SEPTEMBER 2021

Restoration Planning at the Cienega Springs Ecological Reserve: Final 100% Design and Technical Report

PREPARED FOR

California Department of Fish & Wildlife
3883 Ruffin Road
San Diego, CA 92123

PREPARED BY

Stillwater Sciences
2855 Telegraph Ave., Suite 400
Berkeley, CA 94705
with
University of California Santa Barbara
Santa Barbara, CA 93106
and
Santa Clara River Conservancy
P.O. Box 789
Santa Paula, CA 93061

Stillwater Sciences

Suggested citation:
Stillwater Sciences, University California Santa Barbara, and Santa Clara River Conservancy 2021. Restoration Planning at the Cienega Springs Ecological Reserve: Final 100% Design and Technical Report. Prepared by Stillwater Sciences, Berkeley, California; University of California Santa Barbara, California; and Santa Clara River Conservancy, Santa Paula, California for California Department of Fish and Wildlife, San Diego, California.

Cover photo: Looking across remnant watercress beds towards the mountains of Los Padres National Forest.

Table of Contents

Tables

Figures

Appendices

ABBREVIATIONS AND ACRONYMS

Acronym	Definition
1D	one-dimensional
2D	two-dimensional
ac	acres
BMPs	best management practices
CDFW	California Department of Fish and Wildlife
CSER	Cienega Springs Ecological Reserve
cfs	cubic feet per second
cy	cubic yards
EC	existing conditions
FDP	Floodplain Development Permit
FEMA	Federal Emergency Management Agency
ft	feet
h:v	horizontal:vertical
Hwy	Highway
LiDAR	Light Detection and Ranging
LF	linear feet
NFIP	National Flood Insurance Program
NOI	Notice of Intent
NP	404 Nationwide Permit
OHWM	ordinary high-water marks
PC	proposed conditions
Rd	Road
SWMP	Stormwater Management Plan
TOC	Table of Contents
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geologic Survey
yr	year

EXECUTIVE SUMMARY

This Final 100% Design and Technical Report for the Restoration of Sespe Cienega describes the application of scientific knowledge and engineering tools to the restoration of Cienega Springs Ecological Reserve (CSER). These designs are the result of collaboration between the California Department of Fish and Wildlife (CDFW, the property owner), Stillwater Sciences, Santa Clara River Conservancy, and the University of California Santa Barbara. Section 1 of this report details the site history and need for restoration. Section 2 discusses the ecosystem status, values and functions of the site in terms of its physical properties, biological communities, and the past and ongoing human interaction with the site. Of critical importance to the restoration plan is the hydrogeomorphic influence of the Santa Clara River on the site, which includes not only inundation by floodwaters but also the full reworking of land within the active floodplain by channel erosion and deposition. The vision for re-establishing native riparian and aquatic habitat is defined in Section 3, including project goals and objectives. These goals acknowledge the future activity of the river in both constraining and supporting restoration activities; retaining high-functioning portions of the site; establishing a diverse and self-sustaining ecosystem of native vegetation communities and habitats adequate to support sustainable populations of special-status fauna; and providing a visitor experience that allows public access in a manner compatible with the protection of restored ecosystems and compatible with CDFW's ecological reserve status designations. In Section 4, the key design considerations are outlined, particularly the natural flow regime of the Santa Clara River and locally introduced flows from Piru Creek and the adjacent fish hatchery, the selective application of both active and passive vegetation strategies, and the support for public access. The final designs discussed in Section 5 describe the final integration of these various goals with the opportunities and constraints provided by the site, encompassing changes to surface flows and site grading, planting plan and weed management, and the proposed trail network. The future development of a public access and education plan is discussed in Section 6. The final 100% design planset and opinion of probable cost are provided as Section 7 and 8, while Section 9 briefly summarizes plans for permitting. The success of the restoration project depends on successful design advancement and implementation of the following features, Section 10, which are beyond the scope of this phase of restoration design:

1. Settling pond and effluent channel design: This work is critical to implement the restoration as currently designed as it will reroute hatchery effluent flows through Units 5, 6, 9, 10, and 13. Concurrent with this design (to be completed under separate contract), grading adjustments to balance material on site must be made, and the restoration design may be adjusted accordingly.
2. Hydraulic design: Additional survey and design work is needed to verify and finalize design of the proposed culverts on site before construction begins. There is also a potential need for hydraulic control structures to help control surface flows in a future design effort.
3. Public access infrastructure: Details of public access infrastructure including parking areas, trail surfacing and ADA accessibility, signage, fencing, restroom/leach field, and wildlife viewing areas should be advanced in partnership with CDFW in future design phases.
4. Plant propagation facility: a plant propagation facility is proposed to provide plant materials for the restoration project.

1 INTRODUCTION

This report provides the Basis of Design for the Final100% design plans for restoration of the CSER, located on CDFW property alongside the Santa Clara River in Ventura County, California. The CSER occupies an area known informally as Sespe Cienega, an area of historically persistent wetland riparian vegetation in the lower Santa Clara River (Beller et al., 2011, 2015) just upstream of the confluence of Sespe Creek with the Santa Clara River. Within the context of CDFW's ecological reserve program, there is the desire to restore and sustain a functional community of native riparian and aquatic habitats that mimic, if not fully re-create, the rare wetlands that were historically present. This report serves to lay out an understanding of the key factors affecting restoration and enhancement opportunities at the site, to establish the restoration approach through a series of goals and objectives for the project articulated by the design team and various stakeholders, to outline the design elements of assessment and evaluation that form the basis of the design, and to provide a conceptual design plan and the Final100% design planset. These Final 100% design plans have been developed by Stillwater Sciences in conjunction with the Santa Clara River Conservancy (SCRC) and the University of California Santa Barbara (UCSB), following discussion with representatives from CDFW.

During project development, stakeholders constituting a Technical Advisory Committee (TAC) helped review technical analyses and conceptual designs and assisted in the guidance of design iterations. TAC members for this project include representatives from non-profits, academic institutions, and government agencies working to conserve and restore the Santa Clara River.

1.1 Project Location

Located on the Santa Clara River within the middle Santa Clara River watershed in southern California, the CSER property covers approximately 283 acres directly upstream of the town of Fillmore (location in Figure 1-1). The Santa Clara River headwaters are in the mountainous areas of the Angeles and Los Padres National Forests and the river ultimately empties into the Pacific Ocean just south of Ventura. It is historically a perennial river with intermittent stretches where water flows through the sub-surface. The sandy substrate of the channel is prone to shifting, forming a braided channel system within a larger floodplain. The river typically experiences only a few punctuated high flow events that transport a significant amount of sediment. On average, more than half the annual flow in the Santa Clara Rivers occurs over the course of just three to six days (Stillwater Sciences 2007a).

The CSER project area is composed of CDFW-owned parcels adjacent to the Fillmore fish hatchery and The Nature Conservancy's Heritage Valley Parks Santa Clara River Parkway parcel (also referred to as TNC's Shiells/Sommers property) (Figure 1-2). The area extends from the hatchery downslope towards the Santa Clara River and includes a series of former watercress beds and riparian vegetation before crossing the active bed of the Santa Clara River. It includes a small sliver of land on the south bank of the current Santa Clara River.

1.2 Need for the Project

The Santa Clara River drains roughly 1,600 square miles of the Transverse Ranges and is typical of Mediterranean-climate watersheds in that major portions of the floodplain exhibit seasonally intermittent surface flows. However, in river segments where the underlying geology forces groundwater upwards, and/or where hydrologic pressure from upland aquifers create artesian springs adjacent to the main channel, perennial flows support permanent, high-productivity wetlands. These biologically diverse ecosystems provide critical habitat and resources for wildlife and sustained earlier human settlements in the Santa Clara River valley. One of the most extensive such wetland areas was located upstream of the Sespe Creek confluence with the Santa Clara River near the City of Fillmore, and this “Cienega” or marshland was well-known to the Chumash people and early European settlers (Beller et al., 2011, 2015). In 1940, a fish hatchery was built at the site to take advantage of these artesian springs for producing trout for regional anglers, and subsequently a major commercial watercress farm was established to utilize the nutrient-rich water as it flowed from the hatchery.

Now that the property has been acquired by the State of California and agricultural use phased out, a unique opportunity exists to re-establish native riparian and aquatic habitats that mimic, if not fully re-create, the rare wetlands that were historically present. To properly plan for restoration, it is important to establish the extent to which the original subsurface hydrology remains intact, how fluctuations in groundwater elevations impact the potential for plant growth, whether soils have been degraded to the point where remedial action is required to support revegetation by native plant species, and whether modifications to the site require grading activities to offset their impact. Restoration planning needs to consider how future changes to water fluxes might influence the long-term sustainability of restoration actions, especially in the context of the continued operation of the fish hatchery and the proximity of the site to Piru Creek. Annual flow releases from Lake Piru to the creek below Santa Felicia Dam are made for various downstream purposes, which impose varying supplies of water to the site. Climate change may also impose potential future variability or systemic alterations to the flow regime. Likewise, morphological changes that result from large flood events need also to be considered in the restoration design. The overall vision for the CSER is to develop a self-sustaining area of native groundwater-dependent riparian vegetation that supports related native fauna, but there are ancillary needs and potential benefits related to public access and to future CDFW uses for the site that require integration. A full set of project goals and objectives is developed in Section 3.

1.3 Stakeholder Engagement

The development of the restoration design by Stillwater Sciences, SCRC, and UCSB has been informed by numerous discussions and key meetings with CDFW staff. In addition, SCRC has facilitated various outreach efforts to solicit input from local stakeholders.

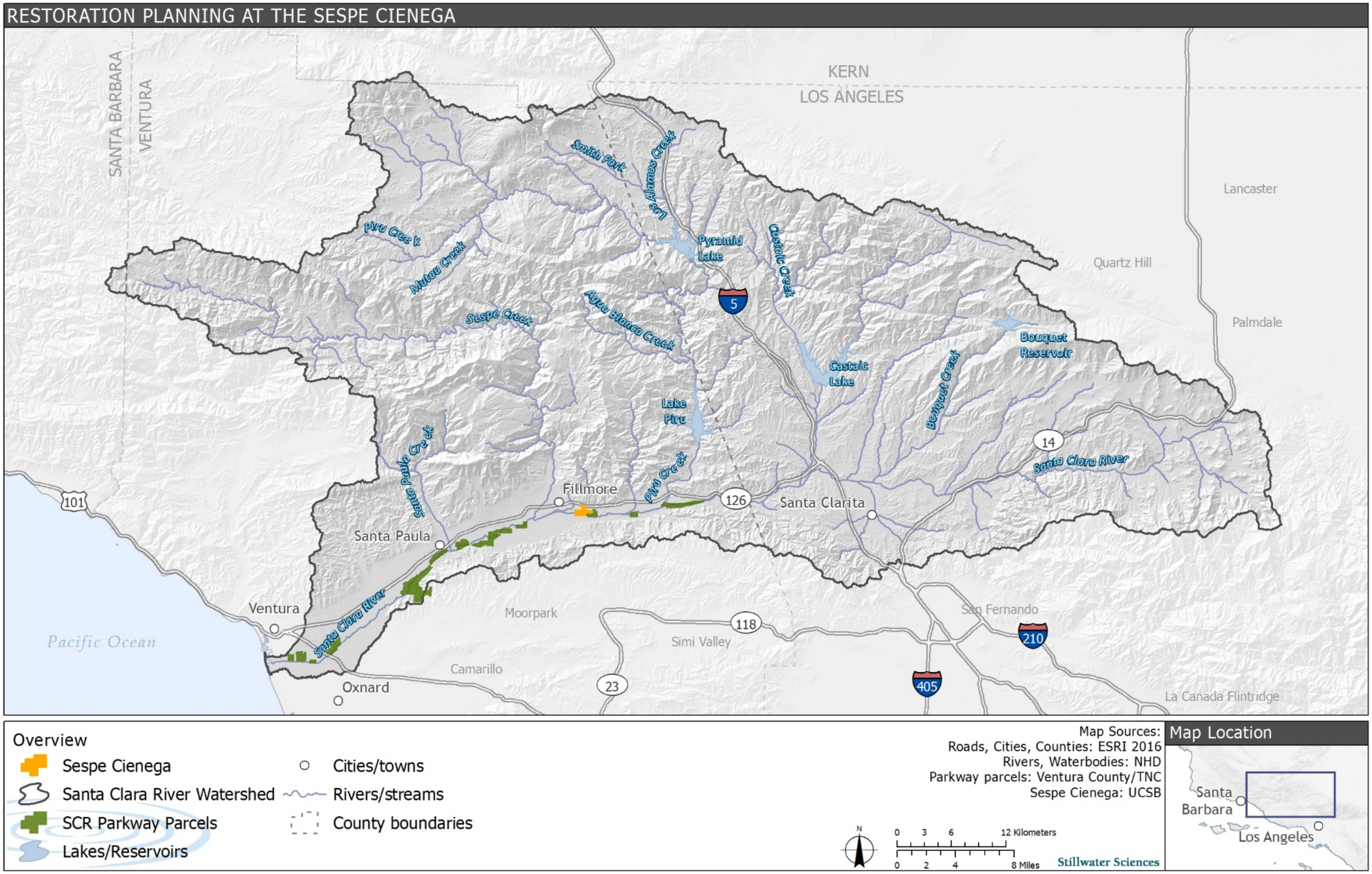

Figure 1-1. Location of the Sespe Cienega project area within the Santa Clara River watershed located in Ventura County.

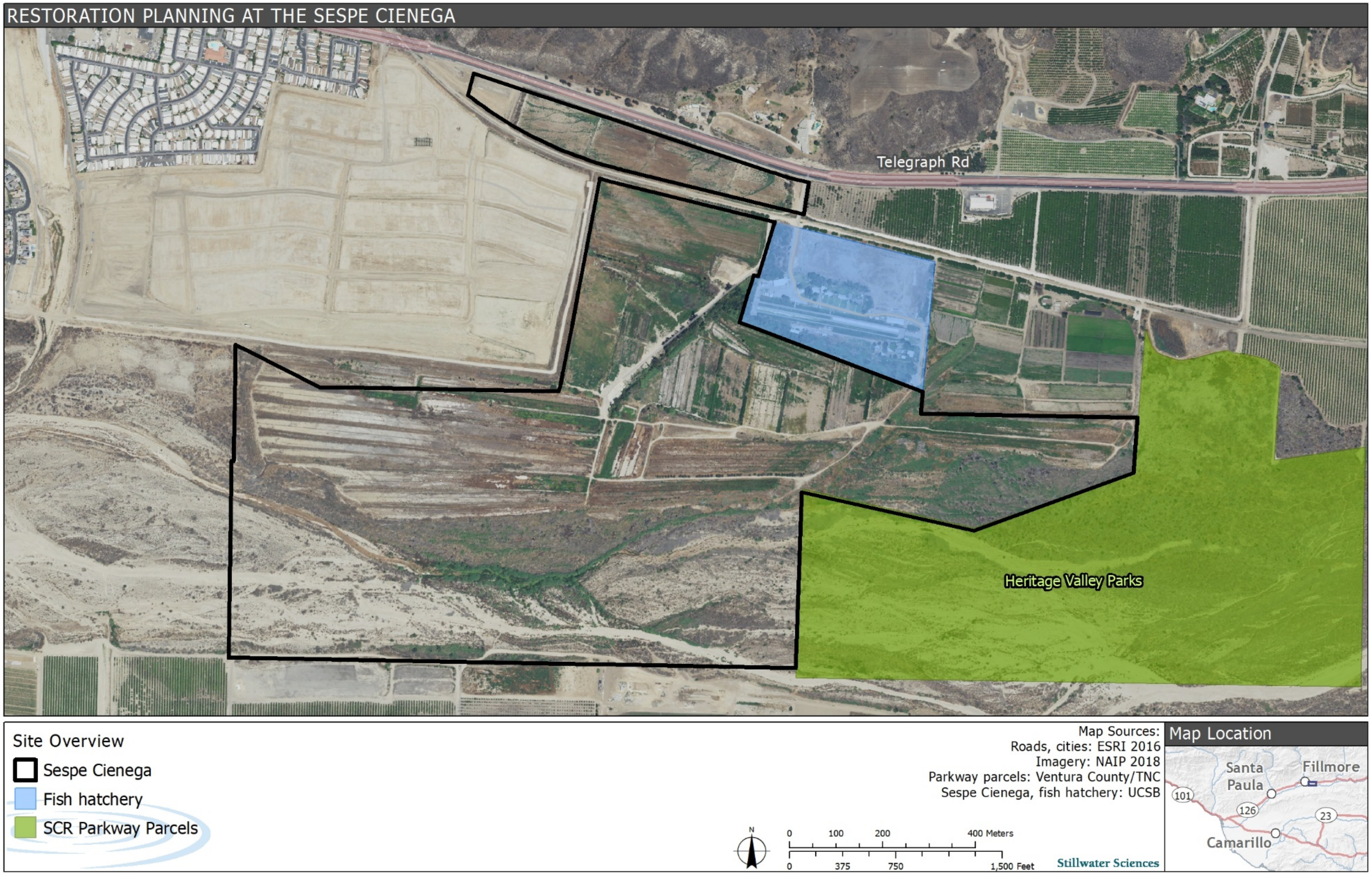

Figure 1-2. Sespe Cienega project area (black line) and adjacent Santa Clara River Parkway Parcel (green) and Fillmore fish hatchery (blue).

2 SESPE CIENEGA ECOSYSTEM VALUES AND FUNCTIONING

The following section presents a brief synopsis of physical, biological, and human factors relating to the ecosystem values and functioning of the Sespe Cienega site. The synopsis is derived from a full review of literature and knowledge related to the site presented as a companion volume (UCSB 2020).

2.1 Physical Properties

2.1.1 Geology and physiography

Located in the distinctive geological province of the west-east trending Transverse Ranges, the Sespe Cienega site sits within the Santa Clara River watershed, a 4,204-square-kilometer (km^2) watershed that retains a relatively natural state compared with other large watersheds in coastal southern California. The Santa Clara River drains westwards from a maximum elevation of 2,700 meters (m) to sea level through four hydrogeomorphic regions, with the Cienega site sitting on the right riverbank, approximately halfway along the downstream-most region, the Santa Clara River Valley. The Santa Clara River drains 2,980 km^2 upstream of Sespe Cienega. The river valley is bounded to the north by the Topatopa Mountains (a part of the western Transverse Ranges) and to south by the Santa Susana Mountain range. Here, the Santa Clara River valley is broad and underlain by extensive alluvial deposits with the mainstem river generally located towards the southern side of the valley, possibly in response to forcing from the alluvial fans that emanate from tributaries on the northern side of the valley. Major faults trending west-east border the valley here, with the San Cayetano Fault forming the northern boundary of the Cienega as it breaks to steep hills and mountains to the north, while the Oak Ridge/Santa Susana Fault marks a similar break on the southern side of the valley. Rocks within and adjacent to the Santa Clara River valley tend to be poorly consolidated, intensely folded and steeply tilted, and so they are susceptible to landslides (Harp and Jibson 1996), erosion by dry ravel (Scott and Williams 1978), and debris flows.

2.1.2 Climate and hydrology

The Santa Clara River is subject to a semi-arid two-season Mediterranean climate, with cool wetter winters and summers that are hot and dry. Near the Cienega, average annual rainfall is approximately 490 millimeters (mm) (unpublished PRISM data 1971–2018), with precipitation usually concentrated in several large storms between November and March. High flows are very flashy (i.e., they peak and subside rapidly in relation to high-intensity rainfall events) with the largest storms associated with the El Niño Southern Oscillation (ENSO) phenomenon (Andrews et al. 2004). Conversely, the rest of year is characterized by very low flows (annually, 50% of days in the lower Santa Clara River have flows <0.3 cubic meters per second (m^3s^{-1})).

While peak flows in the lower Santa Clara River are largely controlled by discharge emanating from wetter uplands of Sespe Creek, the Cienega site sits immediately upstream of Sespe Creek, meaning that its flood flows are dictated by the lower precipitation received in the upper Santa Clara River. High flows are thus best characterized by data from the USGS gage at the Los Angeles/Ventura County Line (USGS gage 11108500) rather than those downstream of the Sespe–Santa Clara confluence at Montalvo (USGS gage 11114000). By comparison, the estimated 1.5-year recurrence interval flow is 3.1 times greater estimated at Montalvo (186 m^3s^{-1}) versus the county line (60 m^3s^{-1}), despite only a 2.6-fold increase in drainage area (URS 2005). In addition, the magnitude of flood flows would likely have been higher at the Cienega site prior to the damming of Piru and Castaic creeks. The completion of the 61-m-high Santa Felicia Dam on Piru Creek in 1955 represented the first large-scale flow regulation in the Santa Clara River, and about 51% of the Santa Clara River watershed by area is now regulated upstream of the Cienega site.

During the extended low-flow periods, the lower Santa Clara River is characterized by alternating reaches of perennial and intermittent flow, the latter historically occurring over about 30% of the channel length (see Beller et al. 2016). The variability is largely a function of geological controls in the Santa Clara Valley groundwater basin, which is subdivided into four groundwater "sub-basins." The Cienega site straddles the boundary of the Piru and Fillmore sub-basins, both of which are characterized by an upper "losing reach" as the valley widens and surface flows percolate rapidly through highly permeable bed materials to deeper groundwater; and a lower "gaining" reach where bedrock constrictions force groundwater towards the surface (Reichard et al. 1999). The Cienega site is an example of the latter and is thus characterized by perennial flow suitable to support the growth of wet woodland species (details in next section).

2.1.3 Groundwater

The majority of the Cienega property lies within the Fillmore sub-basin, but groundwater dynamics at the site are best documented as those for the western end of the Piru sub-basin immediately upstream. Groundwater inputs from the upper Santa Clara River and Piru Creek percolate into the widening valley and provide the greatest volume of recharge to the Santa Clara Valley basin (Reichard et al. 1999). The proximity of faults near the Cienega site creates the so-called "Piru Narrows"; the functionally narrower cross-section of the valley reduces the capacity of groundwater flow in the upper aquifer, forcing groundwater elevations closer to the valley surface. Consequently, the intermittent flow at the eastern end of the sub-basin gives way to perennial flows in all but the driest of years at the western end. Flow releases from Lake Piru also tend to increase groundwater elevations in the western end of the Piru sub-basin, seasonally sustaining the shallow depths to groundwater at the Cienega site even in the absence of precipitation.

In general, the Piru groundwater sub-basin consists of an upper aquifer of Quaternary alluvium, comprising coarse sand and gravel that ranges from 18–30 m deep, underlain by a lower aquifer of permeable sands and gravels from the Pleistocene-aged San Pedro Formation (United Water 2016). However, detailed groundwater investigations in the vicinity of the Cienega (Mann 1958, 1959) determined the thickness of upper alluvium to be only about 18 m near the hatchery with no older alluvial layer beneath. This clay layer at the site may assist in forcing groundwater towards the surface, because it limits the aquifer thickness in combination with the narrowing of the valley. Closer to the mainstem Santa Clara River, the upper alluvial layer increases in thickness towards 30 m with the addition of some older alluvium at depth (Mann 1959).

Groundwater flows are now sustained by fall "conservation releases" from Lake Piru by the local water utility, United Water Conservation District (United Water), in years when reservoir levels are adequate. The releases are designed primarily for the benefit of agricultural irrigation in areas downstream of the Cienega site, but they also variably support domestic, municipal, and industrial water supplies; recreational activities; and salinity control. The volume of the release in most years is limited by the wet-season runoff from the Piru Creek watershed and, to a lesser degree, the amount of State Water purchased by United Water. Conservation releases generally start during the months of August or September and last for one to three months. The release rate is generally between 200 and 400 cubic feet per second (cfs) and between 1999 and 2019, the average conservation release totaled 24,000 acre-feet providing baseline estimates to develop a site water balance to guide adaptive management of restored vegetation. There is usually significant riverbed percolation across the Piru groundwater basin, and river flows near the Piru/Fillmore basin boundary are often 30–60% lower than the upstream releases from Santa Felicia Dam. Percolation rates as high as 350 cfs have been observed during drought years (details: Bram Sercu, pers.comm.).

2.1.4 Fluvial geomorphology

The dynamics of fluvial geomorphology in the Santa Clara River is determined by sediment transport processes that result from the ENSO-dominated flood hydrology, in combination with the extremely large sediment yields from rapidly uplifting western Transverse Ranges to the north (where most of the tributaries originate on relatively weak sedimentary rocks), periodic earthquake-induced landslides, and frequent wildfires. For example, Warrick (2002) estimated that 25% of the total sediment discharge of the Santa Clara River from 1928–2000 occurred in just four days. In arid, high-sediment-load rivers, the large size variation in flood events combined with the non-linear nature of sediment transport concentrations means that the "dominant" (or "channel-forming") discharge is in fact the largest flood of record. In the Santa Clara River, these relationships dictate the natural responsiveness of the river (SWS 2007a, Downs et al. 2013). Other factors also influence the channel's form and processes, including human actions such as sediment regulation by dams, changes in land use and land cover, existence of structures such as levees and grade control that constrain lateral or vertical movement of the channel (respectively), and mechanical modifications such as instream aggregate extraction. It has been estimated that dams in the Santa Clara River have reduced flow to the mainstem by 26% and suspended sediment transport by 21%, changes that are most influential in areas such as the Cienega that are downstream of the most intensive such changes but upstream of the moderating impact of the unregulated Sespe Creek water and sediment inputs.

The Santa Clara River carries a mixture of sand and gravel, with a channel morphology adjacent to the Cienega site best characterized as "compound" (Graf 1988): at low discharges, the channel consists of multiple threads, although one primary thread carries the majority of flow. During flood events, however, the various threads coalesce and can prescribe a large meandering planform. The river reach next to the Cienega site is part of a 5.7-km-long homogeneous reach characterized by mild aggradation and channel narrowing in the modern period (1938–2005: SWS 2007a, Downs et al. 2013), but it has not been subject to extensive embanking or significant historical aggregate extraction. Channel width averaged 480 m ± 163 m from 1969–2005. Two attributes of this channel form are of vital importance to riparian ecosystems. First, as a dryland river subject to episodic large floods, the width of the active channel bed should vary proportionately with the magnitude of the last flood event, with the channel bed widening and consuming part of the riparian area for some years following the flood. Second, because the river operates as a pseudo-meandering channel during large floods, river bends can migrate laterally for tens, if not hundreds, of meters during an individual flood event, eroding large extents of riparian floodplain and, conversely, leading to floodplain gain on the opposite bank. Overlays of aerial photographs from 1938–2005 in GIS (methods based on Graf 2000, Tiegs and Pohl 2005, and Tiegs et al. 2005) illustrate that the reach adjacent to the Cienega possesses a "central tendency" of consistent channel occupation, as shown by the highest active channel location probability class (red areas in Figure 2-1), but also that significant extents of the current Cienega riparian area have been active riverbed during recent history.

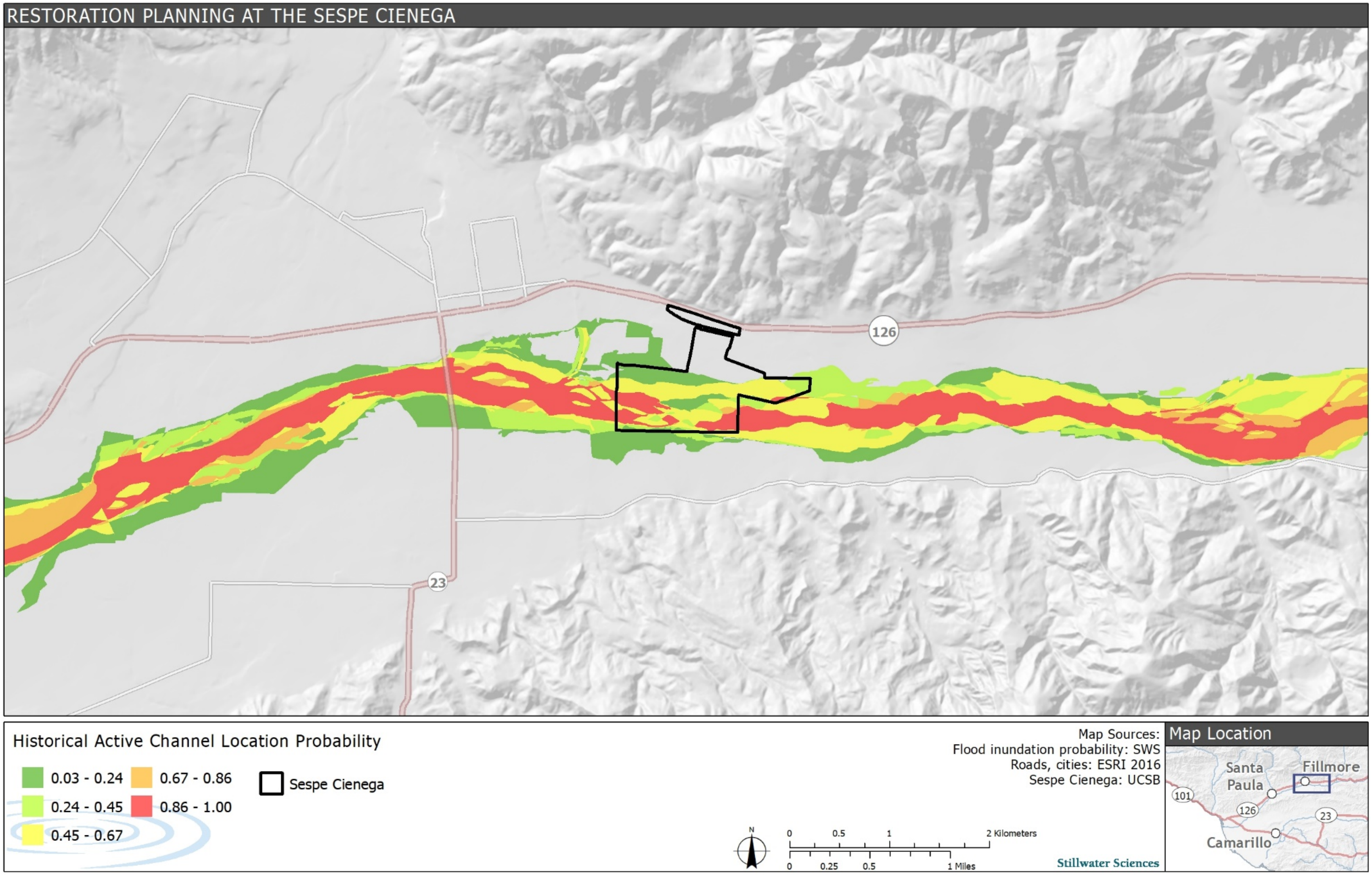

Figure 2-1. Variability of planform position of the Santa Clara River in the vicinity of the Sespe Cienega site.

2.2 Biological Properties

The highly productive and diverse habitats in the project area provide critical resources for wildlife and are a vital link in the landscape-scale corridor connecting the Transverse and coastal mountain ranges and over 100 linear miles of watershed from inland mountains to the ocean. As part of a current weed management program and field data collection for this planning project, a variety of local assessments have been initiated to quantify floral and faunal biodiversity at the CSER, including yearly vegetation surveys, wildlife camera traps, avian point-count surveys, avian nest searches and monitoring, herpetofauna array sampling, invertebrate monitoring, and pollinator surveys (Appendices A and C).

2.2.1 Vegetation communities

The predominant vegetation types in the river are driven by access to moisture and the distribution of gaining (wet) and losing (dry) reaches. Vegetation surveys of the site were conducted in 2006, 2014, and yearly from 2018 through present. The 2006 and 2018 events were vegetation classification and mapping efforts that followed the State of California standard vegetation classification system developed under the auspices of the Vegetation Program of the California Native Plant Society (CNPS) and described in A Manual of California Vegetation (CNPS 2020); the 2018 mapping is shown in Figure 2-2. UCSB completed vegetation surveys of the Cienega site in August 2014 when the property was owned by the Beserra family, as well as the adjacent TNC Shiells property, to assess the extent of giant reed (*Arundo donax*) infestation and the status of native vegetation among these sites. Stillwater Sciences compiled previous vegetation maps in GIS, including the 2006 mapping of the Ventura County river reaches (Stillwater Sciences and URS 2007, Orr et al. 2011). Aerial imagery interpretation and previous vegetation surveys on the river were also used to assign vegetation types and arundo/giant reed percent cover category to all map polygons. Starting in June 2019, SCRC and UCSB conducts annual systematic vegetation surveys at the Cienega to assess baseline conditions and track ecological changes specific to restoration planning and implementation (Appendix A). The dominant vegetation communities and land cover types characterized by these surveys are summarized below.

2.2.1.1 Willow-cottonwood forest

Remnants of willow-cottonwood forests occur along the riverbank, side channels, and terrace where adequate soil moisture is present and flooding disturbance is infrequent. The dominant species in this vegetation type are arroyo willow (*Salix lasiolepis*), red willow (*S. laevigata*), black cottonwood (*Populus trichocarpa*), and Fremont cottonwood (*P. fremontii*). However, much of the potential riparian forest habitat was heavily invaded by arundo (in 2018, over 80% cover in many areas), and to a lesser degree, castor bean (*Ricinus communis*), perennial pepperweed (*Lepidium latifolium*), and tamarisk (*Tamarix ramosissima, T. parviflora*). UC Santa Barbara is removing arundo from the site (with funding from the Wildlife Conservation board) and all arundo in this habitat type has been masticated and treated with herbicide. Although over half of the transects sampled in the historic agricultural and monotypic arundo sites had moist or saturated soils in late summer, characteristics favorable to recruitment and establishment of willows and cottonwoods, these taxa were not documented in those areas during sampling, suggesting that former land use practices excluded these species.

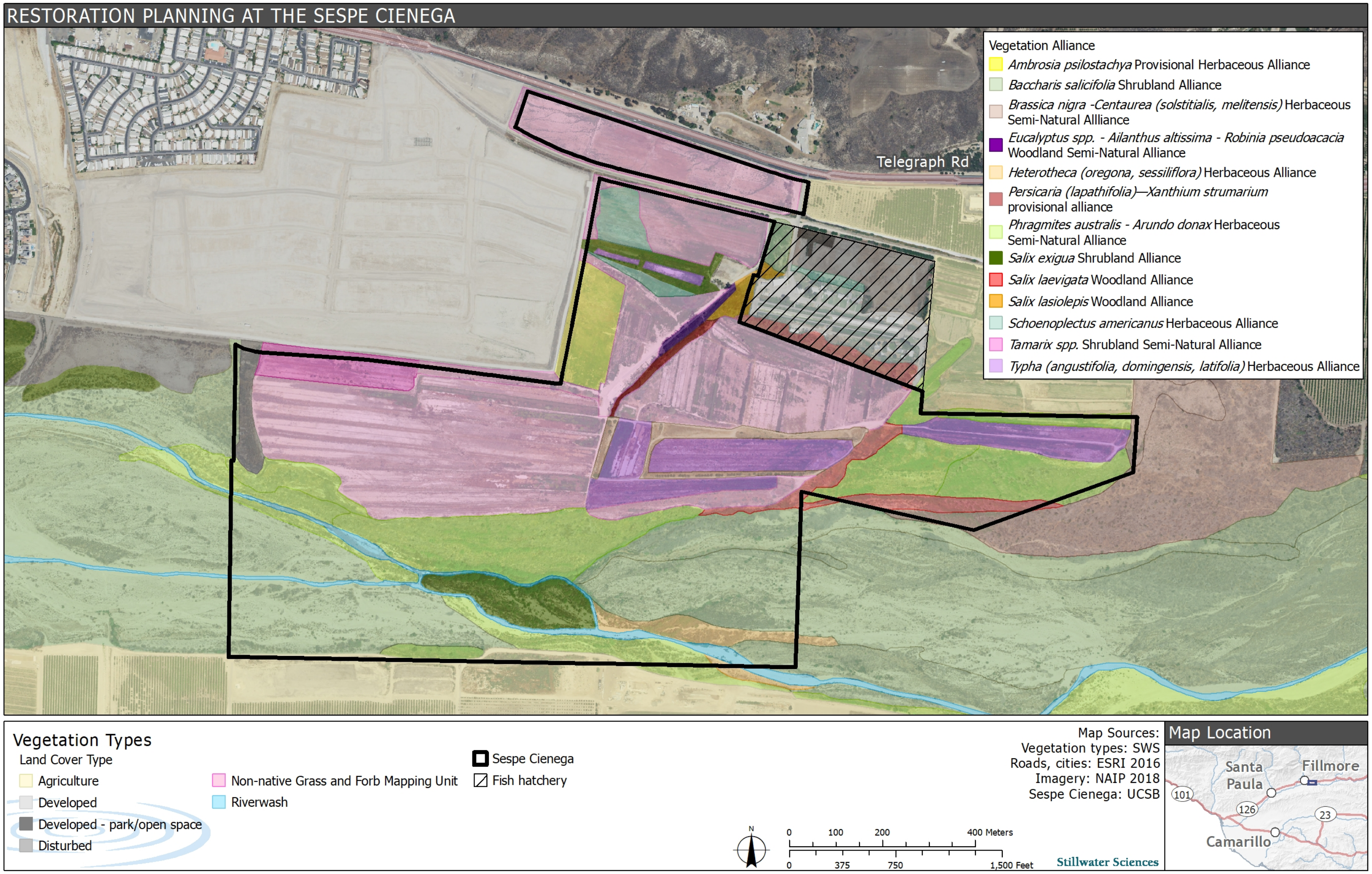

Figure 2-2. Vegetation types and land cover along the Santa Clara River in the vicinity of the Sespe Cienega site. Map is based on vegetation survey conducted in 2018. All giant reed (*Arundo donax*) has been treated and removed from the site since the 2018 mapping effort.

2.2.1.2 Riparian scrub/river wash

Riparian scrub is a major component of the river channel vegetation community within the project area. This vegetation community, including the active river channel, is highly dynamic and diverse, and vegetation associations are dependent on the level of flooding disturbance, sand/silt deposition, and soil moisture. Unvegetated open space makes up a large proportion of this system—approximately 41% of areas sampled in 2019. Sand bars with relatively low levels of disturbance support riparian forest species, including cottonwoods, willows (especially sandbar willow [*S. exigua*]), and mule fat (*Baccharis salicifolia*). Alluvial scrub areas can contain sage-scrub/riparian scrub (*Salvia* spp., *Artemisia californica*, *Acmispon glaber*, *Hazardia squarrosa*, *Heterotheca sessiliflora*, *Croton californicus*, *Eriodictyon crassifolium*), chaparral (*Artemisia tridentata*, *Opuntia littoralis*, *Cylindropuntia californica*, *Atriplex lentiformis*), and wetland plant associates. Arundo, although abundant, does not reach monotypic levels in these areas due to the frequent flooding/scouring regime (8.4% canopy cover in 2019 and 0.4% in 2020; Appendix A) and low productivity owing to desiccation in this often-sandy environment. Tamarisk, short-pod mustard (*Hirschfeldia incana*), castor bean, perennial pepperweed, and invasive annual grasses are also present at low to moderate densities.

2.2.1.3 Former agriculture

Over 50% of the property is abandoned agricultural fields and associated infrastructure. Watercress beds span the central portion of the property and consist of linear depressions that fill with water and emergent, aquatic vegetation during wet periods. Most of the plant species are non-native and invasive, but native cover has increased over the 2019–2020 sampling period and includes cattails (*Typha latifolia*), yellow monkey flower (*Erythranthe guttata*), and stinging nettle (*Urtica dioica*). The dominant invasive species include tamarisk, castor bean, and watercress, but many weedy forbs are also common. Areas formerly used for row crops are now essentially weedy fields with short-pod mustard, horseweed (*Eriogonum canadensis*), white sweet clover (*Melilotus alba*), and annual and perennial grasses.

2.2.1.4 Invasive species

Non-native, invasive and weedy plant species dominate the site owing to the long history of intensive agriculture and associated disturbance. The most abundant and problematic invasive species include, arundo, tamarisk, perennial pepperweed, short-pod mustard, and castor bean (Appendix A). With funding from the Wildlife Conservation Board (Proposition 1 grant program), UCSB and SCRC are removing arundo from the entirety of the 297-acre Cienega property, as well as clearing any remaining arundo from 100 acres of the adjacent TNC Shiells/Sommers property. Removing arundo will eliminate the competitive exclusion of native plants that occurs in arundo-dominated areas, while decreasing excessive transpiration and the risk of detrimental fires. But, as removal continues, other weeds, including perennial pepperweed, tamarisk, short pod mustard, and annual grasses, are likely to increase in abundance until reestablishment of native vegetation. Perennial pepperweed is patchy but widespread across the site, and it is of particular concern owing to its propensity to rapidly spread by rhizome and seed following activities such as weed control or soil disturbance. A comprehensive and long-term weed management plan is being developed for the site to minimize the impacts of weedy species and promote resistant and resilient native vegetation communities for the duration of the project period and sustainably into the indefinite future. This plan will be submitted to CDFW by UCSB in September 2021.

2.2.2 Wildlife at the Sespe Cienega

2.2.2.1 Fish

A variety of fish species have been known to occur in the perennial and seasonal aquatic habitats of the Santa Clara River (South Coast Wildlands 2006, Swift et al. 1993). These species include at least eight native California fish, most with some level of protected status: Arroyo chub (*Gila orcuttii*), southern steelhead/rainbow trout (*Oncorhynchus mykiss iridous*), Santa Ana sucker (*Catostomus santaanae*), and Owens sucker (*Catostomus fumeiventris*), Pacific lamprey (*Entosphenus tridentatus*), prickly sculpin (*Cottus asper*), and, a short distance upstream of the project area, the resident unarmored sub-species of threespine stickleback (*Gasterosteus aculeatus williamsoni*) are also regional residents. Sticklebacks have been recently maintained at the CDFW hatchery for a “conservation nursery” as mitigation for potential disruption by debris flows following wildfire (particularly the Sand Fire) in the watershed (Gerstenslager 2017). Comprehensive fish surveys of the Cienega have not been conducted; however, some of these taxa are likely present in the Cienega wetlands, including escaped trout from the rainbow trout hatchery or others from intentional translocation or opportunistic in-migration from the mainstem Santa Clara River during higher flow periods when there is surface-water connectivity between these habitat elements. Numerous non-native fish are also present in the mainstem, and possibly occasionally in the Cienega area, including catfish/bullheads (mostly black bullhead, *Ameiurus melas*), carp (*Cyprinus carpio*), red shiner (*Cyprinella lutrensis*), threadfin shad (*Dorosoma petenense*), green sunfish (*Lepomis cyanellus*), and likely many others (Howard and Booth 2016, South Coast Wildlands 2006, Swift et al. 1993).

2.2.2.2 Birds

Multiple years of seasonal point count surveys and other avian projects have been conducted at the Sespe Cienega and adjacent areas, revealing a diverse assemblage of species and dynamic variation in interannual abundance (e.g., Kisner unpublished datasets 2018–2020; Hall unpublished datasets 2010–2020). Approximately 125 bird species have been documented using the project area (Appendices G and I). The property retains small remnants of riparian-woodland habitat suitable for the state and federally endangered least Bell’s vireo (*Vireo bellii pusillus*). With restoration, the threatened tricolored blackbird (*Agelaius tricolor*), southwestern willow flycatcher (*Empidonax traillii extimus*), and western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) could use this area for breeding. In addition to these special-status species, migratory Neotropical bird species are already present and breeding on the property, whose breeding should be greatly enhanced with restoration of the riparian woodlands.

A GIS-based model (Hatten and Paradzick 2003, Hatten 2016) that identifies southwestern willow flycatcher (SWFL) breeding habitat suitability using Landsat 8 Thematic Mapper imagery was applied in 2018 and 2019 to the property and adjacent portions of the reach as part of a range-wide habitat modeling for this endangered species (Hatten 2016). The predicted habitat suitability results were used to help identify high-value patches of existing riparian habitat. Similarly, a more recently developed Landsat-based habitat suitability model for western yellow-billed cuckoo (YBCU) breeding habitat (Johnson et al. 2017) also was applied in 2018 and 2019 to the Sespe Cienega and adjacent portions of the Santa Clara River corridor by James Hatten (USGS). Figures 2-3 and 2-4 illustrate the result of these analyses, indicating that under current conditions the CSER provides a few small remnant patches of habitat that are likely suitable as nesting habitat for SWFL and YCBU (i.e., those areas shown in shades of green). The site is assumed to have supported larger patches of suitable habitat under historical conditions (based on the historical observations listed in Beller et al. 2011, 2015; see also the amount of riparian-wetland habitat shown in the 1929 historical aerial photograph of the site in Appendix B), and exhibits the potential for restoring regionally significant amounts of suitable habitat for these two species along with many others.

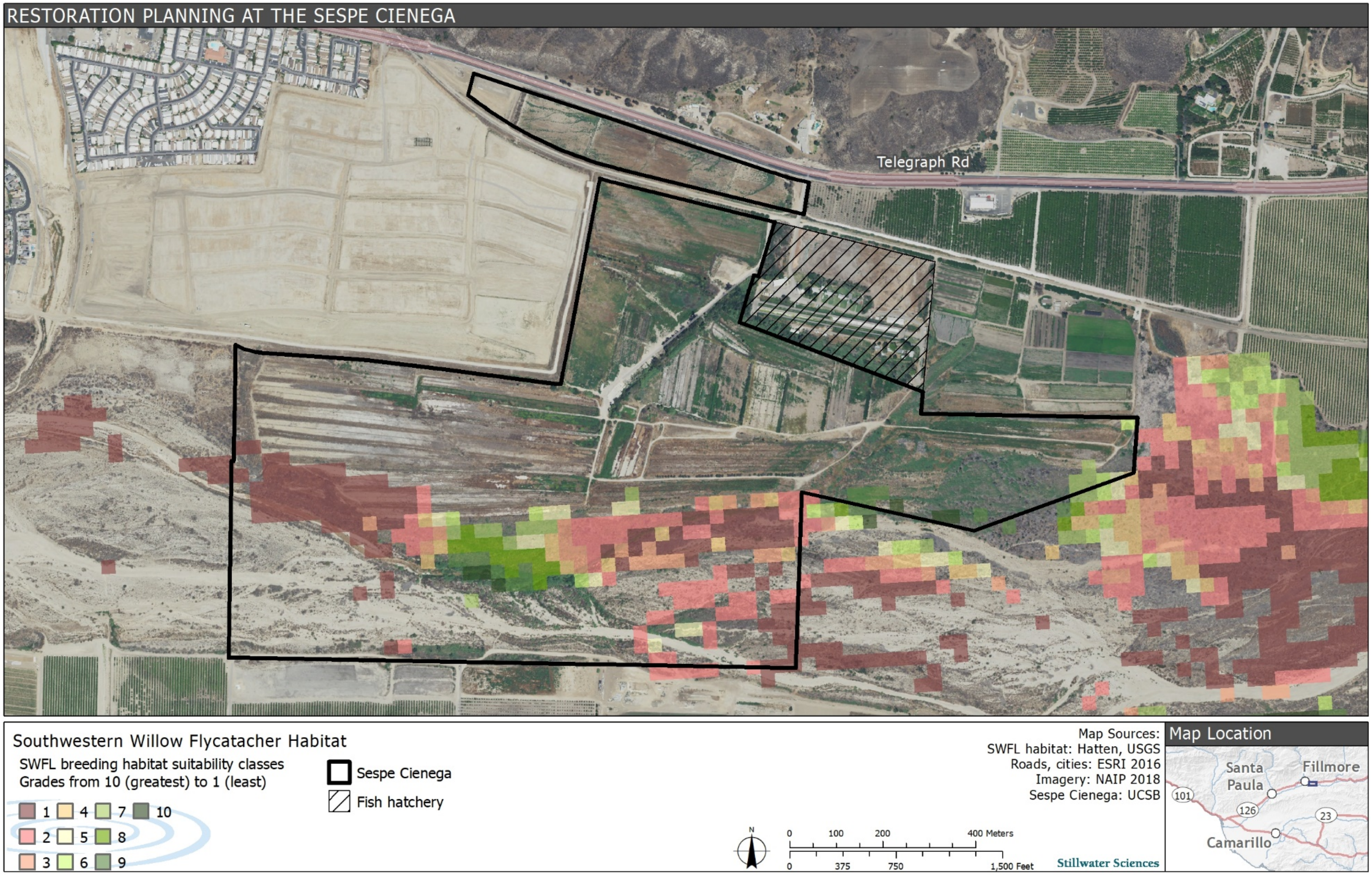

Figure 2-3. Southwestern willow flycatcher habitat along the Santa Clara River in the vicinity of the Sespe Cienega site.

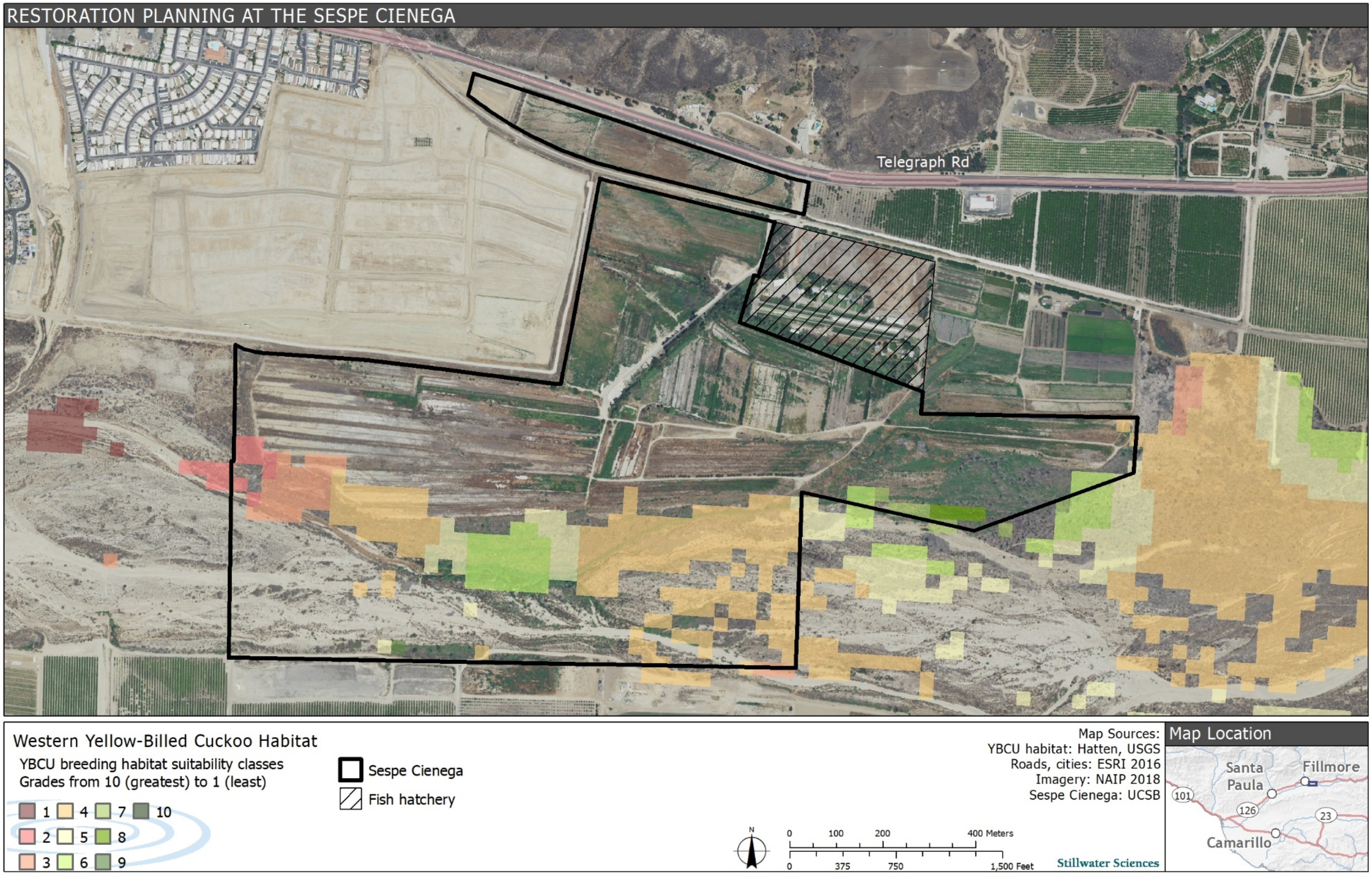

Figure 2-4. Western yellow-billed cuckoo habitat along the Santa Clara River in the vicinity of the Sespe Cienega site.

2.2.2.3 Mammals

Comprehensive mammal surveys of the Cienega have not been conducted; however, wildlife camera traps installed in 2019, in addition to anecdotal observations, indicate an abundance of mammal species utilizing and passing through the site (Appendix C). Coyote (*Canis latrans*), mountain lion (*Puma concolor*), black bear (*Ursus americanus*), bobcat (*Lynx rufus*), mule deer (*Odocoileus hemionus*), striped skunk (*Mephitis mephitis*), Virginia opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), brush rabbit (*Sylvilagus* spp./*S. bachmani*), black-tailed jackrabbit (*Lepus californicus bennettii*), California ground squirrel (*Otospermophilus beecheyi*), and several rodents including woodrat (*Neotoma macrotis*), deer mice (Peromyscus maniculatus, P. boylii), and Pacific kangaroo rat (*Dipodomys agilis*) have been observed. In nearby riparian areas with habitat similar to the Cienega, Hardesty-Moore et al. (2020) used motion-sensitive videography to detect several species listed above, in addition to long-tailed weasel (*Mustela frenata*) and gray fox (*Urocyon cinereoargenteus*). Preliminary bat detection surveys identified the presence of a minimum of 12 species in the general vicinity of the Cienega, over half of which are considered federal and/or state Species of Special Concern (Devyn Orr, UCSB, unpublished data), including pallid bat (*Antrozous pallidus*), Townsend's big-eared bat (*Corynorhinus townsendii*), western mastiff (*Eumops perotis*), western red (*Lasiurus blossevillii*), western small-footed (*Myotis ciliolabrum*), western long-eared (*M. evotis*), and Yuma bat (*M. yumanensis*). These species use riparian trees for roosting and foraging. These surveys also indicated reduced detections in association with arundo-dominated stands (Devyn Orr, UCSB, unpublished data).

2.2.2.4 Herpetofauna

Several Species of Special Concern (SSC) reptiles and amphibians have been observed, both anecdotally and in systematic monitoring efforts (Appendix C). Wetlands and adjacent mesic areas host two-striped garter snake (*Thamnophis hammondii*), south coast garter snake (*Thamnophis sirtalis*), and southwestern pond turtle (*Actinemys pallida*). Along the sandy, open river channel and drier upper terrace habitats, Blainville's horned lizard (*Phrynosoma blainvillii*) have been documented. Several common species regularly encountered in the project area include Baja California chorus frog (*Pseudacris hypochondriaca*), western toad (*Anaxyrus boreas*), gopher snake (*Pituophis catenifer annectens*), southern Pacific rattlesnake (*Crotalus oreganus helleri*), red racer (*Coluber flagellum piceus*), western fence lizard (*Sceloporus occidentalis*), and western side-blotched lizard (*Uta stansburiana elegans*). American bullfrog (*Lithobates catesbeianus*) and African clawed frog (*Xenopus laevis*) are confirmed introduced invasive amphibians that are known predators on native fauna.

The southwestern pond turtle has been recommended as a candidate for listing with the USFWS and is likely to receive protected status by the time restoration work on the Cienega begins. To date, approximately eight independent observations of southwestern pond turtles have been made by SCRC and UCSB staff on the project site, and it appears that project area wetlands and drainages have significant habitat value. Work is underway to determine a pond turtle population estimate at the Cienega and to devise habitat enhancement features in the site restoration goals to support this important species.

The Cienega site has great potential to host yet undocumented SSC species within the diverse habitats present. Silvery legless lizard (*Anniella* sp.) and coastal western whiptail (*Aspidoscelis tigris stejnegeri*) have not been observed but are likely present. The federally threatened California red-legged frog (*Rana draytonii*) is associated with shallow slow-moving stream habitats and likely would have been found at the Cienega historically but is thought to have been regionally extirpated. Federally endangered arroyo toad (*Anaxyrus californicus*) may have been present in the area historically but is now restricted to undisturbed locations in nearby tributaries (USFWS 2014). Suitable seasonal pond habitat also persists on the project area for SSC western spadefoot toad (*Spea hammondii*) that has maintained a foothold in similar habitat between the project area and Santa Clarita but has not been documented on site (Compliance Biology 2010).

2.2.2.5 Invertebrates

UCSB has been monitoring pollinator and ground dwelling arthropod diversity and abundance across the site since 2018 (Appendix C). The European Honey Bee (*Apis mellifera*) has been the most abundant pollinator species found so far, which could partly be due to the high presence of neighboring agricultural fields, but many other genera have been observed, collected, and identified, including *Agapostemon* sp., *Xylocopa* sp., *Lasioglossum* sp., and *Osmia* sp. Pitfall trapping, leaf litter collection, and baiting collected more than 25 species of ants, which are often used as indicators of ecosystem recovery and health. Ant species richness on-site indicates a diverse and recovering insect assemblage, even though the only management action to date has been arundo removal. The highly invasive Argentine Ant (*Linepithema humile*) was not detected during surveys, UCSB conducted an additional survey specifically targeting Argentine ants in July 2021 using baits in locations with conditions favorable for their establishment and persistence. Actively foraging colonies were detected along the channel that carries water from the hatchery outflow. Results of this survey and management recommendations will be provided in f to CDFW by UCSB in Fall 2021.

2.3 Influences and Public Access

The history of the communities in the Santa Clara River valley is defined by their relationship to the river itself. Regional history surrounding the Santa Clara River valley has been defined broadly as falling within a handful of distinct chronological eras: Pre-Historic, Spanish Settlement, Mexican Rancho, Commercial Agriculture, and Industrial. These eras represent critical shifts in land use, demographics, and ecological impacts that have shaped the physical, socio-cultural, and ecological landscape present today. Patterns of settlement and industry have been directly shaped by the river, and vice versa, for millennia. Developing public access and education that brings this history, and the remnant historic sites, together is a significant opportunity in the context of this site.

The human built environment impacts the watershed through two water management operations that are critical constraints on the CSER restoration process. They include the multi-purpose water releases from Santa Felicia Dam on Piru Creek by United Water, and the operation of a fish hatchery by CDFW on the upslope part of the CSER site.

2.3.1 Piru Creek flow releases

Piru Creek flows into the lower Santa Clara River not far upstream of the CSER. As such, flow variability in Piru Creek has a direct influence both on surface flows in the lower Santa Clara River through the CSER site and, due to significant percolation rates in the valley, on shallow groundwater flow elevations in the CSER. Because Piru Creek is regulated by the Santa Felicia Dam (SFD) (see Section 2.1.3), managed releases from the dam by United Water have a direct impact on surface and sub-surface flows at the CSER. This effect is amplified because these releases often occur when the lower Santa Clara River is experiencing low flows. The CSER restoration design needs to accommodate the impact of these flow releases during normally low-flow seasons to maximize benefits to native riparian vegetation.

United Water's flow releases are designed primarily to benefit sub-surface flow elevations downstream in the Santa Clara Valley and the various facilities that receive surface water delivery and groundwater recharge via the Freeman Diversion. The volume of the release in most years is limited by the wet season runoff from the Piru Creek watershed into Lake Piru and, to a lesser degree, the amount of State Water purchased by United Water and delivered via release down middle Piru Creek. Between 1999 and 2019, the average conservation release was 24,000 acre-feet. The following operational objectives are considered when deciding how much stored water is to be released:

- Create enough storage capacity in Lake Piru to minimize the chances of spilling in the following year.
- Increase groundwater storage in downstream basins.
- Satisfy agricultural demands for surface-water deliveries to the Pleasant Valley and the PTP systems.
- Meet the flow requirements in the FERC Santa Felicia Water Release Plan in Piru Creek to support southern California steelhead.
- Maintain a minimum pool of 20,000 AF of storage in Lake Piru.

Conservation releases generally start during the months of August or September, and last for one to three months. The release rate is generally between 200 and 400 cfs. However, United may choose to modify the release timing, duration and rate based on the volume of water stored in Lake Piru and the conditions of the groundwater basins within its jurisdiction. As discussed in Section 2.1.3, there is significant riverbed percolation across the Piru basin, and river flows near the Piru/Fillmore basin boundary are often 30–60% lower than those released at SFD. Percolation rates as high as 350 cfs have been observed during drought years.

In future years, United Water may try to obtain more State Water for release if drought conditions become more commonplace. Releasing flows earlier in the year (e.g., June, July) may also occur more frequently.

2.3.2 Hatchery operations

The adjacent fish hatchery operation is critical to successful implementation of the restoration design. The outflow from the facility empties directly onto the CSER, providing substantial surface flow to augment site water resources that support riparian vegetation. Future hatchery design and operation details will be determined by CDFW and will be incorporated into the designs in the future before the project is constructed.

2.3.3 Public Access

In 2000, the California State Coastal Conservancy proposed the establishment of the Santa Clara River Parkway for the acquisition, conservation, and restoration of floodplain lands within the Santa Clara River corridor. Land acquisition is being conducted based on identifying willing sellers and negotiating land sales with those sellers. The initial focus of the project was in the lower river reach, with increasing focus in the middle river reach over time. The Parkway was established to achieve three goals:

1. Conserve and restore aquatic and riparian habitat for native species, and the hydrologic and geomorphic processes that create and maintain those habitats;
2. Provide enhanced flood protection for adjacent private land and public facilities; and

3. Provide critically needed public access and environmental education for local communities, including the creation of a continuous public trail system along the length of the Parkway.

The implementation of the plan developed by the Sespe Cienega Planning Project will support these goals.

Ever-increasing recreational demands over decades have directly affected the river. As one example, all-terrain vehicles and other motor vehicles have been frequent and illegal intruders on the river bottom and surrounding lands. Tire marks in the river bottom from illegal vehicle traffic have been evident on visits to the river bottom at the Sespe Cienega site. One objective of the project will be to discourage non-compatible recreational uses at the Sespe Cienega site (recreational activities, such as the use of all-terrain vehicles can be enjoyed elsewhere in the Santa Clara River valley) while creating passive, compatible public access into the site.

Central Coast Alliance for a Sustainable Economy (CAUSE) is working to organize, educate, and mobilize residents in Santa Paula and along the Santa Clara River. A key component of this effort is building the stewardship of communities along the river to protect and restore the river, including through low-impact public access. Both anecdotally and as revealed through a CAUSE survey, the Santa Clara River is not accessible to the community, despite measurable and significant demand for passive recreational access. Moreover, use of natural areas is highest when there is clear public access and the natural area is close in proximity to the community. People in the river communities are frustrated that no real access to the river that flows through their towns exists. For example, the Hedrick Ranch Nature Area (HRNA) on the east side of the river is not generally open to the public; the Nature Area is only open on scheduled docent-led workdays and through bird walks led by Ventura Audubon. The trails do not have ongoing maintenance and hence get overgrown in between work events that are scheduled to clear the trails. When a community member conducts a web-based search to discover how to visit HRNA, information is not forthcoming. It is easy to imagine how difficult it would be for a member of the public from the local disadvantaged communities to discover how to visit the site and ultimately see the HRNA. The reservation-required model may serve as a de facto barrier to members of the disadvantaged community that, for example, may not be able to navigate a web-based reservation system. The public access component of the Sespe Cienega project will conceivably provide the most easily accessible visitation to the Santa Clara River and the associated habitats, being right off Highway 126.

2.4 Environmental Monitoring to Inform Design and Restoration Implementation

2.4.1 Water balance investigation

As an attempt to reduce design uncertainties resulting from unknown surface and shallow sub-surface water flows across the CSER, a modest program of water monitoring has been implemented across the site (Appendix D). The program consists of an array of 11 piezometers installed across the site to monitor seasonal variations in shallow groundwater flows at strategic locations, and the mapping of seasonal surface water flows. Piezometer data has been used to develop seasonal depth to groundwater maps for the site.Surface flow rate measurements have been taken biweekly from gauges established at the primary channel transporting hatchery outflow to the restoration site and the main outflow channel from the restoration site to the river. The ongoing hydrologic monitoring program will be used during implementation to fine tune locations for planting based on species requirements (i.e. rooting depth, planting depth for tree pole cuttings, and droughtetc.) and vegetation types across the heterogeneous site based on species rooting depths, flood tolerance, and drought resistance. Further, the program will used to inform adaptive hydrological management of the site to ensure adequate soil moisture during dry periods to support riparian vegetation. This report will be provided to CDFW in September 2021

2.4.2 Soils

A series of soil analyses was conducted on samples collected using a stratified-systematic design deployed across the site. Data were used construct detailed soil maps to guide plant species selection and planting locations for active revegetation (Appendix E). Comprehensive analyses of chemical (elemental, pH, salinity) and physical (texture, bulk density, water holding capacity, moisture content) properties were measured. Soil maps were produced using surface-fitting techniques to interpolate between sample locations and identify microsite suitability for planting target species (Appendix E). A subset of samples was submitted to Fruit Growers Laboratories for comprehensive analysis of soil chemistry and properties, including nutrients and metals. Results are presented in Appendix E.

2.4.3 Vegetation

Twenty-two permanent transects were installed in 2019 and have been surveyed annually to track changes in vegetation composition (Appendix A). The site was divided into four units based on existing vegetation communities and anticipated management goals, and 5 to 7 random transect locations were selected based on a stratified random sampling design. Units include successional agriculture, monotypic arundo, riparian scrub (CDFW), and riparian scrub (TNC). Each transect is 50 meters in length and encompasses several measurements: line intercept to sample cover of shrubs, trees, and arundo; point intercept at 1 meter intervals to assess cover of the woody and herbaceous plant community including the canopy, foliar cover, soil surface, and soil moisture; and frequency quadrats at 5 meter intervals to evaluate species composition. These quantitative vegetation surveys of permanent transects document pre-restoration conditions, the potential for natural recovery of native plants, and track vegetation changes to inform restoration design and adaptive management. Repeated annual datasets will detect changes in the plant community over time to evaluate the success of revegetation and invasive species control efforts and inform adaptive management practices. A list of plant species observed at CSER and surrounding riparian areas is provided in Appendix F.

2.4.4 Wildlife

Baseline monitoring in the proposed project site and the broader area was initiated in 2018 by UCSB and the Santa Clara River Conservancy. This monitoring program has continued to date and will continue through this and future restoration phases. Resulting data are used to evaluate plant community and wildlife responses, and measure progress toward project objectives. A list of confirmed wildlife species and a recent avian survey is provided in Appendix C and G.

2.4.4.1 Avian monitoring

An avian sampling methodology was developed following the *Handbook of Field Methods for Monitoring Landbirds* (Ralph et al. 1993) and *Monitoring Bird Populations by Point Count* (Ralph et al. 1995). Sampling points are located within the vegetation units established above to correlate vegetation attributes with bird species abundance and diversity. Sampling events began in 2018 and occur at least monthly during breeding season and quarterly thereafter. Bird species abundance and diversity are documented by counting all birds detected by sight, song, or call. Changes in bird species abundance and diversity over the project period will be evaluated by analyzing annual bird and vegetation datasets. Monitoring is being conducted by David Kisner and Dr. Linnea Hall.

2.4.4.2 Invertebrate monitoring

UCSB initiated an invertebrate monitoring program in 2019, focusing primarily on insect pollinators and ground-dwelling invertebrates. Insect pollinator diversity and abundance are assessed monthly during the growing season by pan trapping and timed observation. Monitoring of arthropod diversity will continue as restoration proceeds, using a combination of sampling techniques, including sweep netting and pitfall, pan, and malaise trapping to determine species composition and abundance. Sampling will occur least once in the spring, summer, and fall. Insects will be identified either taxonomically, by feeding/functional guild, and/or by size classes to determine food resource availability. Any sensitive insect species will be immediately released. Changes in arthropod diversity over the project period will be evaluated by comparing seasonal and annual datasets. Additional efforts focused on invasive insect species, particularly the polyphagous shothole borer and Argentine ants (Appendix C), will also occur on a more opportunistic basis.

2.4.4.3 Herpetofauna monitoring

In 2019, 45 plywood coverboards were installed across the Cienega site, encompassing 15 sampling locations (arrays) with 5 boards each. Three arrays were randomly located in each of the three management zones: successional agriculture, monotypic arundo, and riparian scrub habitats. "Coverboard" sampling for herpetofauna provides a low-impact, non-intrusive method to observe and document a wide variety of reptile and amphibian species. Sampling involves laying a piece of plywood flush with the ground, undisturbed for periods of time, and checking beneath it for any animals seeking shelter or foraging below. Array locations were selected based on habitat type, as well as proximity to existing vegetation sampling points, so that quantitative vegetation data may be used to better understand habitat changes over time. Coverboard surveys are performed once per month and all observed species and site conditions present at the time of observation are tracked in a database.

2.4.4.4 Mammal monitoring

Six wildlife camera traps have been installed across the project site to monitor mammals and other easily detected wildlife. Locations were subjectively chosen based on the quality and diversity of habitat characteristics. Infrared cameras (without a flash) are used to avoid disturbing any wildlife using the site. Cameras were located near active game trails and areas with perennial water in the willow-cottonwood forest and riparian scrub habitat types. Data cards are retrieved every other month and imagery reviewed and catalogued, including location, date, time of day, species, number of individuals, and activity. Sampling will occur through the tenure of the restoration program.

3 APPROACH TO RESTORATION PLANNING

The overall project vision for the CSER involves the re-establishment of native riparian and aquatic (and aquatic-transitional) habitats that mimic, if not fully re-create, the rare wetlands that were historically present, within the context of past and on-going land use change and water management constraints. The latter factors are especially important in restoring habitats related to Groundwater-Dependent Ecosystems (GDE) such as those along the Santa Clara River. Of particular note in the Cienega area is the water balance implications of the continued operation of the fish hatchery and the fall flow releases from Piru reservoir (which alter the natural timing of low flows) on top of the extreme inter-annual variability in natural hydrological factors at the site. Rehabilitation measures will need to be resilient to fluctuations in water and sediment regimes caused by these and other factors if the restoration approach is to have long-term sustainability. However, successfully promoting ecosystem health at the CSER has the potential to provide experiences that facilitate riparian restoration elsewhere in the Santa Clara Valley and in similar GDEs, and to provide important social benefits (education, recreation) to the local community.

Here, as in most restoration projects, the guiding principles for restoration design are hierarchical (Downs and Gregory 2004) and focus on preserving natural ecosystem processes where they continue to function, limiting changes to functioning ecosystem processes where they are under threat, and prioritizing the restoration of ecosystem processes as the primary basis for site improvement. Assisting in restoration by altering site morphology and actively planting follow in the hierarchy and are more likely to be successful where the higher-level approaches have been achieved, acknowledging that maintaining and restoring populations of native flora and fauna are the ultimate goals of the restoration vision.

3.1 Project Goals

The CSER envisions the project site as a self-sustaining area of native riparian vegetation and related native fauna that is supported by hatchery outflow and shallow groundwater , while also acknowledging the important role of local stakeholders in the project. From this, the following project goals have been developed:

1. Develop a restoration design that functions within the extremes of controlling water and sediment processes that drive the mosaic of physical conditions at the site and facilitate ecosystem recovery and restoration.
2. Retain those near-natural physical system processes where they currently function to sustain a diverse ecosystem of native flora and fauna, especially for aquatic and aquatic-terrestrial transitional habitats that underpin historical ecological values for the reserve.
3. Establish a site-appropriate, self-sustaining, and diverse ecosystem of native vegetation communities of riparian scrub, coastal sage scrub, riparian and upland woodland, understory, and aquatic marginal vegetation.
4. Consistent with restoring a functional ecosystem, recreate habitat adequate to support sustainable populations of special-status fauna.
5. Reduce or eliminate non-native, invasive plants and animals, including aquatic taxa, that could prey on or compete with native species and thus reduce the site's full restoration potential.
6. Provide a visitor experience compatible with restored ecosystems, passive public access, wildlife-dependent recreation, environmental education, and other CDFW site priorities under "ecological reserve" status.

The site will be managed by CDFW as an “ecological reserve”, which is part of CDFW’s commitment to statewide protection for threatened and endangered species as detailed in the Fish and Game code Article 4, §1580: “[T]he policy of the state is to protect threatened or endangered native plants, wildlife, or aquatic organisms or specialized habitat types, both terrestrial and nonmarine aquatic, or large heterogeneous natural gene pools for the future use of mankind through the establishment of ecological reserves.” As such, the restoration goals for the Cienega site are compatible with the primary purpose of ecological reserves as indicated in the California Code of Regulations Title 14, §630: “All ecological reserves are maintained for the primary purpose of developing a statewide program for protection of rare, threatened, or endangered native plants, wildlife, aquatic organisms, and specialized terrestrial or aquatic habitat types.”

3.2 Project Objectives

Developing from the six project goals are a series of project objectives that represent the fundamental processes for achieving the desired restoration. Project objectives are developed according to SMART criteria: they are specific, measurable, achievable, relevant and time-bound. Extending this concept, the notion of SMARTER objectives additionally includes Evaluation and Review, critical components of an adaptive management approach to restoration in which appraisal of post-project performance is viewed as fundamental in improving future management actions. In **Ta**ble 3-1, we outline a series of specific and relevant project objectives according to their achievable actions along with a set of measurable, time-bound indicators that forms the basis for post-project evaluation and review.

Table 3-1. Objectives for Sespe Cienega restoration.

Objective	Action	Indicators
Goal 1: Develop a design that functions within process/flux extremes to support mosaic of ecosystem recovery		
E1. Identify priority ecosystem functions	- develop from interpretation of literature review in combination with on-going monitoring - utilize local "reference" sites for guidance, where available	- partial closure of knowledge gaps in analytical terms - use of literature/monitoring information and data to inform the restoration design - use of reference data to inform the restoration design
E2. Improve floodplain connectivity	- remove or reduce on-site earthen farm berms	- completed modifications of earthen berms
E3. Improve heterogeneity of on-site aquatic habitat	- modify existing ditches to create a varied morphology - modify or remove culverts and footbridges	- (monitored) improvement to aquatic flora and fauna
E4. Establish semi-permanent and seasonal wetlands	- evaluate variability in hatchery runoff magnitude and directions to establish restoration potential for wetlands - develop active measures (sluices, etc.) to provide controlled water management for wetland benefit - modify drainage into former watercress beds to provide shallow water habitat	- (monitored) establishment of semi-permanent and seasonal wetlands
E5. Improve water percolation and soil moisture retention	- improve soil function through additions of sand, organic matter, or clay substrates	- tests of infiltration/hydraulic conductivity into the soil before and after treatments
E6. Improve water quality of hatchery runoff	- determine whether quality of hatchery runoff poses threat to intended uses - potentially, create treatment wetland to "settle" hatchery effluent before passage to other parts of site	- improvement to monitored components of surface water quality
E7. Create a mosaic of areas at different relative elevations above normal groundwater level	- determine usual fluctuation of groundwater levels - consider physical grading of some site areas to develop a greater variety of depths to groundwater, consistent with needs of priority vegetation	- post-restoration monitoring at piezometers sites indicates establishment of desired depth to groundwater and seasonable ranges

Objective	Action	Indicators
E8. Determine long-term ecosystem management needs/actions depending on disturbance probability and environmental perturbations	- measure likely variability in groundwater levels - measure extent of site inundation during floods of different recurrence interval - measure extent of flood scour during historical floods - develop monitoring and management plan for invasive plant and animal populations	- continue monitoring groundwater levels - monitor and develop a new 2D model of flood flow hydraulics based on the final site terrain and to incorporate new levees on adjoining property - use air photos/LiDAR images after flood events to establish patterns of scour and deposition - presence and abundance of target invasive species from ongoing monitoring
Goal 2: Retain near-natural physical system processes where they currently sustain a diverse ecosystem of native flora and fauna		
P1. Preserve areas where existing fluvial processes and floodplain connectivity underpin communities of native flora and fauna	- analyze aerial photographs to determine extent and frequency of flood scour during historical floods - map surface water and saturated soils - characterize soil moisture and chemistry - develop management measures for habitat preservation and enhancement	- retention of native plant cover and associated habitats
P2. Encourage passive revegetation where existing processes favor this approach	- analyze aerial photographs to determine extent and frequency of flood scour during historical floods - map surface water and saturated soils - characterize soil moisture and chemistry - develop management measures for passive revegetation	- increased abundance of native plant cover and associated habitats

Objective	Action	Indicators
Goal 3: Establish a site-appropriate, self-sustaining, and diverse ecosystem of native vegetation		
V1. Determine key underlying physical properties, drought and waterlogging tolerance in order to identify appropriate vegetation composition (palettes).	- delineate underlying soil properties, and depth variability of groundwater to determine likelihood of plant growth and survival - identify areas susceptible to surface water ponding and waterlogged soils	- soil texture, pH, salinity, elemental composition, bulk density, water holding capacity - mean residence time of surface water and waterlogged soils - relative elevation - depth to groundwater (temporal)
V2. Establish plant genotypic diversity to facilitate survival under environmental (climatic) change	- collect and plant genotypes of foundational species (willows, cottonwoods, sycamore, oaks) from throughout the watershed with an emphasis on climatic gradients	- species and genotypic identity, richness, and abundance
V3. Achieve a diverse assemblage of vegetation/habitat types, including state listed habitats (California walnut woodland, south coast live oak riparian forest, southern sycamore alder riparian woodland)	- plant, propagate and seed diverse array of native plantings within appropriate palettes	- species richness and abundance - relative and absolute plant cover
Goal 4: Enhance or recreate habitat adequate to support sustainable populations of special-status fauna		
F1. Provide habitat for special-status and sensitive bird species, including Least Bell's vireo, Southwestern willow flycatcher and yellow-billed cuckoo	- protect and provide nesting structure within habitat - maintain food resources with native plant diversity and abundance - map observational and nesting occurrences - Habitat requirements	- observation, nesting, and breeding occurrences - least Bell's vireo, Southwestern Willow Flycatcher and yellow-billed cuckoo abundance and distribution
F2. Reduce stressors to special-status herpetofauna, including coast horned lizard, two-striped garter snake, and Southwestern pond turtle	- reduce non-native weed cover - reduce Argentine ant populations - manage invasive amphibian populations - manage invasive crustacean populations(crawfish) - evaluate habitat needs for foraging, shelter, reproduction	- relative and absolute plant cover - Argentine ant abundance and distribution - bullfrog, African clawed frog, and red-eared slider abundance and distribution
F3. Provide habitat for pollinators	- assess presence/abundance of host plant species - plant diverse assemblage of flowering plants	- flowering plant diversity and cover

Objective	Action	Indicators
F4. Provide habitat for monarch butterflies	- plant endemic milkweeds and diverse assemblage of flowering plants	- milkweed and flowering plant diversity and cover
Goal 5: Reduce or eliminate non-native, invasive plants and animals, including aquatic taxa		
N1. Eliminate giant reed, tamarisk, castor bean, perennial pepperweed	- mechanical and chemical removal strategies - follow-up maintenance - periodic surveillance	- relative and absolute plant cover
N2. Reduce abundance of invasive, non-native forbs and grasses	- periodic surveillance mechanical and chemical removal strategies - follow-up maintenance	- relative and absolute plant cover
N3. Reduce abundance of invasive, non-native amphibians	-surveillance and manual removal strategies	- presence and abundance
Goal 6: Provide a visitor experience compatible with restored ecosystems, passive public access, environmental education, and other CDFW site priorities under "ecological reserve" status designations		
S1. Develop opportunities for on-site environmental education	- determine optimal route for visitor access - construct interpretative trails for visitors with viewing platforms, information panels and seating	- implementation of trail network, signage, and seating - monitor visitor use of implemented facilities
S2. Facilitate arrival to the site via walking, biking, or driving	- allocate small area for car parking - assist with development of cycle trail from City of Fillmore adjacent to railroad tracks. Provide bike rack at site; restrict cycle access to the trail network within the ecological reserve - discourage site access from housing over flood berm or along the river - discourage access to neighboring properties	- construction of access facilities—parking lot, cycle access, bike rack. - signs and layout that discourages use of cycles on internal site trails - layout of trail network and signs to reduce prospect of unauthorized access - monitor visitor use of implemented facilities
S3. Provide space for new CDFW facilities outside of fish hatchery perimeter	- allocate suitable area for CDFW facilities away from main visitor access parking and trails	- construction of CDFW facilities
S4. Facilitate uninterrupted operation of the fish hatchery	- clearly zone out of bounds areas for visitors that avoid hatchery operations and critical habitat areas	- monitor feedback from hatchery staff regarding visitor access to hatchery areas

3.3 Design Considerations

The general goals for restoration (Section 3.1) and the specific objectives identified to achieve these goals (3.2) require a series of design considerations—factors that strongly influence the feasibility and development of restoration actions and that are central to a design that achieves the desired environmental changes.

3.3.1 Temporal factors and watershed changes

Temporal environmental factors are fundamental determinants of restoration *potential* at the Cienega site because the Santa Clara River watershed does not operate under the same suite of governing processes as it did historically, and additional changes are expected into the future. Stemming from this concern are some critical but ill-defined design considerations, namely:

- What are the **limits to understanding and recovering historical ecosystem functioning** at the Sespe Cienega site, and how can the restoration design reflect historical conditions while functioning effectively under current conditions?
- **How can the design be sufficiently "future proof,"** that is, how can it achieve ecosystem resiliency in the face of probable future changes in surface and shallow sub-surface hydrology resulting from climate change, and on-going and future changes in geomorphic processes that will influence the physical and biological evolution of the Cienega site?

These considerations devolve on a combination of natural and human factors. A summary of historical factors has already been developed for the lower Santa Clara River as a whole (Stillwater Sciences 2007a, Downs et al. 2013) and are known to condition present-day processes, Figure 3-1. In particular, there is now extensive flow regulation in the catchment upstream of the Cienega site, and the watershed population is far more numerous than it was historically. Such factors influence the Santa Clara River's hydrology and subsurface flows through the Cienega site (see Section 2). Further, the precise vegetation community composition and extent prior to Euro-American arrival is unknown, making the design of a vegetation community that approximates historical conditions an integral challenge while cognizant that present-day processes may not maintain such "full" historical conditions, even if they could be known.

Given future climate change and further population increases in the watershed, site design needs to be sufficiently flexible to allow species to migrate across the site as governing processes evolve. However, watershed population increases constrain this potential both indirectly, in causing further hydrological changes but also directly, for instance, the recent development of housing and construction of a flood levee on the site's western boundary adds a permanent physical boundary which did not exist until recently. Similar factors are intrinsic to all restoration efforts but are more marked at the site level where physical boundaries may significantly constrain restoration potential. Various aspects of these factors influence all the considerations listed below.

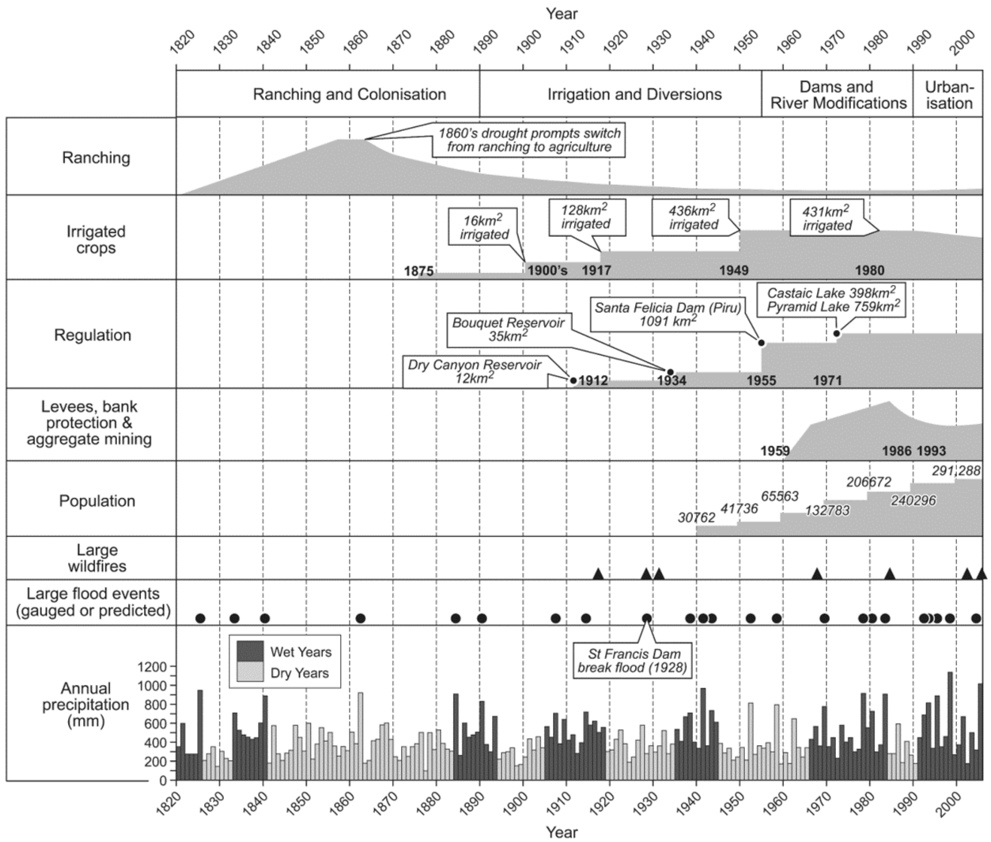

Figure 3-1. Changing conditions in the lower Santa Clara River valley since the early nineteenth century (source: Downs et al. 2013).

3.3.2 Flow regime

Flow regime is a primary design consideration common to all restoration efforts in aquatic ecosystems (including those linked to aquatic transitional ecosystems, such as here). In this design there are four primary considerations, including:

- Accommodating **flood inundation dynamics** in determining the arrangement and palette of native re-vegetation planting. Plants need to be able to withstand short periods of inundation on an approximate 5- to 8-year flood frequency basis, but also floodplain flows with a reasonable flow velocity.
- Accommodating fluctuations in contemporary (and future) **groundwater dynamics** in determining suitability and patterning of native planting. One of the greatest concerns for this project was to ensure that plant species are tolerant of the average groundwater conditions in terms of being able to uptake water according to their rooting structure, but are also tolerant to the extremes in variability of groundwater level.
- Accommodating such changes in groundwater conditions that may arise through continuing and altered schedules of **flow release from Santa Felicia Dam** through Piru Creek. This factor involves the influence of both the volume of release on groundwater levels within the Cienega site, particularly that the fall (and occasionally spring) releases occur during a period that, naturally, would be one of the driest times of year.

- **Modifying the current wetland and flowing water habitats** (i.e., former watercress beds and drainage ditches) to create surface-water and groundwater conditions that will support the desired assemblage of aquatic and semi-aquatic habitats that in turn will be suitable for a rich and diverse native flora and fauna.

3.3.3 Flood dynamics

The Cienega site sits adjacent to the Santa Clara River, a flashy, semi-arid channel with multiple threads that coalesce to act as a large meandering river during large flood events. Through erosion and deposition processes associated with lateral migration, the planform of the riverbed tends to be significantly altered after each flood event with extensive riverbank erosion, large areas of riparian vegetation scoured, and other areas of riverbed subject to depositional infilling. The amount of change is generally proportional to the magnitude of the flood event. As such, the design must:

- Ensure that critical infrastructure is not placed in those areas of the site that are liable to **re-working during flood events**. Limit active planting in areas most likely to be scoured/re-worked during large floods. Analysis of post-flood aerial photographs indicates where flood re-working of the riverbed is most likely (e.g., Figure 2-1).
- Accommodate **local changes in the dynamics of erosion and deposition** that might be brought about by land-use changes, such as the influence of upstream and adjacent levees and effect of vegetation development on flow resistance.
- **Accommodate decadal-scale trends in the elevation and morphology** of the Santa Clara River. In recent decades, for example, the river channel has narrowed and aggraded in the vicinity of the Cienega site.

3.3.4 Revegetation Strategies

A significant project goal is to re-establish a self-sustaining and diverse ecosystem of native riparian and upland vegetation that may have been typical of the historic Cienega site. In addition to developing a palette of species suitable for the prevailing sub-surface hydrology (and surface hydrology for aquatic species) (see Section 3.3.2), the following concerns should be addressed:

- Accommodating and **reducing the potential for weed reinvasion** from adjacent properties, soil seed banks, and giant reed populations upstream.
- Ensuring a **reliable source for** genetically suitable, diverse, and healthy native plant **propagules**
- **Accommodating local variations on soil properties** as they influence suitable planting locations for particular species (in conjunction with knowledge of groundwater dynamics, see above)
- **Determining areas suitable for active versus passive planting**. Passive strategies are required in those areas liable to re-working by flood events, but also suitable in areas of sustained seasonal soil moisture. Active strategies will be concentrated in drier site locations and upslope areas where resource investment is unlikely to be compromised by flood scour and in more limited strategic plantings in other areas to jumpstart passive revegetation.

3.3.5 Site grading

In conjunction with knowledge of shallow subsurface hydrology, soil properties, inundation patterns and areas liable to flood scour, restoring the Cienega site requires grading activities to optimize surface flow to achieve restoration goals. There are, therefore, several considerations that need addressing, including:

- **Establishing a logistics plan for grading activity**. Ideally, a balanced grading strategy can be designed wherein areas of cut are equal to areas of fill. If this is not possible, sources for soil procurement or disposal needs to be sought. Temporary on-site areas may be required for soil storage during the restoration process.
- Determining which of the **former watercress beds need breaching**, and how best to realign drainage and hatchery outflow to maximize its restoration value.
- Developing a strategy for appropriately **surfacing the proposed nature trails**.
- Determining the need for **topsoil salvage or soil amendments** via soil testing (to be completed during pre-construction phase)

3.3.6 Conservation versus recreation

The CSER restoration goals call for a multi-faceted approach that balances environmental education and access with site restoration to some approximation of a functioning Cienega, and all within the remit of CDFW's "ecological reserve" program and other CDFW site requirements. As such, there is an inherent tension between areas of conservation and recreation (broadly defined) at the site. Consideration needs to be given to:

- The **location and extent of public access trails** relative to the requirements of native plant propagation and establishment and the requirement to guide the public to remain within the property boundaries.
- The location and extent of public access trails related to **other CDFW functions,** including offices and the operational fish hatchery.
- **Protection of wildlife**, especially sensitive and special-status species and during vulnerable periods of seasonal activity.

4 DESIGN ELEMENTS

The design considerations for this project, stemming from the project objectives, translate into a series of design elements that need assessment to inform the development of the CSER design plans. These assessments underpin the conceptual design outlined in Section 5.

4.1 Establishing Ecosystem Functioning

4.1.1 Understanding of natural process regimes

Integral to any restoration project is the understanding of the natural process functioning at the site and the extent to which that has been altered in recent history (see Section 3.3). The restoration design can then proceed cognizant of such changes and the extent to which current (and future, see below) processes are likely to maintain the historical ecosystem. It is well established that contemporary watershed processes will rarely sustain restoration of the full historical ecosystem and so a process-based restoration approach such as this will result in a hybrid outcome. This is particularly true here, where the diverse requirements for the CSER site will require a "semi-managed" landscape approach.

Background information for the CSER stems from three sources: the comprehensive review of literature for the site and surrounding area, a series of on-going monitoring activities to establish contemporary conditions, and the prospect of gaining insight of "reference" conditions from neighboring sites. The historical background to the site has been dealt with extensively through historical ecology research (Beller et al. 2011, 2015), ecohydrological assessments (including Stillwater Sciences 2007a,b; 2008; 2011; Stillwater Sciences and URS 2007; Orr et al. 2011) summarized in Appendix H and fluvial systems assessments (e.g., Stillwater Sciences 2007, Downs et al. 2013) and has been subject to a comprehensive review (UCSB 2020), a summary of which appears here in Section 2. On-going assessments in relation to contemporary aspects of the site, including its water balance, soils, vegetation, and wildlife are outlined in Section 2.4. Together, these assessments provide the fundamental underpinning of the conceptual design to date.

Regarding "reference sites," there is potential learning to be achieved from several completed and on-going restoration projects in the Santa Clara River valley. Hedrick Ranch Nature Area and the adjacent properties in Santa Paula, CA, collectively referred to as East Grove (Beller et al. 2011) were used as a guide for identifying appropriate vegetation composition and communities at the CSER. The East Grove is a large riparian/wetland complex about seven river miles downstream of Sespe Cienega that has similar but more extensive artesian hydrology that supports a diverse array of wetland types. Long-term vegetation monitoring at this location provided a comprehensive understanding of the wetland and riparian plant richness and cover of the Groundwater Dependent Ecosystems of this river and how these change through wet and dry climatic periods. Furthermore, the "least impacted" river reaches between Sespe and Santa Paula creeks also provide potentially analogous aquatic and floodplain habitat knowledge. An important consideration was the degree to which the two sites vary in physical conditions, and how that could influence the 'transferability' of reference site features to the CSER.

4.1.2 Implications of changing climate and population increase

Sustainably restoring native species of flora and fauna to the CSER implies that the site will be resilient to projected changes in climate. A recent report downscaling the predictions of 32 Global Climate Models as they apply to Ventura County (Oakley et al. 2019) compares the most likely climate change scenarios for the county in the period 2021–2040 against a baseline from 1950–2004. In summary, average temperatures are projected to increase by 2–3°F at the coast, rising to 3–5°F inland, and the number of days with temperatures in excess of 80°F will increase significantly. Precipitation volumes will not change much but the number of dry days will increase, implying that, when it occurs, precipitation will be more intense. The number of precipitation days falls by 7% during the winter, 11% in the spring, and 20% in the fall. Consequently, evapotranspiration volumes increase by 5–10% in the inland areas with changes focused on the spring and fall.

Numerous implications arise from these forecasts, including changes in groundwater recharge, surface water conveyance, the potential for flash floods and debris flows, the economic viability of some crops, impacts on human health especially in disadvantaged communities, and the extent and abundance of native species. In addition to climatic changes, Ventura County's population is projected to rise from 854,000 in 2017 to 930,000 by 2040 (Ventura County 2018), having already grown by 180,000 since 1990, putting increased (and ongoing) pressure on water resources.

For the CSER, groundwater availability is likely to be prone to increasing periods of drought and/or become increasingly dependent on overflow from fish hatchery operations or from flow releases from Piru Creek (see below), although the latter do not occur at optimal times for plant growth. Plant growth potentially becomes less resilient in the face of greater extremes of groundwater fluctuation and higher daily temperatures. Consideration is also needed about which species might thrive under these altered future conditions, as they may not be those that flourished historically. Further, the likelihood of higher intensity precipitation days may increase the chance of floods with the potential to significantly re-work areas in the lower portions of the CSER site, focusing attention on use of passive restoration approaches and weed control measures to sustain native species in these areas.

4.2 Physical System Characterization

The goal of re-establishing a self-sustaining and diverse ecosystem of native riparian and upland vegetation requires not only historical knowledge but also an understanding of how contemporary site conditions influence the viability of various restoration and planting options. The following set of design elements are thus concerned with characterizing the physical attributes of the CSER site.

4.2.1 Flood inundation dynamics

While the general aridity of the Santa Clara River valley is typical of a groundwater-dependent ecosystem (GDE), periodic flooding, usually associated with ENSO climate anomalies, requires that plants need to be able to withstand short periods of inundation. Flood events rise and fall rapidly on the Santa Clara River, so the period of inundation is short, but the associated floodplain flow velocities are sometimes quite high and frequently result in extensive riverbed and floodplain re-working by scour and deposition processes (see next section).

Knowledge regarding flood inundation dynamics at the CSER stems from a two-dimensional hydrodynamic model of the Santa Clara River previously created in MIKE FLOOD by cbec, Inc. (cbec 2011), extending from the Ventura–Los Angeles County line to the Pacific Ocean. This model was intended to provide general indications of the inundation extent and water-surface elevations for larger magnitude flood events (e.g., greater than 25-year flow). The modeling included the reach along the Sespe Cienega property but occurred prior to nearby housing development and associated levee construction, which will have locally modified flood hydraulics in this area. As indicated in Figure 4-1, a majority of the site would be inundated in a 25-year recurrence interval flood event, and most of the remaining areas of the upslope parts of the site would be inundated during a 100-year event. The model shows that the flood inundation depths in the 100-year event would be in the 1- to 2- meter range in the vicinity of the site.

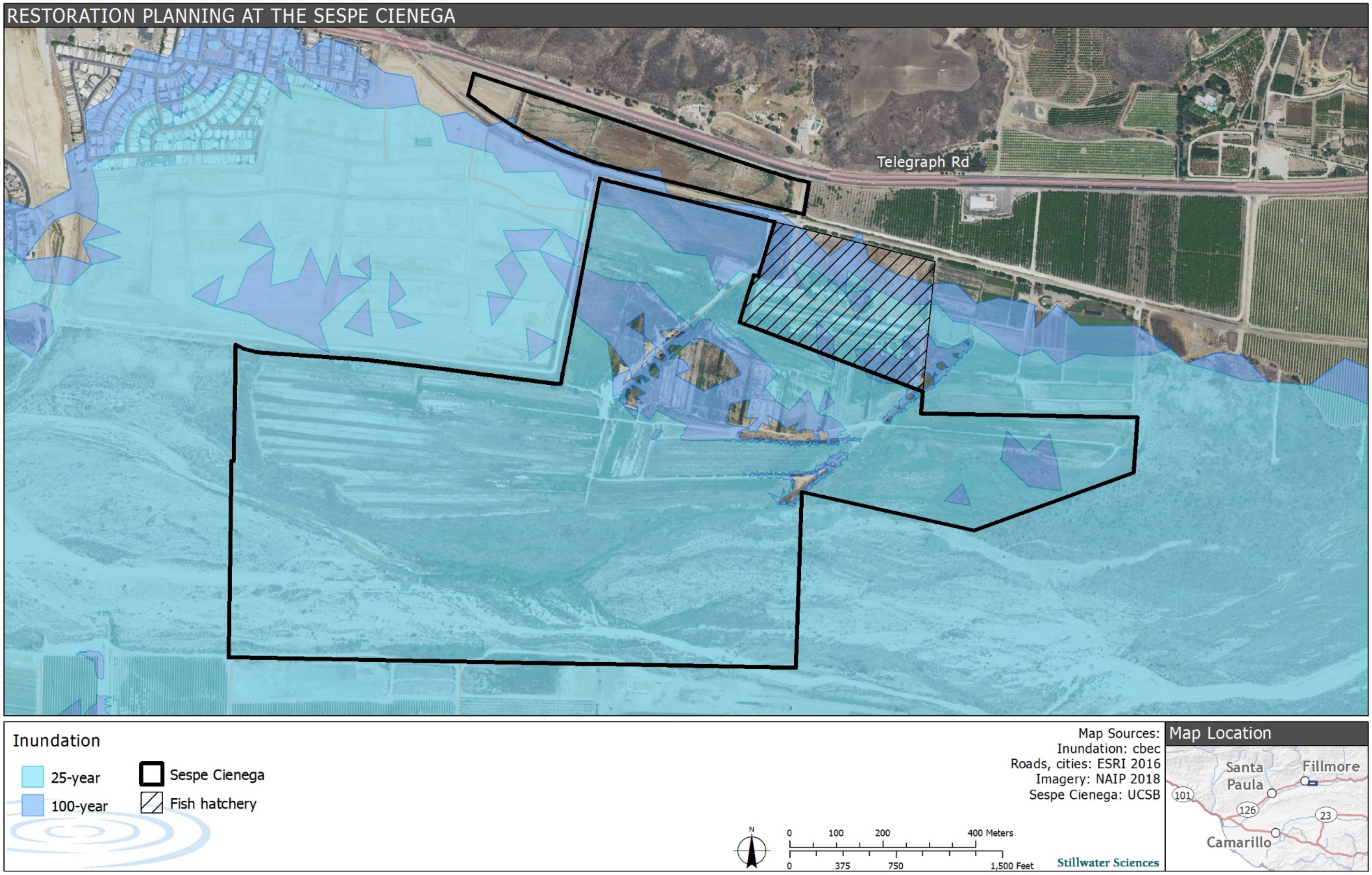

Figure 4-1. Approximate 25- and 100-year flow inundation extents at the Sespe Cienega.

4.2.2 Areas of flood re-working—past and future

Because the CSER site contains the bed of the Santa Clara River and an adjoining floodplain that is subject to significant morphological re-working during flood events, it is critical that infrastructure and active planting are minimized in those areas that are liable to re-working. Previously, areas of flood scour following notable flood events was mapped using post-flood aerial photographs to indicate areas of the riverbed that were completely or partially scoured by the flood event (full details in Stillwater Sciences 2007a). This enabled a valley-wide view of the changeability of the Santa Clara River from 1938–2005 displayed as a probability map of the riverbed occupying a portion of the floodplain (details in Section 2.1.4, and Figure 2-**1**).

Figure 4-2 indicates the re-working, or "reset," of floodplain areas following five recent flood events. The current morphology of the CSER site largely follows erosion that occurred during the last notable flood on the Santa Clara River, during high flows in January and February 2005, estimated to be a 16-year event. It is apparent that the entire southern portion of the site is likely to undergo erosion and deposition processes during such flood events. In even larger events (e.g., the 1969 flood is the gauged flood of record), some three-quarters of the site could be re-worked with only the upslope portion unaffected.

Future changes to the river and floodplain could change some of these patterns. The recent construction of the levee around the adjoining downstream housing development (and other levees locally) may affect scour patterns in future flood events. Conceivably, the hydraulic roughness achieved by the development of a mature riparian forest at the eastern end of the site might act to reduce flood flow velocities and make the CSER more resilient to flood scour in future events. Further detail would require a new two-dimensional hydrodynamic model of area around the CSER.

Figure 4-3 extends the analysis illustrated in Figure 4-2 and illustrates former locations of the active riverbed of the Santa Clara River as a map of weighted probabilities indicating the likelihood of the channel occupying a location. This map is drawn from the same analysis as indicated regionally in Figure 2-1 but is focused on the CSER site. There is a clear corridor in red indicating areas that the riverbed almost always occupies (and would therefore likely occupy in the future) with the less frequently occupied areas in green. Unshaded areas have not ever been occupied by the riverbed in the aerial photographic record. While the general tendency for the channel location is clear, the plot does illustrate quite how changeable the river channel position is and reinforces that those areas more likely to be subject to re-working following flood events should be subject only to passive restoration approaches, given the frequency of their reworking and the likely futility of intensive planting efforts.

4.2.3 Integration with longer-term changes in the river

As indicated in Section 2.1.4, prior analysis has demonstrated that the reach adjacent to the CSER has been subject to narrowing of the channel since 1969 and mild aggradation of the riverbed since 1929. As the floods that drive change and set channel width have not become progressively smaller in time, this suggests the influence of human activities. Given the growth of regulation in the Santa Clara River upstream of the CSER, it also seems likely that flow regulation may be at least partially responsible.

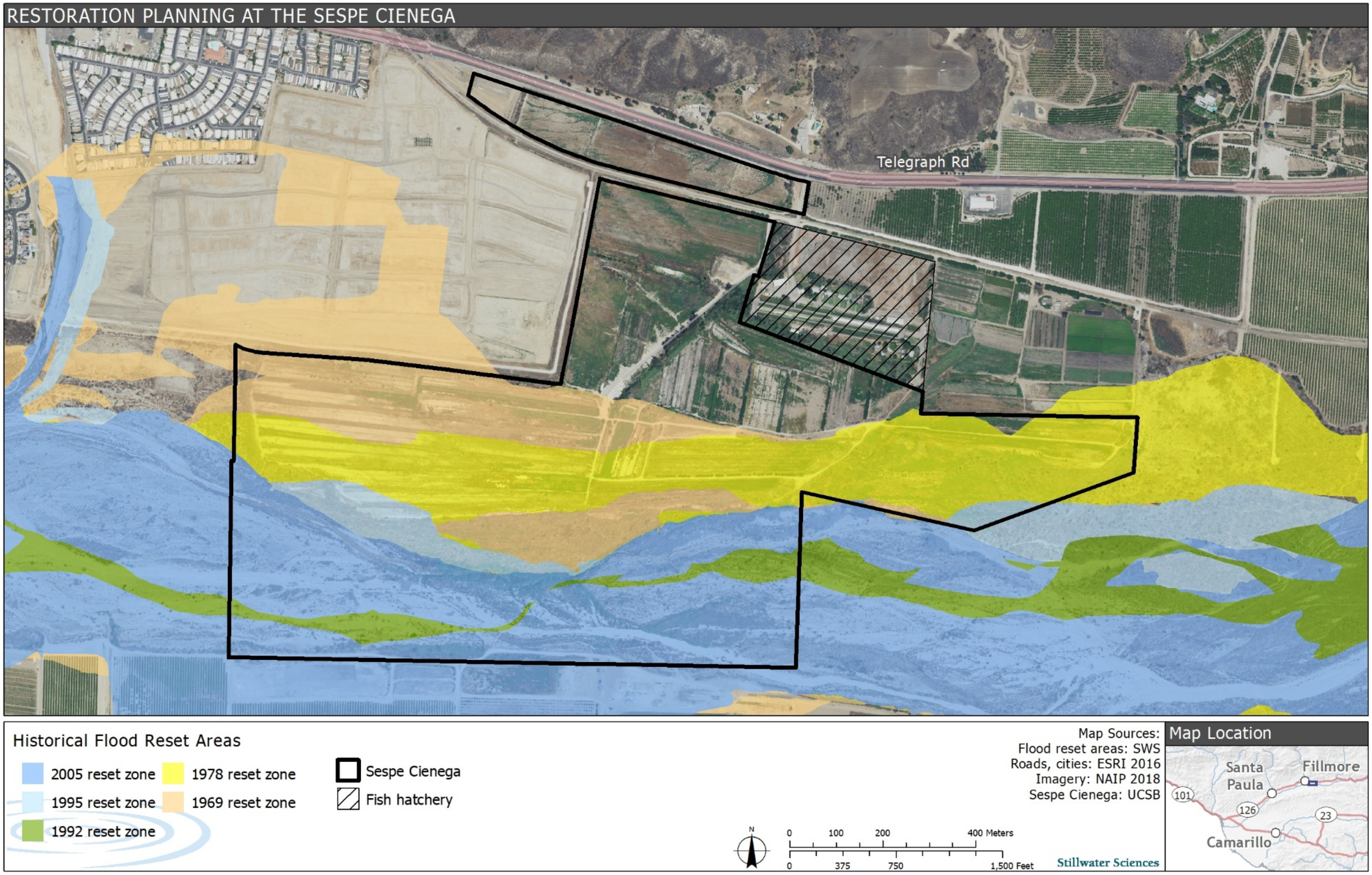

Figure 4-2. Santa Clara River historical flood reset zones along the project site.

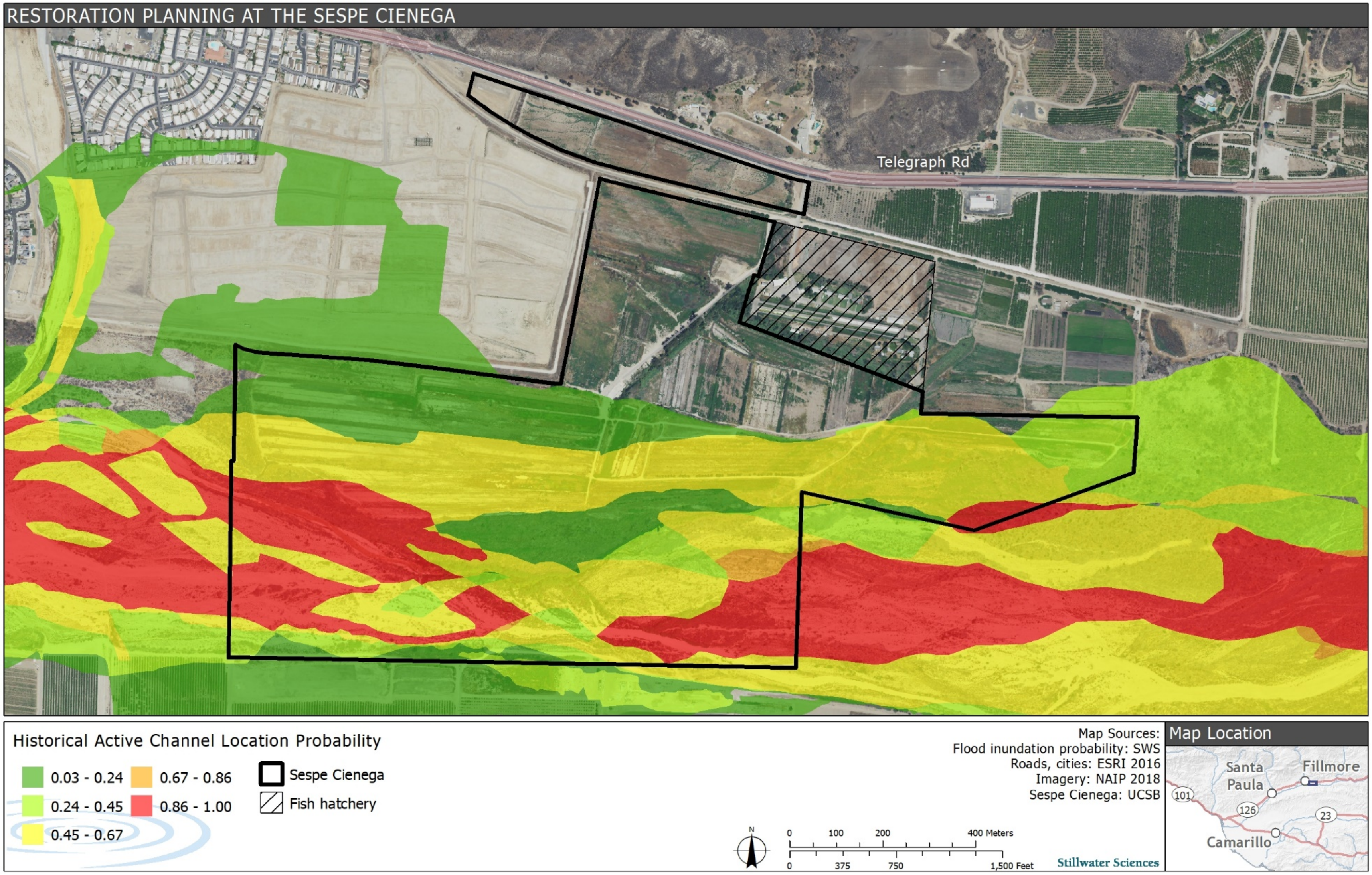

Figure 4-3. Santa Clara River historical active channel location probability zones along the project site.

4.2.4 Understanding of groundwater dynamics

Existing information in the scientific literature (e.g., Greco et al. 2008), personal observations, and unpublished data indicate that native riparian plant species tend to occur in particular topographic positions relative to a river channel. In particular, the relative elevation above the low-flow, or baseflow, water surface in the main river channel is a useful indicator for restoration potential. Relative elevation in a floodplain is generally correlated with depth to groundwater within a given reach (although the relationship will vary depending on whether the reach is a hydrologically gaining, stable, or losing reach), and the frequency of surface saturation and inundation.

Thus, relative elevation, when combined with other GIS layers and field data, provides a powerful tool for assessing restoration potential via passive (natural recruitment processes) or active (horticultural restoration) approaches. Although successful germination of native riparian seedlings depends on a variety of hydrologic and geomorphic variables, seedling survival of phreatophytes such as cottonwoods and willows following germination (or of planted cuttings or container stock under horticultural restoration) is above all contingent on constant contact with the water table and/or its capillary fringe throughout the growing season (McBride and Strahan 1984, Stromberg et al. 1991). Research indicates that when the water table decline is more rapid over a long period than the rate of root growth, seedlings of phreatophytic species become isolated from their water source and suffer high mortality (McBride et al. 1989, Stromberg et al. 1996, Stella et al. 2010). In addition to the importance of groundwater levels for seedling survival, research indicates that groundwater levels play an integral role in determining sapling survivorship and adult riparian community composition (Smith et al. 1991).

In contrast, comparative studies indicate that some non-native invasive plant species (such as tamarisk) tend to be more drought-tolerant than natives, and thus better able to compete along reaches with extreme inter- and intra-annual water table fluctuations (Smith et al. 1991; Freidman et al. 1995; Shafroth et al. 1998, 2000). Thus, to restore self-sustaining hardwood riparian forest, we need to better understand the role of groundwater in species survivorship across time and across species.

Average depth to groundwater, data and maps in Appendix D, will continue to be monitored during implementation in order to guide planting efforts. As restoration and enhancement actions are implemented on the Sespe Cienega, relative elevation mapping can be coupled with groundwater monitoring stations (as described in Section 2.4.4.1) to increase our understanding of groundwater dynamics and increase rate of success when implementing riparian restoration, especially in areas where irrigation of new plantings may not be feasible (e.g., Orr et al. 2014, 2017a,b).

A relative elevation GIS layer was produced for the Sespe Cienega site and adjacent portions of the Santa Clara River using the LIDAR data collected in 2018 and published in 2019 (Figure 4-4). The map displays topographic elevations relative to the low-flow channel elevation with the following categories: less than 0, 0–0.25, 0.25–0.50, 0.5–1, 1–1.5, 1.5–2, 2–3, 3–5, 5–10, 10–20, 20–30, and >30 m.

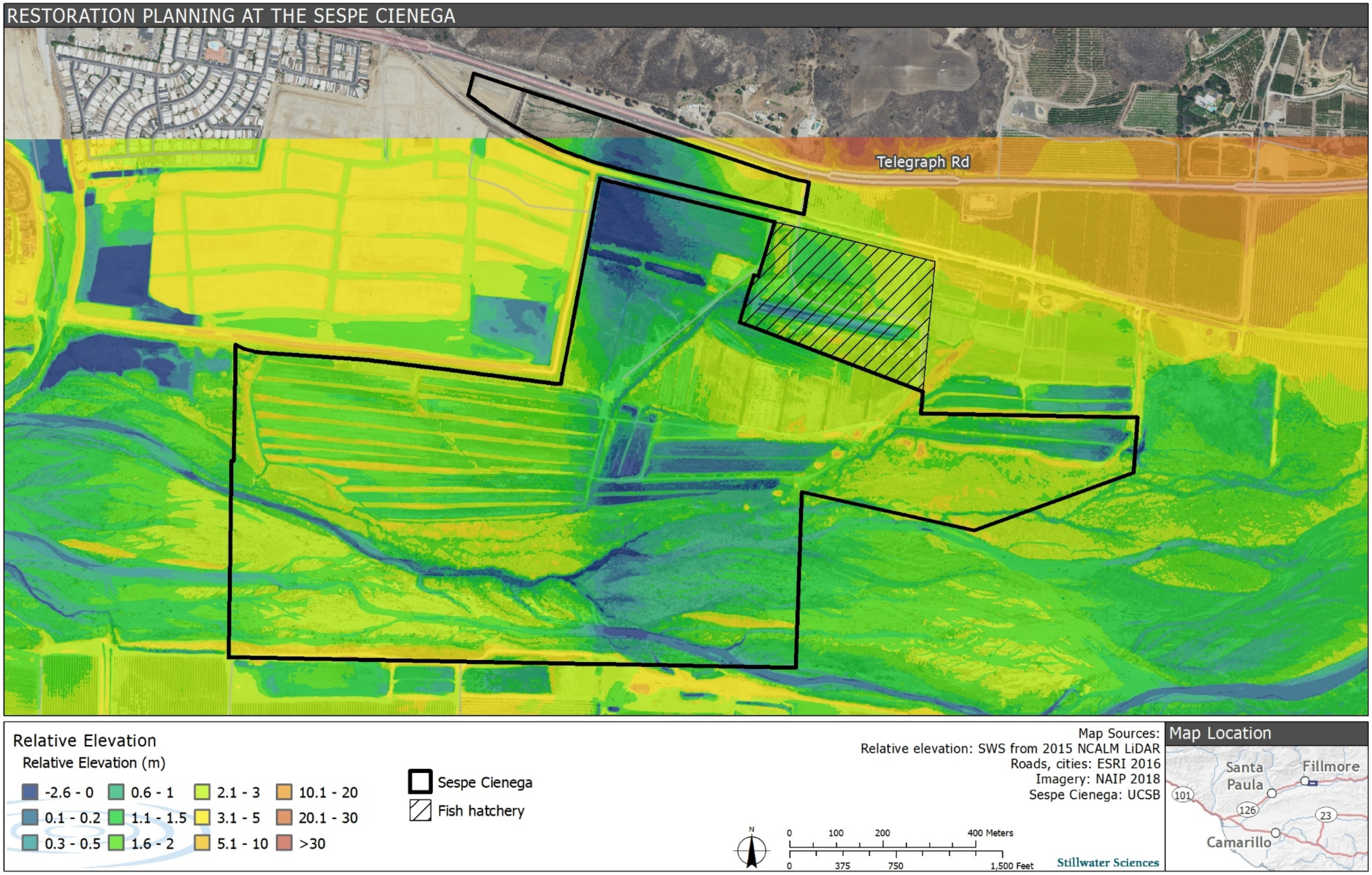

Figure 4-4. Relative elevation for the Santa Clara River within and adjacent to the project site.

4.2.5 Understanding soil variation

The vegetation planting palette is attuned to variations in the physical and chemical properties of soils as they vary across the site. Soil properties were characterized by UCSB (Appendix E), and a series of maps indicating variations in the physical and chemical properties was used to inform the planting design. Soil texture (particle size) was variable across the site with a larger portion of substrate being dominated by sandy soils. Soil texture also influences rates of percolation and evaporation, thus serving as a major control over salinity and pH. Salinity and pH (as measured by conductivity) was greater with distance from the active river channel and areas with higher clay and silt content. Areas in the northern portion of the site had visibly saturated soils for much of the observation period, and residual white deposits during drier periods, indicative of high evaporation and salt accumulation on the soil surface. Generally, soil compaction (as measured by bulk density) mirrored salinity and pH measurements. However, no planting areas were identified as requiring remediation, except along the former agricultural roads that are planned for decommissioning.

4.2.6 Modification of current surface water habitats

The CSER currently contains four primary open-water areas. These include (1) a straight ditch running downslope through the property from the fish hatchery and fed by overflow from the hatchery's well abstractions and operation with some artesian influence, (2) a series of former watercress beds in the downslope portion of the property located in areas with some likelihood of being re-occupied by the channel bed following large floods events (see Figure 4-3), and (3) seasonal depressional ponds towards the northeast and (4) northwest of the property that are fed by artesian upwelling during periods of high groundwater. During wet periods, surface flow from the seasonal wetland in the northeast corner also flows westward through a culvert that feeds water into two man-made ponds. Each is addressed in the restoration design to provide an assemblage of aquatic and semi-aquatic habitats that complement plans for restoring terrestrial habitats and provide an additional expression of native flora and fauna.

4.3 Revegetation Strategies

4.3.1 Developing a palette of suitable species

The development of a palette of suitable plant species to use for revegetation was based on the results from ongoing annual vegetation monitoring of permanent transects throughout the site (Appendix A) and the review of the existing biological communities (i.e., vegetation alliances following Sawyer et al. 2009 and CDFW 2018) on the Sespe Cienega that was previously conducted as part of a larger river corridor mapping study (Stillwater Sciences and URS 2007, Stillwater Sciences 2019; Figure 2-2), and reference site conditions at the downstream East Grove (see Section 4.1.1). In addition, five biological communities or vegetation types (vegetation alliances) have recently been identified and mapped on the Sespe Cienega, including two woodland/forest alliances, one shrubland alliances, and two herbaceous alliances (Lawrey and White 2019). The results of these mapping efforts represent a low diversity and typical assemblage of habitats that provide little to no structure and low value to a small number of plant and animal species. See Design Planting Plan in Section 5.4.

4.3.2 Weed reduction strategies

The percent cover of *Arundo donax* (giant reed or arundo) on the Sespe Cienega was mapped in 2017 using a combination of field surveys and aerial photograph interpretations (including recent imagery collected via unmanned aerial vehicle). Comparison with earlier efforts by California Botanic Garden (under contract with TNC to map percent cover of *Arundo donax* along the Santa Clara River in 2015 based on aerial imagery and field observations) plus observations made by UCSB and Stillwater Sciences in 2017–2019 showed that arundo cover generally decreased during the recent multi-year drought. However, it rebounded with the wetter conditions beginning in 2018 due to increased rainfall in winter 2018–2019 and United Water's flow release operations that included extended spring and summer releases below Santa Felicia Dam to recharge aquifers. UCSB initiated arundo removal in late 2018 and to date, 100% of the stands on the site as well as the adjacent TNC Heritage Valley Properties have received at least one initial herbicide treatment. Follow-up treatments of any remaining resprouts are planned through 2022. Other invasive plants are common across the property (see Section 2.2.1) which will necessitate long-term management to sustain the ecological benefits of restoration. A long-term weed management plan is being developed by UCSB and will provide site-specific guidance for land managers to assist in maintaining restored habitat. The restoration design includes measures to promote plant community resistance and resilience to reduce the need for active weed management. See Weed Management in Section 5.5.

4.3.3 Managing invasive fauna

Invasive animals (African clawed frogs, bullfrogs, polyphagous shothole borer, etc.) are pervasive in the watershed. They are constraints to restoration implementation and factors that will affect habitat value, habitat suitability, and recovery of wildlife at the site. Wildlife species with the most probable impact on the restoration design are identified and management considerations are provided based on best available data.

4.3.4 Reliable source for propagules

Diverse riparian plant communities are present throughout the floodplain and offer ample opportunities for seed and vegetative propagule collection. Project partners, in cooperation with The Nature Conservancy, have an established program for accessing and collecting restoration propagules that represent genetically and ecotypically diverse sources. Collection, storage, and growing protocol will be based on best available science and current restoration practices. The large area that will require revegetation necessitates an on-site growth facility with adequate space for storing materials, possibly under refrigerated conditions, and growing stock that can serve as a reliable source of propagules for the life of the project. Emphasis is placed on both locally adapted species as well as genetic and ecotypic populations that will provide resilience under anticipated climate change. Suggested size and location for these facilities will be developed during the implementation phase.

4.3.5 Active versus passive planting strategies

The type of revegetation—passive, active, or limited active—most appropriate for each management unit at the CSER was identified based on the selected weed treatment type, the amount of proposed grading and anticipated surface flow paths, the proximity of the area to native propagule sources, the potential for inundation by high flows, the elevation and landscape position of the area (including expected patterns of depth to groundwater), and nearby vegetation types.

In areas where floodplain inundation occurs across a wide area, groundwater levels are high, and there is a high potential for flood re-working of the floodplain, revegetation relies primarily on natural recruitment or passive revegetation. These areas are well represented within the lower areas of the CSER property. Vegetation mapping in 2005-2006 and in 2018, and experiments on the nearby Hedrick Ranch, confirm that natural seed sources are adequate for passive revegetation in many reaches of the Santa Clara River, including some portions of the CSER property within the active channel and floodplain (Stillwater Sciences and URS 2007, Stillwater Sciences 2019, Coffman and Ambrose 2011). Passive revegetation is generally ill-suited where flood flows do not inundate at least once every year or two, or where groundwater levels are documented or suspected of being inadequate to sustain plants during the growing season (Stillwater Sciences 2008, 2011). In addition to flood inundation frequency, low or no weed presence (especially arundo), and a diverse assemblage and/or large extent of native plants on-site or nearby that could serve as a seed or propagule source has been used to determine where passive revegetation will be appropriate and effective. These types of areas are generally considered the most appropriate for passive revegetation (Coffman and Ambrose 2011).

Where passive revegetation is not expected to achieve restoration goals because of a lack of upslope or upstream seed supply, less reliable surface inundation, or insufficiently shallow groundwater levels, active revegetation will be implemented. Active revegetation consists of planting, and potentially irrigating during establishment, native species seedlings, cuttings and/or seeds. Active revegetation in the most active or dynamic portions of the floodway (i.e., those portions of the river that are scoured by floods every year or alternating annually) will generally be limited or avoided. Passive revegetation is likely to occur in these areas without any intervention, and subsequent floods are likely to scour active revegetation efforts. In addition to areas with infrequent flood inundation, active revegetation may be recommended for areas where:

- A relatively large area of arundo has been treated;
- Habitat is being restored in a former agricultural field or disturbed area;
- There is a lack of native plants on-site or nearby that could serve as a seed or propagule source;
- There is a high level of site disturbance by humans or the presence of other site conditions (such as great depth to groundwater) that are likely to limit natural revegetation processes; and/or
- Accelerated revegetation is necessary (e.g., highly disturbed or former agricultural areas), to replace the structural habitat needed for least Bell’s vireo and southwestern willow flycatcher, both endangered bird species found in the lower Santa Clara River during breeding season.

Lower cost active revegetation actions (e.g., planting cuttings without irrigation in areas of high groundwater or after wet winters) might also be appropriate in some revegetation areas (e.g., small areas immediately adjacent to the primary flood reset zone). Planting cuttings of willow and cottonwood, which are relatively inexpensive, is more appropriate in areas that receive intermediate levels of scour from flood flows to replace the loss of structure following arundo removal (Stillwater Sciences 2008).

4.4 Consideration of Key Wildlife Species

The Sespe Cienega historically supported a regionally rare complex of native marsh, open water, and riparian habitats that provided critical resources for a diverse array of native wildlife and served as vital link in the landscape-corridor connecting the Transverse and coastal mountain ranges. Recent avian surveys (Appendix G) and ongoing monitoring by UCSB of other wildlife groups (see Section 2.4) document that continuing local and regional importance of this area despite various land and water use alterations that have occurred over the past century.

Important Non-native Habitat: Because the Sespe Cienega property is so degraded currently -- and especially is missing tree cover that provides thermal protection in summer and winter, as well as food and nesting resources -- there are some key non-native plants currently providing resources for breeding and wintering birds that will be retained where feasible while the property is undergoing restoration. Appendix I provides specific recommendations made by Dr. Linnea Hall (Western Foundation of Vertebrate Zoology), based on direct observations in 2019 and 2020, regarding phased removal or alteration of certain non-native habitats.

Considerations to Help Jumpstart Restoration of Native Habitat: Because the full restoration of the property will take many years (and much money) to complete, there is some concern that particular priority bird species will stop using the property because there are no nesting resources available for them because the drought from 2012-2016 killed off so many trees. To address this, there are temporary steps that can be taken to provide resources for such species to ensure that they continue using the property once restoration is complete. Appendix I provides some specific recommendations made by Dr. Linnea Hall (WFVZ) regarding near-term interim actions that could be taken to help enhance habitats that were most degraded by the recent drought to maintain suitable habitat for priority wildlife species until full restoration can be implemented.

4.5 Site Grading Strategies

The site grading strategy was developed based on relationships between surface water and groundwater and areas established for active versus passive restoration. This acknowledges that the CSER is far from a pristine landscape in which restoration requires simply removing current constraints, but that the goals for the site require active intervention for their success.

As indicated under design considerations (Section 3.3.5), the grading strategy is an element of an overall plan for grading that, for economic and ecological reasons, minimizes (and ideally eliminates) the need for import or export of material from the site.

This strategy was incorporated into the restoration design. In particular, see Section 5.2 for proposed changes to surface flow pathways and Section 5.3 for the basic grading plan that underlies the design drawings presented in Appendix J.

4.6 Public and CDFW Access and Infrastructure Elements

A critical requirement in the planning effort for the CSER is for public access elements that provide for environmental education and access to the river and the associated, diverse habitats, but that does not conflict with the designation of the site as a CDFW ecological reserve and other site requirements as delineated by CDFW (see Section 2.3). In summary, the following site considerations guided the design team and CDFW staff:

- Maximizing ecosystem restoration at the site to provide a notable CDFW ecological reserve.
- Protection of wildlife on the site, especially as it relates to special-status species.
- Continued and expanded operation of the CDFW fish hatchery.
- Dedicated space for the construction of several offices to provide facilities for regional CDFW staff.
- Parking facilities for ecological reserve visitors arriving at the site by foot, bicycle, or car.

- Linkage with the proposed pedestrian/bicycle trail from Fillmore adjacent to the railroad tracks.
- A public access trail network that provides access to site's range of ecosystem elements and to the river, and provide a compelling visitor experience, but does not facilitate site access or egress other than in designated areas. The Final 100% design is intended to depict a footprint of restoration design and trail system. The proposed trail alignments, profiles, and widths are compatible with future American Disability Act (ADA) compliance, if and when CDFW or another party is able to support the final design of the trail surfacing and required State Architect's Office review.
- Provision of environmental education elements along the trails using information panels/kiosk, native plant and bird viewing areas, and potentially seating where appropriate.
- Access to shaded "green space" seating/gathering area(s) that helps fulfill the lack of such experiences locally.

5 FINAL 100% DESIGN

Developing from the various project goals, objectives, design considerations, assessed elements, and discussion among the group, Figure 5-1 illustrates the current general design for the CSER (more detailed 100% design plans are included in the Final 100% Planset, Appendix J). The design in Figure 5-1 illustrates various attributes of the restoration proposal including proposed revegetation elements, alterations to surface water flow pathways, the provision of a suite of trails, and indication of infrastructure requirements (parking, CDFW facilities etc). Detailed figures related to certain aspects of the design are provided in the following sections. Table 5-1 details the vegetation habitat type within the series of management units (MUs). The totals at the final rows of the table compare the area of the CSER, 283 ac total; to the Restored Areas within Sespe Cienega land (CSER and CDFW hatchery adjacent land, excluding hatchery), 291 ac total; to the total area of Sespe Cienega (CSER and all CDFW land including hatchery and other CDFW infrastructure), 297 ac total.

5.1 Site Revegetation and Proposed Management Units

Table 5-2 outlines the MUs and their target vegetation habitat type, based on the site's biophysical and ecohydrological characteristics (see Appendix H and Orr et al. 2014, 2017a, b). Site revegetation design accounts the finer scale patterns of micro-topography, soils (texture, salinity, nutrients; Appendix E), water availability (surface water flows, fluctuating depth to groundwater; Appendix D), potential flood re-working of floodplain areas of the site (Figure 4-2), existing patches of desirable native vegetation (Appendix A), and presence of non-native invasive species that require control measures and influence implementation.

Detailed plans for each MU have been developed including a palette of appropriate native plant species, spacing, and quantities selected to match conditions found within each unit and target habitat type (Section 5.4). Several of these habitat types, as well as some of the suggested species, are listed as rare or sensitive in the California Natural Diversity Database (CNDDB). Additional site-based knowledge developed from ongoing research and monitoring will be applied, which may result in modifications of the MUs or changes in the targeted habitat types within each unit. While many other factors also contribute to the success of plant establishment and species distributions within riparian zones (e.g., shade tolerance and other competitive abilities, proximity to seed source, intensity of herbivory or other disturbance, presence of disease), the extensive analyses of physical processes in the Santa Clara River valley and various riparian areas therein, and ongoing research at the CSER by UCSB, mean that the MUs already incorporate a significant database of regional and site-specific knowledge. Thus, the MUs described in Table 5-2 summarize the basis for determining general priorities for habitat restoration and enhancement actions such as earthmoving, continued weed management and reduction, and revegetation within the CSER.

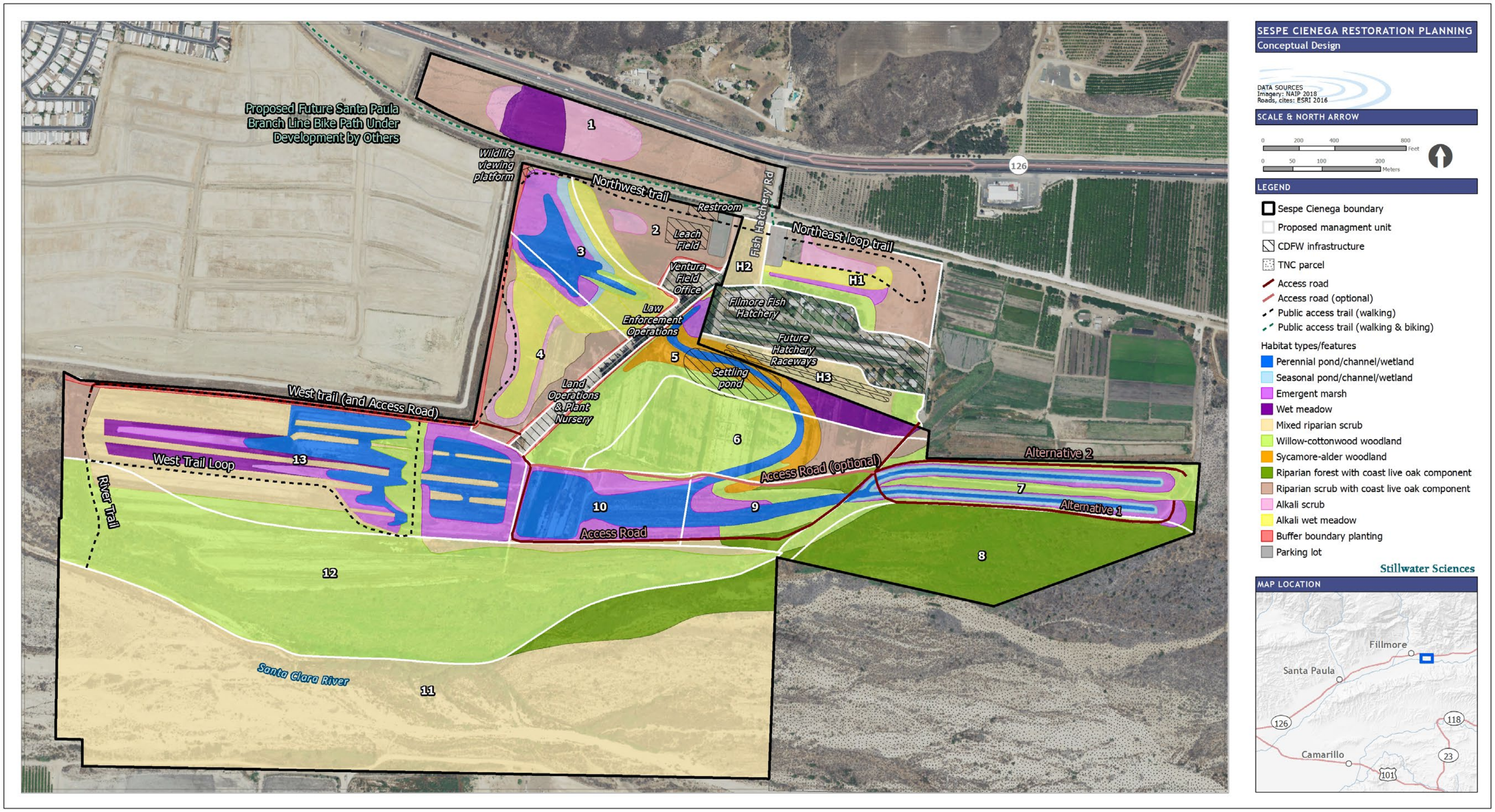

Figure 5-1. Proposed management units, habitat types and design features for the Sespe Cienega site.

Table 5-1. Sespe Cienega Restoration Plan acreage summary.

Management Unit/Planting zone	MU 1	MU 2	MU 3	MU 4	MU 5	MU 6	MU 7	MU 8	MU 9	MU 10	MU 11	MU 12	MU 13	MU H1	MU H2	MU H3	CDFW	Hatchery	Total
Alkali Scrub	3.2	0.5	--	1.6	--	--	--	--	--	--	--	--	--	0.9	--	--			6.2
Alkali Wet Meadow	2.4	1.1	2.4	4.1	--	2.6	--	--	--	--	--	--	--	1.2	--	--			12.9
Buffer Boundary Planting	--	0.2	0.4	1.0	0.5	--	--	--	--	--	--	--	1.9	--	--	--			3.9
Riparian Forest with Coast Live Oak Component	--	--	--	--	--	--	0.4	17.4	1.8	--	6.61	--	--	--	--	--			25.8
Emergent Marsh	--	--	2.1	0.5	0.4	--	2.8	0.1	1.0	2.5	--	--	5.0	0.5	--	--			14.8
Mixed Riparian Scrub	--	--	--	1.3	--	--	--	--	0.3	0.6	72.1	2.6	12.7	--	1.6	3.0			94.1
Perennial Pond/ Wetland	--	--	2.1	0.4	0.8	0.7	1.9	--	1.9	5.4	--	--	8.5	--	--	--			21.7
Riparian Scrub with Coast Live Oak Component	7.5	5.2	--	3.2	0.1	--	0.3	--	--	--	6.6	--	1.5	4.0	--	--			21.8
Seasonal Pond/ Wetland	--	--	0.7	--	--	--	2.1	--	--	--	--	--	--	--	--	--			2.8
Sycamore-Alder Woodland	--	--	--	--	2.4	1.0	--	--	0.2	--	--	--	--	--	--	0.4			4.0
Wet Meadow	--	--	--	--	1.9	--	--	--	--	--	--	--	3.2	--	--	--			6.3
Willow-Cottonwood Woodland	--	--	0.5	--	6.4	9.5	6.1	0.6	2.2	0.5	--	45.3	4.5	1.2	--	0.6			77.3
Non-Planted (Pkg Lot, Native Plant Nursery, CDFW Facilities, Entrance Rd)	0.6	0.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.4	9.1	14.5
Total Acres Sespe Cienega	**13.6**	**7.5**	**8.2**	**12.1**	**12.5**	**13.7**	**13.5**	**18.0**	**7.3**	**9.0**	**78.7**	**47.9**	**37.2**	**8.8**	**1.6**	**4.0**	**3.4**	**9.1**	**297.1**
Total Acres Cienega Springs Ecological Reserve	**13.6**	**7.5**	**8.2**	**12.1**	**12.5**	**13.7**	**13.5**	**18.0**	**7.3**	**9.0**	**78.7**	**47.9**	**37.2**				**3.4**		**282.7**
Total Restored Areas within Sespe Cienega Lands	**13.1**	**7.0**	**8.2**	**12.1**	**12.5**	**13.7**	**13.5**	**18.0**	**7.3**	**9.0**	**78.7**	**47.9**	**37.2**	**7.9**	**1.6**	**4.0**			**291.7**

Table 5-2. Sespe Cienega Restoration Site—target habitat and other design considerations.

Mgmt. Unit	Proposed target habitat	Current vegetation and hydrology	Design considerations	Notes	Acres
1	Riparian scrub with coast live oak component, alkali scrub and grassland understory; central area of wet meadow.	Fallow field, recently high levels of soil saturation. Invasive weeds include prickly Russian thistle, shortpod mustard, horseweed, and castor bean.	Indications of seasonal ponding might affect survival of woody plantings. Modest amounts of excavation and mounding to increase topographic complexity for revegetation. Enhance for pollinators (native milkweeds and other flowering plants).	Riparian scrub with coast live oak component areas include a mix of valley oak and coast live oak, with elderberry, walnut, and native grasses and forbs. Patches of coastal sage scrub. Some variation of alkali scrub in lower zones and coastal sage scrub on higher relative elevation sites. Pilot plantings suggested in this unit to test suitability of different species and source materials given the variable moisture availability in dry versus wet years.	13.1
2	Riparian scrub with coast live oak component, alkali scrub, and grassland understory; transitioning to wet meadow near western edge; buffer boundary planting adjacent to planned Ventura Field Office.	Fallow field, high levels of soil saturation. Invasive weeds include prickly Russian thistle, shortpod mustard, horseweed, castor bean, and perennial pepperweed.	Use excavated material from Unit 3 to create more topographic complexity for range of vegetation plantings. A second parking lot could be constructed at east end to complement the main lot at west end of Unit H1.	Similar planting mix to Unit 1. Future CDFW restrooms in the NE corner of the unit and potential overflow parking lot in the SE corner of unit. Exclude the raised pad area that CDFW wants to use for offices, etc.in the southeast corner and the area designated for CDFWs septic field in the eastern end.	7.0

Mgmt. Unit	Proposed target habitat	Current vegetation and hydrology	Design considerations	Notes	Acres
3	Mixed wetland: Emergent marsh; perennial and seasonal wetland; alkali wet meadow, Riparian scrub with coast live oak component/native grassland around margins on higher relative elevation sites; willow-cottonwood woodland; and buffer boundary planting along west and east edge.	Standing water appears to be natural artesian springs/shallow groundwater feeding this area; includes excavated ditches that at some time might have had connection to hatchery outflow, but no sign of that now. Emergent aquatic vegetation including cattails, sedges, rushes. Invasive weeds common in drier areas.	Additional excavation at the western end to create deeper area for perennial wetland; connect to linear ditches. Use excavated material to create more topographic complexity in Unit 2. Larger trees (willows and cottonwoods) at western end to provide visual screen from residential development.	Perennial wetland at western endto stay inundated in most years, with elevation transition slope to seasonal marsh and then upland at eastern edge.	8.2
4	Riparian scrub with coast live oak component towards eastern and western edges; central portion with alkali wet meadow bordered by alkali scrub and mixed riparian scrub; northern portion includes wet meadow and small portions of emergent marsh and perennial wetland associated with Unit 3; buffer boundary planting along west and east edges.	Drier than fields to the north; Dominated by Bermuda grass, annual weeds, and perennial pepperweed.	Restoration plant growth facility at eastern end of unit. Larger trees (oaks and sycamores) at western end to provide visual screen from residential development.	Some similarities with Unit 1 and 2. This is another appropriate area for planting a diversity of genetic stock of riparian vegetation for use in restoration in various units.	12.1

Mgmt. Unit	Proposed target habitat	Current vegetation and hydrology	Design considerations	Notes	Acres
5	Stream and Riparian Woodland; mix of sycamore-alder, willow-cottonwood, wet meadow, and emergent marsh; buffer boundary planting along west edge adjacent to CDFW infrastructure area. Settling pond will be designed under separate contract to provide water quality treatment of fish hatchery outflow.	Heavily modified stream channel for hatchery outflow conveyance. Mix of native riparian vegetation. Heavily infested with non-native species including Eucalyptus, palms, castor bean. Bordered by former agricultural fields (row crops) with annual weeds.	Remove Eucalyptus and other nonnative vegetation (with consideration of existing wildlife use). Reconstruct a more sinuous and natural looking stream channel (which will feed into the settling pond designed under separate contract), lined with alder, red willow, narrowleaf willow, and cottonwood (Fremont and black cottonwood) with enhanced native understory of shrubs, forbs, and grasses.	Remove/reduce artificial structures. Consider removing concrete pads in southern end. Location for planned construction of hatchery settling ponds designed under separate contract.	12.5
6	Riparian scrub with coast live oak component and grassland understory in the eastern portion, willow-cottonwood woodland in western portion; with stream aquatic and sycamore-alder woodland along banks of the new channel.	Moist to very dry. Primarily weedy annual vegetation, rows of pomegranate trees.	Sufficiently moist for boxelder and sycamore at northern end. Reconstructed stream channel with riparian vegetation.	Similar planting mix to Unit 1 for Riparian scrub with coast live oak component and Unit 5 for the riparian habitats. Add narrowleaf willows along the new channel to take advantage of the perennial flow to provide more reliable southwestern willow flycatcher habitat in all years, but particularly during drier years.	13.7

Mgmt. Unit	Proposed target habitat	Current vegetation and hydrology	Design considerations	Notes	Acres
7	Riparian scrub with coast live oak component, willow-cottonwood woodland; and seasonal to perennial flowing and standing water features throughout.	Former watercress beds. Currently flowing water from artesian features. Vegetation includes giant reed, watercress, cattails, and sedges.	Plant former watercress beds with cottonwood-willow woodland around margins, with emergent marsh surrounding seasonal and perennial water fed by artesian features during wetter years. Potential to add water during drought years via the well in the NE corner of this unit.	Relocate the road to the southern edge of the unit to existing high ground. Target willow-cottonwood woodland surrounding road to promote southwestern willow flycatcher habitat in the areas least likely to be disturbed by the road usage and maintenance.	13.5
8	Sycamore-alder woodland and willow-cottonwood woodland.	Recently was a giant reed monoculture but has since been mowed with one herbicide retreatment. Can be wet but was also drier during the drought.	Both cottonwoods and willows in wetter areas, with more walnut, elderberry, and sycamore in drier portions.	Many trees died during the recent drought. Active plantings will be used to restore a diverse mix of native trees, and passive revegetation will be promoted in some areas that are wetter or more likely to be inundated during annual high flow events.	18.0
9	Sycamore-alder woodland surrounding seasonal and perennial water features; oak woodland with riparian scrub at northern edge.	Former watercress beds. Currently flowing water from artesian features. Vegetation includes tamarisk, watercress, cattails, and sedges.	Target habitat and planting palette will depend, in part, on how wet this area is likely to be after rerouting flow from the reconfigured hatchery effluent channel to the north.	Install flow control structure to convey artesian water from Unit 7 during wet periods. Scarify decommissioned road for seeding/planting. If water flow is persistent enough, this area has potential for SWFL breeding habitat similar to Unit 7. Add more willows in northwest portion to take advantage of the perennial flow in the new channel, which would provide more reliable SWFL habitat during drier years.	7.3

Mgmt. Unit	Proposed target habitat	Current vegetation and hydrology	Design considerations	Notes	Acres
10	Open water ponds and emergent wetland with seasonal wetland fringe.	Open water ponds and emergent wetland; former watercress beds.	Enhance existing pond and wetland habitat in western portion, excavate to increase open water area; modify/remove berms to increase connectivity; use excavated soil to create islands, create seasonal wetland transition in eastern end.	Scarify decommissioned road for seeding/planting.Look for opportunities to create additional SWFL habitat by adding willows along banks of some open-water areas, particularly where there is slow moving water.	9.0
11	Riparian scrub with interspersed patches of alluvial scrub	Active channel/floodplain: riparian scrub with giant reed; includes patches of alluvial scrub.	Maintain more open alluvial scrub habitat suitable for horned lizards and kangaroo rats.	Attention will need to be paid to the river access trail at western end and ways to limit unintended impacts of human use in this area.	78.7
12	Cottonwood-willow forest in floodplain, mixed riparian scrub interspersed; scattered ephemeral wetlands	Formerly giant reed monoculture; masticated and receiving second herbicide treatment.	Consider locating willow mitigation here.	Maintain topographic complexity in the former watercress beds to promote more diverse habitats and increased resiliency to variable hydrology. Look for opportunities to create additional SWFL habitat by adding willows along banks of some open water areas, particularly where there is slow moving water	47.9

Mgmt. Unit	Proposed target habitat	Current vegetation and hydrology	Design considerations	Notes	Acres
13	Perennial and seasonal wetland suitable; riparian scrub and Riparian scrub with coast live oak component at western edge; willow-cottonwood woodland surrounding potential public access trail between perennial wetlands.	Formerly watercress beds; currently mix of native and non-native aquatic and weedy plant species, some tamarisk. Stinging nettle and yellow monkeyflower abundant. Willows are establishing in southern portion of area.	Emergent marsh with some open water in lower elevation areas to the east grading to emergent marsh and then upland riparian to the west. West Loop seasonal trail runs through this unit.	Maintain topographic complexity in the former watercress beds to promote more diverse habitats and increased resiliency to variable hydrology. Look for opportunities to create additional SWFL habitat by adding willows along banks of some open water areas, particularly where there is slow moving water	37.2
H1	Wetland swale in center with willow-cottonwood to south; parking lot and native species plantings at northwest end; remainder as open alkali scrub/Riparian scrub with coast live oak component.	Open field with aquatic vegetation in a shallow channel at southern end.	Provide a kiosk area at west end near parking lot to orient and educate visitors. Include map of site with some background on native species and habitats, plus rules for use of the CESR. Maintain existing native plan educational area near the western end of this unit.	Consider picnic options and a short loop nature trail. Hatchery facility considering relocating houses to field. Expand the shallow to the north so more water is retained in that area, promoting more aquatic/riparian species. This feature may dry out during dry periods.	7.9
H2	Riparian scrub with interspersed patches of alluvial scrub.	Castor bean and other weeds with some remnant native shrubs and trees.	Consider some native tree plantings around margins, perhaps mainly at southern edge if there is a desire to provide visual screening of the fish hatchery.	Connector trail across northern end. Could also expand 'riparian habitats' demonstration plantings.	1.6
H3	Cottonwood-willow, sycamore-alder woodland, and mixed riparian scrub.	Extensive native aquatic and riparian vegetation; some palms, tamarisk and shamal ash. Giant reed has been treated.	Consider red willow, both cottonwood species, sycamore, box elder.	Potential source of propagules for restoration. Future hatchery raceway expansion location. Optimal planting plan and level of effort may depend on anticipated timing of raceway expansion.	4.0
Total					**291.7**

5.2 Changes to Surface Flow Pathways

In addition to restoration via re-vegetation, the CSER restoration objectives include improving the extent and range of fully- and semi-aquatic habitats by modifying the site's surface water drainage patterns. In most years, the existing surface water flows at the CSER are largely artificial in origin, stemming from aquifer water withdrawals for fish hatchery requirements. The proposed surface water drainage pattern will be modified to develop sustainable ephemeral, seasonal, and perennial wetland features.

Currently, hatchery effluent flows empty into a small pond at the western end of the fish runs before flowing southwest in a vegetated channel terminating at culverts feeding watercress beds. The proposed design will relocate the current straight ditch to the east of the current position (Figure 5-1), to a more sinuous hatchery effluent channel and settling pond in Unit 5. The below-grade settling pond will be used to treat hatchery effluent by allowing the solid pollutants to settle to the bottom before flowing to the river. This settling pond provides both water quality improvements and increase soil moisture over a greater area which will increase the extent of adjacent aquatic, wetland, and riparian habitats that directly benefit from proximity to surface water flows. The outflow from the settling pond in Unit 6 and those percolating into the former watercress beds from rising subsurface flows near the east boundary of the site in Unit 7, will be routed through the modified watercress beds in Units 9, 10, and 12, and 13 according to the intention to provide open water, wet meadow, emergent marsh or seasonal wetlands (Figure 5-1).

Those units receiving outflow from the hatchery and settling pond (Units 5, 6, 9, 10, and 13) should have the most reliable supply of surface water and local shallow groundwater recharge. Therefore, assuming fish hatchery operations and water use continue as expected, these units are likely to be the most resistant and resilient to changes in hydrology during drought periods. In addition, during wetter periods, Unit 7 receives water from artesian springs and groundwater upwelling that creates surface flow through the management unit. A proposal for the Fillmore and Piru Basins Groundwater Sustainability Agency to provide supplemental pumped water during drought years to Unit 7 from the supply well at the east end of Unit 7 is currently under discussion.

Flow out of Unit 7 will pass under the proposed road realignment through a proposed 12-ft precast reinforced concrete box culvert. No flow data are available for sizing this culvert, but aerial imagery indicates that existing flow has a top width of approximately 10-12 ft. The culvert will be embedded a minimum of 2 ft for enhanced wildlife passage.

The existing culvert along the border of Unit 7 and 9 will be replaced with two adjacent 6-ft precast reinforced box culverts. The proposed culvert configuration is expected to increase the total flow conveyance into Unit 9 from Unit 7. This configuration also allows the potential use of simple plywood stoplogs on one or both of the culverts to direct more flow south into Unit 12 if needed. The culverts could also be retrofitted with a more formal stop log bay feature in the future if needed.

The existing culverted channel that flows south from Unit 7 into Unit 11 will be plugged, and a new channel will be graded through the existing road (to be decommissioned) to direct flows from the southwest end of Unit 7 (i.e., any flows that are redirected from the preferred flowpath into Unit 9) into Unit 12.

The flows from the effluent channel (Units 5/6) and from Unit 7/9 enter Unit 10 headed west. The access road in the middle of Unit 10 will be decommissioned and breached to allow surface flows to continue west. The existing culvert unit by the access road at the border between Unit 13 and Unit 10 will be replaced with a 6-ft precast reinforced concrete box culvert to accommodate the anticipated increase in flows. Though it is difficult to quantify the expected flowrate, it is expected that any increase from the existing 36-inch culvert is beneficial.

In Unit 13, the field flood control system of culverts along the east end of the unit will be removed and plugged. The existing watercress beds will be selectively breached as shown in the planset to direct flow into the existing ditch that runs west along the northern border of Unit 13. Another 6-ft precast box culvert is proposed to convey flows through the proposed West Loop Trail and into the western portion of Unit 13. Minor handwork is proposed to discourage flow from continuing to the western border of Unit 13 and encourage more surface flows to stay in the proposed perennial/emergent wetland habitat in the middle portion of Unit 13. Three 36-inch corrugated metal pipe (CMP) culverts are proposed to convey minor surface flows east-west through the West Loop Trail segment that bisects Unit 13. These culverts will improve surface flow connectivity and allow for additional wildlife passage. All culverts will be embedded a minimum of 30-50% the height of the culvert per CalTrans/CDFW standard guidance for wildlife passage.

Grading is proposed at the downstream end of the site in Unit 12 to fill the existing flowpath that currently directs flows originating from on-site to the Santa Clara River. The proposed fill will keep more low surface flows within the CSER.

Culvert design sizing must be reviewed and updated in conjunction with the design effort for the settling pond/effluent channel feature. Additional understanding of the expected flows through the Unit 7 culverts is also required to finalize the culvert sizing in Unit 7. Proposed culverts are not intended to accommodate any specific design river flow (e.g., 100-yr) because most of the site is inundated during large flood events.

Field survey is required for final culvert installation design, and/or this may be designed in the field by the selected contractor.

A summary of proposed culverts and existing culverts to be removed is included in the design planset on Sheet 4. Table 5-3 is a summary of changes to flow by management unit.

The existing flow paths in the southern areas (Units 8 and 11) will not be modified. Unit 11 is in the active floodplain and will rely largely on passive restoration to achieve the habitat targets of mixed riparian scrub and some coast live oak riparian. Unit 8 is also more exposed to active floodplain processes than units to the north, so passive restoration will be promoted, along with strategic active planting, to meet the target of developing a diverse coast live oak riparian forest.

Table 5-3. Design elements by management unit.

Units/Trails	Changes to surface flow	Grading	Approximate cut and fill volumes
1	Local changes	Expand two low ponding areas. Eastern area of unit 1 will be raised (1 ft–2 ft) with the excavated soil from low pond area to create topo complexity for habitat	865 cy cut 1579 cy fill* (*can be reduced to 865 to balance locally)
2	Local changes Unit 2 flows southwest into Unit 3	Site of future leachfield (by CDFW) -preliminary est. 3000CY, design to be completed by others Potential cut material disposal site, likely will require imported fill Fill to level parking area	0 cy cut 3,492 cy fill
3	• Flow will follow natural path through various cuts graded into existing berm and no longer follow ditch/berm. • Existing culverts removed post construction.	Unit 3 grading will breach existing berms to create connectivity across the unit. Existing ditch feature will be removed to create topographic variability. Post-construction, existing road between Units 3 & 4 will be removed and revegetated.	2,482 cy cut* (*option to reduce to balance locally) 780 cy fill
4	Local changes, Unit 4 flows continue southwest into Unit 13.	Grading will increase variability through creation of mounds, potentially using fill from Unit 3.	75 cy cut 1,235 cy fill* (*option to adjust fill up or down)
5 & 6	Existing ditch will be relocated a little to the east of current position to a curving hatchery effluent channel and settling pond in Unit 5. The below grade settling pond will be used to treat hatchery effluent by allowing the solid pollutants to settle to the bottom before flowing to the river.	Units 5 & 6 will be graded to accommodate gravity-driven settling ponds and channel from effluent from onsite hatchery. Current grading is conceptual and schematic until settling pond design is completed with new information (under separate contract).	21,000 cy cut* 0 cy fill (*preliminary estimate—to be evaluated under separate contract)
7	Unit 7 flow will continue west, both north and south of the existing road and confluence in Unit 9	Grading to move road to south or north border or Unit 7 (grading shown for southern alignment; property survey required for potential northern alignment) Grading along border with Unit 9 captured here.	695 cy fill 5249 cy cut (*includes removal of large stockpiles in Unit 7 road alignment)
8	No changes to existing flow	No grading planned. Passive restoration will be employed as much as possible.	
9 & 10		Continuation of effluent channel from Unit 5/6	213 cy fill 1993 cy cut (*design of channel may change in future phases)

Units/Trails	Changes to surface flow	Grading	Approximate cut and fill volumes
11	• No changes to existing flow pattern • Passive restoration will be employed	Minor channel grading to plug flow and redirect into Unit 12	35 cy cut 58 cy fill
12	• Some changes to existing flow pattern • Active revegetation will be employed, but passive revegetation will also be employed	Grading will include local topographic variability and connectivity Fill existing channel at downstream end of site	5 cy cut 355 cy fill
13	• Some changes to existing flow pattern • Active revegetation will be employed, but passive revegetation will also be employed	Grading will include local topographic variability and connectivity	17 cy cut 17 cy fill
H1	Local drainage to wetland area expanded.	Excavation work to expand and create more flow into east/west ditch. Ditch will be widened to provide additional flow capacity and topo variability. Unit is slightly net export. Fill to level parking area.	852 cy cut 155 cy fill
Fish Hatchery Road	N/A	Potential fill location to rework entrance road	0 cy cut 1100 cy fill
West Trail Loop	East/West flow will be conveyed with culverts	Significant grading to create trail at elevation higher than surroundings	1860 cy cut 2935 cy fill
Perimeter Trails	Minimal impact	Minor grading to be field-fit to minimize local cut/fill	737 cy cut 540 cy fill
Total cut and fill within Management Units (MUs)			**5230 cy complete-in-place**
Total transport between MUs			**8,553 cy fill 29,930 cy cut**
Total Net Export (*includes prelim. estimate of settling pond/effluent channel cut, to be completed under separate contract)			**22,332 cy cut**

5.3 Grading

The grading objective is to improve hydrological connectivity in the floodplain and maximize wetland habitat potential by breaching the berms along the watercress beds to enhance surface flow connection. Further, the creation of trails and car and bicycle parking facilities may require local grading actions, and there may be a requirement for re-surfacing some of the trails.

Limited site recontouring, including actions to restore floodplain connectivity via berm breaching or removal, culvert removal and bridge upgrading, actions related to site access development, and disturbed area cleanup (e.g., the vegetative debris/slash mounds throughout the site) will be implemented in selected areas on the site. In terms of achieving revegetation objectives, where required, grading serves mainly to create a suitable relative elevation between the ground surface and available subsurface flow. Earth moving is required to develop the new surface drainage configuration. Alterations to existing topography and cut/fill volumes by management unit are summarized in Table 5-3.

Grading plans were developed to create natural flow to permit the active and passive habitat restoration goals on site. The overall site grading strategy involves:

- Limiting the volume of grading overall, in part to minimize grading expenditure (in addition to minimizing soil export from the site);
- Avoiding grading in areas that fall under US Army Corps of Engineers jurisdiction to reduce the need for permitting; and
- Utilizing gravity controls on surface water flows and the site's relative elevation to groundwater level to minimize the vertical extent of grading required.

Additional engineering and earthmoving directed in the field to increase topographic complexity and habitat diversity (including perennial or seasonally inundated channels and floodplain wetlands, in addition to a variety of riparian habitats). See Stillwater Sciences 2008 for additional discussion of this strategy and its application along the Santa Clara River.

Existing conditions include limited stockpiles (mounds) of materials such as mulch and soil or gravel. These materials may be redistributed on site to enhance topographic complexity and increase microhabitat diversity in some management units. Estimated volumes for these stockpiles are not included in Table 5-3, but are included in the Opinion of Probable Cost.

Most of the proposed trails and access road will work with existing grades, with very little grading currently planned. The main exception is the West Trail Loop through Unit 13, which takes advantage of higher grounds on existing berms but still will require significant grading where the proposed trail cuts across existing watercress beds.

Note that the current grading plan is showing a large volume of material export, which is largely from the settling pond. Additional engineering work is needed to balance materials on site, but this work cannot be completed until there is a settling pond/effluent channel design in place (to be completed under separate contract).

The proposed leach field in Unit 2 (est. 3000CY) will also be completed by others, and it is unknown whether there is suitable material available on site to construct this feature.

5.4 Planting Plan

Revegetated areas will include upland habitats (e.g., coast live oak riparian, coastal sage-scrub) and wetland habitats (e.g., emergent marsh, alkali wet meadow, willow-cottonwood woodland) (Table 5-4, Figure 5-1). These habitat types include species that are native to the Western Transverse Ranges within the California Floristic Province (Jepson Flora Project 2021), many of which are already documented within the site and are known to be relatively easy to establish, have relatively high rates of survival, and are commercially available. Dominant and characteristic species have been determined and additional species are included to increase biodiversity, support native pollinators (e.g., *Phacelia* spp.), and add functional redundancy using species with a range of responses to temperature or moisture gradient in hopes of creating a more ecologically resilient community. Plants also have been selected to enhance and restore wildlife habitat quality and have a rich and diverse understory as this has been identified by some as an important source of plant diversity in California riparian systems (Viers et al. 2012).

The planting palette provided in Table 5-4 details the plant species planned for each habitat type differentiated by active planting (A) and passive planting (P). For spacing, densities, and total plants specified see final 100% design planset in Appendix J. Seed mixes areas are provided in Table 5-5. The target habitat types are intended to take advantage of existing opportunities to maintain and enhance native riparian forest communities within the watershed; planting may be reduced in areas targeted for natural recruitment or with retained preexisting native plants. For example, within the perennial pond/wetland and emergent marsh areas, southern cattail (*Typha domingensis*), broad-leaved cattail (*Typha latifolia*), and southern bulrush (*Schoenoplectus californicus*) plants typically recruit successfully naturally, so revegetation plantings of these species can be reduced. In addition, some species thought to be undesirable—western poison oak (*Toxicodendron diversilobum*) and stinging nettle (*Urtica dioica*)—are important to wildlife so have been included but will be planted away from trails.

Table 5-4. Planting palette for Sespe Cienega planting zones[1]. A is Active Planting, P is Passive Planting

Scientific name	Common name	Perennial pond/ wetland	Seasonal pond/ wetland	Alkali wet meadow	Emergent marsh	Wet meadow	Mixed riparian scrub	Willow- cottonwood woodland	Sycamore -Alder Woodland	Riparian Forest with Coast Live Oak	Riparian Scrub with Coast Live Oak	Alkali scrub	Buffer boundary planting
Acer negundo	box elder							A	A	A			A
Acmispon glaber	deerweed										A	A	
Alnus rhombifolia	white alder								A				
Ambrosia psilostachya	western ragweed										P	P	
Anemopsis californica	yerba mansa			A		P							
Artemisia californica	California sagebrush										A	A	
Artemisia douglasiana	mugwort										A		
Artemisia tridentata	big sagebrush										A		
Asclepias californica	California milkweed										A		A
Asclepias eriocarpa	kotolo										A		A
Asclepias fascicularis	narrow-leaf milkweed										A		A
Atriplex canescens	four-wing saltbush										A	A	
Atriplex lentiformis	big saltbush						A				A	A	A
Baccharis pilularis	coyote brush										P		A
Baccharis salicifolia	mule fat			P			A			P	P	P	P
Cylindropuntia californica subsp. parkeri	valley cholla						A						
Cyperus eragrostis	tall flatsedge	P			P								
Datura wrightii	sacred thorn-apple										P		
Distichlis spicata	salt grass			A									
Elymus glaucus	blue wild-rye			A									

Scientific name	Common name	Perennial pond/ wetland	Seasonal pond/ wetland	Alkali wet meadow	Emergent marsh	Wet meadow	Mixed riparian scrub	Willow- cottonwood woodland	Sycamore -Alder Woodland	Riparian Forest with Coast Live Oak	Riparian Scrub with Coast Live Oak	Alkali scrub	Buffer boundary planting
Elymus triticoides	beardless wild rye			A									
Epilobium canum	California fuschia												A
Epilobium ciliatum		P			P	P							
Eriodictyon crassifolium	thickleaf yerba santa						A				A		
Erythranthe guttata	seep monkeyflower	P			P								
Heliotropium curassavicum var. oculatum	seaside heliotrope			A									
Hesperoyucca whippelii	chaparral yucca												A
Heterotheca sessiliflora	sessileflower goldenaster						A						
Isocoma menziesii	coastal goldenbush						A						
Juglans californica	Southern California black walnut						A	A		A	A		
		P			P								
Juncus acutus subsp. leopoldii	southwestern spiny rush			A		P							
Juncus balticus	Baltic rush					P							
Juncus mexicanus	Mexican rush		P	A		P							
Juncus patens	spreading rush					P							
Juncus textilis	basket rush			A		P							
Nasturium officionale	Water cress	P											
Opuntia littoralis	coastal pricklypear						A						A
Phragmites australis	common reed	P											

Scientific name	Common name	Perennial pond/ wetland	Seasonal pond/ wetland	Alkali wet meadow	Emergent marsh	Wet meadow	Mixed riparian scrub	Willow- cottonwood woodland	Sycamore -Alder Woodland	Riparian Forest with Coast Live Oak	Riparian Scrub with Coast Live Oak	Alkali scrub	Buffer boundary planting
Platanus racemosa	western sycamore							A	A	A			A
Pluchea odorata	saltmarsh-fleabane				A								
Pluchea sericea	arrow-weed											A	
Populus fremontii	Fremont cottonwood						A	A	A	A	A		A
Populus trichocarpa	black cottonwood	A						A	A	A			
Quercus agrifolia	coast live oak									A	A		A
Rosa californica	California rose										A		A
Rubus ursinus	California blackberry	A						A	A	A			A
Salix exigua	narrowleaf willow	A		P			P	A	P	P	A		P
Salix laevigata	red willow							A	A	A			
Salix lasiolepis	arroyo willow	A						A	A	A			
Salvia leucophylla	purple sage										A	A	
Salvia mellifera	black sage										A	A	
Salvia spathacea	California hummingbird sage										P		
Sambucus nigra subsp. caerulea	blue elderberry			P			P	A	A	A	A		
Schoenoplectus americanus	Olney's three-square bulrush	P	P	P	P								
Schoenoplectus californicus	southern bulrush	P	A		A								
Solidago velutina subsp. californica	California goldenrod			A									
Toxicodendron diversilobum	western poison oak							P					A

Scientific name	Common name	Perennial pond/ wetland	Seasonal pond/ wetland	Alkali wet meadow	Emergent marsh	Wet meadow	Mixed riparian scrub	Willow- cottonwood woodland	Sycamore -Alder Woodland	Riparian Forest with Coast Live Oak	Riparian Scrub with Coast Live Oak	Alkali scrub	Buffer boundary planting
Typha domingensis	southern cattail	P	P		P								
Typha latifolia	broad-leaved cattail	P	P		P								
Urtica dioica	stinging nettle	P		P	A		P	P			P		
Vitis girdiana	desert wild grape							P					

A is Active Planting, P is Passive Planting

[1] Not all species indicated are required; at least 60% of species indicated for each zone should be included in the planting palette for that zone. If it is not possible to include a species due to pricing, availability, or low success rates, then replacement species may be considered. Estimated plant quantities are included in the Final 100% Design Planset (Appendix J).

Table 5-5. Sespe Cienega restoration seeding mixes[1].

Planting zone	Scientific name	Common name
Alkali Wet Meadow	*Elymus condensatus*	giant wild-rye
	Elymus glaucus	blue wild-rye
	Elymus triticoides	beardless wild rye
Emergent Marsh	*Epilobium ciliatum*	fringed willowherb
	Typha domingensis	southern cattail
	Typha latifolia	broad-leaved cattail
Mixed Riparian Scrub	*Artemisia dracunculus*	tarragon
	Euthamia occidentalis	western goldenrod
	Hazardia squarrosa	saw-tooted goldenbush
	Helianthus annus	common sunflower
	Heterotheca sessiliflora	sessileflower goldenaster
	Phacelia cicutaria	caterpillar phacelia
	Phacelia ramosissima	branching phacelia
Willow Cottonwood Woodland	*Artemisia douglasiana*	mugwort
Riparian Forest with Coast Live Oak component	*Acmispon glaber*	deerweed
	Artemisia douglasiana	mugwort
	Juncus acutus subsp. leopoldii	southwestern spiny rush
	Samucus nigra	blue elderberry
Riparian Scrub with Coast Live Oak	*Artemisia douglasiana*	mugwort
	Astereae	
	Encelia californica	California brittlebush
	Eriogonum fasciculatum	California buckwheat
	Hesperoyucca whippelii	chaparral yucca
	Juncus acutus subsp. leopoldii	southwestern spiny rush
	Phacelia ramosissima	branching phacelia
	Samucus nigra	blue elderberry
Alkali Scrub	*Baccharis pilularis*	coyote brush
	Phacelia cicutaria	caterpillar phacelia
Buffer Boundary Planting	*Acmispon glaber*	deerweed
	Phacelia cicutaria	caterpillar phacelia
	Phacelia ramosissima	branching phacelia

[1] Not all species indicated are required. For ease of implementation, seed mixes may be condensed into two seed mixes (wetland and upland). If it is not possible to include a species due to pricing, availability, or low success rates, then replacement species may be considered.

The existing paradigm of only using locally collected seed or cuttings is now being challenged by those who promote the use of at least some non-local ecotypes that might be better adapted to the predicted future climate conditions (Whitham 2017). For Sespe Cienega, that might mean using seeds and cuttings collected from elsewhere in the Santa Clara River watershed to represent a wider diversity of plant ecotypes and genotypes that can provide additional resiliency of restoration plantings to future changes in climate and site conditions. The type of stock (seed, container, cutting), size or vigor of cuttings and seedlings, and need for irrigation and weed control are important operational considerations that can affect the success of horticultural restoration efforts. A schedule for implementation will also be developed for each phase of restoration. This will include any timing constraints indicated by ecological issues (e.g., plant dormancy, seasonal rains, and soil moisture) or permitting requirements (e.g., work windows to avoid impacts to nesting birds or other listed species). A key lesson learned from past projects is that oversight of restoration implementation by an experienced practitioner is critical.

The level of effort required to irrigate each management unit is defined below and quantified in Table 5-6.

Irrigation Level 1: The work under irrigation level 1 (high level of effort) shall include setting up temporary irrigation system.

Irrigation Level 2: The work under irrigation level 2 (medium level of effort) shall include the use of water trucks weekly in dry season, as identified by the Vegetation Specialist.

Irrigation Level 3: The work under irrigation level 3 (low level of effort) shall include passive or occasional supplemental water trucks, if needed, as identified by the Vegetation Specialist.

Table 5-6. Acres of Irrigation required by Management Unit.

	Acres of Irrigation			
	Level 1	**Level 2**	**Level 3**	**Total**
Unit 1	10.7	2.4	0.0	13.1
Unit 2	5.7	1.3	0.0	7.0
Unit 3	0.0	0.4	7.8	8.2
Unit 4	0.0	12.1	0.0	12.1
Unit 5	8.7	2.5	1.3	12.5
Unit 6	10.4	2.6	0.7	13.7
Unit 7	0.0	0.7	12.8	13.5
Unit 8	0.0	17.9	0.0	18.0
Unit 9	0.0	7.3	0.0	7.3
Unit 10	0.0	0.6	8.4	9.0
Unit 11	0.0	78.7	0.0	78.7
Unit 12	0.0	47.9	0.0	47.9
Unit 13	3.3	12.7	21.2	37.2
Unit H1	4.9	1.8	1.3	7.9
Unit H2	0.0	1.6	0.0	1.6
Unit H3	0.0	0.0	4.0	4.0
Project Total	**43.7**	**190.5**	**57.5**	**291.7**

5.5 Weed Management

Management of invasive nonnative weeds will be required during initial phases of restoration project implementation. The primary invasive weed of concern is *Arundo donax* (giant reed or arundo). Much of the treatment and removal of the major stands of Arundo on the CSER has already been accomplished by UCSB and SCRC with existing grant funding, and the final stages of arundo removal are scheduled to be completed in 2022.

Prior to initiation of grading or planting for restoration, invasive weeds should be intensively managed across all management units to reduce propagule sources and competition with native plants. Target species include castor bean (*Riccinus communis*), tamarisk (*Tamarix* spp.), palms (*Phoenix* and *Washingtonia* species), tree tobacco (*Nicotiana glauca*), blue gum (*Eucalyptus globulus*), Bermuda grass (*Cynodon dactylon*), perennial pepperweed (*Lepidium latifolium*), shortpod mustard (*Hirshfeldia incana*), miscellaneous annual forbs in denser patches that might interfere with establishment of desired native plants, and any remaining patches of Arundo that might still exist on site after completion of current Arundo removal efforts. Annual grasses and some herbaceous species will be opportunistically managed, but these species are widespread and abundant throughout floodplain. Arundo control throughout the sites is nearing completion and any future resprouts will be treated to eliminate this species from the CSER.

As part of the ongoing Arundo removal efforts, CDFW completed a pesticide recommendation to guide weed treatments for the current weed control efforts by UCSB and SCRC on CSER that was incorporated into the Sespe Cienega Arundo Removal and Monitoring Plan (Lambert et al 2019), which is included here as Appendix K. This guidance, or any subsequent revisions, will be followed for weed management. Herbicides and adjuvants approved for aquatic habitats will be used. Weed treatments will follow the herbicide recommendation and the best available scientific information to improve efficacy and guide adaptive management.

Treatments will be selected and employed to minimize non-target effects to native plants and wildlife and include:

> <u>Spray only</u>. This method has been shown to be effective in areas in which native cover is low and/or native plants will not be affected by overspray. Approved herbicides are sprayed directly onto foliage/stems of target weed as indicated on the herbicide label, either using backpack sprayers or vehicle-mounted spray tanks (Katagi et al. 2002).
>
> <u>Basal bark</u>. Herbicide is sprayed directly onto the basal bark/stem region of the plant as indicated on the herbicide label, until thoroughly wet. This method has proved to be effective in treating woody non-native tree species, especially tamarisk. Basal bark treatments should be made to smaller trees with thin bark (DiTomaso et al. 2013).
>
> <u>Bend-and-spray</u>. This method minimizes the risk of herbicide application to non-target vegetation and is one of the most suitable methods for remotely located, small to moderately sized infestations of woody invasives with interspersed native vegetation. The bend-and-spray method involves physically bending stems of target species away from native vegetation and spraying the bent stems with an approved herbicide (Newhouser 2008, Coffman and Ambrose 2011). The sprayed stems should be left in place for at least 5-6 months for full herbicide activity to occur (B. Neill, personal communication).
>
> <u>Cut-and-daub/cut-and-spray</u>. These methods include cutting stems of target species at or near the ground surface and then immediately applying herbicide to cut stems/stumps (Coffman and Ambrose 2011).

The invasive management work can be distinguished by level of effort within each management unit; Table 5-7**.**

Invasive Management Level 1: The work under Invasive Plant Management Level 1 (High Level of Effort) shall include clearing, grubbing, and removing the top 6 inches of soil within the area specified. The work includes disposing of excavated topsoil and plant material.

Invasive Management Level 2: The work under Invasive Plant Management Level 2 (Moderate Level of Effort) shall include applying appropriate herbicide treatments as directed by the Vegetation Specialist and shall include hand work to selectively remove invasive plants as identified by the Vegetation Specialist.

Invasive Management Level 3: The work under Invasive Plant Management Level 3 (Low Level of Effort) shall include minor hand work to selectively remove invasive plants as identified by the Vegetation Specialist.

Table 5-7. Acres of Invasive Management by Management Unit.

	Acres of Invasive Management			
	Level 1	**Level 2**	**Level 3**	**Total**
Unit 1	13.1	0.0	0.0	13.1
Unit 2	7.0	0.0	0.0	7.0
Unit 3	3.2	5.0	0.0	8.2
Unit 4	8.4	3.7	0.0	12.1
Unit 5	9.7	2.8	0.0	12.5
Unit 6	13.7	0.0	0.0	13.7
Unit 7	0.3	11.3	1.9	13.5
Unit 8	0.0	17.9	0.0	17.9
Unit 9	4.4	2.9	0.0	7.3
Unit 10	6.5	2.5	0.0	9.0
Unit 11	78.7	0.0	0.0	78.7
Unit 12	47.9	0.0	0.0	47.9
Unit 13	28.7	8.5	0.0	37.2
Unit H1	7.9	0.0	0.0	7.9
Unit H2	0.0	1.6	0.0	1.6
Unit H3	0.0	4.0	0.0	4.0
Project Total	**229.5**	**60.3**	**1.9**	**291.7**

Weed control measures will be implemented during post-construction restoration where necessary in accordance with the guidelines listed in Appendix K. Control measures may include various treatment methods. Physical removal and chemical control of weedy species will be employed as required and are described in the following subsections. Biological control methods are not prescribed under this Plan but may be considered and implemented if determined to be safe and approved by CDFW. Treatment methods will be based on species-specific and area-specific conditions. Post-construction weed monitoring will include the temporary and permanent impact areas. Weed control measures should be employed generally for Cal-IPC high/moderate weeds and CDFA A/B rated weeds if new discreet weed populations that were not observed prior to construction are discovered. Ubiquitous weeds that are present within the impact areas as well as adjacent areas, will not be treated due to the infeasibility of keeping impact areas free of such weeds.

5.6 Trails

The primary public access amenity will be a comprehensive trail network throughout the site; the proposed trail network is depicted in the Final 100% conceptual design map (Figure 5-1). The network of trails will offer just over 4 miles of unique walking opportunities throughout the ecological reserve. Table 5-8 lists the different trail segments and their respective lengths.

Table 5-8. Sespe Cienega Restoration Site proposed public access trails and length in miles.

Name	Type	Length (miles)
Northeast Loop Trail	Walking	0.34
Northwest Trail	Walking	0.55
Mixed use access trail	Walking/Biking	0.59
West Trail	Walking/Access Road	0.42
River Trail	Walking	0.19
West Trail (seasonal)	Walking	0.48
Total		**2.57**

The proposed trail design includes slopes and widths that do not preclude ADA-compliance in the future. The design of ADA-compliant trail surfacing and submittal of the design plans to the State Architect's Office for ADA-compliance certification are beyond the scope of this restoration project, but CDFW may support this effort in the future. At least the segments of the Northeast Loop trail and Northwest trail (i.e. those closest to the parking area at the Hatchery Entrance) have been identified by CDFW as trails that should be made ADA-compliant.

5.7 Avoidance/Protective Measures

Appendix I includes a list of recommendations developed by Hall (2020) to avoid or minimize impacts to sensitive wildlife species during restoration implementation on the site. Appendix K provides a comprehensive list of avoidance and protective measures developed by Lambert and others (2019) to be implemented during weed treatment and restoration following established best management practices.

6 PUBLIC ACCESS & EDUCATION

The details of future public access and educational programs will be developed by CDFW in a manner consistent with the designation of CSER as an ecological reserve and the purposes of such reserves under California Fish and Game Code, sections 1580, 1584, and 1585. This includes conservation of rare species and specialized habitat types, along with conservation research and educational activities. CDFW will prepare a land management plan which will include programming details, including public access descriptions and educational components. The land management plan development process will take into consideration a number of factors such as the purpose of the property, staffing, facilities, funding, habitat types, plant and animal species, etc. CDFW will also take into consideration partner, stakeholder, and community involvement and interests. The development to the west is interested in partnering with the Ecological Reserve in regard to signage, fencing and planting.

Additional topics to be considered as CDFW develops the public access and education program include educational and wayfinding signage, fencing, benches, and picnic areas to provide additional educational opportunities and to help promote and constrain public use to appropriately designated areas.

7 DESIGN PLANSET

The Final 100% Design Planset has been developed to meet the intent of providing a level of detail that conveys proposed restoration activities in a manner that is readily understandable by reviewers, as well as the broader stakeholder group, so that the planset may be used to support grant applications for construction funding. The planset will remain at a "not for construction" level of completion until there is a design available for the settling pond/effluent channel and concurrence with stakeholders on how to manage potentially more than one contract to complete the restoration work. Notably, additional grading to balance material on site will be needed to accommodate the settling pond excavation, but this work must be completed under a future contract due to the expected timing of the settling pond design.

The Final 100% Design Planset is intended to be implemented in compliance with the Technical Specifications (Appendix L) with close oversight by the UCSB/Stillwater Sciences technical team. The grading and planting plans are intentionally flexible to allow the technical team to direct revisions based on on-the-ground conditions when the project is constructed. The design is conceived with the understanding that the selected contractor will have experience with the flexible nature of restoration work and will be a partner in value-engineering during construction.

This report includes the Final 100% Design Planset in Appendix J.

The Final 100% Design Planset includes the following components:

Sheet 1 Title Sheet
Sheet 2 Existing Conditions & Monitoring Locations
Sheet 3 Site Access & Staging and Epsc Plan
Sheet 4 Proposed Conditions Overview--Key Features
Sheet 5 Proposed Conditions Overview--Sheet Index
Sheet 6 Unit 1
Sheet 7 Unit 2
Sheet 8 Unit 3
Sheet 9 Unit 4
Sheet 10 Unit 3&4--Sections
Sheet 11 Unit 7 (West)
Sheet 12 Unit 7 (East)
Sheet 13 Unit 7 Road Section Views
Sheet 14 Unit 7, 9, and 11 Surface Flow Redirection
Sheet 15 Unit 7 And 9 Culvert Removal and Grade Channel
Sheet 16 Unit 12 And 13
Sheet 17 Unit H1
Sheet 18 Hatchery Entrance
Sheet 19 Proposed Trails Overview
Sheet 20 West Trail Loop (E-W Segment)
Sheet 21 West Trail Loop (Corner Segment)
Sheet 22 West Trail Loop (N-S Segment)
Sheet 23 West Trail Loop--Sections
Sheet 24 River Trail

Sheet 25 River Trail and West Trail
Sheet 26 West Trail
Sheet 27 West Trail and Northwest Trail
Sheet 28 Northwest Trail 1
Sheet 29 Northwest Trail 2
Sheet 30 Northwest and Northeast Trail
Sheet 31 Northeast Trail
Sheet 32 Northeast Trail 2
Sheet 33 Perimeter Trail Sections
Sheet 34 Planting Plan Overview
Sheet 35 Planting Plan - Unit 1
Sheet 36 Planting Plan - Unit 2 Thru 4
Sheet 37 Planting Plan - Unit 5 And 6
Sheet 38 Planting Plan - Unit 7 And 8
Sheet 39 Planting Plan - Unit 9 And 10
Sheet 40 Planting Plan - Unit 12 And 13
Sheet 41 Planting Tables 1
Sheet 42 Planting Tables 2
Sheet 43 Planting Tables 3
Sheet 44 Planting Details
Sheet 45 Erosion and Sediment Control Details
Sheet 46 Wildlife Viewing Platform and Fence Details
Sheet 47 Ds Effluent Channel Area (Units 9&10)
Sheet 48 Settling Pond and Effluent Channel Area (Units 5&6)
Sheet 49 Us Settling Pond and Effluent Channel Area (Units 5&6)
Sheet 50 Settling Pond and Effluent Channel Detail (Placeholder)
CalTrans Standard Plans and Revised Standard Plans

8 OPINION OF PROBABLE COSTS

A Preliminary Opinion of Probable (Construction) Costs (OPC) is provided in support of the Final 100% Design submittal as Appendix M. The OPC is a rough estimate of project costs based on unit costs for project level mobilization and does not account for project phasing.

The OPC will be used to support grant applications and will need to be revised in the future if this project were to go to a competitive bid. Stillwater understands that most likely a qualified contractor will be procured outside of a bid process, and contract line items are expected to be revised accordingly.

9 PERMITTING

After the Final Design Phase, UCSB and SCRC will work with CDFW and USFWS to address permitting and regulatory compliance. It is anticipated that CDFW will serve as the lead agency for CEQA review. USFWS is providing partial funding for restoration implementation, providing a nexus for agency staff to lead Section 7 consultation and complete a Biological Opinion for the project.

Any work within the CalTrans right-of-way will require a CalTrans permit.

10 NEXT STEPS

This technical report outlines the Final 100% design for the CSER and is based on considerable knowledge about the site and its regional setting (as summarized in Downs et al. 2020). The proposed Final 100% design is a collaborative result of assessments by Stillwater Sciences, UCSB, and SCRC, and has involved discussions with representatives from CDFW. The report is also realistic about uncertainty and variability inherent in the physical and biological measurements underlying the design. The monitoring program described in Section 2.4 will continue through the implementation phase to improve our understanding of the site and reduce the level of uncertainty through long-term sampling. This information feeds into our restoration approach (Section 3), with the existing knowledge base used to define a series of viable project goals, objectives, and design considerations that result in a series of design elements (Section 4) whose assessment underpins, optimizes, and constrains the resulting Final 100% design (Sections 5–9). Our ongoing, long-term monitoring of groundwater, soils, hydrology, vegetation, and wildlife at the site and within the floodplain provide the necessary data to plan restoration with the best available science, adaptively manage the project during implementation, and inform long-term management to maintain project benefits and ecosystem integrity.

The permitting process outlined in Section 9 is occurring concurrently with the design and is anticipated to be completed in September 2021. The CEQA evaluation process was initiated in May 2021 by CDFW staff (Richard Brody) and Adam Lambert (UCSB). United States Fish and Wildlife Service is providing funding for the project and is completing the ESA Biological Opinion process for least Bell's vireo (anticipated completion date September 2021).
The restoration design will guide implementation as the next step in the restoration process. Funding for the implementation may be secured through various sources, including grants, mitigation funds, and donations. CDFW has received mitigation funding to reestablish 17 acres of willow-cottonwood riparian habitat. UCSB has applied for and received conditional approval for funding for over 130 acres from the Wildlife Conservation Board. This funding is contingent on Board approval. USFWS is also providing funding to support a portion of the restoration work as cost-share. Implementation will be phased based on Management Unit readiness and availability of funding and is expected to take between 6-10 years to complete (contingent on funding). The Final 100% Design Planset presented herein has the flexibility to be revised as-needed in the future depending on changes in physical and biological features (as identified in ongoing monitoring), the availability of grant funding, and desired contracting terms. Stillwater expects that UCSB and SCRC will manage the construction and provide field oversight of implementation staff and sub-contractors, and therefore there is considerable flexibility in the plans to allow for informed field discretion. It is expected that further technical support will be needed when funding and a contractor have been procured.

Design features that are expected to be completed in a future phase of work include the following:

<u>Settling pond and effluent channel design</u>: This work is critical to implement the restoration as currently designed as it will reroute hatchery effluent flows through Units 5, 6, 9, 10, and 13 and provide the primary water source for supporting wetlands and riparian vegetation. Concurrent with this design (to be completed under separate contract), grading adjustments to balance material on site must be made, and the restoration design may be adjusted accordingly.

Culvert design: Additional survey and design work is needed to verify and finalize design of the proposed culverts on site before construction begins. There is also a potential need for hydraulic control structures to help control surface flows in a future design effort.

Public access infrastructure: Details of public access infrastructure including parking areas, trail surfacing and ADA accessibility, signage, fencing, restroom/leach field, and wildlife viewing areas should be advanced in partnership with CDFW in future design phases.

Advanced trail design: The proposed trail alignments and profiles presented in the Final 100% Design Planset are consistent with the restoration design intent. However, further design effort may be needed in the future to bring certain segments of the trails to an ADA-compliant design. The proposed trail profiles and widths do not preclude ADA-compliance in the future, but trail surfacing design and consultation with the State Architect's Office are required for ADA-compliance and this is beyond the scope of this phase of the restoration project.

Wildlife viewing platform: Field survey and additional work with CDFW is needed to determine the desired design of the proposed wildlife viewing platform/blinds. It is expected that the selected contractor will support final design work for this feature.

Other public access infrastructure: public access features such as signage, fencing, parking lot amenities are expected to be provided in future design phases by CDFW.

Leach field design: The leach field proposed by CDFW will be designed by others, and the materials specifications for that feature will need to be compared to available materials on-site to determine whether on-site materials can be used.

Erosion Prevention and Sediment Control (EPSC): the selected contractor will be responsible for advancing and finalizing the proposed EPSC plan based on their proposed project phases and obtaining required construction stormwater permits.

Plant Propagation Facility: The future plant propagation facility will be designed by others and will serve as a nursery for this restoration project.

11 REFERENCES

Andrews, E.D., Antweiler, R.C., Neiman, P.J., Ralph, F.M., 2004. Influence of ENSO on flood frequency along the California Coast. Journal of Climate 17, 337–348.

Beller, E. E., R. M. Grossinger, M. N. Salomon, S. J. Dark, E. D. Stein, B. K. Orr, P. W. Downs, T. R. Longcore, G. C. Coffman, A. A. Whipple, R. A. Askevold, B. Stanford, and J. R. Beagle. 2011. Historical ecology of the lower Santa Clara River, Ventura River, and Oxnard Plain: an analysis of terrestrial, riverine, and coastal habitats. Prepared for the State Coastal Conservancy. A report of SFEI's Historical Ecology Program, SFEI Publication #641, San Francisco Estuary Institute, Oakland, California.

Beller, E. E., P. W. Downs, R. M. Grossinger, B. K. Orr, and M. N. Soloman. 2015. From past patterns to future potential: using historical ecology to inform river restoration on an intermittent California river. Landscape Ecology, DOI 10.1007/s10980-015-0264-7

Castro J. M., and C. R. Thorne. 2019. The stream evolution triangle: Integrating geology, hydrology, and biology. River Research Applications 35: 315–326.

cbec. 2011. Santa Clara River Levee Setbacks – Appendix of Model Results. Prepared for Stillwater Sciences and California State Coastal Conservancy. August, 2011.

CDFW (California Department of Fish and Wildlife). 2018. Protocols for surveying and evaluating impacts to special-status native plant populations and natural communities. California Natural Resources Agency, Sacramento, California.

CNPS (California Native Plant Society). 2020. A Manual of California Vegetation, Online Edition. California Native Plant Society, Sacramento, CA. Available at: http://www.cnps.org/cnps/vegetation/

Coffman, G. C., and R. F. Ambrose. 2011. Santa Clara River riparian revegetation and monitoring handbook. Prepared for the Santa Clara River Trustee Council.

Compliance Biology, Inc., March 2010, Letter report from Dave Crawford to Matt Carpenter (Newhall) regarding Special Status Species in the NRMP area

Downs, Peter & Gregory, K.. (2014). River Channel Management: Towards Sustainable Catchment Hydrosystems. River Channel Management: Towards Sustainable Catchment Hydrosystems. 1-395. 10.4324/9780203770344.

Downs, P.W., Dusterhoff, S.R. and Sears, W.A. 2013. Reach-scale channel sensitivity to multiple human activities and natural events: Lower Santa Clara River, California, USA, *Geomorphology,* 189: 121–134.

Downs, P, A. Lambert, T. Dudley, E. Hobson. 2020. Restoration Planning at the Sespe Cienega Literature and Data Review. Prepared by UCSB, Santa Clara River Conservancy and Stillwater Sciences for California State Coastal Conservancy and California Department of Fish and Wildlife.

Downs, P.W., Singer, M.S., Orr, B.K., Diggory, Z.E., Church, T.C. and Stella, J.C. 2011. Restoring ecological integrity in highly regulated rivers: the role of baseline data and analytical references. *Environmental Management,* 48: 847–864

Freidman, J. M., M. L. Scott, and W. M. Lewis. 1995. Restoration of riparian forests using irrigation, artificial disturbance, and natural seedfall. Environmental Management 19:547–557.

Graf, W. L. 1988. Fluvial processes in dryland rivers. Springer-Verlag, Berlin.

Graf, W. L. 2000. Locational probability for a dammed, urbanizing stream: Salt River, Arizona, USA. Environmental Management 25, 321–335.

Greco, S. E., E. H. Girvetz , E. W. Larsen , J. P. Mann , J. L. Tuil, and C. Lowney. 2008. Relative Elevation Topographic Surface Modelling of a Large Alluvial River Floodplain and Applications for the Study and Management of Riparian Landscapes, Landscape Research 33: 461–486.

Harp, E.L., Jibson, R.W., 1996. Landslides triggered by the 1994 Northridge, California earthquake. Bulletin of the Seismological Society of America 86, 319–332.

Hardesty-Moore, M., Orr, D., McCauley, D.J. 2020. Invasive plant *Arrundo donax* alters habitat use by carnivores. Biol Invasions 22:1983-1995. (https://doi.org/10.1007/s10530-020-02234-4)

Hatten, J. R. 2016. A satellite model of southwestern willow flycatcher (Empidonax traillii extimus) breeding habitat and a simulation of potential effects of tamarisk leaf beetles (Diorhabda spp.), Southwestern United States. U.S. Geological Survey Open-File Report 2016–1120, 88 p., http://dx.doi.org/10.3133/ofr20161120

Hatten, J. R., and C. E. Paradzick. 2003. A multiscaled model of southwestern willow flycatcher breeding habitat. Journal of Wildlife Management 67: 774–788.

Howard, S. R., and M. T. Booth. 2016. Range expansion of the Shimofuri goby (Tridentiger bifasciatus) in southern California, with emphasis on the Santa Clara River. California Fish and Game 102(2): 45-49

Jepson Flora Project, editors. 2021. Jepson eFlora. http://ucjeps.berkeley.edu/eflora/ [Accessed April 2021].

Johnson, M. J., J. R. Hatten, J. A. Holmes, and P. B. Shafroth. 2017. Identifying western yellow-billed cuckoo breeding habitat with a dual modelling approach. Ecological Modelling 347:50–62.

Lambert, A., S. Carey, L. Pavlishcak, and G. Van Kirk 2019 Sespe Cienega Arundo Removal and Monitoring Plan; Restoration Planning

Mann, J.F. Jr. and Associates, 1958. Preliminary outline of groundwater conditions near State fish Hatchery. Report prepared for United Water Conservation District, Mann, J.F. Jr. and Associates, La Habra, California.

Mann, J.F. Jr. and Associates, 1959. A plan for ground water management. Report prepared for United Water Conservation District, Mann, J.F. Jr. and Associates, La Habra, California.

McBride, J. R., and J. Strahan. 1984. Establishment and survival of woody riparian species on gravel bars of an intermittent stream. The American Midland Naturalist 112: 235–245.

McBride, J. R., N. Sugihara, and E. Norberg. 1989. Growth and survival of three riparian woodland species in relation to simulated water table dynamics. April. Final report. (Environmental Health and Safety Report 009.4-89.3.) University of California Department of Forestry and Resource Management. Berkeley, CA. Pacific Gas and Electric Company, San Ramon, CA.

Merrill, A.G., T.L. Benning, J. Fites-Kaufmann. 2006. Factors controlling structural and floristic variation of riparian zones in a mountainous landscape of Western United States. Western North American Naturalist 66:137–154.

NOAA (National Oceanic and Atmospheric Administration). 2005. California Nevada river forecast center storm summaries – January 7–11, 2005.

Oakley, N.S., Hatchett, B.J., McEvoy, D., Rodriguez, L., 2019. Projected Changes in Ventura County Climate. Western Regional Climate Center, Desert Research Institute, Reno, Nevada. Available at: wrcc.dri.edu/Climate/reports.php.

Orr, B.K., Z.E. Diggory, G.C. Coffman, W.A. Sears, T.L. Dudley, and A.G. Merrill. 2011. Riparian vegetation classification and mapping: important tools for large-scale river corridor restoration in a semi-arid landscape. Pages 212–232 *in* J. Willoughby, B. Orr, K. Schierenbeck, and N. Jensen, editors. Proceedings of the CNPS Conservation Conference: Strategies and Solutions, 17–19 Jan 2009.

Orr, B. K., G. T. Leverich, Z. E. Diggory, T. L. Dudley, J. R. Hatten, K. R. Hultine, M. P. Johnson, and D. A. Orr. 2014. Riparian restoration framework for the upper Gila River in Arizona. Compiled by Stillwater Sciences in collaboration with Marine Science Institute at U.C. Santa Barbara, Columbia River Research Laboratory of U.S. Geological Survey, Desert Botanical Garden, and Colorado Plateau Research Station at Northern Arizona University. Prepared for the Gila Watershed Partnership of Arizona.

Orr, B., M. Johnson, G. Leverich, T. Dudley, J. Hatten, Z. Diggory, K. Hultine, D. Orr, and S. Stone. 2017a. Multi-scale riparian restoration planning and implementation on the Virgin and Gila Rivers. In: B.E. Ralston and D.A. Sarr (eds.), *Case Studies of Riparian and Watershed Restoration Areas in the Southwestern United States—Principles, Challenges, and Successes.* U.S. Geological Open File Report 2017-1091, 116 p., https://doi.org/10.3133/ofr20171091.

Orr, B. K., A. M. Merrill, Z. E. Diggory, and J. C. Stella. 2017b. Use of the biophysical template concept for riparian restoration and revegetation in the Southwest. *In* B. E. Ralston and D. A. Sarr, editors. Case Studies of Riparian and Watershed Restoration Areas in the Southwestern United States—Principles, Challenges, and Successes. U.S. Geological Open File Report 2017-1091. https://doi.org/10.3133/ofr20171091.

Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. General Technical Report PSW-GTR-144-www. USDA Forest Service, Pacific Southwest Research Station, Albany, California.

Ralph, C. J., J. R. Sauer, and S. Droege, editors. 1995. Monitoring Bird Populations by Point Counts. General Technical Report PSW-GTR-149. USDA Forest Service, Pacific Southwest Research Station, Albany, California.

Rasmussen, C.G. and B.K Orr. 2017. Restoration principles for riparian ecosystem resilience. 2017. In: B.E. Ralston and D.A. Sarr (eds.), *Case Studies of Riparian and Watershed Restoration Areas in the Southwestern United States—Principles, Challenges, and Successes.* U.S. Geological Open File Report 2017-1091, 116 p., https://doi.org/10.3133/ofr20171091.

Reichard EG, Crawford SM, Paybins KS, et al. (1999) Evaluation of Surface Water/Ground-Water Interactions in the Santa Clara River Valley, Ventura County, California. USGS Water-Resources Investigations Report 98-4208, Sacramento: US Geological Survey

Sawyer, J. O., T. Keeler-Wolf, and J. Evens. 2009. A manual of California vegetation, 2nd ed. California Native Plant Society, Sacramento, CA.

Scott, K., and R.P. Williams. 1978. Erosion and sediment yields in the Transverse Ranges, Southern California. US Geological Survey Professional Paper 1030

Shafroth, P. B., G. T. Auble, J. C. Stromberg, and D. T. Patten. 1998. Establishment of woody riparian vegetation in relation to annual patterns of streamflow, Bill Williams River, Arizona. Wetlands 18: 577–590.

Shafroth, P. B., J. C. Stromberg, and D. T. Patten. 2000. Woody riparian vegeation response to different alluvial water table regimes. Western North American Naturalist 60: 66–76.

Smith, S. D., A. B. Wellington, J. L. Nachlinger, and C. A. Fox. 1991. Functional responses of riparian vegetation to streamflow diversion in the eastern Sierra Nevada. Ecological Applications 1: 89–97.

Penrod, K., C. Cabanero, P. Beier, C. Luke, W. Spencer, E. Rubin, R. Sauvajot, S. Riley and D. Kamradt. 2006. South Coast Missing Linkages Project: A Linkage Design for the Santa Monica-Sierra Madre Connection. Produced by South Coast Wildlands, Idyllwild, CA. www.scwildlands.org, in cooperation with National Park Service, Santa Monica Mountains Conservancy, California State Parks, and The Nature Conservancy.

Stella, J. C., J. J. Battles, J. R. McBride, and B. K. Orr. 2010. Riparian seedling mortality from simulated water table recession, and the design of sustainable flow regimes on regulated rivers. Restoration Ecology 18, supplement S2: 284–294.

Stillwater Sciences. 2001. Merced River baseline studies: volume II – geomorphic and vegetation investigations report. Final Report. Stillwater Sciences, Berkeley.

Stillwater Sciences. 2007a. Santa Clara River Parkway Floodplain Restoration Feasibility Study: assessment of geomorphic processes for the Santa Clara River Watershed, Ventura and Los Angeles counties, California. Prepared by Stillwater Sciences for the California State Coastal Conservancy.

Stillwater Sciences. 2007b. Santa Clara River Parkway Floodplain Restoration Feasibility Study: analysis of riparian vegetation dynamics for the lower Santa Clara River and major tributaries, Ventura County, California. Prepared by Stillwater Sciences for the California State Coastal Conservancy.

Stillwater Sciences. 2008. Santa Clara River Parkway Floodplain Restoration Feasibility Study. Prepared for the California State Coastal Conservancy, Oakland, California.

Stillwater Sciences. 2011. Geomorphic assessment of the Santa Clara River watershed, synthesis of the lower and upper watershed studies, Ventura and Los Angeles counties, California. Prepared by Stillwater Sciences, Berkeley California for Ventura County Watershed Protection District, Los Angeles County Department of Public Works, and the U.S. Army Corps of Engineers–L.A. District.

Stillwater Sciences. 2019. Vegetation Mapping of the Santa Clara River, Ventura County and Los Angeles County, California. Technical Memorandum. Prepared by Stillwater Sciences, Berkeley, California for the Western Foundation of Vertebrate Zoology, Camarillo, California.

Stillwater Sciences and URS Corporation. 2007. Riparian Vegetation Mapping and Preliminary Classification for the Lower Santa Clara River and Major Tributaries, Ventura County, California. Volume I. Prepared by Stillwater Sciences and URS Corporation for the California State Coastal Conservancy and the Santa Clara River Trustee Council.

Stromberg, J. C., D. T. Patten, and B. D. Richter. 1991. Flood flows and dynamics of Sonoran riparian forests. Rivers 2: 221–235.

Stromberg, J. C., R. Tiller, and B. Richter. 1996. Effects of groundwater decline on riparian vegetation of semiarid regions: the San Pedro, Arizona. Ecological Applications 6: 113–131.

Swift, C. C., T. R. Haglund, M. Ruiz, and R. N. Fisher. 1993. The status and distribution of freshwater fishes of southern California. Bulletin of the Southern California Academy of Sciences. 92(3): 101–167.

Tiegs, S.D., Pohl, M., 2005. Planform channel dynamics of the lower Colorado River: 1976–2000. Geomorphology 69, 14–27.

Tiegs, S.D., O'Leary, J.F., Pohl, M.M., Munill, C.L., 2005. Flood disturbance and riparian diversity on the Colorado River delta. Biodiversity and Conservation 14, 1175–1194.

URS (URS Corporation). 2005. Santa Clara River Parkway Floodplain Restoration Feasibility Study—Water Resources Investigations. Prepared for the California Coastal Conservancy, Oakland, California.

United Water Conservation District. 2016. 2014 and 2015 Piru and Fillmore basins biennial groundwater conditions report, Open-file report 2016-01, June 2016, United Water Conservation District, Santa Paula, CA.

USFWS (U. S. Fish and Wildlife Service) 2014.

Vaghti, M.G. and S.E. Greco. 2007. Riparian vegetation of the Great Valley. Pages 425-455 in M. G. Barbour, T. Keeler-Wolf, and A. A. Schoenherr, editors. Terrestrial Vegetation of California, third edition. University of California Press, Berkeley and Los Angeles.

Viers, J. H., A. K. Fremier, R. A.Hutchinson, J. F. Quinn, J. H.Thorne, and M. G. Vaghti. 2012. Multiscale patterns of riparian plant diversity and implications for restoration. Restoration Ecology 20: 160–169.

Warrick, J.A., 2002. Short-term (1997–2000) and long-term (1928–2000) observations of river water and sediment discharge to the Santa Barbara channel, California. Ph.D. dissertation, University of California, Santa Barbara, USA.

Whitham, T. G. 2017. The reality of climate change and the need for genetics approaches in riparian, river and watershed restoration to maintain biodiversity in changing environments. *In* B. E. Ralston and D. A. Sarr, editors. Case Studies of Riparian and Watershed Restoration Areas in the Southwestern United States—Principles, Challenges, and Successes. U.S. Geological Open File Report 2017-1091. https://doi.org/10.3133/ofr20171091.

Appendices

Appendix A

Vegetation Monitoring

Appendix B

Historical Aerial Photographs

The LiDAR-derived topography and historical aerial photographs were reviewed to characterize the long-term geomorphic change at the Sespe Cienega within the project area and at the confluence with the Smith River. Photographs were acquired from the U.S. Forest Service, California Department of Forestry, USGS, and Google Earth and include the following years: 1929, 1947, 1959, 1963, 1969, 1978, 1992, 1995, 2002, 2005, 2009, 2012, 2014, 2016, and 2018. Background notes are provided below followed by excerpts from the air photos.

1929 Photograph

In 1929 Santa Clara River was primarily along the same alignment as it is today. The project vicinity along the middle Santa Clara River had already begun to be utilized for agricultural purposes, as evidenced by fences, hedge rows, and managed fields with different uses, although most of the Sespe Cienega southern parcel was still riverine with natural vegetation. A diversion channel appears to have been constructed from the main Santa Clara River channel to feed agricultural properties to the south. However, the floodplain pasture along the western side of the river does not appear to have been modified for agricultural use. Portions of Santa Clara River upstream of the Sespe Cienega property were less developed and encroached less into the active floodplain than they are today. The current alignment of California State Route 126, also known as E Telegraph Road, had been built and resembles the current primary road through the area. To the northwest of the Sespe Cienega property, there is a sideroad that runs perpendicular to E Telegraph Road down to the Santa Clara River, which is more evident in later photographs. The railway separates the small northern parcel of the Sespe Cienega property from the larger southern parcel and crosses E Telegraph Road to the northwest of the northern parcel. The active Santa Clara River channel was farther north than it is today and ran along the margin of the floodplain. The Fillmore fish hatchery had not yet been built.

1947 Photograph

By 1947 the main channel appears to have shifted south, with dense riparian vegetation establishing in the vicinity of the 1929 channel. Natural vegetation had established in the eastern portion of the Sespe Cienega property and to the east outside of the property boundary. There are still braided channels and a natural floodplain, which is restricted by a long fence line to the south and bordered by vegetation to the north. The northern boundary of the natural vegetation had been straightened and groomed as agricultural activity expanded and intensified. To the northeast of the Sespe Cienega property vegetation has been cleared to enable development of some buildings associated with the Fillmore Fish Hatchery. Buildings have also been constructed on agricultural land to the northwest of the property. Compared to 1929, agricultural activity had increased significantly in the northern portion of the Sespe Cienega property and to the south and north of Santa Clara River, with some pockets of activity north of E Telegraph Road. Agriculture had also intensified, and by this time the agricultural fields appear to be primarily used for a single crop. A well-established hedge row runs southwest to northeast to the north of the Santa Clara River in the Sespe Cienega property, dividing crop fields to the northwest from what appears to be a substantial sand and gravel mine site to the southeast of the hedge row. The hedge row shelters a ditch constructed to discharge effluent from the Fillmore Fish Hatchery. The ditch turns sharply at the boundary of the Sespe Cienega property and runs east to west adjacent to the groomed periphery of natural vegetation.

1959 Photograph

By 1959 the Santa Clara River had been straightened, with natural braid channels restricted, in a location farther south than in 1947. The ditch along the large hedge row on the Sespe Cienega property remains but the connecting channel has been adjusted to flow south to north from the newly aligned main channel. A new diversion channel into the eastern portion of the Sespe Cienega property has been established, but the eastern portion of the Sespe Cienega property remains vegetated. Additional buildings have been constructed to the northwest of the property and north of E Telegraph Road to the northeast. The mine site to the southeast of the hedge row appears to have been abandoned and revegetated. Some of the vegetation in the central property, near the 1929 channel path, appears to have been cleared. The fence line to the south remains and agricultural activity had intensified compared to 1947. To the south and north, agricultural fields have been subdivided and are neatly separated by hedge rows and fences.

1963 Photograph

In 1963, the positions of the main Santa Clara River channel, ditch, and diversions are similar to 1959. Agricultural activity is of similar intensity. The eastern portion of the Sespe Cienega property has been denuded, but a large, vegetated triangle remains in the middle region of the property where the 1947 mine site was located.

1969 Photograph

Evidence of the damage caused by the great floods of January and February 1969 is prevalent on the 1969 aerial photograph. The flood channel has cut back into a portion of the historic 1929 natural channel path on the eastern portion of the Sespe Cienega southern parcel and continued north of previous flow paths onto the eastern portion of the property. Sediment from floodwaters has inundated about three-quarters of the Sespe Cienega southern parcel and left thick deposits upstream and downstream. The large hedge row remains, but all the diversion systems and agricultural land on the Sespe Cienega property to the south of the hedge row has been destroyed. Agricultural parcels to the south and north of the Sespe Cienega southern parcel are out of the main flood path and less damaged. Aside from the obvious flood damage, it appears that further vegetation was cleared from the Sespe Cienega southern parcel between 1963 and 1969 and additional infrastructure and buildings were constructed outside of the property boundary.

1978 Photograph

Sediment from the 1969 flood is still evident in the 1978 aerial photograph and more than half of the Sespe Cienega southern parcel remains inundated with sediment. The Santa Clara River has been left to take a more natural course again, with braid channels re-establishing. Some of the land that was inundated in 1969 has been reclaimed for agricultural purposes. Surrounding properties are still predominately agricultural, except for a large residential subdivision that has been constructed northwest of the Sespe Cienega property and south of E Telegraph Road.

1992 Photograph

By 1992 the main channel had shifted south again—farther south than in 1947, closer to the alignment of the straightened 1959–1969 channel. East of the Sespe Cienega property, the channel has had more room to meander, and natural braids were present. There is some evidence of sediment excavations adjacent to the channel. The diversion from the Santa Clara River heading north appears to have been re-connected to the new southern channel alignment. Around the channels, vegetation has re-established over the sediment deposits from the 1969 floods. Agricultural activity on the Sespe Cienega property had encroached farther south. The northern parcel has been cleared of vegetation. It appears that there was a continued shift away from mid-century crop farming towards watercress farming both on the Sespe Cienega property and in the vicinity. Crop farming was still prevalent in areas to the northeast and south. To the northwest, the subdivision had been extended to the east. The same sideroad that was present in 1929 is still present west of the subdivision, providing the main connection from the E Telegraph Road down to the river.

1995 Photograph
In 1995, the Santa Clara River channel width was substantially wider than in 1992 and braids had re-established, allowing the channel to take a more natural course across the floodplain. Channels flow in both the historic 1929 channel that was re-carved in the 1969 flood and the more dominant southern alignment that was forced to make room for agriculture mid-century. The wider channel, along with recent sediment deposits, provide evidence of flooding. From mid-property to the east, riparian vegetation is established north and south of the wider channel. In the western portion of the property, a side channel following the approximate 1929 channel alignment had cut into the agricultural pastures, with no buffer between the pastures and Santa Clara River.

2002 Photograph
By 2002 there were few braids, and the channel followed a single dominant path, entering the Sespe Cienega property in the approximate location of the 1929 channel trending in a southerly direction, before bending sharply north again and exiting the property just north of the 1929 alignment. A vegetated buffer had been established between the channel and agricultural pastures to the north, and riparian vegetation had established over large areas of the sediment deposits on the property and in the vicinity. Agricultural use of the site remains consistent with historic use since mid-century. The surrounding area remains dominated by mixed-use agriculture, with the subdivision to the northwest. The agricultural land between the property and the subdivision appears to have changed, with previously subdivided fields merged into large rectangular blocks. Agriculture has expanded along the northern margin of E Telegraph Road but is still limited farther north where the terrain is more challenging.

2005 Photograph
In January 2005 there was another flood (NOAA 2005) that exceeded 280,000 cfs at Sespe Creek near Fillmore and deposited a layer of sediment across the floodplain and damaged agricultural land. The agricultural damage appears more extensive than 1995 but did not damage as much of the Sespe Cienega property as the great floods of 1969. The Santa Clara River continues to flow in the southern portion of the Sespe Cienega property and has taken two major flow paths during the flood which overlap in the center of the property. Agricultural land in the vicinity of the property has been damaged and land to the immediate northwest appears to have been inundated by the storms.

2009 and 2012 Photographs
In 2009 and 2012, there are remnant flood deposits, especially to the west. On the Sespe Cienega property and to the east vegetation has reestablished. The channel enters the property in the same location but flows farther north than in 2002, although not as far north as in 1947. A large portion of the Sespe Cienega property is still being used for watercress. Land to the immediate northwest that was inundated during the 2005 flood appears to have been cleared agricultural use.

2014, 2016, and 2018 Photographs
The channel continues to take the same path in 2014, with a side branch dipping south. Watercress beds in the western portion of the Sespe Cienega property appear to have died off. By 2016, the side branch dipping south appears to have become the main Santa Clara River channel. The river flows much farther south than in 1929 when it cut through the center of the Sespe Cienega property. In 2016 and 2018 the watercress beds on the Sespe Cienega property appear to have browned and are likely no longer in use. The hedge row sheltering the effluent discharge ditch from the Fillmore Fish Hatchery remains on the property. A substantial extension of the subdivision appears to have been laid out on land to the northwest of the property, but as of 2018

was not yet developed. Agricultural land uses to the south of the property have changed and it appears that crops have been planted

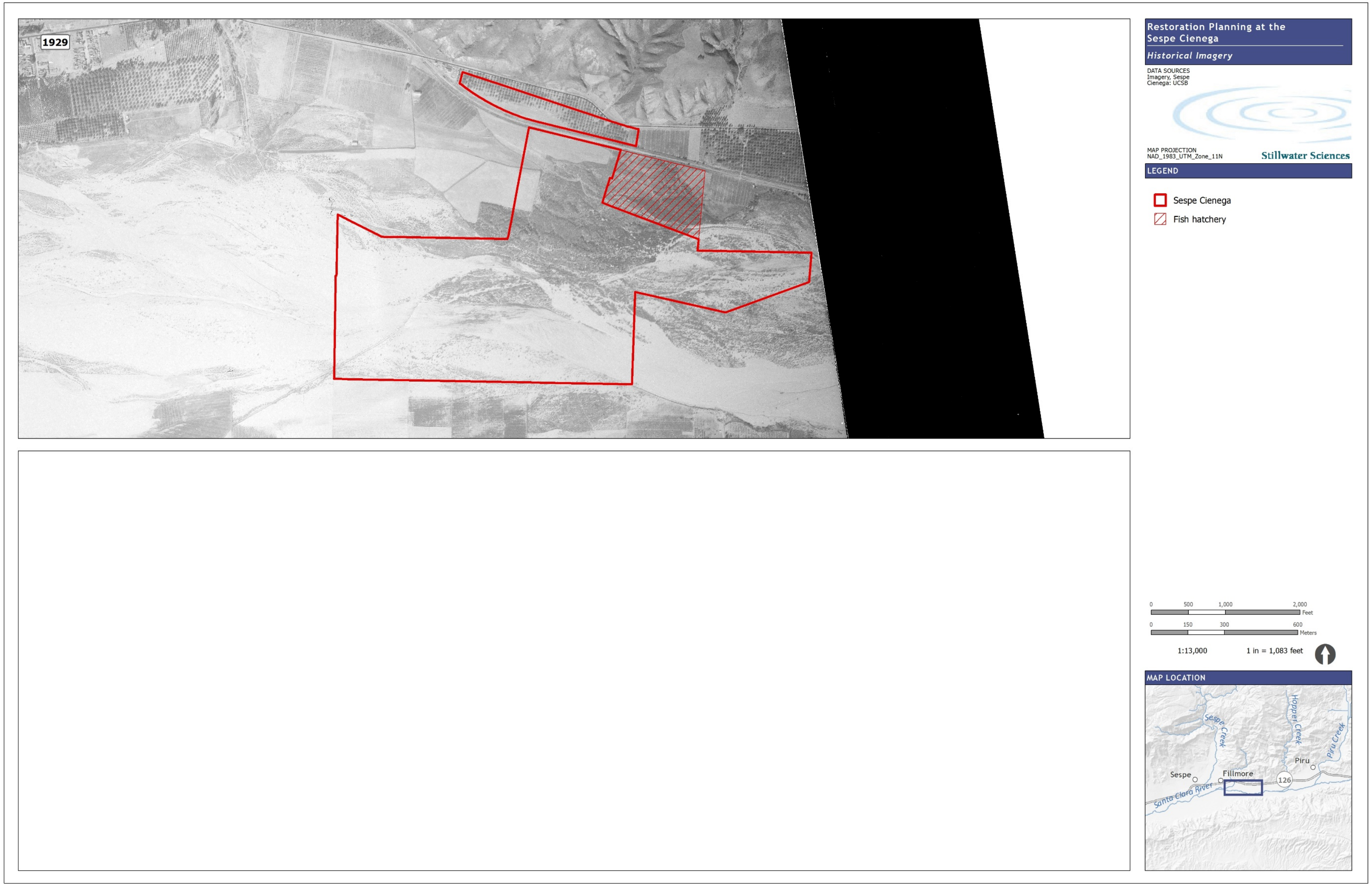

Figure B-1. 1929 aerial imagery in the vicinity of the Sespe Cienega project site.

Figure B-2. 1947 and 1959 aerial imagery in the vicinity of the Sespe Cienega project site.

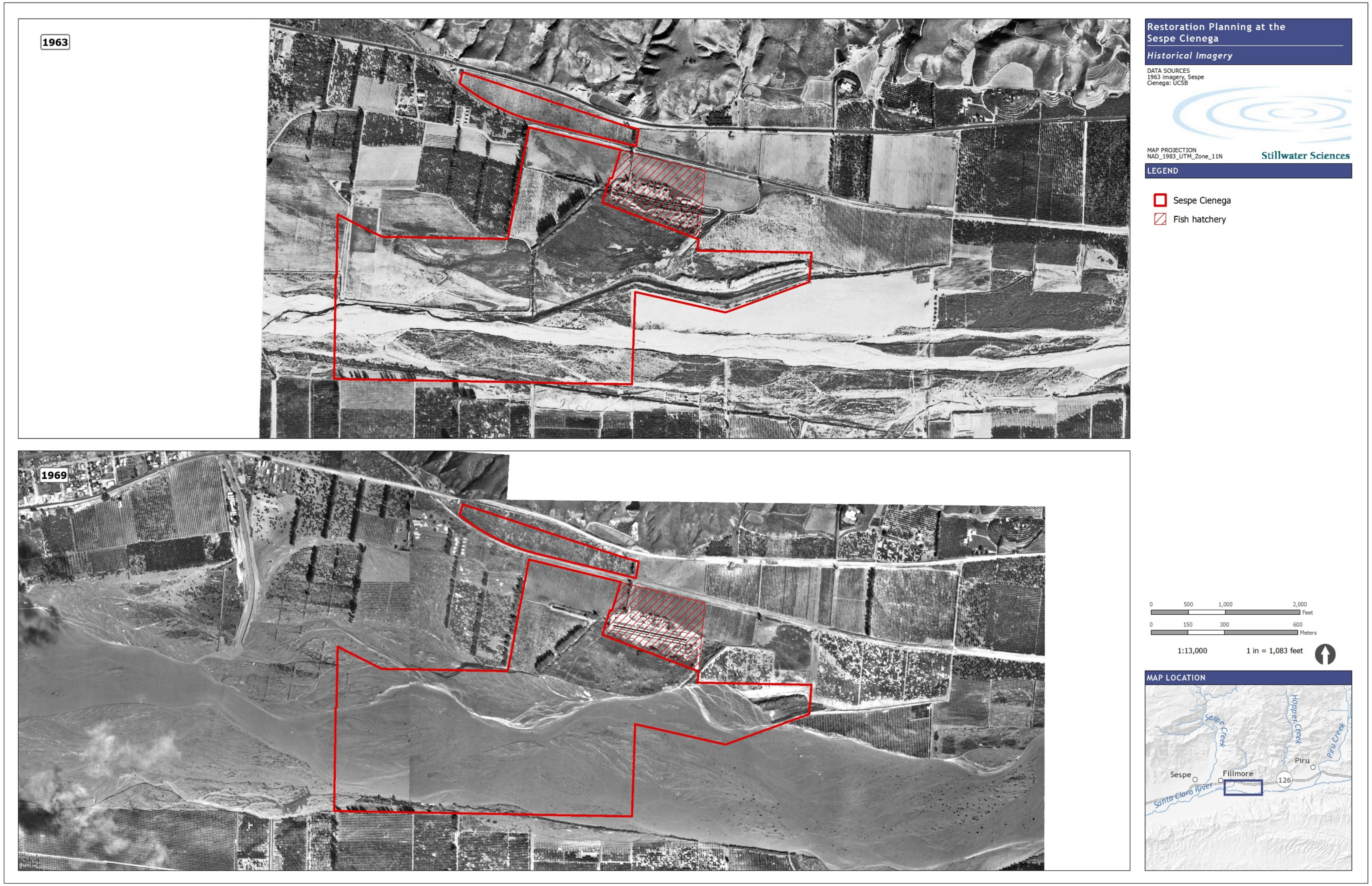

Figure B-3. 1963 and 1969 aerial imagery in the vicinity of the Sespe Cienega project site.

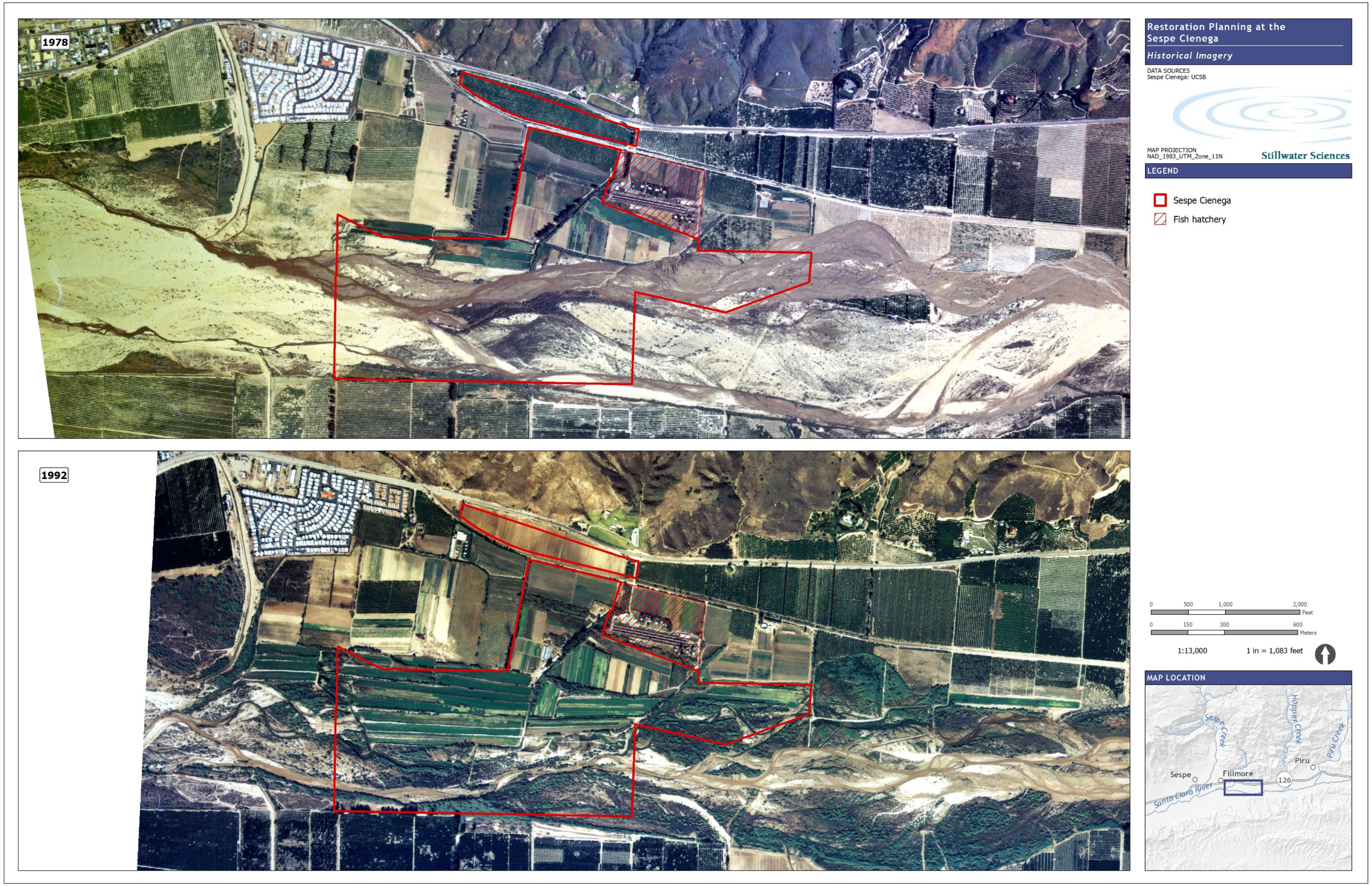

Figure B-4. 1978 and 1992 aerial imagery in the vicinity of the Sespe Cienega project site.

Figure B-5. 1995 and 2002 aerial imagery in the vicinity of the Sespe Cienega project site.

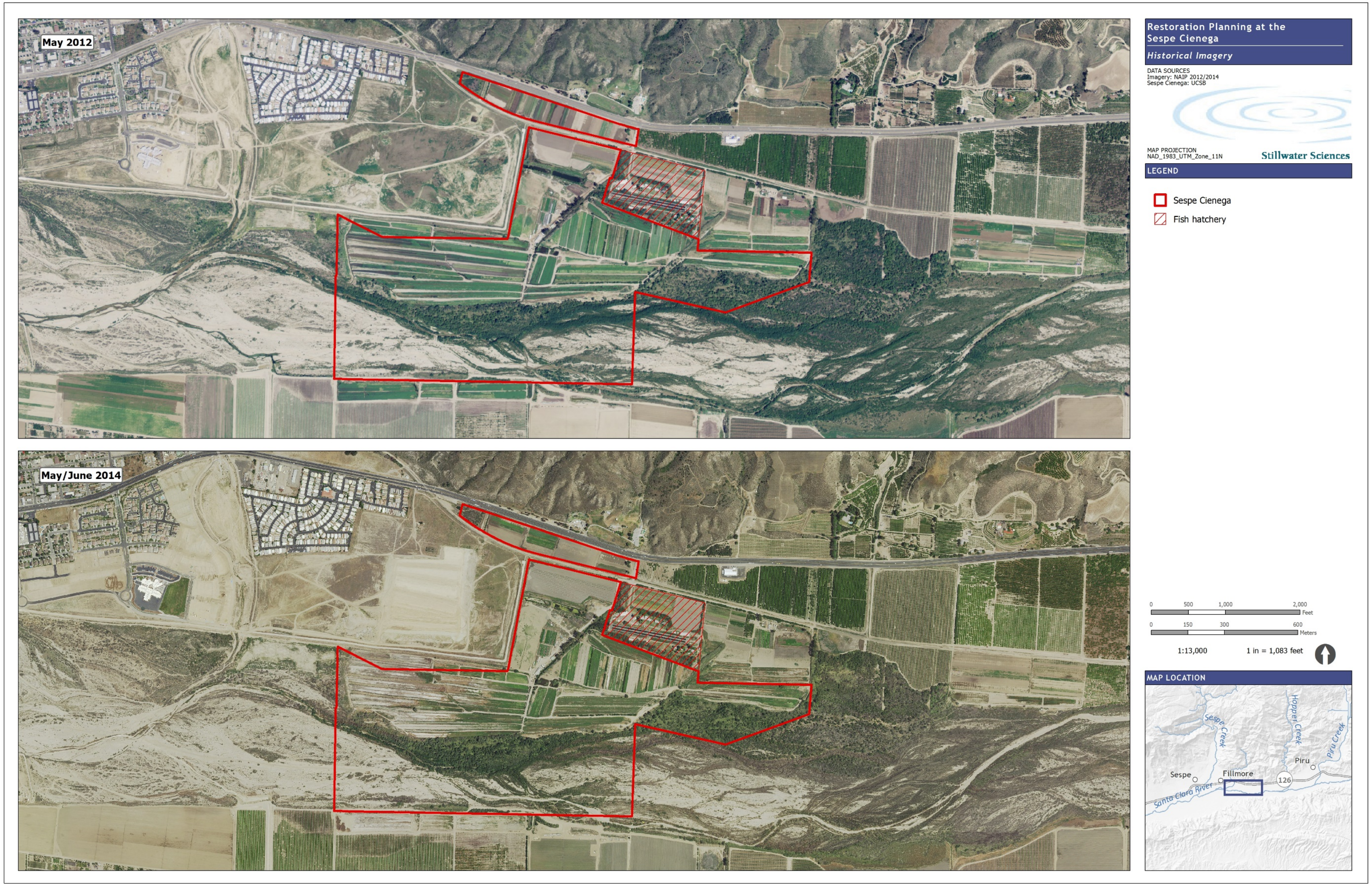

Figure B-6. 2012 and 2014 aerial imagery in the vicinity of the Sespe Cienega project site.

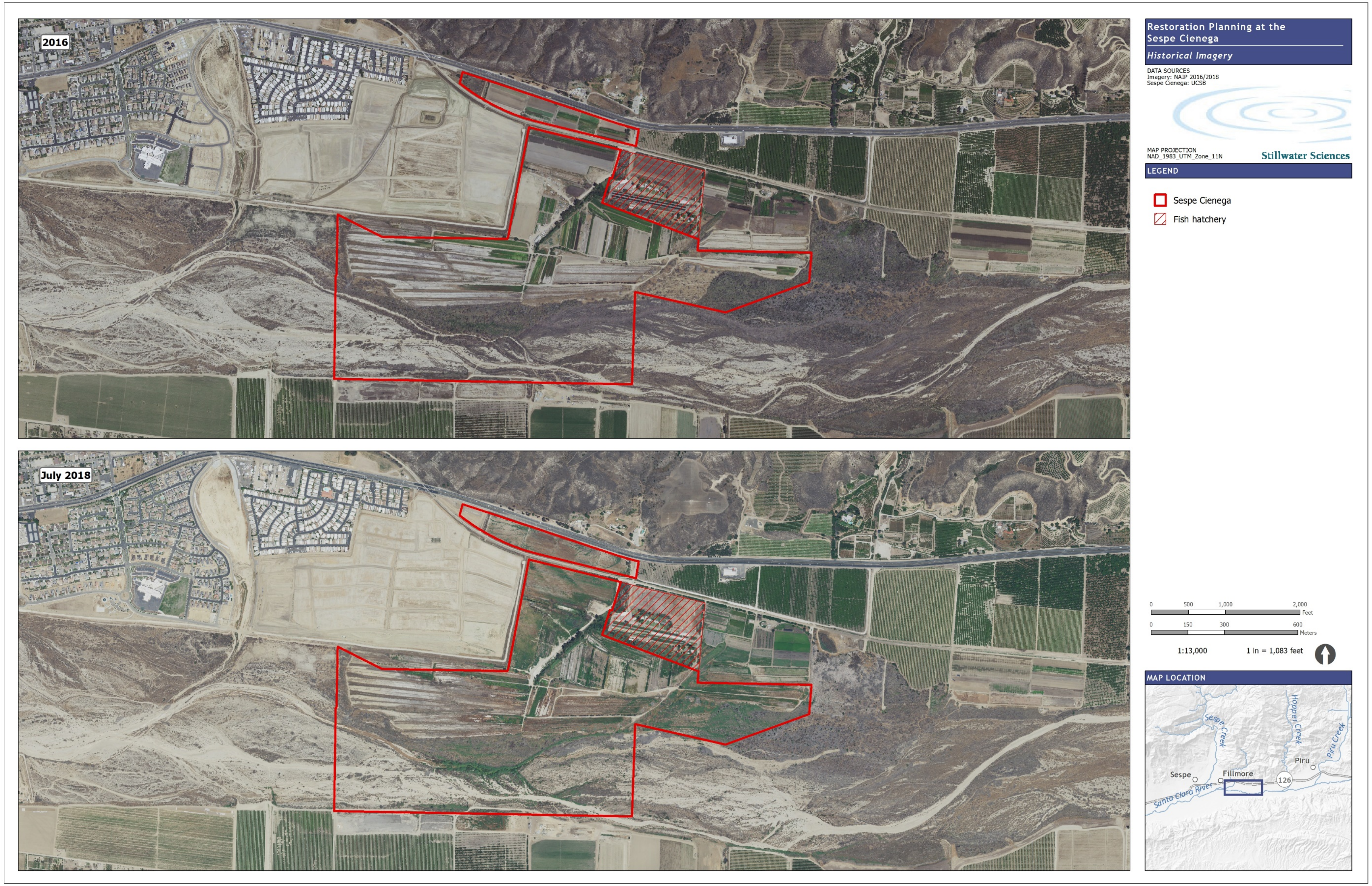

Figure B-7. 2016 and 2018 aerial imagery in the vicinity of the Sespe Cienega project site.

Appendix C

Wildlife Observations

Appendix D

Hydrologic Monitoring

Appendix E

Soil Monitoring

Appendix F

Plant Species Observed at CSER and Surrounding Riparian Areas

Appendix G

Avian Species on Cienega Springs Ecological Reserve

List of Avian Species Observed on the CSER

List of avian species observed (counted, detected) on the CDFW Cienega Springs Ecological Reserve from spring 2018-winter 2021. List compiled by Linnea Hall from observations by D. Kisner and the Western Foundation of Vertebrate Zoology.

Bird species observed	Status
Wood Duck (*Aix sponsa*)	Wintering
Blue-winged Teal (*Spatula discors*)	Wintering
Cinnamon Teal (*Spatula cyanoptera*)	Wintering
Gadwal (*Canard chipeau*)	Wintering
American Wigeon (*Mareca americana*)	Wintering
Mallard (*Anas platyrhynchos*)	Year-round, breeding in small numbers
Green-winged Teal (*Anas crecca*)	Wintering
Bufflehead (*Bucephala albeola*)	Wintering
California Quail (*Callipepla californica*)	Resident
Rock Pigeon (*Feral Pigeon*)	non-native resident; do not breed on property currently
Eurasian Collared-Dove (*Streptopelia decaocto*)	non-native resident; breed on property in small numbers
Common Ground Dove (*Columbina passerina*)	Likely breeding in small numbers on Cienega property
Mourning Dove (*Zenaida macroura*)	Resident
Greater Roadrunner (*Geococcyx californianus*)	Resident
Lesser Nighthawk (*Chordeiles acutipennis*)	Breeding migrant
Vaux's Swift (*Chaetura vauxi*)	Passage migrant
White-throated Swift (*Aeronautes saxatalis*)	Spring/summer visitor, foraging over property regularly; probably breed in cliffs nearby
Anna's Hummingbird (*Calypte anna*)	Resident
Black-chinned Hummingbird (*Archilochus alexandri*)	Breeding migrant; breed in very small numbers
Allen's Hummingbird (*Selasphorus sasin*)	Breeds on property
Costa's Hummingbird (*Calypte costae*)	Breeding migrant
Virginia Rail (*Rallus limicola*)	Resident
Sora (*Porzana carolina*)	Wintering and small numbers of breeding pairs
Common Gallinule (*Gallinula galeata*)	Possibly resident
American Coot (*Fulica americana*)	Resident
Killdeer (*Charadrius vociferus*)	Resident
Greater Yellowlegs (*Tringa melanoleuca*)	Wintering
Wilson's Snipe (*Gallinago delicata*)	Wintering
Double-crested Cormorant (*Phalacrocorax auritus*)	Winter visitor in small numbers on open water patches
Great Blue Heron (*Ardea herodias*)	Resident; do not yet breed on site but may start rookery in native trees when established
Great Egret (*Ardea alba*)	Resident; do not yet breed on site but may start rookery in native trees when established

Bird species observed	Status
Snowy Egret (*Egretta thula*)	Resident; do not yet breed on site but may start rookery in native trees when established
Green Heron (*Butorides virescens*)	Resident; breed in native willows bordering river
Black-crowned Night Heron (*Nycticorax nycticorax*)	Resident; may breed in willows bordering pond at N end of site
American Bittern	Wintering (1 only ever seen)
White-faced Ibis (*Plegadis chihi*)	Wintering and possible small numbers of breeding birds
Turkey Vulture (*Cathartes aura*)	Resident
Osprey (*Pandion haliaetus*)	Use river corridor irregularly currently. With establishment of ponds may increase in use of site
White-tailed Kite (*Elanus leucurus*)	Resident breeder on site; 1 pair
Golden Eagle (*Aquila chrysaetos*)	Fall only (1 only seen in 2019)
Northern Harrier (*Circus hudsonius*)	Wintering
Sharp-shinned Hawk (*Accipiter striatus*)	Wintering
Cooper's Hawk (*Accipiter cooperii*)	Resident; at least one nest on property
Red-shouldered Hawk (*Buteo lineatus*)	Resident; 2-3 pairs nest on property currently
Red-tailed Hawk (*Buteo jamaicensis*)	Resident; 2-3 pairs nest on property currently
Swainson's Hawk (*Buteo swainsoni*)	Passage migrant; 21 hawks seen in roost in Mar 2021, and other small numbers seen early spring in SCR annually
Barn Owl (*Tyto alba*)	Resident
Belted Kingfisher (*Megaceryle alcyon*)	Wintering
Downy Woodpecker (*Dryobates pubescens*)	Resident
Nuttall's Woodpecker (*Dryobates nuttallii*)	Resident
Hairy Woodpecker (*Dryobates villosus*)	Resident
Northern Flicker (*Colaptes auratus*)	Wintering
American Kestrel (*Falco sparverius*)	Possible breeder; pair seen, but no fledglings ever noted
Merlin (*Falco columbarius*)	Wintering
Peregrine Falcon (*Falco peregrinus*)	Late summer-winter; adults bring juveniles to hunt ducks and they stay until about Jan/Feb
Ash-throated Flycatcher (*Myiarchus cinerascens*)	Breeding migrant
Cassin's Kingbird (*Tyrannus vociferans*)	Resident
Western Kingbird (*Tyrannus verticalis*)	Breeding migrant
Willow Flycatcher (*Empidonax traillii*)	Passage migrant
Southwestern Willow Flycatcher (*E. t. extimus*)	Breeding migrant (currently extirpated, but bred on property until 2014 in small numbers)
Pacific-Slope Flycatcher (*Empidonax difficilis*)	Breeding migrant
Black Phoebe (*Sayornis nigricans*)	Resident
Say's Phoebe (*Sayornis saya*)	Resident
Vermilion Flycatcher (*Pyrocephalus rubinus*)	Vagrant

Bird species observed	Status
Least Bell's Vireo (*Vireo bellii pusillus*)	Breeding migrant (approx 10 territories currently)
Loggerhead Shrike (*Lanius ludovicianus*)	Late summer-winter; adults bring juveniles to property. May breed with habitat restoration
California Scrub-Jay (*Aphelocoma californica*)	Resident
American Crow (*Corvus brachyrhynchos*)	Resident; breed in small numbers on property
Common Raven (*Corvus corax*)	Summer-winter visitor; seem to breed elsewhere
Horned Lark (*Eremophila alpestris*)	Resident; do not breed on property yet, or in very small numbers. Will be enhanced with riparian scrub restoration
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)	Breeding migrant
Tree Swallow (*Tachycineta bicolor*)	Breeding migrant
Violet-green Swallow (*Tachycineta thalassina*)	Passage migrant
Barn Swallow (*Hirundo rustica*)	Breeding migrant
Cliff Swallow (*Petrochelidon pyrrhonota*)	Breeding migrant
Bushtit (*Psaltriparus minimus*)	Resident
Wrentit (*Chamaea fasciata*)	Resident
Blue-gray Gnatcatcher (*Polioptila caerulea*)	Resident
Ruby-crowned Kinglet (*Regulus calendula*)	Wintering
House Wren (*Troglodytes aedon*)	Resident
Marsh Wren (*Cistothorus palustris*)	Resident
Bewick's Wren (*Thryomanes bewickii*)	Resident
American Robin (*Turdus migratorius*)	Wintering
European Starling (*Sturnus vulgaris*)	Resident; breed in small numbers in telephone pole cavities at edges of property
California Thrasher (*Toxostoma redivivum*)	Resident
Northern Mockingbird (*Mimus polyglottos*)	Resident
Cedar Waxwing (*Bomycilla cedrorum*)	Visitor; do not breed on the property
Phainopepla (*Phainopepla nitens*)	Summer visitor, possibly breed in summer after arriving from CA deserts
Western Bluebird (*Sialia mexicana*)	Resident
Swainson's Thrush (*Catharus ustulatus*)	Breeding migrant
Hermit Thrush (*Catharus guttatus*)	Wintering
Scaly-breasted Munia (*Lonchura punctulata*)	Non-native; probably now breeds in small numbers on property
House Finch (*Haemorhous mexicanus*)	Resident
Purple Finch (*Haemorhous purpureus*)	Local breeder on SCR; no nests found property yet
Lesser Goldfinch (*Spinus psaltria*)	Resident
Lawrence's Goldfinch (*Spinus lawrencei*)	Breeding local migrant; have only found 1 family group
American Goldfinch (*Spinus tristis*)	Resident

Bird species observed	Status
White-crowned Sparrow (*Zonotrichia leucophrys*)	Wintering
Vesper Sparrow (*Pooecetes gramineus*)	Wintering
Savannah Sparrow (*Passerculus sandwichensis*)	Wintering
Song Sparrow (*Melospiza melodia*)	Resident
Lincoln's Sparrow (*Melospiza lincolnii*)	Wintering
California Towhee (*Melozone crissalis*)	Resident
Green-tailed Towhee (*Pipilo chlorurus*)	Passage migrant
Spotted Towhee (*Pipilo maculatus*)	Resident
Western Tanager (*Piranga ludoviciana*)	Passage migrant
Yellow-breasted Chat (*Icteria virens*)	Breeding migrant
Western Meadowlark (*Sturnella neglecta*)	Wintering
Hooded Oriole (*Icterus cucullatus*)	Breeding migrant
Red-winged Blackbird (*Agelaius phoeniceus*)	Resident
Brewer's Blackbird (*Euphagus cyanocephalus*)	Visitor; do not breed on the property
Great-tailed Grackle (*Quiscalus mexicanus*)	Visitor; do not breed on the property
Golden-winged Warbler (*Vermivora chrysoptera*)	Vagrant
Orange-crowned Warbler (*Leiothlypis celata*)	Resident; seem to breed in very small numbers. Will be enhanced greatly by restoration
MacGillivray's Warbler (*Geothlypis tolmiei*)	Passage migrant
Common Yellowthroat (*Geothlypis trichas*)	Resident
Yellow Warbler (*Setophaga petechia*)	Breeding migrant
Yellow-rumped Warbler (*Setophaga coronata*)	Wintering
Black-throated Gray Warbler (*Setophaga nigrescens*)	Passage migrant
Wilson's Warbler (*Cardellina pusilla*)	Passage migrant, but also breed in small numbers on the SCR
Black-headed Grosbeak (*Pheucticus melanocephalus*)	Breeding migrant
Blue Grosbeak (*Passerina caerulea*)	Breeding migrant
Lazuli Bunting (*Passerina amoena*)	Breeding migrant
Dickcissel (*Spiza americana*)	Vagrant
125 BIRD SPECIES OBSERVED ON PROPERTY, APRIL 2018-Mar 2021	

Appendix H

Ecohydrological Approach

THE ECOHYDROLOGICAL FRAMEWORK FOR RESTORATION PLANNING

Alluvial rivers are dynamic systems that are affected by complex interactions among numerous inputs and processes. Factors that vary at broad landscape scales, such as climate, topography and lithology, shape processes and attributes that affect the riparian community structure and composition through a hierarchy of interaction (Merrill et al. 2006). In our simplified conceptual model (Figure A-1), landscape context (climate, topography, lithology) and natural watershed inputs (such as water, sediment, and nutrients) drive physical processes (such as sediment transport and channel migration) that, in turn, determine geomorphic attributes and physical habitat structure of the river-floodplain system. The geomorphic attributes and habitat structure drive biological responses and are important determinants of plant and animal species abundance, distribution, and composition. Modification of any of the key inputs or processes will influence channel and floodplain geomorphic attributes and, subsequently, affect riparian plant communities and fish and wildlife populations. For example, reduction in peak flows (a watershed input) can alter fluvial processes such as the timing, frequency, extent, and duration of floodplain inundation. This alteration in inundation patterns can result in changes in riparian plant species composition and age-class structure, which can alter habitat suitability for native birds and thus result in a shift in bird community species composition. In turn, riparian vegetation can feed back to affect hydraulic and geomorphic processes (e.g., Castro and Thorne 2019). For example, increased hydraulic roughness provided by newly established vegetation can increase sediment deposition and floodplain accretion, and encroachment of vegetation into the active channel following flow regulation commonly contributes to channel deepening. Natural and anthropogenic disturbances can occur at different scales, ranging from effects of global climate change on regional temperatures, precipitation, and evapotranspiration rates to a 20,000-hectare wildfire in the watershed headwaters, to landslides or flood scour and deposition along a single alluvial reach, to vegetation removal and soil disturbance by invasive turkey or wild boar populations within a single floodplain site. The effects of these disturbances also can occur at multiple scales, including the scale of the original disturbance event, to finer scale processes and structures within a watershed, including habitat structure, complexity, connectivity, and biotic responses (Stillwater Sciences 2001, Vaghti and Greco 2007, Downs et al. 2011). Restoration ecologists need to understand how these landscape- and watershed-scale processes in and around their restoration area respond to abrupt and/or long-term (e.g., punctuated vs. press) sources of disturbance and stress to chart a path towards functional recovery or enhancement of resilient riparian ecosystems within the targeted restoration area (see Orr et al 2017b, Rasmussen and Orr 2017).

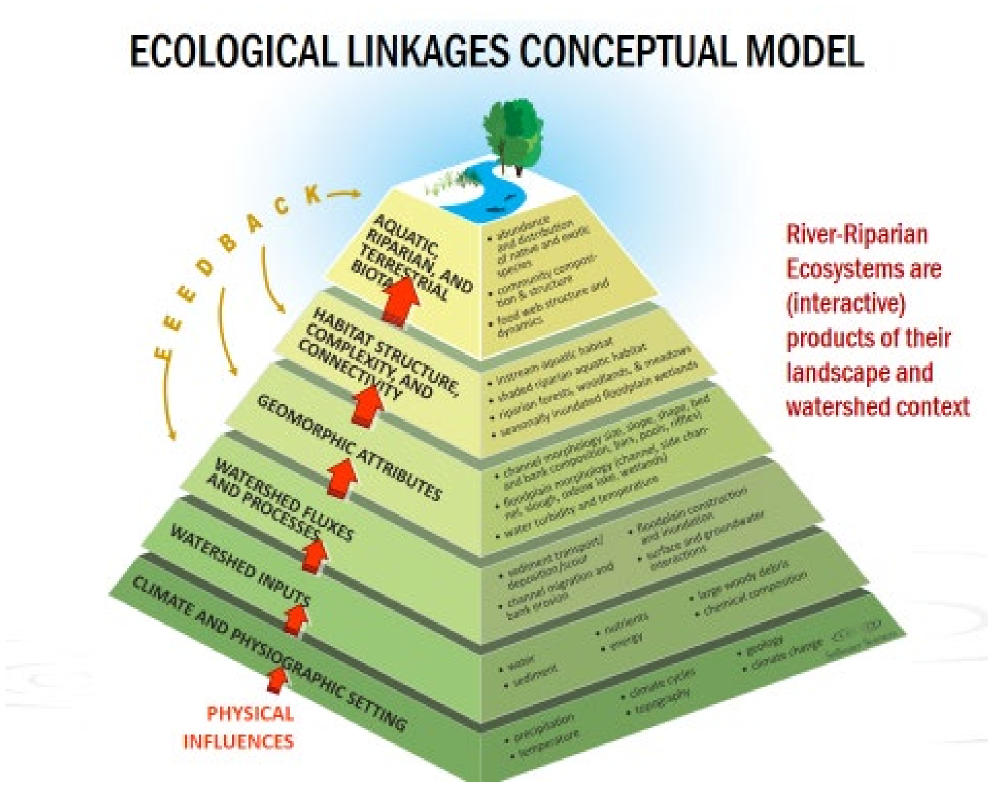

Figure H-1. Conceptual physical and biological framework for alluvial river systems.

An important part of prioritizing restoration and enhancement actions in a watershed or broader landscape is to clearly articulate and match restoration goals and objectives to specific river reaches. It is important to remember that priority restoration reaches and targets can be identified based on landscape differences in ecosystem functions and services currently provided (vs. needed for full restoration), and the distribution of stressors and process domains that affect sensitivity and/or recovery.

Thus, landscape and watershed context matters. For example, the restoration of cottonwood and willow riparian forests on the Santa Clara River is appropriate only in gaining reaches (i.e., where groundwater rises towards the surface and feeds into the river channel) with reliable shallow groundwater, while more xeric types of riparian vegetation (e.g., alluvial scrub) are more appropriate restoration targets in losing reaches (i.e., where river water is being lost downward to the water table) (Orr et al. 2011). Variations in the structure and location of underlying bedrock creates groundwater basins filled with alluvial sediments. Groundwater is typically forced to the surface at the downstream end of such a basin where bedrock and the water table are near the surface, while groundwater is often lost to a deeper water table where the river enters the upstream end of the basin. These physical geological controls can create patterns of intermittent and perennial flow that are consistent over decades or centuries, which in turn can create patterns of vegetation (such as large areas of cottonwood-willow forests and wetlands in gaining reaches and alluvial scrub in losing reaches) which are also persistent over those same temporal scales (Beller et al. 2015). The Sespe Cienega property is located along a gaining reach of the Santa Clara River that has the potential of supporting significant stands of forested wetlands dominated by cottonwoods and willows.

Understanding the Biophysical Site Template

Once a site has been selected, restoration or enhancement plans must incorporate the existing biophysical template and dominant ecosystem processes. Understanding if and how the site's physical structure might limit processes required for full recovery is an important part of restoration planning. Important site-scale processes include floodplain hydrologic connectivity (extent, duration, depth, and timing of inundation), groundwater-surface water interactions, sediment scour and deposition, net primary production, and loss through grazing, fire, or other disturbances. Human land uses and management actions or needs must also be considered at this scale. These include flood control, water use (withdrawals and return flows), public access or use, infrastructure that must be avoided or protected, and legacies of past use (e.g., toxins, altered floodplain topography). Understanding these factors will help determine the appropriate restoration approach for each site. The appropriate strategy should consider whether to employ passive (process-based) or active (e.g., horticultural revegetation, regrading, or recontouring of channel or floodplain) restoration approaches, or a combination of both. For example, if the site does not currently possess the features necessary to support the desired target habitats, can such features be efficiently and sustainably created? If so, is it worth the cost and effort, or should the restoration target be reassessed?

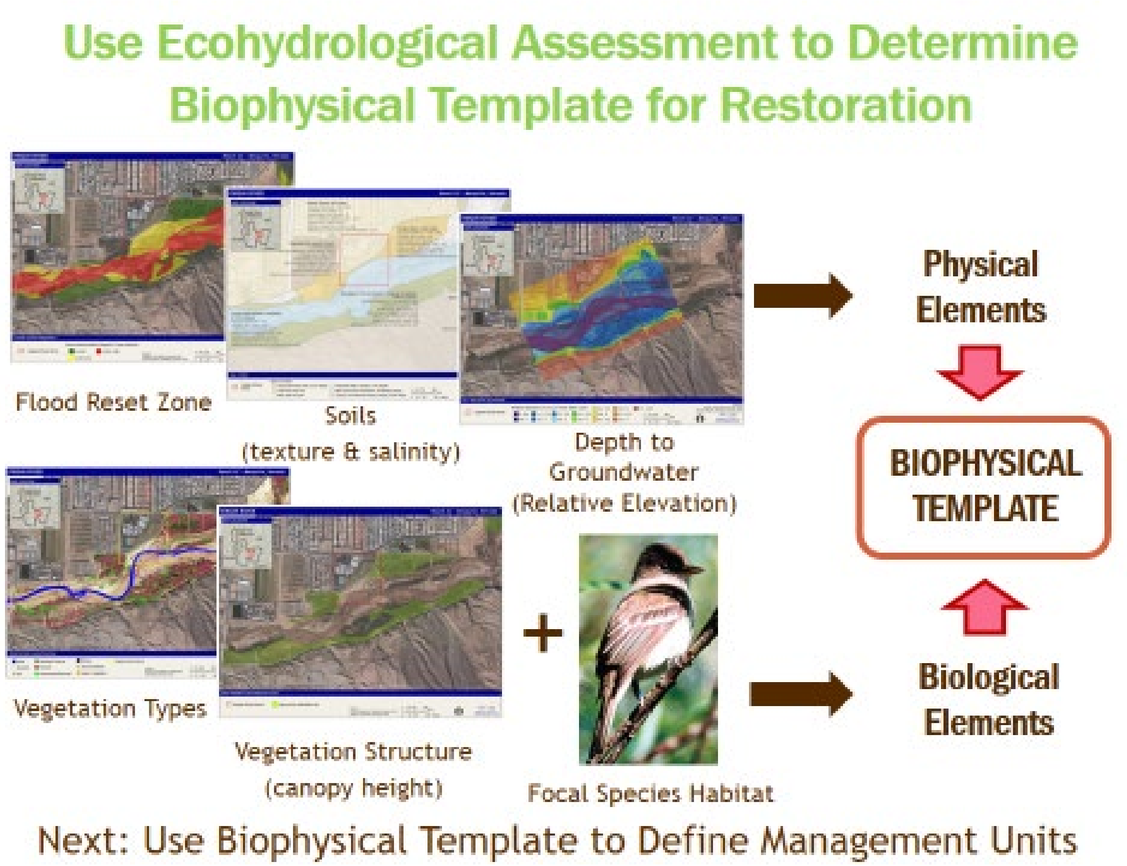

Figure H-2. The ecohydrological assessment helps us identify the key physical and biological drivers that determine the biophysical template that is the foundation for identifying appropriate restoration and management targets for various potential management units on the Property.

Putting It All Together

In using the ecohydrological framework to define the biophysical site template for the Sespe Cienega, we start with a detailed map of vegetation communities, and using GIS we overlay that with high resolution maps of relative elevation and vegetation canopy height, both derived from LIDAR-data collected in 2018, and other available data sources, including estimated percent cover of *Arundo donax*, flood scour dynamics, habitat suitability modeling for two key focal species, recent sightings of special-status wildlife in the vicinity, plus other information on habitat conditions to assess ecohydrological potential for restoration of native willow-cottonwood riparian habitat. This information allows us to delineate potential management units and to determine the primary biological and physical drivers that affect ecological habitat conditions, dynamics, and future potential.

This effort built on prior reach-scale assessments in the area to help us put the Sespe Cienega into its appropriate landscape and watershed context before we drill down into more of the site-specific factors affecting the biophysical template for restoration and management. This multi-scale (regional landscape, watershed, riverscape, river reach, and site scales) approach was required to: (1) provide an improved understanding of the key factors affecting restoration opportunities, constraints, and priorities for the Sespe Cienega, considered within the broader context of goals and objectives for the Reach that have previously been articulated by various stakeholders; and (2) help the Santa Clara River Conservancy, resource agencies, and local stakeholders set priorities for habitat restoration (i.e., primarily arundo removal with active or passive revegetation of native riparian plant species) and conservation purposes.

Appendix I

Sespe Cienega Priority Bird Species for Restoration

**SESPE CIENEGA PRIORITY BIRD SPECIES FOR RESTORATION
TECHNICAL MEMORANDUM
DECEMBER 31, 2020
PREPARED BY LINNEA HALL, WESTERN FOUNDATION OF VERTEBRATE ZOOLOGY**

At least 132 species of birds have been documented as using the Sespe Cienega property in the past few years (2013-2020), with at least 55 breeding bird species, 24 additional wintering species, and several additional fall or spring migrant species consistently using the property's resources.

Of the species already using the property or very likely to use it with some amount of restoration, there are at least 48 species that should currently be seen as targets for restoration projects on the reserve:

Breeding Priority Species (36 species, in order of priority, and all current breeders except for the 10 species below with *italicized notes* indicating lack of recent breeding observations on the property):

1. Southwestern Willow Flycatcher (*bred on the property until approx. 2013; not currently there but could return)*
2. Yellow-billed Cuckoo (*probably has not bred on the property since the 1940s, but could return with appropriate restoration of open and mesic riparian woodland*)
3. Least Bell's Vireo (approx. 15 breeding pairs on the property; will expand greatly with restoration of willow riparian woodland, and black walnut/elderberry woodland)
4. Yellow-breasted Chat (currently nest in small numbers on the property; will expand with provision of higher quality willow/other species of riparian vegetation)
5. Oak Titmouse (breed in very small numbers on property; would expand population if more trees provided, and if nest-boxes were provided before trees gain height and girth)
6. Costa's Hummingbird (breed in small numbers in riverine scrub habitat; would expand population with provision of coastal sage scrub habitat)
7. California Thrasher (currently nest in very small numbers on property; will expand with provision of higher quality riverine scrub and other habitat)
8. White-tailed Kite (*nests very close to property; probably will begin to nest on the property soon with replacement of mature riparian trees*)
9. Loggerhead Shrike (*not currently breeding on the property, but could resume if appropriate habitat is recreated*)
10. White-faced Ibis (*unsure if they are nesting or only bringing their young from elsewhere in early summer*)
11. Virginia Rail (nesting in small numbers in emergent marsh)
12. Sora (nesting in small numbers in emergent marsh)
13. Common Gallinule (probably breed in small numbers)
14. Marsh Wren (nesting in small numbers emergent marsh)
15. Red-shouldered Hawk (likely nesting in eucalyptus in February-April)
16. Red-tailed Hawk (likely nesting in eucalyptus in Feb-Apr)
17. Cooper's Hawk (*probably nesting on Shiells; should resume nesting easily with more woodland trees available on the property*)

18. Northern Harrier (*probably haven't bred on the property since the 1940s, but could likely return with appropriate habitat recreated*)
19. Tree Swallow (currently nests in small numbers; will expand population a lot when provided with recreated woodland, and nest-boxes until trees get more height and girth)
20. Open woodland cavity-nesting Neotropical migrant birds: Ash-throated Flycatcher, Western Bluebird (currently nest in small numbers; will expand population a lot when provided with restored riparian woodland, and nest-boxes until trees get more height and girth)
21. Moist woodland Neotropical migrant birds: Swainson's Thrush, Yellow Warbler, Pacific-slope Flycatcher, Black-headed Grosbeak (breed in small numbers on the property; will expand with recreation of willow woodland)
22. Grass and shrubland Neotropical migrant birds: Lazuli Bunting, Blue Grosbeak (breed in small numbers on the property; will expand with provision of native annual/perennial grassland and meadow)
23. Lesser Nighthawk (breed in small numbers in riverine scrub habitat; will expand when quality improves from arundo removal)
24. White faced Ibis (*may breed already on the property; have not been able to confirm nesting yet*)
25. Green Heron (breed in small numbers on the property; will expand with removal or arundo and reestablishment of tall and medium-sized willow riparian woodland)
26. Black-crowned Night Heron (may currently breed in small numbers on the property; will expand with removal or arundo and reestablishment of tall and medium-sized willow riparian woodland)
27. Great Egret, Snowy Egret, Great Blue Heron (*assuredly bred on the property up until the 1940s; would expand with more habitat. They do seem like they could start a rookery in the euc trees, and I wouldn't be surprised if they start this in spring 2021*).
28. Western Kingbird (a few currently breeding on the property, but population would expand with native annual and perennial grassland and meadow recreated)
29. Horned Lark (*breed in small numbers up and downstream of property; would probably breed on property if provided with better quality riverine scrub habitat*)

In addition, there are 18 wintering species (non-breeding) that also are priority targets (in order of priority):

1. Northern Harrier (feeding on rodents in open meadows)
2. Peregrine Falcon (feeding on ducks)
3. Sharp-shinned Hawk (feed on songbirds)
4. Merlin (feed on songbirds)
5. Hermit Thrush (winter altitudinal migrant in very small numbers currently)
6. White-faced Ibis (winter in large numbers in emergent marsh, *and may breed too*)
7. Marsh Wren (wintering in emergent marsh in very large numbers)
8. Sora (in emergent marsh in very large numbers)
9. Virginia Rail (in emergent marsh in very large numbers)
10. Common Gallinule (winter in small numbers)
11. Green-, Blue-winged and Cinnamon Teal (winter in small numbers in marshes and ponds)

12. Pintail, Gadwall, American Widgeon, Wood Duck, Bufflehead (winter in small numbers in marshes, ponds, and running water)

Important Non-native Habitat

Because the Sespe Cienega property is so degraded currently -- and especially is missing tree cover that provides thermal protection in summer and winter, as well as food and nesting resources -- there are some key non-native plants currently providing resources for breeding and wintering birds that should be retained while the property is undergoing restoration. The following recommendations are based on direct observations in 2019 and 2020:

1. The eucalyptus trees near the primary staging area: these tall trees support breeding of raptors (Red-shouldered Hawk and Red-tailed Hawk, as well as Great Horned Owl), and soon probably will be a rookery for wading birds (herons and egrets). Since there is no other tall tree structure on the property, these trees are critical to retain for the foreseeable future (until native trees of suitable size have been restored to the site). Only suitable replacements are mature oaks and cottonwoods.

2. Palm trees: the date palms currently provide food resources for California Scrub Jays and mammal species, and they and the other exotic palms provide nesting substrate for Hooded Orioles. Although there are not many HOOR on the property currently, the ones that are there are exclusively using the palms. Most likely Bullock's Oriole will replace Hooded Oriole on the property after the restoration, and this would be expected and natural, but retaining one or two of the date palms on the property for the foreseeable future is something to consider.

3. Horseweed: the extensive horseweed that has come up across the property is providing dense breeding cover for California Quail, sparrows (Spotted Towhee, California Towhee), and Lazuli Bunting and Lawrence's Goldfinch (in very small numbers). In winter, it is providing thousands of seeds and cover for wintering sparrows (Lincoln's Sparrow, White-crowned Sparrow, California and Spotted Towhee, Green Towhee [in small numbers], etc). Thus, my suggestion would be to not remove all horseweed at once on the property, but to remove it in stages so that overwintering survival of these birds, especially, is not affected all at once.

4. Pomegranate trees: the hundreds of pomegranate trees on the property are providing resources for several species of breeding birds (California Thrasher, Spotted Towhee, California Quail, Northern Mockingbird): nesting structure (height off ground for birds nesting above ground, and protection of ground nests), summer shade (which is currently greatly lacking on the property because of tree die-off), and food (insects). In the winter, the trees provide cover from cold air and pomegranate seeds, which are consumed by many species. The trees also provide hunting perches for species (Loggerhead Shrike, White-tailed Kite), and general perches for others (Red-winged Blackbird, Merlin, etc). My suggestion would be to remove these trees in stages, and wherever possible, grow native trees between them or around them before the pomegranate trees are removed.

5. The watercress beds: these beds are already supporting breeding and wintering birds, many of which are sensitive species in southern California (the rails, ibis, and Red-winged Blackbirds, in particular). Thus, the restoration of the watercress beds should also be handled in stages across the property, so that each year there is freshwater marsh available. In particular, the availability of these marshes seems really important during winter, when they are used by the most species.

Restoration Considerations

Because the full restoration of the property will take many years (and much money) to complete, there is some concern that a particular priority bird species will stop using the property because there are no nesting resources available for them because the drought from 2012-2016 killed off so many trees. To address this, there are temporary steps that can be taken to provide resources for such species to ensure that they continue using the property once restoration is complete:

1. The lack of native riparian (and upland) woodland tree cover affects Neotropical migrant birds that historically, and even recently, nested on the property. Thus, the provision of willow trees as soon as possible in areas where arundo has now been treated is important so that these bird species do not stop visiting the property looking for places to breed. Especially for Southwestern Willow Flycatcher, which bred until approximately 2013 on the property, the provision of willow for nesting habitat near existing waterways – even before restoration occurs – is critical. The existing eastern spur and other watercress beds are especially important to enhance as soon as possible.

2. One intermediate step until the proposed woodland restoration starts, or until the new trees get large enough to provide nesting habitat, is to provide nest boxes throughout the former woodland for the next few years. These boxes, set on poles in strategic areas, could provide temporary nesting structure for Ash-throated Flycatcher, Tree Swallow, Oak Titmouse, and Western Bluebird, who continue to try to breed on the property, but who will probably cease breeding on the property soon if no new nesting structure is provided.

3. It is also recommended that small numbers of native trees be planted as soon as possible in the terrace areas that will not be graded extensively in the future during restoration activities. Even a few cottonwood, red and arroyo willow, elderberry, and walnut trees would provide much-needed thermal relief and some nesting habitat on the degraded property, and planting them in spring 2021—while there is still substantial surface and artesian water present—would mean they could get off to a good start now. There is concern that waiting even a year to start planting them would mean that we could be in another drought, and so it seems prudent to take advantage of the water we have now.

Appendix J

Sespe Cienega Final 100% Design Planset

Appendix K

Sespe Cienega Arundo Removal and Monitoring Plan; Restoration Planning 2019

Sespe Cienega Arundo Removal and Monitoring Plan;

Restoration Planning

Revised October 2019

Prepared For:

California Department of Fish and Wildlife

and

California Wildlife Conservation Board

Prepared By:

Adam Lambert[1], PhD, Sean Carey[1], Laura Pavliscak[2] and Gus Van Kirk[1]

[1]Marine Science Institute & Cheadle Center for Biodiversity and Ecological Restoration, University of California, Santa Barbara, CA 93110-6150

[2]Santa Clara River Conservancy, PO Box 789, Santa Paula, CA 93061

Contents

I. INTRODUCTION

University of California, Santa Barbara (UCSB), in partnership with the California Department of Fish and Wildlife (CDFW) and Santa Clara River Conservancy (SCRC), has received funding from the California Wildlife Conservation Board (WCB) through the Proposition 1 Grant Program to remove Arundo (giant reed; *Arundo donax*) from CDFW Cienega Springs and fish hatchery properties and an adjacent The Nature Conservancy (TNC) property in the Santa Clara River, Fillmore, CA (Table 1; Figure 1). The project will remove Arundo from nearly 400 acres of the historical Cienega wetlands (Beller et al. 2011). With two adjacent downstream properties (Roth and Nature Park) being held in conservation for mitigation for local housing developments, over 600 acres of contiguous riparian habitat will be conserved permanently. This plan provides technical guidance for implementing, maintaining and monitoring Arundo removal for this four-year project.

Table 1. Properties in the project area where Arundo removal will be implemented.

Property	Ownership	Property Size (Acres)	Work Area (Acres)	Latitude	Longitude
Fish Hatchery and Sespe Cienega	CDFW	302.6	287	34.38738° N	-118.87849° W
Shiells-Somers/Heritage Valley Parks (HVP)	TNC	139	99	34.38872° N	-118.89158° W

Arundo occurs at varying densities through the project area and its distribution is driven by historical flood depositional patterns and available soil moisture (Figure 2). Treatment approaches will be based on Arundo density, presence of native vegetation and sensitive habitat, and site access. Dense stands will be mowed using a low ground pressure masticator or aerial herbicide application, while lower density stands will be treated using spray-in-place and cut-and-daub techniques. Other invasive plants will be treated as encountered, including tamarisk (*Tamarix* spp.), date palm (*Phoenix dactylifera*), perennial pepperweed (*Lepidium latifolium*), castor bean (*Ricinus communis*), mustards, and annual weedy forbs. Effectiveness of treatments will be monitored quarterly, and annual, quantitative vegetation monitoring will assess relative changes in non-native and native plant cover over the project period.

Permitting

The California Department of Fish and Wildlife (CDFW) reviewed the project and provided a Notice of Exemption. The exemption status was a categorical exemption (Non-native vegetation removal outside of nesting/breeding season is beneficial and will improve habitat for fish and wildlife resources). United States Fish and Wildlife Service (USFWS) consultation for

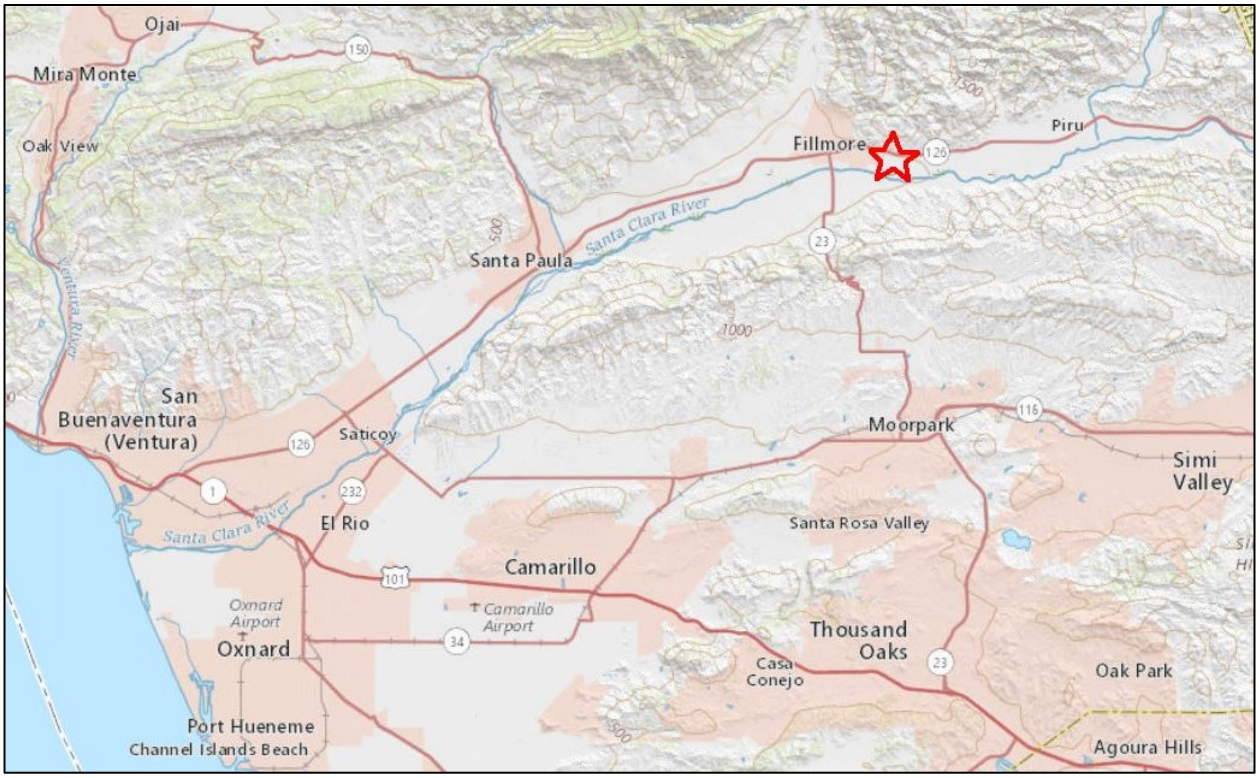

Figure 1. Location of the project site along the SCR in Fillmore, CA.

potential listed species has been completed for the Sespe Cienega and HVP properties in accordance with section 7 of the Endangered Species Act of 1973. Target species include the least Bell's vireo (*Vireo bellii* spp. *pusillus*), southwestern willow flycatcher (*Empidonax traillii*), and yellow billed cuckoo (*Coccyzus americanus*). A Biological and Conference Opinion, and Arundo retreatment guidance document have been developed for the larger restoration program and are applicable to this project (USFWS 2012 and 2017). A portion of the project areas is within the United States Army Corps of Engineers (USACE) jurisdiction (below the ordinary high water mark). Consultation with USACE has occurred and a determination has been made that no permit is required due to the nature of the work and implementation of Best Management Practices (BMP) to avoid adding fill material to the active river channel. A Ventura County Watershed Protection District encroachment permit is not required under the provision that the projects are routine maintenance and improvement of riparian habitat (section 203e). This Arundo removal and monitoring plan is being submitted to CDFW and WCB to document the implementation and monitoring approaches that will be used to fulfill project objectives and avoid impacts to sensitive species and wildlife.

Project Location and Site History

The project is located within an ecologically productive reach of the Santa Clara River (SCR) floodplain which supports emergent marshes, vernal wetlands, riparian forests and extensive oak woodlands. Local hydrology and soil properties are also influenced by adjacent upland agriculture. The project areas are located on CDFW's Fish Hatchery/Sespe Cienega property and TNC's Shiells-Somers/HVP property (Table 1; Figure 1). All project sites are located on the U.S. Geographical Service (USGS) 7.5-minute Fillmore Topographic Quadrangle.

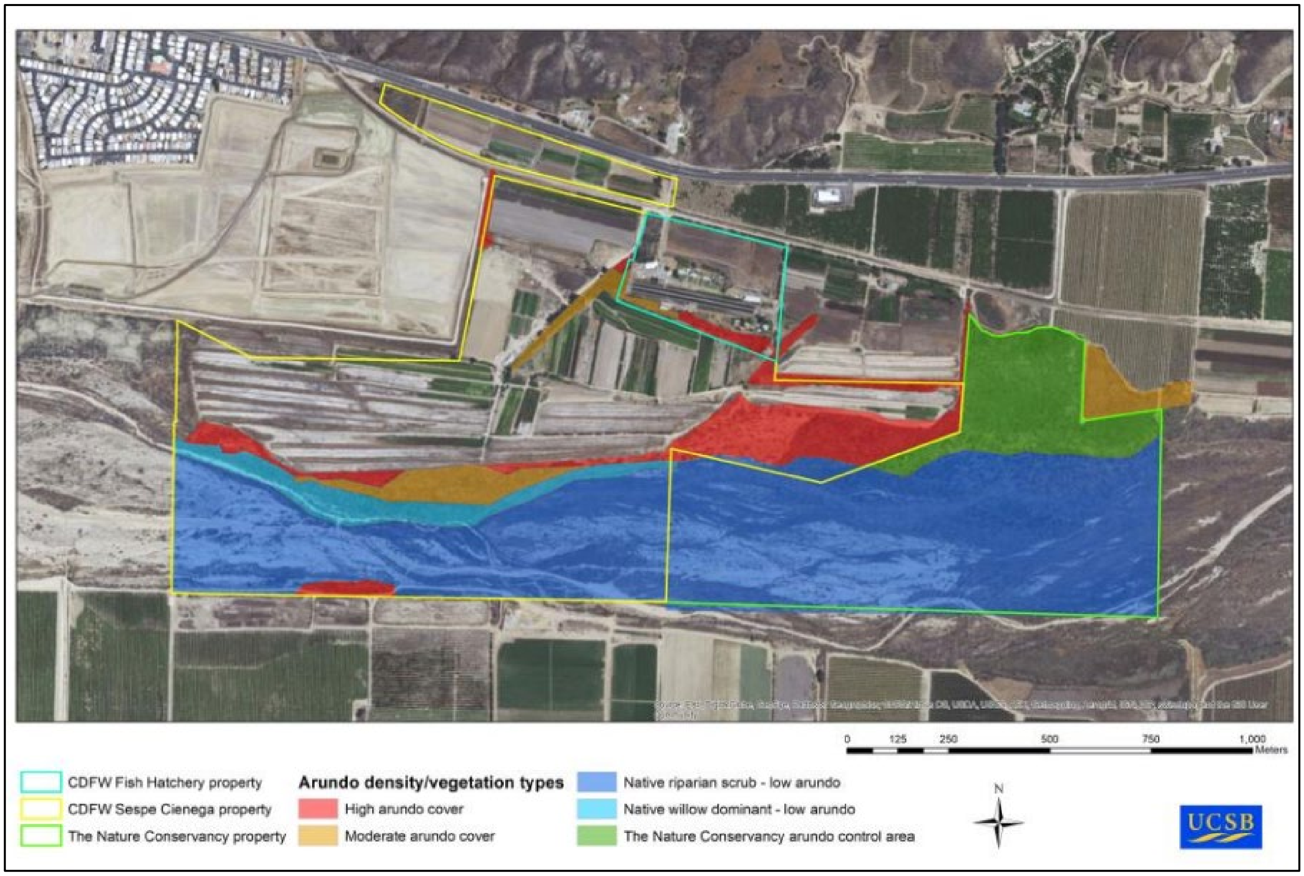

Figure 2. Arundo density and vegetation types for different properties at the Sespe Cienega Arundo removal project area.

II. NON-NATIVE INVASIVE PLANTS

Non-native species are organisms that are transported by humans beyond their endemic range to new regions and continents. These organisms become invasive in their new environments through rapid population expansion, leading to wide-ranging impacts to incipient communities. Non-native, invasive plants, in particular, can displace native plant species by monopolizing resources and altering abiotic conditions. Non-native, invasive plants may be of little or no habitat value for native wildlife and have been associated with declines in sensitive species (Able and Hagan 2003, Maerz et al. 2009).

Arundo is the most problematic non-native plant species in coastal California rivers (Lambert et al. 2010b). It is widespread throughout the SCR floodplain and reaches greatest densities on moist riparian terraces where flooding deposits rhizomes from upstream populations. Arundo is a perennial, clump-forming hydrophyte that is native to western Asia (Polunin and Huxley 1987, Hardion et al. 2014), but an invasive species in Mediterranean, subtropical, and semi-arid riparian zones worldwide. It is the largest of six species in the genus and is one of the tallest grass species (up to 10 m tall). Human additions of nitrogen and water to agricultural watersheds strongly increase the productivity of this species (Lambert et al. 2014).

Arundo invasion has wide ranging ecological and environmental impacts (Bell 1997, Dudley 2000) and is listed among the top five invasive species degrading natural ecosystems in the state by the California

Invasive Plant Council (Cal-IPC 2006). Invasion in riparian areas alters the native vegetative structure (Herrera and Dudley 2003), and rapid growth following floods or wildfires leads to competitive displacement of native riparian vegetation such as cottonwood/willow woodlands (Coffman et al. 2010). This dominance reduces arthropod diversity and abundance (Herrera and Dudley 2003) and also leads to decline in avian diversity and abundance (Kisner 2004). Measures to control Arundo have been widely implemented in California, Texas, Nevada, and other states, including herbicidal control, cutting and removing biomass, and prescribed fire (Bell 1997). These control measures often have short-term efficacy and can incur collateral damage on non-target species (Boose and Holt 1999). Biological control is being implemented as a permanent method for reducing Arundo populations.

III. PROJECT BENEFITS

Over 90% of riparian habitats in southern California have been channelized or converted to urban and agricultural land uses (Dahl and Johnson 1991). These disturbances have led to habitat degradation and fragmentation, and are considered the primary factors in the decline of riparian dependent species (Blaustein et al. 1994), including least Bell's vireo (*Vireo bellii pusillus)*, arroyo toad (*Anaxyrus californicus*), and steelhead trout (*Oncorhynchus mykiss*). Colonization by non-native, invasive plants such as Arundo and tamarisk (*Tamarix* spp.) displaces native plants and provides poor habitat for native species (Dudley and Collins 1995, Herrera and Dudley 2003, Going and Dudley 2008, Lambert et al. 2010b). On a local scale, removing non-native, invasive species is anticipated to reduce competition for space, water, and light resources, allowing existing native plants to increase in cover and density, as well as create additional space for plant recruitment by natural events. On a regional scale, removal of non-native, invasive plants and establishment of native plants will contribute to progress toward the goal of restoring and protecting riparian habitat of sufficient size to support metapopulations of sensitive species. Restoration programs must be based within a landscape-scale context to provide the necessary habitat linkages to recover riparian species, especially aquatic breeding amphibians (Semlitsch 2002).

The objective of this project is to directly remove the primary stressor to riparian habitats in the SCR system: non-native, invasive Arundo and its degradative impacts (e.g. excessive water use, wildfire, and low-quality habitat). Arundo uses approximately 3-4 times the amount of water for evapotranspiration compared with native plants (Dudley and Cole 2010, Giessow 2011) and removal will result in substantial ecosystem water savings from reduced transpiration and result in increased water availability for sensitive terrestrial and aquatic species. Decreasing water loss due to Arundo will also directly improve instream flows. Increased soil moisture and groundwater supply will improve existing native plant communities and facilitate the re-establishment of native vegetation in removal areas, thus increasing the total habitat available for wildlife.

Riparian forests provide nutrient retention and cycling capacity for ecosystems and are often the primary sites for nitrogen removal from agricultural runnoff from adjacent cropping systems (Lowrance et al. 1984, Peterjohn and Correll 1984). Replacement of shallow-rooted Arundo by deeply rooted native plants such as willow (*Salix* spp.), cottonwood (*Populus*), and mule fat (*Baccharis salicifolia*) should improve local water quality through increased sediment filtration and uptake of nutrients from agricultural runoff.

Arundo is a notorious fire promoter that has transformed riparian areas into fire prone systems. Native riparian vegetation has high leaf water content, which reduces flammability and causes these systems to act as natural fire buffers, preventing the spread of wildfires across the landscape. However, the presence of Arundo and weedy grasses and forbs often reduces the buffering capacity of riparian areas by generating large amounts of fine fuels that are easily ignitable (Coffman et al. 2010, Lambert et al. 2010a). The presence of these fuels increases wildfire risk and can potentially alter fire regimes in riparian systems. Although fires adversely affect native riparian plants, Arundo recovers quickly through growth from rhizomes, and can dominate a system after a few fire cycles. Removal of Arundo and replacement with native riparian vegetation, will reduce fire risk and restore the natural fire buffering ability of this riparian area.

IV. SITE BIOLOGICAL RESOURCES

Hydrology

The SCR supports perennial flows within and adjacent to the site. However, water quantities vary greatly throughout the year, generally exhibiting very low flows during the summer and fall, and higher flows and occasional flooding during the winter and spring. River flows may also increase during the dry season when water is released from upstream reservoirs. The active river runs through the project area. Groundwater on the site is supplemented from fish hatchery runoff from the north, creating moist, potentially hydric soils throughout the year. Groundwater within the project area has historically been within one meter of the surface, but has dropped several meters during the current drought (2014-present).

Vegetation Communities

Historically, the SCR valley supported biologically diverse habitats including marshes, vernal and freshwater wetlands, willow-cottonwood riparian forests, extensive oak woodlands, and riparian scrub. Many of these habitats have been converted for agriculture and ranching, and more recently lost to urban development. The Sespe Cienega and HVP properties are located within a region that historically consisted of willow-cottonwood forests and riparian scrub. Vegetation communities on these properties were surveyed in the summer of 2014 and again in August 2018. The vegetation communities, dominant plant species, and Arundo cover identified in these surveys are listed in Table 2.

Willow-Cottonwood Forest. Willow-cottonwood forests occur along the riverbank, side channels, and terrace where adequate soil moisture is present and flooding disturbance is infrequent. This vegetation community consists of willows (*Salix laevigata*, *S. exigua*, *S. lucida* ssp. *lasiandra*, and *S. lasiolepis*) and cottonwoods (*Populus fremontii*, *P. balsamifera* ssp. *trichocarpa*), mule fat (*Baccharis salicifolia*), sycamore (*Platanus racemosa*), blackberry (*Rubus ursinus*), mugwort (*Artemisia douglasiana*), and other understory species. However, much of the potential riparian forest habitat is heavily invaded by Arundo, and to a lesser degree, castor bean (*Ricinus communis*) and tamarisk (*Tamarix ramosissima/chinensis*).

Riparian Scrub. Riparian scrub is a major component of the vegetation community within the project area. This vegetation community, including the active river channel, is highly dynamic and diverse, and vegetation associations are dependent on level of flooding disturbance, sand/silt deposition, and soil moisture. Sand bars with relatively low levels of disturbance support riparian forest species, including cottonwoods, willows (especially sandbar willow; *S. exigua*), and mule fat (*Baccharis salicifolia*). Alluvial scrub areas can contain sage-scrub/riparian-scrub (*Salvia* spp., *Artemisia californica*, *Acmispon glaber*, *Hazardia squarrosa*, *Heterotheca sessiliflora*, *Croton californicus*, *Eriodictyon crassifolium*), chaparral, desert (*Artemisia tridentata, Opuntia littoralis, Cylindropuntia californica, Atriplex lentiformis*), and wetland plant associations. Arundo, although abundant, does not reach monocultural levels in these areas due to the frequent flooding/scouring regime. Tamarisk, short-pod mustard (*Hirschfeldia incana)* and perennial pepperweed (*Lepidium latifolium*), and invasive annual grasses are also present at low to moderate densities.

Upland Mixed Community. An assortment of plant species, often thought of as growing in xeric or upland habitats, are included in the SCR plant communities (particularly on higher terraces) and their presence is often facilitated by sediment deposition of upland soils into the SCR by rain events. This is a natural component of the SCR vegetation and includes a variety of woody species such as California sagebrush (*Artemisia californica*), bush monkeyflower (*Mimulus aurantiacus*), and salvia (*Salvia spp.*), and many other native annuals and perennials. These species are an important component of the vegetation and increase plant diversity and pollinator diversity within the SCR. It is also an important part of the fluctuation in vegetation within the river between periods of drought and periodic flooding. During high precipitation years this vegetation may be replaced by riparian species, though severe scouring events may facilitate temporary establishment of upland vegetation. During droughts, such as the current one, this vegetation does particularly well.

Table 2. Vegetation communities and Arundo densities within management units (see Figure 3).

Property	Management Unit	Vegetation Community	Arundo Density	Representative Native Plant Species
Sespe Cienega/Fillmore Fish Hatchery	CDFW 1	Abandoned agricultural fields/weeds	0-20%; some dense stands	*Baccharis salicifolia*
	CDFW 2	Willow-Cottonwood Forest	80-100%	*Baccharis salicifolia*, *Populus fremontii*, *Populus trichocarpa*, *Salix laevigata*, *Salix lasiolepis*
	CDFW 3	Riparian Scrub	15-70%	*Ambrosia psilostachya*, *Artemisia californica*, *Baccharis salicifolia*, *Croton californicus*, *Opuntia littoralis*
		Active River Channel	0-10%	*Ambrosia psilostachya*, *Ambrosia acanthicarpa*, *Baccharis salicifolia*, *Artemisia tridentata*, *Artemisia californica*
Shiells-Somers/Heritage Valley Parks (HVP)	TNC 1	Riparian Scrub	15-80%	*Ambrosia psilostachya*, *Artemisia tridentata*, *Baccharis salicifolia*, *Croton californicus*, *Opuntia littoralis*
		Active River Channel	0-10%	*Ambrosia psilostachya*, *Ambrosia acanthicarpa*, *Baccharis salicifolia*, *Artemisia tridentata*, *Artemisia californica*

Special-status Species

The highly productive and diverse habitats in the project area provide critical habitat for wildlife, as well as serve as corridors for movement of larger animals. A list of special-status species with potential to occur in the project area are provided in the associated Streambed Alteration Agreement. Least Bell's vireo, yellow-billed cuckoo and southwest willow flycatcher are the primary species of concern and have been documented either within or adjacent to the proposed restoration areas (D. Kisner, Kisner Restoration and Ecological Consulting, personal communication). Information collected on sensitive and special-status species during surveys will be submitted to CDFW and USFWS as part of the reporting process. Permit conditions and Best Management Practices (listed in Appendix K1) will be followed to avoid impacts to these species.

V. RESTORATION IMPLEMENTATION

Restoration activities are scheduled to begin fall of 2018 and be completed within four years (by fall 2022). The anticipated project implementation schedule is listed in Table 3. For planning and implementation purposes, the project area has been divided into four management units based on ownership and habitat type/vegetation community and Arundo cover (Figure 3).

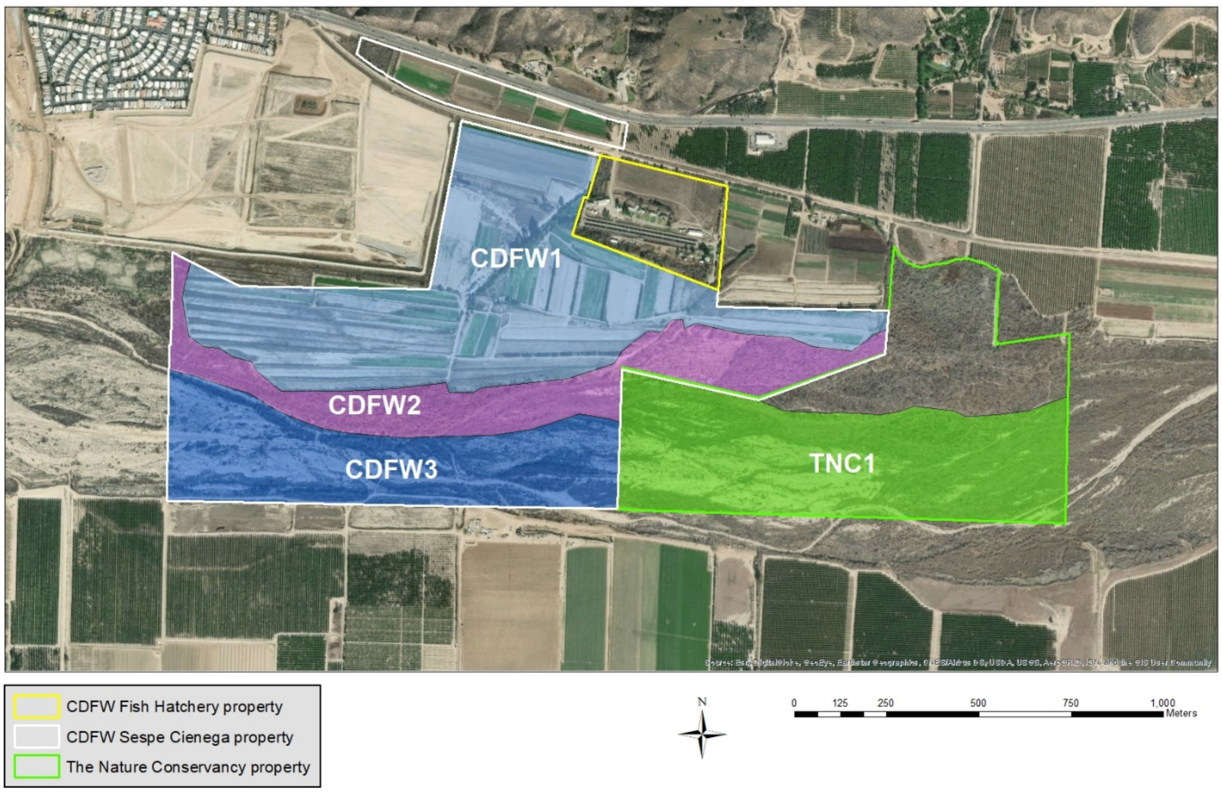

Figure 3. Management units at the Fillmore project site. CDFW = California Department of Fish and Wildlife, TNC = The Nature Conservancy.

Biological Monitor/Restoration Ecologist

Biological monitors (restoration ecologists) from UCSB and SCRC will oversee all necessary monitoring activities. Biological monitors will have experience with habitat restoration, non-native invasive plant removal, and special-status species monitoring in southern California, including familiarity with special-status plants, birds, reptiles, and mammals that may occur in the project area. The biological monitor will oversee all work done by project staff and contractors, and will coordinate and document all aspects of the implementation

Table 3. Arundo removal and monitoring schedule.

Year	Task		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018	Arundo Removal Planning									x	x	x	x	x
	Pre-Work Vegetation Assessment						x	x	x	x	x			
	Pre-Work Surveys/Biological Monitoring												x	x
	Arundo Control (Initial)	Aerial											x	x
		Mowing											x	x
		Cut/Daub											x	x
		Foliar Spray											x	x
Year	**Task**		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2019	Pre-Work Surveys/Biological Monitoring		x	x	x	x	x	x	x	x	x	x	x	x
	Arundo Control (Initial)	Aerial	x	x	x	x	x	x				x	x	x
		Mowing	x	x	x							x	x	x
		Cut/Daub	x	x	x	x	x	x	x	x	x	x	x	x
		Foliar Spray	x	x	x	x	x	x	x	x	x	x	x	x
	Other Invasive Plant Control				x			x			x			x
	Monitoring	Vegetation						x	x					
		Photo							x					
Year	**Task**		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2020	Pre-Work Surveys/Biological Monitoring		x	x	x	x	x	x	x	x	x	x	x	x
	Arundo Control (Retreatment)	Mowing	x	x	x							x	x	x
		Cut/Daub	x	x	x	x	x	x	x	x	x	x	x	x
		Foliar Spray	x	x	x	x	x	x	x	x	x	x	x	x
	Other Invasive Plant Control				x			x			x			x
	Monitoring	Vegetation						x	x					
		Photo							x					
Year	**Task**		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2021	Pre-Work Surveys/Biological Monitoring		x	x	x	x	x	x	x	x	x	x	x	x
	Arundo Control (Retreatment)	Cut/Daub	x	x	x	x	x	x	x	x	x	x	x	x
		Foliar Spray	x	x	x	x	x	x	x	x	x	x	x	x
	Other Invasive Plant Control				x			x			x			x
	Monitoring	Vegetation						x	x					
		Photo							x					
Year	**Task**		**Jan**	**Feb**	**Mar**	**Apr**	**Ma**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2022	Pre-Work Surveys/Biological Monitoring		x	x	x									
	Arundo Control (Retreatment)	Cut/Daub	x	x										
		Foliar Spray	x	x										
	Other Invasive Plant Control				x									
	Completion report					x								

Pre-Project Surveys and Personnel Education

Prior to project implementation, a qualified biologist will conduct pre-work (construction) surveys to assess the project area for the presence of special-status plant and/or wildlife species. If special-status plant and wildlife species are found during surveys or during work, CDFW and USFWS will be notified so coordination can occur. Best management practices will be followed during the project to minimize potential impacts and protect sensitive species (Appendix A).

All project personnel, including contractors, will participate in a pre-project briefing and education program for training on permit conditions and preventing impacts to sensitive organisms. The training will include descriptions of all listed and/or special-status species and associated habitats that may occur in the project area, as determined by pre-work surveys, and include information on best management practices to avoid impacts to these species. Project personnel will also be briefed on safe environmental practices, including proper handling and use of pesticides, spill prevention and response, worker safety, and measures to reduce impacts to native vegetation. Personnel will be notified of locations of foot and vehicle access paths, sensitive areas, and areas closed to access. Copies of all permits will be available on-site and be available for inspection during all restoration activities.

Site Access and Staging Areas

Access to the Cienega and HVP work areas to perform restoration activities has been approved by CDFW and TNC. The Fillmore Fish Hatchery on State Route 126 will be the primary access point for all work, located at Fish Hatchery Road, Fillmore, CA. Access is through existing, paved roads of the fish hatchery and unpaved agricultural roads in the southern portion of the Cienega property (Figure 4). Movement of personnel and equipment within the project area will be limited to designated work and staging areas, and access routes. Designated staging areas will be used for temporary equipment and material storage, and selection will be based on landowner permission, available space, ease of access to work and staging areas, and avoidance of impacts to biological resources. Minimal trimming of trees may occur to provide access paths to the work areas. Roads created through native vegetation for project access will be revegetated with appropriate native species at the end of the project.

Arundo Control Methods

The most common methods for Arundo control in southern California are summarized below. These methods have been adapted from the Stillwater Sciences Arundo Removal Plan for the SCR Watershed (Stillwater Sciences 2011). Arundo is the primary target weed, but other noxious weeds will be controlled as encountered using these methods.

Spray only. This method is effective in areas where leaving dying and dead Arundo stems is appropriate (e.g., in areas with low Arundo cover and/or where dead material will not increase

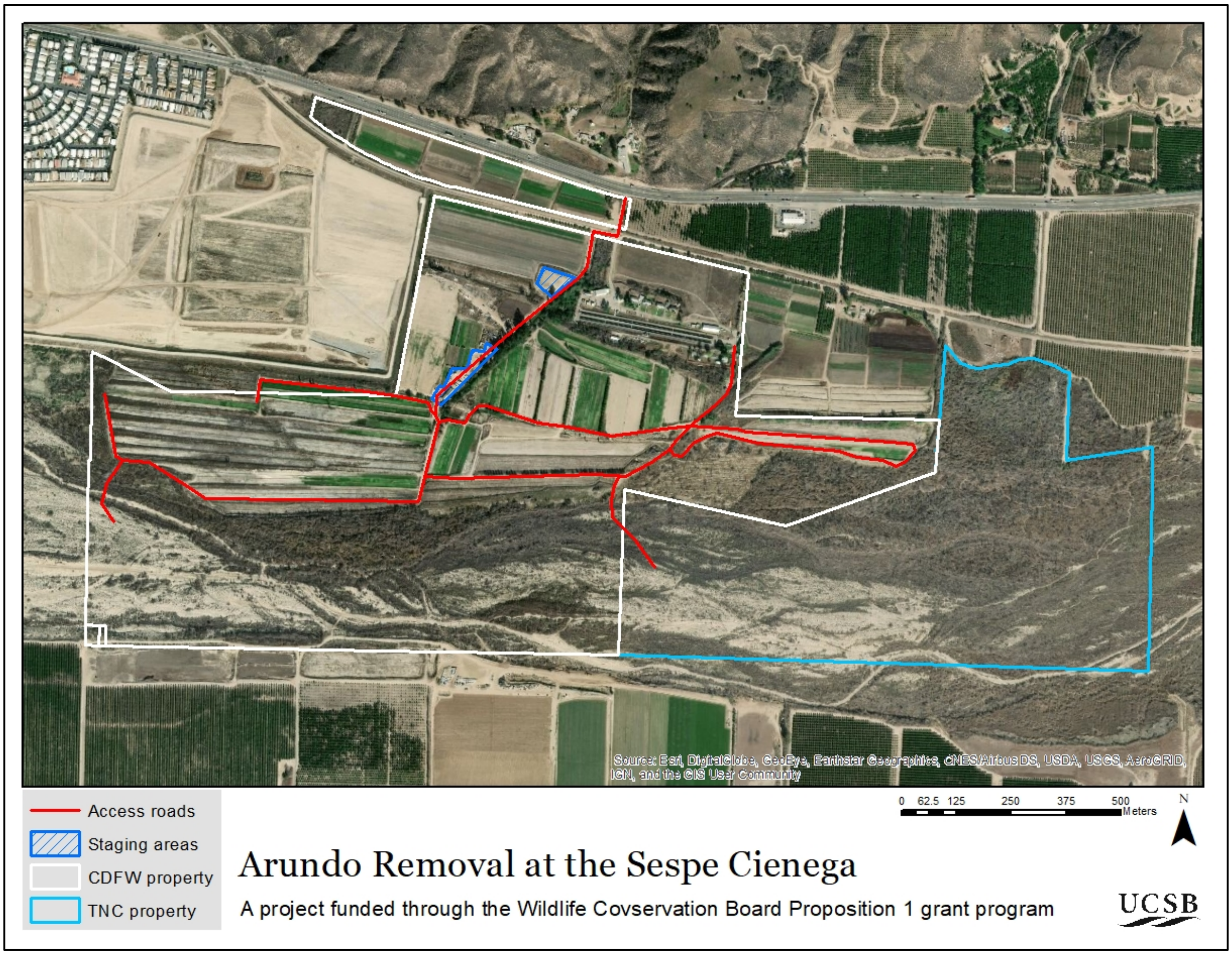

Figure 4. Staging areas and access roads to be used during the project. The Fillmore Fish Hatchery located at State Route 126 and Fish Hatchery Rd, Fillmore, CA.

fire risks) (B. Neill, Riparian Repairs, Inc., personal communication). Approved herbicides are sprayed directly onto standing Arundo stems, either using backpack sprayers or vehicle-mounted spray tanks (Katagi et al. 2002). The sprayed stems should be left in place for at least 5-6 months for full herbicide activity to occur (B. Neill, personal communication).

Contingency. This method is a variation on spray only. Herbicide is sprayed onto Arundo regrowth that has recently been scoured by floods or burned by fire. Under these conditions, much of the biomass and surrounding vegetation has been removed, which facilitates access, reduces the amount of regrowth that must be sprayed, and is the cheapest treatment method to implement. The sprayed stems should be left in place for at least 5-6 months for full herbicide activity to occur (B. Neill, personal communication).

Bend-and-spray. This method minimizes the risk of herbicide application to non-target vegetation and is one of the most suitable methods for remotely located, small to moderately sized infestations with interspersed native vegetation. The bend-and-spray method involves physically bending Arundo stems away from native vegetation and spraying the bent stems with an approved herbicide (Newhouser 2008, Coffman and Ambrose 2011). The sprayed stems should be left in place for at least 5-6 months for full herbicide activity to occur (B. Neill, personal communication).

Cut-and-daub/cut-and-spray. Depending on the method with which Arundo stems are cut, this method can be appropriate in a wide variety of conditions. Both methods include cutting stems at or near the ground surface. Using cut-and-daub, cut Arundo stumps are immediately painted with an herbicide (Coffman and Ambrose 2011). A higher concentration of the herbicide should be used with this method. For example, recommended rates for glyphosate are 50-100 percent concentration. With the cut-and-spray method, cut stems are allowed to regrow to about one to two meters and then sprayed with herbicide. In dense infestations that can be accessed by vehicles, stems can be cut with modified mowers, masticators, and/or mulchers. In less dense infestations or where access is limited, stems can be cut with bladed weed whackers or hand tools.

Mechanical mulching/mowing. Large, dense monocultures of Arundo can be removed with a tractor driven masticator. This process removes the aboveground biomass and creates a mulch layer that prevents further weed invasion and conserves soil moisture. After mowing, the resprouting Arundo is treated with herbicide. This is often the most cost effective method for removal.

Aerial application. Either before or after large, dense Arundo monocultures are physically removed/masticated, helicopters apply an herbicide mix to mature plants or regrowth. This method is effective in areas where acreage of Arundo is sufficiently large that spray only or cut-and-daub/cut-and-spray methods of removal are inefficient. The sprayed stems should be left in place for at least 5-6 months for full herbicide activity to occur (B. Neill, personal communication).

Maintenance/retreatment. Arundo treatment projects should plan for approximately 4-5 years of follow-up treatments or maintenance to ensure that all Arundo biomass is killed (J. Giessow, Dendra, Inc.; B. Neill, personal communication). However, revegetation with native plants can begin after first year regrowth is sprayed, but care should be taken to avoid spray drift with follow-up herbicide treatments.

Arundo Control Plan

The project area has been divided into management units based on property ownership and then habitat type/Arundo density and treatment approach (Figure 2). Arundo control began in October or early November 2018. Control methods for this project will be selected based on level of Arundo infestation, presence of native vegetation and/or sensitive species, and season. It is anticipated that multiple methods will be used depending on the season when control occurs. Retreatments will occur as necessary (but at lease semi-annually) to ensure all Arundo has been killed.

The primary growing season for Arundo is between February and August, although limited growth may occur in the winter. Arundo withdraws nutrients from stems and leaves in September and early October for storage in underground rhizomes during the dormant season. Control of Arundo using foliar sprays of glyphosate-based herbicides is most effective in September and often results in full mortality (Spencer et al. 2008). Spencer et al. (2008) found that effectiveness is significantly reduced when glyphosate is applied in other months, but may still be adequate in October. These studies suggest that foliar application of glyphosate may not control Arundo during winter dormancy or during the active growing season. This is most likely related to glyphosate's mode of action – the chemical is translocated to the roots where it inhibits protein synthesis. Translocation rates to roots and rhizomes are highest in plants after the growing season when plants are resorbing nutrients from aboveground parts (Killingbeck et al. 2002). Research shows that the glyphosate label application rate of 1.5 percent for grasses is relatively ineffective for Arundo and foliar applications should be applied at a 3-5 percent concentration (Spencer et al. 2012).

Studies have shown that imazapyr, another aquatically approved herbicide for Arundo control, is more effective against Arundo during the growing season (B. Neill, personal communication). One study found imazapyr to be ineffective in controlling Arundo when applied in the fall (Spencer et al. 2009). Applicators have also found that combining the two herbicides increases effectiveness and reduces the total amount of chemicals that must be used.

For this project, an aquatic-approved herbicide formulation such as Roundup Custom ® (glyphosate) or Polaris® (imazapyr) will be used in all riparian habitat. Agridex®, a California Department of Pesticide Regulation (DPR) approved non-ionic surfactant registered for use in aquatic habitats, will be used for foliar herbicide applications. A non-toxic marking dye may also be added to the herbicide to enable workers to visualize where application has occurred after the initial evaporation of the solution.

Herbicide applications will be supervised by A. Lambert (UCSB) who holds a current California DPR Qualified Applicator License (QAL). Herbicides will be applied under controlled conditions following all label requirements. BMPs for herbicide use and application are provided in Appendix K1.

Mowing and removal in areas where Arundo is present as a monoculture will occur outside of bird breeding season (beginning after September 15) using a low ground pressure, tractor driven masticator. All native trees greater than 3 inches in diameter will be avoided, but all trees, regardless of size will be avoided when possible. A contractor with extensive experience with mowing Arundo in riparian systems will be used. Surveys will be conducted before all work begins to ensure that no birds or wildlife are present or nesting within or adjacent to the project area. CDFW will be notified at least five days before Arundo control or mowing occurs. In areas where Arundo is too dense and tall to treat before mowing, herbicide will be applied to resprouts after mowing. **Properties: CDFW Cienega and Fish Hatchery**

The spray only method will be used in areas where Arundo exists in discrete stands of manageable size and where overspray on to native plants will be minimal or avoidable. Individual plants will be sprayed with glyphosate and/or imazapyr using a backpack sprayer. The bend-and-spray method will be used on any Arundo plants where overspray onto native vegetation is possible. **Properties: all**

The cut-and-paint and bend-and-spray methods will be used to control Arundo mixed with native vegetation. These methods do not use large machinery, so resulting noise and impacts to wildlife are greatly reduced. These methods are suitable for use when control work, such as follow up retreatment of non-native vegetation, is conducted during bird breeding season or where sensitive species are present. If any work is conducted during the bird breeding season as allowed by the SAA, surveys will be conducted in accordance with all permits and a biological monitor will be present for any work conducted during bird breeding season. USFWS had developed a guidance document for these methods specific to projects in the SCR (Attached at end of plan). **Properties: all**

Retreatment of regrowth will occur at least twice annually for three years to ensure that all Arundo plants have been killed. Masticated biomass will be left in place in areas where it will not be carried downstream by frequent floods. This mulch layer will provide weed suppression and maintain soil moisture, which will facilitate breakdown of biomass (Dudley 2000, Shafroth et al. 2008). Leaving biomass in place will also reduce soil disturbance and bare ground associated with removing biomass that usually leads to secondary colonization by other invasive plant species. Cut biomass will be removed from areas where there is a risk of impacts from frequent flooding (10-year period or less). This biomass will be chipped and used as mulch on site in areas with low flooding frequency. Chipped biomass and mulch will be checked regularly to confirm that resprouting has not occurred.

VI. MAINTENANCE AND ASSESSMENT OF PASSIVE RECOVERY

All sites will be monitored throughout the course of the project period to assess success of Arundo/invasive plant control treatments. Arundo treatments will occur at least twice each year and treatment of other invasive plants will be performed at least quarterly throughout the project period to prevent reestablishment of non-native cover and recolonization by native and non-native vegetation.

Continuous availability of soil moisture throughout much of the project area is expected to facilitate recruitment of native vegetation by natural processes. Native plant cover and colonization will be assess annually as part of project monitoring. Project partners will continue to secure funding for active revegetation/restoration as a second phase of the Cienega restoration program.

VII. MONITORING

Progress Monitoring

Progress monitoring will be performed on a quarterly basis. Monitoring will include qualitative assessment of non-native, invasive plant abundance and distribution, natural recruitment of native species, presence of sensitive species and wildlife, and other site issues (water availability, scouring, flood deposition, etc.) that will assist in adaptive management. Subsequent maintenance and restoration activities will be revised based on monitoring results. A brief monitoring report will be submitted to the California Wildlife Conservation Board (WCB) for each quarterly monitoring event.

Annual Monitoring

Comprehensive (annual) monitoring will be performed once a year in June and July to evaluate the effectiveness of Arundo removal/restoration implementation. Qualitative and quantitative monitoring will assess cover of Arundo, other invasive plants, and native plants in each management unit, summarize wildlife surveys, describe any changes in approaches to invasive plant control to meet project objectives, and identify project priorities for the next project year.

The vegetation sampling scheme will consist of time-series analysis of permanent monitoring points located in each management unit. Sampling intensity (number of points) will be determined for each unit using accumulation curves. If logistically possible, an unmanned aerial vehicle (UAV; drone) will be used to census plant cover over each monitoring point using a standard unit of measure (square meter). If use of a UAV is not possible, cover will be visually assessed by establishing a plot centered on each monitoring point. Absolute percent cover of Arundo, and native and non-native plants will be recorded. A current checklist of all plant species occurring in the restoration area will be compiled.

A draft annual report will be prepared by UCSB for CDFW and WCB review. A final annual report will be submitted to CDFW and WCB in September of 2019-2022. Results of monitoring will also be used to guide adaptive management during the project period.

Photo Documentation

At least three permanent photographic reference points will be established for each management unit to document the progress of Arundo removal and ecosystem status. Photo-point locations will be recorded with a GPS unit, and included in reference maps that accompany the annual monitoring reports. When progress photos are taken, location, direction and angle of view will be recorded. These will be repeated during subsequent occurrences of photo documentation to provide a time-series of photographs. Photographs will also be included in quarterly monitoring reports.

VIII. PERFORMANCE CRITERIA

At the end of this project in 2022, Arundo cover/density will be 1% or less and woody invasive plant species (excluding grasses) will be 5% or less on both the CDFW Cienega and TNC property project sites.

IX. RESTORATION PLANNING

UCSB and SCRC received planning grants from the State Coastal Conservancy and CDFW Proposition 1 programs to develop a comprehensive restoration and public access plan, associated engineering design and specifications, and assist CDFW in completing CEQA for the Sespe Cienega (Cienega Springs) property in Fillmore, CA. Project partners will work with Stillwater Sciences to develop working plans to guide restoration of riparian and wetland habitats and natural river function on the property, and provide public access to the river and restored wetland areas for the nearby communities of Fillmore, Santa Paula, and Piru, all designated as Severely Disadvantaged Communities.

For the planning effort, we will conduct a functional hydrologic analysis of the site to aid in the selection of restoration design alternatives. UCSB, with assistance from SCRC, will collect and integrate site specific environmental data including: topography, groundwater profiles (from wells nearby and installed during this project), surface water features and flood flow frequency, hatchery discharge (from hatchery records and flow measurements), precipitation and evaporation (nearby station and/or measured during this project), water quality (nutrients, pH, salinity, etc.), soil moisture, soil/substrate characteristics (texture, stratification, pH, salinity, nutrient status, etc.), erosion and deposition zones, vegetation composition and distribution, and wildlife presence/diversity. A brief summary of methods for data collection are described below:

Vegetation monitoring

Vegetation across the property will be monitored by the Restoration Team annually to track reductions in cover of invasive plants, and increases in native plant cover and diversity over the project period. Sampling method and locations will be stratified by vegetation type and physiognomy, and then randomly within each of these vegetation units. Permanent (fixed) monitoring points will be established for every 0.5-4 acres (depending on vegetation unit size) and absolute vegetative cover and species richness will be sampled using either fixed area plots or line/point intercepts (sampling method will be consistent within a vegetation unit). Drone (unmanned aerial vehicle – UAV) based aerial surveys at each sampling point will be compared to these ground based sampling techniques, and if statistically comparable, will replace ground based sampling except where greater detail is necessary. Photographic reference points will be established throughout the project area to visually document the progress of vegetative growth over the project period. Photo-point locations will be recorded with a GPS unit and included in reference maps that accompany the annual monitoring reports. When progress photos are taken, location, direction and angle of view will be recorded. Photos will be taken yearly.

Avian monitoring

Sampling methodology will be developed following Handbook of Field Methods for Monitoring Landbirds (Ralph et al. 1993) and/or Monitoring Bird Populations by Point Count (Ralph et al. 1995). Sampling points will be located within the vegetation units established above in order to correlate vegetation attributes with bird species abundance and diversity. Bird species abundance and diversity will be documented by counting all birds detected by sight, song, or call. Changes in bird species abundance and diversity over the project period will be evaluated by analyzing annual bird and vegetation datasets.

Invertebrate monitoring

To monitor arthropod diversity as restoration proceeds, a combination of sampling techniques, including sweep netting, and pitfall, pan, and malaise trapping, will be used to determine species composition and abundance. Pitfall and pan traps will be installed at a subset of the vegetation monitoring locations (see above) to capture ground dwelling and aerial arthropods, respectively. At the same sampling location, a 50-100m transect will be established and insects on vegetation along each transect will be collected using a sweep net. A malaise trap will be set-up at a subset of sampling locations and left for 24 hours to collect flying insects. A black light trap may also be used to evaluate nocturnal insect diversity.Each sampling method may be used at least once in the spring, summer, and fall. Insects will be identified either taxonomically, by feeding/functional guild, and/or by size classes to determine food resource availability. Any sensitive insect species will be immediately released. Changes in arthropod diversity over the project period will be evaluated by comparing seasonal and annual datasets.

Herpetofauna Monitoring

Coverboard sampling for herpetofauna provides a low-impact, non-intrusive method to observe and document a wide variety of reptile and amphibian species. Sampling involves laying a piece of plywood flush with the ground, undisturbed for periods of time, and checking beneath it for any animals seeking shelter or foraging below. The Restoration Team proposes to install 45 new half inch plywood coverboards measuring 122cm x 81cm (48in x 32in) to monitor reptiles and amphibians on the site. Five coverboards will be installed per sampling site (array). Because the Sespe Cienega site encompasses several distinct habitat types (successional agricultural fields, willow-cottonwood forest, and riparian scrub), replicate sampling sites will be installed with three arrays per habitat type (Table 4). Array locations will be selected based on habitat type as well as proximity to existing vegetation sampling points, so that quantitative vegetation data may be used to better understand habitat changes over time. Boards will be checked at least twice monthly throughout the year, and up to once per week. Each array site sampling effort will document species encountered, number of individuals by species, location, date, time of day, and observer. Locations of the arrays and all data will be provided to CDFW. Sampling will occur through the tenure of the restoration plan (2022).

Table 4. Overview of coverboard allocation by habitat type.

Habitat Type	Number of Arrays (one array = 5 coverboards)	Total Number of Coverboards
Agricultural fields	3	15
Willow-cottonwood forest	3	15
Riparian scrub	3	15
Totals	9	45

Mammal Monitoring

In order to understand which mammals may be utilizing resources and/or using the river as a corridor, the Restoration Team proposes to conduct a modest mammal monitoring effort by installing at least two wildlife camera traps in the Sespe Cienega project area. Sampling areas have not yet been identified, but key targets will be active game trails and areas with perennial water in the willow-cottonwood forest or riparian scrub habitat types. Infrared cameras (without a flash) will be used in order to avoid disturbing any wildlife using the site. To avoid theft, each camera will be placed surreptitiously (likely in a locked armored box bolted around/to a tree). Data cards will be retrieved regularly (approximately once per month), reviewed within one month, and data will be catalogued including location, date, time of day, species, number of individuals, and activity. Location of the cameras and all data collected will be provided to CDFW. Sampling will occur through the tenure of the restoration plan (2022).

Groundwater monitoring

Shallow groundwater monitoring wells will be installed across the site to track temporal changes in sub-surface water levels. These data will assist in developing ecosystem water budgets, guide locating of native vegetation communities, esp. phreatophytes. Locations of wells are provided in Figure 5. Wells will consist of a 1.25 inch well point and up to 20 feet of 1.25-inch steel pipe. Wells will be capped to prevent water or wildlife from entering. Water levels in wells will be monitored biweekly to monthly.

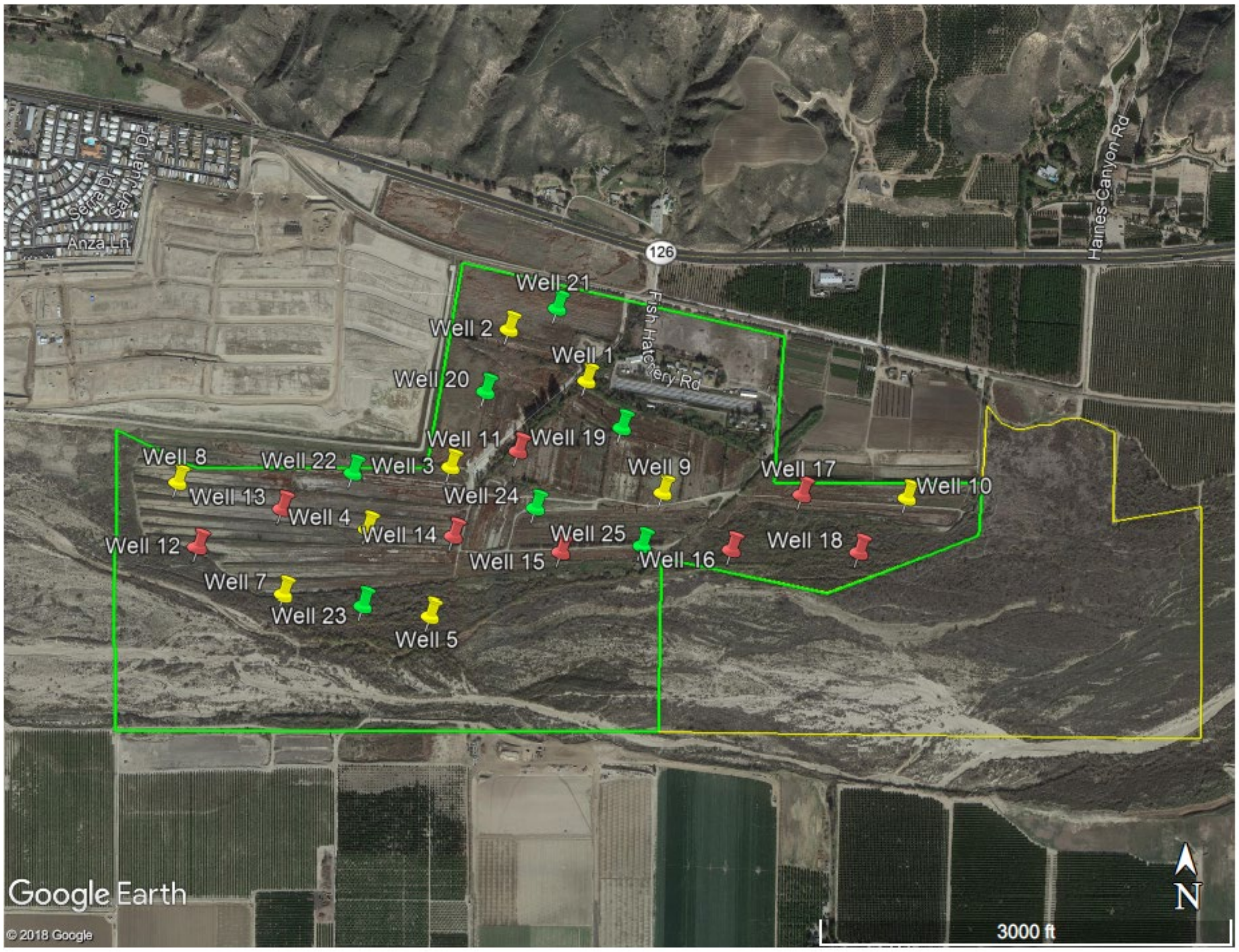

Figure 5. Locations of shallow groundwater wells to be installed. Green = priority, Yellow = secondary priority, Red = if needed.

Soil Texture

Soil samples will be collected within five meters of each of the groundwater well monitoring locations (Figure 5) to evaluate soil texture (percent sand, silt, clay, bulk density, etc.). Samples will be collected at 30 and 90 centimeters using a 3-inch diameter soil corer. Soil pits may be dug using an excavator at up to five locations to analyze soil stratification to a two-meter depth. Locations for these soil pits will be approved by CDFW before excavation.

REFERENCES

Able, K., and S. Hagan. 2003. Impact of common reed, *Phragmites australis*, on essential fish habitat: influence on reproduction, embryological development, and larval abundance of mummichog (*Fundulus heteroclitus*). Estuaries and Coasts **26**:40-50.

Bell, G. P. 1997. Ecology and management of *Arundo donax*, and approaches to riparian habitat restoration in Southern California. Pages 103-113 *in* J. H. Brock, M. Wade, P. Pysek, and D. Green, editors. Plant invasions: studies from North America and Europe. Blackhuys, Leiden, The Netherlands.

Blaustein, A. R., D. B. Wake, and W. P. Sousa. 1994. Amphibian declines: judging stability, persistence, and susceptibility of populations to local and global extinctions. Conservation Biology **8**:60-71.

Boose, A. B., and J. S. Holt. 1999. Environmental effects on asexual reproduction in *Arundo donax*. Weed Research **39**:117-127.

Cal-IPC. 2006. California Invasive Plant Inventory. Publication 2006-02. California Invasive Plant Council, Berkeley, CA.

Coffman, G., and R. Ambrose. 2011. Santa Clara River riparian revegetation and monitoring handbook (Prepared for the Santa Clara River Trustee Council).

Coffman, G., R. Ambrose, and P. Rundel. 2010. Wildfire promotes dominance of invasive giant reed (*Arundo donax*) in riparian ecosystems. Biological Invasions **12**:2723-2734.

Dahl, T. E., and C. E. Johnson. 1991. Status and trends of wetlands in the conterminous United States, mid-1970's to mid-1980's., Washington, D.C.

Dudley, T., and S. Cole. 2010. Preliminary comparison of transpirational water use by *Arundo donax* and replacement riparian vegetation types in California. Report to Madera Co. RCD.

Dudley, T. L. 2000. Noxious wildland weeds of California: *Arundo donax.in* C. Bossard, J. Randall, and M. Hoshovsky, editors. Invasive plants of California's wildlands. University of California Press, Berkeley, CA.

Dudley, T. L., and L. E. Collins. 1995. Biological invasions in California wetlands: the impacts and control of non-indigenous species (NIS) in natural areas. Pacific Institute for Studies in Development, Environment, and Security, Oakland, CA.

Giessow, J. 2011. *Arundo donax* - Distribution and Impact Report. Agreement No. 06-374-559-0 to State Water Resources Control Board, Prepared by: California Invasive Plant Council.

Going, B., and T. Dudley. 2008. Invasive riparian plant litter alters aquatic insect growth. Biological Invasions **10**:1041-1051.

Hardion, L., R. Verlaque, K. Saltonstall, A. Leriche, and B. Vila. 2014. Origin of the invasive Arundo donax (Poaceae): a trans-Asian expedition in herbaria. Annals of Botany.

Herrera, A. M., and T. L. Dudley. 2003. Reduction of riparian arthropod abundance and diversity as a consequence of giant reed (*Arundo donax*) invasion. Biological Invasions **5**:167-177.

Katagi, W., Loper, and N. E. Jackson. 2002. Southern California Integrated Watershed Program Arundo Removal Protocol. Prepared by EIP Associates and Federal Invasive Species Advisory Committee for the Santa Ana Watershed Project Authority.

Killingbeck, K. T., S. L. Hammen-Winn, P. G. Vecchio, and M. E. Goguen. 2002. Nutrient Resorption Efficiency and Proficiency in Fronds and Trophopods of a Winter-Deciduous Fern, *Dennstaedtia punctilobula*. International Journal of Plant Sciences **163**:99-105.

Kisner, D. A. 2004. The Effect of Giant Reed (*Arundo donax*) on the Southern California Riparian Bird Community. San Diego State University, San Diego.

Lambert, A. M., T. Dudley, and C. M. D'Antonio. 2010a. Invasive species and fire in California. Fremontia **38**:29-36.

Lambert, A. M., T. L. Dudley, and J. Robbins. 2014. Nutrient enrichment and soil conditions drive productivity in the large-statured invasive grass *Arundo donax*. Aquatic Botany **112**:16-22.

Lambert, A. M., T. L. Dudley, and K. Saltonstall. 2010b. Ecology and impacts of the large-statured invasive grasses *Arundo donax* and *Phragmites australis* in North America. Invasive Plant Science and Management **3**:489-494.

Lowrance, R., R. Todd, J. Fail, Jr., O. Hendrickson, Jr., R. Leonard, and L. Asmussen. 1984. Riparian forests as nutrient filters in agricultural watersheds. BioScience **34**:374-377.

Maerz, J. C., V. A. Nuzzo, and B. Blossey. 2009. Declines in Woodland Salamander Abundance Associated with Non-Native Earthworm and Plant Invasions. Conservation Biology **23**:975-981.

Newhouser, M. 2008. Using the Arundo hook to bend-and-spray. Cal-IPC News **16**:4-5, 13.

Peterjohn, W. T., and D. L. Correll. 1984. Nutrient dynamics in an agricultural watershed: observations on the role of a riparian forest. Ecology **65**:1466-1475.

Polunin, O., and A. Huxley. 1987. Flowers of the Mediterranean. Hogarth Press, London.

Beller, E.E., R.M. Grossinger, M.N. Salomon, S.J. Dark, E.D. Stein, B.K. Orr, P.W. Downs, T.R. Longcore, G.C. Coffman, A.A. Whipple, R.A. Askevold, B. Stanford, J.R. Beagle. 2011. Historical ecology of the lower Santa Clara River, Ventura River, and Oxnard Plain: an analysis of terrestrial, riverine, and coastal habitats. Prepared for the State Coastal Conservancy. A report of SFEI's Historical Ecology Program, SFEI Publication #641, San Francisco Estuary Institute, Oakland, CA.

Semlitsch, R. D. 2002. Critical elements for biologically based recovery plans of aquatic-breeding amphibians. Conservation Biology **16**:619-629.

Shafroth, P. B., V. B. Beauchamp, M. K. Briggs, K. Lair, M. L. Scott, and A. A. Sher. 2008. Planning Riparian Restoration in the Context of Tamarix Control in Western North America. Restoration Ecology **16**:97-112.

Spencer, D. F., G. G. Ksander, W. Tan, P. Liow, and L. C. Whitehand. 2012. Influence of application timing on the impact of glyphosate on giant reed (*Arundo donax* L.). Journal of Aquatic Plant Management **49**:106-110.

Spencer, D. F., W. Tan, P.-S. Liow, G. G. Ksander, L. C. Whitehand, S. Weaver, J. Olson, and M. Newhouser. 2008. Evaluation of Glyphosate for Managing Giant Reed (Arundo donax). Invasive Plant Science and Management **1**:248-254.

Spencer, D. F., W. Tan, P. Liow, G. G. Ksander, and L. C. Whitehand. 2009. Evaluation of a late summer imazapyr treatment for managing giant reed (*Arundo donax*). Journal of Aquatic Plant Management **47**:40-43.

Stillwater Sciences. 2011. Santa Clara River Parkway strategic plan for *Arundo* treatment and post-treatment revegetation. Prepared for the California State Coastal Conservancy. Oakland, CA.

APPENDIX K1 – BEST MANAGEMENT PRACTICES (BMPs)

Although the implementation of this restoration project will improve habitat quality within the area, some restoration activities may temporarily adversely affect native habitat. BMPs are designed to minimize or prevent deleterious impacts to wildlife and plant communities. The BMP list provided below, or a modified version revised as needed to meet permitting requirements, will be implemented during all phases of the restoration project.

Staging, Access, and Project Work Areas

- The work area, including access and staging areas, shall be limited to the smallest possible area.
- Soil disturbance shall be limited to the smallest possible area.
- Vehicle use shall be minimized as much as possible.
- Project activities, including movement of personnel and equipment, shall be limited to designated work zones, staging areas, and access roads to the extent possible.
- Staging areas shall be located outside the active channel on the upper terrace, levee, or bank of the stream or tributary.
- Staging areas shall be located in degraded areas and/or where the soil is already compacted, preferably near access points when site conditions allow.
- Staging areas will serve as parking locations for work vehicles and equipment when not in use. All vehicles and equipment will be moved to a staging area overnight.
- If any mechanical and/or hand-held equipment was used for non-native invasive plant removal at another site, it shall be pressure washed at a location with appropriate containment of water runoff before it is used at a new project site to prevent the spread of seed or viable plant material.
- Prior to removal activities, treatment areas will be marked, and signs will be clearly posted along access points to the project area.

Herbicide Application

- All herbicide usage will occur only as directed by the written label, California Department of Pesticide Regulation, or the County Agricultural Comissioner.
- Only herbicides registered for use in California by the U.S. Environmental Protection Agency (EPA) and the DPR will be used.
- Only herbicides approved for aquatic use may be used in any area where herbicide has the potential to contact surface water.
- All adjuvants will be registered by the EPA and approved for use by the relevant environmental regulatory agencies.
- Only adjuvants approved for aquatic use may be used where herbicide has the potential to contact surface water.
- Herbicide application will be conducted and/or supervised by an individual with a current California DPR Qualified Applicator License (QAL) or Qualified Applicator Certificate (QAC).
- Herbicide usage will be limited to the minimum amount required to be effective.
- Herbicides will be applied according to the manufacturer’s label specifications.
- Herbicides will be colored with a biodegradable dye to facilitate visual control of application.

- Avoidance measures such as pulling back or temporarily tarping desired vegetation will be used to the extent feasible to prevent unintended herbicide impacts.
- Herbicides will be secured in or removed from staging areas at night.
- Herbicide will not be left unattended unless it is locked in a secure container, vehicle, or structure.
- All containers containing herbicide formulations will be clearly labeled with the herbicide type and concentration of active ingredient.
- Herbicide will not be applied during rain events or when at least 0.5 inches rain is forecast in the next 24 hours.
- Herbicide will not be applied if air temperature exceeds volatization limits of herbicide, unless adjacent native species are protected (e.g., tarped).

Work in Water, Water Quality, Erosion Control

- No vehicles or heavy equipment shall be allowed in flowing or ponded water.
- All contaminated soil, rubbish, oil or other petroleum products, or any other substances, which could be hazardous to aquatic, or terrestrial life, resulting from project related activities, shall be prevented from contaminating the soil and/or entering water bodies.
- All trash items shall be enclosed in sealed receptacles and regularly removed from the site.
- All vehicles and equipment, including the brush grinder, shall be moved to a staging area or removed from the site overnight.
- The fueling and lubrication of vehicles and large mechanical equipment shall be confined to staging areas.
- The fueling and lubrication of small mechanical equipment, such as chainsaws, outside of staging areas shall occur in a sufficiently sized tub or pan so that drips and spills are contained.
- The refilling of herbicide application equipment outside of staging areas shall occur in a sufficiently sized tub or pan so that drips and spills are contained.
- Disposal of project related waste materials such as trash, used equipment, oil, grease, and chemicals will be done in accordance with federal, state, and local regulations.

Noise

- Extraneous noise shall be limited to the maximum extent possible (e.g., radios for entertainment).
- Equipment and machinery use will comply with all applicable local noise ordinances and policies.

Air Quality/Dust Suppression

- All vehicles shall observe a maximum speed limit of 10 miles per hour or lower at the project site and staging areas to avoid generation of dust and for personnel safety.

Biological Resources

- Pre-construction surveys for threatened, endangered, and other sensitive plant and animal species will be conducted prior to initiating work.
- If listed species or species of concern are known to occur in the area, a qualified biological monitor will be retained to recommend measures to protect these species such as rescheduling restoration activities, delineation of the work area, staging area, and access points.
- If listed species are present, a qualified biological monitor will monitor activities as directed by

regulatory agencies.

- All large-scale removal work (use of heavy machinery) will be performed between September 15 and March 1, outside of the bird-breeding season, to avoid impacts to nesting birds, including listed and special-status species, as described in the Migratory Bird Treaty Act (MBTA).
- Known special-status plant locations, if any, will be marked to avoid disturbance and accidental damage or mortality to these species.
- Herbicides will not be used near known or probable locations of special-status plant species.
- Areas identified as potential special-status plant habitat will be surveyed by a qualified botanist prior to commencing work.
-

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ventura Fish and Wildlife Office
2493 Portola Road, Suite B Ventura, CA 93003-7726
Phone: (805) 644-1766 Fax: (805) 644-3958

In Reply Refer To: August 28, 2018
Consultation Code: 08EVEN00-2018-SLI-0821
Event Code: 08EVEN00-2018-E-02119
Project Name: Arundo removal in Santa Paula and Fillmore

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The enclosed list identifies species listed as threatened and endangered, species proposed for listing as threatened or endangered, designated and proposed critical habitat, and species that are candidates for listing that may occur within the boundary of the area you have indicated using the U.S. Fish and Wildlife Service's (Service) Information Planning and Conservation System (IPaC). The species list fulfills the requirements under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the species list should be verified after 90 days. We recommend that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists following the same process you used to receive the enclosed list. Please include the Consultation Tracking Number in the header of this letter with any correspondence about the species list.

Due to staff shortages and excessive workload, we are unable to provide an official list more specific to your area. Numerous other sources of information are available for you to narrow the list to the habitats and conditions of the site in which you are interested. For example, we recommend conducting a biological site assessment or surveys for plants and animals that could help refine the list.

If a Federal agency is involved in the project, that agency has the responsibility to review its proposed activities and determine whether any listed species may be affected. If the project is a major construction project*, the Federal agency has the responsibility to prepare a biological assessment to make a determination of the effects of the action on the listed species or critical habitat. If the Federal agency determines that a listed species or critical habitat is likely to be adversely affected, it should request, in writing through our office, formal consultation pursuant to section 7 of the Act. Informal consultation may be used to exchange information and resolve conflicts with respect to threatened or endangered species or their critical habitat prior to a

written request for formal consultation. During this review process, the Federal agency may engage in planning efforts but may not make any irreversible commitment of resources. Such a commitment could constitute a violation of section 7(d) of the Act.

Federal agencies are required to confer with the Service, pursuant to section 7(a)(4) of the Act, when an agency action is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat (50 CFR 402.10(a)). A request for formal conference must be in writing and should include the same information that would be provided for a request for formal consultation. Conferences can also include discussions between the Service and the Federal agency to identify and resolve potential conflicts between an action and proposed species or proposed critical habitat early in the decision-making process. The Service recommends ways to minimize or avoid adverse effects of the action. These recommendations are advisory because the jeopardy prohibition of section 7(a)(2) of the Act does not apply until the species is listed or the proposed critical habitat is designated. The conference process fulfills the need to inform Federal agencies of possible steps that an agency might take at an early stage to adjust its actions to avoid jeopardizing a proposed species.

When a proposed species or proposed critical habitat may be affected by an action, the lead Federal agency may elect to enter into formal conference with the Service even if the action is not likely to jeopardize or result in the destruction or adverse modification of proposed critical habitat. If the proposed species is listed or the proposed critical habitat is designated after completion of the conference, the Federal agency may ask the Service, in writing, to confirm the conference as a formal consultation. If the Service reviews the proposed action and finds that no significant changes in the action as planned or in the information used during the conference have occurred, the Service will confirm the conference as a formal consultation on the project and no further section 7 consultation will be necessary. Use of the formal conference process in this manner can prevent delays in the event the proposed species is listed or the proposed critical habitat is designated during project development or implementation.

Candidate species are those species presently under review by the Service for consideration for Federal listing. Candidate species should be considered in the planning process because they may become listed or proposed for listing prior to project completion. Preparation of a biological assessment, as described in section 7(c) of the Act, is not required for candidate species. If early evaluation of your project indicates that it is likely to affect a candidate species, you may wish to request technical assistance from this office.

Only listed species receive protection under the Act. However, sensitive species should be considered in the planning process in the event they become listed or proposed for listing prior to project completion. We recommend that you review information in the California Department of Fish and Wildlife's Natural Diversity Data Base. You can contact the California Department of Fish and Wildlife at (916) 324-3812 for information on other sensitive species that may occur in this area.

3

[*A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2) (c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.]

Attachment(s):

- Official Species List

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action."

This species list is provided by:

Ventura Fish And Wildlife Office
2493 Portola Road, Suite B
Ventura, CA 93003-7726
(805) 644-1766

Project Summary

Consultation Code: 08EVEN00-2018-SLI-0821
Event Code: 08EVEN00-2018-E-02119
Project Name: Arundo removal in Santa Paula and Fillmore
Project Type: INVASIVE SPECIES CONTROL
Project Description: Arundo removal will occur on four properties in Santa Paula totaling 250 acres, and two properties in Fillmore totaling 175 acres. The riparian habitat includes willow-cottonwood woodland, riparian scrub, and active river channel. All arundo will be removed from these properties using a range of techniques, including spray only (with herbicides), mowing and herbicide application to regrowth, and cut and daub, depending on presence of native vegetation.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/34.3907244450038N118.88769049403975W

Counties: Ventura, CA

Endangered Species Act Species

There is a total of 12 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.
IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.
See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

---

1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

1.1 Birds

1.1.1 Name — STATUS

California Condor Gymnogyps californianus — Endangered
Population: U.S.A. only, except where listed as an experimental population
There is final critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/8193

Coastal California Gnatcatcher Polioptila californica californica — Threatened
There is final critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/8178

Least Bell's Vireo Vireo bellii pusillus — Endangered
There is final critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/5945

Southwestern Willow Flycatcher Empidonax traillii extimus — Endangered
There is final critical habitat for this species. Your location overlaps the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/6749

1.2 Amphibians

1.2.1 NAME — STATUS

California Red-legged Frog Rana draytonii — Threatened
There is final critical habitat for this species. Your location is outside the critical habitat.
Species profile: https://ecos.fws.gov/ecp/species/2891

1.3 Crustaceans

1.3.1 NAME — STATUS

Riverside Fairy Shrimp Streptocephalus woottoni — Endangered
There is final critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/8148

Vernal Pool Fairy Shrimp Branchinecta lynchi — Threatened
There is final critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/498

1.4 Flowering Plants

1.4.1 NAME — STATUS

California Orcutt Grass Orcuttia californica — Endangered
No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/4923

Gambel's Watercress Rorippa gambellii — Endangered
No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/4201

Lyon's Pentachaeta Pentachaeta lyonii — Endangered
There is final critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/4699

Marsh Sandwort Arenaria paludicola — Endangered
No critical habitat has been designated for this species.
Species profile: https://ecos.fws.gov/ecp/species/2229

Spreading Navarretia Navarretia fossalis — Threatened
There is final critical habitat for this species. Your location is outside the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/1334

1.5 Critical Habitats

There is 1 critical habitat wholly or partially within your project area under this office's jurisdiction.

1.5.1 NAME — STATUS

Southwestern Willow Flycatcher Empidonax traillii extimus — Final
https://ecos.fws.gov/ecp/species/6749#crithab

Appendix L

Technical Specifications

Appendix M

Sespe Cienega Final 100% Design Planset – Preliminary Opinion of Probable Costs