FINAL REPORT

SUNOL REGION MITIGATION AND MONITORING PLAN

Prepared for

San Francisco Public Utilities Commission
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September 2010

URS

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San Francisco Public Utilities Commission
Mitigation and Monitoring Plan for the
SUNOL REGION HABITAT RESERVE PROGRAM

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.

9/14/10

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

9/14/10

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

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List of Acronyms

ACCM	asbestos-containing construction materials
ACDD	Alameda Creek Diversion Dam
ACM	asbestos-containing materials
AF	acre-feet
BA	Biological Assessment
BAAQMD	Bay Area Air Quality Management District
BHR	bank height ratio
Cal-IPC	California Invasive Plant Council
Cal-OSHA	California Occupational Safety and Health Administration
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CDRP	Calaveras Dam Replacement Project
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
cy	cubic yards
DSOD	California Department of Water Resources, Division of Safety of Dams
D16	Deepot
EBRPD	East Bay Regional Park District
ETJV	EDAW & Turnstone Consulting Joint Venture
FAC	Facultative plant, equally likely to occur in wetland and upland conditions (wetland indicator status)
GPS	Global Positioning System
GIS	Geographical Information System
HCP	Habitat Conservation Plan
HEC-HMS	Hydrologic Engineering Center - Hydrologic Modeling System
HRP	Habitat Reserve Program
IATF	Inter Agency Task Force
LiDAR	light detection and ranging
LoE	Los Osos clay loam, 15 to 30 percent slopes (map unit)
MEA	(San Francisco Planning Department) Major Environmental Analysis Section
MMP	Mitigation and Monitoring Plan
MOU	Memorandum of Understanding
NESHAP	National emissions standards for hazardous air pollutant
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
OBL	obligate wetland plant (wetland indicator status)
PgB	Pleasanton gravelly loam 3 to 12 percent slopes (map unit)
PpD2	Pleasanton gravelly loam, 9 to 15 percent slopes, eroded (map unit)
ppm	parts per million
RACM	Regulated Asbestos Containing Materials
RCD	Alameda County Resource Conservation District
RDM	Residual Dry Matter
Rh	riverwash (map unit)
SC	supercell
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SfC	San Ysidro loam, acid variant, 2 to 9 percent slopes (map unit)
SFPUC	San Francisco Public Utilities Commission

STP	soil test pit
TP	Tree pot
URS	URS Corporation
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WRD	available water capacity (map unit)
WSIP	Water System Improvement Program
YaB	Yolo loam, 2 to 5 percent slopes (map unit)
YeC	Yolo silty clay loam, 2 to 9 percent slopes (map unit)
Za	Zamora silt loam 0 to 4 percent slopes (map unit)
ZaC	Zamora loam, 2 to 9 percent slopes (map unit)

1 INTRODUCTION

The purpose of the San Francisco Public Utilities Commission's (SFPUC) Water System Improvement Program (WSIP) is to repair, replace, and seismically upgrade the San Francisco Regional Water System's aging facilities. To comply with federal and state of California environmental laws, the SFPUC identified impacts and compensation measures to mitigate for projected effects to species and habitats from implementing the Calaveras Dam Replacement Project (CDRP) and other WSIP projects (listed in Section 1.1 below). The CDRP is the main WSIP project addressed in this document.

The SFPUC developed the Habitat Reserve Program (HRP) to compensate for impacts to habitat and species primarily associated with WSIP projects. Five HRP mitigation areas are located in the Sunol region and are the subject of this mitigation and monitoring plan (MMP). The mitigation areas are named according to their respective locations at San Antonio Creek, Sage Canyon, South Calaveras, Goat Rock, and Sheep Camp Creek (Figure 1-1 and Figure 1-2).

This MMP for the Sunol Region HRP, has been prepared to support the permit applications that SFPUC has or will submit to the following agencies:

- The U.S. Army Corps of Engineers (USACE)(to obtain a permit to fill in waters of the United States pursuant to Section 404 of the Clean Water Act of 1977 [33 U.S.C. §§ 12511344 (2007)]) and to support the USACE consultation with the U.S. Fish and Wildlife Service (USFWS) pursuant to Section 7 of the Endangered Species Act of 1973 [16 U.S.C. § 1536 (2007)])

- The San Francisco Bay Regional Water Quality Control Board (RWQCB) (to obtain a Water Quality Certification to comply with Section 401 of the Clean Water Act of 1973)

- California Department of Fish and Game (DFG) (to obtain a Streambed Alteration Agreement in compliance with California Fish and Game Code Section 1600)

The MMP quantifies the anticipated species and habitat impacts of Sunol Region WSIP Projects and the compensation that the SFPUC proposes for those impacts. Four types of compensation are addressed in this document and defined below based on the Final Rule published in the Federal Register on April 10, 2008 (USACE 2008b): enhancement, establishment, reestablishment, and preservation (Figure 1-3).

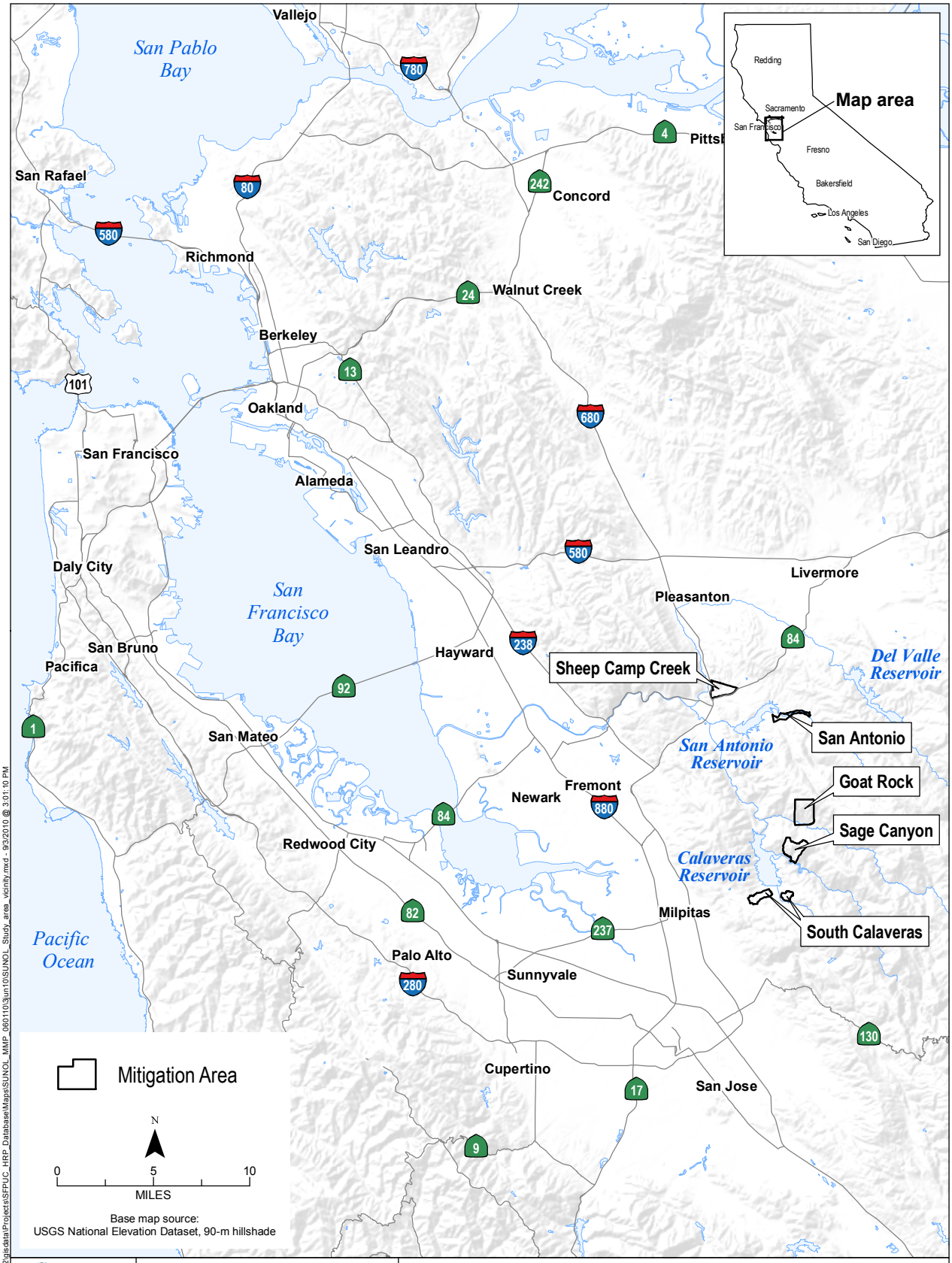
For the purposes of compensatory mitigation, URS defines restoration as the manipulation of the physical or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded resource. Restoration is divided into two sub-types discussed in this document:

- Reestablishment: the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former resource. Reestablishment results in an increase in the function and the area of a resource.

- Rehabilitation: the manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing the natural/historic functions of a degraded resource. Rehabilitation results in a gain in function, but does not result in a gain in area. As defined in the April 10, 2008 Final Rule, rehabilitation differs from enhancement in that rehabilitation is intended to result in a general improvement in the suite of functions performed by a degraded resource. In contrast, enhancement activities focus on increasing one or two functions, rather than all the functions being performed by an existing resource.

Enhancement is defined as the manipulation of the physical or biological characteristics of a resource to heighten, intensify, or improve one or more specific functions. Enhancement results in the gain of selected resource functions, but may also lead to a decline in other resource functions. Enhancement does not result in a gain in resource area. As defined in the April 10, 2008 Final Rule, enhancement differs from restoration, rehabilitation, and re-establishment because the objective of enhancement is usually to improve one or two functions, which may result in a decrease in the performance of other functions. Increasing those particular functions does not change the amount of area occupied by the aquatic resource. In contrast, re-establishment and rehabilitation (which are forms of restoration) are intended to return most, if not all, natural and/or historic functions to a former or degraded aquatic resource.

A fourth compensation type, preservation, will, occur at all mitigation areas. Preservation is defined as the removal of a threat to, or preventing the decline of, a resource. Preservation does not result in a gain in the function or the area of a resource (USACE 2008b). The proposed compensatory mitigation areas would be preserved in perpetuity by a dedicated conservation easement. Financial assurances and property title verifications that support the conservation easement will be provided separately by the SFPUC.



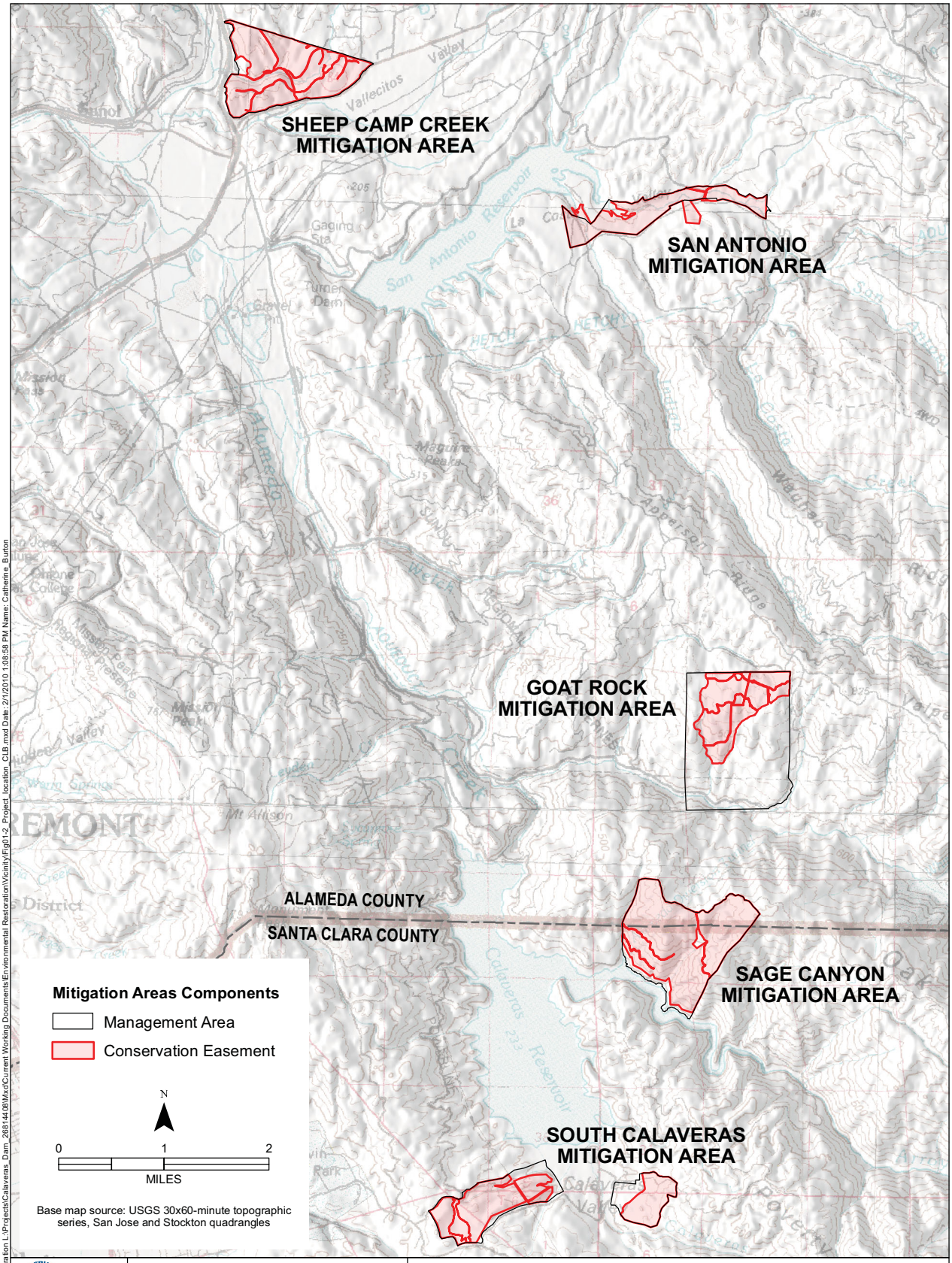
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Figure 1-1
Study area vicinity

Back of Figure 1-1



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San Francisco Public Utilities Commission
Habitat Reserve Program

Figure 1-2
Conservation easements and management areas

Back of Figure 1-2

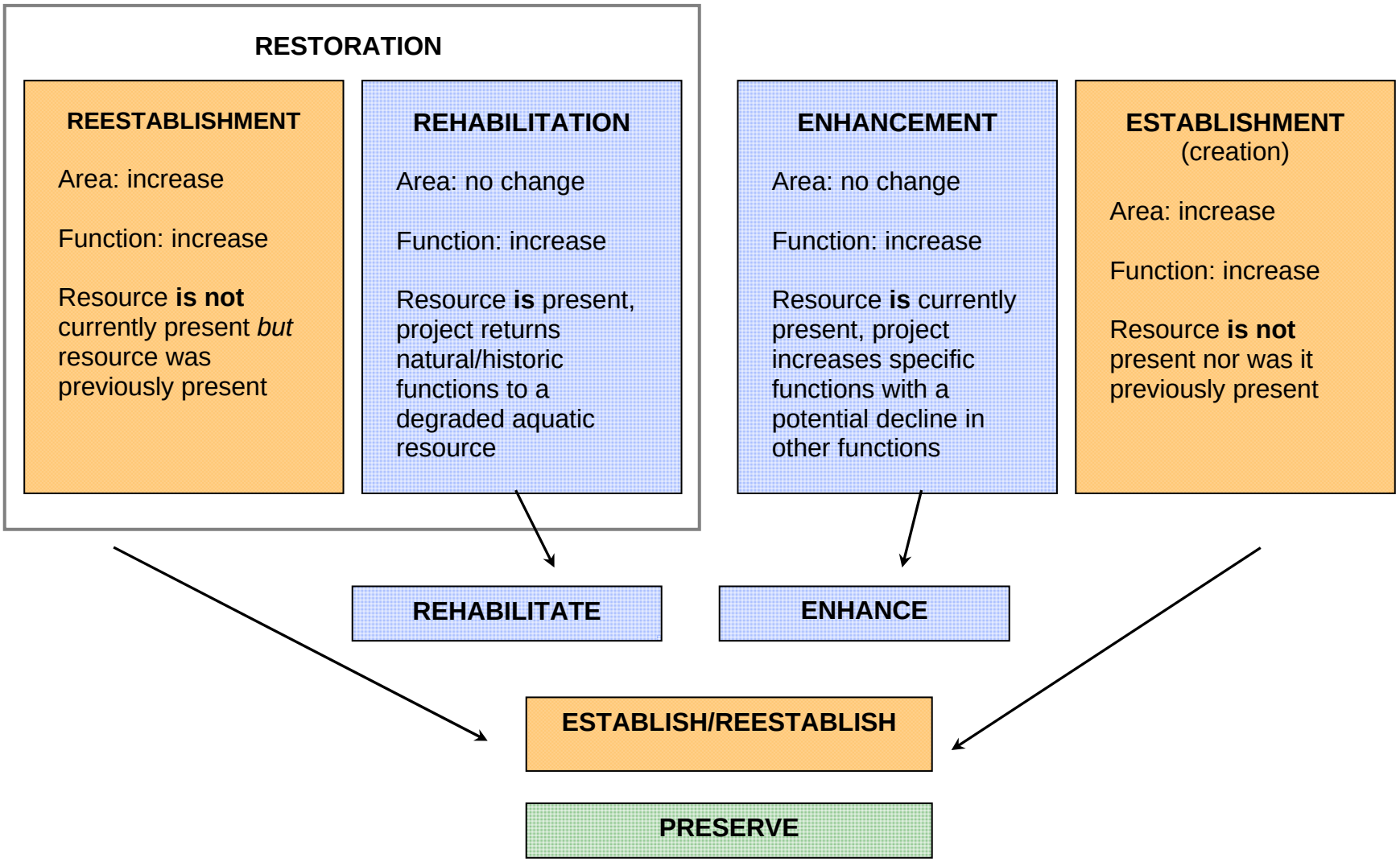


Figure 1-3. Illustration of the relationship among compensation types.

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1.1 WSIP PROJECTS REQUIRING MITIGATION

The compensation presented in this HRP MMP is for impacts to species and habitat associated with the following WSIP projects:

- Calaveras Dam Replacement Project
- New Irvington Tunnel
- Sunol Valley Water Treatment Plant
- Bay Division Pipeline #5
- Bay Division Pipelines #3 and #4 Seismic Upgrade
- San Antonio Backup Pipeline
- Alameda Siphons

Project-specific permit applications provide applicable project details for the seven WSIP projects listed above.

1.2 ORGANIZATION OF DOCUMENT

This document is organized as follows:

- Section 1 provides background information on the purpose of the proposed compensatory mitigation, lists the WSIP projects accommodated in the mitigation areas, defines key terms used in the document, and lists the responsible parties.

- Section 2 provides information regarding the location and boundaries of each HRP mitigation area, present and past uses, and adjacent land uses. This section also describes existing conditions in the HRP mitigation areas, including vegetation communities and associated wildlife, descriptions of special-status and non-native invasive species, aquatic features and jurisdictional areas, topography and soils, hydrology, and hydrogeomorphology.

- Section 3 defines the mitigation goals for the HRP mitigation areas, presents the design and describes the basis of design. The basis of design is crafted from observations, data analysis, and/or ecological principles and comprises the rationale for expecting to achieve success. The basis of design supports the PUC's assertion that the compensation and its commensurate credit are achievable.

- Section 4 describes the implementation process, including site preparation, planting material, installation methods, and water sources and irrigation.

- Section 5 defines interim success criteria and final performance standards based on the mitigation goals described in Section 3. This section also describes a monitoring plan to assess progress toward meeting the mitigation goals and defines the monitoring protocols, including the monitoring methods, data collection parameters, and monitoring schedule. The final section in this chapter describes the required reporting for the project, including as-built reports, performance period reports, and the requirements for completion of mitigation responsibilities.

- Section 6 describes management responsibilities and site maintenance including vegetation maintenance, remedial actions and adaptive management, non-native invasive species control, and the maintenance schedule. Property protections and long-term project funding are described.

- Section 7 provides the references cited in this document.

The following appendices are included to supplement information in the text:

A Soil Data and Descriptions
B Hydrogeomorphic Study Methods
C Hydrology Data
D Maps of Primary Constituent Elements for Listed Species Critical Habitat
E 30 Percent Design Plan Drawings and Design Memo for San Antonio Creek
F 30 Percent Design Plan Drawings and Design Memo for Goat Rock
G 30 Percent Design Plan Drawings and Design Memo for Goldfish Pond
H Cal-IPC Inventory of Plants with Ratings of High or Moderate
I Propagule Collection Memo
J Maintenance Monitoring Form

1.3 RESPONSIBLE PARTIES

The San Francisco Public Utilities Commission is the permit applicant and is financially responsible for the attainment of the success criteria and performance standards defined in this MMP. The contact information is:

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Contact: Greg Lyman
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The landowner is:

San Francisco Public Utilities Commission
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Contact: Tim Ramirez
415/554-3265

URS Corporation prepared this MMP based in part on two documents prepared by EDAW/ETJV, dated July 2009: the Draft Mitigation and Monitoring Plan for Waters of the United States and State, Calaveras Dam Replacement Project (ETJV 2009a) and the Draft Mitigation and Monitoring Plan for Wildlife and Vegetation, Calaveras Dam Replacement Project (ETJV 2009b). This MMP also includes original data generated for the San Francisco Public Utilities Commission by the URS Corporation.

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2 MITIGATION AREAS

This section describes the five proposed HRP mitigation areas. Section 2.1 discusses the selection process and Section 2.2 describes the location and boundaries of each mitigation area. The existing conditions at each mitigation area are detailed in Section 2.3.

2.1 SELECTION PROCESS

The selection of compensation areas was based primarily on an assessment of SFPUC land within the Calaveras Creek, Alameda Creek, and San Antonio Creek watersheds in coordination with the following resource agencies: USACE, USFWS, CDFG, RWQCB, and EPA. Mitigation opportunities were identified according to the following steps:

- A preliminary assessment of the effects of the CDRP and other SFPUC projects on special-status species and habitats was used to determine potential mitigation requirements.
- Mitigation areas were identified in coordination with SFPUC watershed staff and by examining habitat maps prepared for the CDRP (ETJV 2006b) and the Alameda Watershed Habitat Conservation Plan (HCP) (Jones & Stokes 2006).
- Mitigation area boundaries were generally established over a larger area than would be required for the mitigation activities to provide for flexibility in compensation site design and ecological continuity.
- Compensation sites were identified within the five mitigation areas. Sites were selected where habitats had been degraded or impaired due to historical land conversion, development, or other uses, and in locations that would benefit from rehabilitation.
- Reconnaissance field surveys and baseline investigations were conducted to determine suitability of potential compensation sites, and the opportunities and constraints for mitigation planning and implementation.

This MMP incorporates input from the resource agencies provided as written comments and verbal feedback during meetings since the previous draft of the MMP was submitted in June 2010. These meetings are summarized below:

- **June 22, 2010:** HRP team presentation of the revised Sunol Region MMP to the IATF at the SFPUC.
- **July 20, 2010:** SFPUC met with the IATF to discuss comments and questions related to the June 2010 revision of the MMP.
- **August 3, 2010:** SFPUC met with the IATF to receive final comments from CDFG and the RWQCB related to the June 2010 revision of the MMP.

In addition to the recent coordination outlined above, the SFPUC has worked closely with the resource agencies to develop the conceptual mitigation described in this plan. Agency coordination that preceded the June 2010 draft of the MMP is summarized in reverse chronological order below.

- **April 13, 2010** USACE and RWQCB field visit to Sheep Camp Creek to verify jurisdictional delineation.

- **April 6, 2010**: SFPUC and URS presented Sheep Camp Creek design elements to the IATF based on input during the March 18, 2010 field visit.

- **March 23, 2010**: Field visit to Sheep Camp Creek Mitigation Area with CDFG and USFWS to discuss potential design elements and opportunities.

- **March 2, 2010**: IATF meeting discussed the compensation proposal for CDRP and provided details of the San Antonio Creek and Sheep Camp Creek mitigation areas. Based on agency input at this meeting, the SFPUC added the Sheep Camp Creek Mitigation Area to the Sunol Region MMP and initiated additional studies to develop conceptual designs at this location.

- **February 17, 2010** IATF meeting discussed the proposed sites and compensation credits. Agencies questioned proposal for mitigation credit at sites that would be inundated if Calaveras Dam were raised in the future to a spillway elevation of 890 feet. The result of this discussion was deletion of three compensation sites (Stock pond, Ephemeral drainage and Calaveras Creek) in the South Calaveras mitigation area.

- **February 2, 2010:** IATF meeting presented Sunol Region MMP and distributed report on compact disc.

- **January 5, 2010:** IATF meeting, discussed specific CDRP mitigation proposal based on agency feedback.

- **December 1, 2009:** IATF meeting, discussed MMP schedule and financial assurances.

- **October 20, 2009:** IATF meeting, discussed species compensation and conservation easement.

- **October 8, 2009:** Received comments on draft Vegetation and Wildlife MMP (ETJV 2009b) from Charles Armor, CDFG

- **September 25, 2009:** Received comments on Draft Wetlands and Waters of the United States and State MMP (ETJV 2009a) from William Hurley, RWQCB

- **September 8-9, 2009:** Toured proposed HRP sites in the Alameda Region to solicit agency input on proposed actions and the suitability of each site as mitigation for WSIP project impacts.

- **August 4, 2009:** IATF meeting, discussed design.

- **July 7, 2009:** IATF meeting, discussed financial assurances, approach to Section 7, and presented overview of the database and GIS layers.

- **May 5, 2009:** IATF meeting, discussed permitting for the HRP.

- **February 3, 2009:** IATF discussion on the Biological Assessment (BA) for CDRP with USFWS.

- **December 2, 2008:** IATF meeting, SFPUC presented funding and accounting for HRP, PCE approach for success criteria, approach for identifying need for additional habitat or wetlands.

- **November 4, 2008:** IATF meeting; discussed habitat benefits and site of oak woodland and scrub habitats.

- **October 7, 2008:** CDRP team presentation to the IATF on CDRP on updated biology impacts and mitigation. The IATF gave their conceptual approval regarding the mitigation approach.
- **March 10, 2008:** CDRP team presentation to the IATF on CDRP biological impacts and mitigation.
- **September 7, 2008:** IATF meeting, SFPUC presented an overview of Habitat Reserve Program Public Scoping Comments.
- **April 11, 2007:** Field meeting with the SFPUC's HRP team, CDRP restoration ecologist, USFWS, and CDFG to review and discuss potential mitigation/compensation sites, including sites for compensation of effects of the CDRP.
- **March 6, 2007:** Meeting with the SFPUC, project engineers, USFWS, and CDFG to discuss approaches for avoiding and minimizing effects on bald eagle, and for compensatory mitigation, and funding.
- **September 4, 2007:** CDRP team presentation to the IATF on avoidance and minimization measures, preview of impacts and mitigation.
- **January 16, 2007:** IATF meeting, SFPUC provided a summary of the methodology to develop currency and accounting for mitigation and the functional model for classifying habitat for the Habitat Reserve Program.
- **December 6, 2006:** IATF meeting, SFPUC presented an Overview and Discussion of WSIP Habitat Reserve Program: USFWS questioned whether the SFPUC would be creating new or enhancing existing habitats or both. USACE indicated project impacts will dictate whether an HRP site is establishment or enhancement.

2.2 MITIGATION AREA LOCATIONS AND BOUNDARIES

This MMP describes five mitigation areas within the Alameda Creek watershed that are proposed by the SFPUC. The locations of the proposed mitigation areas are shown on Figure 1-2. Additional detail for each mitigation area is provided in Figures 2-1 to 2-5. Each mitigation area consists of two parts: the conservation easement boundary and the management boundary.

Conservation easement area (boundary shown in red) would be protected in perpetuity and corresponds to the areas where the proposed habitat improvements described in Section 1.1 would be implemented. The conservation easements exclude existing easement dedications (e.g., power lines and pipelines), roads, staging areas, or other features that will be used to manage or access the mitigation area.

Management area, (boundary shown in black) is where specific management actions such as grazing, browse protection, invasive species control, or fencing will be implemented according to the MMP. The mitigation management boundary extends beyond the conservation easement to existing and/or proposed fencing that will be used to manage grazing. Fences will delineate grazing unit limits and each grazing unit will have specific prescriptions for resource enhancement.

The mitigation put forth in this MMP to compensate for impacts to WSIP projects (listed in Section 1.1) will occur in the conservation easement areas, i.e., will not accrue from the portions of the Management areas are not also within conservation easement boundary.

The locations and habitat characteristics of the five mitigation areas are briefly described below.

The San Antonio Mitigation Area is situated approximately 6.4 miles from Calaveras Dam. San Antonio Creek is a tributary to San Antonio Reservoir at the northeast end of the Reservoir. The Mitigation Area extends east from the Reservoir approximately 1.8 miles. The north and south boundaries of the mitigation area roughly follow unnamed ranch roads. The mitigation area includes approximately 270 acres along a 1.8 mile reach of San Antonio Creek and approximately 3,105 feet of Indian Creek (Figure 2-1). Habitats in the mitigation area include oak woodland, oak savannah, sycamore riparian, non-native grassland, intermittent and ephemeral streams. The compensation actions include installing a bridge crossing over San Antonio Creek to improve water quality and habitat, bank stabilization, channel rehabilitation, riparian plantings with irrigation, weed control and fencing to manage cattle.

The Sage Canyon Mitigation Area is an approximately 590-acre area that extends approximately 0.7 miles north of the Arroyo Hondo arm of Calaveras Reservoir. It is in the first canyon east of the reservoir, located approximately 2 miles from the dam construction area. The Alameda Diversion Tunnel alignment passes underneath the site. Sage Canyon mitigation area includes stands of Diablan sage scrub, which will be enhanced to mitigate for impacts to the Alameda whipsnake (Figure 2-2).

The South Calaveras Mitigation Area is located in the Calaveras Creek watershed, south of Calaveras Reservoir, approximately 3 miles from Calaveras Dam. The western boundary of the mitigation area is approximately 1,000 feet east of the intersection of Calaveras and Felter roads. The eastern boundary is approximately 2,700 feet east of Calaveras Creek. South Calaveras Mitigation Area consists of two separate parts: a western part that surrounds Goldfish Pond and an eastern part that surrounds North and South ponds, east of Marsh Creek Road. In addition to these three ponds, the mitigation area includes seasonal wetlands, oak woodlands, and non-native annual grasslands that will be enhanced, rehabilitated, or established/reestablished to support special-status species (Figure 2-3). Special status species mitigation that would be provided at South Calaveras Mitigation Area include: California tiger salamander, California red-legged frog, and Callippe silverspot butterfly.

The Goat Rock Mitigation Area is located approximately 0.2 mile north of Camp Ohlone Road and less than 1 mile east of Welch Creek Road. This mitigation area is approximately 2 miles from Calaveras Dam. The proposed enhancement area (approximately 213 acres) comprises the northwestern portion of the Goat Rock Mitigation Area (Figure 2-4). The mitigation area is adjacent to the Sunol and Ohlone Regional Wilderness areas managed by the East Bay Regional Park District. Serpentine grassland and associated rare plants as well as wetlands and ponds at Goat Rock will be enhanced.

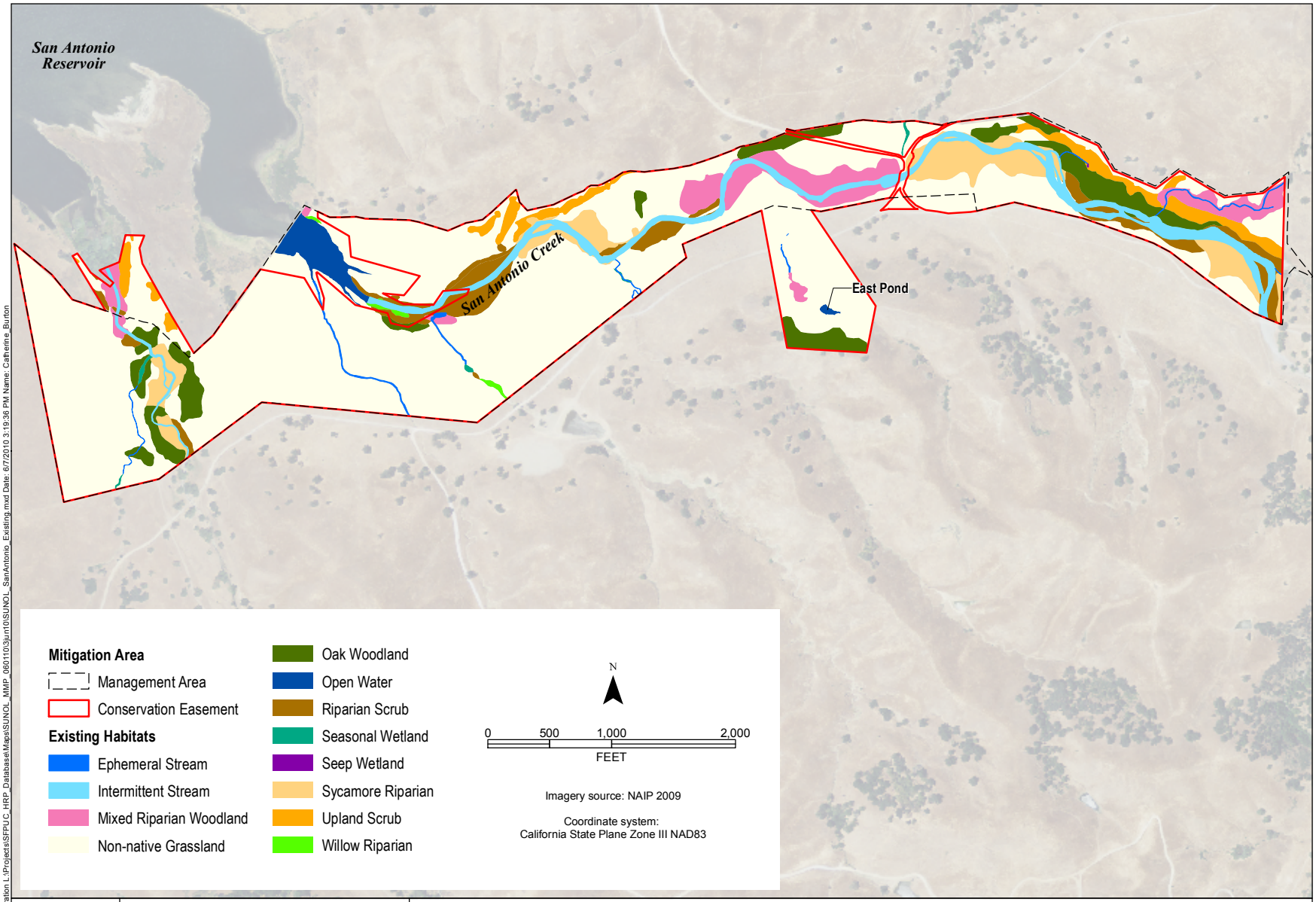
The Sheep Camp Creek Mitigation Area is located 7.5 miles northwest of Calaveras Dam. Interstate 680 roughly bounds the 463-acre mitigation area on the west and State Route 84 borders the south side. The northern border of the mitigation area is adjacent to private properties. Koopmann Ranch, the western-most property adjacent to the northern border, is preserved under an existing conservation easement. The mitigation area includes ponds, streams, wetlands, woodlands, grasslands, and riparian areas that will be enhanced or established/reestablished to support Callippe silverspot butterfly, California tiger salamander, and California red-legged frog (Figure 2-5).

2.2.1 PRESENT AND PAST SITE USES

The five HRP mitigation areas are primarily undeveloped range lands that are managed for cattle grazing and watershed protection. Portions of the areas (not included in the proposed conservation

easements) are traversed by existing access roads, gas pipelines and electric transmission and distribution lines.

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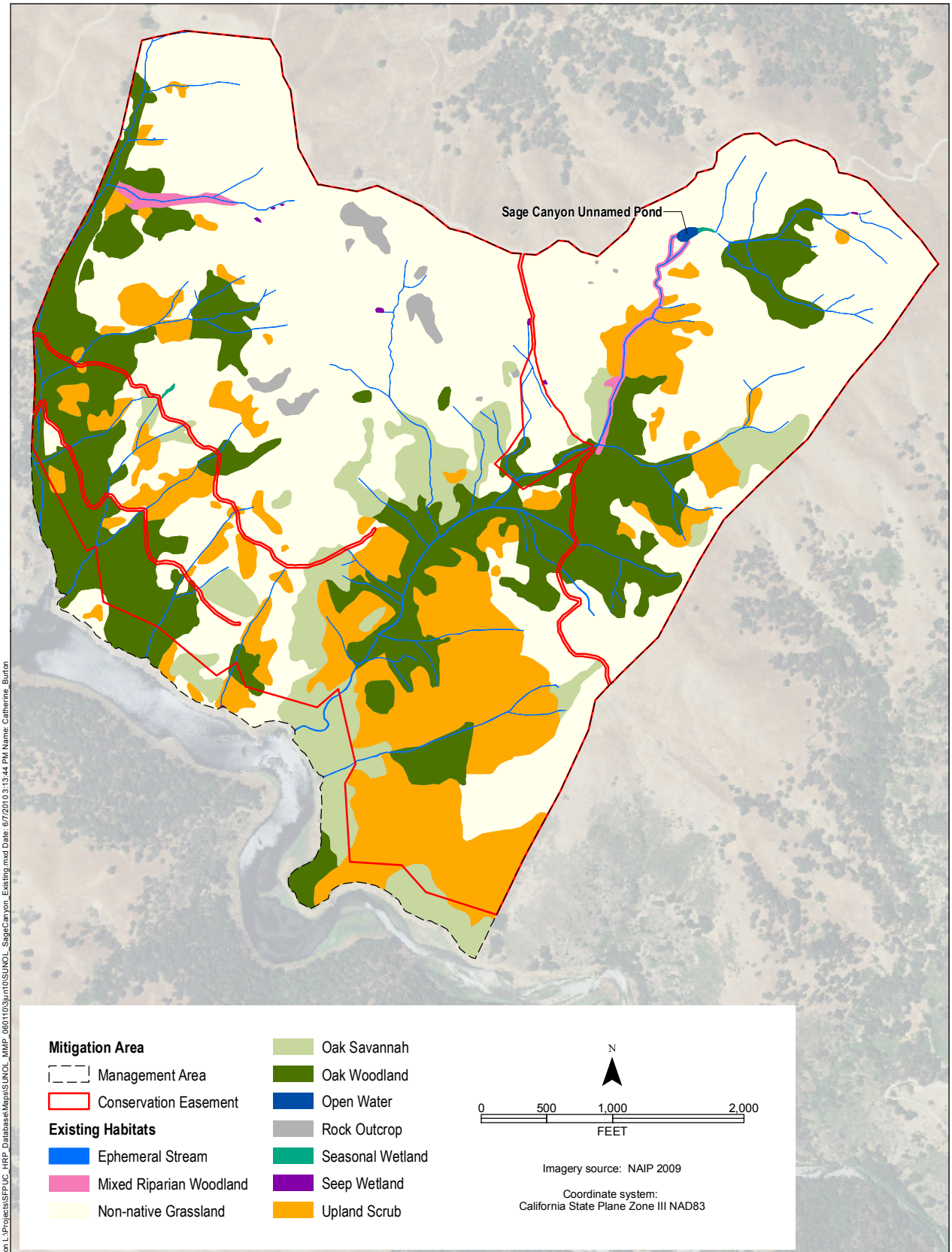
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Habitat Reserve Program

Figure 2-1
San Antonio Mitigation Area: Existing habitat

Back of Figure 2-1



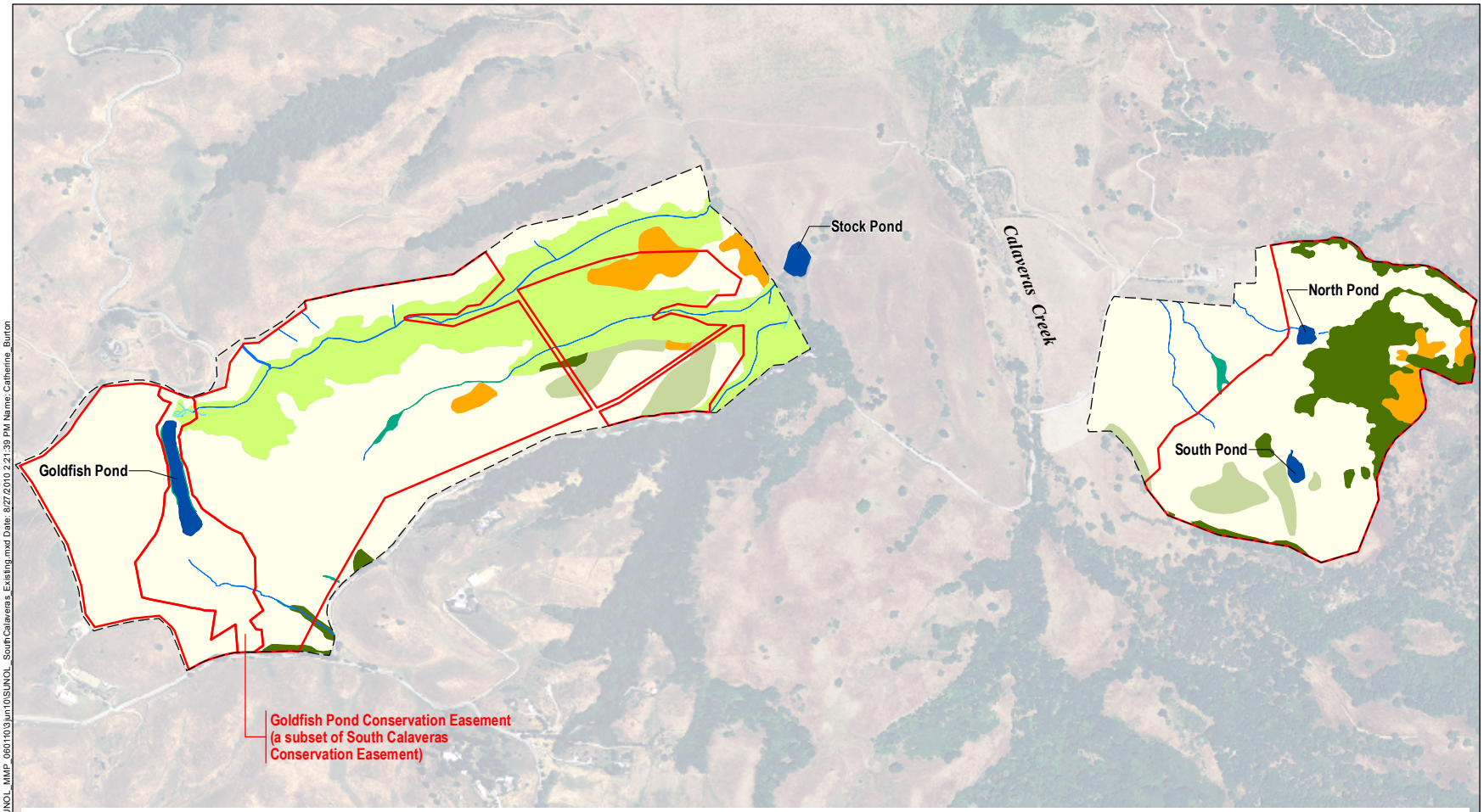
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San Francisco Public Utilities Commission
Habitat Reserve Program

Figure 2-2
Sage Canyon Mitigation Area: Exisiting habitat

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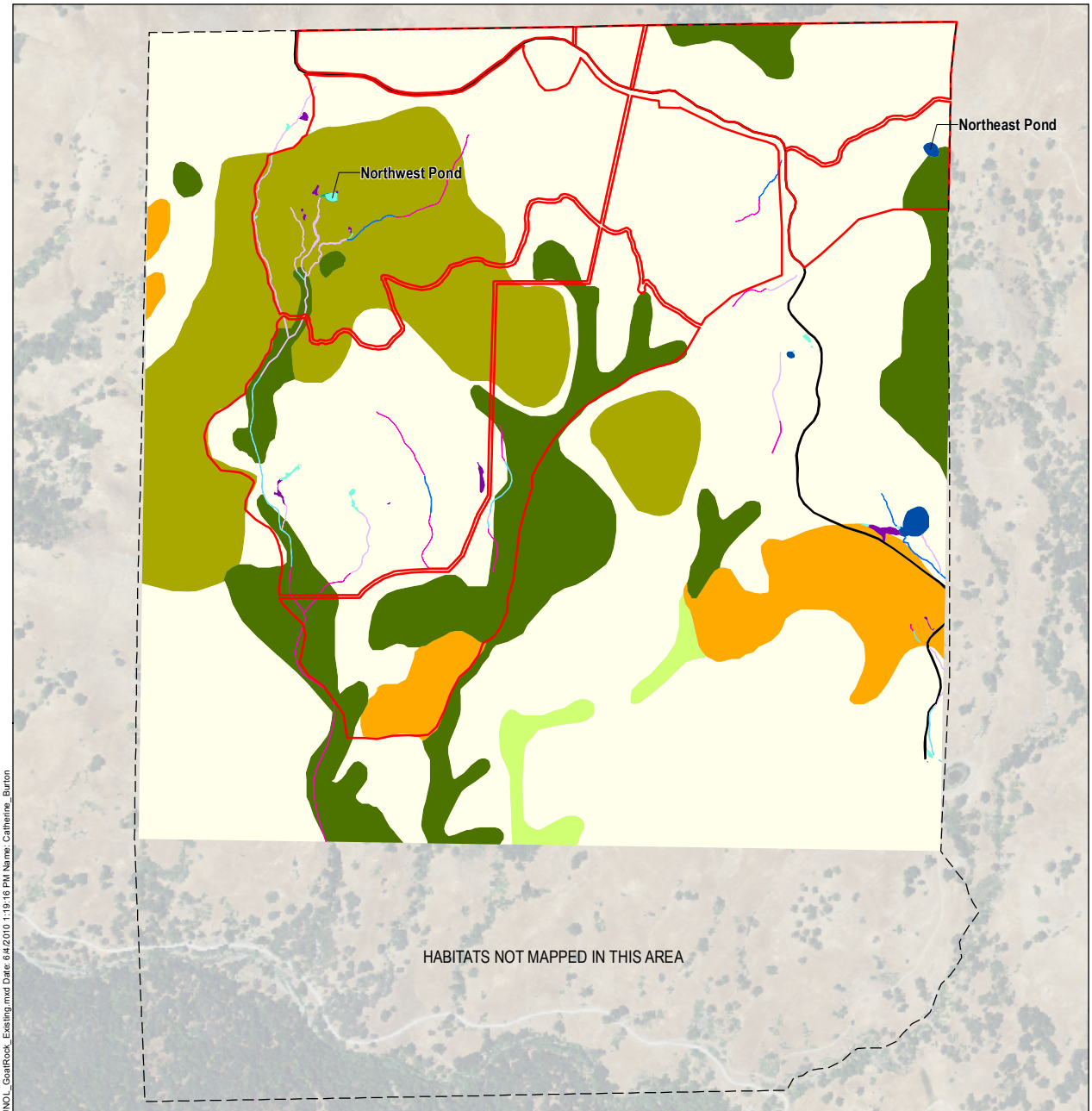
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Habitat Reserve Program

Figure 2-3
South Calaveras Mitigation Area: Existing habitat

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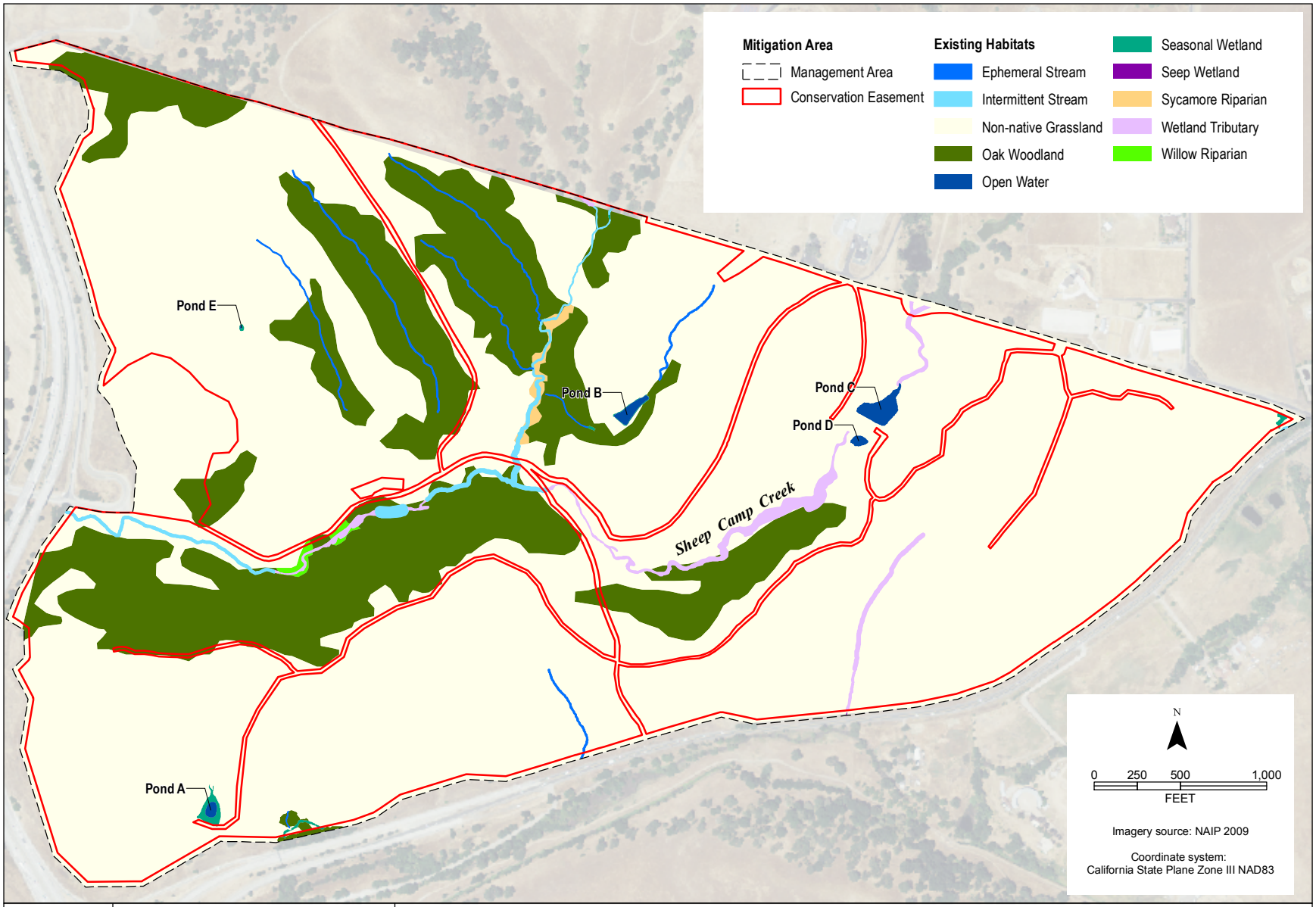


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San Francisco Public Utilities Commission
Habitat Reserve Program

Figure 2-4
Goat Rock Mitigation Area: Existing habitat

Back of Figure 2-4



San Francisco Public Utilities Commission
Habitat Reserve Program

Figure 2-5
Sheep Camp Creek Mitigation Area: Existing habitat

Back of Figure 2-5

2.2.2 ADJACENT LAND USES

The SFPUC owns 35,000 acres, or approximately one-third of the 175-square-mile Alameda Creek Watershed (Watershed). Nearly 32,000 acres of the SFPUC Watershed are grazed. Primary adjacent land uses include water storage and transmission facilities, gas and electricity transmission, agriculture and grazing land, parks and protected areas, commercial landscape nurseries, and mining operations (SFPD 1999).

Water storage facilities in the Watershed include two reservoirs, the San Antonio Reservoir to the north and the Calaveras Reservoir to the south. Water transmission facilities include the Hetch Hetchy Aqueduct, which bisects the Alameda Watershed just south of San Antonio Reservoir. Utilities include a high-pressure petroleum pipeline easement held by Chevron, U.S.A. that traverses the northern portion of the Watershed in the vicinity of San Antonio Reservoir, a Southern Pacific Railroad petroleum pipeline that traverses the Sunol Valley Golf Course, and PG&E power lines (SFPD 1999).

In addition, the SFPUC currently leases land and provides water to eight commercial nurseries that grow landscape products. The nurseries are located east of the town of Sunol, along SR 84 and Calaveras Road. Two major gravel-mining operators, Mission Valley Rock and RMC Pacific Materials (formerly known as RMC Lonestar) hold leases for lands both north and south of I-680 (SFPD 1999).

Recreational uses include two 18-hole courses at the Sunol Valley Golf Course, and trails on PUC Watershed lands leased to the EBRPD as part of the Sunol Regional Wilderness and Ohlone Regional Wilderness (SFPD 1999).

Several major roads traverse the SFPUC properties within the Alameda Creek watershed. The I-680 freeway traverses the northern portion of the Watershed. Calaveras Road extends through the entire Watershed in a north-south direction, from I-680 near Sunol to the southern Watershed boundary just west of Calaveras Reservoir near Milpitas. SR 84, also known as Niles Canyon Road west of I-680 and Vallecitos Road east of I-680, crosses the northern Watershed boundary (SFPD 1999).

The remaining two-thirds of the greater Alameda Creek watershed (approximately 76,000 acres not owned by SFPUC) are either used as public open space or are privately owned and used mostly for grazing or overhead PG&E transmission lines. Public open space areas consist of EBRPD parklands and other parklands in the greater Alameda Creek watershed in Santa Clara County. To the north of the Watershed is the Town of Sunol, which includes residential and commercial uses. To the south, there are small enclaves of development within the Alameda Creek Watershed that are zoned as "Rural Residential," for example adjacent to the northeast edge of the Sheep Camp Creek Mitigation Area. These rural residential areas are located in Santa Clara and Alameda Counties, outside urban service areas and incorporated cities (SFPD 1999).

2.3 EXISTING CONDITIONS

This section characterizes the existing conditions at the five HRP mitigation areas by presenting information on habitats, special-status species, non-native invasive flora and fauna, aquatic features and jurisdictional waters of the United States, topography and soils, and hydrogeomorphology.

2.3.1 HABITATS AND LAND COVER TYPES

Existing land cover types within the five HRP sites were mapped using aerial photos and field surveys (Figures 2-1 to 2-5). In total, nineteen land cover types were identified, including ten vegetation communities, seven wetland/water feature types, and two other types (rock, and developed). These cover types have been grouped and categorized into five habitat types: Grassland, Woodland/Savannah, Riparian, Scrub, Wetland and Waters of the United States, and Others (Table 2-1). These cover types provide habitat for a variety of common and special-status wildlife and plant species. Table 2-1 lists the habitat types, the land cover types, and the five mitigation areas where each land cover type can be found. The table is followed by detailed descriptions of each habitat and cover type.

Table 2-1
Existing habitat types in the HRP mitigation areas.

Habitat Type	Land Cover	San Antonio	Sage Canyon	South Calaveras	Goat Rock	Sheep Camp Creek
Grassland	Non-native grassland	X	X	X	X	X
	Serpentine Grassland				X	
Woodland/Savannah	Oak Woodland	X	X	X	X	X
	Oak Savannah		X	X		
Riparian	Oak Riparian			X	X	
	Willow Riparian	X				X
	Sycamore Riparian	X				X
	Mixed Riparian Woodland	X	X	X		
	Riparian Scrub	X		X		
Scrub	Upland Scrub	X	X	X	X	
Waters of the United States (including wetlands)	Seasonal Wetland (& wetland tributary)	X	X	X	X	X
	Seep Wetland	X	X	X	X	X
	Perennial Wetland				X	
	Open Water	X	X	X	X	X
	Ephemeral Stream	X	X	X	X	X
	Intermittent Stream	X		X	X	X
	Perennial Stream		X			
	Potential Stream (not delineated)				X	
Other	Rock Outcrop		X			
	Developed			X	X	

2.3.1.1 GRASSLANDS

Grassland is the dominant habitat within the HRP mitigation areas. The plant species composition exhibits a high temporal and spatial variability, influenced by climate, land use history and multiple environmental variables such as soils, aspect, slope, and elevation. Grasslands in the mitigation areas are classified as either non-native or serpentine. Serpentine grassland only occurs at Goat Rock, in association with serpentine soils.

Non-native annual grasslands within the HRP mitigation areas are typical of grasslands found throughout the interior Coast Range, Sierra Nevada foothills, and Central Valley of California. The grasslands of the mitigation areas are composed largely of non-native annual grass and forb species, as well as non-native invasive species. The native component of the grasslands is typically small, often comprising no more than 5 percent of the total cover, occurring as scattered individuals or in patches among the non-native plants. The grasslands are short-stature, typically with less than 75 percent bare ground. Grassland composition and structure of the mitigation areas are primarily shaped by abiotic factors, including annual rainfall and temperature patterns, soil chemistry and texture and topographic characteristics such as elevation, slope, and aspect. Management activities, including grazing and farming also have an effect on grassland composition. The grasslands at Goat Rock are heavily influenced by the presence of serpentine soils, and are described separately in the section below which presents the Goat Rock basis of design in Section 3.3.

Characteristic of non-native annual grasslands are European originating grass species such as soft chess (*Bromus hordeacous*), ripgut brome (*Bromus diandrus*), wild oats (*Avena fatua, A. barbata*), and Italian ryegrass (*Lolium multiflorum*). Non-native grasslands may also support additional persistent non-native annual herbs, especially in high-nutrient areas where historic overgrazing and feral pigs have created bare, open soil. Such species include shortpod mustard (*Hirschfeldia incana*), poison hemlock (*Conium maculatum*), Italian thistle *(Carduus pycnocephalus*), stinkwort (*Dittrichia graveolens*), and yellow star thistle (*Centaurea solstitialis*). In less-disturbed situations, non-native grasslands also support a variety of native grasses and forbs, such as California poppy (*Eschscholzia californica*), sky lupine (*Lupinus nanus*), miniature lupine (*L. bicolor*), Johnny-jump-up (*Viola purpurascens*), shining pepperweed (*Lepidium nitidum* var. *nitidum*), and owl's clover (*Castilleja exserta* ssp. *exserta, Orthocarpus* spp., and *Triphysaria* spp.). This community is the most common and can be found in each mitigation area.

Historically, California's grasslands functioned as early succession herbaceous communities following both small and large scale disturbances such as browsing by native mammals and frequent fires (Barry et al 2006). Frequent and variable disturbances served to maintain a patchy landscape, increasing plant diversity and habitat for grassland-inhabiting species. However, fire suppression, heavy livestock grazing, introduction of non-native plants and wildlife, nitrogen deposition, extended droughts and other land use and climatic changes have altered all of California grasslands. Loss of biodiversity and productivity and decrease in water quality and landform stability in California grasslands have resulted from changes in land use and climate.

The non-native grasslands in the Alameda Creek Watershed are typical of non-native annual grassland in California, having experienced fire suppression, some years of heavy grazing, and dry-land farming. They contain multiple non-native, invasive plant and wildlife species, areas of erosion and low native plant biodiversity. As a result, grasslands in the Alameda Creek Watershed provide a great opportunity for enhancement through the reintroduction of fire, changed grazing prescriptions, and the installation of grazing-related infrastructure for resource enhancement, as well as installation of erosion control measures and monitoring to inform adaptive management. Such enhancement could benefit grassland-associated plant species and wildlife species such as California red-legged frog, California tiger salamander, Callippe silverspot and a host of native grassland obligate bird species.

Serpentine grasslands are a unique habitat type that typically supports a rich native flora. These grasslands support uncommon serpentine endemic species, as well as serving as an important refugia for non-endemic native plant species. Serpentine grasslands are found only on soil formed from serpentinite parent material, limiting their extent. Some plant species found in serpentine grasslands in the Alameda Creek Watershed at Goat Rock include purple needlegrass (*Nasella pulchra*),

junegrass (*Koeleria macrantha*), dwarf plantain (*Plantago erecta*), bird's-eye gilia (*Gilia tricolor*) and goldfields (*Lasthenia californica*).

Serpentine grasslands in California function similar to and are subject to similar disturbances as non-native annual grasslands. In contrast to non-native annual grasslands in the Alameda Creek Watershed, the serpentine grasslands at Goat Rock are relatively high in biodiversity and have low percent cover of non-native invasive plants. However, heavy livestock use of serpentine seeps and wetlands within the grassland is evidenced by observations of trampling and some erosion (Figure 2-6). The opportunities for enhancement of serpentine grasslands at Goat Rock include fence installation and development of livestock water sources away from wetlands and the sensitive serpentine grassland. Stocking rates and schedules will also be used to manage livestock, e.g., grazing schedule will specifically be timed to benefit native forb flowering and seed set. Monitoring data will be collected and compared between serpentine grassland plant communities in areas with controlled grazing and with year around grazing. [Additional grazing and monitoring detail is provided in later sections.]

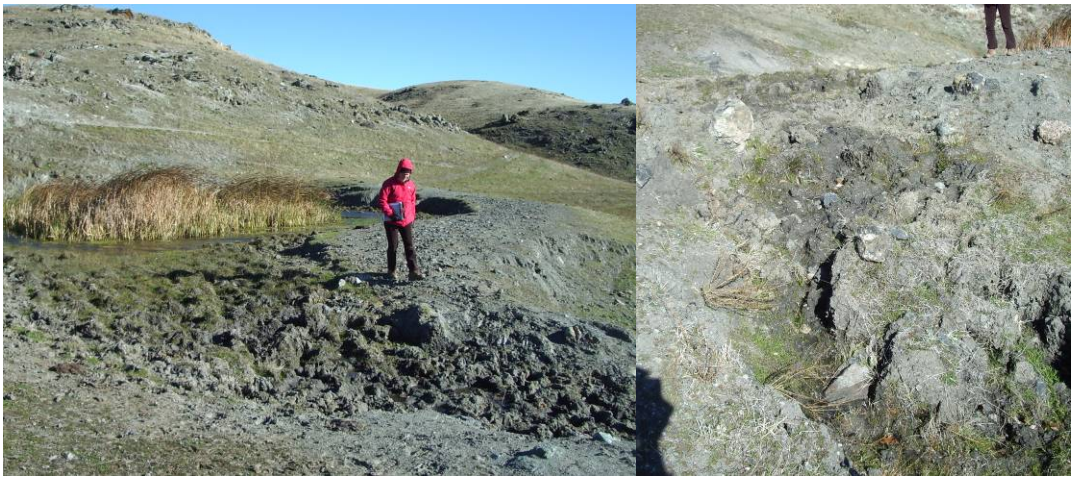


Figure 2-6: Evidence of trampling and degradation at Goat Rock serpentine seep.

WILDLIFE SUPPORTED BY GRASSLANDS

Grasslands may be used by wildlife that require an unobstructed line of sight for hunting, communication, and territorial defense. Grassland habitat attracts animals that feed on grass seeds [e.g., California quail (*Calipepla californica*), mourning dove (*Zenaida macroura*), and meadowlarks (*Sturnella neglecta*)] and insects (e.g., scrub jays [*Aphelocoma californica*], barn swallows [*Hirundo rustica*], tricolored blackbirds [*Agelaius tricolor*], and mockingbirds [*Mimus polyglottos*]). Mammals such as California vole (*Microtus californicus*), deer mouse (*Peromyscus maniculatus*), broad-footed mole (*Scapanus latimanus*), mule deer (*Odocoileus hemionus*), and black-tailed jackrabbit (*Lepus californicus*) forage in and inhabit annual grassland. The presence of small rodents attracts raptors (e.g., red-tailed hawks [*Buteo jamaicensis*] and red-shouldered hawks [*Buteo lineatus*]). Southern alligator lizard (*Elgaria multicarinata*) and Pacific slender salamander (*Batrachoseps pacificus major)* use the grassland to feed on invertebrates found within and underneath fallen logs. Grasslands, when located sufficiently close to breeding populations, can be used for upland and aestivation habitat for the special-status California red-legged frog (*Rana draytonii)* and California tiger salamander (*Ambystoma californiense*). Other listed and sensitive species that may use grassland habitats include San Joaquin kit fox (*Vulpes macrotis mutica*), northern harrier (*Circus cyaneus*), sharp-shinned hawk (*Accipiter striatus*), golden eagle (*Aquila chrysaetos*), white-tailed kite (*Elanus caeruleus*), burrowing

owl (*Athene culicularia*), Alameda whipsnake (*Masticophis lateralis euryxanthus*) and Callippe silverspot butterfly (*Speyeria callippe callippe*).

2.3.1.2 WOODLAND/SAVANNAH

The woodland habitats within the HRP mitigation areas are primarily dominated by oak species (*Quercus* spp.). These habitats are further classified into vegetation communities based on the dominant species present. Vegetation communities identified within the mitigation areas consist of mixed evergreen forest/coast live oak woodland, coast live oak woodland, valley oak woodland, blue oak woodland, valley oak/blue oak woodland, oak woodland, and oak savannah. Each of these woodland types contain oak species, typically some combination of coast live oak (*Quercus agrifolia*), valley oak (*Quercus lobata*), and blue oak (*Quercus douglasii*). Other associated species are madrone (*Arbutus menziesii*), poison oak (*Toxicodendron diversilobum*), California bay (*Umbellularia californica*), big-leaf maple (*Acer macrophyllum*), toyon (*Heteromeles arbutifolia*), California buckeye (*Aesculus californica*), black oak (*Quercus kelloggii*), and California blackberry (*Rubus ursinus*). Species composition and the distribution of these habitats vary on the landscape according to such factors or combinations of factors such as soils and topography.

Oak woodland is defined by the California Fish and Game Code (Sections 1360–1372: Article 3.5 Oak Woodlands Conservation Act) as "an oak stand with a greater than 10 percent canopy cover" . The species of oak present in a given location depends on local soil and hydrology. The community often occurs in transitional areas from grassland or shrublands to riparian forest. It is generally found on moist, well-drained, coarse soils, usually on slopes.

Oak savannah contains the same species as oak woodlands, and can be found growing in similar locations. It is differentiated from the woodland habitats by tree density. Oak savannahs have 10 percent or less canopy cover, but generally must contain at least 1 tree per acre.

Oak woodland and savannah face a suite of novel threats, including nitrogen deposition (Vitousek et al 1997), altered fire regimes (Franklin and Dyrness 1973; Agee 1993), abundant supplies of nonnative invasive plants (Liebhold et al. 1995; Vitousek et al. 1997), habitat loss and fragmentation (Noss 1987; Bennett 1999), and a changing climate. Altered fire regimes, nonnative invasive plants, and changing climate likely play a role in the ecology of oak woodlands in the HRP mitigation areas. Habitat loss and fragmentation just outside the area is particularly important in the Sheep Camp Creek Mitigation Area. Based on modeled nitrogen deposition in the SF Bay Area, nitrogen deposition is not a specific threat at present in the HRP mitigation areas.

Limited oak tree recruitment has been observed in some species throughout California and long-term survival of oak communities may be limited in some sites (Bartolome et al. 2002, Swiecki and Bernhardt 1998, Mensing 1991, Muick and Bartolome 1987). Certain types of oak woodland and savannah are particularly susceptible, namely those containing blue oak, valley oak or coast live oak (Bolsinger 1988, Muick and Bartolome 1987). Potential causes for low or lack of recruitment include grazing by deer and livestock, competition with non-native annual grasses, increased rodent populations, changes in fire regime, in particular fire suppression, and inappropriate climate conditions for recruitment (McCreary 2001). In particular, saplings seem to be the limiting stage in recruitment based on age structure of many oak woodland and savanna stands (Muick and Bartolome 1987). In the HRP mitigation areas, all oak woodland and savannah types are at risk as they contain one or more of the susceptible species. Lack of oak recruitment and the presence of non-native invasive plant and wildlife species are conditions present in all of the oak habitats in the HRP mitigation areas. Areas that were at one time oak savannah at San Antonio are now non-native annual

grassland. These areas are located on flat ground where oaks were likely cut down to for dryland farming of wheat and/or oats (Figure 2-7).



Figure 2-7: Area of historical oak savannah within San Antonio Mitigation Area cleared for farming

WILDLIFE SUPPORTED BY WOODLANDS

Woodlands provide food and shelter for a variety of bird species, including insect eaters such as chestnut-backed chickadee (*Poecile rufescens*), white-breasted nuthatch (*Sitta carolinensis*), and warbling vireo (*Vireo gilvus*). Other species attracted to this habitat include song sparrow (*Melospiza melodia*), California quail, and California towhee (*Pipilo crissalis*), which glean insects from the foliage on the ground. Scrub jays, Nuttall's woodpecker (*Picoides nuttallii*), and squirrels (*Sciurus* spp.) depend on oak woodland acorns during the winter. Raptors such as golden eagle, red-shouldered hawk and Cooper's hawk (*Accipiter cooperii*) are known to nest in dense mature oak woodlands. Cavities within oak trees provide nesting sites for western screech owl (*Otus kennicottii*), western bluebird (*Sialia mexicana*), ash-throated flycatcher (*Myiarchus cinerascens*), and roosting sites for bats. In addition, downed branches provide cover for various reptiles, amphibians, and small mammals. Listed and sensitive wildlife species that may use woodlands include Swainson's hawk (*Buteo swainsoni*), Alameda whipsnake, and the California red-legged frog which may use this habitat as a migration corridor.

2.3.1.3 RIPARIAN

Riparian communities that occur within the HRP mitigation areas include willow riparian forest, oak riparian forest, mixed riparian forest, sycamore riparian, and riparian scrub. These communities differ in dominant species and composition, density, and hydrology requirements. The health and integrity of these riparian communities varies, although they are generally degraded due to years of intense grazing and trampling by cattle and feral pigs. Excessive grazing has resulted in the loss of riparian

tree and shrub cover and low plant species diversity within the HRP mitigation areas. Ground disturbance, browsing, and transport of weed seeds by cattle have facilitated the spread and introduction of invasive plant species in riparian areas. Loss of vegetative cover (cover of riparian plants is generally less than 50%) in riparian areas has left soils vulnerable to bank erosion along many of the streams in the HRP mitigation areas (Figure 2-8).



Figure 2-8. Eroded banks and sparse cover of tree and shrub species at San Antonio Creek.

Willow riparian forests occur in areas with moist soils year-round, such as banks of intermittent streams and reservoirs. Soils vary from clay loams to gravel bars near the larger creeks and streams. In the Alameda Watershed, arroyo willow (*Salix lasiolepis*) is the most common dominant, red willow (*S. laevigata*) is also frequent, along with occasional sandbar willow (*S. exigua*). Mulefat (*Baccharis salicifolia*) and California blackberry are often common in the understory. Willow riparian areas, particularly at the Sheep Camp Creek Mitigation Area, show evidence of heavy browsing and trampling by cattle which has reduced the cover of understory vegetation (Figure 2-9). Existing trees are generally above browse height or have an opportunity to grow tall enough to avoid browsing when cattle are not in the grazing unit.



Figure 2-9. Evidence of browsing and soil trampling by cattle along Sheep Camp Creek.

Oak riparian forests occur in ephemeral drainages of the South Calaveras Mitigation Area in otherwise dry, grass-dominated landscapes. Central coast live oak riparian forests are found in drier areas than willow communities and typically on shallower soils than valley oak savannah. Coast live oaks dominate the overstory while the understory is typically dominated by grasses. Additional understory species include poison oak, coyote brush (*Baccharis pilularis)*, mugwort (*Artemisia douglasiana*), and California rose *(Rosa californica*). There is little recruitment of young coast live oak and native understory shrubs. Potential causes for low or lack of recruitment of oaks include grazing by deer and livestock, competition with non-native plant species, increased rodent populations, changes in fire regime, in particular fire suppression, and inappropriate climate conditions for recruitment (McCreary 2001).

Sycamore riparian occurs along alluvial streams, usually with gravel substrate and periodic high flows capable of moving very large sediment particles. The soils are coarse, very well drained, and often very deep. Common species are California sycamore (*Plantanus racemosa*), California buckeye, blue elderberry (*Sambucus mexicana*), and occasional cottonwoods (*Populus fremontii*), coast live oak, and valley oak. The understory is often dominated by introduced grasses or mulefat. Sycamore riparian woodland is present at both the San Antonio and Sheep Camp Creek HRP mitigation areas. At the Sheep Camp Creek mitigation area, sycamore riparian woodland is restricted to a small stand along a tributary to Sheep Camp Creek. Similar to the oak riparian forests, sycamore riparian woodlands in the mitigation areas are represented by an even aged stand of large, mature

trees. Regeneration is limited to coppice sprouting at Sheep Camp Creek mitigation area, however sprouts are subject to cattle browsing. At San Antonio mitigation area coppice sprouting and seedlings have been observed (on depositional bars), however heavy browsing has prevented successful establishment of trees (Figure 2-10).



Figure 2-10. Browsed sycamore seedlings on a depositional bar along San Antonio Creek.

Mixed riparian forest is a broad classification including the preceding tree-dominated riparian communities. Mixed riparian forests are composed of a mix of red willow, arroyo willow, California sycamore, white alder (*Alnus rhombifolia*), valley oak, Fremont cottonwood, and others. As with the other riparian communities, only small patches of mixed riparian forest still remain at the HRP mitigation sites. Little recruitment by native tree and shrub species is occurring and the understories where cattle frequently access, particularly along San Antonio Creek. Understory areas disturbed by grazing, and are dominated by non-native grasses and herbaceous species.

Riparian scrub is an open community dominated by shrubs rather than trees, and predominantly found in association with active channels of riparian corridors of large intermittent stream channels. Riparian scrub is primarily composed of mulefat, often occurring with smaller amounts of sandbar willow, arroyo willow, California brickellbush (*Brickellia californica*), and many weedy annual species.

2.3.1.4 SCRUB

On the north-facing slopes of fenced or non-grazed areas, grasslands frequently transition to scrub habitat. Scrub habitat is characterized by low- to medium-height, drought-tolerant shrubs. Plant species composition varies greatly with soil moisture availability, disturbance, fire frequency, and, to a lesser degree, with slope aspect and substrate. Shrub canopies are dense and understory plant cover is low.

Upland scrub is found on rocky, exposed, hot southern exposures and ridges on steep slopes with thin soils. It is dominated by coastal sagebrush (*Artemisia californica*), with bush monkeyflower (*Mimulus aurantiacus*), poison oak, and silver lupine (*Lupinus albifrons*). The understory below the shrub canopy is usually very sparse, but openings can have a diversity of native and non-native grasses and forbs. Rock outcroppings, scattered throughout the habitat, support a variety of plant species, such as California snakeweed (*Gutierrezia californica*), common deerweed (*Lotus scoparius*) and false goldenaster (*Heterotheca sessiliflora*). In the Alameda Watershed, Diablan sage scrub is much more common than coyote brush scrub, and it is the dominant scrub type at the Sage Canyon mitigation area.

Scrub habitat in the San Francisco Bay area is threatened due to increased urbanization and habitat fragmentation, as well as interference with the habitat's natural disturbance regime. Upland scrub habitat is adapted to frequent fires and fire suppression in California's scrub habitat has led to these habitats becoming degraded. In the absence of fire, the canopy of scrub species will close, relatively short lived species die, and dead material accumulates (England 1988, as cited in USFWS 2002). This is referred to as a decadent state. Chaparral habitat within California may become decadent within 20 - 25 years (Sampson 1944, as cited in USFWS 2002) and senile when older than 60 years (Hanes 1988, as cited in USFWS 2002). Scrub habitat may also be replaced by other habitat types in the absence of fire. Some evidence exists that coastal scrub may be invaded by chamise, chaparral, forest or woodland species after a 50-year lapse in disturbance (McBride 1974 as cited in deBecker 1988).

Much of the scrub habitat within the HRP mitigation sites is in a decadent or senile stage due to fire suppression. These habitat patches would be enhanced by implementation of controlled burning and modified grazing management, as well as mechanical control within areas where fire management options are not available. By clearing heavy brush, controlled fires or mechanical thinning can create a mosaic of young and old habitat that is more suitable for the whipsnake (USFWS 2002). Improved management of these habitats will improve conditions and result in healthier scrub habitat, which provides benefits for a variety of species, including the Alameda whipsnake.

WILDLIFE SUPPORTED BY SCRUB HABITAT

Shrub-dominated vegetation, often interspersed with other habitats, provides foraging and nesting habitat for species that are attracted to edges of plant communities. Bird species that use the shrub canopy for catching insects include bushtit (*Psaltriparus minimus*) and wrentit (*Chamaea fasciata*). Flowering scrub vegetation such as bush monkeyflower attracts nectar drinkers such as Anna's hummingbird (*Calypte anna*). Raptors, including Cooper's hawk and sharp-shinned hawk, may forage over such areas and prey on some of these small birds as well as on small mammals and reptiles such as California ground squirrel (*Spermophilus beecheyi*), brush rabbit (*Sylvilagus bachmani*), and western fence lizard (*Sceloporus occidentalis*). Mammals, including striped skunk (*Mephitis mephitis*), may use this habitat for protection and foraging grounds. Other reptiles and small mammals that are expected to occur within shrub habitats include the state and federally listed as Threatened Alameda whipsnake, northern alligator lizard (*Elgaria coerulea*), Pacific gopher snake (*Pituophis catanifer*), pocket gopher (*Thomomys bottae*), and deer mouse. Small mammals attract

predators such as bobcat (*Lynx rufus*), coyote (*Canis latrans*), and gray fox (*Urocyon cinereoargenteus*).

2.3.1.5 WETLAND HABITATS

Wetlands are defined as areas that are inundated or saturated by water at a frequency and duration sufficient to support wetland vegetation. The vegetation, hydrology, and soil conditions encountered at each wetland habitat type are described below. USACE jurisdictional features mapped on Figures 2-1 to 2-5 include four types of wetlands: seasonal, tributary, seep, and perennial (May & Associates 2009, ESA 2009). Most wetland features are located adjacent to drainages, along pond margins, and where natural seeps and springs provide sufficient hydrology for the growth of wetland vegetation.

Seasonal wetlands in the HRP mitigation areas occur most frequently in topographic depressions in grassland habitat or along relatively broad watercourse floodplains that remain moist or saturated for several months during the wet season. Seasonal wetlands, also classified as wetland tributary at Goat Rock and Sheep Camp Creek Mitigation Areas, exhibit one or more primary indicators of wetland hydrology, including sediment deposits, oxidized rhizospheres on living roots, biotic crust (algal matting), and/or secondary indicator drainage pattern (within drainage ditches or within topographic depressions). The hydric soils in the seasonal wetlands, which were primarily clay textured (with slight variations), feature either a depleted matrix, depleted dark surface, and/or redox depression. These wetlands are dominated by annual, marginally hydrophytic plants, the most common of which are the non-native Italian ryegrass (FAC), Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*, FAC), and fiddle dock (*Rumex pulcher*, FAC). Other co-dominant hydrophytic plants observed within seasonal wetlands include iris-leaved rush (*Juncus xiphioides,* OBL), Mexican rush (*Juncus mexicanus*, FACW), Baltic rush (*Juncus balticus,* OBL), Pacific rush (*Juncus effusus* var. *pacificus*, OBL), spikerush (*Eleocharis macrostachya,* OBL), Bermudagrass (*Cynodon dactylon*, FAC), various species of sedge (*Carex* species), curly dock (*Rumex crispus*, FACW), rabbit's-foot grass (*Polypogon monspeliensis,* FACW), manna grass *(Glyceria* sp., OBL), occasionally with marsh baccharis (*Baccharis douglasii*, OBL).

Plant species composition varied considerably between the seasonal wetlands; however, invasive plant species, such as Bermuda grass (Figure 2-9), were found in many of the seasonal wetlands in the HRP mitigation areas. Invasive species such as Bermudagrass and milfoil (*Myriophyllum* spp.) create conditions detrimental to native plant and wildlife species that depend on seasonal and other wetlands to survive. Livestock and feral pigs also degrade seasonal wetlands communities by trampling and browsing on vegetation, facilitating the introduction of invasive species, and destroying wildlife habitat. Seasonal wetlands are present at all five HRP mitigation areas.



Figure 2-9. Seasonal wetland (wetland tributary) at Sheep Camp Creek Mitigation Area

Seep wetlands are generally small wetlands with a dense, fairly low growth of sedges, rushes, perennial grasses, and herbs associated with permanent or long-seasonal moist soil around freshwater seeps. Seep wetlands are typically associated with grassland habitats and meadows where groundwater seepage occurs at grade breaks or intersections of different subsurface strata. Typical species include non-native species such as swamp pricklegrass (*Crypsis schoenoides*), as well as native species such as seep monkeyflower (*Mimulus guttatus*), iris-leaved rush, and brown-headed rush (*Juncus phaeocephalus*). Seep wetlands in the mitigation areas are often trampled by cattle and subjected to excessive grazing because forage and water are available at these locations later in the year compared to other grassland areas. The proposed grazing management would enhance these wetlands by removing or reducing the duration of grazing and altering the timing and intensity of grazing to minimize excessive disturbance of these features.

Perennial wetlands are primarily located on pond margins in saturated soils or in water less than 3 feet deep. These areas have positive wetland hydrology due to a perennial or near-perennial water supply, which also accounts for the reduced soil conditions. Perennial wetlands present within the HRP mitigation areas support perennial hydrophytic vegetation such as cattails (*Typha* spp.), tules (*Scirpus* spp.), willows (*Salix* spp.), and other annual and perennial herbaceous hydrophytic plants such as rushes (*Juncus* spp.). Freshwater marshes generally occur adjacent to stock ponds and springs, and are characterized by a year-round water source (Holland 1986). Perennial wetlands are found at the Goat Rock Mitigation Area. Cover provided by willows and other wetland trees and shrubs is generally sparse in perennial wetlands found within the mitigation areas. Additionally, similar to seasonal wetlands, perennial wetlands in the HRP mitigation areas have been degraded by livestock grazing, trampling and invasive species (Figure 2-10).



Figure 2-10. Evidence of grazing in a perennial wetland at the Goat Rock Mitigation Area.

2.3.1.3 OTHER WATERS OF THE UNITED STATES

Under Section 328.3 of the Federal Clean Water Act, "other waters" include lakes, rivers, and streams (including intermittent streams) (33 CFR 328). These areas are differentiated from wetlands because they do not support a prevalence of wetland vegetation either because the water is ponded at a depth that precludes the growth of emergent vegetation (i.e., San Antonio Reservoir, ponds), the velocity is too swift, and/or soil type does not allow for saturated soil conditions promoting the growth of wetland vegetation (i.e., perennial and intermittent streams, ephemeral drainages). The limit of jurisdiction for "other waters" extends to the ordinary high water mark (unless wetlands are adjacent), which is "a line on the shore established by fluctuations of water and indicated by physical characteristics such as clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas" (33 CFR 328).

Ephemeral drainages are linear topographic drainage features that support water flow only during and immediately following storm events, and generally lack a defined creek bed or banks. Most of the ephemeral drainages mapped within the HRP mitigation areas are 0.5 to 4 feet wide, and were dry during summer field surveys. These features generally occur as a result of topography and/or erosion on grassland, scrub, or woodland slopes or along road edges. The ephemeral drainages within the HRP mitigation areas are generally characterized by a lack of, or a very limited amount of, hydrophytic vegetation growing within the drainage, and a faint water flow pattern exhibited by slight scouring along the edges (resulting in exposed soil or rock), a subtle debris pattern or "wrack line", or all vegetation and/or other in-channel elements laying in the direction of downhill flow.

Intermittent streams are linear topographic drainage features that support steady water flows during the wet season (generally November through April or May), but are dry during summer and fall. Most of the intermittent streams mapped within the HRP mitigation areas are from 3 to 20 feet in width. These features are generally characterized by a defined rocky or gravelly creek bed and distinct, unvegetated banks and steady water flows during the winter and spring. Intermittent streams were differentiated from perennial streams by comparing flow observations from the 2006 delineation survey (January and February 2006) to the observations made during the dry season field assessment (July 2007); the creeks that were flowing or wet during both 2006 and 2007 surveys were classified as perennial streams, while those that were dry during the fall 2006 assessment were classified as intermittent streams. Other indicators of flow were also observed, similar to those exhibited by ephemeral drainages, including bank scouring and/or a "wrack line".

Ponds: Numerous ponds occur in the HRP mitigation areas. The ponds in the mitigation areas are primarily stock ponds used to water livestock. Nearly all of the ponds were constructed to collect and impound seasonal drainage; Goat Rock Northwest pond is fed by a seep and South Pond at South Calaveras appears to be fed, in part, by water from a leaking pipe associated with a water tank. The ponds within the HRP mitigation areas are generally more than 1 to 2 feet deep, restricting vegetation, e.g., rushes (*Juncus* spp.), broadleaf cattail (*Typha latifolia,)* to the perimeter (hence pond, not wetland). Ruderal and annual grassland vegetation grows on the pond's berms.

WILDLIFE RESOURCES IN AQUATIC COMMUNITIES

Aquatic species include invertebrates, amphibians, fish, and reptiles. Wetlands may provide breeding habitat for amphibians such as Pacific chorus frog and California newt (*Taricha torosa)*. Reptiles found in this habitat include the aquatic garter snake (*Thamnophis atratus*). Common birds in marsh habitats are red-winged blackbird (*Agelaius phoeniceus*), song sparrow, and brown-headed cowbird (*Moluthrus ater*). Seep habitat and stock ponds with perennial water can provide an important source of water for animals during the dry season, including amphibians (e.g., slender salamander), California black-tailed deer (*Odocoileus hemionus columbianus*), gray fox, mountain lion (*Puma concolor*), and a wide variety of bird species. Listed and sensitive species that use some of the HRP mitigation area aquatic habitats include California red-legged frog, foothill yellow-legged frog (*Rana boylii*), California tiger salamander and western pond turtle.

2.3.1.4 OTHER COVER TYPES

Two other cover types are mapped on Figures 2-1 to 2-5, but are not described above. These include rock outcrops and developed areas.

Rock outcrop areas are unvegetated or sparsely vegetated rocky areas with little to no soils. Rock outcrops can be found in Goat Rock and Sage Canyon and provide valuable habitat for small reptiles that require basking and cover habitat, such as the Alameda whipsnake.

Developed areas contain man-made structures and/or landscape that have been previously disturbed. The existing buildings, corrals, and roadways are mapped as developed. Developed areas may be used by wildlife for cover, but are generally of little value to wildlife.

2.3.2 THREATENED, ENDANGERED, SPECIAL-STATUS SPECIES

Reconnaissance-level biological surveys were conducted for the South Calaveras Mitigation Area and the San Antonio Mitigation Area and included a search for special-status species identified in the

California Natural Diversity Database (CNDDB) as having potential presence in the areas. These surveys focused on identification of habitat for the listed California red-legged frog (FT[1]), California tiger salamander (SCE, FT), Alameda whipsnake (ST, FT) and Callippe silverspot (FT). Tables 2-2 and 2-3 provide the number of occurrences within each site and within 1.0, 3.0, and 10.0 miles of each site. Figures 2-11 through 2-15 illustrate the occurrences for each species within 1.0 mile of each mitigation area. Mitigation is proposed for the following special-status species: California red-legged frog, California tiger salamander, Alameda whipsnake, and Callippe silverspot butterfly. A brief description of the habitats typically utilized by these species is provided below, followed by a discussion of the current known distribution.

Table 2-2
Occurrences of California red-legged frog, California tiger salamander, and Alameda whipsnake near the HRP mitigation areas.

Species	Mitigation Area	Occurrences recorded in conservation easement boundary	Occurrences recorded within 1-10 miles of the mitigation areas		
			1.0 mile	3.0 miles	10.0 miles
California tiger salamander *Ambystoma californiense*	Goat Rock	2	9	24	109
	Sage Canyon	0	11	25	116
	San Antonio Creek	1	12	28	125
	South Calaveras	0	4	14	102
	Sheep Camp Creek	2	6	30	125
California red-legged frog *Rana draytonii*	Goat Rock	2	7	31	69
	Sage Canyon	0	0	28	71
	San Antonio Creek	3	3	18	91
	South Calaveras	1	1	3	57
	Sheep Camp Creek	3	4	11	104
Alameda whipsnake *Masticophis lateralis euryxanthus**	Goat Rock	1	1	3	6
	Sage Canyon	0	1	3	5
	San Antonio Creek	1	1	2	7
	South Calaveras	0	0	1	5
	Sheep Camp Creek	1	2	3	8

*The exact location of Alameda whipsnake observations is suppressed in the CNDDB; as a result, the numbers presented are an approximate. These numbers represent the number of USGS quads that have had AWS occurrences within 1, 3, and 10 miles of each mitigation site.

Data sources: CNDDB 2010, SFPUC 2009 , EBRPD 2009, Nomad Ecology 2009, and May & Assoc 2009

[1] SCE = state candidate for endangered, ST = state threatened, FT = federal threatened, FE = federal endangered.

Table 2-3
Acres of mapped host plant habitat for Callippe silverspot butterfly near the HRP mitigation sites.

	Mitigation Area	Acres of mapped habitat in conservation easement boundary	Acres of host plant habitat within 1-10 miles of the Mitigation Areas*		
			1.0 mile	3.0 miles	10.0 miles
Callippe silverspot butterfly *Speyeria callippe callippe*	Goat Rock	12	76	748	960
	Sage Canyon	38	645	834	959
	San Antonio Creek	0	82	101	959
	South Calaveras	4	80	756	962
	Sheep Camp Creek	8	9	29	829
*These data provide the acres of mapped habitat for Callippe silverspot butterfly. This table does not provide the number of occurrences in the mitigation areas; actual habitat values may be more than those mapped.					

2.3.2.1 SPECIAL-STATUS SPECIES HABITAT REQUIREMENTS

Habitats within the HRP mitigation areas are known or likely to support populations of the federal and state-listed California tiger salamander and Alameda whipsnake, as well as the federally-listed California red-legged frog and Callippe silverspot butterfly. Habitat requirements for each of these species are described below based, where applicable, on the Primary Constituent Elements defined in the critical habitat designations by the U.S. Fish and Wildlife Service.

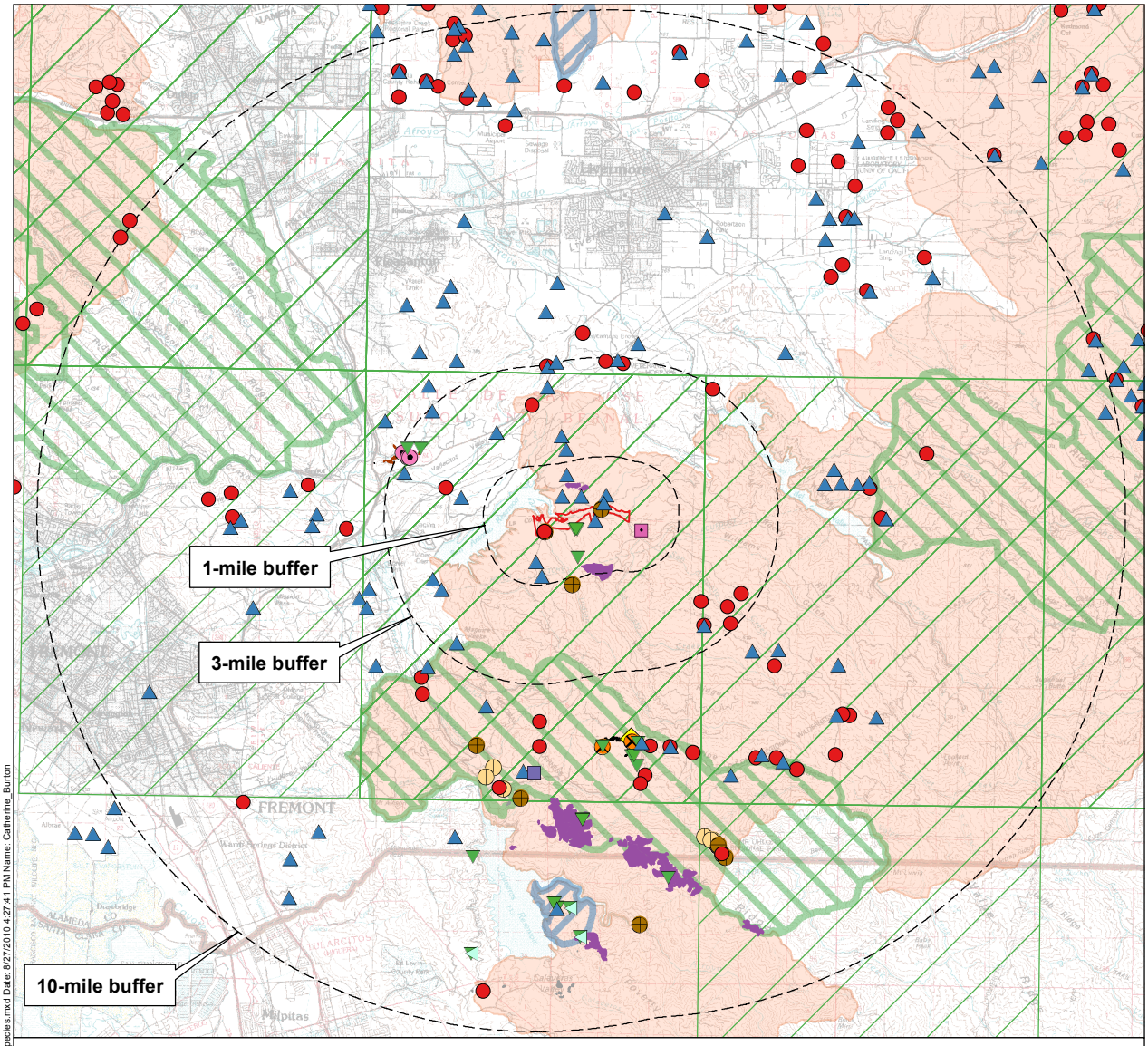
California tiger salamanders require aquatic habitats for breeding, upland refuge and foraging, and upland dispersal habitat. Aquatic habitat may be seasonal or perennial, but must hold water for at least 12 weeks. Upland refuge and forage habitat include of most upland vegetation types. Upland dispersal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

Critical habitat consists of the following primary constituent elements (PCEs) as defined by the U.S. Fish and Wildlife Service (USFWS 2005):

1. Standing bodies of fresh water (including natural and manmade (e.g., stock)) ponds, vernal pools, and other ephemeral or permanent water bodies which typically support inundation during winter rains and hold water for a minimum of 12 weeks in a year of average rainfall.

2. Upland habitats adjacent and accessible to and from breeding ponds that contain small mammal burrows or other underground habitat that CTS depend upon for food, shelter, and protection from the elements and predation.

3. Accessible upland dispersal habitat between occupied locations that allow for movement between such sites.



Special status species: Occurrences (with sources)

- Alameda whipsnake (SFPUC)
- Alameda whipsnake (EBRPD)
- Alameda whipsnake (CNDDB) *Note: Locations generalized; actual locations suppressed*
- California tiger salamander (CNDDB)
- California tiger salamander (Condor Country)
- California tiger salamander (SFPUC)
- California red-legged frog (CNDDB)
- California red-legged frog (Nomad Ecology)
- California red-legged frog (Condor Country)
- California red-legged frog (EBRPD)
- California red-legged frog (SFPUC)
- Callippe silverspot - host plant *Viola pedunculata* (Nomad Ecology)
- Callippe silverspot - host plant *Viola pedunculata* (Entomological Consulting Services, Ltd.)
- Callippe silverspot - host plant *Viola pedunculata* (May and Associates)
- Callippe silverspot - host plant *Viola pedunculata* (SFPUC)
- Callippe silverspot - host plant *Viola pedunculata* (URS Corporation)

Special status species: Critical habitat

Source: U.S. Fish & Wildlife Service (date as indicated)

- California tiger salamander (Aug 2005)
- Alameda whipsnake (Oct 2006)
- California red-legged frog (Mar 2010)
- Conservation Easement

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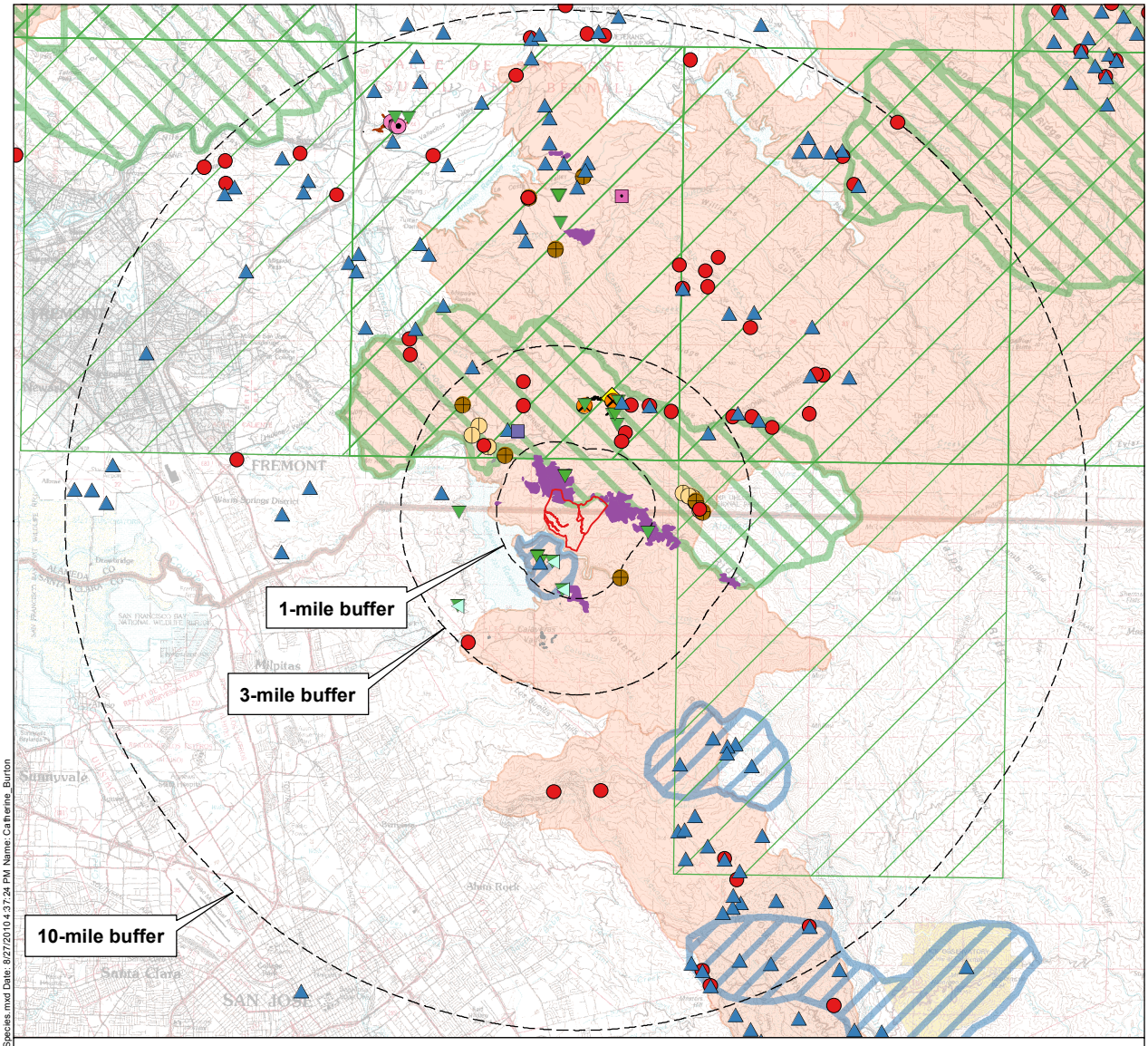
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Figure 2-11. San Antonio Mitigation Area:
Special status species occurrences and critical habitat

Back of Figure 2-11



Special status species: Occurrences (with sources)

- Alameda whipsnake (SFPUC)
- Alameda whipsnake (EBRPD)
- Alameda whipsnake (CNDDB) *Note: Locations generalized; actual locations suppressed*
- California tiger salamander (CNDDB)
- California tiger salamander (Condor Country)
- California tiger salamander (SFPUC)
- California red-legged frog (CNDDB)
- California red-legged frog (Nomad Ecology)
- California red-legged frog (Condor Country)
- California red-legged frog (EBRPD)
- California red-legged frog (SFPUC)
- Callippe silverspot - host plant *Viola pedunculata* (Nomad Ecology)
- Callippe silverspot - host plant *Viola pedunculata* (Entomological Consulting Services, Ltd.)
- Callippe silverspot - host plant *Viola pedunculata* (May and Associates)
- Callippe silverspot - host plant *Viola pedunculata* (SFPUC)
- Callippe silverspot - host plant *Viola pedunculata* (URS Corporation)

Special status species: Critical habitat

Source: U.S. Fish & Wildlife Service (date as indicated)

- California tiger salamander (Aug 2005)
- Alameda whipsnake (Oct 2006)
- California red-legged frog (Mar 2010)
- Conservation Easement

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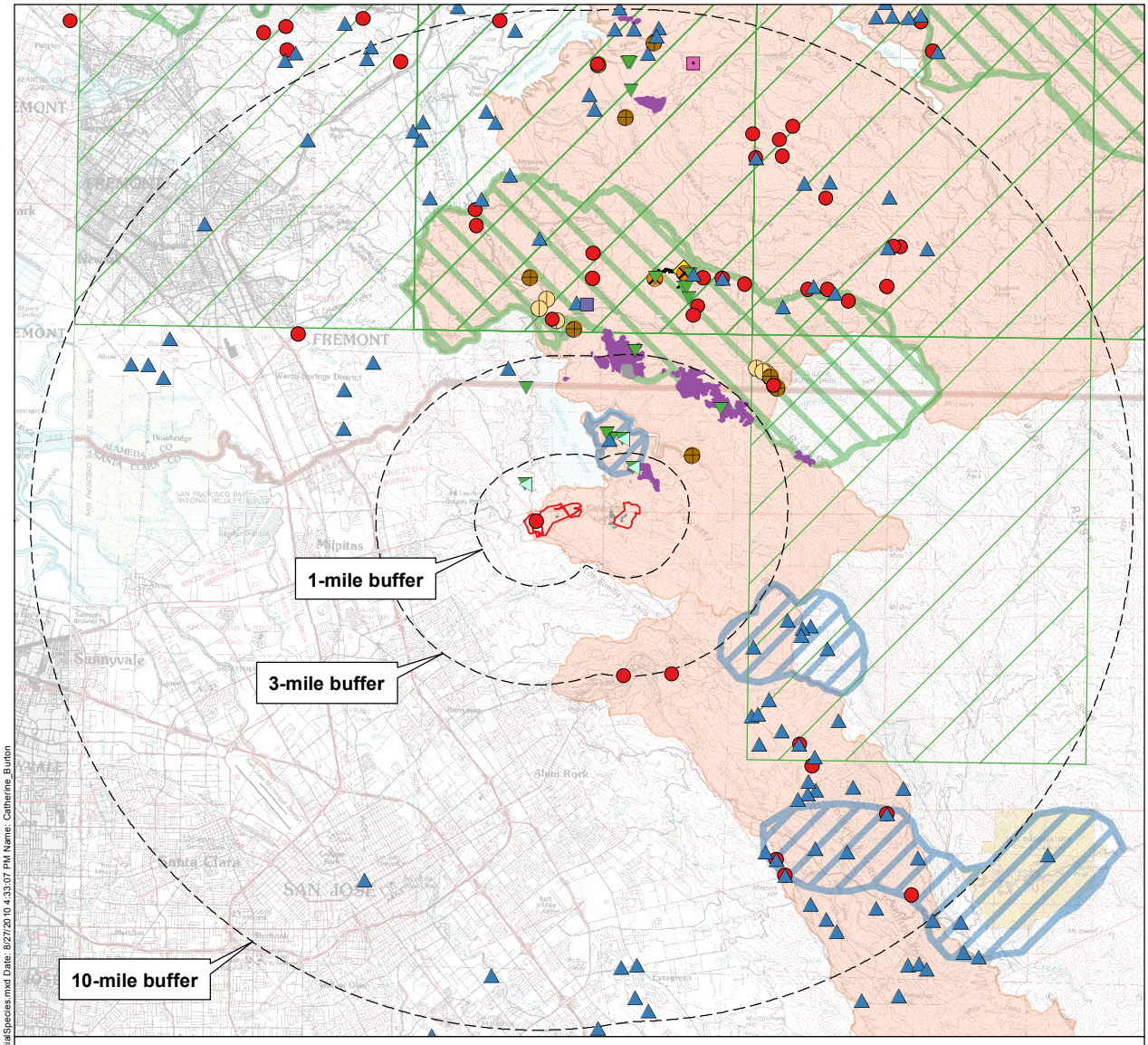
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Figure 2-12. Sage Canyon Mitigation Area:
Special status species occurrences and critical habitat

Back of Figure 2-12



Special status species: Occurrences (with sources)

- Alameda whipsnake (SFPUC)
- Alameda whipsnake (EBRPD)
- Alameda whipsnake (CNDDB) *Note: Locations generalized; actual locations suppressed*
- California tiger salamander (CNDDB)
- California tiger salamander (Condor Country)
- California tiger salamander (SFPUC)
- California red-legged frog (CNDDB)
- California red-legged frog (Nomad Ecology)
- California red-legged frog (Condor Country)
- California red-legged frog (EBRPD)
- California red-legged frog (SFPUC)
- Callippe silverspot - host plant *Viola pedunculata* (Nomad Ecology)
- Callippe silverspot - host plant *Viola pedunculata* (Entomological Consulting Services, Ltd.)
- Callippe silverspot - host plant *Viola pedunculata* (May and Associates)
- Callippe silverspot - host plant *Viola pedunculata* (SFPUC)
- Callippe silverspot - host plant *Viola pedunculata* (URS Corporation)

Special status species: Critical habitat

Source: U.S. Fish & Wildlife Service (date as indicated)

- California tiger salamander (Aug 2005)
- Alameda whipsnake (Oct 2006)
- California red-legged frog (Mar 2010)
- Conservation Easement

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Base map source:
USGS 30x60-minute topographic series

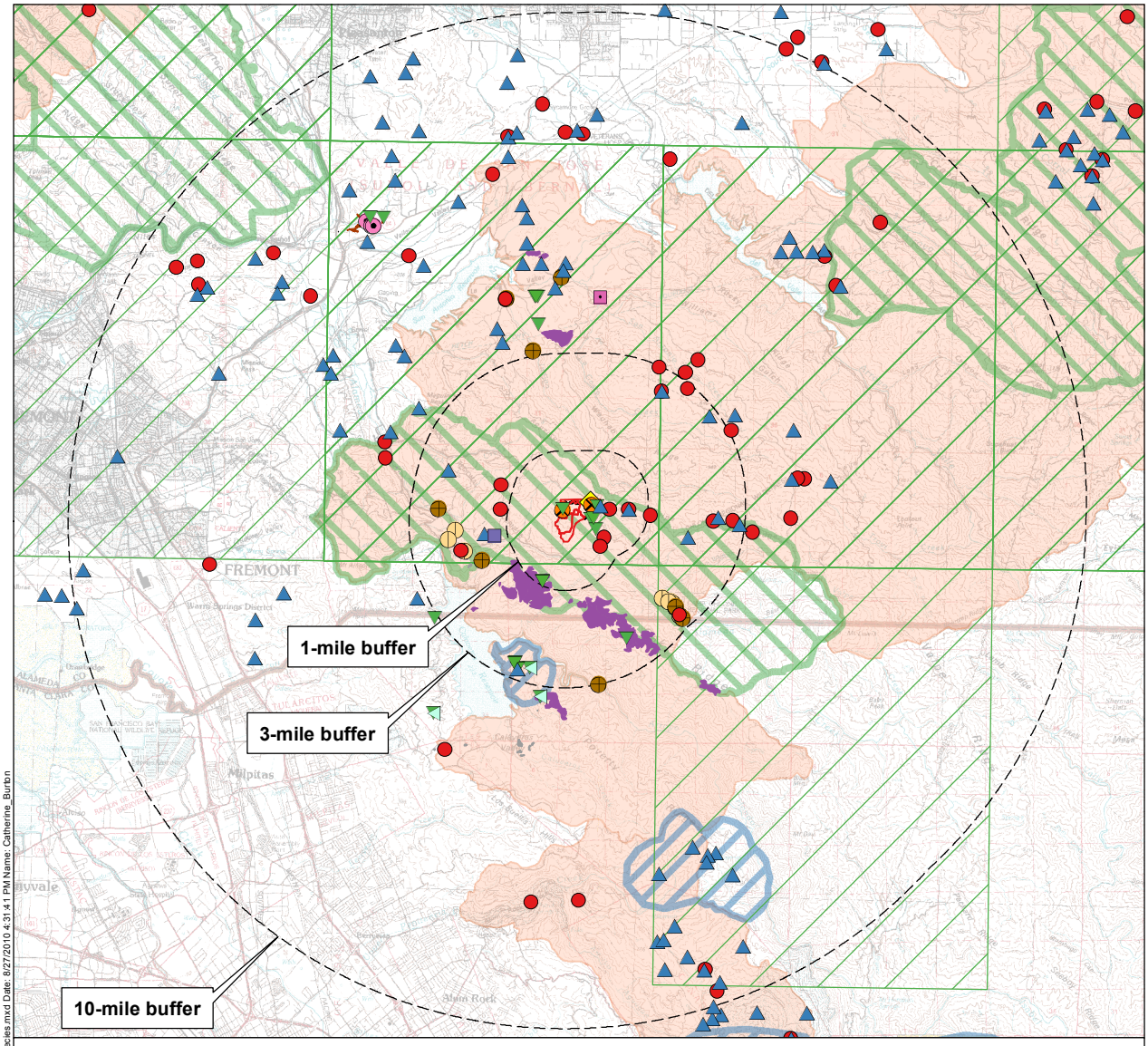
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Figure 2-13. South Calaveras Mitigation Area:
Special status species occurrences and critical habitat

Back of Figure 2-13



Special status species: Occurrences (with sources)

- Alameda whipsnake (SFPUC)
- Alameda whipsnake (EBRPD)
- Alameda whipsnake (CNDDB) — *Note: Locations generalized; actual locations suppressed*
- California tiger salamander (CNDDB)
- California tiger salamander (Condor Country)
- California tiger salamander (SFPUC)
- California red-legged frog (CNDDB)
- California red-legged frog (Nomad Ecology)
- California red-legged frog (Condor Country)
- California red-legged frog (EBRPD)
- California red-legged frog (SFPUC)
- Callippe silverspot - host plant *Viola pedunculata* (Nomad Ecology)
- Callippe silverspot - host plant *Viola pedunculata* (Entomological Consulting Services, Ltd.)
- Callippe silverspot - host plant *Viola pedunculata* (May and Associates)
- Callippe silverspot - host plant *Viola pedunculata* (SFPUC)
- Callippe silverspot - host plant *Viola pedunculata* (URS Corporation)

Special status species: Critical habitat

Source: U.S. Fish & Wildlife Service (date as indicated)

- California tiger salamander (Aug 2005)
- Alameda whipsnake (Oct 2006)
- California red-legged frog (Mar 2010)
- Conservation Easement

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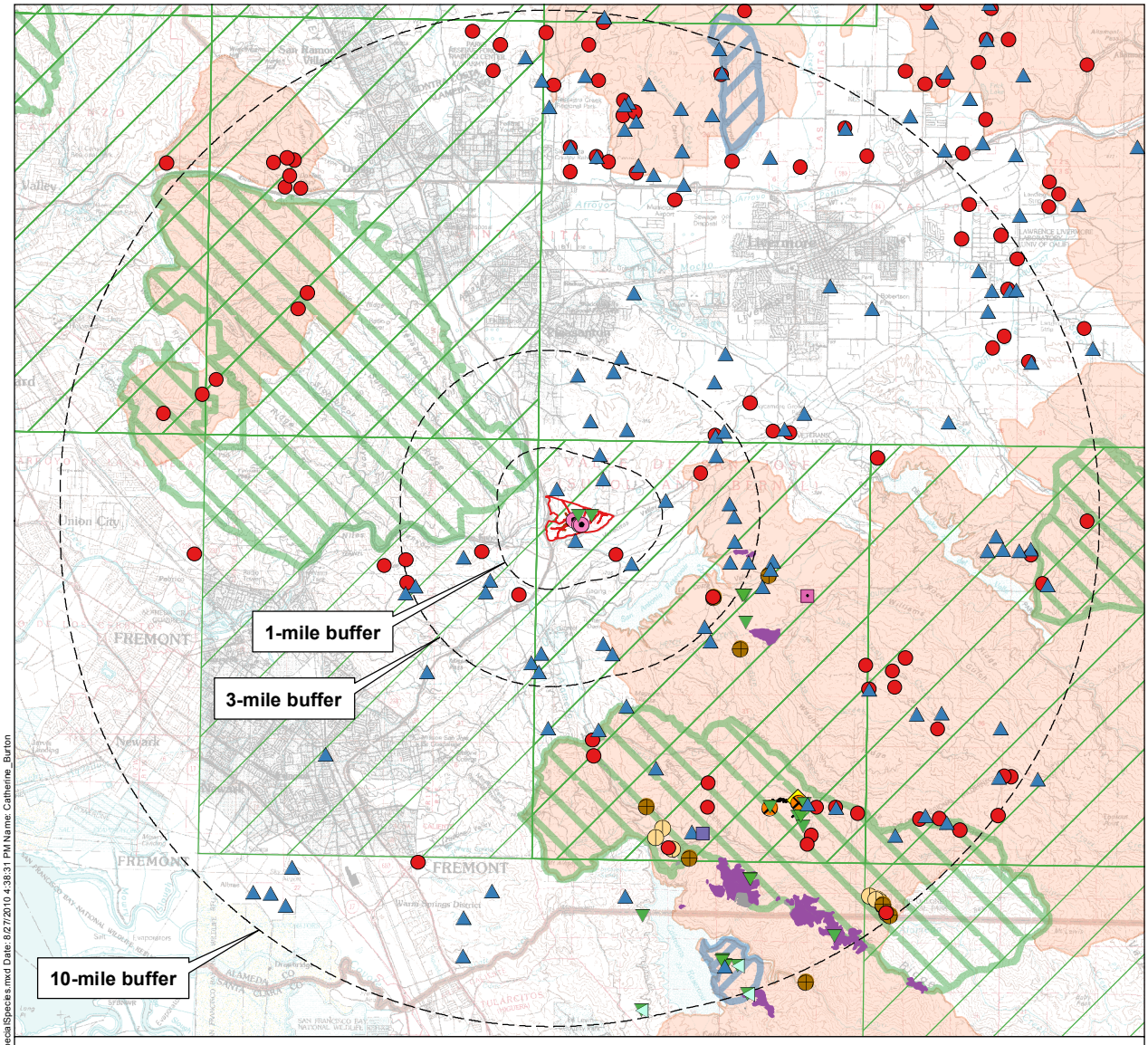
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Figure 2-14. Goat Rock Mitigation Area:
Special status species occurrences and critical habitat

Back of Figure 2-14



Special status species: Occurrences (with sources)

- Alameda whipsnake (SFPUC)
- Alameda whipsnake (EBRPD)
- Alameda whipsnake (CNDDB) *Note: Locations generalized; actual locations suppressed*
- California tiger salamander (CNDDB)
- California tiger salamander (Condor Country)
- California tiger salamander (SFPUC)
- California red-legged frog (CNDDB)
- California red-legged frog (Nomad Ecology)
- California red-legged frog (Condor Country)
- California red-legged frog (EBRPD)
- California red-legged frog (SFPUC)
- Callippe silverspot - host plant *Viola pedunculata* (Nomad Ecology)
- Callippe silverspot - host plant *Viola pedunculata* (Entomological Consulting Services, Ltd.)
- Callippe silverspot - host plant *Viola pedunculata* (May and Associates)
- Callippe silverspot - host plant *Viola pedunculata* (SFPUC)
- Callippe silverspot - host plant *Viola pedunculata* (URS Corporation)

Special status species: Critical habitat

Source: U.S. Fish & Wildlife Service (date as indicated)

- California tiger salamander (Aug 2005)
- Alameda whipsnake (Oct 2006)
- California red-legged frog (Mar 2010)
- Conservation Easement

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Base map source:
USGS 30x60-minute topographic series

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San Francisco Public Utilities Commission
Habitat Reserve Program

Figure 2-15. Sheep Camp Creek Mitigation Area:
Special status species occurrences and critical habitat

Back of Figure 2-15

California red-legged frog 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).

1. *Aquatic Breeding Habitat* is comprised of standing bodies of fresh water (with salinities less than 7.0 ppt), such as natural and manmade (e.g., stock) ponds, slow-moving streams or pools within streams, and other ephemeral or permanent water bodies. These features typically become inundated during winter rains and hold water for a minimum of 20 weeks in all but the driest of years.

2. *Non-Breeding Aquatic Habitat* includes 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 California red-legged frogs. 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.

3. *Upland Habitat* consists of areas up to a distance of 1 mi (1.6 km) from breeding and non-breeding aquatic and riparian habitat. Vegetation is primarily comprised of grasslands, woodlands, wetland, or riparian communities that provide the 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 pool 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.

4. *Dispersal Habitat* is accessible upland or riparian dispersal habitat within a minimum of 1 mi (1.6 km) from occupied locations that allows for movement between such sites. Dispersal habitat includes various natural and altered habitats 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. Large reservoirs over 50 ac (20 ha) in size and other areas that do not contain those features identified in PCE 1, 2, or 3 as essential to the conservation of the subspecies are also not considered dispersal habitat. Agricultural fields without barriers, for example, may serve as dispersal habitat.

Alameda whipsnake habitat is characterized by Diablan sage scrub and other shrub-dominated communities, woodlands or grasslands contiguous to shrub communities, and rocky outcrops, talus, and small mammal burrows (USFWS 2006). South or east-facing slopes and a sufficient prey base of western fence lizards is desirable. The USFWS published PCEs for the conservation of the Alameda whipsnake (USFWS 2006). These include, but are not limited to:

1. Space for individual and population growth and for normal behavior. The Alameda whipsnake is most frequently recorded in close association with chaparral or scrub patches.

These patches serve as the center of home ranges, and provide for concealment from predators and prey-viewing opportunities while foraging. Whipsnake venture into adjacent grasslands or wooded habitats that exhibit, at a minimum, a partially open canopy. The open canopy character is believed to allow development of the primary lizard prey base used by the snake, and efficient thermoregulation and foraging activities.

2. Food, water, air, light, minerals, or other nutritional or physiological requirements. Alameda whipsnake prey extensively on western fence lizards, but also have been known to prey on western skinks (*Eumeces skiltonianus*) as well as frogs, birds, and other snakes (USFWS 2008).

3. Cover or shelter. Rocky outcrops within scrub communities and adjacent habitats provide cover. Small rodent burrows, brush piles and deep soil crevices are also knows to provide cover.

4. Sites for breeding, reproduction, and rearing (or development) of offspring. Dispersal habitat between south-facing scrub habitat is essential for the conservation of the species.

5. Habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

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

- Grasslands with proper topography in the San Francisco Bay Area
- Sufficient larval food plant availability
- Adequate nectar sources
- Located within the area influenced by coastal fog
- Hilltops for mating congregations

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

Nectar sources for adult stage of this species include numerous native and non-native species of forbs and woody plants. These include, but are not limited to: thistles (such as *Silybum* sp. and *Cirsium* sp.), coyote mint (*Monardella villosa*) and California buckeye. Areas where the larval and adult food plants grow do not always coincide with the areas where mate selection and other behaviors occur. Observations of Callippe silverspot adults have been made at locations of more than one mile from the nearest patches of larval food plant (Entomological Consulting Services 2004).

Hilltops with connectivity with grasslands containing nectar sources and larval food plant are vital to hill-topping behavior of the Callippe silverspot behavior. Hill-topping allows the congregation of males and females, which promote mate selection (USFWS 2009).

Critical habitat for this species was first proposed in 1978 (USFWS 1978), and reproposed on March 28, 1980 (USFWS 1980). The five-year review recommended that this species remain listed as

endangered, due to the ongoing threats to its survival (USFWS 2009). The 5-year review did not include a recommendation for designating critical habitat for this species.

2.3.2.2 SPECIAL-STATUS SPECIES AT EACH MITIGATION AREA

Mitigation areas were selected that provide habitat for the special-status species discussed above. Habitat assessments and database searches were used to evaluate the species occurrence potential. Restoration design and monitoring are designed to enhance, rehabilitate, and establish/reestablish additional habitat for these species within the mitigation areas.

SAN ANTONIO CREEK MITIGATION AREA

SFPUC staff has documented California red-legged frogs, foothill yellow-legged frog, and western pond turtle in fish traps and while electro-fishing in San Antonio Creek and Indian Creeks (2002–2005). Western pond turtle could breed throughout the uplands surrounding the creek, while foothill yellow-legged frog would be expected to breed within the stream. Whereas the creek provides the potential for aquatic dispersal, San Antonio Creek does not provide suitable breeding habitat for California red-legged frog or California tiger salamander. Within the channel, water depth is too shallow for breeding and velocities would likely wash out egg masses and larvae. Off-channel pools, while present, are not flooded for sufficient periods of time to support breeding habitat. California red-legged frog and California tiger salamander require relatively stable aquatic conditions for breeding, such as stock ponds or other slow moving conditions, which remain flooded for several months. Successful CTS breeding has been documented at East Pond, which also provides breeding habitat for CRLF, as well as aquatic dispersal habitat for both CTS and CRLF. East Pond is included in the proposed conservation easement for the San Antonio Creek Mitigation Area and will be managed to control non-native predators. Although San Antonio Creek Mitigation Area has limited scrub habitats for the Alameda whipsnake, this mitigation area is located in the corridor designated in the USFWS Chaparral Species Recovery Plan for future connectivity between the Sunol-Cedar Mountain Recovery Unit (Unit 5) and the Pleasanton Ridge Recovery Unit (Unit 7)(USFWS 2002).

SAGE CANYON MITIGATION AREA

The Sage Canyon Mitigation Area has existing scrub and grassland habitats that are suitable to support Alameda whipsnake. This mitigation area is also within the Sunol-Cedar Mountain Recovery Unit where the USFWS has proposed to establish long-term protection for Alameda whipsnake (Recovery Goal #5.3.1.5)(USFWS 2002). Proposed management measures for this mitigation area would enhance the sage scrub habitat which has been degraded by grazing practices and fire suppression. Improved grazing and other management measures would improve decadent stands of chaparral, reduce the risk of catastrophic fires that could cause more extensive whipsnake mortality, and maintain a mosaic of grasslands and scrub habitats required by Alameda whipsnake. Alameda whipsnake occurrence records are suppressed, but the Sage Canyon area is within the larger Sunol-Cedar Mountain Recovery Unit where this species is assumed to be present (USFWS 2002). In addition to the scrub habitats, about 38 acres of Johnny jump-up, the host plant of the Callippe silverspot, have been mapped in the Sage Canyon Mitigation Area.

SOUTH CALAVERAS MITIGATION AREA

The South Calaveras Mitigation Area is located about 0.25 mile west of a section of federally designated critical habitat for California tiger salamander. This section of critical habitat encompasses five ponds, three of which have been documented as occupied by California tiger salamander (LSA Associates 1994, Condor Country Consulting 2008), including one pond 0.9 mile northeast of the

closest pond in the South Calaveras Mitigation Area. Another pond located west of Calaveras Road and 0.7 mile north of Goldfish Pond was occupied by California tiger salamander in 2007 (EDAW 2007) and breeding was detected again in 2010 (Apperson, pers comm. 2010).

The nearest recently documented California red-legged frog records are from 2002-2005 in Arroyo Hondo, 1.7 miles northeast of the South Calaveras Mitigation Area (SFPUC unpublished); and in 2000, 3.0 miles south at Penitencia Creek in the City of San Jose (CNDDB 2008). However, numerous private stock ponds and other aquatic habitat occur near the South Calaveras Mitigation Area, and could provide sources of dispersing adults or juveniles. The South Calaveras Mitigation Area is located within the proposed expansion of federally designated critical habitat for California red-legged frog, which was mapped to maintain the current population structure across the subspecies' range and provide for connectivity between breeding sites that allows for the continued existence of viable and essential metapopulations (USFWS 2008).

California red-legged frog was identified in Goldfish Pond in 1994 (CNDDB 2008, occurrence #179), but was not detected in any of the South Calaveras Mitigation Area ponds during 2007-2008 surveys. California tiger salamander has been identified in the area, but was not present in South Calaveras Mitigation Area ponds during 2007-2008 seine net surveys (Condor Country Consulting 2008). The four ponds at the South Calaveras Mitigation Area are known to support bullfrogs and fish, and it is considered unlikely that these ponds support California tiger salamander or California red-legged frog. The drainages are not likely used by California tiger salamander; however, they provide suitable non-breeding aquatic habitat for California red-legged frog (ETJV 2009b). About 10 acres of grasslands supporting the host plant of Callippe silverspot were mapped within the South Calaveras

North Pond, South Pond, and Stock Pond currently support non-native bullfrogs and fish. These predators likely preclude the presence of the California tiger salamander and California red-legged frog.

GOAT ROCK MITIGATION AREA

The Goat Rock mitigation area supports several rare plant species (Table 2-4) and a diverse assemblage of native grassland and serpentine endemic species. Serpentine endemic species have evolved to grow in the nutrient-poor and toxic (high in heavy metals) environment associated with serpentine. These conditions typically preclude or greatly reduce the ability of non-serpentine endemics to grow, including non-native species. Serpentine soils also support unique plant species, relative to surrounding plant communities, due to the fact the that the serpentine soils are unsuitable for farming and timber, and therefore typically have had less ground disturbance than surrounding areas.

In addition to the presence of a unique and diverse plant species assemblage, several occurrences of California tiger salamander (Condor Country 2008, 2009-2010, CNDDB occurrence #291), California red-legged frog (CNDDB occurrence number #188) and northwestern pond turtle (ESA 2009a) have been observed within the Goat Rock Mitigation Area. Other special-status species that are likely to forage and/or breed the grasslands at Goat Rock include California horned-lark, northern harrier, grasshopper sparrow, prairie falcon and burrowing owl.

Table 2-4
Special-status plants in the Goat Rock mitigation area.

Common Name	Scientific Name	Listing Status*
Serpentine leptosiphon	*Leptosiphon ambiguous*	CNPS List 4.2
Santa Clara thornmint	*Acanthomintha lanceolata*	CNPS List 4.2
Wooly-headed lessingia	*Lessingia hololeuca*	CNPS List 3
Van Houtte's columbine	*Aquilegia eximia*	CNPS Locally rare
Pink spineflower	*Chorizanthe membranacea*	CNPS Locally rare
Red beardtongue	*Keckiella corymbosa*	CNPS Locally rare
Pestle parsnip	*Lomatium nudicaule*	CNPS Locally rare
Brewer's phacelia	*Phacelia breweri*	CNPS Locally rare
Divaricate phacelia	*Phacelia divaricata*	CNPS Locally rare
Brewer's groundsel	*Senecio breweri*	CNPS Locally rare
CNPS Locally Rare: Rare, Unusual and Significant Plants of Alameda and Contra Costa Counties, CNPS List 4.2: Limited distribution (Watch List), CNPS List 3: CNPS review list; Fairly endangered in California; more information on distribution of this species is needed		

SHEEP CAMP CREEK MITIGATION AREA

SFPUC surveys have documented California red-legged frogs and California tiger salamander at the Sheep Camp Creek Mitigation Area (Apperson, pers. comm.). Breeding California tiger salamanders were detected as recently as 2010 in three stock ponds within the mitigation area. Adult red-legged frogs have been observed in Sheep Camp Creek. Although there is only a small area of scrub habitat likely to support the Alameda whipsnake, the Sheep Camp Creek Mitigation Area is located within a corridor that the USFWS has proposed to establish connectivity between the Alameda whipsnake recovery unit on Pleasanton Ridge (Unit 7) and the Sunol-Cedar Mountain Recovery Unit (Unit 5) south of San Antonio Reservoir (USFWS 2002).

2.3.3 NON-NATIVE INVASIVE SPECIES

Non-native invasive species within the HRP mitigation areas include both wildlife and plant species and are described in detail below.

2.3.3.1 NON-NATIVE INVASIVE WILDLIFE

Bullfrogs and non-native predatory fish (e.g., bass, shiner, and mosquitofish) are documented at all four ponds in the South Calaveras Mitigation Area. Table 2-5 summarizes the results of seine and visual surveys conducted at the ponds (1994–2008) (EDAW 2009b). Three of the ponds were seined in 1994 (LSA Associates 1994); no fish were detected, and bullfrogs were present only in the Stock Pond. Twelve years later, EDAW found robust bullfrog populations at all four ponds, and by 2008, predatory fish had been documented in all four of the ponds. In addition to bullfrogs and non-native predatory fish, feral pigs are known to frequent the project area and may cause damage to new plantings, as well as existing or restored areas, by damaging root systems.

Table 2-5
South Calaveras pond survey results.

Survey Year	Source	Method	Species Documented in Compensation Sites			
			Goldfish Pond	Stock Pond	North Pond	South Pond
1994	LSA	Seine	California red-legged frog, western toad, Pacific chorus frog	**bullfrog**, western toad, Pacific chorus frog	California newt	Not surveyed
2006	EDAW	Visual	>40 adult **bullfrogs**, western toad	~30 **bullfrogs**	30 **bullfrogs**, western toad, Pacific chorus frog, California newt	10 **bullfrogs, bass (dead),** western toad
2007, 2008	Condor Country Consulting	Seine	**bullfrog, bass**	**bullfrog, shiner**, western toad, Pacific chorus frog	**bullfrog**, **mosquitofish,** California newt, western pond turtle	**bullfrog**, western toad, California newt

Note:
Nonnative predators are shown in **boldface** type.

2.3.3.2 NON-NATIVE INVASIVE PLANTS

The mitigation areas were surveyed for non-native invasive plant species by Nomad Ecology (Nomad Ecology 2009). Non-native species were considered invasive if they were included on the Cal-IPC list. A list of non-native invasive species occurring within the mitigation area boundaries is provided in Table 2-6.

The majority of occurrences are of herbaceous annuals in isolated, patchy or scattered populations. Particularly heavy infestations were documented in the grasslands around the San Antonio Reservoir and the margins of the Calaveras Reservoir below the former inundation zone; and the lake bottom at the southern end of the Calaveras Reservoir.

Table 2-6
Non-native, invasive species occurring within mitigation area boundaries.

Scientific Name	Common Name	Cal-IPC
Brachypodium distachyon	slender false brome	Moderate
Brassica nigra	black mustard	Moderate
Carduus pycnocephalus	Italian thistle	Moderate
Carduus tenuiflorus	slender flower thistle	Limited
Centaurea calcitrapa	purple starthistle	Moderate
Centaurea solstitialis	yellow starthistle	High
Cirsium vulgare	bull thistle	Moderate
Conium maculatum	poison hemlock	Moderate
Dipsacus sativus	Fuller's teasel	Moderate
Dittrichia graveolens	stink wort	Moderate
Eucalyptus globulus	Eucalyptus	Moderate
Foeniculum vulgare	Fennel	High

Table 2-6
Non-native, invasive species occurring within mitigation area boundaries.

Scientific Name	Common Name	Cal-IPC
Hirschfeldia incana	shortpod mustard	Moderate
Nicotiana glauca	tree tobacco	Moderate
Picris echioides	bristly ox-tongue	Limited
Phalaris aquatica	Harding grass	Moderate
Rubus discolor	Himalayan blackberry	High
Salsola tragus	common Russian thistle	Limited
Silybum marianum	milk thistle	Limited
Taeniatherum caput-medusae	medusahead	High
Tamarix parviflora	salt cedar	High

The most common non-native, invasive species mapped within the San Antonio Creek mitigation area include milk thistle (*Silybum marianum*) and stinkwort. Other relatively abundant, non-native, invasive species in this area include poison hemlock (*Conium maculatum*), yellow starthistle, and fennel (*Foeniculum vulgare*).

A monoculture of purple starthistle (*Centaurea calcitrapa*) was identified in the northernmost portion of the Goldfish Pond compensation site in the South Calaveras mitigation area. Typical species adjacent to the monoculture were yellow starthistle and milkthistle.

The northeastern portion of South Calaveras is heavily invaded with isolated patches of: purple starthistle, yellow starthistle, poison hemlock, and stinkwort.

No substantial infestations were identified at Sage Canyon. One patchily distributed occurrence of medusahead (*Taeniatherum caput-medusae*) was observed just north of the easternmost portion of the site. Substantial patches of medusahead occur in the upland grasslands of Sheep Camp Creek.

2.3.4 AQUATIC FEATURES AND JURISDICTIONAL AREAS

The following summary of jurisdictional features in the mitigation areas is based on three delineation reports: November 2009 Wetlands and Other Waters Assessment South Calaveras, Sage Canyon, and San Antonio Mitigation Areas (ETJV 2009c), SFPUC Habitat Reserve Program: Alameda Watershed Preliminary Delineation of Waters of the United States (ESA 2009b), and the Final Supplemental Delineation of Waters of the United States Potential Mitigation Areas and Access Roads, Calaveras Dam Replacement Project (ETJV 2009d). A generalized description of the wetlands and other waters of the United States found within the HRP mitigation areas are included below.

SAN ANTONIO MITIGATION AREA

The San Antonio Mitigation Area has two major intermittent streams and several ephemeral tributaries to each of the intermittent streams. San Antonio Creek and Indian Creek drain into San Antonio Reservoir, a portion of which is within the mitigation area. Several seep and seasonal wetlands occur within or adjacent to the ephemeral drainages. In addition, the mitigation area has one small stock pond ("East Pond") that has documented occurrences of California tiger salamander (CNDDB 2010, Occurrence #285).

SAGE CANYON MITIGATION AREA

Multiple ephemeral drainage features are located within the Sage Canyon Mitigation Area. These drainages trend southward from Oak Ridge at the northern margin of Sage Canyon to Calaveras Reservoir at the southern margin of the mitigation area. Six small seep and seasonal wetlands occur within or adjacent to the ephemeral drainages. A stock pond connects to an ephemeral drainage via a seasonal wetland.

GOAT ROCK MITIGATION AREA

The Goat Rock Mitigation Area is hilly with perennial and intermittent drainages, generally trending southward between the hills. Several small seeps occur at the headwaters or along these ephemeral drainages. Also, two open water features (Northwest and Northeast Ponds) are present.

SOUTH CALAVERAS MITIGATION AREA

Several jurisdictional features are located within the South Calaveras Mitigation Area which drains toward Calaveras Reservoir. The area also supports several ephemeral drainages that are moderately to severely incised. In addition, the site supports four ponds (Goldfish Pond, Stock Pond, North Pond, and South Pond) that were established to provide water to cattle (stock ponds). South Pond is not a jurisdictional water of the U.S. because it is isolated, but the remaining three ponds are all waters of the U.S. and the state. This mitigation area also supports several ephemeral drainages bordered by dense coast live oak woodland. A section of Calaveras Creek is within the management boundary of the South Calaveras Mitigation Area, but outside of the conservation easement boundary for the mitigation area.

SHEEP CAMP CREEK MITIGATION AREA

Several jurisdictional features are located within the Sheep Camp Creek Mitigation Area, including Sheep Camp Creek and a smaller ephemeral tributary stream with a small stand of sycamore alluvial woodland. Sheep Camp Creek supports degraded seasonal wetlands, and over-grazed willow riparian vegetation. Four stock watering ponds have been constructed within the Sheep Camp Creek Mitigation Area: two on Sheep Camp Creek, one on a tributary to Sheep Camp Creek and a fourth on a small ephemeral tributary to Vallecitos Creek. Three of the stock ponds have been documented to support breeding California tiger salamanders. A small, isolated sag pond is located in the northwest corner of the mitigation area may also support breeding California tiger salamanders although it has not been surveyed for this species.

2.3.5 TOPOGRAPHY

The HRP mitigation areas are located within the western Diablo Range, which rises to elevations of more than 3,000 feet east of southern San Francisco Bay. The Diablo Range is located within the Northern Coast Ranges seismotectonic province, a region of youthful, elevated topography bounded by the San Gregorio and San Andreas faults on the west and the Coast Range–Sierran Block Boundary on the east. These faults are part of the broad zone of deformation that accommodates the relative motion between the Pacific plate and Sierran microplate at this latitude.

The late Cenozoic structure of the Diablo Range is characterized by northwest-trending folds and thrust faults, including the Mount Diablo blind thrust (Aydin 1982; Unruh, 2001) and by north-northwest-striking dextral faults and lineament zones such as the Contra Costa shear zone (Unruh and Kelson 2002). In a regional sense, the Diablo Range lies generally east of the Calaveras fault and consists of Coast Range ophiolite and Franciscan Complex rocks overlain by Plio-Pleistocene age (between about 5.3 and 1.8 million years old) non-marine and marine sedimentary deposits (Wagner

et al. 1990). Quaternary age (less than 10,000 years old) alluvium covers the valley bottom at the San Antonio (Barlock 1988; Graymer et al. 1996) and South Calaveras Mitigation Areas (Helley and Graymer 1997; Dibblee 1973).

Across the Calaveras fault, rocks of the Eastern Belt Franciscan Complex are juxtaposed on the east against Cretaceous sedimentary and younger Tertiary rocks on the west (Page 1982; Wentworth et al. 1999). West of the Calaveras fault, the Santa Clara Valley and the East Bay Hills are underlain by Miocene rocks and sediments, including the Claremont and Briones Formations. Page et al. (1998) note that the Coast Ranges, which include the Diablo Range, underwent late Miocene deformation, followed by two more-recent generations of range building: (1) folding and thrust faulting beginning about 3 million years ago, and (2) subsequent late Quaternary uplift of the ranges.

2.3.5.1 SAN ANTONIO MITIGATION AREA

In the vicinity of the San Antonio Creek east of the San Antonio Reservoir, the non-marine sedimentary rocks that underlie this mitigation area are primarily Livermore Gravels (Graymer et al. 1996; Barlock 1988). The Livermore Gravels Formation is up to about 4,000 feet thick in some areas (Hall 1958). It contains debris from Franciscan rocks and is characterized by cobble-pebble gravels with lesser amounts of pebbly sand and clay.

2.3.5.2 SAGE CANYON MITIGATION AREA

The Sage Canyon Mitigation Area has a southern aspect with two prominent north-south ridges, all aspects are represented within the enhancement area. Oak Ridge Road forms the northern boundary for a distance of about 1.5 miles. The elevation range is from the potential future maximum reservoir spillway elevation of 890 feet to approximately 2,508 feet at a benchmark on Oak Ridge, identified on the Calaveras U.S.G.S. quadrangle.

2.3.5.3 SOUTH CALAVERAS MITIGATION AREA

In the vicinity of the southern end of Calaveras Reservoir near the Goldfish Pond site the sedimentary rocks include Franciscan Complex mélange overlain by Cretaceous age Great Valley Sequence sandstone and shale and Miocene age Claremont Formation shale and Briones Formation sandstone. Pleistocene and Holocene age alluvial deposits locally overlie these bedrock formations.

2.3.5.4 GOAT ROCK MITIGATION AREA

The Goat Rock Mitigation Area is situated between Valpe Ridge (a southeastern continuation of Apperson Ridge) and upper Alameda Creek just downstream from the Alameda Creek Diversion Dam. The ridge generally trends northwest-southeast. Most of Goat Rock Mitigation Area has a southwestern exposure, although lateral canyons containing small perennial and intermittent drainages create additional topographic variation. The elevation range is from about 1,000 feet in the southwestern corner of Goat Rock HRP to about 2,480 feet in the northeastern corner. The name sake is associated with a prominent rock outcrop, Goat Rock, which rises more than 200 feet above the steeply sloping canyon.

2.3.5.5 SHEEP CAMP CREEK MITIGATION AREA

The non-marine sedimentary rocks that underlie the Sheep Camp Creek Mitigation Area are primarily Livermore Gravels (Graymer et al. 1996; Barlock 1988). The Livermore Gravels Formation is up to about 4,000 feet thick in some areas (Hall 1958). It contains debris from Franciscan rocks and is

characterized by cobble-pebble gravels with lesser amounts of pebbly sand and clay. The small valley bordering Sheep Camp Creek and its tributaries is incised into the Livermore Gravels formation.

2.3.6 SOILS

Detailed soils analysis was performed at multiple locations within the Calaveras and San Antonio Mitigation areas. No analysis was performed at either the Goat Rock or Sage Canyon areas but a generalized soil description, based on NRCS soil surveys, is discussed below.

2.3.6.1 SOILS STUDY METHODS

URS analyzed soils from 11 soil test pits (STPs) sampled at the South Calaveras and San Antonio mitigation areas, Table 2-7. The purpose of the soil investigation was to characterize soil properties relative to vegetation selection and establishment at the HRP mitigation areas.

Table 2-7
Locations and numbers of soil test pits.

Soil Test Pit Location	Number of Soil Test Pits
San Antonio Creek	2
Oak Woodland & Savannah	2
Goldfish Pond	2
Wet Meadow	1
Total Soil Test Pits	**7**

All STPs were dug at locations that were deemed important for mitigation plantings and representative of the various National Resource Conservation Service (NRCS) map units depicted within the study area (Appendix A-1). Factors for selection included elevation, aspect, current vegetation, and topography.

All STPs were dug using shovels and picks to a depth of 150 cm, when feasible. Soils were analyzed using the NRCS National Soil Survey Handbook and Field Book for Describing and Sampling Soils. Once the STP had been dug, soil horizons were identified and their boundaries marked. Information recorded from each horizon included soil texture (percent rock fragment, clay, texture class), structure (shape, size and grade), color, consistency, chemistry (pH and presence of $CaCO_3$), amount of roots, drainage class, aspect, runoff and soil temperature (see Appendix A-2 for definitions). Information calculated included hydraulic conductivity, effective rooting depth, and water retention difference. Additionally, pictures were taken of each soil profile and the STP locations were recorded using a Trimble Geo XT GPS unit, with submeter accuracy.

Once the data were gathered, the STPs were refilled, wherever possible (some locations were bank cuts and could not be refilled). Soil profile data were analyzed for its consistency with mitigation planting goals and NRCS soil map units. Soil compatible plant species recommendations are listed in Appendix A-3.

2.3.6.2 SOIL PROFILE RESULTS

The NRCS soil survey provides much useful information on soils, their properties and spatial distribution, and their use in land-planning. Proper use of the survey requires an understanding of how a soil survey is developed and its associated limitations. There are many factors that combine to form

a soil and they may have high spatial variability. Factors such as variation in mapping resolution, the minimum map unit size, and the fact that map units often consist of more than one soil series make field verification particularly important. This is especially true when planning for areas less than 10 acres in size, such as most of the compensation sites.

> *In addition, individual soils on the landscape commonly merge gradually onto one another as their characteristics gradually* change*… The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but if intensive use of small areas is planned, onsite investigation to precisely define and locate the soils and miscellaneous areas is needed* (NRCS 2009*).*

The following sections present the field investigation results for each compensation site. Three tables are included for each area. The first presents an overview of the soil characteristics and the details for each STP are presented in individual tables. The soil characteristics relative to known soil tolerances or requirements of the plant species in the (ETJV 2009b) proposed revegetation plan are discussed. One key soil characteristic reported in the tables for each location is available water capacity (WRD) defined as the volume of water that should be available to plants if the soil, inclusive of fragments, were at field capacity. Field capacity represents the amount of water held by the soil after all gravitational water has been drained.

SAN ANTONIO CREEK MITIGATION AREA

San Antonio Creek

The soils along the banks of San Antonio Creek are well drained, very deep, Pachic Haploxerolls. They are characterized by friable, dark, fertile, surface materials; a xeric moisture regime (where winters are moist and cool and summers are warm and dry); little horizon development; and thick surface horizons consisting of textures finer than loamy fine sand. Rock fragments were found to increase with depth with the highest content (50 percent to 65 percent) occurring below 80 cm. Clay content increases with depth to around 100 cm and then declines with depth. Maximum clay content encountered was 32 percent. No root restricting layers were encountered. Soil pH values ranged from slightly acid to neutral. Soil structure transitions from moderate in the surface horizons to structure-less below approximately 130 cm. Medium, fine, and very fine roots were found throughout the profile, with many at the surface and a transition to few below 100 cm (Table 2-8) (see field data in Appendix A-4).

Table 2-8
San Antonio Creek soil overview.

Soil Pit ID	Drainage Class	Hydraulic Conductivity	Effective Rooting Depth	WRD	Runoff	NRCS Map Unit	Exploration Taxonomy
San Antonio Creek STP1	Well Drained	Moderately High	Very Deep	Low	Low	Pleasanton gravelly loam, 3 to 12 percent slopes	Loamy-Skeletal, Pachic Haploxeroll
San Antonio Creek STP2	Well Drained	Moderately High	Very Deep	Moderate	Low	Riverwash	Fine-Loamy, Pachic Haploxeroll



San Antonio Creek STP1					
Horizon	**Depth (cm)**	**% Rock Fragments**	**% Clay**	**Texture Class**	**pH**
1	0-10	2	12	Silt Loam	6.4
2	10-54	30	24	Gravelly Sandy Clay Loam	6.8
3	54-80	30	32	Gravelly Sandy Clay Loam	6.9
4	80-132	65	28	Extremely Cobbly Sandy Clay Loam	6.9
5	132+	20	1	Gravelly Coarse Sand	7.0



San Antonio Creek STP2					
Horizon	**Depth (cm)**	**% Rock Fragments**	**% Clay**	**Texture Class**	**pH**
1	0-13	3	7	Silt Loam	6.7
2	13-64	7	24	Loam	6.8
3	64-107	23	25	Medium Gravelly Sandy Clay Loam	6.8
4	107-138	50	2	Very Gravelly Coarse Sand	7
5	138+	55	2	Very Cobbly Coarse Sand	7

The two soil profiles examined in the San Antonio Creek area (points: San Antonio Creek STP1 and San Antonio Creek STP2) are located near the boundary of two NRCS map units. These units are mapped as Riverwash (Rh), and Pleasanton gravelly loam, 3 to 12 percent slopes (PgB). The characteristics of the soils encountered in the field more closely resemble those of the Pleasanton map unit. This map unit contains the Pleasanton, the Positas, the Livermore, and the Rincon soil series. Of these soil series, the soils encountered in the field most closely resemble those of the Livermore series.

> *The Livermore series consists of very deep, somewhat excessively drained soils that formed in very gravelly alluvium derived from sedimentary and metasedimentary rocks. They are Loamy-skeletal, Typic Haploxerolls* (NRCS 2009*).*

The soils encountered in the San Antonio Creek area have thicker surface horizons with finer textures than those of the Livermore series but are otherwise similar to the official series description (see Appendix A-5).

Oak Woodland and Oak Savannah

Soil test pits were excavated at representative locations with oak woodland and oak savannah vegetation types. The soils within the oak woodland area are well drained, very deep, Typic Xerofluvents formed from recent alluvium. They are characterized by young, undeveloped soils; whose materials were laid down as a function of fluvial processes; have a xeric moisture regime; and have properties most representative of typical Entisols. Rock fragments were found to increase with depth with the highest content (80 percent by volume) occurring below 130 cm. Clay content varies with depth as is typical in soils of recent floodplains. Maximum clay content encountered was 40 percent. No root restricting layers were encountered. Soil pH values range from moderately acid to moderately alkaline. Soil structure is weak to a depth of 56 cm, structure-less from 56 to 91 cm, and moderate at depths greater than 91 cm. Medium, fine and very fine roots were found throughout the profile with many at the surface transitioning to very few below 130 cm.

The soils of the oak savannah area are well drained, very deep, Pachic Haploxerolls. They are characterized by friable, dark, fertile, surface materials; a xeric moisture regime; little horizon development; and thick surface horizons that consist of textures finer than loamy fine sand. Rock fragments were found to increase with depth with the highest content (75 percent by volume) occurring below 77 cm. Clay content increases with depth to 77 cm and is nearly absent below that. Maximum clay content encountered was 18 percent. No root restricting layers were encountered. Soil pH values range from slightly acid to neutral. Soil structure is moderate to a depth of 77 cm and structure-less below that. Fine roots were found throughout the profile, with many in the surface horizons and few below 77 cm (Table 2-9) (see field data in Appendix A-4).

Table 2-9
Oak Woodland and Oak Savannah soil overview.

Soil Pit ID	Drainage Class	Hydraulic Conductivity	Effective Rooting Depth	WRD	Runoff	NRCS Map Unit	Exploration Taxonomy
Oak Woodland STP1)	Well Drained	Moderately Low	Very Deep	Low	Medium	Pleasanton gravelly loam, 3 to 12 percent slopes	Loamy-Skeletal, Typic Xerofluvent
Oak Savannah STP1	Well Drained	Moderately High	Very Deep	Low	Low	Zamora silt loam, 0 to 4 percent slopes	Loamy-Skeletal, Pachic Haploxeroll



Oak Woodland STP1					
Horizon	**Depth (cm)**	**% Rock Fragments**	**% Clay**	**Texture Class**	**pH**
1	0-24	3	15	Fine Sandy Loam	6.0
2	24-56	35	30	Very Cobbly Sandy Clay Loam	6.6
3	56-91	40	3	Very Gravelly Fine Sand	7.2
4	91-130	40	36	Very Cobbly Sandy Clay	7.5
5	130+	80	40	Extremely Cobbly Sandy Clay	8.0



Oak Savannah STP1					
Horizon	**Depth (cm)**	**% Rock Fragments**	**% Clay**	**Texture Class**	**pH**
1	0-41	6	16	Coarse Sandy Loam	6.7
2	41-77	40	18	Extremely Cobbly Coarse Sandy Loam	6.5
3	77+	75	1	Extremely Cobbly Coarse Sand	6.9

The soil profile examined in the Oak Woodland area (point: Oak Woodland STP1) is located on the Pleasanton gravelly loam, 3 to 12 percent slopes (PgB) map unit. This map unit contains the Pleasanton series, the Positas series, the Livermore series, and the Rincon series. The characteristics of the Oak Woodland soil encountered in the field more closely resemble those of the neighboring Riverwash map unit (Rh). This is not unexpected given the resolution of the soil survey and that the profile was a stream bank cut on an ephemeral drainage.

Riverwash soils generally consist of very deep, stratified coarse alluvium from a river, creek, or other such water feature. They occur on narrow floodplains adjacent to stream channels and inactive stream channels and are generally excessively drained. A typical profile consists

> *of stratified, variable surface and subsurface materials with abrupt changes in texture and rock fragment content* (NRCS 2009*).*

The soils encountered in the Oak Woodland area have somewhat finer textures than those described for the Riverwash series but are otherwise similar to the series description (see Appendix A-5).

The soil profile examined in the Oak Savannah area (point: Oak Savannah STP1) is on the Zamora silt loam 0 to 4 percent slopes (Za) map unit. This map unit consists of the Zamora series, the Pleasanton series, and the Rincon series. The characteristics of the Oak Savannah soil encountered in the field do not meet those described for any of the series of the Za map unit. The soils encountered in the Oak Savannah area are much less weathered than those described in the official series descriptions having little clay accumulation and no evidence of clay translocation (clay films). It is highly likely that NRCS mapped this polygon based on landform and vegetation community alone and did not verify it with a characterized soil pit.

SAGE CANYON MITIGATION AREA

The soils on the south-facing slopes above Calaveras Reservoir are Gaviota loam and Gaviota gravelly loam, 30 to 75 percent slopes, with some mapping units classified as eroded. The upper slopes and ridges are mapped as Vallecitos rocky loam, eroded, 15 to 75 slopes. The parent material for both soil types is hard sandstone and shale (NRCS 2009).

SOUTH CALAVERAS MITIGATION AREA

Goldfish Pond

The soils of STP1 at Goldfish pond were found to be very poorly drained, very deep, Aquic Haploxerepts. They are characterized by weak horizon development; a xeric moisture regime; and the presence of redox depletions in surface horizons along with aquic conditions for some time in normal years. Rock fragment content was less than 2 percent throughout the profile. Clay content varied with depth with the greatest percent (40) occurring from 25-55 cm. No root restricting layers were encountered. Soil pH values range from strongly acid to neutral. Soil structure throughout the profile is weak to moderate. Fine and very fine roots are found throughout the profile with many at the surface transitioning to fewer roots observed below 55 cm.

The soils of STP2 at Goldfish Pond were found to be well drained, very deep, Pachic Argixerolls (Table 2-10). They are characterized by friable, dark, fertile, surface materials; a xeric moisture regime; the presence of an argillic horizon (a subsurface pedogenic accumulation of clay); and thick surface horizons that consist of textures finer than loamy fine sand. Rock fragment content was found to be low (<5 percent) throughout the profile. Clay content increases with depth with the greatest percent (48) occurring below 106 cm. No root restricting layers were encountered. Soil pH values range from moderately acid to slightly acid. Soil structure is moderate and strong in the upper two horizons and is weak below 72 cm. Fine roots were found throughout the profile to a depth of 106 cm with many in the surface horizons transitioning to few below 72 cm (see field data in Appendix A-4).

Table 2-10
Goldfish Pond soil overview.

Soil Pit ID	Drainage Class	Hydraulic Conductivity	Effective Rooting Depth	WRD	Runoff	NRCS Map Unit	Exploration Taxonomy
Goldfish Pond STP 1	Very Poorly Drained	Low	Very Deep	Moderate	Medium	San Ysidro loam, acid variant, 2 to 9 percent slopes	Fine-Loamy, Aquic Haploxerept
Goldfish Pond STP 2	Well Drained	Low	Very Deep	High	High	San Ysidro loam, acid variant, 2 to 9 percent slopes	Fine-Loamy, Pachic Argixeroll



Goldfish Pond STP1					
Horizon	**Depth (cm)**	**% Rock Fragments**	**% Clay**	**Texture Class**	**pH**
1	0-25	<1	30	Silty Clay Loam	6.5
2	25-55	<1	40	Silty Clay	6.7
3	55-97	2	10	Loamy Sand	6.9
4	97-136	<1	9	Sandy Loam	6.5
5	136-150+	<1	30	Sandy Clay Loam	5.5



Goldfish Pond STP2					
Horizon	**Depth (cm)**	**% Rock Fragments**	**% Clay**	**Texture Class**	**pH**
1	0-20	<1	20	Loam	5.7
2	20-72	3	32	Sandy Clay Loam	5.9
3	72-106	3	32	Sandy Clay Loam	6.4
4	106-150+	5	48	Sandy Clay	6.4

The two soil profiles examined in the Goldfish pond area (points: Goldfish Pond STP1 and Goldfish Pond STP2) are located on the San Ysidro loam, acid variant, 2 to 9 percent slopes map unit (SfC). The dominant soil series in this map unit is the San Ysidro series. Neither Test Pit 1 nor Test Pit 2 closely resembles the description for the San Ysidro series. Rather, they more closely resemble the soil series of the surrounding Los Osos clay loam, 15 to 30 percent slopes map unit (LoE). This map unit consists of the Los Osos series, the Los Gatos gravelly loam series, and the Gaviota loam series (see Appendix A-5).

The soil encountered at STP1 is more developed than that of the Gaviota series, but is not as developed as those of the Los Gatos or Los Osos series. This soil is most likely a transition between the two series.

The soil from Test Pit 2 most closely resembles the description of the Los Osos series, a Typic Argixeroll. The Los Osos series consists of well-drained to somewhat excessively drained, moderately deep silty clay loam and silt loam soils. The soil encountered at Pit 2 has a thicker mollic epipedon and is deeper than that of the Los Osos series but is otherwise similar to the official series description (see Appendix A-5).

GOAT ROCK MITIGATION AREA

The soils in most of the Goat Rock HRP area are mapped as Henneke rocky loam, eroded, and Rock land. Henneke soils are formed over serpentinite, and some of the Rock land is also apparently formed in serpentinite. Soils in the lower, more southerly slopes and the more gently sloping areas at the northern portion of the Goat Rock mitigation area are Vallecitos rocky loam, 30 to 75 percent slopes, eroded (NRCS 2009).

SHEEP CAMP CREEK MITIGATION AREA

Soils at the Project Site are predominately mapped as Positas gravelly loam and Perkins loam. Positas gravelly loam areas are divided into areas with 2-20 percent slope and 20-40 percent slope. Positas gravelly loam is the most common soil type making up 90% of the site area. Perkins loam, occurs throughout about 9 percent of the site. Both of these soils contain fine-textured, expansive subsoil horizons and are commonly found in floodplain terraces (NRCS 2008). In addition, a small portion (1 percent) of the site contains Clear Lake clay (0-3 percent slopes) and Zamora silt loam (0-4 percent slopes). Clear Lake clay is a hydric soil occurring on basin floors. Zamora silt loam is not a hydric soil, but can be found in floodplain areas.

2.3.7 HYDROGEOMORPHOLOGY

Rain and stream gages were installed at San Antonio Creek. In addition, mapping, surveys, pebble counts, and cross-section surveys were performed and analyzed. The following sections describe the assessment and results. The study methods are provided in Appendix B. Detailed hydrogeomorphic surveys have not been conducted at Sheep Camp Creek or any of the ephemeral tributaries within the mitigation areas.

The San Antonio Creek stream gage was installed in a riffle approximately 260 feet upstream from the first Ranch Road stream crossing (Figure 2-16). Rain gages were placed near the stream gage locations in clearings free of trees, to avoid the potential for trees to interfere with rainfall collection. The immediate channel area and streambed was walked, and bed features were identified, classified, and mapped. Global Positioning System (GPS), light detection and ranging (LiDAR), and conventional ground topographic surveying were used to collect location and elevation data. Several pebble counts were conducted at San Antonio to characterize the bed material in a given reach and are

used in estimating velocity, sediment competence, sediment entrainment, and stream classification. The overall channel bank and bed stability was assessed using a Pfankuch stability rating. At San Antonio Creek, ratings were subjectively evaluated between each of two representative riffle cross sections for each reach (two ratings per reach).

RAIN GAGE AND STREAM DATA

Results of the first download period for San Antonio Creek is provided in Appendix C-1. Four rain events were logged at San Antonio. Table 2-11 lists the cumulative rainfall recorded during each event.



Figure 2-16. San Antonio Creek stream gage cross section: Upstream view (top photo) and downstream view (bottom photo).

Table 2-11
Rainfall summary.

Date	San Antonio Creek Cumulative Rainfall (inches)
3/21/09-3/22/09	0.41
4/7/09	0.11
4/9/09	0.08
4/11/09	—
4/14/09	0.01

Results of the first download period are provided in Appendix C-1. Of the recorded rainfall events, only the March 21-22, 2009 storm produced a stage response in the creeks. Stage in San Antonio Creek peaked approximately 0.30 feet above the base flow stage (as recorded just before the event.

MAPPING

San Antonio Creek was divided into three reaches based on alternating aggrading and transport reaches. Although the valley slope is approximately the same in all three reaches (1.1 percent on average, varying between 1.0 and 1.2 percent), there are defining features that occur at the reach breaks. A tributary enters San Antonio Creek at the break between Reaches 1 and 2, and evidence of a former debris jam was the basis for the break between Reaches 2 and 3 (see figures in Appendices C-2 and C-3).

Reach 1 begins at the downstream end of the project area and continues upstream approximately 2,100 feet to the confluence of an unnamed tributary entering from the south. This unnamed tributary is located east of the drainage with the stock pond on the south side of San Antonio Creek and near the western terminus of the project. Reach 1 is characterized by large depositional areas, some with regenerating sycamores, alternating with vertical eroding banks on the south side and steep sloughing bluffs on the north side. This reach is bordered by an alluvial stream terrace, which supports numerous valley oaks. Channel incision has disconnected much of the reach from inundating floodplain areas except in storm flows exceeding a 2-year recurrence interval. The grade in this reach is partially controlled by the presence of conglomerate bedrock at discrete locations in the channel.

Reach 2 begins at the upstream end of Reach 1 and extends approximately 4,300 feet upstream to a location that appears to have been previously obstructed by a large debris jam. Three pools are located in close proximity on the downstream side and a very large gravel bar is located on the upstream side of the upper reach break. Reach 2 is characterized as more of a transport reach. Although bedload deposition in the channel occurs throughout the reach, this reach lacks the wide and long bars present in both Reaches 1 and 3, indicating that, during discharge events, bedload is both eroded and replaced with the rising and receding hydrograph limbs. Smaller point bars and longitudinal bars alternate with vertical eroding banks on both the north and south sides of the channel. Like Reach 1, an alluvial stream terrace flanks Reach 2. The floodplain is limited in width along Reach 2, as the channel has incised. The vast extent of the floodplain areas generally inundate above a 2-year recurrence interval. Reach 2 also contains outcroppings of conglomerate and a low-water road crossing.

Reach 3 begins at the upstream end of Reach 2 and extends approximately 2,600 feet to the upstream end of the project area, which is at the second low-water road crossing. Reach 3 is characterized by an over-widened channel with wide and long depositional bars, occasional vertical eroded banks

(somewhat lower than those in the other reaches), multiple high flow channels, and a section of braided stream. In many areas the floodplain is just above the 2-year recurrence elevation as identified from the March 4, 2009 storm. A smaller unstable, largely unvegetated, floodplain has developed in areas where lateral channel migration and widening has occurred. Overgrazing has left these areas vulnerable to erosion and sudden shifts in morphology.

Since each reach contains two representative riffle cross-sections, which was done to better document reach variation, the reaches were divided into two sub-reaches: an upstream and a downstream sub-reach. There is no clear defining break between sub-reaches, and it can be assumed that each sub-reach is approximately one half of its parent reach. The pebble counts, Pfankuch stability ratings, and classifications described below are presented on a sub-reach basis. See Table 2-12 for a list of representative cross-sections by reach listed from downstream to upstream.

Table 2-12
San Antonio Creek: Summary of cross-section locations.

Reach	Sub-reach	Representative Cross Sections
1	Downstream	Riffle 1
		Pool 1
		Glide 1
	Upstream	Pool 2
		Run 1
		Riffle 2
2	Downstream	Riffle 3
		Pool 3
		Glide 2
	Upstream	Run 2
		Riffle 4
		Pool 4
3	Downstream	Riffle 5
		Pool 5
		Glide 3
	Upstream	Riffle 6
		Pool 6
		Run 3

Figures documenting the geomorphic bed features, secondary hydrogeomorphic features, reach breaks, and representative cross-section locations can be found in Appendices C-2 and C-3.

PEBBLE COUNTS

Active bed and riffle pebble counts were conducted at each representative riffle cross-section location. Reach pebble counts were conducted on a sub-reach basis, and bar samples were conducted on a reach basis. Figure 2-17 provides a summary comparison of the pebble data results for San Antonio Creek. Additional figures presenting the full gradation curves by reach and by count type can be found in Appendix C-4.

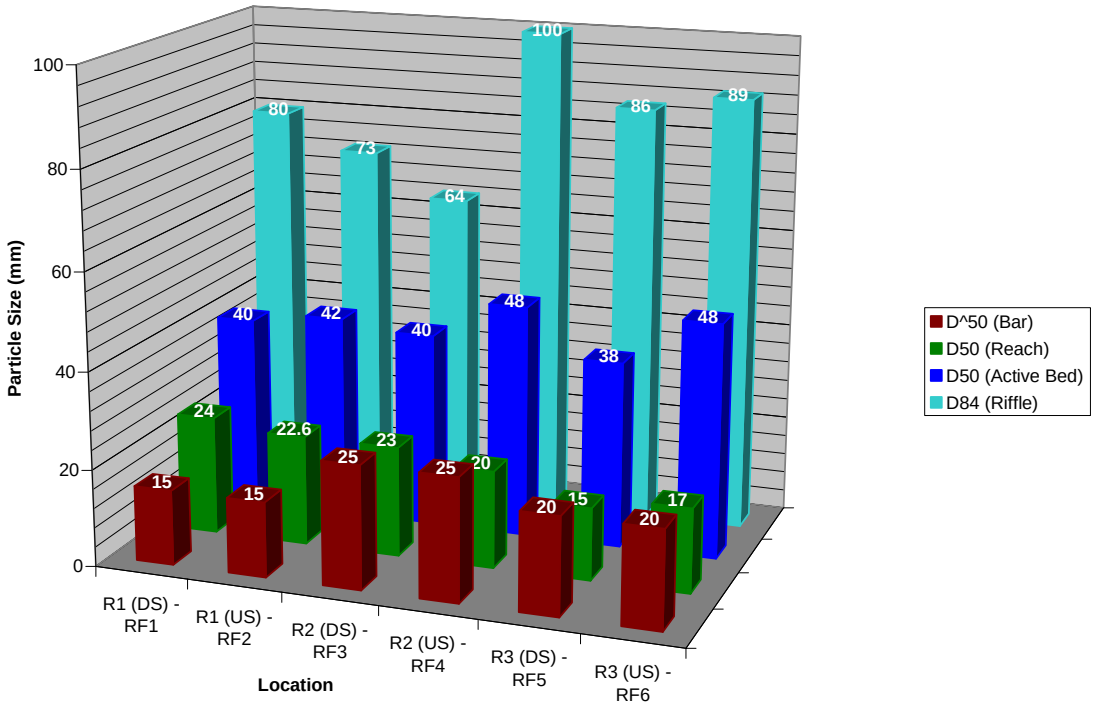


Figure 2-17. San Antonio Creek: D50 and D84 summary chart.

PFANKUCH STABILITY RATING & ROSGEN STREAM CLASSIFICATION

Pfankuch stream channel stability surveys, along with the classifications, were conducted on a sub-reach basis. The Pfankuch survey characterizes the overall stability of the channel by analyzing three zones: the upper banks, lower banks, and channel bottom. Physical characteristics within each zone (indicated below) are given a numeric score according to the presence and extent of certain features that relate to channel stability.

Upper Banks:

- Landform slope
- Mass erosion
- Vegetative bank protection

Lower Banks:

- Channel capacity
- Bank rock content
- Obstructions to flow
- Cutting
- Deposition

Channel Bottom:

- Rock angularity
- Brightness of bed material
- Consolidation of particles

- Bottom size distribution
- Scouring and deposition
- Aquatic vegetation

The score is weighted according to degree of influence each feature has on bank or channel stability. For example the presence and degree of channel and bank scouring in the channel bottom provides the strongest indicator for overall stability. Evidence of cutting and deposition are weighted most as an indication of stability in the lower banks area; mass erosion and vegetative bank protection are equally weighted the most for the upper bank region. Scores for each feature in the three survey regions are summed up to provide the numeric stability score between 38 (excellent) and 152 (poor).

Because not all streams are physically capable of having all the characteristics of producing the best score, Rosgen (1996) modified the ratings to correspond to ranges of values best represented by the particular stream type in which the survey is being conducted. The Rosgen stream classification scheme categorizes single and multiple threaded streams according to quantifiable morphologic features including entrenchment ratio (ratio of flood width to bankfull width), width to depth ratio (ratio of bankfull width to mean depth), sinuosity, bankfull slope, and channel material (bedrock, boulder, cobble, gravel, sand, silt/clay). Streams are classified according to letter (A, B, C, D, D_A, E, F, and G) defined by the above characteristics (except channel material) and number designations 1-6 (boulder – silt/clay, in respective order by size) representing the channel material.

The All sub-reaches where cross sections were surveyed were classified as B4c and C4 stream types with a future potential of a C4 type. A C4 stream type defined by Rosgen (1996) is a single-thread alluvial stream that is slightly entrenched (entrenchment ratio > 2.2), has a moderate to high width to depth ratio (width to depth ratio >12) and sinuosity (> 1.2), slope of 0.1 – 2.0 percent, and gravel sized (2 –64 mm) channel substrate. The geomorphology indicates that San Antonio Creek is in a transition from a C4 to a D4 (multiple channel, high width/depth ratio, low sinuosity) stream type. Portions of the existing channel that are bifurcated or braided would classify as a D4 stream type. This shift to a D-type stream is an indicator of instability as these streams are characteristic of high sediment load, bank erosion, and lack complex bed features (pools, riffles, runs, and glides).

The modified Pfankuch score brackets for a C4 stream are 70-90 for good, 91-110 for fair, and 111-152 for poor condition. The score brackets for a B4 stream are 40-64 for good, 65-84 for fair, and 85+ for poor condition. Stability ratings for all sub-reaches scored in the poor category for this stream type. The San Antonio sub-reaches scored between 111 and 132. Figure 2-18 summarizes the results of the Pfankuch assessment along with preliminary Rosgen stream classifications of the San Antonio Creek reaches. The rating worksheets for each reach can be found in Appendix C-5. The poor ratings are largely the result of mass erosion observed depositing sediment frequently during flows; significant and frequent vertical cut banks over 12-inches high along the lower banks; moderate to extensive deposition of fine particles accelerating bar development; and a large percentage (often greater than 50%) of the channel bottom affected by scour and deposition at obstructions, constrictions, and bends often causing pool filling. These observations are largely attributed to a lack of vegetation to hold banks together and high amounts of bedload and fine sediment entering the stream from within and upstream of the project area. Historic grazing and land management practices are the most likely cause of channel and bank instability.

Location	Rating Total	Existing Stream Type	Potential Stream Type	Rating
R1 RF1	125	C4	C4	Poor
R1 RF2	132	B4c	C4	Poor
R2 RF3	118	C4	C4	Poor
R2 RF4	119	C4	C4	Poor
R3 RF5	111	C4	C4	Poor
R3 RF6	119	C4	C4	Poor

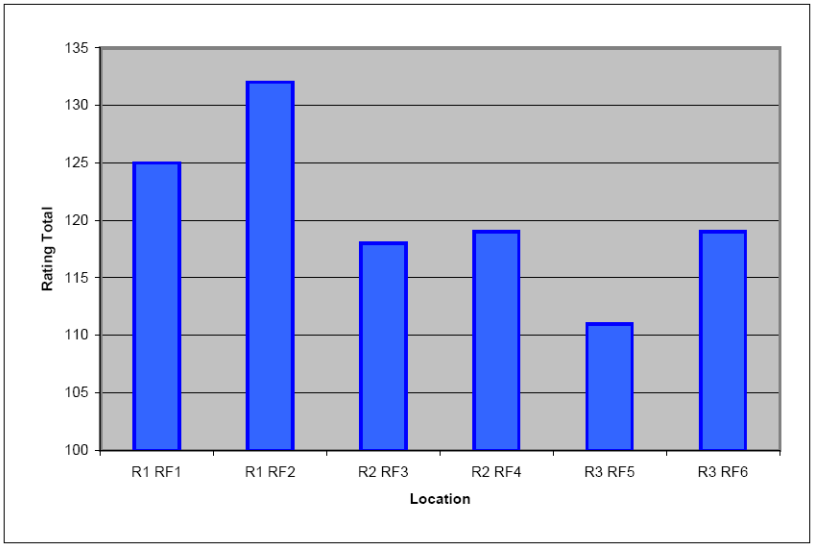


Figure 2-18. San Antonio Creek: Pfankuch stability ratings and classifications.

GAGE DATA ANALYSIS

Figure 2-19 shows the stage and discharge response of the Arroyo Hondo USGS gage for the March 4, 2009, storm. This figure shows that Alameda Creek experienced a similar response to the storm system and corroborates the assumption that the storm event is likely to have produced a similar response in San Antonio Creek as discussed in the methods section above.

Figure 2-20 shows the results of the log-Pearson type III distribution performed on the annual peak flow data for the USGS Arroyo Hondo gage. The peak of the March 4, 2009, storm is also plotted to show agreement with the distribution.

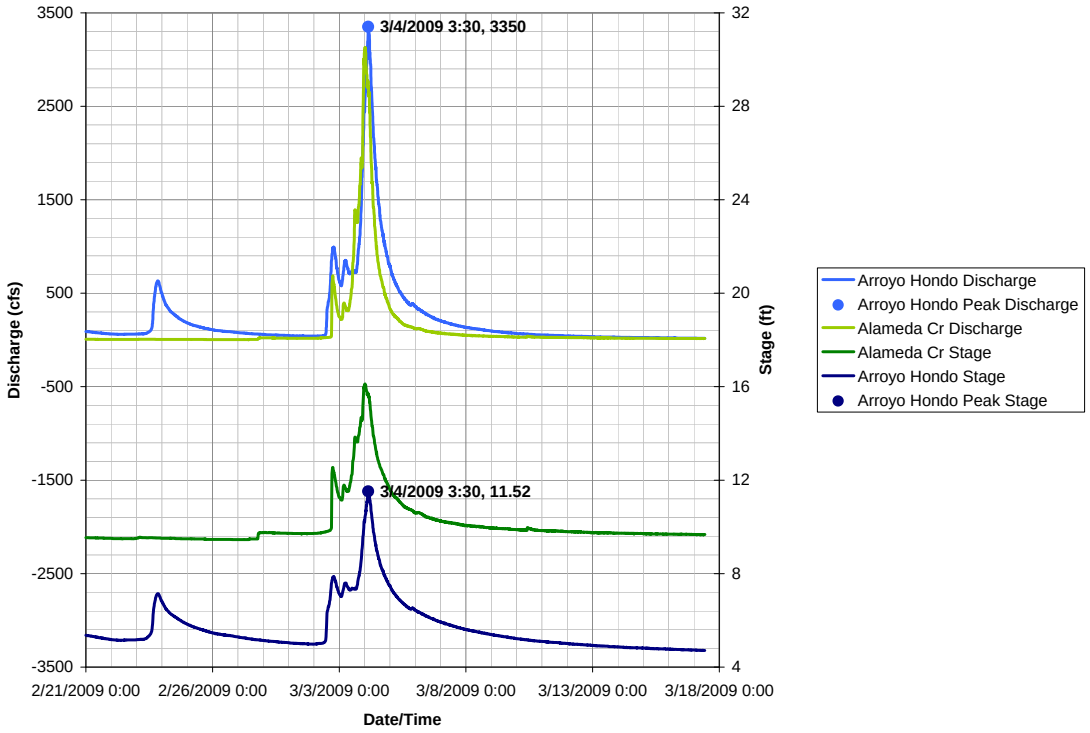


Figure 2-19. Stage and discharge at USGS Arroyo Hondo gages (February 21 to March 18, 2009).

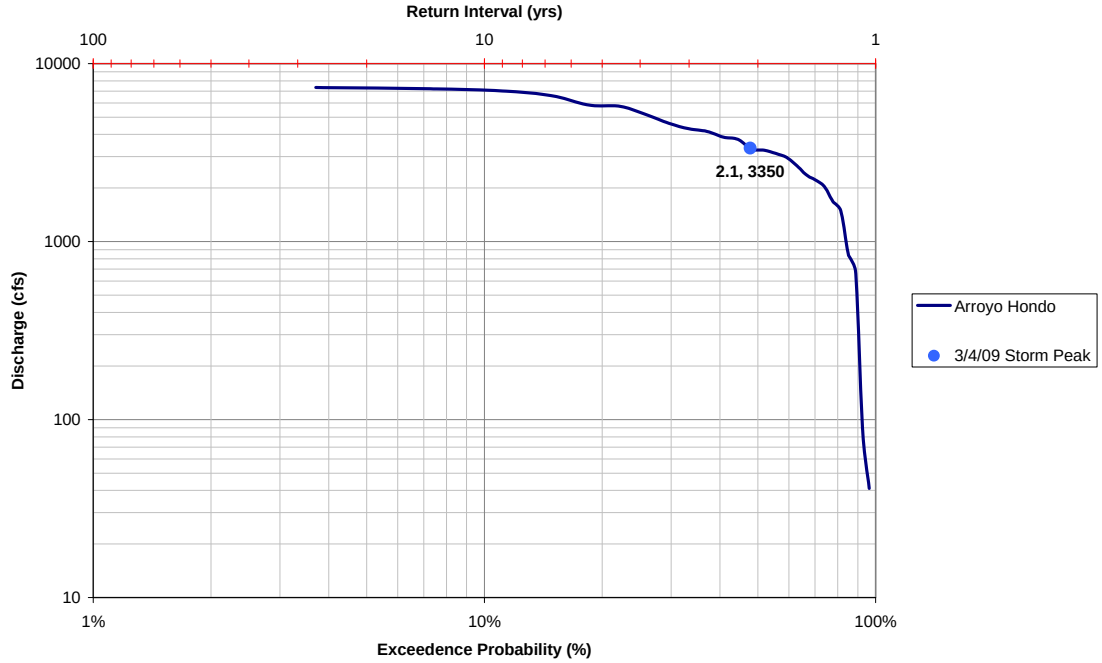


Figure 2-20. Log-Pearson type III distribution of Arroyo Hondo annual peak flows.

3 MITIGATION

The purpose of the mitigation is to compensate for impacts to federal and state listed species and jurisdictional waters from the CDRP and other WSIP projects. The project impacts and the proposed compensation are summarized in Table 3-1. The habitat acreage available for each species within the conservation easements of the HRP Mitigation Areas is quantified in Table 3-2 and mapped in Appendix D.

The primary mitigation elements proposed for each mitigation area are summarized below and are shown on Figures 3-1 through 3-6. These design elements, the ecological processes set in motion by these actions, and mitigation area management will provide valuable habitat for special status species during the various stages of their life cycles. The species habitat expectations are included for each mitigation area.

SAN ANTONIO MITIGATION AREA

San Antonio Mitigation Area, Figure 3-1, will provide upland and dispersal habitat for CTS and CRLF, as well as scrub/ shrub habitat and woodland or grassland adjacent to scrub/ shrub habitat for Alameda whipsnake. Project actions include:

San Antonio Creek

- Creek restoration including bank stabilization and channel rehabilitation (excavation, grading, and filling)
- Excess soil placed at former reservoir borrow site to enhance grasslands
- Bridge construction to reduce disturbance of stream channel at road crossing
- Fence to manage grazing along stream corridor
- Riparian planting
- Irrigation system installation to improve plant establishment

Oak Woodland/Savannah

- Tree and shrub planting
- Weed control
- Fence to manage grazing within tree establishment area
- Install temporary irrigation system to improve plant establishment

SAGE CANYON MITIGATION AREA

Sage Canyon Mitigation Area, Figure 3-2, will maintain and enhance upland and dispersal habitat for CTS, aquatic breeding and non-breeding, upland and dispersal habitat for CRLF, scrub/ shrub habitat and woodland or grassland adjacent to scrub/ shrub habitat for Alameda whipsnake, and host plant habitat for Callippe silverspot butterfly. Project actions include:

- Establish long-term protection for watershed lands to support USFWS Sunol-Cedar Mountain Recover Unit 7
- Invasive plant and wildlife species control (e.g., Cal-IPC identified weeds and feral pigs)
- Succession management, temporary fencing in select areas to allow scrub recovery
- Management of scrub areas to minimize potential for catastrophic wildfire and maintain a habitat mosaic suitable to support Alameda whipsnake

SOUTH CALAVERAS MITIGATION AREA

South Calaveras Mitigation Area, Figure 3-3, will provide aquatic breeding and non-breeding, dispersal and upland habitat for CTS and CRLF, scrub/ shrub habitat and woodland or grassland adjacent to scrub/ shrub habitat for Alameda whipsnake, and habitat for Callippe silverspot butterfly. Project actions include:

Goldfish Pond

- Excavate upland areas to expand existing pond and establish wetlands adjacent to Goldfish Pond
- Implement bullfrog and non-native fish control
- Install a pond outlet drain for water management
- Rebuild pond embankment and install a spillway to improve long-term protection of the pond habitat
- Install a drop structure and associated grade control structure in outlet channel to protect the toe of the dam from erosion
- Install grade control structures on inlet channel and drainage swales to reduce erosion of sediment into wetland and pond habitats
- Riparian, wetland, and native-grassland planting
- Construct fences to manage grazing for CRLF breeding habitat and enhancement of species composition in established wetlands.

North, South and Stock Ponds

- Grazing Management to improve long term management of Callippe silverspot host plant populations and vegetation cover for breeding CRLF and CTS.
- Implement intensive management of ponds to control bullfrog and non-native fish populations

GOAT ROCK MITIGATION AREA

Goat Rock Mitigation Area, Figure 3-4, will maintain and enhance existing stands of Diablan sage scrub and maintain a mosaic of oak woodlands and non-native grasslands adjacent to scrub habitats for the Alameda whipsnake. This mitigation area would contribute to one of the recovery goals of the USFWS recovery plan for chaparral species in the east Bay Area (USFWS 2002). This mitigation area will also protect and enhance populations of the host plant for the federally listed Callippe silverspot butterfly. Project actions include:

- Install water supply pump and pipe system (includes trenching and backfilling)
- Install water troughs and cattle attractant (mineral supplements).
- Construct fence to manage cattle grazing and optimize grazing management for serpentine grassland species.

SHEEP CAMP CREEK MITIGATION AREA

Sheep Camp Creek Mitigation Area, Figure 3-5, has existing aquatic breeding, non-breeding habitat, upland and dispersal habitat for both CTS and CRLF, as well as habitat for the Callippe silverspot butterfly. Aquatic breeding and non-breeding habitat will be improved through predator control, grading to increase water depth, fencing, and water management. Upland habitat will be improved through better grazing management that will target specific habitat functions for listed species. Project actions include:

- Establish long-term protection for a corridor that would link the Alameda whipsnake Pleasanton Ridge (Recovery Unit 7) and Sunol-Cedar Mountain area (Recovery Unit 5) as proposed by the USFWS (2002)
- Install grade control structures upstream of the plunge pools to prevent erosion and head cutting
- Build two off-channel pools identified as potential breeding sites for CRLF, contingent upon hydrology/hydraulic feasibility analysis results
- Stabilize/revegetate erosion gully (grading, excavation, fill, grade control structures)
- Establish and expand existing seasonal wetland vegetation
- Rebuild two eroded embankments
- Resize/Relocate and armor spillways
- Install pond outlet structures, bypass flow structures, and drain pipe
- Riparian planting
- Construct fence to manage cattle grazing in riparian areas
- Predator control in ponds to maintain aquatic habitats utilized by breeding CTS and CRLF

The basis of design includes observations, data analysis, and/or ecological principles and comprises the rationale for expecting to achieve success. The basis of design is the rationale for expecting that the proposed compensation and its commensurate credits are achieved. The 30% Design Plan Drawings and Design Memo for San Antonio, Goat Rock and Goldfish Pond are included in Appendices E, F, and G. Conceptual design for Sheep Camp Creek is shown in Figures 3-6a to g. This section also describes the conceptual plans for grazing and other management tools that would be implemented at the mitigation areas to enhance existing habitats.

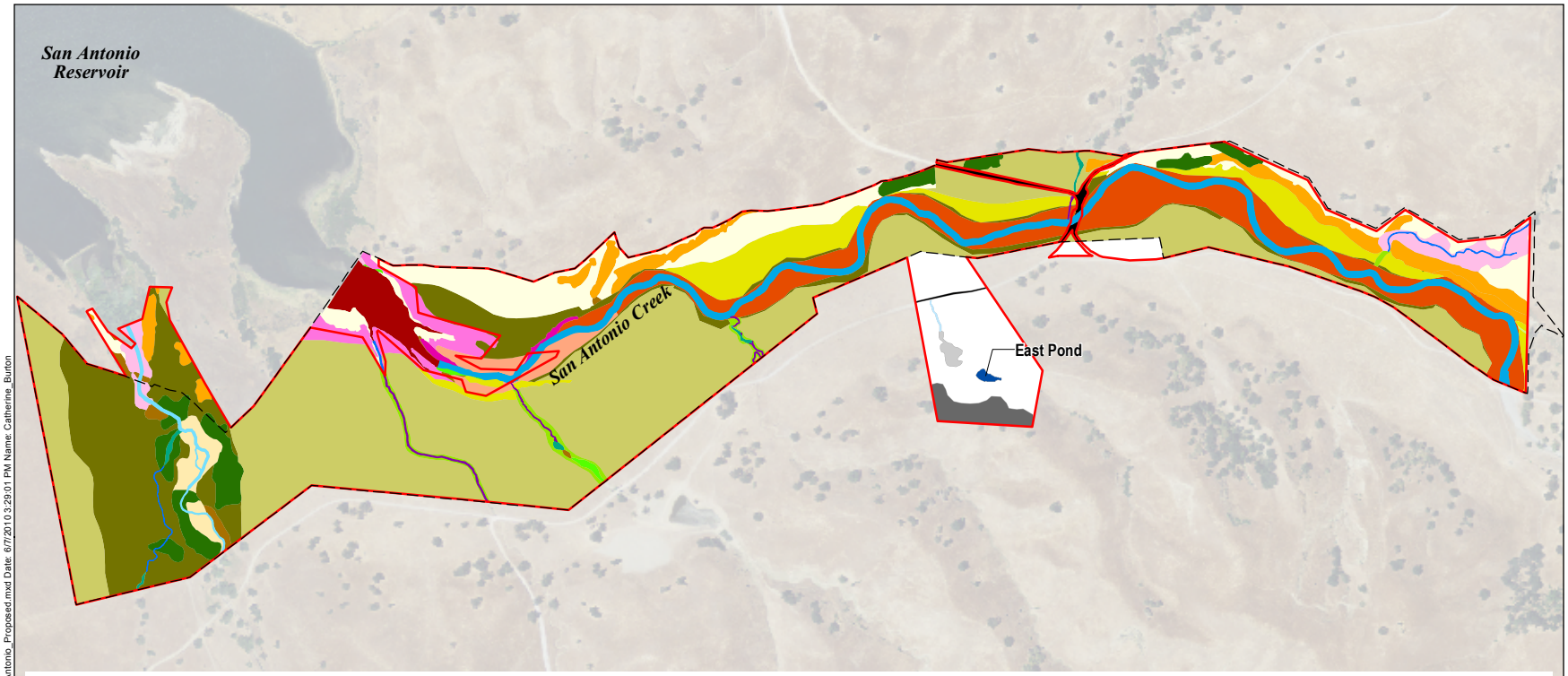
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Table 3-1
WSIP project mitigation requirements and proposed HRP habitat goals.

Habitat Type	Compensation Type	Acres/Linear Feet (LF)	Total Acres/LF Available	Goat Rock									Sage Canyon		Sheep Camp Creek		San Antonio					South Calaveras (includes Goldfish Pond)						
				Habitat Available	Calaveras Dam Replacement	Bay Division Pipeline 5	New Irvington Tunnel	San Antonio Backup Pipeline	San Antonio Reservoir Hypolimnetic Oxygenation System	Alameda Siphons	Sunol Valley Water Treatment Plant	Unassigned	Habitat Available	Calaveras Dam Replacement	Habitat Available	Calaveras Dam Replacement	Habitat Available	Bay Division Pipeline 3 & 4	Calaveras Dam Replacement	San Antonio Backup Pipeline	Unassigned	Habitat Available	Calaveras Dam Replacement	Alameda Siphons	Sunol Valley Water Treatment Plant	Bay Division Pipeline 5 (Goldfish)	Future Watershed Improvement project*	Unassigned
Ephemeral Stream	Enhance	Acres	**4.74**	**0.05**	0.04							0.01	**2.84**	2.84	**1.22**	1.22	**0.20**		0.20			**0.43**	0.33					0.10
		LF	**70700**	**930**	744							186	**46210**	46210	**7277**	7277	**2557**		2557			**13726**	10534					3192
	Preserve	Acres	**0.03**														**0.03**		0.03									
		LF	**227**														**227**		227									
Intermittent Stream	Enhance	Acres	**1.58**	**0.14**	0.13							0.01			**0.61**	0.61	**0.73**		0.63		0.10	**0.10**	0.10					
		LF	**7660**	**1883**	1745							138			**2570**	2570	**2628**		2269		359	**578**	578					
	Rehab	Acres	**8.00**														**8.00**		8.00		0.00							
		LF	**17026**														**17026**		17026									
Potential Stream**	Enhance	Acres	**0.08**	**0.08**								0.08																
		LF	**4860**	**4860**								4860																
Open Water	Enhance	Acres	**5.27**	**0.17**								0.17	**0.31**	0.31	**1.14**	1.14	**0.17**		0.17			**3.48**	3.48					
Wetland Tributary	Enhance	Acres	**2.76**	**0.43**		0.25						0.18			**2.33**	2.33												
		LF	**9395**	**4799**		2817						1983			**4595**	4595												
	Est/Reest	Acres	**1.82**												**1.82**	1.82												
		LF	**4011**												**4011**	4011												
Seasonal Wetland	Enhance	Acres	**1.70**	**0.03**								0.03	**0.18**	0.18	**0.51**	0.51	**0.50**			0.50		**0.48**	0.48					
		LF	**711**														**711**			711								
	Est/Reest	Acres	**4.06**														**0.40**			0.40		**3.66**	2.66	0.30		0.70		
		LF	**1027**														**1027**			1027								
Perennial Wetland	Enhance	Acres	**0.23**	**0.23**								0.23																
	Est/Reest	Acres	**0.46**																			**0.46**	0.46					
Seep Wetland	Enhance	Acres	**0.47**	**0.27**								0.27	**0.20**	0.20														
		LF	**81**										**81**	81														
Riparian Scrub	Enhance	Acres	**1.03**														**1.03**		1.03									
Mixed Riparian Woodland	Enhance	Acres	**8.10**										**3.73**	3.73			**4.37**		4.37									
		LF	**11375**										**6348**	6348			**5027**		5027									
	Preserve	Acres	**0.40**														**0.40**		0.40									
		LF	**364**														**364**		364									
Willow Riparian	Established	Acres	**3.01**												**0.87**	0.87	**1.25**	1.25				**0.89**	0.13				0.76	
		LF	**7432**												**2668**	2668	**3382**	3382				**1382**	202				1180	
	Enhance	Acres	**0.43**												**0.05**	0.05	**0.21**			0.21		**0.17**	0.13		0.04			
		LF	**1276**												**446**	446	**312**			312		**518**	396		122			
	Preserve	Acres	**0.27**														**0.27**		0.27									
		LF	**574**														**574**		574									
Oak Riparian	Enhance	Acres	**51.20**																			**51.20**	51.20					
		LF	**17004**																			**17004**	17004					
	Est/Reest	Acres	**4.55**												**2.31**	2.31	**2.23**			2.23								
		LF	**9371**												**3582**	3582	**5789**			5789								
	Rehab	Acres	**0.02**														**0.02**		0.02									
		LF	**99**														**99**		99									
Sycamore Riparian	Enhance	Acres	**2.66**														**2.66**		1.68	0.51	0.47							
		LF	**2352**														**2352**		1487	450	415							
	Est/Reest	Acres	**3.63**												**1.63**	1.63	**2.00**			2.00								
		LF	**5850**												**3704**	3704	**2146**			2146								
	Rehab	Acres	**23.70**												**0.84**	0.84	**22.87**		22.87									
		LF	**17786**												**1784**	1784	**16002**		16002									
Oak Woodland	Enhance	Acres	**262.01**	**37.69**			9.02				4.63	24.04	**107.78**	107.78	**84.90**	84.90	**7.88**			7.88		**23.76**	23.76					
	Est/Reest	Acres	**38.41**												**5.69**	5.69	**32.72**		28.00	4.72								
	Preserve	Acres	**2.36**														**2.36**		2.36									
	Rehab	Acres	**14.49**														**14.49**			14.49								
Oak Savannah	Enhance	Acres	**48.92**										**34.31**	34.31								**14.61**	14.61					
	Est/Reest	Acres	**96.27**														**96.27**		83.50	12.77								
Non-native Grassland	Enhance	Acres	**1043.39**	**167.07**			143.00		0.10	1.60	22.37		**299.12**	299.12	**335.70**	335.70	**17.67**		17.67			**223.83**	223.83					
	Preserve	Acres	**15.30**														**15.30**			15.30								
	Est/Reest	Acres	**0.00**																									
Serpentine Grassland	Enhance	Acres	**52.89**	**52.89**	35.00	4.00		3.18			10.71																	
Native Grassland	Est/Reest	Acres	**3.94**																			**3.94**	3.94					
Upland Scrub	Enhance	Acres	**121.88**	**6.46**			6.46						**95.40**	95.40			**9.58**		9.58			**10.44**	10.44					
Rock Outcrop	Preserve	Acres	**4.56**										**4.56**	4.56														

NOTES:
*Unassigned willow riparian will most likely be used to mitigate for impacts from the Upper Alameda Creek Filter Gallery Project
**Potential streams were designated in wetland delineation (May & Associates, Inc., 2009)

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Mitigation Area
- Management Area
- Conservation Easement

Proposed Habitats
- Developed
- Ephemeral Stream Enhance
- Ephemeral Stream Preserve
- Intermittent Stream Enhance
- Intermittent Stream Rehabilitate
- Mixed Riparian Woodland Enhance
- Mixed Riparian Woodland Preserve
- Non-native Grassland Enhance
- Non-native Grassland Preserve
- Oak Riparian Establish/Reestablish
- Oak Riparian Rehabilitate
- Oak Savannah Establish/Reestablish
- Oak Woodland Enhance
- Oak Woodland Establish/Reestablish
- Oak Woodland Preserve
- Oak Woodland Rehabilitate
- Open Water Enhance
- Open Water Preserve
- Riparian Scrub Enhance
- Seasonal Wetland Enhance
- Seasonal Wetland Establish/Reestablish
- Sycamore Riparian Enhance
- Sycamore Riparian Establish/Reestablish
- Sycamore Riparian Rehabilitate
- Upland Scrub Enhance
- Willow Riparian Enhance
- Willow Riparian Establish/Reestablish
- Willow Riparian Rehabilitate

N

0 500 1,000 2,000
FEET

Note: SFPUC is not seeking mitigation credit nor are there designated success criteria for any proposed habitats located outside conservation easements.

Imagery source:
NAIP 2009

Coordinate system:
California State Plane Zone III NAD83

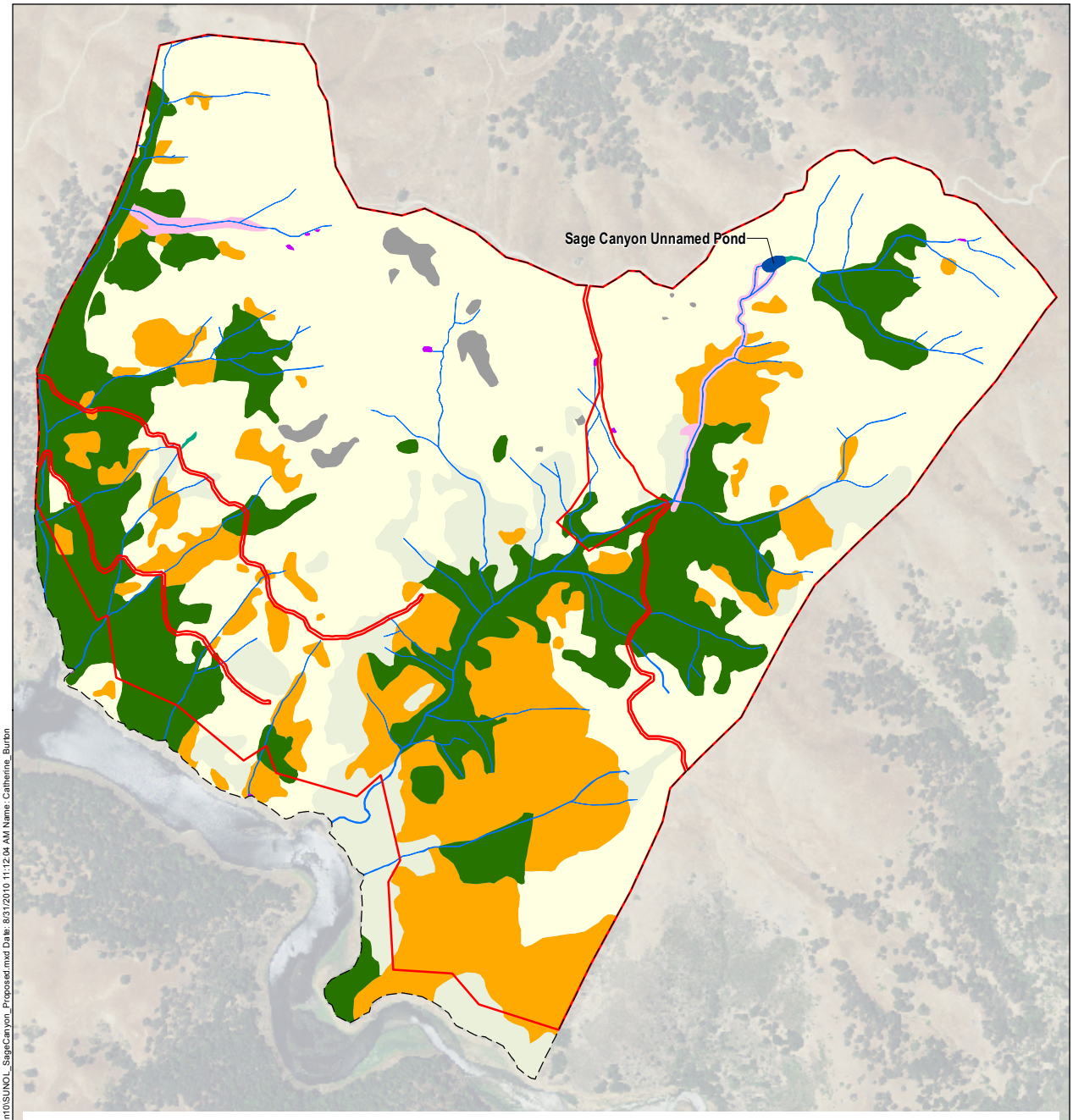
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Figure 3-1
San Antonio Mitigation Area: Proposed habitat

Back of Figure 3-1



Mitigation Area

- Management Area
- Conservation Easement

Proposed Habitats

- Ephemeral Stream Enhance
- Mixed Riparian Woodland Enhance
- Non-native Grassland Enhance
- Oak Savannah Enhance
- Oak Woodland Enhance
- Open Water Enhance
- Rock Outcrop Preserve
- Seasonal Wetland Enhance
- Seep Wetland Enhance
- Upland Scrub Enhance

N

0 500 1,000 2,000

FEET

Note: SFPUC is not seeking mitigation credit nor are there designated success criteria for any proposed habitats located outside conservation easements.

Imagery source:
NAIP 2009

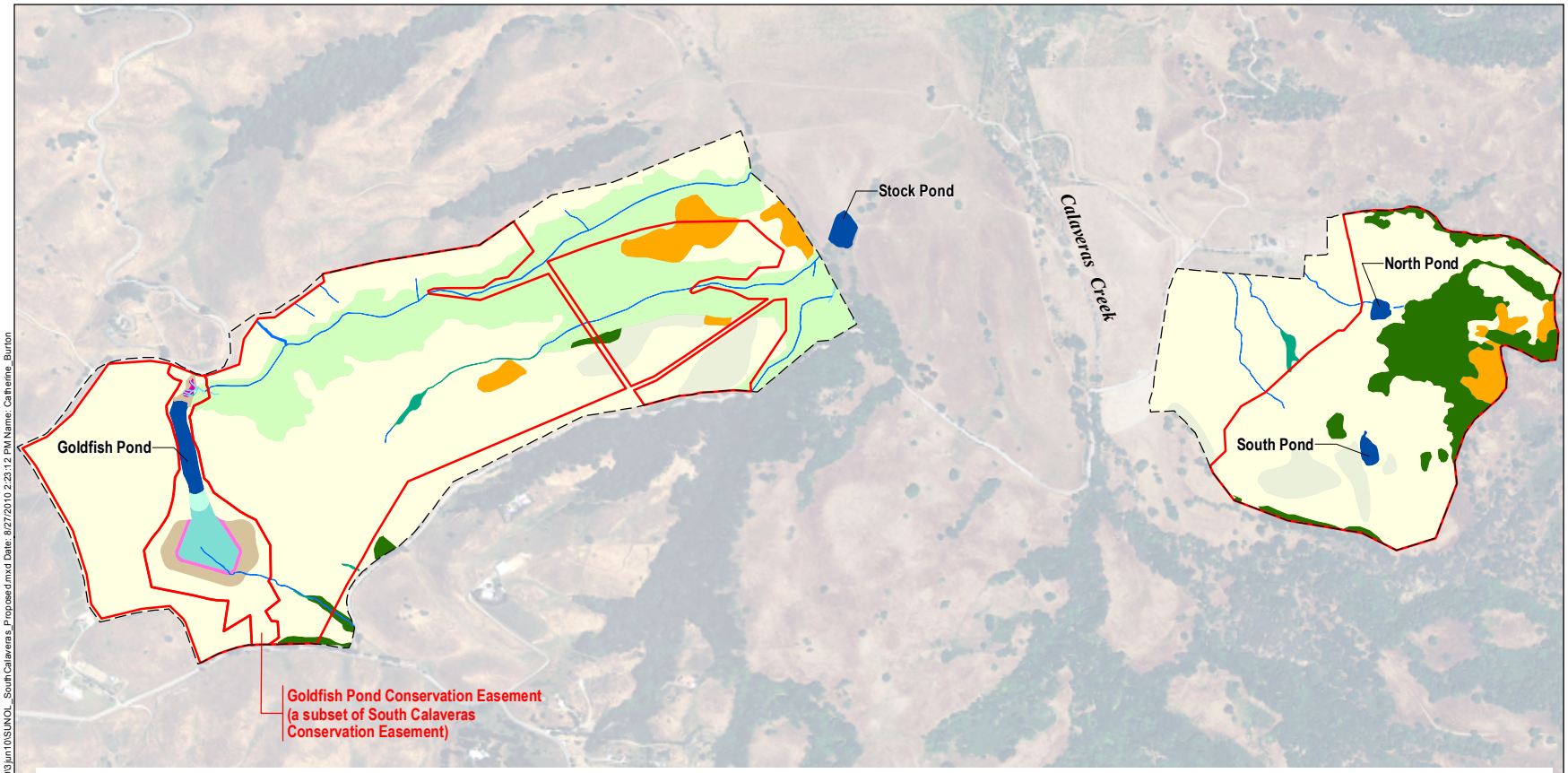
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Figure 3-2
Sage Canyon Mitigation Area: Proposed habitat

Back of Figure 3-2



Mitigation Area
- Management Area
- Conservation Easement

Proposed Habitats
- Developed
- Ephemeral Stream Enhance
- Intermittent Stream Enhance
- Native Grassland Establish/Reestablish
- Non-native Grassland Enhance
- Oak Riparian Enhance
- Oak Savannah Enhance
- Oak Woodland Enhance
- Open Water Enhance
- Perennial Wetland Establish/Reestablish
- Seasonal Wetland Enhance
- Seasonal Wetland Establish/Reestablish
- Upland Scrub Enhance
- Willow Riparian Establish/Reestablish
- Willow Riparian Rehabilitate

N

0 500 1,000 2,000
FEET

Note: SFPUC is not seeking mitigation credit nor are there designated success criteria for any proposed habitats located outside conservation easements.

Imagery source:
NAIP 2009

Coordinate system:
California State Plane Zone III NAD83

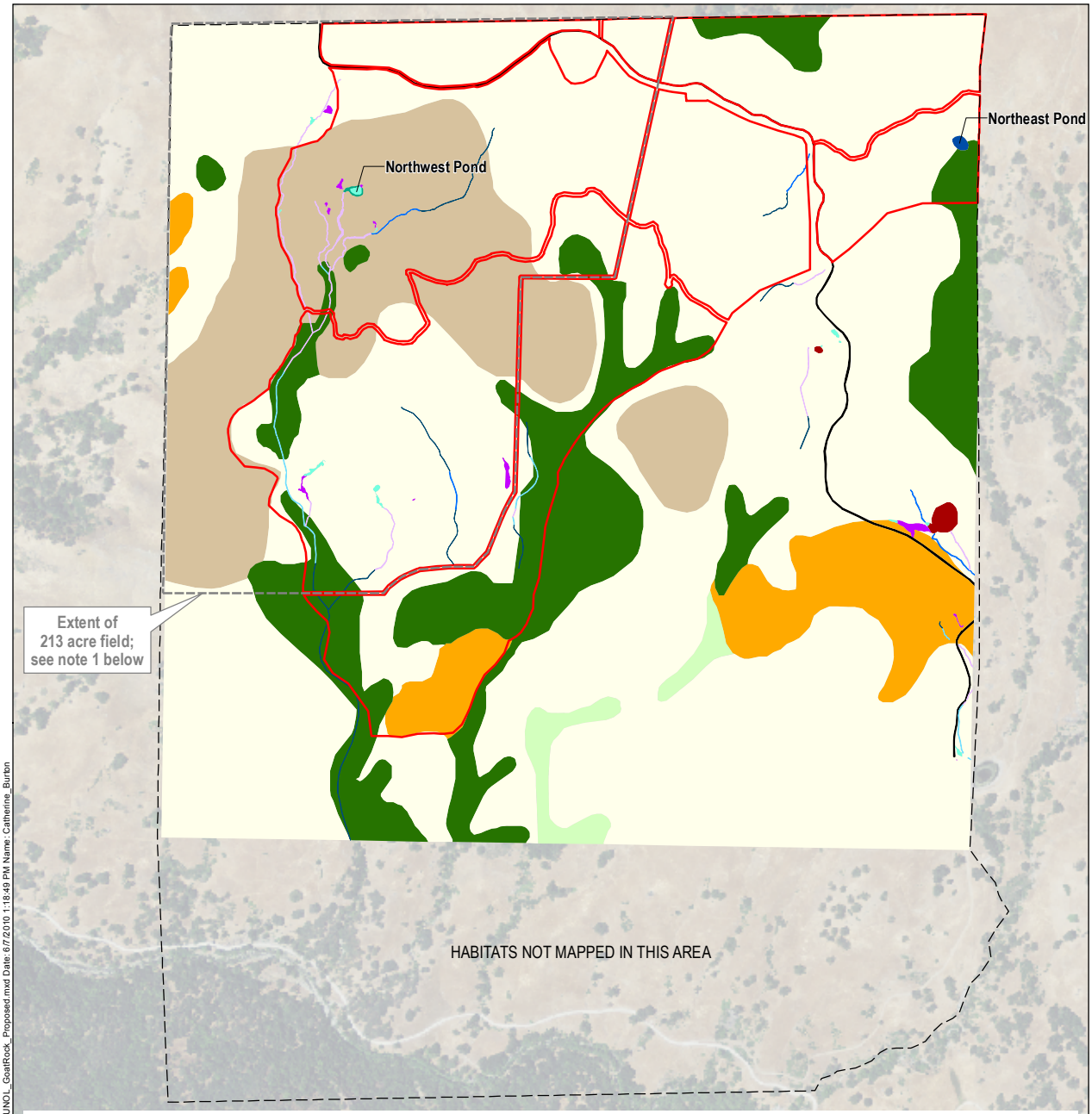
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Figure 3-3
South Calaveras Mitigation Area: Proposed habitat

Back of Figure 3-3



Mitigation Area
- Management Area
- Conservation Easement

Proposed Habitats
- Developed
- Ephemeral Stream Enhance
- Intermittent Stream Enhance
- Non-native Grassland Enhance
- Oak Riparian Enhance
- Oak Woodland Enhance
- Open Water Enhance
- Open Water Preserve
- Perennial Wetland Enhance
- Potential Stream (not delineated)
- Seasonal Wetland Enhance
- Seep Wetland Enhance
- Serpentine Grassland Enhance
- Upland Scrub Enhance
- Wetland Tributary Enhance

N

0 250 500 1,000
FEET

Notes:
1. Grasslands within the 213 acre field at Goat Rock will be grazed (timing, duration, and stocking rates) specifically to enhance serpentine endemic plants. Grasslands outside of the enclosure and within the conservation easement boundary will continue to be grazed year-round, until recommendations can be made on potentially preferable grazing strategies, based on the results of monitoring the 213 acre field.

2. SFPUC is not seeking mitigation credit nor are there designated success criteria for any proposed habitats located outside conservation easements.

Imagery source: NAIP 2009

Coordinate system: California State Plane Zone III NAD83

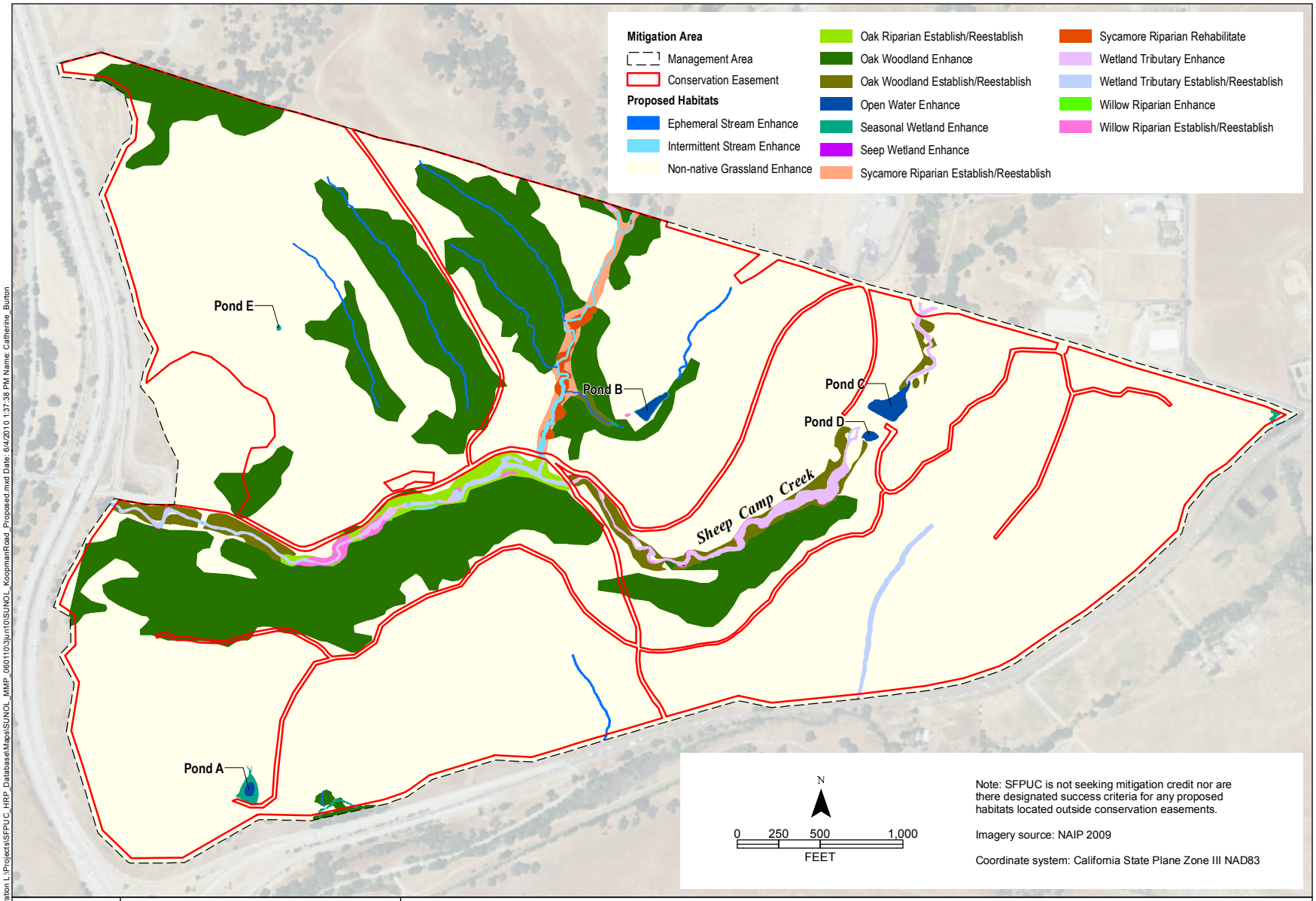
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Figure 3-4
Goat Rock Mitigation Area: Proposed habitat

Back of Figure 3-4



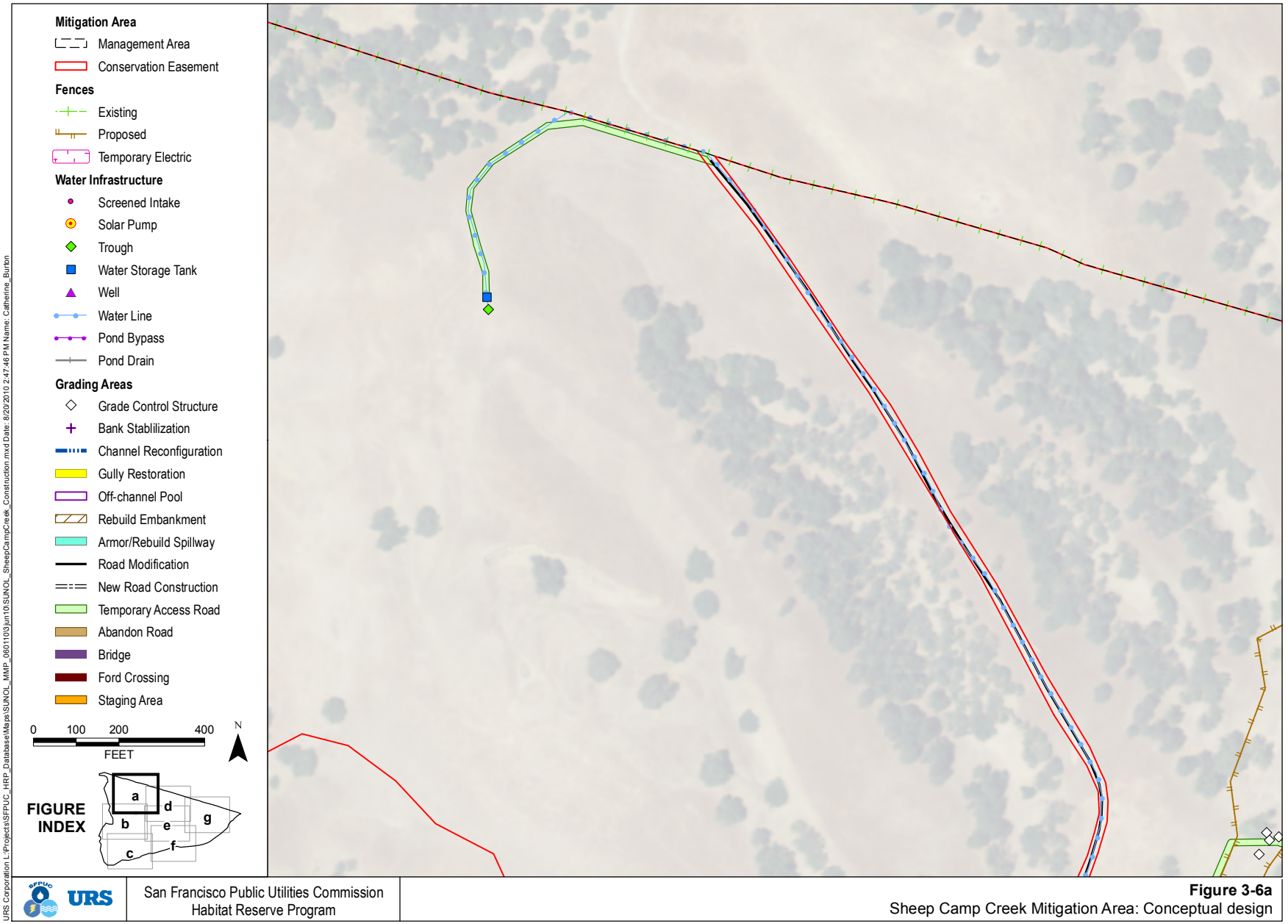
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Figure 3-5
Sheep Camp Creek Mitigation Area: Proposed habitat

Back of Figure 3-5

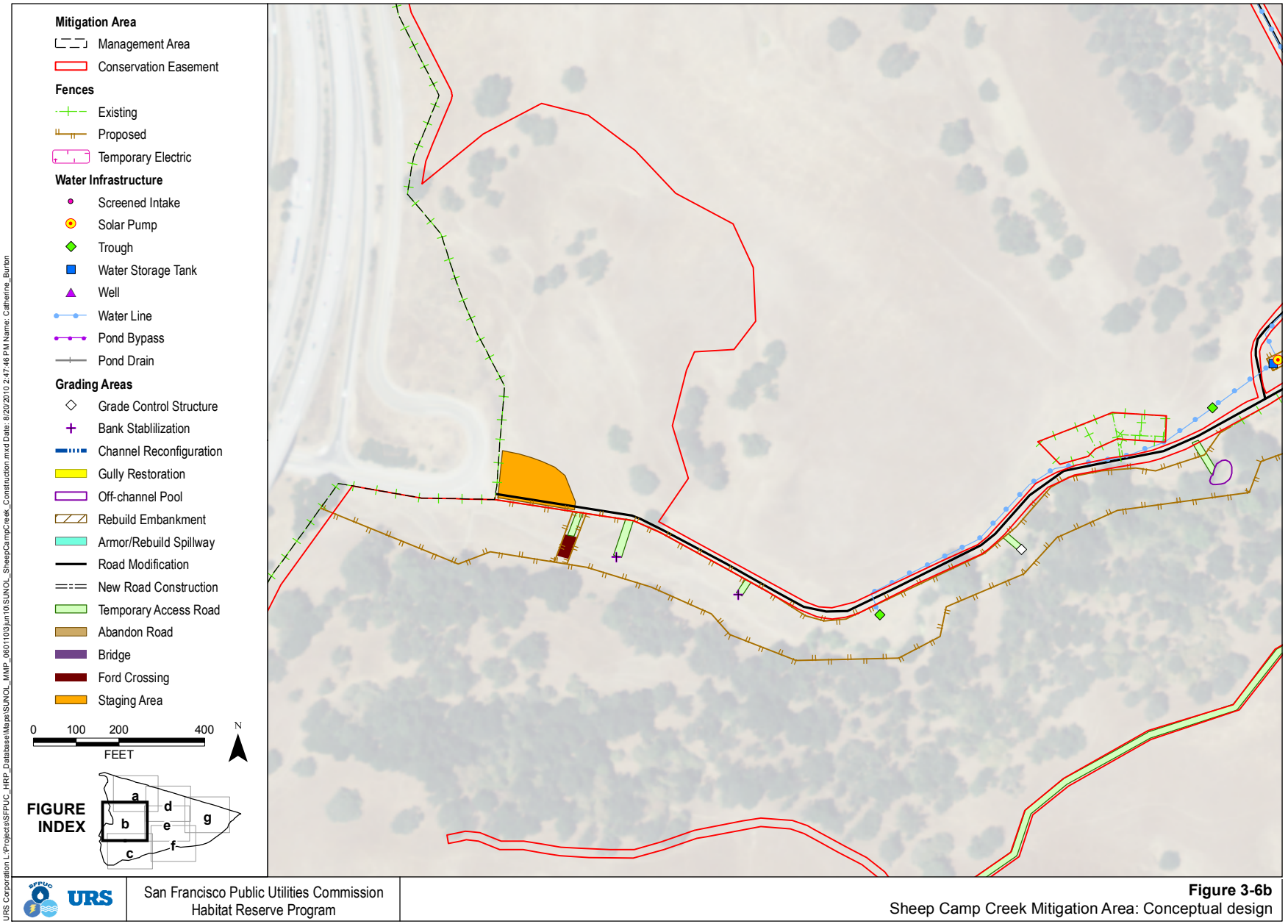


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Figure 3-6a
Sheep Camp Creek Mitigation Area: Conceptual design

Back of Figure 3-6a

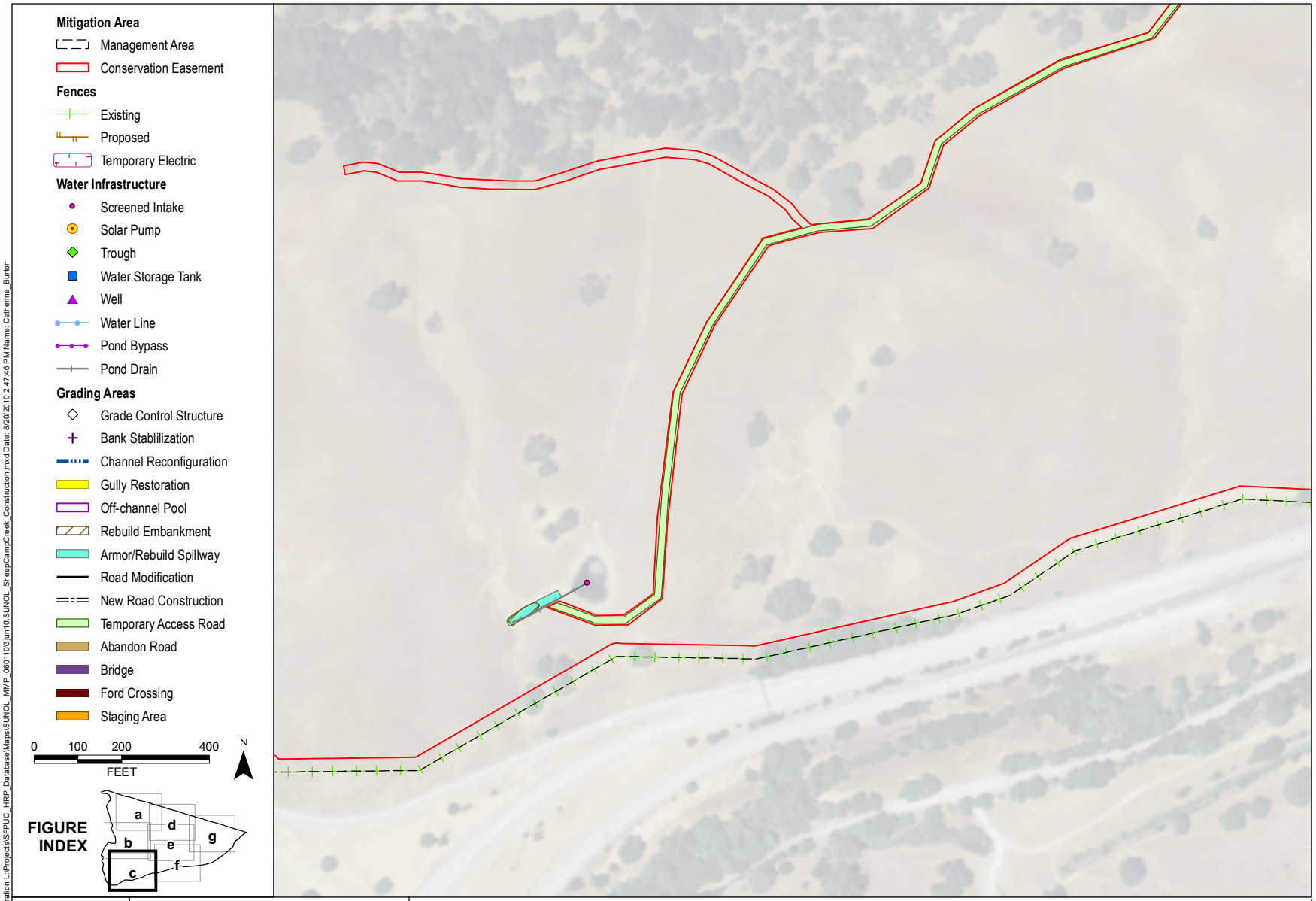


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Figure 3-6b
Sheep Camp Creek Mitigation Area: Conceptual design

Back of Figure 3-6b

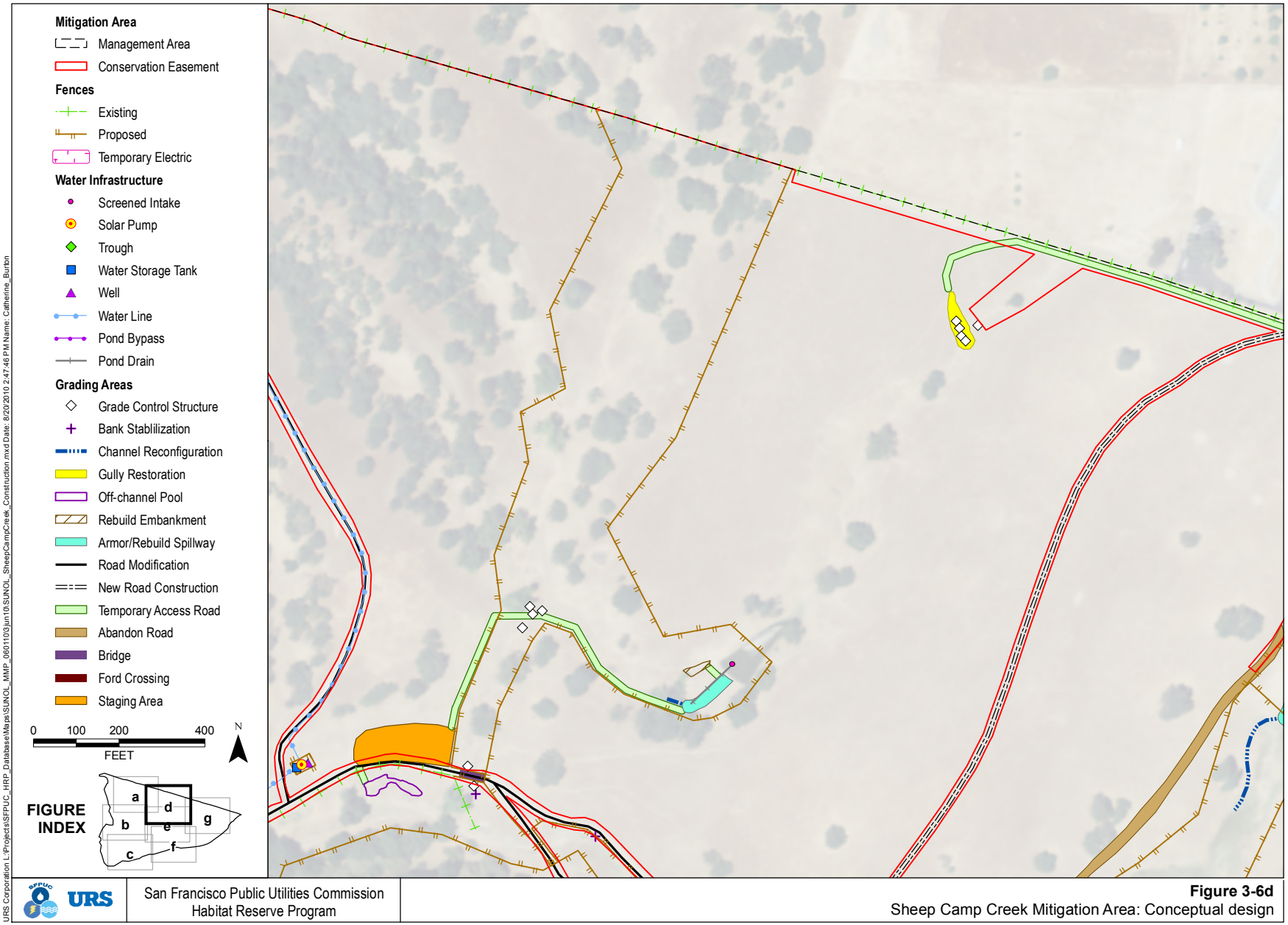


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Figure 3-6c
Sheep Camp Creek Mitigation Area: Conceptual design

Back of Figure 3-6c

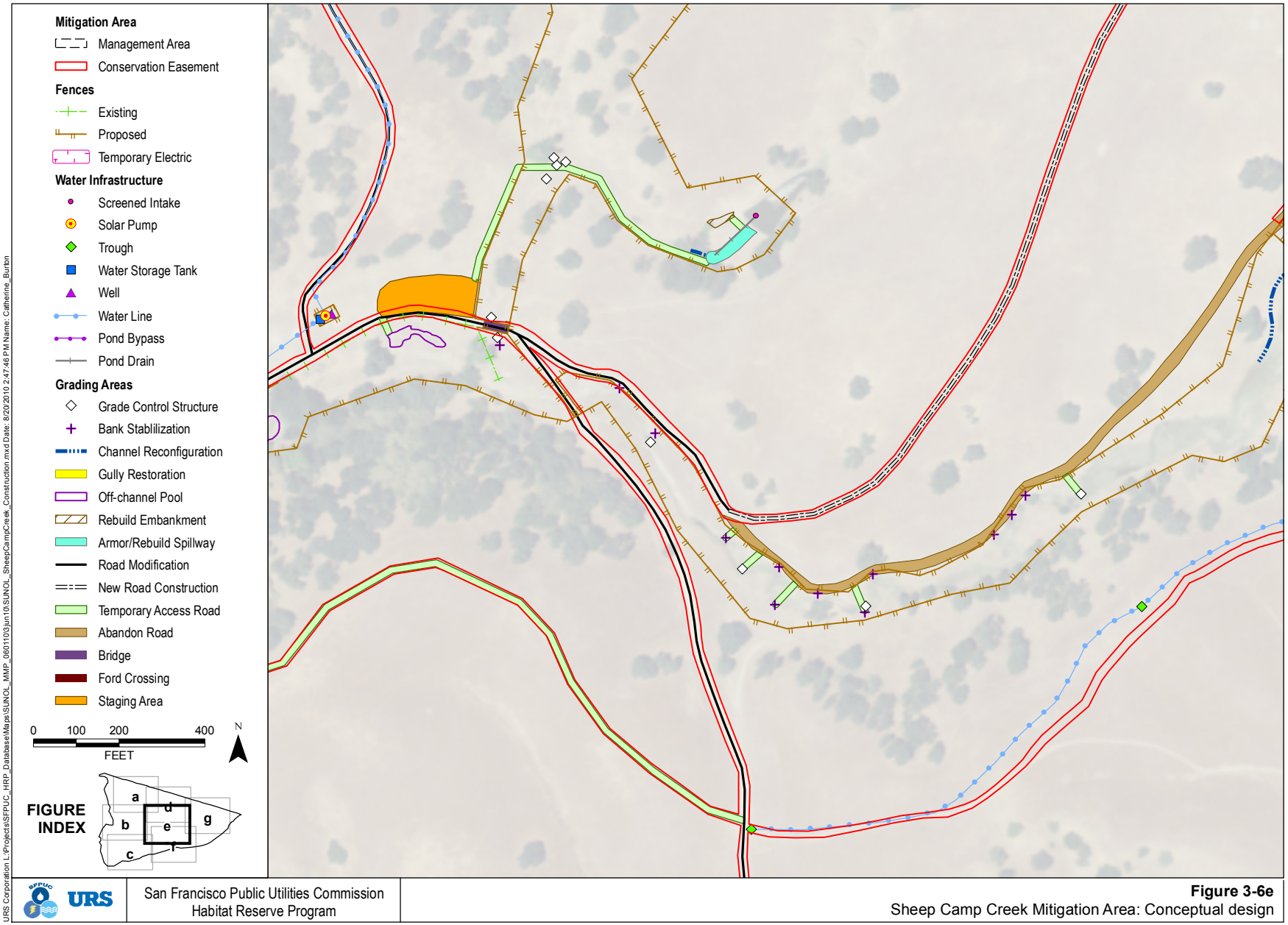


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Figure 3-6d
Sheep Camp Creek Mitigation Area: Conceptual design

Back of Figure 3-6d

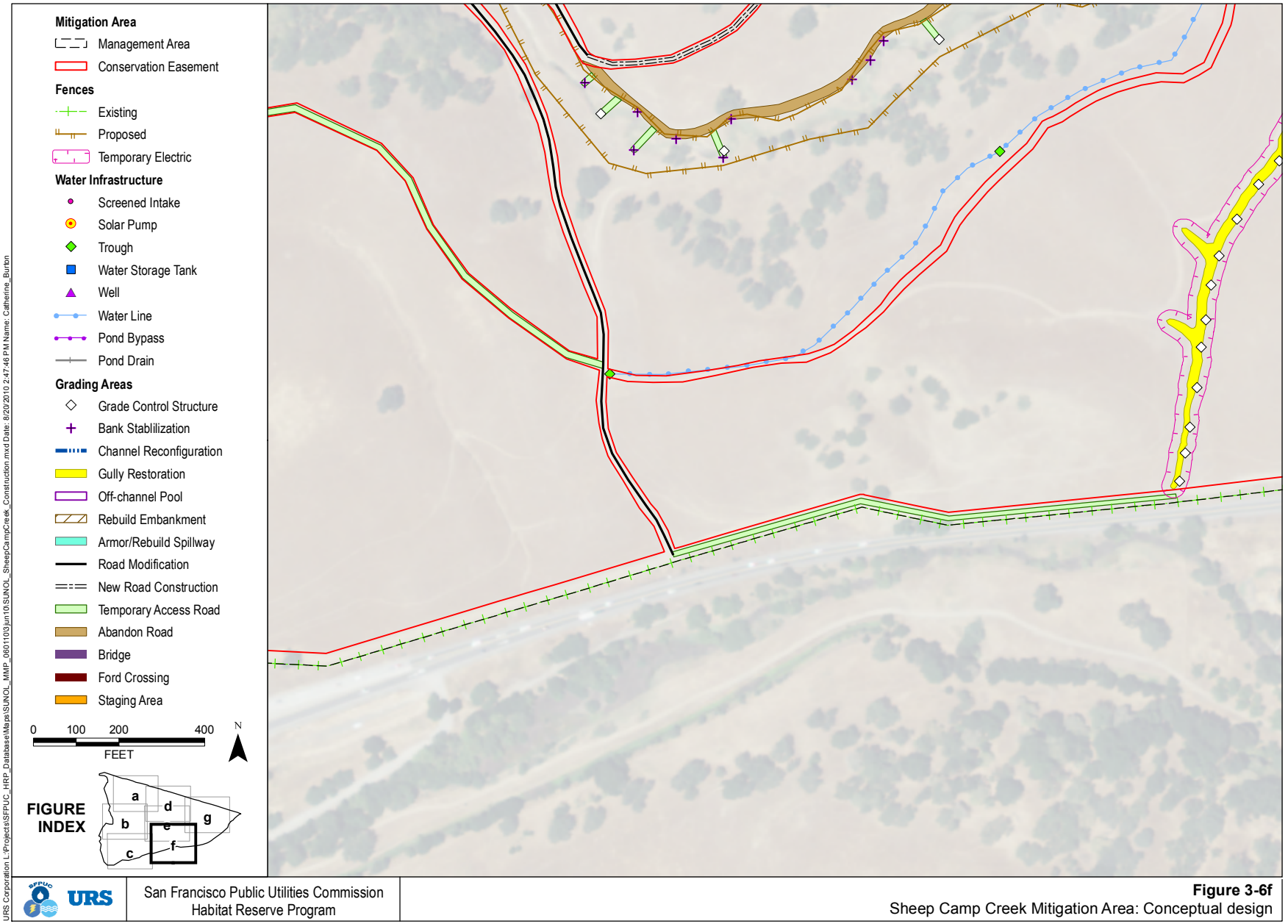


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Figure 3-6e
Sheep Camp Creek Mitigation Area: Conceptual design

Back of Figure 3-6e

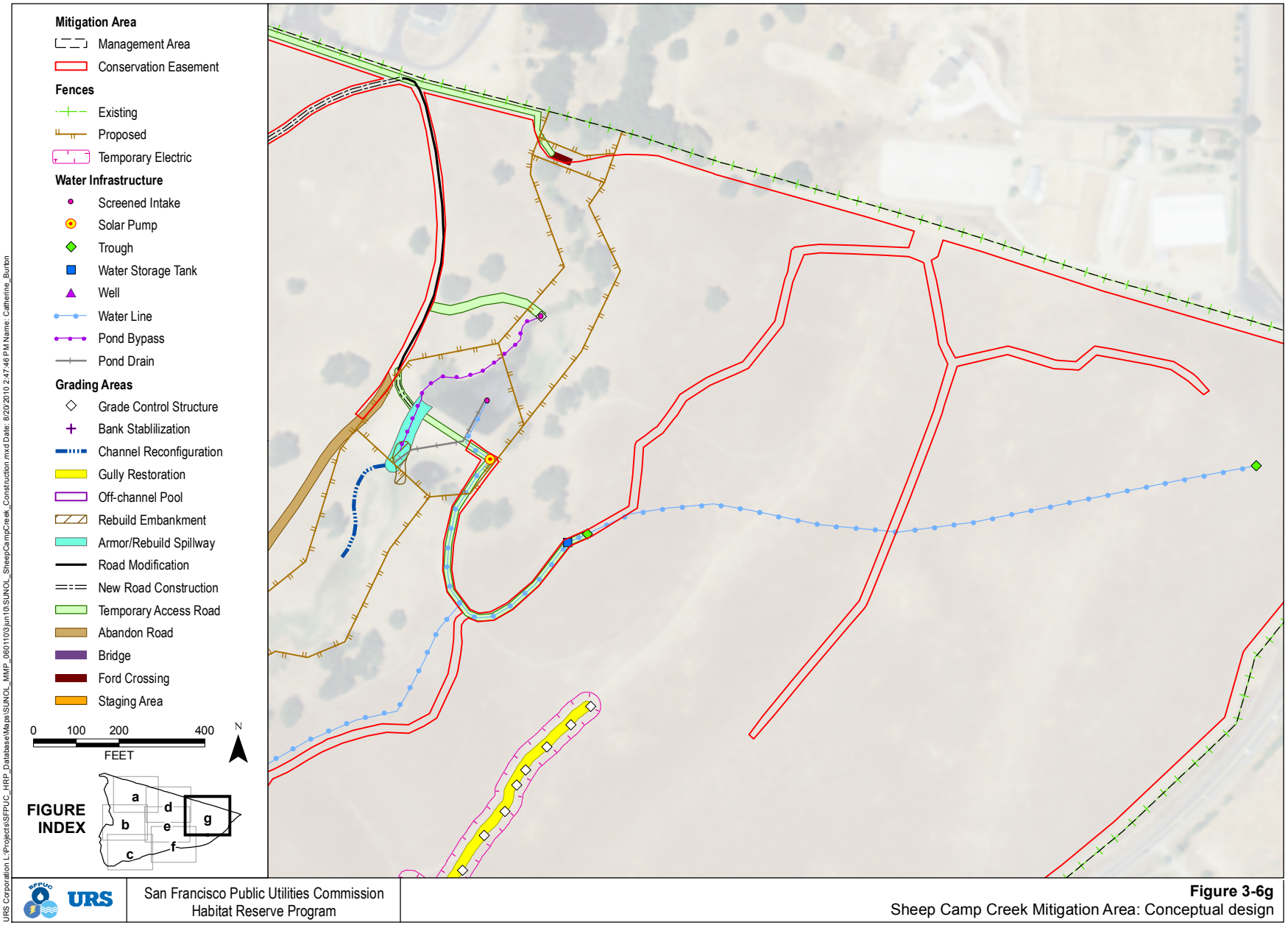


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Figure 3-6f
Sheep Camp Creek Mitigation Area: Conceptual design

Back of Figure 3-6f



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Habitat Reserve Program

Figure 3-6g
Sheep Camp Creek Mitigation Area: Conceptual design

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Table 3-2
Compensation available within conservation easement boundaries of the HRP mitigation areas (in acres) for California tiger salamander, California red-legged frog, Alameda whipsnake, and Callippe silverspot butterfly.

Mitigation Area	California Tiger Salamander		California Red-legged Frog			Alameda Whipsnake		Callippe Silverspot Butterfly
	Aquatic Breeding	Upland Dispersal	Aquatic Breeding	Aquatic Non-Breeding	Upland Dispersal	Core	Upland/ Dispersal	Host Plant (*Viola p.*)
Goat Rock	0.25	265.15	0.17	1.22	263.86	23.31	240.72	12.32
Sage Canyon	0.31	457.70	0.31	3.22	544.91	510.01	38.25	37.99
San Antonio	0.17	231.84	0.17	9.85	232.88	157.16	83.84	0
South Calaveras	4.05	333.24	3.48	5.05	328.69	97.59	231.31	3.86
Sheep Camp Creek	1.14	438.31	1.14	6.49	432.00	0	0	8.41

3.1 SAN ANTONIO AND SHEEP CAMP CREEKS

Proposed habitat improvements at the San Antonio Creek and Sheep Camp Creek mitigation areas will provide compensation for impacts to intermittent channel, ephemeral channel, and riparian habitats (particularly sycamore riparian). This section describes the mitigation design for stream restoration and rehabilitation of riparian vegetation, in-channel wetlands and upland vegetation associated with San Antonio Creek and Sheep Camp Creek.

The San Antonio and Sheep Camp Creek stream corridors include hydrogeomorphic and vegetative components, as described in Chapter 2, above. Successful establishment and sustained regeneration of riparian habitats is highly dependent upon a properly functioning riparian corridor. The proposed actions would reestablish the stream and riparian functions to improve the habitat potential of the sites. At San Antonio Creek this means the reconfiguration of the channel to a more appropriate channel dimension so that riparian vegetation would have access to a floodplain, reestablishment of riparian vegetation, and cattle exclusion. At Sheep Camp Creek the exclusion of cattle and reestablishment or rehabilitation of riparian vegetation in degraded areas provide a path to a properly functioning riparian ecosystem.

The hydrogeomorphic component includes the active channel, lower banks, floodplain or overbank areas, and upper banks that distribute water and sediment to the vegetative component. The vegetative component includes the riparian vegetation (sycamore, willow, and oak riparian) sustained by the stream's water and nutrients. Habitats associated with riparian corridors are related in part to the topography. The hydrogeomorphic design section below is followed by a description of the rationale

for the proposed design for riparian rehabilitation and reestablishment, e.g., for sycamore, willow, and oak riparian habitats.

3.1.1 HYDROGEOMORPHIC BASIS OF DESIGN

The proposed mitigation includes rehabilitation of intermittent and ephemeral streams to improve the function of the riparian corridor. The intermittent streams are San Antonio and Sheep Camp Creeks. Ephemeral streams at the San Antonio Mitigation Area are tributaries to San Antonio Creek. Ephemeral streams at the Sheep Camp Creek Mitigation Area are either tributaries to Sheep Camp Creek or independent reaches draining to other creeks.

The hydrogeomorphic design rationale for San Antonio Mitigation Area is based on a combination of completed fieldwork (described in Section 2, e.g., stream gage data, Pfankuch channel stability ratings and hydrogeomorphic assessment surveys), historical photographs, maps, and typical stream morphology for the valley type and channel substrate observed in San Antonio Creek, and hydrologic and hydraulic modeling, and on-going analyses.

Field evaluations performed in 2009 (URS 2009) by URS hydrogeomorphologists determined that in most cases, the upper banks, lower banks, and bed of San Antonio Creek are in poor to moderately stable condition. This data analysis coupled with the mitigation needs gives rise to the following San Antonio Creek design objectives:

- Reconfigure the creek to a proper dimension, plan, and profile to restore stability and function to the riparian corridor.
- Restore single threaded channel morphology to braided or bifurcated creek reaches
- The morphology of San Antonio Creek includes a meandering channel with active floodplains and distinct point bars.
- Stabilize and revegetate localized areas of erosion

The magnitude of the mitigation actions is greater at San Antonio Creek than at Sheep Camp Creek. The basis of design for stream and riparian restoration at Sheep Camp Creek Mitigation Area is supported by reconnaissance surveys, interaction with the IATF, species surveys, a wetland delineation and will include minor hydrologic modeling as the design details are finalized.

The design approach for increasing habitat value and site appropriate hydrogeomorphic features for intermittent and ephemeral streams is described below in terms of plan form, channel development, and floodplain connection, as applicable to each creek.

3.1.1.1 PLAN FORM RESTORATION

SAN ANTONIO CREEK

San Antonio Creek will retain much of the existing channel position with the exception of areas where the channel is unstable, bifurcated, or braided. The channel plan form will be adjusted where existing meander wavelengths are too long to support the development of typical pool-riffle spacing. At several locations adding an additional meander bend to encourage pool-riffle development breaks up the existing long meander length. Channel position will be manipulated around mature vegetation and utilize the valley contours as possible, to minimize potential ground disturbance. The channel will be realigned at two meander bends where bank erosion is occurring. At these locations streamflow

must make a near 90-degree turn causing excessive bank shear stress and scour. The design moves the thalweg position to avoid impacts to trees and to increase the radius of curvature (meander bend radius) to reduce near bank shear stress.

3.1.1.2 CHANNEL DEVELOPMENT

This section discusses channel development for San Antonio Creek and Sheep Camp Creek.

SAN ANTONIO CREEK

Channel design includes numerous in-stream rock structures (cross vane, J-hook, and W-weir structures). These features provide initial channel bank stability while vegetation becomes established and facilitates stream competence and bed feature development. Rock and/or log structures are placed at specific angles to maintain the concentration of flow at the center of the channel, redirecting flow away from the banks. This reduces near bank shear stress that could otherwise result in bank erosion.

In-stream structures or bed features such as large rock and woody material provide macroinvertebrate habitat as well as breeding and rearing habitat for fish. Channel development processes are interactive, initiated by water flowing in, over, and around bed features. Examples of these processes include:

- Increasing velocity develops a run that scours out a pool.
- A point bar develops from secondary eddy diffusion on the inside of a bend.
- As water turbulence is dissipated, a glide is formed which may transition to a riffle as the bed slope increases.

Channel forming flow or bankfull discharge is used to design the appropriate channel dimensions. Bankfull discharge determined from several methods including: US Army Corps of Engineers Hydrologic Engineering Center - Hydrologic Modeling System (HEC-HMS) modeling, extrapolation from stream gage station data and regional curves, from Manning's Equation calculations would be part of the design. More than one method for calculating Manning's roughness coefficient would be used to verify calculated mean velocities and discharge values.

The proposed design would lay back highly eroded streambanks along San Antonio Creek to the angle of repose to support vegetation establishment and reduce erosion. Banks would be laid back to a 5:1 horizontal to vertical slope, where practicable. Exceptions to this may occur where mature vegetation interferes with the desired slope, in which case, the slope may be steepened to a 2:1 horizontal to vertical slope to protect tree roots. If mature trees must be removed they will be replaced with onsite plantings of the same species. A bankfull bench will be designed into the toe of reconstructed banks to provide additional flood relief and reduce scour at the toe of the slope. The bankfull bench will be densely planted with riparian species to protect the bank. Graded banks will be covered with suitable erosion control products such as straw mulch, wattles, erosion control blankets, or hydro-mulch and revegetated with riparian species.

Ideally a channel design would be based on measurements taken from a reference reach of a Rosgen C4 stream type, in a valley type VIII (broad alluvial valley with established floodplain and stream terraces), similar to the San Antonio Creek. No suitable stream reaches were identified despite a thorough search for potential reference streams located in a similar hydro-physiographic province as San Antonio Creek. As a result, the channel design is based on an analysis of empirically derived regime equations from similar stream types used to determine critical dimensions. Regional curves and equations used to derive channel dimension will be tested against measurements at USGS gauging stations to verify whether the equations are applicable to the project hydro-physiographic

province. Representative values of width and depth for a riffle cross section interpreted from a regional curve analysis (based on drainage area) will be applied to dimensionless ratios developed for a C4 stream type. Appropriate dimensions for width, depth, and slope will be obtained from the dimensionless ratios for each of four morphological bed features (pools, glides, riffles, and runs) (Rosgen 1998). Sediment competence and entrainment calculations will be evaluated for the project reach based on pebble count and bar sampling conducted in 2009 (URS 2009). Dimensionless shear stress (calculated from the pebble/bar sample data) is used to determine the mean channel depth and slope necessary to transport the largest bedload particles at the bankfull stage.

SHEEP CAMP CREEK AND SYCAMORE DRAINAGE

The proposed channel design for Sheep Camp Creek and the tributary Sycamore drainage includes numerous in-stream log/rock cross vane grade control structures. The primary objective of these structures will be to prevent further head-cut erosion and stabilize banks. Grade control structures along Sheep Camp Creek will be located above plunge pools caused by head-cut erosion. CRLF adults have been previously documented from Sheep Camp Creek and the plunge pools provide aquatic habitat that is potentially utilized by this species. Cross vanes will be installed slightly upstream of existing pools to avoid any soil disturbance adjacent to the plunge pools or loss of pool habitat. The upstream portion of the structures (apex) will be installed at the existing thalweg elevation so that it does not impinge on existing flows, and the structures will be appropriately sized to the existing channel dimensions. The structures will provide grade controls that will prevent upstream erosion and encourage pool scour in the event head-cutting continues. Structures will be made of logs salvaged from the Calaveras Dam construction area if sufficient material of acceptable specification can be obtained. In the event sufficient quantities and quality of logs cannot be identified, the structures will be made of rock.

Cross vane grade control structures will be installed at the confluence of the Sycamore Drainage (intermittent tributary to Sheep Camp Creek) with the ephemeral stream leading up to Pond C, where severe head-cut erosion occurs in multiple locations (Figure 3-5). The channel will be contoured into the banks and transitioned into upstream and downstream areas. Two or more cross vane structures may be placed in the channel to effectively "step down" the channel gradient preventing further erosion.

Water flowing around a separated discharge pipe has caused erosion in the channel downstream of Pond C. A solution for this problem will be designed and implemented in conjunction with a potential by-pass described below.

3.1.1.3 FLOODPLAIN CONNECTION

SAN ANTONIO CREEK

Floodplain designs maximize the flood prone area within reasonable extents of soil excavation, confines of the valley width, and minimizing disturbance to existing mature vegetation. Floodplains are essential to maintaining channel stability during large storms and sustained productivity of the riparian corridor. Floodplains are designed to flood at stream flows above bankfull discharge typically with a recurrence interval between 1.1 to 1.8 years (Rosgen 1998). At flood stages, velocities and shear stress in the main channel do not rise discernibly above bankfull. Therefore the integrity of the channel is maintained. Providing the appropriate floodplain area maintains velocities appropriate for floodplain vegetation establishment/reestablishment. The preferred velocity is usually less than two feet per second allowing fine sediment to be deposited, which provides nutrients for sustained plant growth and seed germination.

Floodplains design has a down-valley slope along the channel equivalent to the average bankfull channel slope and a cross sectional slope of less than 1.0 percent (10:1 horizontal to vertical) to allow the recession of floodwaters towards the main channel. The floodplain contours are designed to meander with the stream alignment helping maintain the concentration of flood flow on the main channel alignment. The floodplain elevation is slightly higher on the outside bank of meander bends to reduce potential for lateral channel migration. The profile and elevation of the proposed channel is manipulated to best match the existing topography and, follow the slope or elevation of existing floodplain areas or stream terraces when possible. In some cases the channel has become incised and does not frequent the floodplain within a typical bankfull recurrence interval (1.1 –1.8 years). In these cases the floodplain is lowered to achieve more frequent flooding. The goal in designing the floodplain is to achieve a fairly uniform flood extent similar to relic stream terrace deposits along the length of the project area without negatively impacting existing trees. Excavation around tree root zones would be minimized by avoiding work within the dripline, where practicable.

SHEEP CAMP CREEK

Two shallow off channel pools along Sheep Camp Creek floodplain were identified as potential breeding or rearing pools for CRLF. Successful use of the pools is dependent upon how long water resides in the pools. Enlarging the pools and planting wetland vegetation could enhance the habitat potential of theses pools. A hydrologic analysis of Sheep Camp Creek will be conducted to determine if sufficient water may remain in pools long enough to provide breeding habitat for the CTS and/or CRLF breeding cycles. Results of the hydrologic analysis will determine the feasibility of enhancing two of the off channel pools and aid in pool design.

3.1.1.4 EPHEMERAL STREAMS

SAN ANTONIO MITIGATION AREA

Bed elevations of the San Antonio Creek tributaries will be graded to transition to the designed main-stem channel elevation. Placing in-stream structures at the elevation transition, when the main-stem elevation is below the existing tributary bed elevation at the confluence, prevents channel degradation of the tributary and excessive sediment discharge to the downstream main-stem reaches. The channel bottom will be contoured to the dimensions of a B or C stream type (Rosgen 1998) as appropriate with the valley type, channel slope, and bed materials. Eroding banks of the tributaries will be laid back to a slope no greater than 2:1 horizontal to vertical and stabilized with riparian vegetation and erosion control measures. A small bankfull bench will be incorporated into the toe of the recontoured banks (where space is available) to provide flood relief and areas for seasonal wetland vegetation to become established/reestablished.

SHEEP CAMP CREEK MITIGATION AREA

Gully erosion occurs throughout the mitigation area in ephemeral drainages and swales where grazing pressure or fire break grading stripped vegetation from the channel. Lack of vegetation in combination with a significant change in channel slope caused a “nickpoint” to erode into a gully. Most of the smaller gullies will be revegetated, monitored for regrowth and stability, and managed with a new less intensive and adaptive grazing approach. Two of the larger gullies will be stabilized with grade control structures to control vertical and lateral erosion and will be revegetated with native grasses and/or seasonal wetland vegetation (Figure 3-5).

The first gully (located in the middle of the mitigation area on the south-facing side of the ridgeline above SR 84 is approximately 1,140 linear feet long with three lateral tributary gullies totaling 175 linear feet. The vertical eroded banks will be laid back to a stable 2H:1V slope. Material excavated

from the banks will be used to recreate a consistent bed width and gradient along the length of the gully. The second deeply eroded gully is approximately 100 feet long. The gully is located upstream of Pond B. This gully may involve placement of compacted fill (if available from other onsite grading activities) to reduce the extent of slope contouring needed to achieve a stable bank and bed slope. Grade control structures will consist of rock or log cross vanes placed at intervals along the channel with the invert or upstream apex of the structure placed at grade. Dense plantings of rushes and sedges may be planted in a similar "V-shape" configuration as a cross vane to augment or reduce the number of vanes required.

3.1.2 RIPARIAN AND UPLAND REVEGETATION

The ecological goal for HRP stream mitigation is to integrate channels with their associated riparian corridor. The riparian revegetation rationale for expecting success is presented below for sycamore riparian, oak and willow riparian, seasonal wetland on the first floodplain terrace, followed by oak savannah, oak woodland, and grassland[2].

3.1.2.1 SYCAMORE RIPARIAN

Sycamore riparian rehabilitation and establishment is proposed for the San Antonio and Sheep Camp Creek mitigation areas (Figures 3-1 and 3-5). Sycamore riparian is commonly associated with alluvial valleys and washes that have flashy ephemeral to intermittent stream flow during winter months followed by dry summer conditions. Sycamores grow in the active floodplain where shallow overbank flooding during the dormant period provides suitable conditions for seed germination and stimulates adventitious sprouting (asexual reproduction) of mature trees. Sycamores prefer sandy to gravely soils that remain well aerated from spring into summer and a warm drier spring weather that reduces the likelihood of defoliation due to Anthracnose fungus (Warner and Hendrix 1984). Coppice sprouting (any stem arising from an adventitious or dormant bud at or near the base of a woody plant) is a common asexual regenerative process used by sycamores. As the older stems succumb to disease and damage, the sprouts take over the role of the dominant biomass of the individual, eventually replacing the parent tree. Adventitious sprouting is stimulated by fire and flooding (CDFG 1997). Young seedlings and adventitious sprouts are susceptible to browse by cattle and deer.

Mature sycamores of an even age are present along San Antonio and Sheep Camp creeks, but there is an absence of sycamore recruitment. Potential causes include degradation of the streambed that has isolated many of the sycamore trees from the natural rejuvenation process that stream flooding provides. The presence of cattle grazing year-round and feral pig activity may also be a factor in the lack of sycamore seedling recruitment (CDFG 1997, Serpa 2008).

Reestablishing a hydrologic connection with the former floodplain (San Antonio Creek), planting saplings, and reducing grazing pressure would enhance the sycamore riparian habitat. A hydrologic connection would be established at San Antonio Creek by lowering the elevation of the stream terrace such that the new floodplain would receive periodic overbank flooding above a bankfull flow. Hydrologic and hydraulic modeling will be conducted to inform the grading and vegetation design. Abandoned floodplain areas in San Antonio Creek that reside well above the bankfull elevation will be excavated to achieve the desired elevations and inundation frequency. Existing trees will be preserved in place, and the floodplain will be machine graded outside of the drip lines of the trees, where possible, creating a complex topography of high and low areas. Currently, flood prone areas are buried with gravel and heavily grazed, which reduces the likelihood of sycamore regeneration.

[2] Grasslands occur in all mitigation areas, but are described in Section 3.2 with ponds and wetlands due to the upland habitat that they provide for sensitive species that utilize the ponds and wetlands.

Channel rehabilitation will improve the redistribution of bedload throughout the stream and encourage entrapment of fine sediment on the floodplain rather than gravel and cobbles.

The optimal elevation of the water table during the critical periods for sycamore establishment and survival (spring and winter) is unknown (Matheny et al. 1989). Ground water monitoring wells were installed in the spring of 2009 to monitor the fluctuations in the water table to determine if established sycamores will have sufficient ground water to sustain plantings and encourage seedling recruitment. Seasonal fluctuations in the water table elevation along San Antonio Creek will be measured and used to determine water availability and provide guidance for planting locations. Analysis of the data may indicate the maximum, reasonable elevation that sycamores can be planted where roots can reach the summer water table. It is expected that after a few years of growth, planted sycamore sapling's roots will have access to groundwater.

Cattle exclusion fencing will be installed along San Antonio and Sheep Camp creeks, as well as, the unnamed intermittent tributary to Sheep Camp Creek. The exclusion of cattle from riparian areas will remove grazing pressure and should increase successful establishment of sycamores .

3.1.2.2 WILLOW RIPARIAN

Willow riparian rehabilitation and establishment/reestablishment is proposed for the San Antonio and Sheep Camp Creek Mitigation Areas. Willow riparian establishment areas are proposed where there is frequent inundation from San Antonio Reservoir or where willow roots may reach the summertime water table. These areas are either located along the edge of the reservoir, or along the lower reach of San Antonio Creek where soils are frequently saturated by a backwater effect from a high reservoir level during the rainy season. Willow riparian habitat is prescribed the inundation areas that would otherwise be too wet for the establishment of sycamore or oak riparian vegetation and too dry for emergent wetland species. At the Sheep Camp Creek Mitigation Area willows are used as a bioengineering approach to stabilize eroded banks and along the lower reaches of Sheep Camp Creek where the surrounding vegetation is dominated by willows. Oaks dominate most of the riparian community along Sheep Camp Creek. The intent of establishing pockets of willow riparian habitat is to improve the habitat complexity along the corridor. Willow riparian habitat establishes readily using locally harvested willow poles that would be planted to the depth of the water table.

3.1.2.3 OAK RIPARIAN

Oak riparian habitats will be established/reestablished along Sheep Camp Creek and along banks of the ephemeral tributaries to San Antonio Creek. Oak riparian habitats will be planted along the upper banks of ephemeral streams where slopes are steeper; soils are typically drier, and contain more clay. The majority of the proposed oak riparian planting locations do not receive inundation or flooding from the stream except the toe of the bank during large flood events. The dominant species in this habitat is coast live oak but also includes some valley oak. Drought tolerant understory vegetation typical of California interior coast range riparian environments would be planted in the mitigation areas. Typical species that would be planted within this habitat type include Mexican elderberry, California blackberry, common snowberry (*Symphoricarpos albus* var. *laevigatus*) and mulefat.

3.1.2.4 SEASONAL WETLAND

Seasonal wetland will be rehabilitated and established/reestablished within and adjacent to San Antonio Creek and Sheep Camp Creek. Other seasonal wetlands would be established in tributaries to these streams or in a rehabilitated gully on the south side of the Sheep Camp Creek Mitigation Area.

The design of these seasonal wetlands is described below. Seasonal wetland establishment and rehabilitation at ponds is described separately in Section 3.2.

Seasonal wetland vegetation will be established along the lower reaches of Sheep Camp Creek where the stream has a low gradient and wide floodplain. Seasonal wetlands have not been delineated in this area, however small stands of rushes and sedges have been observed interspaced throughout the proposed area. The soils are gravelly and vegetation has been heavily grazed. By removing the grazing pressure and revegetating the corridor in a successive planting of different species it is anticipated that a seasonal wetland can be established. Planting will begin with more facultative wetland species such as common rush (*Juncus patens)* planted throughout the channel and banks that will help slow water velocities and redistribute flow to a wider cross section. The vegetation will help trap silt and clay which have a higher water holding capacity than the existing sandy soils encouraging further development of hydric soils. The wetland delineation conducted by ESA (2009) identified the soils along Sheep Camp Creek at the sampling point as having redoximorphic features characteristic of sandy soils, indicating that soils are already exhibiting some of the beginning characteristics of a hydric soil. The proposed design would recruit fine sediment, which would provide conditions that may be more appropriate for obligate wetland species. Obligate wetland plant species would become established through natural recruitment or supplemented by plantings, if appropriate.

Seasonal wetland vegetation will be established along the restored gully in the southeast portion of the Sheep Camp Creek Mitigation Area that flows towards SR 84. Seasonal wetland vegetation already occurs along the length of the channel in various areas. The vegetation will be replaced and expanded to cover the entire length of the channel bottom once the bed and banks are restored.

Seasonal wetlands have been delineated near the bottom of some of the ephemeral tributaries to San Antonio Creek. These features occur in lower gradient areas where standing water or saturated soils are present long enough to establish hydric soils and allow wetland plant species to establish. The proposed design for these drainages would establish this type of seasonal wetland vegetation in areas between the existing seasonal wetland features.

3.1.2.5 OAK SAVANNAH

Reestablishment of oak savannah is proposed in large open expanses at the San Antonio Mitigation Area in locations that previously supported this vegetation type. This habitat is located in the dry upland slopes where oak savannah was historically present. Historical photographs (circa 1940) of the site indicate that oak density was once significantly greater than it is today. Currently, only a few oaks are present in the mitigation area. Density of oaks in the mitigation area prior to 1940 is unknown, due to lack of readily available historic photos or other documentation. Therefore, an estimation of oak densities and species composition for planting was made for the oak savannah compensation site based on the 1940 aerial photograph (Appendix H) of a reference site adjacent to the San Antonio mitigation area, as well as observation of oak savannahs in the Alameda Creek watershed. Based on this review, the goal of the re-established oak savannah at the San Antonio mitigation area is to achieve approximately 1 oak per acre.

3.1.2.6 OAK WOODLAND

Oak woodlands in the mitigation areas are dominated by low density stands of valley oak or coast live oak and/or blue oak species. Oak woodlands will be rehabilitated and established/reestablished within the San Antonio Mitigation Area. The mix of species that will be planted depends in part on hydrology and elevation, as in the following examples:

- Valley oak dominated woodlands are proposed for San Antonio Creek where deep, well drained alluvial soils are present at flood plain elevations above the 10-year but below the 100-year recurrence interval where mature tree roots are likely to reach the water table.

- Coast live oak and/or blue oak dominated woodland is proposed for higher elevation areas outside of the riparian corridor that are generally associated with steeper backslopes of hills and drainages.

3.2 PONDS AND ASSOCIATED WETLANDS AND GRASSLANDS

The existing ponds in the mitigation areas were constructed to capture surface runoff and provide water for cattle. The additional water sources allowed ranchers to increase the number of cattle that could be grazed in the watershed. Seasonal and perennial wetlands and upland grasslands are present along the perimeter of some ponds and below pond embankments. The proposed mitigation areas include the following pond sites:

- East Pond in the San Antonio Mitigation Area,
- Goldfish, North, South, and Stock Ponds located within the South Calaveras Mitigation Area,
- Unnamed Pond in the Sage Canyon Mitigation Area,
- Goat Rock Northwest Pond and Northeast Pond at the Goat Rock Mitigation Area, and
- Ponds A-E at the Sheep Camp Creek Mitigation Area.

Compensation design at these ponds and vicinity will focus on enhancing, rehabilitating, or establishing/reestablishing sensitive biological resources such as wetlands, grasslands and riparian habitats and improving aquatic and upland habitats that are utilized by breeding California tiger salamander and California red-legged frog.

Some of the ponds in the mitigation areas support bullfrogs and fish, which forage on larval CTS and RLF tadpoles precluding population establishment at these locations. In addition, intensive grazing occurs around and within the ponds, reducing emergent vegetation that provides cover and breeding substrate. Breeding habitat would be reestablished at these locations by implementing predator control, fencing to establish emergent wetland vegetation where appropriate, and modifications to the outlet structures to allow draining. Emergent vegetation will also be managed in appropriate proportions (through mechanical removal, burning, grazing, etc.) within ponds to provide a balance of open water and vegetative cover. These measures have been implemented elsewhere (e.g., Ohlone Mitigation Bank) and have resulted in successful reestablishment of breeding populations of California tiger salamanders and California red-legged frogs. One of the reasons why these steps are likely to be successful at South Calaveras, Sage Canyon, and Goat Rock is the close proximity of these sites to existing populations of the listed amphibians.

Proposed compensation actions at each of the ponds are listed below. Ponds with similar design objectives and construction components are discussed together.

EAST POND (SAN ANTONIO MITIGATION AREA)

- Manage predators to enhance special status species habitat

GOLDFISH POND, (SOUTH CALAVERAS MITIGATION AREA)

- Maintain storage capacity to 10 acre feet or less
- Rebuild outlet works to facilitate pond draining for predator control and pond maintenance
- Remove or control non-native, invasive plants

- Rebuild embankments and spillway
- Install fences to manage grazing to enhance special status species habitat
- Establish perennial wetlands at southern end of Goldfish Pond
- Rehabilitate seasonal wetlands
- Establish/reestablish seasonal wetlands

NORTH, SOUTH, AND STOCK PONDS (SOUTH CALAVERAS MITIGATION AREA)

- Manage predators to enhance special status species habitat

NORTHWEST AND NORTHEAST POND (GOAT ROCK MITIGATION AREA)

- Install fence (Northwest Pond) to enhance perennial wetlands
- Manage predators to enhance special status species

PONDS A-E (SHEEP CAMP CREEK MITIGATION AREA)

- Rebuild eroded embankments (Ponds A and C)
- Resize and armor existing spillways (Ponds A and C)
- Relocate and armor spillway at Pond B - Triangle Pond
- Install pond drains for predator control (Ponds A, B, and C)
- Manage predators to enhance special status species habitat (Ponds D and E)
- Install a stilling basin below the pond embankment to dissipate energy from the pond spillway, outlet pipe, bypass flow pipe, and drainpipe (Ponds A, B, and C)
- Extend and/or rebuild Pond C outlet pipe
- Install a low flow bypass around Pond C
- Install exclusion fencing to manage grazing (Ponds B and C)
- Install an intake to draft water from Pond C for cattle water troughs

SAGE CANYON UNNAMED POND (SAGE CANYON MITIGATION AREA)

- Manage predators to enhance special status species habitat

The following sections describes the basis of the proposed mitigation designs for Goldfish Pond, North, South, and Stock Ponds, Goat Rock Northwest Pond, and Ponds A-E.

3.2.1 EAST POND (SAN ANTONIO MITIGATION AREA)

No structural or physical habitat improvements are planned at East Pond. The pond will be enhanced through predator control.

3.2.2 GOLDFISH POND (SOUTH CALAVERAS MITIGATION AREA)

Historical topographic maps indicate that Goldfish Pond was constructed between 1953 and 1961. Structural improvements and the manipulation of site topography and bathymetry will occur at Goldfish Pond to establish and rehabilitate existing and proposed habitats for special status species. The pond embankment, previously built of unconsolidated fill, will be rebuilt in place with engineered fill and a clay core. The embankment design includes an outlet structure with a spillway on the left side (looking down drainage) sized to pass a 100-year recurrence storm flow. The spillway will be lined with geotextile fabric and riprap or permanent turf reinforcement matting (with site-

appropriate native grass species seeded into the mat grids). The bottom of the spillway and outlet of the pond drain pipe combine into a single channel and will transition to the existing or proposed drainage channels.

The design approach for establishing seasonal and perennial wetlands at Goldfish Pond is to alter the hydrology and topography around the southern end of the pond. The bottom contours of the valley will be broadened and slope decreased to slow surface runoff velocity and increase infiltration and soil saturation duration. The upper extent of the proposed seasonal wetland is designed at an elevation equivalent to the crest of the pond spillway so that the entire wetland will periodically flood following large runoff events. The cutslope above the seasonal wetland will be tapered and transitioned into the surrounding topography. Between the seasonal wetland and existing grassland area is a transition zone where temporary ponding or saturation may occur during the rainy season and create an ecotone or extend the seasonal wetland. This ecotone is approximately 30 feet wide and will be planted with willow species, over-planting across vertical contours to facilitate "natural selection" of the appropriate elevational niche.

The cut slope above the willow riparian ecotone will be planted in native grass. Cut slopes will be kept as gradual as possible to blend in the existing with the proposed topography. Existing slopes around the proposed wetland area range from 4 – 10 percent. Proposed cut slopes will range from 6 – 11 percent. Slopes will be made more gradual in the areas where swales and an ephemeral stream enter the wetland area. Drainages will be armored with vegetated bio-engineered grade control structures installed along the top and toe of the cut slope to reduce the likelihood of head-cut erosion. The drainage slope will be planted with a higher density of native rush and sedge plantings to bolster the integrity of the slope. Grade control structures will consist of a rock or coir log vane buried at grade and densely planted on either side with rush/sedge species. Rush and sedge rhizomatous roots bind soil while the above ground biomass allows water to filter between the individual stems filtering out sediment. A willow fascine may be used at the toe of the slope for slope protection where more water is available to sustain species.

The bathymetry will be reshaped to achieve a pond storage volume to 10 acre-feet with a configuration that provides wetlands benefits as well as habitat for wildlife species. To accomplish these goals approximately 13,300 cubic yards of soil excavated from the seasonal wetland establishment/reestablishment area will be placed in the pond bottom to adjust the bathymetry. The pond depth at the deepest point will decrease from 12 feet deep to 10 feet deep. Pond water balance analysis indicates that the pond will be dry from September to December in a typical water year (URS 2010). Despite placing fill in the pond bottom, there is a net gain in wetland area (i.e., the surface area of jurisdictional waters and wetlands is increased not decreased). The drain pipe that will be installed in the embankment (see above) will be used to periodically drain the pond, unless it dries out on its own, to eliminate fish and bullfrog larvae.

3.2.3 NORTH, SOUTH, AND STOCK POND (SOUTH CALAVERAS MITIGATION AREA)

No structural or physical habitat improvements are planned at North, South, or Stock Pond. The ponds will be enhanced through predator control. Predator control will include pumping the ponds dry periodically to remove fish and bullfrog larvae.

3.2.4 NORTHWEST AND NORTHEAST POND (GOAT ROCK MITIGATION AREA)

No physical habitat improvements are planned at Goat Rock Northwest Pond. Currently, the pond is heavily used by cattle, as it is one of the few semi-permanent water sources in the area. The pond and a small portion of the surrounding grassland and associated wetlands will be fenced to manage cattle grazing (Figure 3-4). Existing perennial wetlands within the pond will be enhanced by reducing grazing pressure and soil disturbance and through predator control. Goat Rock Northeast pond management will include predator control.

The non-native invasive wetland plant mannagrass (non-native *Glyceria* sp.) will be removed from the Goat Rock Seep Pond.

3.2.5 PONDS A–E (SHEEP CAMP CREEK MITIGATION AREA)

Five ponds at Sheep Camp Creek will be managed to maintain breeding habitat for California tiger salamander and support wetland and riparian vegetation. To accomplish the restoration goals, low-flow bypass structures, armored stilling basins, siphons, outflow pipes, spillways, and/or predator control will be constructed or implemented at the ponds. The activities associated with each pond are summarized in Table 3-3.

Table 3-3
Proposed Modifications at Sheep Camp Creek Mitigation Area Ponds A–D.

Pond Name	Pond Location/ Description	Bypass Structure	Pond Outlet	Predator Control
Pond A	Southwest corner of mitigation area – drains toward Vallecitos Creek	Not needed	Create new spillway and armored basin.	Siphon operated drain will be placed over the embankment. No breeding CTS currently documented from this site.
Pond B	Triangular shaped pond in the center of the mitigation area drains toward sycamore grove tributary	Not needed	Create new spillway and armored basin.	Siphon operated drain will be placed over the embankment. Existing CTS breeding site.
Pond C	Large pond on the east side of the site, also known as 'Sheep Pond'	Two perforated pipes placed in a gravel/cobble infiltration bed in the channel upstream of the pond	Outlet pipe extended to the bottom of the embankment fill slope into an armored stilling basin. Spillway resized and armored.	Siphon operated drain will be placed over the embankment. Existing CTS breeding site.
Pond D	Small, off-channel pond immediately downstream of Pond C in floodplain of stream	Not needed	Pond is isolated from the main channel of Sheep Camp Creek during normal flow periods	Pond will be managed to control predators and invasive species. Not proposing to drain this pond because it is typically dry during summer months. Existing CTS breeding site.

Table 3-3
Proposed Modifications at Sheep Camp Creek Mitigation Area Ponds A–D.

Pond Name	Pond Location/ Description	Bypass Structure	Pond Outlet	Predator Control
Pond E	Small, solitary depression associated with a landslide located in the northwest corner of the mitigation area	Not needed	Pond has no outlet or evidence of over flowing	Pond will be managed to control predators and invasive species. Not proposing to drain this pond because it is typically dry during summer months.

Pond C is the largest pond located on Sheep Camp Creek. Bathymetric surveys will be conducted to determine the volume of the pond to determine if the pond volume is less than or greater than 10 acre-feet. If pond storage exceeds 10 acre-feet then the pond outlet pipe will be lowered to reduce the storage volume to less than 10 acre-feet to facilitate the permitting of appropriative water rights from the State of California.

Spill volume and timing from Pond C to downstream riparian habitat varies with storm patterns, rainfall, and myriad other factors, especially early in the rainy season. To provide water to downstream habitats during storm events when the pond water surface elevation is low, a low flow bypass will be constructed. The bypass structure would be installed below the existing bed elevation to minimize maintenance and avoid disturbing the creek bed. The bypass structure will consist of two perforated pipes placed in a gravel/cobble infiltration bed in the channel upstream of the pond. The pipes will be sized to bypass the desired flow, approximately 1 cubic foot per second (cfs). Water will be conveyed in the bypass pipes by gravity flow around the edge of the pond to discharge to an armored stilling basin below the embankment.

Ponds A and B have smaller storage capacities and spill (release water) soon after stream flow begins, mimicking unimpaired conditions more closely, in regards to providing water to downstream habitats. A low flow bypass is not warranted, nor would it offer appreciable benefit to downstream habitats.

Pond C has an outlet pipe that separated causing erosion of the embankment fill. This pipe will be extended to the bottom of the embankment fill slope into an armored stilling basin. Should the pond volume need to be reduced in storage capacity, the entire culvert pipe will be removed and placed at an appropriate elevation to maintain the pond storage below 10 acre-feet. The spillway will be resized to accommodate a 100-year storm event and be armored with geo-cellular confinement matting allowing herbaceous vegetation to grow in the matting.

A pond drainpipe will be installed over the top of the existing embankment at Ponds A, B, and C that will operate on a siphon. The siphon method will release water gradually (less than 2 cubic feet per second) and not require the continual use of a motorized pump. The drainpipe will discharge into the stilling basin below the embankment. Water would also be drafted from Pond C to a tank at the top of the hill via a solar powered pump for purposes of distributing water to cattle water troughs (Figure 3-6g).

Exclusion fencing will be placed around and through Pond C to exclude cattle from the upstream riparian area and allow wetland vegetation to recruit along the upstream shallow end of the pond. The fencing will allow cattle to have access to the downstream portion of Pond C and Pond D. This shall allow adequate disturbance to reduce vegetation and create turbid water ideal for CTS. Cattle

exclusion fencing will be installed through the middle portion of Pond B excluding cattle from the embankment and downstream habitats.

Pond B has an eroded spillway with mature willows growing in the bottom. The willows are growing below the pond elevation likely receiving groundwater seepage from the pond. The existing spillway at the top of the embankment (where no willows are growing) will be capped with compacted fill to prevent flow entering and further eroding the embankment. A new spillway will be located to the center of the embankment, sized to accommodate a 100-year flow. An armored stilling basin will be installed at the base of the spillway to dissipate flows prior to being released into a portion of the stream channel extended from the existing pond outlet to the proposed basin. The channel will be revegetated with rhizomatous grasses to prevent channel erosion. Cattle exclusion fencing will be installed through the middle portion of the pond excluding cattle from the embankment and downstream habitats.

Pond A will have the spillway/embankment rebuilt and armored similar to the other ponds. An armored stilling basin will be placed at the bottom of the spillway. A siphon operated drain will be placed over the embankment to drain the pond for predator control. Although this pond does not have a documented occurrence of breeding California tiger salamander, it is within 4,425 ft of Pond C and D which have been utilized by breeding tiger salamanders. Predator control and water management would enhance the potential the tiger salamander or red-legged frog may use this pond. Cattle will have access to the pond.

No structural or physical habitat improvements are planned at Ponds D and E. The ponds typically dry up by the end of summer limiting bullfrog breeding. The ponds will be enhanced through predator control, invasive species control, and grazing management.

3.2.6 SAGE CANYON UNNAMED POND (SAGE CANYON MITIGATION AREA)

No structural or physical habitat improvements are planned for the Sage Canyon Unnamed Pond. The pond will be enhanced through predator control.

3.2.7 WILLOW RIPARIAN

Willow riparian habitat will be established at Goldfish pond in the transitional ecotone area between seasonal wetland and native grassland. This area begins at an elevation equivalent to the maximum pond inundation area and will be planted 30 feet up the cut slope in a zone where soils will likely be more wet due to the seeping of subsurface flow that will be effectively "intercepted" by the cut slope created from the excavation of the seasonal wetland habitat area. Detailed discussion of the Goldfish Pond basis of design is described above. Fences will be installed around the willows below the Goldfish Pond embankment to reduce grazing pressure. The eroded gullies near the embankment resulting from hillslope and Calaveras Road runoff will be rehabilitated through recontouring and stabilizing slopes with willow plantings and/or revetment structures (fascines or brush mattresses) made of willows.

3.2.8 GRASSLAND

Grassland establishment/reestablishment is planned adjacent to Goldfish Pond, and grassland enhancement is planned throughout the South Calaveras, San Antonio, Sheep Camp Creek, Goat Rock, and Sage Canyon Mitigation Areas.

Native grassland establishment/reestablishment is planned in an area currently occupied by non-native grassland in the South Calaveras mitigation area at Goldfish Pond. One objective and one management strategy for grassland establishment/reestablishment specific to South Calaveras and Goldfish Pond is listed below. Additional management objectives and strategies for grasslands and other habitat types in the HRP mitigation areas will be included in the HRP long-term management plan (in press).

- **Grassland Objective 1:** Establish grassland habitat at Goldfish Pond to provide soil stability and provide cover for California tiger salamander and California red-legged frog.

  - Grassland Management Strategy 1: Plant native grass and forb species (5 foot on center), remove non-native invasive plants (maintain ≤5% cover of non-native invasive plants during the 10 year monitoring period) in 3.92 acres adjacent to Goldfish Pond

Grassland enhancement in the HRP mitigation areas will primarily be accomplished through utilization of livestock grazing targeted for resource management, controlling or reducing cover of non-native invasive plants species and implementing erosion control measures. Livestock use of grasslands would be timed and stocking rates would be set to maximize benefit to native grasses and forbs, reduction of non-native invasive species where applicable, and reduction of livestock-induced erosion. The grasslands enhancement strategy is based on technical literature and research, as well as interviews with local ecologists, range managers and grassland researchers with California grasslands management experience. Long-term monitoring (see Section 5) will be implemented in the grassland compensation sites to determine the effectiveness of management techniques and to determine if alternate or additional management actions are necessary.

Three objectives and several management strategies for grassland enhancement in the HRP mitigation areas are listed below.

- **Grassland Objective 2:** Decrease the cover of medusahead by 50% over 5 years, relative to the cover at the start of restoration and enhancement activities in grasslands at the Sheep Camp Creek mitigation area.

  - Grassland Management Strategy 2: Determine baseline conditions of medusahead at the Sheep Camp Creek mitigation site by mapping occurrences (areas ≥ 100 square feet with ≥ 25% cover of medusahead) of this species.
  - Grassland Management Strategy 3: Devise and implement a weed control plan for medusahead at Sheep Camp Creek. Weed control strategies may include the use of yearly prescribed fire.
  - Grassland Management Strategy 4: Implement qualitative and/or quantitative monitoring to track effects of management actions on medusahead.

- **Grassland Objective 3:** Maintain or increase occurrences of native grass and forb species from baseline conditions (prior to implementation of enhancement activities) in grasslands of the HRP mitigation areas.

- Grassland Management Strategy 5: Map the location of areas/patches within non-native grasslands in the mitigation areas that contain a relatively high diversity and/or cover of native grass and forb species relative to other areas/patches of grassland in the mitigation areas.

■ **Grassland Objective 4:** Maintain or increase cover of Johnny jump-up from baseline conditions (prior to implementation of enhancement activities) in grasslands of the HRP mitigation areas.

- Grassland Management Strategy 6: Determine target cover of the host plant Johnny jump-up. Target cover would be estimated based on discussions with local experts and review of technical literatures and survey reports where cover of the host plant and occurrence of the Callippe Silverspot butterfly is evaluated.
- Grassland Management Strategy 7: Map the boundaries of Johnny Jump-up occurrences in the HRP mitigation areas prior to implementation of any enhancement activities.
- Grassland Management Strategy 8: Implement a monitoring scheme that is sensitive to changes in cover and establish a threshold for cover of Johnny jump-up in grasslands that contain the host plant that would trigger a management action.
- Grassland Management Strategy 9: Establish and implement a livestock stocking rate that is compatible with management of target cover of Callippe silverspot host plant occurrences (see Grassland Management Strategy #6).

3.3 SCRUB HABITAT ENHANCEMENT

Scrub habitats will enhanced at Sage Canyon, Goat Rock and San Antonio Mitigation Areas. Scrub management would be focused on long-term management of core habitats that are potentially utilized by the Alameda whipsnake. The primary strategy for enhancement of the Diablan sage scrub is through succession management and control of non-native, invasive weeds and wildlife. One objective and one management strategy for scrub enhancement specific to Sage Canyon is listed below.

■ Scrub Objective 1: Manage vegetative cover at Sage Canyon in part to scrub and grassland to support the habitat needs of the Alameda whipsnake.

- Scrub Management Strategy 1: Utilize fire and livestock grazing to maintain a mosaic of scrub and grassland habitats and to reduce decadent scrub cover at Sage Canyon.

3.4 GOAT ROCK HABITAT ENHANCEMENTS

The overall goal of the Goat Rock mitigation site is to provide compensation for impacts to serpentine grassland, annual grasslands, seeps, springs and ponds resulting from CDRP and other WSIP projects. Grasslands in Goat Rock mitigation area are strongly influenced by the presence of serpentine soils, which support grasslands with a high diversity and cover of specialized, serpentine endemic plant species. Serpentine endemic plants at the site include several species that have special-status in California. The grasslands at Goat Rock are classified as both non-native annual and serpentine grassland, both of which are influenced by the presence of serpentine soils. Both grassland types contain native species and serpentine endemic species, however, the serpentine grassland has more annual serpentine forbs and more exposed ground/rock. Grassland enhancement is proposed for the non-native annual and serpentine grasslands at Goat Rock (Figure 3-4). In addition, habitat enhancement of the oak woodlands, wetlands and the seep pond at Goat Rock will be made. Grassland, oak woodland, wetland, and pond enhancement objectives include:

- Control or reduce non-native, invasive plant species
- Maintain or increase cover of native plant species
- Maintain or reduce cover of annual, non-native grasses and forbs
- Maintain or increase the cover of serpentine endemic species
- Reduce cattle impacts to sacrifice areas (areas where cattle congregate)
- Increase oak seeding survivorship in existing oak woodlands
- Remove non-native, invasive aquatic species (e.g., invasive mannagrass [Glyceria sp.]) from Seep Pond
- Remove or strictly limit cattle grazing of Northwest Pond and associated wetlands
- Implement predator control in ponds

The basic strategy for enhancing grasslands includes alteration of the current grazing regime at the mitigation area, and use of water and cattle attractants to better distribute cattle use on the landscape. The 30% design for the Goat Rock Mitigation site, which outlined location of water conveyance system for the site is included in Appendix F. This approach was selected based on technical literature and research, as well as interviews with local ecologists, range managers and grassland researchers with experience with various management techniques for serpentine grasslands. Long-term monitoring will be implemented in the grassland compensation sites to determine the effectiveness of management techniques, and to determine if alternate or additional management actions are necessary. For oak woodland enhancement at Goat Rock, oak seedlings observed at the site will be protected from browsing and grazing through installations of tube shelters and t-stakes. Oak woodlands will be subject to the same grazing regime as the grasslands at Goat Rock. For pond enhancement, a new fence will be installed around the pond to strictly limit cattle grazing, and the non-native invasive species mannagrass will be removed.

3.4.1 TIMING OF GRAZING

The Goat Rock mitigation area and surrounding grasslands is part of the 1,850 acre "Frog Pond" grazing unit currently grazed year round in coordination with the East Bay Regional Park District (EBRPD). Future stocking rates and timing of grazing prescribed to reach habitat enhancement objectives will be detailed in the grazing management plan for the HRP sites (in press), and will be established in coordination with the SFPUC rangeland manager. The current grazing of the Alameda Creek watershed is generally to target a Residual Dry Matter (RDM) level of approximately 1,000 pounds per acre, a level that minimizes soil and nutrient loss. Based on communication with the SFPUC rangeland manager and observed RDM at the mitigation area, cattle use of the mitigation area is most intensive around water sources, including Northwest Pond and several seep wetlands. The current lessee of the Goat Rock mitigation area stated that, at least in recent years, cattle are moved off the property during the spring when the wildflowers begin to bloom (Koopmann, personal communication, 2009).

The approach to grassland enhancement at Goat Rock includes changing the current grazing regime from year round cow-calf, to early season grazing cow-calf (from beginning of growth period through March 30) and potentially late season grazing (July 1 and October 31) within a newly created 213 acre field at Goat Rock. During the early season, cattle preferentially graze non-native annual grasses that are common at the site. Cattle would be removed in the spring when the native wildflowers and native grasses bloom, allowing these species to flower and set seed. Late season grazing may occur, depending on the level of standing biomass at the site. Goat Rock grazing will be bounded by the grazing unit fence, stocking rates and schedule that will be informed and revised using the monitoring and adaptive management described in Section 5. After the stocking rates and timing of grazing have been optimized within the 217 acre field (based on the results of monitoring), the SFPUC would

potentially extend the same grazing management to the eastern and southern portions of the Goat Rock conservation easement.

3.4.2 LIVESTOCK MANAGEMENT INFRASTRUCTURE

Fencing, water, water troughs and cattle attractants will be installed at Goat Rock to disperse cattle and reduce trampling at ponds and wetlands. Multiple water sources are potentially developable. Water would be pumped from either an off-site perennial pond, or from a groundwater well to tanks above the compensation site to supplement the current ponds and fill cattle troughs. The well option is the preferred method, and will be used if testing shows that year round water in sufficient quantities can be provided by the well. Cattle attractant locations, such as placement of mineral supplements, would avoid sensitive areas such as wetlands, ponds, and areas that are prone to erosion. Pumping of water from ponds would be managed to avoid drying up ponds and impacting pond-associated habitats. Fencing will be used to manage cattle from Northwest Pond and its adjacent wetlands. Fencing will also be erected to surround approximately 213 acres within the northwest corner of the Goat Rock mitigation area. Fencing will enable ranchers to control the timing and intensity of grazing in the mitigation area. The location of fencing was selected primarily to encompass portions of the serpentine grassland at Goat Rock while minimizing impacts to sensitive resources, including existing rare plant populations, wetlands and seeps and raptors. Fencing was also routed to allow for a portion of a serpentine grassland with similar vegetation and with a similar landscape position that would be used as reference site for vegetation monitoring.

3.5 BASIS OF DESIGN - SAGE CANYON

The primary goal of the Sage Canyon mitigation site is to provide compensation for impacts to Alameda whipsnake habitat resulting from CDRP and other WSIP projects. Enhancement of Diablan sage scrub, oak savannah, grassland, wetland, and pond habitats is proposed for the Sage Canyon Mitigation Area (Figure 3-2). Diablan sage scrub is the dominant plant community of the dry slopes and ridges of Sage Canyon, and it is a key element of habitat utilized by the endangered Alameda whipsnake. Grasslands are also present but less common than Diablan sage scrub at Sage Canyon. No physical manipulations (e.g., grading, planting) will be conducted at the site. Sage Canyon enhancement objectives include:

- Manage scrub and associated habitats at Sage Canyon to benefit the Alameda whipsnake
- Control or reduce non-native, invasive plant species
- Increase oak seeding survivorship oak habitats
- Implement predator control at Sage Canyon Unnamed Pond

3.6 REFERENCE SITES

Conditions vary substantially across the Alameda Creek watershed making it problematic to find reference sites that can be used to predict future conditions at the compensation sites; thus, reference sites were not used as a basis for success criteria. Instead, observations from reference sites may be helpful for understanding or interpreting temporal variability and landscape scale variation in compensation sites' monitoring results. For instance, if there is an extreme weather event that severely impacts the habitat; stress from the event will be seen in the reference site and the compensation site. The applicability of the reference site varies due to the differences in community structure and age differential among species from both types of sites.

For each habitat below, a reference site is described and the intention of the reference site is discussed. Unless otherwise noted, the reference sites will be used to explain natural environmental variation seen in the mitigation areas during monitoring.

3.6.1 OAK WOODLAND

The reference site for oak woodlands is a 10.3-acre area located on Indian Creek within the San Antonio Mitigation Area. The reference site is located in existing woodlands that will not be modified by proposed mitigation activities. Soils within the reference site are classified as riverwash and Pleasanton gravelly loam. This reference site was selected because of its similarity and proximity to areas that are proposed for oak woodland compensation.

The oaks along Indian Creek are mature, 50 plus years old; therefore, this site was not used as a basis for canopy cover mitigation goals. The canopy cover is far more developed at this reference site than is reasonable to expect for the oak woodland establishment sites for many decades, however it may be useful for predicting long term density goals.

3.6.2 OAK SAVANNAH

The oak savannah reference site is a 38.7-acre area located in an existing oak savannah habitat in the San Antonio Mitigation Area that will not be modified by proposed mitigation activities (Appendix H). Soils are Zamora silt loam and Positas gravelly loam. The SFPUC selected this reference site because of its similarity to the targeted goals for the oak savannah establishment sites, and proximity to that site.

The oak savannah reference site, in conjunction with relevant technical literature, was used to establish target mitigation goals and planting density. Target density of oaks is approximately 1 oak/acre.

3.6.3 SYCAMORE RIPARIAN

Sycamore riparian habitat along Orestimbra Creek on the Simon-Newman Ranch, west of Newman, California, was used as a reference site. This reference site is owned by The Nature Conservancy and has not been grazed for 5 years. The lack of grazing and presence of sycamore regeneration were the conditions that warranted use of this site as a reference site. Newman, California is in the Central Valley so this site receives less precipitation than the Alameda Creek Watershed. The community composition and structure is expected to be different; therefore, this reference site was not used as a reference for a species palette. An extensive literature search was also conducted to best inform the plantings and grading design for the sycamore riparian habitats of the compensation sites.

3.6.4 VIOLA GRASSLANDS

A 5-acre reference site was established in Callippe silverspot habitat mapped for the CDRP (Entomological Consulting Services 2004). The reference site is located on a ridge 1.5 miles northeast of the South Calaveras mitigation area, and 800 feet higher in elevation. Soils are Gaviota-Los Gatos complex. This site was selected for its proximity to the mitigation area, because it is known to support the host plant for Callippe silverspot, and because grazing is managed under the SFPUC's Grazing Management Plan at both sites.

3.6.5 DIABLAN SAGE

The Sage Canyon reference site is a 17.6-acre area near the eastern boundary of the Sage Canyon Mitigation Area. It is located at a similar elevation, slope, and aspect as the mitigation area, and is composed mostly of Diablan sage scrub vegetation.

3.6.6 SERPENTINE GRASSLAND

The Serpentine grassland reference site is a 13.8-acre area located less than 0.1 mile southeast of the Goat Rock Mitigation Area. The reference site is located entirely within serpentine grasslands. Soils are eroded Henneke rocky loam and rock land. This reference site was selected because of its similarity of soils and vegetation, and proximity to, the serpentine grassland compensation site.

4 CONSTRUCTION IMPLEMENTATION

This section, Construction Implementation, discusses compensation site construction and is divided into five components:

1. Site preparation, clearing and grubbing
2. Grading to establish hydrology and vegetation
3. Construction and operation of infrastructure, such as bridges, fences, irrigation, water tanks, and access
4. Pre-construction biological control for non-native, invasive plants and predators (Post construction predator management is discussed separately in Section 5.)
5. Vegetation establishment

4.1 SITE PREPARATION, CLEARING, GRUBBING

Site preparation at Goat Rock, Sheep Camp Creek, San Antonio Creek, and Goldfish Pond includes clearing select woody shrubbery, removal and stockpiling topsoil for grading areas. Topsoil will be stripped and stockpiled where earthwork will occur and reapplied when these features are no longer needed. The project design minimizes disturbance to mature vegetation and trees, however clearing woody shrubbery is necessary in select locations where excavation or fill is required to establish/reestablish or rehabilitate particular habitats. Cleared vegetation will be stockpiled in a staging area to be chipped into mulch that can be used around mitigation plantings, used for in-stream habitat features, or removed to a green-waste recycling facility. Prior to clearing, opportunities for native plant seed collection and transplanting may be afforded to restoration contractors, schedule dependent.

Generally the upper 6 inches of topsoil will be stripped and stockpiled to the side of the excavation or fill grading areas for subsequent spreading as part of finish grading. The biological site monitor will have the responsibility to identify topsoil containing problematic highly invasive weed species for segregation or burying to decrease the weed seedbank that may cause problems with the success of native revegetation. The potential species list will accompany project specifications (see table in Appendix I), however, the biological monitor will be given significant site discretion. One invasive plant species that will be on the list to be removed or segregated is medusahead grass.

4.2 GRADING TO ESTABLISH/REESTABLISH HYDROLOGY AND VEGETATION

A key aspect of providing sustainable riparian and wetland habitat is ensuring that the areas exhibit the water regime to which the proposed vegetation is adapted. This section discusses the construction methods used to establish habitats dependent upon the local hydrology.

Stream channel dimensions will be graded to carry the bankfull design discharge (flow event with a recurrence interval ranging from 1.1 to 1.8 years) and transition between existing slopes and channel dimensions. A floodplain or bankfull bench will be incorporated into over bank areas where room is available without disturbing mature vegetation or requiring major excavation. The floodplain and/or bankfull bench of tributary streams will be graded to match the elevation of the main stem floodplain

at the confluence. In-channel bed features including riffles, runs, pools, and glides will be constructed between in stream structures, where applicable. Eroded upper streambanks will be graded to provide a stable slope and planting area for riparian species.

Wetland habitats adjacent to creeks or ponds are graded to an appropriate elevation that will receive continuous inundation for a minimum of 5 days of the year. In a normal water year, areas may be inundated for many winter months. Creek-side wetlands will be at floodplain elevation or lower and pond fringe wetlands will be set at approximately plus or minus a half foot of the pond's spillway elevation.

Construction of new pond embankments will occur in the dry. The existing embankments will be removed and rebuilt in place with an impermeable core and compacted earthen fill. The new embankments will incorporate an outlet structure to facilitate future pond draining. The spillway will be excavated into the left side (looking downstream) of each embankment and lined with geo-synthetic material and/or riprap to prevent erosion. The elevation of the spillway crest will be such that the pond volume is 10 acre-feet or less.

Excavation and grading will be performed with dozers, excavators, backhoes, loaders, road graders, skid steers, vibratory rollers, and dump trucks. To reduce the potential for erosion, sedimentation, and impacts to species, construction is proposed during late summer when wetland and water features are dry. Temporary fencing will be used during construction to define exclusion zones, in select locations. Biological monitors will be on-site during construction to ensure biological resources are protected. Temporary overland disturbance from equipment traffic will be restored to a pre-disturbance condition by reseeding grasses and installing necessary erosion control products.

Specific grading methods for each compensation site are described below. Appendix E depicts grading limits, staging areas, access road locations, and potential fill locations.

4.2.1 SAN ANTONIO CREEK

At San Antonio Creek the riparian corridor will be graded to provide a consistent floodplain along the entire extent of the project reach. Existing floodplain areas that receive some flooding will be expanded by grading into adjacent areas that currently do not receive flooding. Stream terraces (or at least portions of the stream terrace) adjacent to the creek that do not receive flooding will be excavated to a bankfull elevation. Bifurcated or braided portions of the stream will be abandoned and filled to the floodplain elevation. The channel slope will be balanced to create a smooth transitioning slope from the upper to lower end of the project. The existing stream channel will be graded to match the proposed channel dimensions, which will likely require narrowing and deepening portions of the channel. Excess fill that does not balance within the riparian habitat rehabilitation and establishment/reestablishment areas will be placed in an upland disposal area (the former borrow site for the San Antonio dam) area away from the stream corridor. Fill material placed in any given location will typically be no deeper than three feet and be graded to meet the existing topography avoiding seasonally wet areas or drainages. (Appendix E).

4.2.2 GOLDFISH POND (SOUTH CALAVERAS MITIGATION AREA)

The existing embankment will be removed and rebuilt in place with an impermeable core and compacted earthen fill. The new embankment will incorporate an outlet structure to facilitate future pond draining. The spillway will be excavated into the left side (looking downstream) of the

embankment and lined with a geo-cellular confinement material and/or riprap to prevent erosion. The elevation of the spillway crest will be such that the pond volume is 10 acre-feet or less.

Wetland habitats will be created around the southern end of the pond by excavating soil to broaden and flatten the valley, thereby providing a larger seasonal wetland, saturated by the pond and groundwater over a longer period of the growing season. Where grading is to occur the upper six inches of topsoil will be stockpiled in an upland area to be placed on-site where new plants will be installed. Clayey soils excavated during the wetland grading will be stockpiled and placed aside in upland areas to be used as a pond liner in areas where excavation is below the existing clay layer. If insufficient clay is available onsite, than clay may be brought in from an outside source. A portion of the fill excavated from the seasonal wetland establishment area will be placed within the existing ordinary high water mark of the pond to reduce the storage capacity of the pond so that it does not exceed 10 acre-feet. Fill placed in the pond will extend the seasonal wetland area into the existing pond. The fill slope will taper into the existing slope of the pond bottom. Alternatively, fill may be disposed offsite at an approved soil recycling facility or landfill. Rock or bioengineered grade control structures will be installed at the top and toe of the cut slope. Grade control structures will be buried at grade across swales and the ephemeral drainage that feeds the pond to reduce the potential for head cutting.

The gully erosion below the embankment will be filled and contoured, avoiding mature willow trees where possible. The slope fill will be compacted with an excavator or backhoe bucket and smoothed to reduce the potential for erosion following revegetation. Willow stakes, fascines, or brush mattresses will be installed to stabilize the fill and prevent surface erosion.

Access to the embankment will occur from Calaveras Road by grading the existing eroded road to approximately 12-14 feet wide. The existing access route will be maintained as a vegetated access route following construction. Equipment access to the wetland creation area and drainage (upstream of the pond) will be from an existing gate on Felter Road. (Appendix G).

4.2.3 PONDS A-E (SHEEP CAMP CREEK MITIGATION AREA)

Proposed grading and earthwork at the four ponds in the Sheep Camp Creek Mitigation Area is summarized below.

- **Pond A**: Pond A will have the eroded embankment and spillway rebuilt and armored. Engineered fill will be placed in the eroded portion of the embankment and spillway. A geo-cellular confinement system will be placed in the spillway for scour protection. Soil and gravel mixture will be placed within the cells of the confinement matting along with native grass seed. Fill material will be trucked from road/pond construction areas where excess fill may be generated or clean fill will be trucked in from and offsite location.

- **Pond B**: The existing spillway at the top of the embankment (where no willows are growing) will be capped with compacted fill to prevent flow entering and further eroding the embankment. A new spillway will be located to the center of the embankment, sized to accommodate a 100-year flow. An armored stilling basin will be installed at the base of the spillway to dissipate flows prior to being released into a portion of the stream channel extended from the existing pond outlet to the proposed basin. The channel will be revegetated with native rhizomatous grasses to prevent channel erosion.

- **Pond C**: Similar to Pond A the embankment will be rebuilt with engineered fill. The spillway will be excavated to accommodate a 100-year storm event. A geo-cellular confinement system

will be placed in the spillway for scour protection. Pipe for the siphon drain will be placed in a trench over the embankment. The intake to the low flow bypass system will be excavated into the active bed of Sheep Camp Creek and filled with six-inch rock and gravel providing a pervious surface for water to infiltrate in to the intake and preventing sediment from clogging the piping system. Should the pond volume need to be reduced in storage capacity, the entire culvert pipe will be removed and placed at an appropriate elevation to maintain the pond storage below 10 acre-feet.

- **Ponds D and E**: No structural or physical habitat improvements are planned at Ponds D and E. The ponds will be enhanced through predator control, invasive species control, and grazing management.

4.3 INFRASTRUCTURE

This section describes the construction and operation of bridges and fences; the construction, operation, and water source of irrigation infrastructure; the use of water tanks; and access to the compensation sites.

4.3.1 BRIDGES (SAN ANTONIO AND SHEEP CAMP CREEK MITIGATION AREAS)

The San Antonio Creek mitigation area includes construction of a bridge on Ranch Road over San Antonio Creek to provide rainy season vehicular access to the properties on the south side of the creek (Appendix E). The bridge will be prefabricated from a railroad car or precast concrete. Railcar bridges typically come in widths ranging from 10 to 12 feet. Individual bridge segments are limited to a maximum span of about 85 to 90 feet between abutments. The foundation abutments for the bridge may consist of drilled piers, cast-in-place concrete or prefabricated interlocking concrete blocks. The bridge will be designed to pass a 100-year flow under the span. Preliminary hydrology and hydraulic analysis indicate that a double span railcar bridge with a span length of approximately 150 feet is sufficient to pass a 100-year storm flow. A double span bridge would require with a pier to be placed in the center of the active channel. The elevation of Ranch Road would be raised with compacted fill to provide a gradual approach up to the bridge elevation, thereby preventing aggressive approach angles that would prohibit equipment or trailers from crossing the bridge.

The Sheep Camp Creek riparian compensation site includes construction of a railcar bridge located at the crossing approximately 790 feet upstream of the corral. A natural stream channel dimension will be reestablished mimicking the upstream and downstream reaches following the removal of the existing culvert and road fill.

4.3.2 FENCING (ALL MITIGATION AREAS)

Fencing will be maintained and in some areas constructed to control grazing practices within the mitigation areas for the purposes of enhancing riparian and wetland vegetation, reducing bank erosion, enhancing special status species habitats, and/or non-native invasive plant management. Fencing would be designed to remain serviceable throughout the length of the 10-year monitoring period. Fences will necessarily be placed across some wetlands and waters due to the nature of the sites; however, in these areas, a biological monitor will ensure that impacts are minimized to every extent practicable. Fencing may also be required to cross some active stream channels, to manage cattle access. Fencing designs for these areas would accommodate regular base flows, but would necessarily require maintenance following large flow events. Fences across streams would be monitored as part of stream channel monitoring, and other fencing will be monitored as part of the

vegetation monitoring or species surveys, as applicable. Existing fencing that is neither required for future grazing management or crosses the creeks within the HRP perimeter fence would be removed.

Goldfish Pond, Pond B and Pond C will be partially fenced to use grazing to maintain both vegetated and vegetation-free areas for special status species habitat. Cattle will continue to have unrestricted access to unfenced portions of the ponds and are expected to keep the vegetated cover low in these areas. The North, South, and Stock Pond compensation sites will not be fenced. A small amount of emergent vegetation occurs at the ponds under the existing grazing regime, and this condition is expected to persist in the unfenced areas.

Existing fencing retained, existing fences that will be removed, proposed permanent fencing, and proposed temporary electric fencing are depicted for Sheep Camp Creek in Figures 3-6a through 3-6g, and for San Antonio, Goldfish Pond and Goat Rock in Appendix E, F, and G.

4.3.3 IRRIGATION AT SAN ANTONIO MITIGATION AREA AND SHEEP CAMP CREEK MITIGATION AREAS

Irrigation will be provided to woody plants for a 2-year period to increase plant survival and vigor. Irrigation systems will be designed by a qualified irrigation specialist with successful experience in native plant (particularly oak and sycamore) plantings. Qualifications for the specialist that would design and/or monitor irrigation and other components of this MMP are included in Table 4-1. Should vegetation monitoring recommend further watering beyond Year 2, than the monitoring period will be extended by the equivalent number of years watering was extended regardless of when irrigation was reinitiated. Irrigation water sources and methods of delivery to planting areas are listed in Table 4-2.

Table 4-1
Resource Specialist qualifications

Type of Specialist	Qualifications	Alternative 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

Table 4-1
Resource Specialist qualifications

Type of Specialist	Qualifications	Alternative Qualifications
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
Hydrologist/ Geomorphologist	• Bachelor's degree in hydrology, geology, natural resources management, engineering or similar environmental field or commensurate professional experience • Knowledge of piezometer, rain and stream gauge instrumentation, data collection methods, and processing techniques • Ability to identify field indicators of wetland and stream hydrology including identification and delineation of channel bankfull and ordinary high water • Knowledge of land surveying techniques, stream geomorphology, stream classification, and indicators of channel stability, scour, and erosion	Approved by applicable permitting agencies
Irrigation Specialist	• State of California licensed landscape contractor • Demonstrated experience in designing irrigation systems for native plantings (particularly oak and sycamore)	No alternative qualifications

Table 4-2
Irrigation sources and delivery methods at the San Antonio Mitigation Area.

Mitigation Area or Compensation Site	Planting Areas Requiring Water	Water Source	Delivery Method to Water Tanks	Above or Below Ground Piping
San Antonio Mitigation Area	Sycamore Riparian Oak Riparian Oak Woodland Oak Savannah	San Antonio Reservoir	Solar Pumps	Above
Sheep Camp Creek Mitigation Area	Sycamore Riparian Oak Riparian Willow Riparian Oak Woodland	Well Pond C	Solar Pumps	Above

Water distribution to planting areas would be by gravity feed from various tanks located within the compensation site. Pipelines would be buried in areas where cattle actively graze and above ground in locations excluded from cattle grazing during the vegetation establishment period. A timer controlled irrigation system will regulate the amount, duration and frequency of watering. The irrigation supply and distribution system will be installed during construction or during planting. Water pressure will be regulated to a level that applies sufficient water without causing damage to plants or erosion to the watering basin. Watering basins will be completely filled with water at each application.

SFPUC will select a contractor to design and install the irrigation system and a Restoration Specialist knowledgeable of plant requirements and irrigation to monitor the irrigation during plant establishment. This specialist will be pre-approved by agency staff. The restoration specialist may recommend hand-watering (from a water truck) in areas without a designated irrigation system, including but not limited to plug-planting areas.

As needed hand watering will occur for replants, late-planted plants, certain species, or individual plants that require irrigation after most other plants are weaned. The hand watering will be accomplished in a manner that saturates the root zone (i.e., 1-foot depth, minimum) without damaging the plant, the surrounding grade, or the watering basin.

4.3.3.1 IRRIGATION FREQUENCY AND DURATION

Irrigation is planned for 2 to 5 years, the longer duration may be necessary under drought conditions. Water will be applied in a way that will allow for the "weaning off" of plants. The irrigation schedule will be determined by the pre-approved irrigation and planting Restoration Specialist for each season (approximately June through October). The schedule will typically require deep and infrequent watering for the newly planted woody vegetation. Irrigation and watering applications will be performed in a manner to establish healthy and vigorous plants that are not irrigation-dependent at the end of the maintenance period.

Vegetation installation is weather dependent and may occur between October through December or January after the soils are wetted and sufficiently saturated to sustain plants. Other approaches may also be used to help plants establish, including the use of added mulch around planted trees and shrubs to increase soil moisture retention and Dri-Water (timed released watering system).

4.3.3.2 IRRIGATION WATER SOURCE

Water source is contractor dependent, but at all sites where water will be pumped (Sheep Camp Creek and San Antonio Mitigation Areas), solar generated electricity will provide the power. A backup of gasoline/diesel generator for solar systems is recommended in the event of equipment failure. The quantity of water pumped from each source may vary widely from year to year, depending on weather conditions. Irrigation water sources and routing are listed in Table 4-1 and Appendix E.

4.3.4 WATER TANKS

The water tanks will be placed in areas that provide sufficient elevation to gravity feed water to plants (and water troughs). Vehicular access to the water tank sites will be needed to periodically refill or maintain tanks; therefore, placement be adjacent to permanent or temporary access roads, were possible.

4.3.5 ACCESS

Access to the compensation sites would be via existing permanent and temporary access roads (Appendix E). One permanent access road (permitted through the CDRP) is planned from Marsh Road to the location of the CDRP Borrow Area E (Appendix E). This road for the purposes of the HRP project will be a graded dirt road. Temporary access roads will be provided for the purposes of vehicle and equipment access during construction and planting. Temporary roads may be graded to smooth out rough terrain, but most access will be across existing upland grassland.

At the completion of construction, site disturbance, and maintenance, graded and compacted access roads will be ripped to loosen compacted soil. Access roads will be seeded with native grass and erosion control products (straw mulch, wattles, or hydro-mulch) will be placed on sites that have grades greater than 2:1 (horizontal to vertical). Permanent access roads will be graded to control runoff including the installation of rolling dips to direct runoff from the roadway. Access roads will be located and constructed to avoid existing woody vegetation, wetlands and waters, to the extent feasible.

4.4 BIOLOGICAL SITE PREPARATION

This section describes biological activities associated with implementation of the proposed compensation, including non-native, invasive plant and predator control **methods implemented either prior to or during construction of the compensation project.** Post-construction maintenance actions are described in Section 6.

4.4.1 NON-NATIVE INVASIVE PLANT CONTROL

Actions will be taken to reduce the presence of non-native invasive plants during site construction. These actions include 1) removing select perennial non-native, invasive plants and 2) reducing non-native, invasive plant seed input from annuals and biennials to the site. The purpose of removing non-native, invasive plants before installation of project vegetation is to reduce the likelihood of infestations within the compensation site after restoration activities are completed. Post construction weeding and predator control are described in Section 6.

In 2008 non-native, invasive plant populations were located and mapped using a Global Positioning System (GPS) receiver (Nomad Ecology 2009). These GPS locations were overlain with the compensation site and mitigation area boundaries, using a Geographical Information System (GIS), to identify the non-native, invasive plants that should be targeted for removal during site preparation. Species with a Cal-IPC invasiveness rating of moderate or high are targeted for control (Table 4-3; Appendix I); however, as noted above, the restoration specialist will have discretion to make site-based decisions. Non-native annual grasses included on the Cal-IPC list, with the exception of medusahead, are not included in the species targeted for control in the mitigation areas.

Perennial, non-native, invasive plant removal method selection will be based on the species, size of infestation, presence of nearby sensitive species, and the time of year when construction commences. Multiple management methods may be used including hand tools, power tools, and/or heavy equipment depending on the species and population size. Mowing, or pulling of annuals and biennials should be conducted before seed set (generally late spring and/or early summer) and before grubbing or grading to limit seed dispersal to the site, if construction has a summer start date.

Burning and chemical control methods will be considered only when alternative methods are not practical (i.e., cost prohibitive or accessibility) or as successful. Any use of herbicides would be

applied in accordance with current SFPUC policy to reduce use of pesticides (City and County of San Francisco 1996), and must be approved for use by a Certified Herbicide Applicator.

Woody stems and trunks may be macerated into mulch and used on site.

In most compensation sites, the top six inches of soil will be removed, stockpiled during construction and reapplied to the site once grading is complete. If the seed bank is extremely contaminated with non-native invasive plant seeds a natural pre-emergence treatment may be applied to reduce non-native invasive plant seeds within the compensation site. The pre-emergence treatment would include the following activities:

- Water would be applied to the stockpile to encourage germination.
- Seedlings would then be pulled, or
- Corn meal gluten, which desiccates seeds when they crack open to sprout, would be applied with the water to prevent germination.

Either method would significantly reduce the number of non-native invasive plant seeds in the topsoil before it is reapplied to the site (Gough and Carlstrom1999).

Table 4-3
Cal-IPC moderate- or high-ranking species targeted for control.

Scientific Name	Common Name	Cal-IPC Rating	Life History
Brachypodium distachyon	annual false brome	Moderate	Annual
Brassica nigra	black mustard	Moderate	Annual
Carduus pycnocephalus	Italian thistle	Moderate	Annual
Centaurea calcitrapa	purple starthistle	Moderate	Biennial
Centaurea solstitialis	yellow starthistle	High	Annual
Cirsium vulgare	bull thistle	Moderate	Biennial
Conium maculatum	poison hemlock	Moderate	Biennial
Dipsacus sativus	fuller's teasel	Moderate	Biennial
Dittrichia graveolens	stinkwort	Moderate	Annual
Eucalyptus globulus	blue gum	Moderate	Perennial
Foeniculum vulgare	Fennel	High	Perennial
Hirschfeldia incana	shortpod mustard	Moderate	Biennial
Nicotiana glauca	tree tobacco	Moderate	Perennial
Phalaris aquatica	Harding grass	Moderate	Perennial
Rubus discolor	Himalayan blackberry	High	Perennial
Taeniatherum caput-medusae	medusahead	High	Annual
Tamarix parviflora	salt cedar	High	Perennial

4.4.2 PREDATOR CONTROL AND MANAGEMENT OF NON-NATIVE WILDLIFE

To improve habitat quality for California red-legged frog and California tiger salamander, bullfrogs and predatory fish would be removed from Goldfish Pond and Pond C where pond draining is necessary for restoration work. Methods for removal of predatory fish and non-native amphibian species include:

- Prior to construction, the ponds will be drained or pumped dry.
- USFWS approved biologists will survey the ponds during and after draining to remove and relocate to safe harbor any native amphibian species, all non-native amphibian and fish species will be euthanized humanely. This is described further below.

Goldfish Pond and Pond C will be drained concurrent with implementation of the wetland construction. Intakes to pumps or outlets used to drain the pond will be screened to prevent entrainment of amphibian larvae or movement of non-native fish downstream of the pond. Fish or bullfrogs remaining after the ponds are drained will be smothered with soil that will be placed in the pond to reduce the volume to less than 10 acre fee. Elimination of predators from this pond will provide an opportunity to reestablish breeding populations of California red-legged frog and California tiger salamander at Goldfish Pond and maintain aquatic habitat suitable for California tiger salamander at Pond C.

After pond draining, a qualified biologist will inspect the pond and surrounding area to identify and remove any special status species. Any individual CTS or CRLF will be relocated to a safe location with appropriate cover and habitat. After this survey has been completed, a bulldozer will scrape dry soil from the pond edges and place it on top of mud at the bottom of the pond. The equipment would then make several passes over the soil to compact it, with the objective of smothering remaining non-native fish or bullfrogs. Smothering is only proposed at Goldfish Pond where fill material will be placed in the pond bottom.

Other non-native wildlife that could potentially adversely affect California red-legged frogs and California tiger salamanders will be managed as part of the adaptive management process (i.e., feral pig, mosquitofish). Post-construction biological maintenance actions are described in Section 6.

4.5 VEGETATION ESTABLISHMENT

Plants will be installed at San Antonio Creek, Goldfish Pond, and Sheep Camp Creek. This section contains the draft plant species list, and an overview of propagule source, storage, and propagation techniques. Lastly, this section describes how plants would be acquired and the methods that were used to calculate the quantities for each species.

4.5.1 PLANT SPECIES LIST

The draft planting list (Table 4-3) was compiled following a HRP propagule collection study. The species listed are appropriate natives for each habitat, have been observed thriving in restoration projects, and are abundant within the Alameda Creek watershed. Quantities for each species were calculated using the acreages of each habitat type being established/reestablished or rehabilitated (for more detail, see Section 4.5.3).

4.5.2 SOURCES, STORAGE, AND PROPAGATION TECHNIQUES

Propagules for most species on the planting list will be collected from within the Alameda Creek watershed (Appendix J, Propagule Collection Memo). Other collection sources may be used if quantities cannot be met within the watershed, including East Bay Regional Park District land and the Livermore Area Recreation and Park District. Purchase of commercial seed may be needed to fill quantities. The most ecologically similar seed will be purchased for nursery propagation or direct seeding on-site.

All seed and cuttings for propagation will be stored appropriately to protect and maintain seed quality. Collected and commercially purchased seed will be kept in a cool dry place; not stored in a place exposed to extreme temperatures.

Oak acorns require special treatment before planting on site. Acorns must undergo a float test to ensure that rotten acorns are identified and discarded. After rotten acorns (ones that float when submerged in water) are discarded, the remaining acorns are cleaned in a 5 percent bleach solution. They are then stored in the refrigerator for at least 30 days in a plastic freezer bag filled with perlite. Acorns that have germinated (small protruding radical present) are ideal for planting. Due to the large number of acorns needed for the HRP project, and the known fluctuation in acorn production form year to year, approximately 3,000 acorns were collected and propagated. These will supplement acorns that will be collected in subsequent years for the HRP project.

California blackberry will be propagated vegetatively. Rush species may be propagated vegetatively through salvaged divisions and/or from seed. Proper stratification techniques must be followed for all seeds with such requirements. Specifically rushes, sanicle (*Sanicula* ssp*),* snowberry (*Symphoricarpos* ssp.*),* and buckwheat *(Erigonium fasciculatum)* seeds have stratification needs before planting/germination (see Appendix J for more detail).

4.5.3 PLANT SIZES AND ESTIMATED NUMBER OF INSTALLED PLANTS

Recommended plant sizes and quantities for planting are summarized in Table 4-4. In general, seeds of tree species will either be planted directly on-site or in tree pots (TP). Shrubs will be planted from D16 containers while grasses and rushes will be planted from either supercell (SC) containers or plug plants. Any substitutions of plants in Table 4-4 must be approved by the resource agencies.

Table 4-4
Draft planting list.

Scientific Name	Common Name	Size[1]	Quantity Total
Sycamore Riparian			
Artemisia douglasiana	mugwort	D16	1173
Elymus glaucus	blue wild rye	plug	830
*Hordeum brachyantherum**	meadow barley	plug	488
Juncus balticus	Baltic rush	divisions/plugs	325
Juncus effuses	common rush	divisions/plugs	325
Juncus patens	spreading rush	divisions/plugs	830
Platanus racemosa	western sycamore	TP	845
Ribes sp.	gooseberry	D16	70
Rosa californica	California rose	D16	70
Rubus ursinus	California blackberry	D16	70
Scrophularia californica	bee plant	D16	180
Symphoricarpos mollis	creeping snowberry	D16	70

Table 4-4
Draft planting list.

Scientific Name	Common Name	Size[1]	Quantity Total
Perennial Wetland			
Shoenoplectus acutus	hardstem bullrush	divisions	802
Seasonal Wetland			
*Hordeum brachyantherum**	meadow barley	plug	1,391
Juncus balticus	Baltic rush	divisions/plugs	3,128
Juncus patens	spreading rush	divisions/SC	1,043
Leymus triticoides	creeping wildrye	divisions/plugs	1,391
Oak Savannah			
Bromus carinatus	California brome	plug	23,542
Elymus glaucus	blue wild rye	plug	35,313
Koelaria macrantha	junegrass	Seed	TBD
Melica californica	California melic grass	plug	23,542
Nassella pulchra	purple needlegrass	plug	35,313
Quercus agrifolia	coast live oak	Acorn/TP	10,005
Quercus douglasii	blue oak	Acorn/TP	9,711
Quercus lobata	valley oak	Acorn/TP	9,711
Symphoricarpos mollis	snowberry	D16	36,784
Oak Riparian			
Aesculus californica	California buckeye	seed	145
Artemisia douglasiana	mugwort	D16	1,116
Leymus triticoides	creeping wildrye	divisions/plug	1,488
Quercus agrifolia	coast live oak	Acorn/TP	436
Quercus lobata	valley oak	Acorn/TP	871
Rubus ursinus	California blackberry	D16	192
Sambucus mexicana	blue elderberry	D16	192
Scrophularia californica	bee plant	D16	1,116
Symphoricarpos albus var. *laevigatus*	snowberry	D16	256
Oak Woodland			
Achillea millefolium	yarrow	plug	13,010
Aesculus californica	California buckeye	seed	1.626
Artemisia californica	California sagebrush	D16	4,066
Baccharis pilularis	coyote brush	D16	4,066

Table 4-4
Draft planting list.

Scientific Name	Common Name	Size[1]	Quantity Total
Chlorogalum pomeridianum	soap plant	SC	6,505
Elymus glaucus	blue wild rye	plug	16,262
Lessingia filaginifolia	California sandaster	SC	6,505
Mimulus aurantiacus	bush monkeyflower	D16	6,098
Nassella pulchra	purple needlegrass	plug	6,505
Quercus agrifolia	coast live oak	Acorn/TP	4.879
Quercus douglasii	blue oak	Acorn/TP	4.879
Quercus lobata	Valley oak	Acorn/TP	4.879
Sanicula crassicaulis	pacific sanicle	plug	16,262
Symphoricarpos mollis	creeping snowberry	D16	6,098
Willow Riparian			
Salix exigua	sandbar willow	cuttings	871
Salix laevigata	red willow	cuttings	1,745
Salix lasiolepis	arroyo willow	cuttings	1,745
Native Grasslands			
Achillea millefolium	yarrow	plug	682
*Hordeum brachyantherum**	meadow barley	plug	1,708
Leymus triticoides	creeping wildrye	divisions/plug	1,708
Nassella pulchra	purple needlegrass	plug	1,708
Sanicula bipinnatifida	purple sanicle	plug	683
Sisyrinchium bellum	blue eyed grass	plug	341

[1] Plant container sizes: **Plug:** 1" x 1" x 2.5" deep; **SC** (supercell): 1.5" x 8.25" deep; **D16:** 2" x 7" deep; **TP** (tree pot): 1 gallon (4" x4" x14" deep)

Sycamores will be planted from tree pots, approximately on 15-foot centers throughout the sycamore riparian habitat. Oak trees will be planted on 12-foot centers on average throughout the oak riparian habitat and 15-foot on center throughout the oak savannah and oak woodland habitats. Shrub species will be planted on 10-foot centers on average.. Perennial, graminoid, and emergent species, including native grasslands at Goldfish Pond, will be planted 5-foot on center in perennial and seasonal wetlands and 6-foot on center in the other habitats. All areas with grading will also be hydroseeded with native grass and forb species.

Spacing distances were selected based on target habitat (savannah versus riparian), types and quantities of companion plants being planting in the community, and desired long-term density. Initial spacing was determined from past restoration plans, restoration guides, and previous restoration successes and failures then it was catered for the specific goals of the mitigation area. For instance,

oak species are planted in the woodland areas at 15-feet on center. Based on estimates of the size of mature oaks and assuming the 30% survival criterion is met, this spacing will not require thinning and the product will satisfy oak woodland density and cover requirements. Similarly, herbaceous species are being planted at 5-6 feet on center, this is close enough to keep bare patches from being unsightly and far enough away that we keep total plant propagation numbers down. Sycamore riparian planting densities were based on reference populations identified in the 'The Definition and Locations of Central California Sycamore Alluvial Woodland' (CDFG 1997). If the 30% survival criterion for sycamore plantings is met, then the long-term stand density will approximate the densities of reference populations. In addition, weed abatement activities and a generous spacing distance will reduce intra-specific competition allowing these herbaceous natives room to thrive and spread.

The spacing listed will be used to ensure that each plant has enough space; however, this does not mean that there will be a plant every 6 feet on center throughout the entire site. The planting layout will mimic natural conditions, with a naturalistic planting pattern (i.e., not grid planted) most likely in patches. Plant or patch locations will be pin flagged at each site.

In the following section, plant protection, plant installation methods, and vegetative propagation methods are discussed.

4.5.4 NATIVE SPECIES PROTECTIONS AND EXCLUSIONS

New plantings are subject to browsing by cattle and multiple species of wildlife. The compensation sites and mitigation areas will be fenced to protect both areas from grazing.

Sycamore plantings subject to cattle grazing would be protected with tree shelters coupled with t-stakes to prevent cattle from knocking over plantings when rubbing against the shelters. Tree and shrub plantings in areas not grazed by cattle will be protected with tree and shrub shelters fastened to T-posts. Protection will not be given to herbaceous species in plugs or Supercell containers.

4.5.5 SEED MIX APPLICATION AND PLANTING

Vegetation will be established using a variety of techniques including seed mixes and multiple sizes of container stock.

Seed Mixes: Hydroseeding will primarily be used in areas prone to erosion. After the soil is prepared, grassland seed mixes shall be applied to the site usually hydroseeded. Hydroseed will be applied with a corn starch or *Plantago*-based tackifier product and a natural or recycled (pulp) fiber mulch, such as wood chips or similar wood materials, chipboard, corrugated cardboard or a combination of these processed materials, and free of synthetic or plastic materials. Detailed hydroseeding requirements will be defined in the planting specifications prepared for the plant installation contractor.

Tree Seed: Two species of trees may be propagated from seed: oaks and buckeye. Acorns will be planted three to a hole with the radical pointing downward. A 6-inch planting hole shall be excavated, the spoils will be used to backfill the hole and acorns will be planted 2 inches deep spaced a few inches apart to easily weed out multiple seedlings at a later date. Soil will be added to cover the acorn. Buckeyes will be planted in a shallow depression where the top half of the buckeye is not covered by soil. All planted tree seed will have protective cages installed around them to protect from above ground herbivory. Subsurface cages may be added at the discretion of the planting contractor based on site-specific conditions.

Plug Planting: A plug bar, the same depth as the plug, should be used to plant grass plugs. The plug bar will be pushed into the soil until the plug bar footrest is level with the ground. Next, the plug bar will be removed and the plug will be inserted into the hole. Using a plug bar will provide an easy and consistent method of planting.

Tree pot, Super Cell and D16 Container Planting: For planting of the D16, SC, and tree pot (TP) containers, a 6 to 12 inch circular planting basins with a 4-inch berm around each plant will be prepared for each tube. After the holes have been excavated, the inside surfaces will be scarified to enable root penetration into the soil. Then, the intact root ball will be removed from the container and placed into the hole without damaging the roots. Finally, the excavated soil will be used to fill in the hole while the plant is held in position.

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5 SUCCESS CRITERIA AND MONITORING

This section defines final performance standards and interim success criteria. Final performance standards are assessed at the end of the permit compliance monitoring period to identify whether the site has successfully met the mitigation goals. Interim success criteria are evaluated on an annual basis and are used to track progress towards meeting the final performance standards. Performance standards are based on mitigation goals and incorporate vegetation cover guidelines, habitat value, hydrologic function, and species utilization metrics. Success criteria are defined for each of the proposed habitats listed Table 3-1. Monitoring is proposed that will evaluate the performance and assess whether the final success criteria are satisfied. The locations of proposed habitat establishment/reestablishment, rehabilitation and enhancement are presented on Figures 3-1 through 3-5. This section includes a discussion of the monitoring protocol and methods, data collection parameters, and monitoring schedule for the HRP mitigation areas.

5.1 PERFORMANCE STANDARDS

Successful establishment/reestablishment, rehabilitation and enhancement of the habitats in the HRP mitigation areas will be determined based on set performance standards. Performance standards are observable or measurable attributes evaluated at the end of the monitoring period to assess whether the goals of the mitigation have been accomplished. These standards are based on success of desired vegetation establishment, adequate hydrologic function, and presence of quality habitat for special-status species.

The permit compliance monitoring period ranges from five to ten years, depending on the habitat, e.g., habitats dominated by grasses, herbs, or shrubs, will be five years, while habitats dominated by tree species, which take longer to establish, will be monitored for ten years. Areas where stream channels have been restored or modified by the installation of in stream structures will be monitored for ten years.

Final performance standards, summarized in Table 5-1 by habitat type (Tables 5-1a through 5-1f), are evaluated at the end of the permit compliance monitoring period. Final performance standards are the same for both rehabilitated and established/reestablished areas and include total vegetation cover, total native vegetation cover, special status species habitat, and creek hydrogeomorphology (progressing toward a relative state of dynamic equilibrium). In addition to the specific performance standards presented in Table 5-1, rehabilitated or established/reestablished areas will meet the qualitative performance standards listed below.

- Planted vegetation will be fully established, i.e., not require irrigation, and will be self sustaining (as evidenced by successive years of healthy vegetative growth; observed increase in vegetative cover, canopy cover, and/or plant height; successful flowering, seed set, and/or or vegetative reproduction) at the end of the monitoring period

- Installed infrastructure (e.g., gates, valves, piping, pumps, bridge) should function according to design specifications with no signs of premature wear, and should have demonstrated reliability during the monitoring period. As noted in Section 6, the SFPUC will place conservation easements on portions of the mitigation area and fund a management endowment for use by the leaseholder into perpetuity.

The SFPUC will continue monitoring and management of the mitigation sites after permit compliance is achieved, however the parameters, methods, and frequency will be modified to be commensurate with routine management. The monitoring results and adaptive management developed during the 10-

year compliance monitoring period will provide clear, site tested management guidance, which will be used to inform future management. The SFPUC has notified their Sunol Region grazing leaseholders that new management practices will be required as the compensation projects are implemented.

Table 5-1a
Grassland habitat performance standards

Habitat Category and Compensation Type	Location	Monitoring Duration[1]	Mitigation Objectives	Performance Standards	Method for Measuring Performance Criteria
Native grassland establishment/re-establishment	South Calaveras Mitigation Area (Goldfish Pond)	5 Years[2]	Establish native grass and forb species	Absolute vegetative cover (of native and naturalized plant species) will be at least 55%	1) Baseline assessment of native and non-native invasive plant cover 2) Line-intercept or plot based sampling of cover compared to baseline 3) Permanent photo-monitoring points 4) Aerial photograph in Year 5 5) Visual, qualitative observations
			Minimize cover of non-native invasive plants	Absolute cover of non-native, invasive species will not exceed 5%	
Serpentine grassland enhancement	Goat Rock Mitigation Area	10 Years	Increase cover of native serpentine endemic plant species	Relative cover of native serpentine endemic species at the compensation site will show, on average, an increasing trend over the 10-year monitoring period, relative to baseline conditions	1) Baseline assessment of plant cover and species composition 2) Line-intercept or plot based sampling of cover and composition compared to baseline 3) Visual, qualitative observations
	Goat Rock Mitigation Area	10 Years	Minimize cover of non-native invasive plants	Absolute cover of non-native invasive plant species will show a decreasing trend over the 10-year monitoring period, relative to baseline conditions	
Non-native grassland enhancement	All Mitigation Areas	10 Years	Minimize absolute cover of non-native invasive plants	Absolute cover of non-native invasive plant species will show a decreasing trend over the 10-year monitoring period, relative to baseline conditions	1) Mapped extent of non-native invasive species 2) Visual, qualitative observations
			Provide a mosaic of grassland structure suitable for multiple native wildlife and plant species	Maintain a mosaic of vegetation heights and densities within non-native grasslands comparable to reference sites	Visual, qualitative observations coupled with measurements of residual dry matter (RDM) compared to selected reference sites
			Maintain or increase cover of native plant species	Cover of native plant species will be equal to or higher in cover relative to baseline conditions	1) Baseline assessment of plant cover and composition 2) Line-intercept or plot based sampling of cover compared to baseline 3) Visual, qualitative observations

Notes:

[1]Assuming performance standards are met. Monitoring will be extended if performance standards are not met.
[2] Final monitoring for non-native plant species will be Year 10

Table 5-1b
Wetland habitat performance standards

Habitat Category and Compensation Type	Location	Monitoring Duration[1]	Mitigation Objectives	Performance Standards	Method for Measuring Performance Criteria
Perennial and seasonal wetland and wetland tributary (establish/re-establish)	San Antonio, Sheep Camp Creek, and South Calaveras (Goldfish Pond) Mitigation Areas	5 Years[2]	Establish wetlands with wetland hydrology and vegetation characteristic of impacted wetlands	Wetland vegetation must meet the USACE criteria for dominance of hydrophytic vegetation Hydric soil indicators are observed. Hydrologic conditions are present for each of the five years monitored. To meet this standard, wetland hydrology will be reflective of the type of wetland targeted- i.e., seasonal hydrology needs to be achieved for a seasonal wetland, and perennial hydrology needs to be present for a perennial wetland.	USACE Arid West wetland delineation method, or equivalent. Equivalency means: If the 5 years of monitoring documents wetland soils, vegetation and hydrology at each wetland site, then the wetland Performance Criteria will have been met without the need for performing a formal wetland delineation. The equivalency requirement will be applied on a site by site, wetland by wetland basis.
			Minimize cover of non-native invasive plants	Absolute vegetation cover of each wetland feature will be 70% at the end of Year 5 Absolute cover of non-native, invasive species will not exceed 5%	1) Point-line intercept sampling of cover and species composition 2) Permanent photo-monitoring points 3) Visual, qualitative observations
Perennial, seep, seasonal wetland and wetland tributary enhancement	All Mitigation Areas	5 Years[2]	Maintain or increase cover of native hydrophytic plant species compared to baseline conditions.	Absolute cover of hydrophytic plant species will be equal to or higher in cover relative to baseline conditions	1) Baseline assessment of plant cover and species composition 2) Visual, qualitative observations
			Minimize absolute cover of non-native invasive plants	Absolute cover of non-native invasive plant species will show a decreasing trend over the 5-year monitoring period, relative to baseline conditions	

Notes:
[1]Assuming performance standards are met. Monitoring will be extended if performance standards are not met.
[2] Final monitoring for non-native plant species will be Year 10

Table 5-1c
Riparian habitat performance standards

Habitat Category	Location	Monitoring Duration[1]	Mitigation Objectives	Performance Standards	Method for Measuring Performance Criteria
Establishment/reestablishment and rehabilitate					
Willow riparian	San Antonio, Sheep Camp Creek, and South Calaveras (Goldfish Pond) Mitigation Areas	5 Years[2]	Establish or increase native woody cover along stream banks	Relative canopy cover of willows and other native woody plant species will be at least 60% at Year 5	1) Point-line intercept or plot based sampling of cover and species composition compared to baseline 2) Aerial photography in Years 5 and/or 10 3) Permanent photo-monitoring points 4) Count or estimated area of live plantings within 100 sq meter plots compared to planted density (sycamore and oak riparian)
			Minimize cover of non-native invasive plants	Absolute cover of non-native, invasive species will not exceed 5%	
Sycamore riparian	San Antonio and Sheep Camp Creek Mitigation Areas	10 Years	Increase age diversity and extent of sycamore riparian habitat	Survival of sycamore riparian plantings will be at least 30%	
				Tree planting survival will be at least 30%	
			Minimize cover of non-native invasive plants	Absolute cover of non-native, invasive species will not exceed 5%	
Oak riparian	San Antonio and Sheep Camp Creek Mitigation Areas	10 Years	Increase canopy cover and quality of oak riparian habitat	Survival of planted trees will be at least 30%	
				The relative cover of native species will show, on average, an increasing trend over the 5-year monitoring period	
			Minimize cover of non-native invasive plants	Absolute cover of non-native, invasive species will not exceed 5%	
Enhancement					
Willow riparian	San Antonio, Sheep Camp Creek, and South Calaveras (Goldfish Pond) Mitigation Areas	5 Years[2] (willow & scrub) or 10 Years (other)	Maintain or increase absolute cover of native plant species	Absolute cover of native plant species will be equal to or higher in cover relative to baseline conditions	1) Baseline assessment of plant cover and species composition 2) Visual, qualitative observations 3) Permanent photo-monitoring points 4) Aerial photography in Years 5 and/or 10
Sycamore riparian	Sheep Camp Creek Mitigation Area				
Oak riparian	South Calaveras Mitigation Area		Minimize cover of non-native invasive plants	Absolute cover of non-native invasive plant species will show a decreasing trend over the 5 – 10 year monitoring period, relative to baseline conditions.	
Mixed riparian woodland	San Antonio and Sage Canyon Mitigation Area				

Table 5-1c
Riparian habitat performance standards

Habitat Category	Location	Monitoring Duration[1]	Mitigation Objectives	Performance Standards	Method for Measuring Performance Criteria
Riparian scrub	South Calaveras and San Antonio Mitigation Areas				
Notes: [1]Assuming performance standards are met. Monitoring will be extended if performance standards are not met. [2] Final monitoring for non-native plant species will be Year 10					

Table 5-1d
Oak woodland and savannah habitat performance standards

Habitat Category	Location	Monitoring Duration[1]	Mitigation Objectives	Performance Standards	Method for Measuring Performance Criteria
Establish/reestablish and rehabilitate					
Oak woodland	San Antonio and Sheep Camp Creek Mitigation Areas	10 Years	Increase canopy cover and extent of oak woodland and savannah habitat	Tree planting survival will be at least 30%	1) Point-line intercept sampling of cover and species composition 2) Aerial photography in Years 5 and/or 10 3) Permanent photo-monitoring points 4) Count or estimated area of live plantings within 100 sq meter plots compared to planted density
Oak savannah	San Antonio Mitigation Area			The relative native cover will show, on average, an increasing trend over the 5-year monitoring period	
			Minimize cover of non-native invasive plants	Absolute cover of non-native, invasive species will not exceed 5%	
Enhancement					
Oak woodland	All Mitigation Areas	10 Years	Maintain or increase absolute cover of oak species and other native plant species	Absolute cover of oak and other native plant species will be equal to or higher in cover relative to baseline conditions	1) Baseline assessment of plant cover and species composition 2) Aerial photography in Years 5 and/or 10 3) Visual, qualitative observations 4) Permanent photo-monitoring points
Oak savannah	South Calaveras and Sage Canyon Mitigation Areas		Minimize cover of non-native invasive plants	Absolute cover of non-native invasive plant species will show a decreasing trend over the 5-year monitoring period, relative to baseline conditions	

Table 5-1e
Streams and pond habitat performance standards

Habitat Category and Compensation Type	Location	Monitoring Duration[1]	Mitigation Objectives	Performance Standards	Method for Measuring Performance Criteria
Streams					
Intermittent and ephemeral stream rehabilitate	San Antonio Mitigation Area	10 Years	Decrease bank erosion	Streams should have geomorphic variables within acceptable ranges as defined in Tables 5-4 and 5-5	1) Monitoring of rainfall and groundwater levels 2) Data downloads from rain and stream gauges 3) Data from the piezometers at San Antonio Creek 4) Photo-documentation at representative cross-section locations 5) Aerial photography in Years 5 and 10 6) Longitudinal survey along the thalweg of the stream through the restored reach 7) Cross-sectional surveys at representative cross-section locations
			Provide suitable substrate for native aquatic species		
			Enhance floodplain hydrology		
			Increase native woody cover on the target stream bank, and reestablish appropriate native tree species	Planted vegetation will meeting the performance standards defined for riparian vegetation habitats	Methods as described above for riparian habitats
Intermittent and ephemeral stream enhancement	All Mitigation Areas	10 Years	Increase native plant cover along intermittent streams	Absolute cover of native plant species will be equal to or higher in cover relative to baseline conditions	Methods as described in Table 5-1c above for riparian habitats
Ponds					
Pond enhancement	All Mitigation Areas	10 Years	Enhance habitat that supports breeding of California red-legged frog and California tiger salamander	Ponds will be free of predators to the extent practicable	Annual surveys, as described in Section 5.3.8.1
				Mixture of emergent wetland vegetation and open water and edge habitat will be present. Pond areas open to grazing shall contain less than 35% absolute cover of emergent vegetation.	1) Monitor pond hydrology (sufficient duration of ponding) and pond sedimentation rates 2) Measure maximum water depth 3) Visually estimate cover of emergent vegetation, submerged vegetation, and open water 4) Visually estimate pond turbidity (Secchi disk) 5) Visually estimate vegetation trampling 6) Visual survey of amphibian adult, juvenile or larvae; dipnet, tadpole observations and CTS egg-grid monitoring 7) Bathymetric transect to determine pond sedimentation rate
				Mitigation ponds will hold water for a minimum of 3 months/year for California tiger salamander and 9 months/year for California red-legged frog.	

Table 5-1e
Streams and pond habitat performance standards

Habitat Category and Compensation Type	Location	Monitoring Duration[1]	Mitigation Objectives	Performance Standards	Method for Measuring Performance Criteria
				1) Rodent burrows should be present within 500 feet of breeding habitats 2) Maintain sufficient cover to moderate temperatures and provide protection from predators	1) Visual surveys for upland habitat within 500 feet of mitigation ponds for presence/absence of: burrows or refugia, sufficient cover. 2) Visual estimate of vegetation cover 3) Visual surveys for adult or juvenile frogs and salamanders, larvae or egg mass

Notes:
[1]Assuming performance standards are met. Monitoring will be extended if performance standards are not met.

Table 5-1f
Listed species habitat performance standards

Compensation Type	Location	Monitoring Duration[1]	Mitigation Objectives	Performance Standards	Method for Measuring Performance Criteria
California red-legged frog and California tiger salamander upland habitat	All Mitigation Areas	10 Years	Enhance, rehabilitate, and establish upland habitats that support aestivation and dispersal of endangered California red-legged frog and California tiger salamander	Rodent burrows should be present within 500 feet of breeding habitats	Visual assessment for rodent burrows and/or other underground refugia
				Protection from predators	Visual survey to assess adequacy of cover (deep water, vegetation cover, turbidity) to provide protection from predators
				Appropriate and accessible migration corridors between populations	Migration corridors will be mapped and walked to confirm absence of migratory barriers and presence of appropriate migratory habitat.
Alameda whipsnake habitat	Sage Canyon, South Calaveras, San Antonio and Goat Rock Mitigation Areas	10 Years	Enhance habitat that supports endangered Alameda whipsnake	Maintain or increase area of varying aged scrub stands with rock outcrops and interspersed grasslands suitable for Alameda whipsnake	1) Baseline assessment of vegetation cover using aerial photo mapping 2) Aerial photos in Year 5 and Year 10 3) Assessment of scrub and grassland cover based on aerial photo review or field mapping. 4) Visual, qualitative observations
				Presence of appropriate prey species	Visual, qualitative observations
Callippe silverspot butterfly habitat	Sage Canyon, South Calaveras, and Sheep Camp Creek Mitigation Areas	10 Years	Enhance habitat that supports the host plant for endangered Callippe silverspot butterfly	Maintain presence of other appropriate nectar plants in vicinity of host plant populations[1]	Visual, qualitative observations
				Maintain or increase total cover of the larval host plant *Viola pedunculata* relative to baseline conditions[2]	Point-line intercept vegetation monitoring

Notes:
[1]Assuming performance standards are met. Monitoring will be extended if performance standards are not met.
[2] The metrics for Callippe silverspot performance standards will be finalized after discussions with USFWS. Refer to Section 5.2.3.3

5.2 INTERIM SUCCESS CRITERIA

Interim success criteria will be used to evaluate annual progress towards meeting performance standards and to help SFPUC and others determine if and where remedial actions or adaptive management might be necessary. Annual monitoring, consisting of general observations of plant establishment, non-native invasive cover, erosion, and general site conditions will be used to inform remedial actions. Interim monitoring will be conducted in years 1-5, 7 and 10, and results will be compared to interim success criteria to track progress towards achieving performance standards.

5.2.1 VEGETATION INTERIM SUCCESS CRITERIA

Success criteria for the proposed habitats at the HRP mitigation areas will be based on survivorship of tree and shrub plantings in woodland, savannah, and riparian habitats, as well as percentage of absolute cover of native herbaceous, and willow species in all rehabilitated or constructed habitat types. Tables 5-2 and 5-3 provide success criteria for each interim monitoring year for each vegetation type.

Table 5-2
Vegetative cover interim success criteria
for established/reestablished and rehabilitated areas

Years After Construction	Total Grassland Cover* (Goldfish Pond)	Total Wetland Cover	Wil Riparian Overstory Cover	Target Non-native Invasive Species Relative Cover
Year 1	40%	10%	-	<5%
Year 2	30%	15%	10%	<5%
Year 3	40%	30%	20%	<5%
Year 4	50%	50%	30%	<5%
Year 5	55%	70%	60%	<5%
Year 7	-	-	-	<5%
Year 10	-	-	-	<5%

* For Years 1 and 2, a minimum of 40 percent and 30 percent, respectively, absolute cover of native seeded/planted grass species should be achieved. For Years 3-5, the minimum acceptable general cover will include both native and naturalized species typical of annual grassland communities.

Table 5-3
Percent survival interim success criteria
for planted tree and shrub species.

Years after Construction	Oak Woodland, Oak Riparian and Oak Savannah Habitats	Sycamore Riparian
Year 1	75%	60%
Year 2	60%	55%
Year 3	50%	50%
Year 4	45%	45%
Year 5	40%	40%
Year 7	35%	35%
Year 10	30%	30%

5.2.1.1 GRASSLAND HABITATS

For the grassland establish/reestablished area at Goldfish Pond, the plants installed may be very different from the mixture of grasses and forbs found in the immediate area due to existing non-native grasses and forbs on site. Annual success criteria are set to measure absolute native cover during Years 1 and 2, but switch to measuring absolute total cover in Years 3-5 due to high the potential for non-native species to colonize the site. Since these non-native grass species are naturalized throughout California and provide acceptable habitat for special-status species, there is no criterion set for the amount of non-native grasses in the site. However, SFPUC would control any non-native grasses that may limit the growth of native forbs and are considered particularly invasive (defined by Cal-IPC as moderately or highly invasive).

Grassland areas at Goat Rock are distinguished by the presence of serpentine soils and rock outcrops. Monitoring at Goat Rock will include collection of baseline data of vegetation cover and species composition prior to implementation of new grazing management of the area. Baseline data will inform potential vegetation cover thresholds for management actions, including cover of non-native invasive plants, native plants and/or rare plants. Baseline monitoring will be used to establish these threshold values for Goat Rock grasslands.

5.2.1.2 WETLAND HABITATS

Interim success guidelines for establish/reestablished wetland habitats are designed to monitor progress towards meeting USACE delineation requirements for wetland soils, hydrology and vegetation. Interim success criteria for wetland soils and hydrology are further described in Section 5.2.2.3. Success criteria for hydrophytic vegetation listed in Table 5-2 is intended to monitor progress towards meeting USACE '50/20' rule and a 70 percent total absolute cover of native and non-native species by Year 5. The rule requires 50 percent of assigned dominant vegetative cover (relative cover) to be hydrophytic (native or non-native plant cover) Measuring total vegetative cover each year ensures that the area of bare ground decreases during the monitoring period. Species identified within seasonal and perennial wetlands should be characteristic of these habitats within the region as described in Section 2.3.1.5.

5.2.1.3 TREE HABITATS

Success guidelines for tree-dominated habitats reflect the anticipated growth rate for the target trees (e.g., willows grow faster than oaks) and include parameters for survival and cover. No cover criterion is set for willows in Year 1. The dominant variable affecting willow survival is pole planting location, i.e., vertical bank position relative to water elevation. If the position is right for the channel cross section and assuming a "normal" water year, year 1 willow survival should be 80% and if this is not achieved the planting locations and/or source material should be modified.

The survival expectation of sycamore and oak plantings is low due to the difficulty in establishing sycamore seedlings and germinating oaks from seed. Some losses of planted trees and shrubs are anticipated, but to ensure that mitigation needs are fulfilled, tree survival should be at least 30 percent of the total proposed plantings. Planting densities will be determined with the objective of meeting target tree densities (as determined by review of a reference site) assuming a 30 percent survival. If survival criterion is met, it is assumed that the tree density will be sufficient to provide the desired habitats.

5.2.1.4 NON-NATIVE INVASIVE SPECIES COVER

Relative cover of target non-native invasive species will be monitored annually to show progress towards reducing invasive coverage. Progress will be demonstrated by reduced coverage from baseline conditions in monitoring Years 1 – 2 and total relative cover of less than 5 percent in Years 3 through 5. If relative cover of these species increases during Years 1 – 2 or exceeds 5 percent by Year 3, then non-native invasive plant removal (if no treatment is was previously occurring) or altering control methods (if treatment was occurring prior), will be implemented, as described in Section 6.

5.2.2 HYDROLOGIC/HYDROGEOMORPHIC SUCCESS CRITERIA

Hydrologic and hydrogeomorphic success criteria apply to ponds, streams, and seasonal wetlands.

5.2.2.1 PONDS

The embankment, spillway, outlet and/or diversion structures at Goldfish Pond and Ponds A, B, and C would be inspected annually and during or soon after significant storm events producing rainfall in excess of 4-inches in 24 hours to confirm function and for evidence of erosion or soil piping. Success criteria for maintaining open water habitat requirements for special status species is accumulation of less than 6 inches of sediment in a water year and there should not be increasing trend in sediment accumulation over multiple years. Annual surveys will be conducted to assess sediment deposition trends, taking storm recurrence interval into account. If multiple years of sedimentation are observed, then a sources investigation and management options will be identified, discussed in the annual monitoring report, and implemented (with appropriate regulatory approval). It would be helpful to the project if the regulatory permits allowed adaptive management actions to be implemented with notification.

SFPUC will provide a resource specialist to conduct annual and discretionary inspections. The resource specialist will be knowledgeable of the life cycles and habitat requirements of target special-status species, general hydrology, and wetland vegetation and delineation criteria. The resource specialist will be pre-approved by appropriate agencies and may recommend adaptive management strategies to best meet identified success criteria. Qualifications of the resource specialist are included in Table 4-1.

5.2.2.2 STREAMS

The intermittent reach of San Antonio Creek at the San Antonio Creek Mitigation Area will be rehabilitated. Several ephemeral drainages will be rehabilitated including tributaries of San Antonio Creek at their confluences with San Antonio Creek, ephemeral stream reaches upstream and downstream of Goldfish Pond, and ephemeral streams at Sheep Camp Creek Mitigation Area.

Performance standards for intermittent and ephemeral channel rehabilitation focus on establishing native riparian vegetation and increasing channel stability. Hydrogeomorphic monitoring will be conducted in years 1, 3, 5, 7, and 10. Monitoring results should meet the success criteria for a stable channel stated in Table 5-4 for intermittent streams and Table 5-5 for ephemeral streams. If interim success criteria are not attained, then a fluvial geomorphologist will assess stream type's successional stage shift to determine if the variation is towards a more or less stable condition. If the successional shift is to a more unstable condition then adaptive management actions may be prescribed.

Table 5-4
Acceptable geomorphic design variations for intermittent streams.

Metric	Acceptable Value Range
Bank-Height Ratio	1.0 – 1.3
Width/Depth (W/D) Ratio State (Existing W/D Ratio to Design W/D Ratio)	0.6 – 1.4
Degree of Confinement (Existing Meander Width Ratio to Design Meander Width Ratio)	0.3 – 1.0
Revised Pfankuch Channel Stability Rating for C4 Stream Type	70-90 (Good - Stable)
Bank Erosion Hazard Index (BEHI) Rating	5 – 19.5 (Very Low – Low)
Sediment Competence (Mean Depth & Slope Required to Entrain Largest Particle)	Neither aggrading or degrading

Table 5-5
Acceptable geomorphic design variations for ephemeral streams.

Metric	Acceptable Value Range
Bank-Height Ratio	1.0 – 1.3
Width/Depth Ratio State (Existing W/D Ratio to Design W/D Ratio)	0.6 – 1.4

5.2.2.3 WETLANDS

Wetlands will be established or rehabilitated at San Antonio and Sheep Camp Creek Mitigation Areas and Goldfish Pond compensation site. Year 5 wetland performance standards are to meet the equivalent of an USACE's wetland delineation requirement. Wetland soils should be checked annually to determine presence/absence of hydric soil indicators (redoximorphic features). Wetlands

identified for compensation credits in Table 3-1 shall exhibit inundation or soil saturation for five percent of the growing season in Year 1 (or the earliest year with average precipitation if Year 1 is determined to be an atypical rain year). Five percent of the growing season for southern Alameda County is approximately 14 days. The hydrologic success criteria for these wetlands include measurements and observation of sufficient inundation or soil saturation for at least 14 days a year over the entire extent of the wetland.

5.2.3 SPECIES SUCCESS CRITERIA

Species success criteria provide a benchmark for evaluating if mitigation for California tiger salamander, California red-legged frog, Alameda whipsnake, and Callippe silverspot butterfly is successful. Additional details of species success criteria are provided in the following subsections.

5.2.3.1 SUCCESS CRITERIA FOR CALIFORNIA RED-LEGGED FROG AND CALIFORNIA TIGER SALAMANDER

This section describes the success criteria for California red-legged frog and California tiger salamander, habitat enhancement and rehabilitation, including:

- Enhancement, rehabilitation, and maintenance of upland aestivation habitat
- Enhancement or rehabilitation of aquatic breeding habitat
- Predator removal activities

Habitat restoration for California red-legged frog and California tiger salamander will be successful if the primary constituent elements as described by the USFWS are documented at each pond 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 modification, as described below:

California red-legged frog and California tiger salamander habitat will be considered successful if the following habitat attributes are present:

1. Rodent burrow complexes or other underground refugia available for shelter and aestivation within 500 feet of mitigation ponds and accessible for frog and salamanders both to and from breeding ponds.

2. Sufficient moisture to allow amphibians to survive throughout the non-breeding season (up to 11 months), consisting of the rodent burrow complexes described above or other source of moisture (i.e., seep, springbox, stream).

3. Protection from predators (e.g., deep pools or complex cover such as root masses or thick vegetation and or sufficient turbidity to obscure the pond bottom) until CTS and CRLF juveniles have metamorphed to limit predation.

4. Accessible migration corridors of less than 1 mile, between mitigation ponds and known populations of California red-legged frog and California tiger salamander. (Fellers and Kleeman 2007; Searcy and Shaffer 2008).

5. Fencing and grazing regimes maintain a mixture of open water and emergent vegetation (not exceeding 35% of pond surface area). Suitable open water is necessary for foraging, while vegetative cover is necessary for shelter, protection from predators, and egg attachment.

6. Ponds hold water for a minimum of 3 months/year for California tiger salamander and 9 months/year for California red-legged frog breeding cycles.

7. Predator removal is conducted in late summer and fall after juveniles have left ponds and water level is lowest such that ponds are as close to free of non-native predatory fish and bullfrogs as possible.

The objective is to: (1) maintain known breeding populations of California tiger salamander in the mitigation area conservation easements (Sheep Camp Creek Ponds B, C and D, San Antonio Creek East Pond, Goat Rock Northwest and Northeast Ponds), (2) improve breeding habitat for this species and California red legged frog. Breeding habitat within the conservation easements are shown in Appendix D. There are no current breeding records (within the last 15 years) of California red-legged frog within the HRP conservation easements. If California tiger salamander is not detected in breeding habitats with known occurrences after Year 10, the SFPUC will coordinate with the USFWS and CDFG to evaluate whether additional actions are required to satisfy the assigned mitigation credit.

5.2.3.2 ALAMEDA WHIPSNAKE HABITAT ENHANCEMENT

Habitat enhancement for Alameda whipsnake will be considered successful if the proposed habitat meets performance standards for vegetation in addition to the following criteria:

1. Scrub habitat should consist of varying aged stands with suitable rock outcrops, talus, or small mammal burrows embedded or nearby. This will be measured qualitatively by a USFWS approved biologist familiar with the needs of AWS.

2. There is accessible, diverse dispersal habitat for movement.

3. Potential prey species (lizards, frogs, insects, small rodents, birds, and snakes), are present within the mitigation site.

5.2.3.3 CALLIPPE SILVERSPOT BUTTERFLY HABITAT ENHANCEMENT

Target success criteria for the Callippe silverspot will be set in coordination with local experts and USFWS, review of technical literature and survey reports where cover of the host plant and occurrence of the Callippe silverspot butterfly is evaluated. Habitat enhancement for the Callippe silverspot butterfly will be considered successful if the proposed habitat meets the criteria agreed upon after further discussions with the USFWS.

5.3 MONITORING METHODS

Monitoring provides a tool for determining the progress and attainment of performance standards at the HRP mitigation areas. Detailed methods for monitoring vegetation, hydrology, geomorphology, and species are described in this section. Table 5-1 summarizes the methods that will be implemented at each site. Point-line intercept and plot surveys will be conducted to assess vegetation establishment and progress towards meeting performance standards for vegetation communities. Hydrology data will be collected from installed rain and stream gages and piezometers. Hydrogeomorphic data will be collected using longitudinal and cross-section surveys. For special-status species, the SFPUC will conduct visual surveys to detect presence of special-status species, their prey and predators, and specific habitat characteristics (e.g., burrows). Permanent photo-monitoring locations will be established and aerial photography will also be used to assess site progress.

5.3.1 PHOTO MONITORING

Permanent photo stations will be established and photographs will be taken annually from the same vantage point and in the same direction at each mitigation area and compensation site. At least one permanent photo station will be established for each habitat type, and there will be at least two stations for each compensation site. Photo monitoring stations will be mapped using GPS and marked with rebar following construction. Photo monitoring station locations will include vantage points that capture representative areas of each proposed habitat and be co-located with other stations to the extent feasible.

Photos will be taken with a digital camera with a 35mm fixed zoom, at an approximate height of between 4 feet 8 inches and 5 feet in height above ground level using a standardized tripod or rod to ensure consistency of height between years. For each photo, the photo number, project site, habitat type, photo station location number, azimuth of the image from the photo station, the date, and the weather will be recorded.

In addition to the permanent photo stations, photographs will also be taken from the origin of each vegetation monitoring transect. In years 5 and 10, vegetation cover will be assessed using aerial photos to supplement other data collection methods. Aerial photos will be at a resolution of one foot or greater.

5.3.2 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
- Statistical analysis methods that include t-tests for evaluating whether or not requirement thresholds are exceeded and multiple linear regressions to evaluate significance of trends once there are three or more years of monitoring data.

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

- Vegetation establishment/reestablishment and rehabilitation monitoring will be conducted during years 1-5 for grassland (except Goat Rock), wetland, and willow riparian communities and in years 1-5, 7 and 10 for other riparian, woodland, and savannah communities. Goat Rock grasslands will be monitored yearly for 10 years. 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 trees and shrubs within 100 m^2 plots will be used to estimate tree survival per area. These methods will be used to determine whether rehabilitation and establishment/reestablishment areas are meeting set success criteria for vegetative cover.

5.3.2.1 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:

$$ME = 0.98/\sqrt{n}$$

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 points:

- The specific monitoring targets (e.g., such as whether survival of oaks 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.

5.3.2.2 MONITORING PROTOCOL AND ANALYSIS FOR ESTIMATING TREE SURVIVAL

Data collection for survivorship of western sycamore, coast live oak, blue oak, valley oak, and California buckeye planted trees will involve a biologist evaluating whether a tree is alive or dead at a given number of flagged planting sites in an area (sampling plot).

Sampling plots will be randomly established each year based on a grid overlay of the entire mitigation area. The number of sampling plots depends on the vegetation community, final number of trees to be planted, number and size of planting areas, data collection method and spacing of plantings. Data must be collected at three 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. The plot dimensions may also be altered if necessary, though field monitor biologists should strive to sample 100 m^2 plots with 12 sampling points wherever possible.

Sampling plots will be used to conduct both point-line intercept (for percent cover, see Section 5.3.2.3) and plot-based survivorship surveys. Using GIS, a 10-meter by 10-meter grid will be overlaid on all established/re-established or rehabilitated areas. Each vertex of the 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, two 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.

Five tree species will be planted at San Antonio Creek and Sheep Camp Creek (as of 9/3/2010) in quantities provided in Table 4-4. Trees will be planted in several areas within each site and across four habitat types in San Antonio Creek (sycamore riparian, oak riparian, oak savanna and oak woodland) and three habitats in Sheep Camp Creek (sycamore riparian, oak riparian and oak woodland).

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

Survivorship trends will be analyzed after collecting three 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. Regression 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.

5.3.2.3 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. Number of sampling points would be determined using similar criteria described for tree survivorship[3].

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

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

5.3.3 WETLAND MONITORING

In addition to the vegetation monitoring described above, seasonal wetlands will be visually monitored annually in late spring to assess the establishment of hydrology and hydric soils to support the growth of hydrophytic vegetation. This qualitative assessment will be used to determine if remedial actions are needed Year 5.

Wetland hydrology will be monitored annually up to Year 5 to document that established/reestablished or rehabilitated wetlands have the appropriate hydrological functioning, both immediately after construction, and during the monitoring period. Hydrological functions to be documented include the areal extent (i.e., square feet or acres) of inundation and/or saturation; estimated duration of inundation, and depth of ponding. The hydrological measurements will demonstrate compliance with wetland permit requirements for restoring wetland habitats pursuant to Section 404 and 401 of the CWA. Monitoring conducted in Years 1 and 3 will determine if the conditions measured at construction completion are still present (i.e., are not silting up, eroding or downcutting, and have appropriate inundation and/or saturation periods for the planned seasonal or perennial wetland habitat type) and identify any alteration that may be needed to maintain full credit for the proposed acreage. To prove inundation duration measurements will be taken at least five days (USACE duration requirement) after a large storm event during the rainy season. Soil test pits will be excavated in created wetlands to evaluate the presence of hydric soil indicators.

A formal wetland delineation will not be conducted if the following criteria are met:

- Wetland hydrologic conditions are present for each of the five years,
- Wetland vegetation meets the USACE criteria for dominance by hydrophytic vegetation, and
- Hydric soil indicators are observed.

Hydric soils are those as defined by the NRCS Soil Survey as hydric or any soil exhibiting characteristics of anaerobic conditions as defined by the Army Corps of Engineers Wetland Delineation Manual (NRCS 2009, Environmental Laboratory 1987) If one of the criteria is in question, then in Year 5, a qualified wetland specialist, trained in the delineation of USACE wetlands, using the methodology from the Regional Supplement to the Corps of Engineers Wetland Delineation Manual, will delineate the wetlands. Methods defined in the Arid West Region (Version 2.0) will be used to assess vegetation, hydrology, and soils (USACE 2008a). Dominant species will be recorded and the percentage of cover of native wetland plants (FAC, FACW, and OBL) will be estimated.

5.3.4 NON-NATIVE INVASIVE PLANT MONITORING

During May or June of years 1-5, 7 and 10, non-native invasive plant cover will be calculated from the point intercept data collected from all sites, as described in Section 5.3.2.3. In addition to this monitoring, areas with greater than 5 percent cover of non-native species considered by the California Invasive Plant Council to be moderately or highly invasive and those with red alerts will be mapped using GPS (see Appendix I for a list of these species) 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 and alert species will be compared.

A spring inspection in Years 6 and 8 comparing mapped non-native invasive cover from the prior year will be conducted to determine if a non-native invasive species population has rapidly spread or a new species has invaded. In either case, maintenance activities may be required.

5.3.5 RANGELAND MONITORING

The SFPUC has an existing rangeland monitoring program for the Alameda Creek Watershed (Sage Associates 2007). Monitoring includes photo point observations, rangeland health evaluation and a rangeland species composition determination. In 2009, the species composition monitoring component of the program was adjusted to be comparable to other rangeland monitoring efforts in the region (e.g., East Bay Regional Park District). The new monitoring methods are relatively efficient and relatively objective since personnel will be expected to vary from sampling year to year (ACCP 2010). Some of the existing sampling plots within the watershed-wide monitoring program fall within the HRP mitigation enhancement areas and will continue to be monitored. Additional sampling plots in the HRP mitigation enhancement areas will be added to the monitoring program so as to ensure grazing of the mitigation areas are accurately evaluated. For the HRP sites, monitoring of the plots will be conducted yearly during the mitigation monitoring period. Additional adjustments to the existing Alameda Creek watershed rangeland monitoring program that would be made for the HRP mitigation areas include (as recommended in the 2010 rangeland monitoring report):

- Livestock inventory would be monitored by management unit. Currently, livestock inventories for multiple leases are grouped together as one record. By separating out information on livestock inventory by management unit (stocking rates, timing of grazing, etc.), future vegetation analysis can incorporate livestock stocking information as a variable.

- Incorporate Residual Dry Matter (RDM) measurements into the plots within the HRP mitigation areas.

- Continue to refine the rangeland monitoring program as specified in the 2010 rangeland monitoring report (ACCP 2010).

5.3.6 HYDROLOGIC MONITORING

Hydrologic monitoring includes monitoring surface water, precipitation, and groundwater levels to serve as a local indicator of hydrological variations that may affect the success of mitigation plantings. For example, a sudden increase in tree/shrub mortality may be attributed to a below average annual rainfall, lower stream water stage, or lower groundwater levels. Monitoring data will also be used in the design of future mitigation. Hydrologic monitoring at San Antonio creek will include monthly data downloads during the rainy season and bimonthly downloads in the dry season from the rain and stream gauges installed near the project site. Data from the piezometers installed along San Antonio Creek will be downloaded bi-monthly by a qualified hydrology resource specialist. The hydrology resource specialist will be knowledgeable of the piezometer technology, collection methods, and hydrology field indicators. The resource specialist will be selected by SFPUC. Instrumentation will be inspected and serviced as needed at the time of data downloads.

Hydrologic monitoring of wetland habitat intended as mitigation is described in Section 5.3.3.

5.3.7 GEOMORPHIC MONITORING

A qualified hydrologist/geomorphologist specialist will perform geomorphic monitoring for Goldfish Pond and all rehabilitated intermittent and ephemeral drainages. Qualifications for the specialist are include in Table 4-1. The specialist will be selected by SFPUC.

The goal of the stream monitoring is to document changes in channel, bank, or floodplain stability that could jeopardize riparian plantings or cause significant erosion or sedimentation of nearby

habitat. Monitoring will be conducted years 1, 3, 5, 7, and 10 during the winter months when flow is present in the channels. Monitoring will include photo monitoring, longitudinal, and cross sectional surveys. To have an accurate and representative comparison, surveys need to be setup and documented carefully by installing a permanent benchmark, profile, and cross section pins and identifying locations of measuring tapes and instruments including detailed notes and a site map. Subsequent surveys need to be conducted in the exact methodology and placement as the baseline survey - taking measurements at the same stationing as the baseline survey as well as surveying additional locations where changes have occurred. For instance, the stations at which the cross sections cross the longitudinal profile need to be the same for every survey year improve data comparability. In addition to the aforementioned recommendations, survey practices should follow the procedures described in *Stream Channel Reference Sites: An Illustrated Guide to Field Technique* (Harrelson et al. 1994), monitoring procedures described below and detailed in *River Stability Field Guide* (Rosgen 2008) and *Watershed Assessment of River Stability and Sediment Supply* (Rosgen 2006). Surveys described below will occur exclusively at San Antonio Creek unless specified otherwise.

Photo-documentation points will be established where channel grading occurred at South Calaveras (Goldfish Pond), Sheep Camp Creek, and San Antonio mitigation areas. Representative cross-section locations will be photo-documented using a digital camera by taking a panoramic photo looking upstream through the feature, a panoramic photo looking downstream through the feature, and one photo each of the left and right banks at the cross-section location. Other permanent photo points will be established to capture unique views of the meander bends, in stream structures, and other features to provide a view of areas where channel adjustment typically occurs. Aerial photography will be flown in the summer of Years 5 and 10 to assess changes in channel morphology and assess trend indicators.

Longitudinal surveys will be conducted where channel grading occurred at South Calaveras (Goldfish Pond), Sheep Camp Creek, and San Antonio mitigation areas. A longitudinal survey will be conducted along the thalweg of the stream through the entire length of the restored channel to capture vertical changes in the bed slope. The longitudinal survey would also capture the water surface (when present), bankfull elevation and the low bank height where it departs from the bankfull elevation. The longitudinal profile provides an assessment of changes to bed slope, bankfull slope, and the position and change of bed features (riffle, run, pool, and glide). Low banks are topographic features indicating a previous bankfull elevation. The presence of a low bank diverging from the existing bankfull elevation in a downstream direction is an indication of channel incision occurring within the reach and moving upstream (Rosgen 2006). With such a condition, a detailed bed and water surface profile should capture a nick point or sudden change in channel slope near the point of interception of low bank and bankfull. The reverse condition may be observed where a low bank is observed converging with the existing bankfull elevation, an indication of aggradation within the reach.

Each monitoring period the channel bed and water surface profile will be overlaid with the previous year or baseline bed profile to be analyzed for changes that may indicate shifts towards stability or instability. Evidence of aggradation or degradation may be identified with abrupt changes in channel bed/water surface slope or identification of low banks and subsequent shifts in the bank height ratio (see below). The profile will show shifts in the riffle, run, pool, and glide facet slopes that can explain channel morphological changes such as pool filling, areas of excess scour, or relocation of bed features. Such changes are acceptable to a degree that the channel is neither aggrading nor degrading and the system as a whole remains stable (as measured with the Pfankuch channel stability rating).

Cross-sectional surveys will monitor lateral and vertical adjustments in the channel/floodplain. Permanent cross-sections locations will be located at specific bed features including at least two riffle

and pool cross-sections and one run and glide cross section. In addition, one cross section will be surveyed above and below the San Antonio Creek bridge crossing and the bridge on the tributary to Sheep Camp Creek to monitor any lateral or vertical adjustment influenced by the bridge pier or abutments. All cross-sections will be tied to specific stations identified along the longitudinal survey described above. Cross sections on ephemeral streams or swales that lack defined bed morphology will include at least three cross sections spaced evenly along the longitudinal profile or placed at locations where expected change could occur (bends in the channel, confined or entrenched areas, locations with steep banks or bed slope, etc.).

Like the longitudinal profile, the cross section provides a visual documentation of change and provides valuable data for assessing morphology. Shifts in the width/depth and entrenchment ratio can be measured from the riffle cross section. Since the channel design is based on an empirical approach to channel dimensioning, it is expected that cross sections will adjust in response to the effective discharge and sediment supply unique to the watershed. For instance the channel should begin to form an inner berm that will be visible in the pool and riffle cross sections. The inner berm area increases channel velocities (and boundary shear) and maintains secondary circulation. This feature is critical for maintaining channel competence (Rosgen 2010). The cross sections, particularly at the bends (pools) will provide information as to lateral migration of the channel. As the channel adjusts to a new equilibrium and vegetation becomes established the channel cross section, particularly the banks where near bank shear stress is highest, should stabilize.

The following metrics will be calculated and evaluated with the metrics described above, to determine channel relative stability and departure from the design. These metrics will rate the severity of change and provide means for determining a need for corrective measures. The quantitative metrics that will be utilized to rate channel stability include:

Bank height ratio (BHR): BHR measures the degree of channel incision and is calculated as the ratio of the lowest bank height to the maximum bankfull depth measured at the toe of the study slope. BHR is determined from data collected from measuring the bankfull depth and lowest bank height during the longitudinal survey. From these measurements the beginning and ending BHR can be determined for the reach. Ideally the BHR should be 1.0 indicating no channel incision. A ratio above 1.3 is an indication that channel incision is impacting the stability of the reach.

Width/depth ratio state: This ratio measures the amount of departure in the channel cross-sectional shape from the design. It is calculated by dividing the existing width to depth ratio by the design width to depth ratio. Width/depth ratios are measured at the cross section locations. Typically, the width/depth ratio state is compared to the variability in the reference reach width/depth ratio. Because the project channel dimensions are relative to empirical relationships the comparison will be made with the range in the design width/depth ratios. This metric provides a measure of relative departure from the design parameters, but may not necessarily mean a departure from stability. Other metrics will be necessary to confirm whether the measured trend is towards or away from a stable channel width/depth ratio. It is assumed that the methods used to describe the channel dimensions are suitable for the conditions of the project site, therefore any adjustment outside the 0.6 – 1.4 range should suggest a trend towards instability generally associated with streambank erosion, aggradation, or degradation that should also be identified through the other prescribed metrics and surveys.

Degree of confinement: This ratio measures the amount of departure in the lateral confinement of the channel. It is a measure of the existing meander width ratio (MWR) to the design MWR. MWR is a ratio of the meander belt width to the bankfull width measured at a representative cross section. This ratio, like width/depth ratio state, is intended to be based on a comparison with a stable reference MWR. Typically, a C channel type will have a MWR ranging from 4 – 20 with the average around

11.4 (Rosgen 1996). The intent of measuring MWR in comparison with the design MWR is to determine a percentage of departure from baseline and/or design conditions. The trend could be a shift to a natural stable form or towards a more unstable form. Shifts in the degree of confinement should be documented and explained with supporting data obtained through these metrics, photos, cross sections, and profile measurements.

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

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

Sediment competence: A stable channel should have the capacity to transport on an annual basis the sediment load and be capable of moving the largest particle identified on a point bar or gravel bar (Rosgen 2008). The mean depth and slope required to entrain the largest bedload particle (sample at a point bar) will be predicted and compared to the field measured bankfull depth and slope as an indictor of whether or not the channel is aggrading, degrading, or stable. Predictions will be validated with measurements taken from the installation of two to three scour chains installed across each of two permanent riffle and two glide cross sections located in the upper and lower reaches of the project area on San Antonio Creek. As previously mentioned, more detailed information and procedures on the methods described below can be found in *Watershed Assessment of River Stability and Sediment Supply* (Rosgen 2006) and *River Stability Field Guide* (Rosgen 2008).

A pebble count survey will be conducted on the active bed of a riffle (representative of the reach) near or adjacent to the bar sample location. The location of the surveys should be representative of the reach. The pebble count for this metric involves collecting at least 100 pebble measurements sufficient to establish a gradation curve and determine the D_{50} or particle size at which 50 percent of the particles are of that particular size or finer. The D_{50} from the active bed is compared to the largest particle measured from the point bar (D_{max}) to determine if a point bar sample is necessary. If the ratio of D_{max}/D_{50} is within the range of 1.3 – 3.0 than a point bar sample is not necessary (although provides good comparative data) to continue the analysis. The critical dimensionless shear stress is calculated by the following equation:

$$\tau^* = 0.0384(D_{max} / D_{50})^{-0.887}$$

Where:

τ^* = Bankfull dimensionless shear stress

D_{max} = Largest particle from the point bar (mm)

D_{50} = Active riffle bed material size that is 50% or finer (mm)

If the ratio of D_{max}/D_{50} is outside the 1.3 – 3.0 range than a sample must be collected from the point bar to determine the D_{50} of the particles entrained by the stream ($\hat{D}_{50}$). The bar sample is a sediment core sampled from the downstream third of a point bar on a meander bend. The core is taken midway between the thalweg and bankfull elevation where particle sizes are at a maximum. The core size is the diameter of a 5 gallon bucket sampled a depth of two times the maximum diameter of the largest surface particle. The excavated material is wet sieved (typically through 256, 128, 64, 32, 16, 8, 4, and 2 mm screen size sieves, or similar sizes) and weighed using procedures established by Rosgen (2008). A material gradation curve is plotted from the data from which the $\hat{D}_{50}$ is obtained. The flowing equation is used to calculate the dimensionless shear stress if the $D_{50}/\hat{D}_{50}$ is within the range of 3 – 7:

$$\tau^* = 0.0834(D_{50}/\hat{D}_{50})^{-0.872}$$

Where:

τ^* = Bankfull dimensionless shear stress

D_{50} = Active riffle bed material size that is 50% or finer (mm)

$\hat{D}_{50}$ = Bar sample material size that is 50% or finer (mm)

The mean depth required to entrain the largest particle in the point bar is calculated using the following equation:

$$d = \frac{\tau^* \gamma_s D_{max}}{S}$$

Where:

d = Required bankfull mean depth (ft)

τ^* = Bankfull dimensionless shear stress

D_{max} = Largest particle from the point bar (ft)

S = Existing bankfull slope (ft/ft)

The bankfull water surface slope (S) required to entrain the D_{max} from the point bar is calculated by:

$$S = \frac{\tau^* \gamma_s D_{max}}{d}$$

Where:

S = Required bankfull slope (ft/ft)

D_{max} = Largest particle from the point bar (ft)

d = Existing bankfull mean depth (ft)

If the $D_{50}/\hat{D}_{50}$ is outside the range of 3 – 7 than the dimensional shear stress is calculated using:

$$\tau = \gamma RS$$

Where:

τ = Bankfull dimensional shear stress (lbs/ft^2)

γ = Specific weight of water (62.4 lbs/ft^3)

R = hydraulic radius, substituted by mean bankfull depth, d (ft)

S = Existing slope (ft/ft)

The predicted mean depth required to move the D_{max} (mm) is calculated by:

$$d = \frac{\tau}{\gamma S}$$

Where:

d = Predicted bankfull mean depth (ft) required to move the D_{max}

τ = Bankfull dimensional shear stress (lbs/ft^2)

γ = Specific weight of water (62.4 lbs/ft^3)

S = Existing bankfull water surface slope (ft/ft)

The predicted slope required to move the D_{max} (mm) is calculated by:

$$S = \frac{\tau}{\gamma d}$$

Where:

S = Predicted bankfull water surface slope (ft/ft)

d = Existing bankfull mean depth of the riffle cross section (ft)

Critical shear stress values computed will be checked against the Shields curve and modified Shields curve (Rosgen 2006) based on Colorado data which predict the shear stress required to initiate movement of a particular grain size (D_{max}). Rosgen (2006) has found that the Shields curve tends to underestimate particle sizes in streams with a heterogeneous mixture of bed material between ranges

in the shear stress from 0.5 – 1.5 lbs/ft^2. As a result the validation using scour chain data will adequately address the validity of the predictive method.

Data collected from scour chains installed at two riffles and two glide cross sections will be used validate the above predictions for dimensionless and dimensional shear stress. An adequate validation can only occur after a bankfull flow. The measured depth, slope, and two largest particles (located in close vicinity of the scour chain) are obtained at installation (when baseline surveys are conducted) and the following year (or after a bankfull event). The second survey will identify changes and determine if the two largest particles measured in the first survey were moved and replaced by new particles.

Actual dimensionless shear stress values are determined by back calculating τ^* from depth (d), slope (S), and D_{max} measured from the scour chains using the above equations, where the values of D_{max}/D_{50} is within the range of 1.3 – 3.0 or $D_{50}/\hat{D}_{50}$ is within the range of 3 – 7. For comparison the actual τ^* is plotted against D_{max}/D_{50} or $D_{50}/\hat{D}_{50}$ (whichever is appropriate) and the corresponding regression line (predicted τ^*). The predicted and measured depths and slopes are also compared.

Actual dimensional shear stress values are calculated from the above equations using the scour chain data collected after a bankfull event. The D_{max} measured from the scour chains and the actual shear stress is plotted with the Shields curve and modified Shields curve as before to compare predicted versus measured particle size moved at a bankfull flow.

Revised Pfankuch channel stability rating: This rating ranks the overall channel bank and bed stability. Fifteen unique stream indicators of stability are evaluated along the upper banks, lower banks, and bottom. A numerical score is assigned in each category according to whether the reach is found to be in excellent, good, fair, or poor condition with respect to that category. The scores are summed, and the total score is used to identify the overall condition (good, fair, or poor) of the reach. Scores range from a minimum of 38 to a maximum of 152. A modified version of the Pfankuch stability rating, in which the overall condition varies by stream type, will be utilized (Rosgen 2006, 2008). The Pfankuch survey should be conducted for the area outside the restoration area and for the representative area within the restoration area where the stream type is the same. If a portion of the stream channel morphs into a different stream type than a separate evaluation should be conducted for that particular reach. The Pfankuch rating should increase slightly in the early years following construction as vegetation becomes established and channel adjusts to a more suitable dimension. Should the rating decrease outside the range of a "Good - Stable" rating (70-90 for a C4 channel type) than the other metrics should also indicate a decreasing trend in channel/bank stability.

5.3.8 SPECIES MONITORING

A general wildlife assessment will be conducted during year 5 of the monitoring period to document common wildlife, songbird, and raptor use of the site. Data will be used to assess overall site functioning, not as a performance measure. Detailed monitoring methods for predator removal and particular special status species are provided below.

5.3.8.1 PREDATOR REMOVAL MONITORING

Ponds will be monitored annually to determine presence/absence of non-native predators. The frequency of monitoring and removal shall depend upon results from baseline and subsequent surveys at each pond. Ponds where no predatory fish or bullfrogs are detected in the baseline surveys, shall be monitored once a year to check for predator presence.

Fish: Perennial ponds where only predatory fish are detected shall be drained in Year 1 and all fish removed. Follow-up surveys will be conducted once a year for Years 2 – 5, 7 and 10 to determine if ponds require draining and removal of predatory fish. Pond draining would occur in November or when monitoring of CRLF demonstrates that metamorphosis is complete (typically July – September or 3.5 – 7 months after eggs are deposited).

Predatory fish monitoring surveys shall be conducted by two or more qualified wildlife biologists. Qualifications for the wildlife biologist are listed in Table 4-1. Ponds small or shallow enough should be completely seined to capture most of the fish species in the pond. Larger ponds should have a portion of the pond seined several times and locations within the pond to capture a representative sample. Seining shall be conducted in November or when CRLF metamorphosis is complete (if present). Native fish or amphibians trapped will be released back into the pond. Non-native fish will be removed from the pond. Observations of species encountered will be documented to inform pond management.

Bullfrogs: Ponds with bullfrogs will be drained to remove adults and/or egg masses (and predatory fish if present) in Year 1 and subsequently every other year (e.g., Years 3, 5, 7, 9) to break the bullfrog breeding cycle, increasing to every year, if needed.

Bullfrog monitoring/eradication surveys shall be conducted by two qualified wildlife biologists. Qualifications for the wildlife biologist are listed in Table 4-1. The biologist will conduct one daytime and one nighttime visual and aural encounter survey for bullfrogs at each pond. Each survey will last long enough to allow full visual inspection of the shoreline and emergent vegetation; surveys may require the use of waders, boats, or other floatation devices to fully inspect emergent vegetation. Night surveys will be conducted using binoculars and lights that produce fewer than 100,000 candle watts but are sufficiently bright. In the event that bullfrogs are encountered during the monitoring surveys, they will be hand-captured (e.g., with a dip net or gig) and euthanized by hand; bullfrog egg masses will be collected and removed from the pond. All bullfrogs and other wildlife detected during surveys will be documented.

Feral Pigs: Feral pig populations will be managed within the mitigation sites. It is anticipated that the SFPUC will resume funding the feral pig eradication efforts within SFPUC Alameda watershed lands, including the mitigation sites. If predator control (i.e., hunting) does not adequately address feral pig populations and foraging within the mitigation sites, other options such as installing pig fencing would be evaluated.

5.3.8.2 UPLAND AND AQUATIC HABITAT MONITORING FOR CALIFORNIA RED-LEGGED FROG AND CALIFORNIA TIGER SALAMANDER

Mitigation ponds, uplands, and migration corridors between mitigation ponds and known California red-legged frog or California tiger salamander habitat within one mile of ponds will be monitored as follows. All monitoring of California red-legged frog and California tiger salamander habitat will be performed by qualified wildlife biologists familiar with the species.

1. Possible migration corridors between each mitigation pond and appropriate California tiger salamander/California red-legged frog sightings will be walked twice annually for Years 1-5 and in years 7 and 10 to confirm absence of migratory barriers and presence of appropriate migratory habitat. Annual surveys will occur in the fall, preceding but within a month of the

first heavy rainfall of the season, and in the spring, proceeding the period when California tiger salamander larvae begin to leave breeding pools for upland habitats.

2. Upland habitat within 500 feet of mitigation ponds will be evaluated once annually for Years 1-5 and in years 7 and 10 during the dry season. The metrics on which upland habitats will be evaluated include: presence of burrows or other underground refugia, presence or absence of a riparian corridor, moisture within microhabitats (e.g., in burrows, under vegetative cover) to prevent desiccation, sufficient cover near pools to provide protection from predators and allow temperature regulation, and availability of a diverse prey base in the form of insects and small vertebrates. Data will be analyzed in the HRP's annual monitoring report describing and mapping these features and ranking each feature as excellent, good, degraded, or absent. The habitat will be analyzed to evaluate whether and where it provides the primary constituent elements required for both amphibian species.

3. Mitigation ponds will be assessed twice annually for Years 1–5 and during years 7 and, 10 to assess availability of water in appropriate seasons and for appropriate lengths of time to support both California tiger salamander and California red-legged frog populations. In addition, the following parameters will be analyzed:

    a. Depth (minimum and maximum)
    b. Water temperature in shade and in sun, near surface and near bottom
    c. Percent cover of emergent vegetation
    d. Effect of grazing on turbidity and pond banks. Evidence of trampling in the form of eroded banks and heavily turbid water will be recorded.
    e. Presence or absence of a diverse prey base in the form of aquatic insects and small vertebrates
    f. Presence and species of any amphibian adult, juvenile or larvae. This may consist of dipnet, visual, auditory, and CTS egg-mass surveys
    g. Presence of any potential predator, including snakes, birds, bullfrogs, and fish. Presence of native predators will not be construed as a failure to provide appropriate habitat.
    h. Sedimentation rates to determine the level of sedimentation accumulating in the ponds.

5.3.8.3 ALAMEDA WHIPSNAKE HABITAT MONITORING

Habitat for Alameda whipsnake will be monitored for vegetation (Section 5.3.2). In addition, restored habitat will be monitored annually for Years 1-5 and in Years 7 and 10 by a qualified wildlife biologist with whipsnake experience. Walking surveys will be performed during early March during warm sunny weather to allow for location of lizard prey. In addition to vegetation monitoring, the following site conditions will be observed and recorded:

1. Temperature range within the habitat

2. Presence of adequate talus, rock outcrops, and small mammal burrows in close association or embedded within the essential core scrub or adjacent areas.

3. Presence of prey including lizards, snakes, small mammals, nesting birds and insects. A species list will be recorded and abundance estimated as "abundant, common, occasional, rare, evidence but no sightings, no evidence found."

5.3.8.4 CALLIPPE SILVERSPOT BUTTERFLY HABITAT RESTORATION MONITORING

Habitat for Callippe silverspot butterfly will be monitored for vegetation as detailed in Section 5.3.2. In addition, The spatial extent of host plant and target nectar plants, will be mapped in Years 1-5. The mapped populations will be assessed to determine if larval host plants and nectar plants occur in sufficient abundance and proximity to support Callippe silverspot populations.

5.4 MONITORING SCHEDULE

Monitoring would be timed to coincide with the optimal periods for identification of the performance metrics summarized in Table 5-1. This section describes the suggested schedule of monitoring to evaluate the success criteria for habitats that will be established, re-established, rehabilitated or enhanced in the proposed mitigation areas. Table 5-6 identifies the suggested months in which each type of monitoring would be conducted. Data would be collected at approximately the same time each year to standardize results (i.e., within a 3-week window, adjusted annually to account for seasonal variations in vegetation conditions, weather, precipitation, and temperature). Table 5-7 summarizes the monitoring tasks for each year for the first ten years after construction.

If it appears that any component is not on track to meet final performance criteria, SFPUC will identify adaptive management actions such as additional plantings, changes to the irrigation regimen, erosion control measures, or changes to weeding schedule or method (Section 6).

Table 5-6
Suggested monitoring schedule.

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

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

Table 5-7
Annual monitoring schedule and tasks.

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

5.4.1.1 VEGETATION MONITORING

Grasslands and wetlands will be sampled in years 1-5 (with the exception of Goat Rock grasslands, which will be monitored yearly for 10 years), in spring (late March or early April), depending on elevation, location, and local site conditions. Willow-dominated riparian habitats will also be

monitored in years 1–5, with monitoring conducted in late summer/early fall (late August or early September) when planted shrubs are most likely to exhibit stress. The oak and sycamore habitats will be monitored in August or September in years 1–5, 7 and 10. Each year, photo monitoring will be conducted and non-native invasive plant cover and overall health of plantings will be assessed. The suggested monitoring periods are summarized in Table 5-7.

5.4.1.2 WETLAND MONITORING

The extent of constructed wetlands will be documented in as-built drawings at the completion of construction. The hydrology, vegetation cover, and hydric soil characteristics of constructed wetlands will be monitored annually. Wetland vegetation monitoring and final wetland delineation will occur in the spring when hydrophytic plant species can be readily identified and the vegetation cover is at its peak. Monitoring of enhanced wetland habitats would be timed to occur during the same period.

5.4.1.3 POND MONITORING

Pond monitoring would be more intensive at Goldfish Pond, which will be substantially modified by replacement of the embankment and modifications to the depth and capacity of the pond. Monitoring at Goldfish Pond would include an initial as built pond bathymetry survey following construction. A profile survey will be conducted through Goldfish Pond in Years 1 – 5, 7 and 10 to document sedimentation rates. Profile surveys should ideally be conducted late in the summer or fall when the pond water depth is low (i.e., surveys can be conducted by wading the pond rather than from a boat).

Goldfish Pond and other ponds in the mitigation areas will be surveyed each year for five consecutive years. Surveys will be timed to correspond with the major storm events to document the integrity of the embankments and outlet structures/spillways (if applicable) and to determine if any erosion or sedimentation issues are present. Ponds will also be monitored for vegetation in the spring and amphibian presence in November, March and April. Predator control will be implemented according to the schedule described in Section 5.3.8.1.

5.4.1.4 STREAM MONITORING

Stream monitoring includes as built longitudinal and cross sectional surveys at completion of construction. General hydrogeomorphic surveys will be conducted during Years 1, 3, 5, 7 and 10. Optimal timing of surveys is the rainy season when the depth of stream flow can be measured. Downloading of stream/rain gage and piezometer instrument data should be conducted monthly during the rainy season from December to April and bimonthly thereafter.

5.5 REPORTING (10-YEAR MONITORING PROGRAM)

This section discusses the contents and requirements for three types of reports:

1. As-built report,
2. Routine monitoring reports, and
3. Internal monitoring reports.

Section 5.6 describes a fourth report, the final monitoring report, that will be submitted for agency confirmation after the year 10 monitoring.

The as-built report will be submitted after completion of construction activities. Routine monitoring reports will be submitted after monitoring activities in years 1-5 and in year 7. Internal monitoring reports will be prepared to document site conditions, maintenance activities, and remedial actions that may be required to meet performance criteria during years when routine monitoring is not proposed. As-built and routine monitoring reports will be submitted electronically, unless requested otherwise, to U.S. Army Corps of Engineers, the California Department of Fish and Game, the U.S. Fish and Wildlife Service, the San Francisco Bay Regional Water Quality Control Board, and the U.S. Environmental Protection Agency.

5.5.1 AS-BUILT REPORT

The SFPUC will submit a report to the agencies listed above within 90 days of completion of construction describing the as-built condition of the mitigation projects. The report will summarize construction lessons learned and include field mark-ups of construction drawings to reflect as-built conditions, including counts of installed vegetation. The as-built report will identify the construction completion date used for starting the monitoring schedule, photo point locations and accompanying photos showing the conditions at construction completion (i.e., monitoring baseline condition).

5.5.2 ROUTINE MONITORING REPORT

SFPUC will prepare and submit a report on the interim monitoring conducted in years 1–5, 7, and 9 at the end of each monitoring year. The collected data will be compared to the success criteria and used to assess progress toward meeting the performance standards. The reports will recommend adaptive management actions to address performance shortfalls. At a minimum, the report will include the following:

- A list of names, including titles and affiliations, of all persons who prepared the content of the report and participated in monitoring activities for that year
- A description of the compensation project goals
- A description of the monitoring methods
- Maps identifying monitoring areas, transects, planting zones, and non-native invasive vegetation (if present)
- Monitoring data analysis and assessment of progress toward meeting performance standards and success criteria
- Recommended remedial action
- Photo documentation
- Suggested changes to monitoring
- Summary of maintenance activities
- Copies of field data sheets

The report will summarize the monitoring data collected during the monitoring year and will be submitted by March 1 of the following calendar year.

5.5.3 INTERNAL MONITORING REPORTS

Internal monitoring reports will be prepared to document site conditions, maintenance activities, and remedial actions that may be required to prevent degradation of the compensation sites in years 6 and 8, when complete interim monitoring is not conducted.

SFPUC will prepare these monitoring reports for its own use and will make them available to the agencies listed above on request. The information in the report will be used to evaluate the overall site

conditions and to document remedial actions required to address any performance shortfalls. At a minimum, the report will include the following:

- A list of names, including titles and affiliations, of all persons who prepared the content of the report and participated in stewardship of the sites for that year
- A description of the goals and objectives of the mitigation project
- Maps identifying the mitigation areas, including the locations of problem areas requiring maintenance or remedial actions
- Photo documentation
- Suggested changes to maintenance activities

The report will be prepared and filed annually by January 30 of the following calendar year.

5.6 COMPLETION OF MITIGATION RESPONSIBILITIES

The completion of mitigation responsibilities (Year 10) will be documented by submittal of a final monitoring report with notification to and agreement from the agencies listed above. If performance standards have been met or sufficient contingency plans have been implemented, the agencies should confirm the fulfillment of the mitigation requirements.

5.6.1 NOTIFICATION/FINAL MONITORING REPORT

When the 10-year monitoring program is complete and performance criteria are believed to have been met, SFPUC will notify the agencies listed at the beginning of this section through the submittal of the final annual report. This report will document the completion of the project, a verified wetland delineation or equivalent as described above and a request for a formal acceptance of the mitigation project.

5.6.2 AGENCY CONFIRMATION

The permitting agencies (e.g., CDFG, USFWS, RWQCB, USACE) may require a site visit to confirm the completion of the mitigation effort. After confirmation, the agencies will provide the SFPUC with written confirmation that the SFPUC has met the required conditions for the proposed mitigation of the WSIP projects that include the CDRP, San Antonio Backup Pipeline, New Irvington Tunnel, Sunol Valley Water Treatment Plant, Bay Division Pipeline #5, and Bay Division Pipeline #3 and #4 Seismic Upgrade.

5.7 LONG TERM MONITORING (POST TEN-YEAR MONITORING PROGRAM)

After completion of the 10-year mitigation responsibilities, SFPUC will conduct routine maintenance and monitoring of the HRP sites under conservation easements. The SFPUC will continue monitoring and management of the compensation sites after permit compliance monitoring is complete, however the parameters, methods, and frequency will be commensurate with routine management. The ten year compliance monitoring and adaptive management developed during the monitoring period will result in clear, site tested management guidance for long-term management.

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6 MAINTENANCE

An important element of ensuring success at the compensation sites is to create, to the extent possible, habitats that are self-sustaining and maintenance-free over the long term. Maintenance includes isolated one-time actions or repairs as well as specific maintenance actions that will be needed in perpetuity (e.g., fence repair). Initially, maintenance is often necessary to ensure plant establishment success, especially during early growth when plants are vulnerable to desiccation (i.e., becoming to dry) and browsing (e.g., by deer or cattle). Perennial ponds will require maintenance to eradicate or minimize populations of non-native predators. This section describes infrastructure and biological maintenance activities to be performed at the various sites.

6.1 INFRASTRUCTURE MAINTENANCE

Infrastructure inspections will be performed in approximately April and September at the commencement and termination of each rainy season and at other times during the year at the land manager's discretion; for example, before or after significant storm events at the rehabilitated ponds, as well as Sheep Camp and San Antonio creeks. Infrastructure inspections will be documented using ground-level photographs of irrigation systems, fences, pond berms, water control structures, water distribution facilities, cattle attractants and cattle troughs. Inspection staff will have land management experience and or agency approval for unescorted access to lands.

6.1.1 VISUAL INSPECTION OF IRRIGATION SYSTEMS

The maintenance contractor will be responsible for irrigation system inspection and repair. Irrigation system component parts will be inspected each year before use in late spring and adjustments made during initial operation each season. Malfunctioning or broken irrigation system parts may need repairs or replacement and if uncontrolled application of water causes erosion it will be repaired.

6.1.2 FENCING

Permanent, and in some cases temporary electric fencing will be installed surrounding planted areas after construction to exclude and/or manage cattle access. Where temporary fencing is used, it will be removed as soon as the vegetation has become well-established (approximately 2 to 3 years) and the restoration specialist has determined that it is able to survive without protection. The restoration specialist selected by SFPUC must be familiar with fencing, grazing, and plant requirements in order to determine if plant establishment is complete. This specialist may be the same as the irrigation specialist if qualified. Permanent fencing will be inspected on an annual basis to document general condition. Temporary fencing and associated components will be inspected on a monthly basis. Repairs will be made immediately to damaged fence sections.

6.1.3 PONDS: SPILLWAY, OUTLET, DIVERSION INSPECTIONS, AND REPAIR

Pond inspections will evaluate condition and ability of drainage infrastructure to function properly during the rainy season in order to make necessary repairs. If erosion features are observed that could result in the failure of the mitigation area to meet success criteria, SFPUC will implement an adaptive remedial action plan to address the erosion.

6.2 BIOLOGICAL RESOURCES MAINTENANCE

This section describes the potential maintenance needs and proposed actions for managing biological resources within the mitigation areas. The focus of this section is the sites that will be manipulated to establish, re-establish, or rehabilitate biological resources. However, some of the maintenance activities would also apply to areas proposed for enhancement of existing biological resources.

Maintenance of biological resources will be initiated after inspections conducted by a resource specialist. Multiple specialists may be selected by SFPUC that specialize in particular biological resources (e.g., botanist, wildlife biologist, range manager). Qualifications of the resource specialist are included in Table 4-1. Maintenance topics include grazing, non-native invasive plant control, predator control, pond stability for California tiger salamander and California red-legged frog habitat, and replanting.

6.2.1 GRAZING MANAGEMENT

Grazing management for the mitigation areas will be prescribed in a grazing management plan for the HRP mitigation areas. The plan will reflect the management goals and objectives for the mitigation areas and the strategies to reach these goals and objectives described in the MMP. Livestock grazing is one of the tools that will be used to meet the management goal of enhancing habitat. Cattle are the primary livestock type that will be used to manage vegetation and ponds, however, other types of livestock such as sheep will be considered either initially or as an adaptive management strategy. Livestock grazing will not be allowed in planting areas for the first 2 to 3 years after construction to allow plantings to establish. Grazing exclusion from planted areas will be accomplished with permanent or temporary electric fencing. Livestock stocking rates will be initially set based on available forage and target RDM, which is calculated based on topography, soil type and canopy cover. Total available annual forage for cattle, to which stocking rates are linked, will consider favorable and unfavorable years (for rainfall). Stocking rates and the location of grazing related infrastructure would be adjusted based on observed livestock use of the mitigation areas, as well as results from rangeland monitoring (See Section 5.3.6). Grazing prescriptions will be set in part to habitat performance criteria for special status species, including the California red-legged frog, California tiger salamander and the Callippe silverspot butterfly as specified in Table 5-1.

6.2.2 NON-NATIVE, INVASIVE PLANT CONTROL

Non-native invasive plant management will be conducted within the mitigation areas to improve the performance of plantings, enhance native vegetation cover and to enhance habitats for listed species. Non-native invasive plant management throughout the mitigation areas is important, because many non-native invasive plants colonize disturbed areas. Ground disturbances associated with proposed activities in the mitigation areas may introduce or disperse occurrences of non-native invasive species in the absence of non-native invasive plant management.

6.2.2.1 SPECIES REQUIRING MANAGEMENT

Species identified during the 2009 non-native invasive plant survey are the most likely species that will require removal during the first few years of compensation site maintenance. Removal will be required for more than one year, because these non-native invasive plants have a seed bank that persists in the soil and some plants may not be removed during the first year (Nomad Ecology 2009). Non-native invasive plant management will focus on the plants identified in the compensation sites and mitigation areas that have a Cal-IPC invasive rating of moderate and high. A current list of these species is provided in Appendix I (Nomad Ecology 2009); the presence of any species currently listed

with Cal-IPC as high or moderately invasive would initiate management actions. Management is not restricted to those species identified in Appendix I or in the 2009 Nomad Ecology report. New non-native invasive species not currently identified in California as invasive by the state or Cal-IPC could appear on-site during the extended monitoring period. As a result, the list of non-native invasive species initiating management in the appendix is not finite, and it would be updated as new information is gathered.

6.2.2.2 NON-NATIVE INVASIVE PLANT MANAGEMENT INITIATION

Non-native invasive plant management actions will be determined by a botanical restoration specialist familiar with invasive plant life cycle and control. Inspections will begin in March and continue monthly until September. Non-native invasive plant inspections will coincide with other vegetation monitoring activities where applicable. If non-native invasive plant presence and/or spread are deemed a problem the inspector will initiate non-native invasive plant management with the maintenance contractor. Non-native invasive plant management strategies will be utilized in the mitigation areas after construction is complete and would then be sustained through the biological inspections process. During the first three years of maintenance, non-native invasive plant management activities are expected monthly from April – September.

6.2.2.3 NON-NATIVE INVASIVE PLANT MANAGEMENT

Non-native invasive plant management control techniques within the compensation sites and the greater HRP mitigation areas will include one or a combination of the following: grazing (with timing and intensity prescribed as appropriate), targeted and landscape-level manual removal, chemical treatment, and burning (Table 6-1). Non-native invasive plant management strategies will be dependent upon many factors, including: plant morphology and life history traits, degree of infestation, presence of common and sensitive native species, regulatory requirements, presence of aquatic habitat, terrain and plant species composition.

Non-chemical, targeted and landscape-level treatment will be the preferential choice for non-native invasive plant control in the HRP mitigation areas. Targeted control methods using such methods as manual removal with weed wrenches or string trimmers (also known as a weed whacker) or hand pulling will be used for small non-native invasive plant infestations. Hand pulling of weeds will occur around planting basins unless adequate protection is afforded around plants to protect from mechanical line trimmer damage. Landscape-level methods such as mowing may be used with larger infestations. These non-chemical treatments would be repeated throughout the growing season, as necessary to control re-sprouting and extended germination periods (initiated due to alterations in species population dynamics). Non-native invasive plant removal would be implemented for multiple years to reduce the seed bank and to reduce competition with native plants.

Chemical control methods will be utilized when alternative methods may not be practical or as successful. One such instance where herbicides may be more appropriate is in upland grassland where large patches of yellow star thistle occur and controlled burning and manual removal is too costly, ineffective and/or time consuming. If used, herbicide use will comply with all implementation and reporting guidelines outlined in the Integrated Pest Management Plan (City and County of San Francisco 1996). Any herbicide used will be approved for use in California and specific habitats as appropriate and not be considered a threat to any special status species. Grazing will be implemented in mitigation areas as a means of non-native invasive plant control and potentially within the compensation sites after plants are established.

Prescribed burning would be used to manage grasslands and promote regeneration of native grasses. Prescribed burning would also be used to control non-native invasive plants. The SFPUC would plan the timing and location of prescribed burns in compliance with Bay Area Air Quality Management District regulations and in coordination with the California Department of Forestry and Fire Protection and any cooperating local fire departments. A fire management plan, including a site assessment of understory and over story targets, emergency procedures, and post-burn monitoring, would be prepared for all prescribed burns.

Before starting prescribed burning activities, access roads and firebreaks would be cleared of vegetation using manual and mechanical methods. During prescribed burns, four-wheel drive fire engines would traverse the sites.

Backpack and drip torches would be used to spot burn unwanted vegetation. Four-wheel drive or all terrain vehicles would be used to access remote areas lacking access roads. This technique may be used at times of the year when prescribed burning is not allowed due to wildfire hazards. In addition, in areas where unwanted vegetation is located within sensitive habitat or areas with special-status plants or wildlife, unwanted vegetation would be treated by spot burning.

Table 6-1
Potential non-native invasive plant management techniques for existing non-native invasive plants.

Scientific Name	Common Name	Cal-IPC Rating	Life History	Flowering Period	Seed Bank Longevity (years)	Mowing\ Weed Whacker		Hand Removal	Removal with Tools	Hydro-Mechanical Obliteration	Grazing	Burning*	Notes
Brachypodium distachyon	annual false brome	Moderate	annual	April - June	1				•	•	•	•	
Brassica nigra	black mustard	Moderate	annual	summer	> 3	•			•		•	•	Use weed wrench to pull plants. Mowing will not eradicate.
Carduus pycnocephalus	Italian thistle	Moderate	annual	May - June	> 3	•						•	Weed whack when plants have bolted but before seed set. Treatment needed 2-3 times a year for multiple years.
Centaurea calcitrapa	purple starthistle	Moderate	biennial	July - Aug	> 3	•			•		•	•	Mowing should be conducted before seed set.
Centaurea solstitialis	yellow starthistle	High	annual	June - Sept	1 - 3	•				•	•	•	Mow when plants have 2% buds, repeat every 4-6 weeks
Cirsium vulgare	bull thistle	Moderate	biennial	June - Sept	> 3	•		•	•			•	All activities conducted once bolted but before seed set.
Conium maculatum	poison hemlock	Moderate	biennial	June - Sept	> 3	•		•		•	•	•	Mowing twice a year may control the population but not eradicate
Dipsacus sativus	fuller's teasel	Moderate	biennial	July - Aug	6	•			•			•	
Dittrichia graveolens	stink wort	Moderate	annual	late summer	> 3			•		•		•	
Eucalyptus globules	blue gum	Moderate	perennial	winter	> 3				•	•		•	Cut the trunk and cover with landscape fabric or macerate the remaining trunk using HMO.
Foeniculum vulgare	fennel	High	perennial	May - Sept	> 3	•					•	•	Mow four times a year for four years to eradicate.
Hirschfeldia incana	shortpod mustard	Moderate	biennial	summer	unknown	•			•		•	•	Use weed wrench to pull. Mowing will not eradicate.
Nicotiana glauca	tree tobacco	Moderate	perennial	spring	unknown				•			•	
Phalaris aquatic	Harding grass	Moderate	perennial	May - Sept	unknown				•	•		•	
Rubus discolor	Himalayan blackberry	High	perennial	July - Sept	> 3				•	•		•	
Taeniatherum caput-medusae	Medusahead	High	annual	May - June	< 3						•	•	
Tamarix parviflora	salt cedar	High	perennial	spring	< 1				•			•	

* Prescribed burning will be adaptively used as needed to control non-natives. The timing and intensity of burns will be determined based on the species composition and site goals.

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6.2.3 PREDATOR CONTROL AND NON-NATIVE WILDLIFE ADAPTIVE MANAGEMENT

If the performance criteria for invasive bullfrog and non-native predatory fish are not met during annual monitoring surveys adaptive management will be used to review past performance weaknesses and identify strategies to meet the performance criteria.

Adaptive management is a process which optimizes decision making by using an iterative process based in research and monitoring. This approach allows managers to learn by experience within unique environments and apply lessons learned to remedy deficiencies in a structured and scientific approach. Predator control actions will be evaluated via monitoring and reviewed for efficacy. In the event that predator control fails to meet success criteria, contingency measures for bullfrog control could include:

1. Draining ponds annually.

2. Re-design the ponds so they function as intermittent ponds that self-dry annually

If non-native predatory fish populations become reestablished in a pond, the following options are available:

1. Evaluate the possible origins of the fish

2. Place signage at the ponds to discourage fish introduction and explain the habitat function of the ponds

3. Provide trespass protection such as fencing, monitoring, etc

The maintenance measures will then be monitored and evaluated on an annual basis, and adapted as necessary for other non-native wildlife species as necessary for the purpose of meeting success criteria within a five-year monitoring period.

6.2.4 CALIFORNIA TIGER SALAMANDER/CALIFORNIA RED-LEGGED FROG HABITAT MANAGEMENT COORDINATION

Fence installation at the Goldfish Pond, Pond B, Pond C, and North and South ponds compensation sites (described in Section 4.3.2) will manage cattle access to water and aquatic vegetation, providing a mix of grazed and ungrazed upland habitats as well as appropriate amounts of emergent vegetation and open water habitat within the ponds. To maximize the benefit of grazing on California tiger salamander/California red-legged frog habitat, the SFPUC will document the timing and intensity of grazing within the pond management compensation sites for two consecutive years, beginning at the time of pond retrofit construction completion.

Uplands in the South Calaveras Mitigation Area are currently grazed under management of the SFPUC. These areas will continue to be grazed using the methods described in Section 6.2.1, which are intended to optimize conditions for California tiger salamander and California red-legged frog Small mammal (especially ground squirrel) burrows are important refuges for California tiger salamander in uplands. Rodenticides or other rodent control methods will not be used within 500 feet of ponds identified as potential aquatic breeding habitats for the California tiger

salamander/California red-legged frog except as described below. If rodent burrows threaten the integrity of pond embankments or other infrastructure, manual control methods shall be utilized. As small mammal burrows provide the optimal refugia habitat for California tiger salamander, these controls shall only be used in extreme cases where the infrastructure integrity may become compromised. These may consist of trapping rodents within these areas and installing screen to preclude rodents from burrows. If mechanical methods are unsuccessful at controlling rodent populations in pond berms then a depredation permit will be requested. To be considered for use, a rodenticide must be approved for use in or near aquatic environments by the U.S. Fish and Wildlife Service (USFWS) and only be used to control rodent populations that threaten pond embankments.

6.2.5 REPLANTING

Replanting will be necessary during the installation warranty period and as necessary during the monitoring period to replace dead plants.

The plant installation contractor will have a six month post-installation plant warranty period. Plants that die during the six-month period will be replaced in kind or with approved substitutes by the plant installation contractor during the following rainy season. The six month warranty period does not include all of the warmest and driest months of the year (assuming planting will take place in winter). More casualties are expected during the dry season but these losses will be considered natural thinning and selection of those plants best equipped for the conditions at the site.

Replanting will also be needed if the site does not meet success criteria. If a site fails to meet any vegetative cover criteria then planting recommendations will be made to remedy the lapse in cover. Replanting at this point will be the responsibility of the maintenance contractor but the ecologists responsible for mitigation monitoring and management will create the design and species palette.

In both cases, the plants will not necessarily be replaced with the same species. If a species is not successful at a site or in a certain location within a site then a new species may be planted in its place. If a desired species for replanting is not available in the quantities needed (due to collection or growing issues) then a replacement species may be chosen. A botanical restoration specialist will determine which species will be planted and communicate their decision to the maintenance contractor.

6.3 OTHER POTENTIAL ACTIONS

Maintenance actions are not limited to the listed items above. In the event that an unanticipated situation arises that requires additional action not described in this document, the biological restoration specialist will assemble an adaptive management plan to define remedies for the situation. Potential unforeseen events include catastrophic acts of nature (e.g., floods, severe drought, fire, severe wind, pathogens) and/or human interference including vandalism or non-scheduled grazing.

Hand grubbing of vegetation is planned to occur around individual mitigation plantings to reduce competition from surrounding plants. Grubbing will be no greater than a two and a half foot radius from each planting. Mowing may be utilized to remove dense weedy vegetation or non-native invasive species from larger planting areas. Ripping or tilling may occur in select planting locations where the soil has been compacted by equipment or vehicles.

6.4 MAINTENANCE SCHEDULE

A biological restoration specialist will inspect the sites for maintenance needs according to the schedule shown in Table 6-2. During each visit, a maintenance form will be completed to record additional monitoring that could be helpful in meeting the site's needs (Appendix K). The maintenance form will be reported in the annual monitoring report and will be used to initiate actions by the maintenance contractors.

During the 1 to 3 year plant establishment period, mitigation plantings will receive the following inspections:

- Monthly inspections to assess maintenance needs for non-native invasive plants March through September
- Monthly inspections to assess plant health (herbivory damage, pests, and disease) and mortality March through September
- Monthly inspections for proper functioning of the irrigation system from April through October

In addition, during the monitoring period (Years 1 to 10), sites will also be inspected on the following schedule:

- Annually to inspect for non-native invasive plants
- Annually to assess tree species health (herbivory damage, pests, and disease) and mortality
- Annual assessment of plant mortality in the fall and revegetation, if necessary in the November - February
- Each of the ponds where physical improvements were made will be inspected annually, as well as after major winter storm events, at the land manager's discretion, to check for unexpected or significant erosion requiring immediate repair
- Annually for fence condition and vandalism

Once the mitigation performance criteria have been achieved, the sites will be inspected annually for overall condition of the site, vegetation (including non-native invasive plants), presence of non-native predatory fish and bullfrogs in ponds in the South Calaveras and Sheep Camp Creek Mitigation Areas, and fence condition.

Table 6-2
Maintenance schedule.

Type of Maintenance	Feature	Inspections Conducted*	Minimum Interval of Inspection/ Maintenance	Suggested Timing of Inspections and Maintenance											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Infrastructure and Physical Resources	Fences	Lessees, Watershed Keepers, Restoration Specialist	Annually		X										
	Ponds: Spillways and Dams	Restoration Specialist	Annually		X										
	Erosion	Lessees, Watershed Keepers, Restoration Specialist	Annually		X										
	Irrigation	Plant Maintenance Contractor	4 times a year				X	X	X	X	X	X	X		
Biological	Non-native invasive plants**	Restoration Specialist	7 times a year			X	X	X	X	X	X	X			
	Replanting***	Restoration Specialist	Annually	X	X									X	X

* Repairs and as-needed maintenance can be detected by anyone on-site. Maintenance actions will be initiated by parties listed in the table.
** Non-native invasive plant management should be implemented at the same frequency.
***Planting may occur between November and February – weather and species dependent.

6.5 MANAGEMENT

This section outlines the parties responsible for managing the mitigation areas and ensuring that the prescriptions of this MMP are implemented. Active management is important for meeting design objectives. Management consists of long-term watershed management, grazing management, property protection (e.g., easements), and funding.

The mitigation lands are within the SFPUC-owned Sunol Valley watershed lands (which encompass the Alameda Creek and San Antonio Creek watersheds). SFPUC manages these lands to maintain the long-term health of the watersheds contributing to San Francisco's water supply facilities.

6.5.1 GRAZING MANAGEMENT

Oversight of livestock grazing in the mitigation areas will be provided by the SFPUC rangeland manager. The mitigation areas will be grazed differently than the surrounding SFPUC lands, necessitating the need for the rangeland manager to work closely with either the existing SFPUC grazing lessee or another grazing lessee to ensure the areas are grazed according to the guidelines that will be set forth in a detailed grazing management plan for the sites (in press). Grazing will be prescribed using the parameters described in Section 6.2.1 and monitored as described in Section 5.3.6.

6.5.2 PROPERTY PROTECTIONS

The SFPUC will place conservation easements on the mitigation areas. The Alameda County Resource Conservation District (RCD) or another entity approved to hold conservation easements will hold the conservation easement for the properties. The RCD will be responsible for ensuring that grazing regimens, non-native invasive species and rodent controls, and any other land management prescriptions described in this plan are implemented correctly and in perpetuity.

6.5.3 LONG-TERM FUNDING

SFPUC will provide the funding for implementation of this MMP, including any remedial measures. Funding assumes that implementation will be in 2010. Long-term funding will be established to meet the following objectives:

- Maintain a financial assurance for 10-years to replace the constructed habitat features in the event of failure.
- Maintain a funding source for 10-years of success monitoring
- Create a perpetual funding mechanism for future management monitoring and management activities.

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Appendix A: Soil Data and Descriptions

Appendix A-1
Soils Analysis Survey Locations

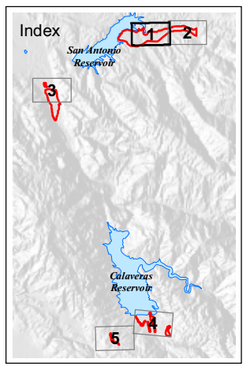
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W
PoE2
PtB2
RoF
Za
PgB
Rh
San Antonio Creek (2)
DaB
PgB
PoE2
Rh
Oak Woodland (1)
Oak Savannah (1)
PgB
Za
AzE2
PoF2
W
PoF2
PoE2
PoC2
PoE2
PoC2
PoC2

Legend

- Compensation area
- Soil permeability
- Soil test pit

Index



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DRAFT

Permeability and Soils Analysis at the San Antonio Creek Area

Habitat Reserve Program

Preliminary Mitigation Design & Engineering

April 2009

Figure A-1.1

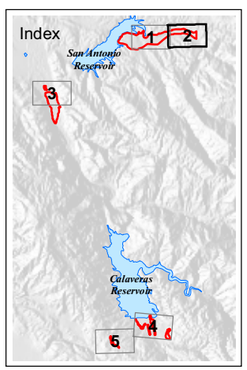
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DbD
DaB
PoE2
PtB2
SdE2
PgB
San Antonio Creek (1)
Za
Rh
SdF3
DaB
PgB
W
AzF2
AzE2
VaE2
PoF2
VaF2
LpE2

Legend

- Compensation area
- Soil permeability
- Soil test pit

Index



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CONTOUR INTERVAL = 5 FT, 50-FT INDEX

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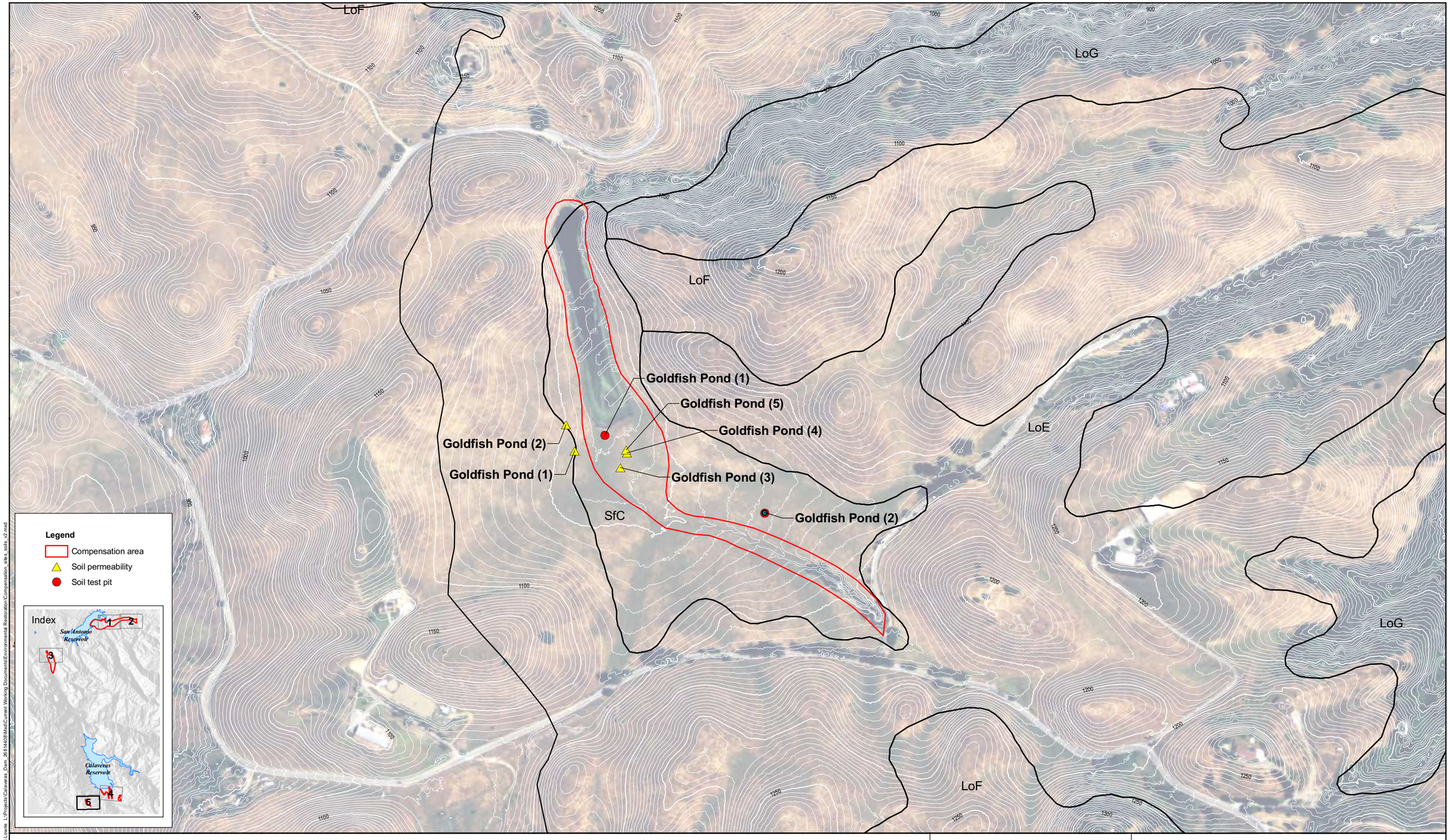
Permeability and Soils Analysis at the San Antonio Creek Area

Habitat Reserve Program
Preliminary Mitigation Design & Engineering

April 2009

Figure A-1.2

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DRAFT

Permeability and Soils Analysis at the Goldfish Pond Area

Habitat Reserve Program

Preliminary Mitigation Design & Engineering

April 2009

Figure A-1.3

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Appendix A-2
Soil Properties

Soil Properties

Map Unit

A map unit is defined by the NRCS as a delineation on a soil map that represents an area dominated by one or more major kinds of soil. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms that have similar use and management requirements.

Soil Series

Map units are comprised of soil series. A series is a group of soils that have horizons similar in arrangement and characteristics. The soils of a series have a relatively narrow range in sets of properties.

Some of the characteristics commonly used to differentiate series are the kind, thickness, and arrangement of horizons and their structure, color, texture, reaction, consistence, content of carbonates and other salts, content of humus, content of rock fragments, and mineralogical composition. A significant difference in any one of these can be the basis for recognizing a different series. Very rarely, however, do two soil series differ in just one of these characteristics. Most characteristics are related, and generally several change together.

Natural Drainage Classes

Natural drainage class refers to the frequency and duration of wet periods under conditions similar to those under which the soil developed. Alteration of the water regime by man, either through drainage or irrigation, is not a consideration unless the alterations have significantly changed the morphology of the soil. The classes follow:

Excessively drained. Water is removed very rapidly. The occurrence of internal free water commonly is very rare or very deep. The soils are commonly coarse-textured and have very high hydraulic conductivity or are very shallow.

Somewhat excessively drained. Water is removed from the soil rapidly. Internal free water occurrence commonly is very rare or very deep. The soils are commonly coarse-textured and have high saturated hydraulic conductivity or are very shallow.

Well drained. Water is removed from the soil readily but not rapidly. Internal free water occurrence commonly is deep or very deep; annual duration is not specified. Water is available to plants throughout most of the growing season in humid regions.

Wetness does not inhibit growth of roots for significant periods during most growing seasons. The soils are mainly free of the deep to redoximorphic features that are related to wetness.

Moderately well drained. Water is removed from the soil somewhat slowly during some periods of the year. Internal free water occurrence commonly is moderately deep and transitory through permanent. The soils are wet for only a short time within the rooting depth during the growing season, but long enough that most mesophytic crops are affected. They commonly have a moderately low or lower saturated hydraulic conductivity in a layer within the upper 1 m, periodically receive high rainfall, or both.

Somewhat poorly drained. Water is removed slowly so that the soil is wet at a shallow depth for significant periods during the growing season. The occurrence of internal free water commonly is shallow to moderately deep and transitory to permanent. Wetness markedly restricts the growth of mesophytic crops, unless artificial drainage is provided. The soils commonly have one or more of the following characteristics: low or very low saturated hydraulic conductivity, a high water table, additional water from seepage, or nearly continuous rainfall.

Poorly drained. Water is removed so slowly that the soil is wet at shallow depths periodically during the growing season or remains wet for long periods. The occurrence of internal free water is shallow or very shallow and common or persistent. Free water is commonly at or near the surface long enough during the growing season so that most mesophytic crops cannot be grown, unless the soil is artificially drained. The soil, however, is not continuously wet directly below plow-depth. Free water at shallow depth is usually present. This water table is commonly the result of low or very low saturated hydraulic conductivity of nearly continuous rainfall, or of a combination of these.

Very poorly drained. Water is removed from the soil so slowly that free water remains at or very near the ground surface during much of the growing season. The occurrence of internal free water is very shallow and persistent or permanent. Unless the soil is artificially drained, most mesophytic crops cannot be grown. The soils are commonly level or depressed and frequently ponded. If rainfall is high or nearly continuous, slope gradients may be greater.

Hydraulic Conductivity

Hydraulic conductivity is a measure of a material's ability to transmit water. It is a specific mathematical coefficient (quantitative) that relates the rate of water movement to the hydraulic gradient.

Hydraulic Conductivity - Saturated Flow		
Class		Soil Properties
Name	Rate (um/s)	Most Limiting Layer or to 150 cm

Very High	> 100	- Fragmental - Sandy with coarse sand or sand texture, and loose consistence
High	100-10	- Other Sandy, Sandy-skeletal, or coarse-loamy soil material that are very friable, friable, soft or loose - When very moist or wet has moderate or strong granular or prismatic finer than very coarse, and many surface featuers except stress surfaces or slickensides on vertical surfaces of structural units
Mod. High	10-1	- Sandy in other consistence classes except extremely firm or cemented - 18 to 35 percent clay with moderate structure except platy or with strong very coarse prismatic, and with common surface features except stress surfaces or slickensides on vertical surfaces of structural units
Mod. Low	1-0.1	- Other Sandy classes that are extremely firm or Low cemented - 18 to 35 percent clay with other structures and surface conditions except pressure or stress surfaces - ≥35 percent clay and moderate structure except if platy or very coarse prismatic, and with common vertical surface features except stress surfaces or slickensides
Low	0.1-0.01	- Continuous moderate or weak cementation ≥35 percent clay and meets one of the following: weak structure; weak structure with few or no vertical surface features; platy structure; common or many stress surfaces or slickensides
Very Low	<0.01	- Continuously indurated or strongly cemented and less than common roots - ≥35 percent clay and massive or exhibits horizontal depositional strata and less than common roots

NRCS saturated hydraulic conductivity classes.

Effective Rooting Depth

The root restricting depth is where root penetration would be strongly inhibited because of physical (including soil temperature) and/or chemical characteristics. Restriction

means the incapability to support more than a few *fine* or *very fine* roots if depth from the soil surface and water state, other than the occurrence of frozen water, are not limiting. The restriction may be below where plant roots normally occur because of limitations in water state, temperatures, or depth from the surface. The evaluation should be for the specific plants that are important to the use of the soil. These plants should be indicated. The root-restriction depth may differ depending on the plant considered.

Root-depth observations preferably should be used to make the generalization. If these are not available—and often they are not because roots do not extend to the depth of concern—then inferences may be made from morphology. Some guidelines follow for physical restriction. Chemical restrictions, such as high extractable aluminum and/or low extractable calcium, are not considered here. These are generally not determinable by field examination alone.

Physical root restriction is assumed at contact to rock, whether hard or soft. Further, certain pedogenic horizons, such as *fragipans*, infer root restriction. A change in particle size distribution alone, as for example loamy sand over gravel, is not always a basis for physical root restriction.

A common indication of physical root restriction is a combination of structure and consistence which together suggest that the resistance of the soil fabric to root entry is high and that vertical cracks and planes of weakness for root entry are absent or widely spaced. Root restriction is inferred for a continuously *cemented* zone of any thickness; or a zone >10-cm thick that when *very moist* or *wet* is *massive*, *platy*, or has *weak* structure of any type for a vertical repeat distance of >10 cm and while *very moist* or *wet* is *very firm* (*firm*, if sandy), *extremely firm*, or has a *large* penetration resistance.

Effective Rooting Depth	
Rooting Class	Depth (cm)
Very Deep	>150
Deep	100-150
Moderately Deep (or Moderately Shallow)	50-100
Shallow	25-50
Very Shallow	<25

Water Retention Difference (WRD)

Water retention difference (WRD) is the amount of water retained in a volume of soil between either 10 or 33kPa, depending on sand content, and 1500 kPa. The WRD value is also known as the available water holding capacity of a soil on a volume basis.

Available water capacity is the volume of water that should be available to plants if the soil, inclusive of fragments, were at field capacity. It is commonly estimated as the amount of water held between field capacity and wilting point, with corrections for salinity, fragments, and rooting depth. Classes of available water capacity are not normally used except as adjective ratings that reflect the sum of available water capacity in inches to some arbitrary depth. Class limits vary according to climate zones and the crops commonly grown in the areas. The depth of measurement also is variable. Available water capacity is an important soil property in developing water budgets, predicting droughtiness, designing and operating irrigation systems, designing drainage systems, protecting water resources, and predicting yields.

Water Retention Difference (WRD)		
Class	Texture	Probable Range on Basis of Texture (cm water/cm soil)
Fine	Clay Silty Clay Sandy Clay	0.15 0.15 0.15
Moderately Fine	Silty Clay Loam Clay Loam Sandy Clay Loam	0.2 0.2 0.15
Medium	Silt Loam Loam Very Fine Sandy Loam	0.2 0.2 0.2
Moderately Coarse	Fine Sandy Loam Sandy Loam Loamy Very Fine Sand Loamy Fine Sand	0.15 0.15 0.1 0.1
Coarse	Loamy Sand Very Fine Sand Fine Sand Sand	0.05 0.05 0.05 0.05

*Where gravel or other coarse fragments are present, values for textures shown above should be reduced by the percent of coarse fragments in the soil mass. If a soil has soluble salts present, the available water holding capacity must be reduced too.

WRD is calculated to 150 cm in depth or to a root limiting layer.

Calculated WRD Classes	
WRD Class	cm of water
Very High	>30
High	22.5-30
Moderate	15.0-22.5
Low	7.5-15
Very Low	<7.5

Surface Runoff

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff differs from subsurface flow or interflow that results when infiltrated water encounters a zone with lower perviousness than the soil above. The water accumulates above this less pervious zone and may move laterally if conditions are favorable for the occurrence of free water.

Historically, a set of runoff classes have been employed "as determined by the characteristics of soil slope, climate, and cover" (Soil Survey Staff, 1951). The current concept is referred to as index surface runoff. The concept indicates relative runoff for very specific conditions. The soil surface is assumed to be bare and surface water retention due to irregularities in the ground surface is low. Steady ponded infiltration rate is the applicable infiltration stage. Ice is assumed to be absent unless otherwise indicated. Finally, both the maximum bulk density in the upper 25 cm and the bulk density of the uppermost few centimeters are assumed within the limits specified for the mapping concept.

The concept assumes a standard storm or amount of water addition from snowmelt of 50 mm in a 24-hour period with no more than 25 mm in any single 1-hour period. Additionally, a standardized antecedent water state condition prior to the water addition is assumed: the soil is conceived to be *very moist* or *wet* to the base of the soil, to 1/2 m, or through the horizon or layer with minimum saturated hydraulic conductivity within 1 meter, whichever is the greatest depth. If the minimum saturated hydraulic conductivity of the soil occurs below 1 meter, it is disregarded and the minimum "to and including 1 m" is employed.

Soil Runoff Classes

Slope Gradient	Saturated Hydraulic Conductivity Class [a, b]					
Pct.	*Very High*	*High*	*Mod. High*	*Mod. Low*	*Low*	*Very Low*
Concave [c]	N	N	N	N	N	N
<1	N	N	N	L	M	H
1 to 5	N	LV	L	M	H	HV
5 to 10	LV	L	M	H	HV	HV
10 to 20	LV	L	M	H	HV	HV
≥20	L	M	H	HV	HV	HV

a. Abbreviations: Negligible-N; Very Low-LV; Low-L; Medium- M; High-H; and Very High-HV.

b. Consult Table 3-7 for definitions. Assumes that the lowest value for the soil occurs above 1/2 m. If the lowest value occurs 1/2 to 1 m, then reduce runoff by one class (medium to slow, for example). If it occurs >1 m, then use the lowest saturated hydraulic conductivity < 1 m.

c. Areas from which no or very little water escapes by flow over the ground surface.

Index surface runoff classes based on slope gradient and saturated hydraulic conductivity.

Soil pH

The numerical designation of reaction is expressed as pH. With this notation, pH 7 is neutral. Values lower than 7 indicate acidity; values higher, indicate alkalinity. Most soils range in pH from slightly less than 2.0 to slightly more than 11.0, although sulfuric acid forms and pH may decrease to below 2.0 when some naturally wet soils that contain sulfides are drained.

The descriptive terms to use for ranges in pH are as follows:

Soil Reaction (pH)	
Class	Range
Ultra acid	<3.5
Extremely acid	3.5-4.4
Very strongly acid	4.5-5.0
Strongly acid	5.1-5.5
Moderately acid	5.6-6.0
Slightly acid	6.1-6.5
Neutral	6.6-7.3
Slightly alkaline	7.4-7.8
Moderately alkaline	7.9-8.4
Strongly alkaline	8.5-9.0
Very strongly alkaline	>9.0

A principal value of soil pH is the information it provides about associated soil characteristics. Two examples are phosphorus availability and base saturation. Soils that have a pH of approximately 6 or 7 generally have the most ready availability of plant nutrients. Strongly acid or more acid soils have low extractable calcium and magnesium, a high solubility of aluminum, iron, and boron, and a low solubility of molybdenum. In addition, these soils have a possibility of organic toxins and generally have a low availability of nitrogen and phosphorus. At the other extreme are alkaline soils. Calcium, magnesium, and molybdenum are abundant with little or no toxic aluminum, and nitrogen will be readily available. If pH is above 7.9, the soils may have an inadequate availability of iron, manganese, copper, zinc, and especially of phosphorus and boron.

Soil reaction is one of several properties used as a general indicator of soil corrosivity or its susceptibility to dispersion. In general, soils that are either highly alkaline or highly acid are likely to be corrosive to steel. Soils that have pH <5.5 are likely to be corrosive to concrete. Soils that have pH >8.5 are likely to be highly dispersible, and piping may be a problem.

Soil Structure

Soil structure refers to units composed of primary particles. The cohesion within these units is greater than the adhesion among units. As a consequence, under stress, the soil mass tends to rupture along predetermined planes or zones. These planes or zones, in turn, form the boundary. Compositional differences of the fabric matrix appear to exert weak or no control over where the bounding surfaces occur. If compositional differences control the bounding surfaces of the body, then the term "concentration" is employed. The term "structural unit" is used for any repetitive soil body that is commonly bounded by planes or zones of weakness that are not an apparent consequence of compositional differences. A structural unit that is the consequence of soil development is called a ped. The surfaces of peds persist through cycles of wetting and drying in place. Commonly, the surface of the ped and its interior differ as to composition or organization, or both, because of soil development. Earthy *clods* and *fragments* stand in contrast to peds, for which soil forming processes exert weak or no control on the boundaries. Some clods, adjacent to the surface of the body, exhibit some rearrangement of primary particles to a denser configuration through mechanical means. The same terms and criteria used to describe structured soils should be used to describe the shape, grade, and size of clods. Structure is not inferred by using the terms interchangeably. A size sufficient to affect tilth adversely must be considered. The distinction between clods and fragments rests on the degree of consolidation by mechanical means. Soil fragments include (1) units of undisturbed soil with bounding planes of weakness that are formed on drying without application of external force and which do not appear to have predetermined bounding planes, (2) units of soil disturbed by mechanical means but without significant rearrangement to a denser configuration, and (3) pieces of soil bounded by planes of weakness caused by pressure exerted during examination with size and shape highly dependent on the manner of manipulation.

Some soils lack structure and are referred to as *structureless*. In structureless layers or horizons, no units are observable in place or after the soil has been gently disturbed, such as by tapping a spade containing a slice of soil against a hard surface or dropping a large fragment on the ground. When structureless soils are ruptured, soil fragments, single grains, or both result. Structureless soil material may be either single grain or massive. Soil material of single grains lacks structure. In addition, it is loose. On rupture, more than 50 percent of the mass consists of discrete mineral particles.

When in the field, the type (shape), size, and grade (distinctness) of the units are described. Field terminology for soil structure consists of separate sets of terms designating each of the three properties, which by combination form the names for structure.

Type - Several basic shapes of structural units are recognized in soils. Supplemental statements about the variations in shape of individual peds are needed in detailed descriptions of some soils. The following terms describe the basic shapes and related arrangements:

Platy: The units are flat and platelike. They are generally oriented horizontally. A special form, lenticular platy structure, is recognized for plates that are thickest in the middle and thin toward the edges.



Strong thin platy structure.

Prismatic: The individual units are bounded by flat to rounded vertical faces. Units are distinctly longer vertically, and the faces are typically casts or molds of adjoining units. Vertices are angular or subrounded; the tops of the prisms are somewhat indistinct and normally flat.



Strong medium prismatic structure. The prisms are 35 to 45 mm across.

Columnar: The units are similar to prisms and are bounded by flat or slightly rounded vertical faces. The tops of columns, in contrast to those of prisms, are very distinct and normally rounded.



A cluster of strong medium columnar pads. The cluster is about 135 mm across.

Blocky: The units are blocklike or polyhedral. They are bounded by flat or slightly rounded surfaces that are casts of the faces of surrounding peds. Typically, blocky structural units are nearly equidimensional but grade to prisms and to plates. The structure is described as angular blocky if the faces intersect at relatively sharp angles; as subangular blocky if the faces are a mixture of rounded and plane faces and the corners are mostly rounded.



Strong medium and coarse blocky peds.

Granular: The units are approximately spherical or polyhedral and are bounded by curved or very irregular faces that are not casts of adjoining peds.



Strong fine and medium granular peds.

Size - Six classes are employed: very fine, fine, medium, coarse, very coarse, and extremely coarse. The size limits refer to the smallest dimension of plates, prisms, and columns. If the units are more than twice the minimum size of "very coarse," the actual size is given: "prisms 30 to 40 cm across."

(Soil) Structure - Size				
Size Class	Code (NASIS)	Criteria: Structural unit size[1] (mm)		
		Granular Platy[2] Thickness	Columnar, Prismatic, Wedge[3]	Angular & Subangular Blocky
Very Fine (Very Thin)[2]	VF (VN)	<1	<10	<5
Fine (Thin)[2]	F (TN)	1 to <2	10 to <20	5 to <10
Medium	M	2 to <5	20 to <50	10 to <20

Coarse (Thick)[2]	CO (TK)	5 to <10	50 to <100	20 to <50
Very Coarse (Very Thick)[2]	VC (VK)	≥10	100 to <500	≥50
Extr. Coarse	EC	-	≥500	-

1 Size limits always denote the smallest dimension of the structural units.

2 For platy structure only, substitute thin for fine and thick for coarse in the size class names.

3 Wedge structure is generally associated with Vertisols (for which it is a requirement) or related soils with high amounts of smectite clays.

Grade - Grade describes the distinctness of units. Criteria are the ease of separation into discrete units and the proportion of units that hold together when the soil is handled. Four classes are used:

(Soil) Structure - Grade		
Grade	Code	Criteria
Structureless	0	No discrete units observable in place or in hand sample.
Weak	1	Units are barely observable in place or in a hand sample.
Moderate	2	Units are well-formed and evident in place or in a hand sample.
Strong	3	Units are distinct in place (undisturbed soil), and separate cleanly when disturbed.

Roots

Quantity, size, and location of roots in each layer are recorded. Using features of the roots—length, flattening, nodulation, and lesions—the relationships to special soil attributes or to structure may be recorded as notes.

Quantity of roots is described in terms of numbers of each size per unit area. The class placement for quantity of roots pertains to an area in a horizontal plane unless otherwise

stated. This unit area changes with root size as follows: 1 cm^2 for very fine and fine, 1 dm^2 for medium and coarse, and 1 m^2 for very coarse. The quantity classes are:

Few: < 1 per unit area

Very few: < 0.2 per unit area

Moderately few: 0.2 - 1 per unit area

Common: 1 - 5 per unit area

Many: > 5 per unit area

Roots are described in terms of a specified diameter size. The size classes are:

Very fine: < 1 mm

Fine: 1- 2 mm

Medium: 2- 5 mm

Coarse: 5- 10 mm

Very coarse: > 10 mm

It is desirable to have class separation at an abundance level where there are sufficient roots to exploit much of the soil water that is present in the withdrawal range of the plant over the growing season. A difficulty is that species differ in the efficiency of their roots. Soybeans and cotton are several fold more efficient than the grasses, and there are undoubtedly other differences among specific groups. The abundance classes have been formulated so that the few-common separation is about where the annual grasses have insufficient numbers of roots for seasonally complete exploitation. The moderately few-very few separation is where soybeans and cotton would have insufficient numbers.

The location of roots within a layer may be described in relation to other features of the layer. Relationships to layer boundaries, animal traces, pores, and other features are described as appropriate. The description may indicate, for example, whether roots are inside structural units or only follow parting planes between structural units.

Quantity, size, and location is a convenient order: "Many very fine and common fine roots" implies that roots are uniformly distributed, since location is not given. This contrasts to examples that provide locational information such as "common very fine and common fine roots concentrated along vertical faces of structural units" or "common very fine roots inside peds, many medium roots between structural units."

Diagram illustrating the visual impressions of abundance classes of Very Fine and Fine Roots and Pores in relation to size.

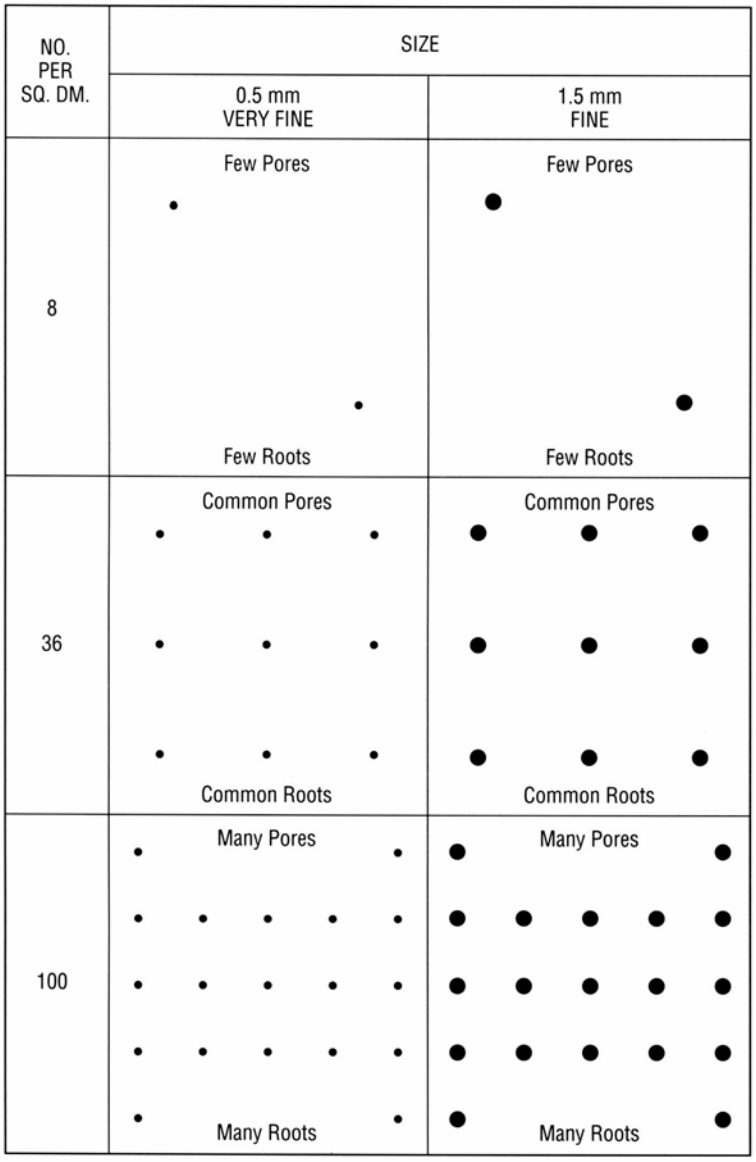
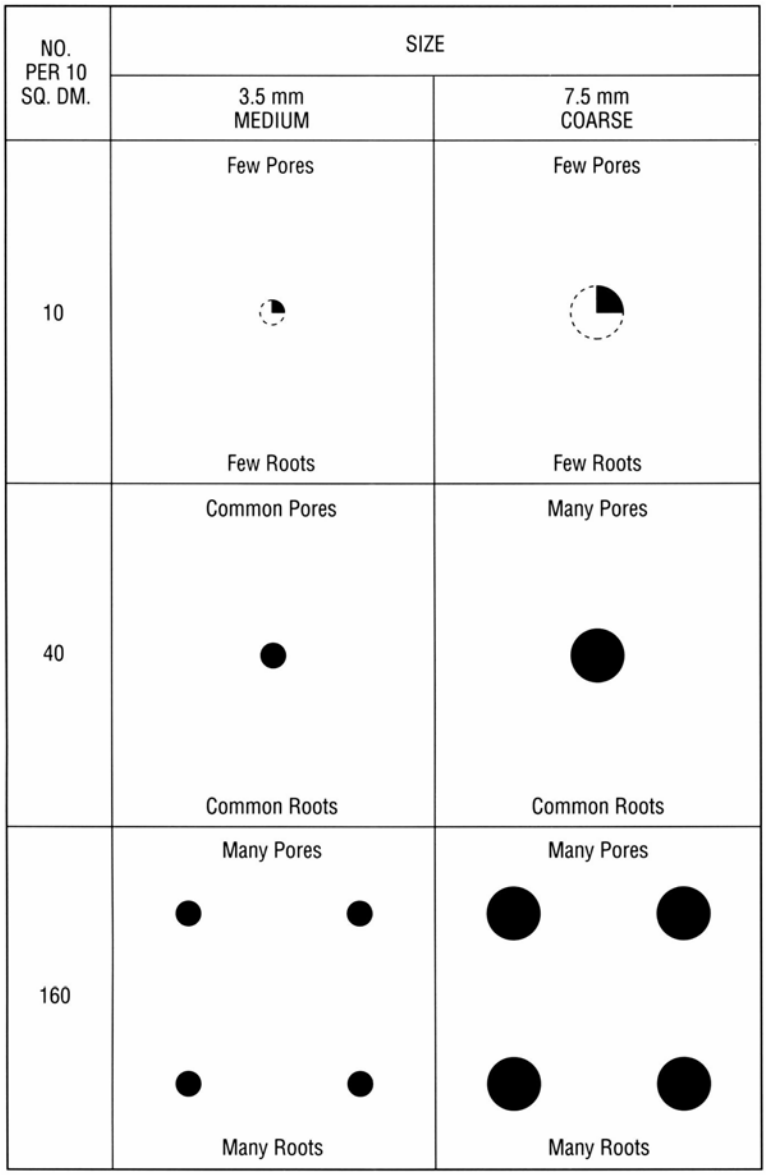


Diagram illustrating the visual impressions of abundance classes of Medium and Coarse Roots and Pores in relation to size



For annual plants, the time of the root observation may be indicated. Root traces (channels left by roots that have died) and the dead roots themselves are sometimes clues to soil properties that change with time. The rate of root decay depends on the species, root size, and the soil moisture and temperature regimes. Local experience must dictate the time after maturity or harvest that the root distribution is affected by decay. Root traces in deep layers may persist for years. Many of these traces have organic coatings or linings. They may occur below the normal rooting depth of annual crops. This suggests that they were left by deeper rooted plants, perhaps native perennials. The presence of

dead roots below the current depth of rooting may indicate a change in the soil water regime. The roots may have grown normally for a few years, then killed when the soils were saturated for a long period.

In addition to recording the rooting depths at the time of observation, generalizations about the rooting depth may be useful. These generalizations should emphasize very fine and fine roots, if present, because these sizes are active in absorption of water and nutrients. The generalizations may be for a few plants or plant communities that are of particular importance. If annual plants are involved, the generalization should be for near physiological maturity.

Horizonation

The capital letters O, A, E, B, C, and R represent the master horizons and layers of soils. The capital letters are the base symbols to which other characters are added to complete the designations. Most horizons and layers are given a single capital letter symbol; some require two.

O horizons or layers*: Layers dominated by organic material. Some are saturated with water for long periods or were once saturated but are now artificially drained; others have never been saturated.*

Some O layers consist of undecomposed or partially decomposed litter, such as leaves, needles, twigs, moss, and lichens, that has been deposited on the surface; they may be on top of either mineral or organic soils. Other O layers, are organic materials that were deposited under saturated conditions and have decomposed to varying stages (Soil Survey Staff, 1975). The mineral fraction of such material is only a small percentage of the volume of the material and generally is much less than half of the weight. Some soils consist entirely of material designated as O horizons or layers.

An O layer may be on the surface of a mineral soil or at any depth beneath the surface, if it is buried. A horizon formed by illuviation of organic material into a mineral subsoil is not an O horizon, although some horizons that formed in this manner contain much organic matter.

A horizons*: Mineral horizons that formed at the surface or below an O horizon, that exhibit obliteration of all or much of the original rock structure, and that show one or more of the following: (1) an accumulation of humified organic matter intimately mixed with the mineral fraction and not dominated by properties characteristic of E or B horizons (defined below) or (2) properties resulting from cultivation, pasturing, or similar kinds of disturbance.*

If a surface horizon has properties of both A and E horizons but the feature emphasized is an accumulation of humified organic matter, it is designated an A horizon. In some

places, as in warm arid climates, the undisturbed surface horizon is less dark than the adjacent underlying horizon and contains only small amounts of organic matter. It has a morphology distinct from the C layer, although the mineral fraction is unaltered or only slightly altered by weathering. Such a horizon is designated A because it is at the surface; however, recent alluvial or eolian deposits that retain rock structure[1] are not considered to be an A horizon unless cultivated.

***E horizons**: Mineral horizons in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these, leaving a concentration of sand and silt particles. These horizons exhibit obliteration of all or much of the original rock structure.*

An E horizon is usually, but not necessarily, lighter in color than an underlying B horizon. In some soils the color is that of the sand and silt particles, but in many soils coatings of iron oxides or other compounds mask the color of the primary particles. An E horizon is most commonly differentiated from an overlying A horizon by its lighter color. It generally has less organic matter than the A horizon. An E horizon is most commonly differentiated from an underlying B horizon in the same sequum by color of higher value, by lower chroma or both, by coarser texture, or by a combination of these properties. An E horizon is commonly near the surface below an O or A horizon and above a B horizon, but the symbol E can be used for eluvial horizons within or between parts of the B horizon or for those that extend to depths greater than normal observation if the horizon has resulted from soil genesis.

***B horizons**: Horizons that formed below an A, E,, or O horizon and are dominated by obliteration of all or much of the original rock structure and show one or more of the following:*

1. *illuvial concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination;*
2. *evidence of removal of carbonates;*
3. *residual concentration of sesquioxides;*
4. *coatings of sesquioxides that make the horizon conspicuously lower in value, higher in chroma, or redder in hue than overlying and underlying horizons without apparent illuviation of iron;*
5. *alteration that forms silicate clay or liberates oxides or both and that forms granular, blocky, or prismatic structure if volume changes accompany changes in moisture content; or*
6. *brittleness.*

All kinds of B horizons are subsurface horizons or were originally. Included as B horizons where contiguous to another genetic horizon are layers of illuvial concentration of carbonates, gypsum, or silica that are the result of pedogenic processes (these layers may or may not be cemented) and brittle layers that have other evidence of alteration, such as prismatic structure or illuvial accumulation of clay.

Examples that are not B horizons are layers in which clay films coat rock fragments or are on finely stratified unconsolidated sediments, whether the films were formed in place or by illuviation, layers into which carbonates have been illuviated but are not contiguous to an overlying genetic horizon, and layers with gleying but no other pedogenic changes.

C horizons or layers*: Horizons or layers, excluding hard bedrock, that are little affected by pedogenic processes and lack properties of O, A, E, or B horizons. The material of C layers may be either like or unlike that from which the solum presumably formed. The C horizon may have been modified even if there is no evidence of pedogenesis.*

Included as C layers are sediment, saprolite, unconsolidated bedrock, and other geologic materials that commonly are uncemented (table 3-14) and exhibit low or moderate excavation difficulty (table 3-21). Some soils form in material that is already highly weathered. If such material does not meet the requirements of A, E, or B horizons, it is designated C. Changes not considered pedogenic are those not related to overlying horizons. Layers that have accumulations of silica, carbonates, or gypsum or more soluble salts are included in C horizons, even if indurated (table 3-14). If the indurated layers are obviously affected by pedogenic processes, they are a B horizon.

R layers*: Hard Bedrock*

Granite, basalt, quartzite and indurated limestone or sandstone are examples of bedrock that are designated R. These layers are cemented and excavation difficulty exceeds moderate. The R layer is sufficiently coherent when moist to make hand digging with a spade impractical, although it may be chipped or scraped. Some R layers can be ripped with heavy power equipment. The bedrock may contain cracks that generally are too few and too small to allow roots to penetrate at intervals of less than 10 cm. The cracks may be coated or filled with clay or other material.

Transitional and Combination Horizons

Horizons dominated by properties of one master horizon but having subordinate properties of another. Two capital letter symbols are used, as AB, EB, BE, or BC. The master horizon symbol that is given first designates the kind of horizon whose properties dominate the transitional horizon. An AB horizon, for example, has characteristics of both an overlying A horizon and an underlying B horizon, but it is more like the A than like the B.

In some cases, a horizon can be designated as transitional even if one of the master horizons to which it is apparently transitional is not present. A BE horizon may be recognized in a truncated soil if its properties are similar to those of a BE horizon in a soil in which the overlying E horizon has not been removed by erosion. A BC horizon may be recognized even if no underlying C horizon is present; it is transitional to assumed parent material.

Horizons in which distinct parts have recognizable properties of the two kinds of master horizons indicated by the capital letters. The two capital letters are separated by a virgule (/), as E/B, B/E, or B/C. Most of the individual parts of one of the components are surrounded by the other.

The designation may be used even though horizons similar to one or both of the components are not present, if the separate components can be recognized. The first symbol is that of the horizon that makes up the greater volume.

Single sets of designators do not cover all situations; therefore, some improvising may be necessary. For example, Alfic Udipsamments have lamellae that are separated from each other by eluvial layers. Because it is generally not practical to describe each lamellae and eluvial layer as a separate horizon, the horizons are combined but the components are described separately. One horizon would then contain several lamellae and eluvial layers and might be designated as an E and Bt horizon. The complete horizon sequence for this soil could be: Ap-Bw-E and Bt1-E and Bt2-C. r material.

Subordinate Distinctions Within Master Horizons and Layers

Lower case letters are used as suffixes to designate specific kinds of master horizons and layers. The word "accumulation" is used in many of the definitions in the sense that the horizon must have more of the material in question than is presumed to have been present in the parent material. The symbols and their meanings are as follows:

a Highly decomposed organic material

This symbol is used with "O" to indicate the most highly decomposed of the organic materials. The rubbed fiber content is less than about 17 percent of the volume.

b Buried genetic horizon

This symbol is used in mineral soils to indicate identifiable buried horizons with major genetic features that were formed before burial. Genetic horizons may or may not have formed in the overlying material, which may be either like or unlike the assumed parent material of the buried soil. The symbol is not used in organic soils or to separate an organic layer from a mineral layer.

c Concretions or nodules

This symbol is used to indicate a significant accumulation of concretions or of nodules. Cementation is required. The cementing agent is not specified except it cannot be silica. This symbol is not used if concretions or nodules are dolomite or calcite or more soluble salts, but it is used if the nodules or concretions are enriched in minerals that contain iron, aluminum, manganese, or titanium.

d Physical root restriction

This symbol is used to indicate root restricting layers in naturally occurring or manmade unconsolidated sediments or materials such as dense basal till, plow pans, and other mechanically compacted zones.

e Organic material of intermediate decomposition

This symbol is used with "O" to indicate organic materials of intermediate decomposition. Rubbed fiber content is 17 to 40 percent of the volume.

f Frozen soil

This symbol is used to indicate that the horizon or layer contains permanent ice. Symbol is not used for seasonally frozen layers or for "dry permafrost" (material that is colder than O° C but does not contain ice).

g Strong gleying

This symbol is used to indicate either that iron has been reduced and removed during soil formation or that saturation with stagnant water has preserved a reduced state. Most of the affected layers have chroma of 2 or less and many have redox concentrations. The low chroma can be the color of reduced iron or the color of uncoated sand and silt particles from which iron has been removed. Symbol "g" is not used for soil materials of low chroma, such as some shales or E horizons, unless they have a history of wetness. If "g" is used with "B," pedogenic change in addition to gleying is implied. If no other pedogenic change in addition to gleying has taken place, the horizon is designated Cg.

h Illuvial accumulation of organic matter

This symbol used with "B" to indicate the accumulation of illuvial, amorphous, dispersible organic matter-sesquioxides complexes. The sesquioxide component coats sand and silt particles. In some horizons, coatings have coalesced, filled pores, and cemented the horizon. The symbol "h" is also used in combination with "s" as "Bhs" if the amount of sesquioxide component is significant but value and chroma of the horizon are 3 or less.

i Slightly decomposed organic material

This symbol is used with "O" to indicate the least decomposed of the organic materials. Rubbed fiber content is more than about 40 percent of the volume.

k Accumulation of carbonates

This symbol is used to indicate the accumulation of alkaline earth carbonates, commonly calcium carbonate.

m Cementation or induration

This symbol is used to indicate continuous or nearly continuous cementation. The symbol is used only for horizons that are more than 90 percent cemented, although they may be fractured. The layer is physically root restrictive. The single predominant or codominant cementing agent may be indicated by using defined letter suffixes, singly or in pairs. If the horizon is cemented by carbonates, "km" is used; by silica, "qm"; by iron, "sm"; by gypsum, "ym"; by both lime and silica, "kqm"; by salts more soluble than gypsum, "zm."

n Accumulation of sodium

This symbol is used to indicate an accumulation of exchangeable sodium.

o Residual accumulation of sesquioxides

This symbol is used to indicate residual accumulation of sesquioxides.

p Tillage or other disturbance

This symbol is used to indicate a disturbance of the surface layer by mechanical means, pasturing, or similar uses. A disturbed organic horizon is designated Op. A disturbed mineral horizon is designated Ap even though clearly once an E, B, or C horizon.

q Accumulation of silica

This symbol is used to indicate an accumulation of secondary silica.

r Weathered or soft bedrock

This symbol is used with "C" to indicate root restrictive layers of soft bedrock or saprolite, such as weathered igneous rock; partly consolidated soft sandstone; siltstone; and shale. Excavation difficulty is low or moderate.

s Illuvial accumulation of sesquioxides and organic matter

This symbol is used with "B" to indicate the accumulation of illuvial, amorphous, dispersible organic matter-sesquioxide complexes if both the organic matter and sesquioxide components are significant and the value and chroma of the horizon is more than 3. The symbol is also used in combination with "h" as "Bhs" if both the organic matter and sesquioxide components are significant and the value and chroma are 3 or less.

ss Presence of slickensides

This symbol is used to indicate the presence of slickensides. Slickensides result directly from the swelling of clay minerals and shear failure, commonly at angles of 20 to 60 degrees above horizontal. They are indicators that other vertic characteristics, such as wedge-shaped peds and surface cracks, may be present.

t Accumulation of silicate clay

This symbol is used to indicate an accumulation of silicate clay that has formed and subsequently translocated within the horizon or has been moved into the horizon by illuviation, or both. At least some part should show evidence of clay accumulation in the form of coatings on surfaces of peds or in pores, or as lamellae, or bridges between mineral grains.

v Plinthite

This symbol is used to indicate the presence of iron-rich, humus-poor, reddish material that is firm or very firm when moist and that hardens irreversibly when exposed to the atmosphere and to repeated wetting and drying.

w Development of color or structure

This symbol is used with "B" to indicate the development of color or structure, or both, with little or no apparent illuvial accumulation of material. It should not be used to indicate a transitional horizon.

x Fragipan character

This symbol is used to indicate genetically developed layers that have a combination of firmness, brittleness, very coarse prisms with few to many bleached vertical faces, and commonly higher bulk density than adjacent layers. Some part is physically root restrictive.

y Accumulation of gypsum

This symbol is used to indicate the accumulation of gypsum.

z Accumulation of salts more soluble than gypsum

This symbol is used to indicate an accumulation of salts more soluble than gypsum.

Conventions for using letter suffixes.—Many master horizons and layers that are symbolized by a single capital letter will have one or more lower case letter suffixes. The following rules apply:

Letter suffixes should immediately follow the capital letter.

More than three suffixes are rarely used.

When more than one suffix is needed, the following letters, if used, are written first: a, e, h, i, r, s, t, and w. Except for the Bhs or Crt^2 horizons, none of these letters are used in combination in a single horizon.

If more than one suffix is needed and the horizon is not buried, these symbols, if used, are written last: c, d, f, g, m, v, and x. Some examples: Btg, Bkm, and Bsm.

If a horizon is buried, the suffix "b" is written last. Suffix "b" is used only for buried mineral soils.

A B horizon that has significant accumulation of clay and also shows evidence of development of color or structure, or both, is designated Bt ("t" has precedence over "w," "s," and "h"). A B horizon that is gleyed or that has accumulations of carbonates, sodium, silica, gypsum, salts more soluble than gypsum, or residual accumulation or sesquioxides carries the appropriate symbol—g, k, n, q, y, z, or o. If illuvial clay is also present, "t" precedes the other symbol: Btg.

Suffixes "h," "s," and "w" are not normally used with g, k, n, q, y, z, or o.

Vertical subdivision.—Commonly a horizon or layer designated by a single letter or a combination of letters needs to be subdivided. The Arabic numerals used for this purpose always follow all letters. Within a C, for example, successive layers could be C1, C2, C3, and so on; or, if the lower part is gleyed and the upper part is not, the designations could be C1-C2-Cg1-Cg2 or C-Cg1-Cg2-R.

These conventions apply whatever the purpose of subdivision. In many soils, horizons that would be identified by one unique set of letters are subdivided on the basis of evident morphological features, such as structure, color, or texture. These divisions are numbered consecutively. The numbering starts with 1 at whatever level in the profile any element of the letter symbol changes. Thus Bt1-Bt2-Btk1-Btk2 is used, not Bt1-Bt2-Btk3-Btk4. The numbering of vertical subdivisions within a horizon is not interrupted at a discontinuity (indicated by a numerical prefix) if the same letter combination is used in both materials: Bs1-Bs2-2Bs3-2Bs4 is used, not Bs1-Bs2-2Bs1-2Bs2.

Sometimes, thick layers are subdivided during sampling for laboratory analyses even though differences in morphology are not evident in the field. These layers need to be identified. This is done by following the convention of using Arabic numerals to identify the subdivision. The Arabic numerals would follow the letter designations and be a part of the horizon designation. For example, four layers of a Bt2 horizon sampled by 10-cm increments would be designated Bt21, Bt22, Bt23, and Bt24. The Bt2 horizon is subdivided for sampling purposes only.

Discontinuities.—In mineral soils Arabic numerals are used as prefixes to indicate discontinuities. Wherever needed, they are used preceding A, E, B, C, and R. These prefixes are distinct from Arabic numerals used as suffixes to denote vertical subdivisions.

A discontinuity is a significant change in particle-size distribution or mineralogy that indicates a difference in the material from which the horizons formed and/or a significant difference in age, unless that difference in age is indicated by the suffix "b." Symbols to

identify discontinuities are used only when they will contribute substantially to the reader's understanding of relationships among horizons. Stratification common to soils formed in alluvium is not designated as discontinuity, unless particle size distribution differs markedly (strongly contrasting particle-size class, as defined by Soil Taxonomy) from layer to layer even though genetic horizons have formed in the contrasting layers.

Where a soil has formed entirely in one kind of material, a prefix is omitted from the symbol; the whole profile is material 1. Similarly, the uppermost material in a profile having two or more contrasting materials is understood to be material 1, but the number is omitted. Numbering starts with the second layer of contrasting material, which is designated "2." Underlying contrasting layers are numbered consecutively. Even though a layer below material 2 is similar to material 1, it is designated "3" in the sequence. The numbers indicate a change in the material, not the type of material. Where two or more consecutive horizons formed in one kind of material, the same prefix number is applied to all of the horizon designations in that material: Ap-E-Bt1-2Bt2-2Bt3-2BC. The number of suffixes designating subdivisions of the Bt horizon continue in consecutive order across the discontinuity.

If an R layer is below a soil that formed in residuum and the material of the R layer is judged to be like that from which the material of the soil weathered, the Arabic number prefix is not used. If it is thought that the R layer would not produce material like that in the solum, the number prefix is used, as in A-Bt-C-2R or A-Bt-2R. If part of the solum formed in residuum, "R" is given the appropriate prefix: Ap-Bt1-2Bt2-2Bt3-2C1-2C2-2R.

Buried horizons (designated "b") are special problems. A buried horizon is obviously not in the same deposit as horizons in the overlying deposit. Some buried horizons, however, formed in material lithologically like that of the overlying deposit. A prefix is not used to distinguish material of such buried horizons. If the material in which a horizon of a buried soil formed is lithologically unlike that of the overlying material, the discontinuity is designated by number prefixes and the symbol for a buried horizon is used as well: Ap-Bt1-Bt2-BC-C-2ABb-2Btb1-2Btb2-2C.

In organic soils, discontinuities between different kinds of layers are not identified. In most cases, the differences are shown by the letter suffix designations if the different layers are organic or by the master symbol if the different layers are mineral.

Boundary

A boundary is a surface or transitional layer between two adjoining horizons or layers. Most boundaries are zones of transition rather than sharp lines of division. Boundaries vary in distinctness and in topography.

Distinctness.—Distinctness refers to the thickness of the zone within which the boundary can be located. The distinctness of a boundary depends partly on the degree of contrast

between the adjacent layers and partly on the thickness of the transitional zone between them. Distinctness is defined in terms of thickness of the transitional zone:

Abrupt: Less than 2 cm thick

Clear: 2 to 5 cm thick

Gradual: 5 to 15 cm thick

Diffuse: More than 15 cm thick

Abrupt soil boundaries, such as those between the E and Bt horizons in many soils, are easily determined. Some boundaries are not readily seen but can be located by testing the soil above and below the boundary. Diffuse boundaries, such as those in many old soils in tropical areas, are most difficult to locate and require time-consuming comparisons of small specimens of soil from various parts of the profile until the midpoint of the transitional zone is determined. For soils that have nearly uniform properties or that change very gradually as depth increases, horizon boundaries are imposed more or less arbitrarily without clear evidence of differences.

Topography.—Topography refers to the irregularities of the surface that divides the horizons. Even though soil layers are commonly seen in vertical section, they are three-dimensional. Topography of boundaries is described with the following terms:

Smooth: The boundary is a plane with few or no irregularities.

Wavy: The boundary has undulations in which depressions are wider then they are deep.

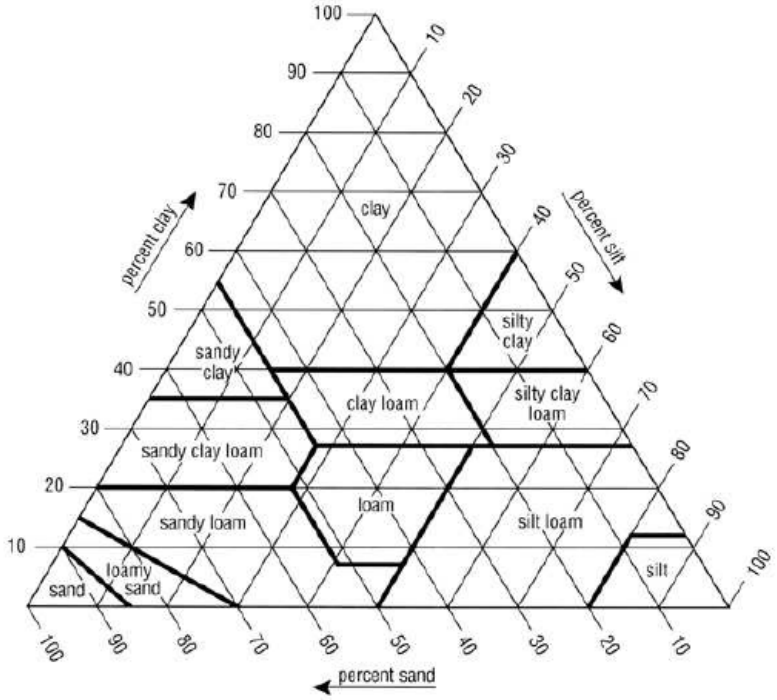
Irregular: The boundary has pockets that are deeper than they are wide.

Broken: One or both of the horizons or layers separated by the boundary are discontinuous and the boundary is interrupted.

Texture

Soil texture refers to the weight proportion of the separates for particles less than 2 mm as determined from a laboratory particle-size distribution. Apparent field texture is a tactile evaluation only with no inference as to laboratory test results. Field criteria for estimating soil texture must be chosen to fit the soils of the area. Sand particles feel gritty and can be seen individually with the naked eye. Silt particles cannot be seen individually without magnification; they have a smooth feel to the fingers when dry or wet. In some places, clay soils are sticky; in others they are not. Soils dominated by montmorillonite clays, for example, feel different from soils that contain similar amounts of micaceous or kaolintic clay. Even locally, the relationships that are useful for judging texture of one kind of soil may not apply as well to another kind.

Soil texture triangle.



Relationships among particle size classes of 5 different systems.

U.S.D.A.	CLAY	SILT		SAND					GRAVEL			COB-BLES	STONES
		fi.	co.	v.fi.	fi.	med.	co.	v.co.	fi.	med.	co.		
	.002			.05					2			76	250mm
INTER-NATIONAL	CLAY	SILT		SAND					GRAVEL			STONES	
				fi.			co.						
	.002		.02						2			20mm	
UNIFIED	SILT OR CLAY			SAND					GRAVEL			COBBLES	
				fi.		med.		co.	fi.		co.		
	.074								4.76			76mm	
AASHO	CLAY		SILT	SAND					GRAVEL OR STONES			BOULDERS	
				fi.			co.		fi.	med.	co.		
	.005			.074					2			76mm	
PHI SCALE													
	.00195		.0078		.031		.125		.5	2	8	32	128	512mm

Definitions of the soil texture classes follow:

Sands - More than 85 percent sand, the percentage of silt plus 1.5 times the percentage of clay is less than 15.

Coarse sand. A total of 25 percent or more very coarse and coarse sand and less than 50 percent any other single grade of sand.

Sand. A total of 25 percent or more very coarse, coarse, and medium sand, a total of less than 25 percent very coarse and coarse sand, and less than 50 percent fine sand and less than 50 percent very fine sand.

Fine sand. 50 percent or more fine sand; or a total of less than 25 percent very coarse, coarse, and medium sand and less than 50 percent very fine sand.

Very fine sand. 50 percent or more very fine sand.

Loamy sands - Between 70 and 91 percent sand and the percentage of silt plus 1.5 times the percentage of clay is 15 or more; and the percentage of silt plus twice the percentage of clay is less than 30.

Loamy coarse sand. A total of 25 percent or more very coarse and coarse sand and less than 50 percent any other single grade of sand.

Loamy sand. A total of 25 percent or more very coarse, coarse, and medium sand and a total of less than 25 percent very coarse and coarse sand, and less than 50 percent fine sand and less than 50 percent very fine sand.

Loamy fine sand. 50 percent or more fine sand; or less than 50 percent very fine sand and a total of less than 25 percent very coarse, coarse, and medium sand.

Loamy very fine sand. 50 percent or more very fine sand.

Sandy loams - 7 to 20 percent clay, more than 52 percent sand, and the percentage of silt plus twice the percentage of clay is 30 or more; or less than 7 percent clay, less than 50 percent silt, and more than 43 percent sand.

Coarse sandy loam. A total of 25 percent or more very coarse and coarse sand and less than 50 percent any other single grade of sand.

Sandy loam. A total of 30 percent or more very coarse, coarse, and medium sand, but a total of less than 25 percent very coarse and coarse sand and less than 30 percent fine sand and less than 30 percent very fine sand; or a total of 15 percent or less very coarse, coarse, and medium sand, less than 30 percent fine sand and less than 30 percent very fine sand with a total of 40 percent or less fine and very fine sand.

Fine sandy loam. 30 percent or more fine sand and less than 30 percent very fine sand; or a total of 15 to 30 percent very coarse, coarse, and medium sand; or a total of more than 40 percent fine and very fine sand, one half or more of which is fine sand, and a total of 15 percent or less very coarse, coarse, and medium sand.

Very fine sandy loam. 30 percent or more very fine sand and a total of less than 15 percent very coarse, coarse, and medium sand; or more than 40 percent fine and very fine sand, more than one half of which is very fine sand, and total of less than 15 percent very coarse, coarse, and medium sand.

Loam - 7 to 27 percent clay, 28 to 50 percent silt, and 52 percent or less sand.

Silt loam. 50 percent or more silt and 12 to 27 percent clay, or 50 to 80 percent silt and less than 12 percent clay.

Silt. 80 percent or more silt and less than 12 percent clay.

Sandy clay loam. 20 to 35 percent clay, less than 28 percent silt, and more than 45 percent sand.

Clay loam. 27 to 40 percent clay and more than 20 to 46 percent sand.

Silty clay loam. 27 to 40 percent clay and 20 percent or less sand.

Clay - 40 percent or more clay, 45 percent or less sand, and less than 40 percent silt.

Sandy clay. 35 percent or more clay and 45 percent or more sand.

Silty clay. 40 percent or more clay and 40 percent or more silt.

Rock Fragments

Rock fragments are unattached pieces of rock 2 mm in diameter or larger that are *strongly cemented* or more resistant to rupture. Rock fragments include all sizes that have horizontal dimensions less than the size of a pedon. The content of rock fragments is determined by estimating the proportion of the soil volume that they occupy. T

Texture Modifiers (Rock Fragments)		
Rock Fragments: Size & Quantity	Nasis Code	Criteria: Percent (By Volume) of Total Rock Fragments and Dominated By (name size):
Rock Fragments (>2 mm; > Strongly Cemented)		
For All	-	≥15% No texture modifier is used.
Gravelly	GR	≥15% but <35% gravel
Fine Gravelly	GRF	≥15% but <35% fine gravel
Medium Gravelly	GRM	≥15% but <35% med. gravel

Coarse Gravelly	GRC	≥15% but <35% coarse gravel
Very Gravelly	GRV	≥35% but <60% gravel
Extremely Gravelly	GRX	≥60% but <90% gravel
Cobbly	CB	≥15% but <35% cobbles
Very Cobbly	CBV	≥35% but <60% cobbles
Extremely Cobbly	CBX	≥60% but <90% cobbles
Stony	ST	≥15% but <35% stones
Very Stony	STV	≥35% but <60% stones
Extremely Stony	STX	≥60% but <90% stones
Bouldery	BY	≥15% but <35% boulders
Very Bouldery	BYV	≥35% but <60% boulders
Extremely Bouldery	BYX	≥60% but <90% boulders
Channery	CN	≥15% but <35% channers
Very Channery	CNV	≥35% but <60% channers
Extremely Channery	CNX	≥60% but <90% channers
Flaggy	FL	≥15% but <35% flagstones
Very Flaggy	FLV	≥35% but <60% flagstones
Extremely Flaggy	FLX	≥60% but <90% flagstones
For All	-	≥90% No modifier used. If <10% fine earth, use the appropriate noun for the dominant size class; e.g., gravel. **Use Terms in Lieu of Texture.**

Color

Elements of soil color descriptions are the color name, the Munsell notation, the water state, and the physical state: "brown (10YR 5/3), dry, crushed, and smoothed."

Physical state is recorded as broken, rubbed, crushed, or crushed and smoothed. The term "crushed" usually applies to dry samples and "rubbed" to moist samples. If unspecified, the surface is broken. The color of the soil is recorded for a surface broken through a ped if a ped can be broken as a unit.

The color value of most soil material becomes lower after moistening. Consequently, the water state of a sample is always given. The water state is either "moist" or "dry." The dry state for color determinations is air-dry and should be made at the point where the color does not change with additional drying. Color in the moist state is determined on moderately moist or very moist soil material and should be made at the point where the color does not change with additional moistening. The soil should not be moistened to the extent that glistening takes place as color determinations of wet soil may be in error because of the light reflection of water films. In a humid region, the moist state generally is considered standard; in an arid region, the dry state is standard. In detailed descriptions, colors of both dry and moist soil are recorded if feasible. The color for the regionally standard moisture state is usually described first. Both moist and dry colors are

particularly valuable for the immediate surface and tilled horizons in order to assess reflectance.

Munsell notation is obtained by comparison with a Munsell system color chart. The most commonly used chart includes only about one fifth of the entire range of hues. It consists of about 250 different colored papers, or chips, systematically arranged on hue cards according to their Munsell notations.

The Munsell color system uses three elements of color—*hue*, *value*, and *chroma*—to make up a color notation. The notation is recorded in the form: hue, value/chroma—for example, 5Y 6/3.

Hue is a measure of the chromatic composition of light that reaches the eye. The Munsell system is based on five principal hues: red (R), yellow (Y), green (G), blue (B), and purple (P). Five intermediate hues representing midpoints between each pair of principal hues complete the 10 major hue names used to describe the notation. The intermediate hues are yellow-red (YR), green-yellow (GY), blue-green (BG), purple-blue (PB), and red-purple (RP). Each of the 10 major hues is divided into four segments of equal visual steps, which are designated by numerical values applied as prefixes to the symbol for the hue name. Four equally spaced steps of the adjacent yellow-red (YR) hue are identified as 2.5YR, 5YR, 7.5YR, and 10YR respectively. The standard chart for soil has separate hue cards from 10R through 5Y.

Value indicates the degree of lightness or darkness of a color in relation to a neutral gray scale. On a neutral gray (achromatic) scale, value extends from pure black (0/) to pure white (10/). The value notation is a measure of the amount of light that reaches the eye under standard lighting conditions. Gray is perceived as about halfway between black and white and has a value notation of 5/. The actual amount of light that reaches the eye is related logarithmically to color value. Lighter colors are indicated by numbers between 5/ and 10/; darker colors are indicated by numbers from 5/ to 0/. These values may be designated for either achromatic or chromatic conditions. Thus, a card of the color chart for soil has a series of chips arranged vertically to show equal steps from the lightest to the darkest shades of that hue.

Chroma is the relative purity or strength of the spectral color. Chroma indicates the degree of saturation of neutral gray by the spectral color. The scales of chroma for soils extend from /0 for neutral colors to a chroma of /8 as the strongest expression of color used for soils.

Dominant Color

The dominant color is the color that occupies the greatest volume of the layer. Dominant color (or colors) is always given first among those of a multicolored layer. It is judged on the basis of colors of a broken sample. For only two colors, the dominant color makes up more than 50 percent of the volume. For three or more colors, the dominant color makes up more of the volume of the layer than any other color, although it may occupy less than

50 percent. The expression "brown with yellowish brown and grayish brown" signifies that brown is the dominant color. It may or may not make up more than 50 percent of the layer.

In some layers, no single color is dominant and the first color listed is not more prevalent than others. The expression "brown and yellowish brown with grayish brown" indicates that brown and yellowish brown are about equal and are co-dominant. If the colors are described as "brown, yellowish brown, and grayish brown," the three colors make up nearly equal parts of the layer.

Mottling

Mottling refers to repetitive color changes that cannot be associated with compositional properties of the soil. Redoximorphic features are a type of mottling that is associated with wetness. A color pattern that can be related to proximity to a ped surface or other organizational or compositional feature is not mottling. Mottle description follows the dominant color. Mottles are described by quantity, size, contrast, color, and other attributes in that order.

Quantity is indicated by three areal percentage classes of the observed surface:

few: less than 2 percent,

common: 2 to 20 percent, and

many: more than 20 percent.

The notations must clearly indicate to which colors the terms for quantity apply. For example, "common grayish brown and yellowish brown mottles" could mean that each makes up 2 to 20 percent of the horizon. By convention, the example is interpreted to mean that the quantity of the two colors *together* is between 2 and 20 percent. If each color makes up between 2 and 20 percent, the description should read "common grayish brown (10YR 5/2) and common yellowish brown (10YR 5/4) mottles."

Size refers to dimensions as seen on a plane surface. If the length of a mottle is not more than two or three times the width, the dimension recorded is the greater of the two. If the mottle is long and narrow, as a band of color at the periphery of a ped, the dimension recorded is the smaller of the two and the shape and location are also described. Three size classes are used:

fine: smaller than 5 mm,

medium: 5 to 15 mm, and

coarse: larger than 155 mm.

Contrast refers to the degree of visual distinction that is evident between associated colors:

Faint: Evident only on close examination. Faint mottles commonly have the same hue as the color to which they are compared and differ by no more than 1 unit of chroma or 2 units of value. Some faint mottles of similar but low chroma and value differ by 2.5 units (one card) of hue.

Distinct: Readily seen but contrast only moderately with the color to which they are compared. Distinct mottles commonly have the same hue as the color to which they are compared but differ by 2 to 4 units of chroma or 3 to 4 units of value; or differ from the color to which they are compared by 2.5 units (one card) of hue but by no more than 1 unit of chroma or 2 units of value.

Prominent: Contrast strongly with the color to which they are compared. Prominent mottles are commonly the most obvious color feature of the section described. Prominent mottles that have medium chroma and value commonly differ from the color to which they are compared by at least 5 units (two pages) of hue if chroma and value are the same; at least 4 units of value or chroma if the hue is the same; or at least 1 unit of chroma or 2 units of value if hue differs by 2.5 units (one card).

Contrast is often not a simple comparison of one color with another but is a visual impression of the prominence of one color against a background commonly involving several colors.

Shape, location, and character of boundaries of mottles are indicated as needed. *Shape* is described by common words such as streaks, bands, tongues, tubes, and spots. *Location* of mottles as related to structure of the soil may be significant. *Boundaries* may be described as *sharp* (color gradation is not discernable with the naked eye), *clear* (color grades over less than 2 mm), or *diffuse* (color grades over more than 2 mm).

Moisture state and physical state of the dominant color are presumed to apply to the mottles unless the description states otherwise. An example, for which a standard moist broken state of the sample has been specified, might read "brown (10YR 4/3), brown (10YR 5/3) dry; many medium distinct yellowish brown (10YR 5/6) mottles, brownish yellow (10YR 6/6) dry." Alternatively, the colors in the standard moisture state may be given together, followed by the colors at other moisture states. The color of mottles commonly is given only for the standard state unless special significance can be attached to colors at another state.

A nearly equal mixture of two colors for a moist broken standard state can be written "intermingled brown (10YR 4/3) and yellowish brown (10YR 5/6) in a medium distinct pattern; brown (10YR 5/3) and brownish yellow (10YR 6/6) dry." If a third color is present, "common medium faint dark grayish brown (10YR 4/2) mottles, grayish brown (10YR 5/2) dry" can be added.

If the mottles are fine and faint so that they cannot be compared easily with the color standards, the Munsell notation should be omitted. Other abbreviated descriptions are used for specific circumstances.

Consistency

Soil consistence in the general sense refers to "attributes of soil material as expressed in degree of cohesion and adhesion or in resistance to deformation on rupture." As employed here consistence includes: (1) resistance of soil material to rupture, (2) resistance to penetration, (3) plasticity, toughness, and stickiness of puddled soil material, and (4) the manner in which the soil material behaves when subject to compression. Although several tests are described, only those should be applied which may be useful.

Consistence is highly dependent on the soil-water state and the description has little meaning unless the water state class is specified or is implied by the test. Previously class sets were given for "dry" and "moist" consistence of the soil material as observed in the field. "Wet" consistence was evaluated for puddled soil material. Here the terms used for "moist" consistence previously are applied to the wet state as well. The previous term "wet consistence" is dropped. Stickiness, plasticity, and toughness of the puddled soil material are independent tests.

For determinations on the natural fabric, variability among specimens is likely to be large. Multiple measurements may be necessary. Recording of median values is suggested in order to reduce the influence of the extremes measured.

Rupture Resistance Block-like Specimens

Different class sets are provided for moderately dry and very dry soil material, and for slightly dry and wetter soil material. Unless specified otherwise, the soil-water state is assumed to be that indicated for the horizon or layer when described. Cementation is an exception. To test for cementation, the specimen is air-dried and then submerged in water for at least 1 hour. The placements do not pertain to the soil material at the field water state.

The blocklike specimen should be 25-30 mm on edge. Direction of stress relative to the in-place axis of the specimen is not defined unless otherwise indicated. The specimen is compressed between extended thumb and forefinger, between both hands, or between the foot and a nonresilient flat surface. If the specimen resists rupture by compression, a weight is dropped onto it from increasingly greater heights until rupture. Failure is at the initial detection of deformation or rupture. Stress applied in the hand should be over a 1-second period. The tactile sense of the class limits may be learned by applying force to top loading scales and sensing the pressure through the tips of the fingers or through the ball of the foot. Postal scales may be used for the resistance range that is testable with the fingers. A bathroom scale may be used for the higher rupture resistance.

Specimens of standard size and shape are not always available. Blocks of specimens that are smaller than 25-30 mm on edge may be tested. The force withstood may be assumed to decrease as the reciprocal of the dimension along which the stress is applied. If a block specimen with a length of 10 mm along the direction the force is applied were to be ruptured, the force should be one-third that for an identical specimen 30 mm on edge. If the specimen is smaller than the standard size, the evaluated rupture resistance should be recorded and the dimensions of the specimen along the axis the stress is applied should be indicated.

Soil structure complicates the evaluation of rupture resistance. If a specimen of standard size can be obtained, report the rupture resistance of the standard specimen and other individual constituent structural units as desired. Usually the constituent structural units must exceed about 5 mm in the direction the stress is applied; expression must exceed weak for the rupture resistance to be evaluated.

If structure size and expression are such that a specimen of standard size cannot be obtained, then the soil material overall is loose. Structural unit resistance to rupture may be determined if the size is large enough (exceed about 5 mm in the direction stress is applied) for a test to be performed.

Rupture Resistance For: Blocks, Peds, and Clods			
Dry Class Code	Moist Class Code	Cementation Class Code	Specimen Fails Under
Loose (L)	Loose (L)	NA	Intact Specimen Not Obtainable
Soft (S)	Very Friable (VFR)	Non-Cemented	Very slight force between fingers. <8 N
Slighly Hard (SH)	Friable (FR)	Extremely Weakly Cemented (EW)	Slight force between fingers 8 to <20 N
Moderately Hard (MH)	Firm (FI)	Very Weakly Cemented (VW)	Moderate force between fingers 20 to <40 N
Hard (HA)	Very Firm (VFI)	Weakly Cemented (W)	Strong force between fingers. 40 to <80 N
Very Hard (VH)	Extremely Firm (EF)	Moderately Cemented (M)	Moderate force between hands 80 to <160 N

Extremely Hard (EH)	Slightly Rigid (SR)	Strongly Cemented (ST)	Foot pressure by full body weight 160 to <800 N
Rigid ®	Rigid (SR)	Very Strongly Cemented (VS)	Blow of <3 J but not body weight 800N to <3 J
Very Rigid (VR)	Very Rigid (VR)	Indurated (I)	Blow of >3 J (3 J = 2 kg weight dropped 15 cm)

Plasticity

Plasticity is the degree to which puddled soil material is permanently deformed without rupturing by force applied continuously in any direction. Plasticity is determined on material smaller than 2 mm.

The determination is made on thoroughly puddled soil material at a water content where maximum plasticity is expressed. This water content is above the plastic limit, but it is less than the water content at which maximum stickiness is expressed. The water content is adjusted by adding water or removing it during hand manipulation.

Plasticity		
Plasticity Class	NASIS Code	Criteria: Make a roll of soil 4 cm long
Non-Plastic	PO	Will not form a 6 mm diameter roll, or if formed, can't support itself if held on end.
Slightly Plastic	SP	6 mm diameter roll supports itself; 4 mm diameter roll does not.
Moderately Plastic	MP	4 mm diameter roll supports itself, 2 mm diameter roll does not.
Very Plastic	VP	2 mm diameter roll supports its weight.

Stickiness

Stickiness refers to the capacity of a soil to adhere to other objects. The determination is made on puddled <2 mm soil material at the water content at which the material is most

sticky. The sample is crushed in the hand; water is applied while manipulation is continued between thumb and forefinger until maximum stickiness is reached.

Stickiness		
Stickiness Class	NASIS Code	Criteria: Work moistened soil between thumb and forefinger
Non-Sticky	SO	Little or no soil adheres to fingers, after release of pressure.
Slightly Sticky	SS	Soil adheres to both fingers, after release of pressure. Soil stretches little on separation of fingers.
Moderately Sticky	MS	Soil adheres to both fingers, after release of pressure. Soil stretches some on separation of fingers.
Very Sticky	VS	Soil adheres firmly to both fingers, after pressure release. Soil stretches greatly upon separation of fingers.

Taxonomy

The limits of most properties of soil series are set by the limits of the higher taxa in which they are classified. Soil Taxonomy (Soil Survey Staff, 1975) is the basic reference book for identification, classification, nomenclature, and correlation of kinds of soils for categories above the series. The system contains six categories. From highest to lowest levels of generalization these are order, suborder, great group, subgroup, family, and series.

Appendix A-3
Soils Recommendations for Plants

Appendix A-3 Soil Recommendations for Plants

SAN ANTONIO CREEK MITIGATION AREA

The species proposed in the mitigation planting (ETJV 2008) along San Antonio Creek include *Aesculus californica, Platanus racemosa, Baccharis salicifolius, Baccharis pilularis* and *Sambucus mexicana.* These species are mostly adapted to deep, coarse and medium textured, moderately well to well drained soils. They have low fertility requirements, varying calcium carbonate tolerance, and can generally tolerate pH conditions of moderately acidic to slightly alkaline (Appendix D-5).

The soils along San Antonio Creek are suitable for the species proposed by the planting plan as they are well drained, very deep soils with medium textures that transition to coarse textures with depth. Rock fragments were found to increase with depth, with the highest content (50-65 %) occurring below 80 cm. No carbonates or root restricting layers were encountered. Soil pH values range from slightly acidic to neutral.

Oak Woodland and Oak Savannah

The species proposed in the mitigation planting plan (ETJV 2008) within the Oak Woodland area include *Quercus lobata, Quercus agrifolia, Aesculus californica, Sambucus mexicana, Baccharis pilularis and Rosa californica*. The overstory species are mostly adapted to moderately deep, coarse and medium textured, and moderately well to well drained soils. They have low to medium fertility requirements, low calcium carbonate tolerance, and can generally tolerate pH conditions ranging from strongly acid to slightly alkaline. The understory species are mostly adapted to very shallow, coarse and medium textured, moderately well to well drained soils. They have low fertility requirements, varying calcium carbonate tolerance, and can generally tolerate pH conditions of slightly acid to moderately alkaline (Appendix D-5).

The proposed species for mitigation within the Oak Savannah area include *Quercus lobata, Quercus douglasii* and *Quercus agrifolia.* These species are mostly adapted to moderately deep, coarse and medium textured, moderately well, to well-drained soils. They have low to medium fertility requirements, no calcium carbonate tolerance, and can generally tolerate a pH ranging from strongly acidic to slightly alkaline (Appendix D-5).

The soils within the Oak Woodland area are suitable for the proposed species as they are well drained, very deep soils with medium textures that transition to coarse textures within the surface 91cm. Finer textured soils were found below 91cm but are not expected to inhibit vegetation development as they occur mostly below the active root

zone. In addition, these finer textured soils were not found to be indurated [soil material cemented into a hard mass that will not soften on wetting (Miller and Donahue, 2005)] and have high rock fragment contents (40-80% by volume). Rock fragment content within the surface 91cm ranged from 3 to 40%. No carbonates or root restricting layers were encountered. Soil pH values range from moderately acid to moderately alkaline.

The soils within the Oak Savannah area are suitable for these species as they are well drained, very deep soils with medium textures that transition to coarse textures with depth. Rock fragments were found to increase with depth with the highest content (75 % by volume) occurring below 77 cm. No carbonates or root restricting layers were encountered. Soil pH values range from slightly acid to neutral.

SAGE CANYON MITIGATION AREA

No planting recommendations were made for the Sage Canyon HRP.

CALAVERAS CREEK MITIGATION AREA

Goldfish Pond

The proposed species for mitigation within the Oak Riparian area of Goldfish Pond include *Aesculus californica, Quercus agrifolia, Sambucus mexicana, Baccharis pilularis, Rosa californica, Artemisia douglasiana* and *Leymus triticoides.* These species are mostly adapted to moderately deep, coarse to fine textured, moderately well to well drained soils. They have low fertility requirements, varying calcium carbonate tolerance, and can generally tolerate pH conditions of moderately acidic to moderately alkaline (Appendix D-5).

The proposed species for the seasonal wetland portion of the Goldfish Pond restoration area are *Eleocharis macrostachya, Juncus mexicanus, Juncus balticus, Juncus xiphioides* and *Hordeum brachyantherum.* These plants are adapted to shallow, fine to coarse textured, very poorly drained to somewhat poorly drained soils. They have low to medium fertility requirements, medium calcium carbonate tolerance, and can generally tolerate pH conditions of moderately acidic to moderately alkaline (Appendix D-5).

STP1 was dug near the ordinary high water mark, along the inlet drainage of Goldfish Pond. The soils in this area are suitable for the proposed seasonal wetland species as they are very poorly drained, and have mottles throughout the profile which indicate a seasonal anaerobic environment resulting from saturated conditions. These soils are very deep, and have fine textures in the upper 55 cm that are underlain by coarse-textures to

100 cm. Rock fragment content was little to none throughout the profile and no carbonates or root restricting layers were encountered. Soil pH values range from moderately acidic to neutral.

The soils in this area are not suitable for the proposed Oak Riparian species as they are very poorly drained and seasonally saturated. The drainage of these soils would need to be improved or water diverted from these soils to be able to support the Oak riparian species. The other properties of this soil are not expected to inhibit the development of these species.

STP2 was located at a slightly farther location from the pond on a gently angled toe slope. This soil is not as well suited for the seasonal wetland species as it is well drained and does not receive enough water for the guaranteed success of these communities. These soils farther away from the pond would have to be modified to support these species. Modifications may include re-grading the landscape to create concave microtopography, adding a clay lining (such as bentonite) to minimize water loss, diverting water from the pond or a combination of these. The other properties of this soil are not expected to inhibit the development of these species. These soils are very deep, with medium textures that transition to fine textures with depth. Rock fragment content was found to be low (<5 %) throughout the profile. No carbonates or root restricting layers were encountered. Soil pH values range from moderately acidic to slightly acidic.

This soil is better suited for the Oak riparian species as it is well drained and does not have evidence of seasonal saturation (redoximorphic features). There are no properties of this soil that are expected to inhibit the development of the Oak riparian species.

GOAT ROCK MITIGATION AREA

No planting recommendations were made for the Goat Rock HRP.

Appendix A-4
Soil Data Sheets

SOIL SCIENCE 321
BRENT G. HALLOCK

SOIL PROFILE DESCRIPTION
- 1998 -

CAL POLY
STATE UNIVERS

Soil Phase Calaveras Creek 1 Name Jan Novak
General Location Calaveras Creek - new channel Date 3/11/09
Legal Description Lat/Long
Nat Veg or Crop annual grasses Rainfall % Slope 2%
Parent Material Alluvium Landform Floodplain / Toeslope Shape Linear Length 5.20 m

Drainage Class	Hyd Cond	Eff Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
WD	ML	VD	Very Low	278°		M	66° F

Land Use Interpretations

Shrink/Swell LCC T/K Factor Unified
Septic Fields Forest Range Wetlands

Horization			Boundary		Texture			Structure			Color D/W		Cons.		Chemistry			Skins	Roots
Master	Sub.	No.	Depth	Dist.	% R.F.	% Clay	Class	Grade	Size	Shape	Hue	V/C	D/M	S/P	pH	Effer.	Morph.	A/D	A/S
A	-	-	0-37	CS	40	10	VMG SiL	2	M	sbk	10YR	6/3 3/3	VFR/VFR	SO/PO	6.8	-	-	-	C/F
2A	-	-	37-105	OW	90	20	XGB SCL			MA	10YR	6/3 3/3	VFR/VFR	MS/SP	7.0	-	-	-	MF/F
3C	-	-	105+	-	90	<2	XGR COS	2	F	GR	10YR	4/4	n/a	SO/PO	7.5	-	-	-	F/F
			(cm)																

notes: Loamy-skeletal, Typic xerorthent

Taxonomic Soil Classification

Epipedon	DSSH(s)	Soil Order	Suborder	Great Group	Family Particle Size
___ Mollic	___ Albic	___ Alfisol	___ Alb	___ Alb	___ Sandy-skeletal
X Ochric	___ Argillic	___ Andisol	___ Aqu	___ Argi	X Loamy-skeletal
___ Umbric	___ Calcic	___ Aridisol	___ Arg	___ Camb	___ Clayey-skeletal
___ None	___ Cambic	X Entisol	___ Ar	___ Calci	___ Sandy
	___ Duripan	___ Inceptisol	___ Fluv	___ Du-	
	___ Gypsic	___ Mollisol	___ Ochr	___ Dy	
	___ Natric	___ Ultisol	X Orth	___ En	
	___ Petrocalcic	___ Vertisol	___ Psamm	___ Ep	
	___ Salic		___ Torr	___ Eu	
	X None		___ Umb	___ Fl	
			___ Xer	___ Gy	
				___ Ha	
				___ Na	
				___ Oc	
				___ Pale	
				___ Sal	
				___ Torri	
				X Xero	

WRD Calc

1 37 (0.2)(1-.40) = 4.44

2 68 (0.15)(1-.90) = 1.02

3 45 (.05)(1-.90) = 0.23

5.69

Very Low

Subsurface Features

___ Abrupt Textural Change

___ Lithic Contact

___ Paralithic Contact

___ Slickensides

___ Hydric Conditions

___ None

PSCS = 25-100 cm

Family: _____

Soil Profile Description

~~Soil Phase~~ Calaveras creek 2 Name JP / JN

General Location East of Calaveras Creek / South of Reservoir Date 2/25/09

Legal Description _____ GPS _____

Nat Veg or Crop _____ Rainfall _____ % Slope 0.5%

Parent Material Alluvium Landform Floodplain Shape _____ Length _____

Drainage Class	Hyd. Cond.	Eff. Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
WD	High 10-100	VD	LOW	SW	788 ft.	N	54

Land Use Interpretations

Shrink/Swell - LCC _____ T/K Factor _____ Unified _____

Septic Fields _____ Forest _____ Range _____ Wetlands _____

Boundary		Structure		Skins	Roots	Consistency		Chemistry			Color			Texture			Horization		
Depth	Dist.	G/S	Shape	A/D	A/S	D/M	S/P	Morph.	Effer.	pH	Redox	Hue	V/C	%R.F.	%Clay	Class	Master	Sub.	No.
20	CS	1/C	ABK	1/F	4/F	SO/VFR	1/1	-	-	6.0	-	10YR	3/2 3/3	10	15	SiL	A	P	
56	CS	1/C	ABK	1/F	3/F	LO/FR	1/1	-	-	6.5	-	10YR	3/2 3/3	35+	15	VGBSiL	2C		
76	CS	SGO	GR/A	0/0	2/F	LO/LO	0/0	-	-	6.9	-	10YR	3/2	65	4	EXGBS	3C		
150+	LS	SGO	0	0/0	1/VF	LO/LO	0/0	-	-	7.0	-	10YR	4/2	75	2	EXCBS	4C		

Notes: Free water at 120 cm

Fertility: 1) ideal towards +1 2) lower 1/3 ideal towards +1 3) borderline +1 4) too little

Loamy-skeletal, Pachic Haploxeroll

Taxonomic Soil Classification

Epipedon	DSSH(s)	Soil Order	Suborder	Great Group		Family Particle Size
X Mollic 0-56	____Albic	____Alfisol	____Alb	____Alb	____Ochr	____Sandy-skeletal
____Ochric cm	____Argillic	____Andisol	____Aqu	____Argi	____Pale	X Loamy-skeletal
____Umbric	____Calcic	____Aridisol	____Arg	____Camb	____Sal	____Clayey-skeletal
____None	____Cambic	____Entisol	____Ar	____Calci	____Torri	____Sandy
	____Duripan	____Inceptisol	____Fluv	____Dur	____Xer	____Loamy
	____Gypsic	X Mollisol	____Ochr	____Dystro		____Clayey
	____Natric	____Ultisol	____Orth	____Endo		____Coarse-loamy
	____Petrocalcic	____Vertisol	____Psamm	____Epi		____Fine-loamy
	____Salic		____Torr	____Eutro		____Coarse-silty
	X None		____Umb	____Fluv		____Fine-silty
			X Xer	____Gyps		____Fine
				X Hapl		
				____Natr		

Subsurface Features:

____Abrupt Textural Change
____Lithic Contact
____Paralithic Contact
____Slickensides
____Hydric Conditions
____None

PSCS: 25-100cm

WRD calc

1 20 (0.2)(1-.1) = 3.6
2 36 (0.2)(1-.35) = 4.68
3 20 (0.05)(1-.65) = 0.35
4 74 (.05)(1-.75) = 0.93
9.56

LOW

Family: _____

SOIL SCIENCE 321
BRENT G. HALLOCK

SOIL PROFILE DESCRIPTION
- 1998 -

CAL POLY
STATE UNIVERS

Soil Phase _____ Name Jan N.
General Location San Antonio Rez. - Oak Woodland Date 3/12/09
Legal Description _____ Lat/Long _____
Nat Veg or Crop _____ Rainfall _____ % Slope 3%
Parent Material Alluvium Landform Stream Bank - Eph Drng Headcut Shape Stream Terrace Length 600 m.

Drainage Class	Hyd Cond	Eff Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
WD	ML	VP	LOW	82°		M	58°F

Land Use Interpretations

Shrink/Swell _____ LCC _____ T/K Factor _____ Unified _____
Septic Fields _____ Forest _____ Range _____ Wetlands _____

Horization			Boundary		Texture			Structure			Color D/M		Cons.		Chemistry (new unit)			Skins	Roots
Master	Sub.	No.	Depth	Dist.	% R.F.	% Clay	Class	Grade	Size	Shape	Hue	V/C	D/M	S/P	pH	Effer.	Morph.	A/D	A/S
A			0-24	CW	3	15	FSL	1	M	SBK	2.5Y	6/3 4/2	FR/VFR	SO/PO	6.0	-	-	-	M/VF
2A			24-56	CS	35	30	CBV SCL	1	M	SBK	10YR	4/2 3/1	VFR/VFR	MS/VP	6.6	-	-	-	M/VF
3C			56-91	CS	40	3	GRV FS	0	F	SGR	10YR	4/2 3/2	L/L	SO/PO	7.2	-	-	-	M/VF
4A	bt		91-130	CS	40	35	CBV SC	2	F	SBK	10YR	2/2 2/1	-/FR	MS/VP	7.5	-	-	C CLF RF	F/F
4B	bt		130+	-	80	40	CBX SC	2	F	SBK	10YR	4/4 3/4	-/FR	MS/VP	8.0	-	-	M CLF; Z	VF/M
																		BR-F BG/RF	

notes : Loamy-skeletal, Typic Xerofluvent

Taxonomic Soil Classification

Epipedon
- ___ Mollic
- X Ochric
- ___ Umbric
- ___ None

DSSH(s)
- ___ Albic
- ___ Argillic
- ___ Calcic
- ___ Cambic
- ___ Duripan
- ___ Gypsic
- ___ Natric
- ___ Petrocalcic
- ___ Salic
- X None

Soil Order
- ___ Alfisol
- ___ Andisol
- ___ Aridisol
- X Entisol
- ___ Inceptisol
- ___ Mollisol
- ___ Ultisol
- ___ Vertisol

Suborder
- ___ Alb
- ___ Aqu
- ___ Arg
- ___ Ar
- X Fluv
- ___ Ochr
- ___ Orth
- ___ Psamm
- ___ Torr
- ___ Umb
- ___ Xer

Great Group
- ___ Alb
- ___ Argi
- ___ Camb
- ___ Calci
- ___ Dur
- ___ Dystro
- ___ Endo
- ___ Epi
- ___ Eutro
- ___ Fluv
- ___ Gyps
- ___ Hapl
- ___ Natr
- ___ Ochr
- ___ Pale
- ___ Sal
- ___ Torri
- X Xer

Family Particle Size
- ___ Sandy-skeletal
- X Loamy-skeletal
- ___ Clayey-skeletal
- ___ Sandy
- ___ Loamy
- ___ Clayey

WRD calc

1 24 (0.15) (1−.03) = 3.49

2 32 (0.15) (1−.35) = 3.12

3 35 (0.05) (1−.40) = 1.05

4 39 (0.15) (1−.40) = 3.51

5 20 (0.15) (1−.80) = 0.6 (Low)

11.77

Subsurface Features
- ___ Abrupt Textural Change
- ___ Lithic Contact
- ___ Paralithic Contact
- ___ Slickensides
- ___ Hydric Conditions
- ___ None

PSCS = 25-100cm

Family: _____

SOIL SCIENCE 321
BRENT G. HALLOCK

SOIL PROFILE DESCRIPTION
- 1998 -

CAL POLY
STATE UNIVERS

Soil Phase _____ Name Jocelyn Brandt
General Location San Antonio Dark Sonora Date 3/12/09
Legal Description _____ Lat/Long _____
Nat Veg or Crop _____ Rainfall _____ % Slope 2
Parent Material _____ Landform Terrace Shape Linear Length 3ac / 500 ft.

Drainage Class	Hyd Cond	Eff Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
WD	MH	VD	LOW	N 15 E		L	64°F

Land Use Interpretations

Shrink/Swell _____ LCC _____ T/K Factor _____ Unified _____
Septic Fields _____ Forest _____ Range _____ Wetlands _____

Horization			Boundary		Texture			Structure			Color moist		Cons.		Small Chemistry			Skins	Roots	Dry Color
Master	Sub.	No.	Depth	Dist.	% R.F.	% Clay	Class	Grade	Size	Shape	Hue	V/C	D (M)	S/P	pH	Effer.	Morph.	A/D	A/S	
A			0-41	GW	6	16%	CoSL	2	Co	SBK	10YR	3/2	VFR	SO/SP	6.7	-	-	-	M/F	2.5Y 4/2
B	w		41-77	GW	40	18%	CBX CoSL	2	M	SBK	7.5YR	3/2	VFR	SS/PO	6.5	-	-	-	M/E	
2C			77+	-	75	1%	CBX CoS	0	F	GR	10YR	3/3	L	SO/PO	6.9	-	-	-	F/F	

notes : Loamy-skeletal, Pachic Haploxeroll

H1 = 116cm H3 = 23 PSCS RF = 43.46
H2 = 36

Taxonomic Soil Classification

Epipedon	DSSH(s)	Soil Order	Suborder	Great Group	Family Particle Size
X Mollic 0-77 cm	___ Albic	___ Alfisol	___ Alb	___ Alb	___ Sandy-skeletal
___ Ochric	___ Argillic	___ Andisol	___ Aqu	___ Argi	X Loamy-skeletal
___ Umbric	___ Calcic	___ Aridisol	___ Arg	___ Camb	___ Clayey-skeletal
___ None	___ Cambic	___ Entisol	___ Ar	___ Calci	___ Sandy
	___ Duripan	___ Inceptisol	___ Fluv	___ Dur	___ Loamy
	___ Gypsic	X Mollisol	___ Ochr	___ Dystro	___ Clayey
	___ Natric	___ Ultisol	___ Orth	___ Endo	___ Coarse-loamy
	___ Petrocalcic	___ Vertisol	___ Psamm	___ Epi	___ Fine-loamy
	___ Salic		___ Torr	___ Eutro	___ Coarse-silty
	X None		___ Umb	___ Fluv	___ Fine-silty
			X Xer	___ Gyps	___ Fine
				X Hapl	___ Very fine
				___ Natr	
				___ Ochr	
				___ Pale	
				___ Sal	
				___ Torri	
				___ Xer	

Subsurface Features

___ Abrupt Textural Change
___ Lithic Contact
___ Paralithic Contact
___ Slickensides
___ Hydric Conditions
___ None

PSCS = 25-100 cm

LRD calc

1 41 (0.15)(1-.06) = 5.78
2 36 (0.15)(1-.40) = 3.24
3 73 (0.05)(1-.75) = 0.91
9.93

LOW

Family: _____

SOIL SCIENCE 321
BRENT G. HALLOCK

SOIL PROFILE DESCRIPTION
- 1998 -

Jon Nowack

CAL POLY STATE UNIVERS

Soil Phase _____ Name Jocelyn Beaudette

General Location _____ Date 3/13/09

Legal Description San Antonio Creek #2 Bank cut of stream Lat/Long _____

Nat Veg or Crop _____ Rainfall _____ % Slope < 2%

Parent Material _____ Landform terrace Shape _____ Length _____

Drainage Class	Hyd Cond	Eff Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
WD	MH	VD	Moderate	355°		L	58 F

Land Use Interpretations

Shrink/Swell _____ LCC _____ T/K Factor _____ Unified _____

Septic Fields _____ Forest _____ Range _____ Wetlands _____

Horization			Boundary		Texture			Structure			Color		Cons.		Chemistry			Skins	Roots	Dry colo
Master	Sub.	No.	Depth (cm)	Dist.	% R.F.	% Clay	Class	Grade	Size	Shape	Hue	V/C	D/M (moist)	S/P (moist)	pH	Effer.	Morph.	A/D	A/S	
A		1	0-13	CS	3	7	SiL	2	F	SBK	10YR	3/2	FR	SO/SP	6.7	—	—	—	3 F	2.5Y 4/2
B		2	13-64	GW	7	24	L	2	M	SBK	10YR	3/2	FR	SS/SP	6.8	—	—	—	3 F	
2C		3	64-107	DW	23	25	GRM SCL	2	F	SBK	10YR	4/2	VFR	SS/SP	6.8	—	—	—	2 M	
3C		4	107-138	CW	50	2	GRV COS	0	F	GR	10YR	4/2	L	SO/PO	7.0	—	—	—	1 M	
4C		5	138+	—	55	2	CBV COS	0	F	GR	10YR	3.5/2	L	SO/PO	7.0	—	—	—	1 M	

notes : Fine-loamy, Pachic Haploxeroll

Taxonomic Soil Classification

Epipedon	DSSH(s)	Soil Order	Suborder	Great Group	Family Particle Siz
X Mollic 0-64 cm	___ Albic	___ Alfisol	___ Alb	___ Alb	___ Sandy-skeletal
___ Ochric	___ Argillic	___ Andisol	___ Aqu	___ Argi	___ Loamy-skeletal
___ Umbric	___ Calcic	___ Aridisol	___ Arg	___ Camb	___ Clayey-skeletal
___ None	___ Cambic	___ Entisol	___ Ar	___ Calci	___ Sandy
	___ Duripan	___ Inceptisol	___ Fluv	___ Dur	___ Loamy
	___ Gypsic	X Mollisol	___ Ochr	___ Dystro	___ Clayey
	___ Natric	___ Ultisol	___ Orth	___ Endo	___ Coarse-loamy
	___ Petrocalcic	___ Vertisol	___ Psamm	___ Epi	X Fine-loamy
	___ Salic		___ Torr	___ Eutro	___ Coarse-silty
	X None		___ Umb	___ Fluv	___ Fine-silty
			X Xero	___ Gyps	___ Fine
				X Haplo	___ Very fine
				___ Natr	
				___ Ochr	
				___ Pale	
				___ Sal	
				___ Torri	
				___ Xer	

Subsurface Features

___ Abrupt Textural Change
___ Lithic Contact
___ Paralithic Contact
___ Slickensides
___ Hydric Conditions
___ None

PSCS = 25 - 100cm

WRD Calc

1	13 (0.2) (1-.03) =	2.52
2	51 (0.2) (1-.07) =	9.49
3	43 (0.15) (1-.23) =	4.97
4	31 (.05) (1-.50) =	0.78
5	12 (.05) (1-.55) =	0.27
Moderate		18.03

Family: _____

SOIL SCIENCE 321
BRENT G. HALLOCK

SOIL PROFILE DESCRIPTION
- 1998 -

CAL POLY
STATE UNIVERS

Soil Phase _____ Name Jaclyn Brandt
General Location Bank cut San Antonio Creek Date 3/12/09
Legal Description _____ Lat/Long _____
Nat Veg or Crop _____ Rainfall _____ % Slope 2°
Parent Material _____ Landform Stream Bank Shape _____ Length _____

Drainage Class	Hyd Cond	Eff Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
WD	MH	VD	LOW	344°		L	

Land Use Interpretations

Shrink/Swell _____ LCC _____ T/K Factor _____ Unified _____
Septic Fields _____ Forest _____ Range _____ Wetlands _____

Horization			Boundary		Texture			Structure			Color (moist)		Cons.		Chemistry			Skins	Roots	Dry Color
Master	Sub.	No.	Depth	Dist.	% R.F.	% Clay	Class	Grade	Size	Shape	Hue	V/C	D/M	S/P	pH	Effer.	Morph.	A/D	A/S	
A		1	0-10	CS	2	12	SiL	2	CO	sbk	10YR	3/1	VFR	SO SP	6.4	–	–	–	3 VF	2.5Y 5/2
2A		2	10-54	GW	30	24	GR SCL	2	CO	sbk	10YR	3/1	FR	SS MP	6.8	–	–	–	2F	
2AB		3	54-80	GW	30	32	GR SCL	2	CO	sbk	10YR	3/1	FR	SS MP	6.9	–	–	–	2F	
3C		4	80-132	GW	65	28	COX SCL	1	M	sbk	10YR	4/2	FR	SS MP	6.9	–	–	–	2M	
4C		5	132+	–	20	1	GR COS	0	VF	GR	10YR	3.5/2	L	SO PO	7.0	–	–	–	–	

notes : Loamy-skeletal, Pachic Haploxeroll
RF of PSCS = 39.3

Taxonomic Soil Classification

Epipedon	DSSH(s)	Soil Order	Suborder	Great Group	Family Particle Size
X Mollic 0-80 cm	___ Albic	___ Alfisol	___ Alb	___ Alb	___ Sandy-skeletal
___ Ochric	___ Argillic	___ Andisol	___ Aqu	___ Argi	X Loamy-skeletal
___ Umbric	___ Calcic	___ Aridisol	___ Arg	___ Camb	___ Clayey-skeletal
___ None	___ Cambic	___ Entisol	___ Ar	___ Calci	___ Sandy
	___ Duripan	___ Inceptisol	___ Fluv	___ Dur	___ Loamy
	___ Gypsic	X Mollisol	___ Ochr	___ Dystro	___ Clayey
	___ Natric	___ Ultisol	___ Orth	___ Endo	___ Coarse-loamy
	___ Petrocalcic	___ Vertisol	___ Psamm	___ Epi	___ Fine-loamy
	___ Salic		___ Torr	___ Eutro	___ Coarse-silty
	X None		___ Umb	___ Fluv	___ Fine-silty
			X Xer	___ Gyps	___ Fine
				X Haplo	___ Very fine
				___ Natr	
				___ Ochr	
				___ Pale	
				___ Sal	
				___ Torri	
				___ Xer	

Subsurface Features

___ Abrupt Textural Change
___ Lithic Contact
___ Paralithic Contact
___ Slickensides
___ Hydric Conditions
___ None

PSCS = 25-100 cm

Family: _____

WRD calc

1	10	(0.2)(1-.02)	= 1.96
2	44	(0.15)(1-.3)	= 4.62
3	26	(0.15)(1-.30)	= 2.73
4	52	(0.15)(1-.65)	= 2.73
5	18	(.05)(1-.20)	= 0.72
	LOW		12.76

SOIL SCIENCE 321
BRENT G. HALLOCK

SOIL PROFILE DESCRIPTION
- 1998 -

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~~Soil Phase~~ OR1 SITE 1 — Name Jan Novak
General Location OR 1 between Alt. PB-6 & PB-6 — Date 3/10/09
Legal Description — Lat/Long
Nat Veg or Crop (FP) — Rainfall — % Slope < 2%
Parent Material alluvium — Landform Floodplain Bdy. / — Shape Toeslope — Length 600 m

Drainage Class	Hyd Cond	Eff Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
WD	MH	VD	High	250°		L	56°F

Land Use Interpretations

Shrink/Swell — LCC — T/K Factor — Unified
Septic Fields — Forest — Range — Wetlands

Horization			Boundary		Texture			Structure			Color		Cons.		Chemistry			Skins	Roots
Master	Sub.	No.	Depth	Dist.	% R.F.	% Clay	Class	Grade	Size	Shape	Hue	V/C	D (M)	S/P	pH	Effer.	Morph.	A/D	A/S
A		1	0-43	GW	1	12	VFSL	2	CO	SBK	2.5Y	3/2	VFR	SS/SP	5.5	-	-	-	M/VF
AC		2	43-78	GW	0	8	VFLS	2	CO	SBK	2.5Y	3/2	VFR	SO/PO	6.5	-	-	-	C/VF
AC2		3	78-115	GW	0	7	VFSL	1	CO	SBK	2.5Y	3/2	VFR	SO/PO	6.5	-	-	-	C/VF
2AC		4	115+	GW	15	2	FLS	0	F	GR	2.5Y	3/1	L	SO/PO	6.0	-	-	-	MF/VF
			(cm)								Any 1 10YR	6/3							
											Any 2 10YR	6/4							
											Any 3 10YR	6/4							

Any 4 10YR 6/3

notes : Coarse loamy, Typic xerofluvent

Taxonomic Soil Classification

Horizon	WRD	Horizon depth cm
1	(0.2)	43 = 8.6
2	(0.1)	35 = 3.5
3	(0.2)	37 = 7.4
4	(0.1)	35 = 3.5

Epipedon

- ___ Mollic
- X Ochric
- ___ Umbric
- ___ None

DSSH(s)

- ___ Albic
- ___ Argillic
- ___ Calcic
- ___ Cambic
- ___ Duripan
- ___ Gypsic
- ___ Natric
- ___ Petrocalcic
- ___ Salic
- X None

Soil Order

- ___ Alfisol
- ___ Andisol
- ___ Aridisol
- X Entisol
- ___ Inceptisol
- ___ Mollisol
- ___ Ultisol
- ___ Vertisol

Suborder

- ___ Alb
- ___ Aqu
- ___ Arg
- ___ Ar
- X Fluv
- ___ Ochr
- ___ Orth
- ___ Psamm
- ___ Torr
- ___ Umb
- ___ Xer

Great G

- ___ Alb
- ___ Argi
- ___ Camb
- ___ Calci
- ___ Dur
- ___ Dystro
- ___ Endo
- ___ Epi
- ___ Eutro
- ___ Fluv
- ___ Gyps
- ___ Hapl
- ___ Natr
- ___ Ochr
- ___ Pale
- ___ Sal
- ___ Torri
- X Xero

- ___ Clayey
- X Coarse-loamy
- ___ Fine-loamy

Horizon		RF correction
1	8.6 (1 - .01)	= 8.5
2	3.5	
3	7.4	
4	3.5 (1 - .15)	= 2.98
		22.9

Subsurface Features

- ___ Abrupt Textural Change
- ___ Lithic Contact
- ___ Paralithic Contact
- ___ Slickensides
- ___ Hydric Conditions
- ___ None

PSCS = 25 - 100 cm

Family: _____

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SOIL PROFILE DESCRIPTION
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Soil Phase _____
General Location ~~CR2~~ RR4 Name Jocelyn Beaudet
Legal Description _____ Date 3/10/09
Nat Veg or Crop _____ Lat/Long _____
Parent Material _____ Landform Wash Shape _____ Rainfall _____ % Slope <3 % Length _____

Drainage Class	Hyd Cond	Eff Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
WD	ML	VD	Very Low	320°		M	

Land Use Interpretations

Shrink/Swell _____ LCC _____ T/K Factor _____ Unified _____
Septic Fields _____ Forest _____ Range _____ Wetlands _____

Horization			Boundary		Texture			Structure			Color Dry		Cons.		Chemistry			Skins	Roots	Mois color
Master	Sub.	No.	Depth	Dist.	% R.F.	% Clay	Class	Grade	Size	Shape	Hue	V/C	D/M	S/P	pH	Effer.	Morph.	A/D	A/S	
A		1	0-53	GW	70	22	CBX SCL	1	CO	SBK	10YR	6/2	VFR	SO/SP	6.7	—	—	—	3/VF	10YR 4/1
2C		2	53-81	CW	75	3	CBX FS	0	F	GR	10YR	5/2	L	SO/PO	7.0	—	—	—	1/VF	10YR 4/2
3C		3	81-97	CW	55	6	GRV LVFS	1	M	SBK	10YR	6/2	VFR	SO/PO	6.0	—	—	—	1/VF	10 YR 4/1
4C		4	97+	—	60	5	CBX LFS	0	F	GR	10YR	6/2	L	SO/PO	7.0	—	—	—	—	10 YR 4/2

notes: NASIS code Loamy-skeletal, Typic Xerofluvent

Taxonomic Soil Classification

Epipedon	DSSH(s)	Soil Order	Suborder	Great Group	Family Particle Size
___ Mollic	___ Albic	___ Alfisol	___ Alb	___ Alb	___ Sandy-skeletal
X Ochric	___ Argillic	___ Andisol	___ Aqu	___ Argi	X Loamy-skeletal
___ Umbric	___ Calcic	___ Aridisol	___ Arg	___ Camb	___ Clayey-skeletal
___ None	___ Cambic	X Entisol	___ Ar	___ Calci	___ Sandy
	___ Duripan	___ Inceptisol	X Fluv	___ Dur	___ Loamy
	___ Gypsic	___ Mollisol	___ Ochr	___ Dystro	
	___ Natric	___ Ultisol	___ Orth	___ Endo	
	___ Petrocalcic	___ Vertisol	___ Psamm	___ Epi	
	___ Salic		___ Torr	___ Eutro	
	X None		___ Umb	___ Fluv	
			___ Xer	___ Gyps	
				___ Hapl	
				___ Natr	
				___ Ochr	
				___ Pale	
				___ Sal	
				___ Torri	
				X Xero	

WRD calc

1 53 (.15)(1-.7) = 2.39
2 28 (.05)(1-.75) = 0.35
3 16 (0.1)(1-.55) = 0.72
4 53 (0.1)(1-.60) = 2.12
5.58

Very Low

Subsurface Features

___ Abrupt Textural Change
___ Lithic Contact
___ Paralithic Contact
___ Slickensides
___ Hydric Conditions
___ None

PSCS: 25cm - 100cm

Family: _____

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SOIL PROFILE DESCRIPTION
- 1998 -

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~~Soil Phase~~ OR1 site 2 Name Joshua Bowden

General Location Wash #2 near sycamores / OR-1 Bank Cut Date 3/10/09

Legal Description _____ Lat/Long _____

Nat Veg or Crop _____ Rainfall _____ % Slope <2

Parent Material _____ Landform Wash / Bank cut Shape _____ Length _____

Drainage Class	Hyd Cond	Eff Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
SWED	H	VD	Very Low	NA		LV	

Land Use Interpretations

Shrink/Swell _____ LCC _____ T/K Factor _____ Unified _____

Septic Fields _____ Forest _____ Range _____ Wetlands _____

Horization			Boundary		Texture			Structure			Color (moist)		Cons.		Chemistry			Skins	Roots	Dry color
Master	Sub.	No.	Depth (cm)	Dist.	% R.F.	% Clay	Class	Grade	Size	Shape	Hue	V/C	D/M	S/P	pH	Effer.	Morph.	A/D	A/S	
A	-	-	0-45	CS	<15	12	LVFS	0	M	SBK	10YR	3/2	FR	SO/PO	6.3	-	-	-	3VF	2.5Y
CA	-	-	45-140+	-	75	1	CBX COS	0	CO	SGR	10YR	3/2	L	SO/SP	7	-	-	-	-	

notes : Sandy skeletal, Pachic Haploxeroll
PSCS RF = 59

Taxonomic Soil Classification

Epipedon	DSSH(s)	Soil Order	Suborder	Great Group	Family Particle Size
X Mollic 0-45 cm	___ Albic	___ Alfisol	___ Alb	___ Alb	X Sandy-skeletal
___ Ochric	___ Argillic	___ Andisol	___ Aqu	___ Argi	___ Loamy-skeletal
___ Umbric	___ Calcic	___ Aridisol	___ Arg	___ Camb	___ Clayey-skeletal
___ None	___ Cambic	___ Entisol	___ Ar	___ Calci	___ Sandy
	___ Duripan	___ Inceptisol	___ Fluv	___ Dur	___ Loamy
	___ Gypsic	X Mollisol	___ Ochr	___ Dystro	___ Clayey
	___ Natric	___ Ultisol	___ Orth	___ Endo	___ Coarse-loamy
	___ Petrocalcic	___ Vertisol	___ Psamm	___ Epi	___ Fine-loamy
	___ Salic		___ Torr	___ Eutro	___ Coarse-silty
	X None		___ Umb	___ Fluv	___ Fine-silty
			X Xer	___ Gyps	___ Fine
				X Haplo	___ Very fine
				___ Natr	
				___ Ochr	
				___ Pale	
				___ Sal	
				___ Torri	
				___ Xer	

Subsurface Features

___ Abrupt Textural Change
___ Lithic Contact
___ Paralithic Contact
___ Slickensides
___ Hydric Conditions
___ None

PSCS = 25-100cm

Horizon	WRD Depth	WRD	RF correction	Calc
1	45	(0.1)	(1-.15)	= 3.83
2	105	(.05)	(1-.75)	= 1.31
				5.14

very Low

Family: _____

Soil Profile Description

Soil Phase _____ Name Jan Novak, Jason Pearson

General Location Goldfish Pond Pit #2 Date 2/24/09

Legal Description _____ GPS _____

Nat Veg or Crop Annual grass, filaree, clover, bicolor lupine Rainfall _____ % Slope 2.5%

Parent Material Sandstone Residuum Landform MS Shape SH Length 250ft

Drainage Class	Hyd. Cond.	Eff. Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
WD	L	VD	High (23.5	West	1070 ft	H	52° F

Land Use Interpretations

Shrink/Swell _____ LCC III T/K Factor 4/ Unified _____

Septic Fields _____ Forest _____ Range _____ Wetlands _____

Boundary		Structure		Skins	Roots	Consistency		Chemistry			Color			Texture			Horization		
Depth	Dist.	G/S	Shape	A/D	A/S	D/M	S/P	Morph.	Effer.	pH	Redox	Hue	V/C	%R.F.	%Clay	Class	Master	Sub.	No.
0-20	CS	2/MK	GR	0/0	4/F	N/A/VFR	0/1	—	0	5.7	—	10YR	5/2 3/1	<1	20	L	A	—	—
20-72	GS	3/NC	ABK	2/D	3/F	N/A/FR	1/2	—	0	5.9	—	10YR	3/1	3	32	SCL	B	t	—
72-106	CS	1/C	ABK MA	0	1/F	N/A/VFR	3/1	—	0	6.4	—	10YR	5/2	3	32	SCL	BC	—	—
106-150+	CS	1/C 0	ABK MA	0	0	EH/VFI	1/3	—	0	6H	—	10YR	6/2 4/2	5	48	SC	C	—	—

Notes: Soils are moist throughout profile, saturation starts 45cm - 106cm (where water percolation is limited by the more impervious C horizon)

Fertility 1) Ideal (mid scale) 2) Ideal (mid-scale) 3) Low side of Ideal 4) Ideal - Too much

Fine-loamy, Pachic Argixeroll

Taxonomic Soil Classification

Epipedon
- X Mollic 0-72 cm
- ____ Ochric
- ____ Umbric
- ____ None

DSSH(s)
- ____ Albic
- X Argillic 20-72 cm
- ____ Calcic
- ____ Cambic
- ____ Duripan
- ____ Gypsic
- ____ Natric
- ____ Petrocalcic
- ____ Salic
- ____ None

Soil Order
- ____ Alfisol
- ____ Andisol
- ____ Aridisol
- ____ Entisol
- ____ Inceptisol
- X Mollisol
- ____ Ultisol
- ____ Vertisol

Suborder
- ____ Alb
- ____ Aqu
- ____ Arg
- ____ Ar
- ____ Fluv
- ____ Ochr
- ____ Orth
- ____ Psamm
- ____ Torr
- ____ Umb
- X Xer

Great Group
- ____ Alb
- X Argi
- ____ Camb
- ____ Calci
- ____ Dur
- ____ Dystro
- ____ Endo
- ____ Epi
- ____ Eutro
- ____ Fluv
- ____ Gyps
- ____ Hapl
- ____ Natr
- ____ Ochr
- ____ Pale
- ____ Sal
- ____ Torri
- ____ Xer

Family Particle Size
- ____ Sandy-skeletal
- ____ Loamy-skeletal
- ____ Clayey-skeletal
- ____ Sandy
- ____ Loamy
- ____ Clayey
- ____ Coarse-loamy
- X Fine-loamy
- ____ Coarse-silty
- ____ Fine-silty
- ____ Fine

Subsurface Features:
- ____ Abrupt Textural Change
- ____ Lithic Contact
- ____ Paralithic Contact
- ____ Slickensides
- ____ Hydric Conditions
- ____ None

WRD calc

1 20 (0.2) = 4

2 52 (0.15) (1-.03) = 7.57

3 34 (.15) (1-.03) = 4.95

4 44 (0.15) (1-.05) = 4.27

High 22.79

Family: _____

Soil Profile Description

~~Soil Phase~~ Goldfish Pond Pit #1 Name JW, JP

General Location Between 2 small inlet channels to Goldfish Pond Date 2/10/09

Legal Description _____ GPS _____

Nat Veg or Crop Annual grass Rainfall _____ % Slope 1%

Parent Material Recent Alluvium Landform FP Shape BL-TS Length 25-30 ft

Drainage Class	Hyd. Cond.	Eff. Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
VPD	Low	VD	Moderate	East	1,045	M	44°F

Land Use Interpretations

Shrink/Swell Low LCC _____ T/K Factor _____ Unified _____

Septic Fields _____ Forest _____ Range _____ Wetlands _____

Boundary		Structure		Skins	Roots/Pores	Consistency		Chemistry			Color			Texture			Horization		
Depth	Dist.	G/S	Shape	A/D	A/S	D/M	S/P	Morph.	Effer.	pH	Redox	Hue	V/C	%R.F.	%Clay	Class	Master	Sub.	No.
0-25	GS	1MGR / MA θ	GR / θ	0	MF/CF	SH/Fr	SS/1	0	—	6.5	D/c	10YR	5/3 3/2	<1	30	SiCL	A		
25-55	AS	1MSBK	SBK	0	CF/CF	S/Fr	SS/1	0	—	6.1	D/m	10YR	6/3 4/2	<1	40	SiC	B	w	
55-97	AC	2MSBK	BK	0	FF/CF	MH/F	S/0	0	—	6.9	D/m	10YR	6/4 5/2	2	10	LS	2C		
97-136	AS	1CSBK / MA θ	SBK / θ	0	FVF/VF	MH/F	0/1	0	—	6.5	D/m	10YR	5/3 5/2	<1	9	SL	3C		
136-150+	CI	1CSBK	SBK	0	FF/MF	MH/VF	S/2	0	—	5.5	D/m	10YR	6/4 3/1	<1	30	SCL	4C		

Notes: Fertility: 1) borderline (too little) borderline 2) ideal 3) borderline (too little) ideal 4) ideal (lower end)
5) barely ideal (too little)

Fine-loamy, Aquic Haploxeept

0.2 × 25 + 0.15 × 30 = 9.5 PSCS clay = 22

Taxonomic Soil Classification

Epipedon	DSSH(s)	Soil Order	Suborder	Great Group		Family Particle Size
____Mollic	____Albic	____Alfisol	____Alb	____Alb	____Ochr	____Sandy-skeletal
__X__Ochric	____Argillic	____Andisol	____Aqu	____Argi	____Pale	____Loamy-skeletal
____Umbric	____Calcic	____Aridisol	____Arg	____Camb	____Sal	____Clayey-skeletal
____None	__X__Cambic 25-55 cm	____Entisol	____Ar	____Calci	____Torri	____Sandy
	____Duripan	__X__Inceptisol	____Fluv	____Dur	____Xer	____Loamy
	____Gypsic	____Mollisol	____Ochr	____Dystro		____Clayey
	____Natric	____Ultisol	____Orth	____Endo		____Coarse-loamy
	____Petrocalcic	____Vertisol	____Psamm	____Epi		__X__Fine-loamy
	____Salic		____Torr	____Eutro		____Coarse-silty
	____None		____Umb	____Fluv		____Fine-silty
			__X__Xer	____Gyps		____Fine
				__X__Hapl		____Very fine
				____Natr		

Subsurface Features:

____Abrupt Textural Change
____Lithic Contact
____Paralithic Contact
____Slickensides
____Hydric Conditions
____None

PSCS = 25-100cm

WRD calc

1 25 (0.2) = 5
2 30 (0.15) = 4.5
3 42 (.05) (1-.02) = 2.06
4 39 (0.15) = 5.85
5 14 (0.15) = 2.1

Moderate 19.51

Family: _____

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SOIL PROFILE DESCRIPTION
- 1998 -

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Soil Phase _____ Name Jocelyn Beaudette
General Location WW4 / Wet meadow Date 3/9/09
Legal Description _____ Lat/Long _____
Nat Veg or Crop _____ Rainfall _____ % Slope 4°
Parent Material _____ Landform _____ Shape _____ Length _____

Drainage Class	Hyd Cond	Eff Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
VPD	ML	VD	High	315°		M	

Land Use Interpretations

Shrink/Swell _____ LCC _____ T/K Factor _____ Unified _____
Septic Fields _____ Forest _____ Range _____ Wetlands _____

Horization			Boundary		Texture			Structure			Color		Cons.		Chemistry			Skins	Roots
Master	Sub.	No.	Depth	Dist.	% R.F.	% Clay	Class	Grade	Size	Shape	Hue	V/C	D/M	S/P	pH	Effer.	Morph.	A/D	A/S
A		1	0-26 cm	GS	1	25	L	1	CO	SBK	10YR	3/2	FR	MS/VP	6.0	–	–	–	3F
BA		2	26-57	GS	4	30	CL	1	CO	SBK	10YR	3/2	1	MS/MP	5.5	–	–	–	2F
BA2		3	57-93	CS	15	35	CL	1	CO	SBK	10YR	3/2	0 to 1	MS/MP	6.2	–	–	–	1VF
C		4	93+	–	2	32	SCL	2	CO	SBK	2.5Y	4/3	1	MS/MP	4.4	–	–	–	–

notes: Fine-Loamy, Oxyaquic Haploxeroll

* Redoxy morphic features: Horizon 1 0-26cm - 15% 10YR 4/4 Root channels within matrix
H4 93+ - 20% 10YR 5/6 w/in matrix

Taxonomic Soil Classification

Epipedon	DSSH(s)	Soil Order	Suborder	Great Group	Family Particle Size
0-93 cm X Mollic	___ Albic	___ Alfisol	___ Alb	___ Alb	___ Sandy-skeletal
___ Ochric	___ Argillic	___ Andisol	___ Aqu	___ Argi	___ Loamy-skeletal
___ Umbric	___ Calcic	___ Aridisol	___ Arg	___ Camb	___ Clayey-skeletal
___ None	___ Cambic	___ Entisol	___ Ar	___ Calci	___ Sandy
	___ Duripan	___ Inceptisol	___ Fluv	___ Dur	___ Loamy
	___ Gypsic	X Mollisol	___ Ochr	___ Dystro	___ Clayey
	___ Natric	___ Ultisol	___ Orth	___ Endo	___ Coarse-loamy
	___ Petrocalcic	___ Vertisol	___ Psamm	___ Epi	X Fine-loamy
	___ Salic		___ Torr	___ Eutro	___ Coarse-silty
	X None		___ Umb	___ Fluv	___ Fine-silty
			X Xero	___ Gyps	___ Fine
				X Hapl	___ Very fine
				___ Natr	
				___ Ochr	
				___ Pale	
				___ Sal	
				___ Torri	
				___ Xer	

Subsurface Features

___ Abrupt Textural Change
___ Lithic Contact
___ Paralithic Contact
___ Slickensides
___ Hydric Conditions
___ None

Family: _____

WRO calc

1 26 (0.2) (1-.01) = 5.15
2 31 (0.2) (1-.04) = 5.95
3 36 (0.2) (1-.15) = 6.12
4 57 (0.15) (1-.02) = 8.38

High

25.6

SOIL SCIENCE 321
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SOIL PROFILE DESCRIPTION
- 1998 -

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~~Soil Phase~~ RD1 vertical bank - near headcut
General Location → Bank cut ephemeral drainage
Legal Description
Nat Veg or Crop
Parent Material
Landform Ephemeral stream (LF)
Shape
Length
Name Jocelyn Bandelli
Date 3/11/09
Lat/Long
Rainfall
% Slope 4°

Drainage Class	Hyd Cond	Eff Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
WD	MH	VD	High	325°		L	

Land Use Interpretations

Shrink/Swell — LCC — T/K Factor — Unified
Septic Fields — Forest — Range — Wetlands

Horization			Boundary		Texture			Structure			Color		Cons.		Chemistry			Skins	Roots
Master	Sub.	No.	Depth	Dist.	% R.F.	% Clay	Class	Grade	Size	Shape	Hue	V/C (moist)	D/M	S/P	pH	Effer.	Morph.	A/D	A/S
A		1	0-32	CS	5	18	L	2	CO	SBK	10YR	3/2	FI	SS/MP	5.8	—	—	—	3VF
2A		2	32-61	CS	5	32	CL	2	CO	SBK	10YR	3/1.5	FR	SS/MP	5.7	—	—	—	2VF
3A		3	61-89	GW	5	32	CL	2	CO	SBK	10YR	3/2	FR	SS/MP	6.1	—	—	—	1VF
4A		4	89-140+	—	20	26	GRL	2	CO	SBK	10YR	3.5/2	FR	SS/MP	6.3	—	—	—	—

dry color
2.5Y 5/1

notes: Fine-loamy Pachic Haploxeroll
saturated below 140 cm.

Taxonomic Soil Classification

Epipedon	DSSH(s)	Soil Order	Suborder	Great Group	Family Particle Size
X Mollic 0-89	___ Albic	___ Alfisol	___ Alb	___ Alb	___ Sandy-skeletal
___ Ochric	___ Argillic	___ Andisol	___ Aqu	___ Argi	___ Loamy-skeletal
___ Umbric	___ Calcic	___ Aridisol	___ Arg	___ Camb	___ Clayey-skeletal
___ None	___ Cambic	___ Entisol	___ Ar	___ Calci	___ Sandy
	___ Duripan	___ Inceptisol	___ Fluv	___ Dur	___ Loamy
	___ Gypsic	X Mollisol	___ Ochr	___ Dystro	___ Clayey
	___ Natric	___ Ultisol	___ Orth	___ Endo	___ Coarse-loamy
	___ Petrocalcic	___ Vertisol	___ Psamm	___ Epi	X Fine-loamy
	___ Salic		___ Torr	___ Eutro	___ Coarse-silty
	X None		___ Umb	___ Fluv	___ Fine-silty
			X Xer	___ Gyps	___ Fine
				X Haplo	___ Very fine
				___ Natr	
				___ Ochr	
				___ Pale	
				___ Sal	
				___ Torri	
				___ Xer	

Subsurface Features

___ Abrupt Textural Change
___ Lithic Contact
___ Paralithic Contact
___ Slickensides
___ Hydric Conditions
X None

PSCS = 25 - 100 cm

WRD calc

1 32 (0.2) (1-.05) = 6.08
2 29 (0.2) (1-.05) = 5.51
3 28 (0.2) (1-.05) = 5.32
4 .61 (0.2) (1-.20) = 9.76

26.67

High

Family: _____

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SOIL PROFILE DESCRIPTION
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STATE UNIVERS

~~Soil Phase~~ Fine-Loamy Pachic Haploxeroll
General Location Stockpond drainage / SP1 - open Pace on vert. bank
Legal Description
Nat Veg or Crop
Parent Material
Landform channel
Name Jan Novak, Jeel, n R.
Date 3/9/09
Lat/Long
Rainfall
% Slope 6°, 54° (hill top to pedon; pedon to creek)
Shape
Length

Drainage Class	Hyd Cond	Eff Depth	Water Reten. Diff.	Aspect	Elevation	Runoff	Soil Temp
WD	MH	VD	High	230°		M	

Land Use Interpretations

Shrink/Swell — LCC — T/K Factor — Unified
Septic Fields — Forest — Range — Wetlands

cm Horization			Boundary		Texture			Structure			Color		Cons.		Chemistry			Skins	Roots
Master	Sub.	No.	Depth (cm)	Dist.	% R.F.	% Clay	Class	Grade	Size	Shape	Hue	V/C	D/M	S/P	pH	Effer.	Morph.	A/D	A/S
A			0-52	DW	<5	24	L	2	CO	SbK	10YR	3/2	FI	SO VP	5.7 (6.2)	-		—	3 VF
2A			52-104	SD	10	30	CL	2	CO	SbK	10YR	3/2	FR	SS VP	5.3 (5.8)	-		—	2 VF
3A			104+	/	11	35	CL	2	CO	SbK	10YR	3/2	FR	SS VP	5.3 (6.0)	-		—	1 VF

Dry color
2.5Y 5/3

notes:
metric
* suspect illuvial accumulation of clay. couldn't determine due to moisture conts of soils. - No clay films.
If % BS is >50% &

Taxonomic Soil Classification

Epipedon	DSSH(s)	Soil Order	Suborder	Great Group	Family Particle Size
X Mollic 0-52cm	___ Albic	___ Alfisol	___ Alb	___ Alb	___ Sandy-skeletal
___ Ochric	___ Argillic	___ Andisol	___ Aqu	___ Argi	___ Loamy-skeletal
___ Umbric	___ Calcic	___ Aridisol	___ Arg	___ Camb	___ Clayey-skeletal
___ None	___ Cambic	___ Entisol	___ Ar	___ Calci	___ Sandy
	___ Duripan	___ Inceptisol	___ Fluv	___ Dur	___ Loamy
	___ Gypsic	X Mollisol	___ Ochr	___ Dystro	___ Clayey
	___ Natric	___ Ultisol	___ Orth	___ Endo	___ Coarse-loamy
	___ Petrocalcic	___ Vertisol	___ Psamm	___ Epi	X Fine-loamy
	___ Salic		___ Torr	___ Eutro	___ Coarse-silty
	X None		___ Umb	___ Fluv	___ Fine-silty
			X Xer	___ Gyps	___ Fine
				X Haplo	___ Very fine
				___ Natr	
				___ Ochr	
				___ Pale	
				___ Sal	
				___ Torri	
				___ Xer	

Subsurface Features

___ Abrupt Textural Change
___ Lithic Contact
___ Paralithic Contact
___ Slickensides
___ Hydric Conditions
X None

WRD Calc

1 52 (0.2) (1-.05) = 9.88
2 52 (0.2) (1-.10) = 9.36
3 46 (0.2) (1-.11) = 8.19
27.43

High

Family: _____

PSCS = 25cm - 100cm

LOCATION GARRETSON CA

Established Series
Rev. AAK/RCH/LCL/ET
02/2003

GARRETSON SERIES

The Garretson series is a member of the fine-loamy, mixed, nonacid, thermic family of Typic Xerorthents. Typically, Garretson soils have brown and yellowish brown, slightly acid, gravelly very fine sandy loam and gravelly loam A horizons and yellowish brown, brown and grayish brown, slightly acid and neutral, gravelly loam C horizons.

TAXONOMIC CLASS: Fine-loamy, mixed, active, nonacid, thermic Typic Xerorthents

TYPICAL PEDON: Garretson gravelly very fine sandy loam - cultivated (Colors are for dry soil unless otherwise stated.)

Ap--O to 10 inches; brown (10YR 5/3) gravelly very fine sandy loam, dark brown (10YR 3/3) moist; weak subangular blocky structure; slightly hard, very friable, slightly sticky, nonplastic; many very fine and few fine roots; many very fine interstitial pores; slightly acid (pH 6.2); gradual smooth boundary. (7 to 10 inches thick)

A12--10 to 29 inches; yellowish brown (10YR 5/4) gravelly loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, very friable, slightly sticky, nonplastic; many very fine roots; many very fine interstitial and common fine tubular pores; slightly acid (pH 6.5); gradual smooth boundary. (6 to 19 inches thick)

C1--29 to 42 inches; yellowish brown (10YR 5/4) gravelly loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, very friable, slightly sticky, slightly platic; many very fine roots; many very fine tubular pores; 20 to 30 percent angular pebbles and cobblestones; slightly acid (pH 6.5); gradual smooth boundary. (4 to 36 inches thick)

C2--42 to 53 inches; bown (10YR 5/3) gravelly loam, dark brown (10YR 4/3) moist; massive; slightly hard, very friable, slightly sticky, nonplastic; many very fine roots; few very fine tubular pores; 30 to 40 percent angular pebbles and cobblestones; slightly acid (pH 6.5); gradual smooth boundary. (11 to 23 inches thick)

C3--53 to 72 inches; gayish brown (10YR 5/2) gravelly loam, dark grayish brown (10R 4/2) moist; massive; slightly hard, very friable, slightly sticky, slightly plastic; few very fine roots; common very fine tubular and interstitial pores; 5 to 10 percent pebbles and cobblestones; neutral (pH 6.8).

TYPE LOCATION: Riverside County, California; north side Sierra Street, 250 feet west of Garretson Avenue, Corona; 1,000 feet west and 750 feet south of N1/4 corner sec. 13, T.45., R.7W. (Projected).

RANGE IN CHARACTERISTICS: The mean annual soil temperature at a depth of 20 inches is 59 degrees to 65 degrees F. and the soil temperature is not below 47 degrees F. at any time. Soil between depths of about 5 and 15 inches is dry in all parts from late April or May until late October or early December and usually is moist in some or all parts all the rest of the year. Texture throughout the profile is generally loam that contains some gravel. The range is very fine sandy loam, loam, clay loam or sandy clay loam. The 10 to 40 inch control section has 18 to 27 percent clay and 15 to 70 percent material coarser than very fine sand. Rock fragments, mostly gravel, make up 2 to 35 percent of the control section and rock fragments usually become

more numerous as depth increases. Fine stratification is lacking, but some pedons have coarse stratification, particularly in the lower part.

The A horizon is brown, grayish brown, dark grayish brown, light brownish gray, yellowish brown, light yellowish brown or pale brown in l0R or 2.5Y hue when dry. The moist value is 3 or 4. This horizon contains 1/2 to 2 percent organic matter. It has weak to moderate granular or subangular blocky structure or is massive and hard or very hard when dry. One or more of the requirements of a mollic epipedon is lacking in each pedon although most properties of a mollic epipedon are present. The A horizon is slightly acid or neutral.

The C horizon has the same color as the A horizon or it has one unit higher value or chroma. It is slightly acid to slightly and in some pedons below a depth of 44 inches the soil is moderately alkaline and a small amount of secondary or disseminated lime is present.

COMPETING SERIES: These are the Balcom, Castaic, Mocho, San Emigdio, Sorrento, Yolo, and Zacharias series. Balcom and Castaic soils have a paralithic contact at depths of 23 to 40 inches. Mocho and Sorrento soils have a mollic epipedon. San Emigdio soils have less than 18 percent clay in the control section. Yolo soils have less than 15 percent material coarser than very fine sand. Zacharias soils have a cambic horizon.

GEOGRAPHIC SETTING: The Garretson soils are on nearly level to strongly sloping fans and floodplains at elevations of 50 to 3,000 feet. They formed in medium textured alluvium, dominantly from sedimentary formations. The climate is dry subhumid mesothermal with warm dry summers and cool moist winters. Mean annual precipitation all in the form of rain is 12 to 25 inches. Average January temperature is about 52 degrees F., average July temperature is about 75 degrees F., and the mean annual temperature is about 61 degrees to 65 degrees F. The freeze-free season is about 250 to 350 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Arbuckle, Cortina, Perkins, and Tujunga soils, and the competing Mocho and Sorrento soils. Arbuckle and Perkins soils have argillic horizons. Cortina soils have more than 35 percent rock fragments. Tujunga soils are sand or loamy san.

DRAINAGE AND PERMEABILITY: Well drained; slow to medium runoff; moderate permeability.

USE AND VEGETATION: Used for the production of deciduous fruit, citrus fruit, avocados, irrigated field crops, alfalfa, and for homesites. Naturalized vegetation in untilled areas is annual grasses and forbs. Native vegetation is chamise, scattered oak trees, and shrubs.

DISTRIBUTION AND EXTENT: Valleys in the western part of central and southern California. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: San Bernardino County (Southwestern Part), California, 1972.

REMARKS: The Garretson soils were formerly classified as Alluvial soils. The Garretson series, a member of the fine-loamy family, is the counterpart of the Yolo series which is a member of the fine-silty family.

The activity class was added to the classification in February of 2003. Competing series were not checked at that time. - ET

OSED scanned by SSQA. Last revised by state on 10/72.

National Cooperative Soil Survey

U.S.A.

LOCATION GAVIOTA CA

Established Series
Rev. GWH/CAF/KP
10/2007

GAVIOTA SERIES

The Gaviota series consists of very shallow or shallow, well drained soils that formed in material weathered from hard sandstone or meta-sandstone. Gaviota soils are on hills and mountains and have slopes of 2 to 100 percent. The average annual precipitation is about 20 inches and the mean annual temperature is about 60 degrees F.

TAXONOMIC CLASS: Loamy, mixed, superactive, nonacid, thermic Lithic Xerorthents

TYPICAL PEDON: Gaviota gravelly loam, grass range. (Colors are for dry soil unless otherwise noted.)

A1--0 to 6 inches; brown (7.5YR 5/4) gravelly loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; neutral (pH 7.0); clear smooth boundary.

A2--6 to 10 inches; brown (7.5YR 5/4) gravelly loam, brown (7.5YR 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; neutral (pH 6.8); abrupt wavy boundary.

R--10 to 17 inches; pale brown (10YR 6/3) hard meta-sandstone.

TYPE LOCATION: Stanislaus County, California; nine miles west of the town of Westley, California; 1,700 feet north and 500 feet east of the southwest corner of section 6, T. 5 S., R. 6 E., MDB&M; USGS Solyo, California Quadrangle, NAD 27.

RANGE IN CHARACTERISTICS: Depth to a lithic contact of hard rock is 6 to 20 inches. The soils become moist below a depth of 6 inches some time between mid-October and mid-December and remain moist all the time in some parts below 6 inches until early April or late May. The mean annual soil temperature is 59 to 64 degrees F. and the soil temperature does not go as low as 41 degrees F. at any time. Texture throughout is sandy loam, fine sandy loam, loam, gravelly sandy loam, gravelly fine sandy loam, and gravelly loam. Clay content is 10 to 18 percent. Rock fragment content is less than 25 percent. Sand content is more than 40 percent of the fine earth fraction. Coarse and very coarse sand content is less than 20 percent.

The A horizon has color of 10YR 6/2, 6/3, 6/4, 5/2, 5/3, 5/4, 5/6, 5/8, 4/3; 2.5Y 6/2, 6/4, 5/2; 7.5YR 5/2, 5/4 or 6/4. Moist values are 4 throughout or if less than 4 they occur only in the upper part or have dry values of 6 or more. Reaction is moderately acid to neutral. Some pedons have a C horizon that differs from the A horizon principally by being one value unit lighter.

COMPETING SERIES: These are the Daulton , Exchequer (CA), Ocraig (CA), Snook (CA) and Whiterock (CA) series. Daulton soils have moist value of 3 and have a massive and hard epipedon. Exchequer soils have less than 50 percent sand in the fine earth fraction. Ocraig soils are neutral, have greater than 20 percent coarse and very coarse sand content. Snook soils are dry in all parts from early June to mid October. Whiterock soils have 25 to 50 percent sand and a mean annual soil temperature of 63 to 67 degrees F.

GEOGRAPHIC SETTING: Gaviota soils are on hills and mountains. Slope is 2 to 100 percent. These soils formed in material weathered from sandstone and meta-sandstone. Elevation is 200 to 4,400 feet. Rock outcrops are commonly associated with this soil and occupy from less than 2 percent to 50 percent of the surface area. The climate is dry subhumid with hot dry summers and cool moist winters. Mean annual precipitation is 10 to 30 inches. Mean January temperature is about 42 degrees F. and about 56 degrees F. along the coast of California; mean July temperature is about 75 degrees F.; mean annual temperature is about 56 to 65 degrees F. The frost-free season is 175 to 350 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Altamont, Los Gatos, Los Osos, Vallecitos and Wadesprings soils. Altamont soils, on uplands, hills and mountains, have a fine particle-size control section. Los Gatos soils, on mountains, are moderately deep and have an argillic horizon. Los Osos soils, on uplands, have an argillic horizon and a paralithic contact at a depth of 20 to 40 inches. Vallecitos soils, on hills, have an argillic horizon and a clayey particle-size control section. Wadesprings soils, on uplands, have an argillic horizon and magnesic mineralogy.

DRAINAGE AND PERMEABILITY: Well and excessively well drained; very low to very high runoff; moderately rapid permeability.

USE AND VEGETATION: Used mostly for livestock grazing. Some of the less sloping areas are cropped to dryland grain. Natural vegetation is California sage, chamise, manzanita, purple needlegrass and annual grasses.

DISTRIBUTION AND EXTENT: Mostly in the California Coast Ranges. The soils are extensive. MLRA 15, 20.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Stanislaus County (Newman Area), California, 1941.

REMARKS: Soils in the Amargosa series as recognized in the Antelope Valley Area, California are not included in the Gaviota series. Soils formed in material weathered from granite are now excluded from the Gaviota series.

The revision made on 09/96 moves the type location to better represent the series as mapped for the Gaviota series.

CEC/Clay ratio estimated from similar soils with laboratory data in the W. Stanislaus Soil Survey Area.

Runoff terminology adjusted 4/96 to adjective criteria of the Soil Survey Manual, 10/93.

Competing series updated 01/2003.

Warmer January temperatures occur along the southern Coastal range. These were phased until a possible later decision to split these out as separate series.

National Cooperative Soil Survey
U.S.A.

LOCATION HILLGATE CA

Established Series
RD: WRR/KRS/WBS/SBS
8/98

HILLGATE SERIES

The Hillgate series consists of very deep, well to moderately well drained soils that formed in alluvium from mixed sources. They are on low terraces with slopes of 0 to 50 percent. Mean annual precipitation is about 16 inches and the mean annual temperature is about 61 degrees F.

TAXONOMIC CLASS: Fine, smectitic, thermic Typic Palexeralfs

TYPICAL PEDON: Hillgate loam, on an east facing slope of 3 percent in rangeland at an elevation of 140 feet. (Colors are for dry soil unless otherwise stated.)

A1--0 to 3 inches; yellowish brown (10YR 5/4) loam; dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky, and slightly plastic; common very fine roots; common very fine tubular pores; few fine distinct light brownish gray (10YR 6/2) iron depletions; slightly acid (pH 6.2); abrupt smooth boundary.

A2--3 to 11 inches; yellowish brown (10YR 5/4) loam; dark yellowish brown (10YR 4/4) moist; strong medium angular blocky structure; hard, friable, slightly sticky, and slightly plastic; common very fine roots; common very fine and few fine tubular pores; common fine distinct light brownish gray (10YR 6/2) iron depletions moderately acid (pH 5.6); clear smooth boundary.

A3--11 to 19 inches; yellowish brown (10YR 5/4) loam; dark yellowish brown (10YR 4/4) moist; strong medium angular blocky structure; hard, friable, slightly sticky, and slightly plastic; few very fine roots; common very fine and few fine tubular pores;common fine faint very pale brown (10YR 7/3) iron depletions; moderately acid (pH 5.6); abrupt smooth boundary.

2Bt1--19 to 38 inches; yellowish brown (10YR 5/4) clay; dark yellowish brown (10YR 3/4) moist; strong coarse prismatic structure; extremely hard, firm, moderately sticky and moderately plastic; few very fine roots; common very fine and few fine tubular pores; many moderately thick clay films; slightly acid (pH 6.2); clear smooth boundary.

2Bt2--38 to 53 inches; yellowish brown (10YR 5/4) clay loam; dark yellowish brown (10YR 3/4) moist; strong coarse prismatic structure; extremely hard, firm, sticky, and plastic; few very fine roots; common very fine tubular pores; many moderately thick clay films; neutral (pH 7.2); clear smooth boundary.

2Bt3--53 to 63 inches; yellowish brown (10YR 5/4) clay loam;, dark yellowish brown (10YR 3/4); moderate medium subangular blocky structure; very hard, firm, sticky, and plastic; few very fine roots; common very fine tubular pores; many moderately thick clay films; slightly alkaline (pH 7.5); clear smooth boundary.

2Bt4--63 to 73 inches; yellowish brown (10YR 5/4) clay loam; dark yellowish brown (10YR 3/4) ; moderate medium subangular blocky structure; very hard, firm, sticky, and plastic; few very fine roots; common very fine tubular pores; many moderately thick clay films; slightly alkaline (pH 7.4).

TYPE LOCATION: Colusa County, California; about 4.5 miles west of Maxwell; 2,400 feet south and

2,500 feet east of the northwest corner of sec. 2, T. 16 N., R. 4 W., MDB&M; 39 degrees, 16 minutes, 10 seconds North Latitude and 121 degrees, 16 minutes, 20 seconds West Longitude, USGS Sites CA quadrangle.

RANGE IN CHARACTERISTICS: The mean annual soil temperature is 63 to 65 degrees F and the soil temperature is not below 47 at any time. The soil between the depths of 6 and 18 inches is dry in all parts from May 15 to October 31 and moist in some or all parts from November 1 to May 15. Weighted average clay content for the 19 to 39 inch textural control section ranges from 35 to 50 percent clay. The solum ranges from 60 to 75 inches thick.

The A horizon has dry color of 10YR 7/2, 6/4, 6/3, 6/2, 5/4, 5/3; 7.5YR 5/4, 4/4 and moist color of 10YR 5/3, 4/4, 4/3, 3/4, 3/3; 7.5YR 4/4, 3/4. Texture is very fine sandy loam, loam, silt loam or clay loam. Reaction is strongly to slightly acid.

The Bt horizon has dry color of 10YR 6/6, 6/3, 5/8, 5/6, 5/4, 5/3; 7.5YR 5/8, 5/6, 5/5, 5/4, 4/6 and moist color of 10YR 5/6, 5/4, 4/6, 4/4, 4/3, 3/4, 3/3; 7.5YR 5/4, 5/6, 4/6, 4/4, 4/3, 3/4. Texture is clay loam or clay. Reaction is slightly acid to moderately alkaline.

COMPETING SERIES: These are the Cometa, Corning, Hytop, Millsap, Orognen, San Ysidro and Yokayo series. Cometa has a solumn thickness of 24 to 40 inches and the Bt includes 5YR colors. The Corning series has Bt colors of 2.5YR or 5YR. The Hytop series has a paralithic contact at 20 to 40 inches. Millsap has a lithic contact at 20 to 40 inches. Orognen has 5YR Bt colors. Yokayo has a solumn thickness of 30 to 50 inches, mean annual air temperature of 57 degrees F. and precipitation of 32 to 44 inches.
Hillgate needs to be competed with San Ysidro during MLRA update. The soils are the same, but Hillgate is mapped on slopes of 0 to 50 percent. The San Ysidro is mapped on 0 to 9 percent slopes and may need to be combined with Hillgate on 0 to 9 percent slopes. Colusa County holds the Hillgate type location which was lab sampled. In Colusa the Hillgate is mapped on 0 to 9 percent slopes. The Hillgate on 9 to 50 percent slopes (in Eastern Santa Clara County) would then be a new series.

GEOGRAPHIC SETTING: Hillgate soils are on nearly level to moderately sloping old terraces at elevations of 15-2,000 feet. The soils formed in alluvium from mixed rock sources. The climate is semiarid to subhumid with hot dry summers and cool moist winters. Mean annual precipitation varies from 14 to 30 inches. Mean annual air temperature ranges from 58 to 65 degrees F. Average January temperature is about 44 degrees and the average July temperature is about 80 degrees F. Average frost free season is about 185 to 300 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Arbuckle, Corning, Kimball, Myers, Tehama, San Ysidro and Zamora soils. Arbuckle, Tehama and Zamora soils all have less than 35 percent clay in the argillic horizon. Kimball soils have a mollic epipedon. Myers soils are fine textured throughout.

DRAINAGE AND PERMEABILITY: Well to moderately well drained. negligable to very high runoff, very slow and slow permeability.

USE AND VEGETATION: Where cultivated, small grains, irrigated pasture, shallow rooted row crops and rice. Areas not cultivated, annual grasses and forbs with open stands of valley and blue oaks.

DISTRIBUTION AND EXTENT: West side of Sacramento Valley and Coast Range valleys, soils are of moderate extent. MLRA 15, 14 and into MLRA 17.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Tehama County, California, 1962.

REMARKS:

Major Diagnostic Horizons:

1. Ochric Epipedon - 0 to 19 inches; (A1, A2, A3) Ranges from 11 to 24 inches thick.
1.1 Chromas are 4 or Values are 6 or more.
1.2 Organic matter is 0.5 percent or less below 3 inches.

2. Argillic horizon - 19 to 73 inches; (2Bt1, 2Bt2, 2Bt3, 2Bt4)

2.1 Many moderately thick clay films.
2.2 Clay increase exceeds 1.2 times the A horizon.
2.3 PSA by Lincoln NSSL:

HORIZON	DEPTH (in.)	CLAY	SILT	SAND
A1	0-3	17.9	38.8	43.3
A2	3-11	19.5	37.3	43.2
A3	11-19	21.4	35.9	42.7
2Bt1	19-38	42.5	27.1	30.4
2Bt2	38-53	36.4	31.0	32.6
2Bt3	53-63	34.6	31.7	33.7
2Bt4	63-73	34.1	29.8	36.1

Other Diagnostic Horizons or Soil Characteristics:

1. Pale great group - Abrupt boundary at 19 inches has more than a 20 percent absolute increase in clay within a vertical distance of 3 inches.

2. Smectitic family - lab data indicates mineralogy is smectitic, superactive.

3. Temperature - Moisture (Xeric-thermic)
3.1 The 6 to 18 inch SMCS is dry in all parts from May 15 to October 31 and is moist in all parts from November 15 to May 1.
3.2 The Soil temperature is above 47 degrees F. for the entire year.
3.3 The MAST is 63 to 65 degrees F.

ADDITIONAL DATA: NSSL sample # S89CA-011-006 Pedon No. 89P-193 and pedons S89CA-103-005 (taxadjunct) and S89CA-103-006

National Cooperative Soil Survey
U.S.A.

LOCATION LIVERMORE CA

Established Series
Rev. PNL/WRR/SBS
8/98

LIVERMORE SERIES

The Livermore series consists of very deep, somewhat excessively drained soils that formed in very gravelly alluvium derived from sedimentary and metasedimentary rocks. Livermore soils are on low nearly level terraces and gently sloping alluvial fans. Slopes are 0 to 9 percent. The mean annual precipitation is about 17 inches and the mean annual temperature air temperature is about 60 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive, thermic Typic Haploxerolls

TYPICAL PEDON: Livermore very gravelly coarse sandy loam.
(Colors given are for dry conditions unless otherwise stated.)

Ap1--0 to 4 inches; brown (10YR 5/3) very gravelly coarse sandy loam, dark brown (10YR 3/3) moist; single grained; loose, friable; very porous; slightly acid (pH 6.4); diffuse smooth boundary. (3 to 6 inches thick).

Ap2--4 to 12 inches; dark grayish brown (10YR 4/2) very gravelly coarse sandy loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, slightly sticky; porous, many fine and very fine roots; many fine and very fine pores; few cobbles; neutral (pH 6.7); diffuse smooth boundary. (4 to 8 inches thick).

A--12 to 21 inches; dark grayish brown (10YR 4/2) very gravelly coarse sandy loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, slightly sticky; abundant fine and very fine roots and pores; few thin discontinuous clay films in pores; few cobbles and stones; neutral (pH 6.8); diffuse smooth boundary. (8 to 12 inches thick).

Bw1--21 to 28 inches; brown (10YR 5/3) very gravelly coarse sandy loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable, slightly sticky; few fine roots; many fine and very fine pores; few thin clay films in pores; few cobbles and stones; neutral (pH 7.0); diffuse, smooth boundary. (5 to 9 inches thick).

Bw2--28 to 34 inches; brown (10YR 5/3) very gravelly coarse sandy loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky; few fine roots; many fine and very fine pores; very thin nearly continuous clay films in pores; few cobbles and stones; neutral (pH 7.1); diffuse smooth boundary. (4 to 10 inches thick).

C--34 to 60 inches; brown (10YR 5/3) very gravelly coarse sand, dark brown (10YR 4/3) moist; massive; slightly hard, friable; few fine roots; many fine and very fine pores; a small amount of colloid in bridges between sand grains and as stains on sand and gravels; neutral (pH 7.1).

TYPE LOCATION: Alameda County, California; about 3 miles southeast of Livermore at a point 2,000 feet east and 2,600 feet north of the southwest corner of section 23, T. 3 S., R. 2 E., MDB&M. 37 degrees North latitude, 39 minutes, 25 seconds, 121 degrees West longitude, 43 minutes,33 seconds.

RANGE IN CHARACTERISTICS:

The Ap and A horizons have dry colors of 10YR 5/3, 5/2, 4/3, 4/2 and moist colors or 10YR 3/3, 3/2, 2/2.

Texture of surface layer ranges from very gravelly coarse sandy loam, very gravelly sandy loam, very gravelly loam, through gravelly loam. Reaction is slightly acid to neutral.

The B horizons have dry colors of 10YR 6/4, 5/4, 5/3; 7.5YR 6/4, 5/4, 4/4 and moist color of 10YR 4/6, 4/4, 4/3, 3/4, 3/3; 7.5YR 4/6, 4/4, 3/4. Texture ranges from very gravelly coarse sandy loam to very gravelly clay loam, inclusive. Reaction is slightly acid to slightly alkaline.

The C horizon has dry colors of 10YR 6/3, 5/4 and moist colors of 10YR 4/4, 4/3, 3/4. Texture ranges from very gravelly loamy coarse sand to very gravelly loam, inclusive. Reactionis slightly acid to slightly alkaline.

COMPETING SERIES: There are no other series in this family.

GEOGRAPHIC SETTING: Livermore soils developed in very gravelly alluvium from sedimentary and metasedimentary rock. The soils occur on low nearly level terraces and alluvial fans. Slopes range from 0 to 9 percent. Livermore soils occur at elevations of 100 to 1600 feet in a dry subhumid, mesothermal climate having a mean annual rainfall of 14 to 22 inches with hot, dry summers and cool, moist winter; an average January temperature of 48 degrees F.; an average July temperature of 71 degrees F.; a mean annual temperature of about 59 degrees F.; and frost free season is 185 to 250 days.

GEOGRAPHICALLY ASSOCIATED SOILS: Livermore soils are geographically associated with Pleasanton, Yolo, Cortina and Positas series and they are similar to Pleasanton, Cortina, and Millrace soils. Pleasanton soils are gravelly and have moderately fine textured B horizons. Cortina soils are very gravelly coarse textured alluvial soils, lacking B horizons. Millrace soils, developed in very gravelly coarse textured alluvium from basalt and andesite, have coarse textured sola but are otherwise similar.

DRAINAGE AND PERMEABILITY: Somewhat excessively drained. Runoff is negligable to low. Permeability is moderately rapid.

USE AND VEGETATION: Mainly cultivated, primarily for vineyards and orchard; native vegetation annual grasses, forbs and scattered oak.

DISTRIBUTION AND EXTENT: Interior and coastal valleys in or adjacent to the Coast Ranges in central California. The Livermore series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Livermore Area, California, 1910. (Name from area.)

ADDITIONAL DATA: NSSL pedons: S59CA-001-003 (series type location) and S59CA-001-004 (taxadjunct).

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon: Zone from the surface to a depth of 12 inches. The organic carbon percent drops to 0.50 percent and less below 12 inches.

CEC class: The CEC/clay is above .80 throughout the pedon.

Cambic horizon: Zone from 21 to 34 inches.

National Cooperative Soil Survey
U.S.A.

LOCATION LOS GATOS CA

Established Series
Rev: WCL/RCH/GMK/ET
02/2003

LOS GATOS SERIES

The Los Gatos series is a member of the fine-loamy, mixed, mesic family of Typic Argixerolls. Typically, Los Gatos soils have brown, light clay loam, granular, slightly acid A1 horizons, brown and yellowish red, slightly and medium acid clay loam and gravelly clay loam Bt horizons over sandstone bedrock at a depth of 36 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, active, mesic Typic Argixerolls

TYPICAL PEDON: Los Gatos clay loam - annual grass and brush. (Colors are for dry soil unless otherwise noted).

A1--0 to 6 inches; brown (7.5YR 5/4) light clay loam, dark brown (7.5YR 3/3) moist; strong medium granular structure; hard, friable, slightly sticky, slightly plastic; common very fine roots; many fine and very fine interstitial, few medium tubular pores; many worm casts and rodent burrows; slightly acid (pH 6.5); clear smooth boundary. (4 to 6 inches thick)

A2--6 to 15 inches; brown (7.5YR 5/4) light clay loam, dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky, slightly plastic; few very fine roots; many fine and very fine interstitial and tubular and few medium tubular pores; common worm casts and rodent burrows; slightly acid (pH 6.3); clear smooth boundary. (5 to 11 inches thick)

BAt--15 to 25 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky, slightly plastic; few very fine roots; many fine and very fine interstitial and tubular and few medium tubular pores; many thin clay films in pores and on peds; slightly acid (pH 6.2); abrupt wavy boundary. (7 to 12 inches thick)

Bt--25 to 36 inches; yellowish red (5YR 5/6) gravelly clay loam, reddish brown (5YR 4/5) moist; weak medium subangular blocky structure; very hard, firm, sticky, plastic; few medium and fine roots; many very fine interstitial and tubular and few fine and medium tubular pores; thin continuous clay films in pores and on peds; about 15 percent medium and fine shale fragments; moderately acid (pH 5.9); abrupt wavy boundary. (8 to 12 inches thick)

R--36 to 46 inches; very pale brown (10YR 7/4) sandstone; reddish brown (5YR 4/4) clay films on rock faces in fractures; rock shattered in upper few inches, becoming nearly massive within depth of 10 inches.

TYPE LOCATION: Santa Clara County, California; road cut on Monte Bello Road, 1 1/2 miles southeast of Black Mountain on the crest of Monte Bello Ridge; southern part of the SW 1/4 SE 1/4 of sec. 19, T. 7 S., R. 2 W.

RANGE IN CHARACTERISTICS: Depth to sandstone is 24 to 40 inches. The soil between depths of about 5 and 12 inches usually is dry from sometime in May until sometime in October. It usually is moist the rest of the year. The mean annual soil temperature is 54 to 58 degrees F and the soil temperature is very briefly, if ever, below 47 degrees F. Typically, there are few rock fragments in the upper horizons and less than 35

percent in the lower horizons. The solum ranges from neutral to moderately acid. Typically, the A horizon is slightly acid and the B horizon is moderately acid.

The A horizon is mostly brown, dark brown, grayish brown, dark grayish brown, or yellowish brown in 10YR or 7.5YR hue and some pedons are reddish brown in 5YR hue. Moist value and moist chroma are 2 or 3. This horizon is fine sandy loam, loam or clay loam. It has granular or subangular blocky structure or has crumb structure in the upper part. The lower boundary of the A horizon is gradual or an A3 horizon or a BA horizon is present. The organic matter ranges from 2 to 6 percent.

The Bt horizon is pinkish gray, light reddish brown, reddish yellow, brown, strong brown, or light brown in 7.5YR hue or reddish brown or yellowish red in 5YR hue. It is heavy loam, sandy clay loam, or clay loam with less than 35 percent clay. Absolute clay increases from A horizon to B2t horizon ranges from about 5 to about 9 percent. The Bt horizon has weak or moderate subangular blocky structure. In some pedons, it rests on bedrock. In other pedons, there is a brownish yellow or yellowish brown B3 horizon or a C horizon above the bedrock.

COMPETING SERIES: These are the Colma, Dragoon, Gilroy, Glenrose, Ladd, Lobitos, Los Osos, Mehlhorn, Sobrante, and Sweeney series. Colma, Lobitos, and Sweeney soils lack brown and reddish color of 7.5YR and 5YR hue in the Bt horizon. Colma, Dragoon, Glenrose, Ladd, and Sweeney soils lack a lithic contact at depths of less than 40 inches. Gilroy soils have a mean soil temperature of 59 to 64 degrees F. Los Osos soils have more than 35 percent clay in the argillic horizon. Mehlhorn soils have a mean soil temperature of less than 54 degrees F. Sobrante soils lack a mollic epipedon.

GEOGRAPHIC SETTING: Los Gatos soils are on steep to very steep mountainous areas at elevations of 200 to 4,000 feet. They formed in residuum from sandstone, shale and metasedimentary rock. The climate is subhumid mesothermal with warm dry summers and cool moist winters. Mean annual precipitation is 20 to 70 inches. The mean annual temperature is about 52 to 56 degrees F with an average January temperature of about 47 degrees F and an average July temperature of about 68 degrees F. Freeze-free season is about 200 to 330 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Gamboa, Godde, Henneke, Maymen, Millsholm, Plaskett, and Sur soils. All of these except the Henneke soils lack an argillic horizon. Gamboa, Henneke, Plaskett, and Sur soils have more than 35 percent rock fragments in the texture control section. Godde soils ahve bedrock at depths of less than 20 inches. Maymen and Millsholm soils have ochric epipedons.

DRAINAGE AND PERMEABILITY: Well-drained; rapid to very rapid runoff; moderate permeability.

USE AND VEGETATION: Most areas are used for watershed or wildlife protection. Some areas are used for range and a few of the lesser sloping areas have been planted to orchards and vineyards. Brush is the principal vegetation with some areas of hardwoods and grass.

DISTRIBUTION AND EXTENT: Coast ranges of northern and central California. The soils are extensive.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Santa Clara County (Santa Clara Area), California, 1946.

REMARKS: The soils formerly were classified as (minimal) Brunizems. Some soils classified as Los Gatos in the past are thermic and are now excluded from the series.

The activity class was added to the classification in February of 2003. Competing series were not checked at that time. - ET

National Cooperative Soil Survey
U.S.A.

LOCATION LOS OSOS CA

Established Series
Rev. DJE/LCL/RWK/AW
10/2001

LOS OSOS SERIES

The Los Osos series consists of moderately deep, well drained soils that formed in material weathered from sandstone and shale. Los Osos soils are on uplands and have slopes of 5 to 75 percent. The mean annual precipitation is about 25 inches and the mean annual air temperature is about 60 degrees F.

TAXONOMIC CLASS: Fine, smectitic, thermic Typic Argixerolls

TYPICAL PEDON: Los Osos loam - grazed range grass. (Colors are for dry soil unless otherwise noted.)

A--0 to 14 inches; brown (10YR 5/3) loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; moderately acid (pH 6.0); clear smooth boundary. (10 to 16 inches thick)

Btss1--14 to 24 inches; yellowish brown (10YR 5/4) clay, dark yellowish brown (10YR 4/4) moist; weak medium prismatic structure; very hard, very firm, sticky and plastic; few very fine roots; few very fine tubular pores; many moderately thick clay films on faces of peds and lining pores; few slickensides; moderately acid (pH 6.0); gradual wavy boundary. (6 to 12 inches thick)

Btss2--24 to 32 inches; light yellowish brown (10YR 6/4) clay loam, dark yellowish brown (10YR 4/4) moist; massive; very hard, very firm, sticky and plastic; few very fine roots, common very fine tubular pores; many moderately thick clay films lining pores; few slickensides; few manganese concretions; slightly acid (pH 6.5); gradual wavy boundary. (4 to 8 inches thick)

C--32 to 39 inches; pale yellow (2.5Y 7/4) sandy loam, light olive brown (2.5Y 5/4) moist; massive; hard, friable, nonsticky and nonplastic; few manganese stains; neutral (pH 7.0); gradual wavy boundary. (0 to 7 inches thick)

Cr--39 to 43 inches; yellowish brown (10YR 5/4) sandstone, brown (10YR 4/3) moist; many moderately thick clay films and few manganese stains coat fracture faces that are less than 10cm apart and less than 1mm in width.

TYPE LOCATION: San Luis Obispo County, California; on the Cal-Poly University campus, approximately 2,000 feet west and 1,500 feet south of the northeast corner of section 23, T. 30 S., R. 12 E., MDB&M; Latitude 35 degrees, 18 minutes, 18 seconds north and Longitude 120 degrees, 39 minutes, 23 seconds west; San Luis Obispo Quadrangle.

RANGE IN CHARACTERISTICS: Depth to a paralithic contact of sandstone or shale is 20 to 40 inches. The mean annual soil temperature at a depth of 20 inches is 60 degrees to 67 degrees F. and the coldest temperature is warmer than 41 degrees F. All of the soil between depths of about 4 and 12 inches is continuously dry after some time in May until some time in October. Some or all of the soil between these depths is moist all the rest of the time. There is 6 to 15 percent clay increase (absolute) from the A horizon to the B2t horizon and the soil lacks an abrupt A/B horizon boundary.

The A1 horizon is grayish brown, dark grayish brown, brown, or dark brown in 10YR or 7.5YR hue and has moist value of 3 or 2. It is loam, silt loam, clay loam, or silty clay loam and it has weak to strong structure. This horizon has 2 to 4 percent organic matter. It is medium acid to neutral.

The B2t horizon is brown, dark brown, grayish brown, dark grayish brown, light yellowish brown, yellowish brown, dark yellowish brown, brownish yellow, pale brown, light olive brown, light brown, or light brownish gray in 10YR, 7.5YR, or 2.5Y hue. In most pedons it has one unit higher value and one or two units brighter chroma than the A horizon. This horizon is heavy clay loam, clay, or silty clay and averages 35 to 50 percent clay. It has weak to strong angular or subangular blocky structure or is prismatic in the upper part and is massive in the lower part in some pedons. The B2t horizon is moderately acid to neutral. Some pedons have a C horizon consisting of a weathering front. The C horizon is sandy loam, loam, or clay loam.

COMPETING SERIES: These are the Fagan, Gabino, Gridley, Marcum, Sespe, Sween, and Todos series. Fagan and Todos are underlain by soft sandstone or shale at depths of 40 to 60 inches. Gabino soils have 5YR hue in the argillic horizon and have 10 to 30 percent pebbles and cobbles. Gridley soils are moderately well drained and are neutral to moderately alkaline. Marcum soils have paralithic horizons at 40 to 80 inches and are neutral to moderately alkaline. Sespe soils have hue of 5YR or 2.5YR in the argillic horizon. Sween soils have 10 to 15 percent (absolute) increase in clay from the A horizon to the B horizon, and have a lithic contact at a depth of 20 to 40 inches.

GEOGRAPHIC SETTING: Los Osos soils are at elevations of 100 to 3,500 feet. They formed in material weathered from firm to hard sandstone and shale. Slopes are 5 to 75 percent. The climate is dry subhumid mesothermal with warm, dry, somewhat foggy summers and cool, moist winters. Mean annual precipitation is 14 to 40 inches. Average annual temperature is 56 degrees to 63 degrees F., average January temperature is about 51 degrees F., and average July temperature is about 65 degrees F. The average freeze-free season is 200 to 320 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Altamont, Arnold, Diablo, Gaviota, Millsap, San Benito, Santa Lucia, and Vallecitos soils. Altamont and Diablo soils are of clay texture throughout. Gaviota, Millsap, and Vallecitos soils have a lithic contact at a depth of less than 20 inches. San Benito and Santa Lucia soils lack an argillic horizon.

DRAINAGE AND PERMEABILITY: Well drained; very high runoff; slow permeability.

USE AND VEGETATION: Used mostly for range, limited areas are cropped to grain and sudan grass pasture. Vegetation is mostly annual grasses and forbs with some perennial grasses, coastal sagebrush, and live oak.

DISTRIBUTION AND EXTENT: Central part of the Coast Range in California. The soils are of moderate extent.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: San Luis Obispo County (San Luis Obispo Area), California, 1928.

National Cooperative Soil Survey
U.S.A.

LOCATION PLEASANTON CA

Established Series
Rev. LEW/GMK
01/2003

PLEASANTON SERIES

The Pleasanton series is a member of the fine-loamy, mixed, thermic family of Mollic Haploxeralfs. Typically, Pleasanton soils have grayish brown, slightly acid or neutral, gravelly fine sandy loam A horizons; brown, neutral, gravelly sandy clay loam B2t horizons; and gravelly fine sandy loam C horizons.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, thermic Mollic Haploxeralfs

TYPICAL PEDON: Pleasanton gravelly fine sandy loam - cultivated. (Colors are for dry soil unless otherwise noted.)

Ap--0 to 9 inches; grayish brown (10YR 5/2) gravelly fine sandy loam, very dark grayish brown (10YR 3/2) moist; massive; hard, friable, slightly sticky, slightly plastic; many very fine, common fine and medium roots; common very fine and fine interstitial pores; slightly acid (pH 6.3); abrupt smooth boundary. (5 to 10 inches thick)

A1--9 to 21 inches; grayish brown (10YR 5/2) gravelly fine sandy loam, very dark grayish brown (10YR 3/2) moist; massive; hard, friable, slightly sticky, slightly plastic; many very fine, common fine and medium roots; common very fine and fine interstitial pores; neutral (pH 6.8); clear smooth boundary. (10 to 14 inches thick)

B2t--21 to 48 inches; brown (10YR 4/3) gravelly sandy clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; very hard, friable, sticky, plastic; common very fine and fine roots; many very fine and fine, few medium tubular pores; common moderately thick clay films on peds and in pores; neutral (pH 7.3); gradual wavy boundary. (12 to 32 inches thick)

B3--48 to 64 inches; brown (10YR 4/3) gravelly loam; dark brown (10YR 3/3) moist; weak medium subangular blocky structure; very hard, friable, sticky, plastic; few very fine roots; many very fine, common fine pores; few thick and few thin clay films on peds and in pores; neutral (pH 7.3); gradual wavy boundary. (8 to 20 inches thick)

C1--64 to 72 inches; yellowish brown (10YR 5/4) gravelly fine sandy loam near gravelly loam, dark yellowish brown (10YR 4/4) moist; weak blocky structure; hard, friable, sticky, slightly plastic; many very fine, common fine, few medium pores; few thin clay films on peds and in pores; slightly alkaline (pH 7.4).

TYPE LOCATION: Alameda County, California; about 5 miles SE of the center of Livermore; SE1/4 NE1/4 NE1/4 sec. 24, T.3S., R.2E. Altamont Quad. lat.37 degrees N. 39 minutes, 45 seconds, long 121 W. 41 minutes, 48 seconds.

RANGE IN CHARACTERISTICS: Solum thickness to the bottom of the B horizon is 60 inches. The soils become moist in November or early December and remain moist until May. Mean annual temperature is about 59 degrees to 64 degrees F.

The A horizon is dark grayish brown, grayish brown, or brown in 10YR or 7.5YR hue. It is moderately acid to neutral (pH 6.0-7.0).

The B horizon is brown to light yellowish brown in 10YR or 7.5YR hue. It is loam, sandy clay loam or clay loam and is gravelly or cobbly in some pedons. It ranges from slightly acid to slightly alkaline.

The C horizon is gravelly fine sandy loam or loam. It is neutral or mildly alkaline and is slightly calcareous in some pedons.

COMPETING SERIES: These are the Arbuckle, Burchell, Coarsegold, Jacinto, Modesto, Perkins, Ramona, Rescue, Sobrante, Trimmer, Whitney and Zamora series. Arbuckle and Ramona soils have A1 horizons with either moist value of more than 3.5 or organic carbon of less than 0.7 percent throughout the upper 4 inches. Burchell and Modesto soils are somewhat poorly drained and are mottled in the lower horizons. Coarsegold, Perkins and Rescue soils have hue of 5YR or 2.5YR in the Bt horizon. Jacinto soils have hue of 2.5Y. Sobrante soils have a lithic contact at depths of less than 40 inches. Trimmer and Whitney soils have a paralithic contact at depths of less than 40 inches. Zamora soils are fine-silty.

GEOGRAPHIC SETTING: The Pleasanton soils are on nearly level to gently sloping alluvial fans and terraces at elevations of less than 2,400 feet. They are in a subhumid, mesothermal climate with hot, dry summers and cool, moist winters. Mean annual precipitation ranges from 12 to 39 inches. Average January temperature is 48 degrees F.; average July temperature is about 73 degrees F.; mean annual temperature is about 59 degrees F.; and the freeze-free season is about 220 to 300 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Arbuckle soils and the Corning, Livermore, Newville, Positas, and Sorrento soils. Corning, Newville and Positas soils have clay argillic horizons. Livermore soils are very gravelly throughout. Sorrento soils lack an argillic horizon.

DRAINAGE AND PERMEABILITY: Well-drained; slow to medium runoff; moderately slow permeability.

USE AND VEGETATION: The soils are used for dry farmed grain and grain hay, wine grapes, deciduous fruits, nuts, roses and row crops. Vegetation is annual grasses and forbs with scattered oaks.

DISTRIBUTION AND EXTENT: The soils occur in the valleys of the Coast Range, Central Valley, and intermountain valleys of southern California. They are moderately extensive.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Livermore Area, California, 1910.

REMARKS: The soils formerly were classified as (medial) Noncalcic Brown soils.

The activity class was added to the classification in January of 2003. Competing series were not checked at that time. - ET

ADDITIONAL DATA: Three pedons sampled in Alameda County, CA: The type location S60CA-001-001 and two taxadjunct pedons, S78CA-001-000 (mesic) and S79CA-001-000 (isofrigid?).

OSED scanned by SSQA. Last revised by state on 10/74.

National Cooperative Soil Survey
U.S.A.

LOCATION POSITAS CA

Established Series
Rev. RCH/GMK/RWK/SBS
8/98

POSITAS SERIES

The Positas series consists ofdeep and very deep, moderately well drained soils that formed in alluvial material from mixed rock sources. Positas soils are on stream terraces and have slopes of 2 to 75 percent. The mean annual precipitation is about 20 inches and the mean annual air temperature is about 60 degrees F.

TAXONOMIC CLASS: Fine, smectitic, thermic Mollic Palexeralfs

TYPICAL PEDON: Positas gravelly loam, annual grass pasture. (Colors are for dry soil unless otherwise noted.)

Ap--0 to 8 inches; brown (10YR 5/3) gravelly loam, dark brown (7.5YR 3/3) moist; massive with weak horizontal partings in the top few inches; hard, friable, nonsticky and nonplastic; many very fine roots; many very fine pores; medium acid (pH 6.0); abrupt smooth boundary. (6 to 20 inches thick)

A--8 to 11 inches; similar to above in all respects except color values are nearly 1/2 chip higher; abrupt smooth boundary. (2 to 6 inches thick)

Bt1--11 to 20 inches; reddish brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; strong coarse prismatic structure; extremely hard, extremely firm, sticky and very plastic; few very fine roots along structure faces; few very fine tubular pores; thick continuous dark reddish gray (5YR 4/2) clay films on faces of peds and nearly filling pores; common slickensides; slightly acid (pH 6.5); gradual smooth boundary. (8 to 12 inches thick)

Bt2--20 to 29 inches; reddish brown (5YR 4/4) dry and moist, clay; strong coarse prismatic structure; extremely hard, extremely firm, sticky and very plastic; few very fine roots along structure faces, few very fine tubular pores; thick continuous clay films on faces of peds and nearly filling pores; common slickensides; moderately alkaline (pH 8.0); abrupt smooth boundary. (8 to 12 inches thick)

Bt3--29 to 39 inches; brown (7.5YR 5/5) clay loam, brown (7.5YR 4/4) and yellowish red (5YR 4/6) moist, strong medium angular blocky structure; very hard, firm, sticky and plastic; few very fine roots; few very fine tubular pores; moderately thick continuous yellowish red (5YR 5/5) clay films on faces of peds and lining pores; common fine (1 to 2 mm) black stains on faces of peds; very weakly calcareous moderately alkaline (pH 8.0); gradual smooth boundary. (8 to 14 inches thick)

Bt4--39 to 54 inches; light yellowish brown (10YR 6/5) clay loam, brown (10YR 5/3) and yellowish red (5YR 4/6) moist; strong medium angular blocky structure; very hard, firm, sticky and slightly plastic; few very fine roots; few very fine tubular pores; moderately thick continuous yellowish red (5YR 4/6) clay films on peds and lining pores; common fine black stains on faces of peds; very weakly calcareous; moderately alkaline (pH 8.0); gradual smooth boundary. (10 to 18 inches thick)

2C--54 to 60 inches; light yellowish brown (10YR 6/5) very gravelly sandy clay loam, yellowish brown (10YR 5/4) moist; few yellowish red (5YR 4/6) dry and moist coatings; massive; slightly hard, friable, nonsticky and nonplastic; moderately alkaline (pH 8.0).

TYPE LOCATION: Alameda County, California; approximately 5 miles southeast of Livermore; 216 feet east of Greenville Road and 168 feet south of the NE corner of sec. 25, T.3S., R.2E.

RANGE IN CHARACTERISTICS: Mean annual soil temperature at a depth of 20 inches is 60 degrees to 68 degrees F. The soil between depths of 4 and 12 inches becomes dry in late May to mid June and remains continuously dry until late October or mid November. It is moist all the rest of the time. Solum thickness is 42 to 70 inches.

The Ap horizon is brown to grayish brown in 10YR or 7.5YR hue. Moist colors in the upper 4 to 8 inches of the Ap horizon are dark brown to very dark grayish brown in 10YR or 7.5YR hue and have 1.5 to 2.5 percent organic matter. In the lower part of the horizon, moist color is brown, dark brown, and very dark grayish brown with .75 to 1.5 percent organic matter. The upper part or all parts of the Ap horizon are massive and hard or very hard. This horizon is sandy loam, fine sandy loam, silt loam, loam or clay loam and is modified by up to 35 percent pebbles, gravel or cobblestones. Reaction is strongly acid to neutral.

The A horizon is indistinct in some pedons, but the lower part of the A horizon contains apparent degraded remnants of the Bt1 horizon with bleached mineral grains on faces of peds.

The Bt horizons are reddish brown, yellowish red, brown, strong brown, dark yellowish brown or yellowish brown in hue of 5YR, 7.5YR or 10YR. The upper part of the horizon has 5YR hue and value of 3 or less. 10YR hue occurs only in the lower portion or is absent in some pedons. Reaction is strongly acid to moderately alkaline becoming more alkaline as depth increases. Texture is clay, silty clay or gravelly clay in some pedons. The upper boundary of the Bt horizon is abrupt and the upper part of the Bt horizon has 20 to 35 percent more total clay than the overlying A horizon. This horizon has strong prismatic, subangular or angular blocky structure and is very hard or extremely hard.

The C horizon ranges from well sorted calcareous silt loam to poorly sorted gravelly and very gravelly sandy loam or sandy clay loam. Colors are yellowish red, reddish brown, dark reddish brown, light yellowish brown, brownish yellow, very pale brown or light olive brown. Reaction is mainly moderately alkaline to neutral, and in some pedons medium acid in the lower part.

COMPETING SERIES: These are the Kimball, Milpitas, Newville, Nicolaus and Tierra series. Kimball and Newville soils lack an A2 horizon. Also, Kimball soils are granular in the upper 2 to 3 inches. Milpitas and Nicolaus soils have a chroma of 4 or more in the upper part of the B2t horizon. Also, Nicolaus soils are weakly cemented below depth of 40 inches. Tierra soils have hue of 10YR and a chroma of 2 in the upper part of the B2t horizon.

GEOGRAPHIC SETTING: Positas soils are on stream terraces and terrace side slopes at elevations of 200 to 1,600 feet. Slopes are 2 to 75 percent. The soils formed in alluvium of mixed origin. The climate is dry subhumid, mesothermal with hot, dry summers and cool, moist winters. Mean annual rainfall is 12 to 45 inches. The average January temperature is 48 degrees F., average July temperature is 61 degrees F., and the mean annual temperature is about 58 degrees to 62 degrees F. The average frost-free season is 185 to 300 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Altamont, Linne, Pleasanton, and Rincon soils. Altamont soils are fine textured throughout and have slickensides. Linne soils lack B2t horizons. Pleasanton soils have less than 35 percent clay in the B2t horizons. Rincon soils have gradual AB horizon boundaries with less than 15 percent clay increase from A horizon to B2t horizon.

DRAINAGE AND PERMEABILITY: Moderately well drained; medium to very high runoff; slow and very slow permeability.

USE AND VEGETATION: Primary use is range. Some soils are used for dryland grain and vineyards. Vegetation is annual grasses, forbs, and scattered oaks.

DISTRIBUTION AND EXTENT: Stream terraces along the Coast Ranges in central and northern California and central foothills of the Sierra Nevada. The soils are moderately extensive.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: San Joaquin County (Tracy Area), California, 1938.

REMARKS: The competing Nicolaus (T) series has never been correlated in California and is under consideration to be dropped.

ADDITIONAL DATA: Pedons sampled in Alameda Co., CA; S59CA-001-001 (type location), S59CA-001-002.

OSED scanned by SSQA.

National Cooperative Soil Survey
U.S.A.

LOCATION RINCON CA

Established Series
Rev. RE/LCL/RWK
02/97

RINCON SERIES

The Rincon series consists of deep, well drained soils that formed in alluvium from sedimentary rocks. Rincon soils are on old alluvial fans and both stream and marine terraces, and have slopes of O to 30 percent. The mean annual precipitation is about 16 inches and the mean annual air temperature is about 60 degrees F.

TAXONOMIC CLASS: Fine, smectitic, thermic Mollic Haploxeralfs

TYPICAL PEDON: Rincon silty clay loam, dry farmed grain. (Colors are for dry soil unless otherwise noted.)

Ap--O to 4 inches; dark gray (lOYR 4/1) silty clay loam, very dark gray (lOYR 3/1) moist; medium size clods; hard, firm, sticky and plastic; many very fine and few medium roots; common very fine tubular pores; slightly acid (pH 6.5); clear wavy boundary. (4 to 10 inches thick)

A12--4 to 16 inches; dark gray (lOYR 4/1) silty clay loam, very dark gray (lOYR 3/1) moist; massive; very hard, firm, sticky and plastic; many very fine and few medium roots; common very fine, few fine and very few medium tubular pores; slightly acid (pH 6.5); gradual wavy boundary. (10 to 13 inches thick)

B21t--16 to 25 inches; dark grayish brown (lOYR 4/2) sandy clay, very dark grayish brown (lOYR 3/2) moist; weak coarse prismatic structure and strong moderate angular blocky; extremely hard, very firm, sticky and very plastic; common very fine roots; common very fine and few fine and medium tubular pores; many thin clay films on faces of peds and common moderately thick clay films lining pores; neutral (pH 7.0); gradual smooth boundary. (9 to 13 inches thick)

B22t--25 to 31 inches; dark grayish brown (lOYR 4/2) sandy clay, very dark grayish brown (lOYR 3/2) moist- coarse splotches of brown (lOYR 5/3), dark brown (lOYR 4/3) moist; moderate medium angular blocky structure; very hard, very firm, sticky and plastic; few very fine roots; common very fine and few fine and medium tubular pores; common thin clay films on faces of peds and lining pores; slightly effervescent, lime segregated in filaments; moderately alkaline (pH 7.9); gradual smooth boundary. (6 to 13 inches thick)

B3tca--31 to 40 inches; brown (lOYR 5/3) sandy clay loam, dark brown (lOYR 4/3) moist; weak medium angular blocky structure; very hard, firm, sticky and plastic; few very fine roots- very few fine and very fine tubular pores; few thin clay films on faces of peds and lining pores; strongly effervescent, lime segregated into soft masses and filaments; moderately alkaline (pH 8.0); gradual irregular boundary. (7 to 15 inches thick)

Cca--40 to 60 inches; yellowish brown (lOYR 5/4) stratified sandy clay loam and sandy loam, dark yellowish brown (lOYR 4/4) moist; massive; hard, firm, sticky and plastic; few very fine tubular pores; strongly effervescent, lime disseminated and segregated into filaments; moderately alkaline (pH 8.0).

TYPE LOCATION: Ventura County, California; 7,400 feet south and 4,200 feet east of the SW corner sec. 25, T.3N., R.21W., SBBM.

RANGE IN CHARACTERISTICS: The solum is 36 to 64 inches thick. Most pedons have essentially no gravel above the C horizon. The soils usually are moist in some or all parts between depths of 4 and 12 inches from November or early December until May. They usually are continuously dry the rest of the time. The mean annual soil temperature is between 59 degrees and 64 degrees F., and the soil temperature is continuously above 47 degrees F.

The A horizon is very dark gray, dark gray, gray, very dark grayish brown, dark grayish brown, or grayish brown; hue is mostly lOYR, in some pedons, it is 2.5Y. This horizon is loam, clay loam, or silty clay loam, and is usually clay loam. Usually the surface or all the Al horizon is hard and massive. If not massive, structure is destroyed after several years of cultivation. This horizon is hard or very hard. It contains about 2 percent organic matter. The A horizon is usually slightly acid to neutral. Some pedons may be medium acid or moderately alkaline in part because of cultural measures.

The B2t horizon is dark gray, dark grayish brown, grayish brown, light brownish gray, brown, yellowish brown, pale brown, light yellowish brown or light olive brown with the higher values and brighter chromas in the lower part in the interior of the peds. It is heavy clay loam, sandy clay or clay and has about 35 to 45 percent clay. The B2t horizon has about 6 to 10 percent more clay than the A horizon. It has weak prismatic to strong angular blocky structure. This horizon is neutral to moderately alkaline and alkalinity generally increases in the lower portion. Segregated lime is present in the lower part of the Bt horizon and upper C horizon. The boundary between the A horizon and B2t horizon is gradual or a transitional A3 or Bl horizon is present.

The C horizon is light gray, light brownish gray, pale brown, light yellowish brown or yellowish brown. It is usually clay loam, but stratification with other textures is present in some pedons. This horizon is mildly or moderately alkaline.

COMPETING SERIES: These are the Azule series in this family and the Contra Costa, Danville, Milpitas Perkins, Pleasanton, Tierra, Trabuco and Zamora series in other families. Azule soils have clear A-B horizon boundaries with about 10 to 15 percent clay increase from A to B2 horizon. Contra Costa soils have a lithic contact at a depth of less than 40 inches. Danville 80il8 have mollic epipedons. Milpitas and Tierra 80il8 have abrupt A-B horizon boundaries with more than 15 percent clay increase. Perkins soils have reddish B2t horizons in hue of 7.5YR to 2.5YR. Pleasanton soils have less than 35 percent clay in the B2t horizon. Trabuco soils have hue of 2.5YR or 5YR in the B2t horizon. Zamora soils8 are silty and have less than 35 percent clay in the B2t horizon.

GEOGRAPHIC SETTING: Rincon soils are on older alluvial fans and both stream and marine terraces at elevations of 20 to 2,000 feet. Gradient is 0 to 30 percent. The soils formed in alluvium from sedimentary rocks. The climate is subhumid, mesothermal with warm, dry summers and cool, moist winters. The mean annual precipitation is about 12 to 20 inches. Average January temperature is about 45 degrees to 52 degrees F., average July temperature is about 68 degrees to 75 degrees F., mean annual temperature is about 59 degrees to 61 degrees F. The freeze-free season averages 200 to 300 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Altamont, Antioch, Azule, Cropley, Docas, Lockwood, and Sorrento soils. Altamont are hilly clay soils with slickensides. Antioch soils have natric horizons. Cropley soils are on fans and lack argillic horizons. Docas and Sorrento soils lack argillic horizons. Lockwood soils have mollic epipedons and have less than 35 percent clay in the argillic horizon.

DRAINAGE AND PERMEABILITY: Well drained; slow to rapid runoff; slow permeability.

USE AND VEGETATION: Used for irrigated citrus, deciduous fruits, row crops, and alfalfa. Some dry farming for grain and pasture. Natural vegetation is annual grasses and forbs.

DISTRIBUTION AND EXTENT: The soils are in the intermountain valleys of the Coast Range and along the west side of the lower Sacramento and Upper San Joaquin Valleys. The soils are extensive.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Ventura Area California, 1917.

OSED scanned by SSQA. Last revised by state on 3/77.

National Cooperative Soil Survey
U.S.A.

LOCATION SAN YSIDRO CA

Established Series
Rev. LAB/GMK/RWK/SBS
02/97

SAN YSIDRO SERIES

The San Ysidro series consists of deep, moderately well drained soils that formed in alluvium from sedimentary rocks. San Ysidro soils are on old, low terraces and have slopes of 0 to 9 percent. The mean annual precipitation is about 20 inches and the mean annual air temperature is about 59 degrees F.

TAXONOMIC CLASS: Fine, smectitic, thermic Typic Palexeralfs

TYPICAL PEDON: San Ysidro fine sandy loam, cultivated field. (Colors are for dry soil unless otherwise noted.)

Ap--0 to 7 inches; light brownish gray (10YR 6/2) fine sandy loam, dark brown (10YR 4/3) moist; few fine distinct mottles of brownish yellow (10YR 6/6); massive; hard, friable, nonsticky and slightly plastic; many very fine, common fine and medium roots; common very fine tubular and interstitial pores; slightly acid (pH 6.5); clear smooth boundary. (5 to 10 inches thick)

A--7 to 14 inches; light brownish gray (10YR 6/2) fine sandy loam, dark brown (10YR 3/3) moist; few fine distinct mottles of brownish yellow (10YR 6/6); massive; hard, friable, nonsticky and slightly plastic; many very fine, common fine and medium roots; common very fine tubular pores; medium acid (pH 6.0); abrupt smooth boundary. (7 to 20 inches thick)

Bt1--14 to 28 inches; dark yellowish brown (10YR 4/4) clay, dark brown (7.5YR 4/4) moist; a thin 1/4 inch bleached layer, light gray (10YR 7/2), light brownish gray (10YR 6/2) moist, rests immediately on top of the prisms; strong coarse prismatic structure; extremely hard, very firm, sticky and plastic; few very fine and fine roots along ped faces; common very fine tubular pores; many moderately thick clay films on faces of peds and lining pores; common fine iron and manganese concretions; slightly acid (pH 6.5); gradual smooth boundary. (10 to 15 inches thick)

Bt2--28 to 40 inches; yellowish brown (10YR 5/6) sandy clay loam, dark yellowish brown (10YR 4/4) moist, dark brown (7.5YR 4/4) coatings moist; strong medium prismatic structure; extremely hard, very firm, sticky and plastic; few very fine and fine exped roots; common very fine tubular pores; many moderately thick clay films on faces of peds and lining pores; common fine iron and manganese concretions; neutral (pH 7.0); gradual smooth boundary. (10 to 14 inches thick)

C1--40 to 54 inches; yellowish brown (10YR 5/4) light sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure; extremely hard, very firm, sticky and plastic; few very fine exped roots; common very fine tubular pores; many moderately thick clay films on faces of peds and lining pores; common iron and manganese concretions; neutral (pH 7.0); gradual wavy boundary. (10 to 15 inches thick)

C2--54 to 68 inches; yellowish brown (10YR 6/4) light clay loam, dark yellowish brown (10YR 4/4) moist, brown (7.5YR 4/4) coatings moist; strong medium prismatic structure; hard, firm, sticky and plastic; few very fine exped roots; common very fine tubular pores; continuous moderately thick clay films on faces of peds and lining pores; moderately alkaline (pH 8.0).

TYPE LOCATION: Solano County, California; approximately 3.5 miles west and 1 mile south of the town of Dixon; approximately 300 yards south and 100 yards west of northeast corner of NW 1/4 sec. 29, T.7N., R.1E. 38 degrees North latitude, 25 minutes, 45 seconds, 121 degrees West longitude, 53 minutes, 16 seconds.

RANGE IN CHARACTERISTICS: The mean annual soil temperature is about 60 degrees to 65 degrees F. The soil is usually moist in some or all parts between depths of 5 and 15 inches from late November or early December until May. The soil usually is dry all the rest of the time.

The Ap horizon is light brownish gray or pale brown in 10YR hue. It is sandy loam, fine sandy loam, or loam. This horizon is medium acid to neutral.

The A horizon is up to 6 inches thick and is present in some pedons or there is a thin layer of bleached grains just above the Bt horizon. Fine yellowish or brownish mottles are present in some pedons in part of the Ap horizon and A horizon where present.

The Bt horizon is brown, light brown, very pale brown, yellowish brown, dark yellowish brown, light yellowish brown or brownish yellow in hue 10YR or 7.5YR. It is heavy clay loam or clay and has about 35 to 45 percent clay in at least the upper part and moderate to strong angular blocky structure in the lower part. Some pedons have columnar structure. The Bt horizon is slightly acid to moderately alkaline and increases in alkalinity with increasing depth. Exchangeable sodium is less than 15 percent.

The C horizon is pale brown, light yellowish or yellowish brown. It is somewhat stratified and ranges from sandy loam to silty clay loam. This horizon is mildly or moderately alkaline and has small amounts of segregated lime in some pedons.

COMPETING SERIES: These are the Hillgate series in this family and the Antioch, Cometa, Corning, Millsap, Newville, Positas, and Tierra series in other families. Hillgate soils lack a subsurface A horizon and lack mottles in the Ap horizon. Antioch soils have more than 15 percent exchangeable sodium in all parts of the B2t horizon. Cometa soils have hue of 7.5YR or 5YR in the B2t horizon. Corning soils have hue of 5YR through 2.5YR in the Bt horizon and are strongly acid throughout. Millsap soils have a lithic contact. Newville soils lack A2 horizons, are gravelly throughout with very gravelly C horizons. Positas and Tierra soils have dark A1 horizons with moist value of 2 or 3.

GEOGRAPHIC SETTING: San Ysidro soils are on old low terraces at elevations of less than 1,500 feet. Gradient is 0 to 9 percent. They formed in alluvium from sedimentary rocks. The climate is dry subhumid mesothermic with hot dry summers and cool moist winters. Mean annual precipitation is 12 to 25 inches, average January temperature is about 46 degrees F., and average July temperature is about 76 degrees F., and mean annual temperature is 58 degrees to 60 degrees F. Average frost-free season is 200 to 300 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Antioch, Capay, Hillgate, Pescadero, Pleasanton, and solano soils. Capay soils lack argillic horizons and have slickensides. Pescadero soils are on slightly lower terraces and have more than 15 percent ESP. Pleasanton soils have less than 35 percent clay and lack an abrupt A-B horizon boundary. Solano soils have more than 15 percent ESP and have natric horizons.

DRAINAGE AND PERMEABILITY: Moderately well drained; slow to medium runoff; very slow permeability.

USE AND VEGETATION: Used for growing dryland grains, dryland pasture, and shallow rooted row crops, and pasture under irrigation. Uncultivated areas have a cover of annual grasses and forbs.

DISTRIBUTION AND EXTENT: Foothills and valleys of the Coast Range of central California. The soils

are moderately extensive.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Gilroy Area, California, 1923.

OSED scanned by SSQA. Last revised by state on 3/77.

REMARKS: San Ysidro needs to be recompeted with Hillgate during MLRA update. Hillgate is the same as San Ysdiro but is mapped on slopes 0-50%. The 0-9% Hillgate map units should be correlated to San Ysidro and Hillgate set up for the 9-50% slope map units.

ADDITIONAL DATA: NSSL pedon S64CA-095-001 (type location but data shows the pedon to be Mollic Haploxeralf, fine-loamy, mixed, active, thermic)

National Cooperative Soil Survey
U.S.A.

LOCATION SYCAMORE CA

Established Series
Rev. WFA/RCH/JJJ
7/98

SYCAMORE SERIES

The Sycamore series wass a member of the fine-silty, mixed, nonacid, thermic family of Aeric Haplaquepts. Typically, Sycamore soils have grayish brown, slightly acid, slightly clay loam A horizons; grayish brown and light brownish gray, distinctly mottled, mildly to moderately alkaline, silt loam B horizons; and stratified light brownish gray and pale brown mottled loam, fine sandy loam and loamy fine sand calcareous C horizons.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, nonacid, thermic Mollic Endoaquepts

TYPIFYING PEDON: Sycamore silty clay loam - cultivated (Colors are for dry soil unless otherwise noted.)

Ap--0 to 14 inches; grayish brown (2.5Y 5/2) silty clay loamy very dark grayish brown (2.5Y 3/2) moist; massive; hard, friable, sticky, plastic; many very fine roots; many very fine pores; moderately low organic matter contest; few mica flakes; slightly acid; clear smooth boundary. (6 to 18 inches thick)

Bg1--14 to 26 inches; grayish brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) moist; few fine distinct mottles of yellowish brown or strong brown (lOYR 5/6 or 7.5YR 5/6); massive; slightly hard, friable, slightly sticky, slightly plastic; many very fine roots; many very fine, common fine pores; few mica flakes; mildly alkaline; gradual smooth boundary. (8 to 18 inches thick)

Bg2--26 to 42 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; common fine distinct mottles of yellowish brown and strong brown (lOYR 5/6 and 7.5YR 5/6); massive; slightly hard, friable, slightly sticky, slightly plastic; few roots; many very fine, common fine pores; slightly calcareous, lime mainly disseminated; moderately alkaline; gradual smooth boundary. (8 to 20 inches thick)

C--42 to 60 inches; stratified light brownish gray (lOYR 6/2) and pale brown (lOYR 6/3) loam, fine sandy loam, and loamy fine sand with some silty lenses, dark grayish brown and dark brown (lOYR 4/2 and 4/3) moist; many fine distinct yellowish brown and strong brown mottles; massive; slightly hard, friable; common very fine and fine pores; slightly calcareous, lime mainly disseminated; water table may fluctuate in this horizon depending on the level of the water in the river; moderately alkaline.

TYPE LOCATION: Colusa County, California; 1/2 mile south of Maxwell-Colusa road and 100 feet west of State Route 45; approximately 4 miles NNW of Colusa, in the NW1/4 of sec. 1, T.16N., R.2W.

RANGE IN CHARACTERISTICS: The mean soil temperature ranges from about 60 degrees to 64 degrees F. Unless the soils have intense drainage measures and are not irrigated, the soils do not become dry in all of the upper 20 inches. Mottles with chroma of 2 or less occur in the upper 20 inches. The 10 to 40 inch section is dominantly silt loam with about 18 to 25 percent clay and less than 15 percent material coarser than very fine sand. The surface is usually massive or is cloddy and is hard or very hard, probably due to intense tillage.

The A horizon is dominantly grayish brown in lOYR or 2.5Y hue and may be gray in lOYR hue. It is fine sandy loam, silt loam, silty clay loam or clay loam. This horizon ranges from slightly acid to mildly alkaline. The 10 to 20 inch section is not calcareous.

The B horizon ranges from grayish brown to light brownish gray or light yellowish brown with hue of 2.5Y, value of 5 or 6, chroma 2 through 4, and has distinct to prominent mottles. It is neutral to moderately alkaline with lime in the lower portion in some pedons.

The C horizon is light brownish gray to pale olive with distinct to prominent mottles. It is stratified loam, silty clay, sandy loam, loamy fine sand, and silt.

COMPETING SERIES: These are the Camarillo, Campbell, Laugenour, Maria, Tamba, Tyndall, Valdez, and Yolo series. Camarillo and Campbell soils lack mottles above a depth of 20 inches. Laugenour and Tyndall soils have less than 18 percent clay in the control section. Maria soils are calcareous in all parts. Tamba soils have more than 35 percent clay and are strongly acid. Valdez soils have pale colored epipedons with a moist value of 4. Yolo soils lack mottles and are dry about 7 months of each year.

GEOGRAPHIC SETTING: Sycamore soils are on nearly level flood plains at elevations of 10 to 100 feet. The soils formed in mixed sedimentary alluvium. The climate is dry subhumid, mesothermal with hot dry summers and cool moist winters. Mean annual precipitation is 15 to 20 inches. Average January temperature is 45 degrees ., average July temperature is 75 degrees F., mean annual temperature is 60 degrees to 62 degrees F.; and average frost-free season is 275 to about 300 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Columbia, Marvin, and Merritt soils and the competing Tyndall soils. Columbia soils have less than 18 percent clay in the 10 to 40 inch section. Marvin soils have argillic horizons, Merritt soils have mollic epipedons.

DRAINAGE AND PERMEABILITY: Sycamore soils formed under poorly drained conditions. Some areas are now drained. Surface runoff is slow to very slow; permeability is moderate to moderately slow.

USE AND VEGETATION: The soils are used for orchard, row, truck, and field crops excluding rice. Natural vegetation consists of annual grasses and oak.

DISTRIBUTION AND EXTENT: The flood plain of the Sacramento River and its tributaries in central California. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Alameda County, California, 1964.

REMARKS: The Sycamore soils were formerly classified as Alluvial soils.

OSED scanned by SSQA. Last revised by state on 6/72.

Series reclassified 5/95. Competing series not updated at that time.

National Cooperative Soil Survey
U.S.A.

LOCATION YOLO CA

Established Series
Rev. WFA/TDC/GMK
12/2000

YOLO SERIES

The Yolo series is a member of the fine-silty, mixed, nonacid, thermic family of Mollic Xerofluvents. Yolo soils have thick grayish brown, neutral silt loam A horizons and brown and pale brown mildly alkaline silt loam C horizons.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, nonacid, thermic Mollic Xerofluvents

TYPICAL PEDON: Yolo silt loam - cultivated (Colors are for dry soil unless otherwise noted.)

Ap1--0 to 2 inches; Grayish brown (2.5Y 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate thick platy structure; hard, friable, slightly sticky, plastic; many very fine roots; many very fine interstitial and tubular pores; neutral (pH 6.7); abrupt wavy boundary. (2 to 10 inches thick)

Ap2--2 to 8 inches; Grayish brown (2.5Y 5/2) silt loam, dark brown (10YR 3/3) moist; massive; hard, friable, sticky, plastic; many very fine roots; common very fine tubular pores; neutral (pH 7.1); clear wavy boundary. (3 to 10 inches thick)

A1--8 to 19 inches; Grayish brown (2.5Y 5/2) silt loam, dark brown (10YR 3/3) rubbed, very dark grayish brown (10YR 3/2) coatings moist; weak coarse subangular blocky structure; hard, friable, slightly sticky, plastic; common very fine roots; many very fine tubular and clusters of interstitial pores associated with worm casts; few thin clay films on peds and continuous thin clay films in pores; neutral (pN 7.2); clear wavy boundary. 6 to 12 inches thick)

A2--19 to 26 inches; Grayish brown (2.5Y 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable, slightly sticky, plastic; many very fine and few fine roots; many very fine tubular pores; neutral (pH 7.3); clear irregular boundary. (6 to 13 inches thick)

C1--26 to 33 inches; Brown (10YR 5/3) silt loam, olive brown (2.5Y 4/4) moist; massive; slightly hard, friable, slightly sticky, plastic; common very fine roots; common very fine tubular and clusters of interstitial pores associated with worm casts; mildly alkaline (pH 7.4); clear irregular boundary. (7 to 24 inches thick)

C2--33 to 41 inches; Pale brown (10YR 6/3) silt loam, olive brown (2.5Y 4/4) moist, dark grayish brown (2.5Y 4/2) stains in root channels moist; massive; soft, very friable, slightly sticky, slightly plastic; few very fine roots; common very fine tubular and many very fine interstitial pores; mildly alkaline (pH 7.4); abrupt wavy boundary. (8 to 30 inches thick)

Ab--41 to 58 inches; Grayish brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; massive; slightly hard, friable, very sticky, plastic; few very fine roots; common very fine tubular pores; mildly alkaline (pH 7.4); clear wavy boundary. (0 to 8 inches thick)

C3--58 to 65 inches; Pale brown (10YR 6/3) silt loam, mottled olive brown (2.5Y 4/4) and olive (5Y 4/3) moist; massive; slightly hard, very friable, slightly sticky, slightly plastic; few very fine roots; many very fine tubular and interstitial pores; mildly alkaline (pH 7.5).

TYPE LOCATION: Yolo County, California; 90 feet east of center of field road, 3,150 feet west of State Highway 113 and 160 feet south of center of Hutchinson Drive, on the property of the University of California at Davis.

RANGE IN CHARACTERISTICS: The mean soil temperature ranges from about 60 degrees to 64 degrees F. and the soil temperature is continuously above 47 degrees F. Some or all parts of the 4 to 12-inch section become moist sometime in November and remain moist until sometime in May. The soils remain dry, unless irrigated, the rest of the year. Little or no gravel is present. The 10- to 40-inch section averages 20 to 35 percent clay and averages less than 15 percent material coarser than very fine sand. The A horizon is grayish brown, dark grayish brown and brown in hue of 10YR or 2.5Y and has value of 4 or 5 dry, 3 or 4 moist, and chroma of 2 or 3 dry and 2, 3, or 4 moist. The upper part of the A horizon ranges from loam or silt loam to silty clay loam and includes sandy loam. It is slightly acid or neutral. Organic matter is approximately 1.5 to 3 percent. The surface is massive or platy and is hard or very hard. The C horizon is pale brown, light yellowish brown, brown, dark grayish brown and grayish brown in 10YR or 2.5Y hue and has value of 4, 5, or 6 dry, 3 or 4 moist and chroma of 2 or 3 dry and 3 or 4 moist. It is usually silt loam or silty clay loam and has thin strata of loam, very fine sandy loam and fine sandy loam in some pedons. This horizon is dominantly slightly acid to mildly alkaline but some portions in some pedons include medium acid and moderately alkaline. Free lime is below depth of 40 inches in some pedons. A few thin clay films are present in some pedons. There is no significant weathering of primary minerals into clay size minerals.

COMPETING SERIES: These are the Balcom, Castaic, Garretson, Nocko, Reiff, Salinas, Sorrento, and Zamora series. Balcom and Castric soils are on shale and sandstone and have a paralithic contact at depths of less than 40 inches. Garretson soils have more than 15 percent material coarser than very fine sand. Nocho, Salinas, Sorrento and Reiff soils have less than 18 percent clay in the 10- to 40-inch section. Zamora soils have an argillic horizon.

GEOGRAPHIC SETTING: Yolo soils are on nearly level to moderately sloping alluvial fans. The soils formed in fine-loamy alluvium derived from sedimentary formations. They are at elevations of near sea level to 2400 feet in a dry subhumid, mesothermal climate having a mean annual rainfall of 12 to 40 inches with hot dry summers ant cool moist winters. The average January temperature is about 45 degrees F., average July temperature is about 75 degrees F., and the mean annual temperature is about 58 degrees to 63 degrees F. The average freeze-free season is about 220 to 300 days.

PRINCIPAL ASSOCIATED SOILS: These are the competing Reiff, Sorrento, and Zamora soils and the Arbuckle, Brentwood, Capay, Cole, Pleasanton, Soboba, and Sycamore soils. Arbuckle and Pleasanton soils are on older landscapes and have gravelly argillic horizons. Brentwood soils are fine-textured and have cambic horizons. Capay soils are fine-textured and have intersecting slickensides. Cole soils have thick mollic epipedons and fine argillic horizons. Soboba soils have more than 35 percent coarse fragments. Sycamore soils have mottles due to poor drainage within 20 inches of the surface.

DRAINAGE AND PERMEABILITY: Well-drained; slow to medium runoff; moderate permeability. Tillage pans have developed over broad areas and tend to restrict permeability.

USE AND VEGETATION: The soil is used for intensive row, field and orchard crops. Original vegetation was annual grasses, forbs, and some scattered oak.

DISTRIBUTION AND EXTENT: West site of Sacramento Valley, central California, and in the valleys of the California Coast Range. The series is extensive.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Woodland Area, California, 1909.

REMARKS: The Yolo soils were formerly classified as alluvial soils. The classification is changed from Typic Xerochrepts to Typic Xerorthents.

OSED scanned by SSQA. Last revised by state on 10/74.

National Cooperative Soil Survey
U.S.A.

LOCATION ZAMORA CA

Established Series
Rev. WFA/RCH/LCL
01/2003

ZAMORA SERIES

The Zamora series is a member of the fine-silty, mixed, thermic family of Mollic Haploxeralfs. Typically, Zamora soils have grayish brown, slightly acid loam A horizons; brown silty clay loam, neutral Bt horizons; and yellowish brown C horizons.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, thermic Mollic Haploxeralfs

TYPICAL PEDON: Zamora silt loam - cultivated (Colors are for dry soil unless otherwise noted.)

Ap--0 to 10 inches; Grayish brown (2.5Y 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; massive; hard, friable, slightly sticky, slightly plastic; many fine roots; common very fine pores; slightly acid (pH 6.3); clear wavy boundary. (8 to 14 inches thick)

B21t--10 to 24 inches; Brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; weak coarse angular blocky structure; hard, friable, sticky, plastic; many fine roots; common very fine pores; few thin clay films on faces of peds and lining pores; neutral (pH 7.0); gradual wavy boundary. (12 to 15 inches thick)

B22t--24 to 40 inches; Brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak coarse angular blocky structure; hard, friable, sticky, plastic; common fine roots; common very fine pores; continuous moderately thick clay films on faces of peds and lining pores; neutral (pH 7.0); gradual wavy boundary. (15 to 17 inches thick)

C1--40 to 51 inches; Yellowish brown (10YR 5/4) silt loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; common fine roots; common very fine pores; few thin clay films line pores; neutral (pH 7.0); clear wavy boundary. (10 to 15 inches thick)

C2--51 to 60 inches; Yellowish brown (10YR 5/4) gravelly loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; few fine roots; common very fine pores; slightly effervescent; lime segregated in concretions; slightly alkaline (pH 7.5).

TYPE LOCATION: Yolo County, California; about 3 miles north of Capay; 0.35 mile north of Road 16-A on Road 85, 45 feet east of Road 85, SW;/4NW1/4NW1/4 sec. 1, T.10N., R.2W.

RANGE IN CHARACTERISTICS: The solum ranges in thickness from 35 to 46 inches. The mean annual soil temperature ranges from about 59 degrees to 64 degrees F. These soils are continually moist between 4 and 12 inches from some time in November until April or May and dry the remainder of the year.

The A horizon is dark grayish brown, grayish brown, dark brown or brown; hue is 10YR or 2.5Y. It is fine sandy loam, loam, silt loam or light silty clay loam. The surface layer is both hard or very hard and massive when dry. The A horizon is about 2 to 4 percent organic matter. Reaction ranges from slightly acid to neutral.

The B2t horizon is dark grayish brown or brown, hue is 10YR or 7.5YR, and chroma is 2 or 3. It is clay loam or silty clay loam that contains less than 15 percent coarser than very fine sand. The upper boundary is

diffuse, gradual or clear and some pedons have a transitional A3 horizon or B1 horizon. It has about 6 to 10 percent more clay absolute than the A horizon, but averages slightly less than 35 percent total clay. It is either massive or has blocky structure and ranges from neutral to slightly alkaline.

The C horizon is brown, grayish brown, yellowish brown, pale brown, light yellowish brown or light olive brown. Hue is 10YR or 2.5Y, value of 5 or 6, and chroma of 2, 3 or 4. Texture is clay loam, silt loam, loam, sandy loam or gravelly loam. In some pedons the lower part of the C horizon is stratified. The C horizon ranges from neutral to moderately alkaline and some pedons contain segregated lime and others lack it.

COMPETING SERIES: These are the Azule, Burchell, Los Robles, Modesto, Perkins, Pleasanton, Rincon, and Tehama series Azule and Rincon soils have 35 to 50 percent clay in the argillic horizon. Burchell, Modesto, Perkins, and Pleasanton soils are members of a fine-loamy family. In addition, Burchell soils are moderately to strongly alkaline in the argillic horizon. Modesto soils have an abrupt or clear boundary with 10 to 15 percent more clay in the arzillic horizon than in the epipedon. Perkins soils have 5YR or 2.5YR hue in the argillic horizon. Pleasanton soils have less than 18 to 25 percent clay in the argillic horizon. Los Robles soils have a cambic horizon and lack a 20 percent increase in clay from A horizon to B2 horizon. Tehama soils have moist values of 4 or more in the A horizon.

GEOGRAPHIC SETTING: Zamora soils are on nearly level to strongly sloping fans and terraces usually 0 to 9 percent slopes at elevations of 30 to 1,300 feet. The soils formed in alluvium from material weathered from mixed sedimentary rocks. They have a dry subhumid mesothermal climate with hot dry summers and cool moist winters. Mean annual precipitation ranges from 14 to 30 inches. Average January temperature is 45 degrees F., average July temperature is 75 degrees F., and mean annual temperature is 58 degrees to 63 degrees F. Average freeze-free season is about 250 to 330 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Los Robles and Rincon soils and the Brentwood, Salinas, Sorrento, and Yolo soils. Brentwood soils lack argillic horizons and have 35 to 40 percent clay in the textural control section. Salinas and Sorrento soils have a mollic epipedon. Yolo soils lack an argillic horizon, but are otherwise very similar.

DRAINAGE AND PERMEABILITY: Well-drained; glow to medium runoff; moderately slow permeability.

USE AND VEGETATION: The soils are used for growing orchards, row, field, and truck crops. Native vegetation is annual grasses and forbs and widely spaced oaks.

DISTRIBUTION AND EXTENT: Along the west side of the Sacramento Valley in central California and other parts of California. The soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Davis, California

SERIES ESTABLISHED: Solano County (Suisun Area), California, 1936.

REMARKS: Zamora soils were formerly classified as Noncalcic Brown soils.

The activity class was added to the classification in January of 2003. Competing series were not checked at that time. - ET

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Appendix A-5
Official Soil Series Descriptions

Appendix B: Hydrogeomorphic Study Methods

Appendix B - Hydrogeomorphic Study Methods

This appendix describes the stream and rain gage installation at San Antonio and Calaveras Creeks. In addition, it describes mapping and hydrogeomorphic analyses, defining stream components (i.e., geomorphic bed features) discussed in the main body of the text.

Stream and Rain Gage Installation

Stream and rain gage installation and the hydrogeomorphic assessments were conducted by Jason Pearson and Shannon Leonard of the Oakland, California, office of URS Corporation. These tasks were conducted over the period from March 10, 2009 to April 23, 2009.

Stream Gage

Stream gages will be used to monitor the depth of flow at a relatively stable cross section. Data from the instruments will be used in hydrologic runoff prediction models to estimate design flows and hydraulic prediction models to map flood elevations.

Location

Stream water level recorders were installed in San Antonio Creek during the period March 10 – 16, 2009. Gage locations are usually located in a stable riffle where flow depths remain relatively consistent over a range of flow volumes. The bed profile of a riffle typically remains consistent neither aggrading nor degrading or experiencing lateral migration (as may occur in other portions of the stream channel).

The San Antonio Creek gage is located in a riffle approximately 260 feet upstream from the first Ranch Road stream crossing (Appendix C-1). The location was chosen where personnel could safely drive up to the gage site without needing to cross the stream ford (since it is not a viable option during high flows when stream velocity measurements are necessary). A more stable alternate location downstream of Ranch Road was not chosen due to a fish trap that was being installed. The fish trap has a tendency to back up water behind the fence as it funnels out-migrating fish into the trap. Therefore false water level readings were a concern had the gage been placed upstream of the trap.

The pressure transducer is installed in the center of the stream and the data logger is located on the right bank of the stream on a wood post (Figure B-1 D-1). A staff gage is mounted on a T-post against the sycamore tree on the left bank of the stream.



Figure B-1. San Antonio Creek stream gage cross section. Upstream view (top photo), downstream view (bottom photo).

In 2008, SFPUC staff installed a water level recorder on Calaveras Creek (Appendix C-1). Data collected from this gage will be used for channel design on Calaveras Creek. The gage is located between two abandoned concrete bridge abutments in the upper reach of the project area approximately 1,400 feet downstream of the Marsh Road crossing (Appendix C-1). The data logger, pressure transducer, and staff gage are mounted on the left abutment (Figure B-2).



Figure B-2. Calaveras Creek stream gage cross section.

Materials

The following materials were used in the installation of each stream gage:

- (1) 2-inch diameter x 4-foot long schedule 40 PVC slotted well pipe, with a threaded well point on one end, used to house the pressure transducer.
- (1) Flexible 1-inch diameter x 50-foot long non-metallic PVC conduit to protect the instrument wiring between the pressure transducer and data logger.
- (2) 1-inch compression/male thread PVC couplings to connect either end of the flexible conduit.
- (2) 1-inch slip/female thread PVC couplings to connect the flexible conduit to the slotted pipe and to the bottom of the data logger housing.
- (1) 1-1/2-inch to 1-1/4-inch PVC reducer slip fitting to connect to the bottom of the data logger housing.
- (1) 2-inch to 1-1/2-inch PVC reducer slip fitting to connect to the bottom of the data logger housing.
- (1) 2-inch PVC slip coupling to connect to the bottom of the data logger housing.
- (1) 2-inch schedule 80 PVC electrical conduit to house the data logger.
- (1) 4-inch to 2-inch PVC reducer slip fitting to connect the data logger housing and support the data logger within the housing.
- (1) 4-inch PVC female thread/slip coupling to provide access to the data logger
- (1) 4-inch ABS male threaded plug to prevent debris from entering the housing.
- PVC glue and primer
- (1) 4-inch x 4-inch x 6-foot arsenic-free pressure treated post to mount the data logger housing.

- (2) 2-inch galvanized pipe holders to mount the PVC pipe data logger housing to the post.
- (4) 2-1/2 inch exterior wood screws to attach the pipe holders to the post.
- (6 minimum) 3-foot long x ½-inch diameter steel concrete stakes to anchor the flex-conduit and transducer housing to the streambed.
- Heavy gauge galvanized wire to tie the concrete stakes together anchoring the flex-conduit and transducer housing to the streambed. Wire was also used to fix the staff gages to the T-posts.
- (1) 8-foot T-post to mount the staff gage plate.

Monitoring Equipment

Water levels are monitored in San Antonio Creek with a Global Water model WL16U data logger. Each instrument has a pressure transducer that monitors changes in the water pressure and correlates the pressure changes to changes in water depth. The transducers have a sensor range of zero to 15 feet over which they monitor water levels within an accuracy of ±0.1% of full scale at constant temperature, ±0.2% over a 35°F to 70°F range. Global Water recorders are equipped with a vented cable so that the unit can automatically compensate for changes in barometric pressure. The instruments also log temperatures between 0 – 50°C with an accuracy of ±1% of the reading. Two 9-volt batteries power the loggers, which typically last up to a year's time depending on the recording interval. The instruments can record readings on a timed, 10 times per second, logarithmic, and exception basis. The data loggers are equipped with a USB connection for downloading data directly to a laptop computer using Global Water software. The San Antonio Creek unit is equipped with a 45-foot cable.

The unit is setup to record water depth and temperature every 15 minutes. The initial depth reading after installation was verified for accuracy by measuring the water depth to the pressure transducer with a rod. Instruments will be downloaded and checked for low batteries or damage every month.

SFPUC fisheries biologists provided a 0.01-foot graduated x 3.3-foot long staff gage at San Antonio Creek so they could visually monitor water levels when they are onsite to check the downstream fish trap.

Installation Method

The following steps detail the stream gage installation:

1. A trench was dug perpendicular to the stream from the thalweg or center of the channel to an elevation above bankfull that does not receive frequent flooding and is easily accessible.

2. A hole was dug up on the bank at least 2 feet deep to set the 4-inch x 4-inch post.
3. The 4-inch x 4-inch post was cut and buried in the hole with at least 1.5 feet remaining above the soil surface to mount the data logger housing.
4. The 1-inch flexible PVC conduit was cut to the length of the trench minus the length of the slotted well pipe used to house the transducer.
5. A 1-inch compression fitting with a male threaded was fixed to one end of the flexible conduit.
6. An approximate 1-foot section of 2-inch PVC conduit pipe was cut long enough to house the length of the data logger.
7. A 4-inch to 2-inch reducer slip fitting was glued the top of the 2-inch PVC housing, which was then glued to a 4-inch slip/female threaded coupling (Figure B-3).
8. A 2-inch slip coupling was glued to the bottom of the 2-inch PVC conduit pipe.
9. A 2 to 1-1/2-inch reducer slip coupling was glued to a 1-1/2 to 1-1/4-inch reducer slip coupling which was glued to the outside of the slip end of a 1-inch coupling with a female treaded end. These reducers were glued to the bottom of the PVC pipe housing (Figure B-3).
10. The flexible conduit was attached to the data logger housing assembly via the threaded couplings. Teflon® tape was applied at all threaded ends.



Figure B-3. Connecting the data logger and transducer housing to the flexible conduit.

11. The pressure transducer was fed through the data logger housing and the flexible conduit.
12. Due to excessive friction between the flexible PVC conduit and the transducer cable (beyond the first 10 feet of pipe), it was necessary to suspend the conduit vertically, such as over a tall ledge or bridge, to feed the instrument through the 50 feet of flexible conduit. An alternate method would be to feed a fish tape through the conduit then pull the transducer through the pipe rather than pushing the device and data cable.
13. A second 1-inch compression fitting with a male thread was slipped over the transducer and fixed to the far end of the flexible conduit (Figure B-3).
14. A slip coupling with female threads was glued to the slotted well pipe.
15. The pressure transducer was fed into the slotted well pipe and positioned near the end of the pipe and the well pipe with well point was threaded to the flexible electrical conduit using Teflon® tape at the joint.
16. The instrument and pipe was placed in the trench and the data logger housing was affixed to the post using galvanized pipe strap/holders and screws.
17. Large rocks were placed in the trench to hold down the pipe while two ½-inch x 3-foot long steel concrete stakes where driven at opposing angles over the pipe firmly securing the pipe/conduit to the streambed in the trench. Pairs of stakes were placed at either end of the well pipe and approximately every 5-10 feet along the length of conduit as was deemed appropriate (Figure B-4).
18. Heavy gage galvanized wire was woven through the predrilled holes in the concrete stakes to tie the stakes together and prevent any separation that could allow the pipe/conduit to dislodge from the streambed during a storm.
19. The trench was backfilled with native soil on the banks, larger rock in the active channel, and clean gravel along the length of the slotted well pipe (Figure B-4).
20. An 8-foot long T-post was pounded into the streambed at the edge of the active channel where the staff gage plate would be fairly protected from damaging storm debris.



Figure B-4. Securing the pipe/conduit to the streambed.

21. The instrument logging settings were saved to the data logger and a depth reading was taken to set the staff gage to the proper height (Figure B-5). A 4-inch threaded ABS plug was threaded onto the top of the data logger housing to protect the logger.
22. The staff gage was wired to the T-post at the appropriate water surface elevation (Figure B-5).



Figure B-5. Saving logging setting to the data logger and setting the staff gage.

Rain Gage

Rain gages will be used to produce rainfall hyetographs, which can be compared to the discharge hydrographs to evaluate watershed characteristics such as the lag time from the peak of the rainfall to the peak of the runoff. Rainfall data will be used in the hydrologic runoff prediction models to estimate storm design flows.

Location

Rain gages were installed at San Antonio and Calaveras Creeks by URS during the period March 10 – 16, 2009. Rain gages were placed near the stream gage locations in clearings free of trees, to avoid the potential for trees to interfere with rainfall collection.

Materials

The following materials were used in the installation of each rain gage:

- (1) 4-inch x 4-inch x 6-foot long arsenic-free pressure treated post to mount the rain gage.
- (1) 2-inch x 12-inch x 12-inch arsenic-free pressure treated board to serve as a platform for the rain gage on the post.
- (4) 2-1/2-inch long exterior wood screws to attach the wood base plate to the post.
- (7) #6 x 1-1/4-inch wood screws to attach the rain gage feet to the wood platform and attach the data logger to the post.
- (1) 50-foot roll of 60-inch high, 4-inch x 2-inch galvanized welded wire fence used to fence out cattle from the rain gage.
- (4) T-posts to support the fence.
- (1) 1-inch x 1-inch x 60-inch long redwood board used as drop-gate post.
- Galvanized wire to attach the fence to the posts.
- Nylon rope to tie the drop-gate closed.

Monitoring Equipment

Rainfall is measured using a standard aluminum eight-inch tipping bucket rain gage (Global Water model RG600) designed by the National Weather Service. Rainfall that falls within the 8-inch diameter funnel is directed over a separator with two plastic buckets on a tipping scale that each hold $1/100^{th}$ an inch of rain before tipping and emptying the bucket. Each tip of a bucket is logged in a Global Water model GL500-2-1 data logger. The GL500-2-1 data logger has two analog channels and one digital channel for data recording. Rainfall is recorded on the digital channel. The data logger operates on two 9-volt batteries and logs over 81,759 recordings in various formats including fast (10 samples per second), programmable interval (1 second to multiple years), logarithmic, and exception. The data logger connects to a laptop computer via USB connection using Global Water software.

All rain gages are set up to record a reading (number of tips) every 15 minutes. Instruments are downloaded and checked for low batteries or damage every month.

Installation Method

The following steps detail the rain gage installation:

1. A hole at least 2 feet deep was dug with a post-hole digger
2. The 2-inch x 12-inch x 12-inch pressure treated wood base plate was attached to the 4-inch x 4-inch pressure treated wood post using four 2-1/2-inch exterior wood screws.
3. The wood post was placed in the hole, leveled, and buried.
4. The rain gage was attached to the wood base plate with three #6 x 1-1/4-inch wood screws (Figure B-6).
5. A 3/8-inch diameter hole was drilled into the base plate and the data logger cable was fed through the hole.
6. The data logger was attached to the post using four #6 x 1-1/4-inch wood screws (Figure B-6).
7. Four T-posts were installed around the rain gage approximately 10 feet from gage.
8. 60-inch high fence wire was stretched around the T-posts to prevent cattle from disturbing the rain gage. Fencing was fixed to the T-post with wire clips or galvanized wire (Figure B-6).
9. The end of the fence was attached to a 1 x 1 x 60-inch redwood board with galvanized steel staples or by twisting the wire back on itself to form a drop-gate post.
10. A loop of galvanized wire was attached to the bottom of the T-post where the drop-gate post closes. The top of the drop-gate was tied closed with a length of nylon rope or wire.
11. A laptop was connected to the data logger to check if the rain gage was functioning properly. The rain gage buckets were tipped 5 times to ensure 0.05-inches of “rain” was recorded. The data logger time was synchronized to the computer time and logging setup files were saved.



Figure B-6. Rain gage installation.

Mapping

Geomorphic Bed Features

Geomorphic bed features including riffles, runs, pools, and glides are formed and maintained by fluvial processes and watershed characteristics. The immediate channel area and streambed was walked. Bed features were identified, classified, mapped, and located with a Trimble® GPS unit. Secondary features either of geomorphic or biological significance were identified and mapped as appropriate. The following are descriptions of the primary bed features presented in their typical sequential order:

Riffles – Longitudinally, the steepest part of the bed where water depth remains roughly consistent along the length of the feature. Riffles typically have a poorly defined thalweg and, in a stable system, occur in the cross-over reaches between bends.

Runs – Here the water depth begins to increase while bed slope decreases from that of the riffle. Runs typically have an identifiable thalweg.

Pools – This is the portion of the reach where water depths are greatest. At flows less than bankfull, the water surface slope is approximately zero. In a stable system, these features typically occur on bends.

Glides – Here the bed slope is negative while the water surface slope, during flows less than bankfull, again becomes positive. Glides can be distinguished from pools by the increase in water velocity and the diminished definition of the thalweg.

Plane bed reaches, where the bed is at a consistent slope without the defining features listed above, were encountered in segments exhibiting substantial aggradation. In the Calaveras Creek project area, significant deposition of gravels and fines left the streambed featureless. Downstream of Marsh Road Calaveras Creek is a loosing reach whereby flow volumes diminish in a downstream direction due to the abundance of aggradation and lack of channel structure. As such, geomorphic bed features were not identified in Calaveras Creek.

Details collected from the geomorphic features, such as lengths, widths, depths, cross-sectional areas, bed slopes, water surface slopes, and bed material will be used to determine the degree of departure from reference conditions in each of the stream design reaches and to inform the design.

Secondary Hydrogeomorphic Features – Sycamores

In addition to bed features, secondary hydrogeomorphic features can provide significant information about a system. For example, sycamores tend to grow at or near the bankfull elevation along the channel. Older sycamores indicate the location and elevation of bankfull around the time of their germination. Regenerating sycamores (seedlings or young plants) indicate the current or more recent location and elevation of bankfull.

Secondary Hydrogeomorphic Features – Rack Lines

Rack lines (floating debris accumulated along banks and on vegetation) created during a particular storm event provide information about the water surface profile during that storm, and if the flow is known, the elevation of the water associated with that flow. Obvious rack lines of small woody debris (wood and leaves less than one half inch) and silts were discernable along the entire length of the San Antonio Creek project area during the assessment phase. The rack lines with the clearest definition that were not influenced by adjacent vegetation were mapped at intervals of every 25-50 feet by locating them via GPS point data and conventional survey. These points will be surveyed with a total station to obtain relative water surface elevations to compare to the channel bed profile.

Bankfull Indicators

Bankfull indicators are channel features found at and around the bankfull elevation of the channel. The bankfull elevation and its associated flow are hydrologically significant because measurements on rivers around the world have shown that bankfull tends to occur on a recurrence interval of every one to two years with an average return of 1.5 years (Leopold, 1964). This means bankfull can be a benchmark from which to compare various rivers and streams.

Bankfull flow is morphologically significant because it is the flow at which the most sediment load is transported over the long term. While large events transport more material per event, and smaller events are more frequent, the bankfull event has the appropriate combination of material transport capacity and frequency to perform the greatest amount of work in forming and maintaining channel shape. This is why it is also referred to as the effective or channel forming flow. (Dunne, 1978)

Bankfull indicators vary by region, topography, geology, and hydrologic regime. The following is a list of the various indicators that may be present in a given channel:

- The floodplain at the incipient point of flooding.
- The flat top of a point bar.

- A break in slope along the banks.
- A change in particle size distribution along the banks.
- Benches adjacent to the banks.
- Staining of rocks.
- Exposed roots below intact soil layer indicating exposure to erosive flows.
- Location of riparian species or changes in vegetation such as the elevation of persistent woody vegetation.

Experience and caution is required in using any of the above features as a means of identifying bankfull, and several indicators are desired to confirm bankfull. Identifying bankfull can be complicated by factors such as: a channel confined between steep hillslopes, channel incision, presence of water tolerant woody vegetation, sustained extremes in water years (several drought or wet years in a row), presence of significant sediment deposition, bars still in the formative process, debris jams, and undercut banks.

At the project sites, clear and definitive bankfull indictors could not be directly observed in the field with sufficient consistency to allow a degree of confidence in identifying bankfull. This was due to channel widening occurring at both San Antonio and Calaveras Creeks. The widening is characterized by severe bank erosion coupled with bedload deposition in the channel which removes, in the case of bank erosion, and covers, in the case of deposition, the bankfull indicators.

Reaches

The project stream areas were divided into reaches based upon field observation of overall changes in the average channel characteristics. For example, a reach break was delineated between a reach exhibiting significant deposition and a reach exhibiting characteristics of bedload transport. Reaches tend to break at confluences with significant flow or sediment inputs, changes in valley slope, changes in valley width, changes in land use, at constrictions, or at grade control locations. In each reach representative cross-sections of: two riffles, two pools, one run, and one glide were surveyed along with a detailed survey at each riffle cross section (described below). Because of the lack of morphological features at Calaveras Creek, representative cross sections will be chosen within each reach, but will not represent specific bed features (e.g., riffle, pool, glide, or run).

Photo Documentation

Representative cross-section locations were photo-documented using a digital camera by taking a panoramic photo looking upstream through the feature, a panoramic photo

looking downstream through the feature, and one photo each of the left and right banks at the cross-section location. Representative cross section photos have not been completed at Calaveras Creek.

Survey

Three types of survey methods and equipment were used to collect location and elevation data: Global Positioning System (GPS), Light Detection and Ranging (LiDAR), and conventional ground topographic surveying. These methods and equipment were used to generate creek cross sections and to map secondary creek (hydrogeomorphic) features. In future project phases, it is intended that the LiDAR data will be combined with the conventional survey data (as applicable) to form the topographic mapping necessary to inform the design.

GPS Survey – Locations of geomorphic features were collected in the field with hand-held sub-meter accuracy GPS units (e.g., Trimble® GeoXT™, GeoXH™). Data were downloaded, and differentially corrected with Trimble® Pathfinder® office software, and interpreted using ESRI® ArcGIS™ software (e.g., ArcMap™).

LiDAR Survey – Topographic contour geospatial data layers at either one- or five-foot contour intervals referenced to the North American Vertical Datum of 1988 (NAVD88) were derived from LiDAR data in a GIS. Topographic contour interval determination was based on resolution and quality of the source LiDAR data with higher resolution and quality data given preference. One-foot contour data was derived for project areas with LiDAR data available as 1.64-foot (0.5-meter) digital elevation models (DEM) from the 2007 National Center for Airborne Laser Swath Mapping (NCALM) Northern California Fault System LiDAR Survey. Five-foot contour data was derived for project areas with LiDAR data available as five-foot DEMs from the 2006 LiDAR surveys for Alameda and Santa Clara counties. Both LiDAR data types were processed similarly using ESRI's ArcGIS software: DEM values were converted to feet referenced to NAVD88 (as needed); contour lines were derived from the DEMs using the ArcGIS Spatial Analyst extension; contour lines were simplified using the ArcGIS Simplify Line tool with a maximum allowable offset of two inches; and contour lines were converted to 3D features using ArcGIS 3D Analyst extension.

Conventional Survey – In areas where available LiDAR data were of insufficient detail to support design, it was supplemented with conventional on-the-ground survey using

total station or sub-inch accuracy real-time kinematic survey (i.e., GPS base stations). The on-the-ground surveys were conducted by the SFPUC survey department.[1]

Representative Cross-Sections

For project areas where LiDAR data was sufficiently detailed (Calaveras Creek), representative cross-sections were drawn using the LiDAR data alone. For project areas where existing LiDAR data was not accurate enough for design purposes (San Antonio Creek), detailed cross-sections were surveyed in the field by SFPUC based on section end points and turning points identified in the field by the URS team. The section end points and turning points were collected with a GPS unit, flagged with pin flags and/or tape flagging, and marked on the ground with marking paint to assist the SFPUC surveyors in locating the sections. At the representative cross-sections, the SFPUC survey team was instructed to collect data via two methods:

- For areas outside the bankfull channel: ground shots at changes in grade.
- For areas inside the bankfull channel: ground shots at a minimum of one every foot and at changes in grade

Representative cross-sections will be used to classify the stream reaches, describe the degree of departure from reference condition, and inform the hydrogeomorphic design. Cross section data has not been received from SFPUC surveyors at this time.

Secondary Hydrogeomorphic Features

Secondary hydrogeomorphic feature locations were documented twice, using GPS and conventional land survey. The field crew flagged each one with pin flags and marked on the ground with marking paint to assist the SFPUC surveyors in locating the features and record the location using conventional land survey for increased precision and accuracy.

Pebble Counts

Pebble counts characterize the bed material in a given reach and are used in the performance of velocity, sediment competence, and sediment entrainment calculations as well as to classify the stream. Several pebble counts were conducted at San Antonio and Calaveras Creeks during the assessment. The counts were conducted based on the procedures outlined in *Stream Channel Reference Sites: An Illustrated Guide to Field Technique* (Harrelson, 1994). The pebble count method utilized is commonly known as a Wolman pebble count (Wolman, 1954) and utilizes a random sampling of 100 individual pebbles to describe the size gradation of the bed material.

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[1] Additional input regarding these surveys has been requested from SFPUC staff.

This method is constructed to minimize sampling error due to operator tendency to visually select for mid-range pebbles. Small particles are often less obvious and are more difficult to select and pick up; large materials are often heavy, difficult to remove from the stream bed, or present occupational hazards by being slick or unstable to walk on.

To minimize these, often subconscious, preferences, pebble sample locations are set at even spacing along specific transects, both of which vary based on the type of count, size of the stream, and extent of the area sampled but are determined without deference to the location of actual material types or sizes. Also, at each pebble sample location, the operator averts his or her gaze and uses the tip of their index finger to touch the bed at the toe of their boot. The first pebble touched is the one selected for the sample.

Following collection of each sample, the pebble's intermediate axis (neither the longest nor the shortest axis) was measured in millimeters and recorded as a count in a size bracket or class. The size classes were divided as shown in Table Error! **No text of specified style in document.**-.

The total number of pebbles counted in each class is converted to a percentage of the total count; then, the percentages are summed cumulatively from smallest to largest sizes to give a "percent finer than" for each size class. The size gradation curve is a graph of the material size on a log scale versus cumulative percent on a normal scale.

The following describes the methods for multiple types of pebble counts: reach, active bed, and riffle pebble counts, bar samples, as well as the purposes of the data extracted from the results.

Table Error! No text of specified style in document.**-1. Pebble Count Size Classes**

Particle Class		**Size (mm)**
Silt/Clay		< 0.062
Sand	Very Fine	0.062-0.125
	Fine	0.125-0.25
	Medium	0.25-0.5
	Coarse	0.5-1.0
	Very Coarse	1.0-2
Gravel	Very Fine	2-4
	Fine	4-5.7
	Fine	5.7-8
	Medium	8-11.3
	Medium	11.3-16
	Coarse	16-22.6
	Coarse	22.6-32

	Very Coarse	32-45
	Very Coarse	45-64
Cobble	Small	64-90
Cobble	Small	90-128
Cobble	Large	128-180
Cobble	Large	180-256
Boulder	Small	256-362
Boulder	Small	362-512
Boulder	Medium	512-1024
Boulder	Large-Very Large	1024-2048
Bedrock		> 2048

Reach Count

The reach count was conducted by collecting the 100 samples equidistantly along a pattern zigzagging from bankfull to opposite bankfull while moving longitudinally along the reach. This pattern creates a random sampling of all bed features (pools, glide, riffles, and runs) along their lengths as well as their widths. It also distributes the samples according to the quantity and length of the bed features, which is representative of the reach.

The reach pebble count is utilized in classifying the stream. According to the Rosgen stream classification method, the stream channel is described by its entrenchment ratio, width/depth ratio, sinuosity, slope, and channel material (Rosgen, 1994). The channel material is represented as the median size of channel materials or the D_{50} of the reach pebble count. D_{50} refers to the particle diameter where 50% of the sample is the same size or finer.

Active Bed Count

The active bed is the wetted or coarsest portion of the riffle bed; it does not include the channel banks. The active bed count was conducted by collecting the 100 samples equidistantly along a pattern zigzagging from edge to opposite edge of the active bed while moving upstream and downstream along the riffle. This pattern creates a random sampling of the active bed along its length and width.

The D_{50} of the active bed count is utilized in the sediment competence and entrainment computations when calculating dimensionless shear stress (Rosgen, 2006).

Riffle Count

The riffle count includes the riffle banks in addition to the active bed and is sampled proportionately across the entire width of the bankfull channel. As a means of speeding the process of performing the various pebble counts, where applicable, the previously

collected active bed data was supplemented with bank-only data to generate the complete riffle data.

In cases where the proportion of the total riffle width to the active bed width was two or less, a count of the banks was conducted and added to the active bed count to obtain data for the entire riffle*. The bank count was conducted by collecting the samples equidistantly along a pattern zigzagging from bankfull to edge of active bed while moving upstream and downstream along the riffle, and the bank sample population was divided proportionately between left and right banks according to their respective widths.

If the proportion of the total riffle width to the active bed width was greater than two, the riffle count was conducted by collecting 100 samples equidistantly along a pattern zigzagging from bankfull to opposite bankfull while moving upstream and downstream along the riffle. This data was not added to the active bed count data because the active bed portion is included in this count.

The D_{84} of the riffle pebble count is utilized in estimating channel velocity and discharge at bankfull. D_{84} refers to the particle diameter where 84% of the sample is the same size or finer.

Bar Sample

The bar sample is a bulk sediment sample taken on the lower third of the point bar approximately half way between bankfull and the thalweg. From within this general vicinity, the sample was specifically located at the two largest particles found on the surface of the bar (see Figure B-7). The two largest particles were measured (intermediate axis) and weighed individually. Then using a bottomless five-gallon bucket at the identified location, the bar sample was collected by digging out the bar sediment within the bucket circumference to a depth equal to two times the size of the largest particle. The sample material was wet-sieved in the field using a set of eight-inch diameter, stacking brass sieves over a five-gallon bucket with drain holes near the top of the bucket. This bucket allows the collection of sands finer than the smallest sieve, but does not collect suspended particles (silts and clays). Sieve sizes utilized were: 2, 4.75, 12.5, 19, 25.4, 37.5, and 75 millimeters. The empty sieves and fines bucket were individually weighed in the field prior to each bar sample in order to obtain the net weight of sieved materials.

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* For example, if the active bed was 10 feet in width and the entire riffle was 14 feet, then four feet of the total width is accounted for by banks. Therefore, the samples from the banks should be approximately 29% (4 ÷ 14 = 0.29) of the total riffle sample. Since the active bed portion is a total of 100 counts, a riffle bank count of 41 pebbles (100 + x = y and $x \div y = 0.29$, therefore $x = 100 \div 2.45 = 41$, where 100 is the number of pebbles from the active bed, x is the number of pebbles from the banks, and y is the total number of pebbles) would be added to the active bed data to obtain the riffle count.

The empty weight of the sieve was subtracted from gross material and sieve weight to obtain the net weight of sieved material. The total quantity of bar material collected was large enough that it could not all be sieved at once, so it was divided into smaller portions, and the results in each size class were summed to arrive at a total material weight by size class. The fines bucket was drained by slowly pouring off excess water so as to retain the sands, and then it was also weighed in the field.

Similar to the pebble counts, the bar sample weight in each class is converted to a percentage of the total weight; then the percentages are summed cumulatively from smallest to largest sizes to give a "percent finer than" for each size class. The size gradation curve is a graph of the material size on a log scale versus cumulative percent on a normal scale.

The D_{50} of the bar sample (notated as $D^{\wedge}_{50}$) is utilized in the sediment competence and entrainment computations when calculating dimensionless shear stress (Rosgen, 2006).

Looking upstream.



Looking towards the left bank.



Looking downstream.



Looking towards the right bank.



Figure B-3. San Antonio Creek: Reach 2 bar sample location.

Pfankuch Stability Rating

The overall channel bank and bed stability was assessed using a Pfankuch stability rating. At San Antonio Creek, ratings were subjectively evaluated between each of two representative riffle cross sections for each reach (two ratings per reach). At Calaveras Creek, ratings were evaluated on each reach. The rating was conducted according to procedures outlined in *Stream Reach Inventory and Channel Stability Evaluation* (Pfankuch, 1975).

Fifteen unique stream indicators of stability are evaluated along the upper banks, lower banks, and bottom. A numerical score is assigned in each category according to whether the reach is found to be in excellent, good, fair, or poor condition with respect to that category. The scores are summed, and the total score is used to identify the overall condition (good, fair, or poor) of the reach. Scores range from a minimum of 38 to a maximum of 152.

A modified version of the Pfankuch stability rating, in which the overall condition varies by stream type, is proposed by Rosgen. The reach conditions are based on this modified model.

Rosgen Stream Classification

Rosgen describes a method of classifying rivers and streams in *A Classification of Natural Rivers* (Rosgen, 1994). The method is intended to provide a common language among practitioners when discussing various channels and to provide a structure for relating one channel to another. According to this method, a stream channel is classified by its entrenchment ratio, width/depth ratio, sinuosity, slope, and channel material. The first four properties will be derived from the topographical survey data. Since the surveys are not yet complete, preliminary classifications presented in the Results Section are based on best professional judgment. These preliminary classifications will be reviewed and adjusted as necessary upon completion of the survey tasks, which is expected to occur in the next project phase.

Data Analysis

Gage Data, Bankfull, & Secondary Hydrogeomorphic Features (Rack Lines)

Some initial gage data analysis was completed in order to determine the validity of collecting rack line data in the field. This section describes the links between the observed rack lines and a particular storm event, the gage data and analysis, and the assumptions made regarding both. As this is a preliminary analysis for the purposes of

validating the collection of additional field data, more data analysis and verification of assumptions is expected to be conducted in future phases of the project.

Obvious rack lines of small woody debris (wood and leaves less than one half inch) and silts were discernable along the entire length of the San Antonio Creek project area during the assessment phase. It was assumed that, unlike the denser washload constituents of silt and sand, the small woody debris portion of rack lines, being the least dense, indicate the approximate peak elevation of the associated storm flow because woody debris will float even during extremely low velocity flows such as those that occur along the margins of overbank flooding.

Just prior to the initiation of the field assessment, a large storm event occurred in the region. According to USGS gauge data at Arroyo Hondo (USGS site number 11173200), the peak of the storm occurred at 3:30 am on March 4, 2009 (USGS, 2009). This event generated elevated discharges in Arroyo Hondo over a period of eight days. Arroyo Hondo was chosen for this review because it is the nearest gauging station with long term data in a watershed without dam-moderated flow.

It was assumed that the observed rack lines were the result of the March 4, 2009 storm because the rack lines were very recent (long continuous woody debris lines and fine silts coating grasses and cool-season weeds which were undisturbed by cattle or subsequent rainfall), and no other large storm events had occurred between the March 4, 2009 storm and the initiation of the field assessment. As a result, it was assumed that the small woody debris elevation indicates the approximate peak flow elevation of the March 4, 2009 storm.

The peak flow at Arroyo Hondo measured 3,350 cubic feet per second. Using 26 years of annual peak flow data from that station (USGS, 2009), a log-Pearson type III distribution was prepared in order to calculate the return interval of the March 4, 2009 storm. Based on the distribution, the storm has a 2.1-year recurrence interval at Arroyo Hondo.

Fluvial geomorphology literature indicates that the typical bankfull flow, or the channel forming flow, has a return interval between one and two years with an average of 1.5 years (Leopold, 1964). This would seem to indicate that the March 4, 2009 storm was slightly larger than a bankfull event. No analysis has yet been conducted to determine the return interval of a bankfull event in Arroyo Hondo.

Although rain data has yet to be reviewed, based on the duration of the storm flow in Arroyo Hondo (eight days), it can be reasonably assumed that rain during the event also

occurred over a number of days, and as such was the result of a large regional weather system and not a small isolated storm. Furthermore, although rainfall distribution can vary within regional storm systems, for the current purposes, it can be reasonably assumed that the return interval of rainfall experienced in the Arroyo Hondo watershed is similar to the rainfall experienced in the project area watersheds.

Clear and definitive bankfull indictors could not be consistently observed in the field due to recent erosion and deposition in the channel; however, the observed rack lines occurred at or above observable bankfull features (intermittent bench or slight grade change). Since 2.1 years is just above the typical range for a bankfull event and the rack lines observed were at or above a discernable stream bank feature, these features are assumed to be near the bankfull elevation of the stream.

On the basis that the rack lines are near in elevation to bankfull and may help to identify appropriate bankfull features, it was determined that collection of the rack line data was valuable.

In future phases, rainfall and bankfull analyses will be conducted to fill in data gaps and ascertain the appropriateness of the above assumptions.

Appendix C: Hydrology Data

C-1 Rain and Stream Gage Figures and Data



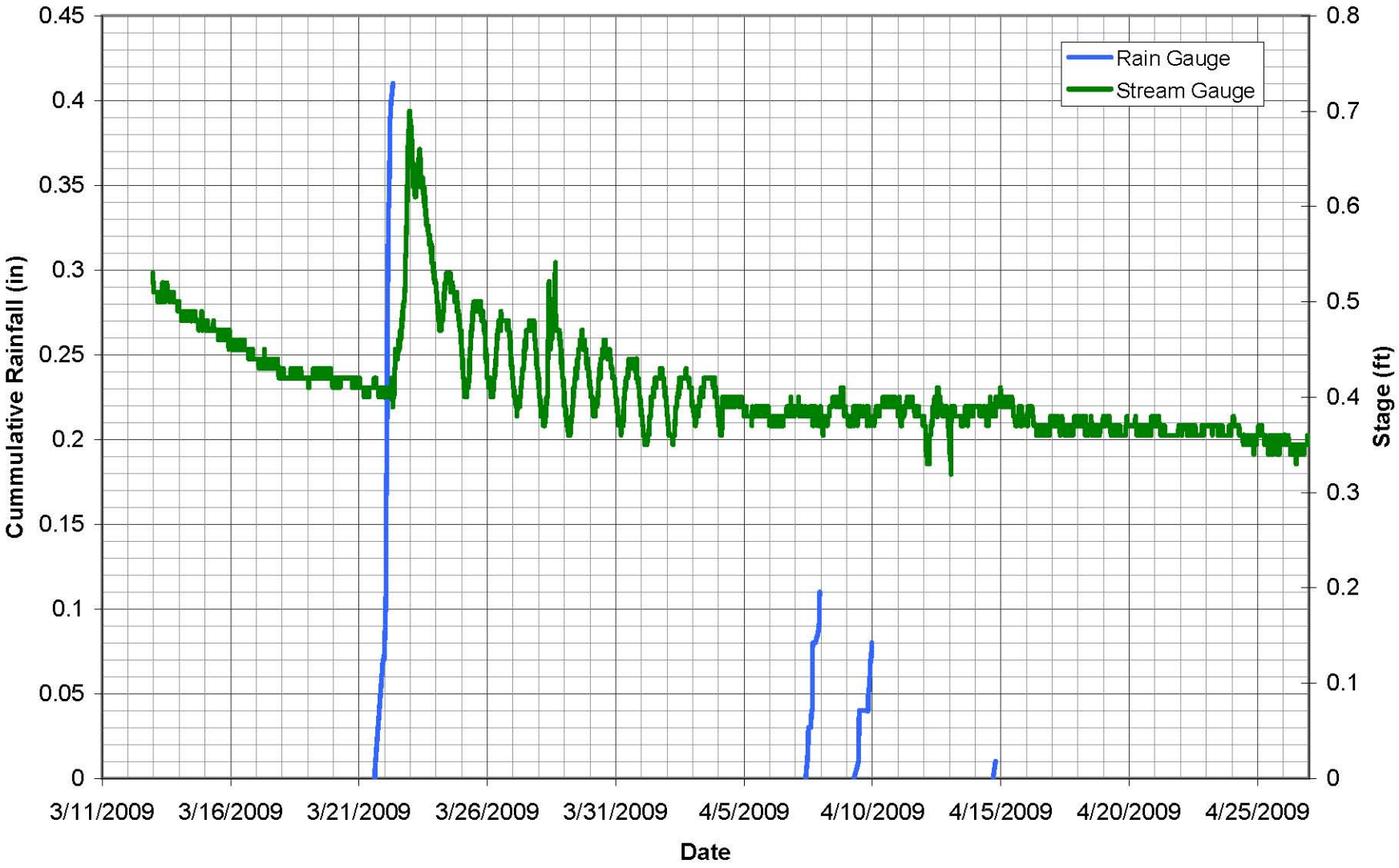
HRP boundary
Rain gage
Stream gage
0 50 100
FEET
N

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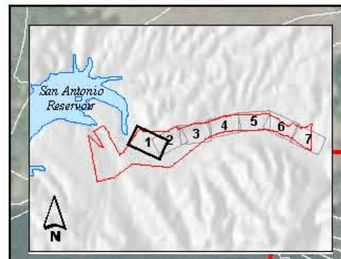
San Antonio Creek
Stream and Rain Gage Locations

Appendix
C-1

L:\Projects\California\San_Jose_28067577\Working Documents\Environmental Restoration\SA_Creek_rain_gage_location.mxd


San Antonio Creek Gages (3/11/09-4/27/09)
Rain Gauge
Stream Gauge
Cummulative Rainfall (in)
Stage (ft)
Date
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
3/11/2009
3/16/2009
3/21/2009
3/26/2009
3/31/2009
4/5/2009
4/10/2009
4/15/2009
4/20/2009
4/25/2009

C-2: San Antonio Creek Mapping Figures



510
505
495
500
490
485
480
485
475
465
470
470
470
480
500

Bank pin
Point bar sample
Rain gage
Stream gage
Rack line point
Bank Erosion-Cutbank
Conglomerate Bedrock
Compensation area
Cross-section
Deposition
Overbank flow path
Pointbar
Rack line
Reach Break
Tributary
Glide
Pool
Riffle
Run
Stream feature end point

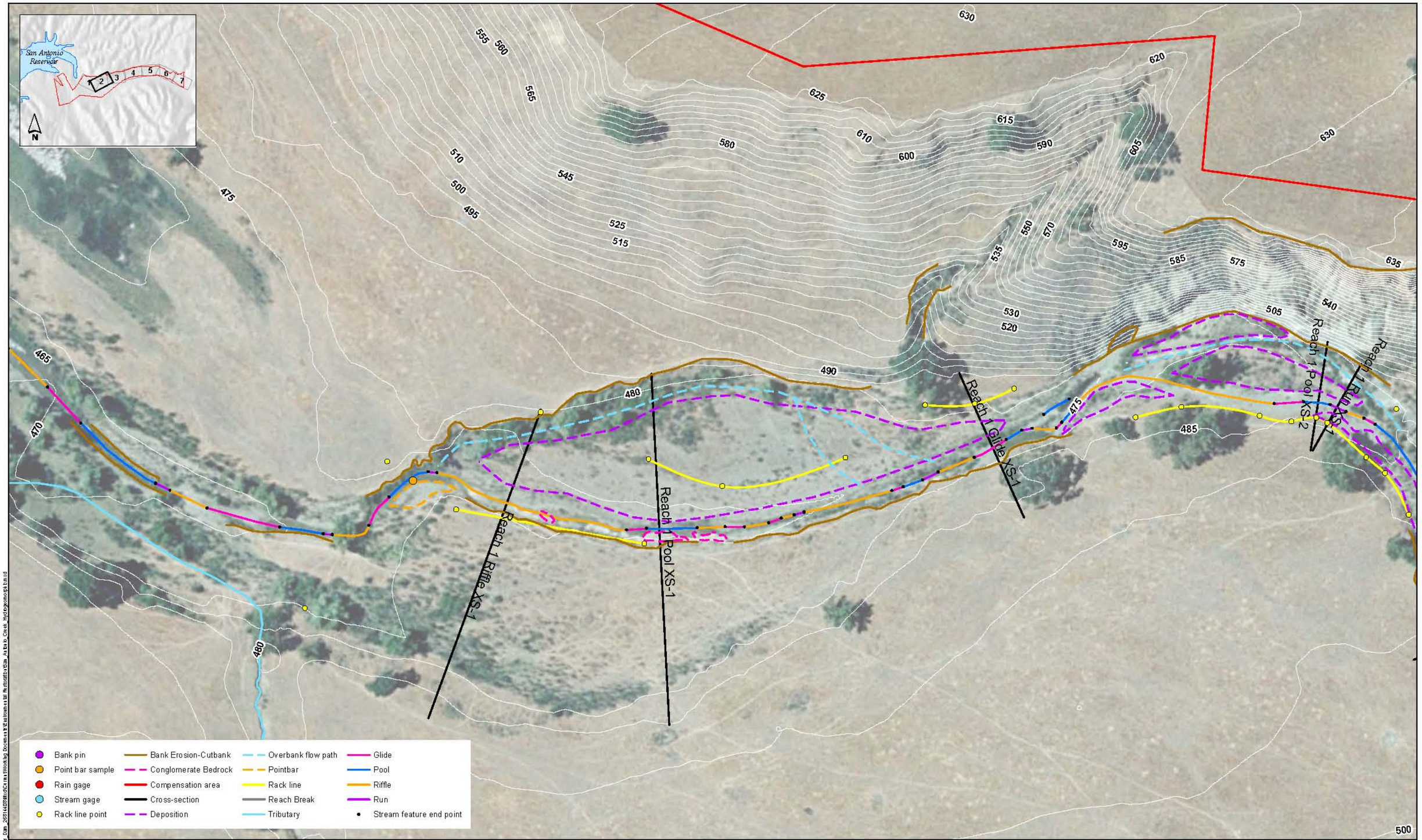
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FEET
CONTOUR INTERVAL = 5 FEET

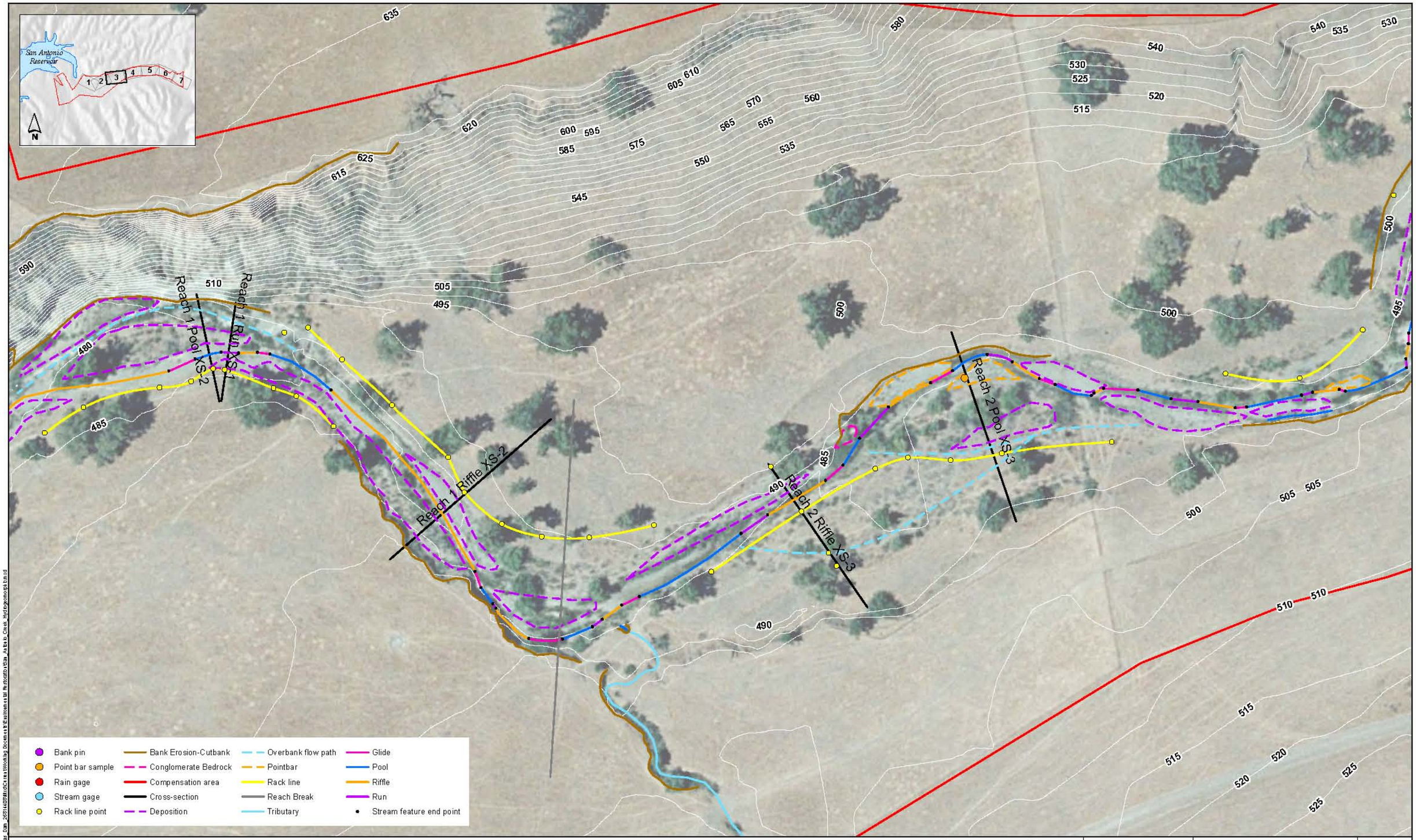
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San Antonio Creek
Hydrogeomorphic Studies

Appendix
C-2.1

L:\Projects\Caltrans_Dan_26514\05Mitig\GCrs\Working Documents\Environmental Restoration\San_Antonio_Creek_HydrogeomorphStudy.mxd


San Antonio Reservoir
1
2
3
4
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N
Reach 1 Riffle XS-1
Reach 1 Pool XS-1
Reach 1 Glide XS-1
Reach 1 Pool XS-2
Reach 1 Run XS-1
Bank pin
Point bar sample
Rain gage
Stream gage
Rack line point
Bank Erosion-Cutbank
Conglomerate Bedrock
Compensation area
Cross-section
Deposition
Overbank flow path
Pointbar
Rack line
Reach Break
Tributary
Glide
Pool
Riffle
Run
Stream feature end point
0
100
200
FEET
CONTOUR INTERVAL = 5 FEET
SFPUC
HABITAT RESERVE PROGRAM
URS PROJECT NO. 28067577
San Antonio Creek
Hydrogeomorphic Studies
Appendix
C-2.2

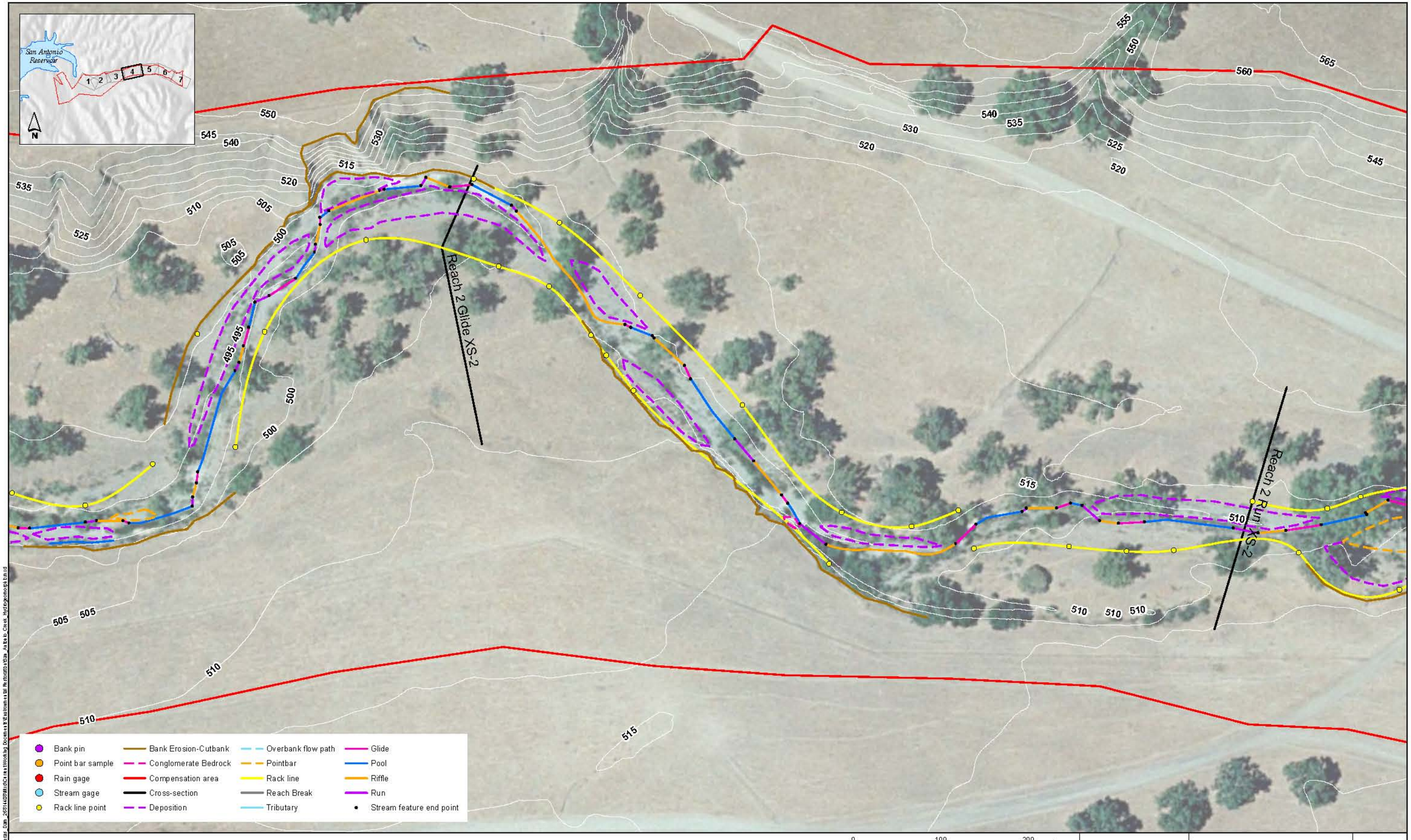


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San Antonio Creek
Hydrogeomorphic Studies

Appendix
C-2.3

L:\Projects\Calaveras_Dam_26514\DWG\Cad\Illustrator Documents\Environmental Reports\San Antonio Creek Hydrogeomorphic.mxd



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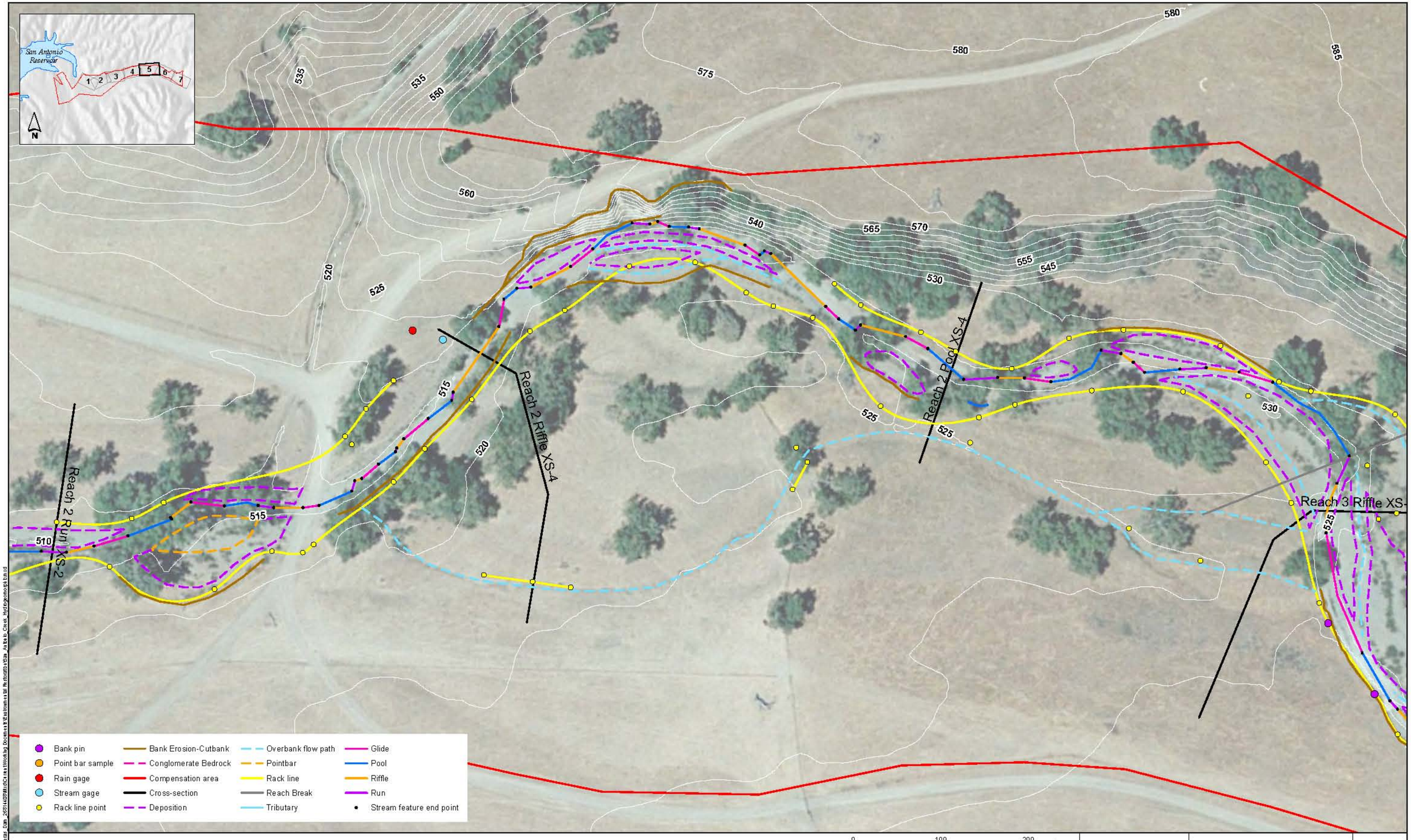
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CONTOUR INTERVAL = 5 FEET

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San Antonio Creek
Hydrogeomorphic Studies

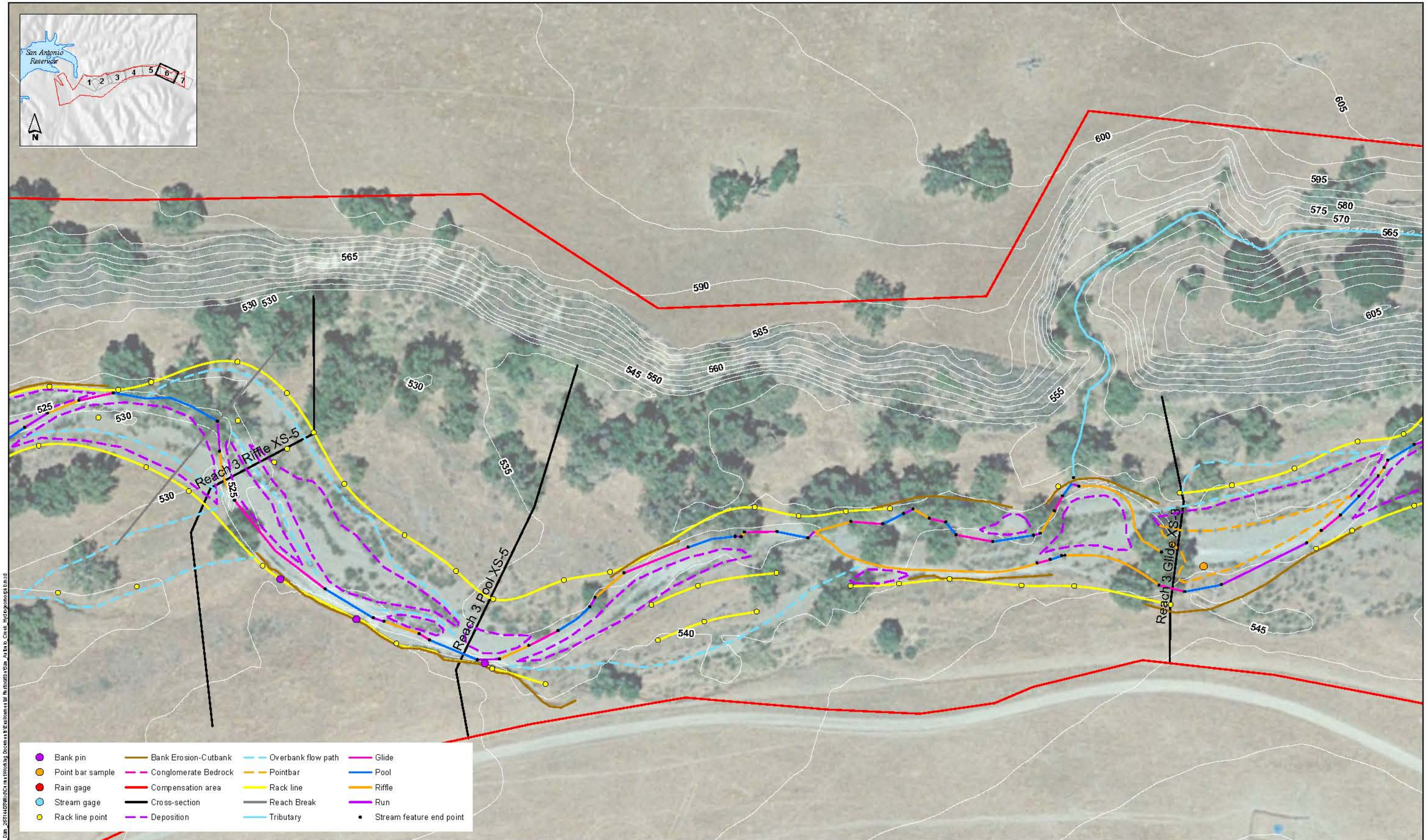
Appendix
C-2.4

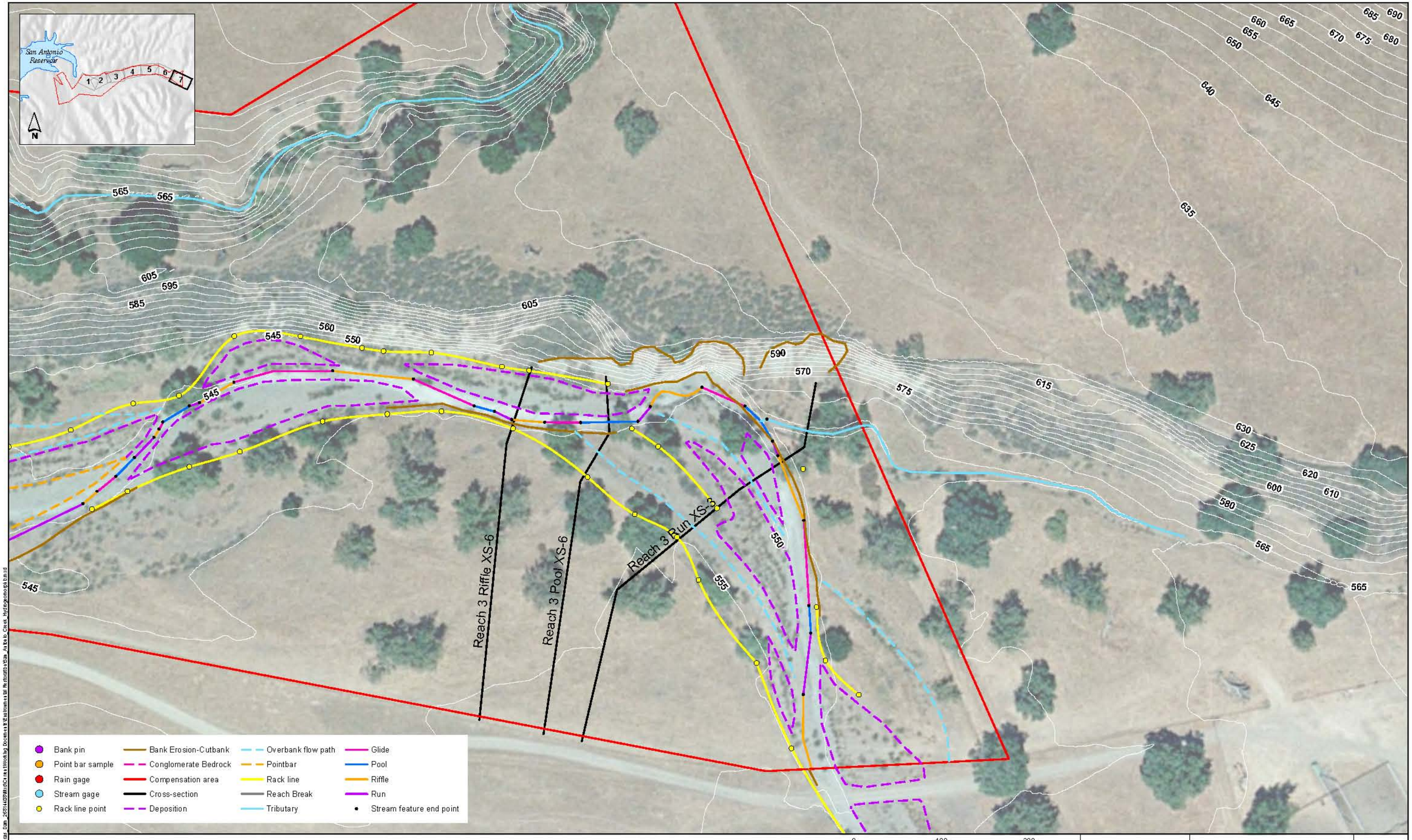


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San Antonio Creek
Hydrogeomorphic Studies

Appendix
C-2.5


San Antonio Reservoir
1
2
3
4
5
6
7
N
565
530
530
590
585
545
550
560
555
600
605
595
575
580
570
565
605
525
530
530
Reach 3 Riffle XS-5
525
535
Reach 3 Pool XS-5
540
Reach 3 Glide XS-3
545
Bank pin
Point bar sample
Rain gage
Stream gage
Rack line point
Bank Erosion-Cutbank
Conglomerate Bedrock
Compensation area
Cross-section
Deposition
Overbank flow path
Pointbar
Rack line
Reach Break
Tributary
Glide
Pool
Riffle
Run
Stream feature end point
0
100
200
FEET
CONTOUR INTERVAL = 5 FEET
SFPUC
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URS PROJECT NO. 28067577
San Antonio Creek
Hydrogeomorphic Studies
Appendix
C-2.6



0 100 200

FEET

CONTOUR INTERVAL = 5 FEET

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URS PROJECT NO. 28067577

San Antonio Creek
Hydrogeomorphic Studies

Appendix
C-2.7

L:\Projects\Caltrans_Dan_26814\MXD\MXDs\Final Working Documents\Figures\Final Restoration Plan_Attach_Creek_Hydrogeomorph.mxd

C-3 San Antonio Photo Pages



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 1. San Antonio Creek Reach 1 Riffle 1 (3/23/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 2. San Antonio Creek Reach 1 Pool 1 (3/23/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 3. San Antonio Creek Reach 1 Glide 1 (3/23/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 4. San Antonio Creek Reach 1 Pool 2 (3/23/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 5. San Antonio Creek Reach 1 Run 1 (3/23/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 6. San Antonio Creek Reach 1 Riffle 2 (3/23/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 7. San Antonio Creek Reach 2 Riffle 3 (3/23/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 8. San Antonio Creek Reach 2 Pool 3 (3/23/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 9. San Antonio Creek Reach 2 Glide 2 (3/23/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 10. San Antonio Creek Reach 2 Run 2 (3/24/09).



Looking upstream.



Looking towards the left bank.

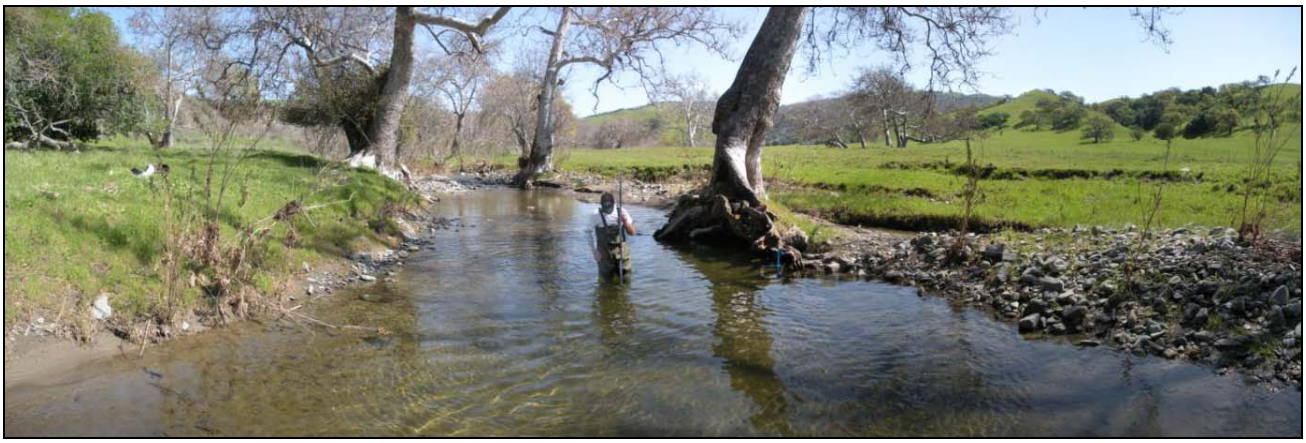


Looking towards the right bank.

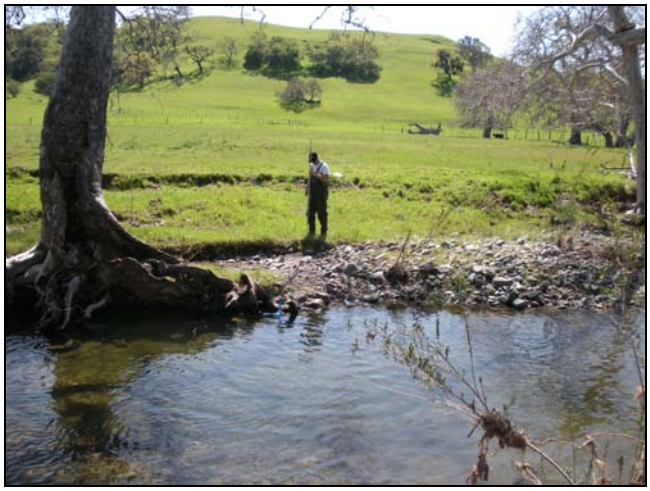


Looking downstream.

Figure 11. San Antonio Creek Reach 2 Riffle 4 (stream gage location) (3/12/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 12. San Antonio Creek Reach 2 Pool 4 (3/24/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 13. San Antonio Creek Reach 3 Riffle 5 (3/25/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 14. San Antonio Creek Reach 3 Pool 5 (3/25/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 15. San Antonio Creek Reach 3 Glide 3 (3/25/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 16. San Antonio Creek Reach 3 Riffle 6 (3/25/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 17. San Antonio Creek Reach 3 Pool 6 (3/25/09).



Looking upstream.



Looking towards the left bank.



Looking towards the right bank.



Looking downstream.

Figure 18. San Antonio Creek Reach 3 Run 3 (3/25/09).

C-4 San Antonio Pebble Data

Pebble Count Analysis

River: San Antonio Creek **Party:** JP & SEL

Location: Reach 1 Riffle 1 **Date:** 30-Mar-09

Particle Class		Size (mm)	Size (finer than)	Active Bed			Riffle Section			Reach (DS Subreach)		
				Total #	Item %	% Cum	Total #	Item %	% Cum	Total #	Item %	% Cum
Silt/Clay		< 0.062	0.062		0%	0%	4	4%	4%	2	2%	2%
Sand	Very Fine	0.062-0.125	0.125		0%	0%	3	3%	7%	2	2%	4%
	Fine	0.125-0.25	0.25	2	2%	2%	14	14%	21%	7	7%	11%
	Medium	0.25-0.5	0.5	8	8%	10%	8	8%	29%	7	7%	18%
	Coarse	0.5-1.0	1	6	6%	16%	3	3%	32%	4	4%	22%
	Very Coarse	1.0-2	2		0%	16%		0%	32%	2	2%	24%
Gravel	Very Fine	2-4	4		0%	16%	2	2%	34%	2	2%	26%
	Fine	4-5.7	5.7	1	1%	17%	3	3%	37%	1	1%	27%
	Fine	5.7-8	8		0%	17%	4	4%	41%	8	8%	35%
	Medium	8-11.3	11.3	3	3%	20%	3	3%	44%	4	4%	39%
	Medium	11.3-16	16	4	4%	24%	2	2%	46%	4	4%	43%
	Coarse	16-22.6	22.6	6	6%	30%	7	7%	52%	6	6%	49%
	Coarse	22.6-32	32	10	10%	40%	3	3%	55%	7	7%	55%
	Very Coarse	32-45	45	16	16%	56%	15	15%	70%	8	8%	63%
	Very Coarse	45-64	64	16	16%	72%	8	8%	78%	12	12%	75%
Cobble	Small	64-90	90	11	11%	83%	9	9%	87%	4	4%	79%
	Small	90-128	128	8	8%	91%	9	9%	96%	9	9%	88%
	Large	128-180	180	2	2%	93%	2	2%	98%	5	5%	93%
	Large	180-256	256	1	1%	94%	1	1%	99%	4	4%	97%
Boulder	Small	256-362	362		0%	94%		0%	99%		0%	97%
	Small	362-512	512		0%	94%		0%	99%		0%	97%
	Medium	512-1024	1024		0%	94%		0%	99%		0%	97%
	Large-Very Large	1024-2048	2048		0%	94%		0%	99%		0%	97%
Bedrock			3000	6	6%	100%	1	1%	100%	3	3%	100%
		TOTALS -->		100			101			101		
				D50	40		D84	80		D50	24	

Pebble Count Analysis

River: San Antonio Creek **Party:** JP & SEL

Location: Reach 1 Riffle 2 **Date:** 3/30/09 - 4/1/09

Particle Class		Size (mm)	Size (finer than)	Active Bed			Riffle Section			Reach (US Subreach)		
				Total #	Item %	% Cum	Total #	Item %	% Cum	Total #	Item %	% Cum
Silt/Clay		< 0.062	0.062		0%	0%	2	2%	2%	1	1%	1%
Sand	Very Fine	0.062-0.125	0.125		0%	0%	2	2%	4%	3	3%	4%
	Fine	0.125-0.25	0.25		0%	0%	4	4%	8%	3	3%	7%
	Medium	0.25-0.5	0.5	3	3%	3%	2	2%	10%	7	7%	14%
	Coarse	0.5-1.0	1	2	2%	5%	5	5%	15%	2	2%	16%
	Very Coarse	1.0-2	2	4	4%	9%	2	2%	17%	5	5%	21%
Gravel	Very Fine	2-4	4	3	3%	12%	3	3%	20%	1	1%	22%
	Fine	4-5.7	5.7	5	5%	17%	2	2%	22%	2	2%	24%
	Fine	5.7-8	8	5	5%	22%	6	6%	28%	3	3%	27%
	Medium	8-11.3	11.3	3	3%	25%	10	10%	38%	6	6%	33%
	Medium	11.3-16	16	3	3%	28%	8	8%	46%	12	12%	45%
	Coarse	16-22.6	22.6	6	6%	34%	7	7%	53%	5	5%	50%
	Coarse	22.6-32	32	5	5%	39%	11	11%	64%	12	12%	62%
	Very Coarse	32-45	45	14	14%	53%	9	9%	73%	12	12%	74%
	Very Coarse	45-64	64	11	11%	64%	8	8%	81%	7	7%	81%
Cobble	Small	64-90	90	12	12%	76%	8	8%	89%	8	8%	89%
	Small	90-128	128	12	12%	88%	7	7%	96%	8	8%	97%
	Large	128-180	180	7	7%	95%	1	1%	97%	3	3%	100%
	Large	180-256	256	4	4%	99%	3	3%	100%		0%	100%
Boulder	Small	256-362	362	1	1%	100%		0%	100%		0%	100%
	Small	362-512	512		0%	100%		0%	100%		0%	100%
	Medium	512-1024	1024		0%	100%		0%	100%		0%	100%
	Large-Very Large	1024-2048	2048		0%	100%		0%	100%		0%	100%
Bedrock			3000		0%	100%		0%	100%		0%	100%
		TOTALS -->		100			100			100		
				D50	42		D84	73		D50	22.6	

Pebble Count Analysis

River: San Antonio Creek
Location: Reach 2 Riffle 3
Party: JP & SEL
Date: 4/1/09 - 4/2/09

Particle Class		Size (mm)	Size (finer than)	Active Bed			Riffle Section			Reach (DS Subreach)		
				Total #	Item %	% Cum	Total #	Item %	% Cum	Total #	Item %	% Cum
Silt/Clay		< 0.062	0.062	1	1%	1%	9	9%	9%	2	2%	2%
Sand	Very Fine	0.062-0.125	0.125	1	1%	2%	5	5%	14%	5	5%	7%
	Fine	0.125-0.25	0.25		0%	2%	1	1%	15%	7	7%	14%
	Medium	0.25-0.5	0.5		0%	2%	3	3%	18%	11	11%	25%
	Coarse	0.5-1.0	1	4	4%	6%	4	4%	22%	3	3%	28%
	Very Coarse	1.0-2	2	4	4%	10%	5	5%	27%	5	5%	33%
Gravel	Very Fine	2-4	4	1	1%	11%	3	3%	30%	2	2%	35%
	Fine	4-5.7	5.7	1	1%	12%	1	1%	31%	2	2%	37%
	Fine	5.7-8	8	3	3%	15%	3	3%	34%	3	3%	40%
	Medium	8-11.3	11.3	4	4%	19%	2	2%	36%	1	1%	41%
	Medium	11.3-16	16	6	6%	25%	8	8%	44%	6	6%	47%
	Coarse	16-22.6	22.6	8	8%	33%	9	9%	53%	3	3%	50%
	Coarse	22.6-32	32	9	9%	42%	10	10%	63%	13	13%	63%
	Very Coarse	32-45	45	12	12%	54%	11	11%	74%	8	8%	71%
	Very Coarse	45-64	64	10	10%	64%	10	10%	84%	11	11%	82%
Cobble	Small	64-90	90	15	15%	79%	10	10%	94%	9	9%	91%
	Small	90-128	128	6	6%	85%	3	3%	97%	4	4%	95%
	Large	128-180	180	7	7%	92%	1	1%	98%	1	1%	96%
	Large	180-256	256	4	4%	96%	2	2%	100%	1	1%	97%
Boulder	Small	256-362	362	3	3%	99%		0%	100%	1	1%	98%
	Small	362-512	512	1	1%	100%		0%	100%		0%	98%
	Medium	512-1024	1024		0%	100%		0%	100%		0%	98%
	Large-Very Large	1024-2048	2048		0%	100%		0%	100%		0%	98%
Bedrock			3000		0%	100%		0%	100%	2	2%	100%
		TOTALS -->		100			100			100		
				D50	40		D84	64		D50	23	

Pebble Count Analysis

River: San Antonio Creek **Party:** JP & SEL

Location: Reach 2 Riffle 4 (Stream Gage) **Date:**

Particle Class		Size (mm)	Size (finer than)	Active Bed			Riffle Section			Reach (US Subreach)		
				Total #	Item %	% Cum	Total #	Item %	% Cum	Total #	Item %	% Cum
Silt/Clay		< 0.062	0.062		0%	0%	4	3%	3%	1	1%	1%
Sand	Very Fine	0.062-0.125	0.125	1	1%	1%	6	4%	7%	6	4%	5%
	Fine	0.125-0.25	0.25	4	4%	5%	26	18%	24%	12	9%	14%
	Medium	0.25-0.5	0.5	3	3%	8%	9	6%	30%	13	9%	23%
	Coarse	0.5-1.0	1		0%	8%		0%	30%	5	4%	27%
	Very Coarse	1.0-2	2	4	4%	12%	4	3%	33%		0%	27%
Gravel	Very Fine	2-4	4		0%	12%		0%	33%		0%	27%
	Fine	4-5.7	5.7		0%	12%		0%	33%	4	3%	29%
	Fine	5.7-8	8	4	4%	16%	4	3%	36%	4	3%	32%
	Medium	8-11.3	11.3	6	6%	22%	6	4%	40%	10	7%	40%
	Medium	11.3-16	16	4	4%	26%	4	3%	43%	8	6%	45%
	Coarse	16-22.6	22.6	5	5%	31%	6	4%	47%	10	7%	53%
	Coarse	22.6-32	32	8	8%	39%	10	7%	53%	4	3%	55%
	Very Coarse	32-45	45	8	8%	47%	9	6%	59%	14	10%	65%
	Very Coarse	45-64	64	16	16%	63%	18	12%	72%	10	7%	73%
Cobble	Small	64-90	90	13	13%	76%	14	9%	81%	11	8%	81%
	Small	90-128	128	11	11%	87%	14	9%	91%	6	4%	85%
	Large	128-180	180	9	9%	96%	10	7%	97%	13	9%	94%
	Large	180-256	256	4	4%	100%	4	3%	100%	6	4%	99%
Boulder	Small	256-362	362		0%	100%		0%	100%	1	1%	99%
	Small	362-512	512		0%	100%		0%	100%		0%	99%
	Medium	512-1024	1024		0%	100%		0%	100%		0%	99%
	Large-Very Large	1024-2048	2048		0%	100%		0%	100%		0%	99%
Bedrock			3000		0%	100%		0%	100%	1	1%	100%
		TOTALS -->		100			148			139		
				D50	48		D84	100		D50	20	

Pebble Count Analysis

River: San Antonio Creek **Party:** JP & DJ

Location: Reach 3 Riffle 5 **Date:** 2-Apr-09

Particle Class		Size (mm)	Size (finer than)	Active Bed			Riffle Section			Reach (DS Subreach)		
				Total #	Item %	% Cum	Total #	Item %	% Cum	Total #	Item %	% Cum
Silt/Clay		< 0.062	0.062		0%	0%	5	5%	5%	2	2%	2%
Sand	Very Fine	0.062-0.125	0.125	1	1%	1%	4	4%	9%	6	6%	8%
	Fine	0.125-0.25	0.25	1	1%	2%	15	15%	24%	4	4%	12%
	Medium	0.25-0.5	0.5	8	8%	10%	6	6%	30%	9	9%	21%
	Coarse	0.5-1.0	1	2	2%	12%	3	3%	33%	3	3%	24%
	Very Coarse	1.0-2	2	1	1%	13%	5	5%	38%	6	6%	30%
Gravel	Very Fine	2-4	4	2	2%	15%		0%	38%	1	1%	31%
	Fine	4-5.7	5.7	2	2%	17%	4	4%	42%	2	2%	33%
	Fine	5.7-8	8	4	4%	21%	2	2%	44%	4	4%	37%
	Medium	8-11.3	11.3	3	3%	24%	1	1%	45%	5	5%	42%
	Medium	11.3-16	16	1	1%	25%	2	2%	47%	10	10%	52%
	Coarse	16-22.6	22.6	9	9%	34%	3	3%	50%	6	6%	58%
	Coarse	22.6-32	32	9	9%	43%	5	5%	55%	6	6%	64%
	Very Coarse	32-45	45	13	13%	56%	11	11%	66%	7	7%	71%
	Very Coarse	45-64	64	11	11%	67%	6	6%	72%	9	9%	80%
Cobble	Small	64-90	90	11	11%	78%	14	14%	86%	9	9%	89%
	Small	90-128	128	10	10%	88%	5	5%	91%	6	6%	95%
	Large	128-180	180	10	10%	98%	6	6%	97%	4	4%	99%
	Large	180-256	256	1	1%	99%	3	3%	100%	1	1%	100%
Boulder	Small	256-362	362	1	1%	100%		0%	100%		0%	100%
	Small	362-512	512		0%	100%		0%	100%		0%	100%
	Medium	512-1024	1024		0%	100%		0%	100%		0%	100%
	Large-Very Large	1024-2048	2048		0%	100%		0%	100%		0%	100%
Bedrock			3000		0%	100%		0%	100%		0%	100%
		TOTALS -->		100			100			100		
				D50	38		D84	86		D50	15	

Pebble Count Analysis

River: San Antonio Creek
Location: Reach 3 Riffle 6
Party: JP & SEL, MC & JP
Date: 3/26/09 & 4/6/09

Particle Class		Size (mm)	Size (finer than)	Active Bed			Riffle Section			Reach (US Subreach)		
				Total #	Item %	% Cum	Total #	Item %	% Cum	Total #	Item %	% Cum
Silt/Clay		< 0.062	0.062		0%	0%		0%	0%	2	2%	2%
Sand	Very Fine	0.062-0.125	0.125		0%	0%		0%	0%	8	8%	10%
	Fine	0.125-0.25	0.25		0%	0%	4	4%	4%	5	5%	15%
	Medium	0.25-0.5	0.5	2	2%	2%	5	5%	8%	10	10%	25%
	Coarse	0.5-1.0	1	5	5%	7%	1	1%	9%	6	6%	31%
	Very Coarse	1.0-2	2	4	4%	11%	1	1%	10%	1	1%	32%
Gravel	Very Fine	2-4	4	2	2%	13%		0%	10%	1	1%	33%
	Fine	4-5.7	5.7	1	1%	14%	1	1%	11%	3	3%	36%
	Fine	5.7-8	8	1	1%	15%	1	1%	12%	3	3%	39%
	Medium	8-11.3	11.3	1	1%	16%	1	1%	13%	3	3%	42%
	Medium	11.3-16	16	7	7%	23%	11	10%	23%	5	5%	47%
	Coarse	16-22.6	22.6	5	5%	28%	7	6%	29%	13	13%	60%
	Coarse	22.6-32	32	7	7%	35%	11	10%	39%	2	2%	62%
	Very Coarse	32-45	45	11	11%	46%	18	17%	56%	12	12%	74%
	Very Coarse	45-64	64	19	19%	65%	17	16%	72%	10	10%	84%
Cobble	Small	64-90	90	8	8%	73%	14	13%	84%	7	7%	91%
	Small	90-128	128	11	11%	84%	9	8%	93%	6	6%	97%
	Large	128-180	180	10	10%	94%	5	5%	97%	2	2%	99%
	Large	180-256	256	6	6%	100%	3	3%	100%		0%	99%
Boulder	Small	256-362	362		0%	100%		0%	100%	1	1%	100%
	Small	362-512	512		0%	100%		0%	100%		0%	100%
	Medium	512-1024	1024		0%	100%		0%	100%		0%	100%
	Large-Very Large	1024-2048	2048		0%	100%		0%	100%		0%	100%
Bedrock			3000		0%	100%		0%	100%		0%	100%
		TOTALS -->		100			109			100		
				D50	48		D84	89		D50	17	

Point / Side BAR-BULK MATERIALS SAMPLE DATA: Size Distribution Analysis

Party: JP & SL

Location: San Antonio Creek Reach 1 (DS of RF1)

Date: 4/9/09

Notes:

SUB SAMPLES

	Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE	
	2 largest		75 mm		37.5 mm		25.4 mm		19 mm		12.5 mm		4.75 mm		2 mm		< 2 mm	
	Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight	
	n/a		1.02 lbs		1.41 lbs		1.61 lbs		1.4 lbs		1.25 lbs		1.1 lbs		0.95 lbs		2.23 lbs	
	Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights	
	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net
1		20.21		5.09	9.93	8.52	3.11	1.5	3.22	1.82	2.94	1.69	1.92	0.82	2.20	1.25	34.00	31.77
2		6.7		1.85	6.65	5.24	5.01	3.4	3.43	2.03	2.78	1.53	1.62	0.52	1.77	0.82		
3											3.25	2	2.13	1.03	2.34	1.39		
4													1.82	0.72	1.90	0.95		
5													3.20	2.1	2.98	2.03		
6													3.21	2.11	4.83	3.88		
7													3.18	2.08	2.17	1.22		
8													3.50	2.4	2.13	1.18		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
Net Wt. Total		26.91		6.94		13.76		4.9		3.85		5.22		11.78		12.72		31.77
% Grand Tot.		22.8%		5.9%		11.7%		4.2%		3.3%		4.4%		10.0%		10.8%		27.0%
Accum. % =<		100.0%	→	77.2%	→	71.3%	→	59.6%	→	55.4%	→	52.2%	→	47.7%	→	37.8%	→	27.0%

117.85

GRAND TOTAL SAMPLE WEIGHT

SURFACE MATERIALS DATA
(Two Largest Particles)

No.	Dia.	WT.
1	149	20.21
2	122	6.70

Data for Plot

Size (Finer Than)	% Cumm
2	27.0%
4.75	37.8%
12.5	47.7%
19	52.2%
25.4	55.4%
37.5	59.6%
75	71.3%
122	77.2%
150	100.0%

D^50	15

NOTES 3" (75 mm) sieve 1st sample weighed w/ no sieve (115 mm) & 2nd sample (108 mm)

Worksheet 26. Bar sample form

Point / Side BAR-BULK MATERIALS SAMPLE DATA: Size Distribution Analysis

Party: JP & SL

Location: San Antonio Creek Reach 2 (@ Pool XS2)

Date: 4/10/09

Notes:

SUB SAMPLES

	Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE	
	2 largest		75 mm		37.5 mm		25.4 mm		19 mm		12.5 mm		4.75 mm		2 mm		< 2 mm	
	Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight	
	n/a		0.87 lbs		0.98 lbs		1.08 lbs		1 lbs		0.87 lbs		0.83 lbs		0.75 lbs		1.78 lbs	
	Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights	
	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net
1		5.60			4.31	3.33	3.06	1.98	2.55	1.55	2.82	1.95	3.38	2.55	2.54	1.79	19.18	17.40
2					10.43	9.45	2.80	1.72	2.15	1.15	2.16	1.29	2.89	2.06	2.60	1.85		
3					1.85	0.87	5.17	4.09	2.69	1.69	2.68	1.81	2.95	2.12	1.87	1.12		
4					16.07	15.09	4.89	3.81	2.60	1.60	3.00	2.13	3.33	2.5	2.76	2.01		
5						0.66												
6																		
7																		
8																		
9																		
10																		
11																		
12																		
13																		
14																		
15																		
Net Wt. Total	5.6		0		29.4		11.6		5.99		7.18		9.23		6.77		17.4	93.17
% Grand Tot.	6.0%		0.0%		31.6%		12.5%		6.4%		7.7%		9.9%		7.3%		18.7%	
Accum. % =<	100.0%	→	94.0%	→	94.0%	→	62.4%	→	50.0%	→	43.6%	→	35.8%	→	25.9%	→	18.7%	

GRAND TOTAL SAMPLE WEIGHT

SURFACE MATERIALS DATA
(Two Largest Particles)

No.	Dia.	WT.
1	164	5.60
2	70	0.66

Data for Plot

Size (Finer Than)	% Cumm
2	18.7%
4.75	25.9%
12.5	35.8%
19	43.6%
25.4	50.0%
37.5	62.4%
75	94.0%
165	100.0%

D^50	25

NOTES 3" (75 mm) sieve 1st sample weighed w/ no sieve (115 mm) & 2nd sample (108 mm)

Point / Side BAR-BULK MATERIALS SAMPLE DATA: Size Distribution Analysis

Party: JP & SL

Location: San Antonio Creek Reach 3 (@ Glide XS 3)

Date: 4/20/09

Notes:

SUB SAMPLES

	Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE	
	2 largest		75	mm	37.5	mm	25.4	mm	19	mm	12.5	mm	4.75	mm	2	mm	< 2	mm
	Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight		Tare Weight	
	n/a		0.97	lbs	1.1	lbs	1.34	lbs	1.02	lbs	0.96	lbs	0.89	lbs	0.87	lbs	1.93	lbs
	Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights		Sample Weights	
	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net
1		19.76		2.77	3.89	2.79	3.35	2.01	2.76	1.74	2.54	1.58	3.24	2.35	2.18	1.31	25.54	23.61
2				2.25	4.49	3.39	3.81	2.47	2.56	1.54	3.18	2.22	3.56	2.67	2.46	1.59		
3				1.79	5.10	4.00	4.21	2.87	2.00	0.98	3.89	2.93	4.67	3.78	3.20	2.33		
4				3.96		3.25	3.01	1.67	2.42	1.40	3.22	2.26	5.01	4.12	4.16	3.29		
5						1.17	4.42	3.08	3.43	2.41	2.95	1.99	4.18	3.29	3.01	2.14		
6						2.79	4.00	2.66	2.93	1.91	3.66	2.70	4.92	4.03	4.24	3.37		
7						1.07												
8						1.27												
9						0.71												
10																		
11																		
12																		
13																		
14																		
15																		
Net Wt. Total	19.76		10.77		20.44		14.76		9.98		13.68		20.24		14.03		23.61	147.27
% Grand Tot.	13.4%		7.3%		13.9%		10.0%		6.8%		9.3%		13.7%		9.5%		16.0%	
Accum. % =<	100.0%	→	86.6%	→	79.3%	→	65.4%	→	55.4%	→	48.6%	→	39.3%	→	25.6%	→	16.0%	

GRAND TOTAL SAMPLE WEIGHT

SURFACE MATERIALS DATA
(Two Largest Particles)

No.	Dia.	WT.
1	200	19.76
2	62	0.71

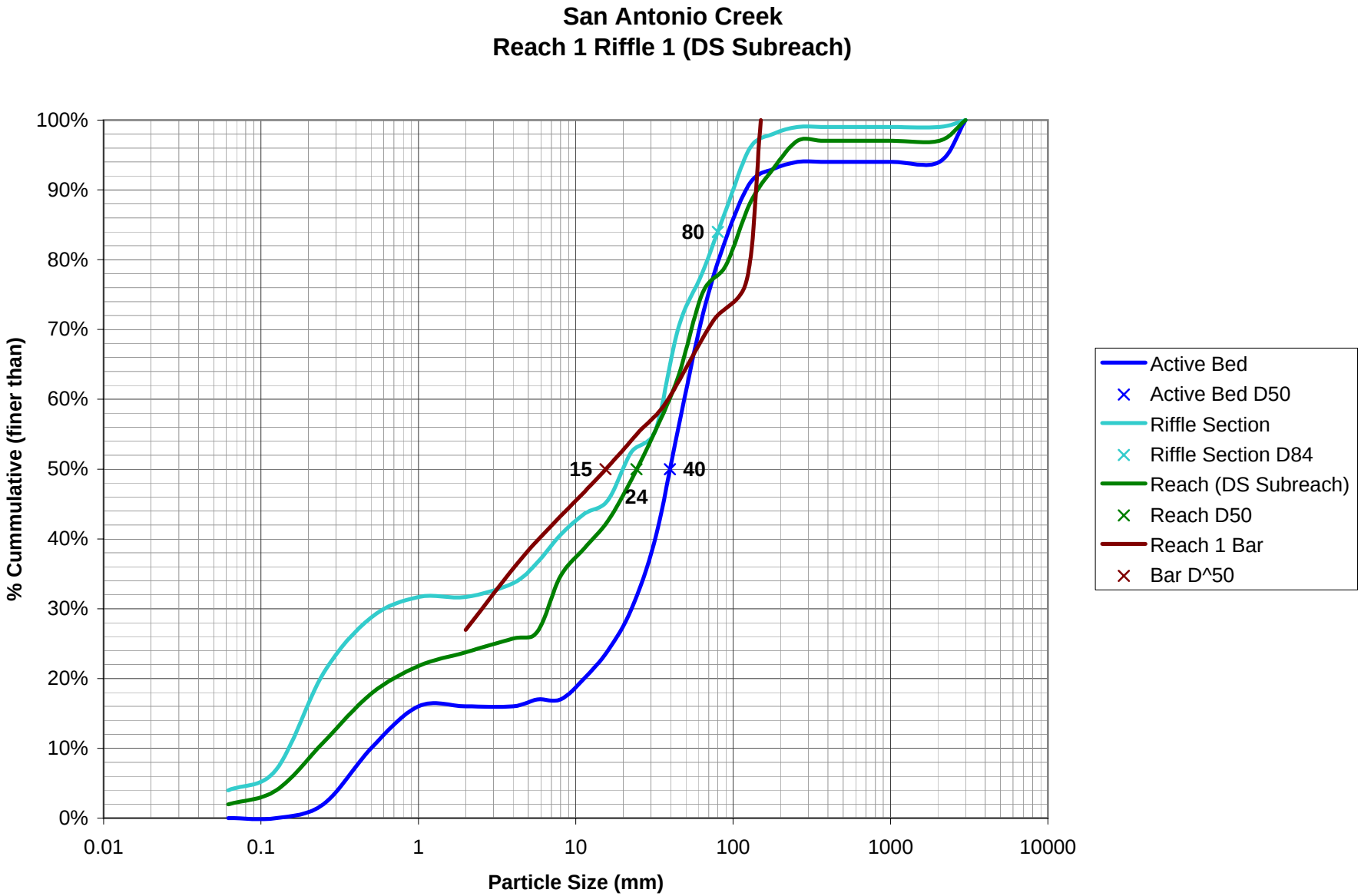
Data for Plot

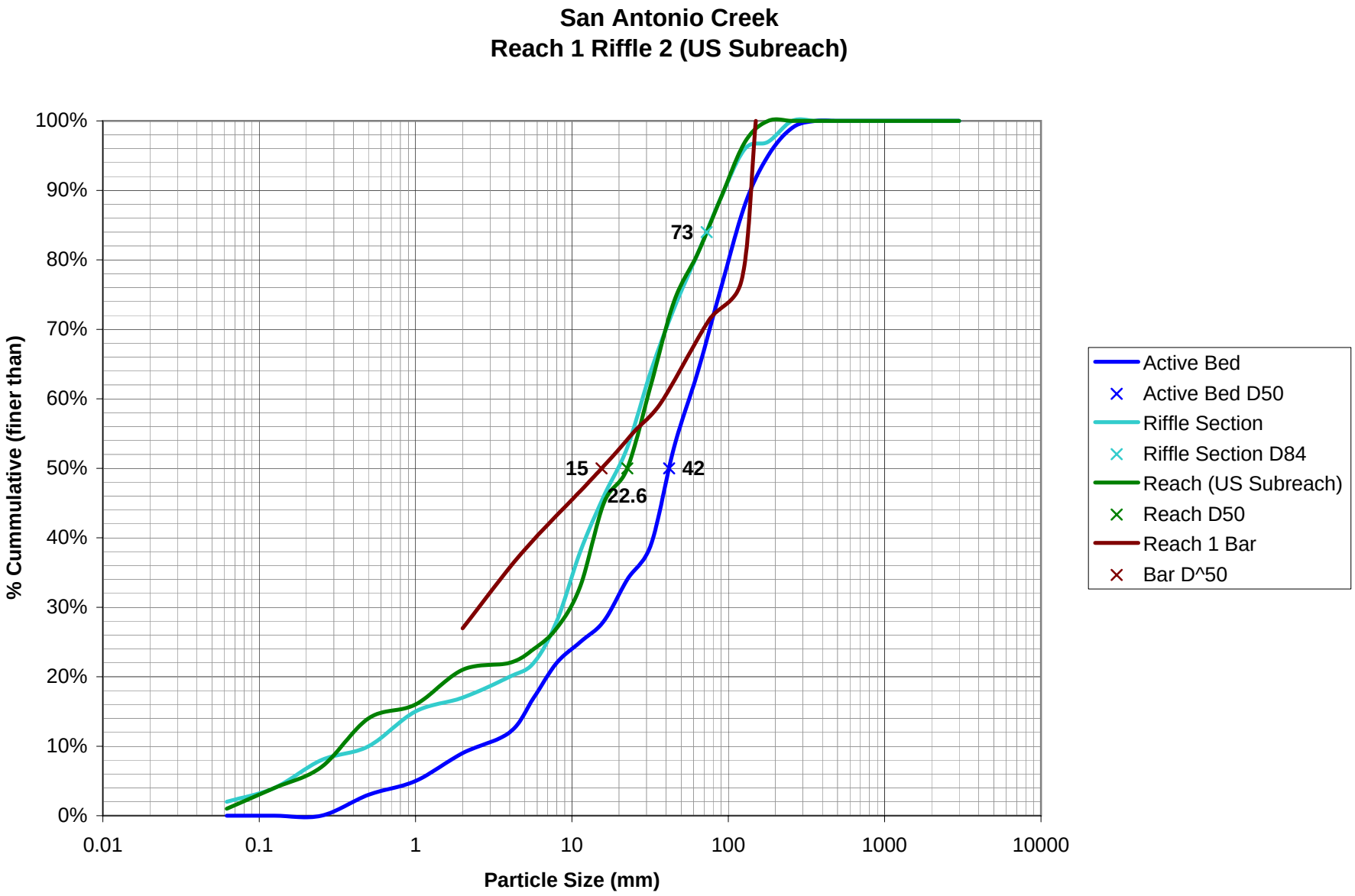
Size (Finer Than)	% Cumm
2	16.0%
4.75	25.6%
12.5	39.3%
19	48.6%
25.4	55.4%
37.5	65.4%
75	79.3%
201	100.0%

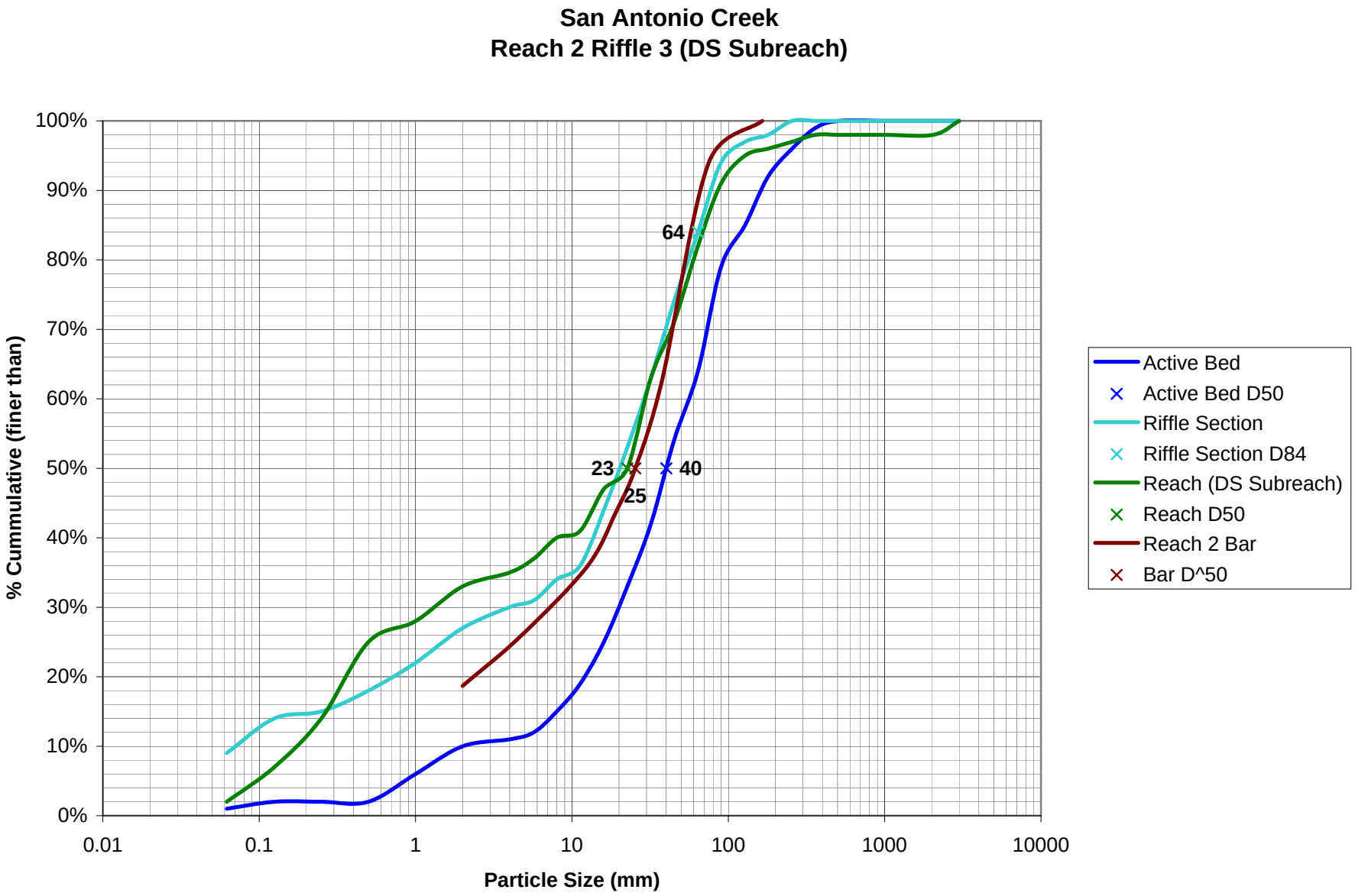
D^50	20

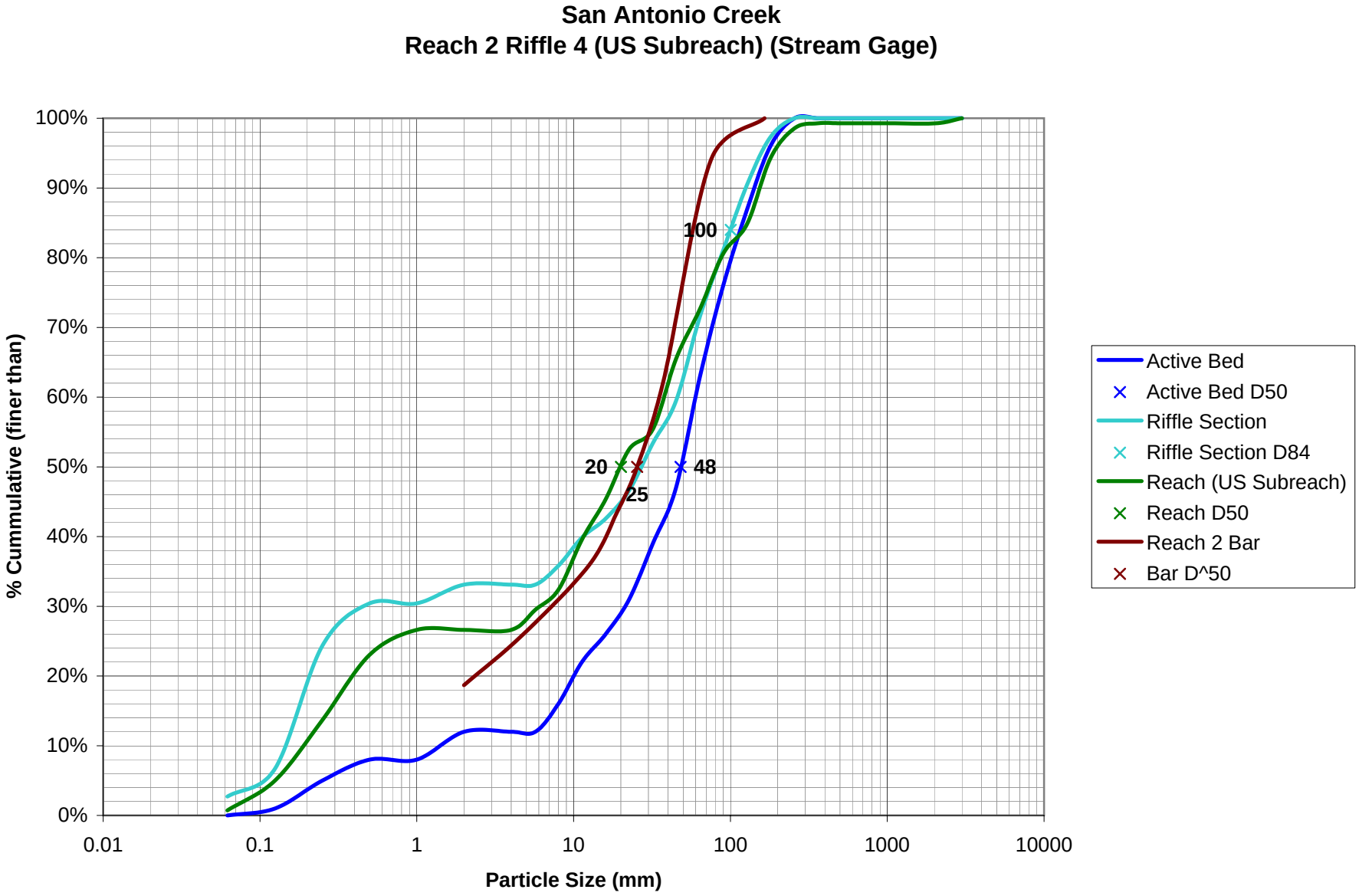
NOTES

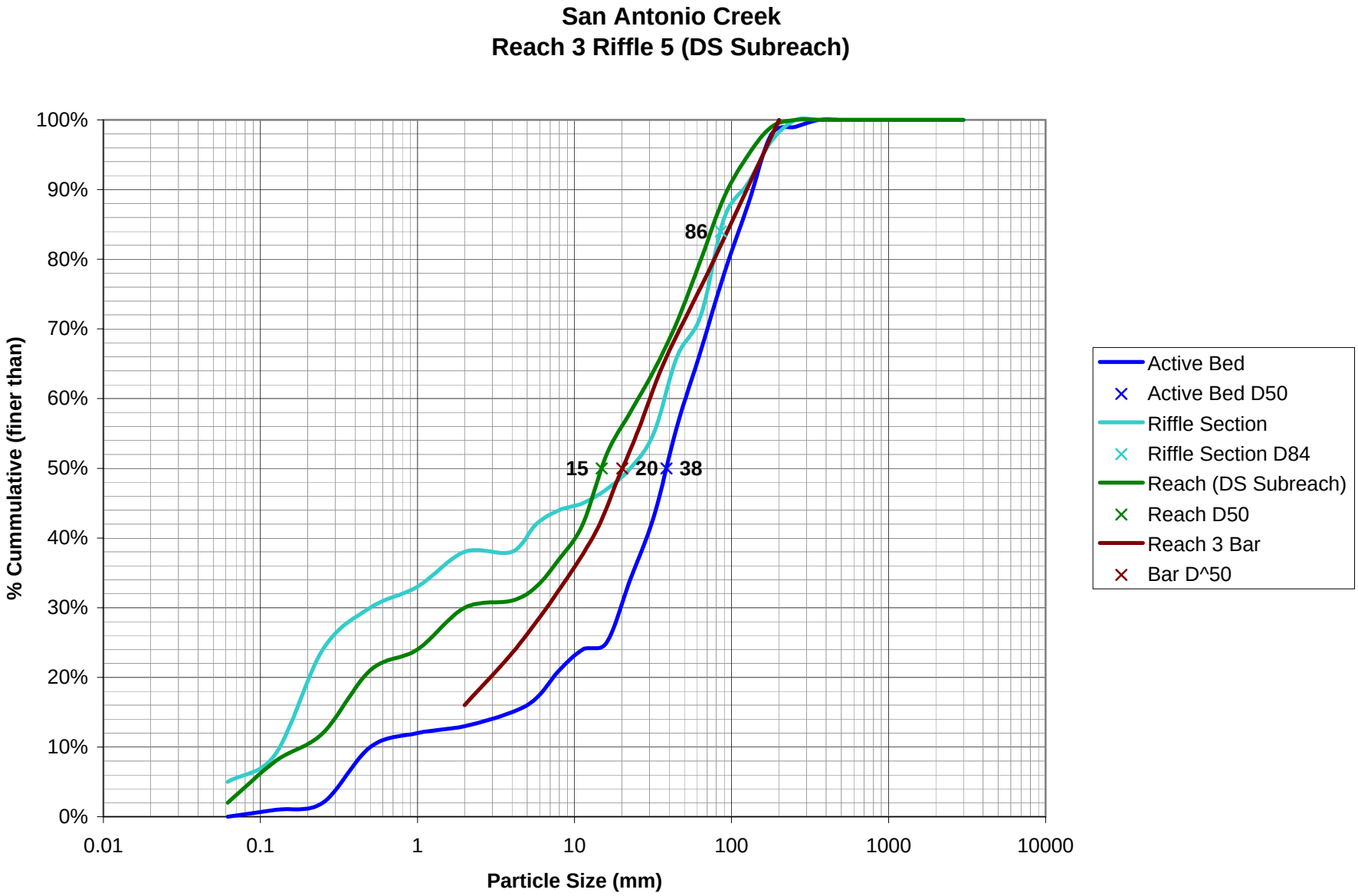
subsample	sieve size	# rocks		subsample	sieve size	# rocks
1	75	1		7	37.5	3
2	75	1		8	37.5	1
3	75	1				
4	37.5/75	3/1				
5	37.5	2				
6	37.5	7				

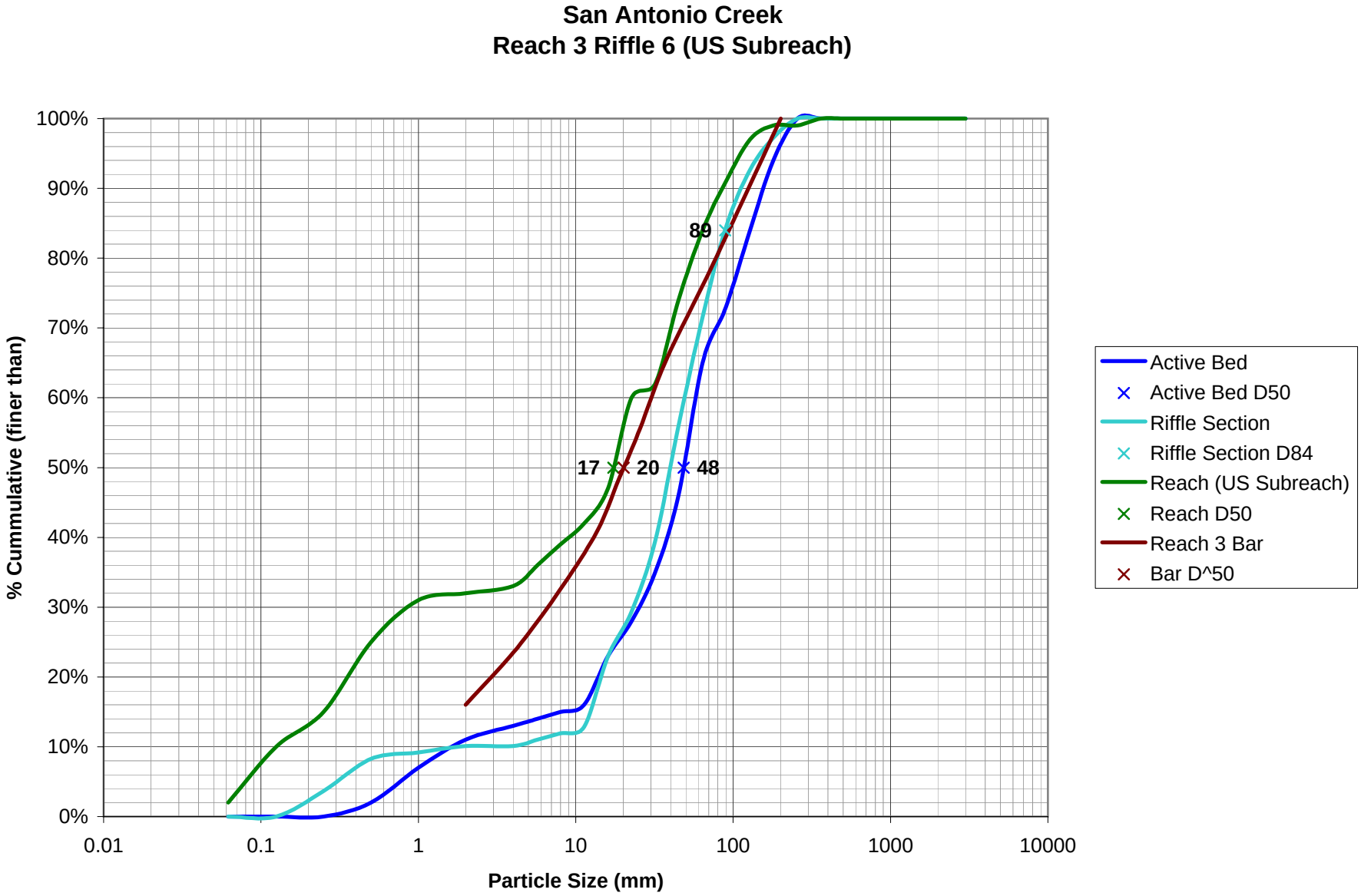

San Antonio Creek
Reach 1 Riffle 1 (DS Subreach)
% Cummulative (finer than)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
80
15
40
24
Active Bed
Active Bed D50
Riffle Section
Riffle Section D84
Reach (DS Subreach)
Reach D50
Reach 1 Bar
Bar D^50


San Antonio Creek
Reach 1 Riffle 2 (US Subreach)
% Cummulative (finer than)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
73
15
42
22.6
Active Bed
Active Bed D50
Riffle Section
Riffle Section D84
Reach (US Subreach)
Reach D50
Reach 1 Bar
Bar D^50

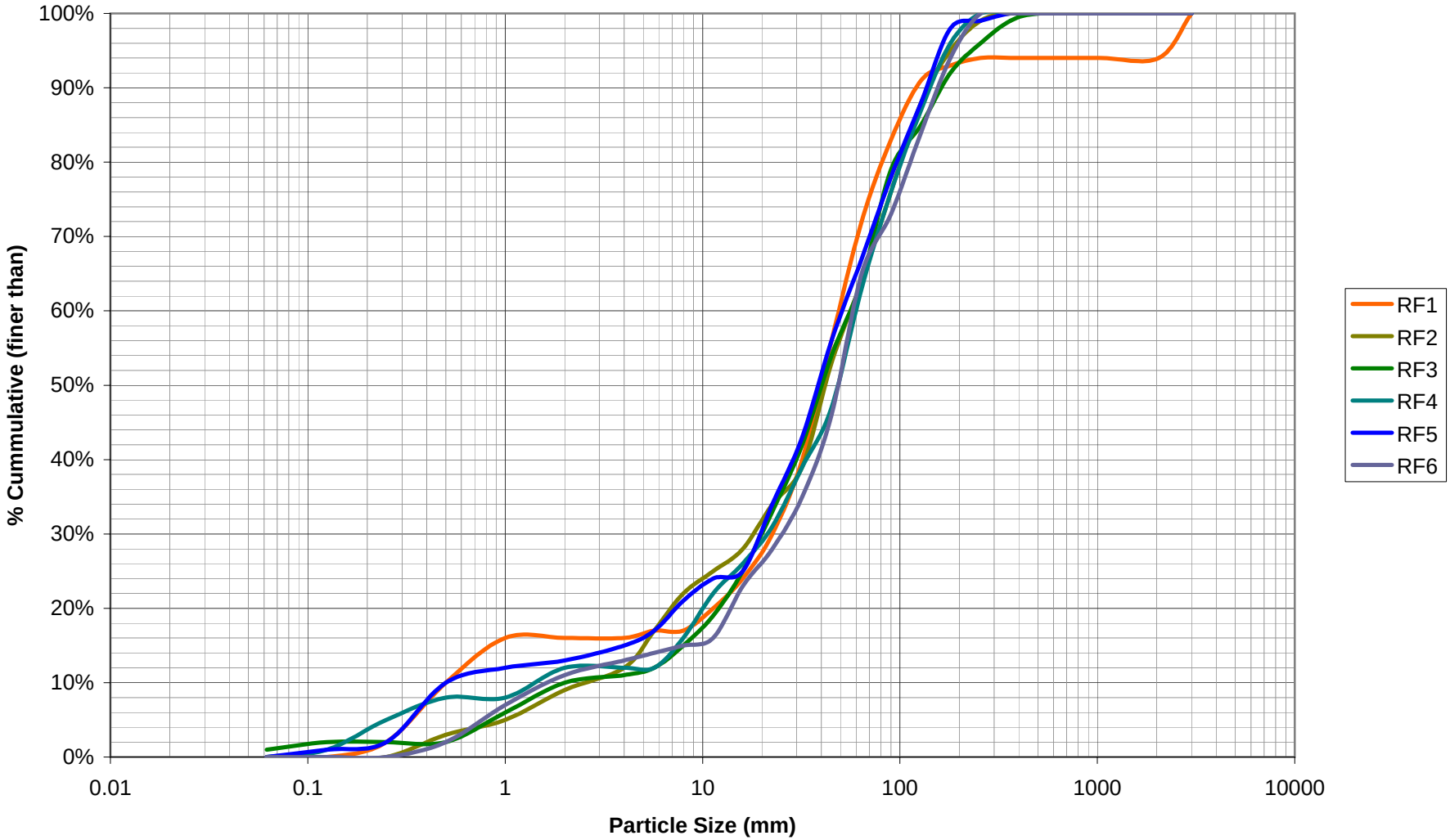

San Antonio Creek
Reach 2 Riffle 3 (DS Subreach)
% Cummulative (finer than)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
64
23
40
25
Active Bed
Active Bed D50
Riffle Section
Riffle Section D84
Reach (DS Subreach)
Reach D50
Reach 2 Bar
Bar D^50


San Antonio Creek
Reach 2 Riffle 4 (US Subreach) (Stream Gage)
% Cummulative (finer than)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
100
20
25
48
Active Bed
Active Bed D50
Riffle Section
Riffle Section D84
Reach (US Subreach)
Reach D50
Reach 2 Bar
Bar D^50

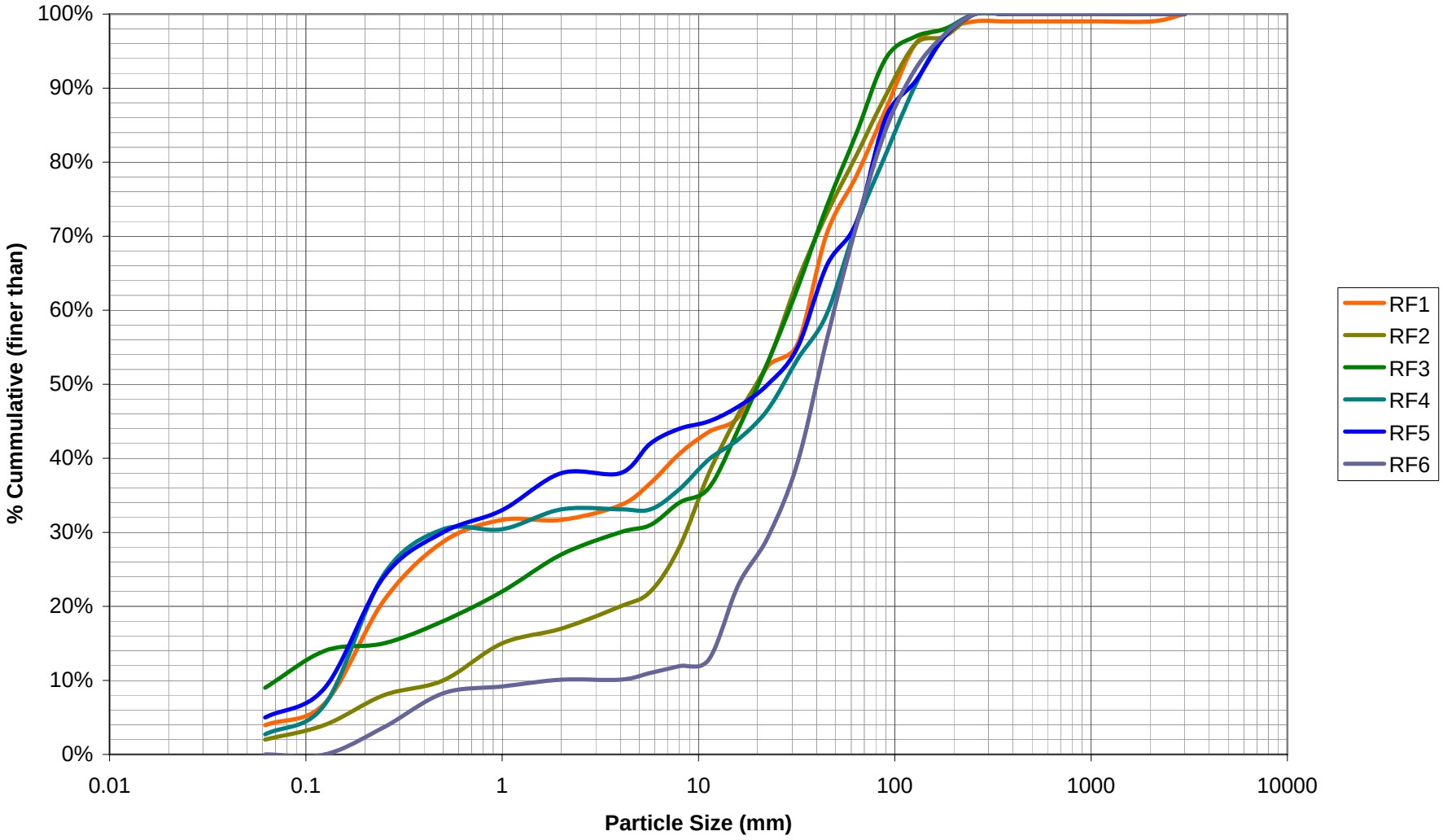

San Antonio Creek
Reach 3 Riffle 5 (DS Subreach)
% Cummulative (finer than)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
86
15
20
38
Active Bed
Active Bed D50
Riffle Section
Riffle Section D84
Reach (DS Subreach)
Reach D50
Reach 3 Bar
Bar D^50


San Antonio Creek
Reach 3 Riffle 6 (US Subreach)
% Cummulative (finer than)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.01
0.1
1
10
100
1000
10000
Particle Size (mm)
89
17
20
48
Active Bed
Active Bed D50
Riffle Section
Riffle Section D84
Reach (US Subreach)
Reach D50
Reach 3 Bar
Bar D^50

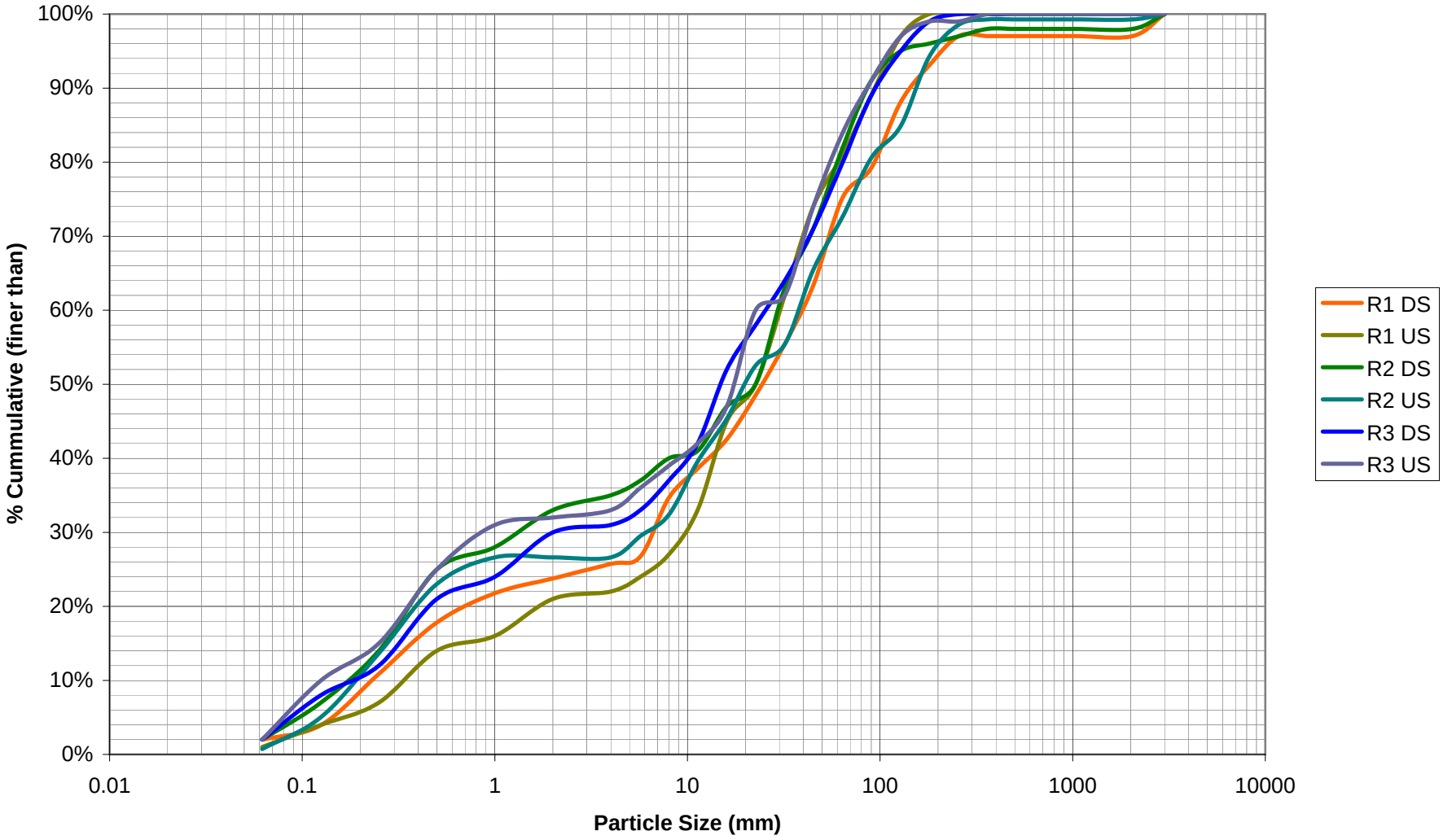
San Antonio Creek
Active Bed Count Comparison



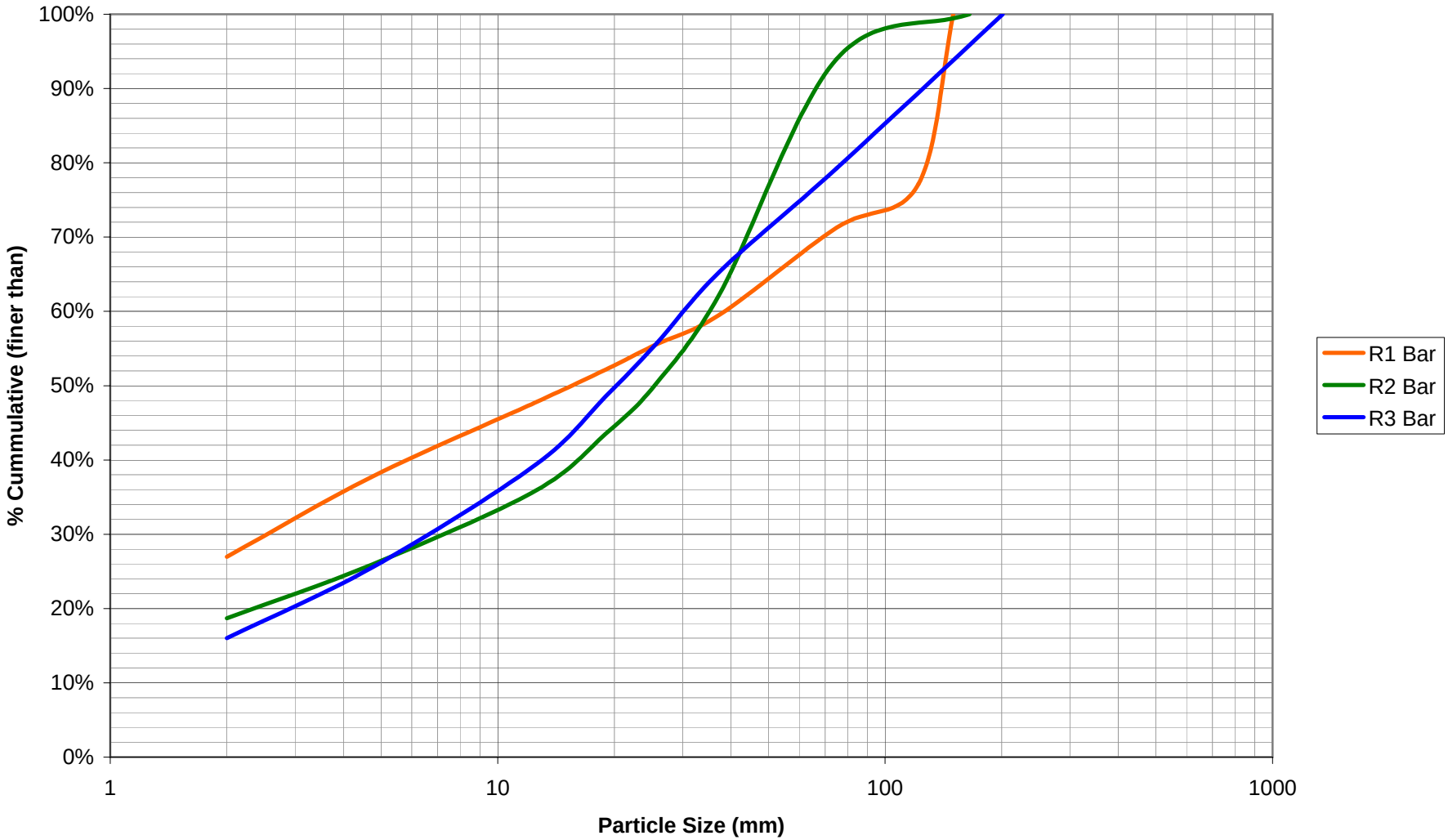
San Antonio Creek
Riffle Section Count Comparison



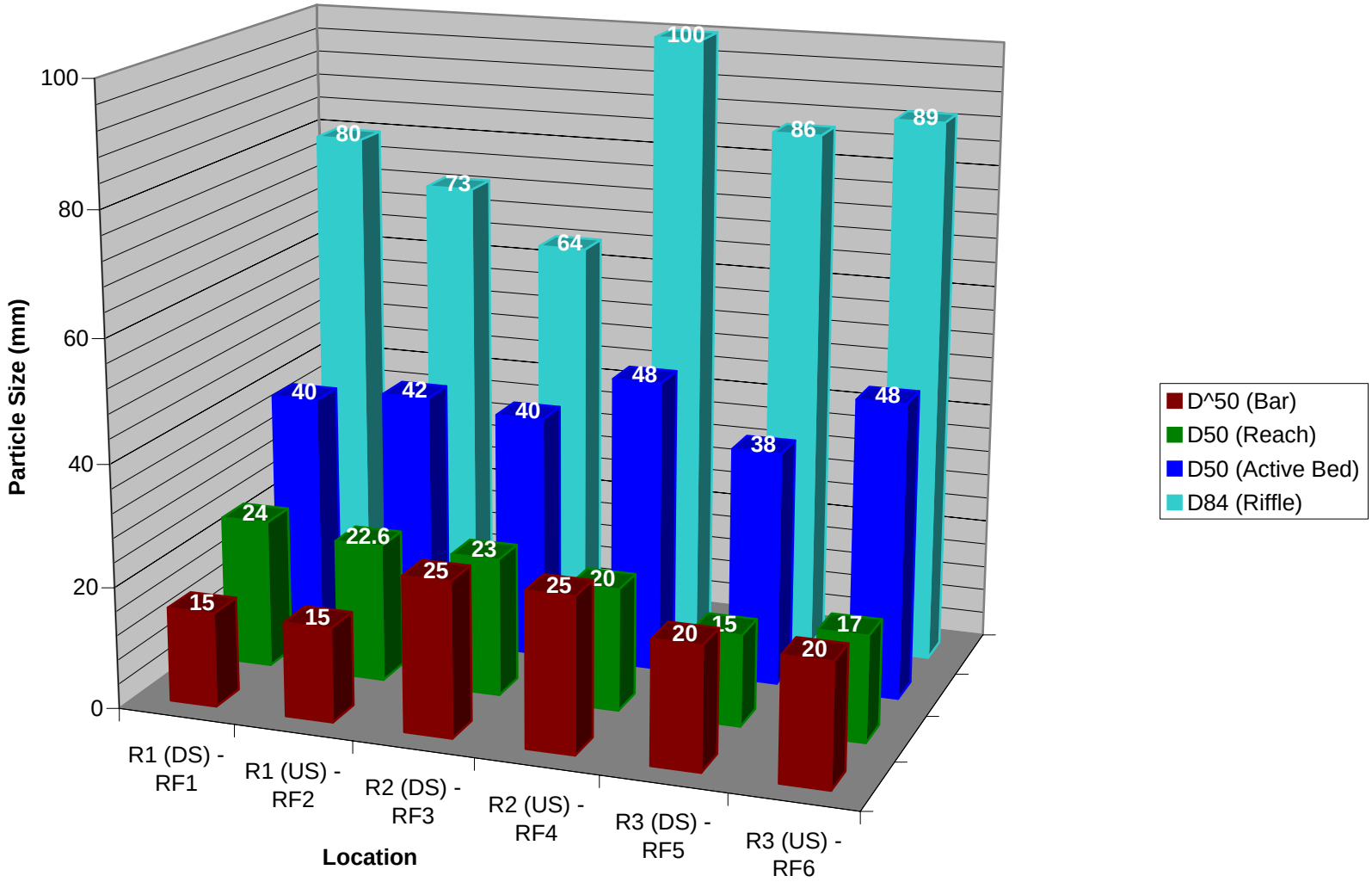
San Antonio Creek
Reach Count Comparison



San Antonio Creek
Bar Sample Comparison



San Antonio Creek
D50 & D84 Summary Chart



C-5 San Antonio Creek Pfankuch and Classification Data

Modified Pfankuch Channel Stability Rating Procedure (as modified by D. Rosgen)

Date: **3/30/2009**

Stream: San Antonio Cr Location: **R1 RF1** Valley Type: Observers: **JP & SEL**

Location	Key	Category	Excellent				Good				Fair				Poor			
			Description	Rating			Description	Rating			Description	Rating			Description	Rating		
Upper Banks	1	Landform Slope	Bank slope gradient <30%	2	y	2	Bank slope gradient 30-40%	4			Bank slope gradient 40-60%	6			Bank slope gradient >60%	8		
	2	Mass Erosion	No evidence of past or future mass erosion	3			Infrequent. Mostly healed over. Low future potential	6			Frequency and magnitude aggravated by normal high water. Subsequent undercutting of unstable areas with increased sedimentation	9			Frequent or large causing sediment nearly yearlong or intermittent danger of same	12	y	12
	3	Debris Jam Potential	Essentially absent from immediate channel area	2			Present, but mostly small twigs and limbs	4			Noticeable accumulation of all sizes.Stream can float it away at certain times, decreasing bank protection and increasing DS debris jam potential	6	y	6	Moderate to heavy amounts, predominantly larger sizes	8		
	4	Vegetative Bank Protection	>90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass	3			70-90% density. Fewer species or less vigor suggest less dense or deep root mass	6			50-70% density. Lower vigor and fewer species form a shallow discontinuous root mass	9	y	9	<50% deensity plus fewer species & less vigor indicating poorm discontinuous and shallow root mass	12		
Lower Banks	5	Channel Capacity	Bank heights sufficient to contain the bankfull stage. Width/depth ratio departure from reference width/depth ratio = 1.0 Bank-height ratio (BHR) = 1.0	1			Bank stage is contained within banks. Width/depth ratio depature from reference W/D ratio = 1.0-1.2. BHR = 1.0-1.1	2			Bankfull stage is not contained. Width/depth ratio departure from reference W/D ratio = 1.2-1.4. BHR = 1.1-1.3	3	y	3	Bankfull stage is not contained, overbank flows are common with flows less than bankfull. W/D ratio departure from reference W/D ratio >1.4. BHR > 1.3	4		
	6	Bank Rock Content	>65% with large angular boulders 12"+ common	2			40-65% mostly boulders and small cobbles. 6-12"	4			20-40% Most in the 3-6" range	6	y	6	<20% rock fragments of gravel sizes 1-3" or less	8		
	7	Obstruction to Flow	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed	2			Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm	4	y	4	Moderately frequent, unstable obstructions move with high flows causing bank cutting and poo, filling	6			Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full. Channel migration occurring	8		
	8	Cutting	Little or none. Infrequent raw banks <6"	4			Some, intermittently at outcurves and constrictions. Raw banks may be up to 12"	6			Significant cuts 12-24" high. Root mat overhangs and sloughing evident	12			Almost continuous cuts, some over 24" high. Failure of overhangs frequent	16	y	16
	9	Deposition	Little or no enlargement of channel or point bars	4			Some new bar increase, mostly from course gravel	8			Moderate deposition of new gravel and coarse sand on old some new bars	12			Extensive deposit of predominantly fine particles, Accelrated bar development	16	y	16
Bottom	10	Rock Angularity	Sharp edges and corners. Plane surfacces rough	1			Rounded corners and edges. Surfaces smooth and flat	2			Corners and edges well rounded in 2 dimensions	3	y	3	Well rounded in all dimensions, surfaces snooth	4		
	11	Brightness	Surfaces dull, dark or stained. Generally not bright	1			Mostly dull, but may have <35% bright surfaces	2			Mixture dull and bright, i.e. 35-65% mixture range	3			Predominantly bright, >65%, exposed ir scoured surfaces	4	y	4
	12	Consolidation of Particles	Assorted sizes tightly packed or overlapping	2			Moderately packed with some overlapping	4	y	4	Mostly losse asortment with no apparent overlap	6			No apcking evident. Losse assortment, easily moved	8		
	13	Bottom Size Distribution	No size change evident. Stable material 80-100%	4			Distribution shift light. Stable material 50-80%	8			Moderate change in sizes. Stable materials 20-50%	12	y	12	Marked distribution change, Stable materials 0-20%	16		
	14	Scouring & Deposition	<5% of bottom affected by scour or deposition	6			5-30% affected. Scour at constrictions and wheere grades steepen. Some deposition in pools	12			30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools	18			More than 50% of the bottom in a state of flux or change nearly yearlong	24	y	24
	15	Aquatic Vegetation	Abundant growth moss-like, dark green perennial. In swift water, too	1			Common. Algae in low velocity and pool areas. Moss here, too	2			Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick	3			Perennial types scarce or absent. Yellow-green, short-term bloom may be present	4	y	4
				Excellent total =		2		Good total =		8		Fair total =		39		Poor total =		76

Stream Type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3
Good (stable)	38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	70-90	60-85	85-107
Fair (mod. unstable)	44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	91-110	86-105	108-132
Poor (unstable)	48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+

Stream Type	D4	D5	D6	DA3	DA4	DA5	DA6	E3	E4	E5	E6	F1	F2	F3	F4	F5	F6	G1	G2
Good (stable)	85-107	85-107	67-98	40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60
Fair (mod. unstable)	108-132	108-132	99-125	64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78
Poor (unstable)	133+	133+	126+	87+	87+	87+	87+	87+	97+	97+	87+	106+	106+	126+	126+	131+	111+	79+	79+

Stream Type	G3	G4	G5	G6
Good (stable)	85-107	85-107	90-112	85-107
Fair (mod. unstable)	108-120	108-120	113-125	108-120
Poor (unstable)	121+	121+	126+	121+

Notes:

Grand Total =	125
Existing stream type =	C4
* Potential stream type =	C4

Modified channel stability rating
Poor

* Rating should be adjusted to potential stream type, not existing.

Modified Pfankuch Channel Stability Rating Procedure (as modified by D. Rosgen)

Date: **4/1/2009**

Stream: San Antonio Cr Location: **R1 RF2** Valley Type: Observers: **JP & SEL**

Location	Key	Category	Excellent				Good				Fair				Poor			
			Description	Rating			Description	Rating			Description	Rating			Description	Rating		
Upper Banks	1	Landform Slope	Bank slope gradient <30%	2	y	2	Bank slope gradient 30-40%	4			Bank slope gradient 40-60%	6			Bank slope gradient >60%	8		
	2	Mass Erosion	No evidence of past or future mass erosion	3			Infrequent. Mostly healed over. Low future potential	6			Frequency and magnitude aggravated by normal high water. Subsequent undercutting of unstable areas with increased sedimentation	9			Frequent or large causing sediment nearly yearlong or intermittent danger of same	12	y	12
	3	Debris Jam Potential	Essentially absent from immediate channel area	2			Present, but mostly small twigs and limbs	4	y	4	Noticeable accumulation of all sizes.Stream can float it away at certain times, decreasing bank protection and increasing DS debris jam potential	6			Moderate to heavy amounts, predominantly larger sizes	8		
	4	Vegetative Bank Protection	>90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass	3			70-90% density. Fewer species or less vigor suggest less dense or deep root mass	6			50-70% density. Lower vigor and fewer species form a shallow discontinuous root mass	9			<50% deensity plus fewer species & less vigor indicating poorm discontinuous and shallow root mass	12	y	12
Lower Banks	5	Channel Capacity	Bank heights sufficient to contain the bankfull stage. Width/depth ratio departure from reference width/depth ratio = 1.0 Bank-height ratio (BHR) = 1.0	1			Bank stage is contained within banks. Width/depth ratio depature from reference W/D ratio = 1.0-1.2. BHR = 1.0-1.1	2			Bankfull stage is not contained. Width/depth ratio departure from reference W/D ratio = 1.2-1.4. BHR = 1.1-1.3	3	y	3	Bankfull stage is not contained, overbank flows are common with flows less than bankfull. W/D ratio departure from reference W/D ratio >1.4. BHR > 1.3	4		
	6	Bank Rock Content	>65% with large angular boulders 12"+ common	2			40-65% mostly boulders and small cobbles. 6-12"	4			20-40% Most in the 3-6" range	6	y	6	<20% rock fragments of gravel sizes 1-3" or less	8		
	7	Obstruction to Flow	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed	2			Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm	4	y	4	Moderately frequent, unstable obstructions move with high flows causing bank cutting and poo, filling	6			Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full. Channel migration occurring	8		
	8	Cutting	Little or none. Infrequent raw banks <6"	4			Some, intermittently at outcurves and constrictions. Raw banks may be up to 12"	6			Significant cuts 12-24" high. Root mat overhangs and sloughing evident	12			Almost continuous cuts, some over 24" high. Failure of overhangs frequent	16	y	16
	9	Deposition	Little or no enlargement of channel or point bars	4			Some new bar increase, mostly from course gravel	8			Moderate deposition of new gravel and coarse sand on old some new bars	12			Extensive deposit of predominantly fine particles, Accelrated bar development	16	y	16
Bottom	10	Rock Angularity	Sharp edges and corners. Plane surfacces rough	1			Rounded corners and edges. Surfaces smooth and flat	2			Corners and edges well rounded in 2 dimensions	3	y	3	Well rounded in all dimensions, surfaces snooth	4		
	11	Brightness	Surfaces dull, dark or stained. Generally not bright	1			Mostly dull, but may have <35% bright surfaces	2			Mixture dull and bright, i.e. 35-65% mixture range	3			Predominantly bright, >65%, exposed ir scoured surfaces	4	y	4
	12	Consolidation of Particles	Assorted sizes tightly packed or overlapping	2			Moderately packed with some overlapping	4			Mostly losse asortment with no apparent overlap	6	y	6	No apcking evident. Losse assortment, easily moved	8		
	13	Bottom Size Distribution	No size change evident. Stable material 80-100%	4			Distribution shift light. Stable material 50-80%	8			Moderate change in sizes. Stable materials 20-50%	12			Marked distribution change, Stable materials 0-20%	16	y	16
	14	Scouring & Deposition	<5% of bottom affected by scour or deposition	6			5-30% affected. Scour at constrictions and wheere grades steepen. Some deposition in pools	12			30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools	18			More than 50% of the bottom in a state of flux or change nearly yearlong	24	y	24
	15	Aquatic Vegetation	Abundant growth moss-like, dark green perennial. In swift water, too	1			Common. Algae in low velocity and pool areas. Moss here, too	2			Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick	3			Perennial types scarce or absent. Yellow-green, short-term bloom may be present	4	y	4
			Excellent total =	2			Good total =	8			Fair total =	18			Poor total =	104		

Stream Type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3
Good (stable)	38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	70-90	60-85	85-107
Fair (mod. unstable)	44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	91-110	86-105	108-132
Poor (unstable)	48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+

Stream Type	D4	D5	D6	DA3	DA4	DA5	DA6	E3	E4	E5	E6	F1	F2	F3	F4	F5	F6	G1	G2
Good (stable)	85-107	85-107	67-98	40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60
Fair (mod. unstable)	108-132	108-132	99-125	64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78
Poor (unstable)	133+	133+	126+	87+	87+	87+	87+	87+	97+	97+	87+	106+	106+	126+	126+	131+	111+	79+	79+

Stream Type	G3	G4	G5	G6
Good (stable)	85-107	85-107	90-112	85-107
Fair (mod. unstable)	108-120	108-120	113-125	108-120
Poor (unstable)	121+	121+	126+	121+

Notes:

4 grass & sage
5 check pfankuch description
9 gravel & coarse sand
12 packing in low flow channel only
13 only in flow flow channel; static or dynamic stability?

Grand Total =	132
Existing stream type =	C4
* Potential stream type =	C4

Modified channel stability rating
Poor

* Rating should be adjusted to potential stream type, not existing.

Modified Pfankuch Channel Stability Rating Procedure (as modified by D. Rosgen)

Date: **4/1/2009**

Stream: San Antonio Cr Location: **R2 RF3** Valley Type: Observers: **JP & SEL**

Location	Key	Category	Excellent Description	Rating			Good Description	Rating			Fair Description	Rating			Poor Description	Rating		
Upper Banks	1	Landform Slope	Bank slope gradient <30%	2	y	2	Bank slope gradient 30-40%	4			Bank slope gradient 40-60%	6			Bank slope gradient >60%	8		
	2	Mass Erosion	No evidence of past or future mass erosion	3			Infrequent. Mostly healed over. Low future potential	6			Frequency and magnitude aggravated by normal high water. Subsequent undercutting of unstable areas with increased sedimentation	9			Frequent or large causing sediment nearly yearlong or intermittent danger of same	12	y	12
	3	Debris Jam Potential	Essentially absent from immediate channel area	2			Present, but mostly small twigs and limbs	4	y	4	Noticeable accumulation of all sizes.Stream can float it away at certain times, decreasing bank protection and increasing DS debris jam potential	6			Moderate to heavy amounts, predominantly larger sizes	8		
	4	Vegetative Bank Protection	>90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass	3			70-90% density. Fewer species or less vigor suggest less dense or deep root mass	6	y	6	50-70% density. Lower vigor and fewer species form a shallow discontinuous root mass	9			<50% deensity plus fewer species & less vigor indicating poorm discontinuous and shallow root mass	12		
Lower Banks	5	Channel Capacity	Bank heights sufficient to contain the bankfull stage. Width/depth ratio departure from reference width/depth ratio = 1.0 Bank-height ratio (BHR) = 1.0	1			Bank stage is contained within banks. Width/depth ratio depature from reference W/D ratio = 1.0-1.2. BHR = 1.0-1.1	2	y	2	Bankfull stage is not contained. Width/depth ratio departure from reference W/D ratio = 1.2-1.4. BHR = 1.1-1.3	3			Bankfull stage is not contained, overbank flows are common with flows less than bankfull. W/D ratio departure from reference W/D ratio >1.4. BHR > 1.3	4		
	6	Bank Rock Content	>65% with large angular boulders 12"+ common	2			40-65% mostly boulders and small cobbles. 6-12"	4			20-40% Most in the 3-6" range	6	y	6	<20% rock fragments of gravel sizes 1-3" or less	8		
	7	Obstruction to Flow	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed	2			Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm	4	y	4	Moderately frequent, unstable obstructions move with high flows causing bank cutting and poo, filling	6			Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full. Channel migration occurring	8		
	8	Cutting	Little or none. Infrequent raw banks <6"	4			Some, intermittently at outcurves and constrictions. Raw banks may be up to 12"	6			Significant cuts 12-24" high. Root mat overhangs and sloughing evident	12			Almost continuous cuts, some over 24" high. Failure of overhangs frequent	16	y	16
	9	Deposition	Little or no enlargement of channel or point bars	4			Some new bar increase, mostly from course gravel	8			Moderate deposition of new gravel and coarse sand on old some new bars	12			Extensive deposit of predominantly fine particles, Accelrated bar development	16	y	16
Bottom	10	Rock Angularity	Sharp edges and corners. Plane surfacces rough	1			Rounded corners and edges. Surfaces smooth and flat	2			Corners and edges well rounded in 2 dimensions	3	y	3	Well rounded in all dimensions, surfaces snooth	4		
	11	Brightness	Surfaces dull, dark or stained. Generally not bright	1			Mostly dull, but may have <35% bright surfaces	2			Mixture dull and bright, i.e. 35-65% mixture range	3			Predominantly bright, >65%, exposed ir scoured surfaces	4	y	4
	12	Consolidation of Particles	Assorted sizes tightly packed or overlapping	2			Moderately packed with some overlapping	4	y	4	Mostly losse asortment with no apparent overlap	6			No apcking evident. Losse assortment, easily moved	8		
	13	Bottom Size Distribution	No size change evident. Stable material 80-100%	4			Distribution shift light. Stable material 50-80%	8			Moderate change in sizes. Stable materials 20-50%	12	y	12	Marked distribution change, Stable materials 0-20%	16		
	14	Scouring & Deposition	<5% of bottom affected by scour or deposition	6			5-30% affected. Scour at constrictions and wheere grades steepen. Some deposition in pools	12			30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools	18			More than 50% of the bottom in a state of flux or change nearly yearlong	24	y	24
	15	Aquatic Vegetation	Abundant growth moss-like, dark green perennial. In swift water, too	1			Common. Algae in low velocity and pool areas. Moss here, too	2			Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick	3	y	3	Perennial types scarce or absent. Yellow-green, short-term bloom may be present	4		
			Excellent total =			2	Good total =			20	Fair total =			24	Poor total =			72

Stream Type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3
Good (stable)	38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	70-90	60-85	85-107
Fair (mod. unstable)	44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	91-110	86-105	108-132
Poor (unstable)	48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+

Stream Type	D4	D5	D6	DA3	DA4	DA5	DA6	E3	E4	E5	E6	F1	F2	F3	F4	F5	F6	G1	G2
Good (stable)	85-107	85-107	67-98	40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60
Fair (mod. unstable)	108-132	108-132	99-125	64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78
Poor (unstable)	133+	133+	126+	87+	87+	87+	87+	87+	97+	97+	87+	106+	106+	126+	126+	131+	111+	79+	79+

Stream Type	G3	G4	G5	G6
Good (stable)	85-107	85-107	90-112	85-107
Fair (mod. unstable)	108-120	108-120	113-125	108-120
Poor (unstable)	121+	121+	126+	121+

Notes:

Grand Total =	118
Existing stream type =	C4
* Potential stream type =	C4

Modified channel stability rating
Poor

* Rating should be adjusted to potential stream type, not existing.

Modified Pfankuch Channel Stability Rating Procedure (as modified by D. Rosgen)

Date: **4/2/2009**

Stream: San Antonio Cr Location: **R2 RF4** Valley Type: Observers: **SL & JP**

Location	Key	Category	Excellent				Good				Fair				Poor			
			Description	Rating			Description	Rating			Description	Rating			Description	Rating		
Upper Banks	1	Landform Slope	Bank slope gradient <30%	2	y	2	Bank slope gradient 30-40%	4			Bank slope gradient 40-60%	6			Bank slope gradient >60%	8		
	2	Mass Erosion	No evidence of past or future mass erosion	3			Infrequent. Mostly healed over. Low future potential	6			Frequency and magnitude aggravated by normal high water. Subsequent undercutting of unstable areas with increased sedimentation	9			Frequent or large causing sediment nearly yearlong or intermittent danger of same	12	y	12
	3	Debris Jam Potential	Essentially absent from immediate channel area	2			Present, but mostly small twigs and limbs	4	y	4	Noticeable accumulation of all sizes.Stream can float it away at certain times, decreasing bank protection and increasing DS debris jam potential	6			Moderate to heavy amounts, predominantly larger sizes	8		
	4	Vegetative Bank Protection	>90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass	3			70-90% density. Fewer species or less vigor suggest less dense or deep root mass	6	y	6	50-70% density. Lower vigor and fewer species form a shallow discontinuous root mass	9			<50% deensity plus fewer species & less vigor indicating poorm discontinuous and shallow root mass	12		
Lower Banks	5	Channel Capacity	Bank heights sufficient to contain the bankfull stage. Width/depth ratio departure from reference width/depth ratio = 1.0 Bank-height ratio (BHR) = 1.0	1			Bank stage is contained within banks. Width/depth ratio depature from reference W/D ratio = 1.0-1.2. BHR = 1.0-1.1	2	y	2	Bankfull stage is not contained. Width/depth ratio departure from reference W/D ratio = 1.2-1.4. BHR = 1.1-1.3	3			Bankfull stage is not contained, overbank flows are common with flows less than bankfull. W/D ratio departure from reference W/D ratio >1.4. BHR > 1.3	4		
	6	Bank Rock Content	>65% with large angular boulders 12"+ common	2			40-65% mostly boulders and small cobbles. 6-12"	4			20-40% Most in the 3-6" range	6	y	6	<20% rock fragments of gravel sizes 1-3" or less	8		
	7	Obstruction to Flow	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed	2			Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm	4	y	4	Moderately frequent, unstable obstructions move with high flows causing bank cutting and poo, filling	6			Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full. Channel migration occurring	8		
	8	Cutting	Little or none. Infrequent raw banks <6"	4			Some, intermittently at outcurves and constrictions. Raw banks may be up to 12"	6			Significant cuts 12-24" high. Root mat overhangs and sloughing evident	12			Almost continuous cuts, some over 24" high. Failure of overhangs frequent	16	y	16
	9	Deposition	Little or no enlargement of channel or point bars	4			Some new bar increase, mostly from course gravel	8			Moderate deposition of new gravel and coarse sand on old some new bars	12			Extensive deposit of predominantly fine particles, Accelrated bar development	16	y	16
Bottom	10	Rock Angularity	Sharp edges and corners. Plane surfacces rough	1			Rounded corners and edges. Surfaces smooth and flat	2			Corners and edges well rounded in 2 dimensions	3	y	3	Well rounded in all dimensions, surfaces snooth	4		
	11	Brightness	Surfaces dull, dark or stained. Generally not bright	1			Mostly dull, but may have <35% bright surfaces	2			Mixture dull and bright, i.e. 35-65% mixture range	3			Predominantly bright, >65%, exposed ir scoured surfaces	4	y	4
	12	Consolidation of Particles	Assorted sizes tightly packed or overlapping	2			Moderately packed with some overlapping	4	y	4	Mostly losse asortment with no apparent overlap	6			No apcking evident. Losse assortment, easily moved	8		
	13	Bottom Size Distribution	No size change evident. Stable material 80-100%	4			Distribution shift light. Stable material 50-80%	8			Moderate change in sizes. Stable materials 20-50%	12	y	12	Marked distribution change, Stable materials 0-20%	16		
	14	Scouring & Deposition	<5% of bottom affected by scour or deposition	6			5-30% affected. Scour at constrictions and wheere grades steepen. Some deposition in pools	12			30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools	18			More than 50% of the bottom in a state of flux or change nearly yearlong	24	y	24
	15	Aquatic Vegetation	Abundant growth moss-like, dark green perennial. In swift water, too	1			Common. Algae in low velocity and pool areas. Moss here, too	2			Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick	3			Perennial types scarce or absent. Yellow-green, short-term bloom may be present	4	y	4
				Excellent total =		2		Good total =		20		Fair total =		21		Poor total =		76

Stream Type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3
Good (stable)	38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	70-90	60-85	85-107
Fair (mod. unstable)	44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	91-110	86-105	108-132
Poor (unstable)	48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+

Stream Type	D4	D5	D6	DA3	DA4	DA5	DA6	E3	E4	E5	E6	F1	F2	F3	F4	F5	F6	G1	G2
Good (stable)	85-107	85-107	67-98	40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60
Fair (mod. unstable)	108-132	108-132	99-125	64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78
Poor (unstable)	133+	133+	126+	87+	87+	87+	87+	87+	97+	97+	87+	106+	106+	126+	126+	131+	111+	79+	79+

Stream Type	G3	G4	G5	G6
Good (stable)	85-107	85-107	90-112	85-107
Fair (mod. unstable)	108-120	108-120	113-125	108-120
Poor (unstable)	121+	121+	126+	121+

Notes:

Grand Total =	119
Existing stream type =	C4
* Potential stream type =	C4

Modified channel stability rating
Poor

* Rating should be adjusted to potential stream type, not existing.

Modified Pfankuch Channel Stability Rating Procedure (as modified by D. Rosgen)

Date: **4/6/2009**

Stream: San Antonio Cr Location: **R3 RF5** Valley Type: Observers: **MC & JP**

Location	Key	Category	Excellent				Good				Fair				Poor			
			Description	Rating			Description	Rating			Description	Rating			Description	Rating		
Upper Banks	1	Landform Slope	Bank slope gradient <30%	2	y	2	Bank slope gradient 30-40%	4			Bank slope gradient 40-60%	6			Bank slope gradient >60%	8		
	2	Mass Erosion	No evidence of past or future mass erosion	3			Infrequent. Mostly healed over. Low future potential	6			Frequency and magnitude aggravated by normal high water. Subsequent undercutting of unstable areas with increased sedimentation	9			Frequent or large causing sediment nearly yearlong or intermittent danger of same	12	y	12
	3	Debris Jam Potential	Essentially absent from immediate channel area	2			Present, but mostly small twigs and limbs	4	y	4	Noticeable accumulation of all sizes.Stream can float it away at certain times, decreasing bank protection and increasing DS debris jam potential	6			Moderate to heavy amounts, predominantly larger sizes	8		
	4	Vegetative Bank Protection	>90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass	3			70-90% density. Fewer species or less vigor suggest less dense or deep root mass	6	y	6	50-70% density. Lower vigor and fewer species form a shallow discontinuous root mass	9			<50% deensity plus fewer species & less vigor indicating poorm discontinuous and shallow root mass	12		
Lower Banks	5	Channel Capacity	Bank heights sufficient to contain the bankfull stage. Width/depth ratio departure from reference width/depth ratio = 1.0 Bank-height ratio (BHR) = 1.0	1			Bank stage is contained within banks. Width/depth ratio depature from reference W/D ratio = 1.0-1.2. BHR = 1.0-1.1	2			Bankfull stage is not contained. Width/depth ratio departure from reference W/D ratio = 1.2-1.4. BHR = 1.1-1.3	3	y	3	Bankfull stage is not contained, overbank flows are common with flows less than bankfull. W/D ratio departure from reference W/D ratio >1.4. BHR > 1.3	4		
	6	Bank Rock Content	>65% with large angular boulders 12"+ common	2			40-65% mostly boulders and small cobbles. 6-12"	4			20-40% Most in the 3-6" range	6	y	6	<20% rock fragments of gravel sizes 1-3" or less	8		
	7	Obstruction to Flow	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed	2			Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm	4			Moderately frequent, unstable obstructions move with high flows causing bank cutting and poo, filling	6	y	6	Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full. Channel migration occurring	8		
	8	Cutting	Little or none. Infrequent raw banks <6"	4			Some, intermittently at outcurves and constrictions. Raw banks may be up to 12"	6			Significant cuts 12-24" high. Root mat overhangs and sloughing evident	12			Almost continuous cuts, some over 24" high. Failure of overhangs frequent	16	y	16
	9	Deposition	Little or no enlargement of channel or point bars	4			Some new bar increase, mostly from course gravel	8			Moderate deposition of new gravel and coarse sand on old some new bars	12	y	12	Extensive deposit of predominantly fine particles, Accelrated bar development	16		
Bottom	10	Rock Angularity	Sharp edges and corners. Plane surfacces rough	1			Rounded corners and edges. Surfaces smooth and flat	2			Corners and edges well rounded in 2 dimensions	3	y	3	Well rounded in all dimensions, surfaces snooth	4		
	11	Brightness	Surfaces dull, dark or stained. Generally not bright	1			Mostly dull, but may have <35% bright surfaces	2			Mixture dull and bright, i.e. 35-65% mixture range	3			Predominantly bright, >65%, exposed ir scoured surfaces	4	y	4
	12	Consolidation of Particles	Assorted sizes tightly packed or overlapping	2			Moderately packed with some overlapping	4	y	4	Mostly losse asortment with no apparent overlap	6			No apcking evident. Losse assortment, easily moved	8		
	13	Bottom Size Distribution	No size change evident. Stable material 80-100%	4			Distribution shift light. Stable material 50-80%	8			Moderate change in sizes. Stable materials 20-50%	12	y	12	Marked distribution change, Stable materials 0-20%	16		
	14	Scouring & Deposition	<5% of bottom affected by scour or deposition	6			5-30% affected. Scour at constrictions and wheere grades steepen. Some deposition in pools	12			30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools	18	y	18	More than 50% of the bottom in a state of flux or change nearly yearlong	24		
	15	Aquatic Vegetation	Abundant growth moss-like, dark green perennial. In swift water, too	1			Common. Algae in low velocity and pool areas. Moss here, too	2			Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick	3	y	3	Perennial types scarce or absent. Yellow-green, short-term bloom may be present	4		
			Excellent total =	2			Good total =	14			Fair total =	63			Poor total =	32		

Stream Type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3
Good (stable)	38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	70-90	60-85	85-107
Fair (mod. unstable)	44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	91-110	86-105	108-132
Poor (unstable)	48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+

Stream Type	D4	D5	D6	DA3	DA4	DA5	DA6	E3	E4	E5	E6	F1	F2	F3	F4	F5	F6	G1	G2
Good (stable)	85-107	85-107	67-98	40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60
Fair (mod. unstable)	108-132	108-132	99-125	64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78
Poor (unstable)	133+	133+	126+	87+	87+	87+	87+	87+	97+	97+	87+	106+	106+	126+	126+	131+	111+	79+	79+

Stream Type	G3	G4	G5	G6
Good (stable)	85-107	85-107	90-112	85-107
Fair (mod. unstable)	108-120	108-120	113-125	108-120
Poor (unstable)	121+	121+	126+	121+

Notes:

2 Not as much as R3b

5 channel braids

6 gravel

8 not continuous cuts, but over 24"

Grand Total =	111
Existing stream type =	C4
* Potential stream type =	C4

Modified channel stability rating
Poor

* Rating should be adjusted to potential stream type, not existing.

Modified Pfankuch Channel Stability Rating Procedure (as modified by D. Rosgen)

Date: **4/6/2009**

Stream: San Antonio Cr Location: **R3 RF6** Valley Type: Observers: **MC & JP**

Location	Key	Category	Excellent				Good				Fair				Poor			
			Description	Rating			Description	Rating			Description	Rating			Description	Rating		
Upper Banks	1	Landform Slope	Bank slope gradient <30%	2	y	2	Bank slope gradient 30-40%	4			Bank slope gradient 40-60%	6			Bank slope gradient >60%	8		
	2	Mass Erosion	No evidence of past or future mass erosion	3			Infrequent. Mostly healed over. Low future potential	6			Frequency and magnitude aggravated by normal high water. Subsequent undercutting of unstable areas with increased sedimentation	9			Frequent or large causing sediment nearly yearlong or intermittent danger of same	12	y	12
	3	Debris Jam Potential	Essentially absent from immediate channel area	2			Present, but mostly small twigs and limbs	4	y	4	Noticeable accumulation of all sizes.Stream can float it away at certain times, decreasing bank protection and increasing DS debris jam potential	6			Moderate to heavy amounts, predominantly larger sizes	8		
	4	Vegetative Bank Protection	>90% plant density. Vigor and variety suggest a deep, dense soil-binding root mass	3			70-90% density. Fewer species or less vigor suggest less dense or deep root mass	6	y	6	50-70% density. Lower vigor and fewer species form a shallow discontinuous root mass	9			<50% deensity plus fewer species & less vigor indicating poorm discontinuous and shallow root mass	12		
Lower Banks	5	Channel Capacity	Bank heights sufficient to contain the bankfull stage. Width/depth ratio departure from reference width/depth ratio = 1.0 Bank-height ratio (BHR) = 1.0	1			Bank stage is contained within banks. Width/depth ratio depature from reference W/D ratio = 1.0-1.2. BHR = 1.0-1.1	2			Bankfull stage is not contained. Width/depth ratio departure from reference W/D ratio = 1.2-1.4. BHR = 1.1-1.3	3	y	3	Bankfull stage is not contained, overbank flows are common with flows less than bankfull. W/D ratio departure from reference W/D ratio >1.4. BHR > 1.3	4		
	6	Bank Rock Content	>65% with large angular boulders 12"+ common	2			40-65% mostly boulders and small cobbles. 6-12"	4			20-40% Most in the 3-6" range	6	y	6	<20% rock fragments of gravel sizes 1-3" or less	8		
	7	Obstruction to Flow	Rocks and logs firmly imbedded. Flow pattern w/o cutting or deposition. Stable bed	2			Some present causing erosive cross currents and minor pool filling. Obstructions fewer and less firm	4	y	4	Moderately frequent, unstable obstructions move with high flows causing bank cutting and poo, filling	6			Frequent obstructions and deflectors cause bank erosion yearlong. Sediment traps full. Channel migration occurring	8		
	8	Cutting	Little or none. Infrequent raw banks <6"	4			Some, intermittently at outcurves and constrictions. Raw banks may be up to 12"	6			Significant cuts 12-24" high. Root mat overhangs and sloughing evident	12			Almost continuous cuts, some over 24" high. Failure of overhangs frequent	16	y	16
	9	Deposition	Little or no enlargement of channel or point bars	4			Some new bar increase, mostly from course gravel	8			Moderate deposition of new gravel and coarse sand on old some new bars	12			Extensive deposit of predominantly fine particles, Accelrated bar development	16	y	16
Bottom	10	Rock Angularity	Sharp edges and corners. Plane surfacces rough	1			Rounded corners and edges. Surfaces smooth and flat	2			Corners and edges well rounded in 2 dimensions	3	y	3	Well rounded in all dimensions, surfaces snooth	4		
	11	Brightness	Surfaces dull, dark or stained. Generally not bright	1			Mostly dull, but may have <35% bright surfaces	2			Mixture dull and bright, i.e. 35-65% mixture range	3			Predominantly bright, >65%, exposed ir scoured surfaces	4	y	4
	12	Consolidation of Particles	Assorted sizes tightly packed or overlapping	2			Moderately packed with some overlapping	4	y	4	Mostly losse asortment with no apparent overlap	6			No apcking evident. Losse assortment, easily moved	8		
	13	Bottom Size Distribution	No size change evident. Stable material 80-100%	4			Distribution shift light. Stable material 50-80%	8			Moderate change in sizes. Stable materials 20-50%	12	y	12	Marked distribution change, Stable materials 0-20%	16		
	14	Scouring & Deposition	<5% of bottom affected by scour or deposition	6			5-30% affected. Scour at constrictions and wheere grades steepen. Some deposition in pools	12			30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools	18			More than 50% of the bottom in a state of flux or change nearly yearlong	24	y	24
	15	Aquatic Vegetation	Abundant growth moss-like, dark green perennial. In swift water, too	1			Common. Algae in low velocity and pool areas. Moss here, too	2			Present but spotty, mostly in backwater. Seasonal algae growth makes rocks slick	3	y	3	Perennial types scarce or absent. Yellow-green, short-term bloom may be present	4		
			Excellent total =	2			Good total =	18			Fair total =	27			Poor total =	72		

Stream Type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6	C1	C2	C3	C4	C5	C6	D3
Good (stable)	38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60	38-50	38-50	60-85	70-90	70-90	60-85	85-107
Fair (mod. unstable)	44-47	44-47	91-129	96-132	96-142	81-110	46-58	46-58	61-78	65-84	69-88	61-78	51-61	51-61	86-105	91-110	91-110	86-105	108-132
Poor (unstable)	48+	48+	130+	133+	143+	111+	59+	59+	79+	85+	89+	79+	62+	62+	106+	111+	111+	106+	133+

Stream Type	D4	D5	D6	DA3	DA4	DA5	DA6	E3	E4	E5	E6	F1	F2	F3	F4	F5	F6	G1	G2
Good (stable)	85-107	85-107	67-98	40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60
Fair (mod. unstable)	108-132	108-132	99-125	64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78
Poor (unstable)	133+	133+	126+	87+	87+	87+	87+	87+	97+	97+	87+	106+	106+	126+	126+	131+	111+	79+	79+

Stream Type	G3	G4	G5	G6
Good (stable)	85-107	85-107	90-112	85-107
Fair (mod. unstable)	108-120	108-120	113-125	108-120
Poor (unstable)	121+	121+	126+	121+

Notes:

1 steep banks, over 60% on part of stream

9 lots of deposits; gravel size

Grand Total =	119
Existing stream type =	C4
* Potential stream type =	C4

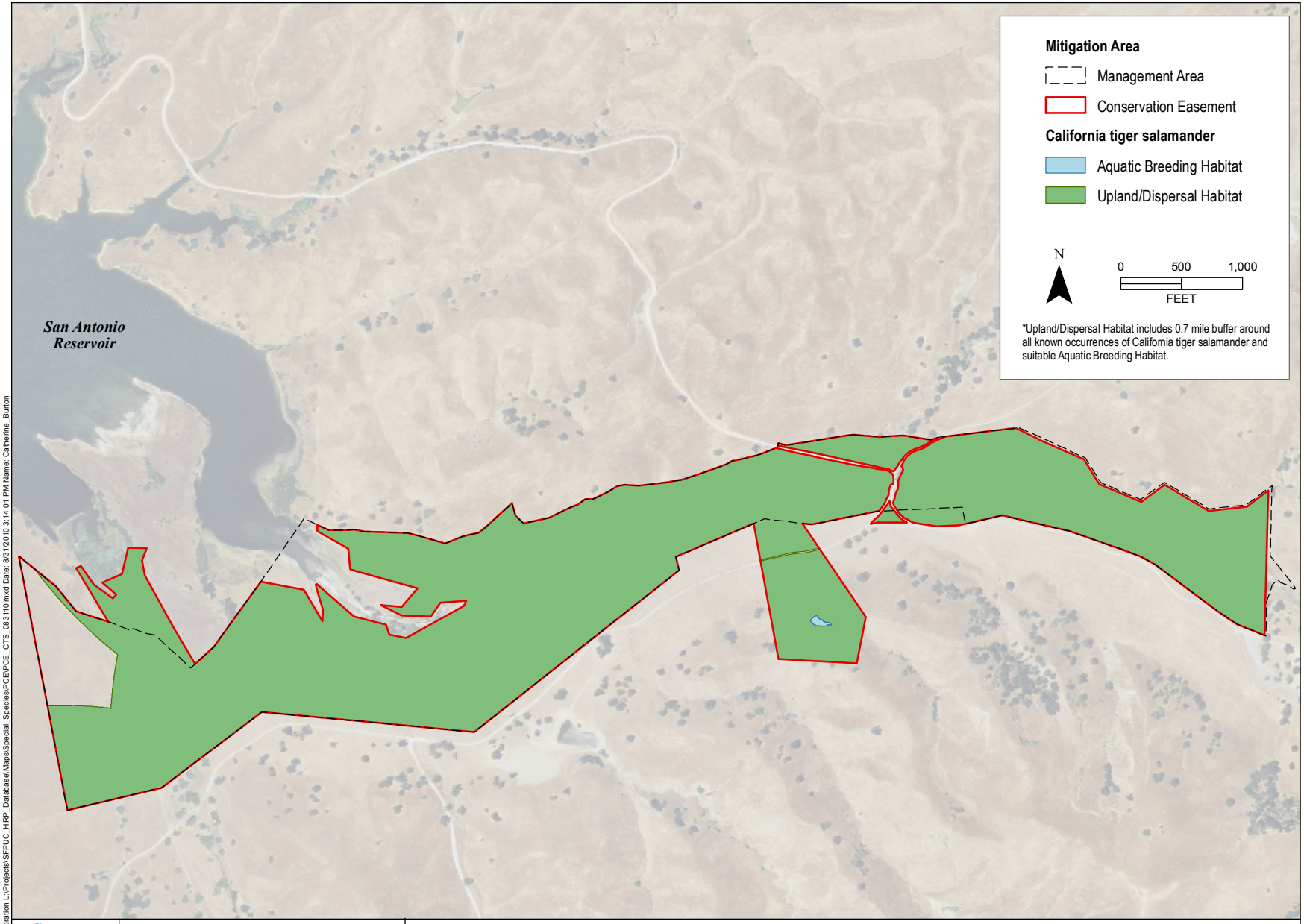
Modified channel stability rating
Poor

* Rating should be adjusted to potential stream type, not existing.

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Appendix D: Maps of Primary Constituent Elements for Listed Species Critical Habitat

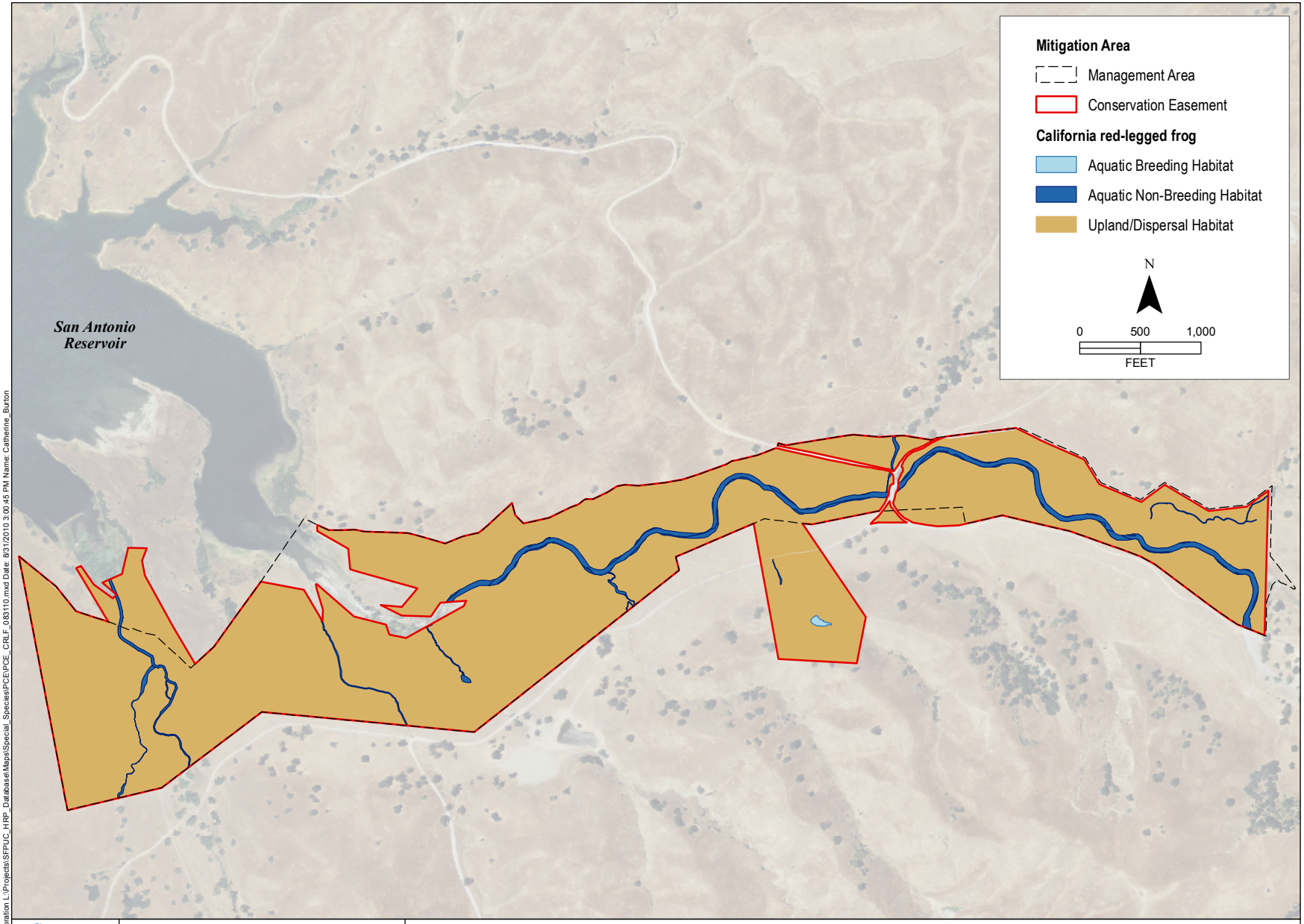
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San Francisco Public Utilities Commission
Habitat Reserve Program

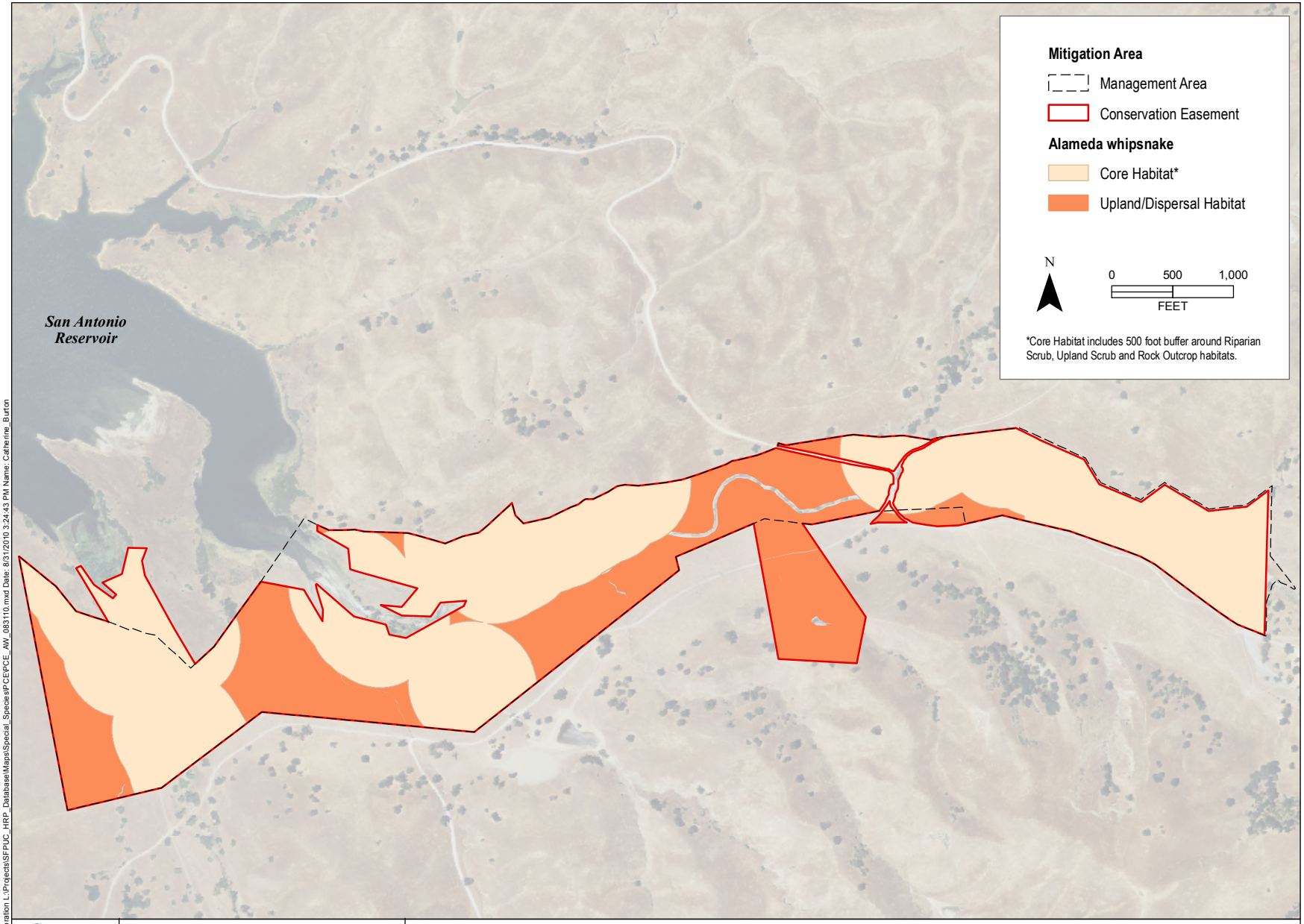
Appendix D - Figure 1a. San Antonio Mitigation Area:
California tiger salamander Primary Constituent Elements of critical habitat



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San Francisco Public Utilities Commission
Habitat Reserve Program

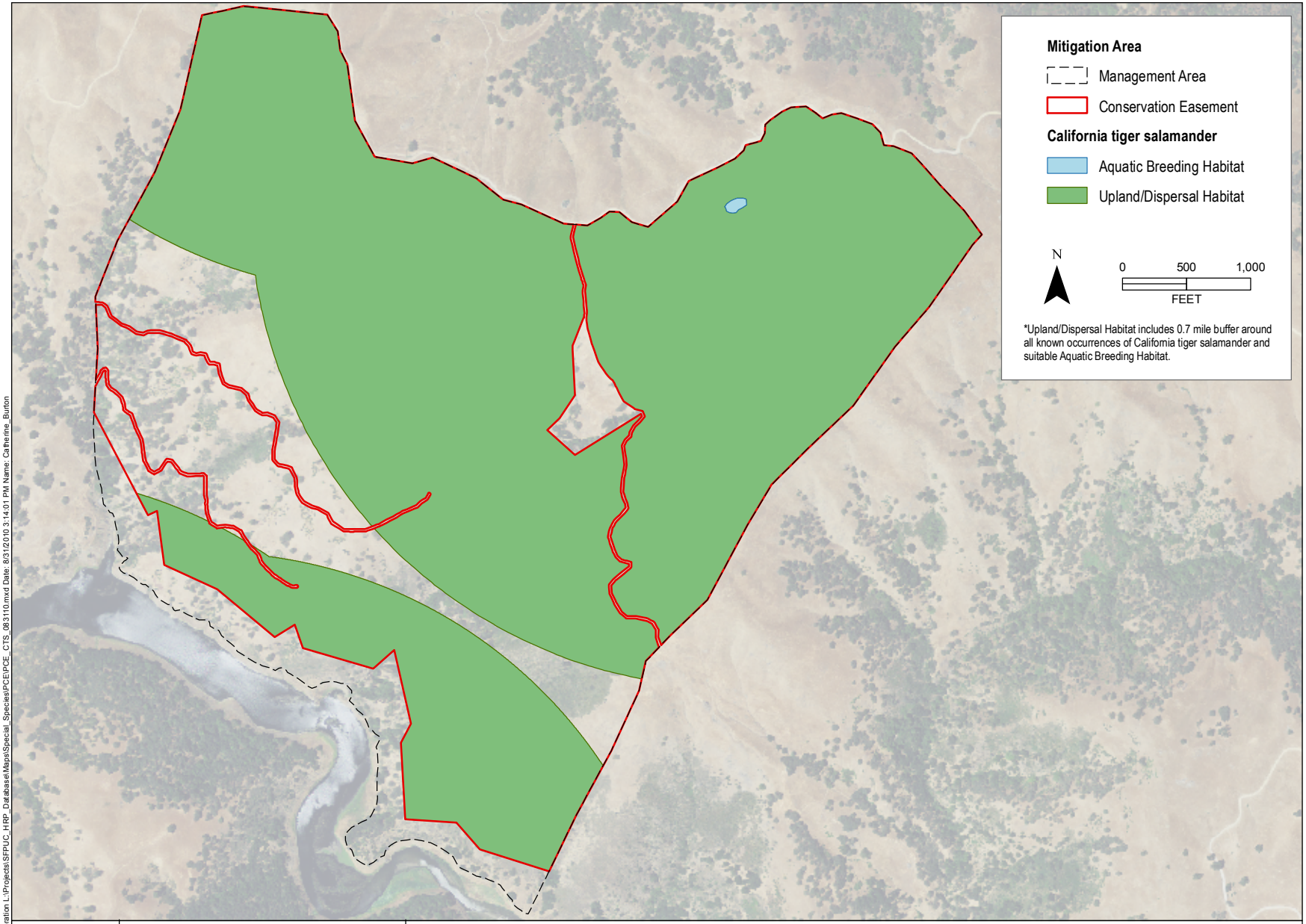
Appendix D - Figure 1b. San Antonio Mitigation Area:
California red-legged frog Primary Constituent Elements of critical habitat



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Habitat Reserve Program

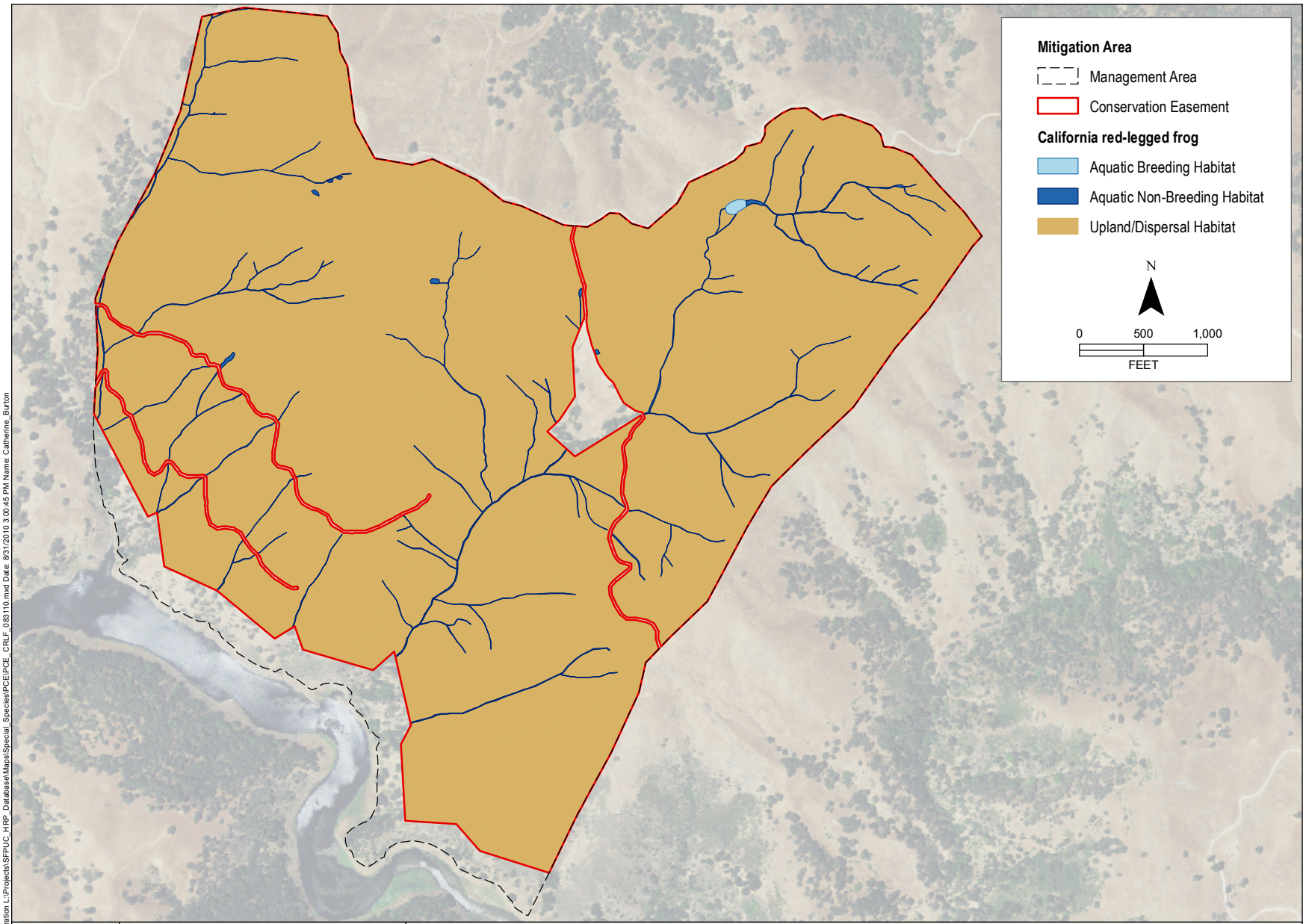
Appendix D - Figure 1c. San Antonio Mitigation Area:
Alameda whipsnake Primary Constituent Elements of critical habitat



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Appendix D - Figure 2a. Sage Canyon Mitigation Area:
California tiger salamander Primary Constituent Elements of critical habitat

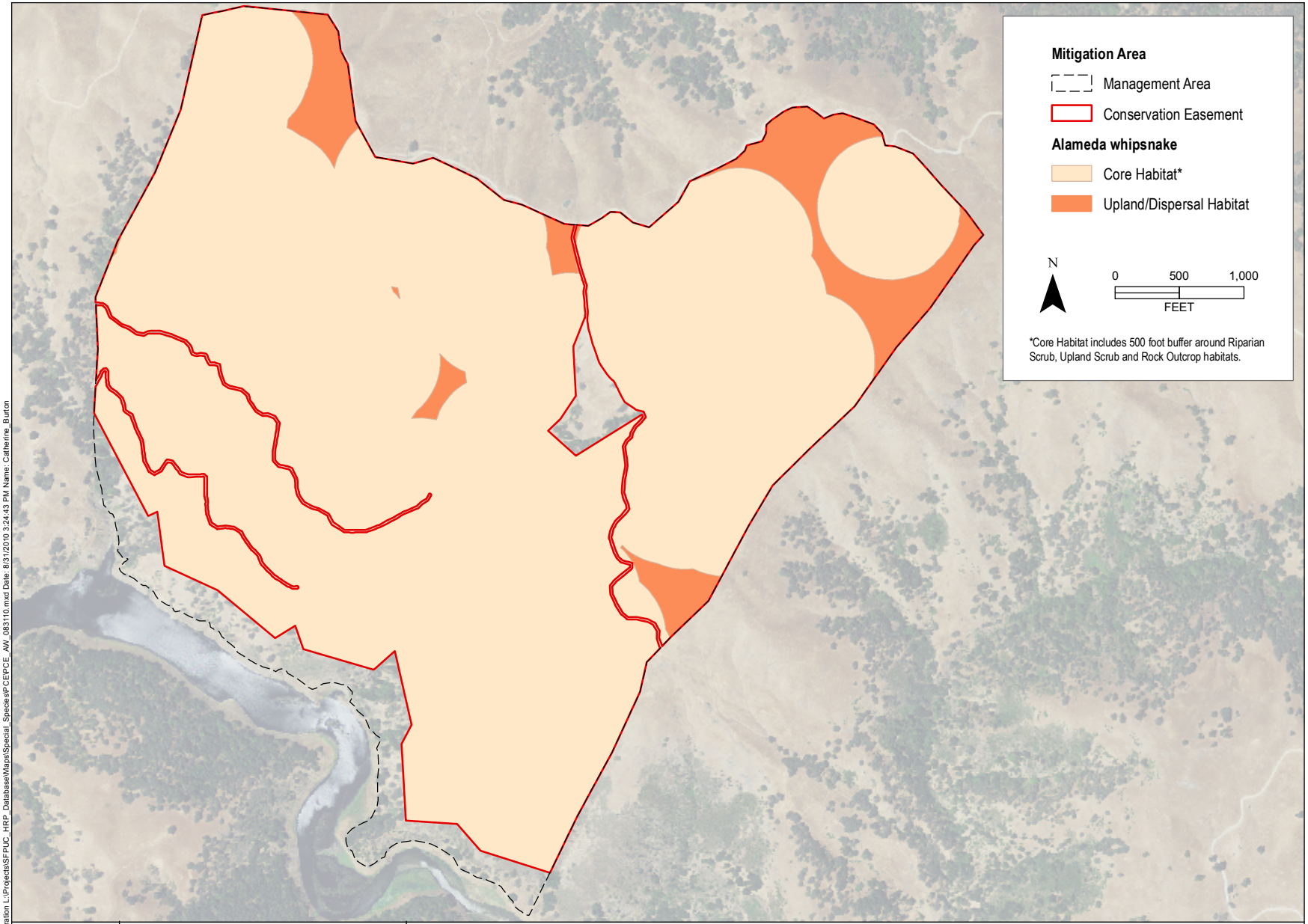


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Appendix D - Figure 2b. Sage Canyon Mitigation Area:
California red-legged frog Primary Constituent Elements of critical habitat

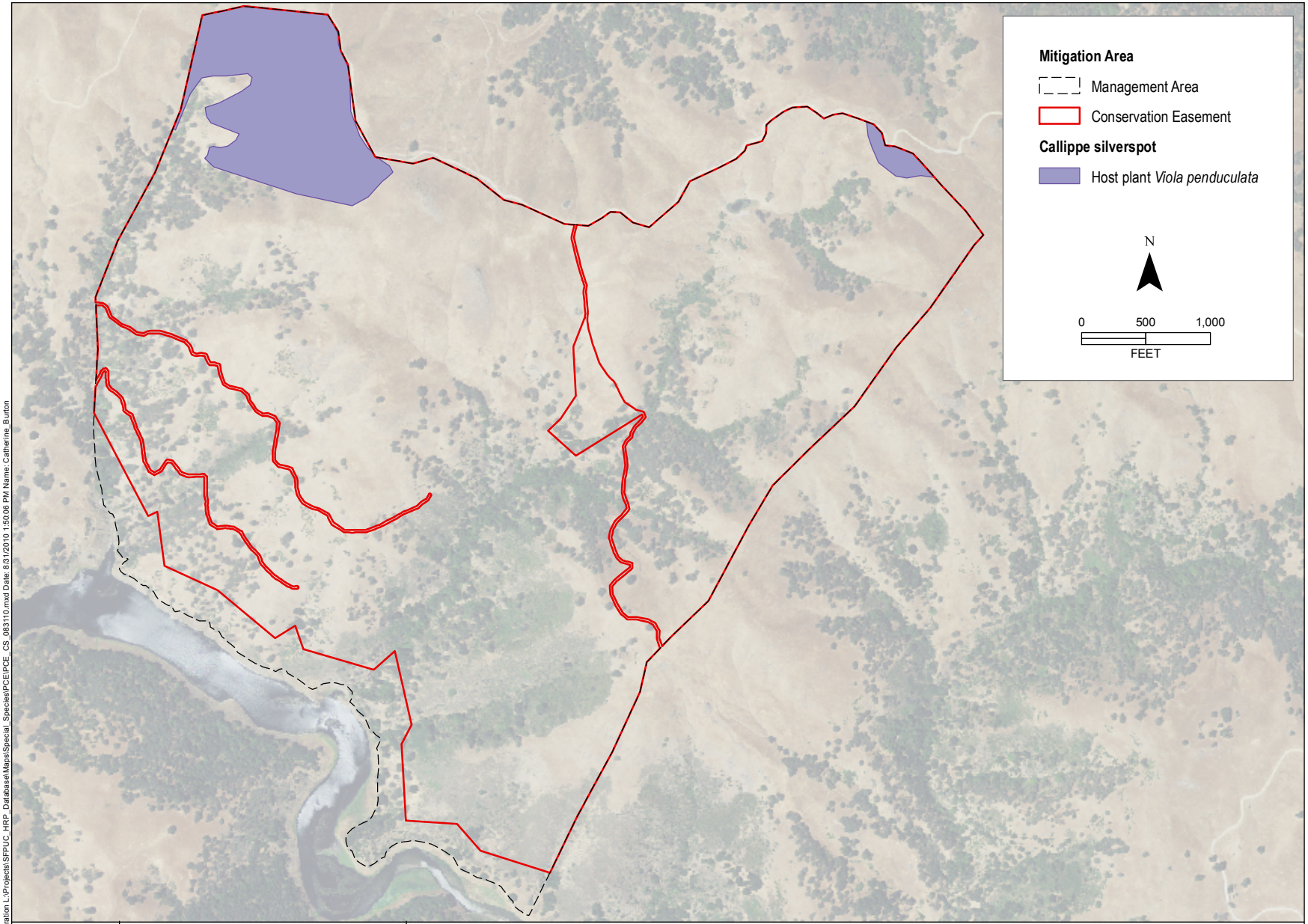


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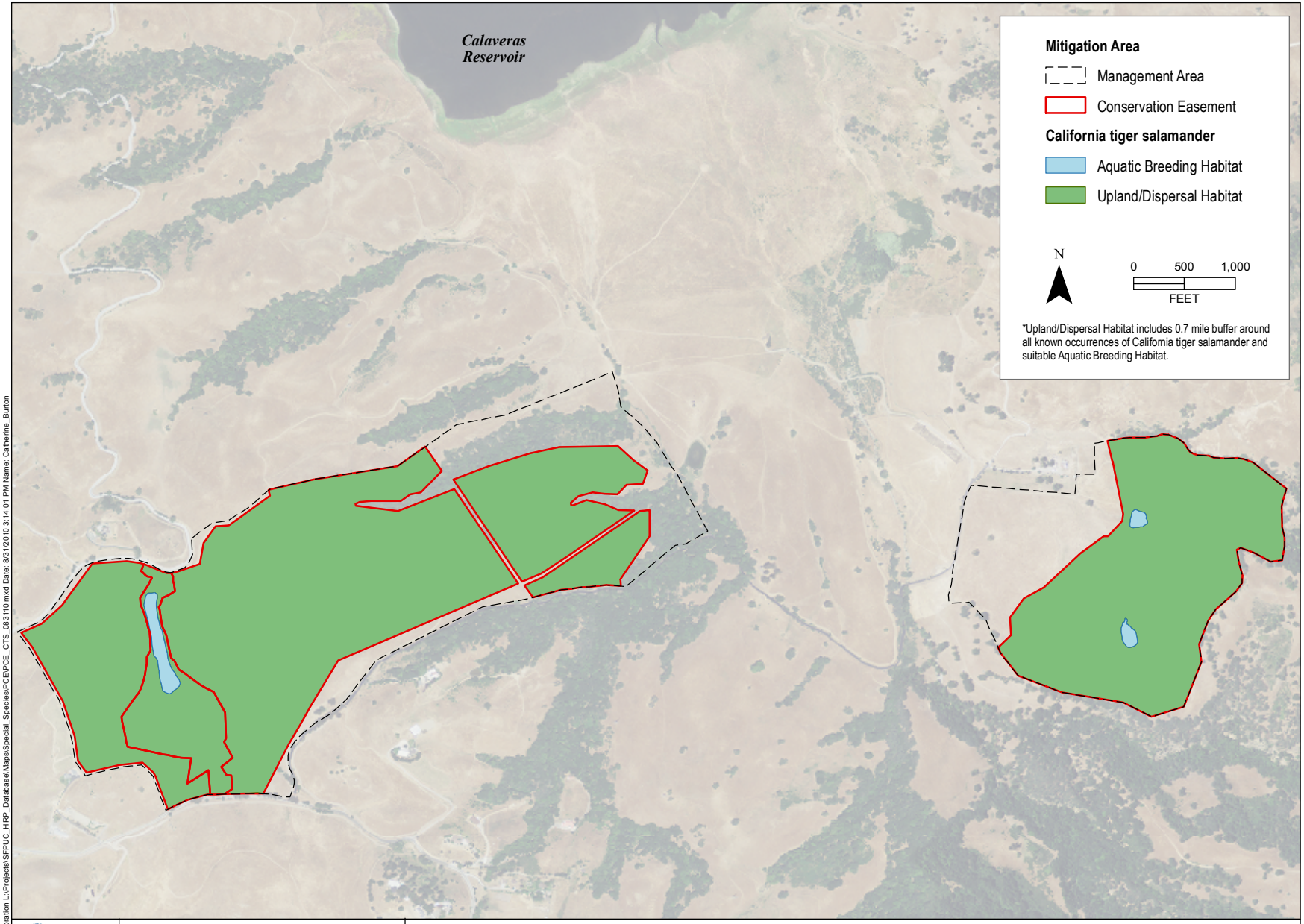
Appendix D - Figure 2c. Sage Canyon Mitigation Area:
Alameda whipsnake Primary Constituent Elements of critical habitat



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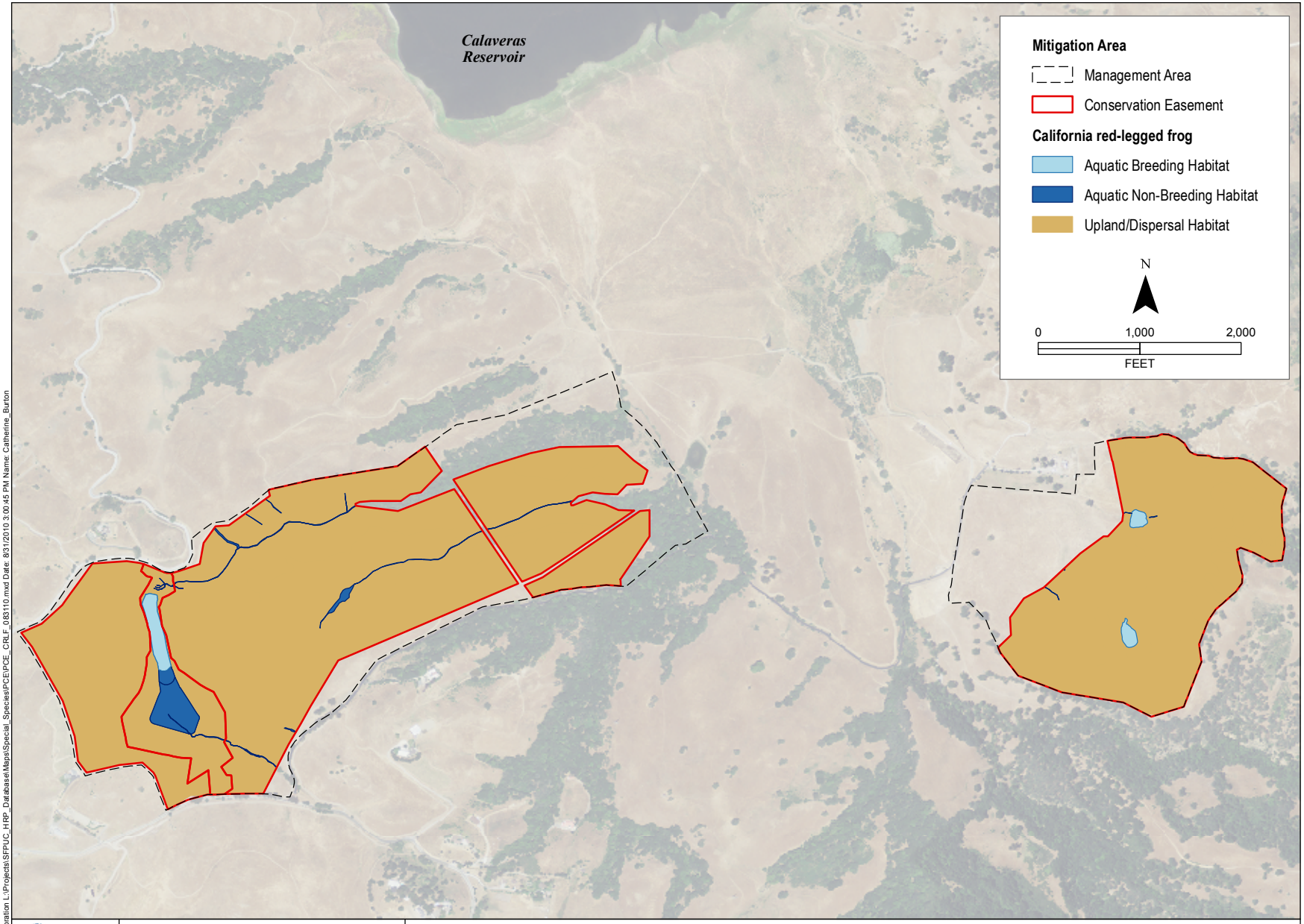
Appendix D - Figure 2d. Sage Canyon Mitigation Area:
Callippe silverspot Primary Constituent Elements of critical habitat



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Appendix D - Figure 3a. South Calaveras Mitigation Area:
California tiger salamander Primary Constituent Elements of critical habitat

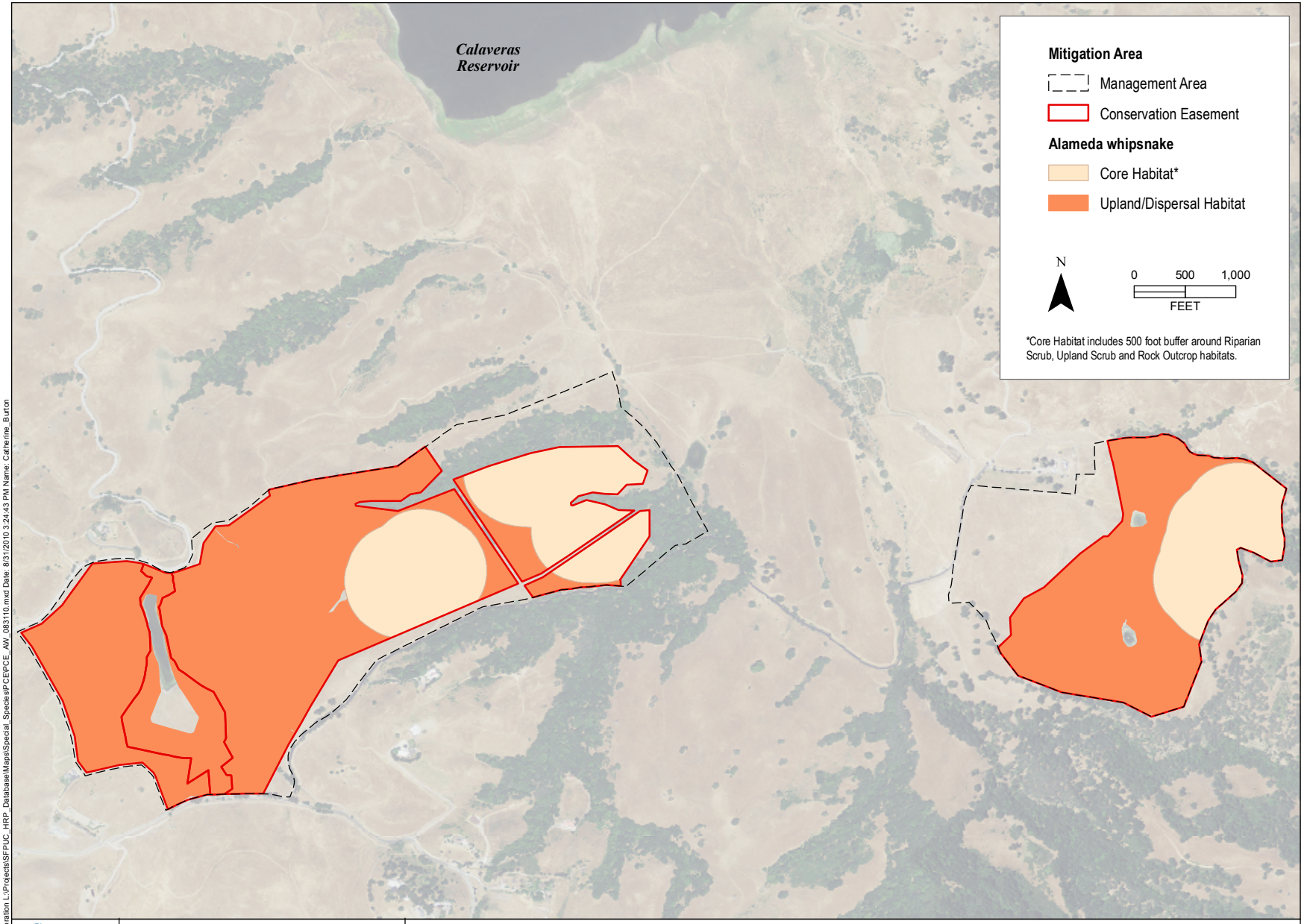


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Appendix D - Figure 3b. South Calaveras Mitigation Area:
California red-legged frog Primary Constituent Elements of critical habitat

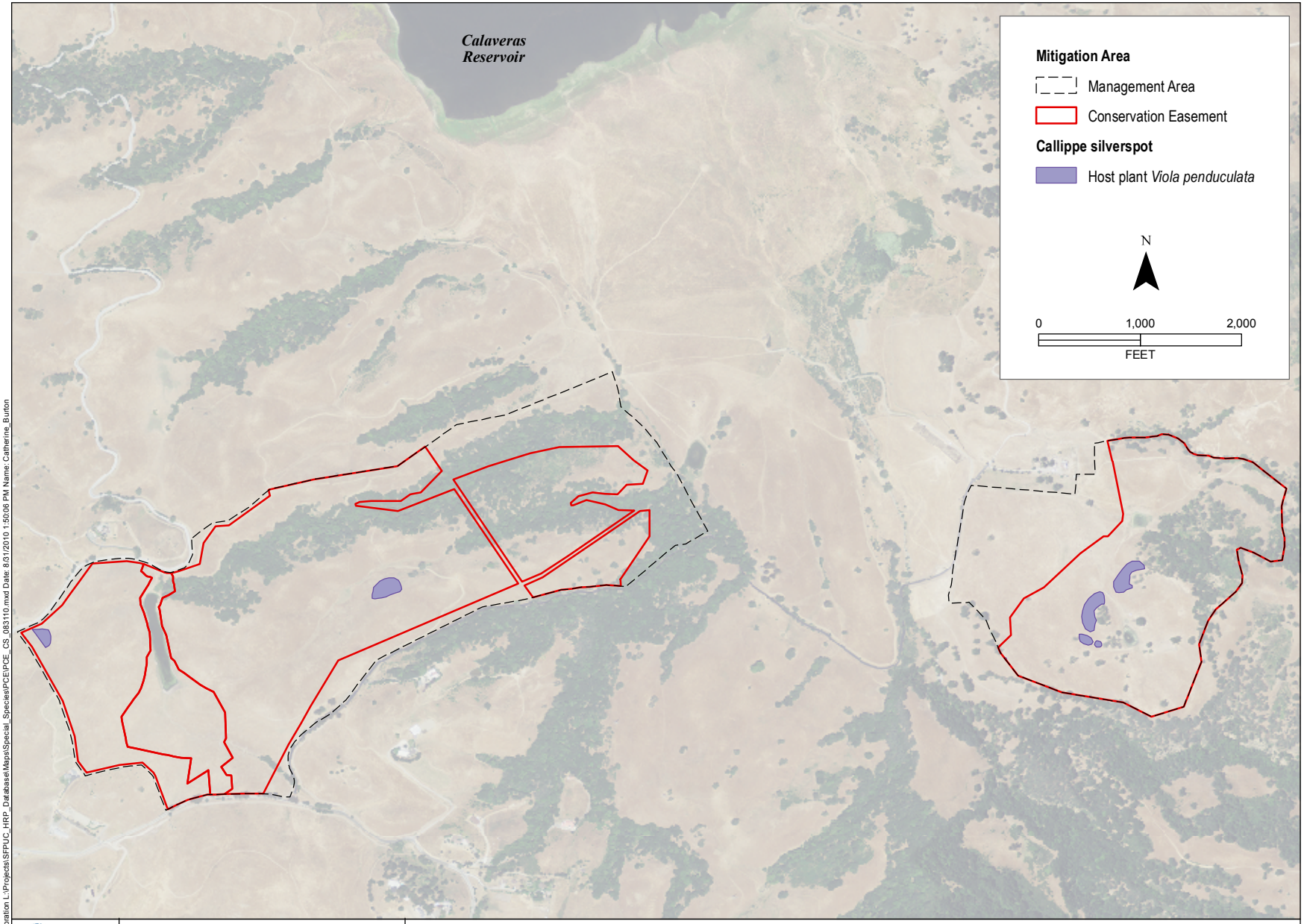


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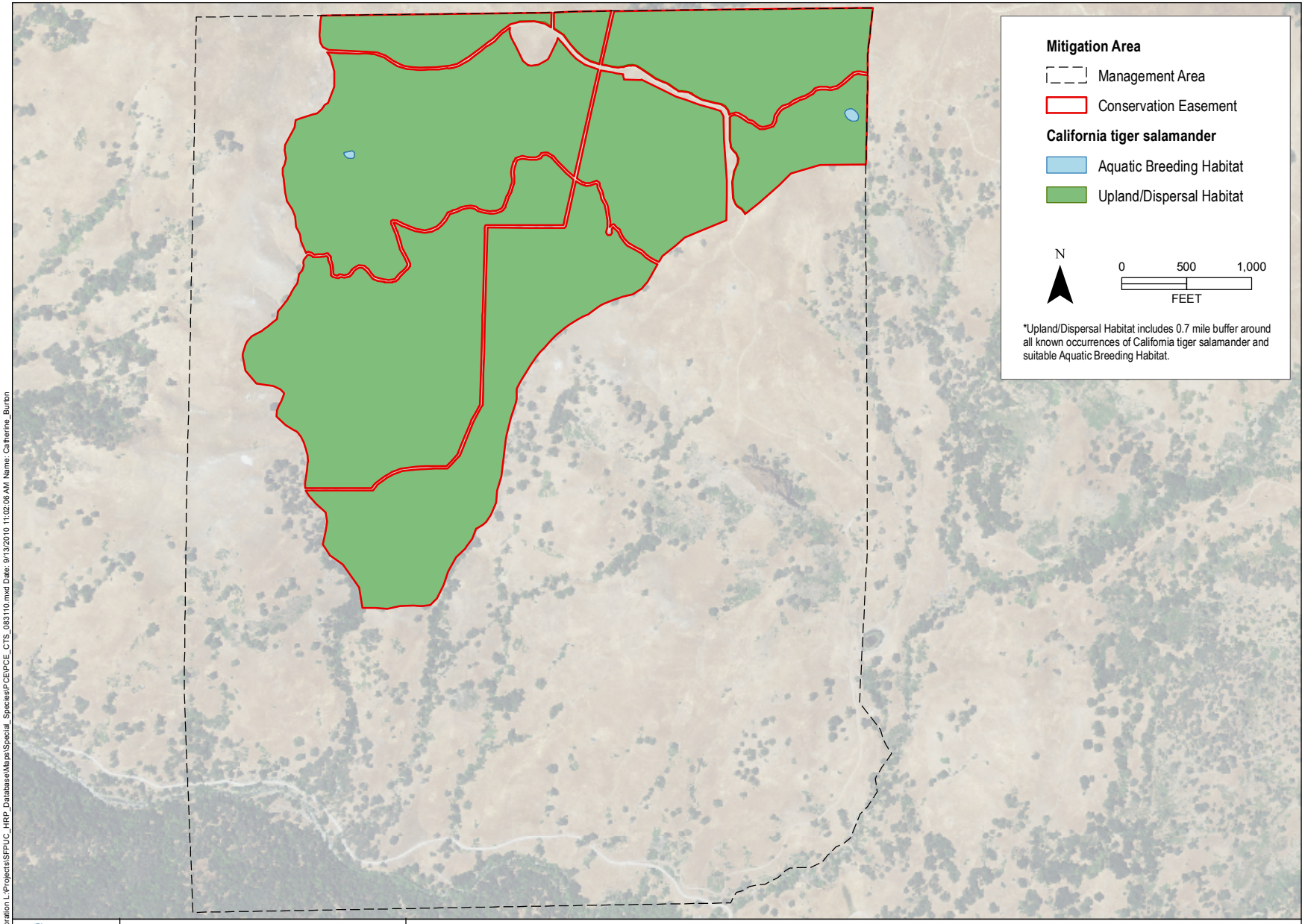
Appendix D - Figure 3c. South Calaveras Mitigation Area:
Alameda whipsnake Primary Constituent Elements of critical habitat



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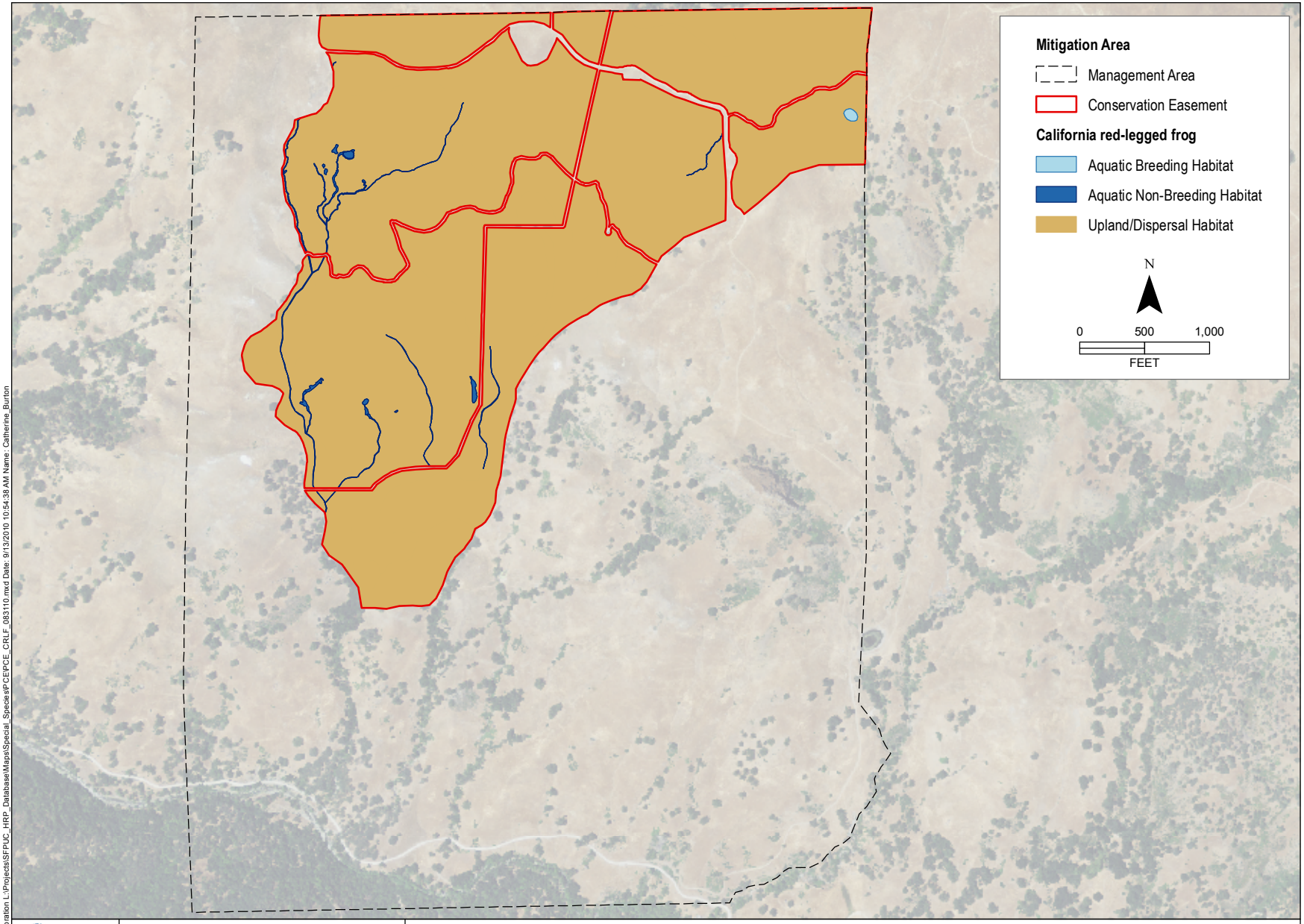
Appendix D - Figure 3d. South Calaveras Mitigation Area:
Callippe silverspot Primary Constituent Elements of critical habitat



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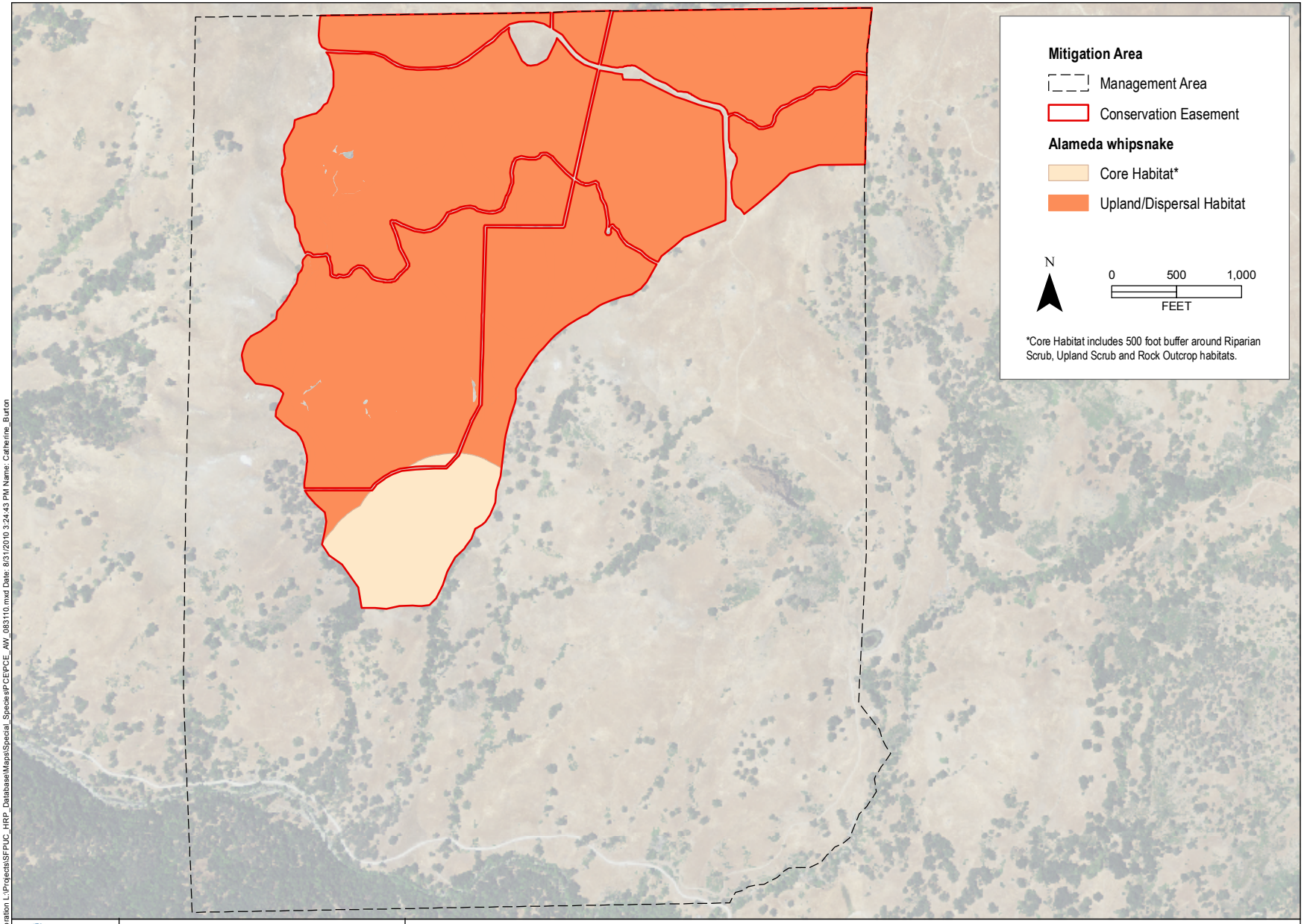
Appendix D - Figure 4a. Goat Rock Mitigation Area:
California tiger salamander Primary Constituent Elements of critical habitat



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Appendix D - Figure 4b. Goat Rock Mitigation Area:
California red-legged frog Primary Constituent Elements of critical habitat

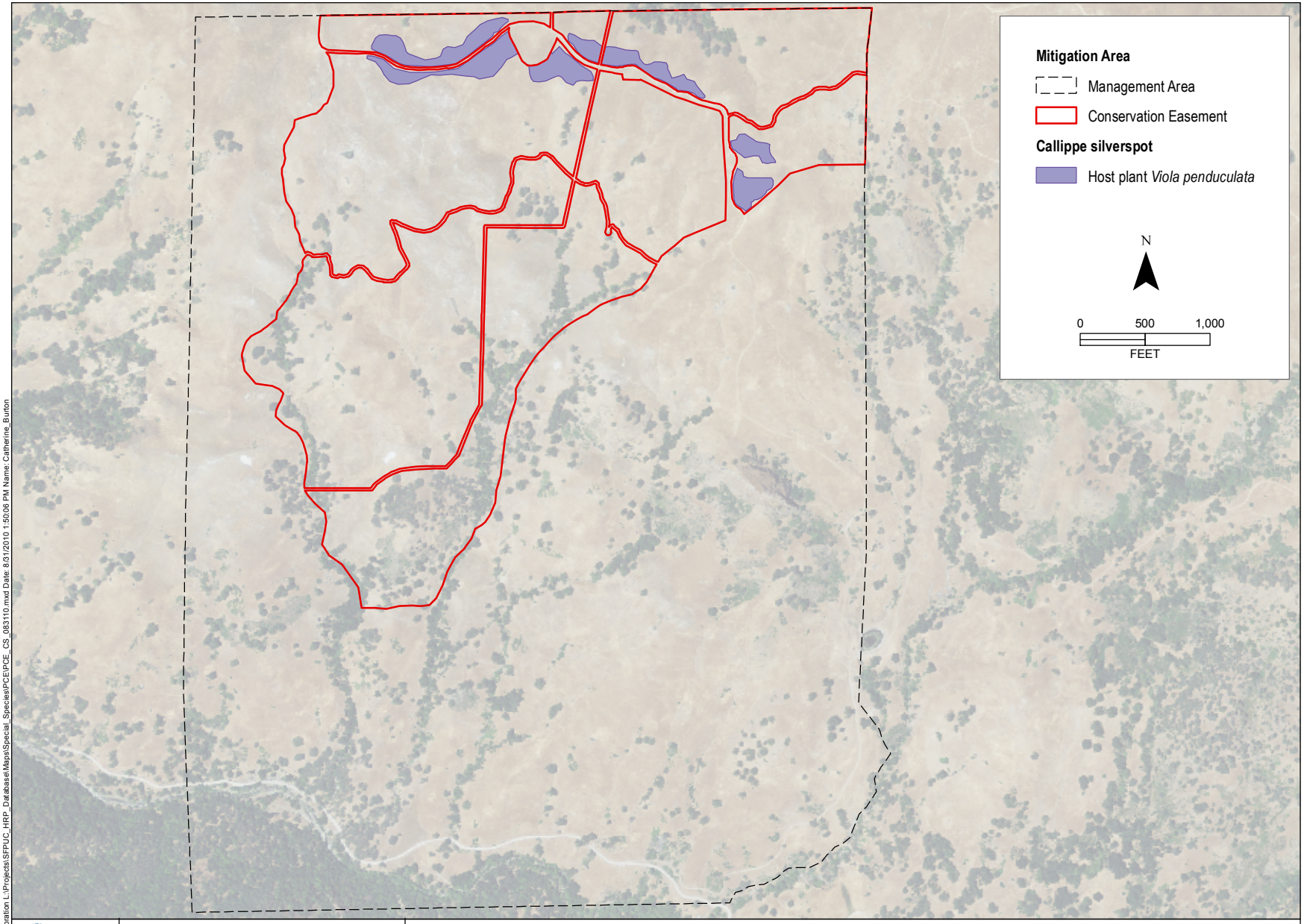


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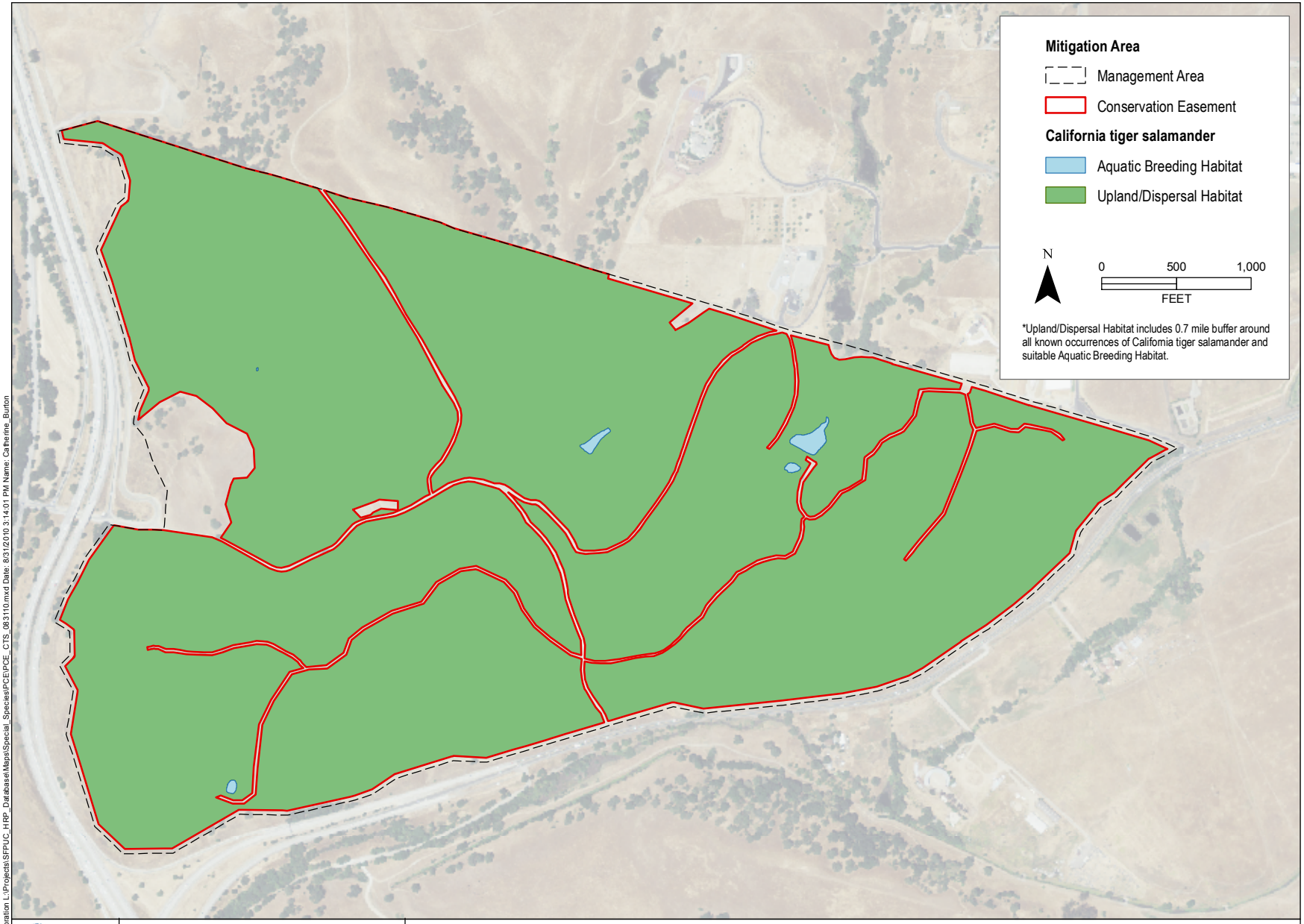
Appendix D - Figure 4c. Goat Rock Mitigation Area:
Alameda whipsnake Primary Constituent Elements of critical habitat



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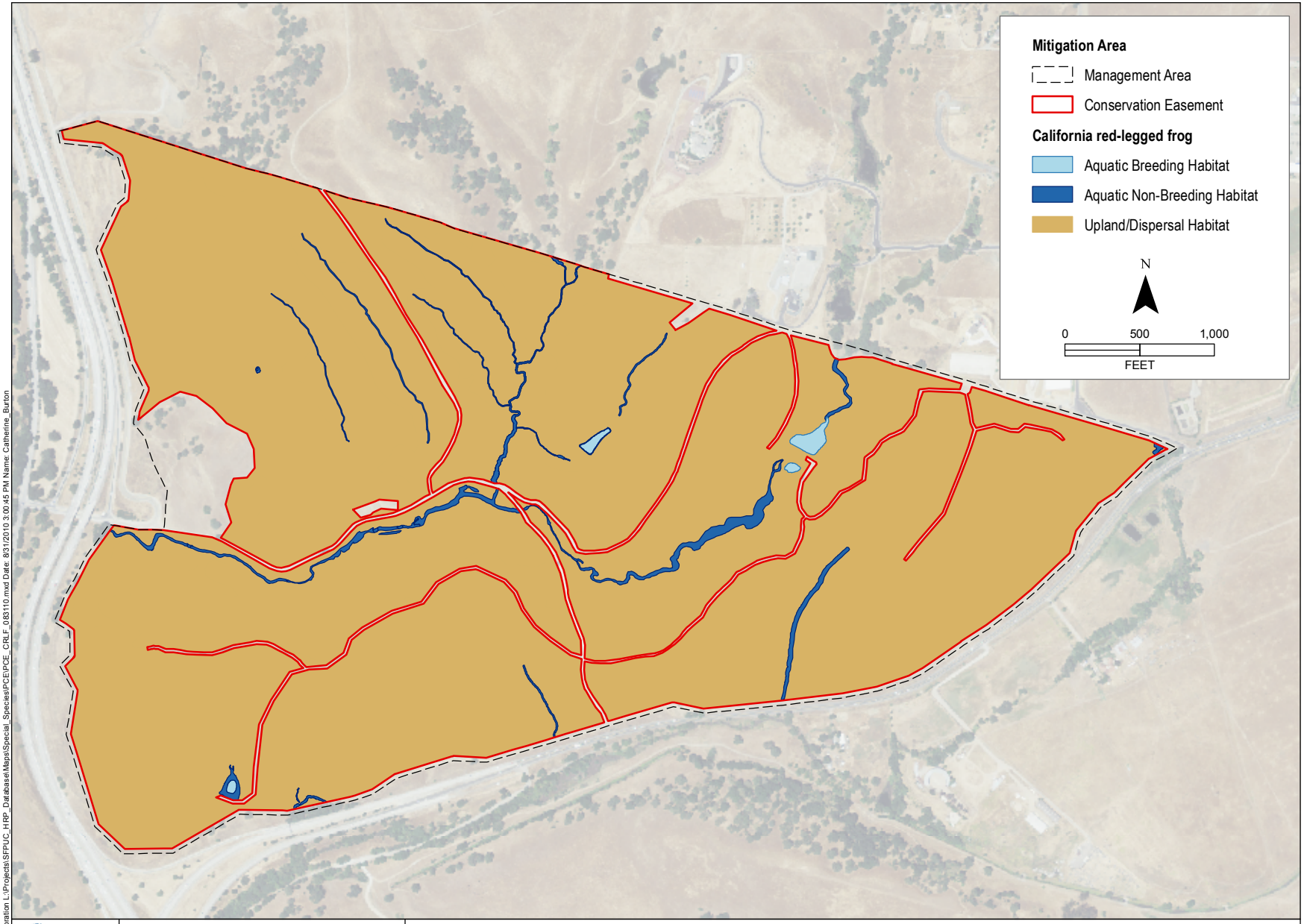
Appendix D - Figure 4d. Goat Rock Mitigation Area:
Callippe silverspot Primary Constituent Elements of critical habitat



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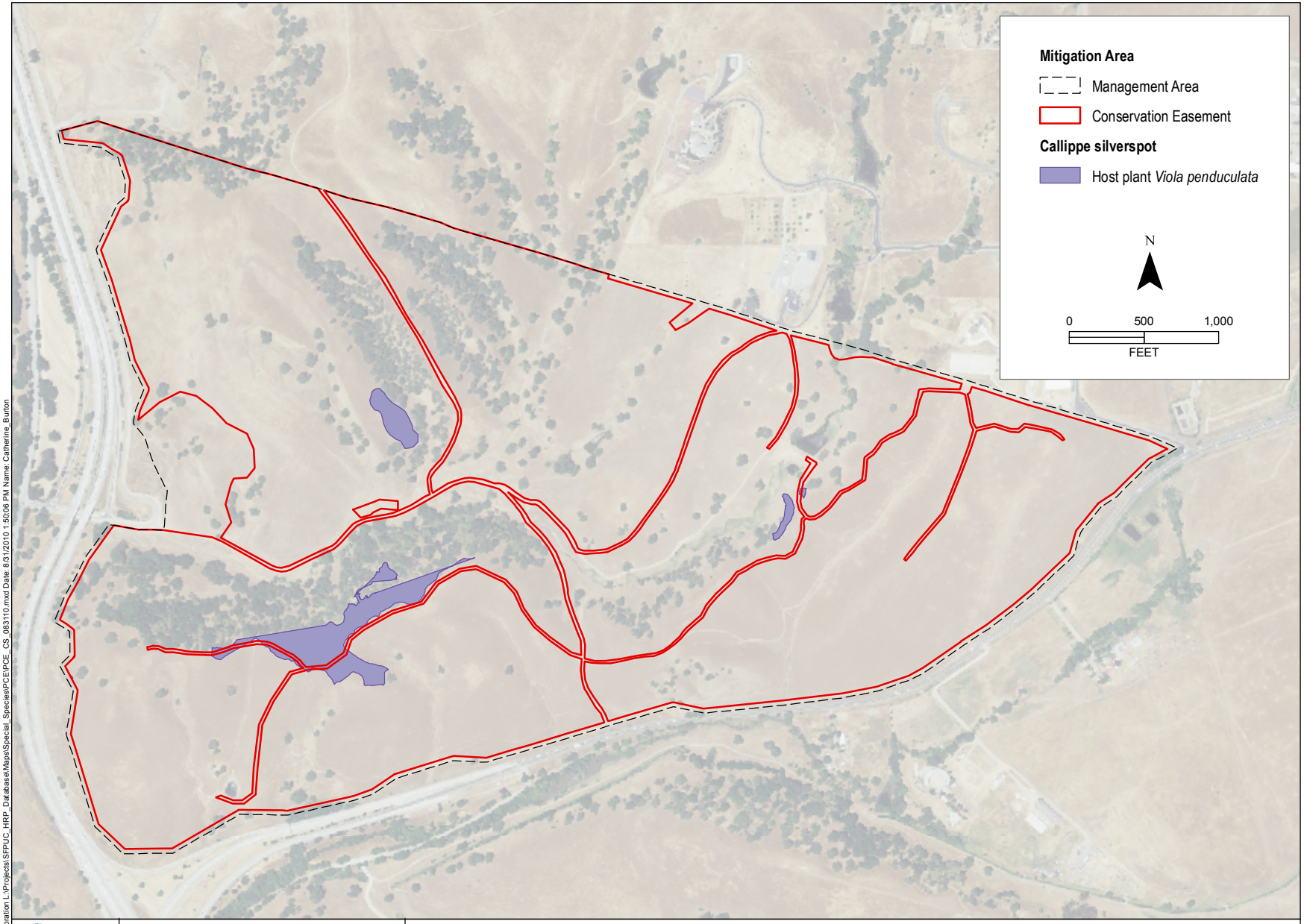
Appendix D - Figure 5a. Sheep Camp Mitigation Area:
California tiger salamander Primary Constituent Elements of critical habitat



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Appendix D - Figure 5b. Sheep Camp Creek Mitigation Area:
California red-legged frog Primary Constituent Elements of critical habitat



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Appendix D - Figure 5c. Sheep Camp Creek Mitigation Area:
Callippe silverspot Primary Constituent Elements of critical habitat

Appendix E: 30 Percent Design Plan Drawings and Design Memo for San Antonio Creek

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30% DESIGN

DETAILED DESIGN REPORT HABITAT RESERVE PROGRAM SAN ANTONIO MITIGATION AREA

Project No. 38802

Prepared for

San Francisco Public Utilities Commission
1155 Market St., 3rd Floor
San Francisco, CA 94103

May 26, 2010

URS Corporation
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List of Abbreviated Terms

ac	acre
AMC2	Antecedent Moisture Condition 2
avg.	average
BMPs	Best Management Practices
cfs	Cubic feet per second
cm.	centimeter
El.	Elevation
fps	Feet per second
ft	feet
GIS	Geographic Information System
GPS	Geographic Positioning System
HEC-HMS	Hydrologic Engineering Center- Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center-River Analysis System
HRP	Habitat Reserve Program
IATF	Inter-agency Task Force
lbs	Pounds
LiDAR	Light Detection and Ranging
mi^2	Square miles
m	meter
mm	millimeter
MMP	Mitigation and monitoring plan
NED	National Elevation Dataset
NRCS	National Resource Conservation Society
O.C.	On-center
PS&E	Plans, Specifications, and Estimate
RI	Return Interval
SCS	Soil Conservation Service (now NRCS)
SFPUC	San Francisco Public Utilities Commission
GPS	Global positioning system
SWPPP	Storm Water Pollution Prevention Plan
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

Chapter 1. Introduction

1.1. BACKGROUND

San Francisco Public Utilities Commission (SFPUC) has established a Habitat Reserve Program (HRP) for the purpose of providing habitat and compensation for impacts to biological resources resulting from SFPUC construction projects. These projects include the Calaveras Dam Replacement Project, Alameda Siphons, San Antonio Back-up Pipe Line, New Irvington Tunnel, and Sunol Valley Water Treatment Plant. The HRP includes a variety of preservation, restoration, enhancement, and creation actions that would be implemented on a number of SFPUC owned sites. The HRP was developed to:

- Provide economy of scale for coordinating and compensating for lost ecological functions and values
- Allow for multiple species and habitats to be supported in a given location
- Provide greater long-term conservation values across regions
- Support and coordinate existing efforts within regions

The primary objective of the program is to compensate for impacts from SFPUC projects by increasing ecological value of habitats for species while efficiently using allocated funds.

1.1.1. Project Location

The San Antonio Mitigation Area (project site) is located in Alameda County, California. The project site comprises approximately 255 acres along San Antonio Creek upstream of and adjacent to the northeast end of the San Antonio Reservoir where Indian Creek and San Antonio Creek flow into the reservoir (Figure 1-1). It extends east approximately 1.8 miles, beginning 0.1 miles west of Indian Creek. The north and south boundaries roughly follow Indian Creek Road and an unnamed ranch road. The area is situated approximately 6.4 miles north-northeast from the Calaveras Reservoir Dam.

1.1.2. Site Background

The project site contains a 2,300-foot reach of Indian Creek and 9,500-foot reach of San Antonio Creek. San Antonio Creek was identified as an opportune location for stream and riparian mitigation credits.

San Antonio Creek is a high beadload intermittent stream. The source of much of the bedload is from many vertical eroding banks along the channel. Lateral channel migration exacerbates bank erosion on meander bends. Bank erosion is largely the result of a lack if vegetative cover on streambanks caused by a history of overgrazing in the riparian area. Mature willows, sycamores, and oak trees as well as mulefat scrub in and along the channel dominate most of the vegetation along the creek. Recruitment of new woody vegetation is critical to maintaining stable channel dimensions. New sycamore seedlings have been observed in some depositional areas, however

are heavily browsed and show a limited likelihood to survive or potential to development into a tree.

Portions of the stream have a high width to depth ration, which reduces the sediment carrying capacity of the stream (competence) causing aggradation and formation of mid-channel and lateral bars. Excessive aggradation has separated flow into two of more channels at three locations further reducing stream competence and encouraging lateral channel migration. Pfankuch stream reach stability surveys conducted in 2009 ranked indicators of streambank stability on upper and lower banks and the bottom of the stream. Six cross-section locations within three reaches of the project area were ranked as "poor" in stability (URS 2009).

Historical aerial photographs also show that the upland areas in the project area once contained oak savannahs. Hay farming was present in the upland areas in the 1940's. As a result of the land use practices, many of the oaks were removed and ephemeral tributaries to San Antonio Creek were channelized. These tributaries lack sufficient vegetation to stabilize banks and provide habitat for species.

Ranch Road, the main access road to the project site, crosses San Antonio Creek as a low water crossing or ford. Impacts to the creek by vehicle traffic include: sediment input, rinsing of contaminants from vehicles (brake dust, oil, grease), disturbance of aquatic organisms, and destruction of a potential spawning area. The crossing also prevents access to some residences and grazing lands on the south side of the project area during high flows.

1.1.3. Mitigation Goals

The project design goals include the establishment and enhancement of riparian and upland habitat types and the establishment of an all-weather creek crossing (Ranch Road crossing). The Ranch Road crossing would provide vehicular access to the south side of San Antonio Creek when stream flows are high while reducing impacts to the stream from vehicular traffic.

Proposed riparian habitats include:

- Intermittent stream
- Ephemeral stream
- Sycamore woodland
- Oak riparian
- Willow riparian

Proposed upland habitats include:

- Oak savannah
- Oak woodland

The proposed creek will be designed to allow channels to adjust to reach a state of dynamic equilibrium in a relatively reasonable length of time without large shifts in degradation or aggradation of instream or adjacent habitats.

1.2. PROJECT SCOPE

The purpose of this design memorandum is to document the project goals, design criteria and analyses that have been completed to support development of the 30% plan and specification submittal. In addition, the construction cost estimate is presented.

The criteria and analyses summarized in this memorandum were selected to meet the goals listed in Section 1.1.3 based on the Draft Mitigation and Monitoring Plan (MMP) and associated Inter-Agency Task Force (IATF) comments. In order to accomplish this, the proposed project design includes the following work items:

- Hydrologic and hydraulic analyses to determine:
  - Bankfull discharge for the purpose of channel design
  - The 100-year storm flow for the purpose of designing the bridge crossing and modeling the performance of the floodplain.
- Design of the proposed channel longitudinal profile, cross section, and plan view dimensions.
- Geotechnical analysis to support improvement and restoration of eroded stream banks.
- Earthwork analysis, coupled with the hydraulic analyses mentioned above, to reconstruct the stream channel and floodplain and support the sycamore riparian vegetative community.
- Grazing management with permanent fencing.
- Planting plan.

1.3. ORGANIZATION OF DESIGN REPORT

This document is organized as follows:

- Chapter 1 provides background information and summarizes the purpose and scope of the project, as well as this memorandum.
- Chapter 2 describes the hydrologic analysis and modeling, channel design, and hydraulic modeling.
- Chapter 3 describes the geotechnical analysis to support improvement of eroded channel banks.
- Chapter 4 discusses the results of preliminary analysis for the Ranch Road crossing.
- Chapter 5 discusses the design associated with the grading of the channel and floodplain.
- Chapter 6 discusses the fencing plan associated with grazing management.
- Chapter 7 provides background on the proposed planting communities and details on the planting plan.

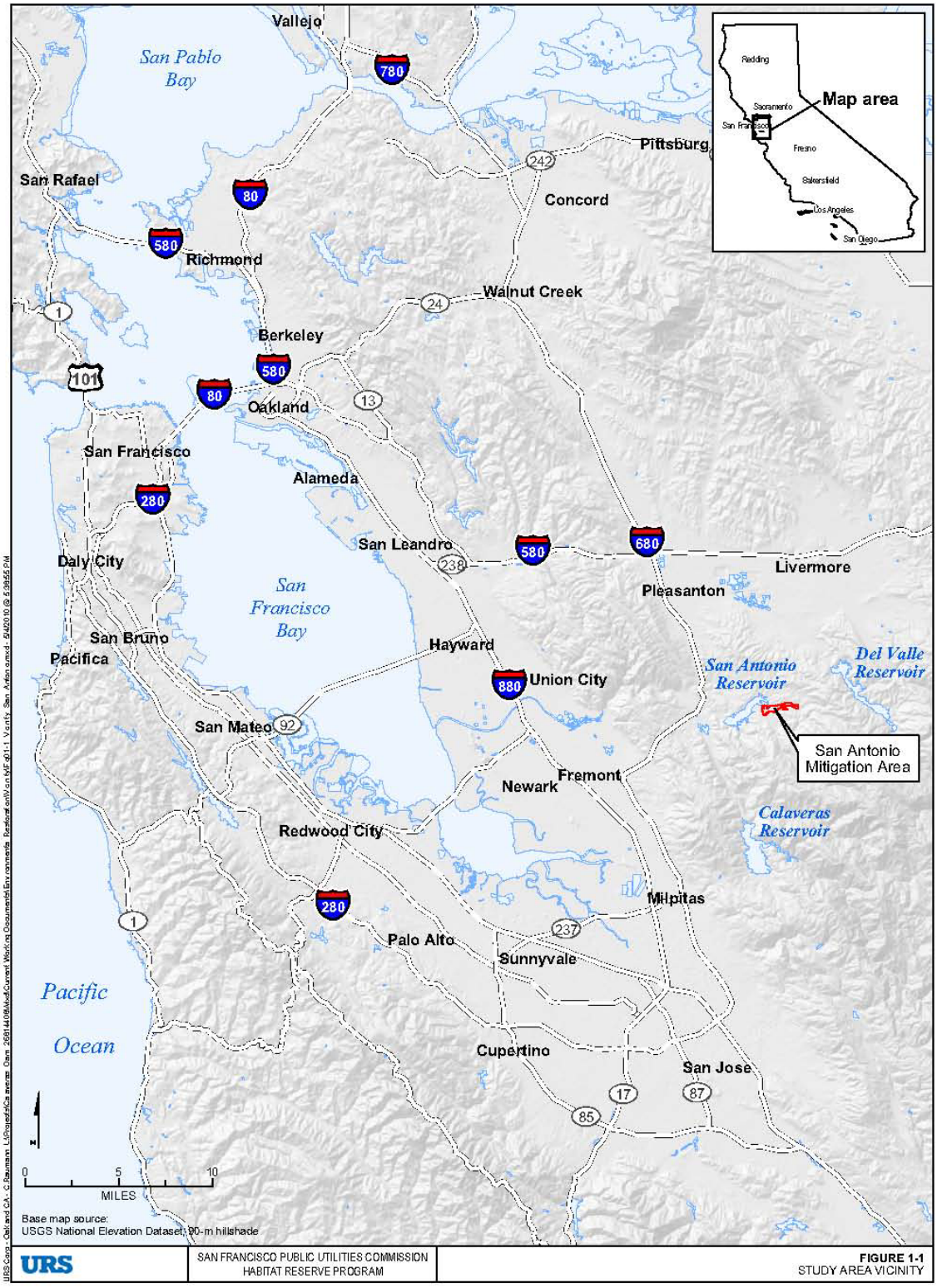


Figure 1-1. Project Vicinity Map

Chapter 2. Hydrologic and Hydraulic Analysis

2.1. PURPOSE

Hydrologic and hydraulic analyses are needed to calculate the design flow(s) for the watershed that will be used to design channel and floodplain geometry and components, as well as support the bridge design. In addition, modeling of the proposed hydraulic conditions is needed to ensure frequency and duration of flooding to support the proposed habitats.

2.2. DESIGN FLOW

Flow estimates are required to adequately design the active channel, floodplain, and the Ranch Road crossing. For channel design, an estimate of the channel forming or bankfull flow (typically with a recurrence interval between 1.1 and 1.8 years (Rosgen 1998)) is used to calibrate the active channel dimensions. For the Ranch Road crossing, the Regional Water Quality Control Board and California Department of Fish and Game require a minimum 100-year design flow.

For this project, bankfull discharge has been estimated using four separate methods: extrapolation from stream gage station data and regional curves, U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center - Hydrologic Modeling System (HEC-HMS), bankfull velocity estimation methods (Rosgen 2009), and regional regression equations (USGS 1993). The 100-year flow was determined using HEC-HMS and a regional regression equation (USGS 1993).

2.2.1. Regional Curve Analysis

Regional curves provide useful approximations of bankfull discharge and channel characteristics for a given watershed drainage area. Regional curves are developed by performing a regression analysis on bankfull flow, width, depth, and cross sectional area data plotted against the drainage area; ideally, for several streams, to generate a curve. These variables have been shown to have a strong statistical correlation with the drainage area.

The use of regional curves for the purpose of design is adequate only when the regional curve can be demonstrated to predict similar values to those determined from gage stations within a similar hydro-physiographic province of the project area. Three regional curves developed for different areas nearest the project area were analyzed for this analysis: San Francisco Bay region (Dunne and Leopold 1978), Santa Cruz Mountains (Howell 2009), and Scotts Creek watershed (Howell 2009).

The regional curves for bankfull discharge were analyzed for relevancy by comparing the results of a field bankfull calibration of Arroyo Hondo Creek at the United States Geological Survey (USGS) gage station with the predicted discharge from the regression equations from the regional curves (Table 2.1).

Table 2.1. Regional Curve Analysis

Method	Bankfull Discharge (cfs)		Return Interval[1]
	Arroyo Hondo Creek (D_A = 77.1 mi^2)	San Antonio Creek (D_A = 20.4 mi^2)	
Arroyo Hondo bankfull calibration method	1,660	N/A	1.3
San Francisco Bay Regional Curve (Dunne and Leopold 1978) $Q_{bkf} = 53D_A^{0.93}$	3,015	875	1.8
Santa Cruz Mountains Regional Curve (Howell 2009) $Q_{bkf} = 27.564D_A^{1.1165}$	3,526	1,182	2.3
Scotts Creek Regional Curve (Howell 2009) $Q_{bkf} = 171.73D_A^{0.6398}$	2,768	799	1.6

[1] RI based on analysis of annual peak discharge data from USGS gage station 11173200, Arroyo Hondo Near San Jose.

The bankfull calibration method involves surveying the bankfull elevation measured in the field at the staff gage and correlating the stage reading to the published stage-discharge rating curve for the gage. Based on field measurement of the approximate bankfull stage at Arroyo Hondo and the stage-discharge rating curve, the estimated bankfull discharge is 1,660 cfs. The discharge at the identified bankfull elevation was checked to determine if the discharge was within a reasonable return interval for a bankfull storm (1.1 –1.8 years). Annual peak discharge data was ranked for the entire record of flow recordings from highest to lowest. The exceedance probability was calculated using the following equation:

$P = [m/(n + 1)] * 100$

Where:

P = exceedance probability

m = rank

n = total number of data recordings

Once the exceedance probability is calculated for the annual peak discharge data the return interval (RI) is determined from the following equation:

$RI = (1/P) * 100$

The return interval versus annual peak discharge was plotted to determine return interval for the bankfull discharge. The plot (Figure 2-1) indicates a return interval of 1.3 years for the identified bankfull discharge of 1,660 cfs, is within the typical range of bankfull return intervals. Because the Arroyo Hondo watershed shares similar rainfall distribution, geology/soils, vegetative types, and is adjacent to the San Antonio watershed - it is assumed that a 1.3-year return interval for a bankfull discharge is applicable to San Antonio Creek.

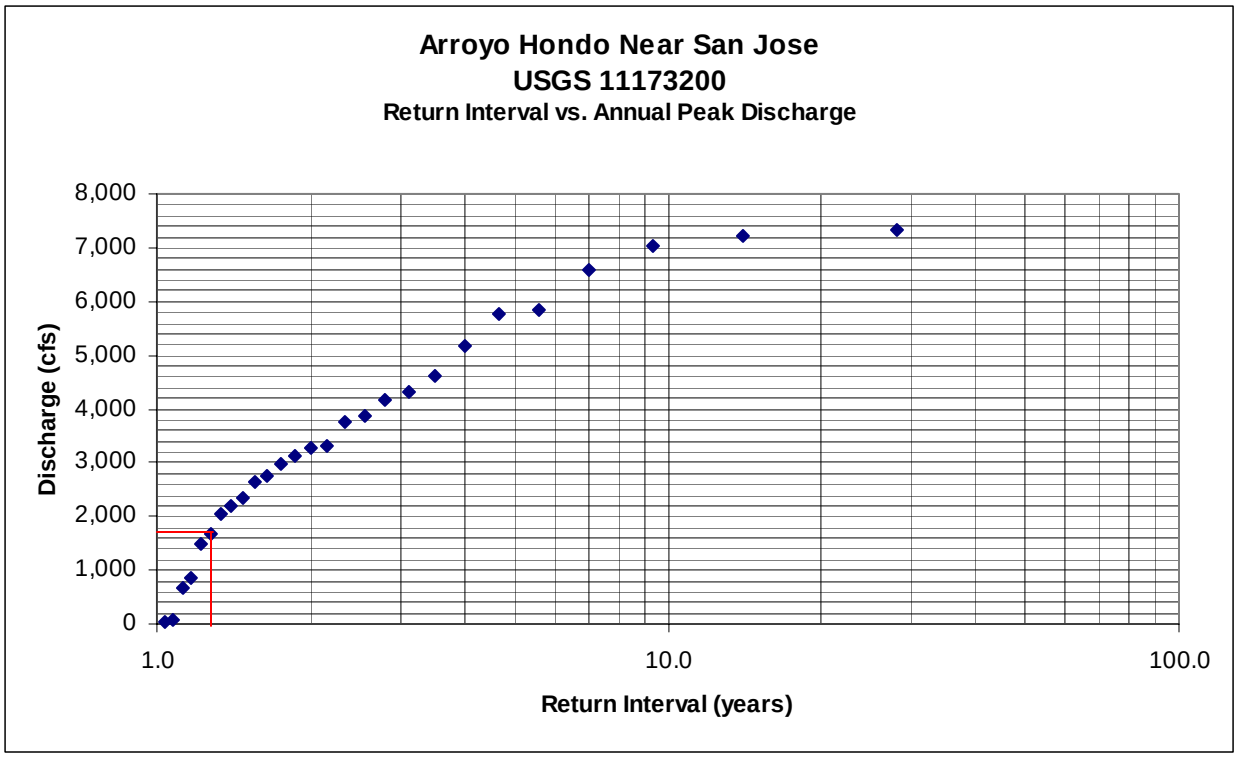


Figure 2-1. Return Interval vs. Annual Peak Discharge

The discharge from the bankfull calibration at Arroyo Hondo was compared to those predicted from regression equations developed for regional curves closest to the project area (Table 2.1). The results indicate that the regional curves may over predict the bankfull discharge for Arroyo Hondo (RI 1.6 – 2.3 years); therefore they may also over predict the discharge for San Antonio Creek. An over prediction is expected since all these regional curves utilize data from coastal streams, which receive more intense rainfall than inland hills of the Bay Area. In order to validate the bankfull discharge using the regional curves at least one other gage station within close proximity of the project area should be measured to verify the regional curves and develop a slope for an adjusted regional curve for the area that can be extrapolated to San Antonio Creek. Surveying Alameda Creek above the Alameda Creek Diversion Dam would be appropriate for this purpose. For the 30% design a 1.3-year bankfull return interval was chosen for further analysis in the HEC-HMS runoff model. For the runoff model, it is assumed that a 1.3-year rainfall event results in a 1.3-year stormflow.

2.2.2. HEC-HMS Model

Hydrologic modeling of the San Antonio Creek watershed was performed using HEC-HMS Version 3.4 (HEC 2009a). The model was used to estimate peak discharges along San Antonio Creek for design storm events to aid in the proposed grading of the channel. Peak discharges from the 100-year, 24-hour rainfall event were used to design the all-weather crossing at Ranch Road. Smaller events were used to assess the performance of the existing and proposed channel.

The main inputs into the HEC-HMS model included the following:

- Watershed characteristics
- Runoff and routing parameters
- Precipitation data

The input parameters are described in the following sections.

2.2.2.1. Method

Two approaches were used to calculate direct runoff (and losses) in the HEC-HMS model. The loss methods included the Soil Conservation Service (SCS, now the Natural Resources Conservation Service) curve number method and the initial and constant loss method. The runoff hydrograph transform methods included the SCS and Snyder unit hydrograph methods. Comparing the peak discharge results from the two approaches can be helpful in estimating the uncertainty associated with the hydrologic model.

The SCS curve number method calculates runoff based on a curve number, which is estimated from soil type and land cover. A curve number is analogous to a runoff coefficient but varies from zero to 100. A low number indicates low runoff potential and a high number indicates a large runoff potential. NRCS has published tables for selecting a curve number based on land cover and condition and soil hydrologic group (A, B, C, or D), where soil group A has high permeability and soil group D has low permeability. The method is empirical and is primarily based on undeveloped watersheds. The land cover in the study area was determined from the National Land Cover Database (USGS 2003), which is in GIS format.

For the first approach, the SCS curve number method was combined with the SCS unit hydrograph method to estimate the direct runoff.

The second approach for estimating runoff was based on guidance provided in the *Alameda County Hydrology and Hydraulics Manual* (ACPWA 2003). The manual is provided to assist in the design of flood control facilities specifically in western Alameda County. The methods in the manual were developed from hydrologic and meteorological data from Alameda County and the vicinity. It was assumed that the methods it would be acceptable to apply to the San Antonio Creek watershed. The manual specifies the use of the initial and constant loss rate as well as the Snyder unit hydrograph transform method. The data required to estimate the uniform loss rate include land cover and hydrologic soil group.

2.2.2.2. Input Data

Watershed Characteristics and Runoff Parameters

The watershed draining to San Antonio Reservoir and the sub-basins draining to San Antonio Creek in the vicinity of the project area were delineated using Geographic Information System (GIS) tools associated with the USACE Hydrologic Engineering Center Geospatial Hydrologic Modeling Extension (HEC-GeoHMS). The watershed delineation shown in Figure 2-2 was based on topographic data in electronic format from the National Elevation Dataset (NED) (USDA/NRCS 2009).

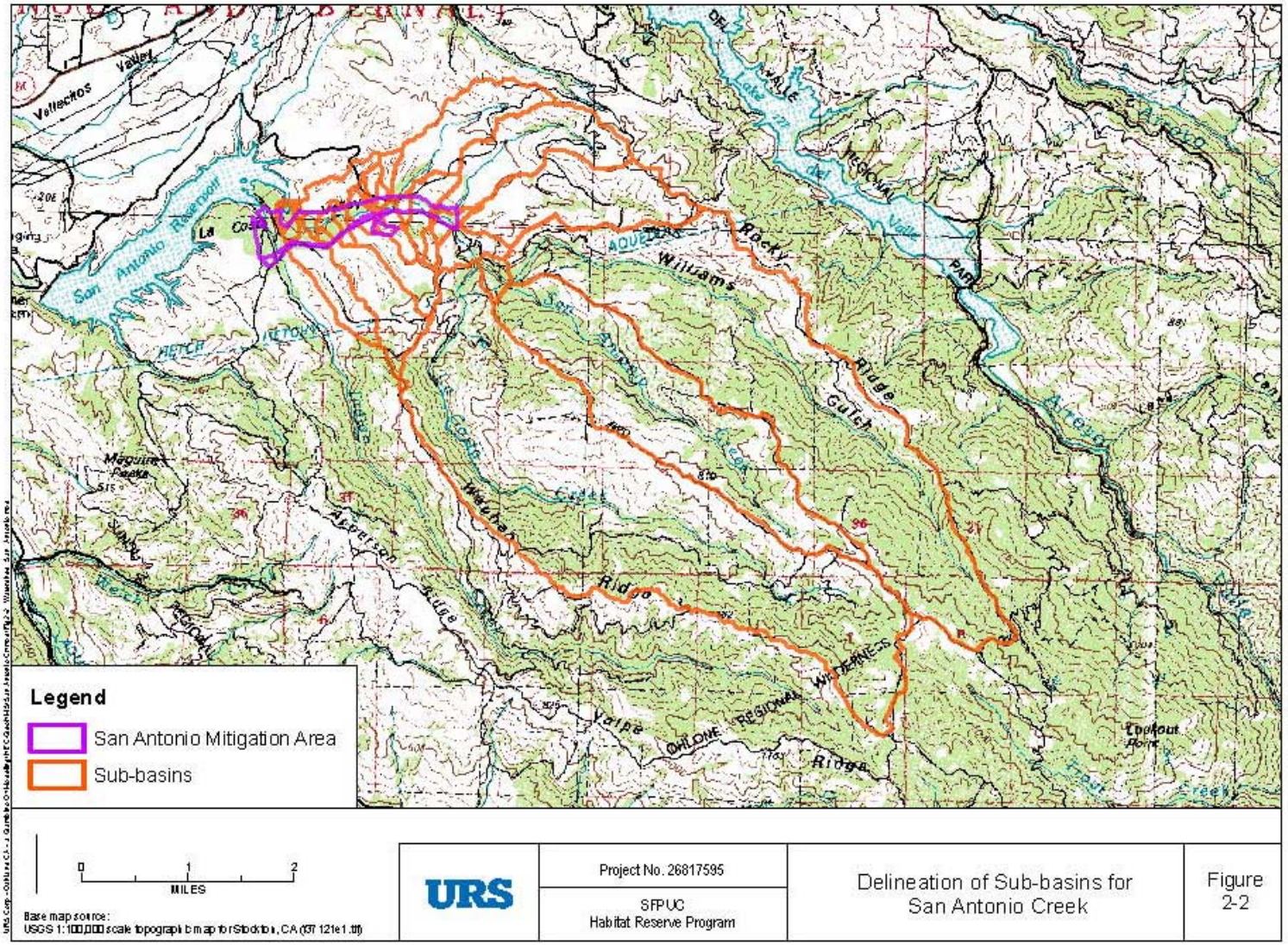


Figure 2-2. Delineation of Sub-basins for San Antonio Creek

The NRCS Soil Survey for Alameda County (USDA/NRCS 2007) was used to determine the soil hydrologic group for the soils within the watershed. Soils in the watershed generally consist of combinations of rock, clay, and loam. The upper watershed generally consists of soil hydrologic groups of C or D, with the lower San Antonio Creek river bed consisting of hydrologic group A, and the area adjacent to the river bed consisting of soils in hydrologic group B.

The watershed is mainly covered by forest and grassland, with a small portion covered by brush, water, or roads and low-density residential use. Therefore, five cover types were selected for use in this study, based on the National Land Cover Database and categories provided in the TR-55 Manual (USDA/NRCS 1986). Curve numbers for use with the SCS method are presented in Table 2.2. Curve numbers for each land use are for antecedent moisture condition 2 (AMC2), which corresponds to average conditions. The area-weighted average curve number that accounted for the different soil types, ground cover, and average antecedent conditions, was 72.8. The SCS method accounts for losses up to the point that runoff begins in the initial abstraction parameter, which is calculated from the curve number, as follows:

$$I_a = 0.2\left(\frac{1000}{CN} - 10\right)$$

Where,

I_a = Initial abstraction (inches)

CN = SCS runoff curve number

The *Alameda County Hydrology and Hydraulics Manual* (ACPWA 2003) specifies loss rates by soil hydrologic group for rural and urban cover types. The entire watershed was estimated as rural area, and the associated uniform infiltration rates are listed in Table 2.2. The manual specifies initial losses of 0.8 inches for a 6-hour design storm, and 1.0 inch for a 24-hour design storm.

The two loss methods used in HEC-HMS also require the percentage of the basin that is covered with impervious area. The percentage of impervious area in each sub-basin was calculated based on the National Land Cover Database layer, and assuming that the area associated with roads and other low density residential uses was 25% impervious. The impervious area for the entire basin was determined to be 0.3% of the total watershed area of 20 square miles.

Table 2.2. Watershed Curve Number and Infiltration Rate Summary

National Land Cover Database[1] land use type	Corresponding land use	Hydrologic condition	Curve number by hydrologic soil group for average antecedent moisture conditions			
			A	B	C	D
Forest	Woods	good	30	55	70	77
Grassland	Meadow	N/A	30	58	71	78
Brush	Brush	good	30	48	65	73
Low density residential	Urban area open space (assumed 25% impervious)	good	39	61	74	80
Water	N/A (assumed 100% runoff)	N/A	100	100	100	100
Rural coverage uniform loss rate[2] (in/hr):			**0.45**	**0.35**	**0.14**	**0.05**

Note: Source of data is from the TR-55 Manual (USDA/NRCS, 1986), except as indicated.
N/A = not applicable
[1] USGS, 2003
[2] ACPWA, 2008

The HEC-HMS model calculates runoff hydrographs from sub-areas using the unit hydrograph methodology. The parameter needed as input to HEC-HMS to calculate the SCS unit hydrograph is the drainage basin lag time. The lag time is defined as the time difference between the occurrence of the center of mass of excess rainfall and the peak of the unit hydrograph. The basin lag time was calculated for each sub-basin using HEC-GeoHMS, which applies the curve number lag method. This method uses the following equation, which is described in the NRCS National Engineering Handbook that was originally published in 1972 (USDA/NRCS 1997):

$$t_{lag} = \frac{L^{0.8}(S+1)^{0.7}}{1900Y^{0.5}}$$

Where,

t_{lag} = basin lag time (hours)

L = hydraulic length of watershed (feet)

S = $\frac{1000}{CN} - 10$, where CN is the curve number

Y = basin slope (%)

The average sub-basin slope was calculated using HEC-GeoHMS with a digital elevation grid from the National Elevation Dataset. Based on the entire watershed area, the average basin slope was 35.7% and the hydraulic length was approximately 30,000 feet. The basin lag time calculated for the entire watershed using the curve number lag method was 1.7 hours (100 minutes). When the entire watershed was subdivided based on the tributaries draining to San Antonio Creek, the sub-basin lag times ranged from 5 minutes to 75 minutes.

The parameters needed as input to HEC-HMS to calculate the Snyder unit hydrograph include the drainage basin lag time and a peaking factor. The *Alameda County Hydrology and*

Hydraulics Manual (ACPWA 2003) specifies the following equation for determining basin lag time:

$$t_{lag} = K \cdot N\left[\frac{L \cdot Lc}{\sqrt{S}}\right]^{0.38}$$

For L > 1.7 miles, K = 24

For L < 1.7 miles, $K = 15.22 + 2.15L + \frac{8.7}{L}$, with $K \leq 30$

Where,

t_{lag} = basin lag time (hours)

L = length of the longest water course (miles)

Lc = length along longest water course measured from the outlet to a point opposite the watershed area centroid (miles)

S = average stream slope (ft/mile)

N = basin roughness factor.

The average stream slope was estimated as the difference in elevation between the top and the bottom of the longest watercourse divided by the length of the longest watercourse.

The basin roughness factor was estimated to be 0.07, which is specified for "rural watersheds with moderate to high levels of vegetation growth, or rock and boulder deposits within the main drainage reaches" (ACPWA 2003).

The calculations resulted in a lag time for the entire watershed of 2.8 hours (170 minutes), and the sub-basin lag times ranged from 5 minutes to 125 minutes.

The peaking factor for the Snyder unit hydrograph method was calculated with the following equation used by ACPWA (2003):

$$Cp = 0.6e^{[0.06(So/A)]}$$

Where,

Cp = peaking factor

So = average watershed slope in percent (So > 5%)

A = Drainage area in square miles (for drainage area < 5 square miles, 5 is used)

Notes: 1) For So ≤ 5%, Cp = 0.6
2) Maximum Cp = 0.85

The calculated peaking factors for the sub-basins in the San Antonio Creek watershed ranged from 0.6 to 0.85, with a watershed average of 0.67.

Routing Parameters

The runoff from the sub-basins draining to San Antonio Creek needed to be routed through each reach segment to account for attenuation of the peak flow going downstream. The Muskingum-Cunge method was selected in HEC-HMS. For each reach, the channel geometry was

represented using a trapezoidal cross section with a specified bottom width and channel side slope. The reach lengths along the main channel were calculated in HEC-GeoHMS. A Manning's roughness coefficient of 0.04 was specified for all the reaches.

Precipitation

The 100-year, 24-hour rainfall event was used for the design of the Ranch Road crossing. The procedures in the *Alameda County Hydrology and Hydraulics Manual* (ACPWA 2003) were followed to develop the 100-year, 24-hour rainfall hyetograph. The total depth of rainfall over the 24 hours was estimated to be 5.47 inches.

The manual provides frequency factors for determining the total rainfall depth for storms with recurrence intervals of 5, 10, 15, 25, and 100 years. For estimating peak flows to use in determining the active channel width for San Antonio Creek, it was assumed that the peak flows from more frequent storms would be more applicable. A curve was plotted of the 24-hour rainfall depth versus the recurrence interval. A logarithmic regression curve was fitted to the plotted data so that the 24-hour rain depth could be estimated for the 2-year and 1.3-year recurrence intervals. These storm depths were calculated to be 2.37 and 2.03 inches, respectively. The use of a recurrence interval of 1.3 years is explained in Section 2.2.1. The rainfall hyetographs used as input to the HEC-HMS model are shown in Figure 2-3 with the rainfall shown in 15-minute increments.

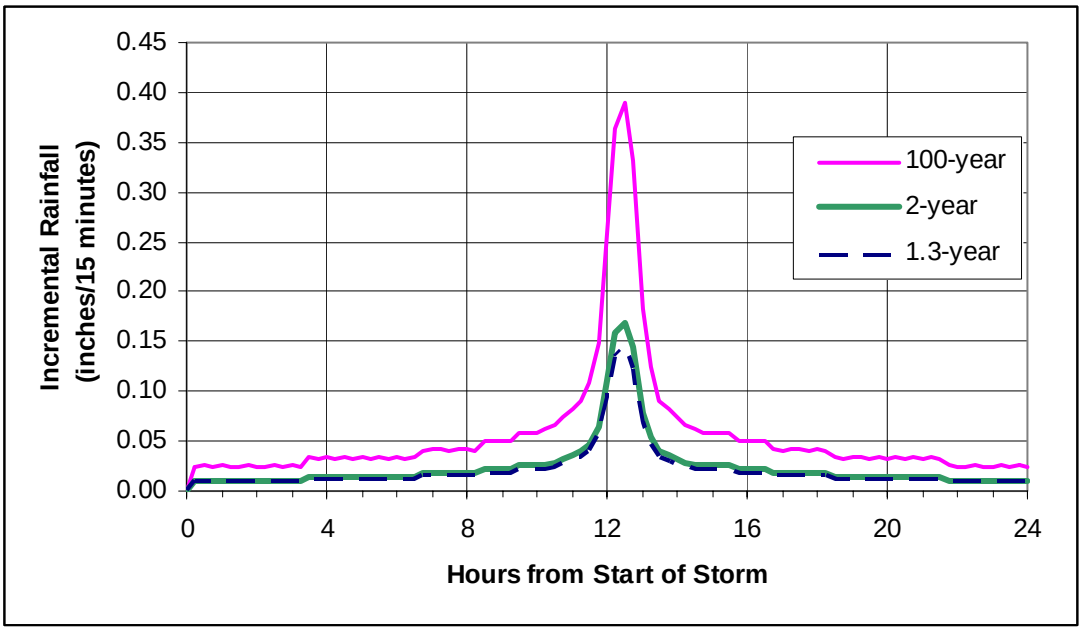


Figure 2-3. Hyetographs for 24-Hour Rainfall Events

2.2.2.3. Results of HEC-HMS

The peak flows calculated with the HEC-HMS model are provided in Table 2.3 at the upstream and downstream ends of the project area and at the Ranch Road crossing. The 100-year peak flow at the crossing was calculated to be approximately 6,500 cfs using the SCS method and approximately 8,000 cfs using the Snyder unit hydrograph method. The bridge design will be based on the larger peak flow to be conservative.

The peak flows calculated for the 2-year and 1.3-year events can be compared to the bankfull flows calculated using other estimates described in the following sections.

Table 2.3. Results from HEC-HMS Model

24-hour Rainfall Event	Peak Flows Along San Antonio Creek (cfs)					
	SCS Unit Hydrograph Method			Snyder Unit Hydrograph Method		
	u/s end of Project Area	d/s of Ranch Road Crossing	u/s of San Antonio Reservoir	u/s end of Project Area	d/s of Ranch Road Crossing	u/s of San Antonio Reservoir
100-year	5,940	6,460	6,780	7,330	8,030	8,510
2-year	930	1,010	1,060	1,950	2,090	2,180
1.3-year	560	610	640	1,120	1,220	1,270

u/s = upstream
d/s = downstream

2.2.3. Bankfull Cross-Section Analysis

Bankfull velocity estimation methods described by Rosgen (2009) use area, width, and depth data from a cross section to predict velocities using several approaches. Bankfull discharge is calculated from the estimated velocities using the continuity equation of the form:

$Q = u A$

Where:

u = velocity

A = cross-sectional area

The purpose of the estimation methods is to determine the validity of using regional curves to predict the channel discharge and dimensions for the project area that would otherwise have a different drainage area than the reference reach.

The project design began by searching SFPUC lands for a reference reach. In order to be considered a reference for design the reference stream needs to be located in a similar hydro-physiographic province and share the same valley and stream type as San Antonio Creek. As indicated in preliminary Pfankuch surveys (URS 2009), San Antonio Creek has potential to be a C4 stream type. A C4 stream type defined by Rosgen (1996) is a single-thread alluvial stream that is slightly entrenched (entrenchment ratio > 2.2), has a moderate to high width to depth ratio (width to depth ratio >12) and sinuosity (> 1.2), slope of 0.1 – 2.0 percent, and gravel sized (2 – 64 mm) channel substrate. The project area is located in a valley type VIII defined as an alluvial valley with a gentile slope and well defined stream terraces and floodplain (Rosgen 1996). The search for a reference reach began by looking for similar valley types and indications of similar stream type in Goggle Earth for all of SFPUC and publicly held land in the Sunol region. Potential reaches were verified in the field. Field investigation of reaches along La Costa, Indian, and Arroyo Hondo Creeks indicated that the streams where either not in a reference condition or were not of the correct stream type.

Since a C4 reference reach was not identified in a similar hydro-physiographic province as San Antonio Creek, existing riffle cross sections were used within the project area to determine the

parameters needed to conduct the velocity estimation methods. Estimated discharge amounts using three approaches were compared to amounts determined from regional curves and from the HEC-HMS model to determine the appropriate discharge to use for hydraulic modeling and channel design.

Three methods are used to estimate bankfull velocity. The first method calculates velocity using a friction factor/relative roughness relationship of the form:

$u = [2.83 + 5.66 \log(R/D_{84})]U^*$

Where:

u = Bankfull Velocity (ft/s)

R = Hydraulic Radius (ft) = A_{bkf}/Wp

A_{bkf} = Bankfull Area (ft^2)

Wp = Bankfull Wetted Perimeter (ft)

D_{84} = Diameter of the cross-sectional bed particles that are 84% or finer (ft)

U^* = Shear velocity = $\sqrt{gRS}$

g = Gravitational Acceleration = 32.2 ft/s^2

S = Bankfull Slope (ft/ft)

In the second method a Manning's roughness coefficient (n-value) is determined from a plot of the resistance (friction) factor versus Manning's roughness. The plot incorporates data identified by stream type (W. Annable, Ontario Canada) and data collected from various small Western U.S streams (Rosgen 2009). The n-value determined from the plot is incorporated into Manning's equation to determine the bankfull velocity. Manning's equation is provided below:

$u = 1.4865*R^{2/3}S^{1/2}/n$

Where:

u = Bankfull Velocity (ft/s)

R = Hydraulic Radius (ft) = A_{bkf}/Wp

S = Bankfull Slope (ft/ft)

n = Manning's n-value

The third method calculates bankfull velocity using Chezy's formula with the C-coefficient calculated from the Manning's n-value determined from the second method. The Chezy's formula is given below:

$u = C\sqrt{RS}$

Where:

u = Bankfull Velocity (ft/s)

C = Chezy C-coefficient ($ft^{1/2}/s$) = $1/nR^{1/6}$

R = Hydraulic Radius (ft) = A_{bkf}/Wp

S = Bankfull Slope (ft/ft)

The bankfull velocity estimation methods predict velocities of 5.5 – 8.0 feet per second. Discharges ranging 595 – 1,399 cubic feet per second are predicted by applying the continuity equation to the estimated velocities and cross-sectional areas from the existing riffle cross sections (Table 2.4). An expanded table of the input variables and results are provided in Appendix A. The results indicate that the existing cross sections do not provide a consistent estimation of bankfull, most likely because the stream is far from a stable reference state. The determination of bankfull was estimated from field drawings of the cross sections with the intent that the bankfull elevations would be surveyed by SFPUC. Bankfull elevations were also interpreted from the existing topographic surface points by looking at the locations of Geographic Positioning System (GPS) points collected from the field. The results do show that the discharge predicted is within the range of values determined by the HEC-HMS modeling (560 – 1,270 cfs) and the regional curve values (799 – 1,182 cfs). For the purpose of design, the regional curve value of 875 cfs was chosen to adequately represent the design discharge of the proposed channel.

Table 2.4. Bankfull Velocity and Discharge Estimates from Existing Cross Sections

Existing Cross Section	Friction Factor/Relative Roughness		Manning's Equation[1]		Chezy C Method	
	Velocity (fps)	Discharge (cfs)	Velocity (fps)	Discharge (cfs)	Velocity (fps)	Discharge (cfs)
Reach 1 Riffle XS-1	5.9	938	6.1	966	6.1	966
Reach 2 Riffle XS-3	7.1	1024	7.4	1063	7.4	1063
Reach 2 Riffle XS-4[2]	6.4	595 - 1110	6.6 - 6.7	621 - 1158	6.6 - 6.7	621 - 1158
Reach 3 Riffle XS-6[2]	5.6 – 7.6	612 - 1331	5.5 – 8.0	607 - 1399	5.5 – 8.0	607 - 1398

[1] Manning's n-value determined from plots of friction factor vs. Manning's n-value (Rosgen 2009).

[2] Range of values represent varying cross-sectional areas measured from different potential bankfull estimates.

2.2.4. Regional Regression Equations

A USGS (1993) method for estimating peak flows for un-gaged watersheds was used to confirm the estimates made using HEC-HMS and the other bankfull estimation methods. The USGS has developed regression equations for calculating the peak discharge associated with the 2, 5, 10, 25, 50, and 100-year return interval events. The two-year event was selected as an approximation of bankfull discharge for the purposes of this method. Drainage area, mean annual precipitation, and an altitude index are independent variables in separate regression equations for each recurrence peak flow. Equations for the 2-year and 100-year peak flows are provide below:

$$Q_2 = 0.0061A^{0.92}P^{2.54}H^{-1.10}$$

$$Q_{100} = 19.7A^{0.88}P^{0.84}H^{-0.33}$$

Where:

Q = Peak discharge (cfs)

A = Drainage area (mi^2)

P = Mean annual precipitation (in) (Rantz 1969)

H = Altitude index, which is the average of altitudes in thousands of feet at points along the main channel at 10% and 85% of the distances from the site to the basin divide.

The project site has a drainage area of approximately 20.4 square miles, 25 inches of mean annual rainfall, and an altitude index of 1.8. This results in a two-year peak flow of 186 cubic feet per second and 100-year flow of 3,471 cubic feet per second. The results from this method are much lower than the results determined from regional regression equations/regional curves, analysis of the existing cross sections, and the HEC-HMS model. This may be the result of the regional scale of the mean annual precipitation map used, which may not fully account for the orthographic affect of the watershed.

2.2.5. Summary

The results from the regional curve analysis, analysis of the existing cross sections, and the HEC-HMS model are all within a similar range of values shown in Table 2.5. Results from the USGS regional regression equations indicate the method is not applicable to San Antonio Creek. The bankfull discharge value from the San Francisco Bay regional curve (875 cfs) seems to approximately represent the average of the values predicted, even though it was believed to be slightly high when looking at the recurrence interval (1.8). For purposes of 30% design, 875 cfs was chosen as the bankfull design discharge for San Antonio Creek. The 100-year flow from the HEC-HMS model using the Snyder unit hydrograph method of 8,510 cfs was chosen as the design flow since it is the most conservative value for the crossing design.

Table 2.5. Summary of Flow Estimation Results by Method

Method	Bankfull Discharge (cfs)	2-year Discharge (cfs)	100-year Discharge (cfs)
Regional Curve Analysis	799 – 1,182	N/A	N/A
HEC-HMS Model	64 – 1,270	1,060 – 2,180	6,780 – 8,510
Bankfull Cross-Section Analysis	595 – 1,399	N/A	N/A
USGS Regional Regression Equations	N/A	186	3,471

2.3. CHANNEL DESIGN

This section describes the method(s) associated with the design of the longitudinal, cross sectional and plan view dimensions of the bankfull channel.

2.3.1. Longitudinal Profile

The proposed longitudinal profile of the stream for 30% design is an approximation of the riffle slope of the stream drawn from a head of a riffle to the head of a riffle. The profile was constructed by drawing an arc from the head of a riffle near the upstream project extent to the head of a riffle at the most downstream portion of the project area that contains survey data from

2009 (Sheets G-1 – G-10). The curve of the arc is controlled by the bed elevation of the existing stream gage so that the gage can remain relatively undisturbed. The stream gage location is one of the more stable reaches in the project area. Setting the grade control of the arc at the stream gage also achieves a good balance between cut and fill occurring along the profile. From this smooth profile a more detailed profile will be created in future design iterations that show the intricacies of the proposed bed morphological features (e.g., pools, glides, riffles, runs). To simplify the design of cross sections, the proposed riffle slope was determined for 2,000-foot increments along the existing channel profile starting at the location where the 2009 survey data starts. The design slope is given below in Table 2.6.

Table 2.6. Proposed Mean Slope

Approximate Station	Slope (ft/ft)
0+00 -15+42	0.0071
15+42 - 35+42	0.0072
35+42 - 55+42	0.0089
55+42 - 75+42	0.0099
75+42 - 102+00	0.01

The most downstream control elevation for the proposed profile does not extend to the end of the project area because the 2009 topographical survey data extents do not include the downstream extent of the project area. Elevation data available for this area of the profile is from 2006 Alameda County LiDAR that is approximately 2 feet higher than the 2009 field survey data (when comparing the stream bed elevations). An additional field survey downstream of the 2009 dataset is necessary to accurately tie the proposed channel elevation into the existing bed elevation where San Antonio Creek meets the upper extent of the reservoir. Once this is complete, the lower portion of the proposed profile for the project area may need to be adjusted vertically to transition the channel slope to the existing grade.

In the final design, the longitudinal profile will indicate the placement and depth of the four major morphological bed features: riffles, runs, pools, and glides. The individual slope of each feature will be predicted using stream-type specific dimensionless ratios that represent the range of acceptable ratios for a stable C4 channel type. The method of determining the streambed feature slopes is discussed below in Section 2.3.2.

2.3.2. Cross Section

Proposed channel cross sections were developed for each bed feature (riffle, run, pool, and glide). The channel is graded by applying the typical cross sections at the appropriate station along the profile and transitioning the channel bed topography from one channel type to the next (in morphological sequence of development).

Typically, the dimensions for a representative riffle would be based on field measurements from a reference reach. Since a stable C4 reference reach with a similar valley type was not found within SFPUC property, dimensions (bankfull width and area) were chosen from the San Francisco Bay regional curves adjusted for the west side of the East Bay hills (Riley 2003). The adjusted San Francisco Bay regional curves for width and cross-sectional area were chosen to more accurately represent the project area due to local proximity and most similar hydro-

physiographic characteristics. Table 2.7 provides the results of other regional curves considered in the analysis.

Table 2.7. Regional curve analysis results considered for San Antonio Creek.

		Adjusted San Francisco Bay (Riley 2003)	San Francisco Bay (Dunne & Leopold 1978)	Santa Cruz Mtns (Howell 2009)	Scotts Creek, Santa Cruz Co. (Howell 2009)
	Bankfull Discharge (cfs)	N/A	875	799	1182
Bankfull Dimensions	Cross-sectional Area (ft^2)	115	170	157.3	181.6
	Width (ft)	41	47	43.8	56.7
	Depth (ft)	N/A	3.3	3.2	3.1

Critical dimensions needed to design a channel (bankfull width, depth, width/depth ratio, and slope for each bed feature) were determined from various dimensionless ratios developed by David Rosgen for a C4 channel type. These dimensionless ratios are shown in Table 2.8. In order to determine the range of predicted channel dimensions the following representative values for a reference riffle are required:

- Mean slope = 0.71 – 1.0 % (from the proposed longitudinal profile described in Section 2.3.1)
- Mean depth = Cross-sectional area/bankfull width = 2.8 ft (determined from regional curves)
- Mean width = 41 ft (determined from regional curves)
- Riffle width/depth ratio = Bankfull riffle width/ Mean riffle depth = 14.6

Applying the above parameters to the dimensionless ratios in Table 2.8 provides the range of typical channel dimensions necessary to design the cross section (Table 2.9).

Table 2.8. Range of typical C4 stream type dimensionless ratios for riffles, runs, pools, and glides.

		Low	High
Pool Ratios	Pool Slope/Mean Slope	0.2	
	Pool Depth/Mean Depth	2.5	3.5
	Pool Width/Mean Width	1.3	1.7
Riffle Ratios	Riffle Slope/Mean Slope	1.5	2.0
	Riffle Max Depth/Mean Depth	1.2	1.5
Run Ratios	Run Slope/Mean Slope	0.6	0.8
	Run Depth/Mean Depth	1.9	2.2
	W/D of Run/W/D of Riffle	0.4	0.5
Glide Ratios	Glide Slope/Mean Slope	0.3	0.5
	Glide Depth/Mean Depth	1.4	1.8
	Glide Width/Mean Width	1.5	1.7
	Glide W/D Ratio/Riffle W/D Ratio	1.1	1.3

Table 2.9. Range of dimensions for riffles, runs, pools, and glides for San Antonio Creek.

		Low	High
Pool	Slope (ft/ft)	0.00204	
	Depth (ft)	7.0	9.8
	Width (ft)	53.3	69.7
Riffle	Slope (ft/ft)	0.0153	0.0204
	Max Depth (ft)	3.4	4.2
Run	Slope (ft/ft)	0.0061	0.0082
	Depth (ft)	5.3	6.2
	W/D	5.8	7.3
Glide	Slope (ft/ft)	0.0031	0.0051
	Depth (ft)	3.9	5.0
	Width (ft)	61.5	69.7
	W/D	16.1	19.0

All cross sections were shaped to represent a C4 channel shape as described by Rosgen (1996). Riffle cross sections are fitted to meet the criteria of a C4 stream type which includes:

- Entrenchment Ratio: > 2.2
- Width/Depth ratio: > 12
- Sinuosity: > 1.2
- Slope: 0.001 – 0.02
- Mean partial size diameter (D_{50}): 2 – 64 mm

In addition to the dimensions given in Table 2.8, the shape of the riffle cross section was adjusted to produce a bankfull discharge similar to 875 cfs (SF Bay regional curve amount).

Pool cross sections were shaped to include a pointbar slope ranging from five to seven percent. A pointbar slope of five to seven percent represents the average range of observed slopes in stable channels or streams in a reference condition. The pointbar slope affects the helical flow around the meander bend that scours the pool and redistributes sediment on the inside of the bend. The pointbar slope will eventually adjust to the channel dimensions affecting development; however, it is important to accurately set the slope initially to prevent excess scour or deposition.

Typical cross-section drawings for each bed feature are shown on Sheets C-10 and C-11 of the 30% design drawings. Cross sections detailing the channel dimensions and floodplain at specific locations along the stream alignment will be provided in future design submittals.

2.3.3. Planview

The channel planview geometry is largely the same as the existing planview with some minor exceptions. Where changes to the planview geometry are proposed, the resulting geometry was maintained within the range of the existing geometry pattern dimensions.

The channel alignment was adjusted to include an additional meander bend between stations 15+00 – 22+00 (Sheet C-2). The existing channel had a long gentle sweeping reach with no defined bed morphology and large depositional lateral bar. The additional meander reduces the

pool-to-pool spacing to within the typical spacing for alluvial streams (5 – 7 bankfull widths (Leopold et al. 1964)) and is intended to improve sediment competence.

The channel alignment was adjusted between stations 30+00 – 33+00 (Sheet C-3) and 41+50 – 43+25 (Sheet C-4) where the channel is eroding a bank and making an abrupt near 90-degree bend. In order to avoid removing trees that have become established on the inside bend, the channel alignment was shifted away from the trees to maintain the desired channel width. The radius of curvature was increased to alleviate the tight bend where bank erosion was a problem and the bank was graded back to a 2H:1V slope per the geotechnical slope stability analysis (Section 3.5.2).

Where the existing creek became bifurcated, the channel was realigned into one meandering channel between the two bifurcated channels (stations 84+00 – 89+00, Sheet C-7). The channel was fit into the area between existing sycamore trees so trees would not need to be removed. The channel was also relocated away from actively eroding banks. Meanders were added to represent the average pool-to-pool spacing (5 –7 channel widths).

2.4. HYDRAULIC MODELING

The HEC-RAS Version 4.1.0 model developed by USACE (HEC 2010) was used to predict the water surface elevations in San Antonio Creek for existing conditions and with the proposed grading. In the HEC-RAS model, the study area is defined by a series of cross sections. Each cross section is subdivided into a main channel and left and right overbank areas. The change in water surface elevation between two sections is determined by the energy losses between sections. Friction loss is evaluated using Manning's equation with user-defined roughness coefficients. For this study, a roughness coefficient of 0.04 was used.

Other input to the HEC-RAS model included geometric data, inflows at the upstream boundary and at tributary confluences, and specification of normal depth with a slope equivalent to the downstream boundary. The geometry and inflow data are discussed in more detail below.

2.4.1. Geometric Data

San Antonio Creek was modeled from San Antonio Reservoir to a point approximately 13,000 feet upstream. The schematic for existing conditions is shown in Figure 2-4.

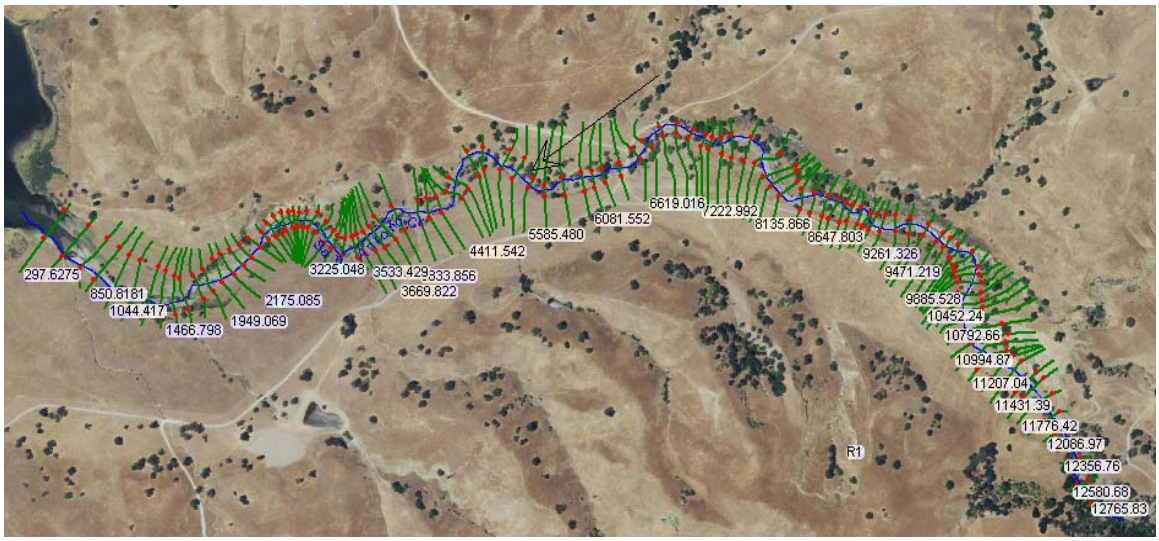


Figure 2-4. HEC-RAS Schematic for Model of Existing Conditions

The cross-section geometry for existing conditions was obtained from a digital elevation model using HEC-GeoRAS, which is a package of GIS tools for support of HEC-RAS using ArcGIS (HEC 2009b). The digital elevation model was developed in GIS from a combination of the 2009 channel survey data and the 2006 Alameda County LiDAR data. The digital elevation model was sampled at each cross section so that it could be imported into the HEC-RAS model for existing conditions.

The cross-section geometry for proposed conditions was modified in the project area to include the proposed grading. The HEC-RAS geometry along the modified reach was also obtained using HEC-GeoRAS with a digital elevation surface that represented the proposed grading.

A bridge crossing was inserted into the HEC-RAS model at Ranch Road. The cross-section geometry at the bridge is shown in Figure 2-5.

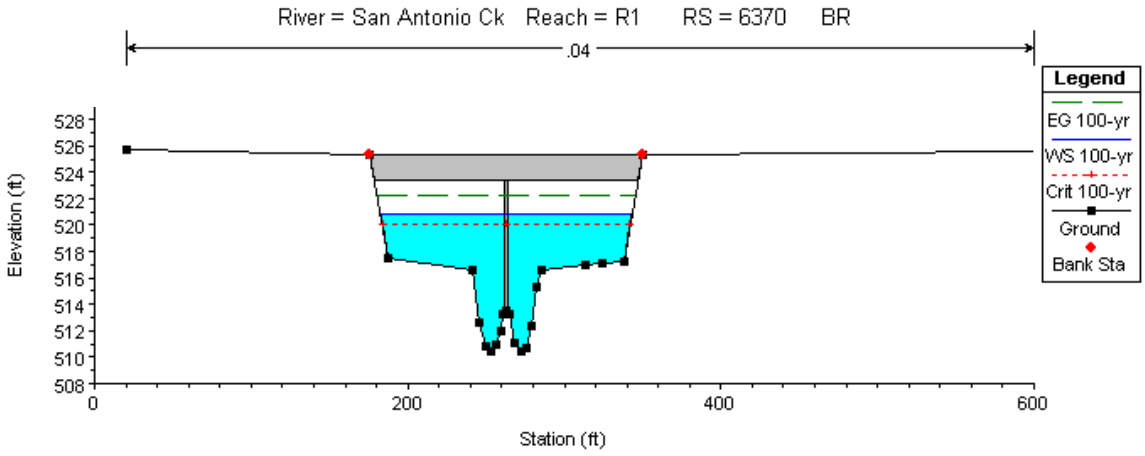


Figure 2-5. HEC-RAS Geometry at Proposed Ranch Road Crossing

2.4.2. Design Inflow

Peak outflows from the HEC-HMS model based on the Snyder unit hydrograph method were used as input to the HEC-RAS model. Design flows included the 100-year, 2-year, and 1.3-year events (see Table 2.3), as well as a constant flow of 875 cfs, which is based on the calculated bankfull discharge using the San Francisco Bay regional curve (see Table 2.7).

2.4.3. Model Results

Based on the output from the HEC-RAS model of existing conditions, it appeared that predicted water surface elevations for the smaller events compared favorably with high-water marks observed in the field after recent storm events. The results for existing conditions reinforced the assumption that the HEC-RAS model could be used as a predictive tool for the proposed channel design.

The proposed bridge at the Ranch Road crossing was large enough to pass the 100-year flow of approximately 8,000 cfs with over two feet of freeboard.

The HEC-RAS model with the preliminary grading for the proposed channel design showed that with a flow of 875 cfs, the water levels were generally at, or slightly above, the channel banks. The average channel velocities (between the channel banks) ranged from 4.5 to 9.0 feet per second in the project area. The HEC-RAS model output can be used to further refine the channel geometry in subsequent phases of the design process.

More detailed output is provided in Appendix B.

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Chapter 3. Geotechnical Analysis

3.1. PURPOSE

Slope stability analysis was performed for the proposed improvements at the San Antonio Creek. The objective of the analysis was to verify if the proposed improvement meets the slope stability criterion.

3.2. EXISTING GEOTECHNICAL DATA

The subsurface conditions and material properties for the engineering analysis were developed based on the results from geotechnical investigations conducted by URS at the project site in February 2009 as part of the Phase 1 site assessment. A total of three (GB-1, GB-2 and GB-2A/PB-3) borings were drilled as part of the Phase 1 site assessment. In addition, five piezometer borings (PB-1 to PB-5) were also drilled along the creek at different locations. Borings were drilled to a maximum depth of about 26 feet below ground surface. Boring GB-1 encountered mostly sand to clayey sand layers to a depth of 20 feet underlain by high plasticity silt layer. Boring GB-2 encountered sand to a depth of 8 to 10 feet followed by low to high plasticity silt. Boring GB-2A/PB-3 encountered mostly sand to silty sand to a depth of 10 to 12 feet followed by low to high plasticity silt. The piezometer borings also indicated similar trend of cohesionless deposits of sand, silt, and gravel.

In-Situ testing of the representative samples from the borings was performed to determine shear strength properties. The boring and piezometer logs from this geotechnical investigation are presented in Appendix C.

The results from the geotechnical investigation are presented in the HRP Phase 1 Status Report (URS 2009). Key findings from this investigation are summarized below:

- Soils mapped at the site include fill soils, alluvium, and the Livermore gravels.
- Alluvium ranges from ground surface up to a depth of 8.5 to 14 feet. Alluvium consists of dense to very dense, silty to clayey sand and sandy silt and hard clayey silt.
- Erosion and scour protection is required for any proposed structure.

3.3. CROSS-SECTION ANALYSIS

In general, the bank slopes range from 3H:1V to 5H:1V, with the exception of few locations where the banks are steeper up to 1H:3V. These steep slopes are due to erosion from high velocity flows in the creek. After a careful review of the available cross-section data along the entire length of the creek, a representative section was selected for the slope stability analysis purposes (see Figure 3-1). The representative section is located approximately 3,000 feet upstream of borings GB-1, GB-2, GB-2A/PB-3) and consists of approximately 1H:3V side slope. The subsurface information for the analysis section was developed based on the available geotechnical data.

3.4. PROPOSED IMPROVEMENTS

In general, a slope of 5H:1V is proposed for bank improvements based on existing slopes along the alignment. However, at several locations 5H:1V could not be accommodated due to space restrictions along the existing channel banks and the need to protect existing trees. Based on these conditions at the site and the results from the geotechnical investigation presented in the HRP Phase 1 Status Report (URS 2009), improvement measures were developed to address the stability of the creek at locations where space was a constraint. The proposed improvements included placement of new engineered fill at a slope of 2H:1V at these locations. The proposed improvements are also shown on Figure 3-1.

3.5. GEOTECHNICAL ANALYSIS

The internal stratigraphy of the analysis section was developed based on the proposed improvement and the results from the field investigation program.

The material properties for the stability analysis were developed from the results of the field tests, published correlations, and experience with similar materials. The shear strengths of the cohesionless materials were characterized with effective stress-drained parameters for long term and short-term stability conditions.

The selected unit weight and shear strength parameters are summarized in Table 3.1. The drained friction angle for the draining materials was estimated using the correlation between blowcount and friction angle (EPRI 1990). The shear strength parameters for the engineered fill were developed based on experience. Compared to results from the in-situ testing for shear strength, the selected parameters are conservative.

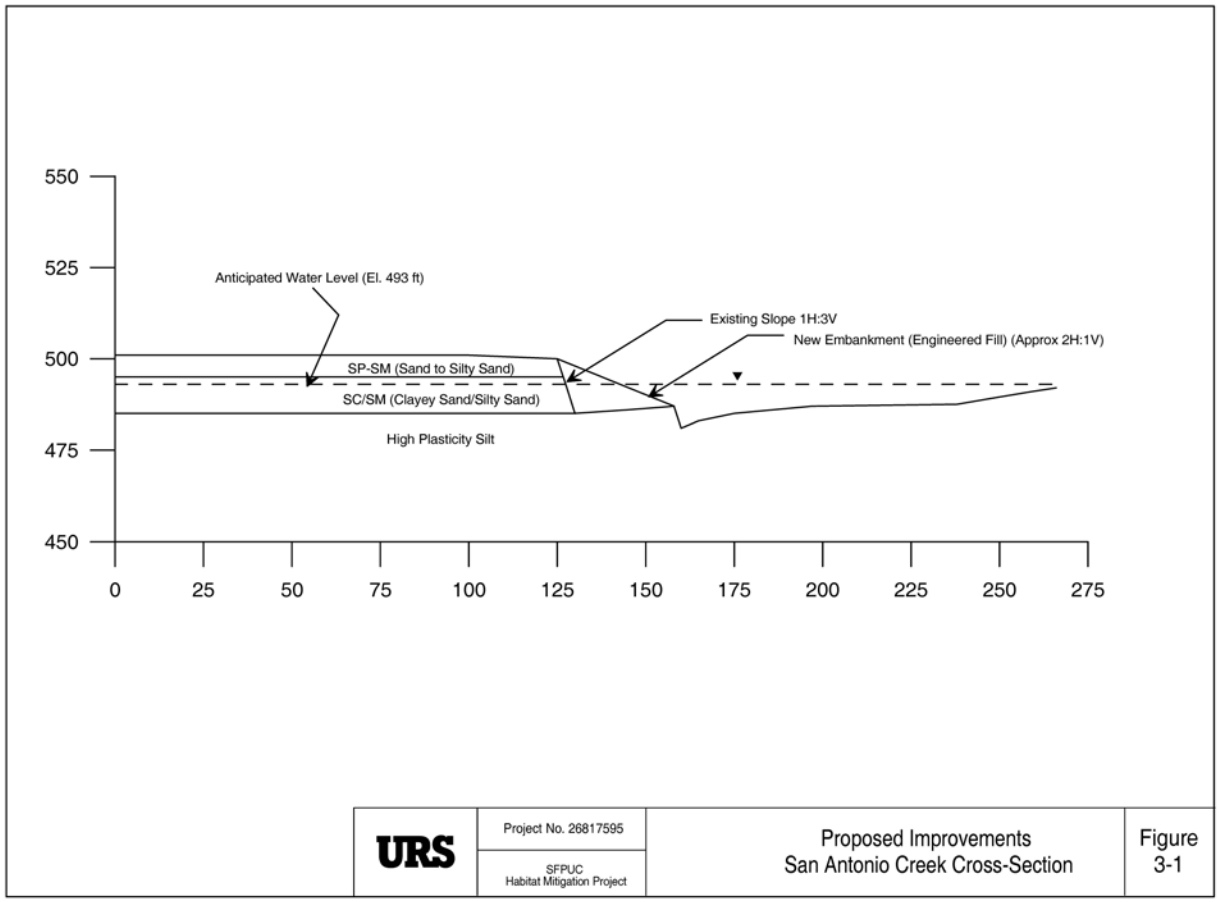


Figure 3-1. Proposed Improvements

Table 3.1. Strength Values for the Stability Analysis

Material Type	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (degrees)
SP-SM	120	0	32
SC/SM	120	0	32
MH	115	0	32
Engineered Fill	120	50	32

3.5.1. Stability Analysis

The stability of the embankment was analyzed using the limit equilibrium method based on Spencer's procedure of slices as coded in the computer program UTEXAS4 (Ensoft 2008). The trial-and-error solution involves successive assumptions for the factor of safety and side force inclination until both force and moment equilibrium are satisfied. The stability analyses were for steady state conditions for two different water levels:

- The water level in the creek was assumed to be at 1 foot above the normal creek level (El. 493 ft). Effective stress drained shear strength parameters were used for this loading case. The phreatic surface is considered horizontal for the analysis.
- The groundwater level was assumed to be at El. 487 feet in the creek, and at El. 485 feet inside the slope. Drained parameters were used for the analysis.

3.5.1.1. Stability Criterion

The criterion adopted for evaluating the results of the stability analyses was primarily based on recommendations provided in the USACE manual EM-1110-2-1913 (USACE 2000):

- Long-term steady state condition: minimum factor of safety equal to or greater than 1.4.

Seismic analysis was not performed for the creek.

3.5.2. Results and Conclusions

The results of the stability analyses are summarized in Table 3.2. The information presented in this table includes minimum factors of safety for steady state conditions. The results are also presented on Figures 3-2 and 3-3. For each section, only the minimum factor of safety is reported in Table 3.2. Trivial cases representing shallow slides that pose no immediate threat to the integrity and safety of the embankment were not considered in selecting the minimum factor of safety. The determination of what constitutes a “trivial” potential slide was based on engineering judgment. The static stability analyses indicated that the proposed improvement meets the minimum required static factor of safety.

It is recommended that the new fill be placed at a slope of 2H:1V and effective erosion protection should be provided at locations along the creek where high velocity may erode the slope material.

Table 3.2. Slope Stability Analysis Results

Scenario	Factor of Safety	Min. Required Factor of Safety
Steady State: Water Level at 493 ft	1.44	1.4
Steady State: Water Level at 487 ft	1.48	1.4

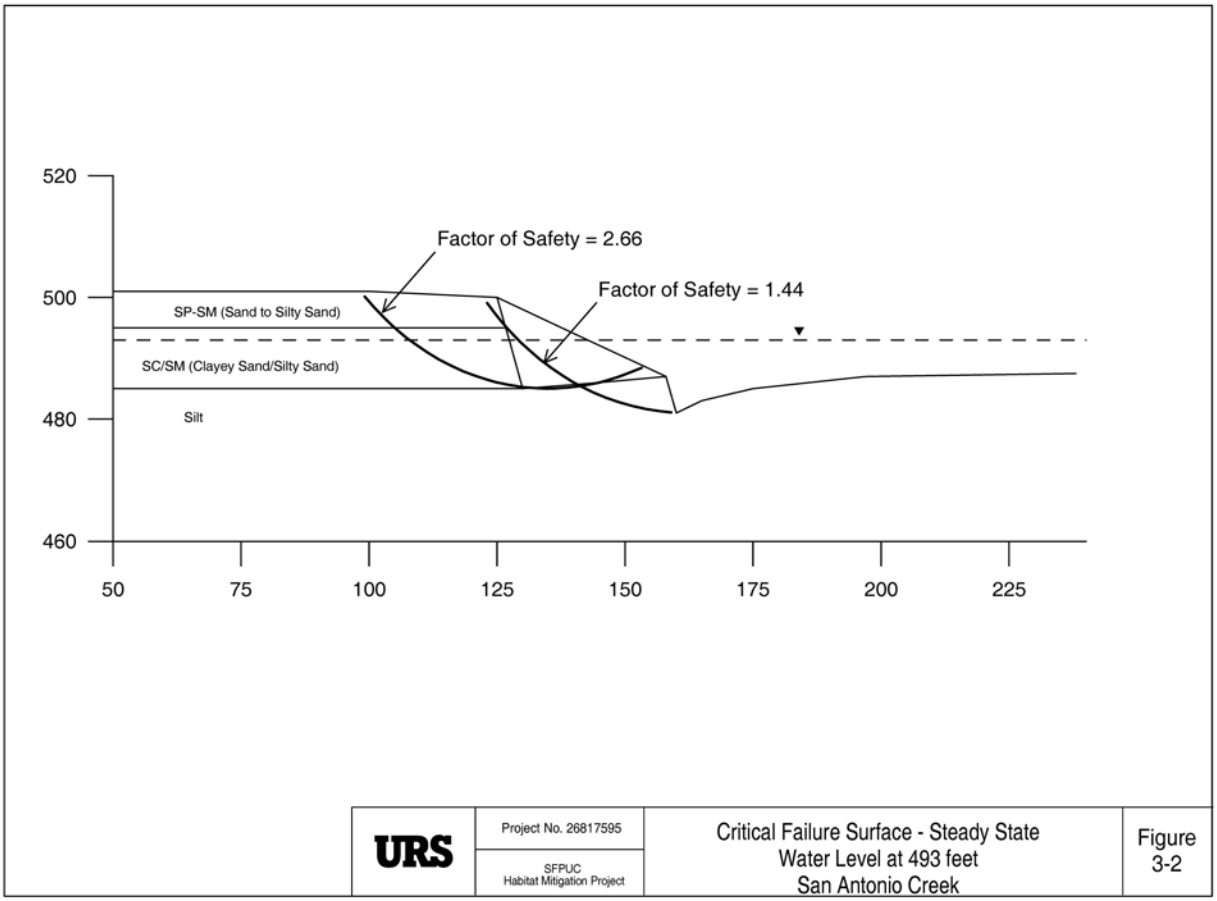


Figure 3-2. Stability Analysis: Water Level at 493 Feet

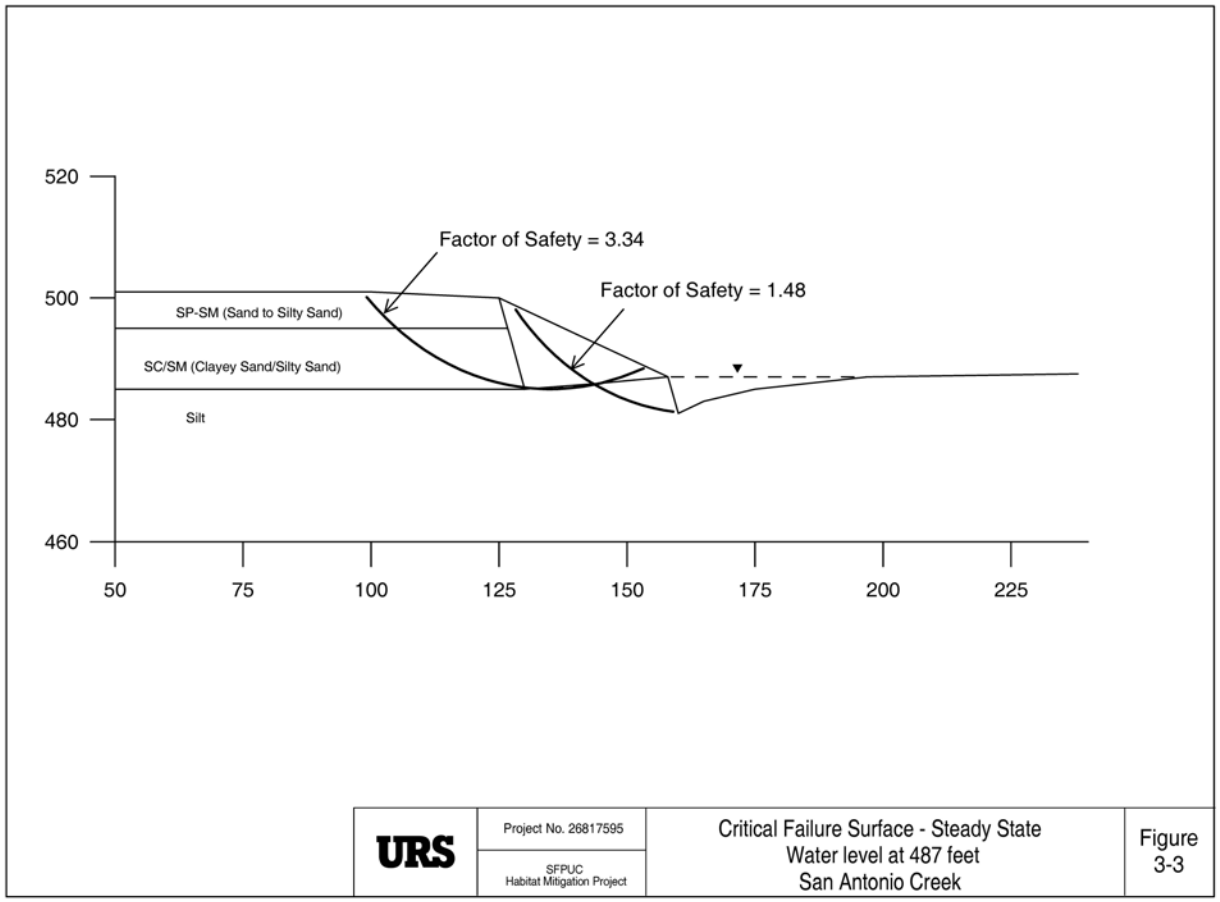


Figure 3-3. Stability Analysis: Water Level at 487 Feet

Chapter 4. Ranch Road Bridge

The Ranch Road low water crossing will be replaced with a bridge. While structural analysis has not been completed as a part of 30% design, hydraulic analysis on proposed cross sections indicates that a 180-foot bridge with a pier set in the channel is sufficient to span the creek and pass a 100-year design storm. Subsequent design will determine the most suitable bridge type based on the complete structural, seismic, scour analysis.

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Chapter 5. Channel and Floodplain Restoration

5.1. INTRODUCTION

The channel, floodplain, and stabilization of eroded stream banks are based on hydraulic, geotechnical and geomorphologic analyses described in previous sections, and are described separately below. These areas have separate grading volumes specified in the cost estimate since cut and fill should be balanced within these areas to reduce hauling costs.

5.1.1. Proposed Channel

The proposed channel requires both excavation and fill to establish the proper channel dimensions. The finished grade of the channel should be lined with at least 8-inches of clean alluvial gravel if the excavation uncovers mineral soil. Gravel should come from areas within the active San Antonio Creek channel. Excess material should be hauled to the disposal area and buried under excess topsoil or subsoil excavated from the floodplain and banks. This practice ensures that the finished grade on the floodplain, as well as, the disposal area has adequate soil conditions to successfully grow vegetation.

Channel grading calculations were simplified for the 30% design by applying the typical riffle cross-section dimensions to the existing topographical surface along the proposed channel corridor alignment. The final design will use specific cross sections spaced throughout the alignment along with typical cross sections (between the specific cross-section stations) for each of the four bed morphological features to calculate the earthwork. See Section 2.3.2 for further description of the dimensioning of typical cross sections shown on Sheets C-10 and C-11.

5.1.2. Floodplain Establishment

The floodplain is designed with an average valley slope of one percent. Valley slope is measured along the contour of the valley from the upstream to downstream end of the project area. The floodplain slope varies along the length of the channel alignment from 0.5 to 1.1 percent according to the bankfull slope provided in Table 2.6. In addition, the floodplain has a cross slope of one percent radiating perpendicular from the channel alignment. Beyond the extent of the proposed floodplain, the ground will be tied to existing grade at a 5H:1V slope. The floodplain grading occurs amongst existing trees that will be protected in place. Best-management measures to avoid damage to existing trees will be used during construction and will be further detailed in future plan submittals.

The floodplain elevation on the outside of meander bends is specified 0.25 – 0.5 feet higher than the floodplain elevation on the inside bend. The elevated floodplain area is intended to taper back down to the bankfull elevation near the inflection point of the meander bend (approximately where the run begins on the upstream side and where the glide ends on the downstream side). This encourages flood flows to meander opposite the channel maintaining the meander alignment.

The 30% design grading assumes a uniform grading surface and does not take into account trees or micro-topographical changes in the floodplain around meander bends. The final design will

include grading that attempts to avoid excavation within the drip line of trees and includes the topographical variations described above.

5.1.3. Eroding Stream Bank Stabilization

Stream banks will be stabilized in locations where the existing channel is actively eroding the alluvial stream terraces. The banks will be stabilized either by excavating a more stable slope of 2H:1V or less or rebuild with engineered fill material compacted no less than 90%. Slopes will be seeded with native grasses, armored with erosion control blankets, and planted according to the planting plans (oak riparian or oak woodland vegetative communities).

5.2. EPHEMERAL DRAINAGE GRADING

There are six ephemeral drainages that contribute to San Antonio Creek within the grading extents of the project site. The confluence of the each ephemeral tributary will be graded to tie the existing tributary stream elevation to the proposed main stem channel elevation. The channel dimensions will correspond to the existing upstream channel dimensions. The small drainages will be excavated across the San Antonio Creek floodplain. A rock cross vane grade control structure will be installed at the upstream most point of tributary channel grading to prevent any head cutting from occurring upstream of where the channel slope was adjusted. Twelve-inch rock should be used in the construction of the cross vane. Specifications for the cross vane are described below and shown on Sheet D-1.

5.3. INSTREAM ROCK STRUCTURES

The channel restoration design includes the installation of three different instream rock structures: cross vanes, J-hooks, and a W-weir. Each structure is located in a specific location along the channel alignment and serves a unique set of purposes. All the structures are built from flat-edged rock ranging in size from 3.0 – 3.3 feet in diameter. Rock size is a function of the bankfull shear stress as indicated in the following equation (Rosgen 2001):

$$S_r = 0.5656\ln(4.8825\tau) + 2.083$$

Where:

S_r = Rock size (ft)

τ = Shear stress (lbs/ft^2)

$\tau = \gamma R s$

γ = specific weigth of water (62.4lbs/ft^3)

R = hydraulic radius (ft)

s = slope (ft/ft)

All the rock structures include a footer rock placed below the top rock offset downstream approximately ½ the diameter of the rock. The footer rock provides scour protection to the structure. Voids between the main rocks of the structures should be hand chinked with smaller rock and stream gravel to reduce the amount of flow that would otherwise flow through the voids rather than over the structure. All the structures include a 12-foot line of 1-foot diameter sill rocks embedded in the floodplain that radiate from the bankfull elevation perpendicular to the

direction of the flood flow. These rocks buried at grade with the floodplain offer additional protection to reduce the likelihood of flood flows flanking the structure during the period that vegetation is becoming established. The purpose and design characteristics of each structure are further described in the flowing subsections.

5.3.1. Cross Vane

The cross vane is a V-shaped grade control structure that is typically located in a riffle. Cross vanes serve several purposes and provide unique benefits including:

- Provides grade control preventing channel degradation
- Protects banks by redirecting flow towards the center of the channel and reducing near-bank velocities
- Improves the streams ability to transport bedload (competence) by increasing mid-channel velocities in the center third of the channel
- Provides morphological habitat for fish by scouring a pool forming a glide and subsequent riffle
- Provides aeration for fish and attachment locations for benthic macro invertebrates

Typical details for a rock cross vane are shown on Figure 5-1. Cross vanes span the width of the bankfull channel and are oriented with the apex or V-portion of the structure pointed upstream. The vane legs occupy the right and left third of the channel width terminating at the bankfull elevation or inception point of the floodplain. The apex of the structure occupied the middle third of the channel. The top rock at the apex is buried at or near-grade to prevent any upstream aggradation. The vane legs slope up from the thalweg at a 2 – 7 % slope at an angle 20 – 30 degrees from the bank-line. Given the bankfull dimensions of San Antonio Creek, the vane geometry works best at approximately a 20-degree angle and near 7% vane slope. The placement or cross vanes were located in areas where small pools would be expected to form without any instream structure due to the shorter meander length and amplitude and larger radius of curvature. This placement offers channel grade control and increases the depth of the pool. Locations of the cross vanes are shown on Sheets C-1 through C-8.

Multiple cross vanes may be warranted for grade control purposes at the confluences of the tributaries if the main-stem grade is adjusted much below the existing grade. By spacing cross vanes along the tributary channel, the existing bed elevation can be tied to the proposed main-stem bed elevation while reducing the risk of inducing headcut erosion on the tributary. The 30% design includes one cross vane at each tributary confluence. The tributary streams have not been evaluated to determine whether multiple structures are needed. Should multiple structures be needed to maintain a steep tributary channel gradient, the structures will be spaced according to the channel slope given in the following equation (Rosgen 2001):

$P_s = 8.2513S^{-0.9799}$

Where:

P_s = Pool – pool spacing/bankfull width

S = channel slope (%)

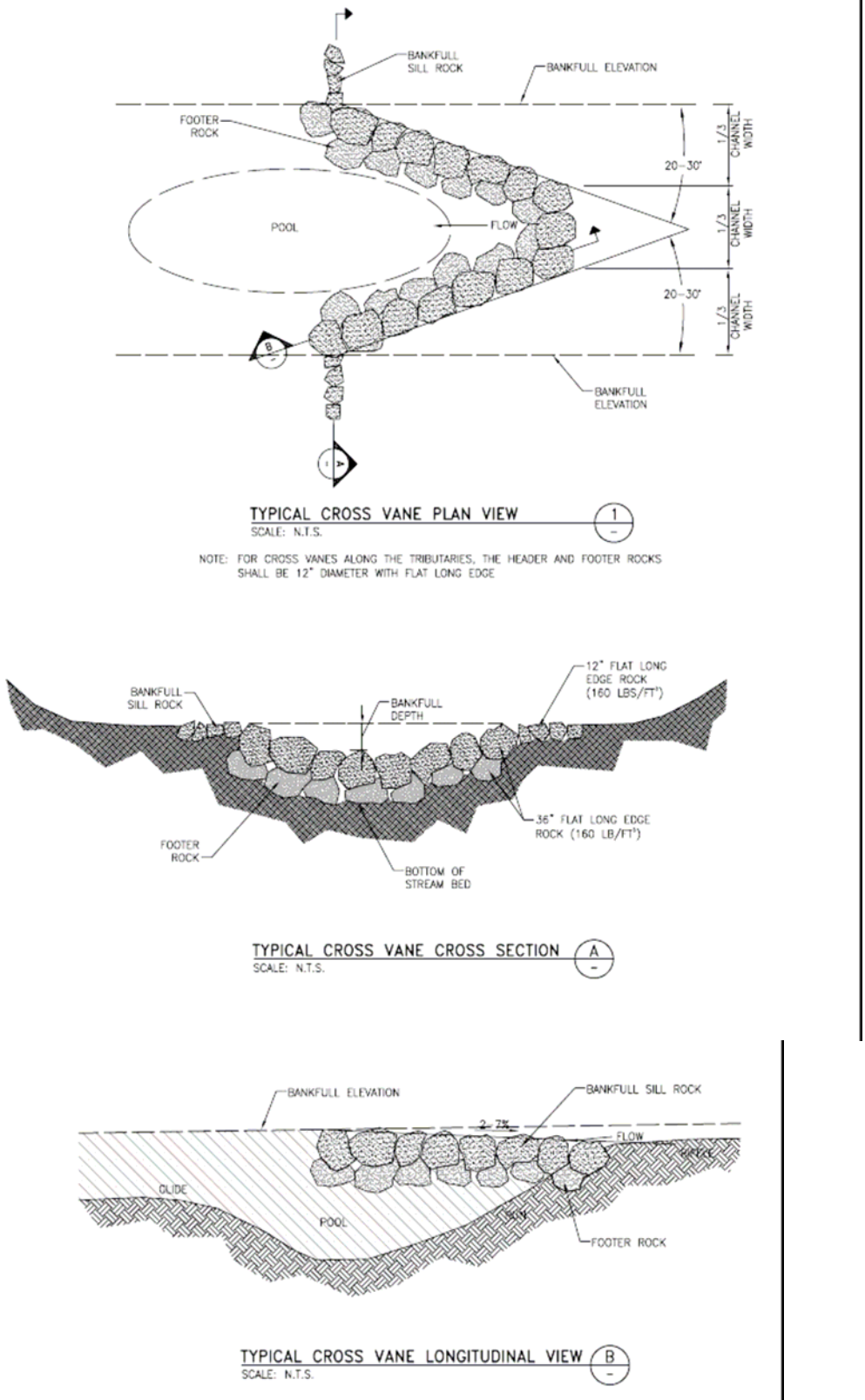


Figure 5-1. Typical Details for a Rock Cross Vane

5.3.2. J-hook Vane

The J-hook vane is a J-shaped structure that is located on meander bends. The purpose and benefits of the J-hook include:

- Reduces outside bank shear stress by deflecting flow away from the outside bank towards the center of the channel (length of bank protected is approximately 2 – 3 times the vane length)
- Maintains width to depth ratio by the redirection of flow towards the center of the channel
- Provides feeding locations for trout by creating multiple eddies
- Improves the streams ability to transport bedload by increasing mid-channel velocities in the center third of the channel

Typical details for a J-hook vane are shown on Figure 5-2. The vane leg is identical to the cross vane except it only occupies one side of the channel on the outside bend of the meander. The hook portion of the structure occupies the middle third of the channel width. The rocks in the middle third of the channel width are spaced apart 1/4 – 1/3 the diameter of the rock (approximately 0.75 – 1.1 feet). The protrusion height for the center top rocks should be 10% of the bankfull depth. Vane spacing on a meander bend is determined from the ratio of vane spacing to bankfull width – a function of the radius of curvature/bankfull width and vane angle from the bank-line. For streams with a radius of curvature to bankfull width ratio of three (San Antonio Creek has an approximate ratio of 3.3) and vane angle of 20 degrees vane spacing is determined with the following equation (Rosgen 2001):

$V_s = -0.006W + 2.4781$

Where:

V_s = Vane spacing/bankfull width (m)

W = bankfull width (m)

Vane spacing on San Antonio Creek with a bankfull width of 41 feet is 99 feet. Sheets C-1 through C-8 indicate the locations of the J-hooks with larger meander bends having multiple structures spaced appropriately.

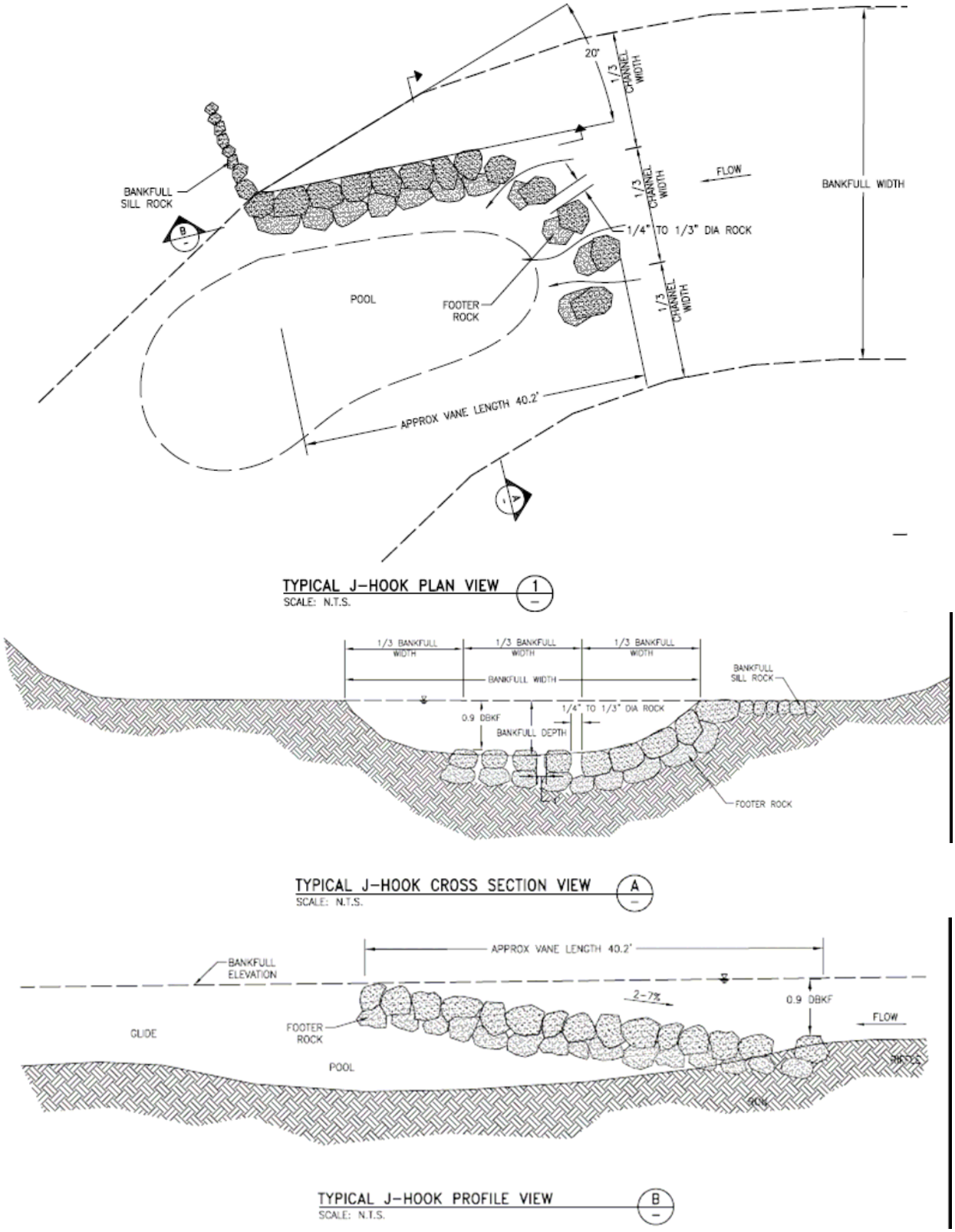


Figure 5-2. Typical Details for a J-hook Vane

5.3.3. W-weir

W-weirs are similar to cross vanes in function and purpose except they separate the flow into multiple zones or thalwegs. W-weirs are typically used in wide rivers or for the protection of bridge piers. A W-weir is used on San Antonio Creek for the purpose of providing scour protection at the Ranch Road crossing bridge pier, as well as bank and abutment protection.

Details of the W-weir design are shown on Figure 5-3. The W-weir is oriented on the upstream side of the bridge with the center apex of the W aligned with the bridge pier. The other two apex portions of the W face upstream similar to the apex of the cross vane with the elevation of the top rocks at these point at or near grade. The elevation of the top rock adjacent to the bridge pier is placed at a depth of ½ bankfull depth. The center V-shape of the weir occupies ½ the bankfull width; the outer two vane legs occupy ¼ the bankfull width. Like the other structures, the outside vane legs terminate at the bankfull elevation or inception point of the floodplain. The vane slope should be 2 - 7%. Because the bridge is located on a bend in the stream the structure is skewed with a longer left bank (looking downstream) vane leg length and lower departure angle from the bank of 20 degrees. The right bank vane-leg length is shorter with a large departure angle of 30 degrees. This skew allows the vane leg on the outside (left) bank intercept a high percentage of the flow redirecting flow around the bend.

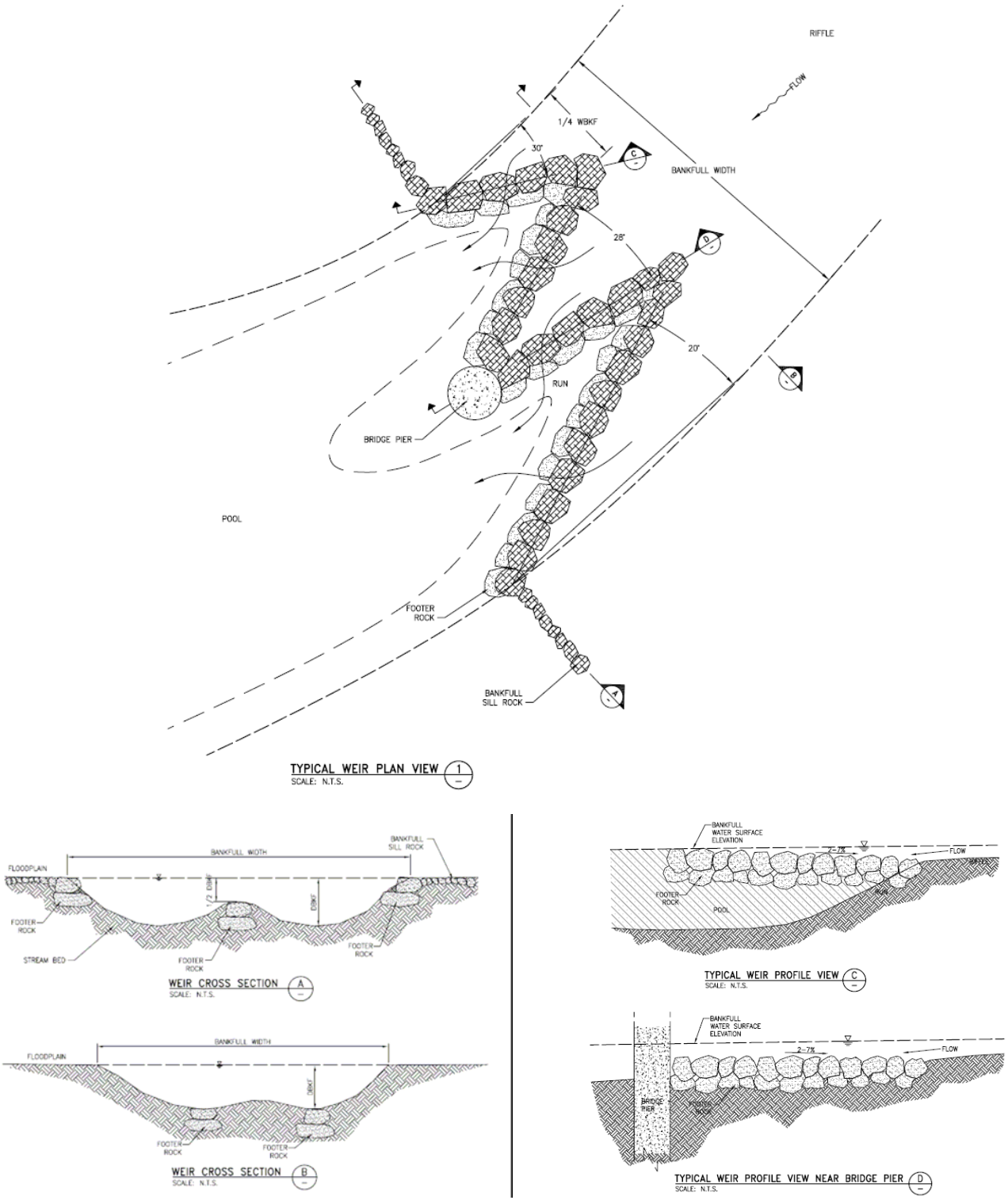


Figure 5-3. Typical Details for a W-weir

Chapter 6. Fencing and Grazing Control

6.1. INTRODUCTION

Fencing and gates will be installed at the project site to manage livestock use along the San Antonio Creek riparian area and surrounding planting areas. The location, purpose, and dimensions of fencing are described below.

6.2. LOCATION AND PURPOSE OF FENCING

Existing barbed wire fences bisect San Antonio Creek dividing the project area in to separate grazing units. The fences that cross the creek are prone to washing out due high flow events when woody debris piles up against the wire. As part of the proposed design, existing fences that cross the creek will be removed and new fence will be installed to exclude cattle from the main riparian area. Degrading fences that are very close to the cliff edge or collapsing over the edge of the slope on the northwestern portion of the project area will be removed and rebuilt along the project boundary. Additional fence will be built where fences are not currently within 20 feet of the project boundary so that planted areas can be managed according to the grazing management plan for the Sunol Region. Livestock exclusion from planting areas will allow plants to establish to a point that they can survive with a limited amount of browsing by livestock. The grazing management plan will stipulate criteria for the timing, duration, and frequency of grazing in the planting areas (including the riparian area for weed control).

Approximately 15,220 linear feet of fencing will be installed around the planting areas and project boundary. Approximately 10,700 feet of fencing will be removed from the project area.

6.3. FENCING AND GATE DIMENSIONS

Fencing will be wildlife friendly, consisting of four wires; two barbed, and two smooth. The top wire (smooth) will be located 40 inches above the ground; the second wire from the top (barbed) will be located 28 inches from the ground; the third wire from the top (barbed) will be located 23 inches from the ground and the bottom wire (smooth) will be located 18 inches from the ground. T-posts will be set every 16.5 feet. A minimum of two access gates will be installed for each enclosure. Gates will be swing type, 16 feet wide, and fabricated from 18-gage galvanized steel.

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Chapter 7. Planting and Habitat Establishment

7.1. INTRODUCTION

Four riparian habitat types and two upland habitat types will be established at the San Antonio Creek Mitigation Area.

Riparian habitats include:

- Seasonal wetland (associated with ephemeral streams)
- Sycamore riparian
- Oak riparian
- Willow riparian

Upland Habitats include:

- Oak savannah
- Oak woodland

In addition, areas temporarily disturbed by construction, including temporary access roads and staging areas, and new embankment crest and slopes will be hydroseeded with a native grass mix. Seeds will be sourced from the Alameda Creek Watershed, to the greatest extent possible. Each habitat type, as well as the hydroseed mix is described below.

7.2. SEASONAL WETLANDS

Approximately 0.3 acre (ac) of seasonal wetlands will be established/reestablished in ephemeral streams where water stays in low gradient areas for enough time to establish hydric soils and allow wetland plant species to establish. Seasonal wetland vegetation will include wetland obligate and facultative wetland plants, with obligate plants planted at lower elevations than the facultative wetland plants (Table 7.1). Plants installed in the seasonal wetland areas will not be irrigated during the maintenance and monitoring period due to sufficient surface and ground water.

7.3. SYCAMORE RIPARIAN

Approximately 24 ac of sycamore riparian habitat will be planted within the active floodplain of the creek where shallow overbank flooding during the dormant period provides suitable conditions for seed germination and stimulates adventitious sprouting (asexual reproduction) of mature trees. Sycamore riparian vegetation includes a sycamore overstory with a facultative and obligate wetland understory (Table 7.1). Sycamore riparian vegetation will be irrigated during the maintenance and monitoring period to improve survivorship and meet success criteria established in the MMP.

7.4. OAK RIPARIAN

Approximately 2 ac of oak riparian habitat will be planted along the upper banks of the ephemeral streams associated with San Antonio Creek. These areas do not receive inundation or flooding from the stream except at the toe of the bank during large flood events. The dominant species in this habitat is coast live oak but also includes some valley oak. Oaks will be planted at lower density in the riparian areas than oak woodland. Oak riparian vegetation will be irrigated during the maintenance and monitoring period to improve survivorship and meet success criteria established in the MMP.

7.5. WILLOW RIPARIAN

Approximately 4 ac of willow riparian will be planted in areas that would otherwise be too wet for the establishment of sycamore or oak riparian vegetation and too dry for emergent wetland species. Willow riparian plantings will consists solely of willow cuttings, planted approximately 5 foot on center. Willow riparian will be located along lower San Antonio Creek near the ordinary high water mark of San Antonio Creek reservoir. Plants installed in the willow riparian areas will not be irrigated during the maintenance and monitoring period due to sufficient surface and ground water.

7.6. OAK SAVANNAH

Approximately 152 ac of oak savannah will be reestablished in large expanses on the dry upland slopes throughout the San Antonio Mitigation Area. Oak savannah plantings will primarily consist of oak woodland species planted at the same density as oak woodland, however the area will not be irrigated. As a result of no irrigation, a higher mortality rate is expected to reduce the spacing to that typical of an oak savannah.

7.7. OAK WOODLAND

Approximately 6 ac of valley oak woodland will be planted along San Antonio Creek where deep, well drained alluvial soils are present at flood plain elevations above the 10-year but below the 100-year recurrence interval where mature tree roots are likely to reach the water table. Oak woodland vegetation will be irrigated during the maintenance and monitoring period to improve survivorship and meet success criteria established in the MMP.

Table 7.1. San Antonio Mitigation Area

Habitat (acres)	Botanical Name	Common Name	Propagation Method	Size*	Remarks
Oak Riparian	*Aesculus californica*	California buckeye	seed	N/A	Vary spacing, cluster some, average 10 ft O.C.
	Quercus agrifolia	coast live oak	Acorn/Container	Acorn/TP	Vary spacing, cluster some, average 12 ft O.C.
	Quercus lobata	valley oak	Acorn/Container	Acorn/TP	
	Artemisia douglasiana	mugwort	Container	D16	Plant @ 10 ft O.C.
	Rubus ursinus	California blackberry	Container	D16	

Table 7.1. San Antonio Mitigation Area

Habitat (acres)	Botanical Name	Common Name	Propagation Method	Size*	Remarks
	Sambucus mexicana	blue elderberry	Container	D16	
	Leymus triticoides	creeping wildrye	Container	plug	Plant @ 10 ft O.C.
	Scrophularia californica	bee plant	Container	D16	
	Symphoricarpos albus var. *laevigatus*	snowberry	Container	D16	
Seasonal Wetland	*Hordeum brachyantherum*	meadow barley	Container	plug	Plant @ 10 ft O.C. just outside of regularly inundated areas
	Leymus triticoides	creeping wildrye	Container	plug	
	Juncus balticus	Baltic rush	Container	SC	Plant @ 10 ft O.C. on the fringes of seasonally inundated areas
	Juncus patens	spreading rush	Container	SC	
Sycamore Riparian	*Platanus racemosa*	western sycamore	Container	TP	Vary spacing, cluster some, average 15 ft O.C.
	Artemisia douglasiana	mugwort	Container	D16	Plant @ 10 ft O.C.
	Elymus glaucus	blue wild rye	Container	SC	
	*Hordeum brachyantherum**	meadow barley	Container	SC	
	Juncus balticus	Baltic rush	Container	SC	Plant @ 10 ft O.C.
	Juncus effuses	common rush	Container	SC	
	Juncus patens	spreading rush	Container	SC	
Willow Riparian	*Salix exigua*	sandbar willow	Pole cuttings	N/A	Plant Willow Cuttings within 6 ft off the water edge. Average 5 ft O.C.
	Salix laevigata	red willow	Pole cuttings	N/A	
	Salix lasiolepis	arroyo willow	Pole cuttings	N/A	
Oak Savannah	*Quercus agrifolia*	coast live oak	Acorn/Container	Acorn/TP	Vary spacing, cluster some, average 15 ft O.C.
	Quercus douglasii	blue oak	Acorn/Container	Acorn/TP	
	Quercus lobata	valley oak	Acorn/Container	Acorn/TP	
	Koelaria macrantha	june grass	seed	N/A	15 LBS / acre
	Lupinus sp.	lupine	seed	N/A	5 LBS / acre
	Elymus glaucus	blue wild rye	Container	SC	Plant @ 10 ft O.C.
	Bromus carinatus	California brome	Container	SC	
	Melica californica	California melic grass	Container	SC	

Table 7.1. San Antonio Mitigation Area

Habitat (acres)	Botanical Name	Common Name	Propagation Method	Size*	Remarks
	Nassella pulchra	purple needlegrass	Container	SC	
	Symphoricarpos mollis	snowberry	Container	D16	
Oak Woodland	*Aesculus californica*	California buckeye	seed	N/A	Vary spacing, cluster some, average 10 ft O.C.
	Quercus agrifolia	coast live oak	Acorn/Container	Acorn/TP	Vary spacing, cluster some, average 12 ft O.C. Plant at higher elevations and on steeper slopes.
	Quercus douglasii	blue oak	Acorn/Container	Acorn/TP	
	Quercus lobata	Valley oak	Acorn/Container	Acorn/TP	Vary spacing, cluster some, average 12 ft O.C. Plant outside 10 yr floodplain, but within 100 yr floodplain
Oak Woodland (cont)	*Elymus glaucus*	blue wild rye	Container	SC	Plant @ 10 ft O.C. within the 100-yr floodplain. 15 ft O.C. outside the 100-yr floodplain
	Lessingia filaginifolia	common sandaster	Container	SC	
	Sanicula crassicaulis	pacific sanicle	Container	D16	
	Symphoricarpos mollis	creeping snowberry	Container	D16	
	Achillea millefolium	yarrow	Container	SC	Plant @ 10 ft O.C. outside the 100-yr floodplain
	Artemisia californica	California sagebrush	Container	D16	
	Baccharis pilularis	coyote brush	Container	D16	
	Chlorogalum pomiridianum	soap plant	Container	SC	
	Mimulus aurantiacus	bush monkeyflower	Container	D16	
	Nassella pulchra	purple needlegrass	Container	plug	

***Sizes:**

Code	Name	Dimensions
SC	Supercell	1.5” diameter x 8.25” deep
D16	Deep pot	2” diameter x 7” deep
plug	plug	1" x 1" x 2 1/2" deep
TP	Tree pot	1 gallon, 4” x 4” x 14” deep
Acorn	Oak acorn	N/A

7.8. HYDROSEEDING

Approximately 50 acres will be hydroseeded after completion of construction. Areas proposed for hydroseeding include staging areas, temporary access roads, floodplain and associated graded

slopes, soil disposal area, and assumed access/disturbance areas for the installation of irrigation systems. Species included in the hydroseed mix are listed in Table 7.2, consisting of native grasses and forbs. The hydroseed mix will consist of straw mulch, tackifier, and seed mix (43 lbs/acre). Mulch will be certified weed free compost and will be free of chemicals, heavy metals or other materials that would be harmful to plant or animal life.

Table 7.2. San Anonio Creek Hydroseed Species Mix

Scientific Name	Common Name	lbs/acre
Nassella pulchra	Purple needlegrass	7.2
Koelaria macrantha	Junegrass	2.4
Bromus carinatus	California brome	4.8
Achillia millefolium	Yarrow	7.2
Eschscholzia californica	California poppy	7.2
Sanicula bipinnatifida	Purple sanicle	7.2
Elymus glaucus	Blue wildrye	7.2
	Total lbs/acre:	43 lbs/acre

Chapter 8. Cost Estimate

8.1. INTRODUCTION

A detailed cost estimate based on the 30% plans for the project site is presented in Table 8.1. Quantities were measured manually from the drawings or using the AutoCAD Civil3D Version 2009 (Autodesk, Inc. 2008) software. Earthwork quantities were typically calculated based on terrain models of the existing and proposed ground surfaces and using the grid method in Civil3D. Unit costs were developed based on a combination of previous, similar project experience and the 2010 R.S. Means Building Construction Cost Data (R.S. Means Company 2009) estimating guide.

8.2. ASSUMPTIONS

The following assumptions were made in developing the cost estimate:

- Topsoil excavation includes removal of upper 9-inches of soil and grass, stockpiling the material onsite to be redistributed at completion of grading.
- Floodplain grading assumes grading and filling not to exceed 3 feet deep. Material would be redistributed with a dozer, road grader, scraper, or similar equipment to achieve desired grade.
- A sufficient amount of gravel is present in the existing channel to line newly graded portions of the channel.
- All excavated material will be reusable as fill material where possible.
- Excess excavated material not used along the floodplain and channel will be hauled to an onsite disposal area.
- A 15% bulking factor is used for compacted fill required for rebuilding stream/floodplain banks, bridge abutments/pier, and roadway.
- Trees to be removed were based on the trees, which occur within the proposed channel area and where slopes will be graded to match the proposed floodplain to existing grade. It was assumed that trees occurring in the floodplain could be avoided, thus not require removal.
- Dewatering cost is assumes that minor ground water dewatering may be necessary to install bridge pier/abutment foundations.
- Bridge cost assumes the installation of two reconditioned 90 ft railroad cars with treated wood decking/rub rails, steel handrail, standard poured in place abutment (HS25 - 90,000 lb loading), and installation kit (bearing plates, anti-vibration pads, concrete fasteners, etc.). Parts and materials cost approximately $94k.
- Direct Cost Subtotal, Indirect Cost Subtotal, Contingency and Project Total costs rounded up to the nearest hundred.
- 30% of Contingency is included in the overall cost estimate.

- Additional costs for material testing and sorting are included in the contingency.
- Additional costs not listed but associated with SWPPP BMPs are included in the contingency.

Table 8.1. 30% Design Cost Estimate

Spec Section	Description	Qty	Unit	Unit Cost ($)	Total Amount ($)
01013	**Mobilization/Demobilization**				**523,215**
	Mobilization/Demobilization (10% of Total Project Cost)	1	LS	523,215	523,215
02052	**Clearing, Grubbing and Stripping**				**229,032**
	Topsoil Excavation -Strip and Stockpile Onsite	46	AC	5,000	229,032
02200	**Excavation and Fill**				**1,056,159**
	Excavation of Alluvial Material (Channel Bottom)	13,754	CY	10	137,540
	Excavation (Floodplain)	31,017	CY	4	124,068
	Excavation (Streambanks/Floodplain Slopes)	11,526	CY	4	46,104
	Excavation (Bridge Abutments & Pier)	250	CY	10	2,500
	Fill Alluvial Material (Channel Bottom)	13,435	CY	10	134,350
	Fill (Flood Plain - No Compaction)	31,630	CY	15	474,450
	Fill (Streambanks/Floodplain Slopes - 90% Compaction)	8,863	CY	12	106,357
	Fill (Bridge Abutments, Pier, and Roadway - 95% Compaction)	2,300	CY	12	27,600
	Haul Excess Alluvial Material - 2-3 Miles	319	CY	10	3,190
02050	**Demolition**				**64,850**
	Existing Fence Demolition	10,700	LF	4	42,800
	Existing Trees Removal	49	EA	450	22,050
02240	**Dewatering**				**20,000**
	Dewatering - one time pumping of 1' ponded water	1	LS	20,000	20,000
02270	**Erosion and Sediment Control**				**616,367**
	Rock Vanes (36 inch Rock)	2,800	TON	200	560,000
	Rock Vanes (12 inch Rock)	76	TON	200	15,163
	Bio-Wattles	5,000	LF	5.50	27,500
	Jute Fiber Mats	45,680	SQ.FT	0.30	13,704
02270	**Rail Car Bridge**				**200,000**
	Rail Car Bridge (Double span-two 90 ft railcars)	1	LS	200,000	200,000
02830	**Fencing**				**370,840**
	Wildlife Friendly Fence	15,220	LF	22	334,840
	Gate	12	EA	3,000	36,000
02920	**Container Plant Installation**				**1,269,137**
	Grass & herb. Perennial plugs- Grow	72	PLUGS	2	144
	Grass & herb. Perennial plugs supercell - Grow	28,188	SC	2	56,376
	Small shrubs- Grow	11,278	Deepot 16	3	33,833
	Large shrubs & trees- Grow	622	Treepot 4	7	4,230
	Grass & herb. Perennial plugs- Install	72	PLUGS	2	144

Table 8.1. 30% Design Cost Estimate

Spec Section	Description	Qty	Unit	Unit Cost ($)	Total Amount ($)
	Grass & herb. Perennial plugs- Install	28,188	SC	4	112,753
	Small shrubs- Install	11,278	Deepot 16	8	90,223
	Large shrubs & trees- Install	622	Treepot 4	16	9,952
	Tree Seed Installation	29,743	N/A	6	178,457
	Plant Protection	30,365	tubex	5	151,824
	Mulch (Approx. 1 SQ. YD/plant)	31,779	SQ. YD	7.45	236,752
	Plant & Irrigation Maintenance (18 months, $2.39/ac/day)	540	DAY	550	297,225
	Plant Replacement During Establishment Period (20% mortality)	8,032	EA	12	97,223
02925	**Pole Cutting**				**7,649**
	Live Willow Staking	1,912	EA	4	7,649
02930	**Hydroseeding**				**366,854**
	Hydroseeding	50	AC	3,000	150,073
	Seed Collection/Mix (43 lbs/ac)	2,151	LB	97	208,652
	Tackifier (125 lbs/ac)	6,253	LB	0.5	3,127
	Mulch (2 ton/ac)	100.0	TON	50	5,002
02935	**Irrigation**				**1,031,266**
	Water Supply and Irrigation System Design	160	HR	200	32,000
	Water Supply and Irrigation System Materials & Installation	3,223,440	SQ. FT	0.31	999,266
	SUBTOTAL				**5,755,368**
	CONTINGENCY 30%	1	LS	1,726,610	1,726,610
	TOTAL COST				**7,481,979**

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Appendix A Velocity and Discharge Estimates at Existing Cross Sections

Bankfull Velocity/Discharge Estimates

Site: San Antonio Creek			Location: Reach 1 Riffle XS-1		
Date: 3/30/09			Valley Type: VIII		
Observers: JP & SL			HUC:		
Input Variables			**Output Variables**		
Bankfull X-Sect Area	158.37	A_{bkf} (ft^2)	Bankfull Mean Depth	2.3	d_{bkf} (ft)
Bankfull Width	69.44	W_{bkf} (ft)	Wetted Perimeter ~2*d_{bkf}+W_{bkf}	71.72	Wp (ft)
D_{84} @ Riffle	80	Dia. (mm)	D_{84} mm/304.8 =	0.26	D_{84} (ft)
Bankfull Slope	0.008	S_{bkf} (ft/ft)	Hydraulic Radius A_{bkf}/Wp	2.21	R (ft)
Gravitational Acceleration	32.2	g (ft/sec^2)	Relative Roughness R (ft)/D_{84} (ft)	8.4	
Drainage Area	20.4	DA (mi^2)	Shear Velocity u* = $\sqrt{gRS}$	0.73	u* (ft/sec)

Estimation Methods		**Bankfull Velocity**		**Bankfull Discharge**	
	n-value / other				
1. Friction Factor/Relative Roughness u = [2.83 + 5.66 log(R/D84)]u*	N/A	5.92	ft/sec	938.3	cfs
2. Roughness Coefficient: a) Manning's n from friction factor/relative roughness u = $1.4865*R^{2/3}S^{1/2}/n$ n =	0.036	6.10	ft/sec	966.1	cfs
2. Roughness Coefficient: u = $1.4865*R^{2/3}S^{1/2}/n$ n = b) Manning's n from Jarret (USGS): $n = 0.39S^{0.38}R^{-0.16}$ Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream s**	0.054	4.08	ft/sec	646.8	cfs
3. Other Methods (Chezy C) $C = 1/n(R^{1/6})$ $u = C\sqrt{RS}$	0.036	6.10	ft/sec	965.7	cfs
3. Other Methods (Darcy-Weisbach friction factor) f = $8gRS/u^2$ $1/\sqrt{f}$ =	2.85		ft/sec		cfs
4. Continuity Equations: a) Regional Curves u = Q/A Return Period (Year) =	-	7.61	ft/sec	875	cfs
4. Continuity Equations: b) USGS Gage Data u = Q/A	0.031	7.08	ft/sec	1121.9	cfs

Bankfull Velocity/Discharge Estimates

Site: San Antonio Creek			Location: Reach 2 Riffle XS-3		
Date: 4/1/09			Valley Type: VIII		
Observers: JP & SL			HUC:		
Input Variables			**Output Variables**		
Bankfull X-Sect Area	144.62	A_{bkf} (ft^2)	Bankfull Mean Depth	2.6	d_{bkf} (ft)
Bankfull Width	56.08	W_{bkf} (ft)	Wetted Perimeter ~$2*d_{bkf}+W_{bkf}$	58.68	Wp (ft)
D_{84} @ Riffle	64	Dia. (mm)	D_{84} mm/304.8 =	0.21	D_{84} (ft)
Bankfull Slope	0.008	S_{bkf} (ft/ft)	Hydraulic Radius A_{bkf}/Wp	2.46	R (ft)
Gravitational Acceleration	32.2	g (ft/sec^2)	Relative Roughness R (ft)/D_{84} (ft)	11.7	
Drainage Area	20.4	DA (mi^2)	Shear Velocity u* = $\sqrt{gRS}$	0.80	u* (ft/sec)

Estimation Methods		**Bankfull Velocity**		**Bankfull Discharge**	
	n-value / other				
1. Friction Factor/Relative Roughness u = [2.83 + 5.66 log(R/D84)]u*	N/A	7.08	ft/sec	1023.7	cfs
2. Roughness Coefficient: a) Manning's n from friction factor/relative roughness u = $1.4865*R^{2/3}S^{1/2}/n$ n =	0.033	7.35	ft/sec	1063.1	cfs
2. Roughness Coefficient: u = $1.4865*R^{2/3}S^{1/2}/n$ n = b) Manning's n from Jarret (USGS): $n = 0.39S^{0.38}R^{-0.16}$ Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream s**	0.054	4.50	ft/sec	650.9	cfs
3. Other Methods (Chezy C) $C = 1/n(R^{1/6})$ $u = C\sqrt{RS}$	0.033	7.35	ft/sec	1062.7	cfs
3. Other Methods (Darcy-Weisbach friction factor) f = $8gRS/u^2$ $1/\sqrt{f}$ =	3.14		ft/sec		cfs
4. Continuity Equations: a) Regional Curves u = Q/A Return Period (Year) =	-	7.61	ft/sec	875	cfs
4. Continuity Equations: b) USGS Gage Data u = Q/A	0.031	7.83	ft/sec	1131.7	cfs

Bankfull Velocity/Discharge Estimates

Site: San Antonio Creek			Location: Reach 2 Riffle XS-4		
Date: 4/1/09			Valley Type: VIII		
Observers: JP & SL			HUC:		
Input Variables			**Output Variables**		
Bankfull X-Sect Area	93.6	A_{bkf} (ft^2)	Bankfull Mean Depth	2.3	d_{bkf} (ft)
Bankfull Width	40.3	W_{bkf} (ft)	Wetted Perimeter ~2*d_{bkf}+W_{bkf}	41.7	Wp (ft)
D_{84} @ Riffle	100	Dia. (mm)	D_{84} mm/304.8 =	0.33	D_{84} (ft)
Bankfull Slope	0.010	S_{bkf} (ft/ft)	Hydraulic Radius A_{bkf}/Wp	2.25	R (ft)
Gravitational Acceleration	32.2	g (ft/sec^2)	Relative Roughness R (ft)/D_{84} (ft)	6.8	
Drainage Area	20.4	DA (mi^2)	Shear Velocity u* = $\sqrt{gRS}$	0.84	u* (ft/sec)

Estimation Methods		**Bankfull Velocity**		**Bankfull Discharge**	
	n-value / other				
1. Friction Factor/Relative Roughness $u = [2.83 + 5.66 \log(R/D84)]u^*$	N/A	6.36	ft/sec	595.0	cfs
2. Roughness Coefficient: a) Manning's n from friction factor/relative roughness $u = 1.4865*R^{2/3}S^{1/2}/n$ n =	0.038	6.64	ft/sec	621.1	cfs
2. Roughness Coefficient: $u = 1.4865*R^{2/3}S^{1/2}/n$ n = b) Manning's n from Jarret (USGS): $n = 0.39S^{0.38}R^{-0.16}$ Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream s**	0.059	4.27	ft/sec	399.7	cfs
3. Other Methods (Chezy C) $C = 1/n(R^{1/6})$ $u = C\sqrt{RS}$	0.038	6.63	ft/sec	620.8	cfs
3. Other Methods (Darcy-Weisbach friction factor) $f = 8gRS/u^2$ $1/\sqrt{f}$ =	2.67		ft/sec		cfs
4. Continuity Equations: a) Regional Curves u = Q/A Return Period (Year) =	-	7.61	ft/sec	875	cfs
4. Continuity Equations: b) USGS Gage Data u = Q/A	0.031	8.13	ft/sec	761.3	cfs

Bankfull Velocity/Discharge Estimates

Site: San Antonio Creek			Location: Reach 2 Riffle XS-4		
Date: 4/1/09			Valley Type: VIII		
Observers: JP & SL			HUC:		
Input Variables			**Output Variables**		
Bankfull X-Sect Area	174.08	A_{bkf} (ft^2)	Bankfull Mean Depth	2.4	d_{bkf} (ft)
Bankfull Width	73.8	W_{bkf} (ft)	Wetted Perimeter ~2*d_{bkf}+W_{bkf}	77.2	Wp (ft)
D_{84} @ Riffle	100	Dia. (mm)	D_{84} mm/304.8 =	0.33	D_{84} (ft)
Bankfull Slope	0.010	S_{bkf} (ft/ft)	Hydraulic Radius A_{bkf}/Wp	2.25	R (ft)
Gravitational Acceleration	32.2	g (ft/sec^2)	Relative Roughness R (ft)/D_{84} (ft)	6.9	
Drainage Area	20.4	DA (mi^2)	Shear Velocity u* = $\sqrt{gRS}$	0.84	u* (ft/sec)

Estimation Methods		**Bankfull Velocity**		**Bankfull Discharge**	
	n-value / other				
1. Friction Factor/Relative Roughness u = [2.83 + 5.66 log(R/D84)]u*	N/A	6.38	ft/sec	1110.2	cfs
2. Roughness Coefficient: a) Manning's n from friction factor/relative roughness u = $1.4865*R^{2/3}S^{1/2}/n$ n =	0.038	6.65	ft/sec	1158.0	cfs
2. Roughness Coefficient: u = $1.4865*R^{2/3}S^{1/2}/n$ n = b) Manning's n from Jarret (USGS): $n = 0.39S^{0.38}R^{-0.16}$ Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream s**	0.059	4.28	ft/sec	745.8	cfs
3. Other Methods (Chezy C) C = $1/n(R^{1/6})$ u = $C\sqrt{RS}$	0.038	6.65	ft/sec	1157.6	cfs
3. Other Methods (Darcy-Weisbach friction factor) f = $8gRS/u^2$ $1/\sqrt{f}$ =	2.68		ft/sec		cfs
4. Continuity Equations: a) Regional Curves u = Q/A Return Period (Year) =	-	7.61	ft/sec	875	cfs
4. Continuity Equations: b) USGS Gage Data u = Q/A	0.031	8.15	ft/sec	1419.5	cfs

Bankfull Velocity/Discharge Estimates

Site: San Antonio Creek			Location: Reach 3 Riffle XS-6		
Date: 4/6/09			Valley Type: VIII		
Observers: JP & SL			HUC:		
Input Variables			**Output Variables**		
Bankfull X-Sect Area	109.8	A_{bkf} (ft^2)	Bankfull Mean Depth	1.7	d_{bkf} (ft)
Bankfull Width	63.4	W_{bkf} (ft)	Wetted Perimeter ~2*d_{bkf}+W_{bkf}	66.4	Wp (ft)
D_{84} @ Riffle	89	Dia. (mm)	D_{84} mm/304.8 =	0.29	D_{84} (ft)
Bankfull Slope	0.012	S_{bkf} (ft/ft)	Hydraulic Radius A_{bkf}/Wp	1.65	R (ft)
Gravitational Acceleration	32.2	g (ft/sec^2)	Relative Roughness R (ft)/D_{84} (ft)	5.7	
Drainage Area	20.4	DA (mi^2)	Shear Velocity u* = $\sqrt{gRS}$	0.79	u* (ft/sec)

Estimation Methods		**Bankfull Velocity**		**Bankfull Discharge**	
	n-value / other				
1. Friction Factor/Relative Roughness $u = [2.83 + 5.66 \log(R/D84)]u^*$	N/A	5.57	ft/sec	612.2	cfs
2. Roughness Coefficient: a) Manning's n from friction factor/relative roughness $u = 1.4865*R^{2/3}S^{1/2}/n$ n =	0.041	5.53	ft/sec	607.1	cfs
2. Roughness Coefficient: $u = 1.4865*R^{2/3}S^{1/2}/n$ n = b) Manning's n from Jarret (USGS): $n = 0.39S^{0.38}R^{-0.16}$ Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream s**	0.066	3.38	ft/sec	371.8	cfs
3. Other Methods (Chezy C) $C = 1/n(R^{1/6})$ $u = C\sqrt{RS}$	0.041	5.52	ft/sec	606.8	cfs
3. Other Methods (Darcy-Weisbach friction factor) f = $8gRS/u^2$ $1/\sqrt{f}$ =	2.51		ft/sec		cfs
4. Continuity Equations: a) Regional Curves u = Q/A Return Period (Year) =	-	7.61	ft/sec	875	cfs
4. Continuity Equations: b) USGS Gage Data u = Q/A	0.031	7.22	ft/sec	793.1	cfs

Bankfull Velocity/Discharge Estimates

Site: San Antonio Creek			Location: Reach 3 Riffle XS-6		
Date: 4/6/09			Valley Type: VIII		
Observers: JP & SL			HUC:		
Input Variables			**Output Variables**		
Bankfull X-Sect Area	174.9	A_{bkf} (ft^2)	Bankfull Mean Depth	2.5	d_{bkf} (ft)
Bankfull Width	69.1	W_{bkf} (ft)	Wetted Perimeter ~2*d_{bkf}+W_{bkf}	72.5	Wp (ft)
D_{84} @ Riffle	89	Dia. (mm)	D_{84} mm/304.8 =	0.29	D_{84} (ft)
Bankfull Slope	0.012	S_{bkf} (ft/ft)	Hydraulic Radius A_{bkf}/Wp	2.41	R (ft)
Gravitational Acceleration	32.2	g (ft/sec^2)	Relative Roughness R (ft)/D_{84} (ft)	8.3	
Drainage Area	20.4	DA (mi^2)	Shear Velocity u* = $\sqrt{gRS}$	0.95	u* (ft/sec)

Estimation Methods		**Bankfull Velocity**		**Bankfull Discharge**	
	n-value / other				
1. Friction Factor/Relative Roughness $u = [2.83 + 5.66 \log(R/D84)]u^*$	N/A	7.61	ft/sec	1331.2	cfs
2. Roughness Coefficient: a) Manning's n from friction factor/relative roughness $u = 1.4865*R^{2/3}S^{1/2}/n$ n =	0.036	8.00	ft/sec	1398.6	cfs
2. Roughness Coefficient: $u = 1.4865*R^{2/3}S^{1/2}/n$ n = b) Manning's n from Jarret (USGS): $n = 0.39S^{0.38}R^{-0.16}$ Note: This equation is for applications involving **steep, step-pool, high boundary roughness, cobble- and boulder-dominated stream s**	0.062	4.62	ft/sec	808.7	cfs
3. Other Methods (Chezy C) $C = 1/n(R^{1/6})$ $u = C\sqrt{RS}$	0.036	7.99	ft/sec	1398.1	cfs
3. Other Methods (Darcy-Weisbach friction factor) $f = 8gRS/u^2$ $1/\sqrt{f}$ =	2.84		ft/sec		cfs
4. Continuity Equations: a) Regional Curves u = Q/A Return Period (Year) =	-	7.61	ft/sec	875	cfs
4. Continuity Equations: b) USGS Gage Data u = Q/A	0.031	9.29	ft/sec	1624.2	cfs

Appendix B Hydrologic and Hydraulic Modeling

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	12765.83	100-yr	6917	577.39	586.54	586.54	589.79	0.013743	14.46	478.28	73.91	1
R1	12580.68	100-yr	6917	575.55	584.09	584.09	587.01	0.014218	13.72	504.11	86.97	1
R1	12356.76	100-yr	6917	572.1	582.08		583.76	0.005588	10.4	664.93	86.7	0.66
R1	12227.77	100-yr	6917	570.86	579.82	579.6	582.62	0.012292	13.43	515.13	84.14	0.96
R1	12086.97	100-yr	6917	570.23	578.76	578.76	580.82	0.010179	11.75	641.47	173.01	0.87
R1	11932.32	100-yr	6917	568.3	575.5	575.5	577.42	0.011389	11.23	649.89	194.17	0.9
R1	11776.42	100-yr	6917	565.91	572.43	572.01	573.82	0.011055	9.45	733.19	208.84	0.85
R1	11649.21	100-yr	6917	563.48	571.22	570.79	572.38	0.010506	8.66	808.18	256.3	0.82
R1	11571.82	100-yr	6917	563.03	570.4	570.06	571.54	0.011082	8.61	817.31	274.26	0.84
R1	11431.39	100-yr	6917	561.38	569.17	568.81	570.03	0.009191	7.69	977.59	392.83	0.76
R1	11320.55	100-yr	6917	561.37	567.54	567.54	568.77	0.013895	8.96	804.53	384.14	0.92
R1	11207.04	100-yr	6917	560.08	565.82		566.74	0.009653	7.73	895.25	288.54	0.77
R1	11107.1	100-yr	6917	558.1	565.28		565.91	0.005917	6.36	1092.47	337.23	0.61
R1	10994.87	100-yr	6917	557.14	563.63	563.56	564.82	0.016364	8.73	791.89	313.72	0.97
R1	10890.11	100-yr	6917	556.44	562.92		563.59	0.007016	6.55	1065.19	358.71	0.66
R1	10792.66	100-yr	6917	554.98	561.76		562.73	0.009026	8.36	926.43	343.22	0.77
R1	10714.72	100-yr	6917	554.92	561.54		562.14	0.004515	6.61	1201.67	471.16	0.56
R1	10660.02	100-yr	7328	554.6	560.47	560.3	561.71	0.010516	9.1	875.1	454.61	0.83
R1	10556.28	100-yr	7328	553.07	559.47	559.44	560.51	0.011732	8.82	962.68	486.22	0.86
R1	10452.24	100-yr	7328	552.73	558.82		559.48	0.007412	7.28	1239.82	587.13	0.69
R1	10380.99	100-yr	7328	552.72	558.19	557.83	558.96	0.008604	7.84	1175.25	622.24	0.74
R1	10318.08	100-yr	7328	551.11	557.63	557.19	558.43	0.00861	7.97	1177.63	629.31	0.74
R1	10205.48	100-yr	7328	550.62	557.37		557.81	0.003471	5.88	1505.15	588.12	0.49
R1	10070.55	100-yr	7328	547.45	555.94	555.94	557.11	0.008958	9.52	966.86	399.51	0.78
R1	9963.673	100-yr	7328	547.86	554.92	554.92	556.08	0.00926	10.12	968.65	376.31	0.8
R1	9885.528	100-yr	7328	547.29	554.14	554.14	555.28	0.008842	10.1	971.41	385.33	0.79
R1	9753.5	100-yr	7328	545.62	552.63	552.52	553.94	0.010241	10.46	892.42	354.63	0.85
R1	9604.528	100-yr	7328	544.44	551.18	550.98	552.48	0.010465	9.75	834.47	289.17	0.84
R1	9471.219	100-yr	7328	543.32	550.43		551.26	0.006837	8.11	1056.69	337.77	0.69
R1	9351.691	100-yr	7328	542.64	549.8		550.58	0.004528	7.5	1077.82	265.79	0.58
R1	9261.326	100-yr	7328	542.15	549.08		550.08	0.006031	8.36	968.57	271.59	0.66
R1	9197.721	100-yr	7700	541.07	548.66		549.72	0.005462	8.69	1013.83	270.5	0.64
R1	9087.427	100-yr	7700	538.97	547.33	547.33	548.9	0.009653	10.48	842.5	277.9	0.83
R1	8990.195	100-yr	7700	538.2	546.15	546.15	547.75	0.010326	10.48	811.99	273.73	0.85
R1	8930.013	100-yr	7700	537.45	545.11	545.11	546.64	0.013067	10.25	811.84	279.29	0.92
R1	8851.071	100-yr	7700	537.61	544.33	544.08	545.55	0.01007	9.21	905.8	291.03	0.82
R1	8762.175	100-yr	7706	535.86	543.06	543.06	544.47	0.014269	10.09	838.71	301.94	0.95
R1	8647.803	100-yr	7706	534.83	541.75		542.75	0.010935	8.51	967.04	331.99	0.82
R1	8543.921	100-yr	7706	533.71	541.25		541.85	0.005195	6.76	1261.9	381.85	0.59
R1	8334.452	100-yr	7706	531.65	539.31	539.31	540.5	0.012062	9.39	936.3	367.63	0.88
R1	8232.678	100-yr	7706	531.36	538.05	537.72	539.1	0.00993	8.4	965.74	340.96	0.8
R1	8135.866	100-yr	7706	531.13	536.86	536.86	538	0.013723	8.84	947.96	426.63	0.91
R1	7993.615	100-yr	7706	529.87	535.69		536.15	0.005097	5.9	1458.59	538.14	0.57
R1	7768.966	100-yr	7706	526.3	533.92		534.79	0.008474	8.11	1088.05	416.44	0.74
R1	7608.564	100-yr	7706	524.06	532.93		533.7	0.005742	7.51	1195.59	412.07	0.63
R1	7509.6	100-yr	7706	523.79	532.03	532.03	533.01	0.00842	9.03	1134.15	526.55	0.76
R1	7397.829	100-yr	7736	520.72	530.44	530.44	531.44	0.00634	9.45	1202.51	546.55	0.69
R1	7340.715	100-yr	7736	521.79	530.24	529.78	530.88	0.003868	7.78	1478.58	565.38	0.55
R1	7222.992	100-yr	7736	520.63	527.76	527.47	529.86	0.018304	13.61	759.56	333.1	1.12
R1	7079.519	100-yr	7736	518.55	526.83	526.67	527.98	0.008474	10.2	1019.33	412.63	0.77
R1	6927.725	100-yr	7736	517.02	525.97		526.88	0.006767	9.44	1203.49	480.21	0.69
R1	6743.053	100-yr	7736	515.38	523.8	523.8	525.43	0.010025	11.29	871.27	317.65	0.86
R1	6619.016	100-yr	7736	513.08	522.37	522.37	523.77	0.011242	10.55	888.54	324.7	0.87
R1	6424.089	100-yr	8027	511.9	520.95		522.1	0.005775	9.3	1005.69	249.87	0.67
R1	6265.335	100-yr	8027	510.66	519.58		520.93	0.009237	9.94	881.76	224.56	0.81
R1	6172.454	100-yr	8027	509.95	518.37	518.37	519.97	0.011255	10.82	838.63	247.18	0.89
R1	6081.552	100-yr	8027	509.07	517.33	517.33	518.88	0.011722	10.49	854.24	271.79	0.89
R1	5902.723	100-yr	8027	504.84	516.07		517.02	0.006013	8.46	1123.96	339.53	0.65

R1	5726.338	100-yr	8059	505.35	515.45		516.19	0.003395	8	1380.67	399.29	0.52
R1	5585.48	100-yr	8059	503.89	513.88	513.88	515.46	0.007517	11.13	950.63	312.1	0.75
R1	5433.843	100-yr	8059	503.17	511.41		512.71	0.009514	9.3	900.98	249.18	0.8
R1	5298.779	100-yr	8059	502.13	510.55		511.54	0.006867	8.47	1114.39	388.38	0.69
R1	5094.216	100-yr	8072	497.75	508.34	508.31	509.76	0.011112	9.95	900.1	304.43	0.86
R1	4967.422	100-yr	8072	498.33	506.61	506.61	508.21	0.01429	10.23	817.03	271.46	0.95
R1	4722.293	100-yr	8075	494.46	504.93		505.91	0.005496	8.03	1066.35	293.72	0.63
R1	4616.473	100-yr	8075	494.57	504.66		505.4	0.003212	7.28	1297	330.63	0.5
R1	4411.542	100-yr	8075	493.25	502.64	501.95	504.31	0.008893	10.48	822.43	280.62	0.8
R1	4301.064	100-yr	8075	492.19	500.67	500.67	503.02	0.014406	12.3	656.42	139.93	1
R1	4220.605	100-yr	8075	491.42	499.87	499.56	501.61	0.012104	10.58	763.97	186.82	0.91
R1	3993.016	100-yr	8075	487.7	498.55		499.52	0.005862	7.89	1023.76	215.63	0.64
R1	3833.856	100-yr	8075	487.23	497.94		498.64	0.004345	6.73	1199.97	259.14	0.55
R1	3742.142	100-yr	8075	487.15	497.22		498.18	0.005274	7.84	1031.09	235.26	0.61
R1	3669.822	100-yr	8075	486.29	496.65	495.26	497.76	0.005812	8.49	998.58	345.34	0.65
R1	3595.137	100-yr	8075	486.09	495.54	495.07	497.16	0.009726	10.25	809.79	219.29	0.83
R1	3533.429	100-yr	8075	486.49	495.65		496.56	0.004449	7.82	1114.98	328.68	0.58
R1	3404.836	100-yr	8160	484.78	495.26		496.06	0.003273	7.46	1235.82	340.38	0.5
R1	3301.296	100-yr	8160	483.94	493.48	493.41	495.42	0.009837	11.66	782.68	191.72	0.85
R1	3225.048	100-yr	8160	483.12	493.68		494.66	0.004235	8.19	1064.84	200.92	0.57
R1	3117.351	100-yr	8160	482.45	492.97		494.13	0.005545	9.01	1004.33	258.07	0.64
R1	3034.507	100-yr	8160	482.04	492.2	491.01	493.59	0.006918	9.51	891.41	235.29	0.71
R1	2969.185	100-yr	8160	481.21	491.89		493.17	0.00514	9.07	917.53	244.83	0.63
R1	2912.532	100-yr	8160	480.68	489.72	489.72	492.56	0.013971	13.53	603.19	107.58	1.01
R1	2879.3	100-yr	8160	478.99	489.03	488.95	491.69	0.0137	13.09	623.96	114.57	0.98
R1	2845.687	100-yr	8160	479.99	489.35		491.07	0.007684	10.53	775.25	126.16	0.75
R1	2786.828	100-yr	8160	478.35	489.75		490.54	0.002628	7.14	1172.67	195.34	0.45
R1	2736.954	100-yr	8160	478.83	488.79		490.27	0.006639	9.8	847.82	173.93	0.71
R1	2673.232	100-yr	8160	478.03	488.92		489.82	0.003079	7.68	1105.61	191.83	0.49
R1	2592.947	100-yr	8160	476.42	486.45	486.45	489.21	0.010814	13.48	636.92	129.66	0.9
R1	2486.201	100-yr	8162	475.58	485.29	485.29	487.56	0.011648	12.19	695.73	169.87	0.92
R1	2377.306	100-yr	8162	474.53	482.99	482.99	484.93	0.013562	11.53	747.67	191.45	0.96
R1	2279.016	100-yr	8162	473.42	481.89	481.53	483.22	0.009743	9.62	910.35	250.15	0.81
R1	2175.085	100-yr	8162	472.81	481.1		482.15	0.009157	8.61	1025.57	322.7	0.78
R1	2069.171	100-yr	8162	470	480.35		481.19	0.007558	7.88	1147.64	365.95	0.71
R1	1949.069	100-yr	8162	471.73	479.73		480.42	0.005061	7.1	1265.53	345.93	0.59
R1	1852.628	100-yr	8162	471.15	479.37		479.98	0.003607	6.45	1320.15	287.37	0.51
R1	1676.374	100-yr	8162	468.84	477.64	477.35	478.87	0.012147	8.96	925.79	294.12	0.87
R1	1572.411	100-yr	8385	471.5	476.53	476.14	477.64	0.010839	8.47	996.03	315.53	0.83
R1	1466.798	100-yr	8385	470.77	475.35	475.08	476.37	0.012762	8.12	1032.12	381.34	0.87
R1	1345.433	100-yr	8385	469.49	474.83		475.35	0.004576	5.78	1450.43	413.66	0.54
R1	1202.862	100-yr	8385	468.71	474.41		474.81	0.00288	5.07	1654.32	408.12	0.44
R1	1044.417	100-yr	8385	466.25	473.83		474.3	0.003452	5.49	1529.98	382.8	0.48
R1	850.8181	100-yr	8385	465.61	472.75		473.45	0.005391	6.71	1253.07	327.32	0.6
R1	704.5021	100-yr	8385	464.07	471.17		472.38	0.00953	8.82	952.26	252.82	0.8
R1	513.2567	100-yr	8512	464.01	469.98		470.75	0.006533	7.04	1213.6	343.3	0.65
R1	297.6275	100-yr	8512	463.08	469.01	467.59	469.61	0.004003	6.34	1413.51	387.63	0.53

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	12765.83	2-yr	1873	577.39	582.98	582.2	583.97	0.008484	7.98	234.57	62.98	0.73
R1	12580.68	2-yr	1873	575.55	580.36	580.36	581.71	0.018149	9.34	200.49	75.47	1.01
R1	12356.76	2-yr	1873	572.1	577.33		578.02	0.005713	6.69	279.89	74.35	0.61
R1	12227.77	2-yr	1873	570.86	576.27		577.16	0.007527	7.57	247.57	67.02	0.69
R1	12086.97	2-yr	1873	570.23	574.48	574.27	575.73	0.013494	8.98	208.55	68.46	0.91
R1	11932.32	2-yr	1873	568.3	572.15	572.15	573.27	0.018455	8.48	220.92	100.89	1.01
R1	11776.42	2-yr	1873	565.91	570		570.61	0.01166	6.27	298.75	151.04	0.79
R1	11649.21	2-yr	1873	563.48	568.87		569.37	0.007839	5.69	329.25	143.1	0.66
R1	11571.82	2-yr	1873	563.03	568.34		568.77	0.007165	5.24	357.39	164.75	0.63
R1	11431.39	2-yr	1873	561.38	567.05		567.58	0.009895	5.85	320.08	159.34	0.73
R1	11320.55	2-yr	1873	561.37	565.28	565.27	566.03	0.020399	6.98	268.48	177.03	1
R1	11207.04	2-yr	1873	560.08	564.02		564.37	0.009682	4.73	396.11	267.69	0.69
R1	11107.1	2-yr	1873	558.1	563.35		563.59	0.005985	3.88	483.27	305.73	0.54
R1	10994.87	2-yr	1873	557.14	562.28		562.66	0.011757	4.95	378.22	274.26	0.74
R1	10890.11	2-yr	1873	556.44	560.99		561.34	0.013381	4.74	394.77	337.43	0.77
R1	10792.66	2-yr	1873	554.98	559.65		560.16	0.010674	5.75	337.56	219.19	0.74
R1	10714.72	2-yr	1873	554.92	559.04		559.42	0.007753	4.94	381.29	220.71	0.64
R1	10660.02	2-yr	1950	554.6	558.69		559.03	0.006122	4.72	414.96	202.96	0.58
R1	10556.28	2-yr	1950	553.07	557.78		558.23	0.0096	5.55	374.26	246.25	0.71
R1	10452.24	2-yr	1950	552.73	557.01		557.35	0.007115	4.9	439.46	325.26	0.61
R1	10380.99	2-yr	1950	552.72	556.4		556.8	0.009218	5.22	415.31	343.14	0.69
R1	10318.08	2-yr	1950	551.11	555.62	555.43	556.11	0.012881	5.77	364.11	306.07	0.8
R1	10205.48	2-yr	1950	550.62	554.88		555.17	0.005473	4.38	472.87	315.15	0.54
R1	10070.55	2-yr	1950	547.45	553.94		554.4	0.005774	5.52	369.53	189.12	0.58
R1	9963.673	2-yr	1950	547.86	552.45	552.01	553.51	0.011131	8.28	240.92	110.87	0.82
R1	9885.528	2-yr	1950	547.29	551.78	551.78	552.6	0.010308	7.54	302.06	207.82	0.78
R1	9753.5	2-yr	1950	545.62	550.29	549.94	550.99	0.010106	6.99	307.09	167.87	0.76
R1	9604.528	2-yr	1950	544.44	549.43		549.8	0.005819	5.06	416.47	212.97	0.57
R1	9471.219	2-yr	1950	543.32	547.71	547.67	548.54	0.016736	7.56	272.57	162.99	0.94
R1	9351.691	2-yr	1950	542.64	546.95		547.32	0.005627	5.02	413.76	199.65	0.57
R1	9261.326	2-yr	1950	542.15	545.95		546.59	0.011021	6.44	302.64	141.41	0.78
R1	9197.721	2-yr	2028	541.07	545.6		546.06	0.005438	5.48	380	152.42	0.57
R1	9087.427	2-yr	2028	538.97	544.37		545.17	0.011952	7.2	281.57	116.06	0.81
R1	8990.195	2-yr	2028	538.2	543.59		544.17	0.007882	6.1	332.47	129.09	0.67
R1	8930.013	2-yr	2028	537.45	542.91		543.57	0.012387	6.55	311.8	160.23	0.8
R1	8851.071	2-yr	2028	537.61	542.36		542.78	0.006986	5.21	398.81	221.22	0.62
R1	8762.175	2-yr	2028	535.86	541.15	541.07	541.84	0.016589	6.78	311.7	224.25	0.91
R1	8647.803	2-yr	2028	534.83	539.86		540.3	0.009955	5.67	391.66	243.14	0.72
R1	8543.921	2-yr	2028	533.71	539.37		539.59	0.004086	4.14	571.71	357.69	0.48
R1	8334.452	2-yr	2028	531.65	537.07	537.07	537.99	0.020444	7.7	263.26	147.44	1.02
R1	8232.678	2-yr	2028	531.36	536.27		536.57	0.005109	4.42	458.54	212.12	0.53
R1	8135.866	2-yr	2028	531.13	534.96	534.96	535.64	0.021378	6.63	305.96	224.27	1
R1	7993.615	2-yr	2028	529.87	533.89		534.1	0.005166	3.8	571.44	401.84	0.51
R1	7768.966	2-yr	2028	526.3	531.48	531.48	532.22	0.016836	7.06	304.58	209.62	0.93
R1	7608.564	2-yr	2028	524.06	530.18		530.49	0.003304	4.6	458.37	159	0.45
R1	7509.6	2-yr	2028	523.79	528.67	528.67	529.8	0.015751	8.69	244.75	109.58	0.95
R1	7397.829	2-yr	2029	520.72	527.07	526.91	528.17	0.012972	8.52	249.11	104.72	0.88
R1	7340.715	2-yr	2029	521.79	526.38	525.97	527.48	0.011319	8.41	247.2	100.08	0.83
R1	7222.992	2-yr	2029	520.63	525.26		526.1	0.010551	8.05	291.29	129.14	0.8
R1	7079.519	2-yr	2029	518.55	524.51		524.99	0.005415	6.02	389.33	172.1	0.57
R1	6927.725	2-yr	2029	517.02	522.86	522.65	523.82	0.011998	8.24	269.48	119.41	0.83
R1	6743.053	2-yr	2029	515.38	521.14		521.93	0.008677	7.19	294.94	128.04	0.73
R1	6619.016	2-yr	2029	513.08	519.44	519.44	520.53	0.014442	8.56	252.24	120.6	0.91
R1	6424.089	2-yr	2094	511.9	517.96		518.5	0.004865	5.91	371.27	153.92	0.56
R1	6265.335	2-yr	2094	510.66	516.53	515.8	517.45	0.008672	7.77	286.34	147.71	0.74
R1	6172.454	2-yr	2094	509.95	515.91		516.56	0.008704	6.55	334.33	160.61	0.71
R1	6081.552	2-yr	2094	509.07	514.86	514.58	515.6	0.012753	6.91	304.23	151.68	0.83
R1	5902.723	2-yr	2094	504.84	512.68		513.44	0.01149	7.01	306.13	141.37	0.79

R1	5726.338	2-yr	2096	505.35	511.52		512.14	0.004867	6.35	346.69	145.42	0.57
R1	5585.48	2-yr	2096	503.89	509.94	509.53	511.06	0.01235	8.49	247.65	98.02	0.85
R1	5433.843	2-yr	2096	503.17	508.71		509.29	0.009175	6.09	344	151.45	0.71
R1	5298.779	2-yr	2096	502.13	507.6		508.19	0.007247	6.17	341.92	133.92	0.65
R1	5094.216	2-yr	2098	497.75	505.68		506.38	0.010973	6.69	313.44	135.42	0.78
R1	4967.422	2-yr	2098	498.33	504.22		504.98	0.011087	6.97	301.2	123.56	0.79
R1	4722.293	2-yr	2099	494.46	501.37		502.01	0.012879	6.43	326.24	170.7	0.82
R1	4616.473	2-yr	2099	494.57	500.96		501.31	0.003316	4.75	441.88	131.7	0.46
R1	4411.542	2-yr	2099	493.25	499.2	498.41	500.03	0.01393	7.3	287.41	130.33	0.87
R1	4301.064	2-yr	2099	492.19	497.94		498.67	0.010539	6.89	304.56	123.4	0.77
R1	4220.605	2-yr	2099	491.42	497.14		497.8	0.010662	6.5	322.99	145.18	0.77
R1	3993.016	2-yr	2099	487.7	495.58		495.95	0.005864	4.88	429.98	186.87	0.57
R1	3833.856	2-yr	2099	487.23	494.54		494.96	0.006469	5.23	401.33	170.53	0.6
R1	3742.142	2-yr	2099	487.15	493.88		494.35	0.006895	5.46	384.34	159.61	0.62
R1	3669.822	2-yr	2099	486.29	493.46		493.88	0.005621	5.22	402.01	154.35	0.57
R1	3595.137	2-yr	2099	486.09	492.4	492.25	493.2	0.015229	7.18	292.3	146.63	0.9
R1	3533.429	2-yr	2099	486.49	491.87		492.42	0.00871	5.97	351.55	154.37	0.7
R1	3404.836	2-yr	2111	484.78	491.31		491.67	0.003702	4.84	436.36	134.32	0.47
R1	3301.296	2-yr	2111	483.94	489.97		490.98	0.011434	8.08	261.37	87.71	0.82
R1	3225.048	2-yr	2111	483.12	489.77		490.27	0.005085	5.64	374.42	117.63	0.56
R1	3117.351	2-yr	2111	482.45	488.96	487.99	489.62	0.006812	6.52	323.73	100.77	0.64
R1	3034.507	2-yr	2111	482.04	487.26	487.26	488.69	0.017443	9.58	220.31	79.19	1.01
R1	2969.185	2-yr	2111	481.21	486.78		487.51	0.00664	6.89	306.37	87.25	0.65
R1	2912.532	2-yr	2111	480.68	485.4	485.39	486.88	0.0166	9.74	216.64	72.52	0.99
R1	2879.3	2-yr	2111	478.99	485.07	484.85	486.29	0.014348	8.88	237.82	80.5	0.91
R1	2845.687	2-yr	2111	479.99	484.74	484.5	485.76	0.013446	8.11	260.31	96.93	0.87
R1	2786.828	2-yr	2111	478.35	484.88		485.23	0.003095	4.74	445.47	123.69	0.44
R1	2736.954	2-yr	2111	478.83	483.63	483.5	484.85	0.015095	8.86	238.4	86.15	0.94
R1	2673.232	2-yr	2111	478.03	483.48		484.05	0.006495	6.11	345.72	116.23	0.62
R1	2592.947	2-yr	2111	476.42	482.89		483.59	0.004901	6.7	315.16	73.12	0.57
R1	2486.201	2-yr	2111	475.58	481.88	481.41	482.79	0.011841	7.68	274.81	101.95	0.82
R1	2377.306	2-yr	2111	474.53	480.41	480.31	481.3	0.015898	7.56	281.85	145.36	0.92
R1	2279.016	2-yr	2111	473.42	479.89		480.28	0.005639	5.07	428.06	206	0.56
R1	2175.085	2-yr	2111	472.81	479.25		479.62	0.007007	4.93	445.71	270.1	0.61
R1	2069.171	2-yr	2111	470	478.29	477.94	478.75	0.009627	5.54	411.6	320.1	0.71
R1	1949.069	2-yr	2111	471.73	476.96		477.51	0.010925	5.97	359.86	220.56	0.76
R1	1852.628	2-yr	2111	471.15	476.63		476.86	0.003539	3.95	563.48	265.67	0.45
R1	1676.374	2-yr	2111	468.84	475.49		475.96	0.007578	5.49	388.1	186.35	0.65
R1	1572.411	2-yr	2156	471.5	474.75		475.1	0.008352	4.69	459.84	282.7	0.65
R1	1466.798	2-yr	2156	470.77	473.58		474.01	0.012702	5.29	407.78	286.16	0.78
R1	1345.433	2-yr	2156	469.49	472.53		472.79	0.007529	4.09	526.66	366.54	0.6
R1	1202.862	2-yr	2156	468.71	471.72		471.92	0.004888	3.56	606.28	377.5	0.49
R1	1044.417	2-yr	2156	466.25	470.9		471.14	0.004947	3.92	550.43	298.57	0.51
R1	850.8181	2-yr	2156	465.61	469.7		470.05	0.006264	4.77	451.59	217.39	0.58
R1	704.5021	2-yr	2156	464.07	468.83		469.18	0.005591	4.76	453.21	200.75	0.56
R1	513.2567	2-yr	2179	464.01	467.59		467.93	0.00778	4.65	468.35	275.64	0.63
R1	297.6275	2-yr	2179	463.08	466.49	465.59	466.72	0.004007	3.83	568.85	272.89	0.47

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	12765.83	1.3-yr	1087	577.39	581.96	581.2	582.58	0.007474	6.32	171.94	60.1	0.66
R1	12580.68	1.3-yr	1087	575.55	579.36	579.36	580.42	0.019669	8.23	132.14	64.4	1.01
R1	12356.76	1.3-yr	1087	572.1	576.1		576.6	0.006188	5.67	191.66	69.78	0.6
R1	12227.77	1.3-yr	1087	570.86	575.12		575.73	0.007222	6.25	173.93	61.14	0.65
R1	12086.97	1.3-yr	1087	570.23	573.55		574.39	0.012513	7.35	147.99	62.29	0.84
R1	11932.32	1.3-yr	1087	568.3	571.29	571.2	572.16	0.016805	7.48	145.31	74.6	0.94
R1	11776.42	1.3-yr	1087	565.91	569.35		569.79	0.012459	5.32	204.42	139.06	0.77
R1	11649.21	1.3-yr	1087	563.48	568.23		568.55	0.007362	4.54	239.57	139.68	0.61
R1	11571.82	1.3-yr	1087	563.03	567.26		567.76	0.01436	5.66	191.9	132.67	0.83
R1	11431.39	1.3-yr	1087	561.38	565.89		566.38	0.007149	5.6	194.09	80.51	0.64
R1	11320.55	1.3-yr	1087	561.37	564.74		565.27	0.014608	5.87	185.3	123.36	0.84
R1	11207.04	1.3-yr	1087	560.08	563.54		563.79	0.010508	4.01	270.85	248.92	0.68
R1	11107.1	1.3-yr	1087	558.1	562.79		562.97	0.006303	3.39	320.81	257.89	0.54
R1	10994.87	1.3-yr	1087	557.14	561.9		562.14	0.008785	3.89	279.52	233.86	0.63
R1	10890.11	1.3-yr	1087	556.44	560.49	560.38	560.82	0.019087	4.64	234.38	270.35	0.88
R1	10792.66	1.3-yr	1087	554.98	559.15		559.49	0.010307	4.64	235.5	186.53	0.7
R1	10714.72	1.3-yr	1087	554.92	558.43		558.71	0.009268	4.24	256.67	198.7	0.66
R1	10660.02	1.3-yr	1121	554.6	557.96		558.23	0.008115	4.14	270.66	194.79	0.62
R1	10556.28	1.3-yr	1121	553.07	557.12		557.45	0.006801	4.66	244.7	148.15	0.59
R1	10452.24	1.3-yr	1121	552.73	556.49		556.73	0.006625	3.95	298.76	235.33	0.57
R1	10380.99	1.3-yr	1121	552.72	555.89		556.18	0.00905	4.38	267.8	240.23	0.65
R1	10318.08	1.3-yr	1121	551.11	555.16		555.5	0.012939	4.78	241.65	230.46	0.76
R1	10205.48	1.3-yr	1121	550.62	554.11		554.37	0.007755	4.09	274.51	203.47	0.6
R1	10070.55	1.3-yr	1121	547.45	552.79		553.23	0.008934	5.32	210.67	110.48	0.68
R1	9963.673	1.3-yr	1121	547.86	551.58		552.24	0.009206	6.49	172.75	68.61	0.72
R1	9885.528	1.3-yr	1121	547.29	550.65		551.43	0.011191	7.11	158.04	67.65	0.79
R1	9753.5	1.3-yr	1121	545.62	549.65		550.08	0.008061	5.46	217.25	117.93	0.66
R1	9604.528	1.3-yr	1121	544.44	548.7		548.98	0.00645	4.37	268.51	172.92	0.57
R1	9471.219	1.3-yr	1121	543.32	547.13	547.01	547.7	0.015288	6.18	189.51	134.18	0.87
R1	9351.691	1.3-yr	1121	542.64	546.18		546.48	0.00647	4.44	265.77	181.78	0.58
R1	9261.326	1.3-yr	1121	542.15	545.12		545.64	0.013587	5.77	194.25	125.4	0.82
R1	9197.721	1.3-yr	1172	541.07	544.77		545.08	0.005095	4.47	262.78	124.5	0.53
R1	9087.427	1.3-yr	1172	538.97	543.5	543.35	544.13	0.015749	6.41	182.84	110.72	0.88
R1	8990.195	1.3-yr	1172	538.2	542.56		543.03	0.007943	5.53	212.04	95.58	0.65
R1	8930.013	1.3-yr	1172	537.45	542.09		542.57	0.007231	5.57	210.47	85.84	0.63
R1	8851.071	1.3-yr	1172	537.61	541.72		542	0.00595	4.23	277.63	156.08	0.55
R1	8762.175	1.3-yr	1172	535.86	540.45	540.39	541.1	0.018453	6.48	183.76	135.33	0.94
R1	8647.803	1.3-yr	1172	534.83	539.1		539.54	0.009702	5.59	236.48	172.98	0.71
R1	8543.921	1.3-yr	1172	533.71	538.58		538.83	0.00434	4.11	316.38	251.66	0.49
R1	8334.452	1.3-yr	1172	531.65	536.29	536.29	537.07	0.021826	7.08	165.58	110.33	1.02
R1	8232.678	1.3-yr	1172	531.36	535.62		535.83	0.005294	3.62	323.5	206.51	0.51
R1	8135.866	1.3-yr	1172	531.13	534.43	534.3	534.94	0.017681	5.73	204.4	161.07	0.9
R1	7993.615	1.3-yr	1172	529.87	533.3		533.47	0.00589	3.48	363.65	316.91	0.53
R1	7768.966	1.3-yr	1172	526.3	530.22	530.22	531.29	0.018205	8.28	142.81	71.93	0.99
R1	7608.564	1.3-yr	1172	524.06	529.14		529.37	0.003035	3.93	307.95	125.06	0.42
R1	7509.6	1.3-yr	1172	523.79	527.82	527.82	528.71	0.017376	7.65	157.49	90.06	0.96
R1	7397.829	1.3-yr	1173	520.72	525.97	525.61	526.84	0.012033	7.49	157.15	66.34	0.82
R1	7340.715	1.3-yr	1173	521.79	525.56		526.21	0.008207	6.47	181.25	66.82	0.69
R1	7222.992	1.3-yr	1173	520.63	524.41		525.1	0.010864	7.12	189.15	111.03	0.79
R1	7079.519	1.3-yr	1173	518.55	523.5		523.9	0.006099	5.3	237.75	115.33	0.58
R1	6927.725	1.3-yr	1173	517.02	521.74	521.56	522.6	0.012702	7.61	163.86	77.8	0.84
R1	6743.053	1.3-yr	1173	515.38	520.25		520.79	0.007216	5.9	198.69	78.14	0.64
R1	6619.016	1.3-yr	1173	513.08	518.44	518.44	519.39	0.01851	7.86	152.09	84.72	0.98
R1	6424.089	1.3-yr	1223	511.9	516.77		517.19	0.006148	5.19	239.08	104.05	0.59
R1	6265.335	1.3-yr	1223	510.66	515.31		516.02	0.008407	6.79	180.13	62.52	0.7
R1	6172.454	1.3-yr	1223	509.95	514.63		515.26	0.007519	6.39	191.38	67.01	0.67
R1	6081.552	1.3-yr	1223	509.07	513.28	513.12	514.29	0.014983	8.05	151.99	62.54	0.91
R1	5902.723	1.3-yr	1223	504.84	511.27		512.07	0.009933	7.18	170.41	59.69	0.75

R1	5726.338	1.3-yr	1224	505.35	510.37		510.79	0.004695	5.25	233.18	77.42	0.53
R1	5585.48	1.3-yr	1224	503.89	508.76	508.57	509.67	0.014566	7.64	160.22	69.4	0.89
R1	5433.843	1.3-yr	1224	503.17	507.66		508.14	0.006378	5.58	219.18	83.29	0.61
R1	5298.779	1.3-yr	1224	502.13	506.66		507.11	0.00883	5.39	227.23	116.93	0.68
R1	5094.216	1.3-yr	1226	497.75	504.49		505.16	0.010128	6.56	186.82	77.09	0.74
R1	4967.422	1.3-yr	1226	498.33	503.56		504.01	0.007303	5.35	229.25	102.06	0.63
R1	4722.293	1.3-yr	1226	494.46	500.38	500.38	501.15	0.020647	7.06	173.65	112.28	1
R1	4616.473	1.3-yr	1226	494.57	499.74		500.02	0.004598	4.31	284.45	125.86	0.51
R1	4411.542	1.3-yr	1226	493.25	497.85		498.65	0.009773	7.15	171.46	60.51	0.75
R1	4301.064	1.3-yr	1226	492.19	497		497.55	0.008718	5.95	205.99	90.17	0.69
R1	4220.605	1.3-yr	1226	491.42	496.43		496.86	0.007695	5.22	234.79	114.58	0.64
R1	3993.016	1.3-yr	1226	487.7	494.53		494.92	0.009321	5.02	244.17	143.62	0.68
R1	3833.856	1.3-yr	1226	487.23	493.42		493.79	0.005539	4.89	250.93	104.65	0.56
R1	3742.142	1.3-yr	1226	487.15	492.8		493.21	0.007204	5.17	237.18	110.08	0.62
R1	3669.822	1.3-yr	1226	486.29	492.33		492.7	0.006619	4.87	251.55	121.09	0.6
R1	3595.137	1.3-yr	1226	486.09	491.35		492.07	0.00966	6.81	179.92	68.57	0.74
R1	3533.429	1.3-yr	1226	486.49	490.89		491.38	0.010363	5.64	217.34	118.33	0.73
R1	3404.836	1.3-yr	1233	484.78	490.15		490.44	0.00491	4.34	283.93	127.68	0.51
R1	3301.296	1.3-yr	1233	483.94	488.79		489.62	0.012618	7.29	169.25	71.57	0.83
R1	3225.048	1.3-yr	1233	483.12	488.57		488.94	0.004514	4.87	253.13	90.5	0.51
R1	3117.351	1.3-yr	1233	482.45	487.78		488.3	0.007626	5.8	212.62	86.02	0.65
R1	3034.507	1.3-yr	1233	482.04	486.16	486.16	487.31	0.01822	8.6	143.38	62.63	1
R1	2969.185	1.3-yr	1233	481.21	485.57		486.13	0.007592	5.99	205.91	80.27	0.66
R1	2912.532	1.3-yr	1233	480.68	484.69		485.55	0.013022	7.42	166.24	70.17	0.85
R1	2879.3	1.3-yr	1233	478.99	484.43	483.98	485.11	0.010498	6.58	187.25	78.83	0.75
R1	2845.687	1.3-yr	1233	479.99	483.71	483.71	484.61	0.020464	7.58	162.69	92.42	1.01
R1	2786.828	1.3-yr	1233	478.35	483.76		483.99	0.002956	3.91	315.47	113.54	0.41
R1	2736.954	1.3-yr	1233	478.83	482.63	482.63	483.61	0.019713	7.95	155.16	80.85	1.01
R1	2673.232	1.3-yr	1233	478.03	482.16		482.7	0.008369	5.91	208.55	89.37	0.68
R1	2592.947	1.3-yr	1233	476.42	481.77		482.2	0.004256	5.27	234.05	70.83	0.51
R1	2486.201	1.3-yr	1233	475.58	480.89		481.55	0.008589	6.51	189.28	70.37	0.7
R1	2377.306	1.3-yr	1233	474.53	479.77		480.38	0.013456	6.28	196.4	108.95	0.82
R1	2279.016	1.3-yr	1233	473.42	479.3		479.53	0.004722	3.92	315.69	174.6	0.5
R1	2175.085	1.3-yr	1233	472.81	478.64		478.92	0.007639	4.2	295.92	217.61	0.61
R1	2069.171	1.3-yr	1233	470	477.48	476.88	477.94	0.010972	5.41	227.71	136.02	0.74
R1	1949.069	1.3-yr	1233	471.73	476.22		476.66	0.010216	5.33	231.25	134.09	0.72
R1	1852.628	1.3-yr	1233	471.15	475.84		476.02	0.003774	3.45	369.5	212.01	0.44
R1	1676.374	1.3-yr	1233	468.84	474.87		475.17	0.006212	4.39	281.29	153.76	0.57
R1	1572.411	1.3-yr	1258	471.5	474.17		474.43	0.007868	4.02	312.88	231.61	0.61
R1	1466.798	1.3-yr	1258	470.77	473.15		473.43	0.011204	4.28	293.8	257.57	0.71
R1	1345.433	1.3-yr	1258	469.49	472.05		472.24	0.008415	3.53	356.73	337.82	0.6
R1	1202.862	1.3-yr	1258	468.71	471.04		471.22	0.006165	3.37	373.55	300.43	0.53
R1	1044.417	1.3-yr	1258	466.25	470.19		470.38	0.00459	3.43	366.4	228.33	0.48
R1	850.8181	1.3-yr	1258	465.61	469.05		469.3	0.006801	4.01	313.52	208.44	0.58
R1	704.5021	1.3-yr	1258	464.07	468.22		468.44	0.005013	3.78	332.55	191.47	0.51
R1	513.2567	1.3-yr	1269	464.01	466.98		467.24	0.008127	4.08	311.13	230.51	0.62
R1	297.6275	1.3-yr	1269	463.08	465.86	465.11	466.02	0.004	3.16	401.42	256.58	0.45

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	12765.83	875 cfs	875	577.39	581.62		582.13	0.007179	5.77	151.6	59.13	0.64
R1	12580.68	875 cfs	875	575.55	579.06	579.06	579.99	0.020487	7.76	112.73	62.03	1.01
R1	12356.76	875 cfs	875	572.1	575.7		576.14	0.006509	5.33	164.03	68.17	0.61
R1	12227.77	875 cfs	875	570.86	574.71		575.25	0.007287	5.85	149.48	58.47	0.65
R1	12086.97	875 cfs	875	570.23	573.33	572.93	573.99	0.010899	6.53	134.01	60.74	0.77
R1	11932.32	875 cfs	875	568.3	570.88	570.88	571.76	0.019611	7.52	116.4	66.62	1
R1	11776.42	875 cfs	875	565.91	568.95		569.42	0.010424	5.49	159.52	90.17	0.73
R1	11649.21	875 cfs	875	563.48	567.94		568.24	0.007654	4.38	199.97	126.75	0.61
R1	11571.82	875 cfs	875	563.03	566.78	566.32	567.4	0.015004	6.33	138.21	83.31	0.87
R1	11431.39	875 cfs	875	561.38	565.53		565.96	0.006948	5.26	166.43	74.28	0.62
R1	11320.55	875 cfs	875	561.37	564.51		564.97	0.011637	5.49	159.36	98.79	0.76
R1	11207.04	875 cfs	875	560.08	563.32		563.57	0.011906	3.99	219.16	222.86	0.71
R1	11107.1	875 cfs	875	558.1	562.54		562.72	0.006172	3.34	262.04	211.67	0.53
R1	10994.87	875 cfs	875	557.14	561.72		561.92	0.008051	3.65	239.99	206.94	0.6
R1	10890.11	875 cfs	875	556.44	560.19	560.09	560.62	0.02066	5.26	166.37	167.96	0.93
R1	10792.66	875 cfs	875	554.98	559		559.27	0.009381	4.2	208.16	163.26	0.66
R1	10714.72	875 cfs	875	554.92	558.19		558.46	0.011607	4.17	209.64	195.81	0.71
R1	10660.02	875 cfs	875	554.6	557.64		557.9	0.008942	4.15	210.92	162.5	0.64
R1	10556.28	875 cfs	875	553.07	556.89		557.16	0.00591	4.12	213.69	130.62	0.55
R1	10452.24	875 cfs	875	552.73	556.27		556.47	0.006997	3.71	246.5	220.42	0.57
R1	10380.99	875 cfs	875	552.72	555.64		555.91	0.008932	4.19	213.76	188.97	0.64
R1	10318.08	875 cfs	875	551.11	554.91		555.24	0.012864	4.64	191.48	180.33	0.75
R1	10205.48	875 cfs	875	550.62	553.77		554.03	0.008666	4.1	213.51	162.05	0.63
R1	10070.55	875 cfs	875	547.45	552.35		552.78	0.009639	5.28	165.81	93.12	0.7
R1	9963.673	875 cfs	875	547.86	551.18		551.74	0.009652	6.02	145.26	67	0.72
R1	9885.528	875 cfs	875	547.29	550.36		550.97	0.009991	6.28	139.43	62.16	0.74
R1	9753.5	875 cfs	875	545.62	549.37		549.74	0.007774	4.99	185.19	113.14	0.64
R1	9604.528	875 cfs	875	544.44	548.39		548.65	0.006649	4.15	218.6	150.98	0.57
R1	9471.219	875 cfs	875	543.32	546.82		547.37	0.014568	6.04	151.98	112.53	0.85
R1	9351.691	875 cfs	875	542.64	545.96		546.2	0.006057	4	226.54	168.82	0.55
R1	9261.326	875 cfs	875	542.15	544.76	544.68	545.29	0.01839	5.81	150.64	120.89	0.92
R1	9197.721	875 cfs	875	541.07	544.42		544.66	0.004912	3.97	220.66	115.79	0.51
R1	9087.427	875 cfs	875	538.97	543.09	542.98	543.7	0.017688	6.25	139.94	95.84	0.91
R1	8990.195	875 cfs	875	538.2	542.02		542.47	0.008887	5.34	163.81	84.5	0.68
R1	8930.013	875 cfs	875	537.45	541.63		542.02	0.005826	4.99	175.48	71.58	0.56
R1	8851.071	875 cfs	875	537.61	541.26		541.52	0.005957	4.09	213.98	123.28	0.55
R1	8762.175	875 cfs	875	535.86	540.19	539.9	540.71	0.014145	5.82	151.53	106.39	0.83
R1	8647.803	875 cfs	875	534.83	538.65	538.53	539.16	0.012946	5.86	164.12	147.04	0.8
R1	8543.921	875 cfs	875	533.71	538.11		538.35	0.004336	3.95	228.17	136.79	0.48
R1	8334.452	875 cfs	875	531.65	535.91	535.89	536.62	0.020166	6.76	129.36	86.68	0.98
R1	8232.678	875 cfs	875	531.36	535.29		535.47	0.005712	3.4	256.99	190.67	0.52
R1	8135.866	875 cfs	875	531.13	534.24		534.63	0.01411	4.99	175.35	143.59	0.8
R1	7993.615	875 cfs	875	529.87	533		533.17	0.007	3.45	274.02	282.01	0.56
R1	7768.966	875 cfs	875	526.3	529.61	529.61	530.67	0.019147	8.3	105.47	49.67	1
R1	7608.564	875 cfs	875	524.06	528.57		528.77	0.002596	3.68	244.37	98.42	0.39
R1	7509.6	875 cfs	875	523.79	527.06	527.06	528.14	0.018353	8.35	105.15	51.95	1
R1	7397.829	875 cfs	875	520.72	525.54		526.23	0.01125	6.69	130.89	57.55	0.78
R1	7340.715	875 cfs	875	521.79	525.19		525.67	0.006897	5.57	157.04	63.68	0.63
R1	7222.992	875 cfs	875	520.63	524.02	523.86	524.64	0.011021	6.65	147.56	98.27	0.78
R1	7079.519	875 cfs	875	518.55	523.04		523.39	0.006549	4.91	188.21	101.86	0.59
R1	6927.725	875 cfs	875	517.02	521.35	521.14	522.05	0.012361	6.87	134.03	72.48	0.81
R1	6743.053	875 cfs	875	515.38	519.7		520.18	0.008017	5.52	158.38	72.73	0.66
R1	6619.016	875 cfs	875	513.08	517.84	517.47	518.8	0.015239	7.85	111.53	47.4	0.9
R1	6424.089	875 cfs	875	511.9	516.19		516.56	0.007763	4.93	179.49	100.25	0.64
R1	6265.335	875 cfs	875	510.66	514.73		515.29	0.007968	6.02	145.43	58.22	0.67
R1	6172.454	875 cfs	875	509.95	514.08		514.57	0.007153	5.62	155.69	63.78	0.63
R1	6081.552	875 cfs	875	509.07	512.71	512.62	513.58	0.016969	7.46	117.26	59.54	0.94
R1	5902.723	875 cfs	875	504.84	510.69		511.31	0.009269	6.35	137.72	55.07	0.71

R1	5726.338	875 cfs	875	505.35	509.81		510.13	0.004413	4.58	190.89	74.27	0.5
R1	5585.48	875 cfs	875	503.89	508.22	508.09	509	0.016808	7.08	123.53	66.99	0.92
R1	5433.843	875 cfs	875	503.17	507.03		507.43	0.006208	5.09	171.84	73.62	0.59
R1	5298.779	875 cfs	875	502.13	505.89	505.46	506.39	0.009672	5.68	153.96	78.1	0.71
R1	5094.216	875 cfs	875	497.75	504.02		504.53	0.008553	5.72	153.01	68.13	0.67
R1	4967.422	875 cfs	875	498.33	503.06		503.43	0.008127	4.9	178.5	98.29	0.64
R1	4722.293	875 cfs	875	494.46	499.35	499.35	500.45	0.01899	8.41	104.04	47.98	1.01
R1	4616.473	875 cfs	875	494.57	498.8		499.14	0.00581	4.68	186.77	86.85	0.56
R1	4411.542	875 cfs	875	493.25	497.13		497.79	0.007191	6.53	134.09	42.88	0.65
R1	4301.064	875 cfs	875	492.19	496.43		496.9	0.007835	5.52	158.5	71.68	0.65
R1	4220.605	875 cfs	875	491.42	495.91		496.27	0.007089	4.81	181.98	94.42	0.61
R1	3993.016	875 cfs	875	487.7	493.89		494.31	0.010483	5.21	168.05	101.61	0.71
R1	3833.856	875 cfs	875	487.23	492.69		493.05	0.006061	4.81	181.8	82.91	0.57
R1	3742.142	875 cfs	875	487.15	491.97		492.41	0.007876	5.3	164.99	78.59	0.64
R1	3669.822	875 cfs	875	486.29	491.45		491.86	0.007067	5.13	170.52	79.52	0.62
R1	3595.137	875 cfs	875	486.09	490.68		491.29	0.007791	6.25	140.02	51.55	0.67
R1	3533.429	875 cfs	875	486.49	490.32		490.76	0.007609	5.33	164.23	77.04	0.64
R1	3404.836	875 cfs	875	484.78	489.64		489.88	0.005486	3.98	219.8	122.57	0.52
R1	3301.296	875 cfs	875	483.94	488.12	488.02	488.91	0.01685	7.13	122.8	66.95	0.93
R1	3225.048	875 cfs	875	483.12	487.79		488.12	0.00517	4.65	188.36	80.2	0.53
R1	3117.351	875 cfs	875	482.45	487.01		487.49	0.006363	5.58	156.84	58.38	0.6
R1	3034.507	875 cfs	875	482.04	485.64	485.64	486.59	0.019356	7.84	111.61	58.69	1
R1	2969.185	875 cfs	875	481.21	485.02		485.47	0.007994	5.38	162.54	77.42	0.65
R1	2912.532	875 cfs	875	480.68	484.3		484.92	0.011586	6.3	138.97	68.91	0.78
R1	2879.3	875 cfs	875	478.99	484.06	483.52	484.54	0.009152	5.54	157.84	77.8	0.69
R1	2845.687	875 cfs	875	479.99	483.34	483.34	484.06	0.02168	6.78	128.98	90.52	1
R1	2786.828	875 cfs	875	478.35	483.21		483.39	0.003033	3.45	253.38	112.39	0.41
R1	2736.954	875 cfs	875	478.83	482.24	482.21	483.02	0.020464	7.09	123.4	78.59	1
R1	2673.232	875 cfs	875	478.03	481.53		482.03	0.01038	5.66	154.56	83.32	0.73
R1	2592.947	875 cfs	875	476.42	481.16		481.49	0.004045	4.57	191.45	69.42	0.49
R1	2486.201	875 cfs	875	475.58	480.35		480.86	0.008397	5.75	152.09	67.2	0.67
R1	2377.306	875 cfs	875	474.53	479.28		479.81	0.011308	5.81	150.72	82.17	0.76
R1	2279.016	875 cfs	875	473.42	478.87		479.06	0.004273	3.51	249.42	140.32	0.46
R1	2175.085	875 cfs	875	472.81	478.12		478.41	0.009614	4.37	200.22	150.56	0.67
R1	2069.171	875 cfs	875	470	476.99	475.94	477.4	0.009352	5.13	170.51	97.42	0.68
R1	1949.069	875 cfs	875	471.73	475.49		476.03	0.013912	5.86	149.33	94.58	0.82
R1	1852.628	875 cfs	875	471.15	475.23		475.41	0.002754	3.4	268.68	135.52	0.39
R1	1676.374	875 cfs	875	468.84	474.54		474.76	0.005138	3.74	233.81	139.63	0.51
R1	1572.411	875 cfs	875	471.5	473.9		474.09	0.008	3.51	249.07	228.63	0.59
R1	1466.798	875 cfs	875	470.77	472.95		473.15	0.009969	3.61	242.5	251.81	0.65
R1	1345.433	875 cfs	875	469.49	471.8	471.54	471.96	0.009453	3.19	273.92	328.46	0.62
R1	1202.862	875 cfs	875	468.71	470.67		470.83	0.006789	3.22	271.75	251.34	0.55
R1	1044.417	875 cfs	875	466.25	469.83		469.97	0.004378	3.04	287.46	207.03	0.46
R1	850.8181	875 cfs	875	465.61	468.69		468.89	0.007234	3.65	239.93	192.83	0.58
R1	704.5021	875 cfs	875	464.07	467.85		468.02	0.004897	3.32	263.45	181.16	0.49
R1	513.2567	875 cfs	875	464.01	466.64		466.85	0.007925	3.68	237.72	201.59	0.6
R1	297.6275	875 cfs	875	463.08	465.53	464.8	465.65	0.004001	2.75	317.91	250.22	0.43

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	12446.45	100-yr	6917	577.39	586.54	586.54	589.79	0.013743	14.46	478.28	73.91	1
R1	12261.31	100-yr	6917	575.55	584.09	584.09	587.01	0.014218	13.72	504.11	86.97	1
R1	12037.38	100-yr	6917	572.1	582.08		583.76	0.005588	10.4	664.93	86.7	0.66
R1	11908.4	100-yr	6917	570.86	579.82	579.6	582.62	0.012292	13.43	515.13	84.14	0.96
R1	11767.6	100-yr	6917	570.23	578.76	578.76	580.82	0.010179	11.75	641.47	173.01	0.87
R1	11612.94	100-yr	6917	568.3	575.5	575.5	577.42	0.011389	11.23	649.89	194.17	0.9
R1	11457.05	100-yr	6917	565.91	572.43	572.01	573.82	0.011055	9.45	733.19	208.84	0.85
R1	11329.84	100-yr	6917	563.48	571.22	570.79	572.38	0.010506	8.66	808.18	256.3	0.82
R1	11252.45	100-yr	6917	563.03	570.4	570.06	571.54	0.011082	8.61	817.31	274.26	0.84
R1	11112.01	100-yr	6917	561.38	569.17	568.81	570.03	0.009191	7.69	977.59	392.83	0.76
R1	11001.18	100-yr	6917	561.37	567.54	567.54	568.77	0.013895	8.96	804.53	384.14	0.92
R1	10887.67	100-yr	6917	560.08	565.82		566.74	0.009653	7.73	895.25	288.54	0.77
R1	10787.72	100-yr	6917	558.1	565.28		565.91	0.005917	6.36	1092.49	337.23	0.61
R1	10675.5	100-yr	6917	557.14	563.63	563.55	564.82	0.016365	8.74	791.87	313.72	0.97
R1	10570.73	100-yr	6917	556.44	562.93		563.59	0.006983	6.54	1066.75	358.75	0.66
R1	10473.29	100-yr	6917	554.98	561.64	561.39	562.69	0.010069	8.65	885.58	333.54	0.81
R1	10398.21	100-yr	6917	554.92	560.5	560.5	561.78	0.013142	9.39	803.3	329.87	0.91
R1	10341.99	100-yr	7328	549.57	557.05	557.05	558.44	0.009058	11.92	876.24	284.13	0.83
R1	10251.58	100-yr	7328	548.65	555.87	555.87	557.45	0.010445	12.46	796.44	230.84	0.89
R1	10148.48	100-yr	7328	547.63	554.93	554.93	556.42	0.01025	12.42	822.07	246.01	0.88
R1	10078.27	100-yr	7328	546.91	554.37	554.37	555.83	0.009663	12.3	845.62	256.83	0.86
R1	10021.56	100-yr	7328	546.33	553.78	553.78	555.2	0.009527	12.19	863.83	269.13	0.85
R1	9931.735	100-yr	7328	545.37	552.91	552.91	554.34	0.009425	12.22	860.55	265.83	0.85
R1	9806.59	100-yr	7328	544.04	552.13		553.46	0.008139	11.86	856.74	224.13	0.79
R1	9698.614	100-yr	7328	542.99	552.22		552.84	0.00282	7.82	1229.39	243.05	0.48
R1	9620.242	100-yr	7328	542.2	550.49	550.49	552.33	0.009491	13.21	762.31	202.41	0.87
R1	9488.005	100-yr	7328	540.86	548.37	548.37	550.07	0.010433	12.84	766.53	208.11	0.89
R1	9341.323	100-yr	7328	539.37	548.3		549.12	0.0039	8.97	1079.98	230.63	0.56
R1	9210.197	100-yr	7328	538.03	546.38	546.38	548.28	0.00937	13.23	747.86	194.69	0.87
R1	9086.38	100-yr	7328	536.8	545.12	545.12	547.04	0.009506	13.26	733.64	186.21	0.87
R1	8987.736	100-yr	7328	535.82	545.31		546.2	0.003832	9.29	1034.1	203.62	0.57
R1	8918.236	100-yr	7700	535.09	545.02		545.97	0.003697	9.46	1060.64	198.59	0.56
R1	8863.458	100-yr	7700	534.5	543.47	543.47	545.5	0.009351	13.83	752.56	180.58	0.87
R1	8767.651	100-yr	7700	533.5	542.77		544.03	0.005326	10.8	927.92	192.21	0.67
R1	8704.892	100-yr	7700	532.87	542.89		543.64	0.002955	8.51	1171.02	210.52	0.5
R1	8614.742	100-yr	7700	531.92	541.11	541.11	543.11	0.008442	13.48	770.67	181.02	0.84
R1	8523.51	100-yr	7706	531	539.11	539.11	541.02	0.009779	13.21	761.11	185.41	0.88
R1	8412.757	100-yr	7706	529.86	537.72	537.72	539.58	0.010424	13.29	764.83	192.68	0.9
R1	8310.911	100-yr	7706	528.83	536.61	536.61	538.35	0.010202	13.04	796.42	210.49	0.89
R1	8122.83	100-yr	7706	526.97	535.08	535.08	536.75	0.008981	12.67	839.62	229.6	0.85
R1	8018.276	100-yr	7706	525.93	533.71	533.71	535.28	0.009549	12.62	855.45	244.99	0.86
R1	7922.666	100-yr	7706	524.97	532.68	532.68	534.23	0.009694	12.61	859.09	249.24	0.87
R1	7787.34	100-yr	7706	523.62	531.07	531.07	532.5	0.009994	12.44	893.6	280.09	0.87
R1	7584.847	100-yr	7706	521.57	529.45	529.45	530.88	0.008896	12.29	915.61	280.72	0.83
R1	7440.574	100-yr	7706	520.11	528.03		529.36	0.00792	11.64	906.85	237.88	0.79
R1	7348.037	100-yr	7706	519.19	527.82		528.71	0.004504	9.38	1075.9	230.52	0.6
R1	7248.13	100-yr	7736	518.21	526.37	526.37	528.03	0.009087	12.75	829.04	216.8	0.85
R1	7190.396	100-yr	7736	517.65	525.15	525.15	526.78	0.010546	12.86	820.18	227.09	0.9
R1	7070.673	100-yr	7736	516.45	523.53	523.53	524.92	0.011127	12.51	884.69	281.35	0.9
R1	6939.061	100-yr	7736	515.13	522.3	522.2	523.36	0.010182	11.84	1019.5	375.68	0.85
R1	6805.899	100-yr	7736	513.77	522.4		522.71	0.001717	5.81	1834.18	418.62	0.37
R1	6643.495	100-yr	7736	512.12	522.22		522.48	0.001123	5.29	2011.12	386.99	0.31
R1	6519.437	100-yr	7736	510.9	521.97	519.45	522.34	0.001407	6.33	1734.45	373.13	0.35
R1	6370		Bridge									
R1	6310.77	100-yr	8027	508.85	517.18	517.18	519.03	0.009825	13.44	811.23	203.72	0.88
R1	6164.775	100-yr	8027	507.39	516.37		517.41	0.004939	10.13	1055.86	227.87	0.64
R1	6073.736	100-yr	8027	506.49	515.03	514.77	516.73	0.008315	12.65	841.7	200.69	0.82
R1	5983.042	100-yr	8027	505.6	513.89	513.89	515.86	0.009931	13.53	780.58	189.67	0.89

R1	5809.553	100-yr	8027	503.88	512.02	512.02	513.95	0.010251	13.55	789.01	196.89	0.9
R1	5645.796	100-yr	8059	502.25	510.33		511.82	0.008311	12.12	890.03	219.62	0.81
R1	5506.579	100-yr	8059	500.85	509.83		510.99	0.005382	10.58	996.93	210.65	0.66
R1	5355.142	100-yr	8059	499.34	508.26	508.14	510.01	0.008178	12.96	850.94	205.65	0.82
R1	5224.855	100-yr	8059	498.01	506.93	506.93	508.86	0.009143	13.66	812.7	198.37	0.86
R1	5031.015	100-yr	8072	496.07	504.59		506.33	0.008283	12.6	806.43	165.08	0.82
R1	4921.839	100-yr	8072	495.09	504.11		505.6	0.006531	11.69	877.72	173.62	0.73
R1	4695.771	100-yr	8075	493.11	502.01	502.01	504.01	0.008966	13.55	778.51	186.53	0.86
R1	4586.748	100-yr	8075	492.17	500.35	500.35	502.39	0.010541	13.8	767.5	183.89	0.91
R1	4358.503	100-yr	8075	490.2	498.62		499.91	0.006583	11.15	953.8	219.99	0.73
R1	4237.954	100-yr	8075	489.17	497.98	497.23	499.3	0.006091	11.09	942.93	202.74	0.71
R1	4151.527	100-yr	8075	488.45	496.58	496.58	498.56	0.010428	13.63	778.3	188.65	0.91
R1	3936.963	100-yr	8075	486.57	495.13		496.57	0.007316	11.88	915.06	217.42	0.77
R1	3783.972	100-yr	8075	485.27	494.98		495.77	0.003243	8.72	1209.77	239.98	0.52
R1	3693.166	100-yr	8075	484.59	494.65		495.44	0.00311	8.75	1199.22	215.94	0.52
R1	3620.749	100-yr	8075	484.06	494.22		495.16	0.00354	9.41	1111.44	202.08	0.55
R1	3548.466	100-yr	8075	483.54	493.8		494.86	0.003869	9.91	1057.03	192.82	0.58
R1	3485.442	100-yr	8075	483.07	493.07		494.54	0.005337	11.46	924.75	185.27	0.68
R1	3366.8	100-yr	8160	482.21	492.96		493.88	0.003491	9.74	1192.55	243	0.55
R1	3274.089	100-yr	8160	481.53	492.98		493.57	0.002068	7.88	1476.62	278.13	0.43
R1	3193.538	100-yr	8160	480.95	492.38		493.36	0.00313	9.68	1155.75	209.75	0.53
R1	3086.114	100-yr	8160	480.18	491.55		492.94	0.004245	11.21	962.19	165.99	0.62
R1	3006.365	100-yr	8160	479.6	489.86	489.86	492.37	0.008333	14.56	726.2	142.78	0.85
R1	2950.441	100-yr	8160	479.17	489.13	489.13	491.71	0.008973	14.77	700.97	133.17	0.88
R1	2895.33	100-yr	8160	478.77	488.92	487.98	490.8	0.006445	12.69	793.15	131.36	0.74
R1	2861.841	100-yr	8160	478.51	487.89	487.89	490.46	0.009929	14.83	688.37	132.52	0.91
R1	2830.722	100-yr	8160	478.26	487.54	487.54	489.99	0.009763	14.57	705.5	139.32	0.9
R1	2771.684	100-yr	8160	477.82	487.88		489.19	0.004767	10.85	958.33	171.81	0.64
R1	2721.609	100-yr	8160	477.46	487.29		488.87	0.005906	11.87	874.06	162.4	0.71
R1	2658.252	100-yr	8160	476.99	487.42		488.4	0.003372	9.37	1073.75	165.03	0.54
R1	2581.916	100-yr	8160	476.43	485.34	485.34	487.85	0.010394	14.64	690.52	134.28	0.92
R1	2482.367	100-yr	8162	475.68	484.56	484.56	486.78	0.009767	14.12	742.94	157.56	0.89
R1	2372.165	100-yr	8162	474.88	483.21	483	485.02	0.009013	12.92	815.37	186.79	0.85
R1	2261.893	100-yr	8162	474.05	483.48		484.18	0.002991	8.23	1325.32	281.54	0.5
R1	2152.043	100-yr	8162	473.28	481.9	481.9	483.58	0.008636	12.98	903.84	251.45	0.84
R1	2069.65	100-yr	8162	472.69	480.54	480.54	482.12	0.009822	12.89	920.02	279.13	0.88
R1	1949.311	100-yr	8162	471.82	479.46	479.4	480.96	0.009884	12.64	927.06	279.35	0.87
R1	1837.343	100-yr	8162	471	479.23		480.04	0.00456	9.15	1244.89	326.1	0.61
R1	1685.242	100-yr	8162	469.9	477.92		479.16	0.00727	11.28	1000.15	264.88	0.76
R1	1567.999	100-yr	8385	469.02	476.82	476.79	478.33	0.009328	12.52	957.08	281.97	0.85
R1	1459.434	100-yr	8385	468.24	475.91	475.91	477.28	0.009388	12.37	1036.4	365.85	0.85
R1	1343.698	100-yr	8385	467.42	475.21		476.12	0.006473	10.39	1244.73	417.2	0.71
R1	1202.354	100-yr	8385	466.39	474.48		475.26	0.005174	9.56	1326.72	402.39	0.64
R1	1044.787	100-yr	8385	465.24	473.62		474.45	0.00513	9.8	1280.19	363.17	0.64
R1	850.818	100-yr	8385	465.61	472.75		473.45	0.005391	6.71	1253.07	327.32	0.6
R1	704.5021	100-yr	8385	464.07	471.17		472.38	0.00953	8.82	952.26	252.82	0.8
R1	513.2567	100-yr	8512	464.01	469.98		470.75	0.006533	7.04	1213.6	343.3	0.65
R1	297.6274	100-yr	8512	463.08	469.01	467.59	469.61	0.004003	6.34	1413.51	387.63	0.53

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	12446.45	2-yr	1873	577.39	582.98	582.2	583.97	0.008484	7.98	234.58	62.98	0.73
R1	12261.31	2-yr	1873	575.55	580.36	580.36	581.71	0.018152	9.34	200.48	75.46	1.01
R1	12037.38	2-yr	1873	572.1	577.32		578.02	0.005713	6.69	279.88	74.35	0.61
R1	11908.4	2-yr	1873	570.86	576.27		577.16	0.007527	7.57	247.57	67.02	0.69
R1	11767.6	2-yr	1873	570.23	574.48	574.27	575.73	0.013495	8.98	208.54	68.46	0.91
R1	11612.94	2-yr	1873	568.3	572.15	572.15	573.27	0.018453	8.48	220.92	100.89	1.01
R1	11457.05	2-yr	1873	565.91	570		570.61	0.01166	6.27	298.75	151.04	0.79
R1	11329.84	2-yr	1873	563.48	568.87		569.37	0.007839	5.69	329.25	143.1	0.66
R1	11252.45	2-yr	1873	563.03	568.34		568.77	0.007164	5.24	357.41	164.75	0.63
R1	11112.01	2-yr	1873	561.38	567.05		567.58	0.009896	5.85	320.14	159.43	0.73
R1	11001.18	2-yr	1873	561.37	565.28	565.27	566.03	0.020413	6.98	268.41	177.01	1
R1	10887.67	2-yr	1873	560.08	564.02		564.37	0.009675	4.73	396.21	267.7	0.68
R1	10787.72	2-yr	1873	558.1	563.35		563.58	0.006096	3.9	480.55	305.64	0.55
R1	10675.5	2-yr	1873	557.14	562.33		562.69	0.010697	4.79	391.43	278.4	0.71
R1	10570.73	2-yr	1873	556.44	560.93		561.32	0.01604	5.01	373.7	337.06	0.84
R1	10473.29	2-yr	1873	554.98	559.81	559.36	560.23	0.008067	5.25	372.63	229.88	0.65
R1	10398.21	2-yr	1873	554.92	558.54	558.54	559.24	0.021068	6.73	278.48	200.31	1
R1	10341.99	2-yr	1949	549.57	554.92	554.92	555.68	0.007094	8.04	346.75	208.43	0.69
R1	10251.58	2-yr	1949	548.65	553.85	553.85	554.6	0.007324	7.97	347.58	211.92	0.7
R1	10148.48	2-yr	1949	547.63	553.04	553.04	553.75	0.006737	7.9	367.45	236.13	0.67
R1	10078.27	2-yr	1949	546.91	552.32	552.32	553.15	0.007402	8.3	336.99	213.22	0.7
R1	10021.56	2-yr	1949	546.33	551.79	551.79	552.6	0.007132	8.19	345.66	225.48	0.69
R1	9931.735	2-yr	1949	545.37	550.72	550.72	551.59	0.007876	8.45	323.79	195.28	0.73
R1	9806.59	2-yr	1949	544.04	549.73	549.73	550.56	0.007611	8.65	333.86	200.47	0.71
R1	9698.614	2-yr	1949	542.99	548.52	548.41	549.22	0.006098	7.67	366.75	223.77	0.64
R1	9620.242	2-yr	1949	542.2	547.54	547.54	548.6	0.009004	9.04	273.81	129.23	0.78
R1	9488.005	2-yr	1949	540.86	546.24	546.24	547.03	0.0072	8.14	336.52	194.85	0.69
R1	9341.323	2-yr	1949	539.37	544.8	544.8	545.6	0.007259	8.24	333.98	190.85	0.7
R1	9210.197	2-yr	1949	538.03	543.32	543.3	544.42	0.009203	9.08	264.3	120.47	0.78
R1	9086.38	2-yr	1949	536.8	542.28	542.28	543.32	0.008337	8.89	279.55	133.93	0.75
R1	8987.736	2-yr	1949	535.82	541.44	541.27	542.21	0.006569	8.03	327.95	157.09	0.67
R1	8918.236	2-yr	2027	535.09	541.36		541.83	0.003339	6.29	420.78	151.1	0.49
R1	8863.458	2-yr	2027	534.5	540.34	540.34	541.46	0.008402	9.33	279.37	122.76	0.76
R1	8767.651	2-yr	2027	533.5	538.98	538.98	540	0.008202	8.84	294.6	141.87	0.75
R1	8704.892	2-yr	2027	532.87	538.97		539.45	0.003774	6.53	422.61	171	0.52
R1	8614.742	2-yr	2027	531.92	537.45	537.45	538.84	0.010191	9.89	238.15	96.87	0.83
R1	8523.51	2-yr	2028	531	536.49	536.49	537.45	0.007636	8.54	308.96	160.55	0.72
R1	8412.757	2-yr	2028	529.86	535.3	535.3	536.17	0.00774	8.5	324.91	169.69	0.72
R1	8310.911	2-yr	2028	528.83	534.18	534.18	535.09	0.008154	8.63	319.97	170.6	0.74
R1	8122.83	2-yr	2028	526.97	532.41	532.41	533.51	0.008574	8.97	283.35	150.85	0.76
R1	8018.276	2-yr	2028	525.93	531.42	531.42	532.33	0.007679	8.55	328.52	194.63	0.72
R1	7922.666	2-yr	2028	524.97	530.46	530.46	531.33	0.0075	8.44	339.71	203.04	0.71
R1	7787.34	2-yr	2028	523.62	529.05	529.05	529.79	0.007164	8.15	370.88	230.25	0.69
R1	7584.847	2-yr	2028	521.57	527.07	527.07	527.95	0.007663	8.54	331.4	188.34	0.72
R1	7440.574	2-yr	2028	520.11	525.7	525.7	526.46	0.00661	8.03	366.96	224.94	0.67
R1	7348.037	2-yr	2028	519.19	524.72		525.35	0.005839	7.5	390.14	212.91	0.63
R1	7248.13	2-yr	2029	518.21	523.71	523.71	524.66	0.008073	8.77	309.57	160.69	0.74
R1	7190.396	2-yr	2029	517.65	523.1	523.1	523.85	0.007124	8.16	364.4	216.74	0.69
R1	7070.673	2-yr	2029	516.45	521.82	521.82	522.43	0.007067	7.96	412.12	271.29	0.68
R1	6939.061	2-yr	2029	515.13	520.63	520.63	521.26	0.008218	8.57	417.19	309.44	0.72
R1	6805.899	2-yr	2029	513.77	519.14	519.14	519.64	0.005228	6.94	493.91	401.85	0.59
R1	6643.495	2-yr	2029	512.12	518.76		518.89	0.001067	3.72	812.29	315.86	0.28
R1	6519.437	2-yr	2029	510.9	518.55	516.37	518.75	0.001226	4.46	695.45	279.85	0.31
R1	6370		Bridge									
R1	6310.77	2-yr	2094	508.85	514.47	514.47	515.44	0.008118	8.92	316.89	156.81	0.74
R1	6164.775	2-yr	2094	507.39	512.89	512.89	513.79	0.00777	8.6	333.39	175.98	0.72
R1	6073.736	2-yr	2094	506.49	512	512	512.99	0.00823	8.88	310.46	150.64	0.75
R1	5983.042	2-yr	2094	505.6	511.1	511.1	512.09	0.008254	8.89	309.23	148.37	0.75

R1	5809.553	2-yr	2094	503.88	509.27	509.27	510.24	0.008485	8.86	311.96	151.26	0.75
R1	5645.796	2-yr	2096	502.25	507.7	507.7	508.54	0.007614	8.46	348.27	190.79	0.72
R1	5506.579	2-yr	2096	500.85	506.61		507.3	0.005798	7.74	374.38	175.88	0.63
R1	5355.142	2-yr	2096	499.34	505.01	505.01	506.21	0.009005	9.48	277.55	126.74	0.78
R1	5224.855	2-yr	2096	498.01	503.72	503.72	504.88	0.00891	9.46	282.91	124.96	0.78
R1	5031.015	2-yr	2098	496.07	501.44	501.44	502.4	0.008635	8.9	312.36	148.78	0.76
R1	4921.839	2-yr	2098	495.09	500.67	500.55	501.54	0.007284	8.44	327.38	148.04	0.7
R1	4695.771	2-yr	2099	493.11	498.59	498.59	499.75	0.009462	9.47	277.32	118.12	0.8
R1	4586.748	2-yr	2099	492.17	497.57	497.57	498.55	0.008461	8.85	309.65	147.77	0.75
R1	4358.503	2-yr	2099	490.2	495.65	495.65	496.51	0.007344	8.31	345.79	190.46	0.7
R1	4237.954	2-yr	2099	489.17	494.58	494.56	495.49	0.007986	8.6	323.31	159.88	0.73
R1	4151.527	2-yr	2099	488.45	493.84	493.82	494.79	0.008363	8.76	313.81	150.85	0.75
R1	3936.963	2-yr	2099	486.57	492.36	492.36	493.22	0.006812	8.4	350.02	190.18	0.69
R1	3783.972	2-yr	2099	485.27	491		491.69	0.005766	7.68	379.66	185.97	0.63
R1	3693.166	2-yr	2099	484.59	490.51		491.15	0.005152	7.44	389.99	175.2	0.6
R1	3620.749	2-yr	2099	484.06	489.86		490.68	0.006511	8.22	338.67	152.09	0.67
R1	3548.466	2-yr	2099	483.54	489.4		490.19	0.006115	8.04	336.91	136.28	0.65
R1	3485.442	2-yr	2099	483.07	488.76	488.41	489.76	0.00724	8.58	290.51	108.06	0.71
R1	3366.8	2-yr	2111	482.21	487.87	487.87	488.86	0.008021	8.95	312.71	145.99	0.74
R1	3274.089	2-yr	2111	481.53	487.85		488.25	0.002914	5.92	467.07	161.39	0.46
R1	3193.538	2-yr	2111	480.95	487.46		488.01	0.003474	6.62	395.21	122.89	0.5
R1	3086.114	2-yr	2111	480.18	486.78		487.56	0.004614	7.7	333.58	105.18	0.58
R1	3006.365	2-yr	2111	479.6	485.75	485.3	487.04	0.00779	9.45	252.29	80.82	0.74
R1	2950.441	2-yr	2111	479.17	484.92	484.92	486.49	0.010582	10.42	229.74	82.11	0.85
R1	2895.33	2-yr	2111	478.77	485.05		485.84	0.005137	7.81	330.99	107.72	0.61
R1	2861.841	2-yr	2111	478.51	484.66		485.62	0.006457	8.59	302.05	106.22	0.67
R1	2830.722	2-yr	2111	478.26	484.19	484.19	485.37	0.00827	9.43	279.37	115.08	0.76
R1	2771.684	2-yr	2111	477.82	483.61	483.61	484.71	0.007943	9.09	297.34	137.99	0.74
R1	2721.609	2-yr	2111	477.46	483.03	482.99	484.16	0.008864	9.29	281.2	115.73	0.78
R1	2658.252	2-yr	2111	476.99	483.09		483.6	0.003953	6.68	408.33	141.73	0.53
R1	2581.916	2-yr	2111	476.43	482.48		483.24	0.005288	7.7	335.4	112.32	0.61
R1	2482.367	2-yr	2111	475.68	481.37	481.37	482.55	0.008727	9.38	281.32	126.96	0.77
R1	2372.165	2-yr	2111	474.88	480.35	480.35	481.29	0.008186	8.79	320.78	157.93	0.74
R1	2261.893	2-yr	2111	474.05	480.28		480.57	0.002132	5.02	543.07	201.85	0.39
R1	2152.043	2-yr	2111	473.28	479.02	479.02	480.1	0.008037	9.06	304.43	156.69	0.74
R1	2069.65	2-yr	2111	472.69	478.18	478.18	479.06	0.007691	8.55	349.28	200.18	0.72
R1	1949.311	2-yr	2111	471.82	477.23	477.23	478.01	0.007408	8.28	371.8	220.27	0.7
R1	1837.343	2-yr	2111	471	476.22	476.11	476.89	0.00616	7.36	397.35	241.42	0.64
R1	1685.242	2-yr	2111	469.9	475.51		476.03	0.004824	6.91	434.03	210.82	0.57
R1	1567.999	2-yr	2156	469.02	474.58	474.58	475.39	0.006907	8.2	376.62	223.25	0.69
R1	1459.434	2-yr	2156	468.24	473.85		474.46	0.00569	7.48	425.26	235.57	0.62
R1	1343.698	2-yr	2156	467.42	473.23	473.23	473.82	0.005255	7.41	481.74	353.47	0.6
R1	1202.354	2-yr	2156	466.39	472.03	471.92	472.63	0.005644	7.47	449.95	288.55	0.62
R1	1044.787	2-yr	2156	465.24	470.79	470.79	471.6	0.007305	8.42	381.33	235.82	0.7
R1	850.818	2-yr	2156	465.61	469.7		470.05	0.006264	4.77	451.59	217.39	0.58
R1	704.5021	2-yr	2156	464.07	468.83		469.18	0.005591	4.76	453.21	200.75	0.56
R1	513.2567	2-yr	2179	464.01	467.59		467.93	0.00778	4.65	468.35	275.64	0.63
R1	297.6274	2-yr	2179	463.08	466.49	465.59	466.72	0.004007	3.83	568.85	272.89	0.47

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	12446.45	1.3-yr	1087	577.39	581.96	581.2	582.58	0.007472	6.32	171.95	60.1	0.66
R1	12261.31	1.3-yr	1087	575.55	579.36	579.36	580.42	0.019678	8.23	132.12	64.4	1.01
R1	12037.38	1.3-yr	1087	572.1	576.1		576.6	0.006188	5.67	191.66	69.78	0.6
R1	11908.4	1.3-yr	1087	570.86	575.12		575.73	0.007222	6.25	173.93	61.14	0.65
R1	11767.6	1.3-yr	1087	570.23	573.55		574.39	0.012513	7.35	147.99	62.29	0.84
R1	11612.94	1.3-yr	1087	568.3	571.29	571.2	572.16	0.016805	7.48	145.31	74.6	0.94
R1	11457.05	1.3-yr	1087	565.91	569.35		569.79	0.012459	5.32	204.42	139.06	0.77
R1	11329.84	1.3-yr	1087	563.48	568.23		568.55	0.007362	4.54	239.57	139.68	0.61
R1	11252.45	1.3-yr	1087	563.03	567.26		567.76	0.014361	5.66	191.89	132.67	0.83
R1	11112.01	1.3-yr	1087	561.38	565.89		566.38	0.007148	5.6	194.1	80.51	0.64
R1	11001.18	1.3-yr	1087	561.37	564.74		565.27	0.01461	5.87	185.28	123.35	0.84
R1	10887.67	1.3-yr	1087	560.08	563.54		563.79	0.010499	4.01	270.93	248.95	0.68
R1	10787.72	1.3-yr	1087	558.1	562.78		562.96	0.006402	3.41	318.73	256.71	0.54
R1	10675.5	1.3-yr	1087	557.14	561.96		562.17	0.007757	3.71	293.34	240.39	0.59
R1	10570.73	1.3-yr	1087	556.44	560.4	560.38	560.81	0.025008	5.11	212.8	260.02	1
R1	10473.29	1.3-yr	1087	554.98	559.3		559.57	0.007308	4.17	264.17	195.54	0.6
R1	10398.21	1.3-yr	1087	554.92	558.1	558.1	558.6	0.024151	5.69	191.06	194.26	1.01
R1	10341.99	1.3-yr	1121	549.57	554.28	554.28	554.92	0.006366	6.82	217.01	193.98	0.63
R1	10251.58	1.3-yr	1121	548.65	553.21	553.21	553.87	0.006761	6.84	214.56	199.21	0.65
R1	10148.48	1.3-yr	1121	547.63	552.24	552.24	552.97	0.007535	7.27	200.65	170.96	0.69
R1	10078.27	1.3-yr	1121	546.91	551.39	551.39	552.25	0.008752	7.68	175.1	135.05	0.74
R1	10021.56	1.3-yr	1121	546.33	550.77	550.77	551.69	0.009418	7.89	166.08	124.64	0.76
R1	9931.735	1.3-yr	1121	545.37	549.86	549.82	550.69	0.008585	7.58	178.87	136.72	0.73
R1	9806.59	1.3-yr	1121	544.04	548.95	548.95	549.71	0.007499	7.58	197.34	152.27	0.69
R1	9698.614	1.3-yr	1121	542.99	547.45	547.45	548.31	0.008812	7.66	174.24	134.21	0.74
R1	9620.242	1.3-yr	1121	542.2	546.62	546.62	547.54	0.009463	7.87	164.25	110.47	0.76
R1	9488.005	1.3-yr	1121	540.86	545.32	545.32	546.2	0.008935	7.71	172.09	138.49	0.74
R1	9341.323	1.3-yr	1121	539.37	544.11	544.11	544.81	0.006651	7.03	207.15	181.29	0.65
R1	9210.197	1.3-yr	1121	538.03	542.58	542.29	543.32	0.007372	7.14	181.51	103.32	0.68
R1	9086.38	1.3-yr	1121	536.8	541.23	540.9	542.23	0.009973	8.1	151.37	95.29	0.78
R1	8987.736	1.3-yr	1121	535.82	540.34	540.34	541.26	0.009325	7.95	167.31	122.46	0.76
R1	8918.236	1.3-yr	1172	535.09	540.32	539.5	540.72	0.003494	5.53	270.18	137.56	0.48
R1	8863.458	1.3-yr	1172	534.5	539.18	539.18	540.32	0.010743	8.73	151.11	88.78	0.82
R1	8767.651	1.3-yr	1172	533.5	537.96	537.69	538.94	0.009742	8.06	160.79	102.24	0.78
R1	8704.892	1.3-yr	1172	532.87	537.45	537.4	538.33	0.008758	7.82	180.37	128.03	0.74
R1	8614.742	1.3-yr	1172	531.92	536.24	536.08	537.39	0.012005	8.65	141.2	65.5	0.86
R1	8523.51	1.3-yr	1172	531	535.33	534.94	536.33	0.010345	8.09	154.55	90.62	0.8
R1	8412.757	1.3-yr	1172	529.86	534.58	534.58	535.31	0.007081	7.21	206.39	161.12	0.67
R1	8310.911	1.3-yr	1172	528.83	533.4	533.4	534.19	0.008024	7.47	196.25	145.67	0.71
R1	8122.83	1.3-yr	1172	526.97	531.47	530.84	532.31	0.008108	7.42	170.78	90.37	0.71
R1	8018.276	1.3-yr	1172	525.93	530.34	530.34	531.34	0.010269	8.19	161.75	110.02	0.8
R1	7922.666	1.3-yr	1172	524.97	529.51	529.51	530.39	0.008862	7.79	180.52	132.48	0.74
R1	7787.34	1.3-yr	1172	523.62	528.4	528.4	529.07	0.006741	7.09	227.63	202.41	0.65
R1	7584.847	1.3-yr	1172	521.57	526.21	526.21	527.04	0.008096	7.59	189.09	144.58	0.71
R1	7440.574	1.3-yr	1172	520.11	524.67	524.67	525.57	0.008978	7.86	177.87	129.66	0.75
R1	7348.037	1.3-yr	1172	519.19	523.78	523.78	524.6	0.008297	7.61	194.44	166.86	0.72
R1	7248.13	1.3-yr	1173	518.21	522.8	522.8	523.68	0.008731	7.81	180.92	121.68	0.74
R1	7190.396	1.3-yr	1173	517.65	522.37	522.37	523.09	0.00733	7.32	213.78	179.17	0.68
R1	7070.673	1.3-yr	1173	516.45	521.24	521.24	521.82	0.00688	7.11	258.79	237.09	0.65
R1	6939.061	1.3-yr	1173	515.13	520.14	520.14	520.66	0.00683	7.21	278.69	256.33	0.65
R1	6805.899	1.3-yr	1173	513.77	518.46	518.46	519.05	0.006009	6.63	251.69	283.65	0.62
R1	6643.495	1.3-yr	1173	512.12	517.02	516.33	517.49	0.004636	6.02	283.77	289.42	0.55
R1	6519.437	1.3-yr	1173	510.9	516.78	515.27	517.07	0.002112	4.75	310.44	129.25	0.38
R1	6370		Bridge									
R1	6310.77	1.3-yr	1223	508.85	513.59	513.59	514.5	0.008685	7.98	187.35	131.16	0.74
R1	6164.775	1.3-yr	1223	507.39	511.97	511.97	512.88	0.009074	7.95	185.36	133.89	0.75
R1	6073.736	1.3-yr	1223	506.49	511.2	511.2	512.04	0.008016	7.66	194.5	137.35	0.71
R1	5983.042	1.3-yr	1223	505.6	510.3	510.3	511.14	0.008059	7.67	194.37	136.42	0.71

R1	5809.553	1.3-yr	1223	503.88	508.51	508.51	509.31	0.008011	7.55	201.31	138.68	0.71
R1	5645.796	1.3-yr	1224	502.25	506.93	506.93	507.73	0.007994	7.6	205.9	162.67	0.71
R1	5506.579	1.3-yr	1224	500.85	505.7	505.7	506.43	0.006798	7.27	220.01	166.04	0.66
R1	5355.142	1.3-yr	1224	499.34	504.01	503.76	504.97	0.009105	8.07	170.24	87.49	0.76
R1	5224.855	1.3-yr	1224	498.01	502.7	502.7	503.73	0.00979	8.38	168.86	98.5	0.78
R1	5031.015	1.3-yr	1225	496.07	500.75	500.75	501.5	0.007611	7.42	211.03	145.19	0.69
R1	4921.839	1.3-yr	1225	495.09	499.79	499.79	500.6	0.007897	7.59	199.67	141.96	0.71
R1	4695.771	1.3-yr	1226	493.11	497.7	497.7	498.64	0.009356	8.09	179.01	103.3	0.76
R1	4586.748	1.3-yr	1226	492.17	496.78	496.78	497.61	0.008206	7.61	196.98	138.71	0.72
R1	4358.503	1.3-yr	1226	490.2	494.71	494.62	495.61	0.008957	7.8	182.32	130.27	0.75
R1	4237.954	1.3-yr	1226	489.17	493.8	493.8	494.6	0.007854	7.47	203.08	150.61	0.7
R1	4151.527	1.3-yr	1226	488.45	493.29	493.05	493.89	0.005859	6.68	232.67	143.23	0.61
R1	3936.963	1.3-yr	1226	486.57	491.15	491.15	492.22	0.010339	8.47	163.59	104.77	0.8
R1	3783.972	1.3-yr	1226	485.27	490.13	489.88	490.83	0.006486	7.08	221.98	165.31	0.65
R1	3693.166	1.3-yr	1226	484.59	489.58	489.29	490.23	0.00597	6.94	231.68	165.35	0.62
R1	3620.749	1.3-yr	1226	484.06	488.85	488.63	489.71	0.007865	7.69	192.14	132.99	0.71
R1	3548.466	1.3-yr	1226	483.54	488.33	488.23	489.13	0.007463	7.49	198.51	123.25	0.69
R1	3485.442	1.3-yr	1226	483.07	488.14		488.69	0.004583	6.2	227.51	96.77	0.55
R1	3366.8	1.3-yr	1233	482.21	486.89	486.89	487.87	0.009425	8.25	177.57	116.4	0.77
R1	3274.089	1.3-yr	1233	481.53	486.46		486.99	0.005001	6.3	251.34	148.25	0.57
R1	3193.538	1.3-yr	1233	480.95	486.04		486.6	0.004849	6.38	231.89	107.11	0.56
R1	3086.114	1.3-yr	1233	480.18	485.27		486.01	0.006101	7.14	194.06	78.68	0.63
R1	3006.365	1.3-yr	1233	479.6	484.52		485.45	0.007635	7.78	166.4	60.02	0.7
R1	2950.441	1.3-yr	1233	479.17	484.09		485.02	0.007781	7.83	168.32	65.37	0.71
R1	2895.33	1.3-yr	1233	478.77	483.94		484.58	0.005289	6.74	215.12	99.97	0.59
R1	2861.841	1.3-yr	1233	478.51	483.58	483.01	484.37	0.006557	7.37	193.29	93.12	0.65
R1	2830.722	1.3-yr	1233	478.26	482.99	482.78	484.09	0.010003	8.56	158.06	78.21	0.79
R1	2771.684	1.3-yr	1233	477.82	482.52	482.19	483.49	0.008894	8.06	169.68	87.29	0.75
R1	2721.609	1.3-yr	1233	477.46	482.06	482.05	483.03	0.009456	8.14	174.13	105.06	0.77
R1	2658.252	1.3-yr	1233	476.99	481.88		482.44	0.005546	6.58	241.53	135.23	0.6
R1	2581.916	1.3-yr	1233	476.43	481.4		482.02	0.005488	6.66	219.26	103.12	0.6
R1	2482.367	1.3-yr	1233	475.68	480.38	480.14	481.32	0.008752	7.97	174.06	90.08	0.74
R1	2372.165	1.3-yr	1233	474.88	479.54	479.54	480.35	0.00814	7.64	201.29	137.98	0.72
R1	2261.893	1.3-yr	1233	474.05	479.17		479.44	0.00245	4.57	340.46	172.42	0.4
R1	2152.043	1.3-yr	1233	473.28	478.01	477.59	478.93	0.00841	7.86	175.46	97.35	0.73
R1	2069.65	1.3-yr	1233	472.69	477.38	477.35	478.21	0.008058	7.65	201.83	157.43	0.71
R1	1949.311	1.3-yr	1233	471.82	476.52	476.52	477.26	0.007465	7.36	223.64	184.4	0.69
R1	1837.343	1.3-yr	1233	471	475.47	474.74	476.06	0.006122	6.41	234.26	180.82	0.62
R1	1685.242	1.3-yr	1233	469.9	474.82	474.52	475.23	0.004376	5.88	293.24	193.84	0.53
R1	1567.999	1.3-yr	1258	469.02	473.66	473.56	474.53	0.008281	7.7	196.53	146.26	0.72
R1	1459.434	1.3-yr	1258	468.24	473.41	473.06	473.8	0.003761	5.68	323.05	230.37	0.5
R1	1343.698	1.3-yr	1258	467.42	472.14	472.07	473.1	0.008925	8.09	183.19	117.14	0.75
R1	1202.354	1.3-yr	1258	466.39	471.24	471.24	471.93	0.006692	7.16	242.52	220.3	0.65
R1	1044.787	1.3-yr	1258	465.24	470.07	470.07	470.79	0.006972	7.31	230.47	180.63	0.67
R1	850.818	1.3-yr	1258	465.61	469.05		469.3	0.006801	4.01	313.52	208.44	0.58
R1	704.5021	1.3-yr	1258	464.07	468.22		468.44	0.005013	3.78	332.55	191.47	0.51
R1	513.2567	1.3-yr	1269	464.01	466.98		467.24	0.008127	4.08	311.13	230.51	0.62
R1	297.6274	1.3-yr	1269	463.08	465.86	465.11	466.02	0.004	3.16	401.42	256.58	0.45

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
R1	12446.45	875 cfs	875	577.39	581.62		582.13	0.007179	5.77	151.6	59.13	0.64
R1	12261.31	875 cfs	875	575.55	579.06	579.06	579.99	0.020487	7.76	112.73	62.03	1.01
R1	12037.38	875 cfs	875	572.1	575.7		576.14	0.006509	5.33	164.03	68.17	0.61
R1	11908.4	875 cfs	875	570.86	574.71		575.25	0.007287	5.85	149.48	58.47	0.65
R1	11767.6	875 cfs	875	570.23	573.33	572.93	573.99	0.010893	6.53	134.04	60.74	0.77
R1	11612.94	875 cfs	875	568.3	570.88	570.88	571.76	0.019622	7.52	116.37	66.61	1
R1	11457.05	875 cfs	875	565.91	568.95		569.42	0.010424	5.49	159.52	90.17	0.73
R1	11329.84	875 cfs	875	563.48	567.94		568.24	0.007654	4.38	199.97	126.75	0.61
R1	11252.45	875 cfs	875	563.03	566.78	566.32	567.4	0.015004	6.33	138.21	83.32	0.87
R1	11112.01	875 cfs	875	561.38	565.53		565.96	0.006949	5.26	166.42	74.28	0.62
R1	11001.18	875 cfs	875	561.37	564.51		564.97	0.01164	5.49	159.31	98.72	0.76
R1	10887.67	875 cfs	875	560.08	563.32		563.57	0.011892	3.99	219.26	222.9	0.71
R1	10787.72	875 cfs	875	558.1	562.54		562.71	0.00623	3.35	261.06	211.16	0.53
R1	10675.5	875 cfs	875	557.14	561.75		561.94	0.007475	3.55	246.28	208.82	0.58
R1	10570.73	875 cfs	875	556.44	560.07	560.07	560.62	0.024041	5.92	147.79	139.7	1.01
R1	10473.29	875 cfs	875	554.98	559.13		559.35	0.007017	3.8	231.4	184.48	0.57
R1	10398.21	875 cfs	875	554.92	557.92	557.92	558.39	0.024928	5.52	158.43	172.4	1.02
R1	10341.99	875 cfs	875	549.57	553.47	553.08	554.4	0.011531	7.74	113.84	54.48	0.82
R1	10251.58	875 cfs	875	548.65	552.84	552.07	553.5	0.007316	6.58	146.83	133.74	0.66
R1	10148.48	875 cfs	875	547.63	551.6	551.2	552.54	0.011366	7.8	115.6	77.77	0.81
R1	10078.27	875 cfs	875	546.91	550.94	550.41	551.78	0.009711	7.35	124.5	88.15	0.76
R1	10021.56	875 cfs	875	546.33	550.23	549.85	551.16	0.011609	7.77	113.85	62.88	0.82
R1	9931.735	875 cfs	875	545.37	549.73	548.9	550.32	0.006264	6.31	161.85	122.97	0.62
R1	9806.59	875 cfs	875	544.04	548.38	548.38	549.31	0.010238	7.95	126.06	91.64	0.78
R1	9698.614	875 cfs	875	542.99	547.02	546.47	547.84	0.009551	7.27	125.23	86.51	0.75
R1	9620.242	875 cfs	875	542.2	546.15	545.71	547.04	0.010814	7.58	117.57	70.53	0.79
R1	9488.005	875 cfs	875	540.86	544.99	544.33	545.74	0.008418	6.98	133.37	93.53	0.71
R1	9341.323	875 cfs	875	539.37	543.26	542.92	544.25	0.012146	7.96	110.6	50.99	0.84
R1	9210.197	875 cfs	875	538.03	542.03	541.44	542.81	0.009165	7.09	128.66	89.84	0.74
R1	9086.38	875 cfs	875	536.8	541	540.29	541.74	0.008025	6.92	131.6	73.37	0.69
R1	8987.736	875 cfs	875	535.82	539.77	539.43	540.76	0.011961	7.97	112.43	70.14	0.83
R1	8918.236	875 cfs	875	535.09	539.61	538.52	540.11	0.004903	5.78	176.82	128.46	0.55
R1	8863.458	875 cfs	875	534.5	538.33	538.23	539.58	0.016389	8.97	97.57	37.2	0.97
R1	8767.651	875 cfs	875	533.5	537.63	536.92	538.35	0.008041	6.84	132.16	72.07	0.69
R1	8704.892	875 cfs	875	532.87	536.8	536.4	537.73	0.011473	7.78	114.96	70.12	0.82
R1	8614.742	875 cfs	875	531.92	535.77	535.37	536.68	0.011603	7.66	114.3	43.44	0.82
R1	8523.51	875 cfs	875	531	535.02		535.73	0.008362	6.79	130.52	62.24	0.7
R1	8412.757	875 cfs	875	529.86	533.94	533.38	534.75	0.009304	7.25	125.88	77.58	0.74
R1	8310.911	875 cfs	875	528.83	532.64	532.32	533.63	0.012768	7.98	109.74	45.37	0.86
R1	8122.83	875 cfs	875	526.97	530.99		531.67	0.007939	6.62	133.74	61.51	0.69
R1	8018.276	875 cfs	875	525.93	529.93	529.38	530.74	0.009598	7.24	124.35	72.51	0.75
R1	7922.666	875 cfs	875	524.97	529.12	528.46	529.87	0.008409	6.99	134.23	99.36	0.71
R1	7787.34	875 cfs	875	523.62	527.66	527.23	528.57	0.010805	7.71	120.27	85.86	0.8
R1	7584.847	875 cfs	875	521.57	525.58	525.07	526.44	0.010137	7.45	120.3	69.56	0.77
R1	7440.574	875 cfs	875	520.11	524.15	523.64	525	0.009888	7.4	123.44	80.65	0.76
R1	7348.037	875 cfs	875	519.19	523.24	522.73	524.08	0.009828	7.4	124.39	92.82	0.76
R1	7248.13	875 cfs	875	518.21	522.46	521.77	523.17	0.00782	6.89	141.38	106.32	0.69
R1	7190.396	875 cfs	875	517.65	521.63	521.27	522.6	0.011728	7.94	113.61	76.67	0.83
R1	7070.673	875 cfs	875	516.45	520.97	520.97	521.51	0.006366	6.5	198.6	208.94	0.62
R1	6939.061	875 cfs	875	515.13	519.88	519.88	520.38	0.006399	6.67	216.76	228.62	0.62
R1	6805.899	875 cfs	875	513.77	517.59	517.16	518.47	0.011228	7.54	117.09	60.86	0.81
R1	6643.495	875 cfs	875	512.12	516.34	515.52	516.98	0.007008	6.48	144.65	92.31	0.65
R1	6519.437	875 cfs	875	510.9	516.14	514.38	516.42	0.002264	4.47	236.45	107.06	0.39
R1	6370		Bridge									
R1	6310.77	875 cfs	875	508.85	512.85	512.46	513.82	0.011499	7.88	114.16	71.62	0.82
R1	6164.775	875 cfs	875	507.39	511.41	510.88	512.24	0.009683	7.3	124.68	83.45	0.76
R1	6073.736	875 cfs	875	506.49	510.51	509.98	511.35	0.009819	7.35	121.85	67.84	0.76
R1	5983.042	875 cfs	875	505.6	509.6	509.08	510.45	0.010034	7.41	120.72	66.63	0.77

R1	5809.553	875 cfs	875	503.88	507.88	507.35	508.71	0.009909	7.36	123.24	85.54	0.76
R1	5645.796	875 cfs	875	502.25	506.35	505.78	507.15	0.009076	7.2	130.15	100.72	0.73
R1	5506.579	875 cfs	875	500.85	504.83	504.39	505.75	0.010957	7.73	114.94	60.84	0.8
R1	5355.142	875 cfs	875	499.34	503.52	502.86	504.26	0.008277	6.97	132.11	69.63	0.7
R1	5224.855	875 cfs	875	498.01	502.04	501.63	502.99	0.011267	7.84	114.06	60.77	0.81
R1	5031.015	875 cfs	875	496.07	500.15	499.6	500.97	0.009362	7.28	129.28	108.34	0.74
R1	4921.839	875 cfs	875	495.09	499.27	498.58	500	0.008045	6.9	136.34	92.47	0.69
R1	4695.771	875 cfs	875	493.11	497.19	496.66	498.02	0.009539	7.34	128.17	94.74	0.75
R1	4586.748	875 cfs	875	492.17	496.17	495.6	496.97	0.00943	7.19	125.79	79.44	0.75
R1	4358.503	875 cfs	875	490.2	494.26	493.55	494.96	0.008063	6.72	134.74	80.09	0.69
R1	4237.954	875 cfs	875	489.17	493.28	492.59	493.99	0.008038	6.79	137.42	94.64	0.69
R1	4151.527	875 cfs	875	488.45	492.64	491.9	493.31	0.007477	6.64	145.01	116.12	0.67
R1	3936.963	875 cfs	875	486.57	490.65	490.09	491.48	0.009589	7.35	121.6	62.3	0.75
R1	3783.972	875 cfs	875	485.27	489.62	488.74	490.23	0.006425	6.4	152.36	107.67	0.63
R1	3693.166	875 cfs	875	484.59	488.89	488.16	489.59	0.007511	6.82	141.05	94.85	0.67
R1	3620.749	875 cfs	875	484.06	488.34	487.58	489.05	0.007482	6.79	136.9	83.17	0.67
R1	3548.466	875 cfs	875	483.54	487.71	487.06	488.47	0.008429	7.04	131.1	80.41	0.71
R1	3485.442	875 cfs	875	483.07	487.52		487.99	0.004729	5.61	170.68	85.45	0.54
R1	3366.8	875 cfs	875	482.21	486.34	485.79	487.18	0.009361	7.36	125.02	75.15	0.75
R1	3274.089	875 cfs	875	481.53	485.79	484.93	486.39	0.006552	6.34	154.66	125.16	0.63
R1	3193.538	875 cfs	875	480.95	485.31		485.88	0.00602	6.2	157.22	95.45	0.61
R1	3086.114	875 cfs	875	480.18	484.49		485.17	0.007124	6.68	138.45	64.85	0.66
R1	3006.365	875 cfs	875	479.6	483.91		484.6	0.007149	6.69	132.65	49.62	0.66
R1	2950.441	875 cfs	875	479.17	483.49		484.2	0.007252	6.75	132.94	53.39	0.66
R1	2895.33	875 cfs	875	478.77	483.19		483.8	0.006196	6.37	148.97	77.02	0.62
R1	2861.841	875 cfs	875	478.51	482.84		483.56	0.00757	6.89	133.8	65.75	0.68
R1	2830.722	875 cfs	875	478.26	482.46	481.88	483.29	0.009149	7.35	122.08	56.12	0.74
R1	2771.684	875 cfs	875	477.82	482.04		482.76	0.00775	6.83	132.92	64.93	0.68
R1	2721.609	875 cfs	875	477.46	481.66	480.94	482.37	0.007826	6.82	136.36	79.91	0.69
R1	2658.252	875 cfs	875	476.99	481.21	480.64	481.86	0.007422	6.68	151.73	127.74	0.67
R1	2581.916	875 cfs	875	476.43	480.72	479.84	481.32	0.006386	6.31	151.71	92.6	0.62
R1	2482.367	875 cfs	875	475.68	480.11		480.71	0.006025	6.28	151.24	81.1	0.61
R1	2372.165	875 cfs	875	474.88	478.54	478.39	479.66	0.015149	8.47	103.28	39.85	0.93
R1	2261.893	875 cfs	875	474.05	478.46		478.76	0.003151	4.55	223.06	145.36	0.44
R1	2152.043	875 cfs	875	473.28	477.58		478.24	0.006861	6.53	139.71	70.98	0.65
R1	2069.65	875 cfs	875	472.69	477.16	476.17	477.7	0.005497	6.05	169.47	130.17	0.58
R1	1949.311	875 cfs	875	471.82	475.55	475.35	476.63	0.014442	8.33	105.05	40.51	0.91
R1	1837.343	875 cfs	875	471	475.21		475.61	0.004414	5.16	191.33	144.75	0.52
R1	1685.242	875 cfs	875	469.9	474.06	473.39	474.72	0.007531	6.67	157.05	159.52	0.67
R1	1567.999	875 cfs	875	469.02	473.29	472.41	473.89	0.006452	6.3	150.64	100.11	0.63
R1	1459.434	875 cfs	875	468.24	472.6	471.73	473.2	0.00628	6.33	161.54	143.07	0.62
R1	1343.698	875 cfs	875	467.42	471.73	470.93	472.42	0.007166	6.69	140.46	88.29	0.66
R1	1202.354	875 cfs	875	466.39	470.64	469.94	471.35	0.007829	6.87	140.39	114.56	0.69
R1	1044.787	875 cfs	875	465.24	469.69	468.8	470.25	0.00582	6.21	168.84	135.93	0.6
R1	850.818	875 cfs	875	465.61	468.69		468.89	0.007234	3.65	239.93	192.83	0.58
R1	704.5021	875 cfs	875	464.07	467.85		468.02	0.004897	3.32	263.45	181.16	0.49
R1	513.2567	875 cfs	875	464.01	466.64		466.85	0.007926	3.68	237.71	201.59	0.6
R1	297.6274	875 cfs	875	463.08	465.53	464.8	465.65	0.004001	2.75	317.91	250.22	0.43

Appendix C Geotechnical Boring Logs

Project: SFPUC Habitat Mitigation Program
Project Location: Alameda and Santa Clara Counties, CA
Project Number: 28067577

Log of Boring GB-1

Sheet 1 of 1

Date(s) Drilled	**4/1/09**	Logged By	**M. McKee**	Checked By	**M. Schmoll**
Drilling Method	**Hollow-Stem Auger**	Drill Bit Size/Type	**8-inch-OD rock bit**	Total Depth of Borehole	**26.3 feet**
Drill Rig Type	**Fraste Multi-Drill XL (track rig)**	Drilling Contractor	**Pitcher Drilling Co.**	Approx. Ground Surface Elevation	**521 feet**
Groundwater Level(s)	**3 feet bgs during drilling**	Sampling Method(s)	**Grab, SPT, Modified California**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Neat cement grout to ground surface**	Location	**S side of creek crossing**	GPS Location	**N 37.58484° W 121.78930°**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
520	0	☒	1				SILTY SAND WITH GRAVEL (SM), brown, slightly moist, sandstone gravel, trace cobbles [ALLUVIUM]				Start at 13:30. First groundwater at 3 ft at 13:40. Composite of 2+3: CORR: pH=7.7 Chloride=ND Sulfate=ND Resistivity= 8800 ohms-cm
		☒	2				Grades less silty ▽				
		☒	3				POORLY GRADED SAND WITH SILT (SP-SM), brown, medium dense to dense, wet, medium-grained sand, trace gravel [ALLUVIUM]				
	5		4A 4B	39	83			9.1	131.8		WA: 6%<#200 sieve
515			5A 5B	35	89		SANDY SILT WITH CLAY (ML), olive, hard, slightly moist, low plasticity (compressibility), trace sandstone fragments to 1/4 inch with trace iron oxide staining/mottling [ALLUVIUM]				
							CLAYEY SAND WITH GRAVEL (SC), bluish gray, dense, moist, fine gravel [LIVERMORE GRAVELS (UPPER PART)]				
	10		6A 6B	51	89			10.5	130.5		
510			7	44	67		Trace carbonate				Soil in sampler shoe bagged at 10.5 ft.
	15		8A 8B	57	100		CLAYEY SILT (MH), bluish gray, hard, slightly moist to moist, high plasticity, trace gravel [LIVERMORE GRAVELS (UPPER PART)]				
505			9	34	67		CLAYEY SAND to SILTY SAND WITH GRAVEL (SC/SM), bluish gray, dense, slightly moist to moist [LIVERMORE GRAVELS (UPPER PART)]				
	20		10A 10B	50/6"	96		Becomes slightly moist, with disseminated carbonate				
500			11	47	67						
							CLAYEY SILT (MH), bluish gray, hard, slightly moist, high plasticity, trace gravel [LIVERMORE GRAVELS (UPPER PART)]				
	25		12A 12B	50/6"	100						PP >4.0 tsf
495			13	85/10"	100						
	30						TOTAL DEPTH = 26.3 feet				Finish drilling at 16:00.

Report: GEO_10B1_OAK; File: OAK_CALHABIT.GPJ; 5/11/2009 GB-01

URS

Project: SFPUC Habitat Mitigation Program
Project Location: Alameda and Santa Clara Counties, CA
Project Number: 28067577

Log of Boring GB-2

Sheet 1 of 1

Date(s) Drilled	**4/2/09**	Logged By	**M. McKee**	Checked By	**M. Schmoll**
Drilling Method	**Hollow-Stem Auger**	Drill Bit Size/Type	**8-inch-OD rock bit**	Total Depth of Borehole	**25.0 feet**
Drill Rig Type	**Fraste Multi-Drill XL (track rig)**	Drilling Contractor	**Pitcher Drilling Co.**	Approx. Ground Surface Elevation	**521 feet**
Groundwater Level(s)	**4 feet bgs during drilling**	Sampling Method(s)	**Grab, SPT, Modified California**	Hammer Data	**Automatic hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Neat cement grout to ground surface**	Location	**Berm W of graded road and N of creek crossing, ~85 ft N of GB-1**	GPS Location	**N 37.58516° W 121.78922°**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
520	0	☒	1				POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM), yellowish brown, dry, fine gravel, trace cobbles to 10 inches [ALLUVIUM]				Start at 08:40. CARB 435
							POORLY GRADED GRAVEL (GP), brown and gray, dry, fine gravel, trace sand [ALLUVIUM]				
		☒	2				▽				First groundwater at 4 ft at 08:55.
			3A				POORLY GRADED SAND (SP), gray to dark gray, medium dense, very moist, medium- to coarse-grained, trace gravel [ALLUVIUM]	15.5	114.6		WA: 4%<#200 sieve
	5		3B 3C	24	83		CLAYEY SILT (ML), olive with yellowish brown mottling (iron oxide-stained sandstone clasts), hard, slightly moist, low plasticity				
515			4	21	100						PP >4.0 tsf
							CLAYEY SILT (ML), olive with yellowish brown mottling, hard, slightly moist, low plasticity [ALLUVIUM]				
	10		5A 5B	57	89		CLAYEY SILT WITH SAND (MH), bluish gray, hard, moist, high plasticity fines, fine-grained sand, trace fine blueschist gravel [LIVERMORE GRAVELS (UPPER PART)]	12.6	125.4		WA: 71%<#200 sieve
510			6	62	89						CARB 435
	15		7A	50/6"	100		SANDY CLAYEY SILT WITH GRAVEL (MH), bluish gray, hard, moist, high plasticity fines, fine-grained sand, fine subrounded blueschist gravel [LIVERMORE GRAVELS (UPPER PART)]				
505			8	55	89						
							Becomes greenish gray to bluish gray, with disseminated carbonate				
	20		9A 9B	54	89						PP >4.0 tsf
500			10	62	56		Fine subrounded gravel consists of dark gray to bluish gray fine-grained sandstone				
	25		11A	50/6"	100						
495			12	50/6"	100		TOTAL DEPTH = 25.0 feet				Finish drilling at 12:00.
	30										

Report: GEO_10B1_OAK; File: OAK_CALHABIT.GPJ; 5/11/2009 GB-02

URS

Project: SFPUC Habitat Mitigation Program
Project Location: Alameda and Santa Clara Counties, CA
Project Number: 28067577

Log of Boring GB-2A/PB-3

Sheet 1 of 1

Date(s) Drilled	**4/2/09 - 4/3/09**	Logged By	**M. McKee**	Checked By	**M. Schmoll**
Drilling Method	**Hollow-Stem Auger**	Drill Bit Size/Type	**8-inch-OD rock bit**	Total Depth of Borehole	**27.0 feet**
Drill Rig Type	**Fraste Multi-Drill XL (track rig)**	Drilling Contractor	**Pitcher Drilling Co.**	Approx. Ground Surface Elevation	**521 feet**
Groundwater Level(s)	**6 feet bgs during drilling**	Sampling Method(s)	**Grab, SPT, Modified California**	Approx. Top of Casing Elevation	**523.3 feet**
Borehole Completion	**Standpipe piezometer, 2-in.-dia. PVC screen 15.5-25.5 ft (see schematic)**	Location	**Berm W of graded road and N of creek crossing, ~75 ft N of GB-1**	GPS Location	**N 37.58531° W 121.78931°**

Elevation, feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	WELL SCHEMATIC AND CONSTRUCTION DETAILS	FIELD NOTES
	0							6-in.x6-in.x5-ft steel stovepipe well box	
520		☒	1				SILTY SAND WITH GRAVEL (SM), yellowish brown, dry, fine gravel [ALLUVIUM]	Cement grout backfill (0-2.4 ft)	Start at 11:50 on 4/2/09. Grab samples collected for corrosivity testing.
		☒	2				Becomes moist		
		☒	3				SANDY SILT (ML), brown to dark brown, moist, low plasticity, trace clay [ALLUVIUM]	Bentonite pellet seal (2.4-4.0 ft)	
	5		4A 4B	22	67		POORLY GRADED SAND WITH SILT (SP-SM), brown and gray, medium dense, very moist, medium- to coarse-grained sand [ALLUVIUM]		WA: 5%<#200 sieve WC=3.3% DUW=107.7 pcf
515			5	30	33		Becomes grayish brown, wet, with trace fine angular to subangular sandstone gravel ▽	8-in.-dia. borehole	First groundwater at 6 ft at 12:10.
	10		6A 6B	56	67		POORLY GRADED SAND (SP), grayish brown, dense to very dense, wet, medium- to coarse-grained sand, trace clay and fine gravel [ALLUVIUM]	2-in.-dia. Sch. 40 PVC solid casing (2.3 ft ags-15.5 ft)	
510			7	56	56				WA: 3%<#200 sieve
	15		8A 8B	58	89		CLAYEY SILT WITH SAND (ML), bluish gray, hard, slightly moist to moist, low plasticity fines, fine-grained sand [LIVERMORE GRAVELS (UPPER PART)]	No. 3 sand (4.0-26.8 ft)	
505			9	50	83				PP >4.0 tsf
	20		10A 10B	44	83		CLAYEY SILT (MH), bluish gray to greenish gray, hard, slightly moist, high plasticity [LIVERMORE GRAVELS (UPPER PART)]	2-in.-dia. Sch. 40 PVC screen, 0.020-in. slot (15.5-25.5 ft)	PP=3.5, 4.2, 4.5 tsf Soil blocky, more clayey; older material?
500			11	48	78				
	25		12A 12B	69	100				
495			13	52	89		With fine-grained sand and disseminated carbonate	Slough	
							TOTAL DEPTH = 27.0 feet		End drilling at 15:30. Place sand to 18 ft, then end for 4/2/09. Complete installing piezometer at 09:45 on 4/3/09.
	30								

Report: GEO_12W_OAK_PIEZPOINT; File: OAK_CALHABIT.GPJ; 5/11/2009 GB-02A

URS

Project: SFPUC Habitat Mitigation Program
Project Location: Alameda and Santa Clara Counties, CA
Project Number: 28067577

Log of Boring / Piezometer PB-1

Sheet 1 of 1

Date(s) Drilled	**3/30/09**	Logged By	**M. McKee**	Checked By	**M. Schmoll**
Drilling Method	**Hollow-Stem Auger**	Drill Bit Size/Type	**8-inch-OD rock bit**	Total Depth of Borehole	**27.0 feet**
Drill Rig Type	**Fraste Multi-Drill XL (track rig)**	Drilling Contractor	**Pitcher Drilling Co.**	Approx. Ground Surface Elevation	**484 feet**
Groundwater Level(s)	**Not encountered during or at completion of drilling**	Sampling Method(s)	**No sampling; logged cuttings**	Approx. Top of Casing Elevation	**486.3 feet**
Borehole Completion	**Standpipe piezometer, 2-in.-dia. PVC screen 17-27 ft (see schematic)**	Location	**Relatively level alluvial terrace ~1/2 mile west of creek crossing**	GPS Location	**N 37.58245° W 121.80074°**

Elevation, feet	Depth, feet	SAMPLES: Type Number	SAMPLES: Sampling Resistance, blows / foot	SAMPLES: Recovery, %	Graphic Log	MATERIAL DESCRIPTION	WELL SCHEMATIC AND CONSTRUCTION DETAILS	FIELD NOTES
484	0					SILTY SAND (SM), grayish brown, moist, trace fine gravel, rootlets [NATIVE SOIL/ALLUVIUM]	6-in.x6-in.x5-ft steel stovepipe well box; Cement grout backfill (0-2.0 ft)	Start at 09:15. Boring advanced only for piezometer installation. No sampling performed. Logged from cuttings. Some reddish brown fine sandstone in cuttings.
						POORLY GRADED GRAVEL WITH SILT to SILTY GRAVEL (GP-GM/GM), gray, dry to slightly moist, subangular to subrounded fine-grained sandstone gravel [ALLUVIUM]		
480						CLAYEY SAND (SC), olive gray, moist to very moist, trace gravel [ALLUVIUM]	Bentonite pellet seal (2.0-4.5 ft)	
	5					CLAYEY SILT (ML/MH), olive, slightly moist, medium to high plasticity (compressibility), homogeneous, trace flecks of bluish gray silt [ALLUVIUM]	8-in.-dia. borehole	Flecks of bluish gray silt in cuttings.
475						POORLY GRADED GRAVEL WITH SILT (GP-GM), gray, slightly moist, subangular to subrounded sandstone and grayish blue meta-sandstone gravel, variable silt content [ALLUVIUM]		
	10					CLAYEY SILT (ML), bluish gray, moist, low to medium plasticity (compressibility), homogeneous [LIVERMORE GRAVELS (UPPER PART)]	2-in.-dia. Sch. 40 PVC solid casing (2.3 ft ags-17.0 ft)	
470								
	15					Becomes greenish gray to bluish gray, well-consolidated	No. 3 sand (4.5-27.0 ft)	
465								
	20						2-in.-dia. Sch. 40 PVC screen, 0.020-in. slot (17.0-27.0 ft)	
460								
	25							Reach 24 ft at 11:30. Hard drilling below 24 ft; 30 min. to drill to 27 ft. No cuttings returned to surface.
						TOTAL DEPTH = 27.0 feet		End drilling at 12:10. Finish piezometer installation at 15:15.
455	30							

Report: GEO_12W_OAK_PIEZPOINT; File: OAK_CALHABIT.GPJ; 5/11/2009 PB-01

URS

Project: SFPUC Habitat Mitigation Program
Project Location: Alameda and Santa Clara Counties, CA
Project Number: 28067577

Log of Boring / Piezometer PB-2

Sheet 1 of 1

Date(s) Drilled	**3/31/09**	Logged By	**M. McKee**	Checked By	**M. Schmoll**
Drilling Method	**Hollow-Stem Auger**	Drill Bit Size/Type	**8-inch-OD rock bit**	Total Depth of Borehole	**28.0 feet**
Drill Rig Type	**Fraste Multi-Drill XL (track rig)**	Drilling Contractor	**Pitcher Drilling Co.**	Approx. Ground Surface Elevation	**508 feet**
Groundwater Level(s)	**9 feet bgs during drilling**	Sampling Method(s)	**No sampling; logged cuttings**	Approx. Top of Casing Elevation	**510.6 feet**
Borehole Completion	**Standpipe piezometer, 2-in.-dia. PVC screen 18-28 ft (see schematic)**	Location	**Relatively level alluvial terrace**	GPS Location	**N 37.58495° W 121.79366°**

Elevation, feet	Depth, feet	SAMPLES: Type Number	SAMPLES: Sampling Resistance, blows / foot	SAMPLES: Recovery, %	Graphic Log	MATERIAL DESCRIPTION	WELL SCHEMATIC AND CONSTRUCTION DETAILS	FIELD NOTES
	0						6-in.x6-in.x5-ft steel stovepipe well box	
						POORLY GRADED GRAVEL WITH SILT (GP-GM), gray and brown, dry, subangular to subrounded gravel and cobbles to 4 inches consisting of fine-grained sandstone, sandy siltstone, and trace hornblende and epidote fragments, variable silt content [ALLUVIUM]	Cement grout backfill (0-2.5 ft)	Start at 08:00. Boring advanced only for piezometer installation. No sampling performed. Logged from cuttings.
505						Becomes brown to reddish brown, with sand		
	5					Grades with more cobbles	Bentonite pellet seal (2.5-4.5 ft)	
							8-in.-dia. borehole	
500						SILTY GRAVEL WITH SAND AND CLAY (GM), brown, very moist, mostly fine gravel [ALLUVIUM]		
								First groundwater encountered at 9 ft at 09:15.
	10					CLAYEY SAND (SC), olive brown, very moist to wet, trace fine gravel [ALLUVIUM/ALLUVIAL FAN DEPOSITS?]	2-in.-dia. Sch. 40 PVC solid casing (2.6 ft ags-18.0 ft)	
						CLAYEY SILT (ML/MH), olive to olive gray, very moist to wet, medium to high plasticity (compressibility) [LIVERMORE GRAVELS (UPPER PART)]		Upper few inches of clayey silt may be slightly oxidized. Drilling firm, harder below 12.5 ft.
495								
	15					CLAYEY SILT to SILT WITH CLAY (MH), bluish gray, moist, high plasticity (compressibility), homogeneous [LIVERMORE GRAVELS (UPPER PART)]	No. 3 sand (4.5-28.0 ft)	
490								Reach 18 ft at 09:30.
	20						2-in.-dia. Sch. 40 PVC screen, 0.020-in. slot (18.0-28.0 ft)	
485								
	25							
480						TOTAL DEPTH = 28.0 feet		Finish drilling at 10:20.
	30							

Report: GEO_12W_OAK_PIEZPOINT; File: OAK_CALHABIT.GPJ; 5/11/2009 PB-02

URS

Project: SFPUC Habitat Mitigation Program
Project Location: Alameda and Santa Clara Counties, CA
Project Number: 28067577

Log of Boring / Piezometer PB-4

Sheet 1 of 1

Date(s) Drilled	**3/31/09**	Logged By	**M. McKee**	Checked By	**M. Schmoll**
Drilling Method	**Hollow-Stem Auger**	Drill Bit Size/Type	**8-inch-OD rock bit**	Total Depth of Borehole	**25.0 feet**
Drill Rig Type	**Fraste Multi-Drill XL (track rig)**	Drilling Contractor	**Pitcher Drilling Co.**	Approx. Ground Surface Elevation	**535 feet**
Groundwater Level(s)	**Not encountered during or at completion of drilling**	Sampling Method(s)	**No sampling; logged cuttings**	Approx. Top of Casing Elevation	**537.5 feet**
Borehole Completion	**Standpipe piezometer, 2-in.-dia. PVC screen 15-25 ft (see schematic)**	Location	**Relatively level alluvial terrace**	GPS Location	**N 37.58527° W 121.78540°**

Elevation, feet	Depth, feet	SAMPLES: Type Number	SAMPLES: Sampling Resistance, blows / foot	SAMPLES: Recovery, %	Graphic Log	MATERIAL DESCRIPTION	WELL SCHEMATIC AND CONSTRUCTION DETAILS	FIELD NOTES
535	0					POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM), brown to grayish brown, moist, trace cobbles [ALLUVIUM]	6-in.x6-in.x5-ft steel stovepipe well box; Cement grout backfill (0-2.0 ft)	Start at 12:45. Boring advanced only for piezometer installation. No sampling performed. Logged from cuttings.
530	5					Grades with more cobbles	Bentonite pellet seal (2.0-4.0 ft); 8-in.-dia. borehole	No cuttings returned to surface from 4 ft to 12 ft.
525	10						2-in.-dia. Sch. 40 PVC solid casing (2.5 ft ags-15.0 ft)	Drilling easier from 7-7.5 ft, then more cobbles.
520	15					CLAYEY SAND to SILTY SAND (SC/SM), olive brown to grayish brown, wet, homogeneous [ALLUVIUM / ALLUVIAL FAN DEPOSITS?]	No. 3 sand (4.0-25.0 ft)	
515	20					CLAYEY SILT (MH), bluish gray, moist, high plasticity (compressibility), trace fine-grained sand [LIVERMORE GRAVELS (UPPER PART)]	2-in.-dia. Sch. 40 PVC screen, 0.020-in. slot (15.0-25.0 ft)	Drilling firm, harder below 17.5 ft.
510	25					TOTAL DEPTH = 25.0 feet		End drilling at 14:30. Finish piezometer installation at 16:00.
505	30							

Report: GEO_12W_OAK_PIEZPOINT; File: OAK_CALHABIT.GPJ; 5/11/2009 PB-04

URS

Project: SFPUC Habitat Mitigation Program
Project Location: Alameda and Santa Clara Counties, CA
Project Number: 28067577

Log of Boring / Piezometer PB-5

Sheet 1 of 1

Date(s) Drilled	**4/1/09**	Logged By	**M. McKee**	Checked By	**M. Schmoll**
Drilling Method	**Hollow-Stem Auger**	Drill Bit Size/Type	**8-inch-OD rock bit**	Total Depth of Borehole	**24.0 feet**
Drill Rig Type	**Fraste Multi-Drill XL (track rig)**	Drilling Contractor	**Pitcher Drilling Co.**	Approx. Ground Surface Elevation	**553 feet**
Groundwater Level(s)	**7.5 feet bgs during drilling**	Sampling Method(s)	**No sampling; logged cuttings**	Approx. Top of Casing Elevation	**555.5 feet**
Borehole Completion	**Standpipe piezometer, 2-in.-dia. PVC screen 14-24 ft (see schematic)**	Location	**Relatively level alluvial terrace**	GPS Location	**N 37.58315° W 121.78028°**

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance, blows / foot	SAMPLES Recovery, %	Graphic Log	MATERIAL DESCRIPTION	WELL SCHEMATIC AND CONSTRUCTION DETAILS	FIELD NOTES
553	0						SANDY SILT WITH GRAVEL (ML), brown, moist, fine subangular to subrounded gravel [ALLUVIUM]	6-in.x6-in.x5-ft steel stovepipe well; Cement grout backfill (0-3.0 ft)	Start at 08:00. Boring advanced only for piezometer installation. No sampling performed. Logged from cuttings.
550							Becomes grayish brown, very moist, with less gravel, little clay	Bentonite pellet seal (3.0-4.0 ft)	
	5						SANDY CLAY WITH GRAVEL (CL), dark brown, very moist, low plasticity fines, fine gravel [ALLUVIUM]	8-in.-dia. borehole	
545							POORLY GRADED GRAVEL (GP), dark gray and black, wet, fine angular to subrounded sandstone gravel [ALLUVIUM]		First groundwater encountered at 7.5 ft at 08:25.
	10						CLAYEY SAND WITH GRAVEL (SC), olive brown, wet [ALLUVIUM]	2-in.-dia. Sch. 40 PVC solid casing (2.5 ft ags-14.0 ft)	
540							CLAYEY SILT (MH), bluish gray, moist to very moist, high plasticity (compressibility), trace fine-grained sand, homogeneous [LIVERMORE GRAVELS (UPPER PART)]		
	15						Possible gravel layer	No. 3 sand (4.0-24.0.0 ft)	Driller reports gravel layer 16.5-17 ft; gravel not observed in cuttings.
535								2-in.-dia. Sch. 40 PVC screen, 0.020-in. slot (14.0-24.0 ft)	
	20								
530									
	25						TOTAL DEPTH = 24.0 feet		End drilling at 10:15. Finish piezometer installation at 11:55.
525									
	30								

Report: GEO_12W_OAK_PIEZPOINT; File: OAK_CALHABIT.GPJ; 5/11/2009 PB-05

URS

CITY AND COUNTY OF SAN FRANCISCO

PUBLIC UTILITIES COMMISSION

SAN FRANCISCO WATER DEPARTMENT

CONTRACT NO. WD-_____

SAN ANTONIO CREEK

30% SUBMITTAL

MAY, 2010

DRAWING INDEX

PLAN NUMBER	DRAWING NUMBER	TITLE
GENERAL		
G-1	E-	COVER SHEET
G-2	E-	LEGEND AND ABBREVIATIONS
G-3	E-	GENERAL NOTES AND PROJECT LOCATION
G-4	E-	SITE LOCATION AND VICINITY MAP
G-5	E-	STAGING AND ACCESS PLAN
G-6	E-	KEY MAP
CIVIL		
C-1	E-	PLAN AND PROFILE STA 0+00 TO 13+04
C-2	E-	PLAN AND PROFILE STA 13+04 TO 26+07
C-3	E-	PLAN AND PROFILE STA 26+07 TO 39+11
C-4	E-	PLAN AND PROFILE STA 39+11 TO 52+14
C-5	E-	PLAN AND PROFILE STA 52+14 TO 65+18
C-6	E-	PLAN AND PROFILE STA 65+18 TO 78+22
C-7	E-	PLAN AND PROFILE STA 78+22 TO 91+25
C-8	E-	PLAN AND PROFILE STA 91+25 TO 102+00
C-9	E-	FENCING LAYOUT
C-10	E-	TYPICAL CHANNEL SECTIONS (1 OF 2)
C-11	E-	TYPICAL CHANNEL SECTIONS (2 OF 2)
DETAILS		
D-1	E-	CROSS VANE GRADE CONTROL STRUCTURE DETAILS (1 OF 3)
D-2	E-	J-HOOK GRADE CONTROL STRUCTURE DETAILS (2 OF 3)
D-3	E-	WEIR GRADE CONTROL STRUCTURE DETAILS (3 OF 3)
D-4	E-	FENCE DETAILS
PLANTING		
P-1	E-	PLANTING PLAN SHEET 1 OF 4
P-2	E-	PLANTING PLAN SHEET 2 OF 4
P-3	E-	PLANTING PLAN SHEET 3 OF 4
P-4	E-	PLANTING PLAN SHEET 4 OF 4
P-5	E-	PLANTING SCHEDULE

GENERAL SYMBOLS

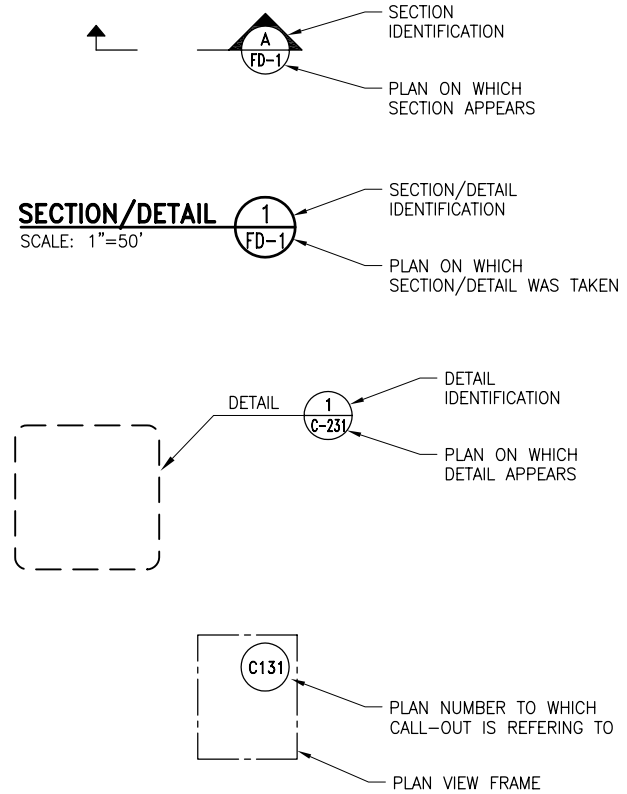
- BORING
- CENTER LINE
- CUT SLOPE
- DIAMETER
- DIRECTION OF FLOW
- EXISTING CONTROL POINT
- EXPLORATORY BORING
- FILL SLOPE
- FLOW LINE
- PIEZOMETERS
- PROPOSED CONTROL POINT
- SLOPE GRADIENT (HOR. : VERT.) — 1.5:1
- SPOT ELEVATION — x
- TREE, SHRUB
- WATER LEVEL ELEVATION
- EXISTING ROADWAY CORRIDOR
- EXISTING FENCE WIRED/BARBWIRED
- FENCE DEMOLITION
- LIMITS OF WORK
- WILDLIFE FRIENDLY FENCE
- (E) CONTOUR MAJOR
- (E) CONTOUR MINOR
- BOLLARDS
- GATE
- GP — GATE POST
- GATE VALVE
- MONUMENT
- CONTROL POINT

- SECTION
- TEMPORARY ACCESS AREAS
- GRAVEL
- STAGING AREAS
- EARTHWORK FILL
- EARTHWORK CUT
- POOL AREA
- SILL ROCK
- FOOTER ROCK
- STREAM BED
- STREAM BANK

GENERAL ABBREVIATIONS

AB	AGGREGATE BASE
AC	ASPHALT CONCRETE
ADD	ADDITION(AL)
ADDL	ADDITIONAL
ALT	ALTERNATE
ASTM	AMERICAN SOCIETY TESTING MATERIAL
APPROX	APPROXIMATE
B, CB	BORINGS
BOT	BOTTOM
BOF	BOTTOM OF FOOTING
BRG	BEARING
CAP	CAPACITY
C/C or CC	CENTER TO CENTER
CF	CUBIC FEET
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CI	CAST IRON
CJ	CONSTRUCTION JOINT
℄	CENTERLINE
CLR	CLEARANCE
CO	COUNTY
CONC	CONCRETE
CONN	CONNECTION
CONT	CONTINUE
CONST	CONSTRUCTION
CP	CONTROL POINT
CTR	CENTER
D	DEPTH
DBKF	DEPTH AT BANKFULL
DET	DETAIL
DIA	DIAMETER
DIM	DIMENSION
DN	DOWN
D/S	DOWNSTREAM
DR	DRAINAGE, DOOR
DWG	DRAWING
(E), E	EXISTING
EA	EACH
EC	END CURVE
EG	EXISTING GROUND
EL, ELEV	ELEVATION
EXIST	EXISTING
FDN	FOUNDATION
FG	FINISH GROUND
FIG	FIGURE
FIN	FINISHED
FL	FLOW LINE
FLEX	FLEXIBLE
FPS	FEET PER SECOND
FS	FACTOR OF SAFETY
FT	FOOT
GA	GAUGE
GALV	GALVANIZED
GEN	GENERAL
GL	GLIDE
GR	GRADE
GRD	GROUND
GRTG	GRATING
GV	GATE VALVE
H	HEIGHT
HGL	HYDRAULIC GRADE LINE
HOR	HORIZONTAL
ID	INSIDE DIAMETER, IDENTIFICATION
IN	INCH
INV	INVERT
JT	JOINT
JCT	JUNCTION
L	LENGTH
LONG	LONGITUDINAL
MATL	MATERIAL
MAX	MAXIMUM
MFR	MANUFACTURE(R)
MIN	MINIMUM
MISC	MISCELLANEOUS
(N), N	NEW
N/A	NOT APPLICABLE
NIC	NOT IN CONTRACT
NMWS	NORMAL MAXIMUM WATER SURFACE
NOM	NOMINAL
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OG	ORIGINAL GROUND SURFACE
OH	OVER HEAD
OPNG	OPENING
PL	PLATE OR PROPERTY LINE
PO	POOL
R	RADIUS, RISER
RCP	REINFORCED CONCRETE PIPE
R/C	REINFORCED CONCRETE
REF	REFERENCE
REQ'D	REQUIRED
RF	RIFFLE
RN	RUN
ROW	RIGHT OF WAY
SA	SAN ANTONIO
S	SLOPE
SCH	SCHEDULE
SECT	SECTION
SFPUC	SAN FRANCISCO PUBLIC UTILITY COMMISSION
SHT	SHEET
SIM	SIMILAR
℄	SPRINGLINE
SPEC	SPECIFICATION(S)
SS	STAINLESS STEEL
STA	STATION
STD	STANDARD
STL	STEEL
STRUCT	STRUCTURE
SWPPP	STORM WATER POLLUTION PREVENTION PLAN
t	THICKNESS
T & B	TOP & BOTTOM
TCE	TEMPORARY CONSTRUCTION EASEMENT
TOC	TOP OF CONCRETE
TOS	TOP OF SLAB
TYP	TYPICAL
THK	THICK
UG	UNDERGROUND
UON	UNLESS OTHERWISE NOTED
U/S	UPSTREAM
V	VALVE
W/	WITH
W	WIDTH, WEST
WBKF	WIDTH OF BANKFULL
WSL	WATER SURFACE LEVEL
WT	WATER TIGHT, WEIGHT

TYPICAL SECTION/DETAIL NUMBERING SYSTEM



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CONTRACT NO. WD–

30% DRAFT
MAY 21, 2010

ELEVATION DATUM
NAVD88

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER: SS	DRAWN: RA
PROJECT MANAGER: FD	DESIGNED: JP
APPROVAL: SAC	CHECKED: EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
LEGEND AND ABBREVIATIONS

CHECKED / APPROVED	DRAWN	SCALE: NONE
SECTION MANAGER	DESIGNED	DATE
APPROVED: MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED: MANAGER, WATER SUPPLY AND TREATMENT DIVISION	
SHEET: OF	PLAN NO.: G-2	DRAWING NO.: E– / REVISION NO.

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

P:\CADD\Sheets\San Antonio\G-2.dwg May 24, 2010 – 12:05pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

GENERAL NOTES:

1. THE NORTH ORIENTATION OF THESE PLANS IS BASED UPON A GRID DIRECTION.
2. THE TOPOGRAPHIC INFORMATION SHOWN ON THE PLANS WAS COMPILED USING LIDAR 2006 DATA OBTAINED FROM ALAMEDA COUNTY AND FIELD SURVEY DATA PERFORMED BY SFPUC IN MARCH 2009.
3. PROJECT COORDINATE SYSTEM AND VERTICAL DATUM ARE AS FOLLOWS:
   COORDINATE SYSTEM: NAD83, CALIFORNIA STATE PLANE ZONE 3
   VERTICAL DATUM: NORTH AMERICA VERTICAL DATUM OF 1988 (NAVD88)
4. ALL DISTANCES WITHIN THESE PLANS ARE BASED UPON THE US SURVEY FOOT AND DECIMALS THEREOF AND ARE GROUND DISTANCES.
5. WHERE THERE IS A DISCREPANCY BETWEEN THE WRITTEN DIMENSION AND SCALED DIMENSION, WRITTEN DIMENSIONS SHALL GOVERN.
6. ALL DISCREPANCIES BETWEEN THE INFORMATION SHOWN IN THE PLANS AND THE ACTUAL FIELD CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE CITY REPRESENTATIVE.
7. THE CONTRACTOR SHALL LIMIT CONSTRUCTION OPERATIONS TO WITHIN THE RIGHT-OF-WAY AND EASEMENTS AND DESIGNATED WORK AREAS AS INDICATED. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR ANY DAMAGES OUTSIDE THE RIGHT-OF-WAY, EASEMENTS, AND DESIGNATED WORK AREAS SHOWN ON THE DRAWINGS.

EXISTING UTILITIES:

1. CONTRACTOR SHALL NOTIFY UNDERGROUND SERVICE ALERT (USA) PRIOR TO DIGGING.
2. LOCATIONS OF ALL UTILITY SERVICE LINES SHALL BE FIELD VERIFIED BY POT HOLING PRIOR TO COMMENCING ANY GRADING, TRENCHING OR EXCAVATION.
3. UTILITIES, EXISTING AT THE TIME OF CONSTRUCTION, ARE UNKNOWN.
4. THE CONTRACTOR SHALL TAKE PRECAUTIONARY MEASURES TO PROTECT ALL EXISTING UTILITY LINES AND STRUCTURES NOT SHOWN ON THESE PLANS.
5. ALL CONTRACTOR WORK AROUND EXISTING UTILITIES SHALL BE IN CONFORMANCE WITH CALIFORNIA GOVERNMENT CODE 4216.
6. THE CONTRACTOR SHALL PROTECT IN PLACE ALL OVERHEAD INTERFERENCE. THE CONTRACTOR SHALL USE EXTREME CAUTION WHEN WORKING NEAR OVERHEAD OR UNDERGROUND POWER, GAS, AND/OR OTHER UTILITIES SO AS TO SAFELY PROTECT ALL PERSONNEL AND EQUIPMENT, AND SHALL BE RESPONSIBLE FOR ALL COSTS AND LIABILITY IN CONNECTION THEREWITH.
7. CONTRACTOR SHALL CONTACT UTILITY POLE OWNER PRIOR TO WORKING IN AREA AND UTILITY POLE OWNER WILL DO ALL WORK ON UTILITY POLES. THE CONTRACTOR SHALL PAY ALL THE COSTS ASSOCIATED WITH UTILITY POLE MODIFICATIONS AND THE CONTRACTOR SHALL INCLUDE THE TIME NEEDED BY THE UTILITY POLE OWNER AS PART OF THE OVERALL WORK.

DEMOLITION NOTES:

1. CONTRACTOR MAY RE-USE MATERIAL SUBJECT TO SUBMITTALS PER SPECIFICATION AND REVIEW BY THE CITY REPRESENTATIVE.
2. ALL EXCAVATION WORK WITHIN DRIP LINE OF EXISTING TREES THAT ARE TO REMAIN SHALL BE PERFORMED BY HAND. CLEANLY CUT ANY ROOT LARGER THAN ONE INCH DIAMETER. DO NOT TEAR ROOTS.

TREE REMOVAL:

1. ALL REMOVAL OR PRUNING OF EXISTING TREES OR SHRUB SHALL BE PERFORMED UNDER THE DIRECTION OF THE CITY REPRESENTATIVE.
2. ALL TREES DESIGNED TO BE REMOVED SHALL BE CLEANLY CUT AND THE STUMP GROUNDED TO ONE FEET BELOW GRADE AND THE MATERIAL SHALL BE DISPOSED IN A LEGAL MANNER.
3. NO GRADING SHALL OCCUR WITH THE DRIPLINE OF AN EXISTING TREE. ANY EXCAVATION THAT OCCURS ADJACENT OR AROUND A TREE MUST MAINTAIN A SLOPE LESS THAN 2H:1V FROM THE DRIPLINE.

EARTHWORK ESTIMATE

ITEM	EARTHWORK (YD^3)
EXCAVATION: CHANNEL BOTTOM	13,754
EXCAVATION: FLOOD PLAIN AND BANKS	31,017
EXCAVATION: STREAM BANKS AND FLOODPLAIN SLOPES	11,526
EXCAVATION: BRIDGE ABUTMENTS AND PIER	250
FILL: CHANNEL BOTTOM	13,435
FILL: FLOOD PLAIN	31,630
FILL: STREAM BANKS AND FLOODPLAIN SLOPES	8,863
FILL: BRIDGE ABUTMENTS, PIER AND ROADWAY	2,300
HAUL EXCESS ALLUVIAL MATERIAL	319

(THESE NUMBERS ARE PRELIMINARY AND SUBJECT TO CHANGE)
* FILL VALUES INCLUDE 15% SHRINKAGE

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CONTRACT NO. WD-

30% DRAFT
MAY 21, 2010

ELEVATION DATUM
NAVD88

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER	DRAWN
SS	RA
PROJECT MANAGER	DESIGNED
FD	JP
APPROVAL	CHECKED
SAG	EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
GENERAL NOTES AND
PROJECT LOCATION

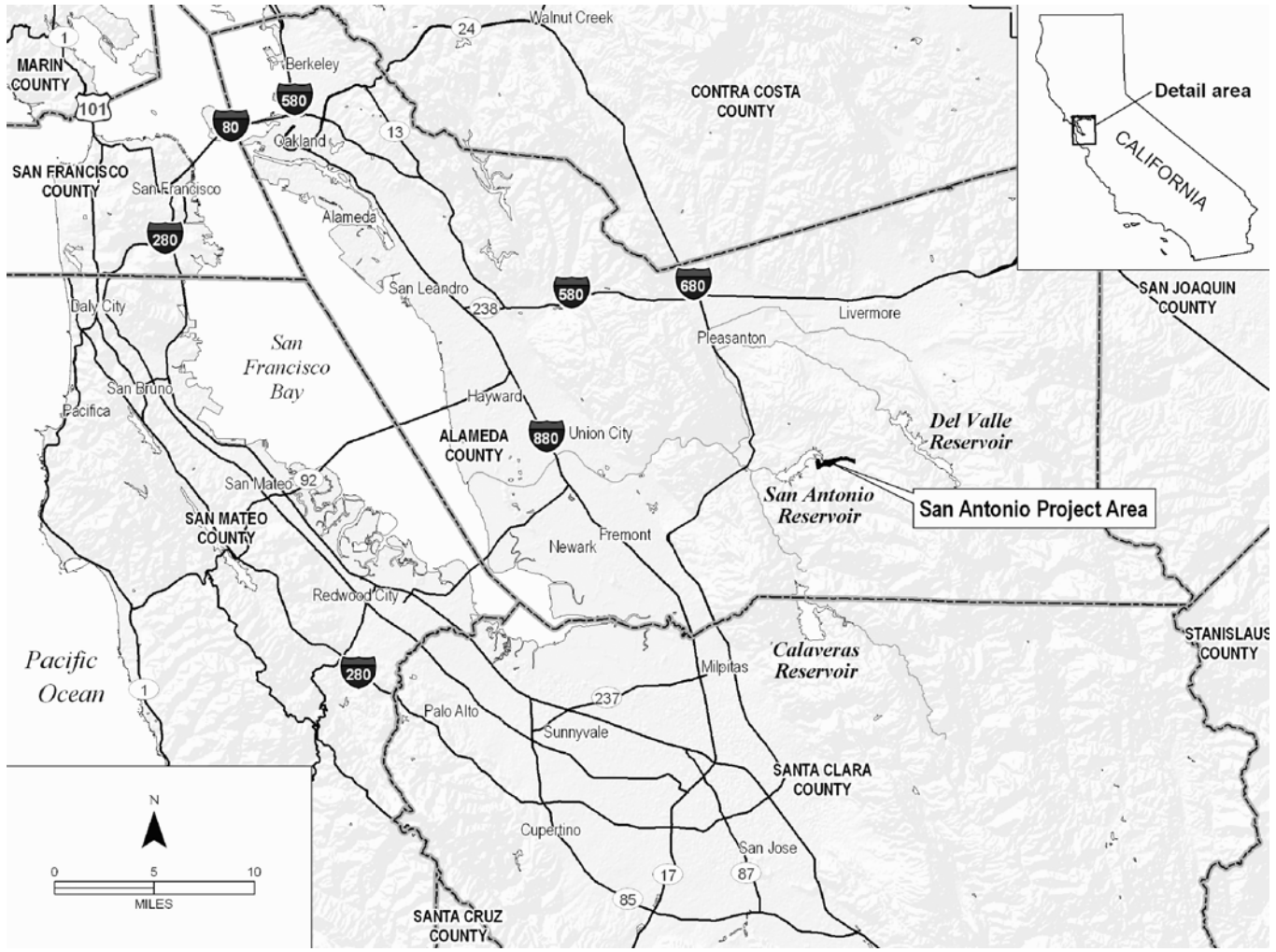
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APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	G-3	E-	

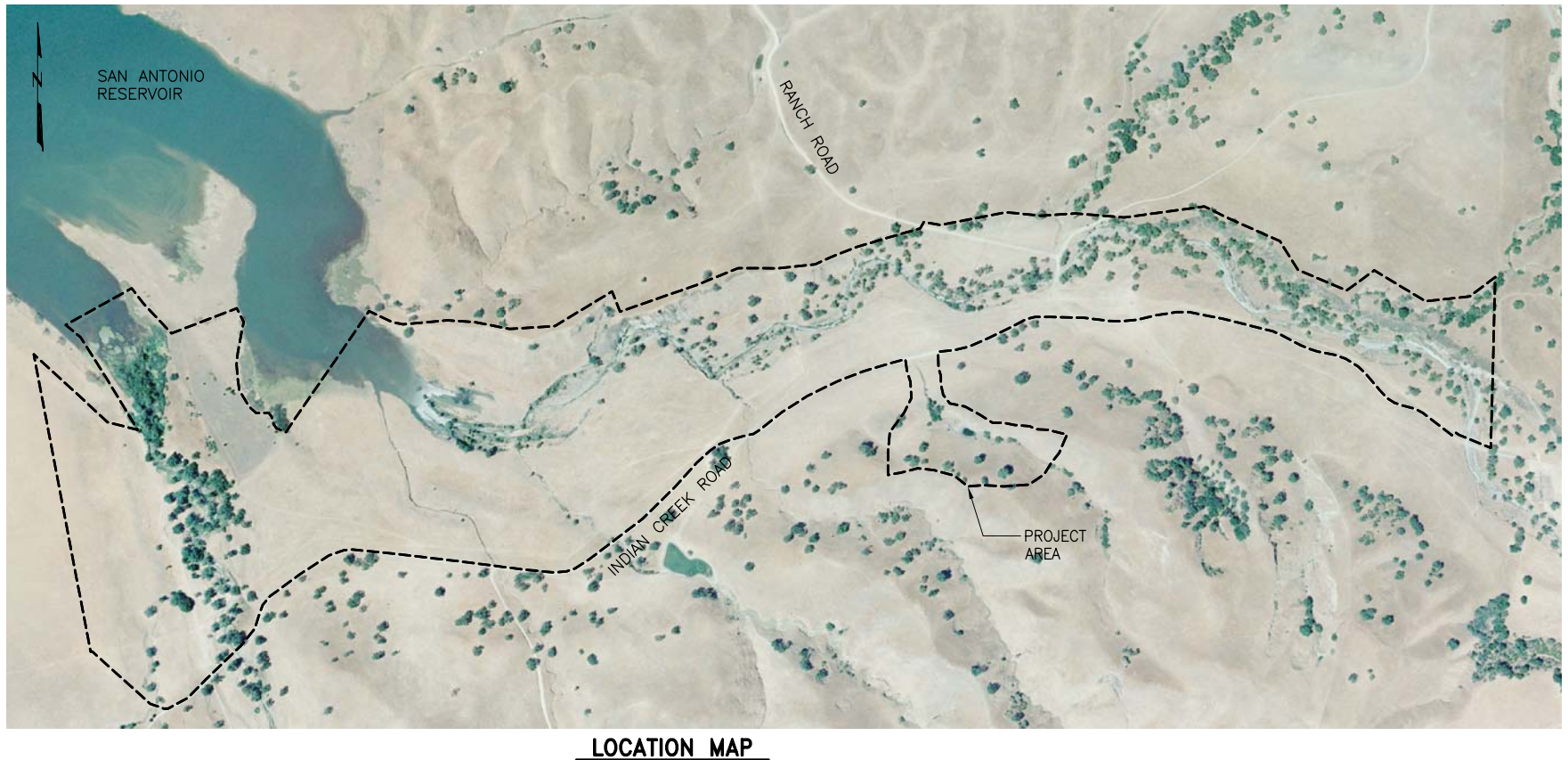
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BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

P:\CADD\Sheets\San Antonio\G-3.dwg May 21, 2010 – 2:41pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



VICINITY MAP



LOCATION MAP
SCALE: 1" = 600'

ELEVATION DATUM
NAVD88

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MAY 21, 2010

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URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER	DRAWN
SS	RA
PROJECT MANAGER	DESIGNED
FD	JP
APPROVAL	CHECKED
SAG	EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
SITE LOCATION AND VICINITY MAP

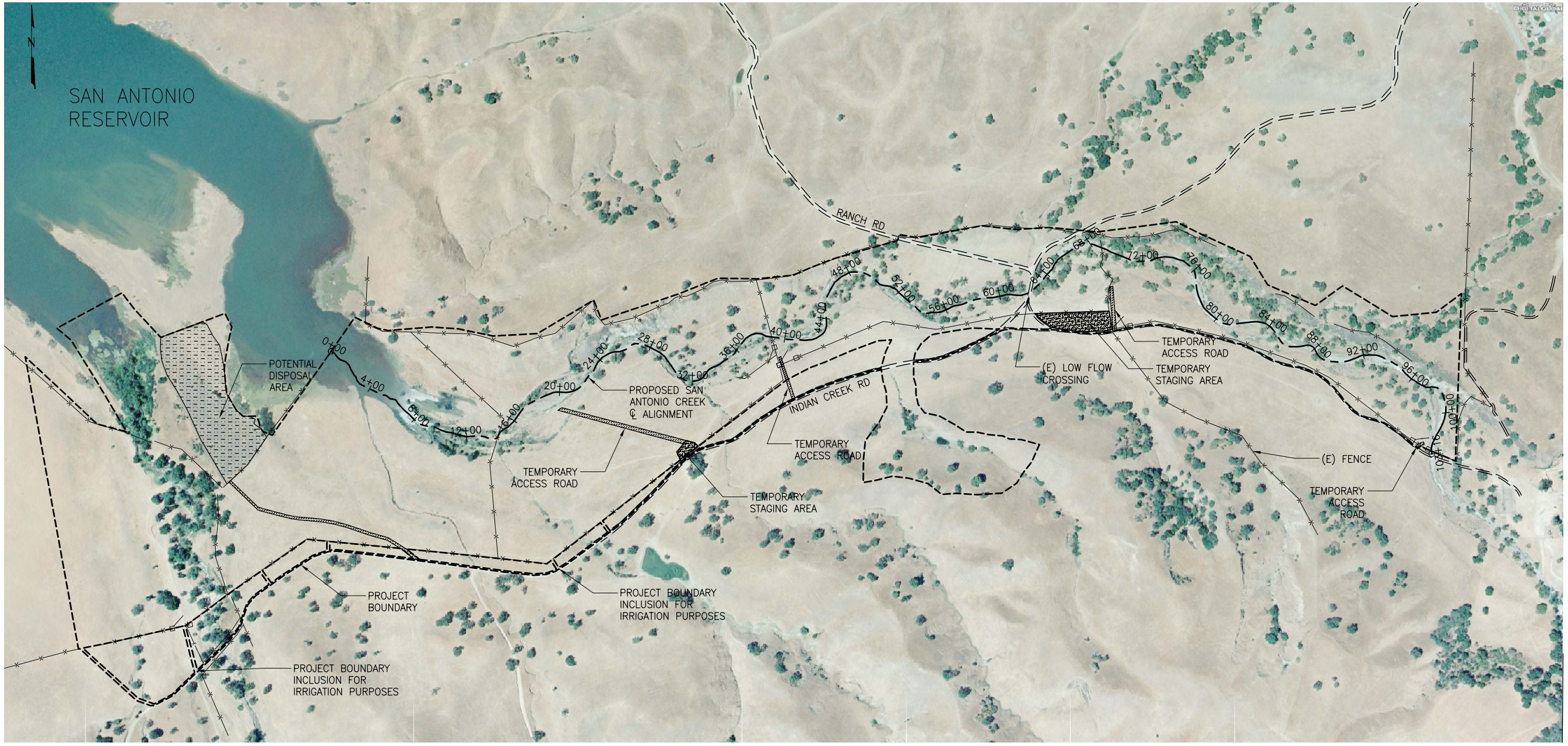
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SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	G-4	E–	

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

P:\CADD\Sheets\San Antonio\G-4.dwg May 24, 2010 – 12:07pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1" = 400'

NOTE:
1. SITE ACCESS IS VIA STATE ROUTE 84/VALLECITOS ROAD TO VALLECITOS LANE/RANCH ROAD.
2. THE SOUTHWEST PROJECT BOUNDARY INCLUDES 7 LINEAR ACCESS POINTS FROM INDIAN CREEK ROAD AND ONE LONGER INCLUSION ALONG INDIAN CREEK ROAD FOR PLACEMENT OF IRRIGATION LINES AND EQUIPMENT ACCESS.

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OAKLAND, CA 94612
PHONE: (510) 893-3600

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
STAGING AND ACCESS PLAN

PROJECT ENGINEER: SS	DRAWN: RA
PROJECT MANAGER: FD	DESIGNED: JP
APPROVAL: SAG	CHECKED: EK

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	G–5	E–	

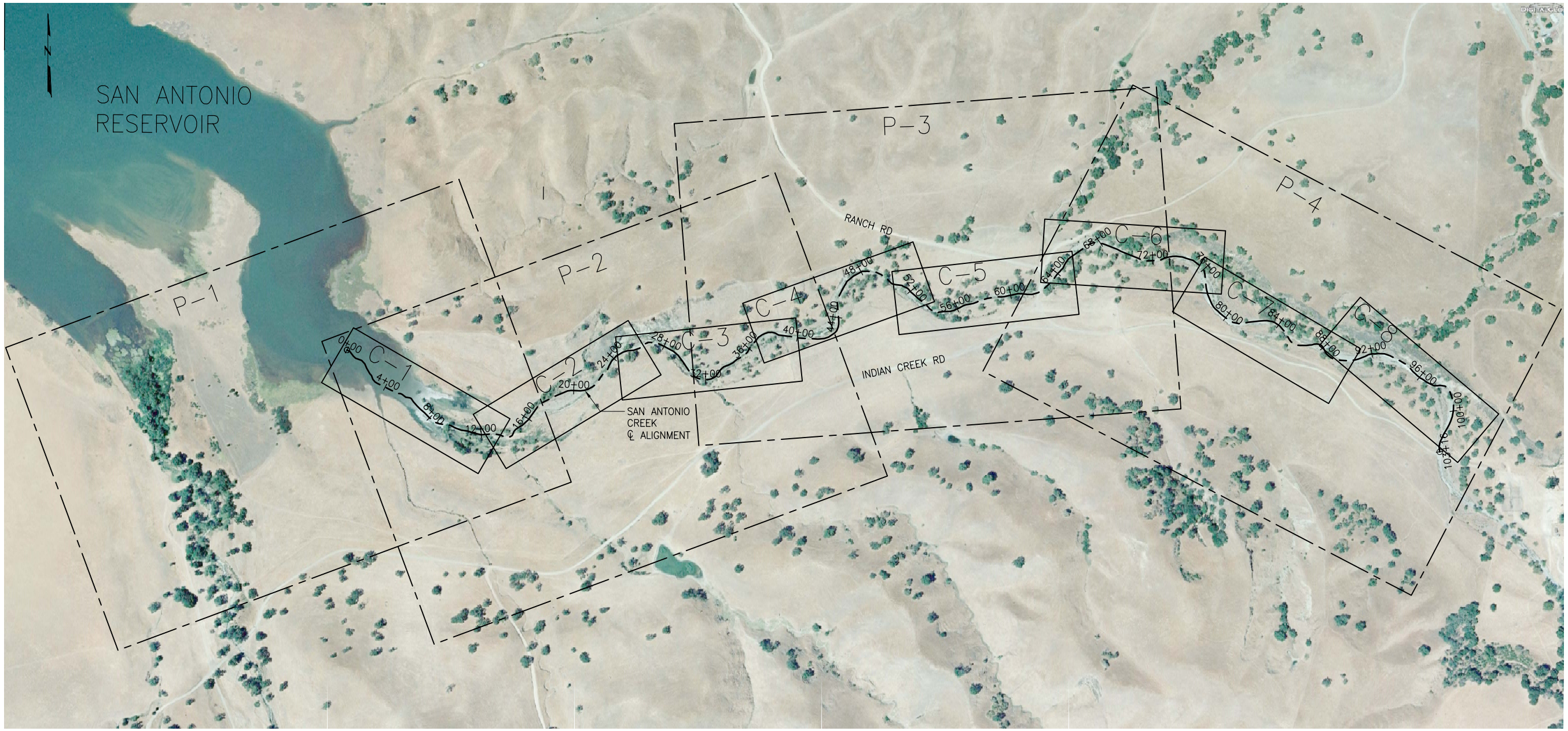
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SCALE 1"=400'

ELEVATION DATUM
NAVD88

PLOT: EXTEND
SCALE: 1:1
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22,34
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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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10 1.00MM
100 0.70MM
210 0.60MM

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FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1" = 400'

400 0 400 800
SCALE 1"=400'

ELEVATION DATUM
NAVD88

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PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER	DRAWN
SS	RA
PROJECT MANAGER	DESIGNED
FD	JP
APPROVAL	CHECKED
SAG	EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

SAN ANTONIO CREEK
KEY MAP

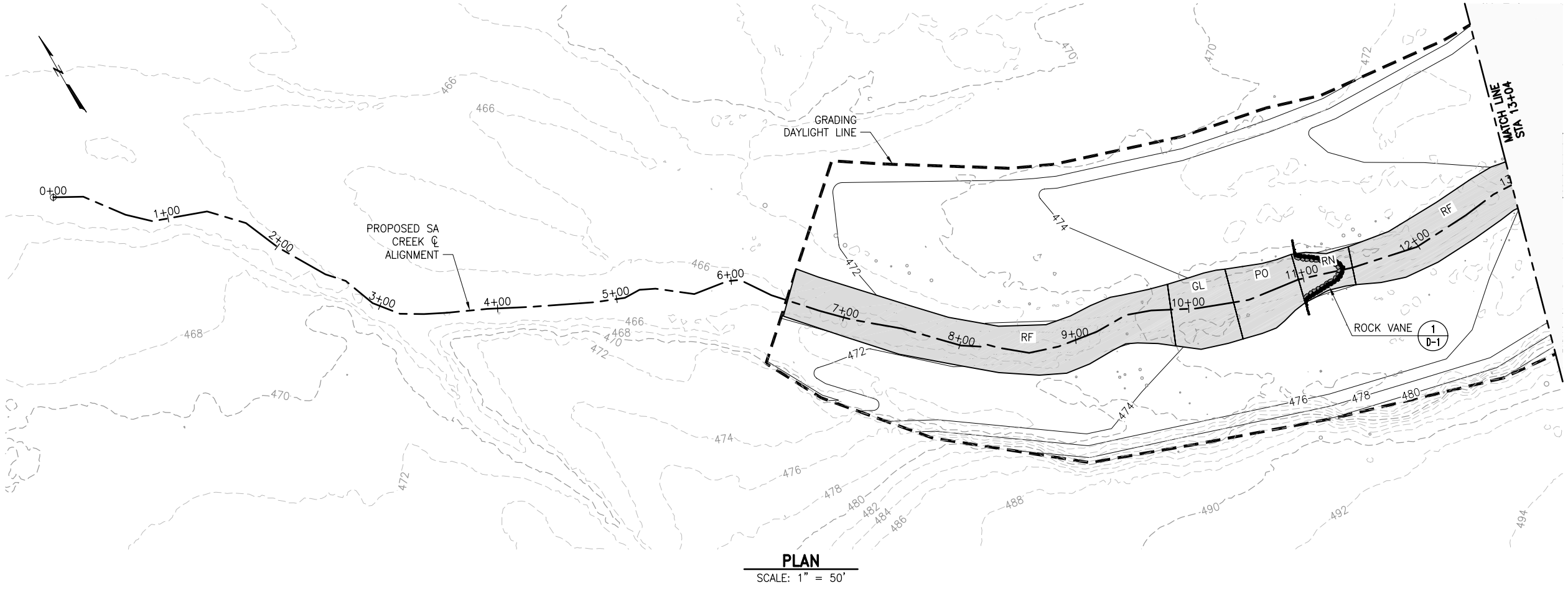
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		AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	G-6	E–	

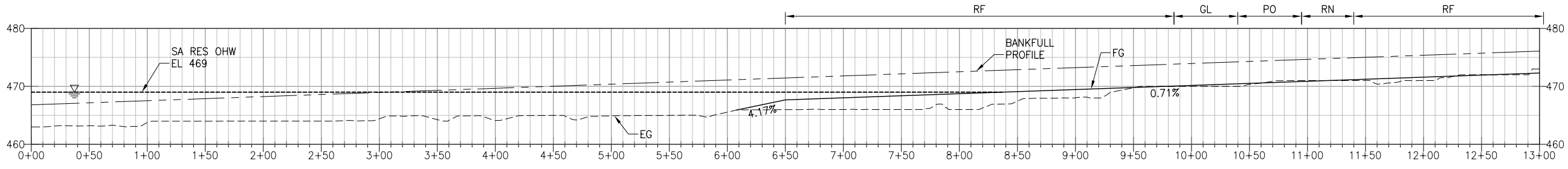
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SCALE: 1:1
BORDER:
22,34
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BLUE 0.50MM
MAGENTA 0.20MM
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GRAY 0.15MM
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10 1.00MM
100 0.70MM
210 0.60MM

P:\CADD\Sheets\San Antonio\G-6.dwg May 24, 2010 – 12:17pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1" = 50'



PROFILE
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'

LEGEND:

RF	RIFFLE
GL	GLIDE
PO	POOL
RN	RUN

NOTE:

1. SEE SHEETS C-10 AND C-11 FOR TYPICAL CHANNEL CROSS-SECTION DETAILS OF RIFFLE, GLIDE, POOL, AND RUN SECTIONS.
2. ONLY THE PROPOSED CENTERLINE ALIGNMENT IS SHOWN. THE EXISTING CENTERLINE ALIGNMENT WILL BE INCLUDED IN EXISTING CONDITIONS SHEETS IN FUTURE DESIGN SUBMITTALS.
3. SA RES OHW DETERMINED FROM 2006 AERIAL PHOTOGRAPH.

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CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
PLAN AND PROFILE
STA 0+00 TO 13+04

PROJECT ENGINEER: SS	DRAWN: AG		
PROJECT MANAGER: FD	DESIGNED: JP		
APPROVAL: SAG	CHECKED: EK		
CHECKED / APPROVED	DRAWN	SCALE: AS SHOWN	
SECTION MANAGER	DESIGNED	DATE	
APPROVED	APPROVED		
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION		
SHEET: OF	PLAN NO.: C-1	DRAWING NO.: E-	REVISION NO.

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

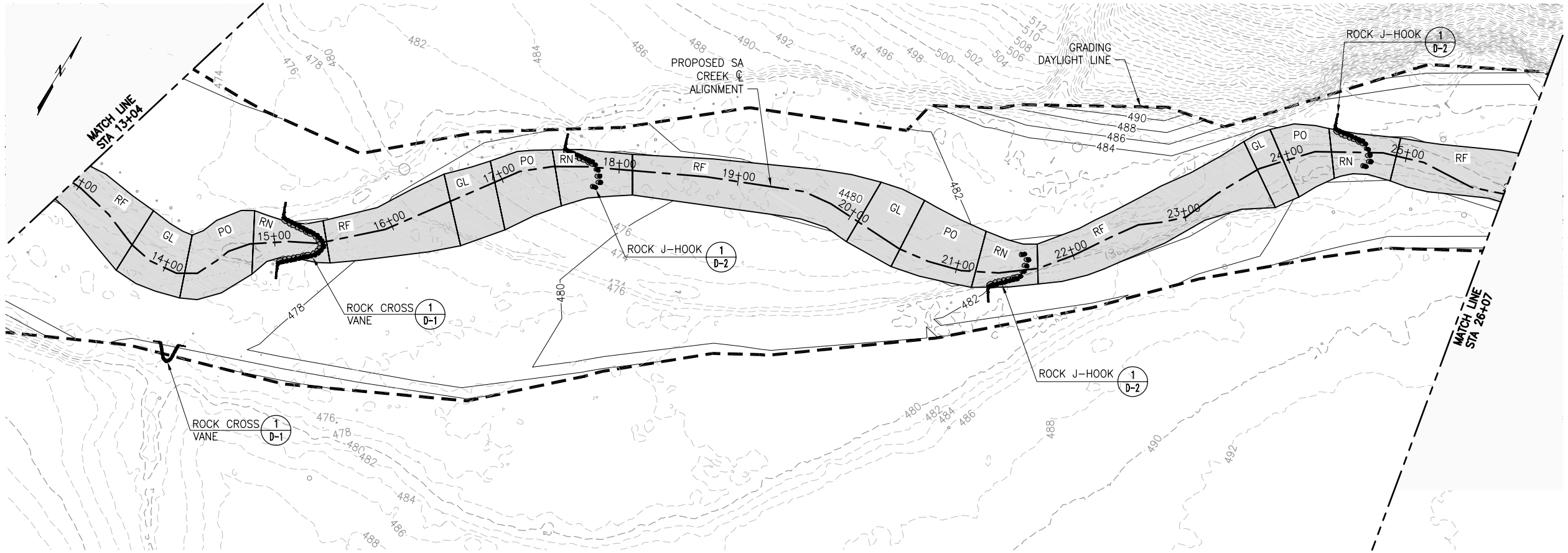
ELEVATION DATUM
NAVD88

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CYAN 0.40MM
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10 1.00MM
100 0.70MM
210 0.60MM

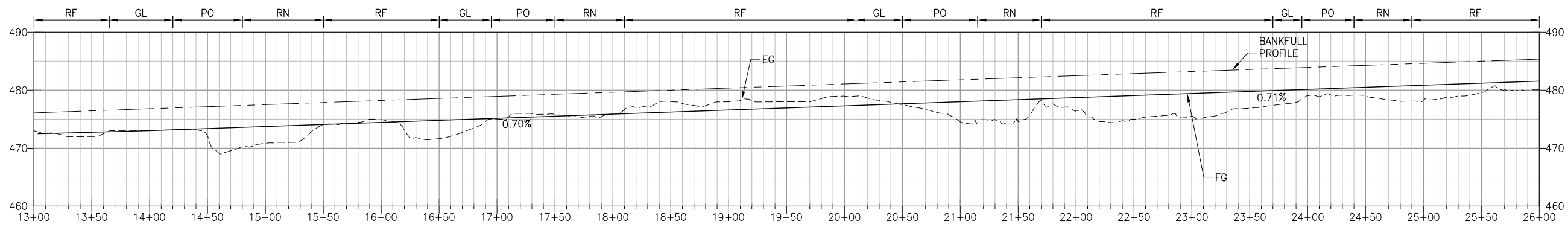
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SCALE 1"=50'

P:\CADD\Sheets\San Antonio\C1-C8.dwg May 21, 2010 - 5:05pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1" = 50'



PROFILE
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'

NOTE:

1. SEE SHEETS C-10 AND C-11 FOR TYPICAL CHANNEL CROSS-SECTION DETAILS OF RIFFLE, GLIDE, POOL, AND RUN SECTIONS.
2. ONLY THE PROPOSED CENTERLINE ALIGNMENT IS SHOWN. THE EXISTING CENTERLINE ALIGNMENT WILL BE INCLUDED IN EXISTING CONDITIONS SHEETS IN FUTURE DESIGN SUBMITTALS.
3. SA RES OHW DETERMINED FROM 2006 AERIAL PHOTOGRAPH.

LEGEND:

RF	RIFFLE
GL	GLIDE
PO	POOL
RN	RUN

50' 0 50' 100'
SCALE 1"=50'

ELEVATION DATUM
NAVD88

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MAY 21, 2010

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER SS	DRAWN AG
PROJECT MANAGER FD	DESIGNED JP
APPROVAL SAG	CHECKED EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK PLAN AND PROFILE STA 13+04 TO 26+07

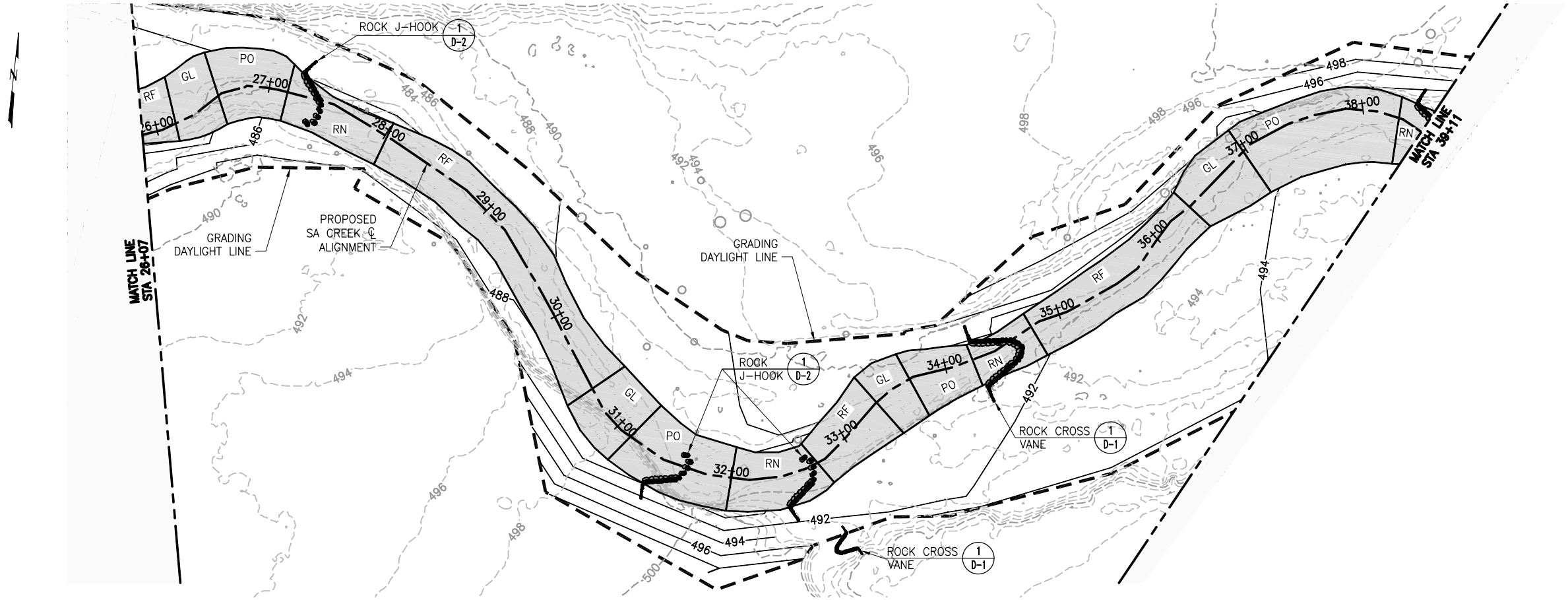
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SECTION MANAGER		DESIGNED	DATE
APPROVED		APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU		MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-2	E-	

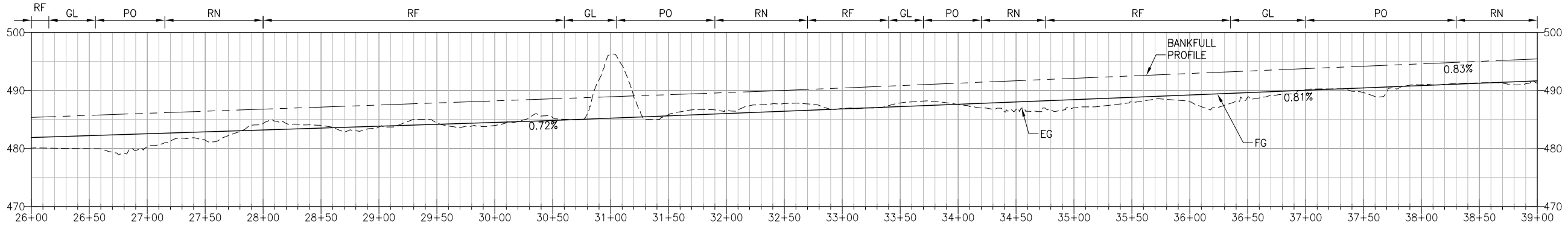
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10 1.00MM
100 0.70MM
210 0.60MM

P:\CADD\Sheets\San Antonio\C1-C8.dwg May 21, 2010 - 5:06pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1" = 50'



PROFILE
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'

NOTE:

1. SEE SHEETS C-10 AND C-11 FOR TYPICAL CHANNEL CROSS-SECTION DETAILS OF RIFFLE, GLIDE, POOL, AND RUN SECTIONS.
2. ONLY THE PROPOSED CENTERLINE ALIGNMENT IS SHOWN. THE EXISTING CENTERLINE ALIGNMENT WILL BE INCLUDED IN EXISTING CONDITIONS SHEETS IN FUTURE DESIGN SUBMITTALS.
3. SA RES OHW DETERMINED FROM 2006 AERIAL PHOTOGRAPH.

LEGEND:

RF	RIFFLE
GL	GLIDE
PO	POOL
RN	RUN

50' 0 50' 100'
SCALE 1"=50'

ELEVATION DATUM
NAVD88

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MAY 21, 2010

URS
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OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER SS	DRAWN AG
PROJECT MANAGER FD	DESIGNED JP
APPROVAL SAG	CHECKED EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

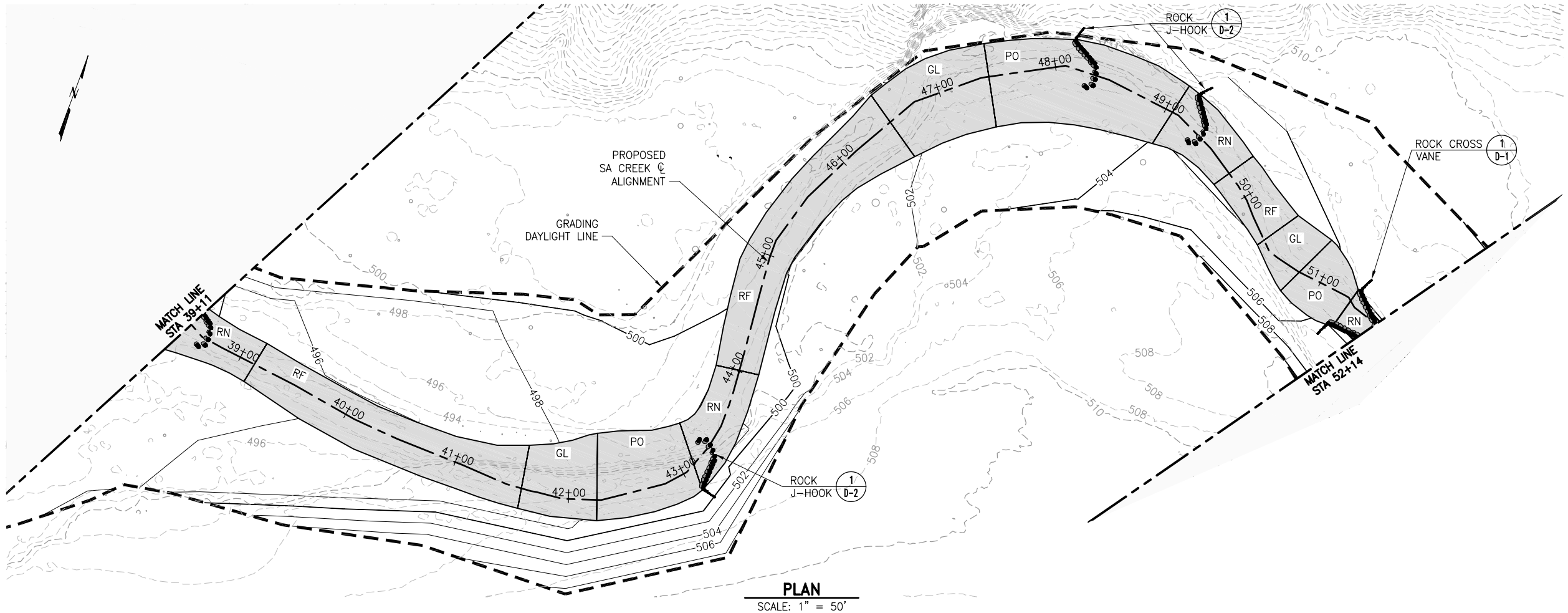
SAN ANTONIO CREEK
PLAN AND PLOT
STA 26+07 TO 39+11

CHECKED / APPROVED	DRAWN	SCALE AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED MANAGER, WATER SUPPLY AND TREATMENT DIVISION	
SHEET OF	PLAN NO. C-3	DRAWING NO. E- REVISION NO.

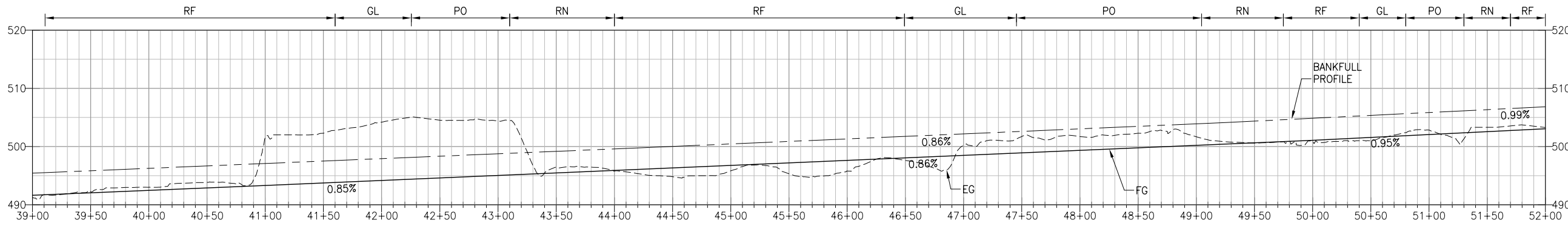
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BORDER:
22,34
COLOR: No.
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GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

P:\CADD\Sheets\San Antonio\C1-C8.dwg May 21, 2010 - 5:08pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1" = 50'



PROFILE
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'

LEGEND:

RF	RIFFLE
GL	GLIDE
PO	POOL
RN	RUN

NOTE:

1. SEE SHEETS C-10 AND C-11 FOR TYPICAL CHANNEL CROSS-SECTION DETAILS OF RIFFLE, GLIDE, POOL, AND RUN SECTIONS.
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3. SA RES OHW DETERMINED FROM 2006 AERIAL PHOTOGRAPH.

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CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
PLAN AND PROFILE
STA 39+11 TO 52+14

PROJECT ENGINEER: SS	DRAWN: AG
PROJECT MANAGER: FD	DESIGNED: JP
APPROVAL: SAG	CHECKED: EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

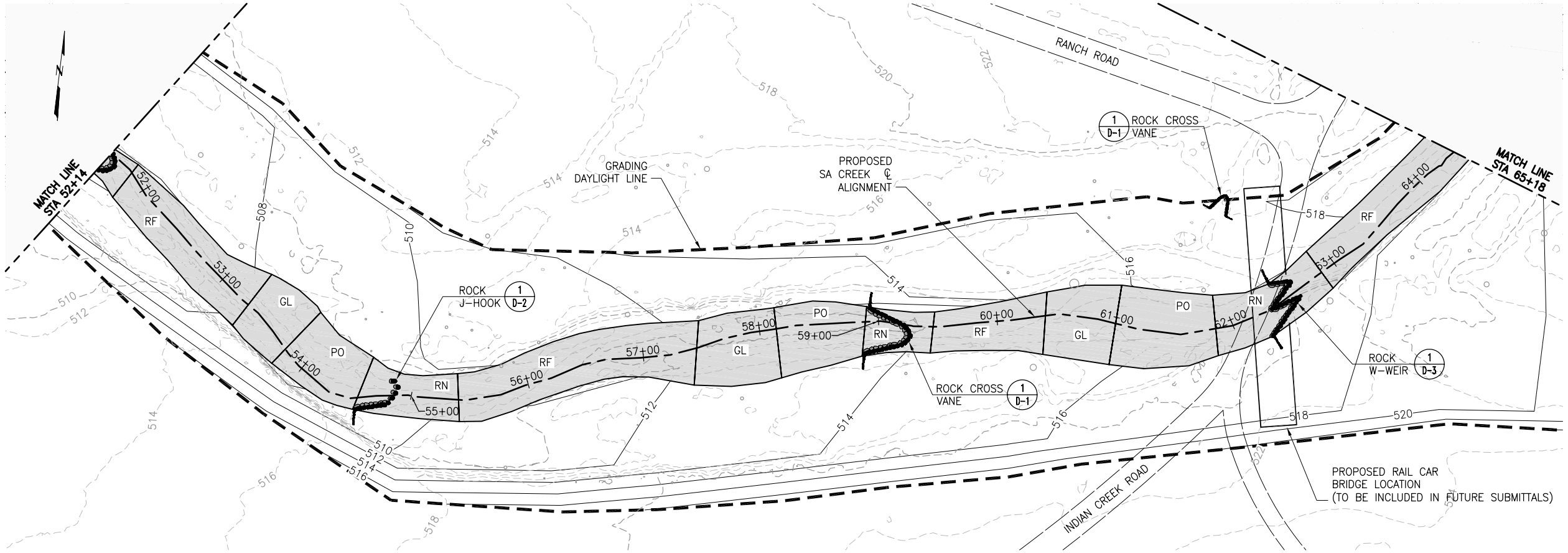
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SECTION MANAGER	DESIGNED	DATE	
APPROVED: MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED: MANAGER, WATER SUPPLY AND TREATMENT DIVISION		
SHEET: OF	PLAN NO.: C-4	DRAWING NO.: E-	REVISION NO.

ELEVATION DATUM
NAVD88

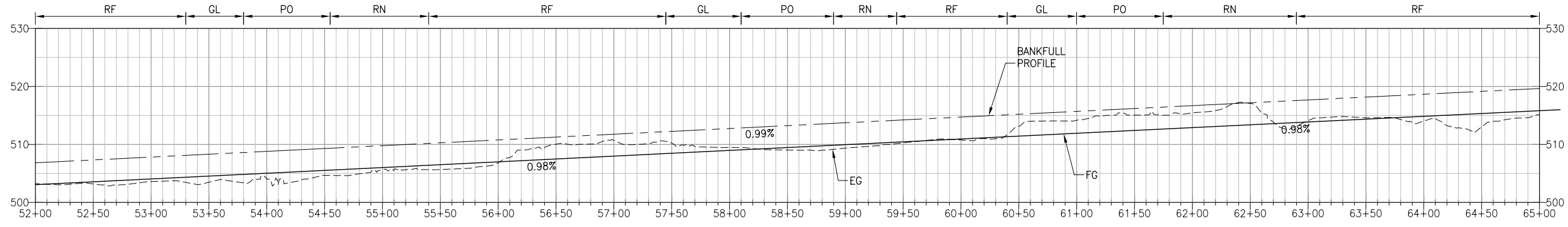
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SCALE: 1:1
BORDER: 22,34
COLOR: No.

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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
9	0.15MM
10	1.00MM
100	0.70MM
210	0.60MM

50' 0 50' 100'
SCALE 1"=50'



PLAN
SCALE: 1" = 50'



PROFILE
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'

LEGEND:

RF	RIFFLE
GL	GLIDE
PO	POOL
RN	RUN

NOTE:

1. SEE SHEETS C-10 AND C-11 FOR TYPICAL CHANNEL CROSS-SECTION DETAILS OF RIFFLE, GLIDE, POOL, AND RUN SECTIONS.
2. ONLY THE PROPOSED CENTERLINE ALIGNMENT IS SHOWN. THE EXISTING CENTERLINE ALIGNMENT WILL BE INCLUDED IN EXISTING CONDITIONS SHEETS IN FUTURE DESIGN SUBMITTALS.
3. SA RES OHW DETERMINED FROM 2006 AERIAL PHOTOGRAPH.

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MAY 21, 2010

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
PLAN AND PROFILE
STA 52+14 TO 65+18

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER: SS	DRAWN: AG
PROJECT MANAGER: FD	DESIGNED: JP
APPROVAL: SAG	CHECKED: EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

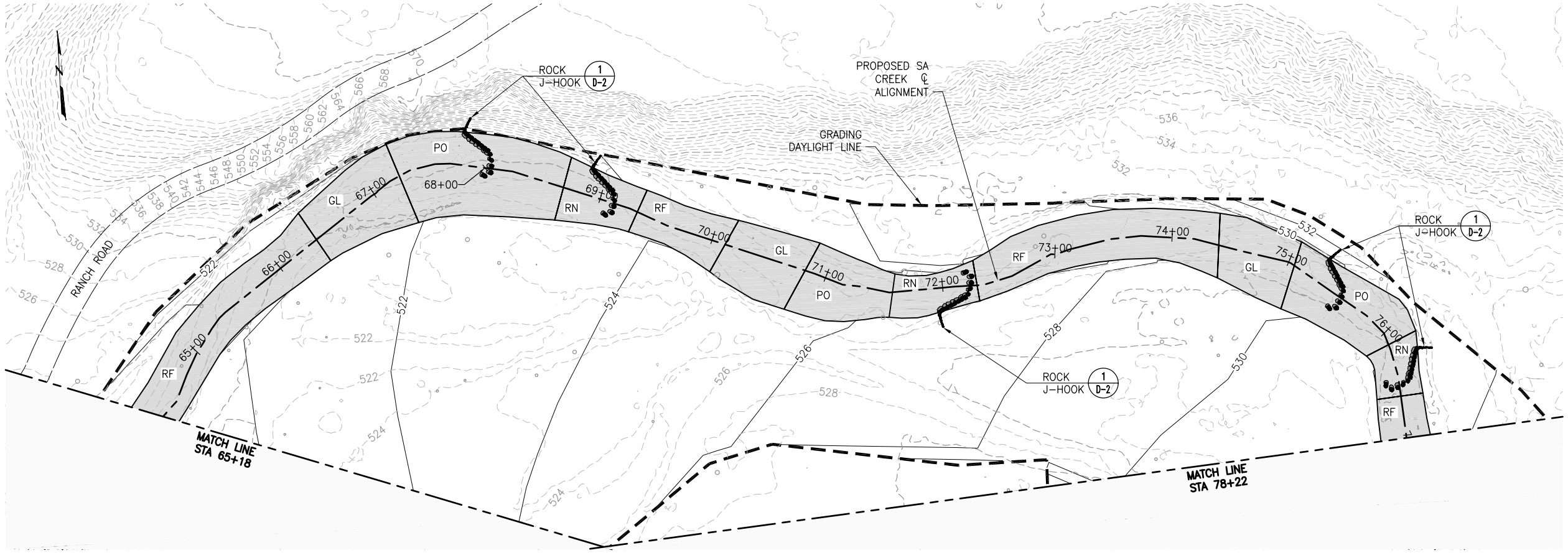
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SECTION MANAGER	DESIGNED	DATE	
APPROVED: MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED: MANAGER, WATER SUPPLY AND TREATMENT DIVISION		
SHEET: OF	PLAN NO.: C-5	DRAWING NO.: E-	REVISION NO.

ELEVATION DATUM
NAVD88

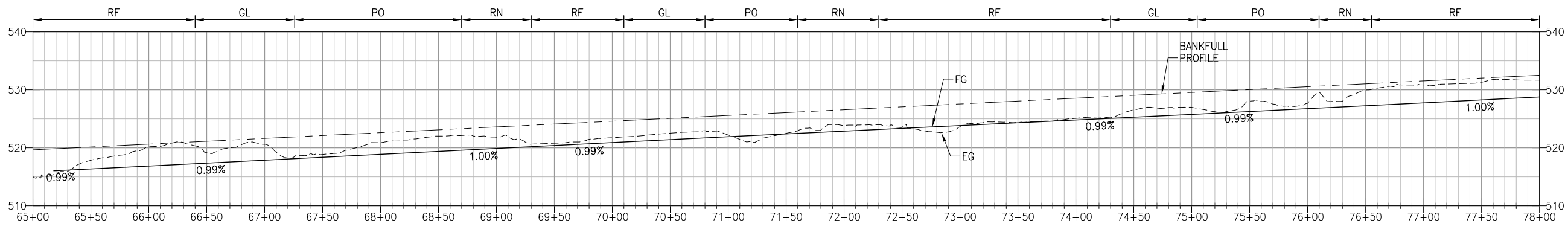
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BORDER: 22,34
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YELLOW	0.20MM
GREEN	0.25MM
CYAN	0.40MM
BLUE	0.50MM
MAGENTA	0.20MM
WHITE	0.35MM
GRAY	0.15MM
9	0.15MM
10	1.00MM
100	0.70MM
210	0.60MM

50' 0 50' 100'
SCALE 1"=50'



PLAN
SCALE: 1" = 50'



PROFILE
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'

LEGEND:

RF	RIFFLE
GL	GLIDE
PO	POOL
RN	RUN

NOTE:

1. SEE SHEETS C-10 AND C-11 FOR TYPICAL CHANNEL CROSS-SECTION DETAILS OF RIFFLE, GLIDE, POOL, AND RUN SECTIONS.
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3. SA RES OHW DETERMINED FROM 2006 AERIAL PHOTOGRAPH.

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MAY 21, 2010

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER: SS	DRAWN: AG
PROJECT MANAGER: FD	DESIGNED: JP
APPROVAL: SAG	CHECKED: EK

REVISIONS

NO.	DATE	DESCRIPTION	BY	APPR'D

ELEVATION DATUM
NAVD88

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
PLAN AND PROFILE
STA 65+18 TO 78+22

CHECKED / APPROVED	DRAWN	SCALE: AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED: MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED: MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-6	E-	

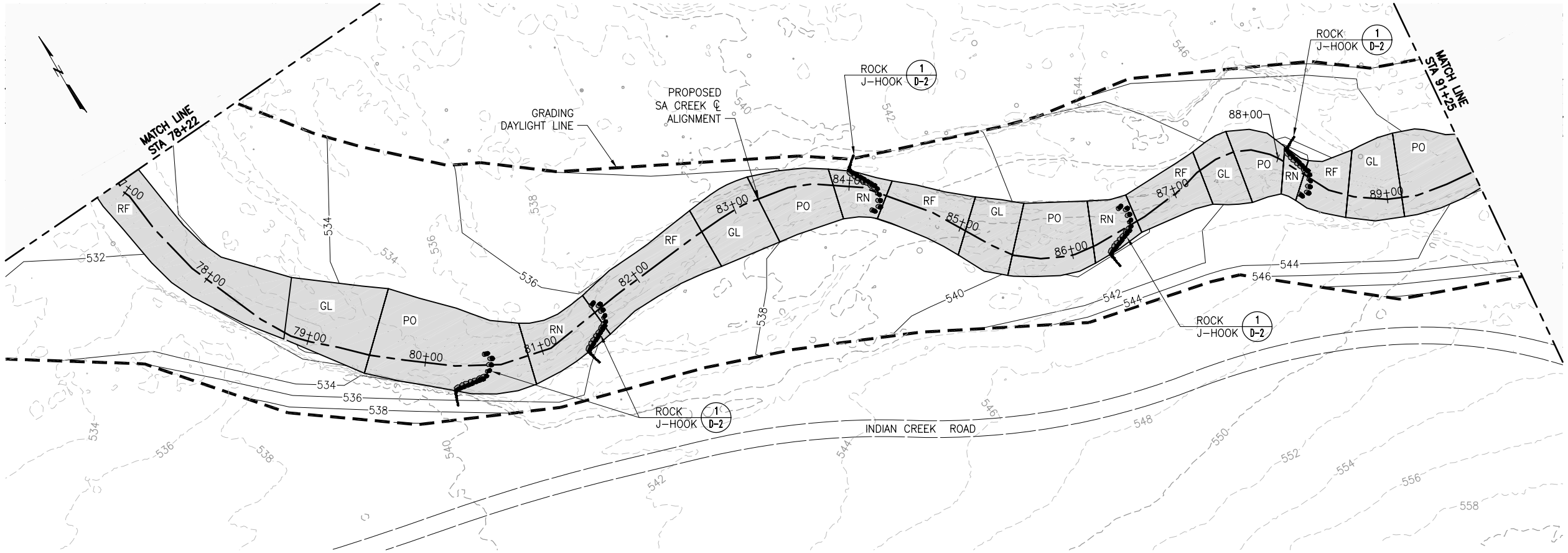
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BORDER: 22,34
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CYAN	0.40MM
BLUE	0.50MM
MAGENTA	0.20MM
WHITE	0.35MM
GRAY	0.15MM
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10	1.00MM
100	0.70MM
210	0.60MM

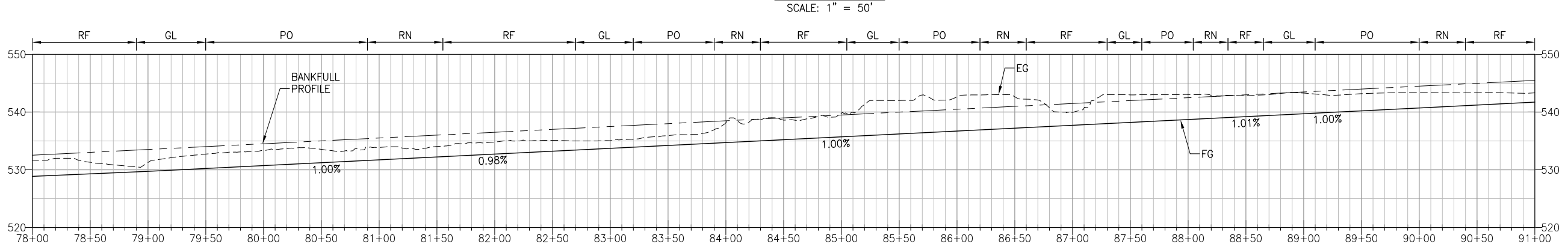
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SCALE 1"=50'

P:\CADD\Sheets\San Antonio\C1-C8.dwg May 21, 2010 – 4:56pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1" = 50'



PROFILE
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'

LEGEND:

RF	RIFFLE
GL	GLIDE
PO	POOL
RN	RUN

NOTE:

1. SEE SHEETS C-10 AND C-11 FOR TYPICAL CHANNEL CROSS-SECTION DETAILS OF RIFFLE, GLIDE, POOL, AND RUN SECTIONS.
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MAY 21, 2010

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER: SS	DRAWN: AG
PROJECT MANAGER: FD	DESIGNED: JP
APPROVAL: SAG	CHECKED: EK

REVISIONS

NO.	DATE	DESCRIPTION	BY	APPR'D

ELEVATION DATUM
NAVD88

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

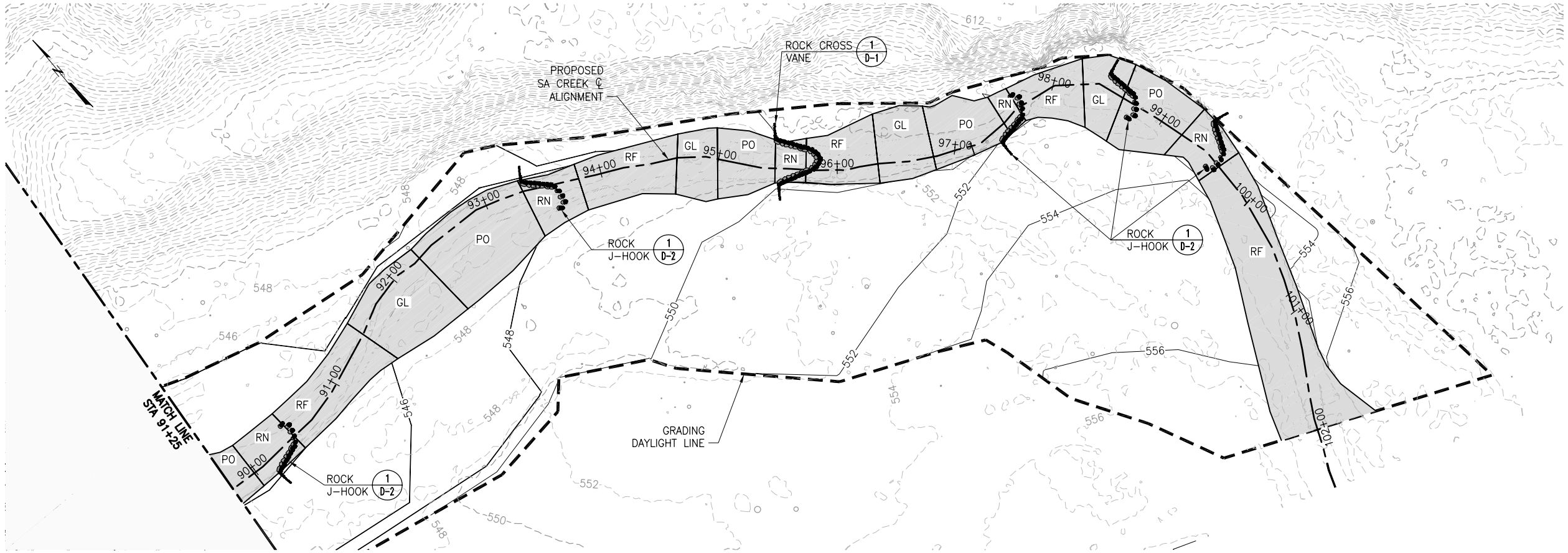
SAN ANTONIO CREEK
PLAN AND PROFILE
STA 78+22 TO 91+25

CHECKED / APPROVED	DRAWN	SCALE: AS SHOWN	
SECTION MANAGER	DESIGNED	DATE	
APPROVED: MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED: MANAGER, WATER SUPPLY AND TREATMENT DIVISION		
SHEET: OF	PLAN NO.: C-7	DRAWING NO.: E-	REVISION NO.

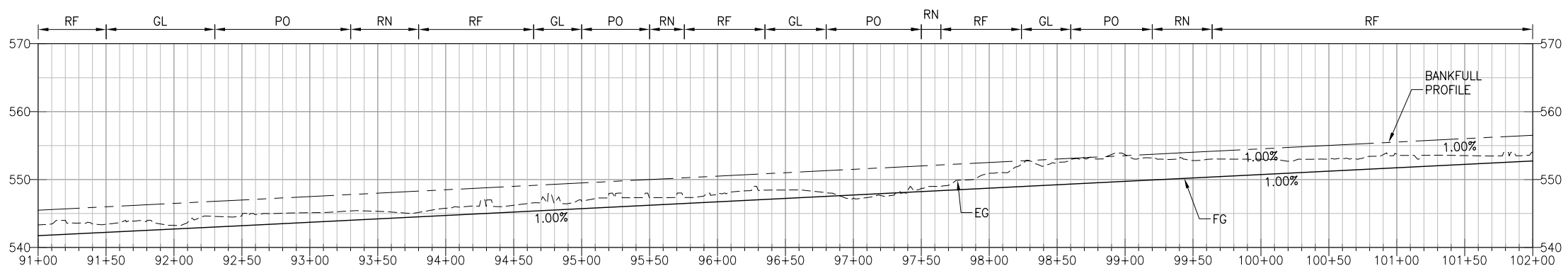
PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.

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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
9	0.15MM
10	1.00MM
100	0.70MM
210	0.60MM

50' 0 50' 100'
SCALE 1"=50'



PLAN
SCALE: 1" = 50'



PROFILE
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'

LEGEND:

RF	RIFFLE
GL	GLIDE
PO	POOL
RN	RUN

NOTE:

1. SEE SHEETS C-10 AND C-11 FOR TYPICAL CHANNEL CROSS-SECTION DETAILS OF RIFFLE, GLIDE, POOL, AND RUN SECTIONS.
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MAY 21, 2010

CITY AND COUNTY OF SAN FRANCISCO
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INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
PLAN AND PROFILE
STA 91+25 TO 102+00

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER: SS	DRAWN: AG
PROJECT MANAGER: FD	DESIGNED: JP
APPROVAL: SAG	CHECKED: EK

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: OF	PLAN NO.: C-8	DRAWING NO.: E–	REVISION NO.

ELEVATION DATUM
NAVD88

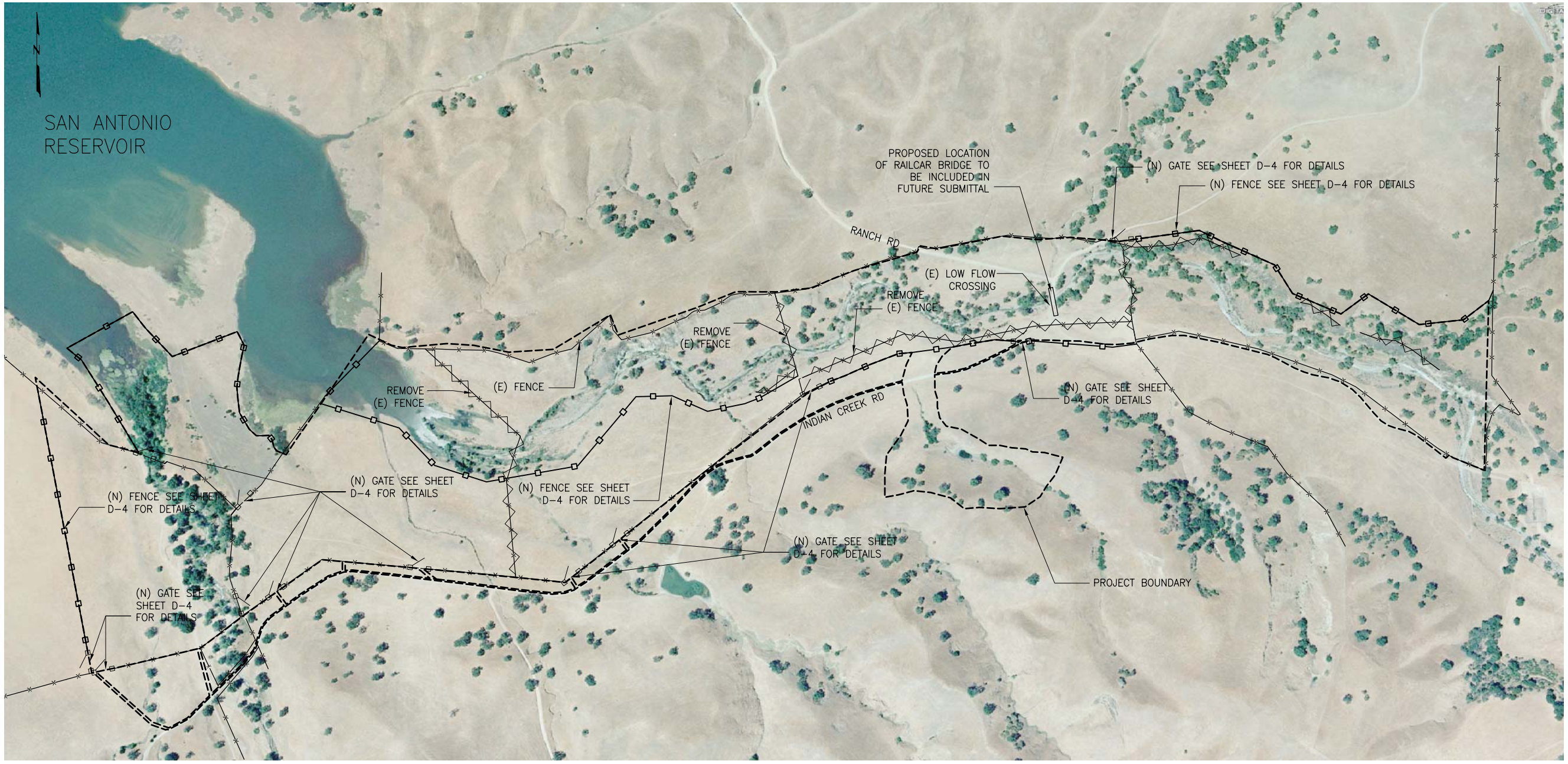
PLOT: EXTEND
SCALE: 1:1
BORDER:
22,34
COLOR: No.

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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
9	0.15MM
10	1.00MM
100	0.70MM
210	0.60MM

50' 0 50' 100'
SCALE 1"=50'

P:\CADD\Sheets\San Antonio\C1-C8.dwg May 24, 2010 – 11:36am

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1" = 400'

400' 0 400' 800'
SCALE 1"=400'

ELEVATION DATUM
NAVD88

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OAKLAND, CA 94612
PHONE: (510) 893-3600

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
FENCING LAYOUT

PROJECT ENGINEER	DRAWN R. ASSAF	CHECKED / APPROVED	DRAWN / SCALE 1"=40'
PROJECT MANAGER	DESIGNED	SECTION MANAGER	DESIGNED / DATE NOV. 2009
APPROVAL	CHECKED	APPROVED	APPROVED
		MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

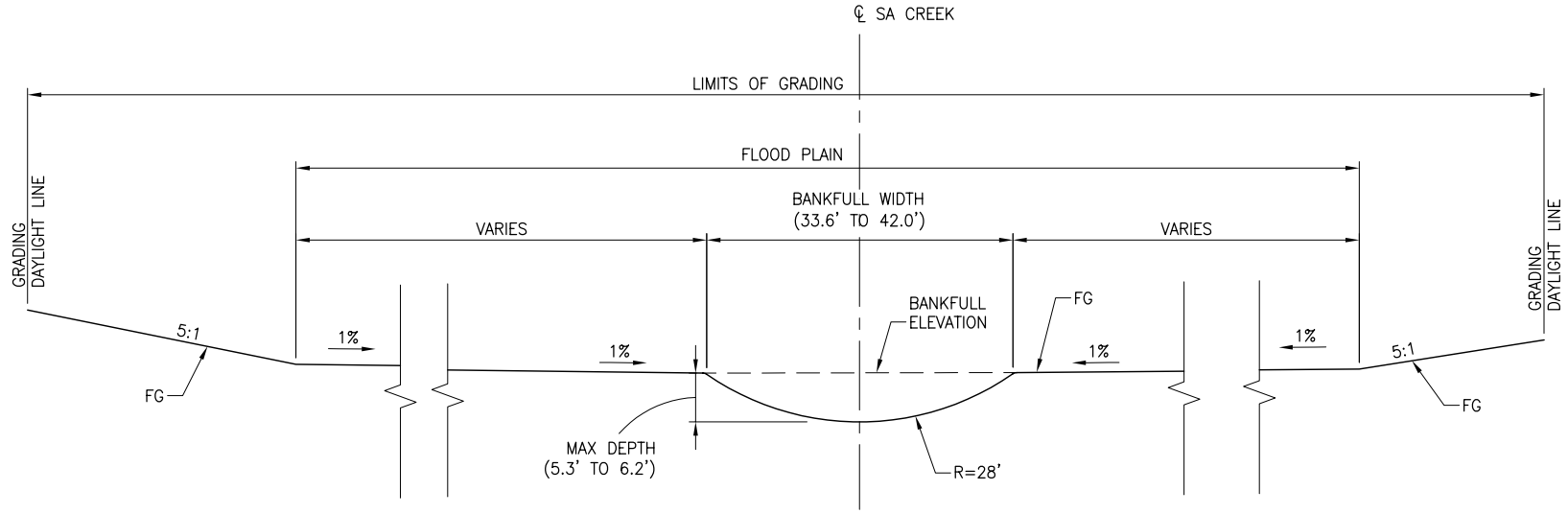
SHEET OF | PLAN NO. C-9 | DRAWING NO. E– | REVISION NO.

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34

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YELLOW	0.20MM
GREEN	0.25MM
CYAN	0.40MM
BLUE	0.50MM
MAGENTA	0.20MM
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GRAY	0.15MM
9	0.15MM
10	1.00MM
100	0.70MM
210	0.60MM

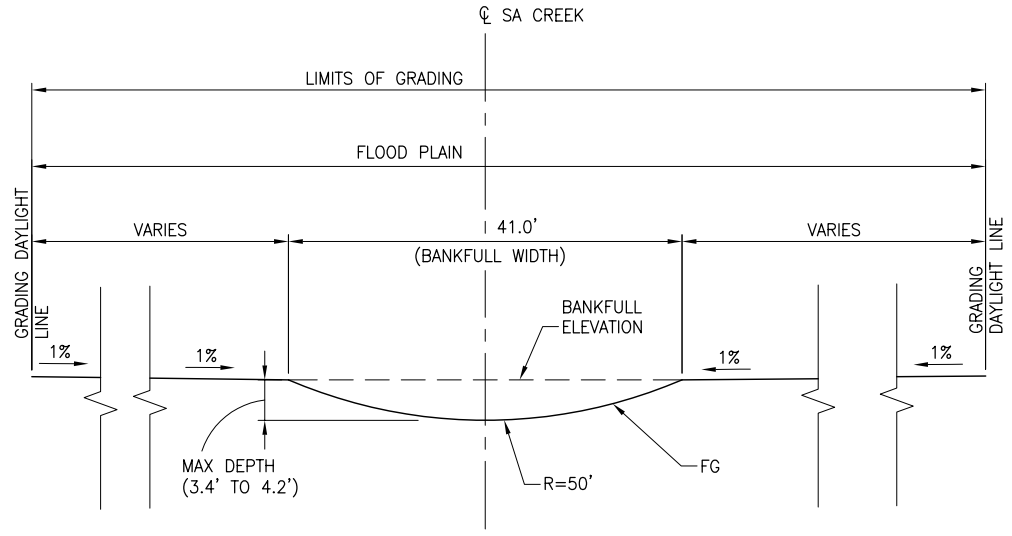
P:\CADD\Sheets\San Antonio\C-9.dwg May 24, 2010 – 11:52am

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



TYPICAL CROSS SECTION – RUN

SCALE: 1" = 10'



TYPICAL CROSS SECTION – RIFFLE

SCALE: 1" = 10'

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ENGINEERING MANAGEMENT BUREAU

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OAKLAND, CA 94612
PHONE: (510) 893-3600

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
TYPICAL CHANNEL SECTIONS
(1 OF 2)

PROJECT ENGINEER: SS	DRAWN: AG
PROJECT MANAGER: FD	DESIGNED: JP
APPROVAL: SAG	CHECKED: EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE: AS SHOWN	
SECTION MANAGER	DESIGNED	DATE	
APPROVED: MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED: MANAGER, WATER SUPPLY AND TREATMENT DIVISION		
SHEET: OF	PLAN NO.: C–10	DRAWING NO.: E–	REVISION NO.

ELEVATION DATUM
NAVD88

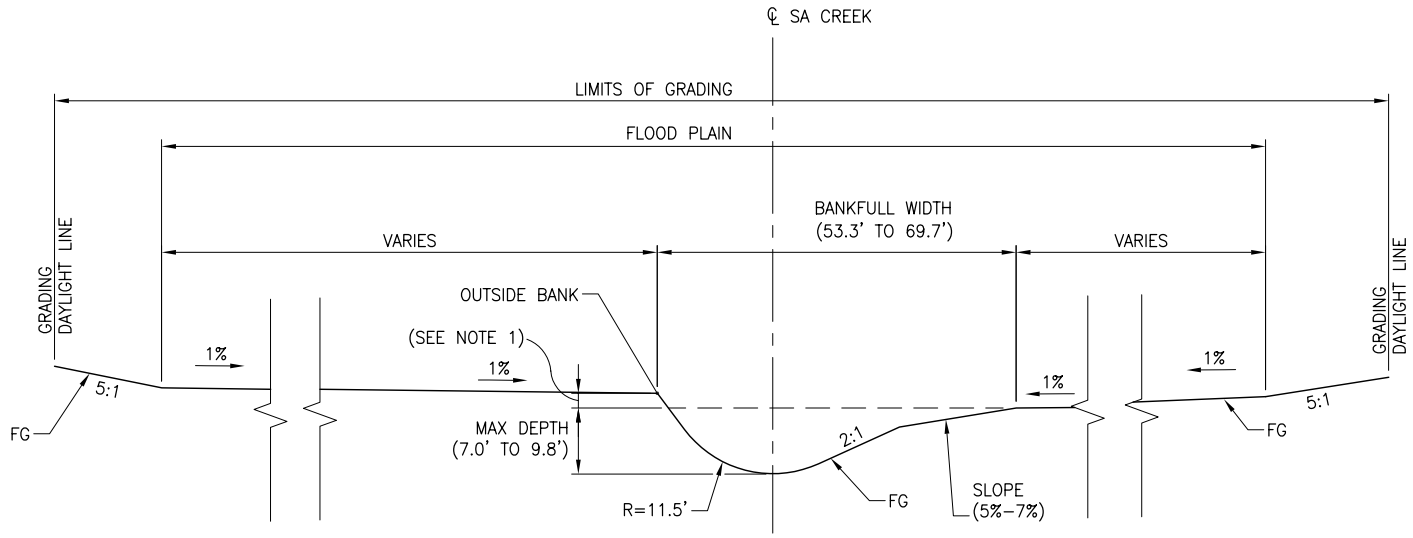
PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.

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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
9	0.15MM
10	1.00MM
100	0.70MM
210	0.60MM

10' 0 10' 20'
SCALE 1"=10'

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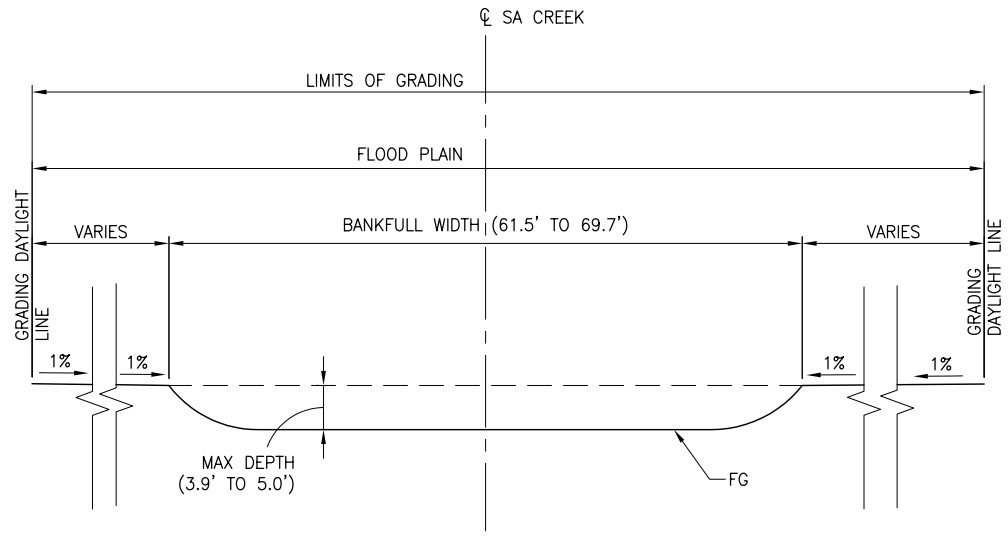
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



TYPICAL CROSS SECTION – POOL (RIGHT MEANDER BEND)

SCALE: 1" = 10'

NOTES:
1. THE OUTSIDE BANK SHOULD BE 0.25' TO 0.5FT HIGHER THAN THE BANKFULL ELEVATION. TAPER THE ELEVATED FLOODPLAIN TO BANKFULL AT HEAD OF RUN / BOTTOM OF RIFFLE.



TYPICAL CROSS SECTION – GLIDE

SCALE: 1" = 10'

NOTES:
1. GLIDE WIDTH TO DEPTH RATIO SHOULD BE BETWEEN 16.1 TO 19.0

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ENGINEERING MANAGEMENT BUREAU

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
TYPICAL CHANNEL SECTIONS
(2 OF 2)

PROJECT ENGINEER	DRAWN	CHECKED / APPROVED	DRAWN / SCALE: AS SHOWN
PROJECT MANAGER	DESIGNED	SECTION MANAGER	DESIGNED / DATE
APPROVAL	CHECKED	APPROVED	APPROVED
		MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C–11	E–	

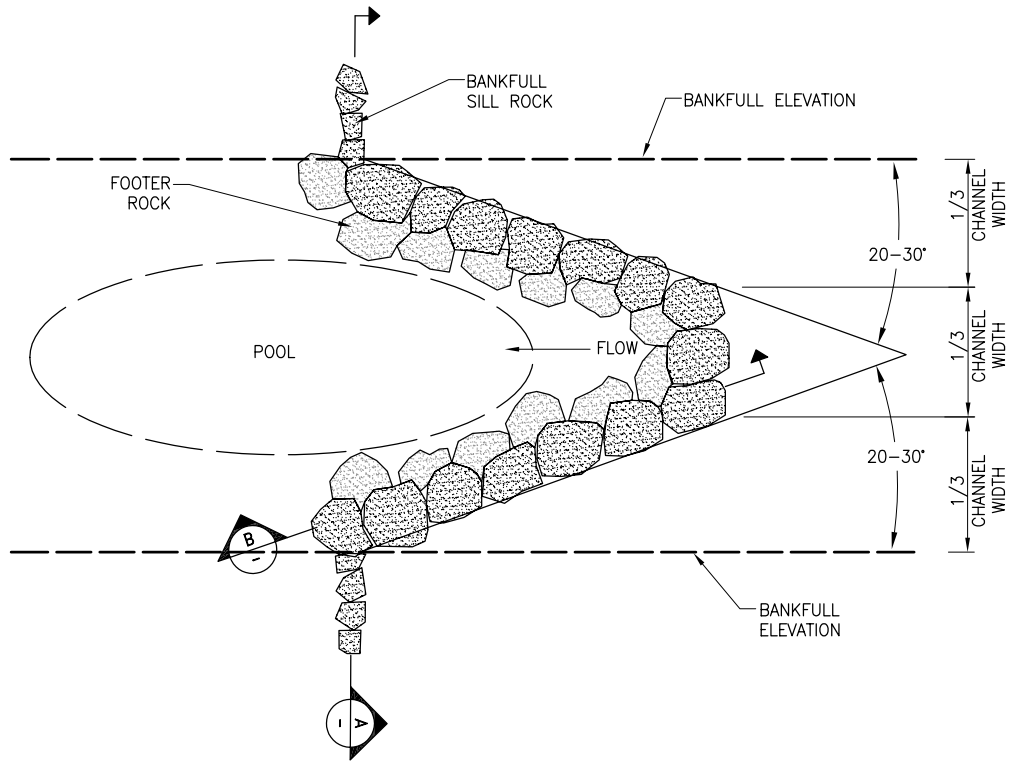
ELEVATION DATUM
NAVD88

PLOT: EXTEND
SCALE: 1:1
BORDER:
22,34
COLOR: No.
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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

10' 0 10' 20'
SCALE 1"=10'

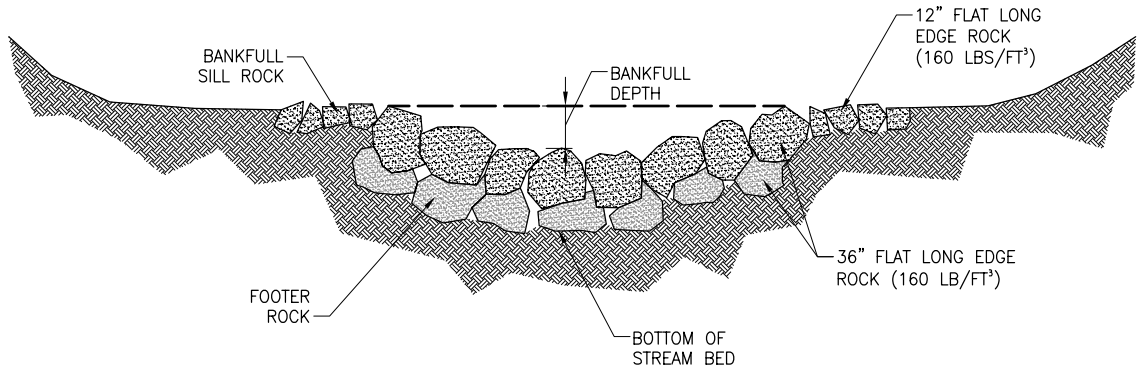
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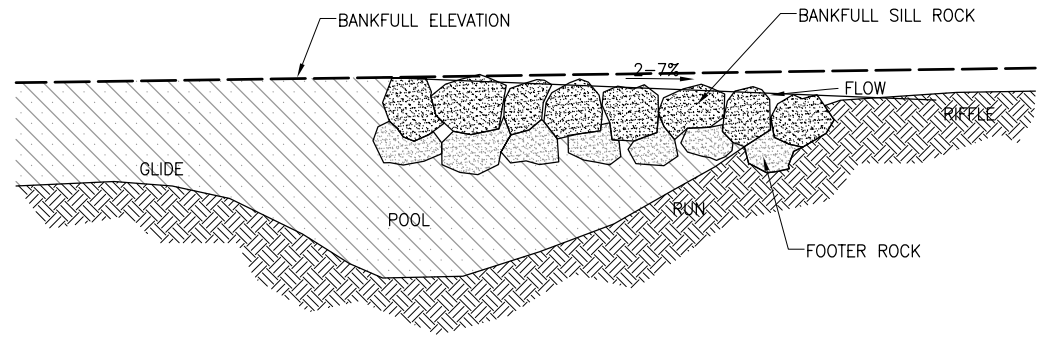


TYPICAL CROSS VANE PLAN VIEW (1/–)
SCALE: N.T.S.

NOTE: FOR CROSS VANES ALONG THE TRIBUTARIES, THE HEADER AND FOOTER ROCKS SHALL BE 12" DIAMETER WITH FLAT LONG EDGE



TYPICAL CROSS VANE CROSS SECTION (A/–)
SCALE: N.T.S.



TYPICAL CROSS VANE LONGITUDINAL VIEW (B/–)
SCALE: N.T.S.

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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

10' 0 10' 20'
SCALE 1"=10'

ELEVATION DATUM
NAVD88

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MAY 21, 2010

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER: SS	DRAWN: RA
PROJECT MANAGER: FD	DESIGNED: JP
APPROVAL: SAG	CHECKED: EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

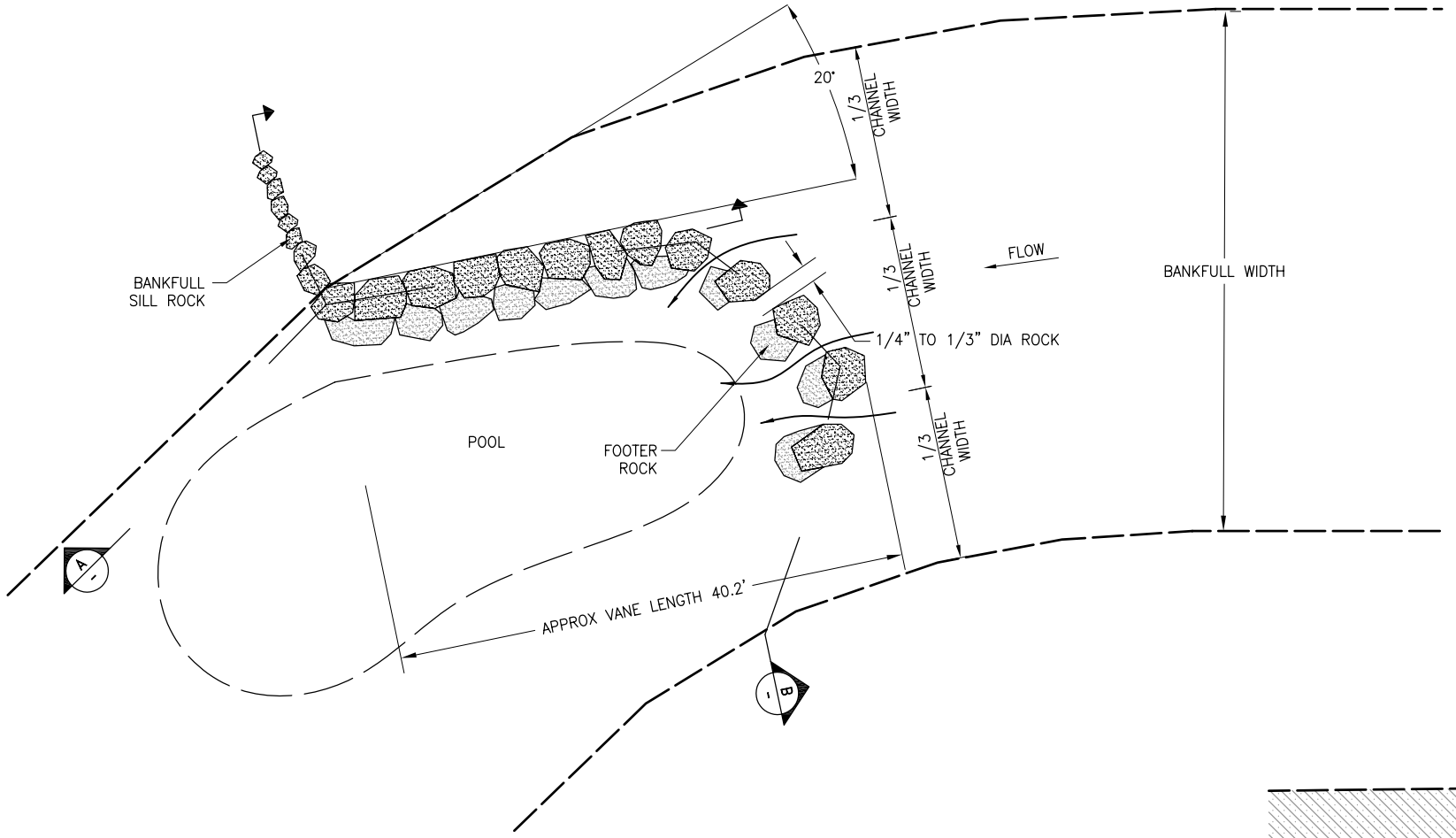
SAN ANTONIO CREEK CROSSVANE GRADE CONTROL STRUCTURE DETAILS (1 OF 3)

CHECKED / APPROVED	DRAWN	SCALE: AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

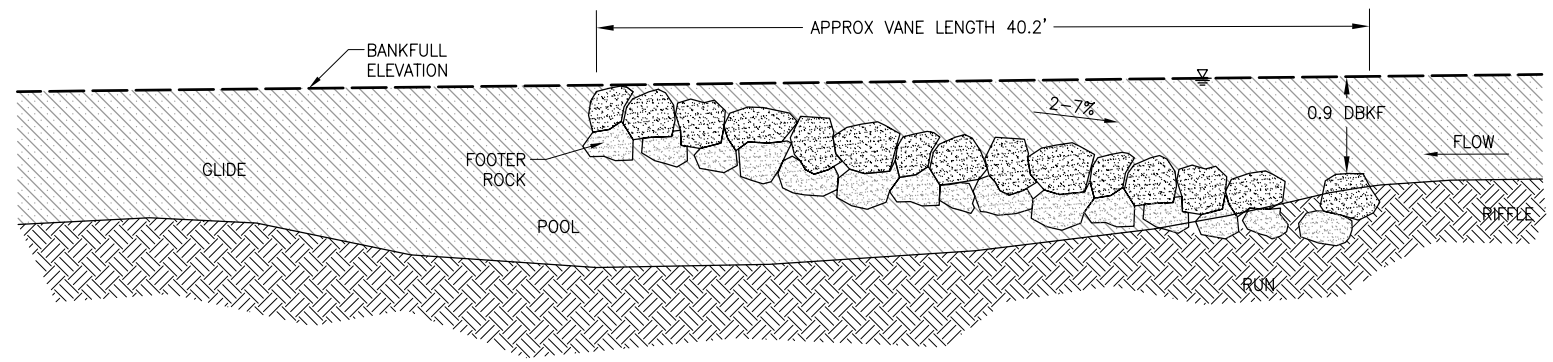
SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	D-1	E–	

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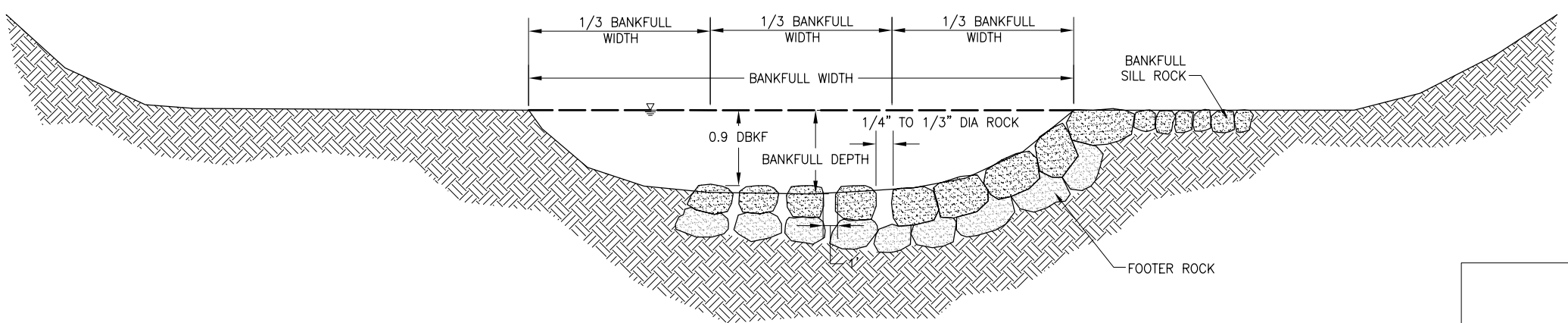
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



TYPICAL J-HOOK PLAN VIEW (1)
SCALE: N.T.S.



TYPICAL J-HOOK PROFILE VIEW (A)
SCALE: N.T.S.



TYPICAL J-HOOK CROSS SECTION VIEW (B)
SCALE: N.T.S.

10' 0 10' 20'
SCALE 1"=10'

ELEVATION DATUM
NAVD88

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MAY 21, 2010

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
J-HOOK GRADE CONTROL
STRUCTURE DETAILS (2 OF 3)

PROJECT ENGINEER	DRAWN	SCALE
SS	RA	AS SHOWN
PROJECT MANAGER	DESIGNED	
FD	JP	
APPROVAL	CHECKED	
SAG	EK	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

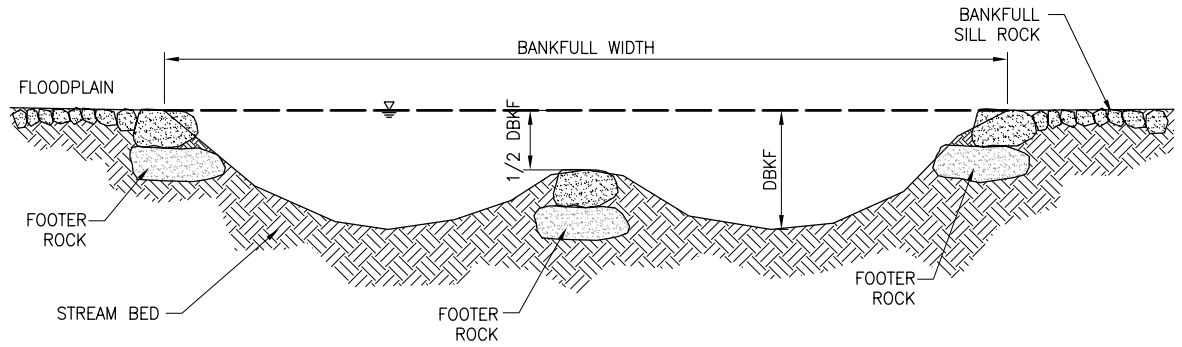
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SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	D-2	E-	

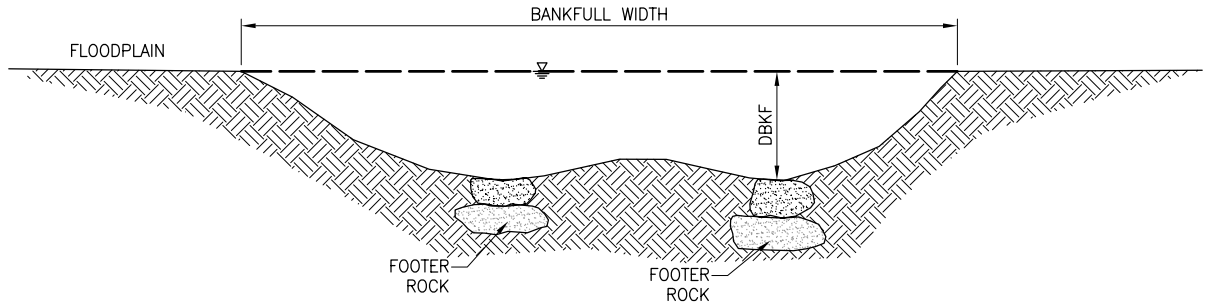
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MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
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210 0.60MM

P:\CADD\Sheets\San Antonio\D-1-D-3.dwg May 24, 2010 – 12:23pm

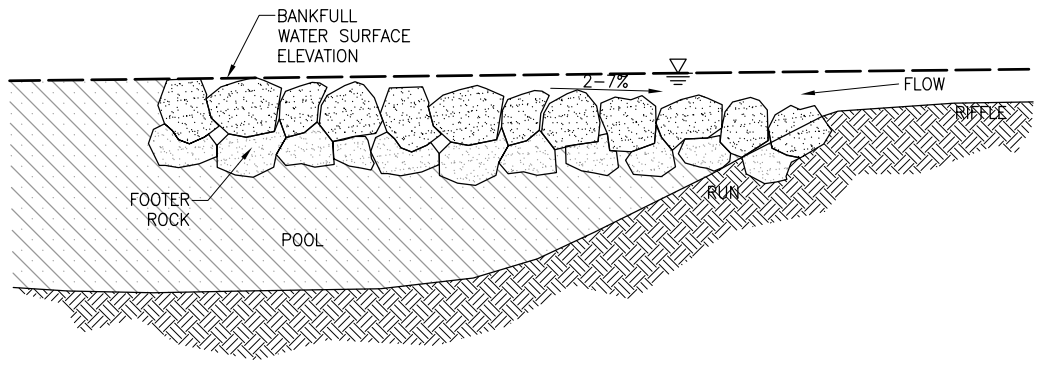
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



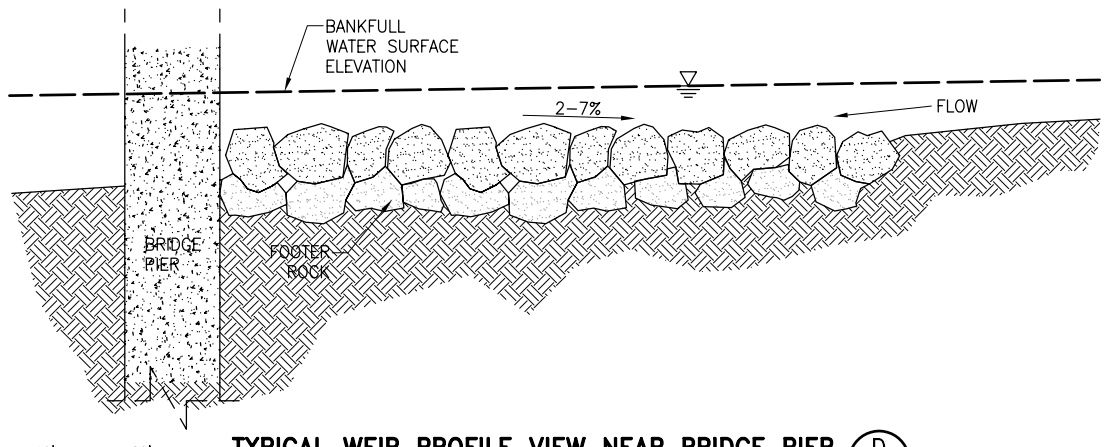
WEIR CROSS SECTION (A)
SCALE: N.T.S.



WEIR CROSS SECTION (B)
SCALE: N.T.S.

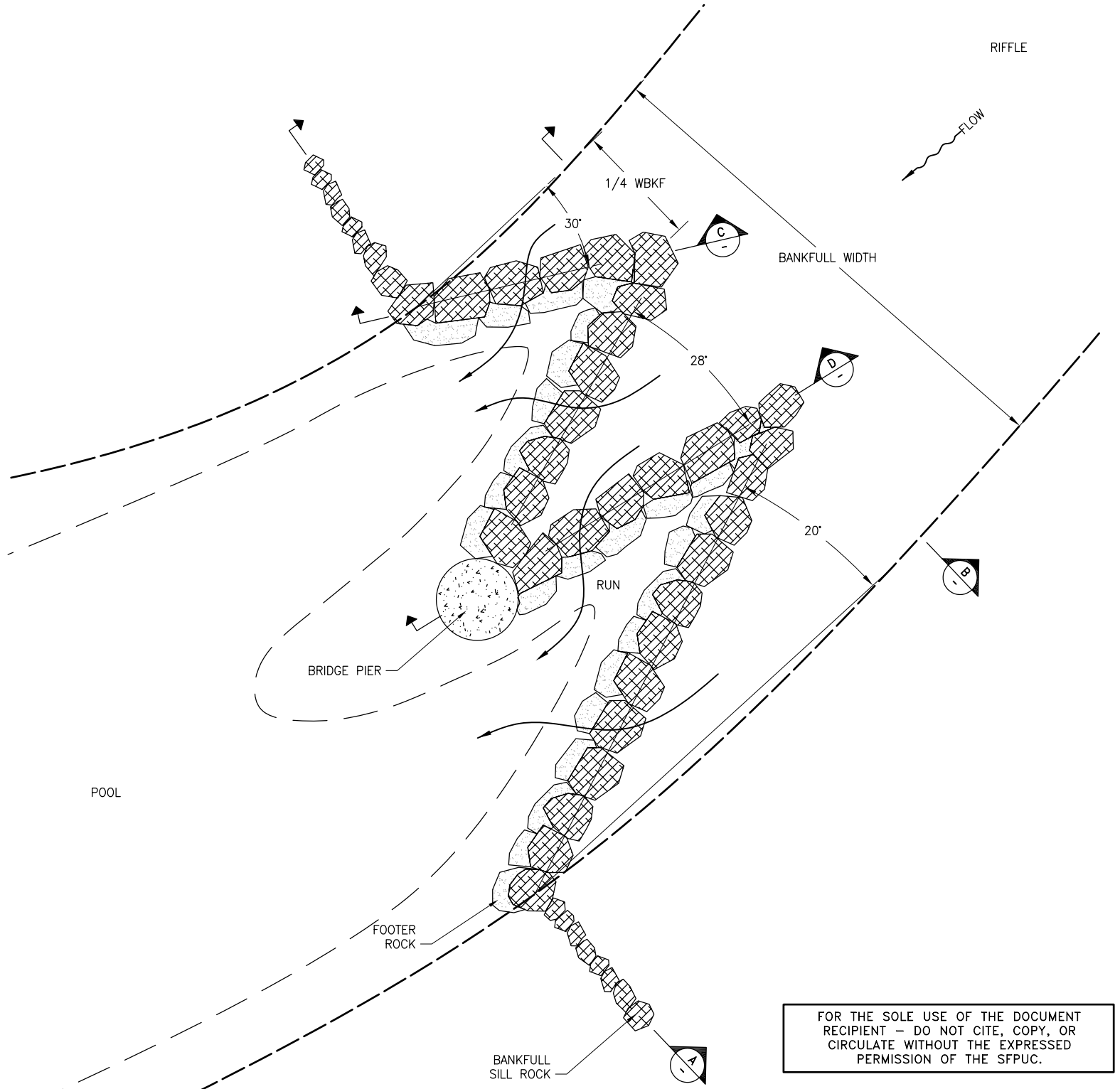


TYPICAL WEIR PROFILE VIEW (C)
SCALE: N.T.S.



10' 0 10' 20'
SCALE 1"=10'

TYPICAL WEIR PROFILE VIEW NEAR BRIDGE PIER (D)
SCALE: N.T.S.



TYPICAL WEIR PLAN VIEW (1)
SCALE: N.T.S.

ELEVATION DATUM
NAVD88

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MAY 21, 2010

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OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER	DRAWN
	RA
PROJECT MANAGER	DESIGNED
PD	JP
APPROVAL	CHECKED
SAG	EK

NO.	DATE	DESCRIPTION	BY	APPR'D
		REVISIONS		

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
WEIR GRADE CONTROL
STRUCTURE DETAILS (3 OF 3)

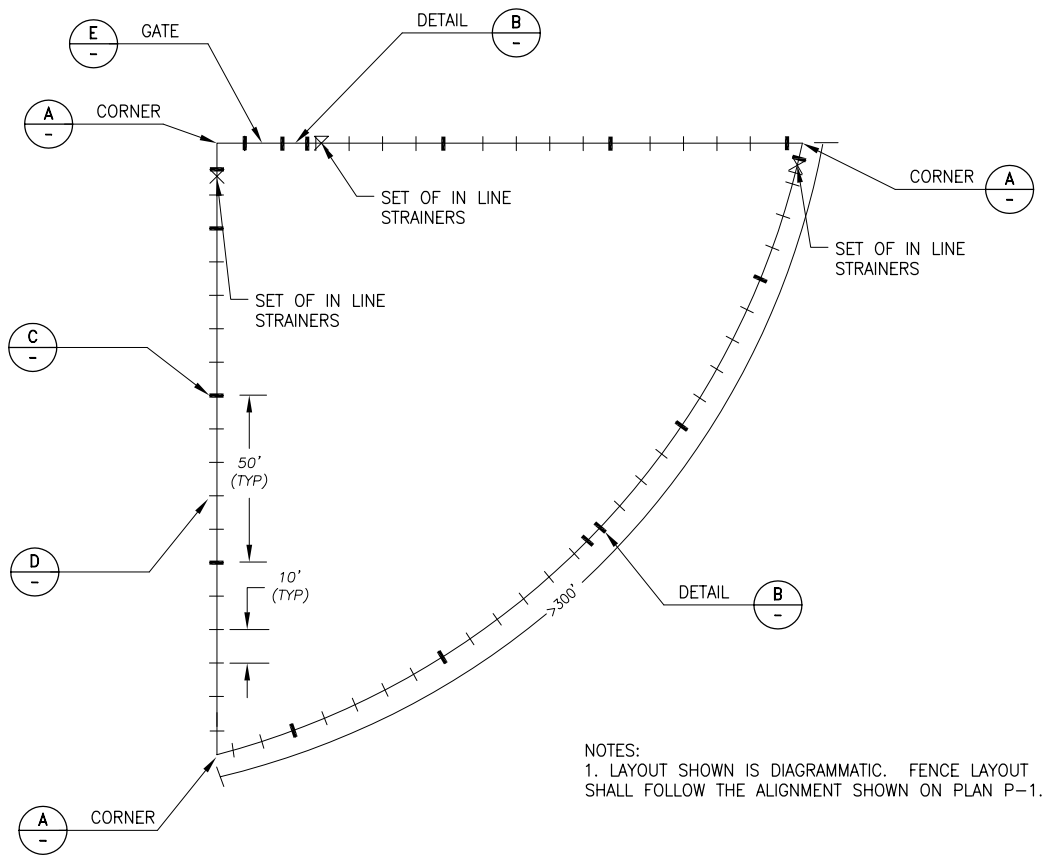
CHECKED / APPROVED	DRAWN	SCALE
		AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	D-3	E–	

PLOT: EXTEND
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22,34
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210 0.60MM

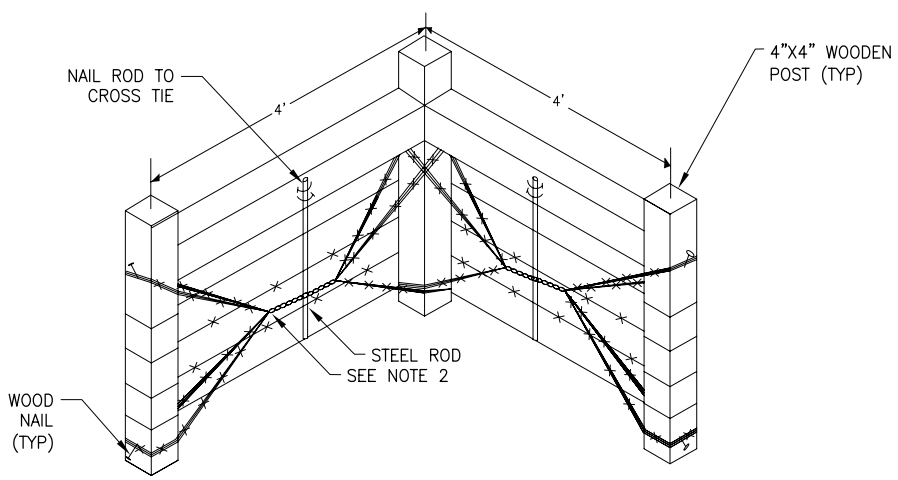
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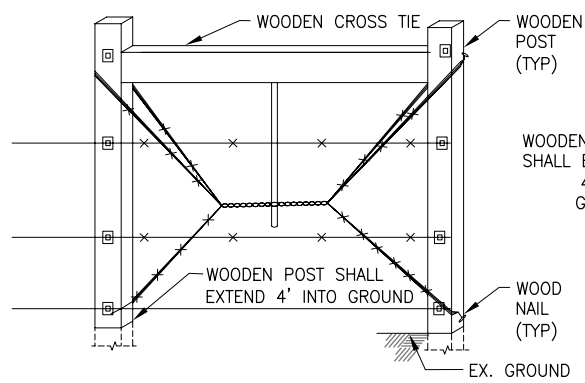
NOTES:
1. LAYOUT SHOWN IS DIAGRAMMATIC. FENCE LAYOUT SHALL FOLLOW THE ALIGNMENT SHOWN ON PLAN P–1.

PLAN
SCALE: NTS



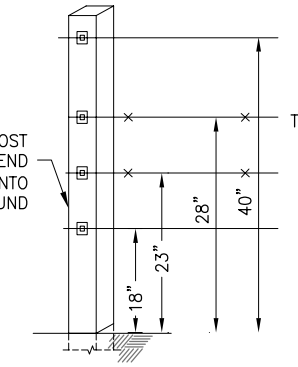
NOTES:
1. DETAIL 'A' SHALL BE UTILIZED AT ALL CORNERS OF FENCE OR ANGLE CHANGES SHARPER THAN 135°.
2. BARBED WIRE SHALL BE NAILED TO THE OUTSIDE EDGE OF EACH POST AT THE TOP AND BOTTOM. WIRE SHALL BE WRAPPED IN A CROSS PATTERN 3X, FOLLOWED BY PLACEMENT OF THE STEEL ROD THROUGH THE CENTER.

CORNER POST DETAIL A –
SCALE: NTS



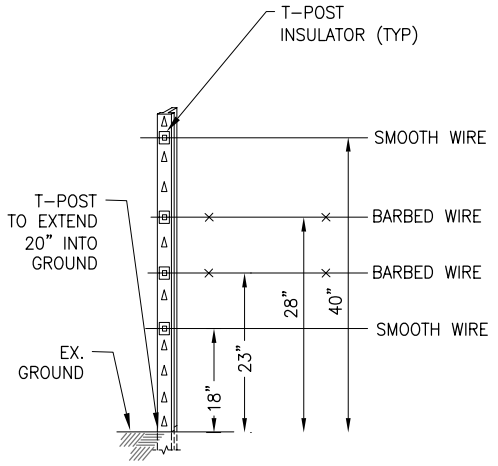
NOTES:
1. DETAIL 'B' SHALL BE USED ADJACENT TO GATES AND FOR LENGTHS GREATER THAN 300'.
2. SEE NOTE 2 FROM DETAIL 'A'.

ANCHOR DETAIL B –
SCALE: NTS



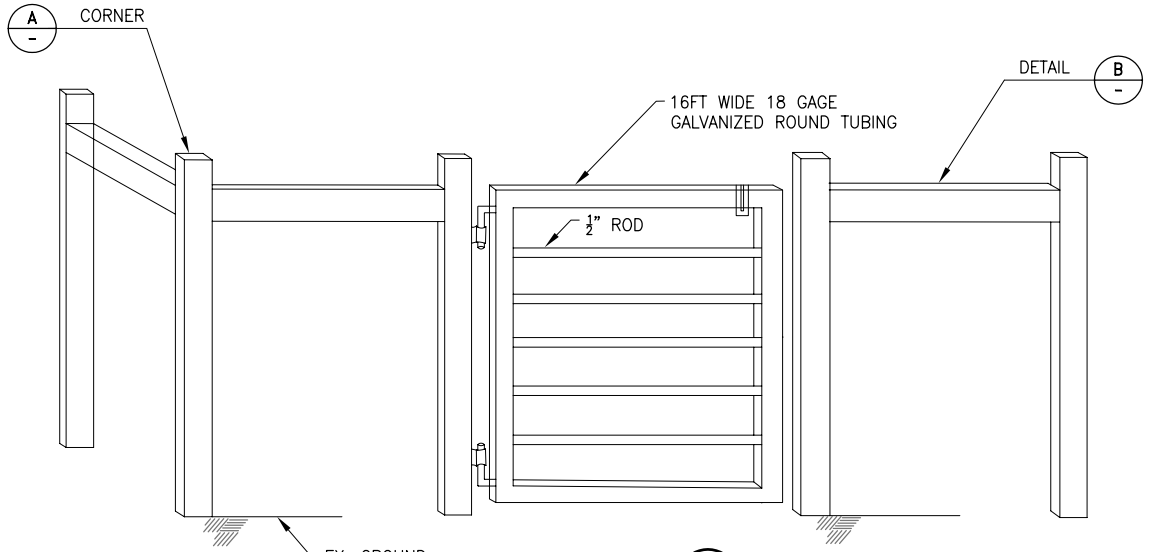
NOTES:
1. DETAIL 'C' SHALL BE USED EVERY 50'.

WOOD POST DETAIL C –
SCALE: NTS



NOTES:
1. DETAIL 'D' SHALL BE USED EVERY 16.5'.

STEEL POST DETAIL D –
SCALE: NTS



GATE DETAIL E –
SCALE: NTS

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MAY 21, 2010

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INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893–3600

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
FENCE DETAILS

PROJECT ENGINEER: SS	DRAWN: AG
PROJECT MANAGER: FD	DESIGNED: AG
APPROVAL: SAG	CHECKED: EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE: AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED: MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED: MANAGER, WATER SUPPLY AND TREATMENT DIVISION	
SHEET: OF	PLAN NO.: D–4	DRAWING NO.: E–

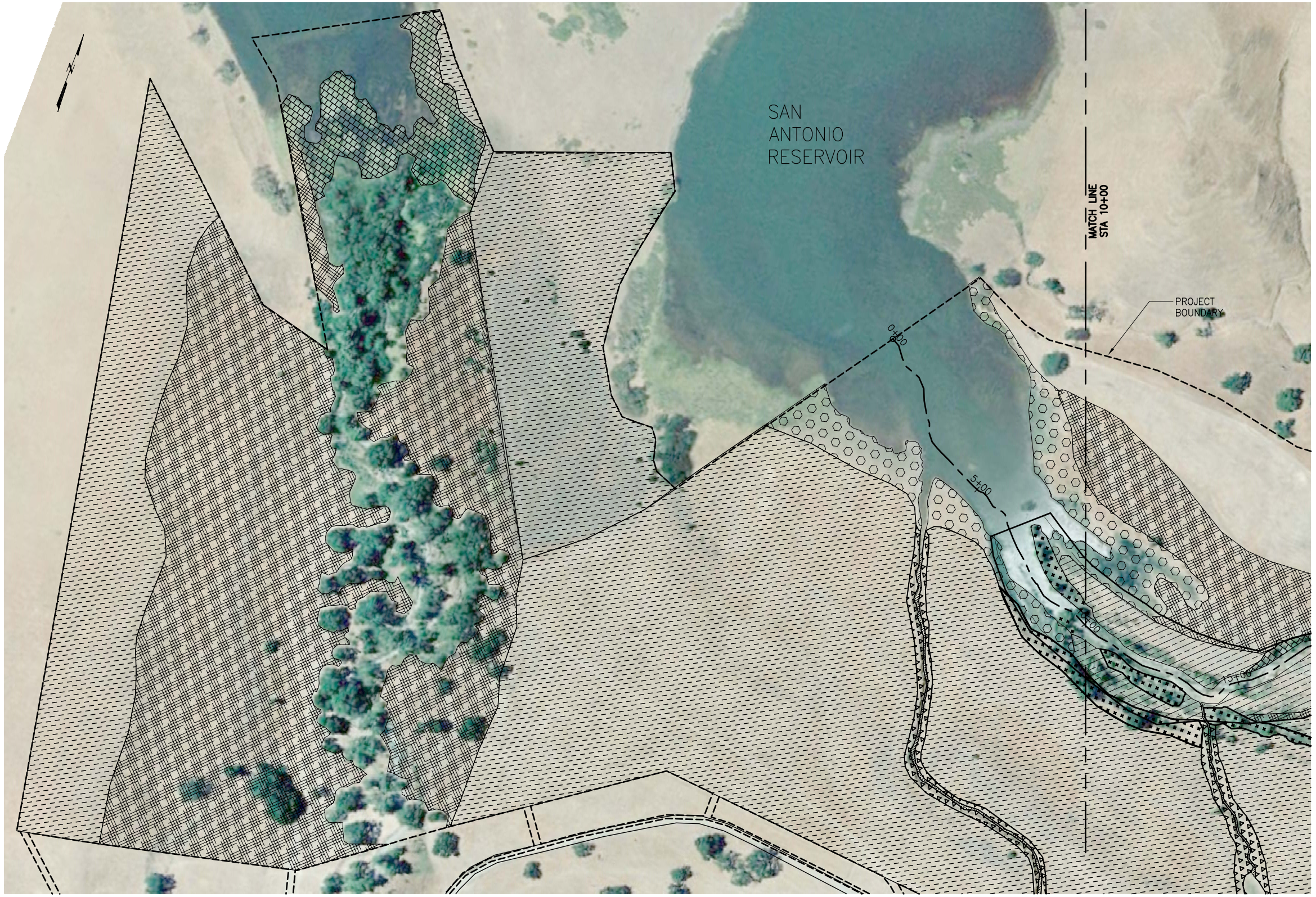
REVISION NO.

ELEVATION DATUM
NAVD88

PLOT: EXTEND
SCALE: 1:1
BORDER:
22,34
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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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10 1.00MM
100 0.70MM
210 0.60MM

P:\CADD\Sheets\San Antonio\D–4.dwg May 24, 2010 – 12:28pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



LEGEND

- SEASONAL WETLAND – ESTABLISH/REESTABLISH
- OAK SAVANNAH – ESTABLISH/REESTABLISH
- OAK WOODLAND – ESTABLISH/REESTABLISH
- OAK RIPARIAN – ESTABLISH/REESTABLISH
- WILLOW RIPARIAN – ESTABLISH/REESTABLISH
- SYCAMORE – ESTABLISH/REESTABLISH
- OAK WOODLAND – REHABILITATE
- OAK RIPARIAN – REHABILITATE
- WILLOW RIPARIAN – REHABILITATE
- SYCAMORE – REHABILITATE

150' 0 150' 300'
SCALE 1"=150'

ELEVATION DATUM
NAVD88

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PROJECT ENGINEER	DRAWN
SS	RA
PROJECT MANAGER	DESIGNED
FD	JP
APPROVAL	CHECKED
SAG	EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK PLANTING PLAN SHEET 1 OF 4

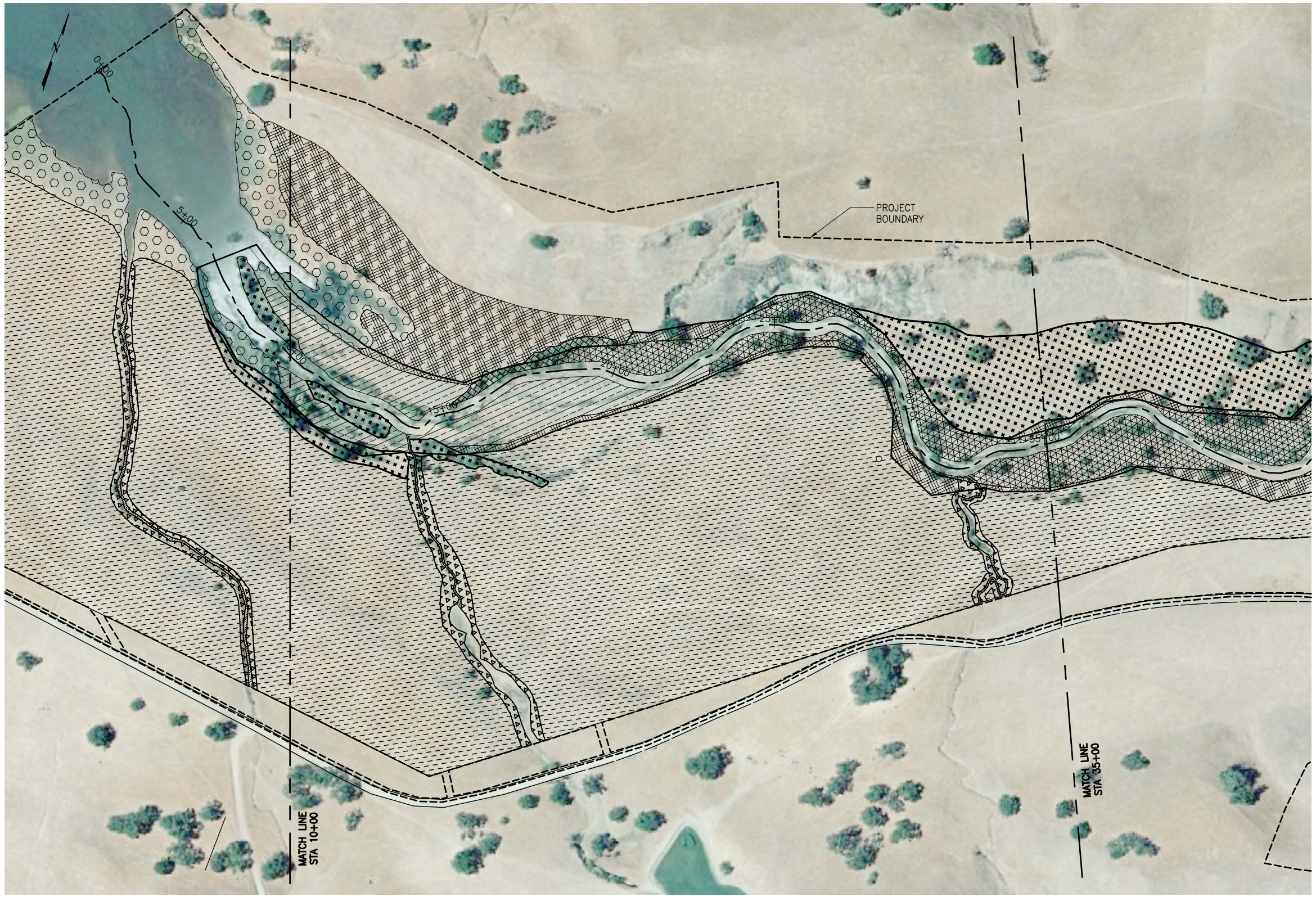
CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	1"=150'
APPROVED	DATE	MAY 2010
MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	P–1	E–	

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
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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
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

P:\CADD\Sheets\San Antonio\P–1–P–4.dwg May 26, 2010 – 4:21pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



LEGEND

- SEASONAL WETLAND – ESTABLISH/REESTABLISH
- OAK SAVANNAH – ESTABLISH/REESTABLISH
- OAK WOODLAND – ESTABLISH/REESTABLISH
- OAK RIPARIAN – ESTABLISH/REESTABLISH
- WILLOW RIPARIAN – ESTABLISH/REESTABLISH
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- OAK WOODLAND – REHABILITATE
- OAK RIPARIAN – REHABILITATE
- WILLOW RIPARIAN – REHABILITATE
- SYCAMORE – REHABILITATE

150' 0 150' 300'
SCALE 1"=150'

ELEVATION DATUM
NAVD88

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MAY 21, 2010

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OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER	DRAWN
SS	RA
PROJECT MANAGER	DESIGNED
FD	JP
APPROVAL	CHECKED
SAG	EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

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PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK PLANTING PLAN SHEET 2 OF 4

CHECKED / APPROVED	DRAWN	SCALE 1"=150'
SECTION MANAGER	DESIGNED	DATE MAY 2010
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	P-2	E–	

PLOT: EXTEND
SCALE: 1:1
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22,34
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GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
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100 0.70MM
210 0.60MM

P:\CADD\Sheets\San Antonio\P-1-P-4.dwg May 26, 2010 – 4:16pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



LEGEND

- SEASONAL WETLAND – ESTABLISH/REESTABLISH
- OAK SAVANNAH – ESTABLISH/REESTABLISH
- OAK WOODLAND – ESTABLISH/REESTABLISH
- OAK RIPARIAN – ESTABLISH/REESTABLISH
- WILLOW RIPARIAN – ESTABLISH/REESTABLISH
- SYCAMORE – ESTABLISH/REESTABLISH
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- OAK RIPARIAN – REHABILITATE
- WILLOW RIPARIAN – REHABILITATE
- SYCAMORE – REHABILITATE

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MAY 21, 2010

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
PLANTING PLAN
SHEET 3 OF 4

URS
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OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER: SS	DRAWN: RA
PROJECT MANAGER: FD	DESIGNED: JP
APPROVAL: SAG	CHECKED: EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED		DRAWN	SCALE: 1"=150'
SECTION MANAGER		DESIGNED	DATE: MAY 2010
APPROVED		APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU		MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	P-3	E–	

150' 0 150' 300'
SCALE 1"=150'

ELEVATION DATUM
NAVD88

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
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CYAN 0.40MM
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WHITE 0.35MM
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100 0.70MM
210 0.60MM

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LEGEND

- SEASONAL WETLAND – ESTABLISH/REESTABLISH
- OAK SAVANNAH – ESTABLISH/REESTABLISH
- OAK WOODLAND – ESTABLISH/REESTABLISH
- OAK RIPARIAN – ESTABLISH/REESTABLISH
- WILLOW RIPARIAN – ESTABLISH/REESTABLISH
- SYCAMORE – ESTABLISH/REESTABLISH
- OAK WOODLAND – REHABILITATE
- OAK RIPARIAN – REHABILITATE
- WILLOW RIPARIAN – REHABILITATE
- SYCAMORE – REHABILITATE

150' 0 150' 300
SCALE 1"=150'

ELEVATION DATUM
NAVD88

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PHONE: (510) 893-3600

PROJECT ENGINEER: SS	DRAWN: RA
PROJECT MANAGER: FD	DESIGNED: JP
APPROVAL: SAG	CHECKED: EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
PLANTING PLAN
SHEET 4 OF 4

CHECKED / APPROVED	DRAWN	SCALE: 1"=150'
SECTION MANAGER	DESIGNED	DATE: MAY 2010
APPROVED: MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED: MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	P–4	E–	

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CYAN	0.40MM
BLUE	0.50MM
MAGENTA	0.20MM
WHITE	0.35MM
GRAY	0.15MM
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100	0.70MM
210	0.60MM

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SAN ANTONIO CREEK MITIGATION AREA

HABITAT	BOTANICAL NAME	COMMON NAME	PROPAGATION METHOD	SIZE*	REMARKS
OAK RIPARIAN (2 ACRES)	AESCULUS CALIFORNICA	CALIFORNIA BUCKEYE	SEED	N/A	VARY SPACING, CLUSTER SOME, AVERAGE 10 FT O.C.
	QUERCUS AGRIFOLIA	COAST LIVE OAK	ACORN/CONTAINER	ACORN/TP	VARY SPACING, CLUSTER SOME, AVERAGE 12 FT O.C.
	QUERCUS LOBATA	VALLEY OAK	ACORN/CONTAINER	ACORN/TP	
	ARTEMISIA DOUGLASIANA	MUGWORT	CONTAINER	D16	PLANT @ 10 FT O.C
	RUBUS URSINUS	CALIFORNIA BLACKBERRY	CONTAINER	D16	
	SAMBUCUS MEXICANA	BLUE ELDERBERRY	CONTAINER	D16	
	LEYMUS TRITICOIDES	CREEPING WILDRYE	CONTAINER	PLUG	PLANT @ 10 FT O.C.
	SCROPHULARIA CALIFORNICA	BEE PLANT	CONTAINER	D16	
	SYMPHORICARPOS ALBUS VAR. LAEVIGATUS	SNOWBERRY	CONTAINER	D16	
WILLOW RIPARIAN (4 ACRES)	SALIX EXIGUA	SANDBAR WILLOW	POLE CUTTINGS	N/A	PLANT WILOW CUTTINGS WITHIN 6 FT OF THE WATER EDGE. AVERAGE 5 FT O.C.
	SALIX LAEVIGATA	RED WILLOW	POLE CUTTINGS	N/A	
	SALIX LASIOLEPIS	ARROYO WILLOW	POLE CUTTINGS	N/A	
SEASONAL WETLAND (0.3 ACRES)	HORDEUM BRACHYANTHERUM	MEADOW BARLEY	CONTAINER	PLUG	PLANT @ 10 FT. O.C. JUST OUTSIDE OF REGULARLY INUNDATED AREAS
	LEYMUS TRITICOIDES	CREEPING WILDRYE	CONTAINER	PLUG	
	JUNCUS BALTICUS	BALTIC RUSH	CONTAINER	SC	PLANT @ 10 FT. O.C. ON THE FRINGES OF SEASONALLY INUNDATED AREAS
	JUNCUS PATENS	SPREADING RUSH	CONTAINER	SC	
SYCAMORE RIPARIAN (24 ACRES)	PLATANUS RACEMOSA	WESTERN SYCAMORE	CONTAINER	TP	VARY SPACING, CLUSTER SOME, AVERAGE 15 FT O.C.
	ARTEMISIA DOUGLASIANA	MUGWORT	CONTAINER	D16	PLANT @ 10 FT O.C.
	ELYMUS GLAUCUS	BLUE WILD RYE	CONTAINER	SC	
	HORDEUM BRACHYANTHERUM	MEADOW BARLEY	CONTAINER	SC	
	JUNCUS BALTICUS	BALTIC RUSH	CONTAINER	SC	
	JUNCUS EFFUSES	COMMON RUSH	CONTAINER	SC	
	JUNCUS PATENS	SPREADING RUSH	CONTAINER	SC	
OAK SAVANNAH (152 ACRES)	QUERCUS AGRIFOLIA	COAST LIVE OAK	ACORN/CONTAINER	ACORN/TP	VARY SPACING, CLUSTER SOME, AVERAGE 15 FT O.C.
	QUERCUS DOUGLASII	BLUE OAK	ACORN/CONTAINER	ACORN/TP	
	QUERCUS LOBATA	VALLEY OAK	ACORN/CONTAINER	ACORN/TP	
	KOELARIA MACRANTHA	JUNE GRASS	SEED	N/A	15 LBS / ACRE
	LUPINUS SP.	LUPINE	SEED	N/A	5 LBS / ACRE
	ELYMUS GLAUCUS	BLUE WILD RYE	CONTAINER	SC	PLANT @ 10 FT O.C.
	BROMUS CARINATUS	CALIFORNIA BROME	CONTAINER	SC	
	MELICA CALIFORNICA	CALIFORNIA MELIC GRASS	CONTAINER	SC	
	NASSELLA PULCHRA	PURPLE NEEDLEGRASS	CONTAINER	SC	
OAK WOODLAND (48 ACRES)	AESCULUS CALIFORNICA	CALIFORNIA BUCKEYE	SEED	N/A	VARY SPACING, CLUSTER SOME, AVERAGE 10 FT O.C.
	QUERCUS AGRIFOLIA	COAST LIVE OAK	ACORN/CONTAINER	ACORN/TP	VARY SPACING, CLUSTER SOME, AVERAGE 20 FT O.C. PLANT OUTSIDE 10 YR FLOODPLAIN, BUT WITHIN 100 YR FLOODPLAIN
	QUERCUS LOBATA	VALLEY OAK	ACORN/CONTAINER	ACORN/TP	VARY SPACING, CLUSTER SOME, AVERAGE 12 FT O.C. PLANT OUTSIDE 10 YR FLOODPLAIN, BUT WITHIN 100 YR FLOODPLAIN
	ELYMUS GLAUCUS	BLUE WILD RYE	CONTAINER	SC	PLANT @ 10 FT O.C. WITHIN THE 100-YR FLOODPLAIN. 15 FT O.C. OUTSIDE THE 100-YR FLOODPLAIN
	LESSINGIA FILAGINIFOLIA	COMMON SANDASTER	CONTAINER	SC	
	SANICULA CRASSICAULIS	PACIFIC SANICLE	CONTAINER	D16	
	SYMPHORICARPOS MOLLIS	CREEPING SNOWBERRY	CONTAINER	D16	
	ACHILLEA MILLEFOLIUM	YARROW	CONTAINER	SC	PLANT @ 10 FT O.C. OUTSIDE THE 100-YR FLOODPLAIN

SAN ANTONIO CREEK MITIGATION AREA

HABITAT	BOTANICAL NAME	COMMON NAME	PROPAGATION METHOD	SIZE*	REMARKS
OAK WOODLAND	ARTEMISIA CALIFORNICA	CALIFORNIA SAGEBRUSH	CONTAINER	D16	PLANT @ 10 FT O.C. OUTSIDE THE 100-YR FLOODPLAIN
	BACCHARIS PILULARIS	COYOTE BRUSH	CONTAINER	D16	
	CHLOROGALUM POMIRIDIANUM	SOAP PLANT	CONTAINER	SC	
	MIMULUS AURANTIACUS	BUSH MONKEYFLOWER	CONTAINER	D16	
	NASSELLA PULCHRA	PURPLE NEEDLEGRASS	CONTAINER	PLUG	

*SIZES

CODE	NAME	DIMENSIONS
SC	SUPERCELL	1.5" DIAMETER X 8.25" DEEP
PLUG	PLUG	1" X 1" X 2 1/2" DEEP
D16	DEEP POT	2" DIAMETER X 7" DEEP
TP	TREE POT	1 GALLON 4" X 4" X 14" DEEP
ACORN	OAK ACORN	NA

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

P:\CADD\Sheets\San Antonio\P-1-P-4.dwg May 21, 2010 - 4:48pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

ELEVATION DATUM
NAVD88

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30% DRAFT
MAY 21, 2010

CONTRACT NO. WD-

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER	DRAWN
SS	RA
PROJECT MANAGER	DESIGNED
FD	JP
APPROVAL	CHECKED
SAG	EK

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

SAN ANTONIO CREEK
PLANTING SCHEDULE

CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE: MAY 2010
APPROVED: MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED: MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	P-5	E-	

SAN FRANCISCO PUBLIC UTILITIES COMMISSION
CITY AND COUNTY OF SAN FRANCISCO

GREGORY LYMAN
PROJECT MANAGER
PUBLIC UTILITIES

PUBLIC UTILITIES COMMISSION
CONTRACT NO. WD xxxx
HABITAT RESTORATION PROGRAM
SAN ANTONIO MITIGATION AREA

SPECIFICATIONS
SECTION DIV 2

COPY NO._____

30% Draft
May 26, 2010

PROJECT NO. 38802

Each bid is to be enclosed in an envelope bearing the superscription:

"Bid for HABITAT RESTORATION PROGRAM – SAN ANTONIO MITIGATION AREA
PUBLIC UTILITIES COMMISSION
(Contract No. WD xxxx)"

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TABLE OF CONTENTS

SPECIFICATIONS

DIVISION 2 – SITE WORK

Section	Title
02050	DEMOLITION
02052	CLEARING, GRUBBING AND STRIPPING
02200	EARTHWORK
02240	DEWATERING
02270	EROSION AND SEDIMENT CONTROL
02830	FENCE AND GATES
02915	SITE PREPARATION FOR PLANTING
02920	CONTAINER PLANT INSTALLATION
02925	POLE CUTTING COLLECTION AND INSTALLATION
02930	HYDROSEEDING
02935	IRRIGATION PERFORMANCE STANDARDS

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for demolition.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary to safely perform the work as shown on the Drawings and as specified herein.

1. Demolition of existing fence.

2. Demolition and disposal of existing concrete foundations, piping, fences, treated wood waste, and other miscellaneous facilities.

C. Salvage, recycling and reuse shall be pursued to the maximum extent possible in accordance with Section 00815, “Waste Management Requirements”

D. Related Sections:

1. Section 01533 - Tree and Plant Protection.

2. Section 02200 - Earthwork.

1.02 SUBMITTALS

A. Working Drawings and Methods Statements:

1. The Contractor shall submit a detailed demolition and disposal work plan. The plan shall include a table including:

a. A detailed listing describing items to be salvaged and demolished;

b. Any special procedures necessary in the demolition process;

c. Timing/sequencing requirements; and

d. Name and location of the disposal or salvage facility.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 GENERAL

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A. The demolition items shown on the Drawings are based on the best information available. However, the specific alignment and detail of fencing and other miscellaneous facilities may differ from those shown on the Drawings.

B. Remove all existing fencing indicated on the Drawings for removal including foundations, gates and accessories. Removed fence in a condition acceptable to the City Representative for salvage and reuse.

C. Inspect all work areas and determine the demolition work required to be performed prior to commencing any earthwork.

D. Conduct demolition operations and removal of debris to ensure minimum interference with construction and maintenance roads, staging areas, and other adjacent occupied or in-use facilities.

3.02 DISPOSAL OF DEMOLITION DEBRIS

A. Comply with federal, state, county, and local regulations, codes, and ordinances that control disposal of debris for disposal of debris that cannot be salvaged. Make provisions, including all required permits, for the disposal of rubbish, timbers, fences, metals, pipes, and other debris. All costs of inspection required by local, county, state, or federal governmental authorities in connection with disposal of demolition debris, other than costs of City inspection, shall be borne by the Contractor.

B. Except as otherwise specified, demolition debris shall not be burned or buried on City property.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for clearing, grubbing and stripping.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary to safely perform the work as shown on the Drawings and as specified herein.

1. Vegetation and trees shall be protected from damage incident to site preparation and construction as specified herein and other applicable sections.

2. The Contractor is advised to inspect the site for estimating purpose prior to bidding for the work under this contract.

C. Related Sections:

1. Section 01533 - Tree and Plant Protection.

2. Section 02200 - Earthwork.

D. Definitions:

1. Drip Line: The limits established by the outermost tips of the branches of comprising a single plant, bush or tree, or group thereof, projected to the ground in plan view.

2. Clearing: The removal of materials including trees, tree stumps, brush, other vegetation, rocks, concrete rubble, trash, and debris.

a. Clearing shall consist of cutting, removing, and disposing of all objectionable material from the ground surface, such as trash, trees, brush, logs, stumps, weeds, grasses, and obstructions of any kind, natural or artificial. Trees, shrubs, and vegetation designated to remain shall not be removed or disturbed. Trees and shrubs adjacent to work areas shall be protected from damage.

b. Work shall be performed in such a manner as to remove all evidence of the objects' presence from the surface. Clearing shall also include the removal and disposal of trash piles and rubbish from the work site created prior to and during the duration of the work.

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3. Grubbing: Grubbing shall consist of cutting, removing, and disposing of all objectionable material found 6 inches below the ground surface, including natural or artificial obstructions. Trees, stumps and roots below the surface requiring removal shall be removed completely from the ground.

4. Stripping: Stripping shall consist of the removal of the top 6 inches of soil after clearing and grubbing have been completed, or as required by the City Representative.

1.02 SUBMITTALS

A. Working Drawings and Methods Statements:

1. The Contractor shall submit a detailed clearing, grubbing and stripping plan. The plan shall include proposed temporary construction haul routes, traffic flows, number and types of equipment, and sequence of work. Include in the plan, the proposed methods of disposal of cleared vegetation and stockpiling of topsoil. The plan should also include but is not limited to:

   a. Extents of areas to be cleared, grubbed, and stripped and identify each work item to be performed within the area depicted

   b. Identify special treatment areas where topsoil will not be conserved.

   c. Show layout, type, and location of barriers for trees to be protected.

   d. Show location and indicate size of trees to be cleared and grubbed. Identify the trees to be removed. For any additional trees proposed by the Contractor to be cleared and grubbed, provide:

      (1) Information on the location, size and species of each tree to be disturbed or removed. Describe the anticipated impacts to construction if the tree remains in place and any feasible alternatives to removal.

      (2) Identify removal trees species (willow or cottonwood) suitable for salvage cuttings. Confirm with City Representative whether stake or pole cuttings are needed for revegetation efforts.

2. Submit a Recycling Program plan describing recycling to the extent possible for any trees, tree stumps, brush, other vegetation, rocks, concrete rubble, trash, metals, and debris.

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PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 GENERAL

A. Prior to any grading, weedy areas of a species listed in Cal-IPC inventory listing (http://www.cal-ipc.org/ip/inventory/weedlist.php) for invasive plants will be identified and staked in the field. Topsoil will not be conserved in areas where weed seed may cause problems with the success of native revegetation. Topsoil for special treatment areas will be hauled to the designated disposal area where infected soil will be capped with a minimum of 6-inches of clean fill soil.

B. Stockpile topsoil for use in areas to be seeded. Stockpile topsoil within the limits of construction, separate from other excavated materials and free of undesirable material. Place topsoil in elongated piles, or "windrows," no greater than 6 feet in height.

C. Prior to stockpiling topsoil, spread clean wheat or barley straw on the ground surface to delineate between the in-situ and salvaged topsoil.

D. Do not allow weed growth on salvaged topsoil stockpiles. Do not apply pre-emergent herbicides on topsoil stockpiles. Remove and dispose offsite any weed growth before weeds produce mature seed heads.

E. If the Contractor fails to perform topsoil salvaging, or if the quantity of topsoil salvaged does not equal the quantity of topsoil available for salvaging due to improper removal, storage or maintenance or stockpiles, the Contractor shall at its own expense import additional topsoil in quantities sufficient to meet the topsoil replacement requirements described in these Specifications. Imported topsoil shall be of natural, friable material possessing the characteristics of representative in situ materials.

F. FILLING OF HOLES: Holes made by removal of existing structures and obstructions and/or clearing and grubbing shall be refilled to adjacent ground levels with compacted fill material. Fill material properties, placement requirements, and construction control testing shall be as specified in Section 02200,"Earthwork".

G. Dispose of non-recycled materials removed during clearing and grubbing to an off-site location. Burning of materials to be cleared and grubbed on-site is not allowed. The Contractor shall stake out all work areas designated for clearing, grubbing, and stripping by survey. The Contractor shall be responsible for the accuracy, maintenance and observation of all lines and elevations.

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1. The location, limits, and methods to be used for clearing, grubbing, and stripping shall be reviewed with the City Representative prior to start of work.

2. The Contractor shall review with the City Representative all trees greater than 4 inches in diameter at a distance of 54 inches above the ground to be removed or trimmed.

H. Do not disturb areas outside the construction limits. Protect areas outside the construction limits from Contractor operations.

I. Do not utilize vegetation as anchorages or for other purposes.

J. Prior to cutting or removing tree limbs or roots have a City Representative inspect and approve cut or removal.

K. Assume all responsibility for injuries to, or death of vegetation arising from Contractor operations.

3.02 CLEARING

A. Clear, grub, and strip within the limits of excavation and grading indicated.

1. Vegetative materials not designated to be protected.

2. Trash piles, surficial rubbish, and fencing, including fence-post footings.

B. All cleared material consisting of vegetation shall be stockpiled at an onsite composting location approved by the City Representative. Shred or chip any trees or shrubs with trunks or branches over 1/2-inch in diameter to improve composting.

C. All other non compost debris and rubbish shall be removed from the site and disposed of legally at an offsite facility.

D. Remove cleared, grubbed, and stripped materials that are not to be recycled from the project site and dispose in accordance with all applicable laws, codes, and ordinances.

E. Recycle tree trunks and limbs to the extent possible.

F. Confirm with City Representative whether willow or cottonwood cuttings are needed prior to removal of tree limbs and rootwad. Should trees be salvaged for revegetation efforts, removal of such species shall be made under direction of the City Representative.

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G. Except as otherwise directed by City Representative, cut, grub, and dispose of concrete, paving, base, vegetation, rubbish, debris and any objectionable material encountered within the limits required for construction. Areas outside the limits of clearing shall be protected from disturbance or damage.

H. If suspected hazardous materials are encountered, immediately notify City Representative. Handle and remove suspected materials in accordance with all local, State and Federal regulations and ordinances.

3.03 REPAIR AND REPLACEMENT

A. Repair injured trees:

1. The term “injuries” in this context shall comprise any bruising, scarring, or breaking of roots, trunks, or branches.

2. Repair or treat injured vegetation as recommended by and under the direction of the Tree Specialist.

B. Plant replacement trees as directed by City Representative.

3.04 RESTORATION, CLEAN UP AND DISPOSAL

A. Remove from site surplus material and debris during the course and at completion of the worksite as Contractor’s property and dispose of in accordance with applicable Federal, State and Local Codes, Ordinances and Regulations. Burning or burying of waste material on site is prohibited.

B. Cleanup any spillage from haul routes and adjacent areas.

C. Remove equipment, temporary protection and barriers and debris.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies the requirements for earthwork.

B. The Contractor shall furnish all labor, equipment, supervision and material necessary to perform all excavation, preparing subgrade, grading, compacting, and hauling. Work incidental to the excavation work including constructing temporary fences, maintaining existing roads, maintaining protective devices to safeguard the public, protecting existing trees, and performing all other work necessary and proper for the execution and completion of the work under this section.

C. Related Sections:

1. Section 02052 - Clearing, Grubbing, and Stripping.

2. Section 02270 - Erosion and Sediment Control.

1.02 REFERENCES

A. Local and Regional Agencies:

1. Bay Area Air Quality Management District Regulations.

2. San Francisco Bay Regional Water Quality Control Board (SFBRWQCB)

B. ASTM International (ASTM):

1. American Society for Testing and Materials (ASTM)

a. ASTM D 422 Method for Particle-Size Analysis of Soils.

b. ASTM D 698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort

c. ASTM D 1556 Density of Soil in Place by the Sand Cone Method

d. ASTM D 2216 Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures

e. ASTM D 2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

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f. ASTM D 2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

g. ASTM D 3017 Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

h. ASTM D 4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils

i. ASTM D 4564 Standard Test Method for Density of Soil in Place by the Sleeve Method

j. ASTM D 4643 Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

k. ASTM D5093 Standard Test Method for Field Measurement of Infiltration Rate Using Double-Ring Infiltrometer with Sealed-Inner Ring

1.03 SUBMITTALS

A. Working Drawings and Methods Statements:

1. Submit Plan and Method Statement for the excavation and fill operation included in the project including but not limited to:

a. Construction and location of lay-down areas and stockpiles.

b. Proposed temporary construction haul routes.

c. Sequence of work.

d. Proposed methods of restoration of the temporary haul roads.

e. List of equipment.

f. Proposed flow of excavated material to temporary stockpile.

2. Erosion and sediment control plan, as required per Section 01062 “Environmental Requirements.”

3. Material Sources: Alluvial, channel bank and flood plain fill: The material for the fill shall be obtained from project excavations within the streambed, floodplain, and banks. Material obtained from the project excavations will require selective removal, processing and stockpiling. At the Contractor's

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option a commercial source may be used. The Contractor shall submit test data showing that the material from the proposed source meets or exceeds the existing available material specifications. Fill material brought from offsite shall have an environmental certificate meeting the requirements in Section 01800 "Environmental Protection."

B. As-Built Survey: Submit an as-built survey for final project approval within 45 days of completing work at the site. As-built survey shall show final grades throughout the work area and all site improvement locations. Approved as-built surveys are required for the receipt of final payment.

C. Quality Control and Assurance:

1. Acceptance Criteria:

a. Construct finished surfaces to 0 to plus or minus 0.1 feet of the elevations indicated on the Drawings.

b. Complete channel bank slopes to plus or minus 0.5 feet of the slope line indicated on the Drawings. Actual slope shall match the slope shown on the Drawings.

2. The City Representative will determine by observation and testing the quality of work and materials during site preparation and grading. The following will be judged:

a. Adequacy of site preparation;

b. Acceptability of available fill material;

c. Correct placement and compaction of fill to specified densities

1.04 JOB CONDITIONS:

A. The Contractor shall adhere to the following:

1. Verify all dimensions in the field and check all field conditions continuously during construction.

2. Excavating, filling, and grading work shall not be performed during weather conditions which might damage or be detrimental to the condition of existing ground, in-progress work, or completed work. When the work is interrupted by rain, excavating, filling, backfilling, and grading work shall not resume until the site and soil condition (moisture content) are suitable for compaction.

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3. Use equipment adequate in size, capacity, and numbers to accomplish the work of this section in a timely manner.

4. Prevention of Erosion: Comply with requirements as stated above, as specified in Section 02270, “Erosion and Sediment Control,” and the following:

   a. Prevent erosion of stockpiles, ditches, embankments, filled, backfilled, and graded areas until such time as permanent drainage and erosion control measures have been installed.

   b. Perform "protective grading" to provide positive drainage and to minimize ponding of surface water.

1.05 SAFETY MEASURES

A. Maintain at the job site a copy of all applicable portions of CAL-OSHA regulations and any other special regulations as may be required by the City Representative.

B. Provide dust control and protection in accordance with Federal, State, and Local requirements. Contractor shall assume responsibility for the alleviation or prevention of any dust nuisance on or about the site (see Section 01800, “Environmental Protection”).

1.06 FIELD VERIFICATION

A. Verify field topography, clearances and dimensions, and actual conditions at the site. Any discrepancy that may affect the proper completion of the work shall be promptly reported to the City Representative in writing. It shall be the responsibility of the Contractor to undertake corrective measures as directed by the City Representative, before starting the work as specified.

1.07 PROTECTION

A. Locate, identify, and protect utilities that remain from damage, and protect benchmarks, survey control points, fences, and other existing site features designated for protection from earthwork equipment and vehicular traffic.

B. Protect existing access road segments to remain during proposed earthwork activities. Any damage to existing surface improvements or infrastructure shall be immediately repaired or replaced by the Contractor to the satisfaction of the City Representative, at no additional expense to the Owner.

C. Provide protective measures and devices required by applicable laws, codes, and ordinances. The Contractor shall be responsible for protecting all sides and slopes of

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the excavations and fill areas against cave-ins and excessive movement of ground and soils.

1.08 REMOVAL OF SUBSURFACE OBSTACLES

A. The Contractor may encounter subsurface obstacles such as: Man-made structures and utility lines not apparent prior to the bid date and/or field conditions differing substantially from those normally encountered and recognized as inherent to the work. The Contractor shall remove such subsurface obstacles to the extent necessary to complete the work, when such excavation is directed and approved by the City Representative. This work will be paid for as additional excavation in the quantity equal to the volume of subsurface obstacle removed.

1.09 TOPOGRAPHIC DATA

A. The topographic information shown on the Drawings was compiled using LIDAR 2006 data obtained from Alameda County through SFPUC and field survey data performed by SFPUC in March 2009.

B. The topographic data has not been field verified and can substantially differ from field conditions. Elevation contours shown are approximate and provided for general reference only. The Contractor shall confirm critical topographic information prior to the commencement of earthwork activities.

1.10 TIME AND CONDITIONS

A. Earthwork related activities shall occur no earlier than June 1 and no later than October 31.

PART 2 - PRODUCTS

2.01 CHANNEL BANK AND FLOODPLAIN FILL:

The material for channel and floodplain fill shall be obtained from channel and floodplain project excavations and its use as fill material shall be limited to fill areas within the channel and floodplain. Fill material shall be free from any debris and organic matter and shall not contain rocks or lumps over 3 inches exceeding 15% by dry weight. The maximum Plasticity Index and Liquid Limit of the soil should not exceed 12 and 45, respectively. The percentage of soil retained on No. 200 sieve shall not exceed 15%.

2.02 ALLUVIAL FILL:

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A. The material for alluvial fill shall be obtained from project channel bed excavation and its use shall be limited to fill areas within the channel bed.

2.03 TOPSOIL

A. Topsoil shall be provided from on-site stripping as specified in Section 02052, "Clearing, Grubbing and Stripping".

PART 3 - EXECUTION

3.01 GENERAL

A. Earthmoving and transportation equipment, water equipment, and compaction equipment are the responsibility of the Contractor. Such equipment shall be of suitable type and capacity to perform the excavation, embankment work, and grading operations in accordance with the specifications and to meet the construction schedule with the soil conditions at the site.

B. All excavation work shall be done in the dry.

C. All excavation shall be conducted without damaging or removing existing structures or substructures not designated for demolition on the Drawings. Where structures or substructures are removed or damaged by the Contractor, said structures or substructures shall be repaired or restored to a condition at least as good as existed before construction of the work hereunder at no cost to the City.

D. Excavations for convenience of the Contractor shall be subject to approval by the City Representative.

E. Excavated material shall be placed at a sufficient distance from edge of excavation so as not to cause cave-ins or bank slides, but in no case closer than three feet from the edge of excavations.

F. SITE EXCAVATION

1. Excavation shall be accurately cut to lines, grades, and cross-sections indicated on the Drawings. Bottoms of excavations shall be undisturbed soil. Debris and loose rock shall be removed.

2. Removing materials: Excavate all materials encountered. Soil conditions at bottom of excavation shall be subject to the approval of the City Representative. Surfaces shall be at straight grades shown on Drawings and clean. Maintain surface in good condition until overlying materials are placed.

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3. Over Excavation: If materials are removed below required elevations, through error or careless excavating, the City Representative will check the design to determine necessary corrective measures. Such corrective measures shall be performed by Contractor at its own expense.

4. Existing Underground Lines and Services: Existing utility lines at the project site are currently unknown. Verify on-site the location and depth of all existing utilities and services before performing earthwork construction. Excavation within 3 feet of a utility line shall be performed by hand. Active and inactive utility lines encountered shall be reported immediately to the City Representative. Carefully uncover, support, and protect lines and services. Do not cut or remove these items without the prior written approval of the City Representative. The Contractor shall repair or replace any damaged lines and services at its expense, to the satisfaction of the City Representative, immediately when requested by the City Representative. Remove unclaimed utilities as directed.

G. EXCAVATED MATERIALS

1. Satisfactory excavated material required for fill shall be placed in the proper section of the permanent work required or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed at a pre-determined on-site location.

H. PLACING FILL MATERIAL

1. Subgrade Preparation For Channel Bank and Floodplain Fill**:** The subgrade to receive fill material shall be free of organics, particles greater than 3 inches, and debris. The upper 6 inches of the subgrade shall be moistened or aerated within -1 to +2 percent of optimum moisture content. All ruts, hummocks, or other uneven surface features shall be removed by surface grading prior to placement of any fill material.

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2. General

   a. Coordinate in a timely manner with the City representative, maintain and leave open fill and subgrade areas until the City representative observes and approves the placement of the materials. Up to one working day shall be provided by the Contractor for such observations.

   b. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

   c. Jetting, flooding, or ponding for compaction shall not be allowed.

   d. Uniformly grade areas to provide a finished surface that is smooth, compacted and free of irregularities. Grade to cross sections, lines and elevations indicated.

3. Placing and Compacting Channel Bank and Floodplain Bank Fill Material

   a. Placement of fill can begin when the subgrade has been prepared in accordance with Paragraph 3.01.F of this specification and has been approved by City representative. Fill placed without approval shall be removed at the Contractor's own expense. Fill shall not be placed on surfaces that are wet, muddy, unstable, or subgrade that are less dense than specified compaction. Fill material shall be placed in uniform lifts not exceeding 8 inches loose thickness before compaction. Each layer shall be compacted to not less than 90% compaction. Topsoil shall be applied to the top six inches of the channel bank and flood plain fill and shall not be compacted to allow vegetation growth.

   b. Moisture conditioning shall be accomplished at the source or stockpile site. Moisture shall be uniformly distributed throughout the layer prior to compaction and be between optimum moisture content and 3 percent above optimum moisture content as determined by ASTM D 698. Fill material shall meet or exceed the required density within the water content limits described above. If the material is too dry for proper compaction, the Contractor will be required to adjust the pre-wetting of the material or to uniformly distribute sufficient moisture in each layer after spreading to permit the desired degree of compaction. The final adjustment of moisture shall be made at the placement location, as required. The material shall be disked at the fill placement location to blend and moisture condition the material until a uniform distribution of

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material and moisture is obtained. Water applied on a layer of fill shall be accurately controlled in amount so that free water will not appear on the surface during or subsequent to compaction. Should too much water be added to any area, so that the material is too wet to obtain the desired compaction, the compaction and all work on that section shall be delayed until the moisture content of the material is reduced to an amount required for proper compaction. If the material is too wet for proper compaction, the Contractor shall aerate the material to a moisture content within the desired limits prior to compaction.

4. Placing and Compacting Floodplain Fill Material

   a. Placement of fill shall begin after the subgrade has been prepared in accordance with Paragraph 3.01.F of this specification and has been approved by City representative. Fill placed without approval shall be removed at the Contractor's own expense. Fill shall not be placed on surfaces that are wet, muddy, unstable, or subgrades that are less dense than specified compaction.

   b. Fill material shall be placed in uniform lifts not exceeding 8 inches loose thickness. Dumped fill must be graded to match proposed final contours. Floodplain fill material shall not be compacted. Finish grade shall be disked at the completion of construction to remove any surface compaction from equipment traffic.

5. Placing Alluvial Fill Material

   a. Alluvial fill shall be placed within the streambed at locations indicated on the Drawings. Prior to placing alluvial fill, the subgrade shall be prepared such that it is free of debris, tree stumps and other organic matter. The finish grade of the channel bed must maintain a minimum 6-inch thickness of clean alluvial gravel.

I. TOPSOIL PLACEMENT

   a. Topsoil stockpiled onsite shall be graded over to areas to be seeded or planted. The final surface shall be disked to remove areas compacted by equipment.

3.02 EARTHWORK BALANCE

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A. Excess site excavated material shall be disposed of on-site by the Contractor at his expense, emplaced as fill within the project site disposal area indicated on the Drawings, or disposed of as directed by the City Representative.

3.03 PROJECT RECORD DOCUMENTS

A. Accurately record located utilities and site features remaining by horizontal dimensions, elevations or inverts, and slope gradients.

B. Any approved deviation from the Drawings shall be accurately recorded on the project record documents by the Contractor.

3.04 FIELD QUALITY CONTROL

A. Cutting and shaping, excavating, conditioning, filling, and compacting procedures require approval of the City Representative as they are successfully performed. Work found to be unsatisfactory, or work disturbed by subsequent operations shall be corrected to the satisfaction of the City Representative. Fill or backfill that does not meet the specified requirements shall be removed or re-compacted until the requirements are satisfied.

1. For determining moisture content, ASTM D 2216, Laboratory Determination of Water Content of Soil, Rock and Soil-Aggregate Mixtures; or ASTM D 3017, Water Content of Soil and Rock in Place by Nuclear Methods; or ASTM D 4643, Determination of Water Content of Soil by the Microwave Oven Method.

2. For gradation, ASTM D 422, Particle-Size Analysis of Soils

3. For determining plasticity index, ASTM D 4318, Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

4. For classifying soils, ASTM D 2487, Classification of Soils for Engineering Purposes.

5. For determining maximum dry density and optimum water content, use the impact method in accordance with ASTM D 698 Standard.

6. For determining field density, ASTM D 1556, Density of Soil in Place by the Sand-Cone Method; or ASTM D 2922, Density of Soil and Soil-Aggregate in Place by Nuclear Methods; or ASTM D 4564, Density of Soil In Place by the Sleeve Method.

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7. For channel bank fill, one field density test shall be performed at every 5 feet vertical thickness of fill placed.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for dewatering.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary to perform the following work items:

1. Dewatering of surface water in the excavation areas prior to construction.
2. Managing infiltration water by intercepting seepage, which would otherwise emerge from the slopes or bottoms of excavations.
3. Disposing of pumped water.

C. Excavation dewatering includes, but is not limited to, pumping, piping, draining and other measures required for the removal or exclusion of water from excavation areas, throughout the entire period of time that construction work is taking place. This also includes the control, treatment (if necessary), and disposal of water produced during dewatering operations. The Contractor shall furnish all materials, tools, equipment, facilities, and services as required for providing the necessary dewatering work and facilities.

D. Definitions:

1. Groundwater: Groundwater denotes all water below the existing ground surface.
2. Perched Water: Perched water denotes unconfined groundwater within the work area that is separated from the underlying main body of groundwater by unsaturated material.
3. Surface Water: Surface water is all water that enters the work area at or above the ground surface, from either natural or artificial sources, including precipitation.
4. Infiltration Water: Reservoir water and groundwater that enters the work area due to seepage through the existing stratum.

1.02 SUBMITTALS

A. Submit Dewatering Plans for the following:

1. Excavations.
2. Dewatering ponded surface water, perched water and infiltration water.

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3. Disposal of pumped water

B. The dewatering plans for excavations shall include drawings and complete design data for the proposed dewatering system, showing the equipment and methods that the Contractor proposes to use to dewater the excavations, and to control and remove surface water, perched water and infiltrated water. The data provided shall include, but not be limited to, the following:

1. Design calculations.
2. Size, depth and location of dewatering wells, well points, sumps, drains, observation wells, and piezometers, if any.
3. The capacities and locations of pumping units.
4. Size and location of collection headers, discharge lines and holding ponds.
5. The proposed methods of installation of the dewatering equipment.
6. The proposed methods of controlling and removing surface water and perched water from within excavations.
7. If employed, discharge treatment and handling systems and facilities for disposal of dewatering water not stored or used on site.
8. Contingency plans, including backup equipment and emergency contact information.
9. If pumped water is discharged on site, the proposed monitoring at the discharge points to ensure rate of discharge does not cause erosion.

1.03 QUALITY CONTROL

A. Acceptance Criteria:

1. Storm Water Pollution Prevention Plan (SWPPP) for the project as specified in Section 01062, “Environmental and Regulatory Requirements.”

2. Testing: Results of discharge water testing shall be in accordance with Regional Water Quality Control Board permit and Sections 01060, “Environmental Requirements” and 01062, “Regulatory Requirements.”

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Dewatering shall be organized to provide a stable, dry subgrade to facilitate construction operations. The subgrade shall be in a firm, well-drained condition,

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and of adequate and uniform load-bearing nature to support construction personnel, construction materials, construction equipment, and steel reinforcing mats, if any, without tracking, rutting, heaving, or settlement.

B. Dewatering shall be performed in accordance with approved shop drawings. The City Representative shall be advised of any changes made to accommodate field conditions and, on completion of the dewatering system installation, revise and resubmit shop drawings as necessary to indicate the installed configuration.

C. The Contractor shall take all steps to become familiar with the site conditions, ground conditions, and the groundwater conditions. The Contractor shall obtain the data that will be required to analyze the water and soil conditions at the site to assure that the means and methods used for the system will perform properly for the duration of the contract. Limited groundwater information is available from borings and soil test pits conducted from previous investigation at the project site. Note that these reflect measurements on the date indicated and may not reflect current conditions.

D. Obtain all required permits for dewatering and monitoring wells.

E. The Contractor's operations shall not compromise safe control and disposal of water, and the Contractor shall be responsible for any damages caused as a result of its operations. Review of the dewatering system plans by the City Representative will not relieve the Contractor of its responsibility for the adequacy of the systems, including responsibility for repairing any damage to the adjacent area and/or construction site caused by the operation, leakage of operating fluids, failure, or inadequacy of the system. The Contractor shall have sole responsibility for all aspects of the dewatering system.

F. Upon completion of the dewatering operations, the dewatering equipment shall be decommissioned in accordance with local, state and federal regulations as applicable.

G. Additional excavation due to insufficient dewatering shall be done at no cost to the City.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies requirements for installation of erosion control features in the graded work areas.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary for the installation of erosion control features as shown on the Contract Drawings and as specified herein.

1. Grade Control Structures

a. Construction of rock cross vanes/ J-hooks/W-weir

2. Erosion Control Blankets

3. Wattles

1.02 REFERENCES

1. State of California Department of Transportation (Caltrans) Section 72 – Slope Protection.

2. American Society of Testing and Materials (ASTM)

a. ASTM C 127 Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate

3. Rosgen, D. L. 2001. The Cross-Vane, W-Weir and J-Hook Vane Structures…Their Description, Design and Application for Stream Stabilization and River Restoration. Wildland Hydrology. Pagosa Springs, CO. Available online at: www.wildlandhydrology.com/assets/cross-vane.pdf

B. Related Sections:

1. Section 02052 - Site Preparation, Clearing, Grubbing, and Stripping.

2. Section 02200 – Earthwork.

3. Section 02930 – Hydroseeding

1.03 SUBMITTALS

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A. Evidence of conformance to the referenced standards shall be submitted for the following materials in accordance with the requirements of Section 01300 SUBMITTALS:

1. Rock

a. Supplier's certification that rock materials meet specified requirements.

b. Source (name and location of quarry) and gradation of rock material.

c. Equipment and methods to be used for rock placement.

d. Procedures to be used for verification of line and grade of placements above and below water level.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Boulder/Rock:

1. Cross Vane/ Rock W Weir/ J Hook Vane Grade Control Structure: Rock shall be angular, long and flat, free of sand, dust, organic material, excessive cracks, mineral lenses or other impurities. Each rock shall weigh a minimum of 170 lbs/ft3 and shall be at least 36 inches in size.

B. Erosion Control Blankets:

1. Woven jute fiber mats, jute/straw/coconut fiber (Western Excelsior SS-3-all natural, or equivalent), jute/coconut fiber (Western Excelsior CS-4-all natural, or equivalent). Blankets must be 100% biodegradable, not to include any plastic netting that may entrap wildlife. Straw must be weed free rice straw

C. Wattles

1. Wattle shall be straw or coconut coir fibers encased in a 100% biodegradable jute/coir mesh (GeoVireo BioD-SiltCheck-9 or equivalent). Straw must be certified weed free. Mesh netting must have moveable intersecting points preventing potential entrapment of wildlife.

PART 3 - EXECUTION

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3.01 GRADE CONTROL STRUCTURE - ROCK CROSS VANES/J HOOKS/W-WEIR – PLACEMENT

A. Rock vanes shall consist of vane rocks and footer rocks and shall be installed as shown on the drawings and as specified here in.

B. Rock vanes shall be constructed so that adjoining rocks taper in an upstream direction, from the bankfull elevation to the stream invert. The angle that these vanes make with the upstream bank (lower) end of the rock vanes shall be approximately 20 -30 degrees to divert flow away from the banks.

C. The downstream end of the rock vane shall be keyed into the streambank at the bankfull elevation. The upstream end of rock vane shall be keyed into the streambed at the invert elevation (cross vane and W-weir only). The rock vane shall be installed with a slope of 2% to 7% from the streambed invert to the bankfull elevation.

D. The legs of the vane extending from bankfull to the channel bed on cross vanes and J-hook vanes should occupy 1/3 the bankfull width of the channel. The apex of the structure should occupy 1/3 the width of the bankfull channel. Cross vanes extend across the entire channel while J-hook vanes occupy 2/3rds the width of the channel on the outside of a meander bend.

E. The W-weir vane leg angles vary on a meander bend with the outside vane leg approximately 20 degrees from the bank and the inside leg 30 degrees from the bank. The elevation of the top rock on the apex of the weir that abuts the bridge pier shall be installed at ½ the bankfull depth. Rock on the two upstream apexes shall be installed at grade with the thalweg.

F. Rock in the center third of the channel width of J-hook vanes shall be spaced apart 1/4 – 1/3 the diameter of the rock (approximately 0.75 – 1.1 feet).

G. A minimum fourteen-foot (14’) long row of sill rocks shall be keyed into the bank or floodplain from the bankfull elevation of the downstream vane leg perpendicular to the flood flowline. Sill rock shall be buried at grade. Sill rock shall consist of 12 inches in diameter, but may include finer material placed in amongst larger rock in the trench.

H. Vane rocks shall be placed in a linear fashion so as to produce the sloping rock vane, and shall be placed with tight, continuous surface contact between adjoining rock. Rock shall be placed so as to have no significant gap between adjoining rock.

I. Vane rocks shall be placed on top of the footer rock such that the vane rocks are offset and rests on two halves of each footer rock directly below the vane rock.

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J. Vane rock shall be placed such that a final smooth surface is created along the top plane of the rock vane. No vane rock shall protrude higher than the other rock in the rock vane. A completed rock vane has a smooth, continuous finish grade from the bankfull elevation to the streambed.

K. The Contractor shall chink all voids, if any, between the footer rocks, and between the footer rocks and vane rocks. Voids shall be chinked with small boulders, cobble or rock fragments. Chinking will be conducted such that no voids greater than four inches (4") in size will be present.

L. Adjacent vane rocks shall be spaced sufficiently as indicated on the drawings to allow for proper riffle and pool development.

M. The protrusion height for the center top rocks on J-hook vanes should be 10% of the bankfull depth.

N. Upon completion of grade control structure, all disturbed sections of the channel, including the banks shall be stabilized and restored to existing or proposed grade lines as appropriate.

3.02 EROSION CONTROL BLANKETS

A. Erosion control blankets shall be installed on slopes greater than 2H:1V.

B. Blankets shall be installed lengthwise down slope perpendicular to the contour of the slope.

C. Blankets shall be keyed into a trench at the top of the slope. Enough material should be stapled and buried into a trench to double over itself after being backfilled. The blanket should again be stapled down over the trench onto the material leading down the slope.

D. Adjoining blankets shall overlap each other at least 3 inches, with the uppermost blanket overlapping in the direction of flow.

E. Blanket should be stabled down to the slope with 6-inch long x 1-inch wide, 11 gauge staples. Staples shall be placed at increments of 3 feet across the slope and 1.5 feet down slope. Additional line of staple shall be placed at breaks in the slope to maintain material contact with the soil. Overlapping seems shall be stapled every foot.

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3.03 WATTLES

A. Wattles shall be installed every 10 feet on any slope 2H:1V – 1H:1V with a length 10 feet or longer.

B. Wattles shall be installed at the top and toe of the slope following the contour of the slope.

C. Wattle shall be set into a 2-3-inch deep trench with excavated soil placed and compacted against the wattle on the uphill side.

D. Secure wattles to the slope with 18 –24-inch wood stakes spaced 3-5 feet apart. Stakes should be pounded into the middle of the wattle perpendicular top the slope and protrude the wattle by 2 –3 inches.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for wildlife friendly wire fence and access gates.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary to safely perform the work as shown on the Contract Drawings and as specified herein

C. Related Sections:

1. Section 02200 - Earthwork.

D. References:

1. AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

a. AWPA C1 (2003) All Timber Products – Preservative Treatment by Pressure Processes

b. AWPA C4 (2003) Poles - Preservative Treatment by Pressure Processes

2. ASTM INTERNATIONAL (ASTM)

a. ASTM A 121 (1999; R 2004) Standard Specification for Metallic-Coated Carbon Steel Barbed Wire

b. ASTM A 702 (1989; R 2006) Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought

c. ASTM F 900 (2005) Industrial and Commercial Swing Gates

PART 2 - PRODUCTS

2.01 Barbed Wire

A. Barbed wire shall conform to ASTM A 121 zinc-coated, Type Z, Class 3, or aluminum-coated, Type A, with 12.5 gauge wire with 14 gauge, round, 4-point barbs spaced no more than 5 inches apart.

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2.02 Smooth Wire

A. Smooth wire shall conform to ASTM A 121 zinc-coated, Class 3, or aluminum-coated, Type A, with 12.5 gauge wire.

2.03 Wooden Posts

A. Wood posts shall be cut from sound and solid trees free from short or reverse bends in more than one place. Tops shall be convex rounded or inclined. Posts shall be free of ring shake, season cracks more than ¼ inch side, splits in the end, and unsound knots. Size and shape of posts shall be as indicated on the Plans. Posts shall be treated in accordance with AWPA C1 or AWPA C4 as applicable.

2.04 Metal Posts

A. Metal Posts shall conform to ASTM A 702 zinc-coated, heavy duty studded T-section; length as indicated on Plans, weighing 1.33 pounds per lineal foot. Accessories shall conform to ASTM F 900.

2.05 Metal Accessories

A. Metal accessories shall include the following:

1. ½-inch steel rod at 32-inch length
2. 4-inch wood nails
3. In-line strainer (ratchet tension device)

2.06 Metal Access Gates

A. Gates shall be of the swing type, 16 feet wide, and fabricated from 18 gage galvanized steel.

2.07 Miscellaneous Fence Items

A. Post top, anchor plates, bar bands and other required fittings and hardware shall be steel, malleable iron or wrought iron and shall be galvanized.

B. Accessories, fittings, hardware and other miscellaneous Equipment shall be as shown on Plans.

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2.08 T-Post Clips

A. T-Post Clips shall conform to ASTM A 121 zinc-coated, Type Z, Class 3, or aluminum-coated, Type A, with 12.5 gauge wire.

PART 3 - EXECUTION

3.01 General

A. Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared a minimum of 2 feet prior to installation. Line posts shall be spaced equidistant at intervals not exceeding 10 feet. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment.

3.02 Fence Installation

A. The wildlife friendly fence will consist of four wires, two barbed, and two smooth as shown on Plans and as indicated herein.

1. The top wire (smooth) will be located 40” above the ground

2. The second wire from the top (barbed) will be located 28” from the ground

3. The third wire from the top (barbed) will be located 23” from the ground

4. The bottom wire (smooth) will be located 18” from the ground

3.03 Corner Post Installation

A. Corner Posts shall consist of treated lumber posts which are 4 inches by 4 inches. Corner post holes shall be dug using a post hole digger and in a manner to ensure that all posts are level and squared. String shall be mounted on the corner post side (corner to corner) for a guide line for digging additional post holes.

B. Corner posts shall contain barbed wire “H-Braces” in order to insure a rigid design. The barbed wire shall be wrapped in a cross pattern three times, followed by the placement of a steel rod through the center to insure the wire does not unwind. Posts will extend four feet into the ground and four feet out of the ground.

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3.04 T-post Installation

A. T-posts shall be driven into the soil using a T-post driver and set apart every 16.5 feet on center driven a minimum of 22 inches into the ground. T-Post clips shall be used to secure both smooth and barbed wires to T-posts.

3.05 Access Gates

A. Access gates shall be installed per manufacturer instructions.

3.06 Quality Control

A. Erection of fence shall have a maximum ¼-inch over 5 feet variation from plumb.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for preparing the site prior to planting.

B. The Contractor shall furnish all labor, equipment, material, and supplies for weed & weed seed removal, de-compaction of soil, spreading and finish grading of soil, plant installation layout, tree and shrub planting pit preparation, and other associated work.

1.02 SUBMITTALS

A. Qualification Data: Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and address of City Representative.

B. Implementation Schedule

C. Equipment List: A list of proposed site preparation, seeding, and mulching equipment to be used in performance of seeding operation, including descriptive data calibration tests.

D. Certificates: The material supplier’s statement certifying that the supplied material meets specified requirements. Each certificate shall be signed by an official authorized to certify on behalf of material supplier and shall identify quantity and date or dates of shipment or delivery to which the certificates apply. Submit specifically for the following materials:

1. Mulches and compost: Certificate shall indicate amounts of weed and heavy metals.

1.03 REFERENCES

A. San Francisco Integrated Pest Management Program, City and County of San Francisco.

1.04 INSPECTIONS

A. It is the Contractor’s responsibility to request site inspections with the City Representative at least 48 hours prior in advance of the date observation is required. The City Representative may at anytime inspect work without notification. The following are key inspection events:

1. Site Layout Inspection: To verify the perimeter boundaries have been staked and to ensure the protection of the existing site features and resources.

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2. Planting Layout Inspection: To verify the plants are located and flagged in accordance with the Specification and Drawings.

B. Contractor's Site Conditions Verification: If, during the Contractor's site investigation, it is determined there are differing site conditions, the Contractor shall immediately notify the City Representative who will verify the conditions in question.

1.05 QUALITY CONTROL

A. Licensing Requirements: Contractor shall possess a State of California Landscape Contractor license.

B. Installer Qualifications: Engage an experienced Installer who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.

C. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that landscaping is in progress.

D. Work shall be performed in accordance with the best standards of practice relating to various trades under continuous supervision of a qualified, experienced foreman.

1.06 SHIPMENT, DELIVERY, STORAGE AND HANDLING

A. Shipment: Preparation for shipment shall be done in a manner that will not cause damage to materials, equipment or adjacent property.

B. Storage: All material shall be stored in accordance with all State and local codes and regulations governing material.

C. Handling: Care shall be taken to avoid injury to people. Materials shall not be dropped from vehicles.

D. Mulch and compost shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, materials may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

E. Seed materials, during delivery and when temporarily stored onsite, shall be kept in a cool dry place, protected from moisture, wind, heat, vandalism, rodents, insects, weather, and other conditions that would damage or impair viability off seed.

1.07 TIMES AND CONDITIONS

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A. Perform the work under this Section only during periods when beneficial results can be obtained. Consider periods of potential flooding due to flows and rain. Optimum period for plant installation is between November and March, or after the first rains of the season have begun and the soil is saturated with water.

B. The Contractor shall be responsible for coordinating and scheduling the delivery of the material and equipment to the project site. The Contractor shall ensure each subcontractor's work is coordinated with the entire work to be performed.

C. Protect existing utilities, paving, and other facilities from any damage caused by landscaping operations.

D. Protect existing trees onsite measure at least 6" diameter at breast height (DBH).

E. It is the responsibility of the Contractor to visit the site to determine existing conditions including access to the site, the nature and extent of existing improvements upon adjacent public and private property, the nature of materials to be encountered and other factors that may affect the work of this section.

PART 2 - PRODUCTS

2.01 PESTICIDE/ HERBICIDE

A. Pesticide use is not allowed in this project. Herbicide will only be considered if and when other non-chemical control methods prove unsuccessful. If used, herbicide use shall comply with all implementation and reporting guidelines outlined in the Integrated Pest Management Plan (City and County of San Francisco 1996) and specified under guidelines in the Mitigation and Monitoring Plan (URS 2010). Any herbicide used shall be approved for use in California and specific habitats as appropriate and not be considered a threat to any special status species.

2.02 LAYOUT MATERIAL

A. Permanent Rebar Stakes: Permanent stakes shall be 48-inch steel rebar. The top 12 inches of the rebar shall be spray painted with fluorescent colored paint and topped with colored surveyor's tape. The tops of the rebar shall be capped with plastic safety caps, manufactured specifically for that purpose.

2.03 EQUIPMENT

A. Power Equipment: All power equipment shall be provided with fire restrictive controls for both equipment and use.

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B. Low Ground Pressure Equipment: Use only low ground pressure equipment with tracks or wide tracks not exerting a pressure higher than 5 psi on the ground in areas designated for seeding or planting.

C. Heavy Equipment: If heavy or wheeled equipment access is necessary and upon written approval from the City Representative, ½" minimum thick steel plate in segments of a minimum 4'-0" x 4'-0" size shall be placed over the entire ground where this equipment will be operating.

2.04 TOPSOIL

A. Topsoil shall be obtained as specified in Section 2052 " Clearing, Grubbing and stripping". Topsoil will be stockpiled to the side of the construction area and spread back over the previous extent at the completion of grading. Prior to any grading, weedy areas of a species listed in Cal-IPC inventory listing (http://www.cal-ipc.org/ip/inventory/weedlist.php) for invasive plants will be identified and staked in the field. Topsoil will not be conserved in areas where weed seed may cause problems with the success of native revegetation.

2.05 SOIL AMMENDMENTS

A. Fertilizer: Use of fertilizers is not allowed.

2.06 WEED-CONTROL PRODUCTS

A. Non-chemical, targeted and landscape-level treatment is the preferred choice for non-native invasive plant control. Methods for small non-native invasive plant infestation include manual removal with weed wrenches or string trimmers (weed whacker) or hand pulling. Landscape-level methods such as mowing and disking may be used with larger infestations.

PART 3 - EXECUTION

3.01 SITE CONDITIONS

A. Site Conditions Verification: Inspect project sites before proceeding with any work, carefully check grades, existing vegetation and verify dimensions and conditions affecting the work. Notify the City Representative immediately, in writing, of any deviations or conflicts between the Drawings, the Specifications, and the site conditions are observed; extra work arising from failure to do so shall be performed at the Contractor's expense. If any deviations or conflicts between the Drawings, Specifications, or site conditions are identified before the start of work, that are

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determined by the City Representative to require the Contractor to perform additional work, payment will be made in conformance with the Contract.

B. Weed and Debris Removal: Field verify that all areas to be planted are clear of weeds and debris prior to soil preparation.

C. Contaminated Soil: Do not perform soil preparation work in areas where soil is contaminated with deleterious materials, construction debris or any other non-natural substances. Report such areas to the City Representative. Do not proceed until contaminated soil is removed.

D. Moisture Content: Do not work soil when moisture content is so great that excessive compaction will occur, or when it is so dry that dust will form in air. Apply water if necessary to bring soil to optimum moisture content for tilling and planting.

3.02 SOIL PREPARATION

A. Re-compaction prevention: Use only extra-light machinery during disking and smoothing operations to minimize re-compaction of soil.

B. Soil Preparation in Areas Disturbed by Grading Activities:

1. Do not work soil when moisture content is so great that an excess compaction will occur, or when it is so dry, that dust will form in the air.

2. Apply water if necessary to provide ideal moisture content for tilling and for planting specified in this Section.

3. Uniformly till soil to depth of 6 inches by disking, rototilling, or any other approved method.

4. If large clods are present during disking, attach a ring roller to break up soil.

C. Soil Preparation in Areas Not Disturbed by Grading Activities:

1. Grub or remove vegetation from a 3-foot diameter circle around the location where the plan will be installed.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for container plant installation.

B. The Contractor shall furnish labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary for installing container plants and other associated work.

1.02 REFERENCES

A. ASFNS- American Standard for Nursery Stock, 1990 edition.

1.03 SUBMITTALS

A. Qualification Data: Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and address of Landscape Architects and Owner, and other information specified

B. Certificates of Compliance: Provide certificates confirming that materials meet the requirements specified, prior to the delivery of materials. Reports for the following materials shall be included.

1. Plant Materials: Must include scientific and common name, size, quantity by species, grade, and nursery grown.

C. Work Schedule: Submit proposed work schedule, indicated dates for each type of vegetation work as listed in this specification. Correlate with specified establishment periods to provide maintenance from date of substantial completion. Do not begin work until such schedule is reviewed and stamped as acceptable by the City Representative and returned to Contractor. Such work schedule, once accepted, may not be revised except for reasons beyond the installer’s control. Provide at least 10 days prior to the intended date of the first delivery. Revise dates only if acceptable by City Representative and after documentation for reasons of delay.

D. Maintenance Instructions: Submit typewritten instructions recommending procedures to be established by SFPUC for maintenance of planting work after completion of contractor’s establishment period, 18 months. Submit preliminary draft to City Representative for review prior to beginning establishment period. Establishment period will not be considered complete until such maintenance instructions are stamped as reviewed and acceptable to City Representative. Provide City Representative with two copies of acceptable establishment plan before beginning warranty period.

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E. Substitutions: Requests for substitutions of materials, equipment, or methods from those given in these Specifications or shown on the Drawings shall be submitted in writing to the City Representative. All submittals shall be made well before that item of work is scheduled for installation. Multiple copies (5) of the literature shall be supplied to allow the City Representative time for review and acceptance or rejection.

F. Site Soil Analyses: The Contractor shall provide the City Representative with two (2) completed project site soil analyses. The soil samples shall be obtained from project locations as directed by the City Representative.

1.04 INSPECTIONS

A. It is the Contractor's responsibility to notify the City Representative at least 5 days prior to each anticipated inspection. The City Representative may at anytime inspect work without notification. The following are key inspection events:

1. Plant Inspection at Nursery: Plant materials shall be subject to inspection at the growing site by the City Representative and the Contractor. If the City Representative rejects provided nursery stock, the Contractor shall be required to find a plant source to replace those rejected plants at no expense to the City.

2. Plant Inspection at Job Site: The City Representative and Contractor shall inspect the plant material upon delivery at the job site (and prior to installation) for conformity to the Container Plant Standards, as per this Specification section. Any unacceptable plant material shall be removed from the job site.

3. Plant Installation Inspection: Plant installation will be inspected by the City Representative for conformance with the Drawings and specifications.

4. Installation Acceptance Inspections: Installation acceptance inspections shall be initiated only after all collective project requirements have been completed, which includes, but is not limited to: site preparation, seeding, infrastructure, planting, and all other associated work.

(1) Preliminary Installation Acceptance Inspection: Prior to the completion of the Installation Period, a preliminary inspection shall be held by the City Representative. Time for the inspection shall be requested in writing by the Contractor at least 5 working days prior to the desired date. The quantity and type of plants installed, clean up requirements and the acceptability of the plants installed, in accordance with the requirements stated herein, shall be determined and noted in writing.

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(2) Final Installation Acceptance Inspection: A final inspection shall be requested in writing by the Contractor at least 5 working days prior to the desired date. At the final inspection, the City Representative will evaluate the deficiencies noted in the preliminary inspection, to ensure they have been corrected. Time for the inspection shall be established in writing. An "Installation Acceptance" will be given after all installation requirements have been satisfactorily completed and approved by the City Representative. PARTIAL ACCEPTANCE OF ANY ITEM OR COMBINATION OF ITEMS WILL NOT BE GIVEN. A written acceptance by the City Representative shall constitute the beginning of the Establishment Period.

1.05 WARRANTY

A. All plants shall be guaranteed to be healthy and in a vigorous growing condition at the time of Installation Acceptance, as determined by the City Representative.

B. Warranty during installation and maintenance periods:

1. Provide warranty that plants remain in healthy vigorous state of growth.

2. Replace and warranty for additional period of 60 calendar days, plants found not acceptable to the City Representative at any time, up to and including the end of the initial 60 day warranty period.

3. Warranty period for plant replacements: Remain in effect for a 60 day period, regardless of time of replacement.

4. Warranty revegetation plantings for the period(s) specified above against defects including death and/or unsatisfactory growth, except for defects resulting from neglect by SFPUC, abuse or damage by others, or unusual phenomena or incidents which are beyond installer’s control.

1.06 DELIVERY, STORAGE AND HANDLING

A. Delivery: Plants shall be picked up by the Contractor from the storage location (on-site or nursery) in and delivered to the installation site.

B. Container-Grown Plants: Containers shall be sufficiently rigid to hold ball shape and protect root mass during delivery. Plants shall be protected from the direct impacts of sun and wind during transport.

C. Plant Protection during Delivery: Preparation for delivery shall be done in a manner that will not cause shock or damage to branches, trunk, root systems or seeds. Plants shall be protected during delivery to prevent desiccation of the plant or damage to the roots or

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balls. Plants shall be delivered in a covered vehicle capable of providing protection from sun and wind. Branches of plants shall be protected by covering all exposed branches.

D. Plant Material: Do not prune prior to delivery unless otherwise instructed by the City Representative. Do not bed or bind trees or shrubs in such manner as to damage bark, break branches, or destroy natural shape. Provide protective covering during delivery, and provide any needed protection on site from traffic, pedestrians, and deleterious effects of climate while planting operations are in progress. Do not drop any planting stock during delivery or planting operations.

E. Deliver plant material after preparations for planting have been completed. Plant as soon as appropriate plant material checks are carried out by City Representative and plant locations have been approved City Representative. If planting is delayed after delivery, set material aside in shaded area out of full sun, protect from weather and mechanical damage, and keep roots moist by covering with mulch, burlap, or other acceptable means of retaining moisture. Do not remove container-grown stock from containers until ready to plant.

F. Container Grown Plants Storage: Container plants not installed on the day of arrival at the site shall be stored and protected in areas designated by the City Representative. Plants shall be protected from exposure to wind and shall be shaded from the sun. Covering that will allow air to circulate and prevent internal heat from building up shall be provided. Plants shall be kept in a moist condition by watering with a fine mist spray until planted.

G. Herbaceous Plug Storage: Plugs not installed on the day of arrival at the site shall be stored and protected in areas designated by the City Representative. Plants shall be protected from exposure to wind and shall be shaded from the sun. Covering that will allow air to circulate and prevent internal heat from building up shall be provided. Plants shall be kept in a moist condition by watering with a fine mist spray until planted.

H. Other Materials Storage: Soil amendments shall be stored in dry locations away from contaminants. Storage of materials shall be in areas designated or as approved by the City Representative.

I. Handling: Care shall be taken to avoid injury to plants. Materials shall not be dropped from vehicles. Container-grown plants shall be handled by the container and by the trunk or stems.

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1.07 TIMING AND CONDITIONS

A. Planting and construction operations shall be performed only during periods when beneficial results can be obtained. When excessive moisture, winds or other unsatisfactory conditions prevail, the work shall be stopped when directed by the City Representative. The Contractor shall schedule planting in the mornings to avoid stressing plants during installation, if the planting schedule calls for installation when the temperature is expected to be 90 degrees Fahrenheit/32 degrees Centigrade or greater. When special conditions warrant a variance to the planting operations, proposed planting times shall be submitted in writing to, and approved by, the City Representative. The Contractor shall be prepared to install plants at the earliest time when all conditions (season, weather, moisture, temperature) are acceptable.

A. Installation Period: The Installation Period begins, when the Notice to Proceed (NTP) is given and continues until all requirements indicated in this specification and accompanying Drawings are completed and approved and the City Representative gives a written acceptance. Optimum period for plant installation is between November and March, or after the first rains of the season have begun and the soil is saturated with water.

PART 2 - PRODUCTS

2.01 PLANTS

A. General: Contract to Grow Contractor will provide native plant material grown from cuttings, seed, or other propagules, as well as full size plants salvaged from the Project site of species, sizes and amounts as indicated on Drawings. All plant material will be collected from natural plant stands native to Project site, areas within the Alameda Creek watershed or other areas designated by SFPUC. Seed, cuttings and salvaged plants will be collected in compliance with permits issued by the City of the property where collected, and applicable laws.

B. Quality: Well shaped, vigorous, healthy plants having proper top growth balanced with well branched root systems shall be provided. Plants shall be provided free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement and abrasion. Plants shall be provided that are typical of the species or variety and as specified herein. Seeds shall be viable free from insect damage, desiccation and abrasion.

C. Size: Plants shall be furnished in sizes indicated. No variation in size will be permitted without prior written permission by the City Representative. All variations requested by the Contractor shall be at no additional cost to the City.

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2.02 BACKFILL

A. Backfill shall be the existing soil stripped of all rocks and root matter so that it is friable and thoroughly mixed.

2.03 PLANT PROTECTION

A. Fencing: Temporary/Permanent fencing will be used in all planting areas to protect plantings from livestock.

2.04 MULCHING

A. Planting basins shall have organic weed-free mulch (redwood bark, bark chips, wood chips or equivalent) applied around planting basins of woody species.

PART 3 - EXECUTION

3.01 PREPARATION

A. Site preparation shall be completed prior to planting.

B. Surface preparation for planting zones:

1. Planting Pits: Provide plant pits as shown on the Drawings.

2. Follow Specification Section 02915 guidelines for soil surface preparation for soil preparation in areas disturbed/not disturbed by grading activities

3.02 INSTALLATION

A. Planting Layout: The planting layout shall mimic natural conditions, with a naturalistic planting pattern (i.e., not grid planted) most likely in patches. Contractor shall locate and pin flag individual plant locations. Plant material locations shall be adjusted, by the Contractor, to meet field conditions, if so directed by the City Representative. All flagging shall be left in the ground for the duration of the installation and establishment periods.

B. Plant Spacing: Plant spacing shall follow the spacing specified in the Planting Layout. The spacing listed shall be used to ensure that each plant has enough space to successfully grow.

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C. Excavation for Planting:

1. Size of planting areas.

a.	Tree pot (TP)	12”dia. X 14” depth of plant soil ball
b.	Deep Pot (D16)	6” dia. X 7” depth of plant soil ball
c.	Super Cell (SC)	6” dia. X 8.25” depth of plant soil ball
d.	Plug	4” dia X 2.5” depth of the plug

D. Container Planting Pits: In sites with no surface revetment, the planting pit for all container material shall be pre-formed (dug or drilled) and shall have a size as indicated above and on the Drawings. Plant pits shall be dug to produce rough vertical sides and un-compacted bottoms. Remove only enough soil within the pits so that the rootball can be freely placed without restriction. The pit shall be of sufficient size as to accept the container material without damage to plant material. The pit size shall be sufficient as to maintain continuous soil contact for the entire root ball.

E. Plug Planting: A plug bar, the same depth as the plug, should be used to plant grass plugs. The plug bar will be pushed into the soil until the plug bar footrest is level with the ground. Next, the plug bar will be removed and the plug will be inserted into the hole.

F. Acorn Planting: Two species of trees may be propagated from seed: oaks and buckeye. Acorns will be planted three to a hole with the radical pointing downward. A 12-inch planting hole shall be excavated, the spoils will be used to backfill the hole and acorns will be planted 2 inches deep. Soil will be added to cover the acorn. Buckeyes will be planted in a shallow depression where the top half of the buckeye is not covered by soil. All planted tree seed will have protective cages installed around them to protect from herbivory.

3.03 SETTING AND BACKFILLING

A. Setting Container Plants & Transplants: Container plants shall be removed from their containers without damage to the plant or root system. Place plant where indicated on the Drawings. Set plant stock upright in relation to surrounding grade so that the root crown is slightly above the surrounding soil or as indicated on the drawings. Backfill carefully, with existing soil, and work around the root-ball. Tamp soil so that the plant is secure and at the proper grade.

3.04 INSTALLING PLANT PROTECTION

A. Protect areas against damage, including erosion and trespass, and provide proper safeguards as may be needed.

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B. Install appropriate browse protection (tubex) supported with a stake as indicated on the Drawings.

C. Take special care to prevent erosion from surface drainage from other areas. Repair or replace any damage from such drainage.

3.05 BUILDING WATER BASINS

A. Water basins shall be constructed around all plants. A 36 in. diameter 3 in. high earth water basin made of existing soil shall be formed around all individual plants. The basin shall be level and compacted to hold its shape for the duration of the Installation and Establishment Periods.

3.06 MULCHING

A. Apply a minimum 4-inch thick layer of mulch within the planting basin to reduce weeds, retain soil moisture and moderate soil temperatures.

3.07 MAINTENANCE DURING THE INSTALLATION PERIOD

A. General: Maintain installed plants in a healthy growing condition. Maintenance shall begin immediately after each plant is installed and continue throughout the Installation Period. The maintenance includes watering, weeding, weed control, pruning, straightening, adjusting, repairing and other necessary operations to ensure each plant is maintained in a healthy growing condition. The area immediately around the plant (18 in. radius) shall be kept free of weeds, non-native grass and other undesired vegetation. Plants shall be checked for settlement and shall be reset to proper grade as necessary. Run-off, puddling and wilting shall be prevented and corrected as necessary. Non-native grasses shall be kept below 3 in. in height. Weeds shall be removed on a regular basis.

B. Watering-In: All plant material shall be watered immediately (within 4 hours) after installation.

C. During the Installation Period, each plant shall receive 5 gallons of water at each watering. The application shall be applied at a rate where runoff does not occur.

3.08 FINALIZE AS-BUILT DRAWINGS

A. The Contractor shall finalize as-built drawings for the work completed herein. The as-builts shall be current with progress of work.

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3.09 RESTORATION AND CLEANUP

A. Access roads and facilities that have been damaged from the planting operation shall be restored to original condition at the Contractor's expense. Excess and waste material from the planting operation shall be removed and disposed of off the site according to all federal, state and local codes.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for pole cutting collection and installation.

B. The Contractor shall furnish labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary to perform work including but not limited to identifying, harvesting, preserving, preparing for installation, transporting and planting willow cuttings and other work as necessary to complete this Project in conformance with the Drawings and Specifications.

1.02 SUBMITTALS

A. Submit to the City Representative information describing the source of material to be used for live pole cuttings. Include the location, species, property owner, and a letter indicating permission has been granted from the property owner to harvest plant material.

1.03 TIME AND CONDITIONS

A. Plant willow cuttings between January and March while willows are dormant, or after the first rains of the season have begun and the soil is saturated with water as specified in Section 3.04 (D) unless otherwise permitted, in writing, by the City Representative.

PART 2 - PRODUCTS

2.01 CUTTINGS

A. General: Provide cuttings of below described species as needed to complete the Project.

B. Origin: Collect cuttings from riparian and mesic areas within the Alameda Creek Watershed. Donor plants will be identified for the City Representative's approval while the plants are in leaf.

C. Species: Collect cuttings of the following species:

1. Arroyo willow - *Salix lasiolepis*

2. Sandbar willow – *Salix exigua*

3. Red willow – *Salix laevigata*

D. Size & Shape: Provide cuttings with a minimum of 2 inches in diameter. Provide cuttings reasonably straight, 3 to 5 feet in length, cleared of side branches or any remaining holes.

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E. Age: Provide only live wood at least one year old or older. Do not collect very old wood. The optimal age is 4-5 years, smooth barked, not with deeply furrowed bark. Do not collect suckers and current year's growth (these do not have sufficient energy reserves).

F. Quality: Cuttings shall be vigorous stock, free of insects and disease.

2.02 FERTILIZER

A. The use of fertilizer or other amendments is not allowed.

2.03 ROOT STIMULANT

A. The use of root stimulant is not allowed.

2.04 LATEX PAINT

A. Use pure latex paint only. Do not use other synthetic paints or paints containing lead additives. Comply with all legal requirements regarding VOC (Volatile Organic Compounds).

PART 3 - EXECUTION

3.01 COLLECTION OF CUTTINGS

A. Collection Time: Collect cuttings when willows are dormant (typically November to March). Cuttings shall be soaked in water overnight before planting. If cuttings must be stored, they shall be placed in a container with water, covered with black trash bags and stored in a cool, dark place.

B. Notification: Notify the City Representative, in writing, at least 10 working days prior to gathering willow cuttings. Take cuttings only from areas shown on the Drawings or other adjacent areas approved by the City Representative.

C. Parent Plants: Take willow cuttings at random from healthy, vigorous plants. Collect cuttings from various sources to ensure genetic diversity of the plant material. Do not cut more than 30 percent of the plants in a designated area. Do not cut more than 30 percent of each individual plant. Leave a minimum of 70 percent of each individual plant intact. Leave a minimal impact to donor areas. Select for collection only branches whose removal will not impair the parent tree's health and appearance. Remove branches from the inside of the crown area rather than the more visually obvious exterior area.

D. Harvesting: Harvest cuttings with pruning shears, lopping shears, small wood saw or brush cutters. Do not use chain saw. Do not use anvil type shears of any type (these tend to crush and split cutting ends). Make cuts with sharp, clean tools. Make clean cuts

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without any additional damage or scarring of parent tree. For easy recognition of top and bottom of pole cutting at time of planting, cut off top end with a horizontal square cut above a leaf bud, bottom end with a cut at 45° angle below a leaf bud. Do not cut pole cuttings down to size after initial collection, (growth hormones concentrate at original cutting ends and subsequent second cutting would remove most of them). For all cuttings, first undercut branch to about 1/3 of its diameter on the underside, then cut branch off on the top side slightly away from the undercut to prevent the pole cutting and its parent branch from splitting. After pole cutting is collected, cut off the stub left on the parent branch just outside of the branch collar. Do not flush cut any parent branches (this can result in slow healing and susceptibility to fungal disease).

3.02 PREPARATION OF CUTTINGS

A. Stripping: Remove all buds, within 1/6 off the top end of the cutting. Remove all side branches and all leaves along the entire length of each cutting, immediately at time of collection, so cutting is one single stem. Spread pruned-off branches and trimmings in the designated willow cutting areas so that no areas are left unsightly.

B. Dipping: Seal top end of each pole cutting by dipping it in 50:50 mix of light colored latex paint in water. Assign one different color to each species.

C. Packaging: Bundle cuttings in quantities of 25 or 50 to facilitate counting, and mark by species (in addition to dipping in paint). Wrap bundles in burlap or other suitable material that protects the cuttings from sunlight, heat, and wind, and allows air to circulate. Soak cuttings in water for a minimum of 24 hours prior to planting. Cuttings may soak for up to 2 days. Only the bottom 1/3 need be placed in water. Avoid soaking latex painted cutting tops.

3.03 PREPARATION FOR PLANTING OF CUTTINGS

A. Layout: Do not plant cuttings in rows or at regular intervals, but at random as shown on the Drawings. Plant cuttings at a greater density of five cuttings per drawing symbol around installed structures, such as flow deflectors and at the beginning and end of linear structures.

B. Planting Area Clearing: Clear an area 24” in diameter of weed growth at each proposed cutting installation location prior to planting. Pesticides shall not be used for weed control.

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3.04 PLANTING OF CUTTINGS

A. Time: Plant cuttings within 48 hours after collection and keep wet until planted. Do not use willow cuttings not planted within 48 hours after cutting, or cuttings allowed to dry out. Dispose of unused willow cuttings.

B. Watering: If the soil in and around the planting area is not wet prior to planting, water the soil and maintain in a wet state until the willow cuttings are planted.

C. Planting holes: Make planting holes perpendicular to the ground line and form with a steel bar or excavate by use of an auger, post hole digger or similar tools. Make plant holes large enough to receive the willow cuttings in order that the willow cuttings may be planted to the proper depths without damage to the bark. Where rock or other hard material prohibits holes from being excavated as specified, new holes shall be excavated and the abandoned holes backfilled.

D. Planting Depths: Plant cuttings with approximately 2/3 of their length into the soil, such that at least two bud scales are visible, and shall be in good contact with soil. At a minimum, stakes shall be buried two feet below ground surface.

E. Cuttings adjustment: Do not prune or cut cuttings secondarily after their initial collection to adjust them to the hole size for any other reason.

F. Installation method: Plant cuttings with the bottom angle-cut ends in the ground and latex painted straight-cut tops above ground. Leaf bud scars shall point up. Avoid damaging pole cuttings, stripping their bark or splitting them during installation. Remove and replace split or damaged cuttings. Do not hammer cuttings into the soil. Pounding willow stakes into the ground is not allowed.

G. Backfilling: It is essential for the planted cuttings to have good contact with the soil for roots to sprout. After inserting the pole cutting into planting hole, prepare mud slurry by mixing soil and water, and fill the planting hole with it. Then tamp thoroughly soil around the cutting to remove any air pockets. Compaction shall be adequate to prevent the willow cutting from being easily removed from the soil.

3.05 CUTTINGS MAINTENANCE

A. General: Water and maintain cuttings in a healthy condition from the time they are planted until acceptance of the contract. Replace dead cuttings immediately. The method of planting replacement cuttings shall be as specified in this section for willow cuttings.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for hydroseeding. The goal of this work is to establish native grasses and herbaceous plants that provide erosion control and wildlife habitat.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances, and services necessary for seeding and mulching of all designated areas and as necessary to complete the Project.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. AGRICULTURAL MARKETING SERVICE (AMS):AMS-01 (Amended through: Aug 1988) Federal Seed Act Regulations (Part 201-202)

2. COMMERCIAL ITEM DESCRIPTIONS (CID) CID A-A-1909 (Basic) Fertilizer

3. FEDERAL SPECIFICATIONS (FS) FS O-F-241 (Rev D) Fertilizers, Mixed, Commercial

1.03 QUALIFICATIONS

A. All work shall be done by an experienced Contractor familiar with native grass and herbaceous plant seeding and its horticulture, and industry methods and standards for seeding. The Contractor shall employ modern equipment and state of the art methods and techniques. The Contractor shall have a minimum of 3 years of applicable on the job experience with herbaceous native plant seeding and weed control.

1.04 SUBMITTALS

A. Schedules.

B. Equipment List. A list of proposed site preparation, seeding, and mulching equipment to be used in performance of seeding operation, including descriptive data and calibration tests.

C. Delivery. Delivery schedules, at least 3 days prior to the intended date of the first delivery.

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D. Maintenance and Establishment Period. Written calendar time period for the maintenance and establishment period. When there is more than one establishment period, the boundaries of the grass area covered for each period shall be described and mapped in the maintenance reports.

E. Certificates. Certificates of compliance certifying that materials meet the requirements specified, prior to the delivery of materials. Certified copies of the reports for the following materials shall be included:

F. Seed: For each species random samples from unopened and labeled containers: percent pure live seed, minimum percent germination, dormant and hard seed, maximum percent weed seed content, date tested and state certification. Certification of seeds by the Association of Official Seed Certifying Agencies (AOSCA) through the California Crop Improvement Association (CCIA) is encouraged.

G. Straw Mulch: Harvest date and location, species, and weed content.

1.05 INSPECTIONS

A. It is the Contractor's responsibility to notify the City Representative at least 5 days prior to each anticipated inspection. The City Representative/City may at any time inspect work without notification. The following are key inspection events:

1. Seed, Equipment & Application Inspection: Seeding work shall not be accepted without this inspection. Seed suppliers and collectors are subject to inspection of methods, materials, and processing. Contractor shall provide supplier and collector names and addresses upon award of contract. Seed shall be inspected upon arrival at the job site by the City Representative for conformity to species and quality. Upon arrival at the Site the Contractor shall provide the City Representative with receipts of the seed purchased and delivered to the site. Receipts shall provide name of company from which the seed was purchased, seed species, seed place of origin, composition, quantity, germination rate, and pure-live-seed (P.L.S.) percentage. Other material shall be inspected for meeting specified requirements. Unacceptable materials shall be removed from the job site and replaced by the Contractor. Immediately prior to commencement of seeding operations, the Contractor shall adjust and calibrate equipment as per manufacturer's specifications and field test in the presence of the City Representative. Seeding operation shall be inspected during equipment calibration, material loading and seed application.

2. Two-part Seeding Acceptance Inspection: Prior to the completion of the Seeding Period, a preliminary seeding inspection shall be held by the City Representative. Time for the inspection shall be requested in writing by the Contractor at least 5 working days prior to desired date. The quantity and type of species seeded, clean-up

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requirements and the acceptability of the seeding operation, in accordance with the requirements stated herein, shall be determined and noted in writing. A final inspection shall be requested in writing by the Contractor at least 5 working days prior to the desired date. At the final seeding inspection, the City Representative will evaluate the deficiencies noted in the preliminary seeding inspection, to ensure they have been corrected. Time for the inspection shall be established in writing. A "Seeding Acceptance" will be given after all seeding requirements have been satisfactorily completed and approved by the City. PARTIAL ACCEPTANCE OF ANY ITEM OR COMBINATION OF ITEMS WILL NOT BE GIVEN. A written acceptance by the City Representative of all project components, in addition to requirements specified in this section, shall constitute the beginning of the Establishment Period.

1.06 SHIPMENT, DELIVERY, STORAGE AND HANDLING

A. Shipment: Preparation for shipment shall be done in a manner that will not cause damage to seeds, and all other material.

B. Delivery: Seeds, fiber, mulch, and all other material shall be protected from weather and contamination during delivery.

C. Storage: Material shall be stored in areas approved by the City Representative. Seed shall be stored in cool, dry locations away from contaminants. Mulch shall be kept covered from rain.

D. Handling: Except for bulk deliveries, material shall not be dropped or dumped from vehicles.

1.07 TIMES AND CONDITIONS

A. Seeding Conditions: Seeding and construction operations shall be performed only during periods when beneficial results can be obtained. When excessive moisture, winds or other unsatisfactory conditions prevail, the work shall be stopped when directed by the City Representative. The Contractor shall be prepared to seed at the earliest time when all conditions (weather, moisture, temperature) are acceptable.

PART 2 - PRODUCTS

2.01 SEED

A. Seed Source: Seed will be sourced from the Alameda Creek Watershed.

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B. Seed Classification: State-certified seed of the latest season's or previous seasons crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS-01 and applicable state seed laws. AOSCA / CCIA certifications for seeds are encouraged.

C. Seed Quality: Weed seed shall not exceed percentage by weight of the total of each species. Wet, moldy, insect infested, or otherwise damaged seed shall be rejected and removed from project site. Open containers of seed or improperly tagged containers will be rejected and removed from project site.

D. Sampling: For all seeds or containers, it is the option of the City to take random samples for each species, and require the Contractor to provide analysis of samples at no extra cost to the City.

E. Seed Mixing: The mixing of seed shall be performed by the Contractor, in the presence of the City Representative, on site and as directed by the City Representative.

F. Substitutions: Substitutions will not be allowed without written request and approval from the City Representative.

2.02 SEED SPECIES AND SEEDING RATES

A. Native Grass and Herbaceous Plant Mix: Native herbaceous plant seed species and seeding rates shall be as indicated on Drawings.

2.03 FERTILIZER

A. Fertilizers shall not be used.

2.04 PESTICIDES

A. Use of pesticides is not allowed.

2.05 MULCH

A. General: Mulch shall be free from noxious weeds and seeds, mold, and other deleterious materials.

B. Straw: Straw shall be stalks from native grasses furnished in air-dry condition and with a consistency for placing with commercial mulch-blowing equipment. Substitutions shall be requested in writing and must be approved by City Representative. Rice straw is not allowed. Wheat or barley straw if used shall not be derived from dry farmed cereal crops and be certified weed free.

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C. Wood Cellulose Fiber: Wood cellulose fiber shall be commercially available and produced from virgin wood fiber. Fiber shall be of such character that fiber will disperse into a uniform slurry when mixed with water. The water content of the fiber before mixing into the slurry shall not exceed 15 percent of the dry weight of the fiber. The moisture content of the fiber shall be clearly marked on the package.

1. Ash Content: Fiber shall not contain more than 7 percent ash as determined by the Technical Association of the Pulp and Paper Industry (TAPPI) Standard T 413, and shall be nontoxic to plant or animal life.

2. Water-holding Capacity: Fiber shall have a water-holding capacity by weight of not less than 1,200 percent. Water-holding capacity of the fiber shall be marked on the package.

3. Coloring: Fiber shall be colored to contrast the area on which the fiber is to be applied. The material used for color shall be nontoxic to plant and animal life and Paper Fiber. Paper fiber mulch is not allowed.

2.06 TACKIFIER

A. Tackifier shall be non-toxic to plant and animal life, non-corrosive, and non-crystalline and be non-staining to concrete or painted surfaces. Tackifier shall be biodegradable.

2.07 WATER

A. Water shall be the responsibility of the Contractor, unless otherwise noted. Water shall not contain elements toxic to plant life.

PART 3 - EXECUTION

3.01 HYDROSEEDING

A. Hydroseeding: Seed species shall be mixed to ensure a seeding rate as specified on Planting Designs. Wood cellulose fiber shall be added to the mixture after the water and other mixture components have been thoroughly mixed to produce a homogeneous slurry. The slurry shall have the proper consistency to adhere to the earth slopes without lumping or running. The time period for the seed to be held in the slurry shall be a maximum of 1 hour. Slurry shall be uniformly applied under pressure over the entire designated area. The hydroseeded area shall not be rolled. The Contractor shall employ the following four-step hydroseeding process:

1. Step 1: Apply the first step as a complete mixture as indicated below:

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(1) Virgin Wood Cellulose Fiber, at a minimum rate of 1,500 lbs. per acre on slopes less than 4H:1V. Slopes 4H:1V to 2H:1V shall have a minimum application rate of 2,500 lbs. per acre.

(2) Seed Mix, as specified and at rate specified.

2. Step 3: Distribute straw with straw blower or by hand:

(1) Native grass straw, at a minimum rate of 4,000 lbs. per acre.

3. Step 4: Apply the thrird step as a complete mixture as indicated below:

(1) Tackifier, at a rate of 125 lbs. per acre.

3.02 MULCH AND TACKIFIER

A. All seeded areas, where designated on the drawings, shall be mulched and tackified after seeding operations.

B. Applying Straw. Straw mulch shall be applied to all seeded areas upon completion and approval of the seeding application by the City. Mulch shall be spread by hand, blower-type mulch spreader or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of a slope and continued uniformly until the area is covered. The mulch shall be applied loose and not be bunched.

C. All seeded areas shall be mulched within 24 hours of seeding.

D. Applying Tackifier. All straw mulch areas shall be anchored with a commercially available organically dyed organic tackifier.

E. Applying Fiber. Wood cellulose fiber shall be applied as part of the hydroseeding operation. The mulch shall be mixed and applied in accordance with the manufacturer's recommendations.

3.03 MAINTENANCE DURING SEEDING PERIOD

A. Maintenance shall begin immediately after seeding is completed and shall continue throughout the Seeding Period. Maintenance of the seeded areas shall include the following until Seeding Acceptance is given: regular observations of the sites, watering, hand removal of weeds, and repair of damaged areas.

B. Watering. The Contractor shall keep the soil at the seeded area constantly moist during the first three weeks after seeding.

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C. Spraying for Weed Control after Seeding. The use of pesticides is not allowed.

D. Repair. All Contractor damaged areas shall be repaired by the Contractor to their original condition within 5 working days.

3.04 CLEANUP

A. Excess and waste material shall be removed from the seeded and staging areas and shall be disposed of off the site.

END OF SECTION

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PART 1 – GENERAL

1.01 SCOPE

A. This section specifies the performance standards for Irrigation System.

B. The Contractor shall provide all labor, materials, tools and equipment necessary to design, install, operate and maintain an irrigation system in an efficient and workmanlike manner. The irrigation system shall provide adequate coverage of each area intended for plant establishment. The Contractor shall provide incidental materials and labor not specifically called for but required to complete the work.

1.02 RELATED SECTIONS

A. Section 02200 – Earthwork

B. Section 02270 – Erosion and Sediment Control

C. Section 02920 – Container Plant Installation

D. Section 01300 – Submittals

1.03 REFERENCES

A. Local and Regional Agencies:

1. Water Efficient Landscape Ordinance AB1881, California Department of Water Resources.

B. Reference Publications:

1. American Society for Testing and Materials (ASTM).

2. American Society of Mechanical Engineers (ASME).

3. Manufacturers Standardization Society of the Valve and Fittings (MSS).

4. National Sanitation Foundation (NSF).

5. National Electric Code (NEC).

6. Underwriters Laboratories (UL).

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7. Uniform Plumbing Code (UPC).

1.04 GENERAL

A. Order of Work: Irrigation system installation shall be performed as indicated below.

1. Grading completion;

2. Water supply system installation;

3. Planting;

4. Erosion Control/tackifier application;

5. Irrigation system installation.

B. Quality Control: Irrigation contractor shall hold a California landscape contractor license. The irrigation system shall be installed under the direct supervision of a Certified Landscape Technician or a California Licensed Landscape Contractor. The irrigation system shall be designed by a person licensed by the State of California to design irrigation systems.

C. Installation Standard: Material and workmanship shall be in compliance with all local, State and federal applicable legal requirements, except where provisions of these Specifications exceed such requirements, these Specifications shall govern.

D. Power and Water: The Contractor shall design and install all power and water supply systems necessary to operate the irrigation system as determined by the Contractor's design.

E. Site Inspection and Layout: Before proceeding with any work, the Contractor shall inspect the site, carefully check grades and verify dimensions and conditions affecting the work. Changes or alterations to the irrigation system to meet actual conditions shall be made at the Contractor's expense.

F. Times and Conditions: The installation of the irrigation system shall be performed only during periods when beneficial results can be obtained without endangering the workers' health and safety. Consideration shall be given especially to periods of potential flooding due to high tides and heavy rain.

G. Existing Utilities: The Contractor shall locate existing utilities and facilities or engage the services of a utilities locating service to locate existing utilities at the

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project site prior to commencement of work. Existing utilities and facilities shall not be disturbed or damaged. The Contractor shall be responsible for any damage to existing utilities and facilities whether or not they are indicated on the Drawings.

H. Pipeline Placement: Parallel pipelines may be placed in a common trench, however, shall be separated by at least 4 inches.

I. Damage by Leaks: The irrigation system shall operate without leaks and without causing erosion. The Contractor shall be responsible for damage to any property or work caused by erosion or leaks in the irrigation system. Contractor shall repair any damage so caused. Repair work shall be done as directed and in a manner satisfactory to the City.

J. Protection: The Contractor shall be responsible for any damage to the irrigation system, including vandalism, which occurs before final irrigation system acceptance. The Contractor shall securely cover all openings into the system and protect all irrigation system components, both before and after being set in place, to prevent obstructions in the piping, breakage, misuse or disfigurement. Contractor shall repair and/or replace damaged components immediately so that no watering events are missed.

1.05 SUBMITTALS

A. Within 15 days following notification of award, the Contractor shall submit to the City the following:

1. Irrigation System Design Analyses and Calculations: The Contractor shall provide design analyses and pressure/friction loss calculations verifying that the system will provide reliable irrigation coverage, match the soil infiltration rate and not cause any erosion or runoff.

2. Irrigation System Design Shop Drawings: The Contractor shall submit complete irrigation system design shop drawings including irrigation layout plans, irrigation component schedule, irrigation system details, irrigation timing schedule and other drawings as required to provide full irrigation coverage of each site with the designed irrigation system. Drawings shall include water source and/or point of connection location, pressure and flow rate, location of key components, main lines and their size and material, laterals with sizes and material, valves and valve boxes, irrigation heads and risers/emitters, low drain valves, quick couplers and all other irrigation system components. The Contractor shall not begin installation work before shop drawings review and approval by the City.

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3. Proposed Materials: For the following materials and any other proposed irrigation system components, the Contractor shall provide the name of the manufacturer, brand name, model number and other pertinent information:

    a. Pipe and fittings.

    b. Irrigation heads.

    c. Valves and valve boxes.

    d. Filter at the point of connection.

    e. Miscellaneous other components

4. Irrigation System Specifications: The Contractor shall provide an irrigation system specification for construction of City approved irrigation system design.

5. Field Tests: The Contractor shall provide performance test reports in a booklet form showing the field tests performed to adjust each component and the field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system.

6. Health and Safety Plan: The Contractor shall provide a detailed report on the procedures defining the Contractor's provisions for accident prevention, health protection and safety precautions for the work to be performed.

7. As-built Drawings: After the installation of the irrigation system is complete, the Contractor shall prepare as-built drawings, which shall provide current, factual information showing locations of all irrigation components including deviations from amendments to the approved drawings and changes in the work.

8. Irrigation Schedule: The Contractor shall provide a proposed irrigation schedule for the installation and plant establishment periods indicating actual flow rates, precipitation rates, cycle time and, soak time and landscape coefficients.

1.06 INSPECTIONS

A. Inspections and testing shall be performed as described elsewhere in this specification. The City may inspect work without notification at anytime. During

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the scheduled inspections, the Contractor shall be responsible for a two-way communication system or sufficient personnel so that directions from the inspection areas to the irrigation system valves can be readily accomplished. It is the Contractor's responsibility to notify the City at least 5 working days prior to each of the following required inspections.

1. Open Trench Pressure Test Inspection.

2. Irrigation System Coverage Test Inspection.

3. Complete System Punch List Inspection.

4. Substantial Completion Inspection.

5. Guarantee period punch list inspection.

6. Final Irrigation System Acceptance Inspection.

1.07 GUARANTEE

A. The Contractor shall provide a written labor and material guarantee for the irrigation system to function properly for a period of nine months after the Final Irrigation System Acceptance Inspection.

B. Guarantee shall include restoration of planted or other areas due to settlement of trenches.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Water Source

1. Irrigation supply water shall be pumped from a floating platform installed in San Antonio Reservoir. The floating platform shall be anchored to prevent drifting. The pumping intake shall be screened to prevent debris or organisms from be entrained in the system.

B. Water Supply Pipe

1. Pipes and fittings shall be high density polyethylene (HDPE) unless otherwise indicated on the Drawings. Pipes shall be primarily 2 inches inside diameter and rated for pressures no less than 200 pounds per square inch (psi), unless otherwise noted.

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2. Couplers, reducers, and other fittings shall be compatible with pipe and rated for same pressure.

3. Where piping connects to equipment it shall be supported by compatible pipe supports and not by the equipment.

C. Water Supply Pump(s)

1. The Contractor shall furnish solar powered pumps. The pumps shall be of the helical rotor type as manufactured by Grundfos, 11SQF-2, or approved equivalent, with internal electric motors capable of working at varying voltages.

D. Control Pannel

1. The Contractor shall furnish eight (8) control panels, Grundfos Model CU 200 or approved equivalent. The CU 200 control unit is a combined status, control and communication unit especially developed for the SQFlex system.

2. The control units shall have monitoring and alarm capabilities as indicated below.

System Monitoring	Alarm Indicators
Water level in reservoir (level switch)	Pump running dry
Pump is on	Service needed
Input power	Over-temperature or overload

E. Solar Electrical Supply for Pumps

1. The Contractor shall furnish solar panels to provide power to the pumps described above. Solar modules shall be of the monocrystalline silicon type, such as the NU-U235F1 as manufactured by Sharp or approved equivalent.

2. The solar modules shall be equipped with plugs and sockets for easy connection of several modules in parallel. One row of 4 modules in series is anticipated to be required for each pump; Contractor shall be responsible for verifying the number of required modules to have the system operate in accordance with requirements stipulated herein.

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3. The solar modules shall come equipped with full solar tracking capabilities along two axis.

F. Irrigation Pipe and Fittings

1. Pipes and fittings shall be polyethylene unless otherwise indicated on the Drawings.

2. All pipe shall be marked with the manufacturer's name, class of pipe and NSF seal. Pipe shall bear no evidence of interior or exterior extrusion marks. Pipe walls shall be uniform, smooth and glossy.

G. Irrigation Heads/Emitters

1. All irrigation heads shall have a built-in pressure-regulating device. The device shall regulate nozzle pressure to the design pressure.

2. All irrigation heads/emitters must not be buried or have direct contact with soil to reduce potential for clogging.

3. All heads/emitters of a particular type or function in the system shall be of the same manufacture and shall be marked with the manufacturer's name and identification in such a position that they can be identified without being removed from the system. Any substitutions for items specified on the Plans must be submitted for approval in writing. Subsequent approval or rejection will be given in writing.

H. Valves, Valve Boxes and Controllers

1. Valves: All valves shall be plastic and shall have hubs suitable for use with the main distribution pipe furnished for the irrigation system. All valves shall be rated for the design pressure.

2. Valve Controllers: Each lateral valve, shall have a battery-operated valve controller. The valve controller shall be compatible with the valves used or appropriate adaptor shall be provided. The Contractor shall provide a remote controller to operate valve controllers without opening valve boxes.

3. Valve Boxes: Lateral circuit control valves, quick couplers, manual control, drain valves and other components shall be enclosed in water proof box with a bolt lock cover and with the word "irrigation" embossed on the cover. The bottom section shall be slotted and shall extend below

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the pipe. The box covers shall have numbered urethane I.D. valve tags or 2-inch high letters and numbers with valve identification numbers. Contractor shall provide two (2) sets of all keys/wrenches required for valves, valve box covers, and protective sleeve covers unless otherwise noted.

I. Miscellaneous Equipment

1. Nonpotable water filter shall be used.

2. Provide other accessories, fittings and materials as required for a complete operating irrigation system.

PART 3 – EXECUTION

3.01 IRRIGATION SYSTEM DESIGN

A. The Contractor shall design the irrigation system to meet the requirements for watering the plants at the frequency, rate, and for the duration of the Installation and Establishment Periods. The design shall consider, and be coordinated with, the planting and weeding requirements. The irrigation system piping shall be installed above ground. Water supply lines shall be installed below ground in areas grazed by cattle and along access roads..

3.02 IRRIGATION SYSTEM LAYOUT

A. The Contractor shall stake the irrigation system following approval of design shown on the shop drawings before the construction begins. Alterations and changes in the layout may be expected in order to conform to the ground conditions and to obtain full and adequate irrigation coverage. It is understood that corrective measures in the system may become necessary, but no changes or alterations in the system as planned shall be made without the prior authorization of the City.

B. Before starting work, the Contractor shall determine whether work may proceed without disruption of activities of other trades.

C. The Contractor shall carefully check grades to ensure that area is ready to begin work.

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3.03 TRENCHING

A. Trenching: Excavate trenches to be straight and support pipe continuously on bottom of trench. Trench bottom shall be clean and smooth with rock and organic debris removed. All trenches must be straight, with appropriate pipe-fittings used to allow pipe to be laid without undue bending and not have abrupt changes in grade.

B. Piping Trenches (Irrigation Supply): The Contractor shall cut trenches to grades and widths to accommodate pipe installation.

1. Trench Width:

a. Piping Smaller than 3 Inches: Trenches shall have a minimum width of 7 inches.

b. Line Clearance: Provide not less than 4 inches of clearance between adjacent lines.

2. Trench Depth:

a. Pressurized Supply Piping: 12 inches from bottom of pipe to finished grade.

C. Topsoil Salvage: The top 6 inches of soil shall be kept separate from the drainage layer subsoil and shall be replaced as the top layer when backfill is made.

D. The use of an underground vibratory plow or similar device to pull pipe will not be permitted.

3.04 PIPE AND FITTINGS INSTALLATION

A. The Contractor shall exercise care in handling, loading, unloading and storing pipe and fittings to avoid damage. The pipe and fittings shall be stored under cover, and shall be transported in a vehicle with a bed long enough to allow the length of pipe to lay flat, so that pipe does not bend excessively. Any pipe that has been damaged shall be discarded until such damage has been cut out and the pipe is rejoined with a coupling. Pipe shall be assembled free from dirt and other material.

B. No water shall be permitted in pipe until a period of at least twelve (12) hours has elapsed for solvent weld setting and curing.

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C. Before pressure testing, weld joints shall be given at least twenty-four (24) hours to cure.

D. Snake pipe in trench as much as possible to allow for expansion and contraction.

E. Great care must be taken to insure that the inside of the pipe is absolutely clean. Any pipe ends not being worked on must be protected and not left open.

3.05 IRRIGATION HEADS/EMITTERS

A. Install heads as shown on the approved shop drawings and details.

B. Number of heads/emitters per plant shall not be reduced for that specified on the approved shop drawings without approval of the City representative.

C. Irrigation lines shall be thoroughly flushed for 5 minutes as approved before installing heads.

D. The Contractor shall provide staking of irrigation heads as described above to secure in place and to minimize the movement or displacement caused by operation of the system.

E. The Contractor shall ensure that adequate water is supplied to each plant over the entire designated planting area.

3.06 VALVES

A. Install valves as per manufacturer’s recommendations and as shown on the approved shop drawings.

B. Before installation of any valves, the supply line must be thoroughly flushed.

C. All valves shall be enclosed in lockable valve boxes with valve box extensions as required.

D. Valve boxes shall be set on concrete block or brick to prevent settlement.

3.07 BACKFILLING

A. The Contractor shall not begin backfilling operations until system tests have been completed. All underground appurtenances shall remain exposed so they can be viewed during testing and located on "as-built" plans. If, for any reason, any part of the irrigation system is back-filled before approved location, testing, or

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inspection is authorized, it shall be completely uncovered and exposed until approved for back-filling by the City.

B. The Contractor shall leave trenches slightly mounded to allow for settlement after backfilling is completed. Trenches shall be finish graded prior to punch list inspection of the irrigation system by City.

C. Excavated material shall be used for backfill purposes. Do not mix subsoil with topsoil. Material not suitable for backfill or surplus shall be disposed of at the Contractor's expense.

D. Back-filling shall be done when pipe is not in an expanded condition due to heat or pressure. Cooling of the pipe can be accomplished by operating the system for a short time before back-fill, or by back-filling in the early part of the morning before the heat of the day.

E. Backfill around the pipe and fittings shall contain no lumps or rocks larger than two inches. A 4-inch separation is required between all pipes when more than one pipe occupies the trench. The top 6 inches of backfill shall be covered by existing topsoil where it exists. Topsoil shall be free of rocks over 1-inch, subsoil or trash. Should existing topsoil not be available or if existing soil is rocky, Contractor shall provide a substitute fill topsoil after City's approval.

F. All roots, rocks and surplus excavation shall be removed from the site unless otherwise directed. Any areas buried under ditch excavation shall be raked clean of any excavated material.

G. Prior to completing backfill, place detection tape 4 inches above installed lateral and supply mains for future line detection. Provide extra length to clearly expose ends in the valve boxes.

3.08 INSPECTIONS AND FIELD QUALITY CONTROL

A. Open Trench Pressure Test

1. City Presence and Notification: Pressure testing shall be performed only in the presence of the City. Notify City at least 5 working days in advance of testing.

2. Open Trench: Piping and other components shall not be backfilled before they have been inspected, tested and approved. Piping can be center-loaded with small amount of backfill to prevent arching or slipping under pressure. No fitting shall be covered.

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3. Test Equipment: The Contractor shall provide necessary test equipment, pump(s), generator, test gauges and other equipment as required to perform the pressure test.

4. Flushing: After piping, heads/emitters, and valves are in place and connected, but prior to installation of irrigation heads, the Contractor shall thoroughly flush piping system under full head of water pressure from dead end fittings. Maintain flushing for 5 minutes through furthermost valves or as approved. After the system is thoroughly flushed, heads/emitters shall be capped off and the system pressure tested.

5. Pressure Testing: The City will visually inspect all piping, valves, joints, swing joints, risers/emitters and other components for leakage when under pressure. The Contractor shall apply the following static water pressure after solvent weld plastic pipe joints have cured at least 24 hours.

6. Main Lines: Main lines shall be tested with lateral valves installed and closed, with all joints exposed to a pressure of 150 psi for 30 minutes until watertight.

7. Lateral Lines: Lateral lines shall be tested with irrigation heads/emitters installed and capped, with all joints exposed to operating pressures required for full functionality for 30 minutes until watertight.

8. Leakage/Pressure Loss: Irrigation pressure test is acceptable if no leakage is evident and the maximum loss of pressure during the 30-minute test period does not exceed 3 psi.

9. Test Validity: To be valid, irrigation pressure test must be witnessed and approved by the City.

10. Pressure Gauge Certification: Pressure gauges used in the testing of water pressure shall be certified correct by an independent testing laboratory before use. Gauges shall be re-tested when directed by City.

11. Timing: Irrigation pressure test shall be approved before the installation of irrigation heads/emitters.

B. Irrigation Coverage Test

1. In the presence of the City, the Contractor shall perform an irrigation coverage test for each habitat zone of the irrigation system. The Contractor shall be responsible to make modifications to the irrigation system

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components at the discretion of the City in order to obtainsufficient water to all irrigated plants with no erosion and runoff.

C. Complete System Punch List

1. Upon approved completion of the Coverage Test Inspection, trenching backfilling and installation of all irrigation system components, the Contractor shall request a Complete System Punch List Inspection of the entire irrigation system including backfilling, irrigation heads, valves, valve boxes and all other irrigation system components.

2. Based on this inspection, a punch list will be prepared by the City and presented to the Contractor for completion. The City shall provide a date for completion of the punch list, not to exceed two weeks.

D. Substantial Completion Inspection

1. Upon completion of all punch list inspection items, the Contractor shall request a Substantial Completion Inspection. The irrigation system shall be substantially complete when all punch list items have been finished to the City's satisfaction and the City issued a written substantial completion notice.

E. Guarantee Period Punch List

1. Upon completion of the plant establishment period, the Contractor shall request a Guarantee Period Punch List Inspection.

2. Based on this inspection, a punch list will be prepared by the City and presented to the Contractor for completion. The City shall provide a date for completion of the punch list, not to exceed two weeks.

F. Final Irrigation System Acceptance

1. Upon completion of all guarantee period punch list inspection items, the Contractor shall request a Final Irrigation System Acceptance Inspection. The irrigation system shall be substantially complete when all punch list items have been finished to the City's satisfaction.

2. Upon completion and approval of all tests, inspections, training, manuals, as-built drawings and other requirements of this Specification, the City shall write a letter to the Contractor transferring the project to the Maintenance Contractor.

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3.09 CLEANUP

A. Upon completion of the irrigation system installation and before the Complete System Punch List Inspection, the Contractor shall remove wires, pipe and other materials not used in the work.

B. Upon completion of operations and prior to watering, the Contractor shall clean all areas of debris caused by the work on this project. All hard surfaced areas shall be washed clean.

3.10 MAINTENANCE EQUIPMENT

A. The following irrigation maintenance equipment shall be turned over to the City: Two sets of special tools required for removing, disassembling, and adjusting each type of irrigation component supplied.

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Appendix F: 30 Percent Design Plan Drawings and Design Memo for Goat Rock

30% DESIGN

DETAILED DESIGN REPORT HABITAT RESERVE PROGRAM GOAT ROCK

Project No. 38802

Prepared for

San Francisco Public Utilities Commission
1155 Market St., 3rd Floor
San Francisco, CA 94103

March 31, 2010

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Oakland, CA 94612

26817595.EA3144

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A SQflex System Package - Brochure

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Acronyms

Ac	acre
AUM	Animal Unit Month
CY	cubic yards
DWR	Department of Water Resources
ea	each
EBRPD	East Bay Regional Park District
HDPE	high-density polyethylene
HRP	Habitat Reserve Program
LF	linear feet
IATF	Inter-Agency Task Force
MG	million gallons
MMP	Mitigation and Monitoring Plan
PS&E	Plan, Specifications and Cost Estimate
psi	pounds per square inch
PVC	polyvinyl chloride
SFPUC	San Francisco Public Utilities Commission
USDA	U.S. Department of Agriculture

Chapter 1 Introduction

1.1 BACKGROUND

San Francisco Public Utilities Commission (SFPUC) has established a Habitat Reserve Program (HRP) for the purpose of providing habitat and compensation for impacts to biological resources resulting from SFPUC construction projects. These projects include the Calaveras Dam Replacement Project, Alameda Siphons, San Antonio Back-up Pipe Line, Upper Alameda Creek Filtration Gallery, New Irvington Tunnel, and Sunol Valley Water Treatment Plant. The HRP includes a variety of preservation, restoration, enhancement, and creation actions that would be implemented on a number of sites owned by the SFPUC. The HRP was developed to:

- Provide economy of scale for coordinating and compensating for lost ecological functions and values
- Allow for multiple species and habitats to be supported in a given location
- Increase long-term conservation values across regions
- Support and coordinate existing efforts within regions

The primary objective of the program is to compensate for impacts from SFPUC projects by increasing ecological value of habitats for species while efficiently using allocated funds.

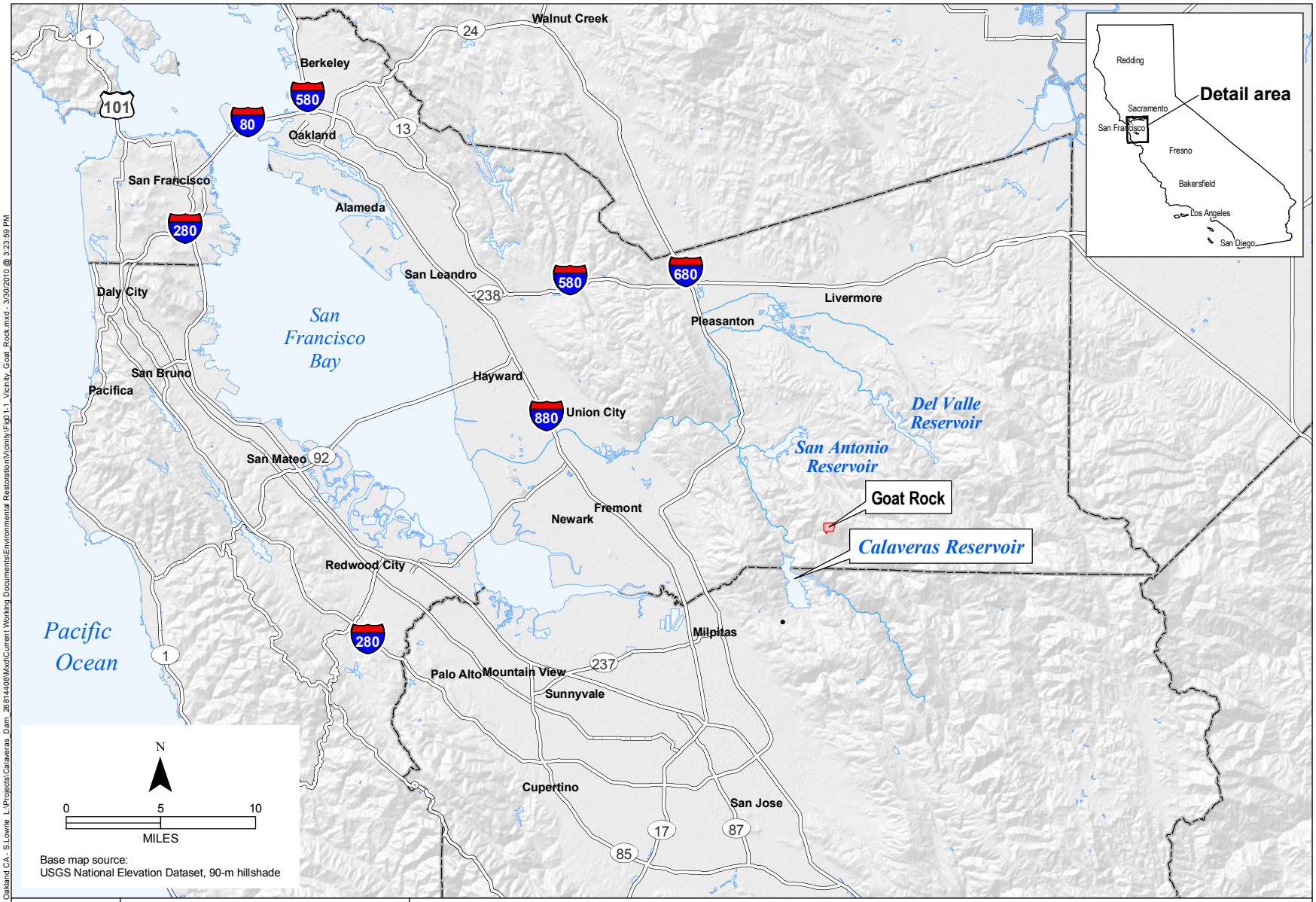
1.2 PROJECT LOCATION

The approximately 210-acre Goat Rock mitigation site (herein referred to as the mitigation site) is located in the Alameda Creek Watershed, north of Geary Road (approximately 0.2 mile) and west of Welch Creek Road (less than 0.1 mile). The mitigation site is approximately 4.7 miles from the Calaveras Dam (Figure 1-1).

1.3 PROJECT SCOPE

The scope of the project includes preparation of a 30% Plan, Specifications and Cost Estimate (PS&E) package and a detailed design report to meet the mitigation requirements listed in the Draft Mitigation and Monitoring Plan (MMP) and associated Inter-Agency Task Force (IATF) comments. The proposed project design includes the following work items:

- Design of a water transport system for cattle that graze on site. The system will include pumps, pipes, troughs, and tanks.
- Design of fencing for management of cattle use (distribution, season of use) on 210 acres of SFPUC lands. Infrastructure will be designed to control and/or remove cattle access to sensitive features, such as wetlands, serpentine grasslands, and the Northwest Pond.
- Improve the existing earthen access road at the site.



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San Francisco Public Utilities Commission
Habitat Reserve Program

Figure 1-1
Vicinity Map

- Allow for adjustment of the current cattle stocking rate (the number of cattle using the site at a given time).
- Develop a Hydroseeding plan.

1.4 EXISTING CONDITIONS

The Goat Rock mitigation site and surrounding grasslands are currently grazed year-round by cow-calf pairs. Grazing is coordinated by the East Bay Regional Park District (EBRPD). Cattle currently have unlimited access to all habitat at the site. Trampling and heavy use of wetlands and the Northwest Pond have resulted in compacted soil, heavily browsed plant material, and terracing. The primary access road at the site is unpaved and steep. Several sections of the road contain deep ruts that hinder vehicle access.

1.5 MITIGATION SITE GOALS

The overall goal of the mitigation site is to provide compensation through habitat restoration/enhancement for impacts to serpentine grassland, annual grasslands, seeps, springs, and ponds that result from the Calaveras Dam Replacement Project and other Watershed Improvement Projects. Habitat restoration/enhancement will address cattle use of the site and the poor condition of access roads at the site.

In addition, cattle-related infrastructure, such as water pumping capacity, will be engineered to allow additional water at and in the vicinity of the mitigation site for future additional cattle management beyond the 210 acres addressed in this document.

1.6 ORGANIZATION OF DESIGN REPORT

This document is organized as follows:

- Chapter 1 provides background information on the location, project scope, and mitigation site goals.
- Chapter 2 describes the water transport system alternatives and identifies the recommended alternative.
- Chapter 3 discusses the design of the water transport system for the mitigation site.
- Chapter 4 describes existing and proposed fencing at the site, and the cattle's stocking rate.
- Chapter 5 describes proposed road improvements.
- Chapter 6 describes hydroseeding to be performed in disturbed areas on the mitigation site.
- Chapter 7 provides the construction cost estimate.
- Chapter 8 lists the references cited in this document.

Chapter 2 Water Transport System Alternatives

2.1 WATER TRANSPORT SYSTEM PURPOSE

The purpose of the water transport system is to convey water for cattle consumption to the upper reaches of the mitigation site. Water would be pumped from one or more sources (Southeast Pond, EBRPD Pond, groundwater well) to one or more water storage tanks at higher elevations. Water would then be conveyed by gravity to several cattle watering troughs and Northwest Pond in the mitigation site (Figure 2-1).

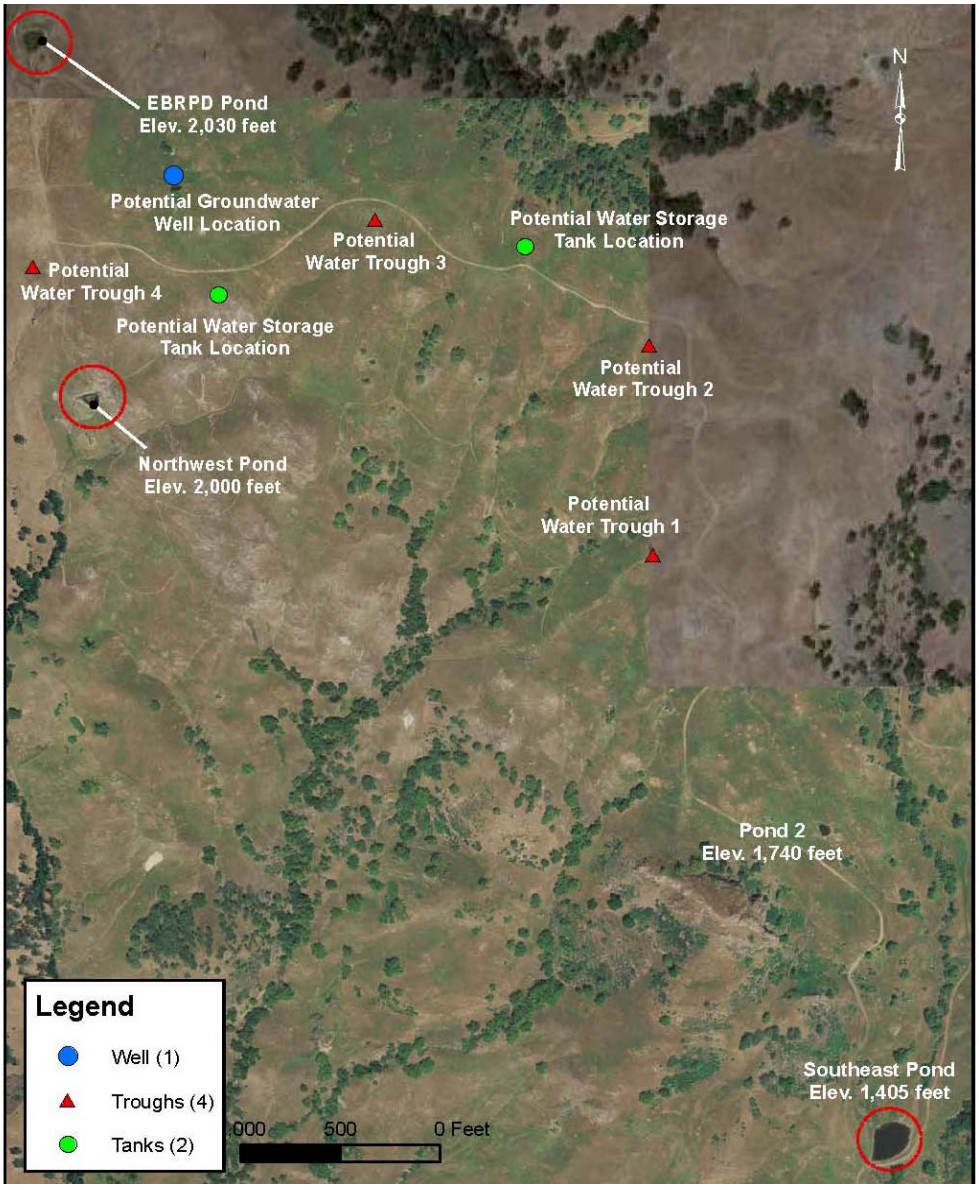


Figure 2-1
Goat Rock Mitigation Site with Relevant Water Features

2.2 EXISTING CONDITIONS

Water is currently available for cattle at three ponds within the mitigation area (the EBRPD Pond is outside the mitigation area). The Southeast Pond is the largest of these, with an estimated volume of 850,000 gallons at a water surface elevation of 1,405 feet (assuming a round pond 180 feet in diameter, with a depth of water of 8 feet and 6:1 [horizontal:vertical] side slopes). A smaller unnamed pond that has been labeled "Pond 2" for this project is directly north of the Southeast Pond at an elevation of 1,740 feet. The Northwest Pond is at elevation 2,000 feet and roughly 1.2 miles driving distance from the Southwest Pond. Pond 2 and the Northwest Pond are substantially smaller than the Southwest Pond. While the Southwest Pond has an approximate waterline diameter of 180 feet, the diameter of Pond 2 is roughly 25 feet and the diameter of Northwest Pond is about 80 feet.

Vehicular access is feasible to the Southeast Pond and Pond 2 via a steep unpaved mountain road. The road is generally sloped at 15 to 20 percent (i.e., there is a 15- to 20-foot drop for every 100 horizontal feet), although some segments have slopes as great as 35 percent.

There is no road to the Northwest Pond. Ground slopes from the existing road to the pond are on the order of 25 to 30 percent.

No cattle watering troughs are within the area of the mitigation site, and no water storage facilities are present other than the ponds described above.

2.3 WATER TRANSPORT SYSTEM ALTERNATIVES

Four water transport alternatives were considered:

- Pump from the Southeast Pond to high-elevation tanks.
- Pump from the EBRPD Pond to high-elevation tanks.
- Pump from a new groundwater well to a high-elevation tank or tanks.
- Pump from the Southeast Pond and the new groundwater well to a high-elevation tank or tanks.

Four water sources were considered:

- Southeast Pond
- EBRPD Pond
- Northwest Pond
- New groundwater well

The relatively low volume and limited area contributing water to the Northwest Pond make it a relatively unreliable water source. Consequently, the Northwest Pond was removed from further consideration as a water source.

2.3.1 Alternative 1 – Pump from Southeast Pond to High-Elevation Tanks

This alternative would use the Southeast Pond, at elevation 1,400 feet, as the water source. As shown on Figure 2-2, the main features of Alternative 1 are:

- Pumps to lift water from the Southeast Pond to higher elevations.
- A pressure pipeline to transport water from the Southeast Pond to water storage tanks at or near the top of the hill near the Goat Rock area.
- Water storage tanks to accumulate several days' supply of water for cattle watering troughs.
- A system of pipes and valves to convey water by gravity from the storage tank to cattle watering sites at four troughs and the Northwest Pond.

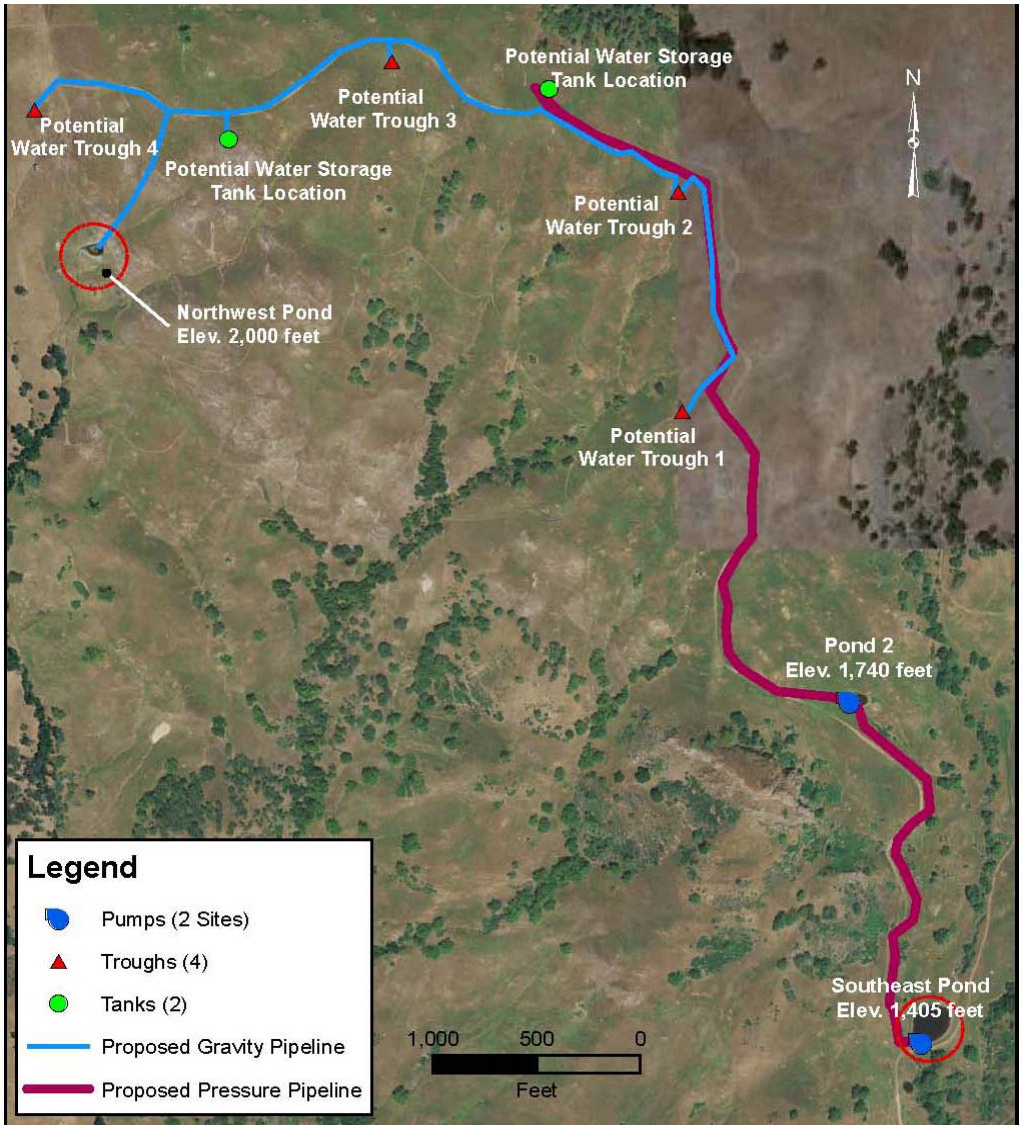


Figure 2-2
Conceptual Layout of Alternative 1: Southeast Pond to Storage Tanks

2.3.2 Alternative 2 – Pump from EBRPD Pond to High-Elevation Tanks

This alternative would use the EBRPD Pond at elevation 2,030 feet as the water source. As shown on Figure 2-3, the main features of Alternative 2 are:

- Pumps to lift water from the EBRPD Pond to higher elevations.
- A pressure pipeline to transport water from the EBRPD Pond to water storage tanks at or near the top of the hill near the Goat Rock area.
- Water storage tanks to accumulate several days' supply of water for cattle watering troughs.
- A system of pipes and valves to convey water by gravity from the storage tank to cattle watering troughs and the Northwest Pond.

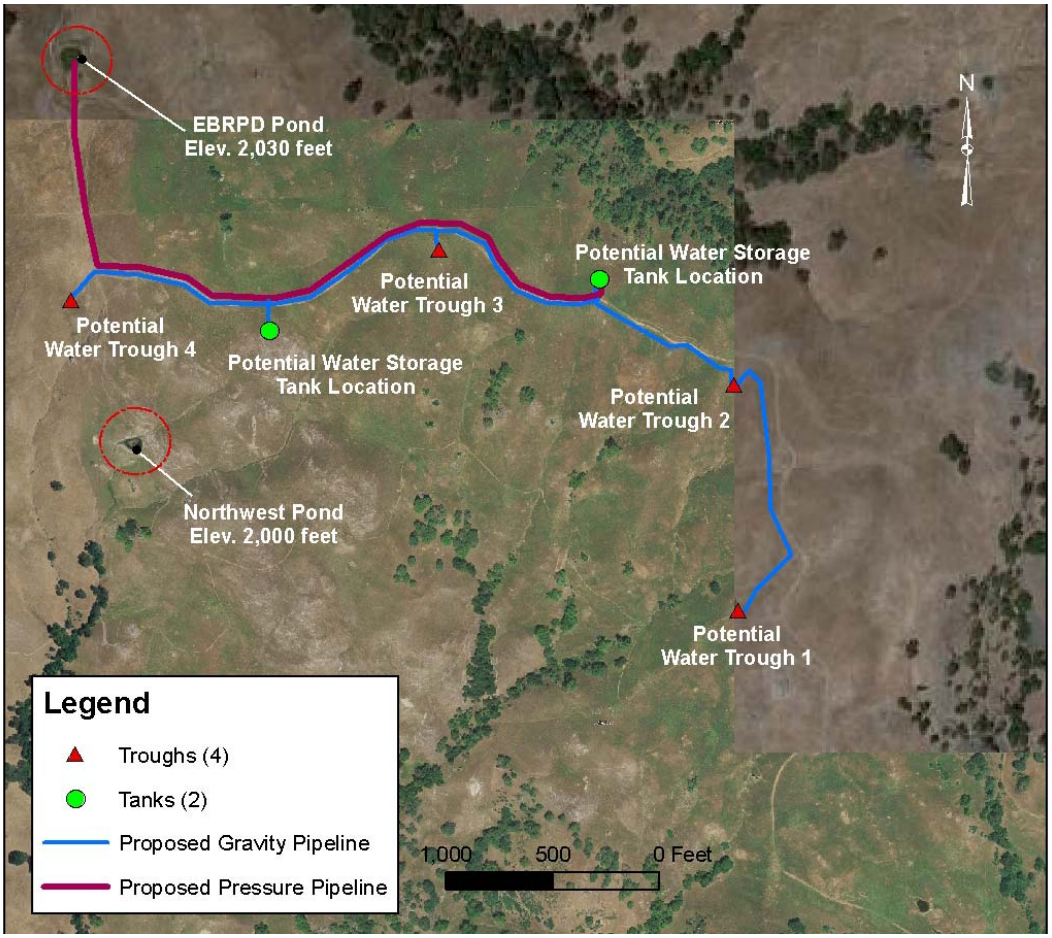


Figure 2-3
Conceptual Layout of Alternative 2: EBRPD Pond to Storage Tanks

2.3.3 Alternative 3 – Pump from New Groundwater Well to a High-Elevation Tank or Tanks

This alternative would use a new groundwater well situated at elevation 2,150 feet as the water source. As shown on Figure 2-4, the main features of Alternative 3 are:

- A deep well and pump(s) to lift water to higher elevations.
- A pressure pipeline to transport water from the new well to one or more water storage tanks at or near the top of the hill near the mitigation site.
- Water storage tanks to accumulate several days' supply of water for cattle watering troughs.
- A system of pipes and valves to convey water by gravity from the storage tanks to cattle watering troughs and the Northwest Pond.

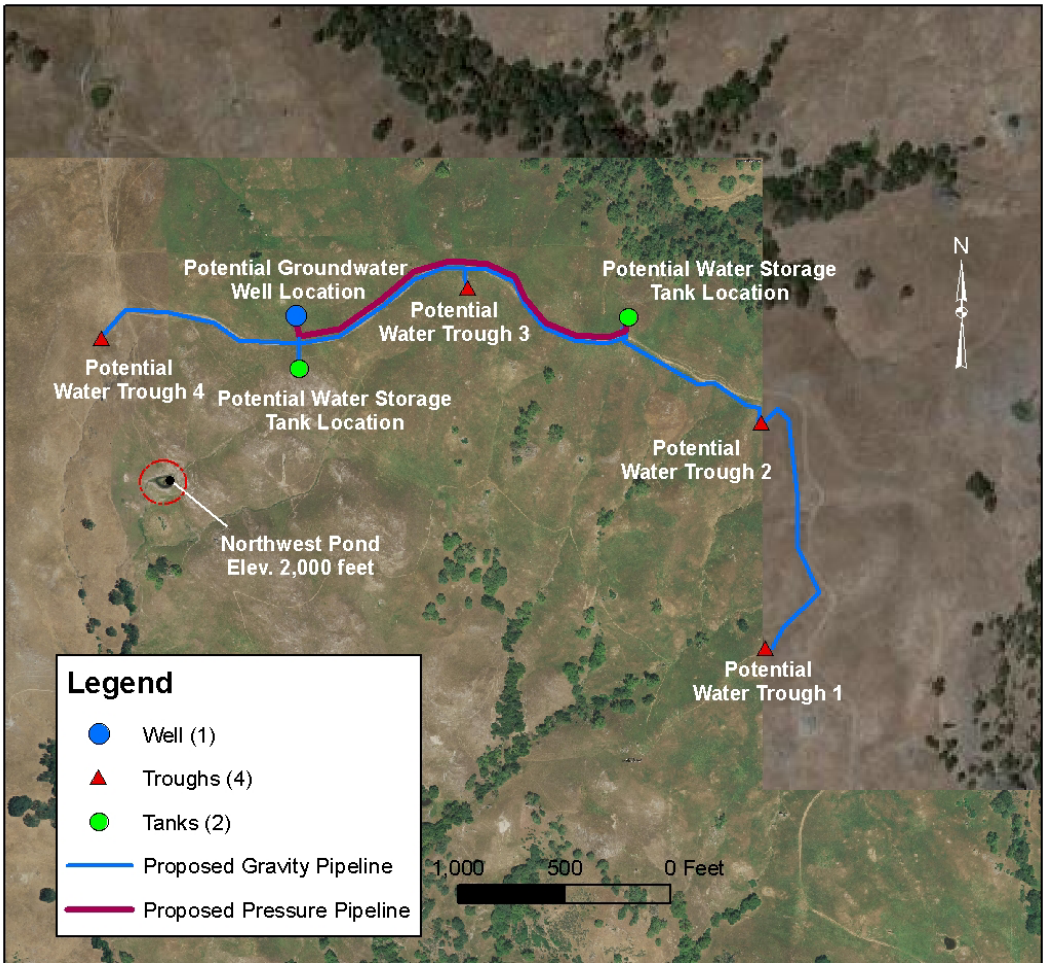


Figure 2-4
Conceptual Layout of Alternative 3: New Groundwater Well to Storage Tanks

2.3.4 Alternative 4 – Pump from Southeast Pond and New Well to a High-Elevation Tank or Tanks

This alternative would use two alternate water sources: the Southeast Pond and a new groundwater well situated at elevation 2,150 feet. Alternative 4 combines features from Alternatives 1 and 3 (see Figures 2-2 and 2-4):

- Pumps to lift water from the Southeast Pond to higher elevations.
- A pressure pipeline to transport water from the Southeast Pond to one or more water storage tanks at or near the top of the hill near the mitigation site.
- A deep well and pump(s) to lift water to higher elevations.
- A pipeline to transport water from the new groundwater well to water storage tanks at or near the top of the hill near the mitigation site.
- Water storage tanks to accumulate several days' supply of water for cattle watering troughs.
- A system of pipes and valves to convey water by gravity from the storage tank to cattle watering troughs and the Northwest Pond.

2.4 WATER TRANSPORT SYSTEM SITE CONSTRAINTS

Design of a water transport system for the mitigation site is subject to a number of site constraints, as described below.

Availability of Power. No electrical power lines are within the mitigation site. Diesel or natural gas-powered generators would present unacceptable emission and noise problems at the environmentally sensitive mitigation site.

Elevation Differentials. Two of the cattle watering troughs that need to be supplied by the water transport system are above elevation 2,300 feet. Water storage tanks would need to be situated above elevation 2,300 feet to supply water by gravity to the watering trough locations. The lifts required from potential water sources would be as follows:

- The Southeast Pond is at an approximate elevation of 1,400 feet; using this pond as a water source would require lifting water about 900 feet.
- The EBRPD Pond is at an approximate elevation of 2,030 feet; the required lift would be reduced to 270 feet.
- The depth to groundwater is not known. Assuming that groundwater can be found 200 feet from a ground surface of 2,150 feet, the required lift would be around 350 feet.

Availability of Water Year-Round. There are no definitive data on the availability of water year-round from the Southeast, Northwest or EBRPD ponds; estimates have to be derived from precipitation, slope, and soil type data. There are likewise no definitive data on the availability of groundwater at higher elevations. Several wells are near the project site, but no maps of aquifer depths are known; and depth to water and volumes available can only be approximated based on the production of nearby wells.

Jurisdiction over EBRPD Pond. The EBRPD Pond, one of three potential water sources, is outside the mitigation site and is not managed directly by the SFPUC.

Environmentally Sensitive Area. Noise and visual impacts need to be considered in the design process. Introduction of materials that might present a hazard to vegetation or fauna would be unacceptable. Impacts on the hydrology and surface water resources of the mitigation site must be minimized. A minimum water level must be maintained in the Southeast Pond to support special-status species, including the California red-legged frog and California tiger salamander.

Accessibility. The project site is in a remote area. Access to higher elevations is through steep and winding dirt roads that receive limited maintenance, with conditions that degrade substantially in the winter months.

2.5 WATER TRANSPORT SYSTEM FEASIBILITY ANALYSIS

2.5.1 Alternative 1 – Pump from Southeast Pond to High-Elevation Tanks

Alternative 1 would require that water be lifted about 900 feet from the Southeast Pond to the top of the hill, over a distance of about 6,000 feet. The magnitude of the required lift presents a challenge for both pump and pipe design.

Pump Lift and Power Demand Considerations. Pumps with low capacity and high head (i.e., lift) are commercially available for lifts in the low hundreds of feet. Pumps typically used in cattle watering generally have capacities under 10 gallons per minute and lifting capacities up to 400 feet. One manufacturer (Grundfos) is offering 700-foot lift pumps, but the reliability of these pumps has yet to be proven.

Due to the unavailability of electric or generator power at the site, pumps would have to be powered by solar cells or wind. As wind conditions are uncertain, solar power is the most feasible alternative.

The amount of power required to lift water 900 feet is relatively high. One solar panel approximately 2 feet wide and 4 feet tall can provide about 80 watts of power. The 900-foot lift, depending on flow rate, would require upwards of 1,200 watts, which translates to an impractically high number of solar panels.

Pumping water from the Southeast Pond to the top of the hill would be feasible if the pumping is done in three stages.

Pipe Pressure Considerations. Pipes that can manage pressures in the order of 900 feet (400 pounds per square inch) would have to be heavy-duty metal pipes, and even among metal pipes there are limited options for these pressure ratings. High pressures increase failure potential at joints and connections. Failures at such high pressures also present a health and safety hazard to humans and animals. Metal pipes also are subject to corrosion and durability problems.

Plastic pipes are the most suitable for use as buried pipes in the environment at the project site. The most commonly available plastic pipes are made of polyvinyl chloride (PVC) and high-density polyethylene (HDPE). Pressure ratings for readily available PVC and HDPE pipes are generally 250 pounds per square inch (psi) or less.

Use of Booster Pumps. Lifting water in three stages avoids the problems presented by high lifts Each stage would require roughly 300 feet of lift. Three separate pumps (or sets of pumps) would be used, each with lift and power requirements well within those of readily available equipment. Pressure on pipes would also stay within the levels that can be sustained by commercially available plastic pipes.

2.5.2 Alternative 2 – Pump from EBRPD Pond to High-Elevation Tanks

Alternative 2 would require that water be lifted about 290 feet, from the EBRPD Pond at elevation 2,030 feet to the top of the hill at an approximate elevation of 2,320 feet. The magnitude of the required lift is manageable for both solar powered pumps and plastic pipes. The lengths of pipe required to transport water from the pond to the tank would be on the order of 3,700 feet. This alternative is therefore feasible in terms of equipment requirements.

Jurisdiction over the EBRPD Pond presents a different type of feasibility issue. Since the pond is outside of the mitigation site and is not managed directly by the SFPUC, using water from the pond would reduce water availability to EBRPD grazing lessees, and would thus require negotiation of special agreements.

2.5.3 Alternative 3 – Pump from New Groundwater Well to High-Elevation Tanks

Alternative 3 depends on the availability of groundwater at the mitigation site, which has yet to be determined. If groundwater were available in sufficient quantities, the pumping and length of pipes required would be similar to Alternative 2, as the well would be in the same general area as the EBRPD Pond. This alternative is therefore feasible in terms of equipment requirements but depends on groundwater levels and availability.

Data from the Alameda County Flood Control and Water Conservation District indicate that there are five wells along Welch Creek Road, within 1.5 miles of the mitigation site. Only one of the five wells, a 160-foot-deep well at 3500 Welch Creek Road, is reported as productive, with a 50-gallon-per-minute flow rate (Figure 2-5). The other four wells, located between the productive well and the mitigation site, are reportedly unproductive.

The potential productivity of wells in the Goat Rock site, however, does not necessarily depend on the productivity (or lack of productivity) of nearby wells. A “Basin and Range Map” from the California Department of Water Resources (DWR, 1980) indicates that the area around the mitigation site is characterized by basin-fill aquifers (i.e., small aquifers that fill from precipitation within their own watershed). Wells in different watersheds, therefore, can be expected to have different characteristics. The only way to ascertain the availability and level of groundwater at the Goat Rock site would be through exploratory drilling.

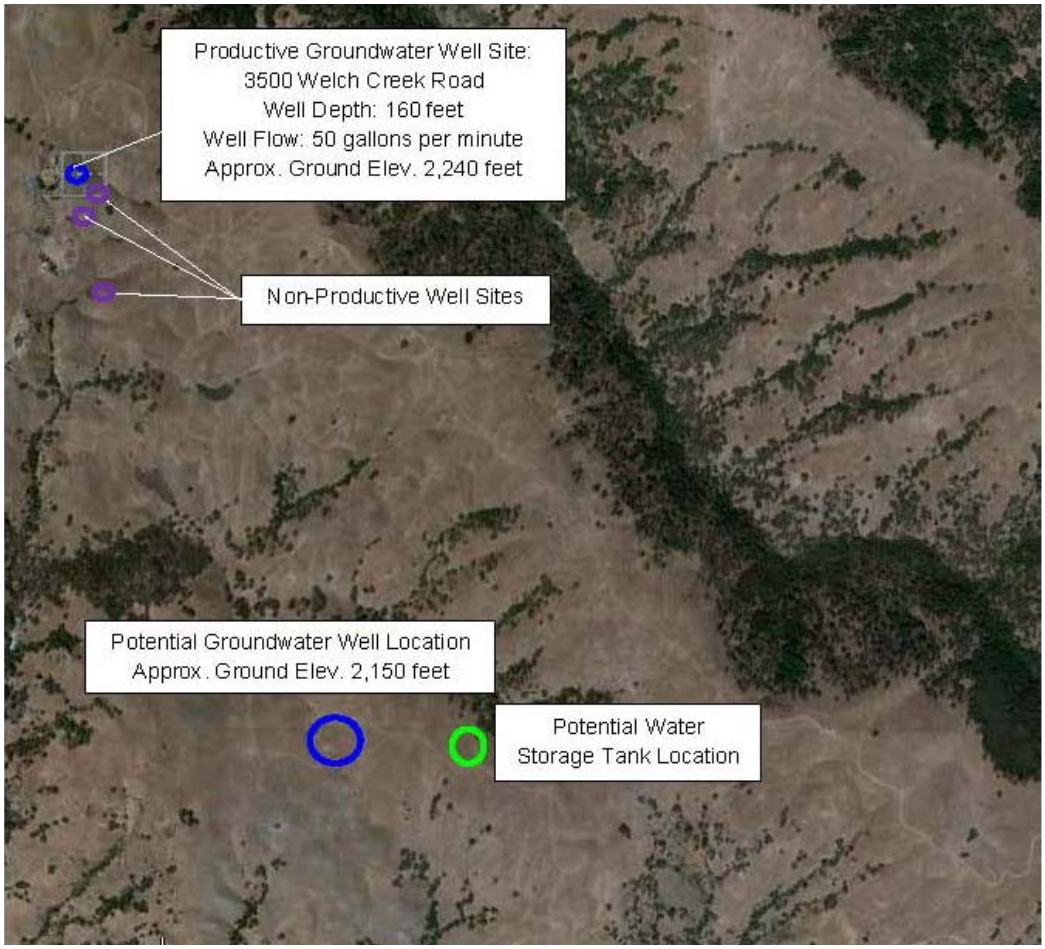


Figure 2-5
Well Site Location

2.5.4 Alternative 4 – Pump from Southeast Pond and New Well to High-Elevation Tanks

Alternative 4 would also depend on the availability of groundwater at the project site and the feasibility of a new well. This alternative would be a combination of Alternatives 1 and 3. Three pumps (or sets of pumps) could be used to lift water from the Southeast Pond (one primary pump and two booster pumps). A fourth pump (or set of pumps) would be installed in the well.

Under this alternative, the well would be the primary source of water. When well water is available, the well pump or pumps would supply the cattle watering troughs and the Northwest Pond via the water storage tank(s). Water would be withdrawn from the Southeast Pond only if the well supply dried up. Lifting of the pond water would require the less efficient use of three pumps over a longer distance.

The cost of this alternative would be higher than that of any of the other alternatives. The reliability of the water supply, however, would be increased.

2.6 RECOMMENDED WATER TRANSPORT SYSTEM ALTERNATIVE

Using the EBRPD Pond as a water source would be the least costly and most reliable alternative. Jurisdictional issues, however, have ruled out that alternative.

Using a deep well situated near the top of the hill as the primary water source would require one relatively complex operation, drilling of the deep well, but would minimize the length and complexity of the piping system. Uncertainties over the availability of groundwater and the feasibility of withdrawing sufficient volumes of water from the well suggest that this alternative should be considered only as a backup to alternatives that offer a more reliable water source.

To maximize the reliability and flexibility of the water transport system, the water source is recommended to be a combination of a new well and Southeast Pond (Alternative 4). Should the well be found to be an infeasible or unreliable water source, one reliable source would remain.

Chapter 3 Water Transport System Design

3.1 DESIGN PARAMETERS

Parameters that need to be considered for the design of the water transport system are listed below and discussed in the following subsections:

- Water demand
- Water availability
- Water storage requirements
- Pump/motor characteristics
  - Lift
  - Flow rate
  - Power
  - Pump selection
- Pipe design
  - Energy loss and diameter
  - Pressure rating
- Well
  - Depth
  - Casing type, diameter
  - Screens
- System operation and maintenance
- Environmentally sensitive area at Southwest Pond

3.1.1 Water Demand

The water transport system is designed to satisfy demand requirements from livestock in the mitigation site. URS estimated that a cow-calf pair would consume approximately 25 gallons per day and that there will be no more than 20 pairs under the new cattle stocking rate. Demand would therefore be 20 pairs × 25 gallons/pair = 500 gallons per day.

Future demands will be assumed to be a total of 200 pairs, for a maximum future demand of 5,000 gallons per day. This will provide SFPUC with the flexibility of stocking additional cattle within and in the immediate vicinity of the mitigation site.

The water transport system will be designed to provide 5,000 gallons per day. Total annual demand, assuming 300 days of service, would be 1.5 million gallons.

3.1.2 Water Availability

The amount of water available year round at the Southeast Pond is uncertain. Based on a cursory analysis of precipitation, size of watershed, and soil characteristics, however, several million gallons of water should be available annually from rainfall that infiltrates through the soil and travels slowly through the granular media into the pond at the lower end of the watershed. Relevant data are as follows:

- Average annual rainfall = 20 inches (from National Weather Service's Regional Climate Maps)
- Approximate watershed area = 106.5 acres
- Total volume of annual rainfall over watershed = 55 million gallons (MG)
- Approximate volume of Southwest Pond = 850,000 gallons

Water that falls over the watershed follows several paths. Some water is lost to evaporation. Some is stored on the surface and on plant material. Part of the rainwater travels to the pond as surface runoff. The remainder infiltrates into the soil and percolates through the underground, eventually reaching the pond at the lower end of the watershed. The pond's holding capacity may be exceeded periodically, especially after major storm events. In those instances, some of the surface runoff and some of the groundwater that reaches the pond may be conveyed downstream of the pond through overflow piping under the pond's perimeter road.

According to the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service Soil Survey for Alameda County, approximately 90 percent of the watershed has loamy soils and 10 percent of the area is rock land. Loamy soils are considered to be well draining soils, with a soil permeability classification of "moderate." These soils are able to absorb a significant portion of the rainfall, with infiltration rates ranging from 0.6 to 2.0 inches per hour (Scherer et al., 1996).

The coefficient of runoff for agricultural lands on slopes of 7 percent or greater can be assumed to be 0.35 (Chow, 1964). This translates to about 35 percent of the total rainfall contributing to surface runoff volumes. Even assuming large losses to evaporation and storage, it is safe to assume that at least 20 percent of the total annual rainfall (or 11 MG) would infiltrate through the soil and eventually enter the Southeast Pond. The theoretical availability of water, therefore, far exceeds the water transport system demand. Monitoring of surface flows and pond water levels over dry and wet years, however, would be needed to more accurately quantify available water volumes. Alternatively, a pond water balance analysis could be conducted to determine the water availability in the design stage. This analysis would require bathymetric information about the pond bottom.

3.1.3 Water Storage Requirements

There are no set requirements for storage volumes. Storage volume is generally determined based on how long a system can meet demand requirements when the primary water source is not available. Considering that the system will rely heavily on pumps that can fail or malfunction at any time, and that bringing pumps back into operation could take several days, it would be prudent to provide several days' storage for future demand needs. For preliminary design

purposes, four days of storage will be provided. That implies a storage volume of 4 × 5,000 = 20,000 gallons.

3.1.4 Pump Design

Lift. Elevations of relevant project components are illustrated schematically in Figure 3-1. Two water storage tanks are assumed, each with a capacity of 10,000 gallons. Two tanks are proposed instead of one to provide a redundancy that allows the water transport system to operate at partial capacity when something goes wrong with one tank.

The primary pump(s) would lift water from the Southeast Pond to an existing pond roughly 340 feet higher, labeled Pond 2. Pond 2 offers water storage at a convenient elevation.

Booster pump(s) would lift water from Pond 2 directly into Trough 1, which is about 360 feet higher in elevation.

Additional booster pump(s) would lift water from Trough 1 to the primary storage tank, Tank 1, which is about 280 feet higher in elevation.

The groundwater well is assumed to pump water from a level 200 feet under the surface. If the well is in close proximity to the secondary water storage tank (Tank 2), at a ground elevation of 2,150 feet, groundwater would be at an elevation of 1,950 feet. The lift from the bottom of the well to Tank 1 would therefore be about 370 feet.

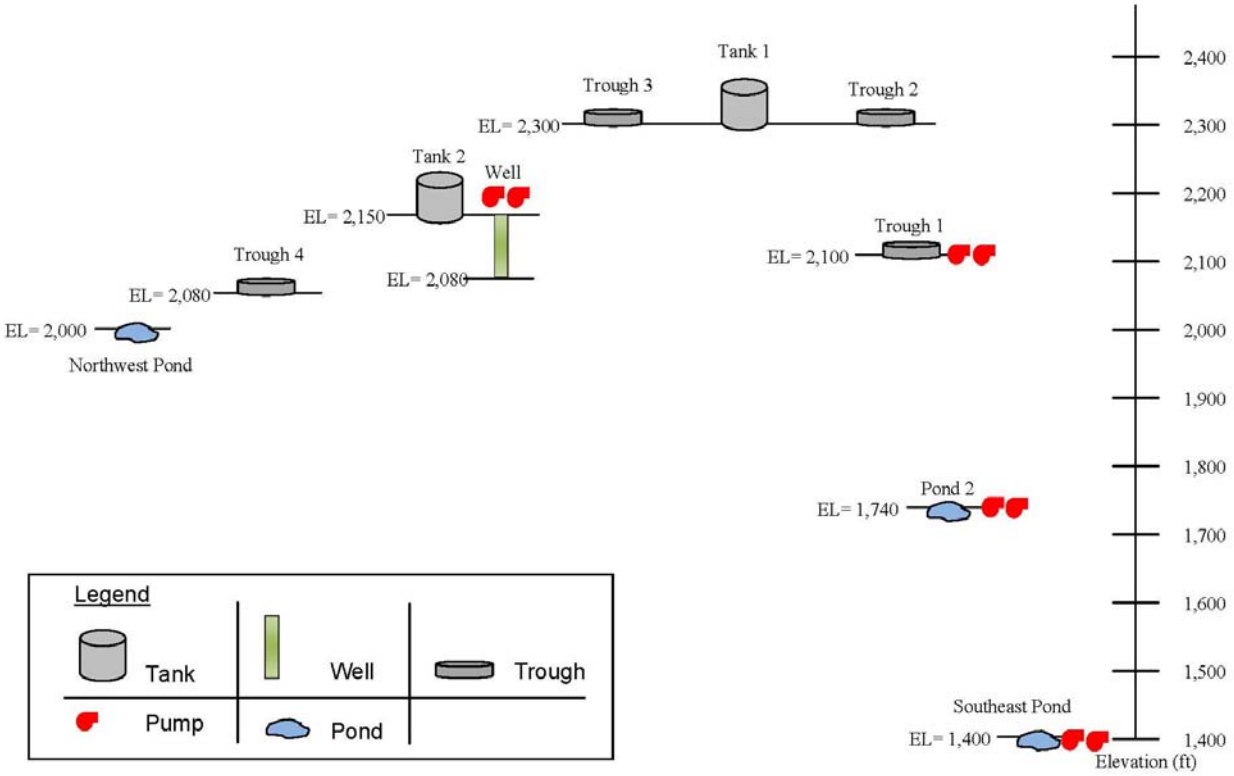


Figure 3-1
Elevation Schematic

Approximate pump lifts, neglecting energy losses through pipes, are summarized in Table 3-1.

Table 3-1
Pump Lifts for Water Transport System

From	To	Approximate Lift (feet)
Southeast Pond	Pond 2	340
Pond 2	Trough 1	360
Trough 1	Tank 1	280
Well	Tank 1	370

Flow Rate. For current demand requirements, the water transport system would need to convey 500 gallons per day. This volume could be delivered by one pump lifting 5 gallons per minute for 100 minutes.

To provide water to 200 cow-calf pairs, the water transport system would need to convey 5,000 gallons per day. This volume could be delivered by one or more pumps in different lengths of time, depending on flow rate: at a rate of 10 gallons per minute pumps would have to operate continuously for 8.3 hours; at twice that rate, 20 gallons per minute, the total volume would be pumped in 4.2 hours.

Power. Solar power is proposed for water transport system pumps. Manufacturers of pumps used for cattle watering generally sell complete packages that include the pump/motor, the solar panels, and a control panel. A brochure for an example of a water transport system power package is included in Appendix A. The whole package can be tailored to the project's needs. Commercially available solar cells generally range in capacity from 80 to 235 watts.

The limited capacity of solar cells, coupled with the large pump lifts required, will make several solar panels necessary at each pump location. Power requirements and numbers of solar panels are illustrated in Table 3-2 for several combinations of lift and flow rate possible at the site.

Table 3-2
Examples of Power Requirements for Various Lift and Flow Rates

Pump Lift (feet)	Flow Rate (GPM)	Power (Watts)	Number of 235-Watt Solar Panels Required
340	10	859	4
360	10	909	4
280	10	707	3
370	10	935	4
340	15	1,288	6
360	15	1,364	6
280	15	1,061	5
370	15	1,402	6

Note:
GPM = gallons per minute

Pump Selection. Grundfos 11SQF-2 pumps would satisfy project requirements (see Figure 3-2). Depending on lift and the amount of solar power available, these pumps can provide 8 to 10 gallons per minute at heads above 300 feet. One of these pumps at each pumping site would deliver around 4,000 gallons in one day (assuming that solar power is available on the average about 7 hours per day). Two of these pumps at each pumping site would comfortably deliver the design volume of 5,000 gallons per day.

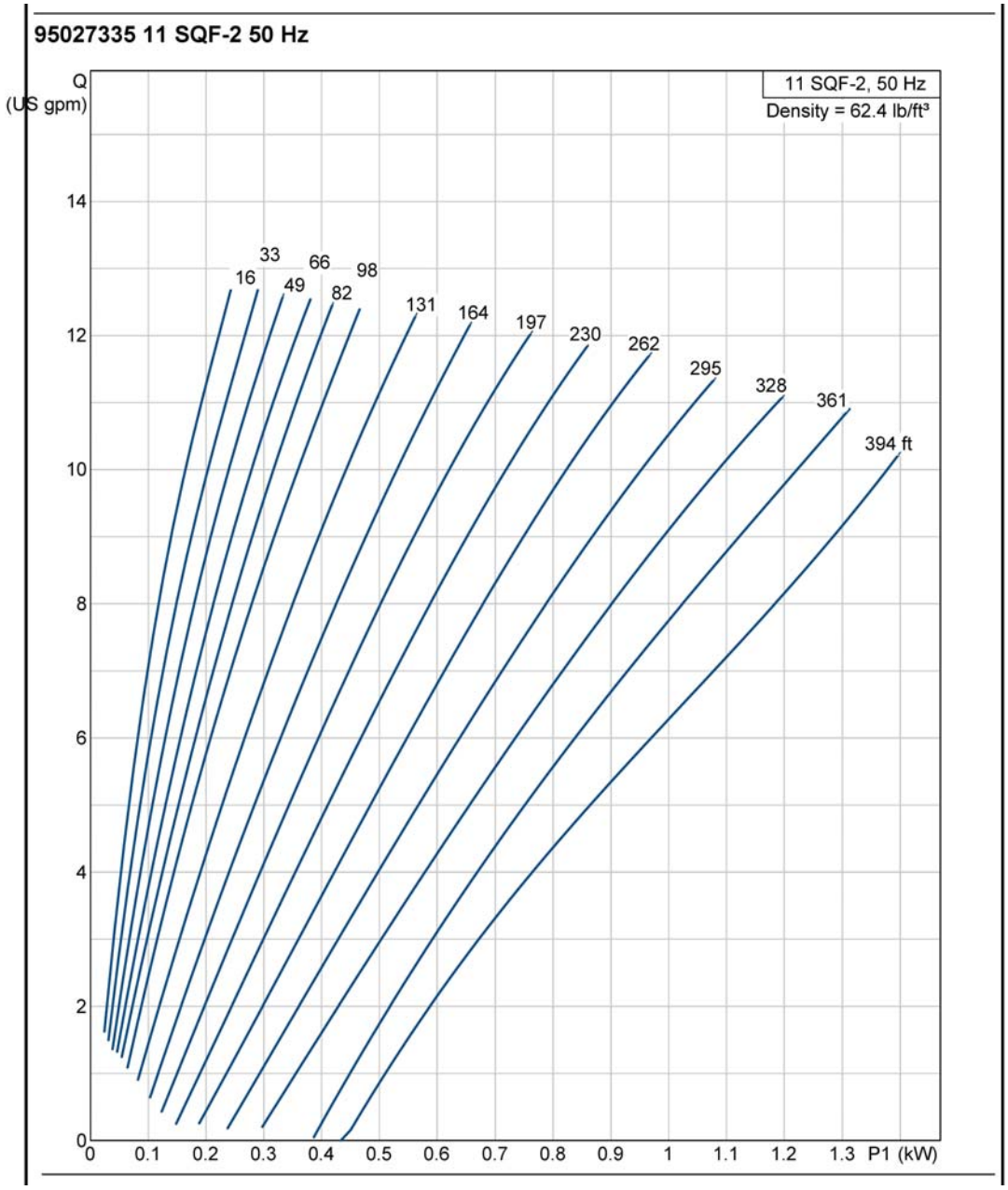


Figure 3-2
Solar-Powered Grundfos Pump Curve

3.1.5 Pipe Design

Energy Loss and Diameter. Pipe diameters are generally selected on the basis of allowable flow velocities and energy losses. In pressurized pipes, flow velocities between 5 and 10 feet per second are generally considered acceptable.

Energy losses are a function of pipe roughness and flow velocity. Energy losses are additive with pump lift; higher losses, therefore, require more pumping. Plastic pipes tend to be smooth (i.e., low roughness). For design purposes a Manning's roughness ("n") value of 0.010 will be assumed. Table 3-3 shows flow velocities and energy losses for several pipe diameters.

Table 3-3
Flow Velocities and Energy Losses for Plastic Pipes with n=0.010

Pipe Diameter (inches)	Flow Rate (GPM)	Flow Velocity (ft/s)	Energy Loss per 1,000 feet of Pipe (feet)
1	10	4.1	189.8
1.5	10	1.8	21.8
2	10	1.0	4.7
1	15	6.1	427
1.5	15	2.7	49.1
2	15	1.5	10.6

Based on the values in Table 3-3, a pipe diameter of 2 inches will be used for the main pipeline of the water transport system.

Pressure Rating. The water transport system will have pipes that convey pumped flows as well as pipes that convey gravity flows. The highest pressure at any point in the system would be 370 feet, as illustrated in Table 3-1 and Figure 3-1. Considering that 1 psi is roughly equivalent to 2.3 feet of head, the highest pressure on the piping system can be anticipated to be 370 feet ÷ 2.3 feet/psi = 161 psi. Pipes rated for 200 psi or higher will have an ample factor of safety for pressure.

3.1.6 Well

Depth. A well depth of 200 feet is assumed. The actual well depth will depend on local conditions, which would have to be determined through exploratory drilling.

Casing Type, Diameter. Well casings can be metal or plastic. PVC pipes are commercially available with enough thickness to withstand the anticipated pressures.

The diameter of the casing has to be large enough to accommodate pumping equipment. The Grundfos pumps under consideration for this project are 3 to 4 inches in diameter and about 48 inches long, and would be placed at the bottom of the well. To accommodate up to two pumps plus power cables and pump lifting cables, an internal diameter of 24 inches will be assumed for the casing.

Screens. Loose sand and gravel are generally kept from entering the well by a properly designed screen. Screens are typically centered over the water-bearing zone of the aquifer. Not enough information is currently available for a proper screen design. For estimating purposes, 30 feet of screen will be assumed.

3.1.7 System Operation and Maintenance

The water transport system needs to be fully automated and as maintenance-free as possible. Controls must be selected that activate and shut off the various pumps when required.

3.1.8 Environmentally Sensitive Area at Southwest Pond

The water transport system design takes into account environmental concerns. At the Southwest Pond in particular, the intake to the proposed pumping facility would be screened and the water level would be controlled for the protection of sensitive species such as the California red-legged frog and the California tiger salamander. Velocities through the intake screen would be maintained under 0.5 foot per second to minimize impacts on aquatic species. Level switches on the solar-powered pumps would shut the pumps off at pre-determined water surface elevations to make sure that sufficient water is maintained in the pond during the breeding season of sensitive species.

3.2 SYSTEM COMPONENTS

The proposed water transport/storage/delivery system for the mitigation site consists of the following major components:

- Four sets of two solar-powered pump packages complete with control panels.
- Two 10,000-gallon water storage tanks.
- Four cattle watering troughs equipped with float controls.
- One deep well with plastic casing and screen.
- About 20,000 feet of 2-inch-diameter HDPE pipe.
- Assorted shutoff and flow control valves, plastic, no more than 2 inches in size.
- Assorted fittings and connections to make the system fully operational.

The location, layout, and installation details for these components are included in the 30% design drawings and specifications.

Chapter 4 Fencing, Gate Design, and Cattle Stocking Rate

4.1 EXISTING CATTLE GRAZING AND CURRENT STOCKING RATE

EBRPD coordinates cattle grazing on the mitigation site, which is part of a larger grazing unit that totals 7,827 acres. The stocking rate of the 7,827-acre unit fluctuates from year to year, depending on site conditions. In 2008-2009, the stocking rate for the 7,827-acre unit ranged from 201 Animal Unit Months (AUM) to 241 AUM.

Cattle currently have unlimited access to all habitat at the site. Trampling and heavy use of wetlands and Northwest Pond have resulted in compacted soil, heavily browsed plant material, and terracing. Fencing currently exists along the northern and western boundaries of the site.

The primary road at the site is unpaved and steep. Several sections of the road contain deep ruts that hinder vehicle access.

4.2 PROPOSED STOCKING RATES

The cattle stocking rate will be adjusted to meet a residual dry matter (remaining vegetative biomass, measured in the fall) level of 1,000 pounds per acre. Based on variables that include the total production estimated by the USDA (USDA, 1996) and total acreage, the initial stocking rate at the mitigation site will be 20 AUM. The season of use will be from approximately October to March (winter to early spring), and potentially July-September, depending on vegetation. The SFPUC rangeland manager and/or grazing lessees will manage cattle grazing according to the above stocking rate.

4.3 PROPOSED FENCING

4.3.1 Fencing Design

Two new fencing alignments are proposed for the mitigation area. The first alignment includes 6,303 linear feet of fenceline that will tie into the existing fenceline on the northern and western boundaries of the site. A second fence alignment, approximately 1,373 linear feet, will surround approximately 3 acres of both Northwest Pond and associated wetlands. Both fencing sections will be used to control cattle access to these areas. Cattle troughs, pipes, pumps, and supplements will be positioned in places that draw cattle away from sensitive features such as wetlands, waters, and rare plant populations. Two gates will be installed: one on the access road on the northern boundary of the site, and a second along the eastern boundary of the site.

4.3.2 Fencing and Gate Dimensions

Fencing will be wildlife friendly, and will consist of four wires, two barbed, and two smooth. The top wire (smooth) will be 40 inches above the ground; the second wire from the top (barbed) will be located 28 inches from the ground; the third wire from the top (barbed) will be 23 inches

from the ground, and the bottom wire (smooth) will be 18 inches from the ground. T-posts will be used every 16.5 feet. A minimum of two access gates will be installed for each fencing enclosure. Gates will be swing type, 10 feet wide, and fabricated from 18 gage galvanized steel.

In addition, reflectors will be installed on fences to increase their visibility to raptors, which often become entangled in fencing. Reflectors will be 3-inch-long pieces of vinyl siding trim which will be wrapped around the wires. Reflectors will be hung from the top wire (four per section) and the third wire from the top (three per section) for visibility purposes.

Chapter 5 Road Improvements

5.1 EXISTING CONDITIONS

A 10-foot-wide unpaved dirt road currently provides access through the mitigation site. This dirt road becomes highly inaccessible during rains, impairing access through the mitigation area. Several portions of the dirt access road (approximately 900 linear feet) are deeply eroded due to improper drainage provisions. To maintain access to the proposed infrastructure at the mitigation site during all seasons, the existing dirt access road will be improved, along its existing alignment to the maximum extent possible, by resurfacing and installing proper drainage structures.

5.2 PROPOSED ROAD IMPROVEMENTS

The improved road will be a 10-foot-wide gravel road with a 2-foot shoulder. The extent of the road improvements is shown on Figure 5-1. A typical cross section of the proposed road is shown on Figure 5-2. Approximately 900 feet of the eroded portion of the road (Figure 5-1) will be improved by installing proper drainage structures such as ditches, pipes, and culverts, adjusting the steep grades with rolling dips, water bars, or other appropriate drainage features. It should be noted that the details of proposed road improvements described in this section are not included in the 30% design submittal package due to a lack of topographic information of the areas needing improvement. A detailed design of the road improvements will be included in a future submittal.

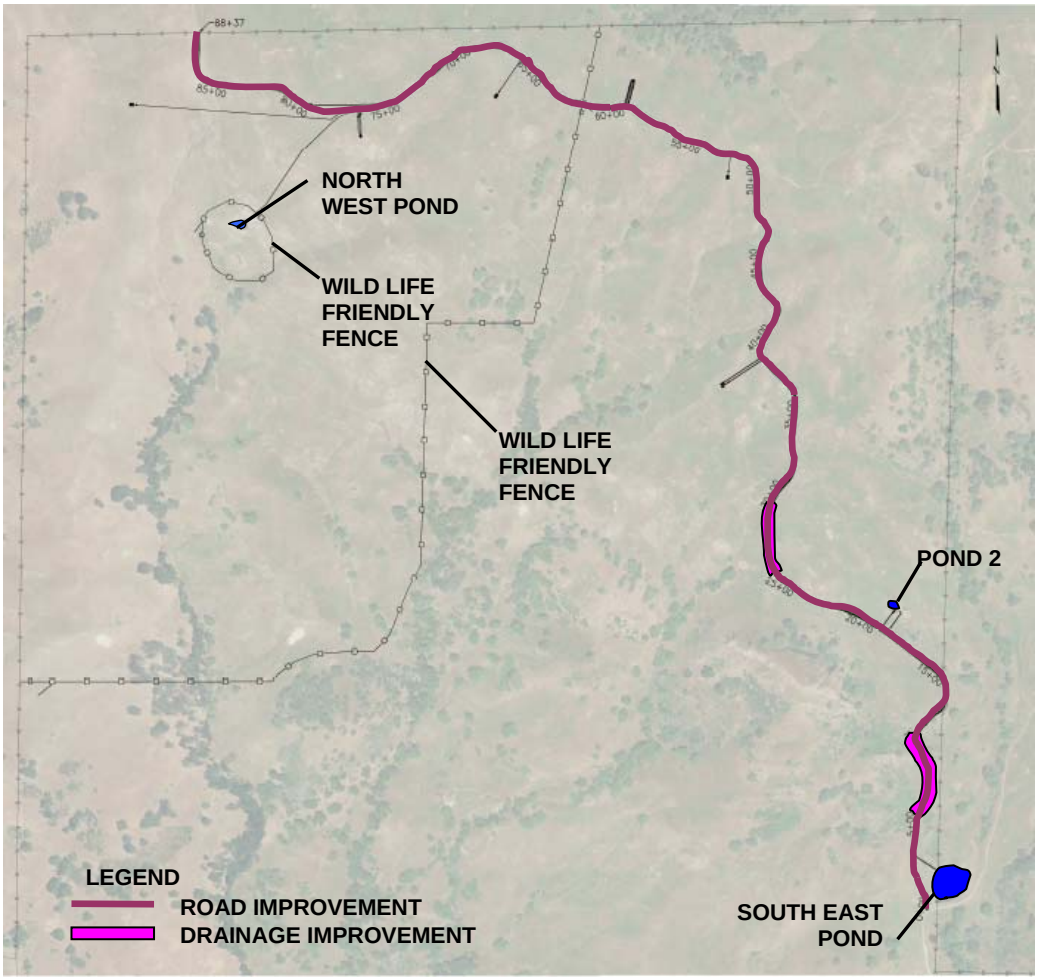


Figure 5-1
Existing Road Improvement Location

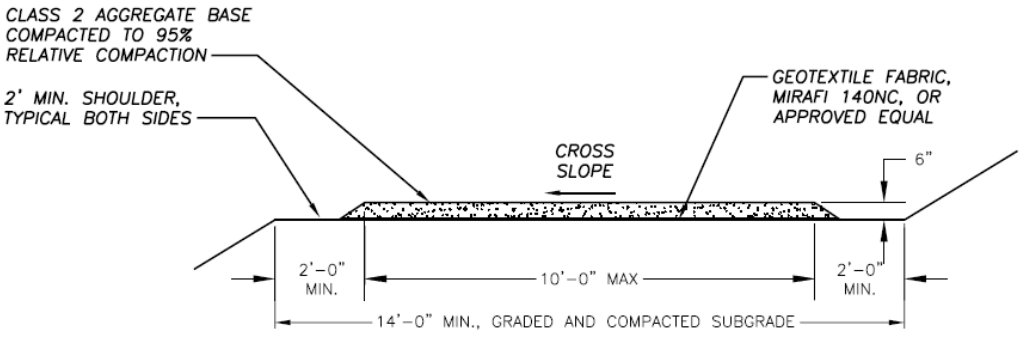


Figure 5-2
Typical Improved Road Cross Section

Chapter 6 Hydroseeding

Approximately 0.4 acre of staging area, 0.8 acres of pipeline route, and 2.65 acres of impacted area from road improvement and infrastructure development (water transport system components) will be hydroseeded after construction is complete. Species included in the hydroseed mix consist of native grasses and forbs, and are listed in Table 6-1. The hydroseed mix will consist of straw mulch, tackifier, and seed mix (90 pounds per acre). Compost will be certified weed-free and will be free of chemicals, heavy metals, and other materials that would be harmful to plant or animal life.

Table 6-1
Hydroseed Species Mix for Goat Rock Mitigation Site

Scientific Name	Common Name	Pounds per Acre
Nassella pulchra	Purple needlegrass	15
Koelaria macrantha	Junegrass	5
Bromus carinatus	California brome	10
Achillia millefolium	Yarrow	15
Eschscholzia californica	California poppy	15
Sanicula bipinnatifida	Purple sanicle	15
Elymus glaucus	Blue wildrye	15
	Total pounds per acre:	**90**

Chapter 7 Cost Estimate

A detailed cost estimate based on the 30% plans and specifications for the project site is presented in Table 7-1. Quantities were measured manually from the drawings or using the AutoCAD Civil3D Version 2009 (Civil3D, Autodesk, Inc., 2008) software. Quantities were calculated using measurements obtained from CAD drawings. Unit costs were developed based on a combination of previous, similar project experience, vendor quotes and the 2010 R.S. Means Building Construction Cost Data estimating guide (R.S. Means Company, 2009).

The following assumptions were made in developing the cost estimate:

- A 30% contingency is included in the overall cost estimate.
- Additional costs for material testing and sorting are included in the contingency.
- A 15% shrinkage factor was assumed for fill material.
- A one-time re-surfacing of the access road from the Southeast Pond to Trough 4.
- There will be one general contract.
- Work is to be performed during regular working hours.
- Allowances have been used for items that are required but are not defined at this time.
- The unit prices used in the direct cost section are composite unit prices that include costs for material including tax, labor, equipment, and subcontractor's/supplier's markups.

The estimate specifically excludes the following:

- Costs for rights-of-way and land acquisition if required
- Abatement of hazardous material, if any
- Legal and financial costs
- Owner's administrative costs
- Environmental Impact Assessment if required
- Fee for designer, engineering, project and construction management, and other soft costs
- Changes during construction
- Cost escalation from the date of this estimate

Items potentially affecting the cost estimate include, but are not limited to, the following:

- Modifications to the scope of work included in this estimate.
- Unforeseen subsurface conditions.
- Restrictive technical specifications or excessive contract conditions.
- Any specified item of equipment, material, or product that cannot be obtained from at least three different sources.

Table 7-1
Estimated Construction Costs for Final Report
(*Based on Unit Costs provided by M Lee Corporation)

Spec. Section	Description	Qty	Unit	Unit Cost	Estimated Cost (2010 Dollars)
01013	**Mobilization/Demobilization**				
	Mobilization/Demobilization (10% of Total Project Cost)	1	LS		$118,065
02052	**Clearing, Grubbing and Stripping**				**$75,896**
	Clearing with Dozer and Brush	3.85	AC	$4,000	$15,400
	Haul Cleared Material – 1 to 2 miles	3,106	CY	$15	$46,585
	Topsoil Excavation – used for site preparation	3.85	AC	$2,000	$7,700
	Till Stripped Material into Seeding Areas – 1 to 2 miles	1,035	CY	$6	$6,211
02200	**Excavation and Fill***				**$440,790**
	Trenching and backfilling	2,800	CY	$40	$112,000
	Gravel bedding for pipes	277	CY	$80	$22,160
	Gravel and sand base for tanks and troughs	19	CY	$80	$1,520
	Gravel Pavement (6 inches thick)	106,044	SQ.FT	$2.50	$265,110
	Road re-grading and drainage improvements	1	LS	$40,000	$40,000
02800	**Site Furnishings***				**$263,010**
	10,000-gallon water storage tanks	2	EA	$8,000	$16,000
	650-gallon cattle watering troughs	4	EA	$2,300	$9,200
	One deep well with plastic casing and screen, 200 feet deep	1	LS	$75,000	$75,000
	2-inch-diameter HDPE pipe for gravity system	6,600	LF	$4	$26,400
	2-inch-diameter HDPE pipe for pressure system	9,000	LF	$4	$36,000
	1-inch-diameter conduit, Schedule 40	9,000	LF	$3	$27,000
	Conductors	9,000	LF	$1.50	$13,500
	Fittings @ 30% of piping cost	1	LS	$30,870	$30,870
	Testing and inspection	1	LS	$5,000	$5,000
	2-inch shutoff valves	4	EA	$800	$3,200
	Float valves	4	EA	$540	$2,160
	Concrete footings for solar panels	8	EA	$1,000	$8,000
	1-foot-square concrete splash box	1	EA	$200	$200
	Wet well for Trough 3	1	EA	$7,480	$7,480
	18-inch HDPE housing for pumps	4	EA	$750	$3,000
02830	**Fencing**				**$200,900**
	Wildlife Friendly Fence	7,676	LF	$25	$191,900
	Gate	3	EA	$3,000	$9,000
02930	**Hydroseeding**				**$85,650**
	Hydroseeding	3.85	AC	$6,000	$23,100
	Seed Collection/Mix	640	LB	$97	$62,080
	Tackifier	740	LB	$0.5	$370
	Mulch	2	TON	$50	$100
15132	**Solar-Powered Pumps***				**$114,400**
	Solar-Powered Pump Package	8	EA	$14,300	$114,400
	Contingencies at 30%				**$389,613**
Total					**$1,688,324**

Chapter 8 References

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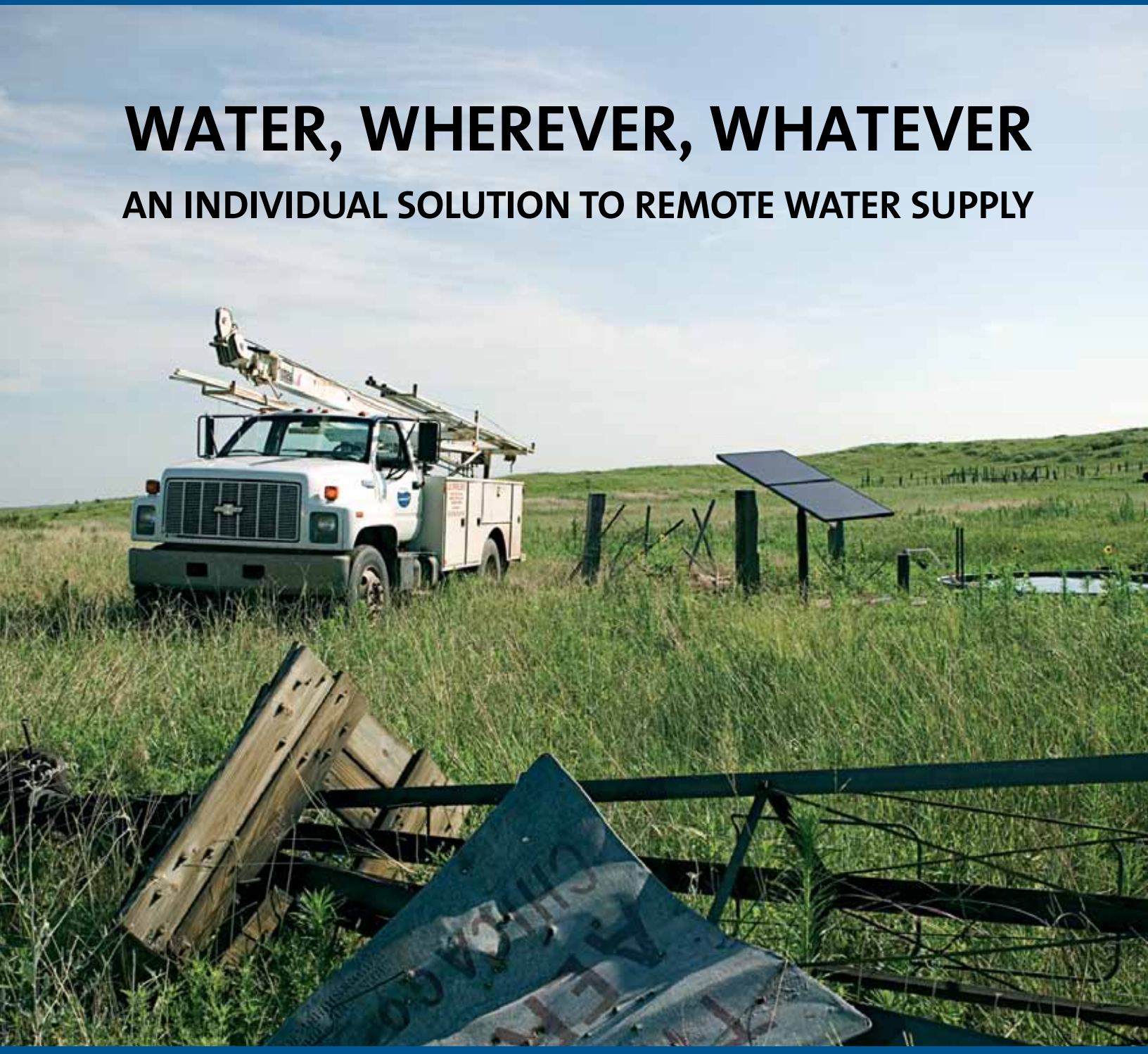
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Appendix A SQflex System Package - Brochure

WATER, WHEREVER, WHATEVER

AN INDIVIDUAL SOLUTION TO REMOTE WATER SUPPLY





SQFlex SYSTEM

The SQFlex system from Grundfos is not just another solar pump; it's a revolution in remote water supply. Designed for maximum reliability, maintenance-free operation, and the flexibility to adapt to virtually any application, SQFlex provides water wherever necessary and whatever the local conditions.



Eleven different pump models cover a wide range of heads and flows to allow pumping at extended depths (820 ft) or at high flow rates (80 gal/min) or anywhere in between, depending on your requirements.

PUMP MODEL	PUMP TYPE	MAX HEAD	MAX FLOW
3 SQF-2	Helical Rotor	395 ft	3 gal/min
3 SQF-3	Helical Rotor	655 ft	3 gal/min
6 SQF-2	Helical Rotor	395 ft	6 gal/min
6 SQF-3	Helical Rotor	820 ft	6 gal/min
11 SQF-2	Helical Rotor	395 ft	13 gal/min
16 SQF-10	Centrifugal	230 ft	22 gal/min
25 SQF-3	Centrifugal	50 ft	40 gal/min
25 SQF-7	Centrifugal	185 ft	40 gal/min
40 SQF-3	Centrifugal	50 ft	70 gal/min
40 SQF-5	Centrifugal	100 ft	70 gal/min
60 SQF-3	Centrifugal	50 ft	80 gal/min



Whether it's used for livestock watering, a pressure system on a remote cabin, or for irrigation, the SQFlex system can be tailored to meet any requirements. Based on the location, depth to water, and the volume of water required, Grundfos' exclusive sizing program finds the best pump and most efficient energy source for your application.

The SQFlex system means:

- **simple installation**
- **reliable water supply**
- **virtually no maintenance**
- **cost-efficient pumping – every day!**



DRY-RUNNING PROTECTION

This unique feature shuts down the pump if it detects water shortage. Every SQFlex pump comes standard with this sensor pre-installed, protecting the well from being over-pumped and the pump from damage.



HELICAL ROTOR PUMP (3”)

Designed to pump high levels very efficiently, these models allow pumping levels as deep as 820 ft. The 3 in. diameter allows the pump to go in installations where others can’t.

CENTRIFUGAL PUMP (4”)

Based on Grundfos’ 40 years of experience in submersible pumps, these models are capable of providing high flows, up to 80 gal/min, at moderate heads.



MATERIALS

All Stainless steel for long pump life.

MOTOR

Only one motor size covers the entire pump range. Designed for peak efficiency and complete reliability, the motor features integrated electronics, eliminating the need for complicated external controls.

MOTOR PROTECTION

Built in protections against over-temperature, overload, and over and under-voltage for reliability, as well as two-way communication with a control box to alert you in case there’s a problem.

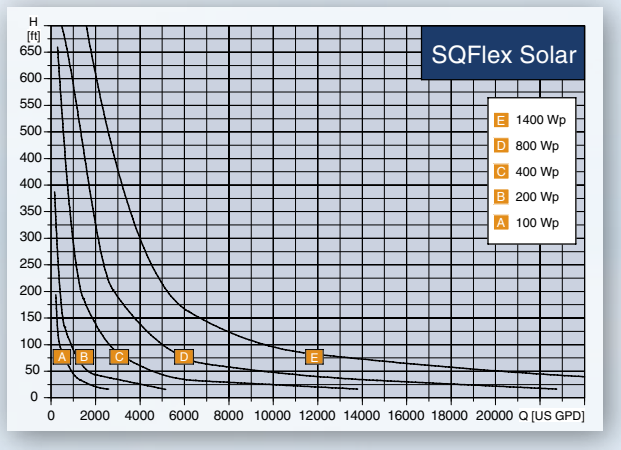
ANY VOLTAGE

The motor can operate under any voltage from 30 - 300 VDC and 90 - 240 VAC without additional controls, making sizing and installation easy, even as a retrofit to existing installations. AC power capabilities mean every SQFlex pump has the ability to use an AC generator for backup power.



SQFlex Solar

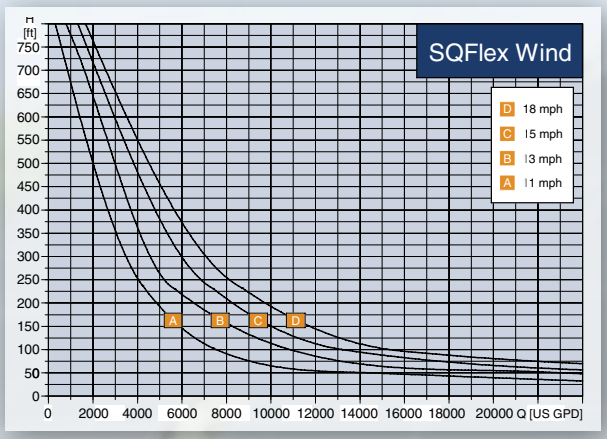
Ideal for most pumping systems, SQFlex Solar provides a reliable supply of water whenever the sun shines. Extremely simple to operate with no moving parts and no maintenance - just clean the panels periodically.





SQFlex Wind

Very cost effective in locations with consistent winds, SQFlex Wind has the ability to pump day and night. The wind turbine design calls for no regular maintenance and provides reliable energy in wind speeds above 7 mph.





SQFlex Combo

Combine wind and solar to get the best of both worlds; you get higher output from the sun in summer and from the wind in winter, giving more consistent water production all year round. Plus, there are very few days when the system can't pump. SQFlex draws power from both sources simultaneously, so there's no switching required and you get maximum production on days that are sunny and windy.



SQFlex Back-Up

If the sun or wind ever fall short, every SQFlex pump has the ability to use a generator for backup power. Built-in electronics switch between AC and DC power automatically, so there are no special control boxes required or settings to change.

L-SQ-SL-010 Rev. 10/09 (US)

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www.grundfos.com

GRUNDFOS

CITY AND COUNTY OF SAN FRANCISCO

PUBLIC UTILITIES COMMISSION

SAN FRANCISCO WATER DEPARTMENT

CONTRACT NO. WD-_____

GOAT ROCK

30% SUBMITTAL
MARCH, 2010

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C-15	TYPICAL WILDLIFE FRIENDLY FENCE DETAIL

ELECTRICAL

E-1	WATER TRANSPORT SYSTEM – PUMP WIRING AND SOLAR ARRAY DETAILS

BORING

CENTER LINE

DIAMETER

GATE

TREE, SHRUB

WATER LEVEL ELEVATION

DOMESTIC WATER PIPING

UNDERGROUND ELECTRICAL LINE

EXISTING ROADWAY CORRIDOR

FENCE WIRED/BARBWIRED

(N) WILDLIFE FRIENDLY FENCE

PRESSURE FLOW PIPE

GRAVITY FLOW PIPE

FLOW DIRECTION

BUFFER ZONE

STAGING AREAS

GENERAL SYMBOLS

AIR VALVE

BOLLARDS

BRASS DISK

BUTTERFLY VALVE

CLEANOUT

ELECTRICAL PULL BOX

FLOW METER STATION

GATE VALVE

HOSE BIB

JOINT POLE

MONITORING WELL

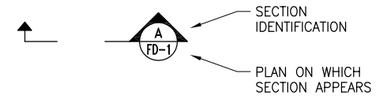
MONUMENT

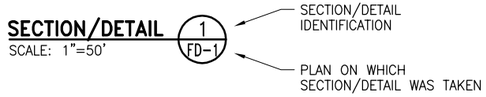
SHUTOFF VALVE

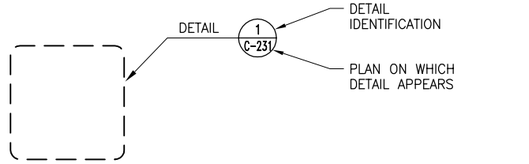
GENERAL ABBREVIATIONS

AB	AGGREGATE BASE
ACWD	ALAMEDA COUNTY WATER DISTRICT
ADAS	AUTOMATIC DATA ACQUISITION SYSTEM
ALT	ALTERNATE
ASTM	AMERICAN SOCIETY TESTING MATERIAL
APPROX	APPROXIMATE
ASSY	ASSEMBLY
AV	AIR VALVE
AVG	AVERAGE
CAP	CAPACITY
C/C or CC	CENTER TO CENTER
CF	CUBIC FEET
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
℄	CENTERLINE
CONN	CONNECTION
COND	CONDUIT
CONST	CONSTRUCTION
CP	CONTROL POINT
CTR	CENTER
D	DEPTH
DET	DETAIL
DIA	DIAMETER
DIM	DIMENSION
D/S	DOWNSTREAM
DWG	DRAWING
(E), E	EXISTING
EA	EACH
EG	EXISTING GROUND
EL, ELEV	ELEVATION
ELEC	ELECTRICAL
EQUIP	EQUIPMENT
EXIST	EXISTING
FG	FINISH GROUND
FIG	FIGURE
FIN	FINISHED
FT	FOOT
GEN	GENERAL
GPM	GALLONS PER MINUTE
GR	GRADE
GRD	GROUND
GV	GATE VALVE
H	HEIGHT
HGL	HYDRAULIC GRADE LINE
HGT	HEIGHT
HOR	HORIZONTAL
HP	HORSEPOWER, HIGH POINT, HIGH PRESSURE
HPI	HORIZONTAL POINT OF INTERSECTION
ID	INSIDE DIAMETER, IDENTIFICATION
IN	INCH
INV	INVERT
JCT	JUNCTION
L	LENGTH
LB	POUND
LEV	LEVEL
LG	LONG
LP	LOW POINT, LOW PRESSURE
MAN	MANUAL
MATL	MATERIAL
MAX	MAXIMUM
MECH	MECHANICAL
MFR	MANUFACTURE(R)
MGD	MILLION GALLONS PER DAY
MIN	MINIMUM, MINUTE
MISC	MISCELLANEOUS
(N), N	NEW
N/A	NOT APPLICABLE
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRICAL CODE
NOM	NOMINAL
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OG	ORIGINAL GROUND SURFACE
PG	PRESSURE GAUGE
PG & E	PACIFIC GAS & ELECTRIC
PH	PHASE
PL	PROPERTY LINE
PI, P.I.	POINT OF INTERSECTION
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PSL	PIPE SLEEVE
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
R	RADIUS, RISER
R/C	REINFORCED CONCRETE
RD	ROAD
REF	REFERENCE
REQ'D	REQUIRED
ROW	RIGHT OF WAY
S	SLOPE
SCH	SCHEDULE
SECT	SECTION
SFPUC	SAN FRANCISCO PUBLIC UTILITY COMMISSION
SFWD	SAN FRANCISCO WATER DEPARTMENT
SHT	SHEET
SIM	SIMILAR
SP	STATIC PRESSURE
SPEC	SPECIFICATION(S)
STA	STATION
STD	STANDARD
t	THICKNESS
TYP	TYPICAL
THK	THICK
UG	UNDERGROUND
VOL	VOLUME
W/	WITH
W	WIDTH, WEST
W.G.	WATER GAUGE
W/O	WITHOUT
WS	WATER SURFACE
WSL	WATER SURFACE LEVEL
YD	YARD

TYPICAL SECTION/DETAIL NUMBERING SYSTEM







ELEVATION DATUM

NAVD88

30% DESIGN
NOT FOR CONSTRUCTION

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CONTRACT NO. WD–

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PROJECT ENGINEER: CC	DRAWN: AD
PROJECT MANAGER: FD	DESIGNED: SS
APPROVAL: SAG	CHECKED: SAG

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
GENERAL LEGEND AND ABBREVIATIONS

CHECKED / APPROVED	DRAWN	SCALE: NONE
SECTION MANAGER	DESIGNED	DATE: NOV. 2009
APPROVED MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	G–2		

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

P:\CADD\Sheets\Goat Rock\G–2.dwg Mar 31, 2010 – 1:03pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

GENERAL NOTES:

1. HEAVY LINES AND SYMBOLS INDICATE WORK TO BE DONE BY THE CONTRACTOR. LIGHT LINES AND SYMBOLS INDICATE EXISTING FEATURES OR WORK TO BE DONE BY ANOTHER ENTITY.
2. WHERE THERE IS A DISCREPANCY BETWEEN THE WRITTEN DIMENSION AND SCALED DIMENSION, WRITTEN DIMENSIONS SHALL GOVERN.
3. ALL DISCREPANCIES BETWEEN THE INFORMATION SHOWN IN THE DRAWINGS AND THE ACTUAL FIELD CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER.
4. PROJECT COORDINATE SYSTEM AND VERTICAL DATUM IS AS FOLLOWS: COORDINATE SYSTEM: THE CALIFORNIA COORDINATE SYSTEM, ZONE III, NAD 1983. VERTICAL DATUM: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88)
5. TOPOGRAPHIC INFORMATION SHOWN ON THE DRAWINGS IS BASED ON THE LIDAR 2006 DATA OBTAINED FROM ALAMEDA COUNTY.

EXISTING UTILITIES:

1. CONTRACTOR SHALL NOTIFY UNDERGROUND SERVICE ALERT (USA) PRIOR TO DIGGING.
2. LOCATIONS OF ALL UTILITY SERVICE LINES SHALL BE FIELD VERIFIED BY POTHOLING PRIOR TO COMMENCING ANY GRADING OR TRENCHING.
3. UTILITIES, EXISTING AT THE TIME OF CONSTRUCTION, ARE UNKNOWN.
4. THE CONTRACTOR SHALL TAKE PRECAUTIONARY MEASURES TO PROTECT UTILITY LINES AND STRUCTURES NOT SHOWN ON THESE PLANS.
5. ALL CONTRACTOR WORK AROUND EXISTING UTILITIES SHALL BE IN CONFORMANCE WITH CALIFORNIA GOVERNMENT CODE 4216.
6. THE CONTRACTOR SHALL PROTECT IN PLACE ALL OVERHEAD INTERFERENCE. THE CONTRACTOR SHALL USE EXTREME CAUTION WHEN WORKING NEAR OVERHEAD OR UNDERGROUND POWER, GAS, AND/OR OTHER UTILITIES SO AS TO SAFELY PROTECT ALL PERSONNEL AND EQUIPMENT, AND SHALL BE RESPONSIBLE FOR ALL COSTS AND LIABILITY IN CONNECTION THEREWITH.
7. CONTRACTOR SHALL CONTACT UTILITY POLE OWNER PRIOR TO WORKING IN AREA AND UTILITY POLE OWNER WILL DO ALL WORK ON UTILITY POLES. THE CONTRACTOR SHALL PAY ALL THE COSTS ASSOCIATED WITH UTILITY POLE MODIFICATIONS AND THE CONTRACTOR SHALL INCLUDE THE TIME NEEDED BY THE UTILITY POLE OWNER AS PART OF THE OVERALL WORK.

DEMOLITION NOTES:

1. CLEAR AND REMOVE ALL ORGANIC MATTER, DEBRIS, AND RUBBISH FROM WITHIN THE LIMIT OF WORK. CONTRACTOR SHALL DISPOSE OF SAID MATERIAL IN A LEGAL MANNER AS HIS PROPERTY.
2. CONTRACTOR MAY RE–USE MATERIAL SUBJECT TO SUBMITTALS PER SPECIFICATION AND REVIEW BY THE ENGINEER.
3. ALL EXCAVATION WORK WITHIN DRIP LINE OF EXISTING TREES THAT ARE TO REMAIN SHALL BE DONE BY HAND. CLEANLY CUT ANY ROOT LARGER THAN ONE INCH DIAMETER. DO NOT TEAR ROOTS.

TREE REMOVAL:

1. ALL REMOVAL OR PRUNING OF EXISTING TREES OR SHRUB SHALL BE PERFORMED UNDER THE DIRECTION OF THE CITY REPRESENTATIVE.
2. ALL TREES DESIGNED TO BE REMOVED SHALL BE CLEANLY CUT AND THE STUMP GROUNDED TO ONE FEET BELOW GRADE AND THE MATERIAL SHALL BE DISPOSED IN A LEGAL MANNER.

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ELEVATION DATUM
NAVD88

30% DESIGN
NOT FOR CONSTRUCTION

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WRE
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SAN FRANCISCO, CA 94105
PHONE: (415) 538–7839

PROJECT ENGINEER	DRAWN
CC	AD
PROJECT MANAGER	DESIGNED
FD	SS
APPROVAL	CHECKED
SAG	SAG

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
GENERAL NOTES

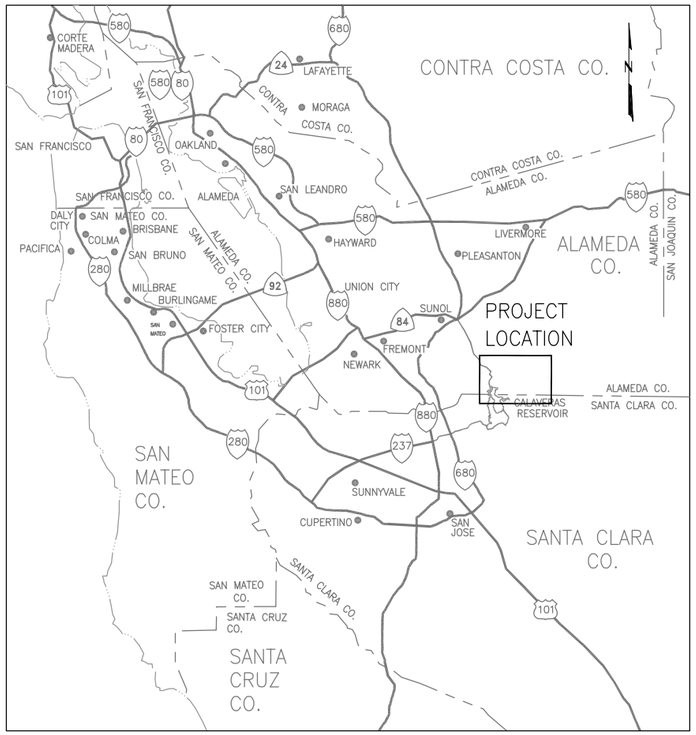
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		NONE
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	G–3		

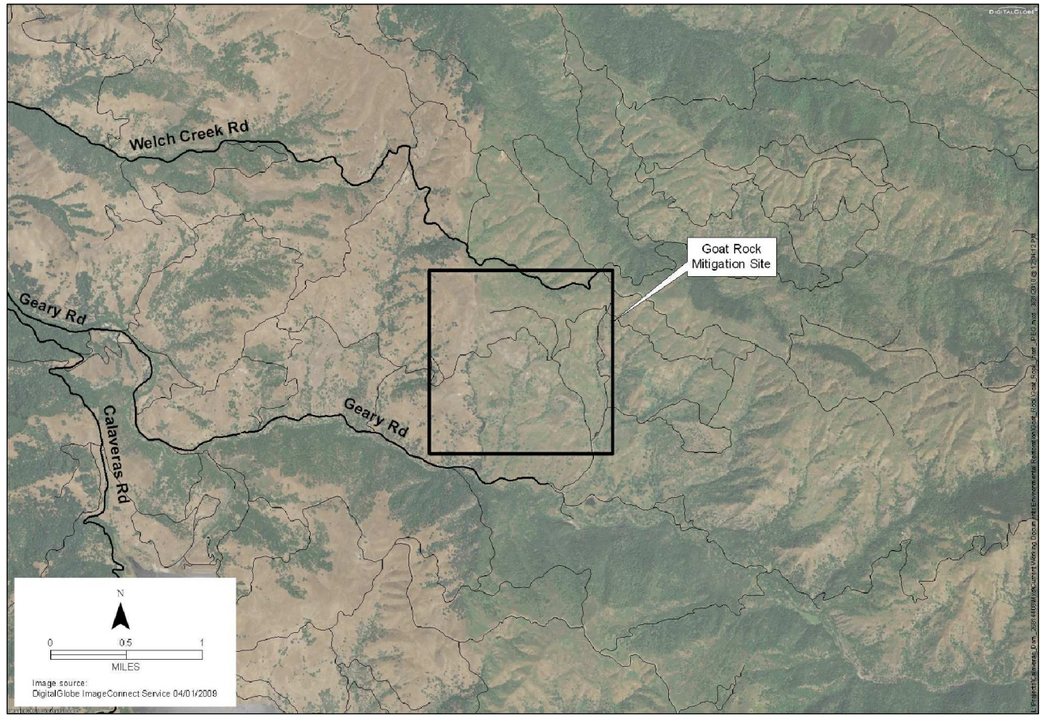
PLOT: EXTEND
SCALE: 1:1
BORDER:
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YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

P:\CADD\Sheets\Goat Rock\G–3.dwg Mar 29, 2010 – 11:31am

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



VICINITY MAP
NOT TO SCALE



LOCATION MAP

30% DESIGN
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INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
SITE LOCATION AND VICINITY MAP

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SAN FRANCISCO, CA 94105
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PROJECT ENGINEER	DRAWN
CC	AD
PROJECT MANAGER	DESIGNED
FD	SS
APPROVAL	CHECKED
SAG	SAG

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE
		NONE
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	G-4		

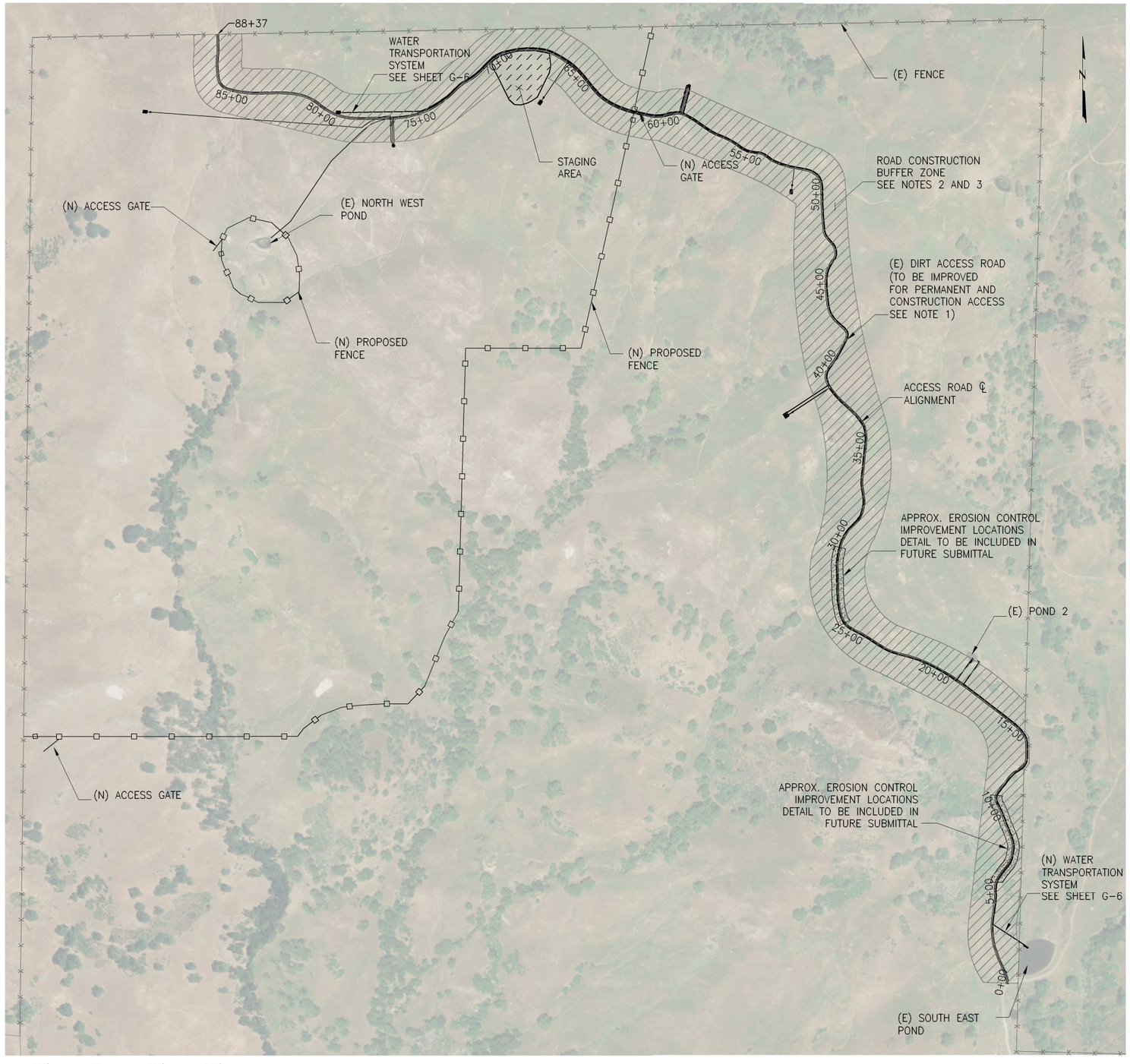
ELEVATION DATUM
NAVD88

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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

P:\CADD\Sheets\Goat Rock\G-4 2010.dwg Mar 31, 2010 – 3:05pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



NOTES:

1. EXISTING DIRT ACCESS ROAD TO BE IMPROVED WITH A 6 INCH THICK GRAVEL ROAD BY THE CONTRACTOR FOR PERMANENT SITE ACCESS AND CONSTRUCTION ACCESS.

2. CONTRACTOR SHALL STAY WITHIN THE BUFFER ZONE DURING ROAD CONSTRUCTION TO MINIMIZE IMPACTS.

3. BUFFER ZONE GENERALLY EXTENDS 125 FEET FROM THE EDGE OF THE EXISTING ACCESS ROAD. WHERE FENCE LINE INTERCEPTS THE BUFFER ZONE, FENCE LINE SHALL DEFINE THE EDGE OF BUFFER ZONE.

ELEVATION DATUM
NAVD88

30% DESIGN
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PROJECT ENGINEER	DRAWN
CC	AD
PROJECT MANAGER	DESIGNED
FD	SS
APPROVAL	CHECKED
SAG	CS

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
SITE LAYOUT, STAGING AND ACCESS PLAN

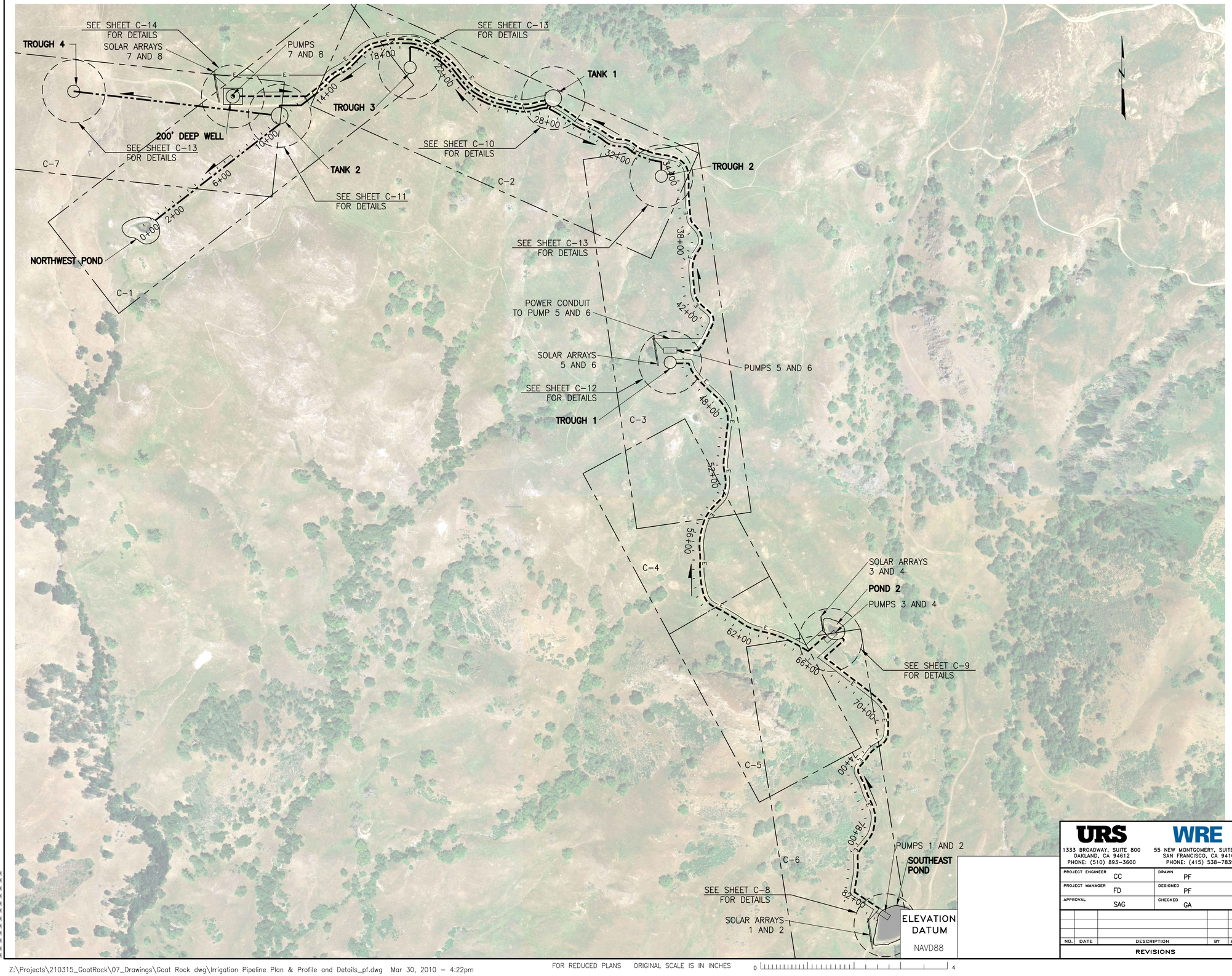
CHECKED / APPROVED	DRAWN	SCALE
		1"=300'
SECTION MANAGER	DESIGNED	DATE
		MAR. 2010
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	G-5		

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

C:\DOCUME~1\ADRIAN~1\LOCALS~1\Temp\AcPublish_3732\G-5.dwg Mar 31, 2010 – 1:21pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



30% DESIGN
NOT FOR
CONSTRUCTION

LEGEND:

- PRESSURE FLOW PIPE
- GRAVITY FLOW PIPE
- ELECTRICAL CONDUIT
- FLOW DIRECTION

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PROJECT ENGINEER	CC	DRAWN	PF
PROJECT MANAGER	FD	DESIGNED	PF
APPROVAL	SAG	CHECKED	GA

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

GOAT ROCK
WATER TRANSPORT SYSTEM
PIPING LAYOUT AND KEYMAP

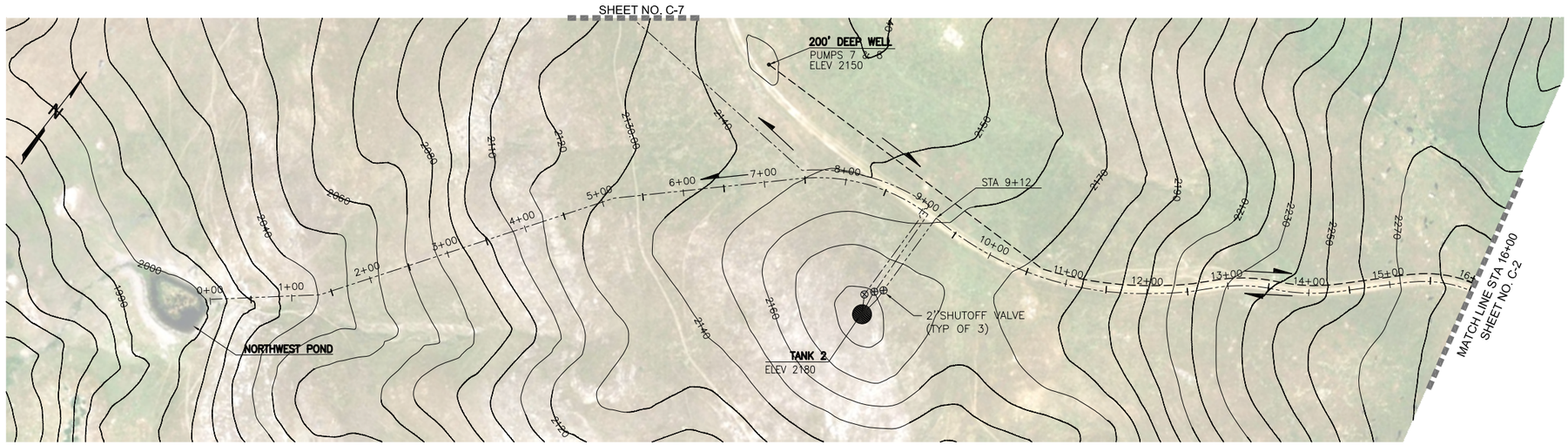
CHECKED / APPROVED	DRAWN	SCALE
SECTION MANAGER	DESIGNED	DATE MAR. 2010
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	G-6		

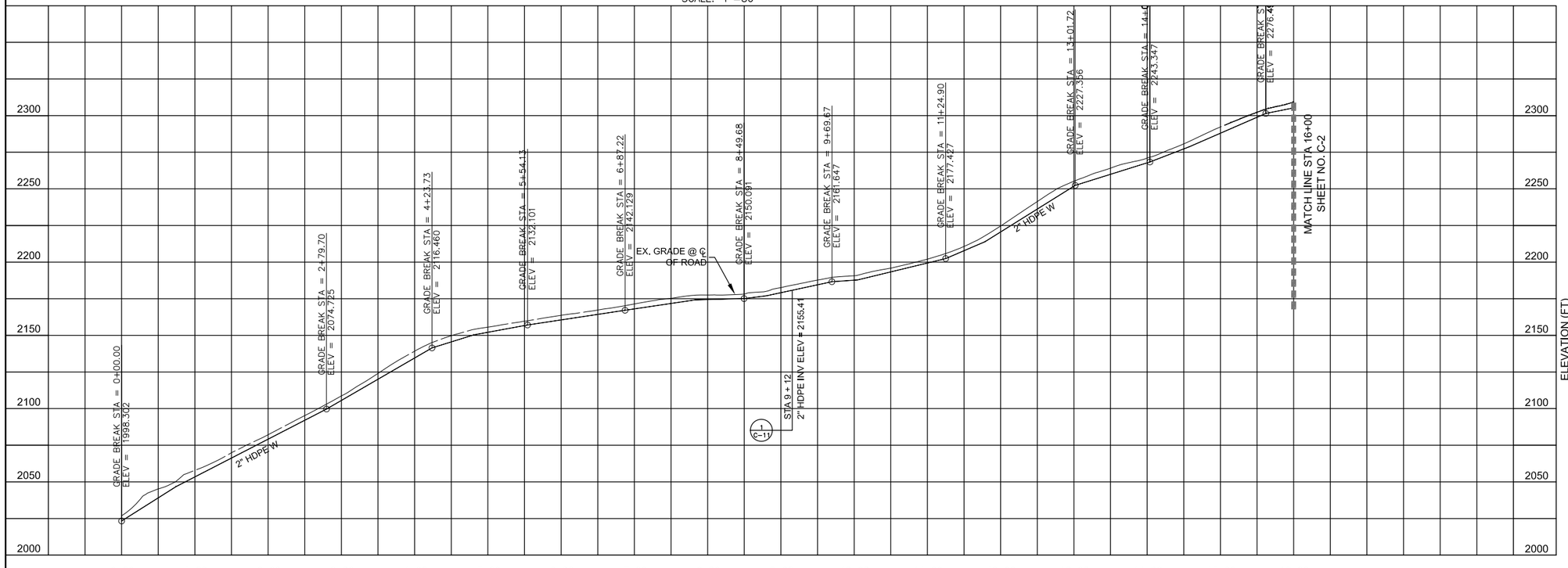
PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
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YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

Z:\Projects\210315_GoatRock\07_Drawings\Goat Rock dwg\Irrigation Pipeline Plan & Profile and Details_pf.dwg Mar 30, 2010 – 4:22pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1"=80'



PROFILE
VERTICAL SCALE: 1"=40'
HORIZONTAL SCALE: 1"=80'

NOTES:

1. USE 2" DIAMETER 200 PSI HDPE PIPE FOR BOTH PRESSURE AND GRAVITY FLOW PIPES
2. USE PLASTIC GATE OR GLOBE SHUTOFF VALVES

KEY

- PRESSURE FLOW PIPE
- GRAVITY FLOW PIPE
- FLOW DIRECTION

30% DESIGN
NOT FOR CONSTRUCTION

80 0' 80 160'
SCALE IN FEET
HORIZONTAL SCALE: 1" = 80'
VERTICAL SCALE: 1" = 40'

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HRP ALAMEDA WATERSHED SITES

GOAT ROCK
WATER PIPELINE PLAN AND PROFILE
(STA. 0+00 TO 16+00)

PROJECT ENGINEER: CC	DRAWN: VI
PROJECT MANAGER: FD	DESIGNED: PF
APPROVAL: SAG	CHECKED: GA

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

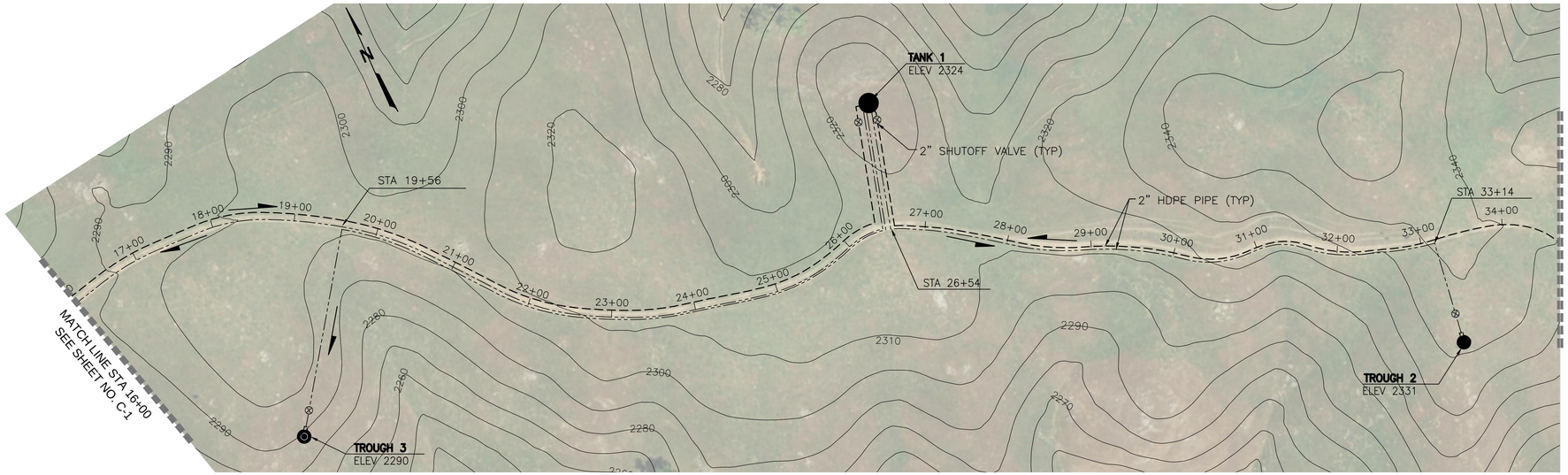
CHECKED / APPROVED	DRAWN	SCALE	
		1"=80'	
SECTION MANAGER	DESIGNED	DATE	
		MAR. 2010	
APPROVED	APPROVED		
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION		
SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-1		

ELEVATION DATUM
NAVD88

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

Z:\Projects\210315_GoatRock\07_Drawings\C-1.dwg Mar 31, 2010 – 12:49pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1"=80'

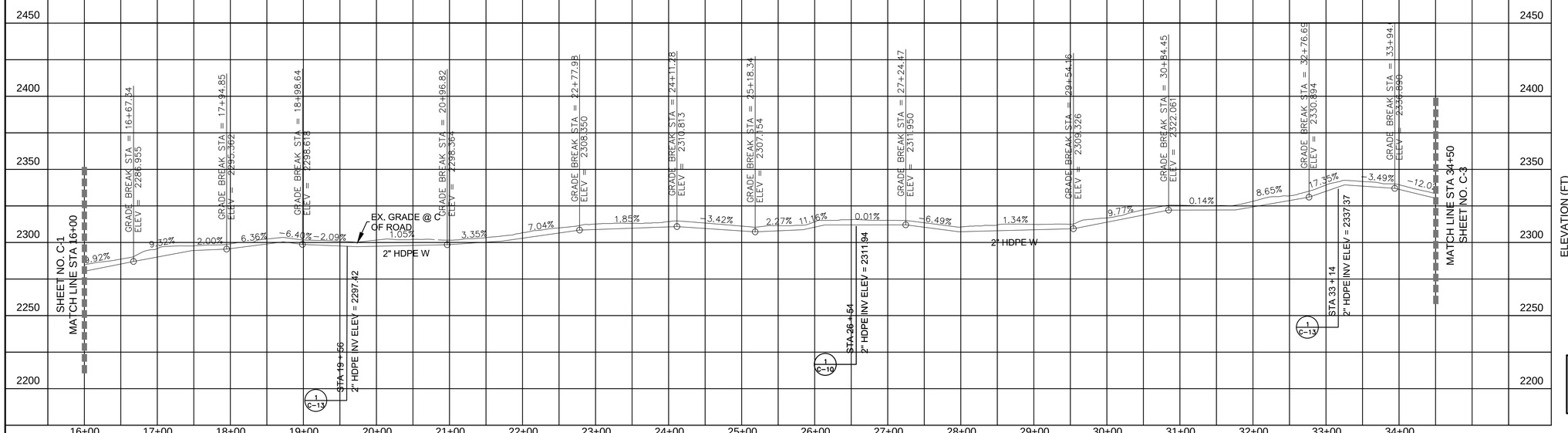
NOTES:
1. USE 2" DIAMETER 200 PSI HDPE PIPE FOR BOTH HIGH PRESSURE AND GRAVITY FLOW PIPES
2. USE PLASTIC GATE OR GLOBE SHUTOFF VALVES

KEY

PRESSURE FLOW PIPE

GRAVITY FLOW PIPE

FLOW DIRECTION



PROFILE
VERTICAL SCALE: 1"=40'
HORIZONTAL SCALE: 1"=80'

ELEVATION DATUM
NAVD88

30% DESIGN
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PROJECT ENGINEER	DRAWN
CC	VI
PROJECT MANAGER	DESIGNED
FD	PF
APPROVAL	CHECKED
SAG	GA

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

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INFRASTRUCTURE DIVISION
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HRP ALAMEDA WATERSHED SITES

GOAT ROCK WATER PIPELINE PLAN AND PROFILE (STA. 16+00 TO 34+50)

CHECKED / APPROVED	DRAWN	SCALE
		1"=80'
SECTION MANAGER	DESIGNED	DATE
		MAR. 2010
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-2		

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

Z:\Projects\210315_GoatRock\07_Drawings\C-2.dwg Mar 30, 2010 – 4:04pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

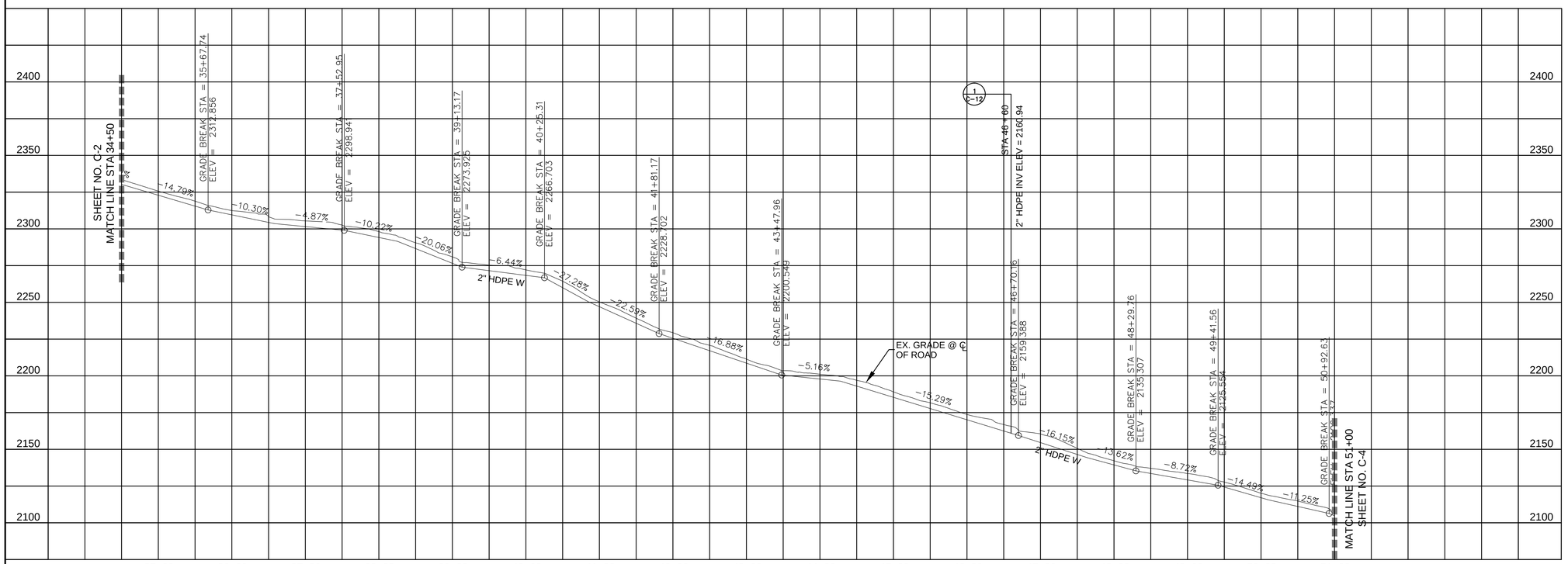


NOTES:

1. USE 2" DIAMETER 200 PSI HDPE PIPE FOR BOTH PRESSURE AND GRAVITY FLOW PIPES
2. USE PLASTIC GATE OR GLOBE FLOAT VALVES

KEY

- PRESSURE FLOW PIPE
- GRAVITY FLOW PIPE
- FLOW DIRECTION



30% DESIGN NOT FOR CONSTRUCTION

80 0' 80 160'
SCALE IN FEET
HORIZONTAL SCALE: 1" = 80'
VERTICAL SCALE: 1" = 40'

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ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
WATER PIPELINE PLAN AND PROFILE
(STA. 34+50 TO 51+00)

CHECKED / APPROVED	DRAWN	SCALE
		1"=80'
SECTION MANAGER	DESIGNED	DATE
		MAR. 2010
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-3		

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PHONE: (415) 538-7839

PROJECT ENGINEER	DRAWN
CC	VI
PROJECT MANAGER	DESIGNED
FD	CC
APPROVAL	CHECKED
SAG	GA

NO.	DATE	DESCRIPTION	BY	APPR'D

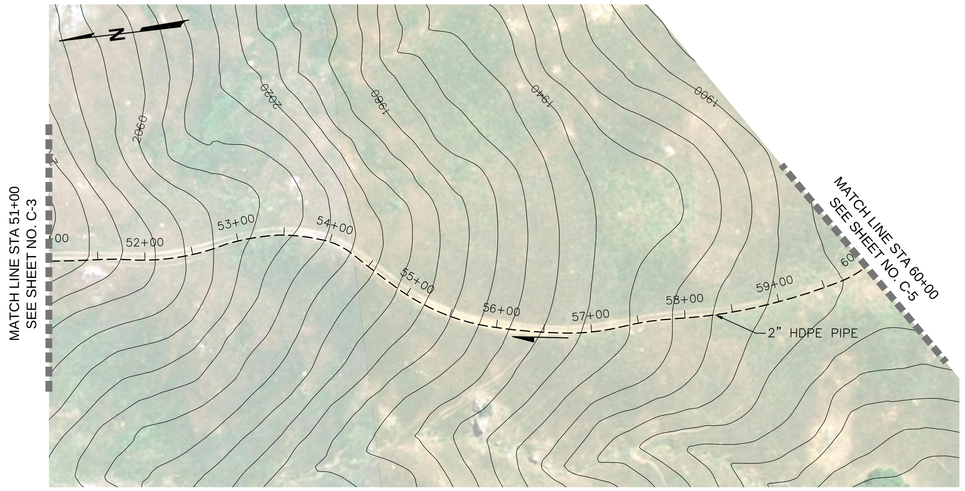
REVISIONS

ELEVATION DATUM
NAVD88

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

Z:\Projects\210315_GoatRock\07_Drawings\C-3.dwg Mar 30, 2010 – 2:23pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

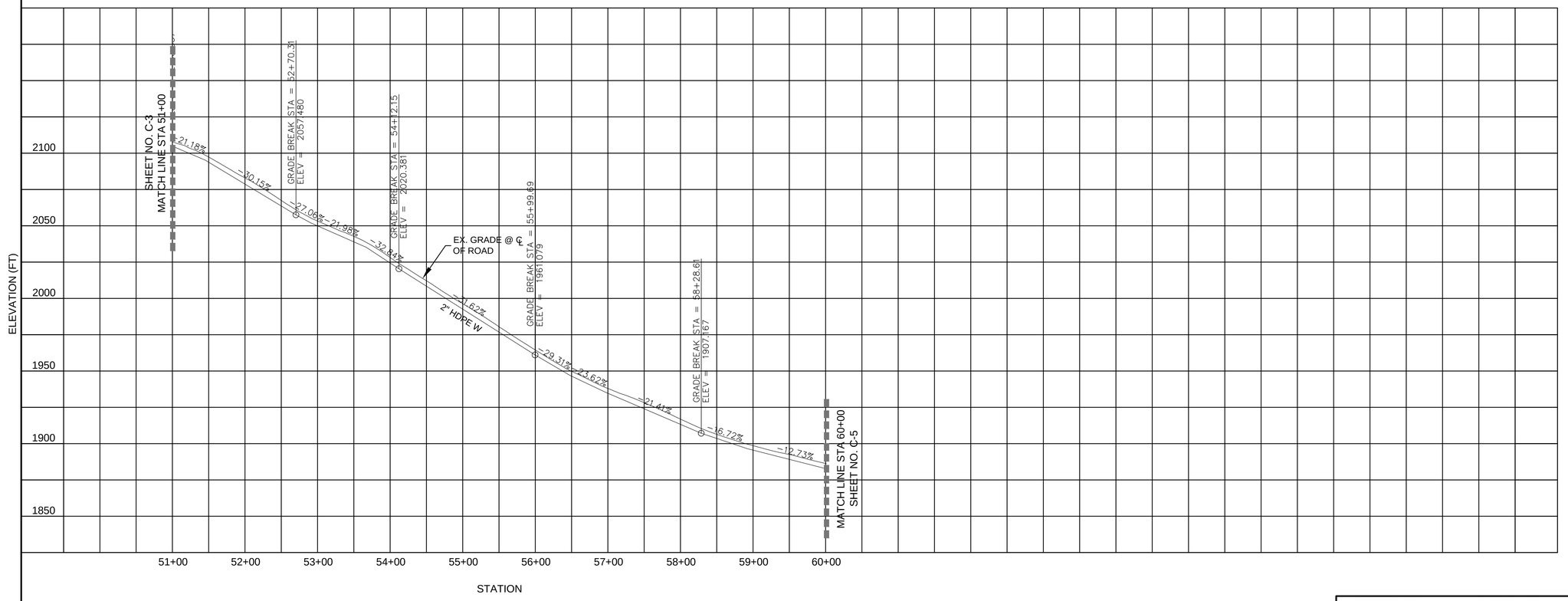


NOTES:
1. USE 2'' DIAMETER 200 PSI HDPE PIPE FOR BOTH HIGH PRESSURE AND GRAVITY FLOW PIPES

KEY

PRESSURE FLOW PIPE

FLOW DIRECTION



ELEVATION DATUM
NAVD88

30% DESIGN
NOT FOR CONSTRUCTION

80 0' 80 160'
SCALE IN FEET
HORIZONTAL SCALE: 1" = 80'
VERTICAL SCALE: 1" = 40'

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HRP ALAMEDA WATERSHED SITES

GOAT ROCK
WATER PIPELINE PLAN AND PROFILE (STA. 51+00 TO 60+00)

PROJECT ENGINEER: CC	DRAWN: VI
PROJECT MANAGER: FD	DESIGNED: PF
APPROVAL: SAG	CHECKED: GA

NO.	DATE	DESCRIPTION	BY	APPR'D

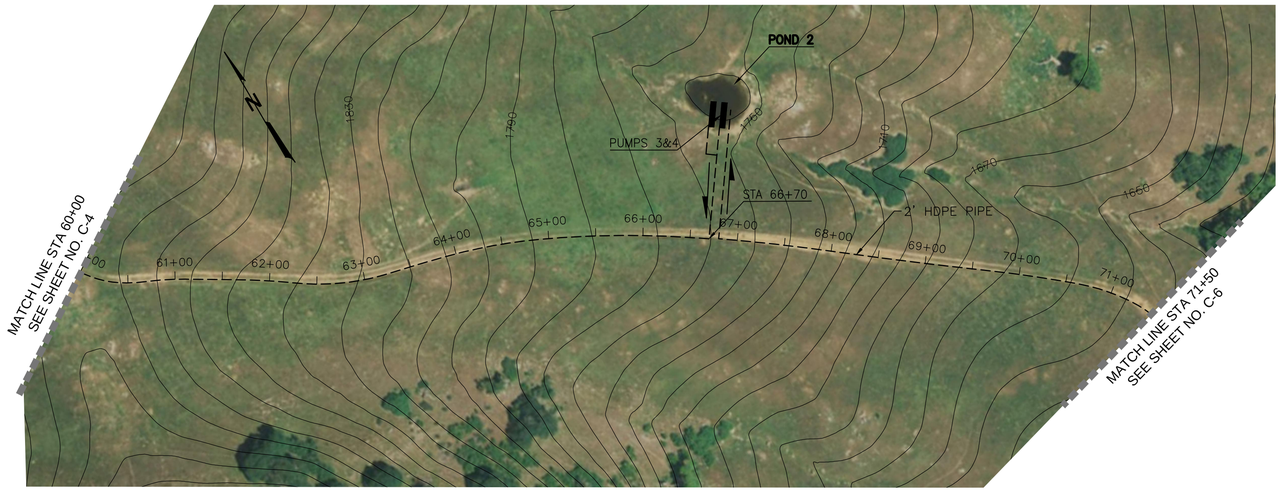
REVISIONS

CHECKED / APPROVED	DRAWN	SCALE	1"=80'
SECTION MANAGER	DESIGNED	DATE	MAR. 2010
APPROVED	APPROVED		
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION		
SHEET OF	PLAN NO. C-4	DRAWING NO.	REVISION NO.

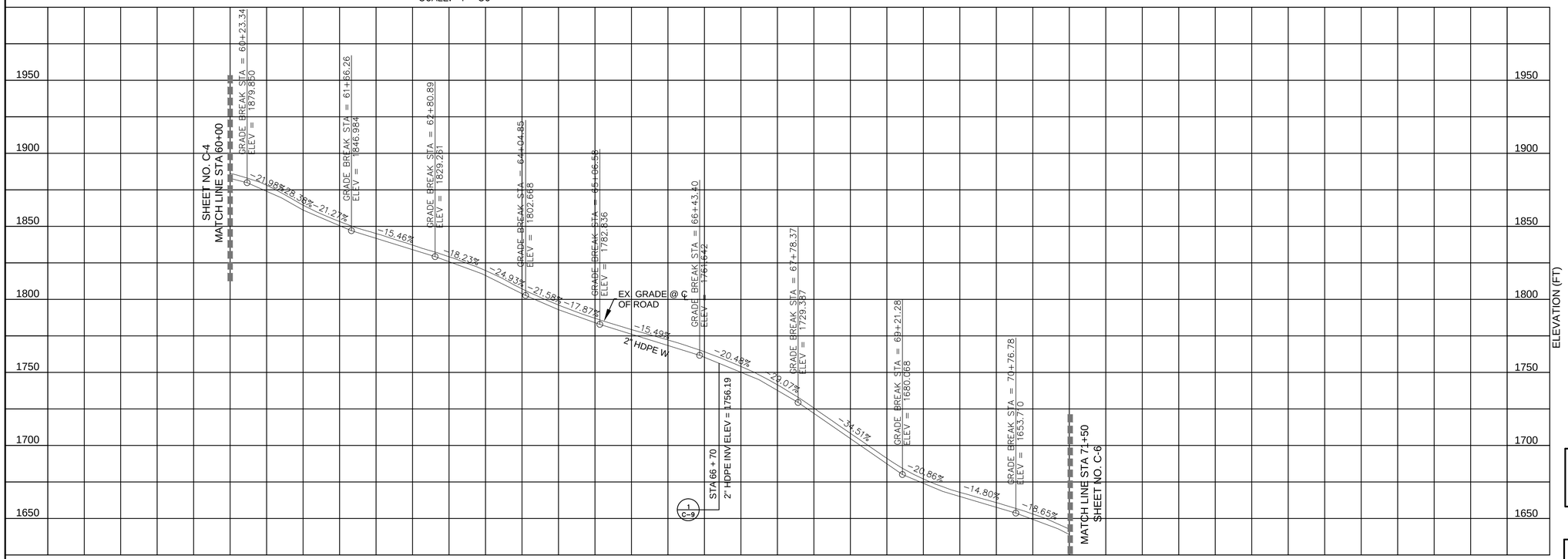
PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
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YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

Z:\Projects\210315_GoatRock\07_Drawings\C-4.dwg Mar 30, 2010 – 4:08pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1"=80'



PROFILE
VERTICAL SCALE: 1"=40'
HORIZONTAL SCALE: 1"=80'

NOTES:
1. USE 2" DIAMETER 200 PSI HDPE PIPE FOR BOTH HIGH PRESSURE AND GRAVITY FLOW PIPES

KEY

PRESSURE FLOW PIPE

FLOW DIRECTION

30% DESIGN
NOT FOR CONSTRUCTION

80 0' 80 160'
SCALE IN FEET
HORIZONTAL SCALE: 1" = 80'
VERTICAL SCALE: 1" = 40'

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PHONE: (510) 893-3600

WRE
55 NEW MONTGOMERY, SUITE 619
SAN FRANCISCO, CA 94105
PHONE: (415) 538-7839

PROJECT ENGINEER: CC	DRAWN: VI
PROJECT MANAGER: FD	DESIGNED: PF
APPROVAL: SAG	CHECKED: GA

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

ELEVATION DATUM
NAVD88

GOAT ROCK
WATER PIPELINE PLAN AND PROFILE
(STA. 60+00 TO 71+50)

CHECKED / APPROVED	DRAWN	SCALE: 1"=80'
SECTION MANAGER	DESIGNED	DATE: MAR. 2010
APPROVED: MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED: MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-5		

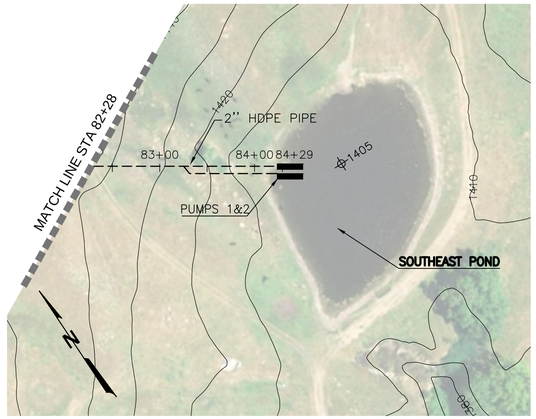
PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.

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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
9	0.15MM
10	1.00MM
100	0.70MM
210	0.60MM

Z:\Projects\210315_GoatRock\07_Drawings\C-5.dwg Mar 30, 2010 - 3:52pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



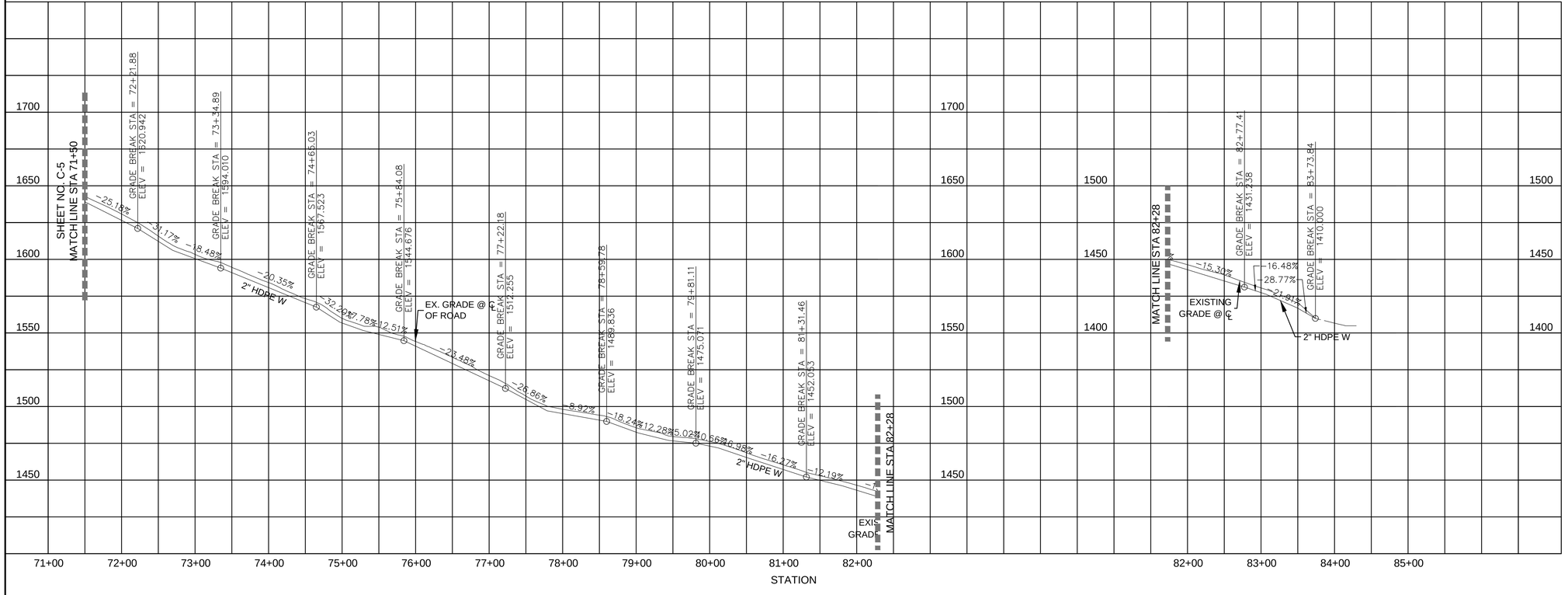


NOTES:
1. USE 2" DIAMETER 200 PSI HDPE PIPE FOR BOTH HIGH PRESSURE AND GRAVITY FLOW PIPES

KEY

PRESSURE FLOW PIPE

FLOW DIRECTION



80 0' 80 160'

SCALE IN FEET
HORIZONTAL SCALE: 1" = 80'
VERTICAL SCALE: 1" = 40'

30% DESIGN NOT FOR CONSTRUCTION

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WRE
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SAN FRANCISCO, CA 94105
PHONE: (415) 538–7839

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
WATER PIPELINE PLAN AND PROFILE
(STA. 71+50 TO 83+73)

PROJECT ENGINEER: CC	DRAWN: VI	
PROJECT MANAGER: FD	DESIGNED: CC	
APPROVAL: SAG	CHECKED: GA	
CHECKED / APPROVED	DRAWN	SCALE: 1"=80'
SECTION MANAGER	DESIGNED	DATE: MAR. 2010
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

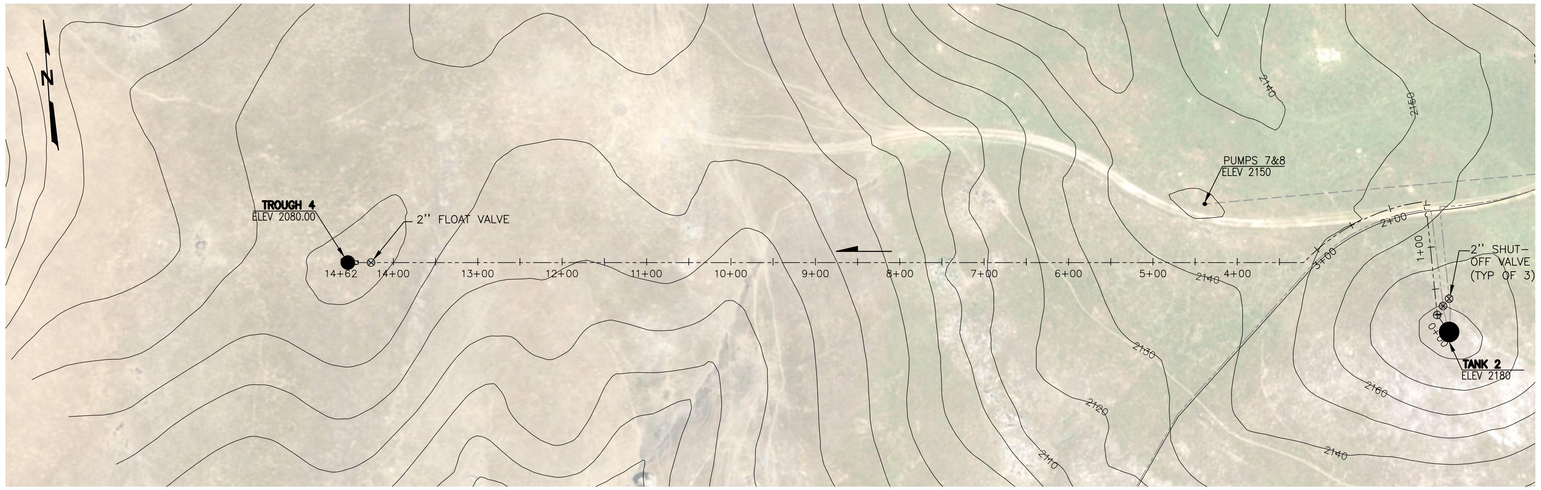
SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C–6		

ELEVATION DATUM
NAVD88

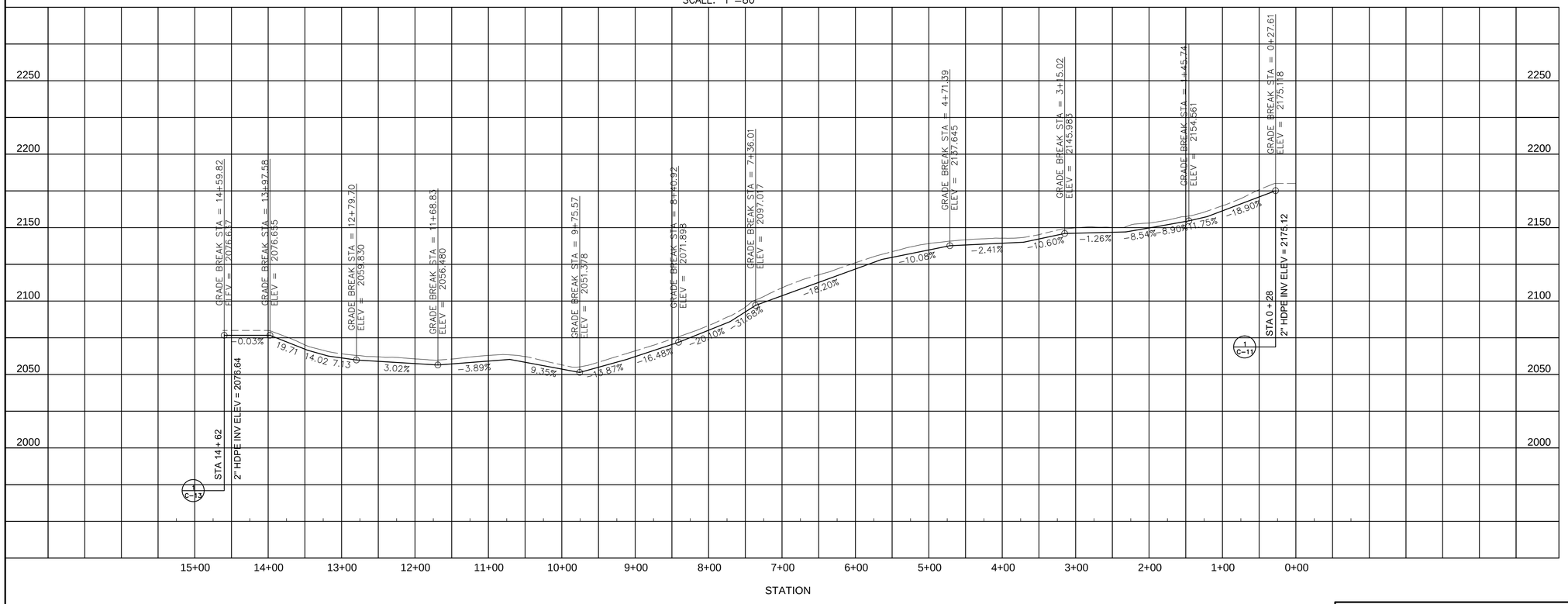
PLOT: EXTEND
SCALE: 1:1
BORDER:
22,34
COLOR: No.
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YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

Z:\Projects\210315_GoatRock\07_Drawings\C–6.dwg Mar 30, 2010 – 3:58pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1"=80'



PROFILE
VERTICAL SCALE: 1"=40'
HORIZONTAL SCALE: 1"=80'

NOTES:

1. USE 2'' DIAMETER 200 PSI HDPE PIPE FOR BOTH PRESSURE AND GRAVITY FLOW PIPES
2. USE PLASTIC GATE OR GLOBE SHUTOFF/FLOAT VALVES

KEY

- PRESSURE FLOW PIPE
- GRAVITY FLOW PIPE
- FLOW DIRECTION

30% DESIGN NOT FOR CONSTRUCTION

80 0' 80 160'
SCALE IN FEET
HORIZONTAL SCALE: 1" = 80'
VERTICAL SCALE: 1" = 40'

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HRP ALAMEDA WATERSHED SITES

GOAT ROCK
WATER PIPELINE PLAN AND PROFILE
(STA. 0+00 TO 14+40)

ELEVATION DATUM
NAVD88

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SAN FRANCISCO, CA 94105
PHONE: (415) 538-7839

PROJECT ENGINEER	DRAWN
CC	VI
PROJECT MANAGER	DESIGNED
FD	PF
APPROVAL	CHECKED
SAG	GA

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

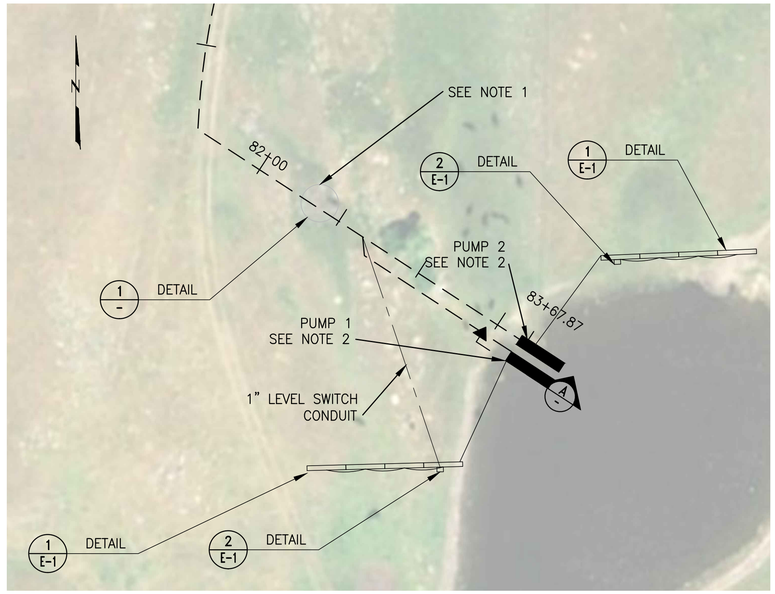
CHECKED / APPROVED	DRAWN	SCALE
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SECTION MANAGER	DESIGNED	DATE
		MAR. 2010
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-7		

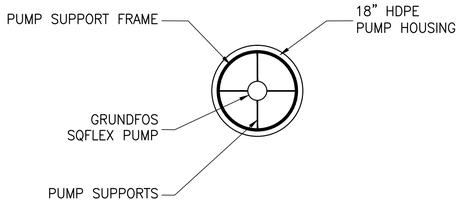
PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
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YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

Z:\Projects\210315_GoatRock\07_Drawings\C7.dwg Mar 31, 2010 – 12:35pm

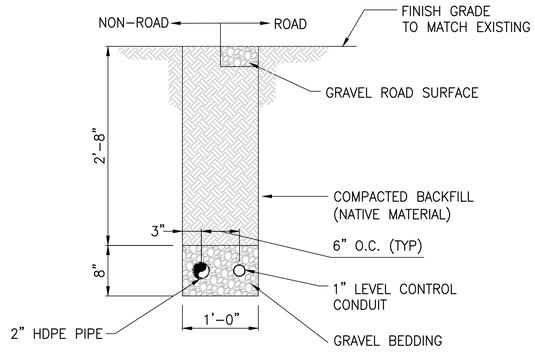
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



SOUTHEAST POND SITE PLAN
SCALE: 1"=40'

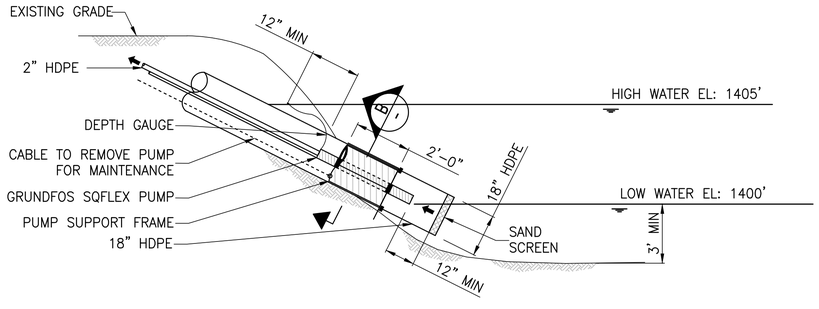


SECTION B/-
SCALE: 3/4"=1'-0"



TRENCH DETAIL AT ROAD 1/-
SCALE: 1"=1'-0"

NOTES:
1. TRENCH TO CONTAIN:
   2" HDPE PIPE FROM PUMPS 1 AND 2 TO POND 2
   1" CONDUIT TO POND 2
2. PUMPS 1 AND 2 ENCLOSED IN 18" HDPE PIPE. LENGTH OF PIPE TO BE DETERMINED IN FIELD.



SECTION VIEW – SOUTHEAST POND PUMP INSTALATION A/-
SCALE: NTS

40' 0 40' 80'
SCALE 1"=40'

ELEVATION DATUM
NAVD88

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55 NEW MONTGOMERY, SUITE 619
SAN FRANCISCO, CA 94105
PHONE: (415) 538-7839

PROJECT ENGINEER	DRAWN
CC	PF
PROJECT MANAGER	DESIGNED
FD	PF
APPROVAL	CHECKED
SAG	GA

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
SOUTHEAST POND
SITE PLAN AND DETAILS

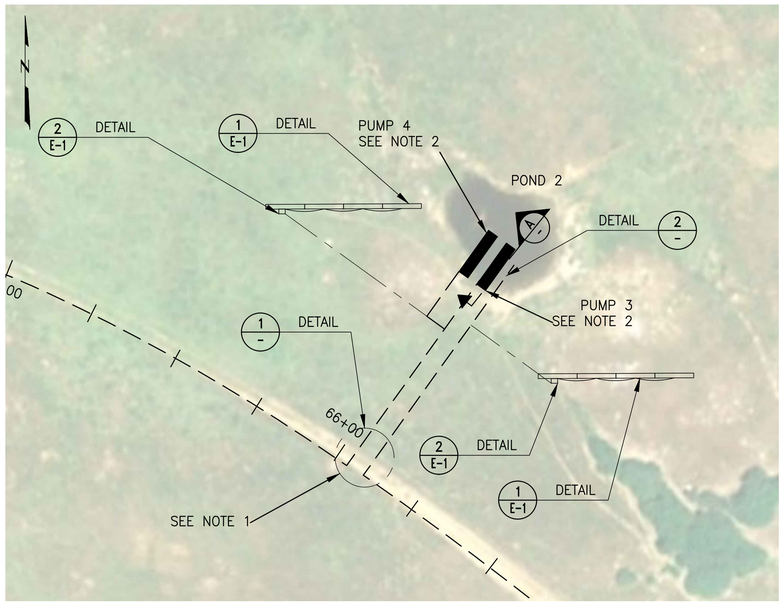
CHECKED / APPROVED	DRAWN	SCALE
		1"=80'
SECTION MANAGER	DESIGNED	DATE
		MAR. 2010
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-8		

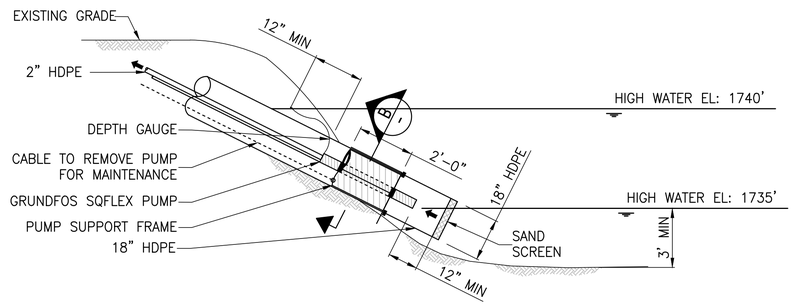
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SCALE: 1:1
BORDER: 22,34
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YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

Z:\Projects\210315_GoatRock\07_Drawings\Siteplan and Detail Sheets.dwg Mar 31, 2010 – 12:48pm

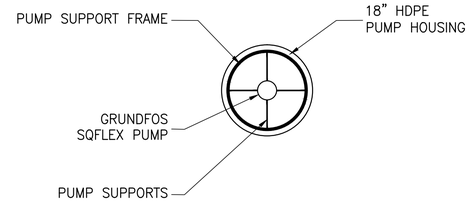
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



POND 2 SITE PLAN
SCALE: 1"=40'

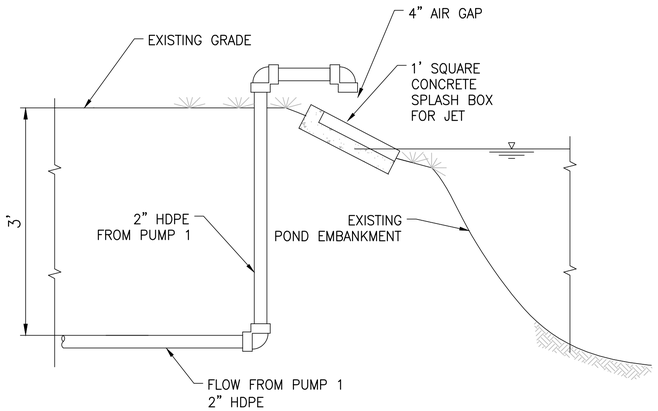


SECTION VIEW – PUMP INSTALLATION POND 2
SCALE: NTS
A –

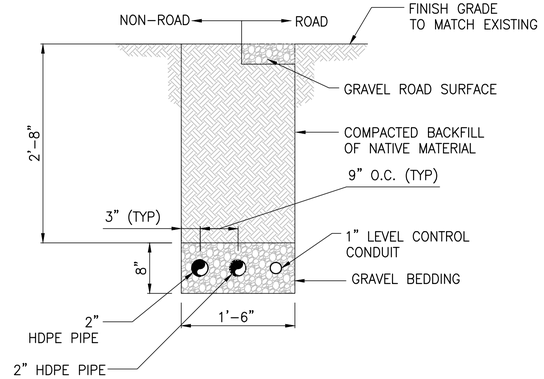


SECTION
SCALE: 3/4"=1'–0"
B –

NOTES:
1. TRENCH TO CONTAIN:
   2" HDPE PIPE FROM PUMPS 3 AND 4 TO TROUGH 1
   2" HDPE PIPE FROM PUMPS 1 AND 2 TO POND 2
   1" CONDUIT
2. PUMPS 3 AND 4 ENCLOSED IN 18" HDPE PIPE. LENGTH OF PIPE TO BE DETERMINED IN FIELD.



AIR GAP DETAIL
SCALE: 1"=1'–0"
2 –



TRENCH DETAIL
SCALE: 1"=1'–0"
1 –

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HRP ALAMEDA WATERSHED SITES

GOAT ROCK
POND 2
SITE PLAN AND DETAILS

URS
1333 BROADWAY, SUITE 800
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PHONE: (510) 893–3600

WRE
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SAN FRANCISCO, CA 94105
PHONE: (415) 538–7839

PROJECT ENGINEER	DRAWN	CHECKED / APPROVED	DRAWN	SCALE
CC	PF			
PROJECT MANAGER	DESIGNED	SECTION MANAGER	DESIGNED	DATE
FD	PF			MAR. 2010
APPROVAL	CHECKED	APPROVED	APPROVED	
SAG	GA	MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C–9		

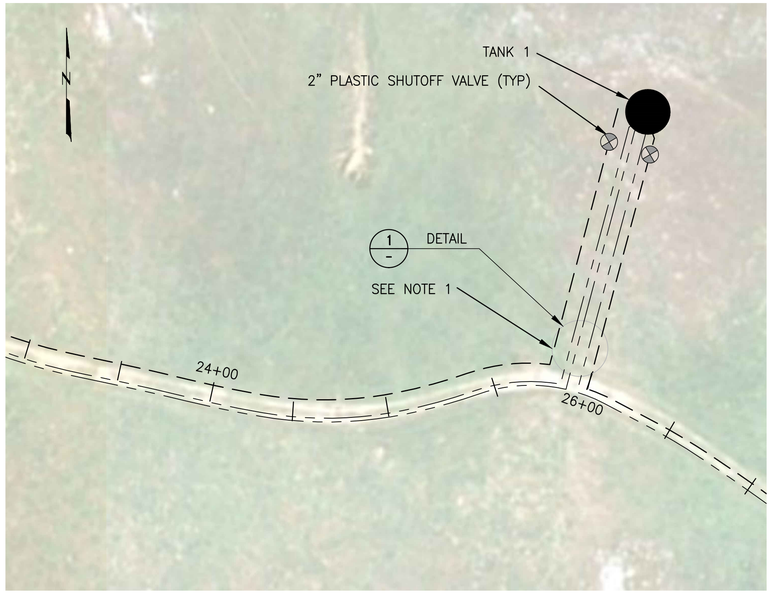
ELEVATION DATUM
NAVD88

PLOT: EXTEND
SCALE: 1:1
BORDER:
22,34
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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
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

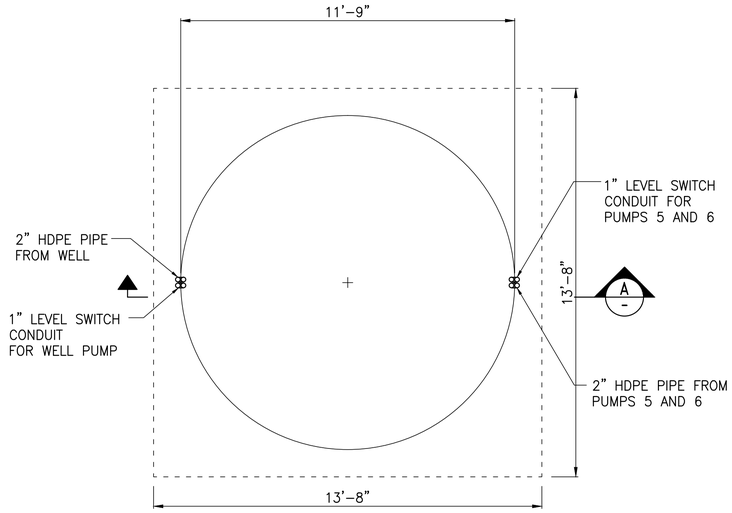
40' 0 40' 80'
SCALE 1"=40'

Z:\Projects\210315_GoatRock\07_Drawings\Siteplan and Detail Sheets.dwg Mar 31, 2010 – 12:49pm

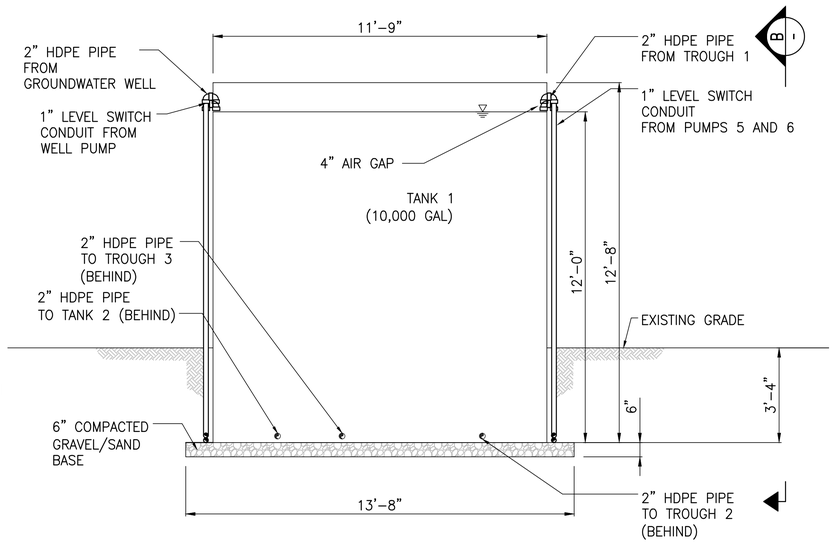
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



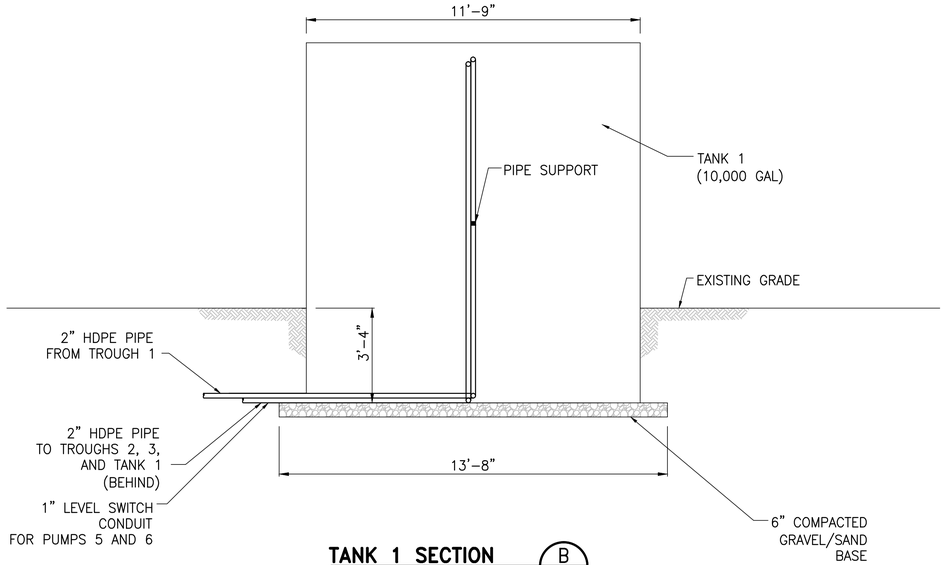
TANK 1 SITE PLAN
SCALE: 1"=40'



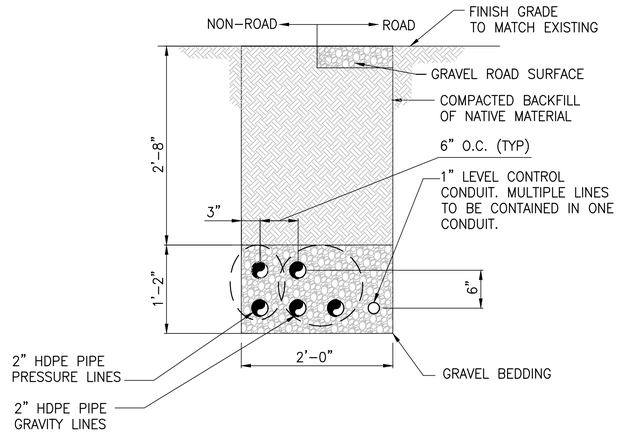
TANK 1 PLAN
SCALE: 3/8"=1'-0"



TANK 1 SECTION
SCALE: 3/8"=1'-0"



TANK 1 SECTION
SCALE: 3/8"=1'-0"



TANK 1 TRENCH DETAIL
SCALE: 1"=1'-0"

NOTES:
1. TRENCH TO CONTAIN:
   - 2" HDPE FROM WET WELL TO TANK 1
   - 1" LINE FROM TROUGH 1 SITE
   - 2" HDPE PIPE FROM GROUNDWATER WELL TO TANK 1
   - 1" LINE FROM GROUNDWATER WELL SITE
   - 2" HDPE PIPE FROM TANK 1 TO TROUGH 2
   - 2" HDPE PIPE FROM TANK 1 TO TROUGH 3
   - 2" HDPE PIPE FROM TANK 1 TO TANK 2

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INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
WATER STORAGE TANK 1
SITE PLAN AND DETAILS

URS
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WRE
55 NEW MONTGOMERY, SUITE 619
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PHONE: (415) 538-7839

PROJECT ENGINEER: CC	DRAWN: PF
PROJECT MANAGER: FD	DESIGNED: PF
APPROVAL: SAG	CHECKED: GA

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

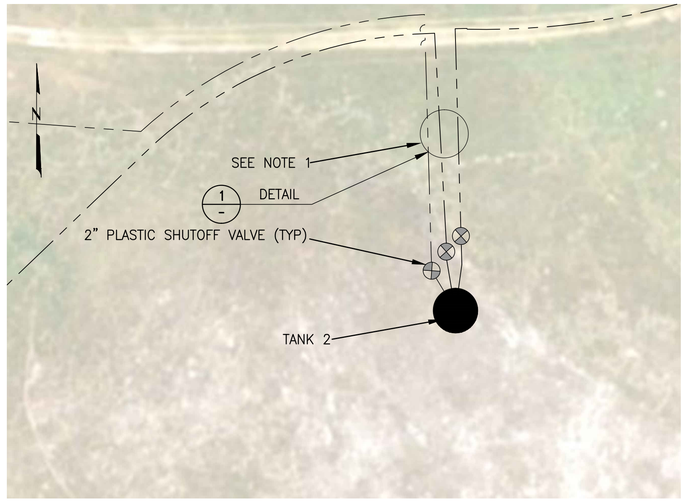
CHECKED / APPROVED		DRAWN	SCALE: 1"=80'
SECTION MANAGER		DESIGNED	DATE: MAR. 2010
APPROVED		APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU		MANAGER, WATER SUPPLY AND TREATMENT DIVISION	
SHEET: OF	PLAN NO.: C-10	DRAWING NO.	REVISION NO.

ELEVATION DATUM
NAVD88

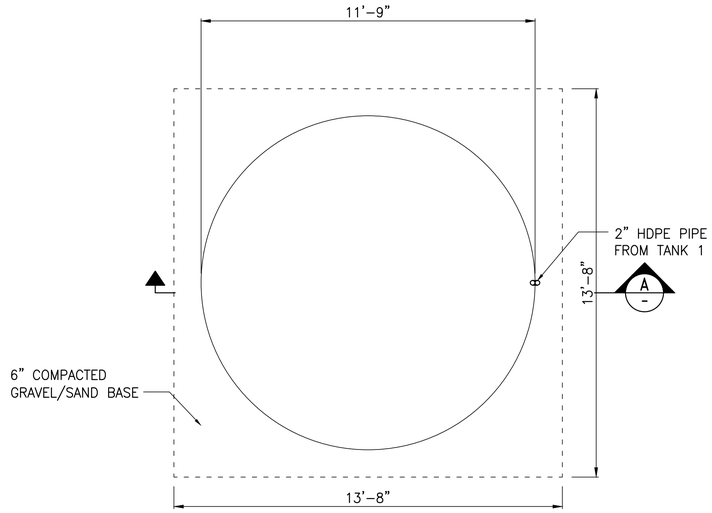
40' 0 40' 80'
SCALE 1"=40'

PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.

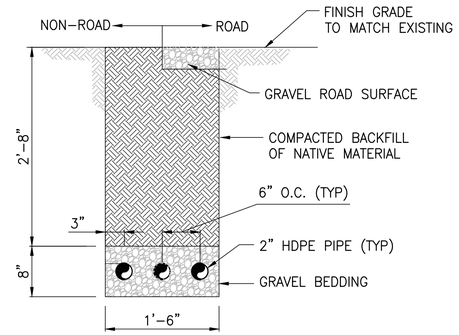
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YELLOW	0.20MM
GREEN	0.25MM
CYAN	0.40MM
BLUE	0.50MM
MAGENTA	0.20MM
WHITE	0.35MM
GRAY	0.15MM
9	0.15MM
10	1.00MM
100	0.70MM
210	0.60MM



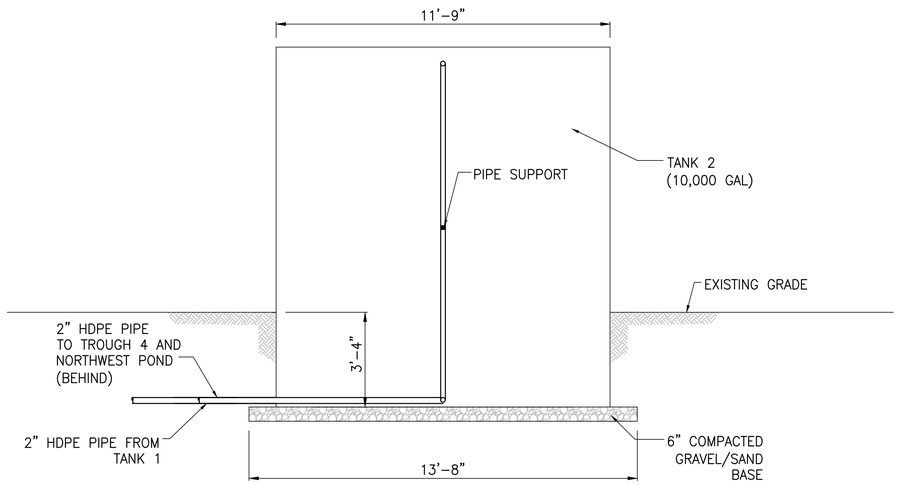
TANK 2 SITE PLAN
SCALE: 1"=40'



TANK 2 PLAN
SCALE: 3/8"=1'-0"

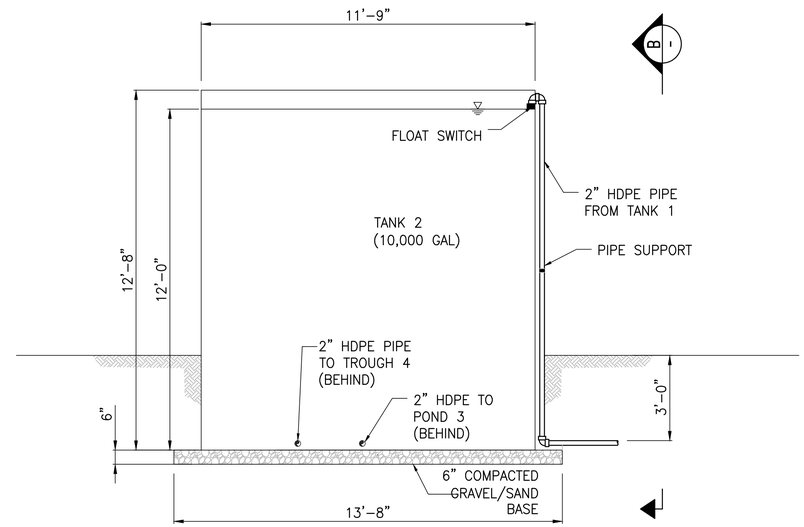


TRENCH DETAIL
SCALE: 1"=1'-0"



TANK 2 SECTION
SCALE: 3/8"=1'-0"

B



TANK 2 SECTION
SCALE: 3/8"=1'-0"

A

NOTES:
1. TRENCH TO CONTAIN:
   2" HDPE FROM TANK 1 TO TANK 2
   2" HDPE PIPE FROM TANK 2 TO POND 3
   2" HDPE PIPE TO TROUGH 4

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CONSTRUCTION

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CONTRACT NO. WD-

40' 0 40' 80'
SCALE 1"=40'

ELEVATION DATUM
NAVD88

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

WRE
55 NEW MONTGOMERY, SUITE 619
SAN FRANCISCO, CA 94105
PHONE: (415) 538-7839

PROJECT ENGINEER	DRAWN
CC	PF
PROJECT MANAGER	DESIGNED
FD	PF
APPROVAL	CHECKED
SAG	GA

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
WATER STORAGE TANK 2
SITE PLAN AND DETAILS

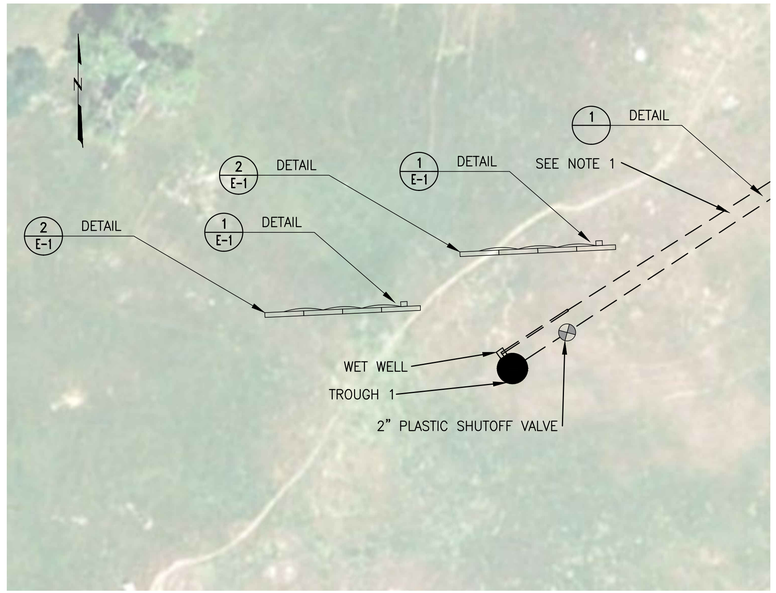
CHECKED / APPROVED	DRAWN	SCALE 1"=80'
SECTION MANAGER	DESIGNED	DATE MAR. 2010
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-11		

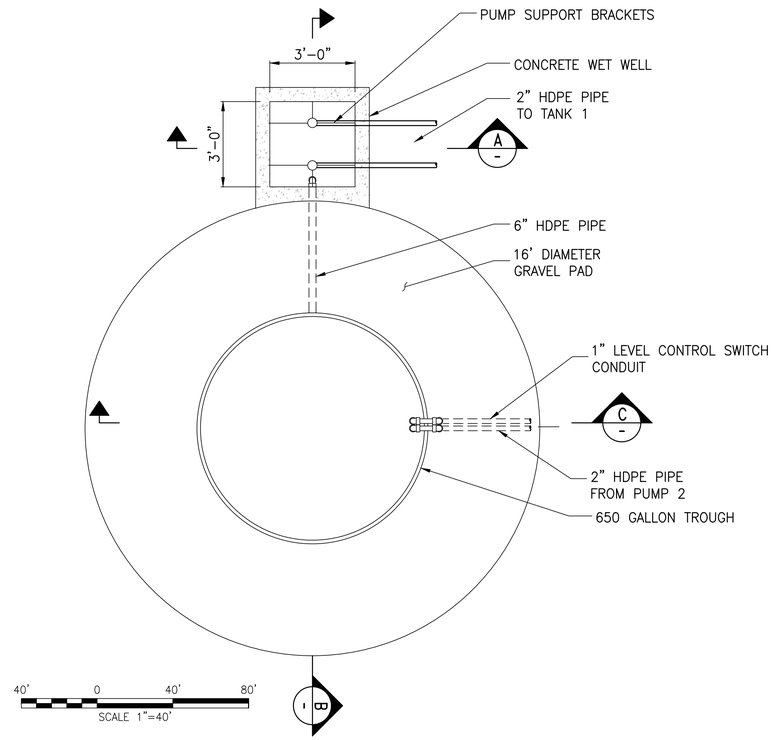
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SCALE: 1:1
BORDER:
22,34
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YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

Z:\Projects\210315_GoatRock\07_Drawings\Siteplan and Detail Sheets.dwg Mar 30, 2010 - 4:14pm

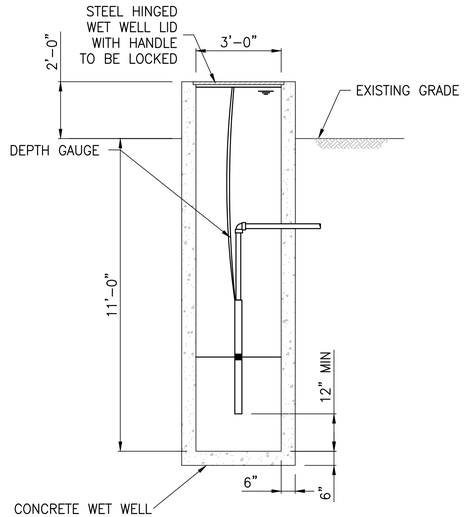
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



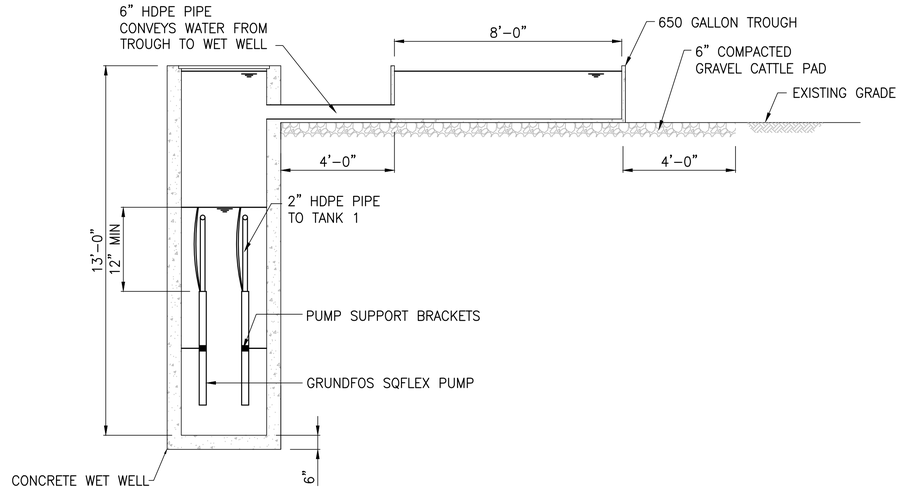
TROUGH 1 SITE PLAN
SCALE: 1"=40'



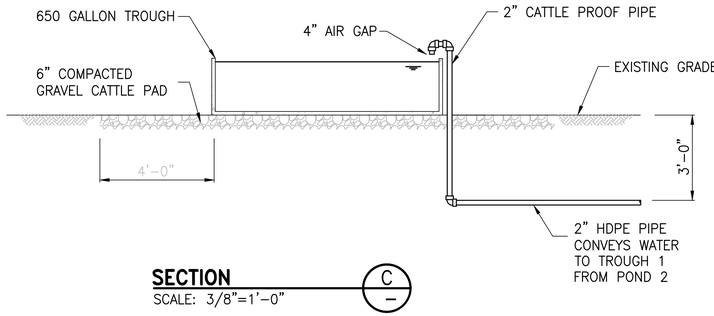
TROUGH 1 PLAN
SCALE: 3/8"=1'-0"



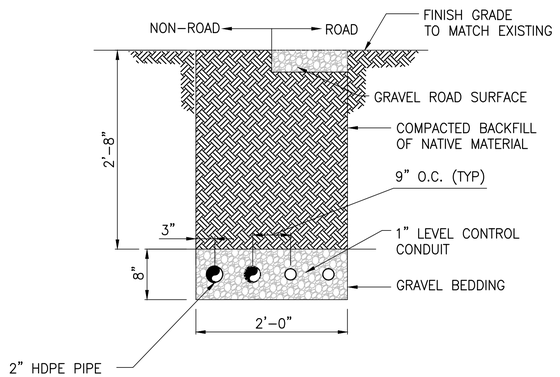
SECTION A
SCALE: 3/8"=1'-0"



SECTION B
SCALE: 3/8"=1'-0"



SECTION C
SCALE: 3/8"=1'-0"



TRENCH DETAIL
SCALE: 1"=1'-0"

NOTES:
1. TRENCH TO CONTAIN:
   - 2" HDPE FROM WET WELL TO TANK 1
   - 1" CONDUIT FROM TROUGH 1 TO TANK 1
   - 2" HDPE PIPE FROM PUMPS 3 AND 4 TO TROUGH 1
   - 1" CONDUIT FROM PUMPS 3 AND 4 TO TROUGH 1

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ELEVATION DATUM
NAVD88

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OAKLAND, CA 94612
PHONE: (510) 893-3600

WRE
55 NEW MONTGOMERY, SUITE 619
SAN FRANCISCO, CA 94105
PHONE: (415) 538-7839

PROJECT ENGINEER: CC	DRAWN: PF
PROJECT MANAGER: FD	DESIGNED: PF
APPROVAL: SAG	CHECKED: GA

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

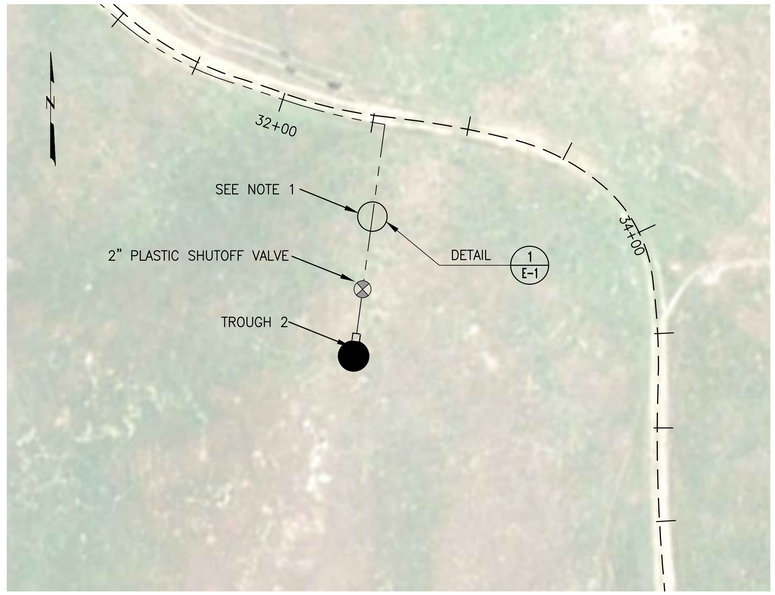
CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

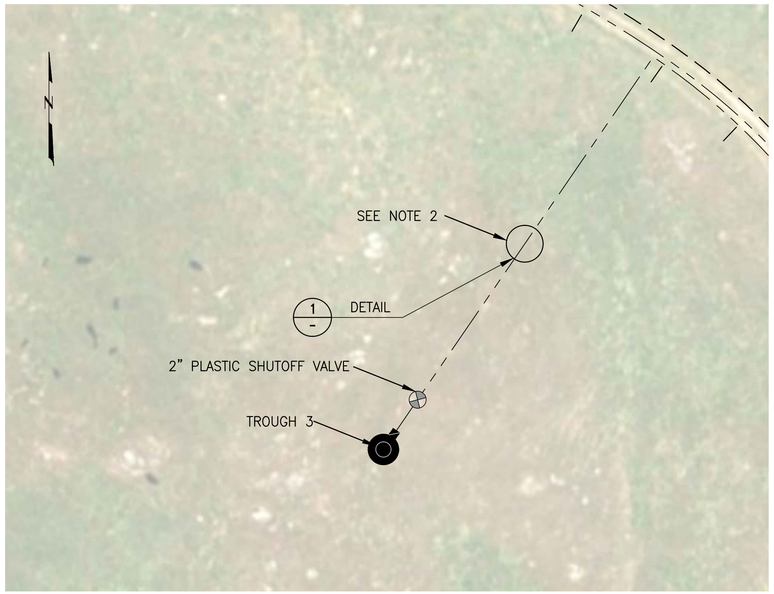
GOAT ROCK
CATTLE WATERING STATION – TROUGH 1
SITE PLAN AND DETAILS

CHECKED / APPROVED	DRAWN	SCALE: 1"=80'
SECTION MANAGER	DESIGNED	DATE: MAR. 2010
APPROVED: MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED: MANAGER, WATER SUPPLY AND TREATMENT DIVISION	
SHEET: OF	PLAN NO.: C-12	DRAWING NO. / REVISION NO.

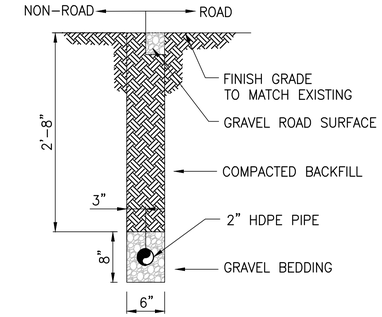
PLOT: EXTEND
SCALE: 1:1
BORDER: 22,34
COLOR: No.
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YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM



TROUGH 2 SITE PLAN
SCALE: 1"=40'

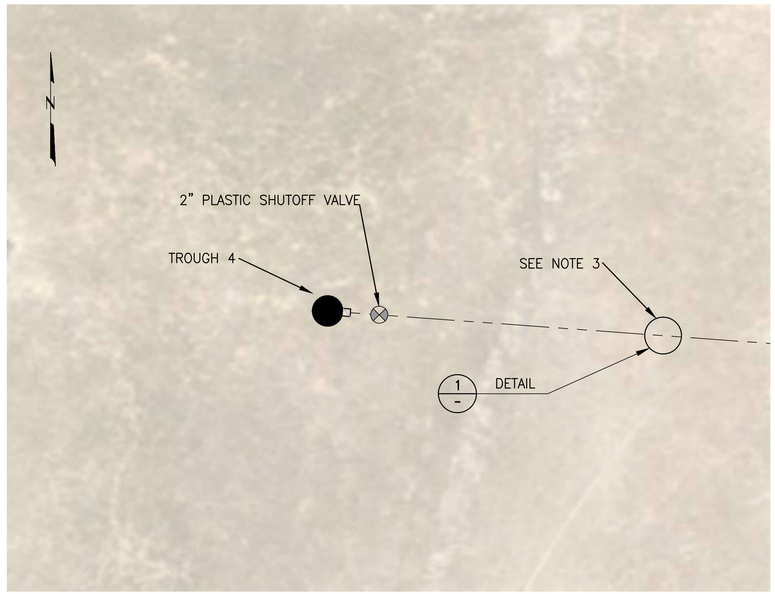


TROUGH 3 SITE PLAN
SCALE: 1"=40'



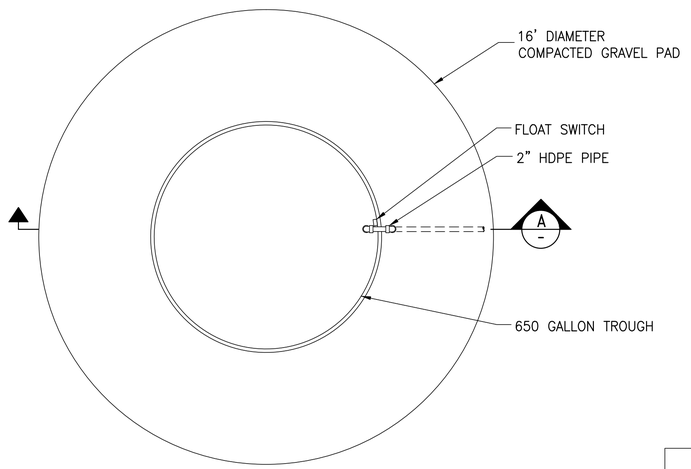
TRENCH DETAIL 1/-
SCALE: 1"=1'-0"

NOTES:
1. TRENCH TO CONTAIN:
   2" HDPE PIPE FROM TANK 1 TO TROUGH 2
2. TRENCH TO CONTAIN
   2" HDPE PIPE FROM TANK 1 TO TROUGH 3
3. TRENCH TO CONTAIN
   2" HDPE PIPE FROM TANK 2 TO TROUGH 4

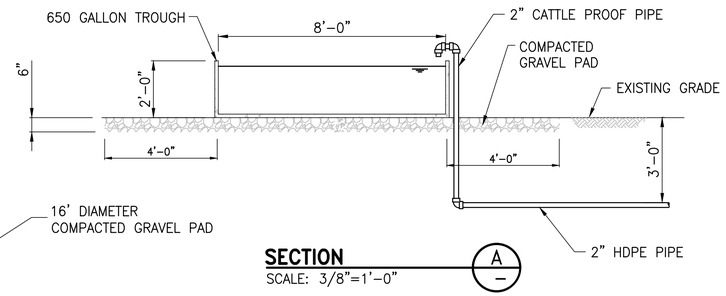


TROUGH 4 SITE PLAN
SCALE: 1"=40'

40' 0 40' 80'
SCALE 1"=40'



TYPICAL TROUGH PLAN
SCALE: 3/8"=1'-0"



SECTION A/-
SCALE: 3/8"=1'-0"

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WRE
55 NEW MONTGOMERY, SUITE 619
SAN FRANCISCO, CA 94105
PHONE: (415) 538-7839

PROJECT ENGINEER	DRAWN
CC	PF
PROJECT MANAGER	DESIGNED
FD	PF
APPROVAL	CHECKED
SAG	GA

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
CATTLE WATERING STATIONS – 2, 3, 4
SITE PLAN AND DETAILS

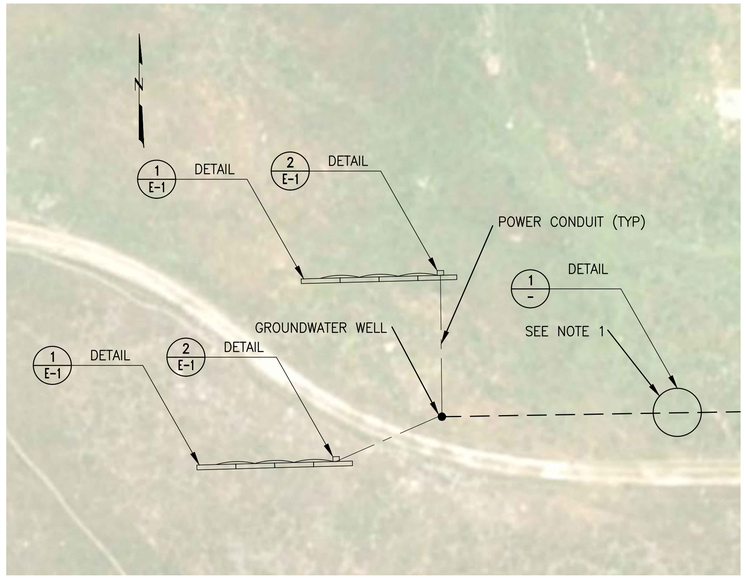
CHECKED / APPROVED	DRAWN	SCALE
		1" = 40'
SECTION MANAGER	DESIGNED	DATE
		JAN. 2010
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-13		

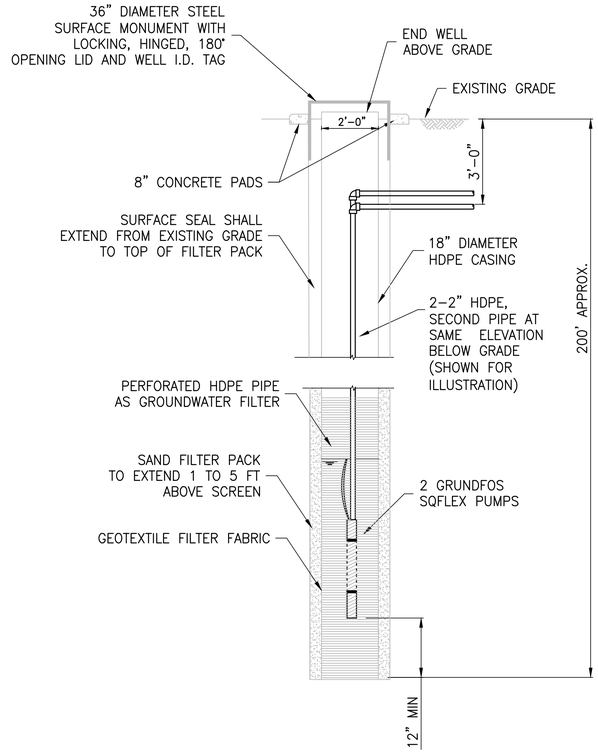
PLOT: EXTEND
SCALE: 1:1
BORDER:
22,34
COLOR: No.
RED 0.70MM
YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

Z:\Projects\210315_GoatRock\07_Drawings\Siteplan and Detail Sheets.dwg Mar 30, 2010 – 4:13pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

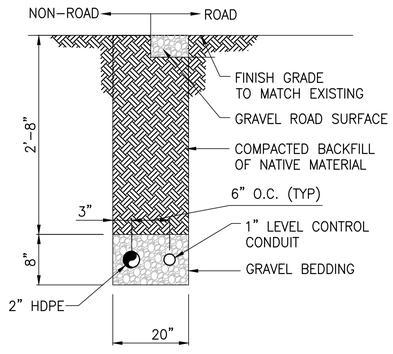


GROUNDWATER WELL SITE PLAN
SCALE: 1"=40'



GROUNDWATER WELL SECTION
SCALE: NTS

NOTES:
1. TRENCH TO CONTAIN:
   2" HDPE PIPE FROM GROUNDWATER WELL TO TANK 1
   1" CONDUIT FROM GROUNDWATER WELL TO TANK 1



TRENCH DETAIL 1/–
SCALE: 1"=1'-0"

40' 0 40' 80'
SCALE 1"=40'

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CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
OPTIONAL WATER SOURCE
GROUNDWATER WELL–SITE PLAN AND DETAILS

URS
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WRE
55 NEW MONTGOMERY, SUITE 619
SAN FRANCISCO, CA 94105
PHONE: (415) 538-7839

PROJECT ENGINEER: CC	DRAWN: PF
PROJECT MANAGER: FD	DESIGNED: PF
APPROVAL: SAG	CHECKED: GA

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

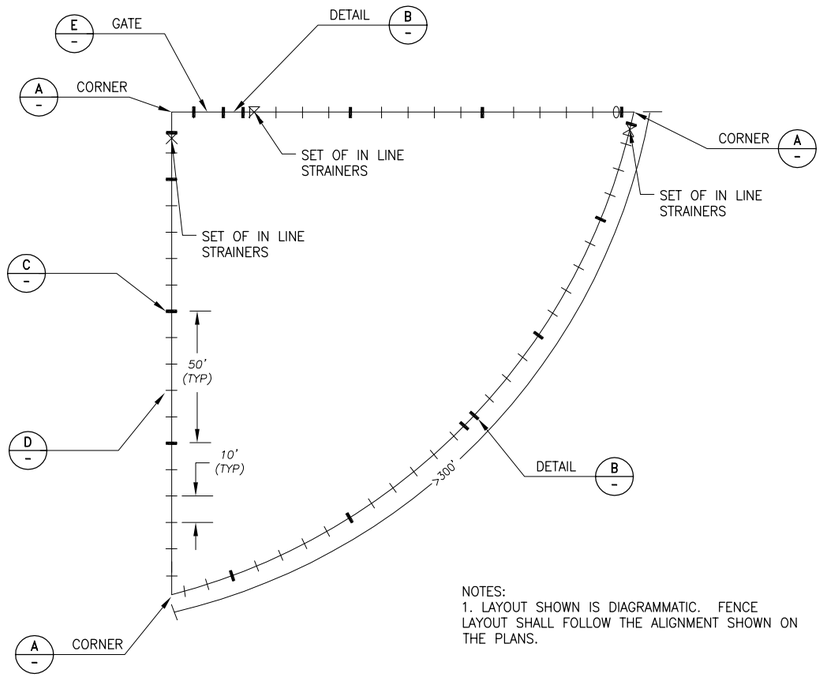
CHECKED / APPROVED	DRAWN	SCALE: 1"=80'	
SECTION MANAGER	DESIGNED	DATE: MAR. 2010	
APPROVED	APPROVED		
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION		
SHEET: OF	PLAN NO.: C-14	DRAWING NO.	REVISION NO.

ELEVATION DATUM
NAVD88

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
9 0.15MM
10 1.00MM
100 0.70MM
210 0.60MM

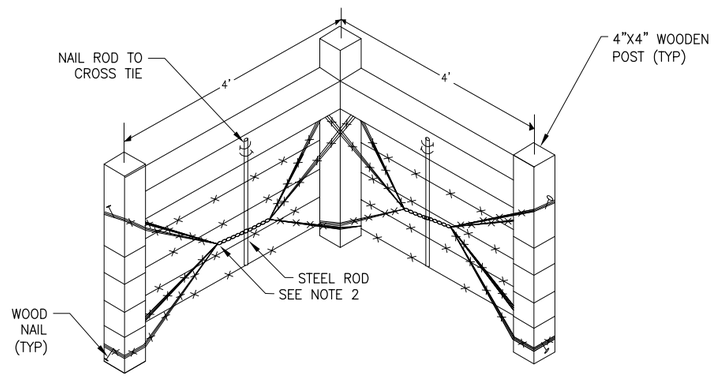
Z:\Projects\210315_GoatRock\07_Drawings\Siteplan and Detail Sheets.dwg Mar 31, 2010 – 12:50pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



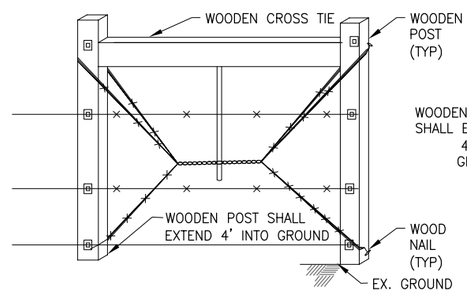
NOTES:
1. LAYOUT SHOWN IS DIAGRAMMATIC. FENCE LAYOUT SHALL FOLLOW THE ALIGNMENT SHOWN ON THE PLANS.

PLAN
SCALE: NTS



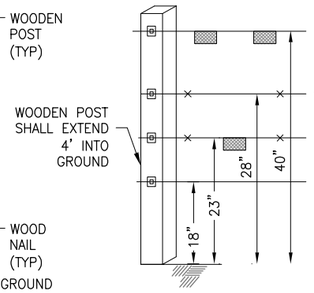
NOTES:
1. DETAIL 'A' SHALL BE UTILIZED AT ALL CORNERS OF FENCE OR INTENSE ANGLE CHANGES.
2. BARBED WIRE SHALL BE NAILED TO THE OUTSIDE EDGE OF EACH POST AT THE TOP AND BOTTOM. WIRE SHALL BE WRAPPED IN A CROSS PATTERN 3X, FOLLOWED BY PLACEMENT OF THE STEEL ROD THROUGH THE CENTER.

CORNER POST DETAIL A
SCALE: NTS



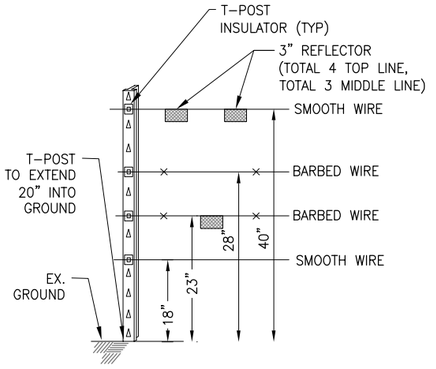
NOTES:
1. DETAIL 'B' TO BE USED ADJACENT TO GATES AND FOR LENGTHS GREATER THAN 300'.
2. SEE NOTE 2 FROM DETAIL 'A'.

ANCHOR DETAIL B
SCALE: NTS



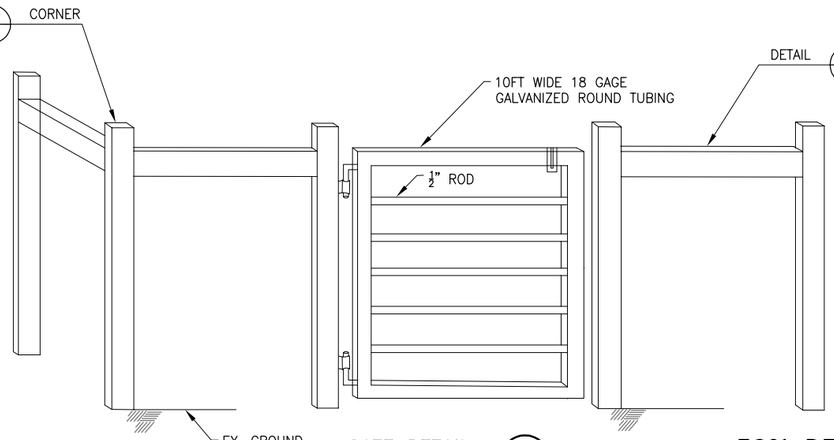
NOTES:
1. DETAIL 'C' TO BE USED EVERY 50'.

WOOD POST DETAIL C
SCALE: NTS



NOTES:
1. DETAIL 'D' TO BE USED EVERY 10'.

STEEL POST DETAIL D
SCALE: NTS



GATE DETAIL E
SCALE: NTS

ELEVATION DATUM
NAVD88

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ENGINEERING MANAGEMENT BUREAU

URS
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WRE
55 NEW MONTGOMERY, SUITE 619
SAN FRANCISCO, CA 94105
PHONE: (415) 538-7839

PROJECT ENGINEER	DRAWN
CC	AD
PROJECT MANAGER	DESIGNED
FD	SS
APPROVAL	CHECKED
SAG	CS

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
TYPICAL WILDILFE FRIENDLY FENCE DETAIL

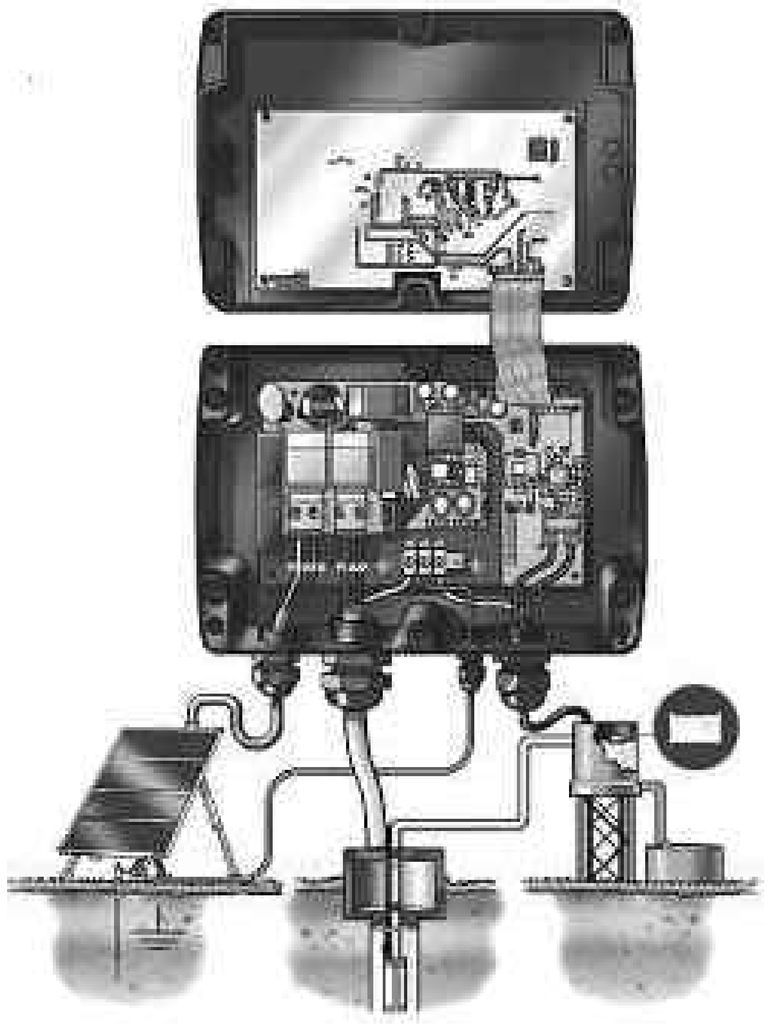
CHECKED / APPROVED	DRAWN	SCALE
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SECTION MANAGER	DESIGNED	DATE
		MARCH 2010
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-15		

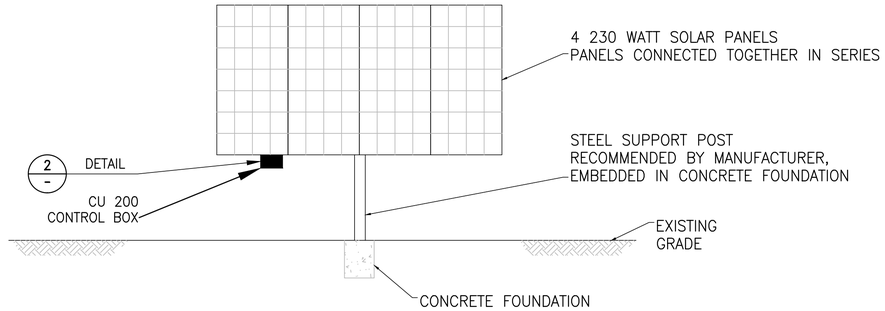
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SCALE: 1:1
BORDER:
22,34
COLOR: No.
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YELLOW 0.20MM
GREEN 0.25MM
CYAN 0.40MM
BLUE 0.50MM
MAGENTA 0.20MM
WHITE 0.35MM
GRAY 0.15MM
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100 0.70MM
210 0.60MM

P:\CADD\Sheets\Goat Rock\C-15.dwg Mar 31, 2010 – 2:46pm

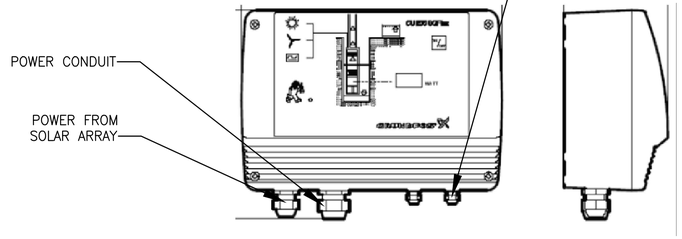
FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



STANDARD PUMP SYSTEM WIRING
SCALE: NTS



SOLAR ARRAY 1/–
SCALE: 1/2"=1'-0"



CU 200 CONTROL BOX DETAIL 2/–
SCALE: NTS

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PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

GOAT ROCK
WATER TRANSPORT SYSTEM
PUMP WIRING AND SOLAR ARRAY DETAILS

URS
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SAN FRANCISCO, CA 94105
PHONE: (415) 538-7839

PROJECT ENGINEER	DRAWN
CC	PF
PROJECT MANAGER	DESIGNED
FD	PF
APPROVAL	CHECKED
SAG	GA

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE
		1"=80'
SECTION MANAGER	DESIGNED	DATE
		MAR. 2010
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	E-1		

ELEVATION DATUM
NAVD88

40' 0 40' 80'
SCALE 1"=40'

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

Z:\Projects\210315_GoatRock\07_Drawings\Siteplan and Detail Sheets.dwg Mar 31, 2010 – 12:51pm

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

SAN FRANCISCO PUBLIC UTILITIES COMMISSION
CITY AND COUNTY OF SAN FRANCISCO

GREGORY LYMAN
PROJECT MANAGER
PUBLIC UTILITIES COMMISSION

PUBLIC UTILITIES COMMISSION
CONTRACT NO. WD xxxx
HABITAT RESTORATION PROGRAM
GOAT ROCK

SPECIFICATIONS
SECTION DIV 2, 15

COPY NO._____

30% Draft
March 31, 2010

PROJECT NO. 38802

Each bid is to be enclosed in an envelope bearing the superscription:

"Bid for HABITAT RESTORATION PROGRAM – GOAT ROCK
PUBLIC UTILITIES COMMISSION
(Contract No. WD xxxx)"

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Section	Title
15132	SOLAR POWERED PUMPS

SECTION 02110

SITE PREPARATION, CLEARING, GRUBBING, AND STRIPPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Specification Section outlines those responsibilities of the Contractor that are scheduled to be performed for site preparation, clearing, grubbing, and stripping.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary to safely perform the work as shown on the Drawings and as specified herein.

1. Vegetation and trees shall be protected from damage incident to site preparation and construction.

2. The Contractor is advised to inspect the site and resolve any questions on site preparation, clearing, grubbing, and stripping with City representative prior to initiation of work.

1.2 RELATED SECTIONS

Section 02200 - Excavation, Backfilling, and Compaction

Section 15132 – Solar Powered Pumps

1.3 SUBMITTALS

A. Working Drawings and Methods Statements:

1. The Contractor shall submit a detailed site preparation, clearing, grubbing and stripping plan. The plan shall include proposed temporary construction haul routes, traffic flows, number and types of equipment, and sequence of work. The proposed methods of disposal of cleared vegetation and stockpiling of topsoil shall be included in the plan. The plan should also include but is not limited to:

a. Extents of areas to be cleared, grubbed, and stripped and identify each work item to be performed within the area depicted

b. Show layout, type, and location of barriers for trees to be protected.

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c. Show location and indicate size of trees to be cleared and grubbed. Identify the trees to be removed. For any additional trees proposed by the Contractor to be cleared and grubbed, provide:

1) Information on the location, size and species of each tree to be disturbed or removed.

2) Descriptions of the anticipated impacts to construction if the tree remains in place and any feasible alternatives to removal.

B. Submit a Recycling Program plan describing recycling to the extent possible for any trees, tree stumps, brush, other vegetation, rocks, concrete rubble, trash, metals, and debris.

1.4 DEFINITIONS

A. Clearing: The removal of materials including trees, tree stumps, brush, other vegetation, rocks, concrete rubble, trash, and debris.

1. Clearing shall consist of cutting, removing, and disposing of all objectionable material from the ground surface, such as trash, trees, brush, logs, stumps, weeds, grasses, and obstructions of any kind, natural or artificial. Trees, shrubs, and vegetation designated to remain shall not be removed or disturbed. Trees and shrubs adjacent to work areas shall be protected from damage.

2. Work shall be performed in such a manner as to remove all evidence of the objects' presence from the surface. Clearing shall also include the removal and disposal of trash piles and rubbish from the work site created prior to and during the duration of the work.

B. Grubbing: Grubbing shall consist of cutting, removing, and disposing of all objectionable material found 6 inches below the ground surface, including natural or artificial obstructions. Trees, stumps and roots below the surface requiring removal shall be removed completely from the ground.

C. Stripping: Stripping shall consist of the removal of the top 2 inches of soil after clearing and grubbing have been completed, or as required by the City representative.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

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A. Stockpile topsoil within the limits of construction, separate from other excavated materials and free of undesirable material. Place topsoil in elongated piles, or "windrows," no greater than 6 feet in height.

B. Prior to stockpiling topsoil, spread clean wheat or barley straw on the ground surface to delineate between the in-situ and salvaged topsoil.

C. Do not allow weed growth on salvaged topsoil stockpiles. Do not apply pre-emergent herbicides on topsoil stockpiles. Remove and dispose offsite any weed growth before weeds produce mature seed heads.

D. If the Contractor fails to perform topsoil salvaging, or if the quantity of topsoil salvaged does not equal the quantity of topsoil available for salvaging due to improper removal, storage or maintenance of stockpiles, the Contractor shall at its own expense import additional topsoil in quantities sufficient to meet the topsoil replacement requirements described in these Specifications. Imported topsoil properties and placement requirements shall be as specified in Section 02200, "Excavation, Backfilling, and Compaction."

E. FILLING OF HOLES: Holes made by removal of existing structures and obstructions and/or clearing and grubbing shall be refilled to adjacent ground with compacted fill material. Fill material properties, placement requirements, and construction control testing shall be as specified in Section 02200, "Excavation, Backfilling, and Compaction."

F. Dispose off non-recycled materials removed during clearing and grubbing to an off-site location. Burning of materials to be cleared and grubbed on-site is not allowed. The Contractor shall stake out all work areas designated for clearing, grubbing, and stripping by survey. The Contractor shall be responsible for the accuracy, maintenance and observation of all lines and elevations.

G. The location, limits, and methods to be used for clearing, grubbing, and stripping shall be reviewed with the City representative prior to start of work.

H. The Contractor shall review with the City representative all trees greater than 4 inches in diameter at a distance of 36 inches above the ground to be removed or trimmed.

I. Do not disturb areas outside the construction limits. Protect areas outside the construction limits from Contractor operations.

J. Do not utilize vegetation as anchorages or for other purposes.

K. Prior to cutting or removing tree limbs or roots have a City representative inspect and approve cut or removal.

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L. Assume all responsibility for injuries to, or death of vegetation arising from Contractor operations.

3.2 CLEARING, GRUBBING, STRIPPING

A. All areas to be excavated or filled shall be cleared, stripped, and grubbed.

B. Remove all organic growth and all debris and rubbish to a depth of up to 6 inches to provide a clean subgrade prior to the placement of fill material and rough grading operations.

C. No burning of combustible material will be permitted. Remove all miscellaneous debris over 1-inch in diameter and dispose of in accordance with all federal, state and local laws, codes, and ordinances in a manner acceptable to the City.

D. Stripping shall include the removal and disposal of all organic sod, grass, grass roots, topsoil, and other objectionable material remaining after clearing and grubbing from the areas designated to be cut or filled.

E. Do not mix stripping with excavated material. Topsoil from the stripping shall be stockpiled and used for the finish site grading. Excess topsoil and stripping will become the property of the Contractor and shall be removed from the site.

F. Protect all existing improvements, utilities, monitoring wells, fences, and adjacent property designated to remain under the Contract Documents.

G. Recycle tree trunks and limbs to the extent possible.

H. If suspected hazardous materials are encountered, immediately notify City representative.

3.3 RESTORATION, CLEAN UP AND DISPOSAL

A. Remove from site surplus material and debris during the course and at completion of the worksite as Contractor’s property and dispose of in accordance with applicable Federal, State and Local Codes, Ordinances and Regulations.

B. Cleanup any spillage from haul routes and adjacent areas.

C. Remove equipments, temporary protection and barriers and debris.

END OF SECTION

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SECTION 02200

EXCAVATION, BACKFILLING, AND COMPACTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Specification Section outlines those responsibilities of the Contractor that are scheduled to be performed for excavation, backfilling, and compaction.

B. This section includes provisions for excavation of all materials, regardless of character and subsurface conditions; placement of backfill for pipe trenches and access road improvements; backfill of depressions resulting from removal of obstructions; backfill of holes, pits, and other depressions within the project area; removal of unsuitable materials; placement of suitable backfill material; preparation of base material for placement of other material thereon; all as shown on the Drawings, as specified in these Specifications, and as directed by City Representative.

C. The elevations shown on the Drawings as existing are taken from the best existing data and are intended to give reasonable, accurate information about the existing elevations. They are not precise, and the Contractor should satisfy himself as to the exact quantities of excavation and fill required.

1.2 RELATED SECTIONS

Section 02200 - Excavation, Backfilling, and Compaction

Section 15132 – Solar Powered Pumps

1.3 SUBMITTALS

A. Working Drawings and Methods Statements:

1. The Contractor shall submit to City representative analytical data and source of material as required herein for all imported, non-City supplied fill material to be used in this project.

2. Sampling requirements are as follows: one 4-point composite sample for each 500 cubic yards of imported fill.

3. Analyses required at a minimum for each sample are: LUFT 5 Metals (Cd, Cr, Ni, Pb, Zn) EPA Method 6010; TPH gas+BTXE EPA Method

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5030/8015M/8020; and TPH diesel, motor oil, kerosene EPA Method 8015M.

4. The Contractor shall submit required analytical data to the City representative prior to delivery of the imported fill to the job site. All analyses are to be performed by a State Certified Laboratory.

1.4 REFERENCE STANDARDS

A. Standard Specification of the San Francisco Public Utilities Commission.

B. State of California Department of Transportation Standard Specification (CTSS), dated May 2006.

C. American Society for Testing and Materials (ASTM)

1. ASTM D 1556 Density and Unit Weight of Soil in Place by the Sand-Cone Method

2. ASTM D 2216 Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures

3. ASTM D 2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

4. ASTM D 3017 Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. The Contractor shall furnish all labor, materials, tools, equipment, and incidentals for doing all work that may be required to install pipes, pumps, tanks, troughs, solar panels, wells, and any appurtenant items.

2.2 ENGINEERING FILL

A. Engineering fill shall consist of imported soil materials or excess locally excavated materials, subject to the approval of the City representative, placed and compacted as specified herein.

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B. Imported fill materials for pipe trenches shall be clean, inorganic, low expansion potential (Plasticity Index less than 12 and Liquid Limit less than 20), and shall contain particles no larger than 3 inches in size.

Grading as follows:

Sieve Sizes	Percentage Passing
3"	100
No. 4	35 - 100
No. 30	20 - 100

2.3 IMPORTED TOPSOIL

A. Imported topsoil material shall have a composition as indicated below, and shall be free of stones, stumps, roots, or other similar objects larger than one inch:

Sand 35-60%

Silt 30-55% (Loam)

Clay 25%

B. The topsoil material salvage shall be used to backfill areas disturbed by installation of pumps, tanks, troughs, solar panels, and wells.

2.4 AGGREGATE BASE

A. Aggregate base for road improvement shall be Class 2 aggregate base free from organic matter and other deleterious substances, and shall be of such nature that it can be compacted readily under watering and rolling to form a firm, stable base.

B. Aggregate shall conform to the grading and quality requirements shown in the following tables. At the option of the Contractor, the grading for either the 1-1/2” maximum or 3/4” maximum shall be used, except that once a grading is selected it shall not be changed without the written approval of the City Representative.

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AGGREGATE GRADING REQUIREMENTS

Sieve Sizes	Percentage Passing			
	1 1/2" Maximum		3/4" Maximum	
	Operating Range	Contract Compliance	Operating Range	Contract Compliance
2"	100	100	—	—
1 1/2"	90-100	87-100	—	—
1"	—	—	100	100
3/4"	50-85	45-90	90-100	87-100
No. 4	25-45	20-50	35-60	30-65
No. 30	10-25	6-29	10-30	5-35
No. 200	2-9	0-12	2-9	0-12

QUALITY REQUIREMENTS

Test	Operating Range	Contract Compliance
Resistance (R-value)	—	78 Min.
Sand Equivalent	25 Min.	22 Min.
Durability Index	—	35 Min.

C. The aggregate shall not be treated with lime, cement or other chemical material before the Durability Index test is performed.

D. If the results of either or both the aggregate grading and Sand Equivalent tests do not meet the requirements specified for “Operating Range” but meet the “Contract Compliance” requirements, placement of the aggregate base may be continued for the remainder of that day. However, another day's work may not be started until tests, or other information, indicate to the satisfaction of the City Representative that the next material to be used in the work will comply with the requirements specified for “Operating Range.”

E. If the results of either or both the aggregate grading and Sand Equivalent tests do not meet the requirements specified for “Contract Compliance,” the aggregate base which is represented by these tests shall be removed.

F. No single aggregate grading or Sand Equivalent test shall represent more than 400 m^3 or one day’s production, whichever is smaller.

PART 3 - EXECUTION

3.1 NOTIFICATIONS

A. Prior to beginning excavation, the Contractor shall notify the City representative of all potential utilities and/or privately owned facilities that may be affected by the work in accordance with the applicable requirements of these Specifications.

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3.2 PROTECTION

A. Preservation of Property: The Contractor shall take necessary precautions to preserve and protect private and public property including support of utilities within and adjacent to the Contract site.

3.3 FILL PLACEMENT

A. Engineered Fill: Place engineering fill materials in lifts not exceeding 8-inch loose thickness. Maintain moisture condition of fill materials at 2% above optimum moisture content and compact to at least 95%.

B. Topsoil: Maintain moisture condition of fill materials at 2% above optimum moisture content and compact to at least 50%.

C. Aggregate Base:

1. Preparation: Prior to constructing the aggregate base course, the underlying subgrade shall be cleaned of all foreign substances. At the time of construction of the base course, the underlying subgrade shall contain no frozen material. The surface of the underlying subgrade shall meet specified compaction and surface tolerances. Ruts or soft yielding spots in the underlying subgrade, areas having inadequate compaction, and deviations of the surface from the requirements set forth herein shall be corrected by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements.

2. The mixed material shall be placed on the prepared subgrade in layers of uniform thickness with an approved spreader. When a compacted layer 6 inches or less in thickness is required, the material shall be placed in a single layer. When a compacted layer in excess of 6 inches is required, the material shall be placed in layers of equal thickness. No layer shall exceed 6 inches or be less than 3 inches when compacted. The layers shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. Where the aggregate base is placed in more than one layer, the previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms, as directed. Such adjustments in placing procedures or equipment shall be made as may be directed to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to insure an acceptable aggregate base.

3. Each layer of the aggregate base shall be compacted as specified with approved compaction equipment. Water content shall be maintained during the

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compaction procedure to within plus or minus 1 percent of the optimum water content determined from ASTM D 1557. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers.

4. Compaction shall continue until each layer has a degree of compaction that is at least the specified percentage of laboratory maximum density through the full depth of the layer. The Contractor shall make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory aggregate base course. Aggregate base course materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification. Aggregate base shall be compacted to a minimum 95 percent of laboratory maximum density.

5. The finished and completed aggregate base course shall conform to the proposed lines, grades, and cross sections.

6. The surface of the top layer shall show no deviations in excess of 3/8 inch when tested with a 10-foot straightedge. Measurements shall be taken in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 50-foot intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

7. Completed portions of the aggregate base course may be opened to limited traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary for construction, and then the area shall be protected against marring or damage to the completed work.

8. The compacted aggregate base shall be maintained in a satisfactory condition until the full pavement section is completed and accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any aggregate base that is not paved over prior to the onset of winter, shall be retested to verify that it still complies with the requirements of this specification. Any area of aggregate base that is

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damaged shall be reworked or replaced as necessary to comply with this specification.

3.4 COMPACTION

A. Compaction shall comply with Section 19-5 "Compaction" of the CTSS and these Specifications, unless specifically indicated otherwise herein.

3.5 EXCAVATION

A. Trench Width

1. Make pipe trenches as narrow as practicable and safe and in compliance with Drawings. Make every effort to keep side of trenches firm and undisturbed until backfilling has been completed and consolidated.

2. Excavate trenches with vertical sides between elevation of center of pipe and elevation 1 foot above top of pipe.

B. Existing Road Surface

1. Existing road surface material shall be excavated and prepared at sufficient depth for the required aggregate base thickness so that the finished aggregate base will meet the designated grades.

3.6 FIELD QUALITY CONTROL

A. Aggregate Base

1. Field tests for compacted or in-place densities for aggregate base shall be made in accordance with ASTM D 1556 or ASTM D 2922. Field tests for moisture content will be made in accordance with ASTM D 2216 or ASTM D 3017. If ASTM D2922 and ASTM D 3017 are used, the first five in-place density tests for each material type shall be determined by both ASTM D 1556 and ASTM D 2922 for correlation of sand and nuclear methods. Thereafter, every fifth nuclear test shall be verified by the sand cone method. If verification testing does not show adequate correlation as determined by the City Representative, all tests shall be performed in accordance with ASTM D 1556.

2. One of each of the following tests shall be performed on samples taken from the placed and compacted aggregate base. Samples shall be taken and tested at the rates indicated.

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a. Two initial field density and moisture tests are required during the first 250 square yards. Density tests thereafter shall be performed on every lift of material placed and at a frequency of one set of tests for every 250 square yards, or portion thereof, of completed area.
b. Sieve Analysis shall be performed for every 500 tons, or portion thereof, of material placed.

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SECTION 02800

SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall furnish and install pipes, valves, water storage tanks, troughs, and appurtenant structures required for fully operational water conveyance systems that deliver water to various locations as indicated on the Drawings. Pumps, control units, and solar panels are covered in Section 15132 of these specifications. This section covers other site furnishings, which include:

1. Pipes and pipe fittings
2. Valves
3. Troughs
4. Water storage tanks

1.2 RELATED SECTIONS

Section 02200 - Excavation, Backfilling, and Compaction

Section 15132 – Solar Powered Pumps

1.3 SUBMITTALS

A. Contractor shall submit shop drawings and product data for all items within this Section to be constructed or installed.

B. Contractor shall submit manufacturer’s instructions and product data.

1.4 QUALITY ASSURANCE

A. The Contractor shall demonstrate experience with the installation of similar systems. Contractor shall provide references demonstrating experience with the installation of plastic piping and valves, concrete troughs, and plastic water storage tanks. Reference contact information shall be provided to City Representative prior to initiation of work.

B. To assure uniformity and compatibility of components, fitting, couplings, and accessories shall be furnished by the same manufacturer that supplies the primary item.

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C. All material furnished by the Contractor shall be new and of current manufacture and shall be guaranteed against defects of workmanship in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 PIPES AND PIPE FITTINGS

A. Pipes and fittings shall be high density polyethylene (HDPE) unless otherwise indicated on the Drawings. Pipes shall be primarily 2 inches inside diameter and rated for pressures no less than 200 pounds per square inch (psi), unless otherwise noted.

B. Couplers, reducers, and other fittings shall be compatible with pipe and rated for same pressure.

C. Where piping connects to equipment it shall be supported by compatible pipe supports and not by the equipment.

2.2 VALVES

A. Plastic valves shall be used throughout the project. Valves must be rated for the same pressure as the pipes/equipment they serve. Valve types and diameters shall be as indicated on the Drawings.

2.3 TROUGHS

A. Cattle waterers or troughs shall be circular fiberglass structures, as manufactured by Rocking' R Water Well Service of Boerne Texas, or approved equivalent. The 660-gallon, 91-inch by 24-inch fiberglass water trough shall be used at all locations in the Drawings that call for a trough.

2.4 WATER STORAGE TANKS

B. Water storage tanks shall be cylindrical polyethylene structures, as manufactured by Norwesco of St. Bonifacius, Minnesotta, or approved equivalent. Tanks shall have 10,000-gallon storage capacity, with 2-inch diameter outlet and drain.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Contractor shall comply with requirements of Section 02200, "Excavation, Backfilling and Compaction."

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3.2 PIPE AND VALVE INSTALLATION

A. Drawings shall indicate general location and arrangement of water piping and valves. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved by City Representative.

3.3 TROUGHS

A. Install troughs in accordance with manufacturer's recommendations and as indicated on the Drawings. The surface under the troughs shall be appropriately leveled and compacted. A gravel ring about 4 feet wide shall be provided around each circular trough, as indicated on the Drawings.

B. Troughs come equipped with float valves. The Contractor shall verify that float valves work and will adjust them to provide the maximum water level in the trough indicated on the Drawings.

C. Water lines into the troughs shall be plumbed to discharge over the top so as to create an air gap of at least 4 inches between the end of the supply pipe and the overflow water level in the trough.

3.4 WATER STORAGE TANKS

A. Tanks shall be installed vertically with the base below grade and the top of tank above ground, as indicated on the Drawings. A bedding surface with a minimum thickness of 6 inches shall be provided under each tank. The bedding shall be a well compacted sand/gravel mixture.

B. Openings for outlet pipes shall be drilled on the side near the bottom of the tank and threaded to insert appropriate pipe adapters.

C. A water level indicator shall be installed in each tank to electrically relay a signal to the level switches that activates filling pumps. The indicator shall be compatible with the solar powered pumps specified in Section 11210, "Solar Powered Pumps".

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SECTION 02830

FENCE AND GATES

PART 1 - GENERAL

1.01 SUMMARY

A. This Specification Section outlines those responsibilities of the Contractor that are scheduled to be performed for wildlife friendly wire fence and access gates.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary to safely perform the work as shown on the Contract Drawings and as specified herein

C. Related Sections:

1. Section 02200 – Excavation, Backfilling and Compaction.

D. References:

1. AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

a. AWPA C1 (2003) All Timber Products – Preservative Treatment by Pressure Processes

b. AWPA C4 (2003) Poles - Preservative Treatment by Pressure Processes

2. ASTM INTERNATIONAL (ASTM)

a. ASTM A 121 (1999; R 2004) Standard Specification for Metallic-Coated Carbon Steel Barbed Wire

b. ASTM A 702 (1989; R 2006) Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought

c. ASTM F 900 (2005) Industrial and Commercial Swing Gates

PART 2 - PRODUCTS

2.01 BARBED WIRE

A. Barbed wire shall conform to ASTM A 121 zinc-coated, Type Z, Class 3, or aluminum-coated, Type A, with 12.5 gauge wire with 14 gauge, round, 4-point barbs spzed no more than 5 inches apart.

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2.02 SMOOTH WIRE

A. Smooth wire shall conform to ASTM A 121 zinc-coated, Class 3, or aluminum-coated, Type A, with 12.5 gauge wire.

2.03 WOODEN POSTS

A. Wood posts shall be cut from sound and solid trees free from short or reverse bends in more than one place. Tops shall be convex rounded or inclined. Posts shall be free of ring shake, season cracks more than ¼ inch side, splits in the end, and unsound knots. Size and shape of posts shall be as indicated on the Plans. Posts shall be treated in accordance with AWPA C1 or AWPA C4 as applicable.

2.04 METAL POSTS

A. Metal Posts shall conform to ASTM A 702 zinc-coated, heavy duty studded T-section; length as indicated on Plans, weighing 1.33 pounds per lineal foot. Accessories shall conform to ASTM F 900.

2.05 METAL ACCESSORIES

A. Metal accessories shall include the following:

   a. ½-inch steel rod at 32-inch length

   b. 4-inch wood nails

   c. In-line strainer (ratchet tension device)

2.06 METAL ACCESS GATES

A. Gates shall be of the swing type, 10 feet wide, and fabricated from 18 gage galvanized steel.

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2.07 MISCELLANEOUS FENCE ITEMS

A. Post top, anchor plates, bar bands and other required fittings and hardware shall be steel, malleable iron or wrought iron and shall be galvanized.

B. Accessories, fittings, hardware and other miscellaneous Equipment shall be as shown on Plans.

2.08 REFLECTORS

A. Reflectors shall be 3” long pieces of vinyl siding trim which will be wrapped around the wires.

2.09 T-POST CLIPS

A. T-Post Clips shall conform to ASTM A 121 zinc-coated, Type Z, Class 3, or aluminum-coated, Type A, with 12.5 gauge wire.

PART 3 - EXECUTION

3.01 GENERAL

A. Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared a minimum of 2 feet prior to installation. Line posts shall be spaced equidistant at intervals not exceeding 10 feet. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment.

3.02 FENCE INSTALLATION

A. The wildlife friendly fence will consist of four wires, two barbed, and two smooth as shown on Plans and as indicated herein.

a. The top wire (smooth) will be located 40” above the ground

b. The second wire from the top (barbed) will be located 28” from the ground

c. The third wire from the top (barbed) will be located 22” from the ground

d. The bottom wire (smooth) will be located 18” from the ground

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3.03 CORNER POST INSTALLATION

A. Corner Posts shall consist of treated lumber posts which are 4 inches by 4 inches. Corner post holes shall be dug using a post hole digger and in a manner to ensure that all posts are level and squared. String shall be mounted on the corner post side (corner to corner) for a guide line for digging additional post holes.

B. Corner posts shall contain barbed wire "H-Braces" in order to insure a rigid design. The barbed wire shall be wrapped in a cross pattern three times, followed by the placement of a steel rod through the center to insure the wire does not unwind. Posts will extend four feet into the ground and four feet out of the ground.

3.04 T-POST INSTALLATION

A. T-post holes shall be dug using a T-post driver and set apart every 16.5 feet on center driven a minimum of 22 inches into the ground. T-Post clips shall be used to secure both smooth and barbed wires to T-posts.

3.05 REFLECTORS

A. Reflectors shall be hung from the top wire (four per section) and the third wire from the top (three per section) for visibility purposes.

3.06 ACCESS GATES

A. Access gates shall be installed per manufacturer instructions.

3.07 QUALITY ASSURANCE

A. Erection of fence shall have a maximum ¼-inch over 5 feet variation from plumb.

END OF SECTION

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SECTION 02930

HYDROSEEDING

PART 1 - GENERAL

1.01 SUMMARY

A. This Specification Section outlines the responsibilities of the Contractor that are scheduled to be performed for hydroseeding. The goal of this work is to establish native grasses and herbaceous plants that provide erosion control and wildlife habitat.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances, and services necessary for seeding and mulching of all designated areas and as necessary to complete the Project.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. AGRICULTURAL MARKETING SERVICE (AMS):AMS-01 (Amended through: Aug 1988) Federal Seed Act Regulations (Part 201-202)

2. COMMERCIAL ITEM DESCRIPTIONS (CID) CID A-A-1909 (Basic) Fertilizer

3. FEDERAL SPECIFICATIONS (FS) FS O-F-241 (Rev D) Fertilizers, Mixed, Commercial

1.03 QUALIFICATIONS

A. All work shall be done by an experienced Contractor familiar with native grass and herbaceous plant seeding and its horticulture, and industry methods and standards for seeding. The Contractor shall employ modern equipment and state of the art methods and techniques. The Contractor shall have a minimum of 3 years of applicable on the job experience with herbaceous native plant seeding and weed control.

1.04 SUBMITTALS

A. Schedules.

B. Equipment List. A list of proposed site preparation, seeding, and mulching equipment to be used in performance of seeding operation, including descriptive data and calibration tests.

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C. Delivery. Delivery schedules, at least 3 days prior to the intended date of the first delivery.

D. Maintenance and Establishment Period. Written calendar time period for the grass maintenance and establishment period. When there is more than one grass establishment period, the boundaries of the grass area covered for each period shall be described and mapped in the maintenance reports.

E. Certificates. Certificates of compliance certifying that materials meet the requirements specified, prior to the delivery of materials. Certified copies of the reports for the following materials shall be included:

F. Seed: For each species random samples from unopened and labeled containers: percent pure live seed, minimum percent germination, dormant and hard seed, maximum percent weed seed content, date tested and state certification. Certification of seeds by the Association of Official Seed Certifying Agencies (AOSCA) through the California Crop Improvement Association (CCIA) is encouraged.

G. Straw Mulch: Harvest date and location, species, and weed content.

1.05 INSPECTIONS

A. It is the Contractor's responsibility to notify the City Representative at least 5 days prior to each anticipated inspection. The City Representative/City may at any time inspect work without notification. The following are key inspection events:

1. Seed, Equipment & Application Inspection: Seeding work shall not be accepted without this inspection. Seed suppliers and collectors are subject to inspection of methods, materials, and processing. Contractor shall provide supplier and collector names and addresses upon award of contract. Seed shall be inspected upon arrival at the job site by the City Representative for conformity to species and quality. Upon Arrival at the Site the Contractor shall provide the Landscape Architect with receipts of the seed purchased and delivered to the site. Receipts shall provide name of company from which the seed was purchased, seed species, seed place of origin, composition, quantity, germination rate, and pure-live-seed (P.L.S.) percentage. Other material shall be inspected for meeting specified requirements. Unacceptable materials shall be removed from the job site and replaced by the Contractor. Immediately prior to commencement of seeding operations, the Contractor shall adjust and calibrate equipment as per manufacturer's specifications and field test in the presence of the City Representative. Seeding operation shall be inspected during equipment calibration, material loading and seed application.

2. Two-part Seeding Acceptance Inspection: Prior to the completion of the Seeding

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Period, a preliminary seeding inspection shall be held by the City Representative. Time for the inspection shall be requested in writing by the Contractor at least 5 working days prior to desired date. The quantity and type of species seeded, clean-up requirements and the acceptability of the seeding operation, in accordance with the requirements stated herein, shall be determined and noted in writing. A final inspection shall be requested in writing by the Contractor at least 5 working days prior to the desired date. At the final seeding inspection, the City Representative will evaluate the deficiencies noted in the preliminary seeding inspection, to ensure they have been corrected. Time for the inspection shall be established in writing. A "Seeding Acceptance" will be given after all seeding requirements have been satisfactorily completed and approved by the City. PARTIAL ACCEPTANCE OF ANY ITEM OR COMBINATION OF ITEMS WILL NOT BE GIVEN. A written acceptance by the City Representative of all project components, in addition to requirements specified in this section, shall constitute the beginning of the Establishment Period.

1.06 SHIPMENT, DELIVERY, STORAGE AND HANDLING

A. Shipment: Preparation for shipment shall be done in a manner that will not cause damage to seeds, and all other material.

B. Delivery: Seeds, fiber, mulch, and all other material shall be protected from weather and contamination during delivery.

C. Storage: Material shall be stored in areas approved by the City Representative. Seed shall be stored in cool, dry locations away from contaminants. Chemical and pesticide material shall not be stored with other landscape materials and shall be stored in a spillage-contained area. Mulch shall be kept covered from rain.

D. Handling: Except for bulk deliveries, material shall not be dropped or dumped from vehicles.

1.07 TIMES AND CONDITIONS

A. Seeding Conditions: Seeding and construction operations shall be performed only during periods when beneficial results can be obtained. When excessive moisture, winds or other unsatisfactory conditions prevail, the work shall be stopped when directed by the City Representative. The Contractor shall schedule planting in the mornings to avoid stressing plants during seeding, if the planting schedule calls for installation when the temperature is expected to be 90 degrees Fahrenheit/32 degrees Centigrade or greater. When special conditions warrant a variance to the planting operations, a proposed seeding time shall be submitted in writing to, and approved by, the City. The Contractor shall be prepared to seed at the earliest time when all conditions (weather, moisture, temperature, etc…) are

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acceptable.

PART 2 - PRODUCTS

2.01 SEED

A. Seed Classification: State-certified seed of the latest season's or previous seasons crop shall be provided in original sealed packages bearing the producer’s guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS-01 and applicable state seed laws. AOSCA / CCIA certifications for seeds are encouraged.

B. Seed Quality: Weed seed shall not exceed percentage by weight of the total of each species as indicated in Section Seed Collection. Wet, moldy, insect infested, or otherwise damaged seed shall be rejected and removed from project site. Open containers of seed or improperly tagged containers will be rejected and removed from project site.

C. Sampling: For all seeds or containers, it is the option of the City to take random samples for each species, and require the Contractor to provide analysis of samples at no extra cost to the City.

D. Seed Mixing: The mixing of seed shall be performed by the Contractor, in the presence of the City Representative, on site and as directed by the City Representative.

E. Substitutions: Substitutions will not be allowed without written request and approval from the City Representative.

2.02 SEED SPECIES AND SEEDING RATES

A. Native Grass and Herbaceous Plant Mix: Native herbaceous plant seed species and seeding rates shall be as indicated on Drawings.

2.03 FERTILIZER

A. Fertilizers will not be used.

2.04 PESTICIDES

A. Use of pesticides is not allowed.

2.05 MULCH

A. General: Mulch shall be free from noxious weeds and seeds, mold, and other deleterious materials.

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B. Straw: Straw shall be stalks from native grasses furnished in air-dry condition and with a consistency for placing with commercial mulch-blowing equipment. Substitutions shall be requested in writing and must be approved by City Representative. Rice straw is not allowed. Wheat or barley straw if used shall not be derived from dry farmed cereal crops.

C. Wood Cellulose Fiber: Wood cellulose fiber shall be commercially available and produced from virgin wood fiber. Fiber shall be of such character that fiber will disperse into a uniform slurry when mixed with water. The water content of the fiber before mixing into the slurry shall not exceed 15 percent of the dry weight of the fiber. The moisture content of the fiber shall be clearly marked on the package.

1. Ash Content: Fiber shall not contain more than 7 percent ash as determined by the Technical Association of the Pulp and Paper Industry (TAPPI) Standard T 413, and shall be nontoxic to plant or animal life.

2. Water-holding Capacity: Fiber shall have a water-holding capacity by weight of not less than 1,200 percent. Water-holding capacity of the fiber shall be marked on the package.

3. Coloring: Fiber shall be colored to contrast the area on which the fiber is to be applied. The material used for color shall be nontoxic to plant and animal life and Paper Fiber. Paper fiber mulch is not allowed.

2.06 TACKIFIER

A. Tackifier shall be non-toxic to plant and animal life, non-corrosive, and non-crystalline and be non-staining to concrete or painted surfaces. Tackifier shall be biodegradable.

2.07 WATER

A. Water shall be the responsibility of the Contractor, unless otherwise noted. Water shall not contain elements toxic to plant life.

PART 3 - EXECUTION

3.01 HYDROSEEDING

A. Hydroseeding: Seed species shall be mixed to ensure a seeding rate as specified below.

Scientific Name	Common Name	lbs/ acre
Nassella pulchra	Purple needlegrass	15
Koelaria macrantha	Junegrass	5
Bromus carinatus	California brome	10
Achillia millefolium	Yarrow	15
Eschscholzia californica	California poppy	15

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Sanicula bipinnatifida	Purple sanicle	15
Elymus glaucus	Blue wilderye	15
	Total lbs/acre:	**90 lbs/acre**

B. Wood cellulose fiber shall be added to the mixture after the water and other mixture components have been thoroughly mixed to produce a homogeneous slurry. The slurry shall have the proper consistency to adhere to the earth slopes without lumping or running. The time period for the seed to be held in the slurry shall be a maximum of 1 hour. Slurry shall be uniformly applied under pressure over the entire designated area. The hydroseeded area shall not be rolled. The Contractor shall employ the following four-step hydroseeding process:

1. Step 1: Apply the first step as a complete mixture as indicated below:

   (1) Virgin Wood Cellulose Fiber, at a rate of 500 lbs. per acre.

   (2) Seed Mix, as specified and at rate specified.

2. Step 2: Apply the second step as a complete mixture as indicated below:

   (1) Virgin wood cellulose fiber, at a rate of 500 lbs. per acre.

3. Step 3: Distribute straw with straw blower or by hand:

   (1) Native grass straw, at a rate of 4,000 lbs. per acre.

4. Step 4: Apply the fourth step as a complete mixture as indicated below:

   (1) Tackifier, at a rate of 120 lbs. per acre.

   (2) Virgin Wood Cellulose Fiber, at a rate of 500 lbs. per acre.

3.02 MULCH AND TACKIFIER

A. All seeded areas, where designated on the drawings, shall be mulched and tackified after seeding operations.

B. Applying Straw. Straw mulch shall be applied to all seeded areas upon completion and approval of the seeding application by the City Representative. Mulch shall be spread by hand, blower-type mulch spreader or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of a slope and continued uniformly until the area is covered. The mulch shall be applied loose and not be bunched.

C. All seeded areas shall be mulched within 24 hours of seeding.

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D. Applying Tackifier. All straw mulch areas shall be anchored with a commercially available organically dyed organic tackifier.

E. Crimping or Punching. As a substitute for tackifying, all straw areas shall be mechanically crimped or punched into soil.

F. Applying Fiber. Wood cellulose fiber shall be applied as part of the hydroseeding operation. The mulch shall be mixed and applied in accordance with the manufacturer's recommendations.

3.03 MAINTENANCE DURING SEEDING PERIOD

A. Maintenance shall begin immediately after seeding is completed and shall continue throughout the Seeding Period. Maintenance of the seeded areas shall include the following until Seeding Acceptance is given: regular observations of the sites, watering, hand removal of weeds, and repair of damaged areas.

B. Watering. The Contractor shall keep the soil at the seeded area constantly moist during the first three weeks after seeding.

C. Spraying for Weed Control after Seeding. The use of pesticides is not allowed.

D. Repair. All Contractor damaged areas shall be repaired by the Contractor to their original condition within 5 working days.

3.04 CLEANUP

A. Excess and waste material shall be removed from the seeded and staging areas and shall be disposed of off the site.

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SECTION 15132

SOLAR POWERED PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Specification Section outlines the responsibilities of the Contractor that are scheduled to be performed to install solar powered pumps.

B. The Contractor shall furnish and install eight (8) solar powered pump systems (SQFlex systems from Grundfos or approved equal) in accordance with manufacturer's recommendations and Drawings.

1.2 RELATED SECTIONS

Section 02200 - Excavation, Backfilling, and Compaction

Section 02800 – Site Furnishings

1.3 SUBMITTALS

A. Contractor shall submit shop drawings and product data for all items within this Section to be constructed or installed.

B. Contractor shall submit manufacturer's instructions and product data.

1.4 QUALITY ASSURANCE

A. The Contractor shall demonstrate experience with the installation of similar systems. Installer must have references from at least 2 separate installations comprising similar equipment. Reference contact information shall be provided to the City representative prior to initiation of work.

1.5 REFERENCE STANDARDS

Hydraulic Institute

ANSI – American National Standards Institute

ASTM – American Society for Testing and Materials

IEEE – Institute of Electrical and Electronics Engineers

NEMA – National Electrical Manufacturers Association

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NEC – National Electrical Code

ISO – International Standards Organization

UL – Underwriters Laboratories, Inc.

PART 2 - PRODUCTS

2.1 PUMPS AND MOTORS

A. The Contractor shall furnish eight (8) solar powered pumps. The pumps shall be of the helical rotor type as manufactured by Grundfos, 11SQF-2, or approved equivalent, with internal electric motors capable of working at varying voltages.

B. The pumps shall have the characteristics listed below. Any deviation from these characteristics shall require prior approval from the City Representative.

Pump body material	Stainless steel AISI 304
Impeller material	Stainless steel AISI 304
Rotor material	Stainless steel AISI 304
Stator material	Stainless steel AISI 304
Motor type	MSF3
Rated voltage AC	1 x 90-240 V
Rated voltage DC	30-300 V
Maximum head	395 ft
Maximum flow rate	13 gallons per minute
Start method	Direct-on-line
Rated speed	500-3600 RPM
Motor protection	Included
Thermal protection	Internal
Length of cable	10 ft for 6 pumps; 250 ft for 2 pumps

2.2 CONTROL PANEL

A. The Contractor shall furnish eight (8) control panels, Grundfos Model CU 200 or approved equivalent. The CU 200 control unit is a combined status, control and communication unit especially developed for the SQFlex system.

B. The control units shall have monitoring and alarm capabilities as indicated below.

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System Monitoring	Alarm Indicators
Water level in reservoir (level switch)	Pump running dry
Pump is on	Service needed
Input power	Over-temperature or overload

2.3 SOLAR PANELS

A. The Contractor shall furnish eight (8) sets of solar panels to provide power to the pumps described above. Solar modules shall be of the monocrystalline silicon type, such as the NU-U235F1 as manufactured by Sharp or approved equivalent.

B. The solar modules shall be equipped with plugs and sockets for easy connection of several modules in parallel. One row of 4 modules in series is anticipated to be required for each pump; Contractor shall be responsible for verifying the number of required modules to have the system operate in accordance with requirements stipulated herein.

C. The solar modules shall come equipped with full solar tracking capabilities along two axis.

2.4 ACCESSORIES

A. The Contractor shall furnish accessories necessary to install and make the solar pump system operational. These are anticipated to include, as a minimum:

Submersible drop cable

Cable termination kits

Cable clips

Straining wires

Wire clamps

Support structures

Row closure kits

Wire kit interpanels for solar array

Wire kit arrays to control box for solar array

Tower installation kits

Augers / anchors

Grease

Level switch

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PART 3 - EXECUTION

3.1 SYSTEM INSTALLATION

A. The Contractor shall install four sets of pumps, control panels, solar arrays, and appurtenant structures, in accordance with manufacturer's recommendations and Drawings. If Drawings are found to be in conflict with manufacturer's recommendations, Contractor shall notify the City Representative. The City Representative will issue a written resolution of the conflict advising Contractor how to proceed. Contractor shall proceed with the work in accordance with written instructions from the City Representative, which will be appended to contract documents.

3.2 SYSTEM TESTING

A. Pumps, control panels, and solar arrays shall be factory-tested by manufacturer as integrated systems. Contractor shall require a certificate of testing from manufacturer and submit it to the City Representative prior to system installation.

B. The Contractor shall conduct performance testing of the systems after installation, in the presence of the City Representative and the City. Tests shall measure the pumps' output (volume of water pumped) for several different heads. Contractor shall submit a test plan indicating test objectives, procedures, and instruments to be used. Testing shall proceed only after the test plan has been approved, in writing, by the City Representative.

C. The Contractor shall be responsible for troubleshooting the systems and for making any necessary modifications identified during performance testing. Each of the pumping systems shall be declared acceptable by the City Representative when they individually meet the performance requirements stipulated in the test plan.

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Appendix G: 30 Percent Design Plan Drawings and Design Memo for Goldfish Pond

30% DESIGN

DETAILED DESIGN REPORT HABITAT RESERVE PROGRAM GOLD FISH POND

Project No. 38802

Prepared for

San Francisco Public Utilities Commission
1155 Market St., 3rd Floor
San Francisco, CA 94103

March 19, 2010

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26817595.EA3144

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List of Abbreviated Terms

ac	Acre
ASTM	American Society For Testing And Materials
avg.	Average
CDEC	California Data Exchange Center
CRLF	California Red Legged Frog
CLS	California Tiger Salamander
cm.	Centimeter
DEM	Digital Elevation Models
DSOD	Division Of Safety Of Dams
DWR	Department Of Water Resources
EL	Elevation
Eq.	Equation
ESA	Environmental Site Assessment
ft	Feet
GIS	Geographic Information System
HRP	Habitat Reserve Program
hr.	Hour
ID	Inside Diameter
IATF	Interagency Permitting Task Force
in.	Inch
K_{sat}	Saturated Hydraulic Conductivity
LiDAR	Light Detection And Ranging
mm.	Millimeter
MMP	Mitigation And Monitoring Plan
NAVD88	North American Vertical Datum Of 1988
NRCS	National Resource Conservation Society
ppm	Parts Per Million
PVC	Polyvinyl Chloride
RSP	Rose Peak Station
SFPUC	San Francisco Public Utilities Commission
GPS	Global Positioning System

SCVWD	Santa Clara Valley Water District
USCS	Unified Soil Classification System
USACE	United States Army Corps Of Engineers
USGS	United States Geological Survey

Chapter 1. Introduction

1.1 BACKGROUND

San Francisco Public Utilities Commission (SFPUC) has established a Habitat Reserve Program (HRP) for the purpose of providing habitat and compensation for impacts to biological resources resulting from SFPUC construction projects. These projects include the Calaveras Dam Replacement Project, Alameda Siphons, San Antonio Back-up Pipe Line, New Irvington Tunnel, and Sunol Valley Water Treatment Plant. The HRP includes a variety of preservation, restoration, enhancement, and creation actions that would be implemented on a number of SFPUC owned sites. The HRP was developed to:

- Provide economy of scale for coordinating and compensating for lost ecological functions and values
- Allow for multiple species and habitats to be supported in a given location
- Provides greater long-term conservation values across regions
- Support and coordinate existing efforts within regions

The primary objective of the program is to compensate for impacts from SFPUC projects by increasing ecological value of habitats for species while efficiently using allocated funds.

1.1.1 Project Location

The 3.2-acre Goldfish Pond site, hereafter referred to as the project site, is located within the South Calaveras Mitigation Area, a 641-acre area south of Calaveras Reservoir (see Figure 1.1). This larger mitigation area is entirely within the Calaveras Creek watershed and located approximately 3 miles from the dam construction area. The eastern boundary of the area lies approximately 1,000 feet east of the intersection of Calaveras and Felter Roads. The boundary follows these two roads for a short distance, and then Marsh Road becomes the southern boundary. Unnamed ranch roads outline the northern boundary. Marsh Road turns north, bisecting the mitigation area. The western boundary is east of North and South Ponds, approximately 0.5 miles west of Marsh Road.

1.1.2 Site Background

The project site currently consists of a pond that supports approximately 0.06 acres of seasonal wetland with an earthen embankment on its northern end. An eroded unlined spillway exists to the west of the embankment. A riparian corridor exists downstream of the toe of the embankment. The pond is very sparsely vegetated with hydrophytic vegetation, including spikerush, rushes (*Juncus spp.*), and broadleaf cattail (*Typha latifolia*) species, along the water's edge, and with ruderal and annual grassland vegetation along the constructed berm. The pond was primarily constructed to collect and impound seasonal drainage for livestock use, and is currently known to support non-native bull frogs and fish. No special status plants or animal species are currently known to occur at the project site.

1.1.3 Mitigation Requirements

The mitigation requirements for the project site are as follows:

- Seasonal Wetland (Establish) – 3.6 acres
- Perennial Wetland (Establish) – 0.46 acres
- Native Grassland (Establish) – 3.92 acres
- Willow Riparian (Establish) – 1.22 acres

In addition, mitigation credits are sought for establishing habitat to support federally listed threatened California Tiger Salamander (CTS) and California Red-legged Frog (CRLF).

1.2 PROJECT SCOPE

The current project scope is to prepare a 30% Plan, Specifications and Cost Estimate (PS&E) package and a detailed design memorandum to meet the mitigation requirements listed in Section 1.1.3 based on the Draft Mitigation and Monitoring Plan (MMP) and associated Inter-Agency Task Force (IATF) comments. In order to accomplish this, the proposed project design includes the following work items:

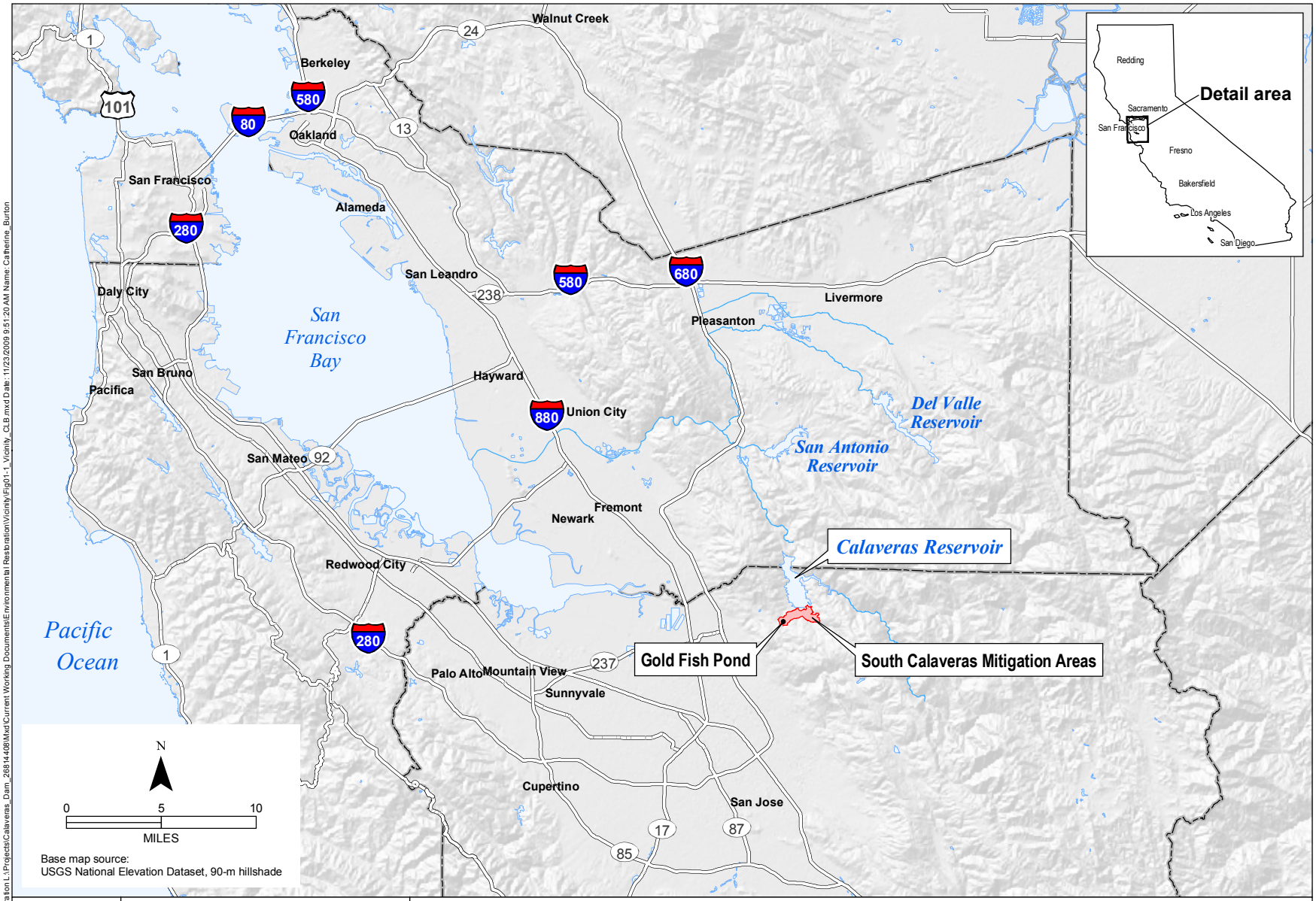
- Hydrologic and hydraulic analyses to analyze:
  - Pond water balance to support seasonal and perennial wetland establishment in accordance with the required mitigation acreage(s)
  - Pond routing to support design of pond outlet structure
- Geotechnical analysis to support design of the earthen pond embankment.
- Pond earthwork analysis to:
  - Reduce pond storage below 10 acre-feet, and
  - Support required wetland mitigation acreage(s)
- Grazing management with temporary and permanent fencing.
- Planting plan.

1.3 ORGANIZATION OF DESIGN REPORT

This document is organized as follows:

- Chapter 1 provides background information on the purpose of the project.
- Chapter 2 describes the water balance calculations, which examine the wetland design criteria, and the hydrologic/hydraulic modeling that supports the sizing of the pond outlet structure to accommodate a 100-year, 24-hour design peak discharge.
- Chapter 3 describes the geotechnical analysis that evaluates seepage through and stability of the proposed embankment.
- Chapter 4 summarizes the required pond earthwork activities and the details of the outlet structure design.

- Chapter 5 describes the design of fencing and gates to manage livestock use of the pond and planting areas.
- Chapter 6 summarizes the planting and habitat establishment in the planting zones and the disturbed areas.
- Chapter 7 provides the references cited in this document.



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San Francisco Public Utilities Commission
Habitat Reserve Program

Figure 1.1
Vicinity Map

Chapter 2. Hydrologic & Hydraulic Analyses

2.1. PURPOSE

Pond water balance and hydrologic pond routing analyses were performed to support the proposed project site design. The objectives of these analyses are to:

- Determine the suitability of the site to meet wetland mitigation acreage requirements by completing a pond water balance analysis.
- Develop an outlet structure design to pass 100-year 24 hours peak design discharge with at least 1 foot of free board, using standard hydrologic and pond routing calculations.

2.2. EXISTING CONDITIONS

The existing pond has a maximum depth of 12 feet, a total seasonal wetland area of approximately 0.06 acres, and an approximate watershed area of 143 acres. The pond consists of a 15-foot high embankment on the northern end of the pond with a crest elevation of 1042 feet[1] and a crest width varying from 7 to 10 feet. An unlined spillway is located at the left end of the embankment and had a crest at elevation of 1040 feet, approximately 13 feet above the pond bottom. Flows discharging through the existing spillway have been eroding the downstream slope of the embankment. The stage-storage relationship for the existing pond is provided in Table 2.1. The stage storage relationship was developed based on the existing topography and bathymetry field survey data provided by the SFPUC.

Table 2-1. Stage-Storage Relationship for Goldfish Pond

Elevation (ft)	Cumulative Area (ft2)	Average Area (ac)	Volume (ac-ft)
1027	634.60	0.01	0.00
1028	2,514.81	0.04	0.04
1029	5,346.90	0.09	0.13
1030	9,984.03	0.18	0.30
1031	16,821.00	0.31	0.61
1032	27,276.41	0.51	1.12
1033	38,046.92	0.75	1.87
1034	50,111.33	1.01	2.88
1035	65,190.68	1.32	4.20
1036	82,869.15	1.70	5.90
1037	101,522.81	2.12	8.02
1038	120,134.67	2.54	10.56
1039	139,504.72	2.98	13.54

[1] All elevations in this report are in NAVD88, feet.

2.3. WATER BALANCE ANALYSIS

The pond water balance analyses summarized in this section were performed to determine the suitability of the site for establishment of 3.63 acres of additional seasonal wetland while satisfying the following design criteria.

- Stock Pond Designation Criteria: Proposed pond volume shall be less than 10 acre-feet to meet agency stock pond designation restrictions.
- Seasonal Wetland Criteria and Diversion Limits: Pond shall meet the U.S. Army Corps of Engineers (USACE) wetland criteria of being inundated or saturated to the surface continuously at least 5% of the growing season in most years (50% probability of recurrence). This criterion is to be met while allowing no retention of flows during the non-diversion period.
- Minimum Bypass Flow: Pond shall maintain a minimum by-pass flow (median February flow) during the diversion period to support the riparian habitat downstream of the embankment.
- CTS, CRLF Criteria: Pond shall maintain a minimum ponding depth during the metamorphosis life stage of California Tiger Salamanders (CTS) and California Red Legged Frogs (CRLF).

2.3.1. Analyses Criteria

2.3.1.1. Stock Pond Designation Criteria

A water rights investigation identified that the existing impoundment capacity of 13.54 ac-feet (See Table 2.1) does not meet the criteria of a stock pond. Per California Water Code Section 1226.1, a water impoundment structure constructed for livestock water use is considered a stock pond only if the capacity of the impoundment structure is less than 10 acre-feet. Therefore the proposed design will reduce the pond volume to below 10 acre-feet.

2.3.1.2. Seasonal Wetland criteria and Diversion Limits Criteria

One of the purposes of the water balance calculation is to evaluate the ability of the wetland to be sufficiently wet to meet the USACE Wetlands hydrology standard of being inundated or saturated to the surface continuously at least 5% of the growing season in most years (50% probability of recurrence).

A WETS table maintained by NRCS can be used to determine the start and end dates of the growing season. The closest station to the project site that has WETS table data is Station Mount Hamilton (Station ID# CA5933) in Santa Clara County, maintained by NRCS. Table 2.2 shows the growing season lengths for the Mount Hamilton station that can be applied to the project site.

Table 2-2. Growing Season Lengths from WETS at Station Mount Hamilton

Probability	Temperature		
	24 F or higher	28 F or higher	32F or higher
50 percent	>365 days	4/11 to 12/5*	5/6 to 11/13*
	>365 days	238 days	191 days

*Beginning to end date in a year

Based on the information presented in Table 2.2, the required number of wet days within the proposed wetland area to meet the USACE criteria is 19 days over an entire year.

The IATF requested that runoff from the watershed outside of the allowable diversion period be allowed to flow directly downstream of the embankment without retention. According to the draft guidelines put forth by CDFG and NMFS for maintaining an in-stream flow to protect fisheries downstream of water diversions, the allowable diversion period starts December 15 and ends on March 31 of each year (CDFG/NMFS). Therefore, the USACE wetland criteria above must be met taking this requirement into consideration.

2.3.1.3. Minimum By-Pass Flow Criteria

In addition to the diversion criteria, IATF required that a minimum by-pass flow be maintained downstream of the embankment during the allowable diversion period to support riparian habitat. As indicated earlier, the allowable diversion period starts December 15 and ends on March 31 of each year. The minimum by-pass flow for the pond water balance purposes is defined as "the flow that is not less than the estimated unimpaired February median flow at the point of diversion" (CDFG /NMFS, 2002).

2.3.1.4. CTS, CRLF Citeria

The proposed pond shall maintain a minimum ponding depth during the metamorphosis life stage (through August) of CTS and CRLF.

2.3.2. Water Balance Method

In order to meet the criteria summarized above, water balance calculations were performed using Equation 2 below.

$\Delta S_1 = P + R - I - Et - E_b$* (Eq. 1)

Where,

Units are in feet

ΔS = change in water depth within the ponds

P = direct precipitation on the ponds

R = watershed runoff

I = infiltration

Et = evaporation

E_b = minimum by-pass flow

* By-pass flow only from December 15 through March 31

When the change in water depth exceeds the maximum storage capacity of the pond, all the runoff is assumed to bypass the wetland and discharge downstream.

2.3.3. Input Data

2.3.3.1. Precipitation

The precipitation data for the project area was obtained from the California Department of Water Resources CDEC database for the Rose Peak (RSP) station (http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=RSP). The data are collected by the California Department of Forestry. The station is located approximately 6 miles south-southeast of the project area at an elevation of approximately 3060 feet. The project site is located at an elevation range of approximately 1027 to 1045 feet. This station was chosen as it was the closest station to the project site whose database contained hourly precipitation records for a relatively long period of record. Hourly precipitation data over an 11 year period (i.e. from Year 1998 to Year 2008) was used for the pond water balance calculations. Figure 2.1 provides a summary of the yearly rainfall total for period of record used in the analysis. Table 2.3 provides a summary by month.

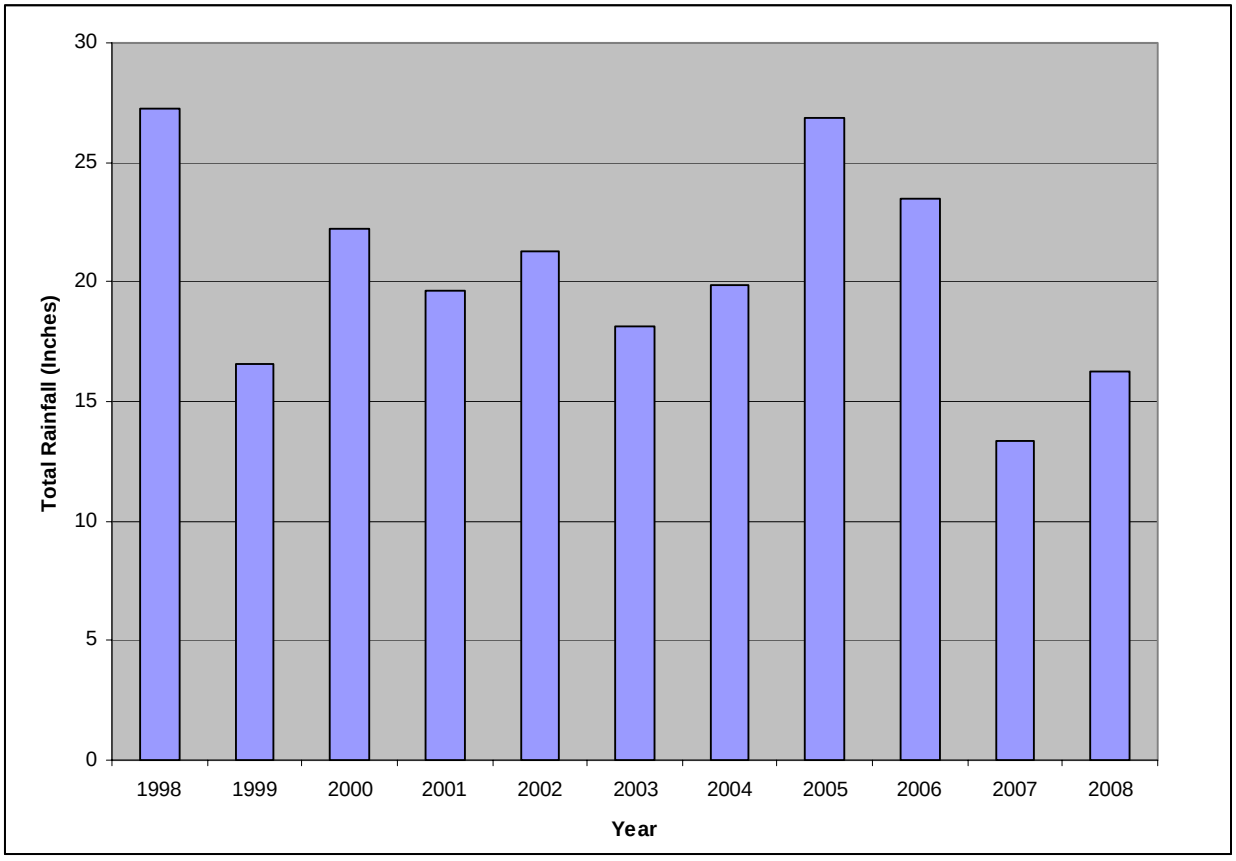


Figure 2.1. Annual Observed Precipitation (Rose Peak Station)

Table 2.3. Summary of Monthly Precipitation and Pan Evaporation Data

	Jan	Feb	March	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Monthly Average Rainfall (in/mo)	0.117	0.143	0.086	0.055	0.032	0.006	0.00	0.001	0.004	0.03	0.07	0.116
Pan Evaporation (in/mo)	1.01	1.42	1.95	3.50	5.04	6.65	7.69	6.58	4.72	3.24	2.39	0.98

In order to accommodate complete pond bypass outside of the allowable diversion period, the precipitation data in Table 2.3 was adjusted by setting the station records outside of the allowable diversion period (i.e. April 1 through December 14 of each year) to zero. Hence, the precipitation input data used for the pond water balance calculation is summarized in Table 2.4.

Table 2.4. Monthly Precipitation Input Data for Water Balance

	Jan	Feb	March	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Monthly Average Rainfall (in/mo)	0.117	0.143	0.086	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.134

2.3.3.2. Runoff

Total volume of surface runoff from the surrounding watersheds was calculated using the formula:

$R = C*P*A$ (Eq. 2)

Where,

R = runoff volume (ft^3)

C = fraction of rainfall that is converted to runoff/or eventually enters pond (unitless)

P = precipitation (feet)

A = watershed area (ft^2)

The coefficient, C, used in Equation 2 is different than the value used in the familiar rational formula which relates rainfall intensity to peak runoff rate. The coefficient actually represents the volume fraction of rainfall that enters the wetlands. This could be through direct runoff or seepage from saturated soils. There is no standard value for this coefficient as there is for the runoff coefficient used in the rational formula. A value of 0.3 was chosen based on the project watershed topography, soil type and cover. This volume of runoff was then converted to pond runoff depth using the following method.

Runoff Depth = Runoff Volume/Area of the Pond corresponding to the existing water depth in the pond

The watershed area for the project site was delineated from topographic maps obtained from 2006 LiDAR survey data obtained from Santa Clara County and field surveys conducted by SFPUC in March 2009. The project site watershed area of approximately 143 acres is shown on Figure 2.2.

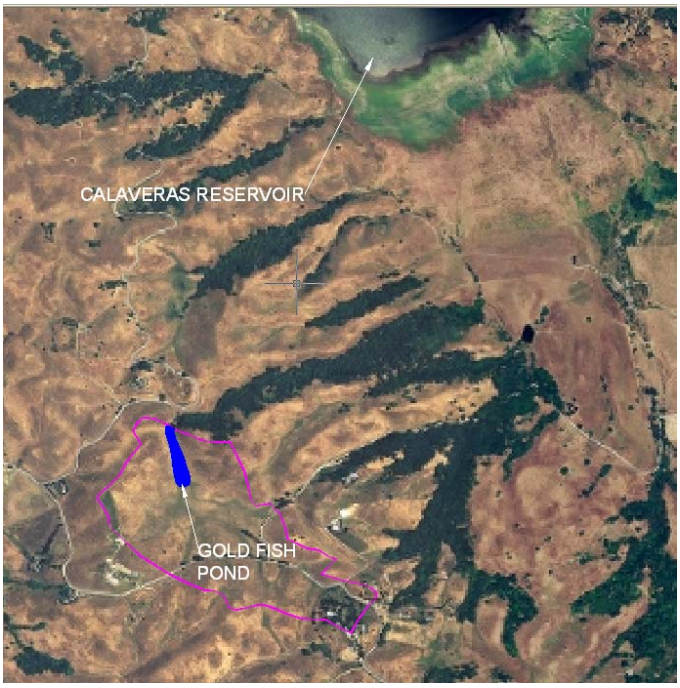


Figure 2.2. Project Site Watershed

2.3.3.3. Infiltration

Soil type logs recorded from soil test pits (approximately 5 feet deep) at the project site indicate that the pond bottom consists of silty clay to sandy clay loam material with varying amounts of clay (9 to 40% clay). The soil types recorded from the soil test pits are shown in Table 2.5.

Table 2.5. Soil Type Log from Soil Test Pits at Goldfish Pond

Goldfish Pond STP1				Goldfish Pond STP2			
Depth (in)	**% Rock Fragments**	**% Clay**	**Texture Class**	**Depth (cm)**	**% Rock Fragments**	**% Clay**	**Texture Class**
0-10	<1	30	Silty Clay Loam	0-20	<1	20	Loam
10-20	<1	40	Silty Clay	20-72	3	32	Sandy Clay Loam
20-38	2	10	Loamy Sand	72-106	3	32	Sandy Clay Loam
38-54	<1	9	Sandy Loam	106-150+	5	48	Sandy Clay
54-59+	<1	30	Sandy Clay Loam				

The infiltration rates of these soil types are considered high for use as a liner material for limiting infiltration. In order to provide for limited infiltration at the proposed pond bottom, it is recommended that the pond bottom be lined with a more impermeable clayey soil with infiltration rates that range from $1x10^{-5}$ cm/sec to $1x10^{-06}$ cm/sec. For the purpose of the pond water balance analysis, an average infiltration rate of $5.5x10^{-06}$ cm/sec (0.0156 ft/day) was assumed. Additionally, a preliminary pond water balance analysis in the HRP Phase 1 Status Report (URS, 2009) indicated that an infiltration of 0.0156 ft/day or lower is required to meet all the design criteria described in Section 2.3.

2.3.3.4. Pan Evaporation

Monthly average pan evaporation values were obtained from Evaporation from Water Surfaces in California (DWR, 1979). The closest pan evaporation data station Calaveras Reservoir (Station ID: E-30- Floating Pan) was chosen to obtain the evaporation rates. A pan correction factor of 0.80 was used to represent the evaporation from the surface of a water body. The values are shown in Table 2.3.

2.3.4. Results & Discussion

Results are summarized for each criteria in the following sections.

2.3.4.1. Stock Pond Designation Criteria

The existing pond will be expanded to create an additional 3.63 acres of seasonal wetland acreage on its southern end (Figure 4.1). To improve long term stability of the pond and embankment, the existing embankment will be reconstructed with a new crest elevation of 1042 feet. The storage capacity of the pond will be reduced to less than 10 acre-feet at the primary outlet structure elevation (1040 feet) to meet the stock pond designation criteria. This will be accomplished primarily by filling in the deeper portions of the existing pond. The majority of the proposed pond bottom will be at elevation 1037 feet in the vicinity of the proposed embankment. A relatively small deeper portion will be created upstream of the embankment to accommodate deeper ponding required for CTS and CRLF breeding. The bottom elevation of this deeper portion will be set at 1035 feet. The stage-storage relationship of the proposed pond is provided in Table 2.6. This stage-storage relationship was developed based on the proposed topography and bathymetry summarized in Chapter 4.

Table 2.6. Stage-Storage Relationship of Proposed Goldfish Pond

Elevation (ft)	Cumulative Area (ft^2)	Avg Area (ac)	Volume (ac-ft)
1035	2,330	0.01	0.00
1036	4,610	0.04	0.08
1037	20,000	0.09	0.36
1038	120,150	0.18	1.97
1039	134,100	0.31	4.89
1040	283,680	0.51	9.68

The proposed 3.63-acre expanded wetland has an average depth of 1 foot with bottom elevations ranging from 1039 to 1040 feet at its southern end. The deeper pool discussed above will be about 5 feet deep when the pond is at its normal maximum water surface elevation.

2.3.4.2. Seasonal Wetland Criteria and Diversion Limits

Based on the water balance results, the number of days each year that the proposed seasonal wetland will have water at or above elevation 1039 feet is shown in Table 2.7. The results show that the proposed 3.63 acres of seasonal wetland on an average will remain wet 36 percent of the total days in the growing season, sufficiently meeting the USACE standards for wetland hydrology even when the runoff from the watershed is not retained in the pond from April 1 through December 14 of each year and a minimum by-pass flow is maintained for downstream habitat during the diversion period. Figure 2.3 shows the depth of water in the pond for a period of 11 years (1998-2008).

Table 2.7. Seasonal Wetland Criteria Results Summary

Month	Average No. of Days Each Year with Ponded Water in Seasonal Wetland	% Days with Water in the Proposed Seasonal Wetland
January	29	92.4%
February	28	100%
March	31	100%
April	28	94%
May	6	20%
June	0	0.0%
July	0	0.0%
August	0	0.0%
September	0	0.0%
October	0	0.0%
November	0	0.0%
December	10	33%
Total	133	36%

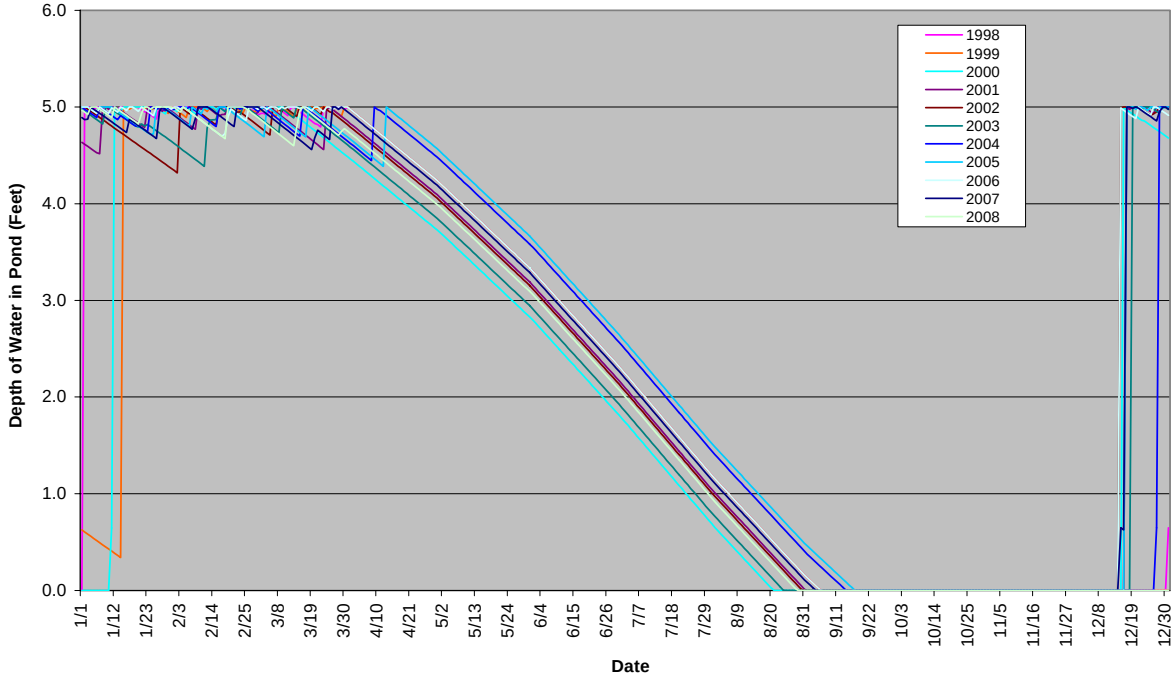


Figure 2.3. Proposed Pond Depth over Period of Record (1998-2008)

2.3.4.3. Minimum Bypass Flow Criteria

The precipitation data used for the pond water balance calculation is described in Section 2.3.3. An average of precipitation data for the month of February was used to determine the minimum bypass flow to be maintained during the allowable diversion period. The average value of February by-pass flow was calculated to be 0.26 cfs. The by-pass flow criterion was accommodated in the water balance calculation (see Section 2.3.2).

2.3.4.4. CTS, CRLF Citeria

In order to meet the CTS, CRLF requirement, the pond should retain some ponded water through August of each year. The water balance results indicate that the pond will typically dry up between late August and late September (Figure 2.3). Thus, the CTS, CRLF criteria would be met.

2.3.5. Conclusion

In summary, all of the design criteria are met for the proposed pond design, given the 0.0156 ft/day assumed infiltration rate for the pond bottom and the historical precipitation data set used for the analysis. It was identified in the water balance analysis that the infiltration rate through the pond bottom significantly affects the success of meeting the criteria. Hence, it is critical that the pond bottom be constructed of material that will result in infiltration rates of 0.0156 ft/day or less.

2.4. OUTLET STRUCTURE SIZING

Hydrologic and hydraulic modeling of the proposed pond was performed using the USACE Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) Version 3.4 (HEC, 2009). The model was used to size the pond outlet so that it would be able to accommodate the runoff from a 100-year, 24-hour rainfall event while maintaining a minimum one foot of freeboard. The freeboard is defined as the distance between the peak water surface elevation in the pond and the embankment crest elevation.

The main inputs into the HEC-HMS model included the following:

- Watershed characteristics and runoff parameters
- Precipitation data
- Proposed pond geometry
- Proposed pond outlet structure characteristics

The input parameters are described in the following sections.

2.4.1. Method

The Soil Conservation Service (SCS, now the Natural Resources Conservation Service) curve number method was used to calculate the direct runoff (and losses) in the HEC-HMS model.

The curve number method calculates runoff based on a curve number, which is estimated from soil type and land cover. A curve number is analogous to a runoff coefficient but varies from zero to 100. A low number indicates low runoff potential and a high number indicates a large runoff potential. NRCS has published tables for selecting a curve number based on land cover and condition and soil hydrologic group (A, B, C, or D), where soil group A has high permeability and soil group D has low permeability. The method is empirical and is primarily based on undeveloped watersheds. The land cover in the study area was determined from the National Land Cover Database (USGS, 2003), which is in GIS format.

2.4.2. Input Data

2.4.2.1. Watershed Characteristics

The NRCS Soil Survey for Santa Clara County (USDA/NRCS 2007) was used to determine the soil hydrologic group for the soils within the pond watershed. Soils in the watershed are generally clayey to gravelly loam with soil hydrologic groups of C or D.

The majority of the watershed is grassland with a small portion covered by forest and roads, or other low density residential use. Therefore, three cover types were selected for use in this study, based on categories provided in the Santa Clara County Drainage Manual (Santa Clara County, 2007): Evergreen forest in good hydrologic condition, grassland in good hydrologic condition, and low density residential (25% impervious) in fair hydrologic condition. Curve number data from the Santa Clara County Drainage Manual are presented in Table 2.8. Curve numbers for each land use were provided for antecedent moisture condition 2 (AMC2), which corresponds to average conditions. However, the Santa Clara County Drainage Manual specifies that for design storms having a return period between 10 years and 100 years, AMC2.5 should be used. The

corresponding curve numbers for these wetter antecedent conditions were obtained from the Santa Clara County Drainage Manual and are also provided in Table 2.8. This resulted in curve numbers ranging from 71 to 83. The area-weighted average curve number that accounted for the different soil types, ground cover, and wetter antecedent conditions, was 78.2. The SCS curve number method in HEC-HMS also requires the percentage of the basin that is covered with impervious area. Based on the National Land Cover Database layer, and assuming that the area associated with roads and other low density residential uses is 25% impervious, the impervious area for the entire basin was determined to be 2.8% of the total watershed area of 143 acres (0.22 square mile).

Table 2.8. Watershed Curve Number Summary

Land Use Type	Hydrologic condition	AMC2		AMC2.5	
		Hydrologic Soil Group		Hydrologic Soil Group	
		C	D	C	D
Evergreen forest	good	62	70	71	78
Grassland	good	69	76	77	83
Low density residential (25% impervious)	fair	71	74	79	81

The HEC-HMS model calculates runoff hydrographs from sub-areas using the unit hydrograph methodology. The parameter needed as input to HEC-HMS to calculate the SCS unit hydrograph is the drainage basin lag time. The lag time is defined as the time difference between the occurrence of the center of mass of excess rainfall and the peak of the unit hydrograph. The basin lag time was calculated using HEC-GeoHMS, which applies the curve number lag method. This method uses the following equation, which is described in the NRCS National Engineering Handbook that was originally published in 1972 (USDA/NRCS, 1997):

$$t_{lag} = \frac{L^{0.8}(S+1)^{0.7}}{1900Y^{0.5}} \qquad \text{(Eq. 3)}$$

Where:

t_{lag} = basin lag time (hours)

L = hydraulic length of watershed (feet)

S = $\frac{1000}{CN} - 10$, where CN is the curve number

Y = basin slope (%)

The average basin slope was calculated using HEC-GeoHMS with a digital elevation grid from the National Elevation Dataset. Based on the catchment for the longest flow path, the average basin slope was 17.7% and the hydraulic length was 4,700 feet. This resulted in a basin lag time of 0.277 hours, or 16.6 minutes.

2.4.2.2. Precipitation

The 100-year, 24-hour rainfall event was used as the design storm. The procedures in the Santa Clara County Drainage Manual were followed to develop the 24-hour rainfall hyetograph. The rainfall hyetograph used as input to the HEC-HMS model is shown in Figure 2.4 with the rainfall shown in 5-minute increments. The total depth of rainfall over the 24 hours was estimated to be 5.68 inches.

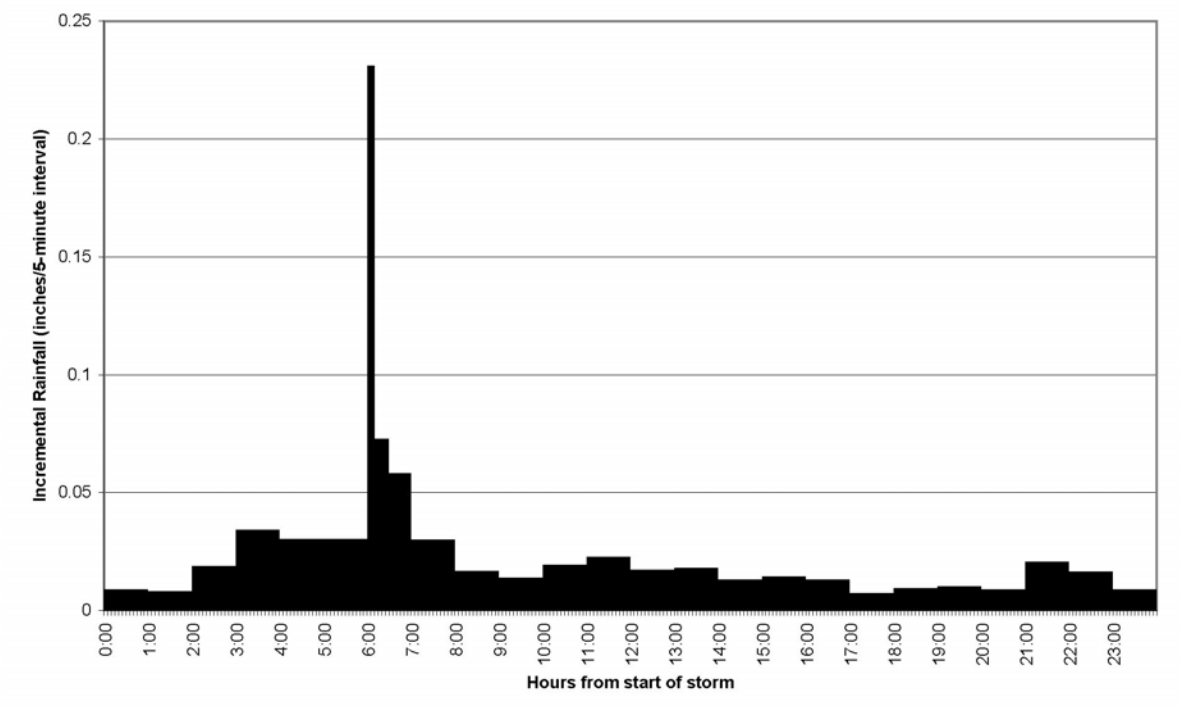


Figure 2.4. Hyetograph for 100-Year, 24-Hour Rainfall Event

2.4.2.3. Pond Geometry

The proposed pond geometry was input to the HEC-HMS model by using an elevation-area curve. The relationship was defined using the elevation and cumulative area shown in Table 2.6.

2.4.2.4. Discharge Curve

In order to confirm that the proposed standpipe would be large enough to result in approximately one foot of freeboard during the design storm event, the discharge through the structure was calculated for water surface elevations between 1040 and 1042 feet so that the elevation-discharge curve could be used as input to the HEC-HMS model. The proposed standpipe was assumed to be 5 feet tall with a 5-foot diameter. The crest of the outlet structure was assumed to be located at an elevation of 1040 feet. The outflow was calculated based on hydraulics for drop inlet spillways described in *Design of Small Dams* (USBR, 1987). The discharge is governed by the weir equation, with the length equivalent to the circumference of the standpipe, as specified in the following equation:

$$Q = C_d(2\pi R)H^{1.5} \quad \text{(Eq. 4)}$$

Where

Q = discharge (cubic feet per second)
C_d = discharge coefficient obtained from Figure 9-57 of *Design of Small Dams* (USBR, 1987) based on the ratio of H/R
R = radius of standpipe (feet)
H = Distance between the water surface elevation and the standpipe crest elevation (feet)

The relationship between the pond water surface elevation and the discharge through the standpipe is shown in Table 2.9.

Table 2.9. Elevation-Discharge Curve for Proposed Standpipe Outlet

Elevation (ft)	Discharge (cfs)
1040	0.0
1040.1	2.0
1040.2	5.6
1040.3	10.3
1040.4	15.7
1040.5	21.5
1040.6	28.0
1040.7	34.7
1040.8	41.7
1040.9	49.0
1041	56.1
1041.1	63.1
1041.2	70.2
1041.3	77.1
1041.4	83.5
1041.5	89.5
1041.6	94.4
1041.7	98.5
1041.8	102.8
1041.9	106.5
1042	109.7

For design purposes, it was conservatively assumed that the pond would be full (at an elevation of 1040 feet) at the beginning of the storm.

2.4.3. Results & Discussion

Based on the inputs to the HEC-HMS model described above, it was determined that the proposed design for the standpipe would allow for approximately 1 foot of freeboard during the 100-year design storm event. The results are summarized in Table 2.10. With the 5-foot diameter standpipe with a crest at 1040 feet, the pond reached a peak water surface elevation of 1040.9 feet, which is more than 1 foot below the dam crest elevation of 1042 feet.

Table 2.10. Results from HEC-HMS Model

Design Storm Event	Peak Inflow (cfs)	Peak Outflow (cfs)	Total Inflow (ac-ft)	Total Outflow (ac-ft)	Peak Elevation (ft)
100-year, 24-hour	112.9	51	40.3	40.3	1040.9

2.5. OUTLET PIPE AND ENERGY DISSIPATOR SIZING

Stormwater flows received by the 60-inch diameter standpipe outlet structure will pass into an outlet pipe that discharges to a riprap-lined energy dissipator to reduce erosion downstream of the embankment. The sizing of the outlet pipe and energy dissipator are based on Manning's Equation and USACE design guidelines, as discussed in Section 4.4.

Chapter 3. Geotechnical Analysis

3.1. PURPOSE

Seepage and slope stability analyses were performed for the proposed Goldfish pond embankment improvements. The objectives for this analysis are:

- Estimate hydraulic gradients, especially localized exit gradients around the embankment toe area for the design water level, and
- Evaluate the waterside and downstream side slope stability of the embankment.

3.2. EXISTING GEOTECHNICAL DATA

The subsurface conditions and material properties for the engineering analysis were developed based on the results from geotechnical investigations conducted by URS at the project site in February 2009 as part of the Phase 1 site assessment. A total of 5 borings (2 geotechnical + 3 piezometric) were drilled at the project site. Representative samples from the borings were tested for index and shear strength properties. The boring logs and laboratory results from this geotechnical investigation are presented in Appendix A.

3.3. EXISTING EMBANKMENT

The existing embankment has a 2H:1V slope on the downstream side, an embankment height of 21 feet and a crest length of about 100 feet. The upstream slope has been modified due to erosion from wave action just below the crest resulting in an overall slope of about 3H:1V. The embankment crest elevation is about 1,042 feet.

Based on the borings, the embankment fill consists of medium stiff to stiff silty clay to clayey silt with gravel. A few fragments of sandstone were also encountered in the borings. The fill is underlain by 4 to 6 feet of alluvium consists of soft silty clay with sand. The alluvium is underlain by highly weathered, highly to intensely fractured, very weak sandstone to the maximum depth of exploration of 6 feet below the ground surface. Groundwater was encountered at a depth of approximately 19 feet below the ground surface at the time of drilling. The groundwater level is expected to fluctuate seasonally.

A preliminary conditional assessment of the existing embankment was previously performed and the results are presented in the HRP Phase 1 Status Report (URS, 2009). The key findings from the assessment are:

- The embankment is in relatively poor quality mainly due to lack of a proper spillway structure. Overflow currently passes over the spillway crest and has eroded gully into the embankment fill on the downstream slope, thus reducing the stability of the embankment.
- Wave erosion on the upstream of the embankment has created a scarp on the upstream slope just below the embankment crest.
- The embankment fill appears to have low strength based on the number of blow counts measured during drilling.

3.4. PROPOSED IMPROVEMENTS

Based on the results from the preliminary condition assessment presented in the HRP Phase 1 Status Report (URS, 2009), improvement measures were developed to address the stability of the embankment. The proposed improvements include replacing the majority of the existing embankment fill with engineered fill and flattening the downstream slope to 4H:1V. The upstream face will be at a uniform slope of 3H:1V. The proposed improvements are shown on Figure 3.1.

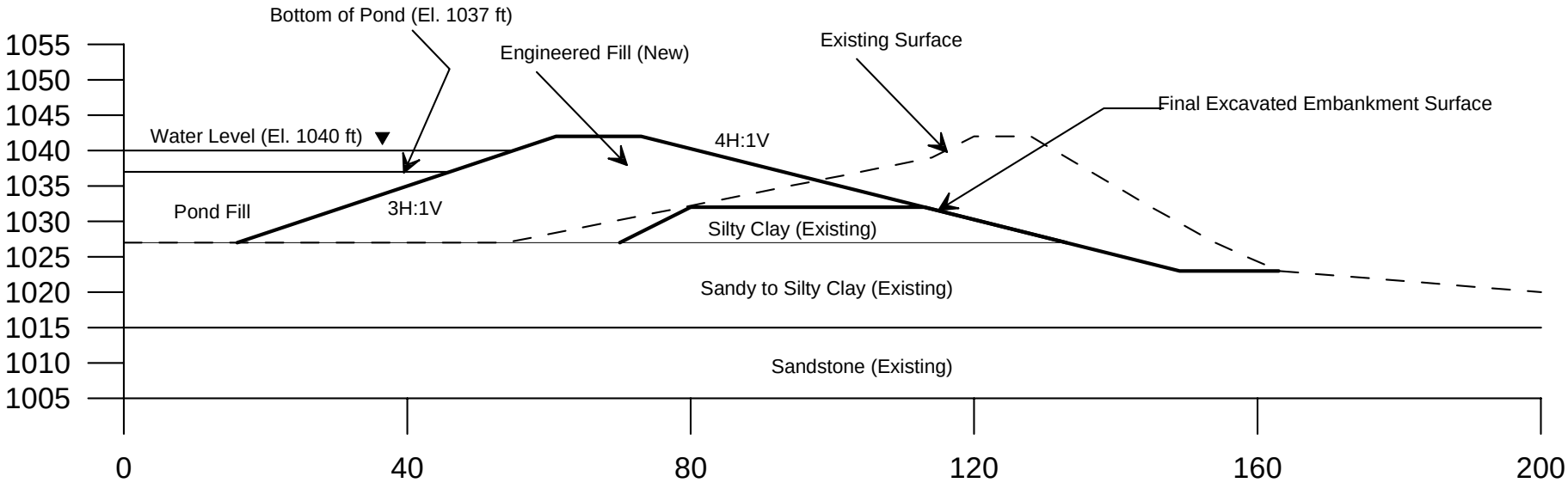
3.5. GEOTECHNICAL ANALYSIS

A typical analysis section was developed for both seepage and stability analyses. The internal stratigraphy of the analysis section was developed based on the proposed improvement (portion of the replaced embankment) and the results from field investigation program for the remaining existing embankment fill and foundation.

The permeability values for the various soil layers in the analysis sections were selected based on the published empirical relationships. Field permeability tests were not performed for this project. The permeability values assigned to the various soils are shown in Table 3.1. The anisotropy ratio of the horizontal-to-vertical hydraulic conductivity was estimated to be 4 for engineered fill and isotropic for the rest of the materials.

Table 3.1. Permeability Values for the Seepage Analysis

Material Type	K_h (ft/day)	K_h / K_v
Engineered Fill	0.028	4.0
CL-ML	0.56	1.0
Sandstone	0.28	1.0



URS	Project No. 26817595 SFPUC Habitat Mitigation Project	Proposed Improvements Goldfish Pond Cros-Section	Figure 3.1

The material properties for the stability analysis were developed from the results of the field and laboratory tests, published correlations, and experience with similar materials. The shear strengths of the materials were characterized with effective stress-drained parameters for long term stability conditions and undrained shear stress parameters for the short term stability conditions.

The selected unit weight and shear strength parameters are summarized in Table 3.2. The drained friction angle for the non-free-draining materials was estimated using the correlation relationship between friction angle and plasticity index (PI) developed by Ladd et al. (1977). The undrained shear strength was estimated using published data for similar materials (e.g. EPRI, 1990). There is a single unconfined compression test at a silty clay with sand sample that induces low strength. This result is not consistent with the material encountered at the site. The shear strength parameters for the engineered fill were developed based on experience.

Table 3.2. Strength Values for the Stability Analysis

Material Type	Unit Weight (pcf)	Effective Cohesion (psf)	Effective Friction Angle (degrees)	Undrained Shear Strength (psf)
Engineered Fill	120	150	32	1200
CL-ML	115	0	31	1000
CL-ML	115	0	31	1000
Pond Fill	115	0	29	500

3.5.1. Seepage Analysis

Steady-state seepage analyses were performed using the computer program SEEP/W (Geo-Slope International 2007). SEEP/W can represent multiple soil types with anisotropic permeability. Some of the assumptions made for the analyses include the following:

- On the downstream side, the water level is assumed to be at two feet below the ground surface. Total head boundary conditions (fixed head), corresponding to the assumed ground water level, are applied along the vertical face of the model on the downstream side. The distance from the downstream side toe of the embankment to the downstream side boundary is at about 500 feet.
- On the upstream side, the analysis section was extended to about 200 feet from the embankment centerline into the pond. A no-flow boundary condition at the vertical face of the elements below the bottom of the pond was used.
- Fixed total head boundary condition was used to model the contact between the water, the bottom of the pond, and the embankment.
- Other portions of the embankment and the ground surface were modeled using review nodes. After the heads are computed for all nodes, the review nodes are modified if any one of the review nodes has a computed head greater than the elevation of the node indicating seepage emanating from the adjacent elements.

Seepage Criteria

The criteria adopted for evaluating the results of seepage analyses were primarily based on recommendations provided in the USACE manuals (USACE 2004, 2005). The USACE guidelines state that "the need for remediation should be based on appropriate exit gradient threshold criteria, uplift or heave factor of safety, severity of seepage, and the performance history of levee and foundation." The threshold exit gradient used for this study is 0.5.

The seepage analysis results indicate very low exit gradients of 0 to 2.5 near the downstream toe. Therefore the seepage criterion as specified by USACE (2004, 2005) is satisfied.

3.5.2. Stability Analysis

The stability of the embankment was analyzed using the limit equilibrium method based on Spencer's procedure of slices as coded in the computer program UTEXAS4 (Shinoak, 2004). The trial-and-error solution involves successive assumptions for the factor of safety and side force inclination until both force and moment equilibrium are satisfied. The stability analyses were for the following loading conditions:

Steady State analysis (long-term): The water level in the pond was assumed to be at the normal operating level (Elevation 1040 ft). Effective stress drained shear strength parameters were used for this loading case. The location of the phreatic surface within the embankment was approximated from the seepage analysis.

End-of-Construction: The undrained shear strength was used for this loading condition. The groundwater level was assumed to be at 1018 feet, which is 2 feet below the ground surface.

Stability Criteria:

The criteria adopted for evaluating the results of the stability analyses were primarily based on recommendations provided in the USACE manual (USACE, 2000). The following criterion for minimum factors of safety is adopted per USACE EM-1110-2-1913 (USACE, 2000):

- Long-term steady state condition: minimum factor of safety equal to or greater than 1.4.
- End-of-construction: minimum factor of safety equal to or greater than 1.3.

Seismic analysis was performed using pseudo-static method. UTEXAS4 was used to estimate yield acceleration values for input to the seismic deformation analysis discussed in Section 3.5.3. The pseudo-static analysis is performed by applying an additional horizontal force to each slice within a potential failure mass to simulate earthquake loading. This application of force is accomplished using a single seismic coefficient (k_h) by which the weight of each slice is multiplied to obtain the additional horizontal body force. The yield acceleration coefficient, k_y, is the seismic coefficient that results in a factor of safety of 1.0. Material properties are as described above for the static analyses, with drained strengths used for the freely-draining material. The water level in the pond was assumed to be at the normal operating level (Elevation 1040 feet).

The results of the stability analyses are summarized in Table 3.3. The information presented in this table includes minimum factors of safety for long term stability and end of construction. The results are also presented on Figures 3.2 and 3.3 for both water and downstream side slopes. For each section, only the minimum factor of safety is reported in Table 3.3. Trivial cases representing shallow slides that pose no immediate threat to the integrity and safety of the

embankment were not considered in selecting the minimum factor of safety. The determination of what constitutes a "trivial" potential slide was based on engineering judgment. The static stability analyses indicated that the embankment meets the minimum required static factor of safety.

Table 3.3. Slope Stability Analysis Results

Scenario	Factor of Safety	Min. Required Factor of Safety
Steady State	1.7	1.4
End of Construction	2.0	1.3

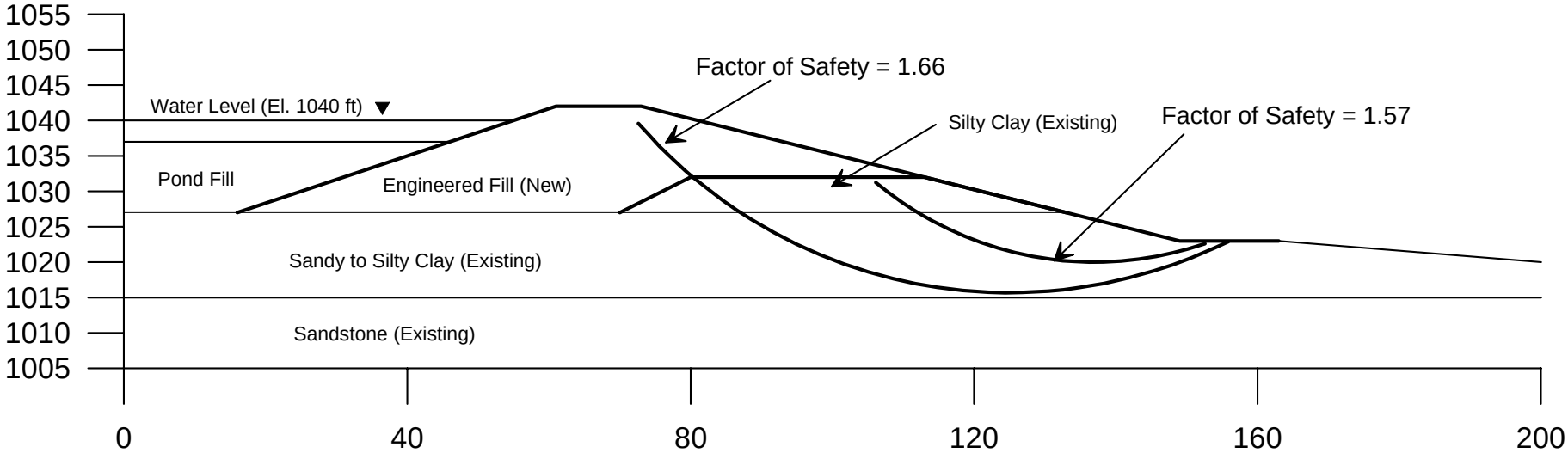
Figure 3.4 shows the slip surfaces and yield coefficients for the pseudo-static analysis. The calculated yield coefficients range from 0.13g to 0.41g for the downstream side.

3.5.3. Seismic Deformation Analysis

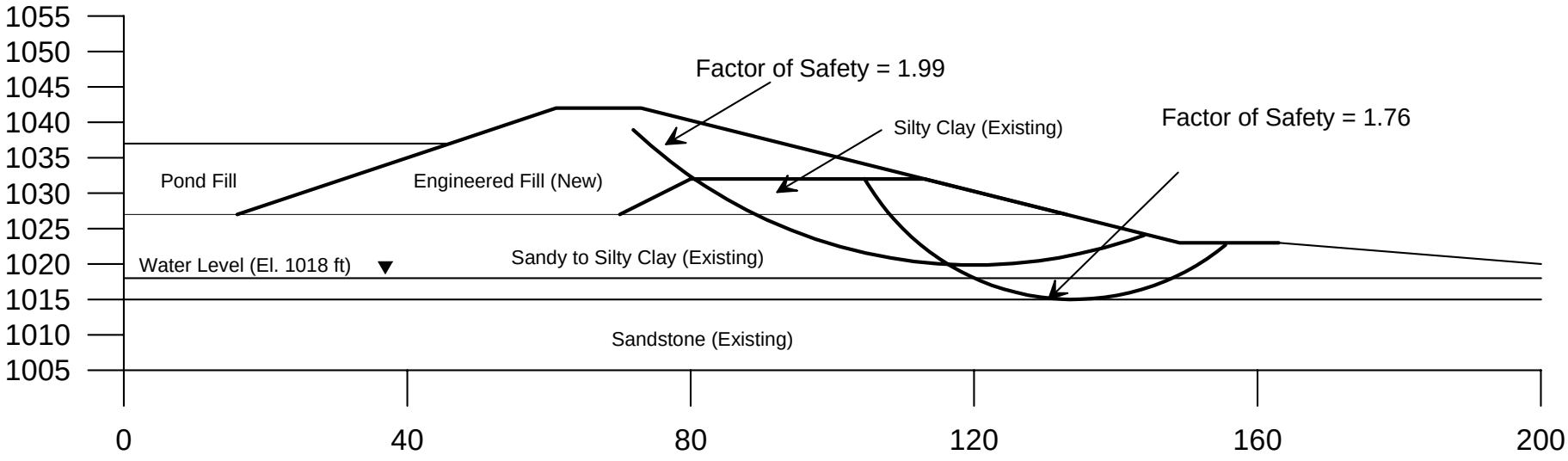
The design ground motion for the embankment is based on an event that has 10% probability of exceedance in 50 years (about 500-year return period). The Peak Ground Acceleration (PGA) was obtained from the seismic hazard map developed by USGS (2008). PGA is estimated to be around 0.7g for a 500 year event. The high PGA is primarily due to the site's proximity to the Calaveras fault.

The seismic-induced deformation for a pre-defined potential sliding mass was calculated using the procedure proposed by Makdisi and Seed (1978). An average acceleration for the sliding mass was developed using the estimated crest acceleration. The deformation was then calculated using the Newmark Double Integration Method (1967). The permanent seismic displacement of the potential sliding block is calculated by double-integration of the portions of the resulting acceleration time history that exceed the yield acceleration. The yield acceleration was calculated from a limit equilibrium slope stability analysis as described in Section 3.5.2

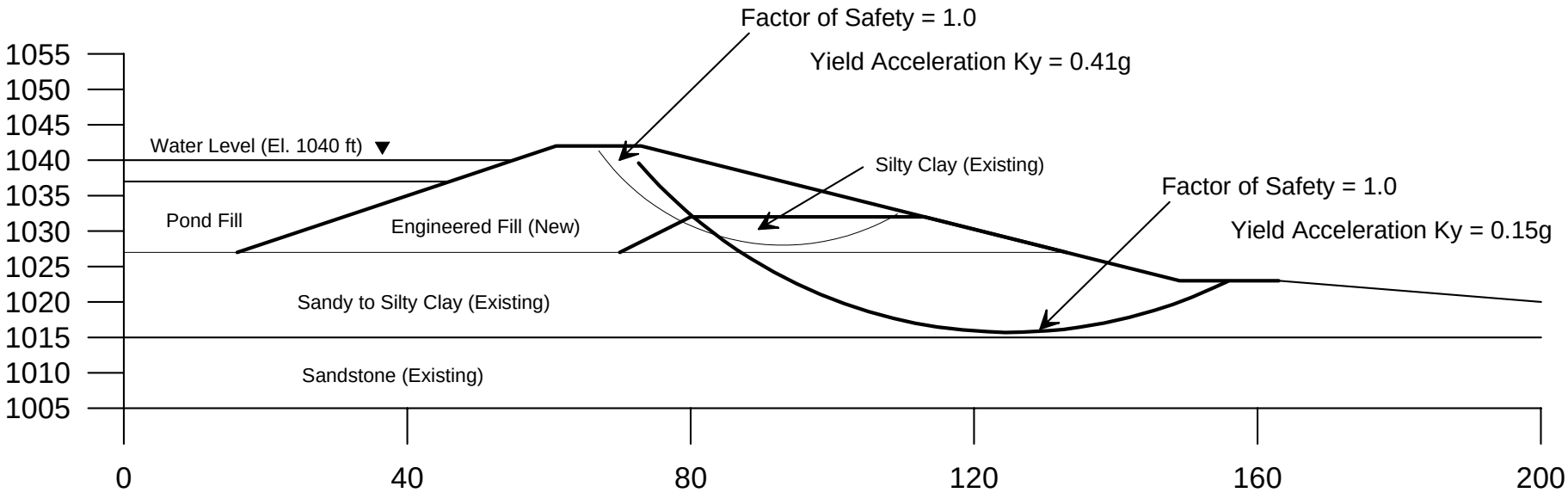
The estimated seismic induced deformation ranges from 0 to 2.5 feet. This range of deformation is not likely to cause embankment instability.



URS	Project No. 26817595 SFPUC Habitat Mitigation Project	Stability Analysis: Steady State Goldfish Pond	Figure 3.2



URS	Project No. 26817595 SFPUC Habitat Mitigation Project	Stability Analysis: End of Construction Goldfish Pond	Figure 3.3



URS	Project No. 26817595 SFPUC Habitat Mitigation Project	Stability Analysis: Seismic Goldfish Pond	Figure 3.4

Chapter 4. Pond Design

4.1. PURPOSE

The proposed design components are based on the analyses discussed in the previous chapters to establish hydrology and habitat establishment to meet the project objectives. Project components include the following:

- Remove the existing embankment and rebuild with engineered fill at stable slopes.
- Reconfigure pond geometry to satisfy the seasonal wetland design criteria, while also accommodating other agency requirements, such as the diversion limits, and minimum bypass flows.
- Design a new outlet structure for the proposed pond that will pass the 100-year, 24-hour design storm event while maintaining at least 1 foot of freeboard from the crest of the new embankment.
- Design an energy dissipater to prevent erosion at the downstream end of the outlet structure.

4.2. EARTHWORK ANALYSIS

A plan and a profile of the proposed grading are shown on Figures 4.1 and 4.2, respectively.

The existing embankment will be excavated, down to elevation 1032 feet, from Station 0+70 to Station 1+60. A new embankment will be built approximately 45 feet south of the existing embankment. As discussed in Chapter 3, the crest of the new embankment will be at elevation 1042 feet, approximately matching the crest of the existing embankment. The new embankment will have side slopes of 4(H):1(V) on the downstream (north) side, and 3(H):1(V) on the upstream (south) side.

The bottom of the existing pond will be raised to elevation up to 1039 feet by placing up to 12 feet of fill material within the existing pond footprint. A portion of the pond, between Station 2+18 to Station 3+18, will only be raised to elevation 1035 feet. This deeper portion is designed to facilitate breeding of CTS and CRLF.

The expanded seasonal wetland area of 3.63 acres will be established from Station 10+60 to Station 15+20 by excavating down to 1039 ft. The established seasonal wetland will be shallow with depths ranging less than 1 feet and will have side slope of 10(H):1(V).

4.3. POND LINING

The pond will be lined using a 12-inch-thick clay layer to ensure infiltration rates low enough to satisfy the design criteria, as discussed in Section 2.3.

4.4. OUTLET STRUCTURE AND ENERGY DISSIPATOR

The outlet structure and energy dissipator are designed for a 100-year, 24-hour peak discharge of 51 cfs. A standard 60-inch concrete manhole with a crest at elevation 1040 ft has been selected for the outlet structure, as discussed in Section 2.4.

A discharge pipe will receive the stormwater that enters the standpipe and release it to the downstream energy dissipator. The discharge pipe is a 48-inch corrugated metal pipe (CMP). The pipe invert elevation will start at 1033.8 feet at the standpipe, and end at 1032 feet at the discharge point, having a horizontal length of 100 ft, and a 1.8% slope. The design flow depth in the pipe will be approximately 1.72 feet, or 43% of the pipe diameter assuming a typical Manning's roughness coefficient for corrugated metal pipe of 0.020. The velocity of the flow during 100-year peak discharge will be about 9.80 ft/sec at the outlet of the pipe.

The dimensions and the riprap lining of the energy dissipator were designed following the USACE Manual for Drainage and Erosion Control Mobilization and Construction (EM 1110-3-136, USACE, 1984). The energy dissipator will be approximately 2 feet deep, 20.5 feet long and 8 feet wide at the bottom, and 32.5 feet long and 20 feet wide at the top. The riprap size was determined using the following equation:

$$D_{50} = 0.15 \cdot (D) \cdot Fc^3 \qquad \text{(Eq. 5)}$$

Where

D50 = 50% Diameter of Riprap

V = Flow Velocity from Outlet Pipe = 9.80 ft/sec

D = Depth of Flow = 1.72 feet

Fc = Froude Number = $V/(g \cdot D)0.5 = 0.86$.

The D_{50} is estimated to be 0.6 feet, or 7.2 inches. 8 inches is used for the design ensure the performance of the energy dissipator. Figure 4.3 shows a profile along the outlet structure and the energy dissipator.

4.5. DOWNSTREAM LOWFLOW CHANNEL AND STEP POOLS

The flows leaving the energy dissipator will enter an existing incised stream channel that has multiple willow trees in the bottom. The channel invert drops from elevation 1032 feet to about elevation 1020 feet in approximately 100 feet of length. A 4-feet wide, 1-foot deep low flow channel will be created, with a series of 2-feet high rock step pools providing grade control. Due to the lack of detailed topographic data and tree survey in this area, the details of the low flow channel and the rock step pools will be developed in future design submittals.

4.6. MINIMUM BYPASS FLOW AND DIVERSION STRUCTURE

The pond water balance calculations were performed assuming minimum bypass flow and diversion of runoff during non-allowable diversion period to meet design criteria. However, the design components to achieve the bypass flows and diversion structure have not been incorporated into the 30% design plans but will be addressed in the future submittal. The required bypass flow will be maintained by installing a 6 inch drain pipe near the bottom of the outlet structure.

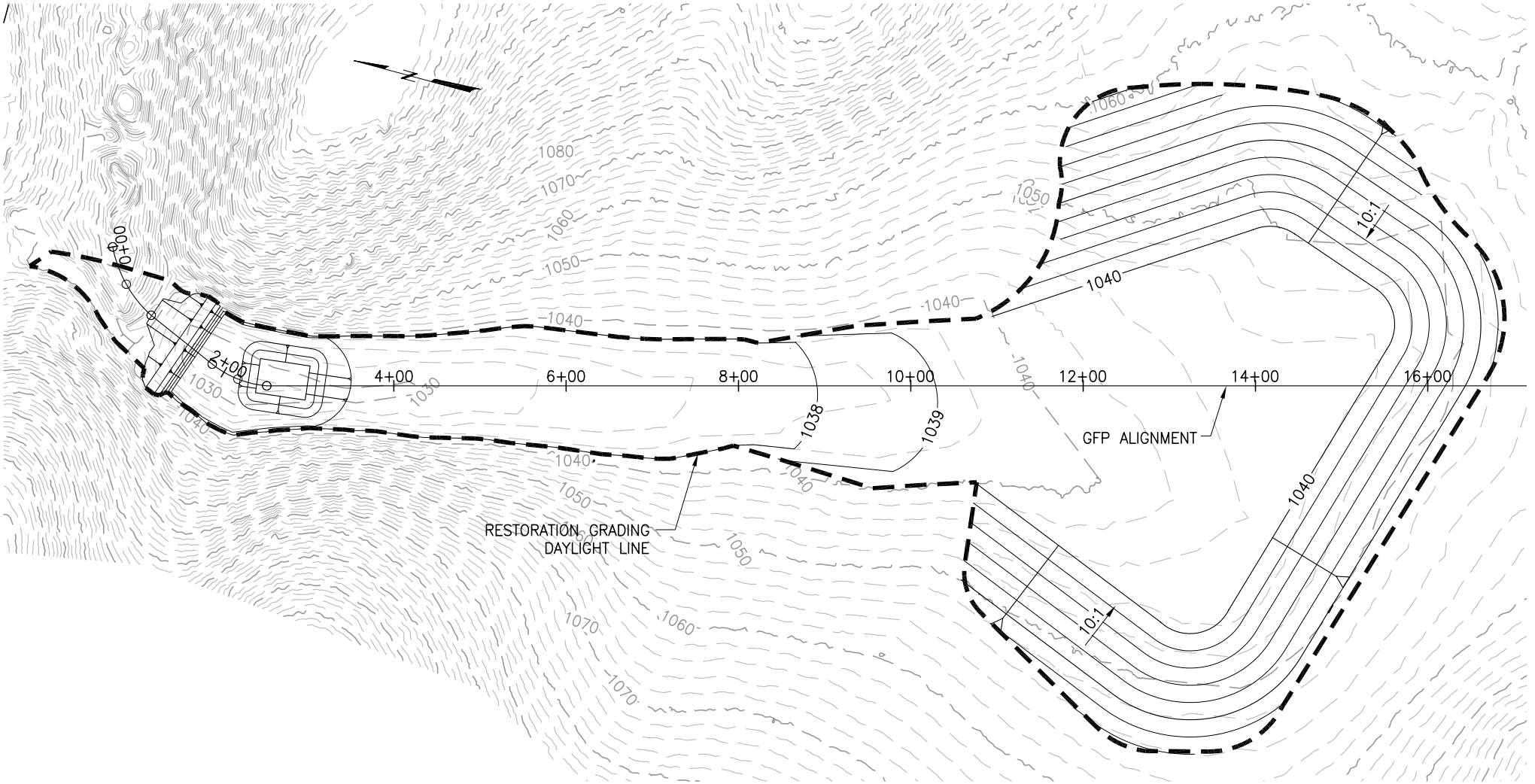


Figure 4.1 Proposed Goldfish Pond Design

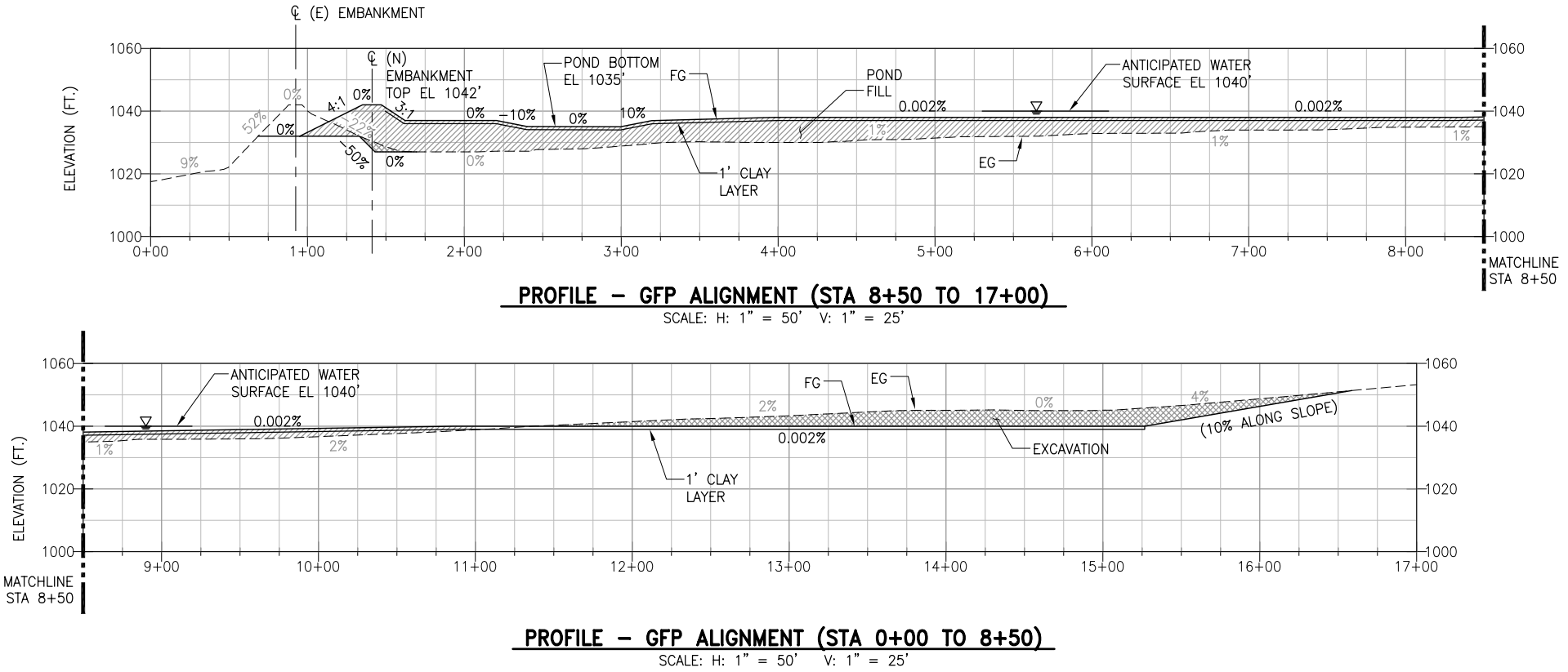


Figure 4.2 Proposed Goldfish Pond Profile

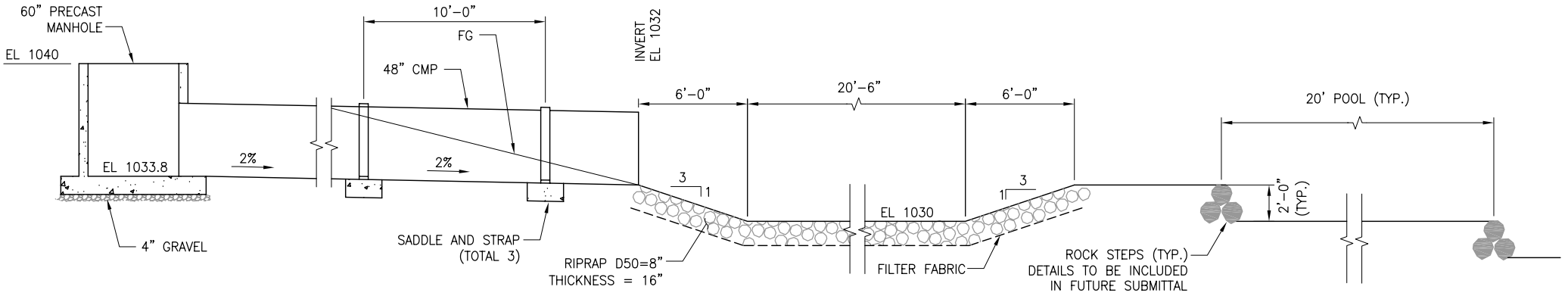


Figure 4.3 Profile of New Outlet Structure and Energy Dissipator

Chapter 5. Fencing and Gates

5.1. INTRODUCTION

Fencing and gates will be installed at the project site to manage livestock use for portions of the pond and planting areas. The location, purpose, and dimensions of fencing are described below.

5.2. LOCATION AND PURPOSE OF FENCING

An existing wire fence exists along the edge of the access road to the west of the existing pond and does not sufficiently limit livestock access to the proposed improvement areas. Therefore, new fencing is proposed to manage livestock access to the proposed project site. Approximately 4,038 linear feet of fencing will be installed around the planting areas and portions of open water. Through this new fencing, livestock will be allowed limited to no access to a portion of the open water and planting areas, and open access to the middle portion of the pond. Livestock exclusion from planting areas and some portions of open water will allow plants to establish to a point that they can survive with a limited amount of browsing by livestock.

5.3. FENCING AND GATE DIMENSIONS

Fencing will be wildlife friendly, consisting of four wires; two barbed, and two smooth. The top wire (smooth) will be located 40” above the ground; the second wire from the top (barbed) will be located 28” from the ground; the third wire from the top (barbed) will be located 23” from the ground and the bottom wire (smooth) will be located 18” from the ground. T-posts will be set every 16.5 feet. A minimum of two access gates will be installed for each enclosure. Gates will be swing type, 10 feet wide, and fabricated from 18 gage galvanized steel.

Chapter 6. Planting and Habitat Establishment

6.1. INTRODUCTION

Four habitat types will be established at the project site:

1. Native grassland;
2. Willow riparian;
3. Seasonal; and
4. Perennial wetlands.

In addition, areas temporarily disturbed by construction, including temporary access roads and staging areas, and new embankment crest and slopes will be hydroseeded with a native grass mix. Seeds will be sourced from the same watershed as the project site, to the greatest extent possible. Each habitat type, as well as the hydroseed mix is described below.

6.2. PERENNIAL WETLANDS

Approximately 0.46 ac of perennial wetlands will be established from elevation 1038 feet to elevation 1039 feet at the east end of the proposed pond. Perennial wetlands will include emergent vegetation (obligate plants), which will be submerged for a portion of the year under approximately 1-2 feet of water (Table 6.1).

6.3. SEASONAL WETLANDS

Approximately 3.63 acres of seasonal wetland will be created at the east end of the proposed pond (outside of the perennial wetlands) from approximately elevation 1039 feet to elevation 1040 feet. Seasonal wetland vegetation will include wetland obligate and facultative wetland plants, with obligate plants planted at lower elevations than the facultative wetland plants (Table 6.1).

6.4. WILLOW RIPARIAN

Approximately 0.90 acres of willow riparian will be created in a 30-foot wide band on the outside of the proposed seasonal wetland, as well as 0.32 acres east of the proposed pond and below the pond embankment. Willow riparian plantings will consists solely of willow cuttings, planted approximately 5 foot on center.

6.5. NATIVE GRASSLAND

Approximately 3.92 acres of native grassland will be created in upland areas where grading has occurred. Species to be planted will include native grasses and forbs; planting will include both container plants and seeds. Container plants will be planted 10 foot on center. Facultative wetland plants would be planted lower in elevation, and therefore closer to the water table.

Table 6.1. Goldfish Pond

Habitat (acres)	Botanical Name	Common Name	Propagation Method	Size*	Remarks
Native Grassland (3.92 ac)	*Hordeum brachyantherum*	Meadow barley	Container	plug	Plant @ 10 Ft. on center (o.c.) in lower, mesic areas closer to standing water and willow riparian
	Leymus triticoides	Creeping wildrye	Cutting/transplant	N/A	
	Sisyrinchium bellum	Blue eyed grass	Container	SC	
	Achillea millefolium	Yarrow	Container	N/A	Plant @ 10 Ft. o.c
	Eschscholzia californica	California poppy	Seed	N/A	5 lbs/acre in more xeric, upland areas
	Lupinus bicolor	Miniature lupine	Seed	N/A	5 lbs/acre in more xeric, upland areas
	Sanicula bipinnatifida	Purple sanicle	Seed	N/A	5 lbs/acre in more xeric, upland areas
	Nassella pulcrha	Purple needlegrass	Container	plug	Plant @ 10 Ft. c.c. in xeric, upland areas
Willow Riparian (1.22)	*Salix exigua*	Sandbar willow	Pole cuttings	N/A	Plant willow cuttings within 6 FT of the water edge. Average 5 FT o.c.
	Salix laevigata	Red willow	Pole cuttings	N/A	
	Salix lasiolepis	Arroyo willow	Pole cuttings	N/A	
Seasonal Wetland (3.63 ac)	*Hordeum brachyantherum*	Meadow barley	Container	plug	Plant @ 10 Ft. o.c. just outside of regularly inundated areas
	Leymus triticoides	Creeping wildrye	Container	plug	
	Juncus balticus	Baltic rush	Container	SC	Plant @ 10 Ft. o.c. on the fringes of seasonally inundated areas
	Juncus patens	Spreading rush	Container	SC	
Perennial Wetland (0.46 ac)	*Shoenoplectus acutus*	Hardstem bullrush	Cutting/transplant	N/A	Plant @ 10 Ft. o.c.

6.6. HDYROSEEDING

Approximately 1.63 acres of proposed staging area and 2.04 acres of access roads, as well as 0.17 acres of new embankment will be hydroseeded after completion of construction. Species included in the hydroseed mix are listed in Table 6.2, consisting of native grasses and forbs. The hydroseed mix will consist of straw mulch, tackifier and seed mix (90 lbs/acre). Compost will be certified weed free compost and will be free of chemicals, heavy metals or other materials that would be harmful to plant or animal life.

Table 6.2. Goldfish Pond Hydroseed Species Mix

Scientific Name	Common Name	lbs/ acre
Nassella pulchra	Purple needlegrass	15
Koelaria macrantha	Junegrass	5
Bromus carinatus	California brome	10
Achillia millefolium	Yarrow	15
Eschscholzia californica	California poppy	15
Sanicula bipinnatifida	Purple sanicle	15
Elymus glaucus	Blue wildrye	15
	Total lbs/acre:	**90 lbs/acre**

Chapter 7. Cost Estimate

7.1. INTRODUCTION

A detailed cost estimate based on the 30% plans for the project site is presented in Table 7.1. Quantities were measured manually from the drawings or using the AutoCAD Civil3D Version 2009 (Civil3D, Autodesk, Inc., 2008) software. Earthwork quantities were typically calculated based on terrain models of the existing and proposed ground surfaces and using the grid method in Civil3D. Unit costs were developed based on a combination of previous, similar project experience and the 2010 R.S. Means Building Construction Cost Data (R.S. Means Company, 2009) estimating guide.

7.2. ASSUMPTIONS

The following assumptions were made in developing the cost estimate:

- 30% of Contingency is included in the overall cost estimate.
- All excavated material will be hauled to a nearby SFPUC project site for future use.
- Certain amount of clay for pond lining may be obtained from onsite excavation, but for cost-estimating purpose it is assumed that all clay will be imported from an off-site location.
- Additional costs for material testing and sorting are included in the contingency.
- A 15% shrinkage factor was assumed for fill material.

Table 7.1. 30% Design Cost Estimate

SPEC SECTION	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL AMOUNT
01013	**Mobilization/Demobilization**				
	Mobilization/Demobilization (10% of Total Project Cost)	1	LS	$ 154,620	**$ 154,620**
02052	**Clearing, Grubbing and Stripping**				**$ 87,983**
	Clearing with Dozer and Brush	8	AC	$ 4,000	$ 30,932
	Haul Cleared Material - 1-2 miles	4,159	CY	$ 10	$ 41,586
	Stripping with Dozer	8	AC	$ 2,000	$ 15,466
02200	**Excavation and Fill**				**$ 1,175,021**
	Embankment Excavation	747	CY	$ 10	$ 7,470
	Embankment Fill	2,984	CY	$ 15	$ 44,764
	Pond Excavation	41,895	CY	$ 10	$ 418,950
	Pond Fill	11,117	CY	$ 10	$ 111,171
	Clay Fill	10,242	CY	$ 30	$ 307,260
	Haul Excess Material - 1-2 miles	28,541	CY	$ 10	$ 285,407
02240	**Dewatering**				**$ 15,000**
	Dewatering - one time pumping of 1' ponded water	1	LS	$ 15,000	$ 15,000
02270	**Erosion and Sediment Control**				**$ 14,989**
	Riprap Material and Placement (with Geotextile Fabric)	18	CY	$ 140	$ 2,489
	Rock Step Pools - Details to be included in later	50	CY	$ 250	$ 12,500

Table 7.1. 30% Design Cost Estimate

SPEC SECTION	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL AMOUNT
	design submittals				
02270	**Storm Drainage**				**$ 22,000**
	60 Inch Dia Concrete Manhole	1	LS	$ 4,000	$ 4,000
	48 Inch Dia Pipe	100	LF	$ 165	$ 16,500
	Supports and Braces	3	EA	$ 500	$ 1,500
02830	**Fencing**				**$ 94,827**
	Wildlife Friendly Fence	4,038	LF	$ 22	$ 88,827
	Gate	2	EA	$ 3,000	$ 6,000
02915	**Site Preparation**				**$ 10,396**
	Till Stripped Material into Seeding Areas - 1-2 miles	2,079	CY	$ 5	$ 10,396
02920	**Container Plant Installation**				**$ 65,608**
	Grass & herb. Perennial plugs- Grow	3,563	PLUGS	$ 4	$ 14,252
	Grass & herb. Perennial plugs- Grow	1,419	SC	$ 8	$ 11,352
	Grass & herb. Perennial plugs- Install	3,563	PLUGS	$ 4	$ 14,252
	Grass & herb. Perennial plugs- Install	1,419	SC	$ 8	$ 11,352
	Plant Maintenance	60	DAY	$ 240	$ 14,400
02925	**Pole Cutting**				**$ 4,600**
	Live Willow Staking	575	EA	$ 8	$ 4,600
02930	**Hydroseeding**				**$ 55,777**
	Hydroseeding	3.85	AC	$ 6,000	$ 23,100
	Seed Collection/Mix	331	LB	$ 97	$ 32,107
	Tackifier	390	LB	$ 0.50	$ 195
	Mulch	7.5	TON	$ 50	$ 375
	SUBTOTAL				**$ 1,700,822**
	CONTINGENCY 30%	1	LS	$ 510,247	$ 510,247
	TOTAL COST				**$ 2,211,069**

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Appendix A Geotechnical Boring Logs

Project: SFPUC Habitat Mitigation Program
Project Location: Alameda and Santa Clara Counties, CA
Project Number: 28067577

Log of Boring GB-3

Sheet 1 of 1

Date(s) Drilled	**2/18/09**	Logged By	**M. McKee**	Checked By	**M. Schmoll**
Drilling Method	**Solid Flight Auger**	Drill Bit Size/Type	**4-inch-OD auger bit**	Total Depth of Borehole	**28.0 feet**
Drill Rig Type	**Minuteman Portable Rig (gas-powered)**	Drilling Contractor	**Access Soil Drilling**	Approx. Ground Surface Elevation	**1027 feet**
Groundwater Level(s)	**Not encountered during drilling**	Sampling Method(s)	**SPT, Modified California, Standard California**	Hammer Data	**Safety hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Neat cement grout to ground surface**	Location	**Site 4 near Calaveras Road; Goldfish Pond Dam**	GPS Location	**N 37.44545° W 121.83006°**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
	0						CLAYEY GRAVEL (GC), brown to yellowish brown, medium dense, moist, gravel consists of angular sandstone fragments [DAM FILL]				Start at 13:30.
1025			1A 1B	20	100						
	5		2A 2B	29	56		SANDY SILTY CLAY WITH GRAVEL (CL), yellowish brown to reddish brown, very stiff to hard, slightly moist, gravel consists of angular sandstone fragments [DAM FILL]				
1020											Driller reports fairly consistent resistance to advance from 5-10 ft.
	10		3A 3B	36	100		CLAYEY SAND WITH SILT AND GRAVEL (SC), yellowish brown to reddish brown, medium dense, slightly moist, angular sandstone gravel [DAM FILL]	17.1	95.0		WA: 43%<#200 sieve
1015											
	15		4A 4B 4C	17	100		SILTY CLAY (CL/CH), dark gray, soft to medium stiff, very moist, medium to high plasticity, homogeneous [ALLUVIUM]				Sample at 14:10; #4A disturbed.
1010							CLAYEY SILT to SILTY CLAY WITH SAND AND GRAVEL (ML/CL), yellowish brown to grayish brown, very stiff, moist, medium plasticity fines, fine-grained sand, fine gravel [ALLUVIUM]				Harder drilling at 17 ft; sandstone fragments.
	20		5A 5B	55	100		SILTY SANDSTONE, yellowish brown [HIGHLY WEATHERED BRIONES FORMATION]				Sample at 14:30.
1005							SANDY CLAY (CL), yellowish brown, hard, moist, low plasticity [COMPLETELY WEATHERED BRIONES FORMATION]	22.8	94.7		
	25		6A 6B	83	100		SANDSTONE, yellowish brown and gray, highly weathered, very weak, soft, intensely fractured [BRIONES FORMATION]				
1000			7	73	100						
	30						TOTAL DEPTH = 28.0 feet				Finish drilling at 15:30.

Report: GEO_10B1_OAK; File: OAK_CALHABIT.GPJ; 5/11/2009 GB-03

URS

Project: SFPUC Habitat Mitigation Program
Project Location: Alameda and Santa Clara Counties, CA
Project Number: 28067577

Log of Boring GB-4

Sheet 1 of 1

Date(s) Drilled	**2/18/09**	Logged By	**M. McKee**	Checked By	**M. Schmoll**
Drilling Method	**Solid Flight Auger**	Drill Bit Size/Type	**4-inch-OD auger bit**	Total Depth of Borehole	**29.3 feet**
Drill Rig Type	**Minuteman Portable Rig (gas-powered)**	Drilling Contractor	**Access Soil Drilling**	Approx. Ground Surface Elevation	**1027 feet**
Groundwater Level(s)	**21 feet bgs during drilling; 18.7 feet bgs at completion**	Sampling Method(s)	**SPT, Modified California, Standard California**	Hammer Data	**Safety hammer; 140 lbs, 30-inch drop**
Borehole Backfill	**Neat cement grout to ground surface**	Location	**Site 4 near Calaveras Road; Goldfish Pond Dam**	GPS Location	**N 37.44541° W 121.82992°**

Elevation feet	Depth, feet	SAMPLES Type	Number	Sampling Resistance, blows / foot	Recovery, %	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, psf	REMARKS AND OTHER TESTS
1025	0		1A 1B	14	100		SANDY SILTY CLAY WITH GRAVEL (CL/CH), yellowish brown to grayish brown, medium stiff, moist, medium to high plasticity fines, coarse-grained sand and fine angular gravel consist of siltstone fragments, root traces [DAM FILL]				Start at 09:15.
1020	5		2A 2B	39	89		CLAYEY GRAVEL (GC), yellowish brown, dense, slightly moist, fine angular gravel consists of fine-grained sandstone and siltstone fragments [DAM FILL]				
1015	10		3A 3B	29	89		SANDY SILTY CLAY WITH GRAVEL (CL), mottled yellowish brown, gray, and reddish brown, stiff, slightly moist to moist, low to medium plasticity fines, fine sandstone gravel [DAM FILL]				
			4	15	78						
1010	15		5A 5B	55	100		Becomes very stiff to hard Cobbles	13.3	104.6		PP=3.3 tsf, >4.0 tsf Groundwater level measured at 18.7 ft at completion of drilling.
1005	20		6A 6B 6C	8	100		SILTY CLAY WITH SAND (CL), dark gray, soft, very moist, medium plasticity fines, fine-grained sand, homogeneous [ALLUVIUM]	26.5 27.5	95.7 96.7	 750	PP=0.75 tsf LL=36, PI=20 WA: 80%<#200 sieve First groundwater at 21 ft at 11:10.
1000	25		7A 7B 7C 8	74/10" 50/4"	78 100		SANDSTONE, yellowish brown and bluish gray, fine-grained, highly weathered, very weak, soft, intensely fractured [BRIONES FORMATION]				#7A only 2 in. Hard drilling below 25 ft.
	30		9	50/4"	100		TOTAL DEPTH = 29.3 feet				

Report: GEO_10B1_OAK; File: OAK_CALHABIT.GPJ; 5/11/2009 GB-04

URS

Project: SFPUC Habitat Mitigation Program
Project Location: Alameda and Santa Clara Counties, CA
Project Number: 28067577

Log of Boring / Piezometer PB-7

Date(s) Drilled	**2/12/09**	Logged By	**M. McKee**	Checked By	**M. Schmoll**
Drilling Method	**Hollow-Stem Auger**	Drill Bit Size/Type	**8-inch-OD rock bit**	Total Depth of Borehole	**33.0 feet**
Drill Rig Type	**Fraste Multi-Drill XL (track rig)**	Drilling Contractor	**Pitcher Drilling Co.**	Approx. Ground Surface Elevation	**1061 feet**
Groundwater Level(s)	**Not encountered during or at completion of drilling**	Sampling Method(s)	**No sampling; logged cuttings**	Approx. Top of Casing Elevation	**1061 feet**
Borehole Completion	**Standpipe piezometer, 2-in.-dia. PVC screen 20.7-30.2 ft (see schematic)**	Location	**Site 4, SW of Goldfish Pond**	GPS Location	**N 37.44225° W 121.83064°**

Elevation, feet	Depth, feet	SAMPLES Type	SAMPLES Number	SAMPLES Sampling Resistance, blows / foot	SAMPLES Recovery, %	Graphic Log	MATERIAL DESCRIPTION	WELL SCHEMATIC AND CONSTRUCTION DETAILS	FIELD NOTES
	0						CLAYEY SILT WITH SAND (ML), dark brownish gray, very moist, fine-grained sand, trace organic matter/rootlets [ALLUVIAL FAN DEPOSITS]	9-in.-dia. Christy box; 2-in.-dia. PVC slip cap on riser	Boring advanced only for piezometer installation. No sampling performed. Material logged from cuttings.
1060								2-in.-dia. Sch. 40 PVC solid casing (0-20.7 ft)	
							SANDY SILT WITH CLAY (ML), brown, medium stiff, dry, weakly cemented [ALLUVIAL FAN DEPOSITS]		Consistency estimated based on thumb pressure.
	5						CLAYEY SAND (SC), yellowish brown, medium dense, slightly moist, weakly cemented, homogeneous [ALLUVIAL FAN DEPOSITS]		
1055							Becomes moist, more clayey, less cemented	8-in.-dia. borehole	
							Becomes olive yellow, moist to very moist	Cement grout backfill (0-9.0 ft)	
	10							Bentonite pellet seal (9.0-11.0 ft)	
1050							SANDY CLAY (CL), yellowish brown to grayish brown, stiff, moist, low to medium plasticity, homogeneous [COMPLETELY WEATHERED BRIONES FORMATION]	No. 3 sand (11.0-33.0 ft)	
	15								Increased moisture content below 14 ft. Streak of gray clay noted in cuttings at 15 ft.
1045							Becomes pale yellow to grayish brown		
	20							2-in.-dia. Sch. 40 PVC screen, 0.020-in. slot (20.7-30.2 ft)	
1040									
							Becomes medium stiff to stiff, very moist		
	25								
1035									
							Increased sand content		
	30								

Report: GEO_12W_OAK_PIEZPOINT; File: OAK_CALHABIT.GPJ; 5/11/2009 PB-07

URS

Project: SFPUC Habitat Mitigation Program
Project Location: Alameda and Santa Clara Counties, CA
Project Number: 28067577

Log of Boring / Piezometer PB-7

Elevation, feet	Depth, feet	SAMPLES: Type Number	SAMPLES: Sampling Resistance, blows / foot	SAMPLES: Recovery, %	Graphic Log	MATERIAL DESCRIPTION	WELL SCHEMATIC AND CONSTRUCTION DETAILS	FIELD NOTES
1030	30					SANDY CLAY (CL), pale yellow to grayish brown, medium stiff to stiff, very moist, low to medium plasticity, homogeneous [COMPLETELY WEATHERED BRIONES FORMATION] (continued)	No. 3 sand (11.0-33.0 ft)	
						TOTAL DEPTH = 33.0 feet		Finish drilling at 10:30.
1025	35							
1020	40							
1015	45							
1010	50							
1005	55							
1000	60							
	65							

Report: GEO_12W_OAK_PIEZPOINT; File: OAK_CALHABIT.GPJ; 5/11/2009 PB-07

URS

Project: SFPUC Habitat Mitigation Program
Project Location: Alameda and Santa Clara Counties, CA
Project Number: 28067577

Log of Boring / Piezometer PB-8

Sheet 1 of 1

Date(s) Drilled	**2/12/09 - 12/13/09**	Logged By	**M. McKee**	Checked By	**M. Schmoll**
Drilling Method	**Hollow-Stem Auger**	Drill Bit Size/Type	**8-inch-OD rock bit**	Total Depth of Borehole	**27.7 feet**
Drill Rig Type	**Fraste Multi-Drill XL (track rig)**	Drilling Contractor	**Pitcher Drilling Co.**	Approx. Ground Surface Elevation	**1040 feet**
Groundwater Level(s)	**Not encountered during or at completion of drilling**	Sampling Method(s)	**No sampling; logged cuttings**	Approx. Top of Casing Elevation	**1040 feet**
Borehole Completion	**Standpipe piezometer, 2-in.-dia. PVC screen 17.0-27.0 ft (see schematic)**	Location	**Site 4, S of Goldfish Pond**	GPS Location	**N 37.44237° W 121.82974°**

Elevation, feet	Depth, feet	SAMPLES: Type Number	SAMPLES: Sampling Resistance, blows / foot	SAMPLES: Recovery, %	Graphic Log	MATERIAL DESCRIPTION	WELL SCHEMATIC AND CONSTRUCTION DETAILS	FIELD NOTES
1040	0					SANDY SILT WITH CLAY (ML), dark brownish gray, very moist, trace rootlets, homogeneous [ALLUVIAL FAN DEPOSITS]	9-in.-dia. Christy box; 2-in.-dia. PVC slip cap on riser	Start at 14:30 on 2/12/09. Boring advanced only for piezometer installation. No sampling performed. Material logged from cuttings.
						SILTY SAND to SANDY SILT (SM/ML), brown, slightly moist, homogenous [ALLUVIAL FAN DEPOSITS]	2-in.-dia. Sch. 40 PVC solid casing (0-17.0 ft)	
1035	5					SANDY SILT (ML), yellowish brown, dry to slightly moist, fine-grained sand with trace medium grains [ALLUVIAL FAN DEPOSITS]		
						CLAYEY SAND WITH SILT (SC), brownish gray, moist, trace rootlets [ALLUVIAL FAN DEPOSITS]	8-in.-dia. borehole	Consistency estimated based on thumb pressure.
						SANDY CLAY (CL), brown, medium stiff, moist, low plasticity fines, homogeneous [ALLUVIAL FAN DEPOSITS]		
1030	10					SANDY CLAY (CL), yellow to yellowish brown, stiff, moist, low to medium plasticity fines [COMPLETELY WEATHERED BRIONES FORMATION]	Cement grout backfill (0-12.0 ft)	
						Mottled with black to dark gray, CLAYEY SILT (ML)	Bentonite pellet seal (12.0-14.0 ft)	
1025	15						No. 3 sand (14.0-27.7 ft)	Drilling advance slower at 17 ft; cuttings returned to surface contain gravel to 3/4 in.
						Becomes very stiff		
1020	20						2-in.-dia. Sch. 40 PVC screen, 0.020-in. slot (17.0-27.0 ft)	Drilling slows at 19-20 ft; no cuttings being returned to surface. Auger stops turning with additional down pressure at 21.5 ft.
						SANDSTONE, yellowish brown, fine-grained, slightly silty, highly weathered, weak, soft, massive, dry to slightly moist [BRIONES FORMATION]		End for 2/12/09. Resume drilling at 24 ft on 2/13/09.
1015	25							
						TOTAL DEPTH = 27.7 feet		
1010	30							

Report: GEO_12W_OAK_PIEZPOINT; File: OAK_CALHABIT.GPJ; 5/11/2009 PB-08

URS

Project: SFPUC Habitat Mitigation Program

Project Location: Alameda and Santa Clara Counties, CA

Project Number: 28067577

Log of Boring / Piezometer PB-9

Sheet 1 of 1

Date(s) Drilled	**2/13/09**	Logged By	**M. McKee**	Checked By	**M. Schmoll**
Drilling Method	**Hollow-Stem Auger**	Drill Bit Size/Type	**8-inch-OD rock bit**	Total Depth of Borehole	**26.5 feet**
Drill Rig Type	**Fraste Multi-Drill XL (track rig)**	Drilling Contractor	**Pitcher Drilling Co.**	Approx. Ground Surface Elevation	**1072 feet**
Groundwater Level(s)	**Not encountered during or at completion of drilling**	Sampling Method(s)	**No sampling; logged cuttings**	Approx. Top of Casing Elevation	**1072 feet**
Borehole Completion	**Standpipe piezometer, 2-in.-dia. PVC screen 15.9-25.9 ft (see schematic)**	Location	**Site 4, SE of Goldfish Pond**	GPS Location	**N 37.44294° W 121.82819°**

Elevation, feet	Depth, feet	SAMPLES: Type	SAMPLES: Number	SAMPLES: Sampling Resistance, blows / foot	SAMPLES: Recovery, %	Graphic Log	MATERIAL DESCRIPTION	WELL SCHEMATIC AND CONSTRUCTION DETAILS	FIELD NOTES
1070	0						SANDY SILT WITH CLAY (ML), dark grayish brown, very moist, fine- to medium-grained sand with trace coarse grains, some rootlets [ALLUVIAL FAN DEPOSITS]	9-in.-dia. Christy bo 2-in.-dia. PVC slip cap on riser	Start at 12:15. Boring advanced only for piezometer installation. No sampling performed. Material logged from cuttings.
							SANDY CLAY WITH SILT (CL), brown to yellowish brown, medium stiff to stiff, moist to very moist, low plasticity fines, weakly cemented [ALLUVIAL FAN DEPOSITS]	2-in.-dia. Sch. 40 PVC solid casing (0-15.9 ft)	
1065	5							8-in.-dia. borehole	Driller reports harder drilling at 7 ft, with auger 4 ft into stiff clay.
								Cement grout backfill (0-9.3 ft)	
1060	10						SANDY CLAY (CL), olive brown, very stiff, moist, low to medium plasticity fines, fine-grained sand with trace coarse subangular grains [ALLUVIAL FAN DEPOSITS]		
							CLAY to SILTY CLAY (CH), yellow, stiff to very stiff, moist, high plasticity, homogeneous [ALLUVIAL FAN DEPOSITS]	Bentonite pellet seal (9.3-13.3 ft)	
1055	15							No. 3 sand (13.3-26.5 ft)	
							CLAY to SANDY CLAY (CL), yellowish brown, very stiff, slightly moist to moist, homogeneous [COMPLETELY WEATHERED BRIONES FORMATION]	2-in.-dia. Sch. 40 PVC screen, 0.020-in. slot (15.9-25.9 ft)	
1050	20								
	25						SANDSTONE, yellow to yellowish brown, fine-grained, highly weathered, very weak, soft, possibly massive [BRIONES FORMATION]		
1045							TOTAL DEPTH = 26.5 feet		
	30								

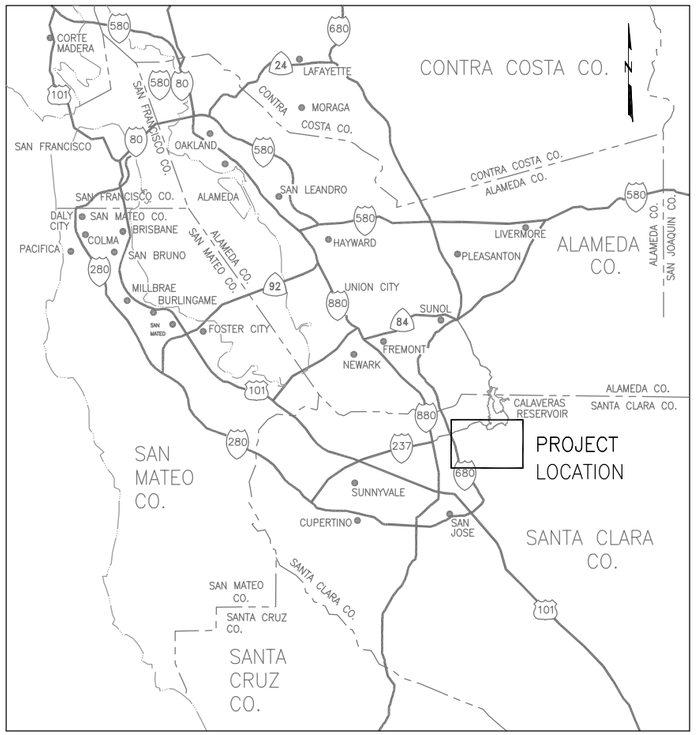
Report: GEO_12W_OAK_PIEZPOINT; File: OAK_CALHABIT.GPJ; 5/11/2009 PB-09

URS

CITY AND COUNTY OF SAN FRANCISCO

PUBLIC UTILITIES COMMISSION

SAN FRANCISCO WATER DEPARTMENT



LOCATION MAP
NOT TO SCALE

CONTRACT NO. WD-_____

HABITAT RESTORATION PROGRAM

GOLDFISH POND

30% SUBMITTAL
MARCH, 2010

DRAWING INDEX

PLAN NUMBER	DRAWING NUMBER	TITLE
GENERAL		
G-1	E-	TITLE SHEET
G-2	E-	LEGEND AND ABBREVIATIONS
G-3	E-	GENERAL NOTES AND PROJECT LOCATION
CIVIL		
C-1	E-	EXISTING CONDITIONS, STAGING AND ACCESS PLAN
C-2	E-	GRADING PLAN
DETAILS		
D-1	E-	EMBANKMENT EXCAVATION PLAN
D-2	E-	(N) EMBANKMENT PLAN AND PROFILE
D-3	E-	FENCE DETAILS
PLANTING		
P-1	E-	PLANTING PLAN

E-_____

GENERAL SYMBOLS

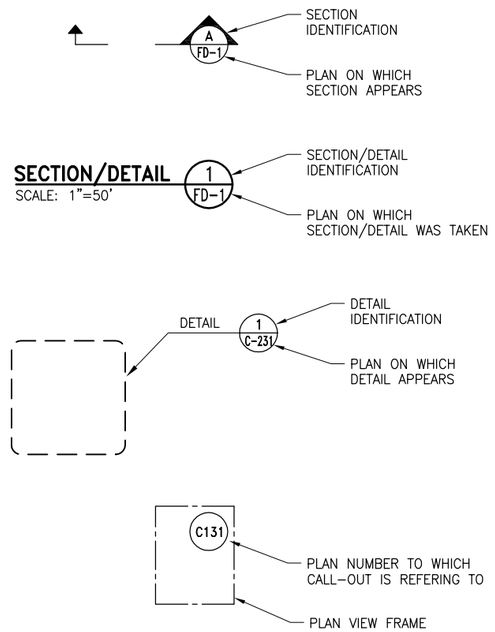
- BORING
- CENTER LINE
- CUT SLOPE
- DIAMETER
- DIRECTION OF FLOW
- EXISTING CONTROL POINT
- EXPLORATORY BORING
- FILL SLOPE
- FLOW LINE
- GATE
- PIEZOMETERS
- PROPOSED CONTROL POINT
- SLOPE GRADIENT (HOR. : VERT.) — 1.5:1
- SPOT ELEVATION
- TREE, SHRUB
- WATER LEVEL ELEVATION
- EXISTING ROADWAY CORRIDOR
- EXISTING FENCE WIRED/BARBWIRED
- LIMITS OF WORK
- WILDLIFE FRIENDLY FENCE
- (E) CONTOUR MAJOR
- (E) CONTOUR MINOR
- BOLLARDS
- GATE
- GATE POST — GP
- GATE VALVE
- MONUMENT
- CONTROL POINT

- SECTION
- TEMPORARY ACCESS AREAS
- GRAVEL
- CONCRETE
- STAGING AREAS
- EARTHWORK FILL
- EARTHWORK CUT

GENERAL ABBREVIATIONS

AB	AGGREGATE BASE
AC	ASPHALT CONCRETE
ADD	ADDITION(AL)
ADDL	ADDITIONAL
ALT	ALTERNATE
ASTM	AMERICAN SOCIETY TESTING MATERIAL
APPROX	APPROXIMATE
B, CB	BORINGS
BOT	BOTTOM
BOF	BOTTOM OF FOOTING
BRG	BEARING
CAP	CAPACITY
C/C or CC	CENTER TO CENTER
CF	CUBIC FEET
CFM	CUBIC FEET PER MINUTE
CFS	CUBIC FEET PER SECOND
CI	CAST IRON
CJ	CONSTRUCTION JOINT
℄	CENTERLINE
CLR	CLEARANCE
CO	COUNTY
CONC	CONCRETE
CONN	CONNECTION
CONT	CONTINUE
CONST	CONSTRUCTION
CP	CONTROL POINT
CTR	CENTER
D	DEPTH
DET	DETAIL
DIA	DIAMETER
DIM	DIMENSION
DN	DOWN
D/S	DOWNSTREAM
DR	DRAINAGE, DOOR
DWG	DRAWING
(E), E	EXISTING
EA	EACH
EC	END CURVE
EG	EXISTING GROUND
EL, ELEV	ELEVATION
EXIST	EXISTING
FDN	FOUNDATION
FG	FINISH GROUND
FIG	FIGURE
FIN	FINISHED
FL	FLOW LINE
FLEX	FLEXIBLE
FPS	FEET PER SECOND
FS	FACTOR OF SAFETY
FT	FOOT
GA	GAUGE
GALV	GALVANIZED
GEN	GENERAL
GR	GRADE
GRD	GROUND
GRTG	GRATING
GV	GATE VALVE
H	HEIGHT
HGL	HYDRAULIC GRADE LINE
HOR	HORIZONTAL
ID	INSIDE DIAMETER, IDENTIFICATION
IN	INCH
INV	INVERT
JT	JOINT
JCT	JUNCTION
L	LENGTH
LONG	LONGITUDINAL
MATL	MATERIAL
MAX	MAXIMUM
MFR	MANUFACTURE(R)
MIN	MINIMUM
MISC	MISCELLANEOUS
(N), N	NEW
N/A	NOT APPLICABLE
NIC	NOT IN CONTRACT
NMWS	NORMAL MAXIMUM WATER SURFACE
NOM	NOMINAL
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OG	ORIGINAL GROUND SURFACE
OH	OVER HEAD
OPNG	OPENING
PL	PLATE OR PROPERTY LINE
R	RADIUS, RISER
RCP	REINFORCED CONCRETE PIPE
R/C	REINFORCED CONCRETE
REF	REFERENCE
REQ'D	REQUIRED
ROW	RIGHT OF WAY
S	SLOPE
SCH	SCHEDULE
SECT	SECTION
SFPUC	SAN FRANCISCO PUBLIC UTILITY COMMISSION
SHT	SHEET
SIM	SIMILAR
℄	SPRINGLINE
SPEC	SPECIFICATION(S)
SS	STAINLESS STEEL
STA	STATION
STD	STANDARD
STL	STEEL
STRUCT	STRUCTURE
SWPPP	STORM WATER POLLUTION PREVENTION PLAN
t	THICKNESS
T & B	TOP & BOTTOM
TCE	TEMPORARY CONSTRUCTION EASEMENT
TOC	TOP OF CONCRETE
TOS	TOP OF SLAB
TYP	TYPICAL
THK	THICK
UG	UNDERGROUND
UON	UNLESS OTHERWISE NOTED
U/S	UPSTREAM
V	VALVE
W/	WITH
W	WIDTH, WEST
WSL	WATER SURFACE LEVEL
WT	WATER TIGHT, WEIGHT

TYPICAL SECTION/DETAIL NUMBERING SYSTEM



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CONTRACT NO. WD–

30% DRAFT
MARCH 19, 2010

ELEVATION DATUM
NAVD88

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

PROJECT ENGINEER: CHH	DRAWN: EH
PROJECT MANAGER: FD	DESIGNED: AG
APPROVAL: SAG	CHECKED: JR

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

GOLDFISH POND LEGEND AND ABBREVIATIONS

CHECKED / APPROVED	DRAWN	SCALE: NONE
SECTION MANAGER	DESIGNED	DATE
APPROVED: MANAGER, ENGINEERING MANAGEMENT BUREAU	APPROVED: MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	G-2	E–	

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

P:\CADD\Sheets\Goldfish Pond\G–2.dwg Mar 19, 2010 – 11:32am

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

GENERAL NOTES:

1. THE NORTH ORIENTATION OF THESE PLANS IS BASED UPON A GRID DIRECTION.
2. THE TOPOGRAPHIC INFORMATION SHOWN ON THE PLANS WAS COMPILED USING LIDAR 2006 DATA OBTAINED FROM SANTA CLARA COUNTY AND BATHYMETRY SURVEY DATA PERFORMED BY SFPUC IN MARCH 2009.
3. THE ELEVATION AND BATHYMETRY CONTOURS OF THE FIELD TOPOGRAPHIC SURVEY ARE BASED UPON NAVD88 DATUM AS DETERMINED THROUGH GPS OBSERVATIONS USING GEOID03.
4. THE COORDINATES OF THESE PLANS ARE BASED UPON CALIFORNIA COORDINATE SYSTEM 1983, ZONE 3, EPOCH 2002 FROM GPS OBSERVATIONS. AN OPUS SOLUTION WAS USED FROM STATIC OCCUPATIONS OF TWO CONTROL POINTS.
5. ALL DISTANCES WITHIN THESE PLANS ARE BASED UPON THE US SURVEY FOOT AND DECIMALS THEREOF AND ARE GROUND DISTANCES.
6. THE FIELD SURVEY WAS PREPARED BY SFPUC SURVEYORS UNDER THE DIRECT SUPERVISION OF R. EDWARD PETERSON, LS, CHIEF SURVEYOR.
7. WHERE THERE IS A DISCREPANCY BETWEEN THE WRITTEN DIMENSION AND SCALED DIMENSION, WRITTEN DIMENSIONS SHALL GOVERN.
8. ALL DISCREPANCIES BETWEEN THE INFORMATION SHOWN IN THE PLANS AND THE ACTUAL FIELD CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE CITY REPRESENTATIVE.
9. THE CONTRACTOR SHALL LIMIT CONSTRUCTION OPERATIONS TO WITHIN THE RIGHT-OF-WAY AND EASEMENTS AND DESIGNATED WORK AREAS AS INDICATED. THE CONTRACTOR IS SOLELY RESPONSIBLE FOR ANY DAMAGES OUTSIDE THE RIGHT-OF-WAY, EASEMENTS, AND DESIGNATED WORK AREAS SHOWN ON THE DRAWINGS.

EXISTING UTILITIES:

1. CONTRACTOR SHALL NOTIFY UNDERGROUND SERVICE ALERT (USA) PRIOR TO DIGGING.
2. LOCATIONS OF ALL UTILITY SERVICE LINES SHALL BE FIELD VERIFIED BY POT HOLING PRIOR TO COMMENCING ANY GRADING, TRENCHING OR EXCAVATION.
3. UTILITIES, EXISTING AT THE TIME OF CONSTRUCTION, ARE UNKNOWN.
4. THE CONTRACTOR SHALL TAKE PRECAUTIONARY MEASURES TO PROTECT ALL EXISTING UTILITY LINES AND STRUCTURES NOT SHOWN ON THESE PLANS.
5. ALL CONTRACTOR WORK AROUND EXISTING UTILITIES SHALL BE IN CONFORMANCE WITH CALIFORNIA GOVERNMENT CODE 4216.
6. THE CONTRACTOR SHALL PROTECT IN PLACE ALL OVERHEAD INTERFERENCE. THE CONTRACTOR SHALL USE EXTREME CAUTION WHEN WORKING NEAR OVERHEAD OR UNDERGROUND POWER, GAS, AND/OR OTHER UTILITIES SO AS TO SAFELY PROTECT ALL PERSONNEL AND EQUIPMENT, AND SHALL BE RESPONSIBLE FOR ALL COSTS AND LIABILITY IN CONNECTION THEREWITH.
7. CONTRACTOR SHALL CONTACT UTILITY POLE OWNER PRIOR TO WORKING IN AREA AND UTILITY POLE OWNER WILL DO ALL WORK ON UTILITY POLES. THE CONTRACTOR SHALL PAY ALL THE COSTS ASSOCIATED WITH UTILITY POLE MODIFICATIONS AND THE CONTRACTOR SHALL INCLUDE THE TIME NEEDED BY THE UTILITY POLE OWNER AS PART OF THE OVERALL WORK.

DEMOLITION NOTES:

1. CONTRACTOR MAY RE-USE MATERIAL SUBJECT TO SUBMITTALS PER SPECIFICATION AND REVIEW BY THE CITY REPRESENTATIVE.
2. ALL EXCAVATION WORK WITHIN DRIP LINE OF EXISTING TREES THAT ARE TO REMAIN SHALL BE PERFORMED BY HAND. CLEANLY CUT ANY ROOT LARGER THAN ONE INCH DIAMETER. DO NOT TEAR ROOTS.

TREE REMOVAL:

1. ALL REMOVAL OR PRUNING OF EXISTING TREES OR SHRUB SHALL BE PERFORMED UNDER THE DIRECTION OF THE CITY REPRESENTATIVE.
2. ALL TREES DESIGNED TO BE REMOVED SHALL BE CLEANLY CUT AND THE STUMP GROUNDED TO ONE FEET BELOW GRADE AND THE MATERIAL SHALL BE DISPOSED IN A LEGAL MANNER.

EARTHWORK ESTIMATE

ITEM	EARTHWORK (YD^3)
EMBANKMENT	FILL (2,984*) , CUT (747)
POND	FILL (11,117*) , CUT (41,895)
1' CLAY LAYER	10,242
HAUL EXCESS TO STOCKPILE	28,541

(THESE NUMBERS ARE PRELIMINARY AND SUBJECT TO CHANGE)
* FILL VALUES INCLUDE 15% SHRINKAGE

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30% DRAFT
MARCH 19, 2010

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

URS
1333 BROADWAY, SUITE 800
OAKLAND, CA 94612
PHONE: (510) 893-3600

HRP ALAMEDA WATERSHED SITES

GOLDFISH POND
GENERAL NOTES AND
PROJECT LOCATION

PROJECT ENGINEER	DRAWN
CHH	EH
PROJECT MANAGER	DESIGNED
FD	AG
APPROVAL	CHECKED
SAG	JR

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CHECKED / APPROVED	DRAWN	SCALE
		NONE
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	G-3	E–	

ELEVATION DATUM
NAVD88

USA North
USA North is the One-Call Center serving Central and Northern California and Nevada.
Call Two Working Days Before You Dig and Dig Safely
1-800-227-2600

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

P:\CADD\Sheets\Goldfish Pond\G-3.dwg Mar 19, 2010 – 11:36am

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4



PLAN
SCALE: 1" = 100'



ERODING GULLY
SCALE: NTS

100' 0 100' 200'
SCALE 1"=100'

NOTE:
1. CONTOUR INTERVAL IS 5 FOOT, UNLESS OTHERWISE INDICATED.

ELEVATION DATUM
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PROJECT ENGINEER	DRAWN
CHH	EH
PROJECT MANAGER	DESIGNED
FD	AG
APPROVAL	CHECKED
SAG	JR

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
INFRASTRUCTURE DIVISION
ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

GOLDFISH POND EXISTING CONDITIONS STAGING AND ACCESS PLAN

CHECKED / APPROVED	DRAWN	SCALE
		AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

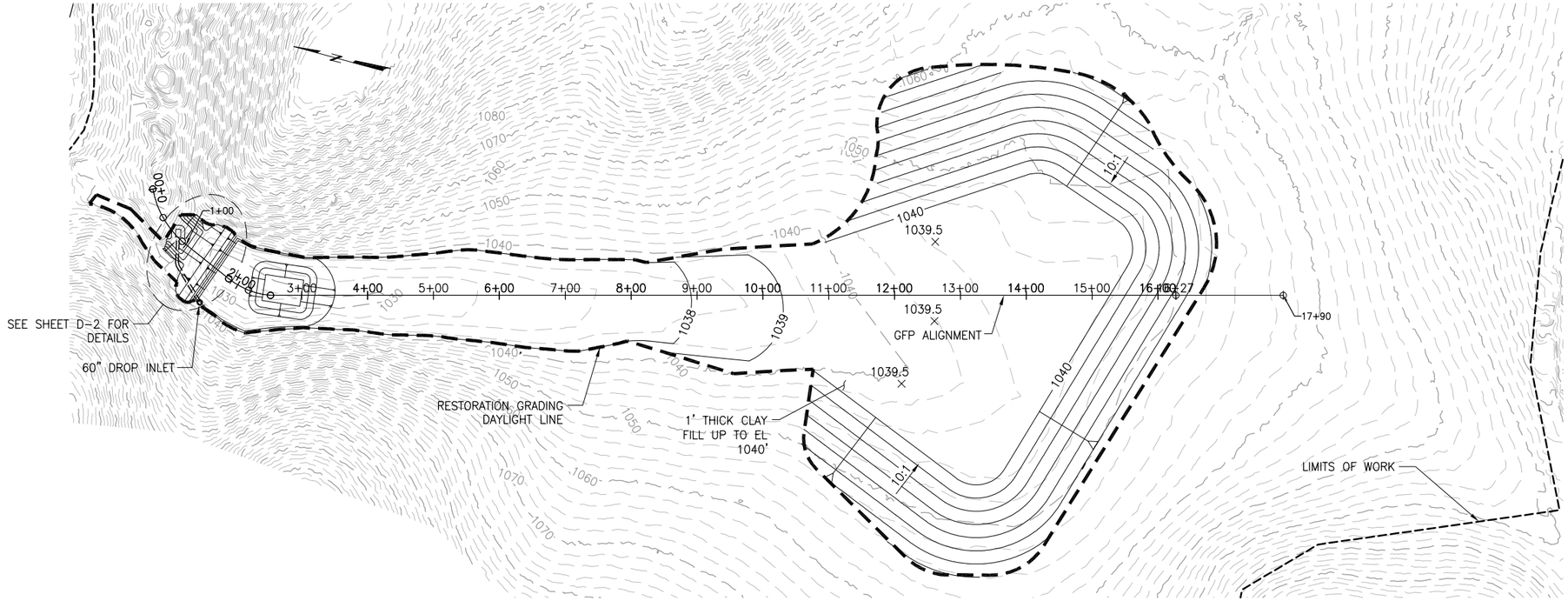
SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-1	E–	

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

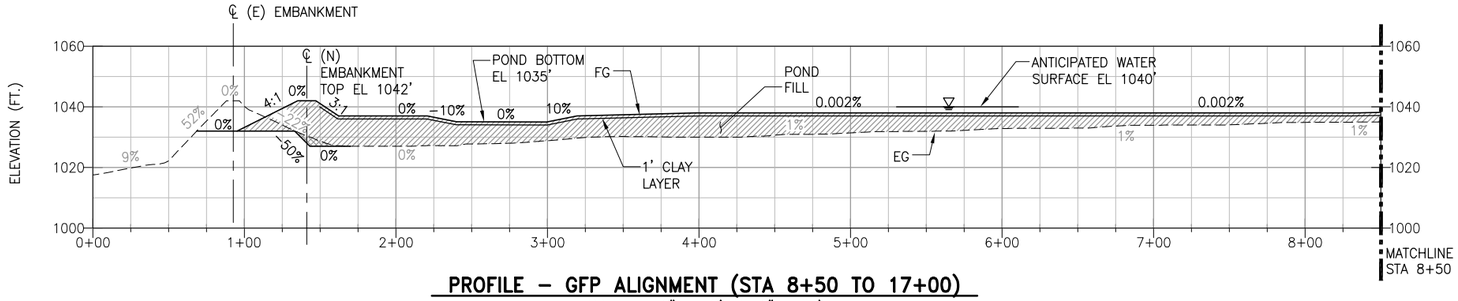
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FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

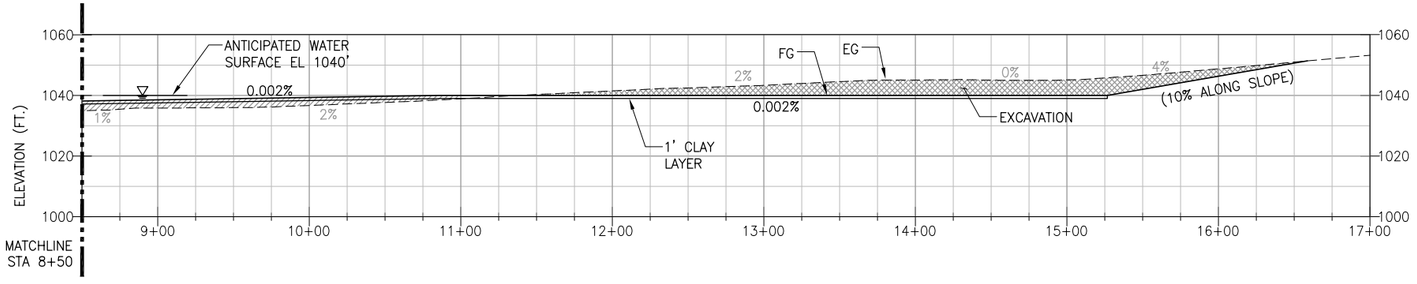


PLAN
SCALE: 1" = 100'

NOTE:
1. EXISTING AND PROPOSED CONTOURS ARE AT 2' INTERVALS UNLESS INDICATED OTHERWISE.



PROFILE – GFP ALIGNMENT (STA 8+50 TO 17+00)
SCALE: H: 1" = 50' V: 1" = 25'



PROFILE – GFP ALIGNMENT (STA 0+00 TO 8+50)
SCALE: H: 1" = 50' V: 1" = 25'

100' 0 100' 100'
SCALE 1"=100'

50' 0 50' 100'
SCALE 1"=50'

25' 0 25' 50'
SCALE 1"=25'

ELEVATION DATUM
NAVD88

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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MARCH 19, 2010

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PROJECT ENGINEER	DRAWN
CHH	EH
PROJECT MANAGER	DESIGNED
FD	AG
APPROVAL	CHECKED
SAG	JR

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

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PUBLIC UTILITIES COMMISSION
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HRP ALAMEDA WATERSHED SITES

GOLDFISH POND
GRADING PLAN

CHECKED / APPROVED	DRAWN	SCALE
		AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

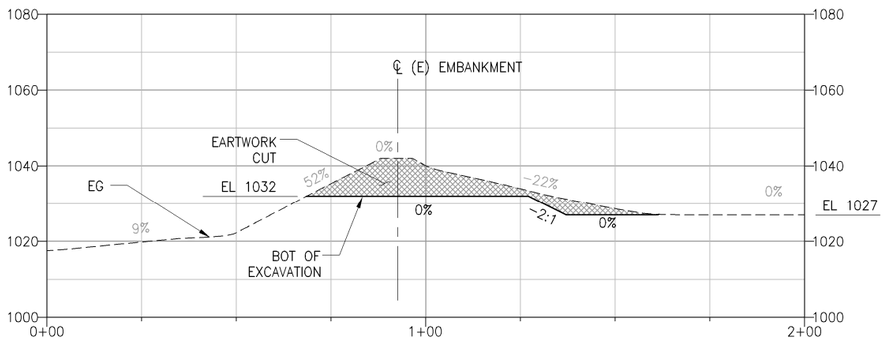
SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	C-2	E–	



EMBANKMENT EXCAVATION PLAN

SCALE: 1" = 20'

NOTE:
1. CUT SLOPES ARE 2:1 (TYP.)
2. EXISTING AND PROPOSED COUNTOURS ARE AT 2' INTERVALS UNLESS OTHERWISE INDICATED



EMBANKMENT EXCAVATION SECTION

SCALE: 1" = 20'

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

20' 0 20' 40'
SCALE 1"=20'

ELEVATION DATUM
NAVD88

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PROJECT MANAGER	DESIGNED
FD	AG
APPROVAL	CHECKED
SAG	JR

NO.	DATE	DESCRIPTION	BY	APPR'D

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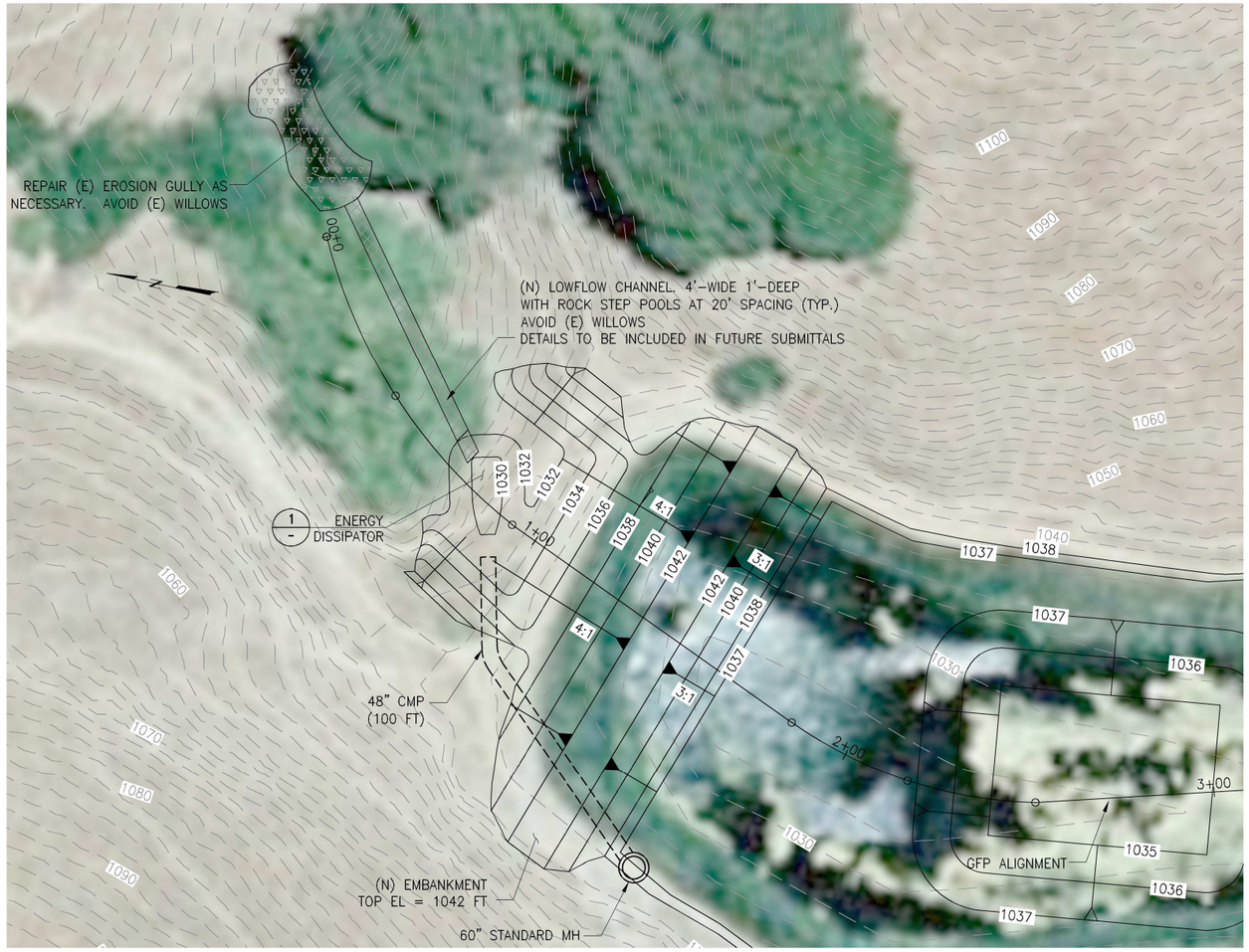
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INFRASTRUCTURE DIVISION
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HRP ALAMEDA WATERSHED SITES

GOLDFISH POND
EMBANKMENT EXCAVATION PLAN

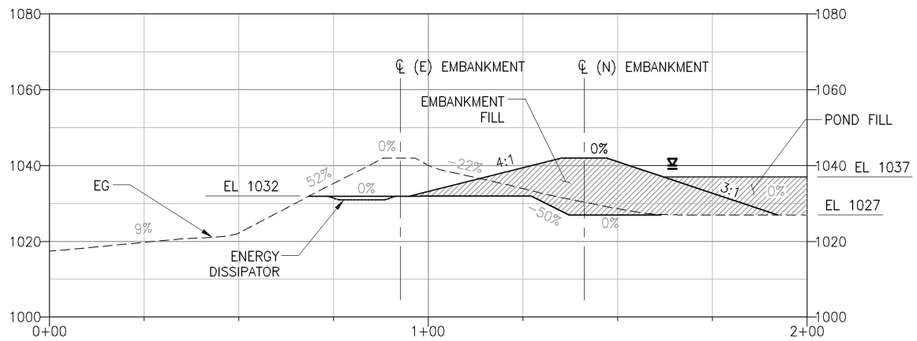
CHECKED / APPROVED	DRAWN	SCALE
		AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	D-1	E–	

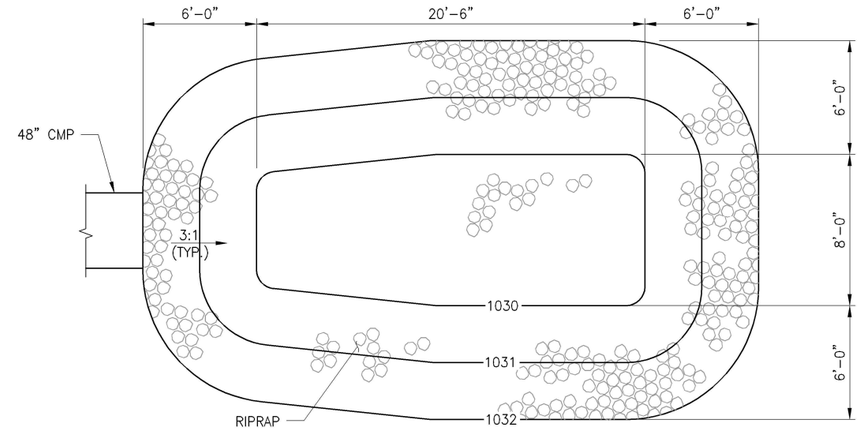


EMBANKMENT PLAN
SCALE: 1" = 20'

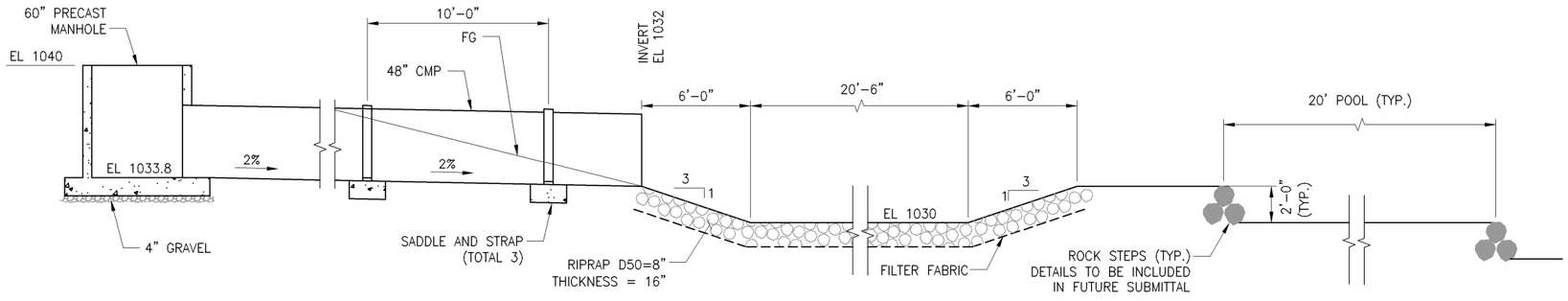
NOTE:
1. EXISITING AND PROPOSED CONTOURS ARE AT 2' INTERVALS, UNLESS OTHERWISE INDICATED.



EMBANKMENT FILL SECTION
SCALE: 1" = 20'



ENERGY DISSIPATOR PLAN (1)
SCALE: 1/4" = 1'-0"



PROFILE ALONG 48" CMP AND ENERGY DISSIPATOR
SCALE: 1/4" = 1'-0"

20' 0 20' 40'
SCALE 1"=20'

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PROJECT MANAGER	DESIGNED
FD	AG
APPROVAL	CHECKED
SAG	JR

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PLAN AND PROFILE

GOLDFISH POND
(N) EMBANKMENT
PLAN AND PROFILE

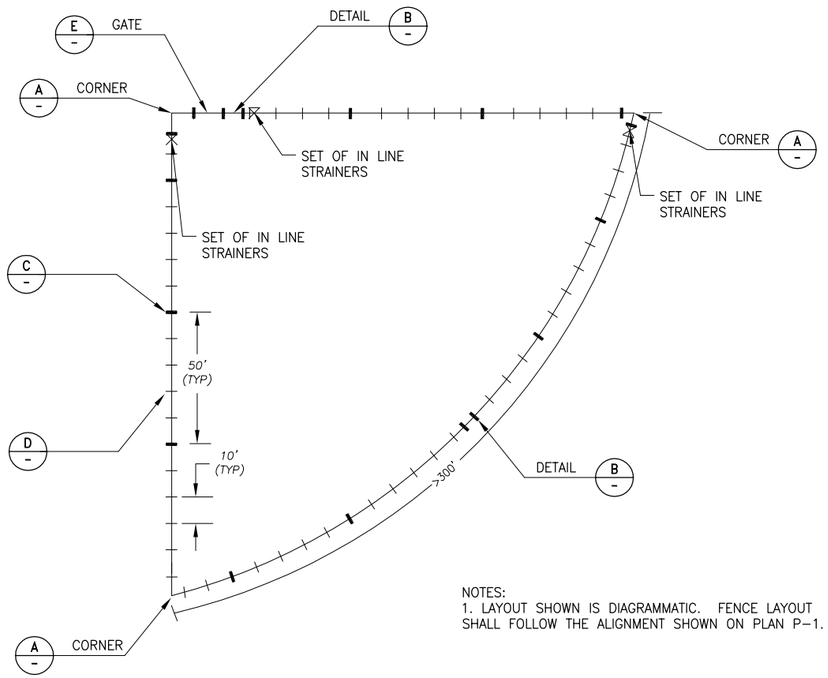
CHECKED / APPROVED	DRAWN	SCALE
		AS SHOWN
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
MANAGER, ENGINEERING MANAGEMENT BUREAU	MANAGER, WATER SUPPLY AND TREATMENT DIVISION	

SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	D-2	E-	

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

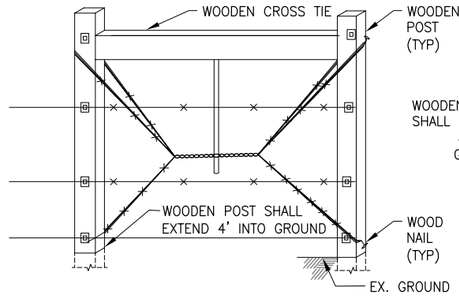
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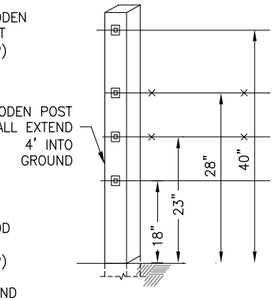
NOTES:
1. LAYOUT SHOWN IS DIAGRAMMATIC. FENCE LAYOUT SHALL FOLLOW THE ALIGNMENT SHOWN ON PLAN P–1.

PLAN
SCALE: NTS



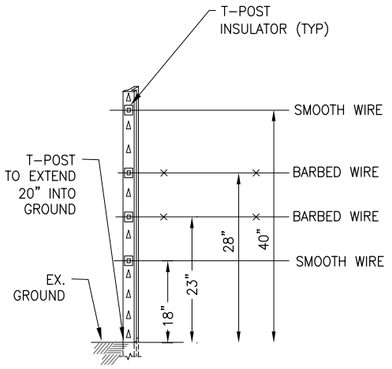
NOTES:
1. DETAIL 'B' SHALL BE USED ADJACENT TO GATES AND FOR LENGTHS GREATER THAN 300'.
2. SEE NOTE 2 FROM DETAIL 'A'.

ANCHOR DETAIL B
SCALE: NTS



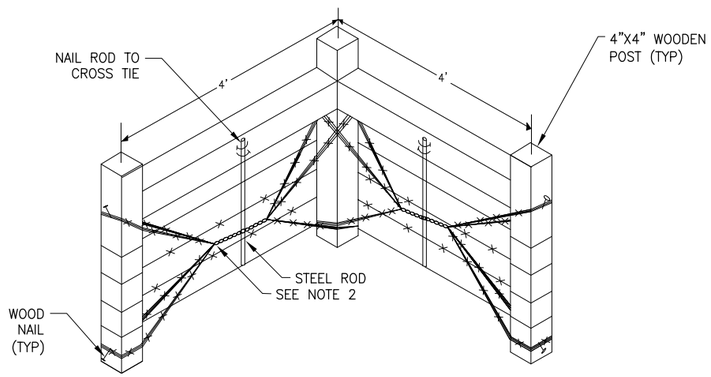
NOTES:
1. DETAIL 'C' SHALL BE USED EVERY 50'.

WOOD POST DETAIL C
SCALE: NTS



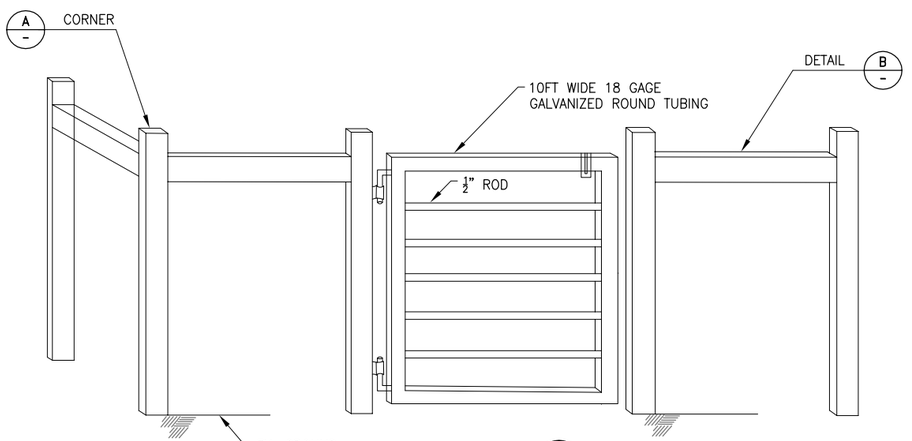
NOTES:
1. DETAIL 'D' SHALL BE USED EVERY 16.5'.

STEEL POST DETAIL D
SCALE: NTS



NOTES:
1. DETAIL 'A' SHALL BE UTILIZED AT ALL CORNERS OF FENCE OR ANGLE CHANGES SHARPER THAN 135°.
2. BARBED WIRE SHALL BE NAILED TO THE OUTSIDE EDGE OF EACH POST AT THE TOP AND BOTTOM. WIRE SHALL BE WRAPPED IN A CROSS PATTERN 3X, FOLLOWED BY PLACEMENT OF THE STEEL ROD THROUGH THE CENTER.

CORNER POST DETAIL A
SCALE: NTS



GATE DETAIL E
SCALE: NTS

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MARCH 19, 2010

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CHH	EH
PROJECT MANAGER	DESIGNED
FD	AG
APPROVAL	CHECKED
SAG	PR

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HRP ALAMEDA WATERSHED SITES

GOLDFISH POND FENCE DETAILS

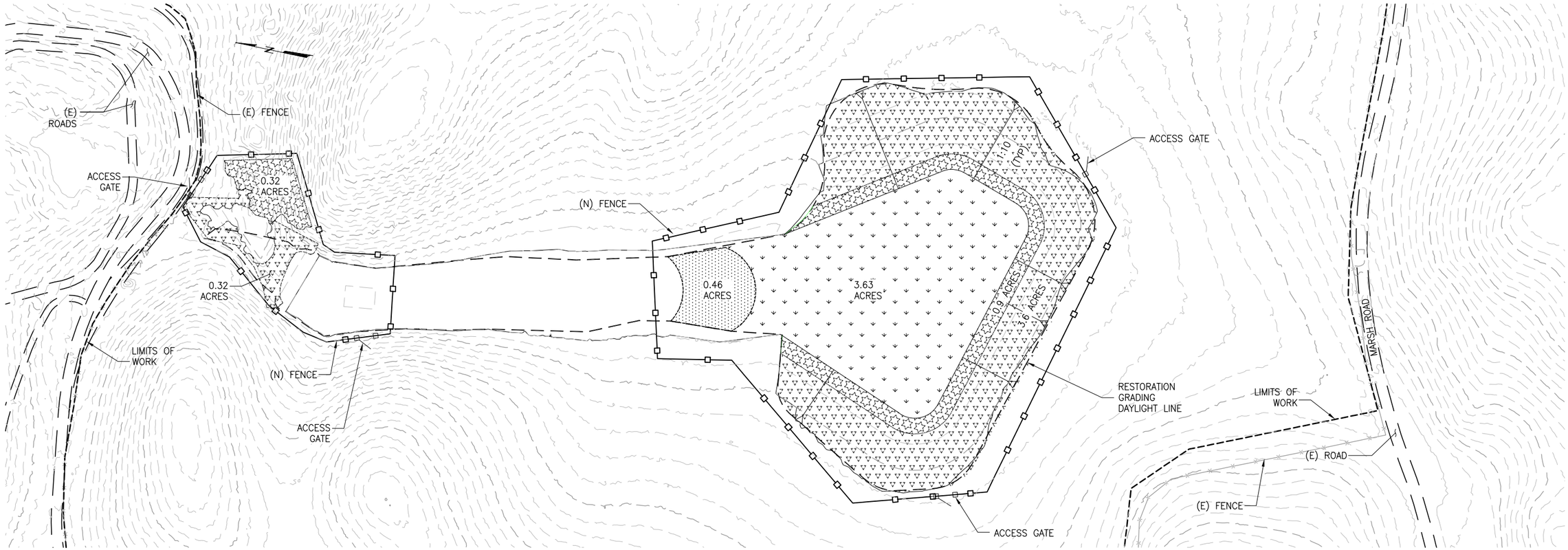
CHECKED / APPROVED	DRAWN	SCALE
		NONE
SECTION MANAGER	DESIGNED	DATE
APPROVED	APPROVED	
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SHEET	PLAN NO.	DRAWING NO.	REVISION NO.
OF	D–3	E–	

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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SOUTH CALAVERAS MITIGATION AREA (GOLDFISH POND)

HABITAT	BOTANICAL NAME	COMMON NAME	PROPAGATION METHOD	SIZE*	REMARKS
NATIVE GRASSLAND	HORDEUM BRACHYANTHERUM	MEADOW BARLEY	CONTAINER	PLUG	PLANT @ 10 FT. O.C. IN LOWER, MESIC AREAS CLOSER TO STANDING WATER
	LEYMUS TRITICOIDES	CREEPING WILDRYE	CONTAINER	PLUG	
	SISYRINCHIUM BELLUM	BLUE EYED GRASS	CONTAINER	SC	
	ACHILLEA MILLEFOLIUM	YARROW	SEED	N/A	5 LBS/ACRE IN MORE XERIC, UPLAND AREAS
	ESCHSCHOLZIA CALIFORNICA	CALIFORNIA POPPY	SEED	N/A	5 LBS/ACRE IN MORE XERIC, UPLAND AREAS
	LUPINUS BICOLOR	MINIATURE LUPINE	SEED	N/A	5 LBS/ACRE IN MORE XERIC, UPLAND AREAS
	SANICULA BIPINNATIFIDA	PURPLE SANICLE	SEED	N/A	5 LBS/ACRE IN MORE XERIC, UPLAND AREAS
	NASSELLA PULCRHA	PURPLE NEEDLEGRASS	CONTAINER	PLUG	PLANT @ 10 FT. O.C. IN XERIC, UPLAND AREAS
WILLOW RIPARIAN	SALIX EXIGUA	SANDBAR WILLOW	POLE CUTTINGS	N/A	PLANT WILOW CUTTINGS WITHIN 6 FT OF THE WATER EDGE. AVERAGE 5 FT O.C.
	SALIX LAEVIGATA	RED WILLOW	POLE CUTTINGS	N/A	
	SALIX LASIOLEPIS	ARROYO WILLOW	POLE CUTTINGS	N/A	
SEASONAL WETLAND	HORDEUM BRACHYANTHERUM	MEADOW BARLEY	CONTAINER	PLUG	PLANT @ 10 FT. O.C. JUST OUTSIDE OF REGULARLY INUNDATED AREAS
	LEYMUS TRITICOIDES	CREEPING WILDRYE	CONTAINER	PLUG	
	JUNCUS BALTICUS	BALTIC RUSH	CONTAINER	SC	PLANT @ 10 FT. O.C. ON THE FRINGES OF SEASONALLY INUNDATED AREAS
	JUNCUS PATENS	SPREADING RUSH	CONTAINER	SC	
PERENNIAL WETLAND	SHOENOPLECTUS ACUTUS	HARDSTEM BULLRUSH	CUTTING/TRANSPLANT	SC	PLANT @ 10 FT. O.C.

PLAN
SCALE: 1" = 100'

*SIZES

CODE	NAME	DIMENSIONS
SC	SUPERCELL	1.5" DIAMETER X 8.25" DEEP
PLUG	PLUG	1" X 1 "X 2 1/2" DEEP

LEGEND

- SEASONAL WETLAND – ESTABLISH (3.63 ACRES)
- PERENNIAL WETLAND – ESTABLISH (0.46 ACRES)
- NATIVE GRASS – ESTABLISH (3.92 ACRES)
- WILLOW RIPARIAN – ESTABLISH (1.22 ACRES)

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MARCH 19, 2010

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PHONE: (510) 893-3600

PROJECT ENGINEER	DRAWN
CHH	EH
PROJECT MANAGER	DESIGNED
FD	AG
APPROVAL	CHECKED
SAG	JR

NO.	DATE	DESCRIPTION	BY	APPR'D

REVISIONS

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ENGINEERING MANAGEMENT BUREAU

HRP ALAMEDA WATERSHED SITES

GOLDFISH POND
PLANTING PLAN

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	P–1	E–	

ELEVATION DATUM
NAVD88

100' 0 100' 200'
SCALE 1"=100'

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

P:\CADD\Sheets\Goldfish Pond\P–1.dwg Mar 19, 2010 – 9:48am

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 4

SAN FRANCISCO PUBLIC UTILITIES COMMISSION
CITY AND COUNTY OF SAN FRANCISCO

GREGORY LYMAN
PROJECT MANAGER
PUBLIC UTILITIES

PUBLIC UTILITIES COMMISSION
CONTRACT NO. WD xxxx
HABITAT RESTORATION PROGRAM
GOLDFISH POND

SPECIFICATIONS
SECTION DIV 2

COPY NO._____

30% Draft
March 19, 2010

PROJECT NO. 38802

Each bid is to be enclosed in an envelope bearing the superscription:

"Bid for HABITAT RESTORATION PROGRAM – GOLDFISH POND
PUBLIC UTILITIES COMMISSION
(Contract No. WD xxxx)"

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SPECIFICATIONS

DIVISION 2 – SITE WORK

Section	Title
02052	CLEARING, GRUBBING AND STRIPPING
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02630	STORM DRAIN PIPE
02830	FENCE AND GATES
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02920	CONTAINER PLANT INSTALLATION
02925	POLE CUTTING COLLECTION AND INSTALLATION
02930	HYDROSEEDING

PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for clearing, grubbing and stripping.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary to safely perform the work as shown on the Drawings and as specified herein.

1. Vegetation and trees shall be protected from damage incident to site preparation and construction as specified herein and other applicable sections.

2. The Contractor is advised to inspect the site for estimating purpose prior to bidding for the work under this contract.

C. Related Sections:

1. Section 01533 - Tree and Plant Protection.

2. Section 02200 - Earthwork.

D. Definitions:

1. Drip Line: The limits established by the outermost tips of the branches of comprising a single plant, bush or tree, or group thereof, projected to the ground in plan view.

2. Clearing: The removal of materials including trees, tree stumps, brush, other vegetation, rocks, concrete rubble, trash, and debris.

a. Clearing shall consist of cutting, removing, and disposing of all objectionable material from the ground surface, such as trash, trees, brush, logs, stumps, weeds, grasses, and obstructions of any kind, natural or artificial. Trees, shrubs, and vegetation designated to remain shall not be removed or disturbed. Trees and shrubs adjacent to work areas shall be protected from damage.

b. Work shall be performed in such a manner as to remove all evidence of the objects' presence from the surface. Clearing shall also include the removal and disposal of trash piles and rubbish from the work site created prior to and during the duration of the work.

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3. Grubbing: Grubbing shall consist of cutting, removing, and disposing of all objectionable material found 6 inches below the ground surface, including natural or artificial obstructions. Trees, stumps and roots below the surface requiring removal shall be removed completely from the ground.

4. Stripping: Stripping shall consist of the removal of the top 2 inches of soil after clearing and grubbing have been completed, or as required by the City Representative.

1.02 SUBMITTALS

A. Working Drawings and Methods Statements:

1. The Contractor shall submit a detailed clearing, grubbing and stripping plan. The plan shall include proposed temporary construction haul routes, traffic flows, number and types of equipment, and sequence of work. Include in the plan, the proposed methods of disposal of cleared vegetation and stockpiling of topsoil. The plan should also include but is not limited to:

   a. Extents of areas to be cleared, grubbed, and stripped and identify each work item to be performed within the area depicted

   b. Show layout, type, and location of barriers for trees to be protected.

   c. Show location and indicate size of trees to be cleared and grubbed. Identify the trees to be removed. For any additional trees proposed by the Contractor to be cleared and grubbed, provide:

      (1) Information on the location, size and species of each tree to be disturbed or removed. Describe the anticipated impacts to construction if the tree remains in place and any feasible alternatives to removal.

2. Submit a Recycling Program plan describing recycling to the extent possible for any trees, tree stumps, brush, other vegetation, rocks, concrete rubble, trash, metals, and debris.

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PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 GENERAL

A. Stockpile topsoil for use in areas to be seeded. Stockpile topsoil within the limits of construction, separate from other excavated materials and free of undesirable material. Place topsoil in elongated piles, or "windrows," no greater than 6 feet in height.

B. Prior to stockpiling topsoil, spread clean wheat or barley straw on the ground surface to delineate between the in-situ and salvaged topsoil.

C. Do not allow weed growth on salvaged topsoil stockpiles. Do not apply pre-emergent herbicides on topsoil stockpiles. Remove and dispose offsite any weed growth before weeds produce mature seed heads.

D. If the Contractor fails to perform topsoil salvaging, or if the quantity of topsoil salvaged does not equal the quantity of topsoil available for salvaging due to improper removal, storage or maintenance or stockpiles, the Contractor shall at its own expense import additional topsoil in quantities sufficient to meet the topsoil replacement requirements described in these Specifications. Imported topsoil shall be of natural, friable material possessing the characteristics of representative in situ materials.

E. FILLING OF HOLES: Holes made by removal of existing structures and obstructions and/or clearing and grubbing shall be refilled to adjacent ground levels with compacted fill material. Fill material properties, placement requirements, and construction control testing shall be as specified in Section 02200,"Earthwork".

F. Dispose of non-recycled materials removed during clearing and grubbing to an off-site location. Burning of materials to be cleared and grubbed on-site is not allowed. The Contractor shall stake out all work areas designated for clearing, grubbing, and stripping by survey. The Contractor shall be responsible for the accuracy, maintenance and observation of all lines and elevations.

   1. The location, limits, and methods to be used for clearing, grubbing, and stripping shall be reviewed with the City Representative prior to start of work.

   2. The Contractor shall review with the City Representative all trees greater than 4 inches in diameter at a distance of 36 inches above the ground to be removed or trimmed.

G. Do not disturb areas outside the construction limits. Protect areas outside the construction limits from Contractor operations.

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H. Do not utilize vegetation as anchorages or for other purposes.

I. Prior to cutting or removing tree limbs or roots have a City Representative inspect and approve cut or removal.

J. Assume all responsibility for injuries to, or death of vegetation arising from Contractor operations.

3.02 CLEARING

A. Clear, grub, and strip within the limits of excavation and grading indicated.

1. Vegetative materials not designated to be protected.

2. Trash piles, surficial rubbish, and fencing, including fence-post footings.

B. All cleared material consisting of vegetation shall be stockpiled at an onsite composting location approved by the Owner's Representative. Shred or chip any trees or shrubs with trunks or branches over 1/2-inch in diameter to improve composting.

C. All other non compost debris and rubbish shall be removed from the site and disposed of legally at an offsite facility.

D. Remove cleared, grubbed, and stripped materials that are not to be recycled from the project site and dispose in accordance with all applicable laws, codes, and ordinances.

E. Recycle tree trunks and limbs to the extent possible.

F. Except as otherwise directed by City Representative, cut, grub, and dispose of concrete, paving, base, vegetation, rubbish, debris and any objectionable material encountered within the limits required for construction. Areas outside the limits of clearing shall be protected. Provide temporary barricades or protection or secure the area from damage.

G. If suspected hazardous materials are encountered, immediately notify City Representative. Handle and remove suspected materials in accordance with all local, State and Federal regulations and ordinances.

3.03 REPAIR AND REPLACEMENT

A. Repair injured trees:

1. The term "injuries" in this context shall comprise any bruising, scarring, or breaking of roots, trunks, or branches.

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2. Repair or treat injured vegetation as recommended by and under the direction of the Tree Specialist.

B. Plant replacement trees as directed by City Representative.

3.04 RESTORATION, CLEAN UP AND DISPOSAL

A. Remove from site surplus material and debris during the course and at completion of the worksite as Contractor's property and dispose of in accordance with applicable Federal, State and Local Codes, Ordinances and Regulations. Burning or burying of waste material on site is prohibited.

B. Cleanup any spillage from haul routes and adjacent areas.

C. Remove equipments, temporary protection and barriers and debris.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies the requirements for earthwork.

B. The Contractor shall furnish all labor, equipment, supervision and material necessary to perform all excavation, preparing subgrade, grading, compacting, and hauling. Work incidental to the excavation work including constructing temporary fences, maintaining existing roads, maintaining protective devices to safeguard the public, protecting existing trees, and performing all other work necessary and proper for the prosecution and completion of the work under this section.

C. Related Sections:

1. Section 02052 - Clearing, Grubbing, and Stripping.

2. Section 02270 - Erosion and Sediment Control.

1.02 REFERENCES

A. Local and Regional Agencies:

1. Bay Area Air Quality Management District Regulations.

2. San Francisco Bay Regional Water Quality Control Board (SFBRWQCB)

B. ASTM International (ASTM):

1. American Society for Testing and Materials (ASTM)

a. ASTM D 422 Method for Particle-Size Analysis of Soils.

b. ASTM D 698 Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort

c. ASTM D 1556 Density of Soil in Place by the Sand Cone Method

d. ASTM D 2216 Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures

e. ASTM D 2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

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f. ASTM D 2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

g. ASTM D 3017 Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

h. ASTM D 4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils

i. ASTM D 4564 Standard Test Method for Density of Soil in Place by the Sleeve Method

j. ASTM D 4643 Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

k. ASTM D5093 Standard Test Method for Field Measurement of Infiltration Rate Using Double-Ring Infiltrometer with Sealed-Inner Ring

1.03 SUBMITTALS

A. Working Drawings and Methods Statements:

1. Submit Plan and Method Statement for the excavation and fill operation included in the project including but not limited to:

a. Construction and location of lay-down areas and stockpiles.

b. Proposed temporary construction haul routes.

c. Sequence of work.

d. Proposed methods of restoration of the temporary haul roads.

e. List of equipment.

f. Proposed flow of excavated material to temporary stockpile.

2. Erosion and sediment control plan, as required per Section 01062 “Environmental Requirements.”

B. Material Sources: Embankment fill and clay fill (to be placed at the bottom of the pond) material shall be obtained either from the designated borrow area and/or may be obtained from required project excavations. Material obtained from the borrow area and project excavations will require selective removal, processing and

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stockpiling. At the Contractor's option a commercial source may be used. The Contractor shall submit test data showing that the material from the proposed source meets the specification requirements to the City Representative 30 days prior to the commencement of fill placement. Material from each location shall be tested at a minimum of every 5,000 cubic yards, unless otherwise approved by the City Representative. Fill material brought from offsite shall have an environmental certificate meeting the requirements in Section 01800 “Environmental Protection.”

C. As-Built Survey: Submit an as-built survey for final project approval within 45 days of completing work at the site. As-built survey shall show final grades throughout the work area and all site improvement locations. Approved as-built surveys are required for the receipt of final payment.

D. Quality Control and Assurance:

1. Acceptance Criteria:

a. Construct finished surfaces to 0 to minus 0.5 feet of the elevations indicated on the Drawings.

b. Complete embankment slopes to plus or minus 0.5 feet of the slope line indicated on the Drawings. Actual slope shall match the slope shown on the Drawings.

c. Complete embankment crown to 0 to plus 2 inches of the elevations shown on the Drawings.

2. The City Representative will determine by observation and testing the quality of work and materials during site preparation and grading. The following will be judged:

a. Adequacy of site preparation;

b. Acceptability of available fill material;

c. Correct placement and compaction of fill to specified densities and permeability rates; and

1.04 JOB CONDITIONS:

A. The Contractor shall adhere to the following:

1. Verify all dimensions in the field and check all field conditions continuously during construction.

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2. Excavating, filling, and grading work shall not be performed during weather conditions which might damage or be detrimental to the condition of existing ground, in-progress work, or completed work. When the work is interrupted by rain, excavating, filling, backfilling, and grading work shall not resume until the site and soil condition (moisture content) are suitable for compaction.

3. Use equipment adequate in size, capacity, and numbers to accomplish the work of this section in a timely manner.

4. Prevention of Erosion: Comply with requirements as stated above, as specified in Section 02270, “Erosion and Sediment Control,” and the following:

   a. Prevent erosion of stockpiles, ditches, embankments, filled, backfilled, and graded areas until such time as permanent drainage and erosion control measures have been installed.

   b. Perform "protective grading" to provide positive drainage and to minimize ponding of surface water.

1.05 SAFETY MEASURES

A. Maintain at the job site a copy of all applicable portions of CAL-OSHA regulations and any other special regulations as may be required by the Owner’s Representative.

B. Provide dust control and protection in accordance with Federal, State, and Local requirements. Contractor shall assume responsibility for the alleviation or prevention of any dust nuisance on or about the site (see Section 01800, “Environmental Protection”).

1.06 FIELD VERIFICATION

A. Verify field topography, clearances and dimensions, and actual conditions at the site. Any discrepancy that may affect the proper completion of the work shall be promptly reported to the City Representative in writing. It shall be the responsibility of the Contractor to undertake corrective measures as directed by the City Representative, before starting the work as specified.

1.07 PROTECTION

A. Locate, identify, and protect utilities that remain from damage, and protect benchmarks, survey control points, fences, and other existing site features designated for protection from earthwork equipment and vehicular traffic.

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B. Protect existing access road segments to remain during proposed earthwork activities. Any damage to existing surface improvements or infrastructure shall be immediately repaired or replaced by the Contractor to the satisfaction of the City Representative, at no additional expense to the Owner.

C. Provide protective measures and devices required by applicable laws, codes, and ordinances. The Contractor shall be responsible for protecting all sides and slopes of the excavations and fill areas against cave-ins and excessive movement of ground and soils.

1.08 REMOVAL OF SUBSURFACE OBSTACLES

A. The Contractor may encounter subsurface obstacles such as: Man-made structures and utility lines not apparent prior to the bid date and/or field conditions differing substantially from those normally encountered and recognized as inherent to the work. The Contractor shall remove such subsurface obstacles to the extent necessary to complete the work, when such excavation is directed and approved by the City Representative. This work will be paid for as additional excavation in the quantity equal to the volume of subsurface obstacle removed.

1.09 TOPOGRAPHIC DATA

A. The topographic information shown on the Drawings was compiled using LIDAR 2006 data obtained from Santa Clara County and bathymetry survey data performed by SFPUC in March 2009.

B. The topographic data has not been field verified and can substantially differ from field conditions. Elevation contours shown are approximate and provided for general reference only. The Contractor shall confirm critical topographic information prior to the commencement of earthwork activities.

1.10 TIME AND CONDITIONS

A. Earthwork related activities shall occur no earlier than July 31 and no later than October 31.

PART 2 - PRODUCTS

2.01 DEFINITIONS

The terms used in this section are defined as follows:

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A. Satisfactory Materials: Satisfactory materials are materials classified by ASTM D 2487 as SM, SC, ML, and CL and any combination thereof with a maximum particle size up to 76 millimeters (3 inches). In addition, satisfactory material shall be free of roots and other organic matter, biodegradable material, rubble, debris, frozen materials, and contaminated soil.

B. Unsatisfactory Materials: Unsatisfactory materials are those materials classified by ASTM D 2487 as CH, MH, OL, PT, OH, GW, GP, GM, SW, and SP and any combination thereof. In addition, all roots and other organic matter, biodegradable material, rubble, debris, frozen materials, and contaminated soil are unsatisfactory materials.

2.02 EMBANKMENT FILL

A. Embankment fill shall consist of satisfactory material that contains not less than 15 percent by weight of material passing the No. 200 mesh sieve, and shall have a plasticity index of not less than 7, a liquid limit not greater than 45 and a maximum particle size of 76 millimeters (3 inches). If the contractor elects to separately stockpile satisfactory excavated embankment material, this material shall be considered as suitable fill material provided that it is free of organics and other deleterious material. Materials excavated from the project site can be expected to undergo a decrease in volume (shrinkage) upon compaction. This condition is normal and shrinkage values ranging from 10% to 20% are not unusual. Any change in volume due to shrinkage, no matter how much, shall not constitute a basis for a claim.

2.03 CLAY FILL

A. Clay fill shall consist of satisfactory material that contains not less than 40 percent by weight of material passing the No. 200 mesh sieve and not more than 20 percent by weight retained on the No. 4 mesh sieve. Maximum particle size for clay fill is 25 millimeters (1 inch). Clay fill shall have a plasticity index of not less than 10 and not more than 30, and a liquid limit greater than 20 and lower than 45. Additionally, plot on the plasticity chart should be above the A-line, defined as PI=0.73(LL-20). The field permeability of the compacted clay fill shall be a maximum of $5.5x10^{-6}$ cm/sec.

2.04 TOPSOIL

A. Topsoil shall be provided from on-site stripping as specified in Section 02052, “Clearing, Grubbing and Stripping”.

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PART 3 - EXECUTION

3.01 GENERAL

A. Earthmoving and transportation equipment, water equipment, and compaction equipment are the responsibility of the Contractor. Such equipment shall be of suitable type and capacity to perform the excavation, embankment work, and grading operations in accordance with the specifications and to meet the construction schedule with the soil conditions at the site.

B. All excavation work shall be done in the dry.

C. All excavation shall be conducted without damaging or removing existing structures or substructures not designated for demolition on the Drawings. Where structures or substructures are removed or damaged by the Contractor, said structures or substructures shall be repaired or restored to a condition at least as good as existed before construction of the work hereunder at no cost to the City.

D. Excavations for convenience of the Contractor shall be subject to approval by the City Representative.

E. Excavated material shall be placed at a sufficient distance from edge of excavation so as not to cause cave-ins or bank slides, but in no case closer than three feet from the edge of excavations.

F. SITE EXCAVATION

1. Excavation shall be accurately cut to lines, grades, and cross-sections indicated on the Drawings. Bottoms of excavations shall be undisturbed soil. Debris and loose rock shall be removed.

2. Removing materials: Excavate all materials encountered, except for existing services and permanent structures noted to remain. Soil conditions at bottom of excavation shall be subject to the approval of the city Representative. Surfaces shall be at straight grades shown on Drawings and clean. Maintain surface in good condition until overlying materials are placed.

3. Over Excavation: If materials are removed below required elevations, through error or careless excavating, the City Representative will check the design to determine necessary corrective measures. Such corrective measures shall be performed by Contractor at its own expense.

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4. Existing Underground Lines and Services: Existing utility lines at the project site are currently unknown. Verify on-site the location and depth of all existing utilities and services before performing earthwork construction. Excavation within 3 feet of a utility line shall be performed by hand. Active and inactive utility lines encountered shall be reported immediately to the City Representative. Carefully uncover, support, and protect lines and services. Do not cut or remove these items without the prior written approval of the City Representative. The Contractor shall repair or replace any damaged lines and services at its expense, to the satisfaction of the City Representative, immediately when requested by the City Representative. Remove unclaimed utilities as directed.

G. PIPE TRENCHING

1. Excavate to the dimension indicated. Grade bottom of trenches to provide uniform support for each section of pipe after pipe bedding placement. Tamp if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 6 inches below the bottom of the pipe.

H. EXCAVATED MATERIALS

1. Satisfactory excavated material required for embankment fill shall be placed in the proper section of the permanent work required or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed at a pre-determined on-site location.

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I. PLACING FILL MATERIAL

1. Subgrade Preparation: The subgrade to receive fill material for the embankment shall be free of organics, particles greater than 3 inches, and debris. The upper 6 inches of the subgrade shall be moistened or aerated within -1 to +2 percent of optimum moisture content; thoroughly mixed, and compacted to at least 95 percent of maximum dry density as determined by ASTM D 698. Subgrade shall not be prepared on slopes steeper than 3H to 1V. For these steeper areas, the Contractor shall over-excavate to create benches at acceptable slopes (less than 3H to 1V) to place fill. All ruts, hummocks, or other uneven surface features shall be removed by surface grading prior to placement of any fill material.

2. General

   a. Coordinate in a timely manner with the City Representative, maintain and leave open fill and subgrade areas until the City Representative observes and approves the placement of the materials. Up to one working day shall be provided by the Contractor for such observations.

   b. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

   c. Jetting, flooding, or ponding for compaction shall not be allowed.

   d. Uniformly grade areas to provide a finished surface that is smooth, compacted and free of irregularities. Grade to cross sections, lines and elevations indicated.

3. Placing and Compacting Embankment and Clay Fill Material

   a. Placement of embankment and clay fill can begin when the subgrade has been prepared in accordance with Paragraph 3.01.I of this specification and has been approved by the City Representative. Fill placed without approval shall be removed at the Contractor's own expense. Fill shall not be placed on surfaces that are wet, muddy, unstable, or subgrades that are less dense than specified compaction.

   b. Moisture conditioning shall be accomplished at the source or stockpile site. Moisture shall be uniformly distributed throughout the layer prior to compaction and be between optimum moisture content and 3 percent

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above optimum moisture content as determined by ASTM D 698. Fill material shall meet or exceed the required density within the water content limits described above. If the material is too dry for proper compaction, the Contractor will be required to adjust the pre-wetting of the material or to uniformly distribute sufficient moisture in each layer after spreading to permit the desired degree of compaction. The final adjustment of moisture shall be made at the placement location, as required. The material shall be disked at the fill placement location to blend and moisture condition the material until a uniform distribution of material and moisture is obtained. Water applied on a layer of fill shall be accurately controlled in amount so that free water will not appear on the surface during or subsequent to compaction. Should too much water be added to any area, so that the material is too wet to obtain the desired compaction, the compaction and all work on that section shall be delayed until the moisture content of the material is reduced to an amount required for proper compaction. If the material is too wet for proper compaction, the Contractor shall aerate the material to a moisture content within the desired limits prior to compaction.

c. Clay fill shall be placed to the lines, grades, and elevations shown on the drawings. Clay fill shall be placed in horizontal uncompacted lifts not to exceed 12 inches. Each layer shall be compacted to a minimum of 70 percent compaction and a maximum of 80 percent compaction as determined by ASTM D 698 to allow for establishment of wetlands vegetation. For restricted spaces or where compaction weight limitations apply, material shall be placed in horizontal uncompacted lifts not to exceed 4 inches and compacted using hand power tampers, and/or walk-behind compactors. Cut slopes shall be roughened and stepped prior to fill placement to insure adequate bonding to the cut slope sides. The surface of any compacted layer shall not be smooth to insure proper bonding with the succeeding layer. When in the opinion of the City Representative, the surface of any compacted layer is too smooth to bond properly with the succeeding layer, it shall be scarified before the succeeding layer is placed. If maximum compaction is exceeded, the Contractor shall submit a plan to the City Representative for approval to responsibly remove and replace the material at the correct compaction level.

d. Testing: Prior to placing clay fill, a small test section shall be constructed in accordance to Paragraph 3.01.I.3.c and tested for infiltration using ASTM D5093 and submitted to the City Representative

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for approval of the test results. Clay fill placement shall not begin until City Representative approves the test results.

e. Each embankment fill layer shall be compacted to at least 95 percent of maximum dry density as determined by ASTM D 698 and within a optimum moisture content range of 0 to plus 3 percent. When material does not meet the specified degree of compaction and required moisture content, the material shall be removed, replaced, or reworked, and recompacted to meet specified requirements, at no cost to the City.

4. TOPSOIL PLACEMENT

a. Topsoil shall be applied to areas to be seeded.

3.02 EARTHWORK BALANCE

A. Excess site excavated material shall be disposed of off-site by the Contractor at his expense, emplaced as fill at the project sites, or disposed of as directed by the City Representative.

3.03 PROJECT RECORD DOCUMENTS

A. Accurately record located utilities and site features remaining by horizontal dimensions, elevations or inverts, and slope gradients.

B. Any approved deviation from the Plans shall be accurately recorded on the project record documents by the Contractor.

3.04 FIELD QUALITY CONTROL

A. Cutting and shaping, excavating, conditioning, filling, and compacting procedures require approval of the City Representative as they are successfully performed. Work found to be unsatisfactory, or work disturbed by subsequent operations shall be corrected to the satisfaction of the City Representative. Fill or backfill that does not meet the specified requirements shall be removed or re-compacted until the requirements are satisfied.

1. For determining moisture content, ASTM D 2216, Laboratory Determination of Water Content of Soil, Rock and Soil-Aggregate Mixtures; or ASTM D 3017, Water Content of Soil and Rock in Place by Nuclear Methods; or ASTM D 4643, Determination of Water Content of Soil by the Microwave Oven Method.

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2. For gradation, ASTM D 422, Particle-Size Analysis of Soils

3. For determining plasticity index, ASTM D 4318, Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

4. For classifying soils, ASTM D 2487, Classification of Soils for Engineering Purposes.

5. For determining maximum dry density and optimum water content, use the impact method in accordance with ASTM D 698 Standard.

6. For determining field density, ASTM D 1556, Density of Soil in Place by the Sand-Cone Method; or ASTM D 2922, Density of Soil and Soil-Aggregate in Place by Nuclear Methods; or ASTM D 4564, Density of Soil In Place by the Sleeve Method.

7. For embankment fill, one field density test shall be performed for every other lift of embankment fill placed.

8. For determining infiltration of clay fill, ASTM D5093,use Double-Ring Infiltrometer with Sealed-Inner Ring.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for dewatering.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary to perform the following work items:

1. Dewatering of surface water in the excavation areas prior to construction.
2. Managing infiltration water by intercepting seepage which would otherwise emerge from the slopes or bottoms of excavations.
3. Disposing of pumped water.

C. Excavation dewatering includes, but is not limited to, pumping, piping, draining and other measures required for the removal or exclusion of water from excavation areas, throughout the entire period of time that construction work is taking place. This also includes the control, treatment (if necessary), and disposal of water produced during dewatering operations. The Contractor shall furnish all materials, tools, equipment, facilities, and services as required for providing the necessary dewatering work and facilities.

D. Definitions:

1. Groundwater: Groundwater denotes all water below the existing ground surface.
2. Perched Water: Perched water denotes unconfined groundwater within the work area that is separated from the underlying main body of groundwater by unsaturated material.
3. Surface Water: Surface water is all water that enters the work area at or above the ground surface, from either natural or artificial sources, including precipitation.
4. Infiltration Water: Reservoir water and groundwater that enters the work area due to seepage through the existing stratum.

1.02 SUBMITTALS

A. Submit Dewatering Plans for the following:

1. Excavations.
2. Dewatering ponded surface water, perched water and infiltration water.

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3. Disposal of pumped water

B. The dewatering plans for excavations shall include drawings and complete design data for the proposed dewatering system, showing the equipment and methods that the Contractor proposes to use to dewater the excavations, and to control and remove surface water, perched water and infiltrated water. The data provided shall include, but not be limited to, the following:

1. Design calculations.
2. Size, depth and location of dewatering wells, well points, sumps, drains, observation wells, and piezometers, if any.
3. The capacities and locations of pumping units.
4. Size and location of collection headers, discharge lines and holding ponds.
5. The proposed methods of installation of the dewatering equipment.
6. The proposed methods of controlling and removing surface water and perched water from within excavations.
7. If employed, discharge treatment and handling systems and facilities for disposal of dewatering water not stored or used on site.
8. Contingency plans, including backup equipment and emergency contact information.
9. If pumped water is discharged on site, the proposed monitoring at the discharge points to ensure rate of discharge does not cause erosion.

1.03 QUALITY CONTROL

A. Acceptance Criteria:

1. Storm Water Pollution Prevention Plan (SWPPP) for the project as specified in Section 01062, “Environmental and Regulatory Requirements.”

2. Testing: Results of discharge water testing shall be in accordance with Regional Water Quality Control Board permit and Sections 01060, “Environmental Requirements” and 01062, “Regulatory Requirements.”

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Dewatering shall be organized to provide a stable, dry subgrade to facilitate construction operations. The subgrade shall be in a firm, well-drained condition,

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and of adequate and uniform load-bearing nature to support construction personnel, construction materials, construction equipment, and steel reinforcing mats, if any, without tracking, rutting, heaving, or settlement.

B. Dewatering shall be performed in accordance with approved shop drawings. The City Representative shall be advised of any changes made to accommodate field conditions and, on completion of the dewatering system installation, revise and resubmit shop drawings as necessary to indicate the installed configuration.

C. The Contractor shall take all steps to become familiar with the site conditions, ground conditions, and the groundwater conditions. The Contractor shall obtain the data that will be required to analyze the water and soil conditions at the site to assure that the means and methods used for the system will perform properly for the duration of the contract. Limited groundwater information is available from borings and soil test pits conducted from previous investigation at the project site. Note that these reflect measurements on the date indicated and may not reflect current conditions.

D. Obtain all required permits for dewatering and monitoring wells.

E. The Contractor's operations shall not compromise safe control and disposal of water, and the Contractor shall be responsible for any damages caused as a result of its operations. Review of the dewatering system plans by the City Representative will not relieve the Contractor of its responsibility for the adequacy of the systems, including responsibility for repairing any damage to the adjacent area and/or construction site caused by the operation, leakage of operating fluids, failure, or inadequacy of the system. The Contractor shall have sole responsibility for all aspects of the dewatering system.

F. Upon completion of the dewatering operations, the dewatering equipment shall be decommissioned in accordance with local, state and federal regulations as applicable.

G. Additional excavation due to insufficient dewatering shall be done at no cost to the City.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies requirements for installation of erosion control features in the graded work areas.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary for the installation of erosion control features as shown on the Contract Drawings and as specified herein.

1. Riprap

    a. At the end of the pipe outlet at Goldfish Pond

2. Filter fabric

    a. At the end of pipe outlet at Goldfish Pond

1.02 REFERENCES

1. State of California Department of Transportation (Caltrans) Section 72 – Slope Protection.

2. American Society of Testing and Materials (ASTM)

    a. ASTM C 127 Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate

    b. ASTM D 3776 Standard Test Method for Mass per Unit Area (Weight) of Fabric

    c. ASTM D 4355 Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water

    d. ASTM D 4491Standard Test Method for Water Permeability of Geotextiles by Permittivity

    e. ASTM D 4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles

    f. ASTM D 4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

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g. ASTM D 4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile

h. ASTM D 4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Goemembranes, and Related Products

i. ASTM D 5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics

j. ASTM D 5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles

B. Related Sections:

1. Section 01561 – Stormwater Pollution Prevention, Erosion and Sediment Control.

2. Section 02052 - Clearing, Grubbing, and Stripping.

3. Section 02200 – Earthwork.

4. Section 02930 - Hydroseeding

1.03 SUBMITTALS

A. Evidence of conformance to the referenced standards shall be submitted for the following materials in accordance with the requirements of Section 01300 SUBMITTALS:

1. Riprap

a. Supplier’s certification that rock materials meet specified requirements.

b. Source (name and location of quarry) and gradation of rock material.

c. Equipment to be used for rock placement.

d. Procedures to be used for verification of line and grade of placements above and below water level.

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PART 2 - PRODUCTS

2.01 MATERIALS

A. Riprap:

1. Riprap shall be clean, sound, hard, angular fragments of rock with no appreciable fines, and shall be free of cracks, seams, or other defects. Riprap shall conform to the quality requirements of Caltrans Specifications Section 72-2.02. Riprap shall have a specific gravity of not less than 2.57, saturated surface-dry basis, when tested in accordance with ASTM C 127.

2. Riprap shall be clean, free of dirt or mud, loose concrete or mortar, trash and organic matter.

3. The points on each individual grading curve shall be between the boundary limits as defined by a smooth curve drawn through specified grading limits plotted on a mechanical analysis diagram. The individual grading curves shall not exhibit abrupt change in slope denoting skip grading or scalping of certain sizes. Specified grading of the material shall be met at both the source and as delivered to the project. In addition, material not meeting the required grading due to segregation or degradation during placement shall be rejected. If rock does not meet the required grading, the hauling operation will be stopped immediately and will not resume until rock processing procedures are adjusted and a gradation test is completed showing gradation requirements are met.

4. Grading of Riprap shall meet the following:
Caltrans Class No.2:

Rock Mass (lbs)	Percentage Smaller by Weight
75	0-5
25	25-75
5	90-100

B. Geotextile filter fabric: Woven Polypropylene with minimum 100 lbs/in2 grab tensile strength

C. Hydroseed and Mulch: Per Section 02930, “Hydroseeding”.

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PART 3 - EXECUTION

3.01 GEOTEXTILE PLACEMENT

A. Geotextile fabric shall be placed prior to placing riprap at the locations shown on the Drawings, or as directed by the City Representative.

B. Prior to placing geotextile fabric, the surfaces upon or against which geotextile is to be placed, shall be made free of loose or extraneous material and sharp objects that may damage the fabric during installation.

C. Geotextile fabric shall be joined, at the option of the Contractor, either with overlapped joints or stitched seams. When fabric is joined with overlapped joints, all adjacent borders of the fabric shall be overlapped not less than 24-inches. The fabric shall be placed such that the fabric being placed shall overlap the adjacent section of fabric in the direction the cover material is being placed.

D. When the geotextile fabric is joined by stitched seams, the fabric shall be stitched with yarn of a contrasting color. The size and composition of the yarn shall be as recommended by the fabric manufacturer. The number of stitches per inch of seam shall be 5 to 7. The strength of stitched seams shall be the same as specified for the fabric, except when stitched seams are oriented up and down a slope the strength shall be a minimum of 80 percent of that specified for the fabric.

E. Equipment or vehicles shall not be operated or driven directly on the geotextile fabric.

F. Geotextile fabric damaged during placement shall be replaced or repaired as directed by the City Representative at the Contractor's expense. Fabric damaged beyond repair, as determined by the City Representative, shall be replaced. Repairing damaged fabric shall consist of placing new fabric over the damaged area. The minimum fabric overlap from the edge of the damaged area shall be 3.2 feet for overlap joints. If the new fabric joints at the damaged areas are joined by stitching, the stitched joints shall conform to the requirements specified herein.

3.02 RIPRAP PLACEMENT

A. Riprap shall not be placed until the geotextile fabric installation is complete.

B. Riprap shall be placed in a manner to produce a well-keyed and stable layer with a uniform surface true to the lines and grades shown on the Drawings.

C. Placement: Place riprap to produce a minimum of voids in the finished fill. Smaller stones shall be uniformly distributed throughout the mass.

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D. Do not dump riprap material directly on geotextile fabric from hauling units. Riprap shall be placed with excavators, cranes equipped with skip or clamshell, or similar equipment.

E. The height of drop for the riprap materials onto the fill surface shall be limited to 5 feet or less, and riprap materials shall not be allowed to roll down the slope.

F. Equipment shall not be permitted on the finished surface of riprap.

3.03 HYDROSEEDING

A. Hydroseeding shall be performed in accordance with Section 02930, "Hydroseeding".

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies requirements for the outlet pipe and structure

B. The Contractor shall furnish labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary to perform work including but not limited to trenching (as appropriate), placement of bedding material, pipe placement, placement of pre-cast manhole structure, backfilling and testing.

C. Related Sections:

1. Section 02200 - Earthwork.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO)

1. AASHTO HB-17 (2002; Errata 2003; Errata 2005) Standard Specifications for Highway Bridges

2. AASHTO M 190 (2004) Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches

3. AASHTO M 243 (1996; R 2004) Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches

B. American Society for Testing and Materials (ASTM)

1. ASTM A 742 (2003) Standard Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe

2. ASTM A 762 (2000) Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains

3. ASTM A 798 (2001) Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications

4. ASTM C 1103 (2003) Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

5. ASTM C 478 (2007) Standard Specification for Precast Reinforced Concrete Manhole Sections

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6. ASTM C 924 (2002) Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method

7. ASTM D 1557 (2002e1) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

8. ASTM D 2167 (1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method

9. ASTM D 6938 (2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.03 Submittals

A. Placing Pipe:

1. Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

a. Certificates

b. Resin Certification

c. Pipeline Testing

d. Hydrostatic Test on Watertight Joints

2. Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed. Certification on the ability of frame and cover or gratings to carry the imposed live load.

B. Watertight Joints between Manhole and Pipe: Prior to ordering project materials, Contractor shall submit shop drawing showing proposed material and method for providing a watertight joint between pipes and manholes to the City Representative for approval.

1.04 Delivery, Storage and Handling

A. Delivery and Storage

1. Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. The

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Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the City Representative.

B. Handling

1. Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 - PRODUCTS

2.01 Polymer Pre-coated Corrugated Steel Pipe

A. ASTM A 762 corrugated steel pipe fabricated from ASTM A 742 Grade 10/10 polymer pre-coated sheet of Type II pipe with annular 2-2/3 by 1/2 inch corrugations.

2.02 Precast Reinforced Concrete Manholes

A. Pre-cast reinforced concrete manholes shall conform to ASTM C 478. Joints between pre-cast concrete risers and tops shall be made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph JOINTS.

2.03 Watertight Joints

A. Watertight joints shall conform to ASTM C 478.

2.04 Grout

A. Proprietary, premixed non-ferrous, non-shrink grout minimum 5000 psi compressive strength at 28 days; Master Builder’s Masterflow 713; Euclid Chemical Co.EucoNS; Five Star Grout; Burke Non-Ferrous-Non-Shrink; or equal.

2.05 Bedding

A. Bedding for corrugated metal pipe shall be in accordance with ASTM A 798. It is not required to shape the bedding to the pipe geometry

2.06 Hydrostatic Test on Watertight Joints

A. A hydrostatic test shall be made on the watertight joint system or coupling band type proposed. The moment strength required of the joint is expressed as 15 percent of the calculated moment capacity of the pipe on a transverse section remote from the joint by the AASHTO HB-17 (Division II, Section 26). The pipe shall be supported for the hydrostatic test with the joint located at the point which develops 15 percent of the

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moment capacity of the pipe based on the allowable span in feet for the pipe flowing full or 40,000 foot-pounds, whichever is less. Performance requirements shall be met at an internal hydrostatic pressure of 10 psi, for a 10 minute period for both annular corrugated metal pipe and helical corrugated metal pipe with factory reformed ends.

PART 3 - EXECUTION

3.01 Excavation

A. Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 02200, "Earthwork" and the requirements specified below.

3.02 Trenching

A. The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 12 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified. Contractor shall not overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the City.

3.03 Removal of rock

A. Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Rock excavation shall be as specified and defined in Section 02200, "Earthwork".

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3.04 Removal of unstable material

A. Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the City Representative, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph 3.08. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the City.

3.05 Placing Pipe

A. Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Pipelines shall be laid to the grades and alignment indicated on the Drawings. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed 5% deflection.

B. Not less than 30 days after the completion of backfilling, the Owner may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced.

C. Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Any unprotected metal in the joints shall be coated with bituminous material as specified in AASHTO M 190 or AASHTO M 243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During transportation and installation, pipe and coupling bands shall be handled with care to preclude damage to the coating, paving or lining. Damaged coatings, pavings and linings shall be repaired in accordance with the manufacturer's recommendations prior to placing backfill. Pipe on which coating, paving or lining has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.

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3.06 Jointing

A. Flexible Watertight Joints

1. Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket; the gasket shall seat properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

3.07 Manhole Structure

A. Construction shall be of pre-cast reinforced concrete. Pipe studs and junction chambers of prefabricated corrugated metal manholes shall be fully bituminous-coated and paved when the connecting branch lines are so treated. Pipe connections to concrete manholes shall be made with flexible, watertight connectors.

3.08 Backfilling

A. Backfilling Pipes in Trenches

1. After the pipe has been properly bedded, selected material from excavation, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 8 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the City Representative,

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that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

B. Backfilling Pipes in Fill

1. For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8 inches.

3.09 Movement of Construction Machinery

A. When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.10 Compaction

A. Minimum Density

1. Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to a minimum density of not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.

B. Determination of Density

1. Testing shall be the responsibility of the Contractor and performed at no additional cost to the Owner. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand

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tamper. Field density tests shall be determined in accordance with ASTM D 2167 or ASTM D 6938. When ASTM D 6938 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D 6938 results in a wet unit weight of soil and ASTM D 6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 6938. Test results shall be furnished to the City Representative. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for wildlife friendly wire fence and access gates.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary to safely perform the work as shown on the Contract Drawings and as specified herein

C. Related Sections:

1. Section 02200 - Earthwork.

D. References:

1. AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

a. AWPA C1 (2003) All Timber Products – Preservative Treatment by Pressure Processes

b. AWPA C4 (2003) Poles - Preservative Treatment by Pressure Processes

2. ASTM INTERNATIONAL (ASTM)

a. ASTM A 121 (1999; R 2004) Standard Specification for Metallic-Coated Carbon Steel Barbed Wire

b. ASTM A 702 (1989; R 2006) Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought

c. ASTM F 900 (2005) Industrial and Commercial Swing Gates

PART 2 - PRODUCTS

2.01 Barbed Wire

A. Barbed wire shall conform to ASTM A 121 zinc-coated, Type Z, Class 3, or aluminum-coated, Type A, with 12.5 gauge wire with 14 gauge, round, 4-point barbs spzed no more than 5 inches apart.

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2.02 Smooth Wire

A. Smooth wire shall conform to ASTM A 121 zinc-coated, Class 3, or aluminum-coated, Type A, with 12.5 gauge wire.

2.03 Wooden Posts

A. Wood posts shall be cut from sound and solid trees free from short or reverse bends in more than one place. Tops shall be convex rounded or inclined. Posts shall be free of ring shake, season cracks more than ¼ inch side, splits in the end, and unsound knots. Size and shape of posts shall be as indicated on the Plans. Posts shall be treated in accordance with AWPA C1 or AWPA C4 as applicable.

2.04 Metal Posts

A. Metal Posts shall conform to ASTM A 702 zinc-coated, heavy duty studded T-section; length as indicated on Plans, weighing 1.33 pounds per lineal foot. Accessories shall conform to ASTM F 900.

2.05 Metal Accessories

A. Metal accessories shall include the following:

1. ½-inch steel rod at 32-inch length
2. 4-inch wood nails
3. In-line strainer (ratchet tension device)

2.06 Metal Access Gates

A. Gates shall be of the swing type, 10 feet wide, and fabricated from 18 gage galvanized steel.

2.07 Miscellaneous Fence Items

A. Post top, anchor plates, bar bands and other required fittings and hardware shall be steel, malleable iron or wrought iron and shall be galvanized.

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B. Accessories, fittings, hardware and other miscellaneous Equipment shall be as shown on Plans.

2.08 T-Post Clips

A. T-Post Clips shall conform to ASTM A 121 zinc-coated, Type Z, Class 3, or aluminum-coated, Type A, with 12.5 gauge wire.

PART 3 - EXECUTION

3.01 General

A. Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared a minimum of 2 feet prior to installation. Line posts shall be spaced equidistant at intervals not exceeding 10 feet. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment.

3.02 Fence Installation

A. The wildlife friendly fence will consist of four wires, two barbed, and two smooth as shown on Plans and as indicated herein.

1. The top wire (smooth) will be located 40” above the ground

2. The second wire from the top (barbed) will be located 28” from the ground

3. The third wire from the top (barbed) will be located 23” from the ground

4. The bottom wire (smooth) will be located 18” from the ground

3.03 Corner Post Installation

A. Corner Posts shall consist of treated lumber posts which are 4 inches by 4 inches. Corner post holes shall be dug using a post hole digger and in a manner to ensure that all posts are level and squared. String shall be mounted on the corner post side (corner to corner) for a guide line for digging additional post holes.

B. Corner posts shall contain barbed wire “H-Braces” in order to insure a rigid design. The barbed wire shall be wrapped in a cross pattern three times, followed by the placement of a steel rod through the center to insure the wire does not unwind. Posts will extend four feet into the ground and four feet out of the ground.

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3.04 T-post Installation

A. T-post holes shall be dug using a T-post driver and set apart every 16.5 feet on center driven a minimum of 22 inches into the ground. T-Post clips shall be used to secure both smooth and barbed wires to T-posts.

3.05 Access Gates

A. Access gates shall be installed per manufacturer instructions.

3.06 Quality Control

A. Erection of fence shall have a maximum ¼-inch over 5 feet variation from plumb.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for preparing the site prior to planting.

B. The Contractor shall furnish all labor, equipment, material, and supplies for weed & weed seed removal, de-compaction of soil, import and installation of topsoil, spreading and finish grading of existing and imported soil, incorporation of amendments, plant installation layout, tree and shrub planting pit preparation and other associated work.

1.02 SUBMITTALS

A. Qualification Data: Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and address of City Representative.

B. Implementation Schedule

C. Equipment List: A list of proposed site preparation, seeding, and mulching equipment to be used in performance of seeding operation, including descriptive data calibration tests.

D. Certificates: The material supplier’s statement certifying that the supplied material meets specified requirements. Each certificate shall be signed by an official authorized to certify on behalf of material supplier and shall identify quantity and date or dates of shipment or delivery to which the certificates apply. Submit specifically for the following materials:

1. Mulches and compost: Certificate shall indicate amounts of weed and heavy metals.

2. Imported topsoil: Certificate shall indicate that soil is weed-free and in compliance with these Specifications.

1.03 REFERENCES

A. San Francisco Integrated Pest Management Program, City and County of San Francisco.

1.04 INSPECTIONS

A. It is the Contractor’s responsibility to request site inspections with the City Representative at least 48 hours prior in advance of the date observation is required. The City Representative may at anytime inspect work without notification. The following are key inspection events:

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1. Site Layout Inspection: To verify the perimeter boundaries have been staked and to ensure the protection of the existing site features and resources.

2. Planting Layout Inspection: To verify the plants are located and flagged in accordance with the Specification and Drawings.

B. Contractor's Site Conditions Verification: If, during the Contractor's site investigation, it is determined there are differing site conditions, the Contractor shall immediately notify the City Representative who will verify the conditions in question.

1.05 QUALITY CONTROL

A. Licensing Requirements: Contractor shall possess a State of California Landscape Contractor license.

B. Installer Qualifications: Engage an experienced Installer who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.

C. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that landscaping is in progress.

D. Work shall be performed in accordance with the best standards of practice relating to various trades under continuous supervision of a qualified, experienced foreman.

1.06 SHIPMENT, DELIVERY, STORAGE AND HANDLING

A. Shipment: Preparation for shipment shall be done in a manner that will not cause damage to materials, equipment or adjacent property.

B. Storage: All material shall be stored in accordance with all State and local codes and regulations governing material.

C. Handling: Care shall be taken to avoid injury to people. Materials shall not be dropped from vehicles.

D. Mulch and compost shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

E. Seed materials, during delivery and when temporarily stored onsite, shall be kept in a cool dry place, protected from moisture, wind, heat, vandalism, rodents, insects, weather, and other conditions that would damage or impair viability off seed.

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1.07 TIMES AND CONDITIONS

A. Perform the work under this Section only during periods when beneficial results can be obtained. Consider periods of potential flooding due to flows and rain. Optimum period for plan installation is between October 1 and December 31.

B. The Contractor shall be responsible for coordinating and scheduling the delivery of the material and equipment to the project site. The Contractor shall ensure each subcontractor's work is coordinated with the entire work to be performed.

C. Protect existing utilities, paving, and other facilities from any damage caused by landscaping operations.

D. Protect existing trees onsite measure at least 6" diameter at breast height (DBH).

E. It is the responsibility of the Contractor to visit the site to determine existing conditions including access to the site, the nature and extent of existing improvements upon adjacent public and private property, the nature of materials to be encountered and other factors that may affect the work of this section.

PART 2 - PRODUCTS

2.01 PESTICIDE/ HERBICIDE

A. Pesticide use is not allowed in this project. Herbicide will only be considered if and when other non-chemical control methods prove unsuccessful. If used, herbicide use shall comply with all implementation and reporting guidelines outlined in the Integrated Pest Management Plan (City and County of San Francisco 1996). Any herbicide used shall be approved for use in California and specific habitats as appropriate and not be considered a threat to any special status species.

2.02 LAYOUT MATERIAL

A. Permanent Rebar Stakes: Permanent stakes shall be 48-inch steel rebar. The top 12 inches of the rebar shall be spray painted with fluorescent colored paint and topped with colored surveyor's tape. The tops of the rebar shall be capped with plastic safety caps, manufactured specifically for that purpose.

2.03 EQUIPMENT

A. Power Equipment: All power equipment shall be provided with fire restrictive controls for both equipment and use.

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B. Low Ground Pressure Equipment: Use only low ground pressure equipment with tracks or wide tracks not exerting a pressure higher than 5 psi on the ground in areas designated for seeding or planting.

C. Heavy Equipment: If heavy or wheeled equipment access is necessary and upon written approval from the City Representative, ½" minimum thick steel plate in segments of a minimum 4'-0" x 4'-0" size shall be placed over the entire ground where this equipment will be operating.

2.04 TOPSOIL

A. Topsoil shall be obtained as specified in Section 2052 " Clearing, Grubbing and stripping". Additional topsoil needed shall be provided from off-site sources. Topsoil will be stockpiled to the side of the construction area and spread back over the previous extent at the completion of grading. Prior to any grading, weedy areas will be identified and staked in the field. Topsoil will not be conserved in areas where weed seed may cause problems with the success of native revegetation.

B. Imported Topsoil Condition: Topsoil shall be guaranteed weed/weed seed free, free of stones, lumps, roots and other debris larger than one inch and shall not contain any herbicides, insecticides or other pesticides, salts, or other chemical compounds toxic to plant growth, aquatic flora and fauna or humans.

C. Imported Soil Amendments: Imported topsoil shall be amended upon City Representative's approval in compliance with the recommendations of the soils report.

2.05 SOIL AMMENDMENTS

A. Fertilizer: Use of fertilizers is not allowed.

2.06 WEED-CONTROL PRODUCTS

A. Non-chemical, targeted and landscape-level treatment is the preferred choice for non-native invasive plant control. Methods for small non-native invasive plant infestation include manual removal with weed wrenches or string trimmers (weed whacker) or hand pulling. Landscape-level methods such as mowing and disking may be used with larger infestations.

PART 3 - EXECUTION

3.01 SITE CONDITIONS

A. Site Conditions Verification: Inspect project sites before proceeding with any work, carefully check grades, existing vegetation and verify dimensions and conditions

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affecting the work. Notify the City Representative immediately, in writing, of any deviations or conflicts between the Drawings, the Specifications, and the site conditions are observed; extra work arising from failure to do so shall be performed at the Contractor's expense. If any deviations or conflicts between the Drawings, Specifications, or site conditions are identified before the start of work, that are determined by the City Representative to require the Contractor to perform additional work, payment will be made in conformance with the Contract.

B. Weed and Debris Removal: Field verify that all areas to be planted are clear of weeds and debris prior to soil preparation

C. Contaminated Soil: Do not perform soil preparation work in areas where soil is contaminated with deleterious materials, construction debris or any other non-natural substances. Report such areas to Landscape Architect/Engineer. Do not proceed until contaminated soil is removed.

D. Moisture Content: Do not work soil when moisture content is so great that excessive compaction will occur, or when it is so dry that dust will form in air. Apply water if necessary to bring soil to optimum moisture content for tilling and planting.

3.02 SOIL PREPARATION

A. Re-compaction prevention: Use only extra-light machinery during disking and smoothing operations to minimize re-compaction of soil.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for container plant installation.

B. The Contractor shall furnish labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary for installing container plants and other associated work.

1.02 REFERENCES

A. ASFNS- American Standard for Nursery Stock, 1990 edition.

1.03 SUBMITTALS

A. Qualification Data: Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and address of Landscape Architects and Owner, and other information specified

B. Certificates of Compliance: Provide certificates confirming that materials meet the requirements specified, prior to the delivery of materials. Reports for the following materials shall be included.

1. Plant Materials: Must include scientific and common name, size, quantity by species, grade, and nursery grown.

C. Work Schedule: Submit proposed work schedule, indicated dates for each type of vegetation work as listed in this specification. Correlate with specified maintenance periods to provide maintenance from date of substantial completion. Do not begin work until such schedule is reviewed and stamped as acceptable by the City Representative and returned to Contractor. Such work schedule, once accepted, may not be revised except for reasons beyond the installer’s control. Provide at least 10 days prior to the intended date of the first delivery. Revise dates only if acceptable by City Representative and after documentation for reasons of delay.

D. Maintenance Instructions: Submit typewritten instructions recommending procedures to be established by SFPUC for maintenance of planting work after completion of contractor’s maintenance period, 60 days. Submit preliminary draft to City Representative for review prior to beginning maintenance period. Maintenance period will not be considered complete until such maintenance instructions are stamped as reviewed and acceptable to City Representative. Provide City Representative with two copies of acceptable maintenance plan before beginning warranty period.

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E. Substitutions: Requests for substitutions of materials, equipment, or methods from those given in these Specifications or shown on the Drawings shall be submitted in writing to the City Representative. All submittals shall be made well before that item of work is scheduled for installation. Multiple copies (5) of the literature shall be supplied to allow the City Representative time for review and acceptance or rejection.

F. Site Soil Analyses: The Contractor shall provide the City Representative with two (2) completed project site soil analyses. The soil samples shall be obtained from project locations as directed by the City Representative.

1.04 INSPECTIONS

A. It is the Contractor's responsibility to notify the City Representative at least 5 days prior to each anticipated inspection. The City Representative may at anytime inspect work without notification. The following are key inspection events:

1. Plant Inspection at Nursery: Plant materials shall be subject to inspection at the growing site by the City Representative and the Contractor. If the City Representative rejects provided nursery stock, the Contractor shall be required to find a plant source to replace those rejected plants at no expense to the City.

2. Plant Inspection at Job Site: The City Representative and Contractor shall inspect the plant material upon delivery at the job site (and prior to installation) for conformity to the Container Plant Standards, as per this Specification section. Any unacceptable plant material shall be removed from the job site.

3. Plant Installation Inspection: Plant installation will be inspected by the City Representative for conformance with the Drawings and specifications.

4. Installation Acceptance Inspections: Installation acceptance inspections shall be initiated only after all collective project requirements have been completed, which includes, but is not limited to: site preparation, seeding, infrastructure, planting, and all other associated work.

(1) Preliminary Installation Acceptance Inspection: Prior to the completion of the Installation Period, a preliminary inspection shall be held by the City Representative. Time for the inspection shall be requested in writing by the Contractor at least 5 working days prior to desire date. The quantity and type of plants installed, clean up requirements and the acceptability of the plants installed, in accordance with the requirements stated herein, shall be determined and noted in writing.

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(2) Final Installation Acceptance Inspection: A final inspection shall be requested in writing by the Contractor at least 5 working days prior to the desired date. At the final inspection, the City Representative will evaluate the deficiencies noted in the preliminary inspection, to ensure they have been corrected. Time for the inspection shall be established in writing. An "Installation Acceptance" will be given after all installation requirements have been satisfactorily completed and approved by the City Representative. PARTIAL ACCEPTANCE OF ANY ITEM OR COMBINATION OF ITEMS WILL NOT BE GIVEN. A written acceptance by the City Representative shall constitute the beginning of the Establishment Period.

1.05 WARRANTY

A. All plants shall be guaranteed to be healthy and in a vigorous growing condition at the time of Installation Acceptance, as determined by the City Representative.

B. Warranty during installation and maintenance periods:

1. Provide warranty that plants remain in healthy vigorous state of growth.

2. Replace and warranty for additional period of 120 calendar days, plants found not acceptable to City Representative at any time, up to and including the end of the initial 120 day Contract maintenance period.

3. Warranty period for plant replacements: Remain in effect for 120 day period, regardless of time of replacement and apply to replacements until they are successfully established for 120 day period.

4. Warranty revegetation plantings for the period(s) specified above against defects including death and/or unsatisfactory growth, except for defects resulting from neglect by SFPUC, abuse or damage by others, or unusual phenomena or incidents which are beyond installer’s control.

1.06 DELIVERY, STORAGE AND HANDLING

A. Delivery: Plants shall be picked up by the Contractor from the storage location (on-site or nursery) in and delivered to the installation site.

B. Container-Grown Plants: Containers shall be sufficiently rigid to hold ball shape and protect root mass during delivery. Plants shall be protected from the direct impacts of sun and wind during transport.

C. Plant Protection during Delivery: Preparation for delivery shall be done in a manner that will not cause shock or damage to branches, trunk, root systems or seeds. Plants shall be

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protected during delivery to prevent desiccation of the plant or damage to the roots or balls. Plants shall be delivered in a covered vehicle capable of providing protection from sun and wind. Branches of plants shall be protected by covering all exposed branches.

D. Plant Material: Do not prune prior to delivery unless otherwise instructed by the City Representative. Do not bed or bind trees or shrubs in such manner as to damage bark, break branches, or destroy natural shape. Provide protective covering during delivery, and provide any needed protection on site from traffic, pedestrians, and deleterious effects of climate while planting operations are in progress. Do not drop any planting stock during delivery or planting operations.

E. Deliver plant material after preparations for planting have been completed. Plant as soon as appropriate plant material checks are carried out by City Representative and plant locations have been approved City Representative. If planting is delayed after delivery, set material aside in shaded area out of full sun, protect from weather and mechanical damage, and keep roots moist by covering with mulch, burlap, or other acceptable means of retaining moisture. Do not remove container grown stock from containers until ready to plant.

F. Container Grown Plants Storage: Container plants not installed on the day of arrival at the site shall be stored and protected in areas designated by the City Representative. Plants shall be protected from exposure to wind and shall be shaded from the sun. Covering that will allow air to circulate and prevent internal heat from building up shall be provided. Plants shall be kept in a moist condition by watering with a fine mist spray until planted.

G. Herbaceous Plug Storage: Plugs not installed on the day of arrival at the site shall be stored and protected in areas designated by the City Representative. Plants shall be protected from exposure to wind and shall be shaded from the sun. Covering that will allow air to circulate and prevent internal heat from building up shall be provided. Plants shall be kept in a moist condition by watering with a fine mist spray until planted.

H. Other Materials Storage: Soil amendments shall be stored in dry locations away from contaminants. Storage of materials shall be in areas designated or as approved by the City Representative.

I. Handling: Care shall be taken to avoid injury to plants. Materials shall not be dropped from vehicles. Container-grown plants shall be handled by the container and by the trunk or stems.

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1.07 TIMING AND CONDITIONS

A. Planting and construction operations shall be performed only during periods when beneficial results can be obtained. When excessive moisture, winds or other unsatisfactory conditions prevail, the work shall be stopped when directed by the City Representative. The Contractor shall schedule planting in the mornings to avoid stressing plants during installation, if the planting schedule calls for installation when the temperature is expected to be 90 degrees Fahrenheit/32 degrees Centigrade or greater. When special conditions warrant a variance to the planting operations, proposed planting times shall be submitted in writing to, and approved by, the City Representative. The Contractor shall be prepared to install plants at the earliest time when all conditions (season, weather, moisture, temperature) are acceptable.

B. Installation Period: The Installation Period begins, when the Notice to Proceed (NTP) is given and continues until all requirements indicated in this specification and accompanying Drawings are completed and approved and the City Representative gives a written acceptance.

PART 2 - PRODUCTS

2.01 PLANTS

A. General: Contract to Grow Contractor will provide native plant material grown from cuttings, seed, or other propagules, as well as full size plants salvaged from the Project site of species, sizes and amounts as indicated on Drawings. All plant material will be collected from natural plant stands native to Project site, areas within the Alameda Creek watershed or other areas designated by SFPUC. Seed, cuttings and salvage plants will be collected in compliance with permits issued by the City of the property where collected, and applicable laws.

B. Quality: Well shaped, vigorous, healthy plants having proper top growth balanced with well branched root systems shall be provided. Plants shall be provided free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement and abrasion. Plants shall be provided that are typical of the species or variety and as specified herein. Seeds shall be viable free from insect damage, desiccation and abrasion.

C. Size: Plants shall be furnished in sizes indicated. No variation in size will be permitted without prior written permission by the City Representative. All variations requested by the Contractor shall be at no additional cost to the City.

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2.02 BACKFILL

A. Backfill shall be the existing soil stripped of all rocks and root matter so that it is friable and thoroughly mixed.

2.03 PLANT PROTECTION

A. Fencing: Temporary/Permanent fencing will be used in all planting areas to protect plantings from livestock.

PART 3 - EXECUTION

3.01 PREPARATION

A. Site preparation shall be completed prior to planting.

B. Surface preparation for planting zones:

1. Planting Pits: Provide plant pits as shown on the Drawings.

2. Soil Preparation:

    a. Do not work soil when moisture content is so great that an excess compaction will occur, or when it is so dry, that dust will form in the air.

    b. Apply water if necessary to provide ideal moisture content for tilling and for planting specified in this Section.

    c. Uniformly till soil to depth of 3 inches by disking, rototilling, or any other approved method prior to raking.

    d. Rake areas, removing clods or rocks larger than 1 ½ inch diameter.

    e. Thoroughly water settled soil.

    f. Emergent Zones: Saturate pond bottom to depth of 18 inches or inundate a minimum of 2 inches on emergent planting zone.

3.02 INSTALLATION

A. Planting Layout: The Planting Layout shall mimic natural conditions, with a naturalistic planting pattern (i.e., not grid planted) most likely in patches. Contractor shall locate and

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pin flagged individual plant locations. Plant material locations shall be adjusted, by the Contractor, to meet field conditions, if so directed by the City Representative. All flagging shall be left in the ground for the duration of the installation and establishment periods.

B. Plant Spacing: Plant spacing shall follow the spacing specified in the Planting Layout. The spacing listed shall be used to ensure that each plant has enough space to successfully grow.

C. Excavation for Planting:

1. Size of planting areas.

   a. Super Cells (SC) 6” dia. X depth of plant soil ball
   b. Plug 4” dia X depth of the plug

D. Container Planting Pits: In sites with no surface revetment, the planting pit for all container material shall be pre-formed (dug or drilled) and shall have a size as indicated on the Drawings. Plant pits shall be dug to produce rough vertical sides and un-compacted bottoms. Remove only enough soil within the pits so that the rootball can be freely placed without restriction. The pit shall be of sufficient size as to accept the container material without damage to plant material. The pit size shall be sufficient as to maintain continuous soil contact for the entire root ball. The method of creating the pit shall not cause soil erosion.

E. Plug Planting: A plug bar, the same depth as the plug, should be used to plant grass plugs. The plug bar will be pushed into the soil until the plug bar footrest is level with the ground. Next, the plug bar will be removed and the plug will be inserted into the hole.

F. Super Cell (SC) Planting: For planting of the SC, a 12-inch circular planting basins with a 4-inch berm around each plant will be prepared for each tube. After the holes have been excavated, the inside surfaces will be scarified to enable root penetration into the soil. Then, the intact root ball will be removed from the container and placed into the hole without damaging the roots. Finally, the excavated soil will be used to fill in the hole while the plant is held in position.

3.03 SETTING AND BACKFILLING

A. Setting Container Plants & Transplants: Container plants shall be removed from their containers without damage to the plant or root system. Place plant where indicated on the Drawings. Ensure that inoculants are placed in contact with the roots. Set plant stock upright in relation to surrounding grade so that the root crown is slightly above the surrounding soil or as indicated on the drawings. Backfill carefully, with existing soil,

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and work around the root-ball. Tamp soil so that the plant is secure and at the proper grade.

3.04 INSTALLING PLANT PROTECTION

A. Protect areas against damage, including erosion and trespass, and provide proper safeguards as may be needed.

B. Take species care to prevent erosion from surface drainage from other areas. Repair or replace any damage from such drainage.

3.05 BUILDING WATER BASINS

A. Water basins shall be constructed around all plants. A 36 in. diameter 3 in. mm high earth water basin made of existing soil shall be formed around all individual plants. The basin shall be level and compacted to hold its shape for the duration of the Installation and Establishment Periods.

3.06 MULCHING

A. No mulching is required with emergent aquatic plants or where planting in surface revetment occurs.

3.07 MAINTENANCE DURING THE INSTALLATION PERIOD

A. General: Maintain installed plants in a healthy growing condition. Maintenance shall begin immediately after each plant is installed and continue throughout the Installation Period. The maintenance includes watering, weeding, herbicide and pesticide spraying, pruning, straightening, adjusting, repairing and other necessary operations to ensure each plant is maintained in a healthy growing condition. The area immediately around the plant (18 in. radius) shall be kept free of weeds, grass and other undesired vegetation. Plants shall be checked for settlement and shall be reset to proper grade as necessary. Run-off, puddling and wilting shall be prevented and corrected as necessary. Grasses shall be kept below 3 in. in height. Weeds shall be removed on a regular basis.

B. Watering-In: All plant material shall be watered immediately (within 4 hours) after installation.

C. During the Installation Period, each plant shall receive 5 gallons of water at each watering. The application shall be applied at a rate where runoff does not occur.

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3.08 FINALIZE AS-BUILT DRAWINGS

A. The Contractor shall finalize as-built drawings for the work completed herein. The as-builts shall be current with progress of work.

3.09 RESTORATION AND CLEANUP

A. Access roads, pavements and facilities that have been damaged from the planting operation shall be restored to original condition at the Contractor's expense. Excess and waste material from the planting operation shall be removed and disposed of off the site according to all federal, state and local codes.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for pole cutting collection and installation.

B. The Contractor shall furnish labor, services, supervision, material, tools, trucks, equipment and all other appurtenances necessary to perform work including but not limited identifying, harvesting, preserving, preparing for installation, transporting and planting willow cuttings and other work as necessary to complete this Project in conformance with the Drawings and Specifications.

1.02 SUBMITTALS

A. Submit to the City Representative information describing the source of material to be used for live pole cuttings. Include the location, species, property owner, and a letter indicating permission has been granted from the property owner to harvest plant material.

1.03 TIME AND CONDITIONS

A. Plant willow cuttings between October 1 and December 31 and not until the soil is moist to a minimum depth of 8”, unless otherwise permitted, in writing, by the City Representative.

PART 2 - PRODUCTS

2.01 CUTTINGS

A. General: Provide cuttings of below described species as needed to complete the Project.

B. Origin: Collect cuttings from riparian and mesic areas within the Alameda Creek Watershed. Donor plants will be identified for the City Representative’s approval while the plants are in leaf.

C. Species: Collect cuttings of the following species:

1. Arroyo willow - *Salix lasiolepis*

2. Sandbar willow – *Salix exigua*

3. Red willow – *Salix laevigata*

D. Size & Shape: Provide cuttings with a minimum of 2 inches in diameter. Provide cuttings reasonably straight, 3 to 5 feet in length, cleared of side branches or any remaining holes.

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E. Age: Provide only live wood at least one year old or older. Do not collect very old wood. The optimal age is 4-5 years, smooth barked, not with deeply furrowed bark. Do not collect suckers and current year's growth (these do not have sufficient energy reserves).

F. Quality: Cuttings shall be vigorous stock, free of insects and disease.

2.02 FERTILIZER

A. The use of fertilizer or other amendments is not allowed.

2.03 ROOT STIMULANT

A. The use of root stimulant is not allowed.

2.04 LATEX PAINT

A. Use pure latex paint only. Do not use other synthetic paints or paints containing lead additives. Comply with all legal requirements regarding VOC (Volatile Organic Compounds).

PART 3 - EXECUTION

3.01 COLLECTION OF CUTTINGS

A. Collection Time: Collect cuttings when willows are dormant (typically January to March). Cuttings shall be soaked in water overnight before planting. If cuttings must be stored, they shall be placed in a container with water, covered with black trash bags and stored in a cool, dark place.

B. Notification: Notify the City Representative, in writing, at least 10 working days prior to gathering willow cuttings. Take cuttings only from areas shown on the Drawings or other adjacent areas approved by the City Representative.

C. Parent Plants: Take willow cuttings at random from healthy, vigorous plants. Collect cuttings from various sources to ensure genetic diversity of the plant material. Do not cut more than 30 percent of the plants in a designated area. Do not cut more than 30 percent of each individual plant. Leave a minimum of 70 percent of each individual plant intact. Leave a minimal impact to donor areas. Select for collection only branches whose removal will not impair the parent tree's health and appearance. Remove branches from the inside of the crown area rather than the more visually obvious exterior area.

D. Harvesting: Harvest cuttings with pruning shears, lopping shears, small wood saw or brush cutters. Do not use chain saw. Do not use anvil type shears of any type (these tend to crush and split cutting ends). Make cuts with sharp, clean tools. Make clean cuts

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without any additional damage or scarring of parent tree. For easy recognition of top and bottom of pole cutting at time of planting, cut off top end with a horizontal square cut above a leaf bud, bottom end with a cut at 45° angle below a leaf bud. Do not cut pole cuttings down to size after initial collection, (growth hormones concentrate at original cutting ends and subsequent second cutting would remove most of them). For all cuttings, first undercut branch to about 1/3 of its diameter on the underside, then cut branch off on the top side slightly away from the undercut to prevent the pole cutting and its parent branch from splitting. After pole cutting is collected, cut off the stub left on the parent branch just outside of the branch collar. Do not flush cut any parent branches (this can result in slow healing and susceptibility to fungal disease).

3.02 PREPARATION OF CUTTINGS

A. Stripping: Remove all buds, within 1/6 off the top end of the cutting. Remove all side branches and all leaves along the entire length of each cutting, immediately at time of collection, so cutting is one single stem. Spread pruned-off branches and trimmings in the designated willow cutting areas so that no areas are left unsightly.

B. Dipping: Seal top end of each pole cutting by dipping it in 50:50 mix of light colored latex paint in water. Assign one different color to each species.

C. Packaging: Bundle cuttings in quantities of 25 or 50 to facilitate counting, and mark by species (in addition to dipping in paint). Wrap bundles in burlap or other suitable material that protects the cuttings from sunlight, heat, and wind, and allows air to circulate. Soak cuttings in water for a minimum of 24 hours prior to planting. Cuttings may soak for up to 2 days. Only the bottom 1/3 need be placed in water. Avoid soaking latex painted cutting tops.

3.03 PREPARATION FOR PLANTING OF CUTTINGS

A. Layout: Do not plant cuttings in rows or at regular intervals, but at random as shown on the Drawings. Plant cuttings at a greater density of five cuttings per drawing symbol around installed structures, such as flow deflectors and at the beginning and end of linear structures.

B. Planting Area Clearing: Clear an area 24” in diameter of weed growth at each proposed cutting installation location prior to planting. Pesticides shall not be used for weed control.

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3.04 PLANTING OF CUTTINGS

A. Time: Plant cuttings within 48 hours after collection and keep wet until planted. Do not use willow cuttings not planted within 48 hours after cutting, or cuttings allowed to dry out. Dispose of unused willow cuttings.

B. Watering: If the soil in and around the planting area is not wet prior to planting, water the soil and maintain in a wet state until the willow cuttings are planted.

C. Planting holes: Make planting holes perpendicular to the ground line and form with a steel bar or excavate by use of an auger, post hole digger or similar tools. Make plant holes large enough to receive the willow cuttings in order that the willow cuttings may be planted to the proper depths without damage to the bark. Where rock or other hard material prohibits holes from being excavated as specified, new holes shall be excavated and the abandoned holes backfilled.

D. Planting Depths: Plant cuttings with approximately 2/3 of their length into the soil, such that at least two bud scales are visible, and shall be in good contact with soil. At a minimum, stakes shall be buried two feet below ground surface. The cuttings shall not protrude more than 1/3of their length above the ground level. Equally, cuttings shall not be less than 1/3 of their length above ground.

E. Cuttings adjustment: Do not prune or cut cuttings secondarily after their initial collection to adjust them to the hole size for any other reason.

F. Installation method: Plant cuttings with the bottom angle-cut ends in the ground and latex painted straight-cut tops above ground. Leaf bud scars shall point up. Avoid damaging pole cuttings, stripping their bark or splitting them during installation. Remove and replace split or damaged cuttings. Do not hammer cuttings into the soil. Pounding willow stakes into the ground is not allowed.

G. Backfilling: It is essential for the planted cuttings to have good contact with the soil for roots to sprout. After inserting the pole cutting into planting hole, prepare mud slurry by mixing soil and water, and fill the planting hole with it. Then tamp thoroughly soil around the cutting to remove any air pockets. Compaction shall be adequate to prevent the willow cutting from being easily removed from the soil.

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3.05 CUTTINGS MAINTENANCE

A. General: Water and maintain cuttings in a healthy condition from the time they are planted until acceptance of the contract. Replace dead cuttings immediately. The method of planting replacement cuttings shall be as specified in this section for willow cuttings.

END OF SECTION

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PART 1 - GENERAL

1.01 SUMMARY

A. This section specifies the requirements for hydroseeding. The goal of this work is to establish native grasses and herbaceous plants that provide erosion control and wildlife habitat.

B. The Contractor shall furnish all labor, services, supervision, material, tools, trucks, equipment and all other appurtenances, and services necessary for seeding and mulching of all designated areas and as necessary to complete the Project.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. AGRICULTURAL MARKETING SERVICE (AMS):AMS-01 (Amended through: Aug 1988) Federal Seed Act Regulations (Part 201-202)

2. COMMERCIAL ITEM DESCRIPTIONS (CID) CID A-A-1909 (Basic) Fertilizer

3. FEDERAL SPECIFICATIONS (FS) FS O-F-241 (Rev D) Fertilizers, Mixed, Commercial

1.03 QUALIFICATIONS

A. All work shall be done by an experienced Contractor familiar with native grass and herbaceous plant seeding and its horticulture, and industry methods and standards for seeding. The Contractor shall employ modern equipment and state of the art methods and techniques. The Contractor shall have a minimum of 3 years of applicable on the job experience with herbaceous native plant seeding and weed control.

1.04 SUBMITTALS

A. Schedules.

B. Equipment List. A list of proposed site preparation, seeding, and mulching equipment to be used in performance of seeding operation, including descriptive data and calibration tests.

C. Delivery. Delivery schedules, at least 3 days prior to the intended date of the first delivery.

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D. Maintenance and Establishment Period. Written calendar time period for the maintenance and establishment period. When there is more than one establishment period, the boundaries of the grass area covered for each period shall be described and mapped in the maintenance reports.

E. Certificates. Certificates of compliance certifying that materials meet the requirements specified, prior to the delivery of materials. Certified copies of the reports for the following materials shall be included:

F. Seed: For each species random samples from unopened and labeled containers: percent pure live seed, minimum percent germination, dormant and hard seed, maximum percent weed seed content, date tested and state certification. Certification of seeds by the Association of Official Seed Certifying Agencies (AOSCA) through the California Crop Improvement Association (CCIA) is encouraged.

G. Straw Mulch: Harvest date and location, species, and weed content.

1.05 INSPECTIONS

A. It is the Contractor's responsibility to notify the City Representative at least 5 days prior to each anticipated inspection. The City Representative/City may at any time inspect work without notification. The following are key inspection events:

1. Seed, Equipment & Application Inspection: Seeding work shall not be accepted without this inspection. Seed suppliers and collectors are subject to inspection of methods, materials, and processing. Contractor shall provide supplier and collector names and addresses upon award of contract. Seed shall be inspected upon arrival at the job site by the City Representative for conformity to species and quality. Upon arrival at the Site the Contractor shall provide the City Representative with receipts of the seed purchased and delivered to the site. Receipts shall provide name of company from which the seed was purchased, seed species, seed place of origin, composition, quantity, germination rate, and pure-live-seed (P.L.S.) percentage. Other material shall be inspected for meeting specified requirements. Unacceptable materials shall be removed from the job site and replaced by the Contractor. Immediately prior to commencement of seeding operations, the Contractor shall adjust and calibrate equipment as per manufacturer's specifications and field test in the presence of the City Representative. Seeding operation shall be inspected during equipment calibration, material loading and seed application.

2. Two-part Seeding Acceptance Inspection: Prior to the completion of the Seeding Period, a preliminary seeding inspection shall be held by the City Representative. Time for the inspection shall be requested in writing by the Contractor at least 5 working days prior to desired date. The quantity and type of species seeded, clean-up

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requirements and the acceptability of the seeding operation, in accordance with the requirements stated herein, shall be determined and noted in writing. A final inspection shall be requested in writing by the Contractor at least 5 working days prior to the desired date. At the final seeding inspection, the City Representative will evaluate the deficiencies noted in the preliminary seeding inspection, to ensure they have been corrected. Time for the inspection shall be established in writing. A "Seeding Acceptance" will be given after all seeding requirements have been satisfactorily completed and approved by the City. PARTIAL ACCEPTANCE OF ANY ITEM OR COMBINATION OF ITEMS WILL NOT BE GIVEN. A written acceptance by the City Representative of all project components, in addition to requirements specified in this section, shall constitute the beginning of the Establishment Period.

1.06 SHIPMENT, DELIVERY, STORAGE AND HANDLING

A. Shipment: Preparation for shipment shall be done in a manner that will not cause damage to seeds, and all other material.

B. Delivery: Seeds, fiber, mulch, and all other material shall be protected from weather and contamination during delivery.

C. Storage: Material shall be stored in areas approved by the City Representative. Seed shall be stored in cool, dry locations away from contaminants. Chemical and pesticide material shall not be stored with other landscape materials and shall be stored in a spillage-contained area. Mulch shall be kept covered from rain.

D. Handling: Except for bulk deliveries, material shall not be dropped or dumped from vehicles.

1.07 TIMES AND CONDITIONS

A. Seeding Conditions: Seeding and construction operations shall be performed only during periods when beneficial results can be obtained. When excessive moisture, winds or other unsatisfactory conditions prevail, the work shall be stopped when directed by the City Representative. The Contractor shall schedule planting in the mornings to avoid stressing plants during seeding, if the planting schedule calls for installation when the temperature is expected to be 90 degrees Fahrenheit/32 degrees Centigrade or greater. When special conditions warrant a variance to the planting operations, a proposed seeding time shall be submitted in writing to, and approved by, the City. The Contractor shall be prepared to seed at the earliest time when all conditions (weather, moisture, temperature) are acceptable.

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PART 2 - PRODUCTS

2.01 SEED

A. Seed Source: Seed will be sourced from the Alameda Creek Watershed.

B. Seed Classification: State-certified seed of the latest season's or previous seasons crop shall be provided in original sealed packages bearing the producer’s guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Labels shall be in conformance with AMS-01 and applicable state seed laws. AOSCA / CCIA certifications for seeds are encouraged.

C. Seed Quality: Weed seed shall not exceed percentage by weight of the total of each species as indicated in Section Seed Collection. Wet, moldy, insect infested, or otherwise damaged seed shall be rejected and removed from project site. Open containers of seed or improperly tagged containers will be rejected and removed from project site.

D. Sampling: For all seeds or containers, it is the option of the City to take random samples for each species, and require the Contractor to provide analysis of samples at no extra cost to the City.

E. Seed Mixing: The mixing of seed shall be performed by the Contractor, in the presence of the City Representative, on site and as directed by the City Representative.

F. Substitutions: Substitutions will not be allowed without written request and approval from the City Representative.

2.02 SEED SPECIES AND SEEDING RATES

A. Native Grass and Herbaceous Plant Mix: Native herbaceous plant seed species and seeding rates shall be as indicated on Drawings.

2.03 FERTILIZER

A. Fertilizers shall not be used.

2.04 PESTICIDES

A. Use of pesticides is not allowed.

2.05 MULCH

A. General: Mulch shall be free from noxious weeds and seeds, mold, and other deleterious materials.

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B. Straw: Straw shall be stalks from native grasses furnished in air-dry condition and with a consistency for placing with commercial mulch-blowing equipment. Substitutions shall be requested in writing and must be approved by City Representative. Rice straw is not allowed. Wheat or barley straw if used shall not be derived from dry farmed cereal crops.

C. Wood Cellulose Fiber: Wood cellulose fiber shall be commercially available and produced from virgin wood fiber. Fiber shall be of such character that fiber will disperse into a uniform slurry when mixed with water. The water content of the fiber before mixing into the slurry shall not exceed 15 percent of the dry weight of the fiber. The moisture content of the fiber shall be clearly marked on the package.

1. Ash Content: Fiber shall not contain more than 7 percent ash as determined by the Technical Association of the Pulp and Paper Industry (TAPPI) Standard T 413, and shall be nontoxic to plant or animal life.

2. Water-holding Capacity: Fiber shall have a water-holding capacity by weight of not less than 1,200 percent. Water-holding capacity of the fiber shall be marked on the package.

3. Coloring: Fiber shall be colored to contrast the area on which the fiber is to be applied. The material used for color shall be nontoxic to plant and animal life and Paper Fiber. Paper fiber mulch is not allowed.

2.06 TACKIFIER

A. Tackifier shall be non-toxic to plant and animal life, non-corrosive, and non-crystalline and be non-staining to concrete or painted surfaces. Tackifier shall be biodegradable.

2.07 WATER

A. Water shall be the responsibility of the Contractor, unless otherwise noted. Water shall not contain elements toxic to plant life.

PART 3 - EXECUTION

3.01 HYDROSEEDING

A. Hydroseeding: Seed species shall be mixed to ensure a seeding rate as specified on Planting Designs. Wood cellulose fiber shall be added to the mixture after the water and other mixture components have been thoroughly mixed to produce a homogeneous slurry. The slurry shall have the proper consistency to adhere to the earth slopes without lumping or running. The time period for the seed to be held in the slurry shall be a maximum of 1 hour. Slurry shall be uniformly applied under pressure over the entire

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designated area. The hydroseeded area shall not be rolled. The Contractor shall employ the following four-step hydroseeding process:

1. Step 1: Apply the first step as a complete mixture as indicated below:

   (1) Virgin Wood Cellulose Fiber, at a rate of 500 lbs. per acre.

   (2) Seed Mix, as specified and at rate specified.

2. Step 2: Apply the second step as a complete mixture as indicated below:

   (1) Virgin wood cellulose fiber, at a rate of 500 lbs. per acre.

3. Step 3: Distribute straw with straw blower or by hand:

   (1) Native grass straw, at a rate of 4,000 lbs. per acre.

4. Step 4: Apply the fourth step as a complete mixture as indicated below:

   (1) Tackifier, at a rate of 120 lbs. per acre.

   (2) Virgin Wood Cellulose Fiber, at a rate of 500 lbs. per acre.

3.02 MULCH AND TACKIFIER

A. All seeded areas, where designated on the drawings, shall be mulched and tackified after seeding operations.

B. Applying Straw. Straw mulch shall be applied to all seeded areas upon completion and approval of the seeding application by the City. Mulch shall be spread by hand, blower-type mulch spreader or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of a slope and continued uniformly until the area is covered. The mulch shall be applied loose and not be bunched.

C. All seeded areas shall be mulched within 24 hours of seeding.

D. Applying Tackifier. All straw mulch areas shall be anchored with a commercially available organically dyed organic tackifier.

E. Crimping or Punching. As a substitute for tackifying, all straw areas shall be mechanically crimped or punched into soil.

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F. Applying Fiber. Wood cellulose fiber shall be applied as part of the hydroseeding operation. The mulch shall be mixed and applied in accordance with the manufacturer's recommendations.

3.03 MAINTENANCE DURING SEEDING PERIOD

A. Maintenance shall begin immediately after seeding is completed and shall continue throughout the Seeding Period. Maintenance of the seeded areas shall include the following until Seeding Acceptance is given: regular observations of the sites, watering, hand removal of weeds, and repair of damaged areas.

B. Watering. The Contractor shall keep the soil at the seeded area constantly moist during the first three weeks after seeding.

C. Spraying for Weed Control after Seeding. The use of pesticides is not allowed.

D. Repair. All Contractor damaged areas shall be repaired by the Contractor to their original condition within 5 working days.

3.04 CLEANUP

A. Excess and waste material shall be removed from the seeded and staging areas and shall be disposed of off the site.

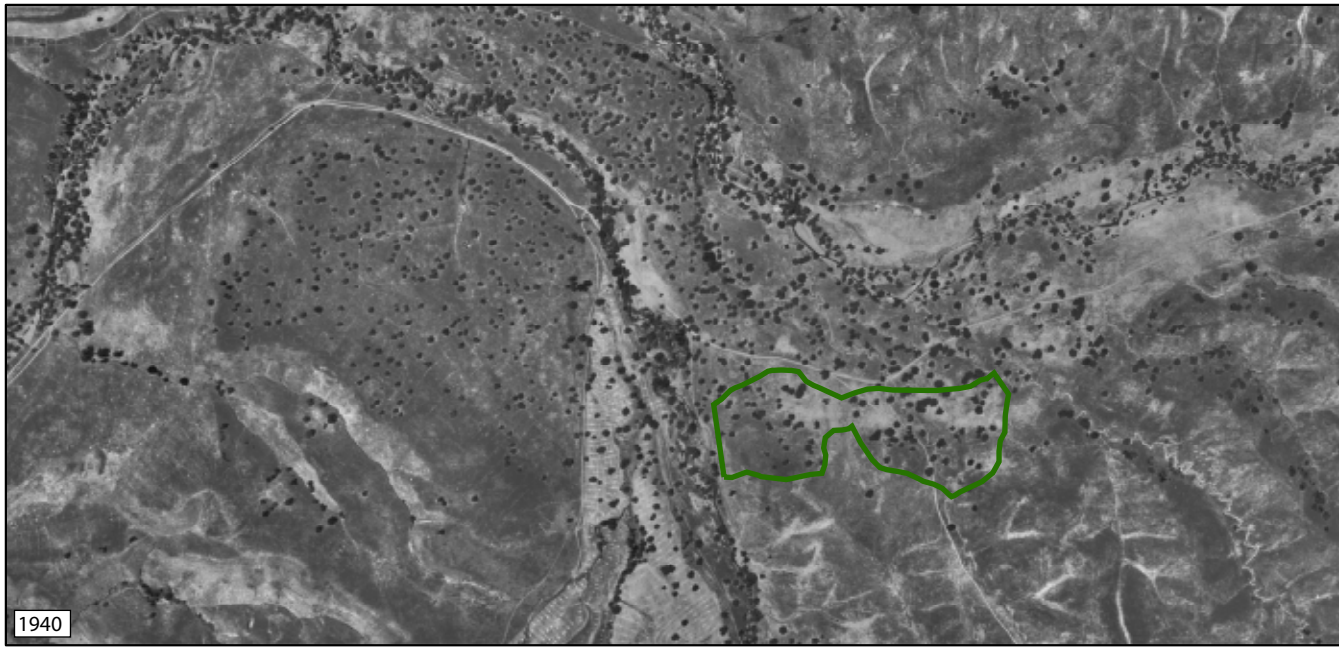
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Appendix H: San Antonio Reference Site

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SOURCE: EDAW & Turnstone JV

LEGEND

San Antonio Mitigation Area Reference Site

URS	26817504 San Francisco Public Utilities Commission Habitat Reserve Program	SAN ANTONIO MITIGATION AREA REFERENCE SITE	Appendix H

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Appendix I: Cal-IPC Inventory of Plants with Ratings of High or Moderate

Appendix I Cal-IPC Inventory of Plants with Ratings of High or Moderate

Cal-IPC Rating – California Invasive Plant Council rates Non-native invasive species as listed in the California Invasive Plant Inventory Database (Cal-IPC 2009).

- **High**: These species have severe ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. Most are widely distributed ecologically.
- **Moderate**: These species have substantial and apparent, but generally not severe, ecological impacts on physical processes, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal, though establishment is generally dependent upon ecological disturbance. Ecological amplitude and distribution may range from limited to widespread.
- **Limited**: These species are invasive but their ecological impacts are minor on a statewide level or there was not enough information to justify a higher score. Their reproductive biology and other attributes result in low to moderate rates of invasiveness. Ecological amplitude and distribution are generally limited, but these species may be locally persistent and problematic.

Scientific Name	Common Name	Cal-IPC Invasiveness Rating
Acacia dealbata	silver wattle	Moderate
Acroptilon repens	Russian knapweed	Moderate
Aegilops triuncialis	barb goatgrass	High
Ageratina adenophora	croftonweed, eupatorium	Moderate
Ailanthus altissima	tree-of-heaven	Moderate
Alhagi maurorum	camelthorn	Moderate
Alternanthera philoxeroides	alligator weed	High
Ammophila arenaria	European beachgrass	High
Anthoxanthum odoratum	sweet vernalgrass	Moderate
Arctotheca calendula (fertile)	fertile capeweed	Moderate
Arctotheca calendula (sterile)	sterile capeweed	Moderate
Arundo donax	giant reed	High
Asparagus asparagoides	bridal creeper	Moderate
Asphodelus fistulosus	onionweed	Moderate
Atriplex semibaccata	Australian saltbush	Moderate
Avena barbata	slender wild oat	Moderate
Avena fatua	wild oat	Moderate
Brachypodium distachyon	annual false-brome,	Moderate
Brachypodium sylvaticum	perennial false-brome	Moderate
Brassica nigra	black mustard	Moderate
Brassica tournefortii	Saharan mustard, African mustard	High
Bromus diandrus	ripgut brome	Moderate
Bromus madritensis ssp. rubens	red brome	High
Bromus tectorum	downy brome, cheatgrass	High

Cardaria chalepensis	lens-podded white-top	Moderate
Cardaria draba	hoary cress	Moderate
Carduus nutans	musk thistle	Moderate
Carduus pycnocephalus	Italian thistle	Moderate
Carpobrotus chilensis	sea-fig, iceplant	Moderate
Carpobrotus edulis	Hottentot-fig, iceplant	High
Carthamus lanatus	woolly distaff thistle	Moderate
Centaurea calcitrapa	purple starthistle	Moderate
Centaurea debeauxii	meadow knapweed	Moderate
Centaurea diffusa	diffuse knapweed	Moderate
Centaurea maculosa	spotted knapweed	High
Centaurea melitensis	Malta starthistle, tocalote	Moderate
Centaurea solstitialis	yellow starthistle	High
Centaurea virgata ssp. squarrosa	squarrose knapweed	Moderate
Chondrilla juncea	rush skeletonweed	Moderate
Chrysanthemum coronarium	crown daisy	Moderate
Cirsium arvense	Canada thistle	Moderate
Cirsium vulgare	bull thistle	Moderate
Conium maculatum	poison-hemlock	Moderate
Cortaderia jubata	jubatagrass	High
Cortaderia selloana	pampasgrass	High
Cotoneaster franchetii	orange cotoneaster	Moderate
Cotoneaster lacteus	Parney's cotoneaster	Moderate
Cotoneaster pannosus	silverleaf cotoneaster	Moderate
Cynara cardunculus	artichoke thistle	Moderate
Cynodon dactylon	bermudagrass	Moderate
Cynoglossum officinale	houndstongue	Moderate
Cynosurus echinatus	hedgehog dogtailgrass	Moderate
Cytisus scoparius	Scotch broom	High
Cytisus striatus	Portuguese broom	Moderate
Delairea odorata	Cape-ivy, German-ivy	High
Dipsacus fullonum	common teasel	Moderate
Dipsacus sativus	fuller's teasel	Moderate
Dittrichia graveolens	stinkwort	Moderate
Egeria densa	Brazilian egeria	High
Ehrharta calycina	purple veldtgrass	High
Ehrharta erecta	erect veldtgrass	Moderate
Ehrharta longiflora	long-flowered veldtgrass	Moderate
Eichhornia crassipes	water hyacinth	High
Elaeagnus angustifolia	Russian-olive	Moderate
Emex spinosa	spiny emex, devil's-thorn	Moderate
Erechtites glomerata, E. minima	Australian fireweed	Moderate
Eucalyptus globulus	Tasmanian blue gum	Moderate
Euphorbia esula	leafy spurge	High
Euphorbia terracina	carnation spurge	Moderate
Festuca arundinacea	tall fescue	Moderate
Ficus carica	edible fig	Moderate
Foeniculum vulgare	fennel	High
Genista monspessulana	French broom	High
Geranium dissectum	cutleaf geranium	Moderate

Glyceria declinata	waxy mannagrass	Moderate
Halogeton glomeratus	halogeton	Moderate
Hedera helix, H. canariensis	English ivy, Algerian ivy	High
Hirschfeldia incana	shortpod mustard	Moderate
Holcus lanatus	common velvet grass	Moderate
Hordeum marinum, H. murinum	Mediterranean barley	Moderate
Hydrilla verticillata	hydrilla	High
Hypericum canariense	Canary Island hypericum	Moderate
Hypericum perforatum	common St. John's wort	Moderate
Hypochaeris radicata	rough catsear, hairy dandelion	Moderate
Ilex aquifolium	English holly	Moderate
Isatis tinctoria	dyer's woad	Moderate
Kochia scoparia	kochia	Moderate
Lepidium latifolium	perennial pepperweed, tall whitetop	High
Leucanthemum vulgare	ox-eye daisy	Moderate
Linaria genistifolia ssp. dalmatica	Dalmation toadflax	Moderate
Linaria vulgaris	yellow toadflax, butter and eggs	Moderate
Lolium multiflorum	Italian ryegrass	Moderate
Ludwigia hexapetala	Uruguay water-primrose	High
Ludwigia peploides ssp. montevidensis	creeping water-primrose	High
Lythrum salicaria	purple loosestrife	High
Mentha pulegium	pennyroyal	Moderate
Mesembryanthemum crystallinum	crystalline iceplant	Moderate
Myoporum laetum	myoporum	Moderate
Myriophyllum aquaticum	parrotfeather	High
Myriophyllum spicatum	Eurasian watermilfoil	High
Nicotiana glauca	tree tobacco	Moderate
Onopordum acanthium	Scotch thistle	High
Oxalis pes-caprae	Bermuda buttercup	Moderate
Pennisetum setaceum	crimson fountaingrass	Moderate
Phalaris aquatica	hardinggrass	Moderate
Polygonum cuspidatum	Japanese knotweed	Moderate
Polygonum sachalinense	Sakhalin knotweed	Moderate
Potamogeton crispus	curlyleaf pondweed	Moderate
Retama monosperma	bridal broom	Moderate
Rubus armeniacus	Himalaya blackberry	High
Rumex acetosella	red sorrel, sheep sorrel	Moderate
Saccharum ravennae	ravennagrass	Moderate
Salsola soda	oppositeleaf Russian thistle	Moderate
Salvinia molesta	giant salvinia	High
Sapium sebiferum	Chinese tallowtree	Moderate
Sesbania punicea	red sesbania, scarlet wisteria	High
Sisymbrium irio	London rocket	Moderate
Spartina alterniflora (and S. alterniflora x foliosa hybrids)	smooth cordgrass and hybrids	High
Spartina anglica	common cordgrass	Moderate
Spartina densiflora	dense-flowered cordgrass	High
Spartium junceum	Spanish broom	High
Stipa capensis	Mediterranean steppegrass	Moderate

Taeniatherum caput-medusae	medusahead	High
Tamarix parviflora	smallflower tamarisk	High
Tamarix ramosissima	saltcedar, tamarisk	High
Tanacetum vulgare	common tansy	Moderate
Torilis arvensis	hedgeparsley	Moderate
Trifolium hirtum	rose clover	Moderate
Ulex europaeus	gorse	High
Vinca major	big periwinkle	Moderate
Vulpia myuros	rattail fescue	Moderate
Washingtonia robusta	Mexican fan palm	Moderate

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Appendix J: Propagule Collection Memo

URS

Memorandum

Date: October 2009

To: Greg Lyman, SFPUC

From: Julie Garren, Ecologist URS

Subject: ***Propagule Collection Study***

1.0 INTRODUCTION

The Calaveras Habitat Reserve Program requires the propagation of over 70,000 plants for seven mitigation projects within the Alameda Creek Watershed. In order to meet the Calaveras Habitat Reserve Program requirement, a propagule collection study was conducted to identify abundant species for propagation and ideal sites from which local genetic stock could be collected.

2.0 METHODS

In order to identify propagule collection sites and develop a collection plan; a number of steps were carried out. First, target plant species were identified for the seven mitigation sites, by reviewing background documents and editing the Mitigation and Monitoring Plan planting list. Second, propagule source locations were identified through interviews with San Francisco Public Utilities Commission (SFPUC) personnel and review of background materials. Third, URS Corporation (URS) field staff recorded target plant species locations in the field including accessible SFPUC land within the Alameda Creek Watershed. Finally, the results from the field surveys and the requirements of the seven mitigation projects were cross referenced to create a plant species palette that match the species that are available for collection and propagation. Collection sites were selected based on the presence of a significant population of uncommon target species or significant numbers of target species. Based on the cross referenced information this collection plan describes the collection methodologies and timing for propagation of specific plant species.

2.1 FIELD SURVEY

In addition to background research, URS coordinated with Tim Koopman (Watershed Keeper, SFPUC) and Loran May (Botanist, May and Associates) to identify species that are ecologically important to the mitigation projects but difficult to obtain; these species include rushes (*Juncus* sp.), native grasses (Poaceae), and sycamores (*Platanus racemosa*). In the spring of 2009, URS biologist conducted field surveys in the Alameda Creek Watershed in habitats where these species may occur. During these surveys URS field biologist recorded the locations of target species. Collection sites were identified and recorded using Global Positioning Satellite (GPS). Coupled with the GPS point, URS biologist recorded the target species present, and estimated the target species population size. The population sizes of ubiquitous species were not estimated or recorded (e.g. oaks, buckeyes, yarrow).

In addition to the field visits and coordination, URS utilized the Habitat Reserve Program documents , the Calaveras Dam Replacement Project Vegetation Community map (May and Associates 2006) and the Draft Sunol Valley Region Study Area: Biological Resources Habitat Reserve Program (ESA+Orion 2009) to identify locations of target species URS had not located and species that required additional collection points.

2.2 CHOOSING SPECIES

Target species for planting in the mitigation areas were compiled from the mitigation and monitoring plans; additional potential target species were gathered from habitat descriptions from the Draft Sunol Valley Region Study Area: Biological Resources Habitat Reserve Program (ESA+Orion 2009) and Description of The Habitat Reserve Program Project for San Francisco Public Utilities Commission's Water System Improvement Program (HRP) (Jones and Stokes 2007). Species that were regionally abundant and suitable for restoration were added to the target species list and species were removed from the list if they were determined to be uncommon or populations were insufficient for the contract to grow. The list of target species will be used in the planting plans and the contract to grow.

2.3 COLLECTION TIMELINE

A collection timeline was created to depict seed collection with planting and propagation timing for each target species. The collection timeline structures the collection needs for the Alameda contract to grow but it also identifies any critical path species that have unique growing requirements or collecting times. In order to create the timeline collection timing and propagation protocols were considered. Information in the timeline was compiled from propagation protocols identified in the Native Plant Propagation Protocol Database (Native Plant Network 2009) and U.S. Department of Agriculture Plants Database (USDA 2009). If the species did not have a propagation protocol, timing was inferred by blooming time and species biology (Calflora 2009, Hickman 1993, and USDA 2009).

2.4 COLLECTION SITE AND AREA SELECTION

Potential collection sites were identified during the field survey. Before selection of collection site accessibility and safety was considered. For example: access to natural areas along Calaveras Road were limited due to a lack of safe parking options and very steep terrain. Additionally, 4 sites were added using incidental observations during the weed survey (Nomad Ecology 2009).

Most GPS points were collected in areas where there were many target species present, however, in some instances GPS points were collect for a specific (single) target species. After all the field surveys were complete and the collection timeline was produced the collection sites were assessed for the number of target species present and proximity to other collection sites. Collection areas were developed by grouping collection sites that are in close proximity to another. Having collection areas provides structure for logistical planning.

Further analysis of the collection sites was conducted to determine which target species would be collected at each site during a given collection season. Collection season priority was given to collection sites that have difficult to obtain target species (native grasses in the spring, oaks and sycamores in the fall). Collection seasons and collection sites were cross checked, and collection sites were added, as necessary, so that all target species were accounted for within their appropriate collection scheduled. Multiple sites were identified within the collection plan for each target species to improve ecological and genetic diversity.

3.0 RESULTS

The results of the propagule collection study include: collection site and area location map, collection maps based on season, a propagule collection timeline, tables by season and target species by collection site, collection site UTM coordinates, table with the locations of the target species, and the raw data of all species recorded by site.

3.1 DATA

The various identified collection sites are depicted in Figure 1, these sites are all located on SFPUC property. The UTM coordinates for each of the collection sites depicted in Figure 1 are provided in Table 1. In some instances, multiple points have the same collection site number. Collection site with multiple points offer target species that are unique to the area and surrounded by common target species and are connected in terms of access. The UTM coordinates of all points (and collection sites) are provided in Table 1.

Table 2 summarizes the target species present at each of the collection sites and collection areas. Table 2 can be utilized to locate target species that have low collection quantities. Notes from the field survey were entered into an excel spreadsheet and include all potential target species identified and their ideal collection months. Some species listed in the raw data were omitted from the collection plan for reason explained in Section 2.2.

3.2 PROPAGULE COLLECTION PLAN

The propagule collection and propagation timeline (Table 3) visually depicts the collection and stratification periods for all species targeted in the contract to grow overlaid with predicted months of collection. This table (Table 3) identifies species with peculiar collection or stratification needs such as sycamore, snowberry (*Symphoricarpos* spp.), and oaks (*Quercus* spp.).

Table 3 can also be utilized to track collection progress and help facilitate discussion with multiple parties. It is anticipated that propagule collection will take place over 1-2 days in spring, early fall, late fall, and winter. Pre-collection reconnaissance visits to the various collection sites will be necessary to verify that the target species' seeds are mature and ready for collection.

Figure 1 depicts the location of all of the collection sites and collection areas identified. For each collection season there is a table for the target species to be collected and an overall collection map for that season (Figures 2 through 6). The season specific collection tables list all reasonable collection opportunities for target species available during that season; whereas, the collection maps and text provide suggested sites for collection. The suggested collection sites are based on need, population, size, and logistical effort. As a result, there are collection sites listed in the Table 3 (but not depicted in Figure can be utilized if needed that are not highlighted on the corresponding map and text.

Late Fall: 2009 and 2010

Late fall propagule collection will be conducted in October and/or November. These visits will be made to collect acorns for oaks, and seeds for buckeye (*Aesculus californica*), sycamore, lessingas (*Lessinga spp)*, mugwort (*Artemisia douglasiana*), California sagebrush (*Artemisia californica*), snowberry, elderberry (*Sambucus mexicana*), and coyote brush (*Baccharis pilularis*). Viable seed availability may vary for each species depending on precipitation and masting dynamics. The combination of plants collected and specific collection times are subject to change. Priority was given to collection sites with sycamores and oak diversity and density (Figure 3, Table 4). Specifically,

- Sycamores, and other species, can be found in collection sites 1, 2, 12, 22
- Oaks can be found at almost every site. Collection sites 5, 6, 12, 16, and 19 offer the best oak species diversity and population density.
- Collection site 20 is the most significant population of mugwort.
- Collection sites 3, 4, 8, and 15 should also be visited to increase quantities and diversity of all collected species listed in Table 4.
- Collection areas 8 and 9, and collection sites 9, 10, 13, 21,and 23,can be avoided in late fall.

Winter: 2009

Vegetative propagules (cuttings or salvaged material instead of seed) will be salvaged for certain species in December (Figure 4, Table 5). Vegetative propatgation by dividing plant material is an effective way to increase numbers and vegetative cover of clonal and rhizomatous species.

- Because populations of creeping wildrye (*Leymus triticoides*) and purple needlegrass (*Nassella pulchra*) will be impacted by the dam construction and they are important restoration species, these two species can be salvaged at collection sites 17 and 21.
- Collection sites 6, 12, and 13 should be visited to salvage California blackberry (*Rubus ursinus*) cuttings. Collection site 12 has the most substantial population of California blackberry and should be visited first.
- Three common rush species can be salvaged from several collection sites:
    - for Baltic rush (*Juncus balticus*) visit collection sites 2, 9, 10, and 11
    - for common rush (*Juncus patens*) visit collection sites 2, 18, and 21, and
    - for iris-leaf rush (*Juncus xiphioides*) visit collection sites 10, 11, and 13.

These rush species can be propagated by seed, obtained during early fall collection; however, propagating through salvaged material will produce more individuals for outplanting in a shorter amount of time. It is suggested that both sexual and vegetative propagation be conducted for these species; propagation from seed improves the genetic diversity of new populations.

Spring; 2010

Collection priority should be given to diverse native grassland collection sites (16, 17, and 21), and collection areas (1, 6, and 8) will be visited first during spring collection in June (Figure 5, Table 6). Collection sites 17 and 21 will most likely be impacted by the Calaveras Dam construction, so it is imperative to harvest as much native seed as possible.

Early Fall 2010

Early fall collection will be conducted in August or September depending on climate condition during the previous year. Any propagules collected during this time will only have a few months to grow in the nurseries before planting begins in winter 2010. Therefore, only species that will be planted onsite as seed or can be planted as a plug will be collected (Figure 5, Table 4).

This visit will be to collect seed from rushes, buckeye, creeping wildrye, California brome (*Bromus carinatus*), lessingas, and prairie junegrass (*Koleria macrantha*); soap plant (*Chlorogalum pomeridianum*) bulbs will be collected at this time as well.

- These species are scattered in all areas including collection 2, 3, 5, 6, 9, 10, 11, 13, 17, 18, 21, and 23.
- Supplemental collection sites listed in Table 4 can be utilized if seed needs are not met.

Winter 2010

Propagule collection in winter 2010 will be conducted specifically for willow pole cuttings (Figure 6, Table 5). Willow pole cuttings can only be cut immediately prior to planting. Pole cuttings should be cut while the willows are dormant. The cuttings can be kept in buckets of water for 24-48 hours before planting. As a result, pole cutting timing is entirely dependent on plant installation timing.

- Willow species are available at collection sites 1, 2, 3, 13, 19, and 22.
- Collection sites 1 and 2 have the most significant populations and should be visited first.

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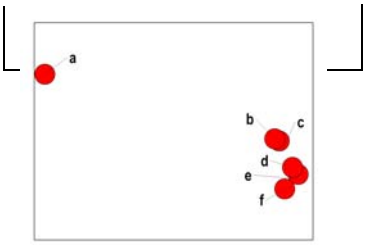
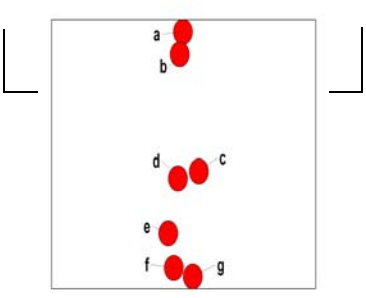
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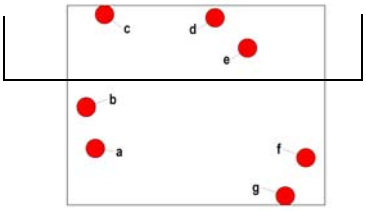
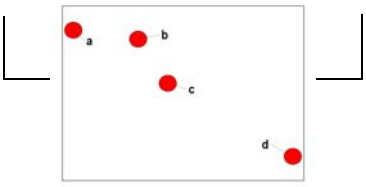
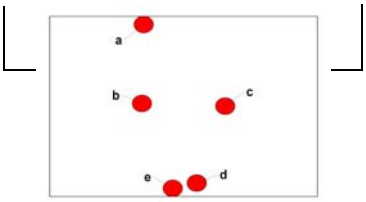
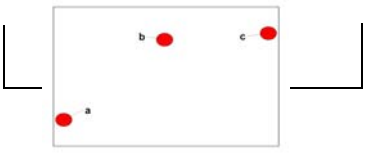
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Table 1 GIS coordinates of Collection Site Points

Collection Area	Collection Site	Individual Point Indicator	Picture of Individual Point Indicators	UTM N	UTM E
1	7	na	no picture necessary	4158428	608120
	8	na	no picture necessary	4157877	606976
	16	north	no picture necessary	4159825	609145
	16	south	no picture necessary	4159493	609250
2	1	west	no picture necessary	4161261	600352
	1	east	no picture necessary	4161214	600501
	10	na	no picture necessary	4159937	601888
	11	na	no picture necessary	4161010	601764
	24	north	no picture necessary	4161400	600864
	24	south	no picture necessary	4161049	600790
3	2	a		4159535	600541
	2	b		4159304	601454
	2	c		4159296	601472
	2	d		4159194	601527
	2	e		4159167	601550
	2	f		4159108	601499
	3	na	no picture necessary	4158675	601713
	4	north	no picture necessary	4159142	600986
	4	south	no picture necessary	4159055	601025
4	18	na	no picture necessary	4156496	599684
	20	na	no picture necessary	4156656	599829
5	12	na	no picture necessary	4156708	601154
	13	na	no picture necessary	4156700	601951
	14	na	no picture necessary	4156717	602138
	15	na	no picture necessary	4157391	602458
	25	na	no picture necessary	4156884	602042
	26	na	no picture necessary	4156561	602337
6	6	a		4150152	603327
	6	b		4150124	603323
	6	c		4149980	603358
	6	d		4149970	603324
	6	e		4149902	603310
	6	f		4149859	603320
	6	g		4149849	603351

	19	na	no picture necessary	4150422	604406
	21	north	no picture necessary	4150460	603424
	21	south	no picture necessary	4150386	603462
7	5	a		4148404	603344
	5	b		4148423	603339
	5	c		4148467	603346
	5	d		4148467	603399
	5	e		4148453	603414
	5	f		4148402	603443
	5	g		4148383	603434
8	17	na		4147995	605180
9	27	a		4154801	601646
	27	b		4154793	601711
	27	c		4154746	601742
	27	d		4154671	601869
	28	a		4152443	603052
	28	b		4152320	603053
	28	c		4152319	603165
	28	d		4152198	603130
	28	e		4152189	603098
	29	a		4151679	603184
	29	b		4151698	603202
	29	c		4151700	603221
10	9	na	no picture necessary	4159495	604996
	22	na	no picture necessary	4160533	607148
	23	na	no picture necessary	4161858	604490

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Table 2. Target Plant Locations

Collection Area		1		2				3			4		5						6			7	8	9			10		
Collection Site		8	16	1	10	11	24	2	3	4	18	20	12	13	14	15	25	26	6	19	21	5	17	27	28	29	9	22	23
Scientific Name	**Common Name**																												
Achillea millefolium	yarrow	•	•			•		•													•	•							
Aesculus californica	buckeye		•			•		•	•				•		•														
Artemisia californica	California sagebrush																		•			•		•					
Artemisia douglasiana	mugwort											•							•										
Baccharis pilularis	coyote brush											•																	
Bromus carinatus	California brome		•																•				•						
Chlorogalum pomeridianum	soap plant								•							•						•	•						
Elymus glaucus	blue wildrye	•	•						•	•						•			•			•	•		•				
Eriogonum fasciculatum	California buckwheat							•																					
Festuca californica	California fescue																								•	•			
Festuca californica or idahoensis									•													•							
Festuca rubra	red fescue		•																				•						
Juncus balticus	baltic rush				•	•		•																			•		
Juncus patens	common rush							•			•			•							•								
Juncus spp.	rush							•												•									
Juncus xiphioides	irisleaf rush				•	•		•						•															
Koleria macrantha	prairie junegrass																						•						
Lessingia filaginifolia	common sandaster	•	•			•		•							•														
Lessingia sp.									•										•			•							
Leymus triticoides	creeping wildrye													•							•		•						•
Lupinus sp. (perennial)	lupine																	•											
Lupinus albifrons	silver lupine														•				•					•					
Lupinus sp. (annual)	lupine															•						•	•						
Melica californica	California melic																				•								
Melica spp.		•							•										•			•	•						
Mimulus aurantiacus	bush monkeyflower	•							•			•							•										
Nassella pulchra	purple needlegrass	•	•				•	•								•	•	•	•		•		•	•	•	•			
Nassella spp.															•														
Platanus racemosa	western sycamore			•				•					•															•	
Poa secunda	one sided bluegrass																						•						
Quercus agrifolia	coast live oak	•	•	•									•						•	•									
Quercus douglasii	blue oak	•	•	•		•													•	•			•						
Quercus lobata	valley oak												•							•									
Quercus ssp	oak														•	•						•							
Rubus ursinus	California blackberry												•	•					•										
Salix exigua	sandbar willow								•																				
Salix laevigata	red willow													•															
Salix lasiolepis	arroyo willow			•																									
Salix spp.	willow			•				•												•								•	
Sambucus mexicana	blue elderberry			•				•																					
Sanicula bipinnatifida	purple sanicle									•													•						
Sanicula crassicaulis	Pacific sanicle		•						•												•								
Scrophularia californica	bee plant							•			•		•						•										
Symphoricarpos spp.	snowberry							•					•						•			•							
Total Number of Species Present		**9**	**11**	**6**	**3**	**6**	**1**	**16**	**9**	**5**	**2**	**3**	**7**	**5**	**5**	**6**	**1**	**2**	**18**	**5**	**7**	**11**	**13**	**3**	**3**	**2**	**1**	**2**	**1**

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Table 3 - Propagule Collection Timeline

	Fall and Winter Collection		Late Fall Collection		Winter Salvage		Growth in Nursery			Early Fall Collection	Growth in Nursery					Outplanting	
	Spring Collection									Spring Collection	Growth in Nursery					Outplanting	
	Species	**Common**	**Annual/ Perennial**	**Oct-09**	**Nov-09**	**Dec-09**	**Jan-10**	**Feb-10**	**Mar-10**	**Apr-10**	**May-10**	**Jun-10**	**Jul-10**	**Aug-10**	**Sep-10**	**Oct-10**	**Nov-10**	**Dec-10**	**11-Jan**
Species Specific Propagule Collection and Ideal Propagation Timing	*Achillea millefolium*	yarrow	Perennial																
	Aesculus californica	california buckeye	Perennial																
	Artemisia californica	California sagebrush	Perennial																
	Artemisia douglasiana	mugwort	Perennial																
	Baccharis pilularis	coyote brush	Perennial																
	Bromus carinatus	California brome	Perennial																
	Chlorogalum pomiridianum	soap plant	Perennial																
	Elymus glaucus	blue wildrye	Perennial																
	Eriogonum fasciculatum	California buckwheat	Perennial																
	Festuca spp		Perennial																
	Juncus spp.	"most rushes"	Perennial																
	Koeleria macrantha	prairie junegrass	Perennial																
	*Lessinga spp.**		Perennial																
	*Leymus triticoides**	creeping wildrye	Perennial																
	Lupinus spp.	lupine	Annual																
	Melica ssp		Perennial																
	Mimulus aurantiacus	bush monkeyflower	Perennial																
	Nassella pulchra	purple needlegrass	Perennial																
	Platanus racemosa†	western sycamore	Perennial																
	Poa secunda	one sided bluegrass																	
	Quercus spp.†	oak	Perennial																
	Rubus ursinus	California blackberry	Perennial																
	Salix spp.†	willow	Perennial																
	*Sambucus mexicana**	blue elderberry	Perennial																
	Sanicula spp *	purple sanicle	Perennial																
	Scrophularia californica	bee plant	Perennial																
	Symphoricarpos spp.	common snowberry	Perennial																

Legend	Comments
Seed Collection Seed Planting onsite Seed Straitification Cutting Collection / Salvage	This timeline depicts the most likely collection times based on species biolog,available timing, and contract milestones. Collecting opportunities outside of the predicted times are also listed in case extra collection visits for a species are needed. *Where no protocol was available, seed collection timing was inferred based on species biology and bloom time. † Species that require special attention including separate collection trips or planting dates.

Table 4 Fall Collection Opportunities				
Collection Area	**Collection Site**	**Species**	**Early Fall**	**Late Fall**
1	8	*Lessingia filaginifolia*	•	•
		Quercus agrifolia		•
		Quercus douglasii		•
		Achillea millefolium	•	•
	16	*Aesculus californica*	•	•
		Bromus carinatus	•	
		Lessingia filaginifolia	•	•
		Quercus agrifolia		•
		Quercus douglasii		•
		Achillea millefolium	•	•
2	1	*Platanus racemosa*		•
		Quercus agrifolia		•
		Quercus douglasii		•
		Sambucus mexicana		•
	10	*Juncus balticus*	•	
		Juncus xiphioides	•	
	11	*Aesculus californica*	•	•
		Juncus balticus	•	
		Juncus xiphioides	•	
		Lessingia filaginifolia	•	•
		Quercus douglasii		•
		Lessingia filaginifolia	•	•
		Quercus douglasii		•
		Achillea millefolium	•	•
3	2	*Aesculus californica*	•	•
		Eriogonum fasciculatum	•	
		Juncus balticus	•	
		Juncus patens	•	
		Juncus xiphioides	•	
		Lessingia filaginifolia	•	•
		Platanus racemosa		•
		Sambucus mexicana		•
		Achillea millefolium	•	•
		Symphoricarpos spp		•
		Juncus spp.	•	
	3	*Aesculus californica*	•	•
		Clorogalum pomiridianum	•	
		Lessingia sp.	•	•
	4	*Quercus spp.*		•
4	18	*Juncus patens*	•	
	20	*Artemisia douglasiana*		•
		Baccharis pilularis		•
5	12	*Aesculus californica*	•	•
		Platanus racemosa		•
		Quercus agrifolia		•
		Quercus lobata		•
		Symphoricarpos spp		•
	13	*Juncus patens*	•	
		Juncus xiphioides	•	
		Leymus triticoides	•	
	14	*Aesculus californica*	•	•
		Lessingia filaginifolia	•	•
		Quercus spp.		•
	15	*Clorogalum pomiridianum*	•	
		Quercus spp.		•
6	6	*Artemisia californica*		•
		Artemisia douglasiana		•
		Bromus carinatus	•	
		Lessingia sp.	•	•
		Quercus agrifolia		•
		Quercus douglasii		•
		Symphoricarpos spp		•
	19	*Quercus agrifolia*		•
		Quercus douglasii		•
		Quercus lobata		•
		Juncus spp.	•	
	21	*Juncus patens*	•	
		Leymus triticoides	•	
		Achillea millefolium	•	•
7	5	*Artemisia californica*		•
		Clorogalum pomiridianum	•	
		Lessingia sp.	•	•
		Achillea millefolium	•	•
		Symphoricarpos spp		•
		Quercus spp.		•
8	17	*Bromus carinatus*	•	
		Clorogalum pomiridianum	•	
		Leymus triticoides	•	
		Quercus douglasii		•
		Koeleria macrantha	•	
9	27	*Artemisia californica*		•
10	9	*Juncus balticus*	•	
	22	*Platanus racemosa*		•
	23	*Leymus triticoides*	•	

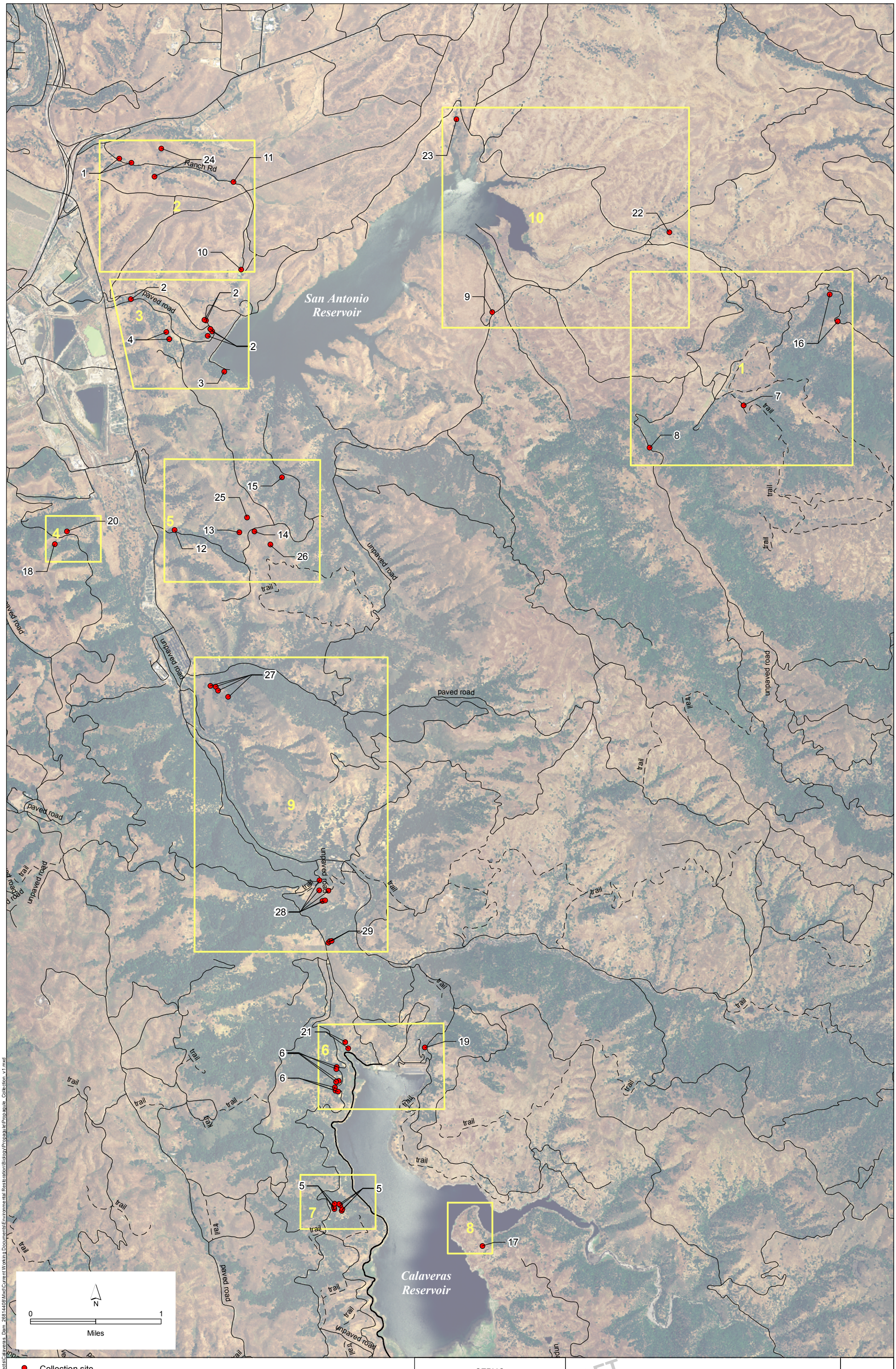
Table 5 Winter Salvage Opportunities		
Collection Area	**Collection Site**	**Species**
2	**1**	*Salix lasiolepis* *Salix sp.*
	10	*Juncus balticus* *Juncus xiphioides*
	11	*Juncus balticus* *Juncus xiphioides*
3	**2**	*Juncus balticus* *Juncus patens* *Juncus xiphioides* *Salix sp.*
	3	*Salix exigua*
4	18	*Juncus patens*
5	**12**	*Rubus ursinus*
	13	*Juncus patens* *Juncus xiphioides* *Rubus ursinus* *Salix laevigata*
6	6	*Rubus ursinus*
	19	*Juncus sp* *Salix sp.*
	21	*Juncus patens* *Leymus triticoides* *Nassella pulchra*
8	17	*Leymus triticoides* *Nassella pulchra*
10	**9**	*Juncus balticus*
	22	*Salix sp.*

Bold collection sites are priority sites for that species.

Table 6 Spring Collection Opportunities		
Collection Area	**Collection Site**	**Species**
1	8	*Elymus glaucus* *Melica sp.* *Mimulus aurantiacus* *Nassella pulchra* *Achillea millefolium*
	16	*Bromus carinatus* *Elymus glaucus* *Festuca rubra* *Nassella pulchra* *Sanicula crassicaulis* *Achillea millefolium*
2	24	*Nassella pulchra*
3	2	*Nassella pulchra* *Scrophularia californica* *Achillea millefolium*
	3	*Elymus glaucus* *Festuca californica or idahoensis* *Melica sp.* *Mimulus aurantiacus* *Sanicula crassicaulis*
	4	*Elymus glaucus* *Sanicula bipinnatifida*
4	18	*Scrophularia californica*
	20	*Mimulus aurantiacus*
5	12	*Scrophularia californica*
	13	*Leymus triticoides*
	14	*Lupinus albifrons* *Nassella spp.*
	15	*Elymus glaucus* *Nassella pulchra* *Lupinus sp. (annual)*
	25	*Nassella pulchra*
	26	*Nassella pulchra* *Lupine sp. (perennial)*
6	6	*Bromus carinatus* *Elymus glaucus* *Melica sp.* *Mimulus aurantiacus* *Nassella pulchra* *Scrophularia californica* *Lupinus albifrons*
	21	*Leymus triticoides* *Melica californica* *Nassella pulchra* *Sanicula crassicaulis* *Achillea millefolium*
7	5	*Elymus glaucus* *Festuca californica or idahoensis* *Melica sp.* *Achillea millefolium* *Lupinus sp. (annual)*
8	**17**	*Bromus carinatus* *Elymus glaucus* *Festuca rubra* *Leymus triticoides* *Nassella pulchra* *Poa secunda* *Sanicula bipinnatifida* *Lupinus sp. (annual)* *Koeleria macrantha* *Melica ssp.*
9	27	*Nassella pulchra* *Lupinus albifrons*
	28	*Elymus glaucus* *Nassella pulchra* *Festuca californica*
	29	*Nassella pulchra* *Festuca californica*
10	23	*Leymus triticoides*

Bold collection sites are priority sites for this season.

FIGURES



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URS PROJECT NO. 26817504

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Propagule Collection Sites Overview

Figure 1

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San Antonio Reservoir

Calaveras Reservoir

Ranch Rd

Paved road

paved road

unpaved road

trail

1 2 3 4 5 6 7 8 9 10

1 24 11 10

2 2 2 2 3

20 18

15 25 13 14 12 26

27 28 29

23 9 22 10

16 7 8 1

21 6 6 19

5 5

17

N

0 1

Miles

Collection site

Late Fall collection site

Collection area

Trail

Road

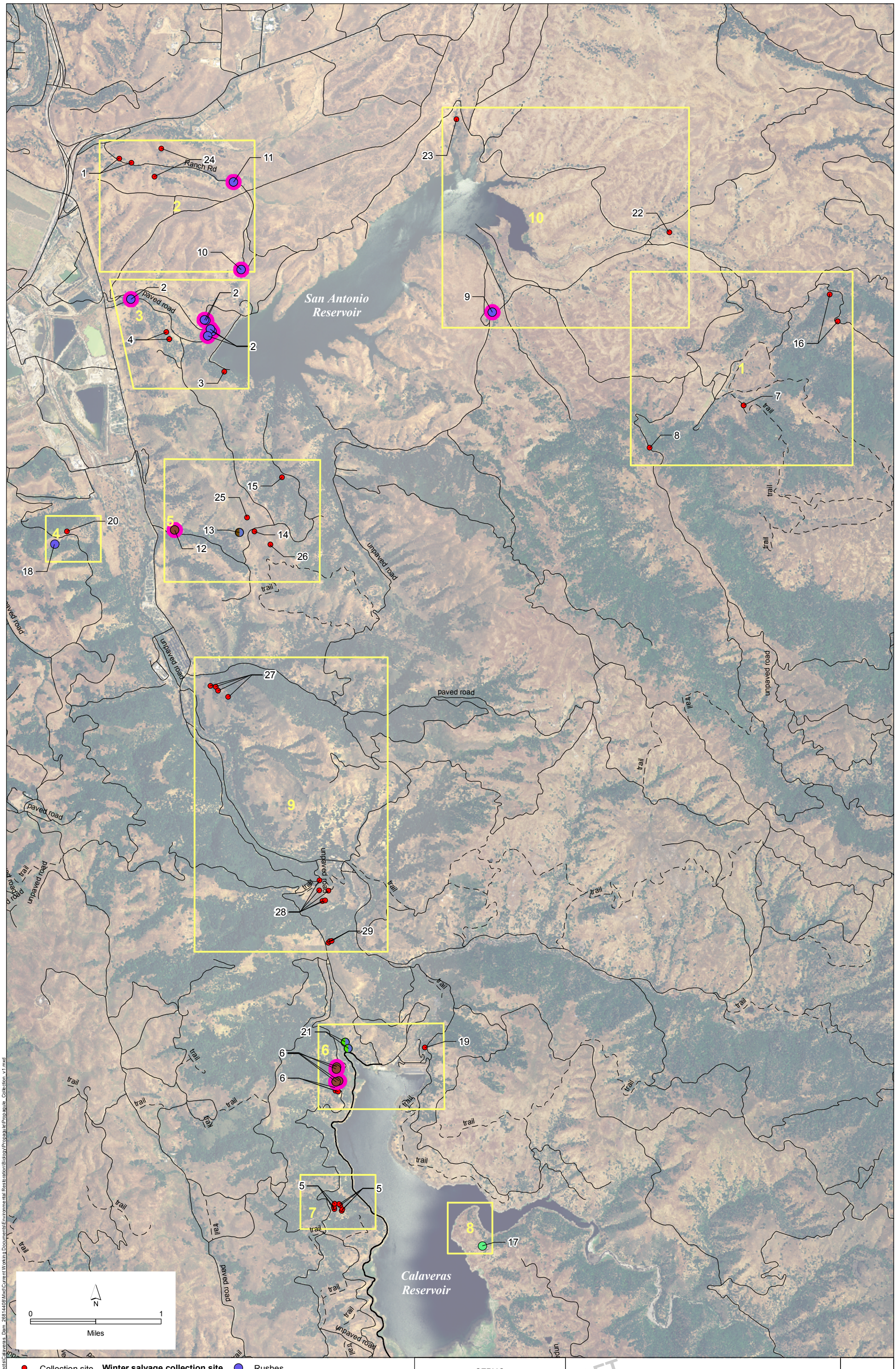
SFPUC
CALAVERAS DAM
HABITAT RESERVE PROGRAM
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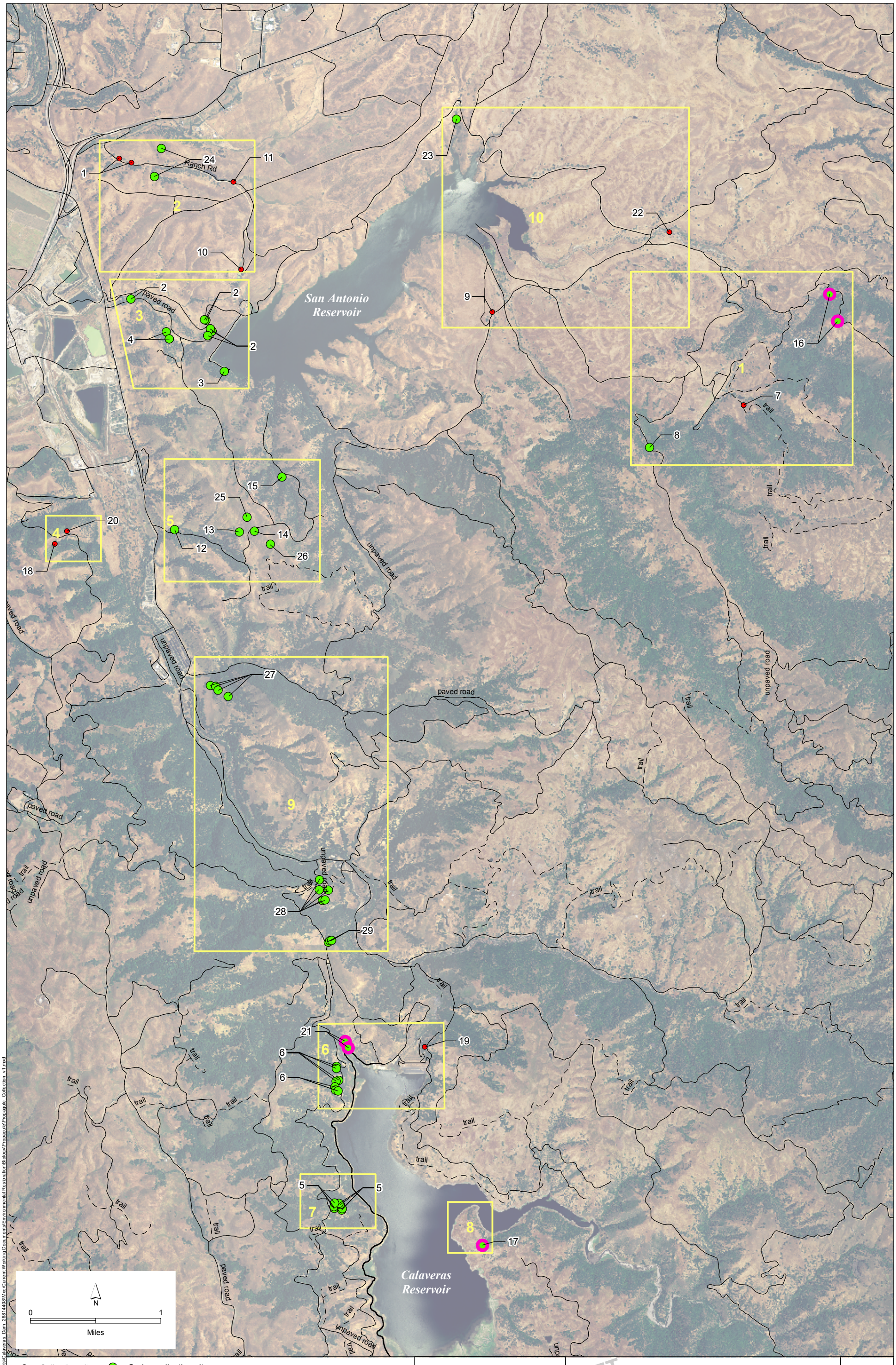
DRAFT

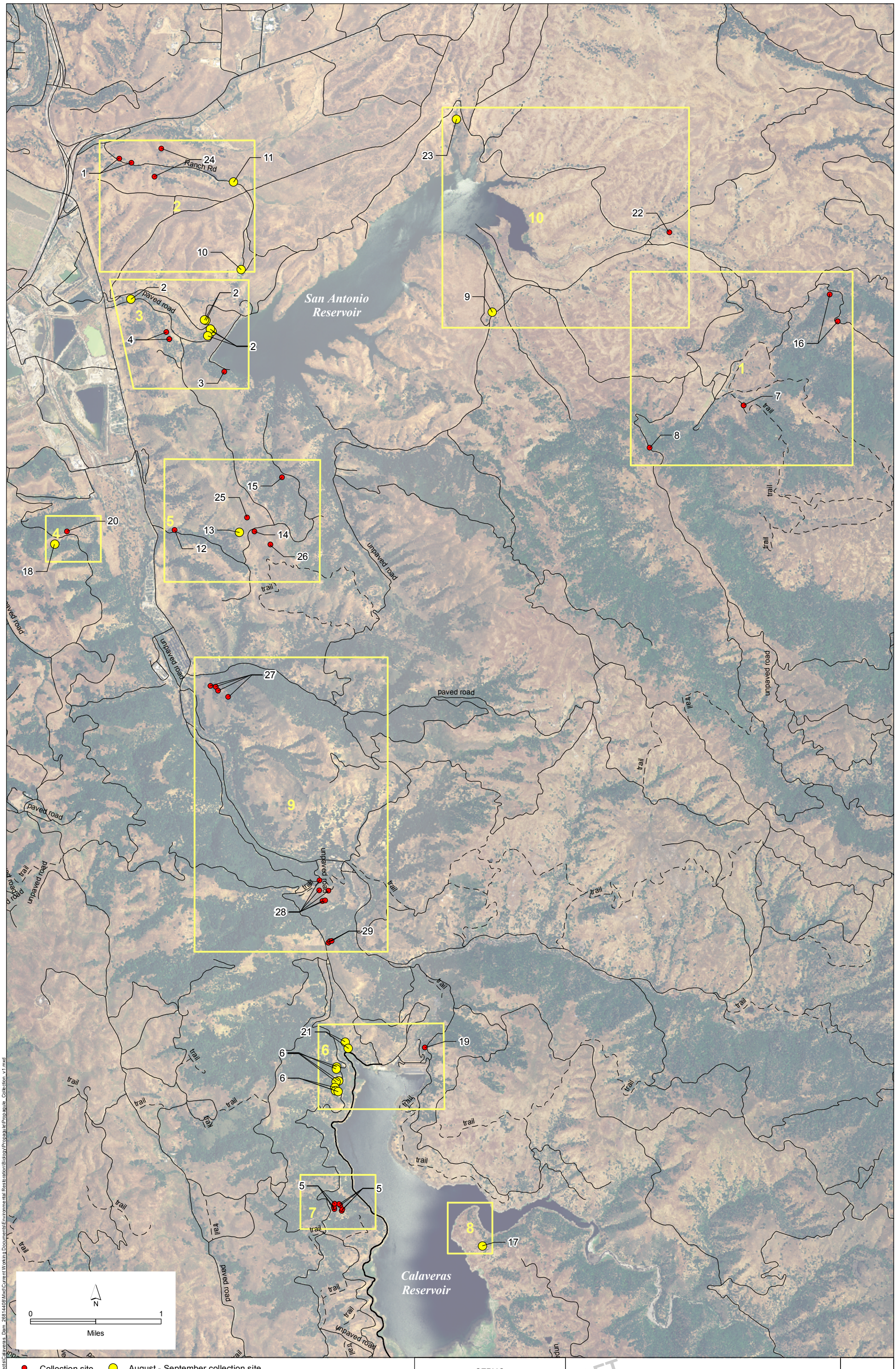
Propagule Collection Sites
Late Fall (Oct. - Nov. 2009)

Figure 2

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San Antonio Reservoir
Calaveras Reservoir
Ranch Rd
paved road
unpaved road
trail
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
0
1
Miles
N
Collection site
Collection area
Trail
Road
Winter salvage collection site
CA Blackberry
Grass
Rushes
Rushes/CA Blackberry
Rushes/Grass
Priority
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Propagule Collection Sites
Winter Salvage (Dec. 2009 - Jan. 2010)
Figure
3
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San Antonio Reservoir
Calaveras Reservoir
Ranch Rd
Paved road
paved road
unpaved road
trail
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
0
1
Miles
N
Collection site
Spring collection site
Collection area
Priority
Trail
Road
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Propagule Collection Sites
Spring Collection (May - June 2010)
Figure
4
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Collection site
August - September collection site
Collection area
Trail
Road

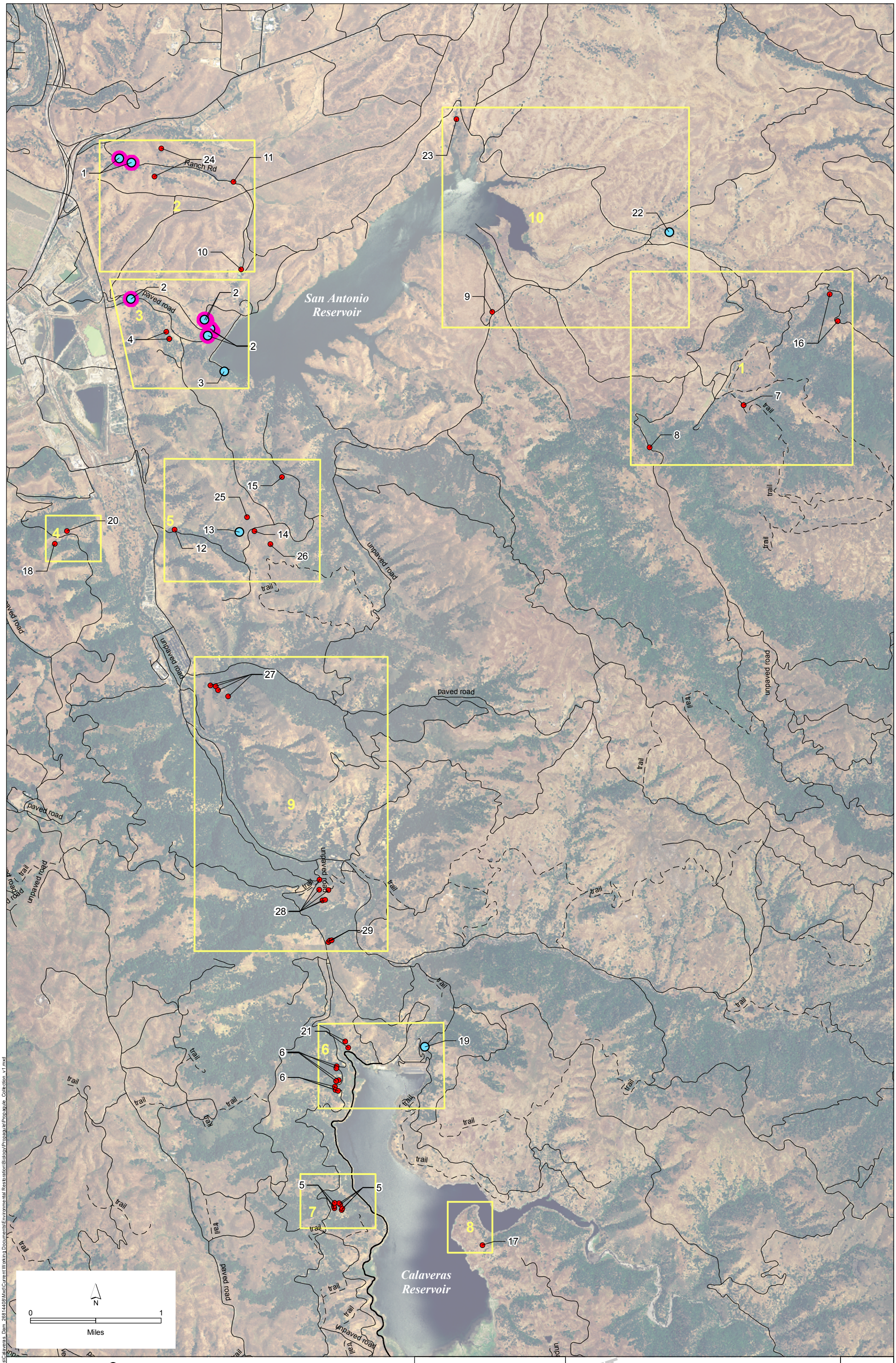
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Propagule Collection Sites
Early Fall (Aug. - Sept. 2010)

Figure 5

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San Antonio Reservoir
Calaveras Reservoir
Ranch Rd
Paved road
unpaved road
paved road
trail
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
0
1
Miles
N
Collection site
Collection area
Trail
Road
Winter Salvage collection site
Priority
SFPUC
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HABITAT RESERVE PROGRAM
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Propagule Collection Sites
Winter Salvage (Dec. 2010 - Jan. 2011)
Figure 6
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Appendix K: Maintenance Monitoring Form

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HRP Mitigation Site Maintenance Inspection Form

Date: _____
Inspectors: _____
Purpose of Visit: _____
Mitigation Site Name:

Infrastructure

Fences: **Picture #:**

Erosion: **Picture #:**

Ponds: Dams and Spillways: **Picture #:**

Irrigation **Picture #:**

Biological

CTS/CRLF Habitat: **Picture #:**

Predator Control: **Picture #:**

Non-native Invasive Plants (species, location, size of population): **Picture #:**

Replanting (planted dead species): **Picture #:**