TECHNICAL MEMORANDUM ◦ OCTOBER 2020

Restoration Planning at the Cienega Springs Ecological Reserve: Basis of Conceptual Design

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

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1 INTRODUCTION

This report describes a conceptual restoration design plan for the proposed Cienega Springs Ecological Reserve (CSER) located on California Department of Fish and Wildlife (CDFW) property alongside the Santa Clara River in Ventura County, California. The plan was developed by Stillwater Sciences in conjunction with the Santa Clara River Conservancy (SCRC) and the University of California Santa Barbara (UCSB) and following discussion with representatives from CDFW. The CSER occupies an area known informally as Sespe Cienega, an historically persistent area of wetland riparian vegetation in the lower Santa Clara River just upstream of the confluence of Sespe Creek with the Santa Clara River (see Beller et al., 2011, 2015). 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 memorandum outlines the key factors affecting restoration and enhancement opportunities at the site, articulates the restoration approach through a series of project goals and objectives developed by the design team and various stakeholders, indicates critical elements of assessment and evaluation that underpin the design, and provides a conceptual design plan and transects as the basis for further development. Future phases of the project will include further studies and discussions that constrain and refine this conceptual plan, resulting in 65% and 100% design plans. A final technical report will provide many of the details outlined in this memorandum.

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 278 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 is prone to shifting, forming a braided channel system within a larger floodplain. The river typically only experiences 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 Shiells/Sommers Santa Clara River Parkway 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 left bank of the current Santa Clara River.

1.2 Need for the Project

The Santa Clara River drains roughly 1600 square miles of the Transverse Ranges, and as is typical of Mediterranean-climate watersheds in which major portions of the floodplain exhibit seasonally intermittent surface flows. However, in river segments where the underlying geology forces groundwater toward the surface, 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 water-cress 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 will require grading activities to offset their impact. Restoration planning will need 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, from which annual flow releases from Lake Piru to the creek below Santa Felicia Dam are made for various downstream purposes, which ensures a (variable) supply of water to the site, along with potential impacts resulting from climate change. Likewise, morphological changes that result from large flood events need also to be considered. The overall vision for the CSER is to develop a self-sustaining area of native groundwater-dependent riparian vegetation that supports associated native fauna, but there are ancillary needs and potential benefits related to public access and to CDFW uses for the site that require additional consideration and integration. A full set of project goals and objectives is developed in Section 3.

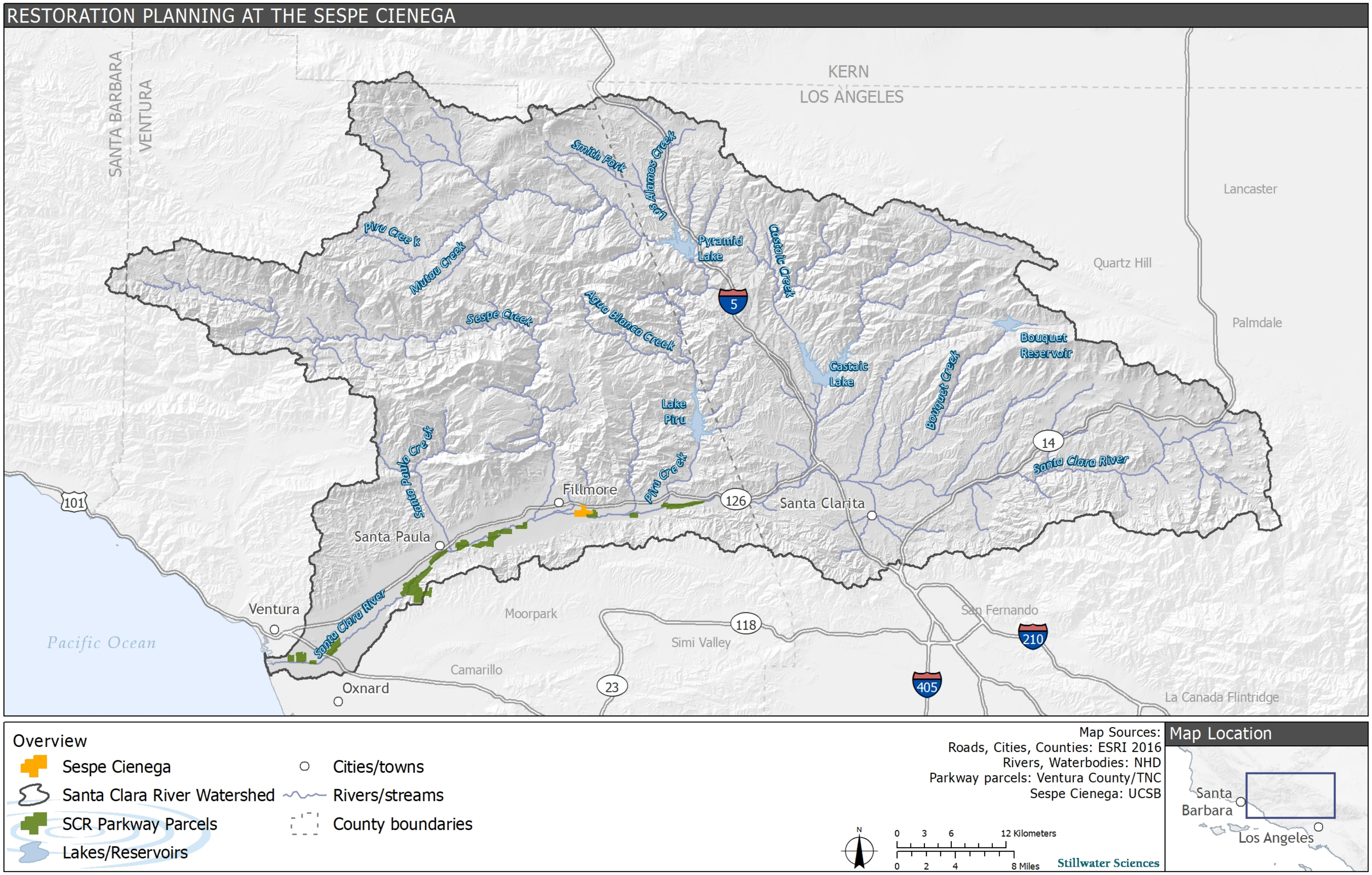

Figure 1-1. Location of the Sespe Cienega project area within the Santa Clara River Watershed located in Ventura County.

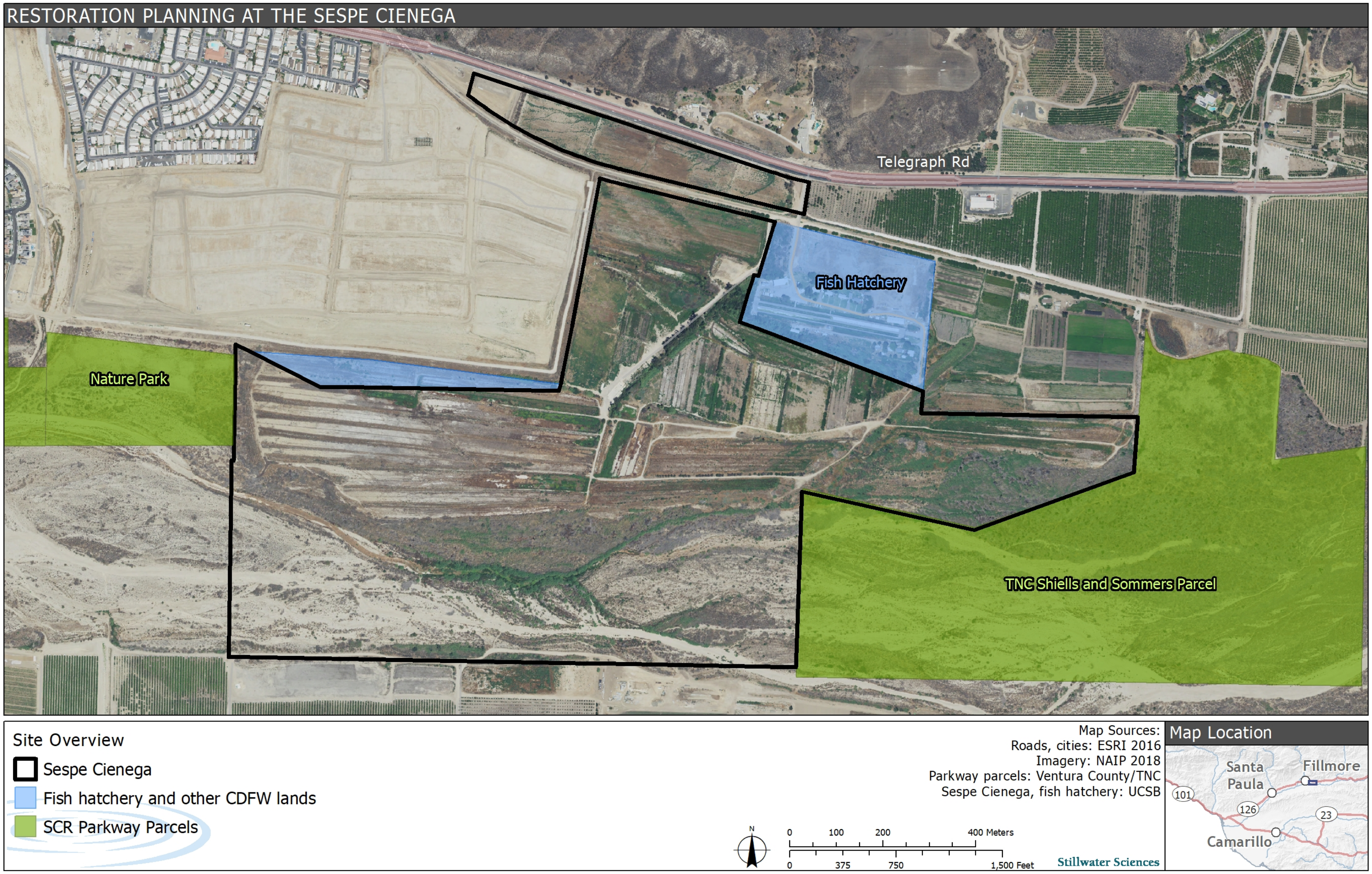

Figure 1-2. CSER project area and adjacent Santa Clara River Parkway Parcel and Fillmore fish hatchery.

2 BACKGROUND INFORMATION ON THE SESPE CIENEGA ECOSYSTEM

A full review of literature, data, and existing knowledge related to of physical, biological and human factors relating to the ecosystem values and functioning of the Sespe Cienega and the CSER restoration site is presented as a companion volume (UCSB et al. 2020) produced under a grant from the State Coastal Conservancy. A synopsis of this information will be included in the final Technical Report that will be produced later as part of this restoration design process (see Section 5 Next Steps below for more details). For the purposes of this brief technical memorandum, we focus here on a summary of knowledge gaps identified from the review process (Section 2.1) and provide short synopsis of on-going monitoring efforts designed to (partially) fill these gaps (Section 2.2). As the design process proceeds, we will need to address those knowledge gaps most critical to the final restoration design through assessment of new monitoring data and additional sources of relevant information. Some of the remaining knowledge gaps may also be addressed by post-project adaptive management and monitoring, as part of evaluating the performance of this project.

2.1 Knowledge Gaps

Review of the existing literature has identified various limits to our understanding of process functions within the CSER site that may result in uncertainties to the restoration design. Many of these limitations relate to details of site-scale physical processes that potentially affect local habitat variability for plant growth and maintenance. A summary of identified gaps follows:

2.1.1 Surface Water Hydrology

- To what extent is the southern boundary of the CSER affected by decadal-scale flood differences in the intensity of combined El Niño–Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) events?
- To what extent is the Cienega area now influenced by backwater effects from unregulated Sespe Creek flows relative to the situation before flow regulation of 51% of the upstream watershed?

2.1.2 Fluvial geomorphology

- Why has Santa Clara River bordering the CSER been characterized by narrowing and aggradation in the modern period?
- What was the long-term signature of the 1928 St Francis dam collapse on fluvial dynamics adjacent to the site?
- To what extent have sediment reductions resulting from the regulation of Piru Creek (and conceivably the construction of several debris basins not far upstream of the site) influenced fluvial dynamics in the vicinity of the CSER?
- To what extent and time did dredging the Santa Clara River by 1.5 m in Sept 1958 influence fluvial dynamics adjacent to the site thereafter? The flood of gauged record in 1969 may have over-ridden this influence.

- How might the focus of lateral migration forces be altered in future flooding as a function of recently constructed levees including those surrounding the housing development adjoining the site downstream?
- How might the focus of lateral migration forces during future flood events be altered if arundo is replaced by stands of native riparian woodland that are resistant to most flood events?

2.1.3 Groundwater

- What has been the overall influence on groundwater levels in the CSER site of abstraction associated with the fish hatchery and adjacent agriculture, and flow releases from Piru Reservoir?
- To what extent are sub-surface flows in the Cienega area fed by seepage from fractured rocks to the north?
- What are the extremes associated with contemporary inter-annual variability in groundwater dynamics?
- Why in the recent drought were there large fluctuations in groundwater levels at the site when historically groundwater levels were considered to be very stable? Is the regulation of Piru Creek since 1955 a factor?

2.1.4 Climate

- To what extent might climate change impacts alter the context of the knowledge gaps and limiting factors identified above?

2.1.5 Vegetation

- What was the historical structure and composition of native plants across the various hydrologic zones in the areas of the Cienega?
- How and to what extent did vegetation on the site change between wet and dry periods?
- What are the full ecological implications of Lake Piru releases occurring during the Fall in what would otherwise have been a very dry period in the Santa Clara valley?

2.1.6 Wildlife

- How do wildlife species respond to changes in hydrology and vegetation across the site?
- How does the removal of arundo and other non-native vegetation affect native wildlife?
- When and where should active revegetation with native plants be used to improve habitat for native wildlife?
- Which aquatic habitat conditions on the site tend to favor native species over non-native species? Does this relationship change with changing hydrology, particularly in drought periods compared to wet periods?

2.1.7 Soils

- To what extent have historic agricultural operations on the site altered the soil chemistry?
- How do soil properties vary across the site?

2.1.8 Public Access

- What is the potential scale of the demand for public access at the site, particularly as it affects the interplay between access requirements and restoration measures across the restored site?

Attempts to fill some of these knowledge gaps are on-going through monitoring efforts being undertaken by the University of California Santa Barbara (UCSB) and collaborators, as described below.

2.2 On-going Monitoring

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 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. Such monitoring addresses many of the identified knowledge gaps and should help reduce (but are unlikely to eliminate completely) some of the uncertainties in the restoration design process as we subsequently proceed to 65% and then 100% design. An opportunity to resolve any critical uncertainties remaining after 100% design is completed may arise through adopting an adaptive management and evaluation protocol following site development.

2.2.1 Water balance investigation

As an attempt to reduce design uncertainties resulting from knowledge gaps about surface and shallow sub-surface water flows across the CSER, a modest program of water monitoring has been instigated across the site. The program consists of the installation of a suite of piezometers to monitoring seasonal variations in shallow groundwater flows at strategic locations, and the mapping of seasonal surface water flows. Gauging of the primary channel of surface water flow is due to commence in Fall 2020. With better knowledge of flow patterns, levels, and volumes, implications from the water balance for the site will be integrated into the later stages of the design process.

2.2.2 Soils

A series of soil analyses is being conducted on samples collected using a stratified-systematic design deployed across the site, with the intention of constructing detailed soil maps to guide plant species selection and location for active revegetation. A comprehensive chemistry analysis (elemental, pH, salinity) and physical properties (texture, bulk density, water holding capacity, moisture content) are being measured. Soil maps will be produced highlighting variability in soil properties, using surface fitting techniques to interpolate between sample locations.

2.2.3 Vegetation

Beginning in 2019, comprehensive vegetation monitoring occurs annually to track reductions in cover of invasive plants and increases in native plant cover and diversity over the project period. Permanent (fixed) monitoring points were established for every 0.5-4 acres (depending on vegetation unit size) and absolute vegetative cover and species richness are sampled using fixed area plots or line/point intercepts. Results will be used to provide high resolution maps of vegetation communities across the site.

2.2.4 Wildlife

2.2.4.1 Avian monitoring

An avian sampling methodology was developed following the *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 are located within the vegetation units established above to correlate vegetation attributes with bird species abundance and diversity. Sampling events 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.

2.2.4.2 Invertebrate monitoring

UCSB initiated an invertebrate monitoring program in 2019 focusing primarily on insect pollinators and ground-dwelling invertebrates. 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, will also occur on a more opportunistic basis.

2.2.4.3 Herpetofauna monitoring

The SCRC and UCSB initiated a herpetofauna monitoring program in 2019. ‘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. Currently, three arrays consisting of five plywood coverboards are deployed in each vegetation type (45 total sampling boards) to monitor reptiles and amphibians on the site. 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.

2.2.4.4 Mammal monitoring

A modest mammal monitoring effort was initiated by SCRC and UCSB in 2019 by installing two wildlife camera traps in the CSER area. Infrared cameras (without a flash) are used to avoid disturbing any wildlife using the site. Cameras are located near active game trails and areas with perennial water in the willow-cottonwood forest or riparian scrub habitat types. Data cards are 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. Sampling will occur through the tenure of the restoration program.

3 RESTORATION VISION

The overall project vision for the CSER involves the re-establishment of native riparian, wetland, and aquatic (and aquatic-terrestrial 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 (GDEs) such as those found along the Santa Clara River. Of particular note in the Cienega area are the water balance implications of the continued operation of the fish hatchery and the fall (and other season) flow releases from Lake Piru 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, while also providing important social benefits (education, recreation) to the local community.

The ecosystem restoration approach pursued here builds on the literature review compilation of existing knowledge (UCSB et al., 2020) about the site and its region, and is made cognizant of the identified knowledge gaps and the on-going monitoring effort to close these gaps (Section 2.2). In general, the foundation for this approach is based on a conceptual model of key ecological linkages, which can be applied at various spatial scales (Orr et al. 2014, 2017a, 2017b, Rasmussen and Orr 2017). The process starts from an understanding of ecosystem processes operating at the coarser landscape and watershed scales (which is why many of the identified knowledge gaps are abiotic in nature, see Section 2.1) and proceeds stepwise to the finer reach and site-specific spatial scales following the principle that processes and inputs from upslope and upstream areas have a strong influence on local conditions and ecosystem dynamics. Explicit integration of natural ecosystem processes operating at appropriate scales is a fundamental part of planning, implementation, and adaptive management. 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 actively altering site morphology and active vegetation 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 drivers of the restoration vision.

3.1 Project Goals

Developing from the vision of the CSER as a self-sustaining area of native groundwater-dependent riparian vegetation that supports related native fauna, and acknowledging the important role of the project for local stakeholders, the following project goals are envisaged:

1. Develop a restoration design that functions within the extremes of the controlling regional water and sediment processes and fluxes to support a mosaic of physical conditions at the site that support upland, riparian, and aquatic ecosystem recovery.
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, environmental education, and other CDFW site priorities under 'ecological reserve' status.

The site will be managed by CDFW as a 'ecological reserve', part of CDFW's commitment to state-wide 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 frequently ascribed according to SMART criteria, that is, they should be 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. Table 3-1 outlines 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 Cienega Springs Ecological Reserve 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 locally '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 water cress 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 water quality 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 desire depth to groundwater and seasonable ranges

Objective	Action	Indicators
E8. Determine long-term ecosystem management needs/actions depending on disturbance probability and environmental perturbations	- understand likely variability in groundwater levels - understand extent of site inundation during floods of different recurrence interval - determine extent of flood scour during historical floods -plan for active revegetation in vulnerable areas after flood scouring -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	- use air photo analysis to determine extent and frequency of flood scour during historical floods - map surface water and saturated soils - characterization of 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	- use air photo analysis to determine extent and frequency of flood scour during historical floods - map surface water and saturated soils - characterization of 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 appropriate vegetation composition (palettes) based on underlying physical properties, and drought and waterlogging tolerance	- 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
N4. Reduce impact of polyphagous shothole borer beetle on riparian tree species	- Modify relative composition of plantings to favor trees with greater resistance/resilience	- Shothole borer abundance - Tree survival and growth
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 auto	- 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 and the specific objectives identified to achieve these goals 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. The following design considerations helped guide the development of the conceptual design recommendations (Section 4). These design considerations will be further developed, as necessary, in the subsequent Technical Report that will set the stage for the 65% and 100% design tasks (see Section 6 Next Steps).

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 further changes are expected into the future. Stemming from this concern are some critical, but somewhat nebulous, design considerations, namely:

- What are the **limits to understanding and recovering historical ecosystem functioning** to the Sespe Cienega site, so that the restoration design both reflects historical conditions but functions effectively under current conditions?
- **How can the design be sufficiently 'future proof'**, that is, how can the design 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 influence the physical and biological evolution of the Cienega site?

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-terrestrial 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 both short periods of inundation, on an approximate 5- to 8-year flood frequency basis, and 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 is 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 of the extremes in variability of groundwater level. On-going monitoring is attempting the develop an initial understanding of the extent of this contemporary variability.
- 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, but also that the fall (and occasionally summer) 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 water cress beds and drainage ditches) to create the desired assemblage of aquatic and semi-aquatic habitats, suitable for supporting a rich and diverse native flora and fauna.

3.3.3 Flood dynamics

The Cienega site sits adjacent to (and indeed spans) the Santa Clara River, a flashy, semi-arid channel with a multi-threaded morphology that coalesces to act as a large meandering river during flood events. Through erosion and deposition processes associated with lateral migration the planform of the riverbed tends to be significantly altered after each major 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 and re-worked during large floods. Analysis of post-flood historical aerial photographs indicates where flood re-working of the riverbed is most likely (Figure 3-1).
- 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 maturing tree plantings.
- **Accommodate decadal-scale trends in the elevation and morphology** of the Santa Clara River. In recent decades, 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 native plant 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 in 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 revegetation**. Passive strategies should be emphasized in those areas most liable to re-working by flood events, but they are also suitable in areas of sustained seasonal soil moisture. Active strategies (i.e., active planting using horticultural techniques suitable for habitat restoration and enhancement) 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.

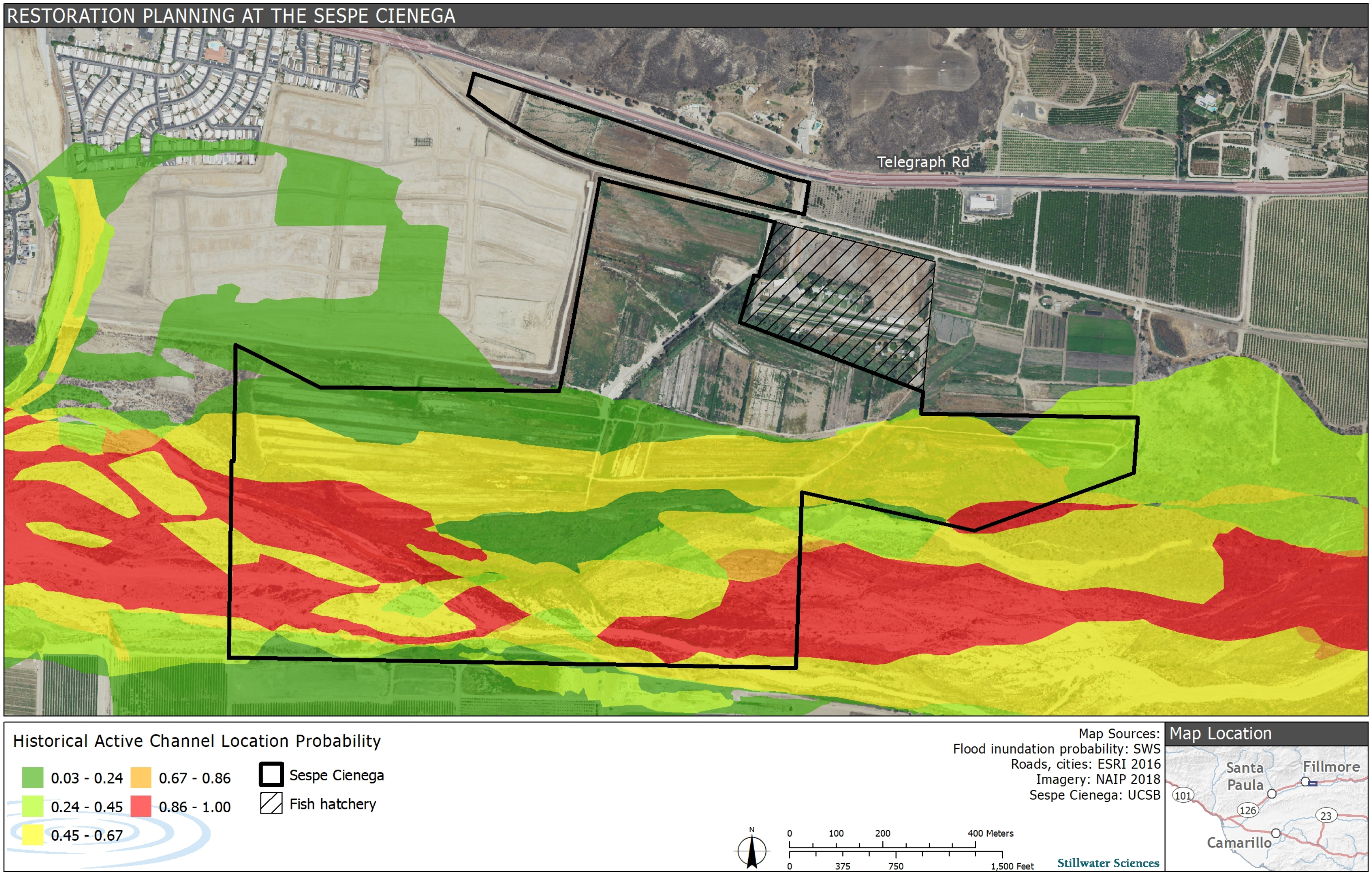

Figure 3-1. Santa Clara River historical active channel location probability zones along the project site.

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 will require grading activities to optimize some of these parameters. There are, therefore, several considerations that need addressing, including:

- **Establishing a logistics plan for grading activity**. Ideally, a zero-sum 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 will need to be sought. Temporary on-site areas may be required for soil storage during the restoration process.
- Determining which of the **current site berms should be removed** to balance the restoration priorities with grading logistics.
- Determining which of the **former watercress beds need in-filling or deepening**, and how best to realign drainage and hatchery outflow to maximize its restoration value.
- Developing a strategy for appropriately **surfacing the proposed nature trails**.

3.3.6 Conservation versus recreation

The CSER restoration goals call for a multi-faceted approach that balances environmental education and access with restoration of the site to achieve 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 fish hatchery operations;
- **Protection of wildlife**, especially sensitive and special-status species, particularly during vulnerable periods of seasonal activity.

3.4 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. Many of these elements are currently being assessed and will be refined as the design process progresses towards the 65% and 100% drawings. They will be described in detail in the final Technical Report for this project, but are listed in abbreviated form here in Table 3-2. Some of these elements relate to flood scour risk (Figure 3-1) or the existing topography of the project site and the relative elevation above the low flow river channel (Figure 3-2), while others focus more on seasonal and interannual patterns of surface flow and depth to groundwater. These assessments underpin the conceptual design outlined in Section 4.

Table 3-2. Objectives for Cienega Springs Ecological Reserve restoration.

Design Category	Design Element
Establishing Ecosystem Functioning	Implications of changing climate and human population increase
	Understanding of 'natural' process regimes
Flow Operations	Accommodating Piru Creek flow releases
	Accommodating hatchery operations
Physical System Characteristics	Accommodating flood inundation dynamics
	Designing around likely areas of future flood re-working
	Accommodating longer-term evolutionary changes in the river
	Understanding and accommodating site groundwater dynamics
	Understanding and accommodating site soil variations
	Modification of current surface water habitats to maximize restoration potential for aquatic and semi-aquatic habitats
Revegetation Strategies	Developing a list of target habitat types as the basis for a diverse native vegetation assemblage
	Developing a palette of suitable native plant species
	Weed reduction strategies to benefit native plantings
	Managing invasive fauna (e.g., shothole borer, Argentine ant, clawed frog) that might affect habitat quality and suitability for native wildlife
	Finding a reliable source for seeds and vegetative propagules
	Determining suitable active versus passive planting strategies
	Consideration of wildlife habitat needs, particularly for special-status and other focal species of native wildlife
Site Grading Strategies	How optimize current topography to support native plants and create suitable habitats and microhabitats
	Achieving cost efficiencies in use of cut and fill
	The physical development of trails, emergency access roads, and other necessary facilities
	Optimizing depth to groundwater and flow and management of surface water on the site by recontouring where necessary
Public and CDFW Access	Maximizing ecosystem restoration to provide a notable CDFW ecological reserve.
	Protection of wildlife 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 railroad tracks.
	A public access trail network that provides access to site's ecosystem elements and to the river, and a compelling visitor experience, but does not facilitate site access or egress other than in designated areas.
	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.

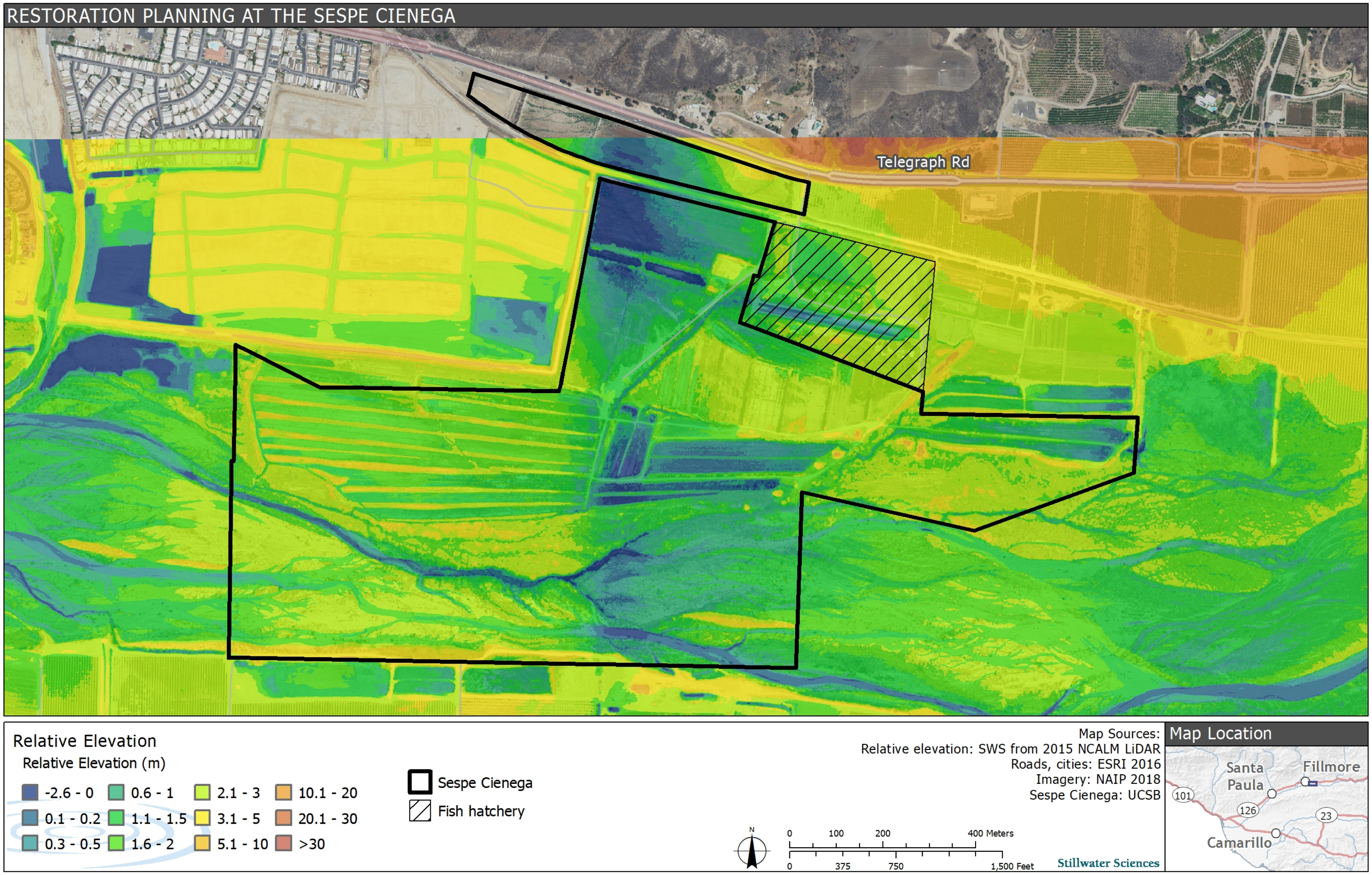

Figure 3-2. Relative elevation (height above the low flow river channel) for the Santa Clara River within and adjacent to the project site.

4 CONCEPTUAL DESIGN PROPOSAL

The initial conceptual design for the CSER developing from the various project goals, objectives, design considerations, assessed elements, and discussion among the group is illustrated in Figure 4-1. The design 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. The conceptual design acts as a starting point for further discussion and design refinement as certain knowledge gaps are closed through on-going monitoring efforts, and feedback from CDFW and others.

4.1 Site Revegetation and Proposed Management Units

Site revegetation design accounts the finer scale patterns of micro-topography, soils (texture, salinity, nutrients), water availability (surface water flows, fluctuating depth to groundwater), potential flood re-working of active floodplain areas, existing patches of desirable native vegetation, and presence of non-native, invasive species that require control measures and influence implementation. The general approach to site planning includes defining and mapping restoration or management units based on the above factors. Vegetation and habitat targets, and a revegetation strategy (e.g. natural recruitment versus replanting using horticultural techniques) are developed for each unit, and specific engineering and earthmoving activities are described if required (if so, an engineering design will need to be developed during project development). The proposed management units, vegetation and habitat targets, plus any additional elements and considerations identified at this stage in the process serve as a reasonable basis for the proposed conceptual design.

Subsequent stages of the design process will involve developing and refining more detailed plans for each management unit. For example, a critical next step is developing a palette of appropriate native plant species selected to match conditions found within each unit and target habitat type. Once the dominant or characteristic species are determined, additional species may be added to increase biodiversity, support native pollinators, or add functional redundancy using species with a range of responses to temperature or moisture gradient in hopes of creating a more ecologically resilient community. Specifying operational guidelines for the planting plan will also be an important next step. This typically includes specifying the source and estimated quantities of plant material. 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). In our case, 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 should also be included in the plan. This should 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.

Table 4-1 outlines a series of proposed management units (PMUs) and their target vegetation habitat type based on the site's biophysical and ecohydrological characteristics (see Orr et al. 2014; Orr et al. 2017a, b). Several of these habitat types, as well as suggest species, are listed as rare or sensitive in the California Natural Diversity Database (CNDDB). Prior to detailed restoration design, additional site-based knowledge developed from ongoing research and monitoring will be applied which may result in modifications of the PMUs 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 PMUs already involve a significant database of regional and site-specific knowledge. Thus, the PMUs described in Table 4-1 should provide a good basis for determining general priorities for habitat restoration and enhancement actions such as earthmoving, continued weed management and reduction, and revegetation within the CSER.

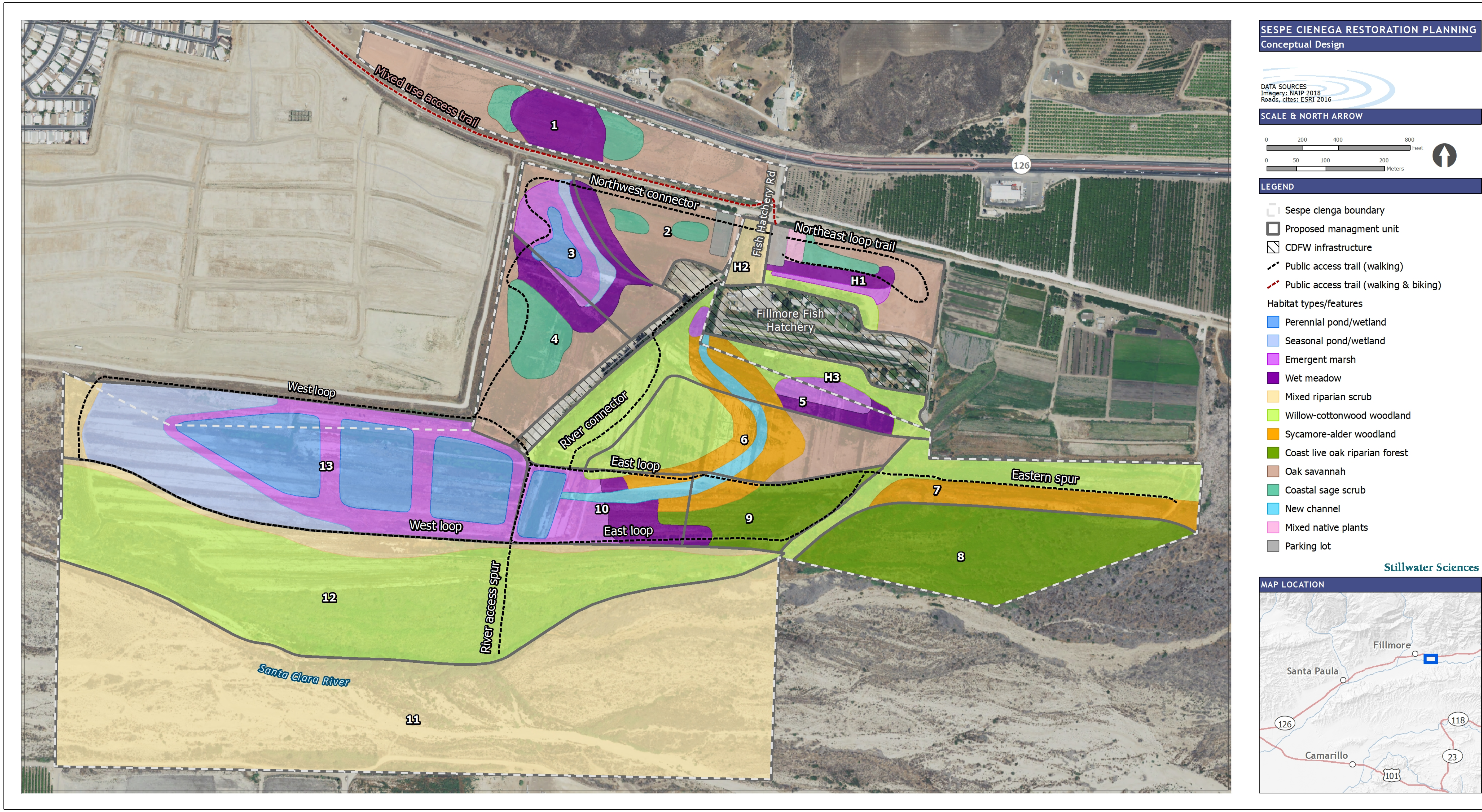

Figure 4-1. Proposed management units, habitat types and design features, and public access trail network for the Sespe Cienega site.

Table 4-1. Sespe Cienega Restoration Site—proposed management units and target habitat.

Unit	Proposed target habitat	Current vegetation and hydrology	Opportunities and constraints, design considerations	Notes	Acres
1	Oak savanna w/coastal sage scrub and grassland understory; central area of wet meadow or seasonal wetland	Fallow field, recently high levels of soil saturation. Invasive weeds include prickly Russian thistle, shortpod mustard, horseweed, and castor bean.	Look for indications of seasonal ponding that might affect survival of woody plantings. Consider modest amounts of excavation and mounding to increase topographic complexity for revegetation. Enhance for pollinators (native milkweeds and other flowering plants).	Oak savanna areas could include a mix of valley oak and coast live oak, with elderberry, walnut, and native grasses and forbs. Patches of coastal sage scrub.	15.6
2	Oak savanna w/coastal sage scrub and grassland understory; transitioning to wet meadow near western edge	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. Possible small overflow parking lot at NR corner of the unit. Exclude the raised pad area that CDFW wants to use for offices, etc.	7.5
3	Mixed wetland: Emergent marsh; perennial and seasonal wetland; oak savanna/native grassland around margins on higher relative elevation sites	Standing water appears to be natural artesian springs 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.	Excavate in western end to create deeper area for perennial wetland - connect to linear ditches, grading to seasonal wetland at eastern end. Use excavated material to create more topographic complexity in Unit 2.	Try to design a perennial wetland at western end that would stay inundated in most years, with elevation transition slope to seasonal marsh and then upland at eastern edge. Install flow control structure to convey hatchery outflow during dry periods.	8.2

Unit	Proposed target habitat	Current vegetation and hydrology	Opportunities and constraints, design considerations	Notes	Acres
4	Oak savanna w/coastal sage scrub and grassland understory	Drier than fields to the north; Dominated by Bermuda grass, annual weeds, and perennial pepperweed.	Similar to Unit 1. Consider locating restoration plant growth facility at eastern end of unit. Larger trees (oaks and sycamores) at western end to provide visual screen from residential development.	Similar planting mix to Unit 1. This may also be an appropriate area for planting genetic stock of riparian vegetation for restoration.	12.1
5	Stream and Riparian Woodland; Mix of sycamore-alder, willow-cottonwood, wet meadow, and emergent marsh	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. Reconstruct a more sinuous and natural looking stream channel, lined with alder, red willow, and cottonwood (Fremont and black cottonwood) with enhanced native understory of shrubs, forbs, and grasses. Enhance/excavate ponds at southern end.	Remove/reduce artificial structures. Consider removing concrete pads in southern end.	12.5
6	Oak savanna w/coastal sage scrub and grassland understory in the eastern portion; cottonwood-willow in western portion; with stream aquatic and sycamore-alder-willow along banks	Moist to very dry. Primarily weedy annual vegetation, rows of pomegranate trees.	May be sufficiently moist for boxelder and sycamore at northern end. Reconstructed stream channel with riparian vegetation	Similar planting mix to Unit 1.	13.7
7	Riparian, willow, coastal sage scrub; ephemeral wetlands in depressions	Former watercress beds. Currently flowing water from artesian features. Vegetation includes giant reed, watercress, cattails, and sedges.	Plant the northern former watercress bed with riparian scrub and cottonwood-willow forest. Plant the southern bed with sycamore and alder.	Possible trail on the berm between the two fields - either as out and back eastern spur or linking with a segment to the south to create another loop trail option.	13.5

Unit	Proposed target habitat	Current vegetation and hydrology	Opportunities and constraints, design considerations	Notes	Acres
8	Mixed riparian forest	Recently was a giant reed monoculture, but has since been mowed with one herbicide retreatment. Can be wet, but also drier during the drought.	Both cottonwoods and willows in wetter areas, with more walnut, elderberry, and sycamore in drier portions. Consider alder (if wet enough - they died in this area during the drought), or possibly ash.	Consider adding another trail segment along the boundary with Unit 7 to create another loop trail, if this would not interfere with ecosystem and wildlife habitat objectives.	18.0
9	Mixed riparian forest; Oak woodland with riparian scrub	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 both the reconfigured hatchery effluent channel to the north and from artesian sources to the east.	Install flow control structure to convey artesian water during wet periods.	7.3
10	Open water ponds and emergent wetland; seasonal wetlands	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 roads for seeding/planting.	9.0
11	Riparian scrub with interspersed patches of alluvial scrub	Active channel/floodplain - riparian scrub with Arundo donax; 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 spur trail and ways to limit unintended impacts of human use in this area.	79.3
12	Cottonwood-willow forest in floodplain and towards toe of the slope on south side of the berm at northern edge of unit, mixed riparian scrub interspersed; scattered ephemeral wetlands	Formerly giant reed monoculture; masticated and receiving second herbicide treatment.	Consider locating willow mitigation here.	Berm with west loop trail along northern border.	47.9

Unit	Proposed target habitat	Current vegetation and hydrology	Opportunities and constraints, design considerations	Notes	Acres
13	Perennial and seasonal wetland, suitable for water quality treatment	Formerly water cress beds; currently mix of native and non-native aquatic and weedy plant species, some tamarisk. Stinging nettle and yellow monkeyflower abundant.	Emergent marsh with some open water in lower elevation areas to the east grading to emergent marsh and then upland riparian to the west.	More discussion of the needs for water quality treatment of hatchery effluent and desire to increase groundwater recharge will be needed to guide engineering design.	37.1
H1	Wetland swale at southern edge; parking lot and native species plantings at NW end; rest as open coastal sage scrub/oak savanna	Open field with aquatic vegetation 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.	Consider picnic options and a short loop nature trail. Hatchery facility considering relocating houses to field.	8.8
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. Hatchery septic field at southern end.	1.6
H3	Cottonwood-willow Riparian; wet meadow and emergent marsh	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.	4.0
Total					**296.2**

4.2 Design transects

Three transect sections (13; Figures 4-2 through 4-4) are provided below to illustrate the design concepts and potential planting palettes.

Transect Section 1

Section 1 runs south to north through Units 12 and 13 and shows the proposed berm and access trail (Figure 4-2). The southern end of the section, closest to the Santa Clara River and at approximately the existing floodplain elevation, is targeted for restoration of willow-cottonwood riparian forest with a subcanopy of riparian shrub species such narrow-leaf willow (*Salix exigua*) and mulefat (*Baccharis salicifolia*), and an overstory of black cottonwood (*Populus trichocarpa*) and red willow (*Salix laevigata).* This forest would grade into a somewhat different willow-cottonwood forest phase to the north – from the existing floodplain elevation, the southern edge of the berm transitions up at a relatively shallow slope (10:1) and includes an upper riparian scrub planting zone (California buckwheat [*Eriogonum fasciculatum*], assorted sage species [*Salvia* spp.], and California sagebrush [*Artemisia californica*]) and a lower riparian planting zone (Freemont cottonwood [*Populus fremontii*] and red willow [*Salix laevigata*]). A few scattered sycamore (*Platanus racemosa*) and coast live oak (*Quercus agrifolia*) may be planted along the access road/trail on top of the berm. North of the trail the berm shoulder would descend at a 5:1 slope that contains upper riparian/landscaped species (California brittlebrush [*Encelia californica*] and black sage [*Salvia mellifera*]) and finally transitions into emergent wetland species at the edge of a pond.

Transect Section 2

Section 2 runs roughly from west to east across the main portions of Units 3 and 2 (Figure 4-3). To the west the site would be excavated to create a perennial pond that would grade into emergent marsh dominated by tules (*Schoenoplectus* spp.) and cattails (*Typha* spp.), seasonal wetland and wet meadow with a mix of sedges (*Carex* spp.), rushes (*Juncus* spp.) and various native grasses and forbs (such as scarlet monkeyflower [*Erythranthe cardinalis*]), before transitioning in the east to oak savanna (with an overstory of coast live oak and valley oak [*Quercus lobata*]) with a scattered subcanopy of California walnut (*Juglans californica*) and elderberry (*Sambucus mexicana*) and an understory of native perennial grassland, interspersed with patches of coastal sage scrub. Some of the excavated soil from Unit 3 could be used to add additional topographic complexity to Unit 2 to increase microhabitat diversity.

Transect Section 3

Section 3 (Figure 4-4) is a visualization of the main target habitat types that would be encountered in going from Unit 9 in the south to Unit 6 and then Unit 5. The exact nature of such a S-N transect across the three units will depend on the final restoration design, particularly the final location and dimensions of the proposed new naturalized stream channel and the riparian vegetation along its banks. In general, the stream channel will be bordered by sycamore-alder-willow woodland dominated by white alder (*Alnus rhombifolia*) immediately adjacent to the channel with a mix of red willow (and possibly arroyo willow [*S. lasiolepis*] which is not shown) and sycamore grading into willow-cottonwood forest with a subcanopy of elderberry and box elder (*Acer negundo*) and a variable understory (from blackberry [*Rubus ursinus*] to wet meadow with yerba mansa [*Anemopsis californica*], creeping wildrye [*Elymus triticoides*], rushes, and various other native grasses and forbs). Depending on location within Unit 6 and the final design, this would grade into more extensive willow-cottonwood forest or oak savanna and native grassland. As one moves south into Unit 9 and lower relative elevations there would be a transition to a more diverse mixed riparian forest interspersed with mixed riparian scrub.

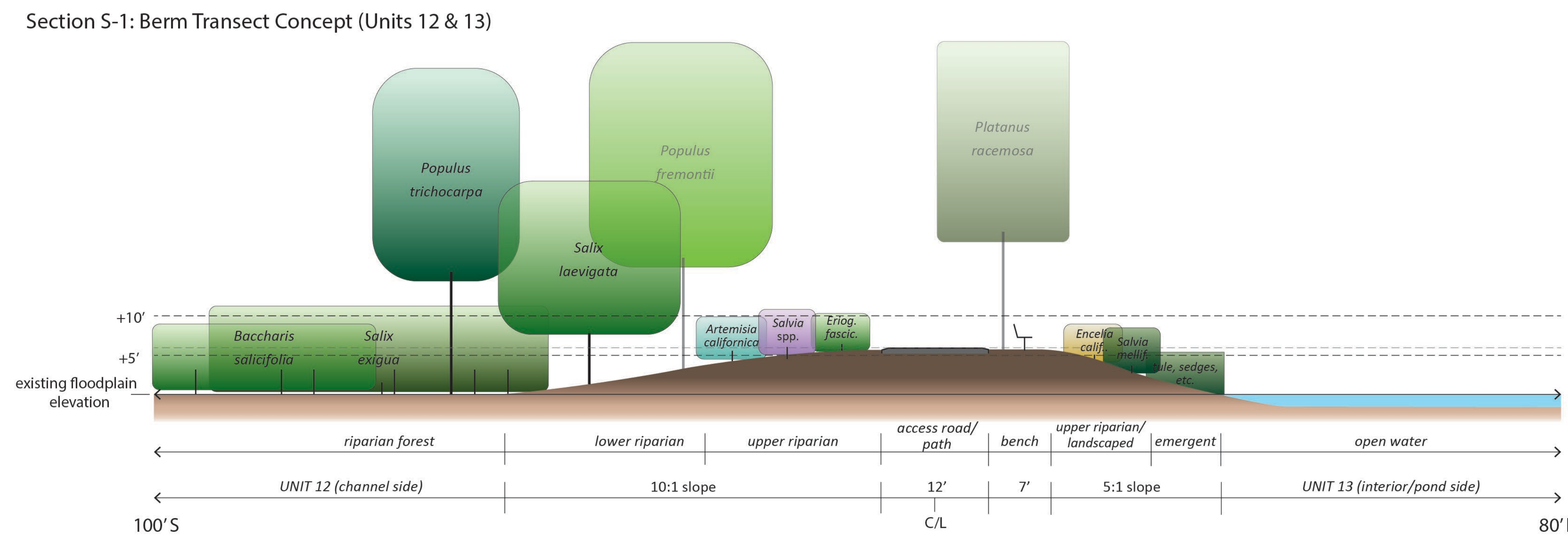

Figure 4-2. Transect 1 - Conceptual South-North cross-section graphic illustrating the proposed habitat types and primary planting palette for a portion of Management Units 12 and 13.

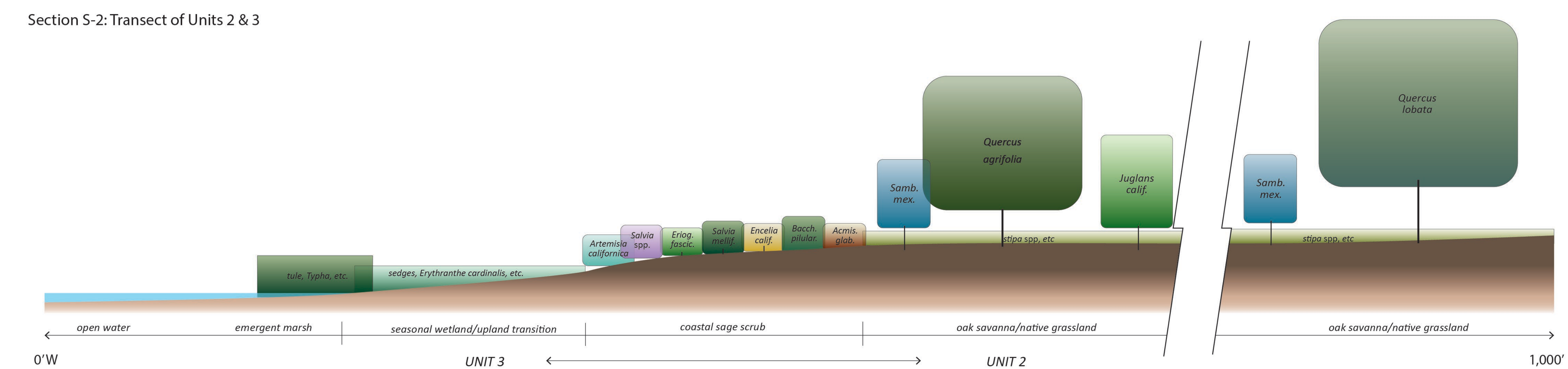

Figure 4-3. Transect 2 - Conceptual West-East cross-section graphic illustrating the proposed habitat types and primary planting palette for Management Units 2 and 3.

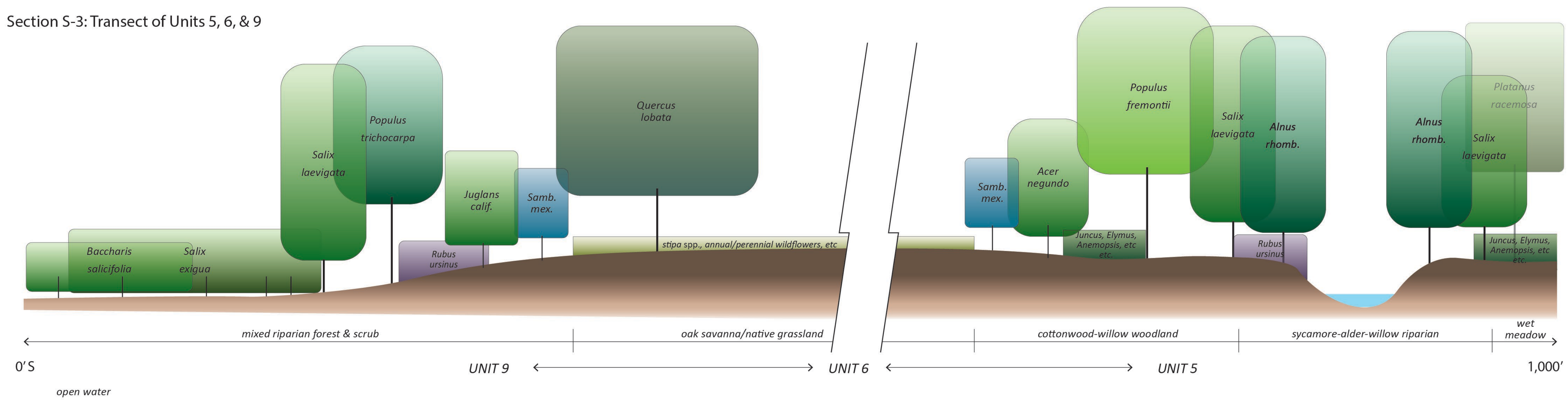

Figure 4-4. Transect 3 - Conceptual South-North cross-section graphic illustrating proposed habitat types and primary planting palette for portions of Management Units 5, 6, and 9.

4.3 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, surface water flows at the CSER are largely artificial in origin, stemming from aquifer water withdrawals for fish hatchery requirements, however there are natural artesian springs and seeps in the area that also contribute to surface flows, especially after high precipitation. Currently, hatchery effluent flow empties 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 design intention is to relocate the current, straight ditch, a little to the east of the current position (see Figure 3-2 and 4-1) to increase soil moisture over a greater area and create a more sinuous course to benefit the extent of adjacent aquatic, wetland, and riparian habitats that directly benefit from proximity to surface water flows. Moving the ditch has a further advantage in that it has been determined that the hatchery effluent may require water quality improvement and be used to recharge local groundwater instead of returning directly to the main river channel. One possible solution is the development of a series of treatment ponds and wetlands to the south and west of the hatchery (depicted in units 10 and 13) and thus emptying these flows into a new surface channel that begins south of the hatchery.

Once through the surface water ditch, hatchery flows and those percolating into the former water cress beds from rising subsurface flows near the east boundary of the site, will be routed through the remaining or modified watercress beds according to the intention to provide a mixture of wet meadow, emergent marsh, and perennial or seasonal ponds and wetlands (see Figure 4-1). Because this objective requires active management, it is anticipated that a series of sluice gates will be required to control outflows. Derivation of a better understanding of the site's water balance based on well analyses and hydrological monitoring by UCSB will contribute to the final design for developing sustainable ephemeral, seasonal, and perennial wetland features.

4.4 Grading

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 will serve mainly to create a suitable relative elevation between the ground surface and available sub-surface flow Earth moving will also be required to develop the new surface drainage configuration and to infill or deepen the former watercress bed habitats.

Grading plans will be developed as the design intention develops and better understanding is achieved regarding soil and groundwater conditions. However, the overall site grading strategy will involve:

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

Typically, some additional engineering and earthmoving is often included 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.

4.5 Trails, Access, and Education

The communities nearby to the Sespe Cienega have a shortage of the kind of recreational needs that the restored ecological reserve will offer. The primary public access amenity will be a comprehensive trail network throughout the site; the proposed trail network is depicted in the conceptual design map (Figure 4-1). The network of trails will offer just over 4 miles of unique walking opportunities throughout the ecological reserve. Table 4-2 lists the different trail segments and their respective lengths.

Table 4-2. Sespe Cienega Restoration Site—proposed public access trails and length in miles.

Name	Length (miles)
Northeast loop trail	0.34
Northwest connector	0.57
River connector	0.27
West loop	0.96
Bridge connector between west and east loops	0.08
East loop	0.85
Eastern spur	0.33
River access spur	0.12
Mixed use access trail	0.59
Total	**4.11**

In addressing the question of how much trail network, or other public access amenities to represent across the site, the goal was to attain some minimum threshold of public access amenities to make the visitor experience compelling and a true amenity for the community as opposed to a token treatment, while acknowledging that a CDFW Ecological Reserve does not have the same public access mandate as a State Park; the access must be low impact and compatible with the Reserve's mandate "to protect critical riverine habitat". An important component of the trail network beyond mere miles of trails is the goal that the trail network will allow the visitor to see the variety of habitats throughout the site, thereby providing a unique educational opportunity and further enhancing the visitor experience.

The effort to maximize trail length to create a compelling visitor experience was balanced against the need to not overburden the site with too many public access elements, again, namely miles of trail. The public access trail footprint must honor the scale of the site and the limitations therein, and, importantly, too much public access trail footprint would potentially compromise the restoration objectives. As far as creating gathering locations, the concept is to have one gathering location in the vicinity of the visitor parking, adjacent to the native plant trail and the kiosk. Visitors may want to gather here at the front of the ecological reserve and have a picnic before or after they walk through the site, or they may only be taking a quick respite off the Highway 126 on a road trip. If they are on a longer visit and/or a targeted visit for educational opportunities for example, once they have embarked into the site, the vision is for the visitor to walk through the site and to view the habitats and vistas, but not stop as a group at gathering locations within/throughout the site. Educational signage and perhaps a few single benches at key vista points may be utilized throughout the site.

The gathering area conceivably will have multiple seating structures and a shade cloth structure. Some portion of the visitors arriving at the ecological reserve may not be coming for environmental educational or necessarily embarking on a comprehensive visit. They might only come for the desirable setting and to sit at a picnic table to eat and walk 30 yards into the native plant trail or around the shortest loop immediately available to them. They may even use the ecological reserve entrance area as a rest stop off the Highway 126. One can envision a wide spectrum of potential visitors, from serious bird watchers and committed walkers that will be intimately involved in the entire site and walk the complete trail network, to the casual visitor that may be there for only 15 to 30 minutes in the vicinity of the entrance. The approach to the public access components attempts to accommodate this entire spectrum of passive use visitors.

A key concern was shared in a public comment at a Fillmore City Council meeting: "It would equally be wonderful to prevent day use access to the actual river. As we've seen in the past along the Sespe, a deluge of waste shows up on the banks from those who are not respectful of our natural habitats." The design team also considered the concern of flood resilience for a trail extending to the active river channel. Ultimately, however, a river access spur trail was included in the design for a number of reasons. An extensive trail footprint close to and parallel to the river was avoided given the aforementioned concerns. But if a designated access point to the river did not exist, a likely reality is that visitors will leave the loop trail that is situated away from the active channel and punch their own trail through native vegetation down to the water, perhaps in numerous unintended and potentially undesirable locations. Consequently, a single, linear spur trail that T's off the loop trail taking the visitor to the water may in the end be desirable to focus public use in one intended location, with the understanding that such a trail might need a higher frequency of maintenance and repair. Importantly, seeing the river itself will undoubtedly enhance the visitor experience.

Another goal is to have the site connected to the City of Fillmore by a bike trail along the ROW adjacent to the railroad track. Visitors biking to the site from downtown Fillmore or the adjacent neighborhood could arrive at the site, lock up their bikes at a bike rack when they arrive, and then commence walking throughout the site. The trail from Fillmore is designated a mixed-use trail on the conceptual map to acknowledge visitors may walk as well as bike along this trail to travel to and from the site. Utilizing the ROW along the railroad track will keep biking and walking visitors safe and removed from the Highway 126, which will be an important component of that connectivity. Notably, biking will not be a compatible use for the trail network inside the ecological reserve, merely a carbon-friendly, exercise-friendly way to access the site from the nearest population center. Clearly, the new, immediately adjacent housing development will be a nearby population likely to visit the site, and this mixed-use trail will be how they most likely access the site, and not by climbing over the berm separating the development from the western edge of the ecological preserve.

Stakeholders in the public access conversation include, on the east side, active farming and The Nature Conservancy's property, on the south side, across the river, active farming, and on the west side, the housing development. Access into the ecological reserve from the neighbors' properties, or from the river bottom for that matter, will not be condoned and is a key consideration in planning and outreach for the public access component of the project, and similarly, the neighbors will not want reserve visitors coming into their respective properties, although that seems less likely. The design team does not anticipate use of physical barriers, but these goals might mean not taking trails right up to those respective edges, active communication with the neighbors, and signage that spells out these expectations.

5 NEXT STEPS

This technical memorandum outlines the initial proposed conceptual design for the CSER. It is based on considerable knowledge about the site and its regional setting (as summarized in UCSB et al. 2020), yet is also realistic about what is not yet known about the site (Section 2.1), part of which is being addressed by ongoing monitoring as part of this project (Section 2.2). The knowledge base has been applied initially to define a series of viable project goals, objectives, and design considerations that result in a series of design elements (Section 3) whose assessment underpins, optimizes, and constrains the resulting conceptual design (Section 4). While the proposed conceptual design is a collaborative result of assessments by Stillwater Sciences, UCSB, and SCRC, and has involved discussions with representatives from CDFW, it is critical that this design is now reviewed by a broad stakeholder community, including representatives from several arms of CDFW, a Technical Advisory Committee (TAC) with representatives from non-profits, academic institutions, and government agencies working to conserve and restore the Santa Clara River, and through outreach with local communities (*e.g.*, through presentations to city councils, etc.). Through such collaboration and the results of the on-going monitoring, 65% and eventually 100% design plans will be developed, and a full Technical Report produced to detail how the design elements were integrated to achieve restoration project goals and objectives.

At this stage, a series of critical next steps are provided as the basis for moving the conceptual design towards the 65% threshold. Aside from the conceptual design review and outreach process described above, next steps include:

- Ground truthing habitat/vegetation communities against physical data (relative elevation, depth to groundwater, flood frequency and scour, etc.). This may include using data from somewhat similar sites on the river to serve as potential reference sites to inform design at CSER.
- Matching native plant species growth requirements with soil properties (analysis to be completed by 31 October 2020) and groundwater availability.
- Consultation with CDFW to finalize the list of focal wildlife species to be considered in design. This will also be used to fine-tune planting palettes.
- Continued monitoring, especially of how the site's water balance and soils influence plant growth and thus how this knowledge can be used to increase the accuracy of delineation of wetland communities and target habitats.
- Detailed consideration of how climate change, hatchery operations and flow release operations below Lake Piru may alter water balance at the site in future years.
- Obtaining details of the location of proposed CDFW infrastructure and operational changes, and discussing desired or appropriate levels of operational and maintenance efforts by CDFW following completion of the initial restoration effort.
- Approval of proposed trail and public access locations and proposed level of access.

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