(S.A.S.S.) MITIGATION & MONITORING PLAN

SHERWOOD POINT OAK RESTORATION, ADOBE GULCH CREEK WETLAND CREATION, SKYLINE QUARRY WETLAND RESTORATION, and SKYLINE BOULEVARD HABITAT IMPROVEMENT

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In Association with:

RMC
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Prepared for:

San Francisco Public Utilities Commission
1145 Market Street, 5^{th} Floor
San Francisco, CA 94103

28 October 2010

Project # 3135-01

San Francisco Public Utilities Commission
Mitigation and Monitoring Plan for the
Sherwood Point Oak Restoration,
Adobe Gulch Creek Wetland Creation,
Skyline Quarry Wetland Restoration, and
Skyline Boulevard Habitat Improvement Projects

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.

10/28/10

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. INTRODUCTION

This Mitigation and Monitoring Plan (MMP) describes a portion of the Habitat Reserve Program (HRP) that the San Francisco Public Utilities Commission (SFPUC) will implement to create, enhance, or restore 2.7 acres (ac) of oak woodland, 4.3 ac of seasonal wetland, 3.9 ac of emergent wetland, 8.35 ac of northern coyote brush scrub, and 0.92 ac of riparian woodland across 4 sites in the SFPUC's Peninsula watershed to compensate for impacts to jurisdictional wetlands [as well as aquatic habitat for the California red-legged frog (CRLF) and San Francisco garter snake (SFGS)], scrub, oak woodland, and riparian woodland habitats (Table 1). This habitat creation, enhancement, and restoration will occur at the Sherwood Point, Adobe Gulch Creek, Skyline Quarry, and Skyline Boulevard sites (collectively referred to as the S.A.S.S. sites) located adjacent to the San Andreas and Crystal Springs Reservoirs, in San Mateo County, California (Figure 1). These sites are owned by the SFPUC. Their selection as mitigation sites resulted from a comprehensive search of SFPUC property by SFPUC staff and Winzler & Kelly as part of the HRP planning. Additionally, the sites were selected because of the potential for the federally endangered SFGS and federally threatened CRLF to utilize the created wetlands; both special-status species have been documented in the freshwater emergent wetlands surrounding the project sites (Figure 2).

The HRP focuses on developing consolidated compensation for the series of projects included in the Water System Improvement Program (WSIP). This 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 habitats.

Table 1. Total Habitat Creation, Enhancement, or Restoration by Site.

HABITAT TYPE	HABITAT CREATION, ENHANCEMENT, OR RESTORATION (AC)				
	Sherwood Point	Adobe Gulch Creek	Skyline Quarry	Skyline Boulevard	Total Acreage by Habitat Type
Oak Woodland	1.40	1.30			**2.70**
Seasonal Wetland	0.10	0.40		3.80	**4.30**
Emergent Wetland	0.20		3.70		**3.90**
Northern Coyote Brush Scrub			5.00	3.35	**8.35**
Riparian Woodland		0.02	0.90		**0.92**
Total Acreage by Site	**1.70**	**1.72**	**9.60**	**7.15**	**20.17**

1.1 RESPONSIBLE PARTIES

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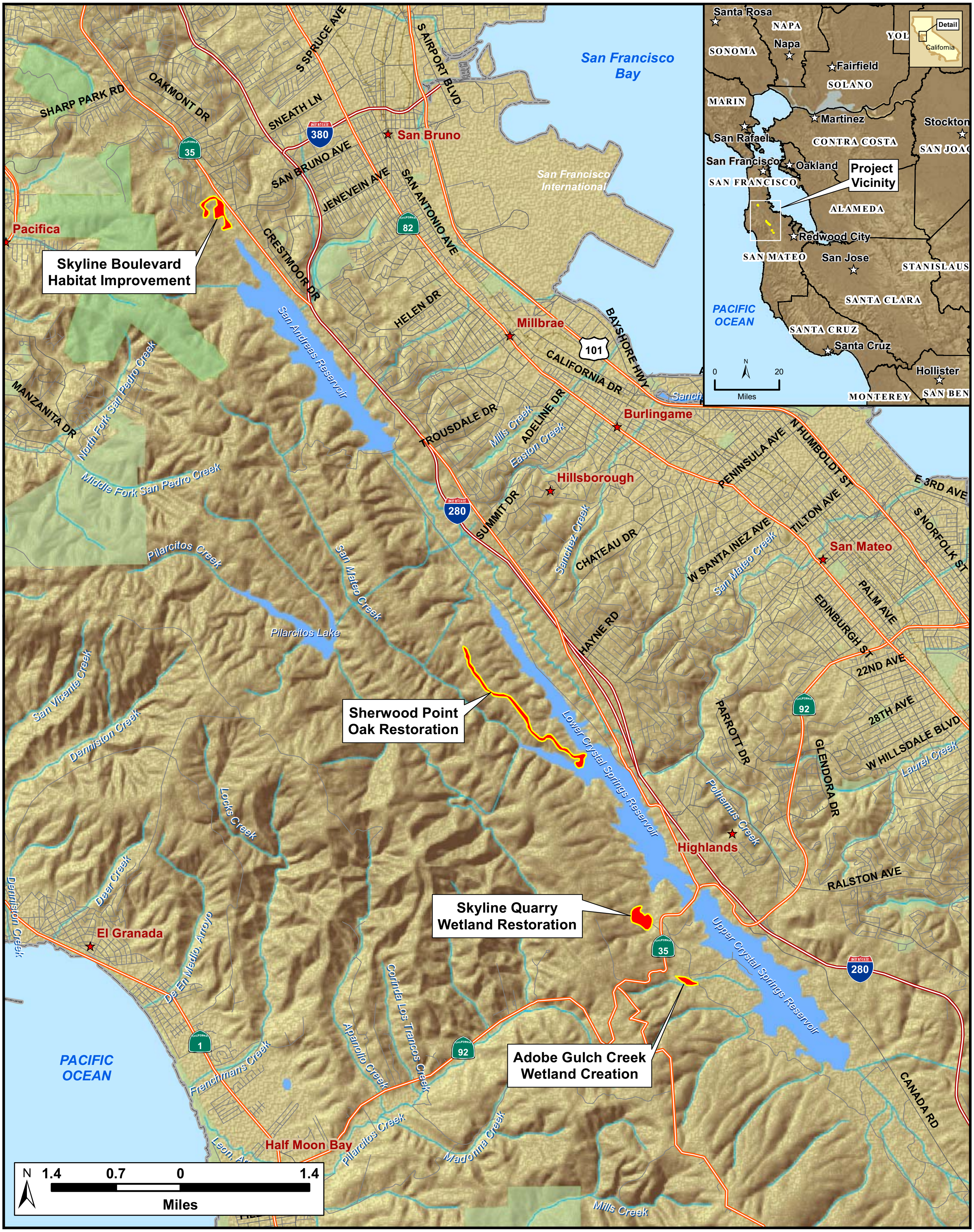

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ECOLOGICAL CONSULTANTS

Figure 1: Vicinity Map

Sherwood Point, Adobe Gulch Creek, Skyline Quarry, and Skyline Boulevard Sites - Mitigation and Monitoring Plan (3135-01)
October 2010

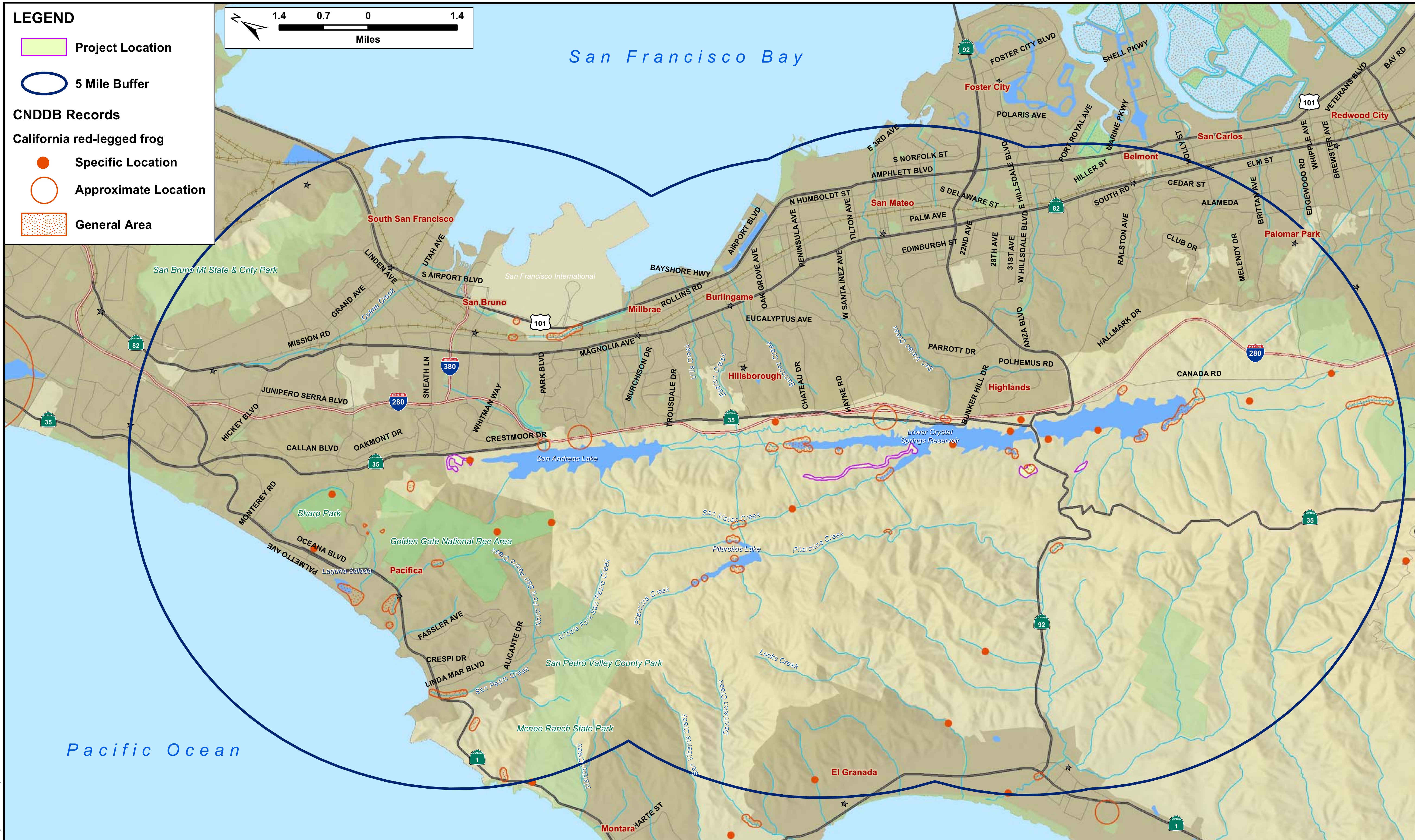

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Figure 2: California red-legged frog CNDDB Records

Sherwood Point, Adobe Gulch Creek, Skyline Quarry, and Skyline Boulevard Sites-Mitigation and Monitoring Plan (3135-01)

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2.0 PROJECTS REQUIRING MITIGATION

The habitats restored, enhanced, and created at the 4 mitigation sites will be used to compensate for impacts from SFPUC projects. This Draft MMP may be referenced in permit applications for SFPUC WSIP projects and SFPUC projects not included in the WSIP. The Sherwood Point, Adobe Gulch Creek, Skyline Quarry, and Skyline Boulevard projects are contributing to compensation for impacts of the Lower Crystal Springs Reservoir (LCSR) Dam Improvement project (Tables 2 and 3).

Table 2. Impacts Related to Lower Crystal Springs Reservoir Dam Improvement Project.[1]

IMPACT TYPE	TOTAL TEMPORARY IMPACTS	TOTAL PERMANENT IMPACTS	TOTAL INUNDATION IMPACTS
Riparian Acres (ac)	0.08	0	7.7
Riparian Linear Footage (LF)	113	0	1,357
Wetland (ac/LF)[2]	1.0 ac / 249 LF	0.45 ac / 113 LF	5.8 ac
Pond (ac)	0	0.06	0
Oaks / Other Sensitive Habitat (ac)	0	0	40.31

[1] Totals include impacts to be compensated for at other SFPUC projects.
[2] Wetlands, including seasonal wetlands and aquatic habitat for CRLF and SFGS. Temporary and permanent impacts to wetlands during construction are associated with a willow riparian wetland which contains a narrow, undefined channel of San Mateo Creek.

Table 3. Compensation Related to Lower Crystal Springs Reservoir Dam Improvement Project by Project Area.[1]

HABITAT TYPE	HABITAT CREATION, ENHANCEMENT, OR RESTORATION ACRES (AC)				
	Sherwood Point	**Adobe Gulch Creek**	**Skyline Quarry**	**Skyline Boulevard**	**Total Acreage by Habitat Type**
Oak Woodland	1.40 restored	1.30 created			2.70
Seasonal Wetland	0.10 created	0.40 created and aquatic habitat (breeding and foraging for CRLF and foraging for SFGS)		3.80 created and aquatic habitat (breeding and foraging for CRLF and foraging for SFGS)	4.30
Emergent Wetland	0.20 created		3.70 enhanced		3.90
Northern Coyote Brush Scrub			2.0 enhanced 3.0 restored	2.35 created and 1.0 restored	8.35

HABITAT TYPE	HABITAT CREATION, ENHANCEMENT, OR RESTORATION ACRES (AC)				
	Sherwood Point	**Adobe Gulch Creek**	**Skyline Quarry**	**Skyline Boulevard**	**Total Acreage by Habitat Type**
Riparian Woodland		0.02 (50 LF) created	0.9 enhanced		0.92
Total Acreage by Site	**1.70**	**1.72**	**9.6**	**7.15**	**20.17**

[1] Total impacts at LCSR are compensated for by mitigation from S.A.S.S. projects and other SFPUC sites; these acreage values do not include the mitigation at the other SFPUC sites.

3.0 SHERWOOD POINT OAK RESTORATION SITE

3.1 LOCATION AND BOUNDARIES

The Sherwood Point Oak Restoration Site (Sherwood Point) is located at the southern terminus of Portola Road at the northern end of Lower Crystal Springs Reservoir (Figure 1). The Sherwood Point site is currently comprised of non-native eucalyptus, needlegrass grassland, non-native grassland, 2 small seasonal wetlands, and barren ground [generally below 280 ft mean sea level (msl) elevation].

3.2 SELECTION PROCESS AND OWNERSHIP

The selection of this SFPUC-owned site is intended to satisfy the oak woodland and wetland compensation needs identified by the SFPUC for impacts to oak woodlands and jurisdictional wetlands associated with the LCSR project. The primary objective of this restoration site is the removal of eucalyptus trees along Sherwood Point that are encroaching into adjacent native habitats. Once removed, native oak woodland will be restored. To maximize habitat diversity, an existing fringe wetland will be expanded by forming a long narrow depression to retain water as reservoir levels recede.

The site boundary is configured to optimize the use of Portola Road while minimizing adverse impacts to sensitive communities, including riparian habitats and Waters of the U.S. that border Portola Road and the reservoir. The proposed habitats and staging area are directly accessible from Portola Road and are comprised of non-sensitive, vegetation communities, including non-native annual grassland and eucalyptus. The wetland boundaries will be based on planned future operations for Lower Crystal Springs Reservoir, which will allow for water levels up to the dam spillway (292 ft msl elevation) and therefore, excavation and grading of the wetlands will not encroach into the reservoir. The location of the staging area was selected because it contains degraded, previously disturbed needlegrass grassland and provides a central location for heavy equipment access and storage. Additionally, existing erosion problems along portions of the access road will be reduced through a combination best management practices.

3.3 EXISTING CONDITIONS OF COMPENSATION SITE

3.3.1 Vegetation

The proposed site consists of a non-native stand of bluegum eucalyptus (Figure 3). Surrounding this is a relatively open stand of coast live oak woodland with an understory of native perennial grasses. Some of the openings, too small to map, were good examples of valley needlegrass grassland. A 0.2-ac area of valley needlegrass will be used for staging. Moving away from the eucalyptus stand, the oak canopy becomes denser and was mapped as coast live oak forest. South-facing exposures along the access road on the ridge support northern coyote brush scrub. An isolated eucalyptus tree is present a little farther to the west of the proposed project activities along the reservoir's edge. Northern mixed chaparral and chamise chaparral are present along the access road. The exposed shore of Crystal Springs Reservoir includes 2 small wetlands dominated by non-native species (ESA+Orion 2009).

3.3.1 Threatened, Endangered, Special Status Species or Sensitive Habitats

Habitats within and surrounding the Sherwood Point site include eucalyptus (non-native), coastal scrub, coastal oak woodland, small patches of perennial grassland, and lacustrine. Species observed during surveys include the spotted towhee, turkey vulture, bushtit, and several San Francisco dusky-footed woodrat nests (ESA+Orion 2009).

No special-status plants were observed within the eucalyptus stand during 2007 surveys conducted for the Lower Crystal Springs Dam Improvement's EIR project. However, the woodland nearby and the access road have moderate potential to support western leatherwood (non-listed special-status species; CNPS List 1B.2), and San Francisco collinsia (non-listed special-status species; CNPS List 1B.2) has been reported on the reservoir edge nearby.

Limited areas of dwarf plantain (*Plantago erecta*), host plant for the federally endangered Bay checkerspot butterfly were observed along the access road, and therefore limited habitat may be present for the butterfly. San Francisco dusky-footed woodrat (California Species of Special Concern) nests were present in many locations on Sherwood Point, except in the eucalyptus grove. SFGS (federal-endangered, California-endangered, and California fully-protected), CRLF (federal-threatened, California Species of Special Concern), and western pond turtles (California Species of Special Concern) are known to occur along the periphery of the Peninsula reservoirs and thus there is a high potential for these species to be present, although there are no documented occurrences of these species here. Birds and bats may nest/roost within the project area or surrounding habitats (ESA+Orion 2009).

3.3.2 Aquatic Features and Jurisdictional Areas

A reconnaissance-level survey of the vicinity of the Sherwood Point site was carried out on 7 May 2008. The topographic lower edge is Lower Crystal Springs Reservoir, a jurisdictional feature (ESA+Orion 2009). Two seasonal wetlands are present within the Sherwood Point site, but they have not been formally delineated due to access restrictions that are in effect during the winter.

3.3.3 Topography, Soils, Substrate, Hydrology

The following descriptions rely on information obtained from the U.S. Geologic Survey (USGS 1999, 2006), the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), SFPUC (2008), the California Geological Survey (CGS 2007, 2007), and site-specific field investigation conducted by AEW (refer to Appendix B for the results of AEW's soil investigation).

Sherwood Point site is located at the base of a shallow ridgeline that descends into Lower Crystal Springs Reservoir. Soils within the vicinity of the Sherwood Point site are mapped as a Zeni-Zeni variant gravely loam on 30 to 75 % slopes in the most recent release of the San Mateo County Soil Survey (NRCS 2008). Soils testing conducted at 3 borings revealed variability in depth to bedrock, ranging from 30 in near the top-central portion of Sherwood Point to 60 in along the lower back slope (refer to Appendix B for boring locations and analysis results). The soils abruptly transition to a strongly weathered sandstone at depth. The soils are characterized

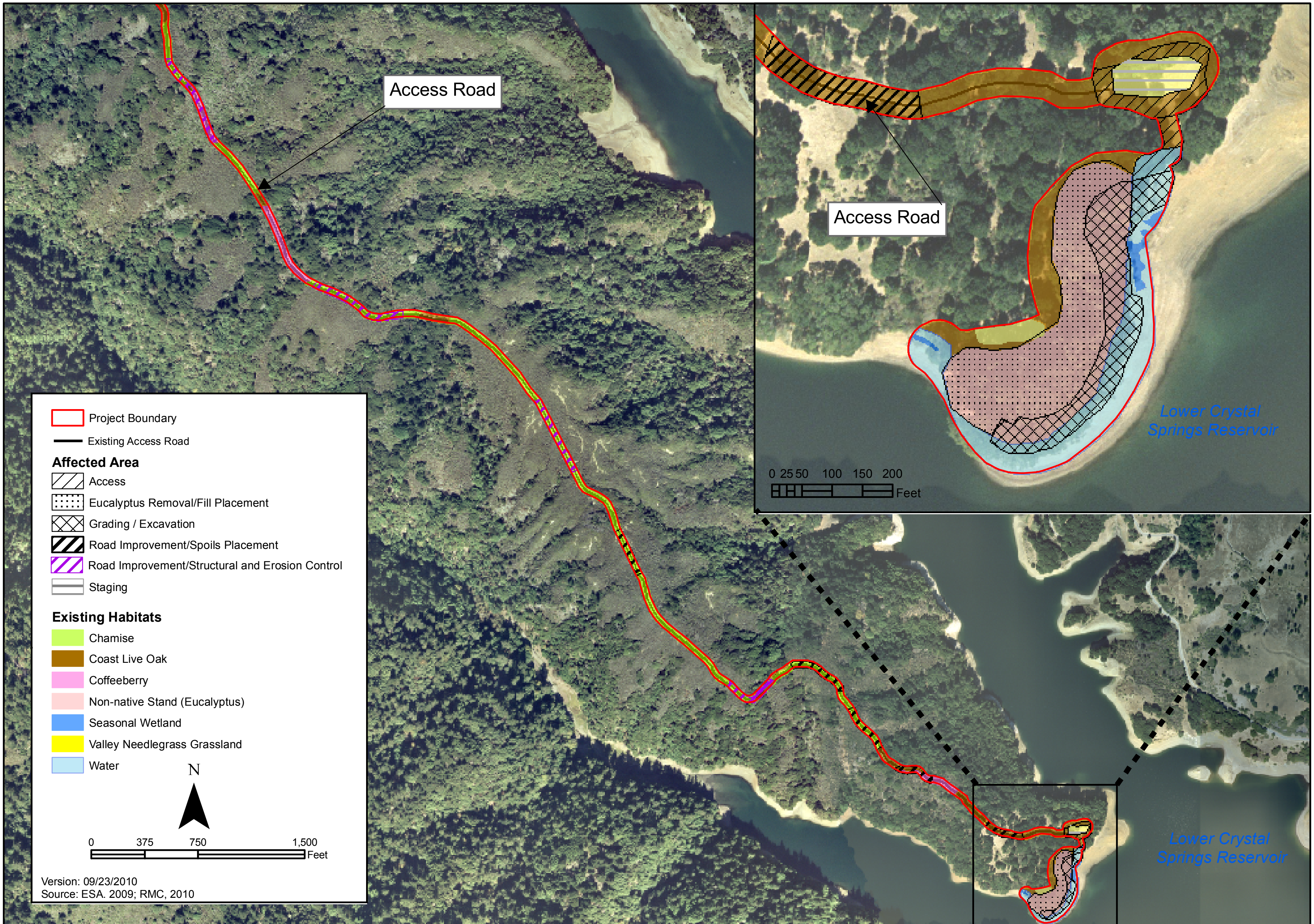

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Figure 3: Sherwood Point Oak Restoration Site Existing Habitats

by a clay loam throughout the profile with a noticeable increase in clay below 4 in and are moderately acidic with an organic content ranging from low to sufficient. Salinity, sodium and boron levels are low. All samples were found to be deficient in nitrogen, phosphorus, potassium and the micronutrient zinc. Under natural conditions, these soils are typically found on convex slopes of greater than 25 % under Douglas-fir, redwood, tanoak or huckleberry.

The site is located in a seismically active region at the boundary between 2 major tectonic plates: the Pacific Plate to the southwest and the North American Plate to the northeast. The San Andreas Fault, which exists in the project area, is the dominant structure in the system that defines the boundary between the 2 tectonic plates, spanning nearly the full length of the state of California. Other major faults associated with the San Andreas system include the San Gregorio Fault about 7 miles (mi) west of the site, and the Hayward Fault about 18 mi east of the Peninsula watershed. Earthquakes occurring along these and other faults are capable of generating strong ground shaking at the sites. However, the project location is in an area with a low susceptibility to landslides, with very low to moderate susceptibility to liquefaction (USGS 1999, 2006).

3.4 MITIGATION PROPOSAL

The habitat design concept for the Sherwood Point site proposes the restoration of oak woodland through the removal of exotic eucalyptus trees. A secondary objective for this site includes the creation of seasonal and emergent wetlands along the fringe of the reservoir (Figure 4). These proposed habitats are discussed further below.

3.4.1 Target Habitats and Quantities

Oak Woodland Restoration: SFPUC is proposing the restoration of up to 1.4 ac of oak woodland through the removal of up to 3 ac of existing eucalyptus trees and associated leaf litter (see Figures 3 and 4). The method for disposing of the eucalyptus tree trunks will include the offsite hauling of the downed logs and chipped materials for subsequent disposal at a landfill. Some of the downed material may be chipped or cut onsite for interim erosion control purposes.

Irrigation for the oak plantings will be needed for up to 3 years. SFPUC is currently considering the use of a floating pump (with screen) in the reservoir to supply the necessary irrigation water during this period. The pump will be solar powered; no electrical supply line or storage of diesel fuel will be required.

Wetland Creation: Restoration of the Sherwood Point site will also involve the creation of up to 0.1 ac of seasonal wetland and 0.2 ac of emergent wetland along the shoreline. The wetlands would be supplied through a combination of direct precipitation and seasonal inundation by LCSR. The functionality of the seasonal and emergent wetlands will be contingent upon the actual hydrology and duration of inundation by LCSR. Based on limited investigations of the onsite soils, soil depths along the middle and upper backslopes of Sherwood Point range from 4 to 5 ft in depth to competent bedrock, and therefore, are suitable for excavating a shallow linear trough along the shoreline. The trough would average 1.5 ft deep with a corresponding floor elevation of 284.5 to 485.5 ft msl (NAVD 83). The rim of the water-side edge of the trough would correspond with an elevation of 286 to 287 ft msl.

The wetland trough would be protected from wave action through the integration of a protective berm on the water-side of the trough, which would also facilitate ponding within the trough. The protective berm would be constructed by maintaining a small lip along the water's edge during excavation or using a combination of excavated soil and rock fragments for fill, where retention of the existing grade is not feasible. Erosion control along the berm would be accomplished through the integration of a combination of best management practices (BMPs), including but not limited to, erosion control blankets, geofabrics, and/or excavated rock fragments.

Irrigation for the wetland plantings and live willow cuttings will be necessary (using the same water supply system installed for the oak restoration plantings) in the first several years to establish this vegetation, as LCSR operations may not have achieved their proposed target elevations at the time of the wetland's creation. Once LCSR reaches its target operations, the reservoir will regularly inundate the wetland and irrigation will no longer be required.

3.4.2 Construction Considerations

Construction access to the site would require temporary access through the Crystal Springs Golf Course. Large organic debris, including tree trunks, along with smaller debris and construction-related import materials would be transported offsite using single haul trucks. As previously indicated, plant debris not removed offsite would be used onsite for erosion control or for coarse woody debris habitat enhancement features.

Surplus soil materials would be used as topsoil for the oak woodland planting area and as fill for the proposed fringe wetland. Any suitable excess fill would be applied, where appropriate, to portions of the existing access road to improve roadway conditions. This roadway work would be limited to specific sections of the road where documented erosion problems exist. SFPUC anticipates that some material imports (e.g., aggregate) will be required along 2 steep sections of the road to stabilize the surface for haul truck use. Sections of the roadway that would be subject to these improvements total approximately 2.3 ac and are situated away from drainage crossings and large oak trees. The construction specifications for these improvements will require that the materials be placed along the crown of the roadway and away from any roadside drainages. Additionally, at the locations where fill is placed along the roadway, SFPUC would provide appropriate erosion control measures, including but not limited to, outsloping, soil stabilizers, aggregate base for the roadway surface, and erosion control blankets or rock-lined V-ditches at drainage outlets. The road will be outsloped with rolling dips integrated at frequent intervals to drain road surface runoff and control road surface erosion (Weaver and Hagans, 1994).

Excavated soils materials will be temporarily stockpiled at the proposed 0.2-ac staging area. Following construction, the staging area will be restored to native needlegrass grassland via tilling to alleviate any soil compaction and seeding (see Section 7.3.1 for seeding details).

A historical drainage ditch previously used by a hotel will need to be avoided to the extent possible. No fill within the drainage ditch is proposed; however, a temporary crossing will be required to allow for the passage of construction equipment.

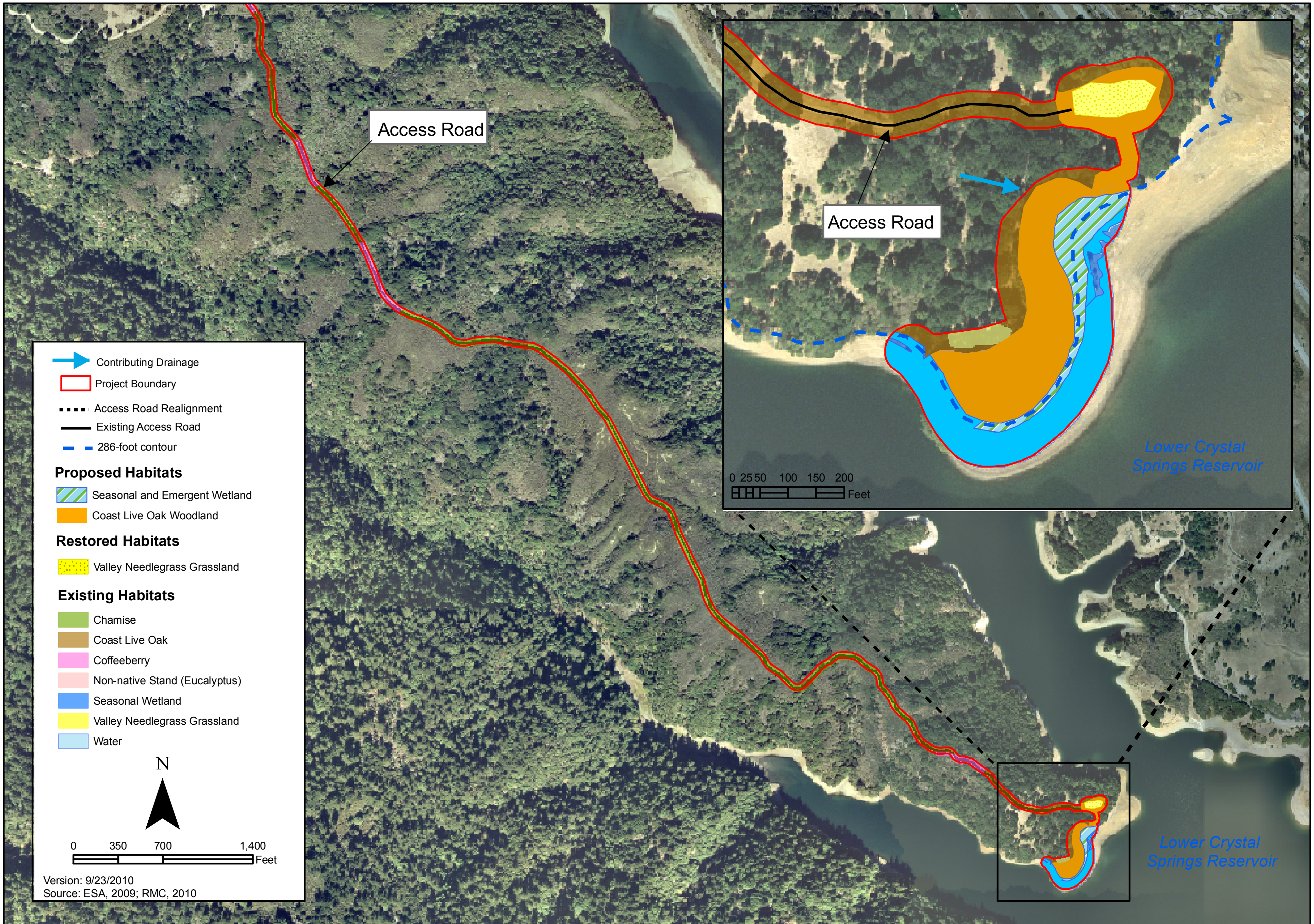

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Figure 4: Sherwood Point Oak Restoration Site Preliminary Design Site Plan

4.0 ADOBE GULCH CREEK WETLAND CREATION SITE

4.1 LOCATION AND BOUNDARIES

The Adobe Gulch Creek Wetland Creation Site (Adobe Gulch Creek) is located along Adobe Creek between Old Cañada Road and Upper Crystal Springs Reservoir (Figure 1). It consists of a remnant homestead site and comprises a small heavy equipment turnout, currently used for fire truck staging, immediately adjacent to Adobe Creek surrounded by eucalyptus and cypress trees. Old Cañada Road, an existing unpaved access road, provides access to the site. The existing turnout is less than 0.1 ac and contains pieces of concrete that are likely remnants of a foundation and several medium to large boulders. Adobe Creek meanders along the northern portion of the site and crosses under the Old Cañada Road via a 36 in culvert to the west of the turnout.

4.2 SELECTION PROCESS AND OWNERSHIP

The selection of this site is intended to satisfy the seasonal wetland and oak woodland compensation needs identified by the SFPUC for impacts to jurisdictional wetlands and woodlands associated with the Lower Crystal Springs Reservoir (LCSR) Dam Improvement project. The proposed habitats identified within the project area will provide approximately 0.4 ac of seasonal wetland creation, 0.2 ac of riparian woodland creation, and 1.3 ac of oak woodland creation. The site is currently under SFPUC's ownership and provides a good opportunity for wetland creation based on a combination of contributing surface hydrology from an existing roadside ditch and previous disturbance resulting from the prior homestead and existing heavy equipment turnout.

The site boundary is configured to optimize the use of Old Cañada Road while minimizing adverse impacts to sensitive communities, including riparian habitats and Waters of the U.S. that border Old Cañada Road in the vicinity of Adobe Gulch Creek site. Existing conditions in the site boundary mainly comprise non-sensitive vegetation communities, including ruderal vegetation, annual grassland, and eucalyptus. However, the site does contain 2 small areas of sensitive vegetation communities; riparian habitat along the northern boundary and arroyo willow riparian forest along the eastern boundary. The proposed wetland will be situated to avoid any permanent, direct impacts, including alterations to existing riparian habitat and hydrology. The location of the riparian creation area was selected due the degraded condition of this section of stream bank and associated riparian corridor. The location of the heavy equipment turnout was selected because it contains non-native eucalyptus habitat and provides a central location for heavy equipment access and storage. Additionally, the relocated heavy equipment turnout would be situated further away from Adobe Gulch Creek, thereby minimizing interactions between sensitive species migrating through the stream corridor and increasing the distance between ongoing maintenance activities and the creek.

The overall biological basis for Adobe Gulch Creek site is to enhance habitat connectivity for CRLF to existing habitats west of Lower Crystal Springs Reservoir and south of SR 92. Additionally, the site was selected because of the potential for the federally endangered, SFGS and federally threatened, CRLF to utilize the created wetlands; both special-status species have been documented in the seasonal and freshwater emergent wetlands near the project area (Figure 2).

4.3 EXISTING CONDITIONS OF COMPENSATION SITE

4.3.1 Vegetation

The Adobe Gulch Creek site includes areas of non-native stand dominated by bluegum eucalyptus (Figure 5). A non-native tree stand dominated by Monterey cypress is located immediately to the west. The stream channel supports a narrow string of riparian scrub, which broadens to a wide thicket farther east. Uplands to the north support northern coyote brush scrub and the slopes to the west and south support coast live oak forest. The existing 0.1 ac heavy equipment turnout is mapped as ruderal (ESA+Orion 2009).

4.3.2 Threatened, Endangered, Special Status Species or Sensitive Habitats

Habitats in the Adobe Gulch Creek site include eucalyptus, closed-cone pine-cypress, coastal oak woodland, valley foothill riparian, and some coastal scrub in the proposed construction staging area located at the western end of the project area. These habitats are abundant surrounding the site; however, the eucalyptus is isolated to only this location. Wildlife species observed during the survey period from May 2008 through January 2009 include San Francisco dusky-footed woodrat, western scrub jay, Anna's hummingbird, American crow, and western gray squirrel (ESA+Orion 2009).

Special-status Species. This area is potential habitat for western leatherwood (non-listed special-status species; CNPS List 1B.2), although the area is so disturbed that its potential to occur is considered to be low. Two other species typically found in mesic sites, bristly sedge (non-listed special-status species; CNPS List 2.1) and Choris' popcorn flower (non-listed special-status species; CNPS List 1 B.2) are also considered to have low potential to occur.

Known populations of several special-status wildlife species are located less than a mile east of this proposed wetland creation area, and these species may utilize nearby habitats: SFGS (federal-endangered, California-endangered, and California fully Protected), CRLF (federal-threatened), and western pond turtles (California Species of Special Concern) are known to occur at the Crystal Springs Reservoir nearby, and salt marsh common yellowthroats have been reported nesting in the valley foothill riparian habitat less than 1 mile to the east. San Francisco dusky-footed woodrat (California Species of Special Concern) nests are present in the coastal oak woodlands, valley foothill riparian, and coastal scrub in close proximity to the wetland creation area. Other special-status species that may inhabit habitats within or surrounding the Adobe Gulch Creek site include nesting raptors and passerines, and roosting bats (ESA+Orion 2009). Most special-status wildlife species do not prefer eucalyptus for habitat, particularly because the eucalyptus' phytotoxic litter limits understory development, and thus provides limited food sources.

Special-status Species Habitat Requirements. Habitat within the Adobe Gulch Creek site supports the federally-listed CRLF and SFGS. Primary constituent elements (PCEs) for the

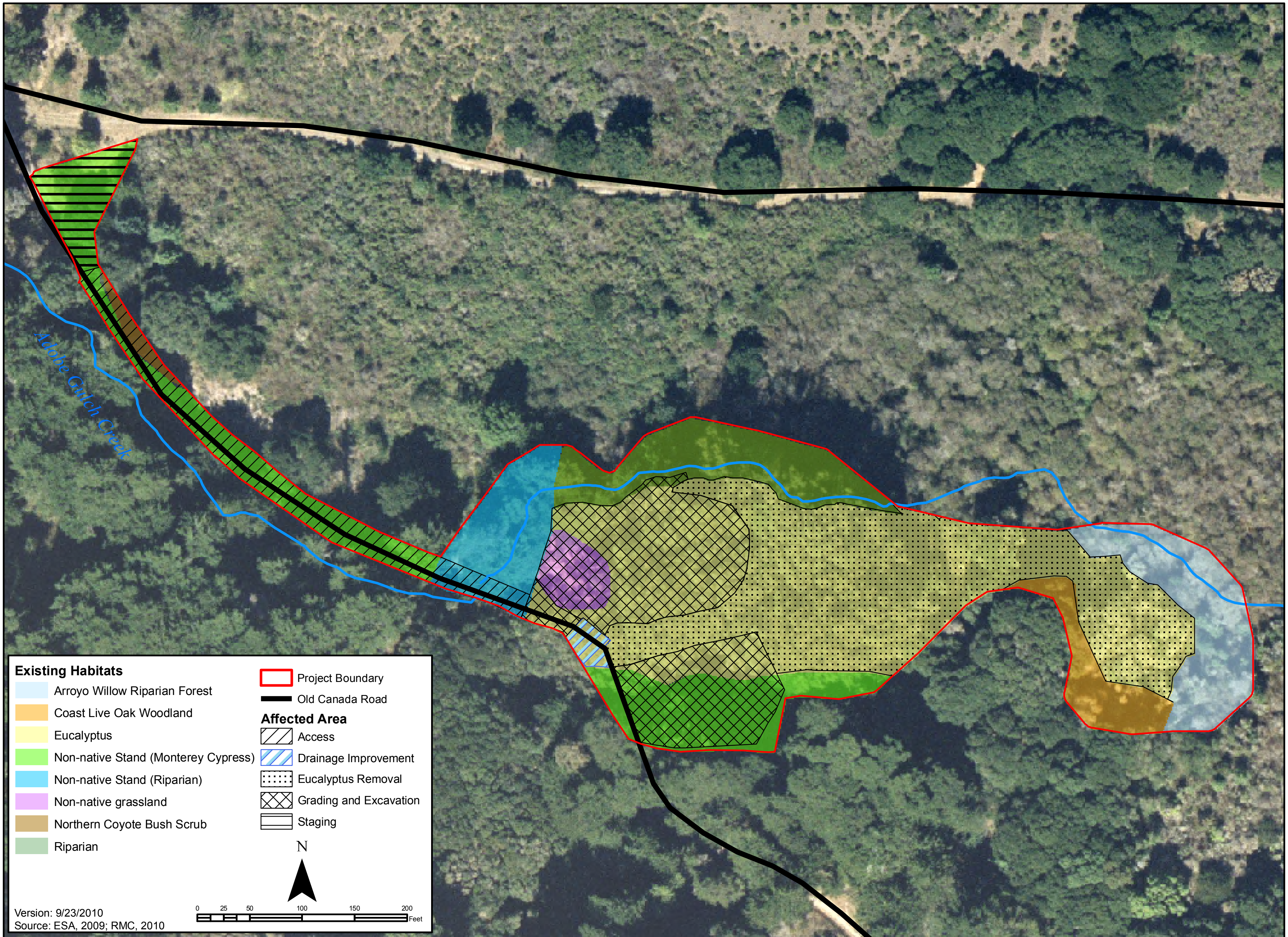

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Figure 5: Adobe Gulch Creek Site Wetland Creation Existing Habitats

CRLF are discussed below. Similar PCEs for the SFGS have not been formalized by the U.S. Fish and Wildlife Service (USFWS) as critical habitat for the SFGS has not been designated.

- **California Red-legged Frog.** CRLF habitat is composed of the following primary constituent elements: aquatic breeding habitat, aquatic non-breeding habitat, upland habitat, and dispersal habitat. A discussion of each of the PCEs deemed essential to the conservation of CRLF is provided below (as described in USFWS 2008).
    - <u>Aquatic Breeding Habitat.</u> Standing bodies of fresh water (with salinities less than 7.0 ppt), including: natural and manmade (e.g., stock) ponds, slow-moving streams or pools within streams, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a minimum of 20 weeks in all but the driest of years.
    - <u>Non-Breeding Aquatic Habitat.</u> Freshwater and wetted riparian habitats, as described above, that may not hold water long enough for the subspecies to hatch and complete its aquatic life cycle but that do provide for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLF. Other wetland habitats that would be considered to meet these elements include, but are not limited to: plunge pools within intermittent creeks; seeps; quiet water refugia during high water flows; and springs of sufficient flow to withstand the summer dry period.
    - <u>Upland Habitat.</u> Upland areas adjacent to or surrounding breeding and non-breeding aquatic and riparian habitat up to a distance of 1 mi (1.6 km) in most cases and comprised of various vegetative series such as grasslands, woodlands, wetland, or riparian plant species that provides the frog shelter, forage, and predator avoidance. Upland features are also essential in that they are needed to maintain the hydrologic, geographic, topographic, ecological, and edaphic features that support and surround the wetland or riparian habitat. These upland features contribute to the filling and drying of the wetland or riparian habitat and are responsible for maintaining suitable periods of inundation for larval frogs and their food sources, and provide breeding, non-breeding, feeding, and sheltering habitat for juvenile and adult frogs (e.g., shelter, shade, moisture, cooler temperatures, a prey base, foraging opportunities, and areas for predator avoidance). Upland habitat should include structural features such as boulders, rocks and organic debris (e.g., downed trees, logs), as well as small mammal burrows and moist leaf litter.
    - <u>Dispersal Habitat.</u> Accessible upland or riparian dispersal habitat within designated units and between occupied locations within a minimum of 1 mi (1.6 km) of each other and that allows for movement between such sites. Dispersal habitat includes various natural habitats and altered habitats such as agricultural fields, which do not contain dispersal barriers (e.g., heavily traveled road without bridges or culverts). Dispersal habitat does not include moderate- to high-density urban or industrial developments with large expanses of asphalt or concrete, nor does it include large reservoirs over 50 ac (20 ha) in size, or other areas that do not contain those features identified in PCE 1, 2, or 3 as essential to the conservation of the subspecies.

- **San Francisco Garter Snake.** Though PCEs are not designated for the SFGS, presence of the species is closely tied to the presence of ranid frogs, and in particular the CRLF, which is a prey item for the snake (Jennings and Hayes 1994). The snake frequents ponds, streams, emergent wetlands, and other similar habitats to forage on CRLF. As a result, enhancing or creating aquatic breeding habitat for the CRLF will also enhance or create aquatic foraging habitat for the SFGS.

4.3.3 Aquatic Features and Jurisdictional Areas

Adobe Creek is located along the northern edge of the site boundary and flows generally eastward toward Upper Crystal Springs Reservoir. Its channel is somewhat incised. Depositional areas in this reach of the creek include gravel bars with relatively large particles (ESA+Orion 2009).

4.3.4 Topography, Soils, Substrate, Hydrology

The following descriptions rely on information obtained from the USGS, the NRCS, SFPUC, CGS and site-specific soils data collected by AEW (see Appendix B).

The Adobe Gulch Creek site is located within a shallow gulch and generally comprises deep hillslope soils, extending to depths of greater than 6 ft to a weathered or fractured sandstone. These soils are mapped as the Alambique-McGarvey complex, 30 to 75 % slopes, in the most recent release of the San Mateo County Soil Survey (2008). These soils are generally characterized by a thick organic layer at the surface and a loamy soil texture within the upper 8 to 12 in of the soil column. Alambique soils are distinguishable from McGarvey soils in that they contain a gravelly loam throughout the soil profile whereas McGarvey soils grade to a clay loam below 12 in. Based on the collection of site-specific soils data, the on-site soil materials are more characteristic of the McGarvey soil series.

Two contributing watersheds are located upslope of the Adobe Gulch Creek site. The upper reaches of Adobe Creek comprise approximately 297 ac to the west of the Adobe Gulch Creek site. Runoff from these areas is conveyed through the main channel that crosses the access road via a 36-in steel culvert and borders the western and northern perimeter of the wetland creation site. No diversion of flow from the main channel is proposed as part of the current design.

The created seasonal wetland and riparian areas would be supplied using surface water from an existing roadside ditch that currently follows the western edge of the access road and discharges into the main channel, just west of the access road. The roadside ditch drains an area comprising approximately 15 ac.

The project is located in a seismically active region at the boundary between 2 major tectonic plates: the Pacific Plate to the southwest and the North American Plate to the northeast. The San Andreas Fault, which exists in the Adobe Gulch Creek site, is the dominant structure in the system that defines the boundary between the 2 tectonic plates, spanning nearly the full length of the state of California. Other major faults associated with the San Andreas system include the San Gregorio Fault about 7 mi west of the site, and the Hayward Fault about 18 mi east of the Peninsula watershed. Earthquakes occurring along these and other faults are capable of generating strong ground shaking at the sites. However, the project location is in areas with a low susceptibility to landslides, with very low to moderate susceptibility to liquefaction (USGS 1999, 2006).

Additional information was collected in Summer 2010 yielding further details below.

At Adobe Gulch Creek site, 1 soil boring and 1 piezometer were installed in June 2010. The soil boring explored to a depth of 14.5 ft below ground surface (bgs). The soil consisted primarily of medium dense clay with varying amounts of sand to 10.5 ft bgs. There was an increase in sand content starting at 8.5 ft. Highly weathered sandstone bedrock was encountered at 10.5 to 15 ft bgs (total explored depth). Groundwater occurred around 8 ft bgs at the time of sampling. Soil samples were collected continuously at 1.5 ft intervals to the bottom of the boring (0.0' to 1.5', 1.5' to 3.0', etc…). The piezometer was installed to a depth of 15 ft bgs, and had a soil profile similar to the soil boring location. Groundwater was also encountered around 8 ft bgs at the piezometer.

Samples from various depths of the soil boring were analyzed for soil characteristics and fertility (refer to Appendix B for boring locations and analysis results). Results classify the soil as a sandy clay loam to 1.5 ft bgs, transitioning to a clay loam at greater depths. This soil type is characterized by moderate infiltration rates. All samples contained moderate levels of organic matter and low salinity, sodium, and boron levels. Nutrient levels were within adequate ranges, with the exception of potassium, which was low in the sample for 5-6 ft bgs.

4.4 MITIGATION PROPOSAL

The primary goals for the Adobe Gulch Creek site are to facilitate the removal of exotic eucalyptus tree species for the creation of oak woodland and seasonal wetland habitat to benefit CRLF and SFGS (Figure 6). The existing heavy equipment turnout will be relocated to the east to facilitate the creation of the seasonal wetland and to increase the distance between roadway operations and Adobe Creek. Each of these proposed habitats are described further below.

4.4.1 Target Habitats and Quantities

Wetland and Riparian Woodland Creation: A 0.4-ac seasonal wetland is proposed just east of Adobe Creek and the associated riparian zone. This area is currently devoid of vegetation and includes several medium and large diameter boulders that will be relocated to the new heavy equipment turnout. The seasonal wetland will outfall into a small 0.02-ac riparian creation area to the north where excess flows will join Adobe Creek along a degraded portion of its southern bank. The wetland will be graded to a depth of up to 2 ft. A minimum of 1 small pond with steep banks will be integrated into the seasonal wetland to provide inundation of up to 3 ft below the wetland bottom. This pond combined with fine grading of the wetland floor is expected to provide a variety of topographical elevations within the seasonal wetland to encourage habitat diversity. Coarse woody debris may be installed in the wetland bottom near the pond to provide cover for CRLF.

An existing roadside ditch, which drains an approximately 15-ac watershed, will be used as the primary water source for the seasonal wetland. This roadside ditch follows the western edge of the access road and currently discharges into Adobe Creek, west of the Old Cañada Road. A concrete rolling dip will be integrated into Old Cañada Road approximately 80 ft east of Adobe Creek to capture and convey this surface water into the proposed seasonal wetland. This design feature will accomplish 2 objectives (1) reduce bank scour at the location where the roadside ditch currently discharges into Adobe Creek; and (2) enhance drainage patterns to resemble a more natural drainage network. For planning purposes, SFPUC has conservatively estimated a 200-square ft permanent footprint for this drainage improvement along with additional construction area.

The seasonal wetland will include bioengineered improvements at the inlet (rolling dip in the road) and outlet (step-pools) to facilitate ponding conditions where desired, minimize erosion within the created wetland, and prevent high discharges at the outlet. At this time, these improvements may consist of 1 or multiple post-construction BMPs including, but not limited to, erosion control blankets, coir fiber mats, geotextile rolls, live cuttings, and/or in limited instances, vegetated rip-rap. Inlet and outlet improvements would be designed to integrate with existing drainage patterns, promote a natural appearance, accommodate predicted hydrologic conditions, and minimize slope angles in-between topographic transitions. The wetland outlet will consist of a step-pool type of channel that will extend approximately 40 ft in length and 0.02 ac in area from the seasonal wetland to Adobe Creek. The step-pools would be constructed using eucalyptus log- or boulder-weir drops. All improvements will occur within the footprint of the proposed seasonal wetland and riparian creation areas.

Oak Woodland Creation: The proposed habitat concept for this site includes the creation of 1.3 ac of oak woodland. Existing exotic tree species, including eucalyptus, will be removed from the site, though several larger Monterey cypress trees along Adobe Creek will remain as they provide bat habitat and are situated within the riparian zone. Removed tree trucks, leaf litter, and other organic debris will be stockpiled at the heavy equipment turnout prior to transport to a designated offsite landfill or compost facility.

Relocated Heavy Equipment Turnout: To facilitate the creation of 0.4 ac of seasonal wetland, SFPUC will relocate the existing heavy equipment turnout to a 0.2-ac area immediately east of the existing turnout.

4.4.2 Construction Considerations

The following items will need to be considered during construction:

- Cultural resource sensitively is high at this location and, therefore, archaeological monitoring will be required during excavation.
- Traffic control from Highway 92 at the Adobe Gulch Creek site's gate entrance will be a challenge due to poor visibility for oncoming traffic and limited area for truck queuing.

SFPUC has estimated an area of temporary construction-related effects to Waters of the U.S. and riparian areas of up to 0.01 ac. These temporary effects will occur along the southern bank of Adobe Creek in the vicinity of the proposed riparian creation area to enable for a smooth hydraulic transition at the confluence of the outlet (step-pool) channel and Adobe Creek.

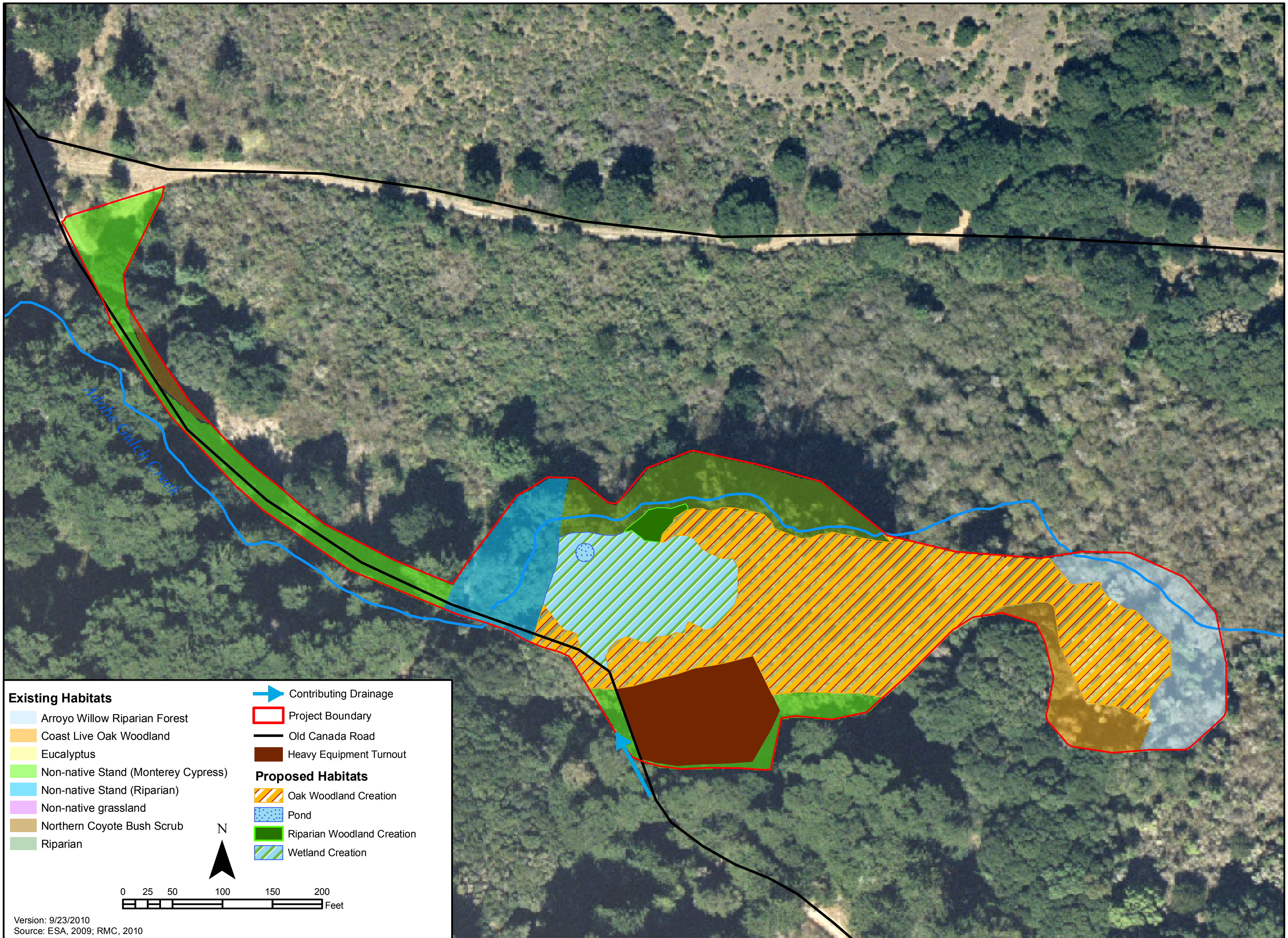

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Figure 6: Adobe Gulch Creek Wetland Creation Site Preliminary Design Site Plan

5.0 SKYLINE QUARRY WETLAND RESTORATION SITE

5.1 LOCATION AND BOUNDARIES

The site's formal name, Skyline Quarry Wetland Restoration (Skyline Quarry), is derived from the nomenclature in SFPUC's Habitat Reserve Program (HRP) documents and as such, the official title has not been altered in this MMP. However, because the mitigation design consists of wetland enhancement rather than restoration, the official site name is misleading and we will refer to the site simply as "Skyline Quarry" to eliminate confusion regarding the mitigation design.

The Skyline Quarry site consists of a reclaimed hard rock quarry located north of SR 92 and directly accessible from Skyline Quarry Road (Figure 1). The site is actively used as a trailhead for the Fifield-Cahill Ridge Trail and includes a restroom and a large parking lot. The large parking lot can be used as helicopter launching pad or staging area for maintenance activities. Only docent-led hiking occurs from this location. Previous mining activities have stripped away much the natural topography within the Skyline Quarry site. Shallow soils across the site generally consist of reclaimed overburden materials used during the reclamation of the mine.

5.2 SELECTION PROCESS AND OWNERSHIP

The selection of this SFPUC-owned site is intended to satisfy the wetland and riparian woodland compensation needs identified by the SFPUC for impacts to jurisdictional wetlands and riparian woodlands associated with the LCSR project. The primary objectives of this SFPUC-owned site are the removal/control of invasive pampas grass and enhancement of an existing emergent wetland and riparian corridor. To facilitate long-term control of pampas grass and discourage reestablishment following removal, those areas will be enhanced or restored to a northern coyote brush scrub habitat.

The site boundary is configured to optimize the use of Skyline Quarry Road and existing staging areas thereby minimizing adverse impacts to sensitive communities, including riparian and wetland habitats that border Skyline Quarry Road in the vicinity of the Skyline Quarry site. The proposed habitats and staging area are directly accessible from Skyline Quarry Road are comprised of non-sensitive, vegetation communities, including ruderal habitats and gravel lots. The larger site boundary does include sensitive vegetation communities, including emergent wetland, riparian, and willow scrub. Enhancement of the emergent wetland will include a combination of invasive plant removal (e.g., pampas grass) and supplemental wetland plantings, where appropriate. The location of the staging area was selected because it contains a gravel parking area, absent of any vegetation that provides a central location for heavy equipment access and storage.

The overall biological basis for Skyline Quarry site is to enhance habitat connectivity for CRLF to existing habitats west of Lower Crystal Springs Reservoir and north of SR 92 while removing invasive plants to encourage CRLF and SFGS to utilize the enhanced wetlands; both special-status species have been documented in the seasonal and freshwater emergent wetlands near the project area (Figure 2).

5.3 EXISTING CONDITIONS OF COMPENSATION SITE

5.3.1 Vegetation

Skyline Quarry is a highly disturbed area, and most of it is mapped as ruderal (Figure 7). However, several natural communities have established in the area. The existing wetlands located at the lowest elevations of the mine floor support a variety of habitats including riparian scrub and emergent wetland dominated by cattails, bulrushes, as well as vernal marsh dominated by spikerush. Some areas within the quarry left undisturbed have developed northern coyote brush scrub, non-native grassland and wetland. To the east of the quarry is a non-native stand dominated by Monterey cypress and bluegum eucalyptus. The area to the east and southeast is also ruderal. The entrance to the quarry supports an area of coast live oak forest. The drainages that empty into the quarry support mixed evergreen forest. The uplands to the south and west support northern coyote brush scrub (ESA+Orion 2009).

5.3.2 Threatened, Endangered, Special Status Species or Sensitive Habitats

The wildlife habitats present within this project area include developed, fresh emergent wetland, and valley foothill riparian, and is surrounded by nonnative closed-cone pine-cypress, coastal oak woodland, and coastal scrub. There is a large rock wall that was likely created from past quarry operations. Several species were observed here during the survey period from May 2008 to January 2009, including American robin, Anna's hummingbird, wrentit, red-tailed hawk, Steller's jay and black-tailed deer. An ESA+Orion biologist observed a red-tailed hawk nesting on the cliff immediately above the wetlands during the 2008 survey period (2009).

Special-status Species. No habitat was noted for any of the special-status plants known from the region. CRLF (federal-threatened) have been reported from the ponds at this site (SBI 2008), and habitat is suitable for the SFGS (federal-endangered, California-endangered, and California fully Protected) and western pond turtle (California Species of Special Concern). The San Francisco dusky-footed woodrat (California Species of Special Concern) is assumed present throughout the project area, particularly in the coastal scrub habitat. The rocky cliffs provide nesting habitat for several species, including bald eagle (California fully Protected species), peregrine falcon (California fully Protected species), black swift (California Species of Special Concern), red-tailed hawk, and other bird species, and may provide roosting habitat for the mastiff bat and other bat species. There is the potential for nesting birds and roosting bats throughout the site and in surrounding habitats (ESA+Orion 2009).

5.3.3 Aquatic Features and Jurisdictional Areas

Ephemeral natural drainages flow into the southwestern and the northwestern corners of the wetland enhancement area from Cahill Ridge. Both empty into the low-lying portion of Skyline Quarry where water collects and appears to persist in most years. This area supports seasonal and perennial wetland features. Groundwater inputs are thought to drain off the mine face via fractured, subsurface flow that is intercepted by the mine excavation. From the quarry, flow passes under the main access road in a corrugated metal pipe, where it converges with a third drainage and heads east and north (ESA+Orion 2009).

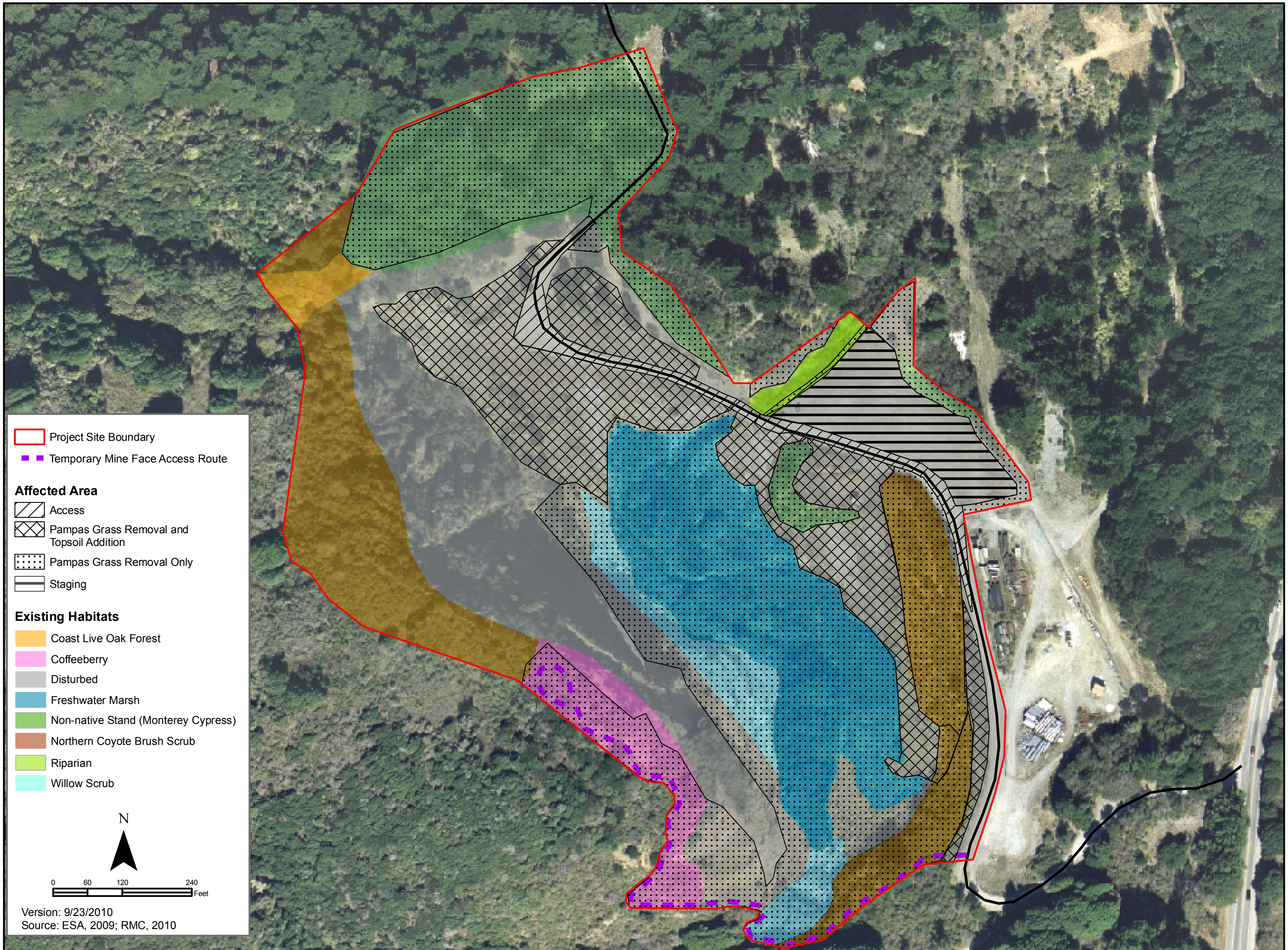

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Figure 7: Skyline Quarry Wetland Enhancement Existing Habbitats

5.3.4 Topography, Soils, Substrate, Hydrology

The following descriptions rely on information obtained from the USGS, the NRCS, SFPUC, and the CGS.

The Skyline Quarry site is located at the base of a reclaimed quarry, which is part of a larger ridge that extends upslope of the project area. Much of the native soil materials have been removed from the project area as part of previous mining activities. The Soil Survey for San Mateo County maps areas within the mine excavation as pits and dumps. Pits and dumps are highly variable in their composition with depths ranging from less than 1 ft to greater than several ft. The underlying substrate is also highly variable in terms of soil texture and the extent of weathering within the underlying bedrock.

Areas immediately upslope of the mine face are mapped as Barneba-Candlestick complex, 30 to 75 % slopes and likely resemble the original soil conditions onsite prior to mining activities. This mapping unit includes soils ranging from 16 to 24 in to weathered sandstone. These soils are characterized by a sandy or gravelly loam within the upper 8 to 12 in of the soil column that grades to a clay loam at depth.

Three contributing watershed units are located upslope of the Skyline Quarry site. The southernmost watershed unit is approximately 121 ac and is the largest contributing watershed. Runoff from the southern watershed unit enters the project area via an existing drainage feature located immediately southeast of the mine face. The northern watershed unit comprises approximately 50 ac. Runoff generated from the northern watershed unit enters the project area to the north of the mine face. A third, approximately 2.5 ac, watershed is located adjacent to the northern watershed unit and converges near the existing access road culvert.

The project is located in a seismically active region at the boundary between 2 major tectonic plates: the Pacific Plate to the southwest and the North American Plate to the northeast. The San Andreas Fault, which exists in the project area, is the dominant structure in the system that defines the boundary between the 2 tectonic plates, spanning nearly the full length of the state of California. Other major faults associated with the San Andreas system include the San Gregorio Fault about 7 mi west of the site, and the Hayward Fault about 18 mi east of the Peninsula watershed. Earthquakes occurring along these and other faults are capable of generating strong ground shaking at the sites. The project location is mapped as an area with very low to moderate susceptibility to liquefaction (USGS 1999, 2006). An active landslide feature is located near the central portion of the existing mine face with rock fall observed during multiple site visits including September 2009 and January 2010.

The 4 soil borings explored in June 2010 (refer to Appendix B for boring locations) indicated that creation of wetlands via excavation would not be feasible due to shallow bedrock:

- The first boring explored to a depth of 18.2 ft bgs. Soil was fill material (likely quarry spoils) consisting of sandy clay and clayey sand with varying amounts of gravel. Competent bedrock (sandstone) encountered at 17 ft bgs. No groundwater was encountered. Soil samples were collected at intervals of 1.5 ft.

- The second boring was completed at the west edge of the parking area, and explored a total depth to 12.5 ft bgs. Soil was fill material (likely quarry spoils) consisting of gravel with sand and clay to 6.5 ft bgs and sand with gravel to approximately 12.5 ft bgs. Competent bedrock encountered at 12.5 ft bgs. No groundwater was encountered. Soil samples were collected at intervals of 1.5 ft.
- A third soil boring location was added north of the existing emergent wetland. The total explored depth of 10.3 ft bgs. Soil was fill material (likely quarry spoils) consisting of gravel with sands to approximately 4.5 ft bgs. Weathered bedrock at 4.5 ft becoming more competent approximately 6 ft bgs. Groundwater was not encountered. Soil samples were collected at intervals of 1.5 ft in the fill material.
- A fourth boring was explored in the lowest elevations of the mine floor northeast of the existing emergent wetland. Soil ranged from 2 to 4 in above bedrock surface. Soil was generally hard and well compacted and not easily penetrated.

Samples from various depths of the soil borings were analyzed for soil characteristics and fertility (refer to Appendix B for analysis results). Results classify the samples as either a clay loam or a sandy clay loam mixed with moderate to high amount of gravel. Soil pH levels ranged from slightly alkaline to highly alkaline, and all soil samples had high levels of lime. Organic content was low, and nutrient deficiencies included phosphorus, potassium, magnesium, zinc and manganese.

5.4 MITIGATION PROPOSAL

5.4.1 Target Habitats and Quantities

The mitigation concept for this site is to enhance and restore northern coyote brush scrub habitat, enhance the existing emergent wetland, and enhance the riparian habitat (Figure 8). To this end, a central objective for the site is to control invasive weeds through the implementation of a long-term pampas grass removal/control program for areas within the boundary of the Skyline Quarry site. These habitat improvements are described below.

Emergent Wetland and Riparian Habitat Enhancement: Up to 3.7 acres of emergent wetland and 0.9 acres of riparian habitat (southwest of the existing emergent wetland) will be enhanced. Enhancement activities at these locations will involve a combination of weed removal, with emphasis on pampas grass, and the placement of supplemental wetland plantings at strategic locations, mainly where weeds are removed.

Pampas Grass Removal: Pampas grass is a large perennial grass that was introduced from South America as an ornamental. As described in the Vegetation Management Plan (Appendix C) it can be controlled by manual removal, cutting/mowing, herbicide application, and controlled burns. Pampas grass removal/control will follow the conservation measures outlined in Section 10.2 and will be achieved through a combination of manual removal and, in limited instances, herbicide application. The initial removal of pampas grass on the vertical walls adjacent to the existing marsh will be conducted by the Contractor where access is readily available from the mine floor (e.g., along level benches). Areas along the mine face inaccessible from the mine floor may be treated via rappelling down from the top of the mine face. However, due to safety

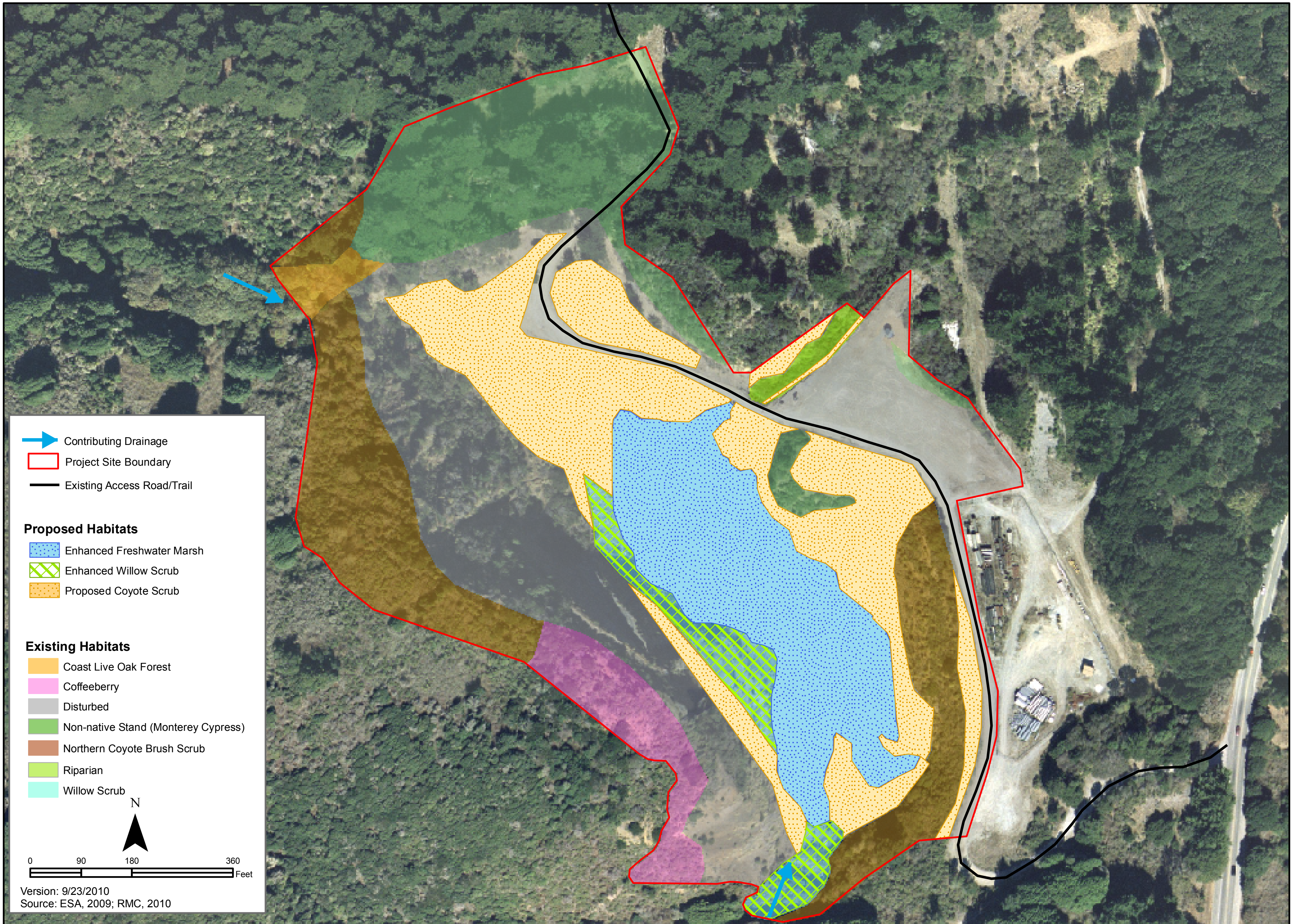

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Figure 8: Skyline Quarry Wetland Enhancement Preliminary Design Site Plan

considerations for workers and the potential for widespread downslope seed dispersal, complete removal from the mine face may not be feasible.

Additionally, in recognition of prior uses at the quarry (e.g., the former firing range), manual removal techniques will not be implemented in lead-contaminated soil areas.

Northern Coyote Brush Scrub Enhancement and Restoration: To facilitate long-term control of pampas grass, non-native grassland areas where pampas grass is removed will be seeded with northern coyote brush scrub species. The seeding is expected to facilitate increased competition with pampas grass thereby discouraging reestablishment following initial removal. To encourage reestablishment of northern coyote brush scrub, especially in nutrient poor areas located along the upper elevations of the mine floor, soil imports and amendments would be used to increase the nutrient supply for the northern coyote brush scrub. Soil import and/or amendment will likely be implemented where degraded soil conditions are indicated by a lack of vegetation establishment. Soil imports would include the addition of up to 5 ft of soil material, which would be placed on top of the existing grade. In locations within 15 ft of the existing emergent wetland, less than 12 in of fill material would be allowed to minimize sedimentation to the wetland. Ripping of the existing grade may be performed in areas not containing any contaminated soils materials to promote a more favorable rooting depth for the northern coyote brush scrub. Areas with slopes greater than 2:1 will be considered enhanced and areas with slopes 2:1 or gentler (where the placement of import soils is possible) will be considered restored.

The project will include a temporary access route that will be accessible by all-terrain vehicles (ATVs) and pedestrians. The temporary access route will begin from the existing access road, near the southern end of the project site, and traverse west up to the southern extent of the mine face. The temporary access route will be created by limbing trees/brush (e.g., poison oak). No earthwork is proposed to create the access route.

5.4.2 Construction Considerations

Construction staging would be centered out of the existing 0.9-ac parking area. Non-native plant material removed from the riparian and emergent wetland enhancement areas will be temporarily stockpiled at the staging area prior to off-site transport. All transport trucks would be required to cover all loads prior to offsite transport to avoid dispersion of seedlings. Similarly, all soil imports to the site would be temporarily stockpiled at the staging area prior to incorporation into non-native grassland areas. Following the removal of pampas grass in areas accessible by the temporary access route, drainage and/or erosion control BMPs will be implemented, where appropriate, to minimize erosion in areas temporarily disturbed by the access route and pampas grass removal activities.

6.0 SKYLINE BOULEVARD HABITAT IMPROVEMENT SITE

6.1 LOCATION AND BOUNDARIES

The Skyline Boulevard Habitat Improvement Site (Skyline Boulevard) is located north of San Andreas Reservoir and west of Skyline Boulevard (Figure 1). The Skyline Boulevard site consists of a valley trough comprised of open, interspersed emergent wetland and herbaceous upland habitats. A linear drainage features bisects the trough in a north-south orientation. Prominent stands of Monterey cypress and eucalyptus are also present in the northwestern and central portions of the site. The Skyline Boulevard site includes known habitat for SFGS and CRLF.

6.2 SELECTION PROCESS AND OWNERSHIP

Site selection is intended to satisfy the wetland compensation needs identified by the SFPUC for impacts to jurisdictional wetlands associated with the Lower Crystal Springs Reservoir (LCSR) Dam Improvement project. The wetland creation areas identified within the Skyline Boulevard site will provide 3.8 ac of wetland mitigation and are currently under SFPUC's ownership. The project area provides 3 opportunistic locations for wetland creation based on a combination of their geomorphic positions, contributing surface and groundwater hydrology, and the presence of non-sensitive habitat (e.g., grassland) or invasive tree species (e.g., Monterey cypress).

The Skyline Boulevard site boundary is configured to avoid impacts to existing wetland areas. The 2 southern wetlands are directly accessible from the access road along the southern perimeter of the site with the third wetland accessed via temporary access roads sited in non-sensitive, annual grasslands. The wetland boundaries are situated to avoid any permanent effects to existing wetlands. The location of the staging area was selected because it contains ruderal, previously disturbed habitat and provides a central location for heavy equipment access and storage.

The overall biological basis for Skyline Boulevard site is to enhance habitat connectivity for CRLF to existing habitats north of San Andreas Reservoir and west of SR 35. Additionally, the site was selected because of the potential for the federally endangered, SFGS and federally threatened, CRLF to utilize the created wetlands; both special-status species have been documented in the seasonal and freshwater emergent wetlands near the project area (Figure 2).

6.3 EXISTING CONDITIONS OF COMPENSATION SITE

6.3.1 Vegetation

Most of the habitat in the general vicinity is dominated by northern coyote brush scrub. The eastern portion of the project area, including the staging area, is a fine-textured mosaic of coyote brush scrub with non-native grassland. The valley bottom is herb-dominated and comprises seasonal wetland in the lower lying portions and non-native grassland in the higher portions. Based on a recent wetland delineation of the site (ESA 2009), the areas proposed for wetland creation are mapped as non-native grassland (Figure 9). There is also an existing pond located along the southern boundary of the project area in the proposed wetland creation location near a small patch of coyote brush. This pond is known red-legged frog breeding habitat and will be protected. The wetland creation areas have also been positioned to avoid a small drainage (classified as seasonal wetland per ESA 2009) that runs down the middle of the meadow (not shown).

The higher areas support velvet grass. The east-facing hill adjacent to this marsh is predominantly a closed-canopy stand of northern coyote brush scrub; however a small stand of Monterey cypress stand is situated immediately adjacent to the marsh on the western side. Near the top of the slope is a relatively small stand of bluegum eucalyptus. Both stands are dense and contain large, mature trees. Some isolated Monterey pine trees are present near the proposed wetland creation as well. Riparian scrub is present in patches along the access road alignment in topographic low areas.

A comparison of 2009 aerial imagery and slightly older vegetation mapping shows that several changes have occurred in this area as a result of recent SFPUC vegetation management (ESA+Orion 2009). A moderate-sized stand of bluegum eucalyptus was recently removed along the service road just west of the proposed impoundment, and a larger stand of bluegum eucalyptus was removed along the service road at the north end of the area along the proposed access for the eucalyptus removal proposed as part of this project (ESA+Orion 2009).

6.3.2 Threatened, Endangered, Special Status Species or Sensitive Habitats

The Skyline Boulevard site supports several wildlife habitat types — annual grassland, wet meadow, eucalyptus (non-native), lacustrine, and closed-cone pine-cypress. During ESA's survey period from May 2008 through to January 2009, wrentit, chestnut-backed chickadee, western scrub jay, Anna's hummingbird, white-crowned sparrow, black-tailed deer, coyote scat, and dusky-footed woodrat nests[1] were observed. In March 2009, ESA observed several CRLF egg masses in the pond at the south end of the project area, in the area proposed for wetland creation (ESA+Orion 2009).

Special-status Species. The special-status plant species with greatest likelihood to occur in the Skyline Boulevard site are western leatherwood (non-listed species; CNPS List 1B.2) and arcuate bush mallow, for which CNDDB has recent occurrence records (2001 and 2000, respectively) less than 1 mile west of the project area. Suitable habitat may also be present for Hall's bush mallow. Also potentially occurring in the vernal marsh is Choris's popcorn flower (non-listed species; CNPS List 1B.2), also reported from the vicinity of San Andreas Reservoir.

Several special-status wildlife species are known to occur in the vicinity of the Skyline Boulevard site: SFGS (federal-endangered, California-endangered, and California fully Protected) and CRLF (federal-threatened) are present at the pond at the south end of this habitat improvement site, and in the fresh emergent wetlands immediately to the south (SBI 2008); there are recent records of mission blue butterflies (federal-endangered) in the grasslands within, southeast, and northeast of the project area (SFPUC 2008); the fringed myotis bat (special

[1] Where San Francisco dusky-footed woodrat nests were observed, the species was assumed present.

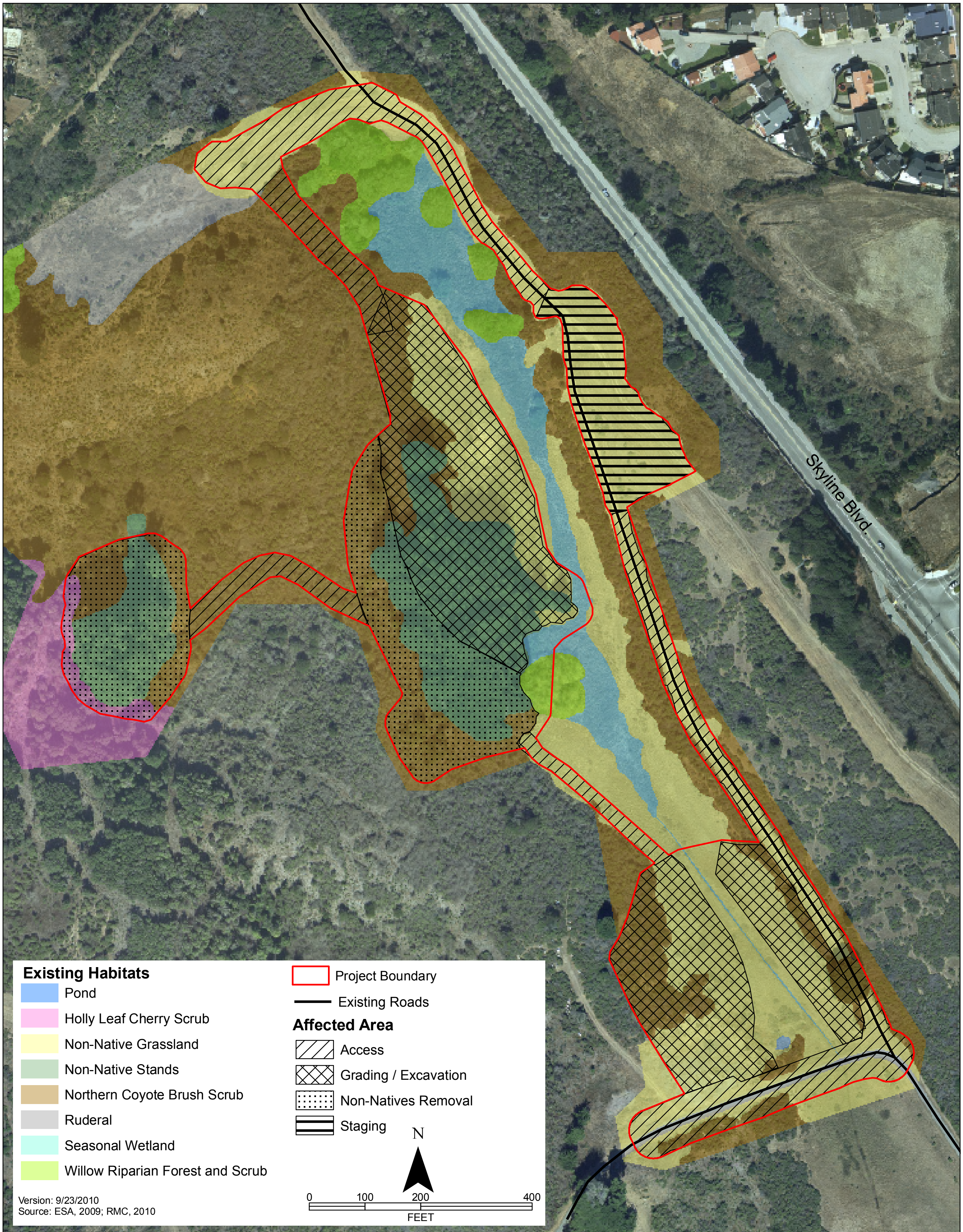

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Figure 9: Skyline Boulevard Habitat Improvements Site Existing Habitats

animal[2]) is known to roost and/or forage within the project area (California Department of Fish and Game (CDFG) 2008); and San Francisco dusky-footed woodrats (California Species of Special Concern) are present throughout. In addition to these known occurrences, there is potential for several additional special-status species to be present within or near the Skyline Boulevard site: western pond turtles (California Species of Special Concern) in the fresh emergent wetland; saltmarsh common yellowthroat (California Species of Special Concern), yellow warbler (California Species of Special Concern (nesting)), and tricolored blackbird (California Species of Special Concern) in the valley foothill riparian; and roosting bats and nesting raptors and passerines in all of the habitats present within 500 ft of the project area (ESA+Orion 2009).

Special-status Species Habitat Requirements. Habitat within the Skyline Boulevard site supports the federally-listed CRLF and SFGS. PCEs for the CRLF are discussed below. Similar PCEs for the SFGS have not been formalized by the USFWS as critical habitat for the SFGS has not been designated.

- **California Red-legged Frog.** CRLF habitat is composed of the following primary constituent elements: aquatic breeding habitat, aquatic non-breeding habitat, upland habitat, and dispersal habitat. A discussion of each of the PCEs deemed essential to the conservation of CRLF is provided below (as described in USFWS 2008).
    - <u>Aquatic Breeding Habitat.</u> Standing bodies of fresh water (with salinities less than 7.0 ppt), including: natural and manmade (e.g., stock) ponds, slow-moving streams or pools within streams, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a minimum of 20 weeks in all but the driest of years.
    - <u>Non-Breeding Aquatic Habitat.</u> Freshwater and wetted riparian habitats, as described above, that may not hold water long enough for the subspecies to hatch and complete its aquatic life cycle but that do provide for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult CRLF. Other wetland habitats that would be considered to meet these elements include, but are not limited to: plunge pools within intermittent creeks; seeps; quiet water refugia during high water flows; and springs of sufficient flow to withstand the summer dry period.
    - <u>Upland Habitat.</u> Upland areas adjacent to or surrounding breeding and non-breeding aquatic and riparian habitat up to a distance of 1 mi (1.6 km) in most cases and comprised of various vegetative series such as grasslands, woodlands, wetland, or riparian plant species that provides the frog shelter, forage, and predator avoidance. Upland features are also essential in that they are needed to maintain the hydrologic, geographic, topographic, ecological, and edaphic features that support and surround the wetland or riparian habitat. These upland features contribute to the filling and drying of the wetland or riparian habitat and are responsible for maintaining suitable periods of inundation for larval frogs and their

[2] "Special Animals" is a general term that refers to all of the taxa the CNDDB is interested in tracking, regardless of their legal or protection status.

food sources, and provide breeding, non-breeding, feeding, and sheltering habitat for juvenile and adult frogs (e.g., shelter, shade, moisture, cooler temperatures, a prey base, foraging opportunities, and areas for predator avoidance). Upland habitat should include structural features such as boulders, rocks and organic debris (e.g., downed trees, logs), as well as small mammal burrows and moist leaf litter.

  - Dispersal Habitat. Accessible upland or riparian dispersal habitat within designated units and between occupied locations within a minimum of 1 mi (1.6 km) of each other and that allows for movement between such sites. Dispersal habitat includes various natural habitats and altered habitats such as agricultural fields, which do not contain dispersal barriers (e.g., heavily traveled road without bridges or culverts). Dispersal habitat does not include moderate- to high-density urban or industrial developments with large expanses of asphalt or concrete, nor does it include large reservoirs over 50 ac (20 ha) in size, or other areas that do not contain those features identified in PCE 1, 2, or 3 as essential to the conservation of the subspecies.

- **San Francisco Garter Snake.** Though PCEs are not designated for the SFGS, presence of the species is closely tied to the presence of ranid frogs, and in particular the CRLF, which is a prey item for the snake (Jennings and Hayes 1994). The snake frequents ponds, streams, emergent wetlands, and other similar habitats to forage on CRLF. As a result, enhancing or creating aquatic breeding habitat for the CRLF will also enhance or create aquatic foraging habitat for the SFGS.

6.3.3 Aquatic Features and Jurisdictional Areas

No well-defined watercourses are present in this project area; however, aerial imagery shows that drainage in the low-lying portion of the valley floor has been facilitated by a shallow cut which directs any surface flow through a culvert below the east-west service road. The low-lying portion of the valley is nearly the elevation of San Andreas Reservoir itself and may sustain hydrologic conditions sufficient to be considered jurisdictional. This area supports a number of species characteristic of wetlands, including teasel, velvet grass, and cattails in the lower areas. Willows grow at the northern end of this valley just north of the staging area, on both the north and south side of the northernmost access road. In addition, there is a pond located east of the southwestern wetland creation site along the southern boundary of the project area (ESA+Orion 2009).

6.3.4 Topography, Soils, Substrate, Hydrology

The following descriptions rely on information obtained from the USGS, the NRCS, SFPUC, and the CGS.

The Skyline Boulevard site is located within a shallow valley trough, approximately 1,000 ft north of San Andreas Reservoir. Soils mapped within the Skyline Boulevard project site include Candlestick-Kron-Buriiburi complex, 30-75 % slopes, along the hillslopes located at the western portion of the site and Candlestick variant loam, 2-15 % slopes, located within the valley trough. The Candlestick-Kron-Buriiburi complex mapping unit includes soils ranging from 18-36 in to an unweathered sandstone. These soils are generally located on moderately steep to steep slopes and characterized by a sandy or gravelly loam within the upper 8-12 in of the soil column that grades to a fine loam at depth. These soils are present in the vicinity of the eucalyptus removal area in the northwestern portion of the site.

Areas along the floor of the valley trough are mapped as Candlestick variant loam and are characterized by a loam within the upper 20 in of the soil column that grades to a clay loam at depth. These soils can extend to depths of greater than 60 in to weathered or semi-weathered bedrock. Based on site-specific soil sampling, soils encountered at each of the 3 proposed wetlands are characteristic of the Candlestick variant loam.

Six small watershed units contribute surface water runoff to the Skyline Boulevard site. Two of these watershed units contribute runoff to the proposed central seasonal wetland, while the other 2 watershed units (totaling approximately 12 ac) contribute runoff to the 2 proposed southern wetlands. The combined watershed area for the 3 seasonal wetlands is estimated at approximately 21.6 ac. The remaining 2 watershed units drain the northern and central sections of the project site and comprise approximately 26 acres.

The project is located in a seismically active region at the boundary between 2 major tectonic plates: the Pacific Plate to the southwest and the North American Plate to the northeast. The San Andreas Fault, which exists in the project area, is the dominant structure in the system that defines the boundary between the 2 tectonic plates, spanning nearly the full length of the state of California. Other major faults associated with the San Andreas system include the San Gregorio Fault about 7 mi west of the site, and the Hayward Fault about 18 mi east of the Peninsula watershed. Earthquakes occurring along these and other faults are capable of generating strong ground shaking at the sites. Based on available geologic mapping for the project area, the project location is located in an area determined to have a low susceptibility to landslides and very low to moderate susceptibility to liquefaction (USGS 1999, 2006).

At Skyline Boulevard, 3 soil borings and 2 piezometers were installed in June 2010 (refer to Appendix B for boring locations) yielding further details below.

The first boring explored to a total depth of 11 ft bgs. Soil consisted of stiff clay with varying amounts of sand to approximately 8 ft. Soil grades to clayey sand with gravel to total explored depth. Groundwater was encountered approximately 10 ft bgs, and soil samples were collected at 1.5 ft intervals throughout the boring. The first piezometer was installed to a depth of 12 ft bgs and had a soil profile similar to its companion soil boring. Groundwater was encountered around 9 ft bgs.

The second boring also explored to a total depth of 11 ft bgs. Soil consisted of medium stiff clay with sand which becomes stiff at 4.5 ft bgs. Groundwater was not observed in boring, however, soil was wet at 8 ft and increased sand content and sand stringers were observed at that depth. Boring was left open more than 2 hours and groundwater was not observed seeping into the borehole. Soil samples were collected at 1.5 ft intervals.

The second piezometer was installed to 5 ft bgs based on conversations with project hydrologists which conveyed the need to screen within the upper (<5 ft bgs) less stiff clay horizon to observe seasonal water depths within the potential wetland creation excavated depth horizon.

Samples from various depths of the soil boring were analyzed for soil characteristics and fertility (refer to Appendix B for analysis results). Soil classifications for the samples varied widely from sandy loams to clays, and there were also varying levels of gravel. Levels of organic matter were high up to depths of 1.5 ft but very low at greater depths. The pH levels were within the ranges acceptable for plant establishment. Nutrient deficiencies include nitrogen, phosphorus, potassium, zinc and manganese. There were also varying degrees of imbalance between calcium and magnesium.

6.4 MITIGATION PROPOSAL

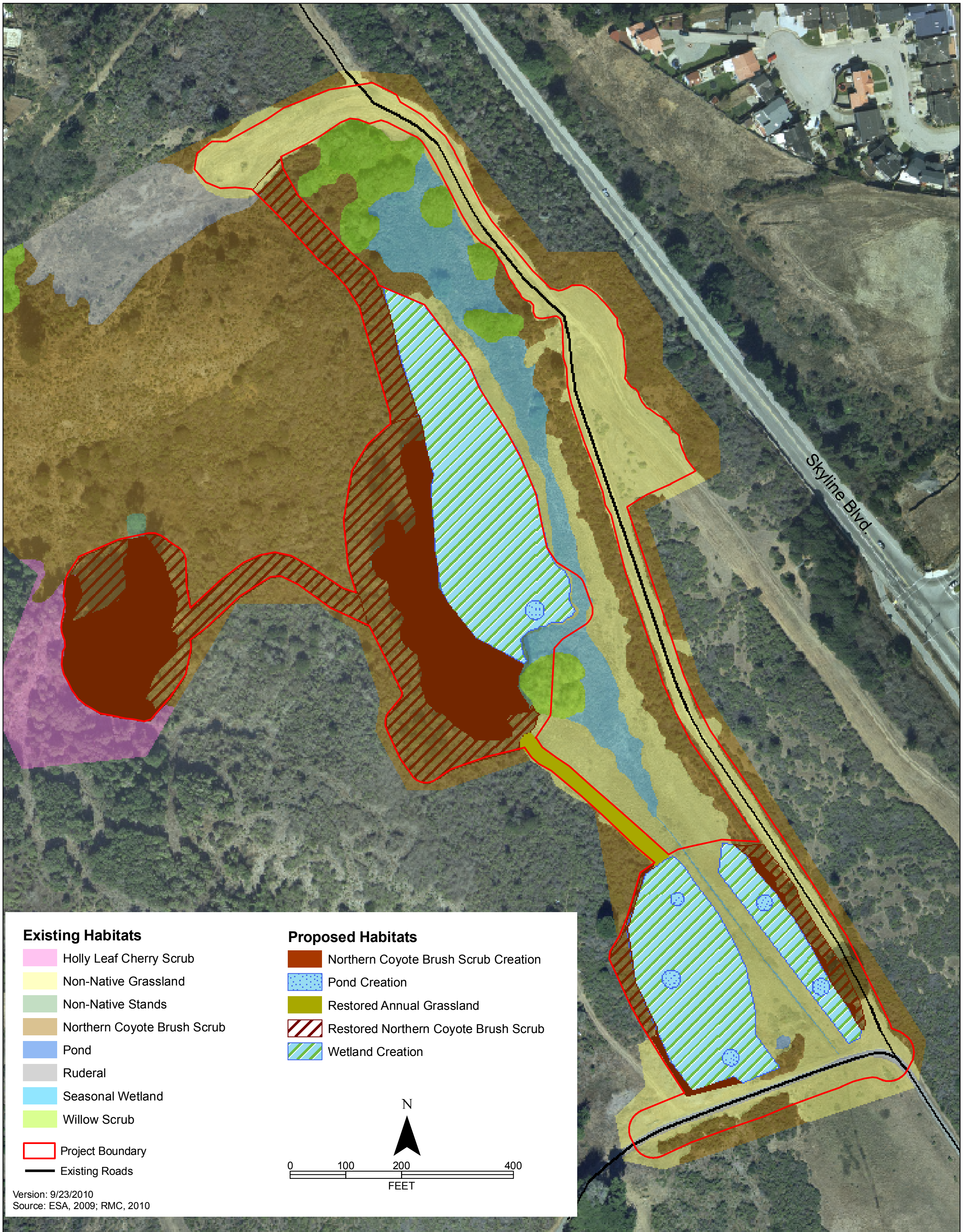
The primary objective of the Skyline Boulevard site is to create additional seasonal wetland habitat in portions of the site currently comprising, non-sensitive habitats. Ideally, these created seasonal wetlands will support breeding and foraging CRLF habitat, and therefore provide foraging habitat for SFGS.

6.4.1 Target Habitats and Quantities

Invasive Tree Removal and Northern Coyote Scrub Brush Creation: The project will involve removal of a stand of Monterey cypress trees located near the geographic center of the improvement site and a eucalyptus stand at the northwestern corner of the site. Upland areas at these 2 locations will be revegetated with northern coyote scrub brush via seeding (2.2 ac, Figure 10). The remaining low–lying area within the existing Monterey cypress stand is proposed for seasonal wetland habitat and described further under the below heading. Within the cypress removal area, the entire root mass should be removed during tree removal to encourage the formation of additional micro-topography in the proposed seasonal wetland. An additional ~0.06 ac and ~0.1 ac of coyote scrub brush will be created along the upland edge of the southeastern and southwestern wetlands, respectively.

Wetland Creation: The habitat improvements proposed at this site will create up to 3.8 ac of seasonal wetland at 3 separate locations: (1) a northern seasonal wetland (2.0 ac), (2) a southwestern seasonal wetland (1.4 ac), and (3) a southeastern seasonal wetland (0.4 ac).

Water supply to the created wetlands would include a combination of sub-surface groundwater flow and surface runoff from the adjacent hillsides. The 2.0-ac northern seasonal wetland will be located at lower elevations within the central Monterey cypress removal area. The wetland receives surface runoff from an approximately 21.6 ac watershed area. Excavation for this wetland will be limited to 10 ft or less with a majority of the excavation occurring within the western section of the proposed wetland. During wetland excavation, up to a 10-ft buffer will be provided from the existing wetland to protect it from potential degradation. Inundation depths within the wetland will average 2 ft with limited areas of deeper ponding. Two ponds will be constructed in the southern and northern corners of the seasonal wetland and will average 3 ft in depth.



San Francisco Public Utilities Commission
Habitat Reserve Program

Figure 10: Skyline Boulevard Habitat Improvements Site Preliminary Design Site Plan

Two additional seasonal wetlands (1.4 and 0.4 ac) will be created in the southern portion of the site, adjacent to the existing drainage and pond. Water depths within these wetlands will average 2 ft, but both will be include a combination of shallow and deeper inundation to promote habitat diversity. Several ponds will be created with water depths averaging 3 ft to promote breeding habitat for CRLF. Coarse woody debris may be installed in the wetland bottom near the pond to provide cover for CRLF. Excavations for the larger southwestern wetland could be up to 8 ft bgs, while excavations for the smaller southeastern wetland are expected to be less than 5 ft bgs. The southwestern wetland receives runoff from an approximately 11.8-acre-watershed; while the southeastern wetland receives runoff from an approximately 5-acre watershed. To ensure flow is routed to the proposed southeastern wetland feature, a reinforced rolling dip would be constructed along the existing eastern access road to intercept drainage runoff that currently follows a roadside ditch that parallels to the road to the east and flows south.

Both of the southern seasonal wetlands may include multiple inlet and outlet control bioengineered features to facilitate ponding where desired and to prevent high flow velocities into adjacent wetlands. These bioengineered improvements would occur within the footprint for each of the proposed wetlands and would include of 1 or multiple BMPs, including, but not limited to erosion control blankets, live wattle/stake plantings, and/or fiber or geotextile mats/blankets.

6.4.2 Construction Considerations

There are several existing utilities located under the existing access route on the northeast corner of the Skyline Boulevard. Several pipelines, including water lines and gas mains, traverse this location. There are several markers along the roadway demarcating the location of these utilities, which will need to be avoided by construction equipment to the extent feasible.

Excavated soil materials will be reused onsite to the extent practicable and temporarily stockpiled within the southern portion of the staging area. The project involves the creation of a new access road.

SFPUC anticipates incorporating some of the excavated soil materials into the new access road to minimize offsite transport. No infrastructure changes are proposed to the existing roadway and associated drainage facilities located along the southern perimeter of the site.

7.0 IMPLEMENTATION

Site implementation activities are described below. The Draft Project Drawings are included in Appendix D (note that these are preliminary 30% working drawings and are not finalized).

7.1 SITE PREPARATION

Mitigation area site preparation involves protection of native species, clearing and grubbing of the site, tree removal, the grading of the site to an elevation appropriate to support seasonal and emergent wetlands, oak woodland, riparian, or scrub habitats, establishing water supply, and invasive plant control.

7.1.1 Native Species Protections and Exclusions

To minimize effects on desirable habitats and species, avoidance measures will be implemented. Temporary access paths (where vegetation will be removed but no grading will occur) and staging areas will be identified, and equipment movement will be restricted to these areas by environmentally sensitive area (ESA) fencing, signage, and other appropriate measures.

7.1.2 Clearing and Grubbing

Clearing and grubbing will include the removal and disposal of all undesirable material, including trees (less than 6 in diameter measured 4 ft from the ground), shrubs, other vegetation, and debris and rubbish of any nature. Earthwork operations will not begin in areas where clearing and grubbing are not complete, except that stumps and large roots may be removed concurrently with excavation. All existing vegetation, outside the areas to be graded will be protected from injury or damage resulting from the Contractor's operations. However, selective removal of invasive non-native species will take place in the adjacent grassland areas.

7.1.3 Tree Removal

Blue Gum Eucalyptus Removal (Sherwood Point, Adobe Gulch Creek, and Skyline Boulevard): the “cut stump” method is recommended for removal of Blue gum eucalyptus (*Eucalyptus globulus*). Cut and fell trees, leaving stumps to approximately 6 in above ground surface. An herbicide should be applied to the cambium layer (living inner bark) of stump immediately after felling the tree. The area should be checked for resprouts on a regular interval (every 2 to 4 months) for at least a year and sprouts can be treated with foliar spray or additional cut-stump herbicide application. The “cut stump” treatment allows for control over the site during herbicide application and therefore has a low probability of affecting non-target species or contaminating the environment. Application in late winter or early spring is especially effective since the remaining plant parts are more effective at translocation of the chemical.

Follow-up monitoring and herbicide treatment will be necessary to prevent resprouting. Stump-grinding may be needed to treat large residual stumps. Grinding should occur in addition to and subsequent to herbicide applications.

Eucalyptus duff currently present on the ground will also need to be removed because it adversely affects soil pH levels and can provide thick ground cover that inhibits understory herbaceous vegetation. Duff removal will be by hand with a biological monitor present (as protected or sensitive species could be found under the duff layer) and material will be removed from the site.

Monterey Cypress Removal (Adobe Gulch Creek and Skyline Boulevard): Mechanical removal of the Monterey cypress (*Cupressus macrocarpa*) will likely be the most effective method.

Because Monterey cypress may have considerable value as saw timber it should be appraised as such prior to determining the disposition method (which could include cutting, drying, or chipping prior to removal for burning). Small material may be composted onsite. A Timber Harvest Plan may be required.

7.1.4 Grading

Grading limits will be clearly defined in the field to prevent damage to existing wetlands or high quality upland habitat. Temporary impacts to any adjacent habitats will be mitigated through in-situ 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.

A construction monitor will be onsite during grading and any other activities which include the use of equipment or ground disturbance. The monitor will be experienced with and have appropriate permits to handle the protected species known to potentially occur onsite. The monitor will check under and around equipment before it is moved after a period of inactivity, and will visually clear each area to be disturbed immediately before work begins. If a protected or sensitive species is located during grading or other ground disturbing activity, construction activity will cease while the monitor determines an appropriate course of action. To the extent practicable, an animal will be allowed to move out of the construction area on its own. In some circumstances the monitor may elect to move the animal a short distance within the site and into appropriate habitat with adequate cover from predators. All other protective measures included in the project regulatory permits and agreements will also be fully implemented.

Sherwood Point: SFPUC will excavate a linear trough along the shoreline within the project area. The trough will average 1.5 ft in depth with a corresponding floor elevation of 284.5 to 285.5 ft msl (NAVD 83). The water-side edge of the trough or rim would correspond with an elevation of 286 to 287 ft msl. No grading is necessary for the oak woodland restoration, though the lower lying portions of this area will be cut to accommodate the wetland creation.

Adobe Gulch Creek: The wetland will be excavated to depths of up to 4 ft with the excavated materials being temporarily stored at the construction staging area located at the western end of the project area. SFPUC anticipates a variety of topographical elevations within the wetland to encourage habitat diversity. No grading is necessary for the oak woodland creation.

Skyline Quarry: For the establishment of northern coyote brush scrub habitat, up to 5 ft of soil material will be placed on top of the existing grade, where appropriate, to match existing grades and create a more uniform topography. Less than 8 in of fill would be allowed within 50 ft of the existing emergent wetland. Ripping of the existing grade may be performed to promote a more favorable rooting depth for the northern coyote brush scrub in locations where the soil surface is free of pre-existing contamination.

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Skyline Boulevard: Excavation for the northern seasonal wetland will be limited to 10 ft or less. Excavation of the 2 southern wetlands will generally be limited to 2 ft or less. In all 3 created wetlands, deeper inundation with water depths of up to 3 ft will be facilitated in limited locations to promote breeding habitat for CRLF.

7.1.5 Soil Preparation

Per the recommendations provided by Soil & Plant Laboratory (Appendix B), in-situ soils at design grade will likely require amendment, either by amending the entire revegetation area or by amending the backfill in the planting holes. During preparation of construction documents the approach for each site will be finalized.

Sherwood Point: Soils should be amended with treble superphosphate and potassium sulfate.

Adobe Gulch Creek: The soils at this site require no amendment unless finish grade levels are 4-6 ft below original grade, in which case an amendment of potassium sulfate should incorporated.

Skyline Quarry: Soil preparation required in the northern coyote brush scrub restoration areas will be dependent on the quality of the imported soil. This requirement will be developed further in the project's construction specifications.

Skyline Boulevard: Soils should be amended with organic mater, treble superphosphate, and potassium sulfate.

7.1.6 Coarse Woody Debris

Coarse woody debris piles may be included in the seasonal wetlands at Skyline Boulevard and Adobe Gulch.

7.1.7 Invasive Plant Control

It is expected that invasive species control will be necessary prior to project implementation. Invasive control should be planned in advance and could be started prior to anticipated initial planting. Anticipated invasive plant species found at the 4 mitigation sites are shown in Table 4, and control methods per species as well as a list of other potential species requiring invasive plant control are detailed in Vegetation Management Plan (Appendix C).

Table 4. Anticipated Project Area Invasive Plant Control.

INVASIVE SPECIES FOR REMOVAL / TREATMENT		PROJECT AREA			
Species Name	**Common Name**	**Sherwood Point**	**Adobe Gulch Creek**	**Skyline Quarry**	**Skyline Boulevard**
Cupressus macrocarpa	Monterey cypress		X		X
Cortaderia jubata	pampas grass			X	
Eucalyptus globulus	blue gum eucalyptus	X	X		X
Genista monspessulana	French broom		X		
Holcus lanatus	velvet grass				X
Phalaris aquatica	Harding grass			X	X
Vinca major	periwinkle		X		

Follow-up treatments for invasive species will also be required during the monitoring period.

For more detail concerning target invasive species and exempted invasive species in non-wetland areas (Table 2, Appendix) refer to the Vegetation Management Plan (Appendix C).

7.2 PLANTING MATERIAL

7.2.1 Plant Species List

The below tables provide lists of container plants to be installed at each site. Less common species [e.g., Western leatherwood (*Dirca occidentalis*), Choris' popcorn flower (*Plagiobothrys chorisianus* var. *chorisianus*), and bristly sedge (*Carex comosa*)] will be also planted throughout the 4 sites in coordination with the California Native Plant Society. Their establishment will not be part of the project's performance criteria.

Table 5. Sherwood Point Plant Species List.

SCIENTIFIC NAME	COMMON NAME	TRIANGULAR ON-CENTER SPACING (FT)	ESTIMATED QUANTITY	
			Oak Woodland (1.40 ac)	**Wetland (0.30 ac)**
Quercus agrifolia[1]	coast live oak	16	135	
Aesculus californica	California buckeye	12	24	
Rhamnus arbutifolia	California coffeeberry	10	35	
Heteromeles arbutifolia	toyon	10	69	
Rosa gymnocarpa	dwarf rose	8	108	
Rubus ursinus	California blackberry	8	54	
Ribes californicum	hillside gooseberry	8	108	
Mimulus aurantiancus	bush monkeyflower	8	54	
Scirpus acutus	bulrush	3		148
Typha sp.	cattail	3		41
Cyperus eragrostis	tall umbrella sedge	3		101

Juncus effusus	common rush	3		101
Juncus patens	spreading rush	3		101
Carex barbarae	Santa Barbara sedge	3		101

[1] Oaks will be installed as 50 % container plants and 50 % acorns.

Table 6. Adobe Gulch Creek Plant Species List.

SCIENTIFIC NAME	COMMON NAME	TRIANGULAR ON-CENTER SPACING (FT)	ESTIMATED QUANTITY		
			Oak Woodland (1.30 ac)	Oak Riparian (0.02 ac)	Seasonal Wetland (0.40 ac)
Quercus agrifolia[1]	coast live oak	16	63	2	
Quercus lobata[1]	valley oak	16	63		
Rhamnus californica	California coffeeberry	10	128		
Heteromeles arbutifolia	toyon	10	96		
Mimulus aurantiacus	bush monkeyflower	8	151		
Salix lasiolepis	arroyo willow	8		3	3
Aesculus californicus	California buckeye	12		2	
Juncus effusus	common rush	3			261
Juncus patens	spreading rush	3			261
Carex barbarae	Santa Barbara sedge	3			261

[1] Oaks will be installed as 50 % container plants and 50 % acorns.

Table 7. Skyline Quarry Plant Species List.

SCIENTIFIC NAME	COMMON NAME	TRIANGULAR ON-CENTER SPACING (FT)	ESTIMATED QUANTITY[1]	
			Riparian (0.9 ac)	Emergent Wetland (3.7 ac)
Salix lasiolepis	arroyo willow	8	11-23	47-94
Juncus effusus	common rush	3		121-241
Juncus patens	spreading rush	3		121-241
Carex barbarae	Santa Barbara sedge	3		121-241

[1] Plants assumed to be installed in 5-10% of the enhancement area.

Table 8. Skyline Boulevard Plant Species List.

SCIENTIFIC NAME	COMMON NAME	TRIANGULAR ON-CENTER SPACING (FT)	ESTIMATED QUANTITY
			Seasonal Wetland (3.80 ac)
Salix lasiolepis	arroyo willow	8	29
Baccharis douglasii	marsh baccharis	8	29
Scirpus acutus	bulrush	3	1502
Juncus effusus	common rush	3	1502
Juncus patens	spreading rush	3	1502
Carex barbarae	Santa Barbara sedge	3	1502

Eleocharis macrostachya	pale spikerush	3	1502

7.2.2 Plant Sources

Container plants will be contract grown by a qualified native plant nursery. After plant propagules (seeds, acorns, plugs, and cuttings) are collected, approximately 12 months of lead time will be required before the plants are ready for installation.

In addition to container plants, live willow cuttings will be installed and 50 % of all oak plantings will be installed by direct seeding of acorns (McCreary 2001).

All propagules should be collected from appropriate woodland, wetland, and riparian habitats within the Peninsula watershed to ensure that native and local material is used.

7.2.3 Plant Size and Estimated Number of Installed Plants

Estimated numbers of required container plants for each species are listed in the above tables. The oak woodland and riparian plants will be delivered in Treepot-4 containers and the wetland plugs (rushes and sedges) in Super Cell containers.

7.3 PLANT INSTALLATION METHODS

7.3.1 Hydroseeding and Broadcast Seeding

Hydroseeding or broadcast seeding may be employed in erosion control areas and other highly disturbed areas if deemed appropriate.

Skyline Boulevard and Adobe Gulch Seasonal Wetlands: Either seed application technique could be used with a native grass and forb seed mix consisting of the species listed in Table 9.

Table 9. Seasonal Wetland Seed Mix.

SCIENTIFIC NAME	COMMON NAME
Achillea millefolium	yarrow
Artemisia douglasiana	mugwort
Bromus carinatus	California brome
Cyperus eragrostis	umbrella sedge / tall flatsedge
Eschscholzia californica	California poppy
Hordeum brachyantherum	meadow barley
Lupinus succulentus	arroyo lupine
Melica californica	California melic
Scrophularia californica	beeplant
Trifolium obtusiflorum	creek clover
Vulpia microstachys	small fescue / 3 weeks fescue

Sherwood Point Emergent Wetlands: Given the access limitations at this site, broadcast seeding is the recommended application technique for the emergent wetland seed mix consisting of cattails and tules (some combination of *Typha latifolia*, *T. angustifolia*, *Scirpus californicus* and *S. acutus*).

Sherwood Point and Skyline Boulevard Grassland: Additional seeding will take place in the staging areas where grassland habitat is to be restored. Either seed application technique could be used with a native grassland seed mix consisting of the following species: *Elymus glaucus*, *Nassella pulchra*, *Deschampsia elongata*, and *Bromus carinatus*.

Skyline Boulevard and Skyline Quarry Scrub Habitat: Either seed application technique could be used. The northern coyote brush scrub habitat will be seeded with the above seed mix with the addition of *Baccharis pilularis*.

Adobe Gulch Creek Grassland: Either seed application technique could be used with a native grassland seed mix consisting of the following species: *Elymus glaucus*, *Nassella pulchra*, and *Deschampsia elongata*.

7.3.2 Wetland Plug Planting Methods

The wetland plugs will be planted on 3-ft centers in clusters of 10-20 plants throughout the seasonal and emergent wetland areas.

1. Immediately prior to planting, all wetland plugs will be thoroughly moistened.
2. Plants will be removed from containers in such a manner that the root ball is not broken and installed immediately after removal from the container.
3. Plants with damaged rootballs will not be installed.
4. If plants are rootbound, the contractor will gently break up lower 1/3 of rootball prior to installation.
5. The contractor will minimize the exposure of the root ball to the air while placing the root ball in the ground.

Planting holes will be created using a shovel or trowel and will, at a minimum, be large enough to accommodate the plant rootball without restriction or distortion. The plants will be installed in the center of the plant hole so that their root crowns are at grade. Planting holes will be backfilled and lightly compacted to remove air spaces between roots and soil. Each plant will be irrigated immediately following installation, if soils are not moist at that time.

7.3.3 Container Planting Methods and Protections

Container plants for the oak and riparian woodland habitats will be planted as follows at the triangular on-center spacing shown in Tables 5-8.

1. Immediately prior to planting, all container plants will be thoroughly moistened.

2. Plants will be removed from containers in such a manner that the root ball is not broken and installed immediately after removal from the container.
3. Do not install plants with damaged rootballs.
4. If plants are rootbound, the contractor will gently break up lower 1/3 of rootball prior to installation.
5. The Contractor will minimize the exposure of the rootball to the air while placing the rootball in the ground.

The planting holes will be at least 2 ft in diameter and as deep as the rootballs. Care will be taken when installing plants under existing trees to minimize damage to roots. All stones greater than 3 in in diameter will be removed from the excavated soils. The sides and bottom of each hole should be scarified and each planting hole will be irrigated before planting and again immediately following planting. The plants will be installed so that their root crowns are at or slightly above (up to ½ in) grade following soil settlement after irrigation. Planting holes will be backfilled and lightly compacted to remove air spaces between roots and soil. A planting basin will be installed at each hole by creating a 3-ft diameter and 4-in high earthen berm at the perimeter of the planting hole. A 3-in thick layer of mulch will be applied within the basin. Finally, 4-ft diameter by 5-ft tall cylindrical foliage protection cages will be installed around those species requiring browse protection.

7.3.4 Acorn Installation Methods and Protections

For those oaks to be installed by direct seeding of acorns (50% of all oak plantings), the valley oak and coast live oak acorns will be installed between late October and December when soils are moist but the acorn's radicals have not yet fully developed. Acorns will be installed 1-½ in below the ground and placed parallel to the soil surface. Three acorns will be installed in each planting hole.

7.3.5 Willow Cutting Installation Methods and Protections

Willow cuttings will be installed at the Adobe Gulch Creek, Skyline Quarry, and Skyline Boulevard sites and may be installed at the perimeter of the fringe wetlands at Sherwood Point. The willow cuttings will be harvested and installed in January or February when the trees are dormant. The cuttings will be approximately 24 in long with a diameter of 0.5-1.5 in. Pilot holes will be created by pounding a 1 in diameter section of rebar perpendicular to the soil surface to a depth of approximately 18 in. The willow cuttings will be irrigated immediately following installation, if soils are not moist at that time. A restoration biologist will supervise the installation efforts. Deer repellent will be applied to the foliage to minimize or prevent herbivory.

Willow cuttings will be handled carefully to ensure that cuttings are not damaged or subjected to excessive heat, wind, or desiccation during handling, transportation, and storage. The bottom ¾ of the cuttings will be placed in buckets filled with water immediately after they are harvested until they are installed. Cuttings should be installed with 24 hours (hr) of harvesting.

7.4 WATER SOURCES AND IRRIGATION

7.4.1 Irrigation Methods and Supply

No irrigation will be necessary for the seeded areas or the proposed seasonal and emergent wetlands (which include installed wetland plugs and willows), as they will be designed to be supported by groundwater and surface runoff (the only exception to this rule is Sherwood Point, as described below). However, if rainfall is more that 20% below average in Years 1 and/or 2, supplemental irrigation may be applied to wetland plugs. However, if the site is irrigated during Years 3 through 5, the 5 year monitoring requirement will be reset to Year 1 and monitoring will resume for a minimum of 5 years after irrigation has ceased.

With the exception of the possible irrigation of the Sherwood Point wetlands, overhead spray irrigation is not recommended due to water use inefficiency and increased establishment of weed species between the mitigation plantings. Site specific irrigation methods and supply are outlined below.

Sherwood Point: Because water truck access to the site is difficult, the use of a floating pump (with screen) in the reservoir may be required to supply the necessary irrigation water. The pump will be solar powered, so no electrical supply line or storage of diesel will be required. Water will be provided to oak woodland habitat plants via an on-grade drip or bubbler irrigation system. If LCSR has not reached its target operations levels at the time of the wetland installation, supplemental irrigation will likely be required for the wetland plants and/or live cuttings until the target water levels are reached.

Adobe Gulch Creek: Given the site's location in a cool microclimate on the east-facing hills, the installation of an irrigation system for the oak woodland habitat may not be necessary, as water could be applied if needed via hoses from a water truck during drought conditions. If an irrigation system is deemed necessary, water will be supplied by a water truck (via a stand pipe connection). Water supplied by the water truck will be suitable for oak woodland plantings and from an appropriate source.

Skyline Quarry: No irrigation will be necessary for the proposed enhancement and restoration activities.

Skyline Boulevard: No irrigation will be necessary for the wetlands and the willow cuttings, as they will be designed to be supported by groundwater, nor the scrub habitat, as it will be installed by seeding.

7.4.2 Frequency and Duration

Where irrigation is required, watering will occur at least until the onset of the cool weather/wet season and/or a prolonged period of early rain in the fall. A forester or restoration specialist will evaluate watering needs after Year 1. If irrigation beyond the 2 year plant establishment period is required, the monitoring period will be reset to start anew at the cessation of irrigation. Thus, under that scenario once irrigation stops, Year 1 of the monitoring would start.

Table 10. Number of Water Events per Month (During Dry Season).

YEAR	GALLONS PER IRRIGATION EVENT	FREQUENCY OF IRRIGATION EVENTS											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	10	0	0	3	3	3	4	4	4	3	3	0	0
2	10	0	0	0	2	3	3	3	3	2	2	0	0
3	10	As needed											

7.4.3 Source and Estimated Quantity

Refer to section "Irrigation Methods and Supply" for information regarding the presumed water source. All oak and riparian woodland plantings will receive 10 gallons per irrigation event.

7.5 IMPLEMENTATION SCHEDULE

Unless otherwise permitted in writing by the SFPUC, container plants will be installed between early December and late January and wetland plants will be installed between early December and late February. Planting shall occur after the onset of winter rain when the soil becomes moist to a minimum depth of 8 in.

8.0 MONITORING

Monitoring data will be collected and used to evaluate the success of the mitigation sites. Information from this monitoring program will provide feedback to direct necessary maintenance and adjustments to planting areas or techniques to ensure the success of the mitigation site. Note that only created or restored habitats will be monitored; enhanced habitats will not be monitored or count towards the sites' success criteria (refer to Table 3 for a breakdown of each site's created, enhanced, and/or restored habitats).

Due to the Sherwood Point created wetland's dependence on LCSR operations, monitoring of the site's seasonal and emergent wetlands will be deferred until the reservoir has reached its target operations and the created wetlands are regularly inundated by the reservoir as planned. Monitoring of the Sherwood Point oak woodland habitat and all monitoring of created and restored habitats at the Adobe Gulch Creek, Skyline Quarry, and Skyline Boulevard sites will begin immediately following installation (i.e., if the plants are installed in 2011, Year-1 monitoring will take place in 2012).

8.1 MONITORING & DATA COLLECTION METHODS

8.1.1 Permanent Photo Documentation Points

Permanent photo documentation points will be established within the project area prior to construction. A minimum of 2 photo documentation points per project area will be established to document site conditions. The location of the photo documentation site will be GPS'd to facilitate relocation and a GIS map of the location created as part of the first monitoring report. The photo documentation points should include landscape features that are unlikely to change over several years (buildings, other structures, and landscape features such as peaks, rock outcrops, large trees, etc.) so that repeat photos will be easy to position. The placement of a permanent T-post or metal fence post marking the photo points will improve consistency between years (State Water Resources Control Board 2010).

Photos will be taken from these photo documentation points at the same camera angle each monitoring year, using a north, south, east, west compass bearing axis at the selected photo points, as appropriate to illustrate site conditions.

Photographs will be taken from approximately 5 ft in height, with exact height recorded using a standardized tripod or rod to ensure consistency of height from year to year.

In addition to the permanent photo stations, photographs will also be taken from the origin of each vegetation monitoring transect looking north, south, east, and west. In Years 5 and 10, vegetation cover will be assessed using aerial photos if available to supplement other data collection methods.

8.1.2 Vegetation Monitoring

Vegetation monitoring will be performed using a statistically robust method known as power analysis to assess tree survivorship and percent cover of native and invasive perennial forbs, grasses, and shrubs. Power analysis would measure percent survivorship to within a margin of error of 10% at the 95% confidence interval (i.e., assesses percent survivorship 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 hydroseeded grassland, and planted or established wetland, and willow riparian communities and in Years 1-5, 7, 9 and 10 for tree dominated communities. The point-line intercept method will be used to estimate total vegetative cover, native cover, hydrophytic cover, and non-native invasive cover. A count of planted hardwood trees within 100 m^2 plots will be used to estimate tree survival. These methods will be used to determine whether mitigation areas are 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: 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:

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

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 sampling plots to estimate survivorship:

- 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 number of trees to be planted and number of different planting areas.

Monitoring Protocol and Analysis for Estimating Hardwood Tree Survival. Data collection for survivorship for planted hardwood trees (primarily oaks) will require a biologist to determine if a given plant is alive or dead at a given number of flagged planting sites in an area (sampling plot).

Sampling plots will be used to conduct survivorship surveys. These plots will be randomly established each year based on a grid overlay of the entire mitigation area. Using GIS, a 10-meter by 10-meter grid will be overlaid on all mitigation areas. Each vertex of that grid will be labeled with a number. Using a random number generator, vertices will be selected to serve as the center of square sampling plots and transects. Once the vertices have been selected, locations will be identified in the field using a GPS device. Biologists will navigate to the coordinates specified by the GPS and establish a center point. From this center point, 2 10-meter transect tapes will be extended, 5 meters in each cardinal direction; the center point will be located at the 5-meter mark for both cross-transects. In each 10 meter by 10 meter plot, each live tree will be counted. In addition, observations regarding tree health (e.g., premature leaf loss, evidence of dieback shoots, severe insect infestation) will be noted, particularly when poor health is an apparent indicator of imminent mortality.

The number of sampling plots depends on the vegetation community, final number of hardwood trees to be planted, number and size of planting areas, data collection method and spacing of plantings. Data must be collected at 3 or more sampling plots to allow for statistical analysis. Since some habitat types (e.g., riparian habitats) are being established/reestablished or rehabilitated in very narrow bands, it is possible that the $100m^2$ plots, will not fall entirely within a single habitat type. If this occurs the plots can be shifted such so the entire plot is in a single habitat type.

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

Survivorship trends will be analyzed after collecting 3 years of data, the minimum required to plot a line. Percent survival mean and 95% confidence interval will be plotted against time along with the minimum allowable percent survival. An analysis of trends in survivorship will evaluate if the survivorship decline rate over time is significantly different than zero. Without replanting or recruitment, survivorship will decline over time, likely modeled as exponential, ideally, flattening over time.

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 grasslands, wetlands, and willow riparian habitats. Point-line intercept surveys will also be used to estimate non-native invasive species cover in all habitats. The number of sampling points would be determined using the power analysis method above[3]. [4].

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[3] 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%

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 2 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 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.

Analysis of percent cover data will be conducted as described above. 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 as described for tree survivorship with the caveat that annual climatic variation may influence the rate of increase in percent cover.

Non-native Invasive Plant Monitoring. During spring or early summer of Years 1-5, and for tree dominated communities in Years 7, 9 and 10, 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.

8.1.3 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.
- Species richness. This general site data will be used for calibrating similar data taken at transects, but is not intended for comparison with success criteria. Data will also help to evaluate whether invasive or non-native species are out-competing native plants, and whether more active management might be required.

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confidence interval). Reducing the margin of error requires increasing the sampling effort, and margins of error within 1% would require prohibitively intensive sampling efforts.

- A visual assessment of cover in planted and hydroseeded areas, invasive species over the entire site, and related observations of vegetation and habitat condition.
- 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 11. 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.

8.1.4 Wildlife Monitoring

Wildlife Assessment. A general wildlife assessment will be conducted in the spring and summer to document wildlife use (particularly special-status species) of the site. We recommend this assessment take place in Years 1, 3 and 5 at all sites and also Years 7 and 10 at woodland sites. The data will be used to assess overall site functioning, and not as a performance measure.

Aquatic Habitat Monitoring for California Red-legged Frog and San Francisco Garter Snake. A qualified biologist familiar with the species will monitor CRLF and SFGS habitat. Qualifications for the specialist that would monitor CRLF and SFGS habitat and other components of this MMP are included in Appendix E. Survey events will consist of both daytime and nighttime surveys and will be conducted at the deeper ponds within the seasonal wetlands at the Adobe Gulch Creek and Skyline Boulevard sites in Years 1–5 (Tables 12 and 13). Survey events will occur 2-4 times annually from March through June; if species presence is not documented during the 2 March and April survey events, additional survey events will be required in May and June. It should be noted that seeing SFGS is unlikely because their population is very small and dispersed. It will therefore be important to document habitat conditions (per the general site assessment described above) and the presence or absence of prey, which includes the CRLF. The following parameters will be analyzed at each survey event:

- Pond depth (minimum and maximum)
- Availability of water in appropriate seasons and for appropriate lengths of time to support breeding for CRLF populations.

- Water temperature in shade and in sun, near surface and near bottom
- Percent cover of emergent vegetation
- Presence of SFGS, CRLF, and other species of amphibian adults, juveniles or larvae. This may consist of dipnet, visual, auditory, larval, and egg-mass surveys.
- Presence of any potential predator, including snakes, birds, bullfrogs, and fish. Presence of native predator species will not be construed as a failure to provide appropriate habitat.

8.1.5 Special Site Assessments

Invasive Plant Assessment. Each monitoring year, an inspection for invasive species will occur once a month in March, May, and July in Years 1 through 5 (Tables 12, 13, and 14).

Wetland Delineation. A formal delineation of the created wetlands will be undertaken at the site 5 years following site construction (Tables 12, 13, and 14). The delineation will include an examination of vegetation, soils, and hydrology to determine the acreage and distribution of the jurisdictional areas associated with each wetland. However, field indicators of hydric soils are not anticipated to be present by Year 5 in the created wetlands. Such features typically develop over long periods of time (e.g., tens to hundreds of years). As such, the protocol outlined in Section F "Atypical Situations," Subsection 4 "Man-Induced Wetlands" of the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) describing the use of 2 parameters (hydrology and plants) will be followed.

If the desired jurisdictional acreage is not achieved in Year 5 or if climatic conditions were atypical in that year, a delineation will be repeated at the site in subsequent years to accurately determine the wetland acreage achieved.

Frequency and Volume of Surface Water Inputs. Surface water inputs into the created seasonal wetland features proposed at the Adobe Gulch Creek and Skyline Boulevard site(s) are expected to be the primary driver of wetland hydrology. For this reason, field observations of the actual flow conditions may be necessary to demonstrate that the created wetland is receiving surface water inputs in addition to evaluating the performance of erosion control BMPs and/or road improvements (e.g., rolling dips). Flows from the contributing drainage may be photo-documented and correlated with actual rainfall (e.g., in of rainfall in 24 hr) from data produced by the California Data Exchange Center (CDEC) for the Crystal Springs Cottage (CSC) weather station. This information combined with measuring the water depth at the monitoring points will enable for a computation of a volumetric flow rate. The field data collection should capture a range of flow conditions and, therefore, be collected over the duration of the rainy season with a minimum of 3 sampling events each year. If any problems are documented (e.g., scour, overtopping, etc), flow monitoring using a hand-held field meter may be conducted to verify the volume and magnitude of flows in relation to the applied design parameters. Particular emphasis should be placed on capturing peak flows during each event sampled, if possible. Note that because the Lower Crystal Springs Reservoir operations will be the primary driver of the hydrology at Sherwood Point, monitoring the frequency and volume of surface water inputs will not be required at this site.

Wetland Hydrologic Functioning Assessment. To better assess the hydrologic functioning of the sites it is important to assess the hydrological functioning of the created wetlands at the Sherwood Point, Adobe Gulch Creek, and Skyline Boulevard site(s), both immediately after construction, and long-term over the monitoring period. Each monitoring year, wetland assessments will occur monthly December – August (Table 13).

Hydrological functions to be documented include the following:

- **Rainfall Data.** A rain gauge will be installed at each project area with created seasonal wetlands and data will be collected monthly to catalogue inter-annual variations in precipitation.
- **Duration and Depth of Ponding.** Monitoring of each seasonal created wetland's ponding (hydroperiod) will be conducted monthly from February through August. Monitoring activities will focus on the collection of water depths via a staff gauge installed in each wetland's low point. If ponding is no longer observed, a small excavation of no more than 12 in will be completed using an auger to assess soil moisture conditions within the upper 12 in.

A hydrological assessment will be conducted for created wetland habitats during Year 1 to document "as built" hydrological functions, and to demonstrate compliance with wetland permit requirements for restoring wetland habitats pursuant to Section 404 and 401 of the CWA. The baseline "as built" hydrologic monitoring will be timed to correspond to initial filling of the wetland, with repeat visits to document the duration, and areal extent and depth of inundation, ponding, or flow in seasonal, intermittent, and perennial wetland habitats. If the created wetlands are not functioning as designed, groundwater levels may need to be assessed via sampling wells or piezometers

Subsequent hydrologic assessments will be conducted in monitoring Years 2-5 to document that the created wetland feature is functioning properly (i.e., is not eroding or accumulating silt), has a lateral extent (i.e., area as expressed in square ft or ac), hydro-period, and depth of ponding similar to Year 1 "as-built" conditions, and as necessary to sustain the intended habitat types.

Riparian Geomorphic Assessment. An assessment of riparian geomorphic condition will be conducted at the Adobe Gulch Creek wetland outfall (step-pools) to monitor stability of the riparian corridor. The assessment will occur once a month in March, May, and July in Years 1 through 3 (Tables 12 and 14). The assessment will consist of photo-documentation and a qualitative review of the geomorphic stability of the corridor, focusing on the step-pool structures and channel banks.

8.2 MONITORING SCHEDULE

Data will be collected at approximately the same time each year to standardize results. Vegetation monitoring for restored or created wetlands, scrub, and woodland habitats are described in the text below; the timelines for other monitoring elements are outlined in Tables 12, 13, and 14.

- Wetlands will be sampled each year for 5 consecutive years, in spring (late March or early April, depending on elevation and local site conditions). As mentioned above, monitoring of the wetlands at Sherwood Point will be delayed until LCSR has reached its target operations levels.
- Scrub habitats will be monitored each year for 5 consecutive years, in late summer/early fall (late August or early September) when shrubs are most likely to exhibit stress.
- Oak woodland and riparian woodland habitats will be monitored each year for 5 consecutive years and then semi-annually, in Years 7, 9, and 10. Due to the cool and wet conditions in the Peninsula region, oak and riparian woodland will be monitored in late summer/early fall (late September or early October) when planted trees are most likely to exhibit stress.

Tables 12, 13, and 14 provide an overview of the monitoring schedule.

Table 12. Project Monitoring Timeline.

MONITORING ELEMENT	**ALL HABITAT TYPES (YEARS 1-5)**									
	OAK AND RIPARIAN WOODLAND HABITATS (YEARS 1-10)									
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Vegetation Survey[1], Photo Documentation, & General Site Assessment	**X**	**X**	**X**	**X**	**X**		**X**		**X**	**X**
Wildlife Assessment	**X**	**X**	**X**	**X**	**X**		**X**			**X**
Aquatic Habitat Monitoring	**X**	**X**	**X**	**X**	**X**					
Invasive Plant Assessment	**X**	**X**	**X**	**X**	**X**		**X**		**X**	**X**
Wetland Delineation (only for seasonal and emergent wetlands)					**X**					
Frequency and Volume of Surface Water Inputs	**X**	**X**								
Wetland Hydrologic Functioning Assessment (only for seasonal and emergent wetlands)	**X**	**X**	**X**	**X**	**X**					
Riparian Geomorphic Assessment (for riparian areas)	**X**	**X**	**X**							

[1] Monitoring transects and quadrats.

Table 13. Annual Monitoring Schedule for Wetlands.

MONITORING ELEMENT	SUGGESTED SCHEDULE											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Vegetation Survey, Photo Documentation, & General Site Assessment			X	X								
Wildlife Assessment				X		X						
Aquatic Habitat Monitoring			X	X	X[1]	X[1]						
Invasive Plant Assessment			X		X		X					
Wetland Delineation				X								
Frequency and Volume of Surface Water Inputs[2]	X	X	X	X								X
Wetland Hydrologic Functioning Assessment[3]	R	R	R	R								R
		P	P	P	P	P	P	P	P			

[1] Per section 8.1.4, the May and June survey events are not required if presence of CRLF is documented during the March and April survey events.
[2] Per section 8.1.5, this monitoring occurs a minimum of 3 times during the rainy season.
[3] R = Rainfall, P = Ponding

Table 14. Annual Monitoring Schedule for Scrub and Woodland Habitats.

MONITORING ELEMENT	SUGGESTED SCHEDULE											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Vegetation Survey, Photo Documentation, & General Site Assessment								X	X	X		
Wildlife Assessment				X	X		X					
Invasive Plant Assessment			X		X		X					
Riparian Geomorphic Assessment			X		X		X					

9.0 SUCCESS CRITERIA

9.1 PERFORMANCE STANDARDS

9.1.1 Vegetation Criteria

The table below presents vegetative cover, invasive species, and plant survival performance standards by habitat type.

For the areas within the mitigation sites expected to have wetland vegetation (i.e., not the deeper ponds at Adobe Gulch Creek and Skyline Boulevard) by the end of Monitoring Year 5, the criteria presented in Table 15 will apply.

Table 15. Performance Standards by Habitat Type.

HABITAT TYPE	PERFORMANCE STANDARD		
	Vegetative Cover	**Invasive Species**	**Plant Survival**
Seasonal Wetland	Greater than 70 % absolute cover of hydrophytic seasonal wetland indicator plant species (as defined in Table 18) by the end of Monitoring Year 5 for the areas within the mitigation sites expected to have wetland vegetation (i.e., not the deeper ponds).	No more than 5% absolute cover of target invasive plants[1] present by the end of the monitoring period.	N/A – there is no survival criterion for wetland plug plantings.
Emergent Wetland	Greater than 75 % absolute cover of hydrophytic emergent wetland indicator plant species (as defined in Table 18).	No more than 5% absolute cover of target invasive plants[1] present by the end of the monitoring period.	N/A – there is no survival criterion for wetland plug plantings.
Scrub Habitats (e.g., Northern Coyote Brush Scrub)	A minimum 25% absolute vegetative cover of target scrub vegetation at the end of Monitoring Year 5.	No more than 10% absolute cover of target invasive plants[1] present by the end of the monitoring period.	N/A – there is no survival criterion for scrub habitats that are installed via seeding.
Oak Woodland	A minimum canopy cover of 40% target tree and shrub species by the end of Monitoring Year 10.	No more than 10% absolute cover of target invasive plants[1] present by the end of the monitoring period.	Mortality rates of planted hardwoods shall not exceed 70% by the end of the monitoring period in Year 10.
Riparian Woodland	A minimum combined canopy cover of 50% target tree and shrub species by the end of Monitoring Year 10.	No more than 5% absolute cover of target invasive plants[1] present by the end of the monitoring period.	Mortality rates of planted hardwoods shall not exceed 35% by the end of the monitoring period in Year 10.

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For more detail concerning target invasive species and exempted invasive species in non-wetland areas (Table 2, Appendix) refer to the Vegetation Management Plan (Appendix C).

9.1.2 Wildlife Criteria

This section describes the success criteria for California red-legged frog and San Francisco garter snake, including:

- Creation of aquatic non-breeding, breeding, and foraging habitat for California red-legged frog (thereby creating foraging habitat for the San Francisco garter snake)
- Predator removal activities

Habitat restoration for California red-legged frog and San Francisco garter snake will be successful if 2 of the primary constituent elements as described by the USFWS, aquatic non-breeding and breeding habitat, are documented at the deeper ponds within the wetlands during the monitoring period and if predator removal programs are successful. Habitat related information will be used to determine whether the mitigation at each site is deemed successful or requires remediation, as described below:

Rehabilitation and Enhancement of Aquatic Breeding and Non-breeding Habitat for Red-legged Frog. Even if no individuals or egg masses are observed, the aquatic breeding and non-breeding habitat for California red-legged frog will be considered successful if the following habitat attributes are present:

- Protection from predators (e.g., deep ponds or complex cover such as root masses or thick vegetation)
- Sunny areas appropriate for red-legged frog basking available within 100 ft of the deeper ponds.
- A mixture of open water and emergent vegetation within the deeper ponds. Suitable open water is necessary for foraging, while vegetative cover is necessary for shelter, protection from predators, and egg attachment. However, emergent vegetation will not exceed 35% cover of deeper ponds' surface area.
- Deeper ponds hold water for a minimum of 9 months/year for California red-legged frog breeding cycles.
- Water in the deeper ponds does not exceed 21° C (Jennings and Hayes 1989) during breeding season and when metamorphs are present. This will be measured at the deepest point in the pond by a Hobo temperature logger (or other similar device).
- The deeper ponds will be free of non-native predators to the extent practicable during each year of the post-construction monitoring.

9.2 ANNUAL SUCCESS CRITERIA

9.2.1 Seasonal and Emergent Wetland Mitigation Areas

This section contains the annual success criteria for wetland mitigation areas. The wetland indicator status of each species from the quadrat and transect data will be determined, and the average percent cover attributed to wetland indicator species, as a group, will be calculated. Obligate and facultative wetland indicator species are hydrophytes that occur "in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present" (Wetland Training Institute 1995; http://plants.usda.gov/wetinfo.html). Facultative indicator species may be considered wetland indicator species when found growing in hydric soils that experience periodic saturation. The wetland indicator status of each species will be determined and the average percent cover attributed to wetland indicator species, as a group, will be calculated.

Monitoring of performance criteria will evaluate the extent to which the created wetland sites are incrementally developing high quality wetland habitat values.

Percent Cover. At Years 2 through 5 the percent cover values will have shown steady trends towards, or will have met the percent cover success criteria of wetland indicator species. Percent cover goals differ between the seasonal and emergent wetland types. The final success criterion for seasonal wetlands is lower than that for the emergent wetland, based on observations of nearby reference habitats.

Percent cover as a success criterion will only apply for the areas that are intended to be vegetated (i.e., not the deeper ponds at Adobe Gulch Creek and Skyline Boulevard). Success guidelines for wetland habitats will include both parameters for hydrologic functioning and for vegetative cover of typical hydrophytic species. The percent cover performance criteria for the mitigation sites are shown in Tables 16 and 17.

Table 16. Seasonal Wetland Habitat Success Criteria.

Seasonal Wetland[1]	**Year 1:** 5 % or greater absolute cover of seasonal wetland species.[2] Positive evidence of proper hydrological functioning (i.e., saturated or inundated soils in the winter, with the upper soil layer drying out in the summer, during a year with normal rainfall amount[3] and distribution[4]). No more than 5% absolute cover of target invasive plants. No evidence of oversaturation or permanent inundation. **Year 2:** 20 % or greater absolute cover of seasonal wetland species Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No evidence of oversaturation or permanent inundation. **Year 3:** 45% or greater absolute cover of seasonal wetland species, Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No large[5] unvegetated bare spots or erosional areas, no field indicators of oversaturation or permanent inundation. **Year 4:** 60 % or greater absolute cover of seasonal wetland species, Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No large unvegetated bare spots or erosional areas, no field indicators of oversaturation or permanent inundation. **Year 5:** Greater than 70 % absolute cover of seasonal wetland species, Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No large unvegetated bare spots or erosional areas, no field indicators of oversaturation or permanent inundation

[1] Note: Uneven vegetative cover success criteria between monitoring years allow for slow growth rates of newly-planted material and accelerated growth rates and natural spread of plants outward from planted material in subsequent years after establishment.
[2] See Table 18 for representative species.
[3] The average rainfall amount will be based on data from California Data Exchange Center (CDEC) for the Crystal Springs Cottage (CSC) weather station.
[4] The average rainfall distribution will be based on data from Weatherunderground.com's San Francisco International (KSFO) station. (http://www.wunderground.com/NORMS/DisplayNORMS.asp?AirportCode=KSFO&StateCode=CA&SafeCityName=Hillsborough&Units=none&IATA=SFO&normals=on).
[5] One contiguous area measuring 2% or more of the total wetland area.

Table 17. Emergent Wetland Habitat Success Criteria.

Emergent Wetland[1]	**Year 1:** 15 % or greater absolute cover of emergent wetland species.[2] Positive evidence of proper hydrological functioning (i.e., saturated or inundated soils in spring during a year with normal rainfall amount[3] and distribution[4] when Lower Crystal Springs Reservoir elevations are at or above 487 msl in spring). No more than 5% absolute cover of target invasive plants. **Year 2:** 30 % or greater absolute cover of emergent wetland species. Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. **Year 3:** 50 % or greater absolute cover of emergent wetland species. Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No large[5] unvegetated bare spots or erosional areas. **Year 4:** 65 % or greater absolute cover of emergent wetland species. Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No large unvegetated bare spots or erosional areas. **Year 5:** Greater than 75 % absolute cover of emergent wetland species. Positive evidence of proper hydrological functioning. No more than 5% absolute cover of target invasive plants. No large unvegetated bare spots or erosional areas.

[1] Note: Uneven vegetative cover success criteria between monitoring years allow for slow growth rates of newly-planted material and accelerated growth rates and natural spread of plants outward from planted material in subsequent years after establishment.
[2] See Table 18 for representative species.
[3] The average rainfall amount will be based on data from California Data Exchange Center (CDEC) for the Crystal Springs Cottage (CSC) weather station.
[4] The average rainfall distribution will be based on data from Weatherunderground.com's San Francisco International (KSFO) station. (http://www.wunderground.com/NORMS/DisplayNORMS.asp?AirportCode=KSFO&StateCode=CA&SafeCityName=Hillsborough&Units=none&IATA=SFO&normals=on).
[5] One contiguous area measuring 2% or more of the total wetland area.

Table 18. Representative Seasonal and Emergent Wetland Species.

SEASONAL WETLAND SPECIES	
Scientific Name	**Common Name**
Carex barbarae	Santa Barbara sedge
Carex harfordii	Harford's sedge
Cyperus eragrostis	umbrella sedge / tall flatsedge
Eleocharis macrostachya	pale spikerush
Euthamia occidentalis	western goldenrod
Juncus balticus	Baltic rush
Juncus effusus	soft rush
Juncus occidentalis	western rush

SEASONAL WETLAND SPECIES	
Scientific Name	**Common Name**
Juncus patens	spreading rush
Juncus xiphioides	iris-leaved rush
Leymus triticoides	creeping wild rye
Salix laevigata	red willow
Salix lasiolepis	arroyo willow
Emergent Wetland Species	
Carex barbarae	Santa Barbara sedge
Eleocharis macrostachya	spike rush
Juncus balticus	Baltic rush
Juncus effusus	soft rush
Juncus occidentalis	western rush
Juncus patens	spreading rush
Juncus xiphioides	iris-leaved rush
Scirpus acutus	hardstem bulrush
Scirpus californicus	California bulrush
Typha sp.	cattail

The list provided in Table 18 is not intended to be exhaustive, but rather a list of species anticipated to be present based on adjacent reference wetlands. Other native wetland species appropriate to the respective target habitat type may be added upon approval from the RWQCB and CDFG.

Deeper Pond Hydrology. The deeper ponds in the created wetlands at the Adobe Gulch Creek and Skyline Boulevard sites will provide appropriate conditions to allow for successful breeding of CRLF. Any deeper ponds will be a minimum depth of 3 ft and will remain ponded long enough into the summer (generally through July) to allow for complete metamorphosis of tadpoles. However, to ensure that bullfrog breeding habitat is not created, these areas must also dry out completely each year.

Wetland Delineation. The total acreage of created jurisdictional seasonal and/or emergent wetlands (meeting success criteria for hydrophytic vegetation and wetland hydrology, but not for hydric soils) will be equal to or greater than 4.50 ac.

9.2.2 Northern Coyote Brush Scrub Mitigation Areas

Success guidelines for northern coyote brush scrub vary depending on the installation method. For areas installed by container stock, the success criteria will include both parameters for both canopy cover and plant mortality. For areas installed by seeding, the success criteria will be based strictly on canopy cover.

Percent Canopy Cover. The percent canopy cover values will have shown steady trends towards, or will have met the percent cover success criteria shown in Table 19.

Table 19. Northern Coyote Brush Scrub Habitat Success Criteria.

Northern Coyote Brush Scrub	**Year 1:** 5 % or greater canopy cover of typical northern coyote brush scrub species. No more than 10% absolute cover of target invasive plants. **Year 2:** 10 % or greater canopy cover of typical northern coyote brush scrub species. No more than 10% absolute cover of target invasive plants. **Year 3:** 15 % or greater canopy cover of typical northern coyote brush scrub species. No more than 10% absolute cover of target invasive plants. **Year 4:** 20 % or greater canopy cover of typical northern coyote brush scrub species. No more than 10% absolute cover of target invasive plants. **Year 5:** 25 % or greater canopy cover of typical northern coyote brush scrub species. No more than 10% absolute cover of target invasive plants.

9.2.3 Oak Woodland and Riparian Woodland Mitigation Areas

Success guidelines for oak woodland and riparian woodland habitats reflect the anticipated growth rate for the target trees and include parameters for both canopy cover and plant mortality.

Percent Canopy Cover. The percent canopy cover values will have shown steady trends towards, or will have met the percent cover success criteria shown in Table 20.

Table 20. Oak Woodland and Riparian Woodland Habitat Success Criteria

Oak Woodland	**Year 1:** 5 % or greater canopy cover of typical oak woodland tree and shrub species. Plant survivorship of planted trees at least 75%. No more than 25% absolute cover of target invasive plants. **Year 2:** 10 % or greater canopy cover of typical oak woodland tree and shrub species. Plant survivorship of planted trees at least 60%. No more than 20% absolute cover of target invasive plants. **Year 3:** 15 % or greater canopy cover of typical oak woodland tree and shrub species. Plant survivorship of planted trees at least 50%. No more than 15% absolute cover of target invasive plants. **Year 4:** 20 % or greater canopy cover of typical oak woodland tree and shrub species. Plant survivorship of planted trees at least 45%. No more than 10% absolute cover of target invasive plants. **Year 5:** 25 % or greater canopy cover of typical oak woodland tree and shrub species. Plant survivorship of planted trees at least 40%. No more than 10% absolute cover of target invasive plants. **Year 7:** 30 % or greater canopy cover of typical oak woodland tree and shrub species. Plant survivorship of planted trees at least 35%. No more than 10% absolute cover of target invasive plants. **Year 9:** 35 % or greater canopy cover of typical oak woodland tree and shrub species. Plant survivorship of planted trees at least 35%. No more than 10% absolute cover of target invasive plants. **Year 10:** 40 % or greater canopy cover of typical oak woodland tree and shrub species. Plant survivorship of planted trees at least 30%. No more than 10% absolute cover of target invasive plants.
Riparian Woodland	**Year 1:** 5 % or greater canopy cover of typical riparian tree and shrub species. Plant survivorship of planted hardwood trees at least 90%. No more than 5% absolute cover of target invasive plants. **Year 2:** 10 % or greater canopy cover of typical riparian tree and shrub species. Plant survivorship of planted hardwood trees at least 85%. No more than 5% absolute cover of target invasive plants. **Year 3:** 15 % or greater canopy cover of typical riparian tree and shrub species. Plant survivorship of planted hardwood trees at least 80%. No more than 5% absolute cover of target invasive plants. **Year 4:** 20 % or greater canopy cover of typical riparian tree and shrub species. Plant survivorship of planted hardwood trees at least 80%. No more than 5% absolute cover of target invasive plants. **Year 5:** 25 % or greater canopy cover of typical riparian tree and shrub species. Plant survivorship of planted hardwood trees at least 75%. No more than 5% absolute cover of target invasive plants. **Year 7:** 35 % or greater canopy cover of typical riparian tree and shrub species. Plant survivorship of planted hardwood trees at least 75%. No more than 5% absolute cover of target invasive plants. **Year 9:** 45 % or greater canopy cover of typical riparian tree and shrub species. Plant survivorship of planted hardwood trees at least 70%. No more than 5% absolute cover of target invasive plants. **Year 10:** 50 % or greater canopy cover of typical riparian tree and shrub species. Plant survivorship of planted hardwood trees at least 65%. No more than 5% absolute cover of target invasive plants.

10.0 MAINTENANCE

10.1 OVERALL DESCRIPTION

Maintenance will be required during the monitoring period at the created, enhanced, or restored wetlands, oak and riparian woodlands, and scrub habitats. Additionally, maintenance will be required at Adobe Gulch Creek, Skyline Quarry, and Skyline Boulevard to provide the desired conditions for CRLF and the SFGS. Maintenance activities will be designed to avoid and minimize take of federally listed species (ICF International (ICF) 2010).

The results of monitoring will be conveyed to the SFPUC to allow the information to be factored into their ongoing maintenance program. Annual reports will be provided to those associated with the site's maintenance. In addition, if monitoring crews notice significant problems related to the site's maintenance and performance, verbal reporting will initiate remediation.

10.2 APPLICABLE CONSERVATION MEASURES (FROM BIOLOGICAL ASSESSMENT)

The following conservation measures from the SFPUC Peninsula Region Habitat Reserve Program Biological Assessment will be implemented to avoid and minimize effects to special-status species during maintenance activities (ICF 2010).

10.2.1 Worker Awareness Training

The SFPUC will develop and implement a worker awareness program (environmental education) to inform project workers of their responsibilities regarding listed species and their habitats present in the action area and vicinity. The program will comply with the following measures:

- **Program Development.** A biologist familiar with the listed species in the action area will develop the training program.
- **Training.** Before any ground disturbing work (including vegetation clearing and grading) occurs in the construction area or spoils disposal areas, a Service and CDFG approved biologist will conduct a mandatory biological resources awareness training for all construction personnel about federally listed species that could potentially occur on site (Mission blue butterfly, Bay checkerspot butterfly, CRLF, and SFGS). Proof of personnel attendance will be kept on file at the SFPUC. Interpretation shall be provided for non-English speaking workers. If new construction personnel are added to the project, the SFPUC will ensure that the new personnel receive the mandatory training before starting work. The subsequent training of personnel can include videotape of the initial training and/or the use of written materials rather than in-person training by a biologist.
- **Content.** Training will provide educational information on the natural history of the listed species that could occur in the area, representative photographs, how to identify the species, legal status of each federally listed species, terms and conditions of the USFWS Biological Opinion and penalties for noncompliance with the terms and conditions. The

biological resource awareness training will include specific information to educate construction workers on how they can minimize and avoid potential mortality of listed species while driving on access roads. The biologist will describe the time periods when listed species are more likely to be crossing the roadway, the need to drive more slowly in rainy conditions, and the need to be aware of snakes that could be basking in or crossing the road. The training will also provide information regarding the importance of preventing the spread of non-native invasive species. Workers doing hand clearing in the vicinity of listed plants and concentrations of larval food plants for listed butterflies will be taught how to avoid effects to these plants.

10.2.2 General Procedures

- **Delineate Limits of Work**. The contractor will clearly delineate the limits of work and prohibit any construction-related traffic outside these boundaries.
- **Off-road Travel.** Project-related vehicles and equipment will restrict off-road travel to the designated work area.
- **Trash Disposal.** The contractor will provide closed garbage containers for the disposal of all food-related trash items (e.g., wrappers, cans, bottles, food scraps). All garbage will be collected at the end of each workday from the action area and placed in a closed container that will be emptied weekly at an approved offsite location. Construction personnel will not feed or otherwise attract fish or wildlife.
- **Speed Limit.** Project-related vehicles will observe a 15-mile-per-hour speed limit on unpaved roads throughout the project areas.
- **Pets and Firearms.** No pets or firearms will be allowed in the project areas.
- **Inspect Open Trenches and Pits.** Any open trenches or pits 2 or more ft deep will be covered before the end of construction activities each day. If this is not feasible, the trenches or pits will be equipped with ramps every 150 ft to allow any animals that might become trapped to escape overnight. Ramps will be constructed of dirt fill, wood planking, or other suitable materials placed at an angle of no greater than 30 degrees. Before any such trenches or pits are filled, they will be thoroughly inspected for trapped animals.
- **Remove All Project Debris.** Upon Project completion, the SFPUC shall remove from the Project area and properly dispose of all construction refuse, including, but not limited to, broken equipment parts, wrapping material, cords, cables, wire, rope, strapping, twine, buckets, metal or plastic containers, and boxes.
- **Maintenance-related Measures to Avoid Spread of Invasive Weeds or Chytrid Fungus**. To reduce the possibility of spreading invasive plants or chytrid fungus to listed species habitat the following measures will be implemented:
    i. All contractors will have sanitation kits on the site for cleaning equipment (sanitation kits should contain chlorine bleach [10/90 mixture bleach to water] or Clorox® Clean-Up® or Lysol®, scrub brush, metal scraper, boot brush, and plastic gloves).

ii. After the completion of work activities, any accumulation of plant debris (especially leaves), soil, and mud will be washed off equipment or otherwise removed on the site, and radiators will be blown out.

iii. Any imported fill material, soil amendments, gravel, and the like required for construction and/or restoration activities to be placed within the upper 12 in of the ground surface will be free of vegetation or plant material.

- **Fueling and Vehicle Maintenance Buffers.** All fueling and maintenance of vehicles and other equipment will be at least 50 ft from riparian habitat or water bodies to the extent feasible.
- **Compliance with Biological Opinion.** To ensure compliance with the Conservation Measures of this Biological Opinion, the Service and CDFG-approved biologist shall have authority to immediately stop any activity that is not in compliance with the Biological Opinion, and/or order any reasonable measure to avoid the unauthorized take of an individual of the listed species.

10.2.3 Herbicide Use

- **Avoid Herbicide Use.** Use chemical weed control methods only when other methods (e.g., weed wrenches, string trimmers, hand removal, mowing, grazing) are unsuccessful. If needed, use only herbicides that are approved for use in California and specific habitats and meet the City of San Francisco's pesticide policy, as appropriate, and do not use any chemicals that are considered a threat to any special-status species have the potential to occur in the area.
- **Exclusion Buffer for Herbicides.** Sensitive locations (e.g., wetlands, riparian corridors, sensitive plant populations, etc) will be marked on a map and provided to the SFPUC herbicide contractors before any herbicide application begins. If federal or state regulations require a buffer around these habitats, that buffer will be delineated in the field with pin flags prior to herbicide application.
- **Weather Constraints on Herbicide Application.** Restrict herbicide use to the weather conditions allowed by regulations as indicated by manufacturer use restrictions.

10.3 REVEGETATION INSPECTION AND MAINTENANCE

Inspections will take place as outlined in the maintenance schedule (Table 21). The summer inspection will be conducted by SFPUC personnel, or their designee.

The revegetation inspection should include the following parameters:

1. Erosion control is in place and functioning properly.
2. Wetland habitats are exhibiting proper hydrological functioning.
3. Plants are not exhibiting water or drought stress.
4. Pioneering populations of invasive plants are absent, or are to be treated immediately whenever detected. Refer to Section 7.1.7 for further detail concerning invasive plants.

5. Distinctive patterns of plant die off (i.e., all species of a single plant die, a cluster of plants within a small area all die).

Maintenance will be conducted annually, and will include the following:

- **Foliage Protection.** Foliage protection cages will protect trees and shrubs from deer browse. Cages will be removed at the end of the plant establishment period (or sooner if plants are being severely restricted or damaged by the cages).
- **Weeding.** Weed whips and mowers can be used to weed between the woodland and riparian revegetation plantings, as needed and with procedures in place to prevent harm to sensitive animal species. Weeds established within 2 ft of these revegetation plantings will be manually removed. No weeding is anticipated in the northern coyote brush scrub or wetland habitats. Herbicides will not be broadly applied for weed control and will only be used to treat non-native invasive plant species.
- **Irrigation.** Revegetation plantings will be irrigated during the plant establishment period per section 7.4.
- Invasive plant removal as described below in section 10.4.

10.4 INVASIVE PLANT INSPECTION AND MAINTENANCE

During the spring and summer unless another time of year is deemed more appropriate by the project monitor to avoid disturbance to sensitive species, or to prevent seed set of invasive species (see Vegetation Management Plan, Appendix C), invasive plant populations within the project area boundary are to be removed/treated as soon as possible following detection. 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, depending on site-specific conditions and invasive species issues at the time of management/maintenance activity.

The maintenance contractor, site supervisor, or monitoring biologist, should have a good understanding of native and invasive plant species so that spot control of invasive species does not impede the establishment of the plantings, or the natural recruitment of desirable native species. If timing of maintenance needs to be modified for certain items, the rationale for the decision will be documented in annual reports.

10.5 PREDATOR INSPECTION AND MAINTENANCE

Management for predators will include monitoring their presence during the annual wildlife assessments (Tables 12, 13, and 14). Deer are the main concern for browsing on the plantings, particularly the oaks and willows. Five-ft high foliage protection cages are recommended to protect these and other trees during establishment Other species of concern are bullfrogs, fish, and other predators that will negatively impact CRLF and SFGS populations.

Each monitoring year, if predators are detected in the wetlands and a pond has standing water in September, the affected wetland will be drained for 10 days in late September or early October if it is not expected to dry out on its own. For bullfrog control, draining of the wetlands disrupts the 2-year development cycle of the bullfrog and substantially reduces or eliminates successful reproduction. For predatory fish species, draining the wetlands will kill adult and juvenile individuals. Manual predator removal measures, such as gigging and taking by hand, may also be implemented to reduce the predator population.

10.6 INFRASTRUCTURE INSPECTION AND MAINTENANCE

The Adobe Gulch Creek and Sherwood Point site(s) include various improvements to existing unpaved roadways to facilitate habitat design along with long-term access. Improvements to the roadway surfaces may include, but is not limited to, a combination of aggregate base material and excavated soil materials. Annual inspection of the improved roadway segments should be performed at each site location to assess its overall condition and to determine whether repairs are needed.

Roadway improvements proposed to convey surface runoff across the roadway would consist of outsloped roads with rolling dips or replacement of existing culverts. Rolling dips will be placed at intervals frequent enough to prevent road surface erosion (Weaver and Hagans, 1994). The locations of these drainage improvements are shown in Figures 3, 5, and 7. The rolling dips would be reinforced with PVC grass pavers or concrete, so they are capable of supporting the anticipated vehicular loads. The PVC grass pavers or concrete dips should be inspected annually to check for differential settlement, loss of soils in pavers (foundation erosion), and for damage such as cracking. The edges of the pavers or concrete dips should also be inspected to ensure that excessive erosion into the roadway is not occurring. Careful inspection of the rolling dips for any signs of settlement of the grass pavers or concrete dips will be critical to minimize the potential for the creation of concentrated flows. Road sections adjacent to the grass pavers or concrete dips should be inspected annually for evidence of erosion at the edges of the pavers. Similarly, culverts replaced as part of the project would require annual inspection to confirm their structural integrity and to assess for any downstream scour.

Monitoring of the roadways and drainage improvements should be done using a GPS unit and digital photo-documentation. Changes in the size and/or shape of these improvements should be monitored. Depending on the extent of erosion observed, various corrective measures could be undertaken to minimize erosion-related impacts. These include installing erosion control blankets, hydroseeding, providing additional plantings, and installing additional fiber rolls or other erosion or sediment control methods. Monitoring frequency at locations subject to any corrective measures would be adjusted as needed to ensure the applied measures are successful.

Inspection of the flow patterns within the wetlands would also be completed to assess for any scour conditions. Two inspections would be completed annually; in mid–January to observe active flow patterns through the wetlands and in July to inspect for bare, non-vegetated areas and any evidence of burrowing rodents. Established wetland vegetation is the preferred long-term method of soil stabilization and, therefore, careful attention should be paid to bare areas along the flow path. Depending on the severity and extent of any scouring observed, maintenance measures that could be undertaken to minimize further scour may include installation of erosion control blankets, hydroseeding, provision of additional planting, or installation of fiber rolls or other erosion control methods.

10.7 REMEDIAL ACTIONS

10.7.1 Potential Actions

Potential remedial actions could include some or all of the following:

1. Weeding around planting sites to reduce competition from non-native grasses and forbs;
2. Supplemental watering of wetland plugs: If rainfall is more that 20% below average in Years 1 and/or 2, supplemental irrigation may be applied to wetland plugs. However, if the site is irrigated during Years 3 through 5, the 5 year monitoring requirement will be reset to Year 1 and monitoring will resume for a minimum of 5 years after irrigation has ceased;
3. Additional erosion control;
4. Additional invasive plant control; and
5. Supplemental replacement plantings (may be in-kind, or if a particular species is not doing well at the site, a replacement species can be substituted for the original plant) if it is deemed that no other procedure could be employed to restore the target habitat to meet monitoring criteria
6. Hydrologic modification: Based on the results of the wetland hydrologic functioning assessment (Section 8.1.5 and Tables 12 and 13), maintenance may be required. If ponding conditions observed suggest a lack of wetland hydrology (e.g., too wet or too dry), additional grading within the wetlands may be required to achieve the appropriate topographical elevation(s).
7. Regrading could be recommended if it is deemed that no other procedure could be employed to create/restore the target habitat to meet monitoring criteria

10.7.2 Initiating Procedures

If annual success criteria are not achieved for any portion of the mitigation project in any year, or if any of the final success criteria are not met, the SFPUC will work with the permitting agencies to prepare an analysis of the cause(s) of failure. If requested by the permitting agencies, a remedial action plan will be prepared in concert with the permitting agencies' action plan within 2 months of the initial request. Implementation of remedial actions would depend on the nature of the work; thus a schedule will be presented to the agencies for review and approval as part of the remedial action plan. Alternative mitigation sites have not been considered at present since the sites appear to be fully suitable for creation and/or restoration. Alternative mitigation site planning will begin if it becomes apparent that the long-term success criteria for the sites will not be achieved in a timely fashion.

Also, if irrigation beyond the 2 year plant establishment period is required for container plant material, the monitoring period will be reset to start anew at the cessation of irrigation. Thus, under that scenario once irrigation stops for container plant material, Year 1 of the monitoring would start.

10.8 MAINTENANCE SCHEDULE

The maintenance schedule for the project areas during the 5-year monitoring period is provided in Table 21.

Table 21. Maintenance Schedule during the Monitoring Period.

MAINTENANCE ITEM	SUGGESTED SCHEDULE											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Revegetation Inspection and Maintenance	M[2]	M[2]	I	I			I			M[3]		M[2]
Invasive Plant Inspection and Maintenance	I, M		I, M	I, M	I, M		I, M		I, M		I, M	
Predator Inspection and Maintenance[1]				I		I			M	M		
Infrastructure Inspection and Maintenance	I						I	M	M			

I = Inspection, M = Maintenance
[1] Predator inspection to occur during wildlife assessment (Tables 13 and 14)
[2] For Adobe Gulch Creek, Skyline Quarry
[3] For Sherwood Point only

11.0 LONG-TERM MANAGEMENT

Long-term management will be required at the created, enhance, or restored seasonal and emergent wetlands, oak and riparian woodlands, and scrub habitats. A Long-Term Management Plan for all of the Peninsula HRP sites, including the 4 sites described in this MMP will be prepared and submitted for agency review by November 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.

12.0 PROPERTY MANAGEMENT

12.1 MANAGERS

The SFPUC is responsible for the long-term management of the S.A.S.S. sites.

12.2 LONG-TERM FUNDING

SFPUC is responsible for funding any adaptive management or additional measures which it determines are necessary and with which the appropriate agencies concur. Letters of credit will be prepared as needed, unless other methods of financial assurance are negotiated with CDFG.

12.3 PROPERTY PROTECTION

The SFPUC will place a permanent conservation easement on the project areas and will create an endowment to ensure that funds are available for all required maintenance, management, and monitoring activities.

13.0 REPORTING

13.1 RECORD DOCUMENTATION

13.1.1 Content

The Record Documentation (commonly referred to as an As-Built Plan) will describe all significant deviations from the conceptual design presented in this document.

13.1.2 Schedule

The Record Documentation will be prepared by a qualified biologist (as defined in Appendix E) and be provided to the regulatory agencies within 8 weeks of completing mitigation construction and planting. The agencies will be notified that mitigation construction and planting has been completed within 72 hr of concluding these activities.

13.2 MONITORING PERIOD REPORTS

13.2.1 Content

Maps showing monitoring locations and copies of photo-documentation will be provided along with reports. Field data sheets will be available for review by the agencies upon request.

Reports will be prepared in the following format:

1. Report Summary
2. Introduction
3. Methods
4. Results
5. Discussion
6. Management Recommendations
7. Literature Cited
8. Appendices

All monitoring reports will include the following photographic documentation:

- Photographs of baseline photo documentation locations, comparing Years 1 (Baseline) to Years 2, 3, 4, and 5 (and also comparing Years 7, 9, and 10 for forested and woodland habitats).
- The format and layout for the comparison photographs should be standardized. The report will provide 4 photos per page with the photo site and date beneath each photo.

- A photograph of each end of the sampling transect facing the opposite end of the sampling transect comparing Years 1 (Baseline) to Years 2, 3, 4, and 5 (and also comparing Years 7, 9, and 10 for forested and woodland habitats).

In addition, the following information will be provided to SFPUC:

- Transect photo documentation data should be provided to SFPUC in printed form, as part of the annual monitoring reports comparing photographs of the same locations over time, and electronically on a separate CD so that SFPUC can prepare and maintain a long-term image database for all its monitoring sites.
- A photograph of each sampling quadrat for future reference (should be provided to SFPUC electronically, but does not need to be part of written monitoring reports).

13.2.2 Schedule

Annual monitoring reports should be due for submittal to SFPUC by 1 November and submitted to the regulatory agencies by 31 December of each year of the monitoring period.

13.2.3 Completion of Mitigation Responsibilities

13.2.3.1 Notification

When final monitoring goals have been met, a final report will be prepared to establish that the mitigation site has successfully met the final success criteria. The report will summarize the mitigation project, evaluate the site's overall performance, and provide ongoing maintenance recommendations. If the site has successfully met the final success criteria, the project proponent will submit a letter to the permitting agencies requesting approval to cease monitoring.

13.2.3.2 Agency Confirmation

Monitoring will cease when the site has met all of the project goals or when the reviewing agencies agree that the site is expected to meet those goals with little chance of failure. 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. Following completion of mitigation responsibilities, the site will be managed in perpetuity as described above.

13.3 LONG-TERM MANAGEMENT REPORTS

An annual account and property management report identifying the management and monitoring actions taken will be produced by the SFPUC and provided to the permitting and resource agencies as well as the conservation easement grantor.

13.3.1 Content

The annual long-term monitoring report will include the following information:

- An accounting of funds received and expended in the management of the site during the previous year;
- A general description of the status of the biological and physical resources located within the site;
- The results of biological and physical monitoring or studies conducted on the site;
- A description of all management actions taken on the site;
- A description of any problems encountered while managing and monitoring the site, and;
- Management recommendations for the upcoming year, including any necessary remedial actions.

13.3.2 Schedule

Annual monitoring reports should be submitted to the regulatory agencies by 31 December, except in Years 6 and 8 when no monitoring is required.

14.0 REFERENCES

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APPENDIX A.
HYDROLOGY REPORT

DRAFT Technical Memorandum

SFPUC Habitat Reserve Program

Subject:	**Habitat Reserve Program Hydrologic Evaluation – Skyline Boulevard Habitat Improvement, Adobe Gulch Creek Wetland Creation, and Sherwood Point Oak Restoration**
Prepared by:	Chris van Lienden, RMC Clint Meyer, RMC
Reviewed by:	Mike Matson, RMC
Date:	September 14, 2010
Reference:	0092-006.03 (formerly 0092-005.21)

1 Introduction

The Skyline Boulevard Habitat Improvement Project, Adobe Gulch Wetland Creation Project, and Sherwood Point Oak Restoration Project (SAS Projects) proposed as part of the Habitat Reserve Program (HRP) are intended to satisfy the wetland compensation needs identified by the San Francisco Public Utilities Commission (SFPUC) for impacts to jurisdictional wetlands associated with the Lower Crystal Springs Reservoir (LCSR) Dam Project. The wetland creation areas proposed for the SAS Project sites would provide up to 4.13 acres of out-of-kind wetland mitigation. This Project site, located in San Mateo County, California (CA), is owned entirely by SFPUC. The purpose of this document is to summarize the hydrologic characteristics of the sites and evaluate the capacity of the contributing surface or groundwater hydrology to support the proposed wetlands.

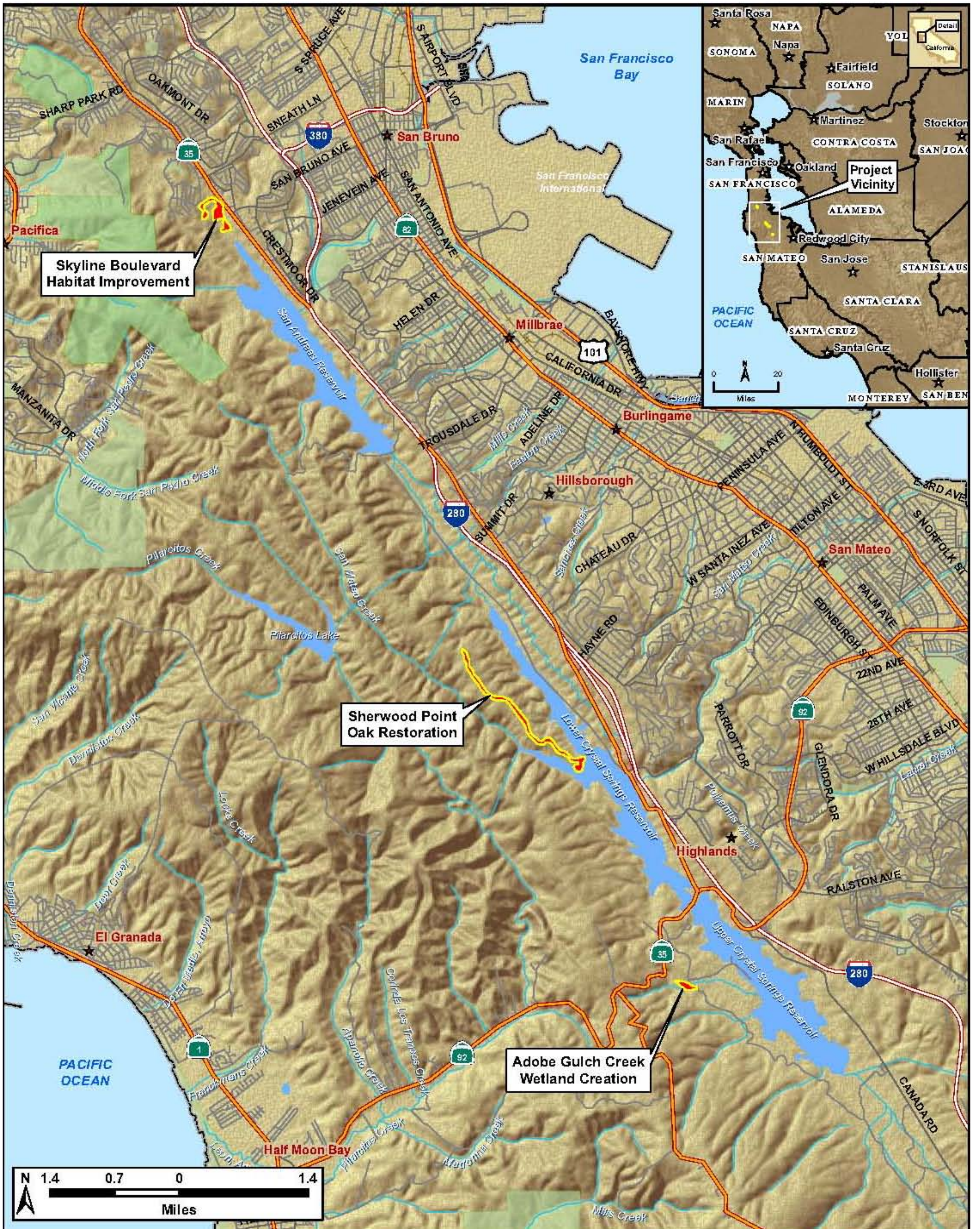
The SAS sites provide five opportunistic locations for wetland creation based on a combination of geomorphic positions, contributing hydrology from upslope drainages, and previous disturbance. The locations of the wetland creation sites are shown in Figure 1. Each of these sites is described further below.

Skyline Boulevard Habitat Improvement Site. The Skyline Boulevard Habitat Improvement Site (Skyline Boulevard) is located north of San Andreas Reservoir and immediately west of Skyline Boulevard. The Skyline Boulevard site consists of a valley trough comprised of open, interspersed emergent wetland and herbaceous upland habitats. A linear drainage feature bisects the trough in a north-south orientation with a small (less than 0.02-acre) pond feature located at the southern end of the site boundary. Prominent stands of Monterey cypress and eucalyptus are also present in the northwestern and central portions of the site. Site elevations range from 460 to 576 feet based on North American Vertical Datum (NAVD) 1988[1]. Scrub habitats are the dominant vegetation community along the east-facing backslopes that rise west of the Project site.

Adobe Gulch Creek Wetland Creation Site. The Adobe Gulch Creek Wetland Creation Site (Adobe Gulch) consists of a remnant homestead site and comprises a large open area immediately adjacent to Adobe Creek, surrounded by eucalyptus and cypress trees, and currently used by SFPUC for vehicle turnaround movements. Adobe Creek meanders along the northern portion of the site and crosses under the Old Cañada Road via a 36-inch culvert to the west of the existing heavy equipment turnout. The proposed habitats identified within the Project site would provide +0.4 acres of out-of-kind wetland creation mitigation, +0.2-acres of riparian woodland, and +1.3 acres of oak woodland creation. Site elevations range from 361 to 374 feet.

[1] All elevations referenced in this document are based on North American Vertical Datum (NAVD) 1988 unless otherwise noted.

Figure 1: SAS Project Site Locations



Sherwood Point Oak Restoration Site. The Sherwood Point Oak Restoration Site (Sherwood Point) is located at the southern terminus of Portola Road at the northern end of Lower Crystal Springs Reservoir (LCSR). The Sherwood Point site is currently comprised of an existing stand of non-native eucalyptus trees, 0.2 acres of needlegrass grassland, two small, fringe wetland features, and barren ground generally below the 280-foot mean sea level elevation. The habitat design concept for Sherwood Point proposes the reestablishment of oak woodland through the removal of exotic eucalyptus trees and establishment of seasonal wetlands along the fringe of LCSR. Site elevations range from 276 to 320 feet.

2 Goals and Objectives

SFPUC's goal and objectives for the project include the following:

- Maximize opportunities for the compensation of wetland impacts resulting from the implementation of the LCSR Dam project on lands owned by SFPUC.
- Demonstrate the feasibility of creating seasonal wetlands at the proposed locations by verifying that the localized hydrology satisfies the Army Corps of Engineer's (ACOE) hydrologic criteria[2] for defining wetlands.
- Complete limited roadway improvements to the existing access roads to facilitate hydrologic connections with the proposed wetland sites.
- Design the wetland features to minimize perennial ponding conditions and avoid the creation of bullfrog breeding habitat.

3 Project Site Design Concepts

This section includes discussion of the design concepts developed for the SAS Project sites.

3.1 Skyline Boulevard

The habitat improvements proposed at the Skyline Boulevard site would create up to 3.5-acres seasonal wetland at three separate locations: (1) a northern seasonal wetland, (2) a southwestern seasonal wetland, and (3) a southeastern seasonal wetland. These wetland features are illustrated conceptually in **Figure 2** and is described in more detail below.

3.1.1 Skyline Boulevard – North Wetland

A 1.8-acre northern seasonal wetland feature would be created within the lower elevations of the Skyline Boulevard site where an existing stand of Monterey cypress would be removed. Excavation depths at this wetland would be up to 10 feet with a majority of the excavation occurring within the western margin of the proposed wetland feature. Inundation depths within the wetland would average less than or equal to 2 feet with limited areas of deeper ponding of up to 3 feet. The wetland would be designed to match the existing grade of the adjacent wetland along the southern border of the proposed wetland, which ranges between 470 and 472 feet. The wetland may include an intermediate ponding area to minimize slope cuts and final slope lengths. Figure 3 is a generalized cross-section of the proposed wetland.

[2] The criteria for Wetland Hydrology (ACOE Manual, 1987) state, "Area is inundated or saturated to the surface for at least 5% of the growing season in most years." This equates to saturated or near saturated soil conditions near the surface for at least 14 consecutive days during the growing season in most years. Where defining soil saturation, the substrate may be considered saturated if the water table is within: (1) 0.5 ft of the surface for sands; or (2) 1.0 ft of the surface for all other soils (e.g. clay loams, sandy loams, etc.).

Figure 2: Skyline Boulevard Habitat Improvement Project – Proposed Conditions

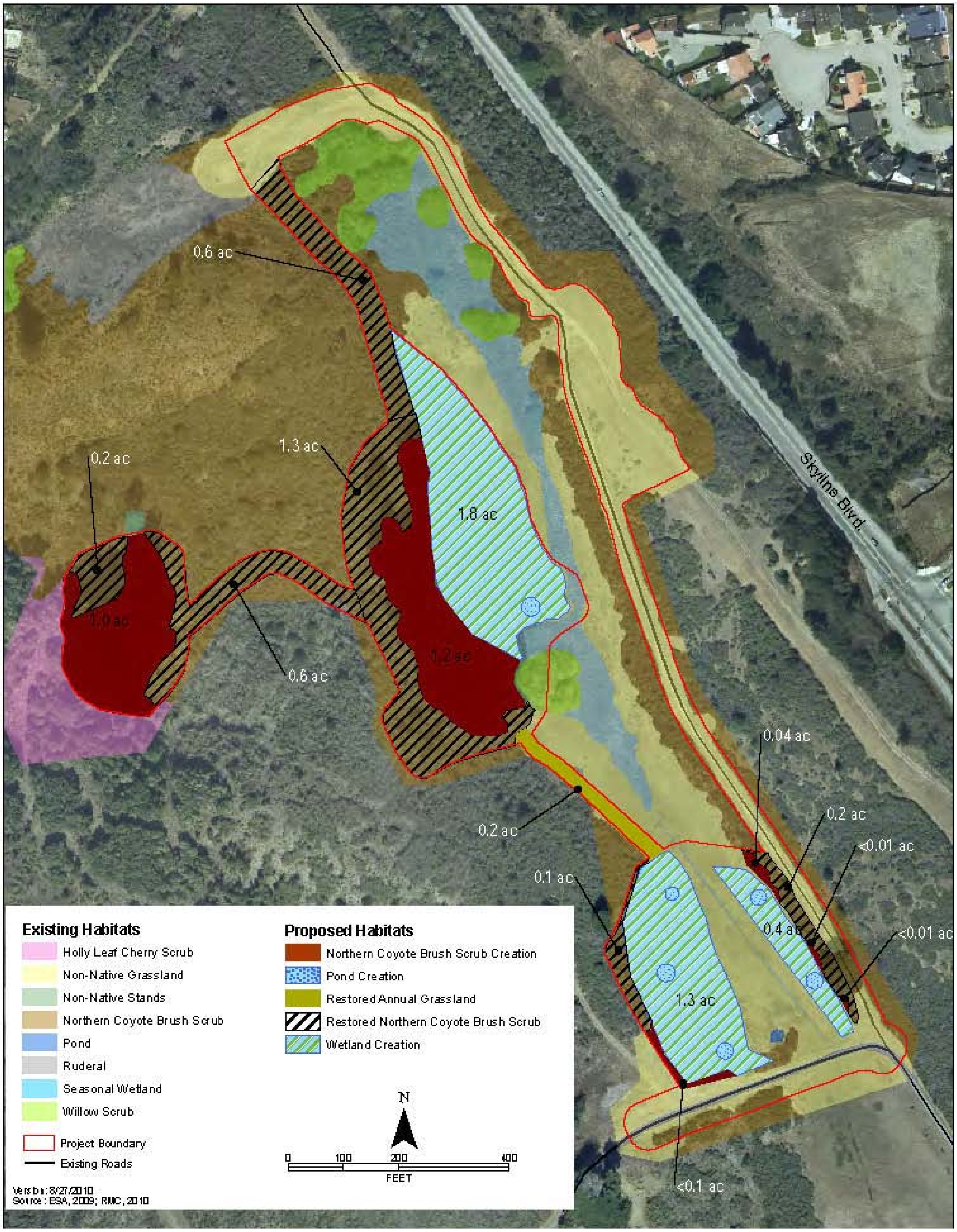
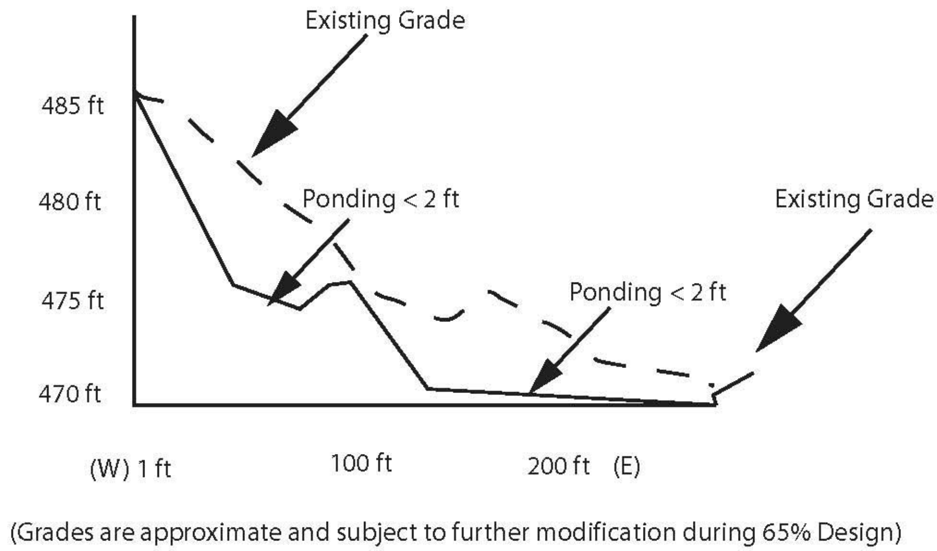


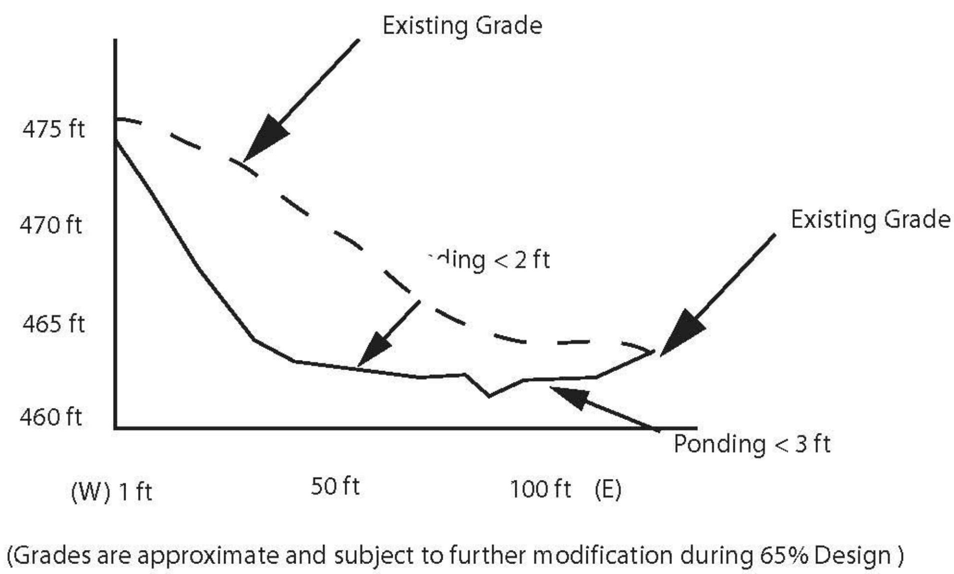
Figure 3: Cross-section Sketch of Skyline Boulevard - North Wetland



3.2 Skyline Boulevard – Southwest Wetland

The proposed southwestern wetland feature at Skyline Boulevard would be up to 1.3 acres. Water depths within this feature would average less than or equal to 2 feet. Deeper inundation would be facilitated in the pond locations to promote breeding habitat with water depths averaging less than or equal to 3 feet. The southwest wetland rim elevation would be placed at approximately 465 feet with a corresponding bottom elevation of 462-463 feet. **Figure 4** is a generalized cross-section of the proposed southwestern wetland.

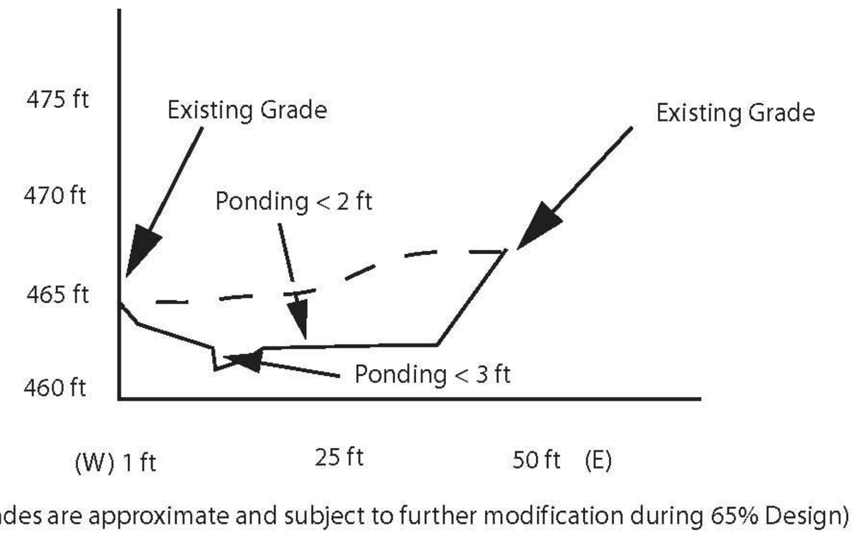
Figure 4: Cross-section Sketch of Skyline Boulevard - Southwest Wetland



3.3 Skyline Boulevard – Southeast Wetland

The proposed southeast wetland feature at Skyline Boulevard would measure 0.4 acres and would be designed to facilitate a combination of shallow and deeper inundation to promote habitat diversity. Water depths within this features would average less than or equal to 2 feet; deeper inundation would be facilitated in the pond locations to promote breeding habitat with water depths averaging less than or equal to 3 feet. The rim elevation for the Southeast Wetland would be placed at approximately 465 feet with a corresponding bottom elevation of 462 feet. **Figure 5** is a generalized cross-section of the proposed southeastern wetland.

Figure 5: Cross-section Sketch of Skyline Boulevard - Southeast Wetland



3.4 Adobe Gulch

One +0.4-acre seasonal wetland feature is proposed just east and south of Adobe Gulch Creek and its associated riparian zone. The seasonal wetland would contain a spillway elevation of 368 feet, which would flow into a small +0.2-acre riparian enhancement area to the north where excess flows would confluence with Adobe Gulch Creek along a degraded portion of its southern bank. The wetland feature would be graded to a bottom elevation of 366 feet with associated inundation of up to 2 feet. A small, less than 0.02-acre pond feature would be integrated into the northwestern corner of the seasonal wetland to provide deeper inundation levels of up to 3-feet. **Figure 6** illustrates the proposed habitat concept and **Figure 7** is a generalized cross-section of the proposed Adobe Gulch wetland.

Figure 6: Adobe Gulch Creek Wetland Creation – Proposed Conditions

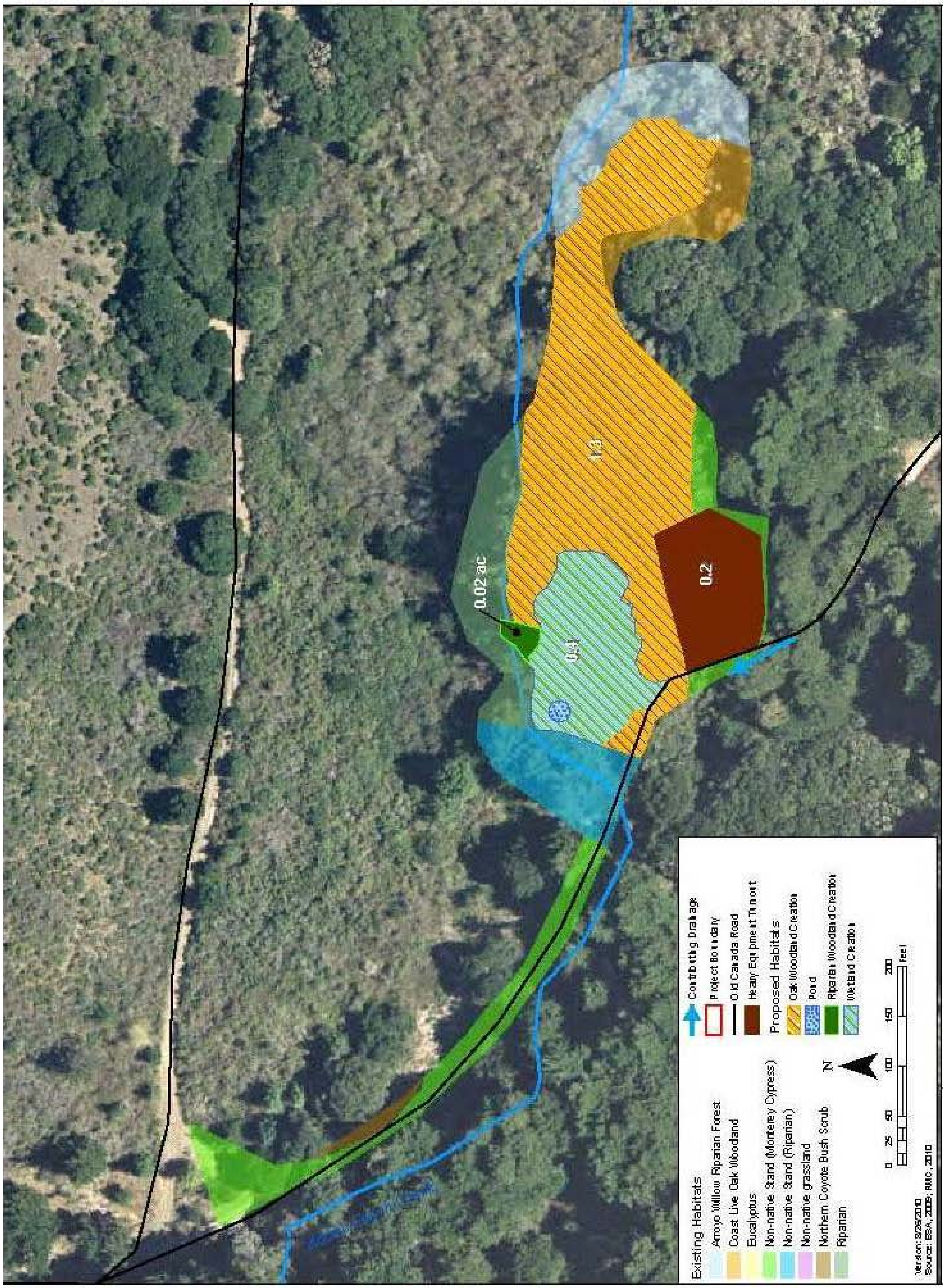
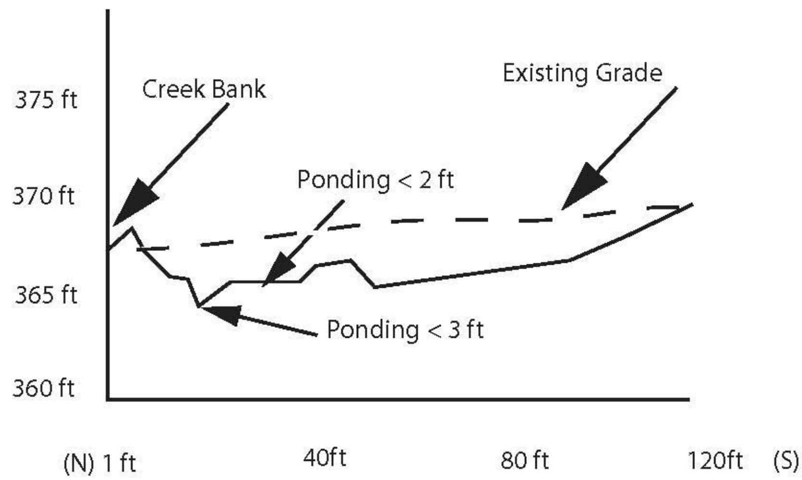


Figure 7: Cross-section Sketch of Adobe Gulch Wetland



(Grades are approximate and subject to further modification during 65% Design)

3.5 Sherwood Point

Restoration of the Sherwood Point site would also involve the creation of up to 0.4 acres of seasonal wetland along the immediate shoreline, which would be supplied through a combination of direct precipitation and seasonal inundation by LCSR. The actual size of the seasonal wetland creation area would be contingent on the anticipated local variation in the depth to bedrock. Soil depths along the middle and upper backslopes of Sherwood Point range between 4 to 5 feet to competent bedrock, based on limited investigation of the onsite soils, and therefore, are suitable for excavating a variable-width, shallow linear trough along the shoreline within the Sherwood Point site boundary. The trough would average 1.5 feet in depth with a corresponding bottom elevation of 284.5 feet. The water-side edge of the trough or rim would correspond with an elevation of 286 feet. The wetland floor would contain variable micro-topography to promote deeper inundation of up to 2 feet in limited locations. **Figure 8** illustrates the proposed habitat concept and **Figure 9** is an approximate cross-section of the proposed wetland.

Figure 8: Sherwood Point Oak Restoration – Proposed Conditions

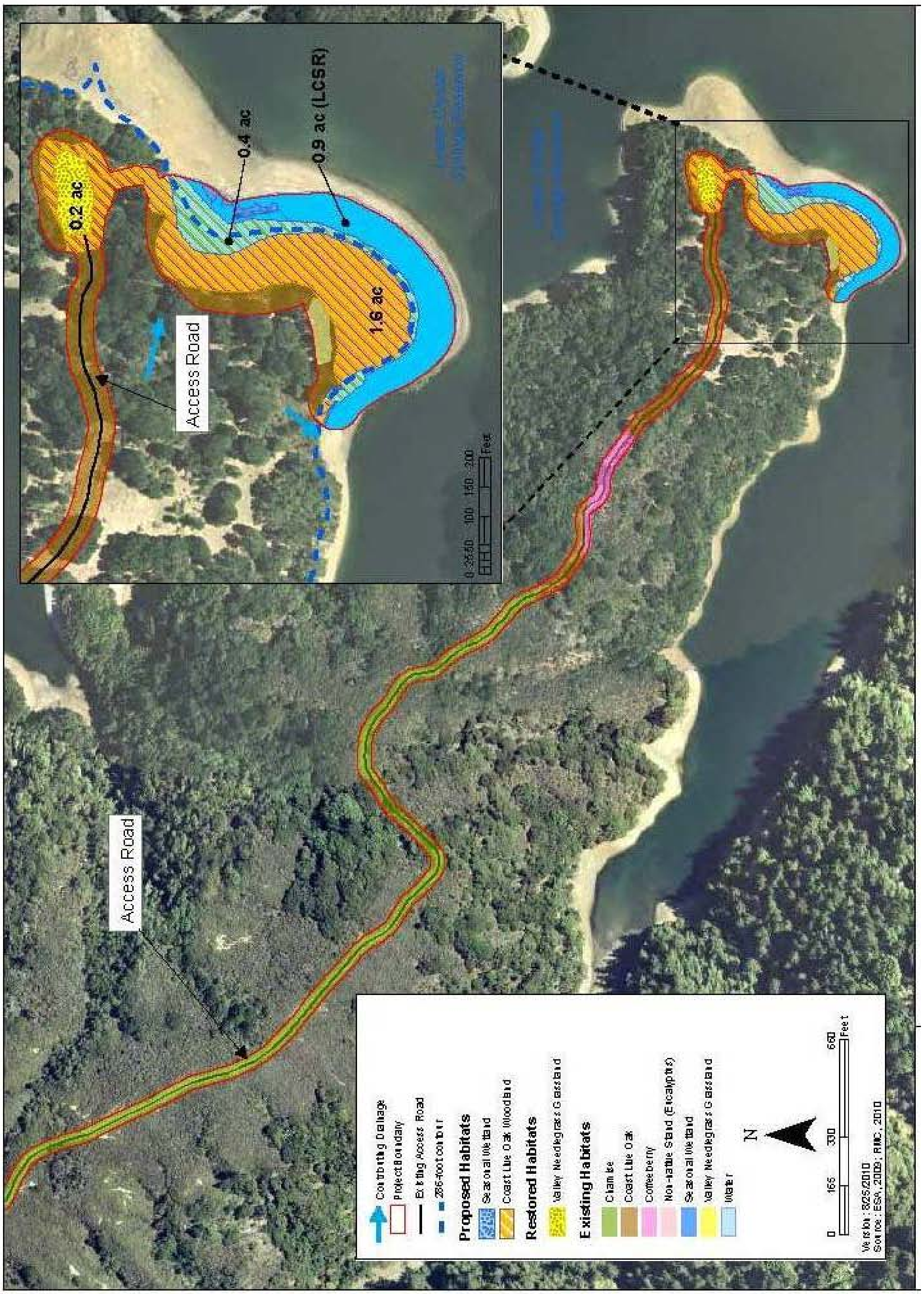
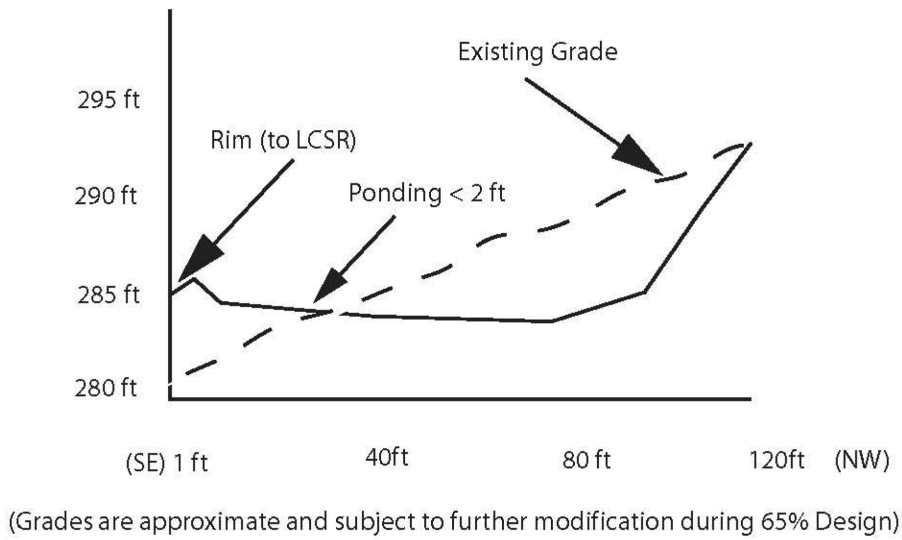


Figure 9: Cross-section Sketch of Proposed South Wetland



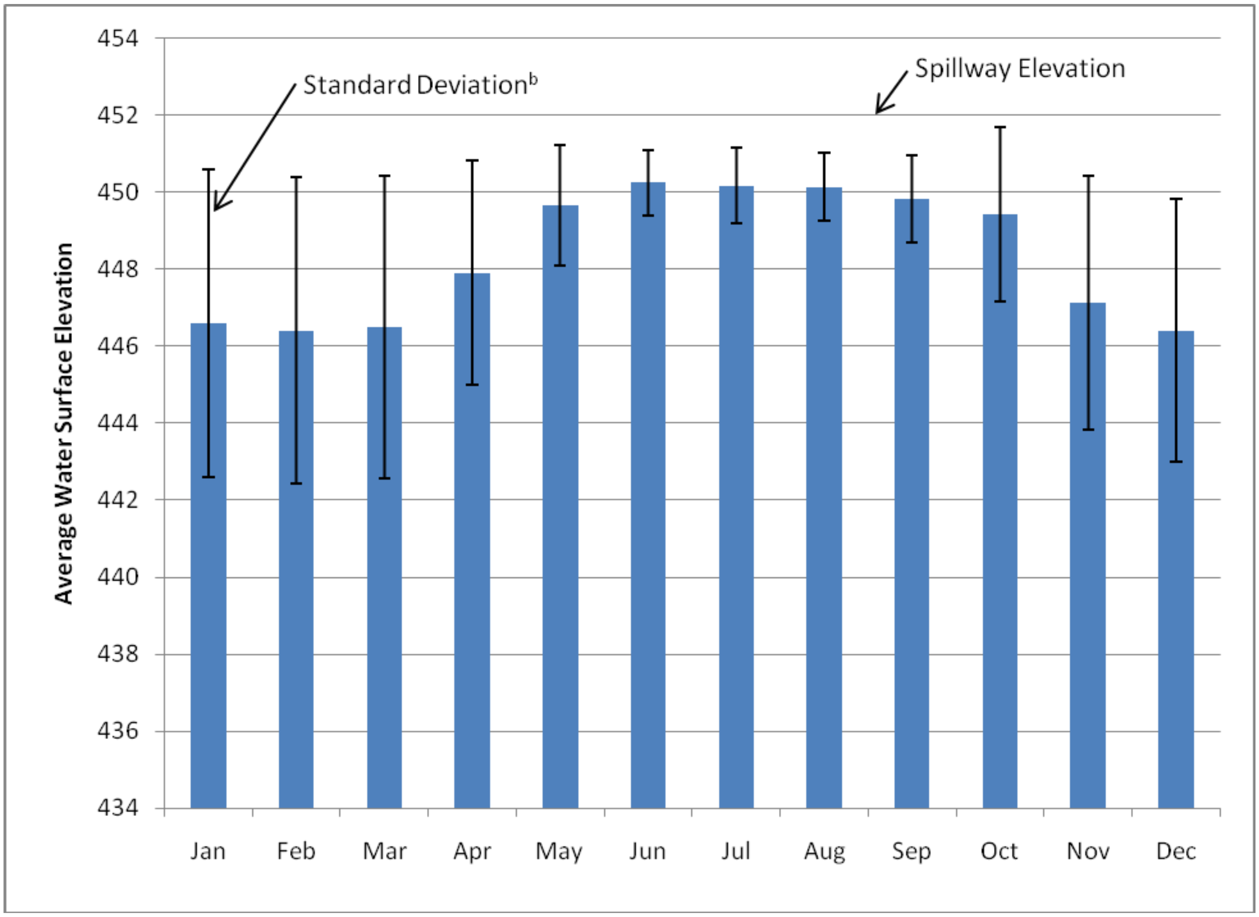
4 Existing Hydrologic Conditions

This section describes the existing hydrologic conditions for the proposed wetland sites. In general terms, the hydrology for the three wetland creation sites are driven by groundwater inflow from adjacent hillslopes and surface runoff from contributing drainage features.

4.1 San Andreas Reservoir

For each of the wetland creation sites at Skyline Boulevard, groundwater levels are expected to be supported by upslope groundwater contributions with the hydraulic gradient set by actual water levels in the San Andreas reservoir. **Figure 10** shows the average monthly water surface elevation of the reservoir based on the last 10 years of data along with the standard deviation. As shown, over the last ten years San Andreas Reservoir has typically maintained an average surface elevation of about 450 feet from June through August. Based on planned reservoir operations, this condition is expected to continue in the future.

Figure 10: San Andreas Reservoir Average Monthly Water Surface Elevation[a]



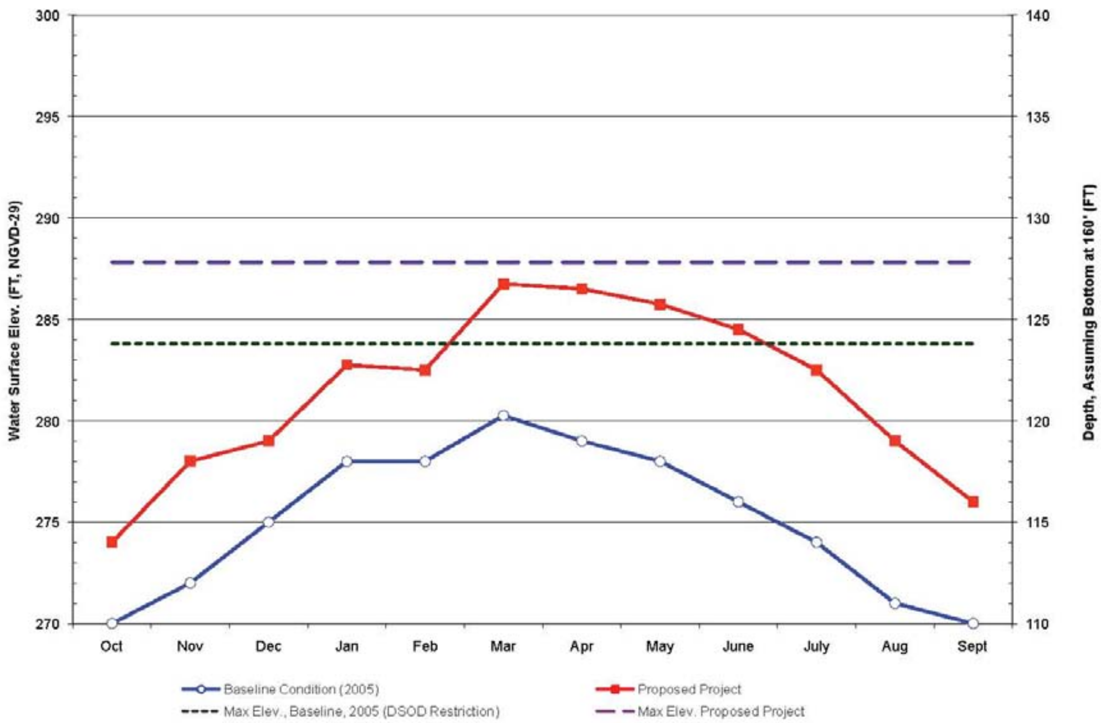
Footnotes:

a. Based on data from January 1, 2000 to February 28, 2010 from SFPUC - Water Enterprise.
b. Typically, 68% of days fall within the first standard deviation of the average, which is shown.

4.2 Lower Crystal Springs Reservoir

The current design for the Sherwood Point wetland creation component is based on the premise that reoperation of Lower Crystal Springs Reservoir (LCSP) will begin following completion of the current dam improvements project. Reoperation of the reservoir would allow for a maximum water elevation of 293 feet; up from the current 284 feet maximum water elevation. Based on these planned reservoir operations, the wetland grades proposed at Sherwood Point would take advantage of the drop in water levels during the May/June timeframe, depending on water year, which occurs on an annual basis. **Figure 11** shows the average monthly water surface elevation for LCSR under current conditions and for planned operations following completion of LCSR Dam improvements.

Figure 11: LCSP Average Monthly Water Surface Elevation, Existing and Proposed Operations



Footnotes:

a. Source: LCSR Dam Improvements Project Draft EIR, March 2010
b. Elevations are shown in NAVD-29 and may be converted to NAVD-83 by adding 2.7 feet to the elevations shown above.

4.3 Adobe Gulch Creek

Groundwater levels at the Adobe Gulch wetland creation site are expected to be controlled by surface water elevations within Adobe Gulch Creek, which straddles the western and northern edges of the proposed wetland. Based on this close proximity, the corresponding groundwater gradient within the wetland is expected to closely resemble conditions within the adjacent channel. At the southwest corner of the proposed wetland, the channel bed elevation is estimated at approximately 370 feet. At the northern edge of the wetland, where the wetland outfall channel confluences with Adobe Gulch Creek, the channel bed elevation is approximately 361 feet. For this analysis, water surface elevations were assumed to coincide with the channel bed elevations. Adobe Gulch Creek in the vicinity of the proposed wetland is a seasonal drainage feature with a drainage area of approximately 297 acres.

4.4 Delineation of Watershed Catchments

The watershed catchments contributing surface water runoff to the sites were delineated for each the SAS sites using ArcGIS, Spatial Analyst, and routing was evaluated to determine surface inflow contributions to the wetland sites. The watershed delineations were based on topographic data gathered using USGS Light Detection and Ranging (LIDAR) data from 2007 and supplemented by 1990 USGS National elevation Dataset (NED) data where the 2007 data had insufficient coverage. **Figures 12**, **13**, and **14** illustrate the delineated watersheds that intersect with each of the wetland areas for the Skyline Boulevard, Adobe Gulch and Sherwood Point sites, respectively.

Figure 12: Watershed Delineation Map – Skyline Boulevard

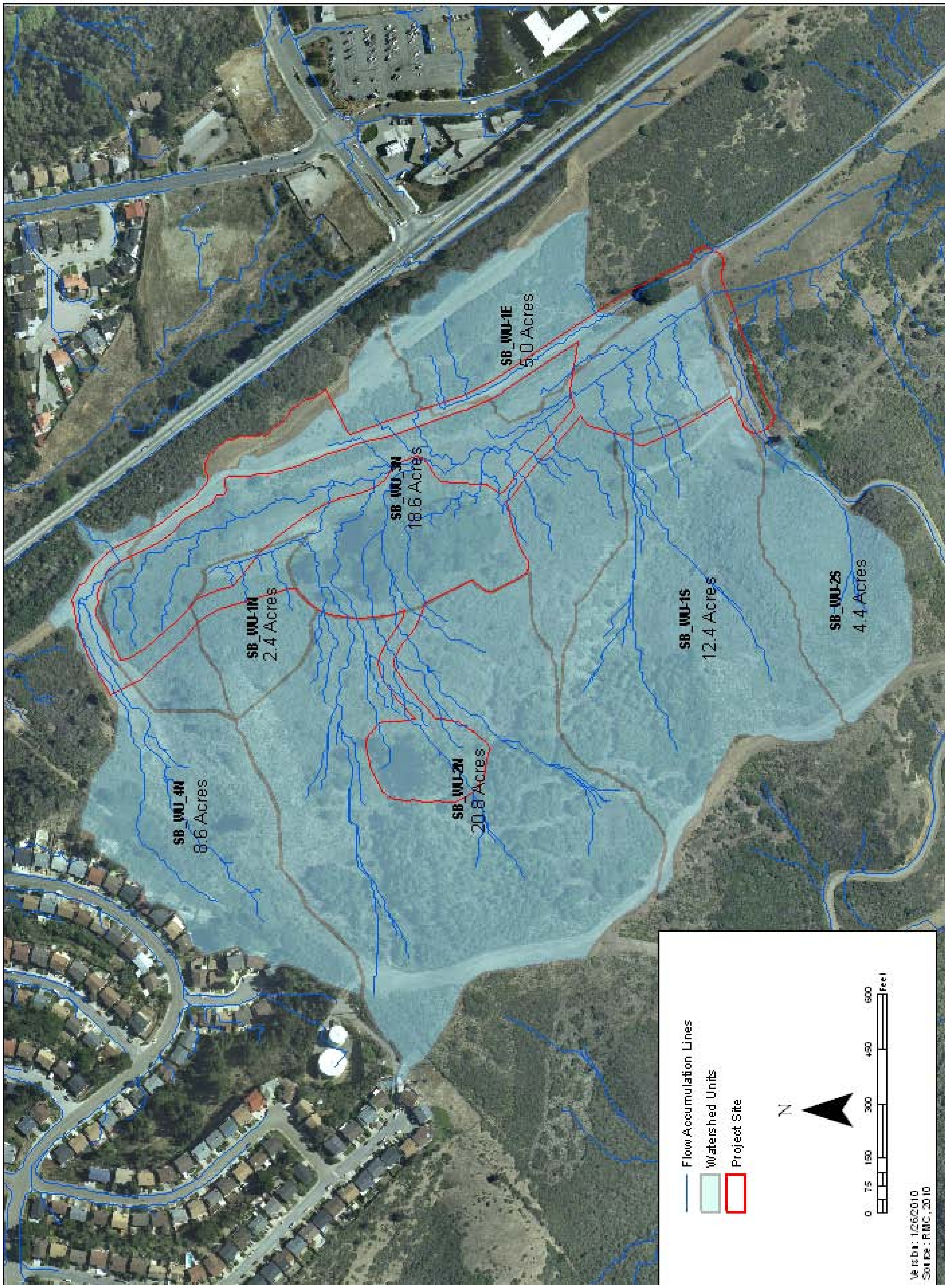


Figure 13: Watershed Delineation Map – Adobe Gulch

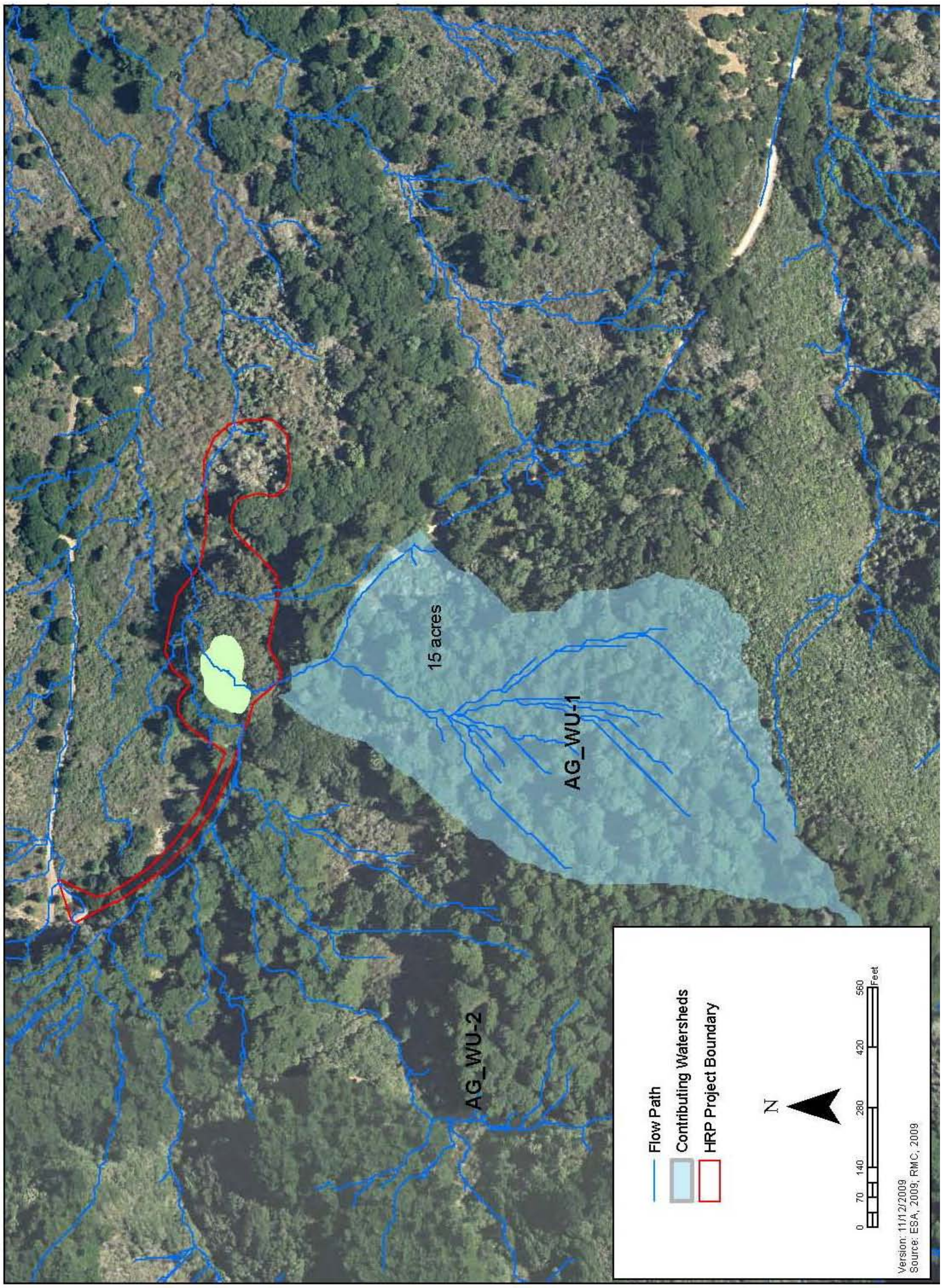
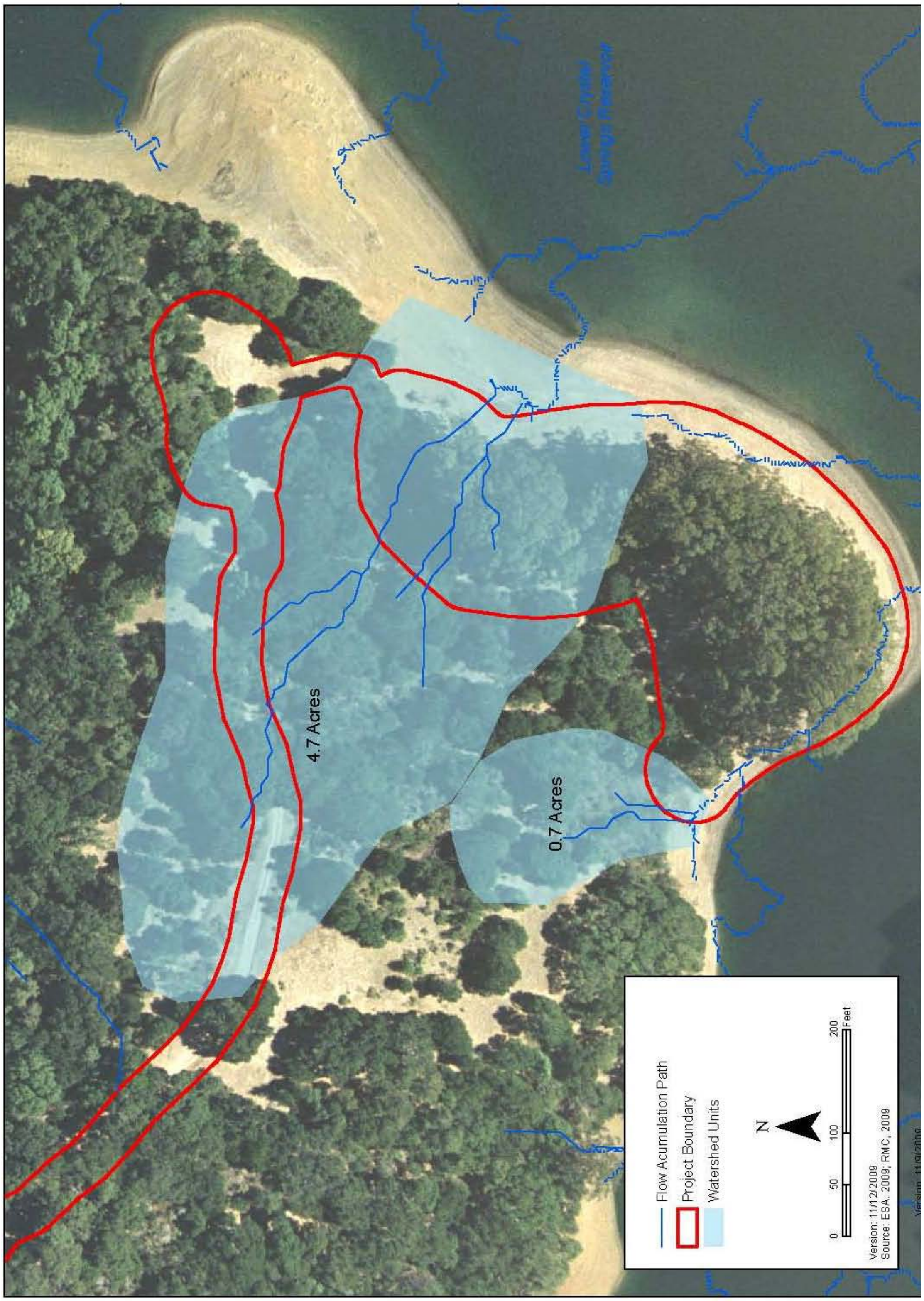


Figure 14: Watershed Delineation Map – Sherwood Point



At Skyline Boulevard, water supply for the northern wetland feature would be supplied from surface runoff originating from an approximately 21.6-acre watershed area via a combination of sheet flow and several, small, poorly-defined drainage features. The southwestern wetland receives runoff from an approximately 11.8-acre-watershed in a similar fashion, with surface water inputs coming from a combination of sheet and shallow-concentrated flow via a series of poorly-defined drainage channels. The southeastern wetland at Skyline Boulevard receives runoff from an approximately 5-acre watershed. To ensure flow is routed to the proposed southeastern wetland feature, a culvert would be constructed along the existing eastern access road to intercept runoff from a roadside ditch that parallels the road to the east and flows south.

At Adobe Gulch, an existing roadside ditch would be realigned to drain into the proposed wetland. This feature drains an approximately 15-acre watershed area and would be used as the primary water source for the seasonal wetland. This roadside ditch follows the western edge of the access road and currently discharges into Adobe Creek, west of the Old Cañada Road.

At Sherwood Point, water supply for the proposed fringe wetland would primarily be supplied by the reservoir. Beyond inundation from the reservoir, the wetland feature at Sherwood Point would also receive inflows from two small 4.7 and less than 1 acre watersheds; however, it is important to note that these features were not considered in the water balance calculation for the Sherwood Point wetland.

The characteristics of the watersheds where surface inflow would be the primary driver of wetland hydrology are summarized in **Table 1**. Routing was determined based on the surface interpolation of the LIDAR data and verified through site visits by RMC staff. Flow accumulation lines shown in **Figures 12**, **13**, and **14** are considered approximate, especially for small drainage areas under consideration that contain no defined drainage feature, and are intended to illustrate the approximate path of surface water runoff.

Table 1: Watershed Characteristics[a]

Watershed Unit	Routing	Area (acres)	Drainage Length (ft)	Average Slope (ft/ft)
SB_WU_1n	Skyline Blvd – North-central wetland	2.4	360	6.4%
SB_WU_1s	Skyline Blvd – Southwest wetland	12.5	840	8.7%
SB_WU_2s	Existing Wetland / Pond	4.4	700	
SB_WU_2n	Skyline Blvd – North-central wetland	21	1,250	8.6%
SB_WU_3n	Skyline Blvd – Existing wetland	18.8	1,900	5.6%
SB_WU_4n	Skyline Blvd – Existing wetland	8.6	1,600	18.6%
SB_WU_1e	Skyline Blvd – Southeast Wetland	5	610	2.7%
AG_WU_1	Drainage from road to Adobe Gulch wetland	15	1,300	3.3%

Footnotes:

a. Based on 2007 and 1990 USGS LIDAR data and RMC field visits.

4.5 Field Data Acquisition

Site specific soil sampling was completed by AEW Engineering (AEW) on June 24, 2010 at Skyline Boulevard and Adobe Gulch to assess groundwater levels, and the soil's suitability for wetland vegetation, excavation, slope stability, and use as fill in limited instances. Site specific sampling for Sherwood Point was completed on July 27, 2010. Piezometers were also installed for monitoring and data collection of seasonal fluctuations in groundwater depth ; although, given the timing of piezometer installation, limited data collection was completed. A map indicating the locations of the piezometer and soil tests is included in **Appendix A**. Test results data sheets are included in **Appendix A**.

4.5.1 Skyline Boulevard – North Wetland

AEW installed a piezometer (SB-PH-1) in the North Wetland area at an elevation of 479 feet that extends to a depth 6.5 feet below the existing grade – or elevation 472.5 feet. Groundwater was encountered at a depth of 5 feet below grade or elevation 474 feet. Initial soil sampling (SB-SH-1) was also completed by AEW down to a depth 8 feet below the ground surface (bgs). The upper 4 feet was comprised of a sandy clay loam that grades to a sandy clay below 4 feet to the bottom depth of sampling[3]. Further upslope to the west, soil depths become progressively shallower with soil depths measuring 3 feet to a bedrock contact in the eucalyptus removal area (SB-SH-2).

The 2008 Natural Resources Conservation Service (NRCS) Soil Survey maps indicate that the North wetland site is situated along the margin of soil map units Candlestick-Kron-Buriiburi complex, 30 to 75 percent slopes, and Candlestick variant loam, 2 to 15 percent slopes. A more detailed description of the soil map unit is provided in **Appendix A**. The Candlestick-Kron-Buriiburi complex mapping unit includes soils ranging from 18 to 36 inches to an unweathered sandstone. These soils are generally located on moderately steep to steep slopes and characterized by a sandy or gravelly loam within the upper 8 to 12 inches of the soil column that grades to a fine loam at depth. Areas along the floor of the valley trough are mapped as Candlestick loam variant. These soils are characterized by a loam within the upper 20 inches of the soil column that grades to a clay loam at depth. These soils can extend to depths of greater than 60 inches to a weathered or semi-weathered bedrock. The sample profile completed by AEW combined with the sieve analysis performed by Cooper Laboratory Testing suggests that soil materials within the North Wetland are representative of the Candlestick loam variant. For this reason, the saturated hydraulic conductivity (K_{sat}) values generated by NRCS for the Candlestick loam variant were considered appropriate for characterizing water movement within the soil profile for the North Wetland.

Due to the timing of the piezometer installation, groundwater sampling at SB-PH-1 was limited to the 6/28/2010 sampling event. In addition to this piezometer, Winzler and Kelly (W&K) installed a piezometer (W&K3) in 2008 (actual installation date not known) along the northern edge of the wetland at an elevation of 483 feet and down to a depth of 3 feet. This piezometer was sampled on September 22, 2009 and there was no observed standing water. This piezometer was also sampled on January 25, 2010, with groundwater recorded within 1 foot of the ground surface. Further to the south and in the vicinity of the southern edge of the North Wetland, groundwater was observed at or near the surface as shown in **Figure 15**.

Figure 15: Groundwater Observations at Skyline Boulevard on 1/25/2010 – North Wetland

[3] All soil characteristics are presented in the Sampling and Analyses Technical Memorandum prepared by AEW and included in Appendix A.

For the purposes of simulating the water balance for the North Wetland at Skyline Boulevard, it should be noted that groundwater levels were assumed to restrict infiltration during the months of November through May due to the presence of high groundwater, which was assumed to be at less than 1 ft bgs. For the month of June through October, groundwater levels were then assumed to drop to the base of the soil column, assumed to be 10 ft bgs for the purposes of the model, thereby allowing infiltration to occur. In reality, this sudden drop may actually not occur due to the continued presence of high groundwater levels through the early summer months. However, without actual groundwater data through the end of September and given the above-average rainfall experienced in the 2009-10 water year, a conservative approach was selected. Nevertheless, it is possible that the impact of infiltration on the results of the water balance may be overstated for the North Wetland under natural conditions.

4.5.2 Skyline Boulevard – Southwest Wetland

For the Southwest Wetland at Skyline Boulevard, AEW installed a piezometer at an elevation of 471 feet to a depth of 12 feet bgs or elevation 459 feet. Groundwater was encountered at 9 feet inches bgs on June 25, 2010 during the soil investigation, which roughly corresponds to an elevation of 463 feet. Similar to the North Wetland at Skyline Boulevard, groundwater was observed near or at the surface on January 25, 2010. Two shallow, piezometers (less than or equal to 3 feet) installed by W&K, were dry when sampled in September 22, 2010.

AEW also completed soil sampling at the site to a depth of 8 feet bgs with the substrate generally comprised of a sandy clay down to the depth of sampling. The 2008 NRCS Soil Survey indicates the North-Central Wetland site is comprised of soil map unit 111 (Candlestick loam variant), which is described in more detail for the Northern wetland and in **Appendix A**. The sample profile completed by AEW combined with the sieve analysis performed by Cooper Laboratory Testing suggests that soil materials within the southwestern wetland are representative of the Candlestick loam variant, but contain a higher fraction of sand and gravel below a depth of 8 feet. For this reason, the saturated hydraulic conductivity (K_{sat}) values generated by the NRCS for the Candlestick loam variant were considered appropriate for characterizing water movement within the soil profile for the Southwest Wetland. However, based on the higher fraction of sand, the higher end of the range was selected for K_{sat}.

4.5.3 Skyline Boulevard – Southeast Wetland

AEW installed a piezometer at the southeastern seasonal wetland site on June 25, 2010 at an elevation of 463 feet to a depth of 5 feet or elevation 458 feet. Groundwater was not observed at the time of sampling; however, standing water was observed at the surface in the vicinity of the Southeast Wetland on January 25, 2010. Figure 16 illustrates this observation and is believed to be partially attributed to a partial or complete obstruction within the culvert that drains the site under the southern access road.

Figure 16: Groundwater Observations at Skyline Boulevard on 1/25/2010

Initial soil sampling was also completed by AEW to a depth of 11 feet bgs with the soil comprised of a clayey sand with an increasing sand content with depth below 2 feet. The 2008 NRCS Soil Survey maps indicate this site is mapped as soil map unit 111 (Candlestick loam variant), which is described in more detail for the North Wetland and in **Appendix A**. The sample profile completed by AEW combined with the sieve analysis performed by Cooper Laboratory Testing suggests that soil materials within the Southeast Wetland are representative of the Candlestick loam variant with a clay content of greater than 40%. For this reason, the saturated hydraulic conductivity (K_{sat}) values generated by the Natural Resource Conservation Service (NRCS) for the Candlestick loam variant were considered appropriate for characterizing water movement within the soil profile for the Southeast Wetland.

4.5.4 Adobe Gulch Wetland

AEW installed a piezometer at an elevation of 370 feet to a depth of 15 feet bgs or 355 feet msl. Groundwater was encountered at 8 feet bgs on June 25, 2010 during the soil investigation, which roughly corresponds with an elevation of 362 feet. No additional groundwater data was collected for this site; however, given the close proximity of Adobe Gulch Creek, groundwater levels at this wetland site is expected to correlate closely with water levels in the adjacent creek, which range from 370 feet near the southwest corner of the wetland to 361 feet in the vicinity of the wetland outfall channel.

AEW also completed soil sampling at the site to a depth of 14.5 feet bgs with the substrate generally comprised of a clayey sand down to the depth of sampling. The 2008 NRCS Soil Survey indicates the Adobe Gulch Wetland site is mapped as the Alambique-McGarvey complex, 30 to 75 percent slopes, in the most recent release of the San Mateo County Soil Survey (2008). The sample profile completed by AEW combined with the sieve analysis performed by Cooper Laboratory Testing suggests that soil materials within the southwestern wetland are representative of the McGarvey series. For this reason, the saturated hydraulic conductivity (K_{sat}) values generated by NRCS for the McGarvey series were considered appropriate for characterizing water movement within the soil profile for the Adobe Gulch Wetland.

4.5.5 Sherwood Point Wetland

The Sherwood Point project site is located at the base of a shallow ridgeline that retreats into Lower Crystal Springs Reservoir. As the wetland hydrology at this location would be primarily driven by inundation from LCSR, no piezometer was installed at this site. However, given the presence of a competent lithic contact between 4 to 5 feet in depth, some perched groundwater inflow may be expected. Soils within the vicinity of the Sherwood Point project site are mapped as a Zeni-Zeni variant gravely loam on 30 to 75 percent slopes in the most recent release of the San Mateo County Soil Survey (2008). These soils are variable in depth, ranging from 20 to 40 inches, and grade to a highly weathered sandstone at depth. The sample soil profile completed by AEW combined with the sieve analysis performed by Cooper Laboratory Testing suggest that soil materials within the vicinity of the fringe wetland are representative of the Zeni-Zeni series. For this reason, the saturated hydraulic conductivity (K_{sat}) values generated by NRCS for the Zeni-Zeni series were considered appropriate for characterizing water movement within the soil profile for the fringe wetland.

5 Wetland Water Balance Methodology

RMC prepared a surface water balance for the SAS seasonal wetland sites to determine their suitability for wetland creation. The water balance was used to establish a hydroperiod[4] for each wetland feature by quantifying the combined inputs of surface water and groundwater and associated outflows. The water balance was performed on an hourly basis over a 40-year (1966-2006) simulation period using historical meteorological data. The basic water balance equation (Mitsch & Gosselink, 2007) is:

[4] A hydroperiod refers to the seasonal pattern of the water level within a wetland. This approximates the hydrologic signature of each wetland type.

$$\frac{\Delta V}{\Delta t} = P - ETo + S_i - S_o - G_i + G_o$$

Where:

$\frac{\Delta V}{\Delta t}$ = Change in volume of wetland during that time step

P = Direct Precipitation in the pond

ETo = Evapotranspiration

S_i = Surface water inflows (runoff)

S_o = Surface water outflows

G_i = Groundwater inflow

G_o = Groundwater losses (infiltration)

It was assumed that when the water depth exceeded the depth of the wetland, any excess water would leave as surface water outflow. The assumptions used for the water balance are described below.

5.1 Precipitation

Hourly precipitation data were obtained from the Environmental Protection Agency's (EPA) Better Assessment Science Integrating point & Non-point Sources (BASINS) software database for the simulation period at the San Francisco Weather Service Office located in South San Francisco near the San Francisco International Airport (SFO). This site was chosen for its proximity to the proposed wetland sites (approximately 3 miles from the sites), and the extended history of available data (greater than 40 years). The site data indicates that annual average rainfall is 20.9 inches/year. **Table 2** summarizes the average rainfall on a monthly basis.

Table 2: Monthly Average Precipitation (inches)[a]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4.58	3.86	3.09	1.37	0.36	0.12	0.02	0.05	0.16	0.96	2.56	3.78

Footnotes:
a. Based on hourly precipitation data obtained from the EPA's BASINS database for the San Francisco Weather Service Office located in South San Francisco near the SFO airport.

5.2 Evapotranspiration

Hourly potential evapotranspiration (PEVT) data were obtained from EPA's BASINS for the simulation period at a weather station located in Duboce Park in San Francisco. This dataset is calculated from daily Min/Max Temperature using Hamon's method (Hamon, 1961). The Duboce Park station was chosen due to the extended history of available data. The hourly data were then adjusted to match the annual average ETo data from the nearest CIMIS station, located in San Mateo County (Station #96, Woodside).

Table 3 indicates the average ETo on a monthly basis.

Table 3: Monthly Average Evapotranspiration (inches)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.12	2.53	3.64	4.41	5.57	6.15	6.20	5.63	4.80	3.86	2.59	2.05

Footnotes:
b. Based on hourly ETo data from EPA BASINS database for a weather station in Duboce Park in San Francisco, adjusted to the annual average ETO for CIMIS station #96 (Woodside) in San Mateo County.

5.3 Runoff

Surface inflow was developed using the Bay Area Hydrology Model (BAHM). BAHM incorporates calibrated model parameters for an internal modeling engine using the Hydrologic Simulation Program –

Fortran (HSPF) model. BAHM was sponsored by the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), Alameda Countywide Clean Water Program (ACCWP) and San Mateo Countywide Water Pollution Prevention Program (SMCWPPP) and developed by Clear Creek Solutions for use in the counties of Alameda, Santa Clara, and San Mateo. Calibration was performed based on Castro Valley Creek and Alameda Creek data in Alameda County. The modeling engine, HSPF, was developed by the United States Geological Survey (USGS) and uses meteorological records and watershed soil, slope and vegetation information to compute stream flow hydrographs. The model incorporates surface runoff, subsurface flow, evapotranspiration, and groundwater storage features to predict the overall surface flows from the watersheds.

No site-specific calibration could be performed, due to the rapid response of the hydrology for the small watershed areas under consideration. For this reason, results of the model were compared with the mean annual runoff estimates for this area generated by Rantz (USGS, 1974). Both the model and the USGS study estimated the mean annual runoff volume to be approximately 8-acre-inches/acre.

5.3.1 Watershed Slope Properties

The slope of the watershed was determined based on the LIDAR data provided by SFPUC. Slopes were separated into four categories and the area of each category was measured and entered into the runoff model. The categories used were: very steep (greater than 20%), steep (10%-20%), moderate (5%-10%), and flat (0-5%). The average watershed slope is indicated in **Table** 1. **Appendix B** includes a breakdown of the watershed areas by slope category.

5.3.2 Watershed Vegetation

Vegetation cover for each contributing watershed was determined by overlaying the delineated watersheds with the data produced by the California Department of Fish and Game's California Wildlife Habitat Relationships (CWHR) GIS dataset. The vegetation classification outputs from CWHR were then re-classified into the closest category provided in BAHM. The vegetation in the project area is summarized in **Appendix B**. In general, the vegetation communities present at Skyline Boulevard include a mix of annual grasslands, coyote brush scrub, and isolated stands of eucalyptus and Monterey cypress. Both the Sherwood Point and Adobe Gulch sites are comprised of non-native stands of eucalyptus; bordered by either oak woodland or annual grassland. The Adobe Gulch site also contains a prominent riparian corridor along Adobe Gulch Creek, which includes stands of Willow and Monterey Cypress.

5.3.3 Watershed Soil

Soil survey data produced by the Natural Resources Conservation Service (NRCS) for San Mateo County, Eastern Part, and San Francisco County, California (CA689, 2008) were used to characterize soil conditions within contributing watersheds. This data were used to determine the proportion of each hydrologic soil group within the contributing watershed. The hydrologic soil group is an identifier given to a soil which describes its ability to infiltrate water and produce water runoff. For example, hydrologic soil group designation A indicates that water infiltrates the soil column quickly, and thus does not produce much runoff, while hydrologic soil group designation D indicates that water infiltrates the soil column slowly, thus producing more runoff. In cases where more than one hydrologic soil group is applied to an individual soil map unit, a weighted average of the major hydrologic groups was used. The soil survey for the area is included in **Appendix B.** In general, the soil survey maps out most of the area as hydrologic soil group C or D.

5.4 Infiltration

It was assumed that three inches of soil moisture could be retained in the rooting layer (for the purposes of this report, this includes the upper 12 inches of soil) of the wetland before complete saturation. Groundwater flows out of the wetland were determined based on Darcy's law:

$$Q = AK_{sat}\frac{\Delta h}{L}$$

Where:

Q = flow rate (ft^3/s)

A= Flow area (ft^2)

K_{sat} = Hydraulic Conductivity (ft/s)

$\Delta h/L$ = hydraulic Gradient (ft/ft)

K_{sat} values for each wetland site were based on a combination of literature review and laboratory analysis (sieve analysis), which were reviewed to assess the suitability of applying K_{sat} values provided in the soil survey. Flow area is the perimeter of the wetland times the flow depth, which is either the depth to bedrock or the depth to the groundwater table. Given that all the wetland sites, with the exception of Sherwood Point, are a substantial distance from local reservoirs, e.g. San Andreas Reservoir and LCSR, a depth to bedrock of 10 feet was assumed for all the sites.

The hydraulic gradients downslope of the proposed wetlands were assumed to be the same as the average slope of the ground surface to the edge of San Andreas Reservoir or LCSR, or Adobe Gulch Creek, as applicable. It was assumed that during summer months, there are no groundwater contributions upslope of the reservoir, and the upslope hydraulic gradient was therefore zero. During winter months (January – March), upslope hydraulic gradients were estimated assuming groundwater levels identified in the field during January 2010 were representative of typical winter groundwater levels. The downslope hydraulic gradients for the each of the wetland sites are summarized in **Table 4**.

The effective summer infiltration rates for the wetland sites were modeled using the K_{sat} value provided in the Soil Survey to characterize existing conditions and $1x10^{-6}$ cm/sec to represented a compacted (or engineered) bottom. This approach was taken to not only characterize existing soil conditions, but also allow for an assessment of potential soil compaction and/or application of a clay-type liner on the wetland floor or within the subgrade (e. g. 6 inches of topsoil above a 6 inch-layer of clay compacted to greater than 90%). **Table 5** identifies the reference sources considered in selection of a K_{sat} value, which included a combination of field data, laboratory analysis results, and literature.

Table 4: Proposed Wetland Hydraulic Gradients

Wetland Site	Elevation (ft)	Distance to Reservoir (ft)	Downslope Gradient
Skyline Blvd. - North Wetland	471[a]-473[b]	1,700[a] – 2,300[b]	1.2%
Skyline Blvd. - Southwest Wetland	463[a]-465[b]	1,000[a] – 1,400[b]	1.3%
Skyline Blvd. – Southeast Wetland	463[a]-465[b]	1,000[a] – 1,400[b]	<1%
Adobe Gulch Wetland	361[a]-368[b]	40[a]-140[b, c]	5%
Sherwood Point Wetland	284.5-286	~20	7.5%

Footnotes:

a. At the upslope edge of the proposed wetland.
b. At the downslope edge of the proposed wetland.
c. Distance to Adobe Gulch Creek

Table 5: Saturated Hydraulic Conductivity Values Considered for the Water Balance

RANGE IN PERMEABILITY VALUES	SOURCE
$1.0x10^{-4}$ cm/sec to $1.0x10^{-6}$ cm/sec	AEW Draft TM; Freeze and Cherry, 1979
$1.4x10^{-4}$ cm/sec to $4.0x10^{-4}$ cm/sec (0.198 in/hr to 0.567 in/hr)	Soil Survey, 2010 – Candlestick Loam, Zeni-Zeni, and McGarvey series
Impermeable to $3.4x10^{-4}$ cm/sec (0 to 0.5 in/hr)	National Engineering Handbook – K_{sat} values for soils with >15% clay; note the higher range occurs when the soil is no longer saturated.

6 Results

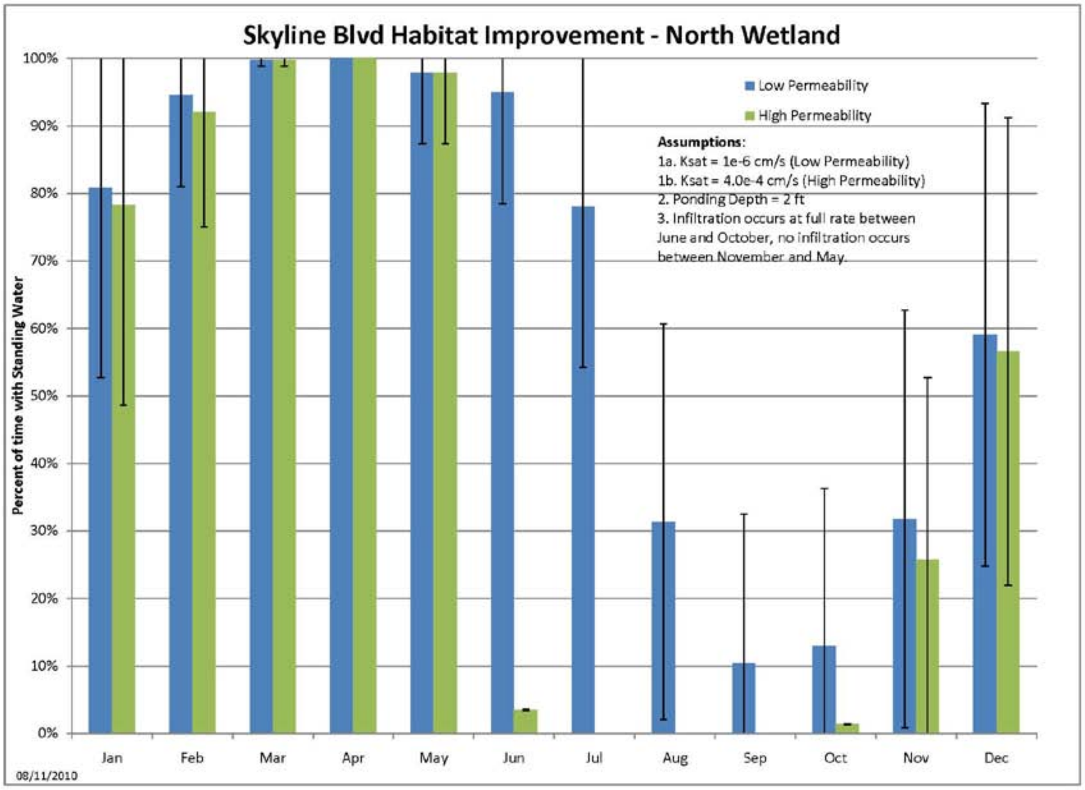
A water balance was used to identify the cumulative impact of the various inputs to and losses from the wetland sites over the course of a year. The inputs include direct precipitation, runoff, and groundwater inflow. Losses included direct outflow, evapotranspiration, and groundwater outflow (infiltration). The water balance is determined through an analysis of the average conditions that are expected and the basis of design for the system to support the growth of hydrophytic vegetation and limit undesirable conditions such as ponding throughout the year that would encourage bullfrog breeding. The water balance is a projection of average conditions based on 40 years of historic data and variations in annual climate conditions that are expected to occur, which may require an adaptive management approach.

6.1 Skyline Boulevard – North Wetland

The runoff model indicates average yearly runoff of approximately 12 AF from the contributing watersheds (SB_WU_1N and 2N) to the North Wetland site. The average percentage of time that the wetland is inundated by month is summarized in **Figure 16** for two scenarios; natural soil conditions and a engineered floor. The results of the water balance indicate that during average rainfall years, the wetland would stay wet through May and ponding would dry out in June, with the corresponding water levels lowering to below the ground surface. Isolated areas within the wetland that are deeper than one foot would remain inundated for a longer duration, but would be expected to dry out within the following month as a result of evaporation combined with infiltration. As shown in **Figure 16**, if the wetland floor is engineered (or compacted) to further restrict infiltration, ponding could be facilitated through the late summer months.

To verify that the new seasonal wetland would not dry out the existing wetland to the east, a separate water balance of the combined existing plus proposed wetland areas (North, Southwest, and Southeast combined) was also performed. For the combined model all the flow from watersheds SB_WU_1N, 2N, 3N, 4N, 1N, 2N, and 1N are expected to flow into the combined system. Based on field observations, RMC assumed that the existing wetland has a capacity to hold up to two feet of ponded water. The size of the combined wetland area (existing and proposed) was approximated at 6.2 acres. **Figure** 17 shows the average percentage of time the combined wetland complex would be inundated by month. Similar to the proposed wetland, the results of the water balance indicate that during average years, the combined wetland area would stay wet through May and dry out in June, with the corresponding water level lowering to below the ground surface.

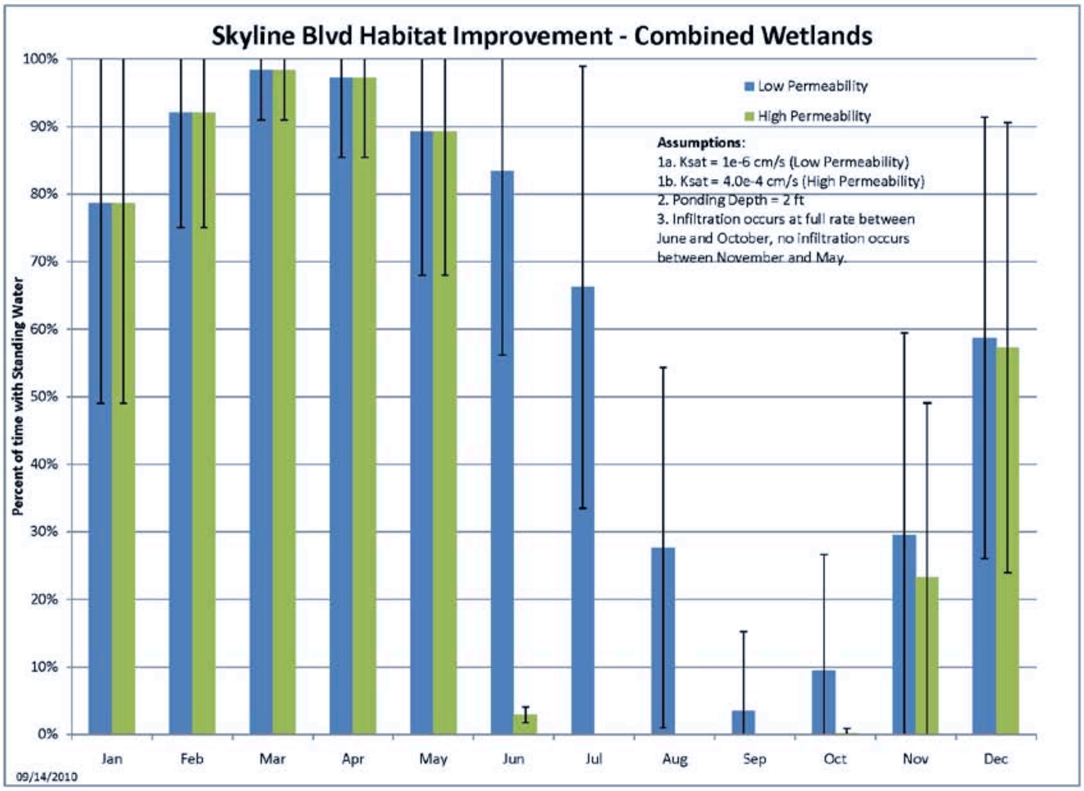
Figure 16: Skyline Boulevard - North Wetland Average Inundation



Footnotes:

a. Approximately 68% of years will fall within the first standard deviation of the average, which is shown.

Figure 17: Skyline Blvd Wetland Complex (Existing + Proposed) Average Inundation



Footnotes:

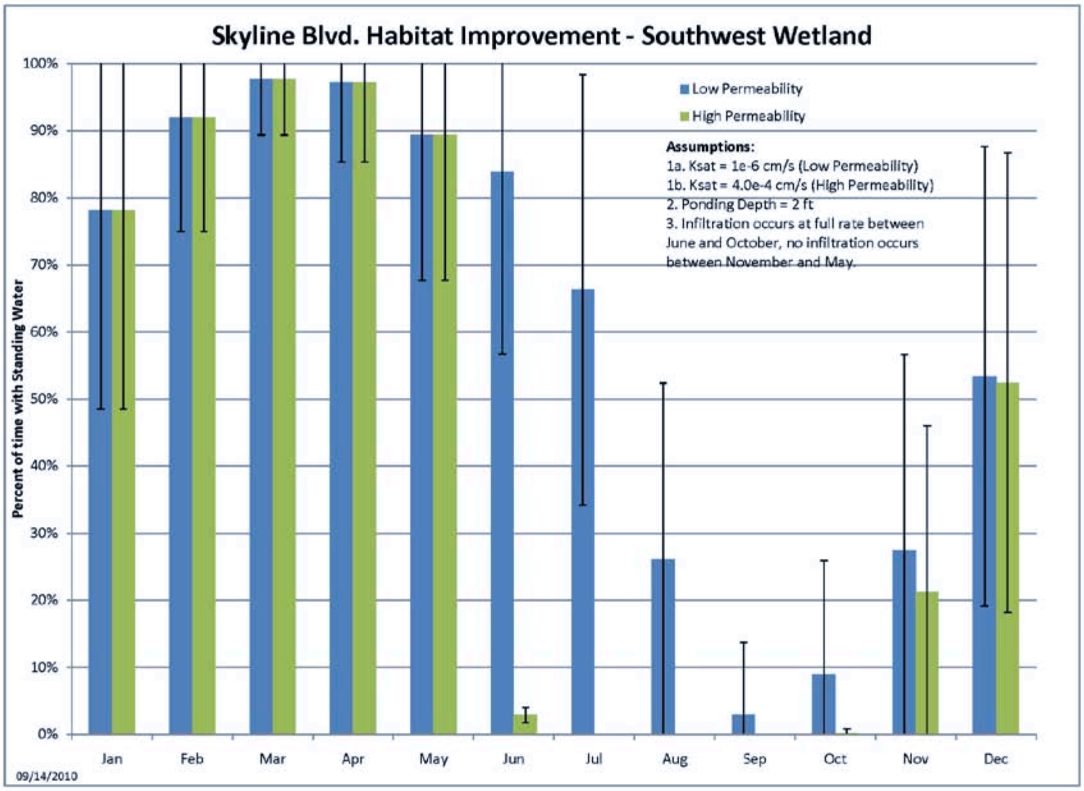
a. Approximately 68% of years will fall within the first standard deviation of the average, which is shown.

6.2 Skyline Boulevard – Southwest Wetland

The runoff model calculated average yearly runoff from the contributing upslope watershed at approximately 8AF. For a conservative estimate of inundation, it was assumed that the ponding depth was 2 feet; although actual depths would range from 1 to 3 feet. The results of the water balance at this site suggest a strong influence from soil infiltration under natural soil conditions, which influences whether the wetland would dry out in May or early June or stay wet through August.

RMC ran two scenarios for the water balance using a K_{sat} value of $4.0x10^{-4}$ cm/sec and $1.0x10^{-6}$ cm/sec to see how the duration of ponding is affected by the rate of infiltration. As shown in **Figure 18**, when applying a $4.0x10^{-4}$ cm/sec, the southwest wetland would be dry by the end of May in most years. This period of inundation would be on the low end of the time necessary for the formation of hydric soils and establishment of wetland plants. Just as important, drying in May would not provide the duration of inundation required to qualify for CRLF breeding habitat. For these reasons, the second scenario uses a lower permeability value of $1.0x10^{-6}$. The results of this model run are presented in **Figure 18**. As shown, with an engineered bottom, inundation could last into late August.

Figure 18: Skyline Boulevard – Southwest Wetland Average Inundation



Footnotes:

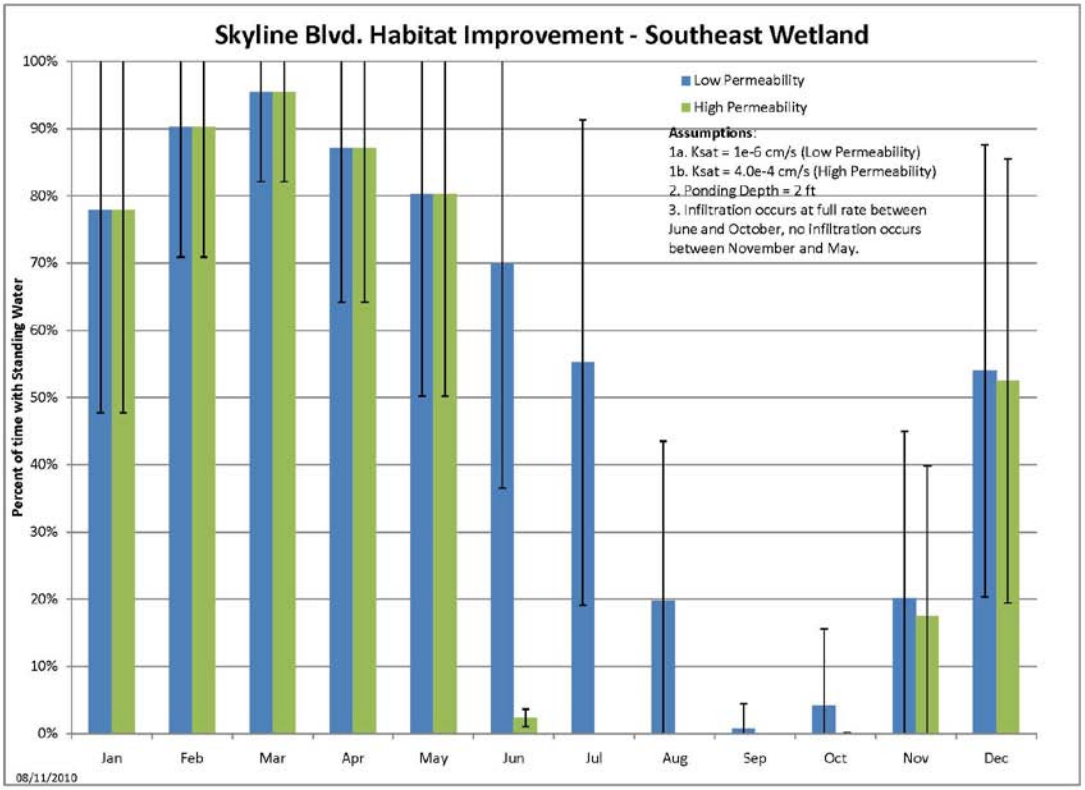
a. Approximately 68% of years will fall within the first standard deviation of the average, which is shown.

6.3 Skyline Boulevard – Southeast Wetland

The runoff model calculated average yearly runoff from the contributing upslope watershed at approximately 3.3 AF. For a conservative estimate of inundation, it was assumed that the ponding depth was 2 feet; although actual depths would range from 1 to 3 feet. Similar to the southwest wetland, the results of the water balance at this site suggest a strong influence from soil infiltration under natural soil conditions, which influences whether the wetland would dry out in May or stay wet through July.

As shown in **Figure 19**, when applying a 4.0×10^{-4} cm/sec, the Southeast Wetland would be dry by the end of May in most years. This period of inundation would be on the low end of the time necessary for the formation of hydric soils and establishment of wetland plants. Just as important, drying in May would not provide the duration of inundation required to qualify for CRLF breeding habitat. For these reasons, the second scenario uses a lower permeability value of 1.0×10^{-6}. The results of this model run are presented in **Figure 19**. As shown, with an engineered bottom, inundation could last into July or early August.

Figure 19: Skyline Boulevard - Southeast Wetland Average Inundation



Footnotes:

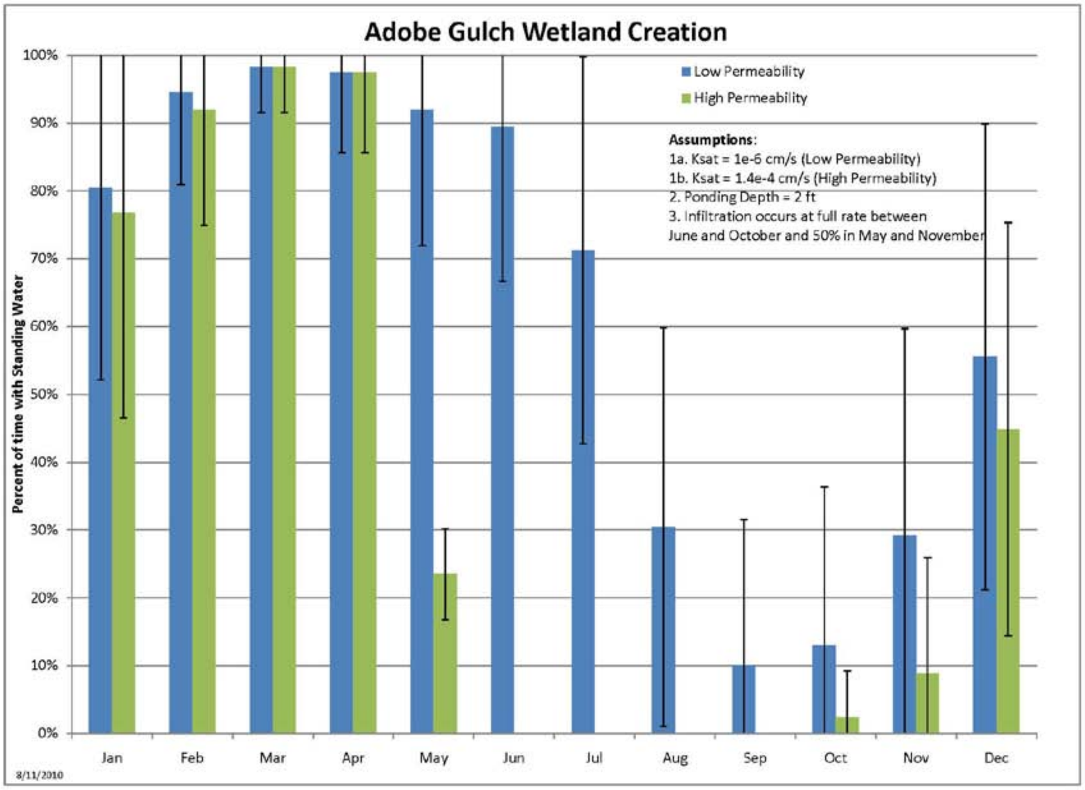
a. Approximately 68% of years will fall within the first standard deviation of the average, which is shown.

6.4 Adobe Gulch Wetland

The runoff model calculated average yearly runoff from the contributing upslope watershed at approximately 10 AF. For a conservative estimate of inundation, it was assumed that the ponding depth was 2 feet; although actual depths would range from less than 1 to 3 feet. Similar to the Skyline Boulevard wetland sites, the results of the water balance at this site suggest a strong influence from soil infiltration under natural soil conditions, which influences whether the wetland would dry out in May or stay wet into early August.

As shown in **Figure 20**, when applying a $4.0x10^{-4}$ cm/sec, the wetland would be dry by the middle of May in most years. This period of inundation would be on the low end of the time necessary for the formation of hydric soils and establishment of wetland plants. Just as important, drying in May would not provide the duration of inundation required to qualify for CRLF breeding habitat. For these reasons, the second scenario uses a lower permeability value of $1.0x10^{-6}$. The results of this model run are presented in **Figure** . As shown, with an engineered bottom, inundation could last into early August.

Figure 20: Adobe Gulch Wetland Average Inundation



Footnotes:

a. Approximately 68% of years will fall within the first standard deviation of the average, which is shown.

6.5 Sherwood Point Wetland

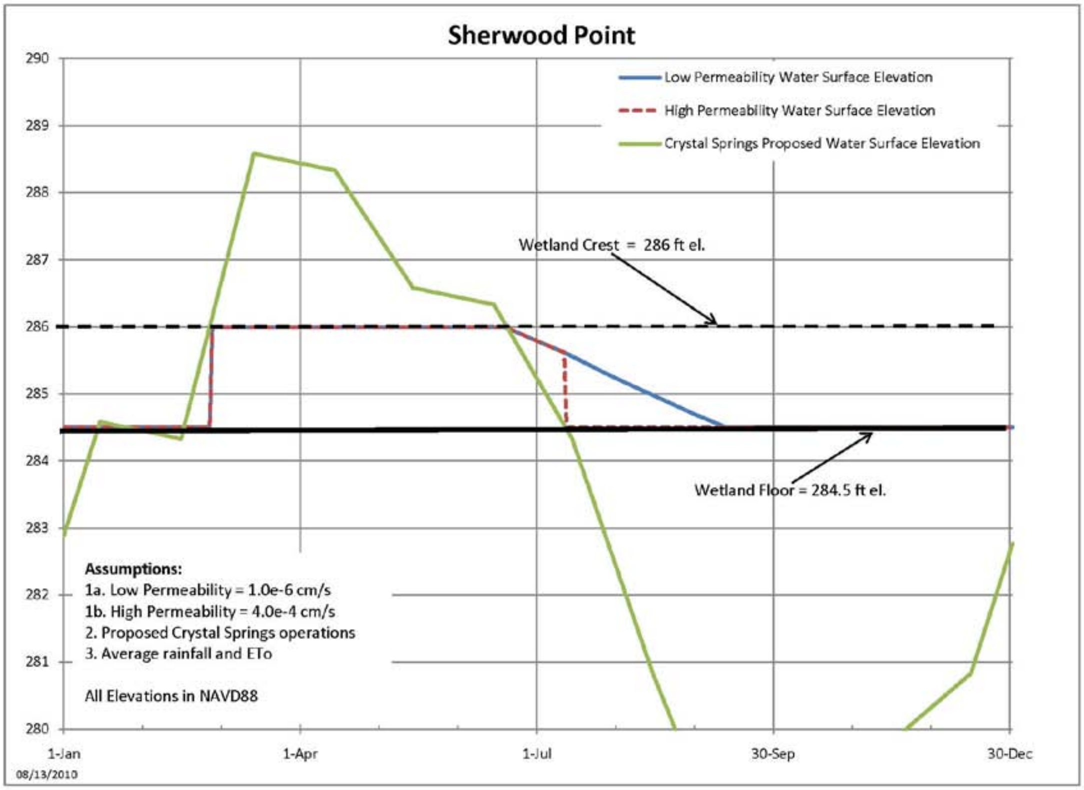
The fringe wetland site at Sherwood Point is anticipated to be supplied by reservoir inundation. The hydrologic basis for the design of this wetland is based on planned reservoir operations following the completion of the LCSR Dam improvements. **Table 6** summarizes the monthly difference between precipitation and evaporation that would need to be made up for with reservoir inundation to maintain ponding conditions.

Table 6: Monthly Water Deficit (Precipitation – Evapotranspiration) (inches)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.46	1.33	-0.55	-3.04	-5.21	-6.03	-6.18	-5.58	-4.64	-2.9	-0.03	1.73

As demonstrated in **Figure 21**, planned operations for LCSR are expected to rise above 286 feet sometime in March and then decline below 286 feet in June. The proposed wetland floor would be graded to below 284.5 feet with a outer rim elevation of 286 feet to allow for retention of reservoir water following the drop in water elevations. As shown in **Figure 21**, the period of inundation would be strongly influenced by the permeability of the wetland floor. As shown, without engineering of the wetland floor to slow infultration, water levels would quickly drain out of the wetland by middle or late July; whereas, if engineered, the wetland could maintain ponding conditions into late August.

Figure 21: Sherwood Point Wetland Average Inundation



7 Roadway Design and Flow Analysis

In contrast to the hydrologic considerations evaluated for the SAS wetland features, which focus on the range in hydrologic variability and averages, the design of roadway drainage facilities is typically more concerned with the peak flows that would need to be accommodated by the proposed structures. The Rational Method is one standard method used for estimating peak drainage discharges from small watersheds 330-acres or less in size per the recommendations of the State of California Department of Transportation (Caltrans). The basic assumptions for the Rational Method are:

- The maximum runoff rate at any design point is a function of the average rate of rainfall during the time of concentration.
- The maximum rate of rainfall occurs during the time of concentration, whereby the variability of the storm pattern is neglected.

The methodology described in the Caltran's Highway Design Manual, Section 819 (Department of Transportation, 2001) was used to evaluate design flows for the SB-WU-1S, 2S, 1N, 2N, 3N, 4N, and 1E and AG-WU-1 watersheds.

As currently proposed, the flows generated by watersheds AG-WU-1 and SB-WU-1E would be conveyed across via one or more, armored[5] rolling dips. In addition, flows generated from the combined watersheds of SB-WU-1S, 2S, 1N, 2N, 3N, 4N, and 1E would continue to be routed across and under the existing southern access road at the Skyline Boulevard site via an existing culvert or newly constructed, oversized culvert or C-space. Peak rainfall intensity was based on the flow length and time of concentration of the watershed.

7.1 Times of Concentration and Intensity

The rainfall intensity for the Rational Method depends on both the duration and return period of the storm event. The duration used in calculations is generally equal to the time of concentration, or the time when all of the drainage area's flow reaches the discharge point. Given the relatively small size of the contributing watersheds and an associated time of concentration less than the 10-minute minimum recommended in the Highway Design Manual, a minimum 10 minute duration was used. Rainfall intensity was determined by the return period-duration-specific (TDS) Regional Equation using the constants from the Santa Clara County Drainage Manual (Santa Clara County, 2007) and a mean annual precipitation of 20.9 inches. The TDS Regional Equation is given by:

$$x_{T,D} = A_{T,D} + (B_{T,D} MAP)$$

Where:

$X_{T,D}$ = precipitation depth for a specific return period storm and storm duration (inches)

T = Return Period (years)

D = Storm duration (hours)

$A_{T,D}$, $B_{T,D}$ = Constants from Santa Clara County Drainage Manual Table B-1 (see **Appendix C**)

MAP = Mean Annual Precipitation (inches)

Precipitation intensity (iT,D) is given by:

$$i_{T,D} = \frac{x_{T,D}}{D}$$

Rainfall intensities for the sites are summarized in Table 6.

Table 6: Rainfall Intensity

Year	Intensity for Watersheds SB-WU-1S, 2S, 1N, 2N, 3N, 4N, and 1E; AG-WU-1 (in/hr)
2 year	1.2
5 year	1.7
10 year	2.0
20 year	2.3
50 year	2.6
100 year	2.8

7.2 Design Flows

Peak flows were determined using the Rational Method equation:

[5] Consisting of concrete grass pavers.

$$Q = CIA$$

Where:

Q = Peak Flow (cfs)

C = Rational Method Runoff Coefficient

I = Rainfall Intensity (in/hr)

A = Drainage Area (acres)

Runoff coefficients were developed for each watershed using guidelines presented in Figure 819.2A in the Highway Design Manual (see **Appendix C**). The coefficients applied for the drainage estimates for each site and results of the analysis are presented in T**able 7**.

Table 7: Peak Flows for Various Rainfall Events

Year	AG-WU-1 (cfs)	SB-WU-1N (cfs)	SB-WU-2N (cfs)	SB-WU-3N (cfs)	SB-WU-4N (cfs)	SB-WU-1S (cfs)	SB-WU-2S (cfs)	SB-WU-1E (cfs)
C-Factor	0.41	0.37	0.38	0.3	0.37	0.38	0.4	0.3
Area (ac)	15	2.42	20.8	7.0	3.9	12.5	4.4	5
2 year	4.2	1.1	9.9	9.7	5.4	**6.0**	**2.2**	**1.9**
5 year	5.7	1.5	13.7	11.3	6.2	**8.2**	**3.0**	**2.6**
10 year	6.6	1.8	15.9	14.5	8.0	**9.6**	**3.5**	**3.0**
20 year	8.5	2.3	20.5	17.4	9.7	**12.3**	**4.6**	**3.9**
100 year	10.3	2.8	24.7	19.8	11.0	**14.8**	**5.5**	**4.7**

8 Limitations of the Analysis

RMC took advantage of the efficiencies offered by BAHM in terms of the readily available meteorological data and calibrated runoff for generating the hydrographs. As BAHM's calibration was performed for other watersheds in the Bay Area, no site specific calibration was deemed necessary. A comparison of peak flows generated by BAHM with those calculated by the rational method indicate that BAHM predicts a significantly higher peak flow. It is believed that BAHM adequately estimates total runoff for the water balance, but the model is not believed to reliably estimate peak flows. As the average annual runoff volume is comparable to the average runoff estimated in the USGS study (Rantz, 1974), it was deemed that BAHM was suitable for the purpose of developing a wetland water balance.

The soil sampling conducted in support of the SAS project site(s) is limited in spatial extent and, therefore, may not detect subtle changes in bedrock lithology, soil stratigraphy, or macroporosity at each wetland site. Additionally, groundwater sampling is limited to a only a few data points collected in advance of the preparation of this report and, therefore, does not reflect the seasonal fluctuations in groundwater levels or multiple water years. For example, groundwater levels could remain higher at the North Wetland at Skyline Boulevard than assumed in the water balance, which assumed groundwater levels would lower and no longer prevent infiltration in June, thereby potentially contributing to longer periods of inundation through the summer months.

Based on the field and laboratory data collected for the wetlands sites combined with extensive literature review, a range of K_{sat} values were assessed in the water balance for the soil types present across the project site, which can generally be characterized by clayey surfaces that grade to a clay or sandy clay loam at depth. Permeability rates based on these sources for clay and clay loam materials indicate a broad range of hydraulic conductivities as described in **Table 5**. Following the application of different K_{sat} values, it was determined that soil permeability could have profound effects on the success of the wetlands. To assess the implications of this broad range in values, a permeability rate was selected to characterize existing conditions and a rate was chosen to represent the design conditions. A permeability rate of $4.0x10^{-4}$ cm/sec was applied to characterize natural soil conditions and a rate of $1.0x10^{-6}$ cm/sec was applied to characterize the design condition. As the field and lab testing were completed at discrete locations and involved some manipulation of the sample, and in the context of the significant range in results, both methods may not be representative of the overall conductivity at each site. Further, the application of a K_{sat} value from the soil survey for natural conditions may over-estimate drying.

Groundwater data was not regularly collected between during the 2009/10 water year since piezometers were not installed until June 25, 2010. As 2010 was a wet year, with significant late-season storms, there is significant uncertainty in groundwater behavior during average and drought years. Additional monitoring of groundwater levels during the summer months will be necessary to confirm the proposed groundwater levels. Likewise, groundwater levels at the Skyline Boulevard sites may not decline as rapidly as modeled for June; however, the current methodology provides a conservative estimate in the event that groundwater levels drop earlier in the season during normal and dry years.

9 References

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Appendices

Appendix A – Field Data and Soils Technical Memorandum

Appendix B – Soil Survey & Watershed Data

Appendix C – Rational Method Supporting Data

Appendix A – Field Data and Soils Technical Memorandum

Geotechnical Test Locations

Geotechnical Analysis Data Sheets

Soils Technical Memorandum prepared by AEW

Draft Technical Memorandum

Date : September 7, 2010

To : Suet Chau, RMC Water and Environment

From: Randall Young

Subject: Skyline Boulevard Habitat Improvements, Adobe Gulch Creek Wetland Creation, Sherwood Point Oak Restoration, and Skyline Quarry Wetland Restoration Geotechnical Investigation

Reference: 2010-001

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This technical memorandum presents the results of the geotechnical investigation conducted at Skyline Boulevard Habitat Improvements, Adobe Gulch Creek Wetland Creation, Sherwood Point Oak Restoration, and Skyline Quarry Wetland Restoration (SASS sites), within the San Francisco Public Utilities Commission's (SFPUC's) Habitat Reserve Program (HRP) in San Mateo County, California.

The primary objective of the field investigation is to collect site information to develop an understanding of the soil and groundwater conditions at the SASS sites for proposed construction for wetland creation design and habitat reserve.

1. Project Overview

The Peninsula Watershed Geotechnical Investigations Project (project) is planned by SFPUC in support of the proposed HRP located on SFPUC watershed land, in unincorporated San Mateo County. The proposed investigation was designed to collect site information on local watershed geologic and hydrologic conditions for the design and implementation of the HRP at the SASS sites.

The SFPUC's proposed HRP provides a comprehensive approach to mitigate for habitat (biological) impacts that are expected to result from implementation of the Water System Improvement Program (WSIP) facility improvement projects in the San Joaquin Valley, Alameda Creek watershed, and Peninsula watershed regions of the SFPUC water system. On the SFPUC Peninsula watershed region, the SFPUC proposes to implement 23 habitat improvement projects that would preserve, enhance, restore, and create a variety of the types of habitats that would be affected by construction and operation of multiple WSIP facility improvements. The SASS sites studied under this geotechnical investigation are four of the 23 habitat improvement projects.

2. Field Investigation

The geotechnical investigation conducted at the SASS sites included the following:

- Collection and analyses of soil samples; and
- Piezometer installations.

2.1. Permits and Pre-Construction Activities

The following permits and notifications were obtained prior to performing the work at the site:

- **SFPUC Access Permit** obtained by RMC Water and Environment (RMC) was approved on January 5, 2010; and

- **Subsurface Drilling Permit Application** was obtained by AEW Engineering, Inc. (AEW) from the San Mateo County Environmental Health (Permit 10-01419, approved on February 12, 2010).

In addition, notification was made to Underground Services Alert (USA) at least 48-hours prior to the start of the field sampling activities (USA Numbers: 0178936 and 0178897). A subsurface utility locator was contracted to conduct underground utilities clearance at each of the boring locations prior to actual field work.

Within two weeks prior to the field work, the soil boring and piezometer locations were marked in the field with wooden stakes and a SFPUC approved biologist (the Project Biologist) conducted pre-construction surveys at each location for biological resources. Prior to the start of the actual filed work, the Project Biologist provided AEW field personnel with training on the sensitive species present at the SASS sites.

2.2. SOIL SAMPLING AND PIEZOMETER INSTALLATIONS

This section presents the soil sampling and piezometer installation protocols at the SASS sites.

2.2.1. Skyline Boulevard Habitat Improvement

On June 24 and 28, 2010 AEW advanced four soil borings designated SB-SM-1, SB-SM-2, SB-SH-1, and SB-SH-2 for the purpose of collecting soil samples within three proposed pond creation/wetland creation areas and habitat creation area for Skyline Boulevard Habitat Improvement (Skyline Boulevard). The approximate locations of the borings are shown on Figure 1. Borings SB-SM-1 and SB-SM-2 were advanced by HEW Drilling Company using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. Borings SB-SH-1 and SB-SH-2 were collected using a manually operated hand auger. The soil borings were advanced to the following depths in the following four areas:

- SB-SM-1: Southwest Pond Creation Area to 11 feet bgs;
- SB-SM-2: Southeast Wetland Area to 11 feet bgs;
- SB-SH-1: Northern Seasonal Wetland Creation Area to 7.5 feet bgs; and
- SB-SH-2: Northern Coyote Brush Scrub Area to 3 feet bgs.

Soil samples for borings SB-SM-1 and SB-SM-2 were collected at 1.5 foot intervals to the total explored depths. The samples were collected using an 18-inch long California-modified split-spoon sampler. The material was transferred from the sampler into 1-gallon zip lock plastic bags and labeled. Immediately following soil sampling, chain-of-custody (COC) documentation was completed. The COC documentation included the following information:

- Project name and number;

- Project contact;
- Name of field samplers;
- Sample identification numbers;
- Sample date and time of collection;
- Sample matrix;
- Sample container type;
- Analyses requested;
- Turnaround time requested for analyses;
- Preservation of sample containers (if applicable);
- Name and address of analytical laboratory; and
- Comments if applicable.

The soil samples were transported to Soil & Plant Laboratory, Inc., San Jose, California (Soil & Plant) and Cooper Testing Laboratory (Cooper Testing) under proper chain-of-custody documentation for testing as presented in Table 1 below.

Soil borings SB-SH-1 and SB-SH-2 were advanced using a manually operated soil sampling auger kit equipped with a 3.25-inch diameter mud auger head, 4-foot extension rods and a "T" handle. Soil samples were collected at 1.5 foot intervals by extruding the material brought up in auger head and transferred it into zip lock plastic bags and labeled. Immediately following soil sampling, chain-of-custody (COC) documentation was completed. The COC documentation protocol was initiated as described above.

Lithologic descriptions of the material for the four borings were logged in the field in accordance with the Unified Soil Classification System (USCS) visual-manual procedures (ASTM D-2488-90). Boring locations SB-SM-1 and SB-SM-2 were backfilled with cement grout following completion of the soil sampling activities. Borings SB-SH-1 and SB-SH-2 were backfilled with bentonite pellets. Copies of the boring logs are included in Attachment A. Photographs of the boring locations are presented in Attachment B.

On June 24 and 28, 2010, three piezometers were installed within the proposed pond creation/wetland creation areas for Skyline Boulevard. The approximate locations of the piezometers are shown on Figure 1.

Two piezometers were installed within the proposed southwest and southeast pond creation/season wetland creation areas using the truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers and one piezometer was installed in the north seasonal wetland creation area. The piezometers were installed to the following depths in the following three areas:

- SB-PM-1: Southwest Pond Creation/Wetland Creation Area to 12 feet bgs;
- SB-PM-2: Southeast Pond Creation/Wetland Creation Area to 5 feet bgs; and
- SB-PH-1: Northern Pond Creation/Wetland Creation Area to 8 feet bgs.

The piezometers were constructed using 2-inch-diameter, schedule 40, polyvinylchloride (PVC) well casing and 0.020-inch machine-slotted well screen. Piezometers SB-PM-1, SB-PM-2, and SB-PH-1 were constructed using screen lengths of 7 feet, 3 feet, and 5 feet, respectively secured on the bottom with a slip cap. The piezometer was then completed using a blank section which extended approximately 2 to 3 feet above ground surface and fitted with a slip cap. After the casing was emplaced to the bottom of the borehole, granular filter pack material was poured into the annular space of the borehole. The filter pack consisted of Monterey #3 gradation sand, which was emplaced in the annular space to a level approximately 12 inches above the top of the screen interval. The piezometer was sealed using a 12-inch thick hydrated bentonite pellets overlying the filter pack followed by cement grout to the ground surface. The piezometer construction details are included in Attachment A. Photographs of the piezometers are presented in Attachment B.

2.2.2. Adobe Gulch Creek Wetland Creation

On June 23, 2010 AEW advanced one soil boring designated AG-SM-1 for the purpose of collecting soil samples within the proposed wetland creation area for Adobe Gulch Creek Wetland Creation (Adobe Gulch). The approximate location of the boring is shown on Figure 2. The boring was advanced by HEW Drilling Company using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. The boring was advanced to 15 bgs. Lithologic descriptions of the material were logged in the field in accordance with the Unified Soil Classification System (USCS) visual-manual procedures (ASTM D-2488-90). The boring location was backfilled with cement grout following completion of the soil sampling activities. A Copy of the boring log is included in Attachment A. Photographs of the boring locations are presented in Attachment B.

Soil samples were collected continuously at 1.5 foot intervals to the bottom of the boring. The samples were collected using an 18-inch long California-modified split-spoon sampler. The material was then transferred from the sampler into 1-gallon zip lock plastic bags and labeled. Immediately following soil sampling, chain-of-custody (COC) documentation was completed. The COC documentation was completed as described above for Skyline Boulevard. The soil samples were transported to Soil & Plant and Cooper Testing under proper chain-of-custody documentation for testing as presented in Table 1 below.

On June 23, 2010, one piezometer designated AG-PM-1 was installed within the proposed wetland creation area for Adobe Gulch. The approximate location of the piezometer is shown on Figure 2. The piezometer was installed using the truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers to a depth of 15 feet bgs. The piezometer was constructed using 2-inch-diameter, schedule 40, polyvinylchloride (PVC) well casing and 0.020-inch machine-slotted well screen. The piezometer was constructed using a 10-foot-long screen interval secured on the bottom with a slip cap. The piezometer was then completed using a blank section which extended approximately 2 feet above ground surface and fitted with a slip cap. After the casing was emplaced to the bottom of the borehole, granular filter pack material was poured into the annular space of the borehole. The filter pack consisted of Monterey #3 gradation sand, which was emplaced in the annular space to a level approximately 12 inches above the top of the screen interval. The piezometer was sealed using a 12-inch thick hydrated bentonite pellets overlying the filter pack followed by cement grout to the ground surface. The piezometer construction details are included in Attachment A. A photograph of the piezometer is presented in Attachment B.

2.2.3. Sherwood Point Oak Restoration

On July 22, 2010 AEW excavated three test pits designated SP-TP-1, SP-TP-2, and SP-TP-3 for the purpose of collecting soil samples, visual inspection of the overburden material, and depth to bedrock within the proposed seasonal wetland and coast live oak restoration areas for Sherwood Point Oak Restoration (Sherwood Point). The approximate locations of the test pits are shown on Figure 3. The test pits were dug using a SFPUC backhoe and operator. The test pits were dug to the following depths in the following three areas:

- SP-TP-1: Season Wetland Creation Area to 4.8 feet bgs;
- SP-TP-2: Coast Live Oak Woodland Area to 5 feet bgs; and
- SP-TP-3: Coast Live Oak Woodland Area to 4.8 feet bgs.

The final depths of the test pits were determined when the backhoe bucket could not easily scrape (rip) the subsurface material. At these depths, moderate strength bedrock was encountered at all three test pit locations. Once the test pit had been dug, soil horizons were identified and their boundaries were measured. A soil sample was collected within the identified soil horizons using the backhoe bucket to scrape the sidewall of the test pit at the target depth. The material was then immediately transferred from the sampler into 1-gallon zip lock plastic bags and labeled. Immediately following soil sampling, chain-of-custody (COC) documentation was completed. The COC documentation protocol was initiated as described above for Skyline Boulevard. The soil samples were transported to Soil & Plant and Cooper Testing under proper chain-of-custody documentation for testing as presented in Table 1 below.

Lithologic descriptions of the material for the three test pits were logged in the field in accordance with the Unified Soil Classification System (USCS) visual-manual procedures (ASTM D-2488-90). Copies of the test pit logs are included in Attachment A. Photographs of the test pits are presented in Appendix B Once the soil samples were collected, the test pits were backfilled with the excavated material and compacted using the backhoe bucket.

2.2.4. Skyline Quarry Wetland Restoration

On June 23 and 24, 2010 AEW advanced three soil borings designated SQ-SM-1 through SQ-SM-3 for the purpose of collecting soil samples within two proposed wetland creation areas and a riparian creation areas for Skyline Quarry Wetland Restoration (Skyline Quarry). The approximate locations of the borings are shown on Figure 4. The borings were advanced by HEW Drilling Company using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. The soil borings were advanced to the following depths in the three areas:

- SQ-SM-1: South Wetland Area to 18.2 feet bgs;
- SQ-SM-2: Riparian Area to 12.5 feet bgs; and
- SQ-M-3: North Wetland Area to 10.3 feet bgs.

Lithologic descriptions of the material were logged in the field in accordance with the Unified Soil Classification System (USCS) visual-manual procedures (ASTM D-2488-90). The boring locations were backfilled with cement grout following completion of the soil sampling activities. Copies of the boring logs are included in Attachment A. Photographs of the boring locations are presented in Attachment B.

Soil samples were collected at 1.5 foot intervals until bedrock was encountered. The samples were collected using an 18-inch long California-modified split-spoon sampler. The material was then transferred from the sampler into 1-gallon zip lock plastic bags and labeled. Immediately following soil sampling, chain-of-custody (COC) documentation was completed. The COC documentation protocol was initiated as described above for Skyline Boulevard. The soil samples were transported to Soil & Plant and Cooper Testing under proper chain-of-custody documentation for testing as presented in Table 1 below.

TABLE 1 LIST OF CHEMICAL AND PHYSICAL ANALYSES

SOIL SAMPLE INFORMATION			CHEMICAL ANALYSES							PHYSICAL ANALYSES
Sample ID	Sampling Location	Sample Depth (ft)	Inorganic Anions (1)	Specific Conductivity (1)	Organic Carbon (1)	pH (1)	ICP Metals (1)	Boron (1)	Metals (1)	Sieve Analyses
SB-SM-1-3'	SB-SM-1	3.0'-4.5'	√	√	√	√	√	√	√	NA(2)
SB-SM-1-8'	SB-SM-1	8.0'-9.5'	√	√	√	√	√	√	√	√
SB-SM-2-0'	SB-SM-2	0.0'-1.5'	√	√	√	√	√	√	√	NA
SB-SM-2-3'	SB-SM-2	3.0'-4.5'	√	√	√	√	√	√	√	√
SB-SM-2-5'	SB-SM-2	5.0'-6.5'			√	√	√	√	√	NA
SB-SH-1-0'	SB-SH-1	0.0'-1.5'	√	√	√	√	√	√	√	NA
SB-SH-1-3'	SB-SH-1	3.0'-4.5'	√	√	√	√	√	√	√	√
SB-SH-1-4.5'	SB-SH-1	4.5'-6.0'	√	√	√	√	√	√	√	NA
SB-SH-2-0'	SB-SH-2	0.0'-1.5'	√	√	√	√	√	√	√	NA
AG-SM-1-0'	AG-SM-1	0.0'-1.5'	√	√	√	√	√	√	√	NA
AG-SM-1-3'	AG-SM-1	3.0'-4.5'	√	√	√	√	√	√	√	NA
AG-SM-1-4.5'	AG-SM-1	4.5'-6.0'	√	√	√	√	√	√	√	√
SQ-SM-1-1'	SQ-SM-1	1.0'-2.5'	√	√	√	√	√	√	√	NA
SQ-SM-1-7'	SQ-SM-1	7.0'-8.5'	√	√	√	√	√	√	√	NA
SQ-SM-1-15'	SQ-SM-1	15.0'-16.5'	√	√	√	√	√	√	√	√
SQ-SM-2-4'	SQ-SM-2	4.0'-5.5'	√	√	√	√	√	√	√	NA
SQ-SM-2-8'	SQ-SM-2	8.0'-9.5'	√	√	√	√	√	√	√	√
SQ-SM-3-1'	SQ-SM-3	1.0'-2.5'	√	√	√	√	√	√	√	NA
SQ-SM-3-4'	SQ-SM-3	4.0'-5.5'	√	√	√	√	√	√	√	NA
SP-TP-1-4.5'	SP-TP-1	4.5' (56")	√	√	√	√	√	√	√	√
SP-TP-2-0.5'	SP-TP-2	0.5'-1.0' (6" to 12")	√	√	√	√	√	√	√	NA
SP-TP-3-0.5'	SP-TP-3	0.5' (6")	√	√	√	√	√	√	√	NA

Notes:

1. See Soil & Plant Laboratory reports for a complete list of analyses and analytical methods.
2. NA = not analyzed.

2.3. SOIL BORING AND PIEZOMETER SURVEY

An elevation and location survey of the completed soil boring and piezometer locations was conducted by SFPUC within 24 hours of completing the field work as required by the County drilling permit. Survey data included both the ground surface elevations and horizontal coordinates for the boring and piezometers. In addition, elevation surveys of the top-of-casing on the north side of the piezometers were performed. Since test pits do not require a drilling permit from San Mateo County, surveys of the test pits was not conducted. A summary of the survey data is presented below in Table 2.

TABLE 2 SURVEY DATA

BORING/PIEZOMETER ID	NORTHING	EASTING	ELEVATION
SKYLINE BOULEVARD HABITAT IMPROVEMENT			
SB-SM-1	2052676.950	5998850.949	468.99- ground surface
SB-SM-2	2052744.121	5999052.779	463.10- ground surface
SB-SH-1	2053534.089	5998403.457	479.32- ground surface
SB-PM-1	2052696.653	5998840.542	468.54- ground surface 471.77- top of casing
SB-PM-2	2052813.779	5999008.442	463.91- ground surface 465.34- top of casing
SB-PH-1	2053543.628	5998400.521	479.73- ground surface 482.01- top of casing
ADOBE GULCH CREEK WETLAND CREATION			
AG-SM-1	2008543.543	6024136.971	369.44- ground surface
AG-PM-1	2008526.223	6024121.204	370.25- ground surface 372.29- top of casing
SKYLINE QUARRY WETLAND RESTORATION			
SQ-SM-1	2012266.689	6021933.999	392.04
SQ-SM-2	2012416.040	6021938.171	384.99
SQ-SM-3	2012423.793	6021693.563	390.35

Note: Survey data is based on state plane coordinates with an epoch of 2007 using the Leica network. The derived orthometric heights are based on the Geoid 09 model.

3. FINDINGS

A summary of the soils encountered and hydrologic findings at each of the SASS sites is presented below.

3.1. SUBSURFACE CONDITIONS

3.1.1. Skyline Boulevard Habitat Improvement

The findings of the soils and hydrologic characteristics are presented in four subareas: (1) Southeast Wetland creation Area; (2) Southwest Wetland creation Area; (3) Northern wetland Creation Area; and (4) Coyote Brush Scrub Creation Area. The approximate extent of these subareas are presented in figure 1.

Southeast Wetland Area

The soils encountered in soil boring SB-SM-2 consisted primarily of alluvium material within the Southeast Wetland area. The alluvium consisted of clay with varying amounts of sand to the maximum explored depths of 11 feet below ground surface. For boring SB-SM-2, clay with minor amounts of sand was observed from the ground surface to a depth of approximately 3 feet bgs. This upper clay horizon graded into a lower horizon characterized by an increase in sand content to the total explored depth of 11 feet bgs. According to the physical testing laboratory reports presented in Attachment C, the clay unit at 3 feet bgs contained 68.6 % clay and silt, 28.9% sand and 2.5% fine gravel. Sand stringers consisting of approximately ¼-inch thick fine sand were observed between 8 to 9.5 feet bgs.

Groundwater was not initially observed in boring SB-SM-2 during the field exploration. Groundwater was measured following the installation of the piezometer SB-PM-2 in July 2010. Depth to groundwater was measured from the north side of the top of piezometer casing using an electronic water level instrument. A summary of the water level measurements is presented below in Table 3.

Southwest Wetland Area

The soils encountered in the soil boring SB-SM-1 consisted primarily of native silt and clay with varying amounts of sand and gravel to the maximum explored depth of 11 feet bgs within the Southwest Wetland Area. For boring SB-SM-1, an upper clay horizon with minor amounts of sand was observed from the ground surface to a depth of approximately 4 feet bgs. This upper clay horizon graded into a lower horizon characterized by an increase in sand and clay content to a depth of approximately 8 feet bgs. This unit graded into a lower sand unit consisting of fine to coarse grain sand and fine gravel with silt and clay to the total explored depth of 11 feet bgs. According to the physical testing laboratory reports presented in Attachment C, this lower unit contained 49 % sand, 20.6% clay and silt, and 30.4% gravel.

Groundwater was not initially observed in boring SB-SM-2 during the field exploration. Groundwater was measured following the installation of the piezometer SB-PM-1 in July 2010. Depth to groundwater was measured from the north side of the top of piezometer casing using an electronic water level instrument. A summary of the water level measurements is presented below in Table 3.

Northern Wetland Area

The soils encountered in the soil boring SB-SH-1 consisted primarily of alluvial silt and clay with varying amounts of sand and gravel to the maximum explored depth of 7.5 feet bgs within the Northern Wetland Area. For boring SB-SH-1, an upper horizon characterized organic clay was observed from the ground surface to a depth of approximately 2.5 feet bgs. This upper organic clay horizon graded into a lower horizon characterized by an increase in silt content to a depth of approximately 5 feet bgs. According to the physical testing laboratory reports presented in Attachment C, this unit contained 36.3 % silt, 30.2% clay and 32% fine sand with 1.5% gravel. This unit graded into a lower sand/clay unit consisting of fine to coarse grain sand to the total explored depth of 7.5 feet bgs.

Groundwater was observed approximately 4 feet bgs in boring SB-SH-1 during the field exploration. Groundwater was measured following the installation of the piezometer SB-PH-1 in July 2010. Depth to groundwater was measured from the north side of the top of piezometer casing using an electronic water level instrument. A summary of the water level measurements is presented below in Table 3.

Northern Coyote Brush Scrub Creation

The soils encountered in the soil boring SB-SH-2 consisted primarily of native clay with minor amounts of sand to the maximum explored depth of 3 feet bgs within the Northern Coyote Brush Scrub Creation Area. Bedrock was encountered at 3 feet bgs at this location which resulted in terminating the boring at that depth. Groundwater was not observed in boring SB-SH-2 during the field exploration.

3.1.2. Adobe Gulch Creek Wetland Creation

The soils encountered in soil boring AG-SM-1 consisted primarily of native silt and clay overlying sandstone bedrock within the proposed Adobe Gulch Creek Wetland Creation. The material consisted of silt and clay with varying amounts of sand to the approximate depth of 10.5 feet bgs. For boring AG-SM-1, an increase in sand content and fine gravel was observed from 8.5 feet to 10.5 feet bgs. According to the physical testing laboratory reports presented in Attachment C, the material at 4.5 feet bgs contained 60.2 % clay and silt, 32.7% sand and 7.1% fine gravel. Deep to moderately weathered sandstone bedrock was encountered at 10.5 bgs. The strength of the bedrock was weak and friable. Partial decomposition of the bedrock was observed with many fractures filled with clay and silt to the total explored depth of 14.5 feet bgs.

Groundwater was initially observed in boring AG-SM-1 approximately 8.5 feet bgs during the field exploration. Groundwater was measured following the installation of the piezometer AG-PM-1 in July 2010. Depth to groundwater was measured from the north side of the top of piezometer casing using an electronic water level instrument. A summary of the water level measurements is presented below in Table 3.

3.1.3. Sherwood Point Oak Restoration

The soils encountered in the three test pits consisted primarily of native sandy clay overlying sandstone bedrock within the proposed Sherwood Point Oak Restoration. The material consisted of clay and silt with varying amounts of sand and gravel overlying sandstone bedrock. Depth to bedrock was encountered at the following depths at the three test pit locations:

- SP-TP-1: 4.5 feet below ground surface;
- SP-TP-2: 4.5 feet below ground surface; and
- SP-TP-3: 1.75 feet below ground surface.

At these depths moderately weathered sandstone bedrock was encountered. The strength of the bedrock was moderate. Partial decomposition of the bedrock was observed at the immediate bedrock surface with many fractures filled with sand and clay. According to the physical testing laboratory reports presented in Attachment C, the bedrock material at 4.5 feet bgs in SP-TP-1 contained 37.3 % clay and silt, 38.7% sand and 24% gravel. Groundwater was not encountered in the three test pits during the field exploration.

The depths of the test pits were dictated by the ability to rip the material. In SP-TP-1 and SP-TP-2, the backhoe was able to continue digging deeper approximately 6 to 8 inches after encountering the weathered bedrock surface to total depths 5 feet bgs. In SP-TP-3 weathered bedrock was shallower (20" below ground surface), however, the backhoe was able to dig approximately 3 feet deeper to a total explored depth of 4' 8". For the three test pits, the excavation was terminated when the backhoe was using all its wait (leveraging off the ground) to rip the soil.

3.1.4. Skyline Quarry Wetland Restoration

The soils encountered in soil borings SQ-SM-1, SQ-SM-2, and SQ-SM-3 consisted primarily of quarry spoils generated from the former quarry operations overlying sandstone bedrock. The quarry spoils consisted of sand and gravel with varying amounts of clay. According to the physical testing laboratory reports presented in Attachment D, the quarry spoils at 15 feet bgs from SQ-SM-1 contained 19.9 % clay and silt, 41.3% sand and 38.8% gravel. Sandstone bedrock was encountered beneath the quarry spoils at each of the boring locations at the following depths:

- SQ-SM-1: 17 feet below ground surface;
- SQ-SM-2: 12 feet below ground surface; and
- SQ-SM-34 feet below ground surface.

At these depths moderately weathered sandstone bedrock was encountered. The strength of the bedrock was moderate and became more competent at each boring location to the total explored depths. Groundwater was not observed in the three boring locations during the field exploration.

TABLE 3 PIEZOMETER WATER LEVELS

PIEZOMETER ID	DATE	DEPTH TO WATER (FT BELOW TOP OF CASING)	DEPTH TO WATER (FT BELOW GROUND SURFACE[1])
SB-PM-1	7/22/10	8.83	-5.60
SB-PM-2	7/22/10	5.29	-3.86
SB-PH-1	7/22/10	2.84	-0.56
AG-PM-1	7/22/10	11.93	-9.89

Notes:

1. Depth to water below ground surface was calculated using survey data presented in Table 2.

3.2. REVIEW OF SOIL PROFILE INFORMATION FROM NATIONAL RESOURCES CONSERVATION SERVICE

The National Resources Conservation Service (NRCS) soil survey was reviewed to obtain further useful information on the soil profile and its properties within the SASS sites. Soil profile information was gathered using the NRCS on-line Web Soil Survey and then mapping the San Andreas Wetlands Creation area as the Area of Interest (AOI). The Map Unit Descriptions for the AOI included soil compositions for the SASS sites are presented below.

3.2.1. Skyline Boulevard Habitat Improvement

The Map Unit Description for the AOI included Candlestick variant loam within the Southwest, Southeast, and Northern Wetlands Creation Areas and Candlestick-Kron-Buriburi complex within the Northern Coyote Brush Scrub Creation area. The Map Unit Descriptions are different in that the Candlestick variant is characterized by alluvial fans while the Candlestick-Kron-Buriburi complex is characterized by Mountain slopes. The Map Unit Description for the Candlestick variant included the following information:

- **Map Unit Setting;**
  - Elevation: 30 to 400 feet;
  - Mean annual precipitation: 20 to 30 inches;
  - Mean annual air temperature: 54 to 57 degrees: and
  - Frost-free period: 300 to 350 days.

- **Map Unit Composition;**
  - Candlestick variant loam, 2 to 15 percent slopes.
- **Setting;**
  - Landform: Alluvial fans;
  - Landform position (two-dimensional): Footslope, toeslope;
  - Landform position (three-dimensional): Tread
  - Down-slope shape: Linear;
  - Across-slope shape: Linear;
  - Parent material: Alluvium derived from mixed; and
  - Candlestick variant loam, 2 to 15 percent slopes.
- **Properties and qualities;**
  - Slope: 2 to 15 percent;
  - Depth to restrictive feature: more than 80 inches;
  - Drainage class: Well drained;
  - Capacity of the most limiting layer to transmit water (Ksat); Moderately high (0.20 to 0.57 in/hr);
  - Depth to water table: more than 80 inches
  - Frequency of flooding: none
  - Frequency of ponding: None;
  - Maximum salinity: Nonsaline(0.0 to 2.0 mmhos/cm); and
  - Available water capacity: High (about 9.5 inches).
- **Interpretive groups; and**
  - Land capability (nonirrigated): 3e.
- **Typical profile.**
  - 0 to 21 inches: Loam; and

- 21 to 65 inches: Clay loam.

The Map Unit Description for the Candlestick-Kron-Buriburi complex included the following information:

- **Map Unit Setting;**
  - Elevation: 200 to 1,340 feet;
  - Mean annual precipitation: 20 to 30 inches;
  - Mean annual air temperature: 54 to 57 degrees: and
  - Frost-free period: 300 to 350 days.
- **Map Unit Composition;**
  - Candlestick and similar soils: 40 percent;
  - Kron and similar soils: 25 percent;
  - Buriburi and similar soils: 20 percent; and
  - Minor components: 14 percent.

Description of Candlestick

- **Setting;**
  - Landform: Mountain slopes;
  - Landform position (two-dimensional): backslope;
  - Landform position (three-dimensional): Mountain flank;
  - Down-slope shape: Concave;
  - Across-slope shape: Convex; and
  - Parent material: Hard fractured residuum weathered from sandstone.
- **Properties and qualities;**
  - Slope: 30 to 75 percent;
  - Depth to restrictive feature: 20 to 40 inches to lithic bedrock;
  - Drainage class: Well drained;

   - Capacity of the most limiting layer to transmit water (Ksat); Moderately high (0.20 to 0.57 in/hr);
   - Depth to water table: more than 80 inches
   - Frequency of flooding: none
   - Frequency of ponding: None;
   - Maximum salinity: Nonsaline(0.0 to 2.0 mmhos/cm: and
   - Available water capacity: Low (about 3.6 inches).
- **Interpretive groups; and**
   - Land capability (nonirrigated): 7e.
- **Typical profile.**
   - 0 to 2 inches: Fine sandy loam;
   - 2 to 20 inches: Loam; and
   - 20 to 24 inches: Sandy clay loam.

Further description of Kron and Buriburi complex is available on the website referenced in the Section 4.

3.2.2. Adobe Gulch Creek Wetland Creation

The Map Unit Description for the AOI included Fagan loam within the Adobe Gulch Creek Wetland Creation. The Map Unit Description for Fagan loam included the following information:

- **Map Unit Setting;**
   - Elevation: 200 to 1,900 feet;
   - Mean annual precipitation: 25 to 35 inches;
   - Mean annual air temperature: 55 to 59 degrees: and
   - Frost-free period: 275 to 330 days.
- **Map Unit Composition;**
   - Fagan and similar soils: 85 percent; and
   - Minor components: 15 percent.

- **Setting;**
  - Landform: Hills;
  - Landform position (two-dimensional): Backslope;
  - Landform position (three-dimensional): Side slope;
  - Down-slope shape: Convex;
  - Across-slope shape: Convex; and
  - Parent material: Residuum weathered from sandstone and shale.
- **Properties and qualities;**
  - Slope: 15 to 50 percent;
  - Depth to restrictive feature: 40 to 60 inches to paralithic bedrock;
  - Drainage class: Well drained;
  - Capacity of the most limiting layer to transmit water (Ksat); Moderately low to moderately high (0.06 to 0.20 in/hr);
  - Depth to water table: More than 80 inches;
  - Frequency of flooding: None;
  - Frequency of ponding: None;
  - Maximum salinity: Nonsaline(0.0 to 2.0 mmhos/cm: and
  - Available water capacity: Moderate (about 7.1 inches).
- **Interpretive groups; and**
  - Land capability (nonirrigated): 6e.
- **Typical profile.**
  - 0 to 5 inches: Loam;
  - 5 to 26 inches: Clay loam; and
  - 26 to 43 inches: Clay.

3.2.3. Sherwood Point Oak Restoration

The Map Unit Description for the AOI included Zeni-Zeni variant gravelly loams, 30 to 75 percent slopes within the Sherwood Point Oak Restoration. The Map Unit Description for Zeni-Zeni variant gravelly loams, 30 to 75 percent slopes included the following information:

- **Map Unit Setting;**
  - Elevation: 300 to 1,100 feet;
  - Mean annual precipitation: 30 to 45 inches;
  - Mean annual air temperature: 54 to 55 degrees: and
  - Frost-free period: 275 to 330 days.
- **Map Unit Composition;**
  - Zeni and similar soils: 40 percent;
  - Zeni variant and similar soils: 35 percent; and
  - Minor components: 24 percent.

Description of Zeni

- **Setting;**
  - Landform: Mountain slopes, upland slopes;
  - Landform position (two-dimensional): Backslope;
  - Landform position (three-dimensional): Mountainflank, side slope;
  - Down-slope shape: Concave;
  - Across-slope shape: Convex, linear; and
  - Parent material: Residuum weathered from sandstone.
- **Properties and qualities;**
  - Slope: 30 to 75 percent;
  - Depth to restrictive feature: 20 to 40 inches to lithic bedrock;
  - Drainage class: Well drained;

- Capacity of the most limiting layer to transmit water (Ksat); Moderately high to high (0.57 to 1.98 in/hr);
- Depth to water table: More than 80 inches;
- Frequency of flooding: None;
- Frequency of ponding: None;
- Maximum salinity: Nonsaline (2.0 mmhos/cm); and
- Available water capacity: Low (about 5.6 inches).

- **Interpretive groups; and**
  - Land capability (nonirrigated): 7e.
- **Typical profile.**
  - 0 to 9 inches: gravelly loam;
  - 9 to 26 inches: gravelly clay loam, gravelly sandy clay loam; and
  - 26 to 30 inches: Weathered bedrock.

Further description of Zeni variant is available on the website referenced in the Section 4.

3.2.4. Skyline Quarry Wetland Restoration

The Map Unit Description for the AOI included Pits and Dumps within the Skyline Quarry Wetland Restoration area. The Map Unit Description for Pits and Dumps included the following information:

- **Map Unit Composition;**
  - Dumps: 50 percent; and
  - Pits: 50 percent.

Description of Pits.

- **Interpretive groups;**
  - Land capability (nonirrigated): 8s.

Description of Dumps.

- **Interpretive groups;**

- Land capability (nonirrigated): 8s.

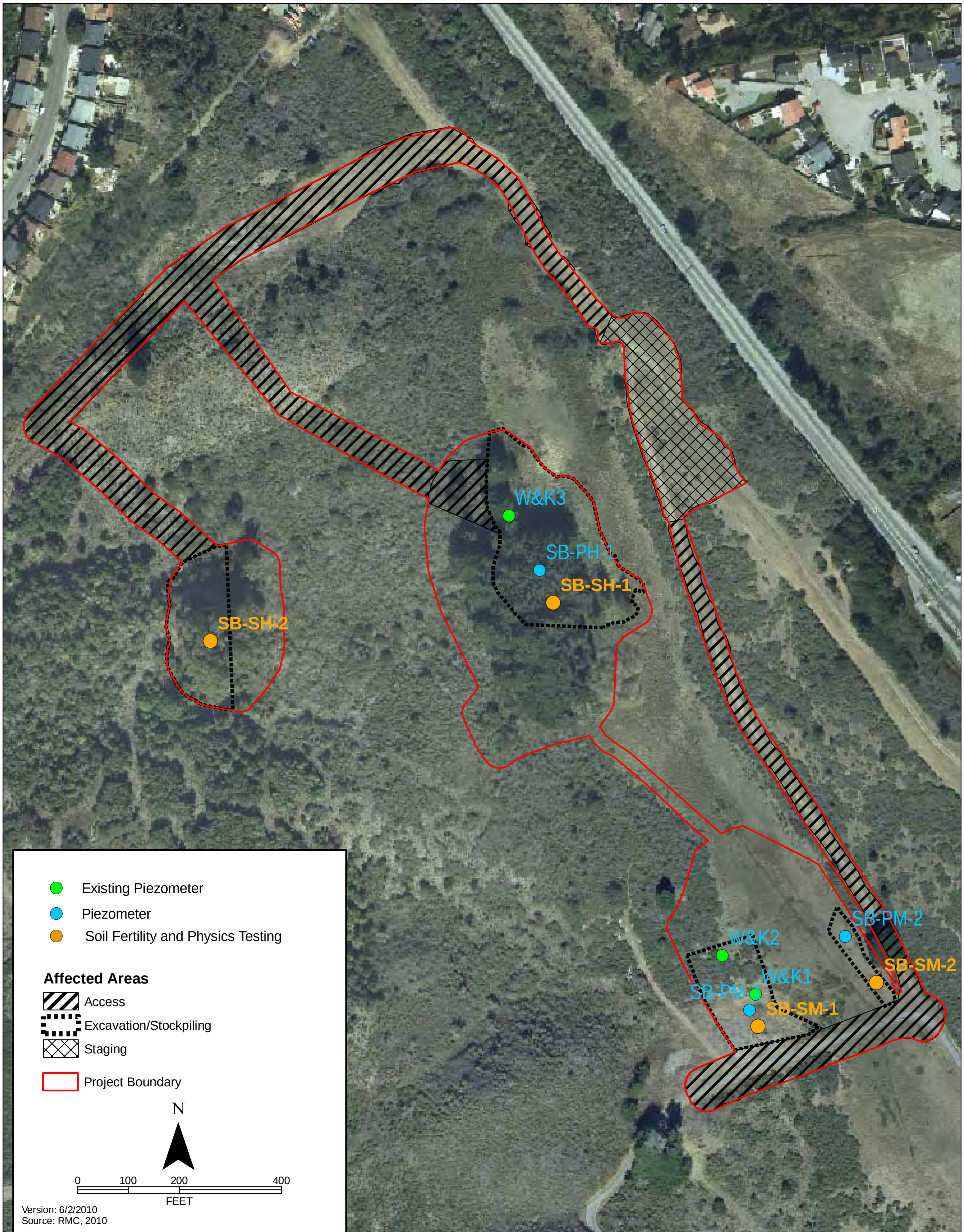
3.3. Soil Testing

Copies of the Cooper Testing reports results are presented in Attachment C. Results of the Soil & Plant testing including recommendations are summarized in the Soil & Plant reports presented in Attachment D.

4. REFERENCES

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/ accessed [06/14/2010].

FIGURES

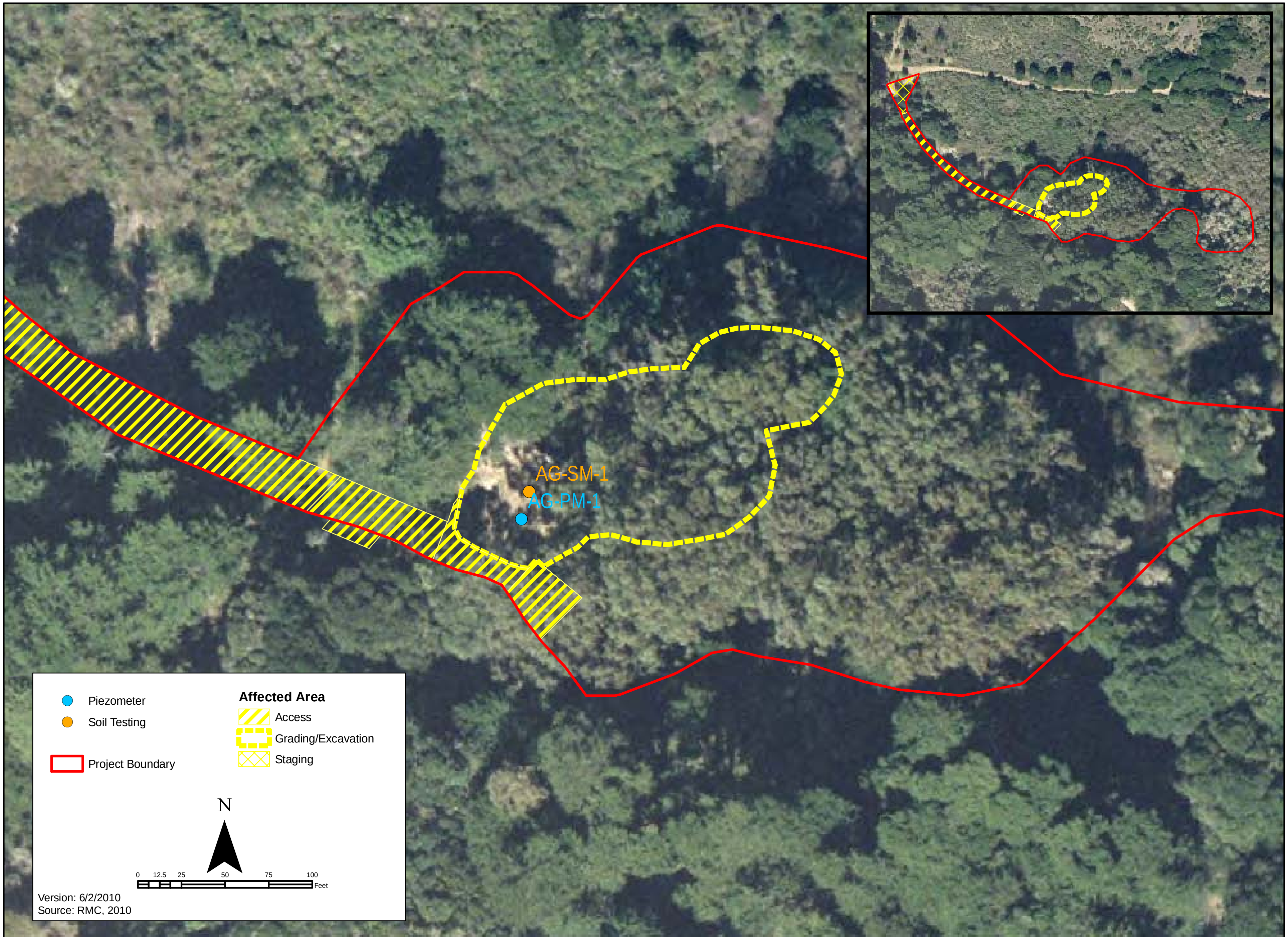


	San Francisco Public Utilities Commission Habitat Reserve Program	Skyline Boulevard Habitat Improvements Geotechnical Investigation

Source: Figure Provided By RMC Environment Inc.

Figure 1

Soil Boring And Piezometer Location Map Skyline Boulevard Habitat Improvement



San Francisco Public Utilities Commission
Habitat Reserve Program

Adobe Gulch Creek Wetland Creation - Geotechical Investigation

Source: Figure Provided By RMC Environment Inc.

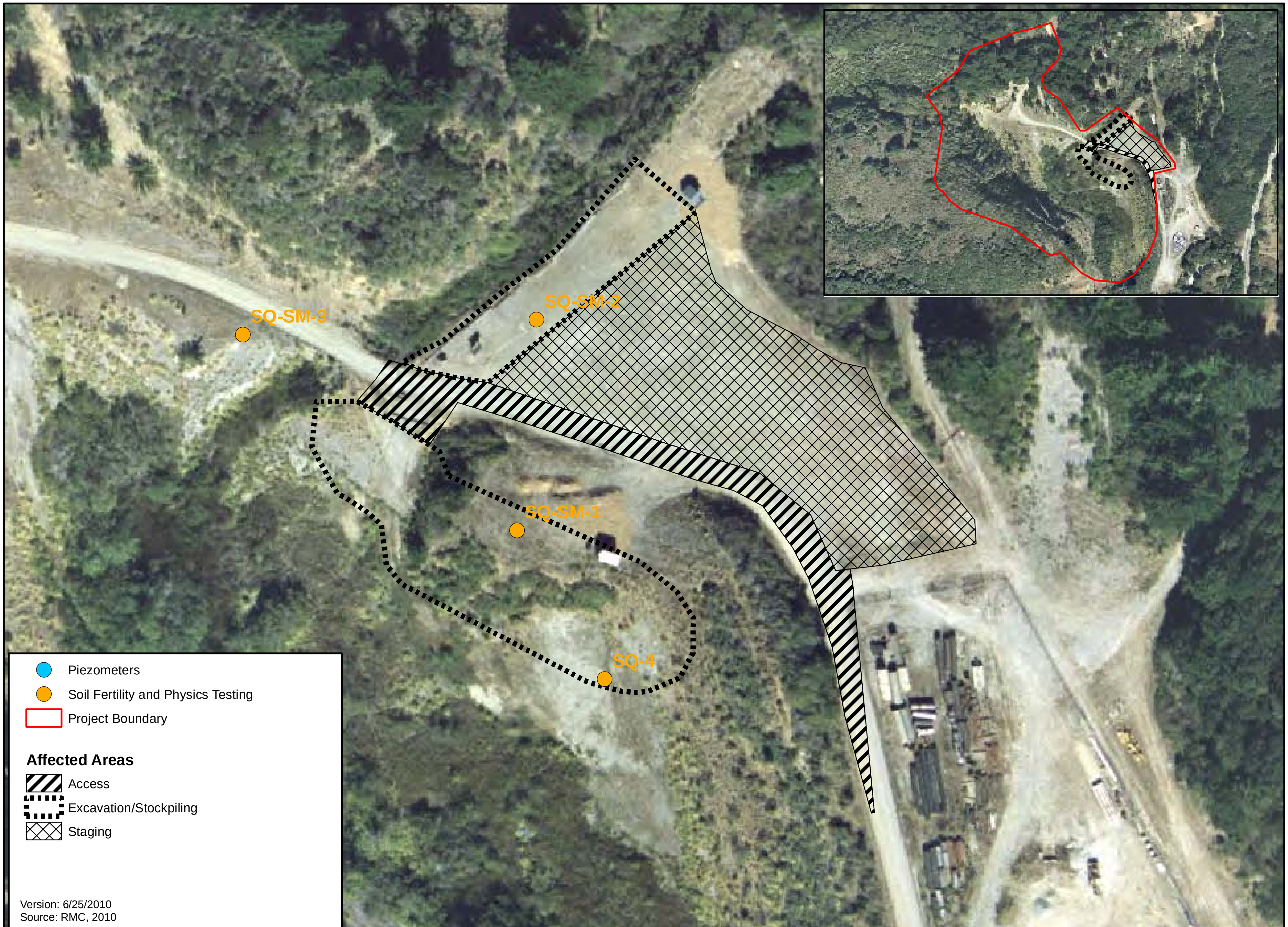
Figure 2
Soil Boring And Piezometer Location Map Adobe Gulch Creek Wetland Creation

San Francisco Public Utilities Commission
Habitat Reserve Program

Sherwood Point Oak Restoration Geotechnical Investigation

Source: Figure Provided By RMC Environment Inc.

Figure 3
Test Pit Location Map Sherwood Point Oak Restoration



San Francisco Public Utilities Commission
Habitat Reserve Program

Skyline Quarry Wetland Restoration Geotechnical Investigation

Source: Figure Provided By RMC Environment Inc.

Figure 4

Soil Boring Location Map Skyline Quarry Wetland Restoration

ATTACHMENT A

BORING LOGS AND PIEZOMETER CONSTRUCTION DETAILS

DATE DRILLED: 6/24/2010	**Log of Boring:** **SB-SM-1**		
DRILLING METHOD: Solid-flight Auger			
HAMMER WEIGHT: 140 lb	DROP: 30"	LOGGED BY: RSY	
SAMPLER(S): RY		TIME	
Surface Conditions: Native grass		START	FINISH
		1410	1440

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0.5			3	SB-SM-1-1.0'		18/16	**CL**	CLAY WITH SAND (CL), brown (10YR 5/3), dry, medium dense, roots to 6", fine grain sand, organics
1			9					
1.5			20	SB-SM-1-1.5'		18/14		
2			27					trace fine gravel, decreasing roots
2.5			22					
3			16	SB-SM-1-3.0'		18/18		
3.5			15					
4			21					
4.5			28	SB-SM-1-4.5'		18/18		
5			24				**CL/SC**	SANDY CLAY/CLAEY SAND (CL/SC), yellow brown (10YR 5/6), stiff, moist, fine to medium sand
5.5			23					
6			26					
6.5								
7								
7.5								
8								
8.5			13	SB-SM-1-8.0'		18/18	**SC**	CLAYEY SAND with GRAVEL (SC), yellow brown (10YR 5/4), medium dense, moist, fine to coarse sand, angular gravel to 1"
9			13					
9.5			15					
10			12	SB-SM-1-9.5'		18/18		▼saturated
10.5			11					
11			12					
11.5								Boring terminated at 11 feet below ground surface.
12								
12.5								

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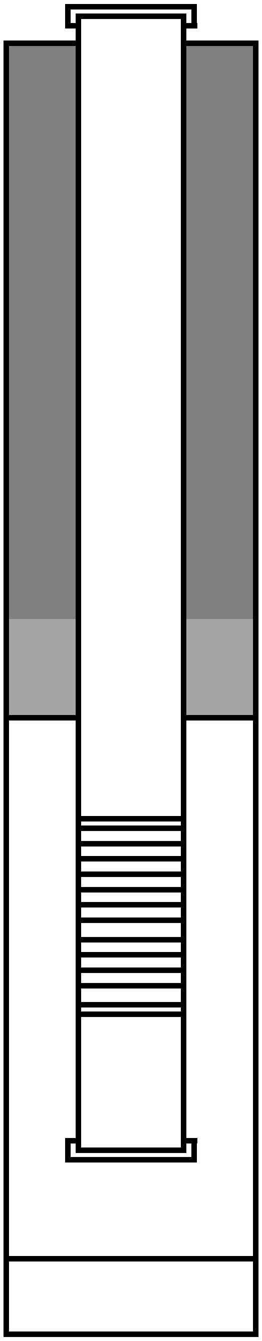

TOP OF CASING APPROXIMATELY
__3__ FEET ABOVE GROUND LEVEL

__8__ INCH DIAMETER
BOREHOLE
__0__ to __12__ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
BLANK CASING
__+3__ to __5__ feet bgs

CEMENT GROUT
SEAL FROM
__0__ to __3__ feet bgs

BENTONITE PELLETS
_3_ to _4_ feet bgs

MONTEREY SAND #3
__4__ to __12__ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
WELL SCREEN
__5__ to __12__ feet bgs

BOTTOM WELL CAP
__12__ feet bgs

BOTTOM OF BOREHOLE
__12__ feet bgs

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DATE DRILLED:	6/24/2010	Log of Boring:	SB-SM-2
DRILLING METHOD:	Solid-flight Auger		
HAMMER WEIGHT: 140 lb	DROP: 30"	LOGGED BY:	RSY
SAMPLER(S):	RY	TIME	
Surface Conditions:	Native grass	START 1100	FINISH 1130

Depth (feet)	Blows per 6 inches	Sample No.	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0.5	4, 3	SB-SM-2-1.0'	18/16	CL	CLAY WITH SAND (CL), black (7.5YR 2.1/1), dry, medium dense, roots to 6", fine grain sand, organics
1.5	4, 5, 7	SB-SM-2-1.5'	18/14		trace fine gravel, decreasing roots
3	10, 13, 16, 19	SB-SM-2-3.0'	18/18		increasing sand content
4.5			18/18		color change to olive gray (5Y 5/2), wet
5	7, 9, 14	SB-SM-2-5.0'			
8					sand stringers between 8.5 and 9.5
8.5	6, 8, 11	SB-SM-2-8.0'	18/18		color change to dark greenish gray (GLEY1 4/5BG)
10	7, 11, 13	SB-SM-2-9.5'	18/18		
11					Boring terminated at 11 feet below ground surface.

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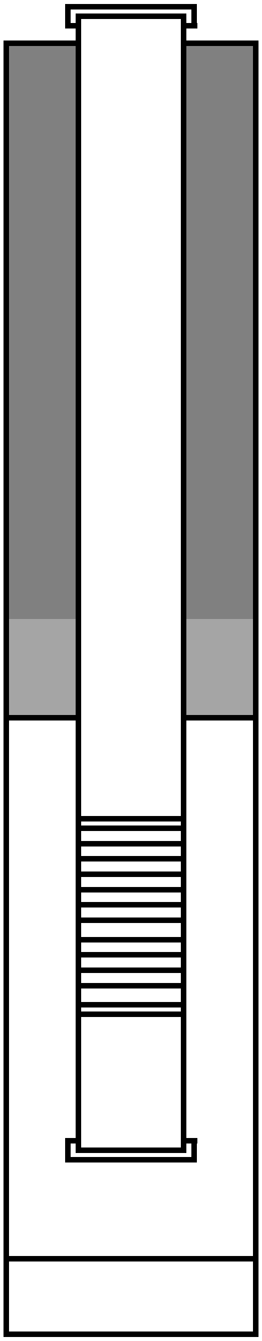

TOP OF CASING APPROXIMATELY
1.5 FEET ABOVE GROUND LEVEL

8 INCH DIAMETER
BOREHOLE
0 to 5 feet bgs

2 INCH DIAMETER
SCHEDULE 40 PVC
BLANK CASING
+1.5 to 2 feet bgs

CEMENT GROUT
SEAL FROM
0 to 1 feet bgs

BENTONITE PELLETS
1 to 1.5 feet bgs

MONTEREY SAND #3
1.5 to 5 feet bgs

2 INCH DIAMETER
SCHEDULE 40 PVC
WELL SCREEN
2 to 5 feet bgs

BOTTOM WELL CAP
5 feet bgs

BOTTOM OF BOREHOLE
5 feet bgs

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DATE DRILLED: 6/28/2010	**Log of Boring:** **SB-SH-1**		
DRILLING METHOD: Hand Auger			
HAMMER WEIGHT: NA	DROP: NA	LOGGED BY: RSY	
SAMPLER(S): JM/RY		TIME	
Surface Conditions: Cypress needles		START	FINISH
		1000	1115

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0.5				SB-SH-1-0.5'			CL	ORGANIC SOIL (OL/OH), very dark brown (10YR 2/2), medium stiff, moist, plants roots, organic mulch
1.5				SB-SH-1-1.5'				
3				SB-SH-1-3.0'			ML	SANDY SILT (ML), yellow brown (10YR 5/4), medium stiff, moist, fine sand
4								▼saturated, trace fine gravel
4.5				SB-SH-1-4.5'				
5							CL/SC	SANDY CLAY/CLAYEY SAND (CL/SC), yellow brown (10YR 5/4), soft, saturated, fine to coarse sand
6				SB-SH-1-6.0'				
7.5								Boring terminated at 7.5 feet below ground surface.

Depth scale: 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5

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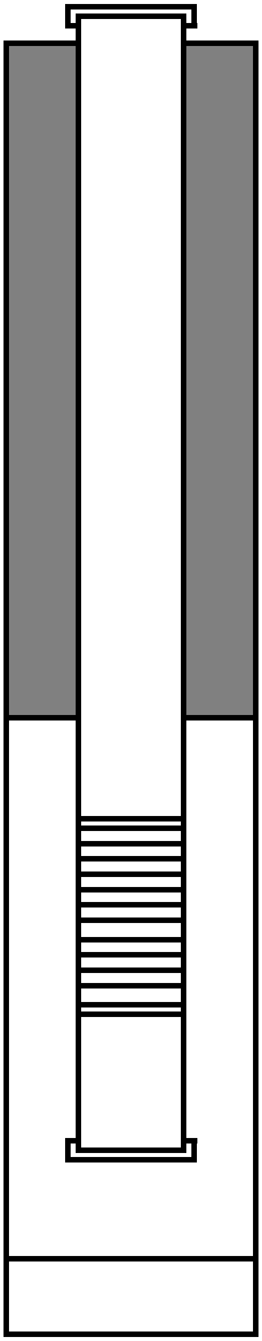

TOP OF CASING APPROXIMATELY
__2.25__ FEET ABOVE GROUND LEVEL

__3.25__ INCH DIAMETER
BOREHOLE
__0__ to __8__ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
BLANK CASING
__+2.25__ to __3__ feet bgs

BENTONITE PELLET
SEAL FROM
__0__ to __2__ feet bgs

Monterey #3
SANDPACK
__2__ to __8__ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
WELL SCREEN
__3__ to __8__ feet bgs

SLIP CAP

BOTTOM WELL CAP
__8__ feet bgs

BOTTOM OF BOREHOLE
__8__ feet bgs

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DATE DRILLED:	6/24/2010	**Log of Boring:**	**AG-SM-1**	
DRILLING METHOD:	Hollow-stem Auger			
HAMMER WEIGHT:	140 lb	DROP: 30"	LOGGED BY:	RSY
SAMPLER(S):	RY		TIME	
Surface Conditions:	Native grass		START	FINISH
			1000	1045

Depth (feet): 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5

Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
		10					
			AG-SM-1-1.0'		18/18	**CL**	CLAY WITH SAND (CL), very dark brown (10YR 2/2), dry, medium dense,
		7					roots to 6", fine grain sand, organics
		9					
			AG-SM-1-1.5'		18/18		
		7					increase sand content
		12					
		16					
			AG-SM-1-3.0'		18/18		
		7					
		8					
		9					
			AG-SM-1-4.5'		18/18		
		5					
		7					
		8					
			AG-SM-1-6.0'		18/18		color change to yellow brown (10YR 5/4), moist
		8					
		13					
		18					
			AG-SM-1-8.5'		18/18		▼ trace fine angular gravel, wet
		20					
		18					
		25					
			AG-SM-1-10.0'		18/18		
		5					SANDSTONE (SS), light yellow brown (10YR 6/4), wet, deep
		11				**SS**	weathering, weak, friable, clay pockets
		16					
			AG-SM-1-11.5'				
		15					
		19					
		31					

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DATE DRILLED:	6/24/2010	Log of Boring:	AG-SM-1
DRILLING METHOD:	Hollow-stem Auger		
HAMMER WEIGHT:	140 lb	DROP: 30"	LOGGED BY: RSY
SAMPLER(S):	RY	TIME	
Surface Conditions:	Native grass	START	FINISH

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
13			27	AG-SM-1-13.0'		18/18		color change to yellow (10YR 7/8)
13.5			27					
14			32					
14.5								
15								Boring terminated at 14.5 feet below ground surface.
15.5								
16								
16.5								
17								
17.5								
18								
18.5								
19								
19.5								
20								
20.5								
21								
21.5								
22								
22.5								
23								
23.5								
24								
24.5								
25								

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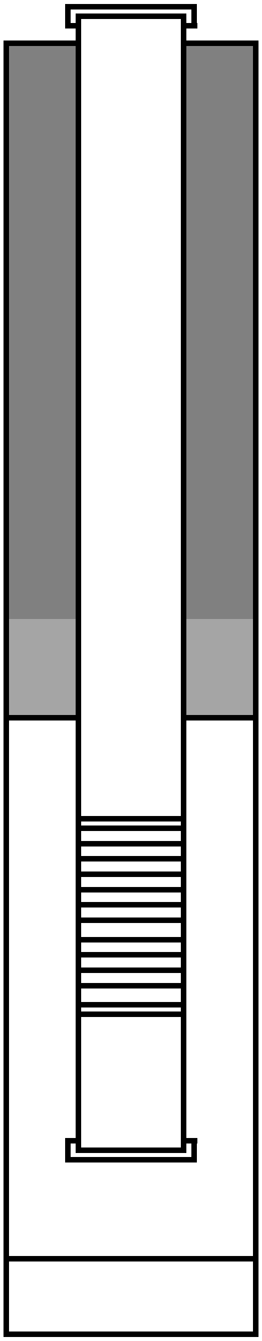

TOP OF CASING APPROXIMATELY
__2___ FEET ABOVE GROUND LEVEL

__8__ INCH DIAMETER
BOREHOLE
__0__ to __15_ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
BLANK CASING
__+2___ to __5___ feet bgs

CEMENT GROUT
SEAL FROM
__0__ to __3__ feet bgs

BENTONITE PELLETS
_3_ to _4_ feet bgs

MONTEREY SAND #3
__4__ to _15_ feet bgs

__2__ INCH DIAMETER
SCHEDULE 40 PVC
WELL SCREEN
__5__ to __15_ feet bgs

BOTTOM WELL CAP
__15_ feet bgs

BOTTOM OF BOREHOLE
__15_ feet bgs

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DATE DRILLED:	7/22/2010	**Log of Test Pit:**	**SP-TP-1**
EXCAVATION METHOD: backhoe			
HAMMER WEIGHT: NA	DROP: NA	LOGGED BY: RSY	
SAMPLER(S): RY		TIME	
Surface Conditions: Native plants		START	FINISH
		1015	1100

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0.5	■			SP-TP-1-0.5'			CL	SANDY CLAY (CL), dark brown (10YR 3/3), medium stiff, moist, fine sand tree roots upper 12"
1.5	■			SP-TP-1-1.5'			ML/CL	SILT/CLAY (ML/CL), dark yellow brown (10YR 4/6), stiff, moist, some fine sand
4.8	■			SP-TP-1-4.8'			SS	SANDSTONE (SS), yellow brown (10YR 5/6, deep to moderate weathering, weak, clay filled fractures, decomposed to coarse gravel
5								Test pit terminated at 5 feet below ground surface.

Depth scale (feet): 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5

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DATE DRILLED: 7/22/2010	**Log of Test Pit:** **SP-TP-2**		
EXCAVATION METHOD: backhoe			
HAMMER WEIGHT: NA	DROP: NA	LOGGED BY: RSY	
SAMPLER(S): RY		TIME	
Surface Conditions: Native plants		START	FINISH
		1110	1140

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0.5	■			SP-TP-2-0.5'			**CL**	SANDY CLAY (CL), brown (10YR 4/3), medium stiff, dry, fine sand, roots
1	■			SP-TP-2-1.0'				
2	■			SP-TP-2-2.0'				color cchange to dark brown (10YR 3/3), trace fine gravel
3.5	■			SP-TP-2-3.5'				increase sand and gravel content, fine subangular gravel
5	■			SP-TP-1-5.0'			**SS**	SANDSTONE (SS), yellow brown (10YR 5/6), moderate weathering, weak, some decomposition to coarse gravel

Test pit terminated at 5 feet below ground surface.

Depth scale: 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5

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DATE DRILLED: 7/22/2010		Log of Test Pit: **SP-TP-3**	
EXCAVATION METHOD: backhoe			
HAMMER WEIGHT: NA	DROP: NA	LOGGED BY: RSY	
SAMPLER(S): RY		TIME	
Surface Conditions: Native plants		START	FINISH
		1145	1230

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0.5	■			SP-TP-3-0.5'			**CL**	SANDY CLAY (CL), brown (10YR 4/3), medium stiff, dry, fine plant roots
1								
1.5								
2	■			SP-TP-3-1.8'			**SS**	SANDSTONE (SS), yellow brown (10YR 5/6, deep to moderate weathering, weak, clay filled fractures, highly fractured, decomposed to coarse angular gravel
2.5								
3								
3.5	■			SP-TP-2-3.5'				moderate strength, moderate weathering
4								
4.5								
5								Test pit terminated at 4.8 feet below ground surface.
5.5								
6								
6.5								
7								
7.5								
8								
8.5								
9								
9.5								
10								
10.5								
11								
11.5								
12								
12.5								

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San Francisco, CA 94105

Drawn By: RSY	**San Francisco Public Utilities Commission**	Project No. 2010-01	
Reviewed By: RY	**Habitat Reserve Program San Mateo, California**	Sheet 1 of 1	

DATE DRILLED: 6/23/2010	**Log of Boring: SQ-SM-1**
DRILLING METHOD: Solid-flight Auger	
HAMMER WEIGHT: 140 lb	DROP: 30" LOGGED BY: RSY
SAMPLER(S): RY	TIME START: 1435 FINISH: 1515
Surface Conditions: Open space with native plants	

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0.5								FILL - CLAYEY SAND/SANDY CLAY (SC/CL) brown/gray (10YR 5/2), medium stiff, dry, fine to coarse sand, some fine angular gravel, some organics - top 3"
1				SQ-SM-1-1.0'		18/18	**CL/SC**	
1.5			7					
2			5					
2.5			8					
3								
3.5								
4				SQ-SM-1-4.0'		18/18		
4.5			4					color change to reddish brown (5YR 4/4), moist, decreasing sand
5			2					
5.5			6					
6								
6.5								
7				SQ-SM-1-7.0'		18/18		some medium angular gravel to 1.5" maximum size
7.5			4					
8			6					
8.5			8					
9								
9.5								
10								
10.5								
11				SQ-SM-1-11.0'		18/18		color change to dark grayish brown (10YR 4/2)
11.5			5					
12			5					
12.5			5					

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55 New Montgomery Street, Suite 722
San Francisco, CA 94105

Drawn By: RSY	**San Francisco Public Utilities Commission**	Project No. 2010-01	
Reviewed By: RY	**Habitat Reserve Program San Mateo, California**	Sheet 1 of 2	

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	DATE DRILLED: 6/23/2010	Log of Boring: SQ-SM-1

DRILLING METHOD: Solid-flight Auger
HAMMER WEIGHT: 140 lb | DROP: 30" | LOGGED BY: RSY
SAMPLER(S): RY | TIME
Surface Conditions: Open space with native plants | START | FINISH

Depth (feet)	Blows per 6 inches / Sample No.	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
13				
13.5				
14				
14.5			SC	FILL - CLAYEY SAND with GRAVEL (SC) dark gray (GLEY1 4/N), medium dense, moist, fine to coarse angular gravel
15	SQ-SM-1-15.0'	18/18		
15.5	6			
16	5			
16.5	6			
17				
17.5			SS	SANDSTONE (SS), light greenish gray (GLEY1 7/1), deep to moderate weathering, moderate strength
18	SQ-SM-1-18.0'	2/2		
18.5				Boring terminated at 18.2' below ground surface.
19				
19.5				
20				
20.5				
21				
21.5				
22				
22.5				
23				
23.5				
24				
24.5				
25				

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San Francisco, CA 94105

Drawn By: RSY	San Francisco Public Utilities Commission	Project No. 2010-01
Reviewed By:	Habitat Reserve Program San Mateo, California	Sheet 2 of 2

DATE DRILLED: 6/23/2010 | **Log of Boring: SQ-SM-2**

DRILLING METHOD: Solid-flight Auger

HAMMER WEIGHT: 140 lb | DROP: 30" | LOGGED BY: RSY

SAMPLER(S): RY

Surface Conditions: Gravel pad

TIME	
START	FINISH
1325	1420

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0.5								FILL - GRAVEL WITH CLAY (GS) gray (GLEY1 6/N), moist, dense, fine to coarse angular gravel
1			14	SQ-SM-2-1.0'		18/18	**CL/SC**	
1.5			14					
2			18					
2.5								FILL - GRAVEL WITH SAND (GP) gray (GLEY1 6/N), moist, dense, fine to coarse angular gravel to 2", fine to coarse sand
3								
3.5							**GP**	
4			35	SQ-SM-2-4.0'		18/18		
4.5			39					
5			31					
5.5								
6								FILL - SAND WITH GRAVEL (SP) dark brown (10YR 3/3), moist, dense, fine to coarse sand, fine angular angular gravel
6.5								
7							**SP**	
7.5								
8			33	SQ-SM-2-8.0'		18/18		
8.5			35					
9			32					
9.5								
10								
10.5								
11								
11.5								
12			60/3"			3	**SS**	SANDSTONE (SS), deep to moderate weathering, moderate strength
12.5								Bottom of boring at 12.5 feet below ground surface.

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Drawn By: RSY	**San Francisco Public Utilities Commission**	Project No. 2010-01
Reviewed By: RY	**Habitat Reserve Program San Mateo, California**	Sheet 1 of 1

DATE DRILLED:	6/24/2010	**Log of Boring:**	**SQ-SM-3**	
DRILLING METHOD:	Solid-flight Auger			
HAMMER WEIGHT:	140 lb	DROP: 30"	LOGGED BY:	RSY
SAMPLER(S):	RY		TIME	
Surface Conditions:	Gravel/Grass		START	FINISH
			855	925

Depth (feet)	Sample	Sample Type	Blows per 6 inches	Sample No.	SPT N-value	Inches Driven/ Inches Recovered	U.S.C.S. Classification	Description
0.5								FILL - GRAVEL (GP) light brown (7.5 YR 6/3), dry, medium dense, fine to coarse angular gravel, fine to coarse sand
1				SQ-SM-3-1.0'		18/18	**GP**	
1.5			13					
2			8					
2.5			7					
3								
3.5								
4				SQ-SM-3-4.0'		18/18		
4.5			24				**SS**	SANDSTONE (SS) light greenish gray (GLEY1 7/1), deep to moderate weathering, weak, friable
5			38					
5.5			39					
6								
6.5								
7				SQ-SM-3-7.0'				
7.5			58/6"			6/3		
8								
8.5								
9								
9.5								
10			62/3"			3/2		increasing strength to moderate
10.5								Boring terminated at 10.3 feet below ground surface.
11								
11.5								
12								
12.5								

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San Francisco, CA 94105

Drawn By: RSY	**San Francisco Public Utilities Commission**	Project No. 2010-01	
Reviewed By: RY	**Habitat Reserve Program San Mateo, California**	Sheet 1 of 1	

ATTACHMENT B

PHOTOGRAPHS

Backfilling Adobe Gulch boring AG-SM-1

Completion of Adobe Gulch piezometer AG-PM-1

Skyline Quarry boring SQ-SM-1

Skyline Quarry boring SQ-SM-2

Drilling Skyline Quarry boring SQ-SM-3

Checking depth of overburden soil at Skyline Quarry within proposed wetland area.

Skyline Boulevard boring SB-SM-1

Completion of Skyline Boulevard piezometer SB-PM-1

Skyline Boulevard boring SB-SM-2

Completion of Skyline Boulevard piezometer SB-PM-2

Skyline Boulevard boring SB-SH-1

Completion of Skyline Boulevard piezometer SB-PH-1

Sherwood Point Test Pit 1 measuring top 1.5-foot soil horizon

Sherwood Pont test Pit 1 measuring final depth at 5 feet

Sherwood Point test Pit 2 measuring top soil horizon

Sherwood Point test Pit 2 measuring final depth to 5 feet

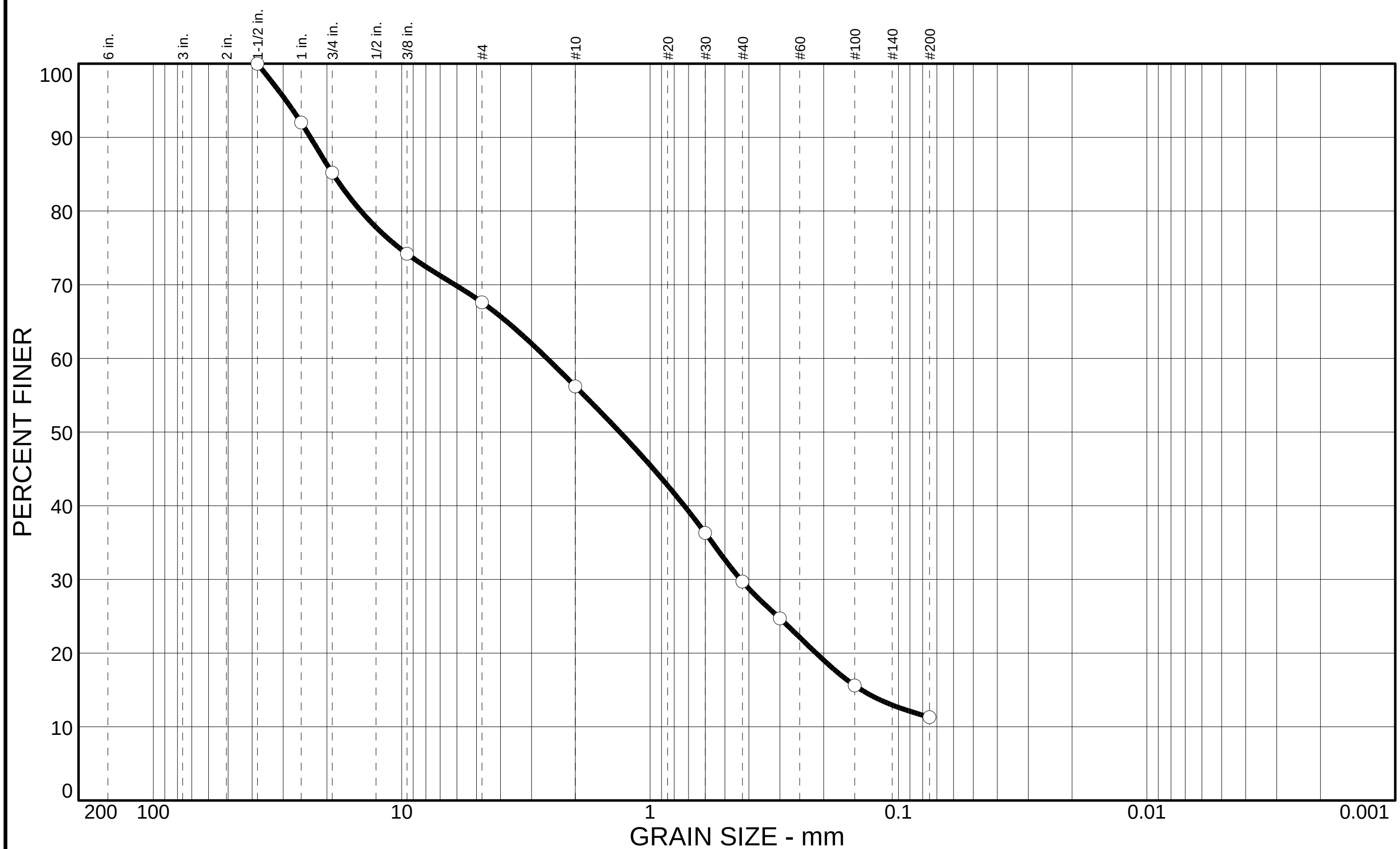
Sherwood Point Test Pit 3 measuring top soil horizon over bedrock

Sherwood Point Test Pit 3 measuring final depth to 4.8 feet

ATTACHMENT C

PHYSICAL TESTING LABORATORY REPORTS

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		32.4	56.3	11.3					

SIEVE inches size	PERCENT FINER ○		
1.5"	100.0		
1"	92.0		
3/4"	85.2		
3/8"	74.2		
	GRAIN SIZE		
D_{60}	2.60		
D_{30}	0.433		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	67.6		
#10	56.2		
#30	36.3		
#40	29.7		
#50	24.7		
#100	15.6		
#200	11.3		

SOIL DESCRIPTION

○ Brown Poorly Graded SAND w/ Silt & Gravel

REMARKS:

○

○ Source: SQ-SM-2

Elev./Depth: 8-9.5'

COOPER TESTING LABORATORY

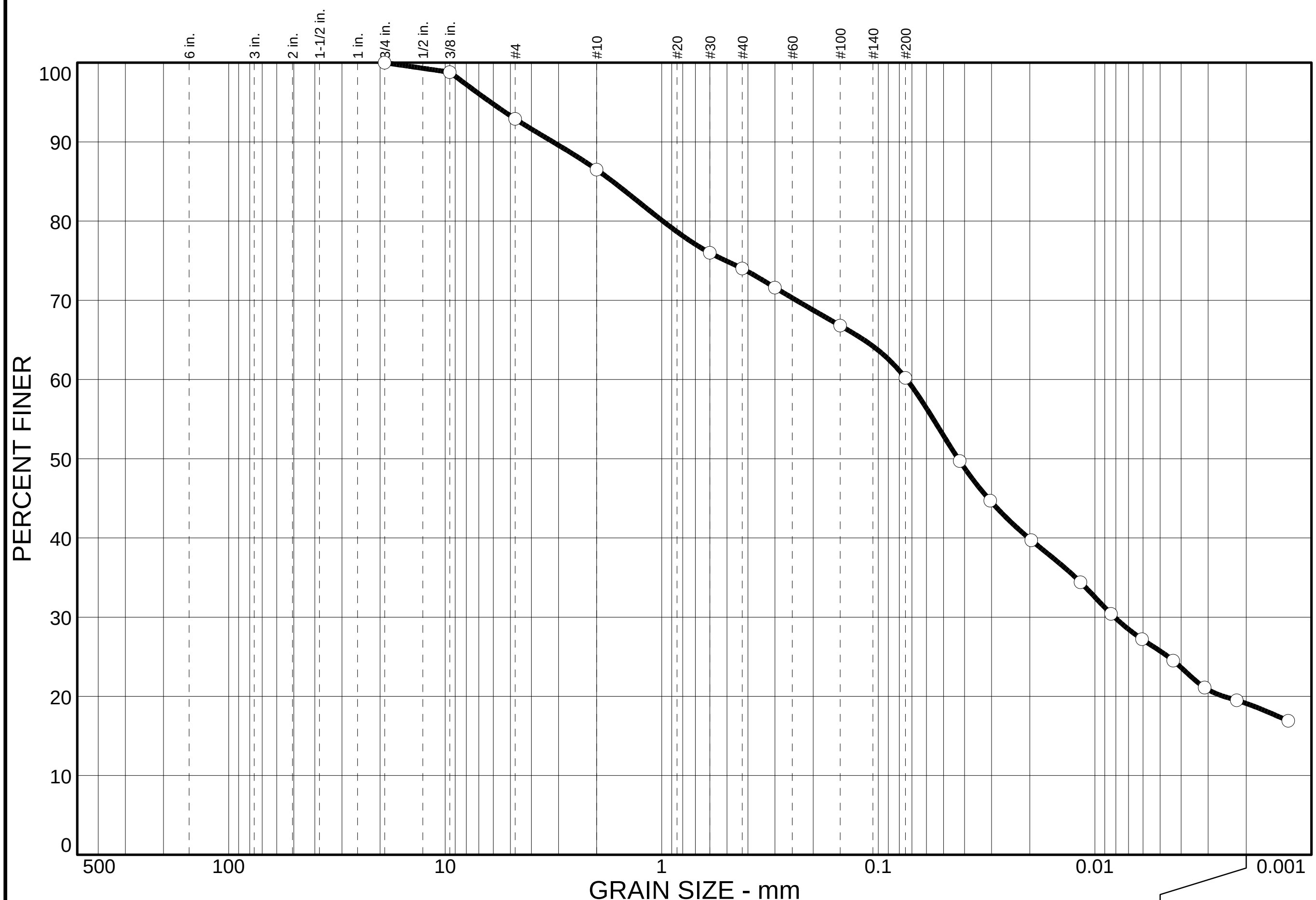
Client: AEW Engineering, Inc.

Project: SFPUC Habitat Restoration - 2010-001

Project No.: 707-002

Figure

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	7.1	32.7	41.1	19.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4 in.	100.0		
3/8 in.	98.8		
#4	92.9		
#10	86.5		
#30	76.0		
#40	74.0		
#50	71.6		
#100	66.8		
#200	60.2		
0.0421 mm.	49.7		
0.0304 mm.	44.7		
0.0197 mm.	39.7		
0.0117 mm.	34.4		
0.0084 mm.	30.4		
0.0061 mm.	27.2		
0.0043 mm.	24.5		
0.0031 mm.	21.1		
0.0022 mm.	19.5		
0.0013 mm.	16.9		

* (no specification provided)

Soil Description

Reddish Brown Sandy CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.68 D_{60}= 0.0740 D_{50}= 0.0428
D_{30}= 0.0081 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

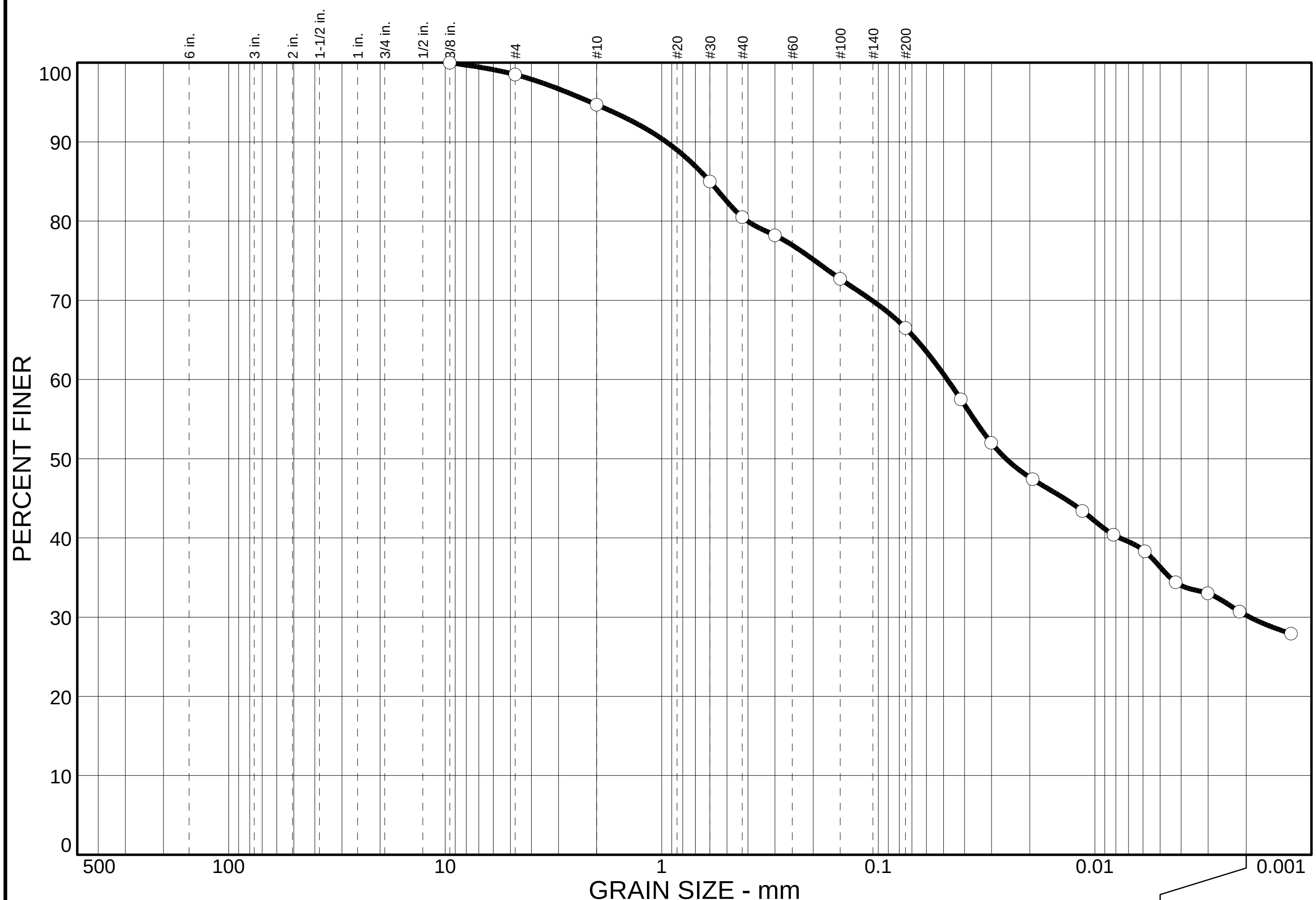
Sample No.: **Source of Sample:** AG-SM-1 **Date:**
Location: **Elev./Depth:** 4.5-6'

COOPER TESTING LABORATORY

Client: AEW Engineering, Inc.
Project: SFPUC Habitat Restoration - 2010-001

Project No: 707-002 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.5	32.0	36.3	30.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	98.5		
#10	94.7		
#30	85.0		
#40	80.5		
#50	78.2		
#100	72.7		
#200	66.5		
0.0416 mm.	57.5		
0.0301 mm.	52.0		
0.0194 mm.	47.4		
0.0114 mm.	43.4		
0.0082 mm.	40.4		
0.0059 mm.	38.3		
0.0042 mm.	34.4		
0.0030 mm.	33.0		
0.0021 mm.	30.7		
0.0012 mm.	27.9		

* (no specification provided)

Soil Description

Reddish Brown Sandy SILT

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.600 D_{60}= 0.0481 D_{50}= 0.0257
D_{30}= 0.0019 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

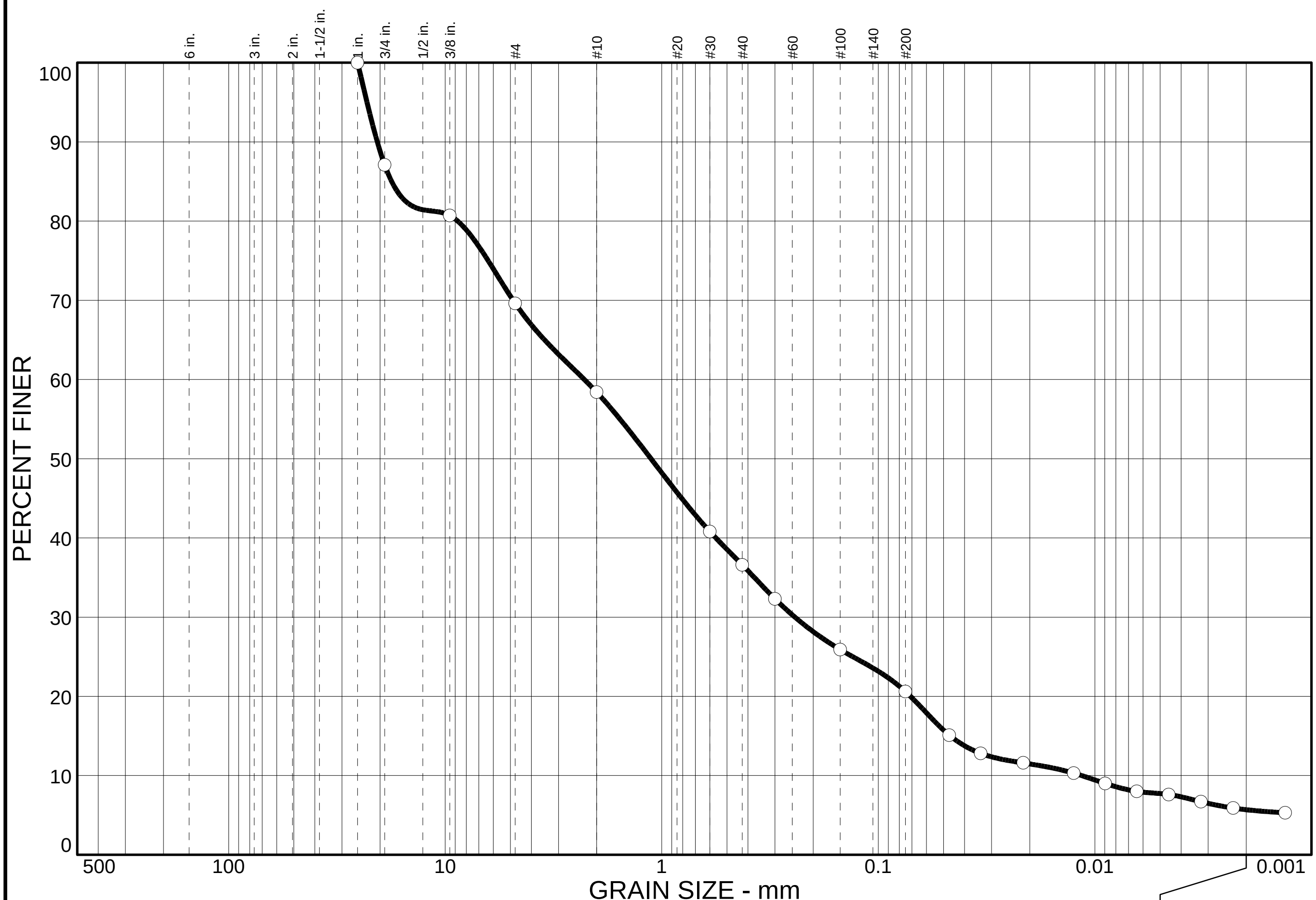
Sample No.: **Source of Sample:** SB-SH-1 **Date:**
Location: **Elev./Depth:** 3-4.5'

COOPER TESTING LABORATORY

Client: AEW Engineering, Inc.
Project: SFPUC Habitat Restoration - 2010-001

Project No: 707-002 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	30.4	49.0	14.9	5.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
3/4 in.	87.1		
3/8 in.	80.7		
#4	69.6		
#10	58.4		
#30	40.8		
#40	36.6		
#50	32.3		
#100	25.9		
#200	20.6		
0.0471 mm.	15.1		
0.0337 mm.	12.8		
0.0214 mm.	11.6		
0.0125 mm.	10.3		
0.0090 mm.	9.0		
0.0064 mm.	8.0		
0.0046 mm.	7.6		
0.0032 mm.	6.7		
0.0023 mm.	5.9		
0.0013 mm.	5.3		

* (no specification provided)

Soil Description

Brown Clayey SAND w/ Gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 17.7 D_{60}= 2.28 D_{50}= 1.12
D_{30}= 0.243 D_{15}= 0.0466 D_{10}= 0.0115
C_u= 197.76 C_c= 2.25

Classification

USCS= AASHTO=

Remarks

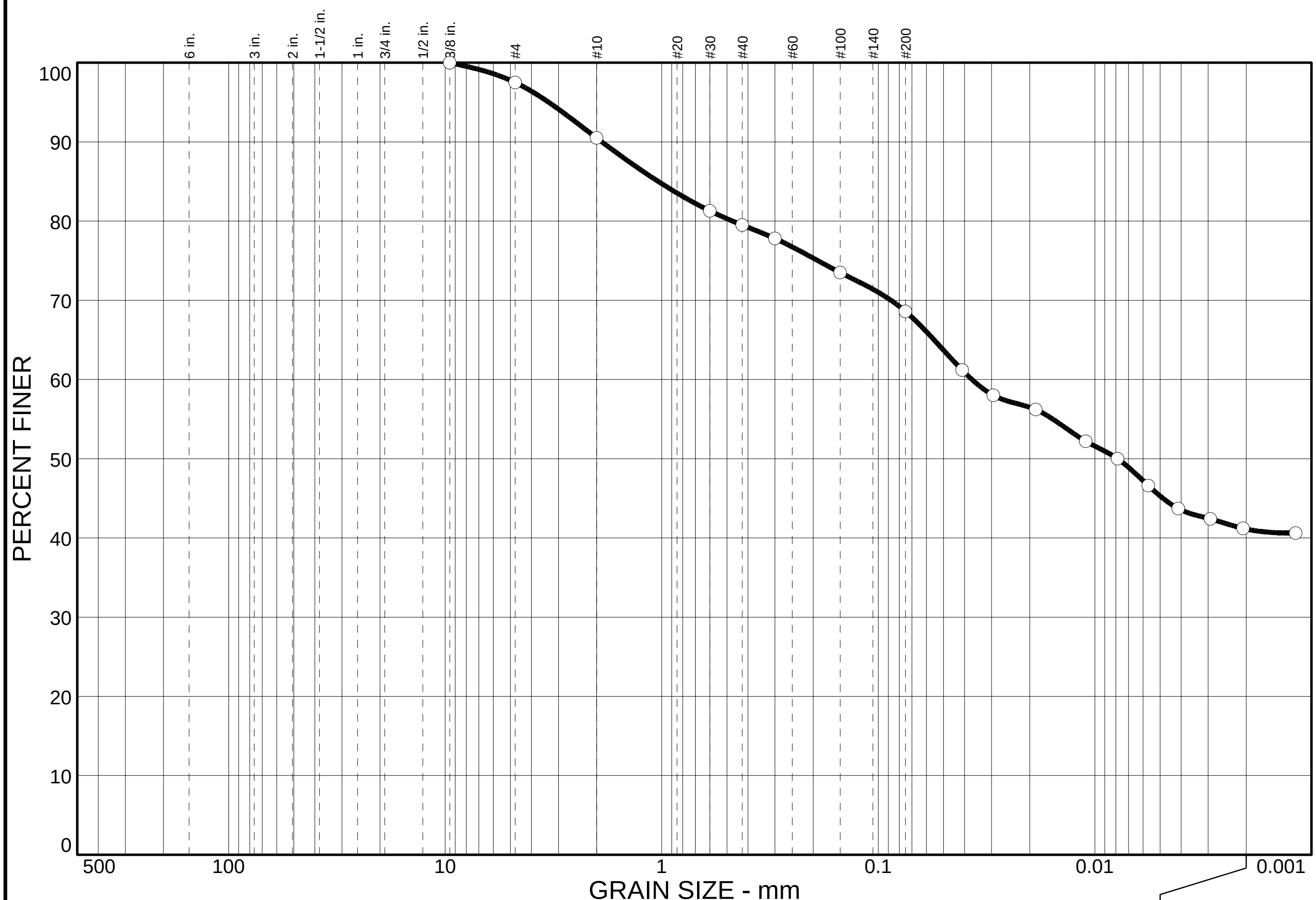
Sample No.: **Source of Sample:** SB-SM-1 **Date:**
Location: **Elev./Depth:** 8-9.5'

COOPER TESTING LABORATORY

Client: AEW Engineering, Inc.
Project: SFPUC Habitat Restoration - 2010-001

Project No: 707-002 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.5	28.9	27.5	41.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	97.5		
#10	90.5		
#30	81.3		
#40	79.5		
#50	77.8		
#100	73.5		
#200	68.6		
0.0410 mm.	61.2		
0.0294 mm.	58.0		
0.0188 mm.	56.2		
0.0110 mm.	52.2		
0.0079 mm.	50.0		
0.0057 mm.	46.6		
0.0041 mm.	43.7		
0.0029 mm.	42.4		
0.0021 mm.	41.2		
0.0012 mm.	40.6		

* (no specification provided)

Soil Description

Dark Gray Sandy CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.04 D_{60}= 0.0369 D_{50}= 0.0079
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

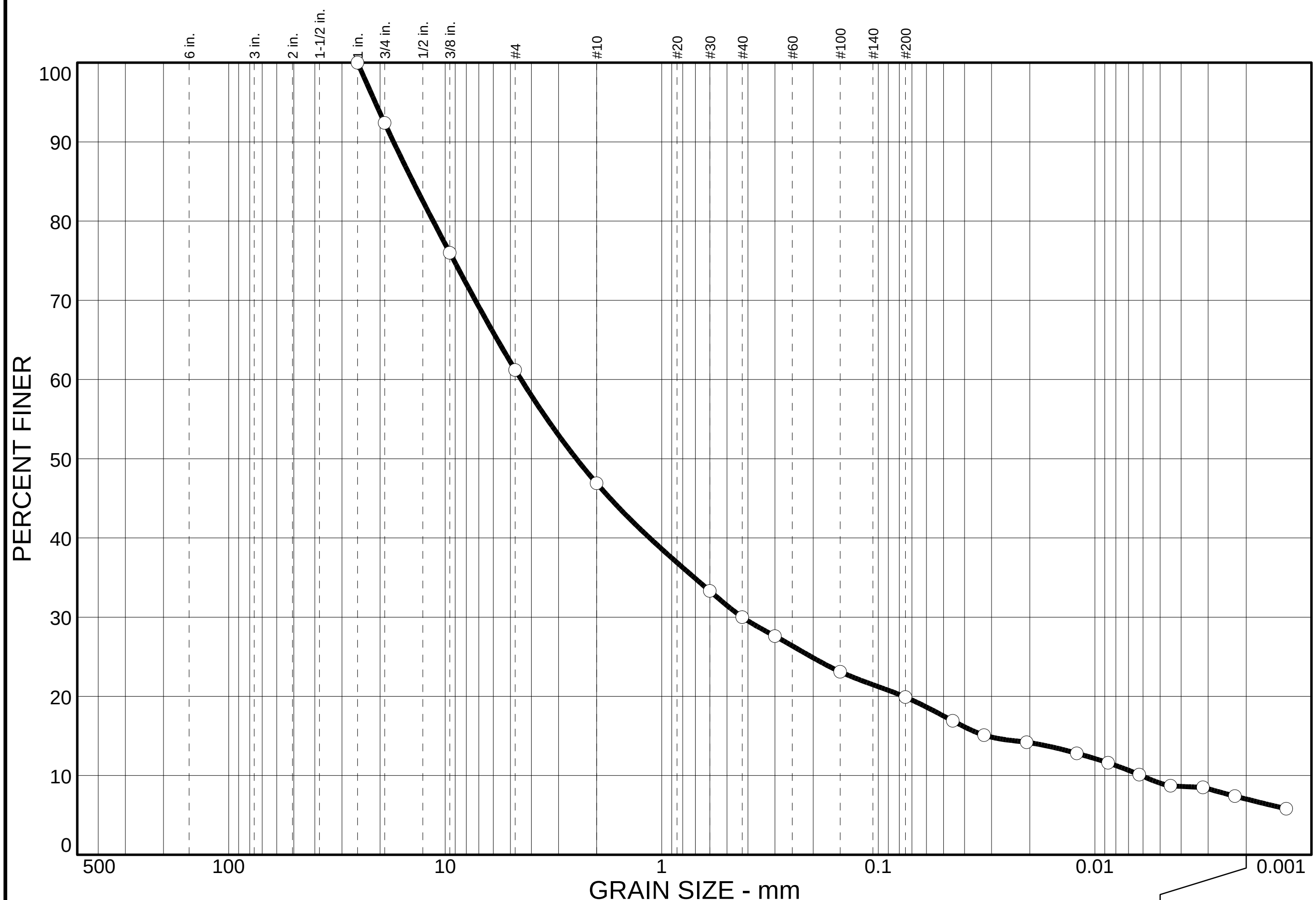
Sample No.: **Source of Sample:** SB-SM-2 **Date:**
Location: **Elev./Depth:** 3-4.5'

COOPER TESTING LABORATORY

Client: AEW Engineering, Inc.
Project: SFPUC Habitat Restoration - 2010-001

Project No: 707-002 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	38.8	41.3	12.9	7.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
3/4 in.	92.4		
3/8 in.	76.0		
#4	61.2		
#10	46.9		
#30	33.3		
#40	30.0		
#50	27.6		
#100	23.1		
#200	19.9		
0.0453 mm.	16.9		
0.0325 mm.	15.1		
0.0207 mm.	14.2		
0.0121 mm.	12.8		
0.0087 mm.	11.6		
0.0062 mm.	10.1		
0.0045 mm.	8.7		
0.0032 mm.	8.5		
0.0023 mm.	7.4		
0.0013 mm.	5.8		

* (no specification provided)

Soil Description

Greenish Brown Clayey SAND w/ Gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 14.1 D_{60}= 4.46 D_{50}= 2.48
D_{30}= 0.425 D_{15}= 0.0316 D_{10}= 0.0061
C_u= 730.32 C_c= 6.62

Classification

USCS= AASHTO=

Remarks

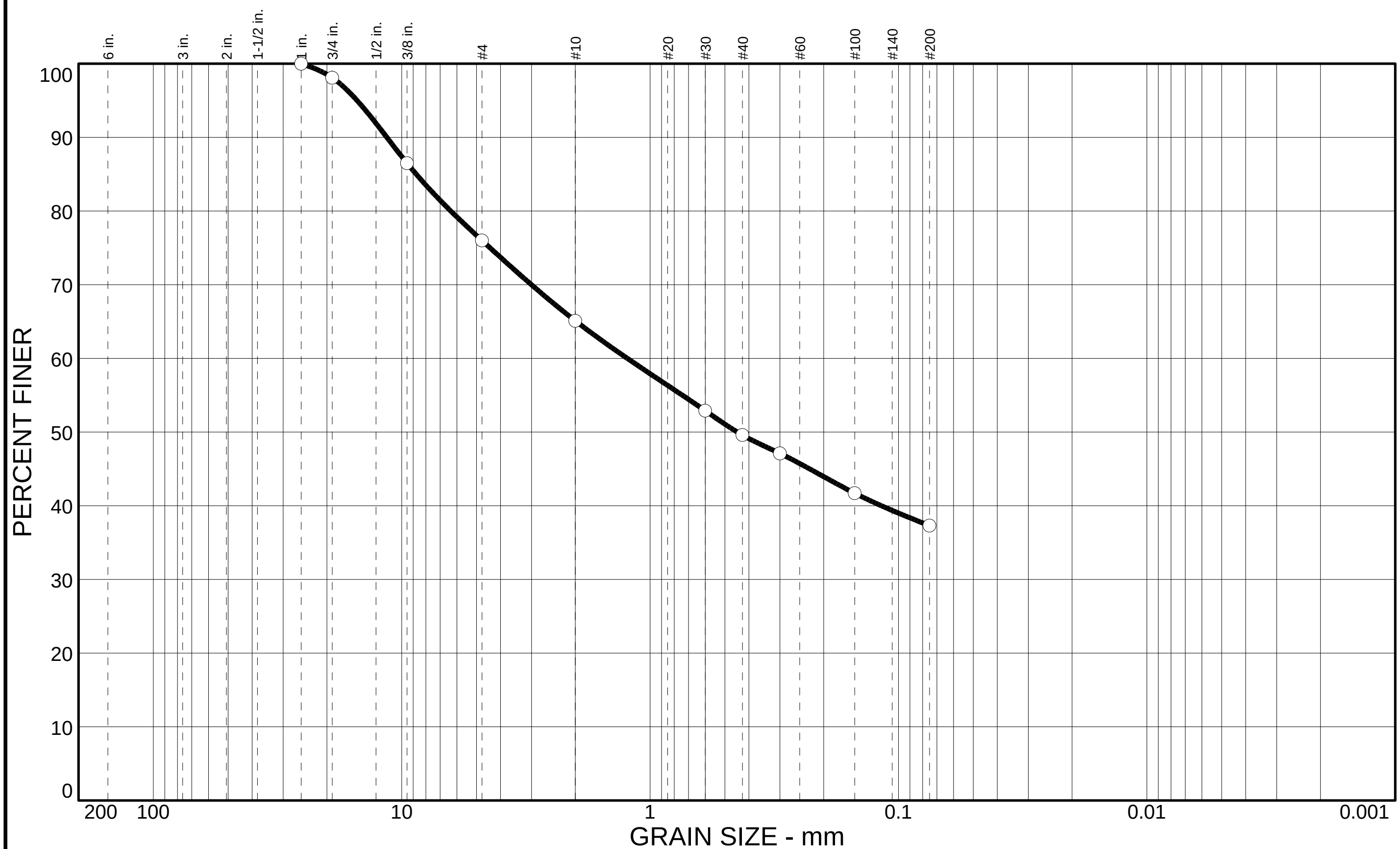
Sample No.: **Source of Sample:** SQ-SM-1 **Date:**
Location: **Elev./Depth:** 15-16.5'

COOPER TESTING LABORATORY

Client: AEW Engineering, Inc.
Project: SFPUC Habitat Restoration - 2010-001

Project No: 707-002 **Figure**

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○		24.0	38.7	37.3					

SIEVE inches size	PERCENT FINER ○		
1"	100.0		
3/4"	98.1		
3/8"	86.5		
	GRAIN SIZE		
D_{60}	1.24		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	76.0		
#10	65.1		
#30	52.9		
#40	49.6		
#50	47.1		
#100	41.7		
#200	37.3		

SOIL DESCRIPTION

○ Strong Brown Clayey SAND w/ Gravel

REMARKS:

○

○ Source: SP-TP-1

Elev./Depth: 56"

COOPER TESTING LABORATORY

Client: AEW Engineering, Inc.

Project: SFPUC Habitat Restoration - 2010-001

Project No.: 707-004

Figure

ATTACHMENT D

SOIL & PLANT TESTING LABORATORY REPORTS

Locations:

1101 S. Winchester Blvd.
Suite G-173
San Jose, CA 95128
(408) 727-0330

4741 E. Hunter Ave.
Unit A
Anaheim, CA 92807
(714) 282-8777

SAN JOSE OFFICE
July 28, 2010
Report 10-196-0047

AEW Engineering, Inc.
55 New Montgomery St., Suite 722
San Francisco, CA 94105

Attn: Randall Young

RE: SFPUC HABITAT RESTORATION, PROJECT #2010-001

BACKGROUND

Samples received 7/15 represent site soils from various depths in the profile from areas that will be revegetated after grading occurs. Soil from each depth examined may eventually end up as topsoil and the key maps showing sample locations also identified existing and proposed habitats for the various areas.

Characteristics of soils at the Adobe Gulch site are represented by three depths from one boring. From the Skyline Quarry site three borings were made with three depths examined at area 1 and two depths from each of the others. At the Skyline Blvd site three borings where made with three depths examined from each.

ADOBE GULCH

ANALYTICAL RESULTS

Characteristics throughout the depth of the profile in this proposed Wetland area are fairly uniform in most respects. Gravel levels are moderate and for the smaller than 2 mm fraction the top 1.5 feet is in the sandy clay loam classification with lower depths clay loam. Organic matter content is good at each depth. Because of the diversity amongst the coarse fractions a higher degree of susceptibility toward consolidation is suggested for the top 1.5 feet and the infiltration rate based on these characteristics is a particularly slow 0.12 inch per hour. For the lower portions of the profile the rate is estimated closer to 0.17 inch per hour.

Reaction values are slightly acidic and with no lime present this is suitable. Salinity, sodium and boron levels are safely low and the SAR values show soluble sodium adequately balanced by calcium and magnesium.

The only major nutrient deficiency is the lack of adequate potassium at 5-6 feet. Throughout the profile zinc is fair and iron rather high with all other required nutrients comfortably within adequate ranges.

RECOMMENDATIONS

The only soil at this site were some amending would be appropriate would be that from 4.5-6 feet where it ends up at finish grade. This should be amended with potassium sulfate (0-0-50) at a rate of 5 pounds per 1000 square feet for blending to 6-inches depth.

SKYLINE QUARRY

ANALYTICAL RESULTS

The SM-1 samples show slight excesses of gravel while SM-2 are moderate in gravel excess. SM-3 at 7-8.5 feet is high in gravel content with the 15-16.5 foot zone very high in gravel. The smaller fractions fall in the clay loam to sandy clay loam classifications. Organic content is good only in the 1-2.5 foot sample from SM-1 and is otherwise very low. Estimated infiltration rates are 0.19 inch per hour for the 1-2.5 and 7-8.5 foot zones and 0.15 at 15 feet from SM-1 and both depths from SM-2. The rate can not be estimated for the SM-3 samples because of their extremely high gravel content.

Reaction values are slightly to moderately alkaline with the exception of strong alkalinity in the 4-5.5 sample from SM-3. All of these soils are high in lime content and the addition of some sulfur is suggested in order to help keep nutrients in more readily available forms. Salinity, sodium and boron levels are safely low and the SAR values show soluble sodium adequately balanced by calcium and magnesium.

Phosphorus is marginally deficient in many of the samples. Potassium is quite deficient in all. Magnesium is marginally low at best in all of the samples from SM-2 and 3. Zinc and manganese also tend to be on the low side except for manganese being particularly abundant in the SM-1 profile. Required nutrients are otherwise adequate.

RECOMMENDATIONS

Rates are suggested to treat 1000 square feet and be blended to 6-inches depth.

Soil Type	Organic Matter cubic yards	Treble Superphosphate pounds, (0-48-0)	Potassium Sulfate pounds, (0-0-50)
SM-1 at 1-2.5 feet	0	1	5
SM-1 at 7-8.5 feet	2	0	5
SM-1 at 15-16.5 feet	3	1	7
SM-2 and 3, both depths	3	1	5

Page-3
AEW Engineering, Inc.
Report 10-196-0047

SKYLINE BLVD

ANALYTICAL RESULTS

These three borings will be Seasonal Wetland areas with the portion adjacent to SH-1 proposed for Coyote Brush Scrub while areas adjacent to SM-1 and 2 will be Grassland. The sample identified as SH-2 was not amongst those submitted.

In this series of samples gravel content is not so much of a concern tending to be slightly excessive only in the SM-1 profile. USDA Classifications for the smaller than 2-mm fractions are widely varied from sandy loam to clay and are as indicated on the attached data sheets. Organic matter levels are particularly abundant for each of the three samples from the top 1.5 feet. There is also a good amount of organic matter at the 3-4.5 foot depth from SH-1 but otherwise soils from these borings are very low in organic content. Infiltration rates are estimated in the range of 0.20 to 0.22 inch per hour with the exception of the clay at 3-4.5 feet from SM-2, where it may be as slow as 0.13 inch per hour.

All reaction values fall in a slightly acidic to slightly alkaline range and with no significant lime present in any of the samples this is suitable. Salinity, sodium and boron levels are safely low and the SAR values show soluble sodium adequately balanced by calcium and magnesium.

Phosphorus is low in all areas except being adequate at the 8-9.5 foot depth from SM-1. Potassium is low in all. Many of these soils are affected by varying degrees of imbalance between low calcium and excessive magnesium. This is particularly extreme at 3-4.5 and 8-9.5 feet from SM-1 and at 3-4.5 and 5-6.5 feet from SM-2. Zinc and manganese also tend to be low in all samples except the top 1.5 feet from SM-1 and 2. Available nutrients are otherwise adequate.

RECOMMENDATIONS

SH-1

All of the samples from this boring location are suggested to be treated with 1-1/2 pounds treble superphosphate (0-48-0) and 12 pounds potassium sulfate (0-0-50) per 1000 square feet for blending to 6-inches depth.

Amendment where the requirement varies is for organic matter which is suggested at a 3 cubic yard rate only for soil from the depth of 4.5-6 feet. Gypsum is suggested at a 120 pound rate for soil from the 3-4.5 foot depth but 90 pounds per 1000 square feet should be sufficient for soils from the higher and lower depths.

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AEW Engineering, Inc.
Report 10-196-0047

SM-1 Soil Type	Organic Matter cubic yards	Treble Superphosphate pounds, (0-48-0)	Potassium Sulfate pounds, (0-0-50)	Gypsum pounds
0-1.5 feet	0	1-1/2	6	0
3-4.5 feet	3	1-1/2	15	100
8-9.5 feet	3	0	15	150
SM-2				
0-1.5 feet	0	2	6	70
3-4.5 feet	3	2	15	150
5-6.5 feet	3	2	15	150

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Project : SFPUC Habitat Restoration, 21010-001

Report No : **10-196-0047**
Purchase Order : 2010-001
Date Recd : 07/15/2010
Date Printed : 07/27/2010

COMPREHENSIVE SOIL ANALYSIS

Sample Description - Sample ID	Half Sat % / TEC	pH / Qual Lime	ECe dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	K ppm	Ca ppm	Mg ppm	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Organic % dry wt.	Lab No.
				Sufficiency Factors											
AG-SM-1, 0'-1.5'	21	6.7	0.6	4	41	27	105	1804	230	2.5	1.5	9	260	3.7	25267
	113	None		1.1		1.1	0.7	1.0	0.9	1.7	0.3	0.7	4.7		
AG-SM-1, 3'-4.5'	18	6.6	0.7	7	41	15	100	1582	383	2.3	1.6	12	277	4.0	25268
	116	None		1.3		0.7	0.7	0.9	1.5	1.6	0.3	1.0	5.0		
AG-SM-1,4.5'-6'	20	6.7	0.6	9	34	24	77	1673	394	2.4	1.6	10	270	3.1	25269
	120	None		1.1		1.0	0.5	0.8	1.5	1.5	0.3	0.8	4.6		
SQ-SM-1, 1'-2.5'	22	7.4	1.1	5	42	17	69	2316	476	1.5	0.8	6	96	3.5	25270
	157	High		1.1		0.6	0.4	0.9	1.4	0.7	0.1	0.3	1.2		
SQ-SM-1, 7'-8.5'	15	7.5	0.8	7	54	22	52	1622	278	3.8	1.0	78	143	2.0	25271
	108	High		2.0		1.2	0.4	1.1	1.4	3.2	0.2	7.6	3.1		
SQ-SM-1, 15'-16.5'	18	7.6	0.6	4	52	11	36	2345	777	2.9	0.5	76	87	1.3	25272
	185	High		1.5		0.5	0.2	0.9	2.3	1.4	0.1	4.4	1.1		

Saturation Extract Values						SAR	Gravel %		Percent of Sample Passing 2 mm Screen					USDA Soil Classification	Lab No.
Ca meq/L	Mg meq/L	Na meq/L	K meq/L	B ppm	SO_4 meq/L		Coarse 5 - 12	Fine 2 - 5	Sand: Very Coarse 1 - 2	Sand: Coarse 0.5 - 1	Sand: Med. to Very Fine 0.05 - 0.5	Silt .002-.05	Clay 0-.002		
3.6	1.5	1.2	0.3	0.04	0.9	0.8	37.3	14.5	18.6	11.0	27.4	21.1	21.8	Very Gravelly Sandy Clay Loam	25267
2.4	1.6	1.7	0.2	0.05	1.5	1.2	20.1	12.1	9.7	7.4	22.7	26.3	33.8	Gravelly Clay Loam	25268
2.4	1.8	1.9	0	0.03	1.2	1.3	15.3	12.7	8.8	6.6	23.3	28.2	32.9	Gravelly Clay Loam	25269
5.5	3.2	2.4	0.2	0.05	4.6	1.2	10.7	9.8	8.4	8.8	23.6	27.2	31.9	Gravelly Clay Loam	25270
2.4	2.8	1.7	0.7	0.04	3.3	1.1	14.9	11.0	10.0	10.1	22.6	25.2	31.9	Gravelly Clay Loam	25271
2.3	2.2	1.5	0.1	0.02	1.4	1.0	29.4	16.1	15.5	10.8	22.4	22.2	28.9	Very Gravelly Sandy Clay Loam	25272

Sufficiency factor (1.0=sufficient for average crop) below each nutrient value. N factor based on 200 ppm constant feed. SAR = Sodium adsorption ratio. Half Saturation %=approx field moisture capacity. Nitrogen(N), Potassium(K), Calcium(Ca) and Magnesium(Mg) by sodium chloride extraction. Phosphorus(P) by sodium bicarbonate extraction. Copper(Cu), Zinc(Zn), Manganese(Mn) & Iron(Fe) by DTPA extraction. Sat. ext. method for salinity (ECe as dS/m),Boron (B), Sulfate(SO_4), Sodium(Na). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm(1/2 inch) sieve. Particle sizes in millimeters. Organic percentage determined by Walkley-Black or Loss on Ignition.

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Date Recd : 07/15/2010
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COMPREHENSIVE SOIL ANALYSIS

Sample Description - Sample ID	Half Sat % / TEC	pH / Qual Lime	ECe dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	K ppm	Ca ppm	Mg ppm	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Organic % dry wt.	Lab No.
				Sufficiency Factors											
SQ-SM-2, 4'-5.5'	15	7.7	1.9	4	29	11	10	1004	73	1.2	0.1	2	33	0.7	25273
	52	High		1.1		0.6	0.1	1.2	0.6	1.8	0	0.3	1.3		
SQ-SM-2, 8'-9.5'	16	7.5	2.5	4	30	10	33	928	35	1.7	0.1	1	60	0.4	25274
	43	High		1.1		0.5	0.4	1.3	0.4	3.1	0.1	0.2	2.9		
SQ-SM-3, 1'-2.5'	13	7.8	0.3	4	14	10	33	1639	78	0.8	1.0	2	22	0.5	25275
	89	High		0.7		0.6	0.4	1.4	0.5	0.8	0.3	0.3	0.6		
SQ-SM-3, 4-5.5'	13	8.1	0.2	4	10	9	20	390	21	1.0	2.5	1	13	0.4	25276
	22	High		0.5		0.6	0.3	1.0	0.4	3.6	2.3	0.3	1.2		
SB-SH-1, 0'-1.5'	29	7.1	0.9	10	17	15	45	2129	1936	2.4	1.5	8	215	6.9	25277
	270	None		0.5		0.4	0.1	0.5	3.3	0.7	0.1	0.3	1.6		
SB-SH-1, 3'-4.5'	24	7.4	0.7	5	26	15	31	1621	2226	2.5	0.4	9	62	2.1	25278
	269	None		0.7		0.5	0.1	0.4	4.3	0.8	0	0.3	0.5		

Saturation Extract Values						SAR	Gravel %		Percent of Sample Passing 2 mm Screen					USDA Soil Classification	Lab No.
									Sand						
Ca meq/L	Mg meq/L	Na meq/L	K meq/L	B ppm	SO_4 meq/L		Coarse 5 - 12	Fine 2 - 5	Very Coarse 1 - 2	Coarse 0.5 - 1	Med. to Very Fine 0.05 - 0.5	Silt .002-.05	Clay 0-.002		
18.0	2.8	1.7	0.7	0.06	23.3	0.5	35.8	16.0	21.3	24.4	33.1	10.2	10.9	Very Gravelly Sandy Loam	25273
26.5	3.0	1.5	0.7	0.13	33.7	0.4	25.0	17.3	24.9	19.0	33.9	12.1	10.0	Very Gravelly Sandy Loam	25274
1.8	0.6	0.6	-0.1	0.03	1.2	0.6	42.1	16.9	18.4	14.0	22.6	21.0	23.9	Very Gravelly Sandy Clay Loam	25275
1.3	0.4	0.5	0.2	0.03	0.6	0.5	69.5	15.3	32.6	20.0	25.1	10.2	12.0	Very Gravelly Sandy Loam	25276
2.1	3.8	2.7	0.7	0.08	1.2	1.6	11.9	10.9	6.3	8.0	21.5	30.2	33.9	Gravelly Clay Loam	25277
1.6	2.8	1.8	0.1	0.05	0.8	1.2	8.4	6.9	5.5	6.5	23.8	25.2	38.9	Gravelly Clay Loam	25278

Sufficiency factor (1.0=sufficient for average crop) below each nutrient value. N factor based on 200 ppm constant feed. SAR = Sodium adsorption ratio. Half Saturation %=approx field moisture capacity. Nitrogen(N), Potassium(K), Calcium(Ca) and Magnesium(Mg) by sodium chloride extraction. Phosphorus(P) by sodium bicarbonate extraction. Copper(Cu), Zinc(Zn), Manganese(Mn) & Iron(Fe) by DTPA extraction. Sat. ext. method for salinity (ECe as dS/m),Boron (B), Sulfate(SO_4), Sodium(Na). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm(1/2 inch) sieve. Particle sizes in millimeters. Organic percentage determined by Walkley-Black or Loss on Ignition.

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Project : SFPUC Habitat Restoration, 21010-001

Report No : **10-196-0047**
Purchase Order : 2010-001
Date Recd : 07/15/2010
Date Printed : 07/27/2010

COMPREHENSIVE SOIL ANALYSIS

Sample Description - Sample ID	Half Sat % / TEC	pH / Qual Lime	ECe dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	K ppm	Ca ppm	Mg ppm	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Organic % dry wt.	Lab No.
				Sufficiency Factors											
SB-SH-1, 4.5-6'	17	7.2	0.5	4	36	11	51	1410	1761	1.7	0.4	4	54	1.2	25279
	222	None		1.2		0.5	0.3	0.5	5.0	0.8	0	0.2	0.7		
SB-SM-1, 0'-1.5'	33	6.7	0.6	9	46	21	99	1761	842	3.3	2.8	13	282	7.7	25280
	161	None		0.8		0.5	0.4	0.7	2.4	1.6	0.3	0.7	3.6		
SB-SM-1, 3'-4.5'	20	7.2	0.5	6	45	10	30	1929	2942	1.8	0.2	5	53	1.1	25281
	353	None		1.3		0.4	0.1	0.5	5.5	0.6	0	0.2	0.4		
SB-SM-1, 8'-9.5'	20	7.6	0.4	4	58	20	11	1602	3947	0.9	0	6	50	0.7	25282
	426	None		1.6		0.8	0	0.3	6.4	0.2	0	0.2	0.3		
SB-SM-2, 0'-1.5'	30	6.4	0.9	10	58	9	61	1282	798	3.4	1.7	14	497	5.1	25283
	138	None		1.1		0.2	0.3	0.6	2.6	1.9	0.2	0.9	7.4		
SB-SM-2, 3'-4.5'	29	7.6	1.2	4	20	10	24	1660	3196	2.1	0.1	1	52	1.0	25284
	354	None		0.4		0.3	0.1	0.3	4.6	0.5	0	0	0.3		

Saturation Extract Values						SAR	Gravel %		Percent of Sample Passing 2 mm Screen					USDA Soil Classification	Lab No.
									Sand						
Ca meq/L	Mg meq/L	Na meq/L	K meq/L	B ppm	SO_4 meq/L		Coarse 5 - 12	Fine 2 - 5	Very Coarse 1 - 2	Coarse 0.5 - 1	Med. to Very Fine 0.05 - 0.5	Silt .002-.05	Clay 0-.002		
1.3	1.8	1.6	0.2	0.03	1.1	1.3	2.0	5.4	5.0	5.2	25.7	27.1	36.9	Clay Loam	25279
2.4	3.2	1.7	0.3	0.09	0.6	1.0	9.3	13.3	13.6	9.4	18	21.0	37.8	Gravelly Clay Loam	25280
1.1	1.1	2.3	0.1	0.05	1.1	2.2	18.2	12.6	10.0	12.1	28.7	21.2	27.9	Gravelly Sandy Clay Loam	25281
0.2	0.9	2.2	0.4	0.03	0.6	3.0	18.4	13.8	15.1	15.8	32	17.1	19.9	Gravelly Sandy Loam	25282
1.0	2.5	3.0	1.3	0.07	1.7	2.3	4.9	5.1	4.3	3.8	27.9	26.0	37.8	Clay Loam	25283
1.9	3.7	3.5	1.1	0.04	1.6	2.1	1.7	9.0	8.6	5.1	22.3	16.0	47.8	Clay	25284

Sufficiency factor (1.0=sufficient for average crop) below each nutrient value. N factor based on 200 ppm constant feed. SAR = Sodium adsorption ratio. Half Saturation %=approx field moisture capacity. Nitrogen(N), Potassium(K), Calcium(Ca) and Magnesium(Mg) by sodium chloride extraction. Phosphorus(P) by sodium bicarbonate extraction. Copper(Cu), Zinc(Zn), Manganese(Mn) & Iron(Fe) by DTPA extraction. Sat. ext. method for salinity (ECe as dS/m),Boron (B), Sulfate(SO_4), Sodium(Na). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm(1/2 inch) sieve. Particle sizes in millimeters. Organic percentage determined by Walkley-Black or Loss on Ignition.

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Project : SFPUC Habitat Restoration, 21010-001

COMPREHENSIVE SOIL ANALYSIS

Report No : **10-196-0047**
Purchase Order : 2010-001
Date Recd : 07/15/2010
Date Printed : 07/27/2010

Sample Description - Sample ID	Half Sat % / TEC	pH / Qual Lime	ECe dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	K ppm	Ca ppm	Mg ppm	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Organic % dry wt.	Lab No.
				Sufficiency Factors											
SB-SM-2, 5'-6.5'	25	7.5	0.6	6	28	14	33	1764	3638	1.6	0.1	2	49	1.2	25285
	397	None		0.7		0.5	0.1	0.3	5.5	0.4	0	0.1	0.3		

Saturation Extract Values						SAR	Gravel %		Percent of Sample Passing 2 mm Screen					USDA Soil Classification	Lab No.
									Sand						
Ca meq/L	Mg meq/L	Na meq/L	K meq/L	B ppm	SO_4 meq/L		Coarse 5 - 12	Fine 2 - 5	Very Coarse 1 - 2	Coarse 0.5 - 1	Med. to Very Fine 0.05 - 0.5	Silt .002-.05	Clay 0-.002		
1.1	2.3	2.1	0.4	0.03	1.0	1.6	6.0	7.7	7.2	6.6	29.1	18.1	38.9	Clay Loam	25285

Sufficiency factor (1.0=sufficient for average crop) below each nutrient value. N factor based on 200 ppm constant feed. SAR = Sodium adsorption ratio. Half Saturation %=approx field moisture capacity. Nitrogen(N), Potassium(K), Calcium(Ca) and Magnesium(Mg) by sodium chloride extraction. Phosphorus(P) by sodium bicarbonate extraction. Copper(Cu), Zinc(Zn), Manganese(Mn) & Iron(Fe) by DTPA extraction. Sat. ext. method for salinity (ECe as dS/m),Boron (B), Sulfate(SO_4), Sodium(Na). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm(1/2 inch) sieve. Particle sizes in millimeters. Organic percentage determined by Walkley-Black or Loss on Ignition.

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SAN JOSE OFFICE
August 11, 2010
Report 10-210-0051

AEW Engineering, Inc.
55 New Montgomery St., Suite 722
San Francisco, CA 94105

Attn: Randall Young

RE: SFPUC HABITAT RESTORATION, SAN MATEO
PROJ. #2010-001, JOB #2010-021

BACKGROUND

Samples received 7/29 represent site soils from three borings from various depths at the Sherwood Point site and a single topsoil sample from the Skyline Blvd site. Areas will be revegetated after grading occurs. The key map showing the sample location at Skyline indicated that would be with Northern Coyote Brush Scrub.

SHERWOOD POINT

ANALYTICAL RESULTS

Particle size makeup of these three samples is fairly uniform placing them in the clay loam classification by USDA standards. There is a slight excess of gravel in TP-1. That sample also shows particularly low organic content with organic matter at 2 and 3 sufficient. The infiltration rate based on these characteristics is estimated at 0.22 inch per hour and may be just slightly slower at 1.

Reaction of TP-2 is moderately to strongly acidic and a bit more so than preferred. The moderate acidity at 3 and slight acidity at 1 are suitable. All show favorably low salinity, sodium and boron with SAR values showing soluble sodium adequately balanced by calcium and magnesium.

All of the samples are deficient in nitrogen, phosphorus and potassium. Calcium is low relative to high magnesium in 1 and 3 with 2 showing a satisfactory balance. Zinc is deficient in each of the samples with the other micronutrients in adequate ranges.

RECOMMENDATIONS

Rates are suggested to treat 1000 square feet and be blended to 6-inches depth.

Soil Type	Organic Matter cubic yards	Treble Superphosphate pounds, (0-48-0)	Potassium Sulfate pounds, (0-0-50)	Gypsum pounds	*CC Lime pounds
TP-1, 56”	3	5	10	70	0
TP-2, 6 and 12”	0	5	10	0	70
TP-3, 6”	0	5	10	70	0

* Lime should be calcium carbonate lime and not dolomite.

SKYLINE BLVD

ANALYTICAL RESULTS

Particle size data for this sample shows a sandy clay loam classification with a slight excess of gravel. Coarse sand sizes are broadly distributed and this along with 51% silt plus clay indicates a moderate susceptibility toward consolidation. The amount of organic matter present is at a very good level to help offset this tendency. Based on these characteristics the infiltration rate is estimated at 0.21 inch per hour.

Reaction is moderately acidic and at a suitable level. Salinity, sodium and boron levels are safely low and the SAR value shows soluble sodium is adequately balanced by calcium and magnesium.

This soil is deficient in nitrogen, phosphorus and zinc with potassium fair at best. The calcium to magnesium balance is proper and the other required nutrients are adequately supplied. Iron is particularly abundant but not problematically high.

RECOMMENDATIONS

Amendment requirements for this soil would be limited to 5 pounds each Treble Superphosphate (0-48-0) and Potassium Sulfate (0-0-50) per 1000 square feet for blending to 6-inches depth.

Jim West

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Email 3 pages.

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Project : SFPUC Habitat Restoration
San Mateo

COMPREHENSIVE SOIL ANALYSIS

Report No : **10-210-0051**
Purchase Order :
Date Recd : 07/29/2010
Date Printed : 08/05/2010

Sample Description - Sample ID	Half Sat % / TEC	pH / Qual Lime	ECe dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	K ppm	Ca ppm	Mg ppm	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Organic % dry wt.	Lab No.
				Sufficiency Factors											
SP-TP-1, 56"	21	6.4	0.4	5	2	3	49	1786	1544	1.3	0.3	8	41	1.9	25484
	221	None		0.2		0.1	0.2	0.6	4.0	0.5	0	0.4	0.5		
SP-TP-2, 6" and 12"	31	5.1	0.3	6	6	1	94	1908	853	3.4	1.6	47	187	4.8	25485
	168	None		0.2		0	0.4	0.7	2.2	1.5	0.2	2.4	2.2		
SP-TP-3, 6"	26	5.5	0.3	6	5	1	91	1994	1738	3.1	1.2	27	120	5.2	25486
	246	None		0.2		0	0.4	0.6	4.0	1.2	0.1	1.2	1.2		
SB-SH-2, 6"	32	5.6	0.6	12	10	8	204	3659	1099	5.7	3.7	32	554	7.0	25487
	277	None		0.3		0.2	0.7	0.9	2.0	1.8	0.3	1.2	4.5		

Saturation Extract Values						SAR	Gravel %		Percent of Sample Passing 2 mm Screen					USDA Soil Classification	Lab No.
									Sand						
Ca meq/L	Mg meq/L	Na meq/L	K meq/L	B ppm	SO_4 meq/L		Coarse 5 - 12	Fine 2 - 5	Very Coarse 1 - 2	Coarse 0.5 - 1	Med. to Very Fine 0.05 - 0.5	Silt .002-.05	Clay 0-.002		
1.1	1.1	1.4	0	0.03	0.5	1.4	11.6	8.4	8.0	9.3	24.2	26.1	32.2	Gravelly Clay Loam	25484
1.1	0.9	0.9	0.2	0.04	0.6	1.0	6.7	4.9	7.0	7.7	20.8	28.1	36.3	Clay Loam	25485
1.2	1.2	1.0	0	0.04	0.8	0.9	3.6	9.3	8.1	8.4	23	27.1	33.3	Clay Loam	25486
2.7	2.3	1.3	0.2	0.08	0.9	0.8	6.1	15.2	17.0	11.6	19.8	21.1	30.4	Gravelly Sandy Clay Loam	25487

Sufficiency factor (1.0=sufficient for average crop) below each nutrient value. N factor based on 200 ppm constant feed. SAR = Sodium adsorption ratio. Half Saturation %=approx field moisture capacity. Nitrogen(N), Potassium(K), Calcium(Ca) and Magnesium(Mg) by sodium chloride extraction. Phosphorus(P) by sodium bicarbonate extraction. Copper(Cu), Zinc(Zn), Manganese(Mn) & Iron(Fe) by DTPA extraction. Sat. ext. method for salinity (ECe as dS/m),Boron (B), Sulfate(SO_4), Sodium(Na). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm(1/2 inch) sieve. Particle sizes in millimeters. Organic percentage determined by Walkley-Black or Loss on Ignition.

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Appendix B – Soil Survey & Watershed Data

Vegetation Map

Soil Survey Map

Watershed Input Data

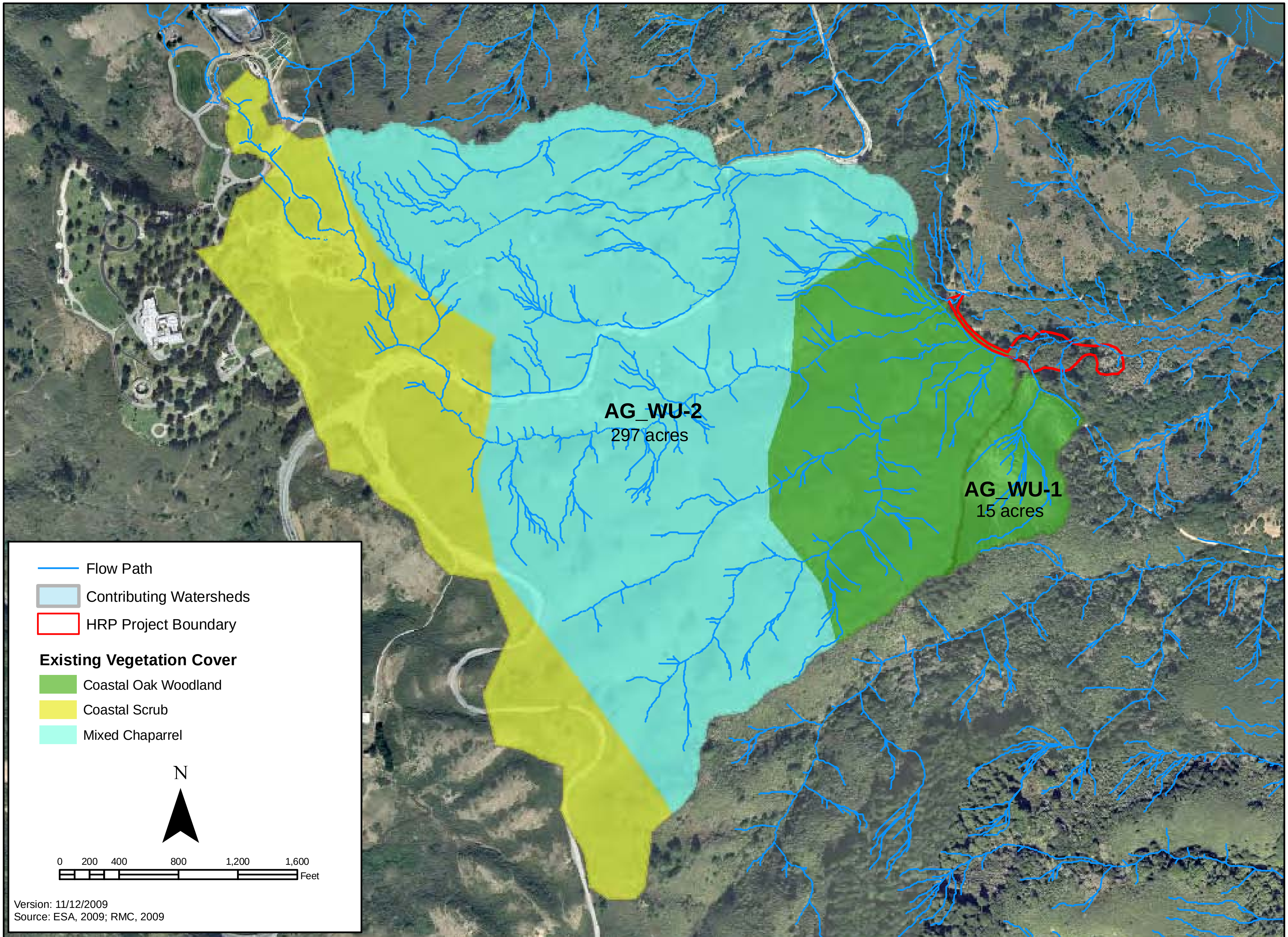
Physical Soil Properties

RUSLE2 Related Attributes

Vegetation Types

Footnotes:

a. Based on California Department of Fish and Game's California Wildlife Habitat Relationships Map, 1998.



San Francisco Public Utilities Commission
Habitat Reserve Program

Figure AG-1: Watershed Hydrology
Adobe Gulch Creek Wetland Creation

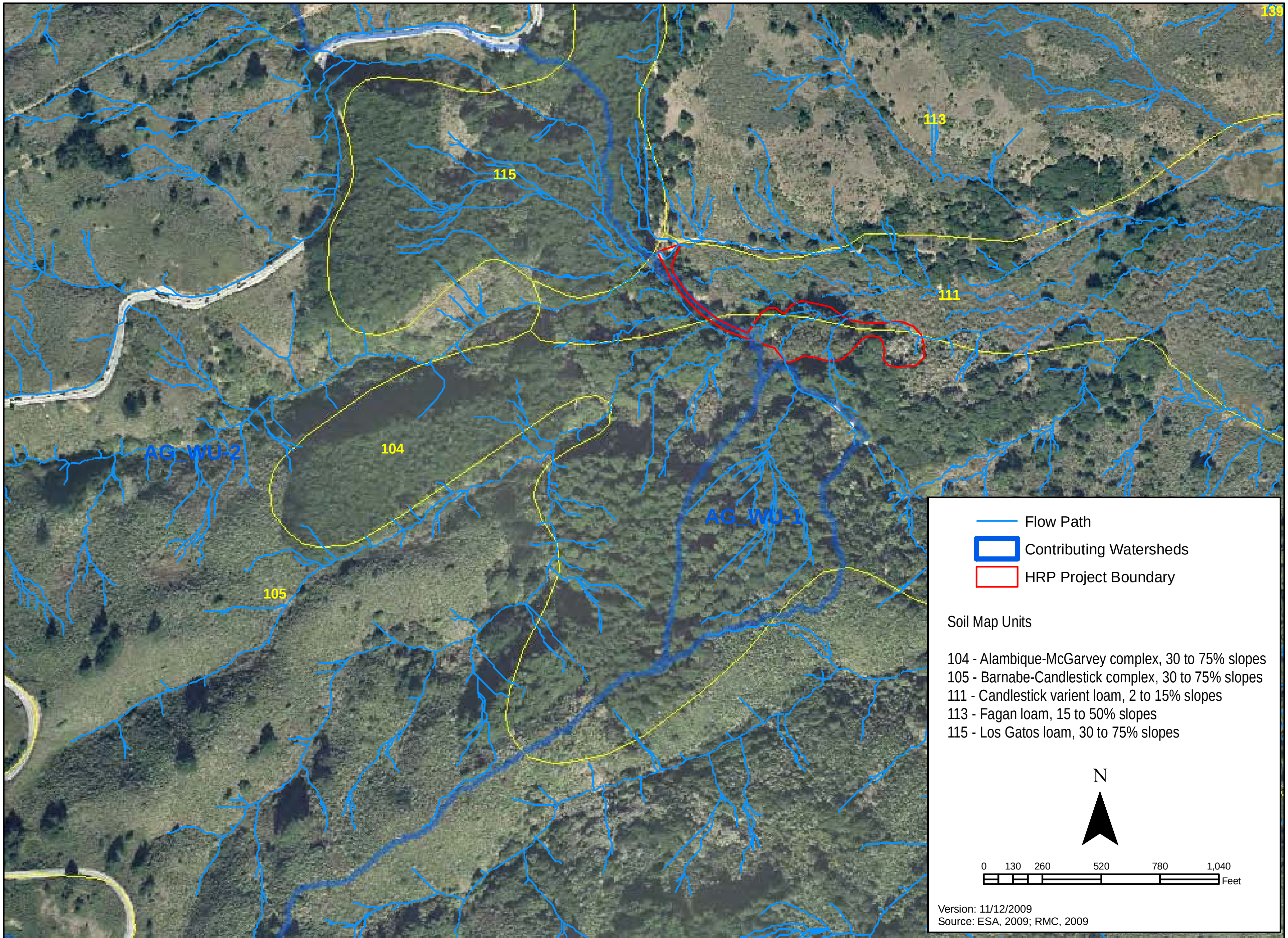
San Francisco Public Utilities Commission
Habitat Reserve Program

Figure SB-3: Watershed Landcover
Skyline Boulevard Wetland Creation

Soil Map Units

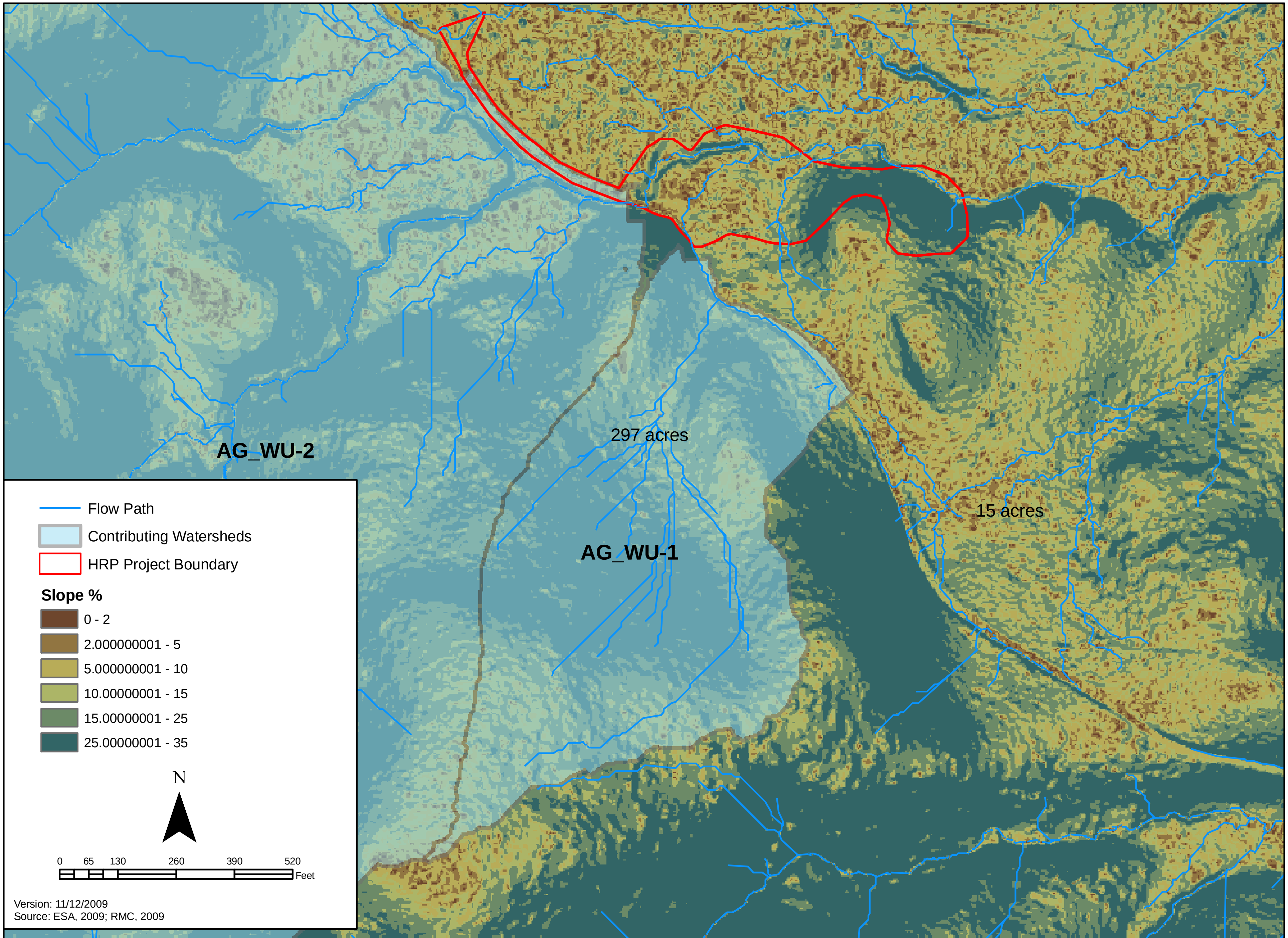
Footnotes:

b. Based on Soil survey data produced by the Natural Resources Conservation District (NRCS) for San Mateo County, Eastern Part, and San Francisco County, California (CA689, 2008).



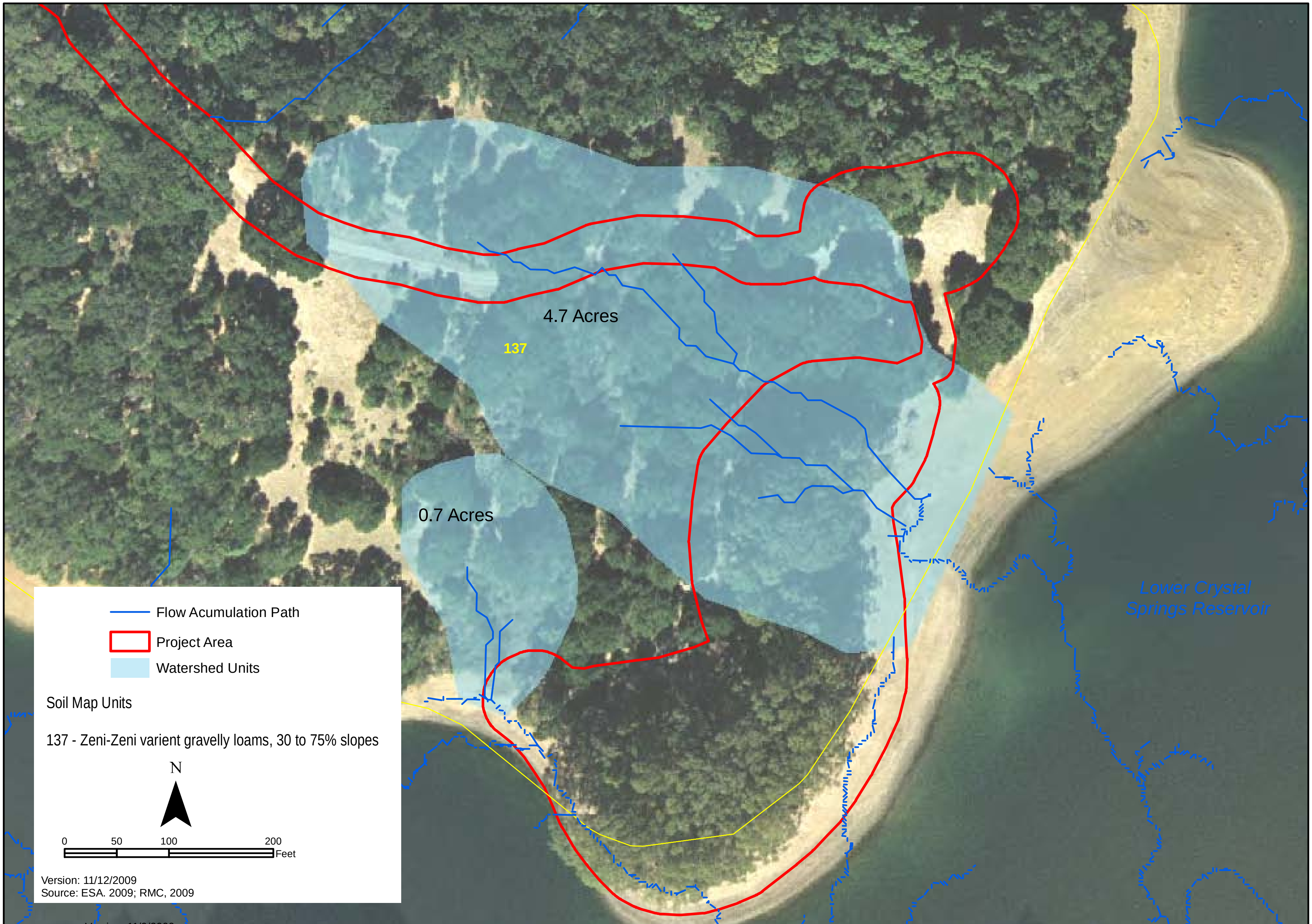
San Francisco Public Utilities Commission
Habitat Reserve Program

Figure AG-2: Watershed Soils
Adobe Gulch Creek Wetland Creation



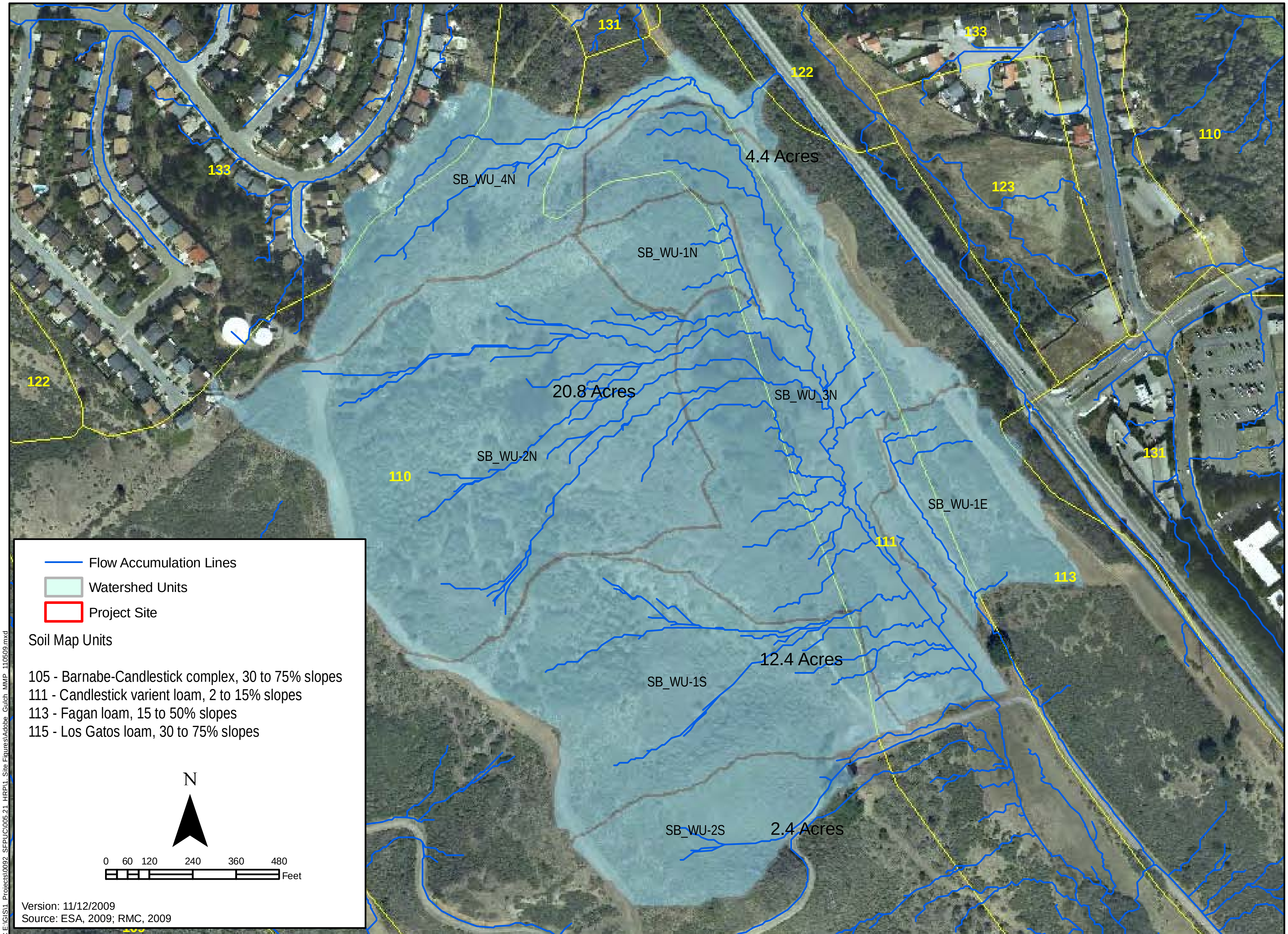
San Francisco Public Utilities Commission
Habitat Reserve Program

Figure AG-4: Watershed Slope
Adobe Gulch Creek Wetland Creation



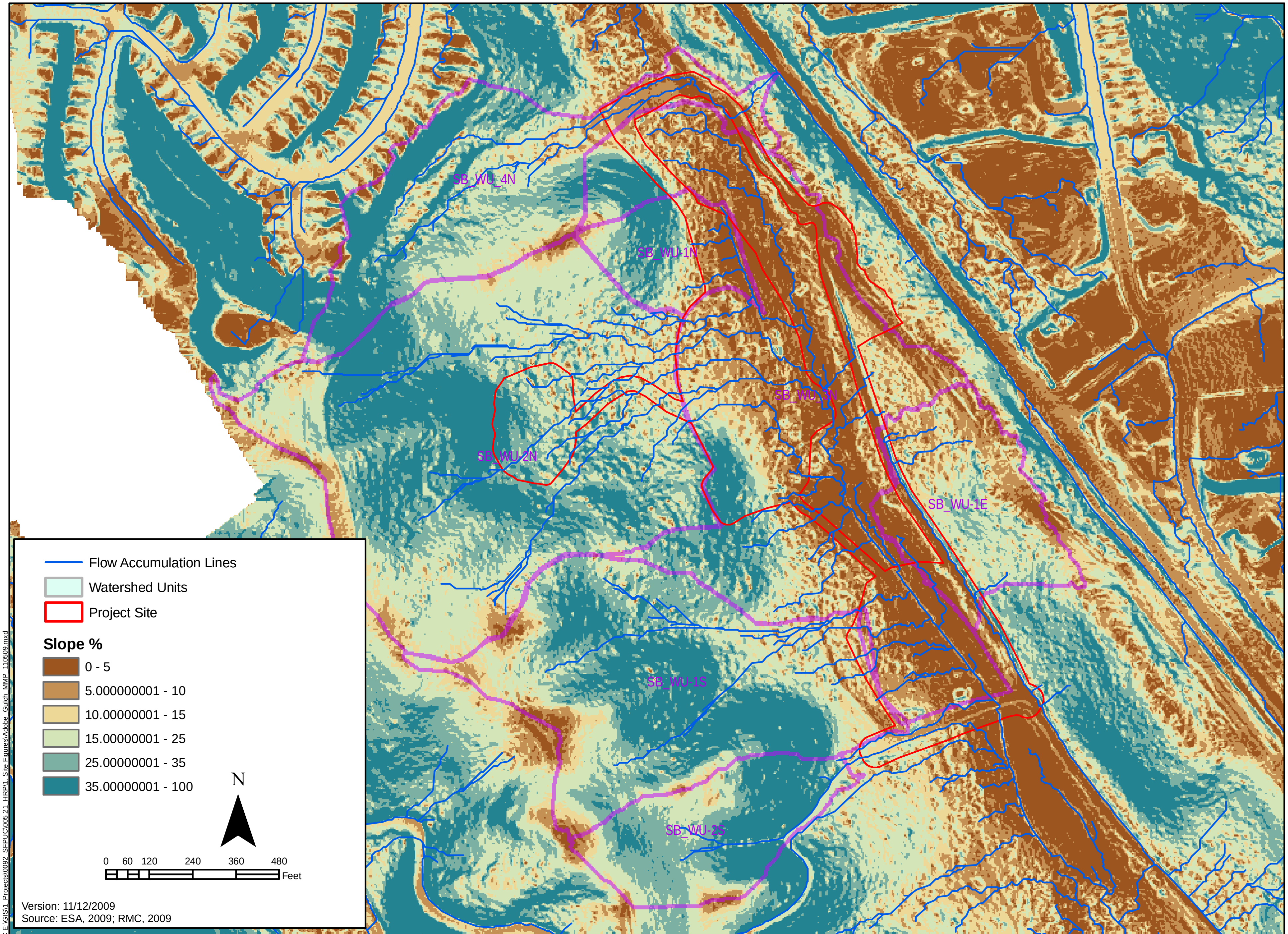
San Francisco Public Utilities Commission
Habitat Reserve Program

Figure SP-2: Soils Map
Sherwood Point Oak Restoration



San Francisco Public Utilities Commission
Habitat Reserve Program

Figure SB-2: Watershed Soils
Skyline Boulevard Habitat Improvement



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San Francisco Public Utilities Commission
Habitat Reserve Program

Figure SB-4: Watershed Slopes
Skyline Boulevard Habitat Improvement

Brief Soil Descriptions (CA)

San Mateo County, Eastern Part, and San Francisco County, California

[Absence of an entry indicates that the feature is not a concern or that data were not estimated. Data applies to the entire extent of the map unit within the survey area. Map unit and soil properties for a specific parcel of land may vary somewhat and should be determined by onsite investigation]

104--Alambique-McGarvey complex, 30 to 75 percent slopes

Composition

- Alambique and similar soils: 45 percent of the unit
- McGarvey and similar soils: 35 percent of the unit
- Maymen soils: 3 percent of the unit
- Rock outcrop: 3 percent of the unit
- Unnamed: 3 percent of the unit
- Unnamed: 3 percent of the unit
- Unnamed: 3 percent of the unit
- Unnamed: 3 percent of the unit

Setting

Landform(s): mountain slopes, mountains
Elevation: 348 to 1988 feet
Precipitation: 30 to 40 inches

Slope gradient: 30 to 75 percent
Air temperature: 54 to 57 ºF
Frost-free period: 275 to 330 days

Characteristics of Alambique and similar soils

Average total avail. water in top five feet (in.): 3.3
Available water capacity class: Low
Parent material: residuum weathered from sandstone
Restrictive feature(s): paralithic bedrock at 20 to 40 inches
Depth to Water table: none within the soil profile
Drainage class: well drained
Flooding hazard: none
Ponding hazard: none

Soil loss tolerance (T factor): 3
Wind erodibility group (WEG): 6
Wind erodibility index (WEI): 48
Land capability class, irrigated:
Land capability class, nonirrigated: 7e
Hydric soil: no
Hydrologic group: B
Runoff class: high
Potential frost action:

Saturated hydraulic conductivity class: Moderately High

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 12	Gravelly loam	1.1 to 1.5	5.1 to 6.0	0.0 to 2.0	0
H2 -- 12 to 30	Gravelly loam	1.6 to 2.4	5.1 to 6.0	0.0 to 2.0	0
H3 -- 30 to 34	Weathered bedrock			Null	Null

Ecological class(es):

Characteristics of McGarvey and similar soils

Average total avail. water in top five feet (in.): 5.8
Available water capacity class: Low
Parent material: residuum weathered from sandstone
Restrictive feature(s): paralithic bedrock at 20 to 40 inches
Depth to Water table: none within the soil profile
Drainage class: well drained
Flooding hazard: none
Ponding hazard: none

Soil loss tolerance (T factor): 3
Wind erodibility group (WEG): 5
Wind erodibility index (WEI): 56
Land capability class, irrigated:
Land capability class, nonirrigated: 7e
Hydric soil: no
Hydrologic group: C
Runoff class: very high
Potential frost action:

Saturated hydraulic conductivity class: Moderately Low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 7	Loam	1.0 to 1.1	6.1 to 6.5	0.0 to 2.0	0
H2 -- 7 to 14	Clay loam	1.2 to 1.3	6.6 to 7.3	0.0 to 2.0	0
H3 -- 14 to 37	Clay	3.2 to 3.7	6.1 to 7.3	0.0 to 2.0	0
H4 -- 37 to 41	Weathered bedrock			Null	Null

Ecological class(es):

105--Barnabe-Candlestick complex, 30 to 75 percent slopes

Composition

- Barnabe and similar soils: 45 percent of the unit
- Candlestick and similar soils: 35 percent of the unit
- Buriburi soils: 3 percent of the unit
- Candlestick var: 3 percent of the unit
- Kron soils: 3 percent of the unit
- Outcrop: 3 percent of the unit
- Unnamed: 3 percent of the unit

Setting

Landform(s): mountain slopes, uplands
Elevation: 200 to 1342 feet
Precipitation: 20 to 30 inches
Slope gradient: 30 to 75 percent
Air temperature: 54 to 57 ºF
Frost-free period: 300 to 350 days

Characteristics of Barnabe and similar soils

Average total avail. water in top five feet (in.): 0.9
Available water capacity class: Very low
Parent material: hard fractured residuum weathered from sandstone
Restrictive feature(s): lithic bedrock at 8 to 20 inches
Depth to Water table: none within the soil profile
Drainage class: well drained
Flooding hazard: none
Ponding hazard: none
Saturated hydraulic conductivity class: Moderately High
Soil loss tolerance (T factor): 1
Wind erodibility group (WEG): 5
Wind erodibility index (WEI): 56
Land capability class, irrigated:
Land capability class, nonirrigated: 7e
Hydric soil: no
Hydrologic group: D
Runoff class: high
Potential frost action: none

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 7	Very gravelly sandy loam	0.4 to 0.6	5.6 to 6.5	0.0 to 2.0	0
H2 -- 7 to 12	Very gravelly sandy loam	0.3 to 0.5	5.6 to 6.5	0.0 to 2.0	0
H3 -- 12 to 16	Unweathered bedrock			Null	Null

Ecological class(es):

Characteristics of Candlestick and similar soils

Average total avail. water in top five feet (in.): 3.6

Available water capacity class: Low

Parent material: hard fractured residuum weathered from sandstone

Restrictive feature(s): lithic bedrock at 20 to 40 inches

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 2

Wind erodibility group (WEG): 3

Wind erodibility index (WEI): 86

Land capability class, irrigated:

Land capability class, nonirrigated: 7e

Hydric soil: no

Hydrologic group: C

Runoff class: very high

Potential frost action: none

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 2	Fine sandy loam	0.2 to 0.3	5.6 to 6.5	0.0 to 2.0	0
H2 -- 2 to 20	Loam	2.5 to 2.9	5.6 to 6.5	0.0 to 2.0	0
H3 -- 20 to 24	Sandy clay loam	0.6 to 0.7	6.1 to 7.3	0.0 to 2.0	0
H4 -- 24 to 28	Unweathered bedrock			Null	Null

Ecological class(es):

106--Barnabe-Rock outrock complex, 15 to 75 percent slopes

Composition

- Barnabe and similar soils: 40 percent of the unit
- Rock outrock: 40 percent of the unit
- Buriburi soils: 3 percent of the unit
- Candlestick soils: 3 percent of the unit
- Kron: 3 percent of the unit
- Unnamed: 3 percent of the unit
- Unnamed: 3 percent of the unit
- Unnamed: 3 percent of the unit

Setting

Landform(s): mountain slopes, uplands
Elevation: 299 to 846 feet
Precipitation: 20 to 30 inches
Slope gradient: 30 to 75 percent
Air temperature: 54 to 57 ºF
Frost-free period: 300 to 350 days

Characteristics of Barnabe and similar soils

Average total avail. water in top five feet (in.): 0.9
Available water capacity class: Very low
Parent material: hard fractured residuum weathered from sandstone
Restrictive feature(s): lithic bedrock at 8 to 20 inches
Depth to Water table: none within the soil profile
Drainage class: well drained
Flooding hazard: none
Ponding hazard: none
Saturated hydraulic conductivity class: Moderately High
Soil loss tolerance (T factor): 1
Wind erodibility group (WEG): 5
Wind erodibility index (WEI): 56
Land capability class, irrigated:
Land capability class, nonirrigated: 7e
Hydric soil: no
Hydrologic group: D
Runoff class: medium
Potential frost action: none

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 7	Very gravelly sandy loam	0.4 to 0.6	5.6 to 6.5	0.0 to 2.0	0
H2 -- 7 to 12	Very gravelly sandy loam	0.3 to 0.5	5.6 to 6.5	0.0 to 2.0	0
H3 -- 12 to 16	Unweathered bedrock			Null	Null

Ecological class(es):

Characteristics of Rock outrock

Average total avail. water in top five feet (in.):

Available water capacity class: NA

Parent material:

Restrictive feature(s): lithic bedrock at 0 to 0 inches

Depth to Water table:

Drainage class:

Flooding hazard:

Ponding hazard:

Soil loss tolerance (T factor):

Wind erodibility group (WEG):

Wind erodibility index (WEI):

Land capability class, irrigated:

Land capability class, nonirrigated: 8s

Hydric soil: no

Hydrologic group: D

Runoff class: very high

Potential frost action: none

Saturated hydraulic conductivity class: Very Low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 60	Unweathered bedrock			Null	0

Ecological class(es):

109--Candlestick-Barnabe complex, 30 to 50 percent slopes

Composition

- Candlestick and similar soils: 45 percent of the unit
- Barnabe and similar soils: 25 percent of the unit
- Buriburi soils: 4 percent of the unit
- Kron soils: 4 percent of the unit
- Orthents cut&fill: 4 percent of the unit
- Rock outcrop: 4 percent of the unit
- Unnamed: 4 percent of the unit

Setting

Landform(s): mountain slopes, mountains

Elevation: 75 to 1204 feet

Precipitation: 20 to 30 inches

Slope gradient: 30 to 50 percent

Air temperature: 54 to 57 ºF

Frost-free period: 300 to 350 days

Characteristics of Candlestick and similar soils

Average total avail. water in top five feet (in.): 3.6

Available water capacity class: Low

Parent material: hard fractured residuum weathered from sandstone

Restrictive feature(s): lithic bedrock at 20 to 40 inches

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 2

Wind erodibility group (WEG): 3

Wind erodibility index (WEI): 86

Land capability class, irrigated:

Land capability class, nonirrigated: 6e

Hydric soil: no

Hydrologic group: C

Runoff class: very high

Potential frost action: none

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 2	Fine sandy loam	0.2 to 0.3	5.6 to 6.5	0.0 to 2.0	0
H2 -- 2 to 20	Loam	2.5 to 2.9	5.6 to 6.5	0.0 to 2.0	0
H3 -- 20 to 24	Sandy clay loam	0.6 to 0.7	6.1 to 7.3	0.0 to 2.0	0
H4 -- 24 to 28	Unweathered bedrock			Null	Null

Ecological class(es):

Characteristics of Barnabe and similar soils

Average total avail. water in top five feet (in.): 0.9
Available water capacity class: Very low
Parent material: residuum weathered from sandstone
Restrictive feature(s): lithic bedrock at 8 to 20 inches
Depth to Water table: none within the soil profile
Drainage class: well drained
Flooding hazard: none
Ponding hazard: none

Soil loss tolerance (T factor): 1
Wind erodibility group (WEG): 5
Wind erodibility index (WEI): 56
Land capability class, irrigated:
Land capability class, nonirrigated: 6e
Hydric soil: no
Hydrologic group: D
Runoff class: medium
Potential frost action: none

Saturated hydraulic conductivity class: Moderately High

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 7	Very gravelly sandy loam	0.4 to 0.6	5.6 to 6.5	0.0 to 2.0	0
H2 -- 7 to 12	Very gravelly sandy loam	0.3 to 0.5	5.6 to 6.5	0.0 to 2.0	0
H3 -- 12 to 16	Unweathered bedrock			Null	Null

Ecological class(es):

110--Candlestick-Kron-Buriburi complex, 30 to 75 percent slo pes

Composition

- Candlestick and similar soils: 40 percent of the unit
- Kron and similar soils: 25 percent of the unit
- Buriburi and similar soils: 20 percent of the unit
- Barnabe soils: 2 percent of the unit
- Orthents cut&fill: 2 percent of the unit
- Rock outcrop: 2 percent of the unit
- Typic Argiustolls: 2 percent of the unit
- Unnamed: 2 percent of the unit
- Unnamed: 2 percent of the unit
- Unnamed: 2 percent of the unit

Setting

Landform(s): mountain slopes, mountains
Elevation: 200 to 1342 feet
Precipitation: 20 to 30 inches
Slope gradient: 30 to 75 percent
Air temperature: 54 to 57 ºF
Frost-free period: 300 to 350 days

Characteristics of Candlestick and similar soils

Average total avail. water in top five feet (in.): 3.6
Available water capacity class: Low
Parent material: hard fractured residuum weathered from sandstone
Restrictive feature(s): lithic bedrock at 20 to 40 inches
Depth to Water table: none within the soil profile
Drainage class: well drained
Flooding hazard: none
Ponding hazard: none
Soil loss tolerance (T factor): 2
Wind erodibility group (WEG): 3
Wind erodibility index (WEI): 86
Land capability class, irrigated:
Land capability class, nonirrigated: 7e
Hydric soil: no
Hydrologic group: C
Runoff class: high
Potential frost action: none
Saturated hydraulic conductivity class: Moderately High

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 2	Fine sandy loam	0.2 to 0.3	5.6 to 6.5	2.0	0
H2 -- 2 to 20	Loam	2.5 to 2.9	5.6 to 6.5	2.0	0
H3 -- 20 to 24	Sandy clay loam	0.6 to 0.7	6.1 to 7.3	2.0	0

Ecological class(es):

Characteristics of Kron and similar soils

Average total avail. water in top five feet (in.): 2.0

Available water capacity class: Very low

Parent material: hard fractured residuum weathered from sandstone

Restrictive feature(s): lithic bedrock at 10 to 20 inches

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 1

Wind erodibility group (WEG): 3

Wind erodibility index (WEI): 86

Land capability class, irrigated:

Land capability class, nonirrigated: 7e

Hydric soil: no

Hydrologic group: D

Runoff class: high

Potential frost action: none

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 3	Sandy loam	0.3 to 0.4	5.6 to 6.5	0.0 to 2.0	0
H2 -- 3 to 14	Loam	1.5 to 1.8	5.6 to 6.5	0.0 to 2.0	0
H3 -- 14 to 18	Unweathered bedrock			Null	Null

Ecological class(es):

Characteristics of Buriburi and similar soils

Average total avail. water in top five feet (in.): 3.6

Available water capacity class: Low

Parent material: hard fractured residuum weathered from sandstone

Restrictive feature(s): lithic bedrock at 20 to 40 inches

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 2

Wind erodibility group (WEG): 7

Wind erodibility index (WEI): 38

Land capability class, irrigated:

Land capability class, nonirrigated: 7e

Hydric soil: no

Hydrologic group: C

Runoff class: high

Potential frost action: none

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 30	Gravelly loam	3.0 to 4.2	5.6 to 6.5	2.0	0

Ecological class(es):

111--Candlestick variant loam, 2 to 15 percent slopes

Composition

- Candlestick variant and similar soils: 85 percent of the unit
- Unnamed: 5 percent of the unit
- Unnamed: 5 percent of the unit

Setting

Landform(s): alluvial fans, alluvial plains
Elevation: 26 to 400 feet
Precipitation: 20 to 30 inches

Slope gradient: 2 to 15 percent
Air temperature: 54 to 57 ºF
Frost-free period: 300 to 350 days

Characteristics of Candlestick variant and similar soils

Average total avail. water in top five feet (in.): 10.4
Available water capacity class: High
Parent material: alluvium derived from mixed
Restrictive feature(s): none
Depth to Water table: none within the soil profile
Drainage class: well drained
Flooding hazard: none
Ponding hazard: none

Soil loss tolerance (T factor): 5
Wind erodibility group (WEG): 6
Wind erodibility index (WEI): 48
Land capability class, irrigated:
Land capability class, nonirrigated: 3e
Hydric soil: no
Hydrologic group: B
Runoff class: medium
Potential frost action: none

Saturated hydraulic conductivity class: Moderately High

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 21	Loam	2.5 to 3.1	5.6 to 6.0	0.0 to 2.0	0
H2 -- 21 to 65	Clay loam	6.6 to 7.9	6.1 to 7.8	0.0 to 2.0	0

Ecological class(es):

Brief Soil Descriptions (CA)

San Mateo County, Eastern Part, and San Francisco County, California

[Absence of an entry indicates that the feature is not a concern or that data were not estimated. Data applies to the entire extent of the map unit within the survey area. Map unit and soil properties for a specific parcel of land may vary somewhat and should be determined by onsite investigation]

113--Fagan loam, 15 to 50 percent slopes

Composition

- Fagan and similar soils: 85 percent of the unit
- Maymen soils: 4 percent of the unit
- Obispo soils: 4 percent of the unit
- Rock outcrop: 4 percent of the unit
- Unnamed: 3 percent of the unit

Setting

Landform(s): hills, uplands
Elevation: 200 to 1988 feet
Precipitation: 25 to 35 inches
Slope gradient: 15 to 50 percent
Air temperature: 55 to 59 ºF
Frost-free period: 275 to 330 days

Characteristics of Fagan and similar soils

Average total avail. water in top five feet (in.): 7.1
Available water capacity class: Moderate
Parent material:
Restrictive feature(s): paralithic bedrock at 40 to 60 inches
Depth to Water table: none within the soil profile
Drainage class: well drained
Flooding hazard: none
Ponding hazard: none

Soil loss tolerance (T factor): 4
Wind erodibility group (WEG): 6
Wind erodibility index (WEI): 48
Land capability class, irrigated:
Land capability class, nonirrigated: 6e
Hydric soil: no
Hydrologic group: C
Runoff class: very high
Potential frost action: none
Soil loss tolerance (T factor): 4
Wind erodibility group (WEG): 6
Wind erodibility index (WEI): 48
Land capability class, irrigated:
Land capability class, nonirrigated: 6e
Hydric soil: no
Hydrologic group: C
Runoff class: very high
Potential frost action: none

Saturated hydraulic conductivity class: Moderately Low

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 5	Loam	0.8 to 0.9	5.6 to 7.3	0.0 to 2.0	0
H2 -- 5 to 26	Clay loam	3.5 to 4.0	5.6 to 7.3	0.0 to 2.0	0
H3 -- 26 to 43	Clay	2.4 to 2.7	5.6 to 7.3	0.0 to 2.0	0

Ecological class(es):

115--Los Gatos loam, 30 to 75 percent slopes

Composition

- Los Gatos and similar soils: 85 percent of the unit
- Fagan soils: 2 percent of the unit
- Maymen soils: 2 percent of the unit
- Obispo soils: 2 percent of the unit
- Orthents cut&fill: 2 percent of the unit
- Rock outcrop: 2 percent of the unit
- Unnamed: 2 percent of the unit
- Urban land: 2 percent of the unit

Setting

Landform(s): hills, uplands
Elevation: 200 to 397 feet
Precipitation: 25 to 35 inches
Slope gradient: 30 to 75 percent
Air temperature: 54 to 57 ºF
Frost-free period: 275 to 330 days

Characteristics of Los Gatos and similar soils

Average total avail. water in top five feet (in.): 5.6
Available water capacity class: Low
Parent material: residuum weathered from sandstone
Restrictive feature(s): lithic bedrock at 20 to 40 inches
Depth to Water table: none within the soil profile
Drainage class: well drained
Flooding hazard: none
Ponding hazard: none
Soil loss tolerance (T factor): 2
Wind erodibility group (WEG): 6
Wind erodibility index (WEI): 48
Land capability class, irrigated:
Land capability class, nonirrigated: 7e
Hydric soil: no
Hydrologic group: C
Runoff class: very high
Potential frost action: none

Saturated hydraulic conductivity class: Moderately High

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 22	Loam	3.1 to 3.5	5.6 to 7.3	0.0 to 2.0	0
H2 -- 22 to 36	Sandy clay loam	1.9 to 2.8	5.6 to 7.3	0.0 to 2.0	0
H3 -- 36 to 40	Unweathered bedrock			Null	Null

Ecological class(es):

137--Zeni-Zeni variant gravelly loams, 30 to 75 percent slopes

Composition

- Zeni and similar soils: 40 percent of the unit
- Zeni variant and similar soils: 35 percent of the unit
- Alambique soils: 6 percent of the unit
- Maymen soils: 6 percent of the unit
- Unnamed: 6 percent of the unit
- Unnamed: 6 percent of the unit

Setting

Landform(s): hills, mountain slopes, mountains, upland slopes, uplands

Elevation: 299 to 1099 feet

Precipitation: 30 to 45 inches

Slope gradient: 30 to 75 percent

Air temperature: 54 to 55 ºF

Frost-free period: 275 to 330 days

Characteristics of Zeni and similar soils

Average total avail. water in top five feet (in.): 3.4

Available water capacity class: Low

Parent material: residuum weathered from sandstone

Restrictive feature(s): lithic bedrock at 20 to 40 inches

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Soil loss tolerance (T factor): 2

Wind erodibility group (WEG): 6

Wind erodibility index (WEI): 48

Land capability class, irrigated:

Land capability class, nonirrigated: 7e

Hydric soil: no

Hydrologic group: C

Runoff class: high

Potential frost action: none

Saturated hydraulic conductivity class: Moderately High

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 9	Gravelly loam	0.9 to 1.4	5.1 to 6.5	2.0	0
H2 -- 9 to 26	Gravelly sandy clay loam	1.9 to 2.5	5.1 to 5.5	2.0	0
H2 -- 9 to 26	Gravelly clay loam	1.9 to 2.5	5.1 to 5.5	2.0	0
H3 -- 26 to 30	Weathered bedrock			Null	Null

Ecological class(es):

Characteristics of Zeni variant and similar soils

Average total avail. water in top five feet (in.): 4.4

Available water capacity class: Low

Parent material: residuum weathered from metasedimentary rock

Restrictive feature(s): lithic bedrock at 20 to 40 inches

Depth to Water table: none within the soil profile

Drainage class: well drained

Flooding hazard: none

Ponding hazard: none

Saturated hydraulic conductivity class: Moderately High

Soil loss tolerance (T factor): 2

Wind erodibility group (WEG): 6

Wind erodibility index (WEI): 48

Land capability class, irrigated:

Land capability class, nonirrigated: 7e

Hydric soil: no

Hydrologic group: C

Runoff class: very high

Potential frost action: none

Representative soil profile:

Horizon -- Depth (inches)	Texture	Available water capacity (inches)	pH	Salinity (mmhos/cm)	SAR
H1 -- 0 to 13	Gravelly loam	1.4 to 1.8	5.6 to 6.5	2.0	0
H2 -- 13 to 31	Very gravelly clay loam	1.1 to 2.2	5.1 to 6.0	2.0	0
H3 -- 31 to 39	Gravelly clay loam	0.9 to 1.2	5.1 to 6.0	2.0	0
H4 -- 39 to 43	Unweathered bedrock			Null	Null

Ecological class(es):

Engineering Properties

San Mateo County, Eastern Part, and San Francisco County, California

[Absence of an entry indicates that the data were not estimated. This report shows only the major soils in each map unit]

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percent passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 Inches	3-10 Inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
104:												
Alambique	0-12	Gravelly loam	GC-GM, GM, SC-SM, SM	A-4	0	0	55-80	50-75	45-65	35-50	25-35	5-10
	12-30	Gravelly loam	GC-GM, GM, SC-SM, SM	A-4	0	0	55-80	50-75	45-65	35-50	25-35	5-10
	30-34	Weathered bedrock	---	---	---	---	---	---	---	---	---	---
McGarvey	0-7	Loam	CL-ML, ML	A-4	0	0	85-95	80-90	65-75	50-70	25-35	5-10
	7-14	Clay loam	CL	A-6	0	0	90-100	90-100	75-85	65-80	30-40	10-20
	14-37	Clay, clay loam	CH, CL	A-7	0	0	90-100	90-100	85-95	75-85	40-55	20-30
	37-41	Weathered bedrock	---	---	---	---	---	---	---	---	---	---
105:												
Barnabe	0-7	Very gravelly sandy loam	GC-GM, GM	A-1, A-2	0	0	45-55	35-50	25-35	15-25	20-30	NP-10
	7-12	Very gravelly loam, very gravelly sandy loam	GC-GM, GM	A-2	0	0	45-55	35-50	25-45	15-30	25-35	5-10
	12-16	Unweathered bedrock	---	---	---	---	---	---	---	---	---	---
Candlestick	0-2	Fine sandy loam	SM	A-4	0	0	90-100	85-100	65-75	35-50	20-30	NP-5
	2-20	Loam	ML	A-4	0	0	90-100	85-100	75-85	50-60	25-35	NP-10
	20-24	Clay loam, sandy clay loam	CL, SC	A-6	0	0	80-95	75-95	70-85	35-60	30-40	10-20
	24-28	Unweathered bedrock	---	A-6	---	---	---	---	---	---	---	---

Engineering Properties

San Mateo County, Eastern Part, and San Francisco County, California

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percent passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 Inches	3-10 Inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
106:												
Barnabe	0-7	Very gravelly sandy loam	GC-GM, GM	A-1, A-2	0	0	45-55	35-50	25-35	15-25	20-30	NP-10
	7-12	Very gravelly loam, very gravelly sandy loam	GC-GM, GM	A-2	0	0	45-55	35-50	25-45	15-30	25-35	5-10
	12-16	Unweathered bedrock	---	---	---	---	---	---	---	---	---	---
Rock outrock	0-60	Unweathered bedrock	---	---	---	---	---	---	---	---	---	---
109:												
Candlestick	0-2	Fine sandy loam	SM	A-4	0	0	90-100	85-100	65-75	35-50	20-30	NP-5
	2-20	Loam	ML	A-4	0	0	90-100	85-100	75-85	50-60	25-35	NP-10
	20-24	Clay loam, sandy clay loam	CL, SC	A-6	0	0	80-95	75-95	70-85	35-60	30-40	10-20
	24-28	Unweathered bedrock	---	---	---	---	---	---	---	---	---	---
Barnabe	0-7	Very gravelly sandy loam	GC-GM, GM	A-1, A-2	0	0	45-55	35-50	25-35	15-25	20-30	NP-10
	7-12	Very gravelly loam, very gravelly sandy loam	GC-GM, GM	A-2	0	0	45-55	35-50	25-45	15-30	25-35	5-10
	12-16	Unweathered bedrock	---	---	---	---	---	---	---	---	---	---
110:												
Candlestick	0-2	Fine sandy loam	SM	A-4	0	0	90-100	85-100	65-75	35-50	20-30	NP-5
	2-20	Loam	ML	A-4	0	0	90-100	85-100	75-85	50-60	25-35	NP-10
	20-24	Clay loam, sandy clay loam	CL, SC	A-6	0	0	80-95	75-95	70-85	35-60	30-40	10-20
	24-28	Unweathered bedrock	CL, GC	A-6	---	---	---	---	---	---	---	---
Kron	0-3	Sandy loam	SM	A-4	0	0	90-100	85-100	50-75	35-50	20-30	NP-5
	3-14	Loam, very fine sandy loam	ML	A-4	0	0	90-100	85-100	65-85	50-65	25-35	NP-10
	14-18	Unweathered bedrock	---	---	---	---	---	---	---	---	---	---

Engineering Properties

San Mateo County, Eastern Part, and San Francisco County, California

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percent passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 Inches	3-10 Inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
110:												
Buriburi	0-30	Gravelly loam	GM, SM	A-4	0	0	55-80	50-75	45-70	35-50	25-35	NP-10
	30-34	Unweathered bedrock	---	---	---	---	---	---	---	---	---	---
111:												
Candlestick variant	0-21	Loam	CL-ML, ML	A-4	0	0	90-100	85-100	75-95	50-75	25-35	5-10
	21-65	Clay loam	CL	A-6	0	0	90-100	85-100	80-90	65-80	30-40	10-20

Engineering Properties

San Mateo County, Eastern Part, and San Francisco County, California

[Absence of an entry indicates that the data were not estimated. This report shows only the major soils in each map unit]

Map symbol and soil name	Depth	USDA texture	Classification		Fragments		Percent passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 Inches	3-10 Inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
113:												
Fagan	0-5	Loam	CL, CL-ML	A-4, A-6	0	0	80-100	75-100	70-95	60-80	25-35	5-15
	5-26	Clay loam	CL	A-6, A-7	0	0	80-100	75-100	70-95	65-85	35-45	15-25
	26-43	Clay, silty clay	CH, CL	A-7	0	0	80-100	75-100	75-100	70-95	40-60	20-35
	43-47	Weathered bedrock	---	---	---	---	---	---	---	---	---	---
115:												
Los Gatos	0-22	Loam	CL-ML, ML	A-4	0	0-5	90-100	80-95	75-85	50-65	25-35	5-10
	22-36	Sandy clay loam	CL	A-6	0	0-5	75-95	75-95	60-80	50-65	30-40	10-20
	36-40	Unweathered bedrock	---	---	---	---	---	---	---	---	---	---
137:												
Zeni	0-9	Gravelly loam	GC-GM, GM, SC-SM, SM	A-2, A-4	0	0-5	55-80	50-75	40-65	30-50	25-35	5-10
	9-26	Gravelly clay loam, gravelly sandy clay loam	GC, SC	A-6	0	0-5	55-80	50-75	45-70	35-50	30-40	10-20
	26-30	Weathered bedrock	---	---	---	---	---	---	---	---	---	---
Zeni variant	0-13	Gravelly loam	GC-GM, GM, SC-SM, SM	A-4	0	0-5	65-80	60-75	55-70	35-50	25-35	5-10
	13-31	Very gravelly clay loam	GC	A-6	0	5-20	55-65	50-60	45-55	35-50	30-40	10-15
	31-39	Gravelly clay loam	CL	A-6	0	0-5	70-80	65-75	60-70	50-65	30-40	10-15
	39-43	Unweathered bedrock	---	---	---	0-5	70-80	65-75	60-70	50-65	---	---

Physical Soil Properties

San Mateo County, Eastern Part, and San Francisco County, California

[Entries under "Erosion Factors--T" apply to the entire profile. Entries under "Wind Erodibility Group" and "Wind Erodibility Index" apply only to the surface layer. Absence of an entry indicates that data were not estimated. This report shows only the major soils in each map unit]

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensi-bility	Organic matter	Erosion factors			Wind erodi-bility group	Wind erodi-bility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
104:														
Alambique	0-12	---	---	15-25	1.45-1.55	4.00-14.00	0.09-0.13	0.0-2.9	1.0-4.0	.15	.28	3	6	48
	12-30	---	---	18-25	1.45-1.55	4.00-14.00	0.09-0.13	0.0-2.9	0.5-1.0	.17	.32			
	30-34	---	---	---	---	---	---	---	---	---	---			
McGarvey	0-7	---	---	15-25	1.45-1.55	4.00-14.00	0.14-0.16	0.0-2.9	1.0-3.0	.24	.32	3	5	56
	7-14	---	---	27-35	1.40-1.50	1.40-4.00	0.17-0.19	3.0-5.9	0.5-1.0	.28	.28			
	14-37	---	---	35-45	1.35-1.50	0.42-1.40	0.14-0.16	6.0-8.9	0.5-1.0	.28	.28			
	37-41	---	---	---	---	---	---	---	---	---	---			
105:														
Barnabe	0-7	---	---	12-20	1.50-1.60	14.00-42.00	0.06-0.08	0.0-2.9	1.0-3.0	.10	.28	1	5	56
	7-12	---	---	15-27	1.50-1.60	4.00-14.00	0.07-0.10	0.0-2.9	1.0-2.0	.15	.32			
	12-16	---	---	---	---	---	---	---	---	---	---			
Candlestick	0-2	---	---	15-20	1.50-1.60	4.00-14.00	0.12-0.14	0.0-2.9	1.0-3.0	.24	.28	2	3	86
	2-20	---	---	18-25	1.45-1.55	4.00-14.00	0.14-0.16	0.0-2.9	1.0-2.0	.24	.28			
	20-24	---	---	27-30	1.45-1.55	1.40-4.00	0.14-0.18	3.0-5.9	0.0-0.5	.20	.24			
	24-28	---	---	---	---	---	---	---	---	---	---			
106:														
Barnabe	0-7	---	---	12-20	1.50-1.60	14.00-42.00	0.06-0.08	0.0-2.9	1.0-3.0	.10	.28	1	5	56
	7-12	---	---	15-27	1.45-1.55	4.00-14.00	0.07-0.10	0.0-2.9	1.0-2.0	.15	.32			
	12-16	---	---	---	---	---	---	---	---	---	---			
Rock outrock	0-60	---	---	---	---	0.00-0.01	---	---	---	---	---	---	---	---

Physical Soil Properties

San Mateo County, Eastern Part, and San Francisco County, California

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensi-bility	Organic matter	Erosion factors			Wind erodi-bility group	Wind erodi-bility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
109:														
Candlestick	0-2	---	---	15-20	1.50-1.60	4.00-14.00	0.12-0.14	0.0-2.9	1.0-3.0	.24	.28	2	3	86
	2-20	---	---	18-25	1.45-1.55	4.00-14.00	0.14-0.16	0.0-2.9	1.0-2.0	.24	.28			
	20-24	---	---	27-30	1.45-1.55	1.40-4.00	0.14-0.18	3.0-5.9	0.0-0.5	.20	.24			
	24-28	---	---	---	---	---	---	---	---	---	---			
Barnabe	0-7	---	---	12-20	1.50-1.60	14.00-42.00	0.06-0.08	0.0-2.9	1.0-3.0	.10	.28	1	5	56
	7-12	---	---	15-27	1.45-1.55	4.00-14.00	0.07-0.10	0.0-2.9	1.0-2.0	.15	.32			
	12-16	---	---	---	---	---	---	---	---	---	---			
110:														
Candlestick	0-2	---	---	15-20	1.50-1.60	4.00-14.00	0.12-0.14	0.0-2.9	1.0-3.0	.24	.28	2	3	86
	2-20	---	---	18-25	1.45-1.55	4.00-14.00	0.14-0.16	0.0-2.9	1.0-2.0	.24	.28			
	20-24	---	---	27-30	1.45-1.55	1.40-4.00	0.14-0.18	3.0-5.9	0.0-0.5	.20	.24			
	24-28	---	---	---	---	---	---	---	---	---	---			
Kron	0-3	---	---	15-20	1.50-1.60	14.00-42.00	0.11-0.13	0.0-2.9	1.0-5.0	.24	.28	1	3	86
	3-14	---	---	15-20	1.45-1.55	4.00-14.00	0.14-0.16	0.0-2.9	1.0-2.0	.49	.55			
	14-18	---	---	---	---	---	---	---	---	---	---			
Buriburi	0-30	---	---	18-27	1.45-1.55	4.00-14.00	0.10-0.14	0.0-2.9	1.0-3.0	.15	.28	2	7	38
	30-34	---	---	---	---	---	---	---	---	---	---			
111:														
Candlestick variant	0-21	---	---	18-27	1.45-1.55	4.00-14.00	0.12-0.15	0.0-2.9	1.0-3.0	.28	.32	5	6	48
	21-65	---	---	27-35	1.40-1.50	1.40-4.00	0.15-0.18	3.0-5.9	0.0-0.5	.24	.28			

Physical Soil Properties

San Mateo County, Eastern Part, and San Francisco County, California

[Entries under "Erosion Factors--T" apply to the entire profile. Entries under "Wind Erodibility Group" and "Wind Erodibility Index" apply only to the surface layer. Absence of an entry indicates that data were not estimated. This report shows only the major soils in each map unit]

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensi-bility	Organic matter	Erosion factors			Wind erodi-bility group	Wind erodi-bility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
113:														
Fagan	0-5	---	---	20-27	1.45-1.55	4.00-14.00	0.15-0.17	3.0-5.9	1.0-3.0	.28	.32	4	6	48
	5-26	---	---	35-40	1.40-1.50	1.40-4.00	0.17-0.19	3.0-5.9	0.5-2.0	.24	.28			
	26-43	---	---	40-60	1.25-1.45	0.42-1.40	0.14-0.16	6.0-8.9	0.5-2.0	.24	.28			
	43-47	---	---	---	---	---	---	---	---	---	---			
115:														
Los Gatos	0-22	---	---	20-25	1.45-1.55	4.00-14.00	0.14-0.16	0.0-2.9	1.0-4.0	.28	.32	2	6	48
	22-36	---	---	25-35	1.45-1.55	1.40-4.00	0.14-0.20	3.0-5.9	0.0-0.5	.32	.37			
	36-40	---	---	---	---	---	---	---	---	---	---			
137:														
Zeni	0-9	---	---	15-27	1.45-1.55	4.00-14.00	0.10-0.15	0.0-2.9	1.0-4.0	.17	.28	2	6	48
	9-26	---	---	15-35	1.40-1.50	4.00-14.00	0.11-0.15	3.0-5.9	0.0-1.0	.15	.24			
	26-30	---	---	---	---	---	---	---	---	---	---			
Zeni variant	0-13	---	---	15-25	1.45-1.55	4.00-14.00	0.11-0.14	0.0-2.9	1.0-3.0	.15	.24	2	6	48
	13-31	---	---	30-35	1.40-1.50	1.40-4.00	0.06-0.12	3.0-5.9	1.0-2.0	.10	.24			
	31-39	---	---	30-35	1.40-1.50	1.40-4.00	0.12-0.15	3.0-5.9	0.0-0.5	.20	.28			
	39-43	---	---	---	---	---	---	---	---	---	---			

[This report shows only the major soils in each map unit]

Map symbol and soil name	Pct. of map unit	Hydrologic group	Kf	T factor	Representative value		
					% Sand	% Silt	% Clay
105:							
Barnabe	45	D	.28	1	65.1	18.9	16.0
Candlestick	35	C	.28	2	63.1	19.4	17.5
106:							
Barnabe	40	D	.28	1	65.1	18.9	16.0
Rock outrock	40	D	---	---	---	---	---
109:							
Candlestick	45	C	.28	2	63.1	19.4	17.5
Barnabe	25	D	.28	1	65.1	18.9	16.0
110:							
Candlestick	40	C	.28	2	68.1	14.4	17.5
Kron	25	D	.28	1	67.2	15.3	17.5
Buriburi	20	C	.28	2	39.8	37.7	22.5
111:							
Candlestick variant	85	B	.32	5	39.8	37.7	22.5
115:							
Los Gatos	85	C	.32	2	39.8	37.7	22.5
122:							
Orthents	85	D	---	5	---	---	---
124:							
Orthents	50	D	---	5	---	---	---
Urban land	35	D	---	---	---	---	---
133:							
Urban land	50	D	---	---	---	---	---
Orthents	40	C	---	5	---	---	---

Skyline Blvd

Slope

	min	max	mean	SD	0-5%	5-10%	10-20%	>20%
sb-wu-1n	0	29.9096	6.452618	4.67581	45.3%	30.9%	23.6%	0.2%
sb-wu-1s	0	30.67332	8.893392	4.691397	24.1%	41.6%	32.5%	1.8%
sb-wu-2n	0	30.29302	8.553616	3.88404	19.1%	51.5%	29.0%	0.4%
sb-wu-2s	0.07793	34.41397	10.13092	4.457606	10.5%	49.0%	38.5%	2.1%
sb_wu-1e	0.052993	16.07232	4.192643	2.652743	65.0%	33.2%	1.8%	0.0%
sb-wu-3n	0	26.2959	3.56891	3.673168	77.9%	13.0%	9.0%	0.1%
sb-wu-4n	0	41.15668	8.370059	5.133165	27.3%	41.1%	29.4%	2.2%

Watershed Area

	acres	
sb-wu-1n	2.42	North-Central wetland
sb-wu-1s	12.46	Southwest wetland
sb-wu-2n	20.8	North-Central wetland
sb-wu-2s	4.43	Southwest wetland
sb_wu-1e	5	Southeast Wetland
sb-wu-3n	18.636	
sb-wu-4n	8.3607	

Soils

	Unit	Acres	Hydro-Group
sb-wu-1n	110	2.08	C
sb-wu-1n	111	0.35	B
sb-wu-1s	110	12.13	C
sb-wu-1s	111	0.35	B
sb-wu-2n	110	20.83	C
sb-wu-2s	110	4.43	C
sb_wu-1e	113	3.38	C
sb_wu-1e	111	1.57	B
sb_wu-1e	131	0.03	D
sb-wu-3n	111	10.5	B
sb-wu-3n	110	6.16	C
sb-wu-3n	113	1.82	C
sb-wu-4n	110	5.18	C
sb-wu-4n	133	1.42	D
sb-wu-4n	111	1.19	B

	sb-wu-1n	sb-wu-1s	sb-wu-2n	sb-wu-2s	sb_wu-1e	sb-wu-3n	sb-wu-4n
A							
B	0.35	0.35	**20.83**	**4.43**	1.57	10.5	
C	**2.08**	**12.13**			**3.38**	7.98	6.37
D					0.03		1.42

	sb-wu-1n	sb-wu-1s	sb-wu-2n	sb-wu-2s	sb_wu-1e	sb-wu-3n	sb-wu-4n
Shrub	**2.43**	8.21	**18.42**		3.34	17.23	4.33
Urban		4.27	2.41	**4.43**	1.64	1.37	4.04

Vegetation

	Acres	Type	
sb-wu-1n	2.43	MCH	Mixed Chaperal
sb-wu-1s	4.27	URB	Urban
sb-wu-1s	8.21	MCH	Mixed Chaperal
sb-wu-2s	4.43	URB	Urban
sb_wu-1e	1.64	URB	Urban
sb_wu-1e	3.34	MCH	Mixed Chaperal
sb-wu-2n	18.42	MCH	Mixed Chaperal
sb-wu-2n	2.41	URB	Urban
sb-wu-3n	17.23	MCH	Mixed Chaperal
sb-wu-3n	1.37	URB	Urban
sb-wu-4n	4.33	MCH	Mixed Chaperal
sb-wu-4n	4.04	URB	Urban

			0-5%	5-10%	10-20%	>20%	
sb-wu-1n	C	shrub	1.1 ac	0.7 ac	0.6 ac	0.0 ac	
sb-wu-1s	C	shrub	2.0 ac	3.4 ac	2.7 ac	0.1 ac	
		urban	1.0 ac	1.8 ac	1.4 ac	0.1 ac	7.1 ac
sb-wu-2n	B	shrub	3.5 ac	9.5 ac	5.3 ac	0.1 ac	
		urban	0.5 ac	1.2 ac	0.7 ac	0.0 ac	7.8 ac
sb-wu-2s	B	urban	0.5 ac	2.2 ac	1.7 ac	0.1 ac	
sb_wu-1e	C	shrub	2.2 ac	1.1 ac	0.1 ac	0.0 ac	
		urban	1.1 ac	0.5 ac	0.0 ac	0.0 ac	
sb_wu-3n	B	shrub	13.4 ac	2.2 ac	1.5 ac	0.0 ac	18.6 ac
		urban	1.1 ac	0.2 ac	0.1 ac	0.0 ac	
sb_wu-4n	C	shrub	1.2 ac	1.8 ac	1.3 ac	0.1 ac	4.3 ac
		urban	1.1 ac	1.7 ac	1.2 ac	0.1 ac	4.0 ac

Adobe Gulch

Slope

	min	max	mean	SD
AG-WU-1	0.07793	29.22693	7.646509	3.32605985
AG-WU-2	0	216.59	34.2	22.61

0-5%	5-10%	10-20%	>20%
25.3%	52.4%	22.1%	0.1%

Watershed Area

15.0 acres To AG Wetland

Vegetation Cover

	Acres	Type	
AG-WU-1	15	Coast Oak Woodland	Drains to Roadside Ditch
AG-WU-2	93.3	Coastal Scrub	Drains to Creek
AG-WU-2	214.6	Mixed Chaparrel	Drains to Creek
AG-WU-2	65.3	Coast Oak Woodland	Drains to Creek

Watershed Area

	Acres	
AG-WU-1	15	
AG-WU-2	297	[No longer applicable]

Soils

	Unit	Acres	Hydro-Group
AG-WU-1	105	0.6	D
AG-WU-1	104	14.4	**B**
AG-WU-2	GIC2	9	C
AG-WU-2	GID2	11.18	C
AG-WU-2	GIE2	1.23	C
AG-WU-2	GIB	12.5	C
AG-WU-2	GIF	2.5	C
AG-WU-2	GoF3	0.01	C
AG-WU-2	104	40.1	B
AG-WU-2	105	262.9	D
AG-WU-2	109	3.2	C
AG-WU-2	111	3.9	B
AG-WU-2	115	26.5	C

	0-5%	5-10%	10-20%	>20%
B, Forest	3.80 ac	7.86 ac	3.32 ac	0.02 ac

Yearly Peaks

1960	2.2637	1960	4.8973	2.163405
1961	0.7917	1961	4.9261	6.22218
1962	4.3985	1962	5.4928	1.248789
1963	2.1866	1963	3.026	1.383884
1964	1.6618	1964	3.9494	2.37658
1965	2.4999	1965	2.5371	1.014881
1966	2.0681	1966	3.7403	1.808568
1967	3.7848	1967	4.2592	1.125343
1968	3.1461	1968	5.412	1.720225
1969	5.9727	1969	5.2367	0.876773
1970	6.3298	1970	7.1493	1.129467
1971	2.4221	1971	5.6913	2.349738
1972	0.7612	1972	0.0622	0.081713
1973	4.8708	1973	8.0684	1.656484
1974	2.5395	1974	11.5887	4.563379
1975	1.9973	1975	5.6504	2.829019
1976	0.0023	1976	0.0027	1.173913
1977	0.4817	1977	2.1125	4.38551
1978	2.1001	1978	9.8963	4.712299
1979	2.2863	1979	8.4791	3.708656
1980	2.8262	1980	5.7624	2.038922
1981	0.8815	1981	1.3983	1.586273
1982	5.989	1982	9.757	1.629153
1983	17.1312	1983	5.8871	0.343648
1984	3.6874	1984	3.6045	0.977518
1985	4.0986	1985	3.0846	0.752598
1986	8.5999	1986	6.5883	0.76609
1987	2.8962	1987	3.0449	1.051343
1988	6.4956	1988	3.5262	0.54286
1989	3.2264	1989	2.4932	0.77275
1990	2.2833	1990	3.4082	1.492664
1991	0.8182			
1992	7.6383			
1993	5.114			
1994	1.268			
1995	6.4672			
1996	0.7141			
1997	5.5072			

Abode Gulch Wetland Water Balance Inputs

Interim Factors Inputs

Soil Depth to Restrictive Layer (Existing) - inches	<42	sandstone	
Surface Elevation (Existing) - ft msl	370	at road	
Surface Permeability (Ksat) - in/hr	0.57-1.98	gravelley, sandy loam - (0-30" in Alambique; 7" in McGarvey)	
Sub-Surface Permeability (Ksat) - in/hr	0.2-0.57	loam or clay loam - (>30 in Alambique;	
	0.06--0.2	clay - >14" in Alambique	
Soil Depth to Restricitive Layer (Proposed) - inches	>24	sandstone	
Surface Elevation (Proposed) - ft msl	368		372
Surface Permeability (Ksat) - in/hr	0.2-0.57	clay loam - 0-12"	
Sub-Surface Permeability (Ksat) - in/hr	0.06-0.2	clay 12 - 24	
Surface Kfactor - soil unit 104	0.32		
Winter Groundwater Elevation (Existing) - inches bgs	bedrock		
Summer Groundwater Elevation (Existing) - inches bgs	bedrock		
Winter Groundwater Elevation (Proposed) - inches bgs	<12		
Summer Groundwater Elevation (Proposed) - inches bgs	>24		
Outlet Height	4 ft		

Groundwater X-Section Inputs

Slope Input (%)	10	
Ksat - in/hr	1.98	
Wetland Area	0.68	ac
Wetland Perimeter	718.5	ft

Final, Field-Verified Factor Inputs

Skyline Blvd Northcentral Wetland Water Balance Inputs

Interim Factors Inputs

Soil Depth to Restrictive Layer (Existing) - inches	<30	[Note site is located at transition between soil units; 111 adjacent >60"]
Surface Elevation (Existing) - ft msl	472	[range 470 - 485]
Surface Permeability (Ksat) - in/hr	0.57-1.98	sandy to fine sandy loam, <24"
Sub-Surface Permeability (Ksat) - in/hr	0.2-0.57	sandy clay loam, clay loam, <24 inches
		bedrock ranges between 18 - 36"
Soil Depth to Restricitive Layer (Proposed) - inches	**36**	
Surface Elevation (Proposed) - ft msl	**470**	
Surface Permeability (Ksat) - in/hr	**0.57-1.98**	**sandy loam @ <12"**
Sub-Surface Permeability (Ksat) - in/hr	**0.2-0.57**	**clay loam or sandy clay loam @ >12"**
Surface Kfactor - soil unit 110	0.28	
Winter Groundwater Elevation (Existing) - inches bgs	n/a	observed @ <4" from surface on 1/25/2010
Summer Groundwater Elevation (Existing) - inches bgs	**n/a**	
Winter Groundwater Elevation (Proposed) - inches bgs	<12	
Summer Groundwater Elevation (Proposed) - inches bgs	>24	

Groundwater X-Section Inputs

Slope Input (%)	10		
Ksat - in/hr	1.98		
Output Height	4 ft		
Wetland Area	2.6	ac	proposed + existing
Wetland Perimeter	1540	ft	

Final, Field-Verified Factor Inputs

Skyline Blvd Southeast Wetland Water Balance Inputs

Interim Factors Inputs

Soil Depth to Restrictive Layer (Existing) - inches
Surface Elevation (Existing) - ft msl
Surface Permeability (Ksat) - in/hr
Sub-Surface Permeability (Ksat) - in/hr

Soil Depth to Restricitive Layer (Proposed) - inches
Surface Elevation (Proposed) - ft msl
Surface Permeability (Ksat) - in/hr
Sub-Surface Permeability (Ksat) - in/hr

Surface Kfactor - soil unit 113

Winter Groundwater Elevation (Existing) - inches bgs
Summer Groundwater Elevation (Existing) - inches bgs

Winter Groundwater Elevation (Proposed) - inches bgs
Summer Groundwater Elevation (Proposed) - inches bgs

Groundwater X-Section Inputs
Slope Input (%)
Cross-sectional area (wetland depth x width of wetland @ slope interface) - ft2 -summer
Cross-sectional area (wetland depth x width of wetland @ slope interface) - ft2 -winter
Ksat - in/hr

Do not start; pending contract amendment

Final, Field-Verified Factor Inputs

Skyline Blvd Southwest Wetland Water Balance Inputs

Interim Factors Inputs

Soil Depth to Restrictive Layer (Existing) - inches	<30		[Note site is located at transition between soil units; 111 adjacent >60"]
Surface Elevation (Existing) - ft msl		466	[range 466 - 4476]
Surface Permeability (Ksat) - in/hr	0.57-1.98		sandy to fine sandy loam, <24"
Sub-Surface Permeability (Ksat) - in/hr	0.2-0.57		sandy clay loam, clay loam, <24 inches
Soil Depth to Restricitive Layer (Proposed) - inches		**42**	
Surface Elevation (Proposed) - ft msl		**464**	
Surface Permeability (Ksat) - in/hr	0.57-1.98		sandy to fine sandy loam, <12"
Sub-Surface Permeability (Ksat) - in/hr	0.2-0.57		sandy clay loam, clay loam, >12 inches
Surface Kfactor - soil unit 110		0.28	
Winter Groundwater Elevation (Existing) - inches bgs	n/a		observed @ <4" on 1/25/2010; @ 466 elevation
Summer Groundwater Elevation (Existing) - inches bgs	n/a		
Winter Groundwater Elevation (Proposed) - inches bgs	**<12**		
Summer Groundwater Elevation (Proposed) - inches bgs	**<36**		

Groundwater X-Section Inputs

Slope Input (%)		10	
Ksat - in/hr		1.98	
Output Height	4 ft		
Wetland Area		1.33	
Wetland Perimeter		1093	

Final, Field-Verified Factor Inputs

Sherwood Point Seasonal Wetland

Factors	**Inputs**
Area (ac)	0.5
Bedrock Type	sandstone
Wetland Floor Elevation - ft msl	283
Natural Permeability (Ksat) - cm/sec	$2.8x10^{-3}$ to $9.9x10^{-3}$
Engineered Permeability (Ksat) - cm/sec	$1x10^{-6}$
Ponding Depth (FT)	1.5
Groundwater Control	no
Winter Groundwater Elevation (Existing) - inches bgs	bedrock control
Summer Groundwater Elevation (Existing) - inches bgs	bedrock control
slope (%)	<3
depth to bedrock	**>10**

Appendix C – Rational Method Supporting Data

Department of Transporation Figure 816.6 – Velocities for Upland Method of Estimating Travel Time for Shallow Concentrated Flow

Department of Transporation Figure 819.2A – Runoff Coefficients for Undeveloped Areas

Santa Clara Drainage Manual TDS Parameters   Watershed Input Data

Figure 816.6

Velocities for Upland Method of Estimating Travel Time for Shallow Concentrated Flow

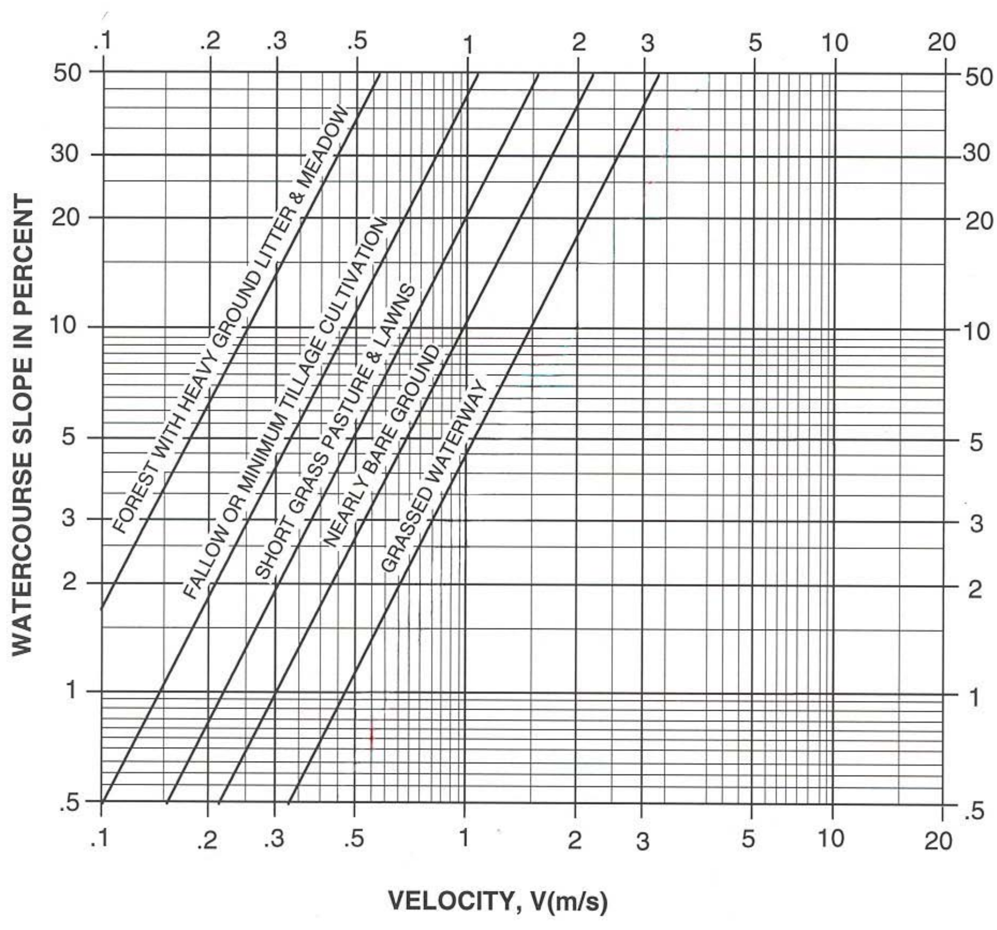


Figure 819.2A

Runoff Coefficients for Undeveloped Areas

Watershed Types

	Extreme	High	Normal	Low
Relief	.28 -.35 Steep, rugged terrain with average slopes above 30%	.20 -.28 Hilly, with average slopes of 10 to 30%	.14 -.20 Rolling, with average slopes of 5 to 10%	.08 -.14 Relatively flat land, with average slopes of 0 to 5%
Soil Infiltration	.12 -.16 No effective soil cover, either rock or thin soil mantle of negligible infiltration capacity	.08 -.12 Slow to take up water, clay or shallow loam soils of low infiltration capacity, imperfectly or poorly drained	.06 -.08 Normal; well drained light or medium textured soils, sandy loams, silt and silt loams	.04 -.06 High; deep sand or other soil that takes up water readily, very light well drained soils
Vegetal Cover	.12 -.16 No effective plant cover, bare or very sparse cover	.08 -.12 Poor to fair; clean cultivation crops, or poor natural cover, less than 20% of drainage area over good cover	.06 -.08 Fair to good; about 50% of area in good grassland or woodland, not more than 50% of area in cultivated crops	.04 -.06 Good to excellent; about 90% of drainage area in good grassland, woodland or equivalent cover
Surface Storage	.10 -.12 Negligible surface depression few and shallow; drainageways steep and small, no marshes	.08 -.10 Low; well defined system of small drainageways; no ponds or marshes	.06 -.08 Normal; considerable surface depression storage; lakes and pond marshes	.04 -.06 High; surface storage, high; drainage system not sharply defined; large flood plain storage or large number of ponds or marshes

Given: An undeveloped watershed consisting of;
1) rolling terrain with average slopes of 5%,
2) clay type soils,
3) good grassland area, and
4) normal surface depressions.

Find: The runoff coefficient, C, for the above watershed.

Solution:

Relief	0.14
Soil Infiltration	0.08
Vegetal Cover	0.04
Surface Storage	0.06
C=	0.32

Table B-1: Parameters $A_{T,D}$ and $B_{T,D}$ for TDS Equation

2-YR RETURN PERIOD		
5-min	0.120194	0.001385
10-min	0.166507	0.001956
15-min	0.176618	0.003181
30-min	0.212497	0.005950
1-hr	0.253885	0.010792
2-hr	0.330848	0.019418
3-hr	0.374053	0.027327
6-hr	0.425178	0.045735
12-hr	0.409397	0.069267
24-hr	0.314185	0.096343
48-hr	0.444080	0.134537
72-hr	0.447104	0.159461
5-YR RETURN PERIOD		
5-min	0.170347	0.001857
10-min	0.228482	0.002758
15-min	0.250029	0.004036
30-min	0.307588	0.007082
1-hr	0.357109	0.013400
2-hr	0.451840	0.024242
3-hr	0.512583	0.034359
6-hr	0.554937	0.060859
12-hr	0.562227	0.094871
24-hr	0.474528	0.136056
48-hr	0.692427	0.187173
72-hr	0.673277	0.224003
10-YR RETURN PERIOD		
5-min	0.201876	0.002063
10-min	0.258682	0.003569
15-min	0.294808	0.004710
30-min	0.367861	0.007879
1-hr	0.427723	0.014802
2-hr	0.522608	0.027457
3-hr	0.591660	0.038944
6-hr	0.625054	0.070715
12-hr	0.641638	0.111660
24-hr	0.567017	0.162550
48-hr	0.832445	0.221820
72-hr	0.810509	0.265469

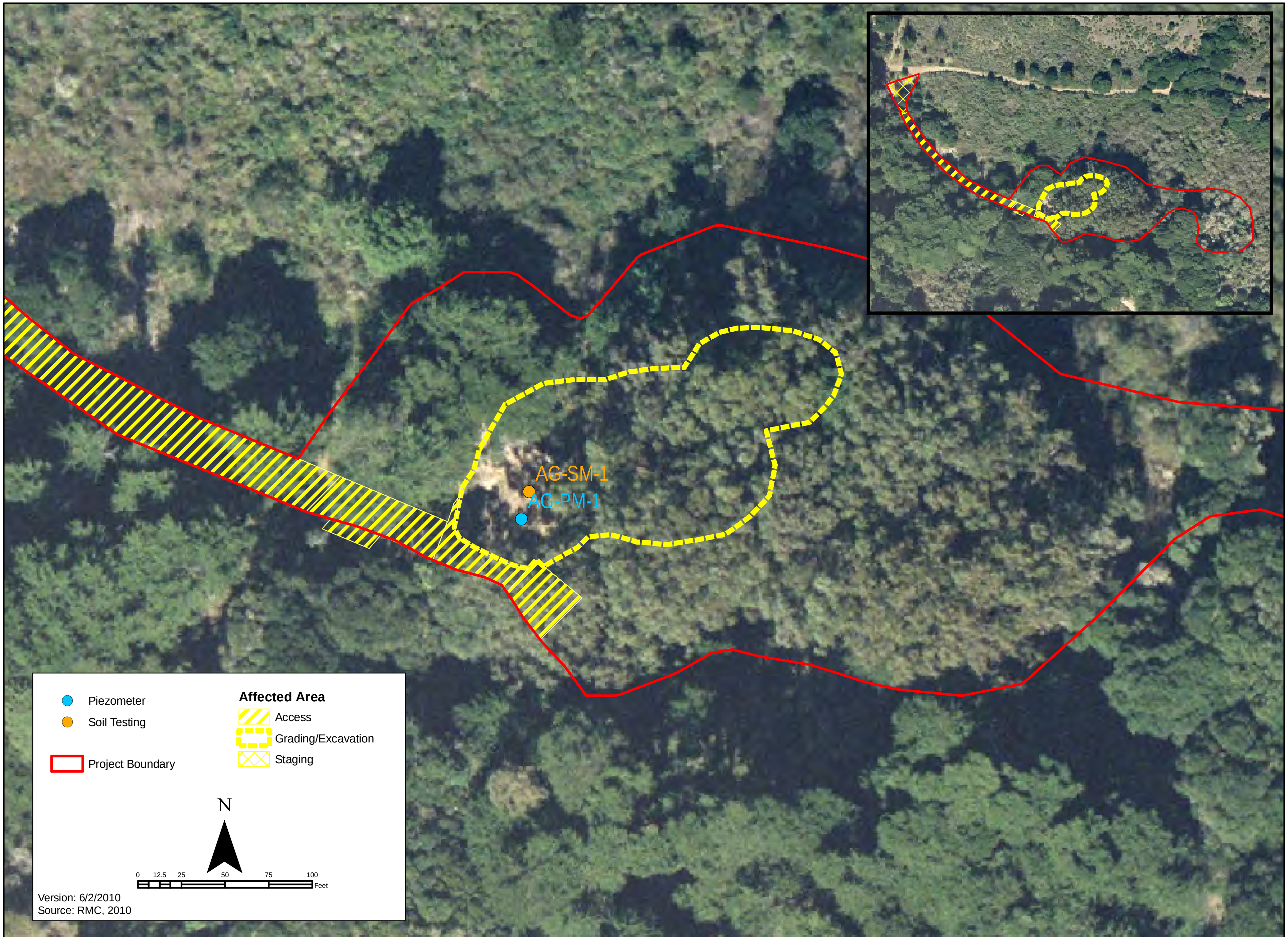
Table B-2: Parameters $A_{T,D}$ and $B_{T,D}$ for TDS Equation

Return Period/Duration	$A_{T,D}$	$B_{T,D}$
25-YR RETURN PERIOD		
5-min	0.230641	0.002691
10-min	0.287566	0.004930
15-min	0.348021	0.005594
30-min	0.443761	0.008719
1-hr	0.508791	0.016680
2-hr	0.612629	0.031025
3-hr	0.689252	0.044264
6-hr	0.693566	0.083195
12-hr	0.725892	0.132326
24-hr	0.675008	0.195496
48-hr	0.989588	0.264703
72-hr	0.967854	0.316424
50-YR RETURN PERIOD		
5-min	0.249324	0.003241
10-min	0.300971	0.006161
15-min	0.384016	0.006315
30-min	0.496301	0.009417
1-hr	0.568345	0.017953
2-hr	0.672662	0.033694
3-hr	0.754661	0.048157
6-hr	0.740666	0.092105
12-hr	0.779967	0.147303
24-hr	0.747121	0.219673
48-hr	1.108358	0.295510
72-hr	1.075643	0.353143
100-YR RETURN PERIOD		
5-min	0.269993	0.003580
10-min	0.315263	0.007312
15-min	0.421360	0.006957
30-min	0.553934	0.009857
1-hr	0.626608	0.019201
2-hr	0.732944	0.036193
3-hr	0.816471	0.051981
6-hr	0.776677	0.101053
12-hr	0.821859	0.162184
24-hr	0.814046	0.243391
48-hr	1.210895	0.325943
72-hr	1.175000	0.389038

APPENDIX B.
SOILS DATA

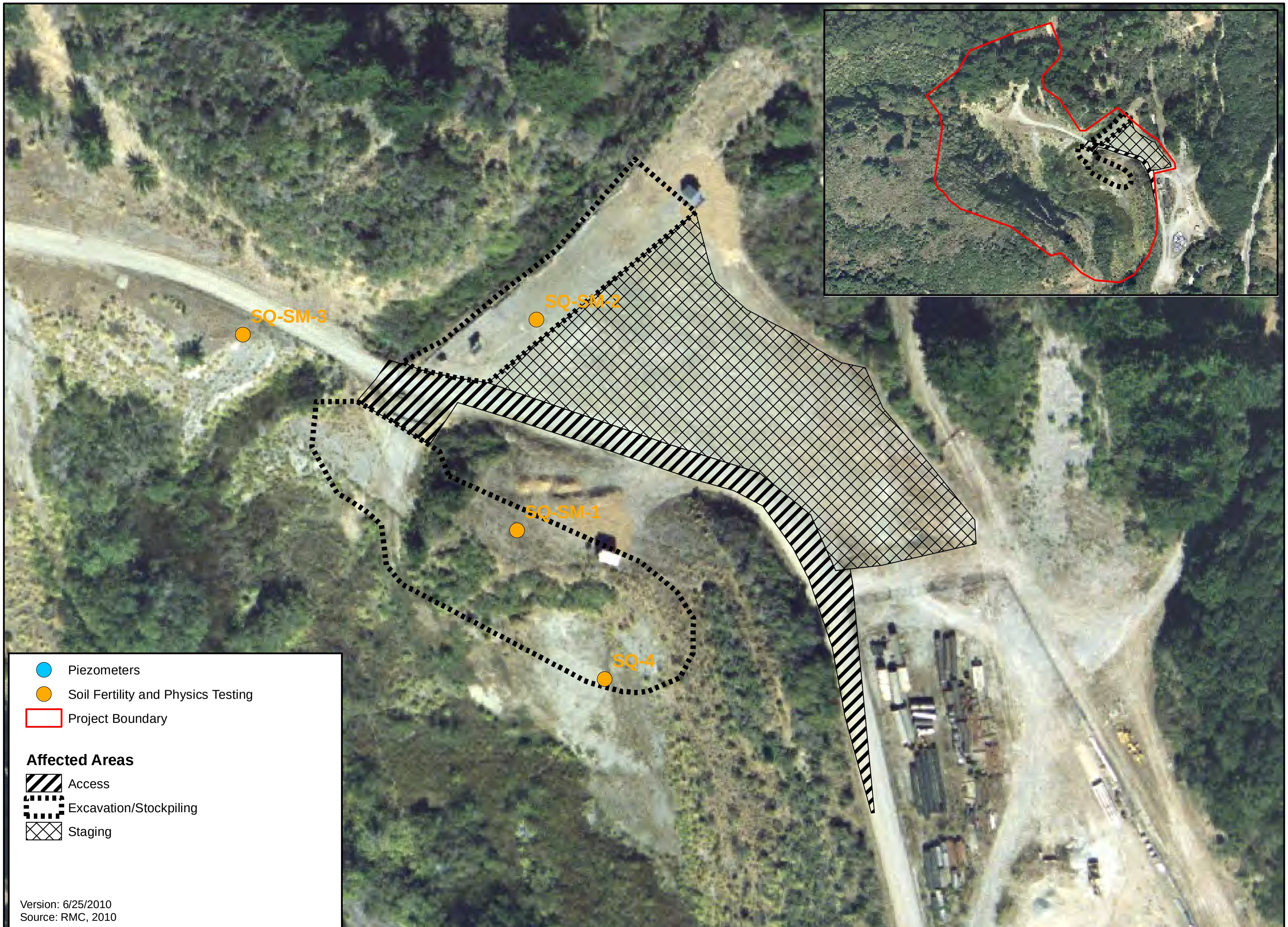
San Francisco Public Utilities Commission
Habitat Reserve Program

Sherwood Point Oak Restoration Geotechnical Investigation



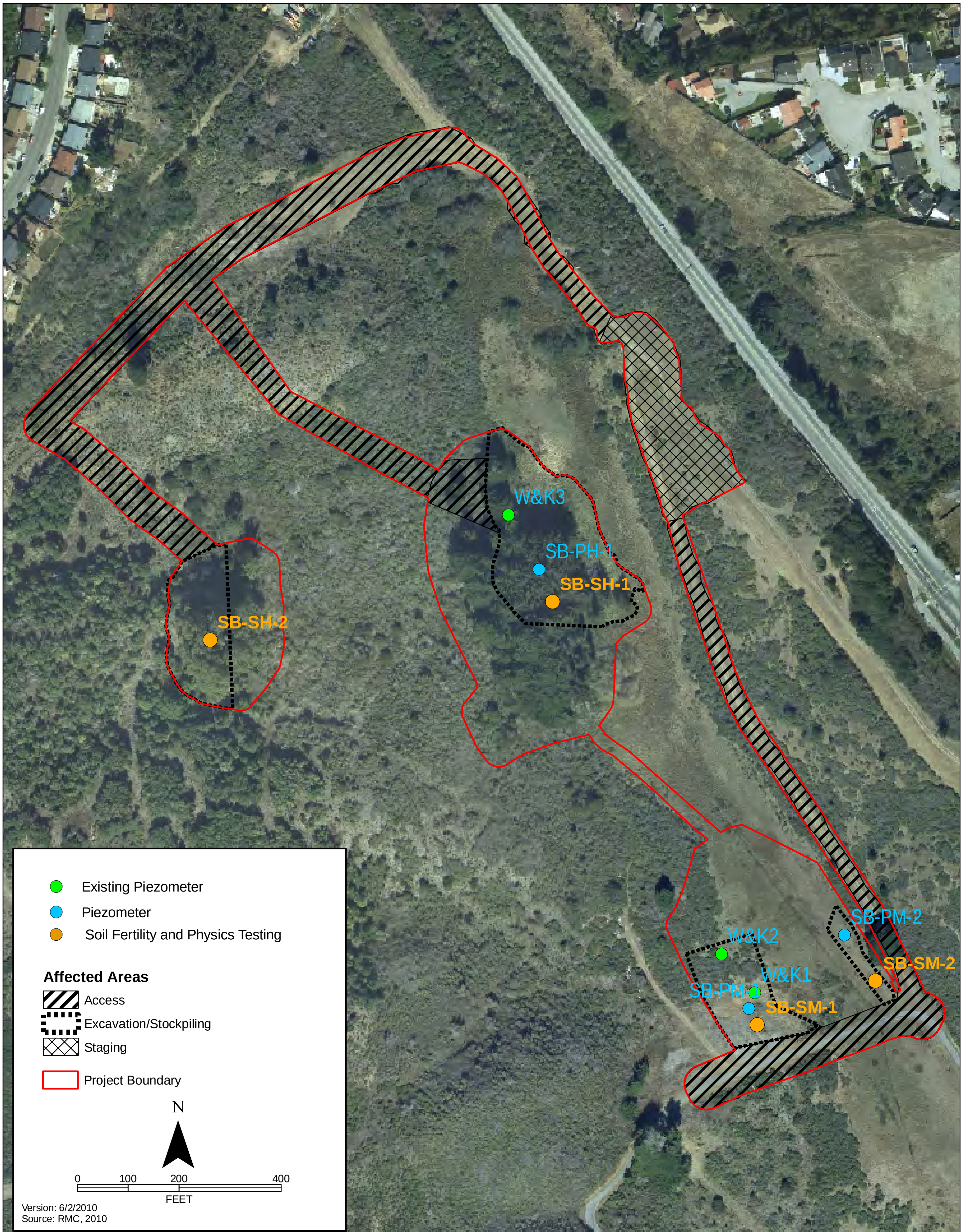
San Francisco Public Utilities Commission
Habitat Reserve Program

Adobe Gulch Creek Wetland Creation - Geotechical Investigation



San Francisco Public Utilities Commission
Habitat Reserve Program

Skyline Quarry Wetland Restoration Geotechnical Investigation



	San Francisco Public Utilities Commission Habitat Reserve Program	Skyline Boulevard Habitat Improvements Geotechnical Investigation

Locations:

1101 S. Winchester Blvd.
Suite G-173
San Jose, CA 95128
(408) 727-0330

4741 E. Hunter Ave.
Unit A
Anaheim, CA 92807
(714) 282-8777

SAN JOSE OFFICE
July 28, 2010
Report 10-196-0047

AEW Engineering, Inc.
55 New Montgomery St., Suite 722
San Francisco, CA 94105

Attn: Randall Young

RE: SFPUC HABITAT RESTORATION, PROJECT #2010-001

BACKGROUND

Samples received 7/15 represent site soils from various depths in the profile from areas that will be revegetated after grading occurs. Soil from each depth examined may eventually end up as topsoil and the key maps showing sample locations also identified existing and proposed habitats for the various areas.

Characteristics of soils at the Adobe Gulch site are represented by three depths from one boring. From the Skyline Quarry site three borings were made with three depths examined at area 1 and two depths from each of the others. At the Skyline Blvd site three borings where made with three depths examined from each.

ADOBE GULCH

ANALYTICAL RESULTS

Characteristics throughout the depth of the profile in this proposed Wetland area are fairly uniform in most respects. Gravel levels are moderate and for the smaller than 2 mm fraction the top 1.5 feet is in the sandy clay loam classification with lower depths clay loam. Organic matter content is good at each depth. Because of the diversity amongst the coarse fractions a higher degree of susceptibility toward consolidation is suggested for the top 1.5 feet and the infiltration rate based on these characteristics is a particularly slow 0.12 inch per hour. For the lower portions of the profile the rate is estimated closer to 0.17 inch per hour.

Reaction values are slightly acidic and with no lime present this is suitable. Salinity, sodium and boron levels are safely low and the SAR values show soluble sodium adequately balanced by calcium and magnesium.

The only major nutrient deficiency is the lack of adequate potassium at 5-6 feet. Throughout the profile zinc is fair and iron rather high with all other required nutrients comfortably within adequate ranges.

RECOMMENDATIONS

The only soil at this site were some amending would be appropriate would be that from 4.5-6 feet where it ends up at finish grade. This should be amended with potassium sulfate (0-0-50) at a rate of 5 pounds per 1000 square feet for blending to 6-inches depth.

SKYLINE QUARRY

ANALYTICAL RESULTS

The SM-1 samples show slight excesses of gravel while SM-2 are moderate in gravel excess. SM-3 at 7-8.5 feet is high in gravel content with the 15-16.5 foot zone very high in gravel. The smaller fractions fall in the clay loam to sandy clay loam classifications. Organic content is good only in the 1-2.5 foot sample from SM-1 and is otherwise very low. Estimated infiltration rates are 0.19 inch per hour for the 1-2.5 and 7-8.5 foot zones and 0.15 at 15 feet from SM-1 and both depths from SM-2. The rate can not be estimated for the SM-3 samples because of their extremely high gravel content.

Reaction values are slightly to moderately alkaline with the exception of strong alkalinity in the 4-5.5 sample from SM-3. All of these soils are high in lime content and the addition of some sulfur is suggested in order to help keep nutrients in more readily available forms. Salinity, sodium and boron levels are safely low and the SAR values show soluble sodium adequately balanced by calcium and magnesium.

Phosphorus is marginally deficient in many of the samples. Potassium is quite deficient in all. Magnesium is marginally low at best in all of the samples from SM-2 and 3. Zinc and manganese also tend to be on the low side except for manganese being particularly abundant in the SM-1 profile. Required nutrients are otherwise adequate.

RECOMMENDATIONS

Rates are suggested to treat 1000 square feet and be blended to 6-inches depth.

Soil Type	Organic Matter cubic yards	Treble Superphosphate pounds, (0-48-0)	Potassium Sulfate pounds, (0-0-50)
SM-1 at 1-2.5 feet	0	1	5
SM-1 at 7-8.5 feet	2	0	5
SM-1 at 15-16.5 feet	3	1	7
SM-2 and 3, both depths	3	1	5

SKYLINE BLVD

ANALYTICAL RESULTS

These three borings will be Seasonal Wetland areas with the portion adjacent to SH-1 proposed for Coyote Brush Scrub while areas adjacent to SM-1 and 2 will be Grassland. The sample identified as SH-2 was not amongst those submitted.

In this series of samples gravel content is not so much of a concern tending to be slightly excessive only in the SM-1 profile. USDA Classifications for the smaller than 2-mm fractions are widely varied from sandy loam to clay and are as indicated on the attached data sheets. Organic matter levels are particularly abundant for each of the three samples from the top 1.5 feet. There is also a good amount of organic matter at the 3-4.5 foot depth from SH-1 but otherwise soils from these borings are very low in organic content. Infiltration rates are estimated in the range of 0.20 to 0.22 inch per hour with the exception of the clay at 3-4.5 feet from SM-2, where it may be as slow as 0.13 inch per hour.

All reaction values fall in a slightly acidic to slightly alkaline range and with no significant lime present in any of the samples this is suitable. Salinity, sodium and boron levels are safely low and the SAR values show soluble sodium adequately balanced by calcium and magnesium.

Phosphorus is low in all areas except being adequate at the 8-9.5 foot depth from SM-1. Potassium is low in all. Many of these soils are affected by varying degrees of imbalance between low calcium and excessive magnesium. This is particularly extreme at 3-4.5 and 8-9.5 feet from SM-1 and at 3-4.5 and 5-6.5 feet from SM-2. Zinc and manganese also tend to be low in all samples except the top 1.5 feet from SM-1 and 2. Available nutrients are otherwise adequate.

RECOMMENDATIONS

SH-1

All of the samples from this boring location are suggested to be treated with 1-1/2 pounds treble superphosphate (0-48-0) and 12 pounds potassium sulfate (0-0-50) per 1000 square feet for blending to 6-inches depth.

Amendment where the requirement varies is for organic matter which is suggested at a 3 cubic yard rate only for soil from the depth of 4.5-6 feet. Gypsum is suggested at a 120 pound rate for soil from the 3-4.5 foot depth but 90 pounds per 1000 square feet should be sufficient for soils from the higher and lower depths.

AEW Engineering, Inc.
Report 10-196-0047

Soil Type	Organic Matter cubic yards	Treble Superphosphate pounds, (0-48-0)	Potassium Sulfate pounds, (0-0-50)	Gypsum pounds
SM-1				
0-1.5 feet	0	1-1/2	6	0
3-4.5 feet	3	1-1/2	15	100
8-9.5 feet	3	0	15	150
SM-2				
0-1.5 feet	0	2	6	70
3-4.5 feet	3	2	15	150
5-6.5 feet	3	2	15	150

JIM WEST
Email 8 pages.

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Soil & Plant Laboratory, Inc.
Leaders in Soil & Plant Testing Since 1946
4741 E. Hunter Ave, Suite A Anaheim, CA 92807 714-282-8777 (phone) 714-282-8575 (fax)
www.soilandplantlaboratory.com

Project : SFPUC Habitat Restoration, 21010-001

COMPREHENSIVE SOIL ANALYSIS

Report No : **10-196-0047**
Purchase Order : 2010-001
Date Recd : 07/15/2010
Date Printed : 07/27/2010

Sample Description - Sample ID	Half Sat % / TEC	pH / Qual Lime	ECe dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	K ppm	Ca ppm	Mg ppm	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Organic % dry wt.	Lab No.
				Sufficiency Factors											
AG-SM-1, 0'-1.5'	21	6.7	0.6	4	41	27	105	1804	230	2.5	1.5	9	260	3.7	25267
	113	None		1.1		1.1	0.7	1.0	0.9	1.7	0.3	0.7	4.7		
AG-SM-1, 3'-4.5'	18	6.6	0.7	7	41	15	100	1582	383	2.3	1.6	12	277	4.0	25268
	116	None		1.3		0.7	0.7	0.9	1.5	1.6	0.3	1.0	5.0		
AG-SM-1,4.5'-6'	20	6.7	0.6	9	34	24	77	1673	394	2.4	1.6	10	270	3.1	25269
	120	None		1.1		1.0	0.5	0.8	1.5	1.5	0.3	0.8	4.6		
SQ-SM-1, 1'-2.5'	22	7.4	1.1	5	42	17	69	2316	476	1.5	0.8	6	96	3.5	25270
	157	High		1.1		0.6	0.4	0.9	1.4	0.7	0.1	0.3	1.2		
SQ-SM-1, 7'-8.5'	15	7.5	0.8	7	54	22	52	1622	278	3.8	1.0	78	143	2.0	25271
	108	High		2.0		1.2	0.4	1.1	1.4	3.2	0.2	7.6	3.1		
SQ-SM-1, 15'-16.5'	18	7.6	0.6	4	52	11	36	2345	777	2.9	0.5	76	87	1.3	25272
	185	High		1.5		0.5	0.2	0.9	2.3	1.4	0.1	4.4	1.1		

Saturation Extract Values						SAR	Gravel %		Percent of Sample Passing 2 mm Screen					USDA Soil Classification	Lab No.
Ca meq/L	Mg meq/L	Na meq/L	K meq/L	B ppm	SO_4 meq/L		Coarse 5 - 12	Fine 2 - 5	Sand: Very Coarse 1 - 2	Sand: Coarse 0.5 - 1	Sand: Med. to Very Fine 0.05 - 0.5	Silt .002-.05	Clay 0-.002		
3.6	1.5	1.2	0.3	0.04	0.9	0.8	37.3	14.5	18.6	11.0	27.4	21.1	21.8	Very Gravelly Sandy Clay Loam	25267
2.4	1.6	1.7	0.2	0.05	1.5	1.2	20.1	12.1	9.7	7.4	22.7	26.3	33.8	Gravelly Clay Loam	25268
2.4	1.8	1.9	0	0.03	1.2	1.3	15.3	12.7	8.8	6.6	23.3	28.2	32.9	Gravelly Clay Loam	25269
5.5	3.2	2.4	0.2	0.05	4.6	1.2	10.7	9.8	8.4	8.8	23.6	27.2	31.9	Gravelly Clay Loam	25270
2.4	2.8	1.7	0.7	0.04	3.3	1.1	14.9	11.0	10.0	10.1	22.6	25.2	31.9	Gravelly Clay Loam	25271
2.3	2.2	1.5	0.1	0.02	1.4	1.0	29.4	16.1	15.5	10.8	22.4	22.2	28.9	Very Gravelly Sandy Clay Loam	25272

Sufficiency factor (1.0=sufficient for average crop) below each nutrient value. N factor based on 200 ppm constant feed. SAR = Sodium adsorption ratio. Half Saturation %=approx field moisture capacity. Nitrogen(N), Potassium(K), Calcium(Ca) and Magnesium(Mg) by sodium chloride extraction. Phosphorus(P) by sodium bicarbonate extraction. Copper(Cu), Zinc(Zn), Manganese(Mn) & Iron(Fe) by DTPA extraction. Sat. ext. method for salinity (ECe as dS/m),Boron (B), Sulfate(SO_4), Sodium(Na). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm(1/2 inch) sieve. Particle sizes in millimeters. Organic percentage determined by Walkley-Black or Loss on Ignition.

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Project : SFPUC Habitat
Restoration, 21010-001

COMPREHENSIVE SOIL ANALYSIS

Report No : **10-196-0047**
Purchase Order : 2010-001
Date Recd : 07/15/2010
Date Printed : 07/27/2010

Sample Description - Sample ID	Half Sat % / TEC	pH / Qual Lime	ECe dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	K ppm	Ca ppm	Mg ppm	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Organic % dry wt.	Lab No.
				Sufficiency Factors											
SQ-SM-2, 4'-5.5'	15	7.7	1.9	4	29	11	10	1004	73	1.2	0.1	2	33	0.7	25273
	52	High		1.1		0.6	0.1	1.2	0.6	1.8	0	0.3	1.3		
SQ-SM-2, 8'-9.5'	16	7.5	2.5	4	30	10	33	928	35	1.7	0.1	1	60	0.4	25274
	43	High		1.1		0.5	0.4	1.3	0.4	3.1	0.1	0.2	2.9		
SQ-SM-3, 1'-2.5'	13	7.8	0.3	4	14	10	33	1639	78	0.8	1.0	2	22	0.5	25275
	89	High		0.7		0.6	0.4	1.4	0.5	0.8	0.3	0.3	0.6		
SQ-SM-3, 4-5.5'	13	8.1	0.2	4	10	9	20	390	21	1.0	2.5	1	13	0.4	25276
	22	High		0.5		0.6	0.3	1.0	0.4	3.6	2.3	0.3	1.2		
SB-SH-1, 0'-1.5'	29	7.1	0.9	10	17	15	45	2129	1936	2.4	1.5	8	215	6.9	25277
	270	None		0.5		0.4	0.1	0.5	3.3	0.7	0.1	0.3	1.6		
SB-SH-1, 3'-4.5'	24	7.4	0.7	5	26	15	31	1621	2226	2.5	0.4	9	62	2.1	25278
	269	None		0.7		0.5	0.1	0.4	4.3	0.8	0	0.3	0.5		

Saturation Extract Values						SAR	Gravel %		Percent of Sample Passing 2 mm Screen					USDA Soil Classification	Lab No.
Ca meq/L	Mg meq/L	Na meq/L	K meq/L	B ppm	SO_4 meq/L		Coarse 5 - 12	Fine 2 - 5	Sand: Very Coarse 1 - 2	Coarse 0.5 - 1	Med. to Very Fine 0.05 - 0.5	Silt .002-.05	Clay 0-.002		
18.0	2.8	1.7	0.7	0.06	23.3	0.5	35.8	16.0	21.3	24.4	33.1	10.2	10.9	Very Gravelly Sandy Loam	25273
26.5	3.0	1.5	0.7	0.13	33.7	0.4	25.0	17.3	24.9	19.0	33.9	12.1	10.0	Very Gravelly Sandy Loam	25274
1.8	0.6	0.6	-0.1	0.03	1.2	0.6	42.1	16.9	18.4	14.0	22.6	21.0	23.9	Very Gravelly Sandy Clay Loam	25275
1.3	0.4	0.5	0.2	0.03	0.6	0.5	69.5	15.3	32.6	20.0	25.1	10.2	12.0	Very Gravelly Sandy Loam	25276
2.1	3.8	2.7	0.7	0.08	1.2	1.6	11.9	10.9	6.3	8.0	21.5	30.2	33.9	Gravelly Clay Loam	25277
1.6	2.8	1.8	0.1	0.05	0.8	1.2	8.4	6.9	5.5	6.5	23.8	25.2	38.9	Gravelly Clay Loam	25278

Sufficiency factor (1.0=sufficient for average crop) below each nutrient value. N factor based on 200 ppm constant feed. SAR = Sodium adsorption ratio. Half Saturation %=approx field moisture capacity. Nitrogen(N), Potassium(K), Calcium(Ca) and Magnesium(Mg) by sodium chloride extraction. Phosphorus(P) by sodium bicarbonate extraction. Copper(Cu), Zinc(Zn), Manganese(Mn) & Iron(Fe) by DTPA extraction. Sat. ext. method for salinity (ECe as dS/m),Boron (B), Sulfate(SO_4), Sodium(Na). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm(1/2 inch) sieve. Particle sizes in millimeters. Organic percentage determined by Walkley-Black or Loss on Ignition.

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Project : SFPUC Habitat Restoration, 21010-001

Report No : **10-196-0047**
Purchase Order : 2010-001
Date Recd : 07/15/2010
Date Printed : 07/27/2010

COMPREHENSIVE SOIL ANALYSIS

Sample Description - Sample ID	Half Sat % / TEC	pH / Qual Lime	ECe dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	K ppm	Ca ppm	Mg ppm	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Organic % dry wt.	Lab No.
				Sufficiency Factors											
SB-SH-1, 4.5-6'	17	7.2	0.5	4	36	11	51	1410	1761	1.7	0.4	4	54	1.2	25279
	222	None		1.2		0.5	0.3	0.5	5.0	0.8	0	0.2	0.7		
SB-SM-1, 0'-1.5'	33	6.7	0.6	9	46	21	99	1761	842	3.3	2.8	13	282	7.7	25280
	161	None		0.8		0.5	0.4	0.7	2.4	1.6	0.3	0.7	3.6		
SB-SM-1, 3'-4.5'	20	7.2	0.5	6	45	10	30	1929	2942	1.8	0.2	5	53	1.1	25281
	353	None		1.3		0.4	0.1	0.5	5.5	0.6	0	0.2	0.4		
SB-SM-1, 8'-9.5'	20	7.6	0.4	4	58	20	11	1602	3947	0.9	0	6	50	0.7	25282
	426	None		1.6		0.8	0	0.3	6.4	0.2	0	0.2	0.3		
SB-SM-2, 0'-1.5'	30	6.4	0.9	10	58	9	61	1282	798	3.4	1.7	14	497	5.1	25283
	138	None		1.1		0.2	0.3	0.6	2.6	1.9	0.2	0.9	7.4		
SB-SM-2, 3'-4.5'	29	7.6	1.2	4	20	10	24	1660	3196	2.1	0.1	1	52	1.0	25284
	354	None		0.4		0.3	0.1	0.3	4.6	0.5	0	0	0.3		

Saturation Extract Values						SAR	Gravel %		Percent of Sample Passing 2 mm Screen					USDA Soil Classification	Lab No.
Ca meq/L	Mg meq/L	Na meq/L	K meq/L	B ppm	SO_4 meq/L		Coarse 5 - 12	Fine 2 - 5	Sand: Very Coarse 1 - 2	Sand: Coarse 0.5 - 1	Sand: Med. to Very Fine 0.05 - 0.5	Silt .002-.05	Clay 0-.002		
1.3	1.8	1.6	0.2	0.03	1.1	1.3	2.0	5.4	5.0	5.2	25.7	27.1	36.9	Clay Loam	25279
2.4	3.2	1.7	0.3	0.09	0.6	1.0	9.3	13.3	13.6	9.4	18	21.0	37.8	Gravelly Clay Loam	25280
1.1	1.1	2.3	0.1	0.05	1.1	2.2	18.2	12.6	10.0	12.1	28.7	21.2	27.9	Gravelly Sandy Clay Loam	25281
0.2	0.9	2.2	0.4	0.03	0.6	3.0	18.4	13.8	15.1	15.8	32	17.1	19.9	Gravelly Sandy Loam	25282
1.0	2.5	3.0	1.3	0.07	1.7	2.3	4.9	5.1	4.3	3.8	27.9	26.0	37.8	Clay Loam	25283
1.9	3.7	3.5	1.1	0.04	1.6	2.1	1.7	9.0	8.6	5.1	22.3	16.0	47.8	Clay	25284

Sufficiency factor (1.0=sufficient for average crop) below each nutrient value. N factor based on 200 ppm constant feed. SAR = Sodium adsorption ratio. Half Saturation %=approx field moisture capacity. Nitrogen(N), Potassium(K), Calcium(Ca) and Magnesium(Mg) by sodium chloride extraction. Phosphorus(P) by sodium bicarbonate extraction. Copper(Cu), Zinc(Zn), Manganese(Mn) & Iron(Fe) by DTPA extraction. Sat. ext. method for salinity (ECe as dS/m),Boron (B), Sulfate(SO_4), Sodium(Na). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm(1/2 inch) sieve. Particle sizes in millimeters. Organic percentage determined by Walkley-Black or Loss on Ignition.

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Project : SFPUC Habitat Restoration, 21010-001

COMPREHENSIVE SOIL ANALYSIS

Report No : **10-196-0047**
Purchase Order : 2010-001
Date Recd : 07/15/2010
Date Printed : 07/27/2010

Sample Description - Sample ID	Half Sat % / TEC	pH / Qual Lime	ECe dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	K ppm	Ca ppm	Mg ppm	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Organic % dry wt.	Lab No.
				Sufficiency Factors											
SB-SM-2, 5'-6.5'	25	7.5	0.6	6	28	14	33	1764	3638	1.6	0.1	2	49	1.2	25285
	397	None		0.7		0.5	0.1	0.3	5.5	0.4	0	0.1	0.3		

Saturation Extract Values						SAR	Gravel %		Percent of Sample Passing 2 mm Screen					USDA Soil Classification	Lab No.
									Sand						
Ca meq/L	Mg meq/L	Na meq/L	K meq/L	B ppm	SO_4 meq/L		Coarse 5 - 12	Fine 2 - 5	Very Coarse 1 - 2	Coarse 0.5 - 1	Med. to Very Fine 0.05 - 0.5	Silt .002-.05	Clay 0-.002		
1.1	2.3	2.1	0.4	0.03	1.0	1.6	6.0	7.7	7.2	6.6	29.1	18.1	38.9	Clay Loam	25285

Sufficiency factor (1.0=sufficient for average crop) below each nutrient value. N factor based on 200 ppm constant feed. SAR = Sodium adsorption ratio. Half Saturation %=approx field moisture capacity. Nitrogen(N), Potassium(K), Calcium(Ca) and Magnesium(Mg) by sodium chloride extraction. Phosphorus(P) by sodium bicarbonate extraction. Copper(Cu), Zinc(Zn), Manganese(Mn) & Iron(Fe) by DTPA extraction. Sat. ext. method for salinity (ECe as dS/m),Boron (B), Sulfate(SO_4), Sodium(Na). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm(1/2 inch) sieve. Particle sizes in millimeters. Organic percentage determined by Walkley-Black or Loss on Ignition.

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SAN JOSE OFFICE
August 11, 2010
Report 10-210-0051

AEW Engineering, Inc.
55 New Montgomery St., Suite 722
San Francisco, CA 94105

Attn: Randall Young

RE: SFPUC HABITAT RESTORATION, SAN MATEO
PROJ. #2010-001, JOB #2010-021

BACKGROUND

Samples received 7/29 represent site soils from three borings from various depths at the Sherwood Point site and a single topsoil sample from the Skyline Blvd site. Areas will be revegetated after grading occurs. The key map showing the sample location at Skyline indicated that would be with Northern Coyote Brush Scrub.

SHERWOOD POINT

ANALYTICAL RESULTS

Particle size makeup of these three samples is fairly uniform placing them in the clay loam classification by USDA standards. There is a slight excess of gravel in TP-1. That sample also shows particularly low organic content with organic matter at 2 and 3 sufficient. The infiltration rate based on these characteristics is estimated at 0.22 inch per hour and may be just slightly slower at 1.

Reaction of TP-2 is moderately to strongly acidic and a bit more so than preferred. The moderate acidity at 3 and slight acidity at 1 are suitable. All show favorably low salinity, sodium and boron with SAR values showing soluble sodium adequately balanced by calcium and magnesium.

All of the samples are deficient in nitrogen, phosphorus and potassium. Calcium is low relative to high magnesium in 1 and 3 with 2 showing a satisfactory balance. Zinc is deficient in each of the samples with the other micronutrients in adequate ranges.

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AEW Engineering, Inc.
Report 10-210-0051

RECOMMENDATIONS

Rates are suggested to treat 1000 square feet and be blended to 6-inches depth.

Soil Type	Organic Matter cubic yards	Treble Superphosphate pounds, (0-48-0)	Potassium Sulfate pounds, (0-0-50)	Gypsum pounds	*CC Lime pounds
TP-1, 56”	3	5	10	70	0
TP-2, 6 and 12”	0	5	10	0	70
TP-3, 6”	0	5	10	70	0

* Lime should be calcium carbonate lime and not dolomite.

SKYLINE BLVD

ANALYTICAL RESULTS

Particle size data for this sample shows a sandy clay loam classification with a slight excess of gravel. Coarse sand sizes are broadly distributed and this along with 51% silt plus clay indicates a moderate susceptibility toward consolidation. The amount of organic matter present is at a very good level to help offset this tendency. Based on these characteristics the infiltration rate is estimated at 0.21 inch per hour.

Reaction is moderately acidic and at a suitable level. Salinity, sodium and boron levels are safely low and the SAR value shows soluble sodium is adequately balanced by calcium and magnesium.

This soil is deficient in nitrogen, phosphorus and zinc with potassium fair at best. The calcium to magnesium balance is proper and the other required nutrients are adequately supplied. Iron is particularly abundant but not problematically high.

RECOMMENDATIONS

Amendment requirements for this soil would be limited to 5 pounds each Treble Superphosphate (0-48-0) and Potassium Sulfate (0-0-50) per 1000 square feet for blending to 6-inches depth.

Jim West

JIM WEST
Email 3 pages.

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Project : SFPUC Habitat Restoration
San Mateo

Report No : **10-210-0051**
Purchase Order :
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Date Printed : 08/05/2010

COMPREHENSIVE SOIL ANALYSIS

Sample Description - Sample ID	Half Sat % / TEC	pH / Qual Lime	ECe dS/m	NO_3-N ppm	NH_4-N ppm	PO_4-P ppm	K ppm	Ca ppm	Mg ppm	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Organic % dry wt.	Lab No.
				Sufficiency Factors											
SP-TP-1, 56"	21	6.4	0.4	5	2	3	49	1786	1544	1.3	0.3	8	41	1.9	25484
	221	None		0.2		0.1	0.2	0.6	4.0	0.5	0	0.4	0.5		
SP-TP-2, 6" and 12"	31	5.1	0.3	6	6	1	94	1908	853	3.4	1.6	47	187	4.8	25485
	168	None		0.2		0	0.4	0.7	2.2	1.5	0.2	2.4	2.2		
SP-TP-3, 6"	26	5.5	0.3	6	5	1	91	1994	1738	3.1	1.2	27	120	5.2	25486
	246	None		0.2		0	0.4	0.6	4.0	1.2	0.1	1.2	1.2		
SB-SH-2, 6"	32	5.6	0.6	12	10	8	204	3659	1099	5.7	3.7	32	554	7.0	25487
	277	None		0.3		0.2	0.7	0.9	2.0	1.8	0.3	1.2	4.5		

Saturation Extract Values						SAR	Gravel %		Percent of Sample Passing 2 mm Screen					USDA Soil Classification	Lab No.
									Sand						
Ca meq/L	Mg meq/L	Na meq/L	K meq/L	B ppm	SO_4 meq/L		Coarse 5 - 12	Fine 2 - 5	Very Coarse 1 - 2	Coarse 0.5 - 1	Med. to Very Fine 0.05 - 0.5	Silt .002-.05	Clay 0-.002		
1.1	1.1	1.4	0	0.03	0.5	1.4	11.6	8.4	8.0	9.3	24.2	26.1	32.2	Gravelly Clay Loam	25484
1.1	0.9	0.9	0.2	0.04	0.6	1.0	6.7	4.9	7.0	7.7	20.8	28.1	36.3	Clay Loam	25485
1.2	1.2	1.0	0	0.04	0.8	0.9	3.6	9.3	8.1	8.4	23	27.1	33.3	Clay Loam	25486
2.7	2.3	1.3	0.2	0.08	0.9	0.8	6.1	15.2	17.0	11.6	19.8	21.1	30.4	Gravelly Sandy Clay Loam	25487

Sufficiency factor (1.0=sufficient for average crop) below each nutrient value. N factor based on 200 ppm constant feed. SAR = Sodium adsorption ratio. Half Saturation %=approx field moisture capacity. Nitrogen(N), Potassium(K), Calcium(Ca) and Magnesium(Mg) by sodium chloride extraction. Phosphorus(P) by sodium bicarbonate extraction. Copper(Cu), Zinc(Zn), Manganese(Mn) & Iron(Fe) by DTPA extraction. Sat. ext. method for salinity (ECe as dS/m),Boron (B), Sulfate(SO_4), Sodium(Na). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm(1/2 inch) sieve. Particle sizes in millimeters. Organic percentage determined by Walkley-Black or Loss on Ignition.

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APPENDIX C.
VEGETATION MANAGEMENT PLAN

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION HABITAT RESERVE PROGRAM VEGETATION MANAGEMENT PLAN

Prepared by:

H. T. Harvey & Associates

Prepared for:

San Francisco Public Utilities Commission
1145 Market Street, 5th Floor
San Francisco, CA 94103

22 July 2010 Project No. 3135-01

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TABLES

INTRODUCTION

The spread of invasive species is one of the world's greatest threats to biological diversity (Bossard et al. 2000). They substantially alter ecosystem function and displace native species and the organisms that depend on them (Cal EPIC 2004; Tu et al. 2001). The eradication of invasive species combined with the replacement with native species is a common habitat restoration technique. Long-term control of invasive species is also generally a central element to long-term management of habitat restoration sites and conservation lands.

The San Francisco Public Utilities Commission (SFPUC) owns and manages lands within the watersheds of the Crystal Springs and San Andreas Reservoirs that serve to store drinking water for the City of San Francisco. Portions of these lands are used as habitat restoration sites that serve to mitigate impacts to biological resources from SFPUC projects. These habitat restoration sites often support invasive plants prior to implementation of restoration activities and/or are invaded by such species following restoration construction. As a result, eradication and control of invasive plant species is of great importance to the SFPUC for establishing successful mitigation sites.

This vegetation management plan provides a general overview of invasive species control approaches, control methods specific to individual invasive species that have been identified at the SFPUC San Andreas Reservoir Wetland Creation, Sherwood Point, Adobe Gulch Creek Wetland Creation, Skyline Quarry, and Skyline Boulevard Habitat Improvement mitigation sites, and a brief invasive species monitoring plan.

METHODS

VEGETATION MANAGEMENT TECHNIQUES

Successful control of invasive species often requires the use of multiple methods and implementation of adaptive management strategies to succeed in the short- and long-term. The methods most often employed include herbicides, mowing, grazing, hand removal, and prescribed fire. A general description of how each of these biological, chemical, and physical methods is typically utilized to control invasive plant species is provided below. Some of this general information was developed in the Homestead Pond Mitigation and Monitoring Plan (Winzler and Kelly 2009). This information, and additional research conducted for this plan, is presented here to provide an overview of the general techniques that are often utilized during the eradication and control of invasive species on SFPUC mitigation sites.

Biological Control

Introduced invasive usually have natural enemies in their native habitats, but this natural control mechanism is often absent in the invaded habitats (Keane and Crawley 2002). Released from their natural competitors, predators, herbivores, pathogens or disturbance regimes, these weeds become successful invaders in their new environment. Biological control is the introduction, or in some cases the re-introduction, of an "enemy" species to limit the spread of an invasive plant. These control agents may outcompete, feed upon, or otherwise limit an invasive species' ability to grow and reproduce. There are, however, several risks associated with biological control (Louda et al. 2003); control agents may impact non-targeted native species, alter ecosystem functions, and become invasive themselves (Simberloff and Stiling 1996). This technique should not be used unless controlled scientific experiments have shown it to be feasible for a particular agent and host and that risks are very minimal if not absent.

Competition. Plants compete for space, nutrients, pollinators, sunlight, and water. Non-invasive plants may effectively outcompete weeds in certain situations. However, in some situations, the aggressive establishment of native species is a potential form of invasive species control. For example, native trees and shrubs may be planted in deteriorating forests and woodlands to shade-out invasive grasses (Cole and Weltzin 2004). Planted subterranean clover may help control yellow starthistle when done in combination with grazing (Thomsen et al. 1997).

Grazing. While grazing alone will almost never completely eradicate invasive plant species (Tu et al. 2001), it is an important tool to limit the spread of many invasive species and to control large weed infestations (Sheley and Petroff 1999). Grazing in combination with other treatments can be extremely effective. The use of grazing as part of an invasive species control program should be done thoughtfully. The timing and intensity of grazing could be effective or alternatively could aid in the spread of particular invasive species if not done properly. Many invasive species, for example, require highly disturbed soils to create conditions to successfully spread. As a result, overgrazing can lead to the spread of some invasive species . In addition, caution should be used when bringing in animals from off site locations as this can also spread of invasive species through seed in their manure. Grazing during seed or flower production can be especially useful at damaging the invasive species without significantly impacting the desired native species. Finally, grazing can also negatively impact native species that are the target of restoration efforts. Thus, grazing is an excellent tool but careful planning is required to implement this strategy effectively.

Insects. Introduced insects have been used to successfully control invasive plants including Klamath weed (*Hypericum perforatum*; Huffaker and Kennett 1959) and ragwort (*Senecio jacobaea*; McEvoy et al. 1991); however, the introduction of insects and other organisms may have unintended consequences. For example, Callaway et al. (1999) introduced a bio-control moth, knapweed root moth (*Agapeta zoegana*), to the highly invasive spotted knapweed (*Centaurea maculosa*) and found that the introduced herbivory stimulated compensatory growth in the weed and increased its competitive ability. The Nature Conservancy prohibits the intentional release of non-indigenous biological control agents on their lands because of the associated risks.

Chemical Control

Herbicide Application. The use of herbicides is a very effective tool in the eradication and control of invasive plant species (Sheley and Petroff 1999, Bossard et al. 2000, Tu et al. 2001). However, great care must be taken in the planning for and application of herbicides to avoid inadvertent impacts to desirable native species, impacts water quality, and injury to herbicide applicators. As a result, the use of herbicides on a habitat restoration site generally requires that a written recommendation be developed by a certified pest control advisor before herbicides are applied. This recommendation should be obtained for herbicide treatments on SFPUC mitigation lands.

The City of San Francisco passed an Integrated Pest Management Ordinance in 1996 which restricts the use of herbicides on lands owned or leased by the City of San Francisco. The ordinance specifies that pesticides (including insecticides, herbicides/weed-killers) should be employed as a method of last resort and only after exploring all applicable non-chemical options. Further, only products listed on the San Francisco Reduced-Risk Pesticide List (RRPL) may be used on City-owned or leased properties. Table 1 below provides the herbicides that are approved for use on SFPUC lands and includes limitations and notes on the proper use of these herbicides. More information is available online at the following links:

- http://www.SFEnvironment.org/ipmchecklist
- http://www.sfenvironment.org/downloads/library/ipmordinance.pdf
- http://www.sfenvironment.org/downloads/library/20100420_sf_pesticide_list__red_legged_frog.pdf

Table 1. Herbicides and Surfactants Approved for Use on SFPUC Lands

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 renovations 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: City of San Francisco. 2009. SF Reduced Risk Pesticide List. City Department of the Environment. http://www.sfenvironment.org/. Accessed 11 March 2010.		
* Can't be used within 60 feet of water bodies within California red-legged frog critical habitat		

Physical Control

Cutting. Pruners, loppers, and saws can be effective tools for controlling invasive trees and shrubs (Holloran et al. 2004); however, some plants may respond to cutting by becoming more vigorous or by colonizing new locales via vegetation spread. Thus, the biology of the target species needs to be considered when considering cutting to control invasive species.

Hand Removal. Hand removal is often the most effective, easiest, and inexpensive way to control invasive plants, especially at the early stages of invasion and during the seedling stage of the plant's development (Tu et al. 2001). Local volunteers are often eager to help with invasive plant removal in their communities. Efforts should be made to remove the entire plant while minimizing soil disturbance that may facilitate invasion by other exotic and/or invasive plants. Proper disposal of removed plant material is important to avoid the spread of seeds and vegetative roots and stems.

Manual and Mechanical Removal. In instances when hand removal is not a feasible or effective means of controlling invasive plant species, manual removal by other means may be necessary. These means may include the use of tools such as weed wrenches, levers, or large equipment (e.g., bulldozers) to uproot and remove individual shrubs or trees.

Mowing. Mowing can be an effective means of controlling invasive annual species when grazing or fire is not feasible. When properly timed, mowing prevents seed development and dispersal, cuts off energy production in photosynthetic leaves, and reduces competition pressures on non-targeted species by exotic annuals (DiTomaso and Healy 2007). However, shifts in species composition from exotic annual grasses to exotic forbs have been observed in California coastal prairie following mowing treatments (Maron and Jefferies 2001; Hayes and Holl 2003a); therefore this control technique may need to be used in combination with others strategies. In addition, each site may respond differently to the same mowing treatment, so site-specific management plans will be needed in order to maximize the benefits of mowing (Hayes and Holl 2003b).

Mulching. Mulch applied as hay, leaf litter, wood chips, or black plastic sheets may be effective at excluding sunlight from invasive seedlings and grasses. Reducing the amount of sunlight a plant receives causes photosynthesis to slow down or stop, thereby cutting off the energy supply it needs to grow and reproduce. Care should be taken to avoid using hay bales and other mulch material that could be contaminated with seeds of invasive plants.

Successional Management

The biological, chemical, and physical techniques described above can control many invasive plant species. However, an ecological approach to weed management may further control these plants by applying successional models to direct plant species composition from invasive and exotic to native assemblages (Krueger-Mangold et al. 2006). Ecological succession refers to changes in natural communities through time. By understanding the causes of succession for a particular community (site and species availability/performance) and the processes associated with that community (e.g., disturbance, dispersal, life history, etc.), land managers can control invasive plant species occurrences and help prevent their future establishment (Sheley et al 2006).

Prescribed fire is a potentially effective tool to control some species of invasive plants which could be evaluate in the future when the need arises.

Target Invasive Species of SFPUC Mitigation Sites

Target species for non-aquatic, upland habitats are species with high or moderate impacts rankings in the California Invasive Plant Council's (Cal-IPC) Central West list (excluding those listed as exempt below), as well as those species that are rated as high or moderate by the Cal-IPC list in the future (but excluding species that are considered to appear rarely in monotypic stands or to have low/minor impacts in our region).

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

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

TREATMENTS FOR INDIVIDUAL SPECIES

Potential treatments for individual species identified in Table 2 have been developed and are described below. The treatment descriptions for blue gum eucalyptus (*Eucalyptus globulus*), European olive (*Olea europaea*), French broom (*Genista monspessulana*), Harding grass (*Phalaris aquatica*), Italian ryegrass (*Lolium multiflorum*), Italian thistle (*Carduus pycnocephalus*), Monterey cypress (*Cupressus macrocarpa*), oat grass (*Avena* spp.), periwinkle (*Vinca major*), Spanish broom (*Spartium junceum*), teasel (*Dipsacus sativus*), and yellow star-thistle (*Centaurea solstitialis*) were developed as part of the Homestead Pond Mitigation and Monitoring Plan (Winzler and Kelly 2009). These treatment descriptions were expanded and new treatments were developed for bull thistle (*Cirsium vulgare*), milk thistle (*Silybum marianum*), Pampas grass (*Cortaderia jubata*; *C. selloana*), Scotch broom (*Cytisus scoparius*), and velvet grass (*Holcus lanatus*) using descriptions and methods found in Bossard et al. (2000) and DiTomaso and Healy (2007). The general control treatments for each invasive species have been summarized in Table 3.

Blue Gum Eucalyptus (*Eucalyptus globulus*). Blue gum eucalyptus is a perennial tree that can grow 150-180 ft tall. It is long-lived and grows well on a variety of soils. Native to Australia, blue gum displaces native plant communities and alters soil chemistry through the addition of chemicals from its leaves. Its impact rating by Cal-IPC is moderate and it is listed by the SFRWQCB as a Tier 1 species. Blue gum removal is recommended using the following physical and chemical techniques:

> **Manual Removal/Cutting.** Eucalyptus trees are often massive, and their removal can be difficult and expensive. Cutting and manual (or mechanical) removal will be needed followed immediately (within 5 minutes) by herbicide treatment of stumps. Cuts should be made as close to the ground as possible. When herbicide treatment of stumps is not feasible, resprout shoots should be cut after they reach 6 ft tall. Repeated treatment will cause the tree to die in 4 or more years. Stump grinding can be effective for eliminating sprouting when there are few individuals growing on gentle terrain; however, the area should be re-visited every 2 to 6 months for at least a year to check for resprouts. Saplings can be hand pulled to prevent the development of new groves. Grinding should occur in addition to and subsequent to herbicide applications. Prescribed burning can help control seedlings; however, this method is ineffective against the fire adapted adults.
>
> **Chemical.** Herbicides are the most effective method for the control of blue gum. Triclopyr (as Garlon 4® and Garlon 3A®) and glyphosate (as Roundup® or Rodeo®) have been shown to be effective at controlling sprouts when applied to freshly cut stumps. Stem or foliar application is less effective. It is important to spray the fresh cambium immediately after cutting in order to ensure the herbicide will be transported by the plant to its roots. A written recommendation from a certified pest control advisor should be obtained before the used of herbicides.

Bull Thistle (*Cirsium vulgare*). Bull thistle is a perennial or biennial forb that is common on grasslands, along the edges of marshes, and in mesic forest openings. It is native to Europe, western Asia and northern Africa, and in California it displaces native and forage plant species.

Its impact rating by Cal-IPC is moderate and it is listed by the SFRWQCB as a Tier 2 species. Physical and chemical techniques can be utilized to control this species.

> **Hand Pulling/Mowing/Cutting.** Hand pulling, mowing or hand cutting 1-2 in below the soil surface shortly before plants begin to flower effectively controls bull thistle. Plants should be removed following cutting, because flower stalks left to decompose may continue to flower and produce viable seeds. Bull thistle can be mowed after it has bolted and before flowering. A second round of mowing one month later will be needed for success. Mowers and clippers should be cleaned so that they do not spread thistle seeds.

Chemical. Herbicides can effectively control bull thistle. Clopyralid, dicamba, MCPA, picloram, and 2,4-D have been shown to be effective when applied to rosettes in spring or fall. Chlorsulfuron and metsulfuron have been shown to be effective when applied to plants during bolting to bud stages. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.**French Broom (*Genista monspessulana*).** French broom is a perennial shrub that was introduced as a landscape ornamental. A member of the pea family (Fabaceae), French broom forms dense thickets on coastal plains, mountain slopes and in disturbed places. It is rated by Cal-IPC as high impact and is listed by the SFRWQCB as a Tier 1 species. Removal can be achieved using physical, chemical, and biological techniques:

> **Hand Pulling/Manual Removal.** Hand pulling and mechanical removal with a weed wrench can help control French broom. These methods are labor intensive and work best with small infestations. Soil disturbance associated with these kinds of physical removal may facilitate the establishment of broom seedlings from the seed bank or other invasive species.
>
> **Cutting.** Cutting shrubs with loppers or saws just above ground level helps minimize soil disturbance; however, the stumps of French broom readily resprout, and they will need to be cut several more times to be eliminated. Stumps can be treated with herbicide to reduce resprouts.
>
> **Mulching.** Mulch can be used to control French broom. A 3 in deep layer of wood bark mulch has been shown to significantly decrease seedling emergence (Bossard et al. 2000). This approach may help reduce impacts in areas where large seed banks have accumulated.
>
> **Herbicide.** A two percent solution of glyphosate (as Roundup®) can be sprayed on the foliage. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.
>
> **Biological.** There are a number of potential biological control agents found in its native range including species of moths, beetles, and weevils (Sheppard 2000); however, none are USDA approved. These control agents would likely impact native species of lupine and should not be released. Another biological control technique is to plant native trees

and shrubs within and around stands of broom to help control infestations through shading and competition.

Harding Grass (*Phalaris aquatica*). Harding grass is a deep-rooted perennial grass rated by Cal-IPC as moderate and listed by the SFRWQCB as a Tier 2 species. Physical, chemical, and biological treatments may be used to help control Harding grass.

Mowing. Mowing is an effective means of controlling Harding grass. If mowing is implemented, it is recommended to be very close to the ground and to occur at least three times within the growing season to keep the plants from overtaking native species. After mowing close to the ground, an herbicide can be applied to reduce the amount of effort needed for subsequent mowing (Cal-IPC, 2004).

Chemical. Spot treatment herbicide sprays with a 2 percent solution of glyphosate have been shown to be effective in the control of Harding grass. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.

Grazing. Intense livestock and geese grazing have been effective at controlling Harding grass. Grazing can effectively decrease abundance of this species and it is known to be planted for forage, but can be toxic when consumed in large quantities by animals.

I**talian Ryegrass (*Lolium multiflorum*).** Italian ryegrass is a non-native annual grass rated by Cal-IPC as moderate and listed by SFRWQCB as a Tier 2 species.

Mowing. Mowing and biomass removal can significantly reduce the abundance of Italian ryegrass and other annual grasses (Maron and Jefferies 2001); however, the cut grass can be left on-site as long as cutting took place prior to the flowering stage of the grass' development.

Biological. Ryegrass can tolerate grazing, and germination may even be promoted under heavy grazing regimes (Deregibus et al. 1994). It does not compete well with other grasses or survive well on infertile soil (DiTomaso and Healy 2007).

Italian Thistle (*Carduus pycnocephalus*). Italian thistle is an annual plant rated by Cal-IPC as moderate and is a listed by the SFRWQCB as a Tier 2 species. There are several physical, chemical and biological techniques that can be utilized to control this species.

Hand Pulling. Small infestations can be controlled through hand pulling individuals during the bolting stage and before flowering while minimizing soil disturbance.

Cutting. Plants should be cut or weed whipped before they flower. During the summer months when the ground is hard, individuals can be cut below the crown with a small pick or trowel. Repeated treatments will likely be needed. Flower and seed heads should be removed from the site and burned.

Grazing. Sheep and goats will graze on the thistle during the early spring when plants are 4-6 in tall. Animals should be allowed to graze for 2-3 weeks and in large numbers (Cal-IPC 2004).

Herbicide. Herbicides can be effective in the control of Italian thistle. Glyphosate (as Roundup®) has been shown to be effective when applied before the flowers go to seed. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.

Biological. The seed output of Italian thistle is increased when it co-occurs with yellow bush lupine (*Lupinus arboreus*), so removal of this lupine and other showy-flowered plants, may help control Italian thistle (Molina-Montenegro et al. 2008). Although yellow bush lupine is native, it is considered invasive by Cal-IPC with a limited rating.

Oat Grass (*Avena* spp.). Slender oat grass (*Avena barbata*) and wild oat (*A. fatua*) are annual grasses that were introduced as forage for livestock. They are rated by Cal-IPC as moderate and are listed by the SFRWQCB as Tier 2 species. Soil disturbance can stimulate germination, and repeated exposure to fire may increase its abundance (Giessow and Zedler 1996).

Biological. Crown rust of oats (*Puccinia coronata* f. sp. *avenae*) has been shown to reduce the competitive ability wild oats (*Avena fatua*; Carsten et al. 2001).

Mulch. Oat grass establishment can be suppressed with a thick layer of mulch (DiTomaso and Healy 2007).

Pampas Grass (*Cortaderia* spp.). Pampas grass is a large perennial grass that was introduced from South America as an ornamental. Its wind dispersed seeds are produced on large plume-like inflorescence. It is often used to control erosion. Pampas grass is rated by Cal-IPC as high and listed by the SFRWQCB as a Tier 1 species.

Hand Pulling/Manual Removal. Hand pulling seedlings limits the spread of Pampas grass. Larger plants will need a pulaski, mattock, or shovel for effective removal. Adult individuals can be removed using a choker cable attached to a truck hitch. Digging around the roots of the plant helps ensure the complete removal of the grass.

Cutting. Pampas grass can be controlled through cutting; however, care needs to be taken to properly dispose of seeds, plumes, and root crowns. Leaves and stems should be cut to the base using an ax, machete, or chainsaw. The exposed root mass will then need to be removed by chopping it into 4 or 5 inch squares and prying it out of the ground. Cutting is most effective when combined with an herbicide treatment.

Herbicide. A 2 percent glyphosate solution can be applied to the plant during active growing periods during the autumn months. Repeated applications will be necessary, even on plants that appear dead as they may survive and regrow the following year. Herbicide should be applied after the plumes and leaves have been cut and carefully disposed of. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.

Periwinkle (*Vinca major*). Periwinkle is a non-native perennial vine from southern Europe and northern Africa. It grows well in damp shaded areas, and once established, becomes a thick groundcover. It is rated by Cal-IPC as moderate and is listed by the SFRWQCB as a Tier 1 species. This species can be controlled by physical and chemical means.

Hand Pulling. Hand pulling can be labor intensive but effective when all of the stolons and root nodes are removed. Areas should be rechecked every 3 months for resprouts.

Herbicide. Periwinkle has been successfully controlled using glyphosate herbicides (Twyford and Baxter 1999). Success is improved when periwinkle is cut with a weed whip or brush cutter prior to spraying in order to increase foliar penetration. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.

Scotch Broom (*Cytisus scoparius*). Scotch broom is a non-native perennial shrub from Europe and northern Africa that grows best on sandy, high-phosphorous soils, but it tolerates a great range of conditions. It rated by Cal-IPC as high and listed as a Tier 1 species by SFRWQCB.

Hand Pulling/Manual Removal. Small plants can be pulled by hand or with a weed wrench. This should be done before they flower and set seed. Efforts should be made to minimize soil disturbance.

Cutting. Cutting is the preferred method of control over manual removal as it helps reduce soil disturbances that can deepen the broom's seed bank (Ussery and Krannitz 1998). Scotch broom can be cut using lopper or pruning saw. Plants should be cut during the end of the dry season to decrease the rate of resprouting (Bossard and Rejmanek 1994).

Herbicide. A 2 percent solution of glyphosate (as Roundup®) can be sprayed on the foliage. Triclopyr ester (as Garlon®) in seed press oil is also effective when it is applied with a wick to basal bark. Prior to the use of herbicides a written recommendation should be obtained by a certified pest control advisor.

Biological. Native trees and shrubs can be planted within and around stands of broom to help control infestations through shading and competition.

Spanish Broom (*Spartium junceum*). Spanish broom is a non-native perennial that grows well on poor, dry, stony soils and tolerates below freezing temperatures. Its impact rating by Cal-IPC is high, but is not listed by SFRWQCB. The best treatment options for Spanish broom are the same as those for Scotch and French broom.

Teasel (*Dipsacus sativus*). Teasel is a non-native biennial herb that grows in disturbed places. It is rated by Cal-IPC as moderate and is not listed by SFRWQCB. Manual removal and mowing are the best options for controlling teasel. Biological control agents are being studied and considered (Rector et al. 2006).

Manual Removal Plants should be removed before they flower and set seed. Removal of the plant to a few inches below the rosette will help control small populations.

Mowing. Mowing teasel before flowering will prevent seed production.

Velvet Grass (*Holcus lanatus*). Velvet grass is a tufted perennial grass that grows best in moist conditions. It is rated by Cal-IPC as moderate and listed by SFRWQCB as a Tier 2 species. Velvet grass can be controlled with manual removal, burning, mowing, grazing, and herbicide treatments.

Hand Pulling/Manual Removal. Clumps of velvet grass can be pulled or manually removed. This should be done prior to seed set. The roots of velvet grass can grow deep, especially in low-nitrogen soils, so care should be taken to avoid breaking them.

Mowing. Mowing treatments should be done in late March before seed set and repeated monthly until July (Holloran et al. 2004).

Grazing. Grazing may help reduce velvet grass cover by 50-75% in mesic grasslands along the central California coast (Hayes and Holl 2003b); however, low-intensity grazing may enhance its establishment and spread (DiTomaso and Healy 2007).

Chemical. The Nature Conservancy has had success using Glyphosate solutions to control velvet grass (Tu et al. 2001).

Yellow Starthistle (*Centaurea solstitialis*). Yellow starthistle is a winter annual (sometimes biennial) forb species that occurs in open hills, grasslands, roadsides, and rangelands. It is rated by Cal-IPC as high and listed by SFRWQCB as a Tier 1 species. Impacts of yellow starthistle include significant increased groundwater consumption, lower forage quality of rangelands, lower plant diversity, and fragmentation of sensitive plant and animal habitats (DiTomaso et al. 2006). These impacts represent a high economic and ecological cost to agriculture (crops and grazing) and sensitive native habitats such as native grasslands and blue oak woodlands. However, it is regarded as an important late-season food source for honey bees (DiTomaso et al. 2006). Numerous methods are employed to control yellow starthistle including mechanical, chemical, and biological; however, complete eradication is currently unlikely in larger sized infestations. The specific elements of an integrated management strategy to control yellow star thistle depend on the ultimate land use objectives for a given area (DiTomaso et al. 2006).

Mowing. Mowing can be an effective means of controlling yellow starthistle if done at a 4 inch blade height when 2 to 5 percent of the seed heads are flowering (Benefield et al. 1999).

Herbicides. Several chemical options are available for treating yellow star thistle including triclopyr and glyphosate. Glyphosate should be applied in late winter or early spring to control seedlings or in late spring or early summer after annual grasses and forbs have senesced.

Grazing. Grazing by cattle, sheep, or goats can effectively control yellow starthistle if it is done at a high intensity for short durations while the plant is bolting but before it becomes spiny.

Competition. Pastures planted with non-native subterranean clover (*Trifolium subterraneum*), rose clover (*T. hirtum*), and native bunchgrasses may benefit, as these plants can outcompete yellow starthistle.

Insects. Three species of weevils and three species of flies have been USDA approved for the control of yellow starthistle. The larvae of these insects feed on the seeds of this host plant; however, lack of successful treatment of this invasive weed has led some to suspect that yellow starthistle compensates by increasing seed production at lower plant densities (Gutierrez et al. 2005).

Table 2. General Control Techniques for Each Target Invasive Plant Species.

Common Name	Species Name	Physical					Chemical	Biological		
		Cutting	Hand Pulling	Manual Removal	Mowing	Mulching	Herbicide	Competition	Grazing	Insect/ Fungi
blue gum eucalyptus	*Eucalyptus globules*	X	X	X			X			
bull thistle	*Cirsium vulgare*	X	X		X		X			
French broom	*Genista monspessulana*	X	X	X		X	X		X	
Harding grass	*Phalaris aquatica*				X		X	X	X	
Italian ryegrass	*Lolium multiflorum*							X		
Italian thistle	*Carduus pycnocephalus*		X				X		X	
oat grass; slender wild oat	*Avena barbata; A. fatua*					X		X		X
Pampas grass	*Cortaderia jubata; C. selloana*	X	X	X			X			
periwinkle	*Vinca major*		X	X			X			
Scotch broom	*Cytisus scoparius*	X	X	X		X	X		X	
Spanish broom	*Spartium junceum*	X	X	X		X	X		X	
teasel	*Dipsacus sativus*			X	X					

Common Name	Species Name	Physical					Chemical	Biological		
		Cutting	**Hand Pulling**	**Manual Removal**	**Mowing**	**Mulching**	**Herbicide**	**Competition**	**Grazing**	**Insect/ Fungi**
velvet grass	*Holcus lanatus*		X	X	X		X		X	
yellow star-thistle	*Centaurea solstitialis*				X		X	X	X	X

MONITORING

The species described above are rarely successfully controlled by a single treatment. Monitoring is therefore critical for assessing the need for follow-up treatments and ensuring the invasive species is properly controlled. Also, monitoring helps detect the recruitment or establishment of new invaders into a previously treated area. Early detection leads to greater success of controlling invasive plants.

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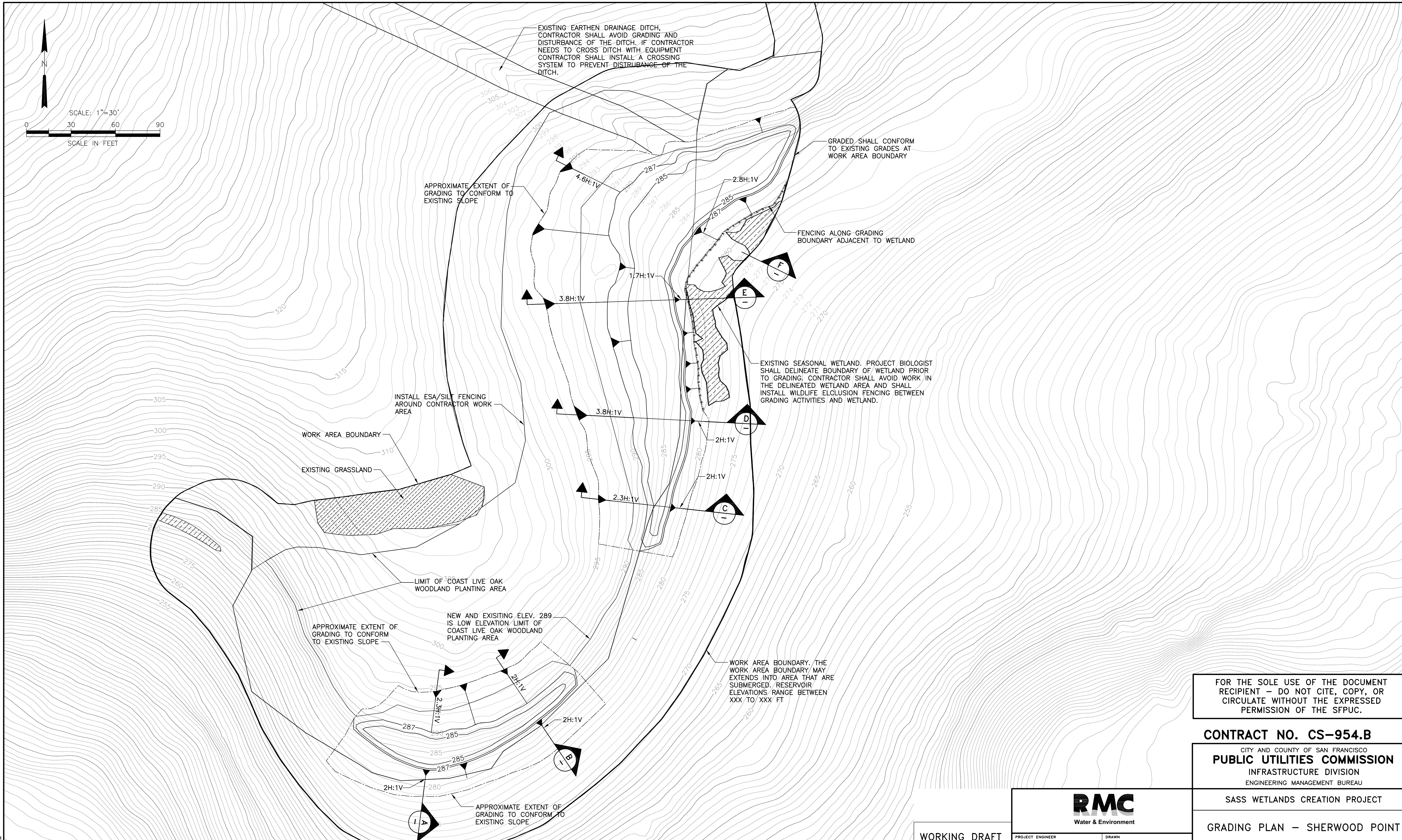
APPENDIX D.
DRAFT PROJECT DRAWINGS



PLAN
1" = 30'

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CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

SASS WETLANDS CREATION PROJECT

GRADING PLAN – SHERWOOD POINT

RMC
Water & Environment

PROJECT ENGINEER MN	DRAWN SJ
PROJECT MANAGER MN	DESIGNED
APPROVAL	CHECKED

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF –		–	

WORKING DRAFT SUBMITTAL

NOT FOR CONSTRUCTION

SEPT 10, 2010

COORDINATE: NAD83

ELEVATION DATUM: NAVD 1988

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

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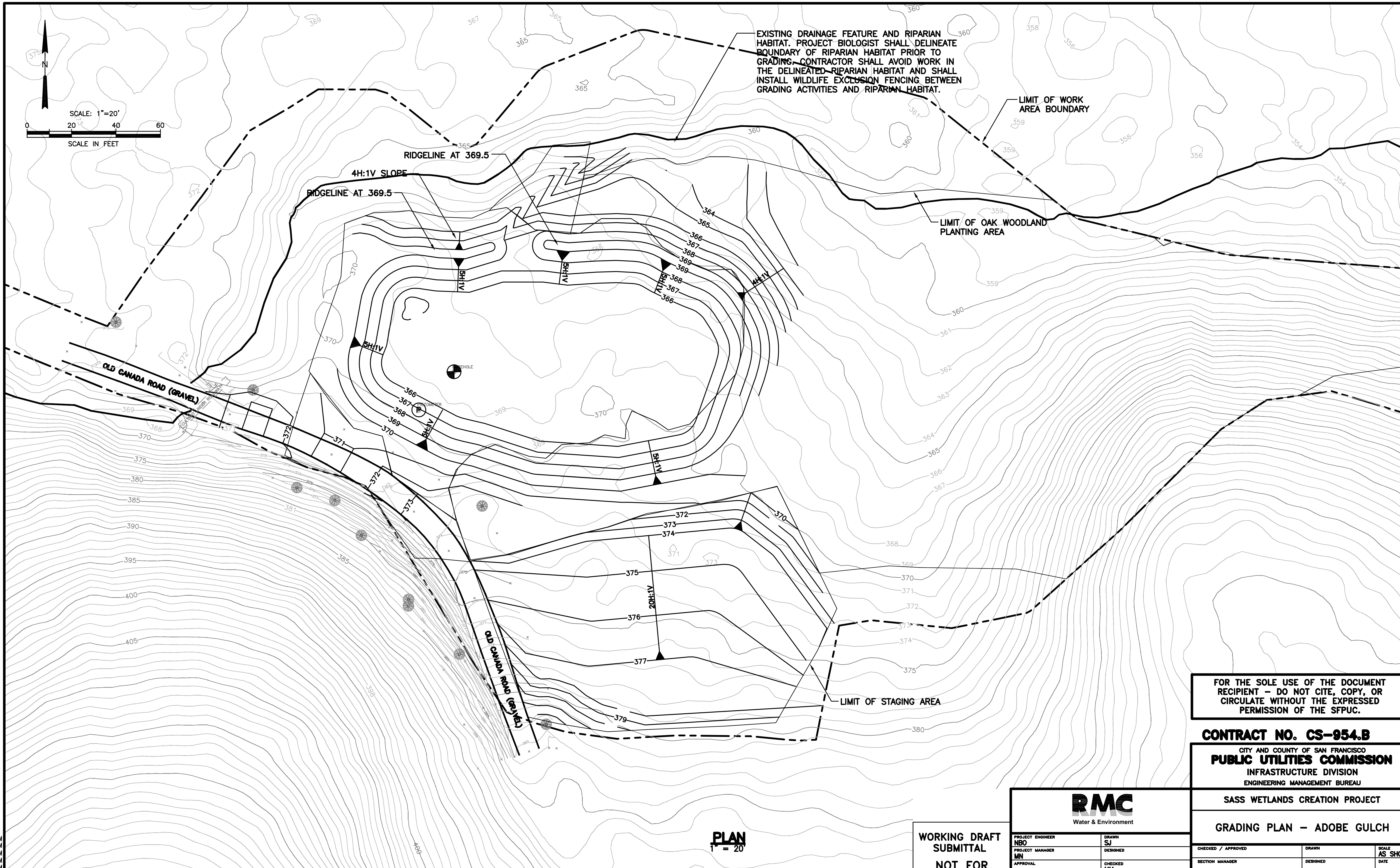
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



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ENGINEERING MANAGEMENT BUREAU

RMC Water & Environment

SASS WETLANDS CREATION PROJECT

GRADING PLAN – ADOBE GULCH

PROJECT ENGINEER NBO	DRAWN SJ
PROJECT MANAGER MN	DESIGNED
APPROVAL	CHECKED MM

NO.	DATE	DESCRIPTION	BY	APPR'D
REVISIONS				

CHECKED / APPROVED	DRAWN	SCALE AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF –		C-1	

WORKING DRAFT SUBMITTAL

NOT FOR CONSTRUCTION

SEPT 10, 2010

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

PLOT: EXTEND
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BORDER: 22,34
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CYAN 0.40MM
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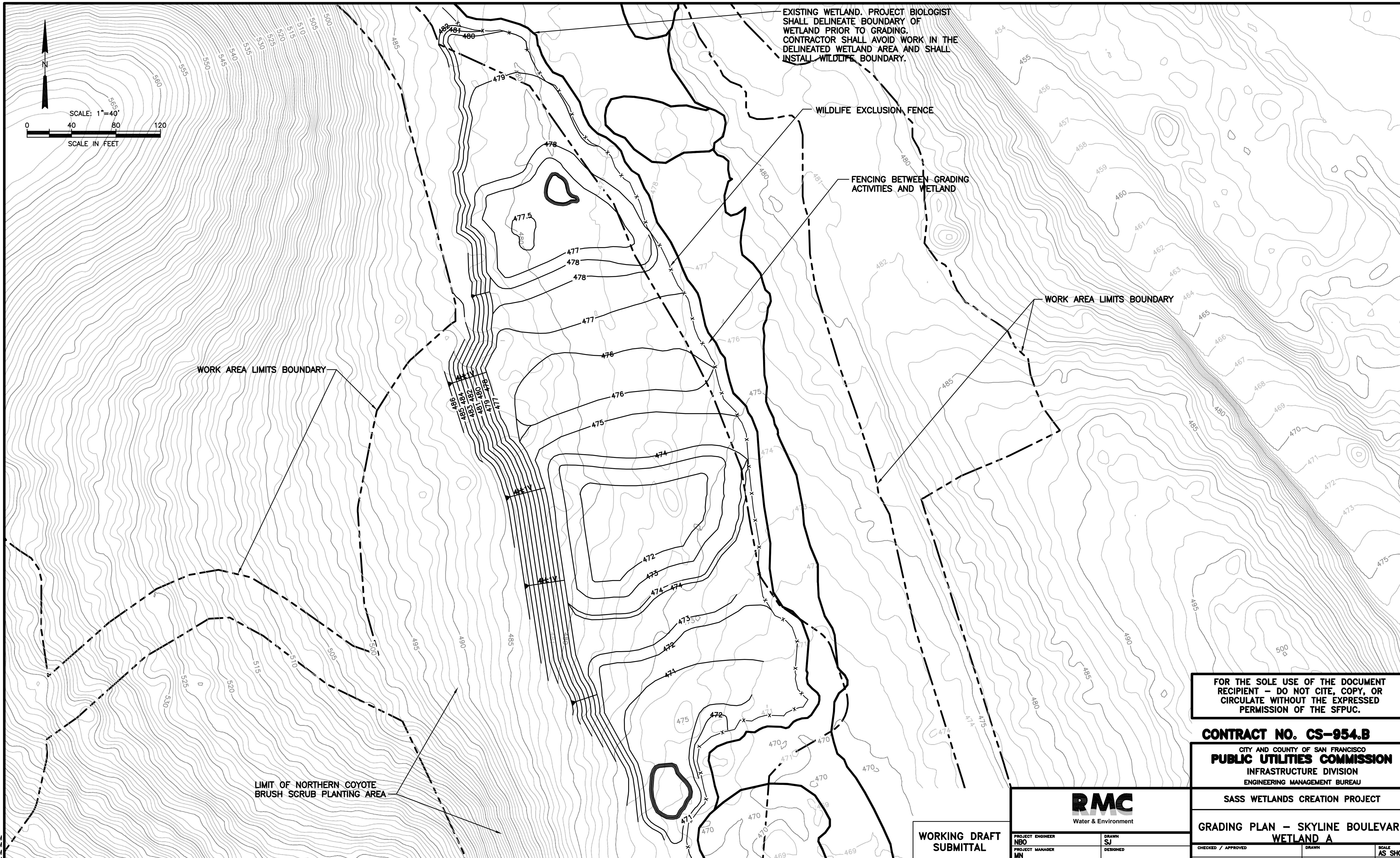

PLAN
1" = 40'

WORKING DRAFT SUBMITTAL

NOT FOR CONSTRUCTION

SEPT 10, 2010

COORDINATE: NAD83

ELEVATION DATUM: NAVD 1988

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CITY AND COUNTY OF SAN FRANCISCO
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SASS WETLANDS CREATION PROJECT

GRADING PLAN – SKYLINE BOULEVARD WETLAND A

PROJECT ENGINEER NBO	DRAWN SJ
PROJECT MANAGER MN	DESIGNED
APPROVAL	CHECKED MM

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE AS SHOWN
SECTION MANAGER	DESIGNED	DATE
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SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF –		C-1	

PLOT: EXTEND
SCALE: 1:1
BORDER:
22,34
COLOR: No.
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YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
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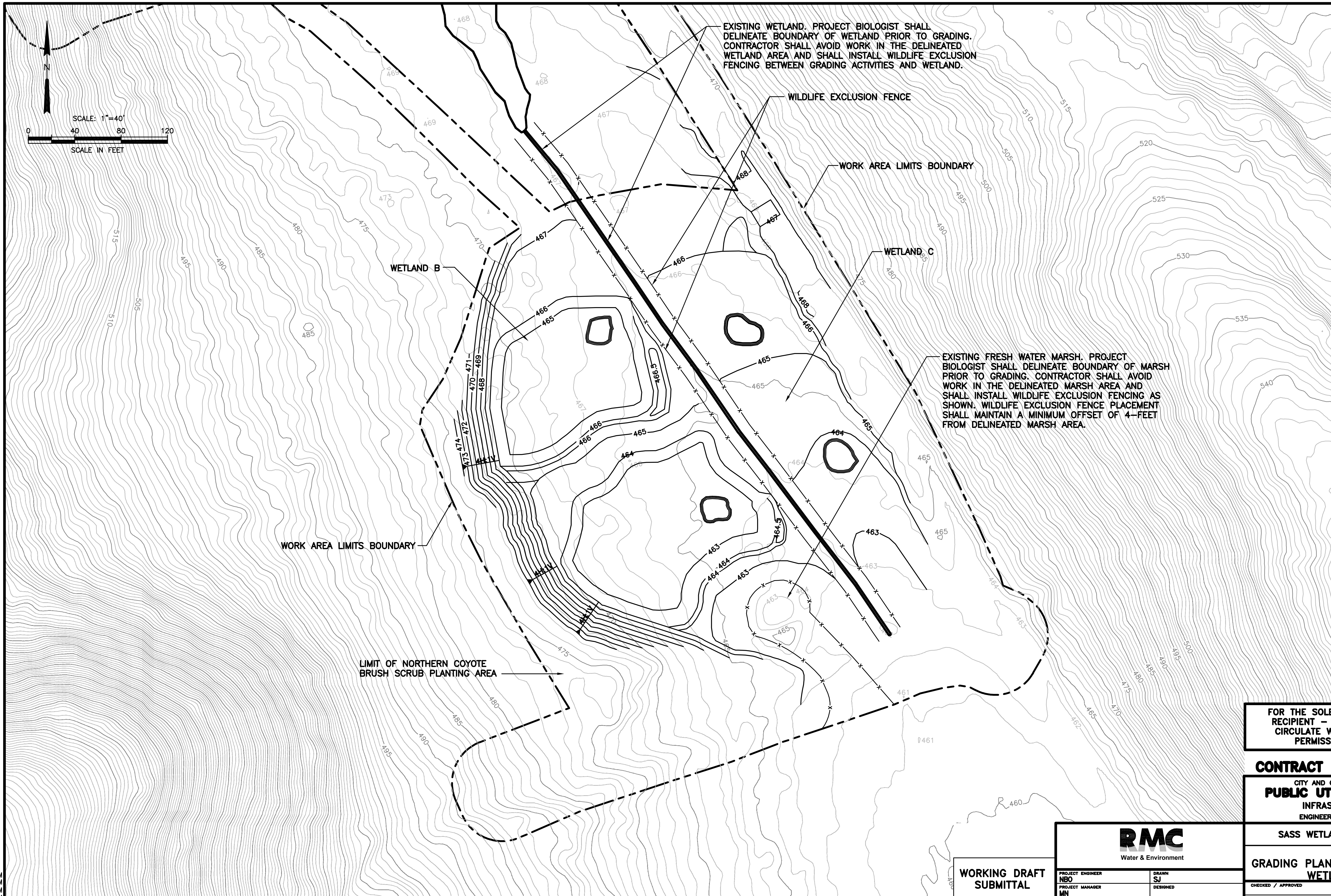

PLAN
1" = 40'

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SASS WETLANDS CREATION PROJECT

GRADING PLAN – SKYLINE BOULEVARD WETLAND B AND C

RMC Water & Environment

PROJECT ENGINEER NBO	DRAWN SJ
PROJECT MANAGER MN	DESIGNED
APPROVAL	CHECKED MM

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF –		C-1	

WORKING DRAFT SUBMITTAL

NOT FOR CONSTRUCTION

SEPT 10, 2010

COORDINATE: NAD83
ELEVATION DATUM: NAVD 1988

PLOT: EXTEND
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GRAY 0.15MM
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210 0.60MM

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FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

APPENDIX E.
RESOURCE SPECIALIST QUALIFICATIONS

Resource Specialist Qualifications

TYPE OF SPECIALIST	QUALIFICATIONS	ALTERNATE QUALIFICATIONS
Botanist/ Vegetation Ecologist/Restoration Specialist	• Bachelor’s degree in a biological or environmental field or commensurate professional experience • Experience conducting floristic and wetland surveys in northern California that demonstrates the following: 1) Ability to identify native, endemic, wetland, and serpentine plant species 2) Ability to identify non-native and invasive plant species 3) Ability to identify characteristic serpentine and wetland soils 4) Ability to assess plant health • Experience conducting vegetation monitoring using methods comparable to those described in the MMP • Experience and/or training in rangeland monitoring, including measuring residual dry matter (RDM) • Knowledge of vegetation ecology	Approved by applicable permitting agencies
Wildlife Biologist	• Bachelor’s degree in a biological or environmental field or commensurate professional experience • Knowledge of life cycles and habitat requirements of target special-status and predatory species • Experience in conducting special-status wildlife surveys • Ability to identify common and sensitive wildlife species	Approved by applicable permitting agencies
Wetland Biologist	• Bachelor’s degree in biology, soil science, natural resources management, or similar environmental field or commensurate professional experience • Experience conducting jurisdictional delineations of wetlands and other waters in accordance with the 1987 edition of the Corps of Engineers Wetlands Delineation Manual	Approved by applicable permitting agencies