FINAL

THREE SISTERS RESERVE
HABITAT RESTORATION PLAN

Prepared for:

Palos Verdes Peninsula Land Conservancy
916 Silver Spur Road, Suite 207
Rolling Hills Estates, California 90274

Prepared by:

EARTHWORKS Restoration, Inc
2116 Arlington Avenue, Suite 301
Los Angeles, California 90018

August 2008

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Prepared for:

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SECTION 1 – OVERVIEW AND EXISTING CONDITIONS

1.1 INTRODUCTION

This restoration plan has been prepared for the Three Sisters Reserve located on the Palos Verdes Peninsula in southern Los Angeles County, California. The Three Sisters Reserve, owned by the city of Rancho Palos Verdes and managed by the Palos Verdes Peninsula Land Conservancy (PVPLC), is approximately 98 acres. The reserve is one of 10 Reserves that comprise the newly created Palos Verdes Nature Preserve. The Palos Verdes Nature Preserve was formed under a draft Natural Community Conservation Plan (NCCP).

The Three Sisters Reserve is bordered by development (single family homes) to the north, south and west and open space to the east. Figure 1 shows an aerial view and general location of the Three Sisters Reserve.

This restoration plan for the Three Sisters Reserve proposes restoration of 21 acres. The plan documents the rationale, methods, and performance criteria for the restoration. The restoration of the Three Sisters Reserve is proposed as part of the restoration funding from the Los Angeles World Airport to satisfy the mitigation requirement for the restoration of 21 acres of coastal sage scrub and native perennial grassland habitats.

This section of the restoration plan documents the existing conditions of the Three Sisters Reserve. Section 2 provides an analysis of soils within the reserve. Section 3 defines the boundaries and specifications for the habitat restoration. Performance criteria and monitoring methods are presented in Section 4 as a means to monitor the restoration process.

1.2 EXISTING CONDITIONS

The Three Sisters Reserve is comprised of three distinct ridges divided by steep ravines. The site is bounded on the west by McCarrell Canyon, and the east by Barkentine Canyon, both steep ravines, and to the north and south by housing developments. Two additional steep ravines occur within the site and separate the three sister ridges. The site ranges from flat to steep slopes with mostly south, east and west aspects.

1.2.1 Existing Vegetation

A vegetation map of the site was provided by PVPLC for use in developing the restoration plan for the site. The vegetation map was created by compiling information from 1994, the initial vegetation mapping effort for the Palos Verdes Peninsula, and with an update and verification of the initial mapping effort completed in 1999. Vegetation polygons were delineated based on plant composition and cover. The vegetation classification was based on the Holland and Keil community classification system as described in California Vegetation (1986). Plant communities mapped within the Three Sisters Reserve are coastal sage scrub, *Rhus* dominated coastal sage scrub,

Figure 1
Regional Location
Three Sisters Reserve
Portuguese Bend Preserve, Palos Verdes Peninsula

southern cactus scrub, and grassland. It is important to note that the grassland habitat of the Three Sisters Reserve is comprised of non-native annual grasses as the dominant species with very few native grass species present. Figure 2 shows the plant communities within the Three Sisters Ecological Preserve as mapped per the 2004 Rancho Palos Verdes Draft NCCP.

In April of 2008, the Three Sisters Reserve was assessed by restoration ecologists for appropriate restoration of coastal sage scrub and native grasslands within the site. The key variables observed and evaluated were the dominant species within the mapped plant communities and soil conditions within the mapped vegetation communities.

The dominant native species occurring in the undifferentiated coastal sage scrub plant community are California sagebrush (*Artemisia californica*), lemonadeberry (*Rhus integrifolia*), purple sage (*Salvia luecophylla*), California encelia (*Encelia californica*), and foothill needlegrass (*Nassella lepida*) (see Figure 2).

The dominant native species occurring in the Rhus dominated coastal sage scrub plant community are lemonadeberry, California encelia, California sagebrush, prickly pear cactus (*Opuntia littoralis*), and ashyleaf buckwheat (*Eriogonum cinereum*) (see Figure 2).

The dominant native species occurring in the southern cactus scrub are prickly pear cactus, California encelia, coastal cholla (*Opuntia prolifera*), foothill needlegrass, and lemonadeberry (see Figure 2).

The dominant exotic species within the grassland community of the Three Sisters Reserve are wild oats (*Avena fatua*) black mustard (*Brassica nigra*), and purple false brome (*Brachypodium distachyon*) (see Figure 2). Other exotic species found throughout the site are short pod mustard (*Hirschfeldia incana*), tocalote (*Centaurea melitensis*), and sweet clover (*Melilotus indica*). In areas with more clay soils, sweet fennel (*Foeniculum vulgare*) and bristly ox tongue (*Picris echioides*) are found among the wild oats and mustard.

Additionally, two rare plant species occur within the Three Sisters Reserve; a population of approximately 50 individuals of Western dichondra (*Dichondra occidentalis*) and approximately 200 individuals of California matchweed (*Gutierrezia californica*). Western dichondra is a California Native Plant Society List 4 special status species. Although California matchweed is not a listed special status species, the population occurring at the Three Sisters Reserve is the only known population to occur on the Palos Verdes Peninsula.

Cattle ranching occurred on the Palos Verdes Peninsula from approximately the late 1700s to the early 1900s (http://www.palosverdes.com/). In addition to cattle ranching, dryland farming occurred on the peninsula in the early 1900s. The moderate slopes of the grassland community likely contributed to relatively more intense disturbance during the historic ranching period. Disturbance from ranching allowed exotic species to invade and continue to dominate the moderate slopes even after the cessation of ranching activities. Conversely, the vegetation on the steeper slope areas within the Three Sisters Reserve is largely dominated by native species of the coastal sage scrub

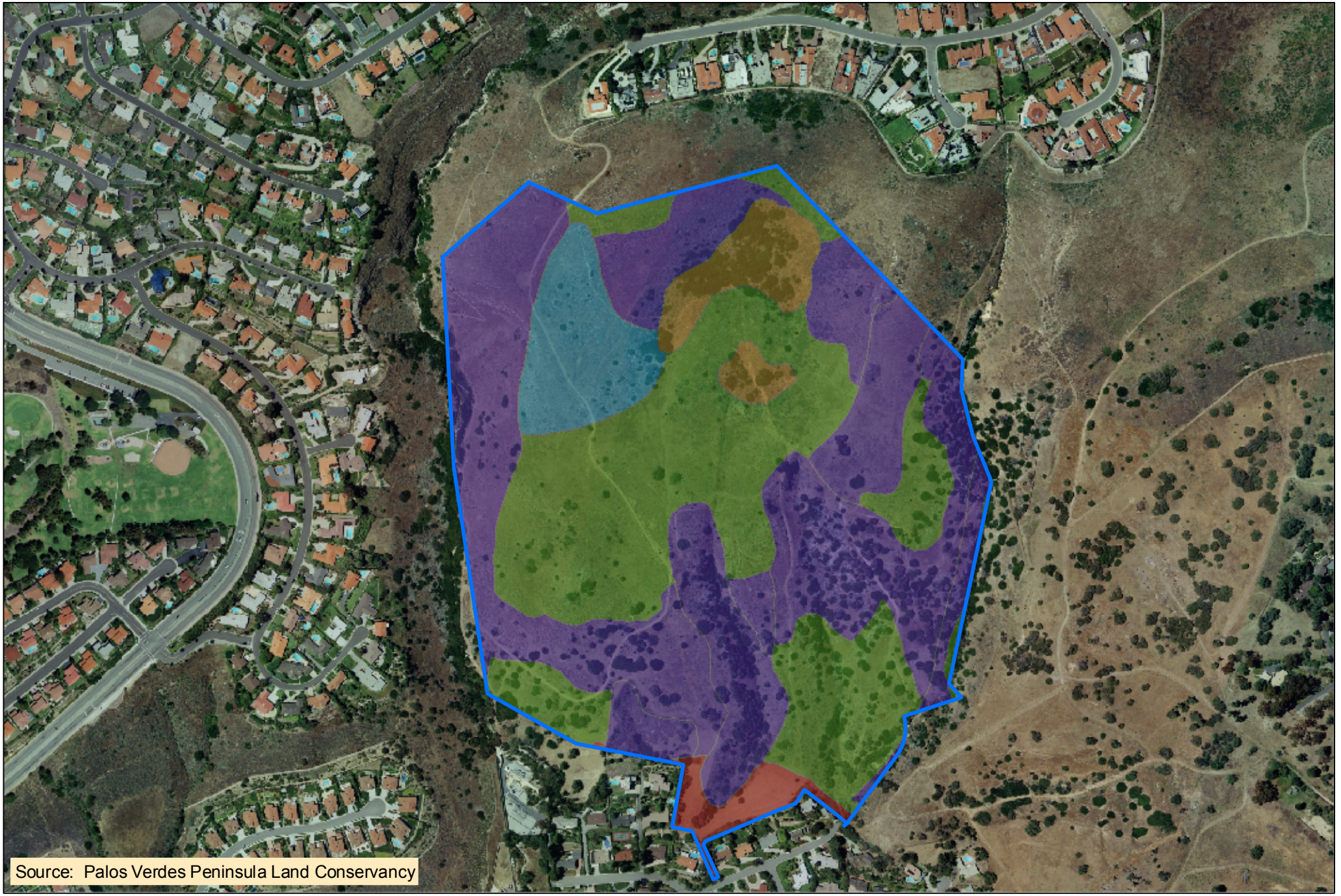

Figure 2
Plant Communities
Three Sisters Reserve
Portuguese Bend Preserve, Palos Verdes Peninsula

plant community. Based on the site evaluation, restoration of the Three Sisters Reserve will concentrate in the areas mapped as grassland.

1.2.2 Fire History

Two documented fires occurred within the Three Sisters Reserve in the last half century (California Department of Forestry and Fire Protection). Approximately one quarter of the Reserve on the west side burned during a fire on May 12, 1953. During the Crenshaw fire on June 22, 1973, approximately two thirds of the Reserve burned on the East side. The burn area of the two fires did not overlap.

1.3 RECENT MANAGEMENT

Management of the Three Sisters Reserve consists of regular monitoring, exotic plant removal for the Targeted Exotic Removal of Plants Program outlined in the Draft NCCP, seed collection from local native plant species, and documentation of invasive species within the reserve and adjacent to the reserve. Additionally the reserve is monitored for the presence of the two sensitive bird species, the California gnatcatcher (*Polioptila californica californica*) and the coastal California cactus wren (*Campylorhynchus brunneicapillus*). During a survey conducted in 2006, 26 California gnatcatchers were observed and 24 California cactus wrens were observed (PVPLC 2007). The population of documented California gnatcatchers consisted of 7 pairs, 11 juveniles, and 1 lone adult. The population of documented Cactus wrens consisted of 7 pairs, 3 juveniles, and 7 lone adults.

SECTION 2 – SITE SOILS AND ANALYSIS

Soil analysis is critical to determine appropriate restoration in the areas that have been historically disturbed and lack clear indications of pre-European native plant communities. The proposed restoration and management recommendations are based in large part on the soils.

Analysis of the Three Sisters Reserve soils began with a review of the Natural Resources Conservation Service's Soil Taxonomy (1999) and Report and General Soil Map, Los Angeles County (1969). The General Soil Map designates soil associations consisting of two or more soil series. A soil association is comprised of named taxonomic soil units that occur together in a characteristic pattern in a geographic area. Unlike a more detailed soil survey map, the specific area of each soil series within a soil association is not mapped independently. Two soil associations consisting of two main soil series occur within the Three Sisters Reserve, and generally, these soils support somewhat different vegetation communities as discussed in the following sections.

2.1 SOIL SURVEY CLASSIFICATION

The soils in the Three Sisters Reserve were formed under the xeric moisture regime of southern California where the Mediterranean climate has cool, moist winters and warm dry summers. Since moisture levels fall during times of lowest evapotranspiration rates, this is conducive for soil leaching. The mean annual soil temperature is lower than 22 degree Celsius (C). At a depth of 50 cm from the soil surface, the mean annual summer and winter temperatures differ by 6 degrees C or more. By definition, xeric soil is dry for at least 45 consecutive days in the summer and is moist for at least 45 consecutive days in the winter (NRCS 1999).

Soil taxonomy is the process by which soils are classified based on key soil characteristics. Soil taxonomy is broken down into categories that are hierarchical because the lower categories fit within the higher categories for diagnostic soil characteristics (Brady and Weil 1999).

The broadest category of soil classification is soil order. Soil orders are defined by formative elements, especially for the presence or absence of major diagnostic horizons. Relevant soil orders are described in the following sections for this restoration plan. Determination of suitable habitat restoration can be facilitated by understanding the formation and classification of soil series. The two most abundant soils within the Three Sisters Reserve are classified within the Vertisol order, while a small percent of the soils are classified within the Mollisol order. All the soils within the mapped association are described below.

2.1.1 Vertisols

Vertisols are mineral soils that have a high content of clay, in particular clays that are sticky and the swelling and shrinking type clays to a depth of one meter or more in the soil. The clays shrink and swell during periods of drying and wetting based on their silica clay lattice structure. Almost all Vertisols are dark in color to a depth of one meter, but this dark color is not indicative of high organic matter content. Deep, wide cracks form due to shrinking in dry periods with the cracks closing as the soil swells in wet

periods. The shrink/swell cracking is a key characteristic in defining a Vertisol soil. Vertisols generally occur in climates that allow for a dry period of several months, such as in southern California. Typical vegetation found on Vertisols is annual and perennial grassland as well as some shrub vegetation such as coyote bush scrub.

The Altamont Series and the Diablo Series, the two soil series that comprise the majority of the two soil associations, Diablo-Altamont association 2 to 9 percent slopes and Altamont-Diablo association 30 to 50 percent slopes of the Three Sisters Reserve, are delineated on the General Soil Map. The two soil associations are classified as Vertisols. Additionally, the Cropley series soils, comprising 5 percent of the Diablo-Altamont Association, are also classified as Vertisols.

Diablo-Altamont Association 2 – 9 Percent Slopes

Soils of the Diablo-Altamont association occur on gently sloping foothills at elevations ranging from sea level to 1,300 feet. The Diablo soils comprise 60 percent of the association and the Altamont soils 30 percent of the association. Typical vegetation found on these soils in the Los Angeles area is annual grasses and forbs.

The Diablo soils are well drained and have slow subsoil permeability. Depth of the soil is 22 to 52 inches and the surface clay layer is approximately 20 inches thick. The surface clay layer is neutral and the underlying subsoils are strongly calcareous clays. At depths of 22 to 52 inches, strongly calcareous shale occurs. The surface can be rocky from hard shale outcrops. The available water holding capacity is moderate at 3.5 to 7.5 inches.

The Altamont series soils are well drained and have slow subsoil permeability. Depth of the soil is 24 to 36 inches, and the surface clay layer is approximately 12 inches thick. The surface clay layer is neutral and the underlying subsoils are calcareous clays. At depths of 24 to 36 inches, partially weathered calcareous soft shale or sandstone occurs. The available water holding capacity is moderate at 4.0 to 6.0 inches.

Other soil series found within the Diablo-Altamont Association are Cropley soils and San Benito soils comprising 5 percent each of the association. The Cropley soils and San Benito soils are described below.

Altamont-Diablo Association 30 – 50 Percent Slopes

Soils of the Altamont-Diablo association occur on steep slopes at elevations ranging from near sea level to 1,500 feet. The Altamont soils comprise 60 percent of the association and the Diablo soils 30 percent of the association. Typical vegetation found on these soils in the Los Angeles area is annual grasses and forbs. At the Three Sisters site, the typical vegetation appears to be coastal sage scrub.

The Altamont soils are similar to the soils described in the Diablo-Altamont association. The primary differences are the landscape position of the soils and soil depth. The soils in this association occur on steeper slopes that are moderately eroded, thereby reducing soil depth. Soil depth for these soils is 20 to 27 inches, and the available water holding capacity is low at 3.0 to 4.5 inches.

The Diablo soils are similar to the soils described in the Diablo-Altamont association with the primary differences being the landscape position of the soils and soil depth. The soils in this association occur on steeper slopes that are moderately eroded, thereby reducing soil depth. Soil depth for these soils is 20 to 39 inches and the available water holding capacity is low at 2.5 to 5.5 inches.

Other soil series found within the Altamont-Diablo Association are San Benito soils comprising 10 percent of the association.

Cropley Series

Cropley soils occur on nearly level alluvial plains and valley floors at elevations from near sea level up to 1,250 feet. Typical vegetation found on these soils is annual grasses and forbs. These soils are likely to occur in the southern areas of the Three Sisters Reserve in the fans formed by the ravines that run through the site.

The Cropley soils are well drained and have slow subsoil permeability. Depth of the soil is greater than 60 inches and the surface clay layer is approximately 38 inches thick. The surface clay layer is neutral to mildly alkaline clay and the underlying subsoils are moderately alkaline and calcareous clays. Clay loam containing approximately 20 percent gravels by volume comprises the substratum. The available water holding capacity is high at 9.0 to 10.5 inches for 60 inches of soil depth.

2.1.2 Mollisols

Mollisols are mineral soils that are characterized by the accumulation of organic matter rich in calcium in the upper soil layer. Most Mollisols of Southern California have a mollic epipedon defined as a dark surface organic horizon that is formed from the accumulation and decomposition of the dense roots systems of the vegetation they support. The mollic epipedon is generally high in calcium and magnesium, which can give it a cation exchange capacity of more than 50 percent saturated with base-forming cations.

Mollisols soils are not hard even when dry, which is a key characteristic of the mollic epipedon. The high organic matter content and the presence of swelling type clays prevent hardening of the soil even when it is dry. Typical vegetation found on Mollisols is annual and perennial grassland as well as some shrub vegetation.

The San Benito soil series is the only series classified as a Mollisol within the Three Sisters Reserve. The San Benito series comprises 5 percent of the Diablo-Altamont Association 2 – 9 Percent Slope, and 10 percent of the Altamont-Diablo Association 30 – 50 Percent Slope.

San Benito Series

The San Benito series has a high organic matter content and shrink–swell clay characteristics. San Benito soils are 36 - 48 inches deep and are well drained with moderately slow subsoil permeability. They have a dark grayish-brown, neutral clay loam surface layers to about 28 inches with moderately alkaline, calcareous clay loam subsoil. Water-holding capacity is moderate at 6.5 – 8.5 inches.

2.2 SOIL SAMPLE ANALYSIS

The General Soil Map was verified in the field through a walkover and examination of surface soil characteristics combined with soil samples in April 2008. Because the General Soil Map is only mapped by associations rather than to detailed definition by each soil series, it was important to observe and note soil characteristics and existing vegetation types in order to define areas of restoration for coastal sage scrub and native perennial grasslands.

Field review of the soils occurring within the Three Sisters Reserve was conducted in each of the mapped vegetation communities to determine patterns of soil and plant species or habitats. Eight samples were collected, with five samples in areas dominated by exotic weeds and three samples in adjacent native dominated areas for comparison. Figure 3 shows the general location of the soil samples. Specific soil sample locations were determined based on observed changes from a previous sample for the soil characteristics in terms of color, texture, and cracks.

Soil samples were collected to characterize potential restoration areas within the Three Sisters Reserve. Figure 3 shows the general location of the soil samples. Samples were collected and pooled in areas dominated by weedy species and in adjacent areas dominated by native species for comparison.

Characterization of the soils consisted of collecting soil samples within the upper six inches of the soil. Within each soil sampled, a composite of three sub samples were pooled as representative for analysis. The soil samples were then sent to Wallace Laboratories to be analyzed for standard soil constituents, agricultural suitability, texture, and cation exchange capacity.

Sample 1 was collected at the north end of the Reserve in an area mapped as *Rhus* dominated coastal sage scrub (see Figure 3). Vegetation cover was dense at close to 100 percent, consisting of lemonadeberry, California sagebrush, ashyleaf buckwheat, California encelia, and prickly pear cactus. The soil in this area was dark in color with small cracks present on the surface. Many coarse and fine roots and small to medium sized gravels occur in the upper 6 inches of soil. Sample 1 was located on a gentle slope with a southeast facing aspect.

Sample 2 also was collected at the north end of the Reserve in an area mapped as grassland, just north of soil sample 1 (see Figure 3). Vegetation cover was dense at close to 100 percent, consisting of wild oats, black mustard, sweet fennel, false brome, bristly ox tongue, and sweet clover. The soil in this area was dark in color with no cracks on the surface. Many fine roots and few small gravels occur in the upper 6

Figure 3
Soil Sample Locations
Three Sisters Reserve
Portuguese Bend Preserve, Palos Verdes Peninsula

inches of the soil. Sample 2 was located on a gentle slope with a southeast facing aspect.

Sample 3 was collected on the eastern side of the Reserve in an area mapped as grassland (see Figure 3). Vegetation cover was dense at close to 100 percent consisting of wild oats, black mustard, false brome and tocalote. The soil in this area was reddish brown with cracks up to ½ inch. Many fine roots, many small gravels, and few medium gravels occur in the upper 6 inches of the soil. Sample 3 was located on a steep slope with a south facing aspect.

Sample 4 was collected on the eastern half in the middle of the Reserve in an area mapped as coastal sage scrub (see Figure 3). The area is dominated by weed species with the vegetation cover dense at close to 100 percent consisting of wild oats, black mustard and shortpod mustard. A few native species present in the area include California encelia and purple needlegrass (*Nassella pulchra*). The soil was light brown in color with small surface cracks present. Many fine roots and many small gravels occur in the upper 6 inches of soil. Sample 4 was located on a moderate slope with a southwest facing aspect.

Sample 5 was collected on the eastern half in the middle of the Reserve, just southwest of sample 4 in an area mapped as coastal sage scrub (see Figure 3). Vegetation cover was dense at approximately 90 percent consisting of lemonadeberry, purple sage, California encelia and foothill needlegrass. The soil was tan in color with very few fine cracks present on the surface. Many fine and coarse roots along with many small gravels occur in the upper 6 inches of soil. Sample 5 was located on a moderate slope with a southwest facing aspect.

Sample 6 was collected in approximately the middle of the Reserve, close to the boundary of the two mapping units grassland and coastal sage scrub (see Figure 3). Vegetation cover was dense at close to 100 percent consisting of wild oats, black mustard, sweet fennel, bristly ox tongue, and shortpod mustard. The soil was very dark in color with large surface cracks greater than ½ inch. Many fine roots and few small gravels were present in the upper 6 inches of the soil. Sample 6 was located on a moderate slope with a west facing aspect.

Sample 7 was collected on the west side of the project in an area mapped as annual grassland (see Figure 3). Vegetation cover was dense at close to 100 percent consisting of wild oats, false brome, sweet fennel, black mustard, acacia (*Acacia sp.*), bristly ox tongue, and tocalote. A few native species present in the area include purple needlegrass, lemonade berry (seedlings), narrow leaf milkweed (*Asclepias fascicularis*), and rattlesnake weed (*Chamaesyce albomarginata*). The soil was reddish in color with small to medium sized cracks present on the surface. Many fine roots and few medium limestone gravels were present in the upper 6 inches of soil. Sample 7 was located on a moderate slope with an east to southeast facing aspect.

Sample 8 was collected on the west side of the Reserve in an area mapped as Southern cactus scrub (see Figure 3). Vegetation cover was approximately 80 percent consisting of California encelia, prickly pear cactus, cholla, foothill needlegrass, and lemonadeberry. In addition to the native species weedy species comprised a good portion of the vegetation cover in the area and consisted of tocalote, ripgut brome (*Bromus diandrus*), red brome (*Bromus madritensis*), sweet clover, and black mustard.

The soil was tan in color. Few fine roots and few medium to large gravels were present within the upper 6 inches of soil. Sample 8 was located on a moderate slope with a south to southeast facing aspect.

Phosphorus is low in all of the samples with the exception of sample 1 in the native *Rhus* dominated coastal sage scrub. In the remaining seven samples, samples from native vegetation areas had higher phosphorus levels than the samples from weedy areas. Nitrogen was very low for all of the samples. These nutrient levels are not surprising in a region with climatic conditions conducive to soil leaching.

The soils of the Three Sisters Reserve are slightly alkaline with a pH ranging from 7.26 to 7.89. Very low, to low salinity levels, presented as electrical conductivity (ECe), were measured for all soil samples. Although the sodium adsorption ratios (SAR) are low for all of the samples, it is interesting to note that the SAR for the native samples is lower than the weedy samples. Sodium levels are also lower for the native samples compared to the weedy soil samples. The overall salinity level likely does not pose a threat to general vegetation since sodium levels are still below potassium levels and should not interfere with nutrient and water uptake.

Calcium levels are high for two of the native soil samples and moderate for one of the native samples. The calcium levels for the weedy samples are moderate for four of the samples and high for one of the samples. Magnesium occurs at very high levels for all of the samples, which could affect plant absorption of nutrients, especially potassium uptake. The optimum calcium to magnesium ratio is between 2 - 3 calcium for one magnesium. The calcium to magnesium ratios for the native samples is 1.5:1 for two of the samples and 2:1 for one of the samples. The calcium to magnesium ratio for the weedy samples is 1:1 or less. However, based on restoration experience in the region where high calcium and magnesium levels are common, and where the calcium and magnesium ratio is not optimum, these soil constituents do not pose an insurmountable obstacle to native species establishment (EARTHWORKS, unpublished data).

The levels of the micronutrients iron and zinc are higher in the native samples than the weedy samples. Iron levels are sufficient in the native samples but low in the weedy samples. Zinc is sufficient for two of the native samples and low to very low for the remaining samples. Sulfur is very low for all of the soil samples, but levels are higher in the native samples compared to the weedy samples.

The results of the soil samples indicate that areas dominated by exotic species have less than optimum nutrient levels for both major and minor components. Recent research has demonstrated that exotic species change the amount and availability of soil nutrients to their own benefit (Eviner 2008). Based on the soil sample analysis, soil amendments will be recommended that will aid establishment of native plants and discourage exotic species. Specifically, container plants will be planted with a slow release fertilizer packet located in the root zone rather than at the soil surface where exotic weeds would also benefit. Additionally, arbuscular mycorrhizal (AM) fungi will be added over all restoration area. AM fungi aid plants in the uptake of phosphorus and water. However, members of the mustard family are not mycorrhizal, and AM fungi are detrimental to mustard plants.

2.3 SUMMARY OF SOILS AND RESTORATION ZONES

The restoration within the Three Sisters Reserve is designated within areas that have been historically disturbed by grazing. Utilizing the previously described soils characteristics, slope and aspect, in conjunction with observations of the density and type of exotic species, presence of native species, and conditions of adjacent native habitats, restoration zones were determined for the Three Sisters Reserve. Two habitat types were determined suitable for restoration based on the distribution of existing native plant species, soils, landscape position and dominant exotic species. Figure 4 shows the general restoration zones, with Zone A proposed for native perennial grassland habitat, and Zone B proposed for coastal scrub habitat.

Zone A is comprised of moderately sloped, clay soil currently dominated by annual grasses and sweet fennel, which indicates good potential for establishment of perennial grassland. Additionally, the native perennial grass, purple needlegrass, a dominant species of native grasslands, occurs in small remnant patches throughout Zone A. The clay nature and depth of the soil favor establishment of perennial grassland (Keeley 1993; Freudenberger and Keeley 1987; Hamilton 1997; Brooks 2008).

Coastal sage scrub habitat is recommended on the steeper slopes in predominately clay loam and gravelly clay soils, currently dominated by wild oats, purple false brome, and black mustard. Generally, coastal sage scrub shrub species require well-draining soils on a slope. The boundary between these habitat types will blur over time as the restoration develops and shrub species move into the grassland during drier years, and die back in wetter years.

Based on the soil agricultural suitability analyses, there does not appear to be any conditions that would interfere with establishment of either native perennial grassland or coastal sage scrub habitats. General soil amendments will consist only of adding AM fungi to the site to give the native seeded species an advantage over the exotic weeds in the mustard family. Specific packets of fertilizer for container plants are recommended to aid the establishment and growth of these plants to out-compete the weedy exotic species.

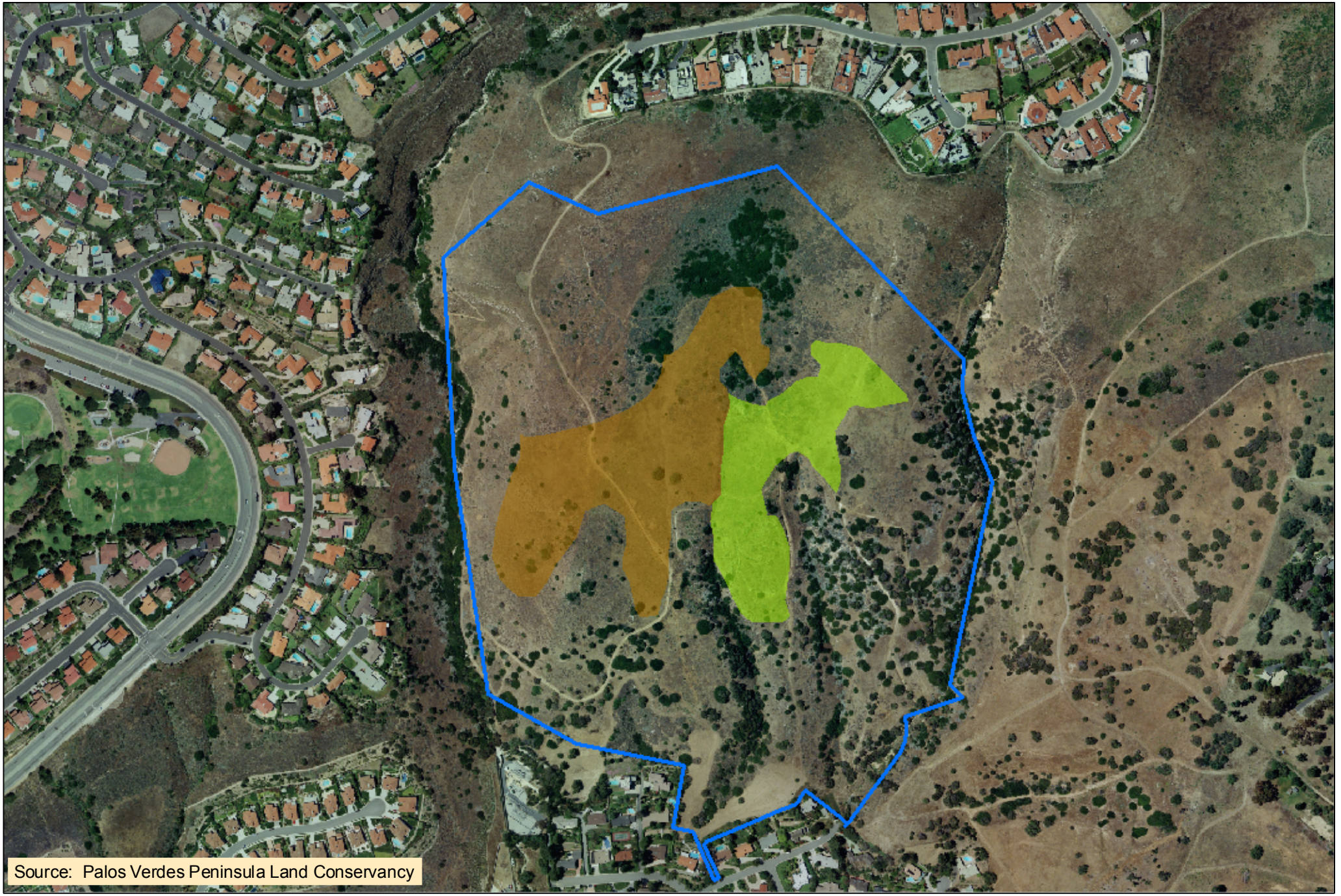

Figure 4
Restoration Zones
Three Sisters Reserve
Portuguese Bend Preserve, Palos Verdes Peninsula

SECTION 3 – RESTORATION SPECIFICATIONS

Once a plan is prepared, restoration generally can be divided into four phases: 1) site preparation, 2) seeding/planting, 3) establishment maintenance, and 4) post-establishment, long-term monitoring and management. For the Three Sisters Reserve restoration, site preparation will be necessary for several seasons to control the exotic weeds within the restoration areas. Concurrent with the site preparation phase, appropriate seeds will be collected, and container plants will be propagated. Planting and seeding will be implemented in the fall following the final year of exotic weed control. Establishment maintenance will likely be required for approximately three to five years, depending on rainfall and the development of the planted and seeded species versus weedy species. Long-term management should consist of periodic site surveys for exotic invasive plants and appropriate management activities based on results of the surveys.

3.1 PROJECT GOALS

The purpose of this habitat restoration is to establish ecologically appropriate native habitats in disturbed areas to enhance the ecological functions of the adjacent native habitats within the Three Sisters Reserve. The following general goals were determined for the habitat restoration after evaluating the existing conditions of the site:

Primary Goal
Increase native plant species diversity and structural diversity of the site by restoring native perennial grassland and coastal sage scrub habitats.

Additional Goals
Establish native habitats that will be self-sustaining in the long-term by encouraging conditions that will allow natural processes to proceed, including soil development, nutrient cycling, plant succession, natural regeneration, and resistance to perturbation.

3.2 SITE PREPARATION

Restoration of each specified habitat requires site preparation. Site preparation, consisting of weed control, will need to be performed for a minimum of one season prior to planting and seeding: however, two seasons of site preparation is recommended. The Three Sisters site has had a history of exotic weeds that have developed a weed seed bank on the site. Therefore, it is prudent to expend effort to control weeds, especially fennel and mustard, prior to planting and seeding.

3.2.1 Weed Control

All areas to be restored are presently dominated by exotic species. Weed control will be required to thin or remove mainly annual grasses, exotic mustards, fennel and acacia. Recommended methods for control of particular species are based on experience, and methods have been cross-referenced using CalWeed Database of the California Interagency Noxious Weed Coordinating Committee and Invasive Plants of California Wildlands (Bossard et. al. 2000). Only herbicides registered for use in wildlands would be used judiciously in the Three Sisters Reserve.

Weed densities will depend on the seasonal rains and temperatures each year. The timing of weed control may be different for each restoration area based on soil moisture, topography, and the growth and development of non-target native plant species. It should be anticipated that monitoring be required for successful weed management. Monitoring is necessary to schedule control methods for the specified time frame according to the phenology of each target weed species.

For efficient control of exotic invasive species, weeds must be controlled before they produce viable seed. Methods of control will depend on the target species, the density of the target species, the area of infestation, and the ecological sensitivity of the existing habitat. Weed removal will employ hand pulling as well as mechanical methods, such as mowing and weed whipping. Limited use of selected herbicides is specified when no other effective alternative is available to remove and control the high priority invasive exotic species. Herbicide treatment is specified for mainly invasive weed species that may re-sprout from tap-roots or stumps.

Areas dominated mainly by annual grasses will be mowed and/or weed whipped when the soil starts to dry in late winter or early spring to prevent re-growth. Where annual grasses such as wild oats and false brome are very dense, the area may be treated with an herbicide specific to control grasses such as flurazifop-p (Fusillade).

Depending on the density of selected broadleaf species, hand weeding may be most effective for mustards and prickly ox tongue. Hand weeding is most effective when these species are between 8 - 12 inches high, and the stem must be cut approximately 1-inch below the surface of the soil using a hand pick. Mustards will re-grow if mowed or weed whipped; therefore, if mowing or weed whipping is employed against mustard, a follow up mowing would be required.

Mature fennel will require cutting, followed by an herbicide application with a glyphosate herbicide since fennel will continue to grow from its bulb and taproot. Seedling fennel may be hand pulled with good results.

The woody acacia shrubs (*Acacia cyclops*) must be cut and removed from the site. It is likely that re-growth from the roots will require one or more applications of a glyphosate herbicide. Seedling acacias should be hand pulled.

The amount of site preparation weeding that is required across the restoration area will vary depending on the amount and timing of rainfall, as well as each soil and soil seed bank. Areas should be evaluated after each weeding event to assess the progress of site preparation and to plan the next step. Areas will be released for planting and seeding depending on whether enough progress has been made in management of the weed species.

In summary, the following methods will be employed over the Three Sisters Reserve in various combinations based on adaptive management of the specific areas for planting and seeding.

- Mowing for annual grasses with limited herbicide treatment if very dense;
- Hand pulling and/or herbicide treatment for mustards and prickly ox-tongue;
- Cut and herbicide application for target weeds, fennel, and acacia:
- Following weed control and prior to seeding, weed thatch will be evaluated and removed, as necessary, to facilitate seed/soil contact.

3.2.2 Soil Amendments

Several soil amendments have been shown to be important tools in native habitat restoration while other amendments are still experimental. Most of these amendments facilitate restoration of the soil ecosystem. The following sections outline the potential use of soil amendments for restoration within the Three Sisters Reserve.

Arbuscular Mycorrhizal (AM) Fungi

Studies currently underway for the past four years have not shown a significant positive effect from addition of native AM fungi inoculum on the early establishment of native grasslands compared to plots with either commercial or no inoculum (EARTHWORKS, in preparation). Studies of native grassland establishment within the Coastal and Central Nature Reserve of Orange County showed little evidence that native AM fungi alone increased native plant establishment; however, the results were based on one year (Smith et al. 2006). Earlier studies on establishment of coastal sage scrub showed no significant difference in establishment of native species between plots treated with and without commercial AM fungi; although plots treated with AM fungi had less mustard and wild radish (EARTHWORKS, in preparation). It is generally known that the Mustard (Brassicaceae) family is not mycorrhizal, and it is believed that AM fungi may have a detrimental effect on mustard species.

The addition of AM fungi would aid in the uptake of phosphorus in the establishing seedlings. Both zones have areas of black mustard and may benefit from AM fungi incorporated in the applied seed mix. Commercially available *Glomus intraradices* is recommended since this is a ubiquitous species and will not impede the development of other native species. The AM fungi used for the project should be provided by a person or company with experience in AM fungi development. The AM fungi supplied for the project should be applied at the rate of at 60 liters per acre (approximately 3,600,000 live propagules per acre) based on the guarantee of the supplier.

Fertilizer

The site soils analysis showed low nutrient levels overall. However, general fertilization is not recommended over the site since lower nutrient soils may favor the establishment of native seedlings over weedy exotic species. Native perennial grassland species and coastal sage scrub species are adapted to lower nutrient soils, unlike weedy exotic species. Furthermore, the addition of AM fungi should favor the uptake of phosphorous and nitrogen of the seeded native species. However, fertilizer packets delivered to the

root zone of container plants installed within the site will benefit the establishment of the plants without also supplying nutrients to the exotic weed species.

For container plants, a fertilizer packet shall be added to the bottom of each planting hole prior to planting. Each packet (10 grams weight) shall contain a blend of 16% total nitrogen, 6% available phosphoric acid, and 8% soluble potash plus minor nutrients. The nitrogen, phosphorous, and potassium shall be coated with a polyurethane coating to provide 15.69% coated slow release nitrogen, 5.09 % coated slow release available phosphate, and 6.8% slowly available soluble potash. Bio-pacs® meeting these specifications are available from Reforestation Technologies Inc.

3.3 PLANT SOURCES AND SPECIES

To the extent possible, all plant material for the restoration shall be obtained from native plant communities growing within the Palos Verdes Peninsula. For those species that function as erosion control (small fescue and wooly plantain) or do not exist in large enough quantities within the specified seed collection area, it will be necessary to either use seed that is commercially grown or extend the collection area on a species by species basis. The PVPLC has in house capabilities for seed collection or may opt to contract with a seed collection contractor specializing in native seed to ensure that seed material will be collected from Palos Verde Peninsula and other coastal sites ranging north through Malibu and south through Upper Newport Bay. The following sections list the species to be used in each specific habitat area defined previously based on the soils, slope, aspect, and existing vegetation.

3.4 PLANTING ZONES

As previously described, there are two basic restoration zones in the Three Sisters Reserve. Zone A consists of 7.7 acres to be restored as native perennial grassland. Zone B consists of 13.3 acres to be restored as coastal scrub. (See Figure 4 for planting zones.)

3.4.1 Zone A

Zone A encompasses areas of gentle slope with clay soils. The habitat to be restored in Zone A is native perennial grassland. The species selected for the native grassland restoration are based on species noted in perennial grasslands within the region. The seed mix to be applied to Zone A is listed in Table 1. Additional species have been included in the seed mix as a nurse crop and for erosion control until the native grassland species establish.

3.4.2 Zone B

Zone B is located mainly on the steeper slopes within the restoration area. The coastal scrub seed mix is designed to model species occurring on the corresponding aspects in the mature coastal sage scrub on adjacent slopes. The species selected for the restoration represent the more common and abundant species observed in the existing adjacent habitat as well as species that are early colonizers in scrub habitats after disturbance such as fires. Some less common species also have been included. Plant species shown in Table 2 were determined from direct observation. Additional species have been included in the seed mix as a nurse crop and for erosion control until the

coastal sage scrub species establish. Container plants will be planted in groups, or clouds, across Zone B, and spacing within groups will follow the specification in Table 3.

Table 1
Native Perennial Grassland
Seed Mix For Zone A – 7.7 Acres

Scientific Name	Common Name	Target Minimum Purity/Germination[1]	Pounds of Seed Per Acre [2]
Amsinckia menziesii	fiddleneck	30/70	0.5
Bloomeria crocea	goldenstars	98/70	0.2
Bromus carinatus	California brome	95/80	3.0
Castilleja exserta	purple owl's clover	50/60	0.5
Deinandra fasciculata	tarweed	20/70	1.0
Dichelostemma capitatum	blue dicks	95/50	0.5
Gnaphalium californicum	California everlasting	10/20	0.5
Lasthenia californica	goldfields	50/60	1.0
Lupinus succulentus	arroyo lupine	98/85	0.3
Lupinus truncatus	collar lupine	98/70	1.0
Nassella pulchra [3]	purple needlegrass	60/60	10.0
Plantago insularis [4]	wooly plantain	98/75	20.0
Sisyrinchium bellum	blue-eyed grass	95/75	1.5
Vulpia microstachys [4]	small fescue	70/70	4.0

[1]Target minimum germination is used to develop bulk seeding rates and may be adjusted after germination tests on special local collection.
[2] Bulk seed rate may be adjusted depending on results of tests for germination.
[3] Seed of *Nassella* spp. shall be de-awned.
[4] Erosion control and nurse crop species.

Table 2
Coastal Scrub Seed Palette
For Zone B – 13.3 Acres

Scientific Name	Common Name	Guidelines for minimum Purity/Germination[1]	Pounds of seed per acre[2]
Artemisia californica	California sagebrush	15/50	1.5
Encelia californica	California encelia	40/60	1.5
Eriogonum cinereum	Ashyleaf buckwheat	TBD	2.0
Eriogonum fasciculatum	California buckwheat	10/65	2.0
Gnaphalium californicum	California everlasting	10/25	0.5
Deinandra fasciculata	fascicled tarweed	10/25	1.5
Isocoma menziesii	coast goldenbush	20/40	1.5
Lotus salsuginosus	alkali lotus	98/70	1.5
Lotus scoparius	deerweed	90/60	6.0
Lotus strigosus	strigose lotus	98/70	1.5
Lupinus bicolor	miniature lupine	98/80	3.0
Lupinus succulentus	arroyo lupine	80/80	1.0
Melica imperfecta	melic grass	90/60	2.0
Nassella lepida[3]	foothill needlegrass	70/60	2.5
Nassella pulchra[3]	purple needlegrass	70/60	2.0
Phacelia ramosissima	branching phacelia	80/70	0.4
Plantago insularis[4]	wooly plantain	98/75	20.0
Vulpia microstachys[4]	small fescue	70/70	6.0

[1] Minimum germination may be adjusted after germination tests on special local collection.
[2] Bulk seed rate may be adjusted depending on results of tests for germination.
[3] Seed of *Nassella* spp. shall be de-awned.
[4] Erosion control and nurse crop species.

Table 3
Coastal Scrub Container Plant Palette
For Zone B (13.3 Acres)

Scientific Name	Common Name	Spacing Within Groups	Plants Per Acre
Artemisia californica	California sagebrush	5’	100
Encelia californica	California encelia	4’	50
Baccharis pilularis	coyote bush	5’	25
Eriogonum cinereum	ashyleaf buckwheat	4’	100
Eriogonum fasciculatum	California buckwheat	4’	30
Isomeris arborea	bladderpod	5’	25
Opuntia littoralis[1]	prickly pear cactus	3’	120
Opuntia prolifera[1]	coastal cholla	3’	30
Rhus integrifolia[2]	lemonadeberry	15’	15
Salvia luechophylla	purple sage	5’	100
Sambucus mexicanus	elderberry	15’	15
Total Plants per Acre			610

[1] Cactus species shall be planted in groups of 30 cactus of only one species in each group.
[2] Lemonadeberry and elderberry shall be planted at least 15’ from any other container plant.

3.5 SEEDING AND PLANTING SPECIFICATIONS

The following methods will be used to seed and plant during the restoration of native grassland and coastal sage scrub habitats within the Three Sisters Reserve. Seeds shall be collected during 2008 and 2009. Seeds collected in 2008 should be dried and stored in airtight containers in a cool, low humidity environment. Seeding and planting should be implemented in October 2009 to take advantage of the entire rain season.

3.5.1 Seeding

Seed shall be applied by hand with a bellyginder in the areas between container plant groupings as well as in between the plants among the container plant groups in all restoration areas. The seed will be mixed together as specified for the seed mix. Specified VAM will be spread by hand with a belly grinder over the seeding area prior to seeding. The seed shall be broadcast and raked, where practical, into the ground to no more than a quarter of an inch to incorporate the seed into the soil to increase germination success.

3.5.2 Planting

Container plants consist of dominant shrubs and 40 to 60 plants will be planted in groups of mixed species throughout the restoration area. However, cactus species will be planted in groups of 60 with no other species planted within the group. The layout for container plants will be determined for each area based on micro topographic features and planting sites will be marked on the site using different colored pin flags under the supervision of the restoration ecologist or PVPLC biologist. Spacing of plants within the groups will follow the specifications presented in the tables for container plant palettes. Groups of container plants will be spaced in a natural looking mosaic in each area.

All container plants are to be planted to the following specifications:

- Planting holes shall be made with the minimum disturbance to accommodate the containers.
- Prior to planting, the planting hole shall be filled with water, and allowed to drain.
- A fertilizer packet shall be added to each planting hole just prior to planting.
- Plants shall be set in the planting hole so that the crown of the root ball is approximately 0.25 inch above finish grade. Under no circumstance should the plant crown be buried.
- A watering basin shall be provided around each plant from 18 – 24 inches in diameter.
- Watering basins shall be filled with water after planting, at least twice.
- The drip irrigation system should be tested to ensure that all emitters are functioning.
- Plant basins shall be mulched with approximately 4 – 6 inches of approved wood mulch after planting and testing of the drip system.

3.6 IRRIGATION SYSTEM

A temporary above ground drip irrigation system is specified for the groups of container plants within the coastal sage scrub restoration areas. The irrigation system will be used, as necessary to supplement the annual rainfall during the establishment period. The temporary irrigation system will be installed after soil preparation and prior to seeding and planting.

The temporary above ground drip irrigation system will be used in the early fall and late spring seasons. The irrigation system will slightly lengthen the growing season to maximize the development of the habitat. Irrigation likely will be required for the first two growing seasons for establishment.

The point of connection (POC) and water used for irrigation will be provided by the closest fire hydrant at the northwest edge of the site. The drip system must be composed of heavy enough gage material to withstand an assault by wildlife such as coyotes and squirrels. An above ground micro sprinkler or “shrubbler®” system may be substituted. The intent of the irrigation system is to deliver water only to the planted container species without irrigating either the target seeded species or, more importantly, the weedy species. The seeded species will germinate and established based on natural rainfall.

The temporary irrigation system should have the following general characteristics:

- PVC mainline from the POC;
- ¾ inch PVC from the mainline to each container plant group;
- ¾ inch heavy gauge drip tube within each container plant group;
- individual drip tube and emitters to each container plant within a group.

3.7 SITE MAINTENANCE

One of the goals for the restoration is to provide self-sustaining habitats. However, initially, maintenance of the restoration area will be necessary to establish the newly planted and seeded areas. Maintenance will include any activities required to meet the performance standards set forth in this plan, in the estimation of the restoration specialist or PVPLC biologist. For the Three Sisters Reserve, these include the following:

- Weed control, at a minimum for fennel, acacia, mustards, wild oats and purple false brome;
- Irrigation for the container plants;
- Replacement hand seeding in areas of more than 200 sq. ft where target seed germination failed after one good season of rainfall;
- Replacement of container plants in areas with less than 80 percent survival in years two and three, based on visual observations of substantial mortality; and
- Pest and disease control, if necessary.

The establishment maintenance period is generally three years duration with the most intense maintenance in the first and second year, and only seasonal weeding activities in the third year. The amount of maintenance each year will depend on weather conditions and how well the site develops. The following specifications for maintenance may require adjustments as determined by the restoration specialist or PVPLC biologist over the three-year maintenance period.

3.7.1 Weed Control

During the active maintenance period, the target cover from exotic weed species will be generally 10 percent or less. Control of the wild oats and purple false brome is especially important because annual grasses have been shown to compete with shrub species in restoration (Eliason and Allen 1997; Corbin and D'Antonio 2004). Purple false brome is a relatively recent invader to southern California, and the habitat of this species is relative dense growth.

Weeds will be controlled during late winter through early summer, as necessary, before they set seed and/or before they reach approximately 12 inches in height. Three weeding events should be estimated for a normal rainfall season, with more or less as dictated by rainfall. Weeds, such as purple false brome will be removed from the site if seeds have set prior to weeding. Since removal of weeded material is expensive, weeded material may be left on site as organic mulch material if seeds have not yet set. Removal of herbicide treated material is not an issue.

Weed control will mainly employ hand pulling, mechanical methods, and spot spraying of herbicides for certain species such as fennel and acacia as described in Section 3.2.1.

3.7.2 Irrigation of Container Plants

Temporary irrigation will only be used in the areas where groups of container plants are to be planted. Irrigation will be used in the first two seasons from planting to extend the rainy season and establish the shrubs, as necessary. The timing of irrigation events will depend on evapotranspiration between irrigation events and soil moisture. The following management scheme is anticipated as a guideline for water management of native trees and shrubs:

- Irrigate soil to full field capacity to the desired depth (approximately 18 inches after planting; and 18–24 inches during plant establishment).
- Allow soil to dry down to approximately 50-60 percent of field capacity in the top 6-12 inches before the next irrigation cycle. Depth of soil dry down between irrigation events will depend on development of container plants.

Wetting of the full root zone and drying of the soil between irrigation events is essential to the maintenance of the plants and the promotion of a deep root zone that will support the vegetation in the years after establishment. A soil probe or shovel should be used to examine soil moisture and rooting depth directly.

3.7.3 Seeding and Plant Replacement

Target values for relative cover of the native vegetation, including nurse and erosion control species, will be as follows with at least 20 percent cover in Year 1, 30 percent in Year 2, and 40 percent in Year 3. Actual cover values will depend mainly on weather conditions (seasonal rainfall and temperature) during the establishment period.

Areas of significant erosion shall be repaired and re-seeded in the first fall season after damage. Re-seeding will occur in areas if coverage is less than 20 percent of native species over any contiguous area of 200 sq ft.

Survival of the container plants within the first growing season should be 80 percent. Plants shall be replaced if survivorship falls below 80 percent in the first season. Replacements will be planted as previously specified and maintained for one growing season, as necessary. As sites develop, it is impractical to implement direct counts of all the container plants. Replacement planting after the first season shall only be specified if the visual estimate indicates substantial mortality and the function of these species has not been replaced by seeded material and natural recruitment.

3.7.4 Pest Management

Local wildlife such as rabbits, pocket gophers and ground squirrels may be expected to browse on the plantings. If the restoration specialist or PVPLC biologist determines that the plantings are being jeopardized by wildlife, corrective measures such as organic, nontoxic deterrents and fencing/plant cages maybe used. Invertebrate pests are rarely a serious problem in perennial grassland or coastal sage scrub restoration.

3.7.5 Summary of Implementation, Maintenance, and Monitoring

Table 3 summarizes the timing and activities for the implementation, maintenance, and monitoring of the habitat restoration. The timing is described in general terms by season. Exact dates for each phase of implementation and maintenance will depend on the onset and duration of seasonal rainfall as well as other factors such as the temperatures prior to, during and following rain events. However, it is important to plan for the site to be ready to seed by early fall. Rainfall and temperature will define the type and the density of weed species as well as native species that will germinate in any given year and season.

Horticultural monitoring will guide weeding and irrigation schedules for the project, and there should be a close coordination between the maintenance supervisor and the restoration ecologist if they are not the same person. Horticultural monitoring should take place daily during seeding, then weekly until seed germinates and plants establish, followed by monthly monitoring during the remainder of the first year. Quarterly monitoring should suffice after the first year through the third year.

Table 4
Summary of Implementation and Maintenance Schedule

Restoration Tasks	Year 1 2008/09				Year 2 2009/10				Year 3 2010/11			
	F	W	S	S	F	W	S	S	F	W	S	S
Seed Collection		X	X	X	*	*	*	*				
Site Preparation Weeding		X	X		X							
Final Site Preparation: Mowing & Weed Thatch Removal					X							
Initial Site Seeding and Planting					X							
Irrigation of Container Plants					X	*	X	*	X	*	*	*
Maintenance Weeding						X	X	X	*	X	X	*
Remedial Seeding									*			
Horticultural Monitoring		Qt	Qt	Qt	W	BW	M	Qt	Qt	M	M	
Performance Monitoring											X	

* = if necessary
Qt = once per quarter unless conditions require more oversight
W = weekly oversight
BW = bi-weekly (every other week) oversight
M = monthly oversight unless conditions require more oversight

SECTION 4 - RESTORATION MONITORING

The restoration site should be monitored annually after installation through the third year. Photo-documentation at permanent points conducted with qualitative description of the species developing over the site, the maintenance that was performed, and recommendations for future maintenance should be included in an annual monitoring report. Quantitative monitoring may be conducted to determine if each restoration area has achieved the goals proposed for the site. Quantitative monitoring should consist of fixed transects randomly determined over each restoration habitat area. The number of samples necessary will be evaluated to ensure statistical confidence based on variation over the site.

Annual performance monitoring should take place each year in mid-spring or as close to mid-spring as each year's rainy season permits to capture the majority of annual as well as perennial species. Results from the annual performance monitoring will be used to evaluate the progress of each habitat toward the ultimate goals of the project. Performance monitoring should be conducted by qualified plant ecologists.

4.1 RESTORATION GOALS

Restoration criteria have been developed to assess the functions and values of each habitat, as stated in the goals for the restoration. Thus, the restoration will be assessed as the habitats develop trends in cover, species diversity, as well as soil development so that the habitat quality of the site is restored. Specifically, the restoration will be evaluated by the following criteria for each habitat type:

Perennial Grassland

- The site does not require significant maintenance measures during the last two years of the establishment period as documented by the restoration specialist's or PVPLC biologist's annual monitoring report.
- The native grasses set seed.
- The site demonstrates 70 percent of the native plant species originally planted in Zone A of the restoration site, after one season of average or above average rainfall

Coastal Scrub

- The site does not require significant maintenance measures during the year of the establishment period as documented by the restoration specialist's or PVPLC biologist's annual monitoring report.
- The majority of plant species set seed, and seedlings of at least five native grassland/coastal sage scrub species demonstrate recruitment in the site in the final year of monitoring based on information from quantitative monitoring.
- The site demonstrates 70 percent of the native plant species originally planted in Zone B of the restoration site.

4.2 QUANTITATIVE MONITORING METHODOLOGY

The selection of variables measured for the final quantitative performance monitoring will be based on the goals of the restoration program, development characteristics of each plant community, and the restoration goals outlined above. Variables will include native species cover, exotic species cover, percent bare ground and litter, as well as species frequency and seedling frequency in monitoring transects. Where applicable, shrub height will also be measured to provide an additional parameter to assess habitat suitability. The number of sampling units in each habitat will be determined by areas to ensure statistical confidence based on the variation over the site, but generally one transect for every three acres for each habitat type is sufficient.

4.2.1 Coastal Sage Scrub Quantitative Vegetation Sampling

Vegetation sampling in coastal sage scrub will utilize the point-intercept method to measure vegetation cover. This method is best suited to measure scrub vegetation and will provide the most efficient method for estimating cover and species composition over the mitigation site.

Locations of transects will be determined randomly within the restoration area, and the same transect locations will be used each year. At each randomly selected site, a 50-meter point-intercept transect will be performed. A 50-meter (m) tape will be stretched taut, at the randomly selected locations. One hundred points are sampled along a randomly placed 50-m tape at 0.5 m intervals starting at 0.5 m and ending at 50 m. A one meter long, 1/4 inch round steel bar is placed vertically at each sampling point, consistently on the same side of the tape. There shall be at least four transects established and monitored for the coastal sage scrub.

All live species that contact the bar, or in the case of overhanging vegetation, intercept the upward projection of the bar are counted. If no vascular plants are intercepted at a sample point, it is recorded as "bare." Total cover is based simply on how many points are covered by vascular plants, regardless of the number of plant species overlapping a given point. In other words, total cover is based on how many points are not recorded as bare of vascular plants. Since several plants often overlap a single point, the sum of individual species covers is generally more than the total cover.

Seedlings will be identified for shrubs and sub-shrubs and will be determined by being small in size, having a non-woody base, and usually the result of germination during the same year as the transect reading. Juveniles and adults will be identified as definitely woody at the base of the stem, with adults in flower and/or with seed. Litter will be recorded in areas of no vegetative cover but with dead vegetative matter covering the ground. Data on the height of the shrubs will also be recorded for all woody shrubs contacted by the bar along each transect.

Cover will be reported as total percentage of points with native plants; cover will also be reported for individual native species and exotic species. Percent cover is determined for a species simply by dividing the number of points covered by that species by the total number of sample points. Total cover is similarly determined. Relative cover for a species is determined by dividing the percent cover for an individual species by the sum of the percent covers for all species (not by total cover). Frequency data will be reported as the percent of transects a species is reported to occur. Height data will be reported as

the average height of the shrub species. Species diversity will be a measure of the number of species encountered in transects.

Additionally, the restoration area will be walked and a list prepared of all species observed. This species list will be reported in the annual report in addition to the transect data.

4.2.2 Perennial Grassland Vegetation Sampling

Vegetation sampling in perennial grassland habitats will utilize the point-intercept method to estimate vegetation cover and species diversity. This method will provide the most efficient method for estimating cover and species composition over the mitigation site.

Locations of transects will be determined randomly within the restoration area, and the same transect locations will be used each year. At each randomly selected site, a 50-m point-intercept transect will be performed. A 50-m tape will be stretched taut, at the randomly selected locations. One hundred points are sampled along a randomly placed 50-m tape at 0.5 m intervals starting at 0.5 m and ending at 50 m. A one meter long, 1/4 inch round steel bar is placed vertically at each sampling point, consistently on the same side of the tape. There shall be at least two transects established and monitored for the native grassland restoration area.

All live species that contact the bar, or in the case of overhanging vegetation, intercept the upward projection of the bar are counted. If no vascular plants are intercepted at a sample point, it is recorded as "bare." Total cover is based simply on how many points are covered by vascular plants, regardless of the number of plant species overlapping a given point. In other words, total cover is based on how many points are not recorded as bare of vascular plants. Since several plants often overlap a single point, the sum of individual species covers is generally more than the total cover.

Seedlings will be identified for shrubs and sub-shrubs and will be determined by being small in size, having a non-woody base, and usually the result of germination during the same year as the transect reading. Juveniles and adults will be identified as definitely woody at the base of the stem, with adults in flower and/or with seed. Litter will be recorded in areas of no vegetative cover but with dead vegetative matter covering the ground.

Cover will be reported as total percentage of points with native plants; cover will also be reported for individual native species and exotic species. Percent cover is determined for a species simply by dividing the number of points covered by that species by the total number of sample points. Total cover is similarly determined. Relative cover for a species is determined by dividing the percent cover for an individual species by the sum of the percent covers for all species (not by total cover). Frequency data will be reported as the percent of transects a species is reported to occur.

Species diversity will be a measure of the number of species encountered in transects. Additionally, the restoration area will be walked and a list prepared of all species observed. This species list will be reported in the annual report in addition to the transect data.

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