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Habitat Mitigation and Monitoring Plan

Upper San Mateo Creek
San Mateo County, California

FINAL

October 2010

Prepared for:

San Francisco Public Utilities Commission
1155 Market Street
San Francisco, CA 94103

Agreement No. CS-883D

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San Francisco Public Utilities Commission
Mitigation and Monitoring Plan for the
Upper San Mateo Creek Wetland Creation Project

SFPUC Water Enterprise, Natural Resources and Lands Management staff, are aware of the following Mitigation and Monitoring Plan (Plan) and agree to oversee its implementation as described, including monitoring and reporting, unless otherwise agreed to by the appropriate regulatory resource agencies. Implementation funding, through the contractor's "warranty period", will be provided via the individual Water System Improvement Program project (WSIP) budgets. The SFPUC Water Enterprise, Natural Resources and Lands Management Division, will fund post-warranty implementation to meet site restoration requirements.

10/20/10

Tim Ramirez — Date
Manager, Natural Resources & Lands Management Division

10/20/10

Greg Lyman — Date
WSIP Habitat Compensation Manager, Bureau of Environmental Management

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1.0 INTRODUCTION

1.1 ORGANIZATION OF DOCUMENT

This Mitigation and Monitoring Plan (MMP) describes part of the Habitat Reserve Program (HRP) the San Francisco Public Utilities Commission (SFPUC) will implement to create and enhance habitat within the Peninsula watershed, located in San Mateo County, California (Vicinity Map, Figure 1). The HRP focuses on developing consolidated compensation for the series of projects included in the Water System Improvement Program (WSIP). The MMP follows the SFPUC Guidance for Consultants Preparing Mitigation and Monitoring Plans (April 2009 Review Draft) prepared by May and Associates (2009) and, more generally, the mitigation and monitoring guidance issued by the U.S. Army Corps of Engineers (USACE, 2004), but has been modified and broadened to include site specific factors and upland habitat.

1.2 Responsible Parties

The applicant is the San Francisco Public Utilities Commission, 1145 Market Street, San Francisco CA, 94103. The contact person is Greg Lyman, (415) 554-1601.

This Mitigation and Monitoring Plan was prepared by Winzler & Kelly, 633 Third Street, Eureka CA, 95501. The authors are Ken Mierzwa and Stephanie Klein. The contact person is Misha Schwarz, (707) 443-8326.

2.0 PROJECTS REQUIRING MITIGATION

2.1 Location

The habitats preserved, enhanced, restored and created would be used to compensate for unavoidable impacts from SFPUC projects. This MMP may be referenced in permit applications for SFPUC Water System Improvement Program (WSIP) projects and projects not included in the program. SFPUC projects that may reference habitat improvements at Upper San Mateo Creek include, but are not limited to Lower Crystal Springs Dam Improvements. Table 1 summarizes habitat impacts of WSIP and other SFPUC projects, for which the Upper San Mateo Creek site may serve as compensation.

Table 1 - Water System Improvement Program Projects and Upper San Mateo Creek Benefit

		Seasonal Wetland Established (CRLF breeding, SFGS aquatic habitat) (Acres)	**Riparian – enhanced (CRLF and SFGS dispersal habitat)** (Acres/LF)	**Grassland Established (CRLF and SFGS upland dispersal habitat** (Acres)
Upper San Mateo Creek	**HABITAT AVAILABLE**	**1.13**	**0.11/75**	**3.34**
	Lower Crystal Springs Dam Improvements	**1.13**	0.11/75	0.90
	Future SFPUC Projects	*0*	*0.00*	*2.44*

3.0 PROPOSED MITIGATION SITE

3.1 Location

The Upper San Mateo Creek Wetland Creation Site included in this Mitigation and Monitoring Plan is located approximately 0.7 mile upstream and northwest of Mud Dam. The site is on the east side of Pilarcitos Road, at an elevation of about 700 feet, within the northern portion of the SFPUC Peninsula holdings (Figure 1, Appendix A).

3.2 Selection Process and Ownership Status

The proposed HRP mitigation site was chosen because it includes or is contiguous with examples of plant community types targeted for mitigation, as well as degraded areas with opportunities to create or expand natural community types. Habitat improvement opportunities include the re-establishment of 3.34 acres of valley needlegrass grassland and 1.13 acres of freshwater marsh. The project will enhance 0.1 acres (75 LF) of existing riparian habitat. Invasive species removal or control will be managed within the project boundaries, which are likely to benefit from habitat improvements. The proposed mitigation sites are owned by SFPUC.

3.3 Existing Conditions

The proposed HRP mitigation site is owned and operated by the SFPUC for water supply protection. Existing conditions at Upper San Mateo Creek are described below.

3.3.1 Jurisdictional Areas

A map of jurisdictional wetlands at Upper San Mateo Creek (ESA, 2009) is included as Figure 2, Appendix A. Riparian and freshwater marsh habitats qualify as jurisdictional wetlands or waters. Small areas of wetland are associated with San Mateo Creek, which parallels Pilarcitos Road just outside the project boundary, and with the lower portion of a small tributary drainage running through the central part of the site.

3.3.2 Functions and Values

The proposed mitigation site is within the Peninsula Watershed, which includes Upper Crystal Springs Reservoir, Lower Crystal Springs Reservoir, San Andreas Reservoir, several streams which flow into the reservoirs, and most of SFPUC's holdings in San Mateo County (Vicinity Map, Figure 1). The SFPUC's mission for managing the Peninsula Watershed is to provide the best environment for the production, collection, and storage of the highest quality water for the City and County of San Francisco and other wholesale customers. The SFPUC seeks to accomplish this by developing, implementing, and monitoring a resource management program which addresses all watershed activities. The watershed management program applies best management practices for the protection of water and natural resources and their conservation, enhancement, restoration, and maintenance while balancing financial costs and benefits (SFPUC

2008). Thus, as a part of the SFPUC-managed Peninsula Watershed, water quality protection is a primary function of the Project Area.

Other functions of the proposed mitigation site include habitat for several endangered, threatened or sensitive species. The Upper San Mateo Creek site has suitable habitat for the western leatherwood *(Dirca occidentalis)* a California Native Plant Society rare riparian shrub, with status 1B.2 (CNPS); though this is not a target species and no success criteria is associated with the establishment of this shrub, post project conditions may yield suitable habitat for this rare plant.

The site is also in close proximity to known occurrences of the federally threatened California red-legged frog (*Rana draytonii*), and the federally endangered and state fully protected San Francisco garter snake (*Thamnophis sirtalis tetrataenia*), as these wildlife species have been observed in San Mateo Creek approximately one mile downstream of the action area Once restoration efforts are completed, there is potential for these special status species to move upstream and occupy the enhanced and newly established habitat. The federally endangered Mission blue butterfly (*Icaricia icarioides missionensis*) has been reported just north and south of the wetland establishment area. Lupine, a host plant for the Mission blue butterfly, is present within 700 meters on roadsides north and south of the wetland establishment area and three species of lupine that benefit the Mission blue butterfly are included in the planting plan. An additional listed invertebrate, the San Bruno elfin butterfly (*Callophrys mossii bayensis*) has been recorded less than a mile to the northwest. This butterfly favors rocky outcrops, cliffs in coastal scrub and its host plant is stonecrop (*Sedum spathulifolium*) a dicot, is a perennial herb that is native to California. The San Francisco dusky-footed woodrat (*Neotoma fuscipes annectans*) a California species of special concern, is known to occur within the project site based on observation of nests.

3.3.3 Hydrology and Topography

The Upper San Mateo Creek site is a nearly level area surrounded by steep slopes. San Mateo Creek flows generally north to south, just west of the site and parallel to Pilarcitos Road, crossing under from the west to the east side of the road at a point near the southern limit of the site. Several ephemeral drainages from slopes to the north and east converge within the site, flowing seasonally through a small channel and into a culvert under Pilarcitos Road and emptying into San Mateo Creek.

Existing topography is shown in Figure 3, Appendix A. A hydrological basemap is shown in Figure 4, Appendix A.

Three piezometers were installed in March 2009 through May 2010 to monitor groundwater levels within the site during the spring and summer drying periods. Hourly Rainfall data from the San Andreas Cottage gage station, located approximately 1 mile northeast of the project area, and from the Crystal Springs Cottage gage station, located approximately 7 miles southeast of the project area, was used in this analysis. Because of the proximity of the San Andreas Cottage gage to the project area, rain gage data from the San Andreas Cottage was the preferred data for model calibration and historical hydrology analysis. Surface water monitoring also occurred

where an ephemeral tributary leaves the site and enters a culvert before flowing into San Mateo Creek. A complete hydrology analysis completed in early July of 2010 is included as Appendix C in this report.

3.3.4 Geology and Soils

The HRP Peninsula Region study area is located within the Coast Ranges Geomorphic Province of California. It is situated on the northern and eastern foothills of the Santa Cruz Mountains, Montara Mountain, and within the San Andreas Fault Zone. The active trace of the San Andreas Fault goes directly through the San Andreas and the Upper and Lower Crystal Spring Reservoirs in a northwesterly direction; resulting in a number of ridges, valleys, and streams with the same orientation. Some prominent physical features west of the San Andreas Fault include Fairfield Ridge, Sawyer Ridge, Cahill Ridge, Sweeney Ridge, and Montara Mountain; east of the San Andreas Fault are Buri Buri Ridge and Pulgas Ridge.

Geology

Bedrock within the HRP Peninsula Region consists of sheared and faulted greenstone, sandstone, serpentinite, Franciscan mélange and chert. Most noteworthy for biological resources are areas of serpentinite (a greenish to bluish-gray metamorphic rock high in magnesium and iron). An area of serpentinite extends for approximately 6 miles along the eastern side of Upper and Lower Crystal Springs Reservoir and several narrow strips extend for approximately 2 miles between San Andreas Reservoir and Pilarcitos Lake. West of the San Andreas and Upper and Lower Crystal Springs Reservoirs bedrock consists mostly of sandstone, shale, and conglomerates, with granitic deposits associated with Montara Mountain.

The Upper San Mateo Creek site has been mapped as a narrow elongate slice of greenstone (green to red altered basaltic rocks, pillow lavas, and tuffs) bedrock. The greenstone rocks are bound within a more extensive greywacke (greenish-gray, fine-to coarse-grained sandstone) unit. Thin alluvium deposits associated with San Mateo Creek overlay the eastern portion of the site along the stream and stream bank consisting of poorly to well-sorted sand, silt, silty sand, gravel, and cobbles.

Soils

The soils of the HRP Peninsula Region study area include several associations that are found closely associated with the San Andreas Rift Zone (Soil Conservation Service, 1991). The Soil Survey maps show the majority of the Upper San Mateo Creek site as “Candlestick-Kron-Buriburi complex, 30-75 percent slopes” [Soil Map Unit 110]. A thin strip of “Candlestick variant loam 2 to 15 percent slope” [Soil Map Unit 111] is mapped along Pilarcitos Road on the western border of the project site (Soil Survey Staff, 2009). Soil characteristics are as follows:

- The Candlestick Series consists of moderately deep, well drained loam soils that formed in residuum derived dominantly from sandstone. These soils are found in upland areas of central coastal California that receive coastal fog and are of small extent. Candlestick soils are found on steep to very steep slopes of 30 to 75 percent. These soils are well

drained; rapid to very rapid runoff; and with moderately slow permeability. Depth to a lithic contact is 20 to 40 inches and have an argillic horizon.

- The Kron series consists of shallow, well drained sandy loam soils that formed in material weathered from hard, fractured sandstone. These soils are on upland gently rolling to very steep slopes of 5 to 75 percent. These soils are well drained; medium to very rapid runoff; with moderate permeability. Kron soils differ from the Candlestick Series in that they have a mollic epipedon, are 10 inches or less to a lithic contact, and are loamy-skeletal.

- The Buriburi series consists of moderately deep, well drained gravelly loam soils that formed in material derived dominantly from hard sandstone. These soils are on uplands and have slopes of 30 to 75 percent. These soils are well drained; rapid to very rapid runoff; with moderate permeability. Depth to a lithic contact of sandstone is 20 to 40 inches. Buriburi soils differ from the Candlestick Series in that they lack an argillic horizon.

The Candlestick-Kron-Buriburi complex has the following land management ratings:

- These soils are rated Severe for construction limitations for haul roads and log landings due to slope and low soil strength.

- The erosion hazard for the Soil Complex is Very Severe with a slope erodibility numeric value of 0.95 from off road/off-trail areas after disturbance activities that exposed the soil surface, and is rated severe with a slope erodibility value of 0.95 for soil loss from unsurfaced road/trails. The numeric value indicates gradations between the point at which a soil feature has the greatest negative impact on the specified aspect of forestland management (1.00) and the point at which the soil feature is not a limitation (0.00). The erosion hazard for the Candlestick variant along the existing road to the west is Slight.

- Soil rutting hazard is Severe due to low strength for the hazard of surface rutting through the operation of forestland equipment. Soil displacement and puddling (soil deformation and compaction) may occur simultaneously with rutting.

- These soils are moderately suited for hand planting due to slope.

- These soils are rated Very Limited for aquifer fed excavated ponds due to depth to permanent groundwater. The soil is rated as having various limitations for pond reservoirs due to depth to bedrock, permeability (some seepage), and slopes. Local site-specific groundwater conditions do not appear to be typical of this general landscape-level soil setting; thus, the site-specific hydrology study shall be consulted for design guidance to promote retaining within the proposed wetland.

Three soil boreholes (SP-6a, SP-6b, and SP-6c) were installed within the proposed wetland mitigation area at Upper San Mateo Creek. The soil surface textures observed at the site are

characterized as loam (at soil pits SP-6b and SP-6c) and gravelly clay loam (at soil pit SP-6a) underlain by gravelly clay loam (at soil pits SP-6b and SP-6c) beginning at a depth of approximately 1 to 2 feet bgs. Soil boreholes SP-6a, SP-6b, SP-6c, and piezometers B1, B2, and B3 are shown on Figure 5. Boring logs for soil pits SP-6a, SP-6b, SP-6c, and piezometers B1, B2, and B3 are attached (Appendix D).

3.3.5 Vegetation

The Upper San Mateo Creek site is dominated by stands of Monterey pine *(Pinus radiata*) with a few Monterey cypress *(Cupressus macrocarpa)*, and by dense coastal scrub habitat with coyote brush *(Baccharis pilularis)* and poison oak *(Toxicodendron diversilobum)*. Surrounding slopes support grassland, with a mix of non-native annuals and perennial native bunchgrasses including needlegrass *(Nassella pulchra)*, generally on the shallower and rockier soils. Scrub covers ravines and drainages on the slopes. Small patches of native grasses persist in places within the scrub and pine habitats with California blackberry *(Rubus ursinus)* and few scattered coast live oaks (*Quercus agrifolia*). In the low, central area of the site arroyo willow and patches of Mexican rush *(Juncus mexicanus)* have been reported. Existing plant communities are shown in Figure 6 (ESA + Orion, 2009).

Interpretation of 1864 General Land Office Survey notes indicates that at the time of the survey, the project site was predominantly open and treeless, with scrub present west of San Mateo Creek (See Appendix E for a more detailed evaluation).

3.3.6 Present and Historical Uses of Mitigation Area

The HRP sites are presently maintained as open space within a larger area maintained by SFPUC as part of a water supply watershed. Small roads or trails pass close to the sites. Prior to acquisition by the City of San Francisco some of the sites were used for grazing, light agriculture, or other relatively low-intensity purposes. An overgrown berm is present on part of the east side of Pilarcitos Road within the project site. Two old segments of culvert pipe are present within the site, on the ground surface, and these may possibly be a remnant of past abandoned attempts at site drainage.

3.3.7 Present and Proposed Uses of Adjacent Areas

Adjacent areas are managed as open space and for water supply protection. No changes in land use are proposed.

4.0 CHARACTERISTICS OF REFERENCE SITES

4.1 Location

Reference sites are located within SFPUC Peninsula Watershed holdings, and are shown on Figure 7, Appendix A. Summary descriptions are provided below, and more detailed information is included in Appendix F. Reconnaissance surveys were conducted on December 12, 2008 by

NRM Environmental, with more detailed sampling by Winzler & Kelly on April 7-9 and May 6-7, 2009.

4.2 Selection Process

Potential reference sites for each major community type to be enhanced, restored, or created were initially identified by SFPUC in consultation with NRM and Winzler & Kelly. NRM then conducted rainy season reconnaissance surveys of each site, and produced a technical memorandum which assessed the suitability of each site and provided an overview description of vegetation and topography (NRM, 2008). NRM determined that most of the sites would be suitable reference sites, in the sense that they reasonably represented target conditions for the community type and were in landscape positions relatively similar to that at the HRP sites. NRM suggested seeking out better examples of certain community types, most notably an example of a semi-permanent wetland. As part of expanding reference sites to encompass restoration targets at HRP sites, Winzler & Kelly and Swaim Biological identified more suitable semi-permanent wetland and valley needlegrass grassland sites. Reference sites are briefly described below based on April and May 2009 site visits and preliminary sampling by Winzler & Kelly. A technical memorandum characterizing reference sites in greater detail is included as Appendix F. Reference sites are being used to guide design, and not for success criteria which are instead based on features found on the project sites.

Only reference sites for communities present at Upper San Mateo Creek are discussed below.

4.3 Reference Site Descriptions

4.3.1 Riparian Forest Reference Sites

Two riparian reference sites (R-1 and R-2) were characterized. However, there is only a very small riparian area within the Upper San Mateo Creek site which will not be disturbed, although invasive species removal will occur, and is shown in the final design.

4.3.2 Valley Needlegrass Grassland Reference Site

One reference site (V-1) was selected as representative for valley needlegrass grassland. The site is located south of Highway 92 and west of Upper Crystal Springs Reservoir, along the Adobe Gulch road at the east and west margins of HRP site 37. The site includes level to rolling terrain and small remnant grassland openings within encroaching scrub. This reference site overlaps with Project Site 37; the western sample plot may be partially impacted by brush clearing and thus is most useful for the gathering of baseline (pre-project information). The eastern plot is separated from the Project Site by a narrow unimproved road. During construction, temporary fencing is recommended to avoid any damage to these plots. At the reference site, dominant species include purple needlegrass (*Nassella pulchra*) and California oatgrass (*Danthonia californica*). This site was later classified as coastal terrace prairie, and differs somewhat from many inland grassland sites.

Few good valley needlegrass sites were identified during the search process. Reference Site V-1 will be combined with datasets from earlier studies (URS, 2004) and specifically with several additional sites (VNG-1, 2, and 3), one located less than one mile to the northeast and two sites approximately 2 mile southeast of the Upper San Mateo Creek site for the purposes of design of grasslands.

4.3.3 Seasonal Wetland Reference Site

One reference site (W-2) was selected, a sag pond, located adjacent to Old Cañada Road. The pond was dry in December, and with shallow (about six inches) water present in April and May. The entire pond is densely vegetated and is dominated by spikerush (*Eleocharis* sp.). The southern boundary is dominated by rushes (*Juncus* sp.) and the northern boundary is dominated by wildrye (*Leymus triticoides*). The surrounding upland area includes coast live oak to the west and coyote brush to the east.

Numerous Pacific tree frog (*Pseudacris regilla*) tadpoles and recent metamorphs were observed at this pond on May 6, 2009. This information is important for the design of seasonal wetlands at HRP sites, because successful recruitment of this species is an important factor in ensuring an adequate prey base for juvenile San Francisco garter snakes.

Site W-2 will serve as a reference site for the shallower margins of wetlands at the Upper San Mateo Creek site.

4.3.4 Semi-permanent Pond Reference Site

One reference site was selected for the semi-permanent pond habitat. This site is located south of San Andreas Reservoir, and west-southwest of the terminus of Trousdale Road at Interstate 280. It is immediately adjacent to reference Site S-3. The pond provides habitat for both California red-legged frog and San Francisco garter snake (K. Swaim, pers. comm., and verified in the field by Winzler & Kelly in April and May of 2009). This reference site will serve as a hydrological and vegetation benchmark to help guide wetland design at Upper San Mateo Creek. The reference site pond is not intended to be tied to success criteria; rather it is intended as a resource to document depth and pond duration and plant species composition of known habitat for target sensitive species, and for potential post-construction comparison in the event that adaptive management is required.

5.0 MITIGATION PROPOSAL

5.1 Basis for Design

The goal of the HRP is to develop self-sustaining natural habitats and consolidate compensation for a variety of projects at a few locations to maximize overall habitat functions and values. The consolidation of compensation for several SFPUC projects will allow simultaneous development of multiple natural community types to create functioning ecosystems. At Upper San Mateo Creek, specific goals are to provide mitigation for federally listed species, waters of the U.S. and

waters of the State, and establishment or enhancement for the following habitats: 3.54 acres of native grasslands,0.1acres (75 linear feet) of arroyo willow (*Salix lasiolepis)* riparian scrub, and 0.84acres of wetlands.

The Project intends to re-establish native valley needlegrass grassland and establish wetland habitat. Adjacent existing coastal scrub will be preserved. The post-project site is intended to provide habitat for several protected species including western leatherwood, a rare shrub, the federally threatened and state endangered/fully protected San Francisco garter snake, (SFGS), the federally threatened California red-legged frog, (CRLF), the federally endangered Mission blue butterfly (MBB), and the San Francisco dusky-footed woodrat a state species of special concern,as well as several nesting birds and mammals with California species of special concern status.

Prior to Euro-American settlement these habitat types were more widespread in San Mateo County. Today these habitats are greatly reduced in extent and fragmented by development and successional changes. Nearby best-remaining examples of similar natural communities were identified as reference sites, and served as the basis for mitigation design and development of the planting palette. The design concept is based on construction beginning in 2011.

5.2 Project Goals

An overall goal of the Upper San Mateo Creek project is to consolidate habitat establishment, re-establishment and enhancement activities at one location to mitigate impacts from multiple projects. Specific goals include:

1. Protect and restore native biodiversity, resulting in a net gain of good quality native habitat;
2. Protect and enhance sensitive species and their habitats;
3. Protect, restore, and mimic ecological processes, to the extent practicable;
4. Increase the area of native valley needlegrass grassland;
5. Increase the area of wetland;
6. Increase the area of seasonal inundation;
7. Protect and enhance of arroyo willow riparian habitat

5.3 TARGET HABITATS

Plant community types to be established or enhanced include valley needlegrass grassland, Arroyo willow riparian forest, and freshwater marsh (off-channel semi-permanent wetlands). Riparian and freshwater marsh habitats also qualify as jurisdictional wetlands or waters.

5.4 TARGET SPECIES

The long term goals above have been identified based on an analysis of habitat requirements of the target species, including San Francisco garter snake, California red-legged frog, and Mission blue butterfly; optimal native plant community compositions, essential ecosystem processes to

maintain the habitat and plant communities, and long-term self-sustainability.

The target species were selected because of their federal or state protected or sensitive status, because SFPUC projects elsewhere may impact habitat for these species, and because as sensitive species they serve as indicators of overall community and ecosystem level quality.

Although not specifically targeted for this project site, two state special concern species, the western pond turtle and San Francisco dusky-footed woodrat, are also known to occur nearby and considerations for habitat needs and avoidance of impacts to these species were considered in project design. Woodrat nests have been observed within the project boundary.

The following accounts summarize known habitat needs and other relevant information for the species identified above. Nomenclature follows CDFG (2009).

San Francisco dusky-footed woodrat *Neotoma fuscipes annectans* (State Special Concern)
This subspecies occurs around the southern part of the San Francisco Bay area. Large permanent stick nests are built, often within riparian forest. Related and more widespread subspecies also utilize a variety of upland shrub and woodland community types.

Woodrat nests have been observed within the site in scrub habitat (ESA, 2009; W&K pers. obs. 2010).

San Francisco Garter Snake, *Thamnophis sirtalis tetrataenia* (Federal Threatened, State Endangered, State Fully Protected)
Breeding habitat for the San Francisco garter snake includes "grassy uplands and shallow marshlands with adequate emergent vegetation, and the presence of both Pacific tree frog (*Pseudacris regilla*) and California red-legged frog breeding populations" (USFWS 2006; McGinnis, 1987). A grassland-shrub matrix with an average of one shrub per 20-30 square meters is thought to provide cover from predators as well as open areas for thermoregulation (Barry, 1994). Understory (bunchgrasses or litter) height of at least 20 cm may be a requirement for cover as well (Barry, 1994). Management techniques to maintain open areas may include light grazing.

Burrows of rodents and other small mammals are used as hibernacula (Larsen 1994) and also provide cover at other times of the year (USFWS, 2006). Burrowing mammals also play a role in maintenance of open grassland habitat by moving nitrogen-poor subsoils to the surface, thus encouraging patches of early successional habitat (Stromberg and Griffin, 1996).

Aquatic habitats supporting San Francisco garter snakes typically include areas of emergent vegetation such as cattails (*Typha* spp.), spike rush (*Eleocharis* spp.), and water plantain (*Alisma* spp.); where emergent vegetation is not present, bordering willows (*Salix* spp) may serve as cover (Larsen, 1994; Barry, 1994). Areas of open water may also be important to sustain the tadpole prey base (USFWS, 2006). Studies elsewhere have shown that excessive woody canopy shading of ponds can reduce food availability for tadpoles and eventually lead to local extirpation of some anuran species (Werner and Glennemeier, 1999).

Shallow wetland margins are thought to be an essential habitat component, because San Francisco garter snakes are more efficient at capturing prey in water less than 5 cm deep (Larsen, 1994). Shallow wetland margins also have a greater frequency of suitable basking locations for snakes (Freel and Giorni, 1994).

Removal of non-native trees and creation of additional wetland acreage will both enlarge and improve the quality of onsite habitat for this species by providing greater structural habitat diversity, decreasing shade, and increasing the prey base.

The nearest known occurrence of San Francisco garter snakes from the project site is at Mud Dam, approximately 0.7 miles south of the site (Swaim Biological, 2008). Although not yet documented within the site boundary, reducing the dense shrub canopy and establishing wetland and grassland habitat is likely to encourage dispersal into the area.

California red-legged frog *Rana draytonii* (Federal Threatened)
The California red-legged frog is known to occur at a number of localities throughout the Peninsula holdings, including several locations in San Mateo Creek downstream of the project site. The closest documented reports have been near Mud Dam, about 0.7 miles to the southeast. (ESA, 2009; Swaim Biological, 2008). Proposed wetland establishment will expand available breeding, foraging and dispersal habitat for this species.

California red-legged frogs breed throughout the rainy season (November to April), with the exact timing varying depending on location and elevation (Storer, 1925). Most eggs are reportedly deposited in March; at Homestead Pond, egg masses have been observed on February 19 and March 13 (Swaim, 2008). Eggs are deposited on the surface of the water but attached to emergent vegetation (Hayes and Miyamoto, 1984). The eggs hatch in 6 to 22 days, and the tadpole stage is relatively long at 11 to 20 weeks (Jennings, 1988; Bobzien et al, 2000; Storer, 1925; Wright and Wright, 1949). Even longer intervals in the tadpole stage have been reported, including overwintering tadpoles noted in the East Bay Area (Bobzien et al., 2000).

California red-legged frogs utilize a variety of habitat types at relatively low elevations (usually below 1,000 meters). Breeding may occur in “streams, deep pools, backwaters within streams and creeks, ponds, marshes, sag ponds, dune ponds, and lagoons” (USFWS, 2002). In streams, deeper areas with slow flow and emergent vegetation may be preferred; however streams are subject to variable flow in the spring, and storm flows may pose some risk to eggs or recently hatched tadpoles (USFWS, 2002). During the day, frogs utilizing streams in Marin County tended to be in or near pools more than 0.5 m deep and with root wads, logjams, or overhanging banks; or on the banks up to 2 m from the water, and under dense vegetation (Fellers and Kleeman, 2007). Ponds, both natural and man-made, are also used for breeding. Frogs were observed under deep water, on banks, or in seasonal wetlands under dense vegetation (Fellers and Kleeman, 2007). Jennings and Hayes (1994) noted the importance of shrubby riparian vegetation, such as arroyo willow thickets, as well as cattail and bulrush (*Scirpus* sp.).

Movement through upland habitat is fairly common, and may extend for distances up to at least

1.6 km (1 mile). Fellers and Kleeman (2007) found that in Marin County, some individual frogs remained at or near aquatic breeding sites all year, but that 66 percent of females and 25 percent of males moved through upland habitat. The greatest straight-line distance moved over a season was 1.4 km. Short movements were noted throughout the year, but movements of more than 30 m were often associated with winter rainfall. When longer movements did occur in the dry season, they usually were prompted by the seasonal drying of a water body. Long-distance movements through open grasslands were common, although multi-night movements tended to follow riparian corridors

The California red-legged frog has suffered from "elimination or degradation of habitat from land development and land use activities and habitat invasion by non-native aquatic species" (USFWS, 2002). Specific threats in the Bay Area include habitat loss or fragmentation, predation by introduced bullfrogs, alterations of flow regime or hydrology, mortality resulting from automobile traffic in areas where roads cross dispersal corridors, and spread of chytrid fungus.

Creation of semi-permanent wetland will provide breeding habitat and expansion of grassland habitat will offer additional foraging areas for this species. Removal of non-native trees will reduce partial barriers to distribution by providing new herbaceous cover in areas presently almost barren at ground level.

Mission blue butterfly, *Icaricia (Plebejus) icaroides missionensis (*Federal Endangered)
The mission blue butterfly inhabits grassland (including openings in coastal scrub habitat) and is closely tied to the presence of three species of lupine: *Lupinus albifrons, L. formosus*, and *L. variicolor* (Arnold, 1983). The species is univoltine, with emergence variable and ranging from late March through early June, depending on elevation, aspect, microclimate, and host plant phenology (Arnold, 1983). Eggs are deposited on lupine, and hatch in four to seven days. Diapause extends through the winter, with larvae feeding for up to several weeks in the spring. Adults may be present over as much as an eight-week span.

Arnold (2007) has monitored mission blue butterfly populations at several locations not far to the north of the Upper San Mateo Creek site, and there are recent observations not far to the south along the unimproved road to Mud Dam. Given the known proximity of mission blue butterfly populations (less than one-half mile) natural colonization of suitable created habitat would be likely.

5.5 Target Communities

Because of the habitat requirements of the species discussed above, and existing habitat features at the site the following plant communities and habitat types are targeted for creation and enhancement.

Plant communities and their vegetative classification present at Upper San Mateo Creek are shown in Figure 6, Appendix A. These community types are summarized below along with brief comments on their relative quality and importance for sensitive species. Community classification follows Holland (1986). Relatively degraded habitat quality due to fire

suppression, hydrological alteration (channelization, excavation, increased evapotranspiration), invasion of non-native species (Monterey pine etc.), and other factors currently limits the value of the site. Planned habitat establishment and re-establishment will increase both the area and quality of habitat for sensitive species.

5.5.1 Riparian Fforest

A small area of arroyo willow riparian forest is present along San Mateo Creek just outside the project boundary, and along the lower 75 feet of the ephemeral tributary which bisects the site. The riparian community will not be disturbed by proposed activities; enhancement actions will be through the removal of invasive species, which will provide cumulative benefits to the native flora and fauna, and microbiology of this location. Riparian forests provide important habitat for California red-legged frogs and San Francisco dusky-footed woodrats.

5.5.2 Valley Needlegrass Grassland and Annual Grasslands

Extensive grasslands are present on steep slopes adjacent to the site to the north and east. Grassland habitat will be re-established to buffer the established wetlands, and will be continuous with the existing grasslands but will be on level to very gently sloped terrain, adding diversity to the site. With management to enhance native grassland structure, these can provide important basking and foraging habitat for San Francisco garter snake and California red-legged frog. Planting a variety of lupine species will encourage expansion of existing nearby Mission blue butterfly habitat.

5.5.3 Wetlands

Seasonal ponds, freshwater marshes, and seasonal wetlands provide important habitat for San Francisco garter snake, California red-legged frog, and western pond turtle. Very little (less than 0.1 acre) wetland habitat is currently present on the site; the project proposes to create1.13 acres of freshwater marsh wetland through excavation and berm construction.

Proposed wetland creation is expected to result in a net gain of jurisdictional wetland area, and habitat for sensitive species. Proposed mitigation activities will provide breeding habitat for California red-legged frogs and Pacific tree frogs, and provide foraging habitat for San Francisco garter snakes.

5.6 Design Schedule

The anticipated design schedule is as follows:

January 13, 2010:	Preliminary Draft Mitigation and Monitoring Plan completed.
July 20, 2010:	Draft Mitigation and Monitoring Plan completed.
August 20, 2010:	65% drawings and specifications.
October, 2010:	Final Mitigation and Monitoring Plan completed
October 2010:	95% drawings and specifications, and hydrology technical memorandum.

Fall 2010: Final drawings and specifications.

Construction is expected to begin in the late summer of 2011.

6.0 IMPLEMENTATION

6.1 Site Preparation

6.1.1 Overview

Target creation and re-establishment acreages are identified in Table 2 below for each habitat type. A staging area will be established along Pilarcitos Road in the northwest corner of the project site. Construction access for the northern half of the project site will be directly from the staging area. To avoid impacts to wetlands or drainageways, equipment will need to enter the southern half of the site from the junction of Pilarcitos Road and the unimproved road to Mud Lake, at the southwest corner of the site. Any parking of equipment or stockpiling of materials will occur within the staging area.

The entire 4.48-acre site will be cleared and grubbed, with the exception of a narrow buffer, approximately 20 feet wide, along the existing east to west ephemeral drainageway through the center of the site and a slightly wider existing riparian area along the lower (western) 75-feet of the channel. Two coast live oaks adjacent to this riparian habitat will also be preserved if possible. The riparian area and oaks will be protected with orange exclusion fencing. Pre-construction surveys are recommended for lupine along road shoulders or in other open areas, and if any is found these should also be fenced and protected to avoid any risk of impacts to the Mission blue butterfly. Existing power lines along Pilarcitos Road will also need to be avoided during construction activity.

Monterey pine and Monterey cypress in two stands within the site will be cut and removed, with the exception of two pines in the northeast part of the site. These trees will be girdled and left standing to provide snag habitat. Most areas of scrub habitat within the project footprint will also be removed. Before removing any trees (especially large ones) they should be surveyed to ensure no adverse impacts will occur to wildlife, or avian species that may be using the trees. Loose bark and cavities within trees should be carefully evaluated. Trees and shrubs will be mechanically removed and chipped. The chipped material from the pines will be used during the revegetation phase of impacted areas or disposed of at an alternate location. Poison oak and coyote brush are the dominant shrubs to be mechanically removed. Though the coyote brush can be chipped and used on site for revegetation, it may be difficult to partition the poison oak which is not recommended for revegetation. Therefore the shrubs will need to be chipped and hauled off site. Additional invasive species in the understory will be identified and removed appropriately.

Approximately 1.13 acres of freshwater marsh will be established by excavating a pair of basins on both sides of the existing channel. The marsh will be fed by a seasonally high groundwater table, by runoff from adjacent slopes, and by overflow from the central channel controlled by

elevation of bordering ground. Based on the calibrated HEC-HMS model for the 2009/2010 rainy season, there are approximately 80 acre-feet of available runoff to support the proposed wetland. The area and depth of the proposed wetlands maximizes the 1-acre (4 acre-feet) of created seasonal wetlands required for mitigation and minimizes the volume of water diverted. Material excavated from wetland basins as well as existing spoil piles near Pilarcitos Road will be graded to create a berm parallel to the road. Excess soil material will be hauled off site.

The wetlands will be replanted with a native hydrophytic plant palette, and adjacent areas will be planted as native needlegrass grassland. There is a narrow band along the northeastern portion of both wetlands where two habitat patches overlap creating a transitional ecotone; both wetland plants and needlegrass grassland plants are specified for this area. There will be a gradual transition between the two habitat types allowing vegetation to take hold where its requirements are best met. The ecotone approach will provide additional complexity to the site, as the edges of habitat communities are known to contain high levels of biodiversity. Some species will be able to tolerate both habitat patches and the transition zone, while some species may be only adapted to the transition zone. In this area, both the grassland and wetland planting zones will be applied to this area. Planting details are included in Sections 6.2 and 6.3, Table 4, and Figure 11, Appendix A.

A grading plan and cross sections are shown on Figures 8A-8C. Acreages of created and enhanced, and re-established plant communities are shown below in Table 2.

Table 2 – Upper San Mateo Creek Existing and Post-Project Habitat

	Pre-project	Pre-project	Post-project	Post-project
	Area (acres)	Distance (LF)	Area (acres)	Distance (LF)
Coastal scrub	1.6	-	-	
Valley needlegrass grasslands – re-established	0.47	-	3.34	-
Wetlands – established	-	-	1.13	-
Monterey pine	2.31	-	-	-
arroyo willow riparian - enhanced	0.1	75	0.1	75
TOTAL	4.48	75	4.48	75

The project will include the specific implementing components described below.

6.1.2 Native Species Protections and Exclusions

To minimize effects on desirable habitats and species, avoidance measures will be implemented. Temporary access lanes and staging areas will be identified, and equipment movement will be restricted to these areas.

Grading limits will be clearly defined and identified to prevent damage to existing wetlands, riparian forest, or adjacent good quality upland habitat. Exclusion fencing will be installed. There are no known rare plants on this site; however, a spring 2011 floral survey should be conducted on the site and within close proximity of disturbance areas as an extra precautionary measure to ensure avoidance of rare plants that may not have been picked up in previous surveys or for plants that may not have been identifiable at the time of the last rare plant survey. Access routes for equipment will be limited to upland areas. The area of excavation (about 1.08 acres) is expected to be limited to the central part of the site. Excavated material will be moved a very short distance to the western edge of the site and used to raise or build a berm parallel to Pilarcitos Road, although some excess material may need to be hauled offsite. The total area of disturbance is expected to be about 4.48 acres, including tree and shrub removal, staging, disturbance associated with wetland excavation, and re-establishment and grassland and enhancement of riparian habitat.

Native trees, especially two small coast live oaks near the western limit of the work area, will be protected during tree and shrub removal. Impacts to native bunchgrass grassland will be minimized, although some limited disturbance is likely near the edges of the site. Temporary impacts will be mitigated through restoration activities including revegetation with native species. The temporary loss of habitat will be compensated by reducing the amount of habitat credit available to compensate other SFPUC projects. Anticipated limits of ground disturbance are shown in Figure 10, Appendix A.

A construction monitor shall be on site during excavation, grading and tree removal, and any other activities which include use of equipment or ground disturbance. The monitor shall be experienced with protected species known to occur or potentially present on site (including San Francisco garter snake, California red-legged frog, and Mission blue butterfly).

6.1.3 Grading

Existing hydrology and drainage patterns, as well as the presence of an ephemeral channel and endangered species habitat, will restrict grading for wetland creation. Excavation and grading is proposed along both sides of the existing ephemeral channel, leaving a narrow 20 foot buffer to avoid impacts to the stream. Grading on grassland re-establishment areas will be limited to repair of any damage from tree removal, clearing and grubbing. Equipment will enter on Pilarcitos Road into a staging area at the northwest corner of the site. Access to areas south of the ephemeral channel will be via a short segment of the unimproved road to Mud Dam, then into the area now dominated by Monterey pine at the southern end of the site. Excavated material will be reused on site to raise and build a berm, not more than 3 feet high to avoid inhibiting wildlife movement, along the western edge of the site (see section 6.1.4, below).

The berm feature increases landscape heterogeneity and habitat structure by adding different micro-elevations on the site which inherently adds microclimate and diversity due to the influence of aspect, solar gain on the west-facing slope, flow of energy and nutrients, microbiology and changes in sub-surface soils moisture availability. The berm will be relatively low, especially in the context of nearby steep terrain, and will add a drier native grassland

element to the planting area (see Planting Plan for species to be planted on the berm). This will increase diversity and potentially offer basking sites for SFGS. The berm will be low and gradual enough to have a relatively natural appearance. The berm will be planted with a native erosion control grass seed mix including species typical of native grasslands on nearby slopes.

Grading of the new wetland basins will include a steep (2:1) slope on the western edge, and a more gradual 6:1 slope on the remaining sides, to mimic known red-legged frog breeding ponds including the reference site. A grading plan and cross sections are included as Figure 8A-8C.

6.1.4 Soil Disposal

Soil excavated to create the seasonal wetland will be moved to the western edge of the site and spread to lengthen and create a berm along the western and southern wetland margins. Soil disposal will avoid existing power lines along Pilarcitos Road. Material will be graded to a consistent height and even slopes, as nearly as practical. The berm is expected to be approximately 3 feet higher than surrounding upland terrain after grading, to and will increase the complexity and landscape diversity of the site. Reuse of the material onsite will minimize construction time and expense, and will reduce the need for truck trips to haul material although some off-site disposal may be necessary. Once the berm is graded, it will be planted with an erosion control blanket or seed mix.

Although local grading may be necessary in selected locations to repair damage associated with tree removal or construction staging, no other soil disposal is anticipated.

6.1.4 Soil Treatment

Soil fertility samples were collected at three locations at the project site (Figure 5). Three subsample locations were selected in the area proposed for wetland mitigation. The surface subsamples at soil borings SP-6a, SP-6b, SP-6c were composited at a 3:1 ratio for laboratory analysis. Subsurface samples were collected from the total depth of the soil auger holes at test pits SP-6b and SP-6c at 24-30 inches depth, and composited at a 2:1 ratio.

The following recommendations are provided for consideration during the design and implementation of proposed site activities. Soil fertility guidelines at soil borehole SP-6(24) for the subsurface soil to support wetland plants, suggests amending the soil with up to 70 pounds per 1,000 square feet of lime. The fertility guidelines also recommend adding a light application of nitrogen/phosphorus/potassium fertilizer, although notes that the organic content of the soils should have a beneficial effect on soil pH and plant growth. Fertilization is not recommended for this site as it could stimulate invasive species and shrubs as well. The application of amendments may affect the pH of the water, cause eutriphocation, and nutrients could move offsite due to water movement. Native wetland plants should be tolerant of local soil conditions. Adaptive management should be used to determine if particular nutrients are inhibiting plant growth, to be evaluated during the annual monitoring. Plant tissue analysis is the most accurate method for determining site-specific and species-specific soil requirements.

Based on results and interpretation of these samples, no soil fertility treatment is recommended for project site soils. Soil fertility results are summarized in a Tech Memo (Winzler & Kelly, July 11, 2010), which is provided along with laboratory analytical results in Appendix D.

6.1.6 Water Supply and Irrigation

Soil should be moistened before plant installation begins, either from rainfall or human procedures. Plantings of tree, shrub, and perennial species should receive a deep watering at time of installation (approximately 10 gallons per individual plant with root ball). Plantings should be irrigated for 24 hours after initial planting if natural rainfall is not imminent. Areas seeded with seed mixes should receive a gentle watering at time of installation. No need for supplemental irrigation is anticipated after planting since there will be no tree plantings at this site.

6.1.7 Invasive Plant and Undesirable Native Species Plant Control

6.1.7.1 Target Invasive Plant Species

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

Target species for non-aquatic, upland habitats 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 those species that are rated as high or moderate by the Cal-IPC lists in the future, but that are considered to rarely appear in monotypic stands, to have low/minor impacts in our region.

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
Brassica nigra	black mustard	Moderate	N	Widespread. Primarily a weed of disturbed sites, but can be locally a more significant problem in wildlands.
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

6.1.7.2 Invasive Plant and Undesirable Native Species Removal Strategies

Invasive species and undesirable native plant control will be necessary prior to project implementation and should be planned ahead of time and started prior to anticipated initial planting, but will also be required post-project for long term management of the site. Invasive or non-native plants currently present on the site that will need to be removed pre-construction include poison hemlock (*Conium maculatum*), teasel (*Dipsacus* sp.), and velvetgrass (*Holcus lanatus*).

The following plants are native to California, but not to the Upper San Mateo Creek site or needs to be managed to promote grassland habitats: Monterey cypress (*Cupressus macrocarpa*), Monterey pine (*Pinus radiata*), coyote brush *(Baccharis pilularis)*, and poison oak (*Toxicodendron diversilobum*). These pioneer trees and shrubs are undesired native plant species intruding on native grassland habitats in this region. The following management tools will be adequate to address both non-native and native undesirable species that are found during project implementation. It is likely that at least a few additional invasive species will be identified during pre-construction surveys.

Many of the invasive species are concentrated on the existing berm near the western edge of the site. Aggressive intervention in this area of disturbed vegetation could show considerable progress in a very short period of time. Considering the proximity to water on this site, mechanical removal, including hand clearing/pulling, mowing or goat grazing, will be the dominant methods of control, and prioritization of methods should follow this sequence. Chemical control should be a last result and only used in the scrub habitat on coyote brush and poison oak. See Chemical methods below for more description.

Below several strategies are described that could assist to address the issue of undesirable plant species at the project site, both before initial planting as well as during the monitoring phase. In many cases, multiple strategies combined will be most effective in eliminating specific unwanted species from the project site, and in all cases monitoring and adaptive management will be key to long-term success of the restored habitats and elimination of invasive species. Once the native target species are established, it is anticipated that they will out-compete the invasive species. After the general strategies discussion below for invasive control, individual invasive species

known to occur at the project site are addressed in the context of which strategy(s) should be considered for feasible elimination of that species. Seasonal control methods and timing may conflict with some species, and care should be taken when evaluating particular methods for more than one species. For example, mowing may favor one species if done is the spring versus eliminating another species if done during the same timeframe. A combination of strategies, in site specific locations, pertaining to individual species will yield the highest success of controlling invasive and undesirable plants on the site.

Hand Removal: The advantages of hand pulling include low ecological impact, minimal damage to neighboring plants, and low cost for equipment or supplies. Pulling is extremely labor intensive, however, and is effective only for relatively small areas, even when abundant volunteer labor is available. Weed wrenches and other tools can be used to remove large sapling and shrubs that are too big to be pulled by hand. To minimize soil disturbance, soil should be replaced to disturbed areas. Trampled and disturbed areas can provide optimal germination sites for additional weeds, and replanting and use of seed mixes and/or erosion control mix is important.

Mechanical: Clearing and Grubbing is recommended for large infestations of cultivated trees and rapidly encroaching shrubs in the grassland areas. Mechanical brush control, clearing, grubbing and grading using mechanical equipment can remove dense patches of undesired plant species. Chipping is recommended for mulching on site from those species that will not reproduce by fragments, such as Monterey pine and Monterey cypress. Some native plants such as poison oak and coyote brush are able to reproduce when roots or stumps are left in the soil requiring grubbing below the surface and removal of the root ball for these species to be controlled. Shearing may also be an effective technique to reduce plants that do not resprout, and occur in small isolated patches. Girdling a tree is a method that will kill the undesired tree, yet the specimen will remain erect and standing for wildlife habitat value.

Mowing: Where grazing is not practical, mowing is sometimes used as a surrogate method of maintaining open grassland structure, as is practiced at nearby Edgewood Park (Friends of Edgewood Natural Preserve, 2008). Mowers can be used on a routine basis to weed around the riparian plantings, woodland, and wetland mitigation site, as needed. The weed management should be done in late summer until riparian plants are established. Stakes and mulch collars would help to keep the weeds and mowers away from the plants. Machinery should not be used at the site during wet conditions. Mowing is difficult on steep, rough, and varied terrain. Height and timing of mowing should be planned to avoid impacts to sensitive species.

Goat Grazing: Light grazing can be a mechanism to maintain open communities and eliminate invasive species, although overgrazing can result in damage including soil erosion. Overgrazing can be prevented with fencing and rotational grazing.

By itself, grazing may not be effective in completely eradicating invasive plants. When combined with other treatment control technique(s), such as hand pulling and mowing, severe infestations can be reduced and small infestations may be eliminated. Grazing on this site is particularly appropriate because herbicide application is not a desired option due to the close

proximity of water on this site. Precautions should be made to not spread invasive seeds as animals are moved from pasture to pasture.

Grazing during seed or flower production can be especially useful at damaging the invasive species without significantly impacting the desired native species. It should be noted though that some species such as cheatgrass (*Bromus tectorum*) will become unpalatable once seeding begins due to stiff awns on the flower. Goats prefer broadleaf herbs and can stand on hind legs to reach higher and as well tend to graze on a wider range of weedy species. Another consideration is availability of the animals for rent or purchase and transportation to the project site. Temporary fencing would be needed to manage animals within plots if grazing is utilized.

Grazing of goats was successfully utilized for the Skagit River Restoration project in the state of Washington, by The Nature Conservancy, where the particularly tough terrain and nature of the site as a restoration project were the main concerns driving invasive species removal methods. The five acre site used 30 goats (moms and kids) rented from Akyla Farms, for a five week period in the early summer, to manage an eight-foot high bramble of blackberries that was pervasive across the project site. Planting of native species was conducted in the fall after the goats were removed and prior to the rainy season.

The goats should be penned for at least 3 days and fed alfalfa without seeds prior to being transported on site to ensure no additional invasives will be brought on site as a result of their presence. At the Upper San Mateo Creek site, use of grazing would likely require exclusion fencing for sensitive habitat areas. California Grazing is one company in the area that could assist in this option.

Chemical Control/Herbicides:

To comply with City of San Francisco requirements for City owned property, use of pesticides (including insecticides, herbicides/weed-killers, fungicides, rodenticides) should be employed as a method of last resort for pest removal, and only after exploring all applicable non-chemical options. Only products listed on the San Francisco Reduced-Risk Pesticide List (RRPL) (*http://www.SFEnvironment.org/ipmchecklist*) in table 3 below, may be used on City-owned properties (SF Environment Code, Chapter 3), and must be used in a manner consistent with limitations described on the RRPL and the US EPA label. Herbicides listed on the 2009 RRPL that may have use at the project site for invasive species removal are summarized in the table below (Year 2011 list should be consulted when published prior to project implementation), and precautions for use in California red-legged frog habitat are noted in the "Limitations / Notes" column. One herbicide that is not yet on the list but may be an option for this site on jubata grass is the potential use of impazapyr, which is currently being tested on controlled pilot plots on jubata grass on SFPUC lands as part of their herbicide resistance management program (SFDEP, 2010).

Herbicides have many methods of application, including, wicking. This technique uses herbicide contained in a reservoir and hand held wick applicators, which whips a concentrated solution on the tops of weeds, while leaving the shorter annuals unaltered. Spot application is another

technique and can be applied with a backpack sprayer. Basal bark treatments are good for woody invaders such as poison oak, coyote brush, French broom and larger individuals of pampas grass. This treatment can be applied any time of year using a sprayer or wiping the basal parts of bush stems. Painting herbicides with a paint brush for sensitive areas has also proven to be effective without adversely affecting adjacent vegetation or sensitive habitats. A basal stem application has proven effective for coyote brush, and stump application has proven effective for poison oak infestation.

If deemed necessary to apply herbicides for site preparation, maintenance, or adaptive management near or around the wetlands and riparian habitats, Aqua master is a nonselective herbicide approved for aquatic applications to control emergent vegetation. Once the active ingredient (glyphosate) makes contact with water, it becomes deactivated; therefore only the vegetation on or above the water is impacted. This herbicide has best results when Activator 90 surfactant, or a similar nonionic surfactant, is added to the mixture. Aquamaster can be applied by spray, cut stump, and with injections. This herbicide is used to control emergent or floating plants, in or along banks, active ingredient glyphosate has been manufactured to be used in wetlands, due to the low oral toxicity to human and animals. Rodeo, or Aqua Master, is the recommend product of glyphosate to be used on the Upper San Mateo Creek project boundary. Rodeo is superior to Round-up in this context as it does not contain surfactants that both Roundup Pro and Roundup Ultra have.

Given the City's direction to consider other feasible options first before defaulting to herbicide use, other strategies discussed below could be utilized as initial procedures to knock down the dominant invasive plants in advance of planting. Subsequent applications of herbicides and/or strategies discussed below may be employed as part of an adaptive management strategy. Herbicides will be hand painted on stems or stumps or injected, when used, near wetland, riparian areas, and areas of special concern.

Table 3. Herbicides Approved for Specific Use

Product and Type	Ingredients	Limitations / Notes
Aqua- master (equivalent to Rodeo) --herbicide in water	glyphosate, isopropylamine salt 53.8%	May damage non-target plants. Use for emergent plants in ponds, lakes, drainage canals, and areas around water or within watershed areas. Only as a last resort when other management practices are ineffective. NOTE: Equivalent to "Rodeo Emerged Aquatic Weed and Brush Herbicide," an older product. Rodeo in storage may be used under the same limitations. Note prohibition on use within buffer zone (generally 60 feet) around water bodies in red-legged frog habitat.
CMR Silicone Surfactant --adjuvant	polymethylsiloxane, nonionic	Use other alternatives pending new review of siloxanes
Eco Exempt HC --herbicide	eugenol (clove oil) 21.4%; 2-phenethylpropionate 21.4%	Do not use in enclosed areas.
EZject Selective Injection --herbicide	glyphosate, isopropylamine salt 83.5%	Tree stump injection especially where resprouting is likely, prefer mechanical methods when possible

Garlon 4 --herbicide	triclopyr, butoxyethylester 61.6%; nonpetroleumbased methylated seed oils	Use only for targeted treatments of invasive exotics via dabbing or injection.
Garlon 4 Ultra --herbicide	triclopyr, butoxyethyl ester 60.45%	Use only for targeted treatments of invasive exotics via dabbing or injection.
Milestone --herbicide	Aminopyralid, triisopropanolamin e salt (5928) 40.6%	For invasive species in natural areas where other alternatives are ineffective, especially for invasive legumes and composites such as yellow star thistle and purple star thistle. *Listed as Tier I due to persistence but toxicity & potential exposure are very low.*
Roundup Pro --herbicide	glyphosate, isopropylamine salt 41%	Spot application of areas inaccessible or too dangerous for hand methods, right of ways, utility access, or fire prevention. Use for cracks in hardscape, decomposed granite and edging only as last resort. OK for rennovations but must put in place weed prevention measures. Note prohibition on use within buffer zone (generally 60 feet) around water bodies in red-legged frog habitat.
Roundup ProDry --herbicide	glyphosate, ammonium salt 71.4%	Same limitations as Roundup Ultra
Sonar A.S. --herbicide in water	fluridone 41.7%	Emergent plants in ponds, lakes, drainage canals. Only as a last resort when other mgmt. practices are ineffective.
Turflon Ester --herbicide	triclopyr, butoxyethyl ester 61.6%	Targeted treatment of turf; broadcast application requires exemption. Note prohibition on use within buffer zone (generally 60 feet) around water bodies in red-legged frog habitat.
Source: San Francisco, City of, 2009. *SF Reduced Risk Pesticide List*. City Department of the Environment. http://www.sfenvironment.org/. April 13, 2009.		

6.1.7.2 Invasive Species and Undesirable Native Species Descriptions

The following non-native invasive species known to occur at the project site will be discussed individually: wild oats (*Avena fatua*), slender oats (*Avena barbata*), poison hemlock (*Conium maculatum*), teasel (*Dipsacus* sp.), and velvetgrass (*Holcus lanatus*).

Slender oats (*Avena barbata*) and wild oats (*Avena fatua*): This species is a cool season annual found in grasslands, oak savanna, and many other habitats. This plant reproduces by seed near the plant and seeds are transported further away by animals, and humans.

- *Mechanical:* Mulching can be a very effective measure at suppressing this species. Mowing before the grass sets seed is also effective.
- *Grazing:* For the grass species, grazing in advance of native plantings could be highly effective in providing an initial reduction in this species.
- *Chemical:* Applying either or both pre and post emergent herbicide as discussed for other species will also be effecting at controlling this annual grass.

A strategy that employs multiple methods as well as monitoring and adaptive management will be key in long-term success of the target habitat where this plant is currently found. For the grass species, grazing in advance of native plantings could be highly effective in providing an initial

reduction in this species. Implementing invasive species control methods in advance of the planting schedule is recommended.

Poison hemlock (*Conium maculatum*): Poison hemlock is a plant that has the ability to spread rapidly in a wide variety of settings from roadsides, to open meadow, fields and pastures, to more mesic habitats of riparian and floodplain habitats. This species does particularly well after a good rain in cleared or disturbed areas. This plant is poisonous to humans, and wildlife - including vertebrates and livestock. Poison hemlock has a long temporal window for seed dispersal from September thru December and some remaining seeds dispersed in February (California Invasive Plant Council, 2009).

- *Mechanical:* Multiple mowing efforts have been effective at controlling this species if timed correctly. Spring mowing is encouraged, with a follow up mowing in the late summer to kill the regrowth of some individuals and new seedling establishment. Lastly, a third mowing should take place in year three after initial control has started due to the seed bank staying viable for up to three years.
- *Manual:* Hand pulling is an effective method of controlling this biennial herbaceous plant. The best time to hand pull is when the soil is moist and prior to the plant setting seed. The reproductive parts of the plant occur after the first year of germination in mid-April with the seed being completely developed by mid-June. Follow up pulling is necessary to eliminate remaining and subsequent growth. The roots do not need to be grubbed.

Teasel (Dipsacus sativus): This is a biennial perennial herbaceous plant that blooms between July and October. This plant can be found in mesic to xeric habitat. This plant species produces 2000 seeds, of which 30-80% will germinate with seeds staying viable for up to two years. The seedlings are typically found close to the parent plant, though it can be dispersed by water increasing its range (Wisconsin Department of Natural Resources, 2004).

- *Mechanical:* Cutting and/or digging are thought to be the best solution to remove this plant. Using a simple hand removal weed tool, such as a dandelion digger. The entire root should be removed to ensure no resprouting will occur from root fragments. If a shaor spade is used, be cautious to not fragment the root. Another option is to cut the stalk before it before the full bud stage inducing mortality of the specimen, and the plant should not reflower. In both situations the plant parts should be removed from the site. If the plant has been cut and the flowering stalk is left behind it seeds may still be able to mature after cutting.

Velvetgrass (*Holcus lanatus*) and smooth catsear (*Hypochaeris glabra):* Velvet grass is a perennial coastal grass that grows in clumps up to two feet tall with a fibrous root system. The inflorescence of this plant can be up to three feet tall, and begins seed production by year two, blooming in May through August. The seeds are wind dispersed and have the ability to germinate quickly. The plant also produces tillers allowing the plant to reproduce by vegetative means. This plant tends to produce a lot of seeds that germinate quickly, and grow rapidly making this an undesirable grass. For invasive grass species and other non-native annuals, grazing in advance of native plantings could be highly effective in providing an initial reduction

in this species. Implementing invasive species control methods in advance of the planting schedule is recommended.

- *Mechanical:* For small isolated patches it is possible to remove the clump of grass by hand before the seed sets. The plant can also be removed by cutting at the base with a paring knife. This is most successful during the winter rainy season from January through April. Weed whacking then scraping is another method used to control the grass before the seed set. Chopping below the root crown using a blade or McLeod is another option. Cutting patches of the grass in the spring followed by mulching with 4-6 inches of onsite material has been used to suppress resprouts in small areas. Follow up treatments are necessary for all hand methods.
- *Disposal:* The plant material should be bagged and disposed of offsite.

6.1.7.3 Native Species Plant Control

The following plants are native to California, but not to the Upper San Mateo Creek site or grassland habitats: coyote brush *(Baccharis pilularis)*, Monterey cypress (*Cupressus macrocarpa*), Monterey pine (*Pinus radiata*), and poison oak (*Toxicodendron diversilobum*). Though these plants are native to California they tend to alter the nutrient and hydrology cycle when they go beyond their range into grassland and prairie habitats. A combination of techniques will yield the most successful reduction of these species. These trees and shrubs and their control methods are discussed individually below.

Coyote brush *(Baccharis pilularis):* Coyote brush is a perennial, evergreen shrub native to California where it is found in northern coastal scrub, foothill woodlands, mixed evergreen forest, and coastal stands communities. This plant typically blooms from August to September. As a result of decreased burning and grazing this plant has become intrusive to native grassland ecosystems.

- *Mechanical:* Mechanical removal of this shrub will likely be the next best method for removing the shrub from this site. Wood should be cut and dried prior to removal for burning. Small material may be composted on site. It is not recommended to chip this material do to the poisonous nature of the material and for its ability to reproduce from root fragments.
- *Chemical*: For coyote brush, glyphosate or Triclopyr applied as a basal stem application has been an effective treatment. It is recommended on this site to use Triclopyr, which has a wider treatment window and can be applied as a 25% basal bark application in an oil carrier after cutting older plants.

Monterey cypress *(Cupressus macrocarpa):* Monterey cypress is a native tree to the Monterey Watershed in California, but not the Peninsula watershed. This tree was previously planted in the Peninsula Watershed as an ornamental landscape plant, for windbreaks, and for erosion control. This evergreen tree has the ability to change the ph in soil and has started to out-compete native flora and coastal vegetation types, including northern coastal scrub, coastal prairie, riparian scrub, woodland, and forest. This tree can create a large canopy contributing to a high cover

throughout the project region and as a result has a sparse understory where it is found. The seeds can last up to 4 years in the cones before they hit the ground. A majority of the infestation is patchy in the project area, where seedlings are found next to the adult tree and cultivated stands. The cypress tree does not regrow from the stump or resprout allowing for manual and mechanical removal of this species to be sufficient. Follow-up monitoring is appropriate to ensure that new seedling emergence is removed as quickly as possible.

- *Mechanical:* Mechanical removal of this tree will likely be the most effective method. Wood may be cut, dried or chipped prior to removal for burning. Small material may be composted on site. Two trees will be girdled and left standing to provide habitat structure.
- *Manual:* For small specimens, seedlings and as a follow-up treatment of this plant, manual pulling is the best method to remove this undesired tree and reduce soil disturbance.

Monterey pine (*Pinus radiate):* Monterey pine is an evergreen tree native in only three places within California. This was once a cultivated tree in California where these source populations have escaped from areas of cultivation and now threaten other sensitive habitat types. This species was previously planted within the Peninsula Watershed where it is currently found in monotypic stands outcompeting native flora in this region. The tree has the ability to augment the ph of soils where it is found. This tree is commonly found to be associated with coast live oak woodlands, northern coastal scrub, northern coyote brush scrub, and serpentine grassland environments which are of interest to this MMP. Approximately 134 data points of this species have been mapped within the watershed by Nomad Ecology, and it is considered to be a widespread issue. This plant tends to support a native understory and caution should be taken when removing individuals from the project area. This tree does not resprout after cutting; therefore manual and mechanical removal of this species is recommended for full eradication and control of this plant. In order to achieve full eradication of this species within the project area, follow-up monitoring for seedlings is encouraged throughout the monitoring timeframe of the project.

- *Mechanical:* Mechanical removal of this tree will likely be the most effective method. Wood may be cut, dried or chipped prior to removal for burning. Small material may be composted on site.
- *Manual:* For small specimens, seedlings and as a follow-up treatment of this plant, manual pulling is the best method to remove this undesired tree and reduce soil disturbance.

Poison oak *(Toxicodendron diversilobum):* Poison oak is a native deciduous shrub to California. This plant is common in riparian environments where it can tolerate shade. It can grow as a vine and use adventitious roots for climbing nearby shrubs and trees; in more open environments such as the coastal grasslands it can take the form of a dense shrub thicket. This plant cannot be killed by cutting, as it has a strong root system and requires the termination and removal of the entire specimen to control or eradicate it from a specific location.

- *Grazing:* Intensive goat grazing has been used to control poison oak and is the main recommendation for controlling this species. Goats are most effective in controlling regrowth following initial control strategies. Goat grazing may be difficult if trying to reestablish natives during the control process since goats will also likely browse the native plants. Goats confined to a small area can help control stands of young shrubs or young re-growth from cut shrubs (Food and Agriculture, CA Department of, 2009). Grazing is also encouraged before a prescribed burn to reduce fuel and thatch.
- *Mechanical:* Mechanical removal of this shrub will likely be the next best method for removing the shrub from this site. Wood should be cut and dried prior to removal for burning. Small material may be composted on site. It is not recommended to chip this material due to the poisonous nature of the material and for its ability to reproduce from root fragments.
- *Manual:* For small specimens, seedlings and as a follow-up treatment of this plant, manual pulling is the best method to remove the undesired shrub and reduce soil disturbance.
- *Chemical:* Stump application can be effective at controlling these species during active times of growth. Immediately after cutting the shrub 2 inches above the ground surface, apply the stump with either glyphosate or triclopyr using a point brush. Basal applications are also effective at controlling this plant and this method can be utilized any time of year. Applying the chemical to 6-12 inches of the basal section is adequate coverage (DiTomaso, 2009).

6.1.7.4 Equipment Sanitation

After the initial invasive species management has taken place it is imperative that machinery be cleaned and inspected for soil and debris. Excavation and earth moving equipment can become contaminated with invasive seed stock. The machinery should be cleaned in an upland area near the areas where invasives were removed. The equipment should be cleaned with a mobile pressure washer in the upland staging and stockpile area. This area will be quickly covered after the construction activities have been terminated with either quick growing erosion control seed mix or covered with an erosion control fabric. The purpose is to prevent unwanted seed stock or propagules from entering unaffected areas, or areas where removal has occurred. Furthermore, this prevents unwanted herbicide (if used) from entering natural areas.

6.1.7.5 Waste Material Removal

Waste material cut from some invasive species including periwinkle and thistle needs to be removed from the site by hand where practical, by placing waste in plastic bags or tarps, to prevent rerouting and seeding of waste material. Waste material should be burned, composted on site, or disposed of in a landfill.

6.2 Planting Material

6.2.1 Plant Species List

A detailed planting plan, broken down by community type, is presented in Table 3. The preliminary list is based on surveys at the project site and at nearby reference sites.

Table 4 - Planting Plan

Table 4: Planting Plan (Approximate Quantities)

			PLANTING ZONE			A	B		↔ (See Figure 12)
			Recommended Minimum PLS[7]	Seeds per/lb	Seed % of Mix	**Grassland Re-establish**	**Wetland Created**	**Erosion Control**	**Notes**
Upper San Mateo Creek		**Planting Acreage**				**3.34**	**1.13**	**0.5** [8]	
Wetland Marsh	*Salix lasiolepis* [1]	arroyo willow					20		
	Scirpus acutus [2]	Bulrush					350		
	Juncus effusus [2]	common rush					350		
	Juncus patens [2]	spreading rush					350		
	Carex barbarae [2]	Santa Barbara sedge					350		
	Eleocharis macrostachys [2]	common spikerush					350		
Valley Grassland[3]	*Bromus carinatus*	California brome	70	100,000	25%	14 lbs			5 lbs/ac
	Danthonia californica	California oatgrass	UNK	40,000	25%	14 lbs			5 lbs/ac
	Elymus glaucus	blue wildrye	72	110,000	25%	14 lbs			5 lbs/ac
	Nasella pulchra	purple needlegrass	63		10%	5 lbs			2 lbs/ac
	Vulpia microstachys [6]	three week fescue	80		10%	5 lbs			2 lbs/ac
	*Lupinus versiicolor**	bicolor lupine	70		5%	3 lb			1 lbs/ac
	*Lupinus albifrons**	Silverleaf lupine				100			D16 per 800 sq ft
	*Sedum spathulifolium**	stonecrop				30			D16 per 800 sq ft
	Eriogonum latifolium	Coast buckwheat				100			D16 per 800 sq ft
			TOTAL		**100%**	**55 lbs**			
Erosion Control Mi	*Bromus carinatus* [6]	California brome	70	100,000	30%			15 lbs	30 lbs/ac
	Elymus glaucus [4]	blue wild rye	72	110,000	30%			15 lbs	30 lbs/ac
	Festuca rubra	red fescue	80	500,000	5%			2.5 lbs	5 lbs/ac
	*Lupinus bicolor**	bicolor lupine	78		5%			5 lbs	10 lbs/ac
	Nasella pulchra	purple needlegrass	63		25%			10 lbs	20 lbs/ac
	Vulpia microstachys [6]	three week fescue	80		5%			2.5 lbs	5 lbs/ac
			TOTAL		**100%**			**15 + 35 lbs**	

1. Willows planted on site as cuttings, 2 sets of plantings of 5 individual clustered cuttings in wetlands.
Stakes and mulch collars are recommended for planting to protect trees (willows) during establishment.

2. Marsh perennials planted as bare root stock, in 6 feet on center spacing, 1,200 plants/acre.
3. Seed quanities for grasslands are calculated based on 20 lbs pounds per acre, number provided is total pounds per species needed for each site (except where noted for
4. Could use E. glaucus 'Berkley' if preferred in local setting

5. Erosion control seed mix is applied at rate of 70 lbs per acre of seed mix this mix includes 15 lbs per acre of extra seed to ensure quick, abundandt coverage. Bare soil areas for erosion control shall be covered with maximum of 4 inches of sterile rice straw, which will protect area from erosion and reduce revegetation from non-native weedy species.

6. Seed produced in CA only
7. PLS = Pure Live Seed = (percent germination x percent purity) / 100
8. Erosion control mix proposed and estimated for berm and staging area (approx. 0.5 acre)
9. California oatgrass (Danthonia californica), 40,000 seeds per lb, seed rate of 35 lb/ac. reported in literature, used here in mix at 20 lbs per acre
10. Riparian creation--assumes apprpoximately 1,135 lf of existing road to be converted to riparian/meander, at approximately 20 feet width=22,700 sf=
11. Species (seeds and plants) to be used as needed for listed butterfly host/nectar source in grassland enhancement

* Host plants for the Mission blue butterfly and the San Bruno elfin butterfly

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Bare soil areas if not proposed for seeding or planting shall be covered with maximum of 3 inches of sterile rice straw, which will protect area from erosion and reduce revegetation from non-native weedy species.

6.2.2 Sources and Storage

Plants will be purchased from nurseries and will be grown from local stock. The nurseries should be selected well in advance so that adequate quantities and sizes of species will be available at time of planting. Prior to site clearing and construction, it is possible for restoration contractors to collect seeds and transplants depending on the schedule. By collecting seed from sources in close proximity to the site, and within the boundaries of the watershed, there will likely be high success due to the well adapted ecotypes being utilized.

Willow cuttings can be gathered and planted on site with adherence to the following procedures:

Willow (*Salix* sp.) Planting Instructions: Willow cuttings can be taken from large vigorous-growing shrubs and trees from December 15 through February 1 (when plants are dormant) prior to bud swelling. The willow-cutting source shall be within a 15-mile radius of the project area. Length of cuttings shall be three feet with a minimum ¾ inch diameter at the base and maximum of three inches. It is recommended that the bottom of the willow cuttings be cut at a 45-degree angle in order to keep track of the correct orientation of the cutting and to facilitate planting. Cuttings shall be placed in a bucket filled with water prior to planting to avoid desiccation and shall be planted within 24 hours of cutting. Willow cuttings shall be placed with the basal 2/3 of the slip in the ground, with approximately 10-12 inches above the soil surface. If holes are dug or augured for the willows the soil shall be tamped around each willow slip so no air void occurs.

6.2.3 Plant Sizes and Estimated Number of Installed Plants

The Planting Plan (Table 3) provides an estimated quantity of each species based on acreage of area to be replaced and enhanced. Table 3 also provides recommended plant sizes and spacing, which are summarized below for reference:

A. Willows will be planted on site as cuttings, two sets of plantings of five individual clustered cuttings in marsh / seasonal wetlands, or 10 feet on center spacing for riparian (if any necessary for replacement).
B. Marsh perennials will be planted as bare root stock, with six feet on center spacing, 1,200 plants/acre.
C. Seed quantities for grasslands are calculated based on 20 pounds per acre for seed mix, (except where noted for erosion control mix that is 70 pounds per acre mix as well as 15 extra pounds per acre for quick coverage).

6.3 PLANT INSTALLATION METHODS

6.3.1 Hydroseeding and Broadcast Seeding

Hydroseeding may be employed in erosion control areas such as the toe of bordering slopes, if deemed appropriate. Broadcast seeding will likely be used for the grassland seed mix (could also be used for erosion control mix).

6.3.2 Rooted Material Planting Methods and Protections

Holes will be dug to twice the size of the root ball. The holes will be refilled with native soil and gently tamped to reduce air pockets. An initial watering will be conducted to further eliminate air spaces and ensure adequate contact of the root surface with the soil medium.

6.3.3 Treatment of Cuttings and Other Non-Rooted Materials

Willow cutting collection and installation are described in Section 6.2.2.

6.4 WATER SOURCES AND IRRIGATION

Dry-season irrigation is not recommended for this site, which will have herbaceous plants and willow cuttings.

6.5 IMPLEMENTATION SCHEDULE

The project is proposed for construction during the approved work window in year 2011. The construction window is likely restricted to the dry season to reduce the potential for significant erosion to occur (a Stormwater Pollution Prevention Plan will be implemented, per RWQCB requirements). Planting shall be done in the wet season between October 15 and February. The site will be seeded with an erosion control mix in between the construction activities to occur in the dry season and planting activities which will occur in the wet season.

Table 5. Development Timeline

Task		Start Date
1	Invasive species removal	June-July 2011
2	Tree removal, clearing and grubbing	August-September 2011
3	Excavation and grading	September 1-October 15, 2011-
4	Seed grassland areas	October 15 – October 30, 2011
5	Seed disturbed areas with erosion control mix after invasive species control	September 15 – October 30, 2011 (or 2 weeks past end of grading)
6	Seed disturbed areas with erosion control mix after construction of wetlands	(2 weeks past end of grading)
7	Planting uplands and wetlands	October 1, 2011-November 15, 2011
8	Complete as-built drawings	March 15, 2012
9	1st year Monitor grassland and wetland success	March 2012

7.0 SUCCESS CRITERIA

Performance standards for Upper San Mateo Creek are intended to be measurable by systematic monitoring methods.

7.1 Hydrology and Soil Criteria

H1: At the end of five years, wetland area will be increased by at least 0.841.13 acres as determined by a jurisdictional delineation.

H2: During an average year of rainfall (28.02 inches), the wetlands will hold (saturated to the surface or ponding on the surface) water until at least June 15 as described in the hydrology report in Appendix B. In order to account for annual variability of rainfall, rainfall data from the San Andreas Cottage gage station, located approximately 1 mile northeast of the project area, and from the Crystal Springs Cottage gage station, located approximately 7 miles southeast of the project area will be analyzed to verify the hydrology model used to design the enhancement and creation of wetlands. This rain data is in calibration with a stream gauge installed in January 2010.

H3: At the end of five years, tributary channel cross sectional area will be maintained at or slightly above pre-construction conditions, as determined by representative channel cross sections. Average slope of channel bottom will be maintained within 10% of baseline value based on cumulative flow from the creek.

7.2 Vegetation Criteria

V-1: For grassland communities post-planting cover shall meet the annual criteria identified in Table 6:

Table 6. Valley Needle Grassland Habitat Success Criteria	
Grassland	Absolute vegetative cover (of native and naturalized species) will be 70 percent after five years. Absolute cover of non-native, invasive species will not exceed 10 percent
* Target invasive plants are defined in Section 6.1.7.1	

V-2: For riparian and canopy cover communities post-planting cover shall meet the annual criteria identified in Table 7:

Table 7. Canopy Cover Habitat Success Criteria	
Willow riparian	**Year 1:** 40 percent or greater absolute willow cover and other native woody plant species. No erosional areas, no evidence of oversaturation or permanent inundation. No more than 5 percent absolute cover of target invasive plants.* **Year 2:** 45 percent or greater relative canopy cover of willows and other native woody plant species No erosional areas, no evidence of oversaturation or permanent inundation. No more than 5 percent absolute cover of target invasive plants. **Year 3:** 50 percent or greater relative canopy cover of willows and other native

	woody plant species. No erosional areas, no evidence of oversaturation or permanent inundation. No more than 5 percent absolute cover of target invasive plants. **Year 4:** 55 percent or greater relative canopy cover of willows and other native woody plant species. No erosional areas, no evidence of oversaturation or permanent inundation. No more than 5 percent absolute cover of target invasive plants. **Year 5:** 70 percent or greater relative canopy cover of willows and other native woody plant species. No erosional areas, no evidence of oversaturation or permanent inundation. No more than 5 percent absolute cover of target invasive plants.
	*Target invasive plants are defined in Section 6.1.7.1

V-3: For wetland communities post-planting cover shall meet the criteria identified in Table 8:

Table 8. Seasonal Wetland Habitat Success Criteria	
Seasonal Wetland	**Year 1:** 5 percent or greater absolute cover of planted and natural recruitment of wetland species. No more than 5 percent absolute cover of target invasive plants*. No large unvegetated bare spots (greater than 25 percent) or erosional areas, no evidence of oversaturation or permanent inundation. **Year 2:** 20 percent or greater absolute cover of planted and natural recruitment of wetland species. No more than 5 percent absolute cover of target invasive plants. No large unvegetated bare spots (greater than 25 percent) or erosional areas, no evidence of oversaturation or permanent inundation. **Year 3:** 45percent or greater absolute cover of planted and natural recruitment of wetland species. No more than 5 percent absolute cover of target invasive plants. No large unvegetated bare spots (greater than 25 percent) or erosional areas, no evidence of oversaturation or permanent inundation. **Year 4:** 60 percent or greater absolute cover of planted and natural recruitment of wetland species. No more than 5 percent absolute cover of target invasive plants. No large unvegetated bare spots (greater than 25 percent) or erosional areas, no evidence of oversaturation or permanent inundation. **Year 5:** 70 percent or greater absolute cover of planted and natural recruitment of wetland species. No more than 5 percent absolute cover of target invasive plants. No large unvegetated bare spots (greater than 20 percent) or erosional areas, no evidence of oversaturation or permanent inundation. Total Acreage meeting success criteria for hydrophytic vegetation, wetland hydrology to or greater than 1.13 acres of created marsh/seasonal wetland.
*Target invasive plants are defined in Section 6.1.7.1	

8.0 MONITORING

8.1 Hydrology and Soils Monitoring Methods

8.1.1 *Hydrology, Geomorphology and Soils Monitoring*

Monitoring of hydrology will be completed through physical survey (topographic measurement

for wetlands), including three (3) monumented (permanently staked) cross sections per wetland basin, of critical locations including where water flows into the site, the rim of the wetland, and where water flows off of the site. If there are changes in elevations at these locations as a result of storm damage, fallen trees, or excessive accumulation of vegetation, corrective actions will be evaluated and, if determined appropriate, a solution will be proposed to the regulatory agencies.

Physical survey of the wetlands will consist of surveying the limit of inundation and recording water levels on gauges (to be installed as part of this project) once during the dry season. Precipitation and weather conditions will be documented. In the event of prolonged drought, extension of the monitoring period or other appropriate adaptive management may be proposed.

Methods for quantifying the geomorphic and hydrologic function of the established wetlands will include:

1) Two sets of monitoring wells will be installed in each established wetland basin equaling a total of 4 wells. One well will be installed on the upland edge (approximately 3 feet) and the second well will be installed within the wetland basin (approximately 5 ft in wetland from the edge). The wells will be monitored three times for each monitoring year during the dry season and once during the wet season.
2) Three staff gauges will be installed in each established wetland basin for a total of 6 staff gauges. The gauges will be monitored three times annually for the duration of the five year monitoring period to measure depth of water and duration of inundation.
3) Water depths taken to the nearest inch are measured along three monumented cross sections perpendicular to the wetland. Cross sections should be placed on the longitudinal axis of the created wetland at a compass bearing that reads perpendicular to the created wetland. Transects should be placed where water flows into the site, the rim of the wetland, and where water flows off. Water depth measurements will be taken every two weeks in May and June after the completion of grading activities, and once a month for the remainder of the year when standing water is present.
4) Surface water depths should be measured every 25 feet along each monumented cross sections. The monitoring pole should be equipped with a flat bottom made of mesh or plastic, one foot in diameter to prevent the pole from sinking in to the wetland bottom for accurate readings. The open water (where no vegetation exists) should be recorded using a measuring tape to the nearest 0.5 foot for each transect. This measurement characterizes the length of transect comprised of surface water.

Soils will be evaluated annually in each wetland cell on the Upper San Mateo Creek site:

- One hole per wetland cell will be evaluated to a depth of 15 inches. The soil is saturated to the surface for 14 consecutive days or there is ponding/standing water on the surface for 7 consecutive days; or a combination of the two.

Methods for quantifying the geomorphic and hydrologic function of the creek will include:

- Installing a pressure transducer within the creek and developing a flow rating curve based on the as-built channel geometry and flow depth to closest 0.1 foot;

A formal jurisdictional wetland delineation or equivalent will be conducted on the created wetlands at the site at the end of the five year monitoring period, in year 2016. The total acreage of the created seasonal wetland will be equal to 1.13 acres or greater.

8.2 Vegetation Monitoring Methods

8.2.1 Permanent Photomonitoring Sites

Permanent photo documentation points will be established within the project site. A minimum of one photopoint per habitat type will be established. For example one photopoint at the seasonal wetland will be identified to document conditions. The restored grasslands will have representative photopoints for both habitat modifications: grassland enhancement and grassland re-establishment. GPS coordinates will be obtained for each photopoint, and the points included on a GIS map of the site.

Photographs will be taken throughout the monitoring period, during each monitoring event. Four photographs will be taken from each monitoring point, looking north, south, east, and west. Photos will be taken with a digital camera with a moderate wide angle lens (approximately 35mm focal length if a full-frame sensor, approximately 24mm focal length if a DX sensor, at the widest setting if a consumer-level digital camera with a built in zoom). The make and model of camera and type and focal length of lens will be noted in monitoring documentation. Photographs will be taken from five feet in height, ideally from a tripod with the height noted and consistent from year to year.

8.2.2 Vegetation Monitoring

Vegetation sampling will occur every year in each of the created or restored habitats on the project site, including established seasonal wetlands and grasslands, for the duration of the five year monitoring period. The goal is estimate the success of each vegetation community's surface area, cover, and composition once construction activities are complete.

Vegetation monitoring will be performed using a statistically robust method known as power analysis to assess percent cover of native, and invasive, perennial forbs and grasses. Power analysis would measure percent cover to within a margin of error of 10% at the 95% confidence interval (i.e., assesses to within +/- 10% of the true value, with a 95% likelihood of covering the true value in that range). The proposed power analysis method includes:

- Development of a monitoring protocol describing data collection techniques;
- Sub-sampling across different planting areas, sites and habitats; and

The proposed method would minimize the data collection effort while meeting requirements for statistical rigor.

Vegetation monitoring will be conducted during Years 1-5 for planted or established wetlands. The point-line intercept method will be used to estimate total vegetative cover, native cover, hydrophytic cover, and non-native invasive cover. This method will be used to determine whether the mitigation area is meeting set success criteria for vegetative cover.

Power Analysis. An *a priori* power analysis will be used to determine the monitoring effort required for the statistical analysis. The design of the statistical analysis influences the power analysis, including: a specific question to be answered and related statistical parameters; in this case, the allowable margins of error and confidence intervals. We define the specific question to be addressed as follows:

Is the true value of the percent cover less than or equal to the percent cover requirement?

The allowable certainty for percent cover will be a margin of error of +/- 10% at the 95% confidence interval. The confidence interval is the probability that the true value would be encapsulated in the margin of error around the reported percentage; the lower the confidence interval, the smaller the margin of error. Margin of error (ME), confidence interval and required number of sampling points (n) are related by the following equation for the 95 % confidence interval:

$$ME = 0.98/\mathrm{sqrt}(n)$$

The number of sampling points required to evaluate percent cover will be calculated using this equation. However, the following factors will be considered in estimating the number of transects and/or sample points to estimate cover:

- The specific monitoring targets (e.g., such as whether survival of some planted species can be pooled resulting in fewer sampling points or must be examined separately by species),
- The target wetland acreage of different mitigation areas.

Monitoring Protocol and Analysis for Estimating Vegetative Cover. Point-line intercept surveys will be used to estimate absolute vegetative cover, native cover, and hydrophytic cover in wetlands. Point-line intercept surveys will also be used to estimate non-native invasive species cover. The number of transects and/or sampling points would be determined as described in the previous section.[1]

Data will be collected along randomly located transects at points established by placing a 2-meter metal rod vertically (perpendicular to the ground) at defined intervals (1 or 5 meters) along a transect tape. The plant species touching the rod within each height category (low, medium, and high) will be recorded. Plant species that touch the rod in more than one height category will be recorded in each height category. The two smallest vegetation height categories, Low (0.0 meter to 0.5 meter) and Medium (0.5 meter to 2 meters), are captured by the height of the

[1] Note that a margin of error will increase the uncertainty around the percent cover of invasive species. The threshold for invasive species 5% cover, however, a value of 4% could represent a value of 0 to 9% cover of invasive species (at the 95% confidence interval). Reducing the margin of error requires increasing the sampling effort, and margins of error within 1% would require prohibitively intensive sampling efforts.

rod (2 meters tall). The High category (over 2 meters) will be estimated using eyesight. In addition to vegetative cover, each point where there is no vegetation, bare ground will be noted.

A t-test will be used to evaluate whether or not percent cover is less than or equal to the interim or final success criteria.

Percent cover trends will be analyzed after collecting three years of data, the minimum required to plot a line. Percent cover mean and 95% confidence interval will be plotted against time along with the percent cover success criterion. Trend analysis may be more informative than examining threshold exceedance because invasive species percent cover increases often are predictive of long-term ecological composition. Trend analysis would be conducted and take annual climatic variation into account, as this variation may influence the rate of increase in percent cover.

Non-native Invasive Plant Monitoring. During spring or early summer of Years 1-5, non-native invasive plant cover will be calculated from the point intercept data collected from all sites, as described above. In addition to this monitoring, areas with greater than 5 percent cover of target non-native species will be mapped using GPS as long as areas are safely accessible. Maintenance activities to control non-native invasive species will be targeted in these areas. Each year the acreage of mapped highly invasive species will be compared.

A spring inspection in subsequent years comparing mapped non-native invasive cover from the prior year will be conducted to determine if a non-native invasive species population has spread or a new species has invaded. In either scenario, maintenance activities may be required.

General Site Assessments

Qualitative data will also be collected each year of monitoring for the purpose of informing management. These general site assessments are intended to assess the overall functioning of the site as a whole, and also to help identify localized or low-level trends such as new invasive species formations, localized changes in species abundance, and other changes that might be important to address through remedial management actions.

The following data will be collected during the site assessment:

- Mortality (presence/absence) of planted trees, to document compliance with landscape contract performance, and to monitor progress relative to success criteria.
- Species richness. This general site data will be used for calibrating similar data taken at transects, and is not intended for comparison with success criteria. Data will also help to evaluate whether invasive or non-native species are outcompeting native plants, and whether more active management might be required.
- Average height of dominant or target plant materials. This information will be used to assess overall health and not for success criteria.
- Canopy cover estimates (by habitat type) using standard field estimation methods.
- Other site characteristics, including patterns of plant die-offs, erosion, hydrological issues, trespass, herbivory or grazing pressure, or other land use issues. This information is intended for use in recommending management actions as necessary.

Table 10. Qualitative Score for Assessing the Health and Vigor of Planted Stock

Score	Description of Score
Excellent	No evidence of stress; minor pest or pathogen damage may be present. No chlorotic leaves, no or very minor herbivory (browse). Evidence of new growth, flowering, seed set on majority (greater than 75 %) of plants observed.
Good	Some evidence of stress. Pest or pathogen damage present, few chlorotic leaves (> 5%), minor evidence of herbivory (browse). Evidence of new growth, flowering, seed set on most (greater than 50%) of plants observed.
Fair	Moderate level of stress; high levels of pest or pathogen damage, some chlorotic leaves (> 10%), some herbivory damage (few snapped leaves, stems, wear mamrks etc.). Evidence of new growth, flowering, seed set on some (less than 50%) of plants observed.
Poor	High level of stress; high levels of pest or pathogen damage, many chlorotic leaves (> 30%), severe herbivory damage (massive forage damage, main stems/leaves stripped etc.). No evidence of new growth, flowering, or seed set, or only a few plants (less than 25%) with these characteristics.

8.2.3 General Wildlife Use

A general wildlife use assessment will be conducted once per year for the entire monitoring period of five years to document common wildlife, songbird, and raptor use of the site. Data are intended to help assess overall site functioning and not as a performance measure. Annual monitoring will be conducted for the San Francisco garter snake, San Francisco dusky-footed woodrat and the California red legged frog special status species. Day and night surveys will occur 2-4 times per year and is to be performed by a qualified biologist.

- Surveys will be conducted between March- June
- Survey will be conducted at the deeper wetlands
- Document habitat conditions
- Document occurrence or absence of prey (for snakes)
- Depth of pond (Dmax)
- Water availability to support the CRLF
- Water temperature (near surface and at Dmax)
- Percent cover of emergent vegetation
- Occurrence of SFGS & CRLF using visual, auditory, dipnet, egg mases, or larval surveys
- Occurrence of additional amphibian species (adults, juveniles and larvae)
- Occurrence of predators including snakes, birds, bullfrogs, and fish (native predators at low density are expected and acceptable within restored habitat

8.3 Monitoring Schedule

Generally, grassland and wetland communities will be monitored from late March through May and the riparian corridor in March, May and July for early detection rapid response of invasive or undesirable plant species. Some flexibility to account for annual variation in weather conditions is acceptable.

Monitoring of vegetation will be completed during the performance period as described below. After the performance period the site will be inspected for general parameters including observations of invasive non-native plants or trees, signs of erosion or vandalism, and vitality of woody trees surviving the performance period as part of the site's long-term management.

Table 11: Annual Monitoring Schedule for Upper San Mateo Creek

Task	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Permanent Photo-monitoring			*	*								
Hydrology Monitoring	*		*			*		*				
Vegetation Monitoring			*	*								
Invasive Species Monitoring			*		*		*			*		
Wildlife Monitoring[*]			*	*	*	*						
Monitoring report												*

*Includes, but not limited to, target species (aquatic and MB butterfly, San Francisco dusky-footed woodrat ;
* only needed if occurrence was not recorded for the CRLF

9.0 MAINTENANCE DURING MONITORING PERIOD

9.1 Processes

The community types present at Upper San Mateo Creek provide habitat for sensitive as well as more common species. Established and re-established habitats have been designed to be as self-sustaining as possible. However, natural ecosystems are dynamic and subject to change over time. This is especially true in modern fragmented urban preserves, where the vast landscapes and ecological processes which once maintained a habitat mosaic may have been partially or completely disrupted. Natural processes include flood and drought, fog, fire, wind, disturbance by burrowing animals, and grazing.

As a result of human-induced change, management is usually required to maintain preserves and prevent gradual degradation. In the short term, management will likely be necessary to minimize resprouting of aggressive native species such as coyote brush and poison oak in grassland areas; while reoccurrence of more mesic invasives may populate the riparian corridor or wetlands. The following discussion identifies approaches to longer term maintenance after the end of the construction and planting period.

9.2 Inspection Tasks and Frequencies

The following inspections will be generally performed on an annual basis at the time of mitigation monitoring. Field notes will document if conditions are normal or abnormal, and the annual monitoring report will recommend remedial actions to address any significant issues, as deemed necessary. The annual monitoring should note whether within each habitat type, the following conditions are observed:

1. Is erosion control in place and functioning properly?
2. Are planting areas exhibiting excessive water or drought stress (too much or too little water as evidenced by leaf wilt, leaf drop, plant die off, etc.), as described in Table 11?
3. Invasive species early detection rapid response - Is there any presence of new or reestablished populations of invasive plants? Pioneer populations of invasives (previously unidentified at the site, such as fennel, pampas grass, etc.) should be treated immediately upon detection. Existing invasive plant populations (as listed in Section 6), or others, are to be managed under an adaptive management plan if reestablishment or continued predominance is detected.
4. Is there a distinctive pattern of plant die off (i.e., all species of a single plant or a cluster of plants within a small area)?
5. Is there excessive overshading of CRLF or SFGS habitat?

9.3 Remedial Tasks

While initial efforts are important, living systems require ongoing maintenance and management. We recommend an adaptive management strategy for maintaining and managing the site. Remedial actions could include one or more of the following tasks (not exclusive):

1. Weeding around planting sites to reduce competition from non-native grasses and forbs; and remove overgrown vegetation from excessively shaded wetland areas.
2. Supplemental watering;
3. Additional erosion control;
4. Additional invasive plant control;
5. Supplemental replacement plantings (may be in-kind, or if a particular species is not doing well at the site, a suitable replacement species can be supplemented for original plant species);
6. Hydrologic modification or minor regrading

9.3.1 Initiating Procedures

Standards for when to implement remediation will be if the percent cover in any monitoring year (averaged over sample plots) is 15% below the target level described under “Annual Success Criteria”, or if final criterion is not met. The hydrologic triggers that will dictate remedial actions are water quantity, erosion, and sedimentation; once again, remediation will occur if monitoring documents results 15% below the success criteria. If annual performance criterion is not met, a report shall be prepared analyzing the cause of failure and, if necessary, proposing remedial action for agency approval.

9.3.2 Replanting

Replanting would be recommended if it is deemed that no other procedure could be employed to restore the target habitat to meet monitoring criteria. If die-off occurs and replanting is necessary monitoring will be reset to year one.

- Replanting may be deemed appropriate during the 6 month installation warranty period to replace dead plants. Plants should be replaced during the next rainy season. This should

be considered throughout the monitoring period, considering the 6 month window may not include potential casualties during the dry season.

- Replanting will also be incorporated if success criteria are not being met to remedy the loss of live plant stems. There is potential to change the plant palette if a lack of species richness occurs.
- If a target species has poor success throughout the site it may be replaced with a new species of botanical significance to the restoration habitats.
- There is potential to increase the amount of special status plant species in a follow-up planting plan for year two. Currently, viable plant stock is not available and seeds will need to be collected this fall to be propagated if they are desired to be planted in year 2 after construction has been completed.

9.3.3 Regrading

Regrading could be recommended if it is deemed that no other procedure could be employed to restore the target habitat to meet monitoring criteria. If regrading occurs and replanting is necessary monitoring will be reset to year one.

9.3.4 Hydrologic Modification

Culvert or weir elevations could be manipulated if hydroperiod does not meet expected criteria.

9.4 Invasive Species Control

9.4.1 Herbivory

Six-foot high metal deer fencing attached to metal posts around the site could be used to protect the new plantings from deer browsing during establishment. Wire mesh or aluminum screen could be used to reduce rodent herbivory of planted material.

9.4.2 Vegetation

Section 6 presents weedy/non-native and invasive species that are known to occur at the site, as well as management strategies to be employed to eliminate these species, as feasible.

Mowers can be used to weed around the riparian plantings, and wetland mitigation site, as needed and with procedures in place to prevent harm to sensitive animal species. Machinery should not be used at the site during wet conditions. Invasive species control will likely require repeated effort for at least several years and possibly throughout the long-term management period. Specific needs will be identified based on each year of monitoring, and documented in annual reports. Vegetation management will also be employed when more than 10% shading is present over the wetland basins. Overshading is not expected to occur within the 5 year monitoring timeframe, but may be problematic for the long-term maintenance of the site and clearing some branches may be appropriate to retain optimal habitat for amphibians using the site.

Adaptive management can include non-chemical applications where the area can be periodically grazed in the spring and late summer, mowing and propane torch flaming for poison oak, and coyote brush; this can be implemented as post activity management techniques.

Appropriate control methods will be utilized depending on the species, the abundance and distribution of the species, and the location within the site and relative to wetlands or other sensitive resources. Adaptive management is emphasized wherein various strategies will be employed, as presented in Section 6.0 depending on site-specific conditions and invasive species issues at the time of management/maintenance activity. Tu et al. (2001) and other publications on invasive species control may be referenced when identifying appropriate methods for use within a habitat enhancement site.

9.6.2 Predators

Predator control actions will be evaluated via monitoring and reviewed for efficacy. Below in Section 9.5 Maintenance Schedule, it is described that predator inspection will occur three times a year beginning in April, then in May, and once more in July. Bullfrogs can be a potential major issue. The pond is designed to dry part of each year but given creek proximity inspections are included to confirm the presence or absence of bullfrogs, and/or other undesired predators.

In the event that predator control fails to meet success criteria, contingency measures include:

- Draining wetlands to ensure the lifecycle for the bullfrog will not be met; if they are not self performing to dry out as intended they will be redesigned.
- Even if pond dries as designed and keeps tadpoles out, subadults may enter pond from San Mateo Creek. These predators will be removed if observed during monitoring.
- If rodents are severely impacting the success criteria of planted grassland or wetland plant stock for target habitats, there may be a need to increase the timing of occurrence to remove the dense ground cover adjacent to the planted material. If deemed appropriate it may necessary to replant rooted specimens with different protection measures.

9.5 Maintenance Schedule

Maintenance will be conducted annually, during the dry season unless another time of year is more appropriate to avoid disturbance to sensitive species, habitats, or resources. If timing of maintenance needs to be modified for certain items, the rationale for the decision will be documented in annual reports.

The schedule for maintenance during the monitoring period is shown in Table 12.

Table 12. Schedule for Maintenance During the Monitoring Period

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Revegetation Inspection and Maintenance			I	I			I					M
Invasive Plant												

Inspection and Maintenance	I,M		I,M	I,M	I,M		I,M		I,M	I,M		
Predator Inspection and Maintenance *				I		I			I			

I = Inspection, M = Maintenance

*Predators (bullfrogs, fish) are not expected to be a significant issue in the seasonal wetlands of the Upper San Mateo Creek site. Management will occur only if inspections identify an issue

10.0 MONITORING REPORTS

10.1 As-Builts

At completion of site grading and planting, as-built drawings will be prepared and provided to appropriate agencies. Drawings will show, at a minimum, post-grading surface contours, typical cross-sections, and limits of each habitat or planting zone. The Water Board shall be notified that mitigation construction and planting has been completed within 72 hours of concluding these activities.

10.2 Annual Reports

Annual reports of monitoring results will be submitted to the U.S. Army Corps of Engineers, San Francisco District, and the Bay Area Regional Water Quality Control Board, California Department of Fish and Game, and U.S. Fish and Wildlife Service. Once the planting efforts are completed, the Water Quality Control Board would like to be contacted within five (5) days. The reports will assess attainment of yearly target criteria and progress toward final success criteria. If final success criteria are met early, then a request for early completion of permit requirements will be made. Photographs of restoration areas shall be included in annual reports, as necessary, to document site conditions.

10.3 Due Dates

As-builts will be provided within 120 days after the completion of construction and planting activities. The Bay Area Regional Water Quality Control Board would like to be notified within 5 days after revegetation activities are completes. The first annual report shall be delivered by December 31 of the year following the first growing season after planting, with a report provided by December 31of each subsequent year until the end of the 5-year monitoring period.

11.0 CONTINGENCY MEASURES

11.1 Initiating Procedures

If an annual performance criterion (averaged over sample plots) is not met for any year, or if final criteria are not met, a report shall be prepared analyzing the cause of failure and, if necessary, proposing remedial action for approval. Potential remedial actions include but are not limited to replanting, modifying management strategies or methods, providing additional offsite mitigation or extending the monitoring period.

11.2 Contingency Funding Mechanism

SFPUC is responsible for funding any adaptive management or additional measures which it determines are necessary and which the appropriate agencies concur. SFPUC will provide the agencies with a financial assurance memorandum of understanding as a standalone document.

12.0 COMPLETION OF MITIGATION RESPONSIBILITIES

12.1 Notification

When performance criteria have been met, the applicant will notify the San Francisco District of the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the California Department of Fish and Game, and the Regional Water Quality Control Board. Documentation will be provided within the accompanying annual report.

12.2 Agency Confirmation

Upon notification of completion the agencies identified above may concur based on written documentation or, at their discretion, may request a site visit to observe the completed project.

13.0 LONG TERM MANAGEMENT

Long-term management will be required at the created, enhance, or restored wetlands, riparian and grassland habitats. A Long Term Management Plan for all of the Peninsula HRP sites, including the sites described in this MMP will be prepared and submitted for agency review by December 2010. This Plan will provide information concerning ongoing management of these sites by SFPUC after the final success criteria described herein have been met. The Long Term Management Plan will define the goals and objectives for each habitat type and prescribe management actions to meet them. Activities that will be addressed in the Plan will include but not be limited to: invasive plant management (including native as well as non-native plants), invasive predator control, erosion and sedimentation, infrastructure management, and grazing. Monitoring, contingency measures, and schedules associated with these activities will also be addressed in the Plan. The Plan will also be of sufficient detail to feed into the PAR analysis and the development of the endowment for the conservation easement.

14.0 SITE PROTECTION

The Upper San Mateo Creek site is well within the larger Peninsula holdings, which are protected by perimeter fencing and gates. Although located within the interior of the site and remote from major roadways, the site is bordered by a narrow paved roadway. Signs will be installed at site access points to educate authorized visitors about the sensitive nature of the habitat. Watershed keepers will patrol the access road and report any damage or other issue.

14.0 LITERATURE CITED

Arnold, R. A. 1983. Ecological studies of six endangered butterflies (Lepidoptera, Lycaenudae): Island biogeography, patch dynamics, and the design of habitat preserves. Univ. of California Press, Berkeley. 161p.

Barry, S. J. 1994. The distribution, habitat, and evolution of the San Francisco garter snake, *Thamnophis sirtalis tetrataenia*. Master's Thesis, Univ. California, Davis. 140p.

Bobzien, S., J. E. DiDonato, and P. J. Alexander. 2000. Status of the California red-legged frog (*Rana aurora draytonii*) in the East Bay Regional Park District, California. Oakland, CA.

California Department of Fish and Game. 2008. Special animals (865 taxa). Biogeographic Data Branch, California natural Divevrsity Database, Sacramento. February 2008.

Cal-IPC, 2006. *California Invasive Plant Inventory*. Cal-IPC Publication 2006-02. California Invasive Plant Council: Berkeley, CA. http://www.cal-ipc.org/ip/inventory/weedlist.php

Cal-IPC, 2004. *The Weed Workers' Handbook: A Guide to Techniques for Removing Bay Area Invasive Plants.* California Invasive Plant Council and The Watershed Project. May 2004.

City of San Carlo.2005. *Revised Recirculated Section 3, Draft Focused EIR Winding Way Property Tax Exchange Agreement Chapter 2 – Revisions to Section 3 of DFEIR.* San Francisco dusky-footed woodrat mitigation measures.
http://www.cityofsancarlos.org/civica/filebank/blobdload.asp?BlobID=4804

DiTomaso, J. M. Dept. of Plant Sciences, UC Davis; and W. T. Lanini, Dept. of Plant Sciences, UC Davis. Produced by UC Statewide IPM Program, University of California, Davis, CA 95616

Elzinga C.L; Salzer, D.W.; Willoughby, J.W. *Measuring and Monitoring Plant Populations.* Bureau of Land Management. National Buisness Center, BC-650B. P.O. Box 25047 Denver, Colorado 80225-0047. BLM Technical Reference 1730-1

Fellers, G. M., and P. M. Kleeman. 2007. California red-legged frog (*Rana draytonii*) movement and habitat use: Implications for conservation. Journal of Herpetology 41(2):276-286.

Fidelibus, W.M. and Mac Aller, R T.F. 1993. *Methods for Plant Sampling.* Biology Department San Diego State University San Diego, CA 92182

Food and Agriculture, CA Department of, 2009. *Encycloweedia: Notes on Identification, Biology, and Management of Plants Defined as Noxious Weeds by California Law***.** CA Department of Food and Agriculture, partnership with UC Davis.
http://www.cdfa.ca.gov/phpps/ipc/encycloweedia/encycloweedia_hp.htm. Copyright 2009.

Freel, K., and C. Giorni. 1994. An assessment of San Francisco garter snake populations and habitat on California Department of Parks and recreation Lands in coastal San Mateo County. Unpublished draft report to California Dept. of Parks and Recreation. 33p.

Friends of Edgewood Natural Preserve. Strategic plan 2009-2012.

Hayes, M. P., and M. M. Miyamoto. 1984. Biochemical, behavioral, and body size differences between the red-legged frogs, *Rana aurora aurora* and *Rana aurora draytonii*. Copeia 1984:1018-1022.

Holland, R. F. 1986. Preliminary descriptions of the terrestrial natural communities of California. California Dept. of Fish and Game, Sacramento. 156p.

HT Harvey. 2010. Habitat Mitigation and Monitoring San Andreas County, California.
Jennings, M. R. 1988. Natural history and decline of native ranids in California. Pp. 61-72 in: H. F. DeLisle, P. R. Brown, B. Kaufman, and B. M. McGurty (eds.), Proceedings of the conference on California herpetology. Southwestern Herpetologists Society Spec. Publ. 4.

Jennings, M. R., and M. P. Hayes. 1994. Amphibian and reptile species of special concern in California. California Dept. of Fish and Game, Inland Fisheries Division, Rancho Cordova, CA.

Larsen, S. S. 1994. Life history aspects of the San Francisco garter snake at the Millbbrae habitat site. Master's Thesis. California State Univ., Hayward. 105p.

Loudermilk W. E. 2008. Regional Manager DFG. Draft Environmental Impact Report (DEIR) Rancho Canada Village Specific Plan SCH No. 2006081150.

McGinnis, S. M. 1987. The distribution and feeding habitat requirements of the San Francisco garter snake (*Thamnophis sirtalis tetrataenia*). Final report, California Dept. of Fish and Game Interagency Agreements C-673 and C-1376.

Masters, L. A. 1996. Monitoring vegetation. Pg. 279-301 *in:* S. Packard and C. F. Mutel (eds.), The Tallgrass Restoration Handbook. Island Press, Washington, D.C.

May & Associates. 2009. San Francisco Public Utilities Commission Guidance for Consultants Preparing Mitigation and Monitoring Plans. 32p.

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons, New York.

Rathbun, G. B., N. Siepel, and D. C. Holland. 1992. Nesting behavior and movements of western pond turtles (*Clemmys marmorata*). The Southwestern Naturalist 37:319-324.

Rathbun, G. B., M. R. Jennings, T. G. Murphey, and N. R. Siepel. 1993. Status and ecology of sensitive aquatic vertebrates in lower San Simeon and Pico Creeks, San Luis Obispo County, California. Unpublished report, National Ecology research center, Piedras Blancas Research Station, San Simeon, CA. Cooperative Agreement 14-16-0009-91-1909.

RWQCB. 2009. Fact Sheet for Wetland Projects.
http:///www.waterboards.ca.gov/sanfranciscobay/certs.shtml

San Francisco, City of, 2009. *SF Reduced Risk Pesticide List*. City Department of the Environment. http://www.sfenvironment.org/. April 13, 2009.

SFPUC. 2008. Summary description of the Peninsula Watershed Management Plan. http://sfwater.org/mto_main.cfm/MC_ID/20/MSC_ID/177/MTO_ID/349

Steinberg, Peter D. 2002. Baccharis pilularis. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2010, July 20].

Stromberg, M., and J. Griffin. 1996. Long-term patterns in coastal California grasslands in relation to cultivation, gophers, and grazing. Ecological Applications 6(4):1189-1211.

Storer, T. I. 1925. A synopsis of the amphibians of California. University of California Publications in Zoology 27:1-342

The Nature Conservancy, 2001. Weed Control Methods Handbook: Tools & Techniques for Use in Natural Areas. Nature Conservancy, Wildland Invasive Species Team, version April 2001.

Tu, M., C. Hurd, and J. M. Randall. 2001. Weed control methods handbook. The Nature Conservancy. http://tncweeds.ucdavis.edu

U.S. Army Corps of Engineers. 2004. Mitigation and monitoring proposal guidelines. Special public notice, San Francisco and Sacramento Districts. 26p.

U. S. Fish and Wildlife Service. 2002. Recovery plan for the California red-legged frog (*Rana aurora draytonii*). Portland, Oregon. viii + 173 p.

U. S. Fish and Wildlife Service. 2006. San Francisco garter snake (*Thamnophis sirtalis tetrataenia*) 5-year review: Summary and evaluation. Sacramento. 42p.

U. S. Fish and Wildlife Service. 2008. Endangered and threatened wildlife and plants; designation of critical habitat for the bay checkerspot butterfly (*Euphydryas editha bayensis*). Federal Register 73(166):50406-50452.

URS Corporation. 2004. Vegetation survey of the Peninsula and Alameda watersheds. Unpublished report to SFPUC, Agreement No. CS-699E.

Werner, E. E., and K. S. Glennemeier. 1999. Influence of forest canopy on the breeding pond distributions of several amphibian species. Copeia 1999:1-12.

Wright, A. H., and A. A. Wright. 1949. Handbook of frogs and toads of the United States and Canada. Comstock Publishing Company, Inc., Ithaca, NY.

Appendix A
Figures

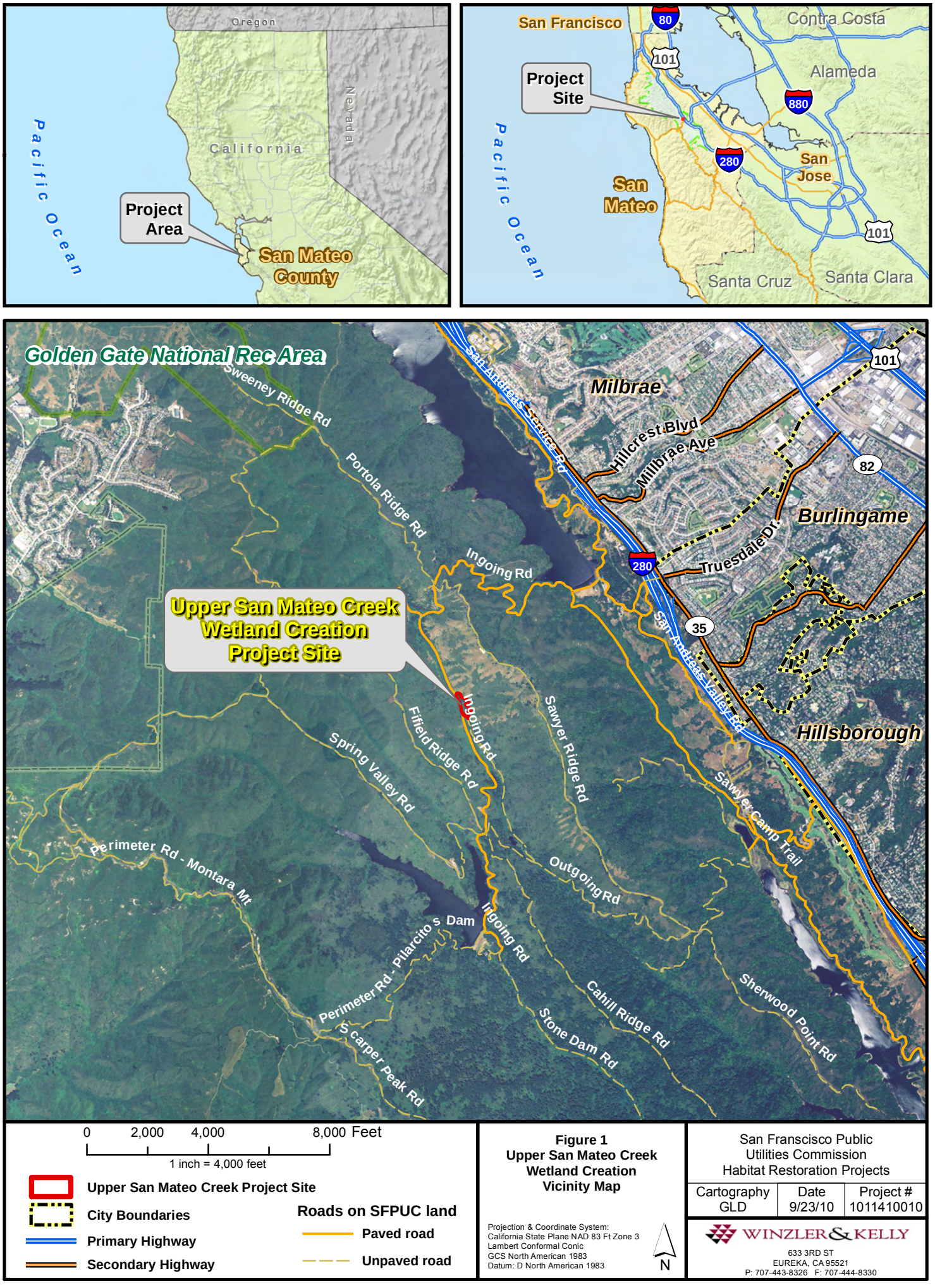

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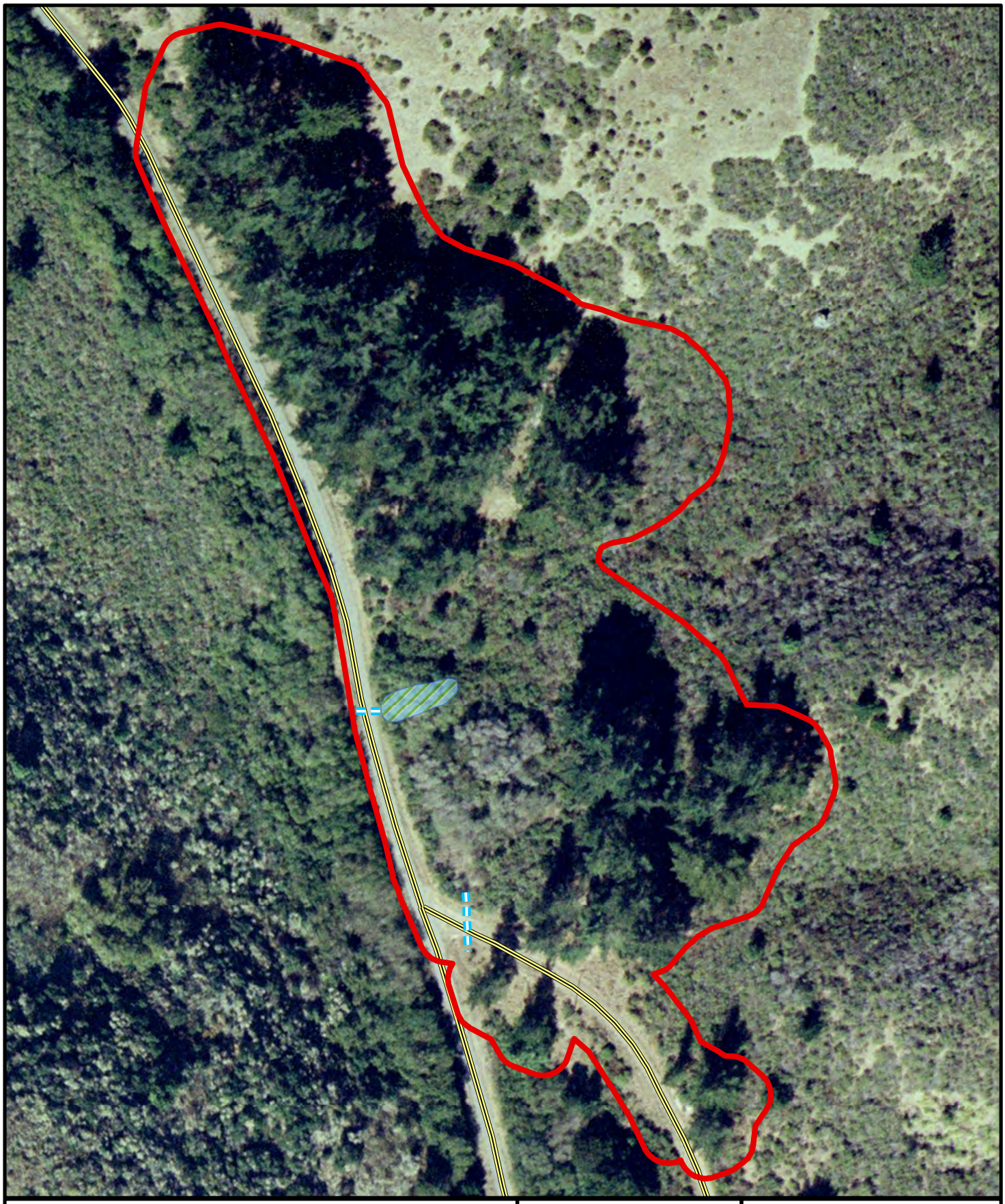
Figure 1
Upper San Mateo Creek Wetland Creation
Vicinity Map

Projection & Coordinate System:
California State Plane NAD 83 Ft Zone 3
Lambert Conformal Conic
GCS North American 1983
Datum: D North American 1983

San Franscisco Public Utilities Commission
Habitat Restoration Projects

Cartography	Date	Project #
GLD	9/23/10	1011410010

WINZLER & KELLY
633 3RD ST
EUREKA, CA 95521
P: 707-443-8326 F: 707-444-8330



0 50 100 200 Feet

1 inch = 100 feet

Upper San Mateo Creek Project Area

Existing Culverts

Existing Wetland

Existing Road

Figure 2
Upper San Mateo Creek Wetland Creation Jurisdictional Wetland Delineation

Projection & Coordinate System:
California State Plane NAD 83 Ft Zone 3
Lambert Conformal Conic
GCS North American 1983
Datum: D North American 1983

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San Franscisco Public Utilities Commission
Habitat Restoration Projects

Cartography	Date	Project #
GLD	7/12/10	1011410010

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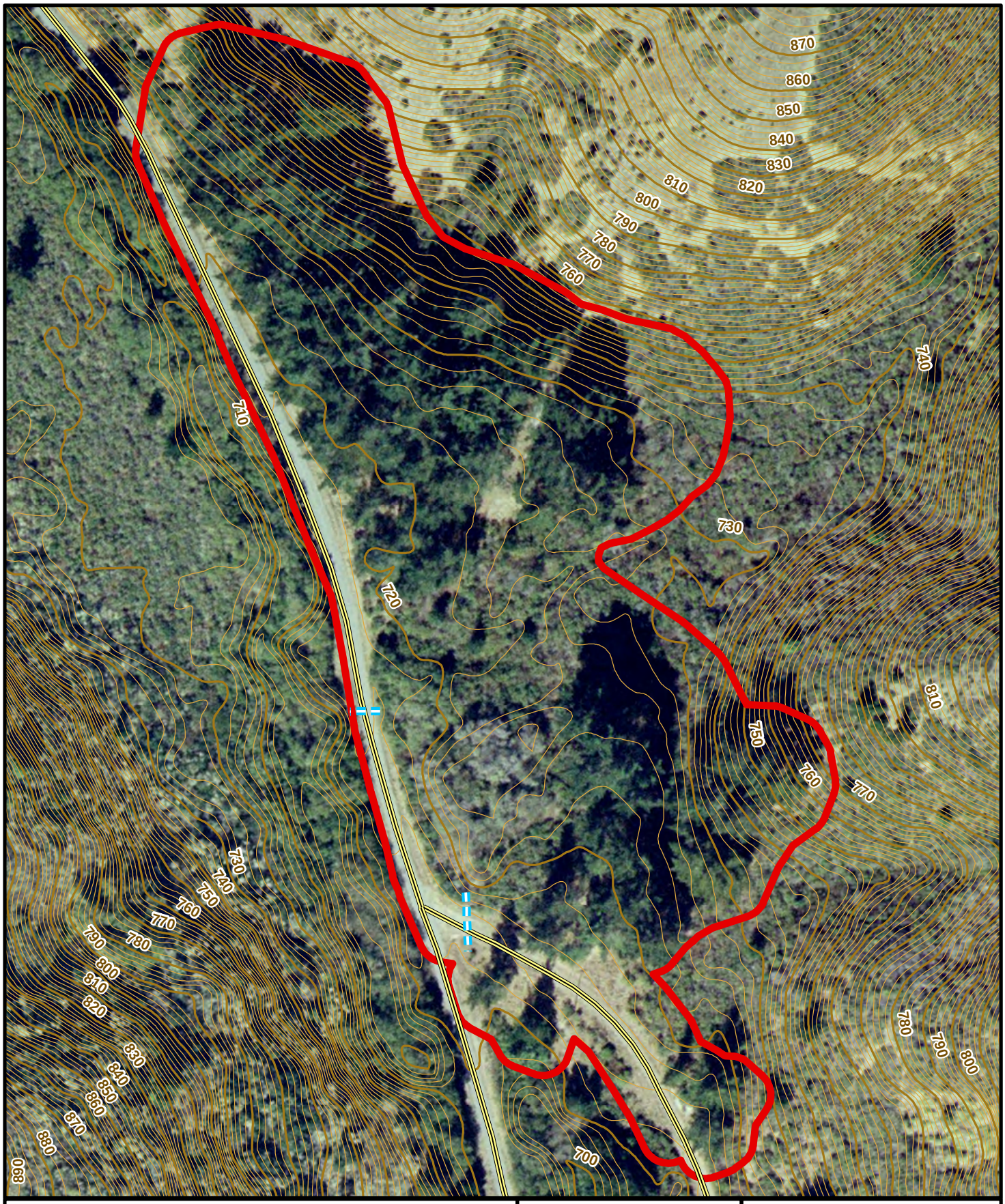
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1 inch = 100 feet
Contours-Index 10Ft
Contours 2Ft
Upper San Mateo Creek Project Area
Existing Road
Figure 3
Upper San Mateo Creek Wetland Creation Topography
Projection & Coordinate System:
California State Plane NAD 83 Ft Zone 3
Lambert Conformal Conic
GCS North American 1983
Datum: D North American 1983
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San Franscisco Public Utilities Commission
Habitat Restoration Projects
Cartography GLD
Date 9/23/10
Project # 1011410010
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633 3RD ST
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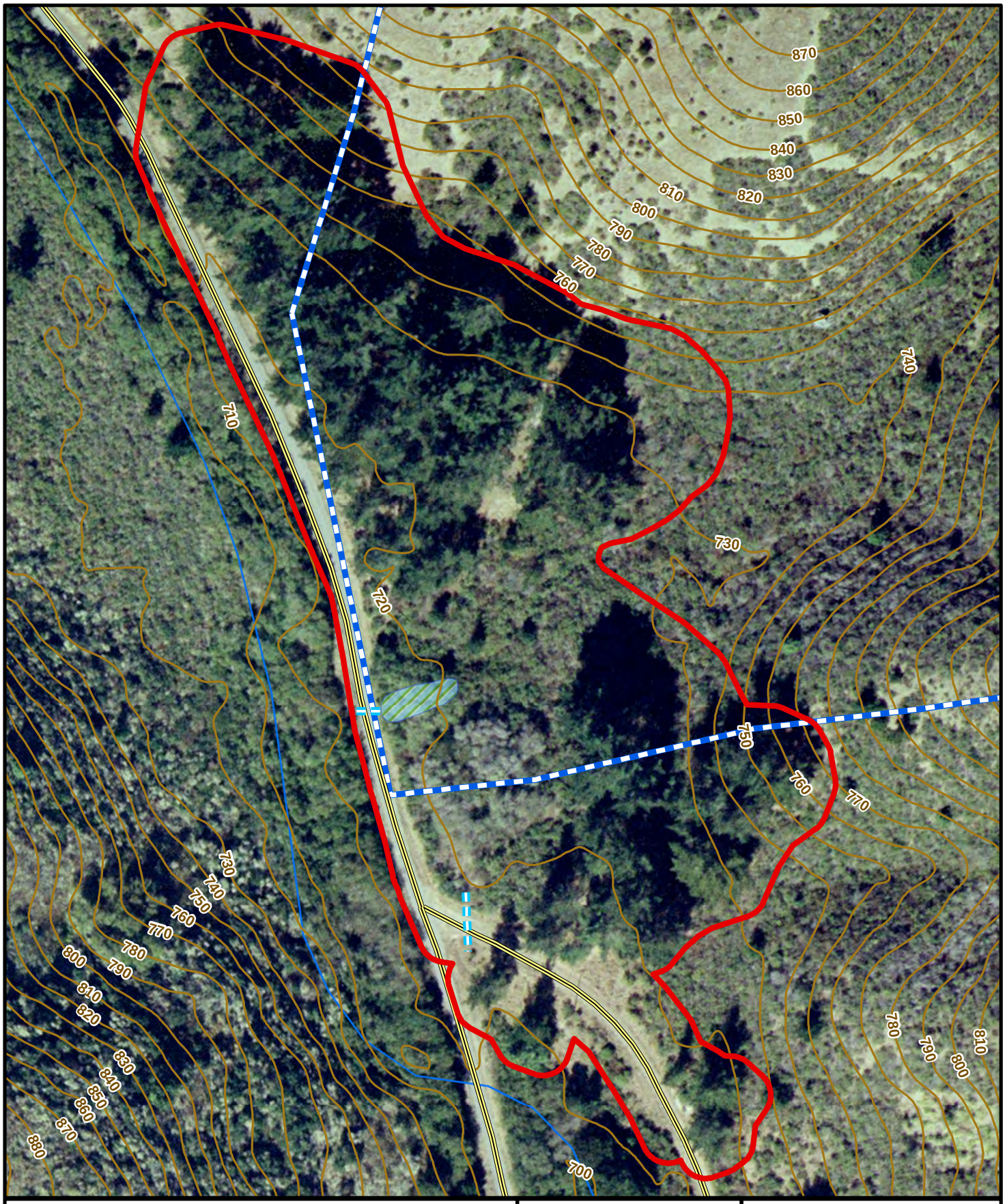
P: 707-443-8326 F: 707-444-8330



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1 inch = 100 feet

- Upper San Mateo Creek Project Area
- Watershed Boudaries
- Existing Wetland
- Contours-Index 10Ft
- Existing Culverts
- Upper San Mateo Crk
- Existing Road

Figure 4
Upper San Mateo Creek Wetland Creation Hydrologic Basemap

Projection & Coordinate System:
California State Plane NAD 83 Ft Zone 3
Lambert Conformal Conic
GCS North American 1983
Datum: D North American 1983
SFPUC: Stream & Road data source

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Habitat Restoration Projects

Cartography	Date	Project #
GLD	9/23/10	1011410010

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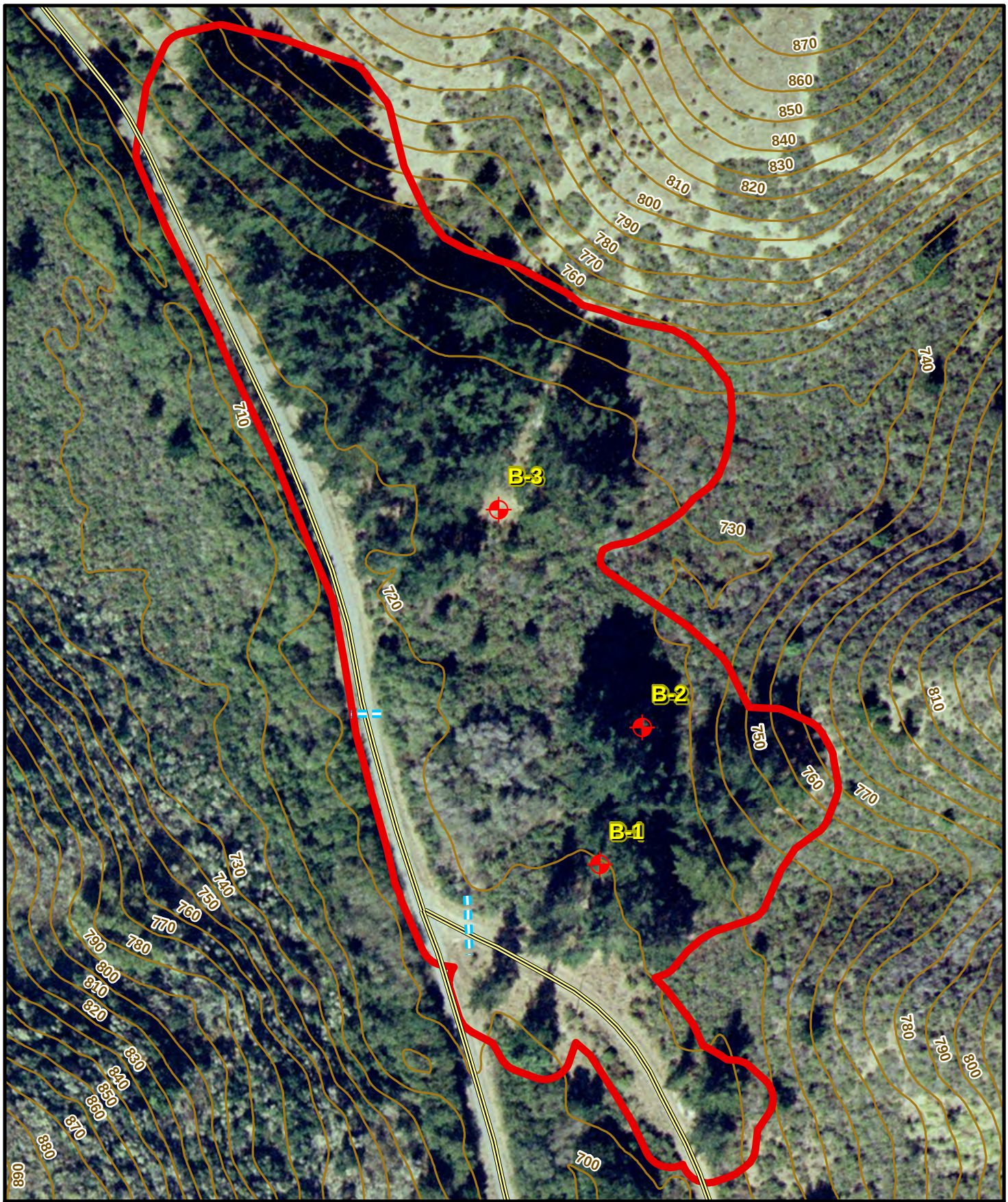

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0 50 100 200 Feet

1 inch = 100 feet

Piezometer/Soil Test Pit

Upper San Mateo Creek Project Area

Contours Index 10Ft

Existing Culverts

Existing Road

Figure 5
Upper San Mateo Creek Wetland Creation Piezometer/Soil Pit Locations

Projection & Coordinate System:
California State Plane NAD 83 Ft Zone 3
Lambert Conformal Conic
GCS North American 1983
Datum: D North American 1983

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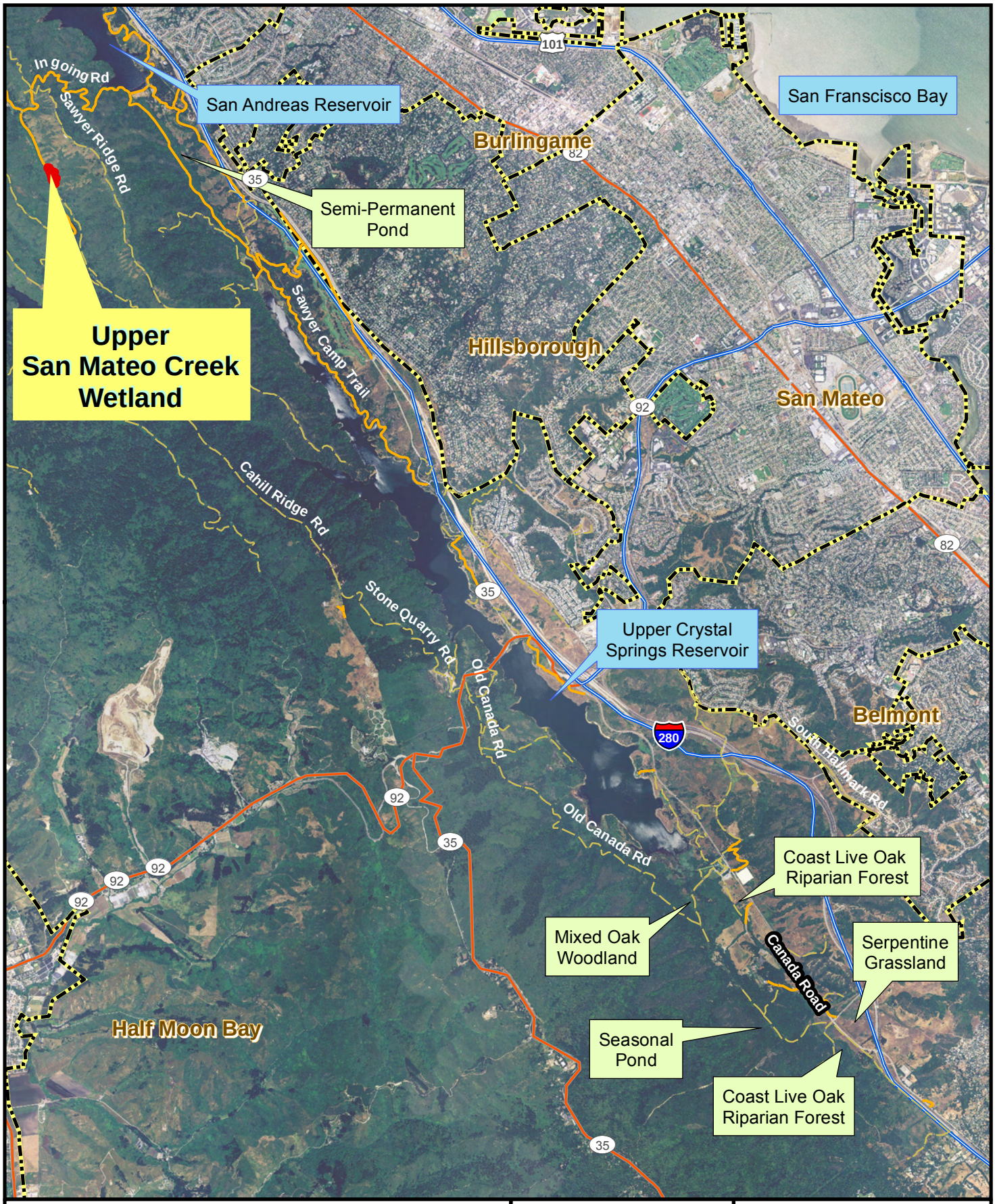
San Franscisco Public Utilities Commission
Habitat Restoration Projects

Cartography	Date	Project #
GLD	9/23/10	1011410010

WINZLER & KELLY
633 3RD ST
EUREKA, CA 95521
P: 707-443-8326 F: 707-444-8330



0 3,050 6,100 12,200 Ft

1 inch = 6,000 feet

Adobe Gulch

City Boundaries

Primary Highway

Secondary Highway

Roads on SFPUC land

Paved road

Unpaved road

Figure 6
Upper San Mateo Creek Wetland Creation Reference Site Locations

Projection & Coordinate System:
California State Plane NAD 83 Ft Zone 3
Lambert Conformal Conic
GCS North American 1983
Datum: D North American 1983

San Franscisco Public Utilities Commission
Habitat Restoration Projects

Cartographer	Date	Project #
GLD	9/23/10	1011410010

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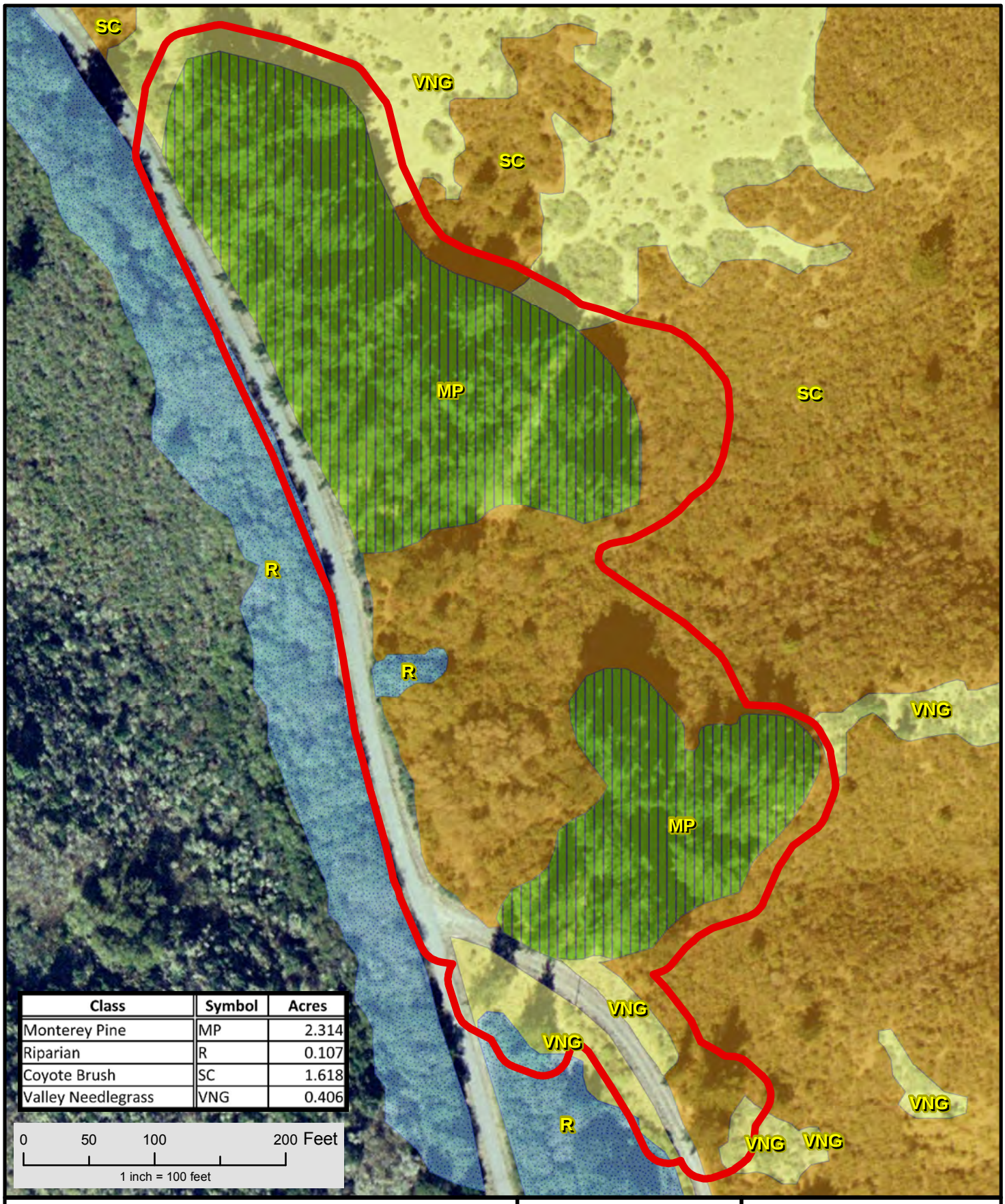

Class	Symbol	Acres
Monterey Pine	MP	2.314
Riparian	R	0.107
Coyote Brush	SC	1.618
Valley Needlegrass	VNG	0.406

Vegetation Classifications

- MP - Monterey Pine
- R - Riparian
- SC - Northern Coyote Brush Scrub
- VNG - Valley Needlegrass

Upper San Mateo Creek Project Area

Figure 7
Upper San Mateo Creek Wetland Creation
Existing Plant Communities

Projection & Coordinate System:
California State Plane NAD 83 Ft Zone 3
Lambert Conformal Conic
GCS North American 1983
Datum: D North American 1983

N

San Franscisco Public Utilities Commission
Habitat Restoration Projects

Cartography	Date	Project #
GLD	9/23/10	1011410010

WINZLER & KELLY
633 3RD ST
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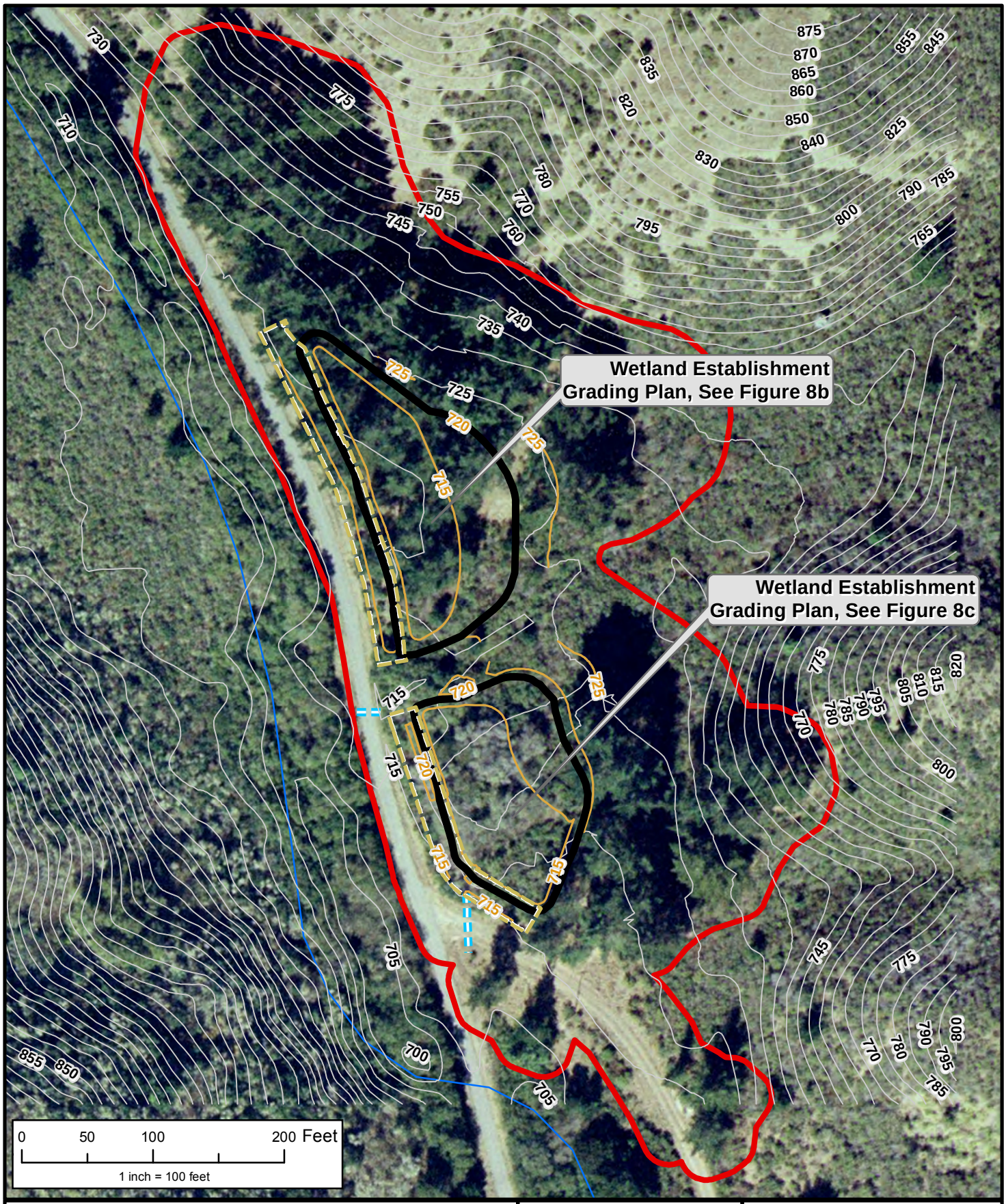

Existing Features

- Project Limits
- Upper San Mateo Crk
- Exisitng Contours 10-ft

Proposed Grading Plan

- Replace Existing Culvert
- Wetland Boundary
- Berm Boundary
- Index Contours 5-ft

Figure 8A
Upper San Mateo Creek
Wetland Creation
Grading Plan

Projection & Coordinate System:
California State Plane NAD 83 Ft Zone 3
Lambert Conformal Conic
GCS North American 1983
Datum: D North American 1983
SFPUC: Stream & Road data source

N

San Franscisco Public Utilities Commission
Habitat Restoration Projects

Cartography	Date	Project #
GLD/RCH	9/23/10	1011410010

WINZLER & KELLY
633 3RD ST
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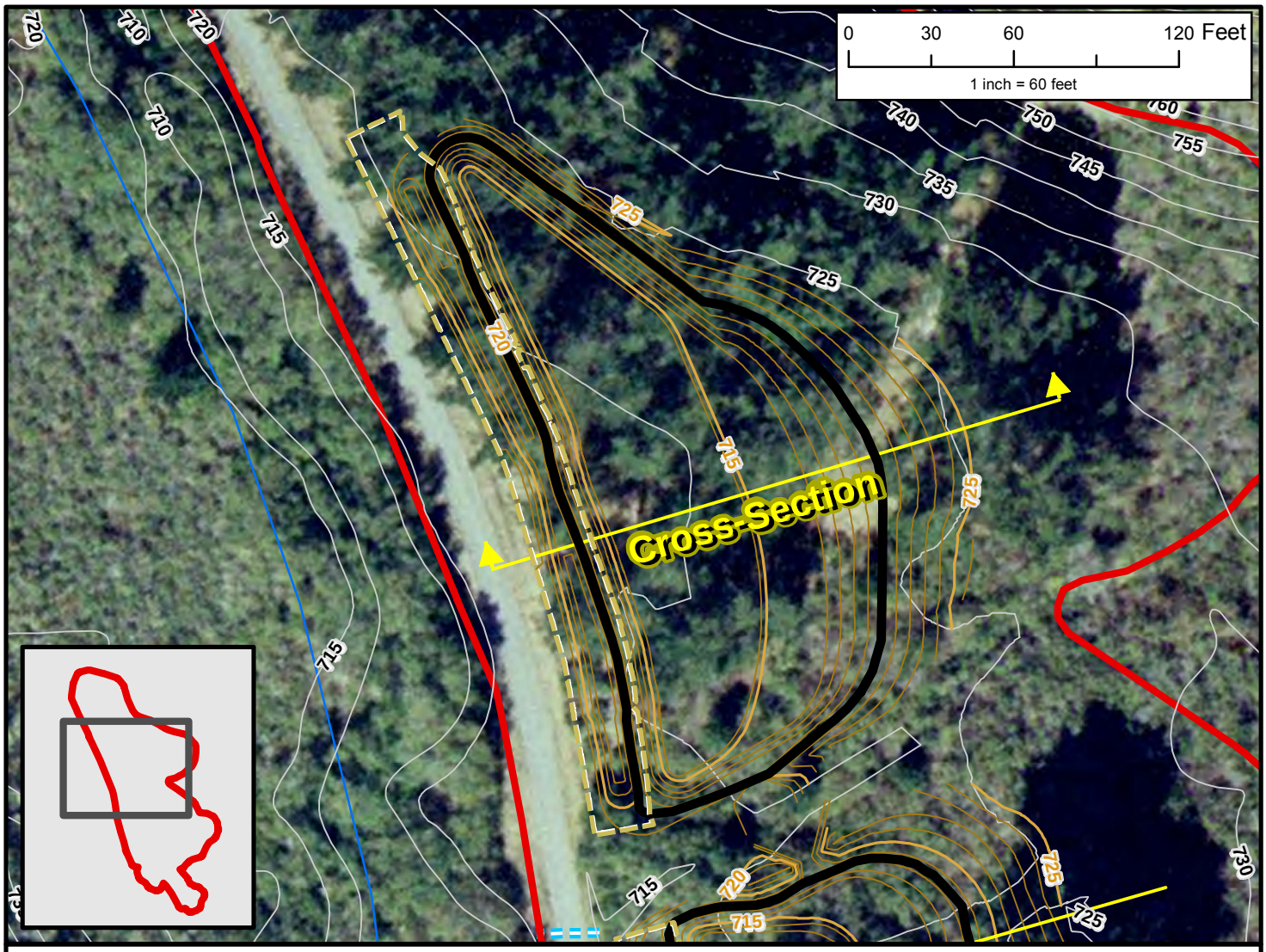

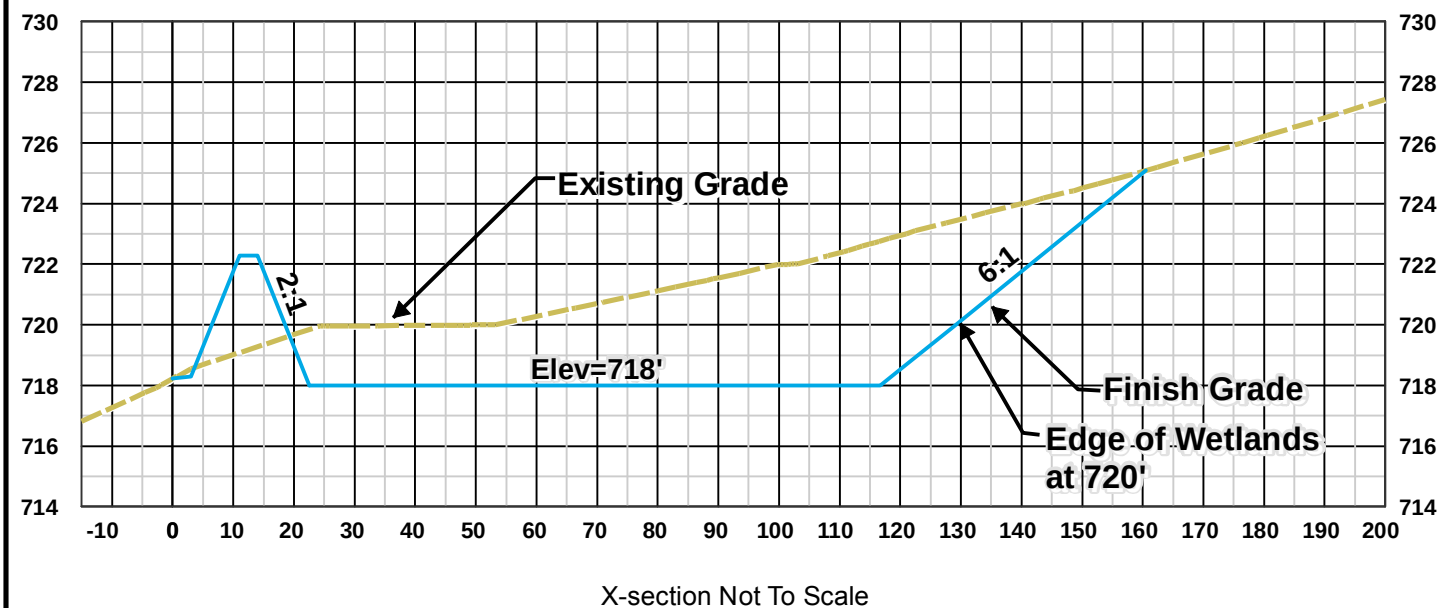

X-section Not To Scale

Existing Features

- Project Limits
- Upper San Mateo Crk
- Exisitng Contours 10-ft

Proposed Grading Plan

- Replace Existing Culvert
- Wetland Boundary
- Berm Boundary
- Index Contours 5-ft
- Contours 1-ft

Figure 8B
Upper San Mateo Creek Wetland Creation
Grading Plan and Cross-section

Projection & Coordinate System:
California State Plane NAD 83 Ft Zone 3
Lambert Conformal Conic
GCS North American 1983
Datum: D North American 1983
SFPUC: Stream & Road data source

N

San Franscisco Public Utilities Commission
Habitat Restoration Projects

Cartography	Date	Project #
GLD/RCH	9/23/10	1011410010

WINZLER & KELLY
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EUREKA, CA 95521
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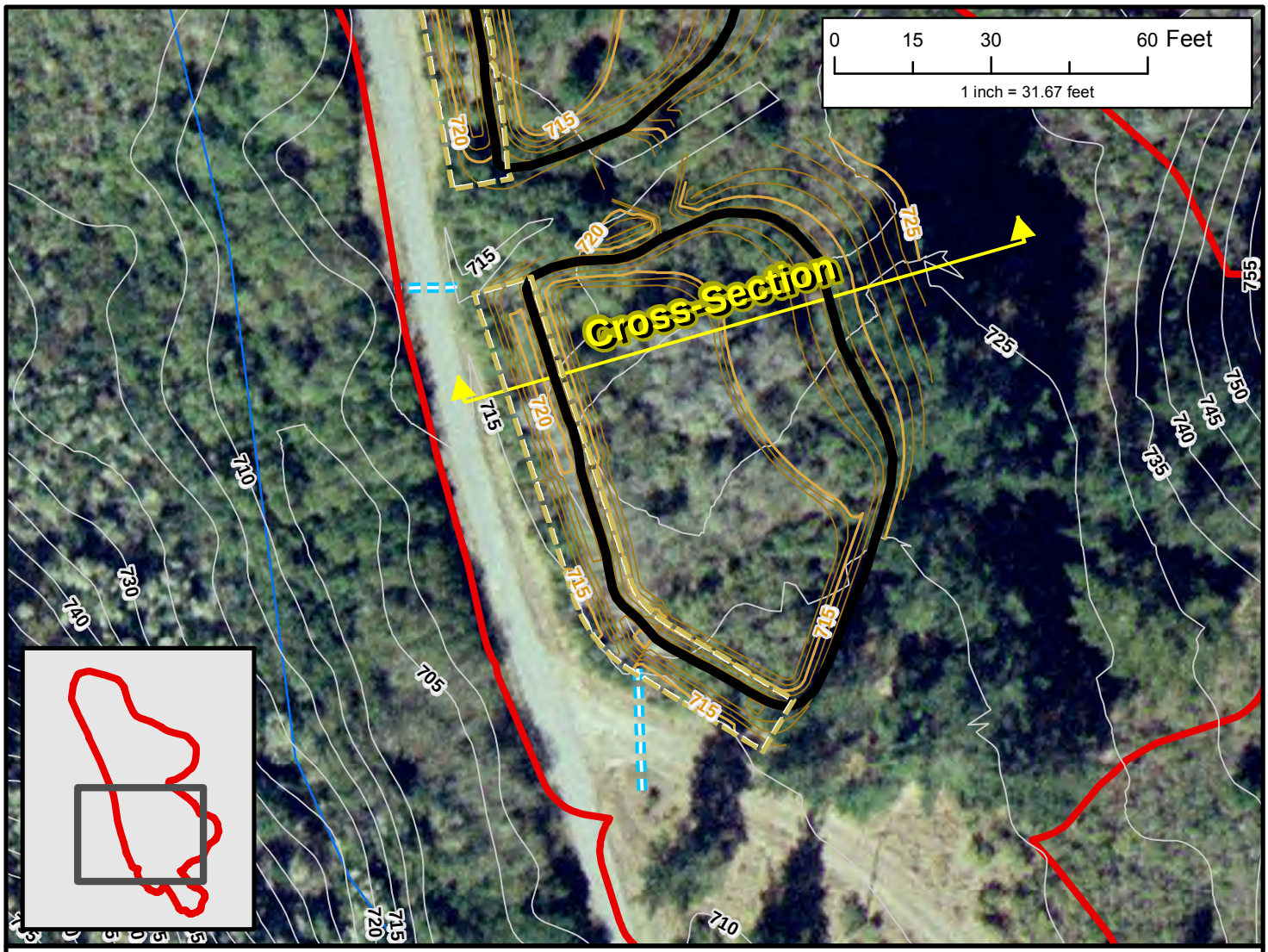

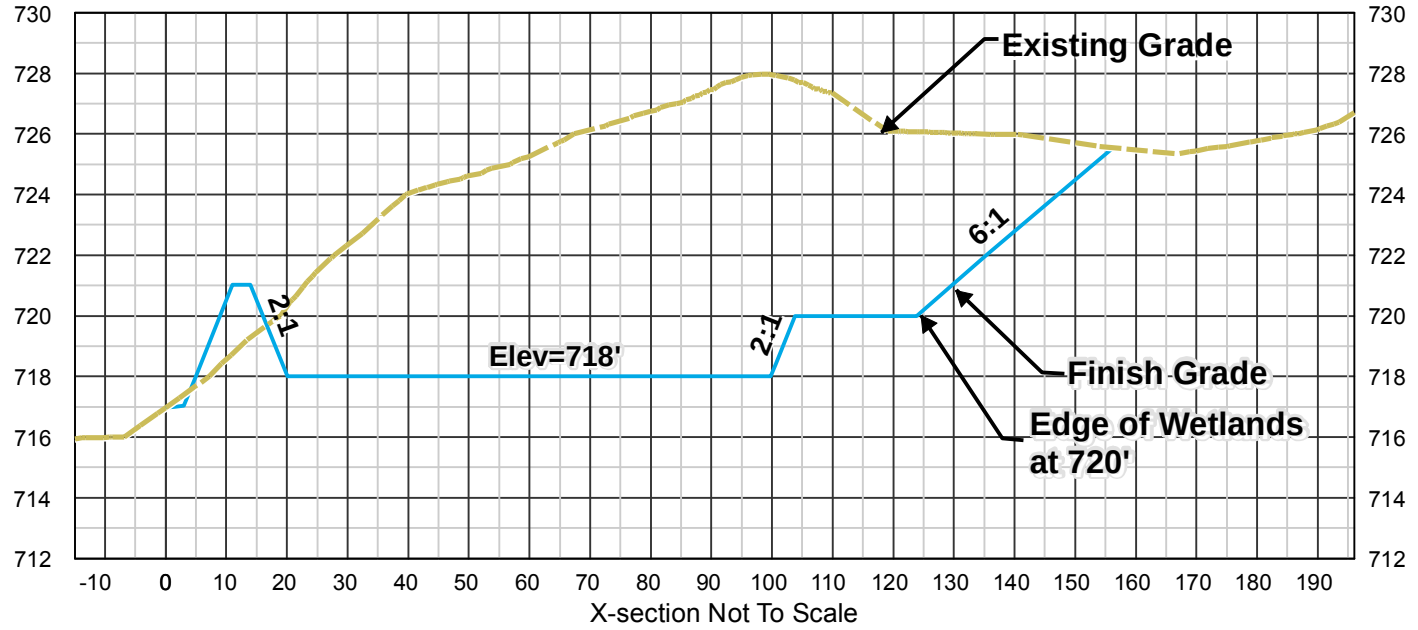

Existing Features

- Project Limits
- Upper San Mateo Crk
- Exisitng Contours 10-ft

Proposed Grading Plan

- Replace Existing Culvert
- Wetland Boundary
- Berm Boundary
- Index Contours 5-ft
- Contours 1-ft

Figure 8C
Upper San Mateo Creek Wetland Creation
Grading Plan and Cross-section

Projection & Coordinate System:
California State Plane NAD 83 Ft Zone 3
Lambert Conformal Conic
GCS North American 1983
Datum: D North American 1983
SFPUC: Stream & Road data source

N

San Franscisco Public Utilities Commission
Habitat Restoration Projects

Cartography	Date	Project #
GLD	9/23/10	1011410010

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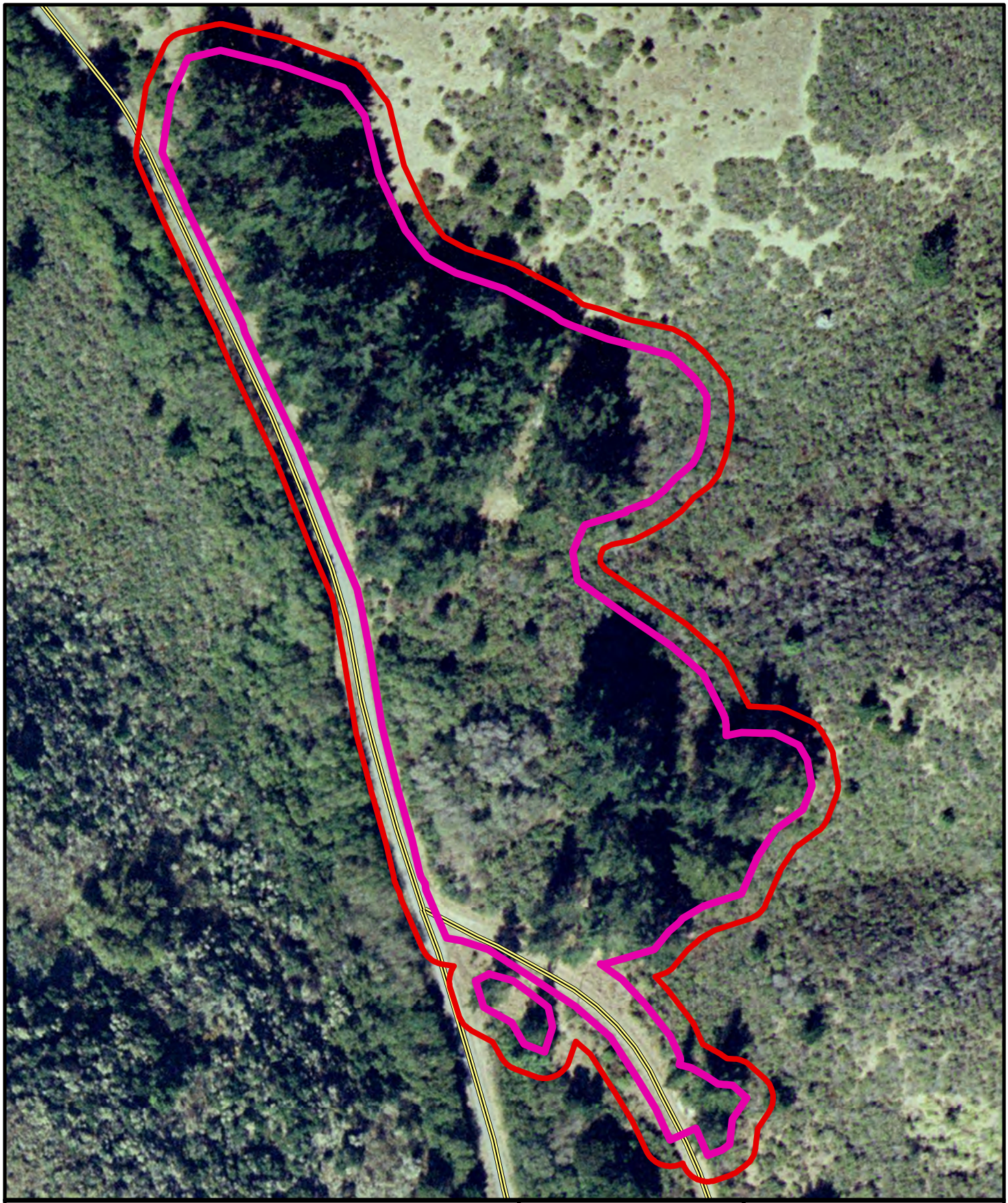


0 50 100 200 Feet

1 inch = 100 feet

Upper San Mateo Creek Project Area

Limits of Disturbance

Existing Road

Figure 9
Upper San Mateo Creek Wetland Creation
Limits of Disturbance

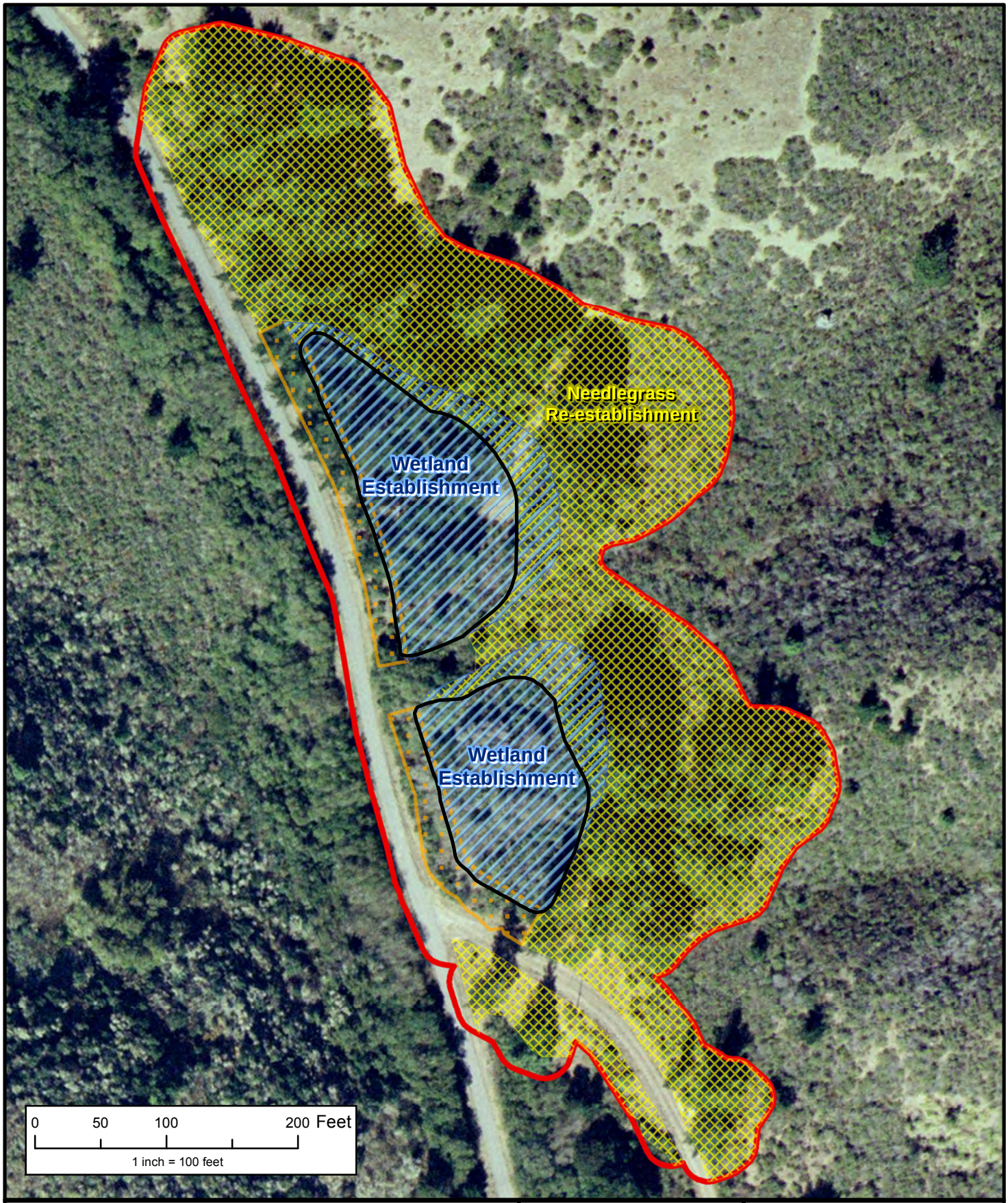
Projection & Coordinate System:
California State Plane NAD 83 Ft Zone 3
Lambert Conformal Conic
GCS North American 1983
Datum: D North American 1983

N

San Franscisco Public Utilities Commission
Habitat Restoration Projects

Cartography	Date	Project #
GLD	9/23/10	1011410010

WINZLER & KELLY
633 3RD ST
EUREKA, CA 95521
P: 707-443-8326 F: 707-444-8330



Berm

Upper San Mateo Creek Project Area

Wetland Boundary

Planting Zones

Needlegrass (Zone A)

Wetland (Zone B)

Wetland/Needlegrass Ecotone (Zones A and B)

Erosion Control (Zone C)

Figure 10
Upper San Mateo Creek Planting Plan

Projection & Coordinate System:
California State Plane NAD 83 Ft Zone 3
Lambert Conformal Conic
GCS North American 1983
Datum: D North American 1983

N

San Franscisco Public Utilities Commission
Habitat Restoration Projects

Cartography	Date	Project #
GLD	9/23/10	1011410010

WINZLER & KELLY
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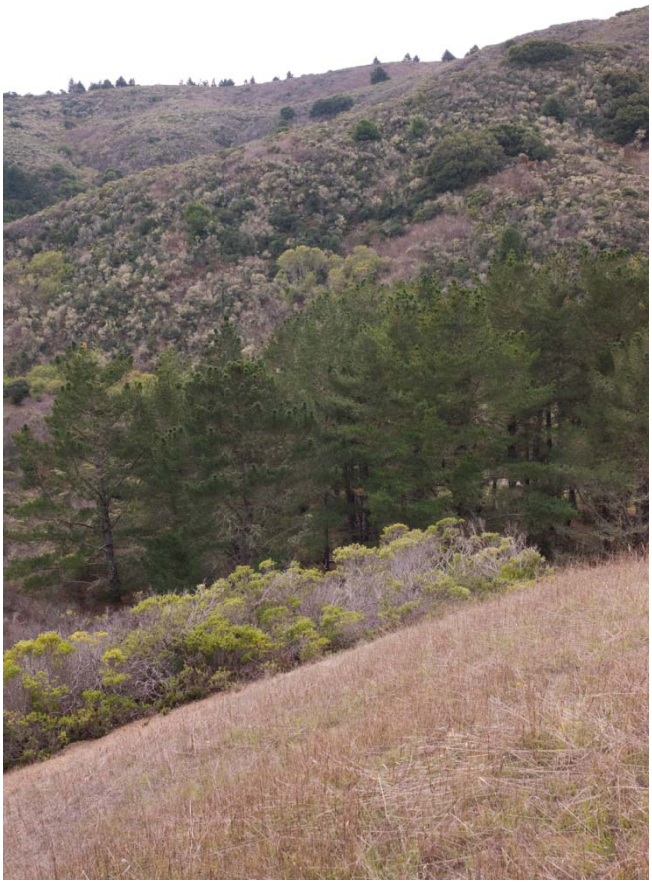
Appendix B
Site Photographs

A view of the interior of the Monterey pine stand at the Upper San Mateo Creek site.

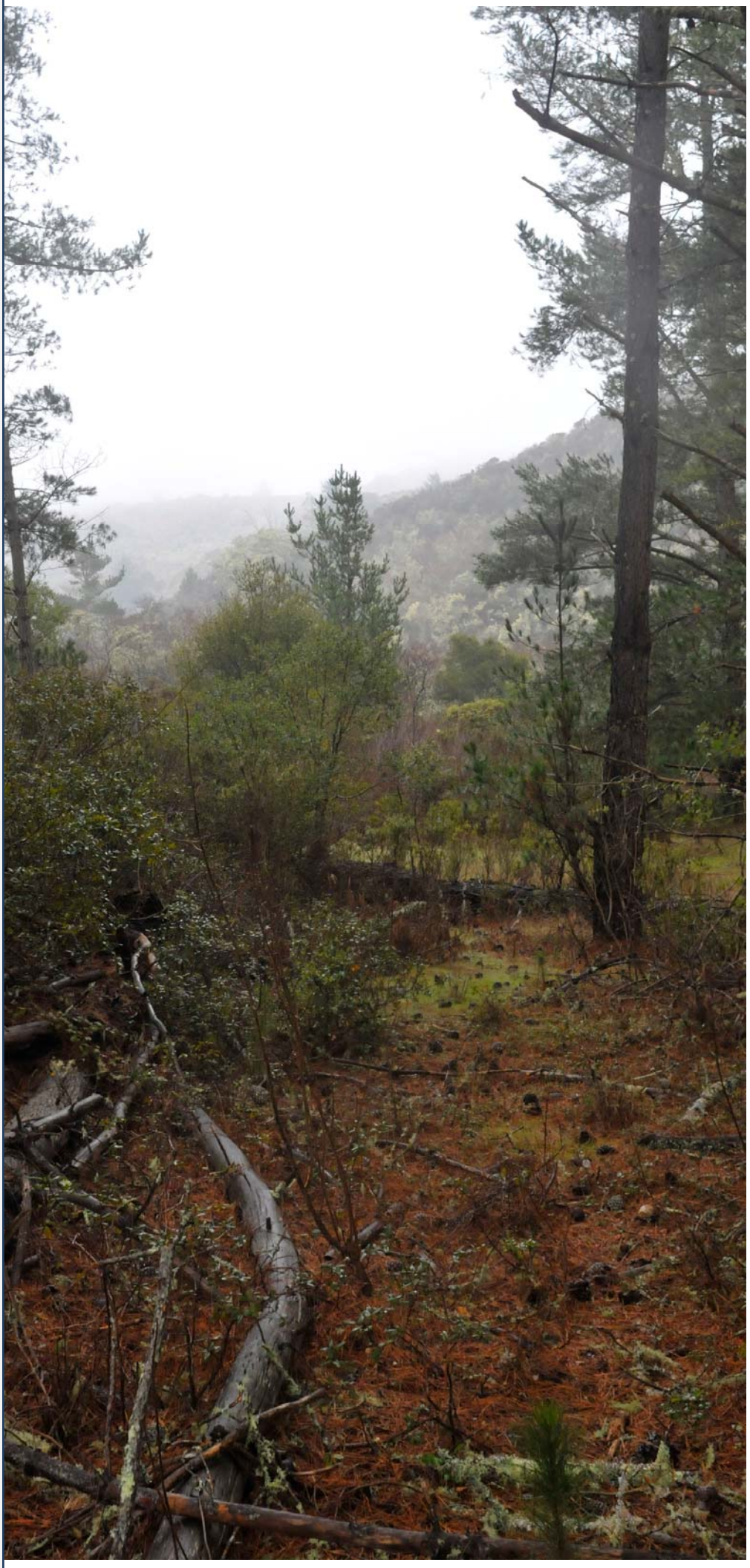
Looking southwest and down on the Upper San Mateo Creek site from the ridge immediately to the northeast. Note the two stands of Monterey pine, with a small part of the riparian corridor along San Mateo Creek and west of Pilarcitos Road just visible between the pine stands. Northern coyote brush scrub is visible in the lower left of the photo, which includes the eastern limit of the project site; and also on ridges in the background, west of Pilarcitos Road.



Another view of the northern stand of Monterey pine, looking southwest. In the foreground is annual grassland on the ridge northeast of the site.

Appendix C
Hydrology Report

Upper San Mateo Creek Hydrology Report



July 2010

Prepared for

SFPUC
WATER
HETCH HETCHY WATER & POWER
CLEAN WATER

Prepared by

WINZLER & KELLY

Section 1 Introduction

The Upper San Mateo Creek Project (Project) is included in the San Francisco Public Utilities Commission (SFPUC) Habitat Reserve Program, which mitigates for the Water System Improvement Program (WSIP). The goals of the Upper San Mateo Creek project are to provide mitigation for federally listed species, waters of the U.S. and of the State, and creation and enhancement for grasslands, riparian scrub and wetlands. The mitigation hydrologically is designed to provide foraging habitat for the California red-legged frog and San Francisco garter snake. The Project will provide habitat for the Mission Blue Butterfly and nesting habitat for the dusky-footed woodrat.

Winzler & Kelly's team is providing environmental planning, biologic, hydrologic, and engineering design services. This Report summarizes the hydrologic analysis that serves as a basis for the design of the proposed seasonal wetlands.

The purpose of this report is to present the Project design and document underlying analysis and demonstrate that the Project does not significantly alter existing hydrodynamics.

Section 2 Existing Conditions

Upper San Mateo Creek Watershed

Refer to **Figure 1** for the Project watershed. The watershed delineation was based on topographic data gathered from the SFPUC, USGS digital elevation models, and additional survey points collected by SFPUC at the project site.

Figure 2 shows the Project area. The Upper San Mateo Creek site is characterized by steep terrain to the east which drains to a valley. There is an existing intermittent creek trending east to west through the center of the site and under a road through a culvert towards Upper San Mateo Creek which terminates in Lower Crystal Springs Reservoir. Elevations within the 62-acre site range from less than 718 feet on the west to just over 780 feet on the east.

A 63-acre watershed (WS-1) drains to the Upper San Mateo Creek site. Coverage of the watershed includes shrub land, grassland, and mixed forest. The watershed characteristics are summarized in **Table 1**.

Table 1 – Watershed Characteristics

Watershed	Area (acres)	Drainage Length (ft)	High Elev (ft)	Low Elev (ft)	Δ Elev (ft)	Average Slope (ft/ft)
WS-1	63.3	2436	1176	720	456	0.19

Runoff from WS-1 is conveyed through localized gullies to the intermittent stream that bisects the project area. The intermittent stream flows west under an existing SFPUC road through a culvert to Upper San Mateo Creek which discharges into Lower Crystal Springs Reservoir.

Field Data

Figure 2 indicates the locations of stream and groundwater gages, and **Table 2** summarizes data used in this report. Winzler & Kelly installed an automated water level gage (stream gage) in the intermittent stream upstream from the existing SFPUC road crossing. Depth of flow data from the stream gage were collected on an hourly basis from January 2010 through May 2010 and was converted to flow using channel geometry from field measurements and Manning's equation. A rating curve for the channel was created for use in the hydrologic model. The stream gage data can be viewed in **Appendix A.**

Table 2 – Summary of Field Data

Source	Type	Period	Application
Winzler & Kelly	Stream Gage/Water Level	01/10 - 05/10	Hydrologic Model Calibration
Winzler & Kelly	Piezometer	03/09- 05/10	Wetland Drawdown Time
SFPUC	Rain Gage (See Table 3)	10/99 - 5/10	Hydrologic Model and Hydrologic Mode Calibration

Three piezometers were installed in the project area by Winzler & Kelly to measure the ground water levels during the spring and summer drying period. The piezometers were installed in March 2009, and monitoring occurred from the date of installation through May of 2010. Based on the two drying periods of data from the three piezometers, the groundwater recession averages 1.1 inches/day. The collected data for the three piezometers can be viewed in **Appendix A**.

Figure 2 indicates the locations of piezometers and stream gage.

Hourly Rainfall data used in this analysis were derived from the San Andreas Cottage gage station, located approximately 1 mile northeast of the project area, and from the Crystal Springs Cottage gage station, located approximately 7 miles southeast of the project area. Because of the proximity of the San Andreas Cottage gage to the project area, rain gage data from the San Andreas Cottage was the preferred data for model calibration and historical hydrologic analysis. Data from the Crystal Springs Cottage gage station were used when rainfall data from the San Andreas Cottage is not available or is incomplete. **Table 3** summarizes the rain gage used for each rainy season.

Table 3 – Summary of Rain Gage Utilized

Rainy Season	Rain Gage Data Utilized
1999/2000	San Andreas Cottage
2000/2001	San Andreas Cottage
2001/2002	San Andreas Cottage
2002/2003	-
2003/2004	Crystal Springs Cottage
2004/2005	Crystal Springs Cottage
2005/2006	San Andreas Cottage
2006/2007	Crystal Springs Cottage
2007/2008	Crystal Springs Cottage
2008/2009	Crystal Springs Cottage
2009/2010	San Andreas Cottage

The San Andreas Cottage rain gage data for January 2010 through May 2010 were correlated with the stream gage data to develop a calibrated hydrologic model of the delineated watershed. Historical rain data were entered into the calibrated model to determine the runoff volume available for the proposed wetlands on an annual basis. This volume was used as the basis for the sizing of the proposed seasonal wetlands and determining what impact, if any, retaining additional runoff in the wetland would have on existing hydrodynamics. Cumulative and rainfall data for 1999 through 2010 and incremental rainfall data for the 2009/2010 rainfall can be viewed in **Appendix A**.

Hydrologic Model

Extended Period Simulation

The United States Army Corps of Engineers hydrologic software model, HEC-HMS, was used for this analysis. An Extended Period Simulation (EPS) model was developed using rain gage data from the San Andreas Cottage and Crystal Springs Cottage gage stations. An EPS model computes runoff as a result of a rainfall event or series of events input by the user. This is different from event-based modeling, which simulates runoff from a statistical storm event, such as the 100-year, 24-hour storm. An EPS model is suited for the analysis of Upper San Mateo Creek because the design criteria for the proposed wetlands are based on the historical seasonal volume of water from the respective watershed and not on a single event. Hourly precipitation data extending from February 19, 2010, through March 6, 2010, was used to calibrate the HEC-HMS model with the observed stream gage. Once calibrated, the HEC-HMS model used hourly rain data from October 1999 through May 2010 for an analysis of the effects of dry, average and wet rainfall years on the proposed wetlands.

The HEC-HMS model was calibrated by adjusting parameters of each sub-watershed within a threshold in order to match observed stream flow with modeled values for the watershed. The parameters adjusted were the rainfall losses associated with infiltration and the storage coefficient within the hydrograph convolution method.

Rainfall Losses

The Deficit Constant Loss method was used to account for losses due to infiltration. This method is appropriate for extended period simulations as it accounts for evapotranspiration and the resulting

drying of soil in between storms. Initial inputs are based on NRCS soil properties shown in **Appendix B**. The model modifies the most sensitive parameter, the constant rate of loss (inches/hour), during model calibration. **Appendix C** shows the watershed's final values for the rainfall losses.

Hydrograph Convolution

The Clark Unit Hydrograph synthetic unit hydrograph method was used for hydrograph convolution. This method uses time of concentration to define the maximum travel time within a sub-watershed and applies a storage coefficient to simulate attenuation of flow. The storage coefficient, R, is an index of precipitation excess in the watershed as it drains to the outlet point. Though R has units of time (hr), there is only a qualitative meaning for the value. As recommended by the *Hydrologic Modeling System HEC-HMS Technical Reference Manual* (March 2000), "R can be estimated via calibration if gaged precipitation and stream flow data are available." The HEC-HMS model was used in conjunction with the observed 2009/2010 rainfall and stream gage data to estimate the value of R. **Appendix C** shows the calibrated parameters.

Calibrated Model

The calibrated HEC-HMS existing conditions model using 2009/2010 rainfall and stream gage data predicts the peak flow and volume within an acceptable level of accuracy. The model output hydrograph and the observed hydrograph are shown in **Figure 3**. **Table 4** compares observed versus modeled output.

Table 4 - Output Comparison

	Peak Flow (cfs)	Time of Peak Flow	Total Runoff Volume (ac-ft)
Computed Results	5.1	3/3/2010 06:10	22.3
Observed Stream Gage Results	4.0	3/3/2010 08:00	13.2

Section 3 Proposed Wetlands

Design Criteria

The proposed wetlands are designed to serve as seasonal wetlands, defined for the purpose of this project as foraging habitat for California red-legged frogs, San Francisco garter snakes and other California species of concern. During an average year of rainfall, the wetlands are designed to hold water until early June. The wetlands are designed to err on the wet side, meaning that staying wet after June in a wet year is preferable to drying before June in a dry year.

Based on information provided by SFPUC, Swaim Biological, and local successful frog ponds, Winzler & Kelly developed conceptual elements for the proposed wetlands. Design concepts include incorporation of a mild bank slope into a shallow end to allow access and to promote vegetative growth, incorporation of a steep bank slope at a deep end to provide shelter from predators and incorporation of structure within the pond for additional shelter. The proposed grading plan will be based on these concepts.

Geometry

The size of the proposed wetlands is limited by site constraints, such as topography and available volume of water from the respective watersheds. The area and depth of the proposed wetlands

maximizes the 1-acre (4 acre-feet) of created seasonal wetlands required for mitigation and minimizes the volume of water diverted. Once the wetlands are at capacity, water will not be diverted towards the wetlands, thus reducing the impact to downstream waters.

The proposed wetlands will have varying depths with a maximum ponding depth of 4 feet and a footprint of 1-acre creating approximately 4 acre-feet of combined storage between the north and south wetland. The wetlands are identified (north/south) by their respective location in relationship to the intermittent stream.

Hydrologic Model

Wetland Filling

The calibrated HEC-HMS model was used to quantify the volume of runoff available for the proposed wetlands. Based on the calibrated HEC-HMS model for the 2009/2010 rainy season, there was approximately 80 acre-feet of available runoff to support the proposed wetland. **Table 4** provides the calculated historical volume of water available to the proposed wetlands. As shown in the table, the proposed size of the wetlands is a negligible percentage of the total available volume, therefore, the existing hydrodynamics are not being significantly altered. The historical volume quantities are based on hourly rainfall data from the San Andreas Cottage and Crystal Springs Cottage rain gages from October 1999 through March 2010 and the calibrated HEC-HMS model. Based on the historical rain data, the proposed wetlands are likely to fill after the first two storm events.

Table 5 – Historical Water Volume

Rainy Season	WS-1 (ac-ft)	Classification
1999/2000	131	Wet
2000/2001	81.1	Average
2001/2002	73.4	Average
2003/2004	68.8	Dry
2004/2005	111	Wet
2005/2006	169	Wet
2006/2007	32.2	Dry
2007/2008	78.1	Average
2008/2009	72.3	Average
2009/2010	79.6	Wet

*2002/2003 data not shown because of missing rainfall data for that season

Wetland Draining/Recession Model

A hydrologic recession model was also used to determine when the water surface elevation (WSE) begins to recede. The hydrologic recession model accounts for the WSE after the last rainfall event and begins draining the pond due to losses. The losses in the pond are associated with infiltration and evapotranspiration. The infiltration rate, 1.1 inches per day, is based on the piezometer groundwater recession trend from the two years of data. The bottom of the wetlands will be compacted to reduce the infiltration rate and allow the wetlands to retain water for a longer period of time to encourage red-legged frog breeding. Based on "Effect of Urban Soil Compaction on Infiltration Rate" published in the

Journal of Soil and Water Conservation, the effective infiltration rate can be reduced by 70 to 90 percent due to soil compaction. Therefore, the infiltration rate measured by the piezometers (1.1 inch/day) will be reduced by 70 percent to 0.33 inches per day to account for the compaction.

The evapotranspiration rates are based on monthly averages from the California Irrigation Management Information System (CIMIS) evapotranspiration gage #96 located in Woodside, CA. Average evapotranspiration rates are shown in **Appendix C.,** and range from 1.83 to 6.47 inches per month.

Based on the calibrated hydrologic runoff model, hydrologic pond recession model, and the proposed wetland geometry, the estimated date that the proposed wetland would dry is summarized in **Table 6**. The recession of the WSE can be viewed in **Figure 4**.

Table 6 – Estimated Historical Drying Date for the Proposed Wetlands

Rainy Season	Estimated Dry Date	Classification
1999/2000	June 16, 2000	Wet
2000/2001	June 13, 2001	Average
2001/2002	June 15, 2002	Average
2003/2004	June 8, 2004	Dry
2004/2005	July 2, 2005	Wet
2005/2006	July 17, 2006	Wet
2006/2007	June 6, 2007	Dry
2007/2008	June 5, 2008	Average
2008/2009	June 12, 2009	Average
2009/2010	July 27, 2010	Wet

Proposed Lateral Weirs

As part of the wetland design, water will be diverted to the proposed wetlands by way of a north and south lateral weir conveying water the respective wetland. The goal of the lateral weirs, location shown in **Figure 2**, is to provide water to the wetlands once the water level within the creek has reached a certain elevation. Based on the observed water level (see **Figure 5**) and measured depth (2 feet) of the intermittent creek, and historical rain data, the stream has not overtopped its banks in the last 10 years. Lateral weirs are needed to transmit flow from the creek to the wetlands.

Table 7 shows the peak flow within the channel and the corresponding water level at the location of the proposed lateral weirs.

Table 7 – Peak Flow and Water Level in the Intermittent Creek

Rainy Season	Peak Flow (cfs)	Water Level (ft)
1999/2000	11.0	1.23
2000/2001	7.7	1.07
2001/2002	11.8	1.27
2003/2004	9.0	1.14
2004/2005	5.8	0.96
2005/2006	14.0	1.36
2006/2007	3.7	0.80
2007/2008	13.9	1.35
2008/2009	9.2	1.15
2009/2010	10.8	1.22

A weir crest elevation set 0.4 feet above the invert of the intermittent stream would divert only the peak flow and supply the wetlands with the required flow to support CRLF. The weir was sized using the weir equation with parameters shown in **Table 8**.

Figure 5 indicates that the peak water level associated with most of the storm events reached or exceeded 0.4 feet within the creek. Only the water that exceeds 0.4 feet will be diverted towards the wetlands and the remaining volume of water below 0.4 feet will be conveyed to Upper San Mateo Creek. This design minimizes impacts to downstream receiving waters while providing runoff to the wetlands multiple times a year. When the wetlands are at capacity, flow will remain in the intermittent channel.

Figure 6 shows the resulting rating curve for the lateral weirs. The curve shows the relationship between diverted flow and flow within the intermittent stream upstream of the lateral weirs.

Table 8 – Lateral Weir Design Parameters

Weir Crest Height	0.4 ft
Weir Crest Length	3.0 ft
Weir Coefficient	3.3

Based on the proposed lateral weirs and HEC-HMS model results, **Table 9** shows the date the proposed wetlands would have reached capacity.

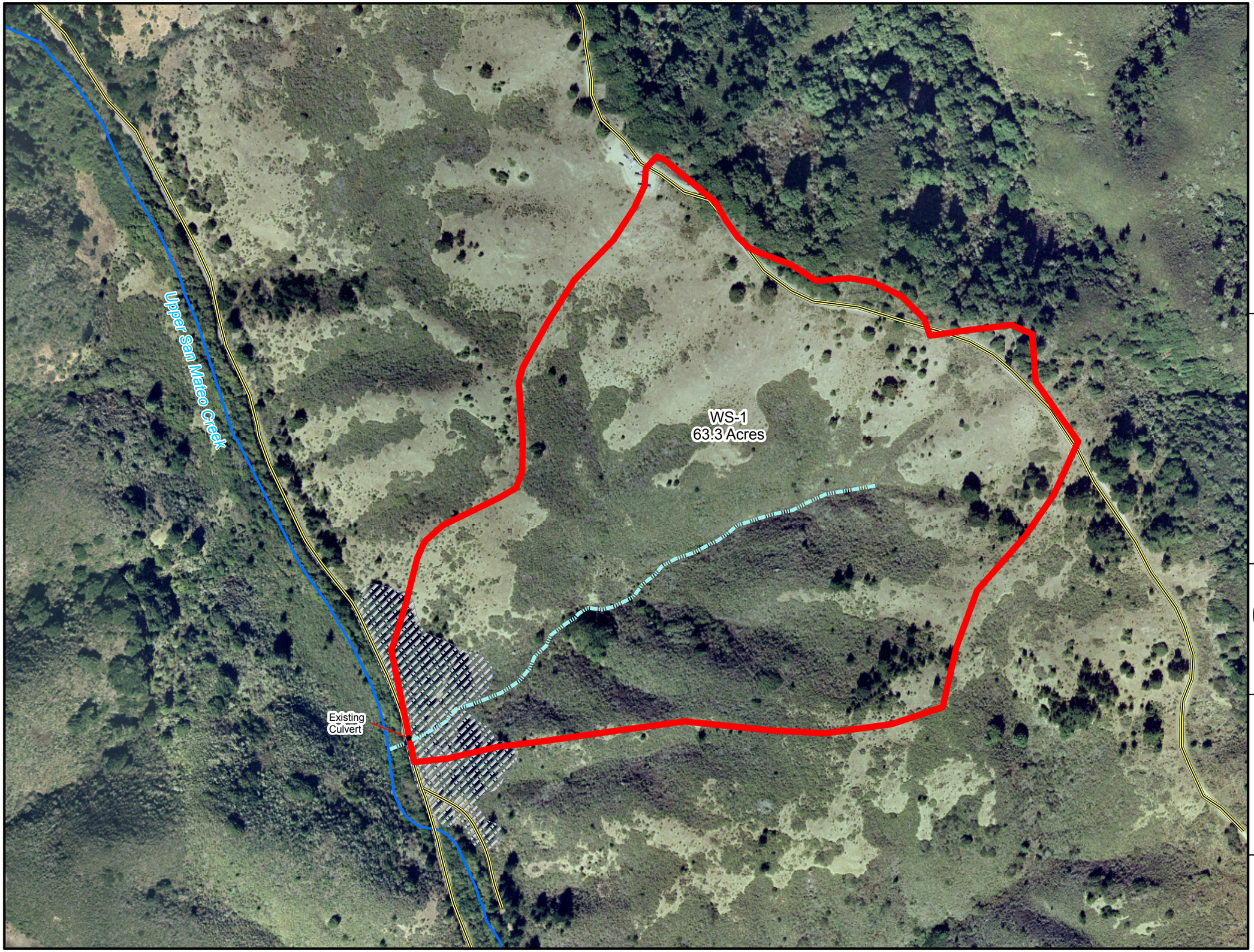
Table 9 – Wetland Capacity Date

Rainy Season	Wetland Capacity Date
1999/2000	January 19, 2000
2000/2001	January 11, 2001
2001/2002	November 13, 2001
2003/2004	December 15, 2003
2004/2005	October 21, 2004
2005/2006	December 18, 2005
2006/2007	February 11, 2007
2007/2008	January 5, 2008
2008/2009	December 26, 2008
2009/2010	January 19, 2010

Section 3 Conclusion

Based on the hydrologic analysis and information provided by SFPUC, the watershed to the proposed wetlands provide sufficient runoff to sustain the wetlands and be provide foraging habitat for California red-legged frogs and San Francisco garter snakes. Based on calibrated models, the wetlands will be at capacity after the first couple significant rainfall event and would drain by early to mid June.

FIGURES



CITY AND COUNTY OF
SAN FRANCISCO
PUBLIC UTILITIES COMMISSION

SFPUC
WATER
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HABITAT RESERVE PROGRAM
UPPER SAN MATEO CREEK
CONTRACT NO. WD-2641

WINZLER & KELLY

Legend

- Intermittent Stream
- Watershed Boundary
- Existing Culvert
- Existing Road
- Project Area
- Permanent Stream

N

0 75 150 300 Feet
1 inch = 300 feet

WATERSHED DELINEATION MAP

FIGURE
1

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION

SFPUC
WATER
HETCH HETCHY WATER & POWER
CLEAN WATER

HABITAT RESERVE PROGRAM
UPPER SAN MATEO CREEK
CONTRACT NO. WD-2641

WINZLER & KELLY

Legend

- Project Area
- Proposed Wetland
- Stream Gage
- Piezometer
- Intermittent Stream
- Existing Culvert
- Existing Road
- Permanent Stream

N

0 25 50 100 Feet
1 inch = 100 feet

PROJECT AREA MAP

FIGURE
2

Figure 3 - Upper San Mateo Creek Flow Calibration

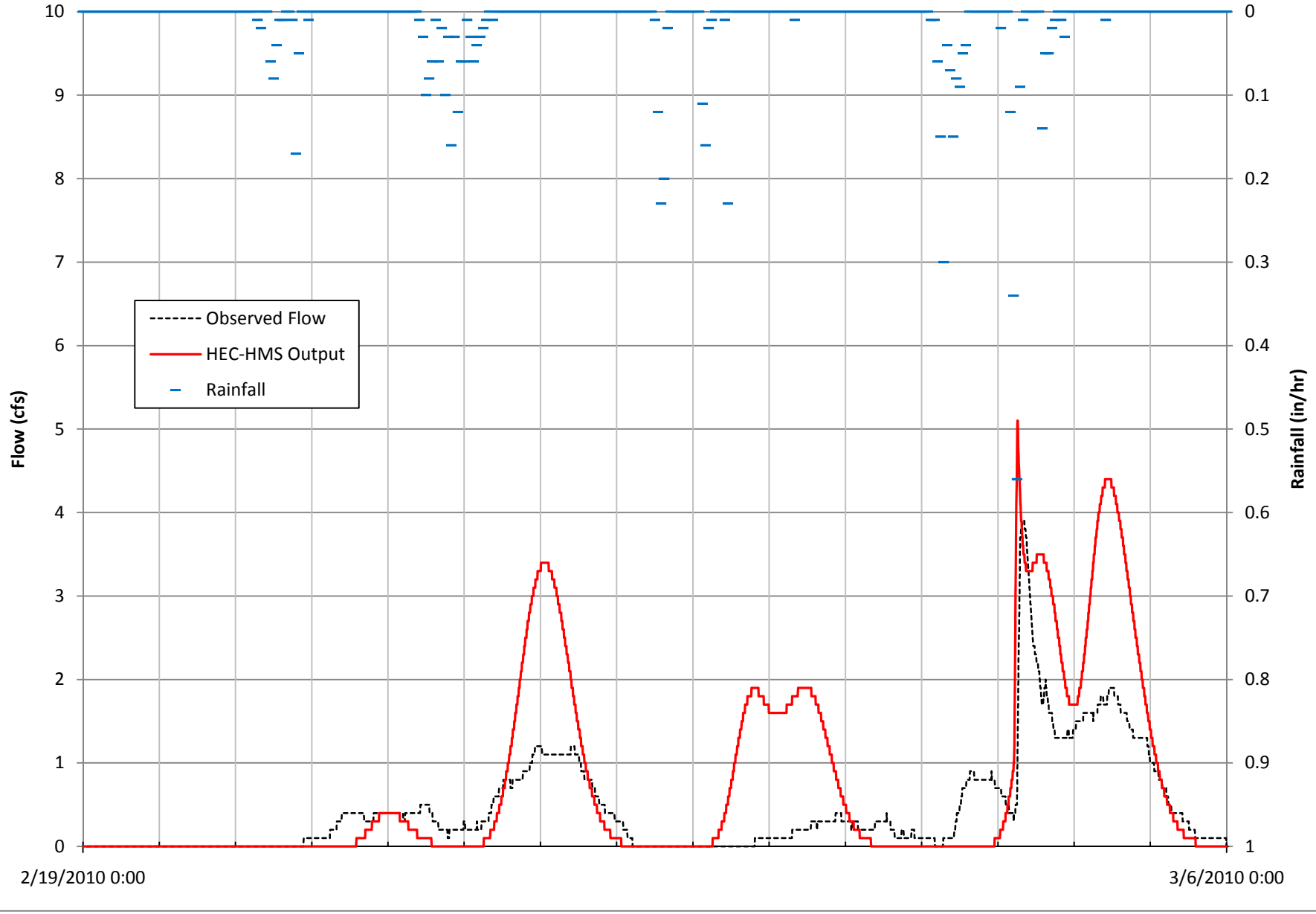


Figure 4 - Proposed Wetland Historical "Dry" Date

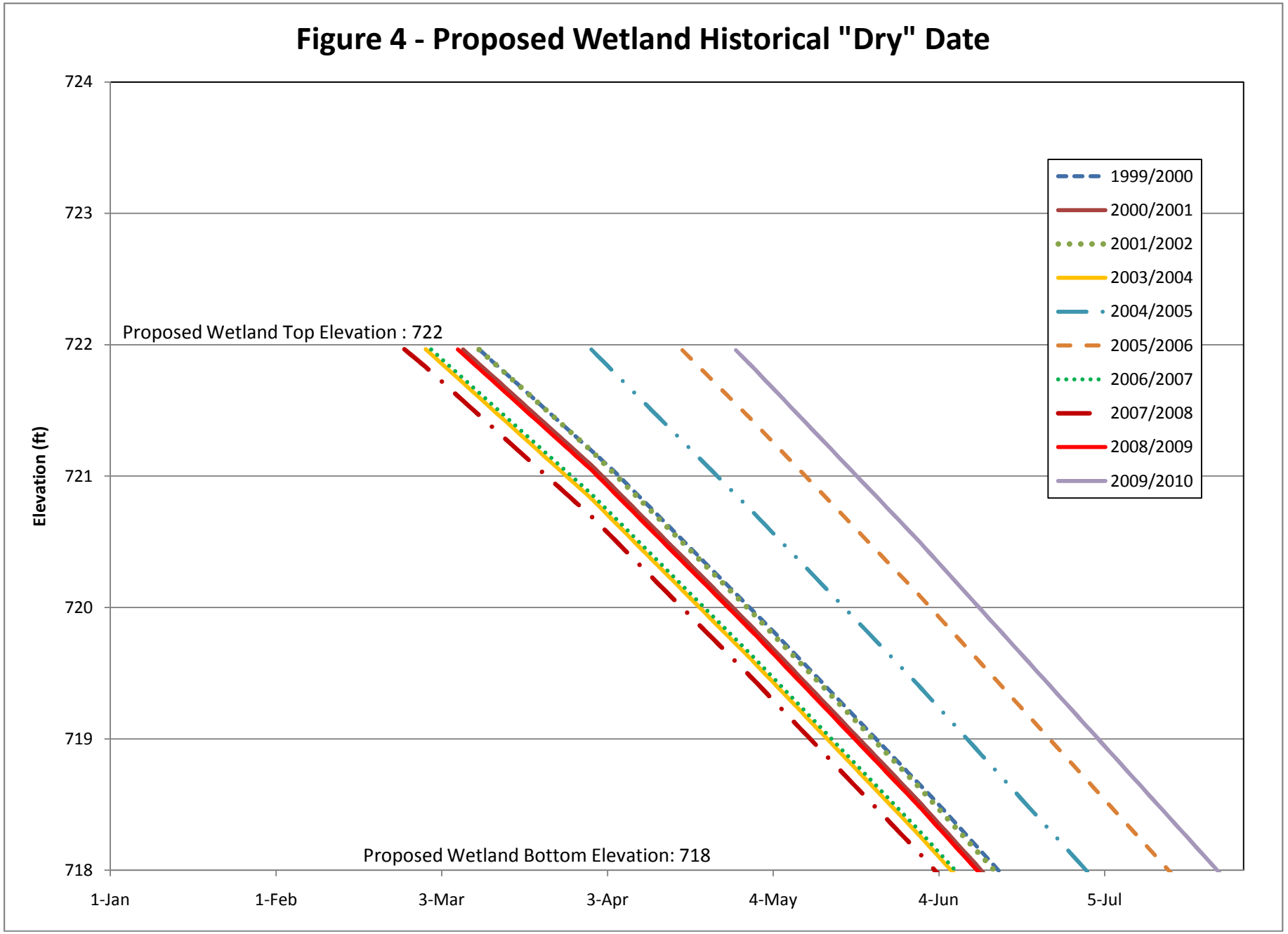


Figure 5 - Intermittent Creek Water Level

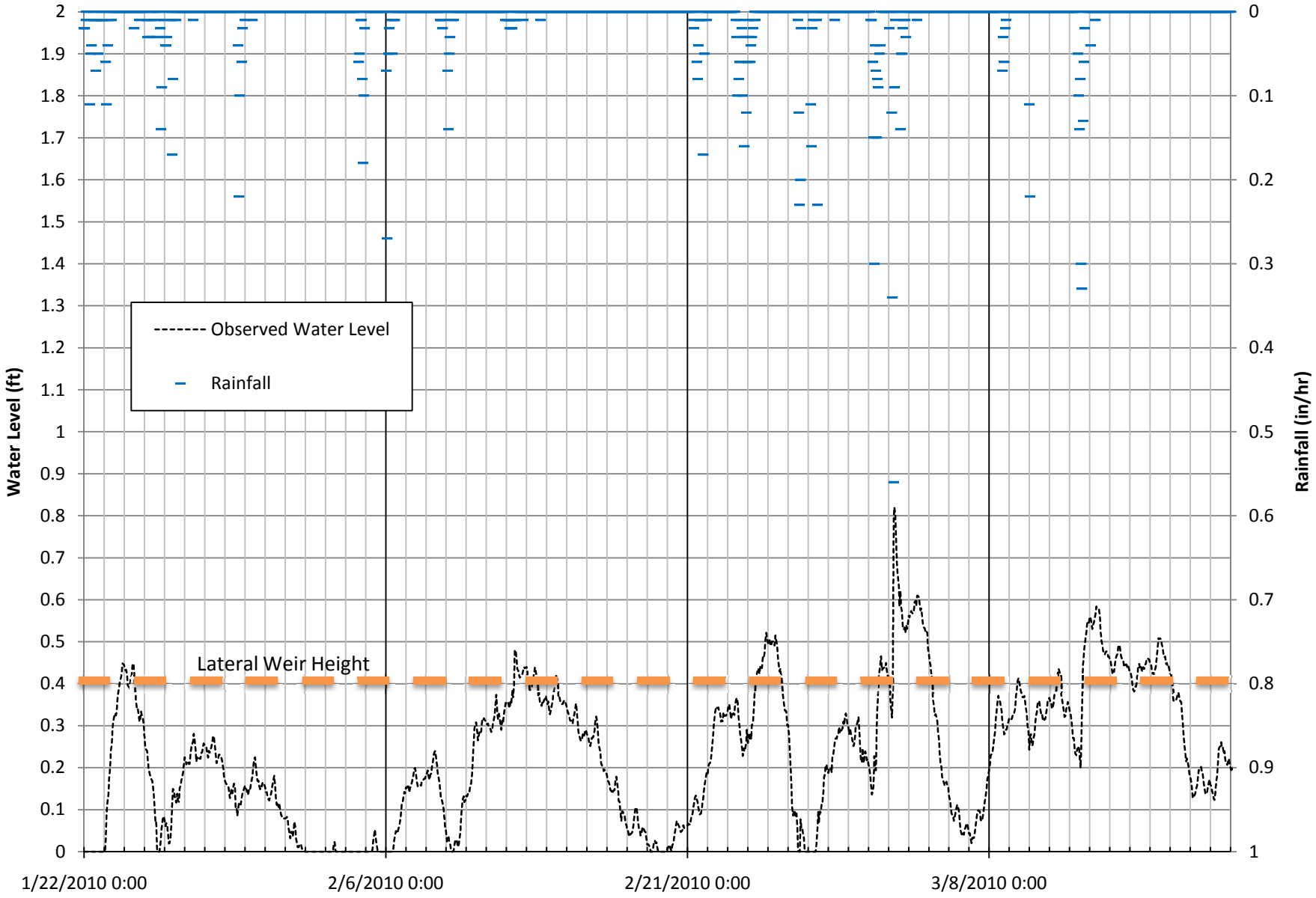
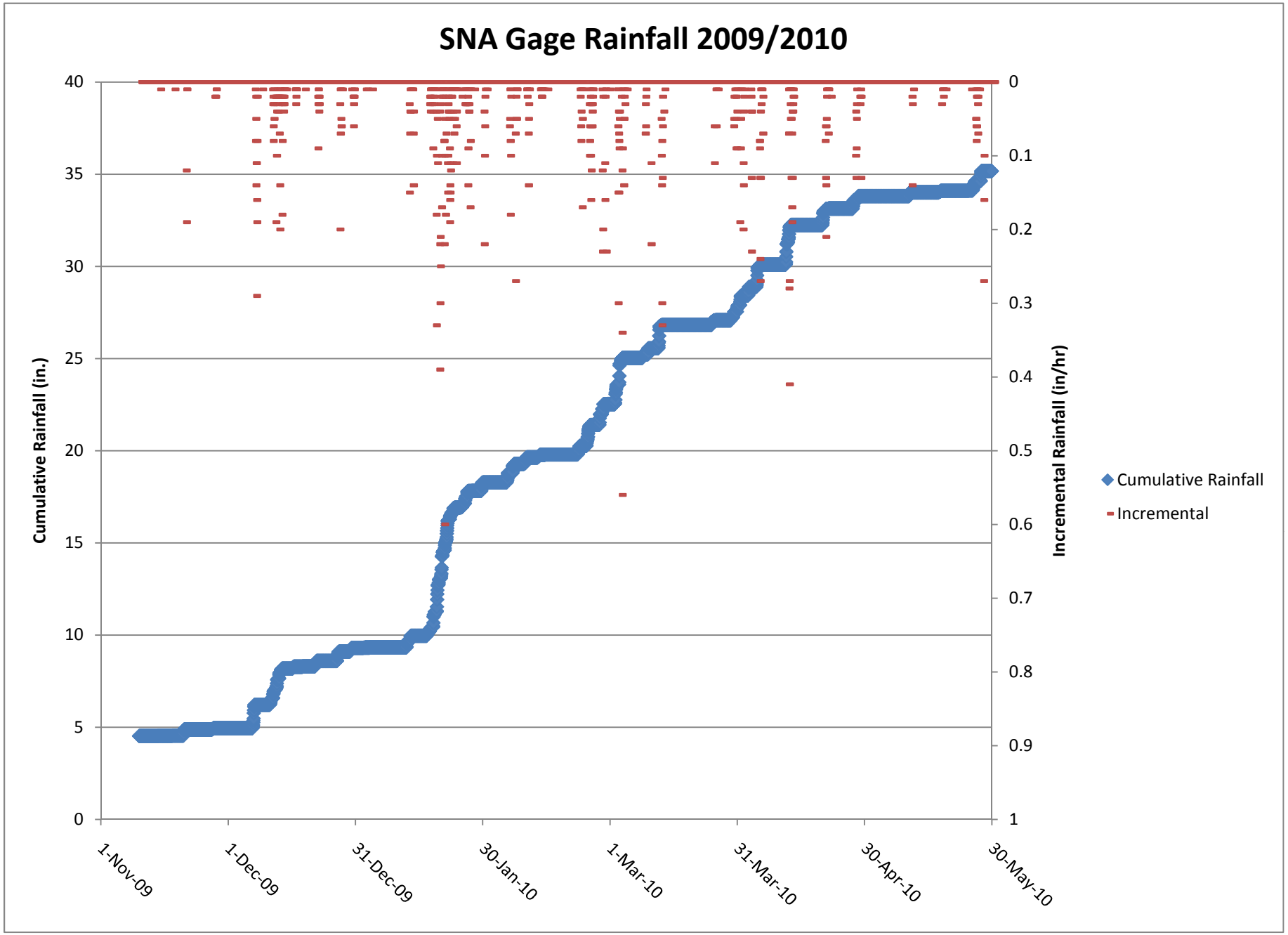


Figure 6 - Lateral Weir Rating Curve

APPENDIX A
STREAM, PIEZOMETER & RAINFALL GAGE DATA


SNA Gage Rainfall 2009/2010
Cumulative Rainfall (in.)
Incremental Rainfall (in/hr)
0
5
10
15
20
25
30
35
40
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1-Nov-09
1-Dec-09
31-Dec-09
30-Jan-10
1-Mar-10
31-Mar-10
30-Apr-10
30-May-10
Cumulative Rainfall
Incremental

Cumulative Rainfall Summary

Rainy Season	Rain Gage Data Utilized	Cumulative Rainfall (in.)
1999/2000	San Andreas Cottage	34.83
2000/2001	San Andreas Cottage	26.40
2001/2002	San Andreas Cottage	23.62
2002/2003	-	-
2003/2004	Crystal Springs Cottage	21.06
2004/2005	Crystal Springs Cottage	36.25
2005/2006	San Andreas Cottage	44.46
2006/2007	Crystal Springs Cottage	15.46
2007/2008	Crystal Springs Cottage	21.94
2008/2009	Crystal Springs Cottage	20.96
2009/2010	San Andreas Cottage	35.23

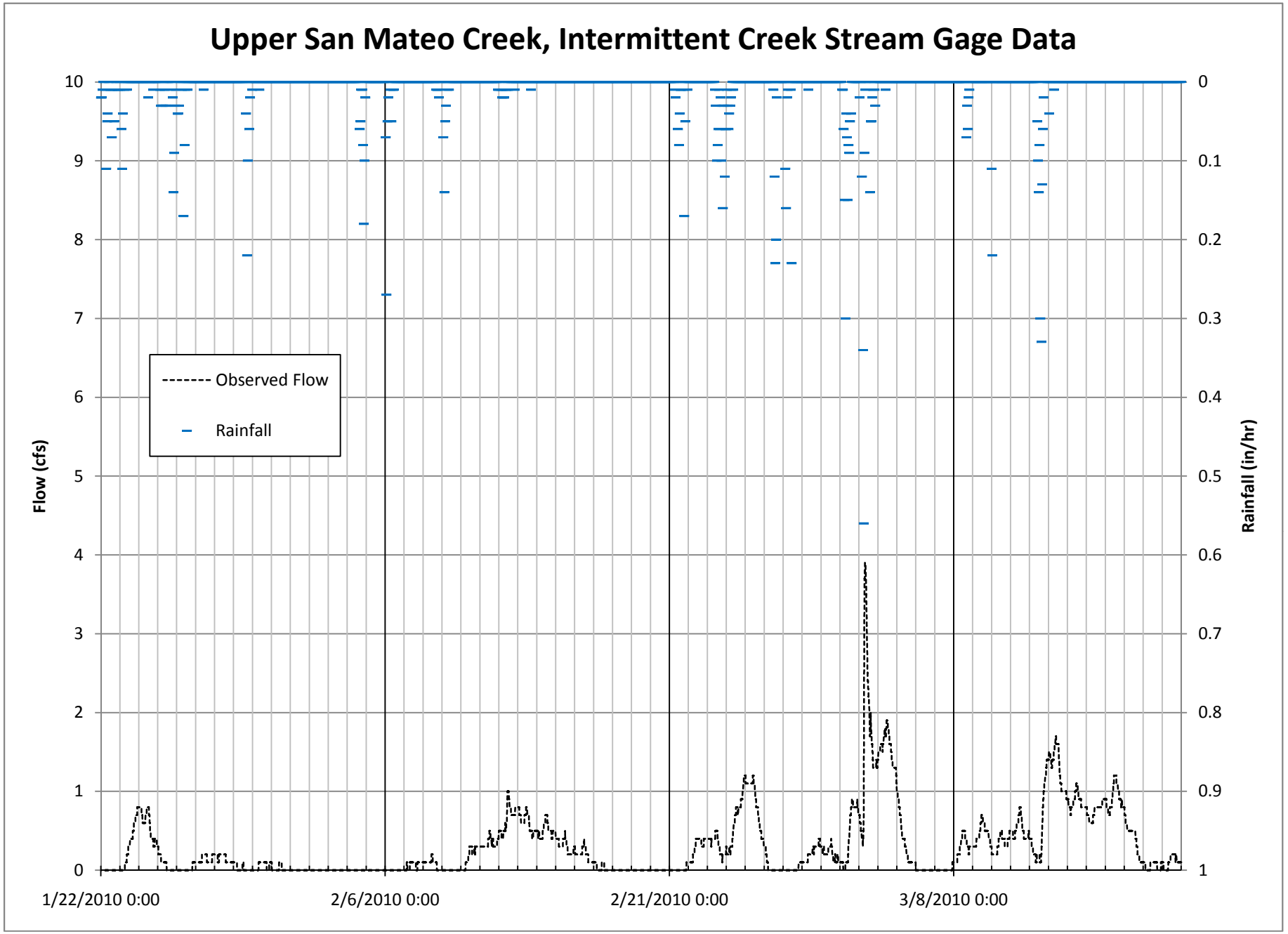
Average	28.02
Median	25.01

Upper San Mateo Creek Wetland Piezometers			
	Depth to Ground Water (ft)		
Date	B1	B2	B3
3/6/2009	1.60	3.24	2.30
3/13/2009	3.35	3.90	3.40
3/16/2009	3.60	4.20	3.60
3/20/2009	3.65	4.35	3.75
3/23/2009	3.57	4.25	3.78
3/28/2009	3.30	4.17	3.82
4/3/2009	3.95	5.15	4.78
4/10/2009	4.45	ND	ND
4/17/2009	ND	ND	ND
2/12/2010	2.90	4.10	3.00
2/18/2010	3.50	4.25	3.40
2/25/2010	2.25	3.80	2.70
3/4/2010	0.95	2.95	1.70
3/19/2010	2.50	3.85	3.35
3/26/2010	3.60	4.50	4.15
4/30/2010	3.15	4.40	4.45
5/7/2010	4.25	ND	ND

*ND - Non Detect - Ground water lower than Piezo

Year	Drawdown (in/day)		
2009	1.06	0.98	1.09
2010	1.45	0.85	1.34
Average	1.25	0.91	1.21

Total Average 1.13


Upper San Mateo Creek, Intermittent Creek Stream Gage Data
Flow (cfs)
Rainfall (in/hr)
Observed Flow
Rainfall
10
9
8
7
6
5
4
3
2
1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1/22/2010 0:00
2/6/2010 0:00
2/21/2010 0:00
3/8/2010 0:00

APPENDIX B
NRCS SOIL DATA


122° 25' 38"
122° 24' 58"
37° 34' 29"
37° 34' 28"
37° 34' 7"
550600
550700
550800
550900
551000
551100
551200
551300
551400
551500
4158700
4158600
4158500
4158400
4158300
4158200
137
105
110
111
Map Scale: 1:4,690 if printed on A size (8.5" x 11") sheet.
N
Meters
0 50 100 200 300
Feet
0 250 500 1,000 1,500

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features

- Cities

Water Features

- Oceans
- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:4,690 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Mateo County, Eastern Part, and San Francisco County, California
Survey Area Data: Version 6, Mar 13, 2008

Date(s) aerial images were photographed: 6/12/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — San Mateo County, Eastern Part, and San Francisco County, California				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
105	Barnabe-Candlestick complex, 30 to 75 percent slopes	D	0.6	1.1%
110	Candlestick-Kron-Buriburi complex, 30 to 75 percent slo pes	C	54.9	94.5%
111	Candlestick variant loam, 2 to 15 percent slopes	B	0.2	0.3%
137	Zeni-Zeni variant gravelly loams, 30 to 75 percent slopes	C	2.4	4.1%
Totals for Area of Interest			**58.1**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: *None Specified*

Tie-break Rule: Lower


122° 25' 38"
122° 24' 58"
37° 34' 29"
37° 34' 28"
37° 34' 7"
550600
550700
550800
550900
551000
551100
551200
551300
551400
551500
4158700
4158600
4158500
4158400
4158300
4158200
137
105
110
111
Map Scale: 1:4,690 if printed on A size (8.5" x 11") sheet.
N
Meters
0 50 100 200 300
Feet
0 250 500 1,000 1,500

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

- <= 4.7236
- > 4.7236 AND <= 7.9672
- > 7.9672 AND <= 9
- > 9 AND <= 20.4
- Not rated or not available

Political Features

- Cities

Water Features

- Oceans
- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:4,690 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: San Mateo County, Eastern Part, and San Francisco County, California
Survey Area Data: Version 6, Mar 13, 2008

Date(s) aerial images were photographed: 6/12/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Saturated Hydraulic Conductivity (Ksat)

Saturated Hydraulic Conductivity (Ksat)— Summary by Map Unit — San Mateo County, Eastern Part, and San Francisco County, California				
Map unit symbol	**Map unit name**	**Rating (micrometers per second)**	**Acres in AOI**	**Percent of AOI**
105	Barnabe-Candlestick complex, 30 to 75 percent slopes	20.4000	0.6	1.1%
110	Candlestick-Kron-Buriburi complex, 30 to 75 percent slo pes	7.9672	54.9	94.5%
111	Candlestick variant loam, 2 to 15 percent slopes	4.7236	0.2	0.3%
137	Zeni-Zeni variant gravelly loams, 30 to 75 percent slopes	9.0000	2.4	4.1%
Totals for Area of Interest			**58.1**	**100.0%**

Description

Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

The numeric Ksat values have been grouped according to standard Ksat class limits.

Rating Options

Units of Measure: micrometers per second

Aggregation Method: Dominant Component

Component Percent Cutoff: *None Specified*

Tie-break Rule: Fastest

Interpret Nulls as Zero: No

Layer Options: All Layers

APPENDIX C
CALIBRATION DATA

Watershed Calibrated Parameters

	Rainfall Loss Parameters			Hydrograph Convolution Parameters	
Watershed	Initial Deficit (in)	Maximum Deficit (in)	Constant Loss Rate (in/hr)	Time of Concentration (hr)	Strorage Coefficient (hr)
WS-1	0.22	1.00	0.4050	0.29	2.00

Evapotranspiration Rates

Month	Evapotranspiration Rate (in/month)
January	1.83
February	2.2
March	3.42
April	4.84
May	5.61
June	6.26
July	6.47
August	6.22
September	4.84
October	3.66
November	2.36
December	1.83

Based on CIMIS Gage #96 in Woodside, CA

Appendix D
Soils Information

WINZLER & KELLY

TECHNICAL MEMORANDUM

Ref: 10114-09009-33038

TO: Ken Mierzwa, Project Biologist

CC: Carlo Quinonez, Project Engineer

FROM: Lia Webb, Project Soil Scientist

DATE: July 11, 2010

RE: **Soil Sampling and Fertility Analysis at SFPUC Upper San Mateo Creek, San Mateo County, California**

Dear Ken:

This memo provides Winzler & Kelly's soil sampling methodology, soil fertility results, and soil treatment recommendations for above referenced site. The soil fertility results and recommendations will be incorporated as part of the Mitigation and Monitoring Plan for creation of wetland mitigation area(s).

Location

The HRP Peninsula Region study area is located within the Coast Ranges Geomorphic Province of California. It is situated on the northern and eastern foothills of the Santa Cruz Mountains, Montara Mountain, and within the San Andreas Fault Zone. The active trace of the San Andreas Fault goes directly through the San Andreas and the Upper and Lower Crystal Spring Reservoirs in a northwesterly direction; resulting in a number of ridges, valleys, and streams with the same orientation. Some prominent physical features west of the San Andreas Fault include Fifield Ridge, Sawyer Ridge, Cahill Ridge, Sweeney Ridge, and Montara Mountain; east of the San Andreas Fault are Buri Buri Ridge and Pulgas Ridge.

Soils

The soils of the HRP Peninsula Region study area include several associations that are found closely associated with the San Andreas Rift Zone (Soil Conservation Service, 1991). The Soil Survey maps show the majority of the Upper San Mateo Creek site as "Candlestick-Kron-Buriburi complex, 30-75 percent slopes" [Soil Map Unit 110]. A thin strip of "Candlestick variant loam 2 to 15 percent slope" [Soil Map Unit 111] is mapped along Pilarcitos Road on the western border of the project site (Soil Survey Staff, 2009). Soil characteristics are as follows:

- The Candlestick Series consists of moderately deep, well drained loam soils that formed in residuum derived dominantly from sandstone. These soils are found in upland areas of central coastal California that receive coastal fog and are of small extent. Candlestick soils are found on steep to very steep slopes of 30 to 75 percent. These soils are well drained; rapid to very rapid runoff; and with moderately slow permeability. Depth to a lithic contact is 20 to 40 inches and have an argillic horizon.

- The Kron series consists of shallow, well drained sandy loam soils that formed in material weathered from hard, fractured sandstone. These soils are on upland gently rolling to very steep slopes of 5 to 75 percent. These soils are well drained; medium to very rapid runoff; with moderate permeability. Kron soils differ from the Candlestick Series in that they have a mollic epipedon, are 10 inches or less to a lithic contact, and are loamy-skeletal.
- The Buriburi series consists of moderately deep, well drained gravelly loam soils that formed in material derived dominantly from hard sandstone. These soils are on uplands and have slopes of 30 to 75 percent. These soils are well drained; rapid to very rapid runoff; with moderate permeability. Depth to a lithic contact of sandstone is 20 to 40 inches. Buriburi soils differ from the Candlestick Series in that they lack an argillic horizon.

The Candlestick-Kron-Buriburi complex have the following land management ratings:

- These soils are rated Severe for construction limitations for haul roads and log landings due to slope and low soil strength.
- The erosion hazard for the Soil Complex is Very Severe with a slope erodibility numeric value of 0.95 from off road/off-trail areas after disturbance activities that exposed the soil surface, and is rated severe with a slope erodibility value of 0.95 for soil loss from unsurfaced road/trails. The numeric value indicates gradations between the point at which a soil feature has the greatest negative impact on the specified aspect of forestland management (1.00) and the point at which the soil feature is not a limitation (0.00). The erosion hazard for the Candlestick variant along the existing road to the west is Slight.
- Soil rutting hazard is Severe due to low strength for the hazard of surface rutting through the operation of forestland equipment. Soil displacement and puddling (soil deformation and compaction) may occur simultaneously with rutting.
- These soils are moderately suited for hand planting due to slope.
- These soils are rated Very Limited for aquifer fed excavated ponds due to depth to permanent groundwater. The soil is rated as having various limitations for pond reservoirs due to depth to bedrock, permeability (some seepage), and slopes. Local site-specific groundwater conditions do not appear to be typical of this general landscape-level soil setting; thus, the site-specific hydrology study shall be consulted for design guidance to promote retaining within the proposed wetland.

Soil Sampling

Soil fertility samples were collected at three locations at the Upper San Mateo Creek project site on November 9th, 2009 (Figure 4). Soil sampling was conducted by installing 2-inch-diameter hand augured boreholes to the maximum depth possible (until refusal at bedrock or gravels). Soil sample locations were selected adjacent to existing piezometers. Where total depth to bedrock could not be reached with hand auger (due to presence of gravels and/or dense material) the boring logs for adjacent piezometers will be relied on for characterization of subsurface soil conditions at the site.

Three soil boreholes (SP-6a, SP-6b, and SP-6c) were installed within the proposed wetland mitigation area. Soil borehole SP-6a was installed to a total depth of 12-inches below ground surface (bgs) at piezometer B2 (also see B2 boring log). Soil borehole SP-6b was installed to a total depth of 2.5 feet bgs at piezometer B1. Soil borehole SP-6c was installed to a total depth of 2.5 feet bgs at piezometer B3. Soils at each borehole were logged to document observed soil conditions at the site. Soil surface subsamples were collected at each of the three soil pits from 0 to 6-inches depth and composited at a 3:1 ratio (laboratory ID SP60). Subsurface samples were collected from the total depth of the soil auger holes at test pits SP-6b and SP-6c at 24-30 inches depth, and composited at a 2:1 ratio (laboratory ID SP624). The soil samples were submitted to a laboratory for chemical testing. All equipment was walked to the sites, and the support vehicle (pick-up truck) remained on an existing service road nearby to avoid unnecessary compaction of surrounding soils and vegetation. Two workers were present at the site during sampling.

Soil boreholes SP-6a, SP-6b, SP-6c, and piezometers B1, B2, and B3 are shown on attached figure. Boring logs for soil pits SP-6a, SP-6b, SP-6c, and piezometers B1, B2, and B3 are also attached.

Results

The soil surface textures observed at the site are characterized as loam (at soil pits SP-6b and SP-6c) and gravelly clay loam (at soil pit SP-6a) underlain by gravelly clay loam (at soil pits SP-6b and SP-6c) beginning at a depth of approximately 1 to 2 feet bgs.

Sub-soil conditions are a primary interest at soil pit SP-3 for water holding potential for creation of proposed wetland and subsurface soil fertility conditions for plant growth. The gravels in the subsoil may promote subsurface percolation and therefore are not ideal for creation of wetland and wetland pond conditions, although the very dense nature of the subsoil coupled with the clay loam texture may promote retention of water at the future surface of the proposed wetland mitigation area to be created. Subsurface soil fertility is also of interest regarding the new soil surface after grading and ability to support wetland plants and promote revegetation. The wetland restoration site surface soil sample SP-6(0) and the subsurface sample (24-30 inches bgs) had the following general notable results:

- Organic matter: high to medium rating in surface/subsurface, respectively;
- Primary macronutrients: low rating for nitrogen and potassium, medium rating for phosphorus;
- Secondary macronutrients rating: low calcium; high magnesium; low sulfur;
- Micronutrients rating: low zinc and boron, low/medium manganese and copper, and high iron;
- Cation Exchange Capacity (CEC) of 16 meq/100g (approximately 35% saturation of magnesium and 42% saturation from calcium);
- pH of 5.8/5.9.

The soil sample analytical results are summarized below in table below and laboratory analytical reports are attached.

Table 3. Summary of Soil Fertility Results

Sample	Depth (inches)	ID #	OM	Macronutrients-Primary (N/P1/P/K)[1]	Macronutrients-Secondary (Ca/Mg/S)[2]	Micro-nutrients (Zn/Mn/Fe/Cu/B)[3]
SP-6	0-6	SP60	H	L/L/**/M	L/H/L	L/M/H/L/L
SP-6	24-30	SP624	M	L/L/**/M	L/H/L	L/L/H/M/L

Summary of Soil Fertility Analysis (continued)

Location	Depth (inches)	pH	CEC (meq/100g)	CEC % Saturation (K/Mg/Ca/H/Na)	Excess Lime Rating	Soluble Salts (mmhos/cm)
SP-6	0-6	5.8	16.2	2.8/34.6/41.2/19.02.4	L	L
SP-6	24-30	5.9	16.6	2.4/35.0/43.8/17.0/1.8	L	VL

Rating Code: Very Low (VL), Low (L), Medium (M), High (H), Very High (VH)
OM = organic matter
CEC = Cation Exchange Capacity
*Phosphorus measurement using Weak Bray (P1) method is unreliable at Medium or High excess lime or pH >7.5
**NaHCO3-P unreliable at this soil pH

1. Primary Macronutrients are Nitrogen (N), Phosphorus using the Weak Bray test (P1), and Phosphorus using the Olson Method that measures $NaHCO_3$-P (P)
2. Secondary Macronutrients are Calcium (Ca), Magnesium (Mg), and Sulfur (S)
3. Micronutrients are Zinc (Zn), Manganese (Mn), Iron (Fe), Cooper (Cu), Boron (B)

Recommendations

The following recommendations are provided for consideration during the design and implantation of proposed site activities, as described by the Mitigation and Monitoring Plan:

Soil fertility guidelines at soil borehole SP-6(24) for the subsurface soil to support wetland plants, suggests amending the soil with up to 70 pounds per 1,000 square feet of lime. The fertility guidelines also recommend adding a light application of nitrogen/phosphorus/potassium fertilizer, although notes that the organic content of the soils should have a beneficial effect on soil pH and plant growth. Fertilization is not recommended for this site as it could stimulate invasive species and shrubs as well. The application of amendments may affect the pH of the water, cause eutriphocation, and nutrients could move offsite due to water movement. Native wetland plants should be tolerant of local soil conditions. Adaptive management should be used to determine if particular nutrients are inhibiting plant growth, to be evaluated during the annual monitoring. Plant tissue analysis is the most accurate method for determining site-specific and species-specific soil requirements.

Based on results and interpretation of these samples, no soil fertility treatment is recommended for project site soils.

A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 | MODESTO, CALIFORNIA 95351 | (209) 529-4080 | FAX (209) 529-4736

REPORT NUMBER: 09-334-021

CLIENT NO: 2664-D

SEND TO: WINZLER & KELLY ENGINEERS
633 THIRD STREET
EUREKA, CA 95503-

SUBMITTED BY: LIA WEBB

GROWER: REF#10114-09009-33035

DATE OF REPORT: 12/07/09

SOIL ANALYSIS REPORT

SAMPLE ID	LAB NUMBER	Organic Matter		Phosphorus		Potassium	Magnesium	Calcium	Sodium	pH		Hydrogen	Cation Exchange Capacity	PERCENT CATION SATURATION (COMPUTED)				
		* % Rating	** ENR lbs/A	P1 (Weak Bray) **** * ppm	$NaHCO_3$-P (OlsenMethod) **** * ppm	K ***** * ppm	Mg *** * ppm	Ca *** * ppm	Na *** * ppm	Soil pH	Buffer Index	H meq/100g	C.E.C. meq/100g	K %	Mg %	Ca %	H %	Na %
SP-56	54204	4.3H	115	6VL	12M	74L	2330VH	469VL	117L	7.2		0.0	22.2	0.9	86.3	10.5	0.0	2.3
SP-60	54205	4.4H	118	11L	15**	179M	679VH	1334L	88L	5.8	6.6	3.1	16.2	2.8	34.6	41.2	19.0	2.4
SP624	54206	3.2M	93	9L	10**	159M	708VH	1459L	68L	5.9	6.7	2.8	16.6	2.4	35.0	43.8	17.0	1.8

** NaHCO3-P unreliable at this soil pH

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		PARTICLE SIZE ANALYSIS			
												SAND %	SILT %	CLAY %	SOIL TEXTURE
SP-56	6L	6L	0.5VL	6M	20H	0.6L	0.3VL	L	0.2VL						
SP-60	9L	5L	1.0L	5M	80VH	0.8L	0.2VL	L	0.3L						
SP624	7L	8L	0.4VL	2L	70VH	1.2M	0.2VL	L	0.2VL						

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE
*** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
**** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P_2O_5
***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O
MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP

Mike Buttress, CPAg
A & L WESTERN LABORATORIES, INC.

A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 ı MODESTO, CALIFORNIA 95351 ı (209) 529-4080 ı FAX (209) 529-4736

REPORT NUMBER: 09-334-021 **CLIENT:** 2664-D

SUBMITTED BY: LIA WEBB

SEND TO: WINZLER & KELLY ENGINEERS
633 THIRD STREET
EUREKA, CA 95503-

GROWER: REF#10114-09009-33035

DATE OF REPORT: 12/07/09

SOIL FERTILITY GUIDELINES

RATE: /1000 sq **PAGE:** 2

Sample ID	Lab Number	Crop	SOIL AMENDMENTS				Nitrogen N	Phosphate P_2O_5	Potash K_2O	Magnesium Mg	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B
			Dolomite	Lime	Gypsum	Elemental Sulfur										
SP-56	54204	GRASSLAND			250		3.1	2.0	5.0			*				*
SP-60	54205	WETLAND		90			3.0	3.5	3.5		0.6	*				*
SP624	54206	WETLAND		70			3.2	4.0	3.5		0.6	*	*			*

COMMENTS

MICRONUTRIENTS: Where levels appear to be high, avoid any further applications for the time being. Very high (VH) levels may not necessarily be toxic, but avoid. Maintain correct soil pH. HIGH levels of organic matter should have a beneficial effect on growth and "soil" pH may not be as critical. However, watch carefully as amendments and extra nitrogen may still be necessary.
* MICRONUTRIENTS: Where levels are low, apply according to label instructions. Maintaining correct soil pH and adequate organic matter levels may be sufficient to correct deficiencies.
* BORON may not necessarily be deficient in the soil, and it is hard to correct an excessive application. Therefore, apply boron only if confirmed deficient through a leaf analysis.
WETLAND VEGETATION may include willow, cottonwood, swamp privet, green ash, rushes and sedges. Many species of oak, maple, hickory and rose, may also withstand long wet periods in certain areas.

NOTES:

Mike Buttress, CPAg
A & L WESTERN LABORATORIES, INC.

LV

SOIL SAMPLE INFORMATION SHEET

A & L WESTERN AGRICULTURAL LABORATORIES, INC.

LAB USE ONLY

MODESTO OFFICE
1311 WOODLAND AVENUE, SUITE #1 • MODESTO, CA 95351 • (209) 529-4080 FAX (209) 529-4736

PORTLAND OFFICE
10220 S.W. NIMBUS AVE., BLDG K-9 • PORTLAND, OR 97223 • (503) 968-9225 FAX (503) 598-7702

N / W / E

CUSTOMER	GROWER	SUBMITTED BY
Winzler + Kelly	WK Ref #:	Lia Webb
633 Third Street	10114-09009-33035	client #2664
Eureka, CA 95501		
PHONE NO: 707-443-8326	PHONE NO:	PHONE NO:

☐ Graphics Report ($1.00 per sample) ☐ Fax Report (____) _____ ☒ Email Report (email address required) liawebb@w-and-s-k.com

SAMPLE ID (5 CHARACTERS)	TEST PACKAGES									CHECK BOX IF RECOMMENDATIONS REQUIRED ☒		LBS PER ACRE ☐	LBS PER 1,000 SQ FT ☒		
	S1B	S1BN	S2	S2N	S3C	S10C	TEXTURE	NEMATODE	OTHER ANALYSES	CROP OR PLANT TYPE	PREVIOUS CROP OR PLANT TYPE	PLANTING DATES	SAMPLE DEPTH	AMENDMENTS APPLIED	METHOD OF IRRIGATION
SP-1(0)					1		NA	NA	NA	grassland	wildland	Fall 2010	0-6"	NA	
SP-1(6)					1		↓	↓	↓	"	"	"	6-12"	↓	
SP-3(18)					1		↓	↓	↓	wetland	grassland	"	18-24"	↓	
SP-4(30)					1		↓	↓	↓	wetland	"	"	30-36"	↓	
SP-5(0)					1		↓	↓	↓	serpentine grassland	semi-forested	"	0-6"	↓	
SP-5(6)					1		↓	↓	↓	"	"	"	6-12"	↓	
SP-6(0)					1		↓	↓	↓	Wetland	"	"	0-6"	↓	
SP-6(24)					1		↓	↓	↓	"	"	"	24-36"	↓	

EXPLANATION OF TESTS (SUBMIT ABOUT TWO CUPS OF SOIL PER SAMPLE)

S1B: BASIC SOIL ANALYSIS. Organic matter estimated nitrogen release, phosphorus (weak Bray and sodium bicarbonate-P), potassium, magnesium, calcium, sodium, sulfate-sulfur, soil pH, buffer pH, C.E.C. and percent cation saturation (computed).
S1BN: BASIC SOIL ANALYSIS plus nitrate-nitrogen.
S2: BASIC SOIL ANALYSIS plus soluble salts and excess lime.
S2N: BASIC SOIL ANALYSIS plus soluble salts, excess lime, and nitrate-nitrogen.
S3C: COMPLETE ANALYSIS. BASIC SOIL ANALYSIS (plus soluble salts, excess lime, nitrate-nitrogen, Zn, Mn, Fe, Cu, and B).
S10C: COMPLETE ANALYSIS plus saturation percentage, SAR, ESP, carbonate, bicarbonate, chloride, and saturated paste boron.
NOTE: Strong Bray Phosphorus may be substituted for Sodium Bicarbonate Phosphorus in S1B package. Ask for package S1A

NO_3-N = Nitrate - N
SO_4-S = Sulfate - S
Zn = Zinc
Mn = Manganese
Fe = Iron
Cu = Copper
B = Boron
Mo = Molybdenum
Cl = Chloride

PRINT NAME OF SAMPLER Lia Webb
SIGNATURE OF SAMPLER Lia Webb
DATE SAMPLES SUBMITTED 11/24/09

EXPLORATION HOLE LOG

DATE: 11/10/09
PROJECT NAME: SFPUC - HRP
METHOD OF EXPLORATION: hand auger
SAMPLER:
TEST PIT NO.: SP-Ga (@ B2)

SHEET OF
PROJECT NO.: 10114-09009-33035
LOCATION: Upper San Mateo
LOGGED BY: LLW
TOTAL DEPTH OF HOLE: 1.0' bgs

SOIL DESCRIPTION				COMMENTS	DEPTH	WELL DIAGRAM
DESCRIPTION & REMARKS	COLOR	MOISTURE	STRUCTURE			
gravelly clay loam	2.5Y 5/2	dry	NA	2" pine needle duff many fine & course roots	1'	Subsample 0-6"
see boring log B2 (piezometer) for location + subsoil description					2'	
					3'	
					4'	
					5'	
					6'	
					7'	

Refusal @ 1.0' (gravels). No GW in piezometer.

WINZLER & KELLY
CONSULTING ENGINEERS

EXPLORATION HOLE LOG

DATE: 4/10/09
PROJECT NAME: SFPUC-ITRP
METHOD OF EXPLORATION: hand auger
SAMPLER:
TEST PIT NO.: SP-6b (@ BL)

SHEET OF
PROJECT NO.: 10114-09009-33035
LOCATION: Upper San Mateo
LOGGED BY: LLW
TOTAL DEPTH OF HOLE: 2.5' bgs

SOIL DESCRIPTION				COMMENTS	DEPTH	WELL DIAGRAM
DESCRIPTION & REMARKS	COLOR	MOISTURE	STRUCTURE			
loam	5Y4/2	dry	NA			Subsample @ 0-6"
gravelly clay loam	5Y4/1	dry	NA	3% f/m 7.5YR 4/4	1'	
					2'	Subsample @ 24-30"
see boring log B1 for subsoil description and location.					3'	
					4'	
					5'	
					6'	
					7'	

No GW. Refusal @ 2.5' bgs (gravels)

WINZLER & KELLY
CONSULTING ENGINEERS

EXPLORATION HOLE LOG

DATE: 11/10/09
PROJECT NAME: SFPUC - HCP
METHOD OF EXPLORATION: hand auger
SAMPLER:
TEST PIT NO.: SP-6c (@ B3)

SHEET OF
PROJECT NO.: 10114-09009-33035
LOCATION: Upper San Mateo
LOGGED BY: LLW
TOTAL DEPTH OF HOLE: 2.5' bgs

SOIL DESCRIPTION				COMMENTS	DEPTH	WELL DIAGRAM
DESCRIPTION & REMARKS	COLOR	MOISTURE	STRUCTURE			
loam	2.5Y 3/1	dry	NA			subsample 0-6"
					1'	
gravelly clay loam	2.5Y 4/1				2'	subsample @ 24-30"
See boring log B3 for soil description and sample location					3'	
					4'	
					5'	
					6'	
					7'	

No GW. Refusal @ 30" (gravels)

WINZLER & KELLY CONSULTING ENGINEERS

EXPLORATION HOLE LOG

PROJ. NAME: HRP - Upper San Mateo	PROJECT NO. 10114-09009	Sheet of
METHOD OF DRILL: Hand Auger	LOCATION: Upper San Mateo	B1
SAMPLER: OD:____ ID:____	LOGGED BY: Steve McDonald	
BORING DIAMETER: 3"	TOTAL DEPTH OF HOLE: 4.5'	
DRILLING CO: Pitcher Drilling	Ht of Riser 12.25 inches	

SOIL DESCRIPTION				COMMENTS	DEPTH	WELL DIAGRAM
DESCRIPTION & REMARKS	COLOR	MOIST.	STRUCTURE			
Loam	5Y 4/2		3, M, SR	groundwater @ 3' Few small gravels		
gravelly clay loam	5Y 4/1	Sat	1/2, M, SBK	3%, F/M 7.5YR4/4	1', 2', 3'	
gravelly clay loam	5Y4/1	SAT	1/2, M/C, SBK	5%, M, 5YR4/4 conc 3% M, 5Y 4/1 depletion larger red gravels 5YR4/4	4', 5', 6', 7', 8', 9', 10', 11', 12', 13', 14', 15'	

1¼" sch 40 PVC cap
1" Sch 40 Solid PVC
Bentonite
Sch 40 Slotted 1" PVC
#20 grade Sand
1" sch 40 cap w/ hole

WINZLER & KELLY

EXPLORATION HOLE LOG

PROJ. NAME: SFPUC - HRP	PROJECT NO. 10114-09009	Sheet of
METHOD OF DRILL: Hand Auger	LOCATION: Upper San Mateo	B2
SAMPLER: OD:____ ID:____	LOGGED BY: Steve McDonald	
BORING DIAMETER: 3"	TOTAL DEPTH OF HOLE: 60" or 5'	
DRILLING CO: Pitcher Drilling	Ht of riser = 12.5"	

groundwater @ 2'

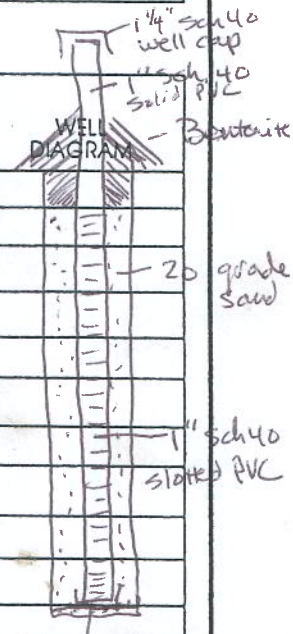
SOIL DESCRIPTION				COMMENTS	DEPTH	WELL DIAGRAM
DESCRIPTION & REMARKS	COLOR	MOIST.	STRUCTURE			
Loam	2.5Y 3/2	Moist	2, M, gr	average of 3" duff layer		1¼" well cap; 1" sch 40 solid PVC; Bentonite
					1'	
gravelly clay loam	2.5Y 3/1	Saturated	2 M SBK	groundwater @ 2'	2'	20 grade SAND
					3'	
					4'	
Very gravelly clay loam	2.5Y 3/1	Saturated	1, M, SBK	2.5 Y 5/3, 5%, M/C 7.5YR 4/4, 3%, F/M	5'	1" sch 40 slotted PVC
					6'	1" sch 40 well cap w/ hole
					7'	
					8'	
					9'	
					10'	
					11'	
					12'	
					13'	
					14'	
					15'	

EXPLORATION HOLE LOG

PROJ. NAME: SFPUC - HRP Project	PROJECT NO. 10114-09009	Sheet of
METHOD OF DRILL: Hand Auger	LOCATION: Upper San Mateo	B3
SAMPLER: OD:____ ID:____	LOGGED BY: Steve McDonald	
BORING DIAMETER: 3"	TOTAL DEPTH OF HOLE: 50'	
DRILLING CO: Pitcher Drilling	~~Depth~~ Ht of Riser = 11.75"	

groundwater @ 12"

SOIL DESCRIPTION				COMMENTS	DEPTH
DESCRIPTION & REMARKS	COLOR	MOIST.	STRUCTURE		
Loam	2.5Y 3/1	moist	2, M, gr	groundwater at 1'	
LOAM	2.5Y 3/1	Sat	1, M, gr	—	1'
Gravelly Clay Loam	2.5Y 4/1	Sat	2, M, SBK	~~5%~~, f/m, ~~5YR~~ 5YR 4/4 3%, m, 10YR 5/6	2'
Very Gravelly Sandy Clay Loam	2.5Y 4/2	Sat	f/M, SBK loosely consolidated	5%, m, 5YR 4/4 5%, m, 10YR 5/6	3' 4' 5'
					6' 7' 8' 9' 10' 11' 12' 13' 14' 15'



WINZLER & KELLY

Appendix E
Presettlement Vegetation

Interpretation of General Land Office Survey Notes for the Upper San Mateo Creek HRP Site

Ken Mierzwa

January 12, 2010

Unlike many of the other Peninsula HRP sites, the Upper San Mateo Creek site is within the area surveyed by the General Land Office for establishment of Township, Range, and Section lines. The survey of Township 4 South, Range 5 West was conducted by A. W. Von Schmidt in September and October of 1864, with the portions relevant to the project site completed on September 22. The following was taken from a transcript of his field notes, and describes a north-south section line passing just east of the project boundary . Distances are in chains, with one chain = 66 feet.

North between Secs. 20 and 21.

13.00 To foot of ridge and enter Pyfield's field.

17.00 To fence, course, N.W. & S.E. & leave field.

17.50 " San Mateo Creek, course South East

20.00 " road, course, W. of N. & S. of E. and second spur of ridge

35.00 To top of spur and descend

39.50 " gulch, 10 lnks. wide, at foot of hill, course, S.W.

40.00 Set ¼ Sec. post in stone mound and ascend.

69.50 To top of ridge, course , N.W. & S.E. and descend.

80.00 Set post in rock mound, for cor. to Secs. 16, 17, 20, & 21, on N.E. slope of hill, in dense chapparal thicket.

Land, hilly. Soil, 2nd rate. Mostly good grazing land. The 1st and last 10 chs. Is dense chapparal.

Of the one-mile length of the section line, the first and last 660 feet, or about 25 percent of the total length of the section line, is described as a shrub-dominated community. The quarter-section post would have been set in the upper end of the ravine feeding into the project site, approximately 250 feet northeast of the project boundary. The need to set a post reflects an absence of standing timber large enough to blaze at this location. The description indicates that "chapparal" (coyote brush scrub) was the dominant cover on northeast-facing slopes to the southwest of San Mateo Creek and east-northeast of Portola Road, also on east facing slopes. The implication is that the central 75 percent of the section line was predominantly open grassland at the time of the survey. The notes make no mention of water

other than the course of San Mateo Creek, but this is not surprising given the fact that the survey was done in the fall.

The notes also indicate that a small area close to San Mateo Creek a short distance south of the project site had already been cultivated by 1864, and that a road was present on the approximate location of the present unimproved road to Mud Dam.

Schmidt's survey of the line between Sections 17 and 20, an east-west line just over one-half mile north of the project site, provides a similar description:

Land, hilly. Soil, 2nd rate. W. ½ covered with brush. E. ½ good grazing & farming land.

Once again, the notes describe "brush" west of San Mateo Creek, and open conditions on the west-facing slope to the east of the creek. There is no mention of trees, although this same surveyor is careful to identify trees by species in other parts of the township.

References

Von Schmidt., A. W. 1864. A transcript of the field notes of the survey of the Subdivision liones in Township 4 & 5 South, Range Five West, of the Mount Diablo Meridian, in the State of California, executed by A. W. Von Schmidt, U.S. Dept. Surveyor, under his contract dated March 24, 1864. #192-8

Plat Map, T4S, R5W MD

Appendix F
Reference

Technical Memorandum No. 1
Habitat Reserve Program (HRP) Reference Site Survey Summary

May 20, 2009

INTRODUCTION

The Habitat Reserve Program (HRP) is designed to create, restore or enhance sensitive habitat types that have been impacted by implementation of SFPUC projects. The Project will restore or create the following habitat types: Serpentine Bunchgrass Grassland, Valley Needlegrass Grassland, Semi-permanent Marsh or Pond, Seasonal Wetland, Coast Live Oak Woodland, Mixed Oak Woodland, and Coast Live Oak Riparian Forest.

Initially, NRM Environmental Consulting (NRM) was contracted by Winzler and Kelly to conduct reconnaissance surveys of references sites in support of the Homestead Pond project. Reference sites were identified by Greg Lyman of the SFPUC, and were provided on a Google Earth Map. Reference sites were chosen that best reflected several of the above mentioned habitats. The present TM is built upon findings included in a memo from NRM dated December 15, 2008, and has been greatly expanded.

With the transition to design for additional HRP sites, a wider range of restoration efforts are now envisioned, and it has become necessary to expand the number of reference sites. The reference sites will be used as a general baseline for the restoration in the Project Areas, particularly to identify habitat structure and dominant or characteristic species. Reference sites are not intended to be tied to mitigation success criteria, although in some cases they may be used to inform decisions as success criteria are formulated. Reference sites were surveyed for dominant vegetation within the tree layer, shrub layer, and understory layer (forbs and grasses).

Native plant species observed at the reference sites, along with information included in a previous vegetation survey (URS, 2004) and other relevant sources, will be used as general guidance for the associated habitat's planting palettes within the Project.

METHODS

Reconnaissance surveys were conducted by NRM on December 12, 2008, when vegetation within the understory layer (grasses and forbs) was predominantly unidentifiable. Many native plants that were identifiable to genus were not identified to species due to the seasonal limitations. After review of the NRM data, Winzler & Kelly conducted more detailed surveys on April 7-9 and May 6-7, 2009. Available regional vegetation surveys in addition to the NRM (2008) data were reviewed, including Schirokauer, et al, (2003), URS (2004) and ESA+Orion (2009). Site vegetation surveys were conducted using the California Native Plant Society Relevé Protocol (CNPS, October 20, 2000, revised April 2004).

RESULTS

A brief summary and representative photo of each reference site follows. Community type nomenclature generally follows Holland (1986). A map of the reference sites is shown in Figure 1, and more detailed information for each site is included in Appendix A

.

1. Herbaceous Communities

1.1 Serpentine Bunchgrass

Three serpentine bunchgrass grassland sites were visited. These are described individually below.

S-1 Edgewood Triangle Serpentine Bunchgrass

Serpentine bunchgrass community at Edgewood Triangle

The Edgewood Triangle site is located directly across Cañada Road to the east of Homestead Pond. The site is a west facing slope with a rocky serpentine soil. The dominant and subdominant plants that were discernible included purple needle grass (*Nassella pulchra*), squirrel tail (*Elymus elymoides*), blue wildrye, meadow barley (*Hordeum brachyantherum*), soap plant (*Chloragalum pomeridianum*), blue-eyed grass (*Sisyrinchium bellum*), California plantain (*Plantago erecta*), purple owl's clover (*Castilleja exserta*), California poppy (*Eschscholtzia californica*), common lomatium (*Lomatium utriculatum*), yarrow (*Achillea millefolium*), Ithuriel's spear (*Triteleia laxa*), blue dicks (*Dichelostemma capitatum*), harvest brodiaea (*Brodiaea elegans*), fringed mallow (*Sidalcea diploscypha*), Coast Range false bindweed (*Calystegia collina*), western larkspur (*Delphinum hesperium*), annual dog's tail (*Cynosurus echinatus*), star thistle (*Centaurea solstitalis*), annual cat's ear (*Hypochaeris glabra*), yellow owl's clover (*Orthocarpus luteus*) and hayfield tarweed (*Hemizonia congesta*). This site is an excellent reference site because it is adjacent to Homestead Pond.

S-2 Lower Crystal Springs Boat Ramp Serpentine Bunchgrass

Serpentine bunchgrass community at Lower Crystal Springs boat ramp. Note fountain thistle at left of image.

The Boat Ramp site is located north of Highway 92 and west of Highway 35 near the boat ramp into the Lower Crystal Springs Reservoir. The site is located on a relatively flat area with a gentle west-facing aspect, and few small rock outcrops. Groundwater seepage is evident along the cut bank at the edge of the reservoir. The dominant and subdominant plants that were discernible included purple needle grass, (*Nassella pulchra*), coyote brush (*Baccharis pilularis*), blue wildrye, fountain thistle (*Cirsium fontinale* var. *fontinale*), perennial hair grass (*Deschampsia cespitosa*), soap plant, blue-eyed grass, California plantain, California oat grass, Fremont's death camas (*Zigadenus fremontii*), common lomatium, yarrow, Ithuriel's spear, blue dicks, harvest brodiaea, soft chess, annual cat's ear , yellow owl's clover and hayfield tarweed. Presence of perennial hair grass, Fremont's death camas and fountain thistle suggest elevated groundwater influence at this site.

S-3 Trousdale Serpentine Bunchgrass

Serpentine bunchgrass community adjacent to Trousdale sag pond

A third site, identified here as the Trousdale site after the nearest I-280 exit, is located well to the north, between San Andreas Reservoir and Tracy Lake. This site is in the rift valley at an elevation of approximately 350 feet, and is nearly level to slightly east-facing with scattered small rock outcrops. Dominant and subdominant native species include purple needle grass, (*Nassella pulchra*), Sandberg's bluegrass (*Poa secunda*), blue wildrye, California oatgrass, ookow (*Dichelostemma congesta*), blue-eyed grass, California plantain, meadow barley, coyote mint (*Monardella villosa*), June grass (*Koeleria macrantha*), yarrow, California goldfields (*Baeria californica*), California melic (*Melica californica*), harvest brodiaea, California brome (*Bromus carinatus*), Coast Range false bindweed, naked-stem buckwheat (*Eriogonum nudum*), annual dog's tail, annual cat's ear, yellow owl's clover and hayfield tarweed. Absent are hydrophylls, such as perennial hairgrass due to the lack of elevated groundwater despite the proximity of the adjacent sag pond. The evident species diversity is high possibly due the distance from the nearest roads and frequent disturbance.

1.2 Valley Needlegrass Grassland

One grassland site was visited. For purposes of site design and planting plan preparation, this site was supplemented with data from three other grassland sites in URS (2004).

V-1 Adobe Gulch Coastal Terrace Prairie

Coastal terrace prairie at Adobe Gulch, just east of Old Cañada Road.

One reference site was visited for native bunchgrass grassland. The site includes multiple remnant grassland openings with the Adobe Gulch area, south of Rt. 92 and between Old Cañada Road and Upper Crystal Springs reservoir. ESA (2009) characterized the overall site as coastal terrace prairie, and hypothesized that the area acted as a fog sink and thus encouraged species more characteristic of areas closer to the coast. Two openings, one at each end of the Adobe Grasslands site, were sampled. The openings are relatively small with encroaching scrub habitat. Native cover is approximately 50%, and dominant and subdominant species include purple needle grass, California oatgrass, blue wildrye, blue-eyed grass, Douglas iris (*Iris douglasiana*), Indian paintbrush (*Castilleja affinis*), yarrow, foothill sedge (*Carex tumulicola*), spreading rush (*Juncus patens*), sun-cups (*Camissonia ovata*), six-week fescue (*Vulpia bromoides*), soft chess, perennial cat's ear (*Hypochaeris radicata*), ripgut brome (*Bromus diandrus*), English plantain (*Plantago lanceolata*), bur-clover (*Medicago arabica*), rattlesnake grass (*Bromus brizaeformis*) and annual hairgrass (*Aria caryophyllea*).

2. Wetland Communities

2.1 Coastal and Valley Freshwater Marsh

Three wetlands sites, each representing a different hydrologic regime, were sampled. These are described individually below.

W-1. Trousdale Semi-permanent pond

Semi-permanent wetland at Trousdale sag pond

One semi-permanent pond was visited. This site is located south of San Andreas Reservoir, and west-southwest of the terminus of Trousdale Road at Interstate 280. The pond provides habitat for both California red-legged frog and San Francisco garter snake (K. Swaim, pers. comm., and verified in the field by Winzler & Kelly in April and May of 2009). The pond serves primarily as a hydrological benchmark, and secondarily as a vegetation reference site. The eastern margin of the pond is steep, while the other three margins have a much more gradual slope. Maximum depth is uncertain but is considerably greater than three feet. Dominant and subdominant vegetation includes Baltic rush (*Juncus balticus*), iris-leafed rush (*Juncus xiphioides*), soft rush (*Juncus effusus*), water parsley (*Oenanthe sarmentosa*), common spikerush (*Eleocharis macrostachya*), willow-leaved dock (*Rumex salicifolius*) and penny-royal (*Mentha pulegium*). Species in the upper margin of the wetland include Creeping ryegrass (*Leymus triticoides*), creeping bentgrass (*Agrostis stolonifera*), spreading rush (*Juncus patens*), foothill sedge (*Carex tumulicola*), arroyo willow (*Salix laevigata*) and red willow (*Salix lasiolepis*)

W-2. Old Cañada Road Seasonal Wetland

Seasonal wetland along Old Cañada Road.

One seasonal wetland reference site was visited, a sag pond, located adjacent to Old Cañada Road. The pond was dry in December 2008 and held shallow water (at least six inches deep) in April and May 2009. During a May 6, 2009 site visit, numerous pacific tree frog (*Pseudacris regilla*) tadpoles and some recent metamorphs were observed, documenting successful amphibian recruitment at this wetland. The entire wetland is densely vegetated and is dominated by spikerush (*Eleocharis macrostachys*) and California semaphore grass (*Pleuropogon californica*). The southern boundary is dominated by creeping rush (*Juncus patens*) and the northern boundary is dominated by creeping wildrye (*Leymus triticoides*). The surrounding upland area includes coast live oak to the west and coyote brush to the east.

W-3. Lower Crystal Springs Fringe Wetland

Above: Fringe marsh along Lower Crystal Springs reservoir, near the boat ramp.

A fringe wetland along Lower Crystal Springs Reservoir, located adjacent to the boat ramp, was sampled. This wetland differs in being subjected to potentially more rapid and more extreme fluctuations in water level as the reservoir is drawn down, and in use by large fish. In May 2009 several large carp were observed within this wetland, with an obvious short-term increase in turbidity related to bottom foraging. Dominant and subdominant plants include Common bulrush (*Scirpus acutus*), narrow-leaved cat-tail (*Typha angustifolia*), marsh baccharis (*Baccharis douglasii*), spreading rush (*Juncus patens*), tall flat-sedge (*Cyperus eragrostis*), common rush (*Juncus effusus*), California dock (*Rumex salicifolius*), horseweed (*Conyza canadensis*), creeping bent-grass (*Agrostis stolonifera*) and poison hemlock (*Conium maculatum*).

3. Woodland and Forest Communities

Two oak woodland communities were visited, one dominated by coast live oak, and one mixed oak woodland with coast live oak and valley oak. In addition, two riparian forest sites were characterized. These sites are described below.

3.1 Coast Live Oak Woodland

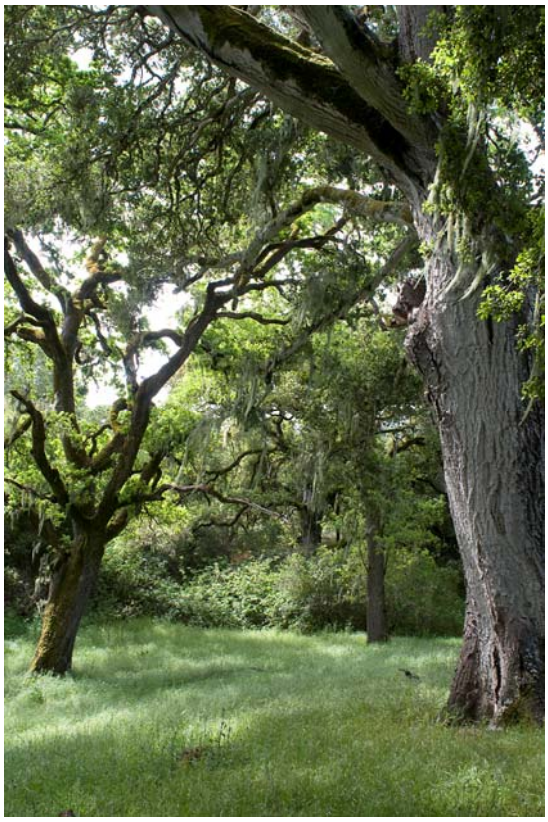
O-1. Adobe Gulch Coast Live Oak Woodland

Above: Coast live oak woodland at Adobe Gulch

One reference site was visited, located on the west side of Crystal Springs Reservoir, near Adobe Point. It can only be accessed along Old Cañada Road. The site is a long, narrow north-south tending ridge that is forested with a mix of coast live oaks and Pacific madrone. Dominant and subdominant species include coast live oak (*Quercus agrifolia*) and Pacific madrone (*Arbutus menziesii*), Poison oak (*Toxicodendron diversilobum*), toyon (*Heteromeles arbutifolia*), California coffeeberry (*Rhamnus californica*), hillside gooseberry (*Ribes californicum*), and common snowberry (*Symphoricarpos albus*). The understory includes California blackberry (*Rubus californica*), Douglas iris (*Iris douglasiana*), blue wildrye (*Elymus glaucus*), Yerba santa (*Satureja douglasii*), hairy honeysuckle (*Lonicera hispidula*), hound's tongue (*Cynoglossum grande*), Pacific sanicle (*Sanicula crassicaulis*), Pacific starflower (*Trientalis latifolia*) and Indian warrior (*Pedicularis densiflora*).

3.2 Mixed Oak Woodland

O-2. Old Cañada Road Mixed Oak Wodland



Above: Mixed oak woodland near Old Cañada Road

This community is intermediate between the valley oak and coast live oak woodlands described by Holland (1986). One reference site was visited, located west of the Pulgas Water Temple and Laguna Creek. It can only be accessed along Old Cañada Road. This reference site is similar to the mixed oak woodland that is currently found at Homestead Pond. The northern boundary is densely vegetated with a mix of California coffeeberry and coast live oaks. The habitat opens up to the south into an oak savanna with an approximate 60/40 allocation of coast live oaks and valley oaks with a mixed grassland understory. Dominant and subdominant native species include coast live oak (*Quercus agrifolia*) and valley oak (*Quercus lobata*), California coffeeberry (*Rhamnus californica*), poison oak (*Toxicodendron diversilobum*), California buckeye (*Aesculus californica*), blue elderberry (*Sambucus mexicana*), and coyote brush (*Baccharis pilularis*). The understory includes yarrow (*Achillea millefolium*), sanicle (*Sanicula crassicaulis*), man-root (*Marah fabaceus*), blue wildrye (*Elymus glaucus*), bedstraw (*Galium aparine*), hound's tongue (*Cynoglossum grande*), and miner's lettuce (*Claytonia perfoliata*). Non-native and invasive species present include dogtail grass (*Cynosurus echinatus*), oat grass (*Avena barbata*), Italian thistle (*Carduus pycnocephalus*), ripgut brome (*Bromus diandrus*), yellow star-thistle (*Centaurea solstitialis*) and milk thistle (*Silybum marianum*).

3.3 Central Coast Live Oak Riparian Forest

Two riparian reference sites were visited. These are similar in composition, and are lumped for description.

Above: Central Coast live oak riparian forest northwest of Homestead Pond Note willows in background, along stream channel, with oaks more prevalent away from the active channel.

Site R-1 is located north of the Project Area west of the Filoli Gardens entrance off of Cañada Road. Site R-2 is located just northwest of Homestead Pond. Both sites are densely vegetated and have intermittent streams measuring approximately 10 to 20 feet across (bank to bank) running through the habitat. Dominant and subdominant native species include coast live oak (*Quercus agrifolia*) and arroyo or red willow (*Salix laevigata*, *S. lasiolepis*), Pacific madrone (*Arbutus menziesii*), California bay (*Umbellularia californica*), Poison oak (*Toxicodendron diversilobum*), California coffeeberry (*Rhamnus californica*), toyon (*Heteromeles arbutifolia*), and coyote brush (*Baccharis pilularis*). The understory includes California blackberry (*Rubus californica*), Douglas iris (*Iris douglasiana*), blue wildrye (*Elymus glaucus*), Yerba santa (*Satureja douglasii*), hairy honeysuckle (*Lonicera hispidula*), mugwort (*Artemisia douglasiana*), and spreading rush (*Juncus patens*). The sites are similar to HRP project sites in location, species makeup, hydrology, and elevation.

LITERATURE CITED

CNPS. 2004. California Native Plant Society Relevé Protocol. CNPS Vegetation Committee.

ESA + Orion. 2009. Peninsula region study area biological resources. Habitat Reserve Program. Unpublished draft report to the San Francisco Public Utilities Commission.

Holland, R. F. 1986. Preliminary descriptions of the terrestrial natural communities California. California Department of Fish and Game.

NRM. 2008. SFPUC - Homestead Pond mitigation reference site survey summary. Unpublished memorandum to Winzler & Kelly, December 15, 2008.

Schirokauer, et al, 2003 Plant Community Classification and Mapping Project, Final Report

URS Corporation. 2004. Vegetation Survey of the Peninsula and Alameda Watersheds (Task 6) Agreement No. CS-699E

Appendix G
Invasive Species Control

Upper San Mateo Creek Mitigation Invasive Plant Species Control Schedule																						
Task	2010		2011				2012				2013				2014				2015			
	S	F	W	SP	S	F	W	SP	S	F	W	SP	S	F	W	SP	S	F	W	SP	S	F
Burning*						Y				Y				Y				Y				Y
Mowing		Y		Y																		
Grazing* *				Y	Y			Y	Y			Y	Y									
Herbicide application		Y	Y	Y		Y	Y	Y														
Invasive specie removal mechanical		Y																				
Invasive specie removal hand removal			Y	Y			Y	Y			Y	Y			Y	Y						
Drill Seed		Y		Y		Y																
Plant natives		Y	Y			Y																
Irrigate***		Y																				
monitor and report			Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

*burning will occur after fall rains, under 57° F and cloudy with conditional permits

** grazing will not occur in the wetland areas after planted has commenced

***irrigation should not be necessary for the USMC site; only initial watering is required after initial planting

Appendix H

Restoration in the Colorado Desert: Management Notes

Methods for Plant Sampling

Prepared for the California Department of Transportation
District 11, 2829 Juan Street, San Diego, CA, 92138
as part of the Desert Revegetation Project
October 1993
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San Diego State University
San Diego, CA 92182

Introduction

The goal of most rstoation and revegetation projects is to recreate the plant cover, distribution, and species compostion of the site prior to disturbance, or of a comparable less disturbed reference site. Accurate data on community compostion is desirable for the planning and evaluation of these projects. While it is impractical to take a complete census of even a relatively small site; cover, density, and frequency of plant species can ve accurately estimated from as little as 1% of the community (Barbour et al., 1987).

The selection of sample site can be based typical sites (releve), random samples, systematic samples in a regular pattern, or by a combination of random and systematic selection (Greig-Smith, 1983). Although the releve method uses subjective choice of sample locations, the process of recording data is relatively rapid and nonmathmatical. Systematic and random methods, which are commonly used in the United States, are more conductive to statistical analysis. In the field, random sampling may be much less convenient than systematic sampling, but the regular sampling of a population showing periodic variation would not bvbe representative of a population as a whole (Eberhardt and Thomas, 1991). The selection of an appropriate sampling technique depends upon the type of data needed, the size of the sampling site and the number of available workers.

Quadrat Sampling

Sampling with quadrats (plots of a standard size) can be used for most plant communities (Cox, 1990). A quadrat delimits an area in which vegetation cover can be estimated, plants counted, or species listed. Quadrats can be established randomly, regularly, or subjectively witin a study site. Since plants often grow in clumps, long, narrow plots often include more species than square or round plots of equal area; especially if the long axis is established parallel to environmental gradients (Cox, 1990; Barbour et al., 1987;Greg-Smith, 1983). However, accuracy may decline as the plot lengthens because, as the perimeter increases, the surveyor must make more subjective decisions about the placement of plants inside or outside the plot. Round quadrats can be most accurate because they have the smallest perimeter for a given area. Round quadrats are also simple to define in the field, requiring only a center stake and a tape measure (Cox, 1990).

The appropriate size for a quadrat depends on the items to be measured. If cover is the only factor being measured, size is relatively unimportant. If plant numbers per unit area are to be measure, then quadra size is critical. A plot size should be large enough to include significant numbers of individuals, but small enough so that plants can be separated, counted and measured without duplication or omission of individuals (Cox, 1990; Barbour et al., 1987). Large quadrats with many plants may require two or more people to obtain an accurate census, while one person may be sufficient for smaller plots or those with

sparse vegetation.

An accurate estimate of the necessary number of quadrats can be determined by plotting data for a given feature (i.e. percent cover) vs. number of quadrats. The appropriate quadrat number will correspond to the point at which the curve plateaus (Figure 1) Barbour et al., 1987). Some field researchers sample until the standard error of the quadrat is within a previously decided, acceptable boundary. A standard error of + or - 15-20% of the mean (i.e. two thirds of all quadrats supply data that fall within this range about the mean) is sometimes used (Barbour et al., 1987)

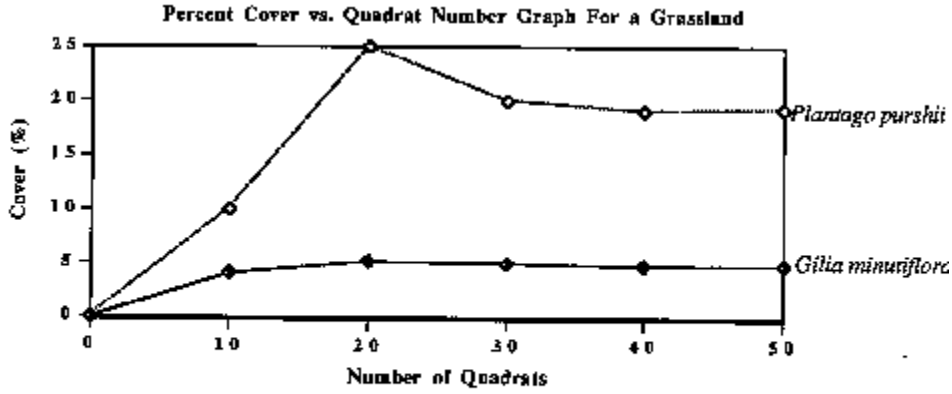

Figure 1: In this grassland, at least 30 quadrats are needed to accurately determine the percent cover for *P. purshii*,. *C. minutiflora* provides less cover and requires fewer quadrats for an accurate cover determination.

Cover, density, and frequency are important aspects of the plant community which can be measured by quadrat sampling. Cover is the percentage of quadrat area beneath the canopy of a given species, FOr the practical estimation of cover, holes in the canopy can be thought of as nonexistant, and the canopy is mentally "rounded out" (Barbour et al., 1987). Plants rooted outside the quadrat are included in cover measurements to the extent that their canopy projects into the quadrat space (Barbour et al., 1987). It is sometimes difficult to accurately estimate cover, especially if the plants are at or above eye level. In these cases, an aerial photo often proves useful. Canopy overlap can further complicate cover measurements. Overlap of the same species should not be counted twice, but recorded as continous cover between two or more plants. If two or more plant spcies overlap, the cover of each should be tallied independently (Barbour et al., 1987). If ther are many ovelapping canopies, it is possible to estimate more than 100% cover and still have open ground.

Density is determined by the number of plants rooted within each quadrat. Relative density is the density of one species as a percent of total plant density. Area per plant, or mean area, is plot area per density.

Frequency is the percentage of total quadrats containing at least one rooted individual of a given species. Relative frequency of one species as a percentage of total plant frequency. Frequency is affected by quadrat size and my ble less meaningful than other measurements.

RelevÈ

In the relevÈ, or "sample stand" method, a person knowledgeable with a region's vegetation develops concepts about certain community types that are repeated in similar habitats and then chooses several representative stands for a community (Barbour et al., 1987). The community is name based on the most abundant species composition (i.e. "Larrea scrub"). The surveyor then walks though each stand recording all of the species encountered and describing the habitat and soil profile. The stand that best

represents the community vegetation and soil profile is selected. In this stand, data from a series of nested quadrats is plotted on a species vs. area curve (Figure 2) to determine the smallest area within which the species of the community are adequately represented (the minimal area).

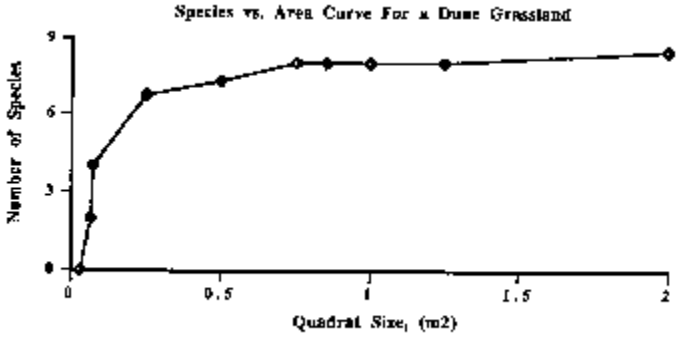

Figure 2: The minimal area required to represent this dune grassland is about .30 m^2.

The presence of addtional species in each larger quadra is recorded. A point is reached where increasing quadrat size does not significantly increase the numer of species encountered. The minimal sample area can then be determined from the species/area curve where the slope is nearly horizontal. This resulting quadra area is called a relevÈ (Barbour et al., 1987). The minimal area is thought to be an important community trait that is just as characteristic as the species that make it up.

In the relevÈ method, cover is measure as a category (a number between zero and seven denoting 0-100% cover, respectively) rather than a precise number (Barbour et al., 1987). An exact estimate of percent cover is thought to give a false sense of precision and cover estimates from mulitple observers rarely agree. Although some precision is lost, categorical classification has good repeatability.

The relevÈ method is quick, nonmathimatical, and should detect nearly all plant species in a given community. Unfortunately, it is sometimes difficult to characterize a community. This method may be most efficient and useful for large scale ecological restoration projects, provided the biologists performing the initial analysis are sufficiently knowledgeable with the regions vegetation.

Plot-less Sampling

Plot-less sampling has partly replaced quadrat sampling in North American studies. In this technique, communities are not sampled with delimited plots, but with sampling points, one dimensional transect lines, or certain distances within the stand (Knapp, 1984). Plot-less methods could be thought of as quadrats shrunk to a line or a point of no dimension (Barbour et al., 1987). The advantages of plot-less sampling are: 1) a sample plot does not need to be established, saving time and 2) elimination of subjective error associated with the sample plot bounderies.

The point method determines the number of points, distributed randomly or regularly in the survey area, where parts of a plant are above ground. The points can be established with a regular grid, randomly chosen coordiante pairs, or regular or random points along a meter tape (transect line). For coordiante pairs and regular grids, an x and y axis are established along the edges of the study area. Random points are selected using a random number generator (on most calculators) or from a random number table. Points can also be established using stratified random sampling. In this method, the area to be sampled is divided into sections with and equal number of random points in each, insuring an adequate distribution of sample points throughout the site. A tape measure and a compass are used to locate the ordered pairs (random or regular) designating field sample points. With transect lines, only a single baseline is

required. A series of points along this baseline are selected using a random, stratified random, or systematic procedure (Cox, 1990). These points serve as starting points for transects throughout the area. With a sufficient number of points, an exact measurement of percent cover is possible (Knapp, 1984).

The number of points necessary for an adequate assessment is partly dependent on the species cover within a survey area. A graph depicting percent cover vs. number of points can help determine the number of necessary points. With only a few points, the curvatures in these graphs oscillate highly. As the points approach a sufficient number, the curvatures become flatter, only fluctuating slightly around the average percent cover (Knapp, 1984). If a plant provides > 20% cove, a smallnumber of points is needed. A much greater number of points is needed for assessing percent cover for species occupying less than 5% of the study area (Knapp, 1984).

In addition to point methods, one dimensional transect lines can also be used to determine cover. The line intercept methods is just accurate as the quadrat method, but much less time consuming. In this technique, only plants which cross the imaginary veritcal plane of the transect line are recorded. Two measurements should be taken for each plant: the length of intercept (I) and the maximum width of the plant perpendicular to the transect line (M). The amount of bare gournd within each transect segment should also be measured and recorded in the same manner (Cox, 1990). In the case of communities with two or more distinct strata (such as herb, shrub, and tree strat in a forest) it is usually necesarry to sample each level separately.

Cover is calculated as the percent of transect line covered by each species. The chance of an indivual being encountered by the transect line is proportional to its width perpendicular to the transect line, so density can be calculated by multiplying the total recipricals of maximum plant width by the unit area/total transect length (Cox, 1990).

Distance Methods

Distance methods measure the distance from a sampling point (or plant) to the nearest plant or n*th* nearest plant. The results of such a technique cna provide important information about the relationships between plants. Distance methods can help determine whether plants are growing in discernible (and often ecologically important) patterns or are randomly dispersed. Many inter and intra-specific plant relationships are difficult to observe without using distance based sampling techniques.

With the nearest individual method, random points are located in a stand, the distance from each sampling point to the nearest plant is measured, the species is identified, and its basal area is measured. Only one measurement is made from each random point, and all distances for all species are summed and divided to yield one average distance (Barbour, 1987).

In the nearest neighbor method, random points are located in a stand and the nearest plant is located. The distance from this individual to its nearest neighbor is measured. Density is calculated as in the nearest individual technique. An advantage of the nearest neighbor method is that it can be used to determine whether plants of the same species are distributed randomly, regularly, or are clumped (Barbour et al., 1987).

In the random pairs method, a line is taken from a point along a transect to the nearest plant. Perpendicular to the line and passing through the point is an exclusion line. The distance from this individual to the nearest neighbor that is on the same side of the exclusion line is measured. A difficulty in using these methods is that if the density is low, it may be impractical to search beyond a certain distance for the nearest individual.

Sampling With Photographs

Traditional sampling methods may be too labor intensive to provide accurate information over large areas. Aerial photography using large scale (1:200) color or infra-red photographs are useful for mapping and recording individual plant species in a range of vegetation types (Hacker et al., 1990). Acceptable estimates of plant cover can be made, and the condition of the soil surface is clearly recognizable, particularly on color infra-red film. Neither film type permits accurate identification of all species and the presence of understory plants may be obscyred by foliage or shadow. Furthermore, the best interpretaton, photographs need to be taken within four to six weeks of effective rain. Unfortunately, the difficulty and expense of establishing permanently marked flight line, and acquiring and printing the photographs, precludes using the technique for some projects.

Helium filled balloons could be a less expensive method of aerial photography. A ground anchored helium balloon could support a camera to photograph a quadrat or permanet plot. Grids placed over the photographs could simplify percent cover estimates. Balloons could also be used with small video cameras to record "video-tansect" lines. Wind patterns must be considered with such data recording techniques. There are obvious difficulties in establishing transect lines against prevailing winds or photographing in high wind areas.

Photgraphic records of permanet experimental sites, or photo points, can be a simple, rapid, and cost effective laternative to aerial photos. Photo points are obtained with a hand held camera from an elevated position, such as the roof of a vehicle (Hacker et al., 1990).

The Western Austrlian Rangeland Monitoring System (WARMS) was developed to integrate the most desirable features of the photo print method with soil and vegetation data. WARMS consists of a photographed area or "photoplot", and a series of fixed "belt" tansects within which shrubs are recorded by species and canopy width and height (Hacker et al., 1990). The belt transects are divided into blocks to allow for a precise estimate of community composition. The density of shrub seedlings, herbs, and grass species, is scored on an interval or "category" scale (as a releve). Plant counts within the photographed area supplement transect data. In areas of low shrub density, the photographs can provide sufficient assessment of change and additional transect data is not needed. Quadrats established in regular intervals between transects are used to assess soil surface condition.

Summary

Quantitative information on the structure of a plant community is desirable for planning, and evaluating the success of restoration and revengetation projects. Traditional plant sampling methods such as quadra sampling, plot-less methods, and distance methods can provide accurate estimates of cover, density, and frequency. However, the extensive labor and preparation needed may make these techniques poorly suited for characterizing large mitigation sites. "Completely randomized sampling will inevitably under sample rare but interesting and ecologically informative kinds of vegetation" (Barbour et al., 1987). The appropriate method of community sampling is dependent upon the project. The terrain investigated, the research goals, and available capital must be considered prior to choosing a sampling technique.

References

Barbour, M.G., J.H. Burk, and W.D. Pitts. Terrestrial Plant Ecology. Chapter 9: Method of sampling the plant community. Menlo Park, CA: Benjamin/Cummings Publishing Co.; 1987.

Cox, G. Laboratory manual. of general ecology 6th Ed. Dubuque, Iowa: WIlliam C. Brown; 1990.

Eberhardt, L.L. , and J.M. Thomas. Designing Environmental Field Studies. Ecological Monographs. 1991; 61(1): 53-73.

Greig-Smith, P. Quantitative Plant Ecology. London: Butterworths; 1964.

Hacker, R., D. Beurle, and G. Gardiner. Monitoring Wester Australia's rangelands. Journal of Agriculture. Western Australia Department of Agriculture. No.1, 1990.

Knapp, R. Ed. Sampling methods and taxon analysis in vegetation science. Handbook of Vegetation Science 1. Part 4. Hague: Junk; 1984.

Equations

Quadrat Sampling Density = # of individuals / area sampled

Relative Density = species density / total density for all species x 100

Frequency = # of quadrats in which species occur / total # of quadrats sampled

Relative Frequency = species frequency / total of frequency values for all species x 100

Point Sampling

Cover = number of points covered by a species / total number of points x 100

Line Intercept Sampling

Cover = sum of intercept lengths for a species / total length of transect x 100

Density = (ℜ 1/M)(unit area / total transect length) where M = maximum width of plant perpendicular to the transect line

Relative Density = species density / total density for all species x 100

Distance Methods

Density = square meters / 2 * (average distance in meters)^2

Relative Density of a Species = # of individuals A encountered / # of all species encountered * (density for all species)

When collected: All quadrat species
Field width: 1 digit
MQO: No errors, at least 80% of the time

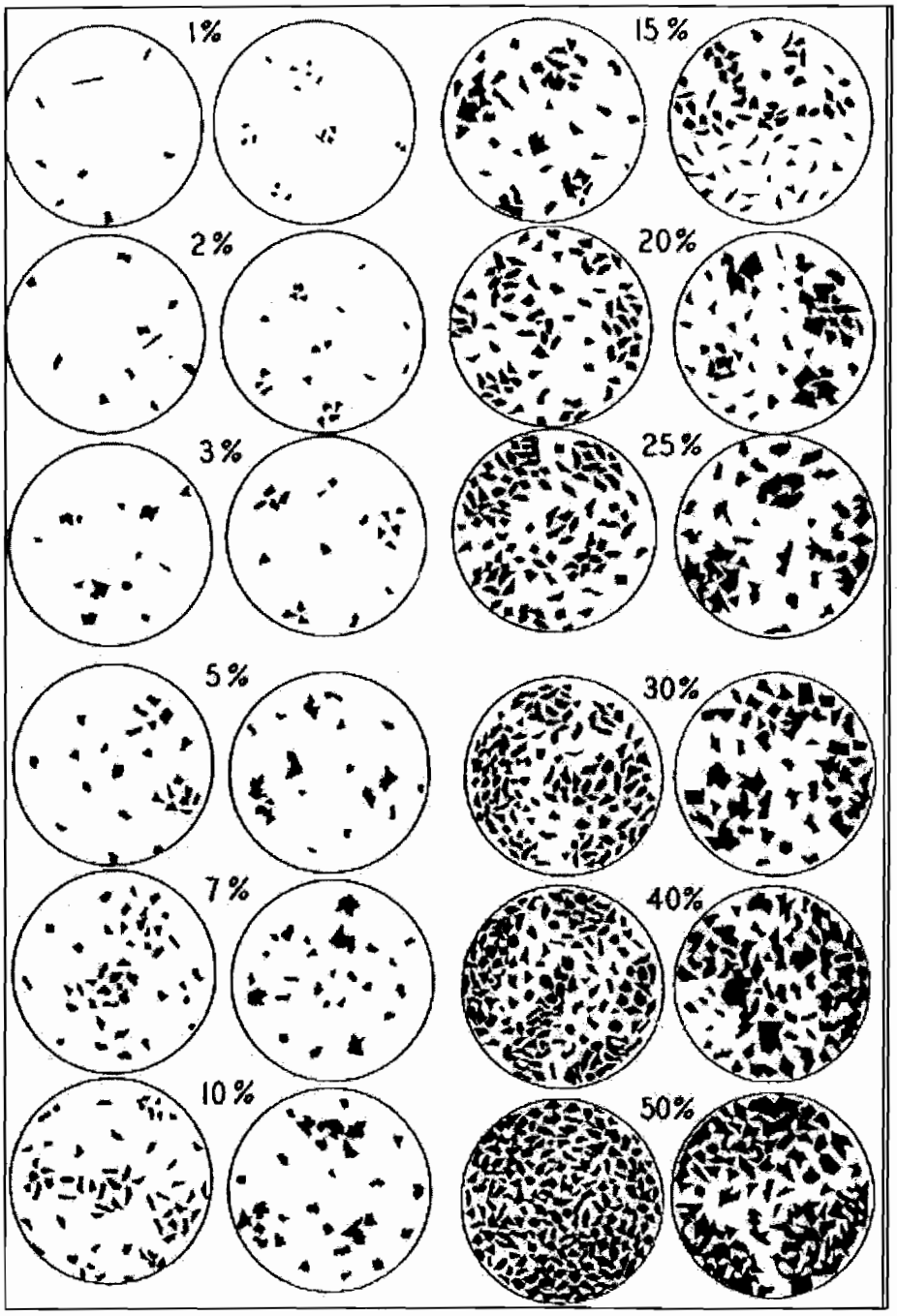

Figure 13-4. Reference plots for cover estimation.

CNPS COVER DIAGRAMS

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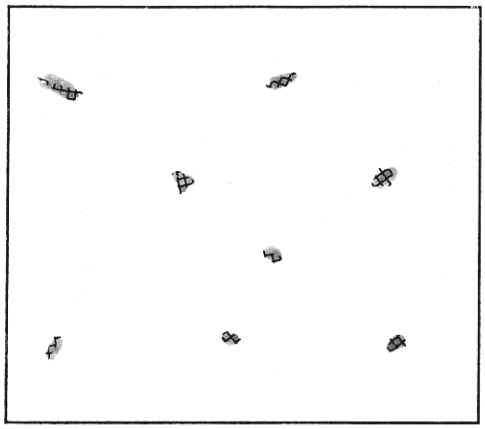

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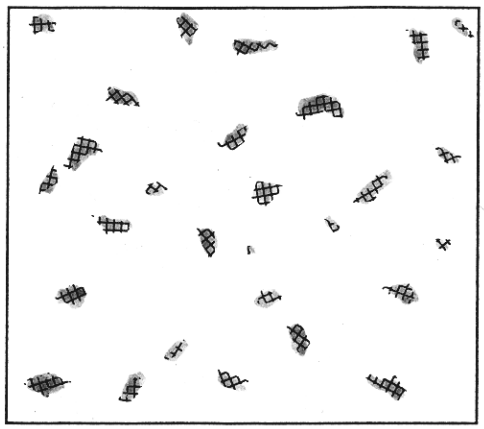

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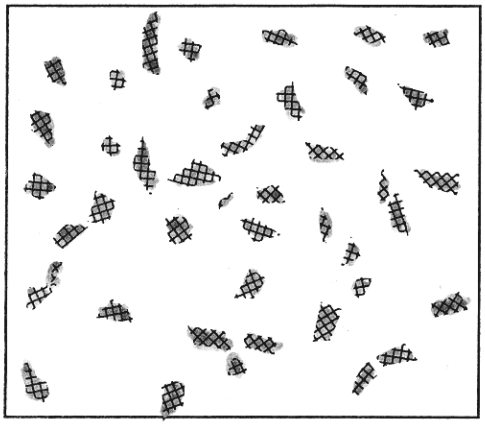

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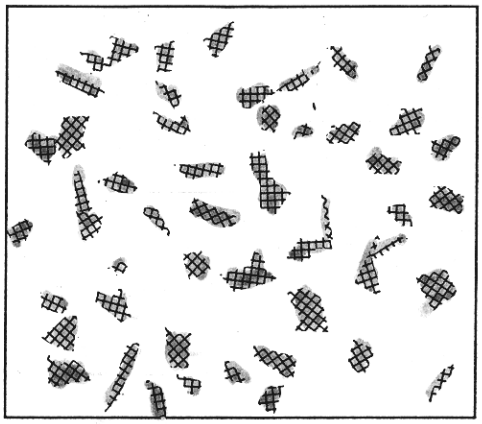

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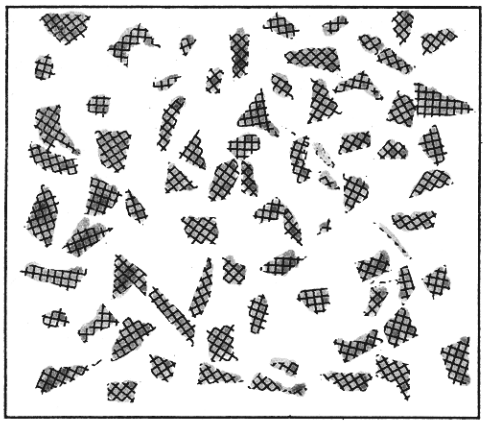

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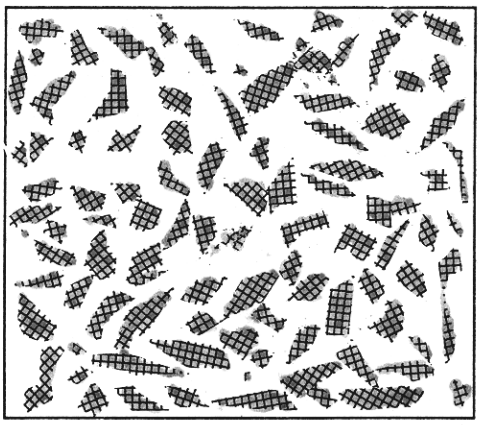

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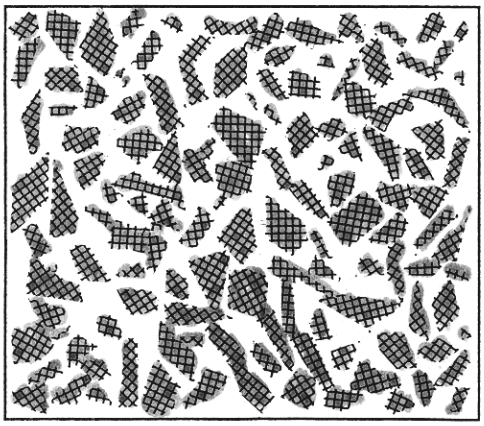

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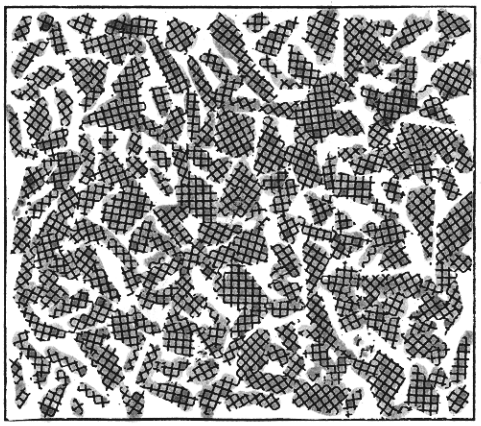

Appendix I