

## Chapter 4

# Regional Waters of the U.S. Types

Waters of the U.S. in the inventory area were classified into principal types according to Cowardin *et al.* (1979). The Cowardin classification is hierarchical, grouping WoUS into systems, subsystems, classes, and dominance types. Examples of systems include riverine, lacustrine, and palustrine. Examples of subsystems in the riverine system include upper perennial, lower perennial, intermittent, and tidal. Examples of classes in the riverine system include rocky bottom and unconsolidated bottom. Dominance types are based on the growth forms of the dominant vegetation in a wetland, such as forest or scrub. The system uses modifiers to further classify WoUS according to other criteria, such as duration of inundation and pH. The Cowardin classification is used here because it is helpful in assessing the functions and values of WoUS. For example, classifying a wetland as Palustrine Persistent Emergent informs us that this wetland is likely to provide habitat and improve water quality to a greater extent than a Palustrine Aquatic Bed WoUS, which is unvegetated. The Cowardin classification is used by the National Wetlands Inventory, as well as by numerous wetlands inventories and assessments.

The inventory area includes the following WoUS types (Cowardin et al. 1979).

- Palustrine Forest/Scrub/Shrub
- Palustrine Persistent Emergent
- Riverine Nontidal
- Riverine Tidal
- Riverine Excavated Artificial
- Impounded Lacustrine
- Palustrine Nonpersistent Emergent and Palustrine Aquatic Bed/Unconsolidated Bottom

These WoUS types and the acreage of each type in the inventory area are listed in Table 4-1. The aerial extent of specific WoUS types is based on data derived from the May 2000 aerial photographs. These data were updated by ground surveys conducted in spring 2003, spring 2004, and other data. Accordingly, data regarding WoUS should reflect current conditions in most of the inventory area as of spring 2004. In the following discussion, the following key characteristics of each WoUS type in the inventory area are described.

**Table 4-1.** Wetland Types and Cross-walk with Other Wetland Classifications.

HCP/NCCP classification	Area occupied by type for the project area (acres)	Cowardin <i>et al.</i> (1979) classification				Ferren <i>et al.</i> 1995 Classification Hydrogeomorphic (HGM) class
		System	Subsystem	Class	Modifiers	
<b>Wetlands</b>						
Permanent or Seasonal (undetermined)	485	Palustrine		persistent emergent	nontidal saturated or seasonally flooded	Valley Bottom depressional wetlands with or without artificial structures (00.0.551) Stream Floodplains, Bottomlands or (00.0.395) Pond Margins
Seasonal	121	Palustrine		persistent emergent	nontidal temporarily or intermittently flooded	Valley Bottom depressional wetlands with or without artificial structures (00.0.551) Stream Floodplains, Bottomlands or (00.0.395) Pond Margins
Alkali	380	Palustrine		persistent emergent	nontidal temporarily or intermittently flooded, alkali soil	Valley Bottom depressional wetlands with or without artificial structures (00.0.551) Stream Floodplains, Bottomlands or (00.0.395) Pond Margins
<b>Aquatic</b>						
Reservoir	1807	Lacustrine	limnetic or littoral	unconsolidated bottom	Impounded	(00.0.154) Lacustrine Montane Reservoirs (00.0.155) Lacustrine River-Valley Reservoirs
Pond	162	Palustrine		nonpersistent emergent/aquatic bed or unconsolidated bottom	excavated or impounded	(00.0.147) Agricultural Ponds, Reservoirs
Slough/channel	213	Riverine	tidal or lower perennial	rock bottom	artificial	(00.0.214) Coastal Plain Stream Channels
Stream	532 total miles	Riverine	intermittent	rock or unconsolidated bottom or		(00.0.212) Foothill/Terrace Stream Channels (00.0.213) Valley Stream Channels
			lower perennial	aquatic bed or rocky shore or		(00.0.212) Foothill/Terrace Stream Channels (00.0.213) Valley Stream Channels
			upper perennial	unconsolidated shore		(00.0.212) Foothill/Terrace Stream Channels

HCP/NCCP classification	Area occupied by type for the project area (acres)	Cowardin <i>et al.</i> (1979) classification			Ferren <i>et al.</i> 1995 Classification Hydrogeomorphic (HGM) class
		System	Subsystem	Class Modifiers	
<b>Riparian woodland/scrub</b>					
	449 total	Palustrine	forested or scrub/shrub	nontidal saturated or permanently, regularly, or seasonally flooded	(00.0.371) Montane Stream-Banks (00.0.372) Foothill/Terrace Stream-Banks (00.0.373) Valley Stream-Banks
<b>Developed</b>					
Aqueduct	26 miles	Riverine		excavated artificial	(00.0.910.0000) Stationary Artificial Structures
Drainage ditches and irrigation canals	158 miles	Riverine		excavated artificial	(00.0.910.0000) Stationary Artificial Structures

- Geomorphic units where found.
- Dominant vegetation.
- Hydrology.
- Location and extent in the inventory area.
- Mapping methods;
- Habitat, water quality, and hydrologic cycling functioning.

The goal of these discussions is to give the reader a familiarity with the landscape level WoUS inventory, as well as to describe the characteristics of WoUS types that are common to multiple subbasins, reducing redundancy in this report.

## 4.1 Palustrine Forest/Scrub/Shrub

Palustrine forest/scrub/shrub wetland is equivalent to riparian woodland/scrub in the HCP/NCCP (Table 4-1).

### 4.1.1 Geomorphic Units

These wetlands are found within montane and foothill geomorphic zones, along stream banks and overbank floodplain terraces.

### 4.1.2 Description

Palustrine forested or scrub/shrub wetlands are dominated by phreatophytic woody vegetation associated with streams and permanent water sources. Palustrine forest is dominated by trees and contains an understory of shrubs and forbs. Tree species include Fremont cottonwood (*Populus fremontii*), western sycamore (*Platanus racemosa*), and red willow (*Salix laevigata*). The understory may also include woody shrubs such as arroyo willow (*Salix lasiolepis*) and coyote brush (*Baccharis pilularis*). Palustrine scrub/shrub areas are dominated by young trees and shrubs that typically represent an early successional stage of riparian woodland. Coyote brush and arroyo willow are the dominant species in palustrine scrub. Palustrine forest/scrub areas are dominated by a mixture of trees and shrubs adapted to saturated and/or flooded soil conditions. The hydrologic regime in this type of wetlands is nontidal and saturated, with some areas that are temporarily or seasonally flooded. Generally, this wetland type occupies narrow corridors in the inventory area, with a canopy only several trees or shrubs wide. This wetland type forms a mosaic with the riverine nontidal wetland type, discussed in further detail below. As noted above, the boundary between palustrine forest/scrub that may be jurisdictional wetland and similar vegetation that is lacking hydric soils and wetland hydrology could not be

mapped from aerial photos. Therefore, much of the mapped palustrine forest/scrub in the inventory area is most likely not jurisdictional wetland.

### 4.1.3 Location and Extent

Palustrine forest/scrub is rare in the inventory area, occurring on only 450 acres (<1%). The largest and longest stands of riparian vegetation are found in and near Pittsburg along Kirker Creek, and along Marsh Creek above and below Marsh Creek Reservoir. Riparian woodland and scrub is also present along Willow Creek, Upper Mount Diablo Creek, Kellogg Creek, Sand Creek, West Antioch Creek, East Antioch Creek and Brushy Creek, as well as along the East County Delta Drainages.

### 4.1.4 Mapping Methods Unique to Wetland Type

This wetland type was identified on the basis of its specific signature in the photographs and proximity to streams, drainages, and lakes or reservoirs. On infrared photographs, riparian areas were discernible by their light signatures. These light-colored signatures indicate areas of rapid vegetative growth. Riparian areas were mapped based on this signature type, topographic location, and canopy density. Because palustrine scrub/shrub is an early successional stage of palustrine forest, and because it was difficult to distinguish on aerial photos, the two categories were combined as palustrine forest/scrub. The minimum mapping unit for palustrine forest/scrub was 1 acre. It was not possible to distinguish between jurisdictional and non-jurisdictional wetland within the palustrine forest/scrub category. It is likely that the amount of palustrine forest/scrub mapped as wetlands overestimates the amount that is jurisdictional.

Some intermittent and ephemeral streams in the inventory area are dominated by a narrow corridor of oaks, California bay, or California buckeye (*Aesculus californica*), with only scattered riparian tree species (e.g., willows [*Salix* spp.] and cottonwoods [*Populus* spp.]) present. Stands in streams dominated by oaks were not mapped as palustrine forest/scrub. In some places (e.g., Contra Loma Reservoir), riparian trees such as cottonwoods have been planted as ornamentals with an understory of irrigated turf. These areas were mapped as turf, not as palustrine forest/scrub.

### 4.1.5 Functions

#### Habitat

Palustrine forest/scrub provides habitat for a wide diversity of wildlife and plant species. The presence of flowing water associated with this wetland type attracts numerous mammals, amphibians, and reptiles. Riparian corridors are also

important for deer migration. Common mammals found in this cover type include mule deer, raccoon, gray fox (*Urocyon cinereoargenteus*), striped skunk (*Mephitis mephitis*), deer mouse (*Peromyscus maniculatus*), harvest mouse (*Reithrodontomys megalotis*), broad-handed mole (*Scapanus latimanus*), and dusky-footed woodrat (*Neotoma fuscipes*). Because of their proximity to rangelands, livestock graze many riparian areas in the inventory area. Numerous birds are also typical of this cover type, including Yellow Warbler (*Dendroica petechia*), Northern Flicker, Bewick's Wren, White-Tailed Kite, Cooper's Hawk (*Accipiter cooperii*), Red-Shouldered Hawk (*Buteo lineatus*), Song Sparrow (*Melospiza melodia*), and Black-Headed Grosbeak (*Pheucticus melanocephalus*) and migrants such as Pacific-Slope Flycatcher (*Empidonax difficilis*) and Wilson's Warbler (*Wilsonia pusilla*). In addition, palustrine forest/scrub provides a source of coarse woody debris in streams, which is an important habitat element for some riparian species.

Palustrine forest/scrub in the inventory area provides variable levels of habitat function. In the upper portions of the subbasins, palustrine scrub/forest provides a high level of habitat function. Riparian woodland, forest, and scrub in these areas are generally well developed, and surrounding lands are managed for grazing or conservation and recreation. In the lower portions of subbasins, palustrine forest/scrub provides a low level of habitat function because it is adjacent to developed areas, generally lacks a complex understory, and occupies a narrow area along streams.

## Water Quality

Palustrine forest/scrub intercepts surface runoff, retains nutrients, contributes to groundwater supplies, and reduces suspended sediments, and therefore improves water quality. Because of the steep topography of the montane and foothill regions, these water features, commonly found at the base of slopes, are fed by surface sheet flow and shallow subsurface groundwater, and provide important flow retention. Shallow groundwater commonly contains high dissolved organic and inorganic nutrients leached from surrounding geology and saturated soils. These nutrients are removed, transformed, and exchanged by wetland vegetation.

Water quality is also improved through filtration of sediments and removal of associated nutrients and metals. Fine sediments are transported with surface sheet flows during storm events. An increased concentration of fine sediment in the water column will increase turbidity, making it difficult for aquatic species to locate food sources, and transport heavy metals and nutrients downstream. Depending on the surrounding geology, toxic heavy metals, such as mercury, can be transported with fine sediment. This phenomenon is especially true with clay sediments. One way to remove these metals from the watershed is through settling and consequent burial of these sediments. Vegetated wetlands serve this function because velocities are slowed and fine sediment is encouraged to settle out, thus removing metals from the water column.

Tall forest and shrub vegetation also provide shade, which maintains and reduces water temperature and improves water quality conditions.

## Streambank Erosion Protection

Wetlands reduce streambank erosion because the roots of vegetation hold the soil in place. The root mass of large trees and shrubs, such as those found in this wetland type, are sometimes exposed to the surface. During storm events, these exposed roots help to slow flow velocity, which encourages sediment deposition. Recruitment of new sediment is important to encourage new vegetation growth and cycling of metals, nutrients, and carbon. Large trees and shrubs growing on streambanks in montane and foothill regions are important for streambank protection, particularly in highly erosive soil types.

## Flood Storage

Palustrine forest and scrub wetlands sometimes occur in areas that are seasonally inundated by floodwaters. The flood storage function offers two main benefits to the surrounding environment: reduction of downstream erosion and reduction of suspended sediments. Wetlands, particularly those found in the montane and foothill regions, capture and slow surface and subsurface waters during storm events. During the peak of a storm hydrograph, flow velocities are the largest and the concentration of suspended sediments is the highest. High flow velocities can physically damage stream banks and residential areas downstream by causing erosion. The velocity reduction by in-stream vegetation and storage of floodwaters in upstream inundation areas or detention basins is important to prevent flood damage to downstream land users. High concentrations of suspended sediment can clog the streambed, therefore reducing groundwater infiltration and interfering with fish feeding. Inundation of wetlands by floodwaters encourages the settling of sediments, which in turn enhances the soil, promoting further vegetation growth. Growth of vegetation increases the cycling rate of nitrogen and phosphorus from the system, further enhancing water quality. Wetlands in the steep topography of the montane region store floodwaters for a shorter period of time because of the abundance of exposed bedrock and steep slopes.

## 4.2 Palustrine Persistent Emergent

Palustrine persistent emergent (PPEM) wetland corresponds to wetland and seasonal wetland in the HCP/NCCP (Table 4-1).

## 4.2.1 Geomorphic Units

These wetland features are found along stream floodplains/bottomlands, pond margins, montane or river-valley freshwater courses, lacustrine-reservoir shores, montane/plateau seeps, foothill seeps, and valley and plain seeps.

## 4.2.2 Description

PPEM wetlands are dominated by herbaceous species that grow in perennially or seasonally flooded, ponded, or saturated soil conditions. Hydrologic regimes are primarily nontidal, and range from seasonally flooded to temporarily flooded. Soil conditions are important in recognizing a subclass of PPEM wetlands that occur on alkali soils, described below.

Perennially flooded PPEM wetlands are characterized by a year-round water source. They are typically dominated by erect, rooted, herbaceous hydrophytic plant species adapted to growing in conditions of prolonged inundation. Common plant species present in this wetland type include cattails (*Typha* spp.) and tules (*Scirpus* spp.). Both tidal and nontidal perennial PPEM wetlands are found in the inventory area.

Seasonally flooded PPEM wetlands are freshwater wetlands that support ponded or saturated soil conditions during winter and spring and are dry through the summer and fall until the first substantial rainfall. The vegetation is composed of wetland generalists, such as hyssop loosestrife (*Lythrum hyssopifolia*), cocklebur (*Xanthium* spp.), and Italian ryegrass (*Lolium multiflorum*) that typically occur in frequently disturbed sites, such as along streams.

Vernal pools are temporarily flooded PPEM wetlands that pond water on the surface for extended durations during winter and spring and dry completely during late spring and summer.

Alkali wetlands support ponded or saturated soil conditions and occur as permanently to seasonally flooded features on alkali soils. The vegetation of alkali wetlands is composed of halophytic plant species adapted to both wetland conditions and high salinity levels. Typical species include those common to both seasonal and alkali wetlands, such as salt grass (*Distichlis spicata*), alkali heath (*Frankenia salina*), and common spikeweed (*Centromadia pungens*).

Freshwater seeps in the inventory area are also PPEM wetlands. Seeps generally occur at grade breaks or intersections of different subsurface strata where groundwater tends to rise to the surface. These features are small and isolated and therefore could not be distinguished from its surroundings on the aerial photographs. Thus, this wetland type was not mapped. Freshwater seeps generally occur in grasslands or meadows where water is permanently near the soil surface, supporting perennial grasses, rushes, sedges, and other wetland species (Holland 1986). Freshwater seeps are likely to be present along

drainages and in other locations. Common species associated with freshwater seeps in the region include Baltic rush (*Juncus balticus*), toad rush (*Juncus bufonius*), creeping spikerush (*Eleocharis macrostachya*), annual rabbit's-foot grass (*Polypogon monspeliensis*), seep-spring monkeyflower (*Mimulus guttatus*), and bull clover (*Trifolium fucatum*).

### 4.2.3 Location and Extent

There are 683 acres of PPEM wetlands in the inventory area at 327 sites (i.e., distinct map units). Vernal pools could not be distinguished on the aerial photographs; they are included as PPEM wetlands.

A total of 18 acres of seasonally flooded PPEM wetlands were mapped at nine sites.

Vernal pools are expected to be very rare in the inventory area based on field surveys in large portions of the inventory area in which vernal pools could be found. In a comprehensive survey of land cover types in the Los Vaqueros watershed (19,600 acres), 15 acres of northern claypan vernal pools were mapped and field-verified (Jones & Stokes 1989). Most of these pools (10.5 acres) were low quality and found behind an artificial dam and were used at the time as a stock pond. In extensive planning surveys for the Cowell Ranch State Park (4,277 acres), 0.4 acres of northern claypan vernal pools were found in six natural and 12 artificial pools (see references in Wagstaff and Associates 1996). Most pools varied in size between 300 and 1,500 square feet; the largest pool was 5,000 square feet. Surveys of a large area around Sand Creek (2,708 acres) found no vernal pools (see references in Mundie and Associates and City of Antioch 2002). Small amounts of vernal pools (< 1 acre) are also found adjacent to the Byron Airport (Stromberg and Ford 2003). The Byron Airport pools include 0.06 acres of vernal pools that were created as mitigation for expansion of the airport in 1992.

Alkali wetlands are rare in the inventory area, occurring at 20 sites on 54 acres (<1%) in the southeastern portion of the inventory area in the Brushy Creek subbasin. Alkali wetlands are also found in the Dry Creek, Deer Creek, and Briones Creek subbasins.

No seeps were mapped in the course of this study. However, verified wetland delineations within the inventory area indicate that seeps are present.

### 4.2.4 Mapping Methods Unique to Wetland Type

Palustrine persistent emergent wetlands were identified on the basis of their aerial photograph signatures and landscape positions that would support wetland hydrology (e.g., wetlands generally have a dark-red signature on the infrared photographs because these areas are greener and are actively growing). The

minimum mapping unit for all PPEM wetland types was 1 acre PPEM wetland subtypes were distinguished based on the darkness of the signature and the density of vegetation. If the type of wetland could not be determined (i.e., the duration of inundation could not be determined from aerial photography), the wetland was classified as the general wetland type. Seasonally flooded PPEM wetlands are likely underrepresented because of the small size, isolated locations, and difficulty in interpreting the photographic signature of individual features. Many seasonally flooded PPEM wetlands were not mapped because they were smaller than the minimum mapping unit of 1 acre or were not visible on the aerial photographs. In addition, many of the mapped seasonal wetlands were included in the general PPEM wetland land cover category because they could not be differentiated from permanently flooded PPEM wetlands. Vernal pool is a subtype of seasonally flooded PPEM wetlands that could not be mapped with available photography but is included in this wetland type. PPEM wetlands greater than 1 acre on alkali soils were mapped as alkali PPEM wetlands. Alkali PPEM wetlands were mapped where wetlands occurred within the alkali grassland land-cover type. Seeps remained unmapped because they lacked a clear signature on the aerial photographs and are smaller than the minimum mapping unit of 1 acre.

## 4.2.5 Functions

### PPEM Habitat Functions

#### Perennially Flooded PPEM Wetlands

The perennially flooded PPEM wetland type is important for a wide variety of wildlife species. Representative waterbirds that forage and rest in these wetlands and associated open-water areas include Great Blue Heron (*Ardea herodias*), Great Egret (*Ardea alba*), Killdeer (*Charadrius vociferus*), American Coot (*Fulica americana*), and Greater Yellowlegs (*Tringa melanoleuca*), as well as various ducks, including Wood Ducks (*Aix sponsa*) and Mallards (*Anas platyrhynchos*). Typical amphibians and reptiles in this cover type include California red-legged frog (*Rana aurora draytonii*), western pond turtle (*Clemmys marmorata*), and garter snakes (*Thamnophis* spp.). Many of the larger mammals, such as mule deer (*Odocoileus hemionus*), may frequent these wetlands and use them as a source of drinking water.

Within the inventory area, the level of habitat function of this wetland type depends on adjacent land use, as well as the density and complexity of the vegetation. Examples of this wetland type include densely vegetated restored freshwater marshes along Kellogg Creek, as well as wetlands constructed for stormwater treatment in developed areas.

## Seasonally Flooded PPEM Wetlands

Seasonally flooded PPEM wetlands provide habitat for different wildlife species depending on the season. During the wet season, these wetlands are commonly used by a variety of wildlife, including various amphibians such as western spadefoot (*Scaphiopus hammondi*), Pacific chorus frog (*Pseudacris regilla*), western toad (*Bufo boreas*), and California tiger salamander (*Ambystoma californiense*); shorebirds such as Killdeer, Black-Necked Stilt (*Himantopus mexicanus*), and American Avocet (*Recurvirostra americana*); and passerines such as Brewer's Blackbird (*Euphagus cyanocephalus*), Red-Winged Blackbird (*Agelaius phoeniceus*), Brownheaded Cowbird (*Molothrus ater*), and American Pipit (*Anthus rubescens*).

During the dry season, a variety of small mammals use the areas, including deer mouse, California vole (*Microtus californicus*), and long-tailed weasel (*Mustela frenata*). Raptors such White-Tailed Kites, Northern Harrier, and Red-Tailed Hawk may forage in this wetland type.

Alkali wetlands provide function and value for wildlife similar to those provided by non-alkaline wetlands. However, these wetlands provide habitat for a suite of alkali plant species, some of which are rare, threatened, or endangered.

Within the inventory area, the level of habitat function of this wetland type depends on adjacent land use, as well as the density and complexity of the vegetation. Examples of this wetland type include floodplain wetlands with native vegetation and surrounded by oak woodland along Upper Marsh Creek, as well as floodplain wetlands dominated by exotic plant species located along intermittent streams in the Willow Creek subbasin.

## Vernal Pool Habitat

Because of their unique hydrology, vernal pools support specialized plants adapted to growing in these stressful conditions, such as coyote thistle (*Eryngium* spp.), goldfields (*Lasthenia* spp.), downingia (*Downingia* spp.), and navarretia (*Navarretia* spp.). These species are generally restricted or nearly restricted to vernal pools. A number of special-status invertebrates, including vernal pool fairy shrimp (*Brachinecta lynchi*), vernal pool tadpole shrimp (*Lepidurus packardi*), and longhorn fairy shrimp (*Brachinecta longiantenna*), may occur in vernal pools.

## Seep Habitat

In the East Bay region, ten special-status plants are recorded in seep habitats, six of which are associated with alkali seeps, two with freshwater marsh, and two with freshwater seeps (California Natural Diversity Database 2003). As with other aquatic habitats, the freshwater seep communities are important because

they provide wildlife species with a source of water for drinking, foraging, and breeding. Freshwater seeps in the inventory area may support reptiles and amphibians such as common garter snake and slender salamander (*Batrachoseps attenuatus*). California red-legged frog and California tiger salamander could also be supported by freshwater seeps. A variety of birds and mammals, such as deer and raccoon, also use seep habitat for drinking and foraging.

## PPEM Water Quality Functions

### Perennially Flooded PPEM Wetlands

Wetland areas inundated by water year-round improve water quality through sediment removal and cycling of nutrients. Vegetation found here is adapted to inundation by water, thus exhibits slow growth and has a long growing season. The continued presence of water encourages more vegetation growth and thus uses large quantities of nutrients. Most of the wetlands in this category in the inventory area are treatment wetlands and tidal marshes.

Treatment wetlands are often constructed to capture stormwater runoff from surrounding areas, such as residential subdivisions and golf courses. These wetlands provide a filter to remove suspended solids, metals, pollutants, and pathogens from stormwater runoff. The fringe vegetation growing around these ponds intercept the stormwater, slowing the velocity and encouraging sediments to settle out of the water column. Sediments contained in runoff from urban areas, including managed lands such as golf courses, can carry adsorbed nutrients, metals, and pathogens. These contaminants are removed from the water column along with the sediment. Treatment wetlands typically allow water to evaporate from their surfaces, thus adding to the hydrologic cycle.

Wetland vegetation has the unique capability of increasing the cycling and storage of nitrogen and phosphorus. The forms of nitrogen contained in stormwater are considered biostimulatory because they promote the growth of aquatic vegetation. In an anoxic wetland environment, nitrogen is removed from the water, transformed into a gaseous form, and released to the atmosphere to complete the nitrogen cycle. Phosphorus is also quickly used by vegetation and soil microbes. When these plants and microbes die, the phosphorus is released and adsorbed into the soil. Large amounts of phosphorus are stored in wetland soils in this manner. The phosphorus is re-released to surface water during winter storms, thus supplying downstream vegetation and water features with available phosphorus.

### Seasonally Flooded PPEM Wetlands

Water quality functioning of seasonally flooded wetlands is similar to that described above, but at a reduced scale. Seasonal wetlands are so called because they receive and retain water flows for a limited amount of time, usually a few

months after the rainy season. The shorter availability of water for vegetation allows for limited nutrient uptake and storage. However, sediment removal functions remain the same. Soil type and topography control the ability of seasonal wetlands to retain water during a storm. Like perennial wetlands, vegetation growing in these areas is adapted to capture nutrients contained in stormwater and adsorbed to sediments. However, short growing seasons result in a shorter period of active nutrient cycling. This implies that smaller quantities of nutrients, phosphorus in particular, are released and stored as part of the cycle. Nonetheless, cycling of nutrients is an important function of seasonal wetlands for the surrounding ecosystem.

Seasonal wetlands serve as important filters of suspended sediment from the water column. Although vegetation in these wetlands is typically of short stature, because of their location at topographic low points, flows are slowed and sediment is encouraged to deposit. Sediment deposition is important for vegetation growth, as described in the perennial wetland discussion above.

## Seeps

Seeps are important for water quality because they are important sources of freshwater and mineral deposition. Seeps form when the groundwater table rises to the surface. Depending on the geology type in which the groundwater travels, different concentrations of minerals can be deposited where seeps daylight at the surface. For example, alkali seeps are formed by groundwater high in salts.

## PPEM Erosion Protection Functions

### Perennially Flooded PPEM Wetlands

Soils surrounding perennial wetlands are typically saturated, thus soil cohesion is high. Therefore, erosion of perennial wetlands does not occur at a rapid rate. Hillslope slumping can occur, however, where there is an increase in slope. Vegetated perennial wetlands are valuable to prevent adjacent land loss from erosion during storm conditions that increase soil moisture. Tidal marshes, in particular, protect the shoreline from eroding. As buffers, rooted vegetation helps to hold soils together and provides structure to the shoreline and adjacent land. The vegetation also encourages sediment deposition, which further stabilizes the bank and increases vegetation growth.

### Seasonally Flooded PPEM Wetlands

Vegetation growing within and on the edge of seasonal wetland areas, such as riparian corridors in stream channels, provides important structure to the soils. Roots of established vegetation prevents erosion during storm events and reduces flow velocity. In the case of seasonal wetlands, vegetation dies out after the

growth season, but its root structure remains within the soil for some time. This structure helps to prevent soil erosion, particularly when the first storm hits the area. Seasonal wetlands dry out during the summer, thus soil saturation and cohesion is sometimes reduced.

A large majority of seasonal wetlands in the project area are present in land heavily grazed by cattle. Properly managed, grazing can be compatible with the conservation of seasonal wetlands. For example, providing alternative water sources, keeping stocking rates low in the dry season, and/or fencing wetlands can protect them from negative grazing impacts. However, if not properly managed, cattle grazing can reduce wetland functioning because cattle may consume and trample wetland plants, leaving the wetland unvegetated. Removing vegetation from wetlands results in increased flood flow velocity and recruitment of sediment by floodwaters. If mismanaged, cattle may also trample and compact soils. Compacted soils absorb less moisture from flood flows and make it more difficult for vegetation to establish. The potential for streambank erosion increases with the presence of cattle on the land.

## **PPEM Hydrologic Cycling Functions**

### **Perennially Flooded PPEM Wetlands**

Perennial wetlands are commonly found at topographic low points or at downstream ends of the watershed. Waters held within this area year-round can provide an important source for groundwater recharge. Groundwater recharge occurs primarily through soils on the outside edges of the wetland because soils within the wetland are less permeable. Water percolating to the groundwater table supplies streams or other surface features down slope. This function is important to maintain the hydrologic cycling within the area. In addition, perennially flooded tidal marshes help to maintain the location of the fresh/saline groundwater interface.

### **Seasonally Flooded PPEM Wetlands**

Seasonal wetlands are also found at topographic low points, which can be found throughout the watershed, not particularly at the downstream end. Hydrologic cycling functions of perennially flooded wetlands also apply to seasonally flooded wetlands, including vernal pools. Seasonally flooded wetlands may have a larger impact on groundwater recharge and hydrologic cycling than perennially flooded wetlands. This is due to their larger wetland perimeter-to-volume ratio. Seasonal wetlands tend to be large and shallow, which produces a large surface area and perimeter from which evaporation and groundwater percolation can occur. Evaporation and groundwater recharge are key functions to continue the hydrologic cycle of a watershed. These types of wetlands are invaluable for fostering cycling of water for plant growth, thus enhancing wildlife habitat.

## Seeps

Like seasonal wetlands, seeps also play key functioning roles in hydrologic cycling of water. Seeps are features dependent on groundwater flow and a steady groundwater elevation. This illustrates again how important groundwater recharge is for the presence of surface water features. Seeps are also important sources of freshwater for wildlife.

## PPEM Flood Storage and Conveyance Functions

### Perennially Flooded PPEM Wetlands

Since perennial wetlands are commonly found at topographic low points or at the downstream end of the receiving watershed, these areas quickly swell with water during storms, causing floodwaters to back up and spread out over adjacent flood plain areas. Flood storage capacity has been reduced from historical levels to enable development of the floodplains for urban and agricultural uses. The lower portions of streams in the project area have been redirected through dikes to capture and convey floodwaters away from natural floodplains and to the Delta. Perennial wetland vegetation has developed within these channels. This vegetation helps to slow the velocity of floodwaters moving through the constructed channels. Though flood storage capacity has been reduced, the reduction in floodwater velocity provided by vegetated channels is important to reduce bank erosion and encourage settling of suspended sediments.

### Seasonally Flooded PPEM Wetlands

Seasonal wetlands can retain water that would otherwise move downstream during storms. The majority of seasonal wetlands are dry before a storm of flood magnitude occurs. As the depressional area or pond fills with the storm flows, floodwaters rise and spread out over adjacent land, the floodplain. Inundation of the floodplain is important for sediment recruitment and plant growth, which stabilizes the stream bank.

Wetlands that provide flood storage can prevent erosion damage to land. This is particularly important in developed areas, such as residential housing subdivisions. Seasonal wetlands slow the velocity of stormwater, thus encouraging settling of sediments and debris carried by the waters.

## 4.3 Riverine Nontidal

Riverine nontidal is equivalent to streams in the HCP/NCCP (Table 4-1).

### 4.3.1 Geomorphic Units

Riverine nontidal features are found in montane stream channels, foothill/terrace stream channels, valley stream channels, and floodplain stream channels.

### 4.3.2 Description

Riverine nontidal WoUS in the inventory area includes intermittent, lower and upper perennial watercourses characterized by a defined bed and bank and/or ordinary high water mark. Bottom types represented include rock, unconsolidated, and aquatic bed. Most riverine nontidal WoUS in the inventory area are intermittent. Mount Diablo Creek and some of its tributaries, Marsh Creek, Kirker Creek, Delta sloughs, and lower Sand and Deer Creeks, are the only perennial streams within the inventory area. Of these, Upper Mount Diablo, Upper Marsh Creek and Kellogg Creek contain areas of upper perennial riverine nontidal WoUS, characterized by relatively narrow channels, steep gradients, and rocky bottoms. The remaining perennial riverine nontidal WoUS are lower perennial, characterized by wider channels, gentler gradients, and unconsolidated bottom or aquatic bed.

### 4.3.3 Location and Extent

Approximately 400 miles of riverine nontidal WoUS are known to exist in the inventory area based on existing data. Stream width in the montane and foothills/upper valley regions was assumed to be an average of 5 feet; stream width in the lower valley/plain and Delta regions was assumed to be an average of 10 feet. Based on these assumptions, it can be estimated that there are 308 acres of riverine nontidal WoUS in the inventory area. In some areas, these riverine nontidal WoUS are intermixed with palustrine forest/scrub and palustrine persistent emergent wetlands to form a mosaic of wetland types.

### 4.3.4 Mapping Methods Unique to WoUS Type

Streams in the inventory area, including riverine nontidal WoUS, were mapped by staff of the Contra Costa County Community Development and Public Works Departments. Mapping was done countywide to support the concurrent development of a county watershed atlas (Contra Costa County 2003). The stream layer was mapped by interpreting digital orthographic photographs (scale 1:200 where available, 1:400 elsewhere), 10-foot contours, and county storm drain data. USGS creek data (2003) were used to help determine the drainages that should be mapped, but substantial drainages absent from USGS maps were included. Draft data were ground-truthed by county staff and reviewed thoroughly by staff and members of the Contra Costa Watershed Forum who were knowledgeable about the specific conditions in individual subbasins. Creek

centerlines were digitized when visible on aerial photos. Otherwise, riparian vegetation, slope breaks, and contour lines were used to locate creek centerlines approximately. Small tributaries were mapped only when a distinct bed and bank were visible on the air photos or sharp contour lines clearly defined a channel. Aerial photo signatures for small tributaries were ground-truthed in the field by county staff to calibrate the mapping. Small tributaries were mapped to a minimum length of 300 feet. Streams that are channelized and contained by levees were mapped as slough/channel, classed as riverine tidal.

## 4.3.4 Functions

### Habitat

Like the palustrine forest/scrub and PPEM wetland types, riverine nontidal WoUS are important because they provide essential habitat for terrestrial and aquatic species. Many upland species rely on seasonal and perennial streams as water sources. In summer and early fall, perennial streams provide the only available water in an otherwise dry landscape. In addition, ephemeral, intermittent, and perennial streams provide habitat for aquatic macroinvertebrates, which are an important food source for local and downstream populations of fish, birds, and other animals.

Upper perennial stream reaches, found in portions of Upper Mount Diablo and Upper Marsh Creeks, retain riparian woodland vegetation in most areas, and are generally adjacent to open space managed primarily for conservation and recreation. They therefore provide a high level of habitat function for organisms such as the California red-legged frog and western pond turtle.

Lower perennial stream reaches in the inventory area are adjacent to grazing land (Lower Marsh), row crops (Lower Marsh), or developed areas (Lower Marsh, and Deer, Sand, Kirker Creeks). Riparian vegetation, such as riparian woodland, is frequently present in a narrow corridor. Lower perennial streams in the inventory area therefore provide a low to moderate level of habitat function.

Intermittent streams in the inventory area provide a variable level of habitat function. In some cases, such as in Kellogg and Brushy Creeks, these stream reaches retain riparian vegetation and are adjacent to forest or woodland managed for conservation and recreation. These reaches provide a high level of habitat function. In other cases, such as Deer and Briones Creeks, these stream reaches are located in areas that appear to be heavily grazed. The banks of these reaches are frequently unvegetated, or vegetation consists of annual grasses and ruderal species. These reaches provide a low to moderate level of habitat function. Other intermittent reaches, such as East Antioch Creek, are located in developed areas. These reaches provide a low level of habitat function because only species tolerant of frequent human disturbance can utilize them as habitat.

## Water Quality

Much like perennial wetlands, riverine nontidal WoUS improve water quality by fostering nutrient cycling. These channels receive waters from urban and agricultural runoff and are commonly found at lower elevations in the watershed. The channels hold water throughout the wet and dry season. During warm summer months, water within the channels will become stagnant, resulting in anoxic conditions. Any vegetation growing within the channel dies and falls to the channel bottom. Microbes facilitate the decomposition of this organic matter, resulting in increased biological oxygen demand and the release of nutrients. Objectionable odors are produced from the decomposing organic matter. The abundance of nutrients within the water provides desired conditions for growth of algae and aquatic macrophytes. Unattractive growth and odors do not appeal to residents, especially since insects like mosquitoes often reproduce in these environments. Particularly in developed areas, such as along Willow Creek, the increase of algae and macrophyte growth and the accompanying mosquitoes are unpopular with local residents. However, these processes are important to the cycling of nutrients, allowing for future vegetation growth and the delivery of nutrients downstream to the Delta.

## Hydrologic Cycling

Riverine areas enhance hydrologic cycling in the watershed area by providing water vapor to the atmosphere through evaporation. The presence of water, either short or long term, increases the moisture content of the air, thus affecting the surrounding climate. Evaporation increases the concentration of water vapor in the air, which encourages precipitation, to a degree. Flood conveyance channels, such as lower Sand Creek, that fall under the riverine nontidal category are commonly impermeable and thus contribute little to groundwater recharge. However, some creeks, such as Dry and Willow Creeks, allow infiltration to surrounding soils. In permeable channels where water is held for long periods of time, water that is not transported downstream will percolate into the surrounding soils and the underlying groundwater aquifer. Replenishment of groundwater supplies maintains hydrology of groundwater-fed wetlands, as well as providing water for human and agricultural use. In the project area, riverine nontidal WoUS also provide a source of water for wildlife.

## Flood Storage and Conveyance

Riverine nontidal WoUS help convey surface water to the Delta. In areas that have been developed for housing or industrial purposes, such as Sand and West Antioch Creeks, floodplain areas that once functioned for flood storage have been removed. Riverine features in these areas function for flood conveyance rather than flood storage. To handle increased flood flows from constructed impervious surfaces, these stream channels have been engineered to capture and convey the maximum amount of surface water runoff during storm events. The

channels function to convey floodwaters to the Delta as quickly as possible, thereby reducing erosion and damage to structures. Flood conveyance channel bottoms are commonly impermeable and thus contribute little groundwater recharge. However, some channels in the project area allow infiltration to groundwater. Vegetation is sometimes allowed to grow within these channels to a limited extent, which does not hinder flood conveyance capacity.

## 4.4 Riverine Tidal

Riverine tidal WoUS are equivalent to sloughs/channels in the HCP/NCCP (Table 4-1).

### 4.4.1 Geomorphic unit

Riverine tidal features are found at the downstream distal ends of subbasin drainages where stream channels enter the tidal zone of the bay/straits region, or along Delta stream channels.

### 4.4.2 Description

Riverine tidal WoUS generally have perennial water and artificial banks (e.g., levees) constructed of natural soil materials and they may contain in-stream vegetation. Although the banks of sloughs are generally composed of soil, portions of sloughs may be lined with riprap, concrete, or rock gabions for bank stabilization. Sloughs are tidally influenced and may contain brackish waters. They may be lined with a narrow corridor of riparian forest or marsh species such as cattails and bulrushes, and may contain in-stream vegetation such as water hyacinth (*Eichhornia crassipes*), abundant in sloughs in the East County Delta Drainages subbasin. Channels include channelized urban streams such as the lower portion of Marsh Creek in Brentwood and Oakley.

### 4.4.3 Location and Extent

This cover type is relatively uncommon, occupying only 254 acres on the east and southeast sides of the inventory area near Discovery Bay and the Clifton Court Forebay.

### 4.4.4 Mapping Methods Unique to Wetland Type

Because levees were clearly visible on the aerial photographs, sloughs and channels could be mapped to the visible waterline. Large channels constructed to

transport drinking water or agricultural water were mapped as riverine excavated artificial WoUS (aqueduct), not as riverine tidal WoUS (slough/channel).

## 4.4.5 Functions

### Habitat

Sloughs and channels can be important to a variety of wildlife because they provide drinking water, foraging habitat, and resting habitat. Common wildlife found associated with this wetland type include garter snakes, a variety of ducks, both wading and shore birds, and large mammals that use these features for drinking water. In addition, the portion of Marsh Creek mapped as slough/channel provides habitat for western pond turtle, juvenile and spawning adult Chinook salmon (*Oncorhynchus tshawytscha*), and a variety of other aquatic species. Land uses surrounding sloughs and channels are generally intensive agriculture, residential, or commercial development. Because of these adjacent land uses, sloughs and channels in the inventory area provide a low to moderate level of habitat function.

### Water Quality

Riverine tidal features transport runoff water from adjacent agricultural lands to the Delta. Return flows from irrigated lands often contain residual fertilizers, pesticides, and nutrients. High concentrations of these constituents can pollute the water, harming surrounding vegetation and wildlife. Incoming tidal waters dilute these constituents and then transport them to the Delta for further dilution. Within the channel, vegetation adapted to saline and brackish water thrives in the nutrient-rich water. This vegetation filters and removes nutrients and other contaminants through immobilization within the plant structure and soils. Thus, vegetated riverine tidal features potentially improve the quality of waters transported from agricultural lands to the Delta. However, continual delivery of sediment and nutrients from agricultural lands and urban runoff may exceed quantity that vegetation can remove from the system. Consequently, the U.S. Environmental Protection Agency has designated the San Joaquin River and many sloughs connecting the Delta as impaired by low dissolved oxygen and high concentrations of pesticides (USEPA 2003).

### Hydrologic Cycling

Much like riverine nontidal features, riverine tidal features convey waters to the Delta. However the majority of the water consists of return flows from nearby irrigated agriculture lands. Because these channels have been constructed at or below sea level, tides influence water level and flow direction within the channel. The natural hydrologic cycle is interrupted by the surrounding land use. In

agricultural areas, water transport is a necessary component of the hydrologic cycle. Water is pumped from groundwater aquifers, replenished by upstream recharge areas, and used to irrigate crops. Runoff waters from the crops are then discharged to the constructed channels and transported to the Delta. Compared to a natural hydrologic cycle, this cycle created by agricultural land use encourages increased evaporation and degrades water quality. However, the water still discharges to the Delta, just as it would in a natural system.

## Flood Conveyance

During periods of high flows, these channels help to convey excess floodwaters to the Delta. However, once channel capacity is reached or exceeded, there is a potential for levees to be breached or overtopped, which could damage adjacent agricultural fields.

## 4.5 Riverine Excavated Artificial

Riverine excavated artificial WoUS are equivalent to aqueduct and to irrigation and drainage ditches in the HCP/NCCP (Table 4-1).

### 4.5.1 Geomorphic Unit

Riverine excavated artificial features are found along stationary artificial structures and in agricultural areas in the Delta and Plain regions.

### 4.5.2 Description

Riverine excavated artificial in the inventory area corresponds to the Contra Costa Canal and to agricultural drainage ditches. The primary purpose of the Contra Costa Canal is to deliver drinking water from the Delta via channels to treatment plants for distribution to consumers. These channels are completely impervious, and human contact with the water is prohibited. All vegetation is removed from the channel banks to reduce the threat of cracking the channel bed. Surrounding surface and groundwater is not allowed to influence the channels or the water they carry.

Agricultural drainage ditches carry water from agricultural fields into larger channels and to the Delta. In contrast to the Contra Costa Canal, these channels may contain abundant marsh vegetation.

### 4.5.3 Location and Extent

The Contra Costa Canal occupies an area of approximately 32 acres within the inventory area. Within the inventory area, the Contra Costa Canal runs primarily east to west through the Cities of Pittsburg and Bay Point. Agricultural drainage ditches are located primarily in the East County Delta Drainages subbasin, as well as in the Lower Marsh Creek and Brushy Creek subbasins. Drainage ditches and irrigation channels occupy approximately 76 acres.

### 4.5.4 Mapping Methods Unique to Wetland Type

All canals and larger drainage ditches that were visible on aerial photos were mapped. Canals and larger drainage ditches are clearly discernible in aerial photographs from adjacent agricultural areas as linear features with dark signatures.

### 4.5.5 Functions

The Contra Costa Canal provides breeding habitat for birds such as black phoebe (*Sayornis nigricans*). It also provides foraging and roosting habitat for waterfowl such as Mallard, which will use open water for loafing, while wading shorebirds such as Great Blue Heron (*Ardea herodias*) and Snowy Egret (*Egretta thula*) may use the canal for foraging. Amphibians such as Pacific chorus frog (*Pseudacris [Hyla] regilla*) and bullfrogs (*Rana catesbeiana*) may also occupy the canal. The canal does not provide suitable breeding habitat for any special-status amphibians because it lacks a vegetative cover and because of the highly disturbed nature of the surrounding area. The special-status western pond turtle might occupy the canal. However, because of the lack of riparian habitat in these channels, this species would only use them as movement corridors.

Agricultural drainage ditches lack open water habitat but do contain wetlands vegetation. They therefore provide foraging, movement, and breeding habitat for birds, amphibians, and reptiles that can tolerate the disturbed nature of surrounding agricultural land.

## 4.6 Impounded Lacustrine

Impounded lacustrine WoUS are equivalent to reservoirs in the HCP/NCCP (Table 4-1).

## 4.6.1 Geomorphic Unit

Impounded lacustrine features are found along lacustrine montane reservoirs and lacustrine river-valley reservoirs.

## 4.6.2 Description

Impounded lacustrine WoUS in the inventory area are those areas designated on USGS topographic maps as named reservoirs. Depending on depth, these WoUS may be limnetic or littoral. Lacustrine features in the inventory area generally have an unconsolidated bottom.

## 4.6.3 Location and Extent

Found in the Los Vaqueros, Contra Loma, Antioch, and Marsh Creek Reservoirs. Los Vaqueros and Marsh Creek reservoirs are fringed by palustrine persistent emergent wetlands. Reservoirs occupy approximately 1,800 acres in the inventory area.

## 4.6.4 Mapping Methods Unique to Wetland Type

Reservoirs were easily discernible on aerial photographs based on the smooth, uniform, dark signatures of open water. Reservoirs were mapped to the high water line, where discernible. The high water line was observed on the aerial photographs as either obvious rings of sparse vegetation or an open water signature (most of the reservoirs appeared to be full or nearly full when the aerial photographs were taken).

## 4.6.5 Function

### Habitat

Reservoirs can provide breeding and foraging habitat to various ducks, including Mallard, Green-Winged Teal (*Anas crecca*), Cinnamon Teal (*Anas cyanoptera*), Gadwall (*A. strepera*), American Wigeon (*A. americana*), and American Coot. Shore and wading birds including Killdeer, Greater Yellowlegs, and several gull species can also be found in reservoirs. Large mammals can use reservoir habitat for drinking water. Western pond turtles have been documented in the vicinity of the Marsh Creek Reservoir.

## Water Quality

Impounded lacustrine features in the project area include the Antioch, Contra Loma, Los Vaqueros, and Marsh Creek Reservoirs. The Antioch, Contra Loma, and Los Vaqueros Reservoirs were constructed to store drinking water for consumers in Contra Costa County. These reservoirs capture surface waters from their surrounding watershed areas. In addition, water is pumped from the Delta and transported to the Los Vaqueros Reservoir for storage. Retention of the Delta water in the reservoir improves water quality of the reservoir because sediments are allowed to settle out of the water column, along with metals and other contaminants adsorbed to the sediment.

The Marsh Creek Reservoir was created in the 1950s to protect against flooding. This reservoir is not used for drinking water primarily because of high levels of mercury whose primary source is an abandoned mine in Upper Marsh Creek. This reservoir retains mercury-contaminated sediments in the reservoir bottom. The removal of mercury from the system improves downstream water quality. However, water and sediments within the reservoir will become increasingly toxic as mercury accumulates.

The Contra Loma and Antioch Reservoirs provide additional water supply for Contra Costa County. The Contra Loma Reservoir is managed by the CCWD, while the Antioch Reservoir is managed by the City of Antioch. Both allow recreation activities, such as swimming and fishing, but are closely monitored to maintain good drinking water quality.

## Hydrologic Cycling

As with perennial wetland features, large reservoirs provide important sources of water vapor for the atmosphere. This is particularly the case for Los Vaqueros, which is situated high in the Kellogg Creek watershed. Reservoirs also function to enhance groundwater recharge. Further discussion of evaporation and groundwater recharge can be found above in the PPEM section (Section 4.2).

## Flood Storage and Conveyance

One of the many functions of reservoirs is flood control. Dams have been strategically constructed to capture storm flows behind a reservoir to prevent flooding of property and residences downstream. This is the case for the Marsh Creek Reservoir and, to some degree, the Contra Loma, Antioch, and Los Vaqueros Reservoirs. When storm flows fill a reservoir, water is released slowly over a long period of time to prevent damage downstream. This represents the alteration of the natural hydrograph, whereby peaks are attenuated and flow duration is typically increased. Lower peak flows minimize downstream erosion in the short term. However, in the longer term, sediment trapping behind dams prevents downstream sediment rejuvenation and sediment delivery to the coastal

zone, and can increase erosion due to greater velocity and erosivity of water without sediment loads.

## 4.7 Palustrine Nonpersistent Emergent and Palustrine Aquatic Bed/Unconsolidated Bottom

Palustrine nonpersistent emergent and palustrine aquatic bed/unconsolidated bottom WoUS are equivalent to ponds in the HCP/NCCP (Table 4-1).

### 4.7.1 Geomorphic Unit

These features are found at agricultural and golf ponds.

### 4.7.2 Description

Palustrine nonpersistent emergent (PNEM) WoUS are small perennial or seasonal ponds dominated by submerged or floating vegetation. Palustrine aquatic bed/unconsolidated bottom (PAB/UB) WoUS are similar, but contain little or no vegetation. If vegetation is present, it is typically submerged or floating. Most PNEM and PAB/UB WoUS in the inventory area were created or expanded for livestock use (stock ponds), although some occur naturally, some were created as a part of golf courses, and others were created for water treatment.

### 4.7.3 Location and Extent

This wetland type is very common in the landscape of the inventory area but occupies a small overall area, a total of 161 acres (<1%) at 407 sites. Ponds are evenly distributed in the foothills/upper valley region of the inventory area, which is dominated by grazing. Ranchers have created ponds in this area to support cattle grazing operations. This pattern can be seen, for example, in the Kellogg, Brushy, Deer, and Briones Creek subbasins.

### 4.7.4 Mapping Methods Unique to WoUS Type

Ponds discernible on aerial photographs were mapped as PNEM or PAB/UB. Pond mapping generally included all open water occupying between 0.25 and 5 acres (including all stock ponds used by livestock). Ponds were easily discernible on the basis of two distinctive aerial photograph signatures. One signature—smooth, uniform, and dark black—indicates deeper and less turbid ponds. The other signature—light gray-brown—generally indicates a shallower

or more turbid pond. The latter signature was more difficult to discern on the aerial photographs and in many cases required field verification. Where discernible, this WoUS type was mapped to the high water line. Some PPEM wetlands were likely included as PNEM WoUS.

## 4.7.5 Function

### Habitat

Like lacustrine WoUS, PNEM and PAB/UB WoUS may support a variety of ducks and shore and wading birds. PNEM WoUS, together with PPEM WoUS, are of particular importance to native amphibians as breeding habitat.

Agricultural ponds are present because of grazing operations. They provide habitat for some species, even when unvegetated. However, heavy livestock use of these ponds reduces their habitat value for some species by causing the loss of emergent vegetation and eutrophication from increased nitrogen due to cattle urine.

Golf course ponds are mostly landscaped and offer little habitat function because they lack native vegetation and complex vegetative structure. Ponds created for water treatment generally offer little habitat function because they are isolated from other habitats that are suitable for wildlife.

### Water Quality

Most stock ponds contain nutrient rich water that is high in suspended sediment and bacteria. While cattle trampling and consumption of wetland vegetation can reduce filtering and nutrient cycling functions in these ponds, the ponds continue to function as sediment traps, reducing the impact of rapidly eroding areas on downstream creeks.

### Hydrologic Cycling

Groundwater infiltration varies in PNEM and PAB/UB WoUS in the study area. Where soil is protected from compaction by good grazing management, PNEM and PAB/UB WoUS soils remain uncompacted, allowing for a high rate of groundwater infiltration. In some areas, heavy trampling by cattle may lead to compaction, reducing the quantity of infiltration to groundwater and absorption in the surrounding area. Thus, compacted soils retain water within the pond for a longer period of time, which serves cattle well. Because these WoUS retain water, they contribute to the hydrologic cycle through evaporation and minor amounts of shallow groundwater recharge. However, these ponds tend to be small and located on clay-rich soils that do not allow much groundwater

infiltration or evaporation. Stormwater retention ponds are commonly constructed to allow infiltration to groundwater supplies.

## **Flood Storage and Conveyance**

PAB/UB functioning as cattle ponds tend to be small and shallow, offering little flood storage capacity. Surface flows from storms fill the majority of these ponds but contribute minutely to groundwater recharge and protection from downstream erosion.

On the contrary, the primary function of stormwater retention ponds is to store runoff from surrounding impervious surfaces. Many developed areas of the project are disconnected with a natural stream network. Developers build stormwater retention ponds to capture and store surface runoff to reduce modifications of the natural hydrograph that would otherwise be caused by an increase in impervious surface. This prevents damage to streets and structures and an opportunity to remove contaminants from the water before it is released to downstream areas. Vegetation is commonly encouraged to grow in these ponds to increase filtering functions. Vegetation and the large storage area reduce the velocity of incoming stormwater flows, thus encourage settling of sediment from the water column. To maintain the flood storage capacity of these ponds, accumulated sediment at the pond bottom is removed regularly.