LEONA QUARRY SLOPE
REVEGETATION PLAN
(Revised in Accordance with
the April 2004 Grading Plan)

H. T. HARVEY & ASSOCIATES

ECOLOGICAL CONSULTANTS

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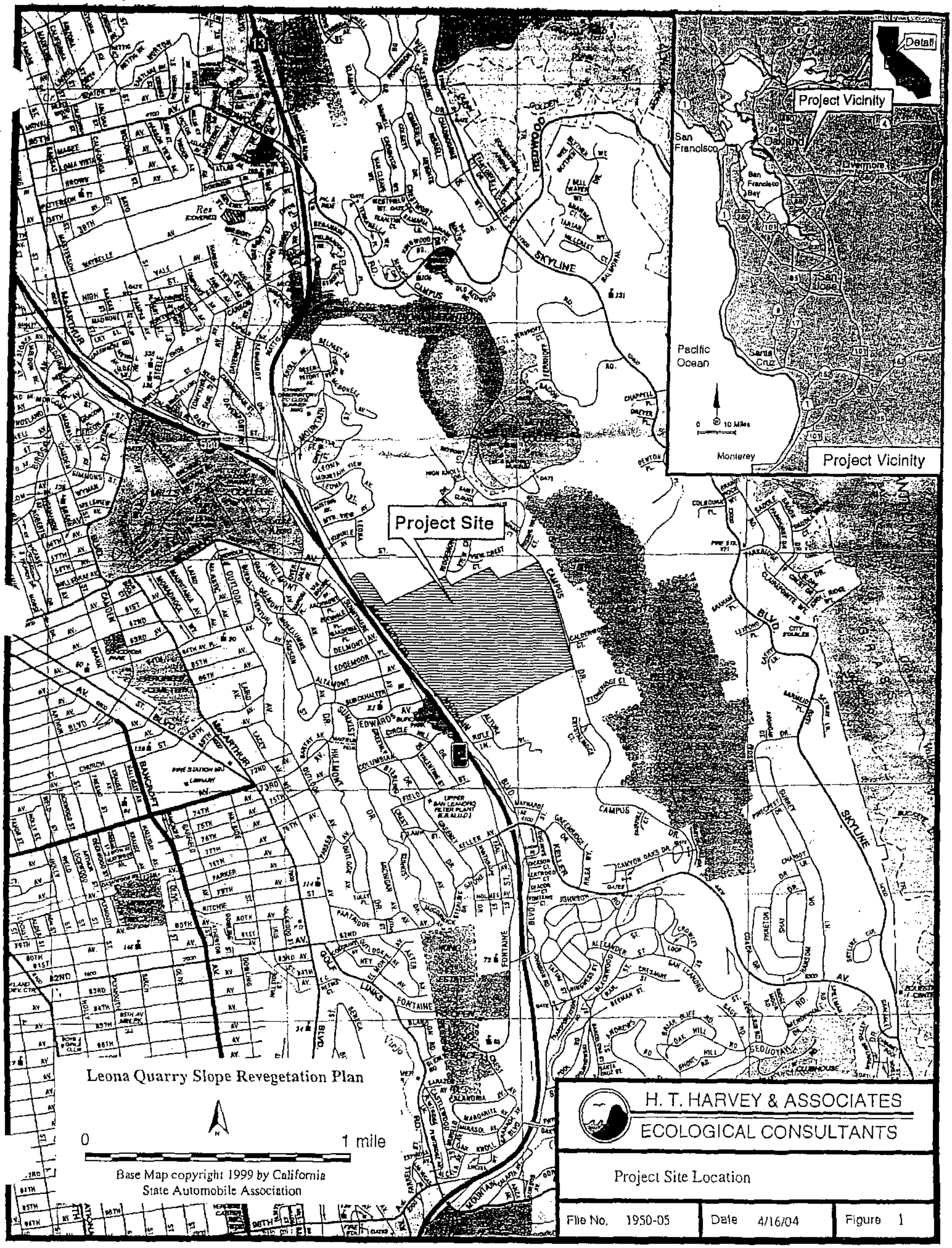
1.0 INTRODUCTION

This revegetation plan for the Leona Quarry was prepared for The DeSilva Groups' Leona Quarry project. This plan presents the revegetation design for the slope reclamation portion of the project and incorporates the most recent grading plans provided to H.T. Harvey & Associates in April 2004 by Carlson Barbee & Gibson, Inc. In addition, the plan incorporates design revisions in response to comments on slope erosion control provided by Lowney & Associates (comments dated January 30, 2004). This plan is based on the Conceptual Revegetation Plan for Reconstructed Slopes (H.T. Harvey & Associates 2001a) that was submitted to the City of Oakland as part of the project's Draft Environmental Impact Report (DEIR) (ESA 2002). In accordance with the City's Conditions of Approval #17, 18, and 21 (approved on October 23, 2002), the plan includes the following:

1. restoration of a minimum of 37 acres of habitat for Alameda Whipsnake (*Masticophis lateralis euryxanthus*) and other native species;
2. more detailed revegetation plans for the main slope that are consistent with the "Conceptual Revegetation Plan for Reconstructed Slopes" (H.T. Harvey & Associates 2001a);
3. revegetation plans for the denuded slopes along the western side of the project (Parcels C-C and D-D) that were not addressed in the "Conceptual Revegetation Plan for Reconstructed Slopes" and;
4. revegetation plans for tree replacement that are consistent with the City's Tree Ordinance and the DEIR tree replacement mitigation measures.

The Leona Quarry project site is located in southeast Oakland, Alameda County, California (Figure 1). Residential development, Highway 580 and Mountain Boulevard border the site to the south and southwest. The site extends upslope and is bordered to the northeast by Campus Drive and residential development. The Leona Heights Regional Open Space Preserve is located approximately 1.5 miles to the northeast. Relatively undisturbed sage scrub, chaparral and oak woodland vegetation border the site to the east and west. Located in the East Bay Hills, elevations at the site range from 300 feet on the southwestern portion of the quarry floor to 1067 feet along the quarry crest adjacent to Campus Drive. The Leona Quarry has been in operation as a rock quarry since the early 1900s. Throughout the life of the quarry, quarrying activities have severely altered the topography, soils and vegetation throughout the majority of the approximately 128-acre site.

The Leona Quarry project proposes a combination of primarily residential development with quarry slope reclamation and revegetation. The majority of the proposed residential development is located in the lower elevation, southwestern portion of the site (Figure 2). The remainder of the residential units is proposed along Campus Drive at the upper elevation portion of the site. Slope reconstruction combined with revegetation is proposed for the existing steep, denuded quarry slope between Campus Drive and the lower development area in the northeast portion of the site. This approximately 37.5-acre revegetation area on reconstructed slopes is shown in Figure 2.



Project Vicinity
Detail
San Francisco
Oakland
Livermore
San Francisco Bay
San Jose
Pacific Ocean
Santa Cruz
Monterey
0 10 Miles
Project Vicinity
Project Site
SKYLINE
CAMPUS
MOUNTAIN
MACARTHUR
BANCROFT
KELLER
Leona Quarry Slope Revegetation Plan
0 1 mile
Base Map copyright 1999 by California State Automobile Association
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ECOLOGICAL CONSULTANTS
Project Site Location
File No. 1950-05
Date 4/16/04
Figure 1

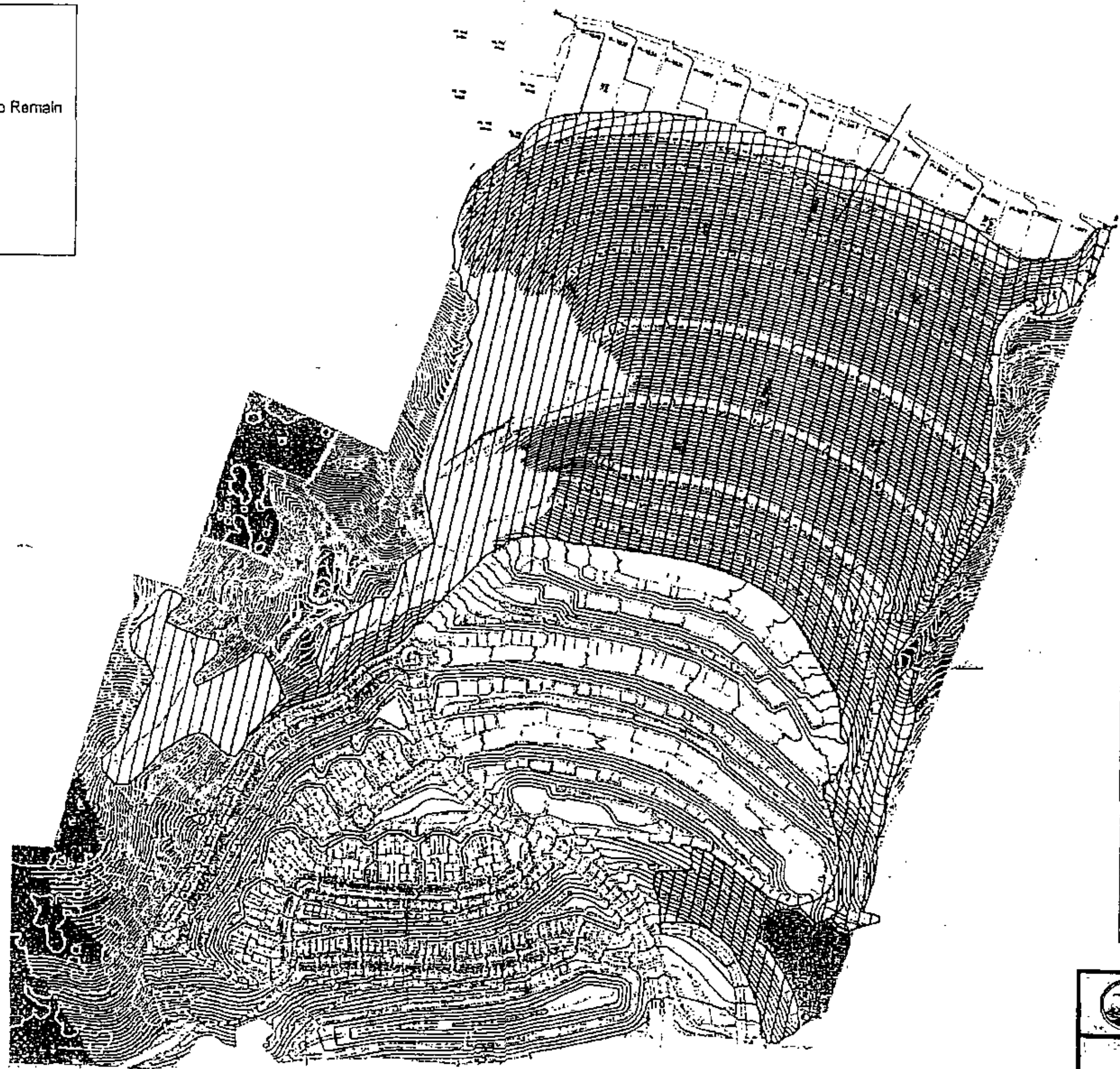
Legend

Slope Revegetation Areas

Existing Well-Vegetated Areas to Remain (No Revegetation Required)

—800— Design Grade

Pilot Revegetation Site (Installed in Fall 2001)



N

0 300 600

Feet

Scale: 1" = 300 ft

Note: Drawing based on Amended Reclamation Plan (CBG, April 2004)

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Location of Slope Revegetation Areas

File No. 1950-05 | Date 4/16/04 | Figure 2

Revegetation is also proposed for portions of the disturbed, unvegetated quarry slopes located beyond the limits of slope reconstruction in the northern and western portions of the site (Figure 2). This area encompasses approximately 8.1 acres.

Currently, an approximately 0.6-acre area within the northwest portion of the project site is being utilized for a pilot revegetation study (Figure 2). The primary purpose of the pilot project is to analyze vegetation response, cost-effectiveness, and relative difficulty of installation of a number of revegetation techniques (H.T. Harvey & Associates 2001b). Five experimental plots were selected for the pilot project to test the various revegetation treatments, which include two irrigation regimes, two soil amendment treatments, and two shrub seeding methods. The experimental plots consist of a tree planting plot, a shrub planting plot, a shrub broadcast seed plot, a shrub hydroseed plot, and a gully planting pocket plot. The pilot plots were installed in Fall 2001 and were subsequently monitored by H. T. Harvey & Associates in Fall 2002 and 2003. Information obtained from the first two years of monitoring was incorporated into the revegetation design presented herein.

The first year results at the pilot shrub and tree planting plots are promising. The dominant plant species, soil amendments, plant installation and maintenance techniques employed resulted in moderate to high survival and growth. Tree survival was 100% and shrub survival was 63% after the first growing season. Based on results of the Year-1 data analysis, there appears to be no significant difference between the manual irrigation treatment and the drip irrigation treatment for any species in terms of survival or growth characteristics, which included height and crown volume (H.T. Harvey & Associates 2003). California sagebrush and chamise seedlings, which received the deep plus shallow amendment treatment, performed slightly better in terms of height and crown volume than those that received only the shallow amendment treatment. These initial findings were used to assist in development of this conceptual plan (Figure 2). Additional replanting, revegetation technique experimentation, and quantitative monitoring was implemented in 2003 within the pilot revegetation plot.

This conceptual revegetation plan proposes soil preparation and revegetation techniques for the slope reconstruction area and the northern, ungraded portions of the slope (Figure 2). The boundary of the reconstructed slope revegetation area was defined by the grading limits to the east and west, the proposed lots along Campus Drive to the north, and by a 50-foot buffer from the proposed roads in the lower development area to the southwest. The boundaries of the northern, ungraded revegetation areas were defined as those areas outside the area of mass grading in the northern portion of the site, which are currently poorly vegetated. The revegetation layout and slope geometry were based the most recent grading plans (Carlson, Barbee & Gibson, Inc., April 2004). Preparation of the revegetation plan involved close coordination and collaboration with the project proponent and the project team's geotechnical engineer (Frank Berlogar of Berlogar Geotechnical Consultants) and civil engineer (Grant Gibson of Carlson, Barbee & Gibson). In addition, soil and vegetation studies were conducted in unquarried, densely vegetated reference sites and throughout the quarry site to provide a basis for the soil preparation plan and revegetation plant species palette.

2.0. EXISTING SITE CONDITIONS AND REVEGETATION PLAN GOALS

2.1 EXISTING REVEGETATION SITE CONDITIONS

The existing quarry slope to be reconstructed (regraded) and revegetated is approximately 350 to 1070 feet above mean sea level (MSL) with an overall gradient of approximately 1.5 Horizontal: 1 Vertical (1.5H:1V). The north slope is approximately 500 to 950 feet above MSL in the northeast section and 450 to 760 feet above MSL in the northwest section and also has an overall gradient of approximately 1.5 horizontal: 1 vertical (1.5H:1V). Slopes are 1H: 1V and steeper in numerous localized areas. The majority of this slope is sparsely vegetated even though historic aerial photography shows that soil disturbance from quarry activities ceased throughout much of the slope between 1988 and 1992. Poor vegetation establishment is likely due primarily to soil instability, low soil fertility, poor development of soil structure, and limited plant available water. Soil erosion and slumping events are too frequent to allow early successional plant species to gain a foothold. Berlogar (2000) observed a number of sidecast fills throughout the quarry slope that are loose and highly susceptible to erosion. Numerous erosional gullies, surficial landslides and debris fans are present (Berlogar 2000).

Scattered patches of vegetation are present and are dominated by French broom *(Genista monspessulana)*, with smaller patches of pampas grass *(Cortaderia ssp.)*. Both French broom and pampas grass are invasive, non-native species common on disturbed soils. French broom is native to the Mediterranean region and pampas grass to South America. A few small patches of arroyo willow *(Salix lasiolepis)* are present in the ephemeral drainage gullies on the slope. The occurrence of willows indicates the likely presence of ground water close to the soil surface throughout the year at these locations. Along the north portion of the slope, small patches of California sagebrush, Santa Barbara Island buckwheat (*Eriogonum giganteum* var. *compactum*) coyote brush (*Baccharis pilularis*), and grasses such as wild oats (*Avena fatua*) and pampas grass occur. Steep, rocky portions (1.5H:1V and steeper) of the north slope are sparsely vegetated with a mixture of grasses and small shrubs (especially Santa Barbara Island buckwheat) growing in small pockets of soil.

2.2 REVEGETATION PLAN GOALS

The overall goal of this conceptual revegetation plan is to establish a moderately dense cover of self-sustainable herbaceous (i.e. grasses and forbs) and woody (i.e. trees and shrubs) vegetation on the reconstructed and north slopes. In this case, the term self-sustainable refers to a self-perpetuating plant-soil system that does not require anthropogenic inputs such as fertilizer, water, or re-planting beyond an approximately 3-year plant establishment/maintenance period. Woody vegetation will be planted within localized planting areas on approximately 40% of the site, while herbaceous vegetation and shrubs will be established via seed, which will be applied throughout the majority of the reconstructed and north slopes. The most efficient means of achieving these goals is to utilize native plant species adapted to the site-specific edaphic (soil) and climatic characteristics and to provide topsoil conditions suitable for their establishment and growth.

The specific revegetation plan goals are as follows:

- control soil erosion;
- restore sustainable native plant communities within localized planting areas similar in species composition to the adjacent undisturbed habitats;
- provide a minimum of 37 acres of restored habitat for the federally-threatened Alameda Whipsnake and other native species;
- utilize existing on-site topsoil and soil amendments as necessary to provide topsoil conditions suitable for colonization by native, site-specific plant species;
- create initial soil-vegetation conditions that will promote the long-term progressive improvement of soil fertility and topsoil development;
- salvage and reuse on-site topsoil;
- minimize the need for long-term vegetation maintenance beyond a 3-year plant establishment period;
- enhance the visual appearance of the landscape;
- break up the linear, human-made appearance of the constructed benches, and;
- provide ecological connectivity across the quarry slope between adjacent undisturbed chaparral and oak woodland habitats.

3.0 BASIS OF REVEGETATION DESIGN FIELD STUDIES

3.1 INTRODUCTION

To meet the revegetation design objectives of establishing a self-sustainable native plant community, a study was conducted of the soils and vegetation within reference sites, the revegetation area for the reconstructed slope, and at potential topsoil harvest sites. Information gathered during this baseline study was utilized to formulate the design of the soil preparation plan and the target plant species composition for the revegetation site. The planting palette was further refined based on plant species performance at the Pilot Revegetation Site.

3.2 CHARACTERIZATION OF REFERENCE SITES

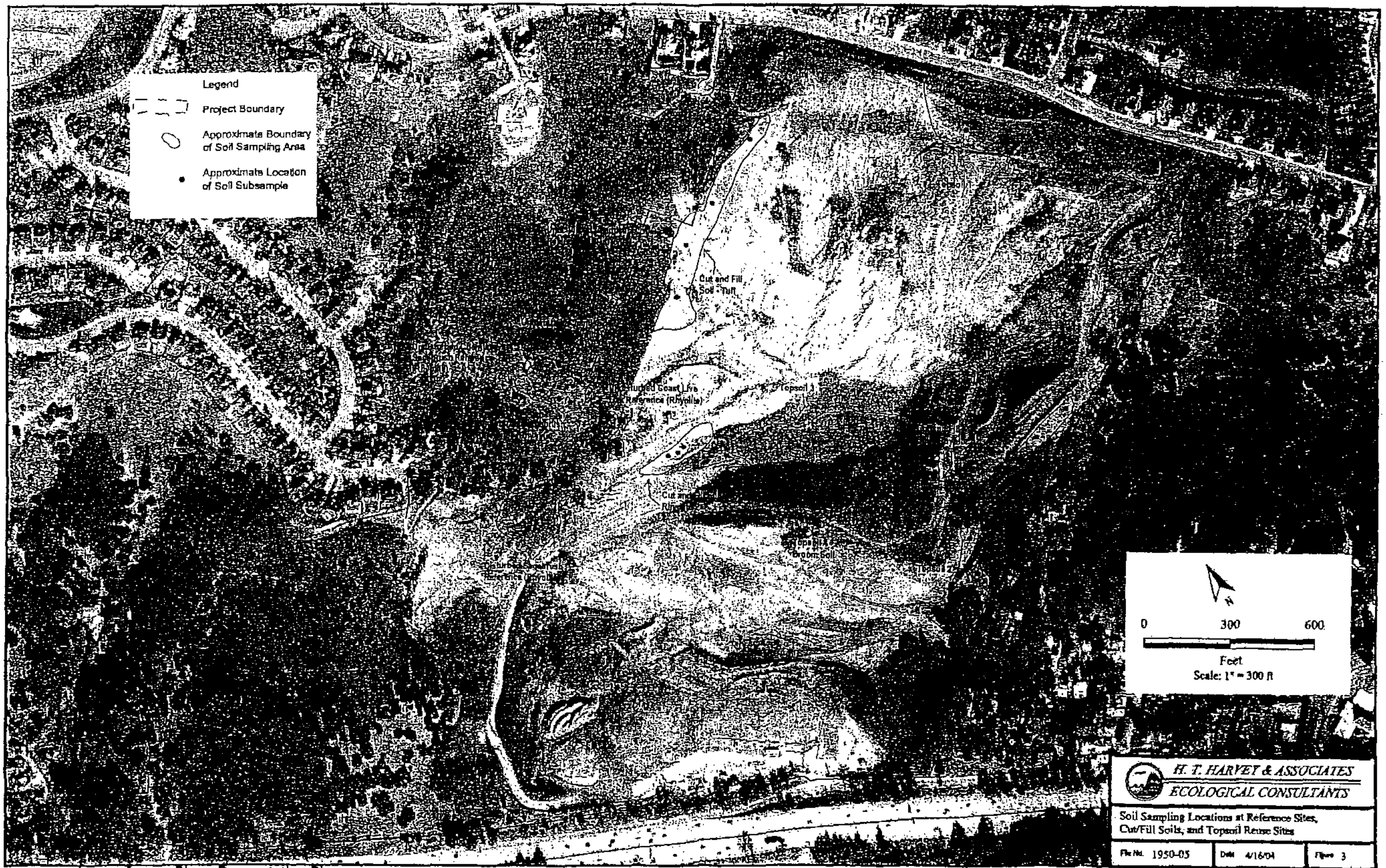
3.2.1 Overview

The term reference site refers to an area of land that comprises a plant community similar to the desired plant community for a restoration project (SERG 2001, Bowler 2000, Read et al. 1996). The reference site provides a model of what the area to be restored should resemble once the revegetated plant community has established. In addition, the reference site provides information about the environmental characteristics that allow the desired vegetation type to grow. Ecological factors are compared between the reference site and the restoration site and typically include such variables as plant species composition, soil profile stratification, depth of topsoil, soil nutrient status, soil texture, soil organic matter content, the status of the soil microbial community, and the slope and aspect of the site. The goal of this comparison is to determine which factors control the composition of species within the desired plant community and to determine if any of these factors can be re-established within the restoration site to increase the probability of successful plant establishment.

To determine the appropriate target species composition and topsoil characteristics for the Leona Quarry revegetation project, six reference sites were identified and analyzed (Figure 3). In this report, reference sites are defined as areas adjacent to the project site where: 1) native vegetation is growing; 2) no quarry activities have occurred, with the exception of the disturbed sagebrush reference site (see below); and 3) the parent material consists of either tuff or rhyolite. The reference sites were then compared to proposed topsoil reuse areas (Section 3.2) and proposed cut and fill soils (Section 3.3) to determine the probability of successful plant establishment.

3.2.2 Methods

Data on the soils, vegetation, and other pertinent environmental characteristics were collected from the six reference sites. The six reference sites were selected based upon the plant species composition, parent material, and proximity to the project site. The reference sites are all located north/northwest of the revegetation site (Figure 3). Soil samples were collected from the sites by digging three to four soil pits (sub-samples) to a minimum depth of 12 inches (30 cm) at each



Leona Quarry Slope Revegetation Plan

site. Sub-samples from each site were composited to create an approximately one-gallon soil sample. All sub-samples were collected starting immediately below the soil litter layer and extending down to the bedrock layer. Large rocks, plant litter, and debris were removed. Data collected from each soil pit included general descriptions of such variables as the soil profile, the percent rock fragment, depth to bedrock, aspect (defined as the direction toward which the land surface is oriented), elevation, rooting zone, and plant community composition. Each variable was qualitatively evaluated and used to assess the environmental characteristics of the site. In addition, soil samples were sent to the Soil and Plant Laboratory (Santa Clara, CA) for nutrient, texture, organic matter content, and pH analysis.

3.2.3 Results

The reference sites are classified as central coastal scrub for the California sagebrush dominated sites and northern mixed chaparral for sites dominated by chamise *(Adenostoma fasciculatum)* (Holland 1986). In addition, soils within a patch of coast live oak woodland were sampled. The majority of the reference sites are outside of the previously disturbed quarry boundaries, with the exception of the disturbed sagebrush reference site (Figure 3). The disturbed site was previously part of the active quarry site, but has since been recolonized by California sagebrush. Because of the disturbed nature of this site, it provides a good reference in terms of the likely conditions present within some of the reconstructed slope locals.

The topography of the reference sites is very steep with gradients of 2H: 1 V and steeper. The reference sites have west to southwest aspects with the exception of the disturbed sagebrush site, which has an aspect that is more to the south. Elevation ranges from 700 feet above mean sea level (MSL) to approximately 1000 feet above MSL. The plant community types form a mosaic across the landscape with each plant community gradually grading into the next.

3.2.3.1 Undisturbed Chamise Reference 1 (Rhyolite). Undisturbed chamise reference site 1 is dominated by a dense cover of chamise with California sagebrush, coyote brush, deerweed *(Lotus scoparius)*, coast range melic *(Melica imperfecta)*, big squirreltail *(Elymus multisetus)*, creeping snowberry *(Symphoricarpos mollis)*, orange bush monkeyflower *(Mimulus aurantiacus)*, poison oak *(Toxicodendron diversilobum)*, and golden yarrow *(Eriophyllum confertiflorum* var. *confertiflorum)* growing in gaps within the chamise canopy. Little to no vegetation grows beneath the dense canopy of the chamise. The plant community type is located at elevations ranging from approximately 700 to 850 feet above MSL.

The parent material of this site is primarily rhyolite. The soil profile consists of a light brown, shallow mineral soil approximately 13 inches thick, overlying unconsolidated bedrock. The mineral soil contains approximately 30-35% rock fragments, with the chamise roots penetrating the unconsolidated bedrock.

3.2.3.2 Undisturbed Chamise Reference 2 (Tuff). Undisturbed chamise reference site 2 is similar to the first chamise reference site including the species composition, rooting characteristics, and aspect. The primary differences between the two sites are that the parent material of reference site 2 is tuff, the soil layer is thicker and the elevation is 750 to 1000 feet above MSL. A leaf litter layer (0.5-1 inch thick) was present underlain by an approximately 4-inch thick dark brown organic matter enriched layer. This was underlain by mineral soil to a depth of at least 18 inches. Relatively well-developed soil aggregate structure was present in the upper 12 inches of the profile.

3.2.3.3 Undisturbed Sagebrush Reference (Rhyolite). The undisturbed sagebrush reference site is dominated by California sagebrush and has a relatively dense understory composed of deerweed, coast range melic, poison oak, golden yarrow, coyote brush, wild cucumber *(Marah fabaceus)*, California poppy *(Eschscholzia californica)*, and caterpillar phacelia *(Phacelia cicutaria)*. The site has less than 10% bare ground, on average. This plant community type occurs at elevations between approximately 500 to 650 feet above MSL.

The parent material associated with the undisturbed sagebrush reference site is composed primarily of rhyolite. The soil has a one-inch thick black organic soil layer on top of a well-developed dark brown mineral soil. The mineral soil is approximately 23 inches thick and contains 10-15% rock fragments overlying the unconsolidated bedrock. The roots of the plants at the site penetrate both the mineral soil and unconsolidated bedrock.

3.2.3.4 Undisturbed Chamise/Sagebrush Reference (Rhyolite). The undisturbed chamise/sagebrush reference site represents a transition, or ecotone, between the undisturbed chamise and undisturbed California sagebrush reference sites. The site occurs at elevations of approximately 650 to 750 feet and is composed of a relatively even mix of chamise and California sagebrush. Other native species occurring in this ecotone include deerweed, California figwort *(Scrophularia californica* ssp. *californica)*, wild cucumber, coast range melic, toyon *(Heteromeles arbutifolia)*, coyote brush, golden yarrow, poison oak, and blue elderberry. The percentage of bare ground is approximately 10-15%.

The chamise/sagebrush site occurs on rhyolite. The soil associated with the chamise/sagebrush reference site has a small, black, organic soil layer (less than a half inch deep) on top of a weakly developed brown mineral soil. The brown mineral soil overlies unconsolidated bedrock. The mineral soil contains approximately 20-25% rock fragments and is approximately 12 inches thick. The roots of many of the understory species penetrate to a depth of about 10 inches, while the roots of the shrubs penetrate both the mineral soil and the unconsolidated bedrock.

3.2.3.5 Disturbed Sagebrush Reference (Rhyolite). The disturbed sagebrush reference site occurs in an area that was previously quarried, but has since been recolonized by California sagebrush and other plant species such as pampas grass, red brome *(Bromus madritensis* ssp. *rubens)*, ripgut brome *(Bromus diandrus)*, deerweed, and coyote brush. Factors contributing to the re-establishment of vegetation at this site may have included moderate slopes, favorable soils, appropriate hydrology, and/or nearby seed source. The disturbed sagebrush reference site occurs at the same elevation and in close proximity to the undisturbed sagebrush reference site. The disturbed site is dominated by California sagebrush and contains a mostly bare ground understory with very little vegetation growing between the sagebrush plants.

The soil that occurs on the disturbed sagebrush reference site is a thin, poorly developed mineral soil approximately 1-2 inches thick that has 80-90% pea-size rocks overlying unconsolidated bedrock. The site is composed of rhyolite parent material. The roots of the California sagebrush penetrate the mineral soil and the unconsolidated bedrock to a depth of approximately 12 inches.

3.2.3.6 Undisturbed Coast Live Oak Reference (Rhyolite). The coast live oak reference site occurs adjacent to the undisturbed chamise and sagebrush reference sites along a small ridgeline at approximately 600 to 800 feet elevation. The site is dominated by coast live oak with an understory comprised of poison oak, wild-cucumber, and coast range melic and about 30-40% bare ground.

Approximately 6-inches of decomposing leaf litter occurs above the soil surface. The leaf debris layer serves as a food source for the soil microorganisms. A thick organic soil layer, which is being created in part by the soil microorganisms breaking down the above ground leaf debris, can be found in the first 2 to 3 inches of soil. Below the organic soil layer is an approximately 13- inch thick, well-developed gray-brown mineral soil, containing approximately 30-40 % rock fragments. The mineral soil overlies the unconsolidated bedrock. The parent material within the coast live oak reference site is rhyolite.

3.2.4 Soil and Plant Laboratory Results

The Soil and Plant Laboratory analysis results and report are presented in Appendix A and summarized below. The reference site soils were characterized as gravelly loam, gravelly clay loam, or gravelly sandy clay loam (Table 1). The soil analysis also indicated that the majority of the reference site soils have low concentrations of nitrogen (5 -13 ppm) and phosphorous (1 - 8 ppm) (Table 1). Potassium levels ranged from 170 - 430 ppm and were considered to be adequate for most plants. The ratios between calcium and magnesium were adequately balanced for all soils within the reference areas. The pH's of the soils were moderately acidic (5.3 - 5.9), with the exception of the disturbed sagebrush site (pH = 7.4). The organic matter contents were unexpectedly high at the undisturbed chamise and sagebrush reference sites (3.7 - 4.4%) and coast live oak site (7.2%). In contrast, the disturbed sagebrush site exhibited a relatively low to moderate percent organic matter (1.1%).

Table 1. Leona Quarry Soil Laboratory Analysis Results for Select Key Factors (See Appendix A for entire soil laboratory analysis results)

Sample ID	% OM*	Texture** (USDA)	% Clay	pH	NO_3 ppm	PO_4 ppm	K ppm	Ca ppm	Mg ppm
Reference Soils									
Undisturbed Chamise 1 (Rhyolite)	3.9	GL	22.9	5.5	13	1	290	1340	330
Undisturbed Chamise 2 (Tuff)	3.7	GL	24.5	5.5	7	2	250	1450	388
Undisturbed Sagebrush (Rhyolite)	4.4	GCL	22.9	5.9	6	4	400	2000	672
Undisturbed Chamise/Sagebrush (Rhyolite)	4.3	GL	20.9	5.9	7	2	250	1860	372
Disturbed Sagebrush (Rhyolite)	1.1	GCL	26.4	7.4	5	6	170	3050	402
Undisturbed Coast Live Oak (Rhyolite)	7.2	GSCL	23.9	5.3	6	8	430	2290	506
Cut and Fill Revegetation Soils									
Rhyolite 1	0.6	GL	24.9	6.9	5	7	70	1620	856
Rhyolite 2	0.6	GSL	16.9	7.3	4	1	120	1430	896
Tuff	0.1	GCL	22.3	5.3	6	6	90	190	828
Topsoils									
Topsoil 1 a (Grass)	0.5	GSCL	25.4	6.8	4	9	60	2140	2050
Topsoil 1 b (Shrub)	0.6	GSCL	21.5	6.7	4	9	70	2440	3220
Topsoil 1 c	0.5	GSL	18.5	6.7	4	4	90	3290	2300
Topsoil 2 – Oak Woodland	3.3	GL	26.8	5.0	6	5	310	1330	546
Topsoil 2 – Grass/Shrub	1.9	GL	26.4	5.7	10	1	120	1560	540
Topsoil 3	1.7	GL	26.5	7.3	4	16	110	2870	830
Topsoil 4	1.6	GCL	26.5	7.3	11	20	190	2330	668

* OM = Organic Matter

** G = Gravelly, S = Sandy, C = Clay, L = Loam

3.3 ASSESSMENT OF SOIL SUITABILITY ON THE CUT AND FILL SLOPE AREAS

3.3.1 Overview

The parent material at Leona Quarry is primarily composed of two types of bedrock: tuff and rhyolite (Berlogar Geotechnical Consultants 2000). Rhyolite is further divided into rhyolite 1 and rhyolite 2 based on weathering and alteration of the bedrock. Following site grading, these parent materials will comprise the majority of the soil and sub-soil within the cut and fill slopes, and therefore, will need to support most of the plant growth. Analysis of these soils provides an understanding of the physical, chemical, and biological make-up of the soil and helped determine which, if any, soil amendments are needed to make the soils more suitable for native plant growth.

3.3.2 Methods

Samples of tuff and rhyolite were collected and analyzed using the same methods that were used for the soils from the reference sites (see Section 3.2.2). Three areas were sampled including a site composed of tuff, a site composed of rhyolite 1, and a site composed of rhyolite 2 (Figure 3). Soils were evaluated based on quantitative data obtained from Soil and Plant Laboratory and qualitative observations made in the field. The cut and fill revegetation soils were each compared to the reference site soils. Soil amendments were partially based on recommendations from the Soil and Plant Laboratory.

3.3.3 Soil Suitability for Vegetation Establishment

The tuff, rhyolite 1, and rhyolite 2 sample areas all occur within the active quarry and are primarily composed of sub-soil exposed by quarry excavation (Figure 3). The tuff sample area contains little vegetation, primarily due to the steep slopes. The rhyolite 1 and 2 sample areas comprise non-native ruderal species including wild oats *(Avena fatua),* red brome, Italian thistle *(Carduus pycnocephalus),* and French broom. The rhyolite 2 sample area is relatively flat, while the rhyolite 1 sample area has a steeper grade. Table 1 provides details about some of the most important soil factors for plant growth at Leona Quarry. The three cut and fill soil samples had low organic matter content (0.1% - 0.6%). The rhyolite 1 and 2 soils had relatively high pH (6.9 and 7.3, respectively), while the tuff sample had a pH of 5.3. Nitrate and phosphate concentrations were similar to the reference sites, while the potassium levels in all three soils were lower than the concentrations in the reference sites. The ratio of calcium to magnesium was also relatively low for all three samples compared to the reference sites indicating a lack of calcium and relatively high magnesium in these soils.

Although the tuff, rhyolite 1, and rhyolite 2 revegetation site soils share some of the same characteristics as the reference site soils (e.g. low nitrate and phosphate concentration), overall the soils do not match those found at the reference sites. Therefore, the cut and fill soils will require soil amendments and/or topsoil placement prior to seeding and planting. The goal of the amendment and topsoil additions is to establish a soil that more closely matches the reference site soils and is thus more appropriate for the establishment of the target habitat.

3.4 ASSESSMENT OF ON-SITE TOPSOIL SUITABILITY FOR POTENTIAL REUSE

3.4.1 Overview

Topsoil provides many benefits to native plantings including providing organic matter, nutrients, native plant seed, and soil microbes to otherwise harsh revegetation conditions (Holmes 2001). Therefore, the potential for topsoil salvage from on-site locations and reuse on the revegetation site was investigated. The primary objective of this investigation was to identify areas that are composed of topsoils that match, as much as possible, the soil found within the reference sites. If necessary, this may require the addition of soil amendments.

Potential topsoil salvage areas were chosen based on multiple factors including the footprint of grading, the characteristics of the soils, size of area, and the composition and density of vegetation. Five potential topsoil salvage areas were identified and are shown in Figure 3. These included an area along Campus Drive (Topsoil 1), an area composed of an oak woodland and grasses and shrubs occurring along the south border of the site (Topsoil 2 – Oak Woodland and Topsoil 2 – Grass/Shrub), an area within the quarry that is composed of fill material (Topsoil 3), an area composed of French broom in the central portion of the quarry (Topsoil 4), and a topsoil adjacent to existing gullies, which will be filled during grading operations (Gully Fill Topsoil).

The majority of the potential topsoil salvage areas are located within the footprint of former quarry activity. As such, the soil profile in these areas has been significantly altered. Therefore, the term topsoil is used loosely in this context to refer to the upper zone of the soil profile. Woody and herbaceous vegetation has recolonized these areas and reinitiated the process of topsoil development.

3.4.2 Methods

Samples from the potential topsoil salvage areas, excluding the Gully Fill Topsoil, were collected and analyzed using the same methods that were used for the soils from the reference sites (see Section 3.1.2). Soils were evaluated based on quantitative data obtained from Soil and Plant Laboratory and qualitative observations made in the field. The determination of which topsoil salvage areas provide suitable topsoil was based on a critical analysis of the similarity of each site's topsoil to the reference sites' topsoils. Soil amendments were based, in part, on recommendations from Soil and Plant Laboratory. The Gully Fill Topsoil was qualitatively assessed in the field to determine whether it was suitable for use within the gully repair sites. Quantitative data was not collected from this topsoil.

3.4.3 Results

The raw chemical and particle size analysis data is presented in Appendix A. Table 1 provides a summary of this data.

3.4.3.1 Topsoil 1. Topsoil 1 occurs at the top of the quarry at approximately 1000 feet above MSL (Figure 3). Topsoil 1 comprised fill from on-site that was placed along Campus Drive sometime in the early 1990's (Chapman 2001, pers. comm.). A sparse cover of predominantly non-native grasses including wild oats and Italian ryegrass *(Lolium multiflorum)* has established. Native species such as coyote brush, poison oak, big squirreltail, and California poppy are sparsely distributed throughout this site. Three soil samples were taken from the Topsoil 1 location (Topsoil 1 a, b, and c). Topsoil 1a and 1b were sampled in January 2003 from areas comprising grasses and shrubs, respectively, while Topsoil 1c was sampled in May 2001 from both grass and shrub dominated areas. All samples had similar characteristics (Table 1). The organic matter content is relatively low (0.5-0.6%) and the pH is higher than that found in the majority of the reference sites (6.7-6.8). Nitrate levels are 4 ppm for all samples, while phosphate range from 4-9 ppm. These levels are similar to the reference sites' nitrate and phosphate levels (Table 1). The potassium levels (60-90 ppm) and the ratio of calcium to magnesium, on the other hand, are low compared to the reference sites.

Topsoil 1 will provide suitable topsoil for the cut slope if appropriate soil amendments are incorporated (see Section 4.3.2.1). It is recommended that the top 12 inches of topsoil be harvested from the site and appropriate amendments incorporated. The total volume of topsoil available at Topsoil 1 is approximately 7450 cubic yards.

3.4.3.2 Topsoil 2. Topsoil 2 is located at approximately 500 to 750 feet above MSL (Figure 3). The area was divided into two sections for topsoil analysis. The first area occurs in the southeast corner of the site and consists of an oak woodland composed primarily of mature coast live oak and valley oak *(Quercus lobata)*. The understory is comprised primarily of a 2 to 3-inch thick layer of leaf litter with patches of grasses growing within gaps in the canopy. The second sample was taken from an area north of the oak woodland composed of open grassland with scattered patches of shrubs. The vegetation within this area consists of coyote brush, California sagebrush, poison oak, wild oats, Italian ryegrass, ripgut brome, squirreltail, and coast range melic. The oak woodland and grass/shrub topsoils have organic matter contents of 3.3% and 1.9%, respectively (Table 1). The pHs of the soils are 5.0 for the oak woodland and 5.7 for the grass/shrub, which are both similar to pHs of the reference sites. The nutrient statuses of the two topsoil samples are also similar to most of the reference sites. Nitrate levels for the oak woodland and the grass/shrub site are 6 ppm and 10 ppm, respectively, the phosphate levels are 5 ppm and 1 ppm, respectively, and the potassium levels are 310 ppm and 120 ppm, respectively. The ratios of calcium to magnesium are slightly low compared to the reference sites for both Topsoil 2 sites.

Because both Topsoil 2 samples are comparable to the reference sites, it is recommended that the topsoil from this site be considered for reuse. The total volume of topsoil available at Topsoil 2 is approximately 2856 cubic yards assuming that 1.5 vertical feet is available for harvest.

3.4.3.3 Topsoil 3. Topsoil 3 is located at approximately 480 feet above MSL (Figure 3) and is composed of many non-native ruderal species including wild oats, ripgut brome, red brome, and French broom. This soil was imported to the site from primarily two off-site sources (Chapman 2001, pers. comm.). The organic matter content is somewhat low (1.7%) and the pH is high (7.3) compared to the reference sites (Table 1). Although nitrate levels are similar to the reference soils (4 ppm), the phosphate level is extremely high (16 ppm). No literature was found concerning the role of phosphate in French broom growth and invasion, but it is hypothesized that the high level of phosphate within the topsoil is the main contributing factor in the success of French broom at this site. In addition, patches of French broom surround the site. The soil potentially has a high number of viable French broom seeds that could germinate on the reclaimed slope, which could be detrimental to the revegetation of the target habitats.

Because Topsoil 3 is composed of fill material of unknown origin and the characteristics of the soil may encourage the expansion of French broom, it is recommended that Topsoil 3 not be used within the revegetation site.

3.4.3.4 Topsoil 4. Topsoil 4 is located along the southern portion of the active quarry at approximately 550 feet above MSL (Figure 3). The site is dominated by French broom and other non-native ruderal species. Soils at this location were high in nitrate (11 ppm), moderate in potassium (190 ppm), and very high in phosphate (20 ppm) (Table 1). This high phosphate level may lead to French broom invasion within the reclaimed slopes. Thus, Topsoil 4 is not recommended for reuse.

3.4.3.5 Gully Fill Topsoil. The topsoils located adjacent to the gullies within the northwest portion of the site, which will be filled with rock riprap and topsoil, were qualitatively analyzed in the field. Soil samples were not taken to the Plant and Soil Laboratory because the area in which the gully fill topsoil will be used will not be planted with native woody vegetation. Three soil pits were dug to a depth of 12 inches. The texture of the soil was found to be similar to the disturbed sagebrush reference soils with a gravelly loam texture. The depth of topsoil is approximately 12 inches. The areas are comprised of a moderate cover of vegetation including California sagebrush, deerweed, coyote brush, and grasses. Patches of French broom are present on the west side of the topsoil area. Based on the soil texture and the presence of desirable plant species on the site, this topsoil will be appropriate for use within the gully repair sites. The total volume of the Gully Fill Topsoil available is approximately 670 cubic yards.

4.0 GRADING AND SOIL PREPARATION PLAN

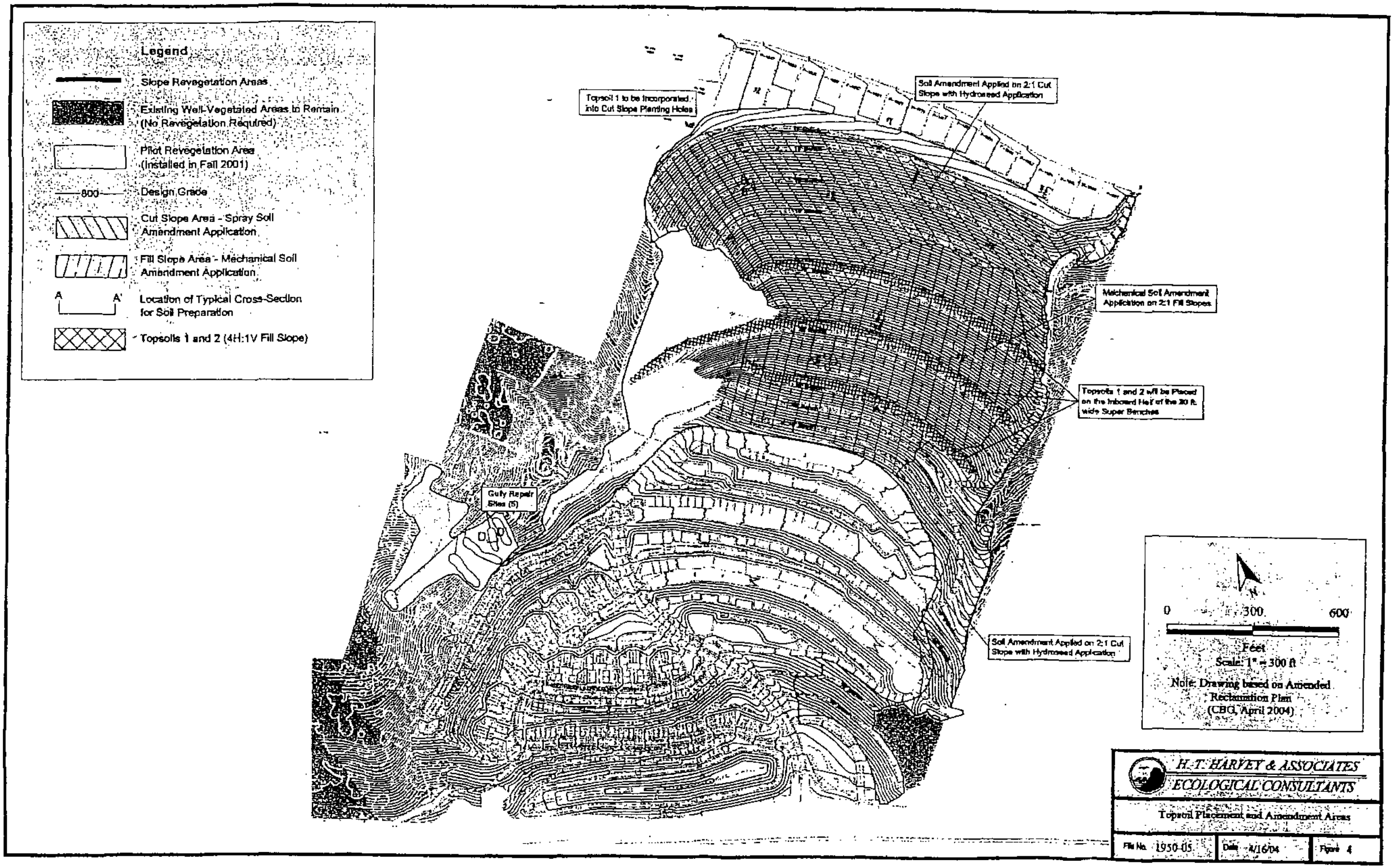
4.1 SLOPE GRADING PLAN

The Leona Quarry conceptual grading plan (Carlson, Barbee, & Gibson, April 2004) proposes to regrade/reconstruct the majority (37.5 acres) of the high quarry slope (Figures 2 and 4). The purpose of the proposed slope reconstruction and grading work from geotechnical and engineering perspectives is to create a stable slope that is safe for the lower development area proposed at the toe of the reconstructed slope. Accordingly, the conceptual grading plan proposes reconstruction of a 2H:1V, benched slope. The majority of the benches will be 10 feet wide and the plan also includes three, 30-foot wide benches (Figure 4). Slope drainage throughout the site would be controlled via a system of cement-lined V-ditches situated at the toe of each slope segment and connected to a network of drainage pipes.

The proposed slope gradient of 2H:1V represents a substantial reduction in steepness from the existing slopes. By cutting the upper portion of the slope and utilizing this cut material to fill the lower portion of the slope, a gentler slope will be constructed. The cut slope area to be revegetated is approximately 18.2 acres and is located across the upper 1/2 to 1/3 of the slope and within the southeastern margin of the site (Figure 4). An approximately 19.3-acre fill slope area is located in the central and lower portion of the revegetation planning area (Figure 4). The fill slope area will be constructed in lifts of up to approximately 160 vertical feet of compacted material harvested from the cut slope area (Berlogar 2003). Soil compaction is expected to be approximately 95% in the interior portion and approximately 85-90% in the upper one (1) foot of the fill slopes (Berlogar 2001, pers. comm.). Based on the surface geology map and borings, the material to be cut and utilized to construct the fill slope will be derived primarily from the Tuff bedrock type with some Rhyolite (Berlogar 2000). Thus, the revegetation site soil surface after slope reconstruction in both the cut and fill areas should be composed of primarily Tuff derived material with some Rhyolite. Since the Tuff is a relatively friable material, a significant component of finer grained soil particles should be generated from grading operations during fill slope construction (Berlogar 2001, pers. comm.).

Four gullies that currently exist in the northwest portion of the development area will be excavated down to bedrock and backfilled with a subdrain system, filter fabric, and rock riprap (Figure 4). The riprap will be filled to the plane of the adjacent slope and will be placed in layers within the gullies. After each rock layer is set within the gullies, a layer of topsoil from the Gully Fill Topsoil area will be placed over the riprap to fill-in the gaps between the rocks to the extent possible. A fifth gully located west of the other gully sites will also be repaired (Figure 4). These repairs will include cleaning out loose soil, installation of a subdrain, and filling with a compacted fill to the grade of the surrounding areas.

The remainder of the slope revegetation area, which primarily occurs within the northern portion of the site, will not be graded, thus keeping its current steep (approximately 1H:1V) grade.



Legend
Slope Revegetation Areas
Existing Well-Vegetated Areas to Remain (No Revegetation Required)
Pilot Revegetation Area (installed in Fall 2001)
800 Design Grade
Cut Slope Area - Spray Soil Amendment Application
Fill Slope Area - Mechanical Soil Amendment Application
A A' Location of Typical Cross-Section for Soil Preparation
Topsoils 1 and 2 (4H:1V Fill Slope)
Topsoil 1 to be Incorporated into Cut Slope Planting Holes
Soil Amendment Applied on 2:1 Cut Slope with Hydroseed Application
Mechanical Soil Amendment Application on 2:1 Fill Slopes
Topsoils 1 and 2 will be Placed on the Inboard Half of the 30 ft wide Super Benches
Gully Repair Sites (5)
Soil Amendment Applied on 2:1 Cut Slope with Hydroseed Application
N
0 300 600
Feet
Scale: 1" = 300 ft
Note: Drawing based on Amended Reclamation Plan (CBG, April 2004)
H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
Topsoil Placement and Amendment Areas
File No. 1950-05
Date 4/16/04
Figure 4

4.2 SOIL PREPARATION/AMENDMENT PLAN

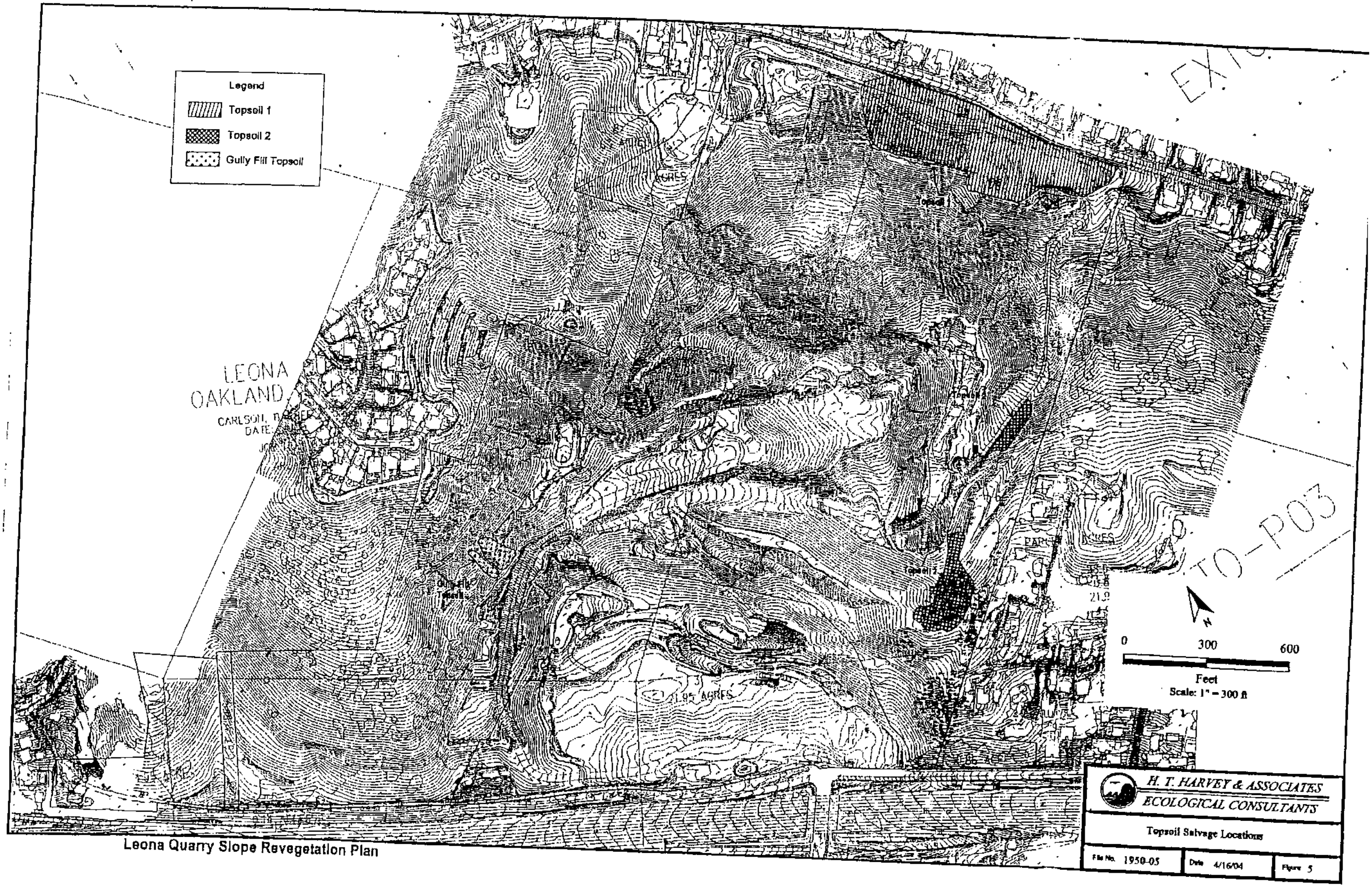
4.2.1 Overview

The proposed conceptual grading plan is a critical first step toward increasing the likelihood of revegetation success since it would transform the majority of the currently unstable, erosive slope into a physically stable soil surface suitable for vegetation colonization and establishment. However, the soil surface following regrading efforts will be composed of subsoil cut from depths far beneath the existing soil surface. Based on comparison of reference site soils to the revegetation site soils (Section 3.0) and on past restoration site experience, poor, slow vegetation establishment would be expected without soil amendments or respread topsoil (Holmes 2001). Subsoil that has not interacted over a substantial time period with vegetation and soil fauna typically exhibits low fertility. Generally, the low fertility of subsoils is due to a lack of plant available nutrients, low organic matter, absence of a functional soil microbial community, low soil aggregate formation, and low water holding capacity (Coleman and Crossley 1996, Jim 2001, Harris 1999). The process of vegetation colonization on newly exposed rock/soil surfaces is known as primary succession (Odum 1959). If left to occur without human intervention, the natural process of primary succession on the site's stable, regraded soil surface would occur over the course of decades and eventually lead to the improvement of soil structure and fertility along with a concomitant gradual increase in vegetative cover. Plant species composition would likely shift from an annual/perennial grass dominated community to a shrub dominated association, and depending on site conditions, potentially a tree dominated association (Connell and Slatyer 1977, Huston and Smith 1987). The soil preparation/amendment plan presented here, coupled with active seeding, planting, and short-term irrigation and weed control, should serve to greatly increase the rate of primary succession at the site.

The goal of the soil preparation/amendment plan is to create edaphic conditions suitable for initial establishment of seeded and planted native vegetation. In addition, the soil amendment and planting plans together are designed to promote the progressive, long-term improvement of edaphic conditions. Successful native plant establishment will lead to progressive soil development via the positive feedback between increasing plant productivity and development of a leaf litter layer (0 Horizon), healthy soil microbial/faunal community, increased organic matter build-up and decomposition, soil aggregate formation, and improved water holding capacity. Composted organic matter will form a key component of the soil amendment strategy because it is well known that organic matter is critical to soil aggregate formation, soil microbial community development, plant available nutrient levels, and water holding capacity (Darwish 1995, Harris 1999).

4.2.2 Topsoil Harvesting and Stockpiling

Topsoils 1 and 2 will be harvested (stripped) and stockpiled as one of the first slope grading operations (Figure 5). A restoration specialist will work with the grading contractor prior to grading operations to determine the exact location of topsoil harvest from these sites. Topsoil 1 will be excavated to an approximate depth of 1 foot, and the upper approximately 1.5 feet will be harvested from Topsoil 2. Tree trunks, branches and root wads greater than 6 inches in diameter



Leona Quarry Slope Revegetation Plan

will be harvested and stockpiled separately for use as large woody debris habitat on the site (Section 5.0). In addition, native tree and shrub branches less than 6 inches in diameter could be chipped and stockpiled for use as wood chip mulch during plant installation (Section 5.0).

Grading operations should be scheduled to minimize the time that topsoil is stockpiled. Topsoil should be labeled and mapped on plans to allow the contractor to distinguish it from other soils. Topsoil piles should not exceed 10 feet in height and should be linear rather than one large heap. The stockpiles will be protected from erosion during the rainy season by hydroseeding in a one-step application. Table 2 lists the species to be used and the pounds of pure live seed (PLS) per acre that will be applied. In addition, wood fiber (700 lbs/acre), non-asphaltic tackifier (120 lbs/acre), and inorganic fertilizer (6N-20P-20K at 300 lbs/acre) will be applied with the seed in the first application. Topsoil stockpiles should be hydroseeded prior to October 15 of each year of storage to ensure that they are protected prior to the first rain event.

Table 2. Hydroseed mix for stockpiled topsoil.

Common Name	Scientific Name	Minimum % Purity	Minimum % Germination	Pounds of PLS/Acre	Total Pounds / Acre
California brome	*Bromus carinatus*	95	80	8	10.5
three week fescue	*Vulpia microstachys*	90	80	5	6.9
regreen sterile wheat	*Triticum* x *Elymus*	90	80	35	48.6
arroyo lupine	*Lupinus succulentus*	98	85	2	2.4
			Total	**50**	**68.4**

4.2.3 Topsoil Amendments

Topsoils 1 and 2 will be amended prior to reuse. Amendments should be incorporated into the salvaged topsoils immediately prior to applying the topsoil to their respective locations.

4.2.3.1 Topsoil 1 Amendment. Amendments for Topsoil 1 will be uniformly mixed into the topsoil prior to topsoil reuse. Table 3 provides the application rates for bulk blending with Topsoil 1. The blend of 50% yardwaste compost and 50% recycled wood fines is recommended as the organic amendment since it has an appropriately low C:N ratio of <23 and has lower phosphate concentrations compared to 100% yardwaste compost. High phosphate concentrations were associated with on-site topsoils dominated by French broom, an undesirable non-native plant.

Table 3. Topsoil 1 Amendments and Application Rates.

Amendment Type	Application Rates
Organic Compost Blend*	2 cy organic matter/10 cy soil
Soil Sulfur	6 lbs/10 cy soil
Potassium Sulfate *(0-0-50)*	6 lbs/10 cy soil
Agricultural Gypsum	22 lbs/10 cy soil

*Blend of 50% yardwaste compost and 50% recycled wood fines. Premium compost blend available from Z-Best Products.

4.2.3.2 Topsoil 2 Amendment. Topsoil 2 will not require additional inorganic amendments because its soil characteristics are similar to the reference site soils (Table 1). However, an organic compost blend shall be mechanically incorporated into Topsoil 2 at a rate of 0.9cy organic matter / 10cy soil prior to topsoil reuse to improve soil conditions. As for Topsoil 1, the organic compost blend of 50% yardwaste and 50% recycled wood fines is recommended.

4.2.3.3 Ordering Amendments. The organic amendment (Premium Compost Blend from Z-Best Products) should be ordered 8-12 months in advance of the installation date to ensure that adequate quantities are available.

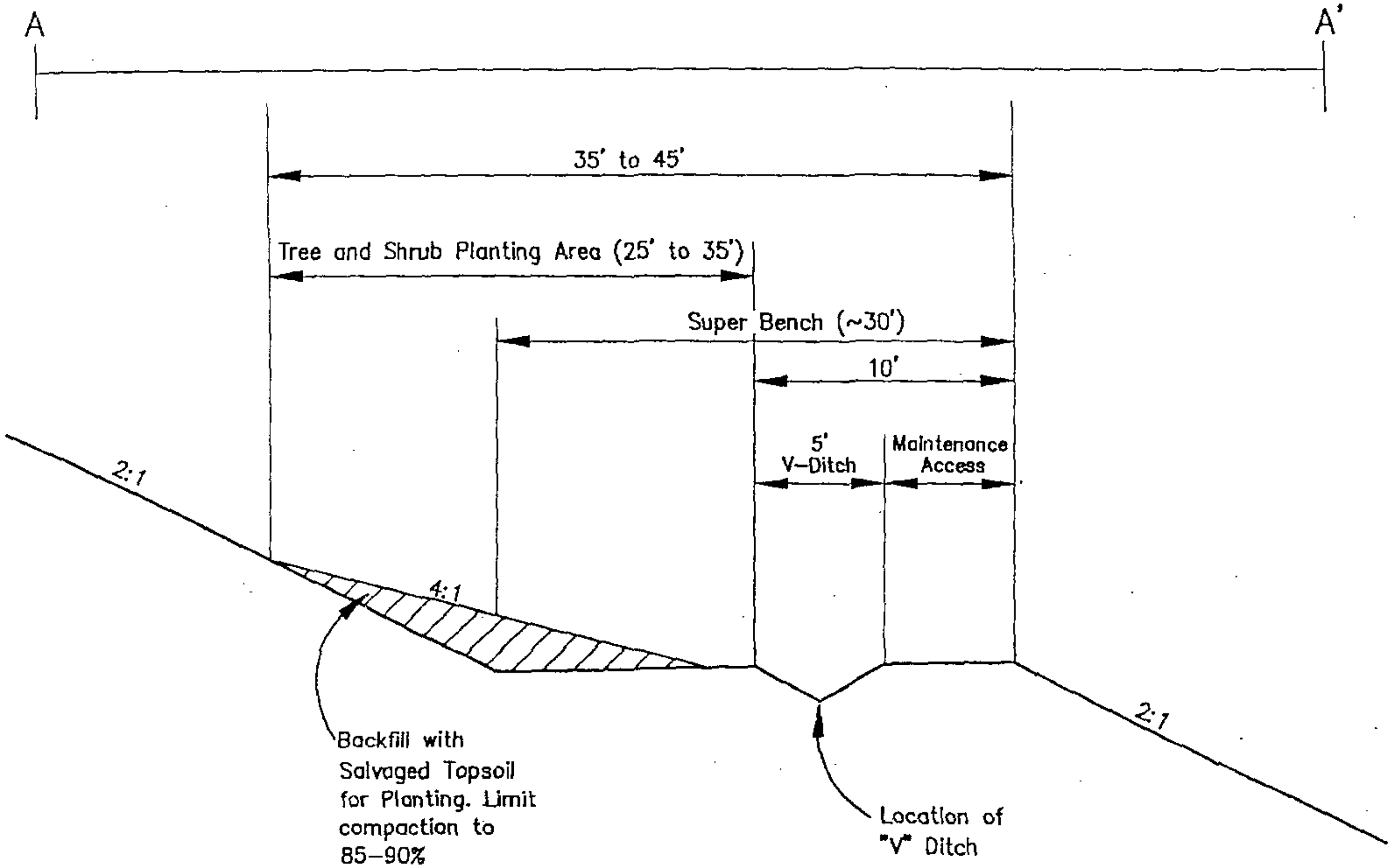
4.2.4 Soil Preparation on Super Benches

The conceptual grading plan shows the three super benches as uniform 30-foot wide benches bordered on either side by 2H: 1V slopes (Figures 2 and 4). The inside (i.e. upslope) portions of each super bench will be filled with Topsoil 1 and 2 to create an approximately 30-foot wide tree-planting area (Figure 6). The available amount of Topsoil 1 and 2 is approximately 9776 cubic yards, while the required amount will be approximately 7432 cubic yards (Table 4). The topsoil fill will be graded to form a 4H:1V slope that will begin at the center of each super bench and continue upslope until it intercepts the 2H:1V slope (Figure 6). The topsoil will be spread across the entire length of each of the super benches and will have a maximum depth of between 3 – 5 feet in the center and a maximum compaction of 85-90%. This configuration provides space for both the V-ditch and maintenance/hiking trail access (15-foot wide) and the revegetation area.

Table 4. Topsoil placement locations and the available and required amounts of topsoil for each location.

Location	Topsoil	Available Amount of Topsoil (cubic yards)	Required Amount of Topsoil (cubic yards)
Cut slope planting holes (2700 holes)	1	530*	530
Inboard half of three 30-foot wide super-benches	1 and 2	6920* + 2856	7432
Northwest slope gully repair sites	Gully Fill	670	350

* Topsoil 1 (7450 cy) will be divided between cut slope planting holes and super-benches



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Topsoil Placement on Super Benches - Typical Section A-A'

File No. 1950-05 | Date 4/16/04 | Figure 6

Leona Quarry Slope Revegetation Plan

Note: Cross-Section Location Shown on Figure 4
Scale: 1" = 10'

4.2.5 Soil Preparation on Cut Slopes

4.2.5.1 Soil Surface Shaping and Amendment. Following site grading, the entire cut slope will be track-walked to create track marks running parallel to the contours (Figure 4). This soil surface modification will facilitate vegetation establishment by increasing water retention and water infiltration, slowing down surface runoff and by capturing litter, soil particles and seeds (Bainbridge 2000). Mechanical application of soil amendments will not be performed on the cut slope surface since these slopes will be too rocky to allow effective physical incorporation of the amendments. Instead, a soil amendment will be sprayed onto the site during hydroseed application (see Section 5.3.3.1) (Figure 4 and 7). This amendment will make the site more conducive for plant establishment.

4.2.5.2 Planting Hole Auguring and Topsoil Installation. Approximately 2700 planting holes will be augured throughout the cut slope. The dimensions of the planting holes will be approximately 1.5 feet in diameter by 3 feet deep (Figure 7). Each of the augured holes will be backfilled with amended Topsoil 1 prior to plant installation. Rough calculations of topsoil cut and fill volumes show that the volume of Topsoil 1 available should be more than adequate to fill each of the planting holes (Table 4). The total volume of topsoil needed to fill the planting holes on the cut slope is approximately 530 cubic yards.

4.2.6 Soil Preparation on 2H:1V Fill Slopes

Fill slopes will be constructed to ensure that compaction in the upper one (1) foot of soil is between 85 and 90% (Figures 4 and 8). In accordance with recommendations from the geotechnical engineer, topsoil will not be spread on the 2H: 1V fill slopes (Berlogar 2001, pers. comm.). Rather, the soil amendments specified in Table 5 will be mechanically incorporated into the upper 3 to 6 inches of the soil profile (Figure 8). Soil amendments will be incorporated as uniformly as possible using tracked equipment and tilling, if required. The soil will be amended such that the final soil surface will have equipment tracks that are parallel to the slope contours.

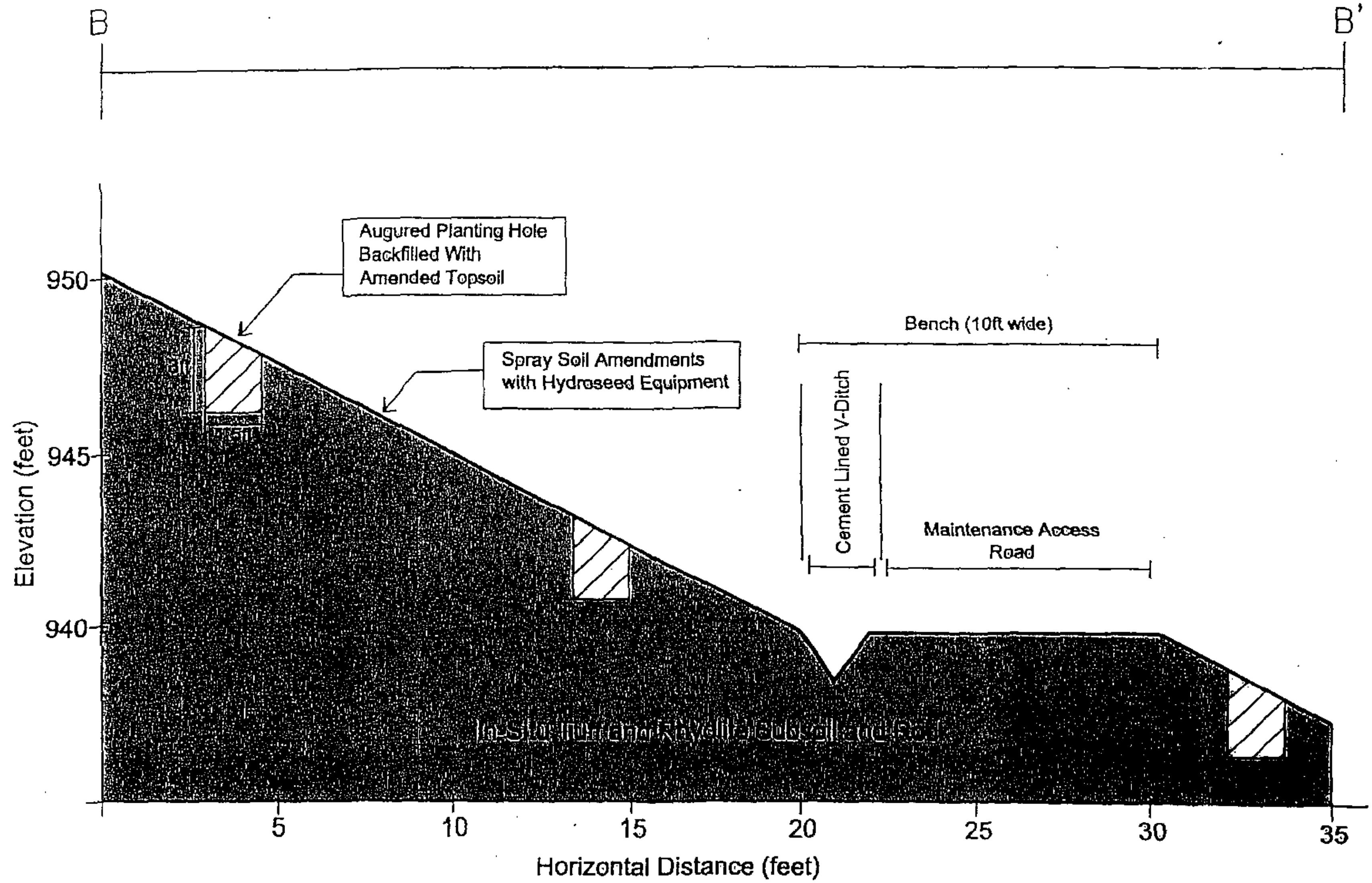
Table 5. Soil Amendments and Application Rates for 2H:1V Fill Slopes.

Amendment Type	Application Rates*
Organic Compost Blend**	166 cubic yards/acre
Potassium Sulfate (0-0-50)	350 lbs/acre
Agricultural Gypsum	1743 lbs/acre

* Incorporated into the upper 3 to 6 inches of soil.

** Blend of 50% yardwaste compost and 50% recycled wood fines (Premium Compost Blend available from Z-Best Products)

After the completion of fill slope construction, the upper 1-foot of soil will be sampled at representative locations to confirm/adjust the amendment protocol for the 2H: 1V fill slopes, to the actual post-construction soil chemistry.



Note: Cross-Section Location Shown on Figure 4

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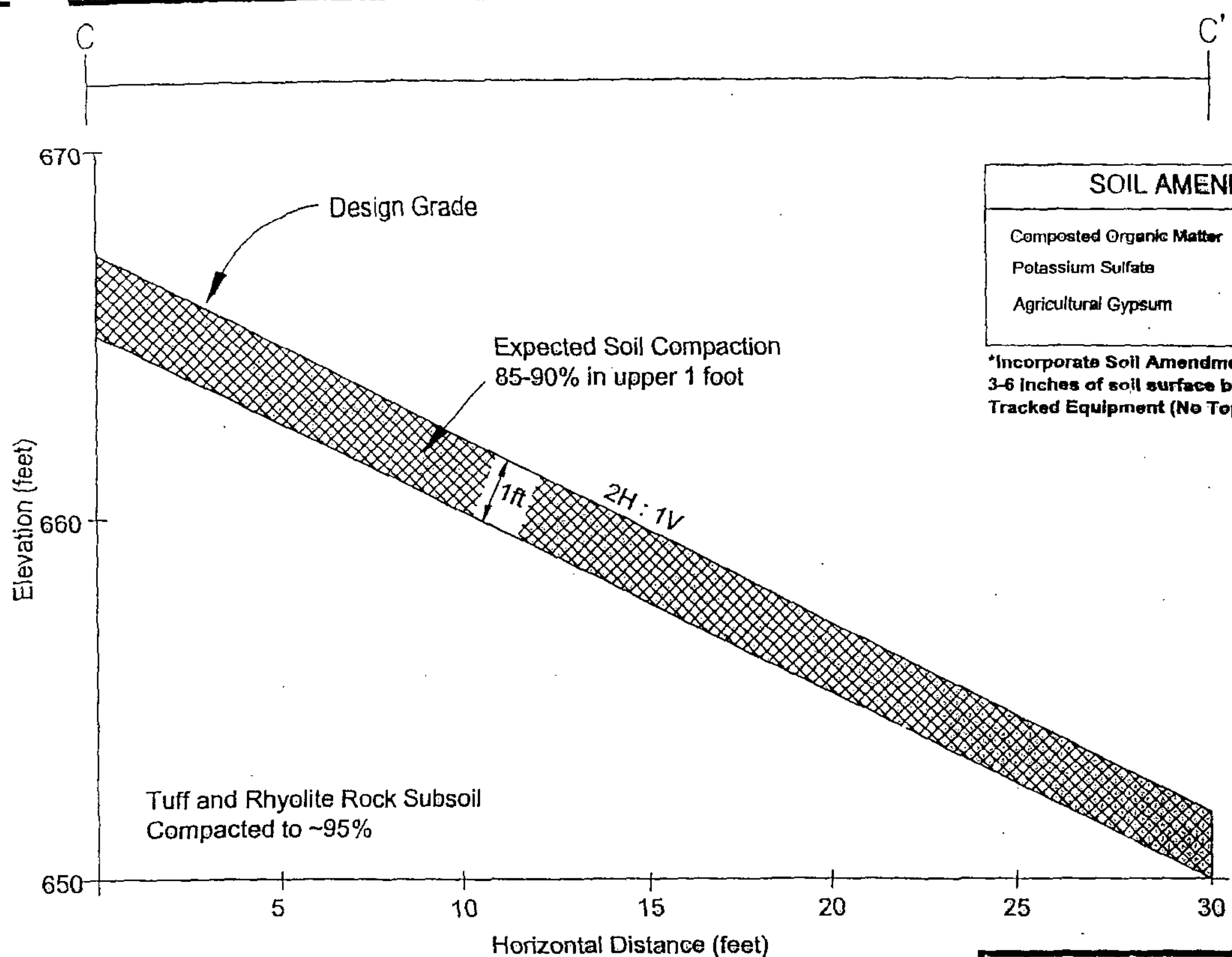
Cut Slope Soil Preparation and Planting Notes - Typical Section B-B'

File No. 1950-05	Date 4/16/04	Figure 7

Leona Quarry Slope Revegetation Plan



SOIL AMENDMENTS*	
Composted Organic Matter	166 cubic yards/acre
Potassium Sulfate	350 lbs./acre
Agricultural Gypsum	1743 lbs./acre

***Incorporate Soil Amendments Into Upper 3-6 Inches of soil surface by using Tracked Equipment (No Topsoil Placement)**

Note: Cross-Section Location Shown on Figure 4

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Soil Preparation on 2H:1V Fill Slopes:
Typical Section C-C'

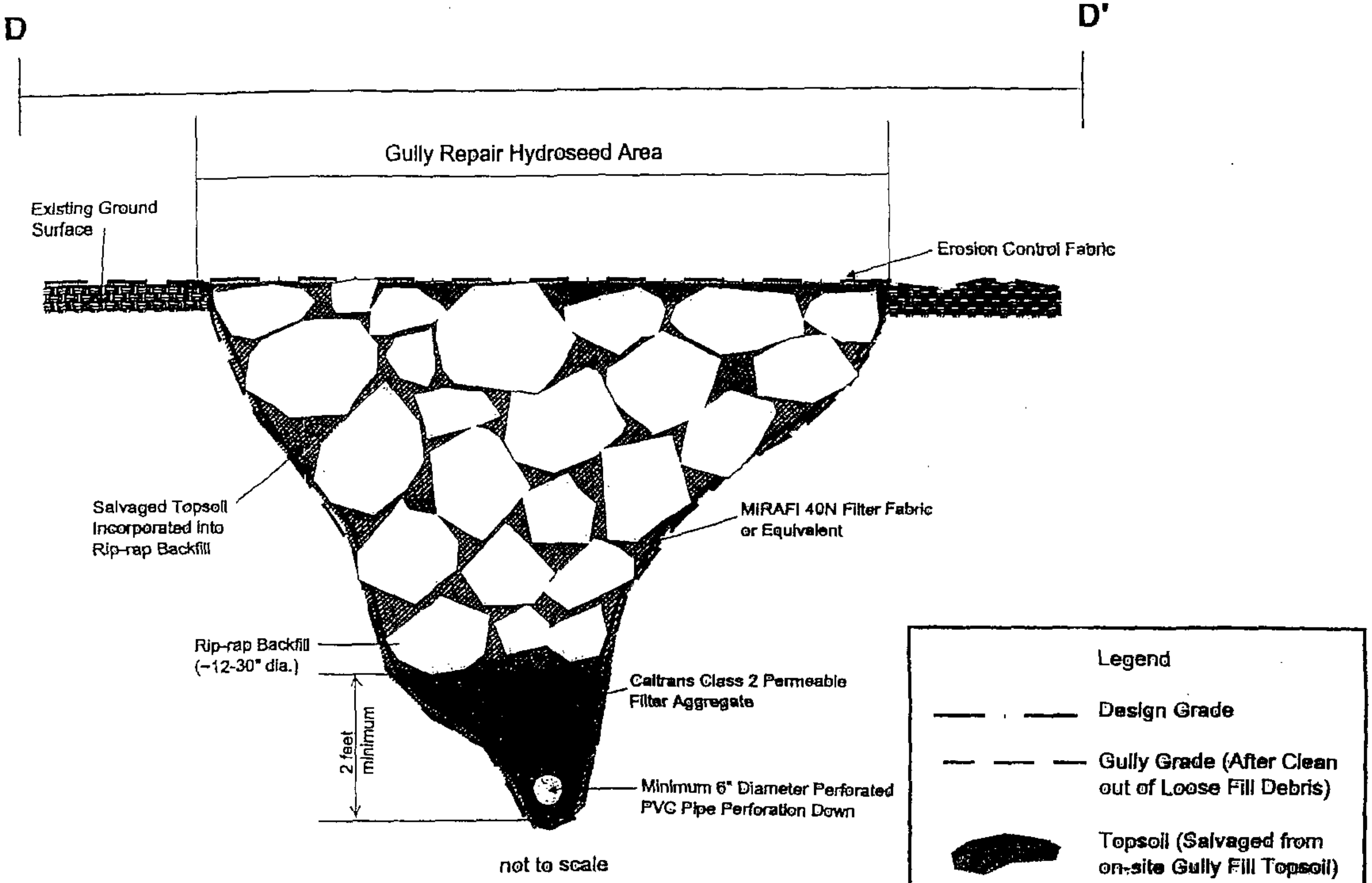
File No. 1950-05	Date 4/16/04	Figure 8

4.2.7 Gully Repair Sites

Salvaged soil from the Gully Fill Topsoil will be spread in layers along with the rock riprap within the gully repair sites (Figure 4 and 9). After each layer of rock riprap is set in place, a sufficient quantity of soil will be spread across the rock and allowed to fill-in the voids between the rocks. This will continue until each gully is filled according to the conceptual grading plan. Approximately 670 cubic yards are available for use within the gully repair site, while approximately 350 cubic yards are required (Table 4). The topsoil used for the gully repair sites will not be amended prior to reuse because the site will receive a soil amendment during hydroseed application (see Section 5.3.4).

4.2.8 Invasive Species Removal From Slope Grading Area

Where the non-native invasive species French broom and pampas grass are cleared from the grading area, care should be taken to remove this vegetation from the site. This will help limit the inadvertent spread of propagules onto the revegetation site.



Note: Cross-Section Location Shown on Figure 4

Leona Quarry Slope Revegetation Plan

H. T. HARVEY & ASSOCIATES *ECOLOGICAL CONSULTANTS*		
Topsoil Placement at Gully Repair Sites-Typical Section D-D'		
File No. 1950-05	Date 4/16/04	Figure 9

5.0 CONCEPTUAL REVEGETATION PLAN

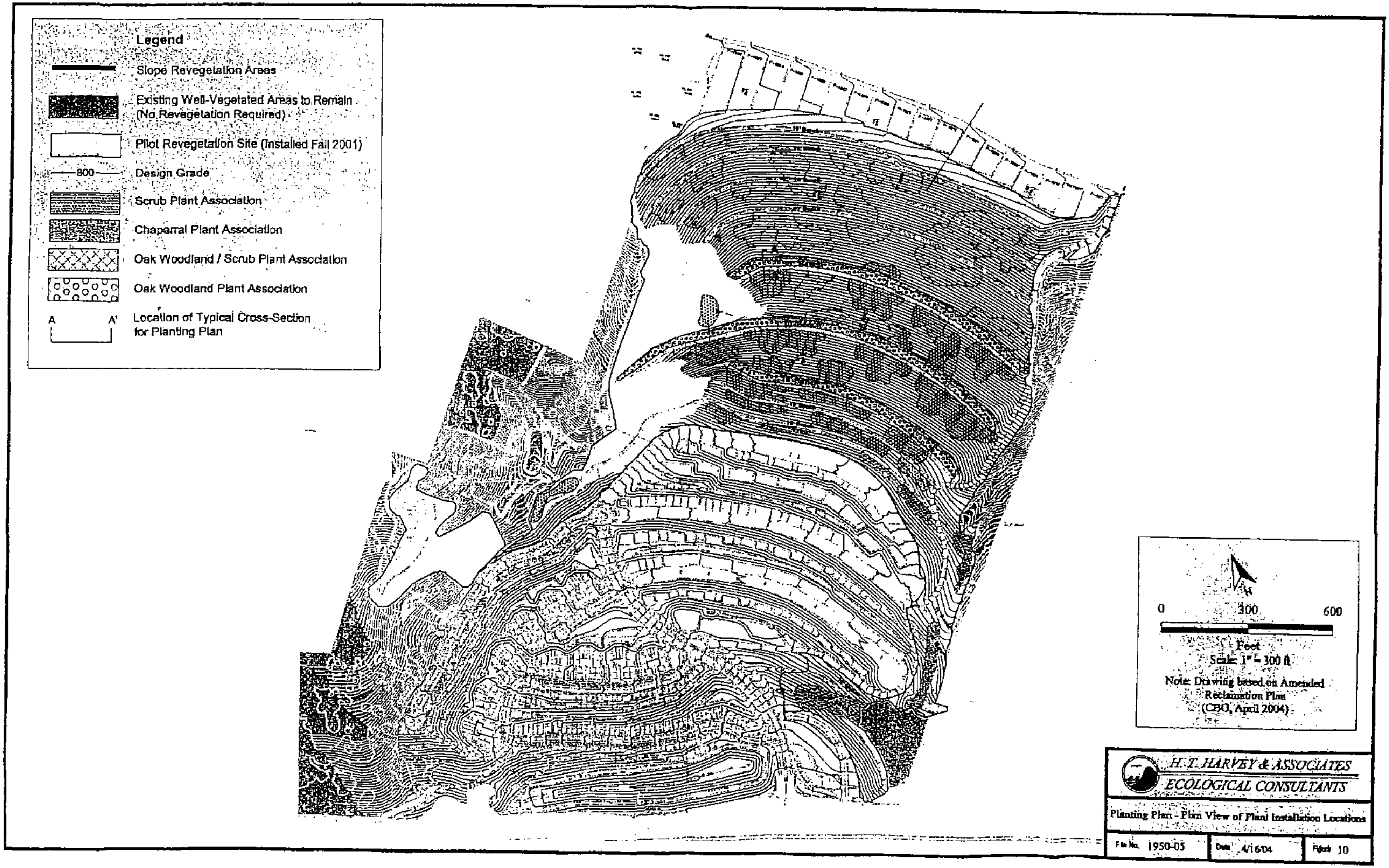
5.1 TARGET HABITATS

The target habitat mosaic for the reclaimed slope consists of patches of native shrub and tree dominated habitats interspersed with grassland (Figure 10). The shrub and tree dominated habitats consist of four plant associations modeled after the reference sites. These include a central coastal scrub (scrub) plant association dominated by California sagebrush, a northern mixed chaparral (chaparral) plant association dominated by chamise, an oak woodland plant association, and an oak woodland/scrub plant association (Figure 10). The scrub and chaparral plant associations are composed of relatively short-statured shrub species while the oak woodland association is dominated by tree species. The oak woodland/scrub association will be comprised of a mix of shrub and tree species. In addition, a diversity of native grasses and forbs are included in the hydroseed plan, which are expected to establish throughout the slope revegetation area. The combination of these species will provide a complex, multi-layered canopy structure that will control erosion, increase wildlife habitat, and enhance the aesthetic of the landscape.

The arrangement of the plant associations is based on the locations of the plant communities in the reference sites. The scrub plant association will occur at the lower elevations of the project site between 600 to 700 feet above MSL. The scrub and chaparral plant associations will overlap between 700 and 800 feet above MSL creating an ecotone between the two plant communities. The chaparral plant association will dominate from approximately 800 feet above MSL to the top of the revegetation area. The oak woodland plant association will occur along the 30-foot wide maintenance benches. The oak woodland/scrub association will occur within the southeast portion of the site at elevations between 350 and 600 feet above MSL.

California sagebrush will dominate the scrub association, whereas chamise will be the dominant species within the chaparral association. Additional native plant species will be planted within the gaps between the chamise and California sagebrush plants. Other shrub species to be planted include blue elderberry, coffeeberry *(Rhamnus californica)*, orange bush monkeyflower, coyote brush, silver bush lupine *(Lupinus albifrons)*, black sage *(Salvia mellifera)*, California buckwheat *(Eriogonum fasciculatum)*, and deerweed. Herbaceous grasses and forbs, including California poppy, arroyo lupine, golden yarrow, Purshings lotus *(Lotus purshianus)*, coast range melic, California brome, purple needlegrass *(Nassella pulchra)*, slender wheatgrass *(Elymus trachycaulus)*, blue wild rye *(Elymus glaucus)* and three-week fescue, will also be found within the scrub and chaparral plant associations. Both habitat types are expected in the long-term to form moderately dense canopies within localized patches throughout the reconstructed slopes.

The dominant species within the oak woodland habitat will be coast live oak. Species that will be associated with coast live oak will include valley oak, California buckeye *(Aesculus californica)*, Mexican elderberry, and California bay *(Umbellularia californica)*. An herbaceous layer consisting of California poppy, coast range melic, California brome, purple needlegrass, slender wheatgrass, and three-week fescue is expected to occur within the oak woodland habitat. At maturity, the oak woodland habitat will consist of multiple canopy layers, which will benefit


Legend
Slope Revegetation Areas
Existing Well-Vegetated Areas to Remain (No Revegetation Required)
Pilot Revegetation Site (Installed Fall 2001)
800
Design Grade
Scrub Plant Association
Chaparral Plant Association
Oak Woodland / Scrub Plant Association
Oak Woodland Plant Association
A A'
Location of Typical Cross-Section for Planting Plan
N
0 300 600
Feet
Scale: 1" = 300 ft
Note: Drawing based on Amended Reclamation Plan (CBO, April 2004)
H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
Planting Plan - Plan View of Plant Installation Locations
File No. 1950-03
Date 4/16/04
Figure 10

wildlife species and add to the diversity of the landscape.

The oak woodland/scrub association will comprise coast live oak and native shrub species. The shrub species will be the same as those found in the scrub plant association. This habitat type will provide a complex habitat that will blend into the surrounding native landscape.

An approximately 8.1-acre area located along the northern portion of the site will not be planted due to the steep (1H:1V) slopes and inaccessibility (Figure 10). These areas, however, will be seeded with a diverse mix of native shrub and herbaceous species.

A relatively large area (25.7 acres) within the northern portion of the Leona Quarry, which was not disturbed by past quarrying activities and is currently well-vegetated with oak woodland, mixed chaparral, and scrub habitats, will not receive any revegetation (Figure 2). These habitats currently consist of a dense cover of woody and herbaceous species that is self-sustainable without human intervention. Because these areas are well vegetated and will not be disturbed during grading operations, they will not require revegetation. This area however, will provide a long-term seed source for natural revegetation of the quarry slopes.

5.2 INTERIM CONSTRUCTION HYDROSEED PLAN

Grading of the reclaimed slope area will likely take place over two construction seasons. Consequently, the following interim construction hydroseed plan was developed as a component of the erosion control strategy to be employed between construction seasons. All areas throughout the project site that have been disturbed by grading activities and are composed of unvegetated soil at the beginning of the rainy season (mid-October) will be protected from erosion by hydroseeding in a one-step application. Table 6 lists the species to be used and the pounds of pure live seed (PLS) per acre that will be applied. The one-step hydroseed application will also consist of wood fiber (700 lbs/acre), non-asphaltic tackifier (120 lbs/acre), and inorganic fertilizer (6N-20P-20K at 300 lbs/acre). Hydroseed application shall occur prior to October 15 of each year to ensure that the areas are protected prior to the first rain event.

Table 6. Interim construction hydroseed mix.

Common Name	Scientific Name	Minimum % Purity	Minimum % Germination	Pounds of PLS/Acre	Total Pounds / Acre
California brome	*Bromus carinatus*	95	80	10	13.2
blue wild rye	*Elymus glaucus*	90	80	5	6.9
three weeks fescue	*Vulpia microstachys*	90	80	7.5	10.4
regreen sterile wheat	*Triticum* x *Elymus*	90	80	25	34.7
arroyo lupine	*Lupinus succulentus*	98	85	2.5	3
			Total	**50**	**68.2**

5.3 POST SLOPE CONSTRUCTION HYDROSEED PLAN AND EROSION CONTROL FABRIC

5.3.1 Introduction

The long-term success of habitat restoration at the project site is dependent upon effective stabilization of the reconstructed soil surfaces. This will be especially important during the first few years of plant establishment when the vegetation cover of shrubs and trees will be limited. To ensure proper erosion control, a hydroseed plan has been devised that will provide erosion control throughout the project site (Figure 11). The entire 45.6-acre site will be hydroseeded. In addition, it is anticipated that the hydroseed plan will contribute to the long-term stability of the site by "filling in" the gaps between the planted trees and shrubs, providing a stable surface for natural recruitment of plant species and hastening soil development.

Hydroseeding with a mixture of California native annual and perennial species, combined with the application of straw mulch and wood chips, will be the primary method of erosion control. The principal objective of the hydroseeding operation is to provide erosion control during the first rainy season after project construction. Secondarily, hydroseeded grasses, forbs, and shrubs will increase the diversity of native species cover at the site.

5.3.2 Seed Mix

Plant species for the hydroseed mix were selected to provide rapid germination and growth for effective erosion control during the first winter and to provide long-term soil stability throughout the project site. A combination of annual and perennial grasses, forbs, shrubs, and sub-shrubs was chosen for the hydroseed mix (Table 7).

Table 7. Hydroseed Mix for Slope Revegetation Area

Common Name	Scientific Name	Type	Approx Number of Seeds per Pound	Minimum % Purity	Minimum % Germination	Pounds of PLS/Acre (Slope Measurement)	Total Pounds/Acre
coast range melic*	*Melica imperfecta*	perennial grass	450,000	90	60	4	7.4
California brome	*Bromus carinatus*	perennial grass	95,000	95	80	10	13.2
blue wild rye	*Elymus glaucus* (Berkeley Hills ecotype)	perennial grass	120,000	90	80	7	9.7
purple needlegrass	*Nassella pulchra* (San Juan Baptista ecotype)	perennial grass	289,000	80	70	2	3.6

Common Name	Scientific Name	Type	Approx Number of Seeds per Pound	Minimum % Purity	Minimum % Germination	Pounds of PLS/Acre (Slope Measurement)	Total Pounds/Acre
slender wheatgrass	*Elymus trachycaulus* (San Juan Baptista ecotype)	perennial grass	146,000	90	80	4	5.6
three weeks fescue	*Vulpia microstachys*	annual grass	500,000	90	80	6	8.3
arroyo lupine	*Lupinus succulentus*	annual legume	15,000	98	85	8	9.6
Purshings lotus	*Lotus purshianus*	annual legume	120,000	98	60	2	3.4
golden yarrow*	*Eriophyllum confertiflorum*	sub-shrub	2,750,000	30	60	0.2	1.1
California poppy*	*Eschscholzia californica*	perennial forb	275,000	98	70	2	2.9
California sagebrush*	*Artemisia californica* (San Francisco Bay Area Source)	shrub	6,500,000	15	50	0.5	6.7
chamise*	*Adenostoma fasciculatum* (San Francisco Bay Area Source)	shrub	580,000	50	50	3**	12
Santa Barbara Island buckwheat*	*Eriogonum giganteum var. compactum*	shrub	900,000	30	60	1***	5.6
black sage*	*Salvia mellifera* (Northern California Collection)	shrub	625,000	70	50	2	5.7
deerweed*	*Lotus scoparius* (Northern California Collection)	shrub	450,000	90	60	3	5.6

Common Name	Scientific Name	Type	Approx Number of Seeds per Pound	Minimum % Purity	Minimum % Germination	Pounds of PLS/Acre (Slope Measurement)	Total Pounds/Acre
California buckwheat*	*Eriogonum fasciculatum* (Northern California Collection)	shrub	325,000	50	10	1	20
					Total	55.7	120.4

* Found in reference sites adjacent to quarry revegetation site
** Seed treated with 10% sulfuric acid solution for 15 minutes prior to hydroseeding
*** Seed applied only on the North Slope Area (slopes 1.5H:1V and steeper)

5.3.3 Erosion Control Fabric

In response to comments received by Lowney & Associates, erosion control fabric will be installed on all slope segments greater than 30 vertical feet tall (Figure 11). Thus, the majority of the slopes will receive erosion control fabric. The erosion control fabric will consist of a 100% coconut fiber matrix with natural fiber netting (North American Green C125BN or equivalent).

5.3.4 Hydroseed Application for 2H:1V Reconstructed Slopes/Benches

The hydroseed application will vary as follows for reconstructed slopes with and without erosion control fabric (Figure 11).

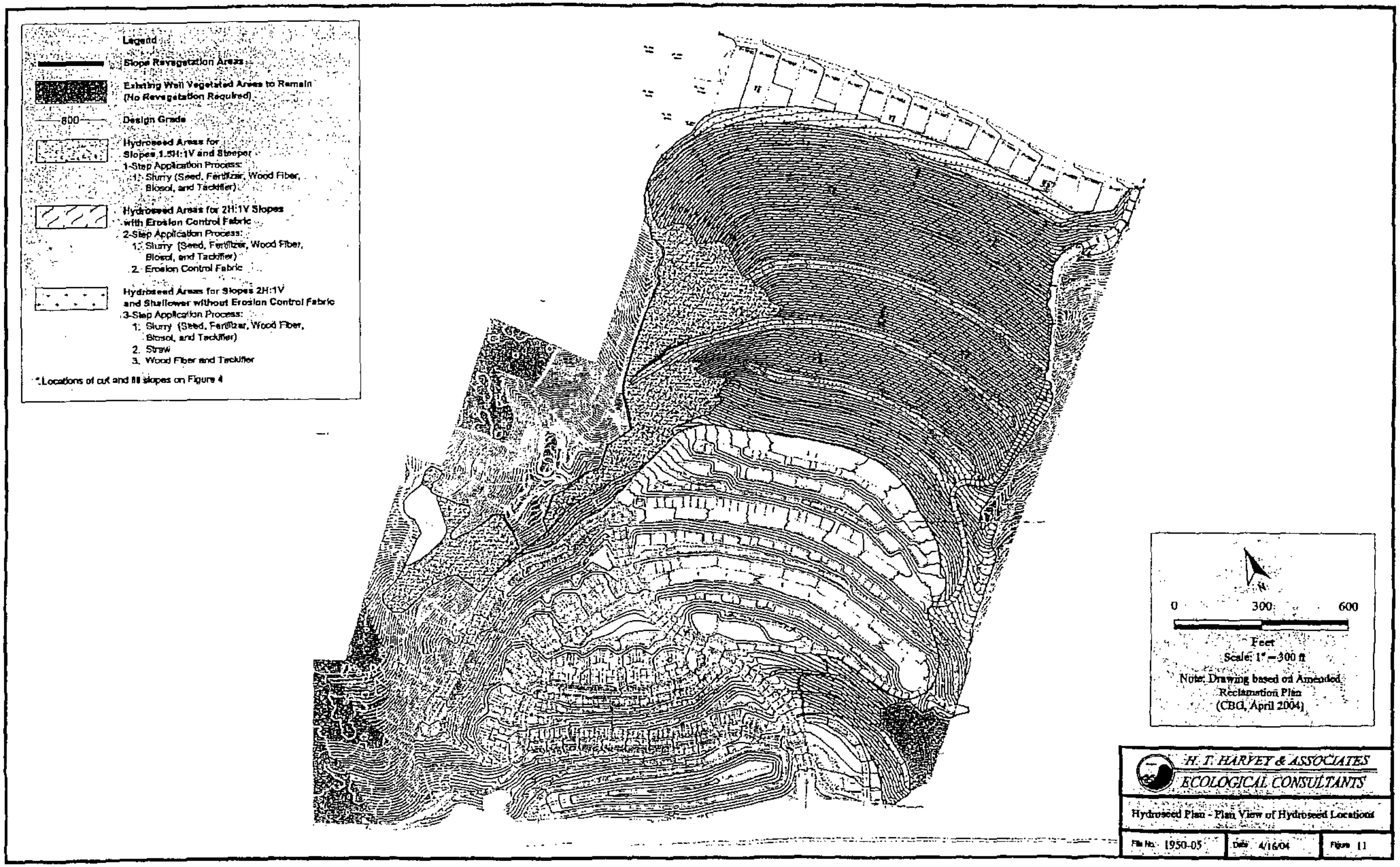
5.3.4.1 Reconstructed Slopes With Erosion Control Fabric. Reconstructed slopes taller than 30 vertical feet will receive erosion control fabric as stated above. These areas will receive a 1-step hydroseed treatment <u>before</u> the erosion control fabric is installed. It will be important to hydroseed the soil surface prior to fabric installation to ensure good seed to soil contact and adequate seed germination and growth. The 1-step hydroseed application will consist of the following:

> Seed mix (Table 7) + Wood fiber (800 lbs/acre) + Biosol (800 lbs/acre) + Potassium sulfate (175 lbs/acre) + Agricultural gypsum (1500 lbs/acre) + Non-asphaltic tackifier (120 lbs/acre)

Seed will be thoroughly mixed to ensure that they are broadcast at the pure live seed rates shown in Table 7.

5.3.4.2 Reconstructed Slopes Without Erosion Control Fabric. Reconstructed slopes equal to or less than 30 vertical feet tall will not receive erosion control fabric. These slope segments will be hydroseeded with a 3-step process as follows to utilize straw for additional erosion protection in lieu of fabric.

- Step 1: Seed mix (Table 7) + Wood fiber (800 lbs/acre) + Biosol (800 lbs/acre) +



Legend
Slope Revegetation Areas
Existing Well Vegetated Areas to Remain (No Revegetation Required)
800 Design Grade
Hydroseed Areas for Slopes 1.5H:1V and Steeper
1-Step Application Process:
1. Slurry (Seed, Fertilizer, Wood Fiber, Biosol, and Tackifier)
Hydroseed Areas for 2H:1V Slopes with Erosion Control Fabric
2-Step Application Process:
1. Slurry (Seed, Fertilizer, Wood Fiber, Biosol, and Tackifier)
2. Erosion Control Fabric
Hydroseed Areas for Slopes 2H:1V and Shallower without Erosion Control Fabric
3-Step Application Process:
1. Slurry (Seed, Fertilizer, Wood Fiber, Biosol, and Tackifier)
2. Straw
3. Wood Fiber and Tackifier
*Locations of cut and fill slopes on Figure 4
N
0
300
600
Feet
Scale: 1" = 300 ft
Note: Drawing based on Amended Reclamation Plan (CBG, April 2004)
H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
Hydroseed Plan - Plan View of Hydroseed Locations
File No. 1950-05
Date 4/16/04
Figure 11

Figure 11. Hydroseed Plan – Plan View of Hydroseed Locations.

5.3.5 One-Step Hydroseed Application for North Slope Area

Slopes that are 1.5H:1V and steeper will receive only one hydroseed application. Only one step will be necessary for these slopes because it is assumed straw mulch would not stay on the steep slopes. The one-step application will consist of the following:

- Seed mix (Table 7) + Wood fiber (800 lbs/acre) + Biosol (6N-1P-3K, 800 lbs/acre) + Potassium sulfate (0N-0P-50K, 175 lbs/acre) + Agricultural gypsum (1500 lbs/acre) + Non-asphaltic tackifier (120 lbs/acre)

5.3.6 Mulching

Rice straw and/or wood fiber mulch will be included in the hydroseed application to minimize soil erosion during the early part of the rainy season prior to the development of herbaceous plant roots. In addition to providing erosion control, mulch provides a more conducive environment for native plant germination and growth by conserving moisture, regulating soil temperatures and increasing microbial activity (Zink and Allen 1998).

5.3.7 Timing of Hydroseed Application

The project site will be hydroseeded between September 15 and October 15 after slope grading work is complete and prior to the onset of winter rains. The entire 45.6-acre site will be hydroseeded after soil preparation, soil shaping, and irrigation system installation and prior to planting of shrubs and trees.

5.3.8 Irrigation

Irrigation will not be necessary for the hydroseeded vegetation since natural precipitation typically supplies sufficient water for the establishment of the grass, forb, and shrub species in the hydroseed mix (Table 7). In addition, irrigation may wash seeds off the slopes or cause the hydroseeded vegetation to fail if the plants become "dependent" on the supplemental water. Furthermore, non-native weed species may be given a competitive advantage over native species by the application of additional irrigation water.

5.4 MYCORRHIZAL INOCULATION

5.4.1 Introduction

Mycorrhiza refers to the symbiotic relationship that occurs in nature between a plant's roots and one of many types of specialized fungus (Smith and Read 1997). Mycorrhizal inoculation has been shown to have many beneficial effects on native plants in restoration projects (Chaudhary and Griswold 2001, St. John 1992). The mycorrhizal fungi attach to a plant's roots and essentially increase the volume of soil from which the roots can extract water and nutrients. This association provides the plant with increased water and nutrient uptake (particularly phosphorous) and may increase the plant's growth rate and long-term survival. At the same time, the fungi receive photosynthates, which are essential for their survival and growth. In addition, mycorrhizal fungi improve soil structure, which is beneficial to plant growth. Many of the species that will be planted and hydroseeded at Leona Quarry are mycorrhizal (Chaudhary and Griswold 2001, Allen et al. 1999, St. John 1996).

5.4.2 Method of Mycorrhizal Fungi Inoculation

Many methods of inoculating restoration sites with mycorrhizal fungi exist. These include allowing natural colonization from surrounding undisturbed native habitats to occur, spreading native topsoil known to contain mycorrhizal fungi across the restoration site, adding native mycorrhizal fungi directly to container grown stock, or inoculating the plants or soil with some form of commercial inoculum (Chaudhary and Griswold 2001). The latter method involves either inoculating container stock while it is in the nursery or spreading the commercial inoculum across the project site either with a land imprinter or in a hydroseed mix.

Establishment of mycorrhizal fungi by means of natural colonization into a highly disturbed area such as Leona Quarry is a slow process that typically takes a few years or more to occur. This means that typically within the first year or two of plant establishment mycorrhizal fungi will not be present in the soil and therefore will not benefit the plants during their most stressful phase of establishment. The addition of native, undisturbed topsoil across the project site is probably the best means to inoculate the soil, but requires a substantial quantity of high quality, properly stored soils. Therefore, this method cannot be used at Leona Quarry due to the lack of available high quality topsoil. Commercial inoculum has been shown to work in some coastal sage scrub-chaparral restoration projects, but the fungi are typically not native species and little quantitative data exists about the long-term success of using the commercial inoculum. Therefore, commercial inoculum will not be used to inoculate the soils with mycorrhizal fungi at Leona Quarry.

Inoculation of the soils with native mycorrhizal fungi will occur at the project site by strategically placing inoculated container grown plants throughout the revegetation site. The nursery grown trees and shrubs will be inoculated by incorporating native duff from the reference sites into the potting material during nursery propagation. The inoculated trees and shrubs will be planted in patches throughout the site once they are ready for planting. In addition, a small amount of topsoil and duff from undisturbed chaparral and oak woodland habitats will be added to the planting holes within the cut and fill slopes at the time of planting to increase the probability of mycorrhizal inoculation. It is expected that within a short time period a network of mycorrhizae will form around each planting group. Species that were hydroseeded onto the site will quickly become inoculated as the mycorrhizal network spreads across the regraded slopes.

5.5 PLANTING PLAN

5.5.1 Introduction

Approximately 14.2 acres of the regraded slope (~ 40% of the reconstructed slope) will be planted with nursery grown trees and shrubs (Figure 10). The trees and shrubs will be divided into four plant associations including the chaparral, scrub, oak woodland, and oak woodland/scrub plant associations. The chaparral association will account for approximately 5.2 acres, the scrub association will cover 5.1 acres, the oak woodland habitat will be planted on approximately 2.6 acres, and the oak woodland/scrub association will cover approximately 1.3 acres. The planting plan is designed to successfully establish the three habitat types designated for the site.

The addition of container grown trees and shrubs was chosen because planting trees and shrubs will give the site some immediate plant cover and structure. Moderate to high survival and growth rates of native trees and shrubs were observed at the Pilot Revegetation Site (H.T. Harvey & Associates 2003). In addition, because non-native annual plants reduce the natural recruitment of many native shrubs including California sagebrush, the addition of container grown plants will increase the likelihood of establishment and long-term sustainability of the project (Eliason and Allen 1997). Therefore, the planting of nursery grown trees and shrubs, which will be irrigated and maintained on-site for a minimum of 3 years during the plant establishment period, will increase the probability of success for the revegetation project.

Planting locations were based on the following criteria: slopes gentler than 1.5H:IV, sites accessible to manual laborers on foot, and soil depths greater than 10 inches. Therefore, portions of the northern, ungraded slope will not be planted with nursery grown trees and shrubs (Figure 10). These areas will, however, receive a hydroseed application of native shrub and herbaceous species.

5.5.2 Plant Species Palette

Table 8 provides the plant species palette for each plant association. Based on the on-center spacings, approximately 500 plants per acre will be planted in the scrub and chaparral plant associations, 195 plants per acre will be planted in the oak woodland plant association, and 327 plants per acre will be installed within the oak woodland/scrub plant associates. The exact number of each species to be planted per acre shall be determined during preparation of restoration plans and specifications.

Table 8. List of Nursery Grown Trees and Shrubs for the Leona Quarry Slope Revegetation Areas Including On-Center Spacing, Container Size, and Percentage

Plant Association	Common Name	Scientific Name	On-Center Spacing (feet)	Container Size*	Approximate Percentage
Scrub	California sagebrush	*Artemisia californica*	10	deepot	35
	coyote brush	*Baccharis pilularis*	10	deepot	15
	blue elderberry	*Sambucus mexicanus*	10	deepot	10
	coffeeberry	*Rhamnus californica*	10	deepot	10
	silver bush lupine	*Lupinus albifrons*	10	deepot	10
	deerweed	*Lotus scoparius*	10	deepot	5
	California buckwheat	*Eriogonum fasciculatum*	10	deepot	5
	black sage	*Salvia mellifera*	10	deepot	5

Plant Association	Common Name	Scientific Name	On-Center Spacing (feet)	Container Size*	Approximate Percentage
	orange bush monkeyflower	*Diplacus aurantiacus*	10	deepot	5
Chaparral	chamise	*Adenostoma fasciculatum*	10	deepot	40
	coyote brush	*Baccharis pilularis*	10	deepot	15
	California sagebrush	*Artemisia californica*	10	deepot	10
	blue elderberry	*Sambucus mexicanus*	10	deepot	10
	silver bush lupine	*Lupinus albifrons*	10	deepot	10
	deerweed	*Lotus scoparius*	10	deepot	5
	orange bush monkeyflower	*Diplacus aurantiacus*	10	deepot	5
	coffeeberry	*Rhamnus californica*	10	deepot	5
Oak Woodland	coast live oak	*Quercus agrifolia*	16	acorn or treepot	50
	blue elderberry	*Sambucus mexicanus*	12	deepot	20
	valley oak	*Quercus lobata*	16	acorn or treepot	15
	California buckeye	*Aesculus californica*	16	treepot	10
	California bay	*Umbellularia californica*	16	deepot	5
	knobcone pine**	*Pinus attenuata*	16	treepot	NA
	foothill pine**	*Pinus sabiniana*	16	treepot	NA
Oak Woodland / Scrub	coast live oak	*Quercus agrifolia*	16	acorn or treepot	40
	California sagebrush	*Artemisia californica*	10	deepot	30
	coffeeberry	*Rhamnus californica*	10	deepot	10
	silver bush lupine	*Lupinus albifrons*	10	deepot	5
	deerweed	*Lotus scoparius*	10	deepot	5

Plant Association	Common Name	Scientific Name	On-Center Spacing (feet)	Container Size*	Approximate Percentage
	California buckwheat	*Eriogonum fasciculatum*	10	deepot	5
	black sage	*Salvia mellifera*	10	deepot	5

* Note: deepot = 2.5" x 10"; treepot = 4" x 14"

** Knobcone pine and foothill pine will only be planted within a 500-foot section at the western end of the middle super bench

5.5.3 Plan View Layout of Planting Locations

Figure 10 provides a plan view of the locations of the plant associations that will be planted throughout the site. A typical planting plan cross-section is provided in Figure 12. The plant associations will be planted in patches. The location of individual patches is based on site elevation, the composition of species within the particular plant association, the depth of topsoil, site constraints (e.g. maintenance access roads), and the location of other patches. The objectives of utilizing vegetation patches are to mimic the natural spatial patterns of the plant communities, add to the aesthetic values on the site, expedite the establish of the mycorrhizal network, and promote the spread of native species across the site by increasing the area of seed rain.

5.5.4 Field Fitting

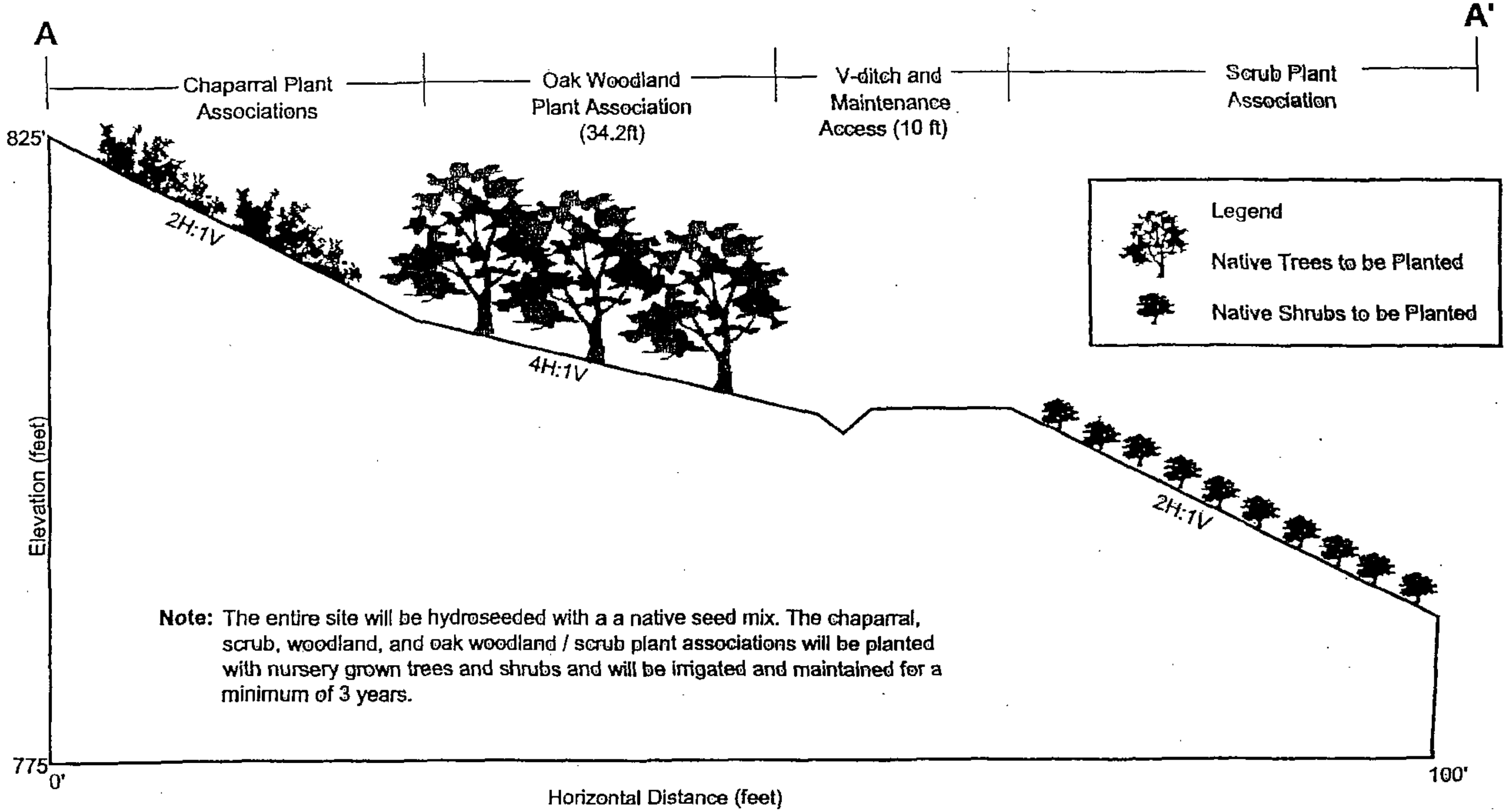
Because it is difficult to predict the site conditions of the final reconstructed slope, the planting plan will need to be "field fitted" following grading operations. A revegetation specialist will assist the earth moving and landscaping crews in locating planting holes along the cut and fill slopes. The exact locations of the planting holes will be determined based upon an examination of the post construction surface soils. The revegetation specialist in cooperation with the site's equipment operators will stake the location of planting holes following the assessment.

In addition, areas of temporary disturbances (e.g. adjacent to V ditches) may also be revegetated following site construction. These areas will be surveyed and mapped by a qualified restoration ecologist who will make recommendations regarding which species to plant in these locations.

The site will also be surveyed during the first two rainy season to determine the location of seeps. Any seeps emerging on the slopes will be mapped and considered for additional planting of appropriate tree species such as arroyo willow, valley oak, California bay, redwood *(Sequoia sempervirens)*, and big leaf maple *(Acer macrophylum)*.

5.5.5 Propagule Procurement

All tree and shrub container plant propagules (seeds and cuttings) used for planting will be of local origin. Propagules will be collected on-site from areas immediately adjacent to the revegetation site. Nearby, off-site locations within Alameda County will be utilized for propagule collection if adequate propagules are not located on-site. Off-site harvest locations must exhibit environmental conditions that are similar to those found within the reference sites.



Note: Cross-Section Location Shown on Figure 10

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Planting Plan: Typical Cross-Section A-A'

File No. 1950-05	Date 4/16/04	Figure 12

Leona Quarry Slope Revegetation Plan

Native duff from the reference sites will be incorporated into the potting material of the nursery grown trees and shrubs prior to planting the propagules in the nursery pots. The purpose of adding the duff to the potting soil is to establish the symbiotic relationship between the plants and the mycorrhizal fungi. The duff will be composed of topsoil and decaying organic matter, which will likely contain spores of the mycorrhizal fungi. The duff should be collected, mixed with the potting material, and placed within each planting pot at the time of planting. The trees and shrubs will be allowed to germinate and grow in the nursery for approximately 8-12 months. During this time, the plants and fungi will form the symbiotic relationship.

5.5.6 Plant Installation

Container grown plants will be installed between October and March, after the onset of winter rains. Prior to digging the planting hole, a 12 to 18-inch wide terrace, which slopes slightly back into the hillside, will be constructed at each planting location. The planting holes should be approximately 1-foot in diameter and 1 foot deep. All rocks greater than 3 inches in diameter will be removed from the excavated soils. A handful of topsoil and duff from undisturbed scrub, chaparral and oak woodland habitat will be added to each of the planting holes at the time of planting. In addition, a slow release fertilizer tablet (14N-14P-14K) will be added to the bottom of each planting holes to reduce transplant shock. The plants will be installed so that their root crowns are at or slightly above (up to ½ inch) grade following soil settlement that occurs after initial irrigation. The plants will also be installed so their root crowns are at the highest position within the irrigation basin. This will minimize standing water at the root crown and reduce root disease.

A 2 to 3-foot diameter irrigation basin with a 4-inch high, 4-inch wide earthen berm will be constructed around each tree and shrub. The basin will help to conserve water for use by the plant and will be kept weed free during the 3-year plant establishment period to reduce plant competition. The appropriate plant protection measure will also be installed immediately following planting.

A 3-inch thick layer of mulch will be spread throughout the bottom of each irrigation basin. Mulch will consist of wood chips, tree bark, or shredded bark. Mulch will be free of salt, leaves, soil clods, sticks, rocks, weeds, or weed seeds. Wood chip mulch that has been chipped and stockpiled from clearing of on-site native trees and shrubs will be used and will be supplemented, as needed, by imported mulch.

5.5.7 Plant Protection

Wildlife browse to the revegetation plantings could be severe if protective measures are not taken. Three foliage protection techniques will be utilized to protect the plants from wildlife browse.

5.5.7.1 Window Screen. Foliage protection cages fabricated from window screen will be installed for chamise and California sagebrush seedlings. Window screen cages will be 2 feet in diameter by 2 feet tall and will be supported by 3 rebar posts. The tops of these cages will be enclosed with window screen.

5.5.7.2. Chicken Wire Foliage Protection Cages. Foliage protection cages fabricated with chicken wire will be installed for all planted California buckeye and Mexican elderberry. Cylindrical foliage protection cages will be 4 feet in diameter by 5 feet tall. The top of the foliage protection cages will be covered with additional chicken wire. All seams in the fabricated cylinder and top will be fastened on 3-6 inch centers with baling wire or plastic ratchet-locking ties. The bottom of the foliage protection cages will be flush with the soil surface. Two 6 to 7-foot long rebar posts will support each foliage protection cage. The foliage protection cage will be fastened to the rebar with baling wire or plastic ratchet-locking ties.

5.5.7.3 Tree Shelters. Photodegradable tree shelters will be used to protect coast live oak and valley oak seedlings. The tree shelters will reduce browsing pressure and increase soil moisture in the vicinity of the oak plantings. Tree shelters have been shown to increase the percent survival and height increment for oak plantings when implemented in concert with weed control (McCreary and Tecklin 1997). Tree shelters should be 3.25 inches to 4.25 inches in diameter by 4 feet long and supported by a pressure-treated wooden tree stake. The tree shelters will be fastened to the tree stake with plastic ratchet-locking ties and the base of the shelter buried approximately 2 inches into the topsoil. Bailing wire will be woven across the top of the tree shelters to prevent birds from inadvertently falling into the shelters.

5.5.8 Coarse Woody Debris

Large woody debris including logs, branches, and root wads (greater than 6 inches diameter) removed during site grading may be incorporated into the planting plan, if practicable. The large woody debris should be randomly placed and partially buried within the oak woodland plant association on 4H:1V slopes. Coarse woody debris would function to increase the structural diversity of the habitat providing additional shelter and nesting sites for wildlife and would also help to establish long-term soil fertility.

5.6 IRRIGATION PLAN

A temporary drip irrigation system will be designed and installed to irrigate the planted trees and shrubs throughout the slope revegetation area. Planted trees and shrubs will be irrigated between April and October during the first 3 years following planting (i.e. plant establishment period). The goal of the irrigation program is to facilitate the development of the plant's root system during the 3-year plant establishment period, while at the same time eliminating the plant's need for a supplemental water source. Because the majority of the species that will be planted are drought tolerant, it is anticipated that limited irrigation will be required. In addition, root diseases may develop if too much water is given. The soils around each plant, therefore, shall be allowed to dry prior to initiation of subsequent irrigation. The quantity and frequency of irrigation will be greatest in Year-1 and will be reduced to an as-needed basis in subsequent years. By Year-3, the roots of the plants should be well developed and able to grow with little to no supplemental water. The exact quantity and frequency of irrigation during the remainder of the plant establishment period will be determined in the field by a qualified restoration ecologist.

Results from the pilot revegetation project are currently being used to determine the appropriate irrigation regime to be utilized for the planted trees and shrubs (H.T. Harvey & Associates 2001). The pilot revegetation project, which was installed in fall 2001, is testing the effectiveness of irrigating the desired plants with 1 gallon of water versus 10 gallons of water every two weeks (H.T. Harvey & Associates 2001). Based on results from the first two years of monitoring it appears that plants receiving 1 gallon of irrigation water once every two weeks have similar growth and survival rates compared to those receiving 10 gallons of water once every two weeks (H.T. Harvey & Associates 2003).

Therefore, trees and shrubs installed from small (restoration sized) container stock will be irrigated with 2-4 gallons of water per event during the plant establishment period. The frequency of irrigation will be approximately 2 times per month during the first dry season after installation. This frequency will be gradually diminished over the three year establishment period to allow the plants to shift to a self-sustainable condition. Irrigation should not be required after year three.

5.7 MAINTENANCE PLAN

5.7.1 Overview

The planted trees and shrubs will be maintained during a 3-year plant establishment period. Adequate maintenance during the first 3 years after planting will be critical to revegetation success. Maintenance activities will include irrigation, weed control, maintenance of foliage protectors, and dead plant replacement.

5.7.2 Plant Replacement

All dead plants that were planted in the four plant associations will be replaced on a yearly basis in Years 1 and 2. In Year 3, all dead plants will be replaced if survival drops below 80%. An adaptive management approach towards plant replacement will be instituted, which will require a critical evaluation of the cause of death and the survival rate of other species. Those species that have high survival rates, and therefore are better adapted to the site, will generally be used to replace the dead plants.

5.7.3 Weed Control

Herbaceous vegetation will be controlled within the 3-foot diameter irrigation basin around each plant during the three-year plant establishment period. Weed control within the irrigation basins will primarily consist of hand-pulling the weeds to maintain the basins free of herbaceous vegetation.

Invasion of the revegetation site by invasive, non-native species can significantly impede the development of the plantings and may reduce the diversity of plants and the aesthetic of the site. Therefore, invasive, non-native species will be monitored and may be controlled within the plant installation areas. Species of concern include French broom, pampas grass, and yellow star thistle. Control of invasive species will be determined on an as needed basis and may include the use of an Environmental Protection Agency (EPA) approved herbicide or manual removal efforts.

5.7.4 Irrigation Basins

Irrigation basins will be maintained during the three-year plant establishment period. Earthen berms, which have failed, will be reconstructed to ensure that the plant receives an adequate amount of supplemental irrigation water. In addition, the 3-inch layer of wood chip mulch within the irrigation basins will be maintained during the plant establishment period.

5.7.5 Plant Protection

Protective cages and shelters will be regularly maintained during the 3-year plant establishment period. If a plant outgrows its cage or shelter prior to the end of the 3-year period, the plant protection will be removed as soon as possible to ensure that the tree or shrub grows unhindered. At the end of the 3-year period, all cages will be removed from the site to allow the plants to grow without obstruction.

All tree shelters will be maintained in a vertical orientation and the bottom buried 2 inches below the grade. The woven wire cover will be removed from the top of the tree shelter when each tree reaches the top of its shelter. Tree shelters and tree stakes will be removed when the tree's height has exceeded the top of the shelter for 2 years (~ 5 years after installation). Premature removal of tree shelters can damage trees if they have not attained sufficient stem girth to remain upright.

5.8 MONITORING PLAN

5.8.1 Overview

The purpose of the monitoring plan is to track vegetation establishment, assess the degree of revegetation success, and provide a basis for adaptive management recommendations. Site visits will be conducted every two months for the first three years during the growing season to qualitatively assess vegetation establishment and to monitor vegetation maintenance. In addition, quantitative monitoring will occur on an annual basis during the first 5 years of plant establishment. A qualified restoration ecologist will perform the site monitoring. The restoration ecologist will make recommendations for replanting and vegetation maintenance as needed based on the monitoring results.

5.8.1.1 Qualitative Growing Season Monitoring. Site visits will be made every two months during the growing season (April - October). Qualitative assessments of the site will be made and reported during these visits. The purpose of monitoring during the growing season is to assess the overall performance of the vegetation and the adequacy of vegetation maintenance. Assessment of the following factors will be made during site visits:

- Vegetation establishment with special attention paid to areas lacking vegetation
- Mortality of planted shrubs and trees
- Plant species composition
- Slope stability and erosion
- Formation of seeps
- Irrigation and maintenance of planted trees and shrubs

- Invasion of revegetation site by non-native, invasive weeds
- Other pertinent site conditions that may influence plant establishment

5.8.1.2 Quantitative Annual Monitoring. Annual monitoring will occur during Years-1, 2, 3 and 5 following plant installation and the field work will be conducted between October and December of each year. Site visits will be conducted to assess site conditions and the establishment of vegetation throughout the project site. Quantitative measurements of percent survival, percent vegetative cover, and plant health and vigor will be made.

5.8.2 Quantitative Annual Vegetation Monitoring Methods

5.8.2.1 Percent Shrub and Tree Survival. In Years 1, 2, and 3, the percent survival for all planted tree and shrub species will be estimated by counting a minimum of 25 % of the trees and shrubs installed. The trees and shrubs will be counted along 30-foot wide, 100-foot long randomly placed transect belts. Percent survival will be calculated by species and for the trees lumped and shrubs lumped. If the percent survival falls below 100% in Years 1 and 2 or 80% in Year 3, all dead trees and/or shrubs will be replaced. Species observed to perform well would be utilized to replace the dead individuals.

5.8.2.2 Percent Vegetation Cover. Vegetation cover is a good measure of vegetation establishment and plant community composition. Therefore, the percent vegetation cover will be quantitatively monitored in Years 1, 2, 3, and 5 to track the development of the vegetation. Detection of an increasing temporal trend in average percent shrub and a tree cover would serve as an indicator of successful vegetation establishment.

Permanent transects will be established at random locations throughout the four plant associations. Percent vegetation cover by species (herbaceous species may be lumped into one category) will be measured using the line intercept method (Bonham 1989). The percent cover of the shrub layer, tree canopy layer and herbaceous layer will be measured separately. The number of transects will be determined by evaluating the average cover values obtained over increasing numbers of transects. The number of transects used will be the point where additional samples do not substantially change the average cover values obtained (Kershaw 1973). The sample area may be slightly increased or decreased after initial data are collected and analyzed and the requisite sample surface area is re-assessed.

5.8.2.3 Average Tree and Shrub Health and Vigor. Average health and vigor will be determined by species for trees and shrubs on a yearly basis to determine which species are best adapted to site conditions. Individual plants selected for the survival tally (Section 5.7.2.1) will also be rated for health and vigor. Species with the highest health and vigor rating will likely be primarily used for dead plant replacement. The average health and vigor by shrub and tree species will be determined based on the following scale:

Rating		Health and Vigor
0	=	Dead
1	=	Very Low Vigor
2	=	Low Vigor

Rating		Health and Vigor
3	=	Moderate Vigor
4	=	High Vigor
5	=	Very High Vigor

5.8.3 Soils Monitoring

If plant survival and growth rates are low in localized areas, soils at various depths in the profile will be sampled and analyzed to help determine the reasons for poor growth and survival. Soil chemistry and structure at various depths would be compared between areas with high and low vegetation performance.

5.8.4 Reporting

Annual vegetation monitoring reports will be prepared in Years 1, 2, 3, and 5 documenting the progress of vegetation establishment and prescribing management recommendations as needed to meet the revegetation goals.

6.0 TREE REMOVAL MITIGATION AND MONITORING PLAN

6.1 INTRODUCTION

Native trees planted in the oak woodland plant association will mitigate for the loss of "protected" trees at the project site as defined by the City of Oakland's Tree Protection Ordinance. Mitigation measure B.10a in the project's Environmental Impact Report (EIR) requires mitigation for the removal of protected trees at a ratio of at least 1:1 (trees removed to trees replaced). A maximum of 151 protected, native, trees (149 coast live oak and 2 California bay) are permitted for removal and require mitigation per the tree removal permit (Tree Permit dated February 19, 2003). The slope revegetation plan presented herein calls for the placement of topsoil and the planting of native tree species (i.e. oak woodland plant association) on the inboard side of the three 30-foot wide super-benches (Figure 10). Approximately 545 trees will be installed within the oak woodland habitat (tree replacement mitigation site), which will encompass approximately 2.6 acres. Table 9 lists the species and number of each species to be installed along the super-benches. Therefore, implementation of this slope revegetation plan will significantly exceed the requirement to mitigate at 1:1 for the removal of the approximately 151 protected, native trees. In addition, hundreds more trees will be planted within the development area.

Table 9. List of tree species to be installed within oak woodland plant association.

Common Name	Scientific Name	On-Center Spacing (Feet)	Total Number
Quercus agrifolia	coast live oak	16	273
Quercus lobata	valley oak	16	82
Sambucus mexicana	blue elderberry	12	109
Aesculus californica	California buckeye	16	54
Umbellularia californica	California bay	16	27
		Total	545

The trees installed within the tree replacement mitigation site will be monitored in Year-1, 2, 3, and 5 during the annual monitoring of the revegetated slopes. Annual monitoring of the mitigation site by a qualified biologist will determine whether the project is fulfilling its mitigation obligations. By Year-5 of monitoring, the trees within the mitigation site should be sufficiently established to determine if they would eventually achieve the long-term goal of self-sustainability. The results of the final year of monitoring will be compared to the final success criteria presented below to determine if they have been met. If the success criteria for the mitigation site have not been met, adaptive management actions will be taken and monitoring will continue until the criteria has been achieved.

6.2 FINAL SUCCESS CRITERIA

The goal of the tree replacement mitigation is to establish a minimum of 151 trees (any combination of the species listed in Table 9) at the site. The minimum number of 151 replacement trees shall be healthy and capable of self-sustained growth in the absence of long-term human maintenance. The final success criteria were crafted to provide quantitative criteria that will indicate that the tree mitigation goal has been achieved.

6.2.1. Percent Survival

A minimum of 1.5 times the required number of replacement trees (1.5 x 151=227 trees) shall be alive within the tree replacement mitigation site two years after the cessation of irrigation and weed control (approximately in Year-5)

6.2.2 Tree Height

Average tree height will be used as an indicator of the growth of planted trees. In Years 1, 2, 3, and 5, the average height of tree species exhibiting relatively high percent survival will have a positive increasing trend. The average height by species will be increased during a minimum of 2 growing seasons following cessation of irrigation and weed control.

6.3. PERFORMANCE CRITERIA

6.3.1 Percent Survival

Percent survival of mitigation tree plantings will be tabulated by species within the mitigation site during Years 1-3. If the percent survival falls below 100% in Years 1 and 2 or 80% in Year 3, all dead trees within oak woodland plant association will be replaced.

6.4 MONITORING METHODS

6.4.1 Percent Survival

In Years 1, 2, 3, and 5, the percent survival for all tree species within the oak woodland plant association will be estimated by counting all individuals installed during the fall of each year. Percent survival will be reported by species. Percent survival will be calculated as follows:

Percent Survival of Species A = (Number of Individuals of Species A Alive During Monitoring Period / Total Number of Species A Alive at Installation) * 100

6.4.2 Tree Height

Tree height will be measured on a minimum of 30% of each tree species installed. Trees will be located throughout the site using a stratified random sampling methodology and will be tagged with a specific number for comparison purposes in later years. Height measurements will be taken along the main stem using a tape or telescopic pole. A clinometer will be used for individual trees that exceed the height of the pole. Average tree height will be determined by species.

6.4.3 Health and Vigor

A qualitative assessment of overall health and vigor of tree species will be made to determine which species are best adapted to site conditions. This assessment will be based on such factors as leaf size and color, bud development, fungal and insect infestation, drought, new growth, herbivory, and physical damage. Average health and vigor assessments will be made on individuals selected and tagged for height measurement and will occur during annual monitoring. Species with the highest health and vigor rating will be used for dead plant replacement. The average health and vigor by tree species will be determined based on the following scale:

Rating		Health and Vigor
0	=	Dead
1	=	Very Low Vigor
2	=	Low Vigor
3	=	Moderate Vigor
4	=	High Vigor
5	=	Very High Vigor

6.5 REPORTING

An annual tree monitoring report will be prepared in Years 1, 2, 3, and 5 documenting the progress of tree establishment and prescribing management recommendations as needed to meet the mitigation requirement including appropriate species replacement recommendations. The monitoring report will be submitted to the City of Oakland by December 31 of each monitoring year.

6.6 COMPLETION OF TREE MITIGATION

When the final success criteria are met, a final report will be submitted to the City of Oakland documenting the achievement of the final success criteria. Tree mitigation monitoring will be discontinued after achievement of the final success criteria.

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