D R A F T R E P O R T

SUNOL REGION HABITAT RESERVE PROGRAM LONG-TERM MANAGEMENT PLAN

Prepared for

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List of Acronyms

AUM	animal unit month
BEHI	Bank Erosion Hazard Index
CDFG	California Department of Fish and Game
EPA	Environmental Protection Agency
HRP	Habitat Reserve Program
GL	grassland
GPS	Global Positioning System
LTM	Long-term management
LTMP	Long-Term Management Plan
MMP	Mitigation Monitoring Program
OWS	oak woodlands and savannah
PW	pond and wetland
RDM	residual dry matter
RWQCB	Regional Water Quality Control Board
RIP	riparian
SFPUC	San Francisco Public Utilities Commission
U.S.C.	U.S. Code
USACE	United States Army Corps of Engineers
USFWS	United State Fish and Wildlife Service
WSIP	Water System Improvement Program

1 INTRODUCTION

The purpose of the San Francisco Public Utilities Commission's (SFPUC's) Water System Improvement Program (WSIP) is to repair, replace, and seismically upgrade the San Francisco Regional Water System's aging facilities. The SFPUC developed the Habitat Reserve Program (HRP) to compensate for impacts to a broad range of habitats and special-status species associated with implementing WSIP projects. The primary WSIP project in the Sunol Region is the Calaveras Dam Replacement Project. The Sunol Region HRP Mitigation Monitoring Plan (MMP) (URS 2010a) defines two categories of compensation:

- Restoration areas where habitats are established, re-established, and or rehabilitated
- Enhancement areas where existing habitats are enhanced

The Sunol Region MMP provides detailed performance-based success criteria and management strategies for Years 1–10 of the restoration areas. The detailed performance-based success criteria and management strategies for Years 1–10 of the enhancement areas are included in this document in Appendix A. After the SFPUC meets the restoration criteria defined in the regulatory permits (listed below) then the compensation areas will be subject to a new management plan: the Sunol Region Habitat Reserve Program Long-Term Management Plan (LTMP). The LTMP describes management of the restoration areas (after the 10-year monitoring) and the enhancement areas commencing at completion of the construction warranty period onward in-perpetuity.

The LTMP presents ecologically-based, practical management strategies. The process of adaptive management, discussed in Section 4, implemented in association with the LTMP (and the MMP), will provide the framework for updating the plan. Monitoring and data analysis will be used to evaluate management effectiveness, incorporate new information, adapt to changing conditions, and refine strategies over time to facilitate attainment of the ecological goals and objectives. As the LTMP is implemented, advancements in the collective understanding of habitat management will be cumulative and synergistic.

1.1 MANAGEMENT UNITS AND MITIGATION REQUIREMENTS

The Sunol Region HRP consists of five management units named according to their locations: Sage Canyon, San Antonio Creek, Sheep Camp Creek, South Calaveras, and Goat Rock (Figure 1). The SFPUC is placing conservation easements on each management unit to ensure protection of these lands in perpetuity. The conservation easement at San Antonio extends beyond the management unit to include a pond with an existing population of California tiger salamander (*Ambystoma californiense*). The conservation easement at Goat Rock is a subset of the management unit (Figure 1).

The LTMP for the Sunol Region HRP supports the SFPUC regulatory permit applications from:

- The U.S. Army Corps of Engineers (to obtain a permit to fill in waters of the United States pursuant to Section 404 of the Clean Water Act of 1977 [33 U.S.C. §§ 12511344 (2007)]) and to support the U.S. Army Corps of Engineers consultation with the U.S. Fish and Wildlife Service pursuant to Section 7 of the Endangered Species Act of 1973 [16 U.S.C. § 1536 (2007)])
- The San Francisco Bay Regional Water Quality Control Board (to obtain a Water Quality Certification to comply with Section 401 of the Clean Water Act of 1973)
- California Department of Fish and Game (to obtain a Streambed Alteration Agreement in compliance with California Fish and Game Code Section 1600)

1.2 MANAGEMENT PLAN GOALS, OBJECTIVES, AND STRATEGIES

Chapter 3 of the LTMP outlines management goals, objectives, and strategies for the management units. Each of these terms is described below.

Goals describe the desired future conditions of a habitat. Each goal translates into one or more objectives that define these conditions in measurable terms.

Objectives are incremental steps to take to achieve a goal. They derive from goals and provide a foundation for determining strategies, monitoring accomplishments, and evaluating success. The number of objectives per goal varies.

Strategies are tools for meeting objectives and goals. Strategies are a "toolbox" of options for achieving management goals and objectives.

1.3 BASELINE SURVEYS

Numerous biological surveys have been conducted in the HRP management units, including wetland delineations/assessments, non-native invasive weed surveys, and special-status plant and wildlife surveys (URS 2010a). Additional baseline information, as listed in Table 1, will need to be collected to implement this plan fully. These baseline surveys would be completed before implementation of the HRP compensation actions, as defined in Chapter 1.

Table 1
Baseline Surveys

Type of Survey	Location of Surveys Completed to Date (February 2011)	Survey Report Documentation (Sources)	General Location of Additional Surveys Required Within Enhancement Areas of the Conservation Easement Boundary
Special-status plant surveys	Entire watershed surveyed for 21 rare plants in 2009 (though surveys did not achieve 100 percent coverage, and were early season only). Sheep Camp Creek and San Antonio Management Units surveyed in 2008. Portions of Goat Rock Management Unit surveyed in 2008. Portions of South Calaveras Management Unit surveyed in 2006, 2008, and 2009.	Nomad Ecology 2009b;ESA and Orion 2009; May and Associates 2006; EDAW and Turnstone 2009b.	Goat Rock, Sage Canyon, and South Calaveras management units (Figures 3, **4**, and 7) (outside of area covered in earlier surveys)
Special-status wildlife surveys	Incidental observations and habitat assessment for Sheep Camp Creek, and San Antonio Creek and portions of Goat Rock and South Calaveras management units in 2008. Non-protocol surveys for California tiger salamander and incidental observations of other special-status wildlife species in the Sheep Camp Creek Management Unit and portions of the South Calaveras Management Unit in 2008, 2009, and 2010.	ESA and Orion 2009; Condor Country Consulting 2008, 2009/2010 (unpublished results)	Goat Rock, Sage Canyon, and South Calaveras Management Units (Figures 3, **4**, and **7**) (outside of area covered in earlier surveys))
Wetland assessment/delineation	Wetland assessments and delineations completed for most of all Management Units in 2008–2009.	EDAW & Turnstone 2009a; ESA 2009; ESA and Orion 2009;	Goat Rock, Sage Canyon, and South Calaveras Management Units (Figures 3, 4, and 7) (outside of area covered in earlier surveys)
Oak and riparian woody plant recruitment	No baseline	—	Oak and riparian habitats in the enhancement portions of the Habitat Reserve Program Management Units
Callippe silverspot surveys and host plant mapping	Butterfly surveys and habitat mapping conducted in Alameda watershed in 2004. Butterfly habitat assessed in the Sage Canyon, San Antonio Creek, and South Calaveras Management Units in 2009. Host plants mapped in Sheep Camp Creek Management Unit in 2010 (URS 2010d). Host plants mapped in Goat Rock and Sheep Camp Creek Management Units in 2010 (SFPUC 2010; URS 2010d).	Entomological Consulting Services, Ltd. 2004; EDAW & Turnstone Consulting 2009b	Goat Rock (Figure 3)(outside of area covered in earlier surveys); South Calaveras-portions of Field D (Figure 7)

Table 1
Baseline Surveys

Type of Survey	Location of Surveys Completed to Date (February 2011)	Survey Report Documentation (Sources)	General Location of Additional Surveys Required Within Enhancement Areas of the Conservation Easement Boundary
Non-native invasive plant mapping	Watershed-wide mapping was conducted in 2009 (though surveys did not achieve 100 percent coverage). Incidental observations recorded for portions of Goat Rock, Sage Canyon, Sheep Camp Creek and San Antonio, and South Calaveras Management Units in 2009.	Nomad Ecology 2009a; ESA and Orion 2009	Enhancement areas of all Habitat Reserve Program management units
Erosion mapping (to identify root cause of source, severity ranking, etc.)	None	—	Enhancement areas of the Habitat Reserve Program management units

2 EXISTING CONDITIONS

This chapter describes the physical location, habitats and species, existing infrastructure, historic and current land use, and natural setting of the five management units in the Alameda Creek watershed.

2.1 LOCATION AND MANAGEMENT UNIT BOUNDARIES

This section discusses the location and boundaries of each of the five HRP Sunol management units. Figure 1 shows Management Unit boundaries and conservation easement boundaries (in red). Figure 2 shows the SFPUC Alameda Creek watershed grazing units and HRP management units (see Section 2.2.2 for more information on coordination of the watershed grazing units). Conservation easements protect the restoration and enhancement areas in perpetuity.

- **Restoration areas**. Restoration area management is defined in the Sunol Region MMP for the first 10 years post construction, until performance criteria are achieved; after which time this LTMP applies.
- **Enhancement areas**. Management of enhancement areas during Years 1–10 post construction and into perpetuity are described in this LTMP.

2.1.1 GOAT ROCK

Goat Rock Management Unit is approximately 823 acres located north of Alameda Creek in the Ohlone wilderness (Figure 3). The primary access road to Goat Rock is Camp Ohlone Road to a dirt road that leads to the ridgetop at the northern boundary of the area. The terrain is steep, generally south facing, with a mixture of non-native annual grassland, serpentine grassland, oak woodlands, and scrub. Stock ponds, often associated with springs and wetlands, are scattered throughout the management unit.

Goat Rock Management Unit

Fencing surrounds the Goat Rock Management Unit on all sides with the exception of approximately 2,280 linear feet in the southeastern portion of the management area. A few cattle troughs are scattered through the area, but watering of cattle primarily is achieved using stock ponds.

2.1.2 SAGE CANYON

Sage Canyon, totaling 584 acres, is located adjacent to and north of Arroyo Hondo (Figure 4). The management unit consists of steep, south facing slopes, with upland scrub, grassland, oak woodlands and savannah. Several ponds and drainages provide water for cattle. Access to this management unit is via several unpaved roads off of Marsh Creek Road. Fencing does not surround this management unit, and therefore, no grazing management will be prescribed for this management unit in the LTMP.

2.1.3 SAN ANTONIO CREEK

San Antonio Management Unit is approximately 234 acres and is adjacent to and east of the San Antonio Reservoir (Figure 5). Primary access to the management unit is via the unpaved Ranch Road. The San Antonio Management Unit consists of a flat valley bottom where San Antonio Creek runs, as well as steep to vertical slopes above and to the north of the creek. Habitats include riparian, oak woodland, and oak savannah, non-native annual grassland and some upland scrub. Fencing surrounds the management unit in part on the north and south and eastern boundaries. Interior cross fences are present, running north south across San Antonio Creek and adjacent to Indian Creek. Water for cattle is primarily from San Antonio Creek, and ponds that are adjacent but outside of the management area.

San Antonio Creek

2.1.4 SHEEP CAMP CREEK

Sheep Camp Creek Management Unit is approximately 474 acres (Figure 6). It is bounded by Highway 84 to the south and Highway 680 to the west. Private land bounds the northern and eastern portions of the management unit. Sheep Camp Creek consists of flat to steep slopes with non-native annual grassland, oak savannah, and oak woodlands.

Several stock ponds and ephemeral drainages serve as water sources for livestock. Corrals are located in the center of the management unit near Sheep Camp Creek. Access to the Management Unit is via Koopmann Road. Perimeter fencing surrounds Sheep Camp Creek Management Unit entirely; no interior fencing is present.

Sheep Camp Creek Management Unit

2.1.5 SOUTH CALAVERAS

The South Calaveras Management Unit is approximately 434 acres (Figure 7). The management unit is located south of Calaveras Reservoir. Primary access to the management unit is via Marsh Creek Road (which is both paved and unpaved). The area is mostly flat, with oak woodlands and non-native annual grassland. Stock ponds, including Goldfish Pond, are present. No water developments (water infrastructure for cattle) are currently in the management unit; stock ponds and drainages within and adjacent to the management unit provide water source to livestock.

2.2 LAND USE

2.2.1 HISTORICAL USE (1769–2010)

The Alameda Creek watershed lands have long been used for agriculture. During the Spanish occupation of California, from 1769 to 1822, the watershed lands fell within Mission San Jose. During this time the primary use of the watershed lands by the Spanish was livestock grazing. Mission San Jose had the largest herd of cattle of any Spanish mission in California, with up to 350,000 stocked cattle at one time. After Spanish occupation and Mexican colonization of California, starting in 1822, the watershed lands were subsumed into Rancho el Valle de San Jose, where the watershed was again used for livestock grazing, as well as farming without irrigation (dryland farming). After the end of the Mexican occupation and California's entry into the U.S., the watershed lands were purchased and managed by the Spring Valley Water Company until 1930.

The Spring Valley Water Company leased their lands to ranchers who grazed cattle and sheep and farmers who farmed without irrigation (dryland farming). In 1930, SFPUC purchased the Spring Valley Water Company properties, as well as several additional parcels from local ranchers to form the approximately 38,000 acre Alameda Creek watershed lands. The SFPUC continued to lease the watershed land to local and adjacent ranchers on an informal lease basis until the late 1960's. In the early 1970's, following a widespread livestock industry advertising campaign, Alameda Creek watershed lands grazing leases were offered to the general public at an open oral auction; leases were awarded to many individuals who were not local to the watershed and who had limited experience with ranching (Koopmann, pers. comm., 2010). From that time until 1997, lack of proper management policies lead to overstocking of lease land and infrastructure deterioration. (UCANR 2006). In 1997, the SFPUC redrew grazing lease boundaries and implemented a new leasing system to ensure better land stewardship and to improve water quality in the watershed. New infrastructure was constructed in the watershed, including fencing and water systems to better distribute livestock on the landscape. This is the grazing system in place in 2010.

2.2.2 CURRENT LAND USE

The SFPUC watershed lands are managed for watershed protection. The majority, with a few exceptions, of the watershed is grazed year-round with cattle (cow-calf pairs). A few units are grazed with stockers (a stocker is a young cow that is younger than 6 months old). Grazing of the watershed is managed by watershed grazing unit, each leased to ranchers (Figure 2). The SFPUC Area Manager coordinates lessees. Table 2 provides details about current grazing management for the areas included in the LTMP.

Table 2
Details of Current Grazing Management: All HRP Management Units

HRP Management Unit	Watershed Grazing Management Unit Name	Watershed Grazing Management Unit Area (acres)	Current Grazing	Months Grazed (as of July 2010)
San Antonio	San Antonio Creek; SA-1	5,830	Stocker plus 135 cow-calf pairs	Stockers November-May; also cow-calf pairs year-round
Sage Canyon	Calaveras Creek; CA-1	10,362	Cow-calf	Year-round
South Calaveras	Calaveras Creek; CA-1	10,362	Cow-calf	Year-round
Sheep Camp Creek	Sheep Camp; LA-6	1,850	Cow-calf	Seasonal; approximately November to June
Goat Rock	Frog Pond; CA-2	481	Cow-calf	Year-round

2.3 SPECIAL-STATUS SPECIES

The HRP management units are known to support or are likely to support numerous special-status wildlife and plant species. Four key wildlife species and one suite of plant species are the focus of restoration in the HRP Management Units and are specifically addressed in this LTMP. These include: California red-legged frog (*Rana draytonii*), California tiger salamander, Alameda whipsnake (*Masticophis lateralis euryxanthus)*, Callippe silverspot butterfly (*Speyeria callippe callippe*), and endemic serpentine plant species. These species are briefly described below. For more detailed descriptions of these species, as well as figures showing the locations of special-status species, refer to the Sunol Region HRP MMP (URS 2010a).

2.3.1 CALLIPPE SILVERSPOT BUTTERFLY

Callippe silverspot butterfly habitat is generally described as San Francisco Bay Area grasslands that support the butterfly's larval food plant Johnny jump-up (*Viola pedunculata*). More specifically, essential features of Callippe silverspot butterfly habitat include (USFWS 2009):

- Grasslands with proper topography in the San Francisco Bay Area (which potentially could include cooler north- and east-facing slopes)
- Sufficient larval food plant availability
- Adequate nectar sources for adults
- Area influenced by coastal fog
- Hilltops for mating congregations

This species requires grasslands that support Johnny jump-up for breeding. Topography and density of larval food plants within grasslands are thought to influence butterfly distributions. One recent study suggests that cooler north and east facing slopes with fairly dense occurrences of both the larval food plant and nectar plants is the best habitat for the butterfly (USFWS 2009).

The Johnny jump-up host plant occurs at the Sheep Camp Creek, South Calaveras, and Goat Rock Management Units (URS 2010a).

2.3.2 CALIFORNIA TIGER SALAMANDER

California tiger salamanders require aquatic habitats for breeding, upland areas for refuge and foraging, and upland dispersal habitat. Aquatic habitat may be seasonal or perennial, but must hold water for at least 12 weeks. Upland refuge and forage habitat includes most upland vegetation types in the HRP management units. Upland dispersal habitat includes any vegetated cover that is free of barriers (e.g., heavy vegetation, roads, canals).

California tiger salamanders occur at Sheep Camp Creek and Goat Rock Management Units. They also occur in the vicinity of these two management units (URS 2010a). Suitable habitat for this species is present in each of the HRP management units.

2.3.3 CALIFORNIA RED-LEGGED FROG

The California red-legged frog inhabits permanent water sources such as streams, lakes, marshes, natural and manmade ponds, and ephemeral drainages in valley bottoms and foothills up to 4,920 ft in elevation (Bugler et al. 2003; Jennings and Hayes 1994; Stebbins 2003). Breeding habitat requires standing or slow moving water, generally 2.5 ft deep, with emergent vegetation, such as cattail (*Typha* spp.), tule (*Scirpus* spp.), or overhanging willow (Hayes and Jennings 1988). Associated upland vegetation is often characterized by poison oak (*Toxicodendron diversilobum*), California blackberry (*Rubus ursinus*), and coyote brush (*Baccharis pilularis*) (Bugler et al. 2003). Suitable habitat for this species is present in the HRP management units and non-breeding occurrences are recorded from HRP management units, except Sage Canyon (URS 2010a).

2.3.4 ALAMEDA WHIPSNAKE

Alameda whipsnake preferred habitat is characterized by Diablan sage scrub and other shrub-dominated communities, woodlands and grasslands contiguous to shrub communities, and rocky outcrops, talus slopes, and small mammal burrows (USFWS 2006). South or east-facing slopes and a sufficient prey base of western fence lizards or other prey are required.

The largest area of Alameda whipsnake habitat in the Sunol Region is in the Sage Canyon Management Unit. Smaller patches of habitat are present in San Antonio, South Calaveras and Goat Rock Management Units. Occurrences of Alameda whipsnake are recorded in the USGS quadrangles in which the San Antonio, Goat Rock and Sheep Camp Creek Management Units fall (CDFG 2010). Goat Rock and Sage Canyon also include critical habitat for this species. Therefore, it is highly likely that the Alameda whipsnake occurs in suitable habitat within the majority of the HRP management units (URS 2010a).

2.3.5 SPECIAL-STATUS PLANTS

Of the five HRP management units, special-status plant species are known to occur only within the Goat Rock Management Unit. These species are listed in Table 3. The Goat Rock Management Unit has serpentine and other unique soils that typically support special-status plants; therefore, it is likely that additional special-status plants are present in the portions of the Goat Rock Management Unit that have not been surveyed to date. In addition, Sage Canyon could support several special-status plants that follow fire (plants that typically germinate when stimulated by fire).

Table 3
Special-Status Plants in the Goat Rock Management Unit

Common Name	Scientific Name	Listing Status*
Serpentine leptosiphon	*Leptosiphon ambiguous*	CNPS List 4.2
Santa Clara thornmint	*Acanthomintha lanceolata*	CNPS List 4.2
Wooly-headed lessingia	*Lessingia hololeuca*	CNPS List 3
Van Houtte's columbine	*Aquilegia eximia*	CNPS Locally rare
Pink spineflower	*Chorizanthe membranacea*	CNPS Locally rare
Red beardtongue	*Keckiella corymbosa*	CNPS Locally rare
Pestle parsnip	*Lomatium nudicaule*	CNPS Locally rare
Brewer's phacelia	*Phacelia breweri*	CNPS Locally rare
Divaricate phacelia	*Phaceliadi varicata*	CNPS Locally rare
Brewer's groundsel	*Senecio breweri*	CNPS Locally rare

CNPS Locally Rare: Rare, Unusual and Significant Plants of Alameda and Contra Costa Counties, CNPS List 4.2: Limited distribution (Watch List), CNPS List 3: CNPS review list; Fairly endangered in California; more information on distribution of this species is needed

3 MANAGEMENT GOALS, OBJECTIVES, AND STRATEGIES

This section includes management goals, objectives and strategies for the following habitat types within the HRP management units: grassland, oak savannah and woodlands, ponds and wetlands, riparian, and scrub.

Goals and objectives in this section refer to long-term goals, objectives, and strategies which apply to restoration and enhancement areas beginning in Year 10, assuming permit compliance is achieved, and continue in-perpetuity. Performance objectives for restoration and enhancement areas immediately post construction warranty period are listed in Appendix A.

The ecological basis for the goals, objectives and strategies, as well as restoration opportunities for each habitat type is also included. This section focuses on the enhancement areas of the management units. The goals, objectives, and management strategies for the restored areas during years 1 to 10 post construction are described in the Sunol Region Mitigation Monitoring Plan (URS 2010a).

Adaptively managing ecological objectives and strategies may require prioritization of those objectives and strategies. Prioritization should be guided by the original intent of the mitigation. For example, for ponds in the HRP management units, objectives and strategies should be prioritized that maximize specific benefit to California red-legged frog and California tiger salamander. Consideration will also be given to how objectives and strategies affect other native plant and animal species and their habitat as well as ecosystem processes.

Table 4 lists habitats located in each management unit's enhancement area. Details on implementation and effectiveness monitoring for each enhancement habitat type are described in Chapter 6.

Target reduction goals included in the objectives in this section (such as target reduction in cover of non-native invasive plants) will be measured independently at each mitigation site and each type of habitat (i.e., data from each mitigation site and habitat will not be pooled with data from any other mitigation site or habitat).

Table 4
Habitats to Be Enhanced in Each HRP Management Unit

Management Unit	Non-native Grassland Enhancement	Serpentine Grassland Enhancement	Oak Woodland and Savannah Enhancement	Pond and Wetland Enhancement	Riparian Enhancement	Scrub Enhancement
Goat Rock	X	X	X	X	X	X
Sage Canyon	X		X	X	X	X
San Antonio	X		X	X	X	X
Sheep Camp Creek	X		X	X	X	X
South Calaveras	X		X	X	X	X

3.1 GRASSLAND

All of the HRP management units include areas mapped as non-native annual grasslands. Serpentine grassland, the only native grassland in the management units, occurs only at Goat Rock.

Non-native annual grassland, Alameda Creek Watershed

3.1.1 ECOLOGICAL BASIS FOR MANAGEMENT

Grasslands are critical resources in California and provide an array of ecological services and benefits. Important functions of these communities include regulating services such as water filtration, flood abatement, and soil nutrient cycling; and supporting services like agricultural crop pollination from wild insects and provision of forage for domestic livestock; and an array of cultural benefits including space for recreational activities (Millennium Ecosystem Assessment 2005). Carbon storage in grassland soils is believed to mitigate greenhouse gas emissions (Jackson et al. 2007). Most low-elevation grasslands west of the Sierra-Cascade crest are identified as "valley grasslands" (Sawyer et al. 2009). Herein, valley grasslands are referred to as non-native annual grasslands. Unique benefits that non-native annual grasslands provide for California residents include aesthetic (rural and open space views) and recreational (hunting, hiking, and wildlife and seasonal wildflower viewing) benefits.

Non-native annual grasslands provide essential habitat to many plant and wildlife species and support a number of rare, endemic, and endangered plant and wildlife species. Some wildlife species depend entirely on non-native annual grasslands throughout their lifecycle while others for only a portion (e.g., breeding habitat or food source). Non-native annual grasslands may be used by wildlife that require an unobstructed line of sight for hunting, communication, and territorial defense. Many bird species are dependent on non-native annual grassland habitat for nesting, foraging, and/or cover and include year-long residents and transitory migrants. In addition to wildlife, a diverse assemblage of native forb and grass species are found in California's non-native annual grasslands. The grasslands of Alameda County are part of the California Floristic Province, a globally recognized conservation hotspot. This ecoregion is recognized for its exceptional biodiversity, particularly the high degree of endemism (a species that is only found in a given region or location and nowhere else in the world); as well as degree of threat from habitat loss and degradation (Myers et al. 2000). Serpentine grasslands found in the Goat Rock Management Unit support several rare plant species and a diverse assemblage of native grassland and endemic serpentine species. Refer to the Sunol Region MMP for discussion of wildlife and plant species found in the HRP management units (URS 2010a).

Californian on-native annual grasslands are considered one of the most dramatic examples of plant invasions worldwide (Mooney et al. 1986). They have been heavily impacted by conversion and fragmentation due to agriculture and development, as well as invasion of non-native species, which can have a negative impact on native species, community structure, and wildlife habitat. Invasive plant species can also affect natural ecosystem functions and/or benefits such as soil nutrient cycling, water infiltration and cycling (leading to erosion or sedimentation), and wildfire (Cal-IPC 2006).

3.1.2 GRASSLAND ENHANCEMENT OPPORTUNITIES

Given the extent of invasion in today's California non-native annual grasslands and the multiple impacts such invasions can have (see Section 3.1.1, above), enhancement activities tend to focus on restoring native species. The presence of so many non-native plant species represents the single greatest impediment to grassland restoration in California (Corbin et al. 2007). The mechanism(s) non-native grassland species use to prevent the return of native perennial grasses is not clear, but non-native plant species that occur in grasslands are highly competitive in many circumstances (Corbin et al. 2007). Non-native species maintain a very large soil seed bank and can overwhelm native seedlings after fall rains. In some cases these non-native species may be allelopathic to natives (Tinnin and Muller 1971, 1972). In the HRP management units, several non-native plant species, including a suite of European annual grasses and forbs, are well established and are not targeted for removal; however, grazing will be used to help manage these species by reducing their height, biomass, and seed production. In this plan, only the non-native invasive plant species that are the most vigorous competitors of native plants and the most detrimental to wildlife habitat, are prioritized for removal from grasslands in the HRP management units. Some of the non-native invasive plant species that are known to occur in the HRP grasslands include medusa head (*Taeniatherum caput-medusae*), purple star thistle (*Centaurea cacitrapa*), yellow star thistle (*Centaurea solstitialis*), and several species of mustard (including *Brassica nigra* and *Hirschfel diaincana*.). Medusa head, in particular, produces seeds and seed heads that are noxious to livestock; its palatability is low because of high levels of silicon dioxide, and its rate of decomposition is low, resulting in the build-up of thick thatch layers. These factors increase medusa head's ability to out-compete native grassland species (Corbin et al. 2007).

Typical grassland restoration goals in California include increasing native species cover, control of non-native invasive species, erosion control or soil stabilization on disturbed sites, site water management (water quality or water retention), forage quality improvements, and/or aesthetic improvements (Stromberg et al. 2007). In terms of increasing native species cover, California grassland restoration generally focuses on native perennial grasses and, to a lesser extent, native forbs. The focus on perennial grasses is based on the assumption that by restoring the structural diversity of perennial bunchgrasses, colonization and survival of associated herbs, shrubs, insects, small mammals, and other community members will eventually occur (Goerrissen 2005). However, in serpentine outcrop areas, restoration focuses primarily on serpentine endemic forbs, with a secondary goal of fostering habitat for native perennial bunchgrasses. This is due to the rarity of serpentine endemic forbs in the Alameda Creek watershed and in California as a whole.

Grassland restoration activities also involve fostering habitat for sensitive species of fauna. The HRP management units provide habitat to many threatened and endangered species including the California red-legged frog, California tiger salamander and Callippe silverspot butterfly. For more information on these species, see Chapter 2 and the Sunol Region MMP (URS 2010a).

Generally, there are two main strategies for grassland restoration: active and passive. Passive restoration may be an appropriate strategy if a site has a population of remnant native grassland species and the non-native species cover is not dominant. A passive restoration strategy can be less intrusive and focus on management (Hayes and Holl 2003; Bartolome et al. 2004). Livestock grazing can be used as part of a passive restoration strategy to achieve management goals, usually in combination with other techniques such as non-native invasive weed control.

Active restoration may be appropriate if a site has no native species, including the native soil seed bank. Active restoration often starts with weed control and seed bed preparation to create an expanse of bare soil as free of non-native species as is practical. The most common techniques for initial weed

control are burning, mowing, mulching, the use of selective or broad-spectrum herbicides, or a combination of these. Timing is a key element. Prescribed burns for non-native species control should ideally be timed to occur after non-native annuals have committed to reproduction (and death) but before the seeds have fully matured and dispersed (Moyes et al. 2005).

3.1.3 GRASSLAND LONG TERM GOALS, OBJECTIVES, AND STRATEGIES

Grassland (GL) Long-Term Management (LTM) Goal 1: Manage native, non-native, and serpentine grassland habitat to provide ecosystem services (e.g., wildlife habitat and abiotic services) within the HRP management unit conservation easement boundaries.

GL LTM Objective 1: Increase or maintain native grass and native forb species in serpentine grasslands and other shallow-soiled grasslands at Goat Rock, relative to conditions measured at Year 10 (or when success criteria have been met) (Appendix A).

GL LTM Strategy 1: Conduct annual or biannual walking surveys of the grasslands of the HRP management units, particularly areas that a) have native grasses and forbs and/or b) are disturbed by livestock and humans (e.g., corrals, roadside) to:

- Identify and schedule removal of new introductions of non-native invasive plants (See Section 5.2 and Table 7 for list of species and management strategies for control of non-native invasive weeds).
- Remove or minimize, where possible, natural or human caused sources that contribute to loss of native plants from serpentine grasslands.

GL LTM Strategy 2: Track monitoring and effects of management actions on native/naturalized and non-native invasive plant species to adaptively manage grasslands. See Chapter 6 (Sections 6.2.1 and 6.2.2) for additional information on monitoring in non-serpentine and serpentine grasslands.

GL LTM Objective 2: Maintain or increase cover of native plants, including uncommon native plants in grasslands.

GL LTM Strategy 3: Track, through monitoring, the extent and composition (species present, approximate size of area, potential threats; see Appendix A) of a subset of areas identified as having high native plant diversity. Several areas of high native plant diversity were identified and mapped in the HRP management units (ESA+Orion 2009; EDAW & Turnstone Consulting 2009b). Other areas will potentially be located during implementation and monitoring of management actions during Years 1–10.

GL LTM Strategy 4: Threats to areas of high native plant diversity will be removed/treated, to the extent possible. Threats could include, but are not limited to, damage from livestock, non-native invasive plant spread and erosion.

GL LTM Strategy 5: Determine grazing strategy or need for alternative management for the serpentine grasslands of the Goat Rock Management Unit. Analyze ten year dataset, collected as described in Appendix A, and consult local experts to inform management of serpentine grasslands. (See Section 5.1 and Table 6 for additional information about specific grazing strategies in serpentine grasslands).

GL LTM Objective 3: Identify and manage appropriate locations for maintaining short grassland habitat structure and unvegetated soil conditions required by certain grassland flora and fauna species (e.g., burrowing owl [*Athene cunicularia]*, Johnny jump-up). Section 2.3.1 includes additional information about the Callippe silverspot butterfly.

> **GLLTM Strategy 6:** Maintain or increase extent of area occupied by Johnny jump-up, relative to conditions measured at Year 10 (or when success criteria have been met), and implement management strategies based on findings from Years 1–10 monitoring (see Appendix A).
>
> **GLLTM Strategy 7:** Develop method to evaluate and resolve potential conflicts between competing objectives to: maintain low stubble height for habitat (stubble height = a measure of herbaceous vegetation after grazing), residual dry matter (RDM) goals, propagation of native species, and invasive species control. Select methods to maintain low stubble height, e.g. livestock grazing, fire or other techniques. For more information, refer to Chapter 5 (Grazing Management): Section 5.1.4.3 on carrying capacity, Section 5.1.4.4 on season of grazing, 5.1.4.5 on use of livestock for management of fenced riparian and pond fields, and Section 5.2 for grazing and non-native invasive weed management with specific strategies for target non-native invasive species.
>
> **GL LTM Strategy 8:** Assess need to plant/seed Callippe silverspot nectar plants including buckeyes (*Aesculus californica*), and larval host plants (Johnny jump-up), based on findings from Years 1–10 (see Appendix A).
>
> **GL LTM Strategy 9:** Maintain a portion of grasslands that have associated habitat components (e.g., ground squirrel population with low (<3 inches) stubble height for wildlife species that require short-stature grasslands for nesting and/or hunting, including burrowing owl and prairie falcon [*Falco mexicanus*]).

In summary, the principles of adaptive management, e.g. results of monitoring and/or newly available scientific research, will be used to adapt management strategies, as needed, to achieve grassland habitat management goals and objectives. Additional details of monitoring of grassland enhancement areas are described in Chapter 6 of this plan and adaptive management is further explained in Chapter 7.

3.2 OAK SAVANNAH AND OAK WOODLANDS

Oak woodlands occur in all of the HRP management units, while oak savannahs occur in the San Antonio, Sage Canyon and the South Calaveras Management Units.

3.2.1 ECOLOGICAL BASIS FOR MANAGEMENT

Functioning and intact oak woodlands and savannahs are critical resources in California. Important functions of these communities range from water filtration and nutrient cycling (Dahlgren et al. 1997; Querejeta et al. 2007), carbon storage (Gaman 2008), and soil formation and erosion prevention (Ridolfi et al. 2000), to recreational, aesthetic, and symbolic values. Oaks improve water quality by decreasing soil erosion thereby decreasing sediment loads to waterways. In addition, oaks span many of California's diverse climatic zones and define the landscape for many of its residents.

Oak woodland and savannah provide critical habitat for wildlife. Oak woodlands are among the most biodiverse California ecosystems, with at least 300 terrestrial vertebrate species, 5,000 arthropod

species, and 1,100 native vascular plant species (Garrison 1996; Swiecki and Bernhardt 2001). They provide breeding, foraging, nesting, roosting, denning, protection, cover, and migration habitats independent from and in conjunction with grassland. Mature oak woodland and savannah can include large decadent trees with abundant cavities that provide nesting sites for birds and foraging opportunities for insect-eating birds. Oak trees are particularly valuable because of the production of acorns, which can be abundant, high quality food for many birds and mammals. Downed wood from oak trees also provides food and cover for a variety of arthropods, fungi, and wildlife species (Standiford et al. 2002). Refer to the MMP document for discussion of wildlife species in oak woodlands and savannah within the HRP management units (URS 2010a).

Remaining oak woodlands and savannahs face a suite of threats, including nitrogen deposition (Vitousek el al. 1997), altered fire regimes (Franklin and Dyrness 1973; Agee 1993), competition from non-native invasive plants (Liebhold et al. 1995; Vitousek et al. 1997), habitat loss and fragmentation (Noss 1987; Bennett 1999), and a changing climate.

Limited oak tree recruitment has been observed in California blue oak, valley oak, and coast live oak communities (Bolsinger 1988, Muick and Bartolome 1987). Long-term survival of oak communities may be limited in some regions (Bartolome et al. 2002; Mensing 1991; Muick and Bartolome 1987; Swiecki and Bernhardt 1998). Potential causes for low or lack of recruitment include grazing by deer and livestock, removal of acorns and seedlings by turkeys (Gluesenkamp, pers. comm., 2010), competition with non-native annual grasses, increased rodent populations, increased feral pig populations, changes in fire regime (particularly fire suppression), and inappropriate climate conditions for recruitment (McCreary 2001). In particular, saplings seem to be the limiting stage in recruitment based on age structure of many oak woodland and savannah stands (Muick and Bartolome 1987).

An additional threat to many oak woodlands is sudden oak death. Sudden oak death is an emerging forest disease that has killed tens of thousands of oaks in California (Rizzo and Garbelotto 2003). Sudden oak death, as of writing of this document, is not documented in the Alameda Creek Watershed. Using a rule-based model, Meentemeyer et al. (2004) created a map of California counties determining varying levels of risk of spread. The majority (93.0 percent) of Alameda's total county area was ranked in the very low and low risk category (1617.7 and 155.2 square kilometers, respectively), but there were regions, encompassing 6.9 percent of the total county area, in the high and moderate risk categories (11.9 and 119.9 square kilometers, respectively). Additionally, sudden oak death has the potential to become more widespread.

3.2.2 OAK SAVANNAH AND OAK WOODLAND ENHANCEMENT OPPORTUNITIES

Given indications that several species of California oak are not recruiting (see Section 3.2.1), researchers have focused on how to enhance oak populations and have found that successful oak establishment is dependent on proper planting, maintenance and protection. Protective measures generally focus on facilitating the growth of seedlings to the sapling size class; in particular research indicates that once seedlings attain a height of about 6.5 feet they are relatively resistant to livestock damage and continue to grow and prosper (McCreary and George 2005).

Installation of tree shelters

The greatest barriers to success are weed competition and animal damage (McCreary 2001).

Controlling weeds around seedlings is essential because direct weed competition and the habitat created by weeds can make it difficult for oak seedlings to survive and grow. Studies have repeatedly shown that weed control can greatly enhance the field performance of blue and valley oaks (Adams et al. 1992; McCreary and Tecklin 1997). A variety of methods can be used to treat weeds, including the following:

- Herbicides (glycophosphate is most commonly used)
- Physical weed removal
- Mulching

The procedure or technique selected for use in the HRP management units will depend on philosophical orientation, equipment or materials available, oak species planted, cost effectiveness, and maintenance.

Without protection from animals, seedlings often stand little chance of survival (McCreary 2001). However, the type of protection necessary depends on the type of animals present. In some situations, large herbivores may be the primary species of concern, while in others, small insects may be the only threat. The following animals pose a risk to seedlings and saplings within the HRP management units:

- Livestock
- Deer
- Feral pigs
- Rodents (e.g., voles, pocket gophers, ground squirrels)
- Insects (e.g., grasshoppers)

Wild, non-native turkeys- Livermore Valley

Wild turkeys may also pose a threat to oak recruitment. A recent unpublished study from oak woodlands in Sonoma County found a significant decrease in the number of acorns, and a non-significant decrease in the number of oak seedlings, in areas with turkeys compared to areas where turkeys were excluded (Gluesenkamp, pers. comm., 2010). Depredation permits for turkeys are being increasingly utilized in California and are effective ways to manage turkey flock densities (Gluesenkamp, pers. comm., 2010).

There are numerous ways to protect seedlings from browsing, including fences and large cages, screen cages, collar-and-screen devices, seedling protection tubes (rigid plastic mesh), repellant and baits, and habitat modification. Tree shelters have proven successful in a variety of trials (McCreary 2010). They protect seedlings from a wide range of animals including livestock, deer, rabbits, voles and grasshoppers, and alter the environment around the seedling and stimulate rapid height growth (McCreary 1997). Tree shelters can be used in combination with T-stakes for structural support (especially useful when livestock are present).

3.2.3 OAK WOODLAND AND OAK SAVANNAH LONG TERM GOALS, OBJECTIVES, AND STRATEGIES

Oak Woodlands and Savannah (OWS) LTM Goal 1: Manage oak savannah and oak woodland habitat to provide ecosystem services (e.g., wildlife habitat and abiotic services) within the HRP management unit conservation easement boundaries.

OWS LTM Objective 1: Encourage oak recruitment in oak savannah and oak woodlands in the HRP management units

> **OWS LTM Strategy 1:** Provide protection from browsing by caging a portion of or all oak seedlings and saplings.
>
> **OWS LTM Strategy 2:** Limit cattle grazing to the winter though early summer in oak woodlands and oak savannahs, when cattle will preferentially graze the non-native annual grasses and avoid oak saplings and seedlings. Remove cattle in the later summer and fall.
>
> **OWS LTM Strategy 3:** Monitor oaks that are protected from browse to track effects of caging on oak seedlings and saplings. Add or modify protections as needed. See Chapter 6 (Section 6.2.5) for additional information on monitoring oak regeneration.
>
> **OWS LTM Strategy 4:** Remove/control/reduce non-native plants around oak seedlings and saplings.
>
> **OWS LTM Strategy 5:** Analyze research on the potential impacts of turkeys on oak recruitment as well as oak recruitment data from monitoring (YRS 1-10). Determine if management strategy to control turkeys is warranted.

OWS LTM Objective 2: Track effects of management actions and update weed control methods for target non-native invasive plant species. (Section 5.2 and Table 7 include a list of sp**ecies** and management strategies for control of non-native invasive weeds in the HRP management units.)

> **OWS LTM Strategy 6:** Conduct annual walking surveys of the HRP management units to identify "new" non-native invasive plant species. These weed species could become a management concern due to introduction into the HRP management units, shifts in climate, and/or management of the management units and would need to be managed using appropriate techniques, before they spread. See Chapter 6 (Section 6.2.8) for additional information on monitoring of non-native species.

OWS LTM Objective 3: Reduce the risk of introduction or spread of plant pathogens such as Sudden Oak Death, and other invasive species, particularly via human actions. Use the guidelines produced in Year 1–10, if applicable, and other relevant materials as references.

OWS LTM Objective 4: Maintain or increase cover of native plants, including uncommon native plants in oak woodlands and savannahs.

> **OWS LTM Strategy 7:** Track, through monitoring, the extent and composition (species present, approximate size of area, potential threats; see Appendix A) of a subset of areas identified as having high native plant diversity. Several areas of high native plant diversity were identified and mapped in the HRP management units (ESA+Orion 2009; EDAW &

Turnstone Consulting 2009b). Other areas will potentially be located during implementation and monitoring of management actions during Years 1–10.

OWS LTM Strategy 8: Threats to areas of high native plant diversity will be removed/treated, to the extent possible. Threats could include, but are not limited to, damage from livestock, non-native invasive plant spread and erosion.

OWS LTM Objective 5: Assess the need for continued control of feral pig populations in the HRP management units.

OWS LTM Strategy 9: Implement pig depredation using approved program, e.g. hunting with appropriate permits.

OWS LTM Objective 6: Reduce the risk of catastrophic fire (catastrophic fire= crown fire, rather than ground or surface fire) in oak habitats in the HRP management units.

OWS LTM Strategy 10: Identify management actions to reduce the risk of catastrophic fire in oak habitats in the HRP management units

OWSLTM Strategy 11: If grazing is removed for two years or longer evaluate the need for fuel load reduction such as by mowing or prescribed burning

OWS LTM Strategy 12: If plant pathogens cause mortality of tree and/or shrub species and result in the presence of ladder fuels and standing snags, evaluate need for fuel load reduction.

In summary the principles of adaptive management, e.g. results of monitoring and/or newly available scientific research, will be used to adapt management strategies, as needed, to achieve oak woodland/savannah habitat management goals and objectives. Additional details of monitoring of oak woodland and savannah enhancement areas are described in Chapter 6 of this plan and adaptive management is further explained in Chapter 7.

3.3 PONDS AND WETLANDS

Management units with ponds that are being rehabilitated will be managed as described in the Sunol Region MMP (URS 2010a). Seasonal wetlands are found in enhancement areas in each management unit. Additionally, several ponds and seep wetlands are found in enhancement areas at Goat Rock and Sage Canyon Management Units. The ecological basis for management, goals, objectives, and strategies for ponds and wetlands in the enhancement areas are described below.

3.3.1 ECOLOGICAL BASIS FOR MANAGEMENT

Ponds and wetlands perform a variety of ecosystem functions including food web support, water flow regulation (e.g., flood abatement), ground water recharge and discharge, and are essential to the survival of many species of aquatic and terrestrial wildlife. Ponds and wetlands provide breeding and refugial habitat for special-status and other amphibians and a diversity of aquatic wildlife. They can provide perennial aquatic habitat, critical to some species during California's dry months.

Wetland soils (particularly clays and peats) can adsorb phosphorus and plants can utilize nitrogen originating from urban and agricultural runoff, thereby improving water quality. Dense wetland vegetation can reduce turbidity by filtering sediments. Wetland plants and detrital material sequester and intermittently release carbon, thus serving important carbon storage functions. In the HRP management units, ponds and wetlands are also important water sources for livestock and terrestrial wildlife.

Pond B- Sheep Camp Creek Management Unit

The food web support function provided by ponds and wetlands includes both primary and secondary productivity. Wetlands produce substantial plant growth that serves as a food source to herbivores (wild and domesticated) and a secondary food source to carnivores. Wetlands provide habitat for insects and other invertebrates that are critical food sources to a variety of wildlife species, particularly birds. In the HRP management units, many species are dependent on ponds and wetlands for their survival, for example several special-status species, including California tiger salamander and California red-legged frog, utilize ponds and perennial wetlands for breeding. Other common wetland and spring associated wildlife includes: western toad, Pacific chorus frog, and California newt; red-winged blackbird, song sparrow, egrets, and brown-headed cowbird. Other species dependent on these habitats include Western pond turtle, California blacktailed deer (*Odocoileus columbianus*), gray fox (*Urocyon*s p.), and mountain lion (*Puma concolor*).

Many factors threaten these habitats within California, including invasive, non-native plant and wildlife species, impacts from livestock, infrastructure failure, and changes to the water regime. More than 90 percent of California's wetlands have been lost due to urbanization and other human induced activities. A study by Davidson et al. (2002) found that habitat destruction due to urbanization has significantly contributed to the decline of California red-legged frog. According to Dodd and Smith (2003), habitat destruction, alteration, and fragmentation are likely the most serious causes of current and future amphibian population declines and species extinctions. Both California red-legged frog and California tiger salamander rely on these aquatic habitats for breeding and refugia, therefore the loss or alteration of these habitats can be devastating.

Non-native invasive species can out-compete or prey on native wildlife species, often resulting in extirpation of native wildlife species from the vicinity. Many of the ponds within the HRP management units have invasive wildlife species present, e.g., ponds with non-native predatory fish that feed on amphibian eggs and larvae and have been implicated in the decline of amphibian populations throughout California. In a recent study, drastic increases in California red-legged frog reproductive success was observed after the removal of predatory fish from stock ponds (Alvarez et al. 2002).

3.3.2 POND AND WETLAND ENHANCEMENT OPPORTUNITIES

Pond and wetland enhancement opportunities focus on habitat required for multiple life stages of California tiger salamander and California red-legged frog. Pond depth and minimum ponding duration are critical factors in fostering breeding habitat for these two amphibian species that use ponds and seep wetlands during multiple life stages, including breeding. Seasonal wetlands are used

as non-breeding aquatic habitat for California red-legged frog, and dispersal habitat for California tiger salamander. California tiger salamander and California red-legged frog use small mammal burrows near ponds for underground refugia. Enhancement opportunities could include maintenance burrows around ponds and wetlands and cessation of ground squirrel depredation. Predators, such as bullfrogs and mosquito fish, can be removed with annual or biannual pond draining. Pond water depth and draining details are listed in Table 5, "Performance Standards by Habitat Categories," in the MMP (URS 2010a).

Fencing of ponds and wetlands to exclude cattle (or greatly reduce cattle access) can either improve or degrade California tiger salamander and California red-legged frog habitat. Excluding cattle can encourage the growth of emergent vegetation such as spikerush (*Eleocharis* sp.) that provides cover and is beneficial to target species. However, it can also lead to increased growth of cattails that are known to decrease the surface area of open water, potentially conflicting with goals set forth in the MMP. In such cases, grazing or mechanical removal of vegetation may be necessary.

Specific management opportunities for ponds and wetlands will be integrated where these habitats are contiguous or adjacent.

3.3.3 POND AND WETLAND LONG TERM GOALS, OBJECTIVES, AND STRATEGIES

Ponds and Wetlands (PW) LTM Goal 1: Manage ponds to provide wildlife habitat for California red-legged frog and California tiger salamander within the HRP management unit conservation easement boundaries.

PW LTM Objective 1: Create conditions in ponds conducive to breeding California red-legged frog and California tiger salamander through management of native (emergent vegetation) and non-native invasive plant cover, pond drainage, pond sedimentation rates, and scheduled surveys and maintenance inspections (See Section 5.2 and Table 7 for a list of target non-native invasive plant species and for management strategies for control of these species in the HRP management units).

PW LTM Strategy 1: Prepare a schedule for each pond identifying frequency of vegetation management. See Chapter 6 (Section 6.2.3) for additional information on monitoring in ponds. Specific activities within this strategy that will need to occur are as follows:

- Thin pond vegetation when necessary via hand removal or short-term grazing.
- Remove invasive non-native aquatic plants that interfere with amphibian breeding, e.g. Brazilian waterweed (*Egeria densa*) and hydrilla (*Hydrilla verticillata*).
- Maintain density of hydrophytic vegetation and pond depths conducive to breeding.

PW LTM Strategy 2: Drain ponds every other year in approximately September to remove predators, e.g. fish and bullfrogs, when present.

PW LTM Strategy 3: Monitor ponds for presence of California tiger salamander and California red-legged frog For each pond determine appropriate survey type (dipnet, visual, auditory, and CTS egg mass) and life stage targeted (egg, juvenile/larval, adult) and frequency of monitoring needed.

PW LTM Strategy 4: For each pond**,** prepare routine maintenance inspection, repair and replacement schedule e.g. water control structures and fences. See Section 5.1.4.5 for additional information about livestock grazing in fenced pond habitats.

PW LTM Strategy 5: Inspect ponds to measure sediment accumulation, inspect drainage area for erosion (sediment sources) and repair if accessible. The measurable objective for sedimentation in ponds will be no more than an annual average sedimentation rate of 1 inch per year.

PW LTM Goal 2: Manage wetland habitat to provide ecosystem services (e.g., wildlife habitat and abiotic services) within the HRP management unit conservation easement boundaries.

PW LTM Objective 2: Manage wetland vegetation to promote native plant cover and remove/control non-native invasive species. The measurable objective for non-native invasive plant and native plant cover in wetlands will be to:

- Limit the overall cover of invasive plants to no more than 20 percent of the overall invasive plant cover measured at the end of the mitigation performance period (or when success criteria have been met).
- Maintain the overall cover of native plants at no less than 80 percent of the native plant[1] cover measured at the end of the mitigation performance period (or when success criteria have been met).

PW LTM Strategy 6: Utilize non-native invasive plant control/eradication techniques, as needed (see Chapter 6 for management techniques).

PW LTM Strategy 7: Continue observational monitoring protocol established in Years 1–10 to track effects of management actions on non-native invasive plant species and native plant cover to modify management as appropriate. (See Section 6.2.3 for additional information on monitoring in wetlands and Section 5.2 and Table 7 for a list of species and for management strategies for control of non-native invasive weeds in the HRP management units.)

In summary the principles of adaptive management, e.g. results of monitoring and/or newly available scientific research, will be used to adapt management strategies, as needed, to achieve pond and wetland habitat management goals and objectives. Additional details on monitoring of pond and wetland habitat enhancement areas are described in Chapter 6 and adaptive management is further explained in Chapter 7.

3.4 RIPARIAN

Riparian enhancement areas are found in all the management units with the exception of Goat Rock. Riparian habitats, in these areas include: willow riparian, sycamore riparian, oak riparian, mixed riparian woodland, and riparian scrub (URS 2010a).

3.4.1 ECOLOGICAL BASIS FOR MANAGEMENT

Serving as the collection and distribution conduit for runoff and sediment, riparian areas serve a vital role in the overall health of a watershed. Riparian areas are ecologically diverse habitats important to the survival of numerous aquatic and terrestrial organisms. Statewide, riparian habitats support more wildlife species than any other vegetation type (Griggs 2008). These systems are complex, dynamic, and sensitive to change. Some of the important ecological roles and functions of the riparian system include:

[1] Only the cover of the species listed in Appendix B will be counted towards achievement of success criteria in seasonal and perennial wetlands.

- Stream channel hydro-geomorphology, vegetation, and large woody debris dissipate the erosive energy from runoff
- Channels and floodplains trap and redistribute sediment
- Vegetation and soils filter, trap, or absorb pollutants preventing contamination of waterways
- Plants, soils, and bacteria breakdown many pollutants into usable or non-toxic forms
- The interaction of hydrology, soils, and vegetation increases biodiversity
- Provide food, cover, and a migration corridor for numerous aquatic and terrestrial wildlife species
- Trees and shrubs regulate stream water temperatures
- Leaves, twigs, and logs provide detritus for benthic macro invertebrates
- Roots and logs in the stream increase the complexity of cover habitat for aquatic species and in many cases protect banks from erosion

The purpose in managing the riparian corridor is to improve the ecological roles and functions of the riparian corridor, where improvement is needed. A stable, functioning, and productive riparian area requires a balance of appropriate vegetation, soils, landform, and watershed hydrology. When a stream has achieved a stable balance of the above inputs, such that the integrity of the system is maintained within a range of conditions including high water events (10-year flood, 100-year flood), drought, and other extreme events, the system has attained a state of dynamic equilibrium (FISRWG 1998). A stream that is in dynamic equilibrium adjusts quickly to changes that disrupt the system (Heede 1986). In fluvial geomorphic terms a stream in dynamic equilibrium has attained a stable dimension, pattern, and profile that over time neither aggrades nor degrades (Rosgen 1996).

Sheep Camp Creek

Disturbances to a stream system may disrupt the system such that the stream may or may not be able to reestablish an equilibrium depending on whether or not the disturbance represents a single event (e.g., flood, catastrophic fire) or if it is ongoing (e.g., overgrazing, poor farming practices, urban development). Because the components (e.g., vegetation, soils, hydrology) of the ecosystem are tied to each other, a disturbance to one component affects other components of the system. Any imbalance may disrupt the system and put it at risk of instability. For example, inadequate vegetation cover caused by an extreme fire event or overgrazing and trampling of plants may destabilize stream banks making them susceptible to erosion resulting in sedimentation of downstream habitat (Hoorman and McCutcheon 2010). Excessive browsing (cattle, deer, elk, and rodents) may prevent new shrub and tree species from establishing. Landslides, banks slumps, or wind-thrown trees that slip or fall into the active stream channel may introduce sediment to the stream, altering flow dynamics that could result in upstream of downstream instability for a period of time.

The lack of spatial diversity in species, age, and size of vegetation limits the utilization of the riparian area by wildlife (Smith and Smith 1998). A variety of species rely on the complex cover provided by different vegetation assemblages to breed, feed, and rest. Disturbances to the riparian area may provide the opportunity for non-native invasive plant species, which out-compete native species, further limiting cover, and food for native wildlife. The lack of adequate vegetation to intercept rainfall and bind soil particles leaves soils susceptible to erosion from raindrops and overland flow. Without adequate vegetation, pollutants from manure and sediment may reach the stream channel where it may be transported downstream. Sediment may fill fish spawning gravels. Poor water quality

limits the productivity of benthic macro invertebrates, a major food source for many fish species. Limited vegetation cover over streams allows solar radiation to warm water temperatures contributing to algal blooms, which respire at night, reducing the concentration of dissolved oxygen available for aquatic organisms.

3.4.2 RIPARIAN ENHANCEMENT OPPORTUNITIES

The greatest opportunity to enhance riparian areas is through vegetation management. Managing vegetation, in most circumstances, will provide the greatest environmental returns for the effort and money spent. Vegetation management goals and strategies are further discussed below in section 3.4.3, however direct and indirect techniques to manage vegetation include grazing management, planting of native vegetation, installing fencing or browse protection, weed removal, fire, flooding, stabilization of gullies, slumps, other upland sediment sources; floodplain and/or streambank rehabilitation, and removal/replacement/upgrading of stream road crossings.

3.4.3 RIPARIAN LONG TERM GOALS, OBJECTIVES, AND STRATEGIES

Riparian (RIP) LTM Goal 1: Manage riparian habitat to provide ecosystem services (e.g., wildlife habitat and abiotic services, such as reducing erosion) within the HRP management unit conservation easement boundaries.

RIP LTM Objective 1: Within riparian areas, maintain or increase [(relative to cover measured at the end of the mitigation performance period (or when success criteria have been met)]:

- The overstory cover of native woody riparian species.
- The understory cover of native shrubs, seedlings, and saplings.
- The native herbaceous understory cover.

RIP LTM Strategy 1: Continue to monitor for woody plant recruitment (shrubs, trees) and cover and composition of herbaceous plants. See Chapter 6 (Section 6.2.5) for additional information on monitoring woody plant recruitment in riparian habitats for Years 1-10 and after Year 10. See the Sunol Region MMP Section 5.3.2 for monitoring herbaceous cover in Years 1-10. After Year 10, monitoring type and frequency for herbaceous cover will be adjusted based on site conditions.

RIP LTM Strategy 2: Maintain (from Years 1-10) and add additional plant protections around woody plants as needed.

RIP LTM Strategy 3: Adjust livestock stocking rate and grazing access if evidence of excessive browsing exists. See Section 5.1.4.5 for additional information about livestock grazing in fenced riparian habitats.

RIP LTM Strategy 4: Utilize additional non-native invasive species control/eradication techniques, as needed. (See Section 5.2 and Table 7 for a list of species and for management strategies for control of non-native invasive weeds).

RIP LTM Strategy 5: Continue observational monitoring protocol established in Years 1–10 to track effects of management actions on non-native invasive plant species and woody riparian plant recruitment in riparian areas; modify management protocols as appropriate.

RIP LTM Objective 2: Reduce rates of erosion and sedimentation within riparian habitats.

RIP LTM Strategy 6: Continue observational monitoring protocol established in Years 1–10 to track effects of management actions on erosion and sedimentation in riparian habitats. See Chapter 6 (Section 6.2.6) for additional information on sedimentation monitoring in riparian habitats.

RIP LTM Strategy 7: Inspect, maintain and or repair water troughs, salt licks, and mineral supplements placed in uplands working properly, are adequately stocked, and are utilized by cattle.

RIP LTM Strategy 8: Install new riparian fencing, as funding is available using funding from the endowment, to reduce potential for over-browsing of riparian vegetation and increased erosion. Prioritize riparian fencing by:

- Areas most degraded by erosion and/or sedimentation
- Stream type (perennial – first priority, intermittent – second priority, and ephemeral – third priority)
- Areas where riparian vegetation is constantly browsed

RIP LTM Strategy 9: Reduce loafing of cattle in riparian areas by:

- Cull loafing cattle when herd is in the riparian area as this behavior is learned by other cattle in the herd and may lead to more riparian area impacts (Adams 2010). Monitoring for these types of cattle would be done by the SFPUC Area Manager, where possible.
- Evaluate if grazing field has adequate shade (particularly summer months) and cover from prevailing winds in upland areas. If not, move cattle to a unit that provides cover or provide alternate shade source (Adams 2010; Leonard et al. 1997).
- Provide scratching posts and dusters in upland areas (Adams 2010).

RIP LTM Strategy 10: Either exclude cattle or reduce grazing pressure (stocking rates, duration) in riparian fields from December 15 to March 15 to reduce cattle disturbance to streambanks and excessive soil compaction.

RIP LTM Objective 3: Increase or maintain complexity of riparian and stream habitat.

RIP LTM Strategy 11: Encourage large woody debris recruitment to stream by allowing greater than 6 inch diameter dead, downed trees and limbs to remain on the ground within 300 feet of the stream, riparian area, and riparian exclusion area, unless there is a safety and/or facilities protection risk.

In summary the principles of adaptive management, e.g. results of monitoring and/or newly available scientific research, will be used to adapt management strategies, as needed, to achieve riparian habitat management goals and objectives. Additional details on monitoring of riparian habitat enhancement areas are described in Chapter 6and adaptive management is further explained in Chapter 7.

3.5 SCRUB

Scrub habitats in the HRP management units occur primarily at the Sage Canyon Management Unit, with smaller occurrences at the San Antonio and Sheep Camp Creek Management Units (URS 2010a).

3.5.1 ECOLOGICAL BASIS FOR MANAGEMENT

Scrub habitats within the San Francisco Bay Area are part of a patchy mosaic ecosystem, intergrading between oak woodland, grassland, and mixed evergreen forests, as well as among communities with differing age classes. Through their close association with fire, scrub habitats are both an integral component and a facilitator of the patchy mosaic vegetation communities (mosaic of differing vegetation types/habitats in a given area, rather than one continuous vegetation/habitat type). Such habitat is characterized by woody vegetation dominated by shrubs that are adapted to survival in relatively harsh environments (Holland and Keil 1995). In the HRP management units, scrub habitats are classified as "upland scrub," which includes Diablan sage scrub and coastal scrub (URS 2010a).

The complex ecology of scrub habitats supports a large number of animal species. A great deal of attention has focused on the importance of patchy mosaics to wildlife (Lindenmayer et al. 2008. Scrub habitat has a relatively high value for wildlife in part because of their patchwork quality. Moreover, this community has a relatively low proportion of non-native invasive species due to dense shrub canopies, dry, fire-prone conditions, and relative isolation from urban land use (East Contra Costa HCP 2006). Many species that inhabit scrub also inhabit adjacent grassland and oak woodlands. However, some birds and mammals found in adjacent habitats spend a large proportion of time in the dense cover and shade of mature scrub stands.

Scrub habitat in the San Francisco Bay Area is threatened by increased urbanization, habitat fragmentation, and interference with fire, the habitat's natural disturbance regime (USFWS 2002). Fire suppression in upland scrub habitat has contributed to scrub habitat degradation. In the absence of fire, the canopy of scrub species will close, relatively short-lived species die, and dead material accumulates increasing the fuel load and risk of catastrophic fire (England 1988). The overgrown conditions that develop in the absence of fire reduces Alameda whipsnake (Swaim 1994) habitat quality. In addition, the unique flora of post-fire scrub habitat supports the highest concentration of special-status plant species of any community in California (Tibor and Vorobik 2001). Sensitive plant species that could occur in the HRP management unit scrub communities include pallid manzanita *(Arctostaphylos pallida)*, Contra Costa manzanita *(Arctostaphylos Manzanita* ssp. *laevigata)*, and Mt. Diablo bird's beak *(Cordylanthus nidularius)*. Special-status wildlife that could occur in this habitat include Alameda whipsnake, Bell's sage sparrow (*Amphispiza belli belli)* and Berkeley kangaroo rat (*Dipodomys heermanni berkeley ensis)*.

3.5.2 SCRUB ENHANCEMENT OPPORTUNITIES

Enhancement opportunities in scrub habitat focus on long-term management of core habitats potentially utilized by the Alameda whipsnake. Scrub habitat is considered core habitat for the Alameda whipsnake. Their preferred habitat is characterized by Diablan sage scrub and other shrub-dominated communities, woodlands and grasslands contiguous to shrub communities, and rocky outcrops, talus slopes, and small mammal burrows (USFWS 2006). They are most frequently recorded in close association with chaparral or scrub.

Much of the scrub habitat within the HRP management units, due to fire suppression, is in a dense and overgrown condition with many older shrubs and few to no young shrubs (Koopmann, pers.

comm., 2010). Scrub enhancement would focus on creating the Alameda whipsnake's preferred habitat: a mosaic of young and old scrub interspersed with grassland habitat. Management actions would also focus on enhancement of areas with south-facing slopes and areas with rock outcrops, both of which are associated with the Alameda whipsnake (McGinnis 1992). An additional goal would be to enhance habitat through control of non-native invasive weeds and wildlife. Scrub habitats would be enhanced at the Sage Canyon, Goat Rock, and San Antonio Management Units.

Methods available for enhancing shrub habitat patches include livestock grazing, prescribed burning, and mechanical manipulation. Livestock grazing, either cessation thereof or overgrazing, has been implicated as a cause of habitat degradation for Alameda whipsnake (USFWS 2002). Overgrazing can significantly reduce or eliminate shrub and grass cover, and has been shown to negatively impact the habitat of Alameda whipsnake in many areas east of the Coast Range (McGinnis 1992). Conversely, tall dense non-native grass and closed-canopy scrub can reduce densities of lizard prey in some situations and hamper foraging success for the visually-oriented whipsnake (Swaim 1994). Grazing can also lower the danger of catastrophic fires that would jeopardize Alameda whipsnake individuals and habitat. With appropriate stocking rates and seasonality, grazing can reduce scrub encroachment on surrounding grasslands, maintaining a mosaic of grassland and scrub habitats.

Brush clearing through prescribed fire or through mechanical thinning can create a mosaic of young and old habitat that is more suitable for the Alameda whipsnake (USFWS 2002). Prescribed fire in Alameda whipsnake habitat would need to be timed to coincide with when Alameda whipsnakes are active and able to leave the burn area or during whipsnake hibernation period when they are below ground. With these considerations in mind, the Tilden Park Alameda Whipsnake Habitat Enhancement Prescribed Fire and Smoke Management Plan conducted prescribed burns between September 1, 2009 and March 15, 2010 (EBRPD 2009). Smoke management and safety issues would also need to be addressed when using prescribed fire for enhancement of scrub for Alameda whipsnake (EBRPD 2009).

3.5.3 SCRUB LONG TERM GOALS, OBJECTIVES, AND STRATEGIES

Scrub LTM Goal 1: Manage scrub habitat to provide habitat for the threatened Alameda whipsnake within the HRP management unit conservation easement boundaries.

Scrub LTM Objective 1: Maintain or increase area of varying-aged scrub stands and interspersed grassland suitable for Alameda whipsnake.

> **Scrub LTM Strategy 1:** Utilize prescribed fire, livestock grazing, and/or mechanical thinning, as needed, to maintain a mosaic of scrub and grassland habitats and to reduce dense and overgrown scrub cover (USFWS 2002).Maintain habitat in a manner that considers factors such as whipsnake activity, smoke management, and safety (EBRPD 2009).
>
> **Scrub LTM Strategy 2:** Continue observational monitoring protocol established in Years 1–10 to track effects of management actions on scrub and associated habitats. See Chapter 6 (Section 6.2.7) for additional information on monitoring in scrub habitats.

Scrub LTM Strategy 3: Monitor for presence of Alameda whipsnake. In summary the principles of adaptive management, e.g. results of monitoring and/or newly available scientific research, will be used to adapt management strategies, as needed, to achieve scrub habitat management goals and objectives. Additional details on monitoring of scrub habitat enhancement areas are described in Chapter 6 and adaptive management is further explained in Chapter 7 of this plan.

4 ADAPTIVE MANAGEMENT

Adaptive management optimizes decision making by using an iterative process based on research and monitoring. This approach allows managers to learn by experience within unique environments and apply lessons learned to remedy deficiencies using a structured and scientific approach. Implementing and monitoring management activities purposefully and with the use of comparative control areas, for example, allows land managers to alter management strategies or techniques to increase success. Modifications may be in response to landscape changes propagated by prior management actions or unforeseen events. Adaptive management actions implemented to address performance shortfalls during years 1 to 10 post construction at the restoration sites will result in clear, site tested management guidance for long-term management at both the restoration and enhancement sites.

Management objectives and strategies set forth in this plan are based on the current understanding of the habitat conditions of the HRP management units, the current threats to these habitats, and the most effective management tools/strategies available to achieve stated management goals. Objectives and strategies were developed based on available scientific research and studies at the time of writing, some of which have not been tested in the HRP management units. However, the inherent uncertainty in management implementation and unforeseen or catastrophic natural habitat change should be recognized as having the potential to significantly impact goals, objectives, and strategies.

Unpredictable natural changes or changes in the status of species occurring or potentially occurring in the HRP management units could necessitate changing the objectives, strategies, and goals set forth in this plan. Some of these changed conditions include but are not limited to:

- Unusual weather patterns, such as extended drought or climate change
- Change in species composition, such as through invasion of new non-native invasive plant and wildlife species or increase in spread of existing non-native plant and wildlife species
- Change in the listing status of species that occur or have potential to occur in the HRP management units
- Dramatic alteration of the management units from catastrophic acts of nature, such as sudden oak death, high intensity fire, floods, severe wind, pathogens, and/or human interference including vandalism or non-scheduled grazing

Adaptive management is a tool to facilitate site-appropriate evolution of management strategies and encourages land managers to take advantage of the information obtained from implementing the goals, objectives and strategies listed in Chapter 3. If monitoring results reveal that a goal or objective is not being met, reasons for lack of success should be examined and an adaptive management plan developed and implemented. In circumstances where it becomes apparent over time that a goal or objective is not site-appropriate within the context of reasonably achievable maintenance and management, it may be appropriate to modify the goal or objectives.

Two types of adaptive management actions are expected- short term adaptive management actions that apply to immediate management concerns, such as repairing failing roads during storm events and performing required maintenance of roads and fences. These decisions are made by the Area Manager. Long term adaptive management decision applies to adaptively managing the management units based on analysis of monitoring data and observed trends. These decisions would be made by SFPUC biologists with input from the Area Manager. SFPUC biologists will consult with the Agencies when a new management strategy is introduced.

Individuals involved in management of the HRP management units include grazing tenants, the SFPUC Area Manager and SFPUC biologists. Grazing tenants will work closely with the Area Manager in decision making regarding grazing of the management units.

Chapters 6 and 7 describe the LTMP monitoring and reporting protocols. Monitoring includes both implementation monitoring and effectiveness monitoring. Implementation monitoring includes documentation of implementation activities, events, maintenance, and interpretive measurements (annual indicators) or observations of effects that influence progress toward accomplishing the objectives. Effectiveness monitoring documents trends toward and achievement of goals and objectives. Analysis of monitoring data and adaptive management results will provide the framework for potential modifications to the LTMP goals, objectives and strategies over time. To ensure that annual monitoring activities, report submittal, and agency meetings are coordinated to optimize opportunity for feedback and adaptive management, a detailed schedule of annual monitoring activities is provided in Chapter 6 (see Table 8), and the schedules for report submittal and agency meetings are provided in Sections 7.1 and 7.2, respectively.

Evaluation reports, as discussed in Chapter 7, will be appended to the LTMP and will provide the mechanism for keeping the LTMP a living document that keeps pace with SFPUC management needs, is consistent with the conservation easement mandates, and promotes technical skills/data transfer internally and externally to the SFPUC.

5 GRAZING MANAGEMENT AND NON-NATIVE INVASIVE PLANT CONTROL STRATEGIES

Chapter 5 describes in detail grazing management and non-native plant control strategies for the HRP management units. In some cases, grazing is used as a tool for non-native plant control; in this case, grazing is described in the grazing section and the non-native plant control section. The grazing management section of the LTMP was created in coordination with and approved by the SFPUC certified rangeland manager for the Alameda Creek watershed.

5.1 GRAZING

5.1.1 ECOLOGICAL BASIS FOR GRAZING

Cattle – Livermore Valley

Cattle grazing is recognized by many land managers and scientists as beneficial to the enhancement of California's habitats. Cattle can reduce the growth of exotic annual grasses, reduce the buildup of litter and thereby creating more open conditions needed by many native forbs and reduce competition with native perennial grasses. Cattle grazing can control the growth of non-native invasive plants, and can also reduce grassland encroachment by native shrubs. The effect of cattle on the landscape is dependent on many factors, including (but not limited to) the habitat that is being grazed, seasonality and intensity of grazing, and climate. Due to the interaction of all of these factors, cattle grazing prescriptions put forth in this document are adaptive; in other words, grazing will be monitored to determine their effectiveness in meeting goals and objectives and identifying potential unanticipated effects.

5.1.2 SEASON FOR GRAZING

Cattle grazing could have both positive and negative effects on the objectives outlined in Chapter 3, in part dependent on the season in which cattle are grazed. Table 5 is an assemblage of management objectives and strategies listed in Chapter 3 that could be facilitated through cattle grazing; the table indicates potential seasonal effects of grazing on each listed objective and strategy.

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Table 5
Potential Effects of Grazing on Management Objectives

Management Objectives [1]	Potential grazing effects, by season √=beneficial, X=negative, Blank=neutral							
	Early Spring	**Late Spring**	**Early Summer**	**Late Summer**	**Early Fall**	**Late Fall**	**Early Winter**	**Late Winter**
Grasslands								
GL LTM Objective 1: Maintain or increase endemic annual forbs and native grasses in serpentine grasslands and other shallow-soiled grasslands at Goat Rock, relative to conditions measured at Year 10 (or when success criteria have been met)	√/ X	X	√/ X	√	√	√		
GL TTM Objective 2: Maintain or increase cover of native plants, including uncommon native plants in grasslands	√/ X	X	√/ X	√	√	√		
GL LTM Objective 4: Identify and manage appropriate locations for maintaining short grassland habitat structure and unvegetated soil conditions required by certain grassland flora and fauna species (e.g., burrowing owl [*Athene cunicularia],* Johnny jump-up)	√	√	√	√	√	√	√	√
Oak Woodland and Savannah								
OWS LTM Objective 1: Encourage oak recruitment in oak savannah and oak woodlands in the HRP management units	√	X	X	X	X	X	√	√
OWS LTM Objective 4: Maintain or increase cover of native plants, including uncommon native plants in oak woodlands and savannahs	X	X	√/ X	√	√	√	√	√
Ponds and Wetlands								
PW LTM Objective 1: Create conditions in ponds conducive to breeding California red-legged frog and California tiger salamander			√	√	√	√		
PW LTM Objective 2: Manage wetland vegetation to promote native plant cover and remove/control non-native invasive species								
Riparian								
RIP LTM Objective 1(a): Within riparian areas, maintain or increase [(relative to cover measured at the end of the mitigation performance period (or when success criteria have been met)]: the overstory cover of woody riparian species;			X	X	X	X		
RIP LTM Objective 1(b): Within riparian areas, maintain or increase [(relative to cover measured at the end of the mitigation performance period (or when success criteria have been met)]:the understory cover of shrubs, seedlings, and saplings			X	X	X	X		
RIP LTM Objective 1(c): Within riparian areas, maintain or increase [(relative to cover measured at the end of the mitigation performance period (or when success criteria have been met)]: the herbaceous native understory cover.	√/ X	X	√/ X	√	√	√		

Table 5
Potential Effects of Grazing on Management Objectives

Management Objectives [1]	Potential grazing effects, by season √=beneficial, X=negative, Blank=neutral							
	Early Spring	Late Spring	Early Summer	Late Summer	Early Fall	Late Fall	Early Winter	Late Winter
RIP LTM Objective 2: Reduce rates of erosion and sedimentation within riparian habitats	X						X	X
Scrub								
Scrub LTM Objective 1: Maintain or increase area of varying-aged scrub stands and interspersed grassland suitable for Alameda whipsnake	√	√	√	√	√	√	√	√

[1] Not all management objectives and strategies are included; only those management objectives and strategies in which cattle could be used to address an objective are included.

5.1.3 METHODS FOR DETERMINING GRAZING SPECIFICATIONS

The following documents, interviews and datasets were utilized to prepare the grazing management plan for the HRP management units:

- Interviews and guidance from Tim Koopmann, SFPUC Certified Rangeland Manager#41 for the Alameda Creek watershed
- USDA range productivity values (USDA 1961, 1974)
- USDA soil survey data (USDA 1961, 1974)
- Review of existing site-specific data for the HRP management units, including:
- Sensitive plant and wildlife survey data, wetland delineations, vegetation mapping, non-native invasive plant and wildlife data (URS 2010a)
- High resolution aerial photography
- Existing and proposed infrastructure and 30 percent design details for all HRP areas (URS 2010b, 2010c)
- Sunol Region Mitigation and Monitoring Plan (URS 2010a)
- Site specific percent slope and aspect values (Sanborne and USGS 2006)

Livestock grazing suitability and stocking rates were determined based on evaluation of environmental variables including slope, aspect, canopy cover, soil type and soil productivity values, as well as the location of existing fences, and then applied to habitat and species management goals and objectives. Stocking rates provided are a starting point and should be adjusted as needed on an ongoing basis as recommended by an experienced rangeland manager, as well as on recommendations of a biologist. Conditions that would warrant adjustments to stocking rates could include periods of drought or higher than average rainfall, events such as wildfire or severe flooding events, as well as advances in understanding of habitat requirements for special-status species (also refer to Chapter 4- Adaptive Management).

5.1.4 GRAZING MANAGEMENT SPECIFICATIONS

The following section describes the specific grazing prescriptions for the HRP management units. Grazing prescription include: grazing field boundaries, kind and class of livestock, season of use, intensity (number of cattle) and proposed new infrastructure.

5.1.4.1 GRAZING MANAGEMENT AREA BOUNDARIES AND FIELDS

The grazing management boundaries for each management unit include all areas within the management unit management boundary, except for Sage Canyon (see Figure 1). Sage Canyon will continue to be grazed with the same management as the CA-1 grazing unit, with no new grazing management or new grazing related infrastructure prescribed under this LTMP. Grazing management applies to the HRP management units, including establish/reestablish, rehabilitation and enhancement, as well as areas where SFPUC is not seeking mitigation credit (see MMP for definitions [URS 2010a]).

Grazing fields are separate fields (also referred to as pastures) that will have a unique grazing prescription. Each grazing management field was evaluated to determine appropriate boundaries for fields within each HRP management unit. Based on the location of exiting fences, as well as the location of restoration plantings, sensitive resources (such as riparian areas, rare plant locations and

ponds), and the location of HRP management unit conservation easement boundaries, individual fields were delineated. The grazing fields for each of the Management Units are shown on Figures 1, 3, 4, 5, and 6. In some cases, new fences are proposed in order to fully contain a field.

5.1.4.2 KIND AND CLASS OF LIVESTOCK

Cattle will continue to be used as a management tool in the HRP management units. Additional livestock types, such as sheep and goat, will be considered for use if the on-going monitoring results suggest that cattle grazing is not sufficient to meet management goals, and that an alternative livestock type may be better suited to achieve said goals. Currently, English cattle breeds are grazed in the HRP management units, including Hereford, Angus and Shorthorn (Koopmann, pers. comm., 2010). Other breeds of cattle, such as Corriente cattle, are not preferred since they could introduce foreign pathogens to the watershed and the beef from these cattle are not as high of quality as that of English breeds (Koopmann, pers. comm., 2010). English breeds will continue to be grazed in the HRP management units, although in the future different breeds may be used.

Currently, cow-calf pairs graze most of the HRP management units, except for the San Antonio Management Unit. Portions of the San Antonio Management Unit also have cow-calf pairs, but additionally have stockers during the winter and spring. This mixture of cow-calf pair and stockers will continue to graze the HRP management units, although in the future different types or combinations of cattle may be used.

5.1.4.3 CARRYING CAPACITY, STOCKING RATES

The carrying capacity of each management unit and associated fields was determined primarily through desktop analysis. Productivity values for soil types defined by the USDA (USDA 1961, 1974) were used to determine the base productivity of a site; these values were adjusted based on characteristics that influence the amount of forage available to cattle, including slope, aspect and canopy cover which all can reduce the amount of forage available.

Once a site carrying capacity was estimated (total forage available at a site), the amount of RDM to be left on the site, as well as disappearance RDM (10 percent of productivity) (Frost et al. 2005) was calculated and subtracted from the available forage for each field. For the HRP management units, between 750 and 1,000 pounds/acre is the range in the amount of RDM to be left onsite. This approximate level of RDM (750 to 1,000 pounds/acre) was chosen to minimize erosion, ensure protection of water quality, reduce light flashy fuels, protect important natural resource values, and enhance habitat for plant and wildlife species. The target RDM level of 750-1,000 lbs/acre is a target level to be used as a guide for establishing stocking rates. Some years, due to non-human caused factors listed in Section 5.1.3, RDM levels may go above or below this target. If livestock are used as a tool to remove or control non-native invasive species, RDM levels may also go below the target levels as the standing biomass of the invasive is removed from that particular area.

The pounds/acre of forage available for livestock was used to determine the number of cattle to stock a given field. The SFPUC uses animal unit months (AUMs) to determine stocking rates and for accounting purposes with SFPUC grazing lessees. An Animal Unit is defined as a 1,000 lb. beef cow with or without a nursing calf with a daily requirement of 26 pounds of dry matter forage. Therefore an AUM is equal to approximately 800 pounds of dry matter forage to sustain a cow or cow calf for 30 days.

Stocking rates for each field of the HRP management units are listed in Table 6. Stocking rate calculation spreadsheets are included in Appendix C.

5.1.4.4 SEASON OF GRAZING

In general, grazing of upland areas and unfenced riparian and pond areas will be seasonal and occur during winter to early summer, at which time the cattle will be taken off the fields. Areas that are fenced due to plantings or to achieve a species-specific goal (Goat Rock Field A, San Antonio Field A,B,C; Sheep Camp Creek Field B and E; South Calaveras Field A and E) will not be grazed during

Table 6
Details of Proposed Grazing for the Sunol Region Habitat Reserve Program Management Units

Field	Acres (approxi-mate total)	Description	Year of Grazing Implementation	Primary Management Considerations (weeds, sensitive species)	Proposed New Infrastructure	Stocking Rate (AUM)[1]	Season of Grazing
GOAT ROCK (Figure 3)							
Field A	0.1	-Small field with Goat Rock Northwest Pond -Seep and seasonal wetlands -South to west facing slopes.	YR 3	Overgrowth of cattails; California red-legged frog, California tiger salamander	259lf of new fencing; 10,556; new water infrastructure	Favorable: 750lbs/acre: TBD 1000lbs/acre:TBD Unfavorable: 750lbs/acre: TBD 1000lbs/acre:TBD Normal: 750lbs/acre: TBD 1000lbs/acre:TBD	Evaluate field for grazing after Year 3[2]
Field B	216.6	-Field with serpentine grasslands and wetlands -67 percent of slopes > 25 percent -76 percent south to west facing slopes -Less that 0.1 percent contains canopies >25 percent	YR 1	Rare plants, endemic serpentine forbs and native grasses; California red-legged frog, California tiger salamander	6,274 lf of new fencing; new water infrastructure	Favorable 750lbs/acre: 23 1000lbs/acre:12 Unfavorable: 750lbs/acre: 1 1000lbs/acre:0 Normal: 750lbs/acre: 11 1000lbs/acre:4	Winter to early spring (approx. 5 months)
Field C	606.5	-Serpentine grasslands -Portion of Alameda Creek -Approximately 80 percent of the field has slopes greater than 25 percent, and 80 percent are south or west facing -20 percent with canopy cover >25 percent	YR 1	Rare plants, endemic serpentine forbs and native grasses; riparian habitat; Callippe silverspot habitat	2,322 lf of new fencing; new water infrastructure	Favorable: 750lbs/acre: 33 1000lbs/acre:19 Unfavorable: 750lbs/acre: 2 1000lbs/acre: 0 Normal: 750lbs/acre: 16 1000lbs/acre: 6	Year-round (12 months)

Table 6
Details of Proposed Grazing for the Sunol Region Habitat Reserve Program Management Units

Field	Acres (approxi-mate total)	Description	Year of Grazing Implementation	Primary Management Considerations (weeds, sensitive species)	Proposed New Infrastructure	Stocking Rate (AUM)[1]	Season of Grazing
SAN ANTONIO (Figure 5)							
Field A	38.3	-Indian Creek and proposed oak woodland -Mostly flat slopes with little canopy cover; primarily north to east facing slopes	YR 3	Cattle damage to banks during rainy season; new plantings	2,022 lf of new fencing; new water infrastructure	Favorable: 750lbs/acre: TBD 1000lbs/acre: TBD Unfavorable: 750lbs/acre: TBD 1000lbs/acre: TBD Normal: 750lbs/acre: TBD 1000lbs/acre:TBD	Evaluate field for grazing after Year 3[2]
Field B	67.5	-Mostly flat and primarily north to east facing slopes -Little canopy cover -Mostly open grassland	YR 3	New plantings; yellow star thistle	Removal of 685 lf of fencing; new water infrastructure	Favorable: 750lbs/acre: TBD 1000lbs/acre: TBD Unfavorable: 750lbs/acre: TBD 1000lbs/acre: TBD Normal: 750lbs/acre: TBD 1000lbs/acre: TBD	Evaluate field for grazing after Year 3[2]
Field C	128.2	-San Antonio Creek -Mostly south to west facing slopes -67 percent of area contains slopes greater than 25 percent -Open grassland with little canopy cover	YR 3	Cattle damage to banks during rainy season, new plantings	4,400 lf new fencing; removal of 2,800 lf of fence; new water infrastructure	Favorable: 750lbs/acre: TBD 1000lbs/acre: TBD Unfavorable: 750lbs/acre: TBD 1000lbs/acre: TBD Normal: 750lbs/acre: TBD 1000lbs/acre: TBD	Evaluate field for grazing after Year 3[2]

Table 6
Details of Proposed Grazing for the Sunol Region Habitat Reserve Program Management Units

Field	Acres (approxi-mate total)	Description	Year of Grazing Implementation	Primary Management Considerations (weeds, sensitive species)	Proposed New Infrastructure	Stocking Rate (AUM)[1]	Season of Grazing
SHEEP CAMP CREEK (Figure 6)							
Field A	136.1	-Upland grassland -Low productivity soils -Pond E -63 percent of field with slopes >25 percent -20 percent of field has canopy cover over 25 percent -Over half south to west facing slopes.	YR1	Callippe silverspot habitat	New water infrastructure	Favorable: 750lbs/acre: 26 1000lbs/acre: 17 Unfavorable: 750lbs/acre: 3 1000lbs/acre: 0 Normal: 750lbs/acre: 14 1000lbs/acre: 6	Winter to early spring (approx. 5 months)
Field B	11.6	-Mixed riparian plantings -Over half with slopes >25 percent and over half south to west facing -Mostly open grassland with little canopy cover.	YR 3	Cattle damage to banks during rainy season; new plantings	4,352 lf of new fencing	Favorable: 750lbs/acre: TBD 1000lbs/acre: TBD Unfavorable: 750lbs/acre: TBD 1000lbs/acre: TBD Normal: 750lbs/acre: TBD 1000lbs/acre: TBD	Evaluate field for grazing after Year 3[2]
Field C	59.8	-Upland grassland -Pond B -Open grassland with 75 percent south to west facing slopes -Mostly flat slopes	YR1	Medusa head, yellow star thistle	None	Favorable: 750lbs/acre: 10 1000lbs/acre: 8 Unfavorable: 750lbs/acre: 1 1000lbs/acre: 0 Normal: 750lbs/acre: 6 1000lbs/acre: 3	Winter to early summer (approx. 7.5 months)

Table 6
Details of Proposed Grazing for the Sunol Region Habitat Reserve Program Management Units

Field	Acres (approxi-mate total)	Description	Year of Grazing Implementation	Primary Management Considerations (weeds, sensitive species)	Proposed New Infrastructure	Stocking Rate (AUM)[1]	Season of Grazing
Field D	247.7	-Southern half of management unit -Pond A -43 percent of this field has slopes > 25 percent, over half south to west facing slopes -Mostly open grassland.	YR1	Callippe silverspot habitat; yellow star thistle, Italian and milk thistle	New water infrastructure	Favorable: 750lbs/acre: 53 1000lbs/acre: 38 Unfavorable: 750lbs/acre: 7 1000lbs/acre: 1 Normal: 750lbs/acre: 33 1000lbs/acre: 18	Winter to early spring (approx. 5 months)[5]
Field E	18.5	-Sheep Camp Creek (intermittent drainage) -Ponds C and D -Field is mostly flat and open grassland/wetland habitats - 67 percent of field with south to west facing slopes	YR 3	Cattle damage to banks during rainy season; plantings; stinkwort	13,569 lf of new fencing, new water infrastructure	Favorable: 750lbs/acre: TBD 1000lbs/acre: TBD Unfavorable: 750lbs/acre: TBD 1000lbs/acre: TBD Normal: 750lbs/acre: TBD 1000lbs/acre: TBD	Evaluate field for grazing after Year 3[2]

Table 6
Details of Proposed Grazing for the Sunol Region Habitat Reserve Program Management Units

Field	Acres (approxi-mate total)	Description	Year of Grazing Implementation	Primary Management Considerations (weeds, sensitive species)	Proposed New Infrastructure	Stocking Rate (AUM)[1]	Season of Grazing
SOUTH CALAVERAS (Figure 7)							
Field A	1.9	-Goldfish Pond enclosure -Field is mostly closed canopy with exception of pond -All slopes greater than 25 percent.	YR 3	California red-legged frog, California tiger salamander	1,387 lf of new fencing	Favorable: 750lbs/acre: TBD 1000lbs/acre: Unfavorable: 750lbs/acre: TBD 1000lbs/acre: TBD Normal: 750lbs/acre: TBD 1000lbs/acre: TBD	Evaluate field for grazing after Year 3[2]
Field B	284.4	-Surrounding Goldfish Pond - Over half of slopes are > 25 percent -36 percent south to west facing and 28 percent -Canopy cover greater than 25 percent.	YR1	Purple star thistle, stinkwort.	None	Favorable: 750lbs/acre: 62 1000lbs/acre: 51 Unfavorable: 750lbs/acre: 17 1000lbs/acre: 8 Normal: 750lbs/acre: 40 1000lbs/acre: 28	Winter to early summer approx. 7.5 months)
Field C	91.5	-South pond -Over half of the field is south to west facing slopes -Mostly flat with little canopy cover.	YR 1	California red-legged frog, California tiger salamander, Callippe silverspot habitat; purple star thistle	None	Favorable: 750lbs/acre: 31 1000lbs/acre: 26 Unfavorable: 750lbs/acre: 3 1000lbs/acre: 0 Normal: 750lbs/acre: 17 1000lbs/acre: 12	Winter to early spring (approx. 5 months)

Table 6
Details of Proposed Grazing for the Sunol Region Habitat Reserve Program Management Units

Field	Acres (approxi-mate total)	Description	Year of Grazing Implementation	Primary Management Considerations (weeds, sensitive species)	Proposed New Infrastructure	Stocking Rate (AUM)[1]	Season of Grazing
Field D	45.0	-North pond -Over half of this field has slopes >25 percent -70 percent of slopes south to west facing -Mostly open grasslands	YR 1	California red-legged frog, California tiger salamander; Callippe silverspot habitat; purple star thistle	None	Favorable: 750lbs/acre: 5 1000lbs/acre: 4 Unfavorable: 750lbs/acre: 0 1000lbs/acre: 0 Normal: 750lbs/acre: 2 1000lbs/acre: 1	Winter to early spring (approx. 5 months)
Field E	10.8	-Goldfish Pond enclosure 1 -Mostly flat slopes -Will be a mixture of willow riparian and wetland vegetation after implementation of restoration	YR 3	California red-legged frog, California tiger salamander, new plantings	2,737 lf of new fencing	Favorable: 750lbs/acre: TBD 1000lbs/acre: Unfavorable: 750lbs/acre: TBD 1000lbs/acre: TBD Normal: 750lbs/acre: TBD 1000lbs/acre: TBD	Evaluate need for cattle at Year 3[2]

[1] AUM = Animal Unit Month. An Animal Unit in this table is defined as a 1,000 lb. beef cow with or without a nursing calf with a daily requirement of 26 pounds of dry matter forage; Favorable year is one with above average rainfall combined with environmental conditions (such as timing of rainfall, temperatures, etc.) that lead to high productivity, as compared with most years; normal year is one with rainfall combined with environmental conditions that lead to normal productivity as compared to most years and low productivity is a year with low rainfall combined with environmental conditions that leads to below average productivity. TBD = to be determined. Two stocking rates are described: the first accounting for the number of AUM in which 750 pounds/acre RDM are left behind, the second for the number of AUM's in which 1000lbs/acre RDM would be left behind.

[2] See Section 5.1.4.5 for factors to be evaluated before using livestock in fenced riparian areas of the HRP management units

the first three years. After this time, these fields will be evaluated as to whether grazing is an appropriate tool to manage the area. In these fields, the factors that will be evaluated to determine if livestock use is appropriate are described in Section 5.1.4.5.

Seasonal grazing management will be implemented, monitored and evaluated to optimize Johnny jump-ups and serpentine endemic forbs. The most beneficial season for grazing areas with Johnny jump-ups is not well documented. These plants occur in abundance in the HRP management areas that are grazed year-round (Goat Rock) and seasonally until late spring/early summer (Sheep Camp Creek). Johnny jump-ups could potentially benefit from seasonal grazing i.e. removing cattle in early spring, Johnny jump-up's typical peak blooming period. Removing cattle in early spring is suggested for Sheep Camp Creek Fields C and D, and South Calaveras Field C because of their Johnny jump-up populations. Goat Rock Field C will continue to be grazed year-round as a comparative control to evaluate effects of the new seasonal grazing prescription on Goat Rock Field B Johnny jump-ups. Monitoring data will be used in part to correlate season of grazing to occurrence/extent of the host plant and inform adaptive management (see Section 6.2.4 for more details on Callippe Silverspot host plant monitoring).

Seasonal grazing at Goat Rock Field B will occur from winter to early spring to manage for serpentine endemic forbs. Cattle will be removed from Field B during the early spring, serpentine endemic forbs' flowering period. Cattle will be reintroduced to the field as necessary, such as if high levels of RDM (1,000 pounds/acre) are observed.

5.1.4.5 USE OF LIVESTOCK FOR MANAGEMENT OF FENCED RIPARIAN AND POND FIELDS

Fencing will surround and /or bisect several ponds and some areas (primarily riparian) planted with native vegetation in the HRP management units. Fencing will be installed to protect plantings from livestock damage and control access to achieve species-specific goals. Goat Rock Field A, portions of Sheep Camp Fields B and E, and South Calaveras Fields A and E are primarily enclosures for ponds that are either known to support or provide suitable breeding habitat for California red-legged frog and California tiger salamander.

Fencing will be used to control livestock access to the ponds. Livestock would be allowed in ponds to support California tiger salamander and California red-legged frog breeding and rearing habitat goals; e.g. maintaining appropriate emergent vegetation cover and egg attachment substrate and creating turbidity in ponds, reducing visibility and predation pressure. Livestock will be allowed access to ponds for short periods of time when emergent vegetation, which is most often cattails, reaches greater than 50 percent cover (approximate) of a given pond.

San Antonio Fields A, B and Sheep Camp Creek Fields E and B will be planted with native vegetation as part of the HRP. All trees planted in these areas will have protective sleeves or cages, attached to t-stakes. Sheep Camp Creek Fields B and C also contain ponds. No livestock grazing will be used in these fields for at least the first three years after planting. After three years, the areas will be evaluated to determine if livestock grazing would be beneficial to the management of these areas. Livestock grazing may be desired to control weeds (such as some thistles and medusa head), reduce loading of fire fuels, or to reduce brush encroachment.

San Antonio Field B is an upland area that will be planted with oak savanna vegetation. All trees planted in these areas will have protective sleeves or cages, attached to t-stakes. Grazing will be excluded from this field for a minimum of three years after planting.

Chapter 5 of the revised Long Term Management Plan presents the methods that will be used to determine stocking rates and season of grazing for each field. Appropriate levels of residual dry matter (or other measure of biomass/forage) will be set based on ecological objectives and yearly conditions. Grazing will be used as a tool to meet ecological objectives such as enhancing habitat for plant and wildlife species, reduction of non-native invasive plants and reducing light flashy fuels where appropriate. This will be balanced with other ecological objectives such as minimizing erosion, ensuring protection of water quality, and encouraging recruitment of native vegetation. In addition, new water developments are proposed in the new riparian fields at Sheep Camp Creek (Field E) and San Antonio (Field E). Water developments at San Antonio include new troughs and tanks located in the uplands of Fields A and B. A new trough and new well are also proposed in the uplands of Sheep Camp Creek Field E. Proposed water developments will help to distribute cattle in the fields and reduce cattle loafing in the creeks. Finally, grazing in the riparian and pond fields would be implemented based on collaboration between a Certified Rangeland Manager (or rangeland specialist with equivalent qualifications) and SFPUC biologists. A decision to graze these areas will be based on the goal of enhancing species habitat and meeting success criteria. Other methods to obtain the same species and/or habitat goals, such as mechanical or chemical control of non-native invasive weeds will be considered before grazing the riparian and ponds fields. The most effective, feasible method to achieve the habitat/species goals will be used. The manner of management of these areas will be based on the latest scientific research, as well as on the unique observed conditions at each location, and the results of monitoring data (for example: vegetation cover, RDM, woody plant recruitment, erosion and sediment monitoring data).

5.1.4.6 PROPOSED INFRASTRUCTURE

Current cattle-related infrastructure is limited to fencing, corrals, and mineral supplements in the HRP management units. Additional fencing and water infrastructure are proposed at several locations, as illustrated on Figures 3 through 6, for the following purposes:

- Fully contain a field so grazing can be controlled
- To protect plantings in established/reestablished and rehabilitated area of the HRP management units
- To enhance riparian and pond habitat
- Better distribute cattle use of fields
- Achieve a species related management goal

Proposed water-related infrastructure includes pumps, tanks, troughs and pipelines for water extraction, storage and distribution. The development of additional water sources for cattle will better distribute cattle on the landscape, and draw them away from sensitive riparian, pond and wetland habitats.

Mineral supplements, including salt licks, will also be utilized to attract cattle away from sensitive habitats. Shade structures may also be used to reduce cattle loafing in sensitive habitats, in particular riparian areas. Placement of the supplements will be selected by the cattle operator, based on observations of cattle use of the new fields. Generally, cattle supplements would be placed a minimum of 1,000 feet away from any permanent watering facility or natural feature.

5.2 NON-NATIVE INVASIVE WEED MANAGEMENT

The ecology of target non-native invasive plants found in the management units and management tools needed to eradicate and/or control current invasions of these species are discussed in this section. A baseline inventory of all non-native invasive plant species will be conducted before

management actions are implemented (Appendix A). This baseline inventory will verify the presence and severity of non-native invasive species in the Management Units. It will also serve to finalize the management plan and treatment regime for each area. Recommended management actions are listed for each species; however, the final decision will be made after the baseline inventory is completed to consolidate treatment types and streamline the management process including herbicide application.Target species for non-aquatic, upland habitats are species with high or moderate impacts rankings in the California Invasive Plant Council's (Cal-IPC) Central West list (excluding those listed as exempt below), as well as those species that are rated as high or moderate by the Cal-IPC list in the future (but excluding species that are considered to appear rarely in monotypic stands or to have low/minor impacts in our region).

Target invasive species for wetland habitats, riparian habitats, and other aquatic habitats regulated by USACE, RWQCB, and CDFG are the same as for non-aquatic/upland habitats, with the addition of the species ranked as Tier 1 and Tier 2 in the Water Board's Fact Sheet for Wetland Projects http://www.waterboards.ca.gov/sanfranciscobay/certs.shtml.

These guidelines are for years 1-10. After success criteria are met we will prioritize species rated Cal IPC High and Water Board Tier 1 as well as species that are known to be an issue at mitigation sites or on nearby watershed lands. We will also prioritize early detection and treatment of new invasive plants that have the potential to become widespread in the mitigation sites

Scientific Name	Common Name	Cal-IPC rating	Considered a Target Invasive by SFPUC?	Rationale for not being considered exempt from the list of target invasives in non-wetland areas
Bromus diandrus	ripgut brome	Moderate	N	Monotypic stands uncommon.
Cynosurus echinatus	hedgehog dogtailgrass	Moderate	N	Impacts vary regionally, but typically not in monotypic stands.
Erechtites glomerata, E. minima	Australian fireweed, Australian burnweed	Moderate	N	Impacts low overall. May vary locally.
Hordeum marinum, H. murinum	Mediterranean barley, hare barley, wall barley	Moderate	N	Generally do not form dominant stands.
Hypericum perforatum	common St. John's wort, klamathweed	Moderate	N	Abiotic impacts low.
Hypochaeris radicata	rough catsear, hairy dandelion	Moderate	N	Impacts appear to be minor.
Lolium multiflorum	Italian ryegrass	Moderate	N	Impacts vary with region.
Rumex acetosella	red sorrel, sheep sorrel	Moderate	N	Widespread. Impacts vary locally.
Trifolium hirtum	rose clover	Moderate	N	Impacts relatively minor in most areas.
Vulpia myuros	rattail fescue	Moderate	N	Rarely forms monotypic stands

This section addresses non-native invasive plant species identified in the management units currently considered to be a priority. Non-native invasive plants that are considered a priority and that are known to occur in or directly adjacent to the HRP management units are listed in Table 7 and discussed in this chapter. It is expected that additional non-native invasive plants are present and that new non-native invasive plants could be inadvertently introduced into the management units. Management units should be monitored for increased spread of known non-native invasive plant species populations, as well as introduction of other target non-native invasive plant species and/or newly-listed species occurring in Cal-IPC weed alerts or other sources.

Because some areas are infested with multiple non-native invasive plant species and treatments are often similar in timing or nature, control methods may act on multiple species. Most of the invasive annual/biennial species have similar life cycles and management of these species can be combined together in the summer. Additionally, irrigating management units during dry summer months to promote premature germination of invasive weeds can be used to help exhaust extensive seed banks of these species. This method; however, is indiscriminant and will also deplete seed bank reserves of native plant species. Therefore, this method should be reserved for areas of non-native monocultures or in areas that will be planted or seeded with native species.

Table 7
Potential Non-native Invasive Plant Management Techniques for Existing Non-native Invasive Plants

Common Name	Scientific Name	Cal-IPC Rating[1]	Management Unit[2]	Life History	Flowering Period	Seed Bank Longevity (Years)	Anticipated Management Treatment
Bermuda grass	*Cynodon dactylon*	Moderate	Sheep Camp Creek	Perennial		Unknown; estimates of 2 years	-Solarization
Black mustard; hoary mustard	*Brassica* spp.; *Hirschfeldia incana*	Moderate	All Management Units	Annual/ Biennial	Summer; summer	> 3; unknown	-Hand/ small tool removal -Solarization
Fennel	*Foeniculum vulgare*	High	-Sheep Camp Creek -Goat Rock -South Calaveras -San Antonio	Perennial	Flowers April – August; seeds produced late May – early November	Several years	-Mowing -Hand pulling/digging -Herbicide application.
Himalayan blackberry	*Rubus armeniacus*	High	San Antonio	Perennial	May – July; fruits ripen from July - Sept	> 3	-Strategic mowing -Hydro-mechanical obliteration -Mechanical removal
Italian thistle	*Carduus pycnocephalus*	Moderate	All mitigation sites	Annual	Sept - December	> 3	-Mowing -Hand pulling/digging -Herbicide application.
Medusa head	*Taeniatherum caput-medusae*	High	-Sheep Camp Creek -Goat Rock	Annual	May - June	< 3	Prescribed burns
Milk thistle	*Silybum marianum*	Moderate	Sheep Camp Creek	Annual/ Biennial	April - July	9	-Mowing -Hand/small tool removal -Solarization -Induced early germination
Pampas grass/ Jubata grass	*Cortaderia jubata/ C. selloana*	High	-None -Observed in vicinity of Sheep Camp Creek	Perennial	July - Sept	1	- Cutting - Hand pulling/digging - Mechanical removal - Herbicide application

Table 7
Potential Non-native Invasive Plant Management Techniques for Existing Non-native Invasive Plants

Common Name	Scientific Name	Cal-IPC Rating[1]	Management Unit[2]	Life History	Flowering Period	Seed Bank Longevity (Years)	Anticipated Management Treatment
Poison hemlock	*Conium maculatum*	Moderate	San Antonio	Biennial	June - Sept	3	-Mowing -Hand/ small tool removal
Purple star thistle	*Centaurea calcitrapa*	Moderate	-South Calaveras -San Antonio	Biennial	July - Aug	> 3	-Digging -Herbicide application.
Smallflowertamarix	*Tamarix parviflora*	High	San Antonio	Perennial	April - July	< 1 yr	-Hand removal (seedlings) -Mechanical removal -Herbicide application
Stinkwort	*Dittrichia graveolens*	Moderate	-Sheep Camp Creek -South Calaveras	Annual	Late summer	> 3	-Herbicide application -Hand removal
Yellow star thistle	*Centaurea solstitialis*	High	-San Antonio -South Calaveras -Sheep Camp Creek	Annual	June - Sept	1 - 3	-Strategic mowing -Herbicide application

[1] California Invasive Plant Council 2006 Invasive Plan Inventory Invasive Rating

[2] Where species are known to occur, as of 2010.

5.2.1 BERMUDA GRASS (*CYNODON DACTYLON*)

5.2.1.1 ECOLOGY

Bermuda grass is a perennial grass species that is used as turf and has a Cal-IPC rating of moderate for invasiveness (Cal-IPC 2006). Seeds germinate from spring through fall whenever temperature and moisture conditions are favorable (CDFA 2010). Seeds can stay viable in the soil for 2 years (Cudney and Elmore 2007). Bermuda grass not only reproduces through seeds but also vegetatively through aboveground creeping stolons and belowground rhizomes. Stolons and rhizomes extend existing Bermuda grass patches and fragments of stolons and rhizomes can also grow new shoots creating new populations from vegetative remnants. Rhizome and stolon fragments can be dispersed through landscaping and agricultural activities and soil movement. Seeds are dispersed through water, soil movement, agricultural and landscape machinery, as a commercial seed impurity, in livestock feeds and bedding, and with other human activities.

5.2.1.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

Bermuda grass occurs in the Sheep Camp Creek Management Unit along the Sheep Camp Creek drainage. This area is potential habitat for both the California red-legged frog and the California tiger salamander. Monocultures of Bermuda grass, a low-growing, wiry grass species, do not provide refuge for these species. Bermuda grass infestations should be removed and wetland species that support these species should be promoted to enhance the habitat value of the area.

5.2.1.3 MANAGEMENT STRATEGIES

Use of clear plastic mulch (solarization) is effective for eradication of Bermuda grass plants and seed if it is applied during periods of high solar radiation (i.e., summer) in relatively unshaded areas (Cudney et al. 1993). Before applying the plastic, the Bermuda grass should be closely mowed, the clippings should be removed, and area should be well-watered. Clear, ultraviolet protected polyethylene should be placed over the population from June through August. The plastic should extend roughly 2 feet beyond the Bermuda grass stolons to make sure the infested area is covered and it must be maintained intact for 4 to 6 weeks. Shade will reduce the effectiveness of solarization because it limits the amount of radiation. Solarization is also less effective if used on north-facing slopes (Cudney et al. 1993; Cudney and Elmore 2007). Bermuda grass is only known to occur, as of October 2010, in the drainage of Sheep Camp Creek. This area is known to support both California tiger salamander and California red-legged frog. Therefore, use of solarization will need to be evaluated for potential negative impacts to these species. Potential measures to avoid impacts to these species using solarization could include using PVC pipes that lead from burrows underneath the plastic to aboveground areas. If appropriate measures cannot be identified, then alternative measures to remove this species will need to be explored.

5.2.2 BLACK MUSTARD (*BRASSICA NIGRA*) AND HOARY MUSTARD (*HIRSCHFELDIA INCANA*)

5.2.2.1 ECOLOGY

Brassica nigra and *Hirschfeldia incana* are erect herbaceous plants in the mustard family (Brassicaceae) with Cal-IPC ratings of moderate for invasiveness (Cal-IPC 2006). These species inhabit roadsides, fields, disturbed waste places, and grasslands. Black and hoary mustard have long tap roots and yellow flowers. Flowering occurs from March through June. The seeds are sticky when wet allowing them to attach to surfaces and animals. Both species are quick growing.

Black mustard usually develops a large, persistent seed bank (DiTomaso and Healy 2007). The foliage, roots, and seeds of black mustard are toxic to livestock when consumed in large quantities over time (DiTomaso and Healy 2007). Black mustard is also reported to have allelopathic chemical that inhibit the germination of native plants. Hoary mustard can behave as an annual, biennial, or perennial. Like black mustard it grows as a rosette for months after germination. Fruiting stems die at the end of summer or early fall when soil moisture is low. New foliage grows from the rootstock after the first fall rain (DiTomaso and Healy 2007).

5.2.2.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

Several mustard species, including black mustard and hoary mustard, are scattered throughout the management units, particularly in grasslands and oak savannahs.

5.2.2.3 MANAGEMENT STRATEGIES

Since mustard species are so widespread in the management units, management efforts should be focused first on infestations within sensitive habitats. Control methods, if implemented over a period of years, will eventually exhaust the seed bank (DiTomaso and Healy 2007). Disturbance; however, promotes the establishment of mustard species so burning and mowing should be avoided. Manual removal using hand tools can control populations. Removal should take place before flowers and seeds are produced. Additional, hand control early in the season when the plants are still rosettes makes removal easier as the tap roots are small.

New research suggests that mustard seeds can be killed through periods of high heat (Tuell-Todd et al. 2009). Solarization using clear polyethylene tarps during the summer months may kill mustard seeds in the soil seed bank. Infested areas should be mowed, then plastic firmly secured to the ground and remain in place and native seeds introduced when plastic is removed.

5.2.3 FENNEL (*FOENICULUM VULGARE*)

5.2.3.1 ECOLOGY

Fennel is an erect, perennial herb often found in annual and perennial grasslands, chaparral, in disturbed areas, and along watercourses and roadsides (The Watershed Project and California Invasive Plant Council 2004). Fennel grows 4-10 feet tall and has a Cal-IPC rating of high for invasiveness (Cal-IPC 2006). Fennel reproduces both by seed and from root crowns if the stem is cut. Seeds can germinate almost any time of the year and higher germination rates occur after soil disturbance (The Watershed Project and California Invasive Plant Council 2004). Fennel blooms between April and August and flowers first appear approximately 1.5 to 2 years after germination. Seed production can start as early as May and continue through early November (Bossard et al. 2000). One plant can produce over 100,000 seeds which are dispersed by water, animals, people, vehicles, and machinery and remain viable in the soil for several years (The Watershed Project and California Invasive Plant Council 2004).

5.2.3.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

Fennel has been observed in the Sheep Camp Creek, Goat Rock, South Calaveras and San Antonio Management Units; however, all observations were of small numbers of individuals. Only one individual of fennel was observed at both the Goat Rock and Sheep Camp Management Units. A few scattered individuals were observed in both South Calaveras and San Antonio Creek Management Units.

5.2.3.3 MANAGEMENT STRATEGIES

Mowing, hand pulling and grubbing, and herbicide application can be used to manage populations of fennel. Small seedlings can be hand pulled when soil is moist; however, it is important to remove as much of the taproot as possible and at least the upper portion of the root crown (The Watershed Project and California Invasive Plant Council 2004). Hand removal is effective on isolated small populations and should be conducted when the plants are mature but before seed set. Areas that have been hand pulled should be checked for seedling growth twice a year, particularly in late winter/early spring (The Watershed Project and California Invasive Plant Council 2004). While mowing can be used for control of this species, timing of mowing is important. Mowing while plants are setting seed will spread the seeds, while mowing too soon before seed set can increase vegetative growth. Mowing should occur 4 times a year beginning around March-April and should not occur during seed set. Herbicide application has also been shown to be effective at controlling fennel (Dash and Gliessman 1994). A 2 percent solution of glyphosate should be applied to green seedlings in the spring before plants begin to bolt (The Watershed Project and California Invasive Plant Council 2004).

Because populations of fennel within the management units are small and isolated, hand pulling and grubbing is a good option for control of this species. However, if another method is already being employed for a different weed in the immediate area then this method could be employed instead.

5.2.4 HIMALAYAN BLACKBERRY (*RUBUS AREMENIACUS*)

5.2.4.1 ECOLOGY

Himalayan blackberry is a perennial shrub native to Western Europe (Hickman 1993) that is rated as high by the Cal-IPC (Cal-IPC 2006). Seeds germinate in the spring and adult plants produce flowers from May to July and fruits ripen from July to September. Himalayan blackberry reproduces both through seeds and vegetatively. Vegetative spread can occur when blackberry branches touch the ground and sprout roots allowing blackberry patches to expand in size each year. Additionally, severed or dislodged root fragments can sprout into new individual plants. Main roots can grow up to 8 inches thick in diameter and lateral roots can be found as deep as 3 feet and 30 feet long (Northcroft 1927). Seeds are dispersed by many mammals and birds as well as through fruits falling to the ground. Seeds can also be spread considerable distances by streams and rivers because Himalayan blackberry often grows in riparian areas (Parsons 1992).

Himalayan blackberry rapidly colonizes disturbed or neglected landscapes and forms dense thickets that block light for native plants trying to survive underneath. This species is a strong competitor and creates an environment hostile to native plant species and, thus, can rapidly displace native plant species. Himalayan blackberry can eventually dominate range and pasture lands if not controlled. Because plants are prickly, livestock, particularly sheep and cattle, avoid grazing near them, effectively decreasing the usable pasture area. In wet areas blackberries may hinder medium-sized to large mammals from gaining access to water.

5.2.4.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

Small, isolated patches of Himalayan blackberry are found along San Antonio Creek in the San Antonio Management Unit.

5.2.4.3 MANAGEMENT STRATEGIES

Management strategies include mechanical removal, hydro-mechanical removal, and grazing by goats or sheep. Methods have access limitations that should be evaluated for each patch. Mechanical removal is recommended for small patches (200 square feet or less) of this species. For larger patches, strategic mowing or hydro-mechanical obliteration can be used depending on road access, slope, and terrain obstacles. Multiple mowing events are necessary to deplete the plant's energy reserves. Mowing should first occur at the beginning of flowering. Mowing events should continue until the roots can no longer sprout and create new plants. Hydro-mechanical obliteration is an effective non-chemical method which uses high pressured water to disintegrate the plant leaving a fine mulch behind (Alvarez et al. 2008). Additional treatment methods for Himalayan blackberry include the use of goats or sheep.

5.2.5 ITALIAN THISTLE (*CARDUUS PYCNOCEPHALUS*)

5.2.5.1 ECOLOGY

Italian thistle is an annual species in the Asteraceae family that is rated as moderate by the Cal-IPC (Cal-IPC 2006). It occurs in open areas such as meadows, pastures, oak savannah and roadsides; it is also commonly found in disturbed areas. Italian thistle can form dense stands that can exclude native species. This species is avoided by livestock during grazing and its spines can even discourage grazing of neighboring plant species. Reproduction only occurs by seed. Germination occurs after the first substantial rain and can continue for months. Plants flower during the following fall. Italian thistle spread is facilitated by drought and disturbance (Wheatley and Collett 1981;Bossard et al. 2000).

5.2.5.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

Isolated patches of Italian thistle occur in the South Calaveras Management Unit, San Antonio Management Unit, and the Sheep Camp Creek Management Unit.

5.2.5.3 MANAGEMENT STRATEGIES

Mowing, hand pulling, and herbicide application are effective management tools for Italian thistle. Because populations of Italian thistle are isolated and small, the method used should be chosen based on methods used on surrounding weeds. If a method is already being employed for another weed in the immediate area then this method should take priority.

Mowing is most effective when the plants are bolting and have 5 percent of their total flowers (Stanton and Maher 2006). Hand removal can be used on small populations and should be conducted when the plants are mature but before seed set. A shovel or weed wrench should be used to remove 2-4 inches of the below ground tap root. Both mowing and hand removal should be repeated 2-3 times during a growing season. Glyphosate containing herbicides (Roundup or Roundup Pro) have been shown to be effective in eliminating populations of Italian thistle (Stanton and Maher 2006). A 2 percent solution should be applied to the basal rosettes in the spring using a wick or a backpack sprayer (Stanton and Maher 2006) of offsite (Parsons and Cuthbertson 1992; Marriott 2010).

5.2.6 MEDUSAHEAD (*TAENIATHERUM CAPUT-MEDUSAE*)

5.2.6.1 ECOLOGY

Medusa head is a winter annual grass native to Europe but is now common in California annual grasslands and oak woodlands. It has an invasiveness rating of high from Cal-IPC (Cal-IPC 2006). Medusa head not only has the ability to displace native flora but is also very unpalatable when reproductive due to its stiff sharp seeds and high silica content. Medusa head reproduces through seed which are dispersed locally with wind and water and to greater distances by attaching to animals, shoes, tires, etc. Most seeds germinate in the fall after the first rain but some seeds remain dormant and germinate in the winter or spring. Seeds can germinate in very high densities under low moisture conditions (DiTomaso and Healy 2007). Seed production occurs weeks later than other common annual grass species. Although each plant only produces an average of 6-9 seeds, medusa head can create dense monocultures containing 1,500 -2,000 individuals per square foot.

5.2.6.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

Medusa head is known to occur in patches of over one acre in the in the grasslands of Goat Rock and Sheep Camp Creek Management Units. It is also expected to occur in smaller patches in the grasslands and oak savannas of the management units.

5.2.6.3 MANAGEMENT STRATEGIES

Mid-spring grazing by sheep has been seen to reduce medusa head presence by 80 percent (DiTomaso et al. 2005). In cases where fire is not practical or possible, sheep are recommended for control of this species. For instance, research conducted at University of California at Davis has shown short duration, high intensity grazing by sheep to be effective in greatly reducing medusa head (LARPD 2009).

Use of controlled burns for two seasons is recommended in patches of less than 10 acres. Burns that are less than 10 acres can be accomplished without a smoke management plan (Bay Area Air Quality Management District Regulation 5, Sections 401.15 and 408). Burns expected over 10 acres are regulated as Wildland Vegetation Management fires that require a smoke management plan. Prescribed burns must take place on a burn day (Bay Area Air Quality Management District Regulation 5, Sections 401.15 and 408). A recent study shows that fire can reduce medusa head by 96-99 percent after two years of burning. The effectiveness of fire increases with an increase of total vegetative biomass. The area surrounding the management units exhibit climate/conditions similar to experimental sites that have successfully controlled medusa head using fire (Kyser et al. 2008; UC IPM 2010). The Management Units are likely to contain enough biomass to produce fire hot enough to eradicate medusa head (Kyser et al. 2008). Burns should be started with propane drip torches and should occur in late May or early June before seeds have been produced. Fire should not be used in areas with yellow star thistle or black mustard because burning primes the area for invasion of these disturbance-loving species.

Due to the barbed awns and sharp seeds, cattle will only graze medusa head during vegetative months. Cattle grazing can be used to control infestations by reducing seed production; however this method is not likely to eradicate the species. Palatability of medusa head decreases as the grass grows; however sheep (not cattle) are more likely to graze medusa head throughout the season especially if stocking rates are high.

5.2.7 MILK THISTLE (*SILYBUM MARIANUM*)

5.2.7.1 ECOLOGY

Milk thistle is an annual/biennial in the Asteraceae family with a Cal-IPC rating of moderate (Cal-IPC 2006). Milk thistle grows in disturbed sites, along roadsides, and in open fields, chaparral and woodlands. This species causes problems because it can grow in dense monocultural stands and nitrates can accumulate in the tissue under stressful conditions such as drought or mowing. These accumulated nitrates are toxic to cattle. This annual species only reproduces by seed. Seeds are dispersed through wind and through water, movement of soil, and by attaching to humans, farm equipment, and animals. Seeds can remain viable in the soil for nine years making control and eradication of this species difficult. Most seeds germinate after the first rain but germination can continue through the winter and early spring. Individual plants can grow very tall reaching 5-6 feet in height. Milk thistle flowers from April to July.

5.2.7.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

Milk thistle is known to occur along the drainages in the Sheep Camp Creek Management Unit; particularly in the coast live oak riparian, riparian scrub, and sycamore alluvial woodland habitats. Small and large patches occur in most habitats of the management units.

5.2.7.3 MANAGEMENT STRATEGIES

A number of control methods are available to manage milk thistle. Small or isolated patches can be removed by hand using hand tools and protective gear. For larger patches or populations mowing or hydro-mechanical obliteration can be used, although there are limitations to both techniques. Mowing can only occur where the terrain is suitable for a driving mower. For hydro-mechanical obliteration the population of milk thistle needs to be 400 feet from a location suitable for parking a truck. Regardless of method, flower heads with seeds should be hand removed and collected before mechanical treatment to minimize seed dispersal.

For populations of milk thistle adjacent to Bermuda grass populations, shoots can be clipped to the ground and the remaining rosette can be placed under the solarization technique used on Bermuda grass. Additional attention must be given to the persistent seed bank because ungerminated seeds can stay viable for up to 9 years. After mowing, hand removal, and or solarization the area should be irrigated to promote germination of seeds. Once a flush of seeds successfully germinate the irrigation should be stopped so that the seedlings will perish in the summer heat. This irrigation method can be implemented in the late summer months. Controlled burns should not be used in areas populated with milk thistle because fire encourages seed germination in this species.

5.2.8 PAMPAS GRASS/JUBATA GRASS (*CORTADERIA* SPP.)

5.2.8.1 ECOLOGY

Pampas grass usually refers to *Cortaderia selloana*; however, jubata grass (*Cortaderia jubata*) is also commonly called pampas grass. Both *Cortaderia* species have a Cal-IPC rating of high for invasiveness (Cal-IPC 2006). The following discussion of "pampas grass" will refer to both *Cortaderia jubata* and *Cortaderia selloana* unless specifically noted.

Pampas grass is a quick-growing, perennial grass that often grows in large clumps and flowering stalks can grow to 20 feet tall. Pampas grass is commonly planted as an ornamental plant throughout

California. In addition to escaping cultivation, pampas grass readily establishes in disturbed areas, such as road cuts and landslides, including along slopes and cliffs, and in coastal scrub and forest clearings (Bossard et al. 2000; The Watershed Project and California Invasive Plant Council 2004). Although jubata grass produces seeds asexually (apomictically), pampas grass only produces seeds sexually. Both species also reproduce vegetatively from tillers or mature plant fragments (The Watershed Project and California Invasive Plant Council 2004). Flowering stalks of pampas grass are typically produced two to three years after germination and inflorescences usually appear between July and September. Seeds are dispersed primarily by wind and can remain viable for approximately one year (The Watershed Project and California Invasive Plant Council 2004). Seedlings require sandy soil, adequate moisture, and light and seedling survival is low in shaded areas (Gadgil et al. 1990 in Bossard et al. 2000).

5.2.8.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

Pampas grass has not been recorded in any of the HRP management units; however, it has been observed in the vicinity of the Sheep Camp Creek management unit. Additionally, a major effort to remove pampas grass along San Antonio Reservoir was implemented in the past (Koopmann, pers. comm., 2010).

5.2.8.3 MANAGEMENT STRATEGIES

Cutting, pulling, and herbicide application are control options for pampas grass. Seedlings can be hand pulled or with a shovel. Leaves and stalks of larger, established plants should be cut and then the root mass removed with a shovel or Pulaski. Root masses should be taken offsite to prevent resprouting. All flowering stalks should be cut before seed production, usually between August to October (The Watershed Project and California Invasive Plant Council 2004). Pampas grass stalks may need to be re-cut as a second seed plume (inflorescence) can be produced from a cut stalk within 1-2 weeks. A 2 percent solution of glyphosate applied during the active growth period (November to July) can help control pampas grass; however, all green growth must be sprayed and the herbicide must contact the entire leaf surface (The Watershed Project and California Invasive Plant Council 2004). Follow up control may be needed as plants treated with herbicide may survive and grow again the following year.

Populations of pampas grass are not currently known to occur in any of the management units. However, San Antonio Creek and Sheep Camp Creek Management Units should be monitored for pampas grass. If any individuals of pampas grass are observed they should be pulled (if seedlings), cut, and/or treated with herbicide immediately to prevent infestations of this species from becoming established in the management units.

5.2.9 POISON HEMLOCK (*CONIUM MACULATUM*)

5.2.9.1 ECOLOGY

Poison hemlock is an erect biennial, native to Europe with a Cal-IPC rating of moderate for invasiveness (Cal-IPC 2006). All plants parts are highly toxic to humans and animals when ingested. Poison hemlock inhabits ruderal fields, pastures, roadsides, ditches, riparian areas, cultivated fields, and other disturbed, often moist, sites (DiTomaso and Healy 2007).

Poison hemlock reproduces by seed. Seeds germinate after the first rains in late winter through early spring. Plants exist as large basal rosettes of leaves during the first year and reproductive shoots are produced during the second year. Flowering occurs during June and July but flowering can be

prolonged if conditions are favorable. Seeds typically fall near the parent plant but some may disperse farther by attaching to animals and through human activities. Seed production ranges from 1,700 to 39,000 seed per plant with taller plants producing the largest amount of seed (Woodard 2008). Seeds can remain viable up to about 3 years under field conditions (DiTomaso and Healy 2007).

This species is a problem because it can easily shade out and out compete native species. Additionally it is toxic to livestock. Poison hemlock is not widespread throughout the management units; as a result, efforts should focus on not allowing this species to become established in areas where it is not currently well established within in the management units. New populations beyond what already exists should be removed as soon as possible.

5.2.9.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

Poison hemlock occurs along San Antonio creek in the San Antonio Management Unit. It is expected that small, isolated patches occur in riparian and mesic areas of the HRP Management Units.

5.2.9.3 MANAGEMENT STRATEGIES

Mowing and hand removal are the two methods recommended to manage poison hemlock. Mowing will prevent new plants from establishing and can reduce competitiveness (Pokorny and Sheley 2001). Plants do not regenerate when hand pulled or are cut below the crown. Removing plants before seeds are produced or mature every year will eventually deplete the seed bank. Repeated mowing or repeated cultivation can eventually control it (DiTomaso and Healy 2007).

5.2.10 PURPLE STARTHISTLE (*CENTAUREA CALCITRAPA*)

5.2.10.1 ECOLOGY

Purple star thistle is a rosette-forming biennial herb in the Asteraceae family rated as moderate by Cal-IPC (Cal-IPC 2006). Under favorable conditions or after several years of unfavorable conditions, some individuals may complete their life cycles as annuals (Roche and Roche 1990). Purple star thistle inhabits open disturbed areas such as pastures and overgrazed rangelands and along roads, ditches, and fences, usually below 3,000 feet (1,000 m). This species reproduces only by seed. Its stiff sharp spines are unpalatable to cattle and, as a result, purple star thistle can displace palatable species in grazed areas (DiTomaso and Healy 2007).

5.2.10.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

Isolated patches of purple star thistle occur in South Calaveras Management Unit and San Antonio Management Unit.

5.2.10.3 MANAGEMENT STRATEGIES

Grubbing/digging and herbicide application are the only known effective methods to control purple star thistle. Grubbing or digging can control small infestations if repeated two to three times throughout the growing season. Plants should be cut at least two inches below the soil surface early in the growing season (Bossard et al. 2000). Plants should be cut after they bolt but before they begin to flower in order to prevent the release of viable seed. If plants are cut after they have begun to flower, they should be removed from the site and destroyed. A few weeks after the first treatment, the site should be revisited and any new sprouts should be removed.

Herbicide choice will depend on grazing restrictions and surrounding sensitive habitat restrictions. Clopyralid, 2,4-D and dicamba, provided effective control of purple star thistle when applied to seedlings and rosettes in the late winter or spring (Whitson et al. 1987). Late winter or spring application is recommended because the seedlings and rosettes are most sensitive to herbicides at this time. Glyphosate can also effective but it is a non-selective herbicide that will injure or kill all other surrounding plants.

5.2.11 SMALLFLOWER TAMARISK (*TAMARIX PARVIFLORA*)

5.2.11.1 ECOLOGY

Smallflower tamarisk is a shrub to small tree with a Cal-IPC rating of high for invasiveness (Cal-IPC 2006). This species is found along streams and lake shores throughout California (Bossard et al. 2000). The ecology of smallflower tamarisk is similar to many other tamarisk species and thus, tamarisk species, in general, are discussed below unless specifically noted.

Tamarisk species, under favorable conditions, can grow to 10 feet in one growing season and can begin flowering by the end of the first year of growth (DiTomaso 1996 in Bossard et al. 2000).The tiny rose-pink flowers of smallflower tamarisk are borne in dense clusters on branches of the previous year's growth. Smallflower tamarisk reproduces both by seed and vegetatively from underground rhizomes and adventitious roots. Flowering occurs in early summer and may persist for several weeks. Seed production is prolific and can continue throughout the growing season and germination can occur within twenty-four hours in warm, moist soil (Zouhar 2003). Seeds are dispersed by water and wind (Zouhar 2003). Tamarisk seeds remain viable for only a short period of time and thus do not produce a persistent seed bank (Alberta Invasive Plant Council 2010).

Mature tamarisk trees can reproduce from adventitious roots, even if the aboveground portion of the plant has been removed (Zouhar 2003). Mature tamarisks produce deep tap roots allowing this species to tolerate extended drought (Alberta Invasive Plant Council 2010). Tamarisk species pose a problem to native ecosystems not only by forming dense thickets, but also because they have been associated with changes in geomorphology, groundwater availability, plant community composition, and native wildlife diversity (Bossard et al. 2000).

5.2.11.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

One individual of smallflower tamarisk has been observed in the San Antonio Management Unit. Another individual has also been observed in the vicinity of the San Antonio Management Unit.

5.2.11.3 MANAGEMENT STRATEGIES

Mechanical and chemical methods can be used to control populations of smallflower tamarisk. Hand pulling is only effective on seedlings. Cutting of mature trees alone is ineffective due to tamarisk's ability to produce adventitious roots from remaining above ground stems and/or sprout from underground rhizomes (Zouhar 2003; Alberta Invasive Plant Council 2010). Mechanical control of established trees must include removal of aboveground stems and underground root crowns (Zouhar 2003). Stress imposed by control methods (e.g., herbicides, cutting) can increases flower and seed production and the entire root system must be killed in order to prevent sprouting (Zouhar 2003). Thus, follow-up control may be needed for at least 2 years to treat root sprouts and monitor for seedlings.

Treating stumps of cut tamarisk with herbicides has also been shown to be effective. Triclopyr and/or glyphosate applied to cut stems in the early fall has shown the best results (Alberta Invasive Plant Council 2010). As this species grows in riparian areas, herbicides chosen must be approved for use in riparian areas and must be applied in accordance with current SFPUC policy to reduce use of pesticides (City and County of San Francisco 1996).

There are only a few known individuals of smallflower tamarisk within and in the vicinity of San Antonio Management Unit, thus either cutting and applying herbicide to the stumps, or cutting and plowing to remove both the underground stems and root crown known individuals are options. Cutting and plowing is the best option if herbicide application is not desired; however, it may be more labor intensive. It is also important to burn or transport removed stems and roots offsite to prevent resprouting of abandoned stems. Areas in the vicinity of the known individuals should be monitored for seedlings and resprouting for the first year or two after treatment.

5.2.12 STINKWORT (*DITTRICHIA GRAVEOLENS*)

5.2.12.1 ECOLOGY

Stinkwort is an invasive annual native to the Mediterranean region reported as an established weed in California in 1997 (Randall 1997). It currently has an invasiveness rating of moderate from Cal-IPC (Cal-IPC 2006). Stinkwort is in the sunflower family (Asteraceae) and is capable of producing 15,000 seeds per plant (Csurhes and Zhou 2008). Seeds germinate in the spring and mature plants flower in the fall; therefore, reproduction of this annual occurs when other species have senesced. The seeds have a pappus and tiny barbs allowing them to be dispersed by wind and by attaching to fur, machinery, clothing, tires, etc. This species thrives in open disturbed areas, including roadsides, and is frequently moved around via roadside earth moving and construction.

Stinkwort is a concern due to its rate of spread, potential for outcompeting natives, extensive seed bank, and because it is detrimental to the health of livestock. The pappus of the seed, when eaten by livestock, can cause enteritis (inflammation of the small intestine) which leads to pulpy kidney disease and sudden death if left untreated. Livestock generally avoid this plant likely due to its strong smell, but will eat it when it is very young; therefore, all infested areas are dangerous for livestock (Parsons and Cuthbertson 1992). Stinkwort is drought tolerant and appears to thrive in wet, open disturbed areas (Beall 2005; Parsons and Cuthbertson 1992).

5.2.12.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

Stinkwort was identified in scattered and isolated patches in all of the management units. Larger patches have been observed at Sheep Camp Creek and the South Calaveras Management Units. It is expected to occur in small patches in grasslands, oak savannahs and adjacent to riparian areas of the management units.

5.2.12.3 MANAGEMENT STRATEGIES

Hand removal and herbicide application are the most effective means of stinkwort control. This species is of particular concern because populations appear to be spreading quickly. Little research on control efforts for this species have been conducted and/or reported. Local resources recommend that herbicide application be conducted two to three times per season for multiple years. Herbicide application is only effective when the plants are not actively flowering; herbicides should be applied twice between May and August(Marriott 2010; Santa Clara Weed Abatement Program 2009). Effective herbicides include: herbicides containing Glyphosate (which can be used near water),

Habitat® (Imazapyr), and Milestone VM Plus® (aminopyralid with Galon). Hand pulling should be utilized once the plants are flowering (Marriott 2010; Santa Clara Weed Abatement Program 2009). The plant's oils are an irritant so protective gloves and eye protection should be worn when handling. If the plants have gone to seed when pulled they should be bagged and disposed

5.2.13 YELLOW STARTHISTLE (*CENTAUREA SOLSTITIALIS*)

5.2.13.1 ECOLOGY

Yellow star thistle is an annual noxious weed in the Asteraceae family with a Cal-IPC rating of high (Cal-IPC 2006). In California's Mediterranean climate, yellow star thistle germinates after the first winter rains. It grows slowly as a rosette until the early spring when it begins to bolt. Flowering occurs during the dry, hot summer when it is one of the few annuals that is still alive. Seed heads produce between 30 and 80 seeds each with the number of seed heads per plant ranging from 1 to 3400 seed heads (Benefield et al. 2001; Thomsen et al. 1996). During the rosette stage most of the plant's energy is used for sending a taproot down to a groundwater source; doing so quickly gives this annual plant a competitive advantage over its neighbors.

Yellow star thistle causes problems because it can form dense monocultures, displace native species, and is unpalatable to livestock in the summer months due to the long thorns on the inflorescences.

5.2.13.2 OCCURRENCE IN THE HRP MANAGEMENT UNITS

Yellow star thistle occurs in most habitats of the management units. Large patches occur in grassland and oak savannah habitats, and openings in oak woodlands.

5.2.13.3 MANAGEMENT STRATEGIES

Herbicide application and mowing are the preferred methods for managing yellow star thistle. Clopyralid (Transline®) or Aminopyralid (Milestone®) should be applied according to advised application rates during the first two years. These herbicides provide pre- and post-emergence control. Additionally, there are no grazing restrictions with these herbicides and they provide selective control causing no injury to grasses and most broadleaf species (DiTomaso et al. 2006). These herbicides should be applied via backpack sprayer when the plants are in the rosette stage (late fall through early spring).

Spot control of adults using herbicides can be conducted after the first few years of control. Glyphosate should be used in areas with native grasses; however, Glyphosate may have grazing or sensitive habitat restrictions. This herbicide should only be applied selectively with a backpack sprayer as it will injure desirable broadleaf and grass species (DiTomaso et al. 2006).

Herbicide use may be restricted due to grazing or due to the presence of sensitive habitat, so in those areas a mowing regime will be implemented. Timing is critical when using mowing to control yellow star thistle populations because each plant has a reserve of energy in its root system allowing it to survive a premature mowing event. Research has shown that multiple rounds of mowing are needed each season to ensure that yellow star thistle seed production is minimal. The first mowing event should take place when approximately 2 percent of the plants flowers are flowering. Mowed plants will grow back more quickly after the first mow; as the plants will put all of their energy into producing seed. The second mowing event should be conducted when the new shoots begin to produce flowers.

6 MONITORING

Monitoring, with the exception of rangeland and serpentine grassland monitoring, will be implemented in the enhancement areas within the conservation easement boundaries, commencing after the construction warranty period is complete. Rangeland and serpentine grassland monitoring will occur within the management unit boundaries, commencing after any changes to the current grazing regime are implemented. Restoration and enhancement area monitoring for Years 1–10 are described in the Sunol Region MMP, and annual monitoring requirements summarized in Table 8. After 10 years, monitoring of the enhancement and restoration areas of the HRP management units will transition from their initial intensive monitoring to a management-centric monitoring scheme. After Year 10, if success criteria are met, monitoring type and frequency (both for the enhancement areas and the restoration areas), will be consistent with the conservation easement requirements for the HRP management units. Monitoring includes both implementation monitoring and effectiveness monitoring:

- Implementation monitoring includes documentation of implementation activities, events, and interpretive measurements (annual indicators) or observations of effects that influence progress toward objectives.
- Effectiveness monitoring documents achievement of objectives and/or measures a trend toward meeting objectives.

Effectiveness monitoring is generally described in this LTMP; more specific details on effectiveness monitoring methods are included in the Sunol Region MMP.

Table 8
Annual Monitoring Schedule and Tasks (Years 1–10)

Time Period	Monitoring Tasks to Be Performed
Pre- Construction	▪ Assess baseline conditions for all mitigation areas
Completion of Construction	▪ As-built habitat mapping ▪ As-built stream channel/pond topography/bathymetry
Years 1 - 5	▪ Vegetation monitoring for all habitats ▪ Hydrology monitoring (stream/rain gages, piezometers, wetlands) ▪ Erosion monitoring in riparian areas ▪ Pond sedimentation ▪ Evaluation of constructed wetlands ▪ Non-native invasive species ▪ Predator monitoring/eradication in ponds ▪ Special-status species monitoring – presence and habitat ▪ General observations and photo points
Year 1, 3, 5	▪ Hydrogeomorphic monitoring (stream thalweg and cross sections)
Year 5 (activities conducted in addition to those in Years 1-5)	▪ Wetland delineation completed using the same method as baseline delineation ▪ Aerial photography
Years 7, 10	▪ Vegetation monitoring for woodland, savannah, oak riparian, and sycamore riparian habitats ▪ Hydrology monitoring (stream/rain gages, piezometers, wetlands) ▪ Hydrogeomorphic monitoring (stream thalweg and cross sections) ▪ Pond sedimentation ▪ Non-native invasive species ▪ Predator monitoring/eradication in ponds as necessary ▪ Special-status species monitoring – presence and habitat ▪ General observations and photo points

6.1 IMPLEMENTATION MONITORING

Implementation monitoring primarily applies to monitoring the implementation of grazing prescriptions and pig and turkey control programs as outlined in Chapter 5. The SFPUC Area Manager oversees the Alameda Creek watershed grazing program. The Area Manager is responsible for ensuring that grazing lessees follow specified grazing prescriptions, and that contracts for non-native wildlife control are executed. Grazing lease monitoring is accomplished though periodic, unannounced checks of stocking rates (by the Area Manager), season of use and livestock type. Non-native wildlife removal monitoring includes review of reports submitted after control activities are completed. The Area Manager also conducts spot checks of RDM levels to ensure that RDM values are within an acceptable range. Grazing lessees must submit an annual report that includes the number of cattle, season of use, and monthly stocking rates. The HRP management units are new, separate fields from the larger watershed grazing unit in which they are located, and therefore will require separate annual reporting to the SFPUC Area Manager. Contractors implementing non-native invasive wildlife control must submit documentation to the SFPUC Area Manager after completion of control activities in the watershed. The Area Manager will work closely with SFPUC biologists in applying adaptive management decisions and sharing of data and reports.

6.2 EFFECTIVENESS MONITORING

Effectiveness monitoring in the HRP management units will document achievement of and measure trends toward meeting objectives. Effectiveness monitoring will include tracking the following parameters:

- Non-native grassland vegetation composition and structure
- Serpentine grassland vegetation composition
- Cover of Johnny jump-ups (map all outer boundaries of patches of Johnny jump-ups)
- Presence and cover of non-native invasive plants
- Hydrologic function in wetlands
- Pond sedimentation rates, cover of emergent native vegetation, presence of non-native aquatic plants and presence of California red-legged frog and California tiger salamander in ponds
- Oak and woody riparian plant recruitment
- Erosion in riparian areas
- Habitat structure, relative cover and size classes of scrub species, and non-native invasive plant cover in scrub habitats

A summary of the schedule for effectiveness monitoring for Years 1-10 is provided in Table 9. After Year 10, the type and frequency of effectiveness monitoring will be reevaluated. While the monitoring schedule applies to Years 1-10, it will be used as a guide when establishing new monitoring guidelines after Year 10.

Table 9. Years 1-10 Effectiveness Monitoring Schedule

Habitat Type	Approximate Timing of Proposed Years 1-10 Monitoring											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Grassland vegetation (including native grasslands)			V	V								
Serpentine Grassland			V	V	V							
Seasonal and Perennial Wetland	H	H	V/H	V								H
Riparian									V	V		
Oak Woodland and Savannah								V	V			
Streams	H		V	V					V	V		H
Ponds	H/P	H	H/A	V/A/P	V			P		H	A/P*	H
Hydrology monitoring (stream/rain gages & piezometers)	H	H	H	H		H		H		H		H
California red-legged frog and California tiger salamander upland habitat (migration corridors, upland refugia)				A	A	A	A	A	A	A		
Alameda whipsnake habitat				W								
Callippe silverspot host plant mapping				C								

Monitoring target: H = hydrology; V= vegetation; A = amphibians; W = Alameda whipsnake, C=Callippe silverspot, P=predator control P*=predator control and pond draining (conducted on biannual basis when California red-legged frog metamorphosis is complete)

6.2.1 NON-NATIVE GRASSLAND VEGETATION COMPOSITION

The SFPUC will use the methods described in the SFPUC rangeland monitoring program (Sage Associates 2007) and the SFPUC Rangeland Monitoring Report (ACCP 2010) to monitor non-native grassland vegetation composition and structure. Monitoring includes photo point observations, measurement of RDM, rangeland health evaluation, and a determination of rangeland plant species composition (point-line transects[2]). In 2009, the species composition monitoring component of the program was adjusted to be comparable to other rangeland monitoring efforts in the region (e.g., East Bay Regional Park District). The new monitoring methods are relatively efficient and objective since personnel will be expected to vary from sampling year to year (ACCP 2010). Some of the existing sampling plots within the watershed-wide monitoring program fall within the HRP management units and will continue to be monitored. Additional sampling plots in the HRP Management Units will be added to the monitoring program to ensure grazing and other parameters can be accurately evaluated, and that a sufficient number of plots are included to provide an accurate representation of species composition in the management units. For the HRP management units, monitoring of the plots will be conducted as described in the Sunol Region MMP. After Year 10, or when success criteria are met, less frequent monitoring will occur and will be dependent on site conditions. Additional adjustments to the existing Alameda Creek watershed rangeland monitoring program that would be made for the HRP management units include (as recommended in the 2010 rangeland monitoring report):

- Livestock inventory stocking rates would be tracked within the boundaries of a HRP management unit grazing field, rather than tracked only within the larger SFPUC grazing unit boundary
- The rangeland monitoring program would continue to be refined as specified in the 2010 rangeland monitoring report (ACCP 2010)

In addition to the rangeland monitoring described above, the existing extent of non-native invasive plant populations will be mapped using a Global Positioning System (GPS) to provide baseline conditions at Years 1 and 10.

6.2.2 SERPENTINE GRASSLAND

Monitoring of serpentine grasslands at the Goat Rock Management Unit will measure serpentine grassland plant species composition. Monitoring will:

- Measure abundance and/or richness of native grassland forbs and grasses
- Measure frequency and extent of non-native, invasive plants
- Compare grassland species composition between seasonal and year-round grazing in serpentine grasslands at the Goat Rock Management Unit
- Increase knowledge of serpentine grasslands
- Monitor rare plants

Using methodology similar to that used for the rangeland monitoring, monitoring design will include stratified random sampling within serpentine grassland that has year-round grazing and seasonal grazing. Monitoring will occur annually for a minimum of 10 years. In addition, the existing extent of non-native invasive plant populations will be mapped using GPS in Years 1 and 10. After 10 years, monitoring frequency will be reevaluated based on site conditions.

[2] Point-line intercept vegetation monitoring methods are described in the Sunol Region MMP

A separate monitoring design sensitive to rare plants may be needed to track these species over time. Spatially, rare plant monitoring will likely overlap with the serpentine grassland monitoring described above.

6.2.3 PONDS AND WETLANDS

Monitoring of ponds and wetlands will measure general condition of the habitats through observations and measurements of non-native invasive plants, hydrologic function, pond sedimentation and use of ponds by special-status species. Monitoring will:

- Observe general wetland and pond hydrologic function and pond sedimentation rates
- Estimate percent cover of non-native, invasive plants
- Record any new non-native invasive plants and provide an opportunity for early removal before plants spread
- Observe pond use by California tiger salamander and California red-legged frog

Quantitative monitoring of wetlands will include visual cover estimates of non-native invasive plants in wetlands and ponds, and pond sedimentation rates (measured via bathymetric transects). Qualitative monitoring will include visual surveys of general hydrology and inspection of wetlands and ponds for newly occurring non-native invasive plant and wildlife species. Qualitative and quantitative monitoring for Years 1-5 of wetlands (plants) and Years 1-5, 7 and 10 (ponds) will occur as described in the Sunol Region MMP. After Year 5 (wetlands) and Year 10 (ponds), the frequency of surveys will be determined based on site conditions.

6.2.4 CALLIPPE SILVERSPOT HABITAT

Callippe Silverspot habitat will be evaluated by recording the extent of Johnny jump-ups in grasslands annually for the first five years to assess progress towards and achievement of objectives. After Year 5, the need for mapping this species will be revaluated. Extent of Johnny jump-ups will be determined in the early spring, when the peak bloom for this plant occurs. The boundaries of the plant occurrences (“patches”) will be walked using a high accuracy (submeter) GPS unit. Extent of mapped occurrences will be compared from year to year to determine if the extent of Johnny jump-up occurrences is changing. A target increase in extent from baseline will be developed by SFPUC in coordination with the USFWS before implementation of this plan. In addition to a target extent, a reduction in the extent of Johnny jump-up at a given site for more than three years will trigger a management action, such as altering the current grazing prescription.

6.2.5 OAK AND WOODY RIPARIAN PLANT RECRUITMENT

Monitoring of oak and woody riparian plant abundance will provide an estimate of oak and woody riparian plant species recruitment in oak woodlands, savannah and riparian habitats.

Seedlings of woody riparian species will be measured using stratified random sampling. Quantitative monitoring will occur annually during the first ten years as described in the Sunol Region MMP; after Year 10, or when success criteria have been met, the frequency and type of surveys will be determined based on site conditions. The sampling design during Years 1-10 will utilize randomly placed quadrats in which seedlings will be counted and recorded. The size of the quadrats will be dependent upon the results of baseline surveys of oak recruitment in the HRP management units.

For oak species, monitoring will target survivorship in oak seedlings and saplings that have been caged after baseline surveys are conducted. Caged seedlings and saplings will be monitored annually during the first 10 years to determine survivorship (live versus dead) of individuals within the cages.

6.2.6 EROSION IN RIPARIAN AREAS

Monitoring of erosion in riparian areas and adjacent to riparian areas will provide an opportunity to reduce sedimentation rates into waterways. Monitoring of erosion will be conducted annually in the spring through a walking survey in Years 1–10. After Year 10, less frequent monitoring will occur, dependent on site conditions. Bank erosion and erosion within 300 ft of a riparian area will be recorded on a site map or with a GPS unit, photographed and described. Streambank erosion will be ranked using the Bank Erosion Hazard Index (BEHI) monitoring procedures described below and detailed in *River Stability Field Guide* (Rosgen 2008) and *Watershed Assessment of River Stability and Sediment Supply* (Rosgen 2006).

BEHI is an adjective rating for bank erosion hazard that combines various input variables to determine the overall hazard rating. These variables include bank height (toe of slope to top of bank), bankfull height (toe of slope to bankfull elevation), bank angle, percent bank surface protection (vegetation), root depth, and percent root density. Each of the variables can be measured (e.g., bank height, bankfull height, bank angle, root depth) or visually estimated (bank surface protection, root density). Numeric BEHI ratings (0 to 10, very low to extreme) are chosen from separate graphs of the ratio of study bank height/bankfull height, root depth/study bank height, weighted root density, bank angle, and surface protection (see Rosgen 2006, 2008). Each of the assigned adjective ratings are summed up with additional adjustments made to the total score if the bank materials (bedrock, cobble, sand, silt/clay) and stratification of bank materials in relation to the bankfull stage influence the stability of the bank.

BEHI should be conducted along the entire reach of stream. Separate ratings should be given for differing areas of bank erosion. These areas should be mapped and identified by right bank/left bank and stationing (from the longitudinal profile) as they occur throughout the reach. As the channel dimensions adjust shape to the watershed conditions a short-term increasing trend may occur from baseline conditions, however as vegetation becomes established the trend should become more stable as bank surface protection, rooting depth, and root densities increase.

Erosion occurring outside the streambanks should be surveyed by measuring the extents of the erosion (length and width and depth at set increments) to determine an approximate annual rate of change. If a high precision GPS is available the extents of the erosional feature may be surveyed to determine annual rate of change. Otherwise quick measurements may be made with a tape measure or laser rangefinder.

6.2.7 SCRUB

Qualitative monitoring of scrub habitat will assess the structural diversity (i.e., size structure) of a scrub patch relative to patch size and assess scrub to grassland cover in a given patch of scrub habitat. Quantitative monitoring will include monitoring cover of non-native plants species.

Monitoring will utilize high resolution aerial photographs, in combination with ground-truthing to observe changes to scrub and scrub-grasslands habitats over time. By comparing these measurements a measurement of how scrub habitat is changing over time can be obtained. These qualitative measurements will be completed every three years during Years 1 – 10 or until success criteria are met; after Year 10, the frequency of monitoring will be determined based on site conditions.

Monitoring non-native invasive plant species in scrub habitat will be initiated if management actions result in openings in scrub habitats of the HRP management units. Currently, most scrub habitats are inaccessible and are not expected to have high densities of non-native invasive plants. However, with the use of prescribed fire and other management techniques, non-native invasive plants may populate scrub habitats. The type of monitoring will be determined based on the planned size and location of management actions.

6.2.8 NON-NATIVE INVASIVE PLANTS

Non-native invasive plant percent cover and extent will be monitored in all habitats of the HRP management units. Monitoring for non-native invasive plants is described for most habitats in Sections 6.2.1 through 6.2.7. In addition, non-native invasive plants will be tracked in oak woodlands, oak savannah and riparian habitats using methods described in Section 6.2.1 through 6.2.7 which includes tracking percent cover and extent over time using point-line intercepts and mapping using GPS. After Year 10, monitoring methods and frequency for non-native invasive plants will be adjusted based on site conditions.

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7 REPORTING AND AGENCY MEETINGS

7.1 REPORTING

Monitoring results for the first ten years of activities within the enhancement areas (performance period- Appendix A) of the HRP management units will be submitted with the Sunol Region HRP MMP annual reports (URS 2010a). Annual reports will be submitted by SFPUC natural resource staff to the Agencies[3] in December of each monitoring year. The final monitoring report for the enhancement area performance period will be prepared in Year 10, assuming the success criteria have been met.

After Year 10 (post-construction), if the success criteria have been met, a new reporting procedure will commence. It should be recognized that Year 10 will vary among the 5 HRP management units because the construction schedule for the Sunol Region compensation sites extends for multiple years. This "rolling start" will allow management unit managers to transfer knowledge from sites that commence long term monitoring sooner to those that begin this stage at a later date. For reporting after Year 10, reports will be submitted to the agencies once every three years, submitted in December. The report will consist of a summary of the management, monitoring, and adaptive management actions for each HRP management unit. Forms will be developed to standardize the reporting format, rendering the data comparable among units. These annual reports will be appended to the LTMP providing a format for recording changes and modifications resulting from the management lessons learned or changes in the ecosystem as a whole.

7.2 AGENCY MEETINGS

Annual meetings will be held with the agencies during the first ten years of implementation of the MMP, or until success criteria are met. After success criteria have been met, meetings will occur at a minimum of once every three years. Meetings will take place in the late spring or summer after vegetation monitoring has occurred.

Additional meetings may be scheduled on an as-needed basis. Such meetings would be called if unforeseen events arose that necessitate implementing management actions significantly different than what is outlined in this LTMP. Example events include floods, wildfires and other natural events as well as the listing or delisting of a species within the HRP mitigation areas. These meetings could involve a site visit to the HRP management units.

[3] The Agencies include CDFG, USFWS, RWQCB, EPA and USACE.

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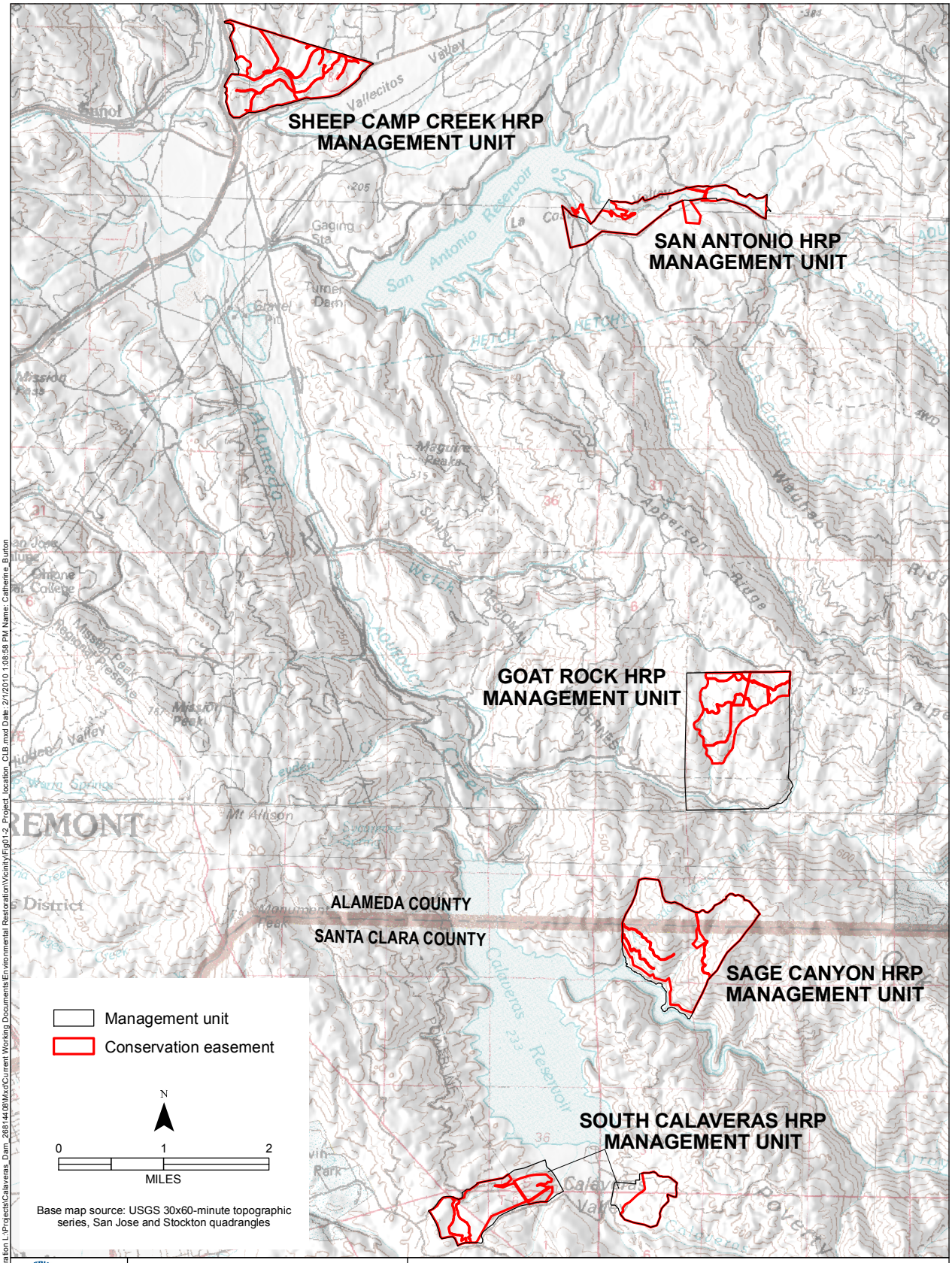

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Figure 1
HRP management units and conservation easements

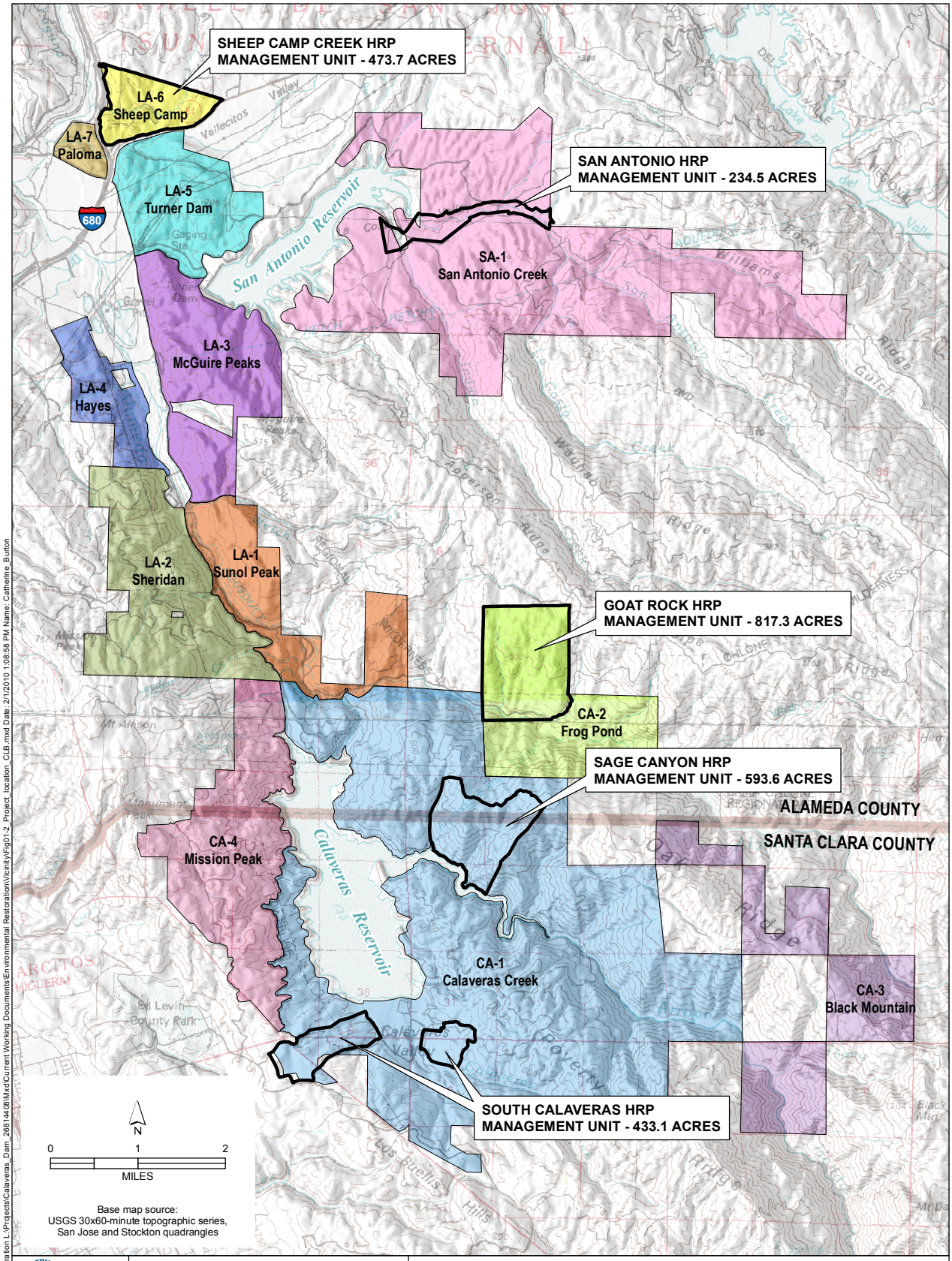

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Figure 2. SFPUC Alameda Creek watershed grazing units and HRP management units

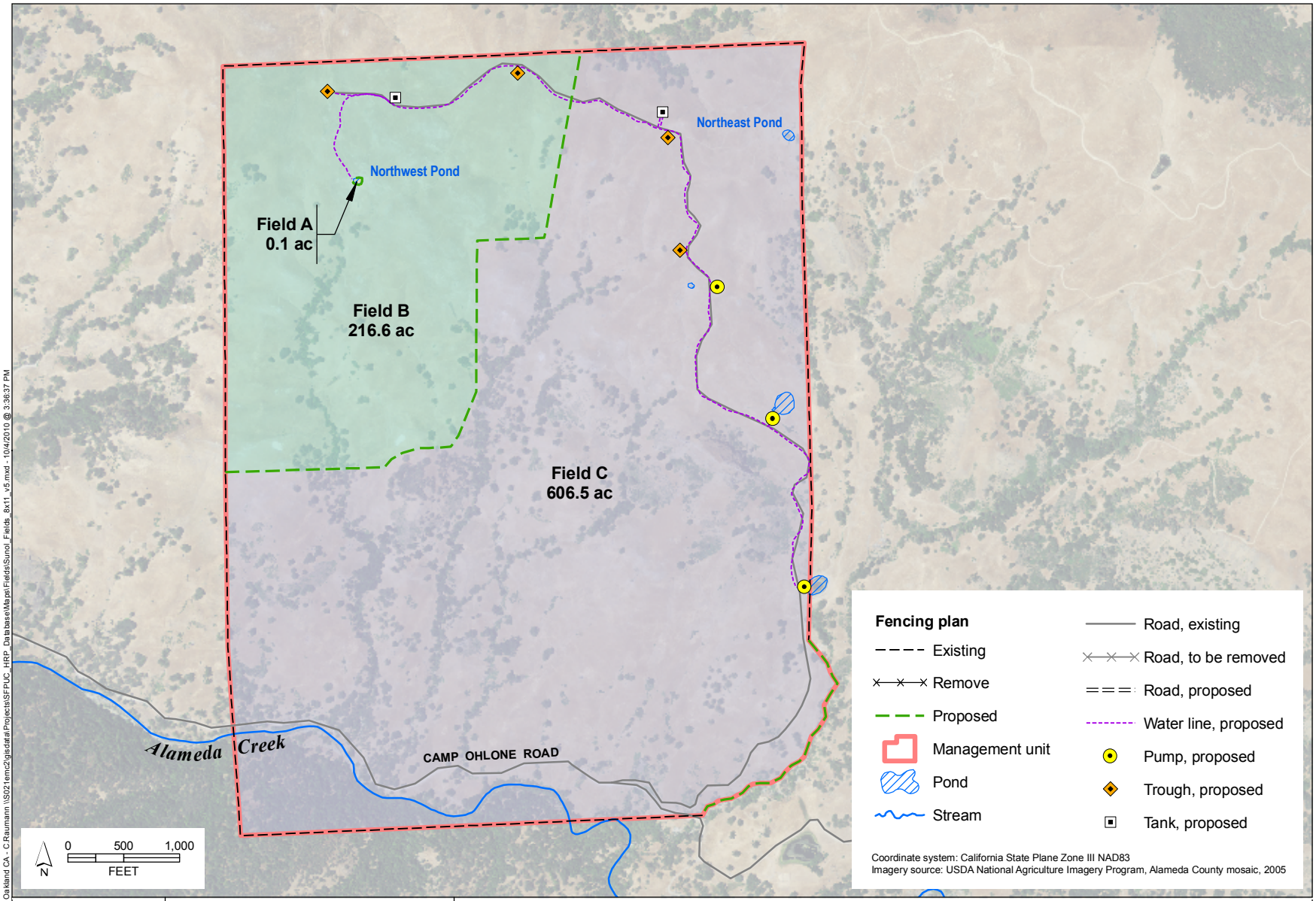

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Figure 3
Long-Term Management Plan Grazing Fields: Goat Rock Management Unit

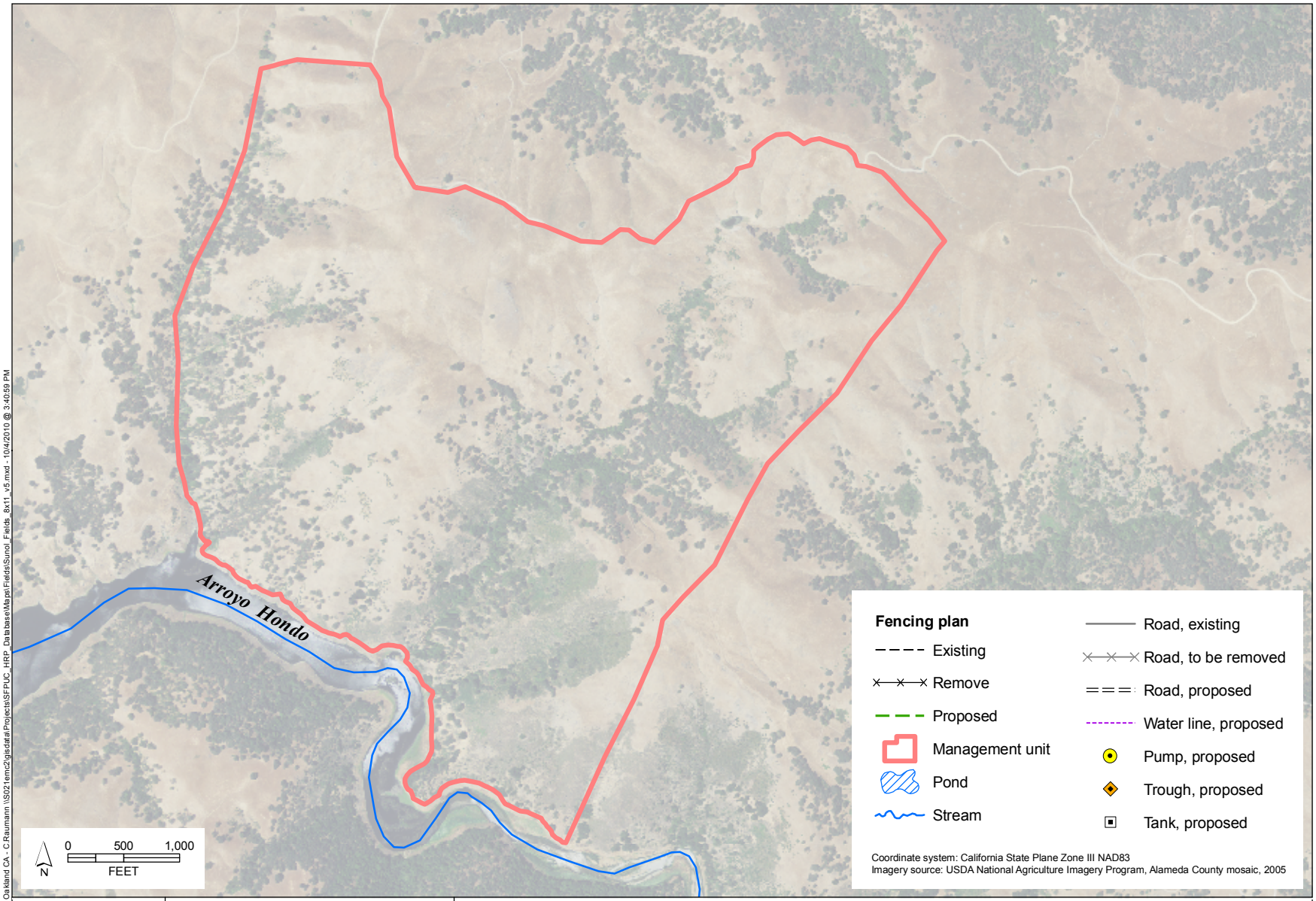

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Figure 4
Long-Term Management Plan Grazing Fields: Sage Canyon Management Unit

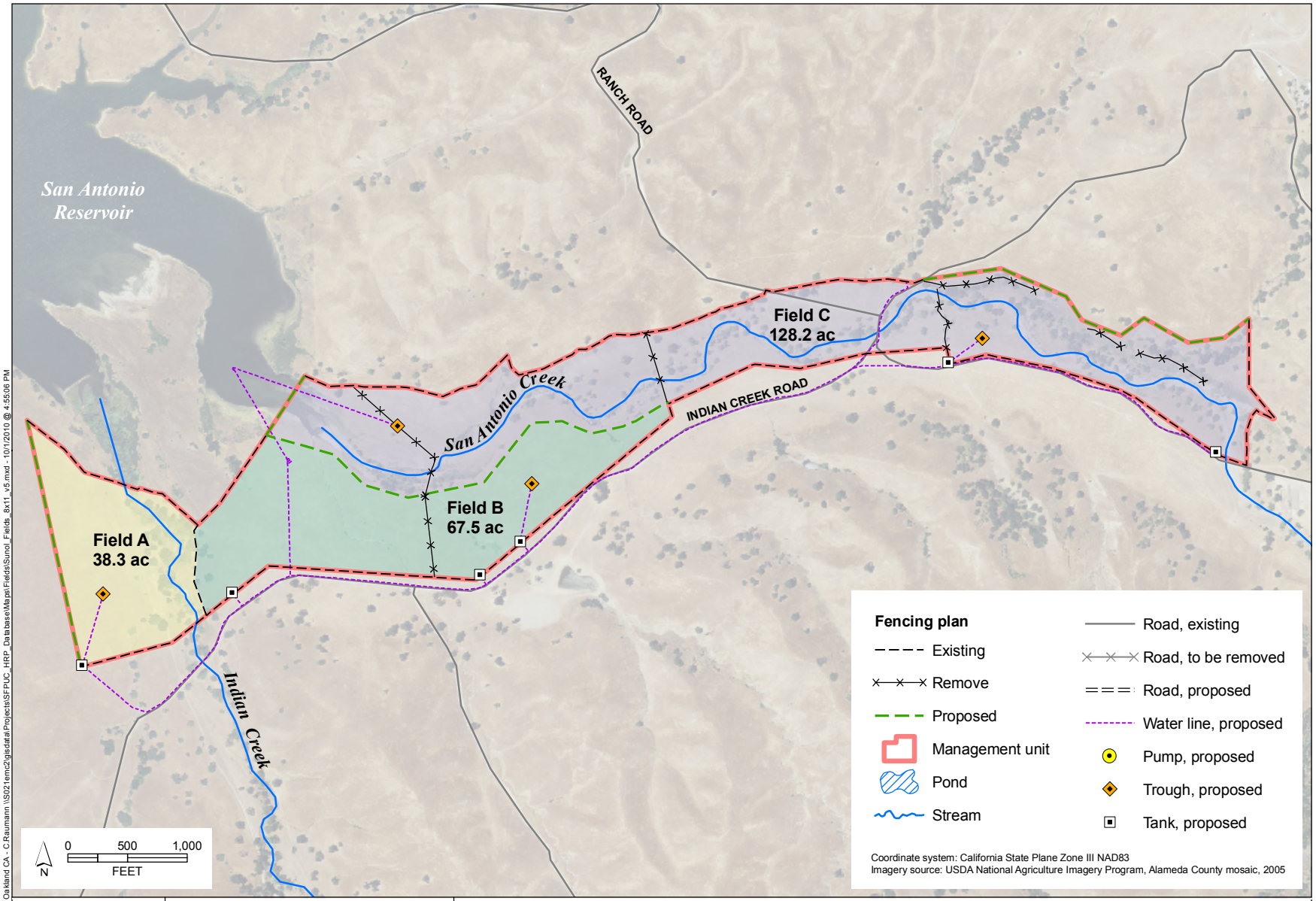

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Figure 5
Long-Term Management Plan Grazing Fields: San Antonio Management Unit

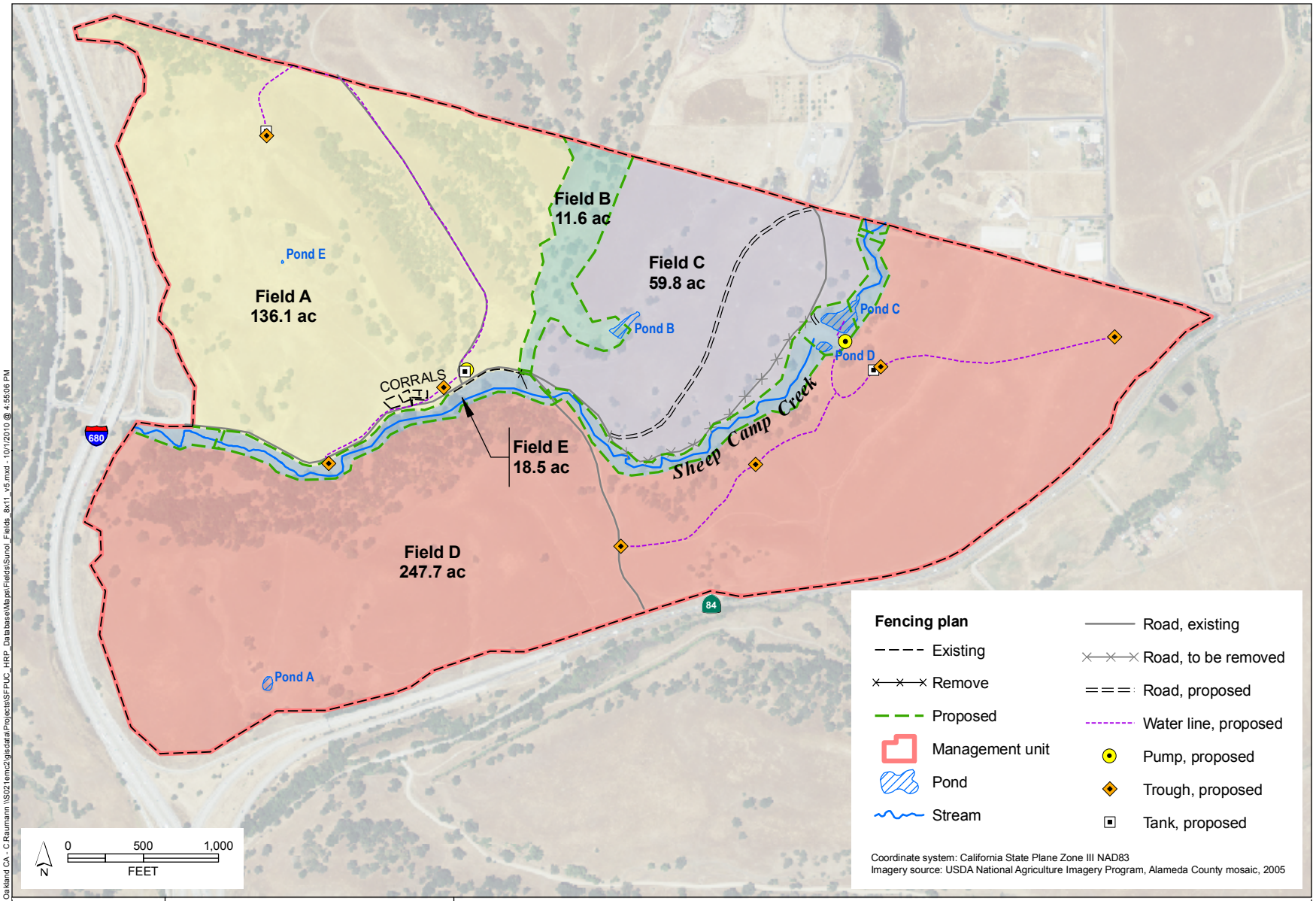

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Figure 6
Long-Term Management Plan Grazing Fields: Sheep Camp Creek Management Unit

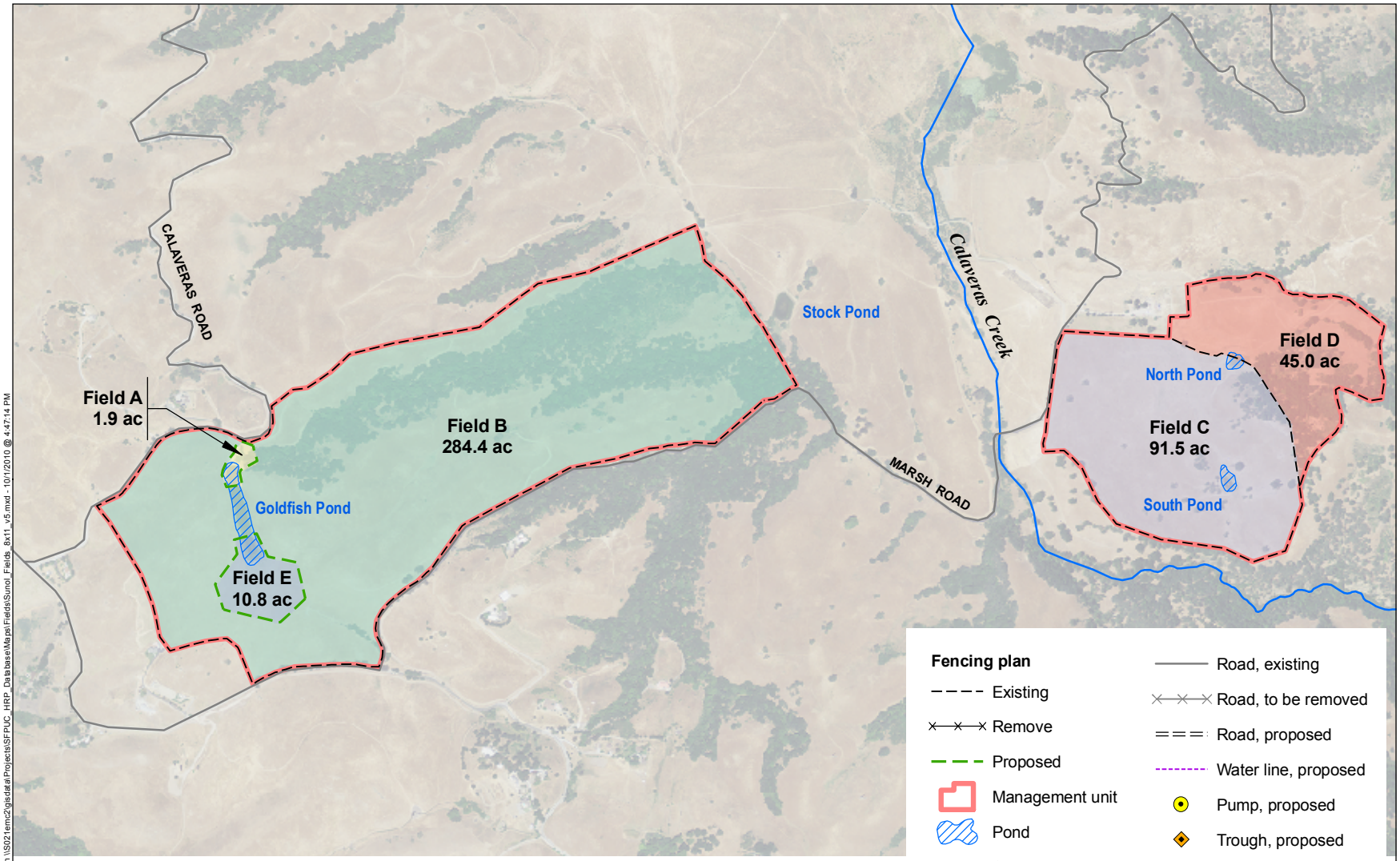

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Figure 7
Long-Term Management Plan Grazing Fields: South Calaveras Management Unit

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Appendix A
Years 1–10 HRP Management Unit Enhancement Area Goals, Objectives, and Strategies

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APPENDIX A: YEARS 1–10 HRP MANAGEMENT UNIT ENHANCEMENT AREA GOALS, OBJECTIVES, AND STRATEGIES

The following management goals, objectives, and strategies apply to the enhancement areas within the Habitat Reserve Program (HRP) management unit conservation easement boundaries (Figure 1). These goals, objectives, and strategies apply to Years 1–10 after construction until the performance criteria are achieved (performance criteria for enhancement areas are listed as objectives). After 10 years, the management goals, objectives, and strategies listed in Chapter 3 will replace those listed here. The management strategies listed are options rather than requirements for achieving management goals and objectives.

Success criteria included in the objectives in this section (such as target percent cover of wetland plants or maximum cover of non-native invasive plants) will be measured independently at each mitigation site and each type of habitat (i.e., data from each mitigation site and habitat will not be pooled with data from any other mitigation site or habitat).

A1.1 GRASSLAND (YEARS 1–10) GOALS, OBJECTIVES, AND STRATEGIES

Grassland (GL) YRS 1–10 Goal 1: Enhance non-native and serpentine grassland habitat within enhancement areas of the HRP management unit conservation easement boundaries.

GL YRS 1–10 Objective 1: Determine baseline conditions (of non-native invasive plant species, areas of high native plant diversity, and Callippe silverspot host plant patch characterization) in grassland habitats before implementation of management strategies outlined in this plan.

GL YRS 1–10 Strategy 1: Determine baseline conditions of non-native invasive plant occurrences in grasslands at all management units by mapping occurrences (areas ≥ 50 square feet with ≥ 25 percent cover) of non-native invasive species. Note location, species, relative size of population, and proximity to sensitive resources. Also, calculations of percent cover of non-native invasive plant species will be made using transects run for vegetation composition throughout the grassland at all management units. See the monitoring section (Chapter 6) for additional information about baseline measurements.

GL YRS 1–10 Strategy 2: Map the location of areas/patches (> 50 feet by 50 feet) containing a relatively high diversity and/or cover of native grass and forbs in non-native annual grasslands.

GL YRS 1–10 Strategy 3: Establish baseline vegetation composition of serpentine grasslands at Goat Rock. Surveys will include both a reference location (control) and those areas where changes in grazing management are proposed.

GL YRS 1–10 Strategy 4: Map the boundaries of Johnny jump-up occurrences before implementation of management activities.

GL YRS 1–10 Objective 2: Reduce cover of non-native invasive plants (all species combined) in grasslands by 50 percent by Year 10, relative to baseline.

GL YRS 1-10 Strategy 5: Non-native invasive plants known to occur in the HRP management units and their approximate acreage are listed below. To meet the overall reduction of 50 percent for all non-native invasive plants (combined cover), target goals for each individual species known to occur in grasslands of the HRP management units are suggested as follows:

- Decrease the cover of medusa head by 35 percent over 10 years. It is estimated that the extent of medusa head in the HRP management units (2010) is approximately 20 acres, all occurring within the Sheep Camp Creek and Goat Rock management units. If baseline surveys show that the extent of this plant is significantly greater than 20 acres, then the 35 percent reduction goal may need to be downwardly adjusted. However, at a minimum, 50 percent of the estimated 20 acres will be reduced by Year 10. Sheep grazing and/or fire should be considered as a tool to control medusa head.
- Reduce by 75 percent the extent of stinkwort infestations in grasslands by Year 10. It is estimated that the extent of stinkwort in the management units is approximately 10 acres (2010). If baseline surveys show the extent of this plant is significantly greater than 10 acres, then the 75 percent reduction goal may need to be downwardly adjusted. However, at a minimum, 75 percent of the estimated 10 acres will be reduced by Year 10.
- Decrease the percent cover of yellow star thistle, by 10 percent in Year 5, and 20 percent by Year 10 in grasslands. This species is widespread in the grasslands, occurring both as dense monocultures as well as sporadically as small numbers of individuals. It is estimated that the extent of yellow star thistle in the management units is approximately 50 acres (2010). If baseline surveys show the extent of this plant is significantly greater than 50 acres, then the reduction goal may need to be downwardly adjusted. However, at a minimum, 25 percent of the estimated 50 acres will be reduced by Year 10.
- Reduce by 75 percent the extent of purple star thistle infestations in grasslands by Year 10. It is estimated that the extent of purple star thistle in the management units is approximately 10 acres (2010). If baseline surveys show the extent of this plant is significantly greater than 10 acres, then the 75 percent reduction goal may need to be downwardly adjusted. However, at a minimum, 75 percent of the estimated 10 acres will be reduced by Year 10.

GL YRS 1–10 Strategy 6: Devise and implement a control plan for non-native invasive plant species in grasslands within 6 months of the baseline mapping efforts (GL YRS 1–10 Strategy 1). Refer to Chapter 5 for detailed control strategies for non-native invasive plant species. The control plan would also address any additional species identified during baseline surveys by providing objectives for control/eradication as appropriate for the ecology, size and extent of occurrences and proximity to sensitive resources.

GL YRS 1-10 Strategy 7: Apply thresholds for management actions for non-native invasive plants in grasslands (Section 6.2.1).

GL YRS 1–10 Strategy 8: Where conditions are favorable, and when compatible with weed control techniques, plant container plants of native species into areas where weed treatment is implemented to provide competition with weeds.

GL YRS 1–10 Strategy 9: Monitor to track effects of management actions on non- invasive plant species, using methods outlined in Chapter 6.

GL YRS 1–10 Strategy 10: Conduct annual or biannual walking surveys of the HRP management units, particularly areas that are disturbed by livestock and humans (e.g., corrals, roadside) to locate new introductions of non-native invasive plants. Implement management actions to remove occurrences. Some example species that are known to occur in the Alameda Creek watershed that could become established in the HRP management units include pampas grass (*Cortaderia* spp.) and artichoke thistle (*Cynara cardunculus*) (Koopmann, pers. comm., 2010). Additional species known to occur in the Alameda Creek watershed are listed and mapped in Nomad Ecology (2009a).

GL YRS 1–10 Objective 3: Maintain or increase endemic annual forbs in grasslands at Goat Rock, relative to baseline conditions.

GL YRS 1–10 Strategy 11: Fence an approximately 213-acre portion of Goat Rock (Figure 3, Field B). Stocking rate will target between 750 and 1,000 pounds/acre of residual dry matter (RDM). Time grazing as follows:

- Early season grazing, cow-calf (from beginning of grassland plant period through approximately March 30) when cattle preferentially graze non-native annual grasses that are common at Goat Rock. Cattle would be removed in the spring when the native wildflowers and native grasses bloom, allowing these species to flower and set seed.
- Late season grazing (July 1 and October 31) will depend on the level of standing biomass at Goat Rock.

GL YRS 1–10 Strategy 12: Apply thresholds for management actions for native and non-native invasive plants in serpentine grasslands (Section 6.2.1).

GL YRS 1–10 Strategy 13: Monitor the 213 acre field at Goat Rock annually for ten years. On the same schedule, monitor control plots with similar soils and topographic position, and where the grazing regime is year-round. The need for the ten year monitoring duration is due to the strong influence of climate and other variables that effect plant species composition in annual grasslands. A 10 year dataset should allow identification of effects, if any, of seasonal (versus year-round) grazing on serpentine grassland species composition.

GL YRS 1–10 Goal 2. Foster short habitat structure required by certain grassland flora and fauna species in grassland habitats within enhancement areas of the HRP management unit conservation easement boundaries.

GL YRS 1–10 Objective 4: Increase or maintain extent of suitable habitat for Callippe silverspot relative to baseline conditions (before implementation of enhancement activities) in grasslands.

GL YRS 1–10 Strategy 14: Determine desired target cover of the host plant Johnny jump-up to set as goal. Target cover would be developed from discussions with local experts, review of technical literature and survey results where cover of the host plant and occurrence of the Callippe Silverspot butterfly is evaluated.

GL YRS 1–10 Strategy 15: Identify a reduction in area (e.g., a percent reduction compared to baseline or a minimum patch size), occupied by Johnny jump-ups that would trigger a

management action to counteract the reduction. Management actions could include modifying timing, intensity and/or type of grazing.

GL YRS 1–10 Strategy 16: Plant/seed Callippe silverspot nectar plants in the HRP management units, including buckeyes (*Aesculus californica*).

GL YRS 1–10 Objective 5: For wildlife species that require short stature grasslands for nesting and/or hunting, including burrowing owl (*Athene cunicularia*) and prairie falcon (*Falco mexicanus*), maintain a portion of grasslands with low (<3 inches) stubble height (stubble height = a measure of herbaceous vegetation after grazing).

GL YRS 1–10 Strategy 17: Using livestock grazing, fire or other techniques, maintain a low stubble height in a portion of the HRP management units.

In summary, the principles of adaptive management (e.g., results of monitoring and/or newly available scientific research) will be used to adapt management strategies, as needed, to achieve grassland habitat management goals and objectives. Additional details on monitoring of riparian habitat enhancement areas are described in Chapter 6 and adaptive management is further explained in Chapter 7.

A1.2 OAK WOODLAND AND OAK SAVANNAH (YEARS 1-10) GOALS, OBJECTIVES, AND STRATEGIES

Oak Woodlands and Savannah (OWS) YRS 1–10 Goal 1: Enhance oak savannah and oak woodland habitat within enhancement areas of the HRP management unit conservation easement boundaries.

OWS YRS 1–10 Objective 1: Determine baseline conditions (location and description of non-native invasive species, areas of high native plant diversity, approximation of oak seedling and saplings) in oak woodlands and savannahs habitats before implementation of management strategies outlined in this plan.

OWS YRS 1–10 Strategy 1: Determine baseline conditions of non-native invasive plant species in oak woodlands and savannahs within all management units by mapping occurrences (areas ≥ 50 square feet with ≥ 25 percent cover) of non-native invasive species. Note location, species, relative size of population and proximity to sensitive resources. In addition, calculations of percent cover of non-native invasive plant species will be made via transects run for vegetation composition throughout the oak woodlands at all management units. See monitoring section (Chapter 6) for additional information about baseline measurements

OWS YRS 1–10 Strategy 2: Map the location of areas/patches (> 50 feet by 50 feet) containing a relatively high diversity and/or cover of native grass and forbs in oak woodlands and oak savannahs. Note species present, approximate size of area and any potential threats.

OWS YRS 1–10 Strategy 3: Conduct baseline surveys to estimate the approximate number of oak seedling and saplings present in oak woodlands and savannahs of the HRP management units.

OWS YRS 1–10 Objective 2: Reduce cover of non-native invasive plants

OWS YRS 1-10 Strategy 4: Yellow starthistle is the primary non-native invasive plant in oak woodlands and savannahs of the HRP management units. To help reach the 50 percent cover reduction of all non-native invasive plant cover, the following target reduction for yellow starthistle will be targeted:

- Decrease the percent cover of yellow starthistle, by 10 percent in Year 5, and 20 percent by Year 10 in oak woodlands and savannahs. This species is widespread in these habitats, occurring both as dense monocultures and as small numbers of individuals. The extent of yellow star thistle in oak woodland and savannah is estimated at approximately 20 acres (2010). If baseline surveys show the extent of this plant is significantly greater than 20 acres, then the reduction goal may need to be downwardly adjusted.

OWS YRS 1–10 Strategy 5: Devise and implement a weed control plan for oak woodlands and savannahs within 6 months of the baseline mapping efforts Refer to Chapter 5 for control strategies for invasive, non-native plant species. The control plan would also address any additional species not listed in OWS YRS 1–10 Objective 2 (identified during baseline surveys).

OWS YRS 1–10 Strategy 6: Apply thresholds for management actions for non-native invasive plants in oak woodlands and savannahs (Section 6.2.8).

OWS YRS 1–10 Strategy 7: Graze oak woodlands in the winter until the early summer, to allow cattle to graze young yellow starthistle plants.

OWS YRS 1–10 Strategy 8: Where conditions are favorable, and when compatible with weed control techniques, plant container plants with native species into areas where weed treatment is implemented to provide competition with weeds.

OWS YRS 1–10 Strategy 9: Monitor to track effects of management actions on non-native invasive plant species, using methods outlined in Chapter 6 of this document.

OWS YRS 1–10 Strategy 10: Conduct annual or biannual walking surveys of the HRP management units, particularly areas that are disturbed by livestock and humans (e.g., corrals, roadside) to locate new introductions of non-native invasive plants. Implement management actions to remove occurrences. Some example species that are known to occur in the Alameda Creek watershed that could become established in the HRP management units include pampas grass (*Cortaderia* spp.) and artichoke thistle (*Cynara cardunculus*) (Koopmann, pers. comm., 2010). Additional species known to occur in the Alameda Creek watershed are listed and mapped in Nomad 2009a.

OWS YRS 1–10 Objective 3: Monitor native plants (including uncommon native plants) within oak woodlands and savannahs; actively manage as needed.

OWS YRS 1–10 Strategy 11: Monitor target native plant occurrences (identified in baseline surveys or during previous surveys) to determine status and trends. Identify potential and current threats. Initiate management to abate threats, increase populations of target species, and benefit native plants.

OWS YRS 1–10 Objective 4: Increase oak recruitment by 10 percent over 10 years in oak woodlands and savannahs. The increase is relative to observed oak recruitment at baseline.

OWS YRS 1–10 Strategy 12: Install plant protection around oak seedlings and saplings to protect from browse. Oak habitats should be checked in April and June, where possible, for germinating oaks. New recruits discovered during these surveys should be protected with a browse protection tubing (tubex) or a 5-foot (or greater) field fence wire secured with rebar or t-posts until trees have grown above the cattle browse height of 6 feet.

OWS YRS 1–10 Strategy 13: Graze cattle from the winter though early summer in oak woodlands and oak savannahs, when cattle will preferentially graze the non-native annual grasses and avoid oak saplings and seedlings. Remove cattle in the later summer and fall.

OWS YRS 1–10 Strategy 14: Apply thresholds for management actions for oak recruitment (Section 6.2.5).

OWS YRS 1–10 Strategy 15: Monitor oaks that are protected from browse to track effects of caging on coast live oak seedlings and saplings.

OWS YRS 1–10 Objective 5: Monitor and/or control feral pig populations in the HRP management units.

OWS YRS 1–10 Strategy 16: SFPUC funded a feral pig control program starting in 1998 in the Alameda Creek watershed. However, the program was discontinued in 2009, and was reinstated in 2010. The pig control program should continue through the implementation of this plan.

OWS YRS 1-10 Objective 6: Analyze research on the potential impacts of turkeys on oak recruitment. Determine if management strategy to control turkeys is warranted.

OWS YRS 1–10 Objective 7: Reduce the risk of introduction or spread of plant pathogens, in particular Sudden Oak Death, via human actions.

OWS YRS 1–10 Strategy 17: Develop guidelines for reducing the risk of introduction of sudden oak death to the HRP management units. Distribute guidelines to SFPUC staff, contractors, consultants and other entities doing work in the Alameda Creek watershed. See the following document, available through the California Oak Mortality Task Force, for guidance: http://www.cnr.berkeley.edu/comtf/html/sanitation___reducing_spread.html.

OWS YRS 1–10 Goal 2: Reduce risk of catastrophic fire in oak habitats within enhancement areas of the HRP management unit conservation easements.

OWS YRS 1–10 Objective 8: Evaluate the need to reduce fuel loading if livestock grazing is removed for two years or longer during the implementation of the LTMP.

OWS YRS 1–10 Strategy 18: Reduce RDM levels with appropriate methods that could include mowing or prescribed burning.

OWS YRS 1–10 Strategy 19: Should sudden oak death be introduced to the HRP management units, and result in dead oaks that become a source of additional ladder fuels and standing snags, mechanical fuel reduction is recommended.

In summary, the principles of adaptive management (e.g., results of monitoring and/or newly available scientific research) will be used to adapt management strategies, as needed, to achieve oak woodland and oak savannah habitat management goals and objectives. Additional details on monitoring of riparian habitat enhancement areas are described in Chapter 6 and adaptive management is further explained in Chapter 7.

A1.3 PONDS AND WETLANDS (YEARS 1–10) GOALS, OBJECTIVES, AND STRATEGIES

PW YRS 1–10 Goal 1: Manage ponds to provide wildlife habitat for California red-legged frog and California tiger salamander within the HRP management unit conservation easement boundaries.

PW YRS 1–10 Objective 1: Determine location and condition of Goat Rock ponds (not previously mapped) and establish baseline conditions of plants and amphibians before implementation of management strategies outlined in this plan.

> **PW YRS 1–10 Strategy 1:** Map and assess baseline conditions of ponds in the Goat Rock mitigation during the first year of implementation of the LTMP. Baseline assessment will include estimation of approximate length of ponding period, depth, pond condition, presence of aquatic non-native predators, non-native invasive aquatic plants, aquatic vegetation type and extent and presence of California tiger salamander and California red-legged frog.

PW YRS 1–10 Objective 2: Control predatory fish and bullfrogs in ponds by draining ponds every other year in approximately September, as needed (refer to Sunol Region HRP MMP for methods).

> **PW YRS 1–10 Strategy 2:** Monitor to assess presence/numbers of aquatic predator species in ponds.

PW YRS 1–10 Objective 3: Control, as necessary non-native aquatic invasive plants that may be documented during baseline surveys,

> **PW YRS 1–10 Strategy 3:** Baseline surveys of ponds in the HRP management units may reveal the presence of invasive-non native aquatic plants. Remove invasive non-native aquatic plants if determined to have a negative impact on the California red-legged frog or California tiger salamander. Potential non-native aquatic invasive plants may include Brazilian waterweed (*Egeria densa*) and hydrilla (*Hydrilla verticillata*). Time the removal of plants with pond draining (PW YRS 1–10 Strategy 4).

PW YRS 1–10 Objective 4: Target the following conditions in ponds to enhance and/or maintain California red-legged frog and California tiger salamander breeding habitat:

- Maintain cover of emergent vegetation at no more than approximately 35 percent in ponds.
- Maintain ponding duration of 3+ months for California tiger salamander and 9+ for California red-legged frog.
- Limit pond sedimentation rates to an average of no more than 1 inch per year.

> **PW YRS 1–10 Strategy 4:** Many of the ponds in the HRP management units will be surrounded entirely or in part by fencing, which may result in an increase in cover of emergent vegetation due to exclusion of cattle. This may result in an overgrowth of emergent

vegetation, in particular cattails and bulrush (*Typha* sp., *Scirpus* sp., *Schoenoplectus* sp.) Periodically evaluate pond for overgrowth of vegetation that could reduce available habitat for California red-legged frog and California tiger salamander.

PW YRS 1–10 Strategy 5: Inspect ponds identified during baseline at Goat Rock as well as all other ponds that support or have potential to support these species every two years to determine if management actions are needed to reduce pond sedimentation. Management strategies include locating sediment sources and removing them, and dredging ponds.

PW YRS 1–10 Strategy 6: Survey ponds annually for the presence of adult, juvenile, or larval California tiger salamander and California red-legged frog. Methods can include dipnet, visual, auditory, and California tiger salamander egg-mass surveys.

PW YRS 1-10 Strategy 7: Apply thresholds for management actions for ponds (Section 6.2.3).

PW YRS 1–10 Goal 2:Manage wetland habitat to provide ecosystem services (e.g., wildlife habitat and abiotic services) within the HRP management unit conservation easement boundaries.

PW YRS 1–10 Objective 5: Determine location and condition of Goat Rock wetlands (not previously mapped) and establish baseline conditions of plants before implementation of management strategies outlined in this plan.

PW YRS 1–10 Strategy 8: Map and assess baseline conditions of wetlands in the Goat Rock management unit during the first year of implementation of the LTMP. Wetland assessment will include a description of vegetation, estimated length of inundation and presence of seeps and any observed threats.

PW YRS 1–10 Objective 6: Reduce cover of non-native invasive plants (all species combined) by 50 percent by Year 10, relative to baseline.

PW YRS 1-10 Strategy 9: Bermuda grass is the primary non-native invasive plant in seasonal wetlands of the HRP management units. To help reach the 50 percent cover reduction of all non-native invasive plant cover, the following target reduction for Bermuda grass will be targeted, as follows:

- Decrease absolute cover of Bermuda grass by 10 percent by Year 3, by 20 percent by YR5 and 30 percent by Year 10 of the LTMP, relative to baseline conditions in wetlands in the HRP management units. Sheep Camp Creek is the only location where this species was noted before plan implementation.

PW YRS 1–10 Strategy 10: Determine baseline cover of non-native invasive plant occurrences in wetlands by mapping occurrences (areas $\geq$ 20 square feet with $\geq$ 25 percent cover) of non-native invasive species. Note location, species, relative size of population and proximity to sensitive resources.

PW YRS 1–10 Strategy 11: Devise and implement a weed control plan for non-native invasive in ponds and wetlands within 6 months of baseline surveys. Weed control will include objectives for control/eradication as appropriate for the ecology, size and extent of occurrences and proximity to sensitive resources. It is anticipated the baseline surveys will

identify additional, non-native plants in wetlands of the HRP management units (in addition to Bermuda grass). Typical non-native invasive wetland plants include tall fescue (*Festuca arundinaceae*), pennyroyal (*Mentha pulgellum*) and Himalayan blackberry (*Rubus discolor*).

PW YRS 1–10 Strategy 12: Apply thresholds for management actions for wetlands (Section 6.2.3).

PW YRS 1–10 Strategy 13: Where conditions are favorable, and when compatible with weed control techniques, plant container plants into areas where weed treatment is implemented to provide competition with weeds.

PW YRS 1–10 Strategy 14: Conduct annual or biannual walking surveys of the HRP management units' ponds and wetlands, particularly areas that are disturbed by livestock and humans (e.g., corrals, roadside) to look for new introductions of non-native invasive weeds. Implement management actions to remove occurrences.

PW YRS 1–10 Strategy 15: Monitor to track effects of management actions on non-native invasive plant species, using methods outlined in Chapter 6 of this document.

PW YRS 1–10 Objective 7: Maintain a minimum cover of 50% hydrophytic native plant species[1] in wetlands (exclusive of emergent vegetation in ponds).

PW YRS 1–10 Strategy 16: Install water troughs, salt licks, and mineral supplements in uplands to attract cattle away from wetland areas and more evenly distribute grazing of pastures. Ensure water troughs and mineral supplements are working properly or adequately stocked and are utilized by the cattle. Adjust locations if necessary.

PW Years 1–10 Strategy 17: Where conditions are favorable, plant container plants of native hydrophytic species (or cuttings) into areas where cover of native hydrophytic species is low.

PW Years 1–10 Strategy 18: Apply thresholds for management actions wetlands (Section 6.2.3).

In summary, the principles of adaptive management (e.g., results of monitoring and/or newly available scientific research) will be used to adapt management strategies, as needed, to achieve pond and wetland habitat management goals and objectives. Additional details on monitoring of riparian habitat enhancement areas are described in Chapter 6 and adaptive management is further explained in Chapter 7.

A1.4 RIPARIAN (YEARS 1–10) GOALS, OBJECTIVES, AND STRATEGIES

Riparian (RIP) YRS 1–10 Goal 1: Provide suitable conditions to support natural recruitment and growth of native riparian vegetation with a diverse community age structure in riparian habitats within the enhancement areas of the HRP management unit conservation easement boundaries.

[1] Only the cover of the species listed in Appendix B will be counted towards achievement of success criteria in seasonal and perennial wetlands.

RIP YRS 1–10 Objective 1: Determine baseline vegetation cover (location and description of non-native invasive plant species, areas of high native plant diversity, approximation of woody riparian species, erosional areas) in riparian habitats before implementation of management strategies outlined in this plan.

RIP YRS 1–10 Strategy 1: Determine baseline cover of non-native invasive plants in riparian habitats at all management units by mapping occurrences (areas ≥ 100 square feet with ≥ 25 percent cover) of non-native invasive species. Note location, species, relative size of population and proximity to sensitive resources.

RIP YRS 1–10 Strategy 2: Conduct baseline surveys to estimate the approximate number of woody riparian vegetation (young plants, such as seedlings, saplings, sprouts) in riparian habitats of the HRP management units.

RIP YRS 1–10 Strategy 3: Identify erosion and its cause in riparian habitats. Identify the root cause of the source, whether or not sediment has potential to be delivered to the stream or has already impacted the stream, and rank the severity of the erosion by size, impact, and condition (stable, stabilizing, worsening).

RIP YRS 1–10 Objective 2: Control non-native invasive plants in riparian habitats, as follows:

- Decrease the cover of poison hemlock by 75 percent over 10 years. It is estimated that the extent of poison hemlock in riparian habitat in the management units is approximately 3 acres (2010). If baseline surveys show the extent of this plant is significantly greater than 3 acres, then the reduction goal may need to be downwardly adjusted. However, at a minimum, 75 percent of the estimated 3 acres will be reduced by Year 10.
- Decrease the cover of Himalayan blackberry by 75 percent over 10 years. It is estimated that the extent of Himalayan blackberry in riparian habitat in the management units is less than 1 acre (2010). If baseline surveys show the extent of this plant is significantly greater than 1 acre, then the reduction goal may need to be downwardly adjusted. However, at a minimum, 75 percent of the estimated 1 acre will be reduced by Year 10.
- Manage target non-native invasive plants not listed above.

RIP YRS 1–10 Strategy 4: Devise and implement a control plan for non-native invasive plant species in riparian habitats within 6 months of the baseline mapping efforts (RIP YRS 1–10 Strategy 1). Refer to Chapter 5 for detailed control strategies for non-native invasive plant species. The control plan would also address any additional species identified during baseline surveys by providing objectives for control/eradication as appropriate for the ecology, size and extent of occurrences and proximity to sensitive resources.

RIP YRS 1–10 Strategy 5: Apply non-native invasive plant thresholds for management actions in riparian habitats (Section 6.2.8).

RIP YRS 1–10 Strategy 6: Where conditions are favorable, and when compatible with weed control techniques, plant container plants into areas where weed treatment is implemented to provide competition with weeds.

RIP YRS 1–10 Strategy 7: Conduct annual or biannual walking surveys of riparian areas in the HRP management units, particularly areas that are disturbed by livestock and humans

(corrals, roadside, etc.) for new introductions of non-native invasive weeds. Eliminate or control new non-native invasive plant species in the riparian habitats of the HRP management units during Years 1–10.

RIP YRS 1–10 Strategy 8: Monitor to track effects of management actions on non-native invasive plant species, using methods outlined in Chapter 6 of this document.

RIP YRS 1–10 Objective 3: Increase recruitment of riparian woody vegetation by 25 percent cover 10 years in riparian habitats. The increase is relative to observed woody plant recruitment at the time of implementation of this plan.

RIP YRS 1–10 Strategy 9: To increase the occurrence of native riparian woody plant species in riparian habitats, check habitat in April and June, where possible, for germinating riparian woody vegetation. Protect seedlings with a browse protection tubing (tubex) or 5-foot (or greater) field fence wire secured with rebar or t-posts until trees have grown above the cattle browse height of 6 feet and shrubs are of sufficient size to survive light browsing. Protect one or more trees for every 300 linear feet of stream spaced or grouped along the riparian corridor per year.

RIP YRS 10 Strategy 10: Install water troughs, salt licks, and mineral supplements in uplands to attract cattle away from riparian areas and more evenly distribute grazing use of pastures. Ensure water troughs and mineral supplements are working properly or adequately stocked and are utilized by the cattle. Adjust locations if necessary.

RIP YRS 1–10 Strategy 11: Monitor woody vegetation and adjust livestock stocking rate and grazing access if evidence of browsing exists.

RIP YRS 1–10 Strategy 12: Monitor woody vegetation that is protected from browse to track effects of caging on woody riparian seedlings and saplings.

RIP YRS 1–10 Strategy 13: Install new riparian fencing, as funding is available (this would be funding outside of endowment), where currently none exist to reduce potential for over-browsing of riparian vegetation. Prioritize riparian fencing by:

- Areas most degraded by erosion and/or sedimentation.
- Stream type (perennial – first priority, intermittent – second priority, and ephemeral – third priority).
- Areas where riparian vegetation is constantly browsed.

RIP YRS 1–10 Strategy 14: Reduce number of cattle loafing in riparian areas by:

- Cull cattle from the herd that are observed to repeatedly loaf in the riparian area as this behavior is learned by other cattle in the herd and may lead to more riparian area impacts (Adams 2010). Monitoring for these types of cattle would be done by the SFPUC Area Manager, where possible.
- Evaluate if grazing field has adequate shade (particularly summer months) and cover from prevailing winds in upland areas. If not, move cattle to a unit that provides cover or provide alternate shade source (Adams 2010; Leonard et al. 1997).
- Provide scratching posts and dusters in upland areas (Adams 2010).

RIP YRS 1–10 Strategy 15: Apply thresholds for management actions for woody plant recruitment in riparian habitats (Section 6.2.5).

RIP YRS 1–10 Goal 2: Reduce rates of erosion and sedimentation in riparian habitats within enhancement areas of the HRP management unit conservation easement boundaries.

RIP YRS 1–10 Objective 4: Reduce the number of actively eroding rills/gullies or soil slumps present within 300 feet of a riparian area by 5 percent by Year 5 and 15 percent by Year 10 from baseline assessment.

RIP YRS 1–10 Strategy 16: Conduct annual walking surveys to GPS the locations and extent of erosional features and monitor change. Identify the root cause of the source, whether or not sediment has potential to be delivered to the stream or has already impacted the stream, and rank the severity of the erosion by size, impact, and condition (stable, stabilizing, worsening).

RIP YRS 1–10 Objective 5: Reduce sediment sources to riparian habitats associated with road system.

RIP YRS 1–10 Strategy 17: Conduct a road sediment source inventory of roads in the HRP management units within 300 linear feet of a perennial, intermittent, or ephemeral stream.

RIP YRS 1–10 Strategy 18: Reduce road related sedimentation to streams by disconnecting road drainage features (ditch relief culverts, waterbars) from discharging directly into or within close proximity to natural stream drainages. Redistribute road runoff in less concentrated form over a larger area by out-sloping roads, installing frequent rolling dips, and cross-drains at appropriate locations and spacing. Redirect runoff to well-vegetated upland areas.

RIP YRS 1–10 Strategy 19: Limit road grading or soil disturbance activities to the dry portion of the year, except in emergency situations to prevent to loss of life, property, or where the situation can be demonstrated to prevent larger environmental damage.

RIP YRS 1–10 Strategy 20: Prohibit or reduce vehicular or equipment traffic off of established access roads within fenced riparian areas or within 300 feet of a perennial stream, 150 feet of an intermittent stream, 50 feet of an ephemeral stream. All-terrain vehicles are acceptable within riparian areas to move cattle, but should not be driven across wet or running stream channels. Where existing roads near watercourses have been identified as point source sediment producers, and continued road use is essential for management, improvements should be made to mitigate for potential impacts such as improving drainage, surfacing roads, installing sediment filters, or road relocation.

RIP YRS 1–10 Objective 6: Reduce the erosion rate from actively eroding streambanks, defined as a bare vertical or sloughing banks greater that 1 foot high and 50 feet long (identified in RIP YRS 1–10 Strategy 3) in riparian habitats.

RIP YRS 1–10 Strategy 21: Conduct annual spring walking survey to identify and monitor bank erosion. Where bank erosion is present install 3 – 5-foot long 3/8 - ½ -inch smooth steel bank erosion pins horizontally into the banks, flush with the existing surface. Photo document bank erosion and GPS pin locations. Measure erosion rates annually and determine plausible cause of erosion. Determine appropriate site enhancement, restoration, rehabilitation, or

management changes to target the cause of the bank erosion and reduce the rate of erosion from the bank. Prioritize enhancement, restoration, rehabilitation, resource management strategies based on erosional rates and potential impact to downstream sensitive habitats and/or species. If enhancement activities (e.g., planting, fencing) or changing management strategies (e.g., grazing rest/rotation, stocking rate) do not show favorable reduction in erosion rates consider physical bank, channel, or other restoration to reduce or solve the problem.

RIP YRS 1–10 Strategy 22: Reduce cattle hoof shear soil disturbance to streambanks and excessive soil compaction by either excluding cattle or reducing grazing pressure (stocking rates, duration) in riparian fields from December 15 – March 15. Riparian areas not fenced should be monitored in the winter for evidence of excessive bank disturbance or trampling of vegetation. If excessive bank disturbance is observed in these areas, SFPUC will evaluate alternative methods for decreasing cattle pressure in these areas (see RIP YRS 1–10 Strategies 7-14). See Section 5.1.4.5 for more details on livestock grazing in riparian areas of the HRP management units.

RIP YRS 1–10 Strategy 23: Apply thresholds for management actions for erosion woody in riparian habitats (Section 6.2.6).

RIP YRS 1–10 Objective 7: Increase or maintain complexity of riparian and stream habitat.

RIP YRS 1–10 Strategy 24: Encourage large woody debris recruitment by limiting the clearing of dead, downed trees and limbs in excess of six-inch diameter within 300 feet of the stream, riparian area, and riparian exclusion area, whichever is greater, except for safety and/or facilities protection.

In summary, the principles of adaptive management (e.g., results of monitoring and/or newly available scientific research) will be used to adapt management strategies, as needed, to achieve riparian habitat management goals and objectives. Additional details on monitoring of riparian habitat enhancement areas are described in Chapter 6 and adaptive management is further explained in Chapter 7.

A1.5 SCRUB (YEARS 1–10) GOALS, OBJECTIVES, AND STRATEGIES

Scrub YRS 1–10 Goal 1: Enhance endangered Alameda whipsnake habitat in scrub within enhancement areas of the HRP management unit conservation easement boundaries.

Scrub YRS 1–10 Objective 1: Determine baseline conditions (location and description of non-native invasive species, cover of scrub and management targets for Alameda whipsnake) before implementation of management strategies outlined in this plan).

Scrub YRS 1–10 Strategy 1: Determine target scrub canopy cover range, patch size and other habitat measures for management of Alameda whipsnake habitat. Target cover would be developed from discussions with local experts and agency staff, as well as review of technical literature and survey results where shrub cover and occurrence of Alameda whipsnake is evaluated.

Scrub YRS 1–10 Strategy 2: Based on target cover range identified in Scrub YRS 1–10 Strategy 1, map areas of dense and overgrown scrub in the HRP management units to

determine target regions for management actions (e.g., reduction of scrub cover, creation of habitat mosaics with appropriate patch sizes).

Scrub YRS 1–10 Strategy 3: Determine baseline cover of non-native invasive plant species in scrub habitat by mapping occurrences (areas ≥ 50 square feet with ≥ 25 percent cover) of non-native invasive species. Note location, species, relative size of population and proximity to sensitive resources.

Scrub YRS 1–10 Objective 2: Control non-native invasive weeds in scrub habitat.

Scrub YRS 1–10 Strategy 4: Devise and implement a weed control plan for the invasive species in scrub habitats at the HRP management units within 6 months of baseline surveys. Establish success criteria for Years 1–10. Refer to Chapter 5 for control measures for non-native invasive plant species.

Scrub YRS 1–10 Strategy 5: Estimate threshold values that would trigger management actions for non-native invasive plant species in scrub areas.

Scrub YRS 1–10 Strategy 6: Where conditions are favorable, and when compatible with weed control techniques, plant container plants into areas where weed treatment is implemented to provide competition with weeds.

Scrub YRS 1–10 Strategy 7: Conduct annual or biannual walking surveys of the HRP management units, particularly areas that are disturbed by livestock and humans (corrals, roadside, etc.) for new introductions of non-native invasive weeds. Eliminate new non-native invasive plant species in scrub habitats of the HRP management units during Years 1–10. Non-native invasive plant species known to occur in the Alameda Creek watershed are listed and mapped in Nomad 2009a.

Scrub YRS 1–10 Strategy 8: Monitor to track effects of management actions on non-native invasive plant species, using methods outlined in Chapter 6 of this document.

Scrub YRS 1–10 Objective 3: Manage for optimal Alameda whipsnake habitat, based on findings of Scrub YRS 1–10 Goal 1.

Scrub YRS 1–10 Strategy 9: Utilize prescribed fire, livestock grazing, and/or mechanical thinning to maintain a mosaic of scrub and grassland habitats and to reduce dense and overgrown scrub cover.

Scrub YRS 1–10 Strategy 10: Monitor to track effects of management actions on scrub and associated habitats, using methods outlined in Chapter 6 of this document.

Scrub YRS 1–10 Strategy 11: Set threshold values for cover of decadent shrub cover that would trigger remedial management actions.

In summary, the principles of adaptive management (e.g., results of monitoring and/or newly available scientific research) will be used to adapt management strategies, as needed, to achieve scrub habitat management goals and objectives. Additional details on monitoring of riparian habitat enhancement areas are described in Chapter 6 and adaptive management is further explained in Chapter 7.

Appendix B
Target Wetland Plant Species

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APPENDIX B: TARGET WETLAND PLANT SPECIES

The following species will be counted towards achievement of success criteria for native vegetation in seasonal and perennial wetlands in the HRP conservation unit boundaries:

Seasonal wetlands: mugwort (*Artemisia douglasiana*); marsh baccharis (*Baccharis douglasii*); bristly sedge (*Carex comosa*), Santa Barbara sedge (*Carex barbarae*); eggbract sedge (*Carex ovalis*); small-bracted sedge (*Carex subbracteata*); bifid sedge (*Carex serratodens*); naked sedge (*Carex nudata*); tall flatsedge (*Cyperus eragrostis*); redroot flatsedge (*Cyperus erythrorhizos*); black flatsedge (*Cyperus niger*); blue-eyed grass (*Sisyrinchium bellum*), tufted hairgrass (*Deschampsia cespitosa*); meadow barley (*Hordeum brachyantherum*); spikerush (*Eleocharis macrostachya*); horsetail (*Equisetum arvense*); red fescue (*Festuca rubra*); iris-leaved rush (*Juncus xiphioides*); Mexican rush (*Juncus mexicanus*); Baltic rush (*Juncus balticus*); toad rush (*Juncus bufonius*); Pacific rush (*Juncus effusus* var. *pacificus*); spreading rush (*Juncus patens*); brown-headed rush (*Juncus phaeocephalus*); creeping wildrye (*Leymus triticoides*); seep monkey flower (*Mimulus guttatus*); water parsley (*Oenanthe sarmentosa*); sandbar willow (*Salix exigua*); red willow (*Salix laevigata*); arroyo willow (*Salix lasiolepis*); and sour clover (*Trifolium fucatum*), California sycamore (*Platanus racemosa*), Mexican elderberry (*Sambucus mexicana*), California beeplant (*Scrophularia californica*), willowherb (*Epilobium ciliatum*) or any other facultative (FAC) or facultative wetland (FACW) plant species that is native to the region (Contra Costa, Alameda, Santa Clara Counties).

Perennial wetlands: hardstem bulrush (*Scirpus acutus*); American bulrush (*Scirpus americanus*); California bulrush (*Scirpus californicus*); river bulrush (*Scirpus fluviatilis*); panicled bulrush (*Scirpus microcarpus*); narrowleaf cattail (*Typha angustifolia*); broadleaf cattail (*Typha latifolia*); southern cattail (*Typha domingensis*), bur reed (*Sparganium eurycarpum* ssp. *eurycarpum*), mannagrass (*Glyceria occidentalis*), coyotethistle (*Eryngium articulatum*), American speedwell (*Veronica americana*) and all species listed for seasonal wetlands above or any obligate (OBL) wetland plant that is native to the region (Contra Costa, Alameda, Santa Clara Counties).

The following management goals, objectives, and strategies apply to the enhancement areas within the Habitat Reserve Program (HRP) management unit conservation easement boundaries (Figure 1). These goals, objectives, and strategies apply to Years 1–10 after construction until the performance criteria are achieved (performance criteria for enhancement areas are listed as objectives). After 10 years, the management goals, objectives, and strategies listed in Chapter 3 will replace those listed here. The management strategies listed are options rather than requirements for achieving management goals and objectives.

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Appendix C
Stocking Rate Calculations

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Estimated Forage Production on Grazeable Acres							Amount Forage--Normal Year							Amount Forage--Unfavorable Year							Amount Forage--Favorable Year						
							Production				Total (lbs.)			Production				Total (lbs.)			Production				Total (lbs.)		
Grazing Unit and field	Soil	production category[1]	% canopy cover	% Slope	Exposure Category	Acres	(lbs./acre)	Production	Production after slope, canopy and exposure[2]	750 lbs/acre residual[3]	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual
Goat Rock Field B	HnF2 - Henneke rocky loam, eroded		0 to 25	0 to 25	North East	12.9	1500	19304	19304	11582	14800	7722	4504	1000	12869	12869	10939	14156	1930	0	2000	25739	25739	12226	15443	13513	10295
Goat Rock Field B	HnF2 - Henneke rocky loam, eroded		0 to 25	0 to 25	South West	31.2	1500	46733	37386	27105	34894	10281	2492	1000	31155	24924	25859	33647	0	0	2000	62310	49848	28351	36140	21497	13708
Goat Rock Field B	HnF2 - Henneke rocky loam, eroded		0 to 25	25+	North East	22.4	1500	33589	26872	19482	25080	7390	1791	1000	22393	17914	18586	24184	0	0	2000	44786	35829	20378	25976	15451	9853
Goat Rock Field B	HnF2 - Henneke rocky loam, eroded		0 to 25	25+	South West	69.6	1500	104357	62614	58440	75832	4174	0	1000	69571	41743	56353	73745	0	0	2000	139142	83485	60527	77920	22958	5566
Goat Rock Field B	HnF2 - Henneke rocky loam, eroded		25+	0 to 25	North East	0.1	1500	196	157	114	146	43	10	1000	131	104	108	141	0	0	2000	261	209	119	151	90	57
Goat Rock Field B	HnF2 - Henneke rocky loam, eroded		25+	0 to 25	South West	0.2	1500	242	145	135	176	10	0	1000	161	97	131	171	0	0	2000	323	194	140	181	53	13
Goat Rock Field B	HnF2 - Henneke rocky loam, eroded		25+	25+	North East	3.5	1500	5277	3166	2955	3835	211	0	1000	3518	2111	2850	3729	0	0	2000	7036	4222	3061	3940	1161	281
Goat Rock Field B	HnF2 - Henneke rocky loam, eroded		25+	25+	South West	4.9	1500	7384	2954	3987	5218	0	0	1000	4923	1969	3889	5119	0	0	2000	9845	3938	4086	5316	0	0
Goat Rock Field B	RoF - Rock land	na	0 to 25	0 to 25	North East	3.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field B	RoF - Rock land		0 to 25	0 to 25	South West	14.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field B	RoF - Rock land		0 to 25	25+	North East	2.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field B	RoF - Rock land		0 to 25	25+	South West	22.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field B	RoF - Rock land		25+	0 to 25	North East	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field B	RoF - Rock land		25+	25+	North East	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field B	RoF - Rock land		25+	25+	South West	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field B	VaE2 - Vallecitos rocky loam, 30 to 45 percent slopes, eroded		0 to 25	0 to 25	North East	2.5	1800	4466	4466	2307	2928	2158	1538	1200	2977	2977	2158	2779	819	198	2000	4962	4962	2357	2977	2605	1985
Goat Rock Field B	VaE2 - Vallecitos rocky loam, 30 to 45 percent slopes, eroded		0 to 25	0 to 25	South West	7.7	1800	13854	11083	6881	8805	4202	2278	1200	9236	7389	6512	8436	877	0	2000	15394	12315	7004	8928	5311	3387
Goat Rock Field B	VaE2 - Vallecitos rocky loam, 30 to 45 percent slopes, eroded		0 to 25	25+	North East	0.9	1800	1688	1350	838	1073	512	278	1200	1125	900	793	1028	107	0	2000	1876	1500	853	1088	647	413
Goat Rock Field B	VaE2 - Vallecitos rocky loam, 30 to 45 percent slopes, eroded		0 to 25	25+	South West	6.8	1800	12305	7383	5865	7574	1518	0	1200	8203	4922	5619	7328	0	0	2000	13672	8203	5947	7656	2256	547
Goat Rock Field B	VaF2 - Vallecitos rocky loam, 45 to 75 percent slopes, eroded		0 to 25	0 to 25	North East	1.1	1800	1966	1966	1016	1289	950	677	1200	1311	1311	950	1223	360	87	2000	2185	2185	1038	1311	1147	874
Goat Rock Field B	VaF2 - Vallecitos rocky loam, 45 to 75 percent slopes, eroded		0 to 25	0 to 25	South West	0.7	1800	1321	1057	656	840	401	217	1200	881	705	621	804	84	0	2000	1468	1174	668	851	506	323
Goat Rock Field B	VaF2 - Vallecitos rocky loam, 45 to 75 percent slopes, eroded		0 to 25	25+	North East	2.0	1800	3685	2948	1830	2342	1118	606	1200	2457	1965	1732	2244	233	0	2000	4095	3276	1863	2375	1413	901
Goat Rock Field B	VaF2 - Vallecitos rocky loam, 45 to 75 percent slopes, eroded		0 to 25	25+	South West	7.2	1800	12931	7759	6164	7960	1595	0	1200	8621	5173	5905	7701	0	0	2000	14368	8621	6250	8046	2371	575
TOTALS:						**216.6**			**190610.2**			**42285.0**	**14393.2**			**127073.4**			**4411.0**	**285.9**			**245699.6**			**90979.4**	**48777.4**

[1] Best estimation from soil survey book (1961) and NCRS website.

[2] Reduction of productivity based on slope, aspect and exposure. Reduction of production by 20% for canopy cover >25%, 20% for slopes >25%, and for south and west facing slopes

[3] After dissapearance RDM and leaving 1000 lbs/acre

[4] After dissapearance RDM and leaving 750 lbs/acre

	Forage Available		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	14393	286	48777
750 lbs/acre residual	42285	4411	90979

	Stocking Rate		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	18.0	0.4	61.0
750 lbs/acre residual	52.9	5.5	113.7

	# of 1,000 lb. Cattle for 7.5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	2.4	0.0	8.1
750 lbs/acre residual	7.0	0.7	15.2

	# of 1000lb Cattle for 5 months		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	4	0	12
750 lbs/acre residual	11	1	23

Estimated Forage Production on Grazeable Acres							Amount Forage--Normal Year							Amount Forage--Unfavorable Year							Amount Forage--Favorable Year						
							Production				Total (lbs.)			Production				Total (lbs.)			Production				Total (lbs.)		
Grazing Unit and field	Soil	production category[1]	% canopy cover	% Slope	Exposure Category	Acres	(lbs./acre)	Production	Production after slope, canopy and exposure[2]	750 lbs/acre residual[3]	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual
Goat Rock Field C	HnF2 - Henneke rocky loam, eroded		0 to 25	0 to 25	North East	2.1	1500	3143	3143	1886	2409	1257	733	1000	2095	2095	1781	2305	314	0	2000	4190	4190	1990	2514	2200	1676
Goat Rock Field C	HnF2 - Henneke rocky loam, eroded		0 to 25	0 to 25	South West	11.9	1500	17900	14320	10382	13366	3938	955	1000	11933	9547	9905	12888	0	0	2000	23867	19094	10859	13843	8234	5251
Goat Rock Field C	HnF2 - Henneke rocky loam, eroded		0 to 25	25+	North East	20.6	1500	30883	24706	17912	23059	6794	1647	1000	20588	16471	17088	22236	0	0	2000	41177	32942	18736	23883	14206	9059
Goat Rock Field C	HnF2 - Henneke rocky loam, eroded		0 to 25	25+	South West	82.2	1500	123359	74016	69081	89641	4934	0	1000	82240	49344	66614	87174	0	0	2000	164479	98687	71548	92108	27139	6579
Goat Rock Field C	HnF2 - Henneke rocky loam, eroded		25+	0 to 25	North East	0.5	1500	729	583	423	545	160	39	1000	486	389	404	525	0	0	2000	972	778	442	564	335	214
Goat Rock Field C	HnF2 - Henneke rocky loam, eroded		25+	0 to 25	South West	2.1	1500	3133	1880	1755	2277	125	0	1000	2089	1253	1692	2214	0	0	2000	4178	2507	1817	2339	689	167
Goat Rock Field C	HnF2 - Henneke rocky loam, eroded		25+	25+	North East	9.1	1500	13714	8229	7680	9966	549	0	1000	9143	5486	7406	9692	0	0	2000	18286	10972	7954	10240	3017	731
Goat Rock Field C	HnF2 - Henneke rocky loam, eroded		25+	25+	South West	16.9	1500	25384	10154	13708	17938	0	0	1000	16923	6769	13369	17600	0	0	2000	33846	13538	14046	18277	0	0
Goat Rock Field C	LpF2 - Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded		25+	0 to 25	North East	2.5	3000	7352	5881	2426	3039	3455	2843	1600	3921	3137	2152	2764	985	372	2300	5636	4509	2289	2901	2220	1608
Goat Rock Field C	LpF2 - Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded		25+	0 to 25	South West	3.0	3000	8883	5330	2754	3494	2576	1836	1600	4738	2843	2505	3245	338	0	2300	6810	4086	2629	3370	1457	717
Goat Rock Field C	LpF2 - Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded		25+	25+	North East	21.5	3000	64473	38684	19987	25359	18697	13324	1600	34386	20631	18181	23554	2450	0	2300	49429	29658	19084	24457	10574	5201
Goat Rock Field C	LpF2 - Los Gatos-Los Osos complex, 45 to 75 percent slopes, eroded		25+	25+	South West	1.6	3000	4704	1882	1364	1756	517	125	1600	2509	1004	1276	1669	0	0	2300	3607	1443	1320	1712	122	0
Goat Rock Field C	RoF - Rock land		0 to 25	0 to 25	North East	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field C	RoF - Rock land		0 to 25	0 to 25	South West	1.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field C	RoF - Rock land		0 to 25	25+	North East	11.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field C	RoF - Rock land		0 to 25	25+	South West	32.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field C	RoF - Rock land		25+	0 to 25	North East	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field C	RoF - Rock land		25+	0 to 25	South West	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field C	RoF - Rock land		25+	25+	North East	3.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field C	RoF - Rock land		25+	25+	South West	9.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goat Rock Field C	VaE2 - Vallecitos rocky loam, 30 to 45 percent slopes, eroded		0 to 25	0 to 25	North East	10.9	1800	19640	19640	10147	12875	9493	6765	1200	13093	13093	9493	12221	3601	873	2400	26187	26187	10802	13530	15385	12657
Goat Rock Field C	VaE2 - Vallecitos rocky loam, 30 to 45 percent slopes, eroded		0 to 25	0 to 25	South West	24.8	1800	44692	35754	22197	28404	13557	7349	1200	29795	23836	21005	27212	2830	0	2400	59589	47671	23389	29596	24283	18075
Goat Rock Field C	VaE2 - Vallecitos rocky loam, 30 to 45 percent slopes, eroded		0 to 25	25+	North East	17.3	1800	31204	24963	15498	19832	9465	5131	1200	20803	16642	14666	19000	1976	0	2400	41605	33284	16330	20664	16954	12620
Goat Rock Field C	VaE2 - Vallecitos rocky loam, 30 to 45 percent slopes, eroded		0 to 25	25+	South West	49.5	1800	89104	53463	42473	54849	10990	0	1200	59403	35642	40691	53067	0	0	2400	118806	71283	44255	56631	27028	14653
Goat Rock Field C	VaF2 - Vallecitos rocky loam, 45 to 75 percent slopes, eroded		0 to 25	0 to 25	North East	3.0	1800	5413	5413	2797	3549	2616	1865	1200	3609	3609	2616	3368	992	241	2400	7218	7218	2977	3729	4240	3489
Goat Rock Field C	VaF2 - Vallecitos rocky loam, 45 to 75 percent slopes, eroded		0 to 25	0 to 25	South West	30.5	1800	54840	43872	27237	34854	16635	9018	1200	36560	29248	25775	33392	3473	0	2400	73120	58496	28700	36316	29797	22180
Goat Rock Field C	VaF2 - Vallecitos rocky loam, 45 to 75 percent slopes, eroded		0 to 25	25+	North East	15.4	1800	27753	22202	13784	17638	8418	4564	1200	18502	14801	13044	16898	1758	0	2400	37004	29603	14524	18378	15079	11224
Goat Rock Field C	VaF2 - Vallecitos rocky loam, 45 to 75 percent slopes, eroded		0 to 25	25+	South West	173.2	1800	311692	187015	148573	191864	38442	0	1200	207795	124677	142340	185630	0	0	2400	415590	249354	154807	198098	94547	51256
Goat Rock Field C	VaF2 - Vallecitos rocky loam, 45 to 75 percent slopes, eroded		25+	0 to 25	North East	3.0	1800	5335	4268	2650	3391	1618	877	1200	3557	2845	2508	3249	338	0	2400	7114	5691	2792	3533	2899	2158
Goat Rock Field C	VaF2 - Vallecitos rocky loam, 45 to 75 percent slopes, eroded		25+	0 to 25	South West	6.6	1800	11889	7133	5667	7318	1466	0	1200	7926	4755	5429	7080	0	0	2400	15852	9511	5905	7556	3606	1955
Goat Rock Field C	VaF2 - Vallecitos rocky loam, 45 to 75 percent slopes, eroded		25+	25+	North East	7.9	1800	14175	8505	6757	8726	1748	0	1200	9450	5670	6473	8442	0	0	2400	18900	11340	7040	9009	4300	2331
Goat Rock Field C	VaF2 - Vallecitos rocky loam, 45 to 75 percent slopes, eroded		25+	25+	South West	30.5	1800	54901	21960	25071	32696	0	0	1200	36600	14640	24339	31964	0	0	2400	73201	29280	25803	33428	3477	0
TOTALS						606			622996			157453	57072			408427			19056	1486			801321			311788	183800

[1] Best estimation from soil survey book (1961) and NCRS website.
[2] Reduction of productivity based on slope, aspect and exposure. Reduction of production by 20% for canopy cover >25%, 20% for slopes >25%, and for south and west facing slopes
[3] After dissapearance RDM and leaving 1000 lbs/acre
[4] After dissapearance RDM and leaving 750 lbs/acre

	Forage Available		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	57072	1486	183800
750 lbs/acre residual	157453	19056	311788

	Stocking Rate		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	71.3	1.9	229.8
750 lbs/acre residual	196.8	23.8	389.7

	# of 1,000 lb. Cattle for 7.5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	9.5	0.2	30.6
750 lbs/acre residual	26.2	3.2	52.0

	# of 1,000 lb. Cattle for 12 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	5.9	0.2	19.1
750 lbs/acre residual	16.4	2.0	32.5

Estimated Forage Production on Grazeable Acres							Amount Forage--Normal Year							Amount Forage--Unfavorable Year							Amount Forage--Favorable Year						
							Production				Total (lbs.)			Production				Total (lbs.)			Production				Total (lbs.)		
Grazing Unit and field	Soil	production category[1]	% canopy cover	% Slope	Exposure Category	Acres	(lbs./acre)	Production	Production after slope, canopy and exposure[2]	750 lbs/acre residual[3]	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual
South Calaveras Field A	LoE - Los Osos clay loam, 15 to 30 percent slopes	fine loamy - SC	25+	25+	North East	0.7	2300	1693	1016	653	837	362	178	1600	1177	706	623	807	84	0	3000	2208	1325	684	868	640	456
South Calaveras Field A	LoE - Los Osos clay loam, 15 to 30 percent slopes		25+	25+	South West	0.4	2300	972	389	356	461	33	0	1600	676	270	344	450	0	0	3000	1268	507	368	473	139	34
South Calaveras Field A	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes	claypan* - SC	25+	25+	North East	0.2	2100	491	295	205	263	90	31	1200	281	168	192	251	0	0	3000	701	421	217	276	203	145
South Calaveras Field A	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes		25+	25+	South West	0.5	2100	966	386	384	499	3	0	1200	552	221	367	482	0	0	3000	1380	552	400	515	152	37
Totals:						**1.9**			**2085.4**			**487.6**	**209.4**			**1366.1**			**83.9**	**0.0**			**2804.7**			**1134.9**	**671.8**

[1] Best estimation from soil survey book (1961) and NCRS website.
[2] Reduction of productivity based on slope, aspect and exposure. Reduction of production by 20% for canopy cover >25%, 20% for slopes >25%, and for south and west facing slopes
[3] After dissapearance RDM and leaving 1000 lbs/acre
[4] After dissapearance RDM and leaving 750 lbs/acre

	Forage Available		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	209	0	672
750 lbs/acre residual	488	84	1135

	Stocking Rate		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	0.3	0.0	0.8
750 lbs/acre residual	0.6	0.1	1.4

	# of 1,000 lb. Cattle for 7.5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	0.0	0.0	0.1
750 lbs/acre residual	0.1	0.0	0.2

Estimated Forage Production on Grazeable Acres							Amount Forage--Normal Year							Amount Forage--Unfavorable Year							Amount Forage--Favorable Year						
							Production					Total (lbs.)						Total (lbs.)						Production				Total (lbs.)		
Grazing Unit and field	Soil	production category[1]	% canopy cover	% Slope	Exposure Category	Acres	(lbs./acre)	Production	Production after slope, canopy and exposure[2]	750 lbs/acre residual[3]	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual
South Calaveras Field B	LoE - Los Osos clay loam, 15 to 30 percent slopes	fine loamy - SC	0 to 25	0 to 25	North East	41.1	2300	94458	94458	40247	50514	54211	43944	1600	65710	65710	37373	47640	28337	18070	3000	123206	123206	43122	53389	80084	69817
South Calaveras Field B	LoE - Los Osos clay loam, 15 to 30 percent slopes		0 to 25	0 to 25	South West	25.2	2300	58057	46446	23576	29887	22870	16559	1600	40388	32310	22163	28473	10147	3837	3000	75727	60582	24990	31300	35592	29281
South Calaveras Field B	LoE - Los Osos clay loam, 15 to 30 percent slopes		0 to 25	25+	North East	14.5	2300	33421	26737	13572	17205	13165	9532	1600	23249	18599	12758	16391	5841	2209	3000	43593	34874	14386	18018	20488	16856
South Calaveras Field B	LoE - Los Osos clay loam, 15 to 30 percent slopes		0 to 25	25+	South West	13.2	2300	30288	18173	11694	14986	6479	3187	1600	21070	12642	11141	14433	1501	0	3000	39506	23704	12247	15539	11457	8165
South Calaveras Field B	LoE - Los Osos clay loam, 15 to 30 percent slopes		25+	0 to 25	North East	0.2	2300	404	323	164	208	159	115	1600	281	225	154	198	71	27	3000	526	421	174	218	247	204
South Calaveras Field B	LoE - Los Osos clay loam, 15 to 30 percent slopes		25+	0 to 25	South West	0.2	2300	530	318	205	262	113	56	1600	369	221	195	253	26	0	3000	691	415	214	272	201	143
South Calaveras Field B	LoE - Los Osos clay loam, 15 to 30 percent slopes		25+	25+	North East	2.9	2300	6719	4032	2594	3325	1437	707	1600	4674	2805	2472	3202	333	0	3000	8764	5259	2717	3447	2542	1811
South Calaveras Field B	LoE - Los Osos clay loam, 15 to 30 percent slopes		25+	25+	South West	5.6	2300	12924	5170	4731	6136	438	0	1600	8991	3596	4574	5979	0	0	3000	16857	6743	4889	6293	1854	450
South Calaveras Field B	LoF - Los Osos clay loam, 30 to 50 percent slopes	fine loamy - SC	0 to 25	0 to 25	North East	19.5	2300	44825	44825	19099	23971	25725	20853	1600	31182	31182	17735	22607	13447	8575	3000	58467	58467	20463	25336	38004	33131
South Calaveras Field B	LoF - Los Osos clay loam, 30 to 50 percent slopes		0 to 25	0 to 25	South West	14.6	2300	33674	26939	13674	17335	13265	9604	1600	23425	18740	12855	16515	5886	2225	3000	43922	35138	14494	18155	20643	16983
South Calaveras Field B	LoF - Los Osos clay loam, 30 to 50 percent slopes		0 to 25	25+	North East	23.7	2300	54577	43662	22163	28095	21499	15566	1600	37967	30373	20834	26767	9539	3607	3000	71188	56950	23492	29424	33458	27526
South Calaveras Field B	LoF - Los Osos clay loam, 30 to 50 percent slopes		0 to 25	25+	South West	18.4	2300	42313	25388	16336	20935	9051	4452	1600	29435	17661	15564	20163	2097	0	3000	55190	33114	17109	21708	16005	11406
South Calaveras Field B	LoF - Los Osos clay loam, 30 to 50 percent slopes		25+	0 to 25	North East	1.5	2300	3400	2720	1381	1750	1339	970	1600	2365	1892	1298	1667	594	225	3000	4435	3548	1463	1833	2084	1715
South Calaveras Field B	LoF - Los Osos clay loam, 30 to 50 percent slopes		25+	0 to 25	South West	0.3	2300	643	386	248	318	138	68	1600	448	269	237	307	32	0	3000	839	504	260	330	243	173
South Calaveras Field B	LoF - Los Osos clay loam, 30 to 50 percent slopes		25+	25+	North East	6.1	2300	14094	8457	5442	6974	3015	1483	1600	9805	5883	5184	6716	699	0	3000	18384	11030	5699	7231	5331	3799
South Calaveras Field B	LoF - Los Osos clay loam, 30 to 50 percent slopes		25+	25+	South West	2.3	2300	5182	2073	1897	2460	176	0	1600	3605	1442	1834	2397	0	0	3000	6759	2704	1960	2523	743	180
South Calaveras Field B	LoG - Los Osos clay loam, 50 to 75 percent slopes	fine loamy - SC	0 to 25	0 to 25	North East	6.3	2300	14552	14552	6200	7782	8352	6770	1600	10123	10123	5758	7339	4366	2784	3000	18981	18981	6643	8225	12338	10756
South Calaveras Field B	LoG - Los Osos clay loam, 50 to 75 percent slopes		0 to 25	0 to 25	South West	1.0	2300	2354	1883	956	1212	927	671	1600	1637	1310	898	1154	411	156	3000	3070	2456	1013	1269	1443	1187
South Calaveras Field B	LoG - Los Osos clay loam, 50 to 75 percent slopes		0 to 25	25+	North East	5.3	2300	12116	9692	4920	6237	4772	3456	1600	8428	6743	4625	5942	2118	801	3000	15803	12642	5215	6532	7427	6110
South Calaveras Field B	LoG - Los Osos clay loam, 50 to 75 percent slopes		0 to 25	25+	South West	1.0	2300	2330	1398	900	1153	498	245	1600	1621	973	857	1110	115	0	3000	3039	1824	942	1195	881	628
South Calaveras Field B	LoG - Los Osos clay loam, 50 to 75 percent slopes		25+	0 to 25	North East	3.4	2300	7932	6346	3221	4083	3125	2262	1600	5518	4415	3028	3890	1386	524	3000	10347	8277	3414	4277	4863	4001
South Calaveras Field B	LoG - Los Osos clay loam, 50 to 75 percent slopes		25+	0 to 25	South West	1.2	2300	2677	1606	1034	1324	573	282	1600	1862	1117	985	1276	133	0	3000	3492	2095	1082	1373	1013	722
South Calaveras Field B	LoG - Los Osos clay loam, 50 to 75 percent slopes		25+	25+	North East	42.9	2300	98707	59224	38109	48838	21115	10386	1600	68666	41199	36307	47036	4892	0	3000	128748	77249	39912	50641	37337	26608
South Calaveras Field B	LoG - Los Osos clay loam, 50 to 75 percent slopes		25+	25+	South West	11.9	2300	27262	10905	9980	12944	925	0	1600	18965	7586	9649	12612	0	0	3000	35560	14224	10312	13276	3912	948
South Calaveras Field B	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes	claypan* - SC	0 to 25	0 to 25	North East	10.8	2300	24796	24796	10565	13261	14231	11536	1600	17250	17250	9811	12506	7439	4744	3000	32343	32343	11320	14015	21023	18328
South Calaveras Field B	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes		0 to 25	0 to 25	South West	6.6	2300	15116	12092	6138	7781	5954	4311	1600	10515	8412	5770	7413	2642	999	3000	19716	15773	6506	8149	9267	7624
South Calaveras Field B	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes		0 to 25	25+	North East	1.8	2300	4027	3221	1635	2073	1586	1148	1600	2801	2241	1537	1975	704	266	3000	5252	4202	1733	2171	2468	2031
South Calaveras Field B	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes		0 to 25	25+	South West	1.5	2300	3553	2132	1372	1758	760	374	1600	2472	1483	1307	1693	176	0	3000	4635	2781	1437	1823	1344	958
South Calaveras Field B	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes		25+	0 to 25	North East	0.1	2300	331	265	134	170	130	94	1600	230	184	126	162	58	22	3000	432	345	142	178	203	167
South Calaveras Field B	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes		25+	25+	North East	0.3	2300	578	347	223	286	124	61	1600	402	241	213	275	29	0	3000	754	452	234	297	219	156
South Calaveras Field B	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes		25+	25+	South West	0.2	2300	437	175	160	208	15	0	1600	304	122	155	202	0	0	3000	570	228	165	213	63	15
South Calaveras Field B	YaB - Yolo loam, 2 to 5 percent slopes	Loamy* - SC	0 to 25	0 to 25	North East	0.4	2100	914	914	418	526	496	387	1200	522	522	379	487	144	35	3000	1305	1305	457	566	848	740
South Calaveras Field B	YaB - Yolo loam, 2 to 5 percent slopes		0 to 25	25+	North East	0.4	2100	765	612	334	425	277	186	1200	437	350	308	399	42	0	3000	1092	874	361	452	513	422
	TOTALS:					**284**			**500264**			**236939**	**169265**			**347820**			**103205**	**49104**			**652708**			**374139**	**303039**

[1] Best estimation from soil survey book (1961) and NCRS website.
[2] Reduction of productivity based on slope, aspect and exposure. Reduction of production by 20% for canopy cover >25%, 20% for slopes >25%, and for south and west facing slopes
[3] After dissapearance RDM and leaving 1000 lbs/acre
[4] After dissapearance RDM and leaving 750 lbs/acre

	Forage Available		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	169265	49104	303039
750 lbs/acre residual	236939	103205	374139

	Stocking Rate		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	211.6	61.4	378.8
750 lbs/acre residual	296.2	129.0	467.7

	# of 1,000 lb. Cattle for 7.5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	28.2	8.2	50.5
750 lbs/acre residual	39.5	17.2	62.4

Estimated Forage Production on Grazeable Acres							Amount Forage--Normal Year							Amount Forage--Unfavorable Year							Amount Forage--Favorable Year						
							Production				Total (lbs.)			Production				Total (lbs.)			Production				Total (lbs.)		
Grazing Unit and field	Soil	production category[1]	% canopy cover	% Slope	Exposure Category	Acres	(lbs./acre)	Production	Production after slope, canopy and exposure[2]	750 lbs/acre residual[3]	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual
South Calaveras Field C	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded	shallow gravelly loam	0 to 25	0 to 25	North East	0.3	850	288	288	282	367	5	0	500	169	169	271	355	0	0	1200	406	406	294	379	112	27
South Calaveras Field C	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded		0 to 25	0 to 25	South West	0.6	850	509	407	490	639	0	0	500	299	239	473	623	0	0	1200	718	575	506	656	68	0
South Calaveras Field C	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded		0 to 25	25+	North East	0.6	850	509	407	490	640	0	0	500	300	240	473	623	0	0	1200	719	575	507	657	68	0
South Calaveras Field C	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded		0 to 25	25+	South West	2.1	850	1809	1086	1705	2237	0	0	500	1064	639	1660	2193	0	0	1200	2554	1533	1750	2282	0	0
South Calaveras Field C	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded		25+	25+	North East	2.0	850	1686	1011	1589	2084	0	0	500	992	595	1547	2043	0	0	1200	2380	1428	1630	2126	0	0
South Calaveras Field C	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded		25+	25+	South West	0.3	850	260	104	240	317	0	0	500	153	61	236	312	0	0	1200	368	147	244	321	0	0
South Calaveras Field C	GmF - Gaviota-Los Gatos complex, 30 to 50 percent slopes	loamy/shallow loamy* - SC	0 to 25	0 to 25	North East	6.0	1900	11351	11351	5616	7109	5735	4242	1000	5974	5974	5078	6572	896	0	2800	16728	16728	6154	7647	10575	9081
South Calaveras Field C	GmF - Gaviota-Los Gatos complex, 30 to 50 percent slopes		0 to 25	0 to 25	South West	11.6	1900	22010	17608	10449	13345	7159	4263	1000	11584	9268	9615	12511	0	0	2800	32436	25949	11283	14179	14666	11770
South Calaveras Field C	GmF - Gaviota-Los Gatos complex, 30 to 50 percent slopes		0 to 25	25+	North East	2.2	1900	4156	3324	1973	2520	1352	805	1000	2187	1750	1815	2362	0	0	2800	6124	4899	2130	2677	2769	2222
South Calaveras Field C	GmF - Gaviota-Los Gatos complex, 30 to 50 percent slopes		0 to 25	25+	South West	9.7	1900	18462	11077	8395	10824	2682	253	1000	9717	5830	7870	10300	0	0	2800	27207	16324	8920	11349	7404	4975
South Calaveras Field C	GmF - Gaviota-Los Gatos complex, 30 to 50 percent slopes		25+	25+	North East	0.1	1900	243	146	111	143	35	3	1000	128	77	104	136	0	0	2800	359	215	118	150	98	66
South Calaveras Field C	HfC - Hillgate silt loam, 2 to 9 percent slopes	claypan - SC	0 to 25	0 to 25	North East	18.5	2100	38933	38933	17798	22433	21135	16500	1200	22247	22247	16129	20764	6118	1483	3000	55618	55618	19466	24101	36152	31517
South Calaveras Field C	HfC - Hillgate silt loam, 2 to 9 percent slopes		0 to 25	0 to 25	South West	33.1	2100	69473	55578	30369	38640	25209	16938	1200	39699	31759	27988	36258	3771	0	3000	99247	79397	32751	41022	46646	38375
South Calaveras Field C	HfC - Hillgate silt loam, 2 to 9 percent slopes		0 to 25	25+	North East	0.3	2100	640	512	280	356	232	156	1200	366	292	258	334	35	0	3000	914	731	302	378	430	353
South Calaveras Field C	HfC - Hillgate silt loam, 2 to 9 percent slopes		0 to 25	25+	South West	0.3	2100	679	407	283	364	124	43	1200	388	233	266	347	0	0	3000	970	582	301	381	281	200
South Calaveras Field C	HfD2 - Hillgate silt loam, 9 to 15 percent slopes, eroded	claypan - SC	0 to 25	0 to 25	North East	2.1	2100	4481	4481	2048	2582	2432	1899	1200	2561	2561	1856	2390	704	171	3000	6401	6401	2240	2774	4161	3627
South Calaveras Field C	HfD2 - Hillgate silt loam, 9 to 15 percent slopes, eroded		0 to 25	0 to 25	South West	1.1	2100	2277	1822	996	1267	826	555	1200	1301	1041	917	1189	124	0	3000	3253	2603	1074	1345	1529	1258
South Calaveras Field C	HfD2 - Hillgate silt loam, 9 to 15 percent slopes, eroded		0 to 25	25+	North East	0.3	2100	604	484	264	336	219	147	1200	345	276	244	315	33	0	3000	864	691	285	357	406	334
South Calaveras Field C	HfD2 - Hillgate silt loam, 9 to 15 percent slopes, eroded		0 to 25	25+	South West	0.2	2100	413	248	172	221	75	26	1200	236	141	162	211	0	0	3000	589	354	183	232	171	122
TOTALS:						91.5			149274.0			67221.8	45831.1			83392.2			11680.8	1653.9			215155.7			125534.4	103927.6

[1] Best estimation from soil survey book (1961) and NCRS website.

[2] Reduction of productivity based on slope, aspect and exposure. Reduction of production by 20% for canopy cover >25%, 20% for slopes >25%, and for south and west facing slopes

[3] After dissapearance RDM and leaving 1000 lbs/acre

[4] After dissapearance RDM and leaving 750 lbs/acre

	Forage Available		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	45831	1654	103928
750 lbs/acre residual	67222	11681	125534

	Stocking Rate		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	57.3	2.1	129.9
750 lbs/acre residual	84.0	14.6	156.9

	# of 1,000 lb. Cattle for 7.5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	7.6	0.3	17.3
750 lbs/acre residual	11.2	1.9	20.9

	# of 1,000 lb. Cattle for 5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	11.5	0.4	26.0
750 lbs/acre residual	16.8	2.9	31.4

Estimated Forage Production on Grazeable Acres							Amount Forage--Normal Year							Amount Forage--Unfavorable Year							Amount Forage--Favorable Year						
							Production				Total (lbs.)			Production				Total (lbs.)			Production				Total (lbs.)		
Grazing Unit and field	Soil	production category[1]	% canopy cover	% Slope	Exposure Category	Acres	(lbs./acre)	Production	Production after slope, canopy and exposure[2]	750 lbs/acre residual[3]	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual
South Calaveras Field D	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded	gravelly loam - SC	0 to 25	0 to 25	North East	2.1	850	1803	1803	1771	2301	32	0	500	1060	1060	1697	2227	0	0	1200	2545	2545	1845	2375	700	170
South Calaveras Field D	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded		0 to 25	0 to 25	South West	2.5	850	2103	1683	2024	2643	0	0	500	1237	990	1955	2574	0	0	1200	2970	2376	2094	2712	282	0
South Calaveras Field D	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded		0 to 25	25+	North East	4.2	850	3609	2887	3473	4535	0	0	500	2123	1698	3354	4416	0	0	1200	5095	4076	3592	4654	484	0
South Calaveras Field D	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded		0 to 25	25+	South West	4.0	850	3401	2041	3205	4205	0	0	500	2001	1200	3121	4121	0	0	1200	4801	2881	3289	4289	0	0
South Calaveras Field D	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded		25+	0 to 25	North East	0.2	850	153	123	147	192	0	0	500	90	72	142	187	0	0	1200	216	173	152	198	21	0
South Calaveras Field D	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded		25+	0 to 25	South West	0.2	850	199	120	188	246	0	0	500	117	70	183	242	0	0	1200	281	169	193	251	0	0
South Calaveras Field D	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded		25+	25+	North East	5.4	850	4596	2758	4331	5683	0	0	500	2704	1622	4218	5570	0	0	1200	6489	3893	4445	5797	0	0
South Calaveras Field D	GhG2 - Gaviota gravelly loam, 30 to 75 percent slopes, eroded		25+	25+	South West	11.6	850	9830	3932	9067	11958	0	0	500	5783	2313	8905	11797	0	0	1200	13878	5551	9229	12120	0	0
South Calaveras Field D	GmF - Gaviota-Los Gatos complex, 30 to 50 percent slopes	loamy/shallow loamy* - SC	0 to 25	0 to 25	North East	0.4	1900	777	777	384	487	393	290	1000	409	409	348	450	61	0	2800	1145	1145	421	523	724	622
South Calaveras Field D	GmF - Gaviota-Los Gatos complex, 30 to 50 percent slopes		0 to 25	0 to 25	South West	8.9	1900	16828	13462	7989	10203	5473	3259	1000	8857	7085	7351	9565	0	0	2800	24799	19839	8626	10841	11213	8998
South Calaveras Field D	GmF - Gaviota-Los Gatos complex, 30 to 50 percent slopes		0 to 25	25+	North East	0.4	1900	700	560	332	425	228	136	1000	369	295	306	398	0	0	2800	1032	825	359	451	467	374
South Calaveras Field D	GmF - Gaviota-Los Gatos complex, 30 to 50 percent slopes		0 to 25	25+	South West	3.1	1900	5880	3528	2674	3448	854	80	1000	3095	1857	2507	3281	0	0	2800	8666	5199	2841	3615	2358	1585
South Calaveras Field D	GmF - Gaviota-Los Gatos complex, 30 to 50 percent slopes		25+	25+	South West	0.1	1900	183	73	79	104	0	0	1000	96	38	76	100	0	0	2800	269	108	83	107	25	1
South Calaveras Field D	HfD2 - Hillgate silt loam, 9 to 15 percent slopes, eroded	claypan - SC	0 to 25	0 to 25	North East	0.1	2100	215	215	98	124	117	91	1200	123	123	89	115	34	8	3000	308	308	108	133	200	174
South Calaveras Field D	HfD2 - Hillgate silt loam, 9 to 15 percent slopes, eroded		0 to 25	0 to 25	South West	1.8	2100	3749	2999	1639	2085	1360	914	1200	2142	1714	1510	1956	203	0	3000	5355	4284	1767	2213	2517	2071
South Calaveras Field D	HfD2 - Hillgate silt loam, 9 to 15 percent slopes, eroded		0 to 25	25+	South West	0.1	2100	194	116	81	104	35	12	1200	111	66	76	99	0	0	3000	277	166	86	109	80	57
	TOTALS					**45.0**			**37076.4**			**8492.4**	**4783.3**			**20614.3**			**298.7**	**8.2**			**53538.5**			**19069.9**	**14051.7**

[1] Best estimation from soil survey book (1961) and NCRS website.
[2] Reduction of productivity based on slope, aspect and exposure. Reduction of production by 20% for canopy cover >25%, 20% for slopes >25%, and for south and west facing slopes
[3] After dissapearance RDM and leaving 1000 lbs/acre
[4] After dissapearance RDM and leaving 750 lbs/acre

	Forage Available		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	4783	8	14052
750 lbs/acre residual	8492	299	19070

	Stocking Rate		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	6.0	0.0	17.6
750 lbs/acre residual	10.6	0.4	23.8

	# of 1,000 lb. Cattle for 7.5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	0.8	0.0	2.3
750 lbs/acre residual	1.4	0.0	3.2

	# of 1,000 lb. Cattle for 5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	1.2	0.0	3.5
750 lbs/acre residual	2.1	0.1	4.8

Estimated Forage Production on Grazeable Acres							Amount Forage--Normal Year							Amount Forage--Unfavorable Year							Amount Forage--Favorable Year						
							Production				Total (lbs.)			Production				Total (lbs.)			Production				Total (lbs.)		
Grazing Unit and field	Soil	production category[1]	% canopy cover	% Slope	Exposure Category	Acres	(lbs./acre)	Production	Production after slope, canopy and exposure[2]	750 lbs/acre residual[3]	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual
South Calaveras Field E	LoE - Los Osos clay loam, 15 to 30 percent slopes	fine loamy - SC	0 to 25	0 to 25	North East	1.9	2300	4416	4416	1882	2362	2534	2054	1600	3072	3072	1747	2227	1325	845	3000	5760	5760	2016	2496	3744	3264
South Calaveras Field E	LoE - Los Osos clay loam, 15 to 30 percent slopes		0 to 25	0 to 25	South West	0.1	2300	192	154	78	99	76	55	1600	134	107	73	94	34	13	3000	251	201	83	104	118	97
South Calaveras Field E	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes	claypan* - SC	0 to 25	0 to 25	North East	4.0	2100	8435	8435	3856	4860	4579	3575	1200	4820	4820	3494	4499	1325	321	3000	12050	12050	4217	5222	7832	6828
South Calaveras Field E	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes		0 to 25	0 to 25	South West	3.7	2100	7868	6294	3439	4376	2855	1918	1200	4496	3597	3170	4106	427	0	3000	11240	8992	3709	4646	5283	4346
South Calaveras Field E	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes		0 to 25	25+	North East	0.6	2100	1190	952	520	662	432	290	1200	680	544	479	621	65	0	3000	1700	1360	561	703	799	657
South Calaveras Field E	SfC - San Ysidro loam, acid variant, 2 to 9 percent slopes		0 to 25	25+	South West	0.5	2100	1045	627	436	560	191	67	1200	597	358	409	533	0	0	3000	1493	896	463	587	433	309
Totals						**10.8**			**20878.2**			**10667.0**	**7959.1**			**12498.1**			**3175.6**	**1178.8**			**29258.3**			**18209.1**	**15501.3**

[1] Best estimation from soil survey book (1961) and NCRS website.
[2] Reduction of productivity based on slope, aspect and exposure. Reduction of production by 20% for canopy cover >25%, 20% for slopes >25%, and for south and west facing slopes
[3] After dissapearance RDM and leaving 1000 lbs/acre
[4] After dissapearance RDM and leaving 750 lbs/acre

	Forage Available		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	7959	1179	15501
750 lbs/acre residual	10667	3176	18209

	Stocking Rate		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	9.9	1.5	19.4
750 lbs/acre residual	13.3	4.0	22.8

	# of 1,000 lb. Cattle for 7.5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	1.3	0.2	2.6
750 lbs/acre residual	1.8	0.5	3.0

Estimated Forage Production on Grazeable Acres							Amount Forage--Normal Year							Amount Forage--Unfavorable Year							Amount Forage--Favorable Year						
							Production	Total (lbs.)						Production	Total (lbs.)						Production	Total (lbs.)					
Grazing Unit and field	Soil	production category[1]	% canopy cover	% Slope	Exposure Category	Acres	(lbs./acre)	Production	Production after slope, canopy and exposure[2]	750 lbs/acre residual[3]	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual
Sheep Camp Creek Field A	PcF2 - Perkins loam, 45 to 75 percent slopes, eroded		0 to 25	0 to 25	North East	0.2	2200	549	549	242	304	307	244	1200	299	299	217	279	82	20	1700	424	424	230	292	195	132
Sheep Camp Creek Field A	PcF2 - Perkins loam, 45 to 75 percent slopes, eroded		0 to 25	25+	North East	0.2	2200	391	313	165	209	148	104	1200	213	171	150	195	20	0	1700	302	242	158	202	84	40
Sheep Camp Creek Field A	PcF2 - Perkins loam, 45 to 75 percent slopes, eroded		25+	25+	North East	4.5	2200	9830	5898	3941	5058	1957	840	1200	5362	3217	3673	4790	0	0	1700	7596	4557	3807	4924	751	0
Sheep Camp Creek Field A	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded	upland terraces	0 to 25	0 to 25	North East	6.0	1800	10749	10749	5553	7046	5195	3702	1200	7166	7166	5195	6688	1971	478	2400	14331	14331	5912	7405	8420	6927
Sheep Camp Creek Field A	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded		0 to 25	0 to 25	South West	11.6	1800	20850	16680	10355	13251	6324	3429	1200	13900	11120	9799	12695	1320	0	2400	27800	22240	10911	13807	11328	8433
Sheep Camp Creek Field A	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded		0 to 25	25+	North East	2.2	1800	3953	3162	1963	2512	1199	650	1200	2635	2108	1858	2407	250	0	2400	5270	4216	2069	2617	2148	1599
Sheep Camp Creek Field A	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded		0 to 25	25+	South West	10.6	1800	19128	11477	9118	11774	2359	0	1200	12752	7651	8735	11392	0	0	2400	25504	15302	9500	12157	5802	3145
Sheep Camp Creek Field A	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded		25+	25+	North East	0.2	1800	395	237	188	243	49	0	1200	263	158	180	235	0	0	2400	526	316	196	251	120	65
Sheep Camp Creek Field A	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded	upland terraces	0 to 25	0 to 25	North East	9.7	1800	17429	17429	9005	11426	8424	6003	1200	11620	11620	8424	10845	3195	775	2400	23239	23239	9586	12007	13653	11232
Sheep Camp Creek Field A	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		0 to 25	0 to 25	South West	19.4	1800	34994	27995	17380	22241	10615	5755	1200	23329	18664	16447	21308	2216	0	2400	46659	37327	18314	23174	19013	14153
Sheep Camp Creek Field A	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		0 to 25	25+	North East	11.9	1800	21434	17147	10645	13622	6502	3525	1200	14289	11431	10074	13051	1357	0	2400	28578	22863	11217	14194	11646	8669
Sheep Camp Creek Field A	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		0 to 25	25+	South West	33.4	1800	60172	36103	28682	37039	7421	0	1200	40115	24069	27479	35836	0	0	2400	80229	48138	29885	38243	18252	9895
Sheep Camp Creek Field A	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		25+	0 to 25	North East	1.5	1800	2638	2110	1310	1676	800	434	1200	1759	1407	1240	1606	167	0	2400	3517	2814	1380	1747	1433	1067
Sheep Camp Creek Field A	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		25+	0 to 25	South West	1.6	1800	2931	1759	1397	1804	362	0	1200	1954	1172	1339	1746	0	0	2400	3908	2345	1456	1863	889	482
Sheep Camp Creek Field A	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		25+	25+	North East	12.9	1800	23170	13902	11044	14262	2858	0	1200	15447	9268	10581	13799	0	0	2400	30893	18536	11508	14726	7028	3810
Sheep Camp Creek Field A	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		25+	25+	South West	10.2	1800	18335	7334	8373	10919	0	0	1200	12223	4889	8128	10675	0	0	2400	24446	9778	8617	11164	1161	0
Totals						**136.1**			**172843.2**			**54519.5**	**24685.6**			**114409.5**			**10580.2**	**1272.3**			**226668.1**			**101923.0**	**69648.6**

[1] Best estimation from soil survey book (1961) and NCRS website.

[2] Reduction of productivity based on slope, aspect and exposure. Reduction of production by 20% for canopy cover >25%, 20% for slopes >25%, and for south and west facing slopes

[3] After dissapearance RDM and leaving 1000 lbs/acre

[4] After dissapearance RDM and leaving 750 lbs/acre

	Forage Available		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	24686	1272	69649
750 lbs/acre residual	54520	10580	101923

	Stocking Rate		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	30.9	1.6	87.1
750 lbs/acre residual	68.1	13.2	127.4

	# of 1,000 lb. Cattle for 7.5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	4.1	0.2	11.6
750 lbs/acre residual	9.1	1.8	17.0

	# of 1,000 lb. Cattle for 5 mo.		
1000lbs/acre residual	6.2	0.3	17.4
750 lbs/acre residual	13.6	2.6	25.5

Estimated Forage Production on Grazeable Acres							Amount Forage--Normal Year							Amount Forage--Unfavorable Year							Amount Forage--Favorable Year						
							Production	Total (lbs.)						Production	Total (lbs.)						Production	Total (lbs.)					
Grazing Unit and field	Soil	production category[1]	% canopy cover	% Slope	Exposure Category	Acres	(lbs./acre)	Production	Production after slope, canopy and exposure[2]	750 lbs/acre residual[3]	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual
Sheep Camp Creek Field C	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded	upland terraces	0 to 25	0 to 25	North East	6.1	1800	10998	10998	5682	7209	5315	3788	1200	7332	7332	5315	6843	2016	489	2400	14663	14663	6049	7576	8615	7087
Sheep Camp Creek Field C	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded		0 to 25	0 to 25	South West	30.7	1800	55289	44231	27460	35139	16771	9092	1200	36859	29487	25986	33665	3502	0	2400	73719	58975	28935	36614	30040	22361
Sheep Camp Creek Field C	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded		0 to 25	25+	North East	0.2	1800	405	324	201	257	123	67	1200	270	216	190	246	26	0	2400	540	432	212	268	220	164
Sheep Camp Creek Field C	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded		0 to 25	25+	South West	1.2	1800	2156	1293	1028	1327	266	0	1200	1437	862	984	1284	0	0	2400	2874	1725	1071	1370	654	354
Sheep Camp Creek Field C	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded	upland terraces	0 to 25	0 to 25	North East	4.0	1800	7116	7116	3676	4665	3439	2451	1200	4744	4744	3439	4428	1305	316	2400	9488	9488	3914	4902	5574	4586
Sheep Camp Creek Field C	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		0 to 25	0 to 25	South West	10.5	1800	18862	15090	9368	11988	5722	3102	1200	12575	10060	8865	11485	1195	0	2400	25150	20120	9871	12491	10249	7629
Sheep Camp Creek Field C	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		0 to 25	25+	North East	2.1	1800	3824	3059	1899	2430	1160	629	1200	2549	2039	1797	2328	242	0	2400	5098	4079	2001	2532	2077	1546
Sheep Camp Creek Field C	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		0 to 25	25+	South West	5.0	1800	8996	5398	4288	5537	1109	0	1200	5997	3598	4108	5358	0	0	2400	11994	7197	4468	5717	2729	1479
Totals						**59.8**			**87508.1**			**33905.4**	**19128.2**			**58338.8**			**8284.8**	**805.0**			**116677.5**			**60157.8**	**45207.1**

[1] Best estimation from soil survey book (1961) and NCRS website.
[2] Reduction of productivity based on slope, aspect and exposure. Reduction of production by 20% for canopy cover >25%, 20% for slopes >25%, and for south and west facing slopes
[3] After dissapearance RDM and leaving 1000 lbs/acre
[4] After dissapearance RDM and leaving 750 lbs/acre

	Forage Available		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	19128	805	45207
750 lbs/acre residual	33905	8285	60158

	Stocking Rate		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	23.9	1.0	56.5
750 lbs/acre residual	42.4	10.4	75.2

	# of 1,000 lb. Cattle for 7.5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	3.2	0.1	7.5
750 lbs/acre residual	5.7	1.4	10.0

Estimated Forage Production on Grazeable Acres							Amount Forage--Normal Year							Amount Forage--Unfavorable Year							Amount Forage--Favorable Year						
							Production	Total (lbs.)						Production	Total (lbs.)						Production	Total (lbs.)					
Grazing Unit and field	Soil	production category[1]	% canopy cover	% Slope	Exposure Category	Acres	(lbs./acre)	Production	Production after slope, canopy and exposure[2]	750 lbs/acre residual[3]	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual	(lbs./acre)	Production	Production including slope, canopy and exposure	750 lbs/acre residual	1000 lbs/acre residual[4]	Remainder w/750 lbs/acre residual	Remainder w/1000lbs/acre residual
Sheep Camp Creek Field D	PcF2 - Perkins loam, 45 to 75 percent slopes, eroded		0 to 25	0 to 25	North East	1.1	2200	2400	2400	1058	1331	1342	1069	1200	1309	1309	949	1222	360	87	1700	1855	1855	1004	1277	851	578
Sheep Camp Creek Field D	PcF2 - Perkins loam, 45 to 75 percent slopes, eroded		0 to 25	0 to 25	South West	0.9	2200	2007	1606	845	1073	761	533	1200	1095	876	772	1000	104	0	1700	1551	1241	808	1036	432	204
Sheep Camp Creek Field D	PcF2 - Perkins loam, 45 to 75 percent slopes, eroded		0 to 25	25+	North East	3.1	2200	6928	5543	2916	3704	2626	1839	1200	3779	3023	2664	3452	359	0	1700	5354	4283	2790	3578	1493	705
Sheep Camp Creek Field D	PcF2 - Perkins loam, 45 to 75 percent slopes, eroded		0 to 25	25+	South West	1.2	2200	2683	1610	1076	1381	534	229	1200	1464	878	1003	1307	0	0	1700	2073	1244	1039	1344	205	0
Sheep Camp Creek Field D	PcF2 - Perkins loam, 45 to 75 percent slopes, eroded		25+	0 to 25	North East	1.9	2200	4143	3314	1744	2215	1571	1100	1200	2260	1808	1593	2064	215	0	1700	3201	2561	1668	2139	893	422
Sheep Camp Creek Field D	PcF2 - Perkins loam, 45 to 75 percent slopes, eroded		25+	25+	North East	27.4	2200	60185	36111	24129	30968	11982	5143	1200	32828	19697	22487	29327	0	0	1700	46507	27904	23308	30147	4596	0
Sheep Camp Creek Field D	PcF2 - Perkins loam, 45 to 75 percent slopes, eroded		25+	25+	South West	3.3	2200	7264	2906	2767	3592	139	0	1200	3962	1585	2635	3460	0	0	1700	5613	2245	2701	3526	0	0
Sheep Camp Creek Field D	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded	upland terraces	0 to 25	0 to 25	North East	19.7	1800	35375	35375	18277	23191	17098	12185	1200	23584	23584	17098	22011	6485	1572	2400	47167	47167	19456	24370	27711	22797
Sheep Camp Creek Field D	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded		0 to 25	0 to 25	South West	52.1	1800	93771	75017	46573	59597	28444	15420	1200	62514	50011	44072	57096	5939	0	2400	125028	100022	49073	62097	50949	37925
Sheep Camp Creek Field D	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded		0 to 25	25+	North East	1.3	1800	2254	1803	1119	1432	684	371	1200	1503	1202	1059	1372	143	0	2400	3005	2404	1180	1493	1225	912
Sheep Camp Creek Field D	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded		0 to 25	25+	South West	4.2	1800	7643	4586	3643	4705	943	0	1200	5095	3057	3490	4552	0	0	2400	10191	6114	3796	4857	2318	1257
Sheep Camp Creek Field D	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded		25+	0 to 25	South West	0.1	1800	257	154	122	158	32	0	1200	171	103	117	153	0	0	2400	342	205	127	163	78	42
Sheep Camp Creek Field D	PoC2 - Positas gravelly loam, 2 to 20 percent slopes, eroded		25+	25+	North East	0.3	1800	501	300	239	308	62	0	1200	334	200	229	298	0	0	2400	668	401	249	318	152	82
Sheep Camp Creek Field D	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		0 to 25	0 to 25	North East	25.7	1800	46216	46216	23878	30297	22338	15919	1200	30810	30810	22338	28756	8473	2054	2400	61621	61621	25419	31837	36202	29783
Sheep Camp Creek Field D	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		0 to 25	0 to 25	South West	37.6	1800	67732	54185	33640	43047	20545	11138	1200	45154	36124	31834	41241	4290	0	2400	90309	72247	35446	44853	36801	27394
Sheep Camp Creek Field D	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded	upland terraces	0 to 25	25+	North East	23.4	1800	42184	33747	20951	26810	12796	6937	1200	28123	22498	19827	25685	2672	0	2400	56246	44996	22076	27935	22920	17061
Sheep Camp Creek Field D	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		0 to 25	25+	South West	39.7	1800	71463	42878	34064	43990	8814	0	1200	47642	28585	32635	42560	0	0	2400	95284	57170	35493	45419	21677	11752
Sheep Camp Creek Field D	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		25+	0 to 25	North East	0.3	1800	558	446	277	355	169	92	1200	372	298	262	340	35	0	2400	744	595	292	369	303	226
Sheep Camp Creek Field D	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		25+	0 to 25	South West	0.4	1800	680	408	324	418	84	0	1200	453	272	310	405	0	0	2400	906	544	338	432	206	112
Sheep Camp Creek Field D	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		25+	25+	North East	3.1	1800	5527	3316	2635	3402	682	0	1200	3685	2211	2524	3292	0	0	2400	7369	4422	2745	3513	1677	909
Sheep Camp Creek Field D	PoE2 - Positas gravelly loam, 20 to 40 percent slopes, eroded		25+	25+	South West	0.4	1800	680	272	310	405	0	0	1200	453	181	301	396	0	0	2400	906	362	319	414	43	0
Sheep Camp Creek Field D	Za - Zamora silt loam, 0 to 4 percent slopes	loamy uplands	0 to 25	0 to 25	North East	0.2	2300	452	452	193	242	260	210	1600	315	315	179	228	136	87	3000	590	590	207	256	384	334
Sheep Camp Creek Field D	Za - Zamora silt loam, 0 to 4 percent slopes		25+	0 to 25	North East	0.1	2300	141	113	57	73	56	40	1600	98	78	54	69	25	9	3000	184	147	61	76	86	71
Sheep Camp Creek Field D	Za - Zamora silt loam, 0 to 4 percent slopes		25+	25+	North East	0.3	2300	755	453	292	374	162	79	1600	525	315	278	360	37	0	3000	985	591	305	387	286	204
Totals						**247.7**			**353211.8**			**132120.8**	**72304.7**			**229020.4**			**29272.2**	**3809.4**			**6656.1**			**211486.9**	**152770.8**

[1] Best estimation from soil survey book (1961) and NCRS website.

[2] Reduction of productivity based on slope, aspect and exposure. Reduction of production by 20% for canopy cover >25%, 20% for slopes >25%, and for south and west facing slopes

[3] After dissapearance RDM and leaving 1000 lbs/acre

[4] After dissapearance RDM and leaving 750 lbs/acre

	Forage Available		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	72305	3809	152771
750 lbs/acre residual	132121	29272	211487

	Stocking Rate		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	90.4	4.8	191.0
750 lbs/acre residual	165.2	36.6	264.4

	# of 1,000 lb. Cattle for 7.5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	12.1	0.6	25.5
750 lbs/acre residual	22.0	4.9	35.2

	# of 1,000 lb. Cattle for 5 mo.		
	Normal	Unfavorable	Favorable
1000lbs/acre residual	18.1	1.0	38.2
750 lbs/acre residual	33.0	7.3	52.9