
SECTION 5: VEGETATION RESTORATION GUIDELINES

5.1 INTRODUCTION

The previous chapter introduced 10 bank stabilization and revegetation treatment alternatives for the San Francisquito Creek Master Plan project area. These treatments included the following:

- No Action
- Vegetation Only
- Repair Protection
- Vegetate Structure
- Remove Structure
- Regrade and Replant
- Terrace
- Riprap Toe
- Vegetated Riprap
- Vegetated Wall

The following sections describe the steps involved in planning habitat restoration that may or may not follow bank stabilization efforts. These sections focus on revegetation work linked to all the treatments except the “No Action” and “Repair Protection”. Methods for non-native species removal and revegetation planning techniques applicable to these 8 bank stabilization treatments are described. In general, the recommendations are appropriate for each bank stabilization treatment. However, modifications may be required at individual sites depending on site-specific opportunities or constraints.

It should be noted that each individual project affiliated with the San Francisquito Creek Master Plan would present a unique set of issues and concerns. The following recommendations are designed to provide *general* restoration concepts on weed management and revegetation planning that would apply to the majority of the projects and would operate in harmony with the bank stabilization work. A final detailed revegetation plan should be developed for each site using the recommendations herein as guidance.

5.2 WEED MANAGEMENT

5.2.1 THREATS POSED BY NON-NATIVE SPECIES

The term “non-native plants” refers to those species introduced and occurring in locations beyond their known historical natural range. As such, they often have no natural grazers or pathogens to limit their reproduction and spread. Non-native plants that spread rapidly, displacing native and/or desired agricultural species, are referred to as invasive species. The proliferation of invasive species within an area leads to the loss of biodiversity since they displace native plants and frequently decrease the habitat value for wildlife. Invasive, non-native species also

Table 5A. Invasive species of greatest concern within the San Francisquito Creek project area, Santa Clara County, CA 1999

Common Name	Scientific Name	Live Form	CalEPPC
acacia	<i>Acacia</i> spp.	Rhizomatous tree	--
black locust	<i>Robinia pseudoacacia</i>	Rhizomatous tree	B
broom	<i>Cytisus</i> spp., <i>Genista</i> spp.	Woody shrub	1A
Cape ivy (formerly German ivy)	<i>Delairea odorata</i> (formerly <i>Senecio mikanioides</i>)	Climbing vine	1A
English ivy	<i>Hedera helix</i>	Climbing vine	1A
eucalyptus	<i>Eucalyptus</i> spp.	Rhizomatous tree	1A
fennel	<i>Foeniculum vulgare</i>	Perennial herb	1A
giant reed	<i>Arundo donax</i>	Perennial cane grass	1A
Himalayan blackberry	<i>Rubus discolor</i>	Climbing vine	1A
pampas grass	<i>Cortaderia jubata</i>	Perennial grass	1A
periwinkle	<i>Vinca major</i>	Creeping vine	B
tree-of-heaven	<i>Ailanthus altissima</i>	Rhizomatous tree	B

California Exotic Pest Plant Council (CalEPPC) List Ratings:

1A = Most Invasive Wildland Pest Plants; Widespread

B = Wildland Pest Plants of Lesser Invasiveness

alter basic ecosystem functions such as nutrient cycling, flood duration and extent, and fire frequency. In riparian systems, species such as giant reed (*Arundo donax*) clog stream channels, increasing the severity of flood-erosion events (Hoshovsky 1986). This species is also highly flammable. In addition, blue gum eucalyptus (*Eucalyptus globulus*) has been implicated in a number of urban wildfires (Bean and Russo 1988).

From field surveys documenting the existing conditions present along San Francisquito Creek, it was determined that approximately 65% of the riparian habitat within the San Francisquito Creek project area is highly threatened by invasive plant species. Non-native infestation of native plant communities is greatest along the lower portions of the creek where concrete-lined banks abut residential development. Those species most likely to displace native vegetation and/or alter ecosystem functions are listed in Table 5A.

These species share a number of biological characteristics that complicate management within riparian systems. All spread via water and animal dispersal of seeds, stems, and roots. All establish readily on disturbed soil and in canopy gaps created by construction, bank erosion, flood scouring, or removal of other invasive species. All are capable of expanding exponentially in extent from a single established plant. All persist in the soil—either as seeds or as rhizomes—after the

aboveground biomass has been removed or killed. Consequently, management of these species requires a multi-seasonal commitment in which invaded habitats are treated repeatedly to prevent re-infestation (Bean and Russo 1988, Morisawa 1999, Trumbo 1999, Tuniso and Hoshvsky 1989).

Benefits of controlling non-native species within the San Francisquito Creek project area include restoring native plant communities, preserving and enhancing existing native habitat, and reducing flood/erosion events exacerbated by dense non-native vegetation in the channel.

5.2.2 GENERAL APPROACH TO INVASIVE SPECIES MANAGEMENT WITHIN RIPARIAN CORRIDORS

- A licensed California pest control advisor should be consulted prior to implementing weed eradication efforts to devise site-specific weed control strategies.
- Management actions should focus on the desired outcome (i.e., wildlife habitat enhancement, bank stabilization) rather than on the absolute elimination of select invasive species. Quantifiable objectives should be established to serve as benchmarks toward success (The Nature Conservancy 1999).
- Riparian corridors should be addressed as a whole since seeds and reproductive plant parts are continually transported downstream from upstream source populations. Removal of canopy species such as eucalyptus trees should be phased to prevent broad scale bank destabilization and loss of shade. When possible, management actions should proceed from the upstream source to downstream sites (Hamingson 1999).
- Priorities should be set with the aim of minimizing the total, long-term workload and preserving existing high quality habitat. Weed management actions are most cost effective when efforts are focused on detecting and eradicating small colonies of invaders *before* they alter ecosystem function and degrade native communities. Initial actions should be directed at monitoring high quality habitat, preventing new infestations, and slowing the spread of existing invasive populations (Moody and Mack 1988).
- Management actions within a particular project site should address multiple invasive species simultaneously. Removal or containment of a single species often encourages the expansion of other invaders in close proximity (The Nature Conservancy 1999).
- Manual, chemical, and biological control methods should be integrated to reduce cost, labor, and potential deleterious effects on existing native vegetation and wildlife (The Nature Conservancy 1999).

- Management actions must be repeated with sufficient frequency to prevent re-establishment of invasive species from rhizomes and/or seeds. Typically, three to four treatments are required annually during the first three years of management with annual to bi-annual maintenance needed thereafter. New project sites should not be initiated until existing ones enter a maintenance phase (Klein et al 1995, Albert et al 1995).
- Once reproductively mature members of an invasive population have been removed, follow-up treatment must be sufficiently frequent to prevent seedlings and saplings from maturing and repopulating the seed bank (Klein et al 1995, Albert et al 1995).
- Following the eradication of non-native species, appropriate native species should be established once the need for herbicide application or aggressive manual weeding has been reduced.

5.2.3 PROJECT AREA CONSTRAINTS TO NON-NATIVE SPECIES MANAGEMENT

5.2.3.1 Bank Stabilization

Erosion control and revegetation with native species should accompany weed management activities. Thick mulch, landscape fabric, straw wattle, and/or cover crops such as local native grasses should be applied following the removal of aboveground biomass. These actions reduce erosion and suppress re-infestation by some weed species. In general woody, native species should not be introduced until the need for herbicide application or aggressive manual weeding has been reduced (Hamingson 1999, Nelson 1993). Weed eradication efforts are generally required for a full growing season to sufficiently control non-native species before planting can begin. In some cases, two or more seasons of eradication may be required before planting. However, in some instances, this may be too long of a timeline, and planting may occur sooner.

5.2.3.2 Herbicide Restrictions

Chemical applications must be restricted to those products approved by the Environmental Protection Agency (EPA) for use in riparian settings and should be applied by a Qualified Licensed Applicator following a written recommendation from a California pest control advisor.

5.2.3.3 Other Wildlife Considerations

Some invasive species such as blue gum eucalyptus and Himalayan blackberry provide limited foraging and nesting habitat to select wildlife species. Even non-native, canopy trees shade the creek channel, which in turn, moderates stream temperatures and potentially enhances the

aquatic habitat. Thus, removal of all non-native, canopy trees in an area should be restricted, and instead, a phased approach undertaken. This method will allow sufficient time for native canopy to regenerate before additional patches of invasive canopy are removed (Adelman 1998).

5.2.4 RECOMMENDATIONS

5.2.4.1 Containment Rather Than Eradication

The extensive stands of non-native vegetation within the project area do provide some function by stabilizing steep creek banks, moderating stream temperatures, and supporting some wildlife habitat, although usually of lower quality. These reasons preclude the eradication of all non-native species at one time within the San Francisquito Creek corridor. A more realistic goal is the containment and gradual reduction of invasive species abundance in association with a steady re-establishment of native species. Containment lines should be established around invasive populations that cannot be removed for logistical, economical, or ecological reasons. Permanent monitoring stations should be established at the boundaries of containment lines and revisited frequently (annually for tree species, bi-monthly for vine species) to ensure that the population does not expand. Saplings, suckers, and tendrils radiating out from core stands should be pruned back. To gradually reduce population size, treatments should be applied from the outer edge, inward (Hamingson 1999).

5.3 REVEGETATION PLANNING

There are eight basic steps involved in developing and implementing a revegetation project, whether the project consists of multiple sites or a single area. These steps generally follow the selection of an appropriate bank stabilization plan. The revegetation steps include the following:

1. Site assessment
2. Revegetation plan preparation
3. Plant selection
4. Plant procurement
5. Site preparation
6. Plant installation techniques
7. Maintenance
8. Monitoring

The following sections provide brief descriptions of the technical elements and approach for each of those eight key steps.

5.3.1 SITE ASSESSMENT

The goal of site assessment is to identify the basic physical opportunities and constraints posed by a site with respect to successfully establishing the target plant species. Optimally, this assessment is conducted by, or with assistance from, an experienced habitat restoration specialist. The site assessment should focus on several key characteristics and address the following general questions:

- **Soil suitability:** Are the soils sufficiently fertile and of a suitable texture? Will soil amendments or mechanical tillage to loosen compaction be required? Is the soil prone to erosion?
- **Aspect and exposure:** Is the site heavily shaded or in full sun? Is it north facing or south facing?
- **Hydrology:** Will the site be frequently inundated by creek flow or rarely wetted, except by incidental rainfall? Will it be subject to scouring flows or sedimentation? How close to the surface is groundwater and how does its position relate to the soil profile?
- **Access:** Can workers and/or equipment access the site to install and maintain vegetation?
- **Existing vegetation within and adjacent to the site:** Are there noxious, non-native species within or adjacent to the site that will threaten the ultimate success of the proposed revegetation unless they are effectively eradicated? Are there native trees or shrubs that need to be protected from damage during site installation?

For this project it will also be essential to carefully consider the type of bank stabilization treatment proposed for each site when developing the site-specific revegetation plan. The bank stabilization treatment to be applied will dictate the availability of planting locations and the characteristics of the planting substrate. Some bank stabilization treatments may limit revegetation to certain regions along the bank. Others may present more challenging planting settings such as within gabion baskets, rock rip-rap, or retaining walls.

5.3.2 REVEGETATION PLAN PREPARATION

Information on plant selection, plant procurement, site preparation, plant installation techniques, maintenance, and monitoring should be addressed in a revegetation plan. This plan should be prepared prior to the start of any revegetation project since it will guide project implementation. This plan can be detailed and complex when prepared for large, multiple, or difficult restoration sites. Conversely, it can be a relatively simple and brief plan when prepared for small sites. A revegetation plan serves as a useful guide for landowners and contractors, facilitates the permitting process, and may help to garner funding. A detailed discussion of the components of any revegetation plan (plant selection, plant procurement, site preparation, plant installation techniques, maintenance, and monitoring) follows in the remainder of this chapter.

5.3.3 PLANT SELECTION

One of the key steps in designing a restoration site is selecting a plant palette appropriate to each site's individual physical characteristics. Plant palette selection should occur as early as possible in the site design process to allow adequate lead-time for plant procurement. The selection of appropriate plants for a site is founded on: 1) a careful assessment of the site's physical characteristics (see Section 5.3.1) that will influence the establishment and growth of the plants, 2) consideration of how plants will be integrated into bank stabilization measures/materials, and 3) plant species that maximize habitat values for wildlife.

Table 5B lists the recommended native tree and shrub species appropriate for use in revegetation projects associated with the San Francisquito Creek Master Plan, as well as their preferred position relative to the creek channel. The list was derived from field observations of native tree and shrub species within San Francisquito Creek's riparian corridor.

Bank Location. The 5 bank locations (toe-of-slope; lower, mid, or upper bank; and upland) listed in Table 5B refer to where each recommended tree or shrub species generally occurs with respect to the creek channel. Particular tree and shrub species to be planted and their locations should be selected based upon the bank configuration of the restoration site. These divisions for bank location are fluid categories

Table 5B. Appropriate plant species and bank locations

Common Name	Scientific Name	Bank Location *				
		TOE	LB	MB	UB	UP
Trees:						
arroyo willow	<i>Salix lasiolepis</i>	x	x			
big-leaf maple	<i>Acer macrophyllum</i>			x	x	
box elder	<i>Acer negundo</i>			x	x	x
California bay	<i>Umbellularia californica</i>			x	x	x
California buckeye	<i>Aesculus californica</i>			x	x	x
California sycamore	<i>Platanus racemosa</i>		x	x		
coast live oak	<i>Quercus agrifolia</i>			x	x	x
Fremont cottonwood	<i>Populus fremontii</i> ssp. <i>fremontii</i>	x	x	x		
holly-leaved cherry	<i>Prunus ilicifolia</i>				x	x
Mexican elderberry	<i>Sambucus mexicana</i>				x	x
Oregon ash	<i>Fraxinus latifolia</i>		x	x		
red willow	<i>Salix laevigata</i>	x	x	x		
sand bar willow	<i>Salix exigua</i>	x	x			
valley oak	<i>Quercus lobata</i>			x	x	x
western dogwood	<i>Cornus sericea</i> ssp. <i>occidentalis</i>		x	x		
white alder	<i>Alnus rhombifolia</i>	x	x			
Shrubs:						
California blackberry	<i>Rubus ursinus</i>	x	x	x	x	
California coffeeberry	<i>Rhamnus californica</i>			x	x	x
California rose	<i>Rosa californica</i>		x	x	x	
coyote brush	<i>Baccharis pilularis</i>			x	x	x
mugwort	<i>Artemisia douglasiana</i>	x	x	x		
mule fat	<i>Baccharis salicifolia</i>	x	x	x	x	
pipestems	<i>Clematis lasiantha</i>			x	x	x
red flowering current	<i>Ribes sanguineun</i>		x	x	x	
snowberry	<i>Symphoricarpos rivularis</i>		x	x	x	x
thimbleberry	<i>Rubus parviflorus</i>		x	x	x	
toyon	<i>Heteromeles arbutifolia</i>			x	x	x
wood strawberry	<i>Fragaria vesca</i> ssp. <i>californica</i>		x	x	x	

* TOE: toe-of-slope; LB: lower bank; MB: middle bank; UB: upper bank; UP: upland

and do not represent rigid classes. The bank locations are described below:

- The Toe-of-Slope (TOE) position occurs closest to the channel. Plant species chosen for this site should be very tolerant of frequent inundation, hydric conditions, and varying levels of scouring.
- The Lower Bank (LB) position occurs close to the channel just above the toe-of-slope. Plant species chosen for this site should generally be tolerant of occasional inundation and hydric conditions.
- The Mid Bank (MB) position occurs midway along the bank above the toe-of-slope. Plant species chosen for this site should be tolerant of occasionally moist soil conditions but possess some degree of drought tolerance.
- The Upper Bank (UB) position occurs above the mid bank. Plant species chosen for this site should be relatively drought tolerant since little moisture input from the creek can be expected to occur.
- The Upland (UP) position occurs above the upper bank at the top-of-bank or beyond and is situated the furthest from the channel. Plant species chosen for this site should be drought tolerant and adapted to drier conditions since minimal moisture inputs from the creek can be expected to occur.

Table 5C describes the soil, moisture, and exposure requirements, preferences, and tolerances for each recommended tree and shrub species. Site conditions should, to the extent possible, meet these criteria proposed for each species to be installed to ensure the success of the restoration site. Descriptions were derived from the *Revegetation Manual for the Alameda County Flood Control and Water Conservation District Revegetation Program* (Harvey & Stanley 1983) and from observations of plant conditions and communities within the project vicinity.

Soil Tolerance. This category describes soil type preferences and tolerances.

Moisture Requirements. This category describes the plants' moisture needs, as well as tolerances for drought conditions.

Exposure. This category describes how shade or sun tolerant a species is at a particular stage of growth (young or mature).

Table 5C. Soil, moisture, and light conditions

Common Name	Plant Requirements		
	Soil Tolerance	Moisture Requirements	Exposure
Trees:			
arroyo willow	Tolerates: clay hardpan, shallow soil and sandy soil, but not heavy soils	Requires: high soil moisture initially to establish; somewhat drought tolerant once established Tolerates: inundation	Prefers: full sun Tolerates: shade
big-leaf maple	Prefers: deep loam with a high humus content Tolerates: clay hardpan and sandy soil	Requires: relatively high soil moisture Tolerates: drought conditions once established	Prefers: full sun Tolerates: shade when young
box elder	Prefers: soils with a high humus content Tolerates: sandy or gravelly soil	Prefers: moist, well-drained conditions Tolerates: drought conditions once established	Prefers: full sun or partial shade Tolerates: some shade when young
California bay	Prefers: deep soils Tolerates: other soil types including alkaline and serpentine	Requires: well-drained soil with relatively high soil moisture Tolerates: inundation, drought conditions once established	Prefers: full sun or partial shade; deep shade when young
California buckeye	Prefers: moist, well-drained loam	Prefers: moist areas Tolerates: drought conditions once established	Prefers: full sun when mature; some shade during seedling stage
California sycamore	Prefers: deep, moist soils Tolerates: many soil types including alkaline and rocky soils	Prefers: moist sites, Tolerates: drought conditions once established	Prefers: full sun; fairly shade intolerant
coast live oak	Prefers: loam with a gravelly subsoil Tolerates: many soil types, even heavy soils	Requires: good drainage Tolerates: drought conditions once established	Prefers: sun Tolerates: some shade when young
Fremont cottonwood	Prefers: sandy, humus soil in river bottoms Tolerates: many soil types	Requires: constant moisture Tolerates: drought conditions if roots tap a good underground water source	Prefers: full sun; shade intolerant
holly-leaved cherry	Prefers: coarse, well-drained soils Tolerates: most soils	Prefers: dry conditions Tolerates: drought conditions once established	Tolerates: full sun or partial shade
Mexican elderberry	Tolerates: many soil types	Requires: good drainage but can thrive with or without year-round moisture Tolerates: drought conditions once established	Prefers: full sun or very light shade; shade intolerant except when young
Oregon ash	Tolerates: many soil types, including alkaline	Tolerates: drought conditions once established	Prefers: full sun when mature, filtered shade when young
red willow	Tolerates: many soil types including clay hardpan, shallow soil, and sandy soil	Requires: high soil moisture to establish, somewhat drought tolerant once established Tolerates: inundation	Prefers: full sun Tolerates: shade
sand bar willow	Prefers: moist, well-drained soils	Requires: high soil moistures	Prefers: full sun

Table 5C. Soil, moisture, and light conditions

Common Name	Plant Requirements		
	Soil Tolerance	Moisture Requirements	Exposure
Trees:			
valley oak	Prefers: deep, loamy soils Tolerates: many soil types including moderately alkaline soils	Requires: good drainage Tolerates: drought conditions once established	Prefers: full sun Tolerates: shade when young
western dogwood	Tolerates: many soil types	Requires: moist conditions	Prefers: full to partial shade
white alder	Prefers: rich soil with a high humus content Tolerates: clay hardpan or sandy soil	Requires: ample, perennial moisture	Prefers: full sun Tolerates: shade
Shrubs:			
California blackberry	Prefers: deep soils	Requires: ample water to establish Tolerates: inundation, drought conditions once established	Prefers: shady areas Tolerates: full sun in areas of high soil moisture
California coffeeberry	Prefers: rocky, well-drained soils Tolerates: many soils	Tolerates: semi-dry conditions once established.	Prefers: partial shade Tolerates: full sun
California rose	Tolerates: many soil types including alkaline and acidic soils	Prefers: moist areas Tolerates: drought conditions once established	Prefers: full sun
coyote brush	Prefers: light, sandy soils Tolerates: wide range of soil conditions including serpentine and slightly saline soils	Prefers: moist or dry habitats Tolerates: drought conditions once established	Prefers: full sun or partial shade
mugwort	Tolerates: many soil types	Prefers: moist conditions Tolerates: inundation and drought conditions once established	Prefers: partial shade Tolerates: sunnier locations
mule fat	Tolerates: many soil types	Prefers: moist conditions Tolerates: drought conditions once established	Prefers: full sun
pipestems	Prefers: deep, well-drained soils	Requires: moist conditions Tolerates: drought conditions once established	Prefers: full sun Tolerates: full shade
red flowering current	Tolerates: many soil types	Requires: moist conditions Tolerates: drought conditions once established	Prefers: partial shade Tolerates: full shade
snowberry	Tolerates: many soil types	Requires: summer water and relatively moist conditions	Prefers: partial shade Tolerates: full sun in moist locales
thimbleberry	Tolerates: moist soils	Prefers: moist conditions	Prefers: partial shade
toyon	Tolerates: most soils	Prefers: drier habitats Tolerates: drought conditions once established	Prefers: full sun or partial shade when mature, filtered sun when young
wood strawberry	Tolerates: most soils	Prefers: moist conditions	Prefers: partial shade

5.3.4 PLANT PROCUREMENT

5.3.4.1 Plant Procurement

After a planting palette has been selected, a source of plant propagules should be identified and plants should be ordered with adequate lead-time to collect and grow plant material (seed, cuttings, etc.). Plants should originate from propagules (seeds and cuttings) collected from the San Francisquito Creek project area or within Santa Clara or San Mateo Counties from sites close to San Francisquito Creek when propagules are not directly available on the creek. Plants should be contract grown to ensure that locally collected plants are available when required. Native plant nurseries such as Cornflower Farms (916) 689-1015, Circuit Rider Productions, (707) 838-6641, Central Coast Wilds, (831) 459-0656, Elkhorn Native Plant Nursery, (831) 763-1207, and Native Revival Nursery, (831) 684-1811, are experienced at custom-collecting and growing the required native plant material. These nurseries generally need approximately 12 months lead-time to contract grow the desired plants. Rana Creek Habitat Restoration, (831) 659-3811, has also been involved with the collection and growth of native California grasses for projects on San Francisquito Creek. In addition, Jim Johnson and Pat Showalter of the Coordinated Resource Management and Planning group (CRMP), (650) 962-9876 have coordinated the propagation of native plants collected from San Francisquito Creek and should be considered as another source of native plant material.

Valley oak and coast live oak plantings can be established by seeding acorns directly or through installation of container stock. Acorns can be harvested from trees located near the project vicinity, along San Francisquito Creek, or in Santa Clara or San Mateo Counties the year the site is to be planted. Generally, acorns mature in the fall between late September and late October. Following collection, all acorns should undergo the “float test”. Those acorns that float to the top should be discarded while those that sink should be dried and retained. The retained acorns should then be visually examined, and acorns showing evidence of insect damage should be discarded. If planting is delayed, acorns should be stored in plastic bags in a mixture of 50% acorns, 50% perlite and refrigerated until ready for planting.

Buckeye can be established through direct seeding or through installation of container stock. Seeds can be harvested from trees located near the project vicinity, along San Francisquito Creek, or in Santa Clara or San Mateo Counties the year the site is to be planted. Buckeye seeds typically mature in late fall. Because buckeye seeds do not generally store very well, they should be planted immediately following collection. However, the seeds can be stored in the refrigerator up to 3-4 months after collection in moist peat moss. Seeds should be planted immediately

after the radicle begins to emerge from the seed (A. Pohl pers. comm.).

Red willow, arroyo willow, sand bar willow, and Fremont cottonwood can be established using container plants or by directly installing cuttings. If cuttings are used, they should be harvested in mid-winter (January-February) when the trees are dormant and installed directly into the ground. Additional information regarding cutting installation can be found in the “Plant Installation Techniques” section (5.3.6).

5.3.4.2 Container Design and Size

Before plants are contract grown, the appropriate type of container design and size should be specified. Most native plant nurseries offer plant materials in a wide range of container designs and sizes. Often, native plants used for habitat restoration projects are grown in special containers instead of conventional nursery containers to enhance survival following transplanting. These unique containers are used to promote deep and straight root systems, improving plant survival following installation. Many of these containers have some or all of the following features:

- A pot depth that is several times larger than pot width;
- Root training ridges to encourage straight, vertical root growth;
- An open bottom to induce air pruning of roots.

These container types help revegetation and restoration projects by limiting circular root growth and helping the plant to overcome the harsh conditions that often exist following planting. A range of container designs and sizes for recommended tree and shrub species related to the San Francisquito Creek project appears in Table 5D. The recommended container sizes are presented in order of preference. A definition for each type follows below:

TreePot-4. This container type measures 4 inches square by 14 inches long. It is appropriate for growing tree species with long, full root development. This container type is recommended for the majority of the tree species.

DeePot. This container type measures 2½ inches in diameter by 10 inches long. It is appropriate for growing tree species with slower and less full initial root development such as California bay, and Mexican elderberry. This container type is also recommended for the majority of the shrub species.

Treband. This container type measures 2¼ inches square by 5 inches long. It is appropriate for propagating California blackberry, which tends to have shallower, more fibrous roots.

Table 5D. Recommended container sizes or propagule types

Common Name	Recommended Container Size or Propagule Types
Trees:	
arroyo willow	TreePot-4, Deepot, Cuttings
big-leaf maple	TreePot-4, Deepot
box elder	TreePot-4, Deepot
California bay	Deepot
California buckeye	TreePot-4, Deepot, Seeds
California sycamore	TreePot-4, Deepot
coast live oak	Acorns, TreePot-4, Deepot
Fremont cottonwood	TreePot-4, Deepot, Cuttings
holly-leaved cherry	TreePot-4, Deepot
Mexican elderberry	Deepot
Oregon ash	TreePot-4, Deepot
red willow	TreePot-4, Deepot, Cuttings
sand bar willow	TreePot-4, Deepot, Cuttings
valley oak	Acorns, TreePot-4
western dogwood	TreePot-4, Deepot
white alder	TreePot-4, Deepot
Shrubs:	
California blackberry	Treeband, Deepot
California coffeeberry	Deepot
California rose	Deepot
coyote brush	Deepot
mugwort	Deepot
mule fat	Deepot
pipestems	Deepot
red flowering current	Deepot
snowberry	Deepot
thimbleberry	Deepot
toyon	Deepot
wood strawberry	Deepot

Cuttings, Acorns, and Seeds. Cuttings, acorns, and seeds are not propagated in a nursery. Instead, propagules are collected and installed directly into the restoration site. Separate discussions of these materials appear in the “Plant Procurement” (5.3.4) and “Plant Installation” (5.3.6) sections.

5.3.5 SITE PREPARATION

Before plants or propagules are installed at a site, some reworking of the soil surface may be required to create a planting surface appropriate for revegetation. Some sites may require extensive site preparation work while others may necessitate no additional site preparation. The need for the following tasks will be based on individual site considerations.

5.3.5.1 Grading

Minor or major grading operations may be required at some sites to form a planting surface appropriate for revegetation. The need for grading will be based upon individual site considerations such as access opportunities and will be linked to the bank stabilization treatments employed at the site. Heavy machinery used to construct bank stabilization features or create an appropriate planting surface can adversely affect the soil surface through compaction. Thus, grading should occur during the dry season, to the extent possible, when soil moisture is relatively low. If possible, heavy machinery exerting low ground pressure should be used to grade the sites, and measures should be taken to minimize soil compaction.

5.3.5.2 Soil Compaction

Care should be taken to minimize soil compaction during site construction and grading, to the extent possible. While specific recommendations to avoid soil compaction should be developed during the design-phase of a project, bank stabilization and grading work should occur during the dry season when soil moisture is relatively low, if possible. If soil compaction does occur, soil can be decompacted using a combined treatment of ripping in two directions to a depth of about 2 feet at most, followed by discing. Because San Francisquito Creek has very steep banks and poor access, there will likely be limited opportunities to incorporate decompaction measures using heavy equipment.

5.3.5.3 Soil Amendments

Soil amendments can be added to the restoration planting soils to improve site conditions. However, it is generally desirable to plant into native soils. If bank stabilization work results in topsoil removal, it can be saved and respread over the planting surface once bank stabilization work is completed. Organic matter can also be blended into existing soil to improve soil fertility and drainage. Stream bottom gravel should not be used for purposes of backfill.

5.3.5.4 Weed Eradication

Habitat restoration sites with significant non-native species present will require one or more growing seasons of eradication efforts before planting can commence. Initiation of planting before weeds are controlled will likely require significantly greater resources as maintenance crews will be required to simultaneously maintain the native plant species installed while controlling large numbers of non-native resprouts that will likely follow initial eradication. Thus, restoration planting should generally commence following the conclusion of weed eradication if bank stability is not compromised. Section 5.2.2 provides further detail on invasive species management.

5.3.5.5 Surface Erosion Control

If surface erosion poses a threat following site preparation activities, the site should be seeded with a native grass seed mix between September 15 and October 15. Native grasses that can be used in the hydroseed mix include: California brome (*Bromus carinatus*), meadow barley (*Hordeum brachyantherum*), and blue wildrye (*Elymus glaucus*). Seeds should be hydroseeded at a combined rate of at least 60 pounds of pure live seed per acre.

5.3.6 PLANT INSTALLATION TECHNIQUES

5.3.6.1 On-Center Spacing

Part of any restoration design consists of choosing where, how far apart, and what species should be installed in the site. How close restoration plantings are initially spaced will help dictate the ultimate density and character of the resulting restoration site. When choosing a planting density, considerations include the unique morphologies and growth structures of each species, the habitat type to be created, and the bank stabilization treatment to be applied. These factors will ultimately dictate the on-center spacing plan for the chosen planting palette.

Table 5E lists a range of recommended on-center spacing dimensions for each tree and shrub planting. The dimensions refer to the distance between plantings. Planting densities should be determined using the triangular spacing methodology where plants are installed on a triangular not a square grid system. The triangular spacing arrangement results in a slightly denser planting region per unit area than the square grid system.

Trees such as valley oak, coast live oak, California sycamore, Fremont cottonwood, and California bay which can assume a large crown when mature, should be spaced farther apart than medium size trees such as white alder, big-leaf maple, Oregon ash, California buckeye, holly-leaved cherry, box elder, and Mexican elderberry. Smaller trees such as the three willow species naturally form dense thickets and thus have closer on-center spacing. Due to their smaller morphologies and denser growth forms, the shrub species have closer on-center spacing. This tighter spacing regime will promote the development of a dense shrub layer, which is an important component of high quality riparian habitat.

The overall planting densities for riparian habitat restoration on San Francisquito Creek should approach approximately 400-500 plants per acre. In general, individual species should be planted in small groups. Tree species should be planted in groups of 2-3, and shrubs should be planted in groups of 3-5 between the tree species with the goal of ultimately establishing riparian habitat with dense tree and shrub layers.

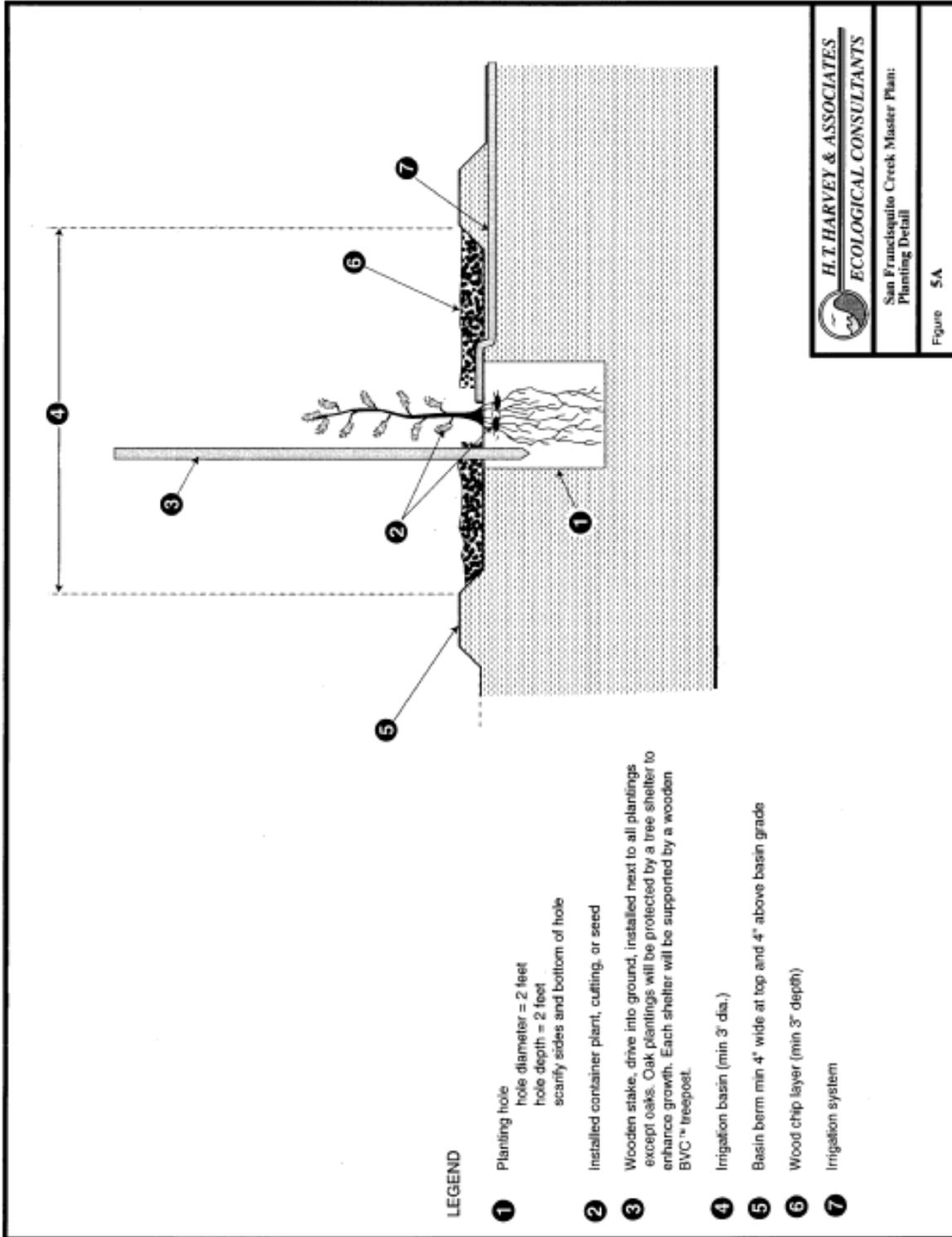
Table 5E. Recommended on-center spacing

Common Name	Recommended On-Center Spacing (Feet)
Trees:	
arroyo willow	8 to 12
big-leaf maple	12 to 18
box elder	12 to 18
California bay	16 to 20
California buckeye	12 to 18
California sycamore	16 to 25
coast live oak	16 to 25
Fremont cottonwood	16 to 25
holly-leaved cherry	6 to 10
Mexican elderberry	12 to 18
Oregon ash	12 to 18
red willow	10 to 12
sand bar willow	8 to 12
valley oak	16 to 25
western dogwood	12 to 18
white alder	12 to 18
Shrubs:	
California blackberry	5 to 10
California coffeeberry	6 to 10
California rose	6 to 10
coyote brush	8 to 10
mugwort	5 to 10
mule fat	8 to 10
pipestems	6 to 10
red flowering current	6 to 10
snowberry	6 to 10
thimbleberry	6 to 10
toyon	6 to 10
wood strawberry	5 to 10

5.3.6.2 Plant Installation

To maximize plant survival and growth, the container plants, acorns, cuttings, and seeds should be installed between approximately October 1 and January 1 to the extent possible. However, container plants can be installed year-round with proper irrigation (see Section 5.3.2.7 “Irrigation”) if project scheduling does not allow for planting in fall or early winter. Figure 5A provides a typical planting detail that incorporates the major elements of a planting design.

Container Plant Installation. The container plants should be installed so that their root crowns are at or slightly above ($\frac{1}{2}$ inch) the soil surface following planting, soil settlement, and initial irrigation. Planting holes should be at least 2 feet wide and 2 feet deep to the extent possible.



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San Francisquito Creek Master Plan:
 Planting Detail

Figure 5A

Deeper and wider holes may be appropriate in difficult planting areas such as those present in the “Vegetate Structure” and “Vegetated Wall” treatments. A 3-foot diameter irrigation basin should be constructed around each plant, and the irrigation basins should be surrounded by 4-inch high, 4-inch wide berms (Figure 5A). The plants should be irrigated immediately following installation.

Acorn and Buckeye Seed Installation. Acorn seeds should be installed 2 inches below the ground while buckeye seeds should be installed barely beneath the surface. Acorns should be placed parallel to the soil surface while buckeye seeds should be positioned with the radicle facing down. Two seeds should be installed in each planting hole. Tree shelters (see “Plant Protection” section below) should be placed around the oak plantings to enhance growth. A 3-foot diameter irrigation basin should be constructed around each plant, and the irrigation basins should be surrounded by 4-inch high, 4-inch wide berms. The plants should be irrigated immediately following installation.

Cuttings. Cuttings from willow or cottonwood plants should be harvested and installed in the mid-winter (January-February) when the trees are dormant. Cuttings should be approximately 18-inches long and one-half to one inch in diameter. Each cutting harvested should be examined and those with insect damage should be discarded. The cuttings can be treated with rooting hormone immediately prior to installation to enhance rooting. However, this is not a requirement as these species readily root without the use of hormone. The cuttings should be installed so that the lower 2/3 of the cutting (12 inches) is buried. The cuttings should be installed immediately following harvesting, if possible. However, they can be stored up to 48 hours after harvesting, if necessary. If stored, the cuttings should be placed in barrels of water in a cool, shady location between harvest and installation.

Planting Collars. Planting collars will be used to support, stabilize, and protect plants (small trees and shrubs) that are installed within rock rip-rap, gabion baskets, and sacked concrete. Planting collars will most likely be used in the “Vegetate Structure”, “Rip-Rap Toe”, and “Vegetated Rip-Rap” treatments, which all incorporate some amount of revegetation embedded within hardscape areas. Planting collars will provide a barrier between plants and adjacent hardscape features while not compromising the integrity of the bank revetment. They can be designed from a variety of materials including wooden beams and concrete boxes. Specific collars should be tailored to each individual site based on the unique needs and conditions of each site. Although the use of planting collars is not optimal due to the difficulty in establishing plants, they will provide a means of potentially establishing native, vegetation in locations that are currently devoid of woody cover.

5.3.6.3 Weed Control

Herbaceous weeds around individual plants should be controlled with woodchip mulch. A 3- to 4-inch thick layer of mulch should be placed around each plant within the 3-foot diameter irrigation basin (Figure 5A). Invasive species throughout the planting areas should be controlled as described in the “Maintenance” section (5.3.7).

5.3.6.4 Plant Protection

Root damage by small mammals could be a threat at some locations. The need for root protectors should be assessed on a site-by-site basis at the time of individual project implementation and used on an as-needed basis. Root protectors are generally constructed of wire mesh formed into cylindrical baskets with open bottoms. They are placed within the planting hole prior to the installation of the plant to protect the roots from damage by small mammals.

Tree shelters are frequently used to protect plantings from animal damage to shoots or roots and provide an environment conducive for plant growth and development (Figure 5A). Because deer do not occur in the project area, browse protectors will be unnecessary for the majority of the tree and shrub species. However, four-foot tall photodegradable tree shelters should be installed around the valley oak and coast live oak plantings to enhance growth. A protective wire cover should be woven into the tops of each shelter to prevent birds from inadvertently falling down the shelters. Tree shelters have been shown to increase the percent survival and height increment for oak plantings when implemented in concert with weed control (McCreary and Tecklin 1997). Tree shelters also help to conserve soil moisture, promote tree growth, and provide protection against animal damage. The bottom 3 inches of the tree shelters should be buried in the ground. A cylindrical BVC™ tree post should be installed to support each tree shelter. Tree shelters should be removed when they start to impede plant growth, approximately 3 years following installation, and disposed of off-site. Care should be taken when removing shelters and tree posts to not damage foliage or roots. Thus, shelters should be clipped in several locations to facilitate their removal, and tree posts should be removed gently to avoid damaging root systems.

A wooden stake should be placed next to all plants to help prevent incidental damage to the plantings during maintenance. This stake will also help identify the restoration plantings.

5.3.6.5 Erosion Control Seeding

Erosion control seeding should be considered to control surficial and splash erosion due to rainfall on the banks. Native grasses that can be used in the seed mix include: California brome, meadow barley, and blue wildrye. Seeds should be hydroseeded at a combined rate of at least 60

pounds of pure live seed per acre. The restoration site should be hydroseeded between September 15 and October 15. Other methods to control surficial erosion include biodegradable erosion control blankets or blown mulch.

5.3.7 MAINTENANCE

Once site installation and planting are complete, the restoration site should be maintained on a regular basis to ensure the success of the site for at least 3 years. The frequency of maintenance activities required depends on the size of the site, the type of plantings installed, the complexity of the site, the invasive species present, and other factors. In general, maintenance will be required 2-4 times per month between March and October and approximately once per month between November and February for at least the first 3 years following site installation. Maintenance activities should include replacing dead plants, irrigating the plants, maintaining the tree shelters in an upright position, maintaining the irrigation basins and woodchip mulch, and monitoring and removing non-native species. The different maintenance tasks are outlined below.

5.3.7.1 Plant Replacement

Dead plants should be replaced annually to the extent possible during the 3-year maintenance period to help achieve a general plant survival goal of 80% for all plants installed five years following initial installation. An adaptive management approach towards plant replacement should be instituted. Thus, the plant species chosen for replacement should be based upon a critical evaluation of the vigor and growth of the plantings installed. Those species that are well adapted to the planting sites and are rapidly establishing should generally be used to replace dead plants.

5.3.7.2 Irrigation

The restoration site plantings will require irrigation for at least the first 3 years during the plant establishment period. The type of irrigation system to be used at each site will depend on site constraints imposed by the bank stabilization treatment, the plant species installed, cost, and other factors. Drip and bubbler irrigation systems have proven to be effective in other habitat restoration projects, and are recommended for the San Francisquito Creek projects. However, other irrigation systems, including water trucks, may be deemed appropriate at specific sites.

After the first year following plant installation (Year 1), the plants should be irrigated with enough regularity (approximately 2-4 times per month) to keep the soils within the root zone moist from approximately March through October. The irrigation schedule in Year 2 should be based on the water requirements of the plants and is anticipated to be substantially less (approximately 1-2 times per month). In Year 3, little irrigation (0-1 times per month) should be required. The progress of the restoration site should be considered before irrigation is discontinued following Year 3.

Actual irrigation of the site will vary depending upon site conditions. Precise irrigation requirements should be determined through site observations using an adaptive management approach toward irrigation. Thus, the frequency of irrigation can be modified as site conditions and plant needs become apparent following site-establishment.

The irrigation system should be regularly maintained during the 3-year plant establishment period. Any component of the system deemed to be non-functioning should be subsequently repaired as part of regular site maintenance. When irrigation is deemed unnecessary, the irrigation system will subsequently be removed and disposed of properly off-site.

5.3.7.3 Weed Control

Weeds within the restoration site should be controlled around each plant and throughout the site as a whole. The irrigation basin around each installed tree and shrub should be kept weed free by maintaining the wood chip mulch layer and manually removing the weeds that become established in the mulch. Weeds throughout the site should be kept to a maximum height of 1-2 feet year round using a mower and/or “weed eater”. Weed control activities should occur before seed set, to the extent possible. Care should be taken to avoid impacting any native woody species that colonize the gaps between plantings. Therefore, maintenance personnel should be trained to differentiate between native and non-native species.

Particularly noxious non-native and invasive species should continue to be controlled throughout the site as a whole as part of the non-native species removal program. Non-native species should be identified as they appear and a program for their removal should be devised in accordance with the techniques outlined in the “Weed Management” section (5.2). Spot treatment of weeds using herbicides approved by the EPA for use in riparian settings is also outlined in that section.

5.3.7.4 Plant Protection

The restoration site’s tree shelters should be maintained in good working order during approximately the first 3 years of the plant establishment period or until they start to impede the plant’s growth. Following Year 3, the conditions of the tree shelters and the plants should be evaluated and the tree shelters removed, if appropriate. At a minimum, the tree shelters should be removed and disposed of off-site when they start to photodegrade (~ Year 5).

5.3.7.5 Natural Recruitment

Care should be taken to avoid damaging naturally recruiting native tree and shrub seedlings during maintenance and non-native species removal activities. Fostering natural recruitment will aid in rapid habitat development.

5.3.8 MONITORING

Monitoring of the revegetation site is a useful tool to evaluate habitat development and could be required by the permitting agencies. Specific elements of habitat development that may be monitored include:

- Percent survival of installed plants
- Percent cover
- Tree height
- Natural recruitment of native and non-native, woody vegetation
- Plant health and vigor
- Photo-documentation
- Non-native reestablishment
- Site maintenance

Prior to the start of site monitoring, a monitoring plan should be developed that includes a monitoring timeline, a monitoring protocol, and specific target functions and values to be measured. Because each restoration site will differ in size and scope, the specific elements contained within each monitoring plan should be tailored to the unique constraints of each site.

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