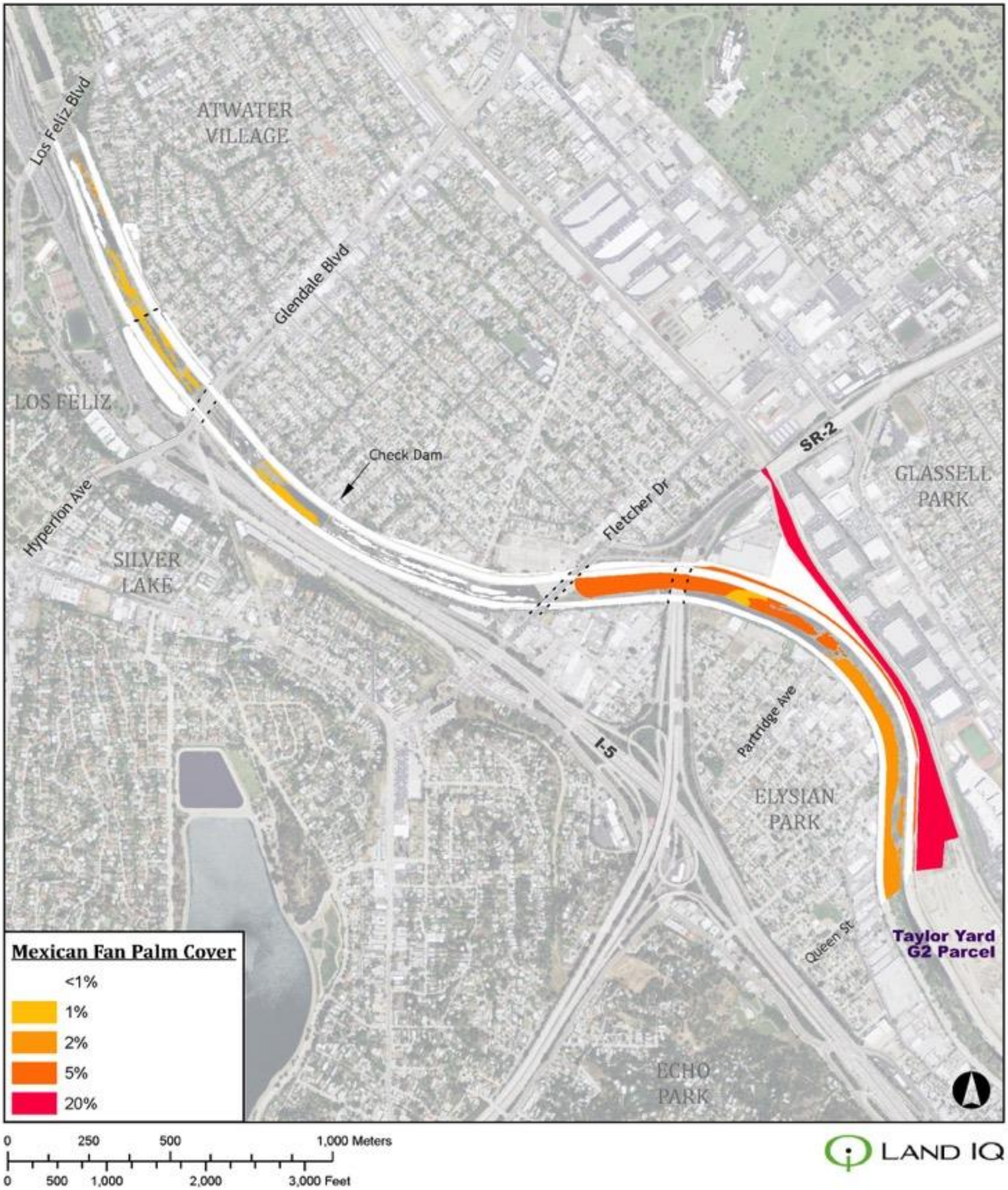


Figure 4-12 Mexican fan palm (Washingtonia robusta) cover of the Los Angeles River in the Elysian Valley (Year 2015).

While the concrete and grouted rock trapezoidal channel slope banks are primarily unvegetated due to the impermeable hardscape, where cracks, expansion joints and regularly spaced weep holes occur, they are commonly colonized by invasive perennial fountain grass. Other non-native species present include veldt grass, castor bean, tree tobacco, Mexican fan palm, and sweet fennel (*Foeniculum vulgare*). Some native species occur in these conditions including mulefat, telegraph weed (*Heterotheca grandiflora*) and willow herb. Where sediment and cobble has built up on the slope concrete toe protection or at the edge of the low flow river water, mulefat, horsetail (*Equisetum* sp.), and Mexican rush (*Juncus mexicanus*) are common.

Vegetation Communities and Vegetation Mapping Classifications

Based on the results of the field surveys, the vegetation was classified and maps were created for comparison with past conditions and to guide management planning for the future. Vegetation community classification and nomenclature is consistent with the second edition of the California Vegetation Manual (Sawyer *et al.* 2009).

All of the in-channel vegetated channel bars were generally defined by either: (1) homogenous Giant Reed Stands; or (2) an upper native willow canopy with Giant Reed Stands and other non-native species in the mid- to lower-canopies. Black willows are the dominant willow species, and have grown up to 50–60 feet tall in some channel bars; however, the suite of native understory species expected in a natural riparian community do not occur. Instead, the herbaceous, lower and mid canopies are primarily opportunistic and highly invasive species. Opportunistic native species with longer distance dispersal mechanisms, such as mulefat, also colonize open ground and understory on the channel bars.

Low native plant diversity may be caused by an unnaturally high perennial flow condition during dry weather (non-storm flow) fed by urban runoff and discharge from water reclamation plants. This flow regime favors a narrower range of native plant species than would be expected historically and less diversity than observed today in flood basins in the San Fernando Valley. Additionally, the confined flood control channel prevents the full range of vegetation communities that are associated with a non-confined floodplain, such as that seen in many locations along the Santa Clara River. Higher than historic peak storm flow velocities, which are due to the concentration of stormwater in the channel from the urbanized watershed, can result in more frequent scouring flows. While scouring flows can be a part of a “healthy” riparian ecosystem, invasive non-native plants, such as giant reed, quickly displace and outcompete native plants for space in the channel following disturbance. The presence of higher than historic perennial dry weather surface flow in the River also favors introduced species, such as giant reed, over native vegetation, except for a few dominant natives that also tolerate this specific hydrological condition (e.g. black willow).

Outside of the channel, the landscaped residential, commercial and park spaces are described broadly, as associations of species in these settings are the result of highly managed systems compared with natural assemblages responding to less active management. Plantings in these settings include common ornamental trees as well as native trees and shrubs. While the native plantings do not comprise a natural plant community alliance that could perhaps support a more habitat-specific fauna, even an individual native plant can contribute to the urban-wildland habitat that supports desired native and naturalized animals.

In-Channel Vegetation Community Alliances

Four in-channel vegetation community types were identified, classified by "Alliance" per the CDFW-CNPS California Vegetation Type Classification Manual, version 2 (Sawyer *et al.* 2009):

Giant Reed Stands; *Arundo donax* Semi-Natural Herbaceous Stands Alliance
Black Willow Thickets; *Salix gooddingii* Woodland Alliance
Mulefat Thickets; *Baccharis salicifolia* Shrubland Alliance
Emergent Vegetation; *Typha* (*angustifolia*, *domingensis*, *latifolia*) (Cattail marshes) Alliance

In-Channel Vegetation Mapping Units

Alliances and land cover features were grouped to create five vegetation mapping units in the channel based on the following four fields: in-channel vegetation community Alliances, abiotic landscape features, the scale of mapping to support habitat enhancement project design, and the patchy distribution of features. These mapping units were selected to distinguish between channel bars that were either dominated entirely by giant reed (Giant Reed Stands), were a patchy mix of giant reed and mulefat (Giant Reed Stands/Mulefat Thickets) or a mix of black willow overstory, giant reed and some emergent vegetation along the channel bar (Giant Reed Stands/Black Willow Thickets with Emergent Vegetation).

The cover of landscape features and vegetation communities are presented in Table 4-5 and Figure 4-13.

GIANT REED STANDS/MULEFAT THICKETS

A few of the channel bars had a mix of these two vegetation communities, Giant Reed Stands and Mulefat Thickets. Giant reed is a ubiquitous and common colonizer of open space where rhizomes have arrived, washed from an upstream population that had been uprooted by a scouring storm flow. Given the high non-flood flow condition, except in the rockiest substrate, it would be expected that areas that currently have a more open habitat, such as the Giant Reed Stands/Mulefat Thickets, would eventually be colonized by giant reed and effectively exclude other vegetation. Mulefat is a common early colonizer and its presence on channel bars with bare ground either indicates that the channel bar substrate is relatively new or recently disturbed, and hasn't had time for larger stature plants, such as willows to establish, or that the conditions are drier (or experiencing a nutrient related extreme soil condition), which prevents the development of willow thickets.

GIANT REED STANDS/BLACK WILLOW THICKETS WITH EMERGENT VEGETATION

The most common vegetation community of the channel bars is a mix of Giant Reed Stands and low diversity Black Willow Thickets, with 1–10% cover of emergent vegetation along the channel bar edge or in low lying depressions within the channel bar. In the faster moving waters of Segment 7, the establishment of dense vegetation and accumulation of sediment have developed channel bars that are up to a few feet above the design channel bottom, defined by the concrete toe protection at the bottom of the trapezoidal slope bank. The constriction of the water flow and the resulting relatively high base flow velocity in-stream reduces the amount of emergent vegetation (Figure 4-6) and effectively excludes floating vegetation (Figure 4-7).

The areas with dense giant reed, including those areas mixed with large black willows, especially in Segments 6 and 7, are heavily populated by homeless encampments.

Table 4-5 Landscape Features and Vegetation Community Cover by Segment.

	1	1A	2	2A	3	4	5	6	6A	6B	7
Total Area (acres)	**21.87**	**1.62**	**10.09**	**4.15**	**16.58**	**24.16**	**12.74**	**16.66**	**21.08**	**5.46**	**25.99**
In-Channel 3:1 Slope Bank (Concrete/Grouted Rock) with Non-Natives	6.06	NA	3.35	NA	4.73	6.98	3.40	4.72	NA	NA	8.57
In-Channel Total Low Flow Area (Water+Channel Bars+Toe Protection)	9.67	NA	4.88	NA	7.76	11.19	6.52	8.39	NA	NA	14.33
Outside of Channel Total Area	6.14	1.62	1.86	4.15	4.09	5.99	2.82	3.55	21.08	5.46	3.09
<u>In-Channel: Low Flow Area Detail (acres)</u>											
Concrete Toe Protection	0.89	NA	0.51	NA	0.88	1.51	---	0.13	NA	NA	0.31
Water	6.29	NA	3.07	NA	5.36	6.77	2.11	3.26	NA	NA	5.73
Channel Bars	2.49	NA	1.30	NA	1.52	2.91	4.41	5.00	NA	NA	8.29
<u>Channel Bar Vegetation Community Cover</u>											
Emergent Vegetation with Giant Reed/Black Willow	---	NA	---	NA	8%	14%	---	---	NA	NA	---
Giant Reed	---	NA	2%	NA	---	---	35%	36%	NA	NA	13%
Giant Reed/Black Willow with Emergent Vegetation	100%	NA	98%	NA	92%	86%	2%	44%	NA	NA	87%
Giant Reed/Mulefat	---	NA	---	NA	---	---	63%	20%	NA	NA	---
<u>Outside of Channel (acres)</u>											
Urban Landscaping	3.35	---	0.74	0.97	1.87	2.74	1.57	1.55	0.08	---	0.60
Urban Park	1.13	1.62	0.04	3.16	0.57	0.65	0.08	---	18.49	5.46	0.29
Revegetated with Coastal Sage Scrub Shrubs	---	---	---	---	---	---	---	0.90	0.58	---	0.71
Hardscape	1.65	---	1.08	0.01	1.65	2.60	1.17	1.10	1.94	---	1.50

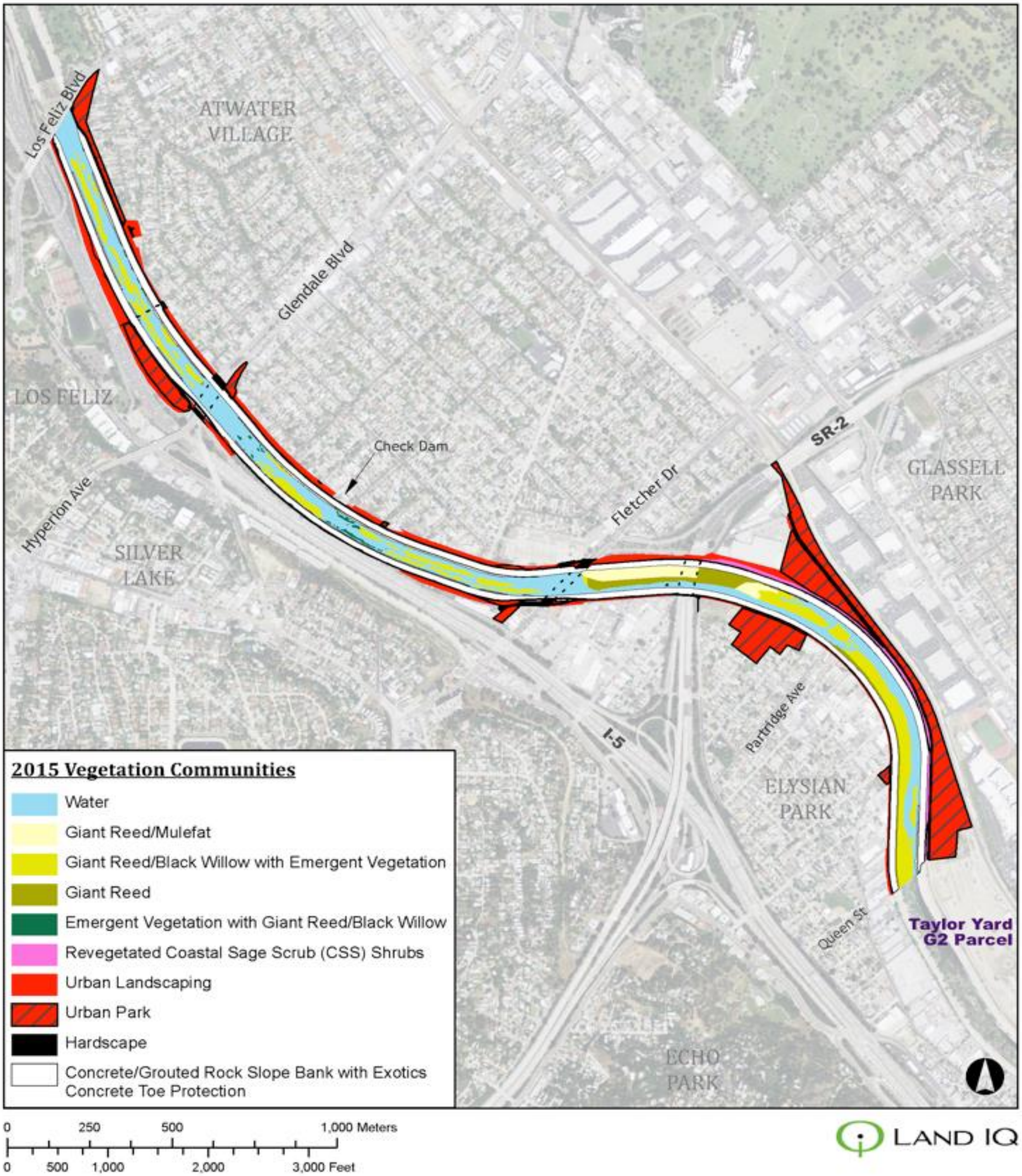


Figure 4-13 Vegetation mapping classes of the Los Angeles River in the Elysian Valley (Year 2015).

GIANT REED STANDS

Channel bars with lower native cover and dominated by Giant Reed Stands were simply defined as Giant Reed Stands. Giant reed grows densely and quickly in warmer temperatures without any water stress due to the availability of year-round water in the current low-flow river condition. While giant reed is the most visible and productive species, the Giant Reed Stands are also host to a number of other invasive and opportunistic native species.

EMERGENT VEGETATION WITH GIANT REED/BLACK WILLOW

Channel bars with more than 10 percent emergent vegetation cover were identified by this mapping classification. The remainder of the channel bar is comprised of Giant Reed Stands and Black Willow Thickets.

CONCRETE/GROUTED ROCK SLOPE BANK WITH EXOTICS

While not a naturally occurring vegetation community, the unique substrate conditions of the engineered slope and regularly spaced weep holes appear to promote establishment by non-natives with adaptations that also make them highly invasive. Hence, fountain grass, Mexican fan palm and castor bean are commonly found wherever a crack, expansion joint or weep hole allows for rooting volume.

Out of Channel Vegetation Mapping Units

Four mapping units were identified outside of the channel in the study area:

REVEGETATED WITH COASTAL SAGE SCRUB SHRUBS

The slope just above the left bank (east-side) of the channel leading up to the flat terrace of the old Taylor Yard, which is now the Bowtie Parcel, owned and operated as a State Park, was at some point enhanced with coastal sage scrub species, including sages, toyon and laurel sumac. Mexican fan palm and other non-natives also persist on this slope. This mapping class could potentially be classified as a sage scrub vegetation community; however, it currently lacks a native herbaceous understory and is likely not a stable vegetation community given its high edge effect (e.g. long linear strip) and level of invasion by non-native species.

URBAN LANDSCAPING

Urban landscaping includes residential yards, privately owned land (some zoned as residential and other areas a commercial zoning classification) that falls within the right-of-way/easement of the Los Angeles Flood Control District, commercial and light industrial property. The plantings are typically ornamental and while non-native, few are considered invasive.

URBAN PARK

The urban parks within the study area include Sunnynook Park, Marsh Park, the Bowtie Parcel, Red Car River Park, Los Feliz Blvd Park and several other smaller pocket parks that have been recently planted with native trees and shrubs, in addition to existing ornamental tree plantings. Each pocket park is unique in its assembly of vegetation.

HARDSCAPE

Hardscape is a landscape feature that generally does not provide much habitat value. However, while not generally vegetated, some sections of the hardscape, including portions of the bike path, do have an upper canopy of trees hanging overhead which provides some aerial habitat for fauna.

Segment 6 and 7 Photo Points: Comparison of 1991–92 to 2015

Photo points initially established for Garrett's (1993) 1991–92 study of avian diversity and habitat associations of the Los Angeles River in the Elysian Valley were retaken in summer 2015 for comparison. The study area for the 1991–92 study of avian fauna extends south of the Glendale Freeway to the Taylor Yard G2 Parcel, and corresponds with Segments 6 and 7 in the current study (see Figure 4-14). Garrett (1993) took representative seasonal photos at nine permanent photo points in fall 1991, winter 1992, spring 1992 and summer 1992. See Appendix H for all of the photo point figures for 1991–92 and 2015.

Management for flood control in the late 1980s discontinued vegetation clearing within the 'soft bottom' channel area, which allowed development of vegetated channel bars within the study area. Since the 1991–92 vegetation survey (Garrett 1993), there has been little change in the general position of the in-channel bars and areas of vegetation, likely due in part to this management change. However, there have been changes in the vegetation cover and species composition over this period of time, with an increase in dominance of the black willow canopy and giant reed. These vegetation changes are apparent in comparisons from photographs taken along the project area in 1991–92 and from the same point in 2015 (e.g. see Figures 4-15a and 4-15b). Most of the comparative photos in Appendix H show an increase in giant reed between 1992 and 2015, with only photo point 6 showing somewhat less giant reed in 2015 compared to native willows.

Wallace (1993) in the Vascular Plant Section of the Report, reported seeing at least three native species of willow in what is segment 7 of this study: sandbar willow (*Salix exigua*), Arroyo willow (*Salix lasiolepis*) and Pacific willow (*Salix lasiandra*). He also reported two unidentified willows (*Salix* sp.), which could have been another species (i.e. perhaps black willow) or individuals Wallace was unable to positively identify because of the lack of key features (e.g. flower parts). Wallace made three trips (May 1991, October 1991 and September 1992) to document occurrence of plant species in what is identified as segment 7 in the current study (identified as Newell St. in the 1993 report). Black willow was not documented, which is now the dominant native over story species in this area. In the current 2015 survey, few Arroyo willow and Pacific willow were found in the channel bars. Sandbar willow, which is associated with drier alluvial soils and openings in the floodplain that follow disturbances (e.g. scouring stormwater discharges) that exist in the current dry weather flow condition in the River, does not currently occur in the study area.

The identity of invasive species and herbaceous annuals and perennials in the study area is generally similar to what Wallace observed in 1991–92. Even the habitat relationships between substrate types within the channel and many plant species remain stable. For example, the prevalence of fountain grass on the concrete channel banks, the occurrence of emergent and floating vegetation like *Ludwigia peploides* in the slower moving waters and Mexican fan palm commonly found on the drier alluvial soils.

Figure 4-16 demonstrates the typical pre- and post-stormwater flow condition of the vegetation in the River. Figure 4-16a shows the vegetation after a summer of vegetative growth, including castor bean, willow trees, giant reed and other various herbaceous plants. The second image is the vegetation after stormwater flows that have flattened or scoured some of the vegetation. Generally, the species that have persisted in the novel habitat conditions of the channelized River are resilient to high velocity flows from stormwater events by repopulating the sand bar from a large seedbank (e.g. castor bean), resprouting from rhizomatous roots (e.g. giant reed) or bending with flexible wood during inundation (e.g. willows). Note that for the example time series in Figure 4-16 and the corresponding summer 1992 photo (Figure 17a) the vegetation has responded with vigorous growth, even during an above average rainfall year (1991–92 water year from October 1991–September 1992; see Figure 3-22).

Comparing Figure 17b from summer 2015 (7-8-2015) to 24-years prior in Figure 17a, the maturation of the black willow trees and persistence of the giant reed colonies is evident.

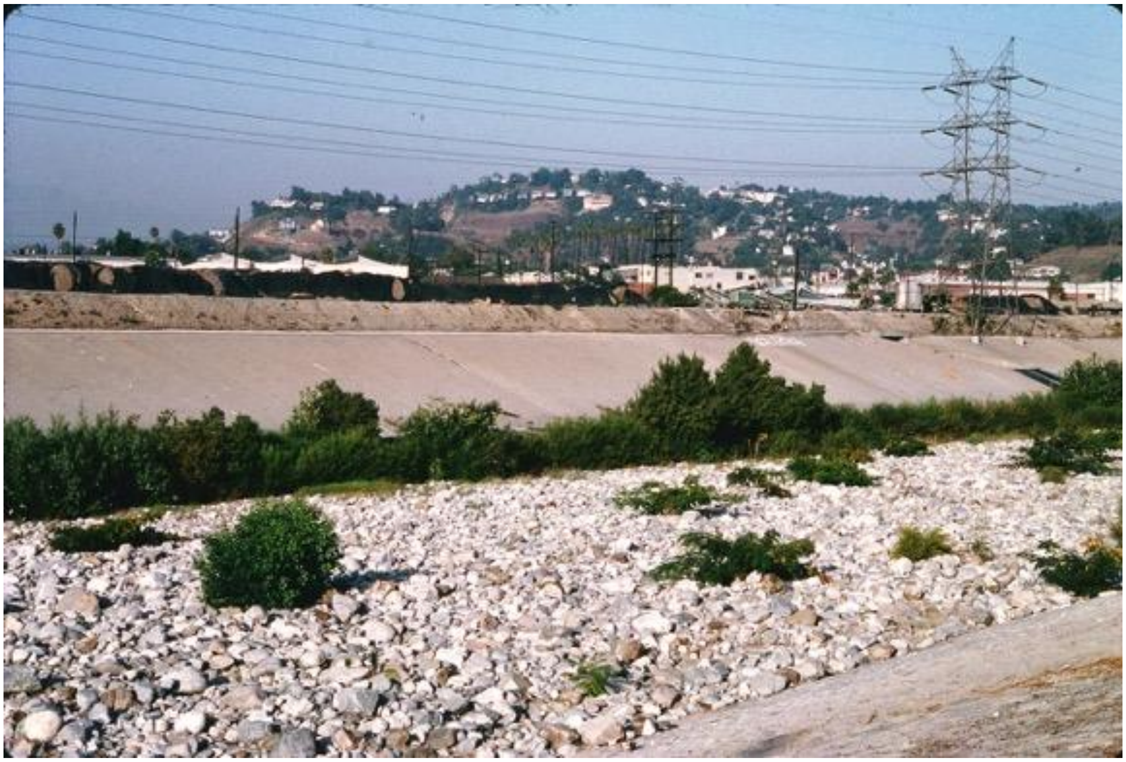
Aerial Land Cover and Vegetation Community Change Between Historic Condition and Present

The study area for the land cover and vegetation community change matches the mapped extent of the reconstructed historic floodplain (Chapter 2), with the limits of the upstream and downstream ends of the focus area for the current study (see Figure 4-18). The aerials selected to be georeferenced and hand digitized for land cover units, were based on the imagery available and the awareness of key events, identified in Chapter 3, that resulted in substantial increases in dry weather baseflows. See Figures 4-19 to 4-25, corresponding to the following imagery years: 1928, 1952, 1972, 1983, 1994, 2005 and 2014.

In Figure 4-26, urban land cover is white, while open space and its corresponding vegetation community has been filled with a color, which corresponds to the colors displayed in the histogram (Figure 4-27). Figure 4-28 presents the legend for both Figures 4-26 and 4-27. Change over time in the histogram and map figures demonstrate the loss of habitat to development of the historic floodplain and the conversion of the historic vegetation communities to novel and less diverse vegetation communities and urbanization. This type-conversion started with the use of the floodplain for commercial activities, such as agriculture and residential developments, but accelerated with the channelization of the River and the build out of the flood control system in Los Angeles, allowing further economic development of the historic floodplain.

Interestingly, following the channelization of the River, the vegetated channel bar positions have not changed much over time between years and storm events, except the shift in the position of the low flow channel from the left river bank to the right, spanning biological survey segments 5, 6 and 7 (below Fletcher Drive Bridge where the channel both bends and reduces significantly in slope). This suggests that sedimentation and erosion within the study area is fairly stable.

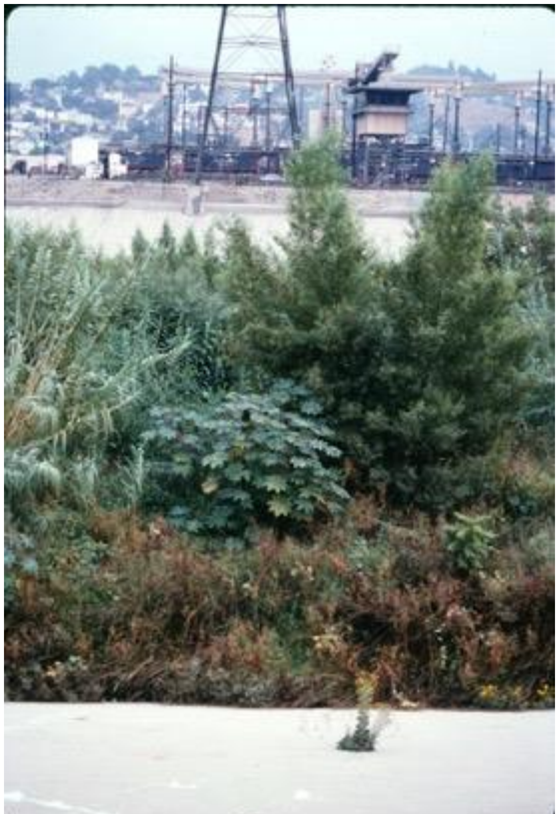
Figure 4-14 Photo Point Locations in Segments 6 and 7 and south of the study area adjacent to Taylor Yard G2 Parcel . Photo Points established by Garrett (1993) for the 1991–92 Biota Study.



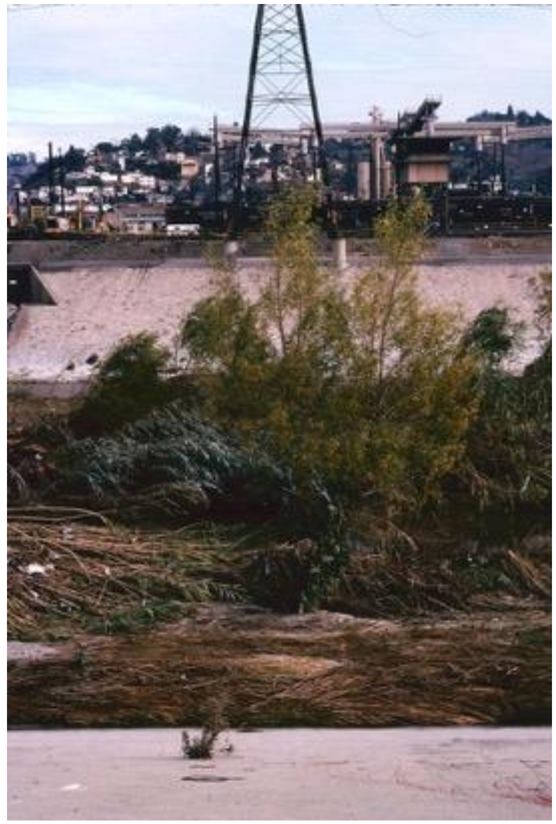
a. Summer 1992 (8-11-1992). Source: Garrett 1993.

b. Summer 2015 (7-8-2015).

Figure 4-15 Photo Point 2a in (a) Summer 1992 and (b) Summer 2015.



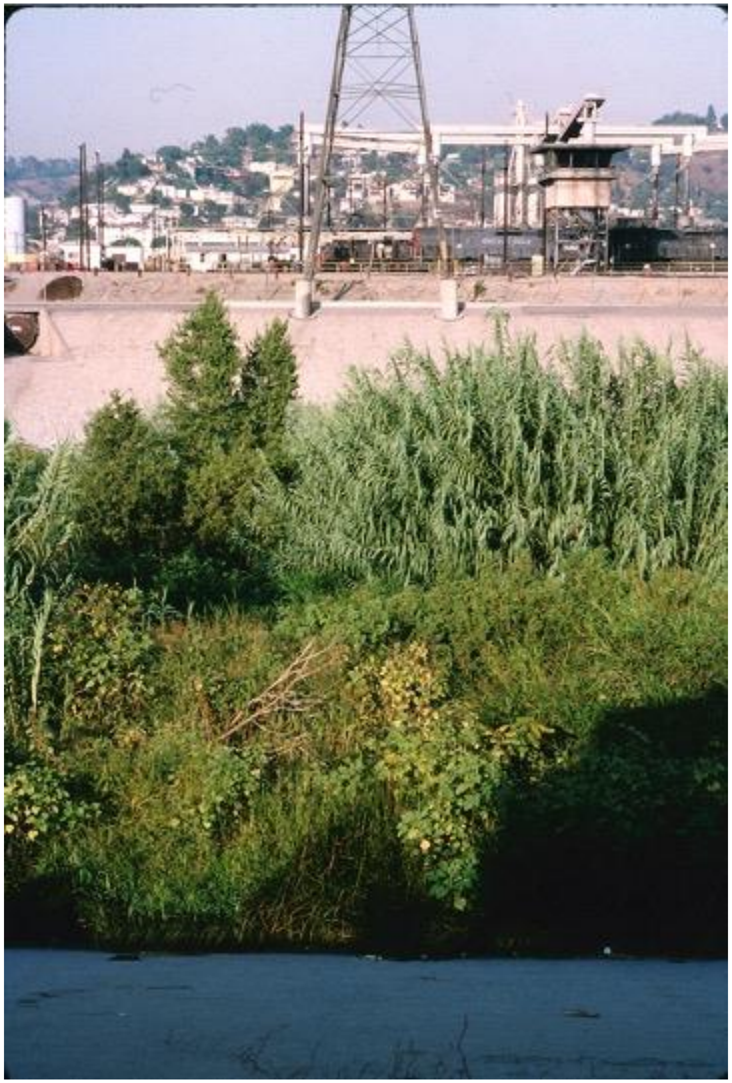
a. Fall 1991 (10-26-1991).



b. Winter 1992 (1-4-1992).

c. Spring 1992 (5-15-1992).

Figure 4-16 Photo Point 7b in (a) Fall 1991, (b) Winter 1992 and (c) Spring 1992. Source: Garrett 1993.



a. Summer 1992 (8-11-1992). Source: Garrett 1993.

b. Summer 2015 (7-8-2015).

Figure 4-17 Photo Point 7b in (a) Summer 1992 and (b) Summer 2015. Source of 1992 photo: Garrett 1993.

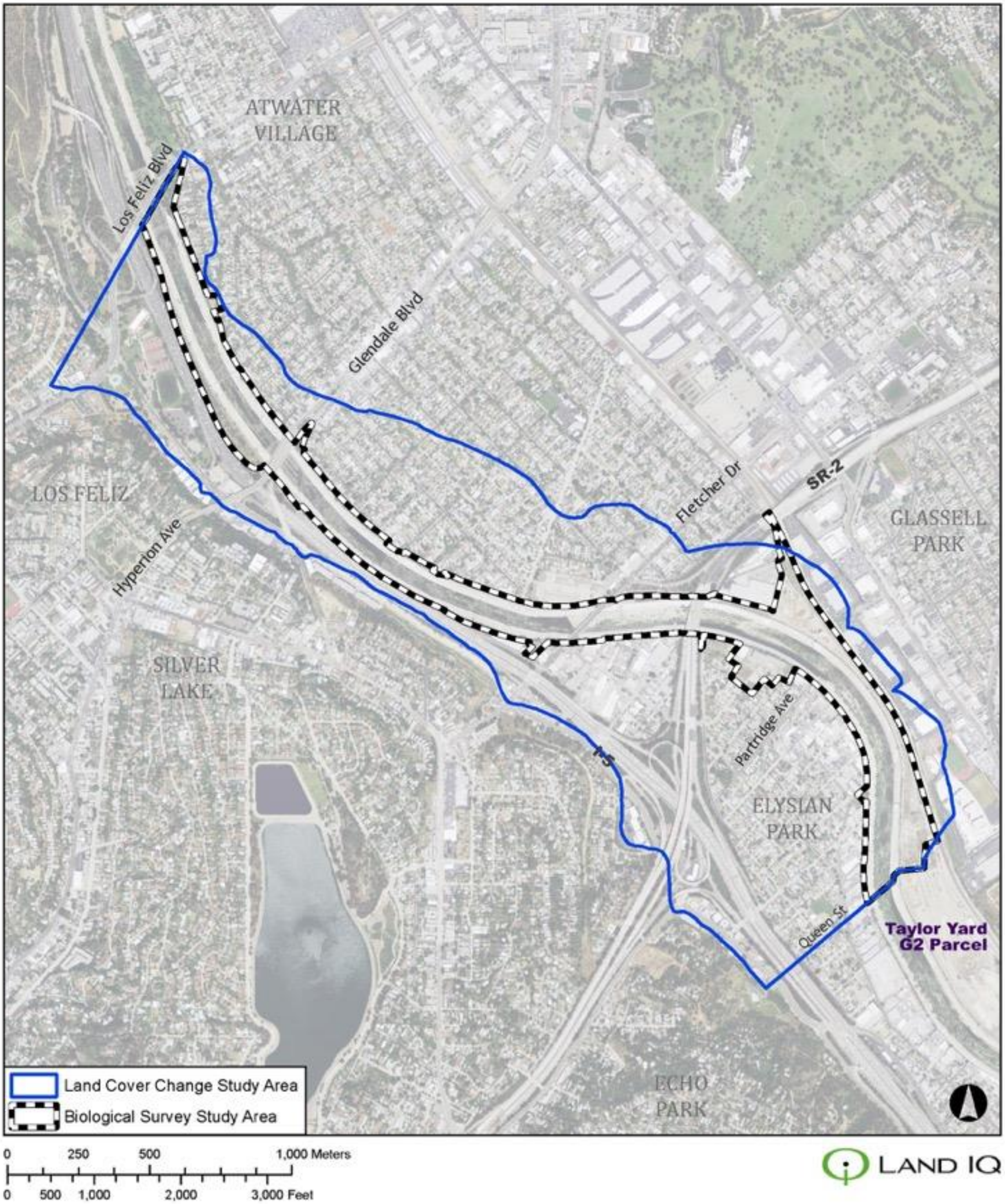


Figure 4-18 Land Cover and Vegetation Community Change Study Area

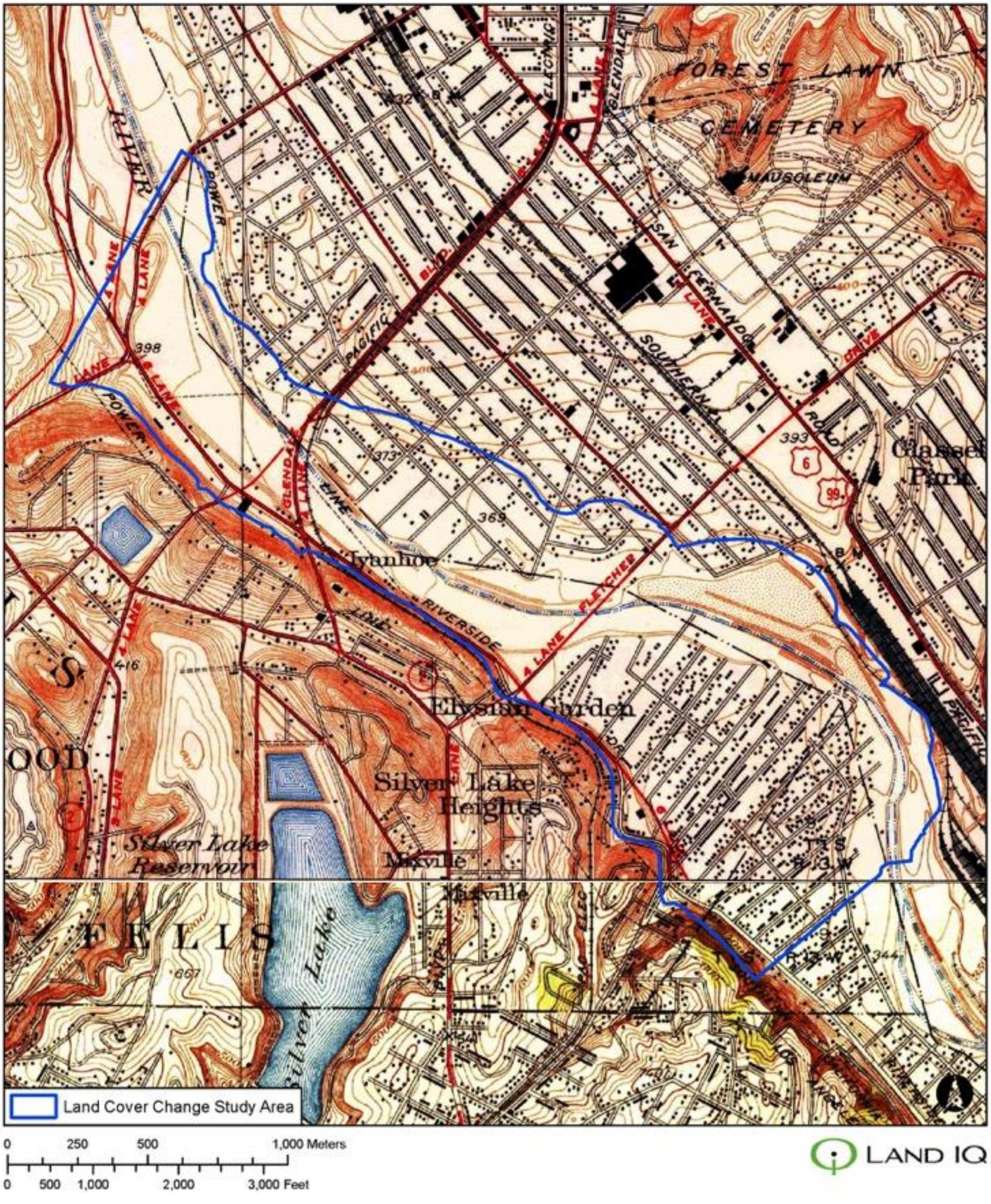


Figure 4-19 Land Cover and Vegetation Community Change: 1928 USGS Topographic Maps of Glendale (top) and Los Angeles (bottom) Quadrangles.

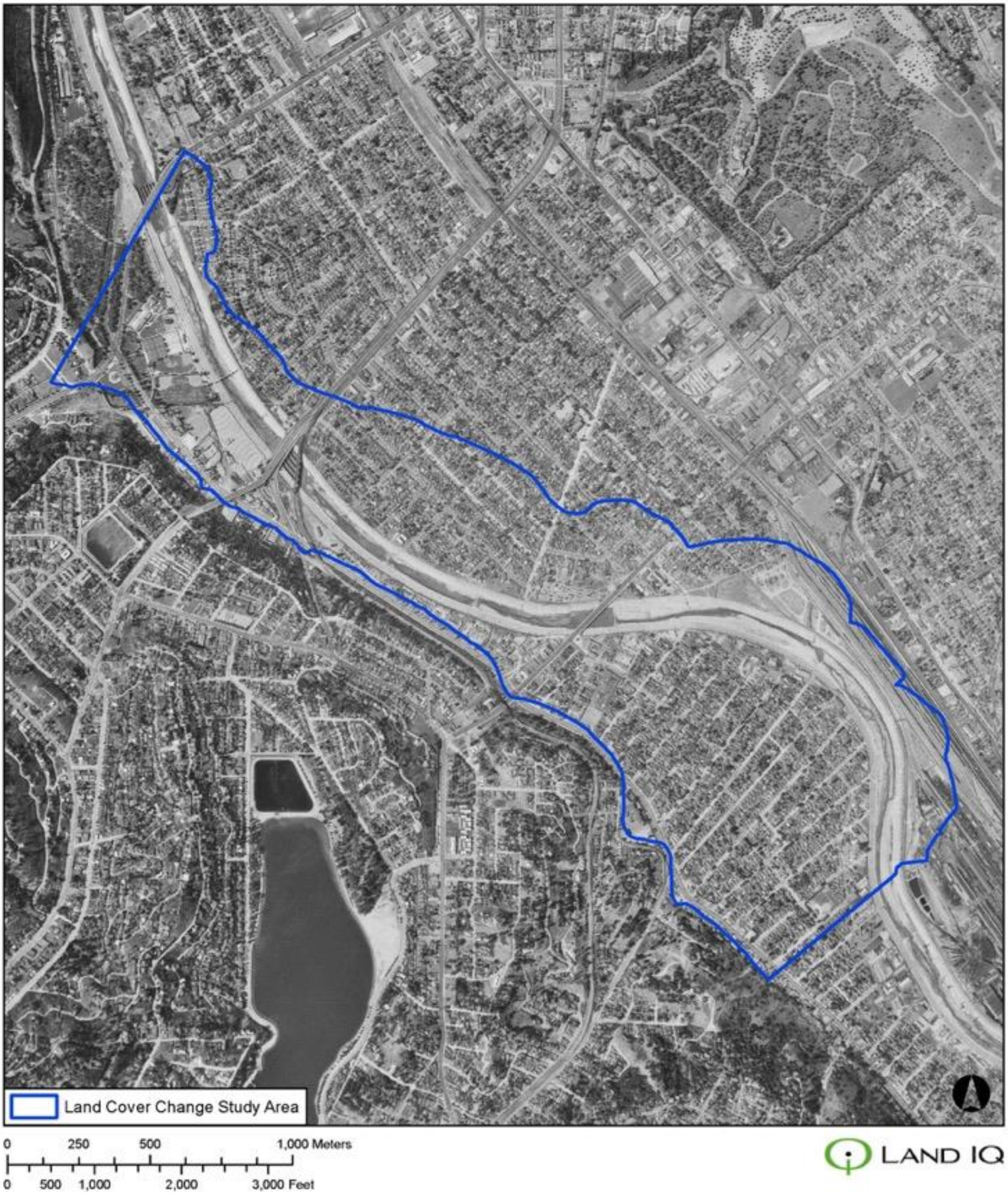


Figure 4-20 Land Cover and Vegetation Community Change: 1952 Black and White Aerial Image (2-foot resolution), Acquired on July 30, 1952.

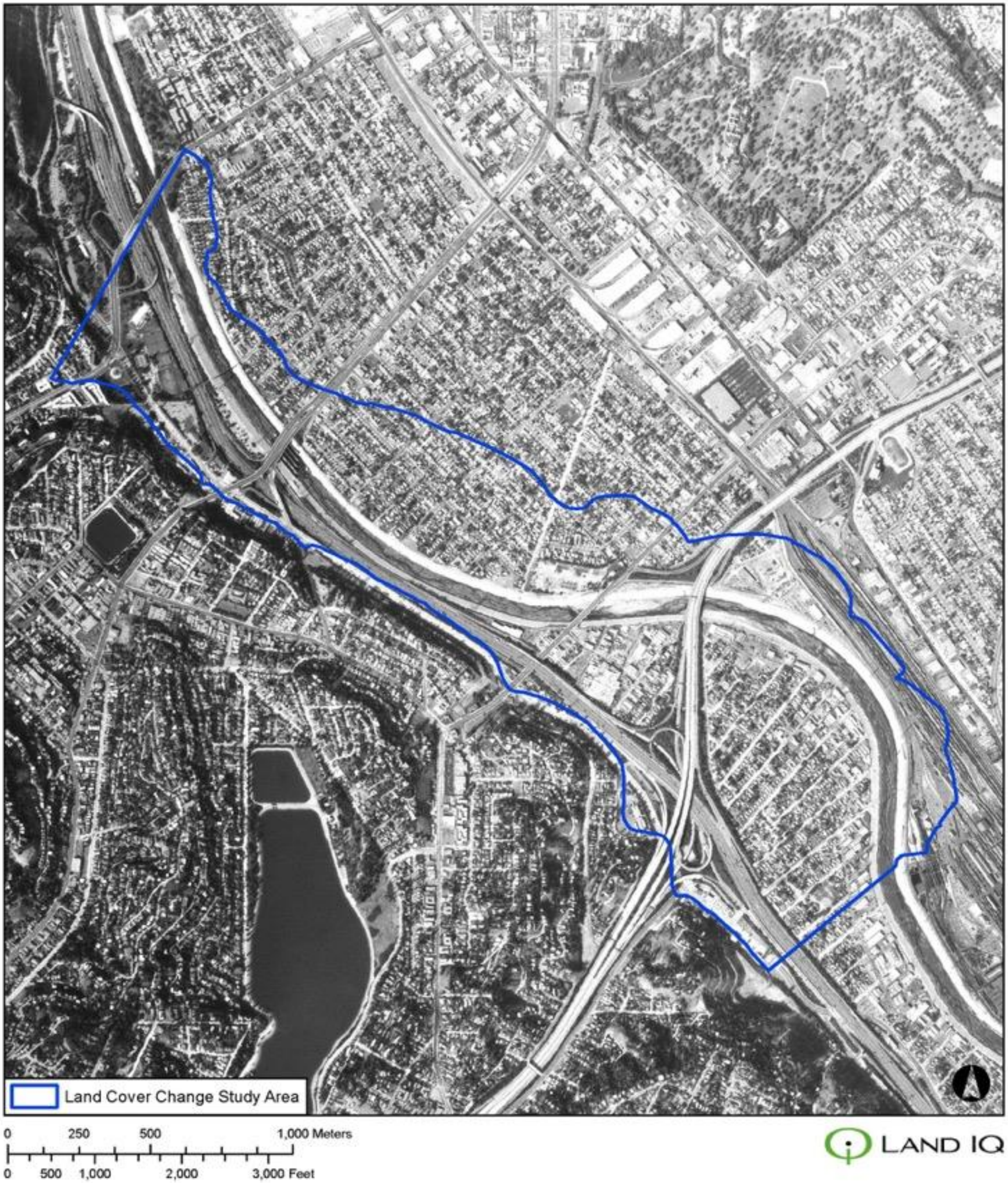


Figure 4-21 Land Cover and Vegetation Community Change: 1972 Black and White Aerial Image (2.6-foot resolution), Acquired on October 25, 1972.

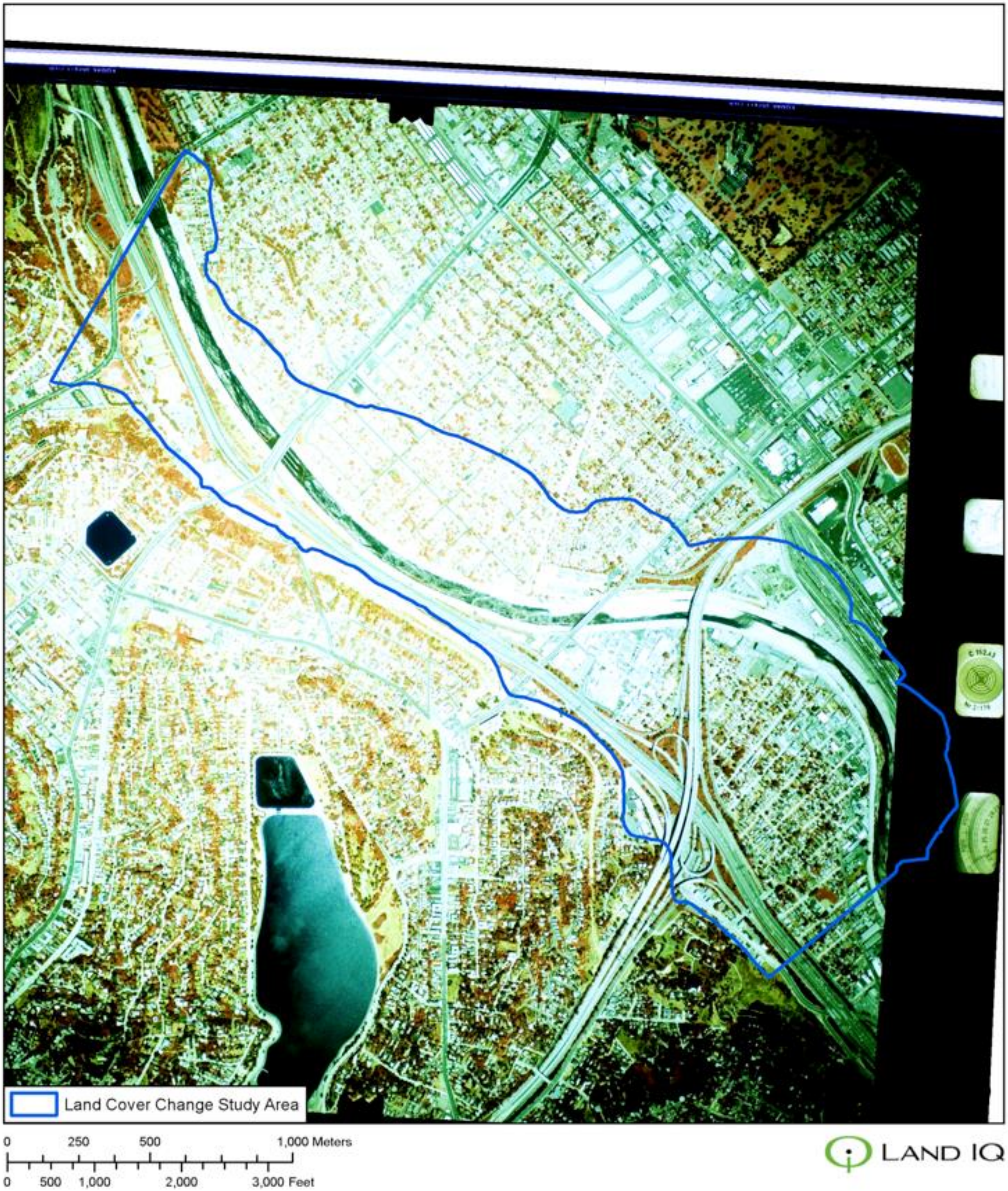


Figure 4-22 Land Cover and Vegetation Community Change: 1983 Color Infrared Aerial Image (4.5-foot resolution), Acquired on July 7, 1983.

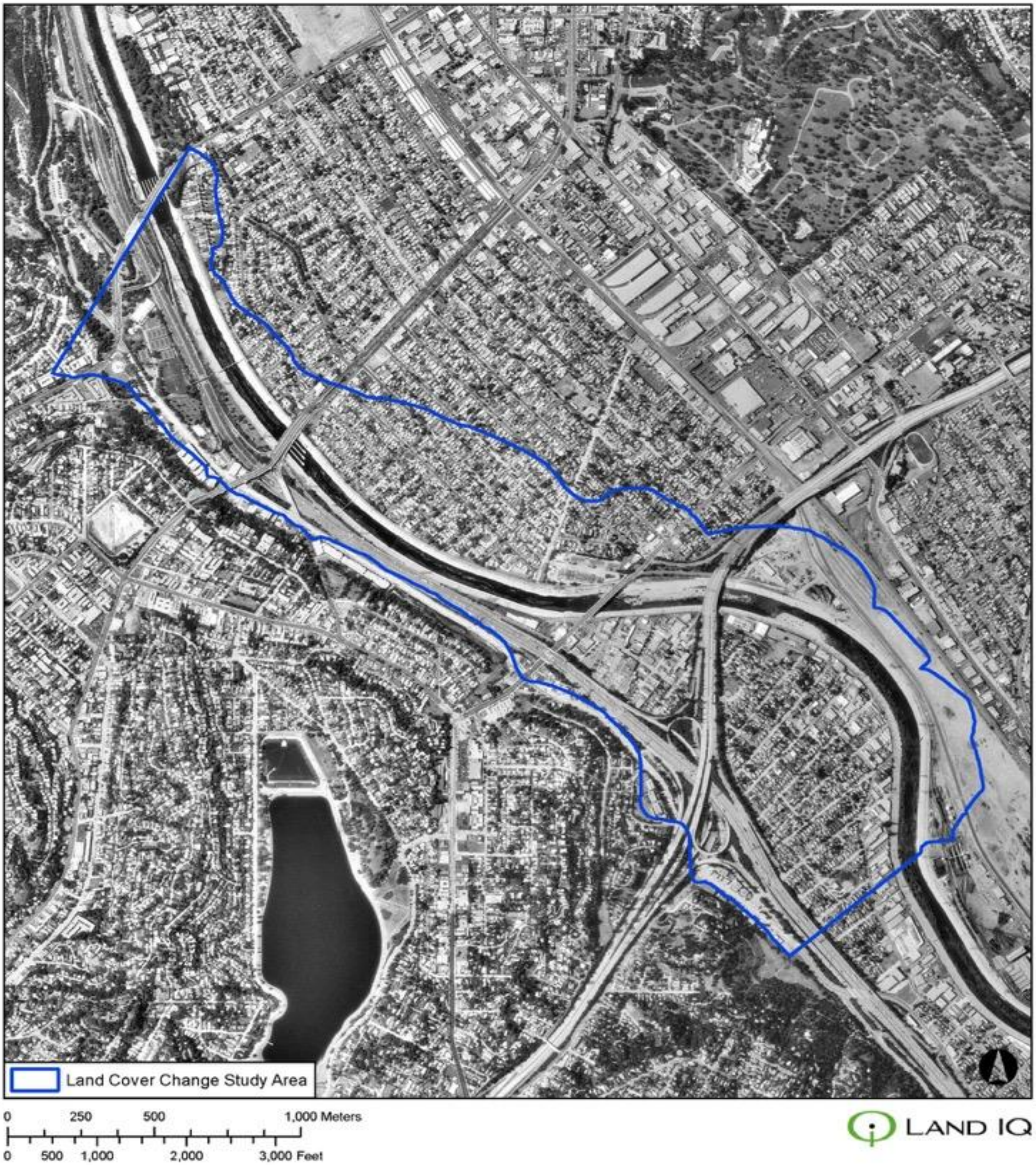
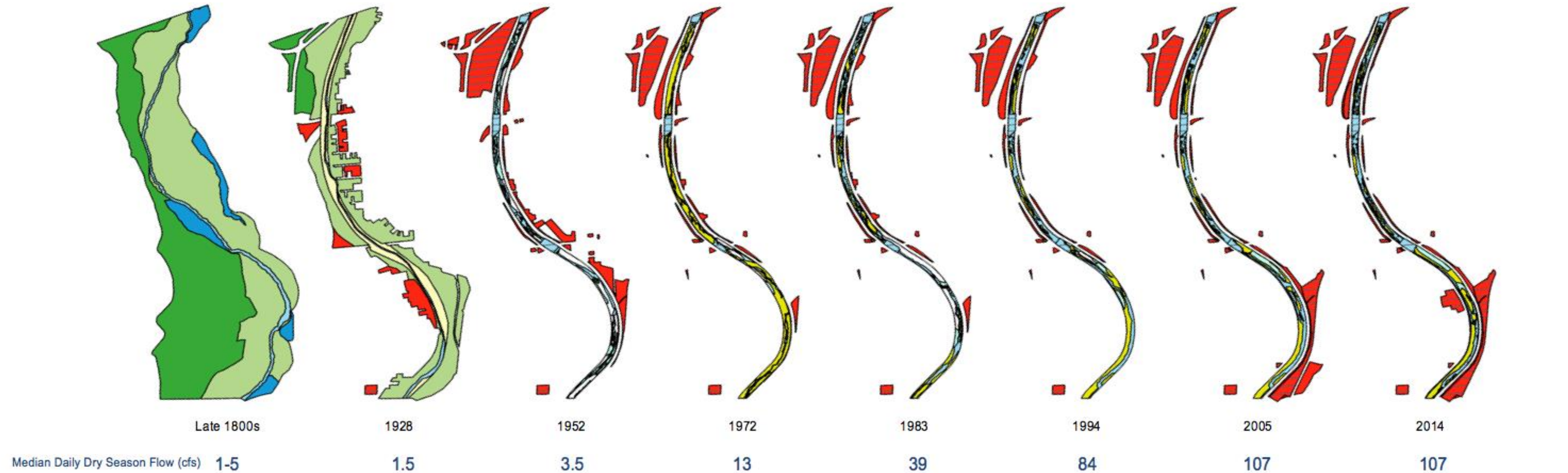


Figure 4-23 Land Cover and Vegetation Community Change: 1994 Black and White Aerial Image (1-meter resolution), Acquired on May 31, 1994.

Figure 4-24 Land Cover and Vegetation Community Change: 2005 Color Aerial Image (1-meter resolution), Acquired on June 19, 2005.

Figure 4-25 Land Cover and Vegetation Community Change: 2014 Color Aerial Image (1-foot resolution), Acquired in Winter 2014.

Figure 4-26 Change in Land Use of the Floodplain, Dry Weather Surface Flow and the Composition of the Vegetation Communities in the Elysian Valley: 1800s to 2014.



Median daily dry season flow calculations: LA City Gage F57C for water year periods 1932-37,1938-65,1966-75,1976-84,1985-86 and 1991-2015.
Extent of analysis: Historic riparian zone in the contemporary floodplain, circa late 1800s, Los Feliz Bridge to Taylor Yard.

Historical Condition (pre-1800s)
- *Intermittent Dry Season Surface Flow*
- *River Wash (Unvegetated and Mulefat Thickets)*
- *Perennial Freshwater Wetlands*
- *Willow Woodlands and Shrublands*
- *California Sycamore – Live Oak Woodlands*

Agricultural & Urban Land Development (Late 1800s–1938)
- *Willow Thickets*
- *Giant Reed Locally Common*
- *Remnant Californa Sycamore – Live Oak Woodlands*
- *Floodplain Veg. Cleared, Low Flow Course Straightened*

Urbanization & Flood Control System (1938–1965)
- *Giant Reed Stands*
- *Mulefat Thickets*
- *Periodic Veg. Clearing and Levees Built for Storm Flood Control*

Increased Dry Weather Flow From Burbank & LA-Glendale Water Reclamation Plant (WRP) Discharge (1966–1985)
- *Giant Reed Stands*
- *Mulefat Thickets and Low Diversity Willow Thickets*
- *Perennial Freshwater Emergent Vegetation*
- *Periodic Vegetation Clearing for Channel Maintenance*

Additional Discharge from Tillman WRP & Little to No Vegetation Clearing in the Channel (1986–2014)
- *Giant Reed Stands*
- *Mulefat Thickets and Low Diversity Black Willow Thickets*
- *Perennial Freshwater Emergent Vegetation*
- *Landscaped Upper Terrace Open Space and Parks*

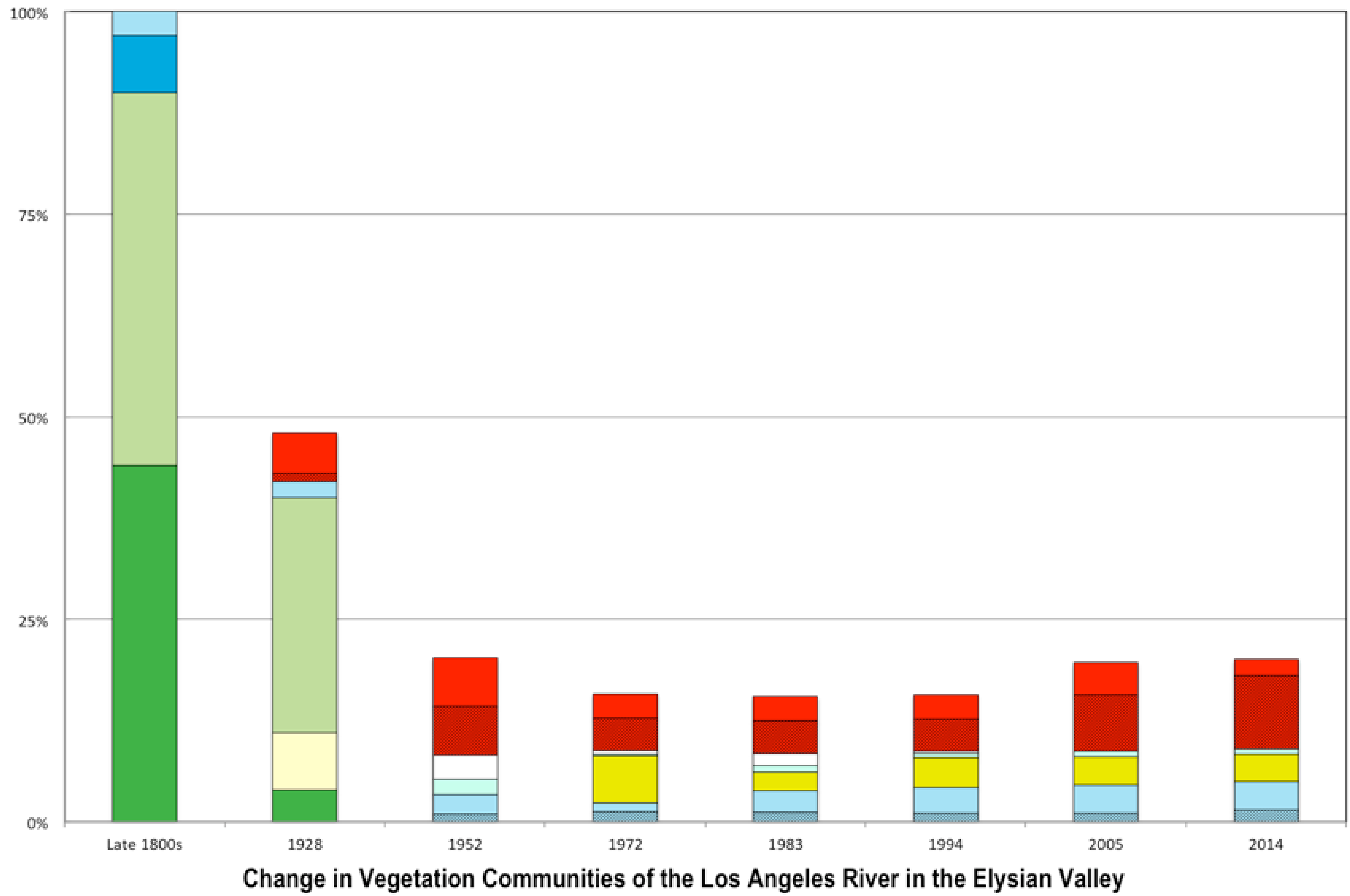


Figure 4-27 Change in the Composition of the Vegetation Communities in the Elysian Valley.

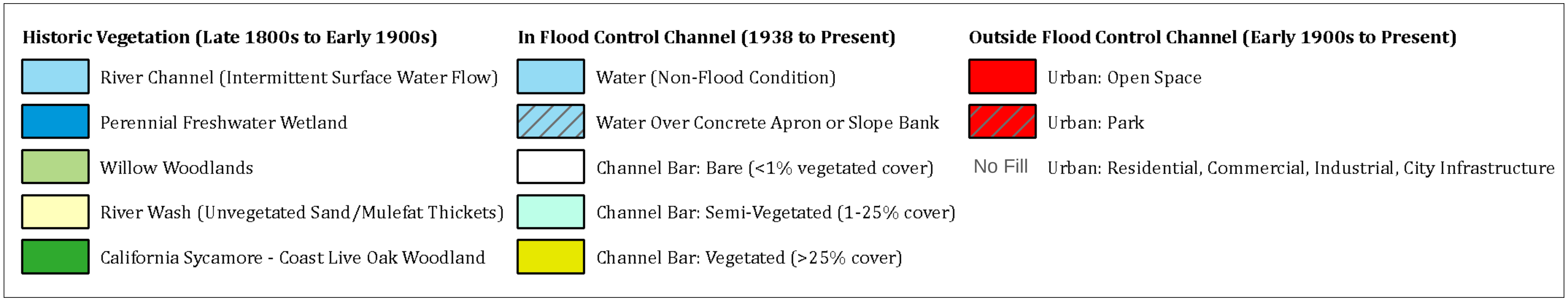


Figure 4-28 Legend for Figures 4-26 and 4-27.

Data Used for Land Cover Analysis:

Chapter 2 of Report: Longcore, T. 2016. Historical Ecology of the Los Angeles River Riparian Zone.

Los Angeles County. 2014. Color Orthogonal Imagery. Acquired in Winter 2014 by Pictometry International Corporation for the Los Angeles Regional Imagery Consortium 4 Project (LAR-IAC4). 1-Foot Resolution. Viewed on LA County GIS Viewer, Accessed January 2016. http://egis3.lacounty.gov/eGIS/gis-mapping-applications/gisviewer/.

National Park Service (NPS). 1983a. Vertical Cartographic Color Infrared Aerial Image. Acquired on July 7, 1983. Scale 1:3,222. United States Geological Survey (USGS), National Center for Earth Resource Observations and Science (EROS), Long Term Archive (LTA), Entity ID ARL830280627217.

NPS. 1983b. Vertical Cartographic Color Infrared Aerial Image. Acquired on July 7, 1983. Scale 1:3,222. USGS, EROS, LTA, Entity ID ARL830280627218.

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USDA. 2005b. NAIP 3-Band Color Image. 1-Meter Resolution. Acquired June 19, 2005. NAIP Entity ID N_3411862_NE_11_1_20050619_20060210.

United States Geological Survey (USGS). 1928. California. (Los Angeles Co.) Glendale Quadrangle. Edition of 1928. 1:24000. Surveyed in 1925. Topography by T.H. Moncure.

USGS. 1928. California. (Los Angeles Co.) Los Angeles Quadrangle. Edition of 1928. 1:24000. Surveyed in 1925. Topography by C.A. Ecklund.

USGS. 1952. Vertical Cartographic Black and White Aerial Image. Acquired on July 30, 1952. Scale 1:23,600. USGS, National Center for Earth Resource Observations and Science (EROS), Long Term Archive (LTA), Entity ID AR1VP0000180081.

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USGS. 1964a. Vertical Cartographic Black and White Aerial Image. Acquired on September 1, 1964. Scale 1:24,000. USGS, EROS, LTA, Entity ID AR1VAWW00010095.

USGS. 1964b. Vertical Cartographic Black and White Aerial Image. Acquired on September 1, 1964. Scale 1:24,000. USGS, EROS, LTA, Entity ID AR1VAWW00040017.

USGS. 1972. Vertical Cartographic Black and White Aerial Image. Acquired on October 25, 1972. Scale 1:30,000. USGS, EROS, LTA, Entity ID AR1VCYY00020097.

USGS. 1994a. Hollywood Northwest 3.75-minute Black and White Digital Orthophoto Quadrangle (DOQ). Acquired on May 31, 1994. USGS, EROS, LTA, Entity ID DI00000000922116.

USGS. 1994b. Hollywood Northeast 3.75-minute Black and White Digital Orthophoto Quadrangle (DOQ). Acquired on May 31, 1994. USGS, EROS, LTA, Entity ID DI00000000922092.

Additional Data Sources for Table:

Gumprecht, B. 1999. *The Los Angeles River: Its Life, Death, and Possible Rebirth*. Baltimore, Maryland: The John Hopkins University Press.

Los Angeles Department of Public Works (LADPW). 2015. Record of Gage F57C on LA River above Arroyo Seco Confluence.

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ULARA/DWR Water Master Annual Water Year Reports from 1968/69 to 2012/13.

Report of Referee Vol.2 1962.

4.2.4. Discussion

Today, Los Angeles River waters are confined to a narrow constructed channel, built for flood protection, which prevents storm flows from extending into the now urbanized historic floodplain. The contemporary dry weather flows are significantly greater than historic conditions (median value of 107 cfs compared with less than 13 cfs before 1966). Following the transition of the primary land use in the Upper Los Angeles River Watershed from agriculture to urban land use, which has relatively impermeable surfaces, in-stream storm flows more than tripled in the study area (e.g. see Figure 3-27). Higher than historic peak storm flows, which are confined to a narrow channel can result in extreme hydraulic forces. Under existing conditions, peak storm flows may negatively impact all but a few native riparian plant species and tend to favor non-native plants with traits that make them highly invasive in this altered hydrologic system. Giant reed (*Arundo donax*) is a conspicuous example of an invasive plant that has flourished in the Los Angeles River, with high rates of vegetative growth from rhizomatous roots following storm flows and tolerance of inundated roots in the perennial dry weather flows. The deviations in River geomorphology (increased velocity of peak storm flows and higher dry weather flows) have created significant changes to the flora and fauna of the River in the Elysian Valley.

Over time, the upper floodplain terraces (and less frequently within the lower terraces of the floodplain) where native California Sycamore and Live Oak Woodlands occurred, were developed (Figures 4-26 to 4-28). The Willow Woodlands and Shrublands of the historic lower floodplain terraces have also disappeared due to development and channelization of the River. A limited number of willow tree species are currently found only on the channel bars in River.

The current native diversity of the riparian vegetation in the channel is low, representing a disturbed vegetation community that, while mimicking some of the characteristics of the historic willow woodland vegetation community, is a very different and novel habitat type (see Section 4.2). In the 1980s and 1990s, two major changes occurred that influenced in-channel habitat. First, Army Corps began to limit the clearing of vegetation within the 'soft bottom' reaches of the River (Grumprecht 1999); and second, dry weather flows increased significantly as Phase I (in 1985) and then Phase II (in 1991) of the Tillman WRP came online (see Figure 3-26). By allowing vegetation to establish and grow in the 'soft bottom' reaches, wind and animal dispersed plants species began to establish on channel bars. By the time of the 1991–92 investigations of the biota of the River, the channel bars were occupied by a few different willow species, including earlier colonizers such as sand bar willow (*Salix exigua*) and yellow willow (*Salix lucida* ssp. *lasiandra*) (Garrett 1993). The timing of the 1991–92 study also marks a transition in dry weather flows from a median of 84 cfs (1985–1991) to 107 cfs, which is similar to the base flow observed today. Between 1991 and 2015, sand bar, yellow and Arroyo willows were rare in the study area, and were replaced in dominance by black willow (*Salix gooddingii*), which tolerates the saturated/standing water conditions that now exist (see Figure 4-26).

Between 1991 and 2015, giant reed cover has increased, which may be in part due to the higher perennial dry weather flows after the Tillman WRP came online and began discharging into the River. Comparisons with the 1991–92 study also demonstrate that castor bean has been a component of the channel bars since at least that time (e.g. see Figure 4-16a). Therefore, it can be assumed that a significant castor bean seed bank is present and will need to be considered in terms of the duration of non-native species control in any restoration or enhancement plan in the project area. It is likely that following giant reed control, a second crop of castor bean and other invasive non-native species will compete with native early colonizers for the open canopy left by removal of giant reed. Consequently, there may be multiple rounds of invasive species control that take many years, before the site is prepared for active seeding or planting of transplants needed to establish the target native diversity and cover.

In terms of the viability of the channel bars for restoration efforts, these bars appear relatively stable and the total cover of native willow vegetation has not been removed by typical high flows in the past 25 years. This is demonstrated both by the size of the black willow present in the project area and the general comparative photos between study periods (see Appendix H). However, the timing of restoration planting and seeding would need to be considered in order to give new transplants and seedlings the longest potential time period to establish prior to winter storm flow.

Despite the habitat loss since the historic condition, there has been an increase in urban park space since the early 2000s. This is due to the conversion of remaining open space in public ownership into urban pocket parks (see Figure 4-27). Many of these 'pocket parks' and the associated green strips along the River have been vegetated with native plantings, which have provided valuable habitat for native animals, as documented in this chapter.

There is currently no riparian transition or open upland habitat, such as alluvial scrub and mulefat scrub, adjacent to the in-channel riparian habitat. Increasing the variety and quantity of complementary floodplain habitat to the existing riparian vegetation would promote more opportunities for wildlife movement, breeding territories, and biodiversity.

4.2.5. References

Garrett, K. 1993. *The Biota of the Los Angeles River*. Natural History Museum of Los Angeles County Foundation, Los Angeles, CA.

Gumprecht, B. 1999. *The Los Angeles River: Its Life, Death, and Possible Rebirth*. Baltimore, Maryland: The John Hopkins University Press.

Los Angeles County. 2014. Color Orthogonal Imagery. Acquired in Winter 2014 by Pictometry International Corporation for the Los Angeles Regional Imagery Consortium 4 Project (LAR-IAC4). 1-Foot Resolution. Viewed on LA County GIS Viewer, Accessed January 2016. http://egis3.lacounty.gov/eGIS/gis-mapping-applications/gisviewer/.http://egis3.lacounty.gov/eGIS/gis-mapping-applications/gisviewer/.

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Sawyer, J. O., T. Keeler-Wolf and J. M. Evens. 2009. *A Manual of California Vegetation, Second Edition*. Sacramento, CA: California Native Plant Society Press.

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USDA. 2005b. NAIP 3-Band Color Image. 1-Meter Resolution. Acquired June 19, 2005. NAIP Entity ID N_3411862_NE_11_1_20050619_20060210.

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USGS. 1994b. Hollywood Northeast 3.75-minute Black and White Digital Orthophoto Quadrangle (DOQ). Acquired on May 31, 1994. USGS, EROS, LTA, Entity ID DI00000000922092.

Wallace, L. 1993. Vascular Plants of the Los Angeles River. Pp. B1-B16 *The Biota of the Los Angeles River*: *an overview of the historical and present plant and animal life of the Los Angeles River drainage*. K. L. Garrett, ed. Natural History Museum of Los Angeles County Foundation, Los Angeles, CA.

4.3. Fish Fauna Review

Surveys for fish within the study area were not undertaken for this report. Results of previous fish surveys were consulted from the Natural History Museum of Los Angeles *Biota of the Los Angeles River* (Swift and Siegel 1993) report and compared to results from 2007 surveys conducted by Friends of the Los Angeles River (FoLAR 2008). Additional information was gathered from encounters with fisher people during current vegetation surveys.

4.3.1. Data Summary

No native fish remain in the study area based on survey results from 1992 (Swift and Siegel 1993) and 2007 (FoLAR 2008), because the channelized condition of the Los Angeles River is unfavorable to native species. Native fish once found along the main stem of the Los Angeles River included seven species: speckled dace (*Rhinichthys osculus*), arroyo chub (*Gila orcutti*), Pacific lamprey (*Lampetra tridentata*), Pacific brook lamprey (*Lampetra pacifica*), unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*), Santa Ana sucker (*Catostomus santaanae*) and southern steelhead (*Oncorhynchus mykiss*). It is likely that most of the species would have been found in various life stages within the current study area.

Surveys carried out by the Natural History Museum in 1992 and by FoLAR in 2007 found five species of non-native fishes within the study area. Both surveys observed mosquito fish (*Gambusia affinis*), fathead minnow (*Pimephales promelas*), tilapia (*Oreochromis sp.*), carp (*Cyprinus carpio*), and goldfish (*Carassius auratus*) in the study area.

According to fish specialist from the NHM (Swift and Siegel 1993), the Los Angeles River in the study area has suitable conditions for native fish, including riffles and slow moving backwaters, as well as various suitable substrates such as rocks, gravel, and sandy areas coupled with aquatic and emergent vegetation. Similar conditions were observed during the current study for vegetation and substrate in 2015. However, the fish summary in *The Biota of the Los Angeles River* goes on to add that the concrete channel banks do not favor native fish since there is no access to refuge areas in the floodplain during high flows. Therefore, the fish would be more likely to be swept out of the otherwise suitable habitat.

4.3.2. Discussion

There were no differences in the species of fish found in the study area during the 1992 survey and those found in the 2007 survey. Arroyo chub and Santa Ana sucker have been suggested as candidates for re-introduction in the study area, representing two native fish that have managed to survive above the Sepulveda Basin and Hansen Dam. The last comprehensive fish survey (Swift and Siegel 1993) suggests that suitable habitat currently exists to support native arroyo chub and Santa Ana sucker within the project area in terms of channel substrates, vegetation and non-flood flow hydrologic conditions. However, it is unlikely that populations of native fish would survive without a floodplain connection providing refuge during flood flow conditions. Current studies are underway to survey for fish pre- and post-flood conditions on the Los Angeles River (R. Dagit, LA Times 2015), and the results may inform restoration conditions for native fish as well.

Other factors such as current water quality may also impact native fish survival. Restoration of former hydrology elements including water quality and pollution control would be necessary for recovery of any native fish species (Longcore 2006). It should be noted that recent fish toxicity studies conducted on non-native species in the River show less toxicity than experts had expected (FoLAR 2008).

4.3.3. References

Friends of the Los Angeles River (FoLAR). 2008. *State of the River 2: The Fish Study*.

Longcore, T. 2006. *Green Visions Plan for 21st Century Southern California: A Guide for Habitat Conservation, Watershed Health, and Recreational Open Space. 8. Conservation of Native Biodiversity in the City: An Assessment of MRCA Projects in the Upper Los Angeles River Watershed*, University of Southern California GIS Research Laboratory and Center for Sustainable Cities, Los Angeles, California.

Swift, C. and J. Siegel, 1993. *The Past and Present Freshwater Fish Fauna of the Los Angeles River.* In: *Biota of the Los Angeles River* (D-1 to D-14).

4.4. Insect Fauna

4.4.1. Introduction

Insects account for the majority of multicellular terrestrial life forms on Earth. The Los Angeles area is home to a diverse fauna of native, warm temperate insects, supplemented by introductions of species from around the world through human commerce. Hogue (2015) estimated the total fauna to be between 3,000 and 4,000 species in this area, but the more recent collecting indicates that totals could be as high as 10,000 to 20,000 species (unpublished data).

The species makeup of this fauna is highly understudied, especially when considering smaller, terrestrial groups. In particular, local Diptera (true flies), Hymenoptera (ants, bees, wasps), and Coleoptera (beetles) have received little attention from taxonomists, who apparently prefer to concentrate their efforts on more exotic localities. Partially to remediate this situation, the Natural History Museum of Los Angeles County (NHM) started the BioSCAN (Biodiversity Science: City and Nature) project in 2012 in an attempt to gain greater knowledge of the insect fauna of urban Los Angeles. This project instituted collections with Malaise traps in 30 localities throughout Central Los Angeles, primarily in private backyards. NHM encountered 30 undescribed species of phorid flies (Insecta: Diptera: Phoridae) (Hartop *et al.* 2015), a number that has since climbed to 43 with the discovery of 13 more described species. Also found were two species of *Drosophila,* previously only found on other continents (Grimaldi *et al.* 2015), and various new records and undescribed species that are being examined by specialist entomologists.

The goal of this study was to broadly survey the insects present in the study area, identify them to the family level, and determine the most productive (species-rich) habitats present. The insect fauna in the study area (see Figures 1-2 and 4-1) was studied using hand collecting, aquatic netting, and hanging Malaise traps. NHM identified any phorid flies (Diptera: Phoridae), the main study group, to the species level, in order to compare them with those species collected in the large-scale insect survey (BioSCAN).

4.4.2. Methods

In total, 60 samples of insects were taken, including 21 aquatic samples between December 2014 and October 2015 (see Table 4-6). Sampling was designed to distribute efforts across the survey area segments (see Figure 4-1) using a variety of sampling methods to capture the greatest breadth of diversity possible. Sampling from different vegetation communities, plant types, water types and physical substrates allows for interpretation of insect-habitat associations in order to describe the existing conditions and reach general conclusions to guide the design of habitat enhancement projects. Given the nature of insect sampling methods and time intensive nature of sampling, sorting and identification, this sample design was determined to be the most efficient method for characterizing the study area. Therefore, the sampling locations are indicated by survey segment, and the discussion of plant and habitat associations with insect taxa are more appropriate than visually displaying sample collection on a map in this case. Sampling methods included sweep nets, aquatic nets, kick sampling, rock scrubbing, dip nets, canopy trapping and sight identification. Sweep nets were dragged through vegetation to collect random insects not easily seen. See Table 4-6 for the sample, location, date and method.

Table 4-6 Insect sample dates, survey segment location and methods.

Survey Segment	Sample Information		
	ID	Dates	Primary Method Used
1	1	12/10/14	Malaise trap
	2	12/10/14	Sweeping
	3	12/10/14	Sweeping
	4	12/10/14	Screen/dish sift
	5	12/10/14	Kick sample
	6	12/10/14	Aquatic net
	7	12/10/14	Kick sample
	8	12/10/14	Kick sample
	9	12/10/14	Aquatic net
	10	12/10/14	kick sample
	11	12/10/14	kick sample
	12	12/10/14	kick sample
	46	4/16/15	Sweep
	47	4/16/15	Kick sample
	48	4/16/15	Kick sample
	53	7/17–24/2015	Canopy Malaise trap
2	16	12/31/14	Sweeping
	17	12/31/14	Kick sample
	18	12/31/14	Kick sample
	49	4/16/15	Sweep
	50	4/16/15	Sweep
	51	4/16/15	Rock scrub
	52	4/16/15	Rock scrub
	54	7/24–31/2015	Canopy Malaise trap
2A	13	12/31/14	Sweeping
	14	12/31/14	Sweeping
	15	12/31/14	Sweeping
	55	7/31/15	Sight Identification
3	19	1/14/15	Malaise trap
	20	1/14/15	Rock scrubbing
	21	1/14/15	Kick Sample
	22	1/14/15	Kick sample
	23	1/14/15	Netting
	24	1/14/15	Sight Identification
	25	1/14/15	Sight Identification
	56	7/31–8/13/2015	Canopy Malaise trap

Table 4-6 Insect sample dates, survey segment location and methods (cont.)

Survey Segment	Sample Information		
	ID	Dates	Primary Method Used
4	26	1/31/15	Malaise trap
	27	1/31/15	Kick Sample
	28	1/31/15	Dip net
	29	1/31/15	Rock scrubbing
	30	1/31/15	Sweeping
5	31	2/12/15	Malaise trap
	32	2/12/15	Sweep
	33	2/12/15	Aquatic sweep
	34	2/12/15	Kick sample
	35	2/12/15	Sweep
	36	2/12/15	Sweep
6	37	3/12/05	Sight Identification
	38	3/12/05	Rock scrubbing
	39	3/12/05	Sweeping
	40	3/12/05	Sweeping
	41	3/12/05	Dip net
	57	9/17–10/2/2015	Canopy Malaise trap
6A	45	4/16/15	Sweep
6B	42	4/1/15	Malaise trap
	43	4/1/15	Sight Identification
	44	4/1/15	Blue vane trap
7	58	9/17–10/2/2015	Canopy Malaise trap

Aquatic nets were dragged through soft sediment in the river, and then sorted to separate the insect collection from debris and sediment. Kick sampling and scrubbing are both aquatic methods of sampling, but rather than dragging the net through the substrate, the net remained stationary for collection while the substrate was disturbed by foot or by scrubbing rocks with a brush to dislodge specimens. Dip nets are smaller hand-held nets that were dipped into smaller stagnant pools. Malaise canopy traps were hung approximately 3-meters above the ground in the willow trees and passively intercepted insects flying through the air. Malaise traps collect continuously over long periods and specimens are preserved in an ethanol bottle attached to the trap. Unfortunately, attempts to use ground Malaise traps and pan traps were not successful due to the pervasive presence of humans in the area. Malaise traps are passive collectors, intercepting insects but not attracting them, thus needing several days to work well. The homeless population of the River area made it risky to leave an expensive trap on site.

Although not directly part of the survey for this project, NHM has results from BioSCAN project Malaise trap site 9, immediately adjacent to the River near the study area on the 2900 block of Knox Ave. This trap was operated continuously for one year, and species of phorid flies, flower flies, crane flies, butterflies, and bees were recorded. Data from this site were reviewed to help interpret the results of this study. However, the data from that site are not included in the results presented below.

4.4.3. Results and Discussion

In general, the insect fauna was sparse and depauperate, except in the urban upper terrace pocket parks and the black willow trees in the river channel. In these two places there was abundant insect activity, especially on the flowers in the pocket parks and in the shade and undergrowth of the willow thickets, where the Malaise traps were hung. Segments 5 and 6A (Bowtie Parcel) had the least amount of insect activity, reflecting the lower vegetation cover in these areas.

A total of 15 taxonomic orders and 102 families of insects were recorded among the several thousand insects collected (see Appendix I). Most of the insect families were in the orders Coleoptera (18 Families), Diptera (37 Families) and Hymenoptera (26 Families). Many were identified to the family level only, as further determination requires expert taxonomic knowledge. Forty insects were identified to genus or species level. Ten spider species were identified.

Key findings include:

- Two species of the ant genus *Cardiocondyla* were found in the canopy Malaise traps in the trees growing in the river channel sediment (Four individuals of *C. obscurior* and one individual of *C. wroughtoni* were collected; identified by Phil Ward). Both are new records for California, and this genus does not occur naturally in North America.
- One male and one female of the rarely-collected fly family Periscelididae were collected in the canopy traps. None have been found in the 30 Malaise traps of the BioSCAN project. The adults feed on sap exuding from wounds, which are common on young deciduous trees such as willows. The successful collection of these flies is likely due to the placement of the traps in the tree canopy.
- One male of a previously undescribed species of the fly family Anthomyzidae was collected in the canopy traps; it will be described by a colleague in Canada.
- First record of a crane fly, *Erioptera (Mesocyphona) eiseni,* from Los Angeles County (previously found in California only in the San Diego area). Three individuals were collected from the willow canopy Malaise traps.

The river had a modest aquatic fauna, probably due to low water quality. On the land, diversity was high among willows on channel bars, and in pocket parks planted with native species. The Malaise traps collected some species not found in the urban biodiversity studies, showing that there is possible value to this reach of the River for the overall insect biodiversity of the Los Angeles basin.

Phorid Flies (Diptera: Phoridae)

All phorid flies (a taxonomic group for which NHM has expertise) were identified to species (Table 4-7). One species, *Phora americana*, was collected in this survey, but not in the adjacent BioSCAN site, which is discussed below. *Phora americana* was collected, albeit infrequently, from other BioSCAN sites.

Table 4-7 Number of observations of Phorid Flies from the study area.

Species	Study Segment (Survey ID) 3 (LARIS 056)	6B (LARIS 042)	6A (LARIS 057)	7 (LARIS 058)
Megaselia agarici	2	1	0	0
M. basispinata	1	0	0	0
M. berndseni	3	2	0	0
M. creasoni	2	0	0	0
M. hansonix	1	0	0	0
M. mikejohnsoni	0	0	1	1
M. nigra	1	0	0	0
M. oxboroughae	1	0	0	0
M. rufipes	0	1	0	0
M. steptoeae	0	1	0	0
M. sulphurizona	3	0	0	0
M. wiegmanae	0	1	0	0
Phora americana	0	0	1	0

Phorid flies collected by the nearby BioSCAN Malaise trap

One site from the LACM BioSCAN project was extremely close to the study site, and represents the expected phorid biodiversity from a backyard immediately adjacent to the study site.

A total of 50 of 101 local species of phorid flies were collected from BioSCAN Malaise trap #7: *Anevrina variabilis*, *Beckerina* sp.1, *Chonocephalus bentcasei, Conicera aldrichi, Conicera similis, Conicera tibialis, Diplonevra setigera, Dohrniphora cornuta, Megaselia agarici, M. albicaudata, M. arizonensis, M. armstrongorum, M. atrox, M. barberi, M. basispinata, M. berndseni, M. carthayensis, M. ciancii, M. creasoni, M.* sp “cup”, *M. donahuei, M. francoae, M.* sp “dark/light”, *M. halterata, M. hansonix, M. hardingorum, M. heini, M. hoggorum, M. largifrontalis, M. lombardorum, M. marquezi, M. mikejohnsoni, M. nigra, M.* sp “not-a-nota”*, M. oxboroughae, M. pleuralis, M. ruficornis, M. rufipes, M. sacatelensis, M. scalaris, M. sidneyae, M. sordida, M. steptoeae, M. sulphurizona, M.* sp “truncate (none)”, *M. wiegmanae, Metopina* sp.*, Phalacrotophora halictorum, Puliciphora occidentalis*, and *Trophodeinus furcatus*.

This is a relatively high portion of the fauna, being 33 species short of the most species-rich trap, which had 83 species. In comparison, the catch from the garden of the Natural History Museum of Los Angeles County was 36 species.

Differences among the catches of the traps can partly be attributed to the presence of Argentine ants at the Los Angeles River sites (and at NHM). Argentine ants (*Linepithema humile*) outcompete native ants, including those that are hosts of parasitic phorid flies. Because of the their presence, the species *Aenigmatias* sp., *Apocephalus aquilonius*, *Apocephalus* sp., *Microselia* sp., *Pseudacteon amuletum*, *P. californiensis*, *P.crawfordi*, *P*. sp, and *Veruanus boreotis* all have been eliminated from most of the Los Angeles basin. Other missing species from trap #7 are intolerant to any urbanization.

Other Flies

Thirty-seven families of flies were collected (Table 4-8). The fauna was dominated by the aquatic families Chironomidae and Simuliidae, but a diverse woodland fauna was also present in the trees growing on channel bar islands.

Table 4-8 Fly families collected.

Anthomyiidae	Empididae	Scatopsidae
Anthomyzidae	Ephydridae	Sciaridae
Asilidae	Lauxaniidae	Sepsidae
Bombyliidae	Millichidae	Simuliidae
Calliphoridae	Muscidae	Sphaeroceridae
Cecidomyiidae	Mycetophilidae	Stratiomyidae
Ceratopogonidae	Mythicomiidae	Syrphidae
Chironomidae	Periscelididae	Tachinidae
Chloropidae	Phoridae	Tephritidae
Cryptochetidae	Platystomatidae	Therevidae
Culicidae	Pipunculidae	Tipulidae
Dolichopodidae	Psychodidae	
Drosophildae	Sarcophagidae	

Butterflies (Lepidoptera)

Because of their bright colors and conspicuous behavior, butterflies are commonly considered to be desired members of a natural area's insect fauna. In the visual surveys, eight species of butterflies were observed (Table 4-9, Figure 4-29). Adult butterflies and moths were collected or observed from all segments of the river in the study area, from Survey Segments 1–7, including the pocket parks. Most of the flowers growing in the pocket parks and along the edges of the river, particularly in areas that are close to homes (for example, the north walkway area between Los Feliz Blvd and Fletcher Drive, Segments 1–4) attracted common urban butterflies such as the mourning cloak (*Nymphalis antiopa*), California sister (*Adelpha californica*), painted lady (*Vanessa cardui*), gulf fritillary (*Agrauliss vanilla*), western tiger swallowtail (*Papilio rutulus*), monarch (*Danaus plexippus*), and marine blue (*Leptotes marina)*. Western tiger swallowtails, mourning cloaks, andhairstreak butterflies will lay their eggs on arroyo willows (*Salix lasiolepis*) and California sycamores (*Platanus racemosa*), so their presence in and along the river is not only for adult nectaring but for provisioning the larvae as well. The area where butterflies were least commonly seen was at the Bowtie Parcel (Segment 6A) and the area of the river that was predominantly dry with cobblestone (Segment 5). Lastly, over 40 specimens of aquatic larval pyralid moths were collected directly from the river in areas where there was slow moving, relatively shallow water (a few inches to a few feet deep).

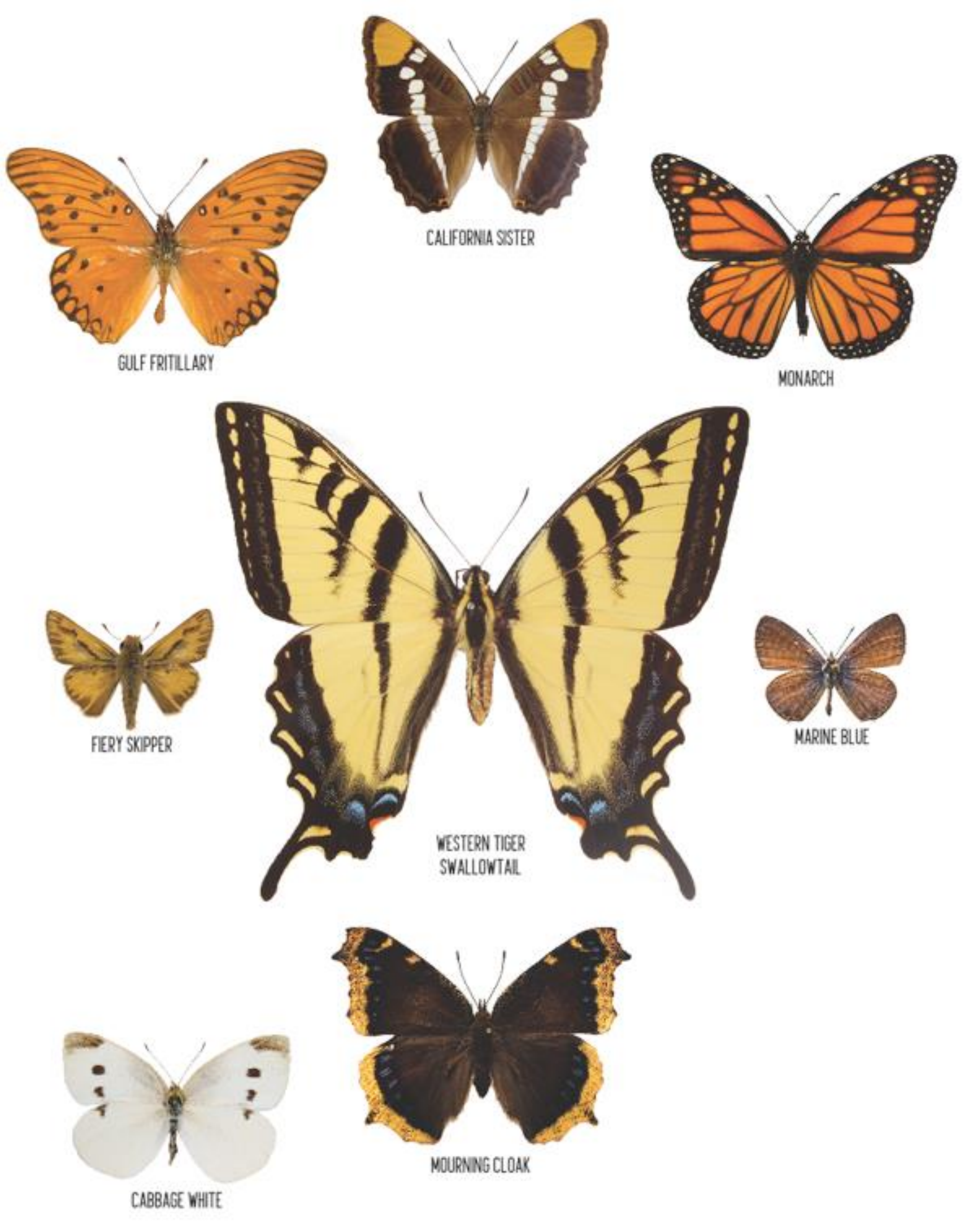

Figure 4-29 Eight species of butterflies observed in the study area during visual surveys.

Table 4-9 Butterfly species observed.

Monarch	Gulf Fritillary	California Sister
Marine Blue	Cabbage White	Fiery Skipper
Western Tiger Swallowtail	Mourning Cloak	

Beetles

Most of the beetles collected are herbivores associated with the willow trees on channel bars in the river (exceptions are noted) (Table 4-10).

The majority of the beetles collected were from the canopy traps placed in willow trees. NHM also collected beetles by hand using insect nets, mainly from the pocket parks and river edges. Although more beetles were collected from the canopy traps, this is not an indicator that the majority of river associated beetles are arboreal; rather this is a result of the canopy traps being more effective for collecting more insects over longer periods of time. If Malaise traps could have been placed in the River-adjacent parks for the same amount of time as the canopy traps without being disturbed, there would have likely been a comparable amount of beetle diversity.

Table 4-10 Beetle Families collected (all herbivorous, except where noted).

Anobiidae	Coccinellidae (predators on aphids)	Pedilidae
Anthicidae	Dermestidae (detritivores)	Ptinidae
Bostrichidae	Elateridae	Scolytidae
Brachypteridae	Lathridiidae	Scrapitiidae
Bruchidae	Mordellidae	Staphylinidae (predators)
Chrysomelidae	Nitudulidae	Throscidae

Hymenoptera

Twenty-six families, mostly of tiny parasitic wasps, were encountered from this order (Table 4-11). Common names are noted when they exist.

Similar to the sightings of adult butterflies nectaring on flowers, bees were found in all segments of the study area and were most common on flowers in the pocket parks and along edges of the channel in areas closest to residential homes. Bees were least common at the Bowtie Parcel (Segment 6A) and in the areas of dry cobble channel bar in Segment 5. The two most common bees encountered were the European honey bee (*Apis mellifera*) and sweat bees in the genus *Lasioglossum*. Both are generalists and incredibly common in urban environments. They are the two most common bees collected in BioSCAN Malaise traps in the Los Angeles basin.

Wasps, unlike bees that are pollen and nectar feeding, have a huge variety of dietary needs and ecological relationships. Therefore, it is difficult to characterize where they would most likely be found in or along the river. Most of the wasps collected are microscopic parasitic wasps and were captured by the canopy traps. As with beetle diversity, had Malaise traps been placed on the ground in the parks and on the river edges for extended periods of time, diverse wasp fauna would have likely been encountered.

Table 4-11 Families of Hymenoptera collected.

Agaonidae—fig wasps	Eucoilidae	Pompilidae—spider wasps
Aphelinidae	Eulophidae	Platygastridae
Apidae—bees	Eupelmidae	Pteromalidae
Bethylidae	Eurytomidae	Scelionidae
Braconidae	Formicidae—ants	Scoliidae
Chalcididae	Halictidae—sweat bees	Signiphoridae
Cynipidae—gall wasps	Ichneumonidae	Tenthredinidae
Diapriidae	Megaspilidae	Trichogrammatidae
Encyrtidae	Mymaridae	

Native Ants and Phorid Flies Impacted by the Argentine Ant

Most disturbed areas in Los Angeles are dominated by the invasive species *Linepithema humile*, the Argentine ant from South America. These ants are strong competitors where disturbance and irrigation predominate, and they eliminate nearly all other ants present. Argentine ants were ubiquitous along the River. It is possible that competition from this species has indirectly excluded many native ant associates, such as parasitic phorid flies (as noted above), parasitic eucharitid wasps, and ant predators such as horned lizards. The latter feed largely on *Pogonomyrmex* ants, which, remarkably, are still found at various locations in the study area, including in Sunnynook Park (Segment 2A).

The other notable ants are the introduced *Cardiocondyla* found in the canopy Malaise traps in the willow trees in Section 6. These ants are native to southeast Asia, but introduced in various places in the world, including Florida, Ohio, and Mississippi in the USA. They are not currently known to be pests or destructive to native ecosystems, but it is unnerving to discover these ants in a semi-native setting. More research should be done to understand their distribution in Los Angeles and to determine what their impact might be on other tree-inhabiting, native ants.

Insects in the River

The fauna of the river was poor, dominated by midge (Chironomidae) larvae, but also including mayflies (Ephemeroptera), black flies (Simuliidae), caddisflies (Trichoptera), aquatic pyralid moth larvae, and dragonflies (Odonata). No aquatic or semi aquatic beetles or true bugs (Hempitera) were found, other than the water treaders (family Veliidae) on the water surface.

Usually, such dominance by chironomids indicates anoxic (no/low oxygen) conditions in the water and particularly in the sediments, which may reflect poor water quality. There are many species of chironomids, and while some are particularly characteristic of anoxic waters and sediments, others are unable to survive in low oxygen conditions. Chironomid larvae were not identified to the species level in this study.

The lack of aquatic beetles and bugs is unusual, but perhaps due to other unfavorable habitat characteristics. Overall, the insect fauna of the river was surprisingly low in diversity. Groups expected in higher diversity and abundance in aquatic habitats, include, but are not limited to the following: tipulid fly larvae, trichopteran (caddisfly) larvae, odonate larvae, hydrophilid and dytiscid beetles, and bugs of the families Gerridae, Belostomatidae, Corixidae, and Notonectidae.

4.4.4. References

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Hogue, C. L. 2015. *Insects of the Los Angeles Basin, Third Edition* (revised and edited by James N. Hogue), Natural History Museum of Los Angeles County, Los Angeles.

4.5. Herpetofauna

4.5.1. Introduction

The channelization of the Los Angeles River, increased dry weather flow, and the near complete loss of upland habitat through the San Fernando Valley and Los Angeles basin have had dramatic impacts on the reptiles and amphibians inhabiting this region. In the 1993 report "Biota of the Los Angeles River," Bezy *et al*. (1993, p. E-3) concluded that "of the original 33 species of amphibians and reptiles found along the channel of the Los Angeles River, 19 (58%) are considered to still be present (or probably present)." The Elysian Valley was historically known for its tremendous frog populations, especially the huge numbers of recently metamorphosed Western Toads (*Bufo boreas*) that would spread across the upland habitat inundating nearby neighborhoods. These high densities of frogs resulted in the Elysian Valley commonly being called "Frogtown." However, the aquatic and upland habitats that allowed toads and other frog species to thrive in this region are now gone, having been destroyed through channelization of the River, increased dry weather flow, and urbanization of upland habitat.

Modification to the Los Angeles River has also allowed a number of non-native species to become established. With the increased flow in the dry-season, permanent water now exists throughout the River. This permanent water allows some non-native species to survive in areas that historically would have been inhospitable because of summer drying. For example, the American Bullfrog and Red-eared Slider Turtle now inhabit stretches of the River that historically would have dried and not been suitable for these aquatic invasive species. Of course, the Atwater Village/Elysian Valley stretch was one of the few reaches of the Los Angeles River that had year-round water. In the narrows, aquifer waters rise to the surface resulting in year-round water from the San Fernando Valley. However, the historic groundwater-fed surface flow was much lower than current dry weather flow in the River due to urban runoff and discharges from water reclamation plants. In addition, the loss of freshwater marsh habitat following development of the historic floodplain and channelization of the River, has reduced the opportunity for slowing and impounding surface flows from rising groundwater. Although Bullfrogs and Red-eared Sliders need permanent water, they prefer slow-moving water, backwaters, etc. The abundance and distribution of these two species have not been studied in the Atwater Village/Elysian Valley or elsewhere in the River.

The changes in the aquatic and upland habitats have had dramatic impacts on the native herpetofauna as well as on nonnative species. Surprisingly, there have been no detailed field surveys of the modern herpetofauna of the Los Angeles River. Bezy *et al*. (1993) summarized occurrence records of reptiles and amphibians in the Los Angeles River watershed based on museum records. They also conducted some site visits to examine current habitat, but did not conduct field surveys.

The study reports on field surveys of the soft-bottomed reach of the Los Angeles River from Los Feliz Blvd. in Atwater Village to near Queen Street in Frogtown/Elysian Valley (see Figures 1-2 and 4-1). Multiple types of field surveys were used as well as data from the Reptiles and Amphibians of Southern California (RASCals) citizen science project.

4.5.2. Methods

Sampling involved three different approaches: visual and acoustic encounter surveys, turtle trapping, and the use of citizen science data. The visual and acoustic encounter surveys were conducted March through June 2015 and RASCals data were tallied through November 21, 2015.

Visual and Acoustic Surveys

These surveys involved 1–3 people conducting visual and acoustic surveys for reptiles and amphibians throughout the study area. Areas surveyed included pocket parks, bike and pedestrian paths, concrete slopes of the river channel, river edge, and river channel bar islands. Areas with three-dimensional structure, whether from man-made structures or surrounding woody vegetation, were closely examined as these are preferred habitats for lizards. Aquatic habitats were surveyed with particular attention given to emergent logs and vegetation, rocks, and debris; these areas are common turtle basking sites and also the most likely areas for aquatic snakes.

The latitude/longitude, measurement error, substrate, sex (when possible), life stage (adult vs juvenile), and amount of sun exposure (full sun, partial sun, and full shade) were recorded for every observation. Latitude/longitude data were taken with a handheld GPS unit using the WGS84 datum. Survey times were adjusted throughout the spring and early summer as well as based on weather conditions to maximize the potential for encounters.

One nighttime survey was also conducted following a rainstorm. This survey involved visual encounter surveys, eyeshine surveys for *Rana catesbeiana* and *Bufo boreas,* and acoustic surveys for calling frogs.

Turtle Trapping

Turtles were trapped using submersible, box-style turtle traps in areas deeper than one meter and with relatively low flow. These traps work much like a minnow trap, except that a net chimney extends from the box trap to the surface. This chimney allows turtles to access the surface and breathe while confined inside the trap. The top of the chimney is held above the surface by a float or by being tied to adjacent overhanging vegetation. Areas where turtles were observed during the visual encounter surveys were selected as trapping sites.

Citizen Science Data

Data were also pulled from the Reptiles and Amphibians of Southern California (RASCals) citizen science project. This project was developed by GBP and went live on the iNaturalist platform June 2013. People across Southern California are encouraged to submit digital photographs and/or audio recordings as vouchers for the occurrence of reptiles and amphibians. Observations can be uploaded directly to iNaturalist or emailed to the Natural History Museum where staff will upload the observations to the project. Although the RASCals project was launched June 2013, citizen scientists can contribute older photographs from a known locality and date; as a result, some observations may be older than June 2013. For this study, only "research-grade" observations were included. "Research-grade" means that an observation includes a voucher photograph, date, locality, and a community supported identification. RASCals observations made within the study area are included, as well as observations made within 1.5 km of any portion of the study area. However, RASCals observations from the southeast corner of Griffith Park are not included unless they were in the flats at the base of the hills. The 1.5 km rule does extend into the hilly areas of nearby Griffith Park, but because the herpetofauna here is much greater than found along the River (e.g. *Crotalus oreganus helleri, Pituophis catenifer, and Diadophis punctatus*), it was excluded from the analysis. Although all of the NHM herpetofauna researchers submitted some observations to the RASCals project that were made during the focal surveys, these are not counted as citizen science observations for the purpose of this report. Only observations made outside of the formal survey period are considered to be RASCals citizen science observations. Only one observation by GBP fits this criterion (iNaturalist No. 852111 from 28-August-2014).

4.5.3. Results

Field Surveys

Field surveys occurred between late March and early June 2015 and included 12 daytime surveys and one nighttime survey following a rain event (Table 4-12). Six species were observed and a total of 722 observations of reptiles and amphibians (Table 4-13; Appendix J). The six species include three lizards, one turtle, and two frogs. The Red-eared Slider Turtle and American Bullfrog are both non-native species, while the remaining four species are all native to this area. The Western Fence Lizard was the most commonly observed species and accounts for 81% of the total observations (Table 4-13).

Observations from the RASCals Project

Citizen science observations submitted to the RASCals projects relevant to the survey include eight observations within the survey stretch and 19 observations within 1.5 km of the survey boundary (Appendix J). Below is a list of significant observations resulting from the RASCals data:

- One observation of an adult Western Toad within the survey area along the Los Angeles River adjacent to Elysian Valley Gateway Park
- Three observations of adult Western Toads from along the Los Angeles River at Shoredale Avenue, approximately 1.4 km straight-line distance SE of the survey area
- Five observations of Western Fence Lizards at a house off Acresite Street, six house lots NE of the River
- A single dead Bullfrog tadpole within the survey area washed up onto the embankment following a storm event
- Seven observations of Southern Alligator Lizards across four house lots in adjacent neighborhoods

Table 4-12 Number of observations per survey day in 2015.

Date	Number of Observations
27-March	76
30-March	67
31-March	61
8-April[1]	8
13-April	66
14-April	58
27-April	123
28-April	76
11-May	47
12-May	50
26-May	33
27-May	34
8-June[2]	25
Total	**724**

1. Nighttime visual and acoustic survey following rain event.
2. Turtle trapping, with visual encounter surveys as time allowed.

Table 4-13 Number of observations per species.

Species	Common Name	Number of Observations	Number of RASCals Observations in Survey Stretch	Number of RASCals within 1.5 km of Survey Stretch
Sceloporus occidentalis	Western Fence Lizard	587	5	8
Uta stansburiana	Side-blotched Lizard	86	0	0
Elgaria multicarinata	Southern Alligator Lizard	10	0	8
Trachemys scripta elegans	Red-eared Slider	29	1	0
Pseudacris regilla	Pacific Chorus Frog	3	0	0
Rana catesbeiana	American Bullfrog	7	1	0
Bufo boreas	Western Toad	0	1	3
	Total	**722**	**8**	**19**

Results by Species

WESTERN FENCE LIZARD (*Sceloporus occidentalis*)

The Western Fence Lizard was by far the most common species observed, accounting for approximately 81% of all observations (Table 4-13; Figure 4-30). As its name implies, this species is highly dependent on the presence of climbable vertical structure. This structure can be man-made, such as fences, walls, and power pole pilings, or it can be woody vegetation such as shrubs, trees, or brush piles. As a result, this species is rarely encountered inside the river channel except when vegetated sediment bars/islands exist. For example, in the 2.25 km stretch upstream of Fletcher Drive, only 8 of the 271 Western Fence Lizard observations were of individuals within the channel (Figures 4-30 and 4-31). Even then, these 8 were associated with man-made structural features high up on the channel slope bank sides near the bike path: one was adjacent to a concrete pillar and wall at the bike overcrossing of Los Feliz Blvd, four were on the south side of the Glendale-Hyperion Bridge adjacent to trash or the bridge abutment, two were on a metal retaining wall just south of the Glendale-Hyperion Bridge, and one was on the base of a power line tower upstream of Fletcher Drive.

Downstream of Fletcher Drive, Western Fence Lizards were relatively common on channel bars that were connected to the bank (Figures 4-30 and 4-32). Even on these sediment "islands," the lizards were still in close association with plants or piles of dead vegetation.

Because Western Fence Lizards are so dependent on vertical structure, large numbers were observed in the pocket parks, even in very small pocket parks (Figures 4-30 to 4-32):

- Sunnynook, 167
- Marsh Park—main area, 71Marsh Park—eastern section, 16
- Elysian Valley Gateway Park, 10

Similarly, Western Fence Lizards were observed taking advantage of very narrow slivers of habitat when vegetation or walls were present. For example, 22 observations were made of Western Fence Lizards in the narrow strip of vegetation between the bike path and the Los Feliz Blvd exit from I-5. These lizards were observed at high densities even when the strip was as narrow as five meters. Similarly, Western Fence Lizards were observed using the planted areas and walls on the north side of the channel just upstream of Fletcher Dr.

Citizen scientists and NHM researchers observed Western Fence Lizards in neighborhoods immediately adjacent to the River (Figure 4-30; Table 5-2). However, Western Fence Lizards do not appear to be widespread in urban neighborhoods of the Los Angeles basin and San Fernando Valley as you move further away from the River. Whereas Southern Alligator Lizards are reported by citizen scientists in multiple neighborhoods away from the River, there are not widespread occurrence records for the Western Fence Lizard. This pattern is apparent with the few citizen science records in the survey area (Figure 4-30) and is also found more broadly across the Basin based on data available through the RASCals project.

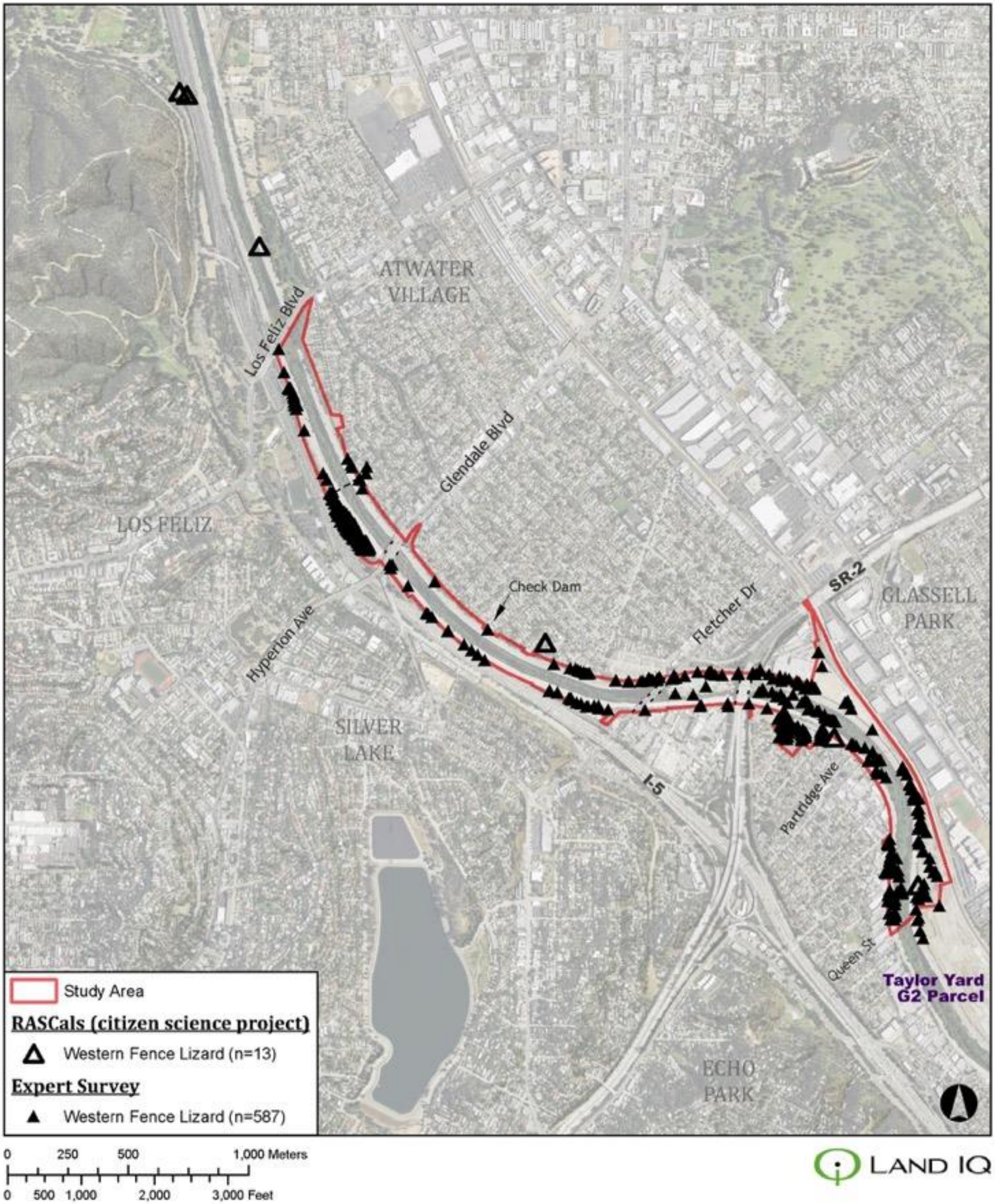

Figure 4-30 Western Fence Lizard observations by expert survey and citizen science.

Figure 4-31 Western Fence Lizard observations in Segment 2 and 2A (Sunnynook Park).

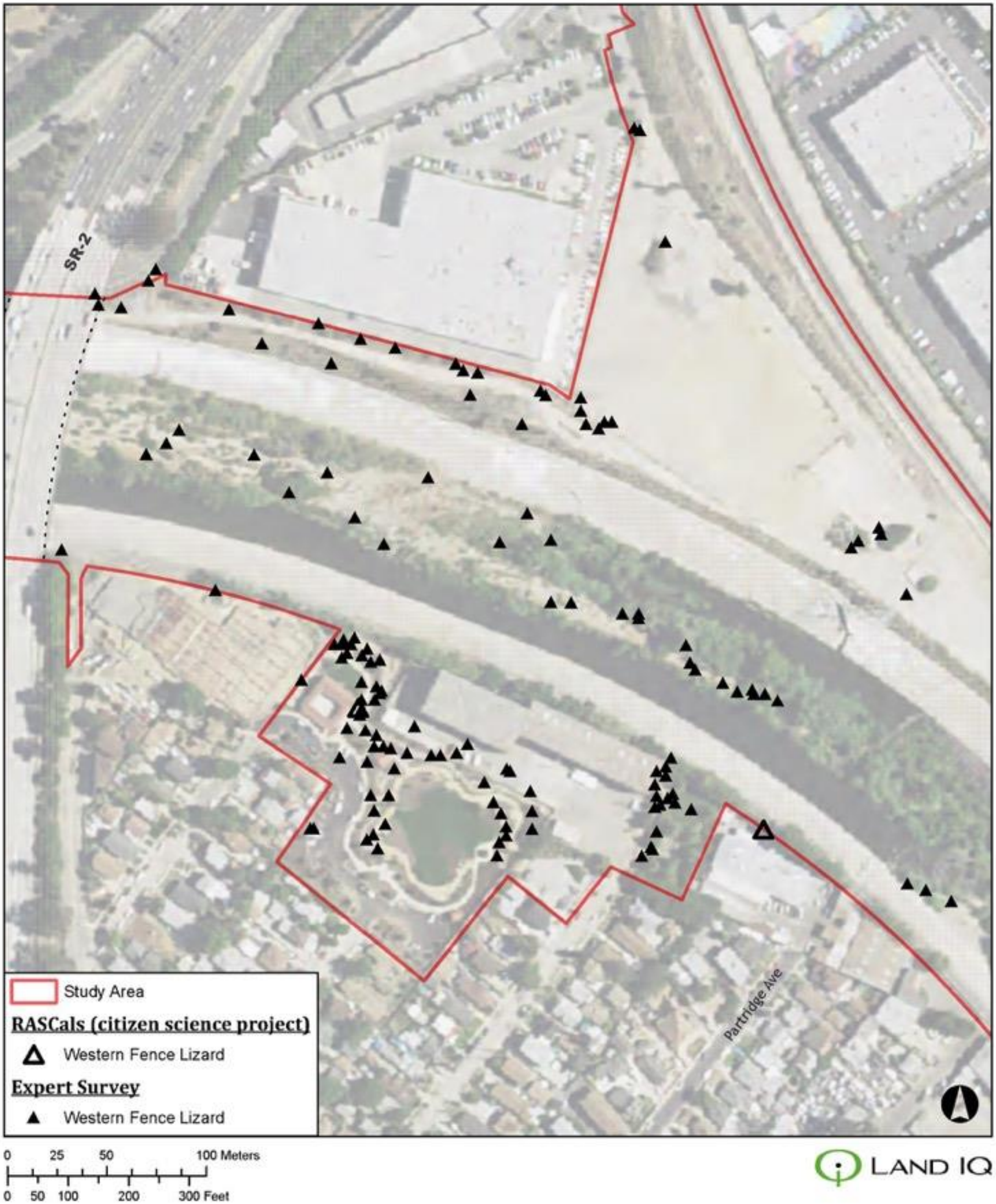

Figure 4-32 Western Fence Lizard observations in Segment 6 and 6B (Marsh Park).

SIDE-BLOTCHED LIZARD (*Uta stansburiana*)

The Side-blotched Lizard was the second most common species observed with 86 total observations, approximately 12% of all observations (Table 4-13). Side-blotched lizards were only found on the Bowtie Parcel (Figure 4-33). No Side-blotched Lizards were observed in surrounding neighborhoods by NHM researchers or citizen scientists (Table 4-13; Figure 4-33). This result is consistent with broader patterns from the RASCals project in which this species does not survive in urban neighborhoods of the Los Angeles basin.

Historically, the Side-blotched Lizard would have been widespread in the Coastal Sage Scrub and other drier habitats of the Los Angeles basin. It is largely a ground-dwelling lizard that can be extremely abundant in areas with boulders and low vegetation where it can find adequate opportunities to bask and escape potential predators beneath cover. Not surprisingly, it is still a common lizard in local chaparral habitats and can be observed in Griffith Park. However, based on this study in combination with the RASCals dataset, it now appears that the Side-blotched Lizard population on the Bowtie Parcel is physically isolated from larger source populations in the adjacent hills.

SOUTHERN ALLIGATOR LIZARD (*Elgaria multicarinata*)

Unlike the Western Fence Lizard and Side-blotched Lizard, which bask in prominent locations, the Southern Alligator Lizard does not commonly bask. Instead, it prefers cooler temperatures and is often found in areas with dense vegetation and leaf litter. Because few such areas exist in the survey stretch, Southern Alligator Lizards were only observed 10 times (Table 4-13; Figure 4-34). Five of these observations were in the Yoga Park on the east side of the channel downstream of Los Feliz Blvd. This area is overgrown with invasive grasses and ivy and has a thick leaf litter from the large trees overhead. Alligator Lizards were also observed at Marsh Park, Elysian Valley Gateway Park, and in dense leaf litter to the side of the bike path at the downstream end of the survey stretch (Figure 4-34; Appendix J). An Alligator Lizard was also found beneath a log on a sediment bar/ "island." Interestingly, the two individuals found at Gateway Park were a male and female in a mating grasp beneath dense vegetation. Thus, reproductive activity is occurring for this species in at least this pocket park along the River.

Citizen science records within 1.5 km of the survey area indicated the Southern Alligator Lizard can be found in neighborhoods adjacent to the River and further into the Los Angeles basin (Figure 4-34; Appendix J). These records were from Griffith Park and from four urban yards on both sides of the River. This pattern is consistent with broader patterns found using the RASCals data in that the Southern Alligator Lizard appears to be the most widespread lizard in urban areas of the Los Angeles basin and San Fernando Valley.

RED-EARED SLIDER TURTLE (*Trachemys scripta elegans*)

The only turtle observed was the non-native Red-eared Slider, which was observed 30 times, 29 times by NHM researchers and once by a citizen scientist (Table 4-13). Six of these observations were slightly downstream of the southern boundary of the survey area in a reach where the River widens and flow decreases (Figure 4-35). Elsewhere, this turtle also tended to be found in the slower moving sections of the River including small backwaters. Many of these turtles were observed basking on the concrete sides of the channel, particularly in areas with an undercut bank or on rocks in mid-channel or near sediment islands.

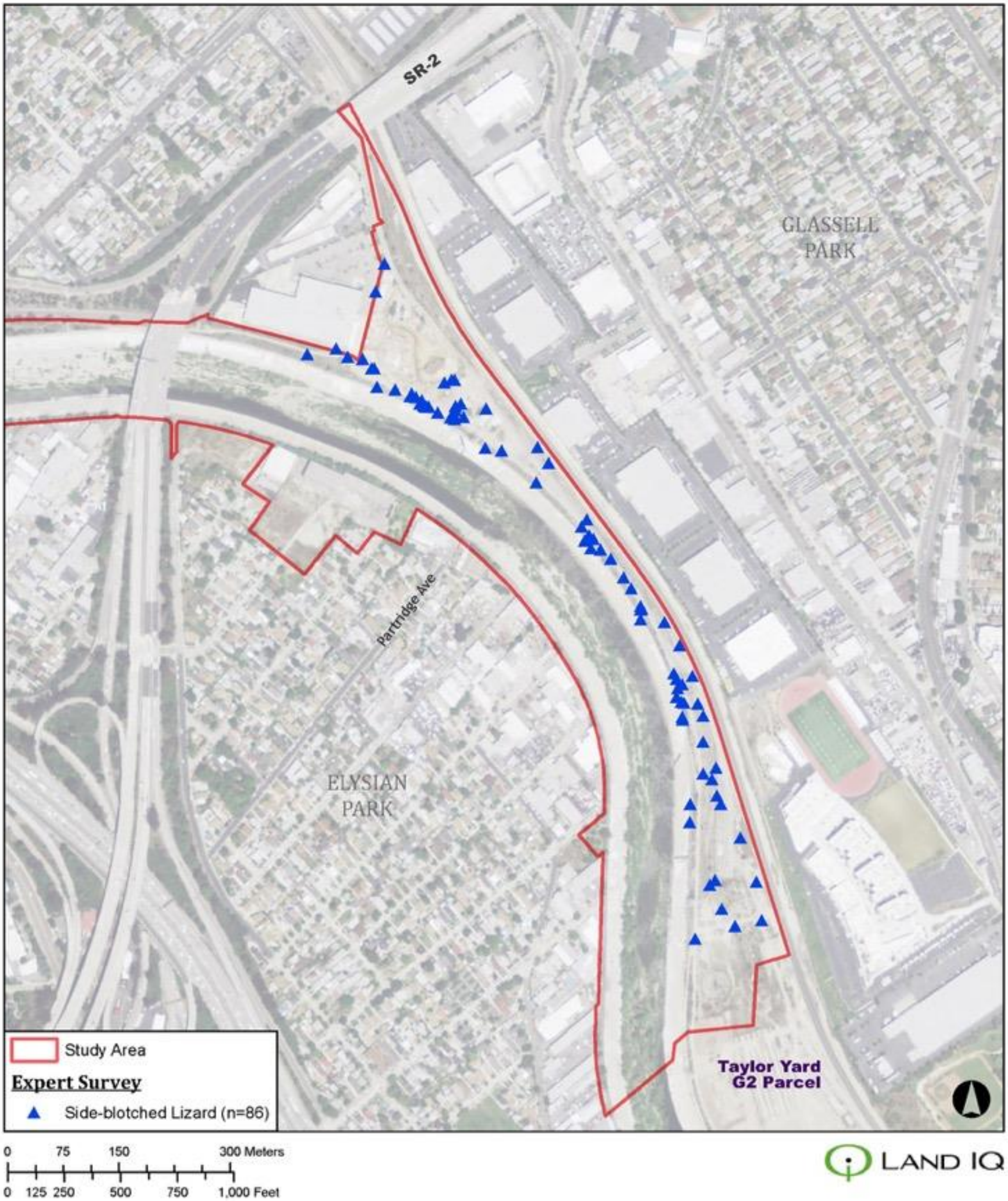

Figure 4-33 Side-blotched Lizard observations by expert survey.

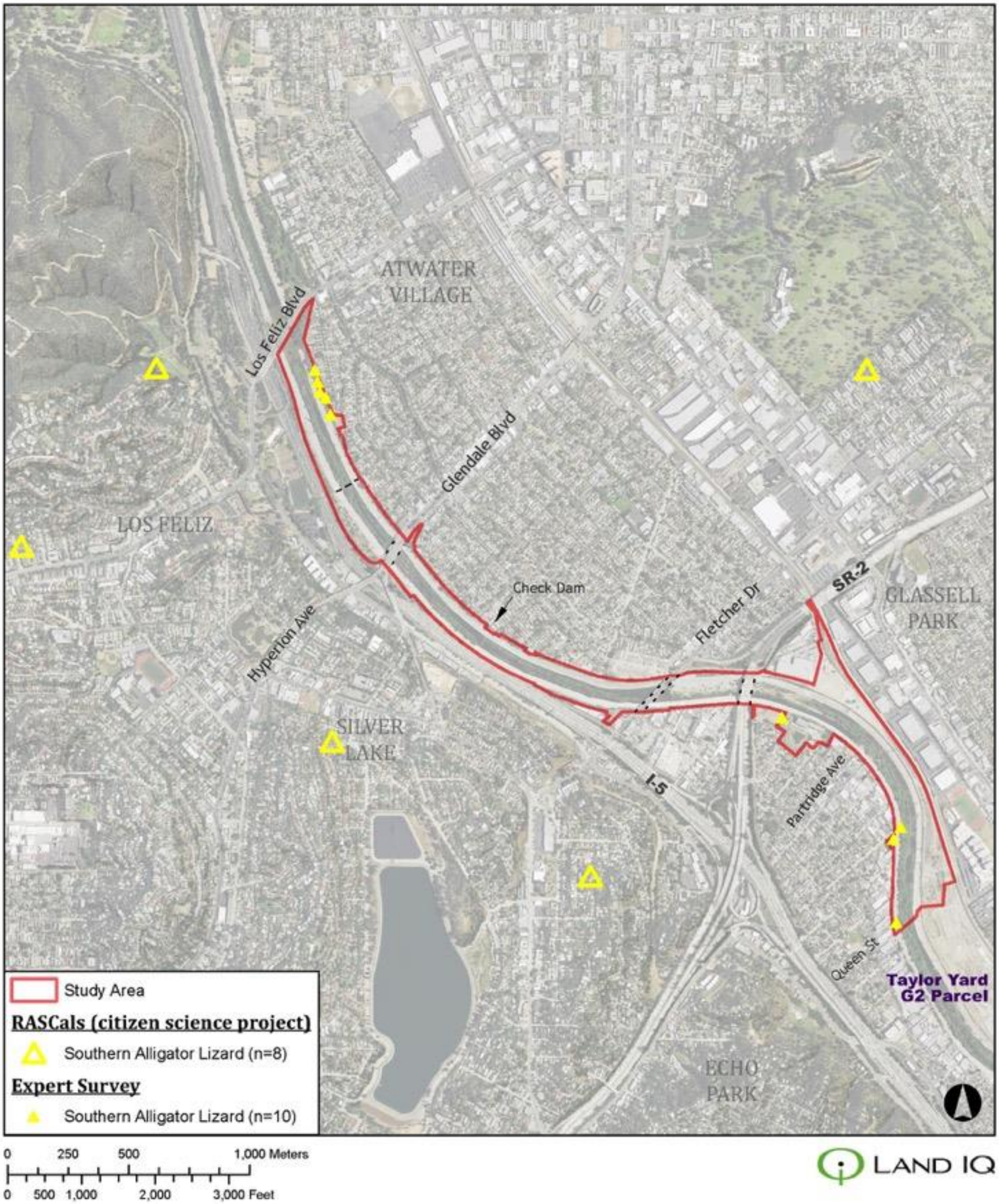

Figure 4-34 Southern Alligator Lizard observations by expert survey and citizen science.

Figure 4-35 Red-eared Slider observations by expert survey and citizen science.

Traps were set on June 8th in areas where turtles had been observed. Three turtles were captured, all in the largest backwater channel in the survey area, which was approximately 330m downstream of the Glendale Freeway adjacent to the upper section of the Bowtie Parcel. Captured turtles included a gravid adult female, an adult male, and a sub-adult female. All have been deposited in the Herpetology Collection at the Natural History Museum of Los Angeles County.

PACIFIC CHORUS FROG (*Pseudacris regilla*)
(=*Pseudacris hypochondriaca* of some authors)

The survey took place during the third year of an extensive drought. Rainfall during the survey period was rare and minimal. As a result, conditions were quite poor for locating frogs. Pacific Chorus Frogs were only observed through call surveys on one night following a light rainfall. Small choruses, likely fewer than four males each, were heard calling from areas with dense emergent vegetation within the channel (Figure 4-36). The choruses were weak, preventing researchers from pinpointing their location.

AMERICAN BULLFROG (*Rana catesbeiana*)
(=*Lithobates catesbeianus* of some authors)

The nonnative American Bullfrog was observed seven times, all in the downstream half of the survey area (Figure 4-36). Four of the seven observations were made through nighttime eye-shine surveys. All bullfrogs were observed in backwaters or other areas with reduced flow. An observation submitted to the RASCals project also recorded a single dead tadpole that had been washed onto the concrete bank and trapped there during a mid-July flood event.

WESTERN TOAD (*Bufo boreas*)
(=*Anaxyrus boreas of some authors*)

As mentioned previously, this area was once well known for its huge numbers of Western Toads that are the source for Elysian Valley's nickname, "Frogtown." However, this species has declined dramatically in the Los Angeles Area in large part because of habitat loss. There were no Western Toads located during the surveys. However, because of the drought conditions and extreme lack of rainfall during the survey period, upland surface activity by these toads was unlikely. Thus, it cannot be ruled out that toads may be found in the survey area. Four observations of toads were submitted to the RASCals project from the Los Angeles River. One of these was at the southern end of the survey stretch at Elysian Valley Gateway Park and the other three were at Shoredale Avenue, approximately, 1.4 km downstream of the survey area.

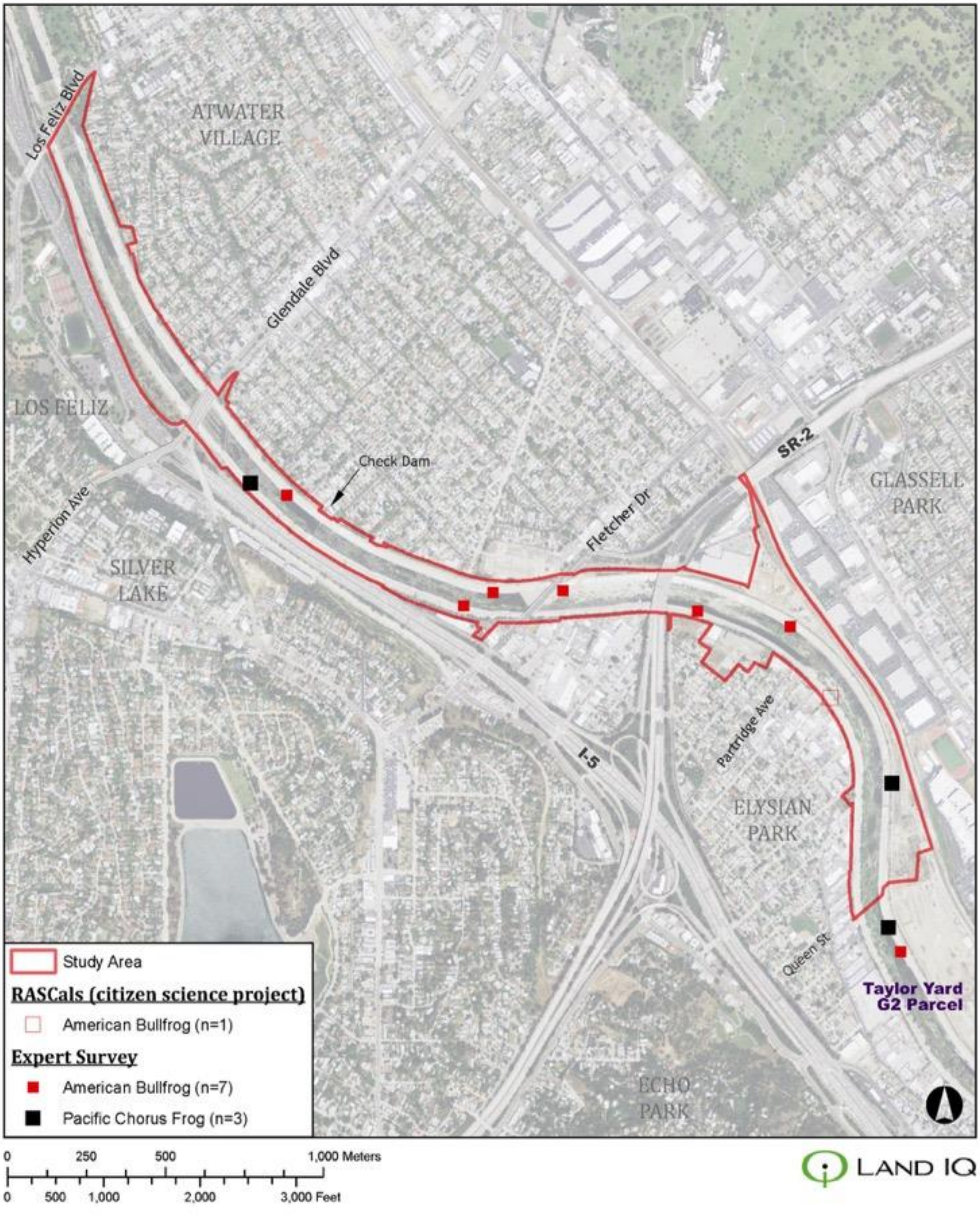

Figure 4-36 Pacific Chorus Frog and American Bullfrog observations by expert survey and citizen science.

4.5.4. Discussion

The extensive modification of riparian and upland habitat along the Los Angeles River has had dramatic impacts on the native reptiles and amphibians. Many species that once inhabited this area have been extirpated because of the extensive habitat modification and impacts of urbanization (e.g., habitat fragmentation, human-subsidized predator populations, and road kill). Species that likely once occurred in this region were reviewed by Bezy *et al.* (1993) and include (but are not limited to) the Tiger Whiptail, Coast Horned Lizard, Gophersnake, California Kingsnake, and Western Pond Turtle.

Within the survey area, flat hardscape (roads, bike paths, sidewalks, etc,) largely excludes the native herpetofauna. Lawns similarly have little habitat value for the native reptiles and amphibians. For example, although Marsh Park is home to Western Fence Lizards and Southern Alligator Lizards, these species are entirely found amongst the plantings and rocks along the outer portions of the park. There was not a single observation of a lizard in the central lawn area of Marsh Park.

Large numbers of lizards, however, were documented in pocket parks and other areas with vegetation. The Side-blotched Lizard inhabited the most open habitat, with some boulders and vegetation present. Areas with more woody vegetation and slightly denser vegetation were inhabited by Western Fence Lizards. Those areas with vegetation and some ground cover, either in the form of plants or leaf litter, were inhabited by Southern Alligator Lizards.

One especially interesting finding is the apparent isolation of Side-blotched Lizards to the Bowtie Parcel, and presumably to Taylor Yard and parts of Rio de Los Angeles State Park. Historically, appropriate upland habitat would have connected these areas to nearby coastal sage scrub and chaparral habitats in Griffith Park, the Elysian Hills, and Mount Washington areas. Now, however, urbanization appears to have isolated this population. Future urban planning will hopefully recognize that this species has minimal habitat in this region and will work to maintain what little remains.

Aquatic species are highly impacted in this region by the increased dry season flow in combination with channelization of the River. The high flow and channelization prevent appropriate backwaters, seasonal wetlands, and other areas with low water flow from forming. Such areas would be ideal breeding sites for Pacific Chorus Frogs and Western Toads. However, even if these species were to breed, the tadpoles and adults would have to avoid predatory non-native fish and non-native bullfrogs. Further, the current water flow conditions also create poor conditions for the non-native bullfrog. Although this frog requires permanent water because its tadpoles have a prolonged developmental period, it does not like areas with high flow. Thus, the current numbers of bullfrogs are very low in this stretch relative to many other urban water bodies in the region (e.g., Ballona Freshwater Marsh). Any efforts to reduce water flow for the benefit of native frogs would also have to incorporate management plans to prevent bullfrogs from similarly benefitting. Otherwise, the bullfrogs can be expected to rapidly increase in numbers and prey on native frogs, birds, and other small animals.

The finding of Red-eared Slider turtles throughout the survey stretch is expected. Urban waterways throughout California are now home to this invasive turtle as a result of former pets being illegally dumped. Although none were observed, Spiny Softshells (*Apalone spinifera*) are expected to occur in this stretch of the River as well as other turtle species commonly found in the pet trade. As with the bullfrogs, the number of turtles in this stretch is not especially high for an urban waterway. Although a gravid female was documented, it is likely that the lack of suitable upland nesting habitat and presence of people, coyotes, raccoons, skunks, and opossums limits successful reproduction. Non-native fish and bullfrogs will also consume hatchling turtles. Turtles in this stretch are also likely to head up and downstream in search of areas with slower flow.

None of the five native reptile and amphibian species found in or near the survey have any state or federal listing status. Locally, however, Side-blotched Lizards have declined with the loss of Coastal Sage Scrub and chaparral habitat. Most alarming, however, is the decline of the native frogs due to the loss of wetland habitat throughout the area. This region was named Frogtown in the mid- to late-1900s for its incredible abundance of Western Toads and Pacific Chorus Frogs, and it is striking that these species are now a challenge to locate in this area.

4.5.5. References

Bezy, R. L., C. A. Weber and J. W. Wright. 1993. Amphibians and Reptiles of the Los Angeles River Basin. Pp. E1-E68 *The Biota of the Los Angeles River*: *an overview of the historical and present plant and animal life of the Los Angeles River drainage*. K. L. Garrett, ed. Natural History Museum of Los Angeles County Foundation, Los Angeles, CA.

4.6. Avifauna

4.6.1. Introduction

The channelized portions of the Los Angeles River contain a highly modified set of ecological habitats, some mimicking features of the habitats formerly associated with natural river hydrology, but others quite unlike pristine habitats and generally dominated by non-native vegetation and unnatural substrates. Upland areas adjacent to the River have been almost completely transformed into urban hardscape. The avifauna of the Los Angeles River (most recently reviewed by Garrett, 1993) includes native riparian and wetland species which have adapted to the River's extreme modifications as well as more generalized species which thrive in urban regions and several naturalized non-native or feral domestic species; many other habitat specialists which formerly occurred along the lowland portions of the Los Angeles River have now been extirpated.

The purpose of the present study is to document the bird species that have adapted to channelized conditions of the River (using it either seasonally or year-round) and which River habitats and substrates are important to them. Using this information and an understanding of those species which were formerly present but now absent (many of which continue to occupy flood basins and other habitats farther upstream in the Los Angeles River system), a prediction can be made of how potential modifications and enhancements to the River's hydrology and associated habitats might increase avifaunal diversity along the River.

More specifically, the goals of this avifauna study are:

(1) Characterize the current (November 2014 through September 2015) avifauna of the soft-bottomed reach of the Los Angeles River from Los Feliz Blvd in Atwater Village to near Queen Street in Frogtown, above the Taylor Yard G2 Parcel.

(2) Determine which habitats, both within and adjacent to the River channel, are utilized by which bird species.

(3) Provide an analysis of changes in bird species composition and abundance in the study area through comparisons with similar bird surveys conducted along Segment 7 of the study area by the author in 1991–92 (Garrett 1993), and to interpret such changes in the context of documented habitat changes in the same time period.

(4) Compare the contemporaneous data on the avifauna of this linear reach of the Los Angeles River to datasets collected by the author and by citizen scientists (through the Cornell Laboratory of Ornithology's eBird initiative) for more extensive flood basins in the Los Angeles River system (Hansen Dam Basin, Sepulveda Basin and Hahamongna [=Devil's Gate Dam] Basin). The purpose of such a comparison is to examine the influence of areal extent and adjacent upland habitats on the species composition and abundance of riparian birds. Finally, this information will allow the development of a series of recommendations for habitat enhancement.

4.6.2. Methods

Avian surveys were conducted in the study area in November 2014 and January, March, April, May, July, August and September 2015. Dates, times and conditions of the eight sets of surveys are given in Appendix K. Each survey was standardized, with coverage divided into segments (see Figure 4-1). In order to complete surveys in the three hours before sunrise, the reach from Los Feliz Ave. to Fletcher St. (study segments 1–4, plus the small park at Los Feliz and the Sunnynook River Park on the west side of the river) was covered on one morning and the remaining reaches (Fletcher to the downstream end of the study area; study segments 5–7 plus Marsh Park) on another, usually consecutive, morning. Segments along the river channel were covered from the east bank; the top of the bank was walked in one direction and the edge of the river at the bottom of the bank was walked on the return coverage. All birds encountered were recorded in a field notebook, with the number of individuals noted, and later entered into an Excel spreadsheet. All observations were assigned to one of several identified habitat/substrate categories. Separate lists were kept for each study area segment.

Habitat-type and substrate categories identified at the outset of the study are presented below. Corresponding vegetation communities identified in Section 4.2, Vegetation Communities (see Figure 4-13), and landscape feature types, identified in Section 3.2.3 (see Figures 3-17 and 3-18) are in parentheses.

IN-CHANNEL

Riparian (Black Willow Thickets)—willows and other shrubs and trees, in many areas with non-native plants, such as ash and eucalyptus present.

Marsh (Emergent Vegetation)—including cattails and bulrush, along with semi-aquatic annuals such as *Ludwigia*, *Polygonum*.

Slow water (Pools or Backwaters)—pooled-up or slow-flowing water within the river channel

Fast water (Low Flow Water Types: Runs and Riffles)—narrow, rapidly flowing water within the river channel

Sheet flow (Low Flow Water Type: Flat)—very shallow and broad flow over concrete, typically bridge concrete aprons or check dams

Rock—in channel, emergent boulders completely surrounded by water

Cobble (Substrate of the unvegetated portions of Semi-Vegetated and Bare Channel Bars)—small boulder/rock/gravel substrate away from water channels (primarily between Fletcher Dr. and the Glendale Fwy.)

Concrete bank at water edge (Channel: Toe Protection)—the river “shoreline” formed by the boundary of the toe of the 3:1 channel bank slopes and river water

Concrete bank (Channel: 3:1 Slope Bank)—the sloped concrete bank itself, including annual plants and small shrubs growing within cracks and drainage weep holes.

Cables/wires—located over the river, serving as artificial perches directly over the water or in-channel habitat

Concrete bridges/buttresses—major structures at the street and highway crossings (Los Feliz, Glendale/Hyperion, Fletcher, Glendale Freeway)

Flying upstream, flying downstream—birds traveling along the river channel (upstream or downstream) were counted as “in-channel” observations

OUTSIDE OF CHANNEL

Residential edge (Urban Landscaping)—landscaping along the fences at the top of the channel and in adjacent residential, industrial or commercial properties within about 25 meters of the fence lines

Top bank riparian (Urban Landscaping)—purposefully planted trees (primarily cottonwoods, sycamores, elderberries) along fence lines at the top of the bank

Power poles—high artificial perches in the form of high-tension power pylons

Flying over, flying west, flying east, aerial—birds flying overhead but not following the river channel, or birds circling or foraging at great heights above the river, were considered to be outside of the channel

The seasonal span of surveys encompassed the breeding season for most species (March through August), spring migration (March through May), fall migration (July through September) and the winter season (November through March); see Appendix K for details. The study area was divided into discrete segments in order to investigate spatial differences in bird occurrence; the total length of the river channel covered was about 4 km.

To investigate changes in the avifauna of the study area in the past 20–25 years, data were used from surveys conducted by the same researcher in 1991–92 (Garrett 1993) in what was essentially the same reach of the River as Segment 7 in the present study. Those surveys were conducted weekly for nearly 1.5 years, but only surveys that were conducted on dates closest to the eight survey dates in the present study were analyzed.

Finally, eBird database (Cornell Laboratory of Ornithology; http://ebird.org; see, for example, Sullivan *et al.* 2009 and Wood *et al.* 2011) was used to characterize the bird fauna of other areas along the Los Angeles River and its tributaries to compare sites with much greater areal extent of riparian habitat and significant areas of adjacent open upland habitat to the avifauna of the channelized portions of the Los Angeles River. The sites chosen were the Sepulveda Basin in the south-central San Fernando Valley, the Hansen Dam basin in the extreme northeastern San Fernando Valley (Tujunga Creek tributary), and the Hahamongna Watershed Park in Pasadena (Arroyo Seco tributary).

4.6.3. Results

Bird Species Recorded

The eight surveys of the study area conducted between November 2014 and September 2015 yielded 2,017 observations (of one or more birds of a species in a particular habitat/substrate on a particular survey segment); each observation pertained to anywhere from a single individual to a group of up to 136 individuals, with the cumulative total number of individuals being 8,693. One hundred and six bird species (plus one additional well-marked subspecies) were recorded on the eight sets of surveys (a full Excel spreadsheet for all surveys is available from the author as supplementary material). The most abundantly encountered bird species (the sum of all individuals detected on all surveys) are presented in Table 4-14.

Table 4-14 Most frequently observed bird species.

Species	Cumulative Count
Mallard	1493
Rock Pigeon	1017
American Coot	578
Bushtit	565
House Sparrow	399
House Finch	354
Scaly-breasted Munia	290
Black Phoebe	287
Yellow-rumped Warbler	241
Song Sparrow	220
Black-necked Stilt	218
Common Yellowthroat	209

These are mostly flocking species (e.g. Mallard, Rock Pigeon, Black-necked Stilt, Scaly-breasted Munia), conspicuous species (e.g. the first three species above, and Black Phoebe), or territorial species (e.g. Common Yellowthroat, Song Sparrow) found along the length of the study area. Ten additional species had 100+ individuals encountered during the surveys; conversely, fifteen species were represented on the cumulative surveys by only a single individual.

Of the 106 species, nine were naturalized non-native species and another six were feral domestic species (including the widespread and abundant Rock Pigeon, but not including feral individuals of the Mallard, a species also detected as [presumably] wild birds). These introduced and feral species included three of the seven most abundantly encountered species (Rock Pigeon, House Sparrow, Scaly-breasted Munia). As might be expected in a highly urbanized setting, a relatively high proportion of bird encounters were of these naturalized non-native species (e.g. see Figure 4-37). Of 8,685 total cumulative bird observations, 2,000 (23%) were of either feral domestic species (Swan Goose, Greylag Goose, Muscovy Duck, feral Mallards, and Rock Pigeons) or naturalized non-native species (Eurasian Collared-Dove, Yellow-chevroned Parakeet, Red-crowned Parrot, Red-whiskered Bulbul, European Starling, House Sparrow, Orange Bishop, Scaly-breasted Munia, Orange-cheeked Waxbill). If all Canada Geese and Mallards observed were also classified as feral (as these mostly represent local subsidized resident populations rather than birds from natural migratory populations), this percentage of non-natives would rise to 41.5% of all observations.

See Appendix L for the scientific names of all bird species mentioned in this report.

Figure 4-37 **Muscovy Ducks.**

Feral domestic ducks are commonly found in the reach just below Los Feliz Blvd. Here is a feral Mallard x Muscovy Duck (left) and two feral Muscovy Ducks.

Species Richness and Density by Survey Segment

Species richness varied by survey segment. The highest species total (76) was in Segment 1 (Los Feliz Blvd. to Sunnynook Bridge); the other six in-channel segments varied from 48 to 68 species (Table 4-15). Off-channel parks and upland native revegetation plots only had from 29 to 34 species (as they were small in areal extent and generally lacked birds associated with open water or marsh). See Appendix M for bird species recorded by survey segment.

By dividing the cumulative number of individual birds recorded in each segment by the area of the segment, then by the total number of surveys (8) of each segment, a rough idea of avian density can be obtained. All segments, including off-channel parks, averaged between 6.2 and 34.8 individuals per hectare per survey. Segment 1, from Los Feliz Ave. to the Sunnynook pedestrian bridge, had the highest bird density (34.8 ind/ha/survey), undoubtedly because it held the highest concentrations of waterbirds (ducks, coots, shorebirds) in extensive shallow water habitat. Segment 3 (at 25.6 ind/ha/survey) had the second highest concentrations, again in part because of more available shallow water habitat. Segment 6 had the lowest bird concentrations (6.2 ind/ha/survey); this segment had a combination of relatively deep and fast flowing water and limited tall riparian growth.

Table 4-15 Species richness and density by survey segment.

Segment	Avian Species Richness	Avian Density
1	76	34.8
1A	34	22.2
2	63	23
2A Sunnynook Park	29	13
3	60	25.6
4	66	16.7
5	48	15.7
6/6A	48	6.2
6B Marsh Park	34	17.2
7	68	12.5

In-Channel and Outside of Channel Habitat Use

For the full dataset, 755 observations out of 2,016 (37.5%) were outside of the channel (birds flying over [but not along] channel, birds on top of bank and adjacent residential and industrial edge); birds in “top bank riparian” habitat were considered outside the channel even though the planted trees mimic in-channel riparian habitat, as were the birds recorded in the River-adjacent parks (Marsh Park, Sunnynook River Park, Los Feliz Park). Not surprisingly, nearly all waterbirds were recorded exclusively, or predominantly, within the river channel; an exception was the gulls, which were mostly seen in flight (generally west to east in the morning) and for which only 49% of observations were of birds in the channel or flying along the channel.

Among terrestrial birds, those species with the highest percentage of observations within the channel were: Song Sparrow—98% in-channel, Red-winged Blackbird—97%, Common Yellowthroat—93%, Scaly-breasted Munia—89%, Bewick’s Wren—87%, Brown-headed Cowbird—87%, Yellow Warbler—84%, Rock Pigeon—68%, Black Phoebe—67%, and American Goldfinch—67%.

Those species with the lowest percentage of observations inside of the channel (and, hence, recorded most often in off-channel parks and residential/industrial developments) were: Western Scrub-Jay—5% in-channel, European Starling—9%, Cassin’s Kingbird—10%, Northern Mockingbird—10%, California Towhee—17%, Lesser Goldfinch—17%, Allen’s/Rufous Hummingbird—20%, House Sparrow—21%, Common Raven—22%, Hooded Oriole—24%, House Finch—25%, Nuttall’s Woodpecker—30%, and Anna’s Hummingbird—32%. Species recorded frequently that were roughly evenly divided between in-channel and outside-of-channel (with percentage of observations in-channel) were: Yellow-rumped Warbler—40%, Bushtit—41%, White-crowned Sparrow—41%, Wilson’s Warbler—46%, Mourning Dove—48%, American Crow—50%, Orange-crowned Warbler—50%, and Ruby-crowned Kinglet—52%.

Birds recorded flying over the study area (flying roughly perpendicular to the channel or flying high above the study area) constituted a total of 107 out of 2,016 observations (5.3%). [Note that birds recorded “flying upstream,” “flying downstream,” and “flying low” are considered “in channel” as opposed to those birds just flying over the area without direct affiliation with river habitats]. This “flying over” category was most frequent for gulls (25 of 50 total observations, or 50%), pigeons and doves (18/150 = 12%), swifts (9/11 = 82%), parrots (14/19 = 74%), crows and ravens (21/53 = 40%), and waxwings (5/7 = 71%).

Species recorded in “sheet flow” habitat (primarily just below the Los Feliz Ave. bridge and on both sides of the Fletcher Ave. bridge; Figure 4-38) were Canada Goose, American Wigeon, Mallard, Cinnamon Teal, Snowy Egret, Green Heron, American Coot, Black-necked Stilt, Killdeer, Spotted Sandpiper, Greater Yellowlegs, Least Sandpiper, and Western Gull. The shorebirds, in particular, were partial to this habitat with 62% of observations of Black-necked Stilt, 86% of those for Greater Yellowlegs, and 71% of those for Least Sandpiper being on this substrate. This “sheet flow” habitat is abundantly represented along the lower Los Angeles River channel south of downtown Los Angeles and represents some of the most important shorebird habitat anywhere in the region (Cooper 2006).

Figure 4-38 View downstream from just below Los Feliz Blvd.

In foreground is shallow sheet flow (note Mallards), beyond the concrete bridge apron is flowing water and rocks. Riparian habitat is seen in the channel beyond that.

Seasonal Patterns of Species Richness

There was some seasonal change in species richness and number of individuals, as expected with complex seasonal migrations in the region. Species richness by survey segment is presented in Table 4-16.

This pattern of a dip in species richness from late spring through mid-summer is typical of the region and closely parallels the seasonal patterns of species richness on surveys in the same area reported by Garrett (1993).

Table 4-16 Species richness by survey segment.

Survey Number	Month-Year	Number of Species
1	November 2014	60
2	January 2015	63
3	March 2015	61
4	April 2015	62
5	May 2015	54
6	July 2015	49
7	August 2015	57
8	September 2015	60

Comparison of 1991–92 and 2014–15 Surveys in Segment 7

Sixty-six bird species were found in Segment 7 in the present 2014-2015 surveys; in the 1991–92 surveys of essentially the same linear reach of the River the species total of 86 was considerably higher. Species found in 1991–92, but not in the present surveys included thirteen species of waterbirds (e.g. five waterfowl, four shorebirds); this reflects the lower vegetation stature and greater extent of open water in the earlier surveys. Additionally, six non-native bird species recorded in 1991–92 were not found in the current surveys, including the formerly common but now largely extirpated Spotted Dove (*Streptopelia chinensis*). Most of the remaining differences involved low numbers of encounters in both time periods of uncommon migrants. Among breeding birds, the Bewick's Wren appears to have colonized this reach of the River since 1992 (up to three territories were noted in spring and summer 2015, but the species was unrecorded on the 1991–92 surveys). One tall riparian woodland specialist, the Yellow Warbler, was not recorded as breeding on the earlier surveys but 7–8 territorial males were present in the 2015 surveys. Riparian understory species such as the Common Yellowthroat and Song Sparrow were roughly equally abundant in both time periods. Red-winged Blackbirds, birds of emergent marsh vegetation and riparian scrub, showed a strong decrease, from 30–99 birds per spring and summer survey in 1991–92 to a high count of only 8 in spring and summer 2015.

Similar to the present surveys, the 1991–92 surveys of what is roughly equivalent to Segment 7 yielded about 28.5% non-native and feral species (34.2% if all Mallards and Canada Geese are considered feral). However, one of the most common non-native species in the present surveys (Scaly-breasted Munia) was not present at all in 1991–92 (e.g. Figure 4-39).

Figure 4-39 **Scaly-breasted Muni, a common and increasing non-native species along the Los Angeles River.**

(A) Seen here perched on bulrush; and
(B) A group foraging on non-native grasses on the riverbank.

Additional Observations from eBird

Only about 10 additional bird species were credibly reported in eBird during the study period from the three major eBird "hotspots" covering the study area (Atwater Village, Los Angeles River--Sunnynook Bridge, and Los Angeles River-Frogtown). These were Wood Duck (*Aix sponsa),* Blue-winged Teal (*Anas discors*), Turkey Vulture (*Cathartes aura*), Say's Phoebe (*Sayornis saya*), Violet-green Swallow (*Tachycineta thalassina*), Oak Titmouse (*Baeolophus inornatus*), Blue-gray Gnatcatcher (*Polioptila caerulea*), Nashville Warbler (*Oreothlypis ruficapilla*), Dark-eyed Junco (*Junco hyemalis*), and Blue Grosbeak (*Passerina caerulea*); all are fairly common and expected migrants in the area, or have resident populations (e.g. Oak Titmouse) in wooded parklands and residential areas near the River.

4.6.4. Discussion

Breeding Species

It was possible to estimate the total number of territories for linear riparian habitat territorial species such as Common Yellowthroat, Yellow Warbler and Song Sparrow by noting singing territorial males. At a minimum, there were 21 Common Yellowthroat territories (5.2/km), 27 Yellow Warbler territories (6.7/km), and 36 Song Sparrow territories (8.9/km). Although it was not a specific goal of this study to document nesting in the study area, it is possible to summarize the possible or proven breeding status of several bird species. Waterfowl breeding was documented by the presence of downy young or pre-flighted juveniles for Canada Goose (Segment 1, 23 April 2015) and Mallard (Segment 1, 28 May 2015 and Segment 6, 3 July 2015). A Black-necked Stilt nest with three eggs was seen on 28 May 2015 in Segment 4 (Figure 4-40). A Nuttall's Woodpecker was seen entering a nest cavity in a topped-off cottonwood on 24 April 2015 in Segment 7 (on the top of the bank near Newell St.). An adult Black Phoebe was seen with three fledglings on 23 April 2015 in Segment 4. Common Ravens were constructing a nest on the Fletcher Avenue bridge on 24 April 2015, and Barn Swallows were nesting on this same bridge on 29 May 2015. Two female Red-winged Blackbirds were seen carrying food (to presumed nestlings) 28 May 2015 in Segment 3. A fledgling Brown-headed Cowbird was observed being fed by an adult Yellow Warbler 20 August 2015 in Segment 4. House Sparrow fledglings were noted on several occasions from April to July, and nest-building was observed on 13 March 2015 in Segment 7. Other species present through the breeding season and almost certainly nesting in the study area were: Pied-billed Grebe, Green Heron, Black-crowned Night-Heron, American Coot, Rock Pigeon, Mourning Dove, Anna's Hummingbird, Allen's Hummingbird, Northern Rough-winged Swallow, Bushtit, Bewick's Wren, Northern Mockingbird, European Starling, Hooded Oriole, House Finch, Lesser Goldfinch, American Goldfinch, and Scaly-breasted Munia.

Habitat Associations

Although in-channel habitat characteristics were not quantified during the survey period (Garrett 1993) or the present period, some important qualitative changes have occurred during this 23+ year period, with associated avifaunal differences. Most of the Los Angeles River channel covered by the study area has seen an increase in the density and height of riparian growth (dominated by willows); this is especially dramatic in Segment 7 (the downstream end of the study area) where tall willows (with an admixture of other tree and shrub species, many non-native) dominate the channel and the flowing river is relegated to relatively narrow channels with fast-moving water. Marsh vegetation (cattails, tules and other emergent vegetation) is now scarce in this segment.

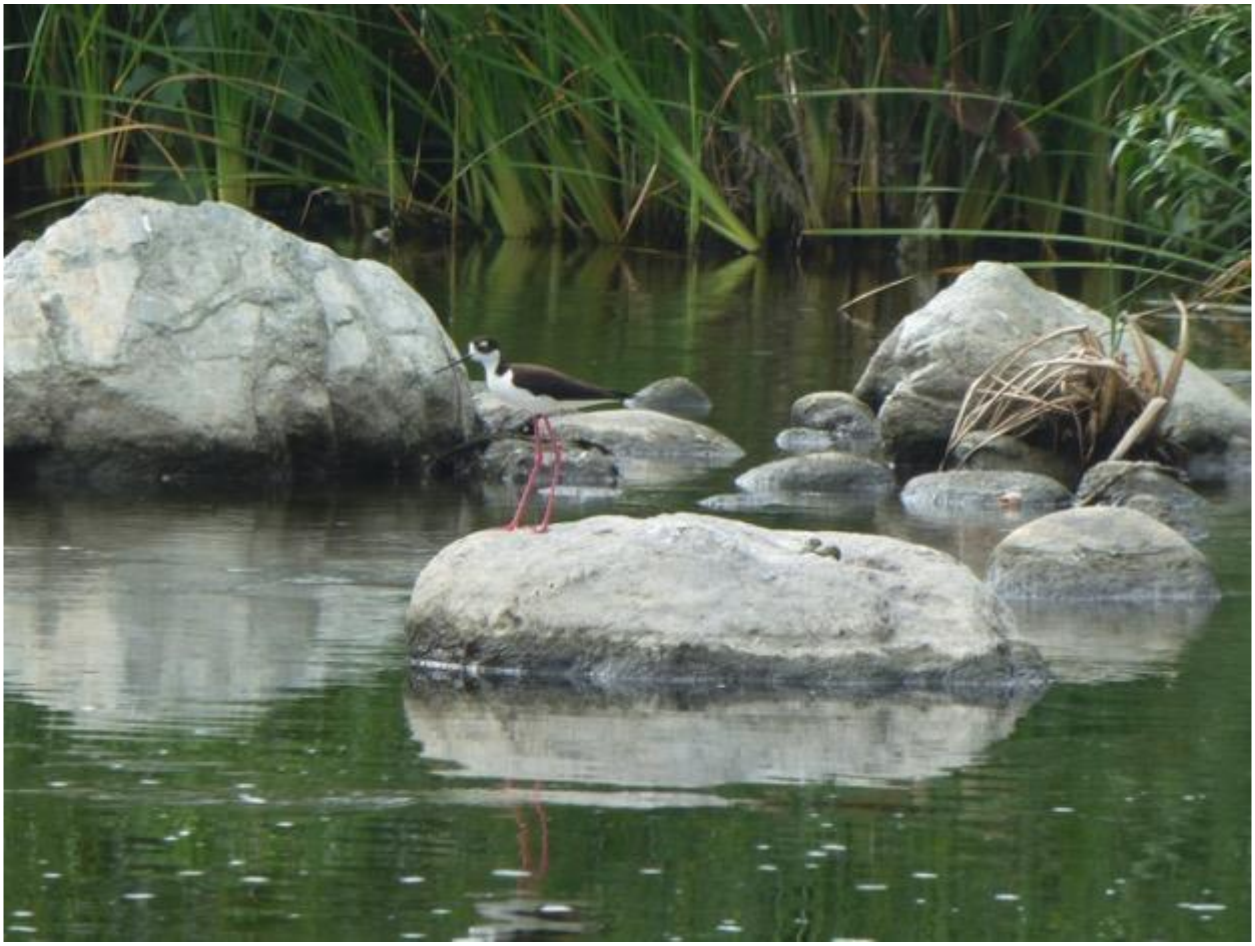

Figure 4-40 Black-necked Stilt.

One of the few waterbirds to nest in the study area is the Black-necked Stilt; here an adult is seen near a clutch of eggs on the flat top of an in-channel rock.

The three rainy seasons preceding the present study, as well as the rainy season of winter 2014-2015, saw well-below-average precipitation resulting in almost historic drought conditions. Because of this, scouring flows of runoff during high rainfall events have not been experienced since winter 2010-2011, likely contributing to the volume of vegetation in the channel. Despite the drought, considerable dry weather flow occurred throughout the year because of urban runoff and, especially, the release of treated effluent from water reclamation plants into the channel.

Quantitative bird survey data are not available for Segments 1-6 prior to the present study. For Segment 7, however, there are comparable data from the surveys as well as the present surveys; these data show a striking reduction in waterbirds and marsh birds due to the increase of in-channel vegetation and the reduction in extensive areas of shallow open water and associated emergent vegetation. Some of this apparent difference might be due to the increased difficulty of observing waterbirds through the tall and dense gallery of trees that has substantially increased in volume since, but the reduction nevertheless appears to be real because open water channels in Segment 7 are now narrower and swifter, low stature marsh vegetation is greatly reduced, and waterbird detections by vocalizations were far fewer. Conversely, species of tall riparian woodland (notably Yellow Warbler) were far more abundant in 2014-15, as were some riparian understory species (e.g. Bewick's Wren).

Currently the largest areas of open, shallow water (upstream ends of Segments 1 and 3, and the border of Segments 4 and 5) attract the largest numbers and variety of waterbirds. Areas of very shallow sheet flow over concrete (e.g. immediately below Los Feliz Blvd.) are the most attractive to Black-necked Stilts and other shorebirds, as well as waterfowl.

Many terrestrial bird species were recorded in roughly equal numbers in vegetation within the channel and in planted residential areas adjacent to the River; these included Mourning Dove, American Crow, Bushtit, and several wintering species (Ruby-crowned Kinglet, Yellow-rumped Warbler, White-crowned Sparrow). These adaptable species are likely to continue to thrive along the River over a broad range of future habitat scenarios, as are the species which were found more often in residential habitats than in the river channel itself (e.g. Allen's Hummingbird, Nuttall's Woodpecker, Cassin's Kingbird, Northern Mockingbird, California Towhee, Hooded Oriole, House Finch and Lesser Goldfinch).

Native plantings in the Sunnynook River Park on the west bank of the River between the Glendale/Hyperion and Sunnynook bridges attracted some species typical of native woodlands and chaparral (e.g. Band-tailed Pigeon, Bushtit and California Towhee; see Figure 4-41), but the limited extent of the habitat and the adjacency of the very busy Golden State Freeway (I-5) rendered this park's avifauna somewhat depauperate.

Comparison of Flood Basin and Channelized River Avifauna

The relatively narrow main channel of the Los Angeles River includes habitats that are generally limited in complexity and extent; furthermore, upland areas adjacent to the River channel consist almost entirely of urban hardscape (residential, industrial, and commercial developments and transportation arteries). Even where the River approaches natural habitats on nearby slopes of Griffith and Elysian Park it is separated from such habitats by multi-lane freeways.

It might therefore be informative to examine the avifauna of extensive flood basins of the Los Angeles River system upstream from the study area to inform planning for the creation of more extensive and diverse habitat along the River. The birdlife of three of these basins—Sepulveda Basin, Hansen Dam Basin and Devil's Gate Dam Basin (=Hahamongna Watershed Park)—has been well-documented by citizen scientists through the eBird database. The author is especially familiar with the Hansen Dam Basin, having submitted bird checklists from over 1,000 visits there, mainly from 2000-2015. Cumulative species totals from eBird submissions over multiple years, while a crude estimate of true species richness, hint at the greater bird diversity supported by more extensive and diverse habitats in the flood basins: 282 species at Hansen Dam, 278 species in the Sepulveda Basin, and 229 species in the relatively small Hahamongna Basin, compared to about 204 species in the present study area.

More important is the suite of breeding bird species found in these basins which are scarce or absent in the soft-bottom reach of the main Los Angeles River Channel. The Bell's Vireo (State and Federal endangered) is a common breeder in willow riparian in the Hansen Dam Basin (up to 30 territories; KLG data), small numbers breed in the Sepulveda Basin, and territorial birds have been noted in the Hahamongna Basin. This study recorded no Bell's Vireos in the study area, although there was a one-day sighting downstream from the study area near Oros Ave. in May 2015 (Daniel S. Cooper, pers. comm. and eBird data). Two other riparian specialists nest in the Hansen Dam Basin, Yellow-

Figure 4-41 **Band-tailed Pigeon.**

This Band-tailed Pigeon is feeding at a planted elderberry in Sunnynook River Park; this pigeon was not found within the river channel habitats but is frequent in surrounding residential areas and hills.

breasted Chat (8-12 territories) and Blue Grosbeak (5+ territories) and both of these species breed in small numbers in the Sepulveda Basin. Other species contributing to the increased avifaunal diversity of the flood basins include: Northern Shoveler (winter), Ring-necked Duck (winter), California Quail, Ash-throated Flycatcher, Hutton's Vireo, Tree Swallow, Wrentit, Western Bluebird, California Thrasher, Spotted Towhee, Chipping Sparrow, Lark Sparrow, Black-headed Grosbeak, Purple Finch and Lawrence's Goldfinch. Important habitat characteristics of the flood basins include extensive acreage of riparian (principally willow) woodlands, extensive lower stature riparian growth (dominated by mulefat) adjacent to willow riparian, open areas with grassland, alluvial scrub, or ruderal annuals, and adjacent oak woodlands (live oaks at Hansen Dam and especially Hahamongna, valley oaks at Sepulveda Basin). Permanent lakes (Lake Balboa and Sepulveda Wildlife Area lakes) in the Sepulveda Basin and a single large lake at Hansen Dam also add to the avian diversity in those places.

Species of Conservation Concern

No state or Federally listed bird species (Threatened or Endangered) were noted on the surveys; breeding populations of the Yellow Warbler are considered a California Species of Special Concern. Listed riparian species such as Bell's Vireo (SE, FE), Least Bittern (CSSC), and Yellow-breasted Chat (CSSC) do occur in the flood basins farther upstream, as noted above.

4.6.5. References

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4.7. Mammal Fauna

4.7.1. Introduction

Prior to its channelization in the early twentieth century, the Los Angeles River meandered freely and unpredictably through the Los Angeles basin, supporting a region rich in biodiversity. At Glendale Narrows, near current Griffith Park, water flowed year-round as it was fed by a productive aquifer in the San Fernando Valley. The riparian and surrounding upland habitats supported populations of native mice, woodrats, shrews, moles, ground squirrels, weasels, badgers, skunks, bobcats, mountain lions, grizzly bears, coyotes, gray foxes, mule deer, and bats (Willett 1941). Dramatic increases in the human population in the Los Angeles basin in the late 1800s altered the landscape, in turn altering the region's flora and fauna. Native carnivores like the grizzly bear, mountain lion and coyote increasingly came into conflict with humans and were reduced in numbers or even eliminated.

Until that time the occasional River flood was considered acceptable because springs and other irrigation sources were recharged and not much infrastructure existed that could be damaged (van Wormer 1991). Accelerated development in the historic floodplain of the Los Angeles River, however, led to increased damage to human life and property with each subsequent flooding event. Particularly devastating floods in 1910-1911 culminated in a proposal to control flooding while simultaneously conserving the precious seasonal supply of water. The plan called for retaining some flood water in reservoirs, distributing some over spreading grounds to recharge the groundwater, and straightening and reinforcing the River channel to quickly and efficiently discharge excess flood water to the ocean thus minimizing damage to property (van Wormer 1991). The manifestation of this plan resulted in the concrete-lined flood control channel that is the Los Angeles River today.

The River and adjacent upland habitats have been so dramatically transformed that only an exceptionally depauperate native biota is supported. Indeed, it has been noted that while more-or-less intact natural areas upriver from the channelized portions support native rodents such as wood rats, deer mice, harvest mice and pocket mice, the channelized portions of the Los Angeles River system are unsuitable for most native mammal species (Barkley 1993). The fragmented and degraded nature of any remaining natural habitat near channelized portions of the River has resulted in only generalist species using those areas. Generalists can meet their shelter and food requirements in a variety of ways and therefore generalist mammal species found in the flood control channel are the same species that are common in the highly urbanized adjacent areas: raccoons, opossums, striped skunks and coyotes. In addition, introduced commensal rodent species (e.g., *Mus* and *Rattus*) that commonly inhabit urban areas are abundant at channelized portions of the River (Barkley 1993).

In light of recent interest in native habitat restoration along parts of the Los Angeles River, an understanding of which species historically inhabited and currently inhabit the River's vicinity is important to inform restoration efforts. Additionally, this information can provide guidance on the feasibility of attracting native species to restored areas. With the exception of the 1993 report "Mammals of the Los Angeles River Basin" (Barkley 1993), virtually nothing is known about the mammalian fauna found within and adjacent to the channelized portions of the Los Angeles River. The purpose of the present study is to document the mammals currently inhabiting the Elysian Valley portion of the Los Angeles River and make recommendations on how restoration efforts may influence changes in the mammalian fauna.

4.7.2. Methods

Initial scouting trips to the study site were conducted in October and November 2014. Beginning at Los Feliz Boulevard and moving south and east to the Bowtie Parcel, the concrete-lined River bottom and bike paths along both sides of the River channel were walked to identify the presence of mammals and mammal sign (scat, tracks) and to reconnoiter potential locations for trail cameras. The use of trail cameras to monitor wildlife activity has several advantages over traditional survey methods. Trail cameras monitor a site passively and are therefore a cost-effective way to monitor activity in a location around the clock without the need for a researcher to continuously be present. Cameras are able to capture activity in nocturnal and crepuscular species that may use areas at times not convenient for human monitoring. Moreover, cameras are non-invasive and have the potential to capture images of species that would avoid areas where they can detect human presence (e.g., by smell or sight). Cameras also provide permanent, verifiable evidence of species presence. Remotely triggered infrared cameras (trail cameras) have successfully been used, for example, to monitor coyote activity (Kays *et al.* 2015) and estimate the abundance of large carnivores (Kelly *et al.* 2008). Similarly, acoustic monitoring of bat activity is an effective means of identifying the presence of bat species, many of which have protected status in the State of California, and thus are otherwise difficult to study.

Trail Cameras

Bushnell Trophy Cam HD trail cameras with infrared flash (Bushnell Outdoor Products, Overland Park, Kansas) were deployed at seven localities in the study area (see Table 4-17 and Figure 4-42). Camera C7, located at the Bowtie Parcel, was deployed by the National Park Service (NPS) to monitor urban coyote activity simultaneously with the study period. NPS biologists provided the raw data from their camera, allowing an increase in the sampling effort.

These cameras have highly sensitive triggers and quick trigger times, efficiently capturing day and night high resolution images of animals passing up to 30 feet or more in front of them. Cameras were set on maximum trigger sensitivity and set to capture two consecutive images per trigger to maximize the chance of a clear identifiable image being recorded of the individual triggering the camera. Additionally, cameras were placed 20–30 cm above ground level to optimize the capture of small species without compromising the likelihood of photographing larger mammal species.

Cameras were checked every two to four weeks to exchange the SD (Secure Digital) memory cards and refresh the 8 AA batteries as needed. For images captured on each memory card, images were individually reviewed and categorized to species level by the authors or by trained student workers from the University of Southern California. For each camera location, a folder was created for each unique species identified, and all images of that species were placed in that folder. Individual animals were not distinguished separately, so abundance of each species was not characterized. Rather, the total number of species and the total number of images of a given species at a particular camera location was counted.

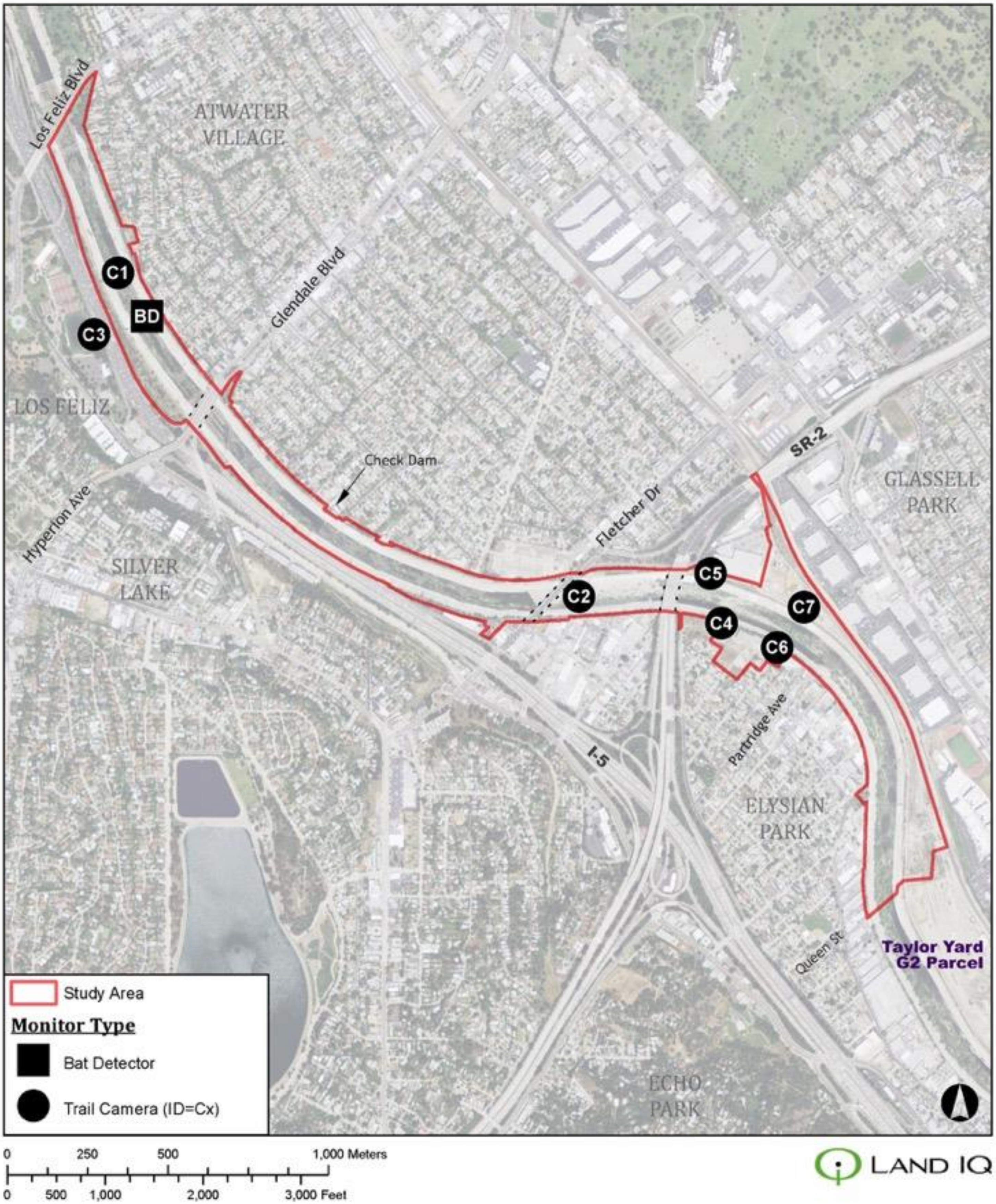

Figure 4-42 Trail Camera and Bat Detector Locations in the Study Area.

Table 4-17 Location names and coordinates of trail cameras (Cx) and bat detector (BD).

Site ID	Location Name	Coordinates	
BD	Sunnynook Pedestrian Bridge	34° 6'58.46"N	118°16'2.29"W
C1	Riverbed North of Sunnynook	34° 7'2.80"N	118°16'5.84"W
C2	Sandbar South of Fletcher Drive	34° 6'30.51"N	118°15'9.69"W
C3	Griffith Park Footbridge	34° 6'56.60"N	118°16'8.69"W
C4	Marsh Park	34° 6'27.87"N	118°14'52.35"W
C5	Dirt Trail West of Bowtie Parcel	34° 6'32.84"N	118°14'53.68"W
C6	Elysian Valley Gateway Park	34° 6'25.46"N	118°14'45.56"W
C7	Bowtie Parcel	34° 6'29.50"N	118°14'42.33"W

Camera locations were chosen to identify mammalian use of specific types of habitats in the study area (e.g., willow stands in the channel bottom surrounded by running water, pocket parks and bike paths upslope of the channel, pedestrian bridges, sandbars with large rocks/boulders, and the mostly barren gravelly Bowtie Parcel). Sunnynook River Park and Sunnynook Pedestrian Bridge were not surveyed due to camera thefts at those locations.

Acoustic Bat Detector

Bat activity was monitored using a Wildlife Acoustics SM3BAT Bioacoustics Recorder running firmware version 1.2.8. (Wildlife Acoustics, Maynard, Massachusetts). Power was initially provided by 6 size D batteries, and later with a 12-volt battery connected to a photovoltaic solar cell that recharged the battery during the day. The recorder was set to turn on at sunset and turn off at sunrise, the period of time when bats are normally active. Frequency range was set from 16 kHz to 192 kHz. To conserve battery power, the bat detector was set to revert to sleep mode until a vocalization within the set frequency range was detected. Calls were recorded as .wav files on up to four 128 MB SD memory cards. Each .wav file was date and time stamped.

The bat detector was mounted in a protective steel security case atop the wood platform of a column supporting the Sunnynook Pedestrian Bridge (see Table 4-17 and Figure 4-42). A microphone extension was threaded through a 2.5-meter length of conduit and placed 2 meters distal from mounted detector apparatus on the bridge support column. The microphone was suspended approximately 15 meters over the surface of the river and a wind protection screen was attached to the microphone to reduce interference from the wind. This location was chosen for the likelihood of bats traversing nearby for watering and hunting for insect prey, and for the increased security of having the detection equipment mounted in a place difficult to access without special safety gear. Rangers from the City of Los Angeles Department of Parks and Recreation assisted in accessing this site.

The detector was visited every 2–4 weeks to download data, change out batteries and ensure proper operation. Data (.wav files) were downloaded to a computer and were passed through a low and high frequency filter developed by Ted Weller, a bat ecologist with the U.S. Forest Service's Pacific Southwest Research Station (Weller and Baldwin 2012). The filtering algorithm removes incidentally recorded non-bat sounds that occur in the ultrasonic range and retains possible calls within the range of frequencies for bat species known to occur in Southern California.

Files that passed the filter were subsequently analyzed with Sonobat species identification software (Sonobat, Arcata, CA). Bat .wav files with at least 4 oscillations verified as a single species were accepted unless the call was from an uncommon species, in which case the call was visually analyzed and the species identification was made based on discrete call characteristics that separate it from other species in the same frequency range. Equivocal species identifications and false positives were eliminated from the results. Common species (*Tadarida brasiliensis*, *Myotis yumanensis*, *Parastrellus hesperus, Eptesicus fuscus*) were accepted simply based on the analysis of Sonobat software. Sonograms identified by Sonobat as rarer species (*Lasiurus blossvillei*, *Lasiurus cinereus*, *Myotis californicus*) were visually evaluated against reference calls. Rarer species have similar frequencies to more common species and can be confused by software as a result. In order to pass as a less common species, more than one detection of the species must be made and sonogram characteristics are evaluated manually (e.g., oscillation shape, pattern, intensity, and frequency).

Other Site Surveys

In the course of identifying sites for cameras and the bat detector, and during the regular collection of data from the passive monitoring devices, evidence of mammal species presence was noted. Evidence of mammal species presence included footprints, scat, active burrows and direct observations. Included were incidental species sighting reports from colleagues conducting concurrent surveys of other taxa in the study area (e.g., birds, insects and herpetofauna).

4.7.3. Results

Trail Cameras

More than 33,000 images were captured on the deployed trail cameras over a total of 667 camera trap days. Of these, 11,798 images were classifiable and used in the analyses. Cameras detected a range of small and medium-sized mammals, both native and introduced, as well as humans and several avian species (Table 4-18). The assemblage of mammals present in the channel is typical of what is found in urban areas: mammals that are generalists and adapted to a range of habitats, including anthropogenically altered habitats. This included the introduced commensal rodents in the genus *Mus* and *Rattus*, the introduced eastern fox squirrel (*Sciurus niger*), and the introduced opossum (*Didelphis virginiana*). Native coyotes (*Canis latrans*) were found at every camera site, although they were observed less frequently at sites where humans and domestic animal were most actively recorded (e.g., bike paths) (e.g. see Figure 4-43). Another native carnivore and habitat generalist, the raccoon (*Procyon lotor*), was documented at several sites, including the river channel island of willow habitat surrounded on both sides by flowing water (site C1, river bottom north of Sunnynook Pedestrian Bridge) (e.g. see Figure 4-44). As is typical following rainfall events, these channel bars are inundated with stormwater discharges for one or two days, as shown in Figure 4-45. Eastern fox squirrels were observed in the pocket park at Los Feliz Boulevard, the Griffith Park Bridge, Marsh Park, and interestingly in the willow island habitat (C1). Native California ground squirrels (*Otospermophilus beecheyi*) were observed at the sandbar south of Fletcher Drive (C2), as well as within and in the vicinity of the Bowtie Parcel (C7 and C5, respectively). Native desert cottontail rabbits (*Sylvilagus audubonii*) were observed at the Bowtie Parcel and the dirt path between the Glendale Freeway and the Bowtie Parcel (again, C7 and C5 respectively).

Table 4-18 Trail Camera Observations.

	Trail Camera Site Observations						
Taxon	**C1** Riverbed North of Sunnynook	**C2** Sandbar South of Fletcher Drive	**C3** Griffith Park Footbridge	**C4** Marsh Park	**C5** Dirt Trail West of Bowtie Parcel	**C6** Elysian Valley Gateway Park	**C7** Bowtie Parcel
Human	---	26 (2.24%)	1,797 (92.49%)	841 (84.44%)	197 (46.46%)	5,437 (89.25%)	36 (26.67%)
Rodent (*Mus* sp. and *Rattus* sp.)	925 (75.51%)	456 (39.21%)	107 (5.51%)	1 (0.1%)	---	---	---
Domestic Dog (*Canis familiaris)*	---	---	13 (0.67%)	35 (3.51%)	42 (9.91%)	543 (8.91%)	2 (1.48%)
Bird	21 (1.71%)	219 (18.83%)	---	42 (4.22%)	2 (0.47%)	28 (0.46%)	2 (1.48%)
California ground squirrel (*Otospermophilus beecheyi)*	---	300 (25.8%)	---	---	2 (0.47%)	---	5 (3.7%)
Unknown	73 (5.96%)	52 (4.47%)	10 (0.52%)	43 (4.32%)	13 (3.07%)	---	---
Coyote (*Canis latrans)*	45 (3.67%)	14 (1.2%)	2 (0.1%)	18 (1.81%)	40 (9.43%)	12 (0.2%)	42 (31.11%)
Raccoon (*Procyon lotor)*	130 (10.61%)	20 (1.72%)	5 (0.26%)	7 (0.7%)	---	2 (0.03%)	---
Vehicle	---	---	---	---	49 (11.56%)	64 (1.05%)	41 (30.37%)
Desert cottontail (*Sylvilagus audubonii)*	---	---	---	---	77 (18.16%)	---	6 (4.44%)
Duck	29 (2.37%)	46 (3.96%)	---	---	---	---	---
Virginia opossum (*Didelphis virginiana)*	---	21 (1.81%)	1 (0.05%)	3 (0.3%)	1 (0.24%)	---	---
Feral cat (*Felis sylvestris)*	---	4 (0.34%)	4 (0.21%)	4 (0.4%)	---	2 (0.03%)	---
Eastern fox squirrel (*Sciurus niger)*	1 (0.08%)	---	4 (0.21%)	1 (0.1%)	---	4 (0.07%)	---
Egret	1 (0.08%)	4 (0.34%)	---	---	---	---	---
Insect	---	---	---	1 (0.1%)	1 (0.24%)	---	---
Striped Skunk (*Mephitis mephitis)*	---	1 (0.09%)	---	---	---	---	1 (0.74%)
Total	**1,225**	**1,163**	**1,943**	**996**	**424**	**6,092**	**135**

Figure 4-43 Coyote activity on river channel bar north of Sunnynook (Camera Trap C1, Taken 2-10-2015 6:45am).

Unsurprisingly, humans and dogs were most frequently captured on the trail cameras placed adjacent to bike paths, walking paths and pedestrian bridges. Human use of the study area is intensive: three of the seven cameras captured humans in more than 80% of total image captures (Table 4-18). In general, the presence of humans and domestic dogs suppresses the presence of other species (George and Crooks 2006; Tigas *et al*. 2002). Although other species used those same spaces, they did so with less frequency than in areas with less human traffic. Domestic cats were captured on cameras located at Marsh Park (C4) and at the sandbar south of Fletcher Drive (C2).

Acoustic Bat Detector

More than 18,000 call sequences were recorded during four detector sessions comprising of 82 total detector nights at the Sunnynook Pedestrian Bridge (Table 4-19). Sessions 1 through 3 ran for approximately two weeks each in the months of July, August and September 2015. Two weeks was the approximate life of the batteries. Late summer months were chosen as this is the time of greatest bat activity due to the abundance of insect prey (Barkley 1993).

Figure 4-44 **Raccoon activity on river channel bar north of Sunnynook (Camera Trap C1, Taken 2-5-2015 10:06pm).**

Figure 4-45 **Example of inundated channel bar during stormwater discharge north of Sunnynook (Camera Trap C1, Taken 2-23-2015 12:26am).**

Table 4-19 Number of bat calls by species.

	Bat Detector Sessions in 2015				
	1 7/08-7/21	2 8/12-8/27	3 9/23-10/06	4 10/07-11/15	Total
Total bat calls detected	4,342	5,784	2,676	5,416	18,218
Total bat calls identifiable to species	**3,202**	**4,258**	**1,902**	**3,944**	**13,306**
Tadarida brasiliensis	1,354	365	129	139	1,987
Myotis yumanensis	1,837	3,881	1,766	3,789	11,273
Myotis californicus	7	6	1	12	26
Eptesicus fuscus	2	---	---	---	2
Parastrellus hesperus	2	6	6	4	18

Of the total bat calls recorded, more than 13,000 call sequences were identifiable to species. Discrete acoustic signatures from five were recorded (Table 4-19). All five species of bats detected are from the insectivorous Vespertilionidae family, and all have previously been documented in the Los Angeles region. The most frequently detected species was the Yuma myotis (*Myotis yumanensis*; 11,000+ detections), followed by the Brazilian free-tailed bat (*Tadarida brasiliensis*; 1,987 detections). Less common were the California myotis (*Myotis californicus*; 26 detections), canyon bat (*Parastrellus hesperus*; 18 detections) and big brown bat (*Eptesicus fuscus*; 2 detections).

These results correspond with a previous study that documented big brown bats and canyon bats along portions of the Los Angeles River drainage system at Big Tujunga Canyon and at the Parker-Mayberry Bridge in the Arroyo Seco (Barkley 1993); and with a previous study that documented 7 bat species occurring within nearby Griffith Park, including the five species documented at the Sunnynook study site (Remington and Cooper 2014). Griffith Park comprises more than 4,200 acres of native and non-native habitats with important connectivity to the Los Angeles River. Bats, with their inherent vagility, most certainly transit between Griffith Park and the nearby Los Angeles River on their nightly foraging bouts.

Other Observations

Walking surveys were conducted during daylight hours and diurnal mammal species were commonly noted along many parts of the channel and nearby areas. Eastern fox squirrels were observed at the small park at the southeast corner of Los Feliz Blvd and the river channel, as well as in Sunnynook River Park and in all of the neighborhoods along the river channel. California ground squirrels were observed at the sandbar south of Fletcher Drive and in burrows undermining the Fletcher Drive overpass of the river channel. Coyote prints were noted in the soft sand of the dirt path below the Glendale Freeway. Coyotes were occasionally active during the day and were observed walking along the channel bed (e.g., Figure 4-46).

Figure 4-46 Coyote active during mid-morning along channel bar in river, May 2015. Photo by K. L. Garrett.

A litter of six striped skunk kits was observed peeking from a nest located under a sidewalk on Sunnynook Drive, adjacent to the bike path at the Sunnynook Pedestrian Bridge. Adult skunks were not observed in the vicinity. Several raccoons were observed in the invasive grass on a sandbar island in the channel near the northwest boundary of the former Taylor Yard.

Desert cottontails were observed on the sandbar south of Fletcher Drive. Although they were not captured on cameras placed at that same location, these observations correspond with camera images of desert cottontails in the vicinity, namely the Bowtie Parcel and the dirt path west of Bowtie.

Domestic cats, possibly feral but also probably pets from adjacent neighborhoods, were commonly observed throughout the study area, typically hiding in shrubs. For example, cats were observed in bushes along Legion Lane, which runs parallel to the bike path on the east side of the channel north of the Sunnynook Pedestrian Bridge, in ivy located in the pocket park just south of Los Feliz Blvd, and in bushes along the chain-link fence between the channel and the 5 freeway approximately 200 meters north of Sunnynook Pedestrian Bridge. A cat was also observed where Acresite Street dead-ends at the east bike path just north of Fletcher Drive.

4.7.4. Discussion

The present study offers a more complete assessment of the mammalian fauna using the Elysian Valley portion of the Los Angeles River than previously reported, probably in large part due to sampling effort. Mammal surveys in the 1991–92 study were conducted in the vicinity of Newell Street and focused only on live-trapping of small mammals using Sherman box traps (Barkley 1993). This style of trap is skewed toward the capture of small mammals, typically rodents and shrews. Not surprisingly, that study documented only the introduced commensal rodent *Mus* in that vicinity.

The 1991–92 study also examined historical data, primarily museum specimen records, to infer which mammal species would have occurred along the River prior to channelization and urbanization of upland areas. While none of the species from the historical records were documented to be using the River and adjacent spaces at the time of the 1991–92 study, many of those species were observed in the course of the present study, including coyote, raccoon, striped skunk, California ground squirrel and desert cottontail. In addition to sampling effort, the increased diversity of mammal species present in the area can be explained by the change in complexity of habitat, particularly within the channel bottom. Formerly, there existed a regime of clearing willows and other vegetation that became established in the soft-bottom reaches of the Los Angeles River. Although the density and height of the riparian growth was not described in the 1991–92 study, photographs included in that analysis (see Appendix H) indicate that since that time there has been a dramatic increase in the biomass of trees and shrubs established in the soft-bottomed portion of the River. The increased vegetation provides cover and food resources for a wide variety of animals, predator and prey alike. Allowing willows and other river bottom plants to grow in soft-bottom portions of the channel has unquestionably led to an increase in the number of vertebrate species using or inhabiting those areas.

Increase in plant density has also positively affected insect populations. This may be one reason why five insectivorous bat species were documented in the current study (Table 4-19) while only two species were observed in the 1991–92 study, albeit at locations several miles away (Barkley 1993). The ability to fly may minimize the physical effects of urbanization that prove challenging to other wildlife, allowing bats to exploit favorable patches of habitat (Gehrt and Chelsvig 2003). Roads, for example, do not affect bats in the way they affect ground-dwelling vertebrate species (Mader 1984, Fahrig *et al.* 1995).

On the other hand, roost availability is the major influencing factor on the presence of bats because they are able to travel to sources of water and prey. Therefore, it is possible that structures associated with River channelization have attracted colonization by certain bat species. The species most commonly detected at the study site, the Yuma myotis (*Myotis yumanensis*), is particularly adapted to man-made structures and inhabits abandoned buildings, preferring crevices as shelter (Braun *et al.* 2015). In fact, the Yuma myotis has so completely adjusted itself to man-made structures that there are no documented records of the species being found in "natural" retreats such as caves (Dalquest 1947). Similarly, the big brown bat (*Eptesicus fuscus*) commonly roosts in buildings and other man-made structures (Kurta and Baker 1990), even for example in expansion joints of concrete bridges and other highway elements. The California myotis (*M. californicus*) roosts in crevices and seemingly prefers riparian groves of willow and sycamore, as well as oak groves (Krutzsch 1954).

It is noteworthy that several bat species are using the River, given their potential use as bioindicators. Broadly defined, bioindicators are “biota that are developed as indicators of the quality of the environment, the biotic component, or humans within an ecosystem” (Burger 2005). Interest in bats as valuable bioindicators relates to the high level that insectivorous bats occupy in the food chain, and the tight correlation with plants for pollinating bats and seed-dispersing bats. As such, bats are highly responsive to habitat changes such as fragmentation, changes in land use and general environmental quality (Russo and Jones 2015). Bats are useful as bioindicators because they can be reliably monitored and recognized, are taxonomically stable, are reactive to environmental stressors, and provide important ecosystem services ranging from insect pest control to pollination and seed dispersal (Jones *et al.* 2009, Jones 2012). These characteristics may even apply to highly modified habitats that meet minimum habitat requirements, because some bat species benefit from artificial bodies of water (Korine *et al.* 2015). In the context of habitat enhancement and ecosystem restoration of reaches of the Los Angeles River, using bats as bioindicators offers the potential to assess ecosystem health and inform policy makers on measures that can mitigate human impact on other biota.

Several native mammal species were not documented in the present study, but may generally be attracted to the area if appropriate restoration measures are enacted. Particularly interesting was the absence of bobcats (*Lynx rufus*). Within the Los Angeles basin, bobcats are mostly relegated to urban edge habitat and are considered to be particularly sensitive to habitat fragmentation and degradation. During the timeframe of the present study, three bobcats were documented in close vicinity but outside of the study area. In November 2014 a bobcat was photographed in a residential neighborhood near the Rowena Reservoir, just 350 meters from the Hyperion Avenue overcrossing of the Los Angeles River (Figure 4-47). Two bobcats (one of them roadkill) were documented near Elysian Park in March and July 2015. The proximity of several bobcats to the study area indicates the potential for that species to expand its use into enhanced areas of the River with sufficient habitat and prey resources. Also, the potential isolation of bobcats along specific sections of the River points toward the heightened value of the River as a potential corridor for wide-ranging mammals that require access to large blocks of core habitat (e.g., Griffith Park, Elysian Park). The functionality of the River as a wildlife corridor may only be sustained by conserving, enhancing, and restoring core habitat along the River and enhancing suitable access points for timid or urban-sensitive species.

Two other native carnivores notably absent from the study area, that would formerly have been common, are the long-tailed weasel (*Mustela frenata*) and the gray fox (*Urocyon cinereoargenteus*). Both are dependent on the presence of native mice, their main prey. Museum specimen records indicate both species inhabited much of the Los Angeles basin prior to urbanization, but they are currently limited to undeveloped areas in the Santa Monica and San Gabriel Mountains. It is worth noting that researchers have documented long-tailed weasels and gray foxes along the edge of Griffith Park, including a weasel photographed outside of an equestrian tunnel near the Headworks DWP property just north of the study area (unpublished data, Griffith Park Connectivity Study 2014). The assemblage of rodent species native to the Los Angeles basin, but mostly absent from urbanized areas, includes two species of wood rats (*Neotoma* spp.), several species in the deer mouse genus *Peromyscus*, the California vole (*Microtus californicus*), the pocket gopher (*Thomomys bottae*), pocket mice (*Chaetodipus* spp. and *Perognathus* spp.), the agile kangaroo rat (*Dipodomys agilis*), the western harvest mouse (*Reithrodontomys megalotis*) and the southern grasshopper mouse (*Onychomys torridus*). Many of these species occur in the relatively intact habitat in adjacent areas such as the Santa Monica Mountains and the upper drainage system of the Los Angeles River (e.g., Big Tujunga Canyon as documented by Barkley, 1993). Native rodents co-evolved with native plants and thus have specialized diets that cannot be met using non-native plants. For this reason, most native rodents are absent from altered habitats. Moreover, native rodents are sensitive to the presence of non-native predators, in particular feral cats. In addition to habitat enhancement of the Los Angeles River, establishing wildlife corridors to adjacent native habitat should be considered, combined with measures to manage feral cat populations.

In general, the channelized portions of the Los Angeles River are currently unsuitable for most native mammal species. Habitat generalists such as raccoons, coyotes and opossums can meet their shelter and food requirements in a variety of ways and are adapted to highly altered habitats. The same is true for introduced species such as commensal rodents and eastern fox squirrels. As such, native habitat generalists and introduced species are the dominant mammal species currently using the Los Angeles River. Absence of sufficient habitat, lack of connectivity to core habitat, and the presence of feral cats and dogs contribute to the paucity of native rodent species. Even with enhancement of habitats and restoration of hydrological connections, recolonization by native rodents would therefore be inhibited. Without native rodents, the native carnivores such as the long-tailed weasel, bobcat and gray fox would not likely recolonize the area. Other requirements of native rodents include the planting of native grasses and de-compacting soil to allow burrowing.

Figure 4-47 Bobcat (*Lynx rufus*) with partially eaten California ground squirrel (*Otospermophilus beecheyi*) near Rowena Reservoir, November 2014.

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4.7.5. References

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Chapter 5. Habitat Enhancement Opportunities

By mimicking conditions in the highly diverse flood basins upstream, the study area could greatly increase its native biodiversity. Opportunities for enhancement include the expansion of Los Angeles River habitats, creation of upper terrace floodplain and complementary upland habitat, and connecting the River to native scrub, chaparral and woodlands in Elysian Park, Griffith Park and other protected areas (see Figure 5-1).

Potential efforts to modify the existing structure, hydrology, seasonal flow regime and habitat composition of the Los Angeles River to increase biodiversity and attract native wetland and riparian species will be constrained by the flood control mandate for the River channel and the paucity of adjacent floodplain and upland habitat.

River habitats will be more constrained in acreage, diversity, quality (e.g. relatively free of invasive exotic plant and animal species) and connectivity than the historic condition. Given these realities and the existing conditions discussed in this report, the following opportunities to increase ecological value and biodiversity in the Elysian Valley (Figure 5-2) are identified:

- Watershed Hydrology Opportunities
- In-Channel Habitat Enhancement Opportunities
- Outside of Channel Habitat Enhancement Opportunities

5.1. Watershed Hydrology Opportunities

Reduce in-channel dry weather flow to below 13 cfs to mimic key elements of a natural flow regime.

The historic condition of the dry weather (non-flood) surface water flow that supported native species and natural vegetation communities was ephemeral surface flow with much lower non-flood surface flow than today. This dry weather flow was due to rising groundwater and influenced by decadal-scale fluctuations in cumulative rainfall replenishing the San Fernando Valley groundwater basin. The vegetation communities native to Southern California and its semi-arid, Mediterranean-type climate (e.g. historic vegetation prior to the late 1800s and some of the contemporary riverine habitat in the Santa Clara River floodplain) are adapted to this dry season condition. The historic hydrological condition of lower dry weather flow supports higher diversity vegetation assemblages and habitat-specific native faunal associations. Many of the native habitat specialists that historically occurred in the lowland portions of the Los Angeles River have now been extirpated.

The contemporary low flow condition of the Los Angeles River differs significantly from the historic condition. Not only does the River currently flow on a perennial basis, but the dry weather flow is much higher than the historic condition. Because of the unnaturally high dry weather flow combined with the modifications to riverine processes for flood control purposes (e.g. channelization), the River channel currently supports novel vegetation assemblages. These assemblages are dominated by introduced, highly invasive species and a few native species that have traits conducive to perennial flow and periodic inundation. Regardless, the existing river water features, vegetation assemblages and unnatural substrates mimic some important features of native faunal habitat. The animals that use these novel urban habitats tend to be habitat generalists, which include native species that have adapted to the River's extreme modifications and/or thrive in urban regions, and naturalized non-native or feral domestic species. However, if appropriate habitat is enhanced and/or created, there are opportunities for populations of native animals to disperse from adjacent upland (e.g. Griffith Park) and riparian areas (e.g. Sepulveda Dam).

While the contemporary low flows in the River (at least 60 mgd, primarily from water reclamation plants, urban runoff, and industrial discharge) serve as the Army Corps Feasibility Study engineering design flow condition, and as the conceptual basis for many visions of a "restored" Los Angeles River—there are several reasons to consider significantly lower low flow conditions (e.g. less than 3 mgd) as the basis for design:

- Likelihood of increased use of reclaimed water from water reclamation plants (e.g., for recycled water applications such as industrial process water or landscape irrigation) in order to reduce water imports to the region.
- Likelihood of decreased urban runoff due to water conservation measures, water quality mandates, and development of new stormwater capture infrastructure.
- Lower flow is consistent with the historical ecological conditions, in which dry weather surface flow was primarily from rising groundwater—hence, vegetation communities and associated animals adapted to ephemeral surface water flow, meandering channels, and intermittent sedimentation from storm flows.
- Lower flow allows for increased diversity of in-channel vegetation communities because decreased flows create slower moving waters, backwater habitats, meandering and braiding streams, and more non-flood dry alluvial substrate.
- Lower flow and the resulting increased diversity of native vegetation communities favors native animals, which often have more specialized habitat requirements than the generalist non-natives, while still allowing urban tolerant generalist wildlife to persist.

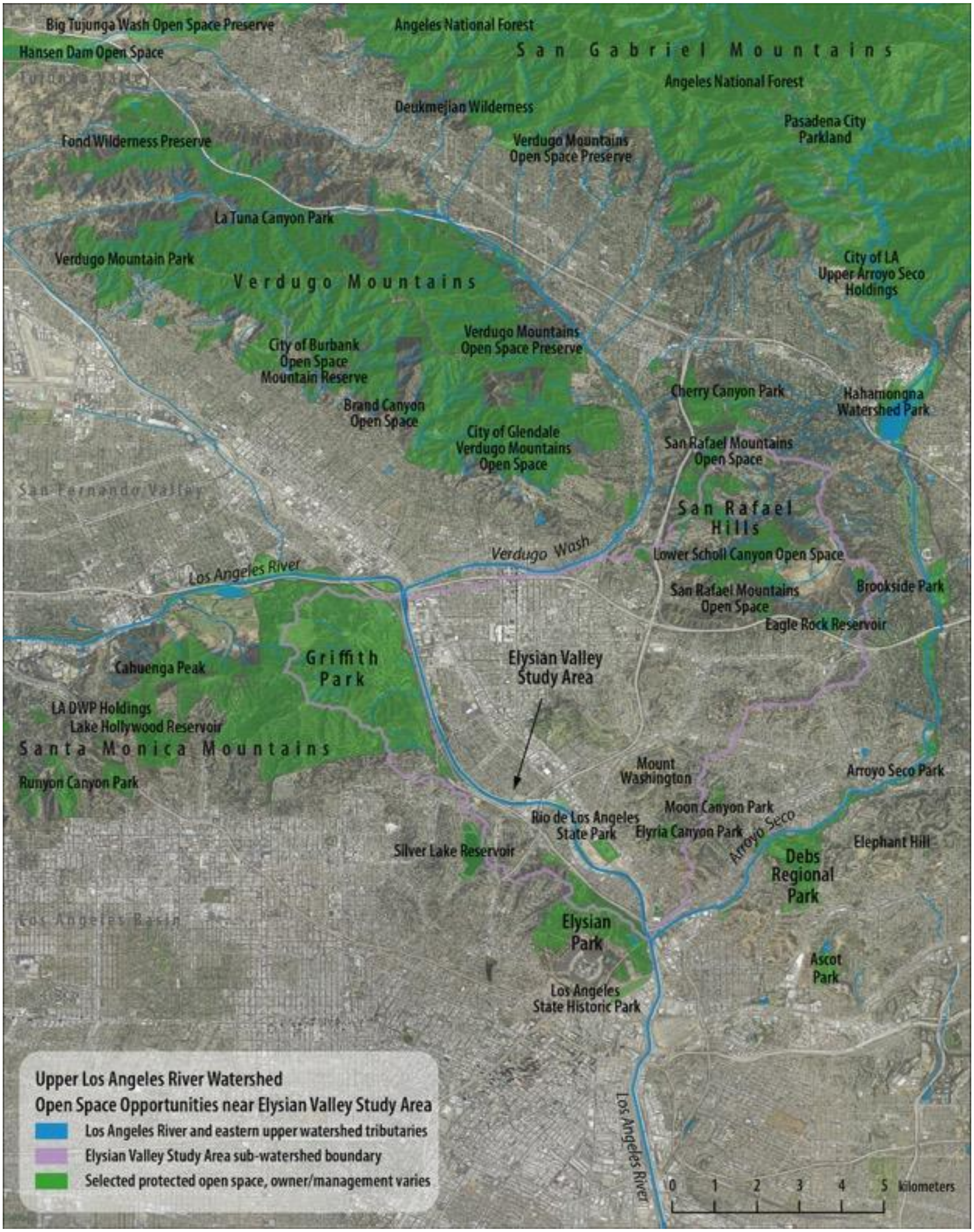

Figure 5-1 Upper Los Angeles River Watershed Open Space near the Elysian Valley.

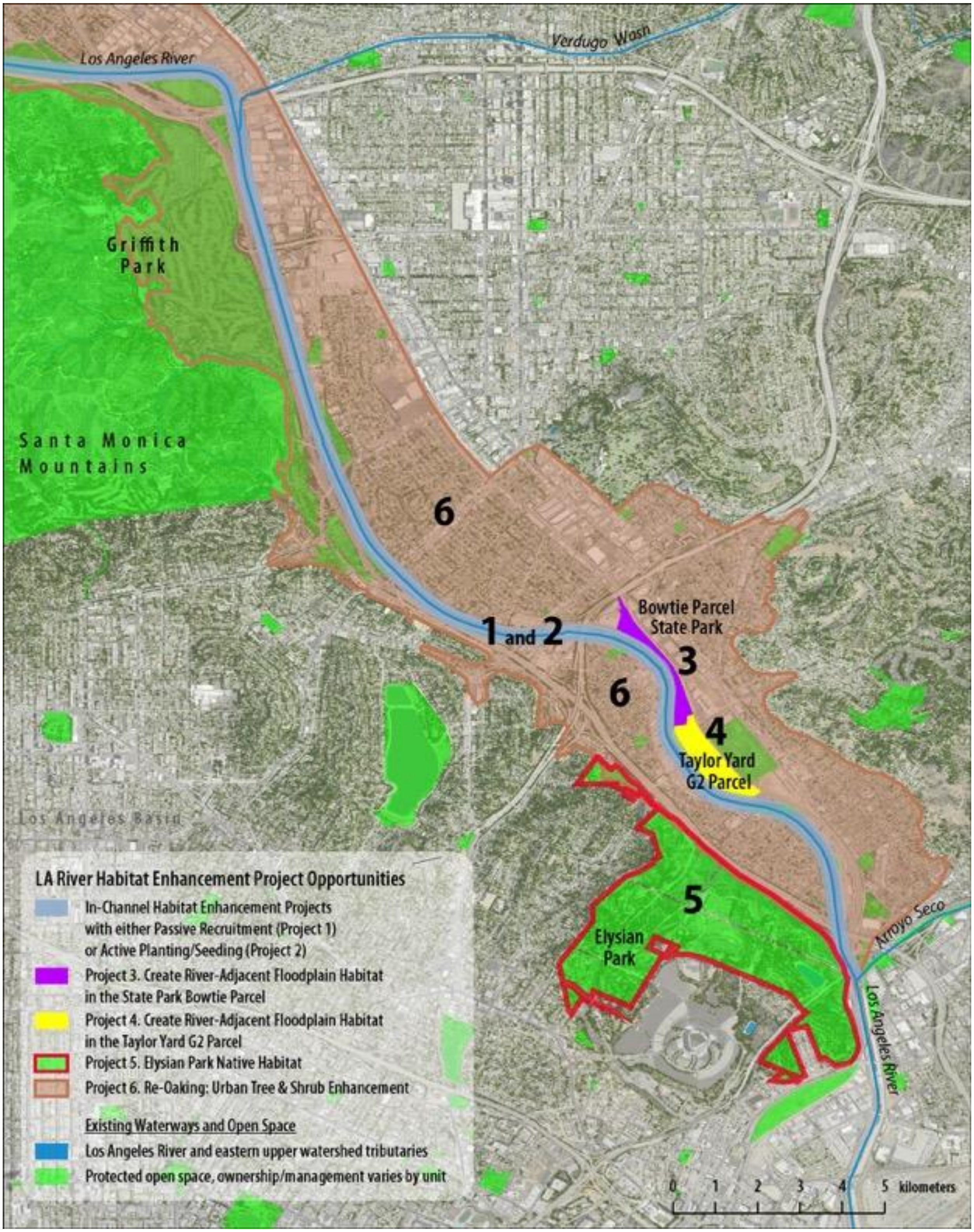

Figure 5-2 Los Angeles River Habitat Enhancement Project Opportunities in the Elysian Valley.

5.2. In-Channel Habitat Enhancement Opportunities

Two habitat enhancement project opportunities were identified within the flood control channel (see Figure 5-2). Both are focused on the control of giant reed and other invasive species, followed by either passive recruitment of native vegetation or active planting and seeding. There are four main issues that will influence the success of these two projects:

1. Dry weather flow regime
2. Stormwater peak flow conditions
3. Addressing the homeless encampments
4. Managing recreation within the project area, including after project completion

The dry weather flow and peak stormwater conditions are a function of a future, multi-partner consensus building and decision making process that will need to occur at the scale of the Upper Los Angeles River Watershed. Because planning for future watershed hydrology is uncertain, four watershed hydrology scenarios have been identified, as discussed in Chapter 3. In Table 5-1 there is a matrix of the six habitat enhancement project opportunities (two in-channel and four outside of the channel) and the four watershed hydrology scenarios, to evaluate the level of restoration project success and effort expected under each scenario. Therefore, depending on the timing of funding and implementation, the most appropriate project(s) can be selected for development given both the current and anticipated future watershed hydrological regime. The six projects can be implemented together to achieve maximum habitat enhancement value within the study area, but they can also each be implemented separately or incrementally as circumstances allow.

Regarding the in-channel homeless encampments, practical and social issues notwithstanding, the homeless population in the vicinity will need to be decreased for any sustainable increase in native species to occur. Encampments in the River are a significant threat, including the ignition source for wildfires, the introduction of non-native species, displacement of wildlife during crucial life stages (e.g. breeding season for birds) and water quality impacts. Reducing the number of homeless people living in the area and removing encampments from the proposed project area are preconditions to commencing in-channel habitat enhancement for reasons of safety and wildlife protection.

The River is an important recreational and natural resource for people in the community and in the County. Access to the River has been provided at several points through the development of landscaped pocket parks and gated access. However, the high level of human activity in the study area does have a tradeoff for the quality of the habitat and its ability to support wildlife.

Project Opportunity 1. In-Channel Habitat Enhancement with Passive Recruitment

Control invasive vegetation in-channel, including giant reed control, and promote native recruitment (see Figure 5-2). Implementation specifications are provided in Chapter 6.

- Removal of woody non-native shrubs and trees from the river channel, and development of a management strategy to prevent their recolonization.
- Removal of most invasive non-native annuals and herbaceous growth is probably impractical, but highly invasive species (e.g. giant reed, castor bean) with little or no wildlife value and which displace native vegetation must be managed intensively.
- Eradication of giant reed populations, which requires several years of sustained effort and multiple treatments per year.
- During the first few years of giant reed and invasive species control on the channel bars, native plant recruitment should be monitored with walkovers and photo point monitoring to determine if conditions are suitable for desirable native species to colonize.
- If there are areas selected for passive recruitment that are not establishing sufficient native cover to exclude the reintroduction of invasive plant species, then a qualified restoration ecologist should determine if modifications to weed management are necessary or if the site needs to be actively planted and/or seeded, as described in the next project opportunity.

Project Opportunity 2. In-Channel Habitat Enhancement with Active Planting/Seeding

Control invasive vegetation in-channel, including giant reed control, and actively plant/seed native material (see Figure 5-2). Implementation specifications are provided in Chapter 6.

- The dense stands of giant reed are most suitable for active planting and seeding following invasive plant control, as outlined in Project Opportunity 1. The process of implementation of Project Opportunity 2 is the same as 1, except sites that are not expected to passively restore following weed control shall be pre-selected, and budgeted for planting and seeding.
- Plant and seed material should originate from the Los Angeles River Watershed when possible. Commercially grown seed and larger seed source collection areas should be selected by the project ecologist on a case-by-case basis.

5.3. Outside of Channel Habitat Creation and Enhancement Opportunities

The presence of transitional riparian, floodplain and upland habitat adjacent to the River is extremely important to supporting biodiversity in-channel (see Figure 5-2 and Table 5-1). Therefore, the following strategies are recommended outside of the River channel.

Project Opportunity 3. Create River-Adjacent Floodplain Habitat in the State Park Bowtie Parcel & Project Opportunity 4. Create River-Adjacent Floodplain Habitat in the G2 Taylor Yard Parcel

Because both parcels are contiguous and offer the same type of floodplain habitat creation opportunities, Project Opportunities 3 and 4 are discussed together. Implementation specifications are provided in Chapter 6.

- Creation of out-of-channel floodplain habitat with lower stature willow and mulefat scrub vegetation (e.g. mulefat, and also low willows, elderberries, etc.) adjacent to in-channel tall riparian (willow/cottonwood) woodlands. Currently, the configuration of habitats is primarily in-channel willows, flowing river water, and concrete banks, with little low stature riparian growth because of the lack of vertical terracing. Increasing the complexity of habitats in a transect from channel bottom to the uppermost portions of the riverbank would benefit avian diversity.
- Restoration of extensive open upland habitats adjacent to the river channel to mimic native grasslands/prairie and alluvial scrub; even ruderal fields are preferable to the hardscape, which now dominates river-adjacent acreage, although turf (as in athletic fields, golf courses, and typical urban parklands) is not. Species of open habitats (e.g. some raptors, shrikes, meadowlarks, pipits, various sparrows) will clearly benefit from restoration of open upland habitat, but riparian-adjacent open areas also benefit riparian species such as Blue Grosbeak.
- Planting of native grasses and reducing soil compaction are necessary to support native rodents now absent from this portion of the River. This would in turn support native reptile, bird, and mammal species that rely on the rodents as a prey base.
- Planting native vegetation would make the largest difference in insect diversity and populations. Currently, the majority of the site is barren concrete and sparse weeds, except in the adjacent pocket parks and treed areas in the midstream sediment islands. Excellent plants for native insect species are oak, buckwheat, sage, and coyote brush. Avoid planting honey bee-attracting plants like Pride of Madeira, non-native sages, and lavenders.
- Connectivity with upstream flood control basins and nearby areas with larger acreage should be explored. Upstream habitats are less degraded, have more native plants and are home to many native rodent species, which in turn are an important prey base for native carnivores such as the bobcat, gray fox, and the long-tailed weasel. These predatory species tend to be more sensitive to habitat degradation and although they survive in urban edge habitat, are absent from highly urbanized areas where native prey species are absent.
- Water quality needs to be improved to increase the insect fauna of the river itself, currently dominated by midge larvae that are indicative of polluted and/or anoxic conditions. Off-

channel infiltration projects, such as day-lighting the Sycamore Canyon drainage that runs through the Bowtie Parcel in a covered culvert to create a dual purpose stormwater infiltration and ephemeral ponding wetland habitat could (a) improve water quality of urban runoff, (b) reduce in-channel dry weather flows and (c) create off-channel habitat.

- Creation of seasonally flooded wetlands on river-adjacent property would provide breeding habitat for Western Toads and Pacific Chorus Frogs. It is critical that such wetlands are seasonal. In this region, year-round wetlands (e.g., ponds or slow moving streams) support non-native aquatic species, including the invasive American Bullfrog and Red-eared Slider Turtle. Permanent wetlands also provide habitat for non-native fish, including mosquitofish, which negatively impact native frogs. Thus, permanent wetlands should be avoided.
- Paved hardscape and lawns in the historic floodplain offer little, if any, habitat value and should be avoided.
- Creation of upland habitat with varied plantings, from open, sparsely vegetated areas to more densely vegetated areas, would be ideal for all lizards currently inhabiting this area and increase the likelihood that snake species currently found in adjacent park lands (e.g., Griffith Park and Elysian Park) would also inhabit the River corridor.
- Modification to the Bowtie Parcel and adjoining areas including Taylor Yard G2 Parcel and Rio de Los Angeles State Park should recognize that the Side-blotched Lizards in this area are physically isolated from larger populations in adjacent parklands.
- Improve water quality of urban runoff entering the River to improve riverine in-channel habitat, especially given the likelihood of decreased discharge from WRPs in the future due to water conservation measures and decreased water imports into the Los Angeles basin, which currently help to dilute poor water quality from dry weather urban runoff.

Project Opportunity 5. Elysian Park Native Habitat Enhancement

Given the proximity of Elysian Park, and its importance for tree-roosting bats, riparian bird species, large roaming mammals and other wildlife, enhancement of the native habitat in Elysian Park has been identified (see Figure 5-2 and Table 5-1). The Park was planted as a traditional city park a century ago with large trees and turf lawns, which are now aging. Combined with recent drought stress and water conservation measures, the urban forest of the Park is in need of replanting. This creates an opportunity to revitalize the Park for the community and engage them in environmental stewardship by enlisting their help in the enhancement of the natural habitat.

While outside the extent of the original study area, a primary finding lead us to select habitat enhancement in Elysian Park as a key project opportunity:

> *Increasing the amount of aquatic and in-channel riparian habitat that already exists in the 'soft bottom' reach of the Elysian Valley is not as ecologically beneficial as enhancing the complementary adjacent transitional riparian, floodplain scrub and upland vegetation communities in adjacent open space.*

A Master Plan for the Park was finalized in 2006. It includes plans to restore the natural communities within the Park, including locally significant walnut woodland, oak and sycamore woodland and coastal sage scrub habitats. These habitats provide important ecosystem services, including habitat for riparian bird and tree-roosting bat species and habitat for large roaming mammals (e.g. coyote and bobcat) in the Elysian Valley. The Park currently serves as a node of dispersal for mammals that use the River as a wildlife corridor. Habitat enhancement would increase the quality of that connection, and help to conserve the diversity of large mammals in Los Angeles. In addition to these likely outcomes, increases in the amount and diversity of native plants will support increased native rodent and insect populations, which are important food resources for riparian and upland wildlife.

Considerations for development and implementation of this project include:

- Conduct baseline surveys of existing conditions and geospatial analysis in order to develop project-level habitat enhancement plans.
- Develop a Habitat Enhancement Plan for the natural areas in the Park that uses the existing Master Plan as the basis for building support, engaging stakeholders and developing consensus for the project.
- Design an operation and maintenance manual for management of the natural areas that is conducive to City Parks and Recreation.
- Consider fuel management requirements and ignition risks with respect to native vegetation and wildlife in the Park.
- Develop public awareness and an education program about wildlife that shares the Park with the surrounding urban community.
- Design strategic native plantings in consultation with mammal experts to provide screening for mammal movement within the Park and to enhance habitat connectivity with the River, while discouraging use by humans by providing more appealing routes and trail design considerations.
- Create a more drought-tolerant Park for public use.

Project Opportunity 6. Re-Oaking: Urban Tree and Shrub Enhancement

The development of the upper stream terraces and the historic floodplain precludes the restoration of the full extent and function of the natural Los Angeles River floodplain ecosystem; yet, within these urban areas, there are opportunities to improve the ecological function of the landscape. Researchers and landscape architects studying the oak savannas of the Santa Clara Valley in Northern California (Whipple *et al.* 2010) have proposed an effort to restore the density of valley oaks that historically occurred across the landscape by planting them within the urban fabric itself. This restoration of oak density is called "re-oaking" and should not only be consistent with existing land uses, it will probably increase sense of place and connection of the community to its environment. A similar project could be envisioned for the Elysian Valley.

Any of the urban communities that are found on the stream terraces above the extent of the historic floodplain (see Figure 5-2) might be enhanced ecologically by aggressive planting of coast live oaks and California sycamores as street trees, along with native upland shrubs in public right-of-ways, where conditions allow. This would serve the purpose of establishing a riparian alluvial tree cover that might approach historic extent and thereby be used by a range of wildlife species characteristic of oak and sycamore woodlands.

It would provide a stepping-stone for bird species and tree-roosting bats that are found in Elysian Park, Griffith Park and along the channelized Los Angeles River to move between these two areas (see Figure 5-1). Importantly, it could potentially galvanize a greater public understanding of the spatial extent of the river-associated habitats and draw attention to the floodplain and channel as an interrelated system.

Table 5-1 Habitat Enhancement Project Opportunities and expected outcomes under four different Watershed Hydrology Scenarios.

	Watershed Hydrology Scenarios			
In-Channel Result Compared to Historic Condition	**Scenario 1** Existing Condition (1991–Present)	**Scenario 2** Stormwater Capture Focus	**Scenario 3** Effluent Recycling Focus	**Scenario 4** Water Supply & Habitat Resiliency Focus
Stormwater Flow:	Higher Peak Flood	Higher Peak Flood; But, Lower than Existing	Higher Peak Flood	Higher Peak Flood; But, Lower than Existing
Dry Weather Flow:	Higher	Higher	Similar, But Higher Due to Urban Runoff	Similar
Project Opportunities				
In-Channel				
1. In-Channel Habitat Enhancement with Passive Recruitment	5–10 years to control giant reed; passive increases over 3–5 years in quality of existing riparian habitat	Same as Scenario 1, but possibility of cleaner urban runoff inputs leading to higher quality aquatic habitat	3–5 years to control giant reed; passive increases over 3–5 years in quality of existing riparian habitat	Same as Scenario 3, but likely faster giant reed control, & reduced threat of scouring flows during plant establishment period
2. In-Channel Habitat Enhancement with Active Planting/ Seeding	5–10 years to control giant reed; increases in quality of existing riparian habitat in 1–3 years	Same as Scenario 1, but possibility of higher quality aquatic habitat; & reduced risk of scouring flows during plant establishment period from large storm	3–5 years to control giant reed; increases in quality of existing riparian habitat in 1–3 years	Same as Scenario 3, but likely faster giant reed control, & reduced threat of scouring flows during plant establishment period
Outside Channel				
3. Create River-Adjacent Floodplain Habitat in the California State Parks Bowtie Parcel	1–3 years of weed control; over 3–5 years increases in quality of adjacent in-channel riparian habitat and creation of high quality floodplain scrub habitat	Same as Scenario 1, but more funding opportunities for creating ephemeral wetland habitat on-site that also provides stormwater capture	Similar to Scenario 1	Same as Scenario 2, with higher biodiversity supported by higher quality, complementary in-stream habitat
4. Create River-Adjacent Floodplain Habitat in the G2 Taylor Yard Parcel	1–3 years of weed control; over 3–5 years increases in quality of adjacent in-channel riparian habitat and creation of high quality floodplain scrub habitat	Same as Scenario 1, but more funding opportunities for creating ephemeral wetland habitat on-site that also provides stormwater capture	Similar to Scenario 1	Same as Scenario 2, with higher biodiversity supported by higher quality, complementary in-stream habitat
5. Elysian Park Native Habitat Enhancement	Higher quality upper terrace and upland habitat, providing complementary ecosystem services and habitat for riparian wildlife in 3–5 years, & engage local community	Same as Scenario 1, but more funding opportunities related to stormwater capture projects	Same as Scenario 1	Same as Scenario 2
6. Re-Oaking: Urban Tree & Shrub Enhancement	Increase oak woodland canopy for benefit of wildlife, over 1–10 years public engagement	Same as Scenario 1, but more funding opportunities related to stormwater capture projects	Same as Scenario 1	Same as Scenario 2

5.4. Other Ecological Considerations in the Watershed

The identified habitat enhancement opportunities are limited to the Upper Los Angeles River Watershed, and more specifically to the Elysian Valley study area. As part of the stakeholder dialogue around reaching consensus on a Watershed Hydrology Regime for the River, the interaction with the full River watershed ecosystem needs to be studied and addressed. For example, one consequence of lower dry weather flows, which would have positive ecological benefits in the Elysian Valley, would be the possibility of reducing the extent of critical migratory shorebird habitat in the Lower Los Angeles River. See the following Section 5.4.1 for a discussion of this topic.

Other issues to consider include the following:

- Single-family homes with landscaped yards adjacent to the river channel contribute to avian diversity along the River, with many bird species occupying in-channel and residential habitats almost equally. This level of intensity of urban development adjacent to the River is compatible with the goal of maintaining or enhancing biodiversity. A trend toward the development of dense condominiums and multi-use commercial/residential construction adjacent to the river channel bring no positive biodiversity values to the area. Therefore, low density and open space zoning favor the conservation of biodiversity along the River corridor.
- The desirability of attracting native mammal species to the area must be addressed. Increases in coyote populations are already a topic of concern in most areas of Los Angeles. Many native species are reservoirs for zoonosis such as endemic typhus, plague, toxoplasmosis, rabies, hantavirus and arenavirus. Proper pet management (e.g., keeping small pets indoors) will reduce the spread of disease between pets and carnivores, reduce pet predation risk, and reduce human-carnivore conflict. Managing for multiple trophic levels of mammals will result in a balanced ecosystem, which in turn minimizes human-mammal conflict and disease risk, and will result in a more functional ecosystem (Crooks and Soulé 1999). Ideally, the scale of habitat enhancement and restoration planning will include neighboring habitat to accommodate wide-ranging species (e.g. bobcat, coyote and mountain lion) in addition to proactive rodent and carnivore management.
- Efforts to increase biodiversity will be constrained by the amount of property available for revitalization. Any increase in complexity in habitat will increase species diversity attracted to the area, but many species (e.g., solitary and territorial medium-large sized mammals) simply need larger territories.
- The proximity of cats, both feral and house pets, will negatively impact the native species upon which they prey. An ongoing program of cat management will be a necessary component of habitat restoration if the goal is to increase native vertebrate diversity.
- The upstream flood control basins are an important source for potentially colonizing bird populations in the main Los Angeles River channel (if appropriate habitat enhancement is enacted), so habitat values in these basins need to be protected and enhanced in parallel with habitat efforts on the main river channel.
- Connectivity with upstream flood control basins and nearby areas with larger acreage should be explored. Upstream habitats are less degraded, have more native plants and are home to

many native rodent species, which in turn are an important prey base for native carnivores such as the bobcat, gray fox and the long-tailed weasel. The latter species tend to be more sensitive to habitat degradation and although they survive in urban edge habitat, are absent from highly urbanized areas where native prey species are absent.

- Local residents and park managers must avoid the use of anticoagulant rodenticides that kill targeted small mammals and negatively affect predators through bioaccumulation.
- It is worth exploring the placement of structures to encourage colonization by bats. Installation of bat houses in restored areas is one option with important outreach and educational opportunities. In addition to important ecological services provided by bats (e.g., controlling insect populations), they are bioindicators of habitat health.
- Serious consideration should be given to NOT adding irrigation to "restored" land and urban parks along the River corridor, because the ecologically dominant Argentine ant thrives under disturbed and irrigated conditions and persists long after restoration (Longcore 2003). Presence of the native *Pogonomyrmex* ants should be maintained, if possible.
- Fauna-focused citizen science projects are an affordable and effective way to help scientists and land managers monitor faunal communities within and along the River. Platforms such as iNaturalist allow citizen scientists (volunteers) to submit georeferenced photographs and audio recordings. Citizen scientists become engaged with local River biodiversity and the scientific process as well as monitoring the impacts of restoration on wildlife along different reaches of the River.

5.4.1. Lower Los Angeles River Migratory Shorebird Habitat

Any habitat planning and other management options for the Los Angeles River need to consider the importance of the lower Los Angeles River channel (from downtown Los Angeles to the River's estuary south of Willow Street in Long Beach) for migratory shorebirds and the potential impacts of habitat and water management on the lower River habitats that sustain these migratory birds (see Figure 5-3). The regional importance of this habitat for migratory shorebirds has been detailed by Garrett (1993) and Cooper (2006).

Where the concrete-bottomed Los Angeles River channel broadens south of downtown Los Angeles, dry weather flows are often restricted to the central "low flow channel," but locally and seasonally expand beyond the low flow channel to cover some or all of the river bottom as a shallow "sheet flow." Particularly south of the 105 Freeway in the Paramount/Compton area, this sheet flow forms a reliable foraging habitat for migratory shorebirds all the way downstream to deep, tidal influenced waters south of Willow Street in Long Beach.

Counts of over 10,000 individual shorebirds in a single day are routine during peak southbound migration from early July through late September. Spring (northbound) shorebird migration generally involves much smaller numbers of individuals because of increased flow in the river channel after winter and spring storms; the numbers of overwintering (e.g., October to February) shorebirds in the lower Los Angeles River channel varies greatly from year to year with flow volume, which is in turn related to rainfall events. Only in very dry winters are significant numbers of wintering shorebirds found here.

Fine sediment and algae form important shorebird foraging substrate on the lower Los Angeles River, with a rich invertebrate prey base. See Uyehara (2013) for a study of substrate, invertebrate fauna, and shorebird foraging in the Willow Street section of the lower River. Importantly, this habitat serves as "*de facto*" replacement for extensive estuarine wetlands at the mouths of the Los Angeles and San Gabriel Rivers that were completely lost with the construction of the ports of Los Angeles and Long Beach. Small, short-legged shorebirds such as the Western Sandpiper (*Calidris mauri*) forage mainly in very shallow (generally <1 cm) water; longer legged shorebirds such as American Avocet (*Recurvirostra americana*) and Black-necked Stilt (*Himantopus mexicanus*) may forage in water as deep as 10–15 cm, and a suite of shorebird species use waters of intermediate depth, as well as mud, bare dirt, and algae substrates. Because the vast majority of shorebirds forage on wet mud substrates or in shallow water no more than a few centimeters deep, significant increases or decreases in water flow could greatly impact shorebird use of the River. Specifically, flows across the entire channel bottom in excess of 10–15 cm would preclude foraging by most shorebirds, and reduction in flow resulting in dry, bare concrete or sediment on the river bottom would also be inhospitable to most foraging shorebirds. Thus, ideal shorebird habitat occurs within a relatively fine range of variation of flow volume, one that has existed somewhat serendipitously over the past few decades during peak southbound shorebird migration.

Most future scenarios point to a reduction in dry weather river flow as water conservation and reclamation and reuse of treated water become more routine. River managers should consider options for maintaining enough flow in the lower Los Angeles River to ensure the extensive sheet flows that provide foraging substrate for migrant shorebirds. Should flows diminish to the point where only the central low-flow channel carries water, engineering modifications that maximize sheet flow (such as installing regularly-spaced blockages in the low-flow channel) should be investigated. Alternatively, outside of the channel, appropriate migratory shorebird habitat could be created or restored to maintain this critical resource under a lower dry weather flow regime.

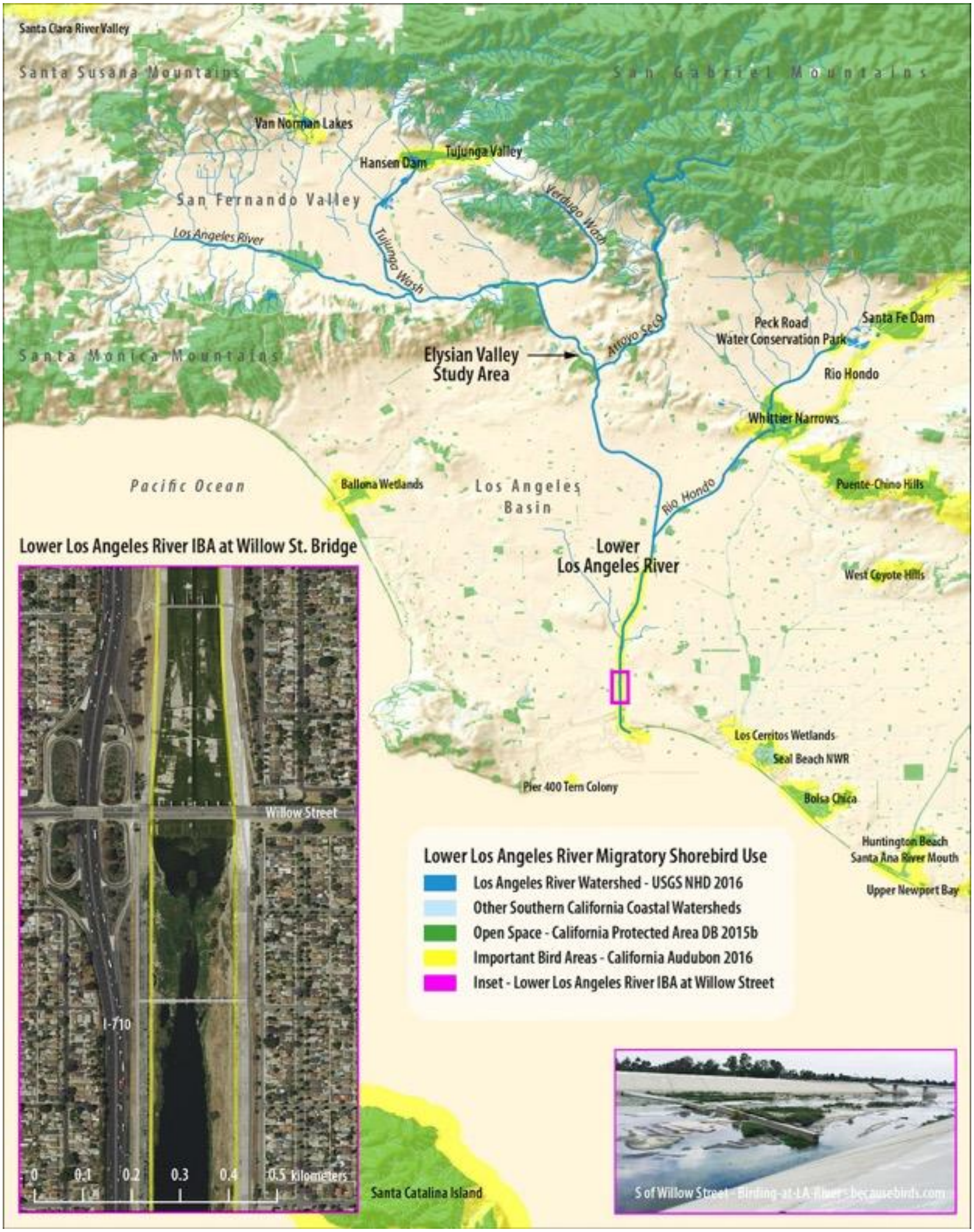

Figure 5-3 Lower Los Angeles River Migratory Shorebird Use.

5.5. References

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Chapter 6. Habitat Enhancement Specifications

This Chapter presents specifications for enhancement of in-channel riparian habitat (Project Opportunities 1 and 2, Section 5.2) and river-adjacent floodplain habitat (Project Opportunities 3 and 4). It includes specifications for site preparation focused on control of invasive species and management of non-native populations (especially non-native annual grasses), followed by active planting and seeding, as needed.

These goals can be accomplished through an adaptive management approach that utilizes a continuum of treatments, which will require active removal of invasive plants followed by either passive or active recruitment of native species. Phasing these treatments across the project area will minimize impacts to wildlife already using available habitat, allow for efficient use of funding, and make it easier to adjust the timing of treatments if and when site conditions change (e.g. in response to drought or wildfire).

The geospatial database (see Appendices F and G) of substrate, vegetation community type and dominant non-native and native species can be used in determining how to phase implementation of in-channel and adjacent upper terrace habitat enhancement projects. Project opportunities identified outside of the initial study area (Figure 1-2), such as Elysian Park Native Habitat Enhancement (see Figure 5-2), will require additional baseline surveys of existing conditions and geospatial analysis in order to develop project-level habitat enhancement plans.

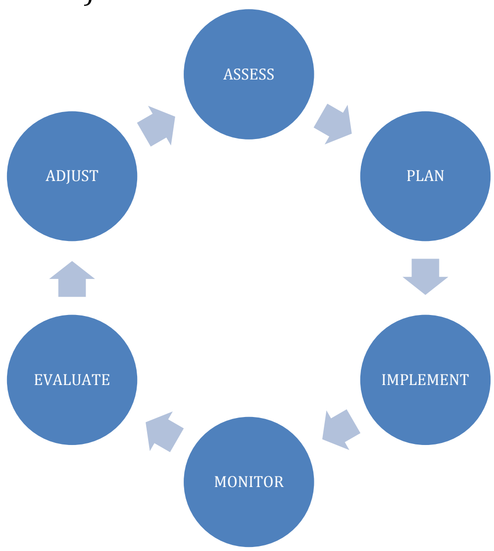
The following habitat enhancement strategies are based on review, analysis and interpretation of the historic and existing conditions in the study area, which were presented in the previous chapters.

6.1. Adaptive Management Approach

Habitat enhancement actions and habitat creation should be implemented with an adaptive management approach, which will allow the level of effort in planting native species to be adjusted according to observations and analysis of site conditions, including the abundance and diversity of native species that recruit to the site during site preparation (e.g. It may take 5-10 years to eliminate targeted giant reed infestations in the project area).

6.1.1. Adaptive Management Framework

An overview of the framework for the "Adaptive Management" approach is presented in the following six-step process (ERI 2009).



Enhancing and creating native habitat is an inherently complex activity and adaptive management provides a framework that allows for adjustments in management activities in response to the feedback provided by regular monitoring. Many variables can influence the success of a native habitat project, including weather conditions, fire events, high-rainfall and river flow events, the distribution and composition of non-native species populations (including the seedbank) and adjacent land management activities. Monitoring is a key component of adaptive management and is necessary for tracking changes to a restoration project over time. Prior knowledge and experience coupled with new research can guide adjustments to management actions while still meeting project objectives and the broader goals of improving riparian, floodplain and upland habitat along the Los Angeles River.

6.1.2. Adjusting the Level of Enhancement Effort

The level of habitat enhancement effort necessary is directly related to conditions that will be conducive for successful natural recruitment during and following giant reed control. Experience informs these recommendations, but an adaptive management approach is prudent given the potential for changes in the dry weather flow regime of the River within the project area that may affect giant reed control. Stochastic events, such as fires from homeless encampments, may also occur within the project area while habitat enhancement efforts are underway.

It will be necessary to continue actions to control targeted non-native species for several years, particularly for giant reed. This may allow natural regeneration of native vegetation to occur from seed sources and propagules within and upstream of the project area while control efforts are underway. Early colonizing natives such as ragweed, followed by shrub species such as mulefat, will begin to fill in areas cleared of the invasive plants. The successional development of the vegetation community will continue with the suppression of giant reed and other high priority non-natives.

6.2. In-Channel Habitat Enhancement

The following are specific methods proposed for the control of giant reed. All methods of giant reed control will take five to ten years depending on the specific hydrology of control areas, with control taking longer in wetter areas. Timing of the initial control and treating re-sprouts is critical. Existing conditions of the in-stream project area include year-round flow in the River, the presence of wildlife and human (homeless) populations.

Giant reed will be a main focus of initial project implementation. Giant reed is detrimental to the habitat of the Los Angeles River for a variety of reasons:

a) Giant reed can reduce channel flood capacity due to its dense structure

b) Giant reed is generally not utilized as habitat by native wildlife species

c) Giant reed has the ability to carry fire into riparian vegetation and increase the intensity of fire, due to the structure and flammability of the standing fuel, from both live and dead plant stalks

The presence of giant reed in the channel will exacerbate the negative effects of fire in the riparian zone and promote the establishment and persistence of additional giant reed populations. Ambrose and Rundel (2007) named this phenomenon the giant reed-fire regime.

Several other invasive plant species should be controlled in the River to enhance the habitat. While a wide variety of non-native plants occur in the project area, control of the species given a "high" threat ranking by Cal-IPC should be prioritized. As giant reed is reduced and then eliminated from the project area, it is anticipated that several other invasive plant species may increase in abundance and need to be controlled to prevent them from dominating the project area before native species can reestablish. Table 6-1 summarizes the invasive species targeted for control within the channel.

Table 6-1 Invasive species to be controlled for in-channel habitat enhancement projects.

Scientific Name	Common Name	Cal-IPC Rank	Prevalence
Alianthus altissima	Tree of Heaven	High	Rare in upper terraces
Arundo donax	Giant reed	High	Locally dominant on channel bars
Conium maculatum	Poison-hemlock	Medium	Locally common on channel bars
Nicotiana glauca	Tree tobacco	Medium	Rare in upper terraces
Stipa miliaceum	Smilograss	Limited	Present on channel bars
Ricinus communis	Castor bean	Limited	Common on channel bars
Washingtonia robusta	Mexican fan palm	Limited	Common on channel bars & adjacent upland areas

Less invasive non-natives are also common in the project area, including many annual grasses of Mediterranean origin. Unfortunately, effective methods for controlling these annual grasses over the long term are not available. Consequently, management of the project area should focus on restoring the variety and abundance of native plants that will provide the most ecological value for riparian habitat.

Long-term, consistent vegetation monitoring can establish whether intervention is required to establish healthy native vegetation communities, and is part of the adaptive management approach.

6.2.1. Giant Reed Removal Methods

Habitat Enhancement in Areas with Greater Than 25% Cover of Giant Reed

SPRAYING

It is difficult to control dense areas of giant reed without first cutting and removing the canes, which allow for efficient herbicide application once regrowth of the canes reaches a height of 12–18 inches. Re-spraying of subsequent giant reed growth may then proceed several times during the first season, depending on the presence of wildlife within the riparian zone.

Neill (unpublished data 2015) discusses treating giant reed with the herbicide Imazapyr immediately after the last flood flow when this species is laying over and is easier to reach. While this will work for an initial treatment, the year-round river flow may allow giant reed to recover and grow anew. Therefore, it is recommended to treat targeted giant reed (*Arundo*) patches at least three times each year, for several years to ensure that all of the Arundo plants and their roots are killed. Furthermore, Imazapyr should only be used in areas of dense giant reed where there are no nearby native species such as willows (*Salix* spp.) because Imazapyr is known to translocate in sandy/silty soil and affect adjacent species. Imazapyr can function as a pre-emergent herbicide if applied to the soil and could interfere with natural recruitment of native species. However, this method was previously used where more traditional methods of mulching in place or cut/remove methods are not recommended for either practicality or cost efficiency.

In areas where dense giant reed is growing with willow species, it is recommended to use the herbicide glyphosate. Although care must be taken to avoid other species, this herbicide generally will not act as a pre-emergent nor translocate in the soil.

CUTTING AND SPRAYING

This method of giant reed control is recommended for dense patches that are accessible with cutting equipment. The cutting can be with either hand held tools, such as a chainsaw or machete, or a small mechanical backhoe with a cutter attachment. The stems are cut to a manageable size varying from one to several feet in height. The cut material generally can be mulched and left on site; however, within the Los Angeles River channel, this method may not be feasible due to the high flows through the area that would carry much of the material downstream. Alternatively, the cut material can be removed from the site. After the Arundo canes have been cut, it is recommended to spray the giant reed again after they have re-sprouted and grown two to three feet high. The period between re-treatments will depend on the season, temperatures and the hydrology of specific areas. Where groundwater or surface water is abundant, complete elimination of Arundo can take five to ten years using glyphosate herbicide, and could be less using Imazapyr.

This method is expensive and difficult, but it is recommended to avoid excess plant material being flushed from the site during flood flows. It will be particularly important to treat new canes that reach two to three feet in height during late summer and autumn (August – November), when Arundo translocates energy (photosynthates) to their rootstocks (TNC 1996).

Two herbicides are recommended in areas of dense giant reed; Glyphosate (aquatic formulation) and Isopropylamine salt of Imazapyr. Both herbicides are broad-spectrum herbicides and must be used cautiously when near native vegetation. The Imazapyr herbicide can translocate in soil and care must be taken to limit application amounts per the label; it is advisable not to use near native trees.

PASSIVE ENHANCEMENT/NATURAL RECRUITMENT

In-stream zones where inundation events are predicted at one to two year return intervals, native species will likely colonize areas cleared of giant reed on their own. Qualitatively monitoring the natural recruitment and establishment of native species and of other non-native species is highly recommended, especially following inundation events.

Results of this monitoring can be used to determine whether control of other non-native species may be required and whether active restoration of native plants will be necessary. Control of less invasive non-native plants is usually not required if adequate recruitment of natives is observed. If it is necessary to control non-native species, methods would include weeding by hand, targeted weed whipping, or herbicide applications.

If no natural recruitment is observed within the two years of the start of giant reed control, then active planting and seeding may be required, as described in subsequent sections.

Habitat Enhancement in Areas with Less Than 25% Cover of Giant Reed

On channel bars where giant reed is mixed with native species and is less dense, giant reed can be sprayed in place. In these areas, native species recruitment is more likely.

SPRAY IN PLACE

In areas with small patches of giant reed, treatment can be with foliar application of herbicide and the treated material left in place. Repeat herbicide applications of Arundo resprouts will be necessary. This method is recommended for small, isolated Arundo patches where the removal of cut biomass is not feasible or desirable due to the potential for damaging existing native vegetation. Also, small giant reed patches are easier to relocate for re-treatment if the standing biomass is left intact.

6.2.2. Seeding and Planting

Seeding may be necessary in areas where native species would not readily or easily regenerate following elimination of invasive plants, and particularly in areas cleared of dense stands of giant reed. Planting container plants or cuttings in the most highly disturbed areas that are presently dominated by dense stands of giant reed is recommended. The species of the cutting/container plants would include early successional species along with more common species of the desired habitat.

It is recommended to control non-native species for at least two years before determining if seeding and/or planting is necessary. Optimally, non-native species should be controlled for multiple years prior to seeding and/or planting; however, the time frame for each project will be dictated by monitoring for adaptive management and budgets. Seeding and/or planting is recommended if native species recruitment fails to occur or is proceeding slowly in areas cleared of non-native species.

Direct seeding to enhance the in-stream areas is not recommended as a first step given the wet season flows within the channel. Instead, it is recommended to plant native perennial grasses that develop from rhizomes and runners, as they tend to establish quickly and hold soil and other plants in place. See Table 6-2 for the conceptual plant palette for in-stream habitat enhancement, to be adjusted based on monitoring as part of adaptive management of the project.

Maintenance would include follow-up control of non-native species for approximately four to five years following installation of planting material. Areas planted with native species might require supplemental water to promote root development down to groundwater levels. This could be supplied by temporary systems. Supplemental irrigation is recommended for one to two seasons at most for in-stream project areas.

Table 6-2 Conceptual plant palette for in-stream habitat enhancement.

Scientific Name	Common Name	Container Size
Artemisia douglasiana	Mugwort	*D-40*
Amorpha fructosa	False indigo bush	1-gal
Baccharis salicifolia	Mulefat	cutting
Juncus acutus	Spiny rush	D-40
Leymus triticoides	Creeping wild rye	liners
Rosa californica	California rose	D-40
Rubus ursinus	California blackberry	1-gal
Salix gooddingii	Black willow	cutting
Salix laevigata	Red willow	cutting
Salix lasiolepis	Arroyo willow	cutting
Salix lucida lasiandra	Shining willow	cutting
Vitus girdiana	Wild grape	1-gal

Planting Notes for Table 6-2: Plant spacing would be determined based on monitoring and natural recruitment within the giant reed control areas. Generally, willow species would be planted 20' from other willows. Amorpha — scattered with mulefat, Blackberry, California Rose, and Wild Grape — 20' from each other. Creeping Wildrye and Mugwort planted 5–10' on-center throughout as understory.

6.3. Creating Adjacent Floodplain Scrub Habitat

Creating and establishing floodplain scrub habitat on suitable parcels adjacent to the River is recommended. Site preparation will be required prior to installation of plant material. Site preparation will be especially important in the Bowtie and Taylor Yard G2 Parcels because significant weed seedbank have likely developed on them. Site preparation activities may last one or three years, depending on monitoring and adaptive management recommendations. Methods of site preparation will include the following, as necessary:

- Mechanical cutting for annual grasses and broadleaf weeds
- Raking/windrowing for removal of weed material
- 'Grow and Kill' method
- Hand pulling of seedlings and saplings where feasible
- Specific herbicide application for target weeds such as fountain grass (*Pennisetum* sp.)

Regular monitoring for invasive plants will be necessary to guide scheduling and the selection of control methods based on the phenology of each target weed species. Areas should be evaluated after each weeding event to assess the progress of site preparation and to plan next steps. Areas may be released for seeding and planting when monitoring data indicate that sufficient progress has been made in invasive plant control and reduction of their seedbanks.

6.3.1. Weed Management

River-adjacent floodplain areas within the project area are presently dominated by non-native species. Weed management methods have been cross-referenced using the Calweed Database of the California Interagency Noxious Weed Coordinating Committee and Invasive Plants of California Wildlands (Bossard et al. 2000).

It is recommended to treat invasive plants in these areas before they produce seed in order to limit additional contributions to the existing seed bank. Treatment methods will depend on the target species, the density of the target species, the area of infestation, and the ecological sensitivity of the existing habitat. They include hand pulling as well as mechanical methods, such as mowing and weed whipping. Mechanical raking and windrowing may be used to remove the dense layers of annual grass material present. Limited use of selected herbicides may be advisable when no effective alternative to remove and control the high priority invasive species is available. Herbicide treatment is specified primarily for perennial or biannual species that may re-sprout from taproots or stumps, such as tamarisk or fountain grass.

CHEMICAL CONTROL METHODS

Limited use of selected herbicides is specified when no other effective alternative is feasible to remove and control the high priority invasive non-native species. For efficient control of weed species, they must be treated before they produce viable seed. Most herbicides are not selective for invasive species only. Therefore, herbicides must be applied with the least harmful effect to non-target native species.

Only herbicides registered for use in wildlands should be used judiciously within the restoration areas. Herbicides that are registered for use in California for natural areas are recommended for particular weed species at specific rates noted on the labels. Recommended herbicides registered for use in California are glyphosate, a non-specific herbicide registered for use on almost all weed species, and fluazifop-p-butyl to control grasses. The following types of applications are recommended for each herbicide.

- Fluazifop-p-butyl (e.g. Fusilade®) will be specified for foliar applications at application rates recommended on the label.
- Glyphosate (e.g. Round-up®) concentrations shall be used according to the type of application required as per the product label for foliar spray application.

The herbicide applicator must have a pest control business license, which requires that at least one individual employed by the business be in possession of a qualified applicator's license. All licenses must be issued by the State of California and be currently registered in Los Angeles County. If a qualified applicator is not present during the herbicide treatment, all applicators must have undergone documented herbicide application training. Personnel must wear all protective clothing required by law and follow all label directions and precautions. All re-entry times specified on an herbicide label shall be observed and posted. Herbicide preparation shall be allowed only in approved staging areas more than 100 feet from a stream course or body of water.

A brightly colored dye is recommended in all herbicide applications to aid the applicator in achieving good coverage of the target species. The material shall be a non-toxic material such as Blazon®, Turf Mark® or the equivalent. The dye shall be mixed with the herbicide at no more than half the rate specified on the label.

Herbicide treatment shall be conducted only when weather conditions are conducive to effective uptake of the herbicide by the target species (e.g. sunny, dry with ambient temperatures around 65°F) and when plants are at the specified growth stage. Wind conditions should be five mph or less to minimize herbicide drift. Treated plants shall not be disturbed until the applied herbicide has had time to take effect per the manufacturer's instruction.

PHYSICAL CONTROL METHODS

Physical methods of weed control recommended during site preparation include weed whipping/mowing, mechanical raking, and hand-pulling. Pulling can be accomplished by hand or with tools to treat isolated individuals of non-native species.

Mowing/Weed Whipping. Repeated mowing or weed whipping treatments prior to seeding is generally the most efficient and least disruptive site preparation method to use in areas dominated by invasive annual grasses and mustards. Mowing machines can be used on gentler terrain and hand-operated mowers can be used on steeper terrain. Weed whipping can be accomplished with a gas operated weed whip fitted with a brush blade, or similar implement. Hand operated mowers and weed whips should be used in areas with high densities of native plants. Fire prevention measures must be taken to avoid accidental fires from sparks during machinery operation. These measures include a water truck on site near the mowing operation at all times and shovels carried on the mower and water truck.

Raking and removal of the weed biomass after mowing or weed whipping is not necessary after each control event unless the weed species has set seed, or if a significant thatch has developed that will not physically decompose during the summer season. Removal of the controlled weed material is recommended prior to seeding to ensure good seed to soil contact.

Hand/Mechanical Pulling. Isolated individuals of select invasive species, such as tamarisk, can be pulled by hand or with a tool such as the Weed Wrench™. Pulling is one of the least disruptive methods of site preparation, but is not as efficient in dense stands of invasive plants. The hand-pulling should be reserved for controlling isolated individuals in areas that are not accessible by equipment, or when high densities of native species are present. When pulling, as much of the root as possible should be removed, especially for invasive plants with long tap roots such as mustard.

6.3.2. Soil Amendments

Several soil amendments have been shown to be important tools in native habitat creation or restoration. Most of these amendments facilitate restoration of the soil ecosystem. The following outlines the potential use of soil amendments for restoration within the restoration areas.

Arbuscular Mycorrhizal (AM) Fungi

If soils sampling indicates deficiencies in essential plant nutrients, such as phosphorous, then application of Arbuscular Mycorrhizal (AM) fungi to the restoration sites during seeding may be advisable. Commercially available *Glomus intraradices* is recommended since this is a ubiquitous species and will not impede the development of other native species. In this project area it is recommended to apply AM fungi at a rate of 60 liters per acre (approximately 3,500,000 live propagules per acre) based on the guarantee of the supplier. It is also recommended to work with and obtain AM fungi for the project only from a person or company with experience in AM fungi development.

Fertilizer

General fertilization is not recommended for the restoration areas since lower nutrient soils may favor the establishment of native seedlings over weedy non-native species. However, soil tests should be conducted prior to seeding and planting to determine if the native plants would benefit from an organic, slow release fertilizer.

6.3.3. Seeding and Planting

Ecologically appropriate plant species have been selected for restoration of the floodplain scrub habitat. Plant palettes were developed generally from observations of this habitat type in the region. As noted by Bowler (1993), species lists that are based on local intact habitat fragments and nearby undisturbed habitats are essential to a restoration project. Additional regional native species have been included to aid initial soil development and soil stabilization. A combination of native species has been specified with both above- and below-ground structural diversity to achieve the desired habitat condition. Understory species such as perennial grasses and ground covers that have dense root systems and hold surface soils are included. Shrub species that have deeper, branching roots provide additional soil stability, and form the mature mid-canopy of the mature habitat are also included. The combination of species in the plant palettes will provide long-term soil stabilization, reduce the risk of erosion and promote the development of soil crusts, where appropriate in the more compact soils of the upper terrace. The above ground diversity of plant structure and height will provide a range of habitats for wildlife.

Native plant seed, container plants, and transplanted materials will be used in the restoration process. The use of seed material provides the basis for the ecological succession model and provides vegetative erosion control over the site early in the process of establishment. The container plants to be used in the plant palettes consist of the larger shrub species that may be harder to establish by seed.

The species selected for the habitat creation represent the more common and abundant species observed in the existing floodplain habitat upstream of the project area. Some less common species are included. Additional species are included in the seed mix as a nurse crop and for erosion control until the shrub species establish. See Table 6-3 for the conceptual seed mix for floodplain scrub enhancement, to be adjusted based on site conditions observed during adaptive management of the project. Similarly, the plant palette (Table 6-4) will be adjusted based on site conditions during site preparation.

Table 6-3 Conceptual floodplain scrub seed mix.

Scientific Name	Common Name	Pounds of Pure Live Seed per Acre[1]
Acmispon americanus	American lotus	1.2
Acmispon glaber	deerweed	3.2
Aristida purpurea	three-awn grass	2.0
Artemisia californica	California sagebrush	0.2
Brickellia californica	Bricklebush	0.1
Deinandra fasciculata	fascicled tarweed	1.5
Encelia californica	bush sunflower	0.7
Eriogonum fasciculatum	California buckwheat	0.3
Festuca microstachys	small fescue	5.0
Isocoma menziesii	coast goldenbush	2.0
Lasthenia californica	goldfields	0.5
Phacelia cicutaria	caterpillar phacelia	0.3
Salvia apiana	white sage	0.2
Stipa lepida	foothill needlegrass	1.1

[1] *Seed test for purity/germination must be reviewed for each species and the bulk rate of seed applied will be adjusted accordingly to meet the range of desired pure live seed (PLS) per acre.*

Table 6-4 Conceptual floodplain scrub container plant palette.

Scientific Name	Common Name	Container Size	Container Plant Spacing[1]	Plants per Acre[2, 3]
Juncus acutus	spiny rush	D-40	6’	100
Opuntia littoralis	coast prickly pear	pads	5’	60
Malosma laurina	Laurel sumac	D-40	40’	10
Rhus integrifolia	lemonade berry	D-40	40’	20
Sambucus nigra spp. caerulea	blue elderberry	D-40	40’	20

[1] *Spacing = feet on-center distance from other cactus within planting groups for cactus pads. Elderberry, laurel sumac and lemonade berry individuals will be planted at least 40’ from cactus groupings and from each other.*
[2] *Cactus pads will be planted in groups to develop as cactus patches.*
[3] *Group spiny rush based on micro-topography of the site.*

To the extent possible, all plant material for the restoration shall be obtained from native plant communities growing within the watershed of the Los Angeles River. For those species that function as erosion control or do not exist in large enough quantities within the specified seed collection area, it may be necessary to use seed that is commercially grown or to extend the collection area beyond the Los Angeles River watershed on a species-by-species basis.

The required container plants shall be contract grown by a nursery that has experience in growing native plants using propagules collected from approved sites. Specified AM fungi shall be used to inoculate the roots of the container plant at the appropriate growing stage in the nursery.

The plant species shall be delivered for planting in a healthy growing condition, with roots filling the container but showing no tendency toward being root-bound. Plant material will be inspected at the nursery at least twice, once early in the process to ensure that adequate material has been propagated, and a second inspection scheduled for three weeks prior to plant delivery. Plants will be inspected again at the time of delivery, and any plant that does not meet the defined specifications will be rejected. The project ecologist and the restoration contractor shall conduct plant inspections.

Seeds shall be collected in the years (one to three) prior to planting during site preparation, including invasive plant control and weed management. Collected seeds should be dried and stored in airtight containers in a cool, low humidity environment until installation begins. Seed application will be timed with the start of the winter rains in late fall/early winter to germinate the seed mix soon after installation and to take advantage of the entire winter rain season. Contract growing of the container plants will be in the year of installation. Installation of container plants will be in the late fall/early winter prior to seed application.

Seeding Method

. A two-step hydroseeding technique shall be used to apply specified seed mix to the restoration areas. Hydroseeding will consist of a hydraulic application of a slurry mixture containing water, cellulose wood fiber, seed, AM fungi, and organic soil stabilizer, applied in two steps that shall be applied in the same day, as follows:

Step One:

- 500 pounds (lbs)/acre of virgin cellulose wood fiber.
- 60 liters/acre of AM fungi (commercial variety *Glomus intraradices*).
- Specified seed mix/acre for each area.
- Once the seed and other materials are added to the mixing tank, application must be made within one hour so that seed, fertilizer, and AM Fungi are not damaged.

Step Two:

- 1,500 lbs/acre of virgin wood cellulose wood fiber.
- 160 lbs/acre of organic soil stabilizer (Ecology Control or comparable product).
- Step two must be applied the same day as step one over each area.

Planting

Container plants will consist of laurel sumac, lemonade berry, blue elderberry, spiny rush, and coast prickly pear pads. The spacing of all planted material within the planting groups and between groups or individuals will follow the specifications presented in Table 6-4. The layout for container plants will be determined for each area based on micro-topographic features. Planting sites will be marked on the site using different colored pin flags under the supervision of a restoration ecologist.

The prickly pear pads shall be collected at least two weeks prior to installation to allow a hardened callous to develop at the cut end. Installation of the prickly pear pads will consist of burying the pad deep enough to cover any root that may have developed and approximately one inch of the pad to avoid rotting.

All container plants and salvaged cactus material are to be planted to the following specifications:

- Planting holes shall be made with the minimum disturbance to accommodate the root ball.
- Prior to planting, the planting hole shall be filled with water and allowed to drain.
- Plants shall be set in the planting hole so that the crown of the root ball is approximately 0.25 inch above finish grade. Under no circumstance should the plant crown be buried.
- A watering basin shall be provided around each plant from 18–24 inches in diameter for container plants and 36–48 inches for large salvaged cactus.
- Watering basins shall be filled with water after planting, at least twice.

6.4. References

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