8 March 2007

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Subject: Post-Fire Vegetation Recovery – Phase 1
Boeing Santa Susana Field Laboratory
Geosyntec Project: SB0363A

Dear Mr. Costa:

Geosyntec Consultants (Geosyntec) is pleased to provide The Boeing Company this initial Phase 1 study regarding post-Topanga-fire erosion recovery at the Santa Susana Field Laboratory (SSFL) (project site). The overall objective of the study was to assess the status of and time to erosion control recovery at the site, subsequent to the September 2005 Topanga fire. The term “recovery” is defined, for the purposes of this analysis, as vegetative and soil conditions that are statistically indistinguishable for comparable burned and unburned areas, therefore indicating that post-Topanga-fire erosion controls and sediment yields will have returned to normal, pre-Topanga-fire conditions.

The specific objective of the Phase 1 study was to provide an initial semi-quantitative assessment of recovery based on literature review and reconnaissance-level survey of conditions at the project site. The 2nd and planned final phase will include a quantitative vegetation survey of the site, timed to occur during the annual species’ peak bloom period, which typically occurs in the spring.

The initial findings from this Phase 1 study suggest that watershed recovery time following a fire is highly variable and dependant upon many factors, however the literature reviewed generally describes the breakdown of water repellency (or the hydrologic effect that fire has on soils) in surface soils to occur within one to three years, and the vegetative recovery in chaparral habitats to occur within approximately six years, plus or minus two years. Both the soil and the vegetative conditions need to be restored for a watershed to be considered recovered in the context of erosion control and sediment yield, and therefore six years (plus or minus two years) serves as an appropriate and preliminary – “preliminary” in that it is subject to refinement during the Phase 2 quantitative survey – estimate of recovery time for the site. The Phase 1
reconnaissance-level survey also confirmed that vegetation at the project site appears to be recovering at rates comparable to this literature-derived recovery time range.

As part of phase 1, a post-fire reconnaissance-level vegetation survey was performed by Western Botanical Services, Inc. (WBS). Wright Water Engineers, Inc. (WWE) provided a technical appendix to WBS’ Phase 1 vegetation recovery report, specifically addressing the hydrologic and sediment yield recovery of similar habitat-type watersheds following fires. Additionally, WWE provided peer review of the Phase 1 study, contributing input that will also assist in the development of the work plan for Phase 2, which will consist of a detailed field-level survey and quantitative assessment of status of and time to near-complete recovery at the site.

In the context of stormwater quality, wildfires such as the Topanga Fire can increase stormwater runoff volumes, peak runoff flows, discharge frequencies, sediment concentrations, and concentrations of sediment-associated pollutants such as TCDD and total metals. Therefore, the study is focused on measurable parameters -- most notably vegetation type/cover, which affect soil stability and erosion potential, and soil water repellency -- which most directly impact these stormwater-related conditions of concern.

Summaries of WBS’ and WWE’s findings on anticipated time for post-fire vegetation and hydrologic recovery are included below. The bibliographic references to citations in this letter are included in the attached reports.

Summary of Vegetation Recovery Literature Review and Site Observations (WBS)
The rate of vegetative recovery following fires is somewhat consistent and predictable based on the initial literature reviewed, but varies according to location of plant communities and other site-specific factors (e.g., slope, aspect, elevation, etc.). The rate of recovery for chaparral communities is greatest during the first six years following a fire, then recovery slows down through the eighth year (Hanes, 1971). By the fifth year following a fire, chaparral resprouts and seedlings dominate the vegetative cover (Hanes, 1971), and stands of chaparral are expected to recover 50 percent of their pre-burn biomass by the eighth year (Wright and Bailey, 1982). Studies have also shown that, following a fire, vegetative cover can increase from approximately 65 percent total cover in the first/second year to almost 150 percent cover in the fifth year (Grace and Keeley, 2006). However, as the following sections indicate, total vegetative cover alone does not fully demonstrate the extent to which erosion controls and sediment yields have recovered in a burned watershed.

Beyond total vegetative cover, the presence of annual species is also significant, with observed conditions at the project site being consistent with literature describing the status of post-fire
recovery after two years. It is expected that annual grasses and forbs (soft, leafy annuals) will prevail during spring and summer 2007, the second growing season following the fire. Evidence of abundant grass seedlings and newly germinating forbs were present during the February 2007 survey. The presence of annuals (e.g., herbaceous species and grasses) is significant from an erosion control perspective because the shallow-rooted annuals can provide protection against impact erosion on bare soil until the deeper-rooted perennials become established. Perennials such as chaparral, however, return more slowly, yet have root structures that are comprised of both deep and shallow roots and are generally capable of holding more soil in place during runoff-producing storm events.

Overall, all areas observed at the project site show signs of regeneration as resprouts and seedlings, consistent with findings in the literature related to fire and chaparral. In the event that weather patterns are somewhat normal\textsuperscript{1} over the next 20-30 years\textsuperscript{2}, and in the absence of any catastrophic events on the burned areas, it is expected that the burned chaparral on the project areas will follow the growth patterns described in literature for recovery of chaparral and coastal sage scrub communities.

**Summary of Hydrologic Recovery and Sediment Yield Literature Review (WWE)**

For the purposes of this review, hydrologic and sediment yield recovery is defined as the return of a watershed to its pre-fire condition in terms of its rainfall-runoff and sediment yield relationship characteristics. Though hydrologic and sediment yield recovery of a burned watershed is a function of multiple factors, two variables that have the greatest effect are vegetation type and cover (covered in WBS’ literature review and visual observations of the site), and soil water repellency.

Consistent with WBS’s findings, WWE’s literature review findings suggested that the dominant chaparral community recovery increases rapidly in the first few years following a fire and less rapidly in the years thereafter. The chaparral community is essentially mature about 25 years following the fire.

\textsuperscript{1} It is worth mentioning here that the current rain season of 2006/07 is, to date, the driest on record. Ensuing climatic conditions, such as continued drought, may effect actual time to recovery at the project site.

\textsuperscript{2} Prior to the Topanga 2005 fire, the last major fire to burn most of the site was in 1970. Smaller portions of the site, particularly along its eastern and western edges, were burned during other fires that occurred in the early 1980’s.
After a fire, soil water repellency can be found as a discrete layer of variable thickness on the soil surface a few centimeters below and parallel to the surface. It is widely recognized that this fire-induced water repellency is a key parameter affecting post-fire runoff and erosion rates. The persistence of this layer is highly variable and little data exist regarding the return of soil water repellency to pre-fire conditions; studies cited in WWE’s appendix suggest that pre-fire repellency may be achieved between one and three years post-fire (McDonald and Huffman, 2004; WWE, 2003).

The literature provides little information on the long-term recovery of burned watersheds with respect to hydrology and sediment yield. Generally, hydrologic recovery time is highly variable and some studies cite ranges between four to five years for an Australian grassland watershed (Brown, 1972) to approximately 20 years for a watershed characterized by sage-pinion-juniper vegetation (WWE, 2003). However, no literature was found reporting on sediment yield recovery times for chaparral habitats. Therefore, given this notable uncertainty, the Phase 2 quantitative assessment will be important in evaluating the status of and time to near-complete hydrologic and sediment yield recovery for the site.

Path Forward – Phase 2
Phase 2 of the study will follow in April and will include a quantitative assessment of recovery through the measurement and analysis of selected vegetation and soil characteristics at the project site. Vegetative, hydrologic, and sediment yield recovery will be defined using measurable site-specific metrics as part of the Phase 2 work plan, and will be fundamentally based on statistical comparisons between burned and unburned (control) areas at or near the project site. Phase 2 of the study will be critical for providing a more precise and site-specific estimate of time to recovery for the project site.

Sincerely,

Ronald S. Johnson, PE  Brandon Steets, PE
Associate  Project Manager

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engineers  |  scientists  |  innovators
Attachments: 1. Post-Fire Vegetation Recovery Reconnaissance Survey Report, prepared by WBS.
2. Technical Appendix G: Hydrologic Recovery of Watersheds Following Fire, prepared by WWE.

Copies to: Cassandra Owens, LA Regional Water Quality Control Board
Paul Costa, The Boeing Company
Lori Wynd, The Boeing Company
Kathleen Wong, The Boeing Company
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Susan Paulson, Flow Science Inc.
Richard Haimann, MWH
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Executive Summary

The 2005 Topanga fire burned nearly the entire approximately 2,850 acres of the Boeing SSFL (project site), located in the Simi Hills of Ventura and Los Angeles Counties. The purpose of this vegetation survey and the subsequent Phase 2 survey is to assess the status of vegetation regeneration at the site, subsequent to the September 2005 Topanga fire. This Phase 1 survey, focused on visually comparing dominant vegetative cover of the areas of the project site that burned in the 2005 Topanga fire to those areas of similar habitat type that did not burn, and performing an initial literature review. A quantitative assessment, including collection and analysis of vegetation field data, will follow as Phase 2 of this study later this spring to evaluate recovery of vegetation on the project site.

A Western Botanical Services Inc. (WBS) biologist conducted a reconnaissance-level botanical survey in February 2007 in order to gain an understanding of the general existing conditions and to evaluate locations and quantities of transects for Phase 2. This survey identified general and specific vegetation common to the project site. This survey also included the measurement of vegetative cover in four transect locations.

Overall, all areas observed show signs of regeneration as resprouts and seedlings as expected based on the findings in the literature related to fire and chaparral. Woody-stemmed plants, which have deeper roots and, therefore, provide greater structure in the soil horizons (i.e., better stabilization of soil), return more slowly than grasses and other rapidly growing, shallower-rooted species. Based on a review of the literature, vegetative recovery occurs most rapidly during the first 6 years of regrowth and less rapidly thereafter. In the event that weather patterns are somewhat normal over the next 20-30 years, and in the absence of any catastrophic events on the burned areas, we expect the burned chaparral on the project areas to follow the growth patterns described in literature for recovery of chaparral and coastal sage scrub communities.

The time frame for vegetation recovery described in the literature is necessarily broad, as the establishment and growth of vegetation is dependant upon several factors, e.g. vegetation type, soil conditions, fire severity, climatic conditions. Quantitative botanical surveys conducted during spring/summer 2007 will provide a more thorough evaluation of species diversity and cover by vegetation in the burned areas, thus providing a more complete picture of how the vegetation is recovering in the different areas throughout the project site.
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Purpose and Scope

This report summarizes the results of a Phase 1 reconnaissance-level botanical survey at the Santa Susana Field Laboratory (SSFL) (project site), located in the Simi Hills of Ventura and Los Angeles Counties (Figure 1). The purpose of this survey and the subsequent Phase 2 survey is to assess the status of vegetation regeneration at the site, subsequent to the Topanga fire which burned throughout the site between September 28 and October 5, 2005. A quantitative assessment, including collection and analysis of vegetation field data, will follow as Phase 2 of this study later this spring to evaluate recovery of vegetation on the project site since the fire. Vegetative “recovery” will be defined using measurable site-specific metrics as part of the Phase 2 work plan, and will be fundamentally based on statistical comparisons between burned and unburned (control) areas at or near the project site.

Introduction

The 2005 Topanga fire burned approximately 70 percent of the approximately 2,850-acre project site. In order to gain an understanding of the general existing conditions and to determine locations and quantities of transects to run during the follow-up (Phase 2) quantitative assessment surveys, a Western Botanical Services Inc. (WBS) biologist conducted a reconnaissance-level botanical survey in February 2007. During this survey, the focus was on visually comparing dominant vegetative cover of the areas of the project site that burned in the 2005 Topanga fire to those areas of similar habitat type that did not burn.

February is a suboptimum time for vegetation surveys. The optimum time to conduct botanical surveys is in the spring and summer when both annual and perennial species are present, blooming, and identifiable. Therefore, the reconnaissance survey conducted in February 2007 did not capture a complete picture of the species diversity and cover by species, as many annual species were not present or identifiable. Quantitative botanical surveys conducted during spring/summer 2007 will provide a more thorough evaluation of species diversity and cover by vegetation in the burned areas, thus providing a more complete picture of how the vegetation is recovering in the different areas throughout the project site.

Methodology

On February 5-9, 2007, the field crew conducted a reconnaissance-level field survey during the hours of 7:00 am – 4:30 pm. The field crew for this survey included Jeannette Halderman, a subcontracted botanist to WBS and Ryan Smith, a Geosyntec geologist. A Boeing employee was
present during the entire survey to escort the consultants to survey locations and to take photographs at chosen photo points.

Field crews used a 1”=600’ aerial photograph taken prior to the September 2005 fire as a reference in the field and to document vegetation and other information observed during field surveys. Information layers printed on the aerial photograph base included project boundaries, unburned vegetation boundaries, watershed boundaries, outfall locations, post-fire aerial mulch application boundaries, post-fire truck mulch application boundaries, and best management practice treated areas.

Plant community maps of the project site available at the time of the survey included the California Department of Forestry and Fire Protection & US Forest Service (USFS) vegetation map (GIS layer, metadata from 2005), and a GIS layer for plant communities mapped by MWH Americas, Inc. (MWH Americas, Inc., 2005). Soil Conservation Service (SCS) soil maps for Los Angeles and Ventura Counties (1970) were also available as a GIS layer.

Prior to the reconnaissance field survey, WBS botanists reviewed available literature applicable to the project site conditions including books, articles, and scientific papers on fire ecology and post-fire recovery of chaparral, scrub, riparian and oak woodland communities. We also reviewed soil maps, vegetation maps (discussed above), fire history and fire intensity maps of and areas surrounding the project site. A list of literature and maps reviewed is listed in Reference Cited section of this report. This literature and additional literature will be more thoroughly reviewed as part of the Phase 2 survey.
Qualitative Survey Methodology

Visual Observation

Field surveys were conducted on foot and by car from accessible roads and trails. Areas were evaluated by watersheds identified on the map as referenced by Outfall number locations. Most of the areas were observed visually from the road or trail. Field crews surveyed some areas on foot, up to 700 feet from the road or trail, to get a general understanding of seedling germination, soil condition, to collect samples of plants for identification purposes, document presence of mulch, and to observe upstream and downstream of drainages that were not visible from roads or trails.

During the surveys, the areas observed were mapped on the aerial photograph by habitat types (excluding microhabitats at this time), based on dominant species present and by cross-referencing USFS and Montgomery Watson vegetation maps. Field crews visually observed approximately 70 percent of the project area (Figure 2). The USFS vegetation GIS layer and the 2005 vegetation community map by MWH Americas, Inc. (Appendix A) were referenced and cross-checked during field surveys. The majority of the areas observed and mapped were as shown on the MWH Americas, Inc. vegetation map. Based on this observation, the assumption was made that the vegetation types for the remaining 30 percent of the project site are approximately as shown on the referenced MWH Americas, Inc. vegetation map (Appendix A).

During the field surveys, plant species present and identifiable were noted (Appendix A). An estimate of percent cover for each identifiable species was estimated visually from accessible roads and trails. The plant root establishment was estimated by visual observation of the above-ground portion of the plants (living or dead), and presence of crown and aerial resprouting in burned areas. In burned areas, field crews noted resprouting vegetation by species (when identifiable), estimated averaged diameter of remaining burned stems, estimated percentage of shrubs resprouting, and height of resprouting vegetation. Remnant vegetative stalks and old flower heads from previous years’ growth, perennials, and seedlings were also noted and identified by species when possible.

The diameter of burned branches following a fire were documented in a 1990 study by DeBano (DeBano, et al., 1998) looking at loss of biomass and severity of burns. Severity of a fire can often affect the rate of species recovery and species diversity. Therefore, the average diameter of burned branches/stems was estimated for the areas that were observed during the survey.

Presence of mulch was generally noted in areas documented as being aerially and truck mulched following the fire in December 2005. The mulch was a combination of wood and paper fiber mulch combined with organic binders (American Civil Constructors, 2005).

The condition of the surface soil was also documented between vegetation and bare ground, and the presence of remaining mulch or visible erosion was noted.

Information collected at each representative location is documented on field forms provided in Appendix B.

Since the goal of this project is to compare the vegetation in burned and unburned areas of the project site, this initial survey also included assessment of potential areas suitable for quantitative
data collection during spring 2007 surveys. As part of this assessment, we identified and described the small percentage of unburned vegetation on the project site.

**Photographs**

Digital photographs were taken of Outfalls 1-11, 14-15 & 18 and surrounding areas, representative plant communities, and along transects. Boeing staff used their Sony digital camera to take photographs where directed by the field crew. The photographs were saved electronically as jpg files. All photographs were recorded on a photo log (see Appendix C).
Figure 2. Site Map
Quantitative Survey Methodology

Transect data were taken solely to get an idea of species composition for burned and unburned areas and to estimate number and locations of transect for data collection as part of Phase 2, to be conducted in Spring 2007. These data were also collected to verify visual estimates of species cover collected throughout the project site. These data were by no means collected to represent statistical findings or to make conclusions of the condition of the post-fire recovery for the entire project site.

Once all qualitative data were collected, two “control” areas were chosen to be used as references of unburned vegetation. These “control” areas were chosen based on presence of unburned chaparral habitat, slope aspect, percent slope, and soil type. Since only a small percentage of unburned vegetation is present within the project site boundaries, all these areas were considered. Those areas that were similar in slope aspect, percent slope, soil type, and vegetation type were chosen to serve as vegetative sample locations. Random transects were chosen within these unburned control and burned sample areas.

Since soil type often is responsible for the presence or absence of plant species, all sample areas were selected in areas with the same soil type: Gaviota rocky sandy loam. Slope aspect is also a known variable to affect the distribution of plant communities, therefore, slopes with southerly aspect were looked at separately than slopes with northerly aspect.

The beginning and end of each 100 foot long transect were marked with fiberglass pinstakes (4’ tall). Compass bearings, Global Positioning System (GPS) coordinates, and photo points at each end of the transects were collected to document each transect (see Figure 2). GPS information was documented on the GPS log provided in Appendix D.

Cover, frequency, and diversity were determined using the point-intercept sampling method. The point-intercept sampling method measures absolute and species-specific cover by vegetation; this method maximizes objectivity and repeatability (Proc. Amer. Soc. Surf. Min. & Recl., 1985 Annual Mtg., Denver, CO). The data recorded include the type of cover (vegetative, non-vegetative, or none) and the species, when applicable, that appear in the vertical plain of each point. Plants intercepted along the transects were identified to the lowest possible taxonomic level. Point data (vegetation, leaf litter, bare ground or rock) were collected at each foot along the transect for a total of one-hundred points per transect. Data were recorded on customized data sheets (Appendix E).

When two or more plant species were present at each point, all were recorded as a hit. When no vegetation was present within the vertical point, bare ground, rock or leaf litter was noted. Bare ground constituted mineral soil and soil/ash. Other qualitative factors noted along the transects included presence of resprouts on burned vegetation and height of resprouting vegetation and existing vegetation.

Table A summarizes each transect.
Table A - Description of Transects

<table>
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<th>Habitat Type</th>
<th>Transect type</th>
<th># Transects</th>
<th>Watershed</th>
<th>Soil Type</th>
<th>Slope Aspect</th>
<th>Percent Slope</th>
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</thead>
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<td>Control (unburned)</td>
<td>1</td>
<td>Outfall 6</td>
<td>Gaviota rocky sandy loam</td>
<td>S</td>
<td>20</td>
</tr>
<tr>
<td>Chaparral</td>
<td>Control (unburned)</td>
<td>1</td>
<td>Outfall 9</td>
<td>Gaviota rocky sandy loam</td>
<td>N</td>
<td>25</td>
</tr>
<tr>
<td>Chaparral</td>
<td>Burned (Mulched)</td>
<td>2</td>
<td>Outfall 2</td>
<td>Gaviota rocky sandy loam</td>
<td>S</td>
<td>35</td>
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<td>1</td>
<td>Outfall 9</td>
<td>Gaviota rocky sandy loam</td>
<td>N</td>
<td>25</td>
</tr>
</tbody>
</table>

Results

Vegetation Community Descriptions

Plant communities used for both the USFS and MWH Americas, Inc. vegetation maps most closely match descriptions of the Terrestrial Natural Communities of California by Holland (1986). Plant communities observed on the project site are described generally since it is too early after the fire to determine the species makeup for each community or put into a vegetation type classified by Holland. Furthermore, because the project site survey was conducted before the majority of the spring annuals germinated and before the peak bloom period for most forbs and shrubs, many key species potentially present were not observed during the survey. An assumption was made as to what vegetation-type was present prior to the fire of September, 2005 based on the USFS and MWH Americas, Inc. vegetation maps.

As stated above, information collected during the reconnaissance survey included visual estimation of vegetation type based on resprouting vegetation, remnant annual plant debris from previous growth, identifiable seedlings, and existing plants that were not severely burned by the fire. Plant species present and most easily identifiable during the surveys were perennial fire-adapted species that resprout within two years after a fire of this degree, dried annual plant species that germinated within the first year after the fire, perennial species that germinated since the fire.

The following plant community descriptions were developed to describe the present condition of the project site following the fire, with the understanding that as the project site recovers, plant communities will become more apparent and will more easily fit into plant communities as described by Holland (1986).

Chaparral/Scrub

Chaparral/Scrub is the predominant plant community on the project site, occurring in differing densities throughout the project site depending on soil type, aspect and age of disturbance, etc. USFS maps identified four chaparral types within the project site including Chamise, Foothill...
Mixed Chaparral, Northern Mixed Chaparral and Sumac Shrub. The MWH Americas, Inc. map (2005) identified five chaparral and coastal sage scrub types including Venturan Coastal Sage Scrub, Venturan Coastal Sage Scrub/Chaparral, Baccharis Scrub, Chaparral, and Chaparral/Coast Live Oak Woodland. These habitat types appear to be as described by Holland (1986) or of some combination thereof.

Chaparral occurs as dense vegetation dominated by thick-leaved shrubs, growing to approximately 5 to 10 feet tall. Chaparral is typically dominated by scrub oak, chamise (Adenostoma fasciculatum) and other thick-leaved species including Ceanothus and manzanita species (Arctostaphylos), all of which are typically deep-rooted. The understory is typically very sparsely vegetated or unvegetated, consisting mostly of leaf litter. Chaparral is adapted to repeated fires, responding by crown sprouting following the fire. Seeds of many of the chaparral species also require heat to germinate.

Northern Mixed Chaparral is shown to occur mostly on northerly facing slopes and is predominately comprised of numerous sclerophyllous-leaved shrub species with no or sparsely vegetated grasses and herbs. This classification most closely represents the stands of unburned chaparral remaining on the north facing slopes of the project site. These areas are dominated by mountain mahogany (Cercocarpus betuloides), holly-leaved cherry (Prunus ilicifolia), and toyon (Heteromeles arbutifolia).

Chamise communities are stands of chaparral vegetation dominated by chamise; one unburned stand was present at the far northwest corner of the project site. Foothill Mixed Chaparral is dominated by a somewhat even mix of various chaparral species, and an occasional coastal sage scrub type species. Sumac communities are areas dominated by laurel sumac; it is difficult to determine location of this habitat type since laurel sumac appears to be present in more than one plant community on the project site. Resprouting laurel sumac and chamise are present in most of the burned areas observed on the project site, but appear to be more abundant in areas described as chaparral on the MWH Americas, Inc. and USFS maps.

Many burned areas observed that had been classified as chaparral on the MWH Americas, Inc. and USFS maps were dominated by those chaparral species that are known to readily resprout after fires including laurel sumac, chamise, scrub oak (Quercus berberidifolia), toyon, etc. (Keeley, et al., 2006). Species that are known to regenerate predominantly by seed following fires were also present including hoary-leaved Ceanothus (Ceanothus crassifolius); it is possible that these species may have been dominant or co-dominant in the community prior to the fire, but are present as seedlings and not highly visible from more than a few feet away. Therefore, during the surveys, seedlings of these species were not always obvious if present in many areas mapped, when the areas were observed from farther than a few feet away.

Venturan coastal sage scrub is comprised of low, soft-wood shrubs, growing to approximately 2 to 6 feet in height. Dominant species often include California sagebrush, buckwheat species (Eriogonum spp.), sage species (Salvia spp.), lemonade berry (Rhus integrifolia), and Our Lord’s
candle (*Yucca whipplei*). This habitat is also adapted to fire, species commonly resprouting from their crown following a fire.

All subcategories for chaparral and scrub identified on the USFS and MWH Americas, Inc. maps were lumped and described as Chaparral/Scrub since chaparral and coastal sage scrub communities that burned are mostly indistinguishable at this stage of post-fire recovery (Figure 3). This was determined by looking at the only unburned patch of coastal sage scrub observed on the project site, located along the trail in the Sage Ranch area. This area was dominated by California sagebrush, California buckwheat (*Eriogonum fasciculatum*) with co-dominants of black sage (*Salvia mellifera*) and California deerweed (*Lotus scoparius*). Other species included California aster (*Lessingia filaginifolia*), Our Lord's Candle, California everlasting (*Gnaphalium californicum*), and other herbaceous species and grasses typical of coastal sage scrub plant community described by Holland (1986). The coastal sage scrub area also contained many of the same chaparral species including laurel sumac (*Malosma laurina*), coyotebush (*Baccharis pilularis*), Yerba Santa (*Eriodictyon crassifolius*), etc. as adjacent areas classified as chaparral on the USFS and MWH Americas, Inc. vegetation maps. Therefore, areas where these species were predominant were noted as potential coastal sage scrub habitat and are considered chaparral/shrub for this report.

Lastly, the project site is situated on areas of sandstone outcroppings due to historical geologic uplifting. Although present, chaparral and other grasses and herbs are sparse in areas of dense and large outcroppings. These areas are also mapped as chaparral/shrub, with the understanding that these areas also contain microhabitats among the rocks made up of plant species that are known to specifically occupy rocky and sandstone formations such as lichens.

**Oak Woodland**

Oak Woodland is present along canyon floors, northerly slopes and scattered along many of drainages throughout the project site (Figure 4). This community is dominated by coast live oak (*Quercus agrifolia*) trees. Oak woodlands on the project site occur among sandstone rocky outcrops with a sparse understory of scattered grasses, herbs and shrub. Oak woodlands on the project site also occur on the bottom of canyons where the understory is dominated by non-native grasses. Oak woodlands on northerly facing slopes and adjacent to drainages often have an understory of species common in chaparral and sage scrub habitats.

Oak trees sustained varying amounts of damage from the fire, depending on location. Many oak trees exhibited burned leaves solely around the lower leaf canopy, while the entire canopy of some oak trees appeared to have been burned. Crown sprouting and some above ground branch sprouting was apparent on most of the burned oak trees on the project site.

**Coast Live Oak Riparian Forest**

Coast Live Oak Riparian Forest was observed along the drainage in the vicinity of Outfall 9 (Figure 4). The canopy cover is dominated by coast live oak with an occasional California bay (*Umbellularia californica*) and willow (*Salix* sp.). The predominant understory species present and identifiable in this plant community include mugwort (*Artemisia douglasiana*), California rose (*Rosa californica*), and poison oak (*Toxicodendron diversilobum*). Other species present include Mexican elderberry (*Sambucus mexicana*), bush monkeyflower (*Mimulus aurantiacus*), and
annual grasses. The oak trees in this area sustained little fire damage as only the fringes of the lower canopy were burned; there was no evidence of fire damage to the understory at the time of the survey. Oak trees in the oak woodland areas upstream and downstream from this area sustained more burn damage to their canopies and understory.
FIGURE 3

Burned Chaparral/Scrub (Aerial Mulched) – Southeast Facing Slope in Outfall 2 Watershed
N 34.21731°, W 11870390°

Unburned Chaparral/Scrub – South Facing Slope in Outfall 6
N 34.22632, W 118.71686

Western Botanical Services, Inc.

Boeing Santa Susana Field Laboratory
Representative Chaparral/Scrub Community

SOURCE:
Looking East from Helipad at Outfall 9 Drainage; Oak Woodland up Canyon Burned; Large Patch In Center (Coast Live Oak Riparian Forest) Mild Burn Damage
N 34.23825°, W 118.69604°

Coast Live Oak Riparian Forest – Along Creek at Outfall 9 (Mildly Burned on Edges of Oak Canopy, No evidence of Burn in Understory) N 34.23851°, W 118.69463°

FIGURE 4

Western Botanical Services, Inc.

Boeing Santa Susana Field Laboratory
Representative Coast Live Oak Communities
Southern Willow Scrub, Mulefat Scrub, and Freshwater Marsh

Southern Willow Scrub occurs along many drainages on the project site; vegetation density in this plant community varies by location, soil type, frequency and length of water inundation, and degree of slope in the drainage. Southern Willow Scrub is dominated by several willow species including arroyo willow (*Salix lasiolepis*) and red willow (*Salix laevigata*) with an occasional Western sycamore tree (*Populus racemosa*).

Mulefat Scrub and Freshwater Marsh plant communities are present with and adjacent to areas where southern willow scrub is present within the project site. Mulefat Scrub is dominated by mulefat (*Baccharis salicifolia*) with an occasional willow and scattered rushes and sedges in more wet areas. It is also present in intermittent drainage channels on the project site. Mulefat scrub also occurs independently of southern willow scrub and freshwater marsh communities in drier drainages on the project site.

Freshwater Marsh is dominated by sedges, rushes, cat-tails and water-loving grasses and forbs. This plant community occurs along the waters edge of the ponds on the project site and in pockets in drainages where moisture is present closer to the surface year-round.

The Southern Willow Scrub, Mulefat Scrub and Freshwater Marsh areas observed to have burned on the project site, are naturally revegetating primarily by crown sprouting.

Drainages and Open Water

Areas described as drainages on the project site vary widely in width and vegetation cover. Many of the drainages at the base of steep slopes dominated with chaparral are narrow (2-4 feet wide) unvegetated soft bottom channel. Species present occasionally include curly dock (*Rumex crispus*), rabbits foot grass (*Polypogon monspeliensis*), western ragweed (*Ambrosia psilostachya*), mugwort, and grasses. Other drainages on the project site are 5-8 foot wide, soft bottom channels with intermittent areas of sandstone along the sides and channel bottom. Vegetation is more prevalent in these drainages and include curly doc, rush (*Juncus* spp.), umbrella sedge (*Cyperus* sp.), mulefat, and mugwort. The sparse vegetation along the bottom of these drainages did not appear to have sustained significant burn damage.

Open water is present primarily in ponded areas on the project site; no vegetation is present in these areas. These open water areas appear to become vegetated with freshwater marsh species as the water recedes with evaporation, drainage flow, and percolation.
FIGURE 5

Burned Southern Willow Scrub – Drainage above Outfall 11 (Burned Willow in Front Represents High Heat of Fire in this Area)  N 34.22726°, W 118.68668°

Burned Southern Willow Scrub – Drainage above Outfall 2 (Burned Sycamore Shown on Front Left)  N 34.21750°, W 118.70519°

Western Botanical Services, Inc.

Boeing Santa Susana Field Laboratory
Representative Riparian/Drainage Communities

SOURCE:
Non-Native Grassland/Ruderal

Non-Native Grassland/Ruderal is present on areas surrounding oak woodlands and previously disturbed areas adjacent to dirt roads and developed areas on the project site (Figure 6). This plant community is dominated by non-native annual grass species, none of which were identifiable at the time of the survey. Ruderal species are also common in these areas and include non-native invasive species including tocalote (*Centauria melitensis*), Italian thistle (*Carduus pycnocephalus*), and mustards (*Brassica* spp. and *Hirschfeldia* sp.). An occasional native needlegrass (*Nassella* sp.) and remnant annual wildflower species were also present.

The Non-Native Grassland/Ruderal areas are within the burned area of the project site, however, at the time of the survey, there was no evidence of the burn as there were few perennial species present that would exhibit identifiable resprouting and remnant burnt branches following the fire.

Burned Shrub Stem Diameter

For burned Chaparral/Scrub areas observed during the survey, the diameter of burned shrub branches ranged in size from 1/4”-1”, when measured at the tallest point. Based on the 1990 DeBano study (mentioned in the methodology section above), size of stems remaining are consistent with a fire of moderate severity.

Burned Shrub Regeneration

Primary evidence of post-fire vegetation regeneration included presence of crown sprouts and seedlings. The presence of this regeneration varied by location. Only native species are listed below, even though numerous non-native species were presently germinating on the project site. Non-native species present included tree tobacco (*Nicotiana glauca*), mustards, Russian thistle (*Salsola tragus*), tocalote, non-native grasses, Italian thistle, etc. Table B summarizes evidence of regeneration that was documented at locations observed during field surveys. Not all species observed are listed; this is intended to represent the most commonly species observed during the survey.

**Table B - Summary of Vegetative Regeneration Observed**

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Height of Crown Sprouts (Feet)</th>
<th>Presence of Seedlings</th>
<th>Visually Estimated Percent Cover Range in Burned Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Adenostoma fasciculatum</em></td>
<td>2-4</td>
<td>X</td>
<td>0-30</td>
</tr>
<tr>
<td><em>Artemisia californica</em></td>
<td></td>
<td>X</td>
<td>0-5</td>
</tr>
<tr>
<td><em>Baccharis pilularis</em></td>
<td>2-5</td>
<td></td>
<td>0-5</td>
</tr>
<tr>
<td><em>Calystegia macrostegia</em></td>
<td></td>
<td>X</td>
<td>20-40</td>
</tr>
<tr>
<td><em>Ceanothus crassifolius</em></td>
<td></td>
<td>X</td>
<td>0-5</td>
</tr>
<tr>
<td><em>Cercocarpus betuloides</em></td>
<td>7-10</td>
<td></td>
<td>0-30</td>
</tr>
<tr>
<td><em>Dudleya pulverulenta</em></td>
<td>0.5-1</td>
<td></td>
<td>0-5</td>
</tr>
<tr>
<td><em>Eriodictyon crassifolium</em></td>
<td>2-4</td>
<td></td>
<td>0-50</td>
</tr>
<tr>
<td><em>Eriogonum fasciculatum</em></td>
<td></td>
<td>X</td>
<td>0-5</td>
</tr>
<tr>
<td><em>Gnaphalium sp.</em></td>
<td></td>
<td>X</td>
<td>0-5</td>
</tr>
<tr>
<td><em>Hazardia squarrosa</em></td>
<td></td>
<td></td>
<td>0-5</td>
</tr>
<tr>
<td><em>Heteromeles arbutifolia</em></td>
<td>1.5-9</td>
<td></td>
<td>0-10</td>
</tr>
<tr>
<td>Species</td>
<td>Height</td>
<td>Spread</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>Keckiella cordifolia</td>
<td>1-3</td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td>Lotus scoparius</td>
<td>X</td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td>Malacothamnus fasciculatus</td>
<td>X</td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td>Malosma laurina</td>
<td>3-4</td>
<td>0-40</td>
<td></td>
</tr>
<tr>
<td>Marah macrocarpa</td>
<td>2-8</td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td>Mimulus aurantiacus</td>
<td>X</td>
<td>0-10</td>
<td></td>
</tr>
<tr>
<td>Phacelia sp. (annual)</td>
<td>X</td>
<td>0-10</td>
<td></td>
</tr>
<tr>
<td>Phacelia ramosissima</td>
<td>1-3</td>
<td>0-30</td>
<td></td>
</tr>
<tr>
<td>Platanus racemosae</td>
<td>6-8</td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td>Prunus ilicifolia</td>
<td>4-12</td>
<td>0-20</td>
<td></td>
</tr>
<tr>
<td>Rhus integrifolia</td>
<td>0-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhus ovata</td>
<td>0-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quercus agrifolia</td>
<td></td>
<td>20-90</td>
<td></td>
</tr>
<tr>
<td>Quercus berberidifolia</td>
<td>3-5</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Salix sp.</td>
<td>3-5</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Salvia mellifera</td>
<td></td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td>Sambucus mexicana</td>
<td>5-7</td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td>Yucca whipplei</td>
<td>1-2</td>
<td>1-5</td>
<td></td>
</tr>
</tbody>
</table>
FIGURE 6

Western Botanical Services, Inc.

Boeing Santa Susana Field Laboratory
Representative Non-Native Grassland/Ruderal Community & Mulch

SOURCE:
**Mulched Areas**

Mulch is still present in patches of varying densities in burned areas that received truck and aerial-applied mulch. The mulch is mostly visible on rock outcroppings (Figure 6), but patches of mulch are still present in some of the areas. Wood fiber mulch over cryptogrammic species as lichen can inhibit growth by reducing photosynthesis and transpiration.

**Transect Data**

Relative vegetative cover was tallied as the percentage of vegetation intercepted by the projected point. Percent coverage of litter, rock, and bare area were calculated separately.

Table C summarizes relative cover data collected along each transect (locations shown on Figure 2).

**Table C - Summary of Relative Cover by Transect**

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Transect type</th>
<th>Shrub</th>
<th>Dead Shrub</th>
<th>Bare/Rock</th>
<th>Litter</th>
<th>Herb Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chaparral – S facing</td>
<td>Control (unburned)</td>
<td>60</td>
<td>20</td>
<td>13</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Chaparral – N facing</td>
<td>Control (unburned)</td>
<td>70.3</td>
<td>0.9</td>
<td>4 bare</td>
<td>14</td>
<td>11.4</td>
</tr>
<tr>
<td>Chaparral – S facing</td>
<td>Burned (Mulched)</td>
<td>2.5</td>
<td>0</td>
<td>21</td>
<td>1.5</td>
<td>75.5</td>
</tr>
<tr>
<td>Chaparral – N facing</td>
<td>Burned</td>
<td>19.3</td>
<td>15.4</td>
<td>7</td>
<td>14</td>
<td>44.9</td>
</tr>
</tbody>
</table>

The chaparral control transect on the south facing slope (Figure 7) was randomly placed. This location of unburned chaparral constitutes an approximately 1,800 square foot area of the project site and is located at the northwestern corner of the project site. The 60 percent scrub cover in this transect is comprised of approximately 48.7 percent relative cover by chamise, 4.4 percent relative cover by Our Lord’s candle, 2.6 percent relative cover of black sage, and 1.7 percent relative cover by hoary-leaved ceanothus (*Ceanothus crassifolius*). The shrub layer along this transect is approximately 4-5 feet tall. Dead branches of chamise constitute approximately 20 percent relative cover of the vegetation along the transect. Bare ground constitutes approximately 12 percent relative cover of the transect; approximately 7 percent of the transect is covered with leaf litter. There is evidence of a previous fire as old burned shrub stumps were present adjacent to the transect. This is most likely remnant vegetation that burned during the 1982 fire (California Department of Forestry/FRAP, 2006). Other species present adjacent to the transect include woolly blue curls (*Trichostema lanatum*) and bigberry manzanita (*Arctostaphylos glauca*).

The chaparral control transect on the north facing slope (Figure 8) was randomly set in a north to south direction. This location is one of six (6) pockets of unburned chaparral on the north facing slopes that are part of the Outfall 9 watershed. This pocket of chaparral is approximately 10 acres in size. The soil type in this area is Gaviota rocky sandy loam. The shrub layer on this transect constitutes approximately 70.3 percent relative cover of this transect, of which approximately 34 percent relative cover is by mountain mahagony, 19 percent relative cover is by toyon, 19 percent relative cover is by holly-leaved cherry, and 1 percent relative cover is by sugarbush (*Rhus ovata*). The shrub layer along this transect is approximately 7-9 feet tall on average. Dead branches of holly-leaved cherry comprise approximately 1 percent relative cover of the transect. Approximately 4 percent relative cover of the transect is bare ground and 13 percent is covered with leaf litter. This transect has an herb layer of approximately 13 percent relative cover and
includes approximately 4 percent relative cover by golden yarrow (*Eriophyllum confertiflorum*), 5 percent relative cover by grass seedlings, 1 percent relative cover by chaparral nightshade (*Solanum xantii*), and 3 percent relative cover by tocalote (a nonnative invasive weed). Other
Control Transect – Unburned South Facing Slope Chaparral/Scrub
N 34.22725°, W 118.72001°

Transect 1 – Burned South Facing Chaparral/Scrub, Aerial Mulched Area
N 34.21935°, W 118.70536°

FIGURE 7

Western Botanical Services, Inc.

SOURCE:
Control Transect – Unburned North Facing Chaparral/Scrub (burned up front)
N 34.23631°, W 118.68769°

Transect 1 – Burned North Facing Chaparral/Scrub, Unmulched Area
N 34.23462°, W 118.68996°

FIGURE 8

Western Botanical Services, Inc.

Boeing Santa Susana Field Laboratory
North Facing Chaparral/Scrub Transects
species present in this area outside the transect include black sage & chia (*Salvia columbariae*). The area surrounding this transect also contained old burned stumps, evidence of a previous historical fire, potentially that occurred around 1970, according to available fire history maps (California Department of Forestry/FRAP, 2006).

The data from the two transects in this area were averaged. The burned (aerial mulched) south facing slope transect (Figure 7) is dominated by California morning glory with an average of 74 percent relative cover. California deerweed and wild cucumber (*Marah macrocarpa*) each occur on less than 1 percent relative cover (average) on the transect, bare ground constitutes 21 percent relative cover (average) of the transect areas, and litter averages less than 2 percent relative cover. The shrub layer is comprised of 2.5 percent relative cover on average by chamise along these transect. The chamise shrubs have resprouted and are approximately two feet tall on average, with burned stems ranging in width from ¼-1” in diameter. Mulch is still present and constitutes approximately 1.5 percent relative cover of the transect not covered by vegetation. Other species present in the surrounding areas include hoary-leaved ceanothus, toyon, laurel sumac, Yerba Santa, scrub oak, and annual phacelia. Numerous native shrub seedlings are also present in pockets surrounding the transects.

The north facing slope chaparral burned transect areas has a shrub layer of approximately 19.3 percent relative cover which is comprised of resprouting toyon shrubs, averaging four (4) feet in height. Approximately 15.4 percent of the transect is covered by burned toyon branches with stems ranging in width from ¼ - 1 inch in diameter. The 44.9 percent understory layer on this transect is comprised of non-native species including tocalote (16.2 percent relative cover) and thistle (5.4 percent relative cover). These two species are annuals and therefore only dead stalks were present at the time of the survey. Native species include heart-leaved snapdragon (*Keckiella cordifolia*) with 6.2 percent relative cover, grass seedlings with 8.5 percent relative cover, yellow yarrow with 3.9 percent relative cover, chaparral nightshade with 0.8 percent relative cover, and phacelia with 0.8 percent relative cover. Approximately 7 percent of the transect area is bare ground and 14 percent is covered with leaf litter. Other species present adjacent to the transect include chamise, black sage, chaparral bush mallow (*Malacothamnus fasciculatus*), California deerweed, laurel sumac, California buckwheat, and red brome grass (*Bromus madritensis rubens*).

**Summary of Preliminary Findings of Post-Fire Vegetation Recovery**

Fire has been a common occurrence in California’s history, and in particular, has occurred frequently in the project area over the course of the last 60 years, as represented by the fire history perimeter maps and substantial literature reviewed. Native plants occurring in these areas of frequent fire have become adapted to fire, as evidenced by survival and regeneration mechanisms including resprouting and seeding strategies.

Strategies that perennial plant species use to recover from fires include crown sprouting, seeding, and branch sprouting. Plants that are adapted to fire are classified as “obligate resprouters”, “facultative seeders”, or “obligate seeders”. Obligate resprouters are plants that depend on resprouting from their underground root systems (including some bulbous plants) and lower stems or burls (lignotuber) to survive after a fire. Facultative seeders both resprout and produce
seeds that germinate after a fire. Obligate seeders are destroyed in the fire and depend on seedlings to replace their populations. The seeds of many of obligate seeder species are fire dependent, meaning their seeds require some fire cue (heat, charred wood, smoke) to germinate.

The rate of regeneration of vegetation following a fire is dependent on numerous factors including severity of the fire, the amount of vegetation in the overstory and understory burned, heating of the soil, proportion of area burned, and length of fire intervals, etc. (DeBano, et al., 1998). Severity of the burn was qualitatively evaluated for discussion purposes only and appeared to vary throughout the project site and were estimated based on visual observations described in (DeBano, et al., 1998) and in Table D.

### Table D - Visual Factors Used to Evaluate Fire Intensity

<table>
<thead>
<tr>
<th>Severity</th>
<th>Litter Present Following Fire</th>
<th>Ash Present Following Fire</th>
<th>% canopy biomass consumed</th>
<th>Diameter (inches) charred plant stems remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Yes (10-15% of pre-fire litter lost)</td>
<td>Gray ash</td>
<td>40</td>
<td>&lt;0.2 (most with leaves)</td>
</tr>
<tr>
<td>Moderate</td>
<td>No</td>
<td>None</td>
<td>40-80</td>
<td>0.2-0.5</td>
</tr>
<tr>
<td>Severe</td>
<td>No</td>
<td>White ash</td>
<td>90</td>
<td>0.5+</td>
</tr>
</tbody>
</table>

**Low Severity** (soil temperature estimated at 225 degrees Celsius at the soil surface and 125 degrees Celsius at 2.5 cm depth) – charred leaf litter, grayish ash most like present immediately following the fire, but soon became inconspicuous.

**Moderate Severity** (maximum soil temperature at mineral surface at almost 430 degrees Celsius, and 200 degrees Celsius at 2.5 cm depth) – bare soil present as leaf litter and fine woody material was consumed by fire. Ash is inconspicuous immediately after the fire. Between 40 and 80 percent of the plant canopy is consumed by the fire; remaining charred twigs would be greater than 0.6 to 1.3 cm in diameter.

**High Severity** (surface soil temperatures just over 700 degrees Celsius and nearly 250 degrees Celsius at 2.5 cm deep) – Fluffy white ash layer present following the fire as a result of the main stems of trees and shrubs that burned.

Based on the burn history of the project site and visual observations, the majority of the Chaparral/Scrub on the project site appears to have burned at a low to moderate severity, varying by location, leaving somewhat of a mosaic of burned and unburned vegetation in some areas. Based on fire history maps, the vegetation was estimated at 25-37 years old at the time of the 2005 fire, and likely contained more than 25 percent dead plant material (fuel). Qualitative data and cursory transect data in the unburned chaparral/scrub communities on the project site represent an example of what the vegetation may have looked like at the time of the fire of 2005. The chaparral were most likely dominated by any combination of chamise, toyon, sugarbush, holly-leaved cherry, and mountain mahogany, approximately 10-12 feet tall, covering approximately 60-70+ percent of the ground surface, with an herb layer of approximately 0-12 percent cover. Leaf litter may have comprised approximately 7-14 percent of the ground in areas not covered with vegetation; approximately 4-13 percent may have been bare soil or rock. This is consistent with descriptions of chaparral and scrub of this age class in other areas researched.

The patchy burn pattern throughout the project area is consistent with descriptions of burn patterns for chaparral and scrub communities that are 25-35 years old (without disturbance).
Chaparral/scrub within the age class are expected to present a mosaic burn pattern, with the north facing moister slopes remaining partially unburned with the drier south facing slopes burning with higher intensity. Similar patterns are observed on the project site as the majority of the burned Chaparral/Scrub areas observed on the southern facing slopes of the project site revealed litter, ash and vegetation characteristics as described for moderate severity burn. However, burned areas on the northern facing slopes appeared to have burned less severely in most areas.

**Time to Recovery: Literature Review**

Chaparral is a dynamic ecosystem that requires disturbance, primarily in the form of fire, in order to persist; hence, the state of recovery following a fire, can be evaluated by looking at the life stages as the community develops back to its pre-burn form (dominated by woody shrubs). Hanes (1971) defines chaparral succession as follows “Chaparral succession is not a series of vegetational replacements, but a gradual ascendance of long-lived species present in the pre-fire stand.”

The life expectancy for a healthy mature chaparral community is between 20-35 years. A fire every 20-30 years keeps chaparral healthy. Following a fire, it can take 20 to 30 years for chaparral to return to its pre-fire physiognomy (form and structure of natural communities) (Hanes, 1971). In the absence of fire for 20 years, chaparral shrubs begin to senesce. Without fire, a large proportion of non-sprouting shrubs eventually die and the community becomes non-productive (Wright and Bailey, 1982).

The rate of recovery is somewhat consistent and predictable based on literatures reviewed, but varies among location of plant communities. The rate of recovery for chaparral communities is greatest during the first six years following a fire, then slows down through the eighth year (Hanes, 1971). By the fifth year following a fire, chaparral resprouts and seedlings dominate the vegetative cover (Hanes, 1971), and stands of chaparral are expected to recover 50 percent of its pre-burn biomass by the eighth year (Wright and Bailey, 1982). Between 18 and 23 years following a fire, chaparral continues to grow but begins to level off by the time it is 20 to 25 years old. At approximately 37 years old, many chaparral plants (i.e., chamise) stops growing and senescence begins; the chaparral community then declines until the next fire.

The effect of slope angle, aspect, and elevation (distance from coast) on rate of recovery of chaparral and coastal sage scrub communities has also been repeatedly studied. Aspect was found to have the greatest influence on rate of recovery (Hanes, 1971; Guo, 2001). For example, the rate of succession was found to be slowest on south-facing slopes below 3,000 feet elevation; the fastest rate of succession was found to be on north-facing slopes above 3,000 feet elevation (Hanes, 1971). Additionally, the north-facing slopes tended to have fewer, if any, coastal sage scrub species present in the chaparral communities, compared to south-facing chaparral communities. In these north-facing areas, the dominant resprouting shrubs and seedlings were primarily responsible for the rapidly closing cover.

Literature also reveals similar results on changes in species composition, species diversity and species richness, responsible for increasing cover during the first eight years follow a fire. Species richness is greatest in the second year, with the presence of annuals and forbs being the biggest contributors; species richness then declines through the forth year, as perennial species
begin to dominate the cover (Guo, 2001; Grace and Keely, 2006). **This is significant from an erosion control perspective because the much greater root depth and area of perennial species (e.g., chaparral) provide greater soil stabilization compared to that of dominant annuals (e.g., annual grasses).** The increasing total vegetation cover over time following a fire, resulting in high biomass production (Grace and Keely, 2006), is comprised of differing life forms during the each of the first five years. During the first to third growing seasons following a fire, the chaparral community is typically comprised of resprouting woody vegetation and post-fire adapted annual and forb species. During the second to fourth year, seedlings of fire adapted perennials are prevalent amongst the annual forbs and grasses. Studies have shown that the vegetative cover during this time increases from approximately 65 percent total cover in the first/second year, to almost 150 percent cover in the fifth year (Grace and Keeley, 2006). For comparison, total vegetative cover measured in the unburned stands of chaparral during the site reconnaissance were 92 and 94 percent¹ for each transect surveyed on a south and north-facing slope, respectively (Table C). In these transect areas it is estimated that the vegetation is approximately 25 to 35 years old. Vegetation recovery is not necessarily defined as having reached 100 percent or more of total vegetative cover (perennials and annuals), but rather attaining cover types and percentages that are representative of pre-fire conditions.

**Time to Recovery: Preliminary Evaluation of Project Site**

Recovery of the burned vegetation on the project site was primarily evaluated by visual observation of the presence of regeneration by documenting the presence of resprouting vegetation and seedlings in the burned areas. Species composition and vegetative structure of the unburned areas were also documented to get an understanding of what the burned areas may have looked like prior to the fire.

Based on numerous studies on recovery of chaparral and sage scrub communities following a fire, the vegetation on the project site is expected to produce vegetation from resprouts and seed at a high rate for the first five years following the fire. The burned vegetation appears to be regenerating as would be expected after one growing season following a fire. For example, some of the obligate and facultative resprouters that are present and have resprouting vegetation from 1 to 10 feet tall include laurel sumac, chamise, toyon, holly-leaved cherry, scrub oak, Yerba Santa, lemonadeberry, and mountain mahogany. Many of the burned areas that face south/southwest and west are dominated by California morning glory (*Calystegia macrostegia*); this is consistent with a study conducted on the recovery of chaparral following the 2003 Santa Monica Mountain fire (Guo, 2003). Many of these areas also contain many coastal sage scrub species including Our Lord’s candle, annual phacelia (*Phacelia sp.*), California aster, and California deerweed seedlings. Resprouting appears to be present on approximately 90 percent of shrubs observed in most areas, with the exception of the burned shrubs on the slope just north of Well 12 that appear to be experiencing approximately 70 percent resprouting (based on visual estimation). This could either be a result of higher fire severity and/or intensity in this area, or the presence of a higher percentage of shrub species (unidentifiable) that do not readily resprout after a fire.

Seedlings of perennial obligate seeders are also present on the burned areas and include hoary-leaved ceanothus, chamise, California deerweed, scrub oak, California sagebrush, and California buckwheat. The average seedling height is 2-10” and varies in density depending on location.

---

¹ Percent dead cover was 23 and 1 percent for the south and north-facing slope transects, respectively.
The presence of annual species on the project site is also consistent with literature describing the vegetation likely to be observed within two years following a fire. For example, the residual skeletons of annual forbs (dominants are Phacelia and California morning glory) are present from the first years’ growth following the fire in most of the burned Chaparral and scrub areas observed. We would expect annual grasses and forbs to prevail during spring and summer 2007, as it will be the second growing season following the fire. Evidence of abundant grass seedlings and newly germinating forbs were present during the February 2007 survey. The presence of annuals (e.g., herbaceous species and grasses) is important because the shallow-rooted annuals can provide protection against impact erosion on bare soil until the deeper-rooted perennials become established. Perennials such as chaparral, however, have root structures that are comprised of both deep and shallow roots and are generally capable of holding more soil in place during runoff-producing storm events.

Literature suggests that the vegetation composition of the grassland areas can be expected to be similar to pre-fire conditions within three years following a fire (Brown, et al., 2000). This quick recovery of vegetation cover is apparent on the project site. During the February 2007 surveys, at nearly two years following the 2005 fire, non-native grassland/ruderal areas appear to already have approximately 90-100 percent cover of remnant vegetative cover consisting of last growing season’s annual grasses and forbs. Remnant stalks from last year’s growth and newly germinating seedlings were present and include non-native grasses, tocalote, Italian thistle, milk thistle (Silybum marianum), doveweed (Eremocarpus setigerous), and mustards.

Oak Woodlands throughout the project site burned differently depending on aspect, location, intensity of the fire, type of plant community, and closeness to rocks and riparian areas. Many of the oak woodlands that appeared to have an understory dominated by annual grasses did not appear to have burned as hot or as high up the trunk and canopy as other areas on the project site, that potentially consisted of woody herbs and perennials. Oak trees and oak woodlands that were surrounded by or adjacent to mature chaparral shrubs sustained more intensive fire damage, some experiencing complete canopy burn. Most of these severely burned oaks are resprouting at the branch nodes, however, a few oaks were seen with little or no resprouting in the areas that appeared to have sustained more burn damage.

Riparian habitats including oak woodland riparian, southern willow scrub, mulefat scrub and freshwater marsh communities that burned mostly appear to be recovering by crown sprouting. However, some of the large willow trees and few sycamore trees in the drainage across from Outfalls 15 and 11 appear to have sustained intensive burn damage as the entire canopy is burned and no vegetation remains above the crown.

Overall, all areas observed show signs of regeneration as resprouts and seedlings as expected based on the findings in numerous literature related to fire and chaparral. Based on a review of the literature, vegetative recovery occurs most rapidly during the first 6 years of regrowth and less rapidly thereafter. In the event that weather patterns are somewhat normal over the next 20-30 years, and in the absence of any catastrophic events on the burned areas, we expect the burned chaparral on the project areas to follow the growth patterns described in literature for recovery of chaparral and coastal sage scrub communities. The time frame for vegetation recovery described in the literature is necessarily broad, as the establishment and growth of vegetation is dependant upon several factors, e.g. vegetation type, soil conditions, fire severity, and climatic conditions. Vegetative recovery will be defined using measurable site-specific metrics as part of the Phase 2
work plan, and will be fundamentally based on statistical comparisons between burned and unburned (control) areas at or near the project site.
Literature Cited and Reviewed


California Department of Forestry/FRAP. 2006??. Fire History Maps (for Boeing Project Area) obtained from Fire Perimeter data. http://frap.cdf.ca.gov/projects/fire_fire_perimeters/


California Regional Water Quality Control Board, Los Angeles Region. 2003. Conditional Certification for Proposed Happy Valley Perchlorate Interim Measures Project, Unnamed Tributary to Dayton Creek, City of Simi Hills, Los Angeles County (File #3-118).


Department of Agriculture, Soil Conservation Service, 1970. Soil Classification Map of Ventura. (GIS overlay on project topography map.)


Holland, Dr. Robert F. 1986. Preliminary Descriptions of the Terrestrial Natural Communities of California, prepared for State of California, The Resources Agency Department of Fish and Game.


MWH Americas, Inc. and AMEC Earth & Environmental, Inc. 2005. Addendum to the Biological Conditions Reports, Santa Susana Field Station, Ventura County, California. Including Vegetation Map with Sensitive Species (Mapped in surveys conducted from 1995-1997)

MWH Americas, Inc. 2006. Figure 8: Summary of Erosion Control Measures, Boeing Santa Susana Field Laboratory.


APPENDIX A: FIGURE 2A - VEGETATION COMMUNITY MAP (MWH AMERICAS, INC)
Vegetation Map with Sensitive Species
Santa Susana Field Laboratory

Legend

Sensitive Wildlife

DD MULE DEER
BC ROBOT CAT
EU TURKEY VULTURE
RO RED-SHOULDERED HAWK
BTJ S.D. BLACK-TAILED JACANA
RTHA RED TAILED HAWK
GROW GREAT BLUE HERON
GRY GREAT HORNED OWL
SHAFA SHARP SHINNED HAWK
RCSP RUFUS CROWDED SPARROW
DCCO DOUBLE-CRESTED CORMORANT
TSCS TWO-STRIPED GARTER SNAKE
COZA COOPER'S HAWK
LOSH LINGERING SHARKE

Sensitive Plants

BTJ SANTA SUSANA MOUNTAIN TARPLANT
BW SOUTHERN CAL. BLACK WALNUT
VCO VALLEY OAK
LR COAST LIVE OAK
APPENDIX B

VASCULAR PLANT SPECIES OBSERVED

The following vascular plant species were observed in the study area by biologist(s) Jeannette Halderman during site surveys conducted on February 5-9, 2007.

* Introduced, nonnative species

PTERIDOPHYTA

Polypodiaceae
Polypodium californicum

Pteridaceae
Pellaea sp.

Selaginellaceae
Selaginella bigelovii

FERNS AND FERN-ALLIES

Wood Fern Family
California polypody fern

Brake Family
Coffee fern

Spike-moss Family
Bigelow's spike-moss

ANGIOSPERMAE: DICOTYLEDONAE

Aizoaceae
*Carpobrotus aequilateralus

Anacardiaceae
Malosma laurina
Rhus integrifolia
Rhus ovata
Toxicodendron diversilobum

DICOT FLOWERING PLANTS

Carpet-weed Family
Sea-fig

Sumac Family
Laurel sumac
Lemonade berry
Sugar bush
Poison oak

Sunflower Family
Western ragweed
California sagebrush
Mugwort
Coyote bush
Mulefat
Italian thistle
Tocalote
Flax-leaved horseweed
Common horseweed
California encelia
Golden yarrow

Asteraceae
Ambrosia psilostachya
Artemisia californica
Artemisia douglasiana
Baccharis pilularis
Baccharis salicifolia
*Carduus pycnocephalus
*Centaurea melitensis
*Conyza bonariensis
Conyza canadensis
Encelia californica
Eriophyllum confertiflorum var. confertiflorum
Gnaphalium bicolor
Gnaphalium californicum
Hazardia squarrosa
Hemizonia minthornii
Heterotheca grandiflora
Heterotheca sessiliflora
* Lactuca serriola
Lessingia filaginifolia
Malacothrix saxatilis var. tenuifolia
* Silybum marianum
* Sonchus asper ssp. asper

Boraginaceae
Amsinckia menziesii

Brassicaceae
* Brassica nigra
* Hirschfeldia incana

Caprifoliaceae
Lonicera subspicata var. denudata
Sambucus mexicana

Chenopodiaceae
* Salsola tragus

Convolvulaceae
Calystegia macrostegia

Crassulaceae
Dudleya lanceolata
Dudleya pulverulenta ssp. pulverulenta

Cucurbitaceae
Marah macrocarpus

Ericaceae
Arctostaphylos glauca

Euphorbiaceae
Eremocarpus setigerus

Fabaceae
Astragalus brauntonii
Lotus scoparius
Lupinus sp.
Vicia sp.

Bicalored cudweed
California everlasting
Saw-toothed goldenbush
Santa Susana tarplant
Telegraph weed
Golden aster
Prickly lettuce
California aster
Cliff malacothrix
Milk thistle
Prickly sow-thistle
Fiddleneck

Mustard Family
Black mustard
Shortpod mustard

Honeysuckle Family
Southern honeysuckle
Mexican elderberry

Goosefoot Family
Russian-thistle

Morning-glory Family
Morning-glory

Stonecrop Family
Lance-leaved dudleya
Chalk dudleya

Gourd Family
Wild cucumber

Heath family
Bigberry manzanita

Spurge Family
Doveweed

Legume Family
Braunton’s milk-vetch
California deerweed
Lupine
Vetch
Fagaceae  
*Quercus agrifolia var. agrifolia*  
*Quercus berberidifolia*

Geraniaceae  
*Erodium cicutarium*

Grossulariaceae  
*Ribes indecorum*  
*Ribes malvaceum*

Hydrophyllaceae  
*Eriodictyon crassifolium*  
*Phacelia sp.*  
*Phacelia ramosissima*

Lamiaceae  
*Marrubium vulgare*  
*Salvia columbariae*  
*Salvia leucophylla*  
*Salvia mellifera*  
*Salvia spathacea*  
*Trichostema lanatum*

Lauraceae  
*Persea americana*  
*Umbellularia californica*

Malvaceae  
*Malacothamnus fasciculatus*

Myrtaceae  
*Eucalyptus spp.*

Nyctaginaceae  
*Abronia maritima*  
*Bougainvillea sp.*  
*Mirabilis californica*

Onagraceae  
*Epilobium sp.*

Beech Family  
Coast live oak  
California scrub oak

Geranium Family  
Red-stemmed filaree

Gooseberry Family  
White-flowered gooseberry  
Chaparral currant

Waterleaf Family  
Thick-leaved yerba santa  
Phacelia  
Branching phacelia

Mint Family  
Horehound  
Chia  
Purple sage  
Black sage  
Hummingbird sage  
Woolly blue-curls

Laurel Family  
Avocado  
California bay laurel

Mallow Family  
Chaparral bush mallow

Myrtle Family  
Gum

Four O'clock Family  
Red sand-verbena  
Bougainvillea  
California wishbone bush

Evening Primrose Family  
Willow-herb
Paeoniaceae
   * Paeonia californica

Papaveraceae
   * Dicentra sp.
   * Eschscholzia californica

Platanaceae
   * Platanus racemosa

Polygonaceae
   * Eriogonum fasciculatum
   * Rumex crispus

Primulaceae
   * Anagallis arvensis

Rhamnaceae
   * Ceanothus crassifolius
   * Rhamnus ilicifolia

Rosaceae
   * Adenostoma fasciculatum
   * Cercocarpus betuloides var. betuloides
   * Heteromeles arbutifolia
   * Prunus ilicifolia ssp. ilicifolia
   * Rosa californica

Rutaceae
   * Citrus sp.

Salicaceae
   * Salix laevigata
   * Salix lasiolepis

Scrophulariaceae
   * Antirrhinum sp.
   * Keckiella cordifolia
   * Mimulus aurantiacus

Solanaceae
   * Nicotiana glauca
   * Solanum xanti

Verbenaceae
   * Verbena lasiostachys

Peony Family
   * California peony

Poppy Family
   * Ear-drops
   * California poppy

Sycamore Family
   * Western sycamore

Buckwheat Family
   * Buckwheat
   * California buckwheat
   * Curly dock

Primrose Family
   * Scarlet pimpernel

Buckthorn Family
   * Hoaryleaf ceanothus
   * Holly-leaved redberry

Rose Family
   * Chamise
   * Mountain mahogany
   * Toyon
   * Holly-leaved cherry
   * California rose

Rue Family
   * Citrus tree

Willow Family
   * Red willow
   * Arroyo willow

Figwort Family
   * Snapdragon
   * Heart-leaved bush-penstemon
   * Bush monkey flower

Nightshade Family
   * Tree tobacco
   * Chaparral nightshade

Vervain Family
   * Western verbena
<table>
<thead>
<tr>
<th>ANGIOSPERMAE: MONOCOTYLEDONAE</th>
<th>MONOCOT FLOWERING PLANTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cyperaceae</strong></td>
<td><strong>Sedge Family</strong></td>
</tr>
<tr>
<td>* Cyperus sp.</td>
<td>Umbrella-sedge</td>
</tr>
<tr>
<td>* Scirpus sp.</td>
<td>Bulrush</td>
</tr>
<tr>
<td><strong>Juncaceae</strong></td>
<td><strong>Rush Family</strong></td>
</tr>
<tr>
<td>* Juncus sp.</td>
<td>Rush</td>
</tr>
<tr>
<td><strong>Liliaceae</strong></td>
<td><strong>Lily Family</strong></td>
</tr>
<tr>
<td>* Agave americana</td>
<td>American century plant</td>
</tr>
<tr>
<td>* Chlorogalum pomeridianum</td>
<td>Wavy-leaved soap plant</td>
</tr>
<tr>
<td>* Dichelostemma capitatum ssp. capitatum</td>
<td>Blue dicks</td>
</tr>
<tr>
<td>* Yucca whipplei</td>
<td>Our Lord’s candle</td>
</tr>
</tbody>
</table>

**Poaceae**

| * Bromus diandrus             | Ripgut grass             |
| * Bromus hordeacus            | Soft chess               |
| * Bromus madritensis ssp. rubens | Foxtail chess            |
| * Leymus condensatus          | Giant wild-rye           |
| * Muhlenbergia rigens         | California deergrass     |
| * Nassella sp.                | Needlegrass              |
| * Polypogon monspeliensis     | Rabbitsfoot grass        |

**Typhaceae**

| * Typha sp.                   | **Cat-tail Family**      |

Taxonomy and scientific nomenclature conform to Hickman (1993). Common names for each taxa generally conform to Roberts (1998), although Abrams (1923, 1944, 1951) and Abrams and Ferris (1960) are used, particularly when species specific common names are not identified in Roberts (1998).
### Field Data Sheet for Monitoring Vegetation and Erosion Control Projects (Reconnaissance Level)

**Project/Location:** Happy Valley
**Date:** 2/9/07

**Treatment Type(s):**
- Performed by: [Name]
- Date of Treatment/ Age of Project: [Date]

**Slope:** 0.5% along bottom of side

**Aspect:**

**Soil Type:** Ful - Silty Sand

**Percent Litter Cover:**

**Percent Rock Cover:**

**Percent Bare:**

**Condition of Drainage Improvements:**
- Infiltration trenches:
- Drop Inlets:
- Collection Systems:

**Runoff Source (onsite or offsite):**

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tocolea - Centaurium melit.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physaria major</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Achillea caly</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salvia officinalis</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nicotiana glauca</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Euphorbus rubens</td>
<td>X</td>
<td></td>
<td>0.3%</td>
</tr>
<tr>
<td>Lapsus scoparius</td>
<td>X</td>
<td></td>
<td>0.5%</td>
</tr>
<tr>
<td>Chamaelusatn</td>
<td>X</td>
<td></td>
<td>0.5%</td>
</tr>
<tr>
<td>Baccharis pilularis</td>
<td>X</td>
<td></td>
<td>0.5%</td>
</tr>
<tr>
<td>Verna sativa</td>
<td>X</td>
<td></td>
<td>0.1%</td>
</tr>
<tr>
<td>Nassella tenuissima</td>
<td>X</td>
<td></td>
<td>10-15% in slope 0%</td>
</tr>
</tbody>
</table>

**Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):**
- Disturbance by vehicle 10' wide along top of soil riprap filters (pic 20-28)
- Road has rills & dominated by tocolate & mustard
- Flat area above bilt riprap filter dam by tocolate, milk thistle with bunch grasses & comiza sp?
- Beach fill on short road (vehicle area)

**Notes:**
- Pics 14-15, 16-17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28.
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects
(Reconnaissance Level)

Project/Location: Tucson Well 13
Date: 2/5/07
Surveyors: Jeannette Halderman

Treatment Type(s):
Performed by:
Date of Treatment/ Age of Project: Chaparral - North facing

Slope: 45° slope
Aspect: N facing
Soil Type: Chatsworth formation

Percent Litter Cover: 50-70%
Percent Rock Cover: 10-20%
Percent Bare: 10-20%

Condition of Drainage Improvements:
Infiltration trenches:
Drop Inlets:
Collection Systems: Visual Observation
Runoff Source (onsite or offsite): Slope

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eriogonum fasciculatum</td>
<td>X</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Eriogonum longifolium</td>
<td>X</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Yucca filamentosa</td>
<td></td>
<td></td>
<td>0-10%</td>
</tr>
<tr>
<td>Sarcobatus vermiculatus</td>
<td></td>
<td></td>
<td>0-10%</td>
</tr>
<tr>
<td>Arizona cress (lava flow) &amp; Seepage</td>
<td></td>
<td></td>
<td>ALL 100%</td>
</tr>
<tr>
<td>Adenostoma fasciculatum (replant 4&quot;)</td>
<td>X</td>
<td></td>
<td>10-30%</td>
</tr>
<tr>
<td>(c) Malacothrix ssp.</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>(c) Phacelia campanula</td>
<td></td>
<td></td>
<td>10-30%</td>
</tr>
</tbody>
</table>

Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):
(c) Phacelia campanula 10-30%

Notes:
- Marah macrocarpa 0-5%
- Hazardia squarrosa 0-5%
- Umbellifer Gulf (burned 8-16 response) 0-10%
- Mexican arborvitae 0-10%
- Local shrubbery 0-5%
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects
(Reconnaissance Level)

Project/Location: Outfall 9 - well 13
Date: 2/5/07
Surveyors:

Treatment Type(s):
Performed by:
Date of Treatment/ Age of Project:

Slope:
Aspect: W facing
Soil Type:

Percent Litter Cover:
Percent Rock Cover:
Percent Bare:

Condition of Drainage Improvements:
Infiltration trenches:
Drop Inlets:
Collection Systems:
Runoff Source (onsite or offsite): __________________________

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromus diandrus</td>
<td></td>
<td>X</td>
<td>50-70%</td>
</tr>
<tr>
<td>Lotus scoparia</td>
<td></td>
<td>X</td>
<td>0-5%</td>
</tr>
<tr>
<td>(c)Ricinus (unidentified) inacce</td>
<td>X</td>
<td>0-5%</td>
<td></td>
</tr>
<tr>
<td>Vulpin ?</td>
<td></td>
<td>X</td>
<td>30-10%</td>
</tr>
<tr>
<td>Distylygey plant</td>
<td></td>
<td>X</td>
<td>0-1%</td>
</tr>
</tbody>
</table>

Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):

Notes:
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects
(Reconnaissance Level)

Project/Location: Banning Well 13
Date: 2/1/01 Surveyors:
P
Treatment Type(s): Performed by: Jeannette Haldeman
Date of Treatment/ Age of Project:
Slope: 60°-70° slope
Aspect: South facing
Soil Type: Chatsworth Formation 60-80% Large sandstone rock face

| Percent Litter Cover: 0-5% | 30-50% Veg Cover |
| Percent Rock Cover: 80-90% |
| Percent Bare: 60-70% |

Condition of Drainage Improvements:
- Infiltration trenches:
- Drop Inlets:
- Collection Systems:

Runoff Source (onsite or offsite):

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaxma lasuinae</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Atriplex ssp.</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Vieca whipp</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Mimulus avinarius</td>
<td>x</td>
<td></td>
<td>0-0%</td>
</tr>
<tr>
<td>Scabiosa ovulataenicient</td>
<td>x</td>
<td></td>
<td>0-0%</td>
</tr>
<tr>
<td>Saline up or Yoda Santa (?)</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
</tbody>
</table>

Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.): Burned

Notes: Dead dormant stalks - low growing shrubs 20-30% mid-lower slope
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects
(Reconnaissance Level)

Project/Location: Boeing-Wellis-out full g
Date: 2/6/07
Surveyors:
Treatment Type(s):
Performed by: Jeannette Halderman
Date of Treatment/ Age of Project:

Slope: oru6- wroyd, 1ruL,
Aspect:

Soil Type: ________________________________
Percent Litter Cover:
Percent Rock Cover:
Percent Bare:

Condition of Drainage Improvements:
Infiltration trenches:
Drop Inlets:
Collection Systems:

Runoff Source (onsite or offsite): ________________________________

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overstory</td>
<td><em>O. virginiana</em></td>
<td>✨</td>
<td>✧</td>
</tr>
<tr>
<td><em>Quercus agrifolia</em></td>
<td>✨</td>
<td>✧</td>
<td>80-90</td>
</tr>
<tr>
<td><em>Salix</em></td>
<td>✨</td>
<td></td>
<td>1-5%</td>
</tr>
<tr>
<td>Understory</td>
<td><em>Calystegia umbellata</em></td>
<td>✨</td>
<td></td>
</tr>
<tr>
<td><em>Vitis labrusca</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>V. vinifera</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Lonicera maackii</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Vaccinium angustifolium*</td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M. maricaria</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. canadensis</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. brachycylla</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. cordata</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. attaphilum</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottom of drainage - <em>P. vulgaris</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>R. aculeata</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>R. crispum</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>R. sedges</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steps under oak canopy</td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>H. virginiana</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>P. virginiana</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>P. occidentalis</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>P. pilosella</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>P. capillaris</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Epilobium</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Dempnhila or phacelia</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Eriophyllum</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>bracken fern</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Lonicera</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Holly leaved cherry</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>mustard</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Malacothamnus</em></td>
<td>✨</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: ________________________________
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects
(Reconnaissance Level)

Project/Location: Bear Trap Valley - outfall 8
Date: 2/5/07
Surveyors: 
Treatment Type(s):
Performed by: Jeannette Halderman
Date of Treatment/ Age of Project:

Slope: 20-25°
Aspect: South facing
Soil Type: Chatsworth formation

Percent Litter Cover: 0-5%
Percent Rock Cover: 10-20%
Percent Bare: 30-40%

Condition of Drainage Improvements:
- Infiltration trenches:
- Drop Inlets:
- Collection Systems:

Runoff Source (onsite or offsite): __________________________

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malverna laevana</td>
<td>x</td>
<td></td>
<td>0-20%</td>
</tr>
<tr>
<td>Hesperostipa comata</td>
<td>x</td>
<td></td>
<td>0-20%</td>
</tr>
<tr>
<td>Genus santal</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Convolvulus or California</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mimulus aurantiacus</td>
<td>x</td>
<td></td>
<td>0-10%</td>
</tr>
<tr>
<td>Rhus micrantha</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Russian-thistle seedlings</td>
<td>x</td>
<td></td>
<td>0-1%</td>
</tr>
<tr>
<td>Scrub oak sprout</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Prosopis glandulosa</td>
<td>x</td>
<td></td>
<td>1 tree, 4-5’ tall</td>
</tr>
<tr>
<td>Conocarpus erectus</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Poison oak seedlings</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Phacelia tanacetifolia</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Euphorbia sp.</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
</tbody>
</table>

Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):
- lots of bare along flat areas
- malverna near drainage & flat not responding as much as those higher up on slope
- Quercus agrifolia along bottom - 40' apart - burned - lots responding
- (Strawberries - BMP area)
- Along drainage in slope
- lots mounded
-etrosion - scattered
- grasses germinating (1-2"
- Chorizanthes (sprouting) x
- Salvia mellifera x

Notes: Hyssop scatd still present
- 0-5% grasses germinating (1-2"
- Chorizanthes (sprouting) x
- 0-5% seedlings
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects
(Reconnaissance Level)

Project/Location: Broom Outfall I
Date: 2/16/07
Treatment Type(s):
Performed by:
Date of Treatment/ Age of Project:

Slope: 
Aspect: 

Soil Type: Soft Sandy bottom and Silty on slopes (out)

Percent Litter Cover: 
Percent Rock Cover: Occasional Sandstone rock on bottom - mostly soft
Percent Bare: Bottom 90-95%

Condition of Drainage Improvements:
- Infiltration trenches:
- Drop Inlets:
- Collection Systems:

Runoff Source (onsite or offsite): 

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rumex crispus</td>
<td>x</td>
<td>0-5%</td>
<td></td>
</tr>
<tr>
<td>Corizza sp.</td>
<td></td>
<td>0-5%</td>
<td></td>
</tr>
<tr>
<td>Baccharis pilul</td>
<td>x</td>
<td>0-5%</td>
<td></td>
</tr>
<tr>
<td>Polygonum mississipicum (grass)</td>
<td>x</td>
<td>0-5%</td>
<td></td>
</tr>
<tr>
<td>Teearus sp.</td>
<td>x</td>
<td>0-5%</td>
<td></td>
</tr>
<tr>
<td>Baccharis silicic</td>
<td>x</td>
<td>0-5%</td>
<td></td>
</tr>
<tr>
<td>Cyperus umbell</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):

Notes:
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects
(Reconnaissance Level)

Project/Location: Boeing Outfall 2 (cow pond) Western Flow

Date: 2/1/10

Surveyors: Jeanette Haldeman

Perfomed by: 

Date of Treatment/ Age of Project:

Slope:

Aspect:

Soil Type: Sandy Salt - Futurity Santa Barbara formation

Percent Litter Cover:

Percent Rock Cover:

Percent Bare:

Condition of Drainage Improvements:

Infiltration trenches:

Drop Inlets:

Collection Systems:

Runoff Source (onsite or offsite):

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eremocarpus setig</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Silphium marianum</td>
<td></td>
<td>x</td>
<td>5-25%</td>
</tr>
<tr>
<td>Medicago sativa - summer</td>
<td></td>
<td>x</td>
<td>20-80%</td>
</tr>
<tr>
<td>Centaurea melitica</td>
<td></td>
<td>x</td>
<td>5-15%</td>
</tr>
<tr>
<td>(exotic) Malva tenuifolia</td>
<td></td>
<td>x</td>
<td>5-15%</td>
</tr>
<tr>
<td>Eriogonum pringlei</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Italian thistle ?</td>
<td></td>
<td>x</td>
<td>5-15%</td>
</tr>
<tr>
<td>Luzula sp</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Thick Stalked Grass - no record</td>
<td></td>
<td></td>
<td>20-30%</td>
</tr>
<tr>
<td>Symphyotrichum ruber</td>
<td></td>
<td></td>
<td>5-15%</td>
</tr>
<tr>
<td>Malacothamnus fasc</td>
<td></td>
<td>x</td>
<td>0-5%</td>
</tr>
<tr>
<td>Nassella sp (pockets)</td>
<td></td>
<td>x</td>
<td>0-5%</td>
</tr>
</tbody>
</table>

Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):

Salvia leucophylla                      |        | x          | 0-5%    |

Notes:
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects
(Reconnaissance Level)

Project/Location: Boeing cutoff
Date: 2/12/02
Surveyors:
Treatment Type(s): Performed by:
Date of Treatment/ Age of Project:
Slope: Draining South
Aspect: Drainage 0-5%
Soil Type: Well-drained sand in bottom on sandstone bedrock

Percent Litter Cover:
Percent Rock Cover:
Percent Bare:
Condition of Drainage Improvements:
  Infiltration trenches:
  Drop Inlets:
  Collection Systems:
Runoff Source (onsite or offsite):

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Quercus agrifolia</em> (oak)</td>
<td>X</td>
<td></td>
<td>0-1%</td>
</tr>
<tr>
<td><em>Rubus arctos</em></td>
<td></td>
<td>0-5%</td>
<td></td>
</tr>
<tr>
<td><em>Ambrosia fellostachya</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Phleum campestre</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Elytrigia montana</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Sphaeralcea copa</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Verbena californica</em></td>
<td></td>
<td>X</td>
<td>0-5%</td>
</tr>
<tr>
<td><em>Juncus sp.</em></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>Cuphea inverts</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Malva parviflora</em> (<em>mal</em></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>Lonicera subspicata</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Aster alpinus</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Siskiyou marum</em></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td><em>Malva marito</em></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):

Notes:

Riparian drainage: Chap on both sides
BMPs - straw woven in slopes not shown on map
(i.e. straw bales on north side)
Some ponded water holes in rock drops as go upstream
Lemonade berry branch in creek

Rock
*Dudleya lanceolata*
*Atriplex*
*Diplotaxis*
*Calochortus*?
(on bank-
*Deyeuxia ciliata*
*Erechtites hieracoides*
*Black mustard*
*Brassica rubus*
*Artemisia douglasiana*
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects
(Reconnaissance Level)

Project/Location: Boeing Outfall 2
Date: 2/16/01
Surveyors: Jeannette Hulderman

Treatment Type(s):
Performed by:
Date of Treatment/ Age of Project:

Slope: 40°
Aspect: SE facing
Soil Type: Chatsworth formation

Percent Litter Cover:
Percent Rock Cover:
Percent Bare:

Condition of Drainage Improvements:
- Infiltration trenches:
- Drop Inlets:
- Collection Systems:

Runoff Source (onsite or offsite):

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenostoma fasciculatum</td>
<td>✓</td>
<td></td>
<td>5-15%</td>
</tr>
<tr>
<td>Convolvulus californicus macrococcus</td>
<td>✓</td>
<td></td>
<td>60-80%</td>
</tr>
<tr>
<td>Lotus scoparius</td>
<td>✓</td>
<td></td>
<td>5-10%</td>
</tr>
<tr>
<td>Erodium cicutarium</td>
<td>✓</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Ceanothus crassifolius</td>
<td>✓</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Malus sargentii (impatiens)</td>
<td>✓</td>
<td></td>
<td>5-15%</td>
</tr>
<tr>
<td>Hesperocyparis squamata</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Quercus berberidophylla</td>
<td>✓</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Prunus serotina (annual)</td>
<td>✓</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Salix myrtillus</td>
<td>✓</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Baccharis pilularis</td>
<td>✓</td>
<td></td>
<td>0-5%</td>
</tr>
</tbody>
</table>

Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):

Notes:
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects  
(Reconnaissance Level)

Project/Location: Boeing Outfall 9  Sage Ranch - Conservation Area

Date: 7/10/07  Surveys:

Treatment Type(s):
- Coastal Sage scrub
- Some burned - some small shrubs didn't burn

Date of Treatment/ Age of Project:

Slope:

Aspect:

Soil Type: Sedimentary Rock Land (SRL)

Percent Litter Cover:

Percent Rock Cover:

Percent Bare:

Condition of Drainage Improvements:
- Infiltration trenches:
- Drop inlets:
- Collection Systems:

Runoff Source (onsite or offsite):

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salvia mellifera</td>
<td></td>
<td></td>
<td>10-20%</td>
</tr>
<tr>
<td>Arctostaphylos californica</td>
<td></td>
<td></td>
<td>20-40%</td>
</tr>
<tr>
<td>Lotus scoparia</td>
<td></td>
<td></td>
<td>5-15%</td>
</tr>
<tr>
<td>Geophyllum californica</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Geophyllum lucidum</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Malosma laurina</td>
<td></td>
<td></td>
<td>10-20%</td>
</tr>
<tr>
<td>Adenostoma fascicola</td>
<td></td>
<td></td>
<td>10-30%</td>
</tr>
<tr>
<td>Brachyotum spicatum</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Yucca whipplei</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Eriogonum</td>
<td></td>
<td></td>
<td>20-50%</td>
</tr>
<tr>
<td>Macleaya</td>
<td></td>
<td></td>
<td>10-20%</td>
</tr>
<tr>
<td>Solanum viniti</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Mustard</td>
<td></td>
<td></td>
<td>5-20%</td>
</tr>
<tr>
<td>Phacelia cam</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Rhamnus lucifolius</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Atriplex cristata</td>
<td></td>
<td></td>
<td>5-15%</td>
</tr>
<tr>
<td>Atriplex canescens</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Controsepyrium fill</td>
<td></td>
<td></td>
<td>0-5%</td>
</tr>
</tbody>
</table>

Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):

Notes:
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects (Reconnaissance Level)

Project/Location: Belling Well 12 > outfall 9

Date: 12/7/07  Surveyors:

Treatment Type(s): Performed by:

Date of Treatment/ Age of Project:

Slope: 70°

Aspect: South-facing

Soil Type:

Percent Litter Cover:

Percent Rock Cover: 20-30%

Percent Bare: 20-30%

Condition of Drainage Improvements:
- Infiltration trenches:
- Drop Inlets:
- Collection Systems:

Runoff Source (onsite or offsite):

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malocea laurinca</td>
<td>y</td>
<td></td>
<td>5-20%</td>
</tr>
<tr>
<td>Adenostoma Fasciculatum</td>
<td>x</td>
<td></td>
<td>5-10%</td>
</tr>
<tr>
<td>Quercus Berlandia</td>
<td>x</td>
<td></td>
<td>5-10%</td>
</tr>
<tr>
<td>Pinyon - Juniper - Hack</td>
<td>x</td>
<td></td>
<td>5-20%</td>
</tr>
<tr>
<td>Odontonate Fine - Pinyon</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Juniper</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Calotheca ornata</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Eucadulea crass</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
<tr>
<td>Malocea laurinca</td>
<td>x</td>
<td></td>
<td>0-5%</td>
</tr>
</tbody>
</table>

Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):

Notes:
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects
(Reconnaissance Level)

Project/Location: Between Wells 12 & B
Date: 21-1-01
Surveyors: [Signature]
Treatment Type(s): [Signature]
Performed by: Jeannette Halderman
Date of Treatment/ Age of Project:
Slope: (north facing) 60°
Aspect:
Soil Type: Sny

Percent Litter Cover:
Percent Rock Cover:
Percent Bare:

Condition of Drainage Improvements:
Infiltration trenches:
Drop inlets:
Collection systems:

Runoff Source (onsite or offsite):

<table>
<thead>
<tr>
<th>Dominant Plant Species</th>
<th>Native</th>
<th>Non-Native</th>
<th>% Cover</th>
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<tbody>
<tr>
<td>Helianthus annuus</td>
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<td>P. ruthenica</td>
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<td>Ripa sp (lg shrub)</td>
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<tr>
<td>Rhamnus /Richteria</td>
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<tr>
<td>Chus ingens</td>
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<td>Cercocarpus spectabilis</td>
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<td>Adenostoma fasciculata</td>
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<td>Chaenomeles californica</td>
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Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):

Notes: unburned mixed chaparral

PIK 61
10-15' tall
drainage below has mulch at bottom
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects
(Reconnaissance Level)

Project/Location: Boeing - by entrance
Date: 7/1/07

Treatment Type(s):
Performed by:
Date of Treatment/ Age of Project:

Slope: 
Aspect: 
Soil Type: 

Percent Litter Cover: 
Percent Rock Cover: 
Percent Bare: 

Condition of Drainage Improvements:
Infiltration trenches: 
Drop Inlets: 
Collection Systems: 

Runoff Source (onsite or offsite): 

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<th>% Cover</th>
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<tr>
<td>Baccharis salicifolia</td>
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<tr>
<td>Salix</td>
<td>x</td>
<td></td>
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</tr>
<tr>
<td>Cistus subcylindricus</td>
<td>x</td>
<td></td>
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<tr>
<td>Rhamnus alaternus</td>
<td>x</td>
<td></td>
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<tr>
<td>Sambucus mexicana</td>
<td>x</td>
<td></td>
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<tr>
<td>Pueraria phaseoloides</td>
<td>x</td>
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Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):

Notes:
Field Data Sheet for Monitoring Vegetation and Erosion Control Projects
(Reconnaissance Level)

Project/Location: Boeing Outfall 15 draws into pond across road
Date: 2/8/07

Surveyors: Jeannette Haldeman

Pond draws into
outfall 11
SWS
Freshwater marsh

Performed by:

Date of Treatment/ Age of Project:

Slope:

Aspect:

Soil Type: ________________________

Percent Litter Cover: ________________________

Percent Rock Cover: ________________________

Percent Bare: ________________________

Condition of Drainage Improvements:
Infiltration trenches: ________________________
Drop Inlets: ________________________
Collection Systems: ________________________

Runoff Source (onsite or offsite): ________________________

Disturbances (e.g. wildlife, foot traffic, neighboring uses, etc.):

Notes:

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<th>Dominant Plant Species</th>
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<th>% Cover</th>
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<tr>
<td>Cirsium arvense ssp.</td>
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<td>Salix lasiolepis</td>
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<td>Phellodendron amurense</td>
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Notes:

1. burned below dam
2. not resprouting - buds
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<th>Photo Log Entry</th>
<th>Description</th>
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**APPENDIX D: PHOTOGRAPH LOG**
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<tbody>
<tr>
<td>1</td>
<td>WELL 13 - Look NW outfall 9 - drawdown oak woodland</td>
</tr>
<tr>
<td>2</td>
<td>WELL 13 - Slope above - burned mix chap</td>
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<tr>
<td>3</td>
<td>WELL 13 - burned sandstone mix chap</td>
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<tr>
<td>4</td>
<td>WELL 13 - LOOK SE outfall 9 - oak woodland undisturbed - east drainage</td>
</tr>
<tr>
<td>5</td>
<td>WELL 13 - WEST drain</td>
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<tr>
<td>6</td>
<td>WELL 13 - up creek to springs</td>
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<tr>
<td>7</td>
<td>WELL 13 - west 2 outfall 9 oak woodland - looking down stream</td>
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<td>8</td>
<td>WELL 13 - west 2 outfall 9 oak woodland - looking down stream</td>
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<td>9</td>
<td>WELL 13 - west 2 outfall 9 oak woodland - looking down stream</td>
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<tr>
<td>10</td>
<td>WELL 13 - west 2 outfall 9 oak woodland - looking down stream</td>
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<tr>
<td>11</td>
<td>WELL 13 - looking east - chaparral, hydromulch, tracks sprayed</td>
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<tr>
<td>12</td>
<td>outfall 8 - looking NW - looking at confluence of outfall 8</td>
</tr>
<tr>
<td>13</td>
<td>outfall 8 - looking SSW - looking up towards pesticide removal site</td>
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<tr>
<td>14</td>
<td>outfall 8 - looking NE</td>
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<tr>
<td>15</td>
<td>outfall 8 - NW</td>
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<tr>
<td>16</td>
<td>outfall 8 - S</td>
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<td>17</td>
<td>outfall 8 - S looking &amp; silt dam to tobacco plant</td>
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<td>18</td>
<td>outfall 8 - S looking &amp; silt dam to tobacco plant</td>
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<tr>
<td>19</td>
<td>outfall 8 - S looking &amp; silt dam to tobacco plant</td>
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<tr>
<td>20</td>
<td>outfall 8 - South Hydromulch</td>
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<tr>
<td>21</td>
<td>outfall 8 - South Hydromulch</td>
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<tr>
<td>22</td>
<td>outfall 8 - looking west - looking at upper part of existing vehicle disturbance</td>
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<td>23</td>
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<td>26</td>
<td>Stepped fill</td>
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<tr>
<td>29</td>
<td>outfall 8 - Hydromulch</td>
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<tr>
<td>30</td>
<td>outfall 8 - Hydromulch</td>
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<tr>
<td>31</td>
<td>outfall 8 - looking at SW facing slope bird weed scrub in CHZane</td>
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<tr>
<td>32</td>
<td>outfall 8 - view looking NW at Singapore tree in wash</td>
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<tr>
<td>33</td>
<td>outfall 8 - view of entire hydromulch on S facing hill slope</td>
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<tr>
<td>34</td>
<td>outfall Z area up winter track cyn NWW grass, CH + OW habitat</td>
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<tr>
<td>35</td>
<td>outfall Z area Panoramic shots of NWW, CH + OW habitat</td>
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<tr>
<td>36</td>
<td>outfall Z area &quot; &quot; &quot; &quot;</td>
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<td>37</td>
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<td>Photo #</td>
<td>Description</td>
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<tr>
<td>021</td>
<td>Outfall 1/  View looking W to BMP's &amp; CH</td>
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<td>022</td>
<td>Outfall 1/ View looking SW to trench</td>
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<td>Outfall 1/ View looking NW up the main channel from flume</td>
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<td>026</td>
<td>Outfall 1/ View looking NW up the main channel from flume</td>
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<td>Outfall 1/ View looking NW to N facing hillslope, CH, BMP, &amp; SW</td>
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<tr>
<td>028</td>
<td>Outfall 1/ View looking W to N facing hillslope, CH, BMP, &amp; SW</td>
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<tr>
<td>029</td>
<td>Outfall 1/ View looking N to hillside and shrub</td>
</tr>
<tr>
<td>030</td>
<td>Outfall 1/ View looking N to hillside and shrub</td>
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<tr>
<td>031</td>
<td>Outfall 1/ View looking N to hillside and shrub</td>
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<tr>
<td>032</td>
<td>Outfall 1/ View looking N to hillside and shrub</td>
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<td>Outfall 1/ View looking N to hillside and shrub</td>
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<td>035</td>
<td>Outfall 1/ View looking N to hillside and shrub</td>
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<td>036</td>
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<td>037</td>
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<tr>
<td>042</td>
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*Note: The descriptions are filled with various annotations and corrections, indicating detailed observations and locations.*
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<td>Outfall 18</td>
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<td>121</td>
<td>Burned Transsect CH, western end of transect 1 Outfall 3 123</td>
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<tr>
<td>122</td>
<td>Burned Transsect 2 in CH western end looking east Outfall 3 124</td>
</tr>
<tr>
<td>123</td>
<td>Burned Transsect 1 in CH western end looking west Outfall 2 124</td>
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<tr>
<td>124</td>
<td>Burned Transsect 1 in CH southern end looking Outfall 9 127</td>
</tr>
<tr>
<td>125</td>
<td>Unburned Control CH southern end looking north Outfall 9 127</td>
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</tbody>
</table>
GPS Way Points

001 - N 34.2382°, W 118.6944°, elevation 1669', top of outfall 9, looking NW towards confluence, 0.5 miles

002 - N 34.2385°, W 118.6943°, elevation 1632', outfall 7 towards

003 - N 34.2385°, W 118.6935°, elevation 1707, outfall 9 down canyon

004 - N 34.2382°, W 118.6944°, 1669'

005 - N 34.2282°, W 118.6754°, 1756', outfall 8, stream channel

006 - N 34.2277°, W 118.6749°, 1739', outfall 8, unburned portion, narrows

007 - N 34.2088°, W 118.6752°, 1830', in Pk removed area, rem. excavation

008 - N 34.2303°, W 118.67551

009 - N 34.2307°, W 118.67513

010 - N 34.2309°, W 118.6742°, 1913', Picture of headwall

011 - N 34.2312°, W 118.6743°, 1925', upper mitigation area, looking west

012 - N 34.2315°, W 118.67551, 1897, outfall 10

013 - N 34.2173°, W 118.70570, 1517', Outfall 2

014 - N 34.2171°, W 118.70546, 1566', Outfall 2, BMPs

015 - N 34.2172°, W 118.70528, 1549', Outfall 2, Flume & Sample Point

016 - N 34.2175°, W 118.70519, 1553', Outfall 2, Sycamore tree

017 - N 34.2171°, W 118.70552, 1564', Outfall 2, headwall on hill slope

018 - N 34.2229°, W 118.71278, 1901', Outfall 2, NNGCH, OW habitat tall canyon

019 - N 34.2230°, W 118.7117°, 1864', Panorama shots of Outfall 2 area

020 - N 34.2162°, W 118.6964°, 1584', Outfall 1, Flume and sample point

021 - N 34.21591°, W 118.69587°, 1599°, 1 looking at BMPs & CH
GPS Waypoints

022 - N 34.22458', W 118.68656', 1784', Outfall 11
023 - N 34.23301', W 118.66571', 1797', Outfall 9, above truck scales
024 - N 34.23846', W 118.68536', 1846', Outfall 9
025 - N 34.25755', W 118.69009', 1757', Outfall 9, well 13 road
026 - N 34.24372', W 118.69164', 1725', Outfall 9, unmarked section
027 - N 34.23895', W 118.67476', 1923', Outfall 9, Sage Marsh, erosion
028 - N 34.23969', W 118.67479', 1941', Outfall 9, unmarked drainage channel
029 - N 34.23369', W 118.67912', 1891', Outfall 14, sample location
030 - N 34.22974', W 118.68497', 1809', Outfall 15, sample location
031 - N 34.22946', W 118.68489', 1806', Outfall 15, pond & wetland habitat
032 - N 34.22726', W 118.68668', 1778', Outfall 11, split in road
033 - N 34.22421', W 118.67891', 1756', Outfall 11, pix loc, upstream
034 - N 34.22350', W 118.68406', 1723', Outfall 11, transect
035 - N 34.22308', W 118.68892', 1738', Outfall 11, sample location
036 - N 34.22378', W 118.67354', 1909', Outfall 11, unburned riparian
037 - N 34.23631', W 118.68767', 1767', Outfall 9, unburned CHT
038 - N 34.23022', W 118.71935', 1848', Outfall 5, sample location
039 - N 34.22979', W 118.71870', 1879', Outfall 5, unburned, pix loc
040 - N 34.23095', W 118.71455', 1821', Outfall 6, post mitigation sampling
041 - N 34.23058', W 118.71742', 1823', Outfall 6, pre-mitigation sampling
042 - N 34.22623', W 118.71686', 2078', in borrow site road
043 - N 34.23056', W 118.71558', 1817', Outfall 7, sample location
044 N. 34.23450°, W 118.71201° 1776  Outfall 3, post-mitigation sample
045 N. 34.23448°, W 118.71141° 1779  Outfall 4, pre-unit sample loc
046 N. 34.23377°, W 118.70478° 1844  Outfall 4, pre-mitigation sample
047 N. 34.23363°, W 118.70475° 1841  Outfall 4, pix loc of linear outfall
048 N. 34.23389°, W 118.70730° 1815  Outfall 4, lower, post-mitigation sample loc
049 N. 34.23372°, W 118.69970° 1843  Outfall 10, upper, pre-run sample loc
050 N. 34.23380°, W 118.70044° 1804  Outfall 10, lower, post-unit sample loc
051 N. 34.23319°, W 118.69822° 1821  Outfall 10, step loc, down upper high embankment
052 N. 34.23382°, W 118.69604° 1812  Outfall 4, pix above the river
053 N. 34.22645°, W 118.70605° 1684  Outfall 15, pix of flume & filter unit, Upper upstream sample loc
054 N. 34.22610°, W 118.70623° 1680  Outfall 18, post-mitigation sample loc
055 N. 34.22718°, W 118.71899° 2012  C-CH-UB-SW, eastern control transect
056 N. 34.22723°, W 118.71801° 2025  C-CH-UB-SW, western control transect
057 N. 34.21934°, W 118.70567° 1665  TH-CH-B-SW-M, western transect outfall
058 N. 34.21935°, W 118.70536° 1633  eastern transect, outfall
059 N. 34.21935°, W 118.70535° 1638  FL CH-B-SW-M, western transect outfall
060 N. 34.21919°, W 118.70489° 1605  T2-
061 N. 34.23462°, W 118.68946° 1916  T1-CH-B-N-MM, southern end transect
062 N. 34.23484°, W 118.68940° 1989  Northern end of transect
063 N. 34.23418°, W 118.68922° 1977  C-CH-UB-N-MM, Southern end of transect
064 N. 34.23441°, W 118.68932° 1934  North end of transect
## Cover Data

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<td>Height of Dom Veg</td>
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*Project: Boeing Recon Post Fire*

*Study Area: C-CH non-burn 2/19/07 2/07 4*

*Sampler's Initials: JHER*
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| Artenfasc (dead)  | 7 | 15 | 15 |        | 15 |         |         |
| Artenfasc (seeding) | 8 | 15 | 15 |        | 15 |         |         |
| Yucca Whip       | 9 | 15 | 15 |        | 15 |         |         |
| Saltme            | 10 | 15 | 15 |        | 15 |         |         |
| Rhoili (c)        | 11 | 15 | 15 |        | 15 |         |         |
| Cen-Cra           | 12 | 15 | 15 |        | 15 |         |         |
| Other Spec        | 13 | 15 | 15 |        | 15 |         |         |
| Crooked Sp ?      | 14 | 15 | 15 |        | 15 |         |         |
| (*) Herpestaph Sp | 15 | 15 | 15 |        | 15 |         |         |

Note: Evidence of old burn
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### Camera Details

- **Project:** Boeing Recon Post-Burn
- **Date:** 2/9/07
- **Time:** 11:00 AM
- **Study Area:** Ch. Unburned sw facings (abandoned transect)
- **Sampler's Initials:** JTHJ, RS
### Cover Data

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**Soils**

**Resolution**

**Height of Dom Veg**

**Transect Number**

**Location**

**Bearing and Aspect**

**Slope (%)**

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**Note:** No survey sticks with this transect.
### Cover Data

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**Camelback Mountain**

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<td>Rock</td>
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**Plant List**

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<td>Acanthus, acer (dead)</td>
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**Stem**

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**Additional Notes**

- Need telescoping measuring stick
- N15
- 5'-0" T1 Chin B Num
- 25°/ Total 100°
- 7/18/03 = 7/17
- Stem = 19'11.5" (23'0"")

*Note: Additional entries and data points may be present in the document that are not captured here.*
HYDROLOGIC RECOVERY OF WATERSHEDS FOLLOWING FIRE

TECHNICAL APPENDIX TO THE POST-FIRE VEGETATION RECOVERY RECONNAISSANCE SURVEY REPORT FOR THE BOEING SANTA SUSANA LABORATORY

Prepared for:

Geosyntec, Inc.
924 Anacapa Street, Suite 4A
Santa Barbara, CA 93101

Wright Water Engineers, Inc.

MARCH 2007

071-013.000
1.0 INTRODUCTION

This appendix provides a review of literature related to the hydrologic recovery of watersheds following the occurrence of fire. Emphasis is placed on the chaparral ecosystem that exists at the 2,700-acre Boeing Santa Susana Field Laboratory site where, in 2005, the Topanga fire burned much of the property. The site is located in the Simi Hills area of Ventura and Los Angeles Counties in southern California, and is dominated by hilly topography and dense chaparral/scrub vegetation, including chamise, scrub oak, and other thick-leaved, deeply rooted species.

For the purposes of the discussion in this appendix, hydrologic recovery of a watershed is defined as the return of a watershed to its pre-fire condition in terms of its rainfall-runoff relationship characteristics. Though hydrologic and sediment yield recovery of a burned watershed is a function of multiple factors, two variables that have a marked effect are: 1) vegetation type and cover, and 2) soil water repellency. For both of these factors, the return to pre-fire conditions has a large bearing on the hydrologic and sediment yield recovery of the watershed.

A brief literature review is presented that addresses vegetation recovery, soil water repellency, and general hydrologic and sediment yield recoveries of watersheds following fire. Studies referenced are for chaparral vegetation unless otherwise noted.

2.0 VEGETATION RECOVERY

Succession of the chaparral vegetation community, in terms of composition and rate of change, is influenced most by aspect, particularly north- and south-facing slopes. Slope steepness is of
lesser importance. The rate of coastal chaparral regrowth after fire is slowest on south-facing slopes below 3,000 feet and is most rapid on north-facing slopes above 3,000 feet (Hanes 1971). Keeley also observed that, at the lowest elevation, site shrub cover was twice as great on the north and east-facing slopes as on the south and west-facing slopes (Keeley 1981).

Chaparral plant species that develop after a fire can be predicted reasonably well based on knowledge of the plant growth present at the time of the fire (Biswell 1974). However, some “new” plant species may appear, as a result of germination of seeds stored in the litter and soil, with the plants themselves having died long before. Some shrubs will stump-sprout after fire nearly 100 percent of the time, while other species, such as chamise chaparral, will produce sprouts in only 70 to 75 percent of plants.

In a Portuguese Mediterranean maquis environment, two years after fire, cover and aboveground biomass was half of the amount found in unburned stands. The rapid recovery was mainly attributed to resprouting species. Herbaceous species were abundant during the first two years after the fire but became scarce in older communities (Clemente et al. 1996).

In the first four years following a fire in California chaparral, annual species were the largest floristic group, but herbaceous perennials and shrubs were the major contributors to community biomass (Guo 2001). Keeley (2005) found that by the fifth year post-fire, approximately half of the species observed were not present in the first year following the fire, but these species compromised only about 10 percent of the cover.

During a four-year study of chaparral shrub succession after a fire in southern California, involving the four major slope faces at three elevations, total cover fluctuated from year to year, and shrub cover increased annually through the third year. There was little or no increase in shrub cover between the third and fourth years (Keeley 1981).

Fire severity affects the recovery of different species in different ways. Some woody species exhibit improved recovery under high intensity burning, whereas others are inhibited by high severity fires. Sites where the immediate post-fire recovery was inhibited by high severity fire exhibited no effect five years after the fire (Keeley 2005). In addition to the variability of
different species, vegetation recovery is significantly controlled by patterns of precipitation (Keeley 2005). On fire-free sites, a chamise-chaparral climax community develops within 25 to 30 years after fire (Biswell 1974 and Hanes 1971).

3.0 FIRE EFFECTS ON SOIL

After a fire, water repellency can be found as a discrete layer of variable thickness on the soil surface a few centimeters below the mineral soil surface and parallel to the soil surface (DeBano 1998). A hypothesis regarding the formation of the water-repellent layer has been developed by DeBano (1998). Heat produced by combustion of the litter layer on the soil surface vaporizes organic substances, which are moved downward in the soil along the temperature gradients until they reach cooler underlying soil layers, where they condense. Organic particles coat and are chemically bonded to mineral soil particles. The final result is a water repellent layer located below and parallel to the soil surface on the burned area. The precise chemical composition of the hydrophobic substances has not been determined, perhaps because of the large number of organic substances that can be altered by soil heating during a fire (DeBano 1998, 2000).

The effects of fire on soil are a function of several factors (DeBano 1998), including:

- Fire severity – More severe fires produce a deeper water repellent layer in the soil, unless the fire is so hot that it destroys all organic matter in the soil.
- Type and amount of organic matter present in the soil - Sufficient organic matter must exist in the soil to provide hydrophobic substances.
- Temperature gradients that develop in the upper mineral soil – Steep temperature gradients foster translocation of hydrophobic substances.
- Soil texture - Sandy and coarse-textured soils are more susceptible to water repellency than more fine-grained soils.
- Soil water content - Water in the soil affects heat transfer and condensation of hydrophobic substances.
Doerr et al. (2003) notes the importance of knowing the soil temperature reached during a wildfire to understand post-fire soil properties, which in turn affect the short- and medium-term erosion susceptibility of burnt slopes. The litter layer present in chaparral is thin, which provides less efficient insulation against heat radiated downward than found with fires in other types of vegetation. Consequently, chaparral fires create temperatures at and beneath the soil surface which are generally higher than corresponding temperatures caused by prescribed fires in forests (USDA 1981). For the southern California chaparral, different fire severities are described by DeBano (1998).

- Low severity burns are characterized by charred leaf litter, with some grayish ash after the fire that soon becomes inconspicuous. Low severity burns reach temperatures of approximately 225 °C at the soil surface and 12.5 °C at 2.5 cm below the surface. When soils are heated to less than approximately 175°C, DeBano (2000) indicates little change in water repellency occurs.

- Moderate severity burns consume leaf litter and fine woody material on the ground and produce a bare-soil seedbed. Moderate severity burns reach a maximum temperature of approximately 430°C at the soil surface and approximately 200 °C at 2.5 cm below the surface. Intense water repellency is formed when soils are heated between 175°C and 200°C (DeBano 2000), and as high as 250°C (Doerr et al. 2003).

- High severity burns are characterized by a fluffy, white ash seedbed. High severity burns reach a temperature of slightly more than 700°C at the soil surface and approximately 250 °C at 2.5 cm below the surface. Destruction of water repellency occurs when soils are heated between 280°C and 400°C (DeBano 2000, Letey 2001).

While it is widely recognized that fire-induced water repellency is a key parameter affecting post-fire runoff and erosion rates (Robichaud 2000; DeBano 1998), few data exist related to the persistence of soil water repellency. McDonald and Huffman (2004) assessed water repellency in the field in a northern Colorado Front Range ponderosa and lodgepole pine forest, following a June 2000 fire, using the critical surface tension (CST) test. The CST involves applying droplets of deionized water to the soil and adding increasing concentrations of ethanol if the
droplets are not absorbed into the soil within five seconds. The CST quantifies the surface tension associated with the lowest concentration of ethanol required to be absorbed into the soil and is a measure of soil water repellency, which has a direct bearing on runoff and sediment yield from a watershed. Soil water repellency was strongest at sites burned at high and moderate severity, and decreased with increasing depth in the soil. Spatially, the repellency was highly variable. The fire-induced soil water repellency progressively weakened over time and within one year post-fire was statistically nondetectable.

For the Cerro Grande watershed near Los Alamos, New Mexico, it was determined that areas initially measured to have high hydrophobicity after the fire that were intensively rehabilitated (including raking, seeding and mulching) were approximately back to pre-fire conditions within three years (WWE 2003). Soil hydrophobicity was measured using a water drop penetration test.

4.0 FIRE EFFECTS ON RUNOFF AND WATERSHED HYDROLOGY

Increases in water yield from wildfires and prescribed fires are highly variable and extrapolation of study findings to watershed scales is difficult because of the high temporal and spatial variability that occurs in the field (Letey 2001). In the fire-prone interior chaparral shrublands, annual streamflow discharge from their watersheds can increase by varying magnitudes, at least temporarily, as a result of wildfires of high intensity (USDA 2005).

Hydrologic recovery of a watershed can be quantified by evaluating the Curve Number (CN) ratio that compares post-fire and pre-fire CNs (WWE 2003) (CN ratio = post-fire CN/pre-fire CN). As the watershed recovers following the fire, and vegetation and soil characteristics gradually return to the pre-fire condition, the hydrologic response transitions toward its natural condition. For the Cerro Grande watershed, a CN ratio of 1.1 indicates a watershed has generally recovered to within approximately 10 percent of the pre-fire condition in terms of hydrologic response. If pre-fire management practices were continued, the watershed would eventually transition toward a CN ratio of 1.0, representing full recovery to pre-fire hydrologic conditions. For perspective on the CN ratio evaluation approach and hydrologic recovery, portions of the Cerro Grande fire area with the most severe burn effects, in Upper Pueblo
Canyon, had a CN ratio of 1.63 immediately following the fire (post-fire CN of 91/pre-fire CN of 56). Three years following the fire, large portions of the Upper Pueblo Canyon watershed with minimal rehabilitation still had a CN ratio of 1.55 (three-year post-fire CN of 87/pre-fire CN of 56), suggesting that complete hydrologic recovery of those areas would take much longer.

As described in WWE 2003, little published data exist regarding the time required for hydrologic recovery of a burned area. Brown (1972) indicates streamflow data show a recovery period of 4 to 5 years for some Australian watershed following brushfires. Helvey (1980) reported that large increases in runoff occurred during years two through seven following fire in a Ponderosa Pine/Douglas Fir forest.

In Mesa Verde National Park in southwestern Colorado, evaluation of vegetation, infiltration rates, and sediment transport in the Prater and Morefield Canyon watersheds indicated the basins exhibited limited recovery, with a CN of 87 immediately post-fire in August 2000 to a CN of 80 in May 2003 (compared with an estimated pre-fire CN of 60 or less in these watersheds). Furthermore, it was estimated that significant watershed recovery would not occur until 2010, with full recovery not occurring until approximately 2020 (WWE 2003). The Prater/Morefield Canyon watersheds are comprised of valley floors covered with sagebrush, grass and small plant growth; steep canyons; and upland areas covered with pinions and junipers interspersed with rock outcroppings and clusters of scrub oak.

### 5.0 EROSION AND SEDIMENT YIELDS

Sediment yields are often highest in the first year following a fire. Nearly all fires increase sediment yield, but wildfires in steep terrain produce the greatest amounts. Sedimentation usually declines in subsequent years as a protective vegetation layer becomes established (DeBano 1998). Post-fire sediment yields are largely indicative of the partial or complete consumption of litter and other decomposed organic matter on the soil surface and a reduction in infiltration, with consequent increase in overland flow (DeBano 1998).

A wildfire on the San Dimas Experimental Forest that burned over an ongoing sediment flux study provided an opportunity to document and quantify the effects of fire on hillslope erosion in...
small watershed units in a semiarid, chaparral-covered, steepland environment (Wohlgemuth 2003). In chaparral watersheds, post-fire dry season erosion was 2 to 3 times greater than unburned levels and post-fire wet season erosion was 9 to 18 times greater than prior to the fire. In the grass watershed, post-fire wet season erosion was more than 300 times greater than comparable unburned values. The dramatic increase in sediment flux attests in particular to the watershed protection provided by the grass vegetation prior to the fire. This study did not, however, address the time required for watershed recovery in terms of sediment yields returning to pre-fire rates.

Sediment yields from a low severity ponderosa pine wildfire recovered to normal levels after three years, but moderate and severely burned watersheds took 7 and 14 years, respectively (Robichaud 2000).

6.0 SUMMARY

Based on the literature reviewed, it can be inferred that the rate of return of chaparral vegetation in a watershed is based in large part on the precipitation conditions in the years following the fire, and on the slope aspect, with north facing slopes having a more rapid rate of return than south-facing slopes. The highest rate of chaparral shrub growth is expected to occur within approximately the first five years, with a climax chaparral plant community developing two to three decades later.

Soil water repellency is likely to be highest in areas with moderate to high burn severity, though extremely high temperatures (above approximately 300°C) may destroy the water repellent layer. Little data exist regarding the return of soil water repellency to pre-fire conditions; the studies cited indicated pre-fire repellency was achieved between one and three years post-fire. This is very dependent on rehabilitation measures and on precipitation during the post-fire period.

Increases in water and sediment yield from fires, and the return to pre-fire conditions, are highly variable. Hydrologic recovery periods in studies cited ranged from approximately 4 to 5 years for an Australian grassland watershed to approximately 20 years for a watershed characterized by sage-pinon-juniper vegetation.
The greatest rate of hydrologic and sediment yield recovery at the Boeing Santa Susana Laboratory project site is anticipated to occur within the first one to three years, as the hydrophobicity of the soil diminishes and vegetation cover returns. The highest rate of chaparral growth is expected to occur for five to six years post-fire, which will further benefit the hydrologic recovery of the watershed and its corresponding effect on sediment yield. Complete return of the watershed to its pre-fire hydrologic and sediment yield condition could take longer, as chaparral vegetation may take decades to return to its pre-fire state, depending on climatic conditions. This estimated time to recovery is based on information available in the literature. Many variables will have a bearing on the actual recovery time, including climate conditions, severity of burn effects in areas of interest, and watershed rehabilitation efforts.

7.0 LITERATURE CITED AND REVIEWED


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Fax: 303.480.1020

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