COASTAL TRAIL AT LANDS END

Habitat Restoration and Enhancement and Trail Management and Maintenance Strategy, Golden Gate National Recreation Area

Staples photos (1925)

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COASTAL TRAIL AT LANDS END
Habitat Restoration Enhancement and Undesignated Trail Management and Maintenance Strategy

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1.0 INTRODUCTION

1.1 Background

The Golden Gate National Parks Conservancy (Parks Conservancy) and the National Park Service (NPS) are seeking to enhance the Coastal Trail corridor at Lands End. The Lands End segment of the Coastal Trail is situated along the high, rugged bluffs south of the mouth of San Francisco Bay on the City's northwest corner. Stretching roughly two miles, the trail spans the area from the Merrie Way parking area above the historic Sutro Baths in the Richmond District and extends northeast along the coastline to the Eagle's Point Overlook near the Sea Cliff neighborhood. The trail offers spectacular, thirty-mile views - east to the Golden Gate Bridge, north to the Marin Headlands and Point Reyes, and west to the Farallon Islands and the Pacific Ocean. Planned improvements include upgrading trails, creating a visitor's center, kiosk, and interpretative displays, enlarging parking facilities, improving visitor access, reducing erosion features, and enhancing trail amenities.

Simultaneously, NPS intends to decommission and rehabilitate approximately nine linear miles of undesignated "social" trails (herein referred to as social trails) located within northern coastal bluff scrub, non-native forest, wetland, and disturbed habitats found in the project area; identify possible trail connections to high priority visitor destinations; and conduct habitat enhancement and restoration in priority areas within the watershed.

This report focuses on priority habitat enhancement and restoration and trail decommissioning activities within the Coastal Trail Corridor in the Lands End Planning Area. The Lands End Planning Area (herein referred to as the "Lands End Planning Area" or "Study Area") is located west of the Palace of the Legion of Honor, extending from the Merrie Way parking lot around Lands End (north of the Cliff House), north to Eagle's Point. The western edge of the Study Area parallels the Pacific Ocean, and the eastern boundary is located below El Camino Del Mar and the Veteran's Hospital (see Figures 1 and 2).

This report is the result of a collaborative planning effort with the Parks Conservancy and NPS staff, intended to provide a comprehensive 10-year strategy for decommissioning social trails and enhancing native and non-native habitat within the Coastal Trail Corridor in the Lands End Planning Area, as well as improving visitor circulation and trail connectivity (in concert with other Parks Conservancy Coastal Trail improvement efforts). This report seeks to synthesize, but not duplicate, information in previous planning documents, vegetation studies, and resource reports into an action-oriented, decision-based approach. The intent is to provide a tool that park planners can use to prioritize, fund, and implement restoration activities that will provide the greatest environmental benefits, visitor experience, and cost benefits to the Lands End Planning Area.

Although this strategy was developed based on a 10-year timeframe, the Parks Conservancy and other partner organizations implementing portions of this strategy may wish to implement actions over a longer timeframe in order to address funding, coordination, compliance, and capacity issues.

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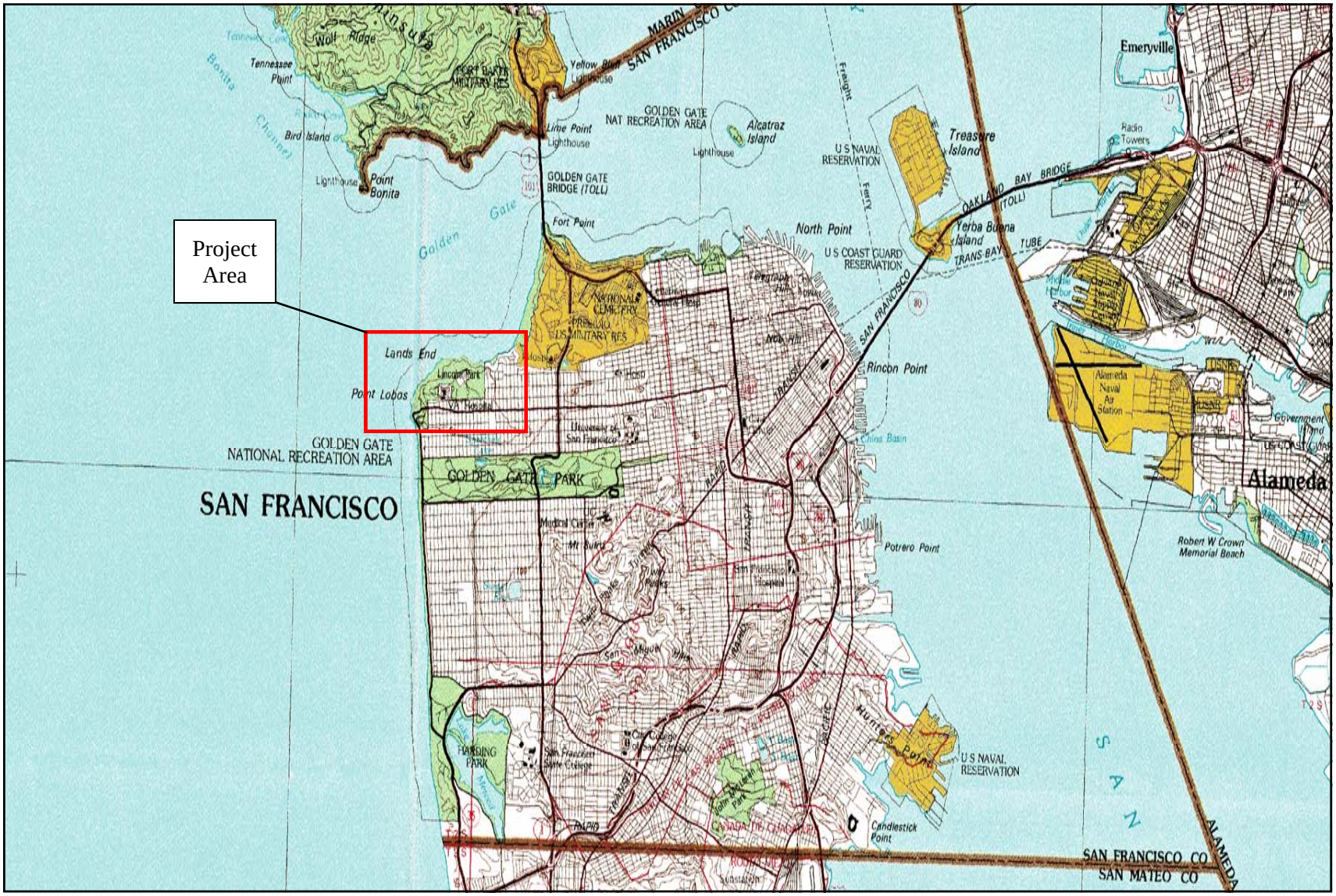
Study Area Location **Figure 1**



Lands End Planning Area

Figure 2

Lands End Planning Area
National Park Service Administrative Boundary
Coastal Trail
Local Trail

N

100 50 0 100 200 300
Meters

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1.2 Purpose and Need

This report is intended to assist decision makers with determining restoration project priorities within a 10-year planning timeframe; provide details on how best to implement prioritized activities; provide detailed cost information to facilitate budgeting and funding of priority actions; and provide future maintenance and monitoring requirements for each of the top priority restoration activities. This report also provides a decision-making model that can be used now and in the future to re-prioritize restoration activities over time.

Specifically, this report is intended to assist the Parks Conservancy and NPS with:

- Assessing and prioritizing the proposed natural resource enhancement actions and the decommissioning of social trails that could be implemented simultaneously with the enhancement of the Coastal Trail;
- Preparing cost estimates and implementation specifications for completing the highest priority actions (as determined in coordination with an internal planning team);
- Reviewing priority actions (including viewshed enhancement, tree thinning, tree stand conversion, etc.) identified in the Vegetation Management Strategy report for the non-native forest (McBride et al., 2005)(Appendix E) and identifying priority tree removal actions that can be conducted in coordination with habitat restoration and social trail decommissioning, and preparing cost estimates for implementation;
- Grouping the social trails into planning categories (for example: trails that traverse through wetlands, trails that have significant gullying, etc.) and preparing specifications and cost estimates to ensure successful closure and revegetation;
- Identifying social trails that may not be easily classified into planning categories, and preparing specifications and cost estimates to ensure successful closure and revegetation;
- Developing an overall strategy for social trail decommissioning, to include prioritization and timeline for revegetating segments; and
- Preparing recommendations and cost estimates for possible trail alignments that would better guide visitors to high destination areas.

1.3 Previous Studies

There are several key planning documents that address various aspects of natural resources management in the Lands End Planning Area and nearby lands. Additionally, recent studies have better determined visitor use and destination patterns. Previous studies that were used in the development of this report include:

- The Sutro Historic District Resource Analysis Studies for the Comprehensive Design and Environmental Analysis Study (National Park Service 1993);

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- Vegetation Management Strategy for Areas Adjacent to The Coastal Trail at Lands End (McBride et. al, 2005)(Appendix E);

- Results of the Vegetation, Cowardin Wetland, and Undesignated Trail Surveys within the Coastal Trail Corridor at Lands End, San Francisco, California (May & Associates, Inc., 2005);

- Phase 1 Report- Preliminary Geology and Geotechnical Evaluation, Lands End Trail Feasibility Evaluation (Rutherford & Chekene, 2004);

- Abbreviated Cultural Landscape Report: Sutro District, Golden Gate National Recreation Area, Merrie Way & The Lands End Street Trails (Martini, 2005);

- Preliminary Bird Monitoring Data, as Provided by PRBO (Gardali, pers. comm., 2005);

- Preliminary Hydrologic Data, as provided by Kamman and Kamman Hydrology Inc., (Kamman, draft, 2005) (Appendix F);

- Final Report, 1999-2002, Monitoring Songbirds in the Presidio (PRBO, 2002); and

- Natural Resources Inventory and Vegetation Management Options Report (Jones & Stokes, 1997).

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2.0 SETTING

2.1 Overview

The Lands End Planning Area is located in the northwestern corner of San Francisco, southwest of the Presidio. It is situated south of the northernmost tip of the San Francisco Peninsula. The planning area roughly follows the existing Coastal Trail alignment located on the historic Pacific and Ocean Railroad right of way. The Lands End Planning Area includes the upland area above the historic Sutro Baths and north of the Cliff House, and lands extending from the Merrie Way Parking lot to Eagle's Point (see Figures 1 and 2).

The Lands End Planning Area is located within the Sutro Historic District, a major recreational destination for over 100 years. This area has undergone extensive and repeated changes in land use throughout its long history. Adolph Sutro constructed a light rail system, the Pacific and Ocean Railroad, in 1886 to provide transportation between the Ferry Building in downtown San Francisco and the Cliff House, Sutro Baths, and surrounding areas. This rail system was in operation until about 1905. An electric trolly replaced the rail, and was operated until approximately 1925 when the tracks were eliminated by an extensive landslide at Lands End. Landscape plantings were installed in the 1920's for the Legion of Honor, Lincoln Park and Golf Course, and El Camino Del Mar. Thousands of Monterey pine *(Pinus radiata)* and Monterey cypress (*Cupressus macrocarpa*) were planted in the mid 1930's as wind breaks, to control sand drifts, and for aesthetic purposes. Each of these changes in land use contributed to a reduction in the native northern coastal bluff scrub, coastal prairie, dune, and riparian vegetation that once dominated the area. As a result, the Lands End Planning Area is primarily dominated by non-native plant species, with isolated patches of remnant wetland and other native vegetation surviving as "islands" in a "sea" of non-native forest, annual grassland, extensive invasive non-native plant populations, and disturbed/developed areas.

This area is heavily influenced by its proximity to the Pacific Ocean. The maritime climate produces fog, salt spray, and high winds that sculpt the vegetation and influence the structure of the non-native forest, and the composition of the natural plant communities.

The Lands End Planning Area is situated on fill, landslide deposits, dune sand, and Colma Formation soils, with some Franciscan Formation soils on the promontory points located near the ocean. The site is subject to heavy erosion from wave action along the western edge, resulting in continuous sloughing into the ocean as well as drainage effects from the lands above the site (some natural, and some a result of upslope land use). The result is a site with very dynamic unstable geologic substrate that is prone to slumps, slides, and wind and water erosion.

Each of these unique geologic, hydrologic, wind and weather conditions, as well as variations in soil chemistry, soil texture, soil moisture, site exposure, and aspect, influence the types of natural communities found in the area, and also the composition and structure of each plant community. These in turn influence the type and usage patterns of wildlife species such as songbirds, and to a certain extent, humans.

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2.2 Natural Resources

The following section describes the natural communities, sensitive species, and invasive non-native plant species that influence the selection and management of restoration projects within the Lands End Planning Area. Refer to Appendix A for common and scientific names of species mentioned in this report.

2.2.1 Vegetation Communities

Historically, native northern coastal bluff scrub, coastal dunes and dune scrub, coastal prairie, and riparian vegetation dominated the Lands End Planning Area (Refer to Historic Site Conditions at Lands End, Figure 3). In the 1920's, the Legion of Honor, Lincoln Park and Golf Course, and El Camino Del Mar were developed. In approximately the mid 1930's, thousands of Monterey cypress and Monterey pine were planted in the vicinity of Lands End. These two species now make up the majority of the non-native forested area, along with blue gum eucalyptus (*Eucalyptus globulus*), blackwood acacia (*Acacia melanoxylon*), plume acacia (*Albizia lophantha*), myoporum (*Myoporum laetum*), and other non-native small trees and shrubs (Jones & Stokes, 1997; McBride et al., 2005)(Appendix E).

The following is a summary of the vegetation communities that exist within the Lands End Planning Area.

Non-Native Plant Communities

The following section identifies the non-native plant communities found within the Lands End Planning Area.

Non-Native Annual Grasslands. Non-native grassland is an herbaceous community dominated by non-native grasses with native and non-native forbs. Within the Study Area, this natural community is widespread, therefore it is not mapped as a separate community in the GIS database mapping efforts, but rather is included in the larger mapping polygons within northern coastal bluff scrub, serpentine bluff scrub, and non-native species mapping polygons. Non-native grassland most often occurs in areas where native vegetation has been continually removed or impacted by past human activities (e.g. road and facility construction, grazing, social trail creation, etc.), but was not replaced with landscaping. Examples of areas that are now dominated by this community are the "rubblefield" area, (where large amounts of concrete debris and rubble were dumped in the past), and areas immediately adjacent to the existing Coastal Trail that in the past were repeatedly re-graded as part of rail line maintenance and repair. Non-native annual grassland is dominated by ripgut brome, *(Bromus diandrus)* soft chess *(Bromus hordeaceus)*, slender oats and wild oats (*Avena* spp.), wild barley *(Hordeum murinum)*, velvet grass (*Holcus lanatus)*, and filaree *(Erodium* spp.*)*, often occurring with native grasses and forbs of the coastal prairie community (Jones & Stokes, 1997).

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Historic Site Conditions at Lands End (1925) **Figure 3**

Native Communities at Lands End

Figure 4

Central Coast Arroyo Willow Riparian Forest
(7,468 sq. meters; 1.8 acres)

Central Coastal Riparian Scrub
(35,692 sq. meters; 8.8 acres)

Dune
(338 sq. meters; 0.08 acre)

Freshwater Seep
(3,734 sq. meters; 0.92 acre)

Northern Coastal Bluff Scrub
(24,662 sq. meters; 6.1 acres)

Serpentine Bluff Scrub
(4,429 sq. meters; 0.95 acre)

Unique Floral Assemblage
(4,640 sq. meters; 1.2 acres)

Vegetation Mapping Boundary
(328,303 sq. meters; 81 acres)

National Park Service Administrative Boundary

Coastal Trail

Local Trail

N

0 50 100 200 300 Meters

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Non-Native Forest Cover at Lands End

Figure 5

Non-Native Tree Cover

National Park Service Administrative Boundary

Coastal Trail

Local Trail

N

0 50 100 200 300 400 Meters

Note: Mapping extent smaller than project area extent.

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Riparian Vegetation at Lands End

Figure 6

Riparian Area (based on Cowardin Wetland Classification)

- Emergent (4,766 sq. meters; 1.2 acres)
- Rock/Unconsolidated Bottom (3,248 sq. meters; 0.8 acres)
- Scrub-Shrub (36,268 sq. meters; 9.0 acres)
- Scrub-Shrub/Emergent (1,043 sq. meters; 0.26acres)
- Scrub-Shrub/Forested Wetland (75 sq. meters; 0.02 acres)
- Coastal Trail
- Local Trail
- National Park Service Administrative Boundary

N

100 50 0 100 200 300 Meters

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Ruderal/Disturbed Areas. Ruderal/disturbed areas are unvegetated, sparsely vegetated, or dominated by weedy vegetation. Much of the Lands End Planning Area has undergone significant disturbance, resulting in a widespread colonization of weedy species. Therefore, this community was not mapped as a separate community in the GIS database mapping efforts. Ruderal/disturbed areas are included in the larger mapping polygons within northern coastal bluff scrub, serpentine bluff scrub, and non-native species mapping polygons. This habitat is made up largely of non-native forbs and grasses such as ripgut brome, soft chess, wild oats, and velvet grass (Jones & Stokes, 1997) but may also be dominated by invasive non-native plants such as mattress wire weed (*Muehlenbeckia complexa)*, tea tree (*Leptospermum laevigatum)*, plume acacia, pampas grass *(Cortaderia jubata, C. selloana*), Cape ivy *(Delairea odorata),* English and Algerian ivy (*Hedera* spp.), iceplant *(Carpobrotus edulis)* and other weedy species.

Non-Native Forest. Non-native forest is a plant community dominated by an almost closed canopy of mature non-native trees, primarily Monterey cypress, Monterey pine, and blue gum eucalyptus. In the Study Area, non-native forest is most common along the highest southeastern border of the Study Area, extending north and west towards the ocean. It is important to note that for this report, GIS-based mapping of non-native forest stands and trees was restricted to areas that were in proximity to the Coastal Trail, and to planned trail enhancement areas where trees were most likely to be affected by planned restoration and trail improvement activities. Therefore, non-native tree mapping information presented herein should not be considered the entire extent of this habitat type in the Study Area (Figure 5). A more comprehensive mapping effort of the entire non-native forest is presented in the Vegetation Management Strategy for Areas Adjacent to the Coastal Trail at Lands End (McBride et. al., 2005).

Native Plant Communities

The following section identifies the remnant native plant communities found within the Lands End Planning Area. Table 1 lists species commonly associated with each of the communities described below. Figures 4 and 6 identify mapped locations of remnant native plant communities.

Central Coast Arroyo Willow Riparian Scrub and Forest. Central Coast arroyo willow riparian scrub is characterized as an open-canopied plant community comprised of willow saplings and trees and other small stature trees and shrubs. This natural community most often occurs along the edges of seeps and waterways, along steep-banked streams, near seeps, and along canyon sides (Figure 4). The dominant vegetation is composed of Arroyo willow mixed with a variety of large shrubs and small trees, including California wax-myrtle (*Myrica californica*), red elderberry (*Sambucus racemosa*), and coyote brush (*Baccharis pilularis)* (Jones & Stokes, 1997). Central Coast Arroyo willow

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riparian forest is similar in species composition and location, but consists of a more mature, closed-canopy plant community dominated by Arroyo willows.

Coastal Prairie. A few small patches of remnant coastal grassland habitat occur within the Lands End Planning Area. Because these habitat polygons are so small, they were not mapped as separate mapping polygons in this report. Instead, locations are noted as points on Figure 4. Dominant species include perennial grasses such as purple needlegrass *(Nassella pulchra),* California brome *(Bromus carinatus)* and red fescue *(Festuca rubra),* occasionally with other native grasses such as California oatgrass *(Danthonia californica),* and melic grass *(Melica imperfecta)*. Forbs include California poppy *(Eschscholzia californica),* annual lupine (*Lupinus spp.)*, and California buttercup *(Ranunculus californicus*).

Foredune. Foredune habitat is a sparsely vegetated community of unconsolidated sand, pockets of sandy soils, and pioneer native beach plants. This habitat is typically found immediately adjacent to the active beach strand. In the Study Area, only one area of remnant dune habitat is present, located south of the historic Sutro Baths (Figure 4). This historic dune area has been repeatedly disturbed by recreational use of the site and site landscaping; therefore it is considered a remnant native plant community. Low perennial herbs and subshrubs are characteristic of dune habitat, including beach sagewort *(Artemisia pycnocephala)*, sand verbena *(Abronia* sp.), silver beachweed *(Ambrosia chamissonis)*, coast buckwheat *(Eriogonum latifolium)*, Chamisso lupine *(Lupinus chamissonis)*, Douglas' bluegrass *(Poa douglasii)*, dune grass *(Leymus mollis ssp. mollis)*, and seaside daisy *(Erigeron glaucus)*. Typically, no single species dominates the cover in this community; however, a large portion of the extant dune habitat within the Study Area is dominated by dune grass (*Leymus mollis ssp. mollis*) adjacent to a freshwater seep. Several invasive non-native plant species, such as iceplant now colonize much of the remnant foredune.

The extent of the dune community has been greatly reduced from its historic distribution, and the community is now rare in California (Jones & Stokes, 1997).

Freshwater Seep. Freshwater seeps are sites with seasonal or perennial soil saturation resulting from groundwater seepage where the groundwater intercepts an impermeable bedrock layer, then 'daylights' on a slope of a hillside. In the project areas, freshwater seeps, while relatively small, are widely distributed (Figure 6), and occur in areas primarily underlain by serpentine and other Franciscan rock. Typically, freshwater seeps are dominated by a diverse assemblage of water-loving forbs and grasses, including natives such as rushes and sedges, horsetails *(Equisetum* spp.*)*, and seep monkeyflower *(Mimulus guttatus)* and non-natives such as velvet grass (*Holcus lanatus)*. This typical seep vegetation can, however intergrade into more typical freshwater marsh vegetation (tules, sedges, rushes) in areas with perennial water. Freshwater seeps and marsh vegetation intergrades with Arroyo willow riparian scrub (described above) (Jones & Stokes, 1997).

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The largest freshwater seep/freshwater marsh is located between the Merrie Way parking lot and the historic Sutro Baths. This seep supports the plants described above for other seeps, and also supports a fairly large population of natives such as horsetails, sedges, rushes, and California blackberry (*Rubus ursinus*); and non-native, invasives such as velvet grass (*Holcus lanatus*), mattress wire weed (*Muehlenbeckia complexa*), maritime rabbitsfoot grass *(Polypogon maritima*), calla lily *(Zantedeschia aethiopica)*, and other hydrophytic (water-loving) plants (Jones & Stokes, 1997; May and Associates, Inc., 2005).

Northern Coastal Bluff Scrub. Northern coastal bluff scrub occurs on steep, ocean and bay-exposed bluffs throughout the Study Area (Figure 4). Once common in the area, this habitat has been severely fragmented and displaced by non-native forest. Vegetative cover may be sparse to dense depending on the steepness of the slope. Dominant species include coyote brush (*Baccharis pilularis*), California blackberry *(Rubus ursinus)*, poison-oak *(Toxicodendron diversilobum)*, coffeeberry *(Rhamnus californica)*, and toyon *(Heteromeles arbutifolia)*. The species composition of northern coastal bluff scrub is very similar to that of serpentine bluff scrub, with the major difference being substrate (e.g. northern coastal scrub is found on a wider variety of soils, including serpentine derivative soils, mixed soils, and Colma soils), vegetation composition (e.g., higher percentage of serpentine associated species such as California blue-blossom *(Ceanothus thyrsiflorus)* in serpentine bluff scrub and vegetation cover (e.g., typically higher vegetation cover in northern coastal bluff scrub) (Jones & Stokes, 1997).

Serpentine Bluff Scrub. Serpentine bluff scrub occurs on steep, ocean- and bay-exposed serpentine bluffs (Figure 4). Once common in the area, this habitat has been severely fragmented and displaced by non-native forest. Vegetative cover may be sparse to moderately sparse depending on the steepness of the slope. Dominant species are California blackberry, California blue-blossom, poison-oak, and toyon. The species composition of serpentine bluff scrub is very similar to that of northern coastal bluff scrub, with differences being the substrate, vegetation composition, and vegetation cover, as described above. Areas mapped as serpentine bluff scrub include small areas of serpentine barrens. (Jones & Stokes, 1997).

Unique Floral Assemblage. The unique floral assemblage classification was used in 2005 mapping of Lands End conducted by May and Associates, Inc. While not a standard classification, this guild was used to cover additional mapping units that did not fall into any of the other mapping categories, but were large enough in expanse, and/or unique enough in species composition to be considered for mapping. Within the Study Area, unique floral assemblages included stands of bracken fern *(Pteridium aquilinum)*, iris *(Iris* sp.*)*, strawberry *(Fragaria chiloensis)*, live-forever *(Dudleya farinosa*), and other forbs persisting in the understory of non-native forest, in gaps between disturbed areas, or on steep, eroded cliff faces (Figure 4.1).

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Table 1. Species Commonly Occuring in Native Plant Communities

Community/Assemblage	Dominant Species	
	Scientific Name	***Common Name***
Central Coast Arroyo Willow Riparian Forest (occurs in wettest zones of perennial creeks or seasonal drainages)	*Alnus rubra*	Red alder
	Cornus sericea ssp. sericea	Creek dogwood
	Myrica californica	Wax myrtle
	Salix lasiolepis	Arroyo willow
	Sambucus racemosa var. *racemosa*	Red elderberry
Central Coastal Arroyo Willow Riparian Scrub (typically a stream- or lake- associated community, found also in drainages)	*Baccharis pilularis*	Coyote brush
	Myrica californica	Wax myrtle
	Rubus ursinus	California blackberry
	Salix lasiolepis	Arroyo willow
Coastal Prairie (uncommon and limited in extent, occurs on well-drained soils, on coastal bluffs)	*Danthonia californica*	California oatgrass
	Eschscholzia californica	California poppy
	Festuca rubra	Red fescue
	Lupinus spp.	Annual lupine
	Melica imperfecta	Small-flowered melica
	Nasella pulchra	Purple needlegrass
	Ranunculus californicus	California buttercup
Foredune / Dune (areas closest to the active ocean and beach strand - mostly unvegetated or sparsely vegetated, pockets of unconsolidated sand and very sandy loam)	*Erigeron glaucus*	Seaside daisy
	Leymus mollis ssp. mollis	Dune grass
Freshwater Seep (herbaceous plant community dominated by rushes & sedges, occurs in areas of soil saturation)	*Carex obnupta*	Sloughsedge
	Juncus lesueurii	Salt rush
	Juncus occidentalis	Western rush
	Juncus patens	Common rush
	Mimulus guttatus	Seep monkeyflower
Northern Coastal Bluff Scrub (ocean- & bay-exposed bluffs, prostrate & low vegetation)	*Baccharis pilularis*	Coyote brush
	Eriophyllum staechadifolium	Lizard tail
	Rubus ursinus	California blackberry
	Toxicodendron diversilobum	Poison oak
Serpentine Bluff Scrub (community is found on serpentine bluffs & outcrops; integrades with serpentine barrens)	*Baccharis pilularis*	Coyote brush
	Ceanothus thyrsiflorus	California blue blossom
	Heteromeles arbutifolia	Toyon
	Rhamnus californica	Coffeeberry
	Rubus ursinus	California blackberry
Unique Floral Assemblage (limited mapping polygon for special conditions)		

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2.2.2 Sensitive Species

The Study Area, because of its rich and diverse assemblage of geologic surfaces, coastal plant communities, and wetlands supports numerous sensitive and locally rare plant and wildlife species. Tables 2 and 3 provide a summary of the sensitive plant and wildlife species known or suspected to occur within the Lands End Study Area, their legal status, associated habitats, and comments regarding location and status within the Study Area. Refer to Figure 7 for the locations of sensitive plant species in the Lands End Study Area.

The section below provides a brief synopsis of issues related to maintaining and restoring habitat and restoring trails in, and near, sensitive plant and wildlife habitats of the Study Area.

Sensitive Plant Species. Table 2 lists plant species known to occur ,or having the potential to occur, within the Study Area. Many of the remaining coastal communities within the Study Area support, or have the potential to support sensitive plant species. These include remnant dune habitat near the historic Sutro Baths that supports several small stands of dune tansy (*Tanacetum camphoratum*), a local species of interest; serpentine bluff scrub habitat just east of Eagle's Point that supports coast rock cress (*Arabis blepharophylla*); and serpentine cliffs near Dead Man's Point that supports San Francisco gumplant (*Grindelia hirsutula var. maritima*), a locally rare species.

All of these rare plants would benefit from expansion of dune and scrub habitat within the Study Area; the continued existence of serpentine barrens (i.e. small patches of disturbance created through natural causes such as slumps and slides, or human-induced); and the control of invasive non-native plants such as Cape ivy (*Delairea odorata*), pampas grass (*Cortaderia jubata, C. sellonoa*), mattress wire weed (*Muehlenbeckia complexa*), and iceplant (*Carpobrotus edulis*).

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Table 2. Sensitive Plant Species Known, or With Potential to Occur in the Lands End Study Area.

Scientific Name	Common Name	Legal Status Fed. / State/ Local	Associated Habitat	Comments
Arabis blepharophylla	Coast rock cress	--/--/4	Occurs in bluff scrub, northern coastal bluff scrub, and coastal prairie communities; often in rocky places.	Occurs adjacent to Study Area near Eagle's Point.
Chorizanthe cuspidata var. cuspidata	San Franciscan spineflower	--/--/1B	Occurs in sandy terraces and slopes of coastal bluff scrub, coastal dunes, coastal prairie and northern coastal bluff scrub.	Located on the Presidio and Fort Funston. Could be supported in the dune habitat near the Sutro Baths once invasive plants are removed.
Cirsium andrewsii	Franciscan thistle	--/--/1B	Occurs on wet sites in bluff scrub and in serpentine habitats.	Not currently located within the Lands End Study Area, however, populations are present at Presidio Bluffs. Habitat exists within the Study Area.
Erysimum franciscanum	San Francisco wallflower	--/--/4	Occurs in foredune, dune scrub, bluff scrub, and northern coastal bluff scrub communities.	Anecdotal sightings near Eagle's Point, but not recently detected in the Study Area. Suitable habitat present.
Grindelia hirsutula var. maritima	San Francisco gumplant	--/--/1B	Occurs in serpentine chaparral and on serpentine soils in bluff and northern coastal bluff scrub communities.	Suitable habitat limited to steep cliffs near Dead Man's Point and other small serpentine bluff areas.
Hesperolinon congestum	Marin dwarf flax	FT/ST/1B	Occurs on serpentine barrens in serpentine chaparral and grassland habitats.	None present. Closest population occurs on the Presidio. Very limited suitable habitat present.
Tanacetum camphoratum	Dune tansy	Species of local interest (Parks Conservancy/NPS)	Coastal dune habitat, beach strand. Prefers sand and sandy loam soils.	Present at Sutro Baths and at Sutro Midden Site. Habitat restoration should seek to protect this species during invasive plant removal and social trail decommissioning and revegetation.
Triphysaria floribunda	San Francisco owl's clover	--/--/1B	Occurs in serpentine chaparral, coastal prairie and scrub, valley and foothill grassland; often on serpentine soils.	One population occurs at the Presidio. No habitat present.

Status explanation: **Federal**
FT = listed as threatened under the federal Endangered Species Act
-- = no legal status

State
ST = listed as threatened under the California Endangered Species Act
-- = no legal status

Local
California Native Plant Society (CNPS)
List 1B = Plants rare, threatened, or endangered in California and elsewhere
List 4 = Plants of limited distribution
-- = no listed status

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Known Sensitive Plant Species Occurrences at Lands End

Figure 7

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Sensitive Wildlife Species. Several resident and migratory birds such as songbirds, raptors, and marine birds either pass through, or nest in and adjacent to the Study Area. Similarly, the Study Area, with its unique coastal flora, supports several rare invertebrates. One such species, the Bumblee scarab beetle, a rare insect, is known from the dunes near the Cliff House adjacent to, but not within the Study Area. Refer to Table 3 for a list of wildlife species with special status (federal, state, and/or local) that occur in the Study Area.

The following generic actions would help ensure the continued existence of a suite of locally rare wildlife species, reduce potential for effects on these species, and could increase suitable habitat 'corridors' within the Study Area:

- Expand and connect riparian habitats wherever possible, with the goal of restoring natural hydrology and drainage patterns.
- Provide for a diverse mosaic pattern of vegetation types and structure, with emphasis on riparian habitats adjacent to scrub and wetland habitats.
- Expand coastal bluff habitats (e.g., scrub and chaparral habitats) wherever possible, strategically remove non-native trees to reduce fragmentation of, and expand existing coastal bluff communities. Creation of corridors will promote the movement and health of wildlife in the area by promoting genetic diversity of offspring.
- Locate trails and other high human use areas away from marine bird habitat and other known high wildlife use areas wherever possible, or use interpretive signage to heighten visitor awareness and landscaping to "screen" important wildlife use areas from access areas.
- Avoid any vegetation and tree removal or trimming during bird nesting season, typically March through August.
- Control trash, especially food-related trash that could attract and sustain native and non-native predators.
- Control non-native and perhaps some native predators that likely impact populations of native species; reduce feral cat feeding stations.

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Table 3. Sensitive Wildlife Species Known, or With Potential to Occur in the Lands End Study Area.

Scientific Name	Common Name	Legal Status Fed. / State/ Local	Associated Habitat	Comments
Invertebrates				
Lichnanthe ursina	Bumblee scarab beetle	SC/--/--	Open coastal sand dunes.	Species has been found south of the Study Area in sand dunes near the Cliff House (Jones & Stokes, 1997).
Amphibians				
Rana aurora draytonii	California red-legged frog	FT/SSC/--	Associated with cold freshwater pools with emergent and submergent vegetation and riparian species along the edges.	Species has been reported from several locations near Study Area and at the Strybing Arboretum in Golden Gate Park (Jones & Stokes, 1997). Suitable habitat is limited to large wetland areas at historic Sutro baths. Because most of the freshwater seeps and associated marshes in the project area are small, shallow, and highly disturbed, they represent marginal habitat for red-legged frogs.
Birds				
Ardea herodias	Great blue heron	--/--/SFLC	Forage in shallow tidal and freshwater habitats as well as adjacent uplands; will also use field and pastures. Nests colonially high in a wide variety of tree species.	Occurs occasionally at Lands End; does not breed. This heron may benefit from restoration of wetlands.
Callipepla californica	California Quail	--/FS/SFLC	Inhabits brushy edges of, or openings in, scrub, woodland, and forest habitats where they border on pasturelands, weedy fields, meadows, and unkempt lawns and yards. Prefer edge situations with low protective cover, open ground for foraging, and water sources. Nests on ground.	Extirpated as a breeder from Lands End and populations in San Francisco County at dangerously low levels (Gardali pers. comm.). Restoration efforts have the potential to increase appropriate habitat at Lands End.
Catharus ustulatus	Swainson's thrush	--/FS/SFLC	Occupies dense shady riparian groves; breeding seasons requisite is presence of dense moist understory or shub layer. Nests low to ground in understory.	Common migrant (Jones & Stokes 1997). Possible breeder in East and West washes (one pair each) (Gardali pers. comm.). Habitat enhancement activities – riparian restoration and predator control – will likely benefit this thrush.
Cepphus columba	Pigeon guillemot	--/--/SFLC	Near-shore coastal waters; nests in rocky crevices.	A few pairs likely nest in rock crevices on cliffs and near-shore rocks at Lands End (Jones & Stokes 1997). Restoration unlikely to affect this species. However, minimizing disturbance (e.g., reduce cliff climbing) should be prioritized.

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Scientific Name	Common Name	Legal Status Fed. / State/ Local	Associated Habitat	Comments
Chamaea fasciata	Wrentit	--/FS/SFLC	Inhabit northern coastal bluff scrub, coastal scrub, and chaparral communities; require a dense continuous shrub layer.	Year round residents that are suspected to be extirpated from San Francisco County (Gardali pers. com). Although this species may not be present in the Study Area, restoration of serpentine chaparral and northern coastal bluff scrub habitat would increase available habitat for the species—especially if predator control is used.
Contopus borealis	Olive-sided flycatcher	--/SSC,FS/SFLC	Prefers conifer trees for nesting but will also use eucalyptus and other non-native trees locally. Prefers areas that are somewhat open for foraging.	At least one pair breeds on or very near the Study Area – near Eagles Point (Gardali pers. comm.). Not likely to be affected.
Dendroica petechia brewsteri	California yellow warbler	--/SSC, FS/SFLC	Nests in riparian areas dominated by willows, cottonwoods, sycamores, or alders, or in mature chaparral; may also use oaks, conifers, and urban areas near stream courses.	Uncommon Spring migrant, common Fall migrant, and rare Winter visitor (Jones & Stokes 1997); does not breed at Lands End, may benefit from riparian habitat enhancement.
Empidonax traillii	Willow flycatcher	--/SE, FS/--	Uses riparian areas and large, wet meadows with abundant willows for breeding; usually occurs in riparian habitats during migration.	Transient only. Uncommon Spring and Fall migrant (Jones & Stokes 1997) may benefit from riparian habitat enhancement.
Falco columbarius	Merlin	SC/--/--	Open woodland, especially when dominated by blue, live, or valley oaks.	Uncommon non-breeding visitor to open forests; the status and usage patterns of this species in the Study Area are unknown, however based on their transitory nature in the areas, they are considered unlikely to be affected (Gardali, pers. comm.).
Falco peregrinus anatum	American peregrine falcon	FE/SE/SFLC	Nests and roosts on protected ledges of high cliffs, usually adjacent to lakes, rivers, or marshes that support large populations of birds.	Uncommon non-breeding resident (Jones & Stokes 1997); a pair breeds on the lower deck of the Bay Bridge and forages throughout San Francisco, including Lands End, where it has been documented in Sutro Heights Park perched in a snag above the artificial cliff (Gardali, pers. comm..); the status and usage patterns of this species in the Study Area are unknown, however based on their transitory nature in the areas, they are considered unlikely to be affected.
Gavia immer	Common loon	--/SSC/--	Near-shore coastal waters and bays; less common at large inland bodies of deep water with productive fisheries.	Extirpated as a breeder from the state. Common non-breeding visitor in spring, fall, and winter (Jones & Stokes 1997). Not likely affected.
Geothylpos trichas sinuosa	Saltmarsh common yellowthroat	SC/SSC/SFLC	Prefers freshwater marshes in summer and saltwater or brackish water in fall and winter, requires tall grasses, tules, and willow thickets for nesting and cover.	Does not breed at Lands End; occurs as migrant and winter resident (subspecies unknown) (Jones & Stokes 1997). May benefit from riparian habitat enhancement and Sutro Baths wetland enhancement.

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Scientific Name	Common Name	Legal Status Fed. / State/ Local	Associated Habitat	Comments
Haematopus bachmani	Black oystercatcher	--/--/SFLC	Inhabits rocky reefs, offshore islets on stretches of exposed coastline. Breeding requirements include shelter from high tides, spray from crashing waves, prevailing winds/storms, and mainland ground predators.	The breeding population is limited to a single pair that breeds on Seal Rocks and perhaps one or two others on the cliffs at Lands End (Gardali pers. comm.). The species is present throughout the year. Restoration unlikely to affect this species. However, minimizing disturbance (reduce cliff climbing) should be prioritized.
Histrionicus histrionicus	Harlequin duck	SC/SSC/-- (breeding only)	Found in turbulent mountain streams in summer and rough coastal waters in winter; forages by diving along rocky shorelines.	Rare winter visitor to rocky, near-shore waters of Lands End coastline (Jones & Stokes 1997). Not likely affected.
Junco hyemalis	Dark-eyed junco	--/--/SFLC	Inhabits openings and edges of moist, shaded mixed evergreen, Douglas fir, bishop pine, and coast redwood forests, to a lesser extent, Montery pine and eucalyptus plantings. Nests on ground.	Common breeding species at Lands End; occurs year-round (Jones & Stokes 1997). Enhancement activities – especially creation of forest openings and predator control – will benefit this species.
Pelecanus occidentalis	Brown pelican	FE/SE/--	Typically in littoral ocean zones, just outside the surf line; nests on offshore islands	Regular visitor to Lands End coastline (Jones & Stokes 1997). Common non-breeding visitor in spring, fall, and winter (Gardali pers. comm.). Not likely affected, however, minimizing disturbance (reduce cliff climbing) should be prioritized.
Phalacrocorax auritus	Double-crested cormorant	--/--/SFLC	Uses rock coastlines, beaches, inland ponds, and lakes; needs open water for foraging, and nests in riparian forests or on protected islands	Common non-breeding resident; occurs on offshore rocks and islands(Jones & Stokes 1997); Although they do not breed at Lands End, they nest on the Bay Bridge and have been recently sighted at the Golden Gate Bridge (Gardali pers. comm.). Not likely affected
Phalacrocorax pelagicus	Pelagic cormorant	--/--/SFLC	Primarily a marine bird occupying near-shore waters; nest on narrow ledges on cliffs, sea caves, coastal bluffs or offshore rocks and islands.	A few pairs likely breed on the cliffs at Lands End (Gardali pers. comm.). Restoration unlikely to affect this species. However, minimizing disturbance (reduce cliff climbing) should be prioritized.
Phalacrocorax pencillatus	Brandt's cormorant	--/--/SFLC	Strictly marine bird; primarily feeds in near-shore waters; nests on offshore islands/rocks and inaccessible mainland cliffs.	Nests on Seal Rock in the near-shore waters at Lands End (Jones & Stokes 1997). Restoration activities not likely to impact this species as long as trails are aligned to minimize disturbance.
Pipilo maculatus	Spotted towhee	--/--/SFLC	Breeds in coastal scrub, brushy riparian thickets, and on shrubby edges and openings of various native and non-native woodlands. Nests on ground.	Extirpated as breeder from Lands End (Jones & Stokes 1997). Enhancement activities including restoration and predator control would likely benefit this wren.

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Scientific Name	Common Name	Legal Status Fed. / State/ Local	Associated Habitat	Comments
Rallus limicola	Virginia rail	--/--/SFLC	Inhabits marshlands at all times of the year.	Does not breed in all of San Francisco County (Jones & Stokes 1997); status in non-breeding season at Lands End is unknown (Gardali pers. comm.). Expansion of wetlands may benefit this rail especially during migration and perhaps overwinter.
Sterna elegans	Elegant tern	SC/--/--	Sandy, coastal areas and adjacent waters, both outside the surf line and in sheltered bays	Uncommon non-breeding visitor in summer and fall; forages over coastal waters (Jones & Stokes 1997). Not likely affected by project.
Thyromanes bewickii	Bewick's wren	--/--/SFLC	Inhabits coastal scrub, riparian thickets, and along brushy margin of various native and non-native woodland types; need moderately dense brush layer with some openings. Primarily places its nest low to the ground.	Extirpated as breeder from Lands End (Gardali pers. comm.). . Enhancement activities including restoration and predator control would likely benefit this wren.
Vireo huttoni	Hutton's vireo	--/FS/SFLC	Prefers evergreen forests of moderate to dense crown closure dominated by live oaks over dense north-facing bay laurel stands or open oak woodlands.	One pair apparently nests in Lands End near the West Wash (Gardali pers. comm.). Restoration has the potential to benefit this vireo.
Zonotrichia leucophrys	White-crowned sparrow	--/FS/SFLC	The local subspecies is a resident of coastal terraces and shrubby areas including weedy yards and parks. Prefers semi-open coastal scrub habitats for breeding. Nests low in shrub layer.	Common breeder and year-round resident at Lands End (Jones & Stokes 1997). Local subspecies joined by others subspecies during fall and winter (Gardali pers. comm.). Enhancement activities – especially creation of coastal scrub and predator control – will benefit this sparrow.
Mammals				
Eumetopias jubarus	Northern (Stellar's) sea lion	FT/--/--	Use rocky shoreline and inter-tidal habitats for haul out areas	Potentially uses offshore rocky areas near coastline for haul out (Jones & Stokes 1997).

Status explanation: **Federal**
FE = listed as endangered under the federal Endangered Species Act
FT = listed as threatened under the federal Endangered Species Act
SC = species of concern to USFWS; Includes many species that were formerly categorized as Category 2
-- = no legal status

State
SE = listed as endangered under the California Endangered Species Act
ST = listed as threatened under the California Endangered Species Act
SSC = California Department of Fish and Games Species of Special Concern
FS = California Partners in Flight Focal Species
-- = no legal status

Local
SFLC = San Francisco Species of Local Concern
-- = no listed status

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2.2.3 Invasive Species

The Study Area supports large expansive populations of several priority target invasive non-native plant species. Target invasive species include those species that are considered the greatest threat to remnant natural communities within the Lands End Study Area. Due to the significant number and overlapping extent of the targeted invasive non-native plants within the Study Area, most species were not mapped individually, but were grouped into classifications or "guilds" based on plant types (e.g. annual, shrub, tree, etc.) and anticipated control methods. See Results of the Vegetation, Cowardin Wetland, and Undesignated Trail Surveys within the Coastal Trail Corridor at Lands End (May and Associates, Inc., 2005) for a description of the targeted invasive non-native plant species mapping methods. Table 4 lists non-native plant guild names and associated species mapped within each guild.

The invasive plant guilds in Table 4 are described below. Refer to Figure 8 for the distribution of invasive species and invasive species guilds at Lands End.

Pampas grass and Cape ivy patches/populations were mapped as individual species, and not grouped into guilds. These species were mapped separately due to their ability to rapidly colonize coastal bluff habitats (as seen on the Presidio and a number of disturbed areas throughout the GGNRA's coastal watersheds). Mapping of these species was conducted individually to facilitate detection and treatment, in an effort to help promote eradication in the Lands End Planning Area.

> ***Cape Ivy (Delairea odorata)***. Cape ivy, also commonly known as German ivy, is a vine like plant with fleshy, bright, waxy, green colored leaves native to the cape of South Africa (Hickman 1993). This species favors moist, semi-shaded areas such as forest margins and wet gullies. In the Study Area, this species is quite widespread, occupying an estimated 6.3 acres in 2005 (within the 60.5 acre mapping boundary). This species has been reported to have rapidly expanded its range over the last 10 years in the Study Area (S. Farrell, pers. comm.). Cape ivy can rapidly reproduce by root and from every leaf node and occasionally from seed. It has been naturalized throughout California coastal riparian regions and is increasingly spreading into inland and drier regions.
>
> ***Pampas Grass (Cortaderia jubata, C. selloana).*** Pampas grass is a rapid-growing perennial grass that is native to South America (Hickman 1993). This species is found along sea cliffs throughout central and northern California, spreading rapidly to cover exposed cliff faces and mudslide areas. In the Study Area, Pampas grass is not yet widespread, and should be monitored and controlled to prevent further colonization along the Lands End bluffs. The species reproduces sexually by seeds or vegetatively by tillers or fragments of mature plants.

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Table 4. Invasive Plant Guilds

Guild Name	Target Species	
	Scientific Name	***Common Name***
Large trees	*Cupressus macrocarpa*	Monterey cypress
	Eucalyptus globulus	Blue gum eucalyptus
	Pinus radiata	Monterey pine
Small trees/large shrubs	*Acacia longifolia*	Golden wattle
	Albizia lophantha	Plume acacia
	Coprosma repens	Mirror plant
	Leptospermum laevigatum	Tea tree
Small woody shrubs and sub-shrubs	*Cotoneaster sp.*	Cotoneaster
	Rubus discolor	Himalayan blackberry
Groundcover plants	*Carpobrotus edulis*	Iceplant
	Hedera helix	English ivy
	Muehlenbeckia complexa	Mattress wire weed*
	Tropaeolum majus	Nasturtium
	Vinca major	Greater periwinkle
Perennial grasses	*Arundo donax*	Giant reed grass
	Dactylis glomerata	Orchard grass
	Ehrharta erecta	African veldt grass
	Festuca arundinacea	Tall fescue
	Lolium perenne	Perennial ryegrass
	Phalaris aquatica	Harding grass
Perennial/biennial herbaceous plants	*Allium triquetrum*	Wild onion
	Amaryllis belladonna	Naked lady
	Cirsium vulgare	Bull thistle
	Conium maculatum	Poison hemlock
	Foeniculum vulgare	Sweet fennel
	Rumex acetosella	Sheep sorrel
	Zantedeschia aethiopica	Calla lily
Annual plants	*Brassica nigra*	Black mustard
	Carduus pycnocephalus	Italian thistle
	Fumaria parviflora	Fumitory
	Hirschfeldia incana	Wild mustard
	Lavatera cretica	Tree-mallow
	Malva neglecta	Common mallow
	Picris echioides	Bristly ox-tongue
	Raphanus sativus	radish
	Sonchus oleraceus	Common sow thistle
	Tetragonia tetragonioides	New Zealand spinach
Target species (individually mapped)	*Cortaderia jubata*	Andean pampas grass
	Delairea odorata	Cape ivy

*mattress wire weed was included in ground cover species for May and Associates, Inc. mapping data .

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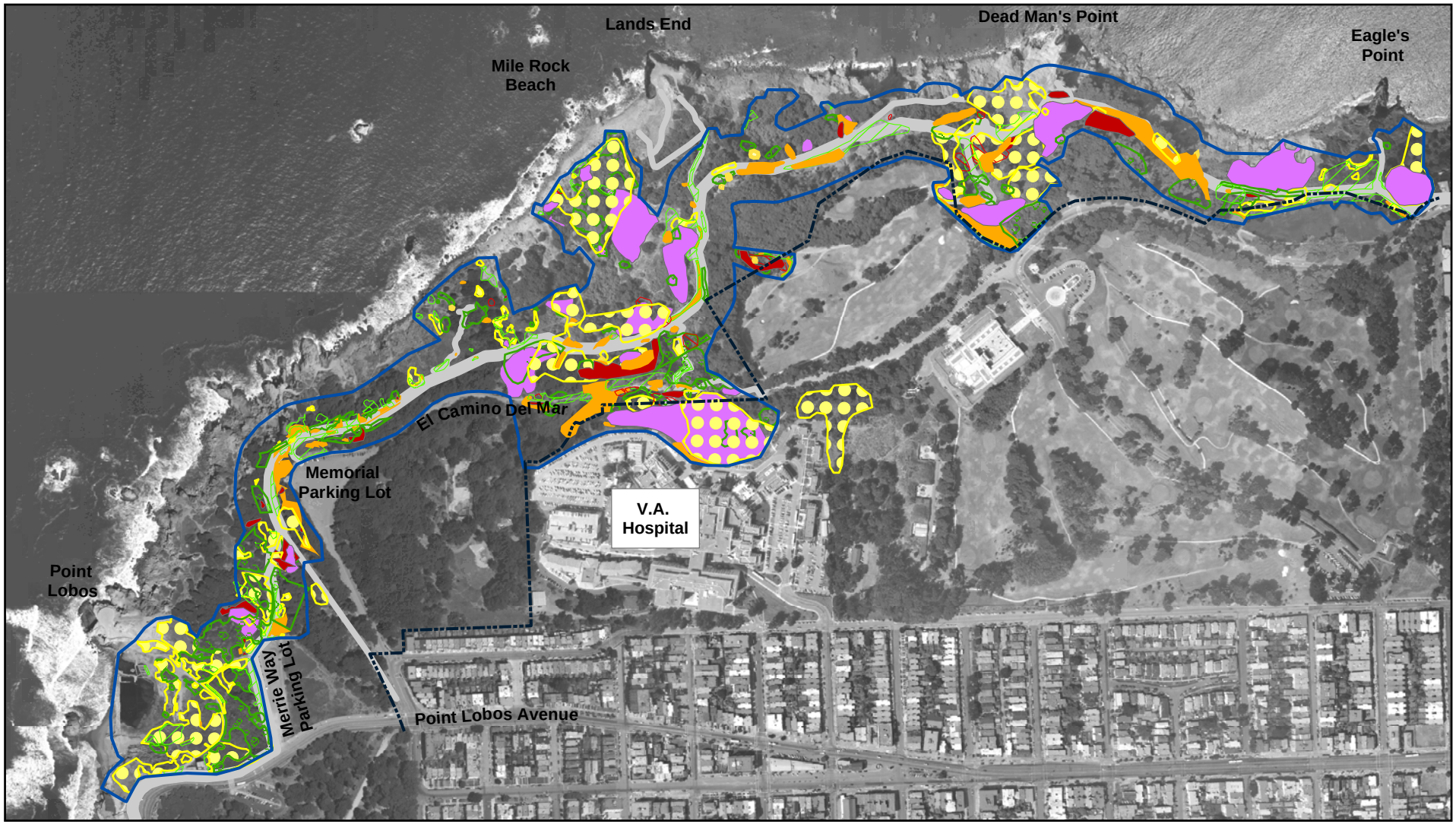
Target Invasive Species at Lands End (by guild)

Figure 8



Annual Plants
(24,445 sq. meters; 6 acres)

Groundcover Plants
(72,757 sq. meters; 18 acres)

Perennial/Biennial Herbaceous Plants
(21,838 sq. meters; 5.4 acres)

Perennial Grasses
(7,244 sq. meters; 1.8 acres)

Small Trees/Large Shrubs
(46,928 sq. meters; 11.6 acres)

Small Woody Shrubs and Sub-Shrubs
(4,987 sq. meters; 1.2 acre)

Pampas Grass (Target Species)
(221 sq. meters; 0.05 acre)

Cape Ivy (Target Species)
(40,586 sq. meters; 10 acres)

Vegetation Mapping Boundary
(328,303 sq. meters; 81 acres)

National Park Service Administrative Boundary

Coastal Trail

Local Trail

Note: Mapping boundary smaller than extent of Lands End project area.

N

100 50 0 100 200 300 Meters

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Non-Native Large Trees. Non-native large trees at Lands End include Monterey cypress, Monterey pine, and blue gum eucalyptus. In the Study Area, these trees form dense to sparse forests that have severely diminished the bluff's native coastal plant communities. Typically these trees support either limited or weedy understory habitat. However, in some areas where the tree cover is sparse, patches of brackern fern (*Pteridium aquilinum*) and California polypody (*Polypodium californicum*) are supported under the canopies.

Non-Native Small Trees, Large Shrubs, Small Woody Shrubs and Sub-Shrubs. Several small trees and shrubs, mostly cultivated species are also present in the Study Area, often on the edges or as an understory layer in the non-native forest, and on the edges of willow riparian communities. Small non-native trees at Lands End are typically trees and shrubs that have escaped cultivation (e.g., from backyard dumping, spread by birds, or other similar garden escapes) or have been planted either directly adjacent to or within the Lands End Study Area. In addition to spreading into coastal bluff and grassland habitat areas, these small trees and shrubs often form dense understory below the forest canopy, areas favored by some as sites for illicit activities, including camping, and other human uses. Removal of dense underbrush would likely discourage inappropriate human uses, and allow for expansion of native scrub and chaparral into non-native forested areas. Removal or trimming of these small trees and shrubs may also open up key viewsheds, and help reduce undesirable human activities by creating more exposed areas.

Invasive small trees and shrubs that were detected and mapped as a part of this guild include:

- Cotoneaster (*Cotoneaster* spp.);
- French broom (*Genista monspessulana*); and
- Golden wattle (*Acacia longifolia*);
- Green wattle acacia *(Acacia decurrens)*;
- Himalayan blackberry (*Rubus discolor*).
- Lollypop tree, myoporum (*Myoporum laetum*);
- Mirror plant (*Coprosma repens*);
- Pittosporum (*Pittosporum* sp.);
- Plume acacia, albizia (*Albizia lophantha);*
- Tea tree (*Leptospermum laevigatum*);

Groundcover Plants. Groundcover plants is a "catch-all category" that was developed to include vining plants that often carpet or cover the understory beneath the non-native forest or cover disturbed habitats within the coastal plant communities. Some of these species can climb and cover vegetation, including trees. Groundcover species include mattress wire weed, ice plant, periwinkle, and Cape ivy, described below.

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Mattress Wire Weed (Muehlenbeckia complexa). Mattress wire weed, also commonly known as Maidenhair vine, is a high climbing, vine like shrub native to New Zealand (Hickman 1993). This species favors moist, semi-shaded areas such as forest margins and wet gullies. In the Study Area, this species currently occupies approximately 2-4 acres of area, but is spreading (Farrell, pers. comm.). It tends to favor moister habitats, often adjacent to trails, wetland seeps, and/or landscaped areas where it has likely originated. Mattress wire weed forms dense twisted masses if no support is available, and where it is available, it climbs into native shrubs and trees (Hickman 1993). Within the Study Area, mattress wire weed dominates the wetland area near Sutro Baths below the Merrie Way parking lot. It is also colonizing high value wildlife habitat within the "East Wash" adjacent to the golf course and the Legion of Honor, overtaking native habitat as well as large stature non-native trees.

Iceplant (Carpobrotus edulis). Iceplant is relatively common, but dispersed throughout the sandy soils of the Colma Formation, mostly in the southwestern half of the Study Area. This species is rapidly displacing native dune and scrub species, and threatening sensitive plant habitat for dune tansy (*Tanacetum camphoratum*) near the historic Sutro Baths project site.

Other Vines. The following invasive vine species were also mapped within the Study Area due to their ability to quickly colonize coastal bluff habitats:

- Algerian ivy (*Hedera canariensis*);
- English ivy (*Hedera helix*); and
- Periwinkle (*Vinca major*).

Perennial Grasses. Several non-native perennial grasses have already established within the Lands End Study Area, and are continuing to expand into disturbed areas within the forest understory and other coastal habitats. Invasive perennial grasses include:

- Ehrharta (*Ehrharta erecta*);
- Harding grass (*Phalaris aquatica*);
- Kikuyu grass *(Pennisetum clandestinum*); and
- Velvet grass (*Holcus lanatus*).

Perennial/Biennial Herbaceous Plants. Several large-stature perennial or biennial forbs have also colonized habitat at Lands End. These include:

- Poison hemlock (*Conium maculatum*);
- Sweet fennel (*Foeniculum vulgare*); and
- Tree mallow (*Lavatera cretica*).

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Annual Plants and Other Early Colonizing Invasive Plant Species. Many weedy species tend to initially colonize newly disturbed areas at Lands End. These species tend to spread throughout the entire Lands End Planning Area, and are not easily controlled. These early colonizing and annual invasive plants include the following:

- Black mustard (*Brassica nigra*);
- Bulb plants such as naked lady (*Amaryllis belladona*), wild onion (*Allium triquetrum*), and calla lily (*Zantedeschia aethiopica*);
- Common mallow *(Malva neglecta)*, and tree mallow *(Lavatera cretica*);
- Fumitory (*Fumaria parviflora*);
- New Zealand spinach (*Tetragonia tetragonioides*);
- Passion fruit vine, pig poa *(Passiflora* sp.);
- Thistles
  - Bristly ox-tongue (*Picris echioides*);
  - Bull thistle (*Cirsium vulgare*);
  - Italian thistle (*Carduus pycnocephalus*);
  - Sow thistle (*Sonchus oleraceus*);
- Umbrella plant *(Cyperus involcratus*); and
- Wild radish (*Raphanus sativus*).

2.3 Soils and Geology

The following section was excerpted in its entirety from the Hydrology and Water Quality Assessment Report prepared by Kamman Hydrology (Kamman, 2005):

"The Lands End project area is underlain by rocks of the Franciscan Complex – an assemblage of discrete rock types accumulated along the California coast. These rocks range in age from about 200 to 800 million years (Elder, 2001; Schlocker, 1974). The discrete blocks or wedges of terrane that constitute the Franciscan Complex represent materials scraped off the descending Pacific oceanic plate as it subducted beneath the North American tectonic plate. The resulting stacked sequence or wedges of semi-coherent rocks are referred to as Franciscan terranes. There are eight distinct terranes recognized in the San Francisco Bay Area, with the age of terranes getting older from west to east. The composition of rocks may vary widely within a given terrane and are referred to as mélange where highly fractured, disrupted, and mixed together. Zones of mélange typically separate distinct terranes.

Two Franciscan Terranes are encountered at Lands End, separated by mélange of the north-northwest trending City College fault zone. The terrane west of the fault zone is referred to as the San Bruno Mountain Terrane (Note: Schlocker tentatively assigned rocks of the San Bruno Terrane to the Great Valley sequence). The northern extent of the City College fault zone underlies the Veterans Administration (VA) Hospital as mapped by Schlocker (1974) and Rutherford & Chekene (2005). Between the Cliff House and Bakers Beach, the exposed rocks along the coastal

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bluffs consist of heavily weathered, eroded, and locally sheared clastic rocks (sandstone, shale, and conglomerate). Differences in sandstone mineral content distinguish the clastic rocks of the San Bruno Mountain and Marin Headland terranes lying on either side of the City College fault/mélange zone (Schlocker, 1974). Much of these rocks have also been hydrothermally altered at some point during emplacement (Ibid). Interspersed within the Franciscan sandstone deposits are younger sandstone of the Colma Formation (the largest outcrop is located immediately east of the former Sutro Baths), serpentine associated with City College fault zone, and minor amounts of greenstone. Landslide deposits and beach sands also cover portions of the Franciscan complex. The flat lying areas atop and east of the bluffs consist of dune sand overlying bedrock."

Refer to Figure 9 for the locations of major geologic formations and soil types at the Lands End Study Area and Table 5 for an overview of geologic formations and associated vegetation communities.

Table 5. Geology, Soils, and Natural Vegetation of the Lands End of San Francisco (Jones and Stokes 1997)

Geological Formation	Parent Material	Soil Type	Vegetation Communities
2. Colma	1. Old dune sand/alluvium	1. Pachic Haplustoll/Typic Ustropept	1. Coastal terrace prairie/ northern coastal scrub 2. Central coast arroyo willow/ live oak riparian forest 3. Coast live oak woodland/ northern coastal scrub 4. Central coast arroyo willow forest
3. Franciscan	1. Soft sandstone/shale	1. Cronkhite	1. Coastal terrace prairie/ northern coastal scrub
	2. Hard sandstone	1. Barnabe/ Kron	1. Coastal terrace prairie
	3. Serpentinite	1. Henneke (variant)/Pachic Argiustoll	1. Serpentine bunchgrass/ serpentine chaparral
	4. Serpentinite (with inclusions) seacliffs	1. Henneke variant)/Ustorthent	1. Northern coastal bluff scrub/ northern coastal scrub/ serpentine chaparral
	5. Siliceous, carbonaceous shale	1. Pablo/Bayview/(variants)	1. Coastal terrace prairie/ northern coastal scrub
	6. Soft sandstone/shale/chert	1. Cronkhite/Barnabe variant	1. Coastal terrace prairie/ northern coastal scrub

Due to the characteristics of underlying materials, portions of the Study Area are prone to geologic hazards such as sheet erosion, rilling, soil creep, gullying, stream downcutting, streambank erosion, and landsliding caused by erodable soils and rock. (Table 5) (Source: http://www.nps.gov/prsf/geology/colma.htm).

Human influences on soils are mostly a result of the recreational use of the Lands End area, including the Sutro Baths area, the Cliff House, Golden Gate Park and Playland. Construction and maintenance of the railroad line, recreational facilities, as well as the Merrie

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Way parking lot resulted in excavations, cuts, and fills. The establishment of non-native forests also changed the characteristics of the native soils. The most apparent change from forest establishment is the formation of a thick layer of organic leaf litter on the soil surface that has likely changed native soil fertility and water-holding capacities. Less obvious changes from forest establishment include changes to wind patterns (and therefore wind-borne movement of soils), and changes in surface water infiltration rates (especially in formerly sandy soils that now are covered with organic materials). In some forested areas, soil characteristics have changed such that dramatically less water infiltrates into normally porous sand, and rill and gully erosion have occurred.

Today, heavy visitor use along or near the Coastal Trail (the former railroad alignment) and substantially altered drainage patterns have resulted in erosion and gullying along the Coastal Trail and within the numerous social trails.

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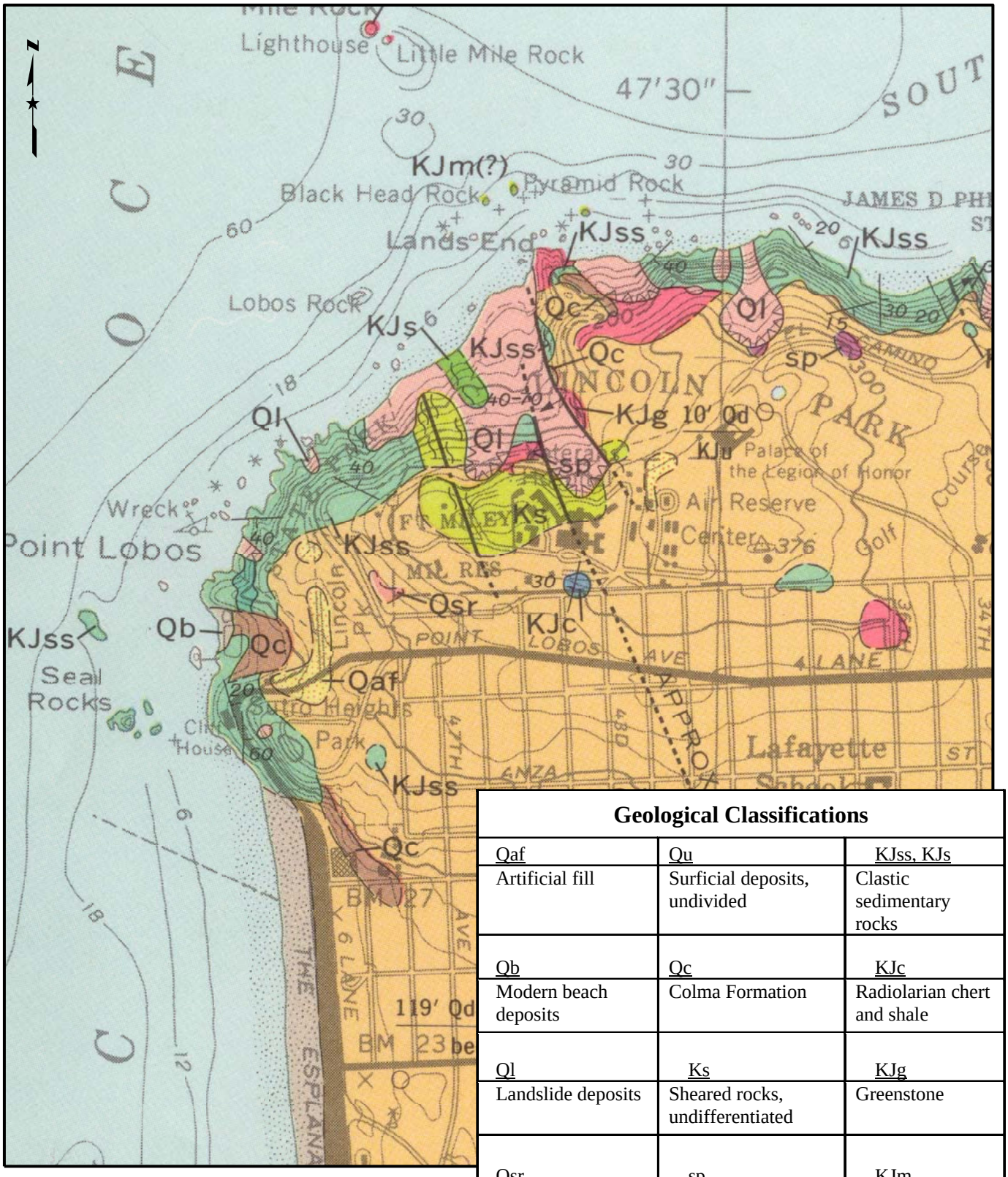
Geology at Lands End
(from *Geology of the San Francisco North Quadrangle, California*, by J. Schlocker, 1974)

Figure 9



Geological Classifications

Qaf	Qu	KJss, KJs
Artificial fill	Surficial deposits, undivided	Clastic sedimentary rocks
Qb	**Qc**	**KJc**
Modern beach deposits	Colma Formation	Radiolarian chert and shale
Ql	**Ks**	**KJg**
Landslide deposits	Sheared rocks, undifferentiated	Greenstone
Qsr	**sp**	**KJm**
Slope debris and ravine fill	Serpentine	Metamorphic rocks
Qd		
Dune sand		

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2.4 Hydrology

The following section was synthesized and excerpted from the Hydrology and Water Quality Assessment Report prepared by Kamman and Kamman Engineering Inc.(2005). Refer to Appendix F for the report in its entirety:

The source of water that flows through the Lands End project area appears to be primarily from surface runoff (e.g. rainfall, fog drip) and natural groundwater that surfaces along geologic fractures and bedrock faces (e.g. seeps, springs).

A focused investigation was conducted in 2005 by Kamman and Kamman Engineering Inc. to investigate the hydrological functioning of three areas of concern at Lands End (Kamman, 2005) (Appendix F):

- The Sutro Baths area;
- The waterways downslope from the Golf Course; and
- The waterways below the Veteran's Administration Hospital Parking lot.

These areas have historically been problematic, with minor and major landslides, erosion, slides, slumps, and erosional areas recorded in areas downslope from these locations.

The hydrologic investigation focused on both identifying the source of the three water features identified above, and analyzing drainage patterns and stability, erosion problems, and flow capacity. Testing was undertaken to determine whether the areas were being fed from a municipal source (e.g., sewer, irrigation, municipal drinking water), or were intercepting water from an upslope source (e.g., runoff from golf course, parking lots, sprinklers, broken water pipes).

> "A water sampling and laboratory analysis program was implemented to determine the source of water at each Study Area. This program consisted of collecting spring water for selected analyses to determine if waters are of a natural or man-made source (e.g., domestic water supply, sanitary source, or golf course surface/subsurface drainage). In order to better evaluate analytical results, a pair of reference samples consisting of treated domestic water were also collected and submitted for laboratory analysis. The results indicated that, based on the lack of any detectible herbicides, pesticides, trihalomethanes, and other indicator substances, that the water source at all of these locations is from natural sources…"

For the area below the Veteran's Administration Hospital:

> "Field reconnaissance and model simulation results suggest that existing channels upstream of the Coastal Trail culvert are unstable and subject to seasonal erosion during winter storms. Active channel erosion and down-cutting currently precludes the establishment of stabilizing vegetation. A reduction in flood flow velocities will be necessary to establish or revegetate the 90-feet of main channel upstream of the culvert. The culvert itself and associated wing-wall and riprap entrance/exit way do

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not appear to be unstable and will likely function sufficiently through floods having between a 50- and 100-year recurrence intervals. Floods that overwhelm the culverts will cause overtopping of the Coastal Trail, possibly leading to erosion of the trail surface" (Kamman 2005).

Channel stabilization is recommended in several problem areas, as well as appropriate use of erosion control and vegetation plantings to help stabilize the slopes and control surface water flows before and after trail and habitat restoration. Special attention must be given to these problem areas, and particular care will be needed to stabilize steep slopes following tree removal. Kamman is currently identifying possible treatments for stabilizing and re-configuring the drainage, reducing non-natural erosion and directing water flows more naturally. Products from this effort will include possible treatments and engineering solutions, and anticipated design and implementation costs.

Kamman is also working directly with Campbell Grading and General Engineering to evaluate slope and trail stability south of Eagle's Point.

2.5 Cultural and Historic Resources

The following section is excerpted largely from the report entitled "Abbreviated Cultural Landscape Report: Sutro District, Golden Gate NRA, Merrie Way & The Lands End Trails" presented to the Golden Gate National Parks Conservancy by John Martini in 2005 (Martini, 2005).

The Lands End Planning Area is within the Sutro Historic District, a major recreational destination for over 100 years. Several railway systems were constructed to link downtown to the Cliff House area, the most famous (and scenic) of which was the Ferries & Cliff House Railroad constructed by Adolph Sutro in 1888 to provide transportation between the Ferry Building in downtown San Francisco and the Cliff House, Sutro Baths, and surrounding areas. It operated as a steam train line until 1905 when it was converted into an electric streetcar route. Very little remains of the original roadbeds (often referred to as the "lower" Lands End trail alignment), partially the result of repeated landslides that reportedly plagued the rail lines from the late 1880s when the rail line was installed, until a major landslide in February 1925 that caused portions of the tracks to wash away and the streetcar line to cease operation altogether. Sections of the historic railroad alignment remain today on the stable geologic sections of the Coastal Trail. The most intact sections that remain today include a section between El Camino Del Mar and an area below the Veterans Administration Hospital, terminating near the concrete wall (described below); a section near Painted Rock beginning at the Lincoln Park service road and continuing east towards Painted Rock to a point just east of an old tunnel location; and the section near Eagle's Point overlook near the intersection of 33rd Ave and El Camino Del Mar (Martini, 2005).

Remaining historic features that should be considered during trail and habitat restoration planning include:

- Two large, intact concrete retaining walls both constructed in 1923 by the San Francisco Department of Public Works (DPW) (Martini, 2005);

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- Historic landscaping near the historic Sutro Baths (historic landscaping of concern includes a single remaining eucalyptus tree and calla lilies that mark the location of the caretaker's house, and landscaped areas below the service road and above the historic Sutro Baths);
- The site of several amusement rides. Although there is no trace of the rides, there is speculation that buried remains of the Firth Wheel may still be present on the east side of the parking lot;
- Mile Rock tunnel, a storm sewer constructed in 1914-1915 by the San Francisco Department of Public Works with its outlet near Lands End Beach;
- The locations of two former railroad tunnels, both of which were "daylighted" by having their overhead cover removed. These tunnel sites are visible as large V-shaped cuts where the railroad grade cuts through the hillside; and
- The alignment and surviving asphalt pavement of the 1923 city street "El Camino Del Mar" that once connected the Palace of the Legion of Honor at Lincoln Park with the present-day Memorial Parking lot.

Over the years, there have been a myriad of trails, roads, and tracks developed in the Lands End area by the military, rail line operators, and construction crews working on various projects for the City of San Francisco Department of Public Works, Civilian Works Authority and others. Of particular note are the following trails, much of which survive today, and remnant social trails, and are still used by the public to access certain beaches and scenic overlooks:

- Lands End Beach Access Road. A trail extending from Merrie Way to Lands End along the cliffs and beaches. The purpose of this trail is unknown, but is suspected to be a construction access road for the Mile Rock Tunnel project (described above).
- CWA trails. During the 1930's the Civilian Works Authority is thought to have hired crews to improve trails at Lands End (Martini, 2005). A 1937 photograph depicts numerous trails criss-crossing the hills from Lincoln Park and the rail line.

Refer to Figure 10 for the approximate locations of non-sensitive historic and cultural resources at Lands End.

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Historic & Cultural Resources at Lands End

Figure 10

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2.6 Land Use - Lands End Visitors Survey

Many of the current and past land uses at Lands End are largely the same: recreational uses related to the enjoyment of natural areas (hiking, picnicking, running, family outings, bird watching), oceans (fishing, swimming, wading, surfing), beaches (sunbathing, strolling, swimming, meeting friends), and recreational facilities (recreational play, interpretive uses).

The following section was largely excerpted from the report entitled "Results of Lands End Trail Visitor Survey" presented by Patrick Tierny Ph.D., Department of Recreation and Leisure Studies, San Francisco State University, June 14, 2005 (Tierny 2005).

The GGNRA conducted a Visitor's Survey at Lands End in May 2005. This research had the following study objectives:

- To determine the priority visitor entry, exit and destination points within the coastal bluff zone;
- To better understand the type and frequency of visitor uses in the Study Area;
- To test management strategies that would reduce number of social trails and increase visitor safety;
- To identify Study Area visitor characteristics; and
- To determine if and what type of additional information is desired by users, and the most effective mechanisms for communicating desired information.

A total of 870 completed surveys were collected. The following tables show the breakout of completed surveys by day and survey site. About 90.1% of surveys were collected on weekends, while 9.9% were collected during weekdays.

Completed Surveys by Date

Date	Count	%
14-MAY-05	169	19.4
15-MAY-05	173	19.9
17-MAY-05	30	3.4
21-MAY-05	250	28.7
22-MAY-05	192	22.1
23-MAY-05	31	3.6
Unknown	30	2.9
Total	**870**	**100.0**

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Completed Surveys by Location

Survey Location	Count	%
Merrie Way	301	35.8
USS SF Memorial	9	1.1
Near Legion of Honor/Golf Course	65	7.7
El Camino Del Mar Trail/Vets Hosp.	214	25.5
Eagle Point/Sea Cliff	251	29.9

The results of this study are summarized as follows:

- Most respondents entered the Coastal Trail system from the Merrie Way parking lot (35.8%), followed by visitors entering the trail from Eagles' Point/Sea Cliff (29.9%) and El Camino Del Mar at the VA Hospital Entrance (25.5%).
- The most popular activities of respondents included walking (76.5%), jogging (13.7%), dog walking (7.3%), and bicycling/other (2.5%).
- Most visitors were from San Francisco (64.2%), and most were 26-35 years of age (31.8%).
- Most visitors drove to the trail in a car (68.3%), followed by visitors who walked to the trail (18.7%).
- Visitors ranked the following activities as Extremely Important:
    - Walking/hiking (61.2%);
    - Observing nature/scenery (52.7%);
    - Being with friends/family (46.9%);
    - Seeing the Golden Gate Bridge (26.5%);
    - Dog walking (22.0%);
    - Jogging/running (23.4%);
    - Learning about the history of the area (14.4%);
    - Picnicking (12.5%);
    - Bicycling (8.1%); and
    - Fishing (5.3%).
- Other activities mentioned included bird watching and wildlife observation, beach use, fresh air, making art and music, photography, intimate time, ropes course, surfing, golfing (note proximity to Lincoln Ave. golf course 6th hole).
- Visitors were extremely interested in the following types of information being available;
    - Trail Map on signs at trail heads (27.0%);
    - Information on animals and plants (24.0%);
    - Area map to be provided along trail (23.9%);
    - Information on distance to points of interest (20.6%);

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  - A take-along trail map (19.0%);
  - Information on history of area (18.3%);
  - Signs with rules and regulations (14.2%);
  - Information on things to do on trail (12.1%); and
  - Other information interests included bird identification dog leash signs, doggie bags, donation box, poison oak warning signs, bike signs, safety signs, and restroom.
- Visitors indicated that they were "very likely" to stay on the designated trails (41.7%) if safe defined trails were provided.

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3.0 OVERVIEW OF PLANNED TRAIL ENHANCEMENTS AND SOCIAL TRAIL CLOSURES FOR THE LANDS END SECTION OF THE COASTAL TRAIL ALIGNMENT

3.1 Coastal Trail Project Goals

The proposed trail project will:

- Rehabilitate the California Coastal Trail at Lands End from the Merrie Way parking lot to Eagle's Point Overlook. The rehabilitation will create a world class trail along one of America's most scenic coastlines and will link important cultural and naturals resource areas in a continuous recreational experience;
- Rehabilitate the failed section of El Camino Del Mar to create a trail alignment that is easy to use and can accommodate bicycle and pedestrian use;
- Provide interpretation of the important natural and cultural resources along the trail;
- Reduce degradation to natural and cultural resources by increased monitoring of public use and control of public access to sensitive areas;
- Reestablish the populist, community recreation legacy of Adolph Sutro and increase a renewed public interest in Lands End;
- Strengthen physical linkages to the GGNRA and enhance image and identity of the GGNRA within the surrounding city neighborhoods to inspire a new generation of park stewards and community support; and
- Complete an important link in the improvement of the California Coastal Trail from Muir Woods to Lands End.

3.2 Project Potential

The project will offer many exciting and enhanced educational and recreational experiences including:

- An accessible ocean-viewing promenade and nature trail in the middle of an urban environment serving thousands of city dwellers and park visitors of all backgrounds;
- An opportunity to directly link the trail to the larger urban and regional populace through public transit, most notably the heavily used #38 Geary MUNI bus line that connects downtown San Francisco and BART with the line's terminus at 48th Avenue and create an innovative informational marketing and outreach program in concert with the bus system;
- An opportunity to increase outreach and partnership offerings to introduce diverse audiences to the trail;
- A trail connection to the VA Medical Center; Palace of the Legion of Honor, USS San Francisco Memorial and Merrie Way parking lot; AND
- Offering new partnerships and volunteer opportunities for the greater Bay Area population including schools, community centers, health service providers and youth service providers in the surrounding neighborhoods and along the Geary corridor.

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3.3 Trail Improvements – California Coastal Trail

Refer to Figure 11 for the location of Planned Coastal Trail Improvements.

3.3.1 Merrie Way to Mile Rock Overlook (Segment 1)

The first segment of the trail – a distance of approximately 450 feet begins at Point Lobos Avenue (Figure 11). A grand overlook will be created along the western edge of an improved Merrie Way parking lot north to the existing trailhead entrance. The overlook will follow Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities along its entire length. At the southern most end of the overlook, a visitor facility will be created along Point Lobos Avenue offering a community and visitor gathering area similar to the Warming Hut at Crissy Field. The facility will include interpretive displays and information on the natural and cultural resources of the site, creating the southern most trailhead for the California Coastal Trail signature project in San Francisco.

Issues to be addressed in the rehabilitation of the trail and new Merrie Way facilities are the geotechnical constraints posed by the fill, natural resource issues such as the ground water seep near Point Lobos Avenue and cultural resource issues such as the historic alignment of the railroad right-of-way. The parking lot will accommodate approximately 130 parking spaces, 5 handicapped parking spaces, and parking for 5 tour buses.

The existing trailhead at the northern edge of the Merrie Way parking lot will be improved to create a more visible entrance to the trail. Bathrooms will be provided at the trail entrance. From there, the trail will be reconfigured to provide an "outdoor access route" (8.33% grade), approximately 500 feet in length, which will intersect with the existing trail on the historic railroad bed coming from the intersection of Point Lobos Avenue and 48th Avenue.

Trees will be pruned to open views to the ocean from the trail. Hazardous trees will be removed. Temporary and/or permanent fencing will be installed to close off social trails that will be regraded and revegetated.

The trail will continue along the old railroad bed approximately 1,200 feet to just east of two historic concrete retaining walls. This portion of the trail will be fully accessible and meet ADAAG guidelines. An overlook will be created at this location to end this trail segment. Past the Mile Rock Overlook, the trail will no longer meet accessibility guidelines.

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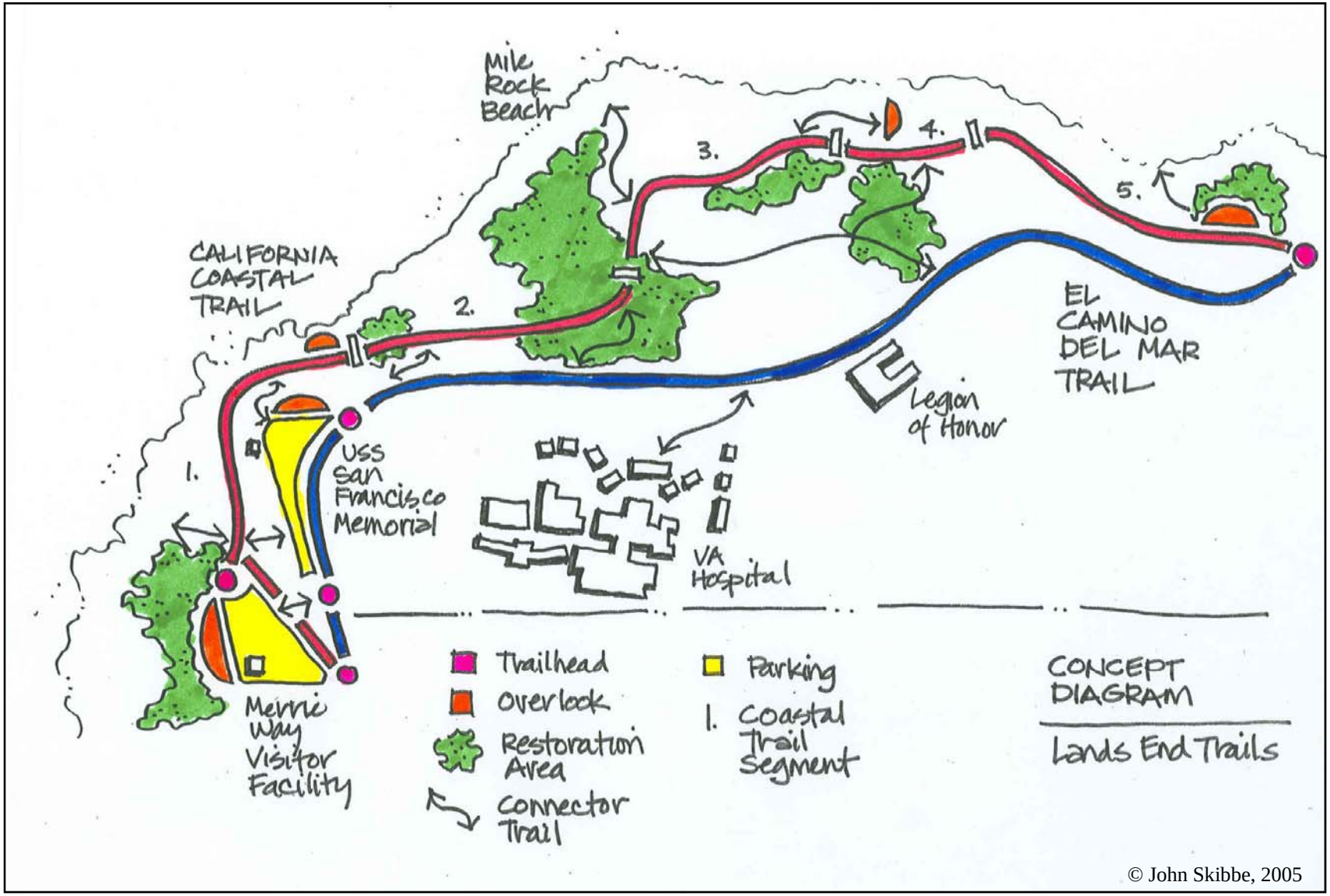
Conceptual Map of Planned Coastal Trail Improvements **Figure 11**



3.3.2 Mile Rock Overlook to Legion of Honor Trail (Segment 2)

This segment of trail runs across a large active landslide as well as several active and incising headwater channels that flow across the slide scarp surface. Unimpeaded runoff, originating from El Camino del Mar and the Veterans Administration (VA) Hospital grounds, flow through these channels. The existing trail and associated trail water crossing infrastructure are not well suited to this environment. Relocating the trail to the south will be a better alignment; providing a more even gradient and an opportunity to create a swale which could moderate runoff and thereby allow enhancement of native vegetation. A trestle or other bridging structure may be employed over the swale to enhance this feature.

A trail connection will be maintained and enhanced to El Camino Del Mar and beyond to the VA Hospital. A trail connection will also be maintained to the existing service road through the Lincoln Park and Golf Course to El Camino Del Mar.

3.3.3 Legion of Honor Trail to Dead Man's Bluff Overlook (Segment 3)

The trail rejoins the stable railroad roadbed alignment on bedrock along this segment. The improved trail and steps to Mile Rock Beach will remain. A spur trail at the old railroad tunnel location will take trail users to an overlook at Dead Man's Bluff (Figure 11).

3.3.4 Dead Man's Bluff Overlook to Dead Man's Point (Segment 4)

The trail again enters a large slide area, this one dating from 1925 (Figure 11). The slide is highly eroded and rerouting of the trail is suggested to provide a better gradient and safer hiking conditions. Proposed improvements include widening the western reach of steps to improve safety and circulation. The slide area has substantial stands of non-native eucalyptus that can be selectively removed slowly over time to offer the opportunity for revegetation of the area with native forest communities such as oak woodland.

Additional rerouting of the trail through the eucalyptus stand may also be accomplished as the trail moves toward Dead Man's Point for better gradient and safer hiking conditions.

A trail connection will be maintained along an old construction road from this trail segment to the Lincoln Park and Golf Course.

3.3.5 Dead Man's Point to Eagle Point (Segment 5)

At Dead Man's Point the trail rejoins the stable historic railroad alignment for several hundred feet before passing through the third landslide area where the trail narrows significantly at several pinch points (Figure 11). Trail connections will be maintained at the narrowest points with stabilizing cribbing or walls; raising the level of the trail over tree roots and widening the trail into upslope areas.

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The Eagle's Point Overlook will be rehabilitated in place. The existing overlook structure will be removed, social trails closed, and native plant communities restored.

A new trailhead will be created on El Camino Del Mar.

3.4 Trail Improvements – El Camino Del Mar Trail

The trail portions of the abandoned El Camino Del Mar right-of-way within NPS lands will be improved to accommodate pedestrian and bicycle use. This section of right-of-way runs through the slide area below the VA Hospital. The trail may be raised above ground level to provide a stabilized and sustainable swale system for runoff. This area would be replanted with appropriate native plant communities. NPS storage piles on the roadbed will be removed.

The USS San Francisco Memorial parking lot and adjacent overlook will be improved to provide accessible access to both areas. The parking lot will be re-striped for approximately 88 vehicular parking spaces, 4 handicapped parking spaces and 3 tour bus parking spaces. In addition, the El Camino Del Mar right-of-way used for vehicular travel will be reconfigured to provide 2 travel lanes and approximately 50 perpendicular vehicular parking spaces along the alignment to the 48th Avenue intersection. The Memorial itself is not fully accessible, and at this time no plans are proposed to upgrade it to current code.

A new trailhead entrance and approximately 4 perpendicular handicapped parking spaces will be created at the intersection of El Camino Del Mar and Point Lobos Avenue (Figure 11).

3.5 Trail Improvements – Link Trails

Link trails provide connections between the Coastal Trail and El Camino Del Mar Trail. They are:

- **Memorial Steps.** Links USS San Francisco Memorial overlook to Coastal Trail;
- **Midden Trail.** Links El Camino Del Mar Trailhead to Midden Trail; and
- **Ocean Terrace Trail.** Links El Camino Del Mar Trailhead to Merrie Way Coastal Trail trailhead.

3.6 Spur Trails

Spur trails provide dead end trail connections to special destinations off the California Coastal and El Camino Del Mar Trails.

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The spur trails are:

- **Dead Man's Bluff Overlook.** Links the Coastal Trail to Dead Man's Bluff Overlook; and
- **Mile Rock Beach Trail.** Links the Coastal Trail to Mile Rock Beach.

3.7 General Notes on Improvements

Emergency vehicles will be able to access most sections of trail to provide emergency services.

The Coastal Trail will be designated primarily for pedestrians while the El Camino Del Mar Trail would be multi-use to include bicycle traffic.

The Coastal Trail will be made accessible for as much of the alignment as possible without eliminating its rugged character, and the varied opportunities that the trail currently provides. Trail rerouting will consider making trail segments more accessible, and will be designed with the intent of solving and/or avoiding hydrologic, erosion, natural resources, tree and other hazard problems wherever possible.

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4.0 TRAIL CONSTRUCTION, SOCIAL TRAIL DECOMMISSIONING, AND HABITAT RESTORATION TECHNIQUES AND APPROACHES

4.1 Overview of Restoration Concepts, Techniques and Applications

4.1.1 Coastal Trail Improvements and Construction of New Connector Trails

Construction of new trails, and social trail decommissioning and subsequent habitat restoration at Lands End are based on the following fundamental goals and objectives:

- Maintaining safety and the accessibility of the Coastal Trail as a whole is the primary objective of trail improvement activities;
- Maintaining the rugged character of the Coastal Trail corridor wherever possible;
- Design trails to address non-natural erosion and drainage problems and reduce long-term maintenance costs;
- Develop new trails as necessary to address existing visitor use and circulation patterns; and
- Where possible, provide interpretive opportunities, improve overall safety (e.g. hazard tree removal) and improve the visitor experience (e.g. interpretive plant and wildlife, historic and cultural signs, viewshed enhancements).

4.1.2 Social Trail Decommissioning and Revegetation

Past trail studies have concluded that the hydrology is the driving factor causing much of the trail instability issues at Lands End. In contrast, this study has concluded that hydrology is not the driving factor causing trail instability; rather, it is human activity. It is important to note that in most cases, social trails are created by human activity, and then exacerbated by surface drainage patterns that follow the down cut of the social trail pathway. Therefore, this study focuses on first creating sustainable circulation patterns that provide visitors safe and well-marked access to popular destination points, then decommissioning and revegetating social trails and restoring nearby habitat.

Unlike other projects, aiding the recovery of various natural habitat type or sensitive species is not the primary driving force behind actions prescribed for the Lands End Study Area. Instead, the removal of social trails requires revegetation which also facilitates and enables the revegetation of nearby native habitats. Hence, closure and associated revegetation actions related to social trail decomissioning will be prescribed based on human use patterns, hydrology, slope, and soil characteristics.

Social trail decommissioning and revegetation at Lands Ends is based on the following fundamental goals and objectives:

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- The success of reducing or eliminating social trails is related to:
    - Providing well-marked safe trails that lead to desired visitor destination points;
    - Erasing the "hydrologic memory" of the old social trail;
    - Removing the "scar" of social trails and providing adequate time for plant establishment; and
    - Providing signage indicating routes, distances, destinations, hazards, trail closures, etc. to encourage visitors to use designated trails.
- Wherever possible, social trails will be decommissioned and revegetated using passive methods to reduce overall costs. Passive revegetation includes installing trail closure signs, brush piles or other physical barriers, and allowing the trails to revegetate naturally.
- If active social trail revegetation is required, revegetation activities will be conducted in a manner that is least intrusive and results in the least amount of re-planting.
- Barrier fencing will be used sparingly so as to maintain the wild and scenic nature of the Coastal Trail. Barrier fencing may be temporary or permanent, depending on site-specific conditions and visitor use patterns. Temporary fencing will be preferred.

4.1.3 Habitat Restoration Concepts, Techniques and Applications

Habitat restoration at Lands End will be largely based on the following fundamental concepts:

- Restoring natural processes to the greatest degree feasible and appropriate;
- Protecting rare and sensitive plant and wildlife habitat, and enhancing and expanding these habitat values wherever possible;
- Increasing overall biological diversity of native species;
- Expanding existing native habitat areas through a combination of both passive (e.g. removing forest canopy overstory, invasive plants) and active restoration (large-scale invasive control, grading, and planting) activities;
- Enlarging and linking smaller isolated wetlands and riparian woodlands into larger habitat restoration corridors, to promote genetic diversity in wildlife populations;
- Creating and/or maintaining a diverse "mosaic" pattern of native habitat types (e.g., grassland, scrub, woodland) and structures for a variety of wildlife species. [Special attention will be given to restoring riparian woodland habitat adjacent to wetland and scrub habitat with the goal of creating large contiguous blocks of high quality songbird habitat];
- Controlling targeted invasive non-native plant species;
- Reducing non-natural erosion sources;
- Creating sustainable park stewardship and sufficiently resourced maintenance programs (especially for sites with problematic invasive plant species issues);
- Offering diverse oportunities for engaging the community in park stewardship;

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- Linking habitat restoration efforts with trail management efforts wherever possible to ensure holistic landscape management and synergistic results; and
- Providing interpretive and educational opportunities wherever appropriate.

4.2 New Trail Construction Techniques

Several new trails are proposed to improve access and circulation, reduce impacts to park resources and address visitor site use and behavior patterns. Construction of these new trails is intended to provide safer site access, to guide visitors to desired destination points and away from other sensitive and unstable areas, and to reduce the potential for future social trails. Trail Construction and Stabilization methods are described below. Refer to Appendix B for more detailed information regarding trail construction and decommissioning guidelines.

4.2.1 Full Cut Bench Construction

The majority of new trails are proposed to be constructed using a full cut bench construction method. Most new trails will be constructed using a combination of the Sweco trail tractor and hand methods to create a 5-foot wide bench cut.

4.2.2 Trail Stabilization Using "Blind" Retaining Walls

This method will be employed where conditions are unstable. In this instance, a larger full cut bench will be constructed, with an extra excavation for a retaining wall below the trail. The retaining wall will be constructed, then covered with compacted dirt so that it is not visible from the trail following construction.

4.2.3 Landings and Steps

In some instances, for example short steep sections, a series of landings and steps will be created for visitor safety. These features will be constructed using standard methods, including using (most functional and ecologically sustainable) pressure-treated lumber to create stairs and landings, securing the lumber to the surface with rebar, and backfilling and compacting the soil to create the landings and steps.

4.2.4 Boardwalk

Boardwalks are elevated features that are used to span a sensitive area, such as a wetland or other area where it is desired to keep traffic off the ground. Boardwalks may be used in combination with trestles at sites where a larger area needs to be spanned.

4.2.5 Free-Span Bridge/Trestle

Free-span bridges/trestles are elevated features that are used where a trail must cross a grade that you cannot construct through, such as a canyon, drainage, or steep slide, and to span a larger sensitive area, such as a wetland.

4.2.6 Puncheon

A Puncheon is a short boardwalk used to span smaller sensitive areas such as wetlands.

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4.2.7 Stairs

Stairs are used in steep conditions to reduce the grade for visitors to a walk-able distance. Two types of stairs are proposed at Lands End: stone staircases and regular stairs (as described above under landings and steps).

Stone staircases are much more expensive than stairs created with pressure-treated lumber and earthen backfill, and are to be used in high visitor use areas such as entrances. Granite is the preferred material for this type of stair, and some granite can be salvaged onsite from the rubble field.

4.3 Social Trail Decommissioning and Associated Habitat Restoration Treatments

Decommissioned trails will be restored in a manner that prevents any further unnatural erosion, and helps ensure the trail site will support native plant materials that are similar to surrounding areas.

The social trails at Lands End were identified, mapped and assessed in the field by May & Associates, Inc. with input by Campbell Grading Inc. (Figure 12). The various types of social trails were then classified by Campbell Grading, Inc, into types, or "guilds" in order to streamline and organize the various types of restoration prescriptions that will be used for trail decommissioning.

Four guilds were identified and are described below.

4.3.1 Type 1: Trails Less Than 4 Feet in Width on Moderate to Gentle Slopes (0-17%)

This type of social trail is considered the least difficult to restore to natural habitat conditions. Depending on the location, these trails would be either mechanically scarified using a Sweco trail tractor, or scarified by hand using a rake, mattock, or similar hand tools. In either case, the top 4 inches of soil would be loosened along the trail. The trail would then be reformed back to natural contours, including recovering any soils on the sides of the trail and reincorporating the soils to form natural site contours. The entire site would then be compacted. In most cases, social trail decommissioning will seek to have a balanced cut and fill (i.e. additional soils needed to create natural contours are obtained from regaining soils adjacent to the trail). Soil compaction may be non-intensive, requiring only hand-dampening, or intensive, requiring use of a 'track-walker" to press the soil and a binder (typically seed-free straw) into the parent soil material. Following the soil compaction, the newly restored area can be covered with a thin layer of small woody debris (i.e. slash less than 4 inches in diameter). On flat to gentle slopes, the woody debris shall be distributed at 90-degree angles to the slope (i.e. perpendicular to the slope), and scattered thinly about the surface of the trail. This debris can help to break up water flow on the new surface.

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Undesignated Social Trails at Lands End

Figure 12

Social Trail (15,665 meters)

National Park Service Administrative Boundary

Coastal Trail

Local Trail

N

100 50 0 100 200 300 Meters

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4.3.2 Type 2: Trails Greater Than 4 Feet in Width on Moderate to Gentle Slopes (0-17%)

In general, the same procedures described above shall be followed for wider trails (greater then 4 feet) on moderate to gentle slopes (slopes from 0-17%). The main difference in these situations is the scarification procedure, which shall encompass the trail, plus a much wider area on each side of the trail (up to 3 feet on either side). This larger area will be scarified and re-contoured using mostly mechanical methods, then compacted and covered with woody debris.

4.3.3 Type 3: Trails on Steep Slopes (Greater than 17%)

As a general rule, all trails located on slopes above 17% grade are treated as special sites requiring more intensive stabilization techniques. The actual stabilization method will be determined in the field based on site-specific conditions.

In general, trails on steep slopes (greater than 17%) shall be stabilized using one or more of the following techniques:

Installation of Checkdams. Checkdams can be installed using either dimensional lumber (commercially-available boards) or logs about 8 inches to 1 foot in diameter. Wood is installed perpendicular to the slope, and at least one foot into the bank on either side of the trail and buried 6 inches into the parent soil surface. The wood is then covered with soil, compacted, then another board of a slightly wider width is installed, backfilled, and compacted. After completing the installation and backfilling, the site is covered with topsoil, and the procedures described above are followed to return the site to natural contours (i.e., scarify, regain soil at edges of trail, compact, install woody debris top coat). Checkdams should not be visible when the site is completed, but will provide structural stability to the surface on steep slopes.

In general, the steeper and more eroded (i.e. the deeper the observed rillying/gullying) the trail is, the closer the checkdams need to be spaced. Following slope stabilization, active revegetation is recommended to stabilize the area.

Trails on slopes between 12% and 17% typically require some stabilization, and trails on slopes less than 12% require only standard trail restoration.

Additional Compaction/More Intensive Erosion Control. Steep sites with less erodible soils may be treated in the same manner described above, but with more intensive erosion control. For example, the compaction of the soil would encompass a larger area, and more seed-free straw would be included into the soil, then more aggressive mechanical compaction shall be undertaken using a "track-walker" to thoroughly press the soil and binder material (typically seed-free straw) into the parent soil material. Additional erosion control (water bars, wattles, etc.) may also be installed. Following treatment, a thicker layer of woody debris can be applied to help stabilize the area for a longer time.

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4.3.4 Type 4: Special Condition Sites

Several existing trails, including social trails scheduled for decommissioning at the Lands End site are considered "Special Condition Sites." These sites include historic and recent slide areas, sites with unstable hydrology or slopes, sites with large rifts or gaps that must be bridged using methods other then check dams, and very steep slopes that have high human use levels. In these special condition sites, one or more of the following additional measures may be required to stabilize the area and decommission the social trail. Special condition sites include social trails on unstable surfaces, (such as on serpentine clays associated with seeps and drainages), historic or recent mudslides, and areas where the trail crossed a drainage or other area where the edges were unstable. In these special circumstance areas, additional trail structures such as free-span bridges, boardwalks, or puncheons will be recommended to "bridge" the unstable area.

Key Way Construction. In areas where instability is caused by subsurface flows (not sheet surface flows), a "Key Way" may be constructed under the trail to collect and divert subsurface flow. In these situations, surface flow is allowed to continue to sheet over the trail following stabilization.

First, the trail is excavated to create a "key", i.e. an excavation approximately 2 feet wide and deep enough to intercept stable parent material. Soil is backfilled into the key in lifts of soil and then compacted. Erosion control fabric is laid down on top of the compacted soil and covered with crushed rock on top. The erosion control fabric is installed 1 foot below the trail at the top end, and wrapped around a perforated pipe at the bottom end of the key. The fabric in essence collects and directs water into the perforated pipe which leads to a T-shaped dissipater structure (typically another short length of perforated pipe), allowing subsurface flow to pass below the trail, and to be dissipated into naturally vegetated areas below the trail. The completed key way is not visible after construction is complete.

Brush Pile Structures. In general, brush piles can be used to protect the soil surface, to divert human use, and to create habitat for songbirds and other wildlife species. Brush piles should be used sparingly, and in most cases, should not be visible from the Coastal Trail. In some special instances, brush can be "woven" to form sculptural elements. Unlike scattered woody debris that is applied to decommissioned social trails, brush piles would be stacked perpendicular to the slope, and would be 3-4 feet in height to form a visual and physical barrier. Brush pile woody debris should still include branches 4 inches or less in diameter to facilitate natural break down of the material over time.

Tree Trimming, Removal of Understory Vegetation. While this application is not strictly a trail decommissioning action, it is included as an action that can help direct and control human uses that create social trails. In some areas of Lands End, social trails are created in areas with a dense understory. These areas are often encampment sites, and areas where illicit activities occur. To help discourage use of social trails in these areas, and to help prevent creation of new social trails, trees

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should be thinned and limbed up, and underbrush vegetation (mostly non-native small trees, shrubs, and blackberry brambles) should be removed to create an open area under the tree canopy that people can't hide in.

4.4 Invasive Plant Control Methods

The following information on suggested invasive non-native plant control techniques was obtained by interviewing professionals involved in local invasive plant control projects (Baxter, pers. comm. Heath, pers comm., Farrell, pers. comm., Alvarez, pers. comm., Evans, pers. comm., Gause, pers. comm.) and from information presented in the Weed Worker's Handbook (The Watershed Project and California Invasive Pest Plant Council, 2004). Consistent with most successful invasive weed control programs, the strategy will be to adaptively implement a diversity of control techniques, with the goal of sustained control.

The information provided below is presented as a tool to help guide and prioritize weed control efforts within the Study Area. The suggested techniques should be modified to meet site-specific, budgetary and compliance-based needs. Additionally, they must follow the GGNRA Integrated Pest Management Plan and projects individually approved through the NPS supervisory vegetation ecologist, Chief of Natural Resources, and Natural Resources Supervisory staff prior to being submitted to the NPS Integrated Pest Management Specialist (IPM). All applications of herbicide, when needed, will be prescribed and applied under directions of the IPM Specialist. All contractors will be required to work under the guidelines of the Park IPM Specialist. All contractor work will be overseen on site by a NPS representative.

Sustained vegetation conversion to healthy forested areas and native plant communities will require a comprehensive public education program, a long-term investment of resources and an active volunteer-based stewardship program.

Best Management Practices shall be employed during invasive plant control to minimize soil disturbance, and to help ensure that biomass is removed from the site, or sufficiently composted and stored out of sight. Removal of large infestations of weeds can result in the increased potential for erosion on slopes and stream banks. Therefore, an erosion control strategy must be in place before large-scale removal efforts are undertaken. In areas where invasive plants occur on steep and unstable coastal cliffs and bluffs, special control methods should be employed (e.g. contractor rappel and spray, broadcast spray and decompose on-site). To this end, Best Management Practices shall be developed in coordination with the NPS to ensure consistency with their policies and guidelines.

4.4.1 Target Invasive Plant Species (Cape Ivy, Pampas Grass)

Cape Ivy *(Delairea odorata)*. Cape ivy is a climbing and spreading perennial vine that primarily reproduces vegetatively. Cape ivy control requires consistent and meticulous removal efforts, as the species can re-root from root, stolon and leaf fragments left in the soil. Due to the resource-intensive nature of controlling Cape

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ivy, creating containment lines around the perimeter of a patch is often implemented as an interim measure rather than complete removal. Containment lines require continual maintenance to remain effective.

Treatment Options: NPS staff and other local practitioners (e.g. firms specializing in invasive plant control) have successfully managed to control Cape ivy by using the following techniques. Cut a containment line by clearing the existing vegetation to bare earth, in an area approximately 5-10 feet wide around the entire perimeter of a Cape ivy infestation. Starting at the outer edge of the area, either remove the cut plant material or pull all Cape ivy inward, working towards the center. If possible, peel back the edges of the infestation where the vine is more lightly rooted, and roll the vegetation on itself similar to rolling a carpet. Remove all above ground vegetation and stolons. Rake the top several inches of soil to remove any remaining root or stem fragments. Cape ivy that is found growing on trees can also be treated by cutting out sections of the climbing the stems with loppers and leaving the upper portion of the Cape ivy to die in the tree.

The resulting biomass must be handled carefully to prevent inadvertent spread to other areas. Plant material should be bagged and removed from the site, composted in other infested areas, or dried on a tarp. Piled biomass should be checked at least 2 times a year in drier areas and 4-6 times a year in moist locations to ensure that no stems or roots are regenerating.

Following initial removal, resprouts in the treatment area can be sprayed with a glyphosate such as Roundup Pro™ or AquaMaster™ if deemed appropriate, or re-treated several times using hand labor where feasible. If continued hand removal efforts are undertaken, ensure that all roots and stems are removed every few months over a period of 2-5 years while working towards long-term eradication.

Preferred Treatment Methods for the Lands End Project: Within the Lands End Study Area, three general treatments are recommended for three distinct types of Cape ivy infestations:

- ***Cape ivy infestations greater than two acres in size*** shall be removed using Contract labor (i.e. hand pulling or machine cutting, rolling the vegetation biomass, spraying the treatment area with Roundup Pro™ or AquaMaster™, and composting the biomass onsite). Contract labor shall be used to install all of the initial containment lines, remove Capy ivy systematically from within each defined patch (as defined by containment line) and remove resprouting ivy from cut areas for no less than 3 years after initial cutting.
- ***Cape ivy infestations 2 acres in size or less located on steep terrain or other unsafe locations*** shall be removed using contract labor either by hand or by chemical means for similar time period as described above.

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- ***Cape ivy infestations 2 acres or less in size located in accessible areas on safe terrain*** can be removed by hand by volunteers[1], rolling the biomass and composting biomass onsite. Optimal size for biomass composting should be at least 1 cubic yard to ensure that the pile sufficiently heats and breaks down in order to keep resprouts to a minimum. Follow up hand removal treatments should be performed every 3 months for the first two years, and at least once a year for years 3 through 5. Herbicides may be applied to volunteer treatment areas if hand removal treatments are ineffective.

Pampas Grass *(Cortaderia selloana, C. jubata)*. Pampas grass is a rapid-growing perennial grass that reproduces sexually by seeds or vegetatively by tillers or fragments of mature plants. Therefore, removal must be done precisely, as it can re-root from fragments left in the soil.

Treatment Options: NPS and other weed control practitioners have successfully controlled pampas grass as follows. For larger plants, cut and dispose of all seed plumes including those that are immature. Next, cut stems and leaf blades to near ground level. Last, remove the root mass using a Pulaski, pick ax, or combination of hand and mechanical tools. Very large plants near a road or other accessible area may also be pulled with a truck hitch and a choker cable around the plant. For plants that are growing on steep or unstable slopes, herbicide (Roundup Pro™ or AquaMaster™) can be applied to either the cut plant or to the entire plant. It is mandatory to apply herbicide consistent with NPS IPM policies and guidelines.

Seedlings may be pulled by hand or pried out of the ground using hand tools.

Following removal, recommend monitoring the removal site for shoots and re-sprouts. When re-sprouts are 1 to 3 feet in height, spray with glyphosate (Roundup Pro™ or AquaMaster™) or remove with hand tools. Herbicide can be effective if applied on all green growth during the active growth period, or when painted on cut stems near the root mass after stems and leaves have been cut away.. New sprouts should be treated when they have grown 1-3 feet. The treatment area should be checked twice a year for re-sprouts for a period of 2 years, then annually in Years 3-5.

Preferred Treatment Methods for the Lands End Project: At the Lands End site pampas grass is typically large, single plants or small clusters of plants, often in remote locations such as cliffs. In most cases, pampas grass will be removed by contract labor as part of other invasive removal efforts within specified areas. Contractor shall remove biomass, spray with herbicides, then monitor for resprouting and re-treatment. In steep locations such as sea cliffs, repeated herbicide application may be the only feasible treatment option. In areas designated for

[1] Volunteers shall conduct removal efforts in areas where poison oak cover is minimal. In areas where poison oak patches are found throughout a patch, Contract labor will augment removal efforts.

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volunteers, removal of pampas grass will primarily use hand removal methods, except where the infestations are not responding to hand removal treatments.

4.4.2 Non-Native Small Trees, Large Shrubs, Small Woody Shrubs and Sub-Shrubs

Small non-native trees at Lands End will be difficult to control given their large distribution and density throughout the Study Area. These species often form a dense understory under the non-native forest canopy, and can spread into lower stature native scrub and grassland habitat. Invasive small trees and large shrubs that were detected and mapped at Lands End include:

- Cotoneaster (*Cotoneaster* spp.);
- French broom (*Genista monspessulana*);
- Golden wattle (*Acacia longifolia*);
- Green wattle acacia *(Acacia decurrens)*;
- Himalayan blackberry (*Rubus discolor*).
- Lollypop tree/myoporum (*Myoporum laetum*);
- Mirror plant (*Coprosma repens*);
- Pittosporum (*Pittosporum* sp.);
- Plumed acacia/albizia albizia (*Albizia lophantha);* and
- Tea tree (*Leptospermum laevigatum*);

All of these species are perennials that reproduce primarily by seeds, however some also spread from underground roots, or canes (e.g., cotoneaster, Himalayan blackberry). Many of these species can also sprout from underground roots or from cut stumps (stump-sprouting) after being cut, therefore follow-up treatments are essential to successful control.

Control treatments that can be applied generically to these species are listed below. Control treatments for French broom and Himalayan blackberry however are described separately.

Treatment Options: NPS and other weed control practitioners have had success treating small trees and large shrubs as follows: cut the plants at just above ground level, then immediately paint the cut surface with Roundup Pro™ or AquaMaster™ depending on their proximity to water. The stump should be painted with herbicide within 10-15 minutes after cutting to ensure that the stump adequately absorbs the herbicide. Larger stumps need only to be painted to cover the outer ring of cells (cambium layer) separating the bark from the wood. Larger infestations can be foliar sprayed, then cut; or cut, then sprayed with a low-pressure nozzle. If herbicide application is not appropriate, cut stumps can be covered with barrier fabrics to reduce resprouting potential.

Volunteers can often remove smaller acacia, myoporum and tea tree plants with weed wrenches and loppers in accessible acreas.

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Preferred Treatment Methods for the Lands End Project: For larger infestations, chainsaw or brush-cut biomass and remove, then paint, or low-pressure nozzle spray the cut stumps with Roundup Pro™ or AquaMaster™, depending on distance to water. Follow-up should primarily focus on hand removal of stump resprouts and seedlings (e.g. hand pulling or weed-wrenching), or in cases where resprouts are located in inaccessible areas or are prolific, re-sprayed with herbicide. For smaller infestations, remove the trees or shrubs in their entirety, including rootball using hand tools, and monitor for re-sprouting. Repeat removal, or if hand removal is not effective, spray re-sprouts as necessary to achieve control.

Himalayan Blackberry *(Rubus discolor)*. Himalayan blackberry is a perennial shrubby vine that reproduces sexually and by a number of vegetative methods. While it is a non-native species of concern in fragile native habitats, it does provide wildlife habitat values, and is not as high a priority for complete extirpation as are other invasives at Lands End. Where appropriate, Himalayan blackberry should be removed from native habitat areas as follows. Himalayan blackberry's stout thorns make the use of protective gloves and clothing necessary during removal work.

Treatment Options: Successful removal methods can include cutting back canes and digging out roots, brushcutting, and cutting and treating. These methods are described in greater detail below.

- **Cut and Dig:** Cut stems close to the ground and dig out the root ball, removing as much of the main rootball and lateral roots as possible.
- **Brushcutting:** Brushcut the canes and clear the vegetation, preferably when the flowers are in bloom but before the fruit sets.
- **Cut and Treat:** Cut stems to about 1 foot in length and treat stumps with 25-50% concentration glyphosate (Roundup Pro™ or AquaMaster™ depending on proximity to water) immediately after cutting. Most successful control occurs in the fall when stored sugars are being translocated in the plant from the leaves and stems to the roots, late September through October. Herbicide should not be used in areas where people may pick and eat the berries. Sprayed areas should be appropriately signed and marked to alert the public.

Preferred Treatment Methods for the Lands End Project: In most instances, Himalayan blackberry will be removed at the Lands End site by contract labor due to the large areas of infestation within the project boundaries. Contractors shall use hand or machine removal (typically brushcutting) followed by painting of the cut canes as the preferred control method. The treated plants should be marked with caution tape or temporary fencing to prevent contact with visitors (i.e. berry harvest). Infestations shall be removed slowly, and to the greatest degree feasible native blackberry or other similar stature native vegetation will be established concurrently to reduce possible impacts to birds utilizing Himalayan blackberry as habitat.

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Smaller accessible infestations will be removed by volunteers using hand tools as described above.

French Broom *(Genista monspessulana)*. French broom is an invasive perennial shrub that spreads quickly in grassland and scrub habitats. Plants establish quickly, and can flower in the first year following establishment. Individual plants typically produce large numbers of seeds that can remain viable in the soil for decades. This shrub is reported to be a crown sprouter, however, in practice, the shrub has re-sprouted from underground roots.

Treatment Options: Successful treatment requires one or more types of treatments over multiple years. For small infestations and newly established infestations, hand removal/hand pulling plants using a weed wrench is highly effective. For larger infestations, a combination of one or more of the following combined with diligent and repeated treatment of re-sprouts and seedlings is required to achieve control:

- **Hand Pull:** In many instances, French broom seedlings and small shrubs are most effectively controlled by hand-pulling in early spring. Use weed wrenches for larger plants, and try to remove the entire plant, including the roots. Seedlings can also be scraped with a hula hoe. Volunteers or independent contractors may perform this activity.
- **Cut**: Most appropriate for larger plants that cannot be pulled in their entirety (described above). Cut the shrubs to the ground surface using pruning sheers, loppers, or brushcutters, ideally during the dry season to stress the plant. Cut stumps that are not sprayed with herbicide will re-sprount and will require follow-up treatment, Alternatively the plant can be girdled by cutting the bark from the circumference of the stem about 2 inches above ground level and peeling back the bark to ground level.
- **Mow and Treat:** Using a weed-eater with a blade, cut shrubs close to the ground late in the growing season followed by herbicide application. Glyphosate application (1-2%) (e.g. Roundup Pro™ or AquaMaster™) may be used with a wick-type applicator immediately after cutting, A follow-up herbicide application may be required after the plants have begun to grow back.
- **Cut and Treat:** Cut stems to near ground level and immediately treat stumps with 25-50% concentration glyphosate (Roundup Pro™ or AquaMaster™ depending on proximity to water) immediately after cutting. Most successful control occurs in the early spring.
- **Flame:** Seedlings less than 1 inch in diameter can be flamed or blanched using a propane torch. Flaming must be conducted in winter when surrounding vegetation is wet to reduce risk of wildfires.

Preferred Treatment Methods for the Lands End Project: In most instances, French broom infestations at Lands End are small and can be removed by volunteers using hand tools as described above. For any larger infestations, contractors shall use hand or machine removal (typically brushcutting) followed by

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painting or spraying the cut stems with glyphosates (1-2%) (e.g. Roundup Pro™ or AquaMaster™).

4.4.3 Groundcover Plants

Groundcover plants at Lands End include:

- iceplant;
- mattress wire weed; and
- other vines (i.e. periwinkle, English ivy, and Algerian Ivy).

Treatment for each of these three groundcover plant groups is described separately below.

Mattress Wire Weed (*Muehlenbeckia complexa*)[2].

- Remove majority of biomass (cut using either mechanical or hand techniques), remove cut biomass by rolling into large clumps and then either composting on site or transporting from the area.
- If possible, scrape remaining vegetation with heavy equipment such as a bobcat.
- Solarize/compost the biomass prior to transporting/disposal to prevent inadvertent spread. If mass is under 1 cubic yard, remove from site.
- Spray remaining vegetation with Roundup Pro™ or AquaMaster™ depending on proximity to water once resprouting begins.
- Allow treatment area to re-sprout, then repeat treatments (hand pull small infestations, hand pull and spray large infestations as necessary (2-3 re-treatments are anticipated).
- In accessible areas, volunteers can hand-pull any sprouts or seedlings to control small infestations following initial removal activities. For large infestations a combination of volunteer efforts and contractor herbicide application (5 years total treatment per site) is recommended.

Iceplant *(Carpobrotus edulis)*.

Like mattress wire weed, iceplant is widespread throughout the Study Area. Iceplant tends to favor well-drained sandy soils, so is often found on remnant dune, coastal bluff, and disturbed sandy soils. Removal of this species will require a combination of contractor and volunteer efforts, given the scale and locations of the infestations.

Iceplant is typically hand removed, and then either transported from the site, or composted onsite by rolling the biomass into tarps and placing the rolls out in a sunny location to dehydrate and decompose. If the biomass will be removed from the work site to a different staging area, we recommend transporting after allowing

[2] A pilot removal effort was initiated at the headwaters of Dragonfly Creek on the Presidio in 2002. A number of treatment plots were established. Monitoring for treatment effectiveness is being conducted by Presidio Trust staff. NPS recommends reviewing the findings from this study prior to initiating removal of mattress wireweed at this site.

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the plant material to dry for a number of weeks following removal. Duff should be raked leaving bare soil. This prevents nutrient enrichment of native soil which promotes invasion of non-native annual species. Alternatively, the iceplant may be stored in large green bins onsite, then removed after decomposition (to prevent inadvertent spread to other areas).

An alternative treatment that may be best applied to steep cliffs and areas that are not visible to the public is to treat the iceplant with herbicide glyphosate, then allow it to decompose in place on-site.

Near Sutro Baths, this species is growing over several dune tansy (*Tanacetum camphoratum*) populations. Control will require careful hand removal to reduce possible impacts to the rare plant habitat. In areas that support dune tansy, and other sensitive species, we recommend that the patches be carefully removed by hand labor, an activity that is ideally accomplished by small groups of volunteers. Herbicide treatment will not be used in areas near dune tansy habitat (within a 20 foot buffer, or distance determined by NPS plant ecologists).

Larger iceplant populations and iceplant infestations in steep areas should be removed by contract labor using Best Management Practices to minimize soil disturbance, and to help ensure that biomass is sufficiently composted and stored out of sight. In areas where iceplant occurs on steep and unstable coastal cliffs and bluffs, special control methods should be employed (e.g. contractor rappel and spray, broadcast spray and decompose on-site).

Other Groundcover Species (Periwinkle, English ivy, Algerian ivy)

Periwinkle and ivies (English, Algerian) are grouped together as they are removed using similar treatment strategies. Like many weedy plants, periwinkle is a garden cultivated plant that has escaped into the wildlands. It is now quite common in forested and riparian communities throughout coastal and interior foothills, and spreads primarily from stolons. English and Algerian ivies are woody evergreen vines that reproduce both sexually and vegetatively. Algerian ivy is a relatively new invasive plant in the San Francisco Bay Area, but is quickly spreading in coastal wildlands.

Treatment Options: Similar to iceplant and mattress wire weed, removal of large infestations of these weeds can result in the increased potential for erosion on slopes and stream banks. Therefore, an erosion control strategy must be in place before large-scale removal efforts are undertaken. NPS and others have successfully controlled these three species as follows: infestations can be pulled or rolled using similar strategies as described under the mattress wire weed section listed above. Woody stems can be cut and the larger roots (typically ivy roots that are less than 0.33 inches in diameter will not resprout. For vines that are climbing into trees, cut the vine at or close to the base of the tree, and then remove a 12-16 inch section of the vine's vertical stem. The portion in the tree will eventually die, and the lower

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portion's stump can be painted with herbicide or cut out. Check for new seedlings 3-4 times a year and remove by hand.

Preferred Treatment Methods for the Lands End Project: Within the Lands End Study Area, these species will be treated using the pull & roll method described above. The treated areas will be monitored. If re-sprouts occur and cannot be controlled with repeated hand removal methods, they will be treated with herbicides using a low-pressure, low volume foliar spray application of Roundup Pro™ or AquaMaster™.

4.4.4 Perennial Grasses

Several non-native perennial grasses occur within the Lands End Study Area, and will continue to spread if left untreated. Targeted non-native perennial grasses of concern within the Study Area include:

- African veldt grass (*Ehrharta erecta*);
- Harding grass (*Phalaris aquatica*);
- orchard grass *(Dactylis glomerata);*
- perennial ryegrass (*Lolium perenne*);
- tall fescue (*Festuca arundinacea*); and
- Velvet grass (*Holcus lanatus*).

Most of these grasses occur as a few individuals or in small clusters throughout the entire Lands End project area. Therefore, control will focus on removal of small infestations in rare plant habitat, sensitive wetlands and in the context of other invasive plant control activities. If larger infestations are found in areas to be treated, additional actions may be required to control these species. Most of these perennial grasses reproduce both sexually and vegetatively, therefore the optimal removal period is prior to the species setting seed. Removal of the entire plant (roots and above-ground plant parts), or treatment with an appropriate herbicide is important to successful control. Disposal should be carefully conducted to prevent inadvertent spread.

Treatment Options: Removal options include cutting, mowing, brush cutting, covering, heavy mulching and herbicide treatment as described below.

- **Cutting**: Cut around the base of the culms, root clump and dig out the roots. Mulch with an approximately 6 inch layer of rice straw to discourage resprouts.
- **Mowing:** Mow close to the ground late in the growing season. Glyphosate (1-2%) (e.g. Roundup Pro™ or AquaMaster™) may be used with a wick-type applicator after the plants have begun to grow back. Alternately, mow at least 3 times, ensuring that plants do not flower.
- **Brushcutting:** Brushcut small patches and cover with landscape fabric or a 6 inch layer of mulch. Pull any emerging plants the following year.

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Preferred Treatment Methods for the Lands End Project: Perennial grasses at the Lands End project site will be controlled in the context of other invasive control activities. Perennial grass control will be conducted by both Contractors and volunteers. In inaccessible areas and areas with dense stands of perennial grasses, Contractors shall apply herbicide or mow infestations. Early colonizing perennial grasses will be removed from restoration sites by volunteers, using hand-removal techniques described above. Additionally, volunteers will be instrumental in controlling small infestations, and where feasible, and resources allow, volunteers will also mow or brushcut larger infestations. Herbicide applications of Roundup Pro™ or AquaMaster™ would be used only when hand treatments are found to be ineffective.

4.4.5 Perennial or Biennial Herbaceous Plants

Perennial or biennial herbaceous plants that have infested the Lands End Study Area include sweet fennel *(Foeniculum vulgare)* and poison hemlock *(Conium maculatum)*. Control strategies for these species are similar, and are described below. Fennel is an aromatic perennial herb that reproduces sexually by seed and vegetatively by regenerative root crowns. Hemlock is usually a biennial, although it can be perennial. Hemlock reproduces by seed only. *Hemlock can kill humans if eaten and can cause skin irritation, nausea, and headaches if touched or inhaled after cutting or mowing.*

Treatment Options: Small seedlings can be pulled out by hand, though larger plants will require tools. If the whole root is unable to be removed, cutting into the root crown just before the plant sets seed reduces the number of resprouts. Be aware that soil disturbance will expose seeds and increase germination. Often hand removal is only partially effective. Additional treatments include mowing/brushcutting 3-4 times a year, about every 1-2 months, beginning in March–April. Mowing during seed set encourages seed spread and should be avoided. Foliar herbicide application (Roundup Pro™ or AquaMaster™) can also be effective for controlling these species. A 2 percent solution of glyphosate (e.g., Roundup Pro™ or AquaMaster™) has been effective when sprayed on the leaves of green seedlings emerging after dormancy in late spring. Each treatment will require a prescription from the park IPM Specialist.

Preferred Treatment Methods for the Lands End Project: Large infestations of fennel and hemlock will be treated by contractors using foliar treatment of 2% glyphosate (i.e. Roundup Pro™ or AquaMaster™). Small infestations and individual plants will be controlled by hand-pulling the entire plant, preferably in spring prior to seed set. Follow-up seedling control treatments should be conducted for 3-5 years following treatment.

4.4.6 Early Colonizing and Annual Invasive Non-Native Plants

Early colonizing invasive non-native plants are those plants that typically are the first to establish in newly disturbed soils, or in areas where large patches of groundcover

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weeds such as iceplant or small stands of non-native trees and shrubs are removed. These plants typically include a large number of quick-growing non-native annual invasive plants. Treatments for the following species are included in this section:

- Black mustard (*Brassica nigra*);
- Bulb plants such as naked lady *(Amaryllis belladona)*, wild onion *(Allium triquetrum)*, calla lily *(Zantedeschia aethiopica)*;
- Common mallow *(Malva neglecta)*, and tree mallow *(Lavatera cretica);*
- Fumitory (*Fumaria parviflora*);
- New Zealand spinach (*Tetragonia tetragonioides*);
- Thistles;
    - Bull thistle (*Cirsium vulgare*);
    - Bristly ox-tongue (*Picris echioides*);
    - Italian thistle (*Carduus pycnocephalus*);
    - Sow thistle (*Sonchus oleraceues*); and
- Wild radish (*Raphanus sativus*).

Treatment Options: Most of these plants are widely distributed throughout the Study Area. They occur in both dense and sparse infestations, consisting in some areas as a few individuals, or in others as concentrated clusters. Therefore, control efforts will focus on the removal of small infestations in the context of other invasive control and restoration activities, and the control of larger infestation from spreading into priority restoration sites. If larger infestations are found in areas to be treated, additional actions may be required to control these species. This group of weeds generally reproduces by seed. Protective clothing and gloves are required when working with thistles to protect from thorns.

There are many removal options for early colonizing and annual non-native invasive plants, each should be analyzed on a site-by-site basis before selecting the most appropriate method for the individual site location. Treatment options include hand-pulling, cutting, mowing, brush cutting, covering, heavy mulching and herbicide treatment as described below.

- **Hand Pulling:** In many instances, secondary invasive species, especially annual species, are easily controlled by hand-pulling the seedlings in early spring. Volunteers or independent contractors may perform this activity.
- **Cutting:** Most appropriate for larger plants that cannot be pulled in their entirety (described above). Cut around the base of the plant and dig out the roots. Mulch with an approximately 6 inch layer of rice straw to discourage resprouts.
- **Mowing:** Mow close to the ground late in the growing season. Glyphosate application (1-2%) (e.g. Roundup Pro™ or AquaMaster™) may be used with a wick-type applicator after the plants have begun to grow back. Alternately, mow at least 3 times, ensuring that plants do not flower.
- **Brushcutting:** Brushcut small patches and cover with landscape fabric or a 6 inch layer of mulch. Pull any emerging plants the following year.

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Preferred Treatment Methods for the Lands End Project: This guild of plants will be primarily controlled by hand-pulling, brush-cutting, mowing or mulching infestations. Volunteers will provide an effective resource for controlling small infestations. Following removal activities, areas should be monitored several times a year to remove new seedlings and re-sprouting plants.

4.5 Non-Native Forest Treatments

Proposed management treatments for the non-native forest at Lands End follow recommendations from the Vegetation Management Strategy for Areas Adjacent to the Coastal Trail at Lands End, San Francisco, California (McBride et al., 2005) (Appendix E). Please refer to this document for detailed information about the various treatments, including hazard tree removal, forest health improvements, and viewshed removals that are prescribed for individual forest polygons within the Study Area. Figure 13 depicts vegetation management units (forest polygons).

The forest treatments that are described in detail in the McBride et al. (2005) report are consolidated into broad treatment categories in this section. Treatment categories include the following:

- Forest thinning;
- Viewshed tree removal;
- Pruning, limbing trees;
- Small tree removal, understory thinning;
- Non-Native Species Removal;
- Forest Enhancement (planting non-native trees within existing stands); and
- Forest Stand Conversion (staged interplanting with native trees and shrubs).

Refer to Table 6 and Figure 13 for a summary of recommended non-native forest health treatments. For full treatment recommendations, refer to Appendix E Vegetation Management Strategy for Areas Adjacent to the Coastal Trail at Lands End (McBride et al., 2005).

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Vegetation Management Strategy Vegetation Units (McBride 2005) & Action Areas

Figure 13

Restoration Action Area

Vegetation Unit

National Park Service Administrative Boundary

Coastal Trail

Local Trail

Note: See Table 6 for Vegetation Management Plan treatment descriptions

0 50 100 200 300 Meters

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Table 6. Summary of Proposed Treatments for Vegetation Units

Vegetation Unit #	Treatment 1	Treatment 2
1	Prune	plant understory
1a	remove trees	plant grassland
1b	remove trees	plant grassland
2	remove trees	plant scrub
3	thin	exotics removal
4	remove trees	plant grassland
5	Thin	plant understory
6	remove trees	plant scrub
7	thin	
7a	remove trees	plant scrub
7b	remove trees	plant scrub
8	exotics removal	plant scrub
9	thin	exotics removal
9a	remove trees	plant scrub
9b	remove trees	plant scrub
9c-e	plant (extend canopy)	
10	thin	plant understory
11	remove trees	plant scrub
12	exotics removal	plant scrub
12a	remove trees	plant riparian
13	thin, plant understory	plant understory
14	thin	exotics removal
15	exotics removal	plant understory
16	exotics removal	plant willow
17	exotics removal	plant scrub
18	exotics removal	plant scrub
18a	remove trees	plant native blackberry
19	exotics removal	plant understory
20	exotics removal	
20a	prune	
22	exotics removal	
23	none	
24	exotics removal	plant riparian
25	thin	exotics removal
26	thin	plant scrub & understory
27	exotics removal	plant riparian
28	remove trees	plant riparian and scrub
29	exotics removal	plant grassland
30	remove trees	plant oak woodland

Vegetation Unit #	Treatment 1	Treatment 2
31	thin	
32	remove trees	plant cypress
32a,b	remove trees	restore cypress
33	exotics removal	plant riparian
34	prune	plant riparian
35	exotics removal	plant scrub/grassland
36	thin, mulch	plant cypress
36a	remove trees	plant cypress
36b	prune	
36c	remove trees	
37	maintain Riparian Scrub	
38	thin	
39	remove trees	
40	remove trees	
41	exotics removal	plant grassland
42	thin	plant understory
43	establish native plant garden	plant grassland
44	exotics removal	
45	thin	plant understory
46	thin	plant understory
47	thin	
48	exotics removal	
49	thin, mulch	
50	remove trees	plant riparian
51	remove trees	plant riparian
52	thin	exotics removal
53	exotics removal	plant grassland
54	thin	
55	exotics removal	plant grassland
56	thin	
57	partial removal	plant riparian
58	remove trees	exotics removal
59	partial removal	plant cypress
60	exotics removal	plant riparian
60a	exotics removal	plant blackberry
60b,c	exotics removal	plant riparian
60d,e	remove trees	plant riparian
61	monitor tree health	
62	partial removal	plant scrub

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4.6 Habitat Restoration Approaches

The proposed habitat restoration activities follow recommendations outlined in Appendix C: Analysis of Non-Designated Trails, Identification of Geologic/Hydrologic Guilds, and Preparation of Associated Rehabilitation Prescriptions.

In summary, the majority of proposed trail and habitat restoration activities will involve a combination of planting and seeding of northern coastal bluff scrub, dune scrub, and riparian vegetation (Arroyo willow riparian forest, Central Coast riparian scrub). Some limited planting of coastal grassland and freshwater seep habitat is also recommended. See Appendix A-2 (attached) for the nursery propagation calendar. Refer to Appendix C for detailed information on site preparation, planting palettes, and planting methods. Restoration of these habitat types is described briefly below.

4.6.1 Northern Coastal Bluff Scrub. Northern costal bluff scrub is the most common native habitat type with the coastal region of the Lands End Study Area, therefore restoration of this habitat is appropriate at most proposed restoration sites, including social trail closure sites, small tree removal sites, and other forest health improvement sites. In addition, because this shrub-dominated habitat is both showy and relatively durable, it is appropriate for planting in high-visitor use areas, including entrances to the Coastal Trail at Merrie Way, the Memorial Parking Lot staircase, and Eagle's Point.

Restoration of northern coastal bluff scrub vegetation at Lands End includes sustained weed control (as described in earlier sections), collection of local seeds from the same watershed under park ecological guidelines, nursery propagation, and installation of the planted nursery stock. Because this process takes time, it is recommended that 1-2 years of lead-time be provided before the start of each restoration activity, Refer to the list of anticipated restoration plantings and anticipated schedule provided in Appendix D. This schedule should be revised on an annual basis, making adjustments as necessary due to seed availability.

In general northern coastal bluff scrub plantings will either expand to link existing scrub habitat areas, or be planted as in-fill along a decommissioned social trail or Coastal Trail buffers (trail edges). In both cases, scrub planting should be distributed in a natural pattern so as to blend into the existing landscape, and should be spaced at an average spacing of 3 feet on center for most shrubs to allow sufficient room for growth infill over time. Refer to Appendix A-2 for a list of suitable native plants for northern coastal bluff scrub restoration areas.

4.6.2 Dune Scrub

Dune scrub habitat will be restored on currently disturbed or weed-infested dune sands, specifically Colma formation sands. Dune scrub restoration is proposed for the ocean-facing slopes above Sutro Baths, and for other areas supporting sandy soils such as Area B. Restoration activities necessary for successful dune scrub

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revegetation within the Lands End Study Area include collection of seed from locally appropriate ecotype (possibly from Fort Funston and Presidio propagules – to be further evaluated by the Park Plant Ecologist), nursery propagation, soils preparation, specifically the reduction of organic material, and the installation of the planted nursery stock. Similar to the restoration of other habitat types, this process generally requires 1-2 years of lead-time prior to outplanting. Because of limited propagule availability, the dune scrub propagation goals should be reviewed and updated on an annual basis with the Project Manager and Nursery staff. Refer to the list of anticipated restoration plantings and anticipated schedule for revegetation activities within the Study Area (Appendix D).

In general, dune scrub planting should be distributed in a natural pattern so as to blend into the existing landscape, and should be spaced at an average of 3 feet on center for most shrubs to allow sufficient room for growth infill over time. Refer to Appendix A-2 for a list of suitable native plants for dune scrub restoration areas. This list will be augmented based upon site-specific conditions and needs prior to establishing revegetation goals.

Planting can be conducted either by contract labor or volunteers, or a combination of both. Volunteers will be supervised by project manager or other park staff.

4.6.3 Arroyo Willow Riparian Forest, Central Coast Riparian Scrub.

In general, the focus for restorating riparian habitats will be on expanding and linking existing habitat areas, based upon hydrology. Wherever feasible, willow pole cuttings and wetland divisions (i.e. rushes, sedges, wire rush species) will be collected from the adjacent existing habitat areas, and installed following invasive non-native plant control efforts. The planting palette will be modified to support a more diverse riparian plant community when desired by inter-planting other native riparian species that will be grown in the nurseries. As described in previous sections, it is recommended that 1-2 years of lead-time be provided for plant propagation before the start of each riparian restoration activity. Refer to Appendix A-2 for a list of suitable native plants for riparian restoration areas. In most instances, Arroyo willow *(Salix lasiolepis)* should be 75-80% of site plantings, with other riparian trees and shrubs making up no more than 25% of the remaining species. Plant spacing should be approximately 15 feet on center for trees, 3 feet on center for shrubs, and 2 feet on center for rush, sedge, and wire rush cluster plantings.

Planting can be conducted either by contract labor or volunteers supervised by project staff, or a combination of both.

4.6.4 Coastal Grassland.

Very limited coastal grassland restoration opportunities exist within the Lands End Study Area. Initial efforts will be focused at Painted Rock (Area D), with limited in-fill plantings within northern coastal bluff scrub habitat where feasible. Approaches for coastal grassland restoration will include a combination of direct seeding and plug plantings of native perennial grasses. Seed sources for coastal grassland seed are

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limited; therefore collection efforts should begin 1-2 years prior to outplanting activities. Refer to the list of anticipated restoration plantings and anticipated schedule provided in Appendix D. Due to limited seed, available seed may be sent to a grass farm to multiply the available stock to sufficient quantities. It should be noted that the park adheres to strict ecological guidelines in seed collection for revegetation projects. No more than 5% of available seed is taken from native habitats; at least 95% is left to promote natural regeneration.

In general, coastal grassland planting should be directly seeded at a rate of 15-25 lbs per acre, or at a rate determined appropriate by the Plant Ecologist, onto prepared (decompacted, scarified, etc.) soils. Plug plantings should be installed within the seeded area, or in areas where seeding would be less appropriate. Refer to Appendix A-2 for a list of suggested species for coastal grassland restoration areas.

Planting can be conducted either by contract labor or volunteers, or a combination of both supervised by park staff.

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5.0 PRIORITIZATION METHODS AND RESULTS

5.1 Criteria Used for Project Prioritization and Selection

Numerous techniques for decision-making and project prioritization were reviewed for their applicability as a tool to help determine project priorities at Lands End.

Techniques that were assessed, but not selected for this project included numerical ranking systems, tiered ranking systems, and flow-chart based decision-making. Each of these techniques were considered, but ultimately rejected because each had limitations in their applicability and utility for this project. Further, these techniques were thought to lack "real-world" decision-making, and were not considered broad-based enough to capture the variety of social, physical, political, scheduling, and biological issues that were critical to the success of this project.

Instead, a modified Delphi approach to decision-making and prioritization was selected for this project. The Delphi technique was developed by the RAND Corporation in the late 1960's as a forecasting methodology. Later, the U.S. government enhanced it as a group decision-making tool in which a group of experts could come to some consensus of opinion when the decisive factors were subjective, and not knowledge-based. The Delphi technique is particularly appropriate when decision-making is required in the context of a political or emotional environment, and works formally or informally, in large or small contexts, and reaps the benefits of group decision making while insulating the process from the limitations of group decision-making (e.g., over-dominant group members, skewing results towards one interest, lobbying). This approach has the added advantage that it works as an informal, subjective model when the decisions are based on opinion, and can be directly converted to a formal model, when the data is more knowledge-based. For the purposes of the Lands End Project, this methodology was combined with a data-driven decision making process to allow for the inclusion of both subjective and objective information.

The remainder of this section describes the steps undertaken for this modified approach, including the general procedures that were used for the Lands End project for defining key criteria and prioritizing items that use those criteria (e.g., project funding).

5.1.1 Modified Delphi Prioritization Procedure used for the Lands End Project

The prioritization process described below allowed the stakeholders and experts to collectively discuss, refine, and finally produce a prioritized list for the Lands End project that would span a 10-year planning timeframe.

- **Select Facilitation Leader.**
  Loran May (Project Management Consultant) was selected as the facilitator for the meetings as she was not a stakeholder, and could participate objectively.
- **Create a Panel Representing Stakeholders and Experts.**
  The following list of stakeholders and experts were selected by the Parks Conservancy and NPS to participate in the Lands End prioritization and ranking

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effort. These participants were selected because of their intimate knowledge of the Lands End Study Area, the Coastal Trail Project, and/or familiarity with technical subject matter that was considered important to the projects (e.g., trail planning, landscape architecture, hydrology, wildlife biology, historical and archaeological studies). The selection to participate was based largely on the participant's "real-world" experience that would enable them to prioritize the project actions effectively. Refer to the table below for a list of selected participants.

Table 7. Lands End Participants

Asha Setty	Nursery Manager, Parks Conservancy	asetty@parksconservancy.org
Barth Campbell	Trail Expert, Campbell Grading, Inc.	campbellgradinginc@sbcglobal.net
Betty Young	Director Of Park Nurseries, Parks Conservancy	byoung@parksconservancy.org
Carmen Busch	Landscape Designer, Steven Wheeler Landscape Architects	cpb@swlarch.com
Dan Collman	Trails Facility Manager, GGNRA	dan_collman@nps.gov
David Kelley	Plant & Soil Scientist, Kelley Consulting	dbkelley@jps.net
Jen Zarnoch	Biologist/GIS Specialist, May & Associates	jenzarnoch@maybio.com
John Martini	Historian	JohnAMartini@comcast.net
Laura Castellini	Environmental Specialist, GGNRA	laura_castellini@nps.gov
Loran May	Project Manager, May & Associates, Inc.	loranmay@mayandassociatesinc.com
Sharon Farrell	Project Manager, Natural Resource Specialist, Parks Conservancy	Sfarrell@parksconservancy.org
Steve Wheeler	Principal, Steven Wheeler Landscape Architects	sjw@swlarch.com
Sue Fritzke	Supervisory Vegetation Ecologist, GGNRA	Sue_fritzke@nps.gov
Tamara Williams	Hydrologist, GGNRA	tamara_williams@nps.gov
Tom Gardali	Avian Ecologist, Point Reyes Bird Observatory Conservation Science	tgardali@prbo.org
Joe McBride	Consulting Forester/ UC Berkeley Professor	jrm@nature.berkeley.edu

In addition to the core group, Nancy Hornor (NPS Planning Director), Carrie Strahan (NPS Architect) and John Skibbe attended the final meeting to integrate the project into other NPS activities in the region, to help make sure appropriate environmental documentation and permitting procedures were in place, and to help facilitate the NPS project review and approval process.

- **Synthesize Existing Resource Data Into a Visual Format.**
  Relevant natural, cultural and visitor use data for the Lands End Study Area was synthesized and compiled using GIS into a single database. A series of mapping layers representing similar resources or subject matter were created as clear acetate overlays to a common base map. The panelists used the various resource layers to identify where there were overlapping areas of concern or there were areas of high resource values and restoration opportunities (e.g. areas with wetland resources, important wildlife areas, and social trails).

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- **Identify an Initial List of Selection Criteria.**
  During a brainstorming session, the panel developed a list of criteria that all participants thought was appropriate to the Lands End project goals and objectives. These criteria were developed largely while reviewing the resource maps.

These criteria were broken into themes and are presented below in alphabetical order:

- Compatibility with overall Coastal Trail project objectives and timelines;
- Controlling non-native invasive species;
- Eliminating as many social trails as possible;
- Improving forest health;
- Improving recreation;
- Improving trail circulation patterns;
- Improving viewshed opportunities;
- Maintaining the "wild" character of the trail system while improving accessibility and safety;
- Project sequencing/timing;
- Protecting historic and cultural resources;
- Protecting important natural resources;
- Providing expanded interpretive opportunities;
- Reducing the need for creating social trails;
- Reducing trail and habitat restoration maintenance costs; and
- Technical feasibility.

Additional criteria were also discussed during the initial meeting, but were later rejected because they were not as applicable to the project or valuable in helping to prioritize the list of projects and sequencing of projects.

- **Conduct Planning Session to Discuss Possible Selection Criteria, Projects.** Once the initial list of criteria was developed, the panel then conducted a free- form discussion of what projects might meet the suggested criteria. The GIS resource layers were referenced throughout the discussion so that all resource issues could be accurately considered.

The group reached partial consensus on both the selection criteria and on the types of projects that the group thought should be considered. In general, the panel agreed to move forward in considering the following types of projects:

  - Projects that stabilized the existing Coastal Trail and reduced overall maintenance costs;
  - Projects that increased visitor safety (e.g., hazard tree removal, improved trail conditions, reducing inaccessible areas, problem areas);

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- Projects that improved the visitor experience (e.g., creating viewsheds, interpretive opportunities, trail and circulation improvements, better signage);
- Projects that maintained the rugged and wild character of the existing trail alignment;
- Projects that linked wetland habitats into corridors of restored habitat with increased wildlife and wetland habitat values;
- Projects that controlled target invasive plant species and provided sustainable restoration opportunities;
- Projects that offered opportunities for increased community involvement;
- Projects that could be easily sequenced with planned Coastal Trail improvements; and
- Projects that created wildlife corridors and enhanced wildlife habitat values.

- **Prepare Revised List of Selection Criteria, Initial List of Project Priorities.** Following the free-form discussion, the panel reached consensus on some, but not all ranking criteria and projects. The intent of the first meeting was not to reach complete agreement on all issues and projects, but rather to "flush out" those projects and issues that were acceptable to all panelists in order to focus on those projects and issues that required more consideration and discussion to reach consensus. Based on the results of the first meeting, the list of initial selection criteria was refined, and a list of possible project priorities was developed that reflected the revised selection criteria. This list was then circulated to the panel in advance of a second planning session meeting.

- **Conduct Second Planning Session.**
  At the second planning session, the panelists spent time discussing the project priorities that were generated from applying the revised selection criteria. The project boundaries, objectives, and timing of each of the various proposed projects were considered, as well as new projects and modified projects. As a result of the second planning session, the panelists came to agreement on most of the major issues, and reached agreement on most, but not all of the project priorities.

- **Assess Capacity, Capabilities, and Planning Timeframe, Adjust Projects Accordingly.**
  The projects that were selected as a result of the second planning session were then screened to see if they could be accomplished within the specified 10-year timeframe, and if the Parks Conservancy/NPS and other stakeholder groups had the staffing and other capacities to successfully implement the selected project with available staff, contractors, or both. A smaller group of senior managers with extensive experience implementing projects was involved with this assessment. As a result of input from these senior managers, the list of projects under consideration was reduced to those that were considered reasonable to

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implement concurrent with planned Coastal Trail improvements within the 10-year planning timeframe.

- **Gather Any Remaining Technical Data Necessary to Finalize Decisions**
  As the proposed project actions were further refined, technical questions surfaced that necessitated additional data collection and assessment efforts. Additional information gathering was conducted to help develop a greater understanding about the feasibility and appropriateness of the proposed project action. For example, a proposed Loop Trail was located in an area considered by both the hydrologist and the trail expert to be unstable. In this example, the hydrologist and trail expert conducted additional field assessment activities to determine if the proposed Loop Trail project should be abandoned, modified, or re-structured into a more technically feasible and affordable manner.

- **Prepare List of Project Priorities**
  Based on the initial list of projects, the capabilities and timeframe assessment, and the additional technical data, a list of "final" project priorities was developed, and circulated to the group for review and comment. The group was encouraged to view the projects in the field, and then submit any final comments suggestions, changes, or approvals.

- **Finalize List of Projects.**
  After receiving final input from panelists, a final list of projects was developed that met project selection criteria. These were considered by the group to be technically sound, feasible to undertake, and possible to coordinate with planned Coastal Trail improvements during the 10-year project timeframe.

5.2 Project Priorities for the Lands End Study Area

Table 8 identifies the agreed upon project priorities. Refer to Figure 14 for a corresponding map of the project priorities.

Table 8. Lands End Study Area Project Priorities

PRIORITY	TOP PRIORITY ACTIONS	LOCATION
1	Hazard Tree Removal	Entire Planning Area
2	Stabilize Coastal Trail near Eagles Point	Area I
3	El Camino Del Mar Trail Linkage; West Wash Hydrological Stabilization; and West Wash Trail Improvements and Restoration	Area B*
4	Sutro Baths Viewshed Enhancement and Restoration	Southern half of Area A

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PRIORITY	TOP PRIORITY ACTIONS	LOCATION
5	Coastal Trail Reroute at East Wash	Area H*
6	Pilot Restoration Project, Enhancement of Area below Memorial Parking Lot	Area C.1
7	Forest Health and Viewshed Enhancement below Memorial Parking Lot	Southern half of Area C
8	Accessible Trail Corridor Improvements; Connector Trails A, B, and C, Between Memorial Parking Lot and Merrie Way	Area C
9	Riparian Restoration and Forest Health Improvements	Area F.1
10	Section 2 Viewshed Enhancement	Area C to Area H*
11	Volunteer Program Development and Habitat Restoration	Area F.2
12	Ocean View Trail Project	Area G
13	Painted Rock Habitat Restoration	Area D
14	East Wash Wildlife Habitat Restoration	Area H*
15	Section 3 Viewshed Enhancement	Area H* to E
16	Eagle's Point Overlook Construction; Eagle's Point Invasive Plant Control and Visitor Improvements	Area E

* Boundaries subject to change pending finalization of Park boundaries.

These priorities were then incorporated into the larger Coastal Trail planning effort at Lands End, and turned into a series of Action Items that were integrated into the schedule for the overall Coastal Trails Project. Refer to Section 6.0 below for information on the integrated list of Coastal Trail improvements and selected trail and habitat restoration priority projects.

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Locations of Action Areas at Lands End

Figure 14

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6.0 HABITAT RESTORATION OPPORTUNITIES AND CONSTRAINTS ANALYSIS

The planned improvements to the Coastal Trail provided some unique opportunities for synergistic effects with planned social trail decommissioning and habitat restoration.

Following development of the Coastal Trail Project and selection of top priority social trail decommissioning and habitat restoration activities, a series of linkages were explored (e.g., scheduling linkages, priorities). For example, at West Wash (Area B), planned slope stabilization provided an opportunity to create an elevated trail through existing riparian vegetation, resulting in a unique interpretive opportunity that was linked with restoration of the waterway and riparian woodland vegetation in the slope stabilization area. A coordinated list of integrated Coastal Trail Projects, social trail decommissioning projets, and habitat restoration projects is presented below to show the natural linkages between various projects.

Table 9. Integrated List of Coastal Trail, and Trail and Habitat Restoration Projects.

Trail and Circulation Improvements	Habitat Restoration and Social Trail Decommissioning and Revegetation	Location
COASTAL TRAIL SAFETY AND ACCESSIBILITY		
	Action 1. Hazard Tree Removal	Entire Planning Area
Action 2. Stabilize Coastal Trail near Eagles Point		Area I
Action 3. Coastal Trail Reroute at East Wash		Area H
COASTAL TRAIL - Merrie Way to Mile Rock Overlook (Segment 1)		
	Action 5. Pilot Restoration Project, Enhancement of Area below Memorial Parking Lot	Area C.1
	Action 6. Forest Health and Viewshed Enhancement below Memorial Parking Lot	Area C.2
Connector Trails A, B, and C, Between Memorial Parking Lot and Merrie Way		Area C
	Action 8. Sutro Baths Viewshed Enhancement and Restoration	Southern half of Area A
	Action 9. Accessible Trail Corridor Improvements	Area C
Action 10. Ocean View Trail Project	Action 10. Ocean View Trail Project	Area G

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Trail and Circulation Improvements	Habitat Restoration and Social Trail Decommissioning and Revegetation	Location
COASTAL TRAIL -Mile Rock Overlook to Legion of Honor Trail (Segment 2)		
Action 11. El Camino Del Mar Trail Linkage		El Camino Del Mar
Action 12. West Wash Hydrological Stabilization		Area B
Action 13. West Wash Trail Improvements and Restoration	Action 13. West Wash Trail Improvements and Restoration	Area B
	Action 14. Riparian Restoration and Forest Health Improvements	Area F.1
	Action 15. Volunteer Program Development and Habitat Restoration	Area F.2
COASTAL TRAIL -Legion of Honor Trail to Dead Man's Bluff Overlook (Segment 3)		
Construct Dead Man's Bluff Overlook	Action 16. Section 2 Viewshed Enhancement	Area C to start of Area H
	Action 17. Painted Rock Habitat Restoration	Area D
COASTAL TRAIL -Dead Man's Overlook to Dead Man's Point (Segment 4)		
Eagle's Point Overlook Construction		
	Action 20. East Wash Wildlife Habitat Restoration	Area H
	Action 21. Section 3 Viewshed Enhancement	Area H to Area E
COASTAL TRAIL -Dead Man's Point to Eagle's Point (Segment 5)		
	Action 19. Eagle's Point Invasive Plant Control and Visitor Improvements	Area E
	Action 4. Light Social Trail Decommissioning, Eagle's Point to East Wash	Area I

* Boundaries subject to change pending finalization of Park boundaries.

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7.0 IMPLEMENTATION PRESCRIPTIONS AND DETAILED COST ESTIMATES FOR PRIORITY TRAIL AND HABITAT RESTORATION ACTIONS

This section describes implementation prescriptions, including detailed cost estimates and schedules for each of the priority actions described in Section 6.0 above. Information developed herein is based on the best available information available in 2005. Priorities are likely to change over time; therefore this section is intended to be a "living document" that should be updated as necessary over its 10-year lifespan.

Because costs will change over time, information provided herein should be treated as preliminary, for use in planning purposes only. Actual costs and scheduled should be updated and finalized when the individual actions are selected for implementation. Costs are presented for each individual project, as well as program-level costs for stewardship, the nursery program, and other non-project specific activities such as bird monitoring and cultural resources monitoring.

7.1 Detailed Implementation Prescriptions

Each of the 21 actions described in Table 10 were evaluated, and a series of implementation prescriptions developed for each action. In general proposed actions include one or more of the following:

- Circulation improvements (Loop and Connector trails, accessible trail, bike and pedestrian connectors);
- Forest health improvements (viewshed enhancement, forest thinning/pruning, understory and small tree removal);
- Habitat restoration (active or passive);
- Improved access and visitor amenities (better signage, improved parking, other amenities);
- Interpretive and educational opportunities;
- Invasive plant control;
- Safety improvements (removal of hazard trees, stabilization of slopes, trails);
- Social trail decommissioning and associated habitat restoration (active or passive); and
- Volunteer-based stewardship opportunities.

Table 10 (Summary of Prescribed Activities) presents a summary of activities prescribed for each of the priority Actions, and **Table 11 (Proposed Schedule)** presents a schedule for these Actions that is integrated into the schedule for the entire Coastal Trail Improvement Project at Lands End.

Refer to Appendix D for detailed prescriptions for each proposed Action, including cost breakdowns, detailed schedules, maps, and activity descriptions. Please note that costs presented in Appendix D are individual, project-specific costs, and do not include program

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costs. Refer to Table 10 for a breakdown of program-level costs for stewardship, the nursery program, and other non-project specific activities such as bird monitoring and cultural resources monitoring.

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Table 10. Summary of Prescribed Activities

Program Budget - Lands End Strategy

Lands End Annual Nursery Program, Volunteer Stewardship, Field Management and Monitoring (assumes nursery production of 25,000 plants, management and coordination of Natural Resources and Trails Stewardship, field-based work, and resource monitoring).	Personnel expenses (Field program, volunteer management, and nursery operations)	Contractor Support: wildlife & vegetation monitoring	Contractor Support: weeding & maintenance	Contractor Support: resource education & public	Contractor Support: archaeology monitoring	Contractor Support: reforestation support	Contractor Support: database	Interns	Supplies & Uniforms	Tools & Equipment (natural resources, forestry, trails)	Staff development	VIP appreciation	Vehicles	Vehicle Insurance	Depreciation - Computers	Facility Maintenance	Total by Year	Schedule
2006 Program Costs (FY 2006)	$ 161,811	$ 6,143	$ 15,120	$ 7,875	$ 26,250	$ 26,250	$ 2,100	$ 10,001	$ 12,075	$ 9,188	$ 1,050	$ 2,100	$ 2,100	$ 3,150	$ 1,050	$ 735	**$ 286,997**	2006
9 Years Remaining Program Costs (FY 2007-2016 with 5% Annual Inflation)	$ 2,137,003	$ 81,123	$ 199,687	$ 104,003	$ 346,678	$ 346,678	$ 27,734	$ 132,084	$ 159,472	$ 121,337	$ 13,867	$ 27,734	$ 27,734	$ 41,601	$ 13,867	$ 9,707	**$ 3,790,312**	2007-16
SUBTOTAL	**$ 2,298,814**	**$ 87,265**	**$ 214,807**	**$ 111,878**	**$ 372,928**	**$ 372,928**	**$ 29,834**	**$ 142,086**	**$ 171,547**	**$ 130,525**	**$ 14,917**	**$ 29,834**	**$ 29,834**	**$ 44,751**	**$ 14,917**	**$ 10,442**		
TOTAL LANDS END PROGRAMMATIC COSTS 2006-2016																	**$ 4,077,309**	

Project Specific Budget

PRIORITY ACTIONS	New Trail Construction and Old Trail Decommissioning	Social Trails Total meters and (meters of trails proposed for active restoration)	Forest Health Improvements: Viewshed (Acres)	Forest Health Improvements: Additional Large tree removal (Acres)	Forest Health Improvements: Small tree removal (Acres)	Invasive Plants: TOTAL ACRES WEEDS	Invasive Plants: Cape Ivy (Acres)	Invasive Plants: Mattress ww (Acres)	Invasive Plants: Iceplant (Acres)	Invasive Plants: Other Weeds (Species and acres	Restoration: TOTAL ACRES RESTORATION	Restoration: Dune (# of plants)	Restoration: Riparian (# of plants)	Restoration: Northern Coastal Bluff Scrub Acres (# of plants)	Restoration: Coastal Grassland Acres (# of plants)	Restoration: Native Forest stand conversion (# of plants)	Project-based Cost Estimate (cost includes 10% field management)	Indirect Costs: 10% overhead	Indirect Costs: 15% general conditions	Indirect Costs: 20% contingencies	Schedule
Action 1. Hazard Tree Removal (*project underway - costs shown are for future actions only*)				51 Hazard trees													$ 62,150.00	$ 6,215.00	$ 9,322.50	$ 12,430.00	2005
Action 2. Coastal Trail Stabilization near Eagle's Point (Area I)	est. 58 m New Trail, including blind retaining wall																$ 142,189.30	$ 14,218.93	$ 21,328.40	$ 28,437.86	2005
Action 3. Coastal Trail Reroute at East Wash (Area H)	215.5m New Trail, 159.9 Old Coastal Trail Decommission										0.58			3,400			$ 196,964.90	$ 19,696.49	$ 29,544.74	$ 39,392.98	2005
Action 4. Social Trail Restoration, Eagle's Point to Dead Man's Point (Area I)		1,069m (290m)									0.26			500			$ 44,150.00	$ 4,415.00	$ 6,622.50	$ 8,830.00	2005
Action 5. Memorial Parking Lot Pilot Restoration Project (Area C.1)						0.26					0.26			1,000	500		$ 57,640.00	$ 5,764.00	$ 8,646.00	$ 11,528.00	2005
Action 6. Memorial Parking Lot Viewshed Enhancement (Area C.2)			0.66		0.09												$ 61,600.00	$ 6,160.00	$ 9,240.00	$ 12,320.00	2006
Action 7. Connector Trails A, B, and C Construction (Area C)	*Action Item removed from Strategy - refer to larger Coastal Trail Project*																				2007
Action 8. Sutro Baths Viewshed Enhancement & Restoration (Area A)		1,226m (245m)	0.95		2.38	2.64	0.26	0.01	0.9	1.47	6.00	17,114	6,070	11,726			$ 220,951.50	$ 22,095.15	$ 33,142.73	$ 44,190.30	2007
Action 9. Accesible Trail Corridor Improvements (Merrie Way Parking Lot to Area C)		1064m (355m)	0.53		1.18	3.22	0.12	est 0.5	0.44	2.16	1.26			1,520		4,995	$ 238,172.55	$ 23,817.26	$ 35,725.88	$ 47,634.51	2007
Action 10. Ocean View Trail Project (Area G)	994 m New Trail, 31.5 Bridge, 7.0 Landings, 92.7 Stairs.	3,547m (710m)				0.16	0.16				0.52			3,040			$ 857,092.50	$ 85,709.25	$ 128,563.88	$ 171,418.50	2010
Action 11. El Camino Del Mar Trail Linkage (El Camino Del Mar)	157m New Trail, 78m Trestle, 147m Old Trail Decommission																$ 1,008,690.10	$ 100,869.01	$ 151,303.52	$ 201,738.02	2009
Action 12. West Wash Hydrological Stabilization (Area B)				30 trees	5.0						5.00	12,836	7,587	5,846			$ 442,675.75	$ 44,267.58	$ 66,401.36	$ 88,535.15	2009
Action 13. West Wash Trail Improvements & Restoration (Area B)*	58m New trail construction, 44m Stairs, 147m Old Trail Decommission	539m (# treated TBD)	TBD	TBD	2.46 (removal acres TBD)	6.45	2.7	TBD	TBD	3.75	TBD						$ 610,000.00	$ 61,000.00	$ 91,500.00	$ 122,000.00	2010
Action 14. Riparian Restoration & Forest Health Improvements (Area F.1)		1937m (639m)			1.3	6.5	2.5			4.0	est. 3.0		6,070	5,846			$ 264,898.70	$ 26,489.87	$ 39,734.81	$ 52,979.74	2011
Action 15. Volunteer Program Development & Habitat Restoration (Area F.2)		118m (118m)			0.2	0.45	0.25				0.15		500				$ 68,552.00	$ 6,855.20	$ 10,282.80	$ 13,710.40	2011
Action 16. Section 2 Viewshed Enhancement (Area C to start of Area H)			1.8														$ 63,480.00	$ 6,348.00	$ 9,522.00	$ 12,696.00	2008
Action 17. Painted Rock Habitat Restoration (Area D)		511m (256m)		1.19 (.56)	0.005	0.79				0.79	1.70			2,000	2,000		$ 118,910.00	$ 11,891.00	$ 17,836.50	$ 23,782.00	2013
Action 18. Eagle's Point Overlook Construction (Area E)	*Action Item removed from Strategy - refer to larger Coastal Trail Project*																				2014
Action 19. Eagles Point Invasive Plant Control & Visitor Improvements (Area E)		614m (614m)			0.01	1.76	0.46			1.3							$ 187,620.30	$ 18,762.03	$ 28,143.05	$ 37,524.06	2014
Action 20. East Wash Wildlife Habitat Restoration (Area H)				1.25	1.31	3.77	0.55			3.22	2.00					500 trees 4,000 shrubs	$ 180,500.00	$ 18,050.00	$ 27,075.00	$ 36,100.00	2013
Action 21. Section 3 Viewshed Enhancement (Area H to Area E)			0.47														$ 32,200.00	$ 3,220.00	$ 4,830.00	$ 6,440.00	2012
Action 22. Coastal Trail Stabilization (Area G, KHE site 1)	44 m New Trail, including blind retaining wall										0.30			2,000			$ 112,604.80	$ 11,260.48	$ 16,890.72	$ 22,520.96	2006
Action 23. Coastal Trail Stabilization (Area G, KHE site 2)	26 m New Trail (elevated boardwalk)										0.50			3,000			$ 262,391.50	$ 26,239.15	$ 39,358.73	$ 52,478.30	2006
Action 24. Freshwater Spring Enhancement, (Area B.1)				est. 96 trees							0.20	857	304				$ 59,713.50	$ 5,971.35	$ 8,957.03	$ 11,942.70	2009
SUBTOTAL		**10,625m (3,227m)**	**4.41**		**13.94**	**26.0**	**7.0**	**0.51**	**1.34**	**16.69**	**20.93**	**30,807**	**20,531**	**39,878**	**2,500**	**9495**	**$ 5,293,147.40**	**$ 523,099.74**	**$ 784,649.61**	**$ 1,046,199.48**	
Indirect costs																				**$ 2,353,948.83**	
5% Inflation																				**$ 264,657.37**	
TOTAL PROJECT-BASED BUDGET																				**$ 7,647,096.23**	

* Cost included is high range of cost estimate to be determined following engineering study and slope grading

TBD = To be determined during future detailed planning

TOTAL LANDS END STRATEGY BUDGET: $ 11,724,405

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Table 11. Schedule of Activities

2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016-2020
Project-Wide Actions											
Action 1. Hazard Tree Removal	Follow-up Hazard Tree Removal, New Trails	Ongoing Hazard Tree Detection and Removal 1X Year									
	Action 6. Forest Health and Viewshed Enhancement below Memorial Parking Lot										
		Action 9. Accessible Trail Corridor Improvements	**Action 16. Section 2 Viewshed Enhancement.**	Follow-up seedlings, resprouts 5 year			**Action 21. Section 3 Viewshed Enhancement**	Follow-up seedlings, resprouts 5 years			
Action 8. Sutro Baths Viewshed Enhancement and Restoration	Follow-up seedlings, resprouts 5 years					**Action 14. Riparian Restoration and Forest Health Improvements**		**Action 20. East Wash Wildlife Habitat Restoration**	Follow-up seedlings, resprouts 5 years		
Actions For Specific Areas											
Merrie Way											
Action 8. Sutro Baths Viewshed Enhancement and Restoration	Install Plantings Area A	Weed Control, Reveg Maintenance 5 years									
Propagate for Area A		**Merrie Way Parking Lot, Visitor Center Construction**									
		Construct Connector Trails A, B, & C, Between Memorial Parking Lot and Merrie Way	Follow up new trail monitoring (2 years)								
SF Memorial											
	Improve Parking Lot at SF Memorial										
Action 5. Pilot Restoration Project, Enhancement of Area below Memorial Parking Lot	Reveg Area G	Weed Control Reveg Maintenance 5 years									
Use NPS Nursery Plants on-hand											
ADA Coastal Trail- Merrie Way Parking Lot to Overlook											
		Construct Coastal Trail Trail, Merrie Way to Overlook	Follow up new trail monitoring (2 years)		Ongoing Trail inspection of Entire Coastal Trail, 1X Year						
	Plant propagation for Coastal Trail Improvement Corridor	**Action 9. Accessible Trail Corridor Improvements**	Install Plants	Weed Control, Reveg Maintenance 5 years							
El Camio Del Mar, Riparian and Bird Interpretive Trail, Restoration Areas B, F.1 and F.2											
	Fix Broken Section of Camino del Mar			**Action 11. El Camino Del Mar Trail Linkage**	Follow up new trail monitoring (2 years)						
	Action 22. Coastal Trail Stabilization (Site 1)			**Action 12. West Wash Hydrological Stabilization**	Follow up new trail monitoring (2 years)						
	Action 23 Coastal Trail Stabilizaton (Site 2)			**Action 24. Freshwater Spring Enhancement**	**Action 13. West Wash Trail Improvements and Restoration**	Follow up new trail monitoring (2 years)					
			Propagate Trees for Reveg Area B	Propagate Shrubs for Reveg Area B	**Action 13. West Wash Trail Improvements and Restoration**	Reveg Area B	Reveg Maintenance, weed control 5 years				
				Propagate Trees for Reveg Area B	Propagate Shrubs for Reveg Area B	**Action 14. Riparian Restoration and Forest Health Improvements**	Reveg Area B	Reveg Maintenance weed control 5 years			
						Action 15. Volunteer Program Development and Habitat Restoration	Weed Control 5 years				
						Reveg Maintenance 3-5 years					
Beach Trail											
				Propagate shrubs for Area G	**Action 10. Ocean View Trail Project**	Reveg Beach Trail - install coastal scrub plants	Reveg Maintenance 5 years				
Painted Rock and East Wash Restoration Sites (Areas D and H)											
Action 3. Coastal Trail Reroute at East Wash	Follow up new trail monitoring (2 years)						Propagate shrubs for Area D	**Action 17. Painted Rock Habitat Restoration**	Reveg Maintenance weed control 5 years		
						Propagate trees for Area H	Propagate shrubs for Area H	**ACTION 20.**	Staged Planting Over 10+ years, Reveg Maintenance, weed control 3-5 years		
Eagle's Point											
Action 2. Stabilize Coastal Trail near Eagles Point	Follow up new trail monitoring (2 years)								**Eagle's Point Overlook Construction**	Follow up new trail monitoring (2 years)	
Action 4. Light Social Trail Decommissioning, Eagle's Point to East Wash									**Action 19. Eagle's Point Invasive Plant Control and Visitor Improvements**	Weed control 3-5 years	

LEGEND:	
Yellow= Coastal Trail Improvements	Light yellow = Trail Restoration
Brown= Tree Removal	Green = Habitat Restoration

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8.0 SUMMARY OF LONG-TERM MAINTENANCE NEEDS

Note: This section was excerpted, and is largely modified from the Presidio Trails and Bikeways Master Plan document (2003).

To ensure that the Park's investment at Lands End is well-maintained, habitat and trail restoration project areas will require ongoing maintenance and care. In time, the need for active maintenance will decrease, and the need for ongoing monitoring and detection will stabilize to a minimal level. The maintenance and monitoring activities described in the section for the Lands End Study Area generally follow recommendations provided in the Presidio Trails and Bikeways Master Plan document.

8.1 Stewardship of Habitat Restoration Areas

Follow-up weed control treatments, habitat restoration activities and monitoring will be conducted by a combination of volunteers, staff members or independent contractors. The initiation, timing and scale of natural resource-based community stewardship activities will vary throughout the Study Area depending upon the type of actions being implemented. In steep, inaccessible areas, sustained contractor support will be critical to maintaining weed control efforts. Contractors will in general be tasked with tree removal activities, large-scale weed infestation removal, herbicide application and activities within large areas supporting poison oak. Volunteer stewards will play an integral role in performing a number of restoration actions within accessible areas, specifically in areas where initial tree removal and weed infestation control efforts have been initiated. Volunteers will also play an important role in collecting seeds and propagating plants within the Park nurseries. It is envisioned that volunteers will also support trail maintenance, monitoring and public education activities, all necessary to sustaining long-term stewardship and overall project success.

In most cases, volunteer stewardship actions will need to continue for a minimum of 5 years following the initial restoration activities. A general rule of thumb is:

- 5 years maintenance for plantings of grasses, forbs, and shrubs (monitoring plant die-off, replacing plants, maintaining planting sites);
- 5-10 years maintenance for riparian plantings (both pole plantings and container stock planting) and native forest conversion plantings (monitoring plant die-off, replacing plants, maintaining planting sites);
- 3-5 years of monitoring and maintenance for invasive non-native plant control that includes removal of the entire plant (e.g., Pampas grass control that includes removal of the entire root ball, iceplant control);
- 3-5 years monitoring and maintenance for small infestations of invasive non-native plants and for invasive plants that are known to respond well to control treatment (e.g., most small trees and shrubs, fennel, poison hemlock, iceplant, mattress wire weed); and
- 5-10 years, or possibly longer for large invasive non-native plant infestations, that reproduce prolifically, have a long-lived seed bank, are early colonizers,

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and for invasive plants that do not respond well to control treatments (e.g., Himalayan blackberry, perennial grasses, Cape ivy, English and Algerian ivy, cotoneaster, French broom).

Follow-up maintenance activities shall be implemented in accordance with established GGNRA procedures, which generally include the following:

- Monitoring of plantings: recording mortality, health and vigor (evidence of new growth, reproduction) of planting materials; and
- Annual site maintenance: (e.g. weeding around planting sites, installing replacement plantings if plant mortality exceeds success criteria, installing herbivore protection structures as necessary, repair of any detected erosion problems, installing any additional fencing, signs needed to protect planting sites); and
- Photomonitoring and reporting: including recommendations for future actions that might be required to successfully restore the site.

8.2 Trail Maintenance

Several types of trail maintenance are recommended. These activities will be performed by a combination of NPS Trails Crews, contractors and staff:

- Initial monitoring of new trails and trail structures (stairs, landings, boardwalks, trestles, etc.) to ensure that new trail features are properly functioning) (2 years following construction);
- Initial monitoring of decommissioned social trails to ensure that revegetation is successful (2 years following restoration);
- Ongoing monitoring and maintenance of the main Coastal Trail and related connector and link trails intended to detect normal use problems (erosion, wear and tear, localized failure or damage, etc); and
- Ongoing monitoring of formation of new social trails in undesirable locations; and ongoing social trail decommissioning and revegetation as needed to control visitor use and maintain integrity of the trail system and adjacent habitat areas.

In general, these types of trail maintenance can be accomplished through an ongoing annual monitoring program, either by volunteers through an "Adopt-A-Trail" program, by paid NPS/ Parks Conservancy staff, or by trail contractors.

One objective in preparing this report was to develop a trail system that would require little ongoing maintenance. Therefore, unless some unforeseen slope failure, structural failure or similar unusual event occurs, ongoing trail monitoring and maintenance should require relatively little effort and be performed at minimal cost. However, it is important to note that trail maintenance and long-term stewardship is an important and essential component of successful project implementation and should not be discounted or underfunded.

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The following section provides an overview of possible actions that could be required to stabilize and maintain the trail system into the future:

- Inspect and repair damage;
- Install additional brush piles, signs, and scattered brush to keep visitors off restored trails;
- Install additional plants, especially large shrubs and shrubs with thorns that will discourage visitors from trespassing into restored areas;
- Inspect and maintain erosion and siltation control devices, install additional devices as necessary (e.g. silt fences, straw wattles, water bars, seed-free straw);
- Fill areas that are settling or eroding. If fill is necessary, using only fill that is certified weed free, is compatible with local hydrologic and ecological conditions, and is appropriate for the enhancement of listed species and restoration activities;
- Avoid over-compacting fill soils;
- Inspect sites for secondary invasive plants, control (hand pull, spray, volunteer work events) as necessary;
- Inspect signs, especially trail closure signs. Remove when trails are fully decommissioned and revegetated, adjust location if new social trails are forming in adjacent areas;

8.3 Ongoing Non-Native Tree Management and Sapling Removal

Tree removal activities under this strategy include hazardous tree removal, viewshed removal, and forest health activities such as stand conversions and small tree and understory removal and thinning. Of these prescribed activities, viewshed removal activities are not expected to require many follow-up control treatments.

Ongoing maintenance activities will be required for the following:

Hazardous Tree Removal. Over time, trees will age and may be damaged by wind, pests, disease, and mechanical damage. Trees that are located adjacent to trails and facilities should be routinely inspected by an experienced forester or arborist. Newly detected hazard trees should be removed as necessary to maintain the health of the forest. It is predicted that 1 to 5 new hazard trees will be detected annually.

Small Tree and Understory Removal and Thinning. Areas that will be treated as part of this program will require follow-up treatment for at least 2-5 years following initial control treatment. Follow-up maintenance includes detection and treatment of saplings, seedlings, and re-sprouts, especially for stump-sprouting trees and shrubs such as eucalyptus and cotoneaster, and for species that produce copious amounts of seed such as French broom and plume acacia/albizia, species that are difficult to control. If annual maintenance is done in spring, many of the new seedlings and re-

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sprouts can be hand-pulled using contract or volunteer labor. For stubborn infestations, chain-sawing or brush-cutting, followed by immediate herbicide application may be required. Covering the area with black tarps to solarize vegetation may also help control localized problem areas.

8.4 Landscape Maintenance and Control in High Visitation Areas

Some extra maintenance may be required in high visitor use areas. Vegetation in these areas may exhibit unusually high wear and tear, and require extra efforts to keep the area in good condition. Areas anticipated to require extra attention include:

- Area C.1: the Memorial Staircase entrance to the Coastal Trail;
- Areas adjacent to the Merrie Way parking lot and Visitor's Center (Area A and Area C);
- Areas near the Eagle's Point Overlook (Area E); and
- Sandy areas between Merrie Way and Sutro Baths (Area A).

These areas already exhibit signs of high use; habitat restoration in these areas will require particular care to ensure that they have sufficient buffers and time to establish. An annual inspection of these high use areas is recommended. Maintenance may include:

- Replanting restoration sites as needed;
- Installing additional temporary fencing and closure signs such as "Areas Closed- Restoration in Progress" ;
- Installing other physical barriers such as brush piles or post and cable fencing. (Note: brush piles do not have to be visible from main entrance points, and if visible, one option could be installation of aesthetically pleasing brush sculptures); and
- Limbing up trees and clearing understory small trees and shrubs to re-direct visitors to other areas.

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APPENDIX A. Supporting Biological Information

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APPENDIX A-1. Common and Scientific Names of Species Mentioned in the Text

Wildlife Species

Scientific Name	Common Name
Accipiter cooperi	Cooper's hawk
Accipiter striatus	Sharp-shinned hawk
Ardea herodias	Great blue heron
Bubo virginianus	Great-horned owl
Buteo jamaicensis	Red-tailed hawk
Buteo lineatus	Red-shouldered hawk
Butorides striatus	Green heron
Callipepla californica	California quail
Catharus ustulatus	Swainson's thrush
Cepphus columba	Pigeon guillemot
Chamaea fasciata	Wrentit
Cistothorus palustris	Marsh wren
Contopus borealis	Olive-sided flycatcher
Coturnicops noveboracensis	Yellow rail
Dendroica petechia brewsteri	California yellow warbler
Empidonax traillii	Willow flycatcher
Eumetopias jubarus	Northern (Stellar's) sea lion
Falco columbarius	Merlin
Falco peregrinus anatum	American peregrine falcon
Gavia immer	Common loon
Geothylpos trichas sinuosa	Saltmarsh common yellowthroat
Haematopus bachmani	Black oystercatcher
Histrionicus histrionicus	Harlequin duck
Junco hyemalis	Dark-eyed junco
Larus californicus	California gull
Lichnanthe ursina	Bumblee scarab beetle
Otus kennicottii	Western screech owl
Pelecanus occidentalis	Brown pelican
Phalacrocorax auritus	Double-crested cormorant
Phalacrocorax pelagicus	Pelagic cormorant
Phalacrocorax pencillatus	Brandt's cormorant
Pipilo maculatus	Spotted towhee
Rallus limicola	Virginia rail
Rana aurora draytoni	California red-legged frog
Sterna elegans	Elegant tern
Thyromanes bewickii	Bewick's wren
Vireo huttoni	Hutton's vireo
Zonotrichia leucophrys	White-crowned sparrow

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Plant Species

Scientific Name	Common Name
Abronia sp.	Sand verbena
Acacia decurrens	Green wattle acacia
Acacia longifolia	Golden wattle
Acacia melanoxylon	Blackwood acacia
Albizia lophantha	Plume acacia
Allium triquetrum	Wild onion
Alnus rubra	Red alder
Amaryllis belladonis	Naked lady
Ambrosia chamissonis	Silver beachweed
Arabis blepharophylla	Coast rock cress
Artemisia pycnocephala	Beach sagewort
Arundo donax	Giant reed
Avena spp.	Slender oats, wild oats
Baccharis pilularis	Coyote brush
Brassica nigra, B. rapa	Mustard
Bromus diandrus	Ripgut brome
Bromus hordeaceus	Soft chess
Carduus pycnocephalus	Italian thistle
Carpobrotus edulis	Iceplant
Ceanothus thyrsiflorus	California blue-blossom
Chorizanthe cuspidata var. cuspidate	San Franciscan spineflower
Cirsium andrewsii	Franciscan thistle
Cirsium vulgare	Bull thistle
Conicosia pugioniformis	narrow-leafed iceplant
Conium maculatum	Poison hemlock
Coprosa repens	Mirror plant
Cornus sericea ssp. occidentalis	Creek dogwood
Cortaderia jubata, C. selloana	Pampas grass
Cotoneaster sp.	Cotoneaster
Cupressus macrocarpa	Monterey cypress
Cyperus involcratus	Umbrella plant
Dactylis glomerata	Orchard grass
Danthonia californica	California oatgrass
Delairea odorata	Cape ivy
Dudleya sp.	Dudleya
Ehrharta erecta	Ehrharta/African veldt grass
Equisetum spp.	Horsetail
Erigeron glaucus	Seaside daisy
Erigonum latifolium	Coast buckwheat
Erodium spp.	Filaree
Erysimum franciscanum	San Francisco wallflower
Eschscholzia californica	California poppy
Eucalyptus globulus	Blue gum eucalyptus
Festuca arundinacea	Tall fescue
Festuca californica	California fescue
Foeniculum vulgare	Fennel

Scientific Name	Common Name
Fragaria sp.	Strawberry
Fumaria parviflora	Fumitory
Genista monspessulana	French broom
Grindelia hirsutula var. maritime	San Francisco gumplant
Hedera canariensis	Algerian ivy
Hedera helix	English ivy
Hesperolinon congestum	Marin dwarf flax
Heteromeles arbutifolia	Toyon
Holcus lanatus	Velvet grass
Hordeum murinum	Wild barley
Iris sp.	Iris
Lavatera cretica	Tree mallow
Leptospermum laevigatum	Tea tree
Leymus mollis ssp. mollis	Dune grass
Lolium perenne	Perennial ryegrass
Lupinus chamissonis	Chamisso lupine
Lupinus nanus, L. bicolor	Bicolored lupine
Malva neglecta	Common mallow??
Melica californica	Melic grass
Mimulus guttatus	Seep monkeyflower
Muehlenbeckia complexa	Mattress wire weed
Myoporum laetum	Myoporum
Myrica californica	California wax myrtle
Nassella purpurea	Purple needlegrass
Passiflora sp.	Passion fruit vine, pig poa
Pennisetum clandestinum	Kikuyu grass
Phalaris aquatica	Harding grass
Picris echioides	Bristly ox-tongue
Pinus radiata	Monterey pine
Pittosporum sp.	Pittosporum
Poa douglasii	Douglas' bluegrass
Polypogon maritime	Maritime rabbitsfoot grass
Pteridium aquilinum	Bracken fern
Ranunculus californicus	Buttercups
Raphanus raphanistrum	Wild radish
Rhamnus californica	Coffeeberry
Rubus discolor	Himalayan blackberry
Rubus ursinus	California blackberry
Salix lasiolepis	Arroyo willow
Sambucus racemosa var *racemosa*	Red elderberry
Sonchus arvensis	Sow thistle
Tanacetum camphoratum	Dune tansy
Tetragonia tetragonioides	New Zealand spinach
Toxicodendron diversilobum	Poison oak
Triphysaria floribunda	San Francisco owl's clover
Vinca major	Greater periwinkle
Zantedeschia aethiopica	Calla lily

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APPENDIX A-2. Seed Collection and Propagation Timeline

YEAR 1
The Year before planting is to begin

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Approved Plant Lists for All Plants List of all plants - **woody, ferns, herbaceous, grass and annual plants** Final list with budget prepared for seed collection, propagation and growing. Comments given on plant list feasibility

Propagation Planning Nursery project manager writes propagation plan for project. Final plant list submitted to NPS park ecologist for approval

FIRST PAYMENT 25% Non-refundable deposit required

Herbaceous Plants - flag plants for seed collection

Woody Plants - seed collection, seed cleaning and pre-germination treatments given

Herbaceous Plants - seed collection, seed cleaning and pre-germination treatments given

Ferns - Spore collection

YEAR 2
Planting Year

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

SECOND PAYMENT 25% Progress Payment

THIRD PAYMENT 25% Progress Payment

FINAL PAYMENT 25% Progress Payment at Pick-Up

Woody Plants - propagation including growing, watering, fertilization, grooming, culling and prevention and treatment of pests

Herbaceous Plants- propagation including growing, watering, fertilization, grooming, culling and prevention and treatment of pests

Infill Grass and Annual Plants - seed collection and propagation

Ferns - First year of 2 year propagation cycle

Site Preparation - removal of exotic species and other site preparations if not near bird nesting sites

Site preparation - after nesting season

OUTPLANT Except ferns

YEAR 3
Infill Planting, and Maintain, Weed and Remove Invasive Plants

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

OUTPLANT Except ferns

Maintain, weed and remove invasive plant materials

Assess Plant Mortality - Monitor plantings for die-back and requirement for infill planting material

Approved plant list for All Plants - infill planting

Infill Herbaceous Plants - flag plants for seed collection

FIRST PAYMENT 25% Non-refundable deposit Infill Plants

Infill Woody Plants - seed collection, seed cleaning and pre-germination treatments given

Infill Herbaceous Plants - seed collection, seed cleaning and pre-germination treatments given

Ferns - Second year of 2 year propagation cycle

Infill Ferns - spore collection

OUTPLANT Ferns

YEAR 4
Infill Planting, and Maintain, Weed and Remove Invasive Plants

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

SECOND PAYMENT 25% Progress Payment Infill Plants

THIRD PAYMENT 25% Progress Payment Infill Plants

FINAL PAYMENT 25% Progress Payment at Pick-Up Infill Plants

Infill Woody Plants - propagation including growing, watering, fertilization, grooming, culling and prevention and treatment of pests

Infill Herbaceous Plants- propagation including growing, watering, fertilization, grooming, culling and prevention and treatment of pests

Infill Grass and Annual Plants - seed collection and propagation

Infill Ferns - First year of 2 year propagation cycle

OUTPLANT Ferns

OUTPLANT Infill plants

Maintain, weed and remove invasive plant materials

YEAR 5
Infill Planting, and Maintain, Weed and Remove Invasive Plants

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

OUTPLANT Infill plants

Infill Ferns - Second year of 2 year propagation cycle

Maintain, weed and remove invasive plant materials

OUTPLANT Infill ferns

YEAR 6
Maintain, Weed and Remove Invasive Plants

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Maintain, weed and remove invasive plant materials

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APPENDIX A-3. Suggested Planting Pallettes, Planting Densities, and Costs Presented by Habitat Type

Common Name	*Scientific Name*	Percentage Observed in Habitat Type (Source NPS records)	Typical Planting Density	Pot Size	Total Number of Plants per Acre	Estimated Cost per Plant	Estimated Installation Cost	Estimated Cost per Acre
Remnant Dune								
Coast sand verbena	*Abronia latifolia*	5%	3 ft on center	D16	419	$ 2.50	$ 3.00	$ 2,303.65
sand verbena	*Abronia umbellata*	5%	3 ft on center	D16	419	$ 2.50	$ 3.00	$ 2,303.65
Yarrow	*Achillea millefolium*	4%	0.5 ft on center	D16	1,216	$ 2.50	$ 3.00	$ 6,685.95
beach bur	*Ambrosia chammisonis*	5%	3 ft on center	D16	419	$ 2.50	$ 3.00	$ 2,303.65
beach sagewort	*Artemisia pycnocephala*	5%	3 ft on center	D16	419	$ 2.50	$ 3.00	$ 2,303.65
seaside daisy	*Erigeron glaucus*	10%	0.5 ft on center	D16	3,039	$ 2.50	$ 3.00	$ 16,714.88
coast buckwheat	*Eriogonum latifolium*	5%	3 ft on center	D16	419	$ 2.00	$ 3.00	$ 2,094.23
dune grass	*Leymus mollis ssp. mollis*	10%	5 ft on center	1GC	302	$ 4.30	$ 7.00	$ 3,410.36
chamisso lupine	*Lupinus chamissonis*	15%	3 ft on center	D16	1,257	$ 2.50	$ 3.00	$ 6,910.96
Douglas' bluegrass	*Poa douglasii*	8%	3 ft on center	LT8	670	$ 1.50	$ 3.00	$ 3,015.69
Sum		**72%**			**8,577**			**$ 48,046.69**
Northern Coastal Bluff Scrub								
prostrate baccharis	*Baccharis pilularis ssp. pilularis*	8%	5 ft on center	4"	241	$ 2.00	$ 3.00	$ 1,207.21
prostrate blue-blossom ceanothus	*Ceanothus thyrsifolius*	7%	3 ft on center	D40	211	$ 4.25	$ 3.00	$ 1,531.64
Lizardtail	*Eriophyllum staechadifolium*	15%	3 ft on center	D16	1,257	$ 2.50	$ 3.00	$ 6,910.96
cow parsnip	*Heracleum lanatum*	5%	Seed		1,000		$ 0.50	$ 500.00
Toyon	*Heteromeles arbutifolia*	4%	5 ft on center	D40	121	$ 4.25	$ 3.00	$ 875.22
bush lupine	*Lupinus arboreus/chammisonis*	15%	3 ft on center	D40	1,257	$ 4.25	$ 3.00	$ 9,109.90
bush monkeyflower	*Mimulus aurantiacus*	10%	3 ft on center	D16	838	$ 2.00	$ 3.00	$ 4,188.46
coffeeberry	*Rhamnus californica*	7%	3 ft on center	D16	586	$ 2.50	$ 3.00	$ 3,225.12
California blackberry	*Rubus ursinus*	3%	3 ft on center	D16	251	$ 2.00	$ 3.00	$ 2,931.92
Yerba buena	*Satureja douglasii*	1%	3 ft on center	4"	84	$ 2.50	$ 3.00	$ 460.73
Sum		**75%**			**5,846**			**$ 30,941.17**

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Common Name	*Scientific Name*	Percentage Observed in Habitat Type (Source NPS records)	Typical Planting Density	Pot Size	Total Number of Plants per Acre	Estimated Cost per Plant	Estimated Installation Cost	Estimated Cost per Acre
Coastal Scrub/ Serpentine Bluff Scrub								
baccharis	*Baccharis pilularis ssp. pilularis*	8%	5 ft on center	4"	241	$ 2.00	$ 3.00	$ 1,207.21
prostrate blue-blossom ceanothus	*Ceanothus thyrsifolius*	12%	3 ft on center	D40	1,005	$ 4.25	$ 3.00	$ 7,287.92
Lizardtail	*Eriophyllum staechadifolium*	17%	3 ft on center	D16	1,424	$ 2.50	$ 3.00	$ 7,832.42
wild strawberry	*Fragaria chiloensis*	5%	0.5 ft on center, clusters	4"	152	$ 1.50	$ 2.00	$ 531.84
cow parsnip	*Heracleum lanatum*	2%	Seed		1,000		$ 0.50	$ 500.00
toyon	*Heteromeles arbutifolia*	1%	5 ft on center	D40	30	$ 4.25	$ 3.00	$ 218.81
bush lupine	*Lupinus arboreus/chammisonis*	10%	3 ft on center	D40	838	$ 4.25	$ 3.00	$ 6,073.27
bush monkeyflower	*Mimulus aurantiacus*	5%	3 ft on center	D16	419	$ 2.00	$ 3.00	$ 2,094.23
coffeeberry	*Rhamnus californica*	5%	3 ft on center	D16	419	$ 2.50	$ 3.00	$ 2,303.65
California blackberry	*Rubus ursinus*	3%	3 ft on center	D16	251		$ 3.00	$ 753.92
Yerba buena	*Satureja douglasii*	1%	3 ft on center	4"	84	$ 2.50	$ 3.00	$ 460.73
Sum		**69%**			**5,863**			**$ 29,264.00**
Unique Floral Assemblage (Note: Variable species composition)								
Dudleya	*Dudleya sp.*	10%	3 ft on center in clusters	D16	419	$ 2.50	$ 3.00	$ 2,303.65
Wild strawberry	*Fragaria sp.*	15%	0.5 ft on center, clusters	4"	456	$ 1.50	$ 2.00	$ 1,595.51
Iris	*Iris douglasii*	15%	0.5 ft on center, clusters	4"-2 YR CROP	456	$ 3.00	$ 3.00	$ 2,735.16
Bracken fern	*Pteridium aquilinum*	15%	5ft on center in clusters	1GC	453	$ 4.50	$ 3.00	$ 3,395.27
Sum		**55%**			1,783			**$ 10,029.59**
Coastal Prairie								
California oatgrass	*Danthonia californica*	15%	5ft on center in clusters	LT8	550	$ 1.75	$ 1.00	$ 1,512.50
California poppy	*Eschscholzia californica*	5%		seed	1 -5 oz	$20/oz	$ 100.00	$ 200.00
California fescue	*Festuca californica*	10%		seed	approx 0.75 lbs	$150/lb	$ 500.00	$ 1,125.00
wild strawberry	*Fragaria sp.*	5%	0.5 ft on center, clusters	4"	152	$ 1.50	$ 2.00	$ 531.84
bicolored lupine	*Lupinus nanus, Lupinus bicolor*	10%	5ft on center in clusters	D16	302	$ 2.50	$ 1.00	$ 1,056.30
California melic grass	*Melica californica*	5%		seed	approx 0.25 lb	$150/lb	$ 200.00	$ 575.00

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Common Name	*Scientific Name*	Percentage Observed in Habitat Type (Source NPS records)	Typical Planting Density	Pot Size	Total Number of Plants per Acre	Estimated Cost per Plant	Estimated Installation Cost	Estimated Cost per Acre
purple needlegrass	*Nassella pulchra*	20%		seed	approx 10 lbs	$350/lb or 100/ton /bale	$ 700.00	$ 4,200.00
buttercup	*Ranunculus californicus*	5%	5ft on center in clusters	D16	151	$ 2.50	$ 1.00	$ 528.15
footsteps of spring	*Sanicula arctopoides*	5%	5ft on center in clusters	D16	151	$ 2.50	$ 1.00	$ 528.15
blue eyed grass	*Sisyrinchium bellum*	5%	5ft on center in clusters	4"-2 yr crop	151	$ 3.00	$ 1.00	$ 603.60
Sum		**85%**			**1,456**			**$ 10,860.55**
Arroyo Willow Riparian Forest								
red alder	*Alnus rubra*	10%	5 ft on center	TP4	302	$ 2.00	$ 3.50	$ 1,659.91
creek dogwood	*Cornus sericea ssp. occidentalis*	2%	5 ft on center	D40	60	$ 4.25	$ 3.00	$ 437.61
California wax myrtle	*Myrica californica*	3%	5 ft on center	D40	91	$ 4.25	$ 3.00	$ 656.42
Arroyo willow	*Salix lasiolepis*	80%	Cane cuttings	TP4	2,431	$ 1.00	$ 3.75	$ 11,548.47
red elderberry	*Sambucus racemosa var racemosa*	5%	5 ft on center	D40	151	$ 4.25	$ 3.00	$ 1,094.03
Sum		**100%**			**3,035**			**$ 15,396.43**
Arroyo Willow Riparian Scrub								
red alder	*Alnus rubra*	3%	5 ft on center	TP4	91	$ 6.00	$ 3.00	$ 814.86
coyote brush	*Baccharis pilularis*	3%	5 ft on center	D16	91	$ 2.50	$ 3.00	$ 497.97
creek dogwood	*Cornus sericea ssp. occidentalis*	1%	5 ft on center	D40	30	$ 4.25	$ 3.00	$ 218.81
California wax myrtle	*Myrica californica*	1%	5 ft on center	D40	30	$ 4.25	$ 3.00	$ 218.81
Arroyo willow	*Salix lasiolepis*	85%	Cane cuttings	TP4	2,583	$ 1.00	$ 3.75	$ 12,270.24
red elderberry	*Sambucus racemosa var racemosa*	3%	5 ft on center	D40	91	$ 4.25	$ 3.00	$ 656.42
Sum		**96%**			**2,915**			**$ 14,677.11**
Freshwater Seep/Freshwater Marsh								
dense sedge	*Carex densa*	5%	0.5 ft on center, clusters	D16	419	$ 2.50	$ 1.00	$ 1,465.96
slough sedge	*Carex obnupta*	5%	0.5 ft on center, clusters	D16	419	$ 2.50	$ 1.00	$ 1,465.96
wire rush	*Eleocharis acicularis*	10%	0.5 ft on center, clusters	LT8	838	$ 2.30	$ 3.50	$ 4,858.62
Baltic rush	*Juncus balticus*	15%	0.5 ft on center, clusters	LT8	1,257	$ 1.75	$ 1.00	$ 3,455.48

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Common Name	*Scientific Name*	Percentage Observed in Habitat Type (Source NPS records)	Typical Planting Density	Pot Size	Total Number of Plants per Acre	Estimated Cost per Plant	Estimated Installation Cost	Estimated Cost per Acre
spreading rush	*Juncus patens*	10%	0.5 ft on center, clusters	LT8	838	$ 1.75	$ 1.00	$ 2,303.65
brownhead rush	*Juncus phaeocephalus*	5%	0.5 ft on center, clusters	D16	419	$ 2.50	$ 1.00	$ 1,465.96
Pacific rush	*Juncus effusis*	10%	0.5 ft on center, clusters	LT8	838	$ 1.75	$ 1.00	$ 2,303.65
seep monkey flower	*Mimulus guttatus*	5%	0.5 ft on center, clusters	4"	419	$ 1.00	$ 3.00	$ 1,675.38
Sum		***65%***			***5,445***			***$ 18,994.67***
Native Forest								
Overstory trees								
California buckeye	*Aesculus californica*	5%	5 ft on center	TP4	151	$ 6.00	$ 3.00	$ 1,358.11
madrone	*Arbutus menziesii*	2%	5 ft on center	D40	60	$ 4.25	$ 3.00	$ 437.61
California hazlenut	*Corylus cornuta var. californica*	3%	5 ft on center	D16	91	$ 2.50	$ 3.00	$ 497.97
toyon	*Heteromeles arbutifolia*	10%	5 ft on center	D40	302	$ 2.00	$ 5.00	$ 2,112.61
Coast live oak	*Quercus agrifolia*	15%	5 ft on center	TP4	453	$ 2.00	$ 5.00	$ 3,168.91
California bay laurel	*Umbelluria californica*	7%	5 ft on center	D16	211	$ 2.50	$ 3.00	$ 1,161.94
Sum		**42%**			**1,268**			**$ 8,737.15**
Shrub layer and understory species								
ceanothus thyrsiflorus	*Ceanothus thyrsiflorus*	10%	5 ft on center	D16	302	$ 2.50	$ 3.00	$ 1,659.91
wild strawberry	*Fragaria chiloensis*	10%	0.5 ft on center, clusters	4"	3,039	$ 2.00	$ 1.00	$ 9,117.21
ocean spray	*Holodiscus discolor*	3%	5 ft on center	D16	91	$ 2.50	$ 3.00	$ 497.97
California wax myrtle	*Myrica californica*	3%	5 ft on center	D40	91	$ 4.30	$ 7.00	$ 1,023.11
bracken fern	*Pteridium aquilinum*	1%	5 ft on center, in clusters	1GC	200	$ 4.50	$ 7.00	$ 2,300.00
coffeeberry	*Rhamnus californica*	10%	5 ft on center	D16	302	$ 2.00	$ 3.50	$ 1,659.91
Ribes menziesii	*Ribes menziesii*	5%	3 ft on center	D16	419	$ 2.50	$ 3.00	$ 2,303.65
thimbleberry	*Rubus parviflorus*	3%	3 ft on center	D16	251	$ 2.50	$ 3.00	$ 1,382.19
snowberry	*Symphoricarpos albus*	3%	3 ft on center	D40	251	$ 4.25	$ 3.00	$ 1,821.98
Sum		**48%**			**4,945**			**$ 21,765.93**
Sum Forest Understory and Overstory								**$ 30,503.08**

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APPENDIX B. Analysis Of Non-Designated Trails, Identification Of Geologic/Hydrologic Guilds, And Preparation Of Associated Rehabilitation Prescriptions

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APPENDIX C. Recommendations For Soil Preparation Associated With Revegetation Needs For Various Soils/Vegetation Guilds

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APPENDIX D. Action Items

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APPENDIX E. Vegetation Management Strategy For Areas Adjacent To The Coastal Trail At Lands End

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APPENDIX F. Hydrology And Water Quality Assessment Report

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