Diegan Coastal Sage Scrub Restoration Plan

Upland Mitigation for the Lake Calavera Trails Master Plan

Prepared for:
City of Carlsbad
Parks and Recreation Department
Carlsbad, CA

Prepared by:
Technology Associates
5930 Priestly Dr.
Carlsbad, CA

October 28, 2009

Table of Contents

Contents Page

List of Figures

Contents Page

List of Tables

Contents Page

1.0 Introduction

This document is a conceptual restoration plan for upland mitigation restoration for the Lake Calavera Master Trail Plan (LCMTP). The purpose of the LCMTP is to establish a formal network of signed, public multi-recreational trails and viewpoints in a manner that avoids biological impacts to the greatest extent feasible. This will be accomplished by improving approximately 5 miles of existing trails around and east of Lake Calavera. Lake Calavera is part of Core Area 3 for the City of Carlsbad Habitat Management Plan (HMP), a Subarea Plan for the Multiple Habitat Conservation Program (MHCP). In addition, it contributes to the Natural Communities Conservation Planning (NCCP) preserve system by serving as a regional movement corridor for the federally threatened California gnatcatcher (*Polioptila californica californica)*.

2.0 Project Description

Lake Calavera is located in the northeastern portion of the City of Carlsbad, San Diego County, California (Figure 1). In this document, "Project" refers to the upland restoration component of the LCTMP referenced above, which will provide mitigation for impacts to gnatcatcher occupied coastal sage scrub and native grassland habitat. The goal this Project is to restore 1 acre of non-native grassland habitat to Diegan coastal sage scrub that is (a) self-sustaining, (b) suitable habitat for the California gnatcatcher, and (3) free of non-native invasive species that could invade adjacent native habitat. The restoration will occur in the northeastern corner of Lake Calavera Preserve (Figure 2). The south side of the restoration area is adjacent to existing coastal sage scrub habitat that is known to support the coastal California gnatcatcher (*Polioptila californica californica*); the north side of the restoration area is adjacent to a 60-foot (recently reduced from 100-feet) fuel modification area that is regularly mowed; and to the west (although not adjacent to the project area) is 5 acres of habitat that will be restored to coastal sage scrub as part of a TransNet Environmental Mitigation Program grant project.

Figure 1. Regional Location Map

Figure 2. Project Site Map

3.0 Existing Site Conditions

3.1 Site Conditions

Lake Calavera Preserve consists of approximately 262 acres of upland and wetland habitats. A total of eighteen vegetation communities were mapped between 2002 and 2006 (Merkel and Associates 2009). The most common upland communities are Diegan coastal sage scrub (71.3 acres), chaparral (67.8 acres), and non-native grassland (38.7 acres). Dominant wetland habitats include southern willow scrub (22.4 acres), freshwater marsh (9.8 acres), and open water (13.1 acres). In addition, seventeen sensitive species were reported from the Preserve, including at least four pairs of federally threatened coastal California gnatcatcher. Lake Calavera Preserve is surrounded by dense residential development on the west, north, and east sides. The Preserve has a long history of heavy recreational use, which has resulted in a network of unauthorized trails, some of which will be restored. Although not part of the current Project, public outreach and education will be a critical component of the TransNet EMP grant project, which will occur concurrently with this Project.

3.2 Reference Area Vegetation Sampling

Ecological restoration should consider the natural species composition and ecological conditions that would be extant on the site under natural conditions. To restore the area to coastal sage scrub habitat with a species composition and percent cover that is consistent with surrounding coastal sage scrub habitat, quantitative sampling was conducted along 30-meter transects at 2 locations within the Preserve (Figure 2). Sampling locations were chosen in areas of high quality habitat. Reference area sampling data were then used to generate an average cover model, which identifies the most significant shrub and herbaceous species in the surrounding habitat (Table 1). This information was used to determine the plant palette selection for this Project (Section 5.3.1).

Sampling was conducted in the summer of 2009 after the opportune detection period – therefore, the list in Table 1 is not comprehensive. Thus, other considerations included assumptions about the climax conditions and age structure of the community, including species size at maturity and survivorship of germinated seed for each species. Introducing annual native species to the seed mix was also considered to increase coastal sage scrub community diversity. Native annual species were not observed during the reference area sampling period because it was conducted during the summer, when most annual species

are dormant. To determine appropriate native annual species for this restoration project, reference sampling results and plant palettes for restoration plans developed for Lake Calavera and adjacent Robertson Ranch preserves (Planning Systems 2006 a. and 2006 b.) were reviewed as well as the biological technical report and species compendium for the LCTMP (Merkel & Associates 2009), and comments from the California Department of Fish and Game (David Mayer, pers. comm.). Because the installation for this project does not use irrigation, the planting specifications include higher quantities and denser placements compared to an irrigated installation to account for anticipated losses.

Table 1. Average Cover Model for Coastal Sage Scrub
Based on Reference Area Sampling

Percent Cover	Plant Type	Species (Scientific Name)
60%	Dominant shrubs	*Artemisia californica*
20%	Sub-dominant shrubs	*Encelia californica, Salvia mellifera, Isocoma menziesi, Baccharis pilularis*
10%	Other shrubs	*Adolphia californica, Opuntia littoralis, Mimulus aurantiacus Malosma laurina, Rhus integrifolia, Sambucus mexicana, Hazardia squarrosa, Malacothamnus fasciculatus,*
5%	herbaceous species	*Gnaphalium californicum, Nassella sp,. Deinandra fasciculata, Asclepias fascicularis*
5%	Bare Ground	

3.3 Soil Testing

Three composite agricultural soil samples were taken in the Project (Figure 2) area and sent to Wallace Laboratory to be analyzed for pH, EC (electrical conductivity, a measure of salt content), physical property, and nutrients. Each composite consisted of three individual samples within a given area. Results of the soil tests were used to determine the appropriate seed mix for the restoration (Appendix A; see also, Section 5.2.3).

4.0 Personnel and Supplies

4.1 Restoration Ecologist

Installation, maintenance, and monitoring will be supervised by a qualified Restoration Ecologist, who will have overall responsibility for implementation of this Project, and will oversee the work of the Landscape Maintenance Contractor. The Restoration Ecologist will be responsible for successful implementation of the restoration plan by the

implementation team by providing direction, technical expertise, and coordination. The Restoration Ecologist will manage the work of the implementation team. One written specification document and one set of plans will be used as the contract documents to complete the restoration. The Restoration Ecologist can be an individual or a group of qualified professionals.

The Restoration Ecologist will have the following minimum qualifications:

1. Bachelor degree in biology, ecology, botany, or an acceptable related field such as landscape architecture.
2. 5 years experience with implementing successful upland mitigation projects with an emphasis on coastal sage scrub restoration in southern California. The Restoration Ecologist will provide documentation of at least three successful coastal sage scrub restoration implementation projects that have been successful after a 3-year monitoring period.
3. In accordance with state law, the Restoration Ecologist must hold a valid Pest Control Adviser's license to make specific pest control recommendations.

The Restoration Ecologist will oversee and direct the installation at the following stages of progress:

- Preconstruction conference
- Review of special measures to be taken to protect existing habitats and plants
- Staking of proposed limit of disturbance
- Ensuring that the contractor does not negatively impact surrounding native habitat during the installation process or during weed control activities
- Fencing and signs
- Tagging of soil samples
- Tagging of weed removal areas
- Identification of weeds to be removed
- Review of site preparation prior to planting
- Weed management
- Installation completion review (acceptance starts establishment period)
- Completion review at 120 days
- Post-implementation, monitoring, and reporting

4.2 Landscape Maintenance Contractor

The Landscape Maintenance Contractor (Contractor) will implement the restoration plan. The Contractor will have a valid C-27 Landscape Contracting License from the State of

California, a valid Maintenance Gardener Pest Control Business License or Pest Control Business License, and a Qualified Applicator Certificate or Qualified Applicator License, with Category B, that will allow them to perform the required work for this project. The Contractor will have specific documented experience with the installation and maintenance of multiple upland restoration projects in southern San Diego County. In addition, the Contractor will have demonstrated experience using the imprinting method for successful native habitat restoration. At least three references must be provided by the Contractor to qualify as a successful bidder for the project.

The Contractor's responsibilities will entail site preparation installation, and maintenance services, including weed control, trash removal, fence repair, and reseeding. Planting (imprinting/seed application) will be conducted by the Contractor under the supervision of the Restoration Ecologist. The Contractor will be familiar with native and non-native plant species in the region. A successful project is one that was accepted by the permitting agencies or has fulfilled success criteria after 3 to 5 years of post-restoration monitoring.

4.3 Contract Nursery/Seed Supply

Restoration is planned to be accomplished through seeding and a limited number of cuttings and container plants. Seeds and plants will be supplied by a Contract seed supply and/or grower for the upland restoration through an experienced native plant nursery or seed company such as, but not limited to, Tree of Life Nursery, San Juan Capistrano, California; Green Oaks Ranch Nursery, Vista, California; Mockingbird Nursery, Riverside, California; El Nativo Growers, Azusa, California; Las Pilitas Nursery, Escondido, California, and S&S Seeds, Carpinteria, California. No substitutions will be accepted.

5.0 Restoration Implementation

5.1 Preconstruction Meeting

One or more preconstruction meetings will be held with all applicable individuals to establish relative authority and responsibilities, identify sensitive habitat areas, discuss appropriate access, and review methodology for site preparation and installation. The Restoration Ecologist will hold the authority to make field changes that affect the scope of work of the project and to issue stop work orders. A schedule identifying proposed construction activities, work area boundaries, off-limit areas and activities, and applicable permits will be distributed to all appropriate parties prior to commencing construction.

5.2 Site Preparation

Site and seed bed preparation do not require grading or contouring. However, the site requires fencing, access controls, weed removal and potential erosion control as described in the following sections. See Section 5.3.3 for information about imprinting equipment requirements.

5.2.1 Fencing and Signs

The area designated for restoration currently experiences intense recreational use, including hiking, dog walking (often with unleashed dogs), and mountain biking. However, informational signage has not yet been installed to educate the public about restricted uses. As such, hikers, bikers, and/or dogs often go off-trail, which can result in damage to the adjacent habitat. This type of unauthorized use is especially heavy in the vicinity of the restoration area due to dense residential development along the north side of the Preserve. To minimize potential damage to the restoration area from unauthorized use, temporary fencing will be installed around the restoration area prior to site preparation and installation.

Sensitive biological areas, such as adjacent native habitat, are deemed as "no construction" areas. "No-construction" zones shall be clearly flagged by the Restoration Ecologist prior to the onset of construction activities. If the Restoration Ecologist deems it necessary, sensitive biological areas shall be surrounded by fencing or other protections to prevent direct or indirect impacts.

To help promote a successful restoration, the boundary of the restoration area may be refined in the field from that shown in Figure 2, if recommended by the Restoration Ecologist, based on accessibility, public use patterns, locations of authorized and unauthorized trails, slope or soil type. Prior to fencing, the Restoration Ecologist will stake the restoration area. After the initial planting, protective temporary fencing shall be installed around the restoration area to preclude disturbance. Specifications for fencing are included in the contract.

Silt fencing to control erosion and damage by herbivores shall be installed around the entire perimeter of the restoration areas and remain in place until the restoration project is complete. The silt fencing shall be regularly maintained to ensure that it remains effective. Torn or broken fencing shall be replaced routinely.

In addition, temporary signs will be installed at various locations around the restoration site to identify the area as a sensitive habitat restoration site, and to describe recreational

use restrictions in the area. The restoration area shall be posted by the restoration contractor with a sign that indicates the area is not to be entered and that vegetation is being established. The sign shall contain a contact telephone number and name of the restoration contractor.

5.2.2 Site Access and Best Management Practices

Heavy equipment and construction activities shall be limited to the existing developed and disturbed areas to the degree feasible as determined by the Restoration Ecologist. Vehicles shall be required to remain within the construction corridor, unless otherwise noted on the drawings. All vehicles shall use existing access roads/fire breaks.

If the site contains trash or debris, the Maintenance Contractor will remove all trash and debris accumulated within the project boundaries and dispose of the collected debris in an appropriate location off-site.

Best Management Practices (BMP) should be applied throughout the restoration project to prevent erosion and siltation of any adjacent wetlands or waterways, if deemed necessary by the Restoration Ecologist. BMP measures could include, but are not limited to, the installation of silt fencing, coir rolls (for example installed in a V-shape with the tip of the V pointing uphill), fiber mats, etc.

5.2.3 Soil Preparation

No chemical fertilizers or other growth enhancing products should be added to the restoration planting to avoid compromising the beneficial effects of natural soil organisms and mycorhizal fungi. However, if the Restoration Ecologist determines that the extant soils are unsuitable to ecological restoration based on the results of the soils analysis or other site characteristics, recommendations will be provided for natural soil amendments suitable for native habitat restoration, such as mulch and organic fertilizers. Results of the soils analysis included in Appendix A can be used to make this determination, or the Restoration Ecologist can take new samples, and have them analyzed at a qualified laboratory.

Agricultural-grade gypsum shall be a calcium sulfate ($CaSO_4$ H_20) product - 94.3 percent. 90 percent shall pass a 50-mesh screen. Control of dust during application is mandatory. Iron Sulfate shall be ferrous sulfate in pelletized or granular form containing not less than 20.0 percent iron expressed as metallic iron. Iron Sulfate pellets shall be of size and gradation such that 98 percent is retained on a 10-mesh screen.

The site will be decompacted by cross-ripping to a depth of six to twelve inches. At this time, the recommended soil amendments will be added, if necessary. Mycorrhizal fungi inoculation shall occur during installation, as described below. If necessary, erosion control measures, such as silt fencing, will be installed to ensure that the restoration area is not damaged by erosion or siltation during the rainy season. If deemed necessary by the Restoration Ecologist, weed control will be conducted by the Contractor, using methods recommended by the Restoration Ecologist.

5.2.4 Pre-Planting Weed Eradication

Prior to restoration implementation, manual weed control shall be conducted by the Contractor. All actively growing non-native vegetation shall be removed prior to the onset of seeds, removing the entire root system, seeds, and seed heads. An acceptable method of weed removal would be to water and germinate the plants of concern, and then remove them before they set seed. Irrigation of weedy areas for several weeks prior to weed eradication will encourage germination of weed seeds in the soil. However, if sufficient winter rains have encouraged the growth of weedy species, irrigation may not be necessary. Herbicide can also be used to eradicate weeds if deemed necessary and approved by the Restoration Ecologist. If this method is chosen, all herbicide use shall be restricted to the restoration area and not enter the nearby sensitive areas. See Section 6.1.1 for herbicide specifications. Pre-emergents are prohibited and shall not be used.

5.3 Installation

Coastal sage scrub habitat is naturally drought adapted and thrives on small amounts of precipitation during the winter months. Therefore, this restoration project has been designed to use rainfall to establish coastal sage scrub habitat. As such, an irrigation system will not be installed, unless recommended by the Restoration Ecologist and approved by the City (to be contracted separately). Prior to seedbed preparation, the Restoration Ecologist shall ensure that the appropriate seed mix, cuttings, and container plants have been collected by the Contract Grower.

5.3.1 Seed and Plant Procurement and Inspection

The seed mix will be contract-ordered and prepared using the plant palette in Table 2. All seeds shall originate in the vicinity of coastal North San Diego County (target area). Seed materials will be purchased from a qualified vendor specializing in native seeds (for example S&S Seeds or equivalent) and experienced in the collection and preparation of native seed material for native habitat restoration/revegetation. If seed is not readily

available from a reputable supplier (see Section 4.3), it must be collected within the target area (within a 30 mile radius from the project site), except where noted in Table 2.

Table 2. Plant Palette for Restoration Project

Scientific Name	Common Name	Percent Purity	Percent Germination	Seed Qty lbs/acre
Artemisia californica	California sagebrush	15	50	6
Encelia californica	California encelia	40	60	3
Eriogonum fasciculatum	California buckwheat	5	60	4
Eriophyllum confertiflorum	Golden yarrow	30	60	0.5
*Eschscholzia californica**	California poppy	98	80	3
Gnaphalium californicum	California everlasting	10	25	1
Hazardia squarrosa	Saw-toothed goldenbush	15	20	2
Isocoma menziesii	Coast goldenbush	30	30	4
Lotus scoparius	Deerweed	90	60	1.5
*Lasthenia californica**	Goldfields	98	85	2
*Lupinus bicolor**	Miniature lupine	98	80	3
Malacothamnus fasciculatus	Bush mallow	15	60	1
Mimulus aurantiacus	Coast monkeyflower	2	55	3
*Nassella pulchra**	Purple needlegrass	70	60	1
Salvia mellifera	Black sage	70	50	1
*Sisyrinchium bellum**	Blue-eyed grass	95	75	1
Plantago ovata (insularis)*	Wooly plantain	98	75	6

*Note: seeds indicated with an * may be obtained from a commercial source.*

All seed shall be labeled according to state and federal laws, and be delivered to the Project site in sealed containers. The quantity of pure live seed supplied shall meet or exceed the quantity shown in the specified mixes. Seed shall not contain more than 0.5 percent weed seed by volume. Each sealed container shall include original seed supplier's tags indicating the container weight, seed type (genus and species), source, collection date, percent purity of the seed, percent seed germination, and date the seed was tested. If not guaranteed by the supplier, at time of delivery, samples must be drawn from each seed mix by the Restoration Ecologist and tested to ensure compliance with the seed specifications. The seed supplier shall certify, in writing, the location and date of seed collection.

The seed imprinting will be supplemented with cuttings of coast cholla (*Opuntia prolifera*) and coast prickly pear cactus (*Opuntia littoralis*), and with 1-gallon container-grown California adolphia (*Adolphia californica*). The cuttings and container plants will be contract grown and purchased from a qualified vendor, as described above for seed mixes. All plant material will be inspected by the Restoration Ecologist for non-native ant

species and other pests prior to being delivered onto the site. A total of 100 California adolphia, 50 coast prickly pear, and 30 coast cholla will be planted in a non-uniform manner that mimics natural plant distribution.

Seed types shall be as specified in Table 2, and shall be applied at the rates indicated. Cuttings and container plants shall be applied as specified above. No fertilizer of any sort shall be applied during seed application, applied in the planting holes or backfill, or applied as topdressing. Organic materials or other amendments may be used as needed to improve soil drainage and aeration.

5.3.2 Mycorrhizal Inoculation

Mycorrhizal is a symbiotic association between a fungus and the roots of a plant. Vesicular-arbuscular mycorrhizal is the form of endotrophic mycorrhiza that will be used to inoculate the site. In this form, the fungus lives between the cells of the cortex and forms temporary hyphal projections that penetrate the cortical cells. Plants that commonly develop such associations cannot grow normally without the appropriate fungus. As a rule, mycorrhizal infection enhances plant growth by increasing nutrient uptake via increases in the absorbing surface area, by mobilizing sparingly available nutrient sources, or by excretion of chelating compounds or ectoenzymes. Mycorrhizal infection may also protect roots from soil pathogens, thereby increasing root growth and nutrient acquisition of the host root. The imprinting seed mix (coastal sage scrub only) will be supplied with a mycorrhizal inoculation prepared by the seed supplier. Commercially available (EndoNet™ or equivalent) granular arbuscular mycorrhiza inoculum will be incorporated into the seed mixture prior to application

5.3.3 Imprinting Equipment

To ensure successful germination, imprinting methodology will be used. Land imprinting is the formation by mechanical means of smooth-walled V-shaped furrows in the soil surface. It shapes the soil, creating small depressions which concentrate water, seed, litter, and other resources and prevent seeds being washed out by rainfall. Seeds are pressed into the soil, promoting capillary contact and improving germination, and mycorrhizal inoculum is injected into the root zone. This method has been shown to be more successful than hydroseeding in establishing native species in arid climates, such as southern California, when irrigation is not used.

The imprinter should either be a tractor-drawn or winch-pulled implement with angular teeth welded to a steel roller. The imprinter differs dramatically from conventional

method of tillage such as plowing, discing, cultivating or drill-seeding in that it does not turn over the soil and entails minimal disruption of the surface litter. It is equipped with machinery for dispensing seed and other materials, and chambers to accommodate ballast. The ballast is adjusted to produce optimum imprints in a range of soil conditions. Imprinting should be conducted following the specification below.

Characteristics of Imprinting Teeth

- The height of the imprinting teeth shall be at least four inches.
- Imprinting teeth shall be V-shaped in transverse section, and may be rectangular or triangular in longitudinal section.
- Any imprinter used on a slope greater than 4:1 shall have teeth ten inches or less in length, with a gap of two inches or more between the end of one segment and the beginning of the next. If the imprinting teeth are longer than ten inches, the machine shall be operated at all times with the long dimension in a horizontal orientation to the slope.
- The crest-to-crest spacing between teeth shall be less than two feet. One foot is often optimum for land restoration.
- The apical angle of the triangular cross section of the imprinting teeth shall be ninety degrees or less, with acute teeth preferred for the steepest slopes.
- Any imprinter use on a slope greater than 2:1 shall have a "saw tooth" pattern, in which the apex of the tooth is offset, giving a long and a short side to each tooth. The angle between front and rear faces of the imprinting teeth shall be 60 degrees or less. The imprinter shall be operated so that the long face of the impression lies upslope of the short face.

Weight Per Unit Area on Teeth

- The static pressure on the soil surface is measured by dividing the total weight of the imprinter, including any ballast, by the total area of tooth contact when the teeth have penetrated half way into the soil.
- The static pressure on the soil surface shall be at least 12 pounds per square inch and less than 48 pounds per square inch. The lower weights are for softer soils and the higher weights for harder or drier soils.
- No more pressure shall be used than that required to obtain a full-tooth imprint.

Maximum Length of Roller

- No individual roller shall be more than eight feet in length, except in the case of level, rock-free land that will not cause a long roller to leave unimprinted areas.
- More than one roller may be attached to a single imprinting device as long as each roller swivels independently over surface obstructions. In this case, the combined rollers may be any practical width.

5.3.4 Imprinting Execution

Desired Soil Conditions

- The soil may be imprinted when dry if it is soft enough to allow penetration of the imprinting teeth to their full depth, and firm enough to permit the formation of smooth-walled, firm impressions.
- If the dry soil does not allow formation of quality impressions, it shall not be imprinted until rainfall or irrigation leaves it in a suitable condition.
- Soil that is too hard to accept a pattern that conforms to performance specifications, with a properly weighted imprinter, may be ripped before imprinting. Adjustment of the imprinter ballast is preferred over ripping where feasible.
- Clay soil shall not be imprinted while it is so wet that substantial quantities of it stick to the roller.

Form of Impressions

- Impressions shall be of V-shaped cross section and ten inches or less in length if used on a slope exceeding 4:1.
- A pyramidal shape is acceptable as long as the apical angles between all faces are ninety degrees or less.
- The imprinting pattern shall provide a raised soil ridge that prevents continuous movement of drainage water between impressions.
- At least 70 percent of the soil surface shall bear impressions, apart from any peripheral turn-around area and areas rendered untreatable by rocks or other natural features.
- At least 70 percent of the impressions shall reach 90 percent of the full tooth depth.
- At least 70 percent of the impressions shall have smooth and firm soil over at least 70 percent of their surface area.

Compaction of Finished Impressions

- Bulk density is defined as the oven-dry weight of soil per unit of original field volume, and shall be calculated per standard soil testing methods.
- No portion of the imprinted soil profile shall exceed the bulk density indicated for the soil type in Table 3.

Table 3. Maximum Allowable Bulk Densities after Imprinting

Soil	Maximum Bulk Density (Mg/m^3)
Loamy Sand	1.75
Sandy Loam	1.65
Loam	1.55
Silt Loam	1.45
Clay Loam	1.45
Clay	1.40

Vegetation Cover

- The imprinting operation shall be carried out on bare earth or on land that has only a minimal vegetative cover, except as specified below.
- If the amount and nature of vegetative cover is sufficient to interfere with soil contact and the formation of quality impressions, such vegetation shall be removed prior to imprinting by burning, raking, or other suitable means.
- Interfering vegetation may be cut or chopped into fragments of eight inches or less if the depth of accumulated material is small enough to allow the formation of quality impressions.

Operating Procedures

- The imprinter shall be pulled at a speed low enough to ensure that the full weight of the roller bears upon the soil at all times.
- If the impressions are longer than ten inches, the long dimension of each imprint shall lie parallel to the contour of the slope.
- If imprint length is ten inches or less, the imprinter may be used in any orientation to the slope.

Proximity to Edges of Seeded Area

- The imprinting pattern shall extend fully to the boundaries of the project area.

- The area at the project boundary may serve as a turn-around area and normally will be imprinted by a final pass along the project perimeter. If conditions do not permit imprinting the perimeter, a turn-around area within the project need not be fully imprinted.
- Any unimprinted turn-around area on the project boundary shall be no wider than the smallest turning radius allowed by the equipment.

Seed Distribution

- Seed dispensed by the imprinting device shall be in firm contact with the soil.
- The seed bin shall contain no residual seed from previous uses.
- Wheat bran or approval substitute shall be mixed with seed to appropriate dilution ratio to prevent seed segregation. The optimum mixing radio is usually 1:1 by volume.
- Planting shall take place before germination of the seeds introduced by imprinting unless approved by the Restoration Ecologist.
- The planting crew shall step in the impressions rather than the ridges to preserve the imprinting pattern.
- No irrigation, weeding, or other maintenance activity shall be allowed to damage or modify the imprinting pattern.

5.3.5 Supplemental Irrigation (Optional)

The goal for this coastal sage scrub restoration effort is to obtain growth with the least amount of irrigation. Frequent irrigation encourages weed invasions and leaches nutrients from the soil. Native plantings that are infrequently irrigated may grow slower initially, but will become established with minimal distortions in the root-to-shoot ratio and with less competition from weeds.

If necessary, as determined by initial post-establishment monitoring, irrigation by water truck shall be supplied for plant establishment. Irrigation volume shall be determined by the Restoration Ecologist and may be based upon weather conditions (no irrigation should be supplied from July through September). However, deep irrigation should always be favored over short periods of shallow irrigation. The Contractor shall ensure that sufficient water for plant establishment be supplied to the restoration area. Following the plant establishment period, the Project Ecologist shall be responsible for directing the frequency and duration of irrigation applied to the site as needed.

5.4 Installation Schedule

Implementation of the planting must occur during the winter months (November through February) to take advantage of lower temperatures, lower albedo effect, and precipitation. Installation of this restoration plan is expected to occur as soon as site conditions are appropriate, and after all applicable approvals have been secured. Currently, the anticipated start date is November 30, 2009. The entire installation is expected to be completed within four weeks after starting (Table 4). The Restoration Ecologist will certify, in writing, that the restoration installation has been completed. If requested, the Restoration Ecologist will meet with the City on site to review the installation.

Table 4. Recommended Installation Schedule

Sequence	Activity	Target Date
1	Seed procurement/collection	2 months prior to installation
2	Boundary delineation (staking) and site protection (erosion control)	Prior to December 2009
3	Installation of fencing and signage	Prior to December 2009
4	Weed removal	Prior to December 2009
5	Soil decompaction (cross-ripping)	Immediately prior to seeding
6	Seed imprinting, mycorrhizal inoculation	December 2009
7	Supplemental irrigation (if needed)	As needed

6.0 Project Maintenance and Monitoring

6.1 120-Day Establishment Monitoring and Maintenance

Post-installation maintenance and monitoring insures that the installation contractor establishes a successful restoration project prior to the onset of the long-term monitoring period. Post-installation maintenance shall be performed by the Contractor for 120 days upon installation acceptance or until specified success standards have been met to the satisfaction of the City. Acceptance of the project prior and after the 120 day establishment period will be provided by the City. The 120-day establishment period completes the installation phase and commences the long-term monitoring and maintenance phase.

Installation monitoring and maintenance shall begin as soon as installation is complete, and continue for 120 days. During this time, the Restoration Ecologist shall evaluate establishment failures and determine the appropriate remedial actions.

The target schedule for the establishment monitoring and maintenance is described in Table 5:

Table 5. Recommended Establishment Monitoring and Maintenance Schedule

Sequence	Activity	Target Date
1	Start of 120-day establishment period	When installation is complete
2	Monitoring for signs of problems	Weekly
3	Remediation activities	As needed
4	Re-seed, if necessary	Prior to February 2010
5	Supplemental irrigation, if necessary	As needed, prior to June, 2010
6	Complete As-Built plans	At completion of installation
7	Final acceptance of installation (bond release)	120 days after installation

Maintenance activities, to be conducted by the Contractor, will include the following:

6.1.1 Weed Abatement

Control of invasive species will be a critical maintenance activity. Weed control shall be performed weekly during the establishment period. All personnel involved with weed abatement must be trained to identify native and non-native plant species. All "high" and "moderate" risk species, as identified in the California Invasive Plant Council (Cal-IPC) invasive plant inventory (Appendix B) shall be targeted for immediate removal. The Restoration Ecologist shall approve of all weed control methods (e.g., hand pulling, spot treatment by herbicide, mass treatment by herbicide, or mechanical methods) prior to implementation by the Contractor. All pesticides and herbicides shall only be applied by an on-site licensed pest-control contractor, and used in their appropriate applications with strict adherence to manufacturer's specifications and instructions. Postemergent herbicide for all areas shall be Glyphosate, N-(phosphonomethyl) glycine, in the form of its isopropylamine salt such as Roundup Pro, Diquat, Montar, or approved equal. Pre-emergent herbicide shall not be used. Weed abatement activities will be consistent with the following guidelines:

- High risk non-native exotic species shall have 0% cover.
- Other invasive species shall not account for more than 10% vegetation cover.
- Weeds shall not be allowed to set seed over an area of ¼ acre (cumulative total of one or more areas) or more at any time during the contract period.
- Weeds shall be removed before reaching six inches in height or prior to flowering, whichever comes first.
- Once removed, weed biomass shall be collected and removed from the site and disposed of in a legal manner.

- If used, herbicides will be applied in a manner that does not result in overspray into adjacent native habitat areas.

6.1.2 Vandalism Control and Trash Removal

Vandalism of the planted area, fences, or signs, must be reported by the Contractor to the Restoration Ecologist within three working days of discovery. Trash removal and repair of fences and signs will be conducted by the Contractor as needed, and just prior to the end of the 120-day maintenance obligation. All trash and debris will be removed from the site and disposed of in a legal manner.

6.1.3 Erosion Control

The Contractor shall repair all erosion-related problems immediately upon discovery, and report the problems to the Restoration Ecologist. The Contractor and Restoration Ecologist shall inspect the site to determine the cause of the problem, and the Contractor shall install erosion control measures as directed by the Restoration Ecologist. Erosion control may include the installation of Best Management Practices (BMP), such as the installation of fiber coirs, silt fencing, Bio-Fiber Matrix (BFM), silt traps, and filling and securing of erosion gullies. All erosion control materials must be free of invasive species seeds. After the area is repaired, re-seeding of the area will be conducted if deemed necessary by the Restoration Ecologist. The above specified seed mixes and unit metrics shall be used to determine quantities.

6.1.4 Herbivory/Predator Control

The Contractor shall look for signs of herbivory on a regular basis. If signs of herbivory are found, the problem shall be remediated immediately using methods to be determined by the Restoration Ecologist. Remedial actions may include installing and maintaining herbivory cages; installation of fine-mesh flashing along the bottom 36 inches of fences; burying fences to a depth of 12-18 inches; maintaining and repairing fences. Material for a typical herbivory cage should consist of one-inch mesh poultry wire supported by two wood stakes. Caging for each plant shall form a circle around the plant, extending at least three inches into the soil, and one foot above the plant tip to allow sufficient height for at least two years of growth. The upper edges of the cage shall be folded over each other creating an "envelope" around the plant. The removal of the cages shall be determined by the Restoration Ecologist.

If necessary, predator control will be evaluated by the Restoration Ecologist on a case-by-case basis and shall be restricted to methods recommended by the Restoration Ecologist, including rodent control, ant control, and animal trapping and translocation.

6.1.5 Completion of 120-day Maintenance

At the end of the 120-day establishment period, the Contractor and Restoration Ecologist will conduct a walk-through to determine if the restoration has been successful. Success criteria include (a) uniform germination of native species throughout the site; (b) 0% cover of invasive species identified as high risk [Appendix B], (b) no more than 10% cover of all other non-native invasive plant species, (c) trash and debris removed from the site, and (d) no sign of problems with erosion or vandalism). If it has been determined that success criteria have not been met, the Restoration Ecologist will provide a written description of necessary remedial action to the City and the Contractor. If the establishment failure is determined to be the fault of the Contractor, all labor and materials associated with remedial actions, including re-seeding, shall be the responsibility of the Contractor. The method of re-seeding will be determined by the Restoration Ecologist. Once 120-day performance standards have been met, the Restoration Ecologist will conduct a final walk-through with the City, and provide a final report.

At the completion of the establishment monitoring period, as-built maps will be prepared showing the location of the restoration areas. As-built maps will be of the same scale as the original plan to facilitate data presentation. These maps will serve as base maps for the long-term monitoring and maintenance efforts.

6.2 Long-Term Monitoring and Maintenance – Separate Contract

Long-term monitoring and maintenance will be contracted separately from the installation and 120-day maintenance period. A primary measure of success for restoration is the ability of a revegetated native plant community to be self-supporting (the ability to sustain itself with natural water and nutrient sources) and self-maintaining (the ability to successfully reproduce). This plan is intended to meet the following objectives:

- To attain a community of CSS that is biologically diverse and consistent with the existing natural system.
- To attain a plant community of CSS that is self-supporting and self-maintaining at the end of five years.

Long-term maintenance and monitoring shall begin on the day following completion (sign-off) of the 120-day establishment period, and continue for a total of five years as described below and summarized in Table 6.

Table 6. Recommended Long-Term Monitoring and Maintenance Schedule

Sequence	Activity	Target Date
First 3 years maintenance and monitoring		
1	Start of long term monitoring program	At completion of 120-day maintenance period
2	Quarterly qualitative monitoring	Sept, Dec, March 2010 - 2015
3	Monthly qualitative monitoring	March thru June 2011 - 2015
4	Quantitative monitoring	May* 2010 - 2015
5	Weed abatement	As needed
5	Annual restoration monitoring reports submitted	August 2010 - 2015
6	Remedial activities	As needed
7	End of 5-year monitoring period – final walk through	June 2015
8	Final 5-year report submitted	September 2015

* Quantitative monitoring will begin in July of 2010, and be conducted during the month of May thereafter.

6.2.1 Long-term Monitoring

Long-term monitoring will include qualitative and quantitative data collection to measure the long-term success of the restoration project. For five years, the monitoring will be conducted by the Restoration Ecologist, who will also inform the Maintenance Contactor of any remedial measures necessary to ensure restoration success.

Qualitative Monitoring (Horticultural Monitoring)

After the establishment period has been completed, during each year of the long-term monitoring period, the restoration site will be quarterly monitored during the growing season (March through June) and quarterly (September and December) for the remainder of the year. Qualitative surveys will consist of a general site walk-through and a characterization of the restoration planting. General observations, such as health of planted and seeded species, signs of over/under watering, and drought stress will be noted. Restoration plantings will be examined to visually estimate percentage of cover, species mortality, species composition, seedling recruitment, and soil, weed, and pest problems. Special attention and observations of host plant populations, life cycle stages, duration of life cycle, and seed production will be noted during these visits. Maintenance needs will be recorded and submitted to the Restoration Ecologist for appropriate action subsequent to each survey.

The Restoration Ecologist will also advise the Maintenance Contractor if supplemental irrigation for the purpose of plant establishment is necessary during the first monitoring year (excluding summer months). If necessary, the Restoration Ecologist and Maintenance Contractor will devise a temporary irrigation strategy that will not harm or disturb any natural vegetation communities.

Quantitative Monitoring (Botanical Monitoring)

To augment qualitative survey data, more precise data will be collected and analyzed by the Restoration Ecologist to document and evaluate the progress of the restoration program toward meeting habitat goals and performance standards. Transect data will be collected from all treatment areas. At least two control transects will be selected in adjacent naturally functioning habitats of similar vegetation community structure as the restoration site. Changes in habitat condition will be measured over time and compared to baseline conditions at each monitoring station. In addition, treatment area data will be compared to control site data to determine if the restored areas are compatible with adjacent pre-existing habitat.

Habitat condition will be assessed by measuring *species richness* (the number of species in a given area), and *cover* (percentage of an area covered by a given species) of native and non-native plant species. The quadrat method, as described below, is best suited for capturing small plants, plants that are rare or that have low cover, and overall species richness; however, it is time-consuming and inferior when recording large plants (Deutschman and Strahm 2009). The point intercept method, which is less time consuming, works well for large and small plants, abundant species, and estimating cover. It does not work well for capturing rare or low cover plants.

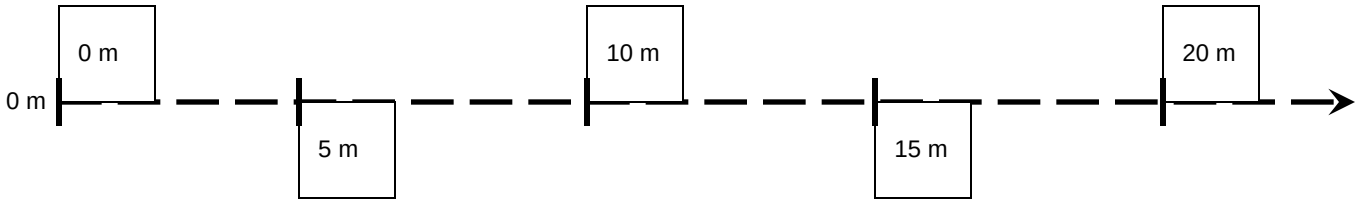
Permanent transect locations (treatment and control) will be established during the first quantitative monitoring period, marked in the field with rebar, and recorded on maps. To allow for initial seedling establishment and minimize damage to establishing seedlings, the baseline quantitative data collection will be performed in July 2010; subsequent sampling events will occur annually in May of each following year. The actual timing may be adjusted by the Restoration Ecologist based on climate conditions.

Quantitative monitoring should follow the specifications below, or equivalent, as determined by the Restoration Ecologist.

- Each monitoring station will consist of a 50-meter transect. The location and direction of transects will be chosen randomly, and once established, will remain the same throughout the monitoring period. Five stations will be established in polygon A (western-most polygon of the five-acre restoration area); three stations will be established in polygon B (the polygon just east of A); and three stations will be established in the 1-acre mitigation site (eastern-most polygon).

- **Quadrats (1-meter square):** Quadrat measurements shall be taken every five meters on alternating sides, starting on the left, from meter 0 to 50. Two measurements will be taken within each quadrat: (a) absolute percent ground cover, not to exceed 100 percent; and (b) relative cover by plant species, which can exceed 100 percent for overlapping plants. Ground cover classes include litter, bare, rock, stem, cryptobiotic crust, and moss. Unknown plant species can be collected for later identification.

- **Point Intercept:** The point intercept method will be used along the same 50-meter transect. A ½ inch wooden dowel, one meter long, shall be placed perpendicular to the ground at every meter on the left side (facing the end point) starting at meter-0 and ending at meter-50. Two measurements will be taken at each meter: (a) ground cover type, as described above, and (b) species touching the dowel (can be more than one). Abundance will not be recorded.



These sampling stations will be surveyed in the spring of each year (at the peak of annual growth) to determine germination and transplant success, species mortality, pest problems, percentage of cover, and species composition. Consistent sampling techniques will be used throughout the monitoring process to maintain accuracy and comparative analysis.

6.2.2 Performance Standards

Performance standards are critical to attain measurable restoration success, as identified above. The survival criteria for all CSS vegetation shall be 60 percent plant cover at the end of three years following restoration, and 80% at the end of five years. The success criteria described in Table 7 will determine if the restoration meets the required performance standards.

Table 7. Success Criteria

Assessment Period	Success Criteria
Monitoring/Maintenance to be Conducted by Maintenance Contractor and Restoration Ecologist	
120-day establishment period	• Uniform germination of native species throughout the site; • At least 50% survival of container plants and cuttings; • 0% cover of high risk invasive species; • No more than 10% cover of all other non-native invasive species; • No sign of trash or debris on site; • No sign of erosion on site; and • No signs of vandalism on fences, signs, or restoration area.
Year 1	• Native perennial species cover at least 30%; • At least 50% survival of container plants and cuttings; • Species richness of at least 10 native species; • 0% cover of high risk invasive species; • No more than 10% cover of moderate risk invasive species; and • No more than 30% cover of other non-native species.
Year 2	• Native perennial species cover at least 45%; • At least 60% survival of container plants and cuttings; • Species richness of at least 10 native species; • 0% cover of high risk invasive species; • No more than 5% cover of moderate risk invasive species; and • No more than 15% cover of other non-native species.
Year 3	• Native perennial species cover at least 60%; • At least 70% survival of container plants and cuttings; • Species richness of at least 10 native species; • Evidence of native species recruitment; • Cover of high to moderate risk invasive species 0%; and • No more than 5% cover of other non-native species.
Year 4	• Native perennial species cover at least 70%; • At least 80% survival of container plants and cuttings; • Species richness of at least 10 native species; • Evidence of native species recruitment; • Cover of high to moderate risk invasive species 0%; and • No more than 5% cover of other non-native species.
Year 5	• Native perennial species cover at least 80%; • At least 80% survival of container plants and cuttings; • Species richness of at least 10 native species; • Evidence of native species recruitment; • Cover of high to moderate risk invasive species 0%; and • No more than 5% cover of other non-native species.

These performance standards will be evaluated annually as described in this section. Successful habitat restoration should not be dependent upon human intervention by the end of the monitoring period.

Performance standards must be attained within Treatment Areas at the end of each of the five years following planting. A replanting program, including supplemental irrigation, will be initiated within the restoration site, if the Restoration Ecologist determines that

plant mortality, erosion problems, or seed germination progress are unacceptable. Should the Restoration Ecologist determine that part of the restoration site has failed to meet annual performance standards, the Restoration Ecologist will recommend corrective measures to be implemented immediately.

6.2.3 Long-Term Maintenance

Long-term maintenance activities will generally be the same as those described in Sections 6.1.1 through 6.1.4 above. Maintenance activities will occur as needed based on the results of regular maintenance monitoring visits conducted by the Contractor and Restoration Ecologist as described in Section 6.2.1.

Weed abatement shall be accomplished by the Maintenance Contractor. Workers shall be closely supervised if they are not familiar with native coastal sage scrub plant species. Weed abatement shall be performed on a weekly basis for six months and then bi- or tri-monthly, or as determined necessary by the Restoration Ecologist, for the remainder of the maintenance/monitoring period.

6.2.4 Contingency Measures

Upon receipt of each annual monitoring report, if the City determines that the restoration effort is not meeting success criteria, the Restoration Ecologist and Contractor will be notified in writing. The Restoration Ecologist and Contractor will then have 30 days to respond, challenge, or confirm the determination that remedial work must be done. Potential remediation measures may include extending the monitoring/maintenance period, installing erosion control measures, repairing fencing, weed abatement activities, or re-seeding. Plantings that fail to become established shall be replaced in-kind or with similar materials. Any re-seeding on site should be conducted between November and February to take maximum advantage of the winter rainy season. If rainfall is insufficient to fully establish the native plants, the Restoration Ecologist, Contractor, and City will discuss the possibility of applying temporary irrigation using water trucks or other cost-effective method. The restoration site must be irrigation-free for two growing seasons prior to successful completion of the long-term monitoring period.

6.2.5 Reporting and Project Completion

Annual monitoring reports will be prepared by the Restoration Ecologist and submitted to the City by August 31 of each year. Annual reports will include qualitative and quantitative monitoring results, photographs taken at photo-documentation stations, comparison of results with success standards, and recommended remedial measures. At the end of Year 5, a report will be submitted by the Restoration Ecologist evaluating the

performance of the restoration effort and whether all of the performance criteria of the restoration plan have been met. At the end of five years, if success criteria have been met as determined by the Restoration Ecologist, the Restoration Ecologist and the City will meet at the site for a final walk-through, and a final report will be submitted to the City. If success criteria have not been met, the maintenance and monitoring period may be extended.

7.0 References

Deutschman, D., and S. Strahm. 2009a. Improving Statistical Sampling and Vegetation Monitoring for the San Diego MSCP. Final Report. Prepared for the San Diego Association of Governments, contract 5001033 (January 2009).

Merkel and Associates. 2009. Lake Calavera Trails, City of Carlsbad. Biological Resources Report. General Biological Survey, Jurisdictional Wetland Delineation, and Focused Surveys. Prepared for the City of Carlsbad, June 8, 2005. Revised May 14, 2007.

Planning Systems, 2006 a. Robertson Ranch, Extensive Upland Habitat Restoration (Coastal Sage Scrub – "Area B") and Modest Habitat Re-introduction ("Area C" and "Future CSS Re-introduction) Program. Prepared for Robertson Family Trust, October 26, 2006.

_____. 2006 b. Habitat Revegetation, Maintenance, and Monitoring Program. Calavera Dam Remedial Improvements Project, Carlsbad, California. Prepared for City of Carlsbad, October 26, 2006.