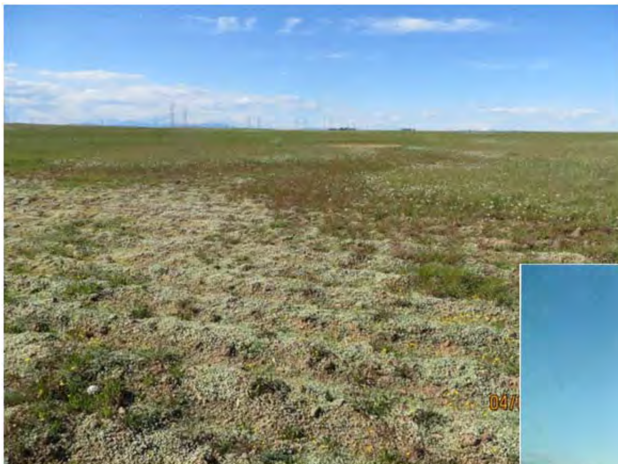
U.S. Department of Justice
Expert Team Report
Duarte Nursery, Inc. et al US Army Corps of Engineers/United States v. Duarte Nursery, Inc. et al.



Prepared For

Environment and Natural Resource Defense Section
U.S. Department of Justice
Washington, D.C.

Prepared By

Lyndon C. Lee, Ph.D., PWS
Richard A. Lis, Ph.D.
Wade L. Nutter, Ph.D., PH
Mark C. Rains, Ph.D., PWS
Scott R. Stewart, Ph.D., CPSS
W. Clark Hurst

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SIGNATURE PAGE

Lyndon C. Lee, Ph.D., PWS
Ecosystem Ecology, Wetland & River Science

Richard A. Lis, Ph.D.
Plant Ecology & Systematics

Wade L. Nutter, Ph.D., PH
Hydrology

Mark C. Rains, Ph.D., PWS
Hydrologic Science, Ecohydrology

Scott R. Stewart, Ph.D., CPSS (30105)
Soil Science & Geomorphology

W. Clark Hurst
GIS Specialist

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LIST OF ACRONYMS

BP	Before Present
CCCA	Coyote Creek Conservation Area
DIN	Dissolved Inorganic Nitrogen
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
DOJ	Department of Justice
EPA	Environmental Protection Agency
ESRI	Environmental Systems Research Institute
ESU	Evolutionary Significant Unit
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
GPS	Global Positioning System
HDPE	High-density Polyethylene
HGM	Hydrogeomorphic
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NSE	NorthStar Environmental
NTCHS	National Technical Committee for Hydric Soils
NWI	National Wetland Inventory
OHW	Ordinary High Water
PG&E	Pacific Gas & Electric
PGT	Pacific Gas Transmission
SC	Specific Conductance
SRP	Soluble Reactive Phosphorus
T	Temperature
TNW	Traditional Navigable Waters
USAC	US Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WETS	Wetlands Determination

I. INTRODUCTION AND OBJECTIVES

This report has been developed to document observations and conclusions of an expert team retained by the Environment and Natural Resources Defense Section of the U.S. Department of Justice in the matter of DUARTE NURSERY, INC., a California Corporation; and JOHN DUARTE, an individual, v U.S. Army Corps of Engineers (No. CIV. S-13-2095 LKK/DAD) and United States v. Duarte Nursery, Inc. et al.

The DOJ Expert Team members and their roles are as follows:

Lyndon C. Lee, Ph.D., PWS	Ecosystem Ecology, Wetland & River Science
Richard A. Lis, Ph.D.	Plant Ecology & Systematics
Wade L. Nutter, Ph.D., PH	Hydrology
Mark C. Rains, Ph.D., PWS	Hydrologic Science, Ecohydrology
Scott R. Stewart, Ph.D., CPSS	Soil Science & Geomorphology
W. Clark Hurst	GIS Specialist

II. DUARTE SITE LOCATION & DESIGNATIONS

A. Location

Duarte Nursery, Inc. owns an approximately 450-acre property located east of Paskenta Road in rural Tehama County, California (hereafter Duarte Site). The Duarte Site is located south of the city of Red Bluff and roughly three miles west of Interstate 5 (Figure II-1). The straight line distance east from the Duarte Site to the Sacramento River is approximately 7.2 miles. The Latitude/Longitude coordinates for the approximate centroid of the property are 40^{o} 05’ 08.26” N and 122^{o} 16’ 06.44” W. Included within the Duarte Site are Tehama County Assessor’s Parcel Numbers (“APN”) 037-070-35-1 and 037-070-37-1. As of this writing, the DOJ Expert Team does not have an exact legal description of the 450-acre Duarte Site.

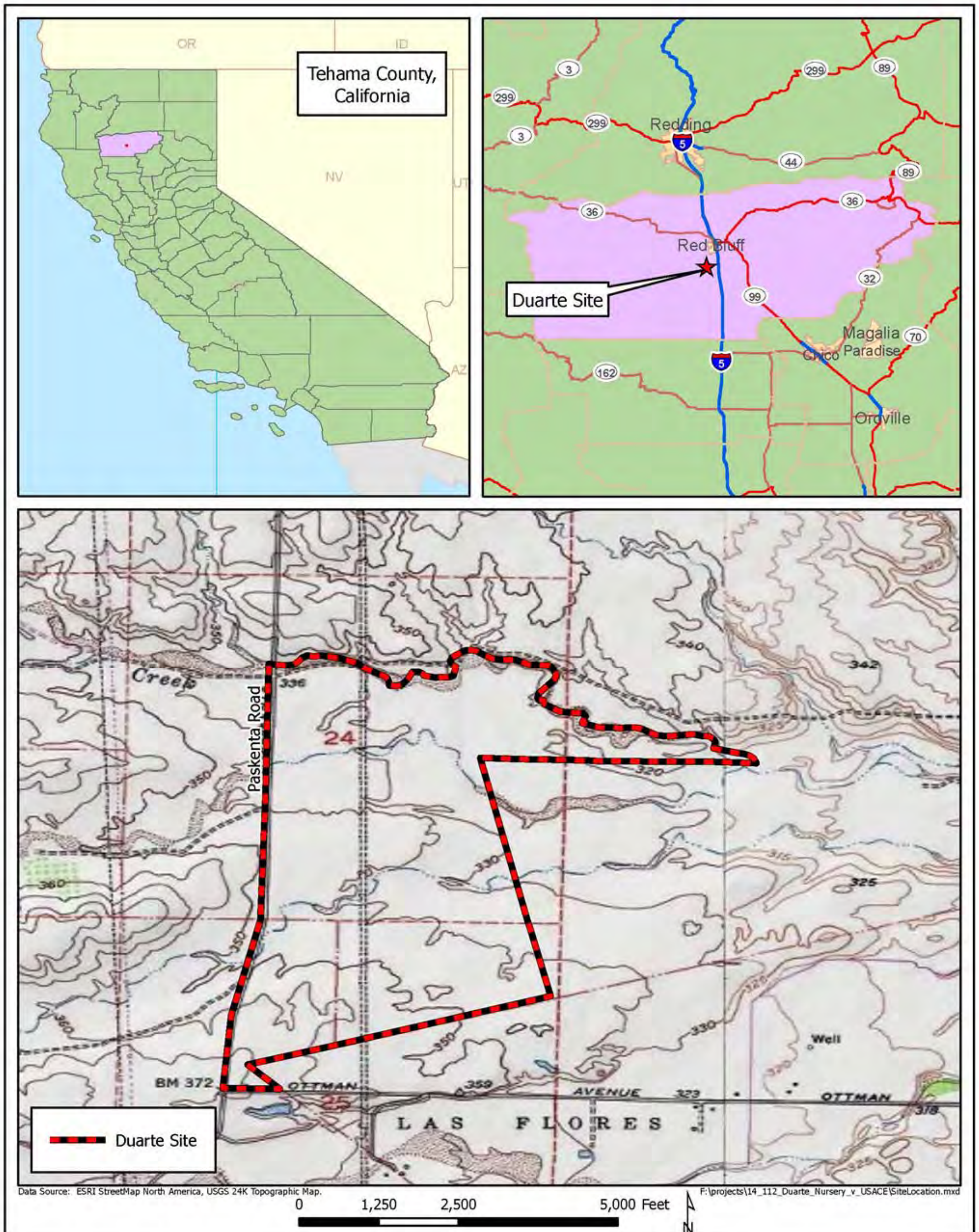

Figure II-1. Location of Duarte Site, Red Bluff, Tehama County, California, USGS 1:24,000.

The Duarte Site is bounded (approximately) on the north by the north bank main stem channel system of Coyote Creek. Paskenta Road forms the western boundary, and Dusty Way bounds the southwestern extent of the property. The majority of the southern boundary consists of a barbed wire fence system that runs on a diagonal course from the southwestern extent of the property and generally northeast to the eastern property boundary. The approximate eastern boundaries of the Duarte Site consist of a series of barbed wire fences that are oriented (a) generally south to north northwest, and (b) east to west, roughly parallel to and south of the main stem of the Coyote Creek channel system.

B. Designations

1. Zoning - The Duarte Site is zoned as "Agricultural" by Tehama County.

2. Critical Habitat **-** The Duarte Site is within the boundaries of Unit 6, Red Bluff Unit, Tehama County critical habitat for the U.S. Federally listed (Threatened) fairy shrimp (*Branchinecta lynchi*) Figure II-2). (Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon, 2005 http://www.fws.gov/sacramento/es/Recovery-Planning/Vernal-Pool/es_recovery_vernal-pool-recovery.htm]).

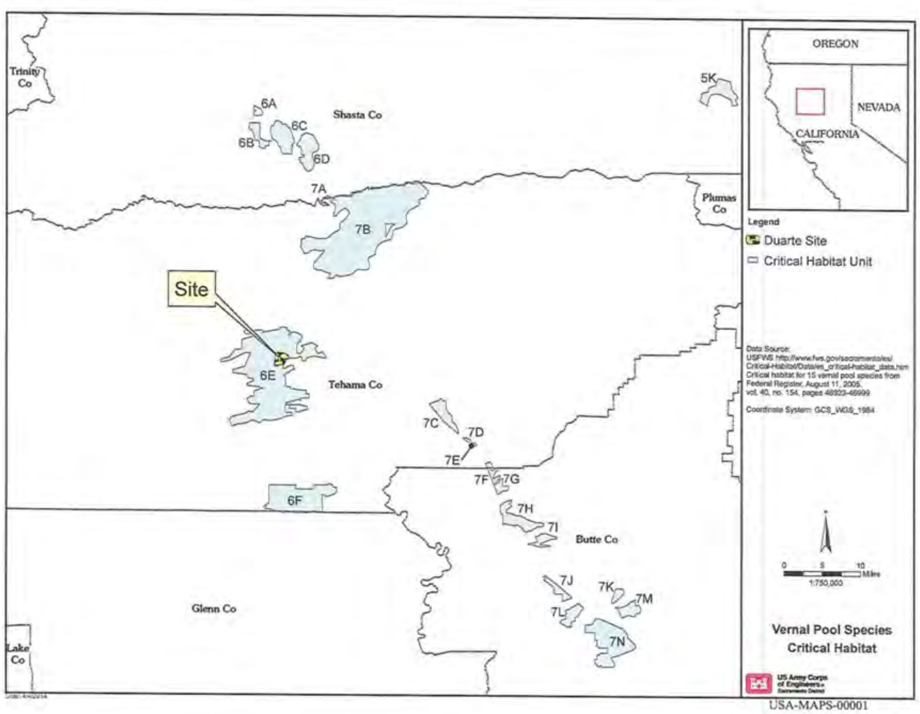

Figure II-2. The Duarte Site is within the boundaries of Unit 6, Red Bluff Unit, Tehama County critical habitat for the U.S. Federally listed (Threatened) fairy shrimp (*Branchinecta lynchi*).

3. According to the National Oceanographic and Atmospheric Administration's September 2014 Central Valley Chinook Salmon & Steelhead Recovery Plan [www.westcoast.fisheries.noaa.gov/publications/recovery_planning/] Chinook Salmon and Steelhead are U.S. Federally listed species in the Sacramento River as follows:

   Winter Run Chinook = Endangered
   Spring Run Chinook = Threatened
   Steelhead = Threatened

Federal Register notices concerning these listings can be found at: [http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/chinook/chinook_salmon_federal_register_notices.html] and [http://www.westcoast.fisheries.noaa.gov/maps_data/species_population_boundaries.html]

Figure II-3 is a map of the Critical Habitats for the Chinook Salmon on the West Coast of the US.

The Coyote Creek Watershed is included in the Sacramento River Winter-run Chinook Salmon ESU (Figure II-4), Critical Habitat Area for Central Valley Spring Run Chinook Salmon (Figure II-5) and the Critical Habitat Area for Central Valley Steelhead(Figure II-6).

4. Federal Emergency Management Agency (FEMA) Flood Hazard Zone – Figure II-7 shows the FEMA mapped Flood Hazard Zones (1% Annual Chance Flood Hazard) for the Duarte Site.

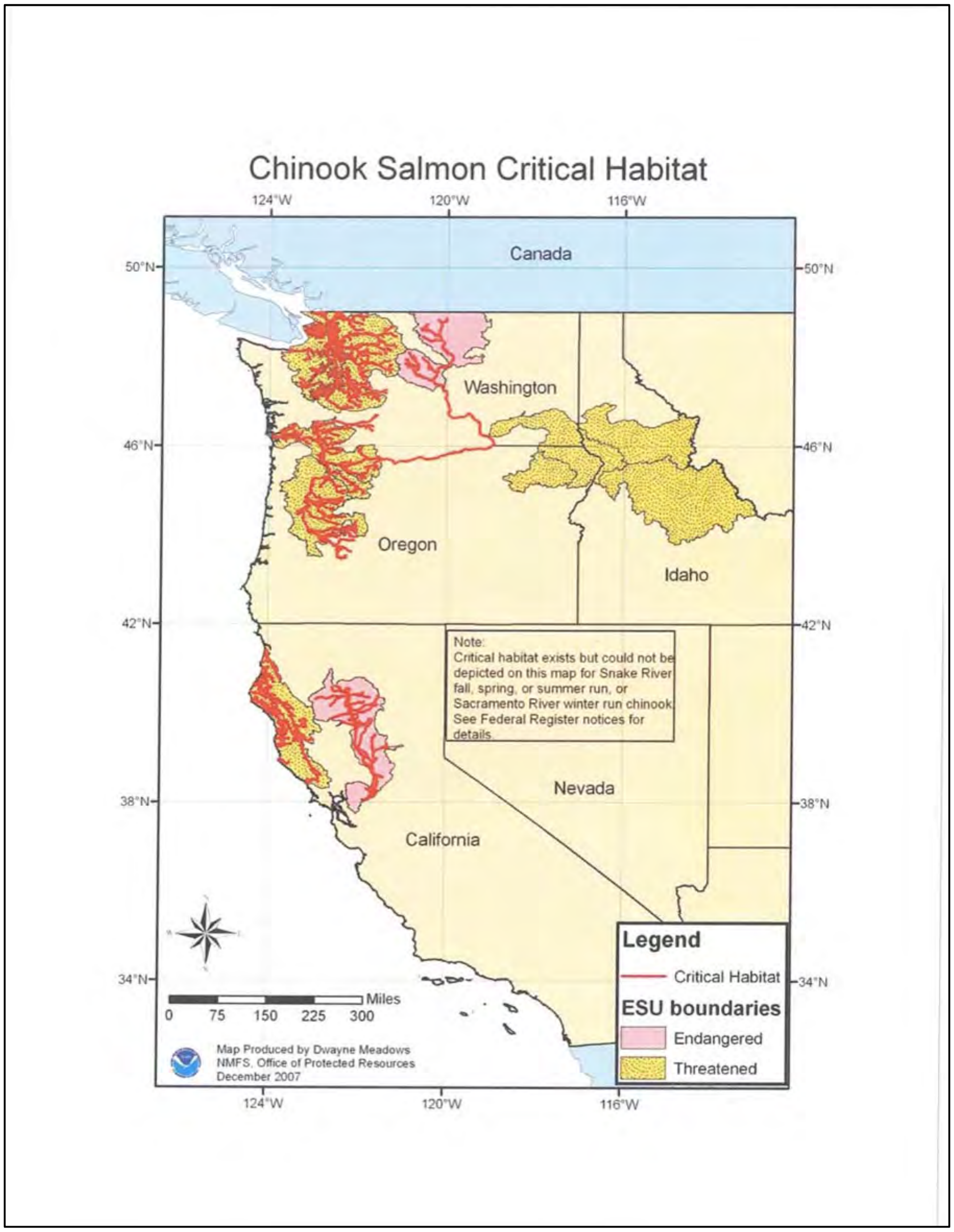

Figure II-3. Chinook Salmon critical habitat on the West Coast of the U.S.

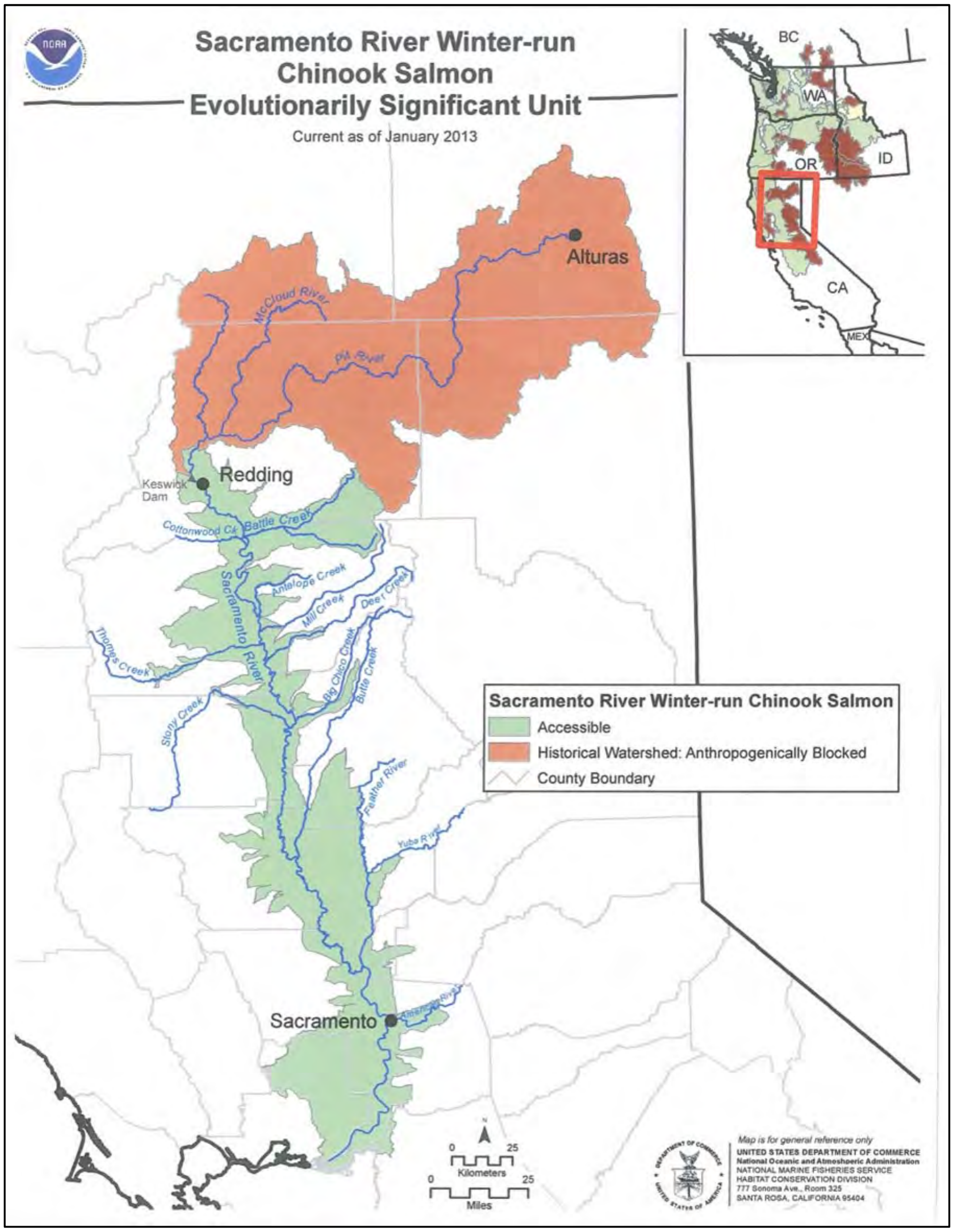

Figure II-4. Sacramento River Winter-run Chinook Salmon Evolutionarily Significant Unit

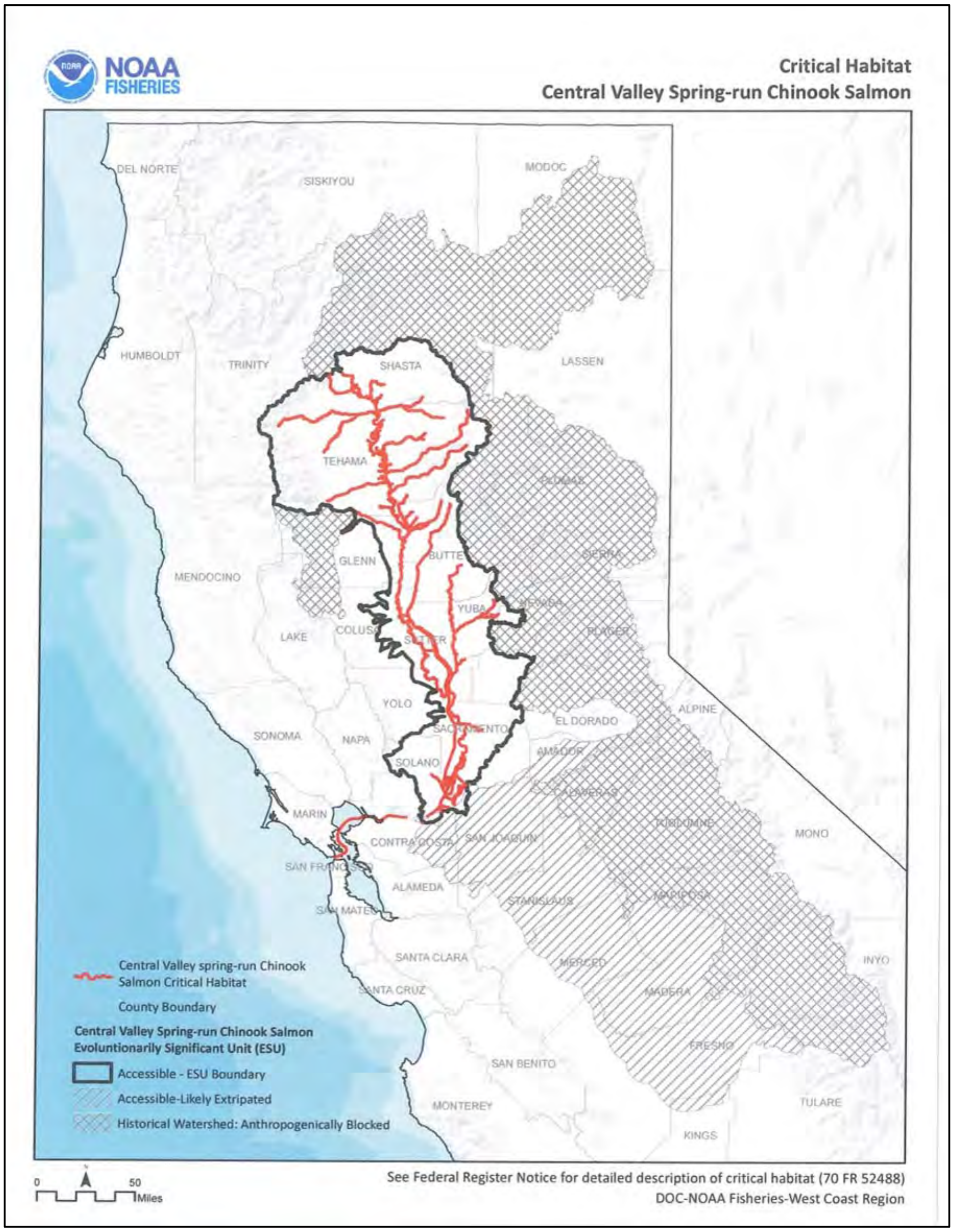

Figure II-5. Distribution of Critical Habitat Central Valley Spring-run Chinook Salmon.

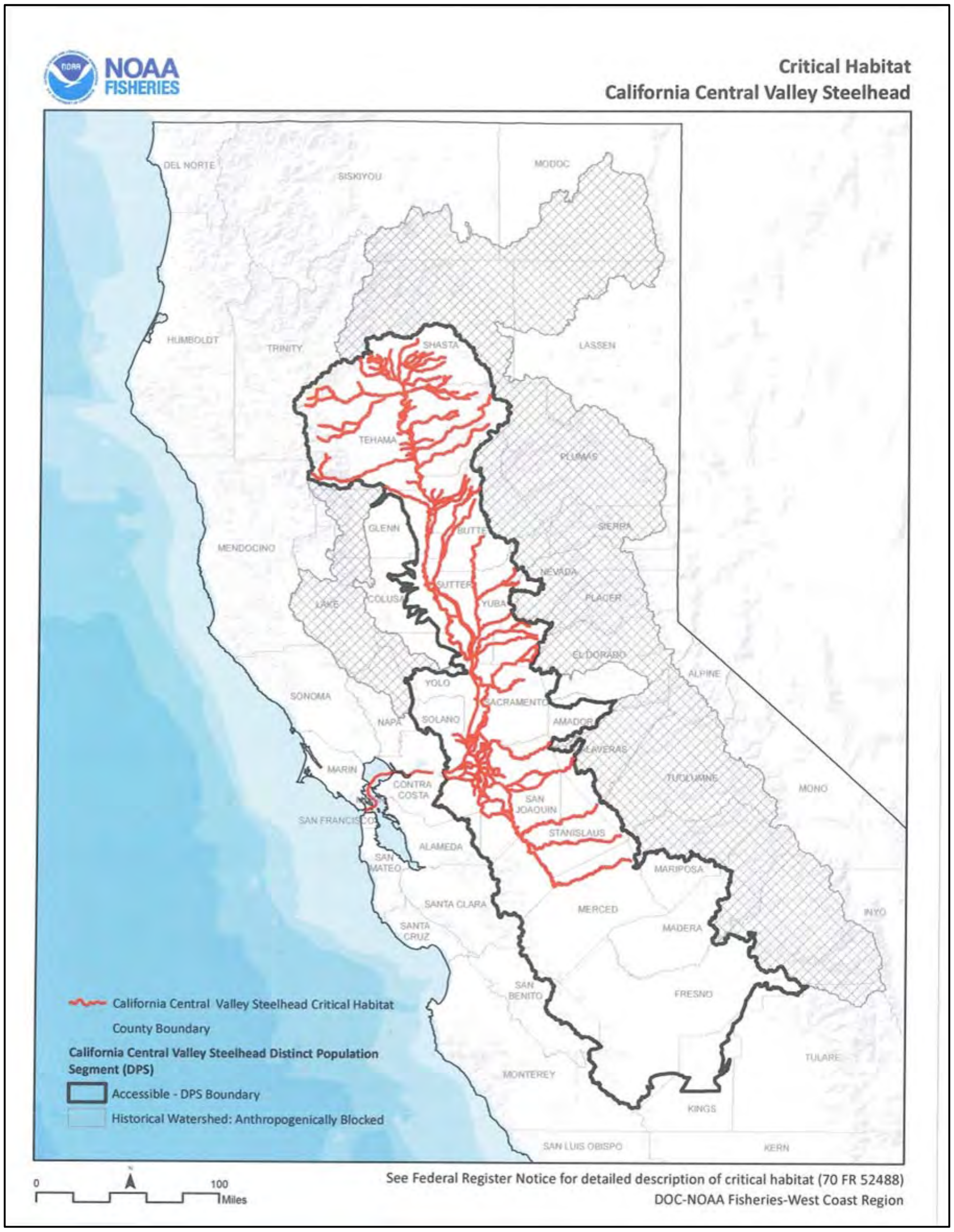

Figure II-6. Distribution of Critical Habitat California Central Valley Steelhead.

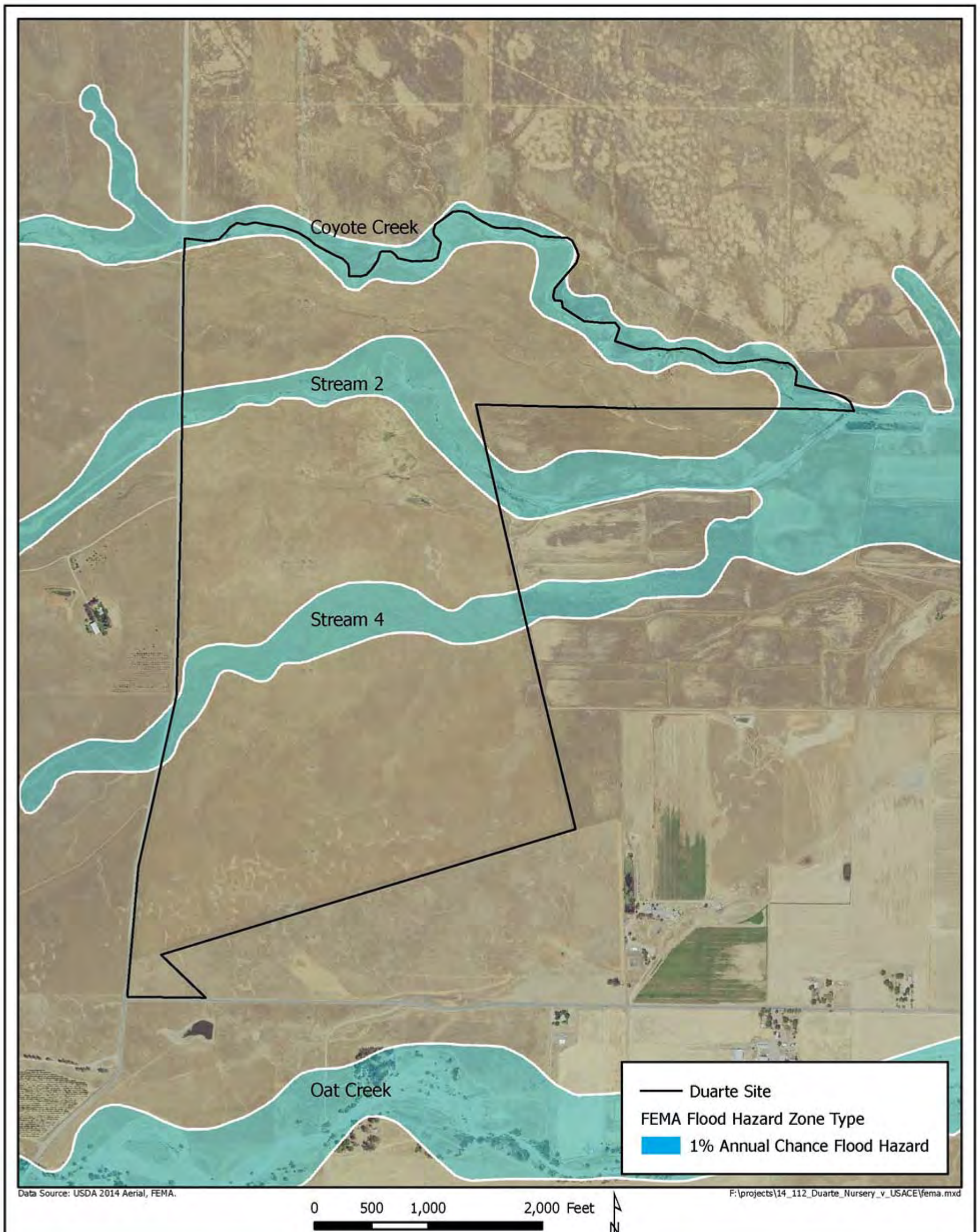

Figure II-7. FEMA Flood Hazard Zones.

III. OVERVIEW OF THE GEOMORPHOLOGY, CLIMATE, AND STREAM ECOSYSTEM STRUCTURE AND FUNCTIONING IN THE VICINITY OF THE DUARTE SITE.

A. Geomorphology

The Duarte Site is located on a regional land form that consists of Pliocene and/or Pleistocene sandstone, shale, and gravel deposits in the north central valley, California (Jennings, 2010; Figure III-1). Both east and west sides of the Sacramento Valley are draped with Pleistocene to Pliocene alluvial fans terminating at the Holocene basin floor along the Sacramento River. These alluvial fans are nearly level to undulating but gently slope toward the basin floor. They have well-developed drainage networks, being dissected by streams and rivers tributary to the Sacramento River. They are generally considered to comprise two geomorphic features relative to the Sacramento River—a regional low terrace, just up gradient from the basin floor, and a regional high terrace, just up gradient from the low terrace. Major geologic formations include the Riverbank formation on the regional low terrace and the Red Bluff formation on the regional high terrace, though other similarly situated and developed formations occur. The Riverbank formation is characterized by weathered reddish gravel, sand, and silt forming terraces and fans, and is 130K-450K BP in age; the Red Bluff formation comprises a thin veneer of highly weathered, bright-red gravels, sands, and silts overlying terrace and fan deposits of the Laguna, Tehama, and Tuscan formations, and is 450K-1.08M BP in age (Helley and Harwood, 1985).

A representation of the primary surfaces in the Coyote Creek drainage basin of high and low terraces and floodplain is presented in Figure III-2.

These formations are old enough for substantive soil forming (pedogenic) processes to have occurred (Helley and Harwood, 1985; Smith and Verrill, 1998). The USDA–Natural Resources Conservation Service (NRCS) has mapped several soil series on these formations with clay-rich and/or clay-enriched (argillic) horizons, including the Clear Lake, Corning, Hillgate, Red Bluff, and Redding series (Figure III-3). The NRCS soils map for the Duarte Site is included in this report as in section IV.E.2. These clay-rich and argillic horizons tend to either perch water or significantly slow its movement downward in the soil because they are relatively impermeable. Depths to these clay-rich and/or argillic horizons range from the soil surface (e.g., the Clear Lake Clay) to as much as 73 inches below the soil surface (e.g., the Hillgate loam). The NRCS also has mapped several soil series with silica- and iron-cemented layers (duripans) on these formations, including the Redding series. Duripans are also relatively impermeable and will significantly impede or stop the movement of water downward in soil profiles where they occur. All the above listed series have been mapped on both the regional low and high terraces with the exception of the Hillgate series, which is mapped only on the regional low terrace. These formations are also old enough for substantive erosion to have occurred. Consequently, microtopographic relief also is well developed, with mound-depression topography and irregular to coherent (tree-like or “dendritic”) and intermittent to seasonal drainage networks commonly connecting headwater depression and slope (hereafter “swale”) features to streams and rivers that in turn connect with larger streams (e.g. Oat Creek) and then the Sacramento River (Smith and Verrill, 1998).

Figure III-1. California geologic map.

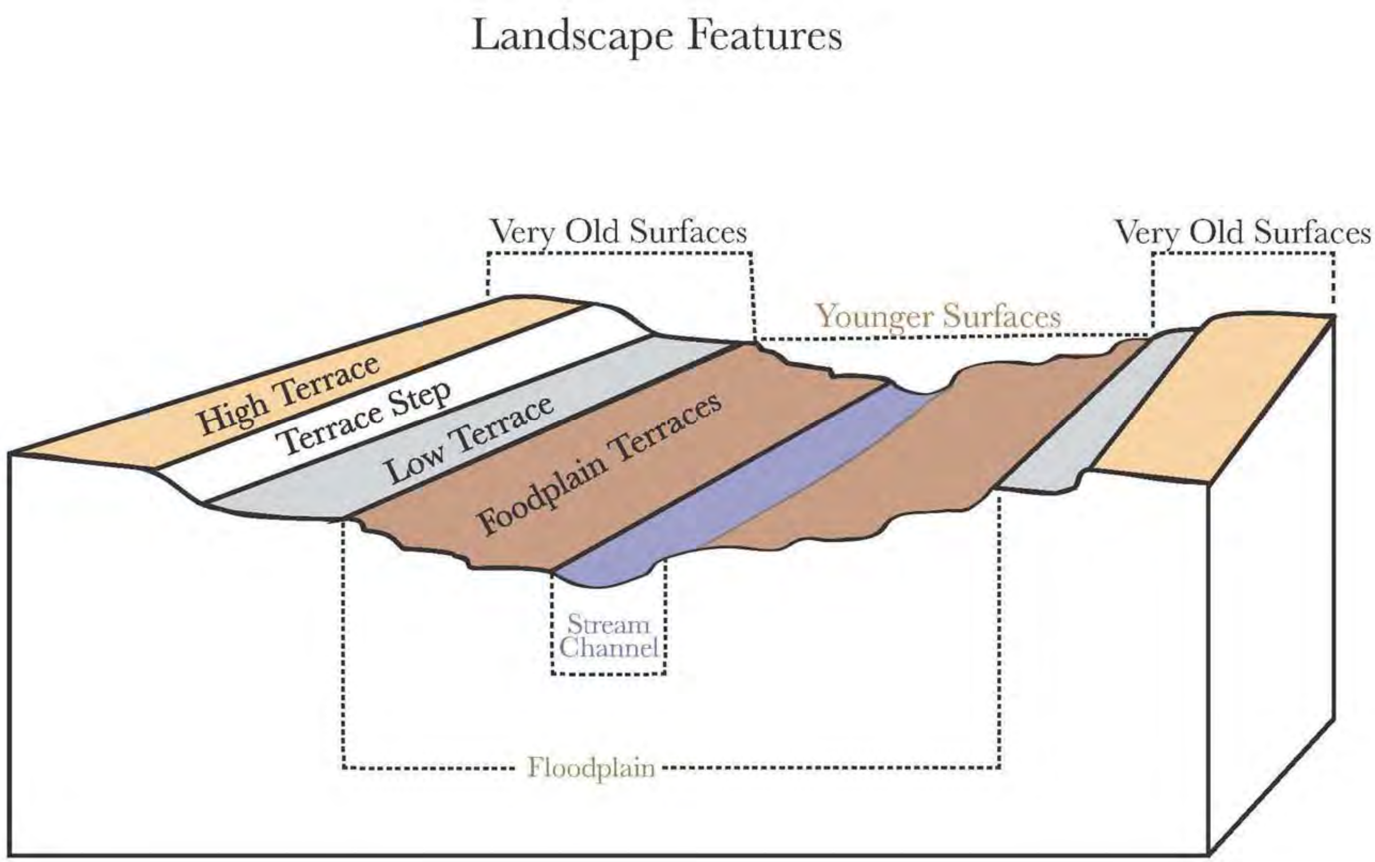

Figure III-2. Block diagram depicting the primary geomorphic surfaces found in the Coyote Creek and Oat Creek drainage basins. (Not to scale)

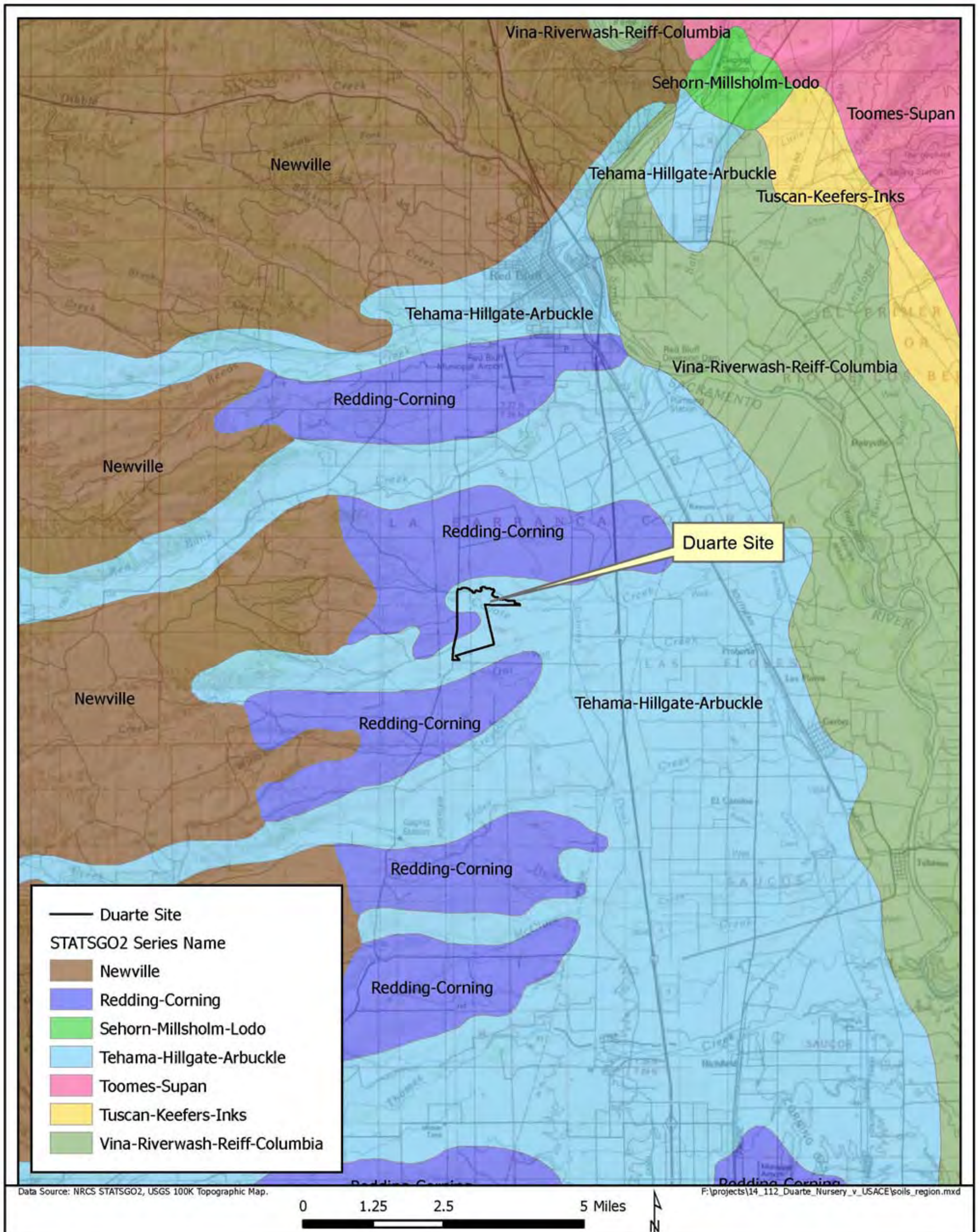

Figure III-3. Regional soil map in proximity to the Duarte site.

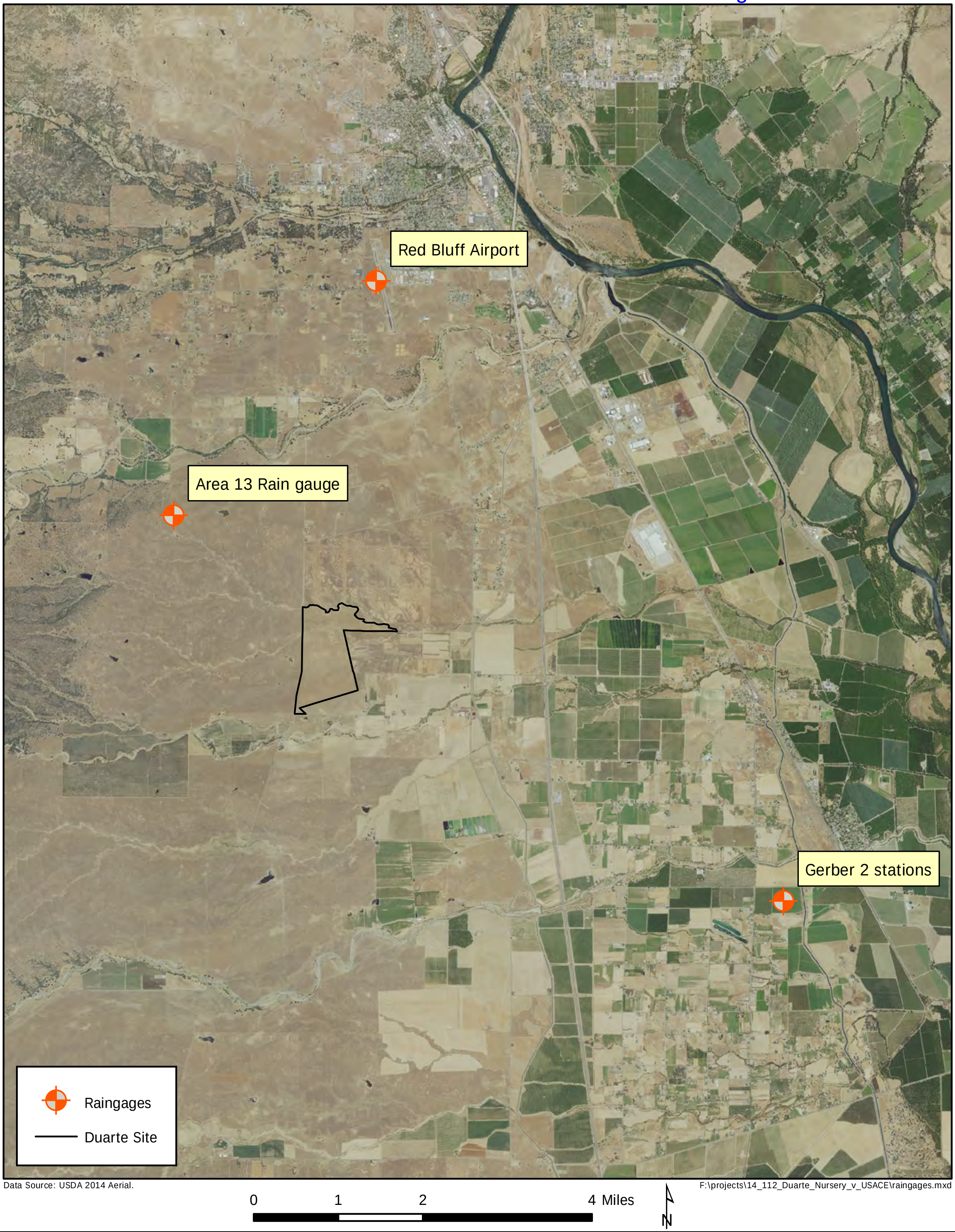

Figure III-4. Map showing location of rain gages used in the study in relation to the Coyote Creek watershed.

B. An Overview of Regional Climate and the Current Drought

1. Climate Data

The DOJ Expert Team used three sources of data to analyze rainfall. Historical and recent rainfall were obtained from the California Department of Water Resources, California Irrigation Management System, Gerber (Station 8) and Gerber South (Station 212), hereafter called the Gerber data, and from the National Oceanic and Atmospheric Administration, Red Bluff Municipal Airport (Station 24216), hereafter called the Red Bluff data. Rainfall also was measured since October, 2012 using a tipping bucket rain gauge and data logger located at the Coyote Creek Conservation Area (N 46° 06' 35.31", W 122° 17' 55.34"), hereafter called the Coyote Creek Conservation Area data.

2. Climate Summary

The climate in Tehama County is Mediterranean. The Red Bluff data show that the climate is characterized by mild, wet winters and hot, dry summers (Red Bluff Municipal Airport, Station 24216, 1981-2010). The mean, maximum, and minimum daily temperatures are 75.4, 50.3, and 62.9 °F, respectively. Mean annual precipitation is 24.8 inches, with ~95% falling during the months of October-May. It is important to note that in comparing worldwide Mediterranean climatic regions, precipitation patterns in California are the most variable and erratic (Bonada and Resh, 2013). The precipitation pattern in Tehama County is dominated by long periods of no precipitation (June-September) and intermittent periods of low intensity and short periods of high intensity precipitation (October-May).

3. Analysis of Current Drought Conditions

Over the last four years, California has been in a deep and persistent drought. Statewide annual rainfall totals have been well-below normal, and there is evidence that this is the most severe drought in the last 1200 years (Griffin and Anchukaitis 2014).

The Gerber data indicate drought conditions, with regional annual rainfall totals being well-below normal. Total annual rainfall was 16.35 inches or 66% of normal in Water Year 2013, 11.55 inches or 46% of normal in Water Year 2014, and 15.86 inches or 64% of normal in Water Year 2015 to date (i.e., April 10, 2015) (Figures III-5, III-6, and III-7). (A Water Year is October 1-September 30.)

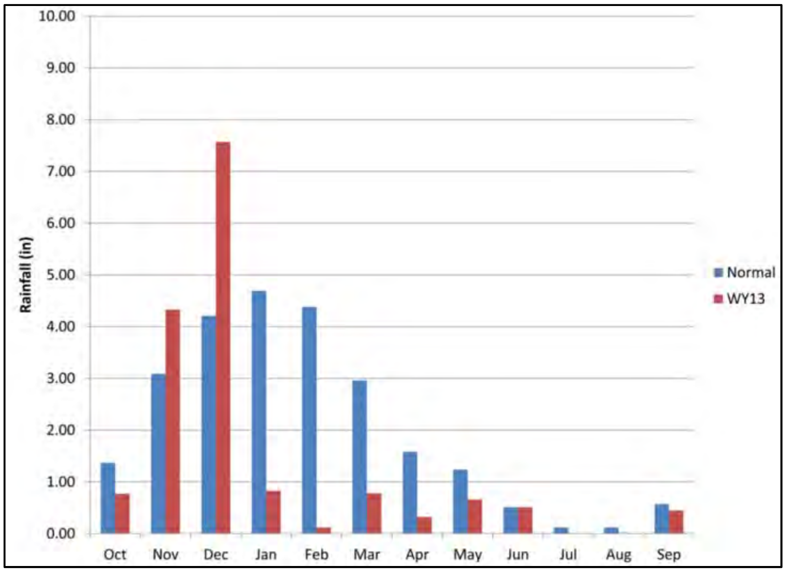

Figure III-5. Normal rainfall for 1981-2010 (Red Bluff data) and measured rainfall for Water Year 2013 (Gerber data). Total annual rainfall for Water Year 2013 was 16.35 inches, or 66% of normal.

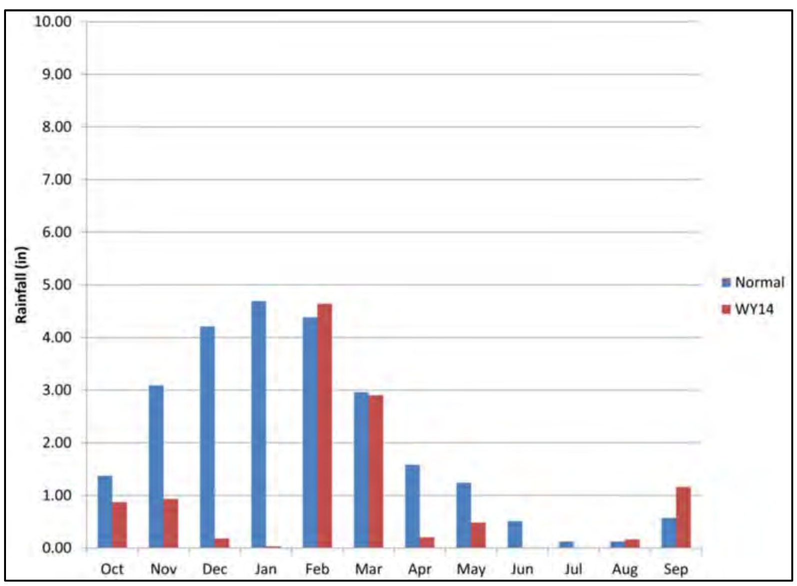

Figure III-6. Normal rainfall for 1981-2010 (Red Bluff data) and measured rainfall for Water Year 2014 (Gerber data). Total annual rainfall for Water Year 2014 was 11.55 inches, or 46% of normal.

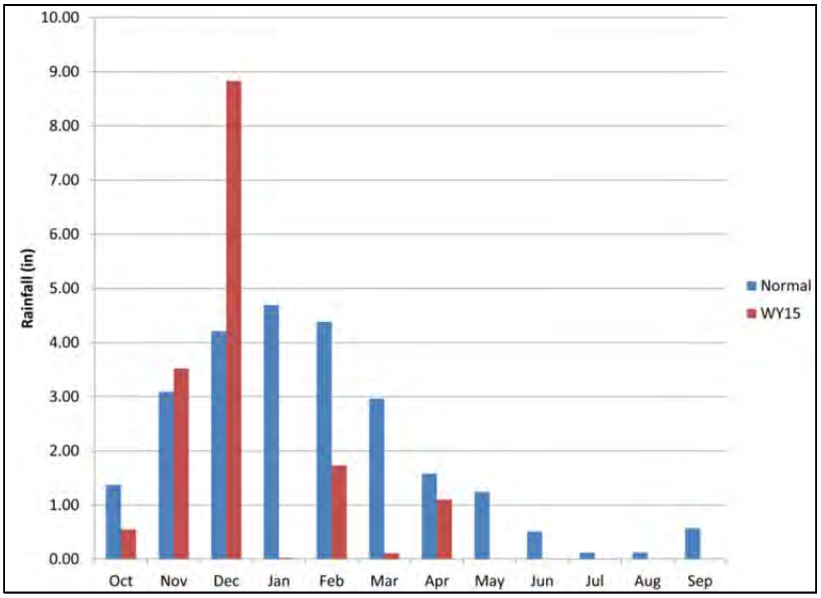

Figure III-7. Normal rainfall for 1981-2010 (Red Bluff data) and measured rainfall for Water Year 2015 to date (Gerber data). Total annual rainfall for Water Year 2015 to date is 15.86 inches, or 64% of normal.

A complete recent rainfall record for the region was compiled from the Coyote Creek Conservation Area and Red Bluff data. The Coyote Creek Conservation Area data covered the intervals February 5-June 18, 2013; September 28-December 6, 2013; March 4-May 16, 2014; and October 20-Decemver 17, 2014. When the tipping bucket rain gage and data logger malfunctioned, the Red Bluff data were used to infill the record. The combined Coyote Creek Conservation Area-Red Bluff data also indicate drought conditions, with total annual rainfall being 15.06 inches or 61% of normal in Water Year 2013, 14.41 inches or 58% of normal in Water Year 2014, and 18.70 inches or 75% of normal in Water Year 2015 to date (i.e., April 10, 2015) (Table III-1; Figures III-8, III-9, and III-10).

Table III-1. Monthly rainfall totals from the combined Coyote Creek Conservation Area-Red Bluff data. Water years are October 1-September 30. For example, Water Year 2013 is October 1, 2012-September 30, 2013.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2013	0.59	4.59	7.17	0.89	0.09	0.45	0.21	0.04	0.52	0.00	0.00	0.51	15.06
2014	0.00	1.39	0.27	0.06	6.41	3.10	0.24	0.36	0.00	0.01	0.13	2.44	14.41
2015	0.82	2.63	11.61	0.04	2.10	0.71	0.79	--	--	--	--	--	18.70

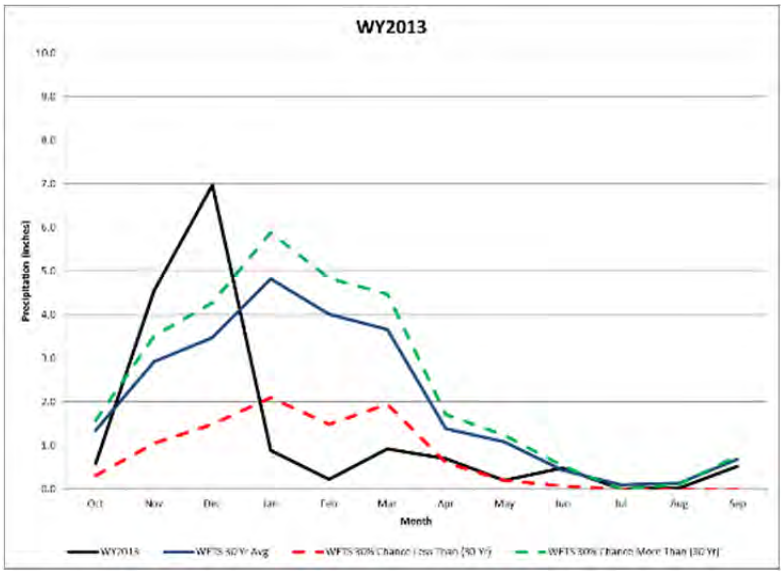

Figure III-8. Normal rainfall for 1981-2010 (Red Bluff data), expressed as the average (blue line), the average plus a standard deviation (dashed green line), and the average minus a standard (dashed red line) compared to actual rainfall for Water Year 2014 (Coyote Creek Conservation Area-Red Bluff data). Roughly two-thirds of all measurements should fall between the dashed green and red lines.

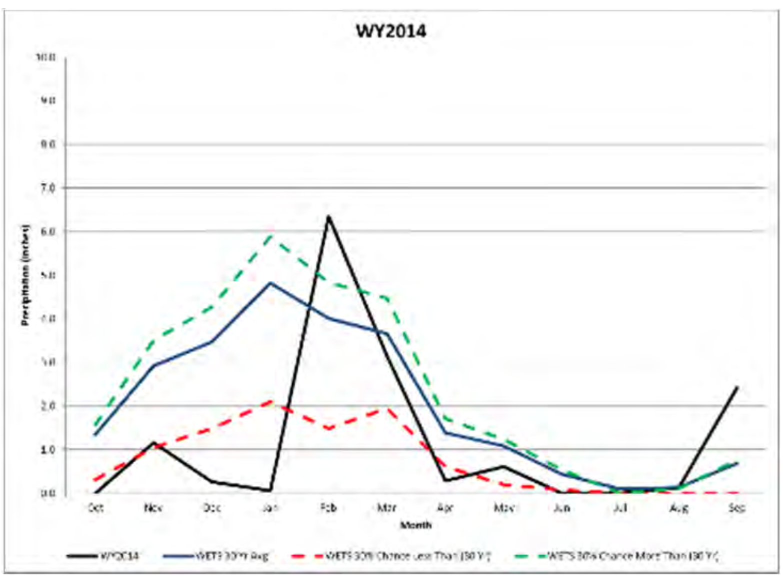

Figure III-9. Normal rainfall for 1981-2010 (Red Bluff data), expressed as the average (blue line), the average plus a standard deviation (dashed green line), and the average minus a standard (dashed red line) compared to actual rainfall for Water Year 2014 (Coyote Creek Conservation Area-Red Bluff data). Roughly two-thirds of all measurements should fall between the dashed green and red lines.

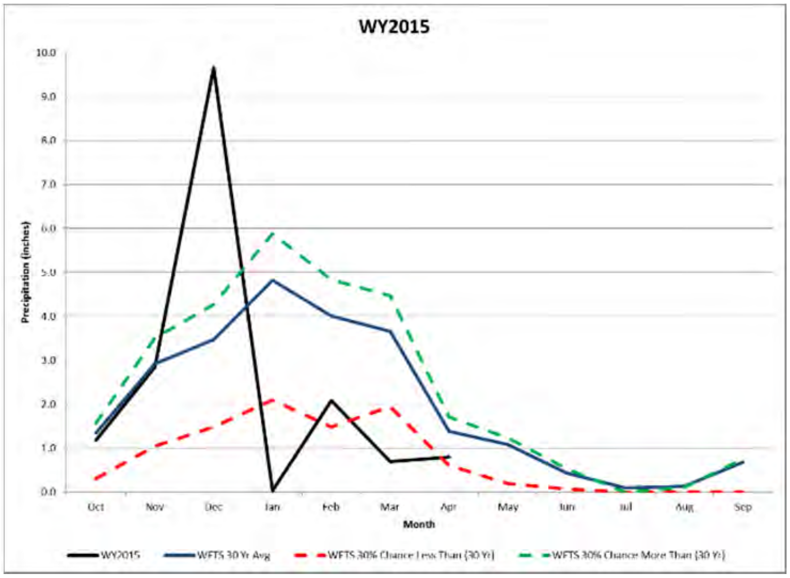

Figure III-10. Normal rainfall for 1981-2010 (Red Bluff data), expressed as the average (blue line), the average plus a standard deviation (dashed green line), and the average minus a standard (dashed red line) compared to actual rainfall for Water Year 2015 (Coyote Creek Conservation Area-Red Bluff data). Roughly two-thirds of all measurements should fall between the dashed green and red lines.

The DOJ Expert Team also used a standard Wetlands Determination (WETS) table analysis to examine drought conditions. The WETS table was generated using the Red Bluff data and Natural Resources Conservation Service Method 1 (http://www.wcc.nrcs.usda.gov/climate/navigate_wets.html). The WETS table expresses both normal and extremely wet and dry conditions on monthly intervals (Table III-2). Normal conditions are expressed as average monthly rainfall totals. Extremely wet and dry conditions are expressed as threshold monthly rainfall totals, with a 30% probability that actual monthly rainfall totals will be greater than the threshold (i.e., extremely wet conditions) and a 30% probability that actual monthly rainfall totals will be less than the threshold (i.e., extremely dry conditions). Four months were extremely dry in Water Year 2013, five months were extremely dry in Water Year 2014, and one month has been extremely dry in Water Year 2015 to date. Some notable examples were January 2013 where the threshold value is 2.10 inches and the actual total was 0.89 inches, February 2013 where the threshold value is 1.48 inches and the actual total was 0.09 inches, December 2013 where the threshold value is 1.49 inches and the actual total was 0.27 inches, January 2014 where the threshold value was 2.10 inches and the actual total was 0.06 inches, and January 2015 where the threshold value was 2.10 inches and the actual total was 0.04 inches.

Table III-2. WETS analysis results.

WETS Station : RED BLUFF MUNI AP, CA216 Creation Date: 05/04/2015
Latitude: 4009 Longitude: 12215 Elevation: 00353
State FIPS/County(FIPS): 06103 County Name: Tehama
Start yr. - 1971 End yr. - 2000

Month	Temperature (Degrees F.)			Precipitation (Inches)				
	avg daily max	avg daily min	avg	avg	30% chance will have less than	30% chance will have more than	avg # of days w/.1 or more	avg total snow fall
January	55.7	37.7	46.7	4.82	2.10	5.88	7	0.9
February	60.9	40.8	50.9	4.01	1.48	4.84	7	0.0
March	64.8	43.7	54.3	3.66	1.95	4.47	7	0.3
April	71.9	47.0	59.5	1.39	0.61	1.71	3	0.0
May	81.8	54.1	68.0	1.09	0.20	1.24	3	0.0
June	90.7	61.4	76.1	0.44	0.07	0.54	1	0.0
July	97.6	65.5	81.6	0.10	0.00	0.00	0	0.0
August	96.0	63.4	79.7	0.14	0.00	0.11	1	0.0
September	90.5	59.3	74.9	0.68	0.00	0.76	1	0.0
October	79.1	51.1	65.1	1.35	0.31	1.57	3	0.0
November	63.1	42.3	52.7	2.92	1.05	3.51	6	0.1
December	55.4	37.1	46.3	3.47	1.49	4.27	6	1.0
Annual	-----	-----	-----	------	18.38	28.00	--	----
Average	75.6	50.3	63.0	------	------	------	--	----
Average	-----	-----	-----	24.07	------	------	40	2.9

C. Overview of Stream Ecosystem Physical Structure and Landscape Hydrologic Responses of Stream Ecosystems and Associated Headwater Depressions and Swales to Precipitation

1. Stream Ecosystem Physical Structure

The general physical structure of stream ecosystems, including their associated headwater wetland depressions (vernal pools) and swales in the vicinity of the Duarte Site is repeated throughout the region. As in many Mediterranean regions of the world, the depression, swale, and stream channel systems that originate on and in the vicinity of the Duarte Site have a tree-like or "dendritic" structure. The structure of a generalized dendritic channel network is illustrated in Figure III-11. In Figure III-11, the conventional mechanism for naming stream sizes or "orders" is closely tied to map scale (Meyer and Wallace 2001). For example, within the Coyote Creek watershed and at a map scale of 1:24,000 (Figure II-1) on the National Hydrography Dataset [http://nhd.usgs.gov/] Coyote Creek as it crosses under the Paskenta Road bridge would be named a "third order" stream. This is because it exists downstream from the junction of at least two small "second order" channel systems that originate in the headwardmost or "headwater" landscape positions within the Coyote Creek reserve. Therefore, on the Duarte Site, there are first-, second-, and third-order streams when mapped at the 1:24,000 scale.

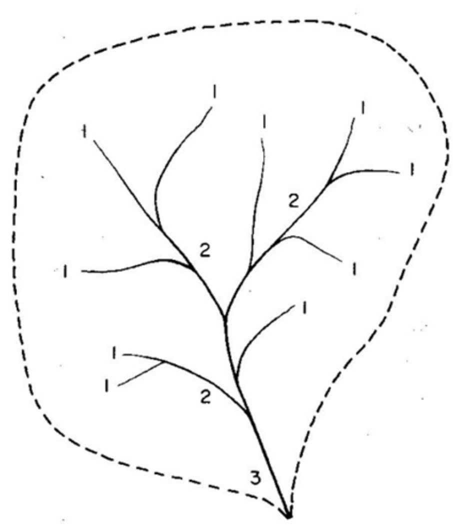

Figure III-11. Depiction of stream orders. From Lee 1980.

2. Landscape Hydrologic Responses of Stream Ecosystems and Associated Headwater Depression and Swale Wetlands to Precipitation

In Mediterranean climates such as the Sacramento River Valley in Central California, stream and river ecosystems and their associated headwater wetlands are hydrologically unique in that stream flow regimes closely reflect the pattern of precipitation (Bonda and Resh, 2013). As introduced above in the Climate section of this report, the precipitation pattern in the Central California region is dominated by long periods of significant summer droughts, intermittent periods (days) of low-intensity precipitation, and short periods (hours) of high-intensity precipitation. Consequently, headwater wetlands and associated streams are "flashy", with water levels and flows changing rapidly in response rainfall, with rapid increases when rainfall occurs and rapid decreases when rainfall ceases.

Worldwide, runoff generation and related stream flows are largely functions of interactions among climate, geology, and topography (Winter 2001). These are regional factors, so runoff generation and related stream flows tend to be similar within given regions (Wolock et al. 2004). One such region is the northwestern Sacramento Valley, from the South Fork Cottonwood Creek in the north to Stone Corral Creek in the south, and including Coyote and Oat Creeks. Within this region, there are seven US Geological Survey stream gages with at least three years of daily flow data in watersheds much like the Coyote-Oat Creek Watershed (i.e., they have Mediterranean climates; they are largely on the Pleistocene to Pliocene alluvial fans and major geological formations include the Riverbank and Red Bluff Formations; and they are nearly level to undulating but gently slope toward the basin floor).

Flows on these streams are usually intermittent with flows occurring in response to wet-season rainfall and long-term subsurface flow to the stream channel network. Mean annual days of flow are highly correlated with watershed area (Table III-3; Figure III-12). In general, those stream ecosystems with the smallest watershed areas have the fewest annual days of flow while those with the largest watershed areas have the most annual days of flow. This relationship is remarkably linear, indicating that climate, geology, and topography are similar in each of the watersheds and that the largest source of variation is the volume of accumulated rainfall which is itself a function of watershed area and local storm patterns.

During the wet season, the wettest portions of the watershed are near the interlinked dendritic networks of depressions, swales, and streams. These areas are wettest due to the migration of water along shallow subsurface low-permeability soil horizons. In addition, precipitation delivered to these wetter areas leads to a rapid surface and shallow subsurface flow response in interlinked dendritic networks of depressions, swales and streams. As the precipitation event continues, the watershed becomes wetter and the area contributing flow to the depressions, swales, and streams (“contributing area”) expands and flow increases as described by the variable source area concept demonstrated in Figure III-13.

Table III-3. US Geological Survey stream gages with long-term records in the same physiographic region as the Coyote-Oat Creek Watershed with the periods of record, the watershed areas, and the mean annual days of flow.

ID	Period of Record WY	Years of Record	Watershed Area mi2	Mean Annual Days of Flow
USGS 11390672 STONE CORRAL C NR SITES CA	1959-1985	27	38.2	142
USGS 11390655 SF WILLOW C NR FRUTO CA	1964-1978	15	38.9	106
USGS 11378800 RED BANK C NR RED BLUFF CA	1960-1982	23	93.5	186
USGS 11378860 RED BANK C A RAWSON RD BR NR RED BLUFF CA	1965-1967	3	109	209
USGS 11380000 ELDER C NR HENLEYVILLE CA	1931-1941	11	130	233
USGS 11380500 ELDER C A GERBER CA	1950-1969	20	136	243
USGS 11375820 SF COTTONWOOD C NR COTTONWOOD CA	1963-1978	16	217	317

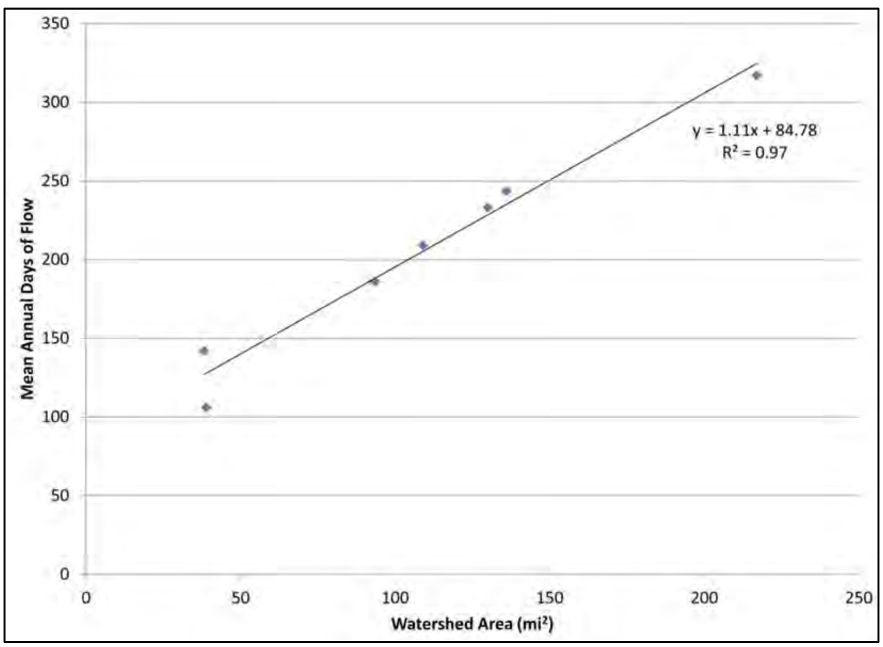

Figure III-12. Mean annual days of flow as a function of watershed area for the seven US Geological Survey stream gages with long-term records in the same physiographic region as the Coyote-Oat Creek Watershed.

Because the Duarte Site soils are typically shallow above the slowly permeable soil horizons, the watershed contributing area shrinks quickly following decreases or cessation of incoming precipitation. In these conditions, flow within and downstream from the depressions, swales and stream complexes diminishes; depressions and swales first, and then streams. Depressions and swales that have not been altered will generally retain ponded or slowly flowing water for a longer period of time, slowly yielding water to evapotranspiration and downslope seepage along the lower permeability subsurface horizons.

Figure III-14 demonstrates for arid regions of the U.S. west the typical changes that occur in the flow regime of the channel system progressing from low flow (base flow) conditions to increased discharge as the result of a precipitation event and inundation of the floodplain terraces.

D. Overview of the Importance of Physical Linkages Among River and Stream Ecosystems and Associated Headwater Depressions and Swales to Biogeochemical, Plant Community, and Faunal Support/Habitat Ecosystem Structure and Functioning

As discussed throughout the introductory sections of this report, Mediterranean river ecosystems occur worldwide. They include the streams with watersheds largely in the Sacramento Valley, including Coyote and Oat Creeks. As with most Mediterranean river ecosystems, the condition and functioning of direct physical linkages among incoming precipitation, runoff responses within depression, swale, and channel systems and delivery of runoff to down gradient streams (e.g. Coyote Creek, Oat Creek) and the Sacramento River are important (Grantham et al.; 2013; Herskovitz and Gasith, 2013; Cooper et al., 2013). For example, intact physical linkages among components of Mediterranean river ecosystems have been shown to exert important controls over the chemical integrity of downstream waters (Bernal et al., 2013). Further, the timing, volume, and quality of waters delivered along an intact continuum of relatively small depression, swale, and stream systems to downstream floodplains and waters has also been shown to have important effects on the structure and functioning of riparian plant communities (Stella et al., 2013).

Closely linked to these connections and maintenance of intact riparian plant communities are a range of complex and highly structured "wildlife" (faunal) habitats and the faunal species and food webs that they support (Hershkovitz and Gasith, 2013; Power et al., 2013; Romani et al., 2013)

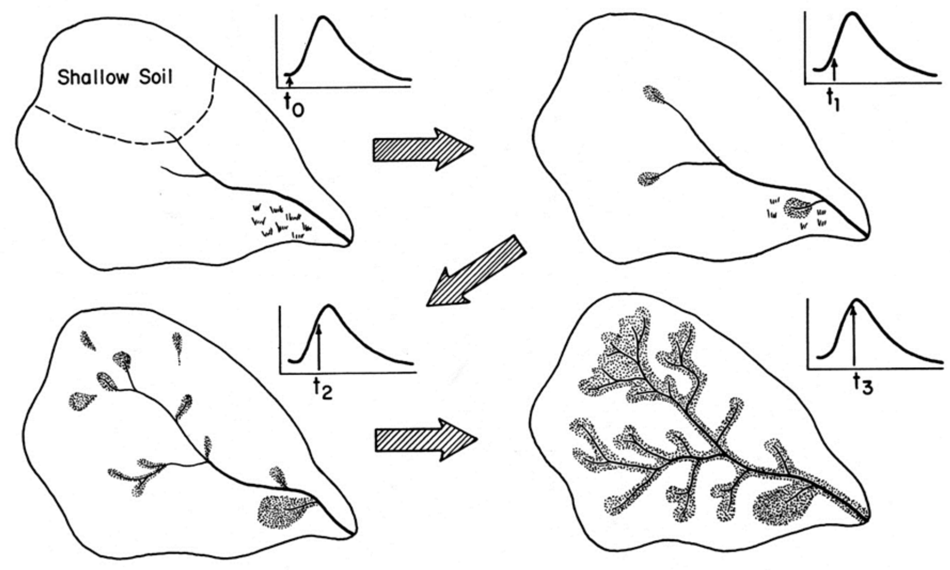

Figure III-13. The Variable Source Area concept demonstrating the response of a watershed to a rainfall event sufficient enough to generate flow in the channels. The stream network grows as the depressions and swales become wetter by direct rainfall and lateral flow. As the swales become wetter the subsurface system capacity for retaining water is exceeded and surface flow is initiated. From Hewlett and Nutter 1970.

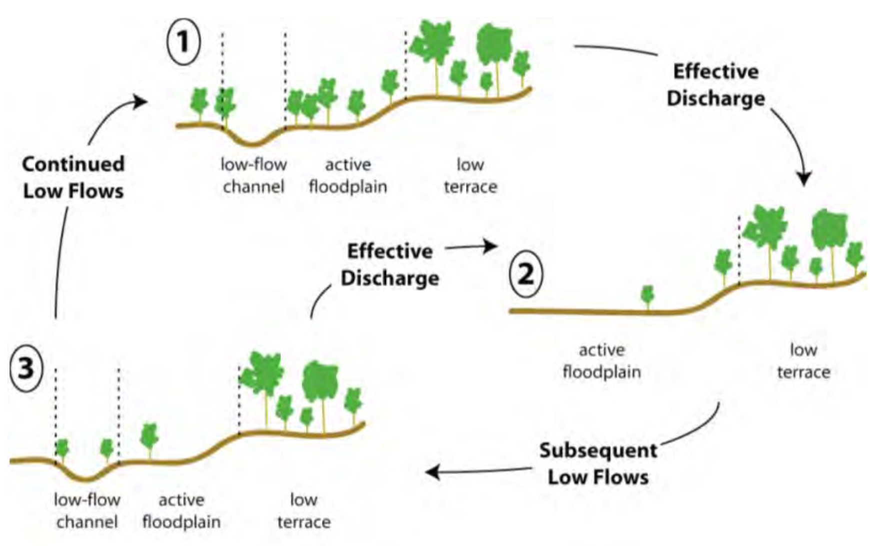

Figure III-14. Model of changes within the active floodplain and low-flow channel associated with discharge events. (Note: There may be aggradation or degradation after step 2.) From Lichvar and McColley 2008.

IV. METHODS

A. Review of Background Materials

1. Standard Materials

Starting on or around May 8, 2012 and continuing to June, 2015 members of the DOJ Expert Team reviewed standard background materials and information concerning the low order depressional, swale, and stream ecosystems situated on Pliocene and/or Pleistocene sandstone, shale, and gravel deposits in the North Central Valley, California. This effort was initially focused on developing means and methods to design a study that would document hydrologic conditions, connections and ecosystem functioning in vernal depressions, swales, and streams in "reference" areas that had not been perturbed by activities such as grazing, tillage, grazing and tillage, and conversion to walnut and olive or other agricultural production. Specifically, the DOJ Expert Team worked to identify a range of reference areas in various grazed, tilled, grazed and tilled, or fallow conditions for comparison with recently tilled and converted conditions at the Anchordoguy Site. The Anchordoguy Site is located due east of the I-5 corridor, due west of Highway 99, north of Coyote Creek, and south of the Walmart Distribution Center in Red Bluff. Standard reference materials were located and reviewed. For example, these materials included, but were not limited to the following:

U.S. Geological Survey (USGS) maps at scales of 1:100,000 and 1:24,000

National Wetland Inventory (NWI) maps

NRCS soils mapping of soil series and soil properties

Federal Emergency Management Agency (FEMA) flood hazard and floodplain maps

Geological Maps of the State of California

Existing Lidar imagery along the PG&E and PGT pipeline project

Imagery from Google Earth Pro

Monitoring Records and briefing materials/manuals from the Tehama County Resource Conservation District

1994 and 2012 Waters/Wetland Delineations of the Duarte Site and properties to the east along the pipeline corridor paralleling I-5

2. *Documents and Electronically Stored Information Produced in Discovery*

Starting on October 9, 2014, the DOJ Expert Team focused its attention to review of background materials associated with the Duarte Site. In addition to the standard materials listed immediately above, the DOJ Expert Team reviewed and considered several types of materials that provided context for examining conditions on the Duarte Site.

In addition to the standard material listed immediately above, the DOJ Expert Team has reviewed and considered the discovery produced by the parties to date (excluding discovery on Duarte's finances) and material provided by third parties in response to sibpoenas.

3. *Other Background Material*

B. Interviews

1. *Federal Employees*

Mary Butterwick (Retired) – U.S. Environmental Protection Agency, Region Nine, San Francisco, CA (Fall, 2012)

Joe Silviera – Wildlife Biologist, Sacramento Wildlife Refuge Complex, U.S. Fish and Wildlife Service (Several times since Fall of 2012)

Matt Kelley, – U.S. Army Corps of Engineers, Redding Field Office (Several times since Fall, 2012)

Jamie Robb – U.S. Army Corps of Engineers, Redding Field Office (Several Times since October, 2014)

2. *California State*

Richard A. Lis – Senior Environmental Scientist - Specialist, California Fish and Wildlife, Northern Region, Redding, CA (Several times since Fall of 2012)

3. *Private Corporations*

Steve Keleher - I-5 Rental Staff, 8443 Commercial Way, Redding, CA 96002 (March – April, 2015

Travis Burke - Equipment Operator, I5 Rentals, 8443 Commercial Way, Redding, CA 96002 (March-April, 2015)

Ryan Phillips - Equipment Operator, I5 Rentals, 8443 Commercial Way, Redding, CA 96002 (March-April, 2015)

4. *Academics*

Michael Marchetti , Professor, St Mary's college **http://www.stmarys-ca.edu/tags/michael-marchetti**

5. *Land Owners and Managers*

Al Bianchi – Landowner adjacent to Duarte Site (March- April, 2015

Lyle Dawson – Manager, Coyote Creek Reserve (Several Times since Fall of 2012)

C. *Dates of Field Visits to Reference Areas and to the Duarte Site*

Table IV-1. Dates and Purposes of Site Visits by Investigators.

1. Lyndon C. Lee		
2012		
5-13 to 16	Field Work	Initial Reconnaissance & Reference Site Selection
10-13 to 20		Hobo data begins 10/17 +10/18/12 (install)
11-16 to 19		Downloads & Observations of tillage activities on Duarte Site
12-06 to 19		Downloads & Observations of further tillage activity on the Duarte Site
2013		
2-2 to 6	Field Work	Reference Observations & Download
4-18 to 19		
6-17 to 19		
9-8 to 10		
12-4 to 7		
2014		
3-3 to 5	Field Work	Reference Observations & Downloads
3-24 to 4-2-14	Downloads	
5-15 to 17		
10-13 to 16		
2015		
3-1 to 5	Field Work	Reference Observations & Downloads
3-29 to 4-15		Duarte Site, Initial data and report synthesis
5-14 to 16		Decommission or service instrument arrays for dry season

Table IV-1. Dates and Purposes of Site Visits by Investigators. (Continued)		
2. Richard A. Lis		
3/31 to 4/15, 2015	Duarte and Reference Area Field Work	Data Synthesis
3. Wade L. Nutter		
2012		
10-14 to 19	Field Work	Reference Observations & Downloads
12-16 to 20		
2013		
2-3 to 7	Field Work	Reference Observations & Downloads
3-25 to 4/2		
2014		
10-12 to 17	Field Work	Reference Observations & Downloads
2015		
3-1 to 5	Field Work	Reference Observations & Downloads
3-29 to 4/15		Duarte Site Field Work & Data/Report Synthesis
4. Mark C. Rains		
2012		
5-14 to 16	Field Work	Reference Observations & Downloads
10-14 to 18		
12-17 to 19		
2013		
2-4 to 6	Field Work	Reference Observations & Downloads
9-27 to 29		
2014		
3-26 to 27	Field Work	Reference Observations & Downloads
5-16		
10-13 to 15		
12-14		
2015		
3-2 to 4	Field Work	Reference Observations & Downloads
3-30 to 4-4		
4-9 to 10		
5. Scott R. Stewart		
2012		
5-13 to16	Field Work	Reference Observations & Downloads
10-15 to 18		
12-16 to 20		
2013		
02-03 to 07	Field Work	Reference Observations & Downloads
2014		
03-03 to 06	Field Work	Reference Observations & Downloads
03-25 to 4-02		
10-12 to 17		
2015		
03-01 to 05	Field Work	Reference Observations & Downloads
03-29 to 04-16		

D. Reference Systems

1. Documentation Study of Hydrologic Conditions in Vernal Depression, Swale, and Stream Landscapes, Northern Sacramento Valley, California

a. Introduction and Objectives

As discussed in the introductory sections of this report, hydrologic conditions and processes in vernal depression, swale, stream and riverine landscapes have been documented in several locations in the Central Valley of California (Rains et al. 2006, Rains et al. 2008). Starting in the fall of 2012 and as part of the U.S. v Anchordoguy effort, the DOJ Expert Team reviewed background materials as described above. We also conducted reconnaissance trips in many of the watersheds and stream systems that occur west of Interstate 5 from Redding to south of Red Bluff at State Route 20, west of Williams, CA. As part of our reconnaissance efforts, we examined several potential reference areas in the vicinity of the Duarte Site. These included but were not limited to the SW corner of the Duarte Site, several sites along Oat Creek, several sites within the Coyote Creek Conservation Area, and several sites within the Thomes Creek Ecological Reserve, and in downstream reaches of Thomes Creek.

Following our reviews and reconnaissance efforts, we designed a study to focus on conditions within and connections among vernal depression, swale, stream, and riverine landscapes located in western Tehama County. As the Anchordoguy site was also located in the Coyote Creek watershed, the chief objective of that study was to develop a reference system that would assist our expert team in documenting hydrologic, and if possible, biogeochemical conditions and connections in landscapes that include vernal depressions and wetlands and swale wetlands and associated streams within the Coyote Creek/Oat Creek watersheds. The location and functioning of connections of the Coyote Creek/Oat Creek systems to the Sacramento River were also highlighted.

The location of the Coyote Creek Conservation Area (CCCA) reference areas are shown in Figure IV-1. Respectively, they are called “Area 13” and the “Agricultural Area”. Area 13 exists in a “grazed only” condition. It was never tilled and slowly permeable soil layers remain intact. Our analysis of Google Earth Pro and other historical imagery shows that the Agricultural Area does not appear to have been tilled since sometime before August, 1998. Our reconnaissance field work shows that slowly permeable soil layers remain intact (i.e., the depth of tillage was shallow). The Agricultural Area was also historically and currently is grazed. Our working hypothesis for the hydrologic study based on our review of background materials and literature was that the main Area 13 and Agricultural Area reference systems and similarly situated vernal depressions, swales and streams occur in the Coyote Creek/Oat Creek watershed. These wetland and stream systems are supported by seasonal surface water and perched subsurface water hydrologically and biogeochemically connect uplands, vernal depressions and swales, and streams at the watershed scale (e.g., Rains et al. 2006).

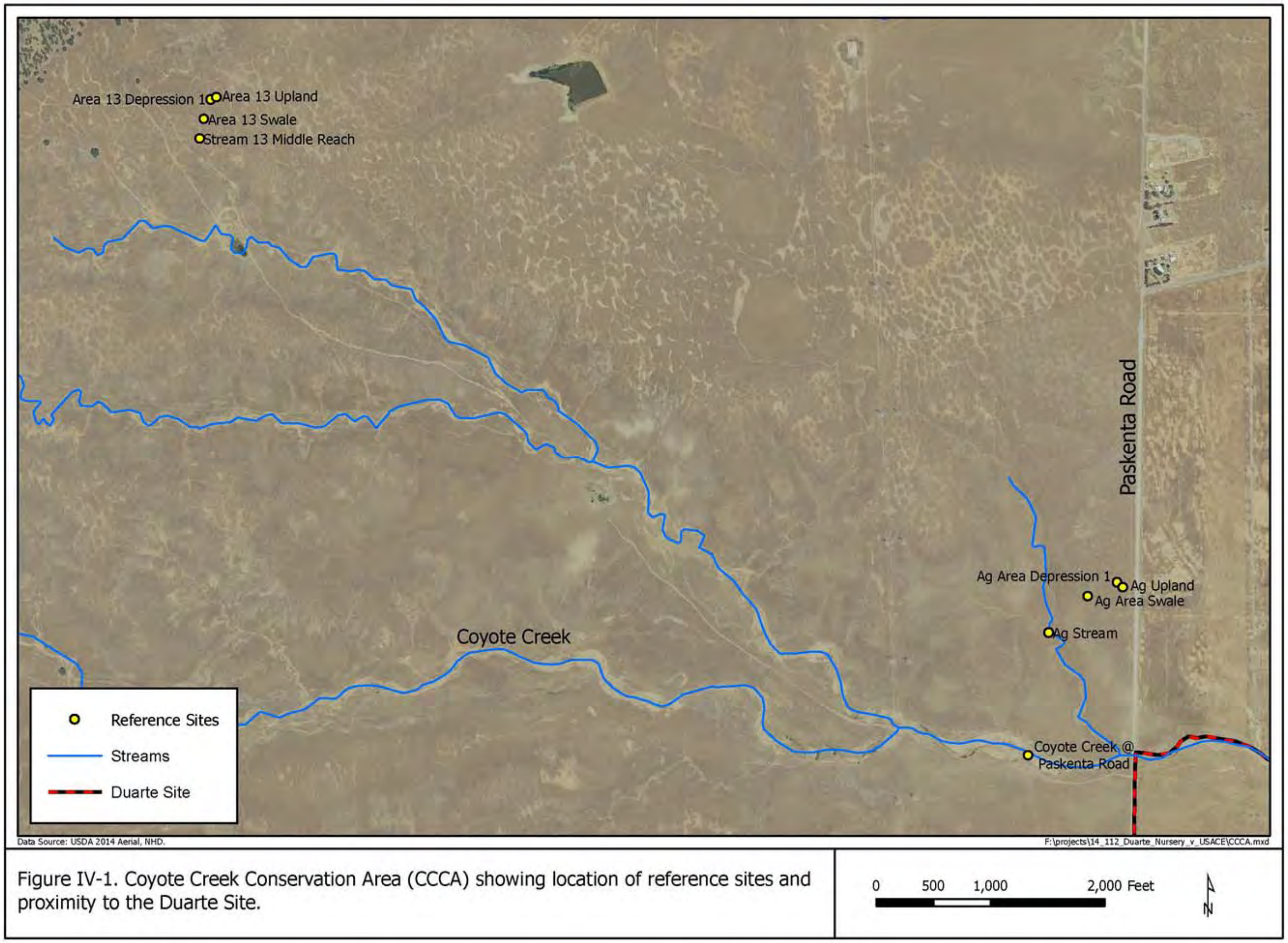

Figure IV-1. Coyote Creek Conservation Area (CCCA) showing location of reference sites and proximity to the Duarte Site.

b. Reference Site Descriptions

As introduced above, a major part of this study took place within and downstream from the CCCA, an approximately 2,900-acre preserve. The CCCA is privately owned by Red Bluff Farms and monitoring is conducted by the Tehama County Resource Conservation District. This area is exemplary of vernal depression, swale and associated stream landscapes in the northern Sacramento Valley. It is our opinion that it is an excellent reference area because it has numerous intact complexes of vernal depressions and swales and a network of streams that ultimately connect Coyote Creek to Oat Creek, and the Sacramento River (Figure IV-2). In summary the CCCA has the following natural and cultural features which make it an excellent reference area:

a. High terrace transitioning to low terrace geomorphic surfaces;
b. Low terrace transitions to floodplain and stream surfaces;
c. Elevation/local relief features that are comparable to the Duarte Site;
d. Mapped and confirmed soil types consisting of Corning – Redding Gravelly Loams on 0 to 5% slopes;
e. A range of land uses including grazing only and grazing combined with some agriculture;
f. Limited human uses other than grazing and relatively light and passive recreational uses; and
g. Safe and secure/controlled access.

c. Reference System Hydrologic and Water Sampling

1. Hydrologic Sampling

The initial phase of this study took take place during the wet season of 2012-2013. Data collection continued for the wet seasons of 2013-2014, and 2014-2015. The study is on-going as of this writing (June 5, 2015).

Rainfall have been obtained from the California Department of Water Resources, California Irrigation Management System, Gerber (Station 8) and Gerber South (Station 212), hereafter called the Gerber data, and from the National Oceanic and Atmospheric Administration, Red Bluff Municipal Airport (Station 24216), hereafter called the Red Bluff data. Precipitation can vary substantially, even over short distances, at the same elevation, and during a single storm. Therefore, additional precipitation data are, and still continue to be, collected from an Onset Corporation (Bourne, MA) “tipping-bucket” rain gage located in sampling Area 13 in the CCCA. The tipping bucket gage is mounted on a steel post driven into the upland soils adjacent to but not within vernal depressions and swales or streams. The tipping bucket records each 0.01 inch of rainfall on a microchip. These data are downloaded to an Onset Corporation USB shuttle and transferred via Onset Corporation software (“Hoboware”) to an Excel spreadsheet for integration with the water level graphics.

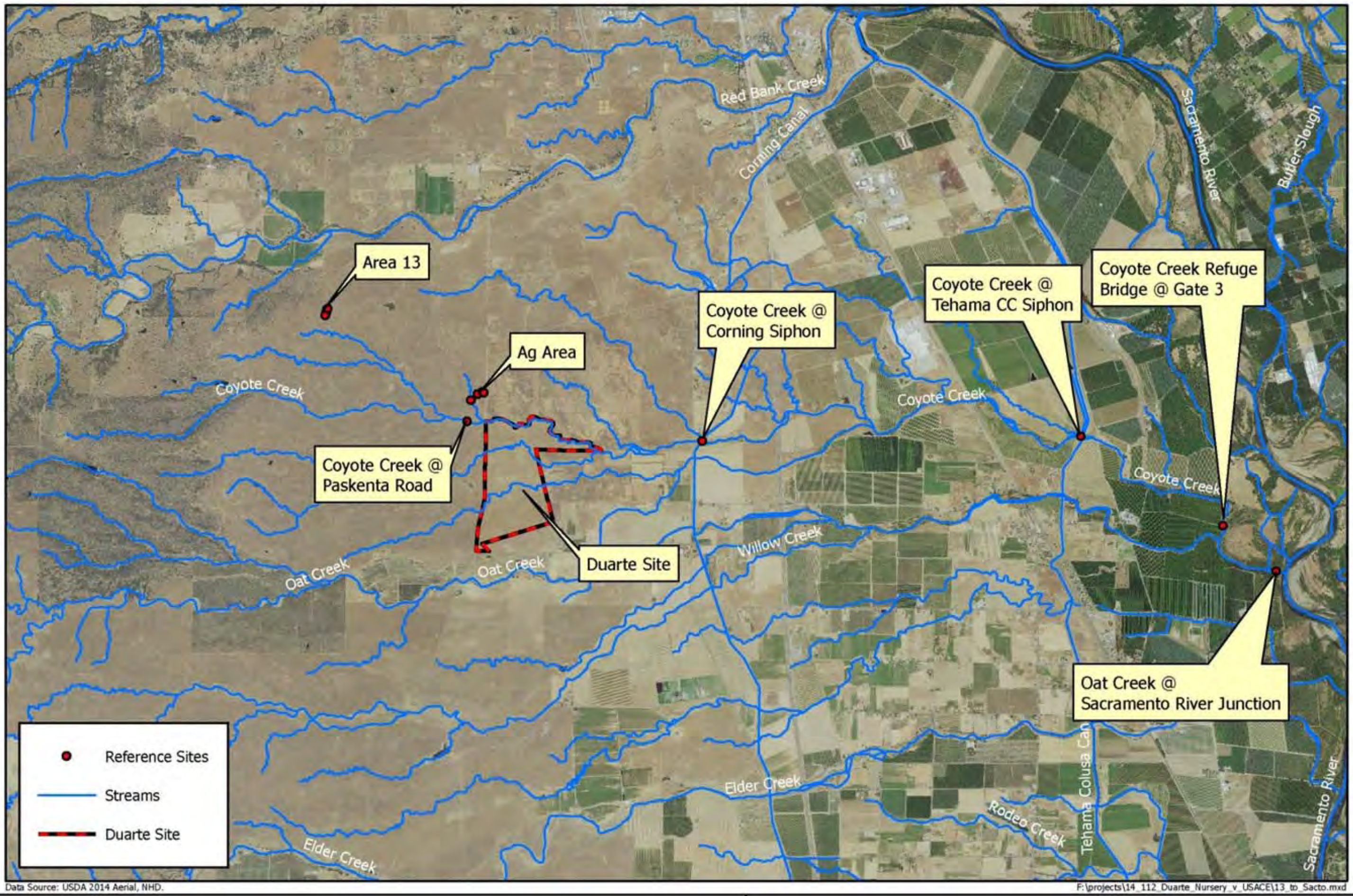

Figure IV-2. Reference site locations in the Coyote Creek watershed and connection to the Sacramento River.

Non-destructive, continuous (i.e., automatic) and storm-timed (i.e., manual) measurements of water levels and swale and tributary stream flows have been made in

a. Uplands adjacent to the vernal depressions and swales,

b. Vernal depressions and swales; and

c. Streams located in the west-central (Area 13) and the Agricultural Area of the CCCA. (Refer to Figures IV-1 for locations).

Sampling has also taken place in representative reaches of the streams located downstream from the CCCA sites and along Coyote Creek and Oat Creek, until the Coyote Creek/Oat Creek watershed joins the Sacramento River. (Refer to Figure IV-2 for locations).

Water levels have been measured using Onset Corporation "Hobo" pressure transducer/data loggers installed in shallow stand-pipe systems (USDA 2008) (Photo IV-1). The stand pipes were constructed of 2-inch diameter slotted PVC. These PVC stand pipes are supported by metal "T" posts. The posts were driven into the soil where cattle and/or flowing water and accumulating debris might damage an unsupported monitoring well. An example of a Hobo standpipe setup is shown in Photo IV-1. The location of the photograph is the Agricultural Area Upland and Depression 1. The shallow stand pipes were installed entirely above any slowly permeable soil horizons. To install the monitoring wells, "pilot" boreholes, 2 inches in diameter, were hand augured. The stand-pipes were then installed in the boreholes, and the annuli (i.e., the empty space between the monitoring wells and the walls of the boreholes) backfilled with native material and compacted by hand. Stand pipe systems were then surrounded by a fence enclosure to prevent damage to instruments from livestock. (Photo IV-1)

The Hobo water level recorders were programmed using proprietary and standard software from the manufacturer, Onset Computer Corporation, Bourne, MA. Programming consisted of using a laptop computer to set the measurement time interval, record sample location, start times, etc. During the rainy season the time interval was set for short intervals (i.e., 6 minutes). During the hot, dry season the Hobos were removed from the CCCA to prevent damage from heat and the downstream Hobos were left in place but set for longer measurement intervals (i.e., a 10-minute measurement interval). All measurements were downloaded and initially curated by L.C. Lee in the field. He used a standard Hewlett-Packard PC computer loaded with standard Onset "Hoboware" software. To adjust for fluctuations in barometric pressure of the water level recorders, two additional Hobos were located in a free standing position (i.e., open to the atmosphere) to record ambient barometric pressure. One of the barometric Hobos was located in the Area 13 sampling location in the CCCA and the other just upstream of the Oat Creek-Sacramento River junction. Using the barometric Hobos and standard Onset software, the downloaded Hobo water level data were corrected for barometric pressure. The corrected data were then transferred to a Microsoft Excel spreadsheet for review and preliminary graphing. Because there were several years of data, associated with this study the ease of handling the data for graphing within Excel was exceeded and the data were transferred to the MatLab computer program for graphing and presentation.

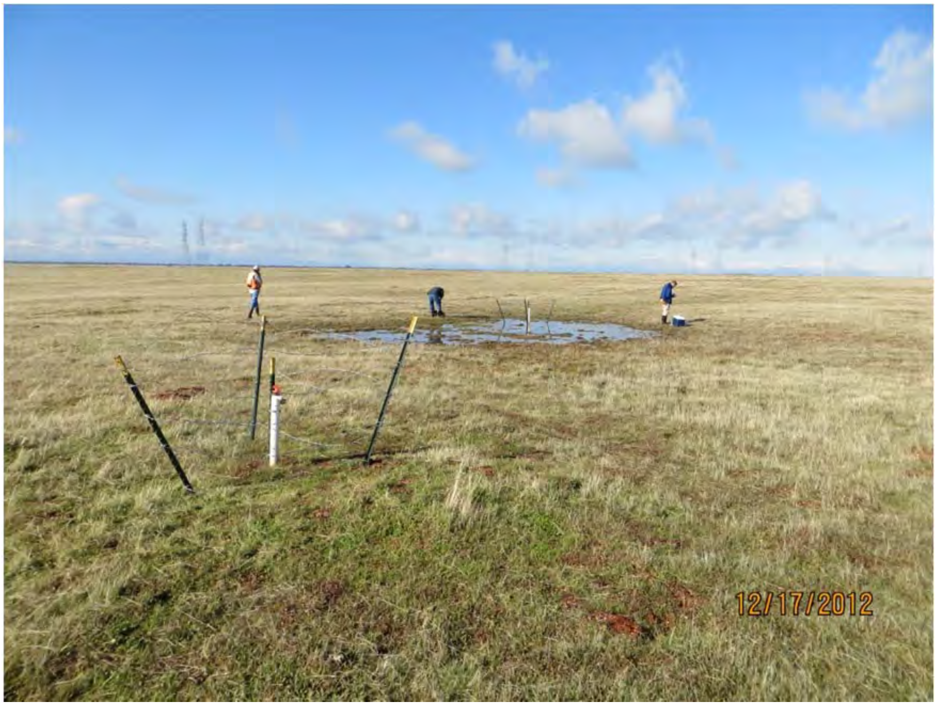

Photo IV-1. Water level standpipe installations with cattle excluders at the Agricultural Area Upland (foreground) and Depression 1 (background).

In addition to the Excel/MatLab plotting, recorded water-level measurements have been converted to estimates of flows during several storm events in the swales and tributary streams using a combination of DOJ Expert Team field calibration observations measurements.

2. Water Sampling

Past work in similar types of vernal pools and swales indicates that water that is enriched in nutrients and depleted in organic carbon flows into vernal pools and swales, where vernal pool and swale biota rapidly uptake the nutrients and convert them to organic carbon (Rains et al. 2006), which is then available for export to downgradient waters such as Oat Creek and the Sacramento River. We hypothesized that this would be the case in the Coyote-Oat Creek Watershed.

In December 2012 and February 2013, we collected and analyzed water samples in (a) vernal pools and swales located on the Coyote Creek Conservation Area and (b) streams and Irrigation District canals located on and downgradient of the Coyote Creek Conservation Area. We collected and analyzed a total of seven samples in vernal pools and swales and 13 samples in streams and canals.

We analyzed each sample for temperature (i.e., T; the temperature of the water), pH (i.e., pH; the negative log of the activity of the hydrogen ion activity in an aqueous solution, where solutions with a pH<7 are acidic and solutions with a pH>7 are alkaline), dissolved oxygen (i.e., DO; the amount of oxygen dissolved in the water in terms of the percent of oxygen saturation, which is a function of temperature), specific conductance (i.e., SC; an analog measure proportional to the concentration of dissolved ions in the solution), dissolved inorganic nitrogen (i.e., DIN; the inorganic nitrogen readily available for biological uptake), soluble reactive phosphorous (i.e., SRP; the inorganic phosphorus readily available for biological uptake), and dissolved organic carbon (i.e., DOC; the organic carbon readily available as a food supplement for microorganisms that comprise the base of the food chain).

We measured T, pH, DO, and SC in the field with a standard hand-held meter (e.g., YSI 556 MPS, YSI, Yellow Springs, Ohio). We collected water samples by pumping water through 0.45 µm filters into acid-washed HDPE sample bottles. We maintained the water samples at 4 ± 2 °C during the day in the field, and froze the water samples in the evening and until we could thaw and analyze the samples at a later date. We analyzed water samples for ammonium and nitrite+nitrate according to the indophenol (ammonium) and vanadium chloride (nitrite+nitrate) colorimetric procedures (Hood-Nowotny et al. 2010). Total dissolved inorganic N (DIN) equals the sum of ammonium+nitrite+nitrate. We analyzed water samples for soluble reactive phosphorus (SRP) using the malachite green colorimetric procedure (D'Angelo et al. 2001). We conducted both the DIN and SRP analyses with a microplate spectrophotometer (BioTek Epoch, Winooski, VT, USA). We analyzed for non-purgeable organic carbon, hereafter referred to as dissolved organic carbon (DOC), by high-temperature combustion followed by infrared detection of carbon (Skalar Formacs, Breda, The Netherlands).

E. Field Observations of Reference Site and Duarte Site Conditions

1. Hydrology

Determination of wetland hydrology followed the standard procedures outlined in the 1987 Corps Manual (Environmental Laboratory, 1987), and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region (Version 2.0) (September 2008). The Wetland Determination Data Form – Arid West Region was used in the field to guide some aspects of inspection for and determination of wetland hydrology. Prior to the field investigation rainfall records for the preceding 6 months were obtained and studied. Wetland hydrology indicators as described on the data form and in the Regional Supplement were evaluated at the same time that the soils and vegetation experts were making their evaluations. The investigation consisted of walking around the area noting landscape position, indicators of previous flow vectors, and other signs of water flow such as wrack, directionally bent vegetation, sediment deposition and rill erosion. Wetland hydrology indicators were noted and checked on the Arid West data form and field observations confirmed with the other members of the expert team as necessary. The impacts of tillage operations were noted to the extent that wetland hydrology was altered in accordance with the atypical approach outlined in the 1987 Delineation Manual. A separate Data Form was used for each site evaluated.

2. Soils

Prior to the field delineation, existing information relative to the property was collected and reviewed. Information included, but was not limited to, the U.S. Geological Survey (USGS) 1:24,000 maps, aerial photography, Soil Survey of Tehama County (USDA-NRCS, 1967, Web Soil Survey 3.1, 2015), regional climate data, and national and local (county) hydric soils lists.

As a result of tillage operations across the Duarte Site, guidance for the atypical approach was used and included the examination of intact/reference soils in reference areas to the west, south, and east of the disturbed soils.

Soils at the Duarte property were evaluated for the hydric parameter consistent with criteria articulated in the 2008 Regional Supplement Manual, current regulatory guidance, and U.S. Department of Agriculture Natural Resource Conservation Service (USDA - NRCS) guidelines (1996, 1998, 2010, 2012) as well as County and national hydric soils lists. Hydric soils are defined as "…soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part" (National Technical Committee for Hydric Soils [NTCHS], 1994, Federal Register 1994).

Technical criteria can be satisfied using a combination of published soils information and field indicators. Field indicators for assessing whether a soil satisfies the hydric soil definition and the technical criteria for hydric soils are listed in the Field Indicators of Hydric Soils in the United States (USDA - NRCS, 1996, 1998, 2010). Field indicators published in this document are intended to update guidance provided in the *1987 Corps of Engineers Manual* (online edition) (Environmental Laboratory, 1987).

Due to extensive drought and resultant soil conditions, a small Yanmar Track Hoe was used to excavate soil pits to approximately 24 to 30 inches. The face of each pit was "cleaned" with shovels and knives and then examined for hydric soil indicators consistent with the 2008 Regional Supplement and Field Indicators of Hydric soils in the United States.

3. Vegetation

Prior to the wetland vegetation inspection of the Duarte and reference sites, the 1987 Manual (Environmental Laboratory, 1987), and the Regional Supplement to the Army Corps of Engineers Wetland Delineation Manual, Arid West Supplement (U.S. Army Corps Of Engineers, 2008) were consulted and reviewed. In addition the National List of plant species that occur In wetlands (USDA, 2015; http://rsgisias.crrel.usace.army.mil/NWPL - using the North America Region and the Arid West Sub-Region) and plant species lists from Tehama County California Department of Fish and Wildlife Ecological Reserves were reviewed for species that may potentially occur on the Duarte or reference sites. Taxonomic nomenclature in the report follows Baldwin et al., 2012.

Consistent with standard plant ecological field protocols, vegetation at the Duarte and reference sites was evaluated and plant associations and communities were noted during the days of reconnaissance work. For example, on the Duarte Site and for the first two days of field work, species occupying potential waters/wetland areas were noted for: (a) their developmental stage, and (b) variability in morphological characteristics in response to varying soil moisture conditions, soils, slope, aspect, and other microtopographic conditions.

Species identifications were made at each waters/wetland plot location. Areal (%) canopy coverage of each species was estimated as an absolute percentage to the nearest 1% for species coverage of >1%, and to the nearest 0.1% for species coverage <1%. Percent cover estimates were made using a metal quadrat of 1 square meter, within which cover for each species was estimated. Using a standard quadrat results in estimates that are more accurate and repeatable (Arid West Supplement, U.S. Army Corps of Engineers, 2008, Page 15). Identifications of species were constantly checked at each waters/wetland feature when varying soil moisture conditions affected plant morphology.

Tillage operations across the Duarte Site necessitated the use of the 1987 Corps Manual (Environmental Laboratory, 1987) guidance for the “Atypical Approach”, which included examination of intact reference areas for vegetation to the west and south.

For species whose identity was in question at the time of field inspections, specimens were collected and marked with an identification number and pressed and preserved using standard herbarium techniques for dried plant specimens. Plant identifications were checked and confirmed using Baldwin et al. (2012), Hickman, (1993), and Hitchcock et al. (1969) .A duplicate of each pressed sample was prepared in identical manner and these duplicates were submitted to the Duarte Site monitors. The monitors were instructed in the care of the specimens and the specimens were carefully placed in large flat brown paper bags and secured so the specimens would not slip out of the newspaper presses. Specimens were examined to confirm identifications and all specimens collected will be preserved and archived by the collector.

Attention was given to the variation in species composition on the furrow tops and bottoms as a result of tillage operations, which produced strong microtopographic relief within a waters/wetland features.

4. Sediment Characterization

We determined grain-size distributions on representative reaches at both the CCCA and the Duarte Site by a modified Wolman pebble count procedure (Wolman 1954). We established grain-size classes of <1, 1-<2, 2-<4, 4-<8, 8-<16, 16-<32, 32-<64, 64<256, and >256 mm. We could not consistently distinguish between the <1 and 1-<2 mm grain-size classes, so the two categories were later merged into a single category of <2 mm. At each representative reach, we took random walks, stopped at set intervals, reached down and touched the ground surface, and measured the diameter of the first grain touched. We measured the diameters of at least 50 grains at each representative reach.

Overall, grain-size distributions were similar between the Coyote Creek Conservation Area and the Duarte Site. The difference was that the Duarte Site had been tilled. Tillage results in the detachment of sediments and the disruption of soil structure and root cohesion, so tilled soils are more susceptible to erosion (Mamo and Bubenzer 2001a; Mamo and Bubenzer 2001b). Of particular concern are fine-grained sediments, because these are readily mobilized and transported in flowing water (van Rijn 1993) and can have widespread deleterious effects ranging from decreasing light penetration and thereby reducing primary productivity to clogging the interstices between substrate clasts and reducing the available habitat for benthic organisms and spawning fish (Wood and Armitage 1997). Therefore, our analysis focused on the likelihood that fine-grained sediments would be mobilized and transported at the Duarte Site.

We represented fine-grained sediments as the D10, defined herein as the grain size that is greater than or equal to 10% of the sediments counted in a given pebble count. Our analysis required a single grain size, not a grain-size range, so each grain-size range was converted to the midpoint of the grain-size range (e.g., the <2 mm grain-size category included all grains 0-2 mm in diameter, and this was converted to 1 mm for further analysis). We then calculated the depth of flow required to transport that grain size using the Shield's dimensionless shear stress approach (Shields 1936; see, for example, Knighton 1998) where

$$\Theta = H\,S\,/\,(\rho_s/\rho\text{-}1)d$$

and where θ is the Shields parameter, taken as 0.045 (Miller 1977), H is depth, s is slope, ρ_s is the density of the sediment, taken as 2.65 g/cm^3, ρ is the density of water, taken as 1.00 g/cm^3, and d is the grain diameter.

F. Review and Refinement of Existing Waters/Wetlands Identifications and Delineations

1. Reference Materials and Procedures

As part of our background review and field work, the DOJ Expert Team focused on identification and reviews and refinements of existing delineations of waters of the U.S, including wetlands on the Duarte Site. To accomplish this phase of work, we used and considered the following standard definitions, manuals, guidance, and mapping products.

Definitions of waters provided at 33CFR 328,3(a)(1-8).

A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States A Delineation Manual. Robert W. Lichvar and Shawn M. McColley August 2008

Environmental Laboratory. (1987). "Corps of Engineers Wetlands Delineation Manual," Technical Report Y-87-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

U.S. Army Corps of Engineers. 2008. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region (Version 2.0), ed. J. S. Wakeley, R. W. Lichvar, and C. V. Noble. ERDC/EL TR-08-28. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

Munsell Color. 2000. Munsell Soil Color Charts. Munsell Color, Macbeth Division of Kollmorgen Instruments Corp., New Windsor, NY.

U.S. Army Corps of Engineers. 1982. "Clarification of "Normal Circumstances" in the Wetland Definition." Regulatory Guidance Letter No. 82-2.

U.S. Army Corps of Engineers. 1986. "Clarification of "Normal Circumstances" in Wetland Definition (33 CFR 323.2(c)." Regulatory Guidance Letter No. 86-9.

U.S. Army Corps of Engineers. 1990. "Clarification of the Phrase "Normal Circumstances" as it pertains to Cropped Wetlands." Regulatory Guidance Letter No. 90-

U.S. Army Corps of Engineers. 1992. "Clarification and Interpretation of the *1987 Manual*." 3-92 Memorandum.

U.S. Army Corps of Engineers. 2007. "Practices for Documenting Jurisdiction Under Sections 9 & 10 of the Rivers & Harbors Act (RHA) of 1899 and Section 404 of the Clean Water Act (CWA)." Regulatory Guidance Letter No. 07-01.

USDA, NRCS. 2010. Field Indicators of Hydric Soils in the United States, Version 7.0 L.M. Vasilas, G.W. Hurt, C.V. Noble (eds.). USDA, NRCS, in cooperation with the National Technical Committee for Hydric Soils, Fort Worth, TX.

Federal Register. July 13, 1994. Changes in Hydric Soils of the United States. Washington, D.C. (Hydric soil definition).

Federal Register. September 18, 2002. Hydric Soils of the United States. Washington, D.C. (Hydric Soil Criteria).

National Wetlands Inventory mapping of the Duarte Site.

National Hydrologic Data Base [http://nhd.usgs.gov/]

2. *Rationale for Using the Atypical Situations Determination of the Geographic Extent of Waters/Wetlands*

Based upon guidance provided in the 1987 Manual (Environmental Laboratories 1987) and the Regional Supplement to The Corps of Engineers Wetland Delineation Manual: Arid West Region (Version 2.0; 2008), and in Regulatory Guidance Letters 82-2, 86-9, and 90-7, wetlands that have been disturbed through natural and/or anthropogenic alterations of hydrology, soils, and/or vegetation do not necessarily exist under “normal circumstances.” In addition to the significant regional drought that has occurred over the past four years, recent disturbances to hydrologic conditions on the Duarte Site include activities such as tillage, ditching on adjacent parcels, County Road construction and culvert maintenance activities, and redirection and/or consolidation of storm water flows into the site from the west and from the site along the property boundary immediately south of the main stem of Coyote Creek in the eastern half of the property. Disturbances to soils include tillage, operation of heavy equipment in moist soil conditions resulting in development of ridges and furrows and some compacted soil conditions, erosion of tilled surfaces, sedimentation and “turn around” ridges, scours and displacement of soils. Disturbances to native vegetation include disruption and some clearing of native and non-native plant communities via tillage and operation of equipment. Due to the combination of site disturbances and their effects on current hydrologic, soil, and vegetation conditions on the Duarte Site, the DOJ Technical Team chose to delineate Duarte Site wetlands using an “Atypical Approach” as articulated in the 1987 Manual (Environmental Laboratories 1987). Consistent with guidance for using the atypical protocol, we used several areas within the CCCA (Area 13 and the Agricultural Area) and the southwestern portion of the Duarte Site as our principal reference sites.

3. Review and Refinement of 1994 and 2012 Delineations on the Duarte Site

As part of our field activities, the DOJ Expert Team performed a peer review of the 1994 North State and 2012 NorthStar delineations of waters of the U.S., including wetlands (hereafter “waters/wetlands). In these reviews, the DOJ Expert Team used existing maps and our Trimble GPS systems to locate mapped polygons. We walked through and examined most of the waters/wetlands polygons delineated by North State and NorthStar. Consistent with the Atypical Approach outlined in the 1987 Corps Manual, during these visits team members inspected and documented hydrology, soils and vegetation conditions, the areal limits of mapped polygons, and connections among polygons and downstream waters. As necessary, we used our reference framework to make inferences about Duarte Site conditions prior to the 2012 tillage operations. At each sampling site, we determined as a team if we agreed with either delineation (1994 or 2012) of if adjustments in the size, shape or connections among mapped polygons needed to be made. If waters/wetland areas were omitted or missed in the 1994 and 2012 delineations, we added these features. Downgradient hydrologic connections were documented using a combination of site walks by team members and where appropriate, determinations of elevation changes using a Spectre Precision Laser GL 412 level system (Photo IV-2). In this manner, the expert team built our own delineation map.

Photo IV-2. Field set-up showing the Spectre Precision Laser GL 412 level system, Track Hoe, vegetation assessment frames, and soil pit.

4. Site Locations and Cartographic/GIS Products

For site locations and development of maps and other cartographic products, we used a Trimble® GeoXT™ 3000 series handheld Global Positioning Systems (GPS) unit to navigate and locate points in the field. The Trimble receivers are sub-meter accurate with differential correction. Map bases from the 1994 and 2012 delineations were uploaded to the Trimble receivers to be used as backgrounds for locations in the field. In this way, the DOJ Expert Team could navigate to previously mapped boundaries and other locations in the field. Locations of interest were recorded, differentially corrected, and exported as shape files to be used in ArcGIS via Trimble's GPS Pathfinder Office software. Mapping, air photo, soils, and topographic bases used to develop GIS products were as follows:

ESRI World Imagery aerials

USDA 2012 Ortho Aerial

USDA NAIP 2010 Aerial

USDA/NRCS - Soil Survey Geographic (SSURGO)

USDA/NRCS - U.S. General Soil Map (STATSGO2)

USGS - 12 Digit Watershed Boundary Dataset

USGS - National Hydrography Dataset (NHD) - 24k

USDA/NRCS - National Elevation Data 10 meter or better

USDA/NRCS-NCGC Digital Raster Graphic MrSID Mosaic (USGS Topographic Quadrangle)

U. S. Fish and Wildlife Service, National Wetland Inventory (NWI)

FEMA National Flood Hazard Layer (NFHL)

ESRI Street Map North America

5. Characterization of Duarte Site Conditions in 2015

In addition to a peer review and refinement of the Duarte Site waters/wetland delineation for conditions prior to late fall of 2012, the DOJ Expert Team worked to characterize Duarte Site conditions (e.g. hydrology, soils, vegetation, connections) as of 2015, and to compare these conditions to our observations of similar conditions at our reference sites. At most of our 31 sampling stops and as appropriate given the landscape features we were sampling, we used the Spectre Precision Laser GL 412 to develop cross sections and longitudinal profiles of streams and swales, and long and short axis cross sections of depressions. We also used the laser level system to characterize representative microtopographic features that were the result of tillage activities. As appropriate in stream and some swale systems, we completed pebble counts. All sampling sites were photographed to document conditions and features that were the result of tillage activities. Most photographs are geo-referenced.

G. Assessment of the Functions of Waters/Wetlands Ecosystems

To address the U.S. national guidance on assessing impacts to waters/wetlands in light of changes in area and ecosystem functioning, the DOJ Expert team developed a “Guidebook for Assessment of the Functions of Low Order Riverine, Slope, and Depressional Waters/Wetlands Situated on Pliocene and/or Pleistocene Sandstone, Shale, and Gravel Deposits in the North Central Valley, California”(Appendix D, Part 1). This Guidebook was developed specifically to assess the condition of and any changes in the hydrologic, biogeochemical, plant community, and faunal support/habitat ecosystems functions of riverine (stream), slope (swale) and depressional waters/wetlands on the Duarte Site and in the Coyote and Oat Creek watersheds. These changes could arise, for example, due to tillage activities on site, diversion of water flowing to the Duarte Site from the west, ditching, and consolidation drainage. Consistent with Federal guidance for use of best available science (Federal Register, 1997) this Guidebook relies on the hydrogeomorphic (HGM) approach for assessment of waters/wetland ecosystem functions (Brinson, 1993 a and b; Brinson et al., 1995; Brinson, 1995; Smith et al., 1995; Federal Register, 1997). Means and methods used to develop the Guidebook and recommended field sampling protocols are detailed in the introductory sections of the Guidebook.

H. Evaluation of Waters/Wetland Frequency and Dispersion

1. Wetlands/Waters Frequency and Dispersion Data Acquisition

We completed a frequency and dispersion analysis of wetlands and other waters in a 557-acre reference area, mostly located in the Coyote Creek Conservation Area, using standard tools available in ArcGIS 10.1 and 10.2. To support this effort, we acquired several ancillary GIS files:

GeoEye1 Imagery, May 1, 2010 (Source: LandInfo Inc.)

Pleiades Imagery, June 18, 2014 (Source: LandInfo Inc.)

USA_Topo (Source: ArcGIS online http://goto.arcgisonline.com/)

World_TopoMap (Source: ArcGIS online http://goto.arcgisonline.com/)

OpenStreetMap (Source: ArcGIS online http://goto.arcgisonline.com/)

Corps Data JD1994 (Source: Project files)

Geotagged photographs (Source: Field data collected on October 13, 2014)

National Hydrography Dataset (Source: ftp://nhdftp.usgs.gov/; January 28, 2015)

National Wetlands Inventory (Source: http://www.fws.gov/; January 28, 2015)

Hydric Soils (Source: http://websoilsurvey.sc.egov.usda.gov/; January 28, 2015)

The GeoEye1 and Pleiades imagery was received as orthorectified, 4-band, pan-sharpened imagery files. The Pleiades imagery was received as two files which we mosaiced into a single TIFF file using ArcGIS 10.2. The imagery layers were viewed during photointerpretation as true color images and as color infrared images.

2. Frequency/Dispersion Nodes

We utilized standard ArcGIS 10.2 tools to create a digital grid overlay of 60,536 points (i.e., frequency/dispersion nodes), spaced 20 feet apart, across the 557-acre reference area and to randomly select ~1% (i.e., 607) of the frequency/dispersion nodes as frequency nodes used to calculate wetland/waters frequency (Figures IV-3 and IV-4). The polygon delimiting the 557-acre reference area inadvertently included 1.0 acres of land east of Paskenta Road. The single randomly selected frequency node that fell within this area was eliminated from the data set, for a final total of 606 frequency nodes.

Figure IV-3. Wetland/Water Frequency Determination: Frequency/Dispersion Nodes. We created a digital grid overlay of points spaced 20 feet apart, resulting in 60,536 points (i.e., frequency/dispersion nodes) which, at this scale, appear as a solid dark object covering the 557-acre reference area.

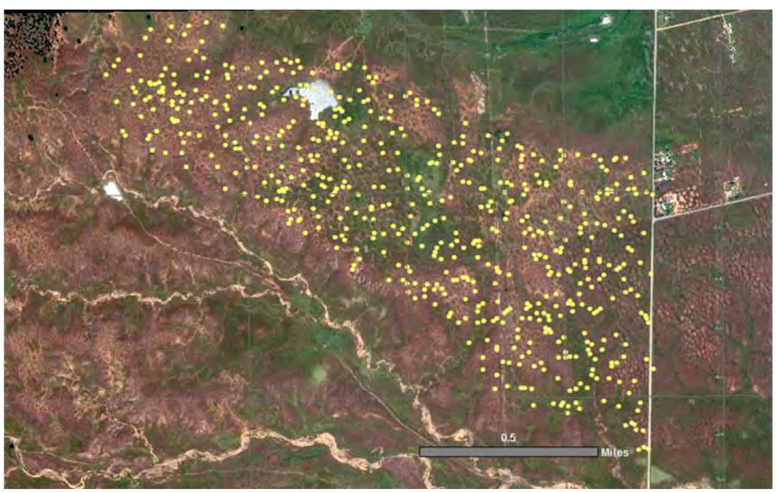

Figure IV-4. Wetland Water Frequency Determination: Frequency Nodes. We randomly selected a total of 606 frequency nodes (yellow) from the initial pool of 60,536 frequency/dispersion nodes. We referenced imagery and other supporting GIS files to determine whether these point locations intersected wetlands/waters.

3. Waters/Wetlands Frequency

We calculated the abundance of wetlands/waters in the 557-acre reference area through photointerpretation and reference to ancillary GIS layers (see above) at the 606 randomly selected frequency nodes (Figures IV-3 and IV-4). We assumed that the percentage of the 606 frequency nodes located in wetlands or other waters was equal to the overall frequency of wetlands or other waters in the entire 557-acre reference area. Some frequency nodes were in transitional locations, requiring particularly careful consideration of the location of these nodes. This sensitivity was compounded by a slight frame shift between GeoEye1 and Pleiades imagery. To increase the precision of determinations at transitional locations, we viewed the placement of these frequency nodes locations at a scale of up to 1:200 and, where frames shifts occurred, considered the frequency node to be located as depicted in the Pleiades imagery, as opposed to the GeoEye1 imagery.

4. Waters/Wetlands Dispersion

The coefficient of dispersion can be used to quantify the distribution of a feature or organism across an area (e.g., Chaulk et al. 2007). We used the coefficient of dispersion to assess the degree of dispersion of wetlands/waters across the 557-acre reference area. If the coefficient of dispersion is greater than one, then the distribution of waters/wetlands is considered aggregated or clustered; if the coefficient of dispersion is less than one, then the distribution of waters/wetlands is considered scattered. We intersected each of the frequency nodes occurring within wetlands/waters with the dispersion/frequency digital grid overlay and designated the eight dispersion/frequency nodes surrounding each of the wetland/waters frequency nodes as dispersion nodes (Figure IV-5). We used photointerpretation and reference to ancillary GIS layers (see above) to determine the number of dispersion nodes intersecting wetland/water features. We recorded this number at each wetland/water dispersion node and then calculated the coefficient of dispersion by dividing the variance of the mean by the mean.

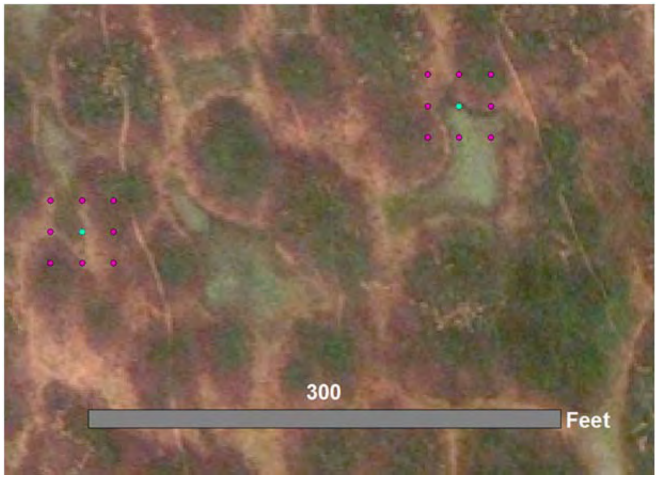

Figure IV-5. Wetland Dispersion. This aerial view includes two frequency nodes located in wetlands (blue), each surrounded by eight equidistant dispersion nodes (pink). We used photointerpretation and ancillary GIS layers to sum the number of dispersion nodes (per wetland/water frequency node) intersecting wetland/water features. We then calculated the coefficient of dispersion by dividing the variance of the mean by the mean.

V. RESULTS

A. Overview of Landscape Hydrologic and Ecosystem Connections among Duarte Site Depressions, Swales, and Streams and the Traditional Navigable Waters of the Sacramento River and Downstream to the Pacific Ocean

As discussed in the introductory sections of this report, the Duarte Site consists of approximately 450 acres. It is fully contained in the Coyote Creek watershed in Tehama County. Coyote Creek is connected hydrologically with Oat Creek, thence to the Sacramento River. This hydrologic connection is shown in Figure V-1 by the National Hydrologic Database (NHD) on the USGS 1:100,000 scale map. Figure V-2 is the USGS 1:24,000 scale map showing a closer view of the Coyote Creek watershed in proximity to the Duarte Site.

The Sacramento River joins the San Joaquin River at River Mile "0", which is located north of Winter Island at an approximate Latitude/Longitude of 30^{o} 03' 44.21" N / 121^{o} 52" 09.62" W. The Sacramento/San Joaquin systems flow generally west into San Francisco Bay and San Francisco Bay flows into the Pacific Ocean. The following narrative provides detail concerning the Coyote Creek and Oat Creek systems in the context of their hydrologic connections to the Traditional Navigable Waters (TNW) of the Sacramento River at Red Bluff, and then downstream to the junction of the Sacramento and San Joaquin Rivers, and the TNW's of San Francisco Bay and the Pacific Ocean. This discussion is keyed to Figure V-3.

1. Coyote Creek

The Coyote Creek watershed from its headwaters to its junction with Oat Creek is 25.5 mi2 (16,309 acres). It flows generally easterly and southeasterly to its junction with Oat Creek. As discussed in the introductory sections of this report, the Duarte Site is bounded by Coyote Creek to the north and Paskenta Road to the west (Figure V-2). In addition to the main stem of Coyote Creek flowing onto and through the Duarte Site, there are four tributaries of Coyote Creek that flow across Paskenta Road and onto the Duarte Site before joining the main stem of Coyote Creek (Streams 1, 2, 3, and 4 in Figure V-4). Stream 1 flows through the Duarte Site parallel with Coyote Creek before exiting the site at the north fence, it then joins Coyote Creek near the eastern Duarte Site corner with Coyote Creek. Streams 2, 3, 4, 5, 6, 8, 9, and 10 flow to channels in adjacent properties to the east before connecting to Coyote Creek near the eastern Duarte Site boundary with Coyote Creek. Stream 7 is a short connecting swale complex between Streams 6 and 8 and depending on the magnitude of rainfall may flow either to Stream 6 or 8, or both (i.e., Stream 7 flow can be bidirectional).

The area of the Coyote Creek main stem watershed at Paskenta Road is 3.9 mi2 (2,466 acres). Streams 1, 2, 3 and 4 contribute flow from off-site across Paskenta Road. These four streams and the main stem Coyote Creek represent all off-site inflow. The total area of the Coyote Creek watershed at the eastern Duarte Site boundary is 8.8 mi2 (5,626 acres). Watershed areas internal to the Duarte Site and total area, including off-site areas are presented in Table V-1.

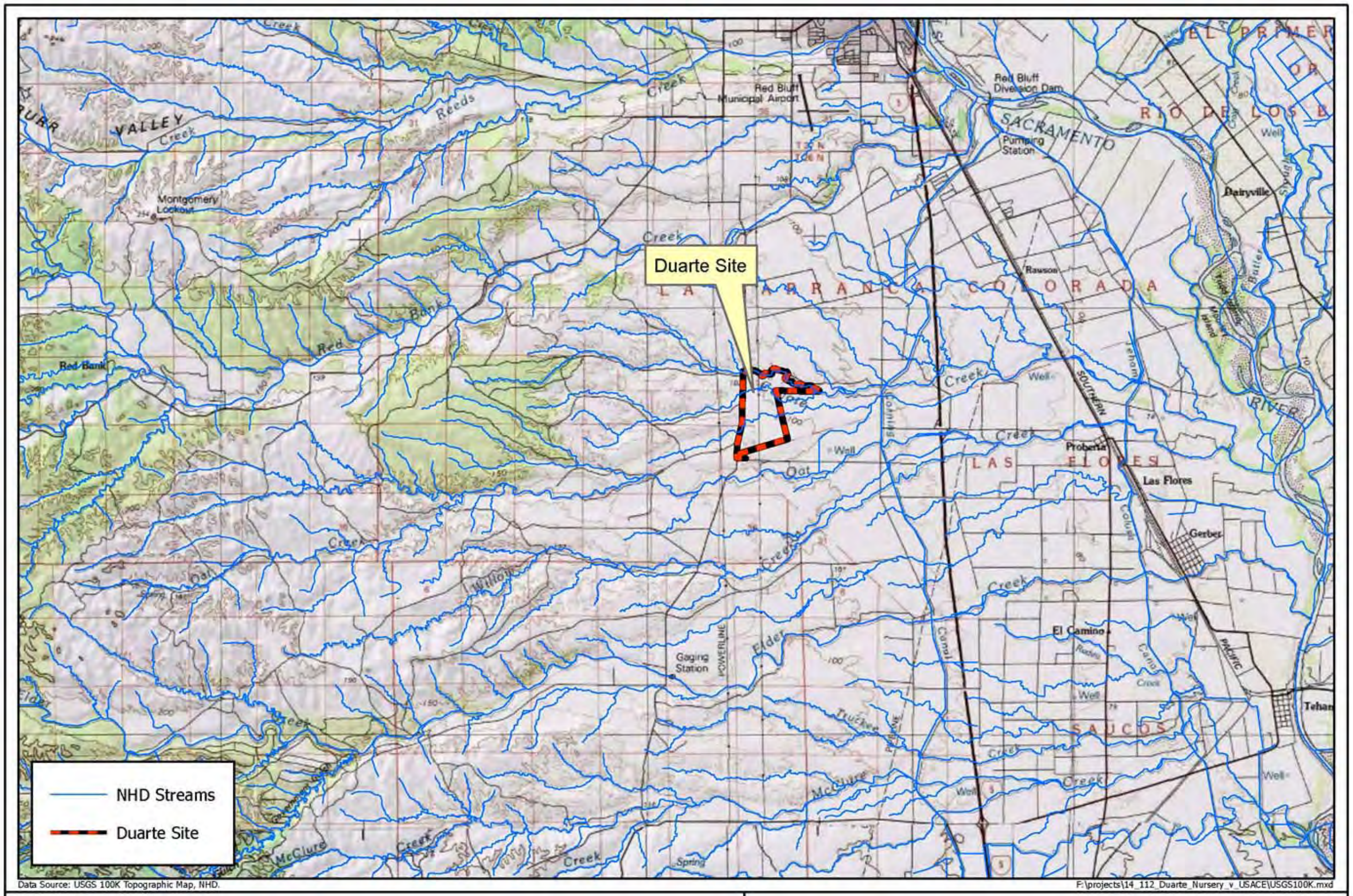

Figure V-1. Regional topographic map of the Coyote and Oat Creek stream network, USGS 1:100,000.

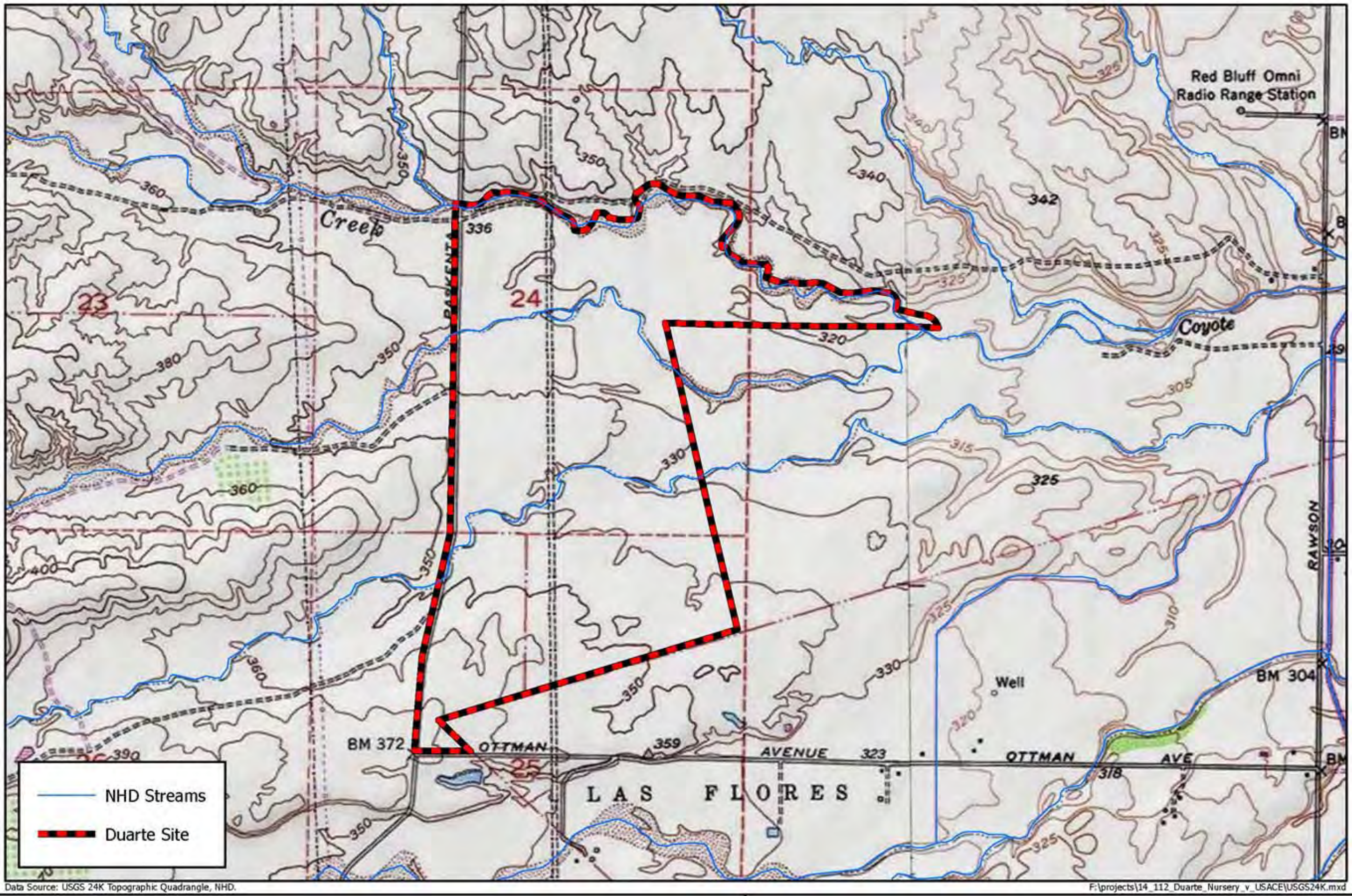

Figure V-2. Site topographic map, USGS 1:24,000.

0 1,250 2,500 5,000 Feet

N

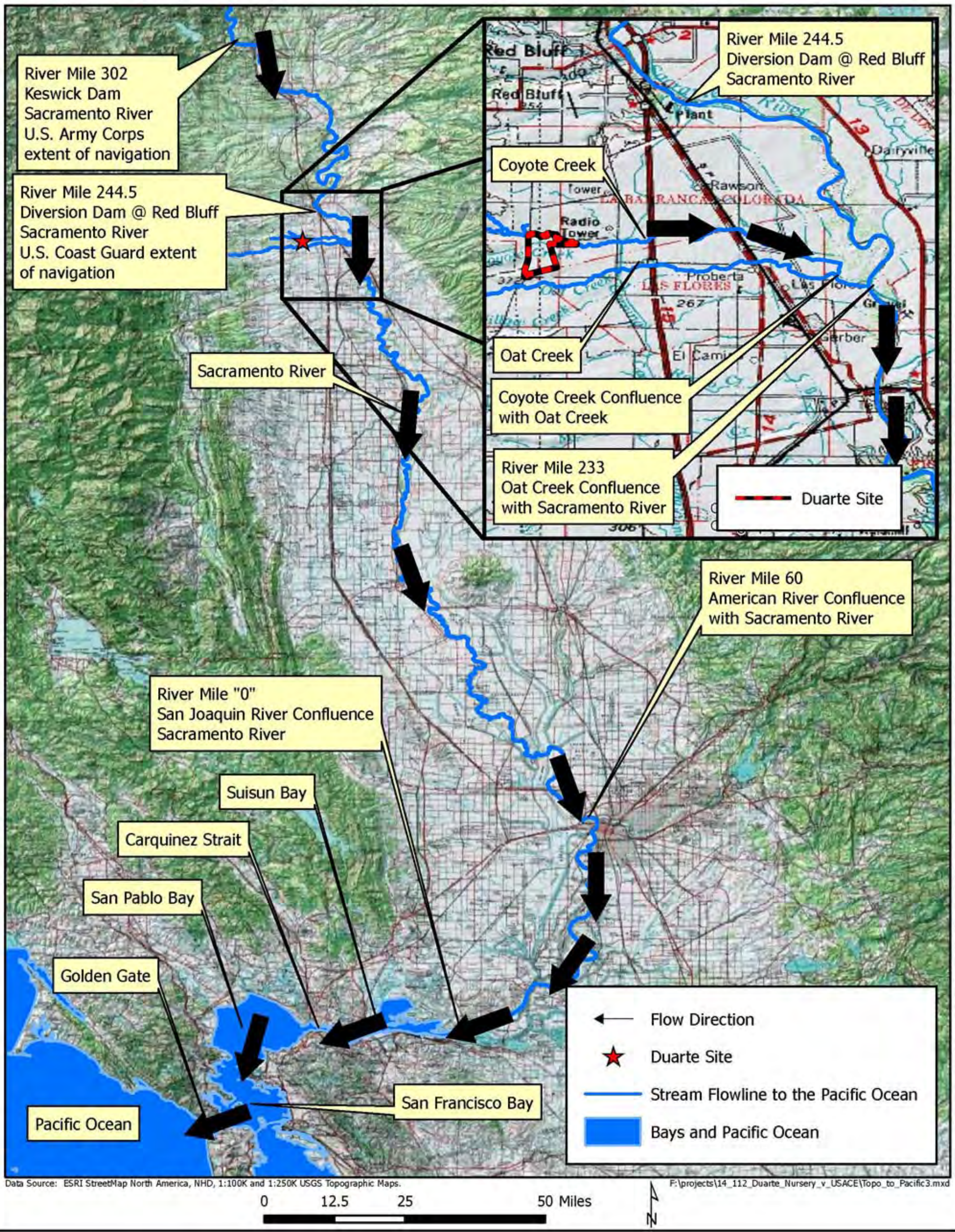

Figure V-3. Location of Duarte Site, Red Bluff, Tehama County, California.

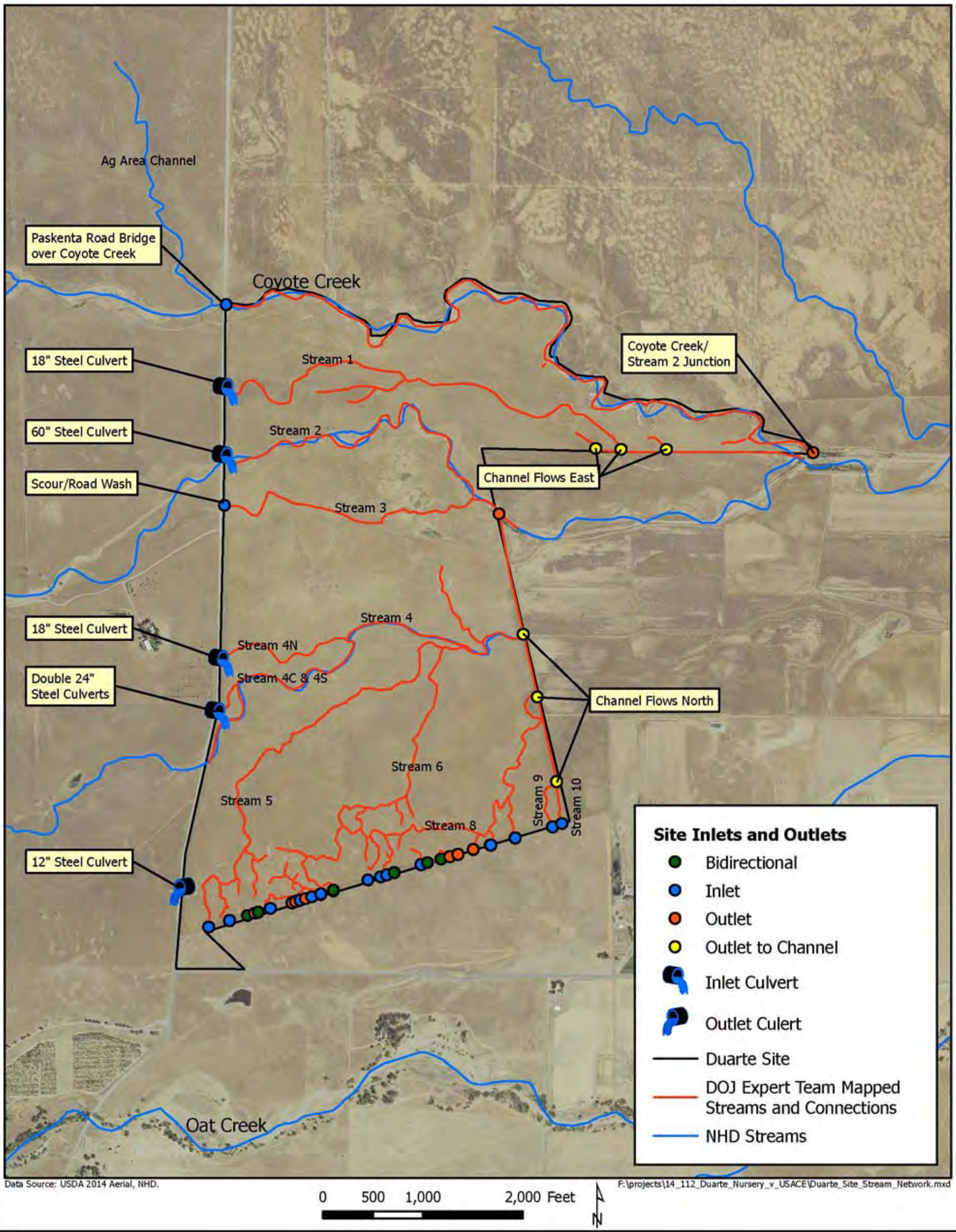

Figure V-4. Duarte site stream network.

Table V-1. Watershed areas for streams flowing into and from the Duarte Site. All Streams are in Coyote Creek Watershed.

	Durate Site Internal Watershed Area	**Total Watershed Area**
	mi^2 (acres)	
Stream 1	0.093 (59.3)	0.167 (107)
Stream 2	0.068 (43.4)	2.49 (1593)
Stream 3	0.072 (46.1)	0.108 (69.0)
Stream 4	0.130 (83.0)	0.926 (592)
Stream 5	0.099 (63.6)	No inflow to site
Stream 6	0.076 (48.5)	
Stream 8	0.061 (38.9)	
Stream 9	0.003 (2.1)	Potential small off-site contributing area
Stream 10	0.001 (0.7)	
East Property Line Swale	0.017 (10.8)	No inflow to site

Based on the National Hydrologic Database and the 1:24,000 USGS map, Coyote Creek at the east Duarte Site boundary is 3rd order (Figure V-2). Coyote Creek's watershed area at its junction with Oat Creek is 25.5 mi^2 (16,309 acres) and consistent with the stream classification system summarized in Figure III-11, its stream order is 4th. From its headwaters to the junction with Oat Creek at approximately 40° 04' 40.39" N and Longitude 122° 08' 13.51" W, the river distance is 14.5 miles.

The Coyote Creek ecosystem represents one of many streams that feed into the Sacramento River in Tehama County. As such it performs most of the riverine functions that are described in the National List of Riverine Functions (Table V-2) (Brinson et al., 1995). Through its connection to the Sacramento River, the Coyote Creek ecosystem functions along a stream to river continuum and thus contributes to the maintenance of the physical, chemical, and biological integrity of the Sacramento River (Vannote et al.; 1980). For example, alteration in the timing and volume of water flows and sediment transport delivered from the Coyote Creek ecosystem to Oat Creek and then to the Sacramento River will alter conditions in the traditional navigable waters of the Sacramento River for maintaining:

1. Water quality and navigation due to loading of sediment, nutrients, and contaminants (Domagalski, et al. 2000; Domagalski and Dileanis, 2000; Domagalski, 2001; Saleh et al., 2003; Domagalski et al., 2004).

2. Suitable habitat for support of several classes of aquatic faunal species such as macroinvertebrate communities (food webs for fish), and resident and non-resident adult and juvenile fishes (Dr. Michael Marchetti, Pers. Comm. To DOJ Expert Team Members Lee, Rains, and Stewart, May 16, 2012; Walther, 2009).

A reduction in any one or all of the riverine functions listed in Table V-2 represent a cumulative loss in maintenance of ecosystem functioning in both Coyote Creek and the Sacramento River.

2. Oat Creek

The Oat Creek watershed is located generally south of Coyote Creek (Figure V-1). Oat Creek has developed in a comparable geomorphic setting as Coyote Creek and its land use is similar in that it consists primarily of grazed uplands, irrigated orchards and other crops, conservation areas, and patches of suburban and industrial development. From its headwaters, it flows generally in an easterly and northeasterly direction for 21.5 river miles to its junction with Coyote Creek, and then east for 0.8 river miles to its junction with the Sacramento River at River Mile 233. The area of the Oat Creek watershed at its junction with Coyote Creek is 34.9 mi^2 (22,308 acres) and its stream order (at a scale of 1:24,000) and consistent with Figure III-11 stream order is 4th. At the Oat Creek junction with the Sacramento River its stream order is 5th.

As with the Coyote Creek ecosystem, Oat Creek represents one of many streams that feed into to the Sacramento River in Tehama County. As such it performs most of the riverine functions that are described in the National List of Riverine Functions (Table V-2) (Brinson et al., 1995). Through its connection to the Sacramento River, Oat Creek functions along the stream to river continuum and thus contributes to the maintenance of the physical, chemical, and biological integrity of the Sacramento River (Vannote et al., 1980). For example, alteration in the timing and volume of water flows and sediment transport delivered from the Oat Creek ecosystem to the Sacramento River will alter conditions in the traditional navigable waters of the Sacramento River for maintaining:

1. Water quality and navigation due to loading of sediment, nutrients, and contaminants (Domagalski, et al. 2000; Domagalski and Dileanis, 2000; Domagalski, 2001; Saleh et al., 2003; Domagalski et al., 2004).
2. Suitable habitat for support of several classes of aquatic faunal species such as macroinvertebrate communities (food webs for fish), and resident and non-resident adult and juvenile fishes (Dr. Michael Marchetti, Pers. Comm. To DOJ Expert Team Members Lee, Rains, and Stewart, May 16, 2012; Lorig et al., 2012).

A reduction in any one or all of the riverine functions listed in Table V-2 represent a cumulative loss in maintenance of ecosystem functioning in both Oat Creek and the Sacramento River.

Table V-2. The National Hydromorphic Method list of Riverine Waters/Wetland Functions.

Riverine Waters/Wetland Functions-National List (Following Brinson et al. 1995)	
Hydrology	**Plant Community**
1. Dynamic Surface Water Storage	10. Plant Community
2. Long-term Surface Water Storage	11. Detrital Biomass
3. Energy Dissipation	
4. Subsurface Storage of Water	**Faunal Support/Habitat**
5. Moderation of Groundwater Flow or Discharge	12. Spatial Structure of Habitat
	13. Interspersion and Connectivity of Habitats
Biogeochemistry	14. Distribution and Abundance of Invertebrates
6. Nutrient Cycling	15. Distribution and Abundance of Vertebrates
7. Removal of Dissolved Elements and Compounds	
8. Retention of Particulates	
9. Organic Carbon Export	

3. Sacramento River

The Sacramento River has been determined by the Corps of Engineers to be navigable from its tidally influenced mouth at River Mile "0" to the Keswick Dam at River Mile 302 [http://www.spk.usace.army.mil/Missions/Regulatory/Jurisdiction/NavigableWatersoftheUS.aspx]. The U.S. Coast Guard has determined that the Sacramento River is navigable from river mile zero as described immediately above to the decommissioned diversion dam at Red Bluff, which occurs at approximately River Mile 244.5. As such, both the U.S Army Corps of Engineers and the U.S Coast Guard have determined the Sacramento River to be a "Traditional Navigable Water" (TNW) upstream of the point where the Oat Creek/Coyote Creek ecosystem join the Sacramento River.

The Sacramento River is the largest river in California. Its average annual discharge is about 30,000 cubic feet per second (850 m^3/s), carrying over 22,000,000 acre feet (27 km^3) of water each year. The headwaters of the Sacramento River are in the Klamath Mountains, and it flows generally south for 445 miles before reaching the Sacramento–San Joaquin River Delta and San Francisco Bay. The river drains about 27,500 square miles in 19 California counties [http://en.wikipedia.org/wiki/Sacramento_River#Discharge].

In a historical context, and quoting/excerpting from various web sites that are focused on the Sacramento River and its watershed:

> [http://www.sacramentohistory.org/resources_essay.html and http://www.sacdelta.com/hist.html]

“In 1839, John Augustus Sutter, a Swiss immigrant, along with three German carpenters, two mechanics, and eight Hawaiians, began his journey in the labyrinth that is the DELTA in search of land for other migrating Europeans. Departing Yerba Buena (San Francisco) he outfitted three boats and set sail through an area populated only by Indians and mosquitoes. Journeying closer to what is now Sacramento, it took Sutter twelve days to find the entrance to the American River, the approximate extent of tidal influence, landing at what would become Scaramento. During the mid to late 1800’s, , the Sacramento River was the major route for steamboats with over fifty boats plying the river between San Francisco and Sacramento

[http://www.sacramentohistory.org/resources_essay.html and http://www.sacdelta.com/hist.html]

“The Sacramento and its wide natural floodplain were once abundant in fish and other aquatic creatures, notably one of the southernmost large runs of chinook salmon in North America. For about 12,000 years, native peoples have drawn upon the natural resources of the watershed, which had one of the densest American Indian populations in California. The river has also been used as a trade and travel route since ancient times. Hundreds of tribes sharing regional customs and traditions inhabited the Sacramento Valley, though they received little disturbance upon the arrival of Europeans in the 1700s.”

[http://www.sacramentohistory.org/resources_essay.html and http://www.sacdelta.com/hist.html]

In the 19th century the gold find in the Sierra Nevada was the impetus to the California Gold Rush with an enormous population influx. Overland trails such as the California Trail and Siskiyou Trail followed the Sacramento and other tributaries, guiding hundreds of thousands of people to the goldfields and the growing agricultural region of the Sacramento Valley. By the late part of the century, many populous communities had been established along the Sacramento River, chief of which was the city of Sacramento. Intensive agriculture and mining contributed to pollution in the Sacramento, and significant changes to the river's hydrology and environment.

[http://www.sacramentohistory.org/resources_essay.html and http://www.sacdelta.com/hist.html]

Since the 1950s the watersheds have been intensely developed for water supply and the generation of hydroelectric power. Today, large dams impound the river and almost all of its major tributaries. The Sacramento is used heavily for irrigation and serves much of Central and Southern California through the canals of giant state and federal water projects. While now providing water to over half of California's population and supporting one of the most productive agricultural areas in the nation, these changes have left the Sacramento greatly modified from its natural state and have caused the decline of its once-abundant fisheries.

Other websites are maintained by various organizations and private entities, touting many recreation and fishing opportunities in the Sacramento River and general information about the rivers and its resources. These sites include:

http://www.sacramentoriver.org/article.php?article_id=151 – Recreation
http://www.fishkevinbrock.com/trout-fishing.html - Fishing
http://www.sacramentoriver.org/forum/ - General Information, Maps, Planning Tools, etc.
http://www.sacramentoriver.org/forum/index.php?id=gis – Mapping tools on a GIS Base

The Sacramento River runs 302 miles from the Keswick Dam to River Mile "0 "at its mouth, which is the confluence of the Sacramento and San Joaquin Rivers. The City of Redding at the Califormia Route 44 bridge is between River Miles 296-297. The Interstate 5 bridge at Red Bluff is at River Mile 246. The Coyote Creek/Oat Creek system meets the Sacramento River downstream from Red Bluff at approximately River Mile 233. The headward/eastern extent of tidal influence in the Sacramento River system varies with dam releases, wind strength and direction and several other factors, but it is approximately at the junction of the Sacramento River with the American River (between River Miles 60 and 61). The City of Sacramento is located at River Mile 60. River Mile 26 is designated by the Corps of Engineers and on National Oceanographic and Atmospheric Administration nautical charts as the extent of the deep water channel. River Mile "0" is located at the junction of the Sacramento and San Joaquin Rivers near the northern tip of Winter Island (Approximate Latitude/Longitude of 30^{o} 03' 44.21" N / 121^{o} 52" 09.62" W).

It is 15 miles from River Mile 0 to the Interstate 680 Benecia-Martinez Bridge. "Downstream" 4.3 miles in this tidal (bidirectional) system is Carquinez Strait, which passes Port Costa (south bank) and Benecia (north bank). Approximately 6.6 miles west, Carquinez Strait flows under U.S.Highway 80 at the Lincoln Highway Bridge. The entrance to San Pablo Bay is 2.4 miles further "downstream" in this tidal system, and the approximate center of San Pablo Bay is another 8.9 miles east and "downstream" in this tidal system.. In another 9.2 miles, the tidal waters of San Pablo Bay pass under the Interstate 580 bridge. From the Interstate 580 bridge to Point Blunt Rock on Angel Island is 6.1 miles. The distance from Point Blunt Rock to the Golden Gate Bridge is 4.2 miles west. From the Golden Gate Bridge and west to the open and TNW waters of the Pacific Ocean is approximately 3.5 miles.

The Sacramento River is the largest river that flows into to the TNW/Estuarine waters of the San Francisco Bay Delta, San Pablo and San Francisco Bays complex, and the Pacific Ocean. It performs the suite of riverine functions that are described in the National List of Riverine Functions (Table V-2) (Brinson et al., 1995). In its' tidally influenced downstream reaches, the Sacramento River also performs important estuarine ecosystem functions. Through its connection to the TNW waters of the San Francisco Bay Delta, San Pablo and San Francisco Bay complex and the Pacific Ocean, the Sacramento River functions along a river to estuarine continuum to contribute significantly to the maintenance of the physical, chemical, and biological integrity of all of the downstream, tidal TNW's, including near shore reaches of the Pacific Ocean (Vannote et al., 1980). For example, alteration in the timing and volume of water flows and sediment transport delivered from the Sacramento River to downstream TNW's will alter conditions in:

1. Navigation and Maritime Commerce – due to loading of navigable channels with sediment, and requiring costly maintenance dredging (See page 1, column 2: http://pubs.usgs.gov/fs/2014/3090/pdf/fs2014-3090.pdf);
2. Water Quality - Degrading the water quality of the San Francisco Bay Delta, San Pablo and San Francisco Bay complex and the Pacific Ocean via large inputs of sediment and associated (ie. sorbed or chelated) nutrients, organic matter and contaminants (Wood and Armitage, 1997; Bergamaschi, et al., 1997, 1999, 2003); and
3. Faunal Support/Habitat support or several classes of freshwater, estuarine, and salt water aquatic faunal species such as macroinvertebrate communities (food webs for fish), resident and non-resident adult and juvenile fishes, marine mammals, and humans.

A reduction in any one or all of the riverine functions listed in Table V-2 and in the functions of tidally influenced freshwater to brackish to salt water transitional areas (i.e. estuaries) represent a cumulative loss in maintenance of ecosystem functioning in one of largest estuarine complexes on the west coast of the North American continent.

B. An Analysis of Similarly Situated Vernal Depression and Swale Complexes and Streams in the Coyote Creek and Oat Creek Watersheds

Figure V-5 was prepared by members of the DOJ Expert Team including Peter Stokely, L.C. Lee, Wade Nutter, and Mark Rains. Mr. Stokely has also prepared an Expert Report summarizing his analyses of similarly situated water bodies in the Coyote Creek Watershed (Stokely, In Prep, 2015). Consistent with the descriptions of hydrologic processes that occur on reference and Duarte Site landscapes, Figure V-5 shows that in 1998 and within the Coyote Creek watershed, approximately 853 acres of vernal depression and swale complex landscape features contribute surface and shallow subsurface water flows to and thus directly connect with many small branches of the tree-like (dendritic) Coyote Creek channel system. The Oat Creek ecosystem, while larger in size, has essentially the same type of hydrologic system structure (i.e., vernal depression and swale complexes linking to small stream branches in the Oat Creek watershed) (Figures V-1 and V-2). We estimate that the Oat Creek system has approximately 351 acres of vernal pools and swales (Stokely, In Prep., 2015). As described above, Coyote Creek flows into Oat Creek at approximately latitude 40^{o} 04 '40.39" N and Longitude 122^{o} 08' 13.51" W. Oat Creek joins the Sacramento River at River Mile 233. We have considered the structure and connection of the Coyote Creek and Oat Creek hydrologic systems in light of current guidance (U.S. Environmental Protection Agency and Department of the Army, 2008). It is our opinion that it is reasonable and logical to describe the Coyote Creek and Oat Creek vernal depression and swale complexes and the many branches of the Coyote Creek and Oat Creek channel systems as being “similarly situated”. It is also our opinion that for the purposes of describing the functioning of these systems and their combined influence on the physical, chemical, and biological processes that occur in the Sacramento River, it is logical to aggregate the vernal depression, swale and channel systems.

C. Summary of Hydrologic and Chemical Hydrology Study Results in the Coyote Creek Conservation Reference Area Depressions, Swales, and Streams (and by Inference, at the Duarte Site Prior to Late Fall of 2012)

1. Hydrologic Study – Overview and Event Analyses

To establish and document reference conditions a hydrologic study was initiated in October 2012 in the Coyote Creek Conservation Area (CCCA). The objectives of the study were to determine hydrologic connections among depressions, swales, and streams and the Sacramento River; relationships between landforms and hydrologic connectivity; and differences in hydrologic responses due to limited changes in land use.

The Coyote Creek and Oat Creek geomorphic and hydrologic landscape is comprised of a series of similarly situated depressions, swales, and streams that “gather” water in the landscape hydrologic network and direct it to the Sacramento River. The principal sinks, or losses, of water in the watershed are evapotranspiration from the soil and vegetation, surface (overland) and subsurface flow to the hydrologic network, and deep seepage. The latter is a minimal loss in this Mediterranean landscape due to the presence of slowly permeable soil horizons (refer to soil section for discussion of these horizons and importance to the soil water regime). The “gathering” of water in the landscape is exemplified by the Variable Source Area concept (Hewlett and Nutter 1970) as illustrated in Figure III-13. In a relatively undisturbed landscape, surface flow (often referred to as sheet flow and overland flow) does not occur except in the most intense periods of rainfall. If there is overland flow, it flows to any one of the parts of the hydrologic network, i.e., depressions, swales, and streams.

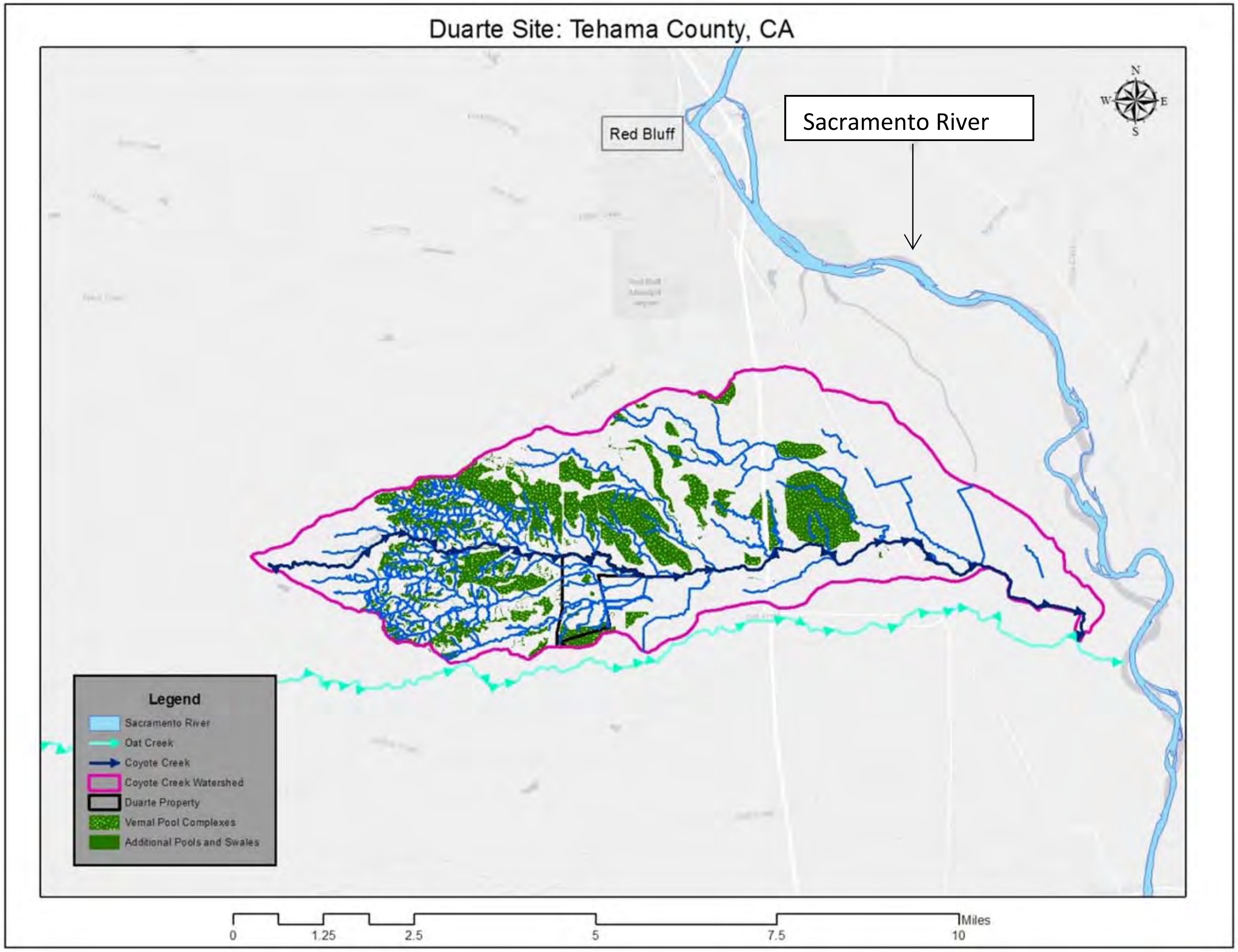

Figure V-5. Analysis of similarly situated vernal depression and swale complexes and streams in the Coyote Creek and Oat Creek Watersheds (Figure 2, Stokley Expert Report, In Prep. 2015).

When it rains the depressions fill by direct precipitation and from lateral subsurface flow directed by the low permeability soil horizons. As the depressions fill and the soil becomes wetter along the swales, and subsurface flow is initiated in the swales. As the soil in the swales becomes nearly saturated, surface flow may be initiated as the rainfall continues. In this manner the depressions, swales, and streams “gather” the flow and deliver it to the streams and, in the case of the Coyote and Oat Creek watersheds, to the Sacramento River. When the rain diminishes and/or stops, flow within the watershed slowly decreases as water continually moves from upper slopes down gradient to channels within the watershed. Thus, with time the source area “shrinks” and flow in the swales and first order channels diminishes. After some time, depending on how much rain fell in the event and in recent events, surface flow in the streams declines, and in the case of Coyote Creek upstream of irrigation return flow input, surface flow stops and only occasional pools remain. Although surface flow may cease, underground flow in the course gravels and sands of the channel may continue for some time (days or weeks). Depressions may fill to the level of an outlet and overflow to a swale completing a surface connection in addition to the subsurface connection. When the depression does not overtop the surface outlet, it is connected in most cases by lateral, subsurface flow to the down gradient swale and stream. Water generally remains in the depressions for long periods of time during the rainy season, with water loss primarily by evapotranspiration. The expansion and contraction of the surface and subsurface flow network represented by the Variable Source Area concept (Figure III-13) explains the dynamic expansion and contraction of the watershed contributing area to flow and the continuous surface and subsurface connections of the hydrologic network of depressions, swales, and streams during and following rain events.

The Variable Source Area can be used as a tool to describe the response of the Coyote Creek watershed to rainfall events was confirmed by the hydrologic study commenced in October 2012. (Refer to Methods Section IV for a description of the instrumentation and locations.) As described in the Methods Section, hydrologic instruments were placed in the Coyote Creek Conservation Area (CCCA) in depressions, swales, and streams. One set of instrumentation was in a light to moderately grazed area with no tillage (Area 13) and another set in a light to moderately grazed area that had been shallow tilled (Ag Area). Both sites are in the same landscape setting. Water level recorders (Hobos) were also placed in Coyote Creek at Paskenta Road and at three additional downstream locations upstream of the Coyote Creek confluence with Oat Creek. The last, and most downstream instrument, was installed near the junction of Oat Creek with the Sacramento River.

Three water years (October through September in 2012-2013, 2013-2014, 2014-present) of monitoring water level and duration of water presence and flow data in the Coyote Creek watershed were analyzed and reviewed in graphical format. Analyses of the hydrologic data confirm a continuous connection of flow in the Coyote Creek watershed to the Sacramento River during the rainy season when sufficient rainfall occurs. Just when flow is initiated in the landscape, whether subsurface and/or surface, is a function of the amount and timing of rain. Rain begins to wet the soil satisfying the soil water deficit (antecedent soil moisture) and the amount and timing of the rain event leads to flow. Graphs of the complete stage hydrograph and pluviographs for each station are presented in Appendix B. Figures V-6, V-7, V-8 and V-9 present the hydrographs for two rainfall events and demonstrates the flow connection from the headwaters of Coyote Creek to the Sacramento River.

The first event is for a rainfall event from November 28, 2012 through December 5, 2013 with a total rainfall over 8 days of 5.33 inches. The second event is for a rainfall event from February 5, 2014 through February 13, 2014 with 3.16 inches of rainfall over 9 days. Both rainfall events were measured at the Red Bluff Airport. As shown in Figures V-6 and V-7, during the water year 2012-13 event there was significant rainfall on 7 of the 8 days (0.33 inches and greater, with a maximum of 1.13 inches on the 5th day). Figures V-8 and V-9 show the responses during the February 2014 (water year 2013-14) event where there was significant rainfall on 2 of the 9 days (0.85 inches on the 4th day and 1.75 inches on the 5th day).

The water year 2012-13 plots in Figures V-6 for Area 13 and Ag Area show the wetting up of the depression first followed by the swale and then the streams in both Area 13 and the Ag Area. The upland depression perched water table in both areas does not extend to the surface and ponded water does not occur. Flows at each location are coincident and verify the continuous connection of the landscape hydrologic features of the Coyote Creek watershed with Oat Creek and then the Sacramento River. The depressions had an immediate response to rainfall with continuous ponding for more than 80 days in Area 13 (continuous ponding supplemented by periodic rainfall) and 11 days in the Ag Area before declining to saturation beneath the soil surface. The downslope depression/swale complex also responded to the rainfall event but because they are in a sloping landscape position, the soil became saturated by direct rainfall and lateral subsurface flow as illustrated by the water level rising to the soil surface and at sometimes becoming surface flow (Area 13 and Ag Area Swale graphs in Figures V-6). Note that the Hobo instruments measure only free water, i.e., at atmospheric pressure whether in an open pond or in the soil. The differences in the Ag Area ponding time and soil saturation in the swales is attributed to the greater presence of larger pores in the lofted soil due to past tillage in the Ag Area. Tillage is an impact that potentially increases rate of loss by subsurface flow and possibly decreases the height of the outlet(s). Further downslope surface flow in the stream (Area 13 Stream Middle Reach and Ag Stream, Figure V-6) was more prominent with the addition of subsurface flow indicated by soil saturation. The Ag Area stream receives additional flow from another watershed, thus the higher flows indicated in the graph. Continual flow was observed at each of the downstream Coyote Creek stations (Coyote Creek at Paskenta Road, Corning Siphon, Tehama Siphon, and Refuge Bridge Gate 3 Figure V-7) commensurate with the flow in the headwaters as well as in Oat Creek at the Sacramento River junction. The record at the junction also shows the occasional backwater stage from high flows in the river.

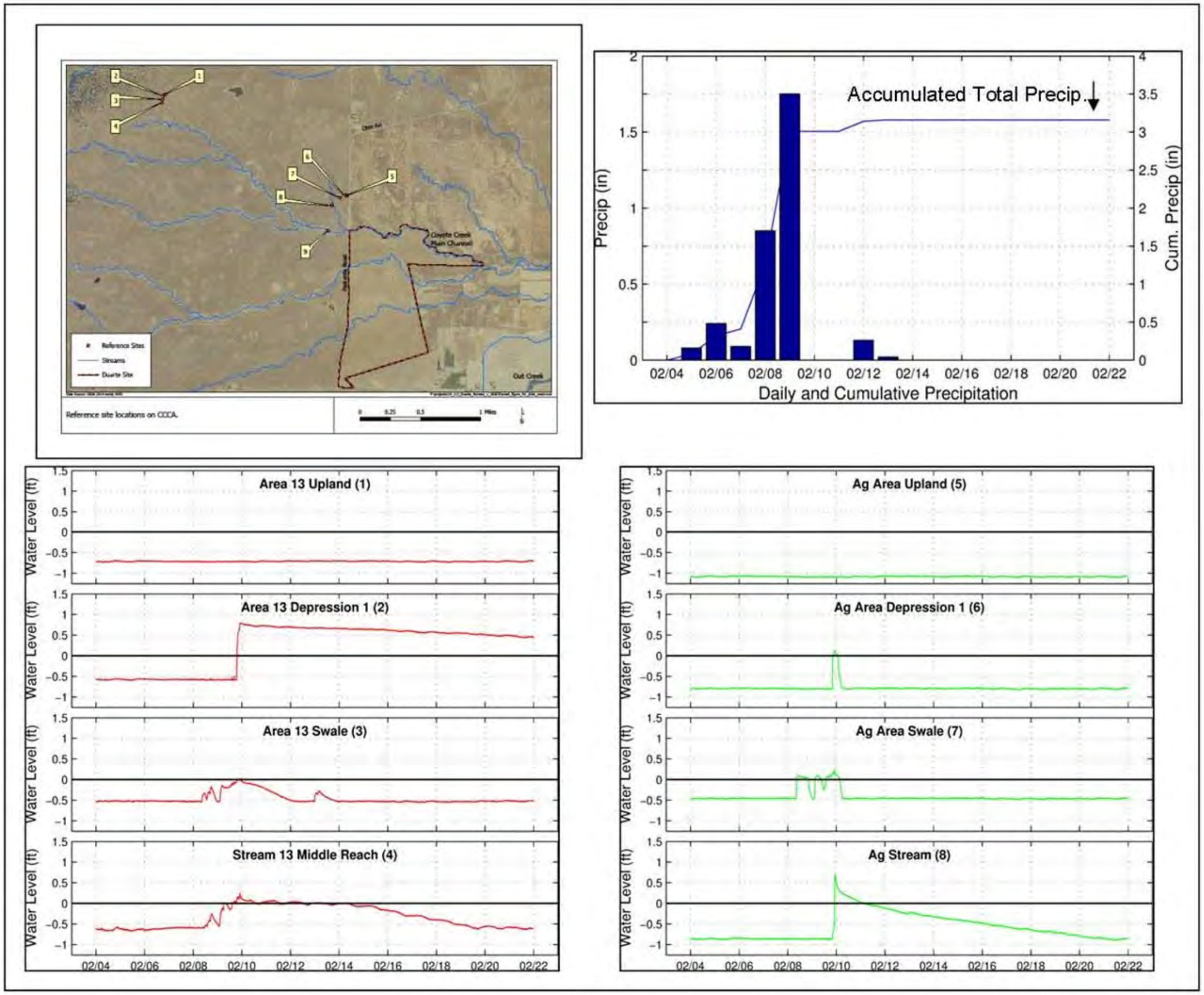

Figure V-6. Reference area depression and swale responses to precipitation for an event starting November 28, 2012.

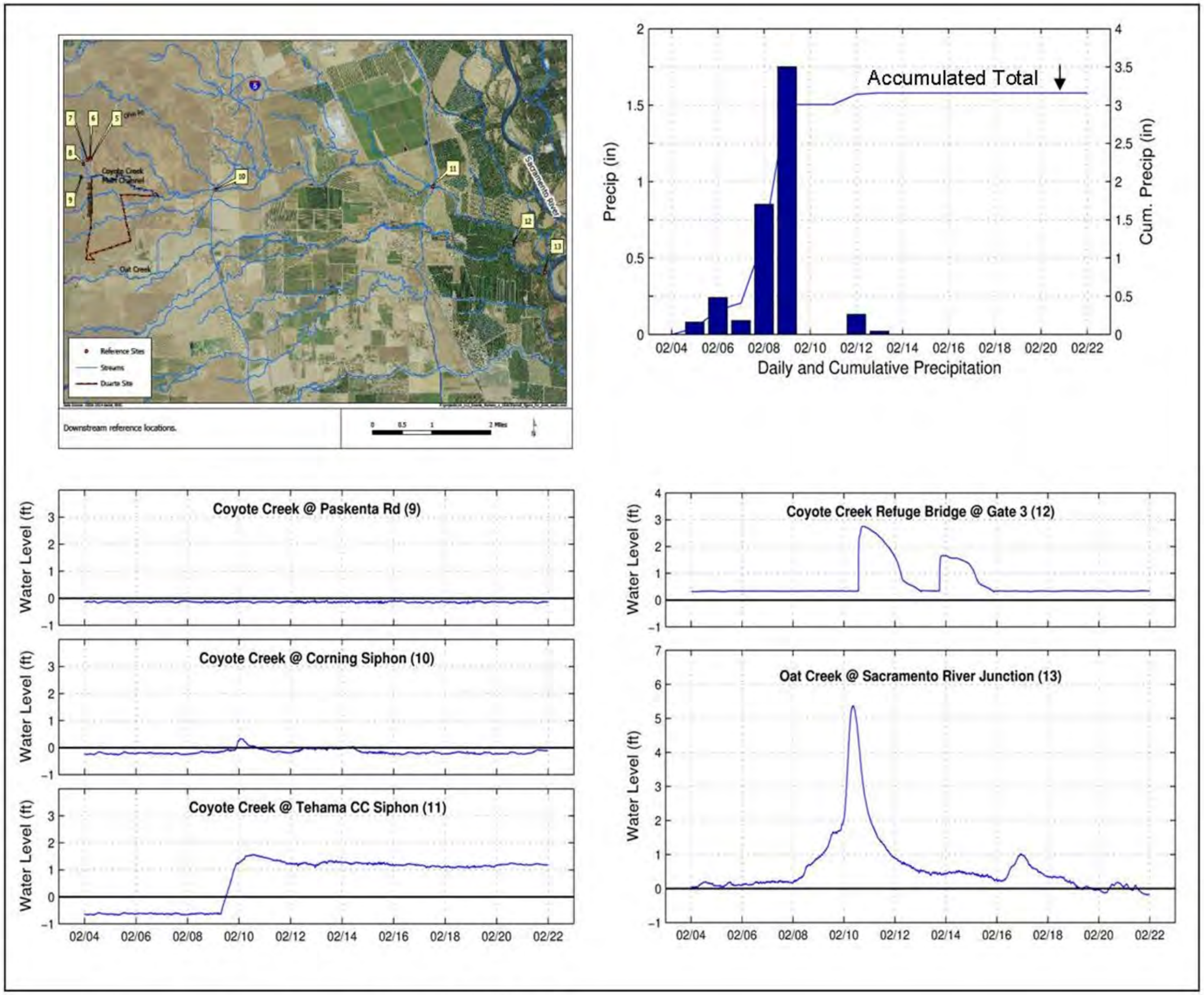

Figure V-7. Stream responses for an event starting November 28, 2012

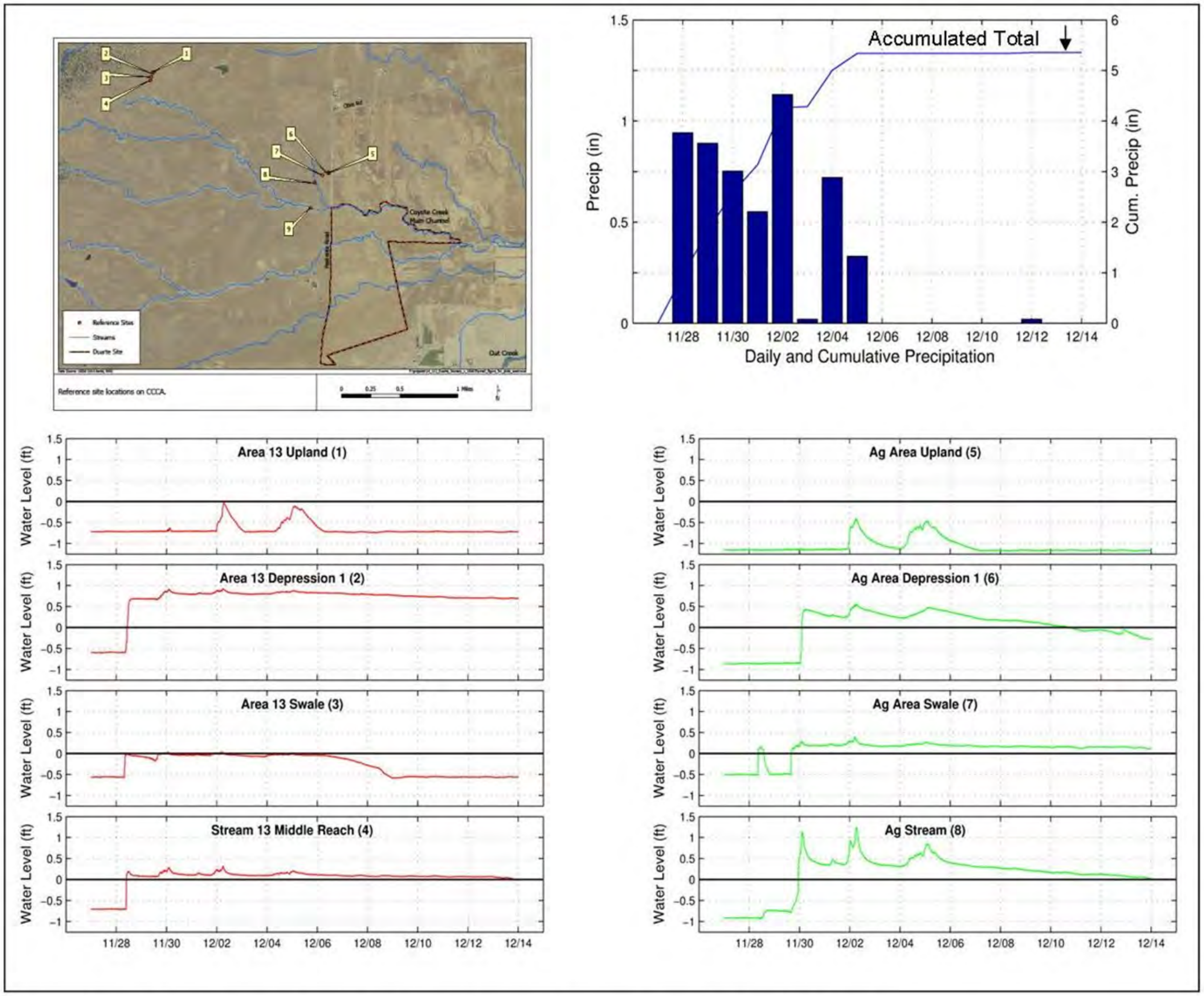

Figure V-8. Reference area depression and swale responses to precipitation starting February 5, 2014.

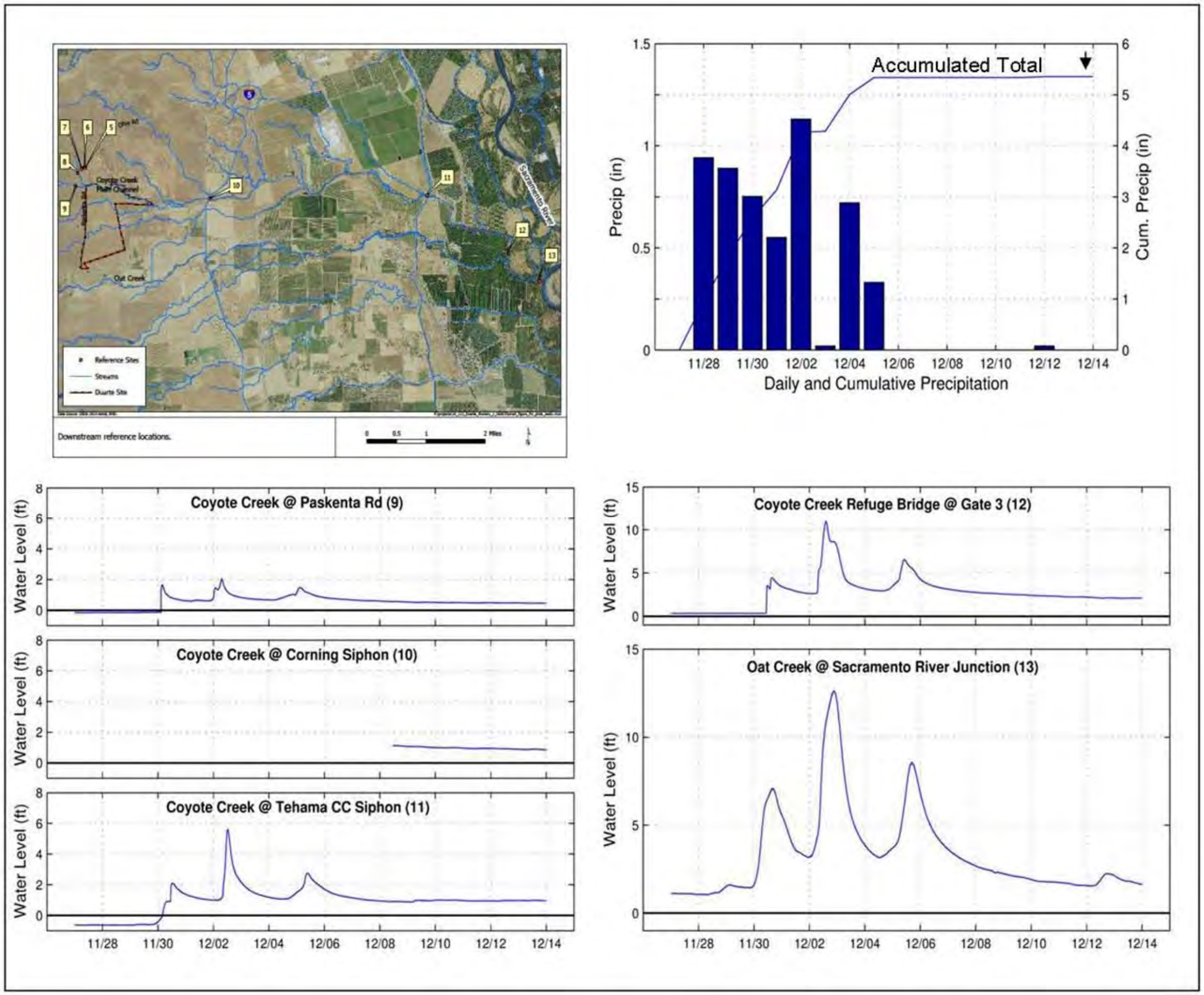

Figure V-9. Stream response for an event starting February 5, 2014.

The results for the shorter duration storm event in water year 2013-14. Figure V-8 for Area 13 and Ag Area are similar to the results for 2012-2013 except that magnitudes of flow and soil wetness are somewhat lower. An exception is the Area 13 depression that filled quickly and remained ponded for more than 60 days (ponding maintained by periodic rainfall). The Ag Area depression was ponded for less than one day and additional rainfall did not cause ponding.

The hydrologic gauge instrument (stage recorder) at Oat Creek is approximately 200 feet upstream from the junction with the Sacramento River and the hydrograph for that location shows the effect of backwater from the River into Oat Creek. Several members of the DOJ Expert Team have traversed the entire length of Coyote Creek to its junction with Oat Creek and then Oat Creek to the Sacramento River and verify that there is a continuous physical hydrologic connection from the headwaters of Coyote Creek to the Sacramento River which is classified as a Traditional Navigable River (TNW). Figure V-3 shows the extent of navigability as determined by the U.S. Army Corps of Engineers, Sacramento District.

The DOJ Expert Team measured streamflow at a few of the stream monitoring locations on December 17-18, 2012. Table V-3 presents the results of the instantaneous measurements. As expected, the stream discharge increases as one travels downstream from Coyote Creek @ Paskenta Road to the location near the Corning siphon and then to the location at the Refuge Bridge. The Ag Stream's junction with Coyote Creek is between the Coyote Creek gage and Paskenta Road. These data support the continuous flow and connection of the Coyote Creek reference stream to Oat Creek and then to the Sacramento River.

Table V-3. Instantaneous measurements of discharge in Coyote Creek.

Location	Date	Watershed Area acres (mi^2)	Discharge efs	Method
Coyote Creek @ Paskenta Rd.	12/17/12	2,465 (3.85)	2.6	Float
Ag Stream	12/17/12	132 (0.21)	0.45	Float
Coyote Creek @ Corning Siphon	12/12/12	8,313 (13.0)	4.0	Float
Coyote Creek @ Refuge Bridge	12/18/12	16,145 (25.2)	24.2	Price Current Meter

In addition to the water level measurements over time, cross-sections of landforms such as depressions, swales, and streams were measured to describe the topography and positional relationships between landform features. Cross-sections were also measured at all the locations where water levels were gauged.

The maximum peak stage recorded in each of the water years (2013, 2014, 2015) were selected for the stations at Coyote Creek @ Paskenta Road, Coyote Creek, and Coyote Creek @ Corning

Siphon, and Coyote Creek @ NW Refuge Bridge. The maximum stage recorded for a station installed in October 2014, South Fork to Coyote Creek @ Paskenta Road (same as Stream 2 flowing into the Duarte Site) was also selected. The stage hydrographs for all the stations gaged are presented in Appendix B.

Note that an examination of the stage hydrograph for Coyote Creek @ NW Refuge Bridge (Appendix B) indicates a higher peak stage a few days later than that shown in Table V-4. There was no precipitation event of a magnitude to produce this higher stage and no other station recorded such an event on the same date. There was a reported flooding event at the bridge immediately downstream from the Coyote Creek @ Tehama CC Siphon station. There were several large beaver dams in Coyote Creek upstream of the bridge and they apparently gave way leading to the large flooding event at the Refuge Bridge.

Table V-4 includes the time the peak stage occurred at each location. The graphs in Figure V-10 show the stage hydrograph at the sequential downstream gaging stations for each storm event. Note that the travel time for the peak to move downstream ranges from about 6.5 hours to a little less than 9 hours. These peak travel times and the fact that stage increases as one moves downstream is verification that the Coyote Creek stream network is continuous and connected, and by implication and direct observation, connected to the TNW Sacramento River.

Table V-4. Maximum stage for selected gaging stations on Coyote Creek.

Location	Date	Time	Stage ft
Coyote Creek @ Paskenta Rd.	12/21/12	10:30	1.70
	2/26/14	23:36	1.71
	12/6/14	3:40	2.23
Coyote Creek @ Corning Siphon	12/21/12	11:44	3.22
	2/27/14	03:03	2.90
	12/6/14	05:35	3.35
Coyote Creek @ NW Refuge Bridge	12/21/12	17:34	10.1
	2/27/14	05:58	5.82
	12/6/14	11:32	6.91
South Fork Coyote Creek (Stream 2)	12/6/14	03:57	3.81

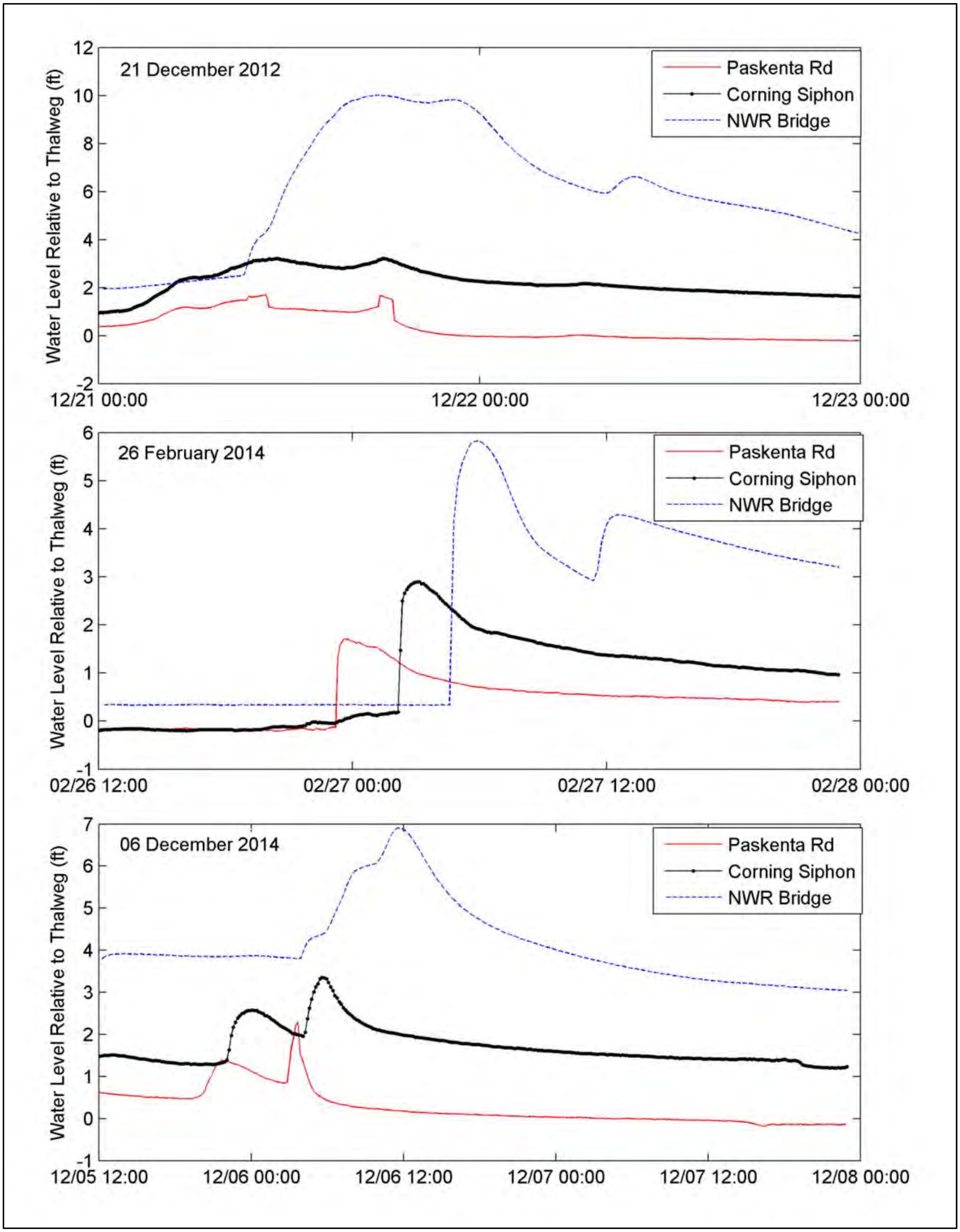

Figure V-10. Stage hydrographs for maximum peak stage events showing time lag of the peak moving downstream.

2. Hydrologic Study - Days of Flow from Vernal Pools to Down Gradient Waters - Reference Areas (and by Inference – Duarte Site Prior to Late Fall of 2012)

Vernal pools and swales occur in the uppermost headwaters settings where watershed areas are small. Taking the mean annual days of flow as a function of watershed area for the seven U.S. Geological Survey stream gages with long-term records in the same physiographic region as the Coyote-Oat Creek Watershed and extrapolating back to the smallest watershed areas, the expected annual days of flow from these small watersheds would be 85 days (Figure III-12). This would be consistent with past work in similar types of vernal pools which showed that the annual days of flow from vernal pools in small watersheds was ~90 days (Rains et al. 2006). Therefore, we hypothesized that rainfall would result in ~75-100 days of flow annually from the reference area vernal pools and swales.

Annual rainfall totals were well below average (Section III.B.2). Nevertheless, there were flows out of the reference area vernal pools and swales (Photo V-1 and V-2). However, due to low rainfall, the annual days of flow from the reference area vernal pools and swales were well below the expected ~75-100 (Section III.B.2). In water years 2012-2013, 2013-2014, and 2014-2015 (to date), annual rainfall was 16.35 inches (66% of average), 11.55 inches (46% of average), and 15.86 inches (64% of average), respectively; the annual days of flow at Area 13 were 50, 19, and 40, respectively; and the annual days of flow at the Ag Area were 54, 17, and 36, respectively. In both Area 13 and the Ag Area, the annual days of flow are linear functions of annual rainfall. If rainfall is average (i.e., x = 100%, or 1.0), then the projected average annual days of flow in the Area 13 and Ag Area reference sites would be 96 and 103 days, respectively (i.e., y = 96 days and 103 days, respectively).

3. Chemical Hydrology

T, pH, and DO did not differ significantly between the vernal pools and swales and the streams and canals (Table V-6; Figures V-12, V-13, and V-14). SC was significantly lower in the vernal pools and swales than in the streams and canals (Figure V-15). The enrichment seen in the stream and canal water likely indicates the effects of groundwater discharge due to irrigation water returning to the streams (i.e., irrigation return flow) and/or concentration due to evaporation of stream water, which may have been on the surface and therefore subject to evaporation for a longer period of time (i.e., evapoconcentration).

Photo V-1 Flow generation in the Agricultural Area of the Coyote Creek Conservation Area. The flow originates in the Agricultural Area vernal pool immediately upstream of the photograph and is continuous and unbroken until it reaches Coyote Creek downstream and to the left of the photograph. The photograph was taken within a few minutes of Photo V-2.

Photo V-2 Flow at the Agricultural Area stream of the Coyote Creek Conservation Area. The flow originates in the Agricultural Area vernal pool upstream of the photograph and is continuous and unbroken until it reaches Coyote Creek downstream and just out of site on the photograph. The photograph was taken within a few minutes of Photo V-2.

Table V-5. Annual rainfall (inches, %normal) and annual days of flow (actual, projected normal) at the Area 13 and Ag Area reference sites. Projected normal annual days of flow are calculated by extrapolating from the relationships in V-11.

	Annual Rainfall		**Annual Days of Flow, Area 13**		**Annual Days of Flow, Ag Area**	
Water Year	in	% Normal	Actual	Projected Normal	Actual	Projected Normal
2012-2013	16.35	66	50	96	54	103
2013-2014	11.55	46	19	96	17	103
2014-2015[1]	15.86	64	40	96	36	103

1 Through February 2015

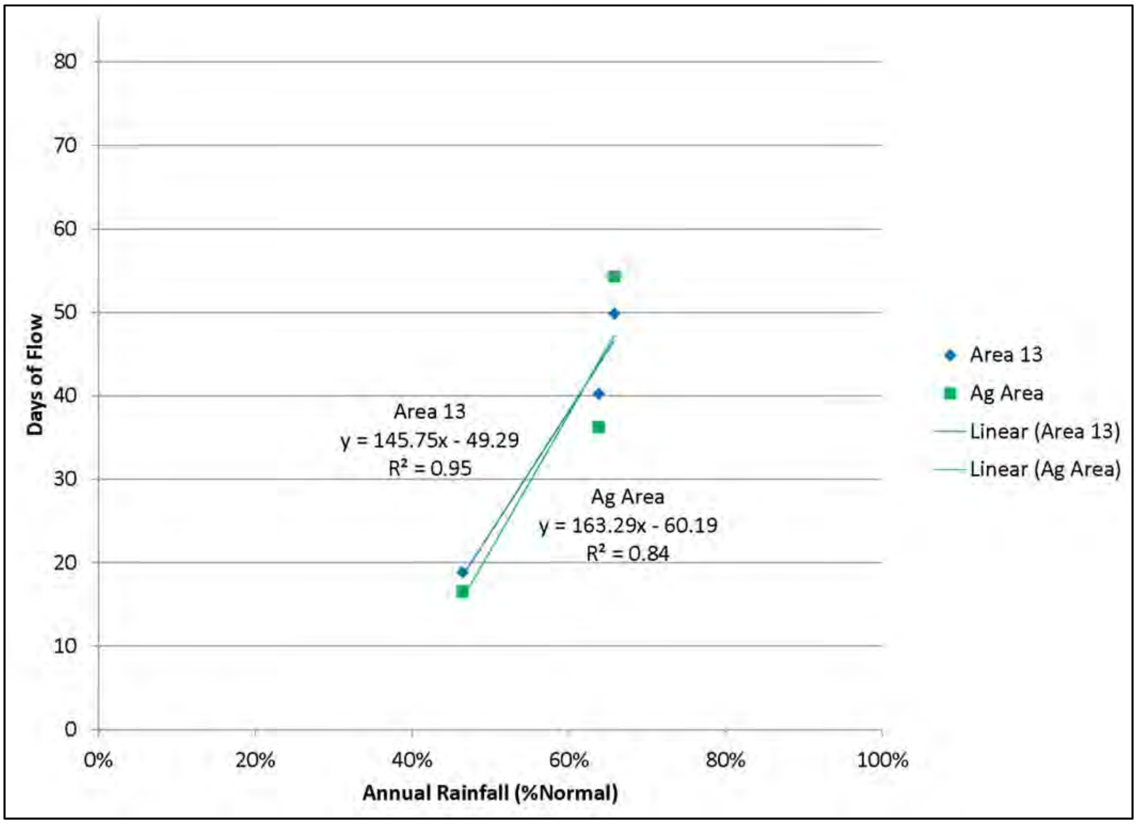

Figure V-11. Annual days of flow (days) as a function of annual rainfall (%normal) at the Area 13 and Agricultural Area reference sites. Both relationships indicate that the annual days of flow are linear functions of annual rainfall. Extrapolating both relationships to normal rainfall (i.e., *x* = 100%, or 1.0), the projected normal annual days of flow at Area 13 and the Agricultural Area would be 96 days and 103 days, respectively.

DIN and SRP were significantly lower and DOC was significantly higher in the vernal pools and swales than in the streams and canals (Figures V-16, V-17, and V-18). This is consistent with the hypothesis that water that is enriched in nutrients and depleted in organic carbon flows into the vernal pools and swales, where vernal pool and swale biota rapidly uptake the nutrients and convert them to organic carbon, which is then available for export to down gradient waters. This is a critical function of many headwater wetlands. If the nutrients were to be exported directly, then they could cause algal blooms on the down gradient waters. Instead, those nutrients are uptaken and converted into organic carbon. This organic carbon is then available for export to down gradient waters, where it can serve as the fuel at the base of the food chain leading from microorganisms, to invertebrates, and to vertebrates, including fish.

This effect is likely most pronounced early in the wet season due to the asynchrony between hydrological and biological processes in Mediterranean climates (Tate et al., 1999; Holloway and Dahlgren, 2001; Rains et al. 2006). In the dry season, annual plants senesce, organic matter decomposes, nitrogen and phosphorous are mineralized and accumulate in soils. Annual grasses germinate early in the wet season, but do not develop substantial biomass until the middle- to late-growing season, so there is little biological demand for nitrogen and phosphorous. Nitrogen mostly occurs in ionic forms that readily dissolve in water. Therefore, nitrogen readily dissolves in the early-season rainfall, then flows laterally to the nearby vernal pools. Phosphorous mostly occurs adsorbed to iron-oxide complexes. (The Redding soils derive their name from their red color, indicative of iron oxides, or rust.) When flooded by early-season rainfall and runoff, these iron oxides can temporarily be reduced, and the adsorbed phosphorous can be released. This simultaneous release of nitrogen and phosphorous provides biota with the two most important limiting nutrients. (Note that commercial fertilizer commonly displays an N-P-K ratio, which indicates the balance of nitrogen, phosphorous, and potassium in the product.) With these limiting nutrients in abundance, early-season vernal pools can have extremely high primary productivity, with the nutrients being converted into organic matter, which is then available for export to downgradient waters if the vernal pools overtop their outlets and water is directed down swales to downgradient streams.

D. Overview of Reference Area Soils (and by inference Duarte Site Prior to December 2012)

1. Soil and Site Description

The soils at all waters/wetlands sample locations on the reference sites were hydric by meeting the definition of a hydric soil. Additionally, the soils met one or more of the hydric soils indicators listed on the Arid West supplement data sheets. The most common indicator was redox depressions (F8). In some locations this indicator was used in swale landforms. While not strictly depressions, many of these locations had the ability to pond water due to low gradients and/or the presence of subtle microtopograpic features that could facilitate the ponding of water. All waters/wetlands sample locations had indicators of surface water present seasonally and the redox descriptions for this particular indicator were met at these locations.

All reference locations are located on the reference area soil map (Figure V-19).

Table V-6. Physical and chemical properties of water samples collected in vernal pools and swales (n = 7) and streams and canals (n = 13). Those properties highlighted in red are significantly different at the α = 0.05 level.

Constituent	Vernal Pools and Swales (n = 7)		Streams and Canals (n = 13)		Statistics	
	Mean	SD	Mean	SD	t-value	p-value
T (oC)	10.38	1.09	9.25	1.88	1.45147	0.16385
pH	7.38	0.65	7.38	0.55	-0.01083	0.99148
SC (S/cm)	42.29	12.93	129.31	76.95	-2.93363	0.00888
DO (%)	88.43	9.40	89.15	13.21	-0.12815	0.89945
DIN (mg/L)	0.02	0.01	0.98	0.55	-4.52640	0.00026
SRP (mg/L)	0.01	0.00	0.03	0.02	-2.16216	0.04432
DOC (mg/L)	17.38	6.75	6.18	1.85	5.71212	0.00002

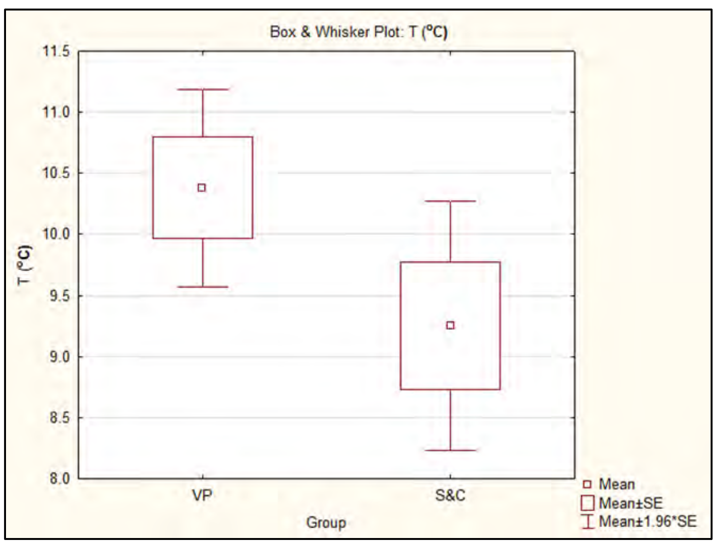

Figure V-12. Temperature (°C) of the surface water in vernal pools and swales (VP) and streams and canals (S&C). Temperature is not significantly different between the two groups. Small squares are the sample means; large squares are the sample means ± the standard error, within which ~68% of the samples would be expected to occur; and bounding bars are the sample means ± 1.96 times the standard error, within which ~95% of the samples would be expected to occur.

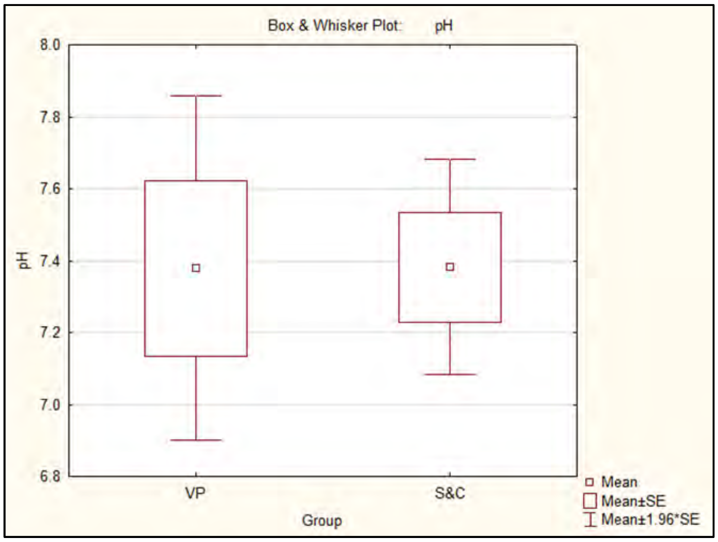

Figure V-13. pH of the surface water in vernal pools and swales (VP) and streams and canals (S&C). pH is not significantly different between the two groups. Small squares are the sample means; large squares are the sample means ± the standard error, within which ~68% of the samples would be expected to occur; and bounding bars are the sample means ± 1.96 times the standard error, within which ~95% of the samples would be expected to occur.

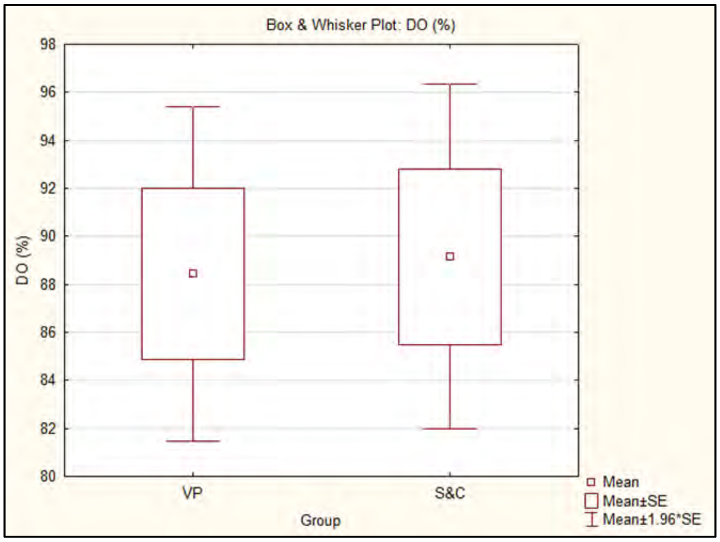

Figure V-14. Dissolved oxygen (%saturation) of the surface water in vernal pools and swales (VP) and streams and canals (S&C). Dissolved oxygen is not significantly different between the two groups. Small squares are the sample means; large squares are the sample means ± the standard error, within which ~68% of the samples would be expected to occur; and bounding bars are the sample means ± 1.96 times the standard error, within which ~95% of the samples would be expected to occur.

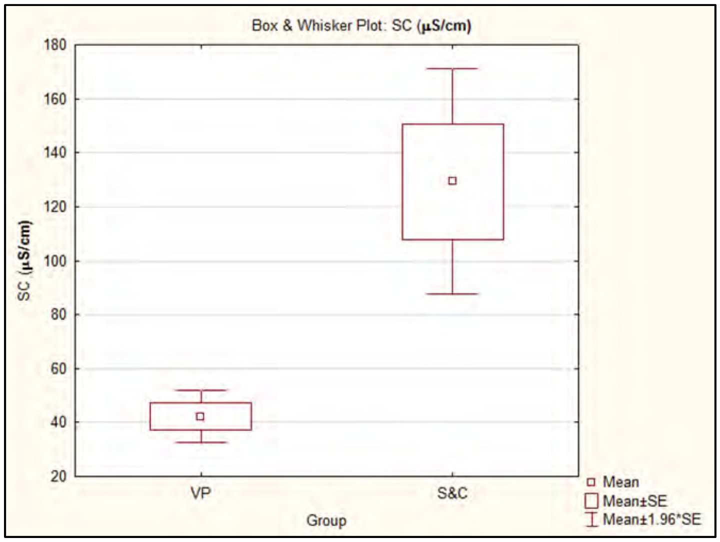

Figure V-15. Specific conductance (µS/cm) of the surface water in vernal pools and swales (VP) and streams and canals (S&C). Specific conductance is significantly higher in the streams and canals than in the vernal pools and swales. Small squares are the sample means; large squares are the sample means ± the standard error, within which ~68% of the samples would be expected to occur; and bounding bars are the sample means ± 1.96 times the standard error, within which ~95% of the samples would be expected to occur.

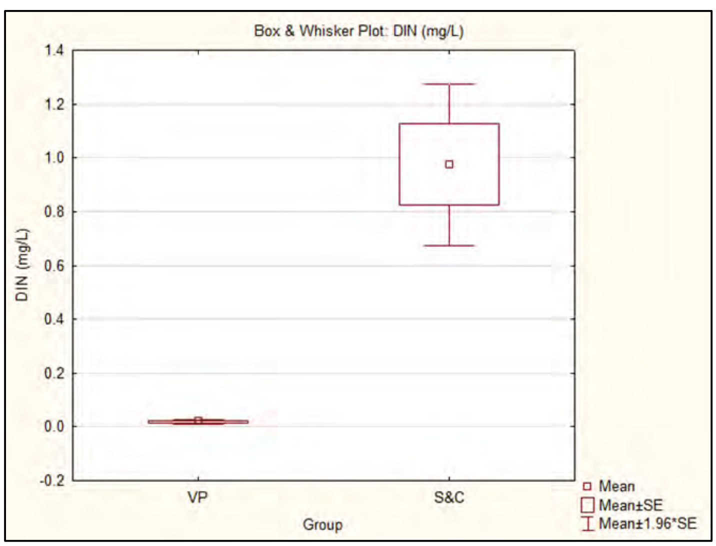

Figure V-16. Dissolved inorganic nitrogen (mg/L) of the surface water in vernal pools and swales (VP) and streams and canals (S&C). Dissolved inorganic nitrogen is significantly higher in the streams and canals than in the vernal pools and swales. Small squares are the sample means; large squares are the sample means ± the standard error, within which ~68% of the samples would be expected to occur; and bounding bars are the sample means ± 1.96 times the standard error, within which ~95% of the samples would be expected to occur.

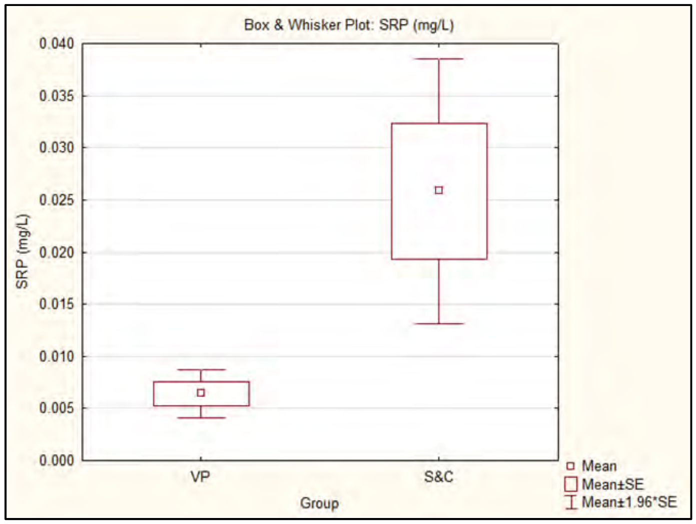

Figure V-17. Soluble reactive phosphorous (mg/L) of the surface water in vernal pools and swales (VP) and streams and canals (S&C). Soluble reactive phosphorous is significantly higher in the streams and canals than in the vernal pools and swales. Small squares are the sample means; large squares are the sample means ± the standard error, within which ~68% of the samples would be expected to occur; and bounding bars are the sample means ± 1.96 times the standard error, within which ~95% of the samples would be expected to occur.

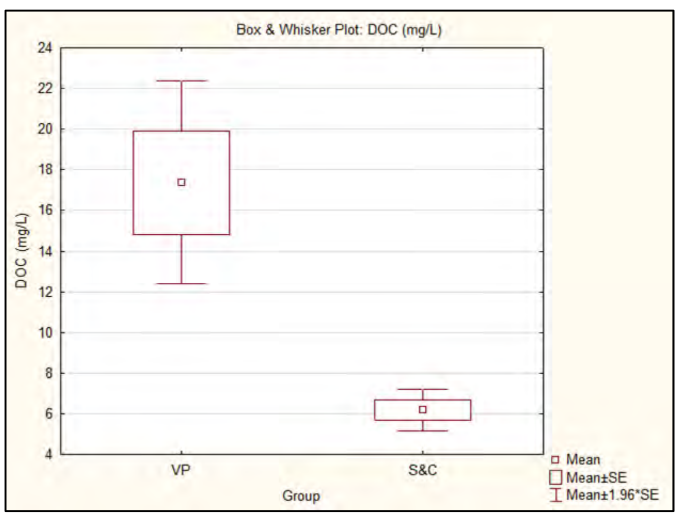

Figure V-18. Dissolved organic carbon (mg/L) of the surface water in vernal pools and swales (VP) and streams and canals (S&C). Dissolved organic carbon is significantly higher in the vernal pools than in the streams and canals. Small squares are the sample means; large squares are the sample means ± the standard error, within which ~68% of the samples would be expected to occur; and bounding bars are the sample means ± 1.96 times the standard error, within which ~95% of the samples would be expected to occur.

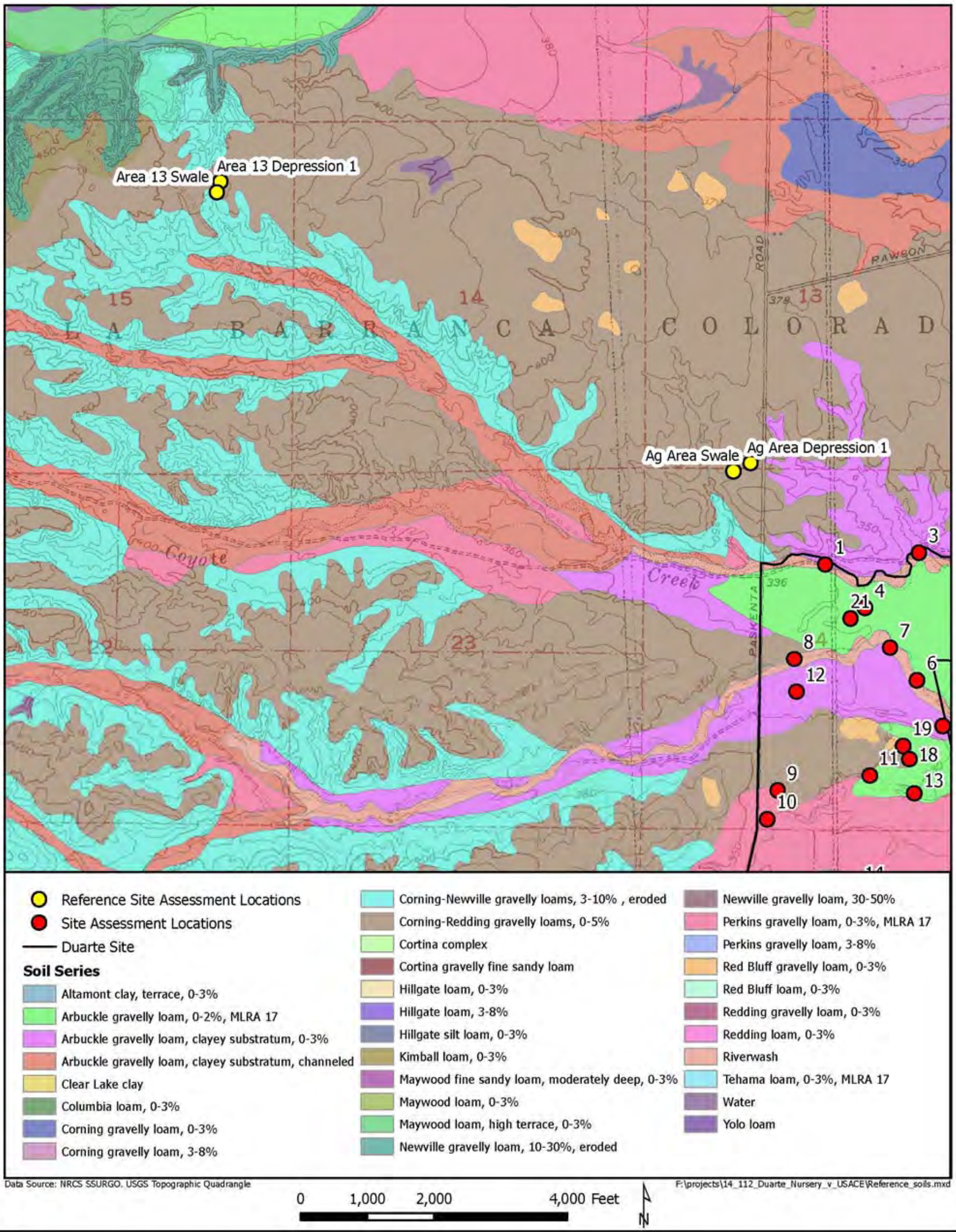

Figure V-19. Reference Site Soils.

The Corning-Redding map unit is a complex of Corning and Redding soils. The Redding series consists of moderately deep soil to a duripan, well or moderately well drained soils formed in alluvium derived from mixed sources. These soils are on nearly level or dissected and undulating high terraces with 0-5% slopes on the reference sites. The average annual precipitation is approximately 22 inches with the mean annual air temperature of about 61 degrees F. (USDA – NRCS, 05/2006 revision). Both the Corning and Redding soils are found on the hydric soils lists due to the presence of unnamed hydric depressions.

The Corning series consists of very deep, well or moderately well drained soils formed in gravelly alluvium weathered from mixed rock sources. Corning soils are on high terraces with mound, intermound microrelief. Slopes are 0 to 30 percent. The mean annual precipitation is about 23 inches and the mean annual temperature is about 62 degrees F (01/2001 revision).

2. Dispersion of Wetlands

The evaluation of the frequency and dispersion of wetlands/waters was described in Chapter IV.H. The results of the evaluation indicated that one hundred forty-one (23 percent) of the 606 randomly selected frequency nodes intersected water/wetland features, while 465 (77 percent) intersected upland features. Thus, the abundance of wetlands/waters in the reference area is 23 percent. Each of the 141 frequency nodes occurring in water/wetlands was encircled by 8 dispersion nodes, for a total of 1128 dispersion nodes. On average, slightly fewer than half (3.6) of the eight dispersion nodes around each frequency node also intersected wetland/water features. We calculated the coefficient of dispersion (0.75) by dividing the variance of the number of dispersion nodes intersecting waters/wetlands (2.7) by the mean of the number of dispersion nodes intersecting waters/wetlands (3.6). Coefficient of dispersion values less than one indicate the target features, i.e., wetlands/waters in the Reference Area, are scattered across the landscape rather aggregated into distinct quadrants or sections (Chaulk et al. 2007).

E. Overview of Reference Area Vegetation (and by inference Duarte Site prior to December 2012)

1. Physical Setting for Vegetation

California is in a region of Mediterranean climate in which precipitation primarily occurs in the late fall, winter, and early spring and the remainder of the year is dry. The cyclical pattern of precipitation followed by drought has led to many survival strategies among different species of plants. For wetland and riparian plant species the abundance of water in the winter (when the growing conditions are poor in terms of heat and light) followed by dry summers when growing conditions are better (abundant heat and light), present difficult conditions for growth and reproduction. On the landscape, wetland or riverine species are found in depressions, swales, channels, and creeks and streams, which exist in a matrix of upland vegetation. In these depressions and swales, which hold and carry water in the winter and dry out in the summer, a large number of unique species of plants (Jokerst 1990) and Crustaceans (Simovich 1998) have evolved to survive these extreme conditions. These species are collectively referred to as vernal pool species, named for the abundance of flowers they display during the spring, the pools and surrounding wetlands often present very beautiful displays of color.

The series of depressions, swales, and streams, that comprise the watershed in which the depressional and swale wetlands, often collectively referred to as "vernal pool" areas, have formed in areas where the soils, geologic formations, and landforms (Smith and Verrill 1998) and in conjunction with a Mediterranean climate have resulted in the development of a vernal depression and swale wetland landscape. Soil forming processes and the anaerobic conditions of the wetlands result in low pH and accelerated weathering of the soils above the duripan, with the development of subsurface horizons enriched in clay (Hobson and Dahlgren, 1998). These areas of depressions and swales supporting a unique flora and fauna with many endemic species have formed on relatively old soils, that through the weathering and erosional processes resulting in relatively infertile wetland habitats with difficult growing conditions that may be hostile to plant species which are not adapted to such conditions. These sites have developed a suite of species uniquely adapted to
these conditions and as such are regions of high endemism and biodiversity (Keeler-Wolf et al. 1998). These conditions of old climatically buffered infertile landscapes (OCBIL) was characterized by Hopper (2009) and identified in areas of south-western Australia, south Africa, and the Pantepui Highlands in Venezuela. Although the soils of the Southern Oregon and California vernal pool landscapes are not as old as those described by Hopper, they have the same characteristics and the soils have weathered more rapidly under the Mediterranean climate of the Pacific Coast.

2. Vegetation Structure, Function and Conditions

The Coyote and Oat Creek watershed are located in the northwestern Sacramento Valley vernal pool region (USF&WS 2005) which extends from southwestern Shasta County south through parts of western Tehama, Glenn, and Colusa Counties. Most of the depressions in this vernal pool region are small (varying from 6 to 100 feet in diameter) and typically occur in complexes of mima-mound topography (Reed and Amundson 2007). These mima-mound complexes of swales and depressions are common in the Coyote Creek and Oat Creek watershed. The wetlands, swales, watercourses, intermittent streams in these watersheds have unique and common species that are adapted to varying soil moisture and hydrologic conditions that result in varying, yet unique associations of species that can be found together as hydrology, soil moisture, soil properties, soil composition, and position in the watershed co-vary to produce habitats that support an association of plant species. At different scales these associations of plants species may appear discrete or gradational and indiscrete. For example a depression (or pool) can appear as clearly bounded and with unique species very different from an adjoining mound with upland species. Upon closer inspection the edge of the pool is not as clear as the initial water boundary appeared. The species along the boundary vary compositionally in a wider zone than first appeared, from a few inches to many feet. Within the depression, the species may occupy zones of water depth or periods of inundation that influence which species can survive best in those microhabitat conditions. The depression has its own gradient of species as does the margin out toward the upland mound apex, and also toward the outlet of the depression into the swale, while in the swale will be found a slightly different compositional mix of species that may change laterally and directionally as the water flow moves down slope. The species compositional shifts may be sharp, but usually are gradational and changing reflecting the current hydrological regime as well as multiple previous seasons depending upon whether annual or perennial species are being observed. The progression from wetland depression to swale to low energy tributary, to intermittent streams is gradual and reflected in the compositional mix of plant species observed. Where sharp boundaries exist such as at a waterfall, or where a rock outcrop adjoins a deep soil, the plant species will reflect this as well.

3. Landscape Structure Influences on Vegetation

Prior to tillage the Duarte Site would have been characterized as a vernal pool landscape or on the upper (southern) terrace that transitions into depression swale system on the lower terrace prior to meeting Coyote Creek. The description as a vernal pool landscape would be used to emphasize the predominance of plants and/or macroinvertebrate branchiopods (fairy shrimp) that would occur in the depressions and swales (Keeley and Zedler 1998). Vernal pool plants typically inhabit depressions or swales that pond, or carry a preponderance of water during the winter and are dry during in the summer. Vernal pool plant species are often annuals, although there are some perennials, adapted to germinating and establishing growth while submerged under water or in saturated conditions and transitioning to flowering and reproductive stages as the depressions or swales dry up. On the lower terrace there is a mixture of vernal pool species and also other freshwater wetland plant species that are adapted to submergence, longer saturated conditions or variations in moisture regime. An example of such a species is *Eleocharis palustris* which occurs in side channels of Coyote Creek and in greater frequency in wetlands of the lower terrace in depressions and swales, while on the upper terrace it is absent or occurs in substantially reduced density.

4. Landscape Function Influences on Vegetation

With the onset of fall and winter rains the upper (southern) terrace would receive rain that would infiltrate the soil and begin to saturate the soils; with recurrent rains the soils would saturate and eventually the depressions would fill and hold standing water. As the pools reached maximum capacity, they would spill out into swales, whose soils had become saturated and the swales would carry water down gradient. With consistent rains the saturated soils, depressions, and swales would promote the germination of seeds of annual plants or the re-establishment of growth by perennial plants that had dormant roots, tubers, or bulbs, underground. The surrounding mounds would rarely saturate unless continued rain events occurred, but even then the soil moisture would percolate out of the mound and into the swale continuing to recharge the swale and depression system with additional water. The mounds would see the germination of non-wetland plant species that are unable to tolerate the varying anaerobic conditions of the wetland areas of swales and depressions. A continually varying gradient of species from those incapable of tolerating wetland conditions (upland species) to those requiring well developed wetland conditions (obligate species) would be found on the landscape.

These wetlands (depressions, swales, channels) are thus dependent upon the subsurface soil structures (both permeable and impermeable layers), the subsurface saturation by water, and the surface water, whether it is flowing, ponding or infiltrating. All of these conditions are varying together from year to year, which develops the microtopographic site conditions that support the wetland plants adapted to each wetland site. The site, soil, and hydrologic characteristics of each site result in a repeating set of species that often occur together across the local landscape. These co-occurring species can be identified as associations of species.

5. Rationale for Comparison of Reference Sites and the Duarte Site Conditions prior to December 2012

The vegetation in the reference area and the Duarte property are both in the Coyote Creek watershed experience the same climate, have the same soils, and have the same species occupying the uplands and wetlands. Prior to the arrival of the Spanish, these lands experienced the same biotic and abiotic processes and primarily varied in vegetational species composition based upon local soil and hydrological factors (see Holland and Hollander 2007 for an assessment of vernal pool habitat in California prior to European settlement). After the Spanish arrival, the lands were used in large blocks primarily for pastures for horses, sheep, cattle. From the 1850 to 1950's these lands were primarily range lands for grazing and only sporadically, on small scales, were efforts made to raise crops. In the 1950's and later sporadic efforts were made to dry farm and raise crops or hay. Through these incursions many non-native species took hold in the area; however, these were primarily in the uplands and particularly in the form of grass species. These changes were landscape wide and occurred throughout the Central Valley. These non-native grasses forbs did not seriously invade wetlands such as depressions and swales. Thus, the reference area and Duarte Site are very similar geographically, historically, climatically, pedologically, geologically, and geomorphologically

6. *Vegetation Associations as Derived from Reference Area Survey and Wetland Delineations*

a. Reference Area 13 Depressions

This association is typical of the depressions in having a large number of species varying from 15 – 20 or more. The absolute percent cover of each species in the depression will vary depending upon the local hydrology, rainfall year (timing, frequency, duration), and the grazing pressure. The only known (current and historical) agricultural disturbance to the site has been grazing.

Primary Characteristic Taxa: *Eryngium castrense, Downinigia* spp., *Treiteleia hyacinthinia, Hemizonia* spp., *Juncus bufonius* var. *bufornius, Deschampsia danthonioides, Lolium perennne, Blennosperma nanum, Psilocarphus* spp. *Navarretia* spp., *Plagiobothrys* spp., *Eleocharis palustris*.

b. Reference Area 13 Swale

This association is found on swales throughout reference area 13. Relative to the depressions, the plant species diversity is lower, absolute cover by non-natives is higher, cover by perennials (*Eryngium* and *Eleocharis*) is lower.

Primary Characteristic Taxa: *Blennosperma nanum, Deschampsia danthonioides, Erodium cicutarium, Navarretia* spp., *Plantago elongata, Vulpia* spp., *Hypochaeris glabra, Brodiaea* spp.

c. Agricultural Area Depression

This area was farmed in the past and shows remnant furrows and ridges in various areas of the site. The remnant furrows and ridges are no longer are visible in the depression.

Primary Characteristic Taxa: *Hypochaeris glabra, Eryngium castrense, Psilocarphus* spp., *Hordeum marinum* ssp. *gussoneanum, Blennosperma nanum, Juncus uncialis, Deschampsia danthonioides, Plagiobothrys* spp.

d. Agricultural Area Swale

This area was farmed in the past and shows remnant furrows and ridges in various areas of the site, although the furrows and ridges are no longer visible in the swale and pools.

Primary Characteristic Taxa: *Erodium cicutarium*, *Lolium perenne*, *Juncus bufonius* var. *bufonius*, *Hypochaeris glabra, Eryngium castrense, Psilocarphus* spp., *Hordeum marinum* ssp. *gussoneanum*, *Bromus* spp.

7. Connectivity of Vegetation Associations

The associations listed above will show either gradual or rather sharp transitions from one association to another as one traverses the landscape. These gradual or sharp transitions that may be apparent due to their varying component plant species are still fully connected in space and time. Using the Duarte Site associations as the example the upper terrace depression association will be the first to collect and begin to hold water in a season, while the rest of the soil begins to saturate. The upper terrace flats will also saturate quickly and these soils and depressions saturate and hold water the seeds of the annual plants will begin to germinate and grow in saturated soils or underwater. The swales will saturate as will the soils of the rest of the site and as these sites saturate the water will flow from depressions through the swales and down into the stream channels and finally into Coyote Creek. The initial flows of water may move seeds of the plants that were released the previous spring down the swales and re-distribute the seed bank. With annual re-distribution of the seed bank there is additional genetic exchange between generations of plants from various years of growth. As the plants mature into the spring the pollinators of various species (e.g. bees) are able to move through the plant associations selecting species they preferentially are pollinating, thereby facilitating genetic exchange and connectivity in the current season and across the landscape. For many vernal pool plant species there are specialist solitary bees that nest in the uplands adjacent to the depressions and swales (Thorp 1990 and 2007). The plant associations can be identified as comprising separate units, but they are not independent units that can exist outside of the connectivity provided by the landscape of hydrology, soils, and climate.

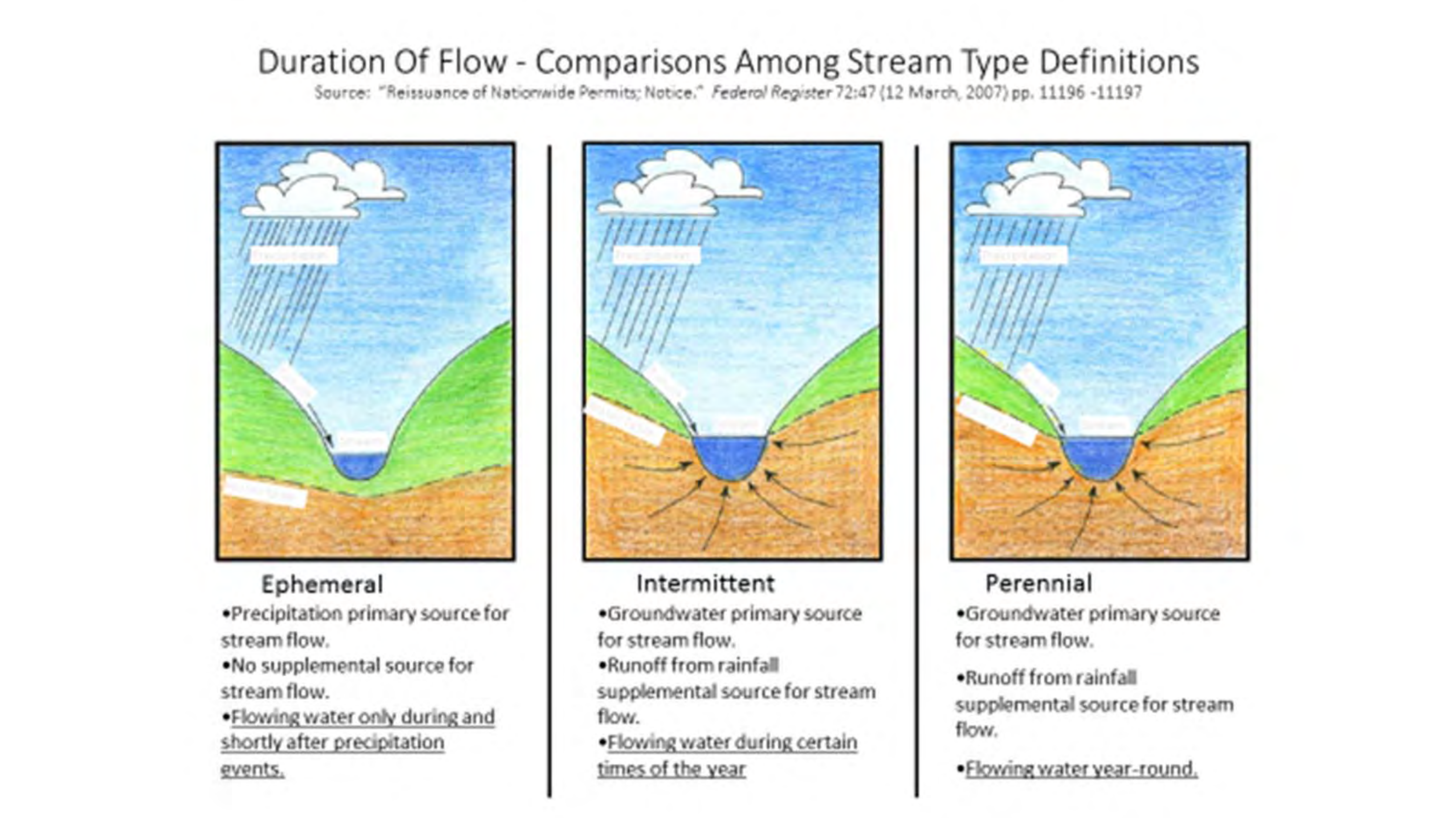

Figure V-20. Comparisons of Duration of Flow (from U.S. Corps of Engineers "Reissuance of Nationwide Permits")

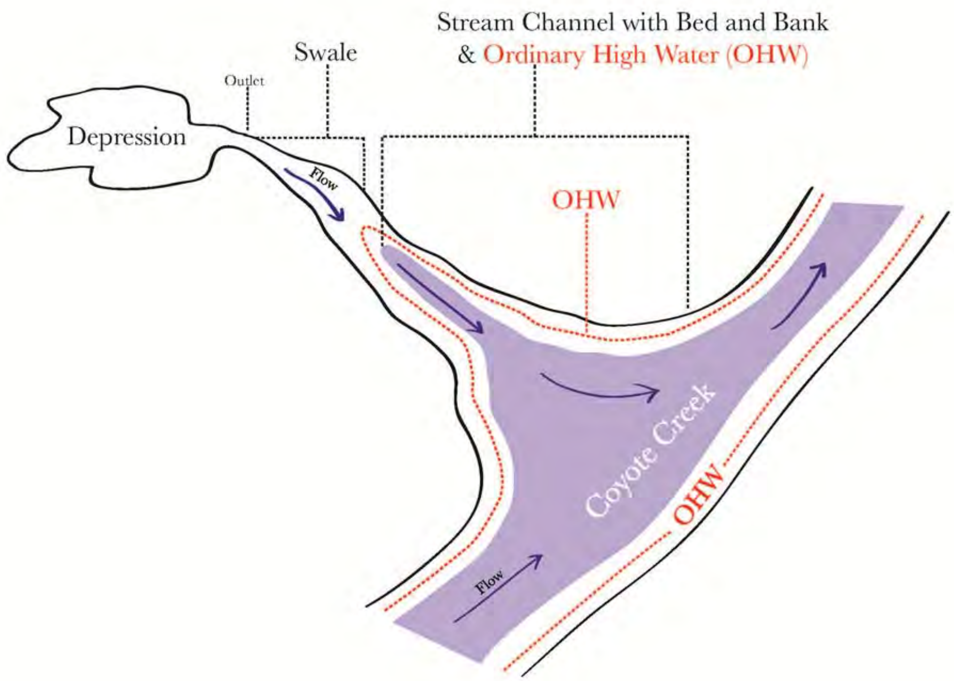

Figure V-21. Schematic of the typical geomorphic setting and relationships among depression/swale/stream landforms found on the CCCA Reference Area and the Duarte Site. (Not to scale)

F. Reference Site Conditions (and by Inference, Duarte Site Conditions) Prior to Late Fall of 2012 Activities – Identification and Delineation of Waters of the U.S., Including Wetlands (Waters/Wetlands) and Functional Assessments

1. Duarte Site Field Work and Additional Materials Reviewed and Relied Upon to Describe Duarte Site Conditions Prior to Late Fall of 2012 Activities

In addition to our Reference Site and Duarte Site field work (March 31 – April 10, 2015) and in addition to reference materials cited in the Introduction and Methods sections of this expert report, the following materials were examined and relied upon by the DOJ Expert Team to gain an understanding of conditions on Reference Sites and on the Duarte Site prior to 2012 tillage activities:

a. USGS quadrangle maps at scales of 1:100,000, and 1:24,000 (Figures V-1 and V-2). These figures show Coyote Creek and two other "blue line" streams running west to east through the Duarte Site. At a scale of 1:24,000, Figure V-2 shows crenulations in contour lines indicating numerous flow patterns on the site. Also at a scale 1:24,000, it is important to note that the USGS has mapped Coyote Creek and the two other blue line streams on the Duarte Site with a series of continuous blue lines that are interrupted by series of dots (i.e., . . .). These mapped symbols mean that the USGS cartographer interpreted the stream system on the Duarte Site to have intermittent" flow characteristics. Figure V-20 provides a comparison among different types of flow patterns in stream systems. Definitions in Figure V-20 are taken from "Reissuance of Nationwide Permits; Notice." *Federal Register* 72:47 (12 March, 2007) pp. 11196 -11197.

b. In addition to examination of flow patterns, the geomorphic setting of and relationships among depressions, swales, and streams was considered. Figure 21 depicts the geomorphic setting found on the Reference Area and the Duarte Sitre.

c. National Wetland Inventory (NWI) Maps (Figure V-22) - showing one mapped "Freshwater Emergent Wetland" mapped in the east central portion of the site. The riverine systems of Coyote Creek and Streams 1 through 10 are not mapped by NWI.

c. Federal Emergency Management Agency Maps (Figure II-7) – showing three 1% Annual Chance Flood Hazard Zones running west to east through the Duarte Site

d. Air photos including:

(1). USDA – 1952. Showing some ponded water in riverine and depressional features associated with lower terrace and Coyote Creek channel and floodplain landscape positions

(2). USDA – 1972. Showing relatively dry conditions throughout the Duarte Site

(3). USDA – 1979. Showing some residual pools in the Coyote Creek main channel system and in Stream 2, some ponded water in depressions on lower terrace/toeslope surfaces, and what appears to be mowing activities throughout the southern two-thirds of the Duarte Site.

e. Water year 2010 precipitation records combined with the March 26, 2010 aerial photograph of the Duarte Site. Figure V-23 shows antecedent precipitation conditions in March, 2010 wherein the February, 2010 precipitation total was 4.74 inches and the March, 2010 total prior to March 26 was 0.87 inches. Figure V-24 shows the Duarte Site with a great deal of ponded water on the site in depressional and swale features, and a mix of residual pools and flowing water conditions in Coyote Creek and in Streams 1 through 10.

f. True color and color infrared photographs from May 1, 2010 and June, 18, 2014 showing relatively dry conditions in the Coyote Creek main channel system within the CCCA and on the Duarte Site.

g. All photos of reference site conditions taken by the DOJ Expert Team members.

h. A preliminary Clean Water Act jurisdictional analysis regarding the Anchordoguy site on Coyote Creek prepared by U.S. EPA Region 9 staff (Mary Butterwick) – documenting the presence of depressional, swale and riverine wetlands on the Anchordoguy property and their significant nexus with the downstream traditional navigable waters of the Sacramento River.

i. U.S. Army Corps Power Point presentation graphics (U.S. Army Corps of Engineers Power Point Presentation – entitled "Zdraft Remote Imagery Examples and prepared by James Robb) – showing a chronosequence of air photos of the Duarte Site and areas immediately north of the Duarte Site prior to and after Late Fall of 2012.

j. Prior delineations of wetlands on the Duarte Site (North State Report, 1994; NorthStar Report, February 23, 2012 and June, 2012 revision) and related North State and NorthStar correspondence with clients, (including the Duartes) and the U.S. Army Corps of Engineers.

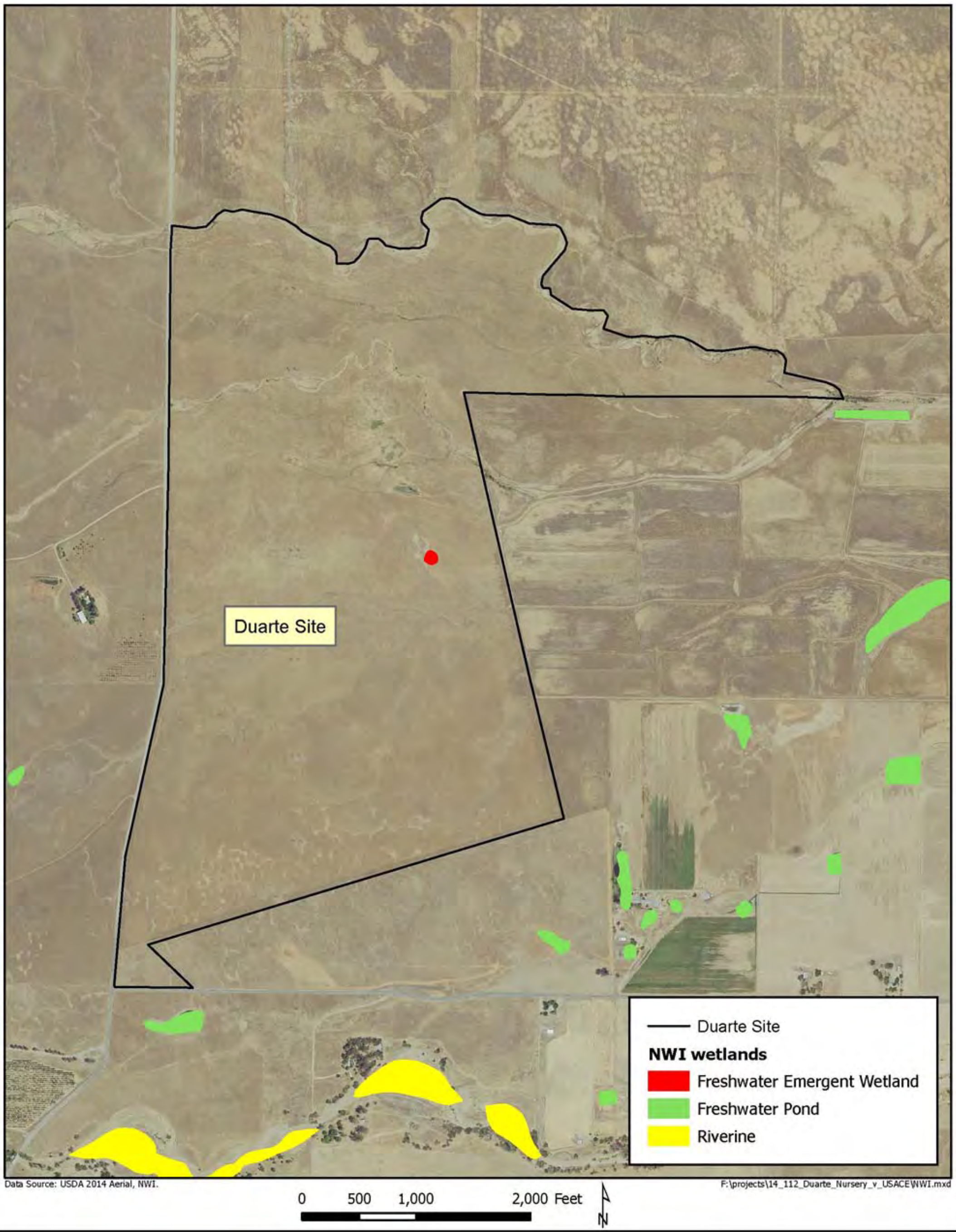

Figure V-22. National Wetland Inventory (NWI).

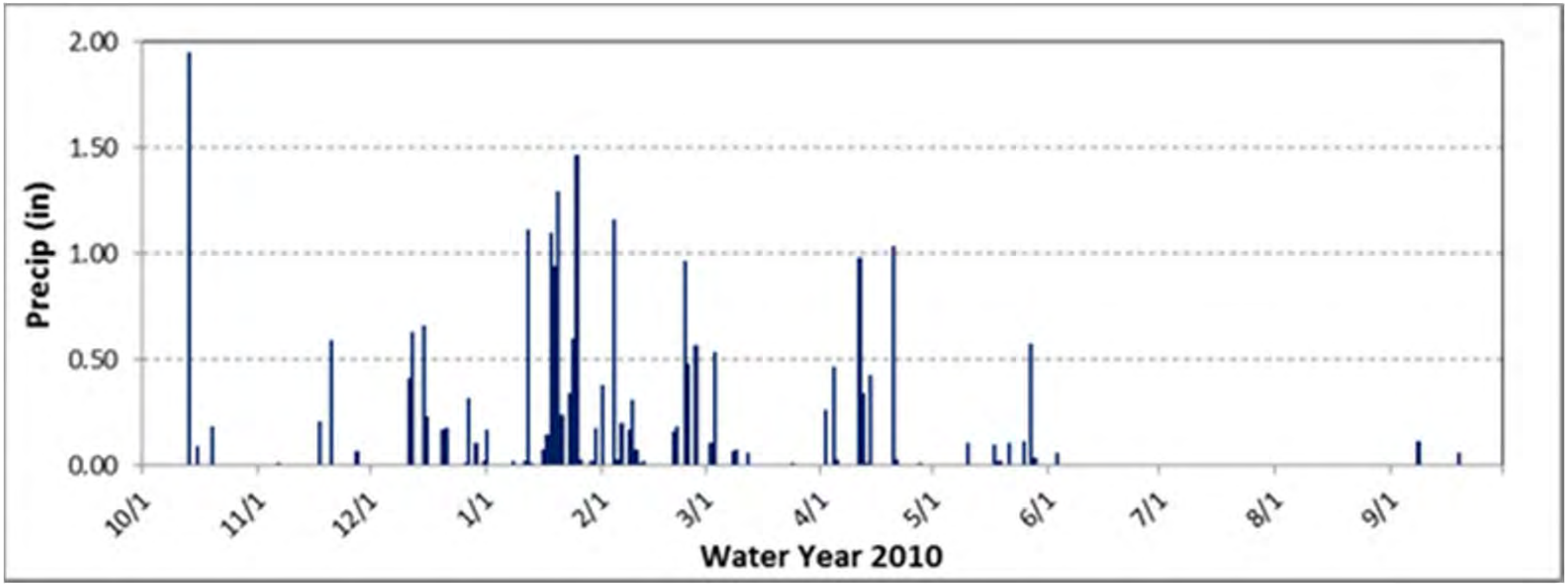

Figure V-23. Precipitation at the Red Bluff Airport for Water Year 2010.