

An Evaluation and Determination of Groundwater Dependent Ecosystems in the Cosumnes Subbasin (DWR 5-022.16)



***An Evaluation and Determination of
Groundwater Dependent Ecosystems in the
Cosumnes Sub-Basin (DWR 5-022.16)***

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*An Evaluation and Determination of Groundwater Dependent
Ecosystems in the Cosumnes Subbasin (DWR 5-022.16)*

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Ecosystems in Cosumnes Sub-Basin (DWR 5-022.16)**

GeoSystems Analysis, Inc. 2021

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EXECUTIVE SUMMARY

GeoSystems Analysis, Inc. conducted an evaluation of Groundwater Dependent Ecosystems (GDEs) in the Cosumnes Subbasin (herein referred to as the “Subbasin”) under sub-contract with EKI Environment and Water. The analysis involved field and desktop-based evaluations to confirm previously mapped GDEs in the Subbasin and support Groundwater Sustainability Plan development. Desktop evaluations relied on a variety of existing vegetation, wetland, soils, geologic and groundwater data sources in combination with a remote sensing-based vegetation analysis. Fieldwork during late-February through early-March 2021 utilized GDE evaluation survey methodology developed specifically for this Subbasin. A GDE classification schema was also specifically developed for this project, to streamline the evaluation and ensure consistency with how GDEs were characterized in different segments of the Subbasin.

Within the Subbasin, GDE types include open water, riparian forests and shrublands, wet meadows, and marshes which appear to provide high quality habitat for numerous wildlife species. GDEs in connection with the principal aquifer are defined as Sustainable Groundwater Management Act (SGMA) GDEs. A total of 990 acres of SGMA GDEs are present within the Subbasin; another 819 acres are most likely SGMA GDEs, but need local groundwater monitoring data to confirm their status. Approximately 2,430 acres appear to be disconnected from the principal aquifer and supported by surface water and perched water conditions and are therefore not SGMA GDEs. A total of 4,019 acres were classified as unknown SGMA GDE status due to uncertainty with groundwater elevation data in the Foothills Subarea. Field observations and satellite analyses indicate that the Cosumnes Subbasin currently supports a mosaic of diverse, healthy GDEs, particularly in the Preserve portion of the project site.

1.0 Introduction

1.1 Purpose and Need

EKI Environment and Water, Inc. (EKI) was contracted by Sacramento County to develop the Groundwater Sustainability Plan (GSP) for the Cosumnes Subbasin Groundwater Sustainability Agencies (GSAs) consistent with the requirements of the Sustainable Groundwater Management Act of 2014 (SGMA). SGMA requires the Cosumnes Subbasin to have an adopted GSP in place by January 31, 2022, and the GSP is required to identify Groundwater Dependent Ecosystem (GDEs) that are dependent on the principal aquifer used as the primary groundwater source for anthropogenic use. This assessment used data available from the California Department of Water Resources (DWR) or the best available alternative information. A Proposition 68 Sustainable Groundwater Management Grant awarded to the Cosumnes Subbasin by DWR funded this study to confirm GDE communities in data sources provided by DWR. EKI sub-contracted GeoSystems Analysis, Inc. (GeoSystems) to technically evaluate these previously mapped GDEs within the Cosumnes Subbasin, and this technical memorandum summarizes the methods and results of work conducted by GeoSystems.

The Cosumnes Subbasin (DWR 5-022.16, referred to herein as the “Subbasin”) spans approximately 210,275 acres within the southern portion of Sacramento County and western portion of Amador County, CA (Figure 1). Two major eco-regions (EPA, 2016) converge within the Subbasin: 1) Central California Foothills and Mountains (Camanche Terraces), which are primarily composed of oak woodlands; and 2) Central California Valley (Northern Terraces), which supports a variety of agricultural crops, but primarily vineyards, intermixed with interior wetlands and vernal pools. The area also supports a diverse agricultural economy. Surface water in the Subbasin is supplied by numerous creeks draining from the mountain and foothill areas, which notably include, the Cosumnes River, Dry Creek, Badger Creek, Browns Creek, Willow Creek, Laguna, Skunk Creek, and Jackson Creek. The Mokelumne River and Cosumnes River confluence forms the westernmost edge of the Subbasin and this segment supports an abundance of sloughs, including numerous backwater features to include Grizzly Slough and Bear Slough.

The Cosumnes River is the only free flowing river on the western slope of the Sierra Nevada mountains, and because it remains undammed, it experiences the seasonal overbank flooding that was once a common feature of rivers in California's central valley (CDFW, 2021). Overbank flooding is a key phenomenon to support natural recruitment of riparian and floodplain vegetation species, which support a high diversity of wildlife, including numerous protected species. According to the California Department of Fish and Wildlife (CDFW), more than 250 bird species have been identified on the Cosumnes River Preserve, which lies on the western portion of the Subbasin (CDFW, 2021), and includes various species of egrets and herons, sandhill cranes, stilts and avocets, phoebes and flycatchers, and yellow and Wilson’s warblers. Additionally, over 40 fish species and approximately 230 plant species have been identified.

GeoSystems Analysis Inc.

The Cosumnes Subbasin is managed by seven GSAs:

- Omochumne-Hartnell Water District
- Sloughhouse Resource Conservation District
- Galt Irrigation District
- Clay Water District
- City of Galt
- Amador County Groundwater Management Authority
- Sacramento County

Specific to the GDE evaluation process, GeoSystems identified and diagnosed GDEs throughout the Subbasin using a combined field and desktop process, which primarily involved:

- Compilation, review, and analysis of numerous existing datasets to develop an initial GDE status map
- Field verification of GDEs mapped within the Subbasin
- Development of a custom field protocol, datasheet, and application (“app”) for assessing GDEs on site
- Preliminary GDE mapping classification framework development
- Use of the classification framework to evaluate and identify GDEs within the Subbasin based on a combination of field observations, apparent depth to groundwater, vegetation type, anthropogenic modifications, geologic and geomorphic conditions
- Assessment of GDE sustainability and vigor with support from the GDE Pulse tool and Sentinel-2 satellite imagery

Methods and results of this GDE evaluation process are described in Sections 2.0 and 3.0.

1.2 GDE Definition

The SGMA regulations define GDEs as ecological communities or species that depend on groundwater emerging from aquifers or occurring near the land surface. This definition and other proposed definitions (i.e. Stillwater 2020) were used to develop the following specific qualifying criteria for GDEs in the Cosumnes Subbasin:

- Groundwater is a key hydrologic component of the feature during at least part of the year, AND
- Groundwater is important to survival, reproduction, and function of inhabiting vegetation and/or wildlife species, AND
- Groundwater is associated with the Principal Aquifer used as the primary groundwater source for anthropogenic use, which in the case of the Cosumnes Subbasin, is the regional aquifer.

GDEs identified in the initial desktop evaluation were not classified as subject to SGMA (SGMA GDE) if one or more of the following was true:

- It is supported by perched/mounded water that may be replenished by surface water, but that is not reliant on the Principal Aquifer¹
- It is supported by an open water feature (e.g. stream, ditch, pond, wetland) whose hydrologic regime is primarily controlled by:
 - Surface discharge or drainage from an upslope man-made structure such as irrigation canal, agricultural field, reservoir, stock tank, or water treatment facility; or
 - Precipitation inputs in locations with surface soil stratigraphy that facilitates prolonged ponding, such as vernal pools or swales and low permeability soils.

1.3 GDE Field Investigation Guidance Documents

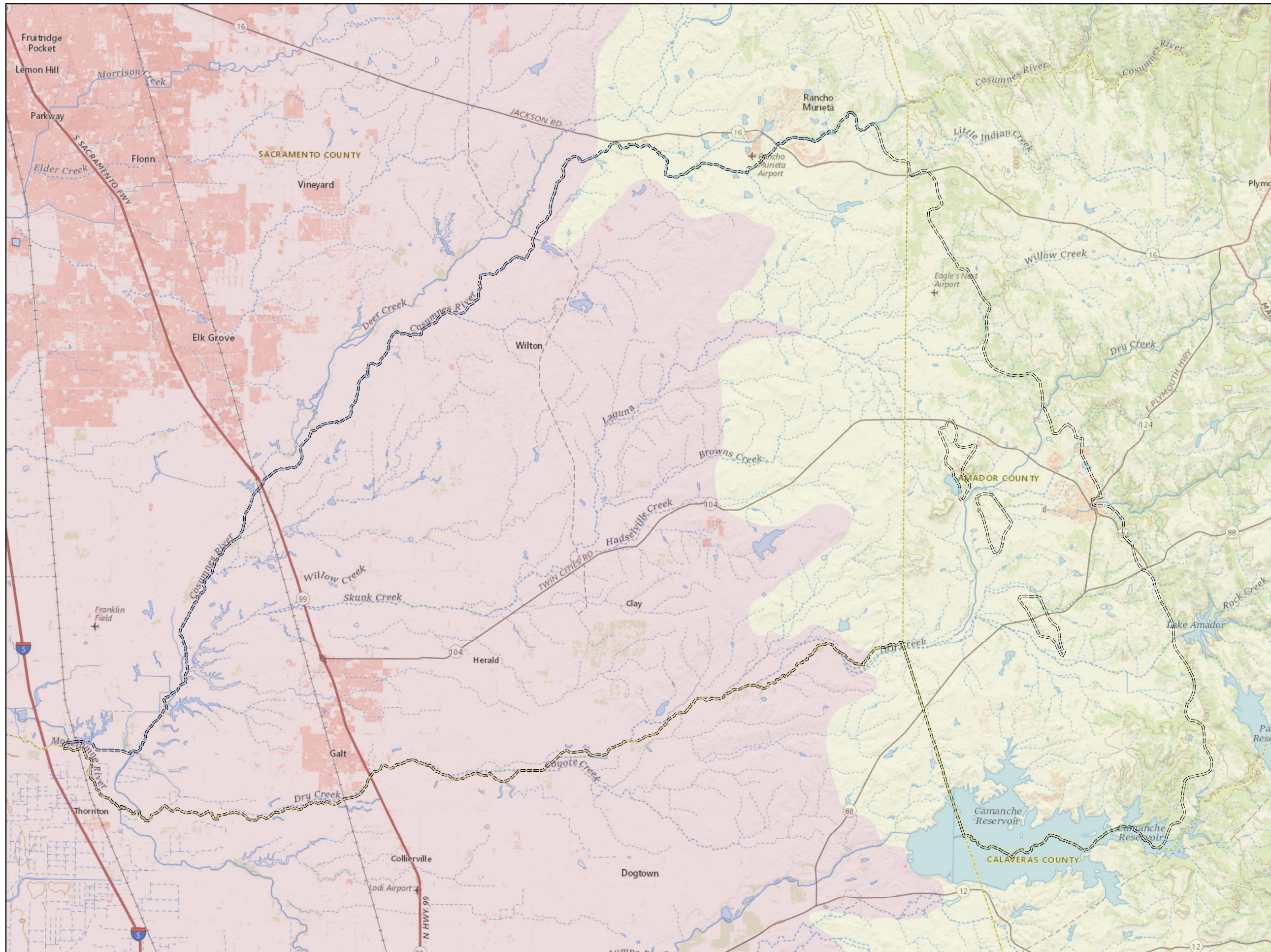
To streamline, guide, and normalize GDE identification and assessment, several field guides were developed. The primary references that GeoSystems used to support the field analyses included:

- The Nature Conservancy, 2018. Groundwater Dependent Ecosystems under the Sustainable Groundwater Management Act: Guidance for Preparing Groundwater Sustainability Plans
- The Nature Conservancy, 2019. Identifying GDEs under SGMA. Best Practices for Using the NC Dataset
- US Forest Service, 2012. Groundwater Dependent Ecosystems: Level II Inventory Field Guide: Inventory Methods for Project Design and Analysis. Technical Report 86-b
- Rhode, Melissa, Sara Sweet, Craig Ulrich, and Jeanette Howard, 2019. A transdisciplinary approach to characterize hydrological controls on groundwater dependent ecosystems. *Frontiers in Environmental Science*.




Additionally, we reviewed GDE evaluation techniques published throughout the scientific literature. Amongst these reports, Perez Hoyos et al. (2016) validates the importance of integrating both field evaluations and remote sensing analyses, as were implemented during this project.

¹ “Principal aquifers” refer to aquifers or aquifer systems that store, transmit, and yield significant or economic quantities of groundwater to wells, springs, or surface water systems, and are the primary groundwater source for anthropogenic use.

Cosumnes Subbasin: Groundwater Dependent Ecosystem Evaluation - General Location



Legend

-  Cosumnes Subbasin
- Eco-Regions (per EPA)**
-  Central California Foothills and Coastal Mountains
-  Central California Valley

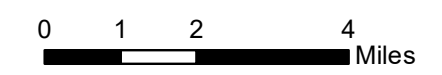


Figure 1. Cosumnes Subbasin General Location Map

2.0 METHODS

As a systematic process, and as described in the following sub-sections, the following steps were conducted to evaluate potential GDEs based on the best currently available information:

1. Evaluate Natural Communities Commonly Associated with Groundwater (NCCAG) data with alternative sources of vegetation and wetland mapping data to determine whether potential inaccuracies exist in NCCAG classifications or whether potential GDEs were omitted in the NCCAG data
2. Evaluate land ownership to identify potential public lands for field evaluations, and coordinate with private landowners to gain access to priority (based on vegetation, soil, and groundwater conditions) parcels for field assessments
3. Evaluate soil, groundwater, and geologic conditions to assess the potential effect of these parameters on the presence of GDEs found within the Subbasin
4. Conduct a field assessment to understand the vegetation mapping reliability, document habitat conditions, vegetation health, natural reproduction, and aid in the identification of GDEs
5. Use a consistent GDE classification schema to normalize GDE evaluations and identify GDEs in the Subbasin based on inferred depth to groundwater, vegetation conditions, manmade modifiers, and geomorphic position
6. After zones with groundwater conditions that appeared to support GDEs were identified, wetland and riparian areas omitted from existing data but clearly visible on recent imagery were drawn in
7. Assess whether the results of the GDE identification process are consistent with remote sensing analyses, and leverage remote sensing processes to gauge GDE health

2.1 Groundwater Dependent Ecosystem (GDE) Initial Desktop Classification

In partnership with CDFW and The Nature Conservancy (TNC), the CDWR developed and distributes a GIS-ready dataset that specifies NCCAG features. This dataset is intended for use by GSAs to map GDEs and support SGMA related evaluations. Per the DWR, the

“NCCAG dataset can be used as a starting point to investigate and identify GDEs within a groundwater basin. Identifying GDEs requires detailed understanding of the land use, groundwater levels, hydrology, and geology of a location. This comprehensive understanding of geology, hydrology, and biology is not available at the statewide scale. Further investigation and verification of the connection and dependence between groundwater and mapped vegetation and wetlands at a local scale may be needed for water managers in sustainable groundwater management planning.”

The National Wetlands Inventory (NWI) wetlands dataset and various, regional vegetation mapping products are the primary sources compiled in the NCCAG database within the Subbasin; these source data were produced between 1985 and 2014.

The NCCAG data maps show approximately 5,800 acres of potential GDEs within the Subbasin, and differentiates “vegetation” communities dominated by phreatophytic (i.e. deep rooted) riparian species versus “wetland” communities, which include emergent plus shrub-scrub palustrine wetlands, wetland forests, and riverine types. Within “vegetation” types, the NCCAG assigns a (typically monospecific) dominant woody plant composition for an individual map feature while “wetland” types list the NWI type per Cowardin (1979).

To better understand the reliability of NCCAG data within the Subbasin, GeoSystems compared features within the NCCAG dataset to the raw NWI data and recent satellite imagery. As intended by DWR, the NCCAG dataset is a “starting point” for identifying GDEs; however, GeoSystems’ review identified inconsistencies in the dataset. GeoSystems integrated the NCCAG “wetland” and “vegetation” data with U.S. National Vegetation Classification System (NVCS; obtained from VegCAMP) and National Wetlands Inventory (NWI) data to confirm potential GDEs had not been omitted from the NCCAG and increase data set reliability. Additional wetlands that NCCAG omitted from NWI were further evaluated when their apparent wetness and vegetation type (per recent satellite imagery) met typical GDE criteria (riparian/wetland types with the potential to be supported by groundwater).

The NCCAG and riparian/wetland features omitted from the NCCAG but identified in other sources were merged together into a comprehensive geo-database that served as the basis for the GDE evaluations conducted during this project. These coverages are shown in Figure 2. For example, the South Sacramento County Habitat Conservation Plan (SSHCP; County of Sacramento et al., 2018) includes valuable descriptions for land cover types and the associated habitat value for various wildlife species throughout the Subbasin. The associations between wildlife and vegetation species were leveraged to understand their ecological importance and build detailed site descriptions. A detailed compilation of the acreage of each riparian vegetation or wetland type identified in NCCAG, NWI, and NVCS is listed in Table 1.

Cosumnes Subbasin: Groundwater Dependent Ecosystem Evaluation - NCCAG Data and Alternative Vegetation and Wetland Mapping Sources

Legend

GDE Evaluation Results (Existing Datasets)

Source

- NCCAG
- NVCS
- NWI
- Cosumnes Subbasin

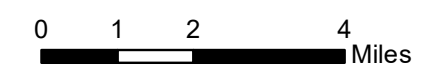
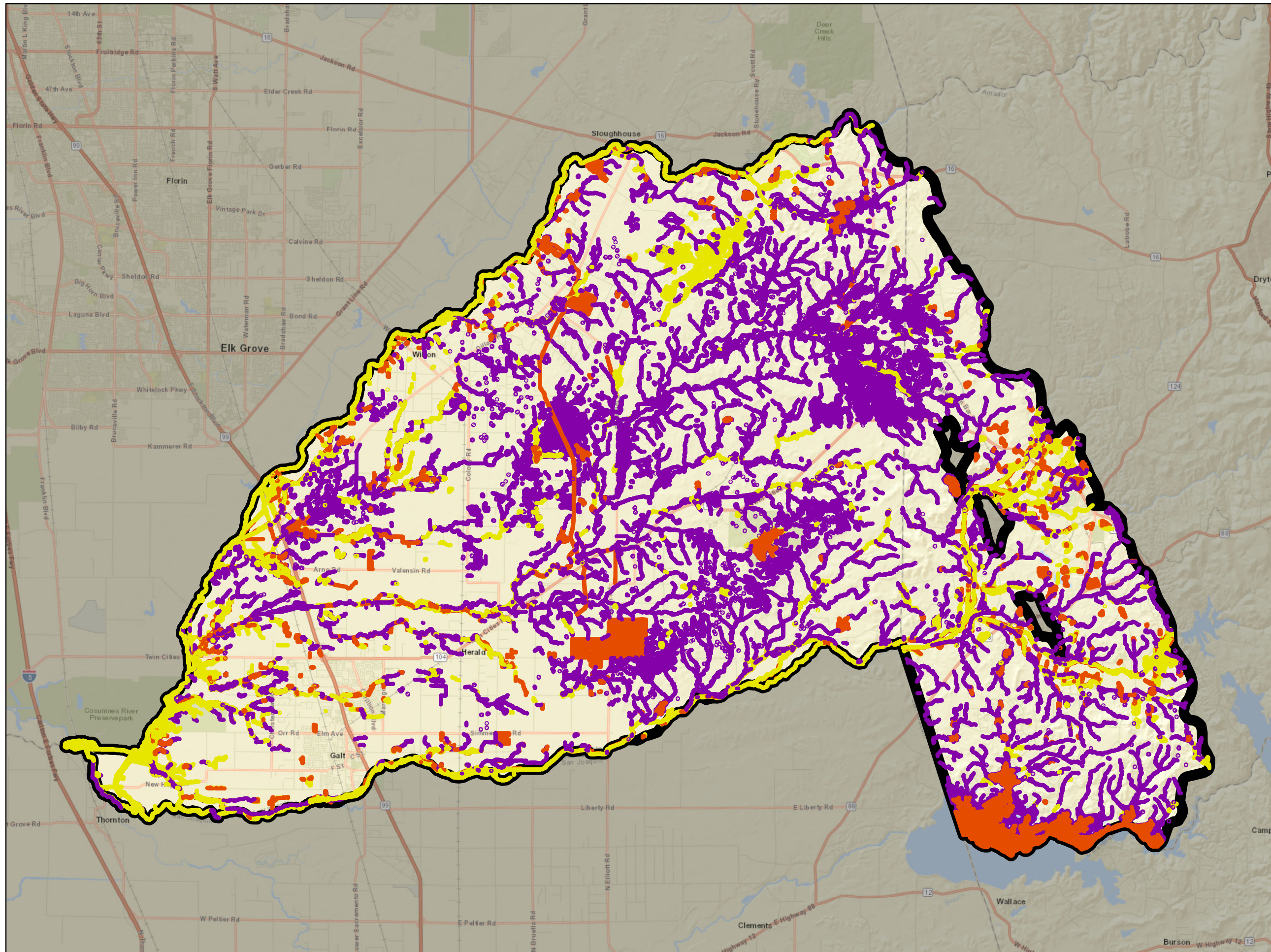


Figure 2. Initial GDE Classification Data Sources, Cosumnes Subbasin

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Table 1. Acreage of riparian and wetland communities contained within various existing geo-spatial datasets for the Subbasin

Type	NCCAG (Acres)	NVCS ¹ (Acres)	NWI ² (Acres)	Grand Total (Acres)
Acer negundo	18.6			18.6
Ailanthus altissima	17.1	0.2		17.3
Alnus rhombifolia	6.2			6.2
Arid West freshwater emergent marsh	3.6			3.6
Azolla (filiculoides, microphylla)		39.0		39.0
Baccharis pilularis		72.3		72.3
California Warm Temperate Marsh/Seep	105.7	1.3		107.0
Eichhornia crassipes		16.0		16.0
Eucalyptus spp. - Ailanthus altissima - Robinia pseudoacacia		1,095.9		1,095.9
Fraxinus latifolia	1.2			1.2
Freshwater Emergent Wetland	1,301.1	0.9	5,463.7	6,765.8
Freshwater Forested/Shrub Wetland		3.0	162.7	165.7
Freshwater Pond	105.8	0.1	536.7	642.6
Heterotheca oregona	0.1			0.1
Introduced North American Mediterranean woodland and forest		49.6		49.6
Juglans hindsii and Hybrids	41.4	2.2		43.6
Juncus arcticus (var. balticus, mexicanis)	8.9			8.9
Lacustrine Wetland			1,253.0	1,253.0
Lemna (minor) and Relatives		10.5		10.5
Lepidium latifolium	0.7			0.7
Ludwigia (hexapetala, peploides)		204.3		204.3
Naturalized warm-temperate riparian and wetland group		383.7		383.7
Persicaria lapathifolia - Xanthium strumarium	12.8			12.8
Populus fremontii	1,018.2	17.4		1,035.6
Quercus lobata	2,242.8	78.4		2,321.2
Riparian Evergreen and Deciduous Woodland	7.4			7.4
Riverine Wetland	260.1		1,040.6	1,300.7
Rubus armeniacus	66.2			66.2
Rubus armeniacus - Sesbania punicea - Ficus carica		9.7		9.7
Salix exigua	131.1	2.9		134.0
Salix exigua - Salix lasiolepis- Rubus discolor	8.5			8.5
Salix gooddingii	192.1	3.8		195.9
Salix laevigata	20.2			20.2
Salix lasiolepis	1.0			1.0
Schoenoplectus (acutus, californicus)	64.3	2.3		66.6
Seep or Spring	0.9			0.9
Temperate freshwater floating mat		4.5		4.5
Typha (angustifolia, domingensis, latifolia)	126.0	22.0		148.1
Water		3,239.7		3,239.7
Western North American Freshwater Marsh	0.8			0.8
Grand Total	5,763	5,260	8,457	19,479.4

¹NVCS includes riparian/wetland acreages omitted from NCCAG and evaluated as part of this project.

²NWI includes acres of possible GDEs supported by recent satellite imagery but omitted from NCCAG and were therefore reviewed as part of this project.

2.2 Selected GDE Priority Sites and Access Constraints

Figure 3 shows the distribution of private, tribal, and public land within the Subbasin, per various regional land ownership datasets, including the Cosumnes tribal land coverage, the California Protected Area and U.S. Land Surface Estate coverage, Database and the Amador² and Sacramento County³ assessors' geo-databases. Based on this information, the Subbasin mainly includes private land. Thus, field survey locations and methods were determined by landowner cooperation.

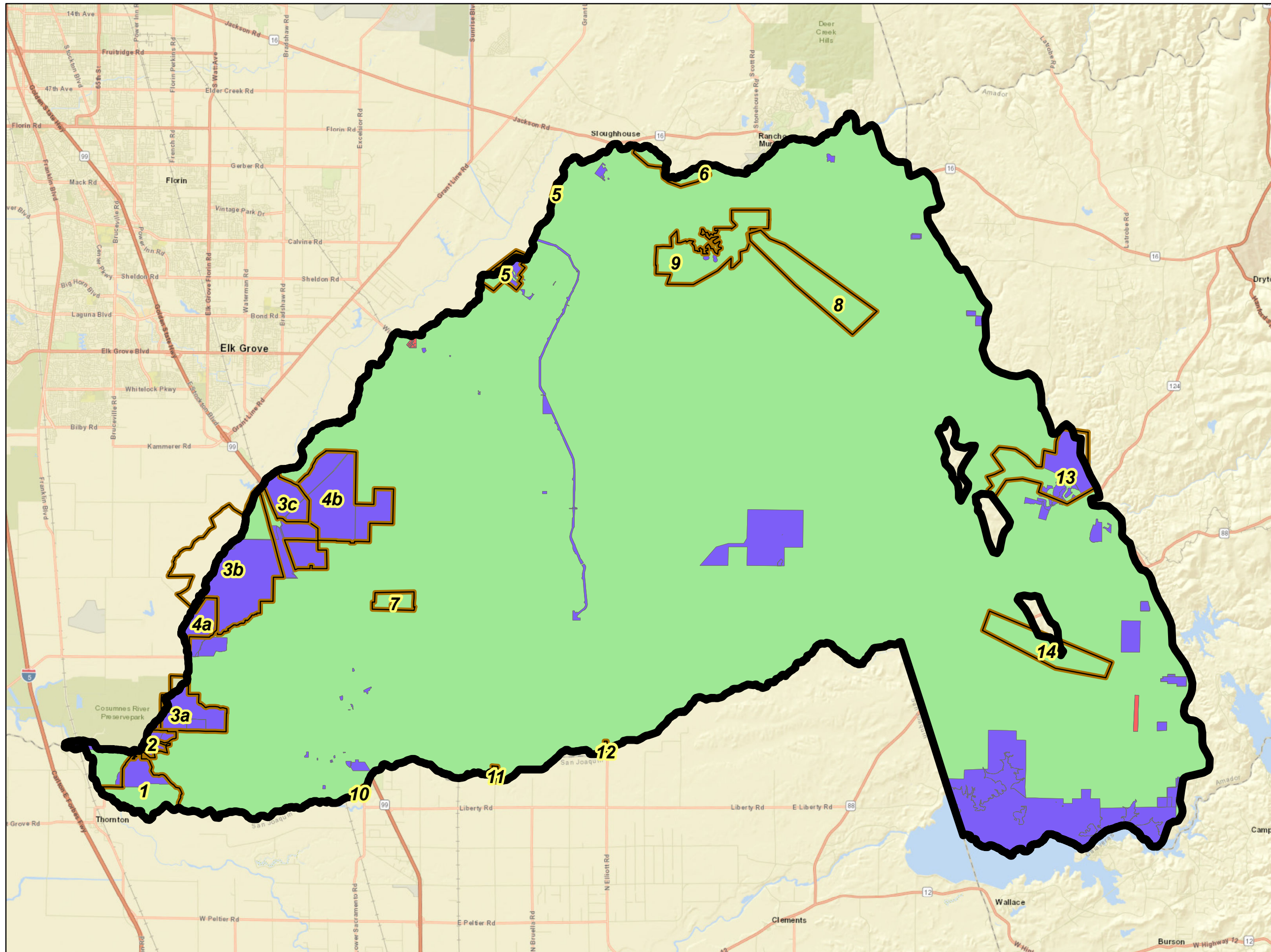
GeoSystems provided a list of priority survey sites to EKI and the appropriate GSA coordinated access prior to conducting the field work.

Table 2 lists the priority sites surveyed; a total of 14 priority sites were evaluated during the field survey. Two of these sites (Cosumnes River Preserve and Cosumnes River Ecological Reserve) were further sub-divided into geographically distinct sub-sites. While in the field, GeoSystems also remotely surveyed less accessible sites when: 1) it had relatively high NCCAG diversity, density, and/or extent; 2) the wetland/riparian areas were visible from public land or roadways; and 3) it was necessary to capture a representative sample of NCCAG types by geographic location and waterway.

² <https://www.amadorgov.org/departments/information-technology/gis/gis-viewer-and-parcel-search>

³ <https://assessor.saccounty.net/MapsPropertyDataAndRecords/Pages/AssessorParcelViewer.aspx>

Cosumnes Subbasin: Groundwater Dependent Ecosystem Evaluation - Field Survey Locatons



Legend

- Cosumnes Subbasin
- Priority Survey Areas

Land Ownership Status

- Assumed Private
- Public
- Tribal

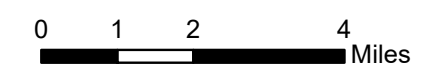


Figure 3. Map showing Priority Survey Sites, Cosumnes Subbasin

Table 2. Priority GDE assessment sites.

Site ID	Site Name	Landownership Status	Notes
1	Grizzly Slough Area	Mixed public and private land	Assessed from public roadways. Expansive wetlands and riparian areas near confluence of Mokelumne and Cosumnes Rivers
2	BLM Property Near Preserve	Public land, owned by Bureau of Land Management (BLM)	BLM land with high NCCAG diversity, expansive wetland and riparian areas
3	Cosumnes River Ecological Reserve	Accessed with CDFW permission	High NCCAG diversity, expansive wetlands and riparian types on public lands. Divided into three geographically isolated evaluation sites: 3A, 3B, and 3C
4	Cosumnes River Preserve	Managed as a public-private partnership, access coordinated through TNC	High NCCAG diversity, expansive wetland and riparian areas. Divided into three geographically isolated evaluation sites: 4A and 4B
5	Middle Cosumnes	Private land, access granted by Kautz Family Vineyards	Middle portion of Cosumnes River, representative NCCAG diversity
6	Upper Cosumnes	Private land, access granted by Kautz Family Vineyards	Upper portion of Cosumnes River, includes a high diversity of NCCAG types
7	Valley Oak	Private land, access granted by private landowner	Feature with high concentration of valley oaks along Laguna and Skunk Creeks
8	Vernal pools	Private land	Evaluated from roadways, site has high concentration of vernal pools in the foothills/valley transition zone
9	Cottonwood and placer mine tailings	Private land, access granted by private landowner	Unique area, portion with placer mine tailings and high proportion of cottonwood. Note this appears to coincide with "Mine tailing Riparian Woodland Cover" in SSHCP
10	Lower Dry Creek	Private land	Lower segment of Dry Creek, high NCCAG diversity, assessed from public roadways and improved trails
11	Alta Mesa Road Crossing (Middle Dry Creek)	Private land	Middle segment of Dry Creek, high NCCAG diversity, assessed from public roadways
12	Clay Station Road Crossing (Middle to Upper) Dry Creek	Private land	Middle segment of Dry Creek, representative NCCAG diversity for the area
13	Foothills Riparian	Primarily private land	Foothills segment with high NCCAG concentration, assessed from public roadways
14	Jackson Creek	Private land	Assessed from roadways and public access points

2.3 Desktop Geology, Soils, Groundwater and Surface Water Evaluations

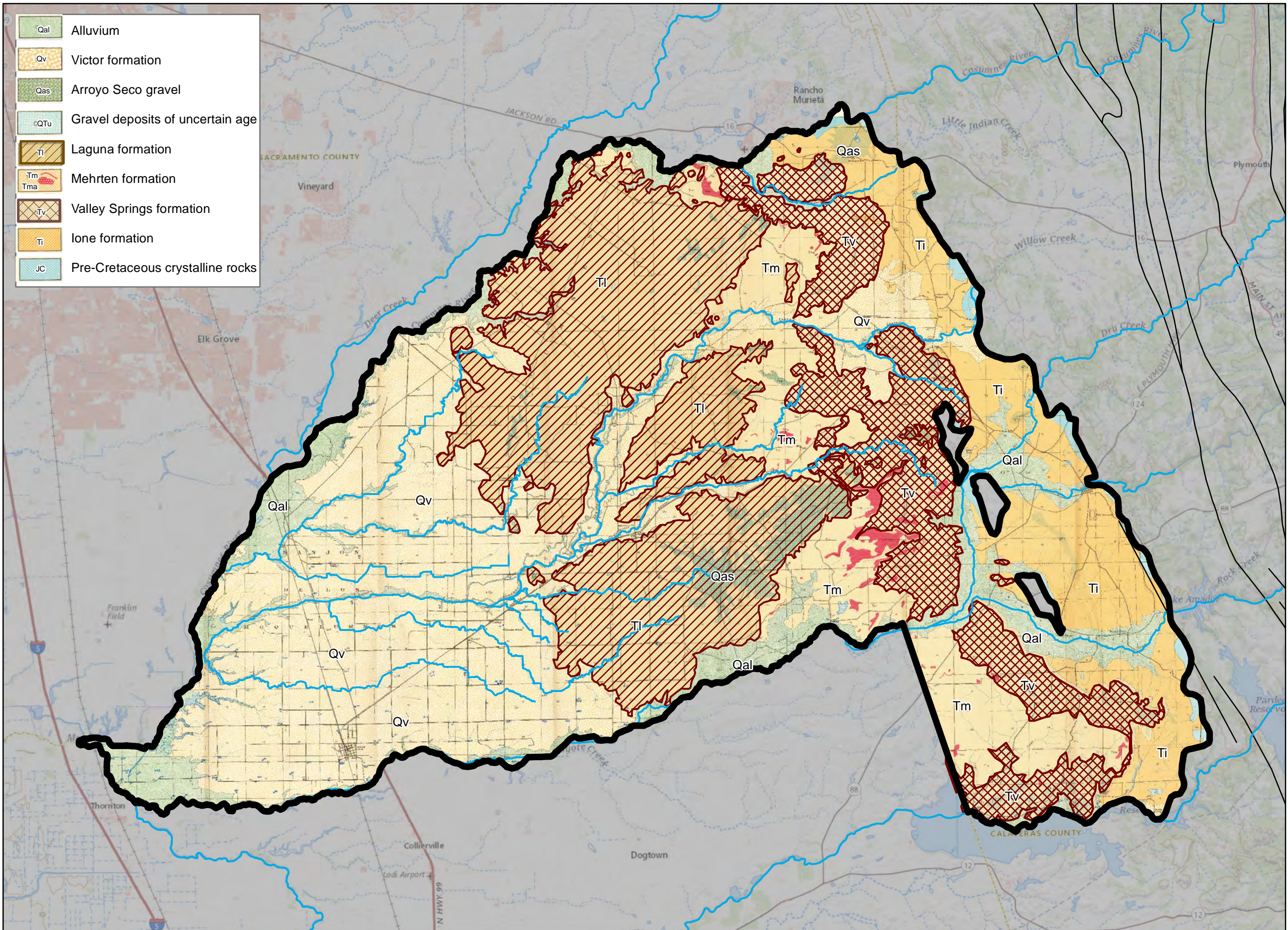
Desktop geologic, soils, surface water and groundwater data evaluations were performed to assess the potential effect of these parameters on the GDEs found within the Subbasin. Specifically, the presence of fine-grained and high available water holding capacity sediments and lithologic units in areas not in connection with the Principal Aquifer could help support GDE features if sufficient surface water from the wet season, or from agricultural practices, is available to saturate soils or create perched subsurface water conditions.

2.3.1 Geology

Geologic data were derived from the surficial geology maps and geologic cross-sections previously developed for the Cosumnes Subbasin (EKI, 2019). The geologic formations that make up the regional groundwater system underlying the Cosumnes Subbasin include (overlying from youngest to oldest): Younger (Recent) Alluvium (Qal), Older Alluvium (Quaternary Victor Formation (Qv) and Tertiary Laguna Formation (Tl)), and the Tertiary Mehrten (Tm), Valley Springs (Tv), and Lone (Ti) Formations. The surface exposures of each of these formations are shown in Figure 4.

The Victor and Laguna formations primarily consist of unconsolidated silt, sand and gravel fluvial deposits. The Mehrten Formation in this area consists of two distinct units: (1) black volcanic sand, silt, and clay layers (“Black Sands”); and (2) dense tuff breccia (DWR, 1974). The black sand layers are highly permeable, whereas the tuff breccia beds can act as local confining layers. Groundwater extraction within the Subbasin is primarily from the Victor and Laguna formations and the black sand layers of the Merhten Formation (EKI, 2019). The Valley Springs Formation is primarily composed of clay and pumice that have low permeability, whereas the Lone Formation consists primarily of interbedded sandstone and claystone layers. These formations are considered low permeability and semi-consolidated; groundwater extraction occurs from higher permeability lenses within the formation(s) that may be under confined conditions.

Based on the cross-sections prepared by EKI (2019), the geologic formations form a wedge-shaped geometry of youngest to oldest sediments that increases in thickness to the west. The younger unconsolidated units (Qv and Tl), pinch out to the east whereas the older units are exposed in outcrops within the Subbasin foothills. In general, it can be assumed that the older geologic formations have lower permeability sediments and/or low permeability sediment layers that could result in perching layers.



- Qal Alluvium
- Qv Victor formation
- Qas Arroyo Seco gravel
- QTu Gravel deposits of uncertain age
- Tl Laguna formation
- Tm Mehrten formation
- Tv Valley Springs formation
- Tl lone formation
- JC Pre-Cretaceous crystalline rocks

- Legend**
- Cosumnes Subbasin
 - Major streams
 - Faults
 - Gray background

Geology: USGS, 1939. Geology and Ground-Water Hydrology of the Mokelumne Area, California. USGS Water-Supply Paper 780. Faults: USGS, 2007. Preliminary integrated geologic map databases for the United States, Western States. Version 1.3. Updated December 2007. USGS Open-File Report 2005-1305.

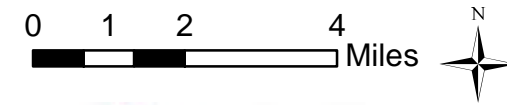


Figure 4. Surficial Geology

2.3.2 Near-surface Soils

Near-surface (< 6-ft) soils data were retrieved using Soil Data Viewer, the GIS application from the U.S. Natural Resources Conservation Service Web Soil Survey (NRCS, 2021). Soil map units with Unified Soil Classification System (USCS) classifications were grouped into soil types as follows:

- Gravelly or sandy - GW, GP, GM, GC, SW, SP
- Sands with fines - SM, SC
- Silts and clays - ML, CL, OL, MH, CH, OH

Soil map unit designations for which USCS codes were not listed were grouped into three additional categories: Mine tailings and Riverwash, Rock, and Water. Soil map unit data directly related to soil permeability and water storage capacity, including saturated hydraulic conductivity (Ksat), clay percentage, and depth to a restrictive soil or rock layer, were also mapped and analyzed in order to assign a relative surface permeability category to each soils map unit. The methods used to create the relative permeability determinations and supporting soils data is presented in Appendix A.

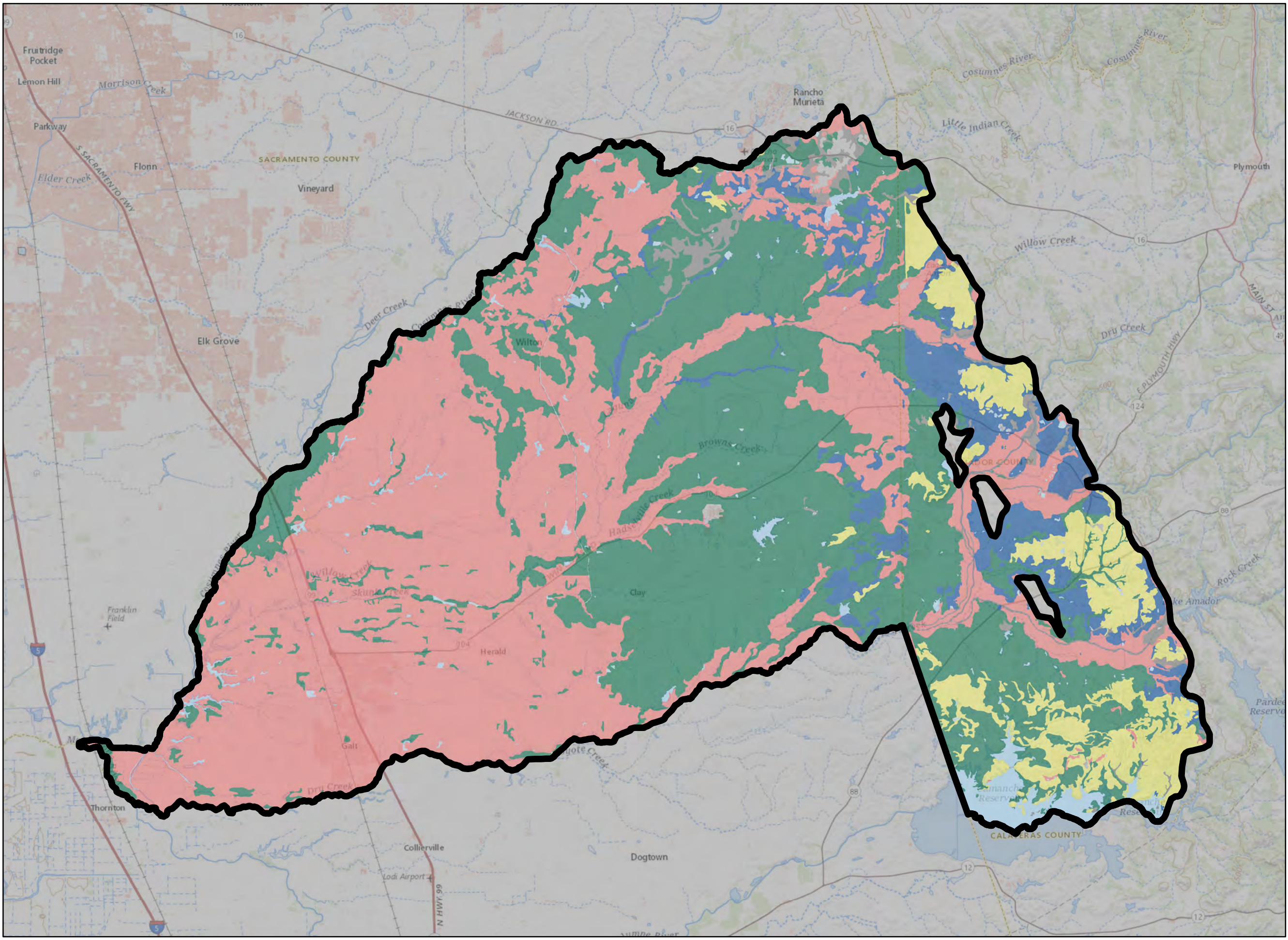
Figure 5 shows the spatial distribution of different soils based on the USCS soil classification group. Fine-grained silt and clayey soils predominant in the western portion of the subbasin, whereas soils in the center portion of the basin are predominantly sandy material with fines (SM, SC) with silt and clay soils found along the major drainages, most likely present as overbank deposits. The eastern portion of the basin in the foothills shows a mix of silty and clayey soils along major drainages and coarser grained material in the inter-drainage areas. The soil classifications generally follow the mapped surface geology (Figure 4), whereby the silty and clayey soils correspond to the Qv and Tm formations. Sandy soils with fines generally correspond with the Tl and Tv formations; and “rock” is coincident with the Ti Formation. Finally, gravelly or sandy soils are found in the foothills in areas as either Tm or Qa formation material.

Figure 6 presents the predicted relative soil permeability based on the NRCS data. Large areas of the western and central areas of the Subbasin are predicted to have relatively low permeability near-surface soils (i.e. < 3 inches/day) with the largest continuous areas of low Ksat (0.1 to 1 inch/day) in the western end of the subbasin, and along Laguna Creek in the subbasin center.

The near-surface soils and surficial geology data indicate generally fine-grained and low permeability soils predominate throughout the Sub-basin. It is likely that the older Tv and Tm materials have sufficient fine-grained layers within the near-surface to support wetland type vegetation in the absence of groundwater. This is confirmed by the presence of vernal pools in the central portion of the basin (See Appendix C) and the presence of riparian trees (Cottonwood) in the placer mine tailings areas (See Appendix C) in the absence of permanent sources of

groundwater or surface water. In the area of the placer mine tailings, it is expected that precipitation and surface water is retained by low permeability layers below the tailings that support the riparian vegetation.

Although the western portion of the basin has an absence of wetland type vegetation compared to the central and eastern portions, the predominance of low-permeability soils indicates that wetland vegetation would likely be present in the absence of development. Finally, except for the placer tailings area, riparian tree vegetation is primarily limited to within ephemeral stream channels and finer-grained soils associated with over-bank deposits along these drainages. Recharge from surface water flows in these channels is likely retained by fine-grained soils or perching layers that support the riparian trees during periods without surface water flow.



Legend

Cosumnes subbasin

Soil classification

- Gravelly or sandy
- Sands with fines
- Silts and clays
- Mine tailings and riverwash
- Rock
- Water
- Gray background

Soils data from:
 United States Department of Agriculture,
 Natural Resources Conservation Service,
 2021. Web Soil Survey. Available:
<http://websoilsurvey.sc.egov.usda.gov/>.
 Accessed 12/28/20.

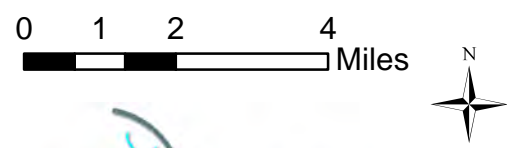
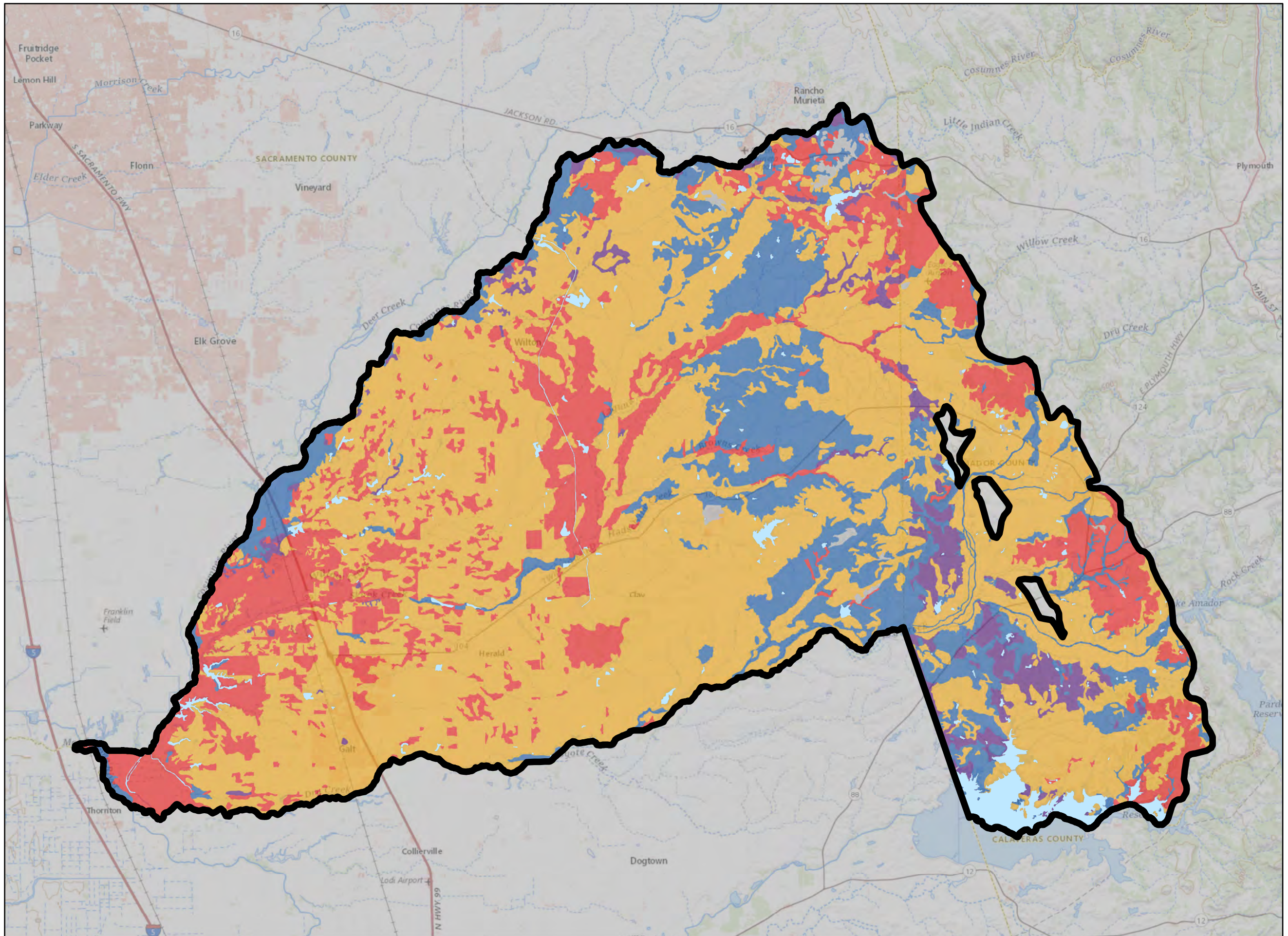










Figure 5. Soil classification groups



Legend

-  Cosumnes Subbasin
- Modified Ksat (inches/day)**
-  No Ksat
-  0.1 - 1.0
-  1.1 - 3.0
-  3.1 - 6.0
-  > 6.0
-  Gray background
-  Water

Soils data from:
 United States Department of Agriculture,
 Natural Resources Conservation Service,
 2021. Web Soil Survey. Available:
<http://websoilsurvey.sc.egov.usda.gov/>.
 Accessed 12/28/20.

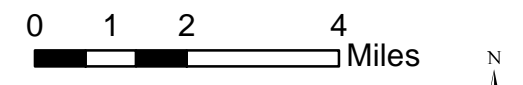


Figure 6. Estimated Soil Permeability

2.3.3 Groundwater

Depth to groundwater conditions within the Cosumnes Subbasin are shown in Figure 7 based on October 2018 groundwater measurements and groundwater elevation mapping from EKI (2019). For purposes of this GDE evaluation, depth to groundwater contours were grouped into:

- < 10 ft below ground surface (bgs) – adequate to support GDE species such as cottonwood (*Populus fremontii*) and willow (*Salix* spp), seep willow (*Baccharis* spp), and herbaceous wetlands
- 10 to 30 ft bgs – adequate to support GDE species such as valley oak (regardless of size/age), box elder (*Acer negundo*), Oregon ash (*Fraxinus latifolia*), walnut (*Juglans* spp), and mature cottonwood
- >30 to <50 ft bgs – conservatively assumed adequate to support deeper rooting GDE species such as mature valley oak due to spatial and temporal variability (see discussion below).
- >50 ft bgs – inadequate to support GDEs

Depth to groundwater ranges from 10 to 30 ft bgs in the west and transitions progressively deeper to greater than 100 ft bgs in most of the central portion of the Subbasin. The selection of areas between 30 and 50 ft bgs as adequate to support SGMA GDEs is justified because Figure 7 relies on a single point of time (Fall 2018), which does not account for seasonal and interannual variability. Additionally, there was an absence of monitor well data in the western portion of the Subbasin in the Fall of 2018, and thus local groundwater elevations in the area between the Cosumnes and Dry Creek drainage are not accounted for. Figure 8 shows the median and minimum depths to groundwater measured over the time period of 1950-2020, with most of the data representing the 2010-2020 period. These data indicate that seasonal water levels can range about 10 feet in the Basin and that areas proximal to recharge sources such as the Cosumnes River and Dry Creek show higher groundwater elevations compared to other regional wells. It is likely that surface water transmission losses can elevate the underlying water table associated with the Principal Aquifer or create localized perched water conditions that could support GDEs, as observed near the confluence of Deer Creek and the Cosumnes (Figure 8). Nevertheless, the uncertainty in local groundwater elevations in areas mapped as between 10 to 50 ft bgs and in areas proximal to the Cosumnes and Dry Creek drainages represent a data gap to resolve during GSP implementation.

Within the Foothills Subarea, the depth to groundwater decreases; some wells show artesian conditions (EKI, 2019). However, depth to water estimates in the Foothills Subarea are highly uncertain due to variability in well completion intervals and general lack of spatial data. Wells within the Foothills Subarea that show shallow depth to groundwater levels appear to be completed in the deeper Ione Formation and may be representative of confined or semi-confined

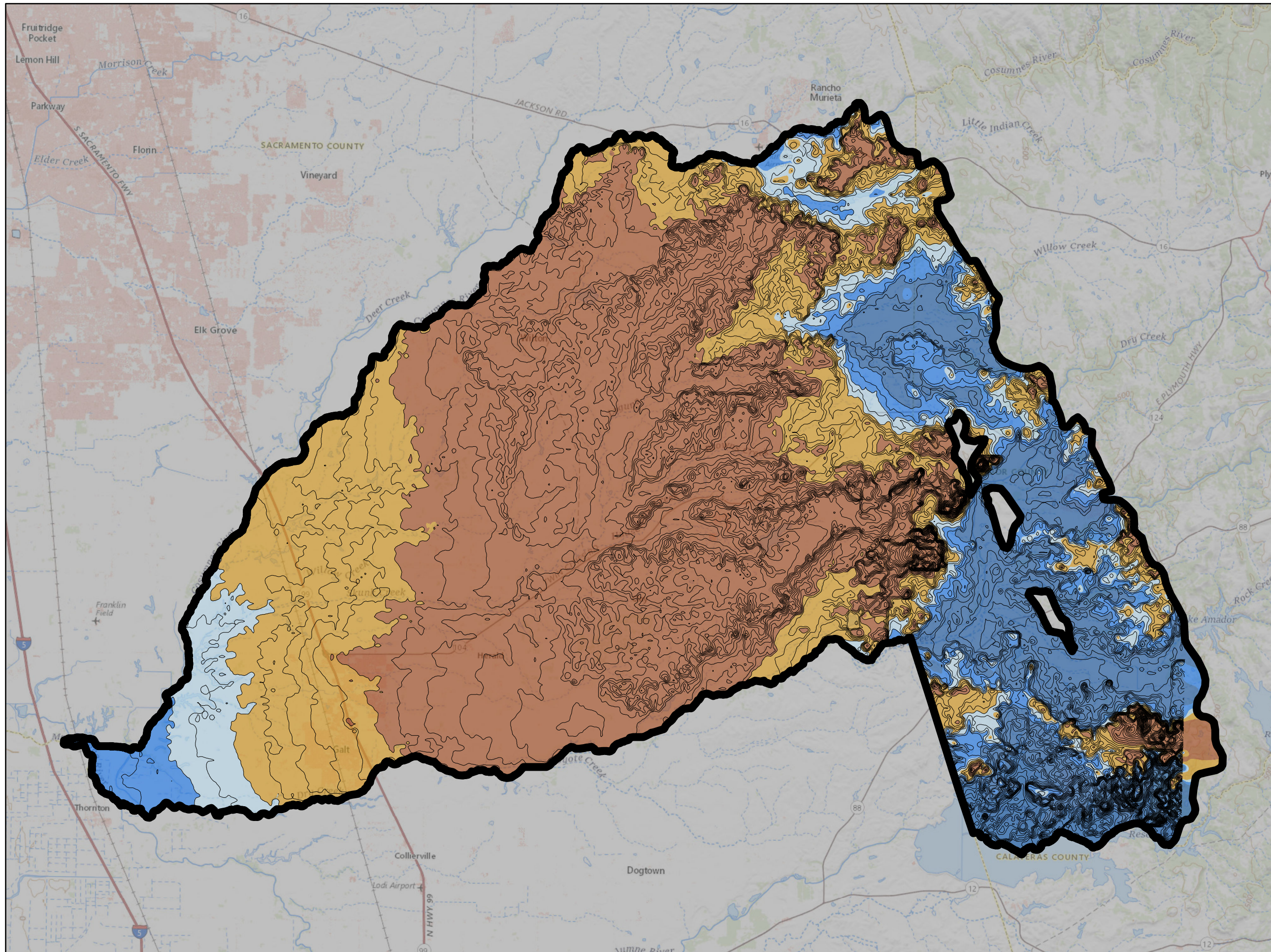
conditions, whereas wells showing deeper groundwater depths appear to be completed in the Valley Springs or shallow Lone Formations of the Principal Aquifer. This is evidenced by depth to groundwater measurements greater than 50 ft bgs in three wells to the northeast of the Camanche Reservoir (Figure 7), whereas other wells within the same general area show depth to water measurements less than 10 ft bgs. Without reliable information on depth to the water table in these areas, mapped GDEs cannot be confirmed, and water levels in the shallow sediments represents a data gap to resolve during GSP implementation.

2.3.4 Surface Water-Groundwater Interactions








Depth to groundwater contours mapped for the Subbasin (Figure 7) indicate that groundwater is typically encountered at depths greater than 30 ft bgs, and thus surface water flows and groundwater are likely disconnected from the Principal Aquifer across most of the Basin (EKI, 2019). However, available data indicate that portions of the Cosumnes River west of its confluence with Deer Creek may be temporarily interconnected for one or more months during some years (but not all), and for less than the entire year. Moreover, the westernmost reach of the Cosumnes River is understood to be more regularly interconnected. These areas are conservatively considered to have “interconnected surface water”, at least for short time periods, but the actual relationships between surface water and the underlying Principal Aquifer is complex and remains a data gap in the GSP (EKI, 2019).

Surface water-groundwater interaction studies along the Cosumnes River have been reviewed by Wiener (2021). Fleckenstein et al. (2006) and Niswonger and Fogg (2008) developed numerical models to evaluate the potential of subsurface heterogeneities to cause localized groundwater mounding and perched water(s) in disconnected surface water-groundwater reaches along the Cosumnes. These studies concluded that the occurrence of fine-grained sediment layers below coarse-grained riverbed sediments could cause perching above the fine-grained layer, which could extend seasonal flows in the Cosumnes by a few days (Fleckenstein et al., 2006) and also support increased evapotranspiration for riparian species (Niswonger & Fogg, 2008). Perched water systems conceptually may develop below any of the surface water features in the Subbasin when surface water flows are sustained for a period of time. However, underlying low-permeability perching layers are most likely spatially variable and inconsistent through the various reaches.

Cosumnes Subbasin: Groundwater Dependent Ecosystem Evaluation Results - Depth to Groundwater



Legend

-  Cosumnes Subbasin
-  Fall 2018 depth to groundwater contours (10 Ft Interval)
- Fall 2018 depth to groundwater (ft)
-  < 10
-  10 - 30
-  30 - 50
-  50 - 100
-  > 100

Water level data from: EKI, 2019.

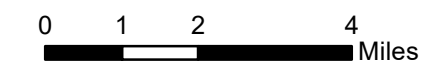
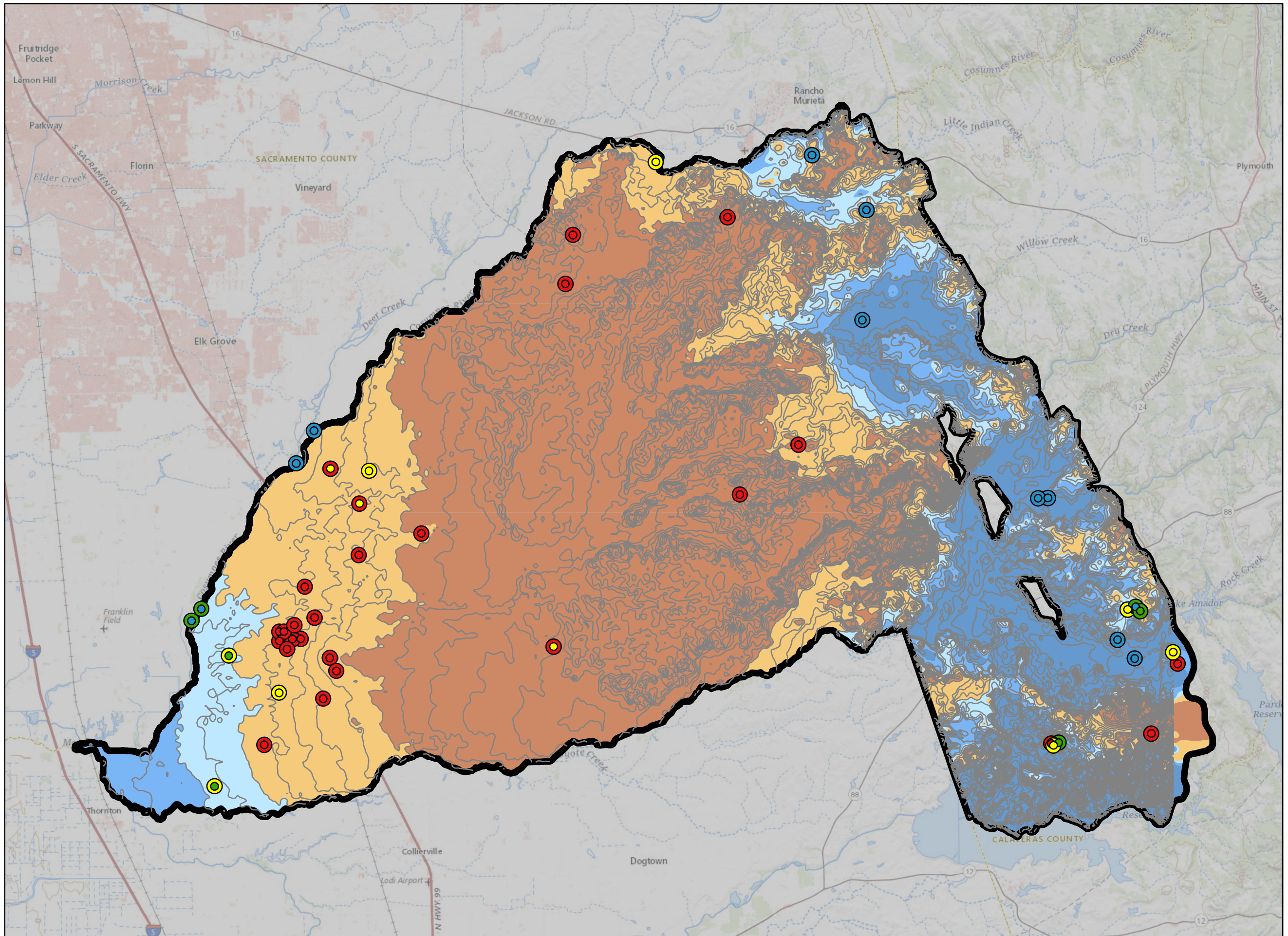


Figure 7. Depth to groundwater 2018



Legend

Cosumnes Subbasin

Minimum depth to water (ft)

- ≤ 15
- 15.1 - 30
- 30.1 - 50
- > 50

Median depth to water (ft)

- ≤ 15
- 15.1 - 30
- 30.1 - 50
- > 50

— Fall 2018 depth to groundwater contours (10 ft intervals)

DpRng

- <10 Feet
- 10-30 Feet
- 30-50 Feet
- 50-100 Feet
- >100 Feet

Water level data from: EKI, 2019.

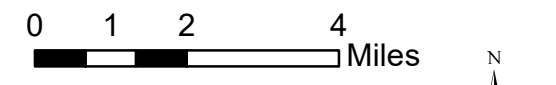


Figure 8. Historic Median and Minimum Depth to Water Levels, 1950-2020 (most data from 2010-2020)

2.3.5 Field Verification Methods

Field vegetation assessment methods entailed two different monitoring intensities: 1) “full, onsite” assessment; and 2) a relatively “rapid, remote” assessment. Regardless of the assessment method (full vs. rapid/remote), the assessment was aimed to meet the following objectives:

- Confirm the vegetation/wetland community is accurately described in the existing mapping (e.g. NCCAG or alternative sources). If not, record the actual type.
- Document vegetation vigor, survival, canopy dieback, structure, diversity, prominence of native vs. exotic species, and natural reproduction.
- Document whether or not the feature appears to be a GDE.
 - Are there alternative sources of water besides groundwater (natural or manmade)?
 - Is the feature near a spring, river, or stream? If the site is along a river or stream, does it appear to be a gaining or losing reach?

The full and rapid/remote assessments both focused on documenting similar attributes and answering the same questions; however, the full intensity assessment method gathered more precise, detailed (e.g. info on soil conditions and herbaceous vegetation), and quantitative (primarily within cover classes) data than the rapid/remote method. Regardless of the relative intensity, the ecologist utilized either a custom smartphone/tablet application to log GDE-related field attributes or an identically replicated hardcopy datasheet to log observations (depending on whether the hardcopy or electronic form was assumed to be more efficient at a specific site). Sample hardcopy datasheets are provided in Appendix B. GPS-enabled maps that included study site boundaries, roads, NCCAG features, and riparian/wetland areas identified in alternative sources were loaded onto field tablets and used by field ecologists to plot their field location in relation to these site attributes.

Key data collection variables during the full intensity assessment method included:

- Visible evidence of groundwater
- Dominant vegetation species, subdominant woody vegetation species, aerial vegetation cover class (woody species, graminoids, weeds), vegetation structure (i.e. vertical distribution of canopy layers based on canopy layer cover), and list of observed weed species
- Indications of moisture stress (proportion live vs. senescent canopy), and indications of natural reproduction (density, distribution, and size class)
- Ecological conditions (e.g. Biological Condition Gradient Classification Scheme, [EPA 2016] and Stillwater et al. [2020]; see Table 3)
- Ground cover: Bare ground, rock, litter, cobble, basal vegetation (within cover classes)
- Soils: texture, moisture, and redox indicators in top 6 inches

- Surface Water: Presence/absence of surface water and surface water indicators, apparent flow consistency, channel dynamics, surface water fate (if applicable), and erosion indicators
- Human influence and disturbance: Manmade structures, manmade hydrologic alterations, animal effects, soil disturbance indicators, water diversion observations, and land use changes
- GDE classification: Per a GDE schema (classification system) that assigns a GDE type for this basin – combines a moisture class, predicted aquifer source, and manmade modifier
- General notes
- Geotagged field photos (included in the project geo-database)

Table 3. Biological condition gradient classifications

Level	Definition
Level 1—Natural or native condition	Native structural, functional, and taxonomic integrity is preserved. Ecosystem function is preserved within the range of natural variability. Functions are processes required for the normal performance of a biological system and may be applied to any level of biological organization.
Level 2—Minimal changes	Minimal changes in the structure of the biotic community and minimal changes in ecosystem function. Most native taxa are maintained with some changes in biomass and/or abundance. Ecosystem functions are fully maintained within the range of natural variability.
Level 3—Evident changes	Evident changes in the structure of the biotic community and minimal changes in ecosystem function. Evident changes in the structure due to loss of some highly sensitive native taxa; shifts in relative abundance of taxa, but sensitive ubiquitous taxa are common and relatively abundant. Ecosystem functions are fully maintained through redundant attributes of the system.
Level 4—Moderate changes	Moderate changes in the structure of the biotic community with minimal changes in ecosystem function. Moderate changes in the structure due to the replacement of some intermediate sensitive taxa by more tolerant taxa, but reproducing populations of some sensitive taxa are maintained; overall balanced distribution of all expected major groups. Ecosystem functions largely maintained through redundant attributes.
Level 5—Major changes	Major changes in the structure of the biotic community and moderate changes in ecosystem function. Sensitive taxa are markedly diminished or missing; organism condition shows signs of physiological stress. Ecosystem function shows reduced complexity and redundancy.
Level 6—Severe changes	Severe changes in the structure of the biotic community and major loss of ecosystem function. Extreme changes in structure, wholesale changes in taxonomic composition, extreme alterations from normal densities and distributions, and organism condition is often poor.

When landowner access was not granted or to maximize the number of sites visited, GeoSystems staff utilized the rapid/remote survey method by assessing sites from nearby roads, often aided by binoculars. These rapid assessments were frequently completed from bridge crossings over key waterways. Primary data collection variables during the rapid/remote method survey included:

- Visible evidence of groundwater
- Dominant vegetation species
- Indications of moisture stress (proportion live vs. senescent canopy), indications of natural reproduction, and ecological conditions (e.g. EPA, 2016)
- Surface Water: Presence/absence of surface water and surface water indicators, apparent flow consistency, channel dynamics, surface water fate (if applicable)
- Human influence and disturbance: Manmade structures, manmade hydrologic alterations, animal effects, soil disturbance indicators, water diversion observations, land use changes
- General notes
- GDE classification
- Geotagged field photos (included in the project geo-database)

As discussed in the Results section of this document, the findings supported our overall assessment of map reliability and were ultimately leveraged to verify GDEs within the Subbasin, including the classification of probable, uncertain and non-GDE status, and document vegetation health and recruitment within sites, regardless of whether GDEs were confirmed at a site (see Section 3.2.3). Results were then qualitatively extrapolated to other map areas not visited during the field survey. To clearly document which features were surveyed, all field observations and field photographs were geo-tagged with a latitude and longitude location.

2.3.6 GDE Classification Framework

For this project, GeoSystems developed a classification system for evaluating and coding specific types of potential GDEs. The GeoSystems GDE classification system is intended to normalize and streamline the characteristics of different types of potential GDEs and support GSP development (Table 4). This GDE classification schema considers four key attributes for each potential GDE:

1. **Geomorphic Setting:** differentiates ponds/lakes (e.g. appear to be perennially wet “lacustrine” types per NWI) and riverine segments from isolated depressions that seasonally collect rainwater, stormwater, or agricultural runoff (e.g. vernal pools or other closed basin features).
2. **Dominant Vegetation Class:** differentiates woody-dominated (tree-shrubs), herbaceous-dominated (graminoids, forbs), and water dominated features using a hierarchal approach.
3. **Inferred Source Aquifer:** as determined by whether a feature appears to be supported by shallow groundwater (e.g. perched), the Principal Aquifer, or both.

4. **Man-Made Modifier:** distinguishes naturally occurring features from features that are wholly or partially supported by a surface water diversion, groundwater extraction (e.g. well), agricultural runoff, or a stock tank/impoundment.

During survey post-processing, data gathered during the field effort was extrapolated to refine and improve the GDE dataset by cross-analysis with alternative vegetation mapping data, satellite imagery, the TNC rooting depth database (TNC, 2018, and available geologic, groundwater, and surface water-related information. Each feature within the geo-database was assigned a representative GDE class value, regardless of whether the site was visited on the ground. Recent satellite imagery and orthophotography was used to digitize (or electronically draw) in features not captured in existing vegetation mapping, and to evaluate for presence/absence of various elements in the GDE classification schema for locations not visited in the field. This result was then used to apply a consistent conceptual model for confirming/predicting GDEs in the Subbasin.

Table 4 . GDE classification schema developed in support of this project.

Geomorphic Setting	R	D	P		
	Riverine	Depressional	Pond/Lake		
Dominant Vegetation Class	T	H	W	U	
	Trees/shrubs, woody dominated	Herbaceous	Water	Unvegetated/ Riverine	
	No visual evidence of surface water or groundwater; not dominated by phreatophytic/hydrophilic plants	No visual evidence of surface water or groundwater; however, site is dominated by phreatophytic/hydrophilic plants	Visual evidence of surface and/or groundwater, site is dominated by phreatophytic/hydrophilic plants; however, surface water suspected to be ephemeral or intermittent		
Suspected Source Aquifer	a	B	r	U	Na
	Site appears to be supported by shallow groundwater separate from regional principal aquifer	Site appears to be supported by shallow groundwater and regional principal aquifer	Site appears to be supported by the regional principal aquifer	Unknown, supported by shallow alluvium above bedrock and or perched layers, or regional aquifer	Not connected to groundwater
Man-Made Modifier	n	l	d	T	a
	Naturally occurring GDE	Created/ supported by a man-made impoundment or excavation	Created/ supported by a man-made diversion	Created/supporte d by placer mine tailings	Created/ supported by agriculture via direct irrigation, runoff, conveyance structures

2.3.7 Remote Sensing Analysis

GeoSystems conducted a remote sensing-based analysis of vegetation with the entire Subbasin via analyzing GDE Pulse data (TNC, 2021), and evaluating “greenness” trends between spring and fall 2019 and 2020 from Sentinel-2 satellite images (ESA, 2021). Remote sensing data analyses were intended to serve two main purposes: 1) to validate and support GDE identification, and 2) characterize the historic, current, and apparent trajectory of vegetation health and soil moisture

availability. The health of GDEs is affected by numerous variables including water management, climate, pests, land management, and water quality.

To provide GSAs with a rapid means of assessing GDE health, the creators of the GDE Pulse tool specifically analyzed 34 years of Landsat satellite data (1996 to 2018) for GDEs in all groundwater basins within California to show how their greenness, or photosynthetic vigor (via Normalized Difference Vegetation Index (NDVI)), and canopy moisture content (via Normalized Difference Moisture Index (NDMI)), have changed over this period. Both NDVI and NDMI are intended to provide an ongoing, quick proxy to monitor GDE health trends. GDE Pulse data are only available for features identified in NCCAG data and as the average annual NDVI and NDMI value. Thus, seasonal trends in NDVI and NDMI cannot be analyzed, and wetland/riparian areas not previously identified within NCCAG also cannot be evaluated with the GDE Pulse tool.

For this project, GeoSystems acquired GDE Pulse data from the TNC GDE Pulse website (<https://gde.codefornature.org/#/home>) and overlaid the GDE Pulse NDVI and NDMI intensities with a simplified version of vegetation types that were originally defined within the NCCAG data. Values were then graphed to compare to annual precipitation based on Western Regional Climate Center data from the Sacramento airport.

Ten-meter Sentinel-2 satellite data were obtained for four recent time periods: April 2019, October 2019, April 2020, October 2020. Those specific timeframes were selected because GDEs should have more consistent “greenness” through the growing season, and soil moisture is expected to be most abundant during the spring and most limited during the early fall. Per Rhode et al., 2019 (who also captured electrical resistivity tomography data in the project site during September and October), riparian forests in the Cosumnes Subbasin are expected to be most reliant on groundwater during the late summer/early fall dry period. NDVI values were rescaled from the initial -1 (low greenness) to 1 (high greenness) range yielded by the standard calculation to a 0 to 200 range and then differenced (by subtracting fall from spring) to compare early versus late season photosynthetic rates for each year. The rasterized results of the subtraction were then converted to a vector format (shapefile point) and intersected with the GDE evaluation polygons for the Subbasin to enable comparisons of greenness trends within vegetation classes (per the GDE classification schema), geomorphic type, and SGMA GDE probability classes.

3.0 RESULTS

3.1 Reliability of Existing Mapping

The combination of NCCAG, NVCS, and NWI data proved to be a reliable “starting point” for identifying and evaluating potential GDEs. A detailed discussion of the reliability of existing vegetation mapping is provided for each individual site in Appendix C of this memorandum. Please note that Appendix C also provides detailed reproduction observations, canopy dieback, soil conditions, dominant vegetation species, hydrologic observations, biological conditions gradients, exotic species observations, habitat value, and includes representative photos for each field site. General reliability trends for existing vegetation data in this Subbasin are:

- NCCAG’s typical approach of only assigning one dominant tree/shrub species to a specific area (or polygon feature) under-represented the vegetation species richness and diversity within nearly every feature.
- While not quantitatively evaluated, the dominant vegetation species assigned to a feature in NCCAG mapping was actually a co-dominant species at least half of the time.
- NCCAG vegetation data reliably captured the total aerial extent of potential GDEs within most sites.
- NCCAG types identified as valley oak and/or cottonwood dominated were often actually Eucalyptus (a non-native species) dominated types.
- Walnut and box elder were typically well captured.
- Communities identified as valley oak in NCCAG were sometimes intermixed with or entirely dominated by blue oak (*Quercus douglasi*), but blue oak did not appear to be groundwater dependent in these locations.
- Oregon ash and elderberry (*Sambucus nigra*) were often not described in the NCCAG data when they were (co-) dominant species.
- Coyote willow (*Salix exigua*) shrublands identified in NCCAG data were often dominated by elderberry instead of coyote willow.
- Marshes, ponds, and herbaceous wetlands were accurately represented (both in terms of type and extent).

3.2 Distribution and Extent of Groundwater Dependent Ecosystems

As described in Section 2.1.6, GDEs were characterized according to vegetation and geomorphic classes, probable source aquifer, and man-made modifiers so that a streamlined, consistent conceptual framework could be used to assign GDE status. The following sub-sections summarize the aerial coverage and distribution of each type (or sub-type) yielded from this classification schema.

3.2.1 Geomorphic Setting

Per the GDE classification schema, each individual feature was assigned a specific geomorphic setting as follows:

- Riverine: feature immediately adjacent to a flowing waterbody (e.g. stream, creek, river), and roots from phreatophytic (deep-rooted) tree and shrub species could theoretically access a perched aquifer if one existed and/or receive supplemental surface water during flood events.
- Pond/Lake: natural or unnatural waterbody filled with non-flowing water year-round.
- Depressional: isolated depressions such as vernal pools, vernal swales, and other low-lying riparian/wetland features where surface water could collect that are not underwater year-round (i.e. a pond/lake) and do not have a direct hydraulic connection to a flowing water feature (i.e. river/stream).

Most of the potential GDEs in the Subbasin were characterized as a riverine (8,245 acre) geomorphic setting. Depressional areas were the second most prominent geomorphic setting characterized (6,099 acres) and had a relatively even spatial distribution across the Subbasin compared with the lake/pond and riverine types (Figure 9). Pond/lake types composed 5,349 acres, much of which includes Camanche Reservoir.

3.2.2 Vegetation Class

Per the GDE classification schema, each individual feature evaluated to determine GDE status was also assigned a specific vegetation class that differentiates whether the site is dominated by woody species (i.e. trees and/or shrubs), herbs, underwater, or unvegetated (e.g. a barren riverbed per NWI “riverine” type). According to this framework, most (6,710 acres) of the GDEs mapped in NCCAG, NVCS, NWI, or hand-digitized after the field work are dominated by herbaceous vegetation. The tree/shrub class and water class had a relatively similar areal coverage. The distribution of the vegetation classes is shown on the map provided as Figure 10.

Cosumnes Subbasin: Groundwater Dependent Ecosystem Evaluation Results - Geomorphic Setting

Geomorphic Setting	Acres
Depressional	6,099.0
Pond/Lake	5,349.2
Riverine	8,245.0
Grand Total	19,693.2

Legend

GDE Evaluation
Results (GeoMorph
Type)

- Depressional
- Pond/Lake
- Riverine
- Cosumnes Subbasin

Geomorphic Setting	Acres
Depressional	6,099.00
Pond/Lake	5,349.20
Riverine	8,245.00
Grand Total	19,693.20

0 1 2 4 Miles



Figure 9. Cosumnes Geomorphic Setting Classes

**Cosumnes Subbasin:
Groundwater Dependent
Ecosystem Evaluation
Results -
Vegetation Class**

Vegetation Class	Acres
Herbaceous	6,710.0
Tree/Shrub	5,749.8
Unvegetated Riverine	1,300.8
Water	5,932.6
Grand Total	19,693.2

Legend

**GDE Evaluation Results
(Vegetation Class)**

- h: herbaceous
- t: tree/shrub
- u: unvegetated riverine
- w: water
- Cosumnes Subbasin

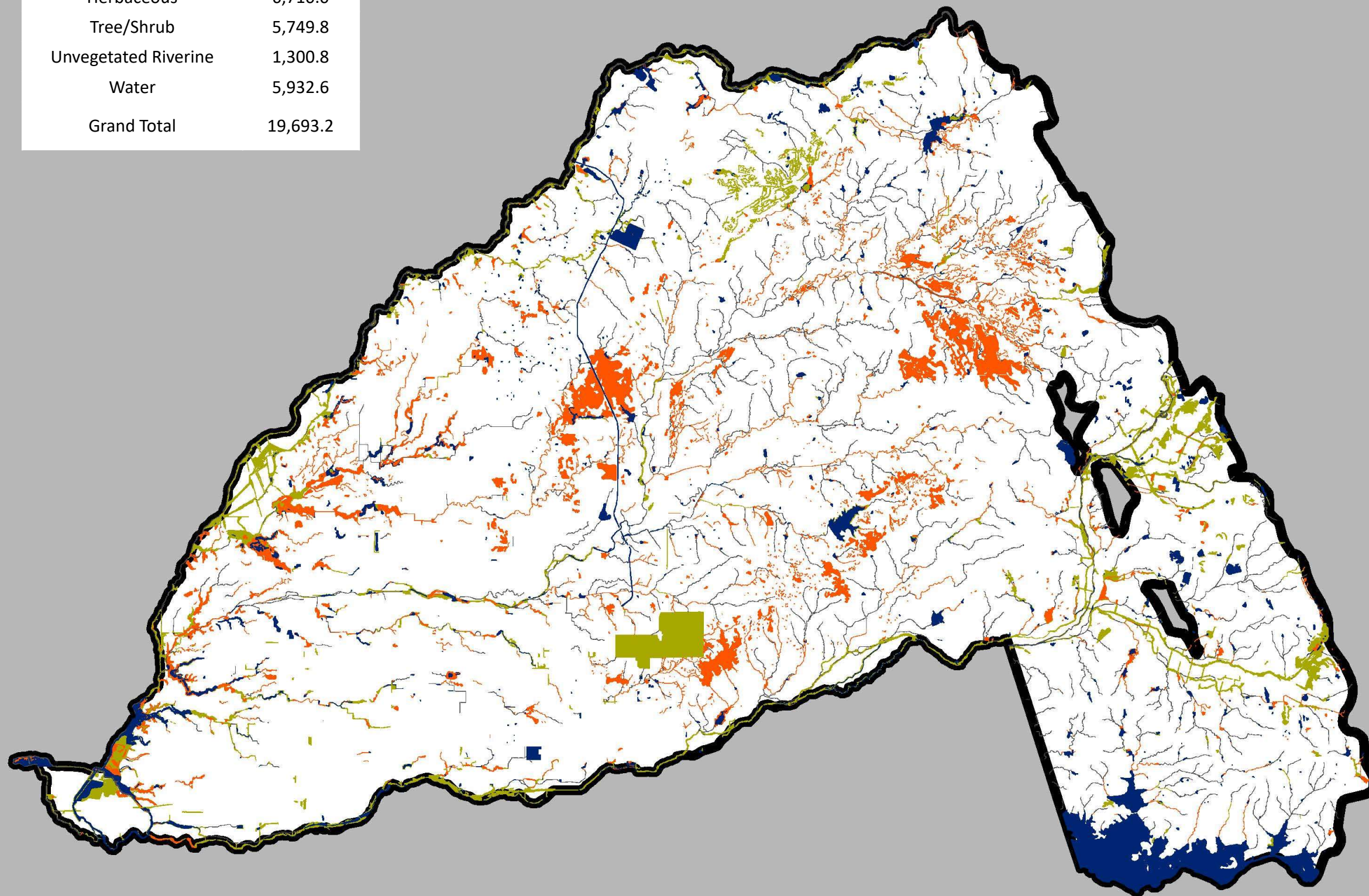


Figure 10. Vegetation Classes

3.2.3 Inferred Source Aquifer

Based on the groundwater elevation data (Figure 7), GDE features were assigned a probable source aquifer as follows:

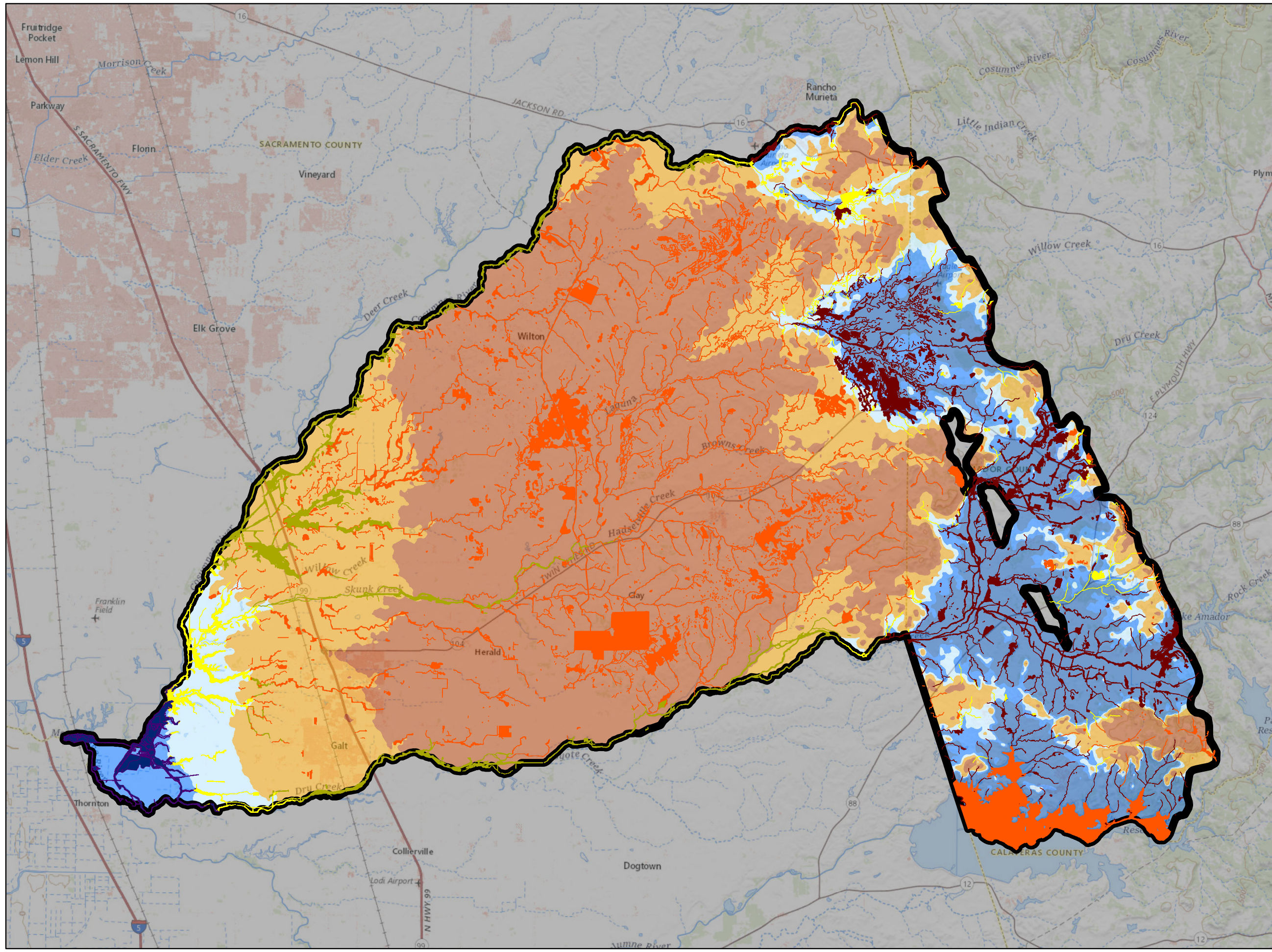
- Riparian/wetland areas within 30 feet of the regional aquifer (per Fall 2018 depth to water contours) were assigned to the “r” aquifer class: “supported by the regional aquifer”
- Features dominated by mature woody vegetation that occur within 30 to 50 feet depth to groundwater areas, and that were also a riverine geomorphic class were conservatively assigned to the “b” (for both) aquifer class: “supported by both regional aquifer and potentially perched water”
- Herbaceous vegetation was assigned “na”: “not connected to groundwater,” throughout most of the subbasin because soils are fine-grained enough to support herbaceous wetlands, especially when they lie in depressions (e.g. vernal pools and swales). Open water habitats and woody vegetation communities were also assigned an “na” class if located in areas with a depth to groundwater that exceeded 50 feet.
- Locations with contiguous woody vegetation that fell outside aquifer classes “b” and “r” but which inhabited riverine geomorphic settings were assigned to aquifer class “a”: “supported by surface water and/or perched water”
- Lastly, “u” was assigned to foothills locations where the depth to groundwater is less than 30 feet (and often less than 10 feet), but it is currently unknown whether the measured water elevations represent water table conditions or are influenced by deeper piezometric pressures

Based on this evaluation, most (11,438 acres) of the riparian and wetland communities within the subbasin are not connected to groundwater (Table 5 and Figure 11). In the western portion of the Subbasin, approximately 990 acres of riparian/wetland types are predicted to be connected to the water table of the Principal Aquifer and therefore considered GDEs, while an additional 819 acres are probably supported by localized higher groundwater elevations in the Principal Aquifer and/or by shallow perched water (i.e. aquifer class “b”). Sites assigned to the “b” class are also assumed to probably be GDEs. Another 2,430 acres of riparian/wetland habitats are classified as aquifer class “a” (areas supported by surface water and/or perched water) and are therefore not GDEs. Finally, the connection of 4,019 acres of GDEs in the Foothills area to the Principal Aquifer is uncertain due to lack of well-defined groundwater elevation data and the inferred source aquifer is “u”.

Table 5. Inferred Source Aquifer for Potential GDEs

Inferred Source Aquifer	Acres
a: supported by surface water and/or perched water	2,428
b: supported by seasonal shallow water table associated with Principal Aquifer or possibly perched water	819
Na: not connected to groundwater	11,438
r: supported by Principal Aquifer	990
u: unknown, supported by shallow alluvium above bedrock and/or perched layers, or Principal Aquifer	4,019
Grand Total	19,693⁴

⁴⁴ Please note that acreages in the results section of this report differ from Table 1 because wetland/riparian areas clearly visible on imagery in the Preserves area but omitted from existing data were digitized and added to the GDE acreage.



**Cosumnes Subbasin:
Groundwater Dependent
Ecosystem Evaluation
Results -
Predicted Source Aquifer**

Legend

**GDE Evaluation Results
(Probable Aquifer)**

SrcAq

- a: supported by surface water and/or perched water
- b: supported by regional aquifer and potentially perched water
- na: not connected to groundwater
- r: supported by regional aquifer
- u: unknown, supported by shallow alluvium above bedrock and/or perched layers, or regional aquifer

Cosumnes Subbasin

Fall 2018 Depth to Groundwater

- <10 Ft
- 10 - 30 Ft
- 30 - 50 Ft
- 50 - 100 Ft
- >100 Ft

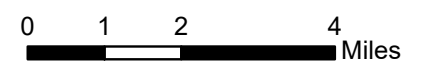
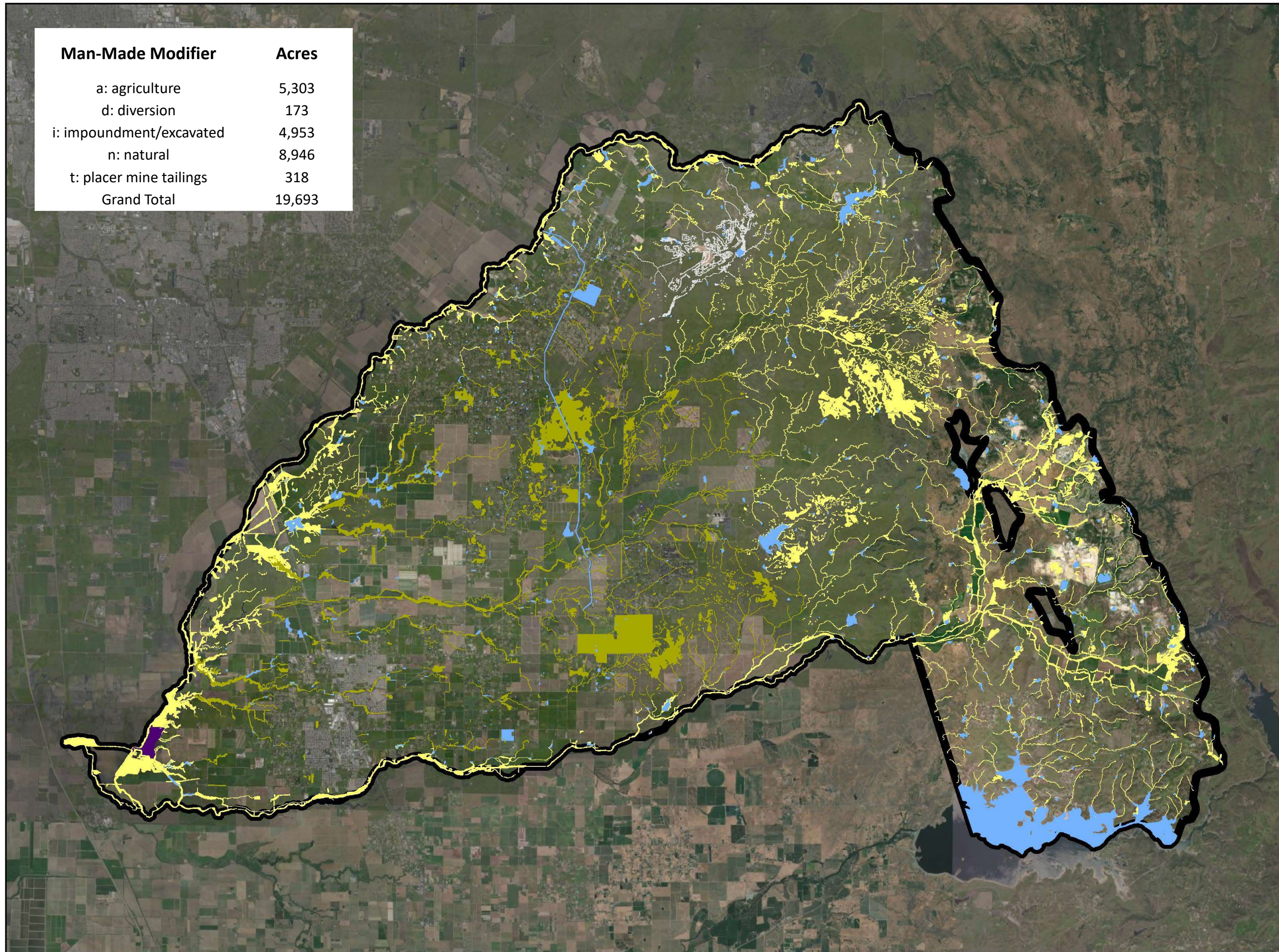


Figure 11. Cosumnes Probable Source Aquifer

3.2.4 Man-made Modifier

Most of the area (8,946 acres) composed by riparian/wetland types appears to be naturally occurring (Figure 12). Diversion supported wetlands cover 173 acres and riparian trees located in placer mined tailings areas constitute 318 acres, respectively. These areas are examples of fine-textured, high water holding capacity soils that capture precipitation and runoff to support GDEs. Agriculture appears to provide supplemental water in various capacities including runoff, irrigation water conveyance facilities, tailwater, etc., to approximately 5,300 acres of the riparian/wetland sites in the subbasin, while 4,953 acres lie in excavated areas and/or impoundments that include reservoirs, irrigation ponds, stock tanks, etc.



Man-Made Modifier	Acres
a: agriculture	5,303
d: diversion	173
i: impoundment/excavated	4,953
n: natural	8,946
t: placer mine tailings	318
Grand Total	19,693

**Cosumnes Subbasin:
Groundwater Dependent
Ecosystem Evaluation
Results -
Man-Made Modifier**

Legend

**GDE Evaluation Results
(ManMade Modifier)**

- ManMod**
- a: agriculture
 - d: diversion
 - i: impoundment/excavated
 - n: natural
 - t: placer mine tailings
 - Cosumnes Subbasin

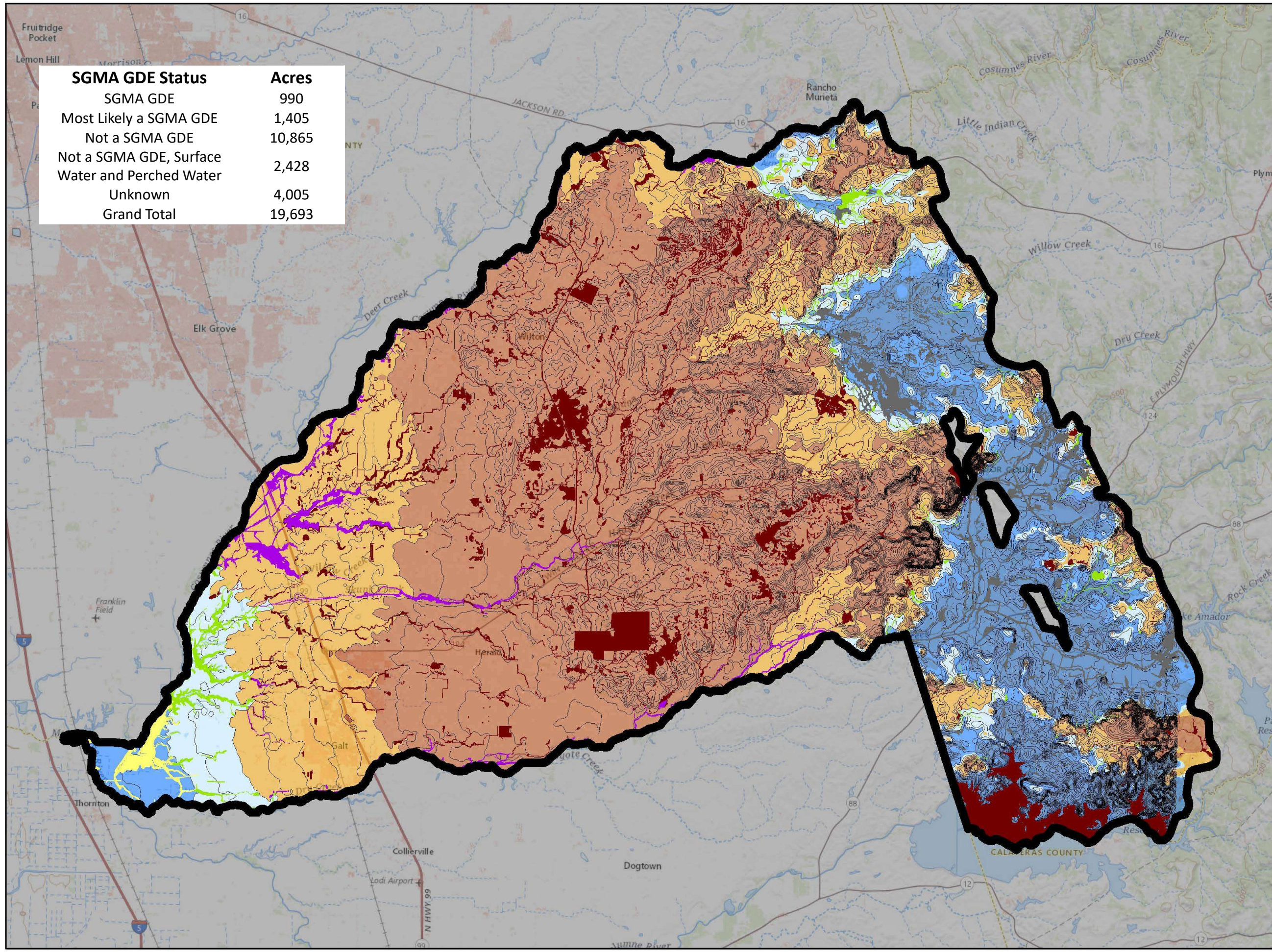
0 1 2 4 Miles



Figure 12. Cosumnes Man-Made Modifier

3.3 GDE Evaluation Summary

A total of 990 acres of GDEs were identified within the Subbasin, and another 819 acres are probably GDEs based on the analyses presented in Section 3.2 (Figure 13). The probable GDEs are most likely supported by localized and seasonal groundwater elevation increases in response to leakage from surface water flow (See Section 2.3.3). Meanwhile, 11,438 acres of the riparian/wetland areas evaluated were determined to not be connected to groundwater and thus not GDEs. A relatively smaller acreage (2,428 acres) is most likely supported by surface water and/or perched groundwater, but not the Principal Aquifer, and therefore not characterized as GDEs. A total of 4,019 acres were classified as having an unknown GDE status due to uncertainty in the water table elevations within the Foothills Subarea, and conservatively retained as a potential GDE.



SGMA GDE Status	Acres
SGMA GDE	990
Most Likely a SGMA GDE	1,405
Not a SGMA GDE	10,865
Not a SGMA GDE, Surface Water and Perched Water	2,428
Unknown	4,005
Grand Total	19,693

Cosumnes Subbasin: Groundwater Dependent Ecosystem Evaluation Results - SGMA GDE Status

Legend

Cosumnes Subbasin

GDE Evaluation Results

Most Likely a SGMA GDE

Not a SGMA GDE

Not a SGMA GDE, Surface Water and Perched Water

SGMA GDE

Unknown

Fall 2018 Depth to GW Contours (10 Ft Interval)

Fall 2018 Depth to Groundwater

<10 Ft

10 - 30 Ft

30 - 50 Ft

50 - 100 Ft

>100 Ft

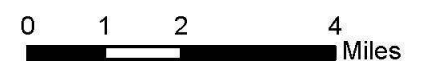


Figure 13. Cosumnes SGMA GDE Status

3.4 Remote Sensing Analysis

The results of GDE Pulse analysis revealed the following trends for NCCAG types in the Subbasin:

- Average annual NDVI derived “greenness” is on an increasing overall trend within the basin (Figure 14 and Figure 15). We believe this trend is primarily driven by:
 - Aerial canopy cover of phreatophytic species has expanded as they matured between 1985 and 2018; thus, the proportion of LANDSAT pixels with canopy cover increased during this timeframe. This phenomenon is detectable by comparing historic and recent satellite imagery on Google Earth.
 - Based on field observations (See Appendix C), riparian corridors throughout the Subbasin have dense, understory trees and shrubs that appear to have established after 1985.
 - Potential conversion of (co-) dominant species over time.
 - Some locations that had been covered by surface water have become productive emergent wetlands and probably to a lesser degree forested. This is shown in Figure 15 which shows substantially increased greenness for herbaceous wetlands.
 - A portion of previously unvegetated riverine types have become vegetated (per increased NDVI intensity for unvegetated NWI wetlands).
 - An indication that riparian/wetland areas within the Subbasin remain healthy overall.
- Average annual NDVI and NDMI appear to be correlated with average annual precipitation. Riparian/wetland areas appear to be negatively affected by droughts but then recover.
- Like NDVI, NDMI also shows an increasing trend over the analysis period, though with lower intensity. This is likely due to a combination of factors that appears to include the emergence of dense understory vegetation that has established since 1985.
- NDVI trends are spatially variable throughout the Subbasin (
- Figure 16). Identified GDEs and most likely GDEs in this report are concentrated near the Preserve area and have relatively stable greenness trends since 1985. Riparian bands along creeks in the Foothills Subarea and Dry Creek have also shown a consistent increase in greenness since 1985.
- NDVI increases and decreases appear paired with wet years and drought periods as would be expected. For example, increased NDVI intensity occurred in NCCAG types in the period between 1996-2000 (Figure 14 and
- Figure 16) following several years of above average precipitation. Whereas NDVI values decreased following the drought that occurred from 1999 to 2004 and 2007.

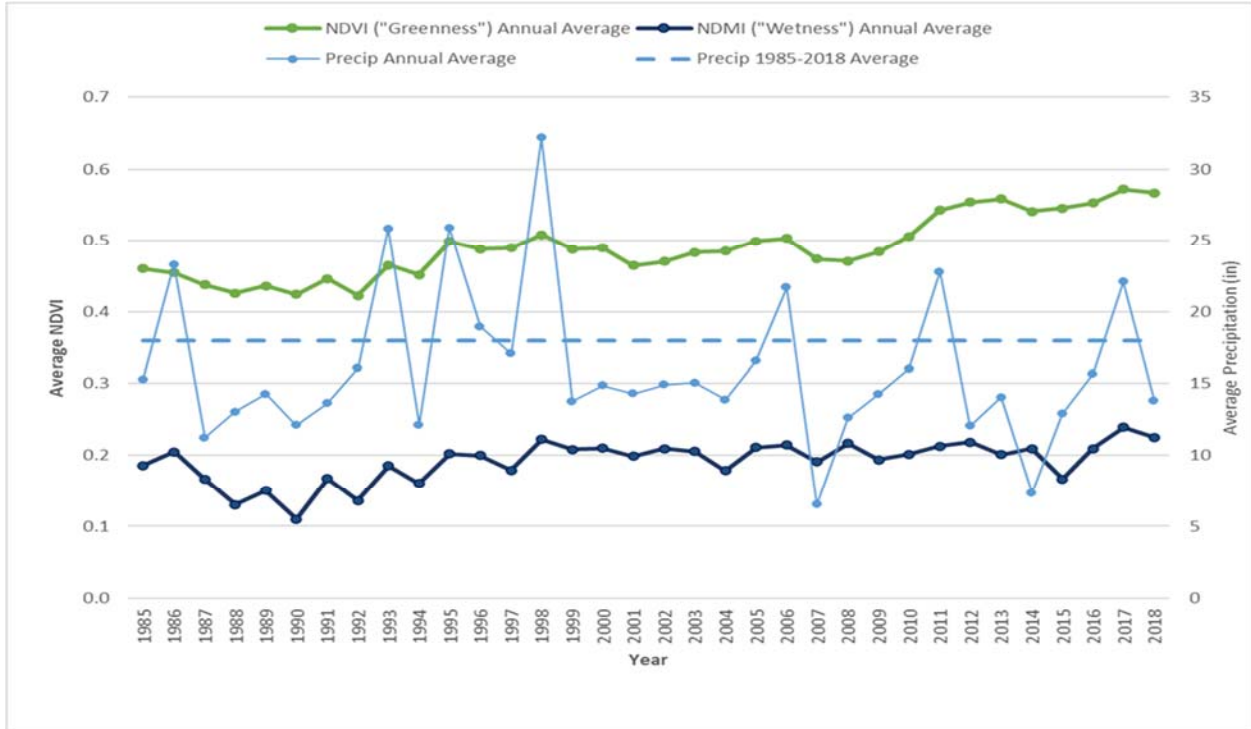


Figure 14. GDE Pulse derived NDVI and NDMI trends for NCCAG GDEs in the Cosumnes Subbasin and average annual precipitation.

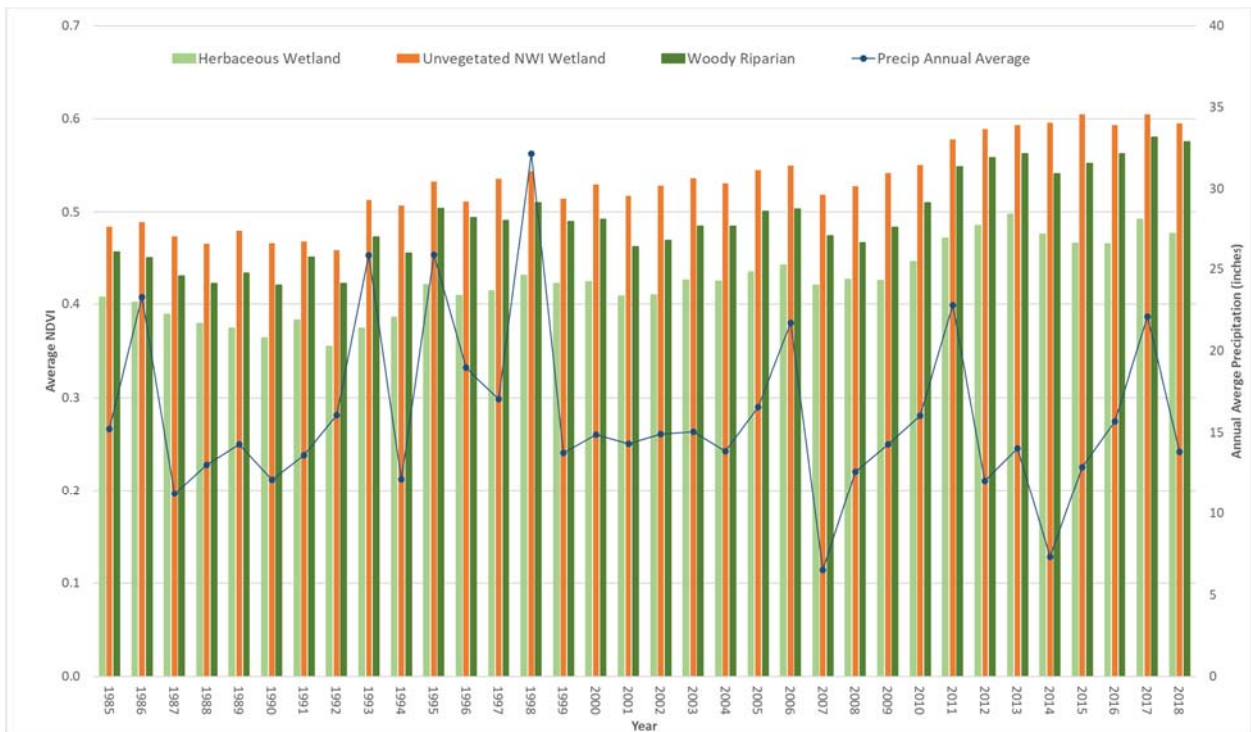
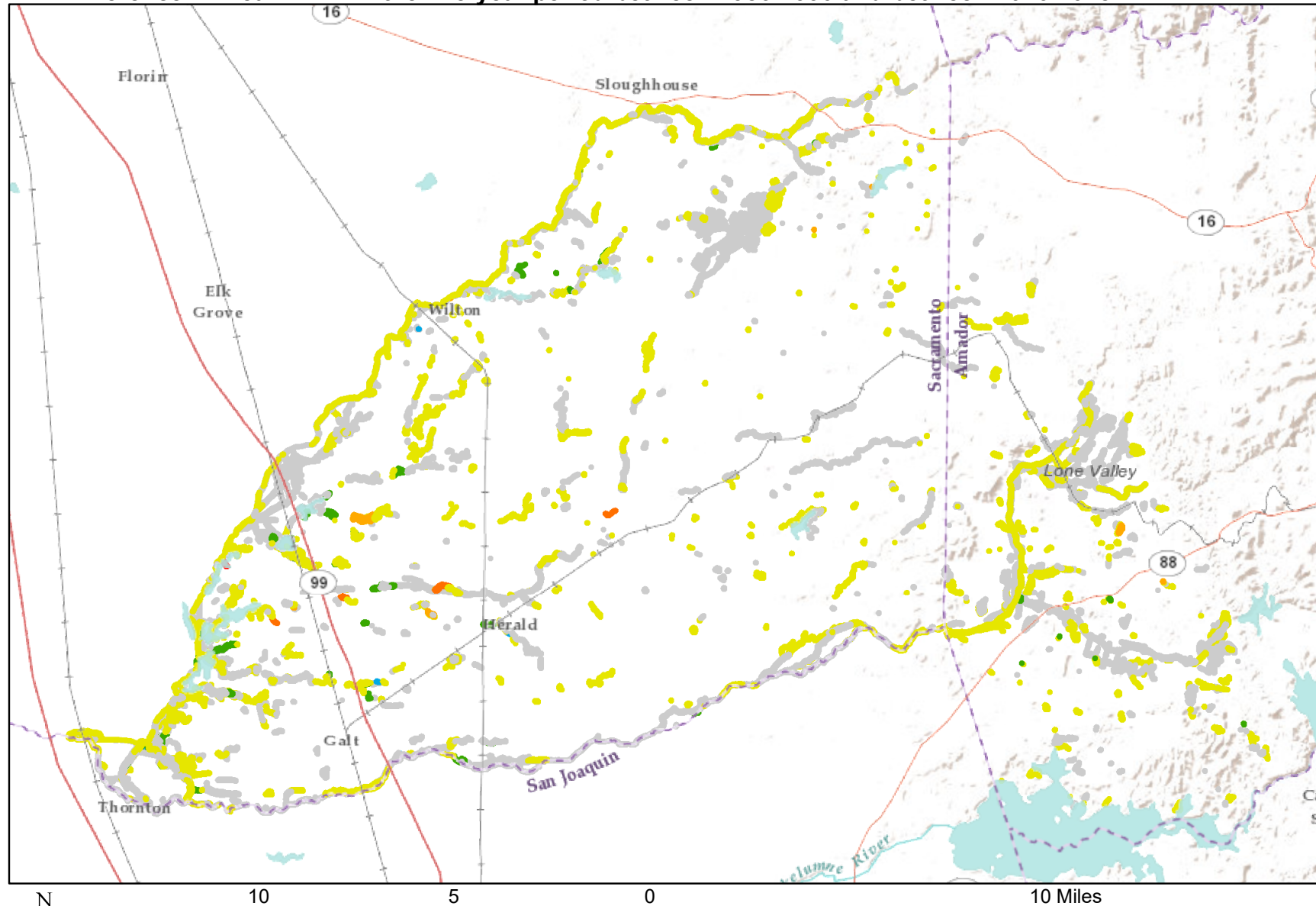


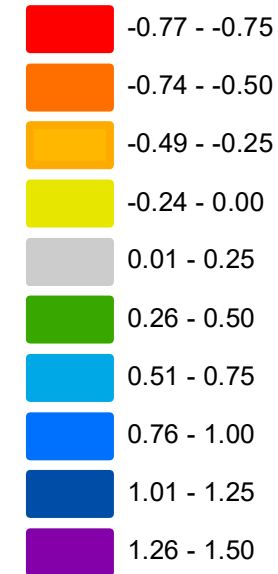
Figure 15. GDE Pulse derived NDVI trends for generalized NCCAG vegetation types.

Difference in mean NDVI in the five-year period between 1986-1990 and between 2016-2018



Legend

Difference NDVI 1986-1990 and 2016-2018

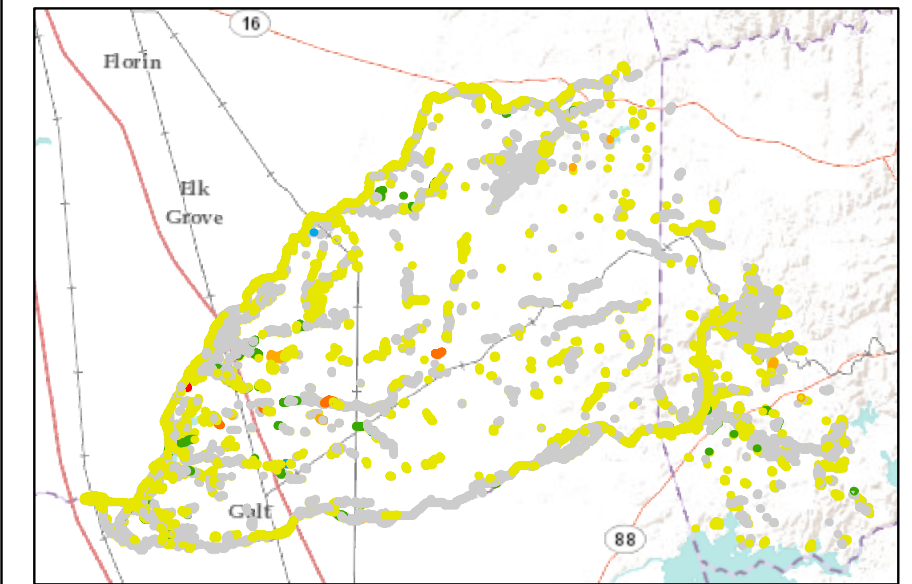


Positive numbers indicate increasing photosynthetic vigor

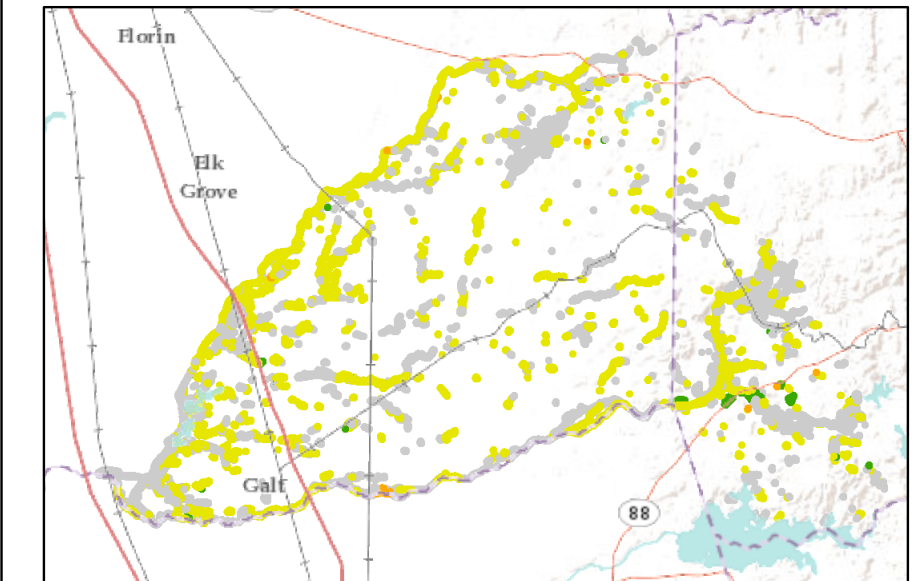


GDE Pulse Tool Derived NDVI Trends During the Period of Record (1985 to 2018)

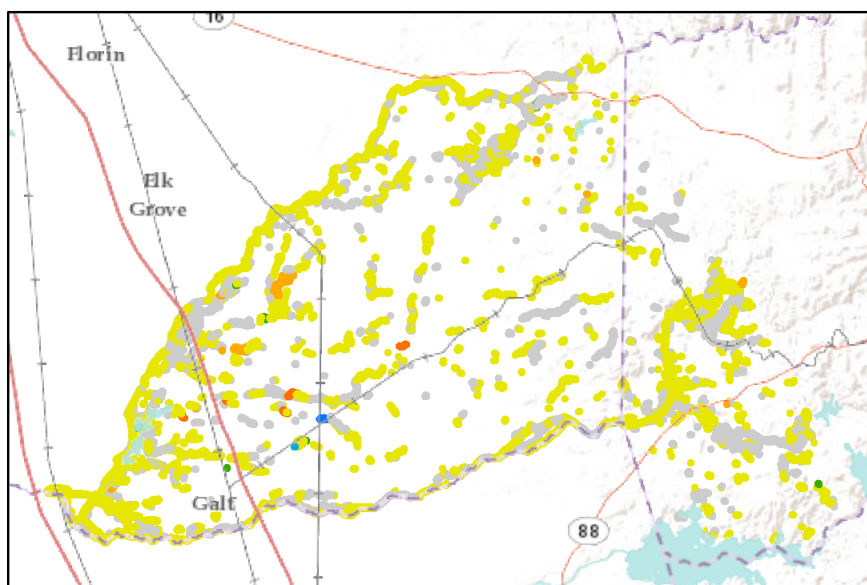
NDVI difference 1991-1995 and 1996-2000



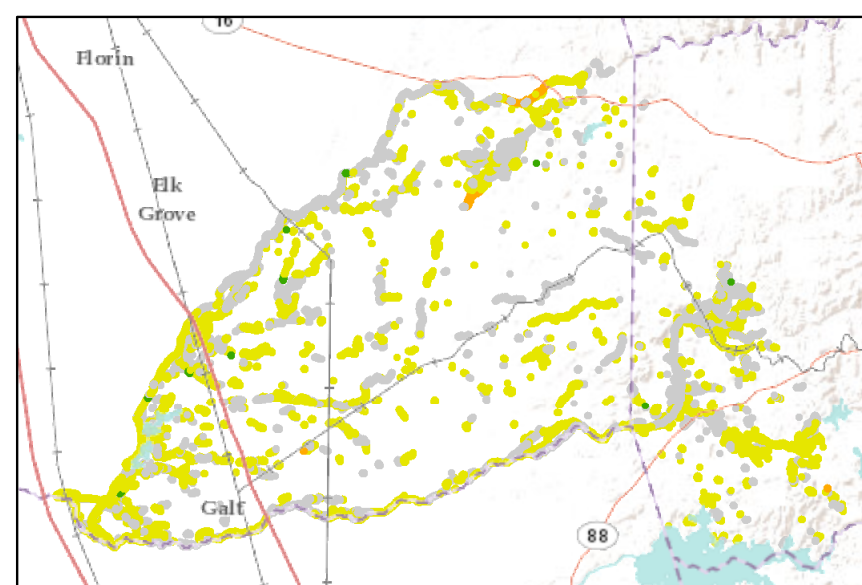
NDVI difference 1996-2000 and 2001-2005



NDVI difference 2011-2015 and 2016-2018



NDVI difference 2006-2010 and 2011-2015



NDVI difference 2001-2005 and 2006-2010

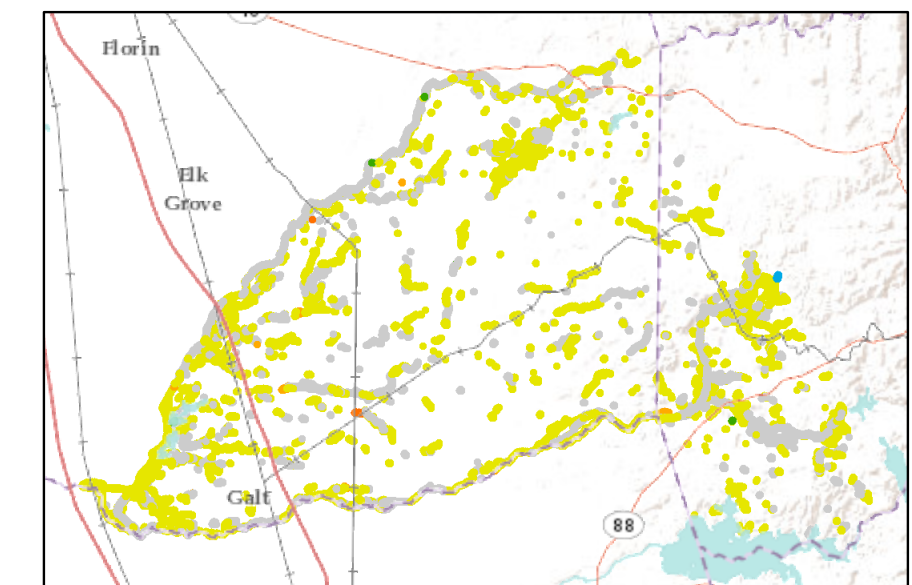
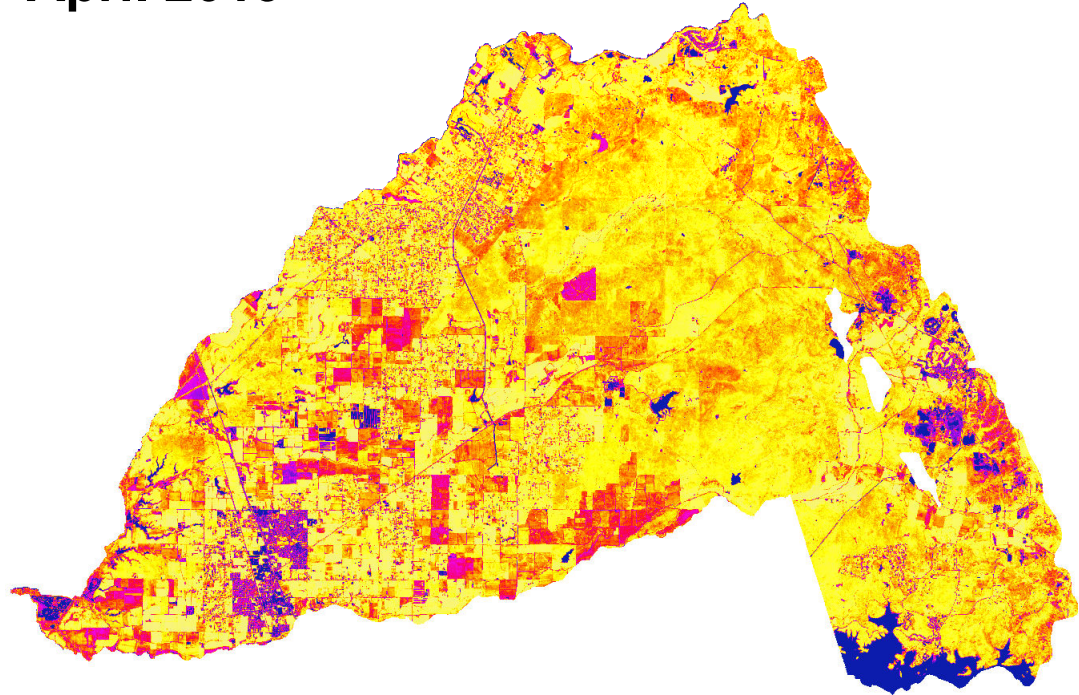


Figure 16. Differences in NDVI trends over 5-year periods

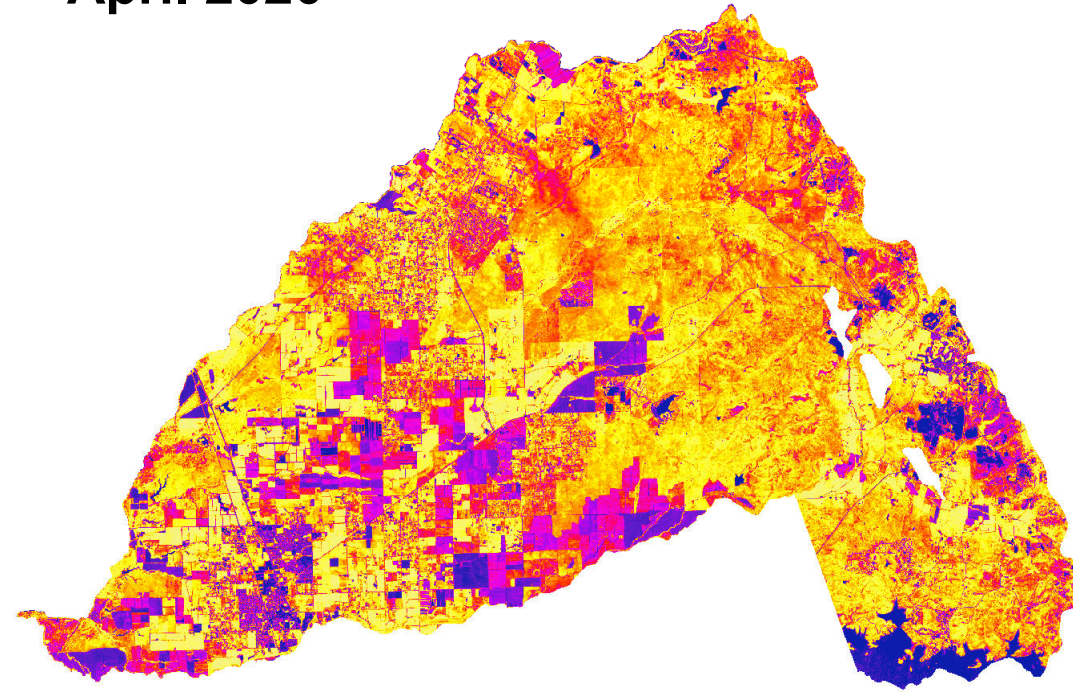
Sentinel-2 NDVI greenness trends from 2019-2020 are also consistent with the GDE analysis results in this report:

- As indicated in Figure 17, overall greenness decreases in most of the Subbasin between April and October. This is particularly pronounced in locations with high concentrations of vernal pools, the Foothills Subarea, and agricultural areas in the eastern portion of the Subbasin.
- However, identified GDEs and most likely GDEs (Figure 13) displayed increasing greenness from April to October during both 2019 and 2020 which clearly deviates from overall trends in the Subbasin. This observation is most pronounced in the Preserve area (Figure 18).
- Potential GDEs in the Foothills Subarea show less conclusive greenness trends than in the valley (Figure 17). The only vegetation class that increased in greenness from April to October is the tree/shrub class.
- Throughout the basin, the trees/shrub class and riverine geomorphic classes exhibit more stable NDVI values from spring to fall than the other vegetation classes (Figure 17).
- Locations identified as not GDEs have the greatest reductions in greenness from Spring to Fall (Figure 13 and Figure 17).
- Sites designated as “a: supported by surface water and/or perched water” also exhibit upward NDVI intensity from spring to fall, but at a lower rate than zones classified as GDEs (Figure 19).

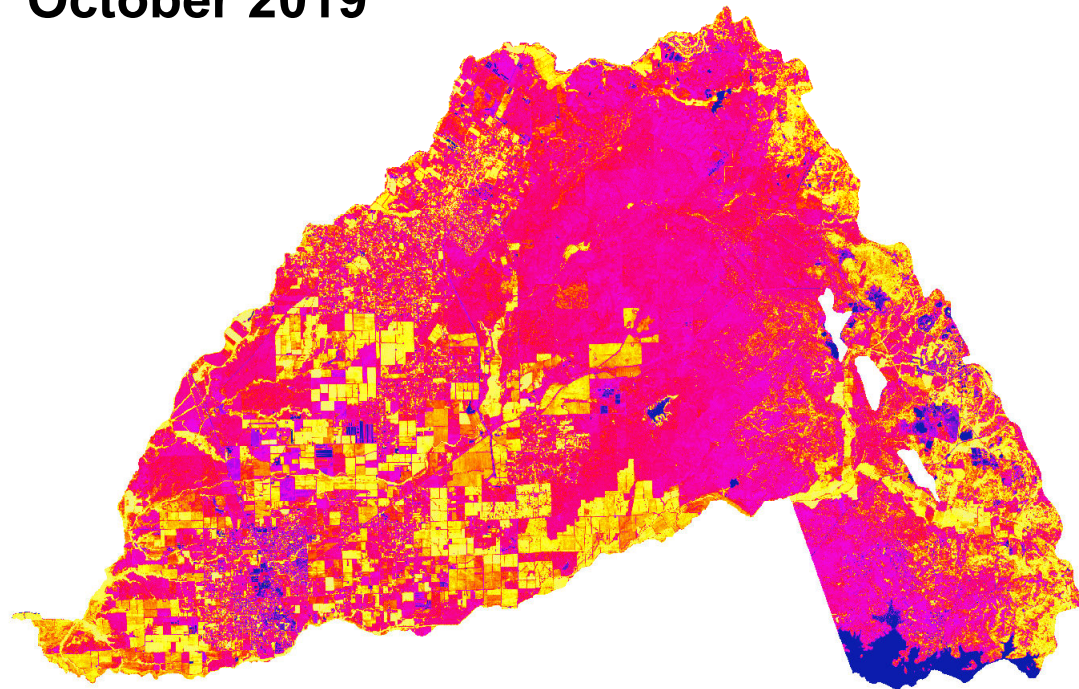
April 2019



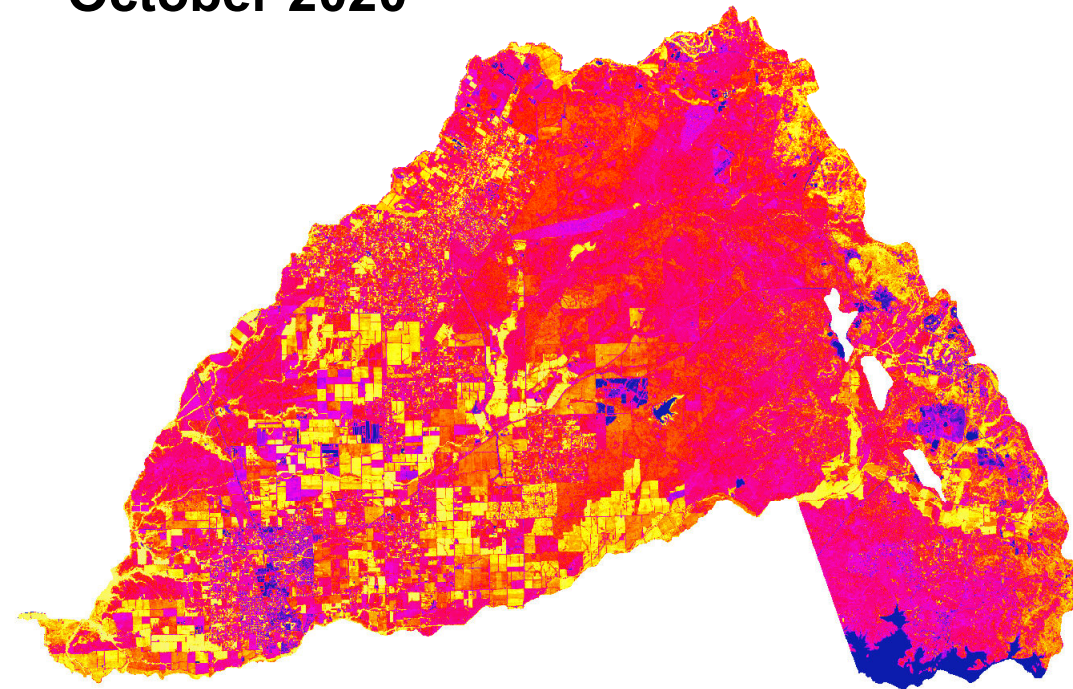
April 2020



October 2019



October 2020



**Cosumnes Subbasin:
Groundwater Dependent
Ecosystem Evaluation
Sentinel NDVI Intensity**

Legend

**NDVI Greenness
Intensity**

Value

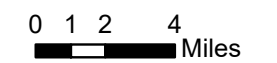
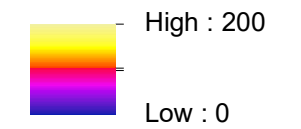
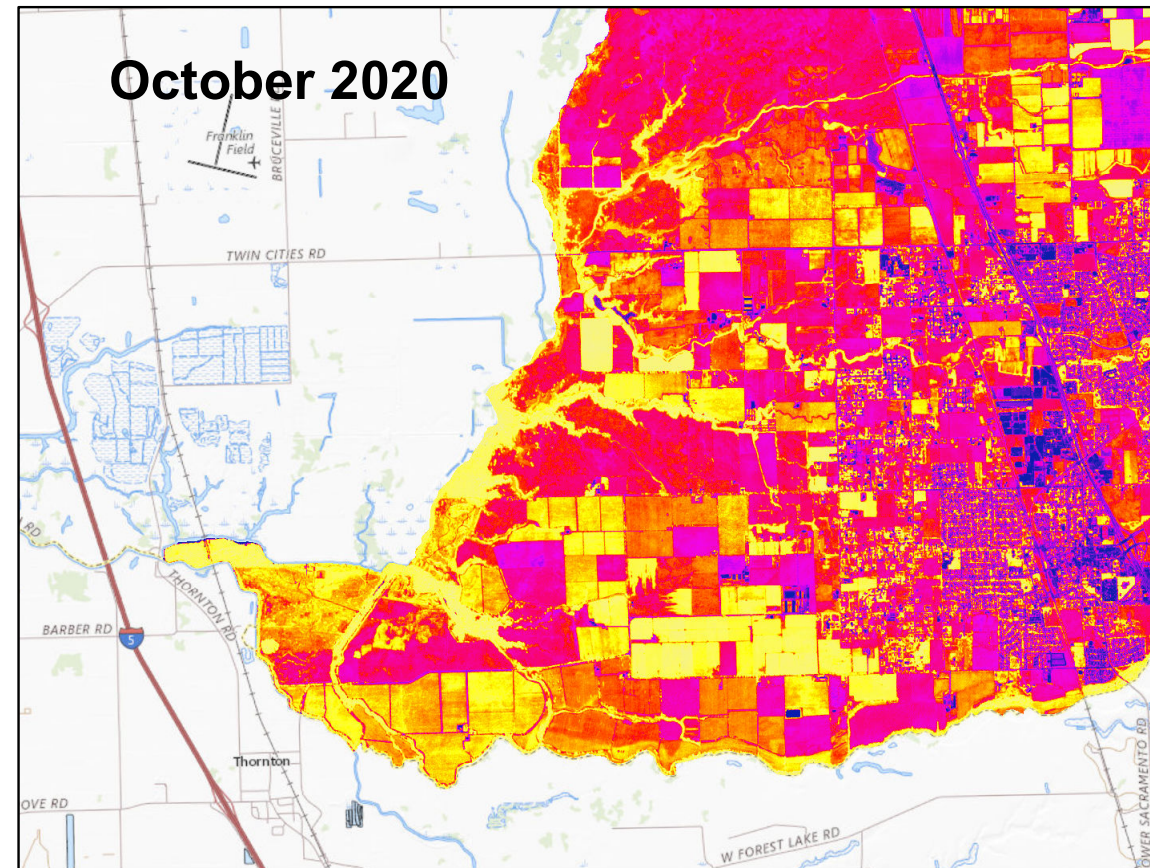
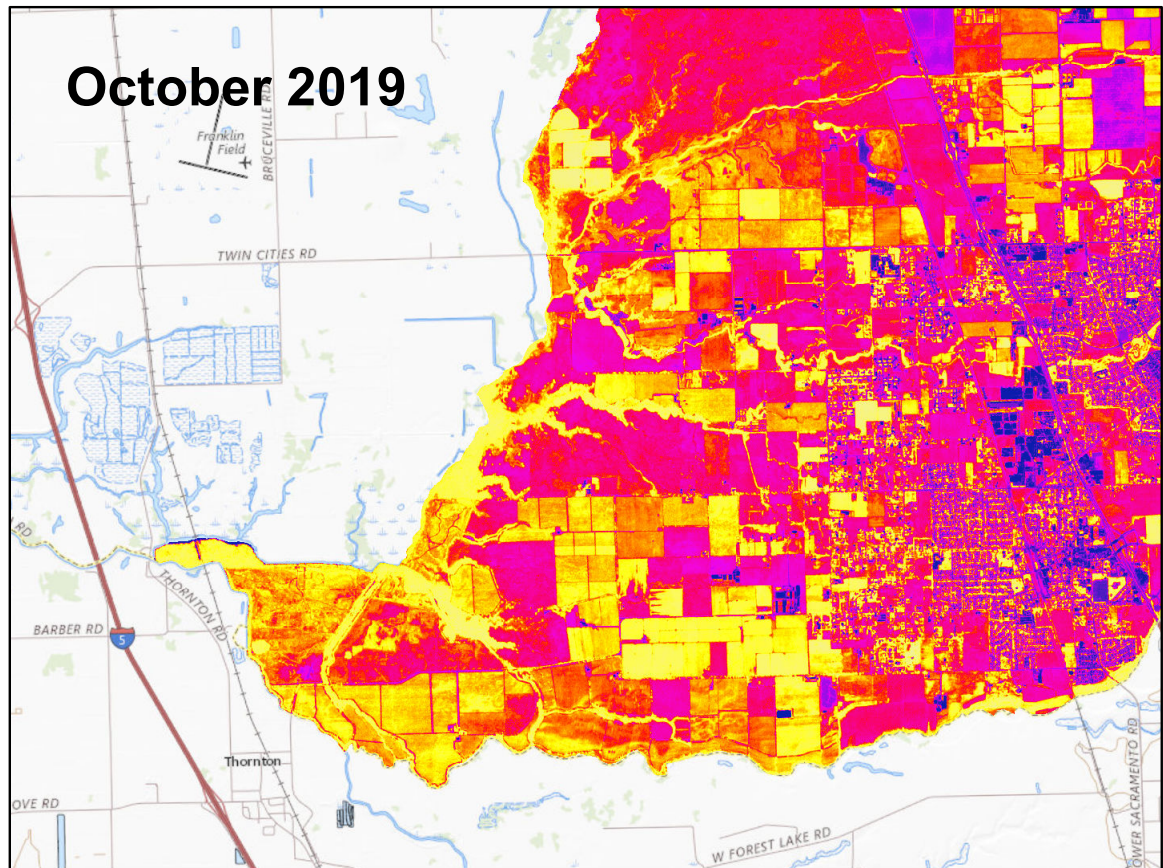
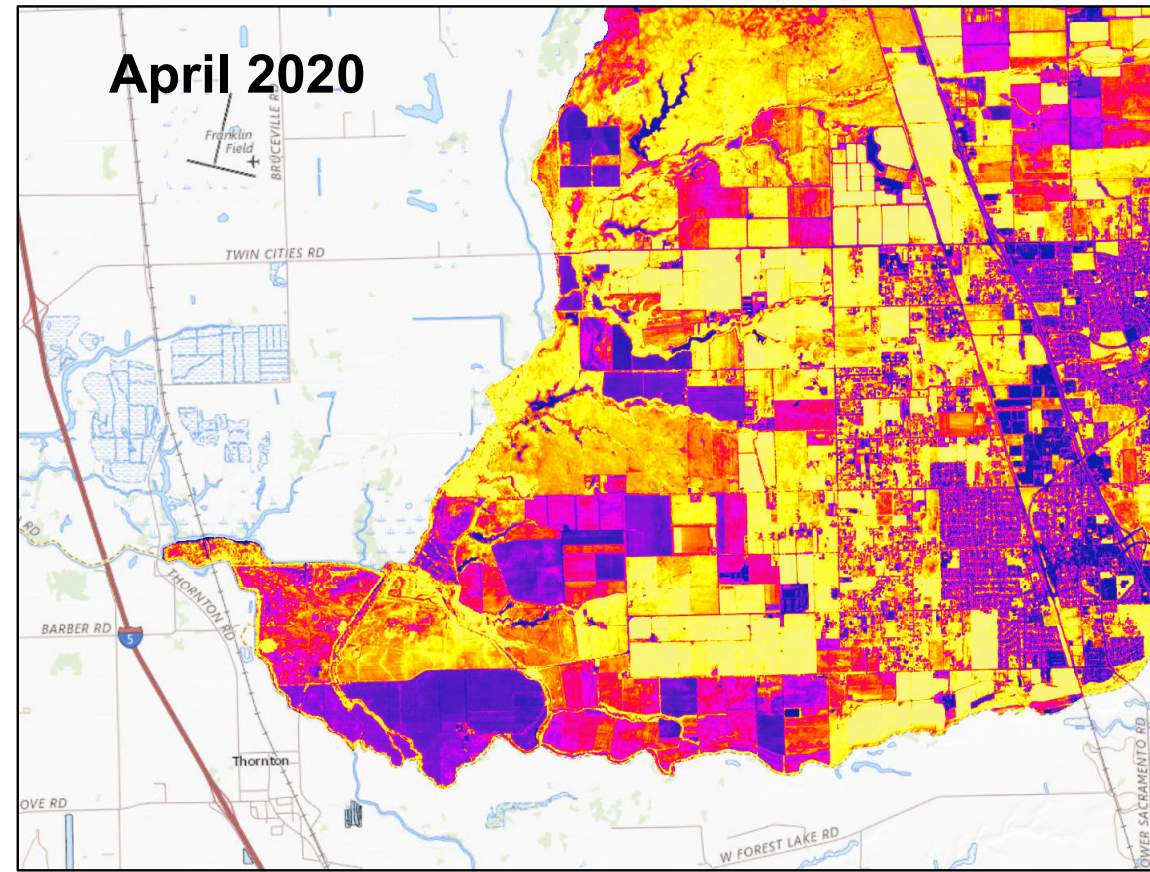
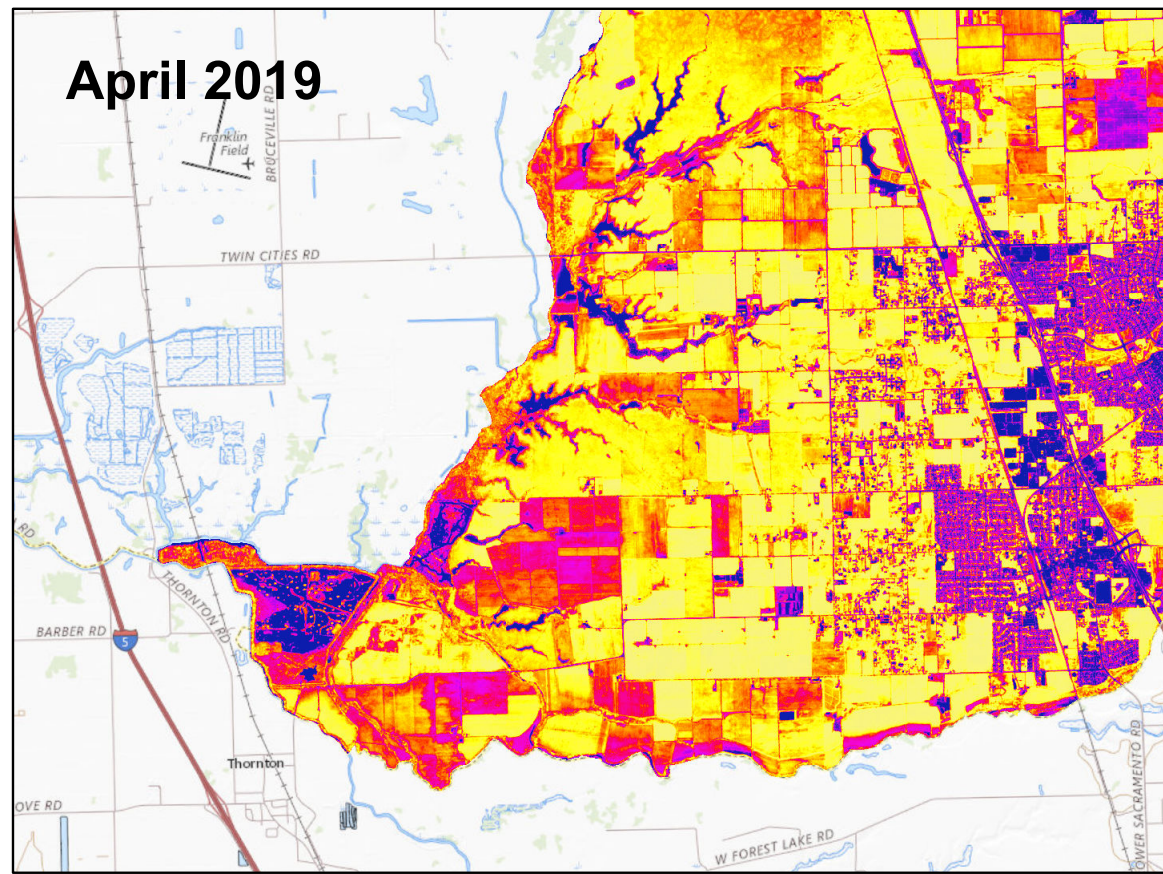


Figure 17. Cosumnes Sentinel NDVI Analysis



**Cosumnes Subbasin:
Groundwater Dependent
Ecosystem Evaluation:
Sentinel NDVI Intensity
in Preserve Area (Zone
With High SGMA GDE
Concentration)**

Legend

**NDVI Greenness
Intensity**

Value

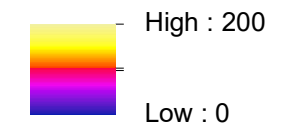


Figure 18. Cosumnes Sentinel NDVI Analysis Zoomed to Preserve Area

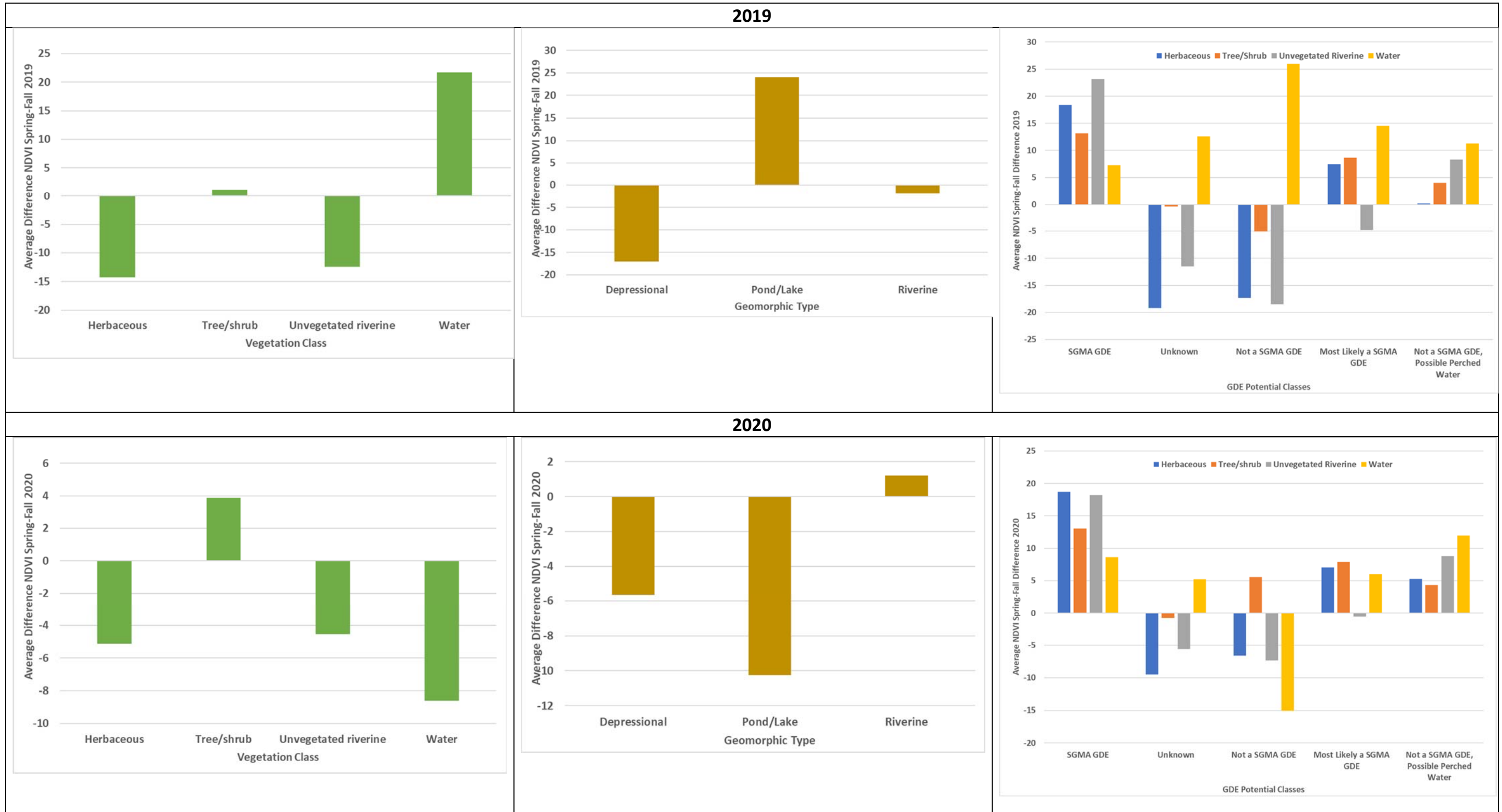


Figure 19. Charts displaying Sentinel-2 derived greenness trends during 2019 and 2020 by vegetation, geomorphic, and GDE classes.

4.0 CONCLUSIONS

GeoSystems conducted a field and desktop assessment to determine the extent and distribution of GDEs in the Cosumnes Subbasin. A total of 990 acres of GDEs were identified within the Subbasin, another 819 acres are most likely GDEs supported by regional groundwater (less than 50 ft bgs) and perched water conditions. Approximately 2,430 acres of GDEs were identified in areas where the depth to groundwater indicates they are not in direct contact with the Principal Aquifer; these GDEs appear to be dependent on surface water and/or perched water. A total of 4,019 acres were classified as an unknown GDE status due to uncertainty with groundwater elevation data in the Foothills Subarea.

Remote sensing derived data from the GDE Pulse tool and recent acquisitions of Sentinel-2 data were used to inform and validate our assessment of GDEs in the Subbasin. The Cosumnes Subbasin currently supports a mosaic of diverse, healthy GDEs, particularly in the Preserve portion of the project site. GDE types include open water, riparian forests and shrublands, wet meadows, and marshes. Surface water presence and persistence varies by GDE location. Current rooting depth databases (TNC, 2018) indicate that the field verified GDE species require shallow groundwater to sustain their existence at the locations where they are currently found.

5.0 RECOMMENDATIONS

- Expand groundwater monitoring in areas identified as b: “supported by seasonal shallow water table associated with Principal Aquifer or possibly perched water”, and a: “supported by surface water and/or perched water, which are concentrated in riverine segments with contiguous groves of phreatophytic woody species.”
- Expand groundwater monitoring proximal to surface water drainages in the Foothills Subarea, in areas of “Unknown” GDE Status, to better quantify water table elevations in this portion of the Subbasin. The GDEs in this area may rely on the Principal Aquifer.
- Leverage the detailed site summaries included in Appendix C to prioritize exotic species management. Consider eradicating saltcedar (*Tamarix* spp., only detected at the Foothills Riparian site) and tree of heaven (*Ailanthus altissima*) due to their invasive potential and current manageable condition.
- Conduct annual remote sensing analysis with Sentinel or other similar resolution sensors to monitor interannual and inter-seasonal greenness trends, conduct ongoing GDE health monitoring and improve characterization of seasonal greenness trends for riparian/wetland sites throughout the Subbasin. If NDVI intensities begin to form a consistent downward trend, conduct site visits to monitor riparian/wetland vegetation health.
- Repeat reconnaissance level site visits and analyses as part of the required GSP five-year updates to monitor trends in GDE function and health.

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APPENDIX A – SOIL ANALYSIS METHODS

SOIL ANALYSIS METHODS

To identify areas in the Cosumnes subbasin with low permeability soils that could support GDE habitat, soil property data were retrieved using the Soil Data Viewer add-in to ArcGIS from the United States Department of Agriculture Natural Resources Conservation Service Web Soil Survey (NRCS, 2020).

Two properties directly related to soil permeability and water storage capacity, saturated hydraulic conductivity (Ksat) and soil texture, were mapped and analyzed. Within the data set (NRCS, 2020), estimates of Ksat and Unified Soil Classification System (USCS) class, based on soil particle size distribution, were provided for most soil map units. These data are estimates and apply to a depth of not more than approximately 6.5 feet (200 cm) below ground surface (bgs).

Table 1 summarizes the data and estimated properties for each of the soil map units based on the soil survey. Based on GSA experience with field measurement of effective hydraulic conductivity and long-term infiltration characteristics, the NRCS estimates of Ksat were reduced by a factor of 10 to more closely approximate long-term infiltration characteristics in the soil profile.

To determine texture-based soil type groups, soil map unit USCS codes were grouped as shown in Table 2, with rock, water, and high-permeability mine tailings and riverwash established as additional categories for map units where the NRCS data did not include USCS codes or where map unit names indicated a mine location. The least permeable classification of silts and clays occupy most of the subbasin’s western half and significant areas along Laguna Creek and creeks along the subbasin eastern edge.

Appendix A Table 1. Estimated relative permeability of soil map units

Map Unit Name	Estimated Saturated Hydraulic Conductivity (inches/day)	Soils Type
Amador-Gillender complex, 2 to 15 percent slopes	2.5	Silts and clays
Argonaut gravelly loam, 3 to 31 percent slopes	1.0	Gravelly or sandy
Argonaut-Auburn complex, 3 to 8 percent slopes	3.7	Silts and clays
Auburn extremely rocky silt loam, 3 to 31 percent slopes	2.4	Silts and clays
Auburn silt loam, 0 to 31 percent slopes	2.4	Silts and clays
Auburn silt loam, 2 to 30 percent slopes	7.2	Silts and clays
Auburn silt loam, moderately deep, 3 to 16 percent slopes	2.2	Silts and clays

Map Unit Name	Estimated Saturated Hydraulic Conductivity (inches/day)	Soils Type
Auburn very rocky silt loam, 3 to 31 percent slopes	2.4	Silts and clays
Auburn very rocky silt loam, 31 to 51 percent slopes	2.4	Silts and clays
Auburn-Argonaut silt loams, 0 to 16 percent slopes	1.9	Silts and clays
Auburn-Argonaut very rocky silt loams, 3 to 31 percent slopes	1.9	Silts and clays
Auburn-Argonaut-Rock outcrop complex, 8 to 30 percent slopes	4.3	Silts and clays
Bruella sandy loam, 0 to 2 percent slopes	3.5	Sands with fines
Bruella sandy loam, 2 to 5 percent slopes	3.5	Sands with fines
Capay clay loam, 0 to 2 percent slopes, occasionally flooded	0.3	Silts and clays
Clay pits	ND	ND
Clear Lake clay, partially drained, 0 to 2 percent slopes, frequently flooded	0.5	Silts and clays
Columbia fine sandy loam, clayey substratum, partially drained, 0 to 2 percent slopes	7.7	Sands with fines
Columbia sandy loam, clayey substratum, drained, 0 to 2 percent slopes	6.5	Sands with fines
Columbia sandy loam, clayey substratum, drained, 0 to 2 percent slopes, occasionally flooded	6.5	Sands with fines
Columbia sandy loam, drained, 0 to 2 percent slopes	9.5	Sands with fines
Columbia sandy loam, drained, 0 to 2 percent slopes, occasionally y flooded	9.5	Sands with fines
Corning complex, 0 to 8 percent slopes	1.3	Sands with fines
Corning-Redding complex, 8 to 30 percent slopes	1.1	Sands with fines
Cosumnes silt loam, drained, 0 to 2 percent slopes	0.7	Silts and clays
Cosumnes silt loam, drained, 0 to 2 percent slopes, occasionally flooded	0.7	Silts and clays
Cosumnes silty clay loam, drained, 0 to 2 percent slopes, occasionally flooded, MLRA 17	0.8	Silts and clays
Coyotecreek silt loam, 0 to 2 percent slopes, occasionally flooded	1.4	Silts and clays
Coyotecreek silt loam, 0 to 2 percent slopes, occasionally flooded	1.6	Silts and clays
Creviscreek sandy loam, 0 to 3 percent slopes	5.1	Sands with fines
Dams	ND	ND
Dierssen clay loam, deep, drained, 0 to 2 percent slopes	0.4	Silts and clays
Dierssen sandy clay loam, drained, 0 to 2 percent slopes	0.3	Sands with fines
Durixeralfs, 0 to 1 percent slopes	0.0	Silts and clays
Egbert silty clay loam, partially drained, 0 to 2 percent slopes, MLRA 16	1.5	Silts and clays
Exchequer and Auburn loams, 3 to 31 percent slopes	2.3	Silts and clays

Map Unit Name	Estimated Saturated Hydraulic Conductivity (inches/day)	Soils Type
Exchequer and Auburn very rocky loams, 3 to 31 percent slopes	2.3	Silts and clays
Exchequer and Auburn very rocky loams, 31 to 51 percent slopes	2.3	Silts and clays
Exchequer very rocky silt loam, 3 to 31 percent slopes	2.1	Silts and clays
Exchequer very rocky silt loam, 31 to 51 percent slopes	2.1	Silts and clays
Fiddymment fine sandy loam, 1 to 8 percent slopes	1.1	Sands with fines
Galt clay, 0 to 1 percent slopes, MLRA 17	0.2	Silts and clays
Galt clay, 0 to 4 percent slopes, MLRA 17	0.2	Silts and clays
Galt clay, leveled, 0 to 1 percent slopes	0.2	Silts and clays
Hadselville-Pentz complex, 2 to 30 percent slopes	7.1	Sands with fines
Hedge loam, 0 to 2 percent slopes	2.5	Silts and clays
Hicksville gravelly loam, 0 to 2 percent slopes, occasionally flooded	1.3	Gravelly or sandy
Hicksville loam, 0 to 2 percent slopes, occasionally flooded	2.1	Silts and clays
Hicksville loam, bedrock substratum, 2 to 5 percent slopes, occasionally flooded	1.3	Silts and clays
Hicksville sandy clay loam, 0 to 2 percent slopes, occasionally flooded	0.9	Sands with fines
Honcut clay loam, over clay	1.1	Silts and clays
Honcut silt loam	1.6	Silts and clays
Honcut very fine sandy loam	1.6	Silts and clays
Honcut very fine sandy loam, channeled	2.6	Silts and clays
Honcut very fine sandy loam, moderately well drained	1.6	Silts and clays
Inks loam and Rock land, 3 to 45 percent slopes	2.5	ND
Inks loam, deep variant, 3 to 16 percent slopes	1.5	Silts and clays
Iron Mountain very stony loam, 9 to 51 percent slopes	2.6	Sands with fines
Keyes sandy loam, 2 to 15 percent slopes	2.9	Sands with fines
Kimball silt loam, 0 to 2 percent slopes	1.5	Silts and clays
Kimball silt loam, 2 to 8 percent slopes	1.5	Silts and clays
Kimball-Urban land complex, 0 to 2 percent slopes	1.4	Silts and clays
Laniger sandy loam, 2 to 16 percent slopes	8.5	Sands with fines
Laniger sandy loam, thick surface, 0 to 5 percent slopes	8.7	Sands with fines
Lithic Xerorthents, 2 to 8 percent slopes	ND	ND
Liveoak sandy clay loam, 0 to 2 percent slopes, occasionally Flooded	4.3	Sands with fines
Loamy alluvial land	9.5	Silts and clays
Madera loam, 0 to 2 percent slopes	0.8	Silts and clays

Map Unit Name	Estimated Saturated Hydraulic Conductivity (inches/day)	Soils Type
Madera loam, 2 to 8 percent slopes	0.8	Silts and clays
Madera-Galt complex, 0 to 2 percent slopes	0.5	Silts and clays
Mine pits	ND	ND
Mine tailings and Riverwash	31.3	ND
Mixed alluvial land	31.3	Sands with fines
Mixed wet alluvial land	10.5	Silts and clays
Mokelumne coarse sandy loam, 5 to 36 percent slopes	2.3	Sands with fines
Mokelumne gravelly loam, 2 to 15 percent slopes	0.8	Sands with fines
Mokelumne sandy loam, 2 to 5 percent slopes	2.3	Sands with fines
Mokelumne soils and alluvial land	6.7	Sands with fines
Mokelumne variant sandy clay loam, 2 to 8 percent slopes	1.2	Sands with fines
Mokelumne-Pits, mine complex, 15 to 50 percent slopes	0.8	Sands with fines
Orangevale coarse sandy loam, 2 to 5 percent slopes	4.9	Sands with fines
Pardee cobbly loam, 3 to 31 percent slopes	1.6	Sands with fines
Pardee-Ranchoseco complex, 3 to 15 percent slopes	2.2	Gravelly or sandy
Pentz gravelly sandy loam, 2 to 16 percent slopes	20.9	Sands with fines
Pentz sandy loam, 15 to 50 percent slopes	5.6	Sands with fines
Pentz sandy loam, 16 to 31 percent slopes	7.9	Sands with fines
Pentz sandy loam, 2 to 15 percent slopes	5.4	Sands with fines
Pentz sandy loam, 9 to 16 percent slopes, eroded	13.1	Sands with fines
Pentz sandy loam, very shallow, 2 to 51 percent slopes	20.9	Sands with fines
Pentz-Bellota complex, 2 to 15 percent slopes	4.1	Silts and clays
Pentz-Lithic Xerorthents complex, 30 to 50 percent slopes	7.8	Sands with fines
Perkins loam, 3 to 16 percent slopes	1.9	Silts and clays
Perkins loam, moderately deep and deep, 0 to 3 percent slopes	1.1	Silts and clays
Peters clay, 2 to 8 percent slopes	0.9	Silts and clays

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Map Unit Name	Estimated Saturated Hydraulic Conductivity (inches/day)	Soils Type
Peters clay, 3 to 9 percent slopes	0.3	Silts and clays
Pits	ND	ND
Placer diggings and Riverwash	31.3	Sands with fines
Quarries	ND	ND
Red Bluff-Mokelumne complex, 16 to 36 percent slopes, eroded	2.1	Gravelly or sandy
Red Bluff-Mokelumne complex, 5 to 16 percent slopes	1.7	Gravelly or sandy
Red Bluff-Mokelumne-Mine pits complex, 2 to 16 percent slopes	1.8	Gravelly or sandy
Red Bluff-Mokenlumne complex, 0 to 5 percent slopes	1.8	Gravelly or sandy
Redding gravelly loam, 0 to 8 percent slopes, MLRA 17	2.1	Sands with fines
Redding loam, 2 to 8 percent slopes	0.5	Silts and clays
Reiff fine sandy loam, 0 to 2 percent slopes, occasionally flooded	8.8	Sands with fines
Reiff fine sandy loam, 0 to 2 percent slopes, occasionally flooded	8.8	Sands with fines
Riverwash	ND	ND
Rock land	0.1	0
Ryer silty clay loam, 0 to 3 percent slopes	1.1	Silts and clays
Sailboat silt loam, drained, 0 to 2 percent slopes, MLRA 17	1.5	Silts and clays
Sailboat silt loam, drained, 0 to 2 percent slopes, occasionally flooded, MLRA 17	1.5	Silts and clays
Sailboat silt loam, drained, 0 to 2 percent slopes, wet, occasionally flooded, MLRA 17	0.4	Silts and clays
San Joaquin complex, 0 to 1 percent slopes	0.8	Silts and clays
San Joaquin silt loam, 0 to 3 percent slopes	1.2	Silts and clays
San Joaquin silt loam, 3 to 8 percent slopes	1.2	Silts and clays
San Joaquin silt loam, leveled, 0 to 1 percent slopes	1.2	Silts and clays
San Joaquin-Durixeralfs complex, 0 to 1 percent slopes	0.8	Silts and clays
San Joaquin-Galt complex, 0 to 3 percent slopes	0.7	Silts and clays
San Joaquin-Galt complex, leveled, 0 to 1 percent slopes	0.7	Silts and clays
San Joaquin-Urban land complex, 0 to 2 percent slopes	1.2	Silts and clays
San Joaquin-Xerarents complex, leveled, 0 to 1 percent slopes	1.2	ND
Sedimentary rock land	0.2	0
Slickens	ND	ND
Snelling fine sandy loam, 5 to 9 percent slopes	1.9	Sands with fines

Map Unit Name	Estimated Saturated Hydraulic Conductivity (inches/day)	Soils Type
Snelling sandy loam, 16 to 31 percent slopes	4.0	Sands with fines
Snelling sandy loam, 9 to 16 percent slopes	5.1	Sands with fines
Tehama loam, 0 to 2 percent slopes, clay loam substratum, MLRA 17	1.3	Silts and clays
Urban land	ND	ND
Vina fine sandy loam, 0 to 2 percent slopes, MLRA 17	2.8	Sands with fines
Vina fine sandy loam, 0 to 2 percent slopes, occasionally flooded	3.6	Sands with fines
Vleck gravelly loam, 2 to 15 percent slopes	0.9	Gravelly or sandy
Vleck-Amador-Pits, mine complex, 15 to 50 percent slopes	1.6	Silts and clays
Water	ND	ND
Whiterock loam, 3 to 30 percent slopes	10.1	Silts and clays
Xerarents-Redding complex, 0 to 2 percent slopes	0.5	ND
Xerarents-San Joaquin complex, 0 to 1 percent slopes	0.9	ND
Xerarents-Urban land-San Joaquin complex, 0 to 5 percent slopes	0.9	ND
Xerofluvents, 0 to 2 percent slopes, flooded	ND	ND
Xerorthents, dredge tailings, 2 to 50 percent slopes	31.3	Gravelly or sandy

Appendix A Table 2. Soil classification assignment

USCS Codes	Soil Classification
GC, GC-GM, GM	Gravelly or sandy
SC, SM, SC-SM	Sands with fines
CL, CL-ML, MH, ML, CH	Silts and clays
Map Unit Name	
Placer diggings and Riverwash	Mine tailings and riverwash
Mine tailings and Riverwash	
Riverwash	
Xerorthents, dredge tailings, 2 to 50 percent slopes	
Slickens	Rock
Inks loam and Rock land, 3 to 45 percent slopes	
Sedimentary rock land	
Rock land	
Lithic Xerorthents, 2 to 8 percent slopes	
Xerofluvents, 0 to 2 percent slopes, flooded	
Water	Water

References

NRCS – See United States Natural Resources Conservation Service

United States Natural Resources Conservation Service, 2020. Soil Data Viewer. Online: <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcseprd337066>.

APPENDIX B – SAMPLE HARDCOPY DATASHEETS

Full Intensity GDE Assessment										
Background Information										
Observer	Name of the observer (s)	Text								
SiteID	Unique name for the map unit(s) being assessed	Text								
Date	Observation date	Date								
Precip	Indications of recent precipitation	Single choice	Recent rain	Rain during survey	Snow/hail during survey	Snow on the ground	No recent precipitation	Notes:		
Vegetation Conditions										
ExistVeg	Dominant vegetation type assigned to the map unit within the NCCAG dataset or alternative sources	Text								
OverCvr	Overstory (>40 ft) cover	Single choice	<5%	6-10%	11-25%	26-50%	51-75%	76-90%	>90%	Notes:
UnderCvr	Understory (<40 ft) cover	Single choice	<5%	6-10%	11-25%	26-50%	51-75%	76-90%	>90%	Notes:
ActDomVg	Dominant vegetation type inhabiting map unit per field observations	Text								
SbDomTrSh	Sub-dominant tree and shrub species field observed in the map unit	Text								
PctCanDie	Proportion of the canopy exhibiting signs of senescence	Single choice	<5%	6-10%	11-25%	26-50%	51-75%	76-90%	>90%	Notes:
DieBackSpp	Species most affected by canopy dieback (if applicable)	Text								
RecruitDis	Woody riparian spp recruitment	Single choice	NONE	Rare	Uncommon	Common	Abundant	Notes:		
RecruitSiz	Woody riparian spp recruitment size	Multiple choice	NONE	Seedling	Sapling	Notes:				
BioCond	Biological Condition Gradient per EPA 2016	Single choice	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Notes:	
Groundcover and Herbaceous										
BareGrCvr	Bare ground cover within the map unit	Single choice	<5%	6-10%	11-25%	26-50%	51-75%	76-90%	>90%	Notes:
LitterCvr	Litter cover within the map unit	Single choice	<5%	6-10%	11-25%	26-50%	51-75%	76-90%	>90%	Notes:
GraRockCvr	Gravel and rock cover within the map unit	Single choice	<5%	6-10%	11-25%	26-50%	51-75%	76-90%	>90%	Notes:
PerGraCvr	Perennial grass cover within the map unit	Single choice	<5%	6-10%	11-25%	26-50%	51-75%	76-90%	>90%	Notes:
DomGrSpp	Dominant graminoid spp observed within the map unit during the field survey	Text								
PerFbCvr	Perennial forb aerial cover within the map unit	Single choice	<5%	6-10%	11-25%	26-50%	51-75%	76-90%	>90%	Notes:
WeedCvr	Weed aerial cover within the map unit	Single choice	<5%	6-10%	11-25%	26-50%	51-75%	76-90%	>90%	Notes:

NoxWeSpp	Noxious weed species observed within the map unit	Text													
Soil Conditions															
SoilTxt	Composite soil texture within the top 6 inches from the surface	Single choice	Sand/loamy sand	Loamy	Clayey loam	Clay	Notes:								
SoilMoistCnt	Soil moisture content within the top 6 inches from the surface	Single choice	Dry	Slightly moist	Moist	Wet	Saturated	Notes:							
RedoxInd	Redox indicators observed in the top 6 inches from the surface	Single choice	Yes	No	Unknown	Notes:									
Hydrologic Conditions															
NonPrWtr	Is non-precipitation caused surface water present within the map unit?	Single choice	Yes	No	Unknown	Notes:									
MUPosition	Map unit hydrologic position	Multiple choice	Within a stream/riverbed	Within a pool	Within a stream/riverbed	Adjacent to a stream/river (floodplain)	Notes:								
SurfWtrInd	Specific surface water indicators observed within the map unit	Multiple choice	NONE	Moist soil	Surface water present	Debris in vegetation	Watermarks on vegetation	Sediment deposits	Drainage patterns	Groundwater surfacing	Overbank flooding	Notes:			
FlowCons	Apparent flow consistency	Single choice	Dry intermittent	Erratic intermittent	Regular intermittent	Perennial	Notes:								
GainLose	Gaining or losing stream/river reach	Single choice	Gaining	Losing	Unknown	Not Applicable	Notes:								
ObsFtSW	Observable fate of surface water within the map unit	Multiple choice	Disappears underground	Continues as far as can be seen	Confined to pool	Flows into another water feature	Unknown	Diverted	Becomes intermittent	NOT applicable	OTHER/Notes:				
Anthropogenic Conditions and Landuse															
HydAlt	Basic types of hydrologica alterations within the map unit	Multiple choice	Downgradient capture	Extraction from a spring source	Extraction of water from within a wetland	Irrigation runoff	NONE	Regulated flow by impoundment	Upgradient extraction	Water diversion	Wells	OTHER/Notes:			
HydStru	Manmade structures observed within the map unit	Multiple choice	Buried utility corridors	Enclosure fence	Erosion control structures	Irrigation facilities	NONE	Pipeline	Point source pollution	Powerlines	Road	Stock tank	Well	Trails (human or animal)	OTHER/Notes:
PeopImp	Recreation and other anthropogenic impacts observed within the map unit	Multiple choice	Camp sites	Trash Dumping	Horseback	Vehicle (including off road)	Biking	NONE	OTHER/Notes:						
AnEff	Types of animal effects observed within the map unit	Multiple choice	Ferel animals	Livestock grazing	Beaver activity	Wildlife browsing	Trampling	NONE	OTHER/Notes:						
GDE Determination and Notes															
GDEType	GDE Type	Text													
GenNotes	General notes	Text													

Rapid Intensity GDE Assessment												
Background Information												
Observer	Name of the observer (s)	Text										
SiteID	Unique name for the map unit(s) being assessed	Text										
Date	Observation date	Date										
Precip	Indications of recent precipitation	Single choice	Recent rain	Rain during survey	Snow/hail during survey	Snow on the ground	No recent precipitation	Notes:				
Vegetation Conditions												
ExistVeg	Dominant vegetation type assigned to the map unit within the NCCAG dataset or alternative sources	Text										
OverCvr	Overstory (>40 ft) cover	Single choice	<5%	6-10%	11-25%	26-50%	51-75%	76-90%	>90%	Notes:		
UnderCvr	Understory (<40 ft) cover	Single choice	<5%	6-10%	11-25%	26-50%	51-75%	76-90%	>90%	Notes:		
ActDomVg	Dominant vegetation type inhabiting map unit per field observations	Text										
SbDomTrSh	Sub-dominant tree and shrub species field observed in the map unit	Text										
PctCanDie	Proportion of the canopy exhibiting signs of senescence	Single choice	<5%	6-10%	11-25%	26-50%	51-75%	76-90%	>90%	Notes:		
DieBackSpp	Species most affected by canopy dieback (if applicable)	Text										
RecruitDis	Woody riparian spp recruitment	Single choice	NONE	Rare	Uncommon	Common	Abundant	Notes:				
BioCond	Biological Condition Gradient per EPA 2016	Single choice	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Notes:			
Hydrologic Conditions												
NonPrWtr	Is non-precipitation caused surface water present within the map unit?	Single choice	Yes	No	Unknown	Notes:						
MUPosition	Map unit hydrologic position	Multiple choice	Within a stream/riverbed	Within a pool	Adjacent to a pool	Adjacent to a stream/river (floodplain)	Notes:					
SurfWtrInd	Specific surface water indicators observed within the map unit	Multiple choice	NONE	Moist soil	Surface water present	Debris in vegetation	Watermarks on vegetation	Sediment deposits	Drainage patterns	Groundwater surfacing	Overbank flooding	Notes:
FlowCons	Apparent flow consistency	Single choice	Dry intermittent	Erratic intermittent	Regular intermittent	Perennial	Notes:					
GainLose	Gaining or losing stream/river reach	Single choice	Gaining	Losing	Unknown	Not Applicable	Notes:					
ObsFtSW	Observable fate of surface water within the map unit	Multiple choice	Disappears underground	Continues as far as can be seen	Confined to pool	Flows into another water feature	Unknown	Diverted	Becomes intermittent	NOT applicable	OTHER/Notes:	

Anthropogenic Conditions and Landuse															
HydAlt	Basic types of hydrological alterations within the map unit	Multiple choice	Downgradient capture	Extraction from a spring source	Extraction of water from within a wetland	Irrigation runoff	NONE	Regulated flow by impoundment	Upgradient extraction	Water diversion	Wells	OTHER/Notes:			
HydStru	Manmade structures observed within the map unit	Multiple choice	Buried utility corridors	Enclosure fence	Erosion control structures	Irrigation facilities	NONE	Pipeline	Point source pollution	Powerlines	Road	Stock tank	Well	Trails (human or animal)	OTHER/Notes:
PeopImp	Recreation and other anthropogenic impacts observed within the map unit	Multiple choice	Camp sites	Trash Dumping	Horseback	Vehicle (including off road)	Biking	NONE	OTHER/Notes:						
AnEff	Types of animal effects observed within the map unit	Multiple choice	Ferel animals	Livestock grazing	Beaver activity	Wildlife browsing	Trampling	NONE	OTHER/Notes:						
GDE Determination and Notes															
GDEType	GDE Type	Text													
GenNotes	General notes	Text													

APPENDIX C – SITE DOCUMENTATION

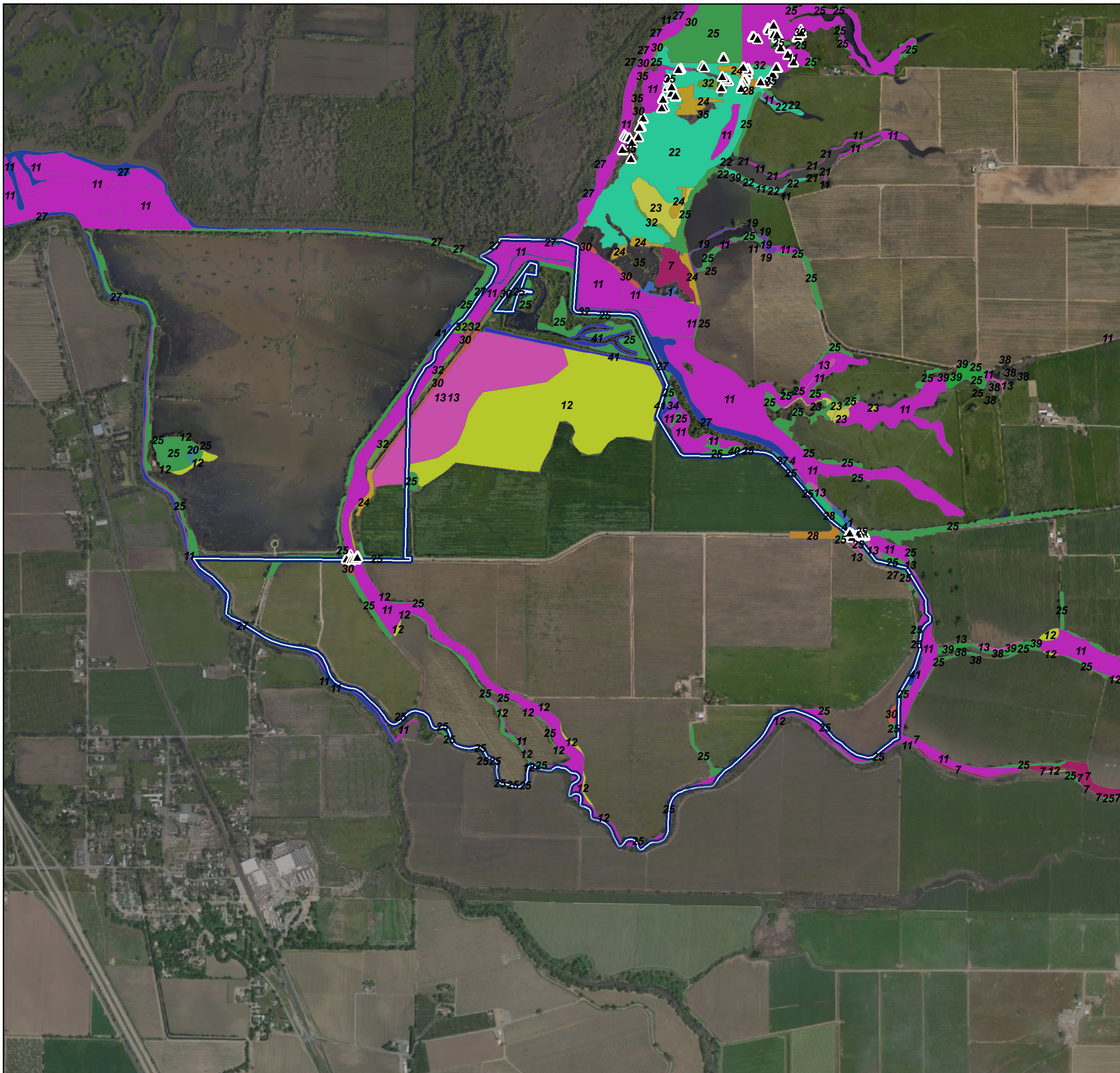
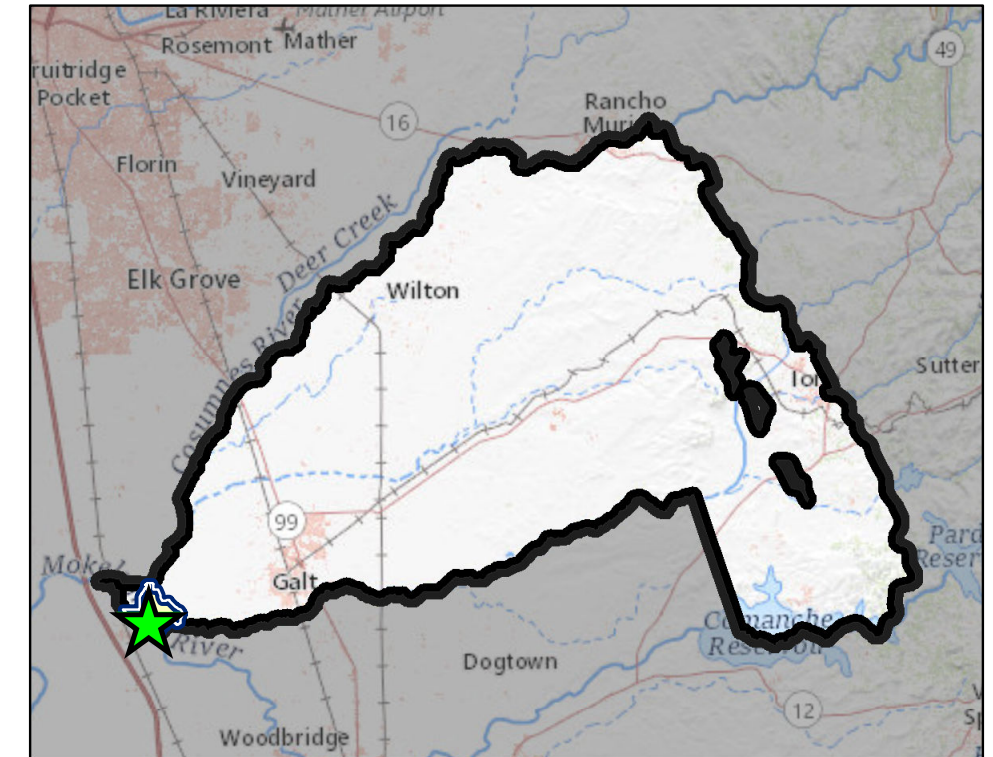
Site	Site 1. Grizzly Slough Area
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	Freshwater Emergent Wetlands, Freshwater Pond, <i>Quercus lobata</i> , <i>Rubus americanus</i> , <i>Acer negundo</i>
Dominant Vegetation Type(s) Actually Observed in the Field	Expansive freshwater ponds, emergent wetlands, and marshes, with woody species along the edges of sloughs and in larger patches where trees have not been previously cleared for agriculture. Dominant woody species include valley oak (<i>Quercus lobata</i>), Goodding's willow (<i>Salix gooddingii</i>) and Oregon ash (<i>Fraxinus latifolia</i>). Sub-dominant, intermixed species include California grape (<i>Vitus californica</i>), Cottonwood (<i>Populus fremontii</i>), Coyote willow (<i>Salix exigua</i>), Rose (<i>Rosa</i> sp.), Walnut (<i>Juglans</i> sp.), Box elder (<i>Acer negundo</i>), Pacific poison oak (<i>Toxicodendron diversilobum</i>), soft-stem bulrush (<i>Schoenoplectus</i> sp.), and tree of heaven (<i>Ailanthus altissima</i>). Duckweed (<i>Lemna</i> sp.) commonly floating on sloughs and linear features with standing water. Occasional herbaceous dominated depressional wetlands also present beyond extent of open water areas.
Description of Overall Accuracy of Existing Vegetation Mapping	NCCAG and NVCS mapping are reliable with detecting valley oak and open water wetlands at this site, however, not all forested wetlands or ponds are captured in any of the existing vegetation mapping. Woody species diversity is grossly under-predicted in existing data.
Typical canopy structure	Forested types typically contain 5-25% overstory canopy cover and 51-75% understory canopy cover.
Predominant Geomorphic Setting for Wetland/Riparian Communities	Riverine bands and lakes/ponds intermixed, appear to be highly influenced by the Cosumnes and Mokelumne River confluence. Networks of backwater sloughs abundant off the Cosumnes River throughout this segment of the project area.
Hydrological Conditions Summary	Most of the open water features appear to be perennial, debris in vegetation, distribution of sediment deposits suggest regular overbank flooding into forested areas, drainage patterns.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer is 10-30 feet throughout the site.
Invasive Non-Native Species Observed	Patches of tree of heaven observed.
Canopy Dieback Summary	Canopy dieback was 6-10% at both sites observed. Affected species include cottonwood, oak, walnut, and Oregon ash.
Natural Recruitment Summary	Evidence of natural recruitment was uncommon, isolated pockets of coyote willow and ash saplings observed at both assessment locations but not in abundance.

<i>Biological Condition Gradient Summary</i>	Level 3
<i>Soil Conditions Summary</i>	Moist to saturated soil throughout, primarily loamy. Redox indicators abundant, even within 6 inches
<i>Land Use and Anthropogenic Alterations Summary</i>	Trash dumping and livestock enclosures present.
<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat
<i>General Notes</i>	High diversity mosaic of habitats to include riparian forests, shrublands, sloughs, marshes, emergent wetlands. Recommend treating tree of heaven. Site just upstream of the confluence of the Cosumnes and Mokelumne River confluence. Wildlife browse observed (including beaver activity) and site heavily used by a diverse abundance of waterfowl.
<i>GDE Evaluation Summary</i>	Classified as a SGMA GDE



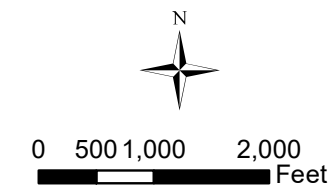
Top photo: open water slough with a diversity of trees and shrubs along the margins, Bottom left and middle right: complex woody structural diversity in canopy layers layers.

Site 1 - Grizzly Slough Area: Vegetation Types Described in the Existing NCCAG and NVCS Vegetation Data



Legend

- ▲ Field Observation Locations
 - Site Location
- | Vegetation Type | |
|---|---|
| 1, Acer negundo | 25, Quercus lobata |
| 11, Freshwater Emergent Wetland | 27, Riverine Wetland |
| 12, Freshwater Forested/Shrub Wetland | 28, Rubus armeniacus |
| 13, Freshwater Pond | 30, Salix exigua |
| 19, Lemna (minor) and Relatives | 32, Salix gooddingii |
| 20, Lepidium latifolium | 34, Salix lasiolepis |
| 22, Naturalized warm-temperate riparian and wetland group | 39, Water |
| 23, Persicaria lapathifolia - Xanthium strumarium | 4, Arid West freshwater emergent marsh |
| 24, Populus fremontii | 40, Western North American Freshwater Marsh |
| | 41, Salix exigua-(Saix lasiolepis)-Rubus discolor |
| | 7, California Warm Temperate Marsh/Seep |



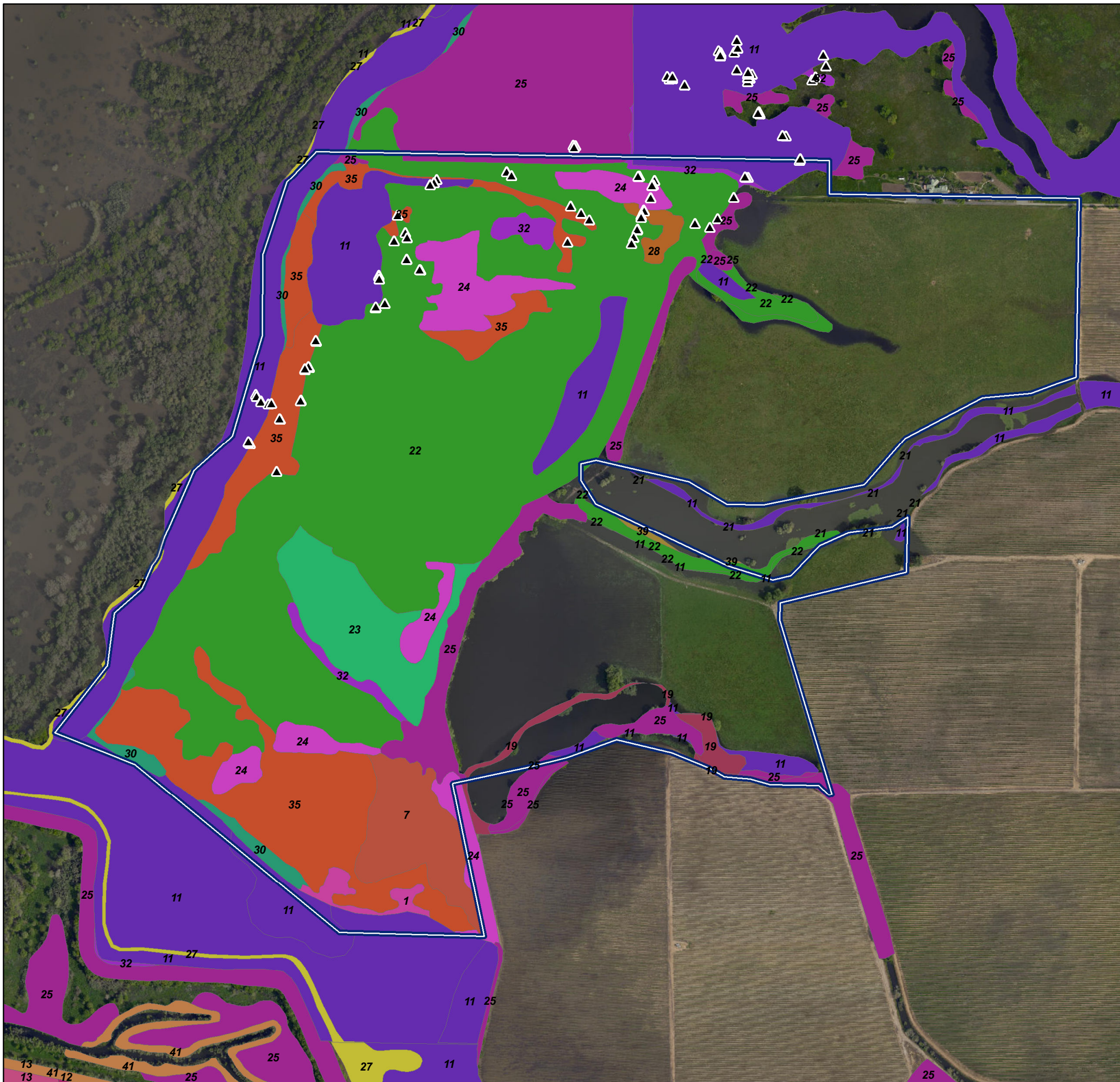
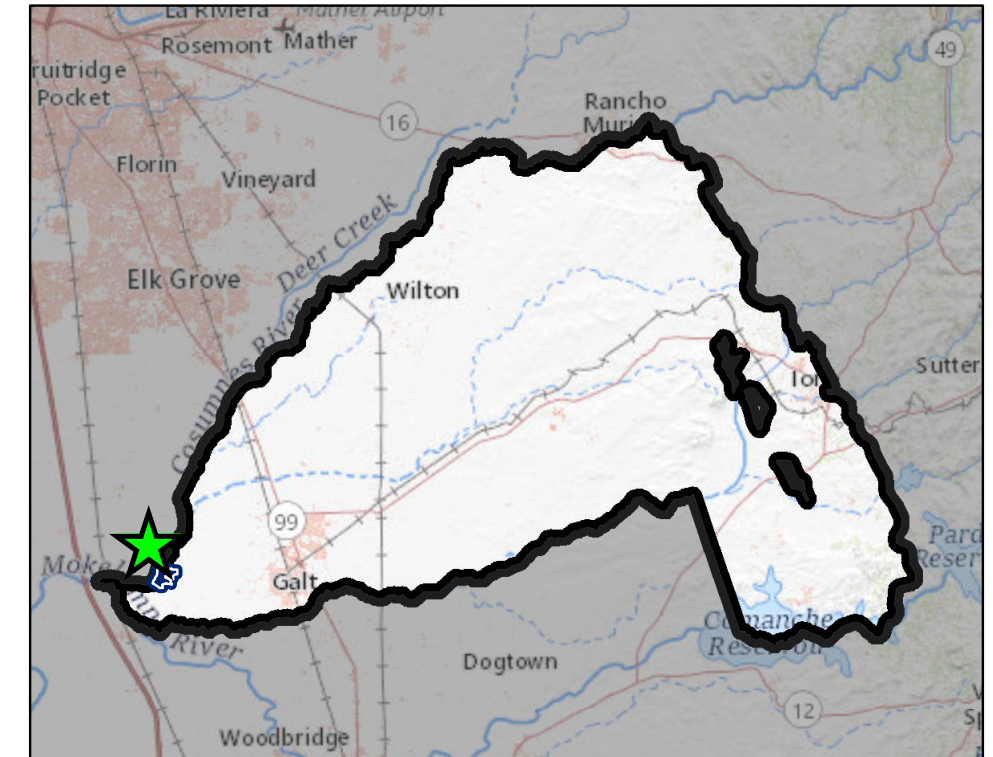
Site	Site 2. BLM Property near Preserve Areas
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Acer negundo</i> , <i>Populus fremontii</i> , <i>Quercus lobata</i> , <i>Salix exigua</i> , <i>Salix gooddingii</i> , Freshwater Emergent Wetland, <i>Lemna</i> , <i>Ludwigia</i> , Naturalized warm temperate riparian and wetland group, <i>Persicaria lapathifolia</i> - <i>Xanthium strumarium</i> , <i>Schoenoplectus</i> , Riverine Wetland, California Warm Temperate Marsh/Seep, Water, <i>Typha</i> , and <i>Rubus armeniacus</i> .
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species include valley oak (<i>Quercus lobata</i>), Goodding's willow (<i>Salix gooddingii</i>), cottonwood (<i>Populus fremontii</i>), and box elder (<i>Acer negundo</i>); as defined in NCCAG and NVCS data. Pacific poison oak (<i>Toxicodendron diversilobum</i>), California buckeye (<i>Aesculus californica</i>), Baccharis, buttonbush (<i>Cephalanthus occidentalis</i>), and coyote willow (<i>Salix exigua</i>) also present. Isolated ponds, often with aquatic spp, and marshes (<i>Typha</i> and <i>Schoenoplectus</i> dominated) also occur. Large wetland with no surface water present during site visit appears to regularly inundate and has an herbaceous wetland species richness, including sections dominated by <i>Juncus</i> , <i>Schoenoplectus</i> , <i>Typha</i> , <i>Persicaria lapathifolia</i> and <i>Xanthium strumarium</i> . Riverine wetlands (per NWI) present.
Description of Overall Accuracy of Existing Vegetation Mapping	Existing mapping captures extent of wetland herbaceous communities, woody riparian areas, and aquatic habitats relatively well but diversity and complexity grossly under-represented by NCCAG and NVCS data.
Typical canopy structure	Forested types contain variable overstory cover ranging from 11-25% to 26-50% typically with a dense understory that exceeds 25% cover.
Predominant Geomorphic Setting for Wetland/Riparian Communities	Entire site lies within a riverine setting.
Hydrological Conditions Summary	Based on distribution of woody debris, flow paths, watermarks on vegetation, and sediment; site appears to inundate regularly. Active inundation was observed within portions of riparian forests during the site visit. Cosumnes River appears to gain in this reach, substantially more volume than in Upper and Middle Cosumnes segments. Sloughs also present. Cosumnes likely perennial in this section.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer is less than 10-30 feet deep throughout the site.
Invasive Non-Native Species Observed	Perennial pepperweed (<i>Lepidium latifolium</i>) most abundant invasive species of significance.
Canopy Dieback Summary	Canopy dieback typically 6-10% in portions with woody vegetation, primarily dead branches on valley oak.
Natural Recruitment Summary	Natural recruitment of native riparian species common in segments dominated by woody species. Goodding's willow, valley oak, and box elder saplings observed.

<i>Biological Condition Gradient Summary</i>	Level 1/Level 2, depending on individual feature
<i>Soil Conditions Summary</i>	Clayey loam to loam textured soils, often moist to saturated near surface, redox indicators frequently present in top 6 inches.
<i>Land Use and Anthropogenic Alterations Summary</i>	Irrigation structures present in large wetland, site in natural condition with little disturbance.
<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat. Marshes are important for western pond turtle, giant garter snake, northern harrier, tricolored blackbird, and western red bat.
<i>General Notes</i>	Reconnaissance level survey conducted on foot within targeted features throughout the site, which is owned and managed by the Bureau of Land Management. Site contains high habitat complexity, beautiful mosaic of wetland and riparian habitats.
<i>GDE Evaluation Summary</i>	SGMA GDE



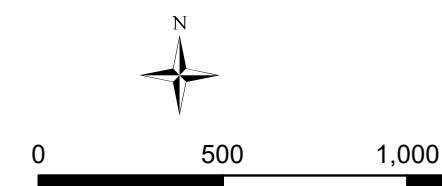
Top photo: Diverse herbaceous wetlands compose a substantial proportion of the site. Bottom left: Goodding's willow swale. Bottom right: structurally diverse forest with high species richness inundated during the field visit.

Site 2 - BLM Property Near Preserve: Vegetation Types Described in the Existing NCCAG and NVCS Vegetation Data



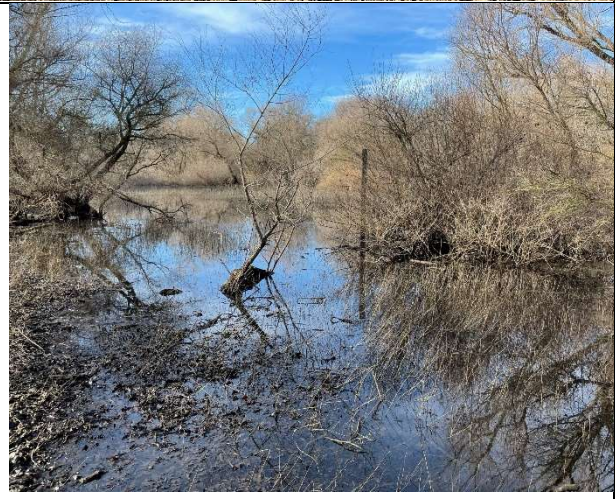
Legend

- | | |
|---|--|
| ▲ Field Observation Locations | 24, <i>Populus fremontii</i> |
| ▭ Site Location | 25, <i>Quercus lobata</i> |
| Vegetation Type | |
| 1, <i>Acer negundo</i> | 27, Riverine Wetland |
| 11, Freshwater Emergent Wetland | 28, <i>Rubus armeniacus</i> |
| 12, Freshwater Forested/Shrub Wetland | 30, <i>Salix exigua</i> |
| 13, Freshwater Pond | 32, <i>Salix gooddingii</i> |
| 19, <i>Lemna</i> (minor) and Relatives | 35, <i>Schoenoplectus</i> |
| 22, Naturalized warm-temperate riparian and wetland group | 39, Water |
| 23, <i>Persicaria lapathifolia</i> - <i>Xanthium strumarium</i> | 41, <i>Salix exigua</i> -(<i>Saix lasiolepis</i>)- <i>Rubus discolor</i> |
| | 7, California Warm Temperate Marsh/Seep |



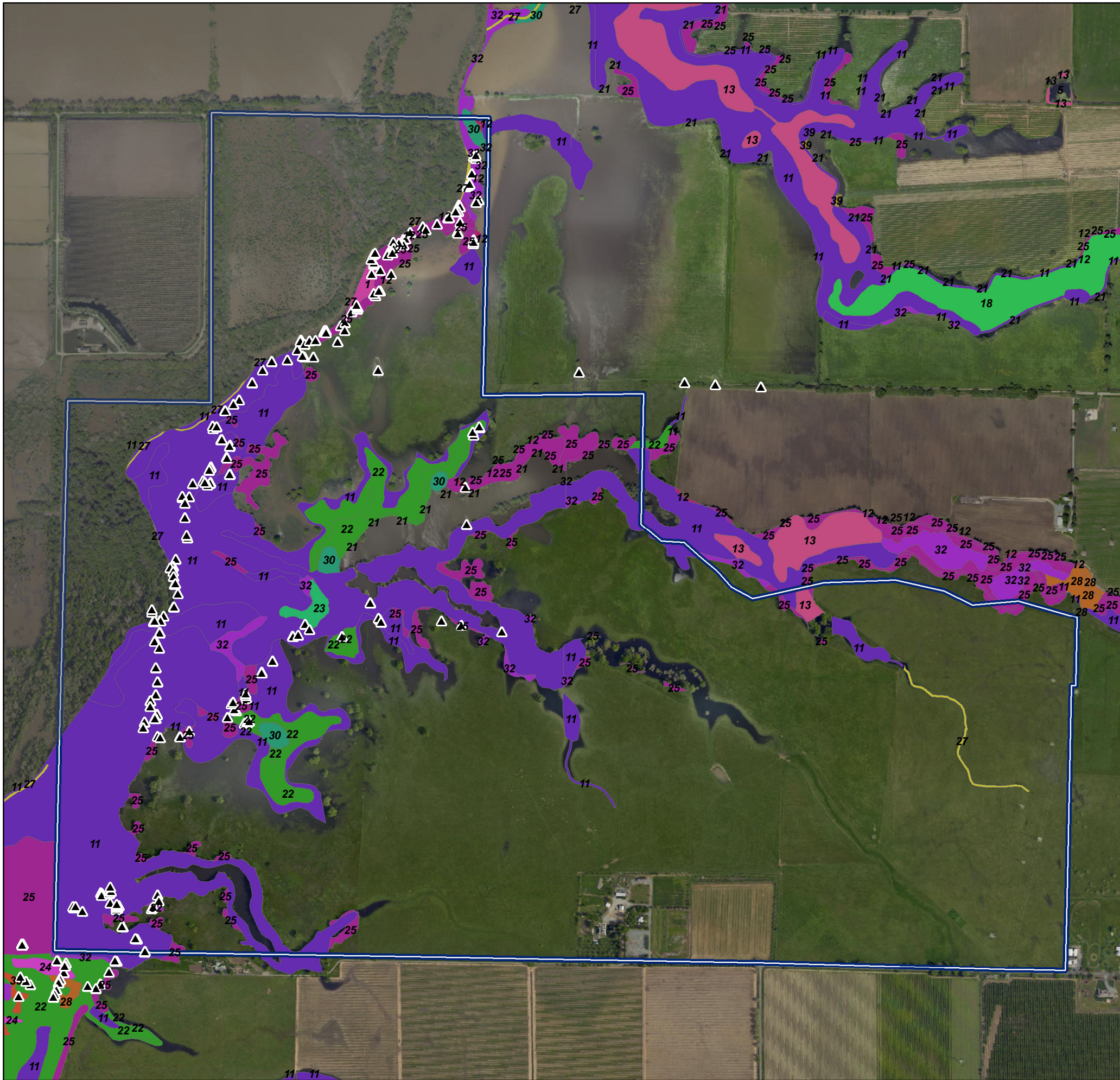
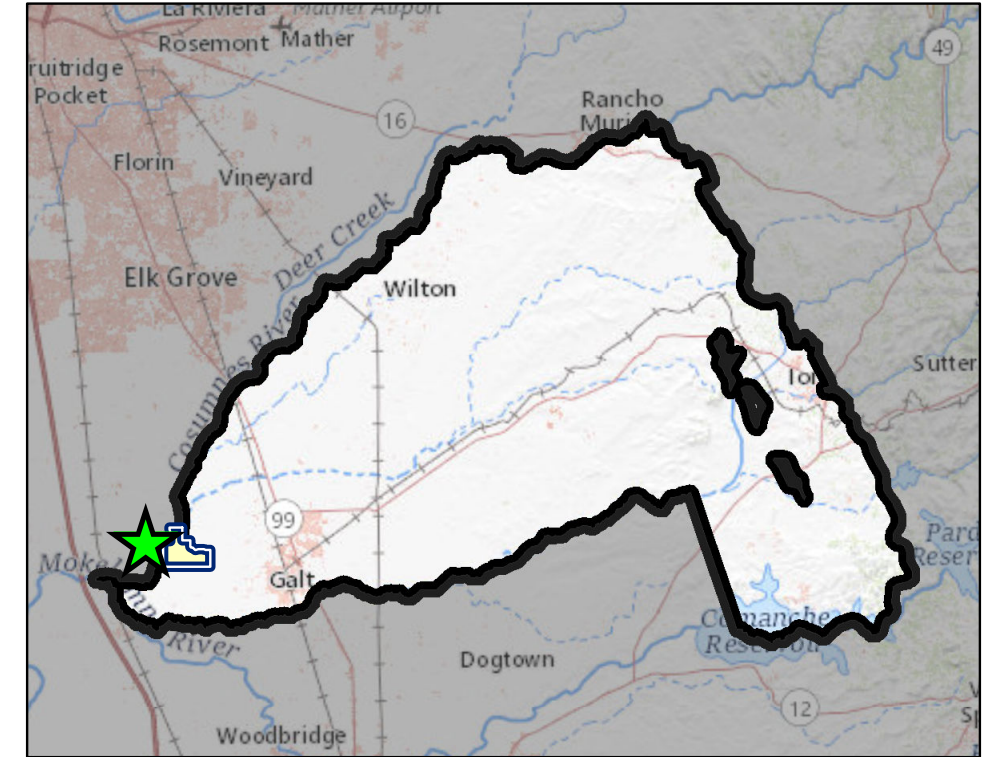
Site	Site 3A. Cosumnes River Ecological Reserve
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Acer negundo</i> , <i>Populus fremontii</i> , <i>Quercus lobata</i> , <i>Salix exigua</i> , <i>Salix gooddingii</i> , Freshwater Emergent Wetland, Freshwater Forested/Shrub Wetland, Freshwater Pond, <i>Ludwigia</i> , Naturalized warm temperate riparian and wetland group, <i>Persicaria lapathifolia</i> - <i>Xanthium strumarium</i> , <i>Schoenoplectus</i> , Riverine Wetland, <i>Schoenoplectus</i> , and <i>Rubus armeniacus</i> .
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species include valley oak (<i>Quercus lobata</i>), Goodding's willow (<i>Salix gooddingii</i>), coyote willow (<i>Salix exigua</i>), cottonwood (<i>Populus fremontii</i>), Oregon ash (<i>Fraxinus latifolia</i>), and box elder (<i>Acer negundo</i>); like NCCAG and NVCS data. Pacific poison oak (<i>Toxicodendron diversilobum</i>), buttonbush (<i>Cephalanthus occidentalis</i>), California buckeye (<i>Aesculus californica</i>), rose, and <i>Baccharis</i> also present. Isolated ponds, often with aquatic spp, and marshes (<i>Typha</i> and <i>Schoenoplectus</i> dominated) also occur. Expansive sloughs spur off the Cosumnes mainstem channel. Isolated marshes and depressions dominated by <i>Persicaria lapathifolia</i> and <i>Xanthium strumarium</i> . Riverine wetlands (per NWI) present.
Description of Overall Accuracy of Existing Vegetation Mapping	Existing mapping captures extent of wetland herbaceous communities, woody riparian areas, and aquatic habitats relatively well but diversity and complexity grossly under-represented by NCCAG and NVCS data. Oregon ash more expansive than existing vegetation data suggest.
Typical canopy structure	Forested types contain variable overstory cover ranging from 11-25% to 26-50% typically with a similarly variably understory cover that ranges from <10% to segments with a dense understory that exceeds 25% cover, often achieving 50 to 75%.
Predominant Geomorphic Setting for Wetland/Riparian Communities	Entire site lies within a riverine setting.
Hydrological Conditions Summary	Based on distribution of woody debris, flow paths, watermarks on vegetation, and sediment; site appears to inundate regularly. Active inundation was observed within high flow channels within riparian forests during the site visit. Cosumnes River appears to gain in this reach, substantially more volume than in Upper and Middle Cosumnes segments. Sloughs abundant, often with lots of floating debris. Cosumnes likely perennial in this section. Seeping groundwater observed.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer within riparian corridor is less than 10-30 feet deep while sloughs extend into segments where groundwater contouring predicts regional aquifer is 30-50 feet below ground.
Invasive Non-Native Species Observed	Perennial pepperweed (<i>Lepidium latifolium</i>) and Himalayan blackberry are the most abundant invasive species of significance.

<i>Canopy Dieback Summary</i>	Canopy dieback typically 6-10% in portions with woody vegetation, primarily dead branches on valley oak and Goodding's willow.
<i>Natural Recruitment Summary</i>	Natural recruitment of native riparian species common in segments dominated by woody species. Goodding's willow, valley oak, and box elder saplings observed.
<i>Biological Condition Gradient Summary</i>	Level 2/Level 3, depending on individual feature
<i>Soil Conditions Summary</i>	Clayey loam to loam textured soils, often moist to saturated near surface, redox indicators frequently present in top 6 inches. Heavy gleying in depressions.
<i>Land Use and Anthropogenic Alterations Summary</i>	Site in natural condition with little disturbance.
<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat. Marshes are important for western pond turtle, giant garter snake, northern harrier, tricolored blackbird, and western red bat.
<i>General Notes</i>	Reconnaissance level survey conducted on foot, which is owned and managed by the California Department of Fish and Wildlife. Site contains high habitat complexity, beautiful mosaic of wetland and riparian habitats. Abundant waterfowl observed throughout the site.
<i>GDE Evaluation Summary</i>	SGMA GDE



Top photo: Forested areas intermixed with shrublands, herbaceous wetlands, and pools. Bottom left: currently abandoned flow channel that appears to inundate during high flow events. Bottom right: large slough with Gooding's willow.

Site 3A - Cosumnes River Ecological Reserve: Vegetation Types Described in the Existing NCCAG and NVCS Vegetation Data



Legend

- ▲ Field Observation Locations
 - ▭ Site Location
- Vegetation Type**
- | | |
|---|---|
| 1, Acer negundo | 23, Persicaria lapathifolia - Xanthium strumarium |
| 11, Freshwater Emergent Wetland | 24, Populus fremontii |
| 12, Freshwater Forested/Shrub Wetland | 25, Quercus lobata |
| 13, Freshwater Pond | 27, Riverine Wetland |
| 18, Lacustrine Wetland | 28, Rubus armeniacus |
| 22, Naturalized warm-temperate riparian and wetland group | 30, Salix exigua |
| | 32, Salix gooddingii |
| | 35, Schoenoplectus |
| | 39, Water |

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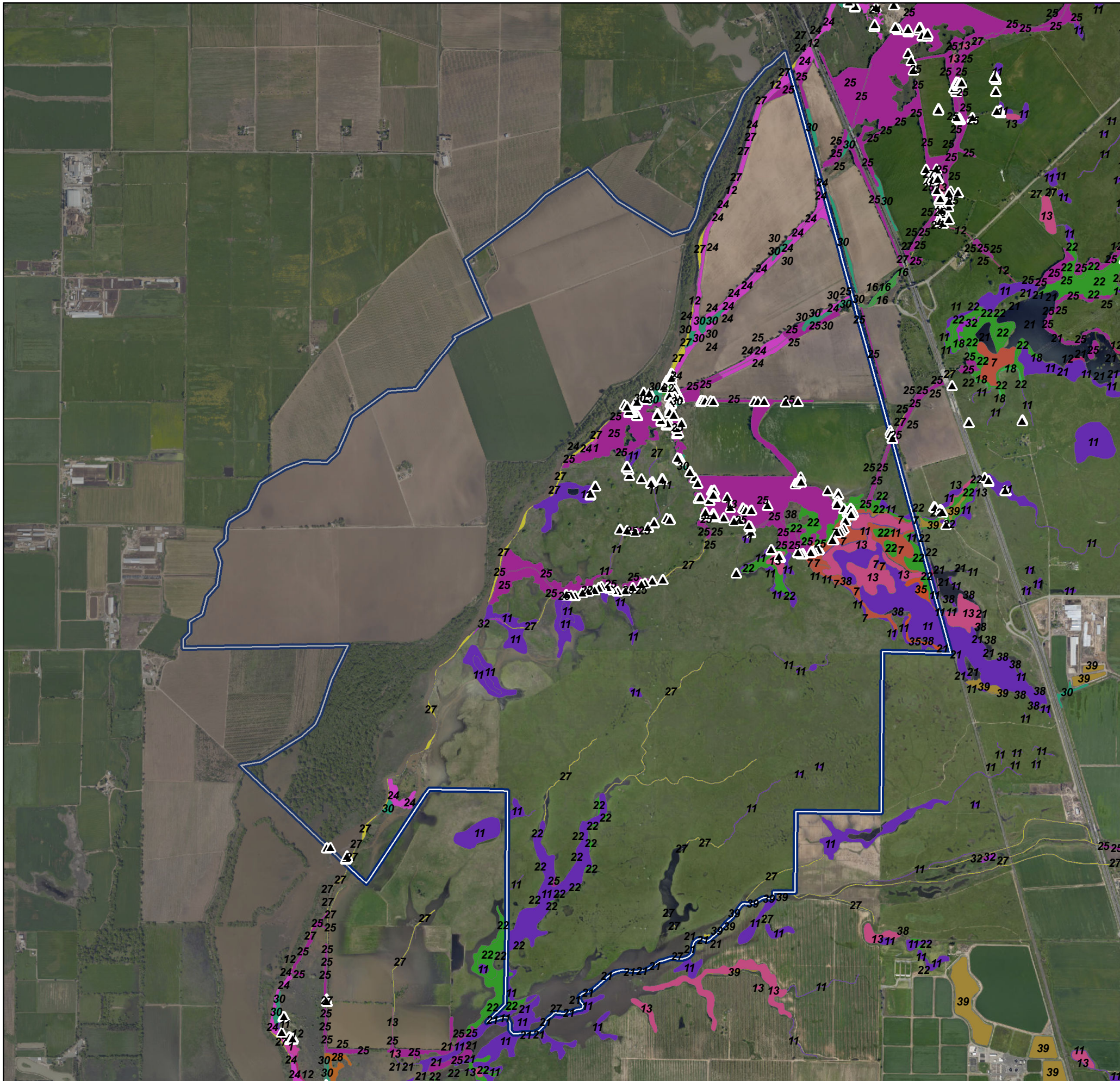
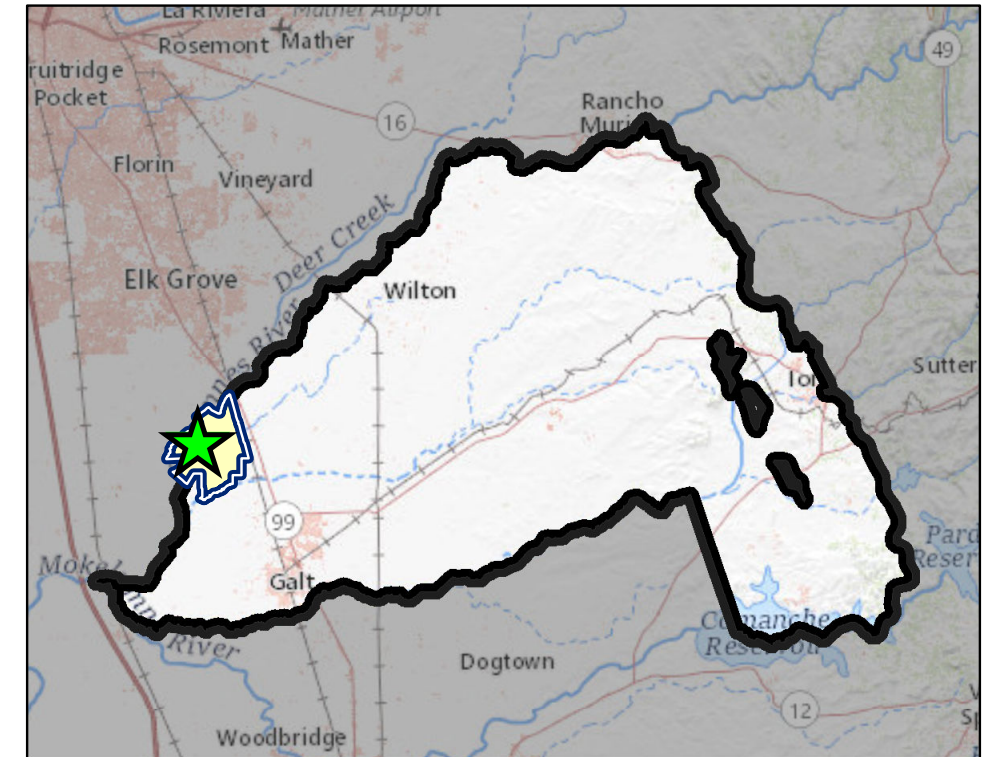
Site	Site 3B. Cosumnes River Ecological Reserve
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Acer negundo</i> , <i>Populus fremontii</i> , <i>Quercus lobata</i> , <i>Salix exigua</i> , <i>Salix gooddingii</i> , Freshwater Emergent Wetland, Freshwater Forested/Shrub Wetland, Freshwater Pond, <i>Ludwigia</i> , <i>Juglans hindsii</i> and hybrids, Naturalized warm temperate riparian and wetland group, <i>Schoenoplectus</i> , Riverine Wetland, <i>Schoenoplectus</i> , <i>Typha</i> , Water and California Warm Temperate Marsh/Seep.
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species include valley oak (<i>Quercus lobata</i>), Goodding's willow (<i>Salix gooddingii</i>), coyote willow (<i>Salix exigua</i>), cottonwood (<i>Populus fremontii</i>), Arroyo willow (<i>Salix lasiolepis</i>), red willow (<i>Salix laevigata</i>), Oregon ash (<i>Fraxinus latifolia</i>), walnut (<i>Juglans</i> spp.), and box elder (<i>Acer negundo</i>); as described in NCCAG and NVCS data. Pacific poison oak (<i>Toxicodendron diversilobum</i>), buttonbush (<i>Cephalanthus occidentalis</i>), California buckeye (<i>Aesculus californica</i>), rose, and <i>Baccharis</i> also present. Isolated ponds, often with aquatic spp, and marshes (<i>Typha</i> and <i>Schoenoplectus</i> dominated) also occur. Sloughs spur off the Cosumnes mainstem channel. Isolated depressions dominated by <i>Juncus</i> , <i>Eleocharis</i> , <i>Rumex crispus</i> , cocklebur (<i>Xanthium strumarium</i>), <i>Persicaria lapathifolia</i> , and water plantain (<i>Alisma subcordatum</i>). Riverine wetlands (per NWI) present.
Description of Overall Accuracy of Existing Vegetation Mapping	Existing mapping captures extent of wetland herbaceous communities, woody riparian areas, and aquatic habitats relatively well but diversity and complexity sometimes under-represented by NCCAG and NVCS data.
Typical canopy structure	Forested types contain variable overstory cover ranging from 26-50%. Understories relatively open below oak forests, understory density increases closer to the mainstem channel. Understory cover that ranges from <10% to typically narrow segments with a dense understory that exceeds 50% cover.
Predominant Geomorphic Setting for Wetland/Riparian Communities	Most of site lies within a riverine setting, occasional pond/lakes, and isolated depressions.
Hydrological Conditions Summary	Based on distribution of woody debris, abandoned flow paths, watermarks on vegetation, and sediment; site appears to inundate regularly. High flow channel in gallery forests with remnant pools from recent floods. Cosumnes River appears to gain in this reach, appears to be more volume than in Upper and Middle Cosumnes segments. Sloughs abundant, often with lots of floating debris. Cosumnes likely near perennial in this section.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer within riparian corridor 50 to 100 feet below ground.
Invasive Non-Native Species Observed	Himalayan blackberry is the most abundant invasive species of significance.

<i>Canopy Dieback Summary</i>	Canopy dieback typically <5% in portions with woody vegetation.
<i>Natural Recruitment Summary</i>	Natural recruitment of native riparian species common in segments dominated by woody species and more diverse than most of the other sites surveyed. Goodding's willow, valley oak, Oregon ash, and box elder saplings observed, valley oak in greatest abundance.
<i>Biological Condition Gradient Summary</i>	Level 2/Level 3, depending on individual feature
<i>Soil Conditions Summary</i>	Clayey loam to loam textured soils, often moist near surface, redox indicators frequently present in top 1.5 feet.
<i>Land Use and Anthropogenic Alterations Summary</i>	Site in natural condition with little disturbance.
<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat. Marshes are important for western pond turtle, giant garter snake, northern harrier, tricolored blackbird, and western red bat.
<i>General Notes</i>	Reconnaissance level survey conducted on foot, which is owned and managed by the California Department of Fish and Wildlife. Site diverse and complex. Riparian forests and sloughs, while present, are less extensive than downstream at site 3A. Abundant waterfowl observed throughout the site, including foraging in open fields.
<i>GDE Evaluation Summary</i>	Unlikely a SGMA GDE, possible perched alluvial aquifer



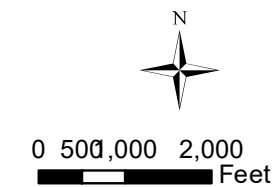
Top photo: Valley oak forest with open understory. Bottom left: remanant pool in flow channel within the gallery forest. Bottom right: narrow slough, with patches of relatively sparse woody vegetation but recent recruitment observed.

Site 3B - Cosumnes River Ecological Reserve: Vegetation Types Described in the Existing NCCAG and NVCS Vegetation Data



Legend

- ▲ Field Observation Locations
 - ▭ Site Location
- Vegetation Type**
- | | |
|---|---|
| 1, Acer negundo | 24, Populus fremontii |
| 11, Freshwater Emergent Wetland | 25, Quercus lobata |
| 12, Freshwater Forested/Shrub Wetland | 27, Riverine Wetland |
| 13, Freshwater Pond | 28, Rubus armeniacus |
| 16, Juglans hindsii and Hybrids | 30, Salix exigua |
| 18, Lacustrine Wetland | 32, Salix gooddingii |
| 22, Naturalized warm-temperate riparian and wetland group | 35, Schoenoplectus |
| | 39, Water |
| | 7, California Warm Temperate Marsh/Seep |



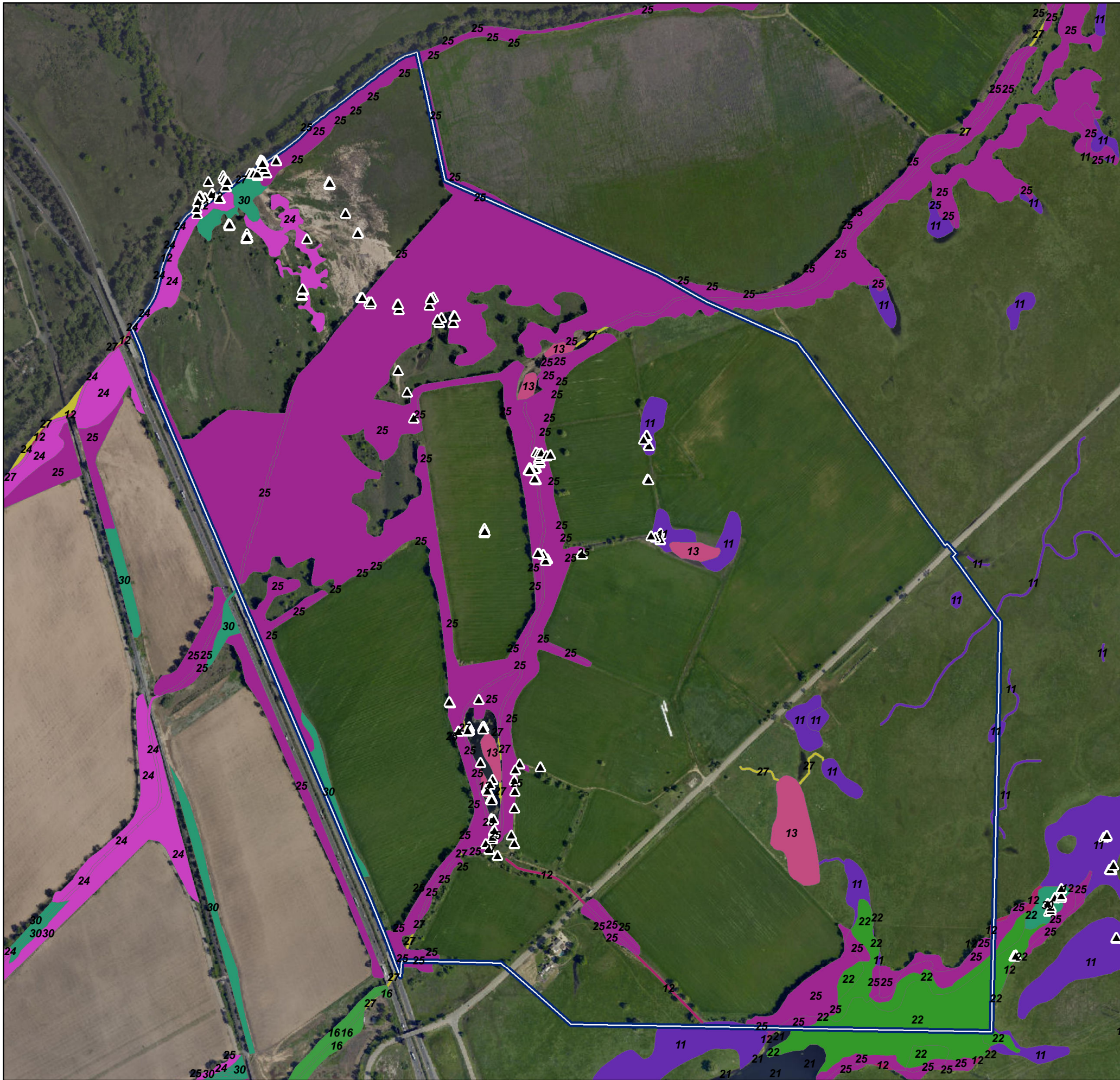
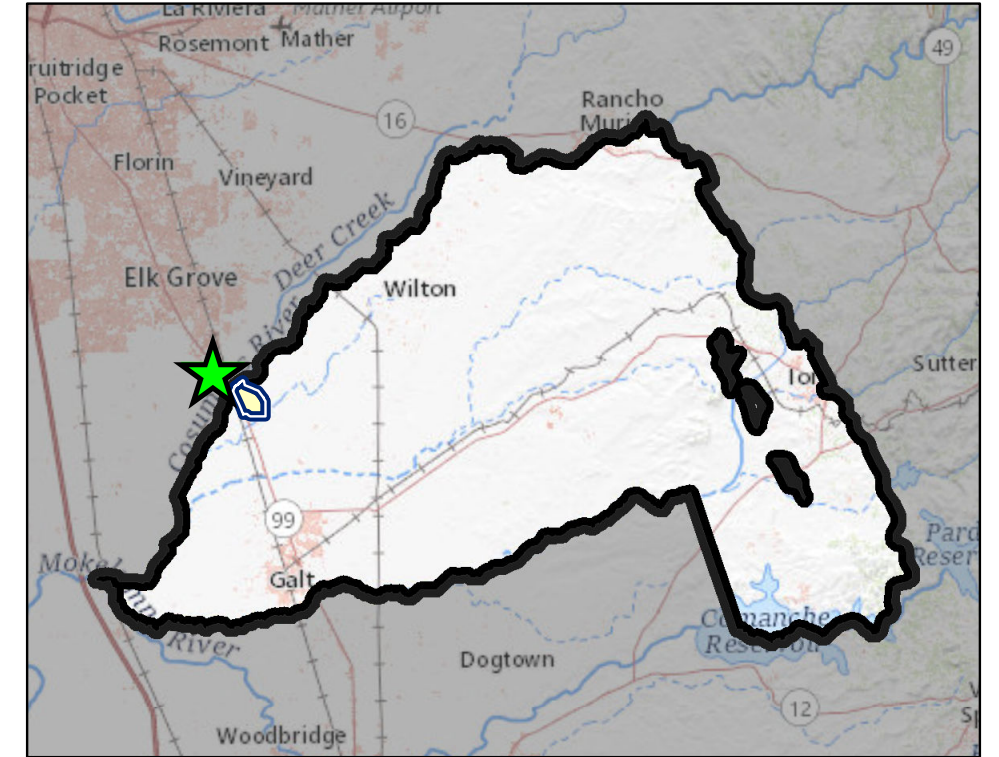
Site	Site 3C. Cosumnes River Ecological Reserve
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Populus fremontii</i> , <i>Quercus lobata</i> , <i>Salix exigua</i> , <i>Salix gooddingii</i> , Freshwater Emergent Wetland, Freshwater Forested/Shrub Wetland, Freshwater Pond, <i>Ludwigia</i> , <i>Juglans hindsii</i> and hybrids, Naturalized warm temperate riparian and wetland group, <i>Schoenoplectus</i> , Riverine Wetland, <i>Schoenoplectus</i> , <i>Typha</i> , Water and California Warm Temperate Marsh/Seep.
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species include valley oak (<i>Quercus lobata</i>), Goodding's willow (<i>Salix gooddingii</i>), coyote willow (<i>Salix exigua</i>), cottonwood (<i>Populus fremontii</i>), Oregon ash (<i>Fraxinus latifolia</i>), walnut (<i>Juglans</i> spp.), and box elder (<i>Acer negundo</i>); similar NCCAG and NVCS data. Elderberry (<i>Sambucus nigra</i>), rose, and <i>Baccharis</i> also present. Isolated ponds, often with aquatic spp, and marshes (<i>Typha</i> and <i>Schoenoplectus</i> dominated) also occur. Sloughs spur off the Cosumnes mainstem channel. Isolated depressions dominated by <i>Juncus</i> , <i>Eleocharis</i> , cocklebur (<i>Xanthium strumarium</i>), and <i>Persicaria lapathifolia</i> . Riverine wetlands (per NWI) present.
Description of Overall Accuracy of Existing Vegetation Mapping	Existing mapping captures extent of wetland herbaceous communities, woody riparian areas, and aquatic habitats relatively well but diversity and complexity commonly under-represented by NCCAG and NVCS data.
Typical canopy structure	Forested types contain variable overstory cover ranging from 11 to 25% class to 26-50%. Understory density increases closer to the mainstem channel, variable, sometimes exceeds 50% cover.
Predominant Geomorphic Setting for Wetland/Riparian Communities	Most of site lies within a riverine setting, occasional pond/lakes, and isolated depressions.
Hydrological Conditions Summary	Based on distribution of woody debris, abandoned flow paths, watermarks on vegetation, and sediment; site appears to inundate regularly. Sloughs common. Cosumnes likely near perennial in this section. Residual standing water from recent overbank flooding observed.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer within riparian corridor 50 to 100 feet below ground.
Invasive Non-Native Species Observed	Annual bromes observed but native dominated throughout.
Canopy Dieback Summary	Canopy dieback typically <5% in portions with woody vegetation.
Natural Recruitment Summary	Natural recruitment of native riparian species rare to common in segments dominated by woody species. Valley oak, walnut, and box elder saplings observed.
Biological Condition Gradient Summary	Level 2/Level 3, depending on individual feature

<i>Soil Conditions Summary</i>	Loamy textured soils, often moist near surface, redox indicators frequently present in top 1.5 feet.
<i>Land Use and Anthropogenic Alterations Summary</i>	Site in natural condition with little disturbance.
<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat. Marshes are important for western pond turtle, giant garter snake, northern harrier, tricolored blackbird, and western red bat.
<i>General Notes</i>	Reconnaissance level survey conducted on foot. Site is owned and managed by the California Department of Fish and Wildlife. Site diverse and complex. Riparian forests and sloughs, while present, less extensive than downstream at site 3A. Abundant waterfowl observed throughout the site, including foraging in open fields.
<i>GDE Evaluation Summary</i>	Unlikely a SGMA GDE, possible perched alluvial aquifer



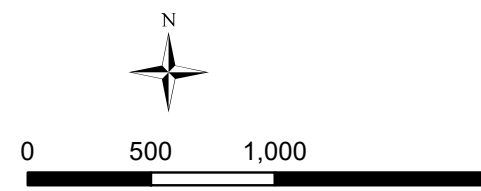
Top photo: remnant overbank flooding in a side channel with recent sand deposits along the bank.
Bottom left: Baccharis shrubland. Bottom right: Cosumnes mainstem channel at this location.

**Site 3C - Cosumnes River Ecological Reserve:
Vegetation Types Described in the Existing
NCCAG and NVCS Vegetation Data**



Legend

- ▲ Field Observation Locations
 - ▭ Site Location
- Vegetation Type**
- 11, Freshwater Emergent Wetland
 - 12, Freshwater Forested/Shrub Wetland
 - 13, Freshwater Pond
 - 16, Juglans hindsii and Hybrids
 - 22, Naturalized warm-temperate riparian and wetland group
 - 24, Populus fremontii
 - 25, Quercus lobata
 - 27, Riverine Wetland
 - 30, Salix exigua



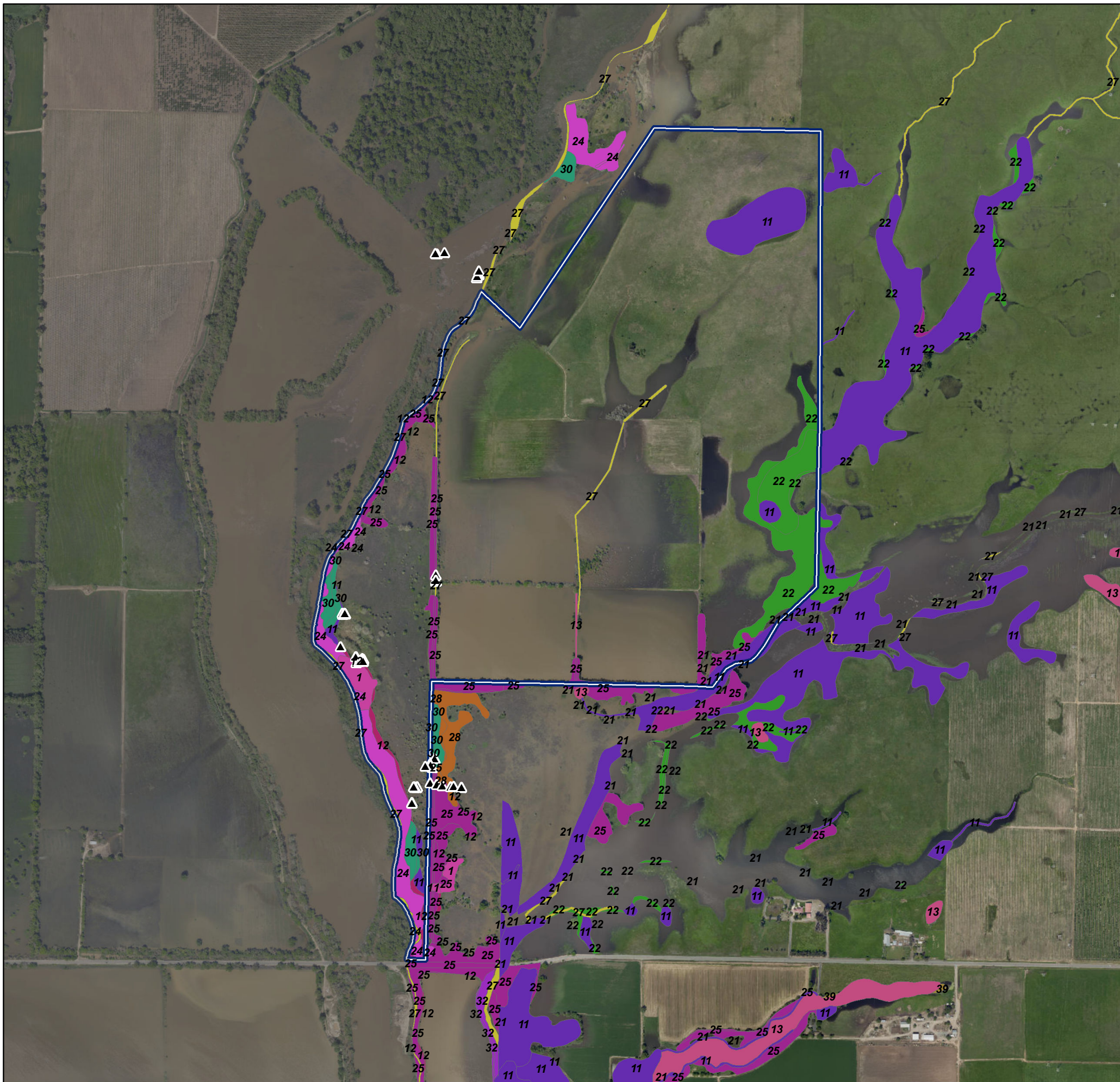
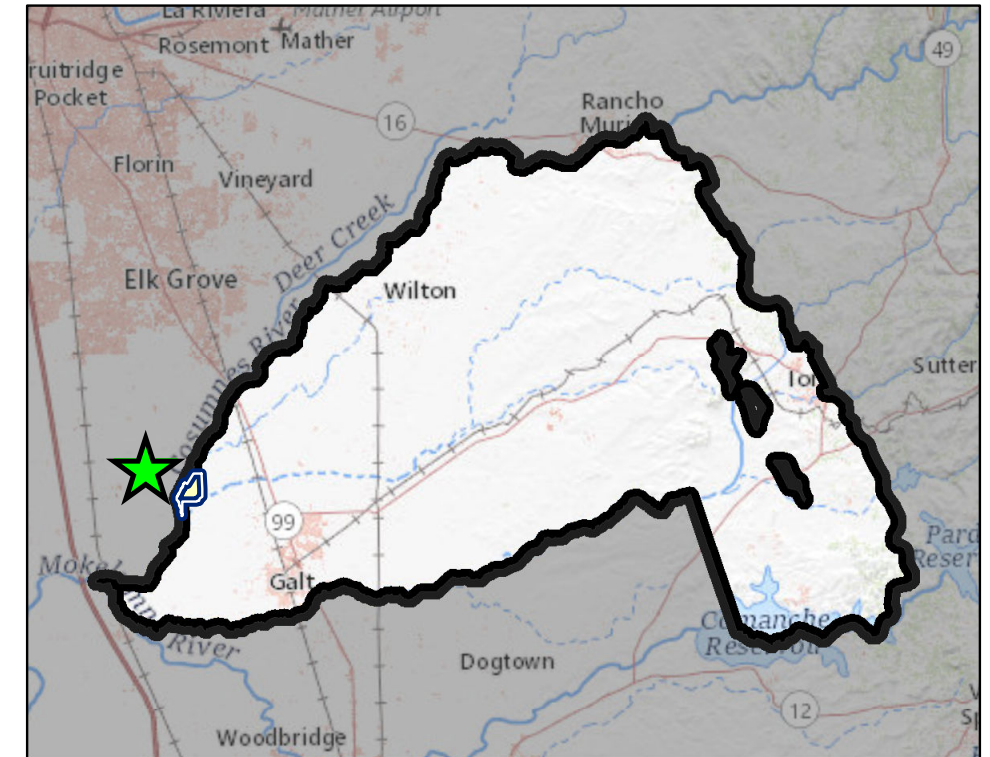
Site	Site 4A. Cosumnes River Preserve
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Acer negundo</i> , <i>Populus fremontii</i> , <i>Quercus lobata</i> , Freshwater Emergent Wetland, Freshwater Forested/Shrub Wetland, Freshwater Pond, <i>Ludwigia</i> , Naturalized warm temperate riparian and wetland group, Riverine Wetland, <i>Rubus armeniacus</i> , and <i>Salix exigua</i>
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species cottonwood (<i>Populus fremontii</i>), box elder (<i>Acer negundo</i>), valley oak (<i>Quercus lobata</i>), coyote willow (<i>Salix exigua</i>), and Himalayan blackberry (<i>Rubus armeniacus</i>). Rose (<i>Rosa</i> sp.), Goodding's willow (<i>Salix gooddingii</i>), elderberry (<i>Sambucus nigra</i>), and Oregon ash (<i>Fraxinus latifolia</i>) common sub-dominants. Isolated ponds, often with aquatic spp (e.g. <i>Ludwigia</i>) and riverine wetlands (per NWI) present. Herbaceous wetland herbaceous communities (e.g. <i>Carex/Juncus</i> dominated) often inhabit openings between woody vegetation.
Description of Overall Accuracy of Existing Vegetation Mapping	Overstory species accurately characterized but understory species not captured and under-represented in existing mapping. Substantially more structural and species diversity than suggested by existing vegetation mapping data.
Typical canopy structure	Forested types typically contain 11-25% overstory canopy cover (with a scattered distribution) and 51-75% understory canopy cover (more contiguous).
Predominant Geomorphic Setting for Wetland/Riparian Communities	Most of the lies within a riverine setting with isolated, typically small depressions and ponds. Cosumnes mainstem less incised than upstream segments, dynamic floodplain.
Hydrological Conditions Summary	Cosumnes becomes a wider, less incised, lower velocity, and flow appears more perennial than upstream sites (e.g. Upper Cosumnes and Middle Cosumnes). Increased volume relative to upstream segments indicates this may be a gaining reach. Sediment deposits, debris, water marks on vegetation, and drainage patterns indicative of regular overbank flooding.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer 30 to 50 feet throughout the site.
Invasive Non-Native Species Observed	Himalayan blackberry abundant, often forming thick patches. Milk thistle (<i>Silybum marianum</i>) observed along with occasional dense patches of fennel (<i>Foeniculum vulgare</i>) which often inhabit small depressions and transitions between forested and open areas.
Canopy Dieback Summary	Canopy dieback 6-11%, primarily dead branches on box elder.
Natural Recruitment Summary	Natural recruitment of native riparian species common, including ash, oak, and box elder saplings, young coyote willow.

<i>Biological Condition Gradient Summary</i>	Level 2
<i>Soil Conditions Summary</i>	Loamy textured soils, moist near surface, redox indicators present in top 1.5 feet.
<i>Land Use and Anthropogenic Alterations Summary</i>	Roadway and bridge on downstream end of site, dirt road through site. Overall low disturbance. Portions may receive supplemental irrigation and runoff based on distribution of irrigation structures.
<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat.
<i>General Notes</i>	Relatively large site. Reconnaissance level survey conducted on the ground by walking floodplain areas and from the dirt road. Site collaboratively managed by multiple landowning partners; access coordinated through The Nature Conservancy. Site notably more structurally diverse and higher ecological function than Middle Cosumnes and Upper Cosumnes sites. Woody riparian species concentrated along the banks of the Cosumnes and adjacent isolated bands.
<i>GDE Evaluation Summary</i>	Not a SGMA GDE, but potential for perched alluvial aquifer.



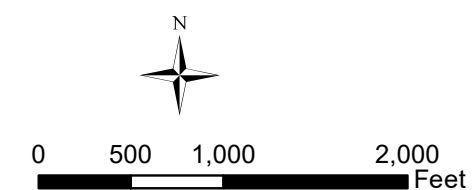
Photos: Cosumnes mainstem channel wider, floodplain is broader, more dynamic, and diverse than upstream segments. High diversity of woody species.

Site 4A - Cosumnes River Preserve: Vegetation Types Described in the Existing NCCAG and NVCS Vegetation Data



Legend

- ▲ Field Observation Locations
 - ▭ Site Location
- Vegetation Type**
- 1, Acer negundo
 - 11, Freshwater Emergent Wetland
 - 12, Freshwater Forested/Shrub Wetland
 - 13, Freshwater Pond
 - 22, Naturalized warm-temperate riparian and wetland group
 - 24, Populus fremontii
 - 25, Quercus lobata
 - 27, Riverine Wetland
 - 28, Rubus armeniacus
 - 30, Salix exigua
 - 32, Salix gooddingii
 - 39, Water



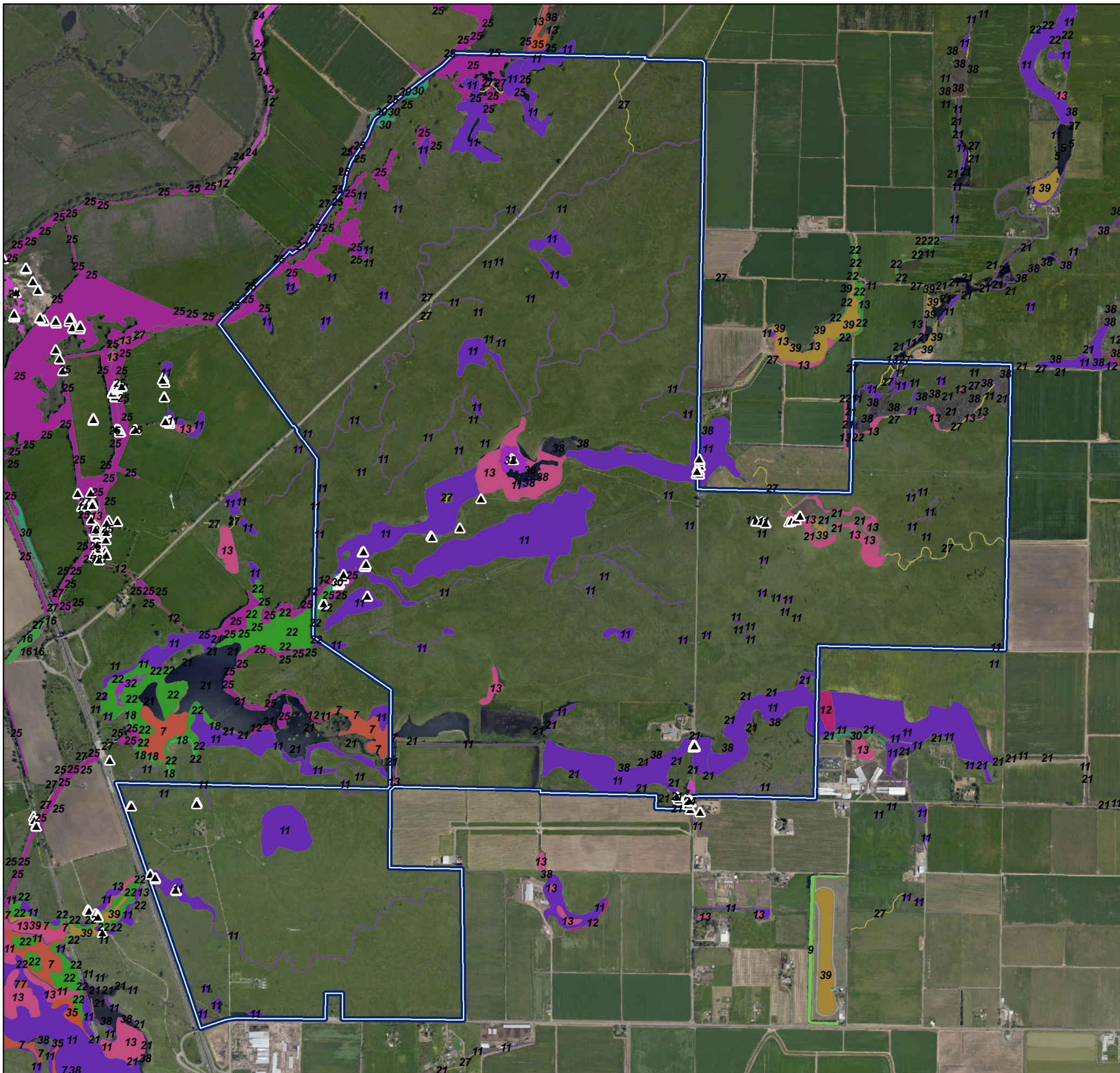
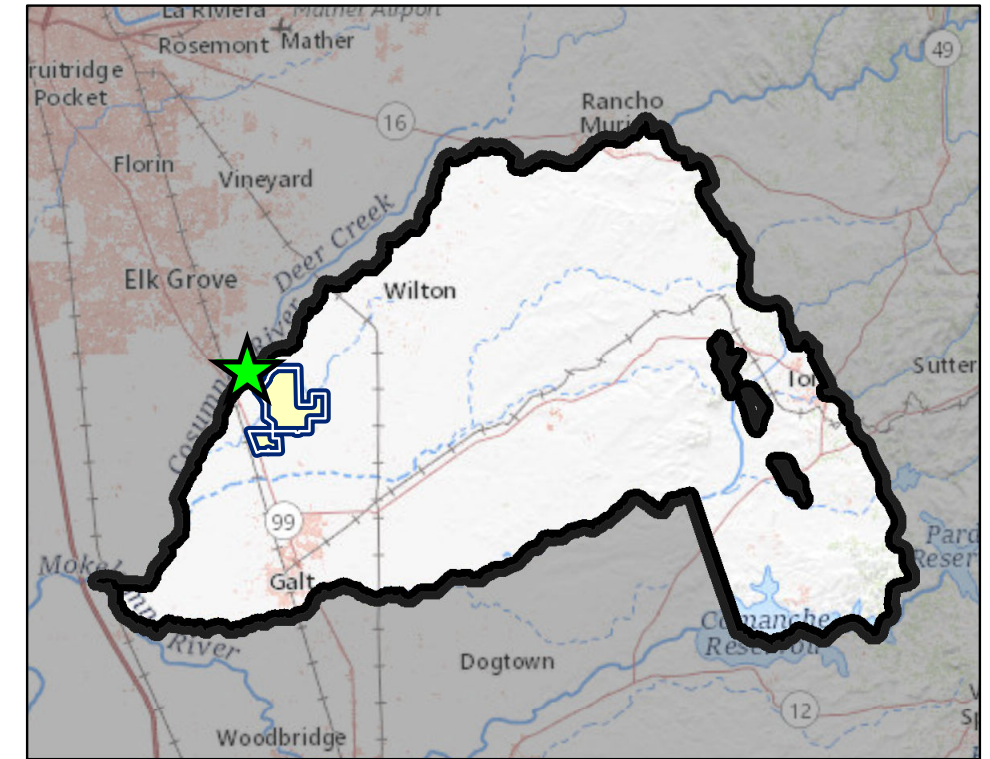
Site	Site 4B. Cosumnes River Preserve
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Populus fremontii</i> , <i>Quercus lobata</i> , <i>Salix exigua</i> , <i>Salix gooddingii</i> , Freshwater Emergent Wetland, Freshwater Forested/Shrub Wetland, Freshwater Pond, <i>Ludwigia</i> , Naturalized warm temperate riparian and wetland group, Riverine Wetland, California Warm Temperate Marsh/Seep, Water, <i>Typha</i> , and Lacustrine Wetland.
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species include valley oak (<i>Quercus lobata</i>), coyote willow (<i>Salix exigua</i>), Goodding's willow (<i>Salix gooddingii</i> ; dominant in isolated swales composed by woody species), and Eucalyptus. Red willow (<i>Salix laevigata</i>) and arroyo willow (<i>Salix lasiolepis</i>) also present, often along the edge of aquatic features. Isolated ponds, often with aquatic spp, and marshes (<i>Typha</i> and <i>Schoenoplectus</i> dominated) abundantly scattered in depressions in and around Badger Creek. Riverine wetlands (per NWI) present. Herbaceous wetland herbaceous communities (e.g. <i>Carex/Juncus/Eleocharis</i> dominated) often inhabit depressions, vernal pools, and vernal swales. <i>Persicaria lapathifolia</i> and <i>Xanthium strumarium</i> also sometimes dominant in moist soil depressions.
Description of Overall Accuracy of Existing Vegetation Mapping	Existing mapping captures extent of wetlands herbaceous communities and aquatic habitats with reasonable accuracy. Eucalyptus actual dominant species in some areas characterized as cottonwood dominated.
Typical canopy structure	Forested types contain variable overstory cover ranging from 11-25% to 26-50% and understory cover that also ranges from approximately 11% to 50%, depending on feature.
Predominant Geomorphic Setting for Wetland/Riparian Communities	Most of the lies within a riverine setting with intermixed ponds (sometimes large) and isolated depressions.
Hydrological Conditions Summary	Badger Creek is the primary flowing surface water feature within the site, which appears to have perennial surface water.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer 50 to 80 feet throughout the site.
Invasive Non-Native Species Observed	Milk thistle (<i>Silybum marianum</i>), Bull thistle (<i>Cirsium vulgare</i>) and fennel (<i>Foeniculum vulgare</i>) observed, abundant annual <i>Bromus</i> spp.
Canopy Dieback Summary	Canopy dieback typically 6-10% in portions with woody vegetation, primarily dead branches on Eucalyptus and Goodding's willow.
Natural Recruitment Summary	Natural recruitment of native riparian species uncommon overall, but recent reproduction of <i>Salix</i> spp. observed.
Biological Condition Gradient Summary	Level 2 in marshes and ponds, forested areas classified as Level 3 (when native dominated) or Level 5 (when Eucalyptus dominated)

<i>Soil Conditions Summary</i>	Clayey loam to loam textured soils, often moist to saturated near surface, redox indicators frequently present in top foot.
<i>Land Use and Anthropogenic Alterations Summary</i>	Roadway and bridge intersect Badger Creek, dirt road through site. Lots of recent trash dumping off roadway. Overall low disturbance. Portions may receive supplemental irrigation and runoff based on distribution of irrigation structures. Livestock grazing, trampling, wildlife browsing observed.
<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat. Marshes are important for western pond turtle, giant garter snake, northern harrier, tricolored blackbird, and western red bat. Vernal pools provide habitat vernal pool tadpole shrimp, vernal pool fairy shrimp, conservancy fairy shrimp, Ricksecker's water scavenger beetle, western spadefoot toad, California tiger salamander, and numerous wintering migratory birds.
<i>General Notes</i>	Reconnaissance level survey conducted on foot within targeted features throughout the site, which is collaboratively managed by multiple landowning partners; access coordinated through The Nature Conservancy. Site contains an abundance of valuable aquatic features with variable size, depth, aquatic plant species, and woody species along margins.
<i>GDE Evaluation Summary</i>	Not a SGMA GDE, but potential for perched alluvial aquifer.



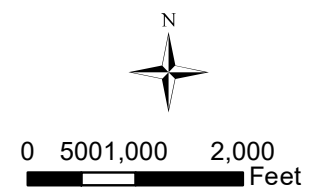
Top photo: Relatively large Goodding's willow community that has established in a swale. Bottom left: marsh feature with a variety of aquatic species. Bottom right: Eucalyptus grove with olive tree windbreak that was classified as cottonwood in existing vegetation mapping.

Site 4B - Cosumnes River Preserve: Vegetation Types Described in the Existing NCCAG and NVCS Vegetation Data



Legend

- ▲ Field Observation Locations
 - ▭ Site Location
- | Vegetation Type | |
|---|---|
| 11, Freshwater Emergent Wetland | 24, Populus fremontii |
| 12, Freshwater Forested/Shrub Wetland | 25, Quercus lobata |
| 13, Freshwater Pond | 27, Riverine Wetland |
| 16, Juglans hindsii and Hybrids | 30, Salix exigua |
| 18, Lacustrine Wetland | 32, Salix gooddingii |
| 22, Naturalized warm-temperate riparian and wetland group | 35, Schoenoplectus |
| | 39, Water |
| | 7, California Warm Temperate Marsh/Seep |
| | 9, Eucalyptus spp. - Ailanthus altissima - Robinia pseudoacacia |



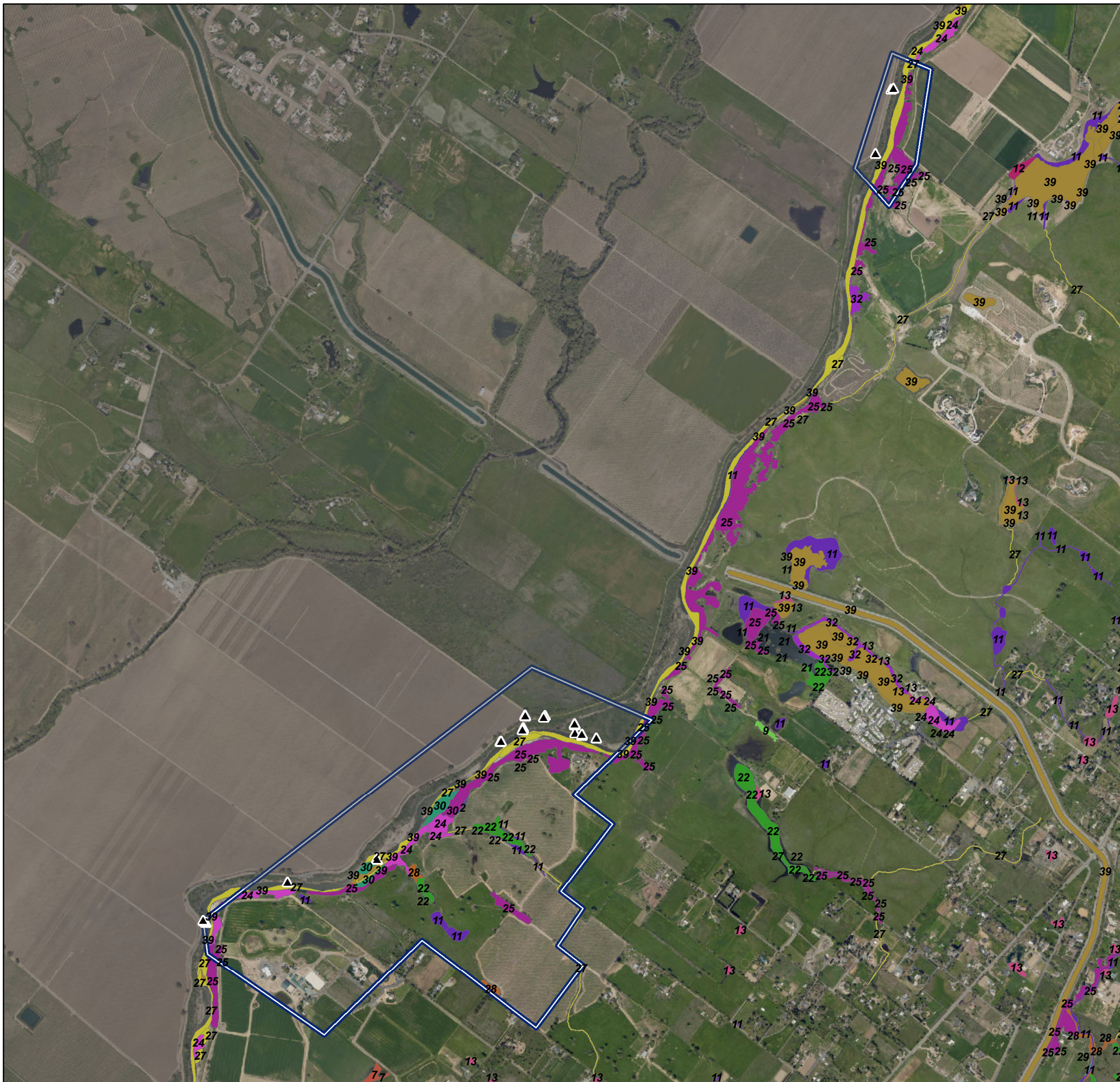
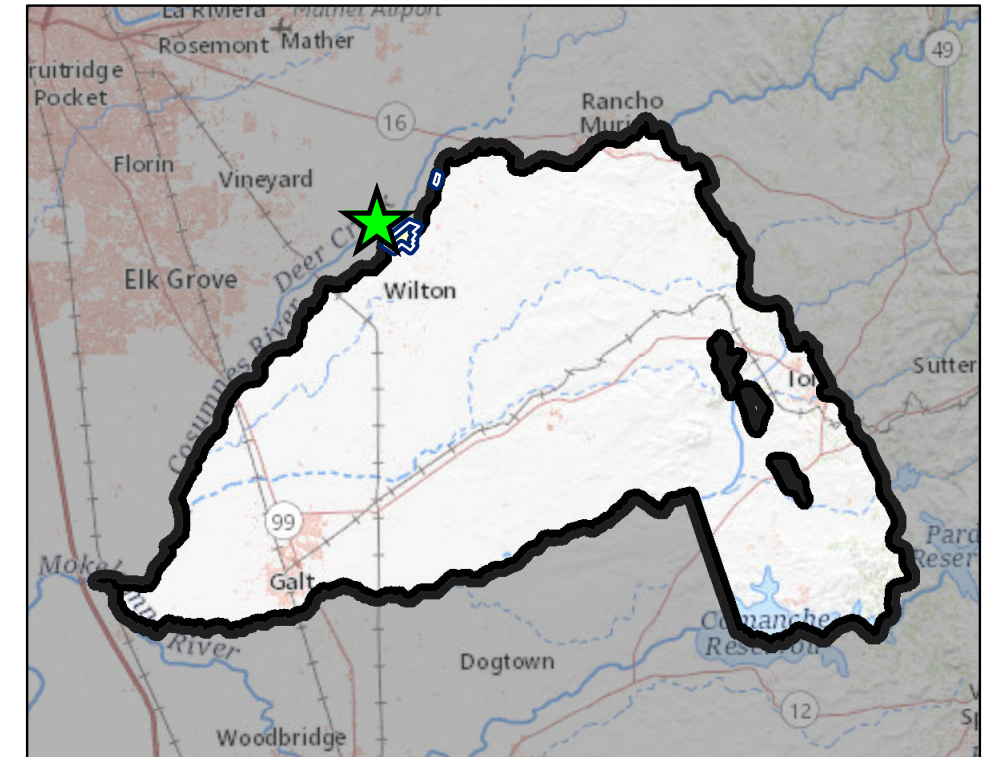
Site	Site 5. Middle Cosumnes
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Populus fremontii</i> , <i>Quercus lobata</i> , <i>Salix exigua</i> , Freshwater Emergent Wetland, <i>Ailanthus altissima</i> , Naturalized warm-temperate riparian and wetland group, Riverine Wetland, <i>Rubus armeniacus</i> , Water
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species include valley oak (<i>Quercus lobata</i>), blue oak (<i>Quercus douglasii</i>), Oregon ash (<i>Fraxinus latifolia</i>), Cottonwood (<i>Populus fremontii</i>), Coyote willow (<i>Salix exigua</i>), as indicated in existing mapping. Arroyo willow (<i>Salix lasiolepis</i>) on point bars, elderberry (<i>Sambucus nigra</i>), seep willow (<i>Baccharis</i> sp.), Oregon ash (<i>Fraxinus latifolia</i>), and California buckeye (<i>Aesculus californica</i>) co-dominants and/or sub-dominants on banklines. Tree of heaven (<i>Ailanthus altissima</i>) also observed along with Himalayan blackberry (<i>Rubus armeniacus</i>). Riverine type (per NWI) types and in channel open water present as indicated in existing data.
Description of Overall Accuracy of Existing Vegetation Mapping	While dominant species specified in existing mapping are the actual dominant species at the site, their current distribution is frequently misaligned with the existing mapping. Species diversity often under-represented within features, valley oak communities also contain blue oak in this segment. Bankline communities (while narrowly confined to exposed banks) typically not captured in existing mapping.
Typical canopy structure	Forested types typically contain 25-50% overstory canopy cover and <10% understory canopy cover. Shrubland areas have <5% overstory cover and 25-50% understory cover.
Predominant Geomorphic Setting for Wetland/Riparian Communities	The entire site lies within a riverine setting. The mainstem channel through the property is entrained, but less incised than the Upper Cosumnes site. The active floodplain is primarily limited to low set gravel/cobble/sandy, point bars that have formed immediately adjacent to the channel margins. High aquatic habitat diversity with pools intermixed with short riffle segments.
Hydrological Conditions Summary	Flow appears regular intermittent, suspected to be less perennial than Upper Cosumnes site. Steep, unstable banks isolate mid-and high-terraces from more active floodplain.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer is greater than 100 feet throughout the site.
Invasive Non-Native Species Observed	Tree of heaven is the main exotic woody species, occasional Himalayan blackberry. Giant reed (<i>Arundo donax</i>) inhabits point bars, but in low density. Observations were conducted from the opposite side of the river, so herbaceous weeds were not easily detectible.
Canopy Dieback Summary	Canopy dieback typically less than 5%, primarily restricted to mistletoe infested cottonwood.

<i>Natural Recruitment Summary</i>	Natural recruitment of native riparian species detected but rare, primarily as cottonwood saplings and young coyote willow on instream bars.
<i>Biological Condition Gradient Summary</i>	Level 3
<i>Soil Conditions Summary</i>	Not evaluated.
<i>Land Use and Anthropogenic Alterations Summary</i>	Manmade channel alterations (canalization).
<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat
<i>General Notes</i>	Survey conducted from opposite side of river accompanied by Melinda Frost-Hurzel. Numerous songbirds observed. The aquatic habitat within the Cosumnes is currently complex and highly valuable. The channel gradient varies from riffles to deep pools, lots of wood of varying size is deposited on the riverbed, and riverbed substrate also varies.
<i>GDE Evaluation Summary</i>	Not a SGMA GDE, but potential for perched alluvial aquifer.



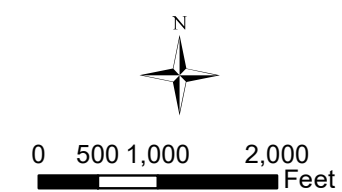
Top photo: typical conditions at the site. Oak communities (blue oak and valley oak, sometimes intermixed) concentrated on elevated terrace, cottonwood/willow recruitment occurs on point bars which have variable substrate and often barren. Bottom left: tree of heaven patch, bottom right: point bar with willow and a variety of shrubs, mistletoe infested cottonwood on the terrace with valley oak.

Site 5 - Middle Cosumnes: Vegetation Types Described in the Existing NCCAG and NVCS Vegetation Data



Legend

- | | |
|---|--|
| ▲ Field Observation Locations | 25, <i>Quercus lobata</i> |
| ▭ Site Location | 27, Riverine Wetland |
| Vegetation Type | |
| 11, Freshwater Emergent Wetland | 28, <i>Rubus armeniacus</i> |
| 12, Freshwater Forested/Shrub Wetland | 29, <i>Rubus armeniacus</i> - <i>Sesbania punicea</i> - <i>Ficus carica</i> |
| 13, Freshwater Pond | 30, <i>Salix exigua</i> |
| 2, <i>Ailanthus altissima</i> | 32, <i>Salix gooddingii</i> |
| 22, Naturalized warm-temperate riparian and wetland group | 39, Water |
| 24, <i>Populus fremontii</i> | 7, California Warm Temperate Marsh/Seep |
| | 9, <i>Eucalyptus</i> spp. - <i>Ailanthus altissima</i> - <i>Robinia pseudoacacia</i> |



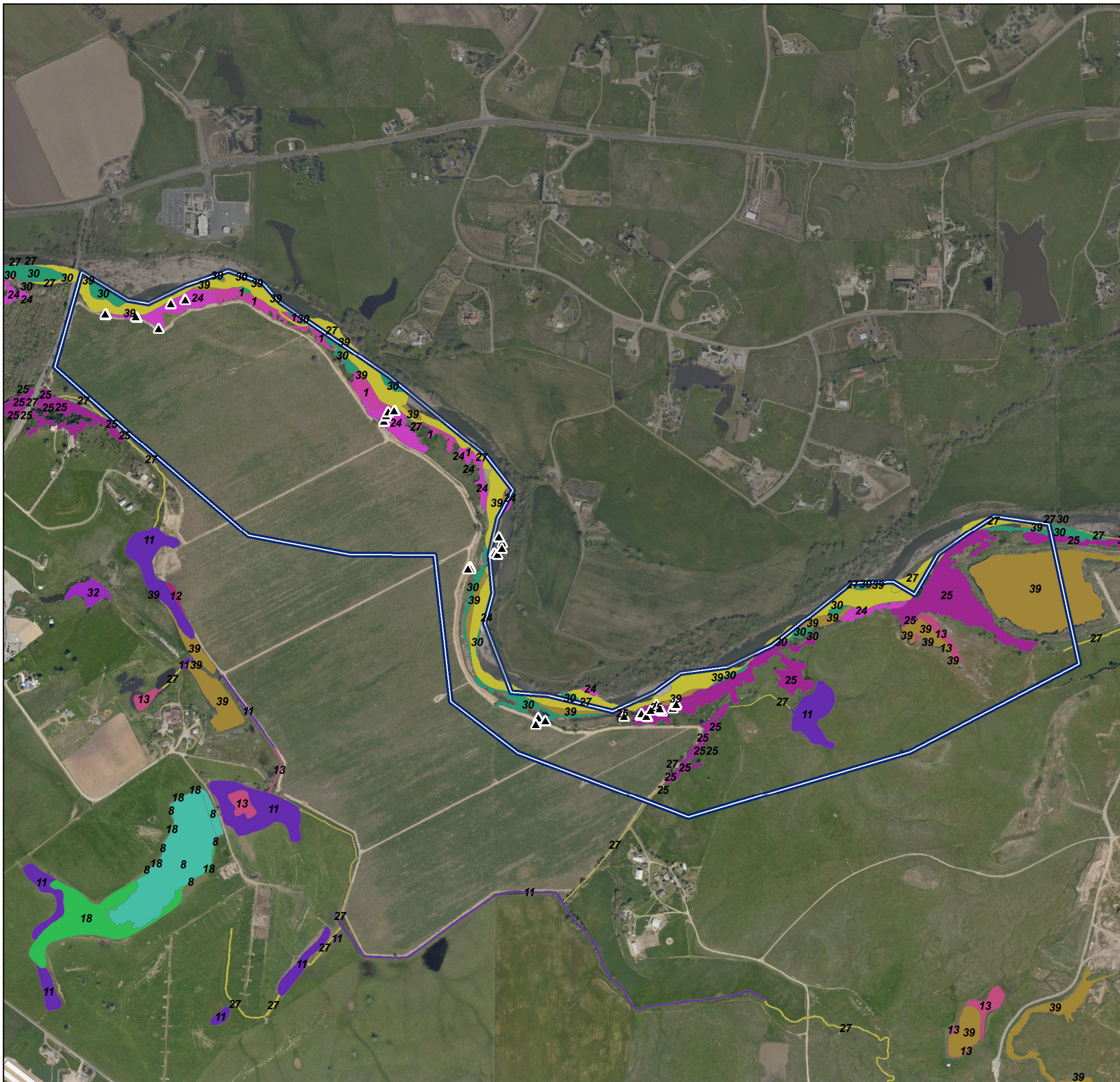
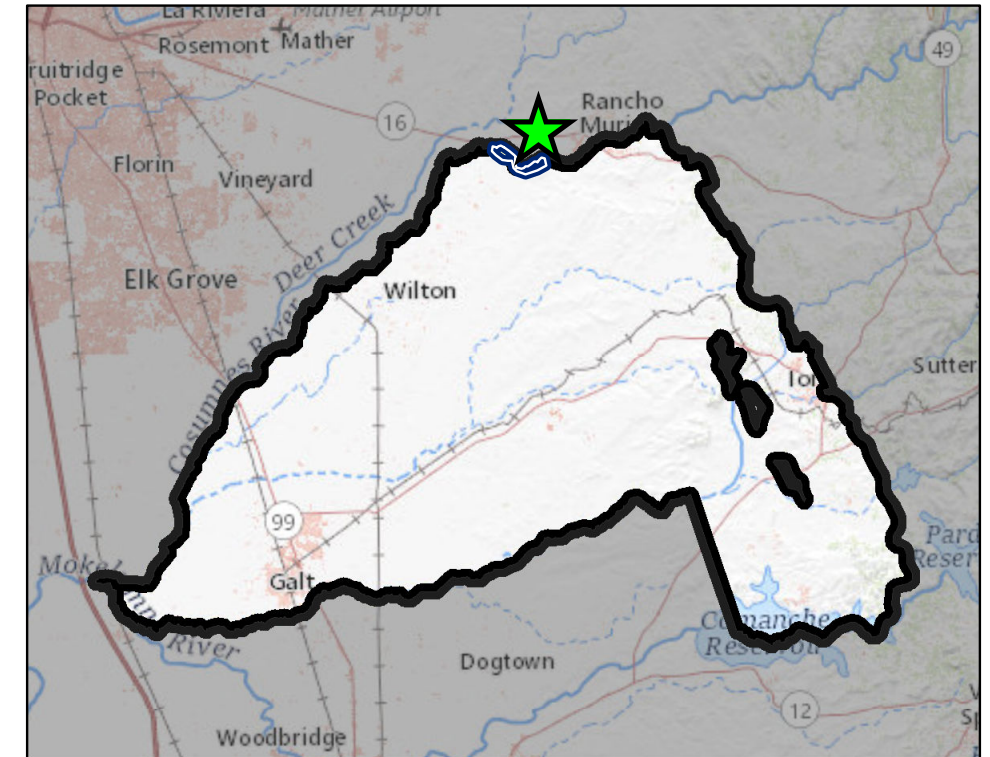
Site	Site 6. Upper Cosumnes
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Populus fremontii</i> , <i>Quercus lobata</i> , <i>Salix exigua</i> , <i>Acer negundo</i>
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species include valley oak (<i>Quercus lobata</i>), Oregon ash (<i>Fraxinus latifolia</i>), Cottonwood (<i>Populus fremontii</i>), Coyote willow (<i>Salix exigua</i>), as indicated in existing mapping. Arroyo willow (<i>Salix lasiolepis</i>) and elderberry (<i>Sambucus nigra</i>) also common co-dominants and/or sub-dominants in lower canopy layers. Tree of heaven (<i>Ailanthus altissima</i>) was also observed.
Description of Overall Accuracy of Existing Vegetation Mapping	While dominant species indicated in existing mapping are the actual dominant species at the site, their current distribution is frequently misaligned with the existing mapping. Species including elderberry and arroyo willow were also sometimes co-dominants but neither species is identified in existing mapping. Several features mapped as coyote willow were dominated by elderberry.
Typical canopy structure	Forested types typically contain 25-50% overstory canopy cover and 11-50% understory canopy cover. Shrubland areas have <5% overstory cover and 25-50% understory cover.
Predominant Geomorphic Setting for Wetland/Riparian Communities	The entire site lies within a riverine setting. The mainstem channel through the property is deeply entrained and channel incision appears to be advancing. It is our understanding that the channel was initially canalized years ago by the U.S. Army Corps of Engineers. Under the current condition, the active floodplain is primarily limited to low set gravel/cobble/sandy, coyote willow dominated bars that have formed immediately adjacent to the channel margins or on islands.
Hydrological Conditions Summary	Flow appears regular intermittent to perennial. Throughout the site, geomorphic features often abruptly transition via sharp banks that divide active floodplains from high terraces. Banks are composed of unstable, erosive sheer drops. High terraces with mature oaks and cottonwoods often sit 20+ feet above the water surface elevation. Remnant flow paths apparent through the mid- and high- terraces, suggesting they used to have a more direct hydraulic connection with the Cosumnes.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer is 10-30 feet throughout the site.
Invasive Non-Native Species Observed	Except for annual grasses (mainly <i>Bromus</i> spp.), most of the site is dominated by native species. Tree of heaven is the main exotic woody species. Two noxious weeds were observed – milk thistle (<i>Cirsium vulgare</i>) and a skeleton that appeared to be a species of star thistle.

<i>Canopy Dieback Summary</i>	Canopy dieback ranges from 5% to 40%, depending on species. Affected species include cottonwood, oak, and box elder. Mistletoe is most prominent on cottonwood and canopy senescence prominent on both valley oak and cottonwood.
<i>Natural Recruitment Summary</i>	Natural recruitment of native riparian species detected but rare, primarily as cottonwood saplings on instream bars, but not in abundance.
<i>Biological Condition Gradient Summary</i>	Level 3/Level 4 depending on specific feature
<i>Soil Conditions Summary</i>	Near surface conditions are sandy loam to loamy, dry to slightly moist. Redox indicators only evident within bars.
<i>Land Use and Anthropogenic Alterations Summary</i>	Manmade channel alterations (canalization).
<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat
<i>General Notes</i>	Kautz Vineyard property near Rancho Murieta. Survey was accompanied by Melinda Frost-Hurzel. The field evaluation limited to segments of the property between the Cosumnes mainstem channel and the levee. Numerous songbirds inhabit the riparian corridor, a bald eagle was observed. The aquatic habitat within the Cosumnes is currently complex and highly valuable. The channel gradient varies from riffles to deep pools, lots of wood of varying size is deposited on the riverbed, and riverbed substrate also varies.
<i>GDE Evaluation Summary</i>	Not a SGMA GDE, but potential for perched alluvial aquifer.



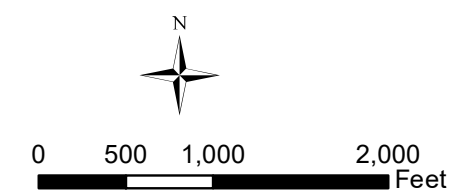
Top photo: riparian trees on opposite bank with exposed roots extending below water surface elevation. Bottom left: tree of heaven patch, bottom right: point bar, typical of features with active recruitment (but sparse overall).

**Site 6 - Upper Cosumnes:
Vegetation Types Described in the Existing
NCCAG and NVCS Vegetation Data**



Legend

- | | |
|---------------------------------------|-------------------------|
| ▲ Field Observation Locations | 18, Lacustrine Wetland |
| □ Site Location | 24, Populus fremontii |
| Vegetation Type | |
| 1, Acer negundo | 25, Quercus lobata |
| 11, Freshwater Emergent Wetland | 27, Riverine Wetland |
| 12, Freshwater Forested/Shrub Wetland | 30, Salix exigua |
| 13, Freshwater Pond | 32, Salix gooddingii |
| | 39, Water |
| | 8, Eichhornia crassipes |



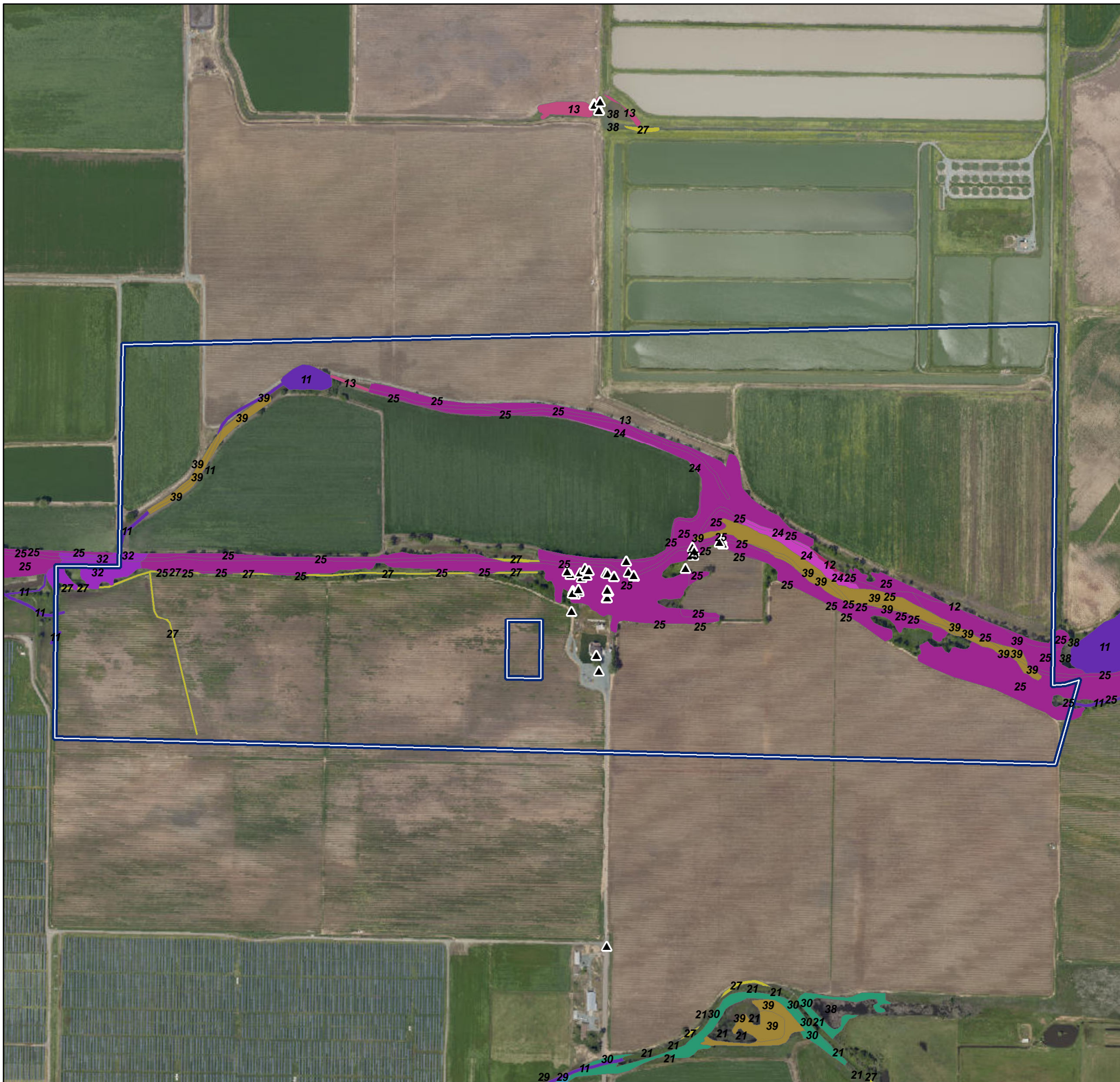
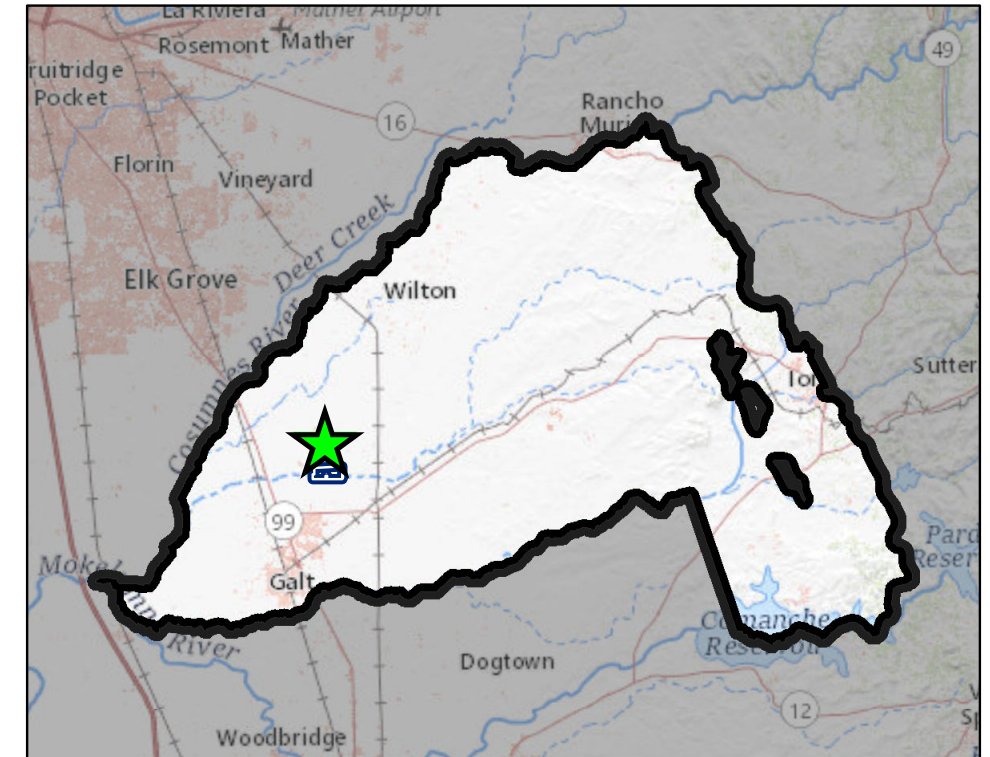
Site	Site 7. Valley Oak
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Quercus lobata</i> , (predominant type) <i>Salix gooddingii</i> , Freshwater Emergent Wetland, Freshwater Forested/Shrub Wetland, Riverine Wetland, Water
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species is valley oak (<i>Quercus lobata</i>) through most of site. Cottonwood (<i>Populus fremontii</i>), Gooddings willow (<i>Salix gooddingii</i>) also present. Oregon ash (<i>Fraxinus latifolia</i>) is dominant shrub species in most of area. Riverine type (per NWI) types and in channel open water present as indicated in existing data.
Description of Overall Accuracy of Existing Vegetation Mapping	Existing mapping is accurate overall but under-represents species diversity within features.
Typical canopy structure	Forested types typically contain 25-50% overstory canopy cover and 26-50% understory canopy cover.
Predominant Geomorphic Setting for Wetland/Riparian Communities	The entire site lies within a riverine setting. Channel braided within the riparian forest. Laguna and Skunk Creeks converge near this location.
Hydrological Conditions Summary	Flow appears regular intermittent, possibly perennial. Debris and sediment distribution suggest there is periodic overbank flooding through the gallery forest.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer is 50 to 100 feet throughout most of the site.
Invasive Non-Native Species Observed	None observed.
Canopy Dieback Summary	Canopy dieback typically less than 5%, healthy oak throughout.
Natural Recruitment Summary	Natural recruitment of native riparian species common, primarily ash and occasional valley oak.
Biological Condition Gradient Summary	Level 3
Soil Conditions Summary	Soils loamy, and moist to saturated near surface. Redox indicators observed within the top foot.
Land Use and Anthropogenic Alterations Summary	Surrounded by vineyards. Per irrigation structures present in the site, it appears that irrigation water is periodically discharged into the creek.

<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat
<i>General Notes</i>	Survey conducted with permission of the property owner, Marlin Strapp. Beautiful, healthy valley oak community with variable aged trees lines Laguna Creek. Moist soils throughout, high recruitment abundance. Per landowner, irrigation discharges into the creek are less frequent now that most of the adjacent vineyards have converted to drip irrigation.
<i>GDE Evaluation Summary</i>	Not a SGMA GDE, but potential for perched alluvial aquifer.



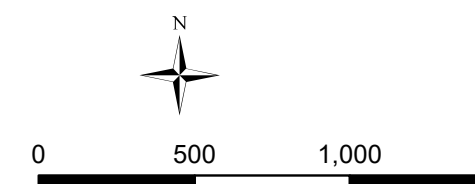
Top photo: typical conditions at the site. Oak communities on both sides of Laguna Creek. Bottom left: healthy oak, variable aged inhabits site. Bottom right: channel includes multiple braids, some active, others inactive during the survey.

Site 7 - Valley Oak: Vegetation Types Described in the Existing NCCAG and NVCS Vegetation Data



Legend

- ▲ Field Observation Locations
 - Site Location
- Vegetation Type**
- 11, Freshwater Emergent Wetland
 - 12, Freshwater Forested/Shrub Wetland
 - 13, Freshwater Pond
 - 24, Populus fremontii
 - 25, Quercus lobata
 - 27, Riverine Wetland
 - 29, Rubus armeniacus - Sesbania punicea - Ficus carica
 - 30, Salix exigua
 - 32, Salix gooddingii
 - 39, Water



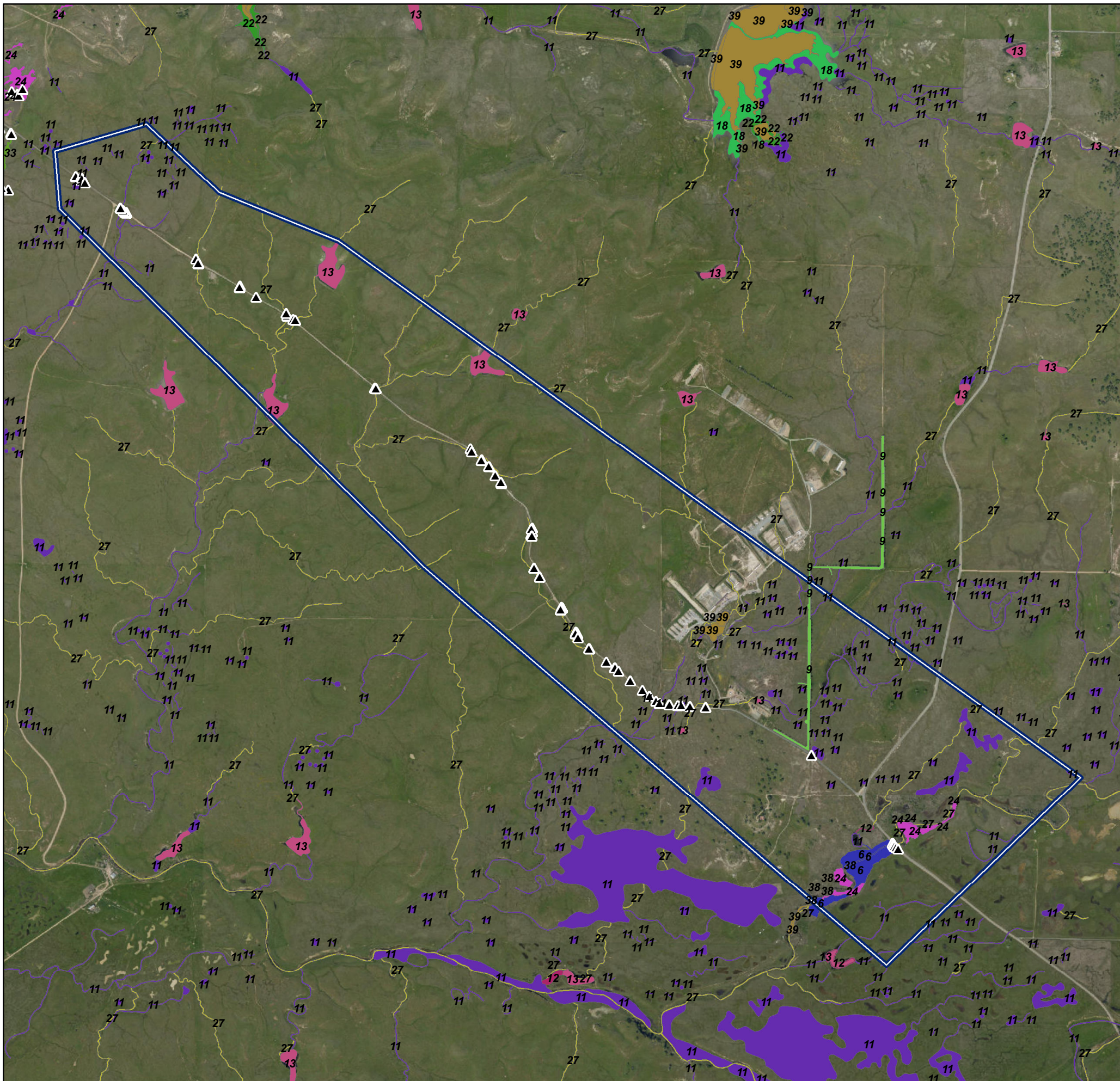
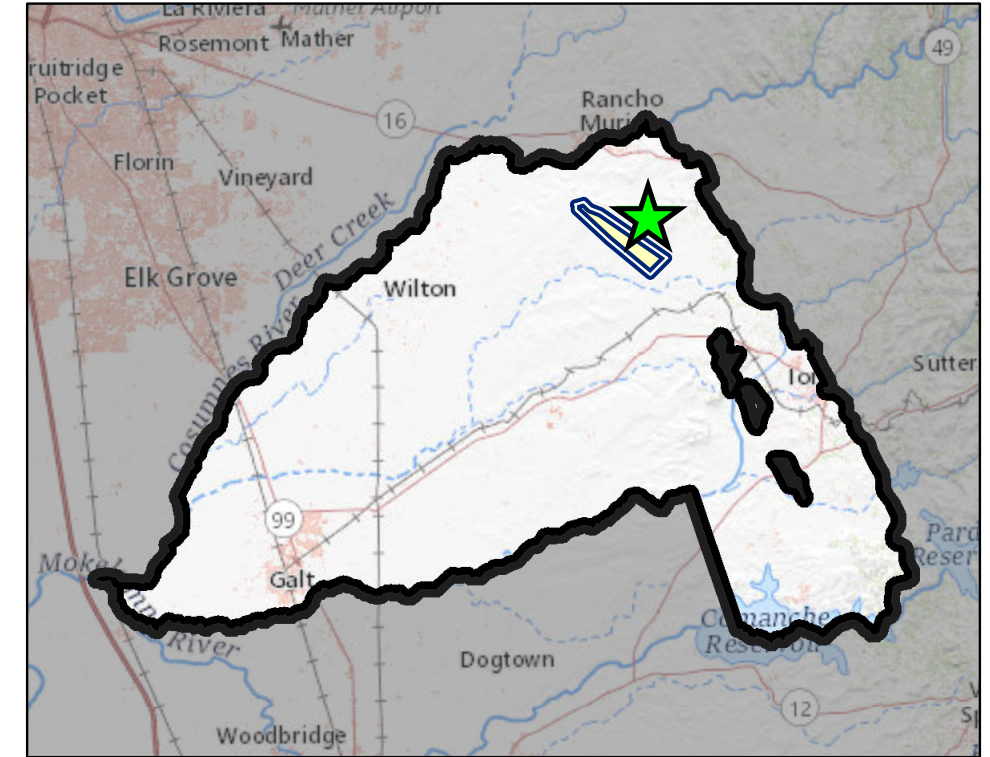
Site	Site 8. Vernal Pools
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	Freshwater Emergent Wetland
Dominant Vegetation Type(s) Actually Observed in the Field	Vernal pools and swales, typically dominated by herbaceous species, e.g. <i>Juncus</i> spp and graminoids. Duckweed (<i>Lemna</i> spp.) common on pools.
Description of Overall Accuracy of Existing Vegetation Mapping	Existing mapping has variable accuracy throughout this site. Valley oak communities often mis-identified as Eucalyptus dominated communities in existing data. Prominent wetland types described in existing data all present, but diversity under-represented on a feature-by-feature basis.
Typical canopy structure	Woody cover <5% throughout.
Predominant Geomorphic Setting for Wetland/Riparian Communities	Depressional setting throughout
Hydrological Conditions Summary	Seasonally inundated
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer is greater than 100 feet at the site.
Invasive Non-Native Species Observed	<i>Bromus</i> occasional along margins, primarily native spp.
Canopy Dieback Summary	None observed
Natural Recruitment Summary	None observed
Biological Condition Gradient Summary	Level 1/Level 2, depending on degree of livestock grazing and soil disturbance
Soil Conditions Summary	Soils loamy and saturated. Redox indicators abundant.
Land Use and Anthropogenic Alterations Summary	Livestock grazing, trampling, enclosure fences, occasional vehicle/off-road tracks

<i>Habitat Potential for Sensitive Species</i>	Vernal pools provide habitat vernal pool tadpole shrimp, vernal pool fairy shrimp, conservancy fairy shrimp, Ricksecker's water scavenger beetle, western spadefoot toad, California tiger salamander, and numerous wintering migratory birds.
<i>General Notes</i>	Large site, evaluated within several isolated locations throughout. Vast complex of vernal pools in foothills to foothills/valley transition zone.
<i>GDE Evaluation Summary</i>	Not a SGMA GDE



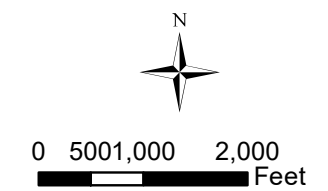
Photos: Numerous vernal pools with varying degrees of vegetation cover, water depth and area are abundant throughout the site, particularly in the foothills to valley transition area.

Site 8 - Vernal Pools: Vegetation Types Described in the Existing NCCAG and NVCS Vegetation Data



Legend

- ▲ Field Observation Locations
 - ▭ Site Location
- Vegetation Type**
- 11, Freshwater Emergent Wetland
 - 12, Freshwater Forested/Shrub Wetland
 - 13, Freshwater Pond
 - 18, Lacustrine Wetland
 - 22, Naturalized warm-temperate riparian and wetland group
 - 24, Populus fremontii
 - 27, Riverine Wetland
 - 33, Salix laevigata
 - 39, Water
 - 6, Baccharis pilularis
 - 9, Eucalyptus spp. - Ailanthus altissima - Robinia pseudoacacia



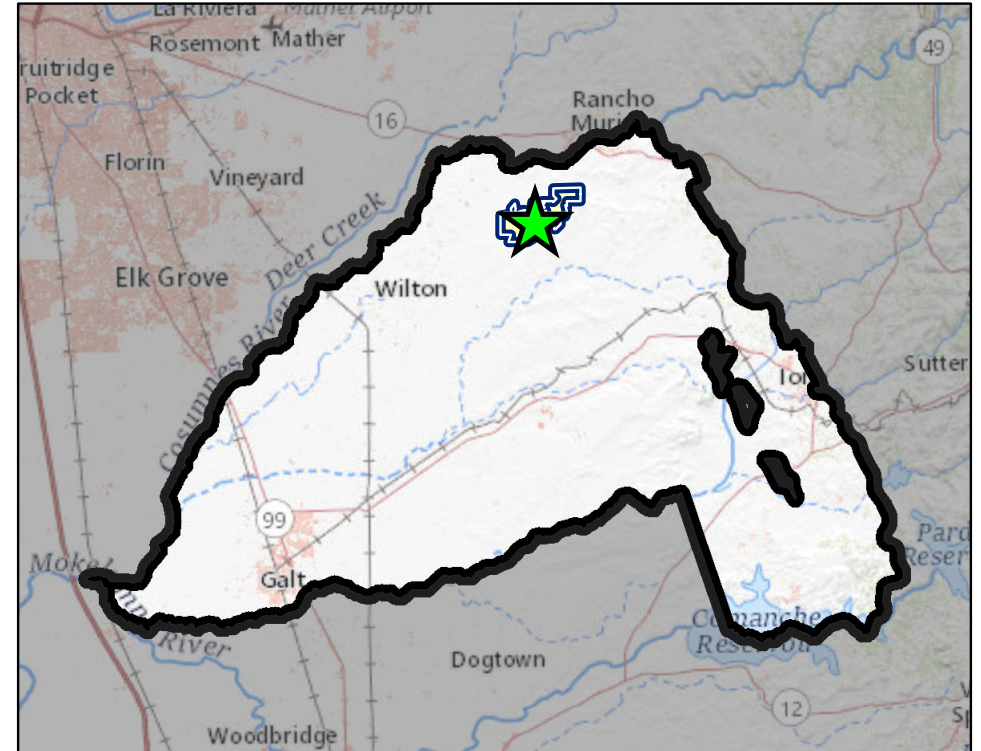
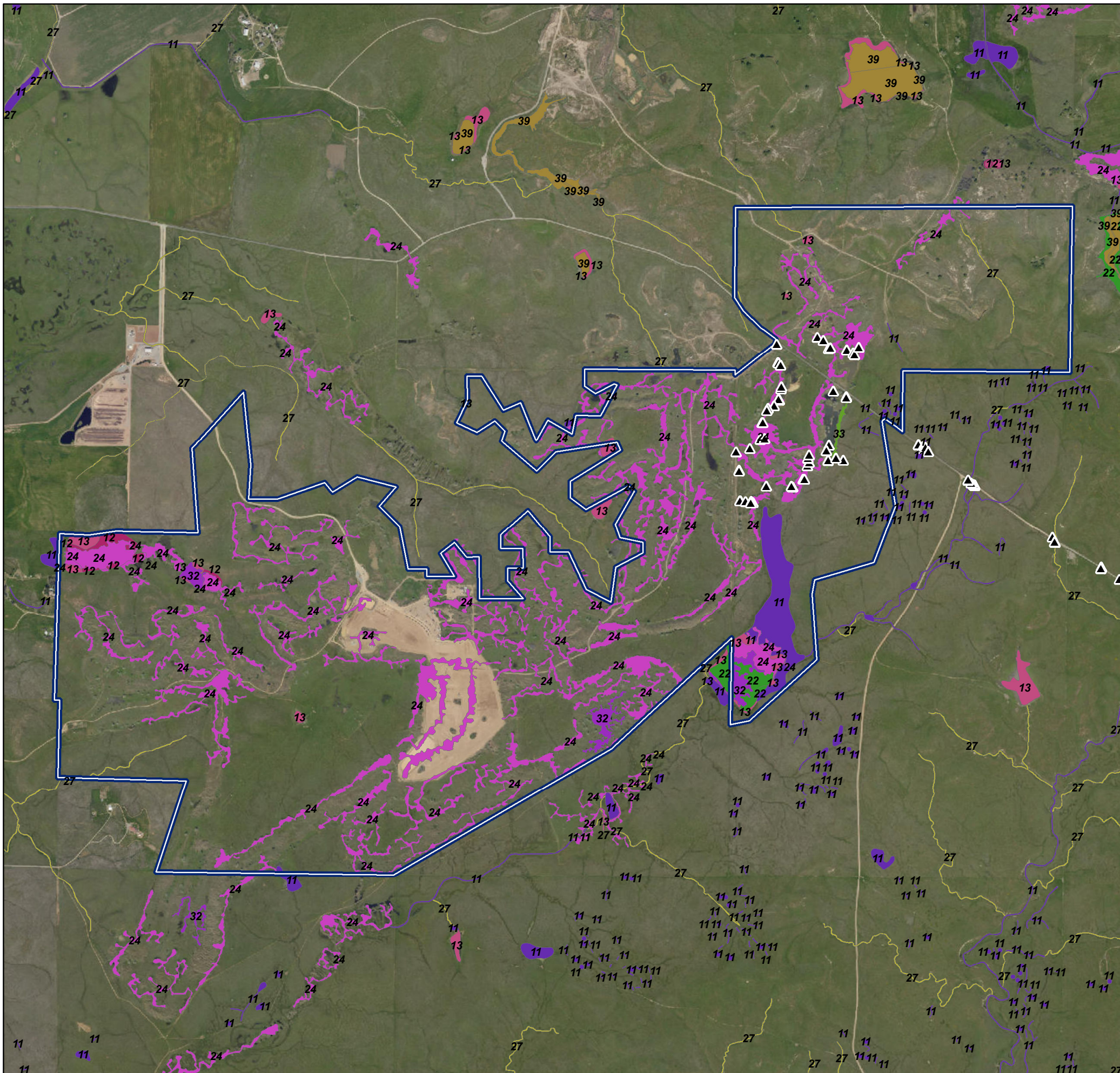
Site	Site 9. Cottonwood and Placer Mine Tailings
Predominant Vegetation Type(s) Described in Existing Data	<i>Populus fremontii</i> (predominant type), Freshwater Emergent Wetlands, Freshwater Pond, <i>Salix laevigata</i>
Dominant Vegetation Type(s) Actually Observed in the Field	Linear bands of cottonwood (<i>Populus fremontii</i>), pockets of Goodding's willow (<i>Salix gooddingii</i>) swales in small, closed basin bottomlands; Red willow (<i>Salix laevigata</i>) band along an unnamed stream feature that runs along the east perimeter of the site, stock tanks (i.e. freshwater ponds). Occasional herbaceous dominated vernal pools also present.
Description of Overall Accuracy of Existing Vegetation Mapping	NCCAG and NVCS mapping are reliable at this site overall but Goodding's willow communities not detected in existing mapping.
Typical canopy structure	Forested types typically contain 11-25% overstory canopy cover and 6-10% understory canopy cover.
Predominant Geomorphic Setting for Wetland/Riparian Communities	Wetland/riparian species primarily concentrated along linear networks or wider closed basin depressions. An unnamed ephemeral riverine feature and stock tank ponds also present.
Hydrological Conditions Summary	Except for improved stock tanks, surface water appears to be ephemeral. Active ponding observed in closed basins.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer exceeds 100 feet throughout the site.
Invasive Non-Native Species Observed	Heavy infestations of non-native annual grasses, primarily <i>Bromus</i> spp.
Canopy Dieback Summary	Cottonwood is heavily infested with mistletoe, lots of fallen cottonwood trees and dead snags. Most live cottonwood individuals have dead branches. Willow species are healthy overall with little indication of moisture stress or branch senescence.
Natural Recruitment Summary	No evidence of recent natural recruitment.
Biological Condition Gradient Summary	Level 4
Soil Conditions Summary	Soil texture clayey soils mixed with fine crushed rock (i.e. placer mine tailings). Low permeability throughout, moist surface soil and abundant redox indicators.
Land Use and Anthropogenic Alterations Summary	Trash dumping and livestock enclosures present. Heavily grazed by cattle. Trampling in bottomlands and livestock browse evident on lower willow branches.
Habitat Potential for Sensitive Species	Western pond turtle, Cooper's hawk, loggerhead shrike, white-tailed kite, and western red bat habitat present at the site.

General Notes	Location contains one of the largest contiguous concentrations of cottonwood in the Subbasin. Site analogous to the "Mine Tailings Riparian Woodland" type described in the South Sacramento Habitat Conservation Plan. As described in that document, riparian types are distributed in networks of relatively narrow linear areas that naturally established on abandoned mine tailing surface deposits. Site is largely human-made land cover type. Accessed with permission of the private landowner.
GDE Evaluation Summary	Unlikely an SGMA GDE



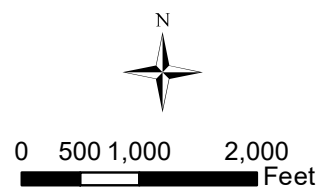
Top photo: mistletoe infested band of cottonwood, Bottom left: Goodding's willow in swale, Bottom right: trampled bottomland area.

Site 9 - Cottonwood and Placer Mine Tailings: Vegetation Types Described in the Existing NCCAG and NVCS Vegetation Data



Legend

- ▲ Field Observation Locations
 - ▭ Site Location
- Vegetation Type**
- 11, Freshwater Emergent Wetland
 - 12, Freshwater Forested/Shrub Wetland
 - 13, Freshwater Pond
 - 22, Naturalized warm-temperate riparian and wetland group
 - 24, Populus fremontii
 - 27, Riverine Wetland
 - 32, Salix gooddingii
 - 33, Salix laevigata
 - 39, Water



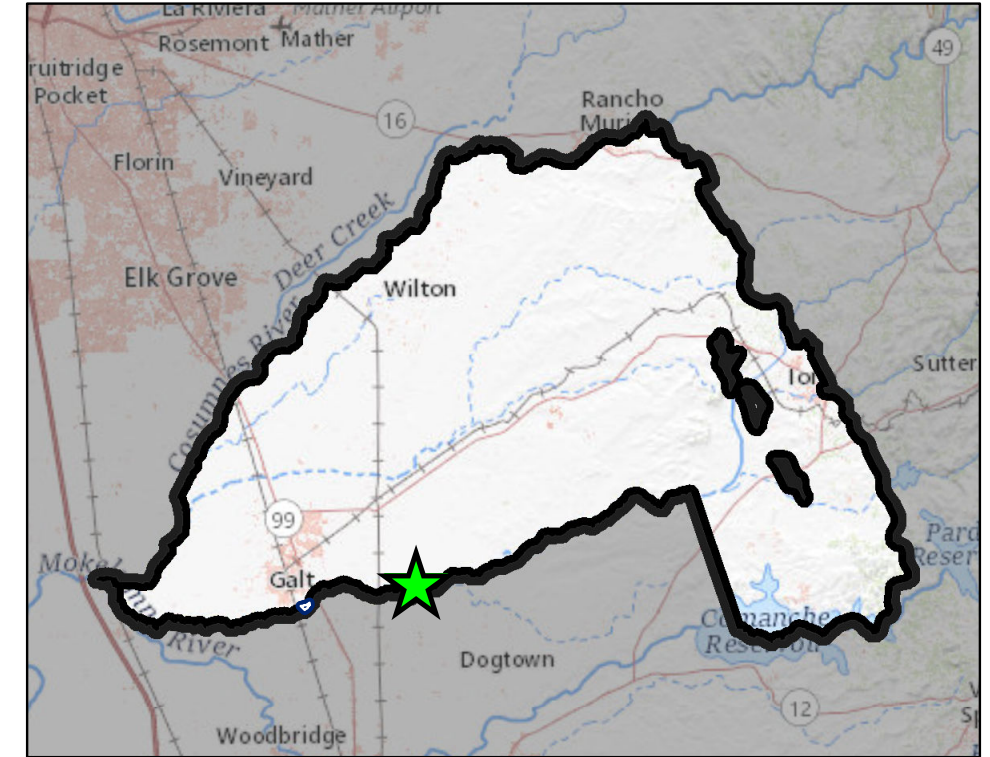
Site	Site 10. Lower Dry Creek
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Populus fremontii</i> , <i>Quercus lobata</i> , Freshwater Emergent Wetland
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species include marshes, cottonwood (<i>Populus fremontii</i>), box elder (<i>Acer negundo</i>), valley oak (<i>Quercus lobata</i>), Goodding's willow (<i>Salix gooddingii</i>), coyote willow (<i>Salix exigua</i>), and Himalayan blackberry (<i>Rubus armeniacus</i>). Rose (<i>Rosa</i> sp.), interior live oak (<i>Quercus wislizeni</i>), Oregon ash (<i>Fraxinus latifolia</i>), and California buckeye (<i>Aesculus californica</i>) common sub-dominants.
Description of Overall Accuracy of Existing Vegetation Mapping	Overstory species accurately characterized but understory species not captured and under-represented in existing mapping. Site overall shrubbier than forested (as existing vegetation mapping indicates). Substantially more diversity than suggested by existing data.
Typical canopy structure	Forested types typically contain 11-25% overstory canopy cover (with a scattered distribution) and 51-75% understory canopy cover (more contiguous).
Predominant Geomorphic Setting for Wetland/Riparian Communities	The entire site lies within a riverine setting. Channel broader and less incised than upstream segments of Dry Creek.
Hydrological Conditions Summary	Flow appears regular intermittent, likely more perennial than Alta Mesa Road Crossing. Increased volume from upstream segments indicates this may be a gaining reach. Sediment deposits, debris, water marks on vegetation, and drainage patterns indicative of regular overbank flooding.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer 50 to 100 feet throughout the site.
Invasive Non-Native Species Observed	Himalayan blackberry and Milk thistle (<i>Silybum marianum</i>) observed
Canopy Dieback Summary	Canopy dieback 6-10%, primarily dead branches on box elder.
Natural Recruitment Summary	Natural recruitment of native riparian species common, primarily as Oregon ash, oak, and box elder saplings.
Biological Condition Gradient Summary	Level 2/Level 3, depending on specific feature
Soil Conditions Summary	Loamy textured soils, moist near surface, redox indicators present in top 6 inches.

<i>Land Use and Anthropogenic Alterations Summary</i>	Human trails, bridge, overall less disturbed than sites upstream on Dry Creek.
<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat. Marshes are important for western pond turtle, giant garter snake, northern harrier, tricolored blackbird, and western red bat
<i>General Notes</i>	Survey conducted from bridge crossing, both the upstream and downstream sides evaluated, throughout floodplain areas, and off paved walking path. Higher flow volume than Alta Mesa Road Crossing, suggesting this is more of a gaining reach than middle portions of dry creek. Higher recruitment abundance, habitat diversity, and better ecosystem function than segments upstream on Dry Creek. Floodplain broad, appears to flood more regularly, lots of abandoned channel depressions and topographic diversity.
<i>GDE Evaluation Summary</i>	Not a SGMA GDE, but potential for perched alluvial aquifer.



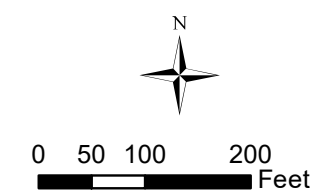
Photos: channel wider, floodplain is broader, more dynamic, and diverse than upstream segments. Marshes (like bottom left photo) are intermixed with diverse, multi-storied forests and shrublands.

**Site 10 - Lower Dry Creek:
Vegetation Types Described in the Existing
NCCAG and NVCS Vegetation Data**



Legend

- ▲ Field Observation Locations
- ▭ Site Location
- Vegetation Type**
 - 11, Freshwater Emergent Wetland
 - 24, Populus fremontii
 - 25, Quercus lobata



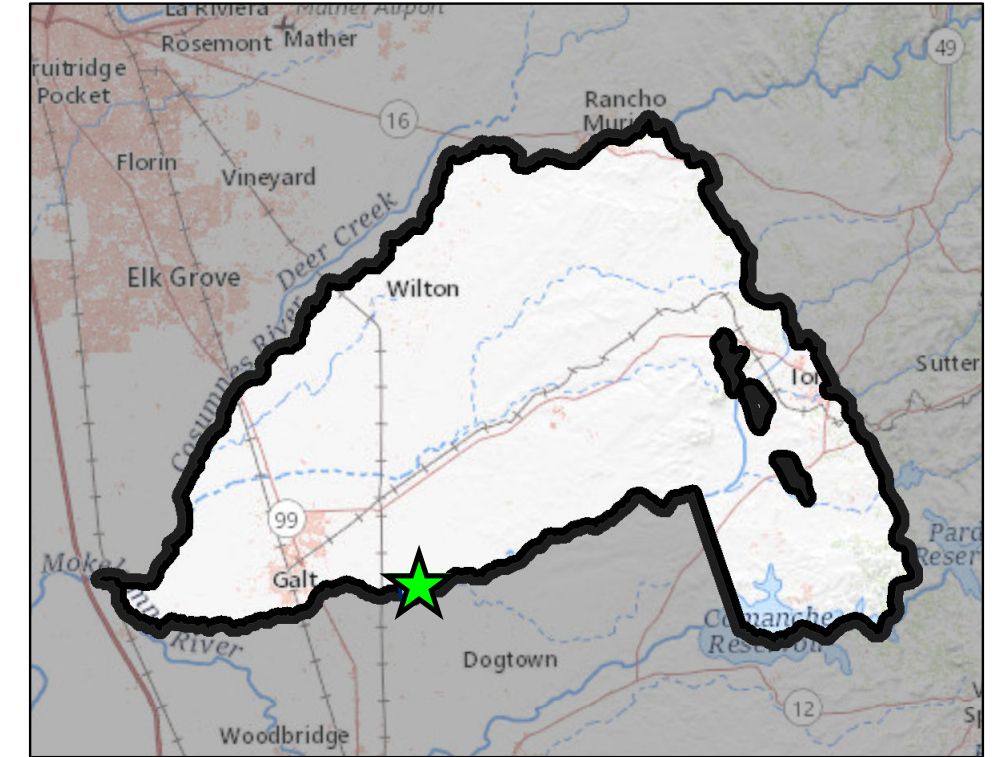
Site	Site 11. Alta Mesa Road Crossing (Dry Creek)
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Juglans hindsii</i> and hybrids, <i>Quercus lobata</i> , Riverine Wetland
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species include walnut (<i>Juglans</i> spp), valley oak (<i>Quercus lobata</i>), elderberry (<i>Sambucus nigra</i>), coyote willow (<i>Salix exigua</i>), and Himalayan blackberry (<i>Rubus armeniacus</i>).
Description of Overall Accuracy of Existing Vegetation Mapping	Overstory species accurately characterized but understory species not captured and under-represented in existing mapping.
Typical canopy structure	Forested types typically contain 11-25% overstory canopy cover and 51-75% understory canopy cover.
Predominant Geomorphic Setting for Wetland/Riparian Communities	The entire site lies within a riverine setting. Channel narrow and incised. Riparian band confined to terraces on both sides of the active channel.
Hydrological Conditions Summary	Flow appears regular intermittent but volume less than the Clay Station Crossing upstream, suggesting this is a losing reach. Sediment deposits, debris, and drainage patterns indicative of periodic overbank flooding.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer is greater than 100 feet throughout the site.
Invasive Non-Native Species Observed	Thick patches of tree of heaven (<i>Ailanthus altissima</i>), and blackberry. Milk thistle (<i>Silybum marianum</i>) also observed.
Canopy Dieback Summary	Canopy dieback 26-50%, highest proportion observed anywhere during the field survey. Valley oak and walnut have heavy canopy senescence.
Natural Recruitment Summary	Natural recruitment of native riparian species uncommon, primarily as young coyote willow.
Biological Condition Gradient Summary	Level 4
Soil Conditions Summary	Loamy textured soils, moist near surface, redox indicators present in top 6 inches.
Land Use and Anthropogenic Alterations Summary	Trash dumping off bridge (including animal carcasses), off road vehicle tracks in riparian forests and surrounding areas.

<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat
<i>General Notes</i>	Survey conducted from bridge crossing, both the upstream and downstream sides evaluated. Lower flow volume, lower recruitment abundance, and higher canopy dieback than the Clay Station Crossing site. Channel deeply incised, lots of non-native annual grasses (e.g. Brome).
<i>GDE Evaluation Summary</i>	Not a SGMA GDE, but potential for perched alluvial aquifer.



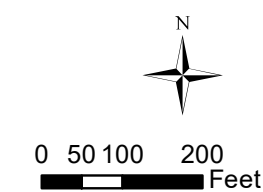
Photos: channel narrow and incised, heavy canopy dieback, and larger proportion of non-native woody species than most other sites.

**Site 11 - Alta Mesa Road Crossing (Dry Creek):
Vegetation Types Described in the Existing
NCCAG and NVCS Vegetation Data**



Legend

- ▲ Field Observation Locations
- ▭ Site Location
- ▲ 24, *Populus fremontii*
- ▲ 25, *Quercus lobata*
- ▲ 27, Riverine Wetland
- ▲ 11, Freshwater Emergent Wetland
- ▲ 16, *Juglans hindsii* and Hybrids
- ▲ 30, *Salix exigua*
- ▲ 32, *Salix gooddingii*



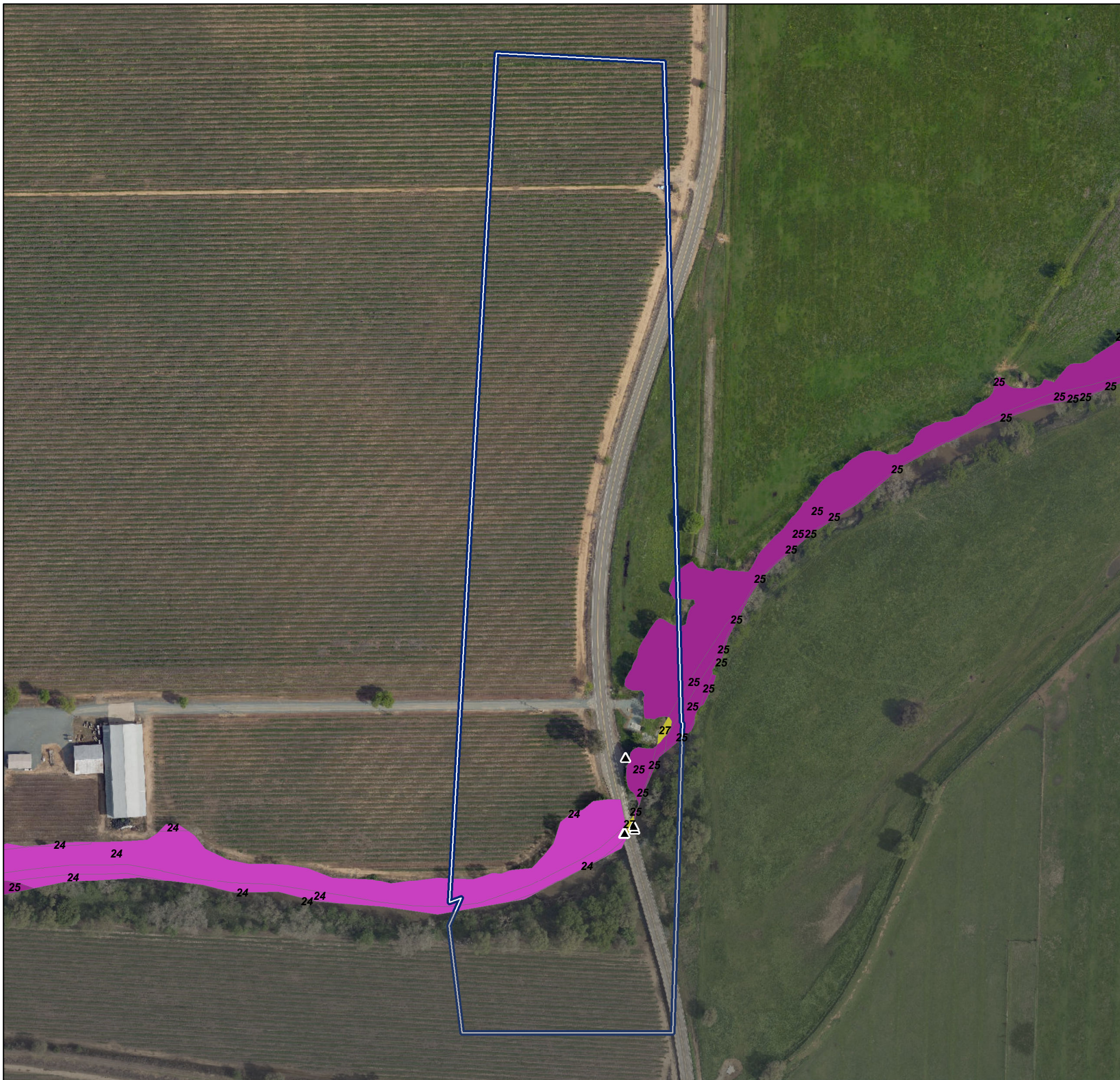
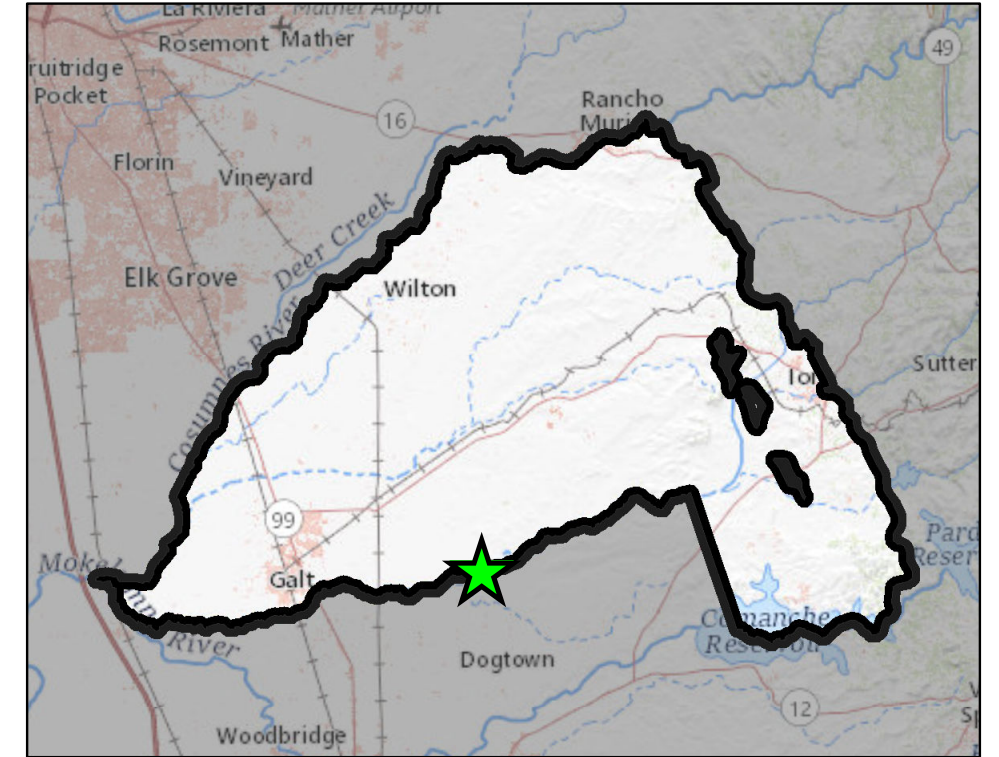
Site	Site 12. Clay Station Road Crossing (Dry Creek)
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Populus fremontii</i> , <i>Quercus lobata</i> , Riverine Wetland
Dominant Vegetation Type(s) Actually Observed in the Field	Actual woody vegetation an approximately even mix of 5 species: valley oak (<i>Quercus lobata</i>), Oregon ash (<i>Fraxinus latifolia</i>), Cottonwood (<i>Populus fremontii</i>), Coyote willow (<i>Salix exigua</i>), and Goodding's willow (<i>Salix gooddingii</i>). Tree of heaven (<i>Ailanthus altissima</i>), California buckeye (<i>Aesculus californica</i>) and interior live oak (<i>Quercus wislizeni</i>) also observed.
Description of Overall Accuracy of Existing Vegetation Mapping	Species and structural diversity grossly under-represented in existing mapping.
Typical canopy structure	Forested types typically contain 25-50% overstory canopy cover and 25-50% understory canopy cover. Shrubland areas have 6-10% overstory cover and 51-75% understory cover.
Predominant Geomorphic Setting for Wetland/Riparian Communities	The entire site lies within a riverine setting. Channel narrow and incised. Riparian band confined to terraces on both sides of the active channel.
Hydrological Conditions Summary	Flow appears regular intermittent. Sediment deposits and drainage patterns indicative of periodic overbank flooding.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer is greater than 100 feet throughout the site.
Invasive Non-Native Species Observed	Tree of heaven is the main exotic woody species.
Canopy Dieback Summary	Canopy dieback typically 6-10%, primarily restricted to mistletoe infested cottonwood.
Natural Recruitment Summary	Natural recruitment of native riparian species common, primarily as Oregon ash and oak saplings and young coyote willow.
Biological Condition Gradient Summary	Level 3
Soil Conditions Summary	Loamy textured soils, moist near surface, redox indicators present in top 6 inches.
Land Use and Anthropogenic Alterations Summary	Riprap present on downstream side of bridge, trash dumping off bridge, off road vehicle tracks in riparian forests and surrounding areas.

<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garters nake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat
<i>General Notes</i>	Survey conducted from bridge crossing, both the upstream and downstream sides evaluated. High abundance and diversity of natural recruitment.
<i>GDE Evaluation Summary</i>	Not a SGMA GDE, but potential for perched alluvial aquifer.



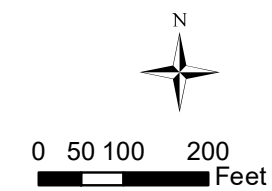
Photos: channel narrow and incised, lined with a variety of woody species with diverse canopy structure.

**Site 12 - Clay Station Road Crossing (Dry Creek):
Vegetation Types Described in the Existing
NCCAG and NVCS Vegetation Data**



Legend

- ▲ Field Observation Locations
- Site Location
- 24, *Populus fremontii*
- 25, *Quercus lobata*
- 27, Riverine Wetland



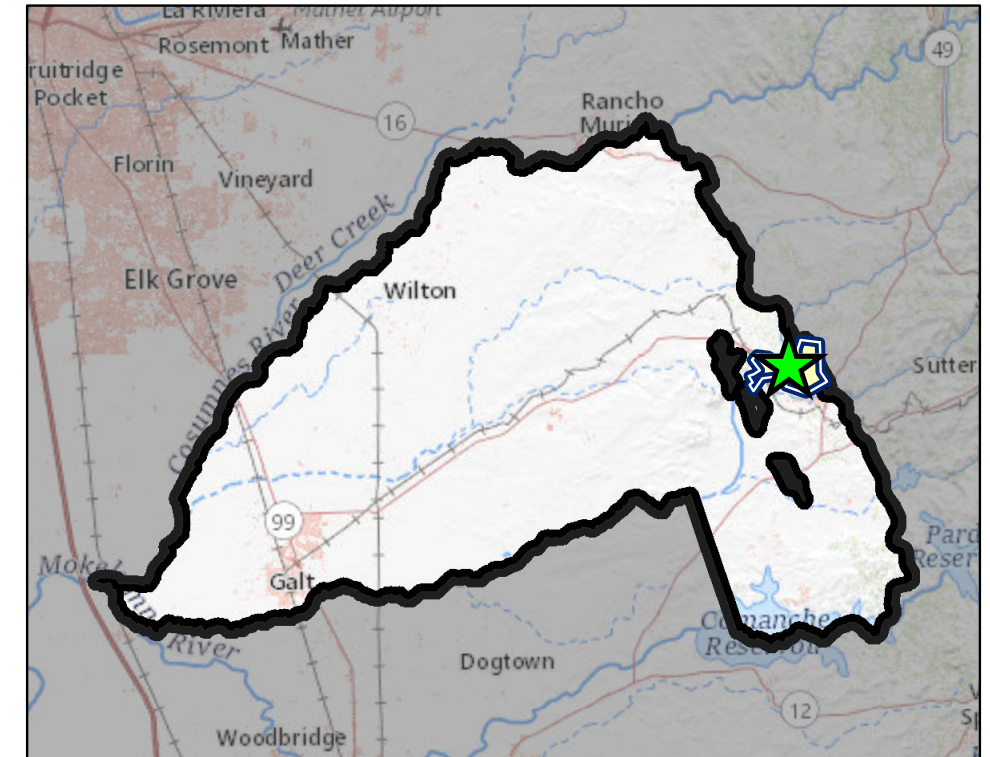
Site	Site 13. Foothills Riparian
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Quercus lobata</i> , (predominant type), <i>Populus fremontii</i> , Freshwater Emergent Wetland, Riverine Wetland, <i>Rubus armeniacus</i> , <i>Salix gooddingii</i> , Water, <i>Azolla</i> , <i>Baccharis pilaris</i> , <i>Eucalyptus</i> spp. – <i>Ailanthus altissima</i> – <i>Robinia pseudoacacia</i> , Introduced North American Mediterranean woodland and forest, and Freshwater Pond
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species include valley oak (<i>Quercus lobata</i>), Himalayan blackberry (<i>Rubus armeniacus</i>), Gooddings willow (<i>Salix gooddingii</i>), Eucalyptus, and elderberry (<i>Sambucus nigra</i>). Common sub-dominants intermixed with varying dominance are cottonwood (<i>Populus fremontii</i>), <i>Baccharis pilaris</i> , tree of heaven (<i>Ailanthus altissima</i>), black locust (<i>Robinia pseudoacacia</i>), emergent wetlands, and riverine wetlands also present per existing vegetation mapping data. Vernal pools also scattered throughout this site.
Description of Overall Accuracy of Existing Vegetation Mapping	Existing mapping has variable accuracy throughout this site. Valley oak communities often mis-identified as Eucalyptus dominated communities in existing data. Prominent species described in existing data all present, but diversity under-represented on a feature-by-feature basis.
Typical canopy structure	Forested types typically contain 25-50% overstory canopy cover and 26-50% understory canopy cover.
Predominant Geomorphic Setting for Wetland/Riparian Communities	Most of the site lies within a riverine setting (Mule Creek and foothills segments of Dry Creek) and riparian species present along narrow linear bands on both banks. Depressional features also present in relatively small closed basins, vernal pools, and off roadways.
Hydrological Conditions Summary	Flow appears perennial and channels are only narrowly incised. Debris and sediment distribution, drainage patterns suggest there is periodic overbank flooding.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer is less than 10 feet at the site.
Invasive Non-Native Species Observed	Heavy patches of Himalayan blackberry, Eucalyptus, tree of heaven, and black locust. Saltcedar (<i>Tamarix</i> sp.) was observed at this site and should be considered a high management priority. This is the only location where saltcedar was observed within the Subbasin. Annual bromes, milk thistle (<i>Silybum marianum</i> , and bull thistle (<i>Cirsium vulgare</i>) are common.
Canopy Dieback Summary	Canopy dieback typically 6-10%, predominantly affecting oak and cottonwood. Heavy mistletoe infestations in cottonwoods.
Natural Recruitment Summary	Natural recruitment of native riparian species common, primarily valley oak, willow, and non-native species.
Biological Condition Gradient Summary	Level 3

<i>Soil Conditions Summary</i>	Soils loamy, and moist to saturated near surface. Redox indicators observed within the top foot.
<i>Land Use and Anthropogenic Alterations Summary</i>	Trash dumping off bridge, enclosure fences, roads, and riprap intersect wetland/riparian areas evaluated.
<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat. Vernal pools provide habitat vernal pool tadpole shrimp, vernal pool fairy shrimp, conservancy fairy shrimp, Ricksecker's water scavenger beetle, western spadefoot toad, California tiger salamander, and numerous wintering migratory birds.
<i>General Notes</i>	Large site, evaluated within several locations throughout. Riparian areas and vernal pools both present. High vegetation species diversity, and often complex structure. Groundwater wells indicate there is shallow groundwater throughout this site. Site contains the greatest abundance of exotic species amongst sites surveyed as part of this study.
<i>GDE Evaluation Summary</i>	Possibly a SGMA GDE, also potential for perched alluvial aquifer.



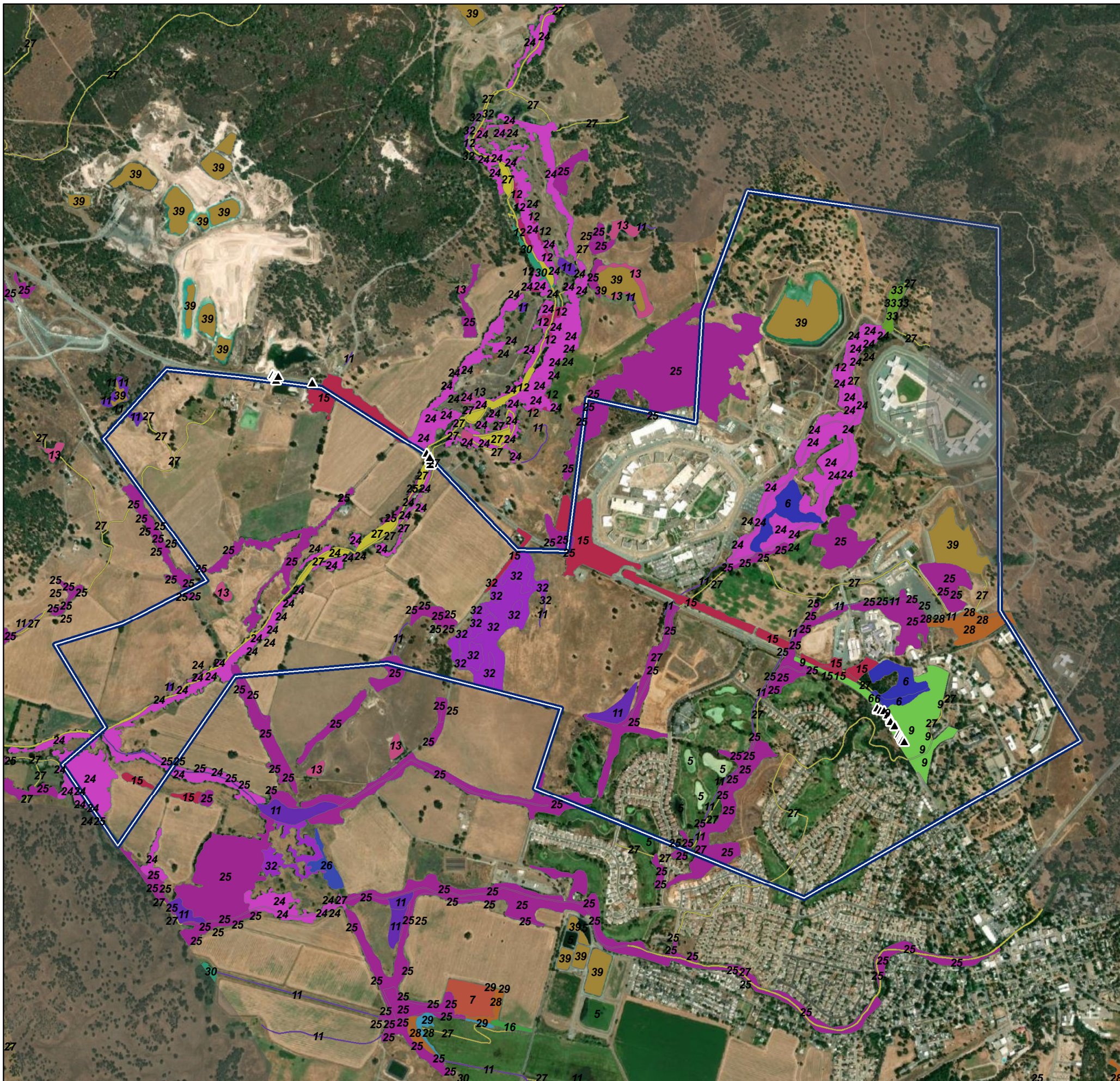
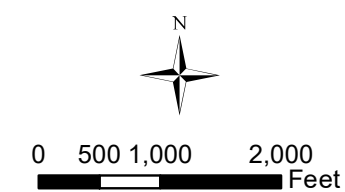
Photos: Site includes riparian communities along foothills portions of Dry Creek and Mule Creek. Riparian communities often multi-storied, variable structure, sometimes open canopied, and exotic species are present throughout.

Site 13 - Foothills Riparian: Vegetation Types Described in the Existing NCCAG and NVCS Vegetation Data



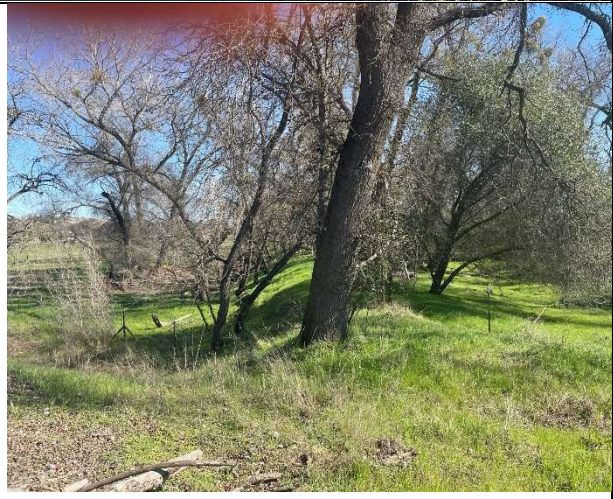
Legend

- ▲ Field Observation Locations
 - Site Location
- Vegetation Type**
- 11, Freshwater Emergent Wetland
 - 12, Freshwater Forested/Shrub Wetland
 - 13, Freshwater Pond
 - 15, Introduced North American Mediterranean woodland and forest
 - 16, Juglans hindsii and Hybrids
 - 24, Populus fremontii
 - 25, Quercus lobata
 - 26, Riparian Evergreen and Deciduous Woodland
 - 27, Riverine Wetland
 - 28, Rubus armeniacus
 - 29, Rubus armeniacus - Sesbania punicea - Ficus carica
 - 30, Salix exigua
 - 32, Salix gooddingii
 - 33, Salix laevigata
 - 39, Water
 - 6, Baccharis pilularis
 - 7, California Warm Temperate Marsh/Seep
 - 9, Eucalyptus spp. - Ailanthus altissima - Robinia pseudoacacia



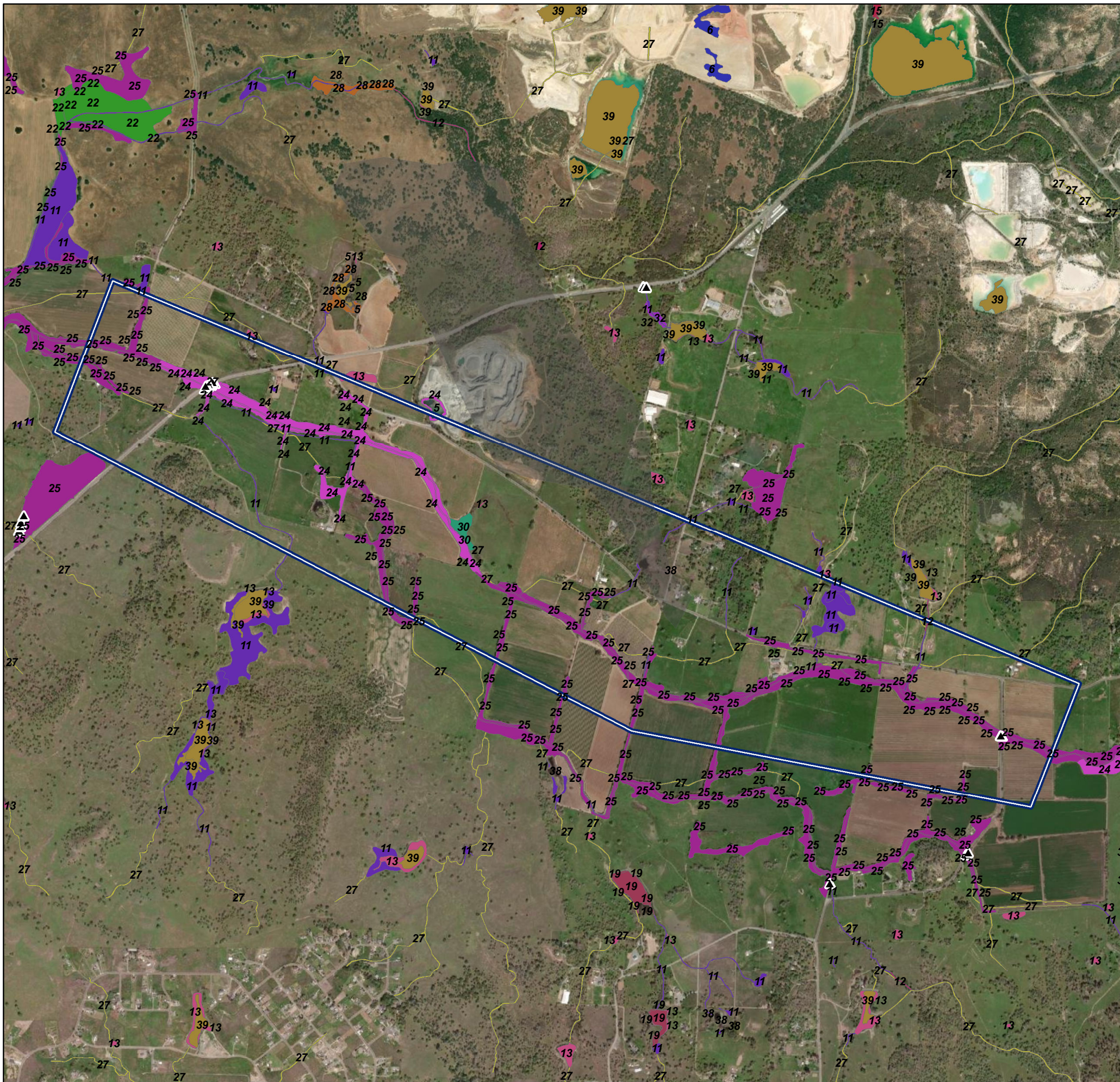
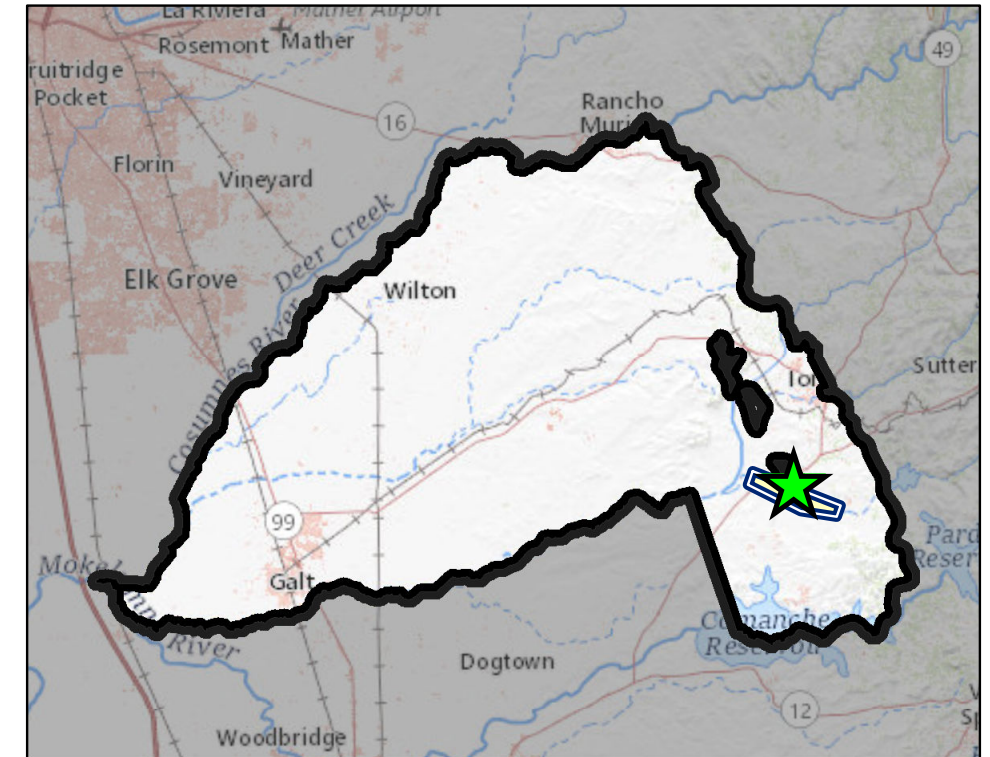
Site	Site 14. Jackson Creek
Predominant Vegetation Type(s) Described in Existing Data (within view of specific locations evaluated)	<i>Quercus lobata</i> , (predominant type), <i>Populus fremontii</i> , Freshwater Emergent Wetland, Riverine Wetland
Dominant Vegetation Type(s) Actually Observed in the Field	Actual dominant woody species is valley oak (<i>Quercus lobata</i>) through most of site with Himalayan blackberry (<i>Rubus armeniacus</i>) as the dominant understory species. Cottonwood (<i>Populus fremontii</i>), Gooddings willow (<i>Salix gooddingii</i>), Oregon ash (<i>Fraxinus latifolia</i>), and elderberry (<i>Sambucus nigra</i>) common sub-dominants. Riverine type (per NWI) types present as indicated in existing data.
Description of Overall Accuracy of Existing Vegetation Mapping	Existing mapping is accurate overall but under-represents species diversity within features.
Typical canopy structure	Forested types typically contain 25-50% overstory canopy cover and 26-50% understory canopy cover.
Predominant Geomorphic Setting for Wetland/Riparian Communities	The entire site lies within a riverine setting, adjacent to Jackson Creek. Entrenched, narrow channel, riparian species as linear bands on both banks.
Hydrological Conditions Summary	Flow appears regular intermittent, possibly perennial. Debris and sediment distribution, watermarks on vegetation, drainage patterns suggest there is periodic overbank flooding.
Apparent Depth to Groundwater Summary	Fall 2018 depth to groundwater contours indicate that depth to the regional aquifer is less than 10 feet at the site.
Invasive Non-Native Species Observed	Heavy Himalayan blackberry.
Canopy Dieback Summary	Canopy dieback typically 6-10%, predominantly affecting oak and cottonwood. Heavy mistletoe infestations in cottonwoods.
Natural Recruitment Summary	Natural recruitment of native riparian species uncommon, primarily valley oak.
Biological Condition Gradient Summary	Level 3
Soil Conditions Summary	Soils loamy, and moist to saturated near surface. Redox indicators observed within the top foot.
Land Use and Anthropogenic Alterations Summary	Surrounded by vineyards, supplemental runoff from vineyards. Trash dumping off bridge.

<i>Habitat Potential for Sensitive Species</i>	Open Water habitat is used by western pond turtle, giant garter snake, tricolored blackbird, and western red bat. Species associated with the riparian forests and shrublands include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, loggerhead shrike, white-tailed kite, and western red bat
<i>General Notes</i>	Site evaluated from bridge crossing. Lots of blackberry. Moist soils throughout.
<i>GDE Evaluation Summary</i>	Possibly a SGMA GDE, also potential for perched alluvial aquifer.



Photos: typical conditions throughout the site. Mainstem channel is entrained but remnant high flow channel depressions abundant throughout the site. High woody species diversity and diverse canopy structure.

Site 14 - Jackson Creek: Vegetation Types Described in the Existing NCCAG and NVCS Vegetation Data



Legend

- ▲ Field Observation Locations
 - ▭ Site Location
- ### Vegetation Type
- | | |
|---|---|
| 11, Freshwater Emergent Wetland | 22, Naturalized warm-temperate riparian and wetland group |
| 12, Freshwater Forested/Shrub Wetland | 24, Populus fremontii |
| 13, Freshwater Pond | 25, Quercus lobata |
| 15, Introduced North American Mediterranean woodland and forest | 27, Riverine Wetland |
| 19, Lemna (minor) and Relatives | 28, Rubus armeniacus |
| | 30, Salix exigua |
| | 32, Salix gooddingii |
| | 39, Water |
| | 6, Baccharis pilularis |

