APPENDIX E

Land Cover Type Report/
Vernal Pool Watershed Mapping

APPENDIX E1

Land Cover Type Report

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Land Cover Type Report

1 INTRODUCTION

The purpose of developing a land cover type map of the Plan Area is to provide current land cover type baseline data for use in the development of the South Sacramento Habitat Conservation Plan (SSHCP) and of other necessary permits (e.g., Clean Water Act Section 404). Classification of habitats in the Plan Area, particularly aquatic resources, is necessary to ensure protection of a vast array of aquatic, wetland, and riparian land cover types. This effort to map land cover types should not be confused with General Plan Land Use designations that are used by local governmental jurisdictions to define what type of uses are allowed to occur on any given parcel. Land cover types are defined as the dominant feature of the land surface discernible from aerial photographs and defined by vegetation, water, or human uses.

2 METHODS

The original delineation of vernal pool and swale land cover types are based on the interpretation of black and white aerial imagery dated March 2001. All vernal pool or swale cover types, approximately 5,000 acres, were mapped at a scale of 1 inch = 200 feet (1:2,400). The original delineation of all other land cover types are based on the interpretation of color aerial imagery dated November 2002. A total of approximately 336,000 acres were mapped at a scale of 1 inch = 400 feet (1:4,800). As SSHCP planning progressed, approximately 3,000 additional acres were mapped and included in the Plan Area. Changes to habitat that occurred after the initial mapping (e.g. changing from a natural habitat to an urban land use) are reflected on the land cover type map as of 2014.

Twenty-five (25) different land cover types are displayed on the land cover types map. Seventeen land cover types are classified as SSHCP "natural land covers," which includes native and naturalized environments and agricultural lands that have habitat value for SSHCP Covered Species. Eight SSHCP land cover types are classified as "developed/non-habitat land covers" and provide minimal habitat value for native species, including the SSHCP Covered Species These 25 land cover types reflect the most comprehensive coverage of land cover types discernable at the chosen mapping scales. Land cover type categories are roughly based on the habitat types described in the California Department of Fish and Game's (CDFG) List of California Natural Communities and were modified to meet the needs of Sacramento County for inclusion in the SSHCP process.

Initial field surveys were conducted on approximately 4,000 acres of selected, County-owned parcels located throughout the Plan Area to provide recognition of signatures for aerial interpretation of the remaining portions of the Plan Area. These areas were selected by the County primarily for accessibility reasons. Areas used in field verification included a parcel

along the Cosumnes River in Rancho Murieta, Gene Andal Park and Wetlands Preserve, the Sacramento Regional County Sanitation District (SRCSD) Bufferlands, the Nicholas Ranch and Valensin Ranch parcels of the Cosumnes River Preserve, and Deer Creek Hills. Problematic aerial signatures that were not contained in the field survey areas or easily identified from aerial photographs were spot-checked from public roads to the degree feasible.

Vernal Pool and Swale Mapping Conducted by the Geographical Information Center

Initial mapping was completed in two phases: Phase I included all maps contained in the Urban Development Area (UDA) and Phase II included all of the remaining non-UDA maps located in the south Sacramento County area. The black and white ortho-photographic images were brought into ArcView 3.3 Geographic Information System (GIS) software and the vernal-wetland signatures were heads-up digitized into polygons which were recorded as a shape file. Vernal pool/wetlands were identified primarily by visual signatures, including contrasting shades (color) and to some degree texture and shape. Geographic Information Center (GIC) cartographers then vectorized, and attributed these maps to create a seamless GIS layer for both Phase I and Phase II of the Plan Area.

All Other Land Cover Type Mapping Conducted by EDAW

Initial mapping was completed in two phases: Phase I included all maps contained in the UDA and Phase II included all of the remaining non-UDA maps located in the south Sacramento County area. The entire Plan Area was hand-mapped by qualified EDAW botanists onto color print-outs of the aerial photographs based on interpretations using habitat signatures verified in the field. EDAW GIS specialists and Geographic Computer Technologies (GCT) scanned, vectorized, and attributed these maps to create a seamless GIS layer for both Phase I and Phase II of the Plan Area.

Land cover types mapped by EDAW that were identified in the field, but that were not discernable at the mapping scale of 1:4,800, were not included in the resulting map layer. If features were present during 2004 field surveys (e.g., new development, additional restoration activities) that were not yet present when the 2002 aerial photographs were flown, these features were omitted from the initial mapping effort. Similarly, care was taken by EDAW botanists and GIS specialists when mapping portions of the Plan Area familiar to the botanists to delineate only the aerial signatures readily identifiable at the 1:4,800 scale to reduce potential sources of bias.

Integration of EDAW and GIC Mapping Efforts

Upon completion of both mapping efforts by EDAW and GIC, Sacramento County staff integrated the GIC vernal pool and swale shape file into the broader EDAW land cover type shape file. This was done by first clipping the EDAW land cover types shape file with the GIC

vernal pool and swale shape file. The GIC vernal pool and swale file and the EDAW land cover type map were then merged to create the final land cover types map.

Sacramento County staff then reviewed the final land cover type map for shape file registration errors and inaccurately labeled land cover types and modified the map where needed. This included identifying intersections between land cover type features that should not intersect, such as vernal pools intersecting open water features. Intersections where then reviewed against aerial images and corrected where necessary.

SSHCP Expansion Area Mapping Conducted by PMC

The initial SSHCP study area excluded lands west of Interstate 5. These lands, approximately 33,000-acres, were later included within the final Plan Area. Experienced PMC GIS specialist heads-up digitized 2009 aerial imagery creating habitat features into polygons. The mapping was conducted utilizing ArcView 9.3 at a maximum scale of 1:4,800 (1 inch = 400 feet). This area was then added to land cover type mapping prepared for the Plan Area to create a seamless land cover type layer for the entire Plan Area.

Periodic Map Updates and Refinement

Overtime, the SSHCP land cover type mapping required periodic updates to reflect changes to the environment (e.g., development, conversion of agricultural lands, and habitat restoration) as well as further refinement to better inform the SSHCP planning process (e.g., more precise mapping of agricultural residential areas).

- **Vernal swale** – initial mapping efforts included two categories of swales – vernal swales that provide habitat for listed vernal pool invertebrate species and swales that do not provide habitat for listed vernal pool invertebrate species. In consultation with the Wildlife Agencies, it was determined that it was not possible to differentiate between these two cover types using aerial photography. All features that were classified as vernal swale were re-classified as swale.
- **Vernal impoundment** – initial mapping efforts included a vernal impoundment land cover-type classification. In consultation with the Wildlife Agencies, it was determined that vernal impoundments would be re-classified to vernal pool, open water or seasonal wetland land cover types. Each feature that was classified as vernal impoundment was checked against four sets of aerial photos flown during the summer months (2003, 2005, 2009 & 2010). If water or vegetation was present in at least three of the four aerial photos the feature was re-classified as open water or seasonal wetland. The open water classification was applied when at least half of the feature was inundated. When little or no water was present but vegetation was present indicating that the feature did not completely dry down,

then the feature was re-classified as seasonal wetland. If water or vegetation was not present in at least three of the four aerial photos then the feature was re-classified as vernal pool with a few exceptions. Those exceptions are if woody vegetation was present around the perimeter or within the feature, then the feature was re-classified to open water or seasonal wetland. If a feature was surrounded by an agricultural cover type or within topography dominated by mine tailings the feature was re-classified as open water or seasonal wetland. Features completely surrounded by non-habitat cover types were re-classified to the surrounding non-habitat cover type classification.

- **Seasonal impoundments** –The same methodology used to reclassify vernal impoundments was used to reclassify seasonal impoundments.
- **Wetland Restoration** – initial mapping efforts included a land cover type classification that attempted to identify restored or created wetlands. This classification was abandoned as it was difficult to accurately identify all restored or created wetlands using aerial photography. All features with the wetland restoration land cover type classification were re-classified to an appropriate wetland land cover type classification. The SSHCP land cover type database does include coding that identifies if a vernal pool feature is suspected of being created or restored.
- **Woodland Restoration –** initial mapping efforts included a land cover type classification that attempted to identify restored or created riparian woodland areas. This classification was abandoned as it was difficult to accurately identify all restored or created riparian woodland using aerial photography. All features with the woodland restoration land cover type classification were re-classified to either mixed riparian scrub or mixed riparian woodland.
- **Agricultural-residential mapping** – the initial mapping under represented the acres of upland habitats (e.g., valley grassland) in areas characterized by small parcels (less than 5 acres in size); therefore, it was determined that further refinement of the land cover type mapping was necessary to assess effects to covered species habitat in these areas. Specifically at issue is that many backyard areas within Agricultural-residential developments were mapped as grassland and a number of larger fields were mapped as low density development. Areas with agricultural-residential development were reviewed against aerial photos and where appropriate were re-classified to reflect the correct cover type. All parcels less than 5-acres were reviewed against March 2009 aerial imagery and the land cover type mapping was adjusted were upland habitats represented more than 0.5 acres.
- **Streams/creeks and swales** – the initial mapping relied on aerial interpretation of streams. In February 2008, the United States Army Corps of Engineers (USACE) Research and Development Center conducted an "Assessment of the Riparian Integrity

for the South Sacramento Habitat Conservation Plan." The draft document reported on the hydrology, water quality, and habitat integrity of stream reaches inside the SSHCP Urban Development Area (UDA). The assessment also produced a GIS data set of the stream reaches inside the UDA. This data is a reliable representation of streams within the UDA and more accurate than the original aerial interpretation. The land cover type map was then reviewed against the USACE derived data to ensure the land cover type map was consistent with the USACE derived data. Features mapped as streams/creeks where the USACE did not identify a stream were reclassified as a swale or other land cover type based on March 2009 imagery.

- **Streams/creek vernal pool invertebrate habitat (VPIH)** – The stream/creek VPIH land cover type was created in late 2012 to distinguish intermittent drainages that provide suitable habitat for vernal pool crustaceans from those that do not. The stream/creek (VPIH) land cover type is vegetated with valley grassland plant species and conveys water after rain events. Unlike the Swale land cover type, the Stream/Creek (VPIH) land cover is less likely to support vegetation characteristic of vernal pools, and the SSHCP does not consider the Stream/Creek (VPIH) land cover habitat for vernal pool plant Covered Species. However, the Stream/Creek (VPIH) land cover is known to provide movement corridors and may provide habitat for vernal pool crustaceans.
- **Eucalyptus woodland and valley oak riparian woodland** – These two land cover type classifications were included as part of the initial mapping efforts, but are no longer used by the SSHCP. The eucalyptus woodland classification was abandoned after a large grove was removed leaving only small scattered clusters of eucalyptus trees that are difficult to discern form aerial photos. The valley oak riparian woodland classification was abandoned after it was determined that features mapped valley oak riparian woodland were indistinguishable from the mixed riparian woodland land cover type classification.

Minimum Mapping Units and Linear Features

The minimum mapping units listed in Table E-1 reflect the level of accuracy at which particular land cover types could be identified and delineated from aerial photographs and digitized using ArcMap. Minimum mapping units were calculated based on an average of the five smallest complete polygons for each cover type. Linear features (i.e., streams and creeks, aqueducts, and roads) do not have associated minimum mapping units. Linear features with discernable widths were mapped as polygons wherever possible; however, stream features for which widths were indiscernible at the mapping scale of 1:4,800 were digitized as line features and subsequently buffered. The average width of small streams and drainage ditches during the field verification surveys was identified as 6 feet with the concurrence of Sacramento County staff. Therefore, a 3-

foot buffer was added to each side of these line features and the resulting polygons were then merged into the land cover type layer using batch erase and union functions.

Table E-1
Minimum Mapping Unit for SSHCP Land Cover Type Map

Land Cover Type	Minimum Mapping Unit (acres)
Aqueducts	3.8
Blue Oak Savanna	3.8
Blue Oak Woodland	2.0
Cropland	2.5
Disturbed	0.9
Freshwater Marsh	0.01
High Density Development	0.4
Irrigated Pasture-Grassland	0.7
Low Density Development	0.08
Major Road	1.7
Mine Tailing Riparian Woodland	0.1
Mine Tailings	0.4
Mixed Riparian Scrub	0.1
Mixed Riparian Woodland	0.04
Open Water	0.1
Orchards	0.5
Recreation/Landscaped	0.2
Seasonal Wetlands	0.1
Streams/Creeks	0.02
Streams/Creeks (VPIH)	0.02
Swale	0.003
Valley Grassland	0.01
Vernal Pool	0.001
Swale	0.001
Vineyards	1.2

3 LAND COVER MAPPING RESULTS

Each of the 25 land cover types is described below. Total acreages and percentages of the total Plan Area covered by each land cover type are listed in Table E-2.

Table E-2
Acreages and Percentages of Land Cover Types Within the Plan Area

SSHCP Land Cover Type	Area (Acres) in Plan Area	Percentage of Total Plan Area
Natural Land Cover Category (have habitat value)		
Aquatic Land Cover Types		
Vernal Pool	4,536	1.4
Swale	1,252	0.4
Seasonal Wetland	2,600	0.8
Freshwater Marsh	2,954	0.9
Mixed Riparian Woodland	5,856	0.2
Mixed Riparian Scrub	1,454	0.5
Mine Tailings Riparian Woodland	641	0.2
Stream/Creek (Vernal Pool Invertebrate Habitat)*	73	0.02
Stream/Creek	2,778	0.9
Open Water	2,344	0.7
Terrestrial Land Cover Types		
Valley Grassland	135,152	42.5
Blue Oak Savanna	5,637	1.8
Blue Oak Woodland	9,132	2.9
Cropland	51,829	16.3
Orchard	3,907	1.2
Vineyard	26,460	8.3
Irrigated Pasture	15,991	5.0
Developed / Non-Habitat Land Cover Category		
Aqueduct	264	0.1
Disturbed	6,288	2.0
High-Density Development	13,073	4.1
Low-Density Development	18,608	5.9
Major Roads	2,764	0.9
Mine Tailings	1,098	0.3
Recreation/Landscaped	2,180	0.7
Not Mapped	784	0.2
Total	**317,655**	

Land Cover Type Descriptions

Vernal Pool Land Cover

Vernal pools are seasonal ephemeral wetlands that fill and dry each year. In Central Valley annual grasslands, they form in shallow depressions that are underlain with a soil or a soil layer impermeable to water. In California's Mediterranean climate (rainy winter months followed by a hot, dry season), vernal pool soils typically become wetted in November. Water collects in the

depressions and stands during late winter and early spring, then recedes as temperatures rise and rainfall diminishes. The soil, however, remains moist through April and May, then it desiccates and stays dry until the cycle begins again. The specific regime of vernal pool inundation—too short and unpredictable to support aquatic species but long enough to eliminate upland species—is what characterizes vernal pools as ephemeral wetlands and differentiates them from other aquatic ecosystems such as alkali meadows and seasonally flooded emergent bulrush or tule marshes (Solomeshch et al. 2007).

Vernal pools support unique assemblages of highly specialized plants and animals that are adapted to the annual cycle of winter inundation and summer drought. Consequently, vernal pools are one of the few habitats in California still dominated by native plant and animal species (Rains et al. 2008). Many vernal pool plant genera and species are endemic to California, and their presence indicates the specific hydrology and water chemistry of the vernal pool. Vernal pools were once a very common element of the Central Valley landscape, but only a small portion has not been converted to agricultural and urban developments; consequently, many vernal pool taxa are now rare and endangered.

Vernal pools provide habitat for rare and endangered animals such as vernal pool tadpole shrimp (*Lepidurus packardi*), vernal pool fairy shrimp (*Branchinecta lynchi*), conservancy fairy shrimp, Ricksecker's water scavenger beetle (*Hydrochara richseckeri*), and several amphibians (e.g., western spadefoot toad (*Spea hammondii*), California tiger salamander (*Ambystoma californiense*)), and vernal pools support a number of migratory birds in the winter (Alexander 1976; Helm 1998; Silveira 1998; Solomeshch et al. 2007; USFWS 2004b). A specific group of plant taxa occupies vernal pools, most of which are annuals capable of slow underwater growth in winter and rapid development and reproduction in spring after the water is gone but before soils dry. Plant species are not distributed evenly through the pools, but grow in concentric zones that reflect different lengths of inundation as the pool dries (Solomeshch et al. 2007). As discussed in Chapter 2, Central Valley vernal pools occur on many geological surfaces, but in all cases, vernal pools are underlain by a low-permeability layer such as claypans, hardpans (e.g., silica-cemented duripans), mudflows, or bedrock (Rains et al. 2008). Because vernal pools are associated with specific landforms, geologic formations, and soils (Smith and Verrill 1998), vernal pools tend to be clustered at the landscape scale, forming vernal pool complexes (Rains et al. 2006; USFWS 2006). Based on a vernal pool's landform, underlying geology, nature of the soil's water-restricting layer, frequency of ponding, and ponding duration, Sawyer and Keeler-Wolf (1995) have identified five vernal pool types in Northern California. As discussed in Section 2.3, most vernal pools in the Plan Area are broadly classified as Northern Hardpan vernal pools and Northern Volcanic Mudflow vernal pools (Jones and Stokes 1990). In addition, a less specialized vernal pool type with generally lower species richness is found on Drainageway formation soils in the Plan Area.

Northern Volcanic Mudflow vernal pools occur on ancient mudflows called lahars (see Section 2.3). These pools are small, form in irregular depressions in gently sloping surfaces, and are often rocky and shallow. Water chemistry is mixo-saline, fresh (Sawyer and Keeler-Wolf 1995). In the Plan Area, Northern Volcanic Mudflow vernal pools are found on the Mehrten and Valley Springs formation in rocky soil series and complexes such as Hadselville-Pentz, Red Bluff-Redding, Corning-Redding, Amador-Gillender, and Pardee-Rancho Seco (Jones and Stokes 1990). Mudflow pools in the Plan Area are hydrologically complex; in some areas, vernal pools are in complex reticulated drainage networks with a high density of interconnected pools, swales, and ephemeral drainages (Jones and Stokes 1990). The seasonal hydrology of Northern Volcanic Mudflow vernal pools includes a perched water table (see Section 3.2.3), but pool hydrology is relatively "flashy" (i.e., pools fill and drain relatively rapidly). Northern Volcanic Mudflow vernal pools contain relatively rich flora that includes several vernal pool obligate species. The species richness and ecological complexity of Northern Mudflow pools in the Plan Area exceed that of the Young-Terrace Northern Hardpan pools and the Drainageway vernal pools in the Plan Area. Possible explanations of the rich (less specialized) flora of Northern Mudflow pools include the recent origin of the pools and their quickly changing or "flashy" hydrology. Mudflow pools fill and drain rapidly, and may be less stressful to most plant life than pools that remain flooded for extended periods, such as the Old-Terrace Northern Hardpan vernal pools (Jokerst 1990; Jones and Stokes 1990).

Northern Hardpan vernal pools form on alluvial terraces in old, acidic, nutrient-depleted soils with iron-silicate cemented soil layer. These soils often exhibit well-developed mound-intermound topography to form aggregations of pools and "mima mounds." Water chemistry is mixo-saline fresh (Sawyer and Keeler-Wolf 1995; USFWS 2005). Northern Hardpan vernal pools typically have a conductivity of 40 to 70 mhos per 1 centimeter, which is similar to an oligotrophic high Sierran lake (Keeley and Zedler 1998; Williamson et al. 2005). Water in hardpan vernal pools is not only low in dissolved salts, but also in dissolved nitrogen. For example, Rains et al. (2006) reported that, during the growing season, nitrate and phosphate concentrations were below detection limits (i.e., 0.006 milligrams per liter (mg/L) and 0.03 mg/L, respectively), and the amount of ammonium was negligible (0.1 mg/L). Within the Plan Area, Northern Hardpan vernal pools occur on the low (younger) terrace Riverbank Formation soil series (e.g., San Joaquin, Galt, Madera, Tehama), as well as on the high (older) terrace Laguna Formation and Arroyo Seco gravels (e.g. Corning, Redding, Red Bluff, Mokelumne soil series). Vernal pools occur extensively on both landforms types (Jones and Stokes 1990).

The Plan Area's Low-Terrace Northern Hardpan vernal pools (e.g., on San Joaquin soils) are of recent geologic origin, which may explain their relatively unspecialized flora that often includes non-native plants, low species richness, scarcity of vernal pool obligates, and low numbers of special-status plants. Most young terrace sites in the Plan Area have been plowed, graded, or

heavily grazed because of their arable soils and proximity to reliable water; this may also account for their less specialized flora. Low-Terrace Northern Hardpan vernal pools also serve an important function as habitat for shorebirds, waterfowl, and raptors because of their location in the central portion of the valley along the Sacramento River (Jones and Stokes 1990; Silveira 1998).

High-Terrace Northern Hardpan vernal pools (e.g., on Corning and Redding soil series) are the most complex type of vernal pool in the Plan Area because of their rich and varied flora, presence of special-status plant and invertebrate species, and complex hydrology, and because they often occur in areas with complex, highly convoluted interspersions of several soil types. Soils on high-terrace landform sites varies over short distances such that sites in proximity to each other may have entirely different restricting layer types, depth, and vernal pool plant community. High-Terrace Northern Hardpan vernal pools are floristically rich and dominated by vernal pool obligate plant species (true "specialists"), and typically support special-status species. The tremendous age and geographic location of High-Terrace Northern Hardpan pools may account for their rich and highly specialized flora (Jones and Stokes 1990). Little of the high-terrace landform has been farmed in the Plan Area because irrigation water is lacking and many sites are not arable. Some high-terrace vernal pool areas were dryland farmed in the past with wheat or oats; this type of farming appears to have had little effect on high-terrace vernal pools, while on other formations, this disrupted vernal pool surface hydrology. Consequently, High-Terrace Northern Hardpan vernal pools are relatively abundant in the Plan Area (Jones and Stokes 1990).

Drainageway vernal pools are located on no particular Plan Area geologic formation, but formed on recent alluvial deposits adjacent to the incised channels of active watercourses. Consequently, Drainageway vernal pools are interspersed throughout the other three vernal pool types present in the Plan Area. Drainageway vernal pools fill and drain rapidly, and may depend on overland runoff and direct precipitation to maintain their hydrology relative to the other vernal pool types (Jones and Stokes 1990). Additionally, the basins of Drainageway vernal pools are often shallow and susceptible to evaporation, or slightly sloped, which encourages drainage. Drainageway vernal pools have an unspecialized flora relative to the other three vernal pool types in the Plan Area (Jones and Stokes 1990).

The four types of vernal pools present in the Plan Area can be further classified by the presence or absence of certain dominant or less abundant vernal pool plant species (Sawyer et al. 2009). Vernal pool community structure (i.e., the type, number, and relative abundance of species) is largely determined by the pool's physical makeup (e.g., size, depth, substrate, water chemistry) and the pool's hydrology; different patterns of species dominance and the presence or absence of certain species can be indicative of physical and hydrology differences among vernal pools (Holland and Jain 1988). Vernal pools in the Plan Area exhibit a great variety of size, depth, soil, and water chemistry. Key physical parameters may include pool drainage area, slope, soil type, soil structure and depth, pool size and depth, timing of the pool hydrologic cycle, and pool

interconnectivity. In particular, several SSHCP vernal pool Covered Species require large, deep pools that are long lasting to successfully complete their life cycles, including Boggs Lake hedge-hyssop (*Gratiola heterosepala*), Sacramento Orcutt grass (*Orcuttia viscida*), slender Orcutt grass (*Orcuttia tenuis*), vernal pool tadpole shrimp, California tiger salamander, and western spadefoot toad. Other vernal pool Covered Species are found in small to medium-sized "flashy" pools that dry out relatively quickly, but may inundate and dry out several times during the wet season, including Ahart's dwarf rush (*Juncus leiospemus* var. *ahartii*), dwarf downingia (*Downingia pusilla*), and pincushion navarretia (*Navarretia myersii*). For some plants in the latter category, the edges of larger vernal pools may provide conditions equivalent to the smaller, flashy pools. Other Covered Species associated with vernal pools include legenere (*Legenere limosa*), vernal pool fairy shrimp, Ricksecker's water scavenger beetle, most of the bird Covered Species (mostly as foraging habitat), American badger (*Taxidea taxus*), and western red bat (*Lasiurus blossevillii*) (see Table 3-2).

Preserving the full range of physical and hydrologic conditions found in Plan Area vernal pools is necessary to ensure that all vernal pool Covered Species and representative examples of the different Plan Area vernal pool types and existing variation in vernal pool plant and animal associations are considered and protected (Jones and Stokes 1990). By protecting the range of diversity in vernal pool types, the SSHCP can ensure that the entire range of known and unknown ecological and biological values is represented in a Preserve System, and that the intrinsic values of this facet of the region's natural heritage are considered. Preserving the range of plant and animal associations also provides natural laboratories to study the factors influencing the presence or absence of species, migration, and establishment of species, patterns of species dominance, and other phenomena (Jones and Stokes 1990).

Plan Area vernal pools occur in complexes of pools interconnected by intermittent surface swales and by the seasonal perched aquifer that forms between the soil surface and the sub-surface restricting layer. Consequently, the Vernal Pool land covers in the Plan Area cannot be described or analyzed in isolation of their ecologically and hydrologically connected SSHCP land covers of Swale, Valley Grassland, and Stream/Creek (Vernal Pool Invertebrate Habitat (VPIH)). Therefore, in addition to discussing the Vernal Pool land cover individually in SSHCP Chapters 3, 6, and 7, the Plan Permittees also define and discuss an SSHCP Vernal Pool Ecosystem (see Section 3.2.3).

Seasonal Wetland Land Cover

Seasonal Wetland is an ephemeral wetland that ponds for extended periods during a portion of the year, generally the rainy winter season, then dries relatively slowly, typically in the summer and early fall. Seasonal Wetland tends to occur as an isolated wetland within moderate to large depressional features in Valley Grassland; along streams, creeks, and rivers; and along the edges

of open water. Seasonal Wetland is often characterized by herbaceous annual and perennial species such as curly dock (*Rumex crispus*) and bulrush (*Scirpus* spp.).

Seasonal Wetland provides habitat for some Covered Species (Table 3-2). The SSHCP does not consider Seasonal Wetland to be suitable habitat for vernal pool crustaceans.

Covered Species associated with the Seasonal Wetland land cover include Bogg's Lake hedge-hyssop, legenere, Sanford's arrowhead (*Sagittaria sanfordi*), California tiger salamander, western spadefoot, giant gartersnake (*Thamnophis gigas*), all of the bird Covered Species (mostly as foraging habitat) except Cooper's hawk (*Accipiter cooperii*), American badger, and western red bat.

Swale Land Cover

The movement of surface water between vernal pools can occur in a network of narrow and intermittent surface "swales" (Solomeshch et al. 2007). Swales are shallow seasonal drainages found in flat to gently rolling Valley Grassland in association with vernal pool complexes, on soils with an impermeable layer (see Section 2.3). Swales convey runoff as shallow, gently sloping ephemeral wetlands during, and for short periods after, winter rainstorms. Soils within the Swale land cover type may remain saturated during the winter and early spring, but dry by summer. Swales are associated with vernal pools and provide intermittent conduits between vernal pools for movement of surface water and propagules of vernal pool plant and animal Covered Species (seeds, cysts, eggs, and spores), and movement of adult California tiger salamanders and western spadefoots. Swales support several native plant species commonly found in vernal pools. Swales also often include smaller shallow depressional features that may pond during the rainy season to provide suitable reproductive habitat for some vernal pool Covered Species, and may be considered vernal pools. Generally, the Swale land cover provides suitable habitat for portions or all of the life cycle of many of the Covered Species that occur in the Vernal Pool land cover types, including Ahart's dwarf rush, dwarf downingia, pincushion navarretia, mid-valley fairy shrimp (*Branchinecta mesovallensis*), vernal pool fairy shrimp, vernal pool tadpole shrimp, Ricksecker's water scavenger beetle, and western spadefoot. In addition, all of the bird Covered Species (except Cooper's hawk and greater sandhill crane (*Grus canadensis tabida*)) use Swale land cover (primarily as foraging habitat), along with American badger and western red bat (see Table 3-2).

The Swale land cover type cannot be adequately described or analyzed separately or in isolation of other ecologically and hydrologically connected SSHCP land covers (i.e., Vernal Pool, Valley Grassland, and Stream/Creek VPIH). Therefore, in addition to discussing the Swale land cover individually in SSHCP Chapters 3, 6, and 7, the Plan Permittees also define, discuss, and analyze a combined SSHCP Vernal Pool Ecosystem (see Section 3.2.3 below).

Stream/Creek Vernal Pool Invertebrate Habitat Land Cover

As discussed below, the larger SSHCP Stream/Creek land cover type includes intermittent and perennial linear water features such as rivers, streams, creeks, and drainages. The SSHCP Stream/Creek VPIH land cover type is typically an intermittent drainage that is vegetated with Valley Grassland plant species and conveys water after rain events (is ephemeral). Unlike the Swale land cover type, the Stream/Creek (VPIH) land cover is less likely to support vegetation characteristic of vernal pools, and the SSHCP does not consider the Stream/Creek (VPIH) land cover habitat for vernal pool plant Covered Species. However, the Stream/Creek (VPIH) land cover is known to provide movement corridors, and may provide suitable habitat for vernal pool crustaceans, including mid-valley fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp, within depressional features of the drainage that pond water between storm events. Western burrowing owl (*Athene cunicularia hypugea*) may also use Stream/Creek (VPIH) habitat. See Figure 3-2 for locations of Stream/Creek (VPIH) habitat.

The Stream/Creek (VPIH) land cover cannot be adequately described or analyzed separately or in isolation of other ecologically and hydrologically connected SSHCP land covers (i.e., the Vernal Pool, Valley Grassland, and Swale land covers). Therefore, in addition to discussing Stream/Creek (VPIH) individually in SSHCP Chapters 3, 6, and 7, the Plan Permittees also define, discuss, and analyze a combined SSHCP Vernal Pool Ecosystem (see Section 3.2.3).

Freshwater Marsh Land Cover

Most of California's freshwater marshes occur in the Sacramento Valley and San Joaquin Delta regions. The majority of Freshwater Marsh in the Plan Area occurs along the perennial Cosumnes River and Deer Creek, and along the margins of streams and open water in the Plan Area. Freshwater Marsh is typically dominated by perennial herbaceous plant species such as cattails (*Typha* spp.), tules (*Scirpus* spp.), and other emergent plant species, and is generally found along the edges of aquatic habitats such as ponds, lakes, and rivers. It is important habitat for western pond turtle (*Actinemys marmorata*), giant gartersnake, northern harrier (*Circus cyaneus*), tricolored blackbird (*Agelaius tricolor*), and western red bat (Table 3-2).

Open Water Land Cover

Open Water includes perennial or features, such as natural or built ponds, lakes, and reservoirs. Open Water may contain no vegetation, or non-rooted aquatic vegetation, such as algae, floating pondweeds, and other plants. Along shorelines, rooted, emergent vegetation may occur, forming Freshwater Marsh. Like Freshwater Marsh, Open Water habitat is used by numerous bird, mammal, amphibian, and reptile species, including several Covered Species, such as western

pond turtle, giant gartersnake, tricolored blackbird, and western red bat. The marshy shorelines may be used by tricolored blackbird for nesting colonies (Table 3-2).

The Open Water land cover type is found throughout the SSHCP area. Open Water features are largely unnamed with the exception of Blodgett Reservoir inside the Urban Development Area (UDA) and Rancho Seco Lake outside the UDA.

Stream/Creek Land Cover

Outside of the UDA, the Stream/Creek land cover type includes intermittent and perennial linear water features such as rivers, streams, creeks, drainages, and roadside and irrigation ditches. Within the UDA, this land cover type includes streams identified by the U.S. Army Corps of Engineers. A separate category was created for aqueducts throughout the Plan Area.

The SSHCP Stream/Creek land cover includes rivers such as the Cosumnes River, streams such as Laguna Creek, and smaller intermittent or perennial creeks. The Stream/Creek land cover type was mapped from aerial photographs. Where a river or stream channel was not discernable because of dense over story cover, the centerline of the channel has been approximated and buffered by a width of 6 feet. Polygons of the Stream and Creek land cover occur in Valley Grassland, Blue Oak Woodland, Blue Oak Savanna, Agriculture, and Developed land cover types.

Covered species associated with the Stream/Creek land cover type include Sanford's arrowhead, giant gartersnake, western pond turtle, and western red bat (Table 3-2).

Mixed Riparian Woodland Land Cover

Riparian land covers are associated with Plan Area streams and creeks and typically occur in the zone between the active stream channel and adjacent upland land covers. While "riparian" has various definitions, the SSHCP uses the National Research Council's 2002 definition: "Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect water bodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas in the Plan Area are adjacent to perennial, intermittent, and ephemeral streams, lakes."

Riparian ecosystems are highly dependent on landscape setting and numerous physical and biotic interactions. Riparian ecosystems provide essential foraging, shelter, and breeding habitat for several of the Covered Species and other native plant and animal species, including both resident and migratory species.

The Mixed Riparian Woodland land cover type is distinguishable by an open canopy layer dominated by tall Fremont cottonwood trees. Beneath this open layer, a moderately dense mid-canopy layer is composed of tree species such as Oregon ash (*Fraxinus latifolia*), Goodding's willow (*Salix gooddingii*), California black walnut (*Juglans californica* var. *hindsii*), valley oak (*Quercus lobata*), and box elder (*Acer negundo*). In some areas, a subcanopy of dense Riparian Scrub dominated by willow species, including arroyo willow and sandbar willow, is present. A discontinuous shrub layer is also present, particularly along the northern boundary of the Plan Area, and includes species such as blue elderberry, Himalayan blackberry, coyote-brush, wild rose, and wild grape. The understory is sparsely to densely vegetated with herbaceous species. Invasive weeds that have colonized portions of the Mixed Riparian Woodland in the Plan Area include tamarisk (*Tamarix* spp.) and giant European reed (*Arundo donax*).

Included in the Mixed Riparian Woodland Land Cover Type are valley oak riparian woodlands. Although they are not a separate land cover type, owing to an inability to distinguish them from other riparian communities, valley oak riparian woodlands are notable as they were once a dominate community along waterways in the Plan Area. Valley oak riparian woodland intergrades with the Valley Grassland land cover type and wooded borders along streams and agricultural fields in the Plan Area. Tree associates in the Plan Area include California sycamore (*Platanus racemosa*), California black walnut, interior live oak (*Quercus wislizeni*), box elder, and blue oak. The shrub understory consists of western poison-oak, blue elderberry, California wild grape, toyon (*Heteromeles arbutifolia*), California coffeeberry, and California blackberry (*Rubus ursinus*). Various sorts of wild oats (*Avena* spp.), brome (*Bromus* spp.), barley (*Hordeum* spp.), ryegrass (*Lolium* spp.), and needlegrass (*Nassella* spp.) dominate the ground cover.

Covered species associated with the Mixed Riparian Woodland land cover type include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, Swainson's hawk, white-tailed kite, and western red bat (Table 3-2).

Mixed Riparian Scrub Land Cover

Mixed Riparian Scrub land cover type is interspersed with Mixed Riparian Woodland in the floodplains of waterways throughout Sacramento County. In the Plan Area, this land cover type consists of an open to dense shrubby thicket dominated by a mixture of sandbar willow (*Salix exigua*), arroyo willow (*S. lasiolepis*), red willow (*S. laevigata*), and immature stands of mixed riparian woodland tree species (see description below). This plant community can also be a subcanopy community in Mixed Riparian Woodland. Though dense stands of Riparian Scrub in the Plan Area typically lack an understory, some of the more open canopy mixed Riparian Scrub stands do support an understory of native and non-native species, including wild rose (*Rosa californica*), wild grape (*Vitis californica*), perennial pepperweed (*Lepidium latifolium*), Himalayan blackberry (*Rubus discolor*), curly dock (*Rumex crispus*), and various non-native grasses.

Covered species associated with the Mixed Riparian Scrub land cover type include valley elderberry longhorn beetle, giant gartersnake, western pond turtle, Cooper's hawk, loggerhead shrike, Swainson's hawk, white-tailed kite, and western red bat (Table 3-2).

Mine Tailing Riparian Woodland Land Cover

The Mine Tailings Riparian Woodland land cover type is distributed among older mine tailings. This land cover type contains species commonly found in Riparian Woodlands and Riparian Scrub habitats, such as Fremont cottonwood (*Populus fremontii*), blue elderberry (*Sambucus mexicana*), willow (*Salix* spp.), and coyote-brush (*Baccharis pilularis*). In the Plan Area, this land cover type can also intergrade with mixed riparian forest along bodies of water.

Covered species associated with the Mine Tailing Riparian Woodland land cover type include valley elderberry longhorn beetle, western pond turtle, Cooper's hawk, loggerhead shrike, white-tailed kite, and western red bat (Table 3-2).

Valley Grassland Land Cover

Valley Grassland is by far the most common single land cover in the Plan Area. Including non-habitat land covers, it accounts for about 43% of the land covers in the Plan Area. Valley Grassland, being so widespread throughout the Plan Area, is essential for both the long-term survival of many of the Covered Species and for conserving ecological functions of other land cover types within the Plan Area.

Valley Grassland in the SSHCP Plan Area is an annual herbaceous plant community now characterized mostly by naturalized annual grasses. Generally, its composition in the Plan Area varies with geographic, and land use factors, such as rainfall, temperature, elevation, slope, aspect, grazing, and other herbivory (e.g., livestock, wildlife, rodent, songbird, and insect use), and fire frequency and duration. In the Plan Area, Valley Grassland is dominated by naturalized herbaceous annual forbs, and patches with relatively high proportions of native grasses and forbs.

Valley Grassland in the Plan Area is associated with several natural communities, including vernal pools, and occurs as an understory within Valley Oak Riparian Woodland, Blue Oak Woodland, and Blue Oak Savanna. Valley Grassland also may occur as a co-dominant with perennial grasses within some of the areas mapped as Valley Grassland in the Plan Area. For example, purple needlegrass (*Stipa pulchra*) can be found as the dominant grass (i.e., comprising greater than 20% cover) in small patches along ridgetops of low-lying hills in the eastern portion of Sacramento County.

Valley Grassland supports numerous wildlife species, including several Covered Species. Covered Species associated with Valley Grassland included California tiger salamander, western

spadefoot giant gartersnake, western pond turtle, all of the bird Covered Species (except Cooper's hawk), American badger, and western red bat (Table 3-2).

As part of the Vernal Pool Ecosystem mapping unit, Valley Grassland also supports wetland-dependent species (vernal pool crustaceans and plants) by maintaining and moderating hydrology for wetlands that they occupy.

Cropland Land Cover (Row and Field Crops)

Cropland is concentrated in the western part of the Plan Area in the Sacramento River and Cosumnes River floodplains. Cropland includes annual row and field crops (e.g., small grains, corn, tomatoes, melons, peppers, safflower, sunflower) and short-term perennial crops (e.g., asparagus). Rice is a row crop grown in Sacramento County, but seldom in the Plan Area. Small fields of rice have recently been planted on the existing Cosumnes River Preserve.

An important ecological function of Cropland in the Plan Area is to provide rodent and insect prey and plant material forage for a number of the bird Covered Species. Small rodents are important prey for raptors, such as Swainson's hawks, white-tailed kite, and Cooper's hawk. Western burrowing owls consume a mix of small rodents, arthropods, and other small animals. Loggerhead shrikes primarily prey on ground-dwelling insects but also take small rodents. Swainson's hawks switch to a diet of insects after the breeding season. Greater sandhill crane is a winter visitor that forages for seeds and small animals, and tricolored blackbird forages on invertebrates during the nesting season and plant material during the non-nesting season (Table 3-2).

Irrigated Pasture-Grassland Land Cover

Irrigated Pasture-Grassland is scattered throughout much of the Plan Area in relatively small patches. Irrigated Pasture-Grassland is fairly common, but occurs in a scattered distribution generally in the central portion of the Plan Area. The Irrigated Pasture-Grassland land cover includes hay production (alfalfa, clovers, and mixed grasses), seasonal summer pasture for livestock (primarily cattle), and year-round pasture for livestock (primarily cattle or horses). Seasonal pasture appears to be the most common use. Irrigated Pasture-Grassland is typically seeded, cut/grazed, and reseeded on a regular basis on an approximately 5- to 7-year cycle before the fields are left fallow to rest, and the cycle is started over again.

Within the Irrigated Pasture-Grassland land cover type, alfalfa fields provide by far the most productive foraging habitat for raptors and are used by other Covered Species, such as greater sandhill crane, and tricolored blackbird (Table 3-2). As a perennial crop grown for several years before removal and replacement, alfalfa provides good cover for rodents and time for establishment of a good prey base. Farming operations during the growing season consist of

periodic flood irrigation and four to six mowings. Both types of operations result in temporary increases in prey availability.

Many of the Covered Species that use Cropland also use Irrigated Pasture-Grassland. Pasture is suitable tricolored blackbird foraging habitat if it is within two miles of a colony nesting site. Greater sandhill cranes use Irrigated Pasture-Grassland for roosting and foraging (Table 3-2).

Orchard Land Cover (Fruit and Nut Orchards)

Orchards are scattered throughout the Plan Area, with the largest concentration along the western boundary of the Plan Area. The Orchard land cover has limited wildlife habitat value (Table 3-2), but provides perches for raptors foraging in adjacent Cropland and Valley Grassland. In particular, larger nut trees and other trees at these edge areas may be used by "sight predators" such as Swainson's hawk for perches to find prey in adjacent fields. Western red bat is known to roost in orchards, including apricot, peach, pear, almond, walnut, and orange trees (Constantine 1959; Pierson et al. 2006) (Table 3-2).

Vineyard Land Cover

Vineyard land cover is located mostly in the southern portion of the Plan Area outside of the UDA. In Sacramento County, vineyards are primarily established for wine grape production, with some minor table grape producers. Vineyards are primarily "clean cultivated," meaning no other vegetation is allowed to grow between the rows or on the edges of fields and irrigation ditches. As such, vineyards typically provide only limited habitat for native plants and wildlife (Table 3-2). However, vineyards using "environmentally friendly" management practices may provide habitat value through use of bat boxes, raptor perches, and owl boxes to encourage presence of these species and reduce insect and predation damage.

Blue Oak Woodland Land Cover and Blue Oak Savanna Land Cover

Blue Oak Woodland and Blue Oak Savanna comprise approximately 5% of the Plan Area, a majority of which is located in the far eastern portion of the Plan Area.

Blue oaks are typically drought-tolerant, and unlike interior live oaks, are deciduous, dropping their leaves during periods of extreme moisture stress. This survival trait may explain the observed patterns of blue oak distribution, with blue oaks occupying drier, shallower, and well-drained soils than interior live oaks or valley oaks (McDonald 1985).

In general, the SSHCP differentiated and mapped Blue Oak Woodland land cover and Blue Oak Woodland Savanna by their tree-cover densities.

Blue Oak Woodland is characterized by greater than 10% tree cover formed primarily by blue oak with other foothill tree species mixed in. Blue Oak Woodland generally has a sparse shrub layer and well-developed Valley Grassland layer, sometimes including vernal pools and other wetland features. Other tree species that may occur in Blue Oak Woodland include foothill pine (*Pinus sabiniana*), interior live oak (*Quercus wislizenii*), valley oak (*Quercus lobata*), and California buckeye (*Aesculus californica*). The shrub layer, where present, only includes scattered individuals of poison oak (*Toxicodendron diversilobum*), and coyote brush (*Baccharis pilularis*). Blue Oak Woodland often has a relatively open canopy, when compared to the riparian land covers present in the Plan Area.

Blue Oak Savanna land cover type is characterized by a sparse (less than 10%) tree canopy structure that ranges from scattered blue oak trees and small clusters of blue oaks, to small areas of blue oak stands. Like Blue Oak Woodland, it generally has little to no shrub layer, but has a well-developed Valley Grassland layer. Blue Oak Savanna is typically transitional between Valley Grassland and Blue Oak Woodland.

Oak Woodland and Savanna provide important cover, nesting, and roosting sites for native bird species, as well as caching sites for acorn storage, for a variety of birds, mammals, and other native species. Covered Species that use Blue Oak Woodland and/or Savanna include American badger, western red bat, Cooper's hawk, western burrowing owl, and white-tailed kite. Where suitable aquatic land cover occurs in association with Blue Oak Woodland and Blue Oak Savanna land cover, California tiger salamander, western spadefoot, and western pond turtle may also occur. Old, large oak trees are of particular habitat value, providing an array of living and dead branches as sites for woodpeckers to excavate cavities and for insect-eaters to forage for larvae and adult insects. Dead branches and trunks are critically important for cavity nesting birds, for mammals as storage sites for acorns, and as perches for sight-dependent predators, such as raptors (Gutierrez and Koenig 1978). The fallen logs of dead oaks provide sustenance and cover for arthropods, fungi, and wildlife, and may potentially extend activity periods for these species in drier climates by retaining soil moisture and providing shade (Giusti et al. 2004).Oak trees produce a critically important food crop, acorns. Acorn production is typically episodic, some years with copious acorn production and other years with minimal acorn production. High yield acorn years appear critical in triggering pulses in invertebrate and vertebrate population sizes (McShea and Rappole 2000; McShea and Schwede 1993). Blue Oak Woodland and Blue Oak Savanna provide different habitat functions for some of the Covered Species. For example, western burrowing owl and American badger may occur in the open savannas but not denser woodlands. White-tailed kites may nest in woodlands and forage in savannas.

Aqueduct Land Cover

The aqueduct land cover type in the Plan Area is represented by the Folsom South Canal.

Disturbed Land Cover

The disturbed land cover type is defined as open-space areas that have been subject to previous or ongoing disturbances such as along roadsides, trails, and parking lots. Scraped or graded land, gravel mining, and waste disposal sites are included in this land cover type. Disturbed land cover type is vegetated with diverse weedy flora. These areas are of special concern as they tend to harbor and facilitate the spread of invasive plant species. Vascular plant species associated with the disturbed land cover typically include Johnson grass, Canadian horseweed (*Conyza canadensis*), milk thistle (*Silybum marianum*), yellow-star thistle (*Centaurea solstitialis*), stinkwort (*Dittrichia graveolens*) and field bindweed (*Convolvulus arvensis*).

High-Density Development Land Cover

The high-density development land cover type includes urban and suburban residential neighborhoods, urban centers, industrial areas, airports, and wastewater treatment plants. Most of this high-density development occurs in the SSHCP UDA in the northwestern portion of the Plan Area.

Low-Density Development Land Cover

The low-density development land cover type consists of relatively sparse residences and other structures, such as farm buildings, and small rural neighborhoods with large individual property sizes per house. Plant nurseries are also included in this category. While the majority of low-density development occurs outside of the UDA, it is found throughout the Plan Area.

Major Roads Land Cover

The major roads land cover type includes linear features with paved surfaces and can vary from large freeways to smaller arterial roads found within urban settings. Smaller roads not mapped as Major Roads were mapped as an element of High-Density or Low-Density Development.

Mine Tailings Land Cover

Mine Tailings Land Cover is defined by the large tailing piles that rise significantly above the surrounding landscape as a result of gold dredging occurring in the early 1900s through approximately 1960. The large tailing piles are composed almost entirely of rounded river rock that was excavated from ancient riverbeds. Most of the mine tailings are associated with historic gold mining are located in the northeastern portion of the Plan Area. Smaller outcroppings of tailings in are often the result of current and recent gravel mining activities. The mine tailings are

unvegetated; the SSHCP mapped any woody vegetation observed between tailings piles as the Mine Tailing Riparian Woodland land cover type (see Section 3.2.1).

Recreation/Landscaped Land Cover

The recreation/landscaped land cover type includes gardens, parks, golf courses, off-highway vehicle (OHV) parks, and greenbelts. Most landscaped and recreation areas are planted with non-native grasses, shrubs, and trees. Species composition in urban habitats varies with planting design and climate. Monoculture is commonly observed in tree groves and street tree strips. For example, many of the windbreaks in south Sacramento County are planted with pure stands of eucalyptus, olive (*Olea europaea*) trees, or other hardwoods. Most recreation and landscaped areas are regularly maintained by irrigation, mowing, pruning, or other management techniques.

Not Mapped

There is a small section of the Plan Area along the Sacramento River that was not mapped. This area was not mapped as it is in-between the river side toe of a levee and the center of the river.

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