

Chapter 5

Subbasin Analysis and Results by Geomorphic Region

In this chapter, each major subbasin is described in detail. Subbasin descriptions are organized according to the following four subjects.

- Physical setting.
- Waters of the U.S. types.
- Waters of the U.S. functions.
- Management considerations for WoUS preservation and enhancement.

The physical setting discussions describe geology, soil, climate, hydrology, and land-use conditions to provide context for WoUS occurrence and hydrogeomorphic functioning. The discussions of WoUS types describe the types found in each subbasin. The discussions of WoUS function describe habitat, water quality, and hydrologic functioning of each WoUS type in the subbasin. The discussion of management considerations summarizes the opportunities and constraints for wetland protection, enhancement, or restoration. This chapter discusses WoUS types and functions on a subbasin level. Table 5-0 shows the approximate size of each subbasin, as well as the amount and number of each WoUS type mapped as being present. A list of each mapped WoUS in the inventory area, classified by Cowardin type and geomorphic class, and ranked according to overall functional value, is presented in Appendix A. Appendix B includes aerial photographs of each mapped WoUS.

5.1 Montane Region

The montane region supports a small portion of the Upper Mount Diablo Creek subbasin and the entire Upper Marsh Creek subbasin.

5.1.1 Upper Mount Diablo Creek

The Upper Mount Diablo Creek subbasin consists of the portion of the Mount Diablo Creek watershed from the headwaters downstream to approximately the northern boundary of the City of Clayton. The portion of the watershed

Table 5-0. Impervious Cover and Waters of the U.S. Types by Subbasin in the Inventory Area

Subbasin	Total Size (acres)	Existing Condition (acres and % of subbasin total)		Waters of the U.S. Types										
		Impervious Land Cover ¹	Pervious Land Cover ²	PPEM (Alkali)	PPEM (Seasonal)	PPEM (Permanent or Seasonal [undetermined])	Palustrine forest/scrub	PAB/UB and PNEM (ponds)	Lacustrine impounded (Reservoir)	Total WoUS Acres (and number mapped)	Riverine nontidal (Upper and lower perennial, intermittent)	Riverine tidal (Slough)	Riverine excavated artificial (Aqueduct, drainage channels)	Total Riverine Miles
Briones Creek	4,257	143 (3%)	4,384 (97%)	5 (2)	7 (3)	4 (13)	0.1 (1)	8 (8)	2 (1)	26.1 (28)	19	0	0	19
Brushy Creek	24,557	991 (4%)	23,566 (96%)	384 (60)	42 (6)	161 (55)	15 (5)	29 (48)	46 (11)	677 (185)	47	8.7	48.5	104.2
Deer Creek	4,034	901 (22%)	3,133 (78%)	6 (2)	1 (3)	7 (6)	0	10 (20)	7 (1)	31 (32)	12	0	0	12
Dry Creek	2,668	725 (27%)	1,943 (73%)	17 (7)	1 (1)	3 (7)	0	8 (25)	0	29 (40)	7	0	0.3	7.3
East Antioch Creek	7,170	5,027 (70%)	2,143 (30%)	0	0	10 (3)	13 (3)	1 (2)	21 (2)	45 (10)	7	0.7	0.3	8
East County Delta Drainages	20,385	2,101 (10%)	18,284 (90%)	0	13 (5)	110 (21)	11 (2)	6 (6)	34 (5)	174 (39)	0	3	93	96
Kellogg Creek	20,732	269 (1%)	20,463 (99%)	15 (3)	11 (4)	48 (36)	26 (20)	20 (57)	1437 (2)	1,557 (122)	56	11.5	4	71.5
Kirker Creek	9,496	3,059 (32%)	6,437 (68%)	0	12 (7)	7 (19)	43 (10)	3 (15)	7 (1)	72 (52)	41	0.2	0.4	41.6

Subbasin	Existing Condition (acres and % of subbasin total)			Waters of the U.S. Types										
	Total Size (acres)	Impervious Land Cover ¹	Pervious Land Cover ²	PPEM (Alkali)	PPEM (Seasonal)	PPEM (Permanent or Seasonal [undetermined])	Palustrine forest/scrub	PAB/UB and PNEM (ponds)	Lacustrine impounded (Reservoir)	Total WoUS Acres (and number mapped)	Riverine nontidal (Upper and lower perennial, intermittent)	Riverine tidal (Slough)	Riverine excavated artificial (Aqueduct, drainage channels)	Total Riverine Miles
				(acres, with number mapped shown in parentheses)								(Miles)		
Lower Marsh Creek	10,454	4,654 (45%)	5,800 (55%)	0	0	18 (11)	46 (14)	1 (4)	26 (5)	91 (34)	4	6	10.4	20.4
Oakley	3,892	2,755 (71%)	1,137 (29%)	0	1 (1)	29 (10)	7 (3)	3 (1)	64 (3)	104 (18)	0	0	0.1	0.1
Sand Creek	9,611	1,261 (13%)	8,351 (87%)	11 (3)	75 (7)	13 (9)	20 (3)	17 (43)	0	136 (65)	29	2	0	31
Upper Marsh Creek	28,375	360 (1%)	28,015 (99%)	0	1 (2)	19 (29)	171 (30)	35 (104)	31 (2)	257 (167)	90	0	0	90
Upper Mt Diablo Creek	8,235	1,800 (22%)	6,434 (78%)	0	0.3 (2)	3 (7)	13 (4)	6 (19)	0	22.3 (32)	36	0	0	36
West Antioch Creek	8,018	3,433 (43%)	4,586 (57%)	0	2 (1)	19 (17)	45 (14)	3 (14)	126 (2)	195 (48)	25	0.8	0.1	25.9
Willow Creek	11,372	6,018 (53%)	5,354 (47%)	0	14 (6)	52 (34)	39 (18)	10 (16)	12 (1)	127 (75)	28	0	1	29
Total	173,256	33,497	140,030	438 (77)	180.3 (48)	503 (277)	449.1 (127)	160 (382)	1813 (36)	3,543 (947)	401	32.9	158.1	592

¹ Estimate of impervious cover mapped as urban, aqueduct, wind turbines, and landfill.

² All other land cover types mapped in the HCP including grassland, chaparral, oak woodland, wetland, aquatic, irrigated agriculture, and turf.

downstream of Clayton is not included in the inventory area. This subbasin covers approximately 8,235 acres, representing approximately 5% of the inventory area. Figure 5-1a shows the location of WoUS types found in the Upper Mount Diablo Creek subbasin.

Physical Setting

Geology

Mount Diablo Creek flows off the northern slopes of Mount Diablo, draining narrow, steep canyons. In the lower portion of the subbasin, the stream transitions to a wider valley, where the City of Clayton is located. Much of the exposed bedrock in the upper portion of the watershed is classified as Oakland conglomerate, which is made up of silicic volcanic rocks and quartz sandstone. An interesting feature of the subbasin's geology is the presence of what appears to be an ancestral drainage, marked by patches of poorly sorted gravel, sand, silt and clay up to 164 feet thick. These formations are sediment sources for the creek downstream. Dense sand and gravel alluvial deposits are located along the channel of Mount Diablo Creek, particularly at the transition zone towards the base of the mountain. Most of the creek channel is occupied by alluvial deposits composed of less-dense sand and gravel.

Soils

The headwaters of the subbasin are located in the rock outcrop-xerorthents association, characterized by steep to very steep areas of rock outcrop and excessively drained, very shallow loamy soils that formed in material weathered from sedimentary rock and basic igneous rock on uplands. This area has low potential to form wide floodplains or offstream wetlands.

The lower portion of the subbasin is located within the Tierra-Antioch-Perkins association, characterized by nearly level to moderately steep, well-drained clays and well-drained loams and clay loams that formed in old alluvium on terraces. The Brentwood-Rincon-Zamora association, which is characterized by nearly level to gently sloping, well-drained clay loams and silty clay loams on valley fill, alluvial fans, and low terraces also occurs in this subbasin. The well-drained soils of this subbasin result in a relatively low potential to form wetlands.

Zamora silty clay loam deposits are found along the Mount Diablo Creek channel for much of its length, with adjoining areas of Perkins gravelly loam and Capay Clay. The creek's tributaries traverse areas of Los Osos clay loam and Lodo clay loam. Patches of Gilroy clay loam and rock outcrop-xerorthents associations comprise soils of the uppermost portions of the subbasin.

Climate

Precipitation in the subbasin averages 18 inches per year. Precipitation decreases from south to north down the mountain from a high of about 22 inches on the slopes of Mount Diablo to about 16 inches at the City of Clayton's northern boundary.

Hydrology and Land Use

Upper Mount Diablo Creek subbasin contains the following tributaries: Mitchell Creek, Deer Flat Creek, Back Creek, Donner Creek, Russellmann Creek, and Irish Creek. Portions of these creeks are spring-fed and perennial. Groundwater flows through fractured bedrock to supply water to these drainages. In addition to groundwater and storm flows from the upper watershed, diverted runoff from streets, houses, and parking lots in the lower urbanized area of the watershed are delivered to lower stream channels.

The upper portion of this subbasin is within Mount Diablo State Park; other upper areas are used for grazing. Upper portions of the subbasin are forested. Riparian forest along the stream channels provides wildlife habitat and shading. Minimal floodplain areas are present.

The lower portion of the subbasin, which constitutes the majority of the subbasin's area, is dominated by urban development. While Mount Diablo Creek remains in a natural channel throughout most of its length, several tributaries have been redirected underground through culverts in the City of Clayton.

Waters of the U.S. Types

WoUS types in the Upper Mount Diablo Creek subbasin include four of the general types described in Chapter 4.

- Riverine nontidal (upper perennial and intermittent streams).
- Palustrine forest (riparian forest).
- Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (golf course ponds and agricultural ponds).
- Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands).

Figure 5-1b shows representative photos of WoUS types commonly found in this subbasin. Table 5-1 summarizes the functions of each WoUS type found in the Upper Mount Diablo Creek subbasin.

Apart from the streams themselves, most other WoUS types in the subbasin are palustrine forest (riparian woodland) and PAB/UB (ponds). Most of the mapped

Table 5-1. Upper Mount Diablo Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic (HGM) Class	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal (upper perennial and intermittent streams)	Montane Stream Channels	Pool and riffle formations within the channel provide unique habitat for rare wildlife species, such as CRF and juvenile fish.	High	Steep topography and transport of sediment and large woody debris to the channel creates step-pools, thus providing high quality in-channel habitat for fish and wildlife. Cold water inputs to the channel reduces water temperature thus improving water quality.	High	High	High
Riverine nontidal (upper perennial and intermittent streams) continued	Foothill/Terrace Stream Channels Valley Stream Channels	Areas protected by state parks provide moderate to high quality plant and wildlife habitat. Where adjacent land is grazed or occupied by residential use the channel contains less species diversity.	Moderate	Residential use in the lower subbasin has reduced groundwater recharge and flood storage functions. Many reaches of stream channels have been routed underground to prevent flood damage to property, thus reducing hydrologic functions.	Low	Moderate in protected areas Low in residential areas	High in nonresidential areas Low in residential areas
Palustrine forest (riparian forest)	Montane Stream-Banks	Rare plant and wildlife species found in the high quality habitat provided by upper riparian woodlands	High	Riparian vegetation, particularly tall trees, contributes to the formation of step-pools when branches or tree trunks fall and become lodged in the channel. This improves water quality and hydrologic functioning.	High	High	High
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	Valley Bottom depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	Adjacent land is occupied by grassland or oak woodland habitat that is managed for cattle grazing or open space. High quality habitat for	High	These wetlands function to improve water quality through filtration of sediment and nutrients from surface flows.	High	High	High

foothill and valley
species is found here.

Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Agricultural Ponds and Reservoirs	Breeding habitat for CTS and other amphibians are provided by these ponds	Moderate	Ponds function to provide small quantities of flood storage and groundwater recharge.	Low	Moderate	Moderate
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* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio		Wetland Preservation Needed (acres)	Wetland Available for Preservation ^a (acres)	Wetland Needed for Restoration (acres)
			Preservation	Restoration			
Riverine nontidal (upper perennial and intermittent streams)	36						
Palustrine forest (riparian forest)	13						
Palustrine persistent emergent (PEM) (seasonally or temporarily flooded wetlands)	3.3						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	6						

^a Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

WoUS in the Upper Mount Diablo Creek subbasin are located in or adjacent to the creeks themselves. Ten WoUS, mostly agricultural ponds, were identified and mapped outside the creek channel and floodplain.

Waters of the U.S. Functions

Habitat

Riverine Nontidal (Upper Perennial Streams)/Palustrine Forest

The perennial stream reaches of the subbasin provide a high level of habitat function. These reaches are principally found near the headwaters of Mount Diablo Creek and its tributaries, where groundwater seeps provide year-round flow. Riparian woodland along upper perennial streams provides habitat for rare plant species such as Diablo helianthella (*Helianthella castanea*) and Mount Diablo fairy lantern (*Calochortus pulchellus*), both of which have been documented along streams in the subbasin (CNDDDB 2003). These wetland types may also provide habitat for California red-legged frog (CRF), which has been documented in the subbasin (CNDDDB 2003). Pools and riffles in these reaches provide prime habitat for wildlife, particularly juvenile fish species. Palustrine forest serves an important role in the subbasin in maintaining lower water temperatures, which is particularly important because Mount Diablo Creek historically supported a population of Central California Coast steelhead.

Intermittent Streams/Palustrine Forest

Intermittent streams in the subbasin provide variable levels of habitat function. Some intermittent stream reaches are located in Mount Diablo State Park or in grazing land, both of which enable moderate to high levels of habitat function. The stream corridor, which frequently retains riparian woodland in a narrow band along the channel, provides valuable habitat for wildlife in these areas. Rare plant species, such as Diablo helianthella, may be found along these reaches. Other intermittent stream reaches are located in residential areas. These stream reaches in residential areas have lower habitat value, but they may provide a movement corridor for a more diverse suite of species to the 8-mile reach of undeveloped floodplain in the Concord Naval Weapons Station.

Palustrine Aquatic Bed/Unconsolidated Bottom

General comments in Chapter 4 on habitat functions provided by PAB/UB apply to the Mount Diablo Creek subbasin. Seasonal ponds in the subbasin may provide breeding habitat for the California tiger salamander (CTS), which has been documented in the subbasin (CNDDDB 2003), and other amphibians.

Palustrine Persistent Emergent (Seasonally or Temporarily Flooded)

All the mapped seasonal wetlands in the subbasin are surrounded by grassland or oak woodland, managed either for grazing or open space, enhancing their habitat function relative to seasonal wetlands in developed areas. No field visits were made to seasonal wetlands in this subbasin because access and budget were limited.

Water Quality

Riverine Nontidal/Palustrine Forest

A steep gradient stream, such as Upper Mount Diablo Creek, functions to supply sediment from upland sources to downstream depositional reaches. Streams of this type commonly form a step pool and riffle sequence. This channel form promotes channel bed scour and sediment transport, as well as increasing dissolved oxygen concentration and recruitment of large woody debris (fallen trees), which forms and stabilizes the pools and riffles. Coarse sediment transport from upstream areas is important to prevent erosion downstream because sediment-starved waters may have greater erosivity.

Palustrine Aquatic Bed/Unconsolidated Bottom (Ponds)

Ponds enhance water quality by reducing suspended sediments and removing phosphorus and nitrogen through adsorption to the aluminum and iron in the subbasin's clay soils. Ponds also function as important sources of groundwater recharge. Contaminants that could pollute a groundwater aquifer, such as mine drainage, pesticides, and organic matter, are retained in bottom sediments of ponds.

Palustrine Persistent Emergent (Seasonally or Temporarily Flooded)

Seasonal wetlands adjacent to streams enhance water quality by filtering fine sediments, nutrients, and heavy metals from surface flow entering streams. Isolated seasonal wetlands enhance groundwater quality through the same mechanism by filtering out nutrients and heavy metals that might otherwise enter the groundwater.

Hydrologic Cycling and Flood Storage

Riverine Nontidal

The well-drained alluvial soils of the subbasin allow groundwater recharge, reducing surface runoff and flooding. Flood storage and groundwater recharge would naturally be concentrated at the transition zone from steep to gentle gradients and in the lowland areas of the watershed. While Mount Diablo Creek and a narrow buffer have been conserved in most of the subbasin, much of the transition zone and lowland areas have been developed for residential and industrial use, which has reduced groundwater recharge and flood storage in this area. Partly to cope with the increased flooding that could result, several tributaries of Mount Diablo Creek have been routed underground to prevent damage to developed areas.

Palustrine Aquatic Bed/Unconsolidated Bottom

These WoUS types provide flood storage by collecting surface runoff and slowly releasing it into the groundwater, streams, and the atmosphere. Because most of the subbasin's ponds are in the higher elevation area of the subbasin, they collect surface runoff from a smaller area and provide less flood storage.

Palustrine Persistent Emergent (Seasonally Flooded)

The general discussion in Chapter 4 describing PPEM functions applies to PPEM wetlands present in this subbasin.

Management Considerations for WoUS Conservation and Enhancement

WoUS in the upper portion of this subbasin currently provide a high level of habitat function because of the presence of well-developed riparian woodland vegetation. Habitat, water quality, and hydrologic functioning of the lower portion of the watershed are constrained by development. Table 5-1 summarizes the overall quality of WoUS types.

Without large and impractical changes in land use, little potential exists to increase habitat, water quality, and hydrologic functioning in this subbasin. Residential development has encroached into the mountain transition zone, where steep gradients transition into gently sloping lowlands. This transition zone and gradient break is important for groundwater recharge because surface waters from higher elevations will flow subsurface to the underlying aquifer.

Some increase in WoUS function could result from the restoration of riparian woodland to intermittent stream reaches in the upper portion of the subbasin. The restoration of woodland vegetation to these reaches would result in better cover, increased food sources, and more complex structures for wildlife. Woodland vegetation would also reduce fine sediments in the creek and water temperature, thus improving habitat conditions for fish.

Restoring and enhancing emergent marsh vegetation surrounding ponds and streams would also improve habitat and water quality in this subbasin. Once vegetation regenerated, it would trap sediment, nutrients, and minerals, thus improving water quality downstream.

5.1.2 Upper Marsh Creek

Physical Setting

This subbasin covers approximately 28,375 acres, representing approximately 16% of the inventory area. Figure 5-2a shows the location of WoUS types found in the Upper Marsh Creek subbasin.

Geology

Like Upper Mount Diablo Creek, Upper Marsh Creek flows off the steep slopes of Mount Diablo. The subbasin can be divided into three geomorphic regions:

montane (44% of stream miles), foothills/upper valley (52%), and lower valley/plain regions (4%). Upper Marsh Creek is classified as a montane subbasin because its high percentage of montane area is unusual for the subbasins in the inventory.

Closest to their headwaters, Marsh Creek and many of its tributaries are confined to steep, bedrock canyons. The creek then enters a narrow valley bottom that cuts across several ranges of foothills before opening out into a wide valley. Marsh Creek flows through this valley to the Marsh Creek reservoir.

The Upper Marsh Creek subbasin comprises early and late Cretaceous sandstone and shale. The upper tributaries cut through cobble conglomerate overlaying conglomeratic sandstone and white rhyolite tuff. Bands of medium- to coarse-grained sandstones and shales are encountered throughout the basin. The creek channel cuts through these bedrock formations; thus large cobbles and boulders are transported throughout the upper basin.

Soils

Upper Marsh Creek, upstream from the confluence with Curry Canyon Creek and including Curry Canyon Creek, is overlain by soils of the Dibble series. These consist of shallow, well-drained silty clay loam soils interbedded with soft shale and sandstone. Exposed bedrock outcroppings are found along high-elevation ridgetops. The mid portion of this basin is located in the Los Osos-Millsholm-Los Gatos association, characterized by moderately steep to very steep, well-drained clay loams and loams that formed in material weathered from interbedded sedimentary rock on uplands. Soils of the lower reach of Upper Marsh Creek, from approximately 1.5 miles west of Deer Valley Road to the Marsh Creek Reservoir, are Brentwood clay loam. These soils are moderately alkaline, and well drained. The lowermost tributary, Round Valley Creek, flows through Altamont-Fontana silty clay loam and Cropley clay in its upper reaches and Los Osos clay loam in its lower reaches. These lower subbasin soils have slow infiltration rates and high runoff. Though the slopes in the area with Cropley clay are shallow, 2 to 5%, surface waters may runoff too quickly and in volumes too small for wetlands to form.

Climate

Average annual rainfall for the entire Marsh Creek watershed is approximately 17 inches. Rainfall decreases rapidly from west to east across the upper subbasin, from a high of approximately 25 inches at the headwaters to a low of approximately 14 inches at Marsh Creek Reservoir.

Hydrology and Land Use

Upper Marsh Creek drains the foothills to the southeast of Mount Diablo. The main channel runs in a narrow valley that widens as the creek turns to flow southeast. The Upper Marsh Creek subbasin includes the following large tributaries: Curry Canyon, Sycamore, and Round Valley. Portions of these tributaries, as well as parts of Marsh Creek itself, have valley foothill characteristics—wide functioning floodplain areas conveying upland flow and sediment in a narrow meandering channel. Steep topography in the upper canyon reaches lead to increased erosion of bedrock materials. Due to the steep topography, natural wetlands are lacking in the upper montane area. WoUS in this area consist of the stream channels themselves and stock watering ponds. Most reaches of Upper Marsh Creek are perennial, changing to seasonal downstream. The streambed contains small boulders and large cobbles. The channel carries high flows through narrow valleys that widen further downstream. As the topography flattens, flow gradients become gentler, the channel widens, and fine-grained sediments and gravels dominate the streambed. Increased grazing activities add nutrients, which encourages algae growth in slow moving waters and ponded areas.

Little development has occurred in this subbasin. Portions within Cowell Ranch State Park and land under EBRPD management are protected open space. Land use in this subbasin consists of grazing, residential, and recreational park use.

Waters of the U.S. Types

WoUS types in Upper Marsh Creek can be subdivided into the following five categories described in Chapter 4.

- Riverine nontidal (upper perennial, lower perennial, and intermittent stream).
- Palustrine forest/scrub.
- PAB/UB.
- Impounded lacustrine (Marsh Creek Reservoir).
- PPEM (perennially, seasonally, and temporarily flooded).

Figure 5-2b shows representative photos of WoUS types commonly found in this subbasin. Table 5-2 summarizes the functions of each WoUS type found in the Upper Marsh Creek subbasin.

Apart from the streams themselves, the majority of the WoUS types in the subbasin consist of palustrine forest (riparian woodland). Ponds and the Marsh Creek Reservoir make up most of the remaining WoUS types. The majority of the mapped WoUS in the Upper Marsh Creek subbasin are located in or adjacent to the creeks themselves. Approximately one third of the WoUS in the subbasin are off-channel WoUS, or are found outside the creek channels. These WoUS

Table 5-2. Upper Marsh Creek Subbasin: Summary of Wetland Functions/Valuation

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
Riverine nontidal upper perennial	Montane stream channels	Pool and riffle formations, sandy point bars, within the channel provide a variety of habitats. Habitat for rare wildlife species, such as CRF and WPT.	High	Mercury contamination downstream of Dunn Creek. Sediment sources.	Moderate (most upper perennial reaches are upstream of Dunn Creek)	High	High
Riverine nontidal lower perennial	Valley Stream Channels	Habitat quality varies depending on adjacent land cover (riparian forest or grassland). CRF and WPT occurrences documented.	Moderate	Mercury contamination. Filtration capacity higher in eastern portion of subbasin where high clay soils are found. High flood storage and groundwater recharge function, especially at transition from steep to gentle gradients.	Low	Low	Moderate
Riverine nontidal intermittent	Montane stream channels, Foothill/Terrace Stream Channels	Intact riparian forest adjacent to channel provides high quality habitat for species such as CTS.	High	Mercury contamination downstream of Dunn Creek. High clay content in the Brentwood soils, concentrated in eastern part of subbasin, facilitate filtration.	Low	Moderate	Moderate
Palustrine forest (riparian forest)	Montane Stream-Banks	Rare plant and wildlife species found in the high quality habitat provided by upper riparian woodlands	High	Generates coarse woody debris, increasing channel variability. Maintains cool water temperatures.	High	High	High
Palustrine persistent	Valley Bottom	Habitat quality varies	Moderate	Filtration capacity	Moderate	Moderate	High

Functional Type	Hydrogeomorphic Class (HGM)	Biological Functions	Biological Quality	Hydrologic Functions	Hydrologic Quality	Overall Quality	Potential Quality*
emergent (PPEM) (seasonally or temporarily flooded wetlands)	depressional wetlands, Stream Floodplains, Bottomlands or Pond Margins	with adjacent land use. Adjacent land is occupied by grassland or oak woodland habitat, sometimes overgrazed.		higher in eastern part of subbasin because of high clay soils. Wetlands in and adjacent to streams provide greater water quality functioning because of lower livestock impacts.			
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	Agricultural ponds	Breeding habitat for CTS and other amphibians are provided by these ponds	Moderate	Ponds function to provide small quantities of flood storage and groundwater recharge. In-stream ponds store mercury in trapped sediments.	Low	Moderate	Moderate
Impounded lacustrine	Reservoir	Woodland surrounding reservoir enhances habitat. WPT occurrences documented.	Low	Stores mercury in sediments on reservoir bottom. Sediment sink results in sediment starved waters downstream, increasing erosivity of creek flows. Provides flood storage and groundwater recharge.	Low	Low	Low

* “Potential” as related to management considerations or mitigation efforts as proposed here or in the HCP.

Functional Type	Est. Total in Inventory Area (acres)	Est. Impact (acres)	Mitigation Ratio		Wetland Preservation Needed (acres)	Wetland Available for Preservation ^a (acres)	Wetland Needed for Restoration (acres)
			Preservation	Restoration			
Riverine nontidal upper perennial	90 miles						
Riverine nontidal lower perennial							
Riverine nontidal intermittent							
Palustrine forest (riparian forest)	171						
Palustrine persistent emergent (PPEM) (seasonally or temporarily flooded wetlands)	20						
Palustrine aquatic bed/unconsolidated bottom (PAB/UB) (ponds)	35						
Impounded lacustrine	31						

^a Available within Land Acquisition Analysis Zones with moderate or high acquisition priority

are mostly agricultural ponds, although there are a number of PPEM wetlands off the streams in this subbasin as well.

Waters of the U.S. Functions

Habitat

Riverine Nontidal (Upper Perennial)/Palustrine Forest

The perennial stream reaches of the subbasin provide a high level of habitat function. These reaches are principally found near the headwaters of Marsh Creek and its tributaries, where groundwater seeps maintain water in some pool and stream reaches year-round. Riparian forest and woodland lines the stream corridor, and in some places marshes or seasonal wetlands are found in the adjacent floodplain. Variation in the form of bedrock in the stream channels results in a diverse stream profile with deep pools and shallow riffles that provide a variety of habitat types.

This portion of the subbasin provides habitat for rare, threatened, and endangered wildlife species such as CRF and Western pond turtle (WPT) (CNDDDB 2003). The combination of perennial pools and stream reaches for breeding with woodland and forest vegetation in adjacent areas provides good habitat for CRF. The intact riparian vegetation and open space adjoining the channels in these reaches provide foraging and breeding habitat for WPT. Sandy point bars provide basking habitat for WPT.

Riverine Nontidal (Lower Perennial)/Palustrine Forest

The lower perennial stream reaches in the subbasin provide a variable level of habitat functioning. Upstream of the point where Marsh Creek enters a broad valley and flows southeast (approximately 1.5 miles upstream of Deer Valley Road), the creek flows through a landscape with extensive riparian woodland and forest. Downstream, Marsh Creek enters a wide valley managed intensively for agriculture, primarily grazing. Although the creek maintains a corridor of riparian woodland vegetation, the surrounding land use is less suitable for some wildlife species than it is upstream. Occurrences of WPT and CRF have been documented throughout the lower perennial reaches of this subbasin (CNDDDB 2003).

Riverine Nontidal (Intermittent)/Palustrine Forest

The intermittent streams in the subbasin provide high levels of habitat function. Most intermittent stream reaches are located in Cowell Ranch State Park, EBRPD lands, or in privately held woodland and forest, land uses which provide moderate to high levels of habitat function. The stream corridor retains riparian woodland and forest along the channel and provides valuable habitat for wildlife in these areas. Ephemeral stream reaches adjacent to natural vegetation may provide habitat for CTS. Occurrences of CTS have been documented in and adjacent to the intermittent stream reaches of the subbasin (CNDDDB 2003).

Palustrine Aquatic Bed/Unconsolidated Bottom and Lacustrine Impounded

Seasonal ponds in the subbasin adjacent to grasslands may provide breeding habitat for the CTS and other amphibians. CTS have been documented in the subbasin. A band of woodland vegetation surrounds the Marsh Creek Reservoir. WPT has been documented in the reservoir (CNDDDB 2003).

Palustrine Persistent Emergent (Perennially to Seasonally Flooded)

Perennial wetlands in the subbasin provide a variable level of habitat function. Intact freshwater marsh vegetation adjacent to grassland, woodland, and riparian forest provide access to a variety of habitats for foraging, breeding, movement, and aestivation for a diverse suite of wildlife. In some parts of the subbasin, marsh vegetation is found in and adjacent to the creek channel, but the surrounding floodplain is heavily grazed. Perennial wetlands in the subbasin may provide habitat for CRF and WPT.

Palustrine Persistent Emergent (Seasonally Flooded)

Seasonal wetlands in the subbasin provide a variable level of habitat function depending on their management and the surrounding land use. Some seasonal wetlands in the subbasin are relatively undisturbed, while others may be heavily grazed or mowed. While vernal pools were not mapped for this study, they are likely to be present in the subbasin, providing habitat for some rare, threatened, and endangered species.

Because seasonal wetlands in the subbasin are adjacent to natural grasslands and woodlands, they provide suitable habitat for CTS, which has been documented in the subbasin (CNDDDB 2003).

Water Quality

Water quality of Marsh Creek is impaired by mercury contamination, originating primarily from the historic Mount Diablo Quicksilver Mine. The historic mine is drained by Dunn Creek, a tributary which joins Marsh Creek approximately 2 miles from the headwaters of Marsh Creek. Mercury-contaminated waters and sediments from the upper watershed mine site are distributed throughout the length of the downstream system.

Riverine Nontidal/Palustrine Forest

Water quality functioning is variable in the upper perennial stream in the subbasin. Some upper perennial reaches have steep gradients that generate sediment for delivery downstream. Other reaches have gentler gradients and contain a fringe of marsh vegetation that slows and filters water flow. Riparian woodland and forest along these reaches maintain cooler water temperatures.

The low stream gradient found in vegetated perennial reaches of the subbasin, combined with high clay content in the Brentwood soils, facilitate filtration of nutrients, heavy metals, and sediment.

Palustrine Aquatic Bed/Unconsolidated Bottom (Ponds and Reservoir)

Ponds and the reservoir have variable levels of water quality functioning. The stock ponds and reservoir in the subbasin enhance ground and surface water quality by reducing suspended sediments and removing phosphorus and nitrogen through adsorption of nutrients, trapping sediments and heavy metals (notably mercury) carried by the sediments. This function is at a higher level in the eastern portion of the subbasin where Brentwood soils with higher clay content are found.

Palustrine Persistent Emergent (Perennially to Seasonally Flooded)

Marshes in this subbasin filter nutrients, sediments, and heavy metals from surface water. Vegetation growing in these wetlands immobilizes heavy metals and other contaminants within the plants themselves and in the sediment. Perennial wetlands with well-developed marsh vegetation provide this function at a higher level than perennial wetlands where vegetation is severely impacted by grazing or other land uses. Perennial wetlands in and adjacent to streams are generally protected from grazing in this subbasin, while grazing has degraded isolated off-channel wetlands. The presence and continued functioning of these wetlands improve water quality.

Palustrine Persistent Emergent (Seasonally Flooded)

Seasonal wetlands in the subbasin adjacent to streams enhance water quality in streams by filtering fine sediments, nutrients, and heavy metals from surface flow entering streams. Isolated seasonal wetlands enhance surface water quality through the same mechanism by filtering out nutrients and heavy metals that might otherwise enter the groundwater. As is the case with perennial wetlands, seasonal wetlands provide a higher level of habitat function when they are located in Brentwood soils with high clay content and when they have well-developed vegetation (generally when they are adjacent to streams or in protected open space).

Hydrologic Cycling and Flood Storage**Riverine Nontidal (Upper Perennial)/Palustrine Forest**

Headwater steep channel reaches with shallow soils do not provide significant flood storage or groundwater recharge. These reaches contribute to hydrologic cycling through cold water input from springs and sediment transport to downstream reaches.

Riverine Nontidal (Lower Perennial)/Palustrine Forest

Lower perennial streams have a high capacity to store floodwater and facilitate groundwater recharge due to their location in the subbasin. These streams lie in valleys at transitional zones in the topography between steep and gentle sloping gradients. Because of the gradient brakes, groundwater contributes to these streams during the late spring and early summer months. The Zamora and Brentwood soils found along these reaches have good water retention properties. The presence of a broad channel with a developed flood plain, supporting marsh

and woodland vegetation, provides flood storage and some groundwater recharge.

Riverine Nontidal (Intermittent)/Palustrine Forest

Intermittent streams in the subbasin provide a variable level of hydrologic functioning. Some intermittent stream reaches in the subbasin, such as parts of Perkins and Curry Creeks, have steep gradients and thin soils. These reaches transport pulses of sediment and nutrients downstream during storm events. Intermittent stream reaches with gentler gradients and deeper soils, such as those found in Round Valley Creek, have wide channels that provide flood storage and groundwater recharge.

Palustrine Aquatic Bed/Unconsolidated Bottom (Ponds and Reservoir)

Ponds and the Marsh Creek Reservoir provide flood storage and groundwater recharge functions. They also serve as sediment traps, which is particularly important for improving water quality through the removal of mercury-contaminated sediments from the system.

Palustrine Persistent Emergent (Perennial and Seasonal Wetlands)

Perennial and seasonal wetlands in the subbasin provide variable levels of flood storage and groundwater recharge, depending on the degree to which natural vegetation has been removed by grazing.

Management Considerations for WoUS Conservation and Enhancement

Much of the WoUS in the subbasin provide high-level habitat functioning. The gradients and channel forms in the upper subbasin are functioning at the level expected based on the steep morphology of the region. The upper portion of the subbasin provides an important source for channel sediment and downstream water supply. This area should be monitored to ensure that a balance of sediment and flow quantity and velocity is maintained, in order to prevent negative downstream impacts. Table 5-2 summarizes the overall quality of WoUS types.

Mercury contamination from the historic Mt Diablo Quicksilver Mine on Dunn Creek continues to impair water quality. This contamination will continue to degrade water quality because of the complexity of remediating the mine.

Restoring woodland and emergent marsh vegetation in and adjacent to WoUS in the lower portion of the subbasin (valley-plain region) could increase wildlife habitat, water quality, and hydrologic functioning. One element in the restoration could involve a change in existing grazing regimes in the small portion of the subbasin downstream of where Marsh Creek enters a broad valley (about 1.5 miles upstream of Deer Valley Road). Restored woodland vegetation would provide better cover, increased food sources, and more complex structures for wildlife. Woodland vegetation would also reduce fine sediments in the creek and

water temperature, thus improving habitat conditions for fish. Increased emergent marsh vegetation surrounding ponds and streams would also improve habitat and water quality in the lower portion of the subbasin.