Corona and Twin Peaks
Mine Drainage Treatment Project
Revegetation Plan

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1.0 INTRODUCTION

1.1 PROJECT SCOPE AND LOCATION

This Revegetation Plan is associated with the Corona and Twin Peaks Mine Drainage Treatment Project. The project area is located in northeast Napa County, California and consists of two near-by locations at lat 38.669239° and long -122.538248° (Corona site) and lat 38.662502° and long -122.534455° (Twin Peaks site).

Revegetation activities will follow consolidation, stabilization and earthwork related to water quality treatment. This document addresses the following general locations and activities within the project area:

1. Corona waste rock and calcine piles: consolidate materials, cap and revegetate
2. Corona upper adit infiltration trench: regrade and improve flow
3. Twin Peaks waste rock and calcite piles: re-contour, cap and revegetate
4. Twin Peaks infiltration trench regrade and improve flow
5. Corona lower adit drain: stabilize and revegetate disturbance from water treatment activities

1.2 EXISTING ENVIRONMENTAL CONDITIONS

The current habitat surrounding the revegetation areas is characterized by a montane hardwood-conifer community overstory with several oak species, madrone, California bay, California nutmeg Douglas fir and pine species. The chaparral understory contains dogwoods, redbud, ceanothus, coyote bush, toyon and various forbs and grasses (Burleson Consulting, 2012).

Annual rainfall at Cobb Mtn. located 15 miles to the northwest ranges between 22 and 130 inches over the 90 year between 1923 and 2012 with an average rainfall of 65.8 inches. Modeled storm intensities (NOAA, 2016) vary between 0.8 in/hr for a 2-yr, 1-hr event to 1.35 in/hr for a 25-yr, 1-hr event. Storm water delivery for day-long events is between 5.26 inches per 24 hr for a 2-yr return frequency event up to 9.17 inches per 24 hr for a 25-yr return frequency event. A complete NOAA storm intensity and duration table is provided in Appendix 2. These rainfall patterns suggest a need for both rapid infiltration of scarce rains during dry cycles but also the need for a well-protected soil surface and flow paths for more intense events.

In contrast to the relatively high average winter rainfall amounts, the area experiences a near complete lack of rain from April through November of most years. Lack of additional moisture along with warm to hot temperatures suggests that the dense woody vegetation in the area experiences moisture stress in middle to late summer months. This condition suggests that soil treatments for revegetation should include deep rooting access to withstand this period of environmental stress.

Existing soils in the upper slopes of the area are mapped as Kidd series soils. These soils have thin, 14 to 18 inch deep rooting zones over fractured rhyolitic tuff. On the lower slopes of the sites, along Bateman and James creeks, the mapped soils are the Felton series that form 60 to 65 inch deep soils over shale or sandstone. The fractures below the Kidd series soils and the deep rooting depth of the Felton soils allows extensive deep rooting and facilitates growth of the dense vegetative cover in spite of the extended dry summer season. Most of the revegetation activity as part of this project will not occur on existing soils, but the example of the deep rooting potential of these existing soils is used as a model for regeneration of growth conditions on the treated mine waste soils to also allow deep rooting volumes to provide adequate moisture for late summer growth.

1.3.0 REVEGETATION STRATEGY

1.3.1 General approach

Mined-land revegetation projects through previous decades have often used extremely aggressive plants that can tolerate and grow rapidly on the existing conditions of the mine-altered, acidic substrates. However, plant materials that can tolerate such extreme conditions often also have a tendency to subsequently invade and spread into adjacent, less disturbed areas. Given the natural scenic and biological value of the general area surrounding this project, revegetation is designed to regenerate a generally similar plant community cover on disturbed locations as on adjacent undisturbed sites. The foundation of such a comparable plant cover is a substrate that has comparable baseline function, especially for soil moisture availability. This function is accomplished by evaluation and treatment of harsh substrates to ameliorate harsh growth conditions so that locally occurring native species can again grow successfully on the remediated mine-site and blend with the surrounding ecosystem.

1.3.2 Strategy for soil amelioration

The strategy for regenerating sustainable revegetation cover on the barren or sparsely vegetated disturbed areas at the project area is to evaluate representative mine-disturbed substrates and then to identify treatments that support growth of native perennial shrubs and trees as needed. Activities to consolidate scattered areas of mine wastes, geotechnical stabilization and erosion control will all occur prior to revegetation activity. Consolidated mine impacted materials will be covered with a cap of subsoil material from adjacent non-mine impacted areas. Most of these borrow sites are already disturbed, including existing road cuts or excavation faces without vegetative cover. All mine wastes will be neutralized to pH 6.5 prior to covering by a cap. Cap thickness will be three feet deep over coarse calcite material and eighteen inches deep over finer mine overburden or waste rock material.

1.3.3 Strategy for revegetation with a natural plant cover

Because of the high average winter precipitation levels in the surrounding area, plant growth is dense and reproduction high. Areas of historical disturbance are typically covered with colonizing native species of grasses and forbs that gradually transition to woody shrubs and trees. These existing ‘disturbed-but-revegetated’ types of sites are used to select plant species that will also do well on currently disturbed substrates. Seeds are generally available and revegetation activity with the project is spread over several years. This provides an extended time when locally adapted plant seeds or cuttings can be collected and used on the project revegetation areas. The historically disturbed but revegetated locations also guide the substrate treatments to regenerate suitable long term growth conditions based only on short-term tests. Because of the relatively small aerial extent of the current disturbances, container plants of woody trees and shrubs are viable as well as some grasses and forbs.

1.4.0 GOALS AND OBJECTIVES

1.4.1 Goals

The primary goal of the revegetation cover is to reduce sediment mobilization from historic mined areas and disturbed areas relating to water quality treatment activities. A secondary goal is to blend disturbed areas into the surrounding natural landscape.

1.4.2 Objectives

The specific objectives pursuant to the goals include:

1. Evaluation of existing substrate conditions and comparison to currently vegetated reference areas.

2. Generation of appropriate treatments to develop growth conditions on mine-altered substrates that are sufficient to support growth of species similar to those on less disturbed areas.
3. Install treatments and verify that conditions have been attenuated.
4. Install plant materials on a planting density that is similar to that found on adjacent, less disturbed sites.

2.0 GENERAL SCOPE OF REVEGETATION ACTIVITIES

This Revegetation Plan addresses five general locations and activities within the project area:

1. Corona waste rock and calcine piles: consolidate materials, cap and revegetate
2. Corona adit infiltration trench: regrade and improve flow
3. Twin Peaks waste rock and calcite piles: re-contour, cap and revegetate
4. Twin Peaks infiltration trench regrade and improve flow
5. Corona lower adit drain: stabilize and revegetate disturbance from water treatment activities

Revegetation activities will start after over-steepened slopes are geotechnically stabilized and run-on from up-slope drainages is controlled or routed to rock-stabilized channels. Local sediment basins will be constructed below revegetated sites to retain transitory erosion events during plant establishment.

The Corona waste pile is already partially regraded. Additional work to consolidate smaller areas of outlying waste rock material will precede revegetation work. Substrate growth conditions on existing, disturbed-but-revegetated areas and newly treated areas will be evaluated and some areas will get additional substrate treatment even though not re-graded during this work.

Several areas with exposed calcine deposits that will be consolidated in the north portion of the exising pile and then covered with a 3 ft. cap of non-mine impacted sedimentary or volcanic country rock from existing road cuts or excavation disturbed areas.

The upper terrace at the Twin Peaks waste pile, although currently revegetated, is expected to be disturbed and regraded to construct a water treatment basin. The lower, talus slope of calcine deposits below the mid-level terrace will be regraded with smaller benches and covered with non-mine impacted country rock as a revegetation cover.

The existing linear infiltration trenches at both the Corona and Twin Peaks sites will be modified to improve flow and infiltration function. These disturbance areas will be revegetated with minimal substrate amendment since they are expected to be relatively less impacted by mining activities. Areas needed for vehicle access will be planted to perennial grasses and down-slope berms will be planted with deep rooted native shrubs. Similar revegetation activities are expected at other disturbances related to water treatment activities after these facilities are constructed.

3.0 PROCEDURES

3.1 Substrate evaluation

All substrates to be used as growth media, whether mine-impacted or native subsoil used as cap materials will be evaluated similarly. This evaluation includes the following steps:

1. Field measurement of infiltration, rock content, rooting depth, sampling of substrates by horizon as needed for lab analysis.

2. Preparation of field-collected materials including measurement of rock content, preparation of a fine soil fraction (< 2 mm) and standard commercial analysis of plant-available fertility (A&L Western Agricultural Labs, Modesto CA; S3C suite of complete plant-available nutrients).
3. Interpretation of the output from these standard fertility tests are interpreted for nutrient levels adequate for wildlands plant growth rather than for production agriculture.
4. Evaluation of soil moisture retention
5. Evaluation of soil organic matter fractions
6. Interpretation of infiltration rates and moisture retention for perennial shrub or tree growth under varying rainfall scenarios.
7. Substrates with acid reaction will be evaluated for liming amendments needed to reach pH 6.5.
8. Amendments will be added to substrates to attain 'low' or 'moderate' levels as incidated by agricultural fertility tests. As much as possible, amendments will be added to subsurface horizons rather than being surface applied, in order to discourage rapid weed colonization.
9. Substrates that are compacted during earthwork and regrading will be ripped to decompact in a manner that does not destabilize the slope or lead to piping during saturation.

3.2 Seed and plant materials

Site collected seed will be collected from plants growing locally on site or from forestry nurseries. Seed collection is on-going but the species in Appendix 1 are anticipated to be the primary ones used. Some native grass seed from appropriately local accessions (adjacent counties of the North Bay Area, and southern part of the Interior North Coast Range) is available commercially and will be used to increase grass seeding density.

Shrubs, trees and some grasses will be propagated during the dry season for out planting after fall rains begin. These materials are grown in cardboard sleeves that are planted intact into field sites to avoid disruption to the developing rooting system. This allows outplanting of smaller materials and reduces the length of time needed for propagation. Some grasses will be started as plugs to increase first year plant density and size. All container plantings will receive an appropriate native live soil inoculum at the beginnning of their popagation period. Inocula will be selected from similar vegetative stands to provide mycorrhizal fungi and other symbiotic microorganisms as appropriate.

During earthwork, some areas may be used as a source for salvaged plants. These will be excavated to maintain root mass but will be pruned to leave minimal shoot growth. All plants will be maintained in a moist holding area and re-planted within ten days after excavation.

3.3 Outplanting

Target plant density of container shrubs or trees or grass plugs will be 2 ft. on center, with 25 % of plantings as woody shrubs or trees. Container plants will be installed with a shallow basin to retain surface irrigation if needed during the first summer. Areas that need to retain vehicle access will be seeded by hand on prepared substrates and lightly raked in. On both container planted and seeded sites, a one inch thick mulch cover of coarse-shredded woody material is applied to the slope to reduce crusting and rain drop impact and summer heat loading. This mulch cover will have a ground cover density of about 50%. Mixed grass seed will be applied at approximately 50 lb per acre.

Woody plants are collected from seed or cuttings and propagated in planting sleeves that are directly outplanted with the onset of cooler fall weather. Substrate profiles may be fully wetted for one single event to advance planting before the fall rains occur.

3.4 Irrigation
Woody plants are installed with planting basins that can be irrigated during the first growing season if rainfall is inadequate. One or two deep watering events are anticipated the first summer season.

4.0 SUCCESS CRITERIA
Dead plants will be replaced as noted during the rainy season between November and February of 2016-17 or 2017-18 as needed. Plants dying during late spring and summer will be replaced the following fall. The success target is that greater than 80 % of woody plants are alive by the end of the project.

In the event any mature tree must be removed, replacement trees shall be replaced with similar native tree species at a 2:1 ratio or greater, resulting in no net loss of trees on site. Replacement trees used shall be less than 4 inches diameter.

5.0 MONITORING
Plant survival and erosion stability will be evaluated monthly. Successful plant establishment will be evaluated as survival after the first summer dry season after planting. Areas of soil surface erosion will be treated for short term stability with additional coarse woody material covered with jute netting.

6.0 CORRECTIVE MEASURES
Long term pH neutralization incubations will be maintained for a year after application. Indications of buffering or reacidification will be treated to return to pH 6.5.

7.0 REPORTING
Plant condition and survival will be reported at dry-down in June of 2017 and 2018. Survival through the summer will be monitored and replanting will occur when substrates wet up in fall.

8.0 WEED MANAGEMENT
Weed management starts with minimizing areas of disturbance to existing vegetated areas and by minimizing nutrient amendments to the treated substrates. The surrounding area is forested ground, not agricultural ground, so weed pressure is less. Hand weeding before seed set and spot herbicide applications are anticipated to be needed periodically.

Some weedy annual grass colonization is anticipated, but the emphasis on larger woody plantings is expected to shade out these weeds within a few years. Invasive plants targeted for periodic elimination by physical removal or herbicide treatment include pepperweed, invasive thistles, broom, and tree of heaven. Prevention of reproduction is a primary priority.

9.0 SCHEDULE OF SUBSTRATE REGENERATION AND REVEGETATION ACTIVITES

Season and Year	Corona waste pile revegetation	Corona infiltration trench improvement	Twin Peaks waste pile revegetation	Twin Peaks infiltration trench
Winter 2016	soil and substrate evaluation, collect seed, cuttings		delineate disturbance area	
Spring 2016	generate revegetation treatments, collect seed, cuttings		soil and substrate evaluation, collect seed, cuttings	
Summer 2016	consolidate calcines, cap and prepare for planting	track geochemical analysis, generate revegetation treatments	soil and substrate evaluation, collect seed, cuttings	track geochemical analysis, evaluate substrates, generate and install treatments
Fall 2016	install plants and erosion controls	track geochemical analysis, generate revegetation treatments	generate treatments, propagate plants	install plants and erosion controls
Winter 2017	monitor plants and erosion control	propagate plants	generate treatments, propagate plants	monitor plants and erosion control
Spring 2017	monitor	propagate plants	propagate plants	monitor
Summer 2017	monitor	sample substrates during construction; generate and install treatments	consolidate calcines, cap and prepare for planting	monitor
Fall 2017	monitor	install plants and erosion controls	install plants and erosion controls	monitor
Winter 2018	monitor	monitor plants and erosion control	monitor plants and erosion control	monitor
Spring 2018	monitor	monitor	monitor	monitor
Summer 2018	monitor	monitor	monitor	monitor
Fall 2018	final evaluation, generate report	final evaluation, generate report	final evaluation, generate report	final evaluation, generate report

10.0 REFERENCES

Burleson Consulting. August 2012. Report of Findings Reconnaissance Level Biological Survey for the Corona and Twin Peaks Mine Drainage Treatment Project. 68 pg.

Appendix 1. Potential native plant list for revegetation of calcine and waste rock substrates at the Corona & Twin Peaks Mines

Unless otherwise noted, all of these species were observed on calcine substrates.

Grasses

Bromus (*carinatus, lavipes sp.*)
Elymus glaucus
Festuca californica
Festuca idahoensis
Melica californica
Stipa (*Nassella*) *pulchra* (not observed on calcine)
Vulpia microstachys

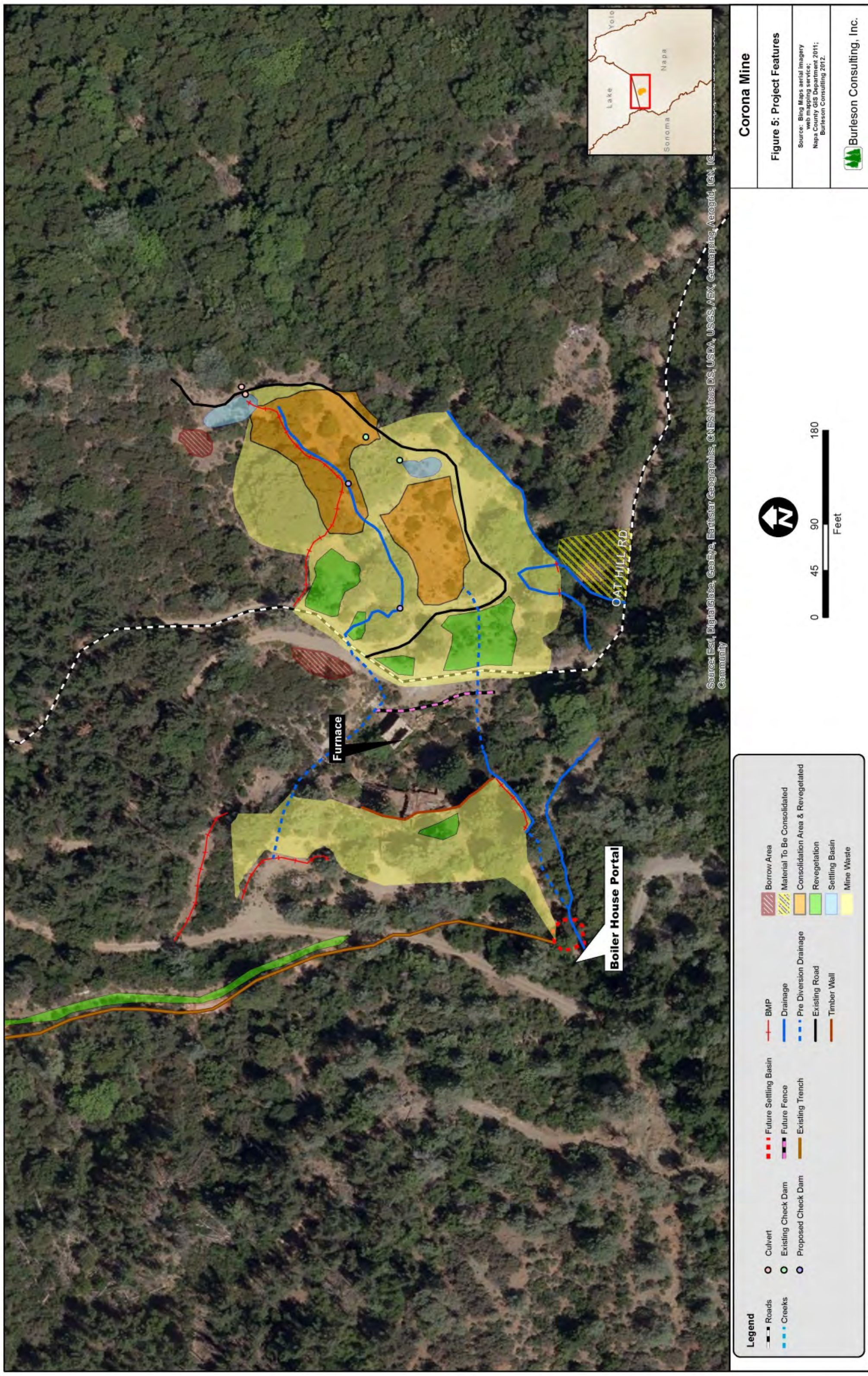
Shrubs
Arctostaphylos manzanita
Baccharis pilularis (coyote bush; need to check more closely for calcine occurrence)
Ceanothus sp.
Eriodictyon californica (yerba santa)
Heteromeles arbutifolia (toyon)
Lotus scoparius (California broom)
Rhamnus californica (coffee berry)
Toxidendron diversilobum

Trees
Arbutus menziesii (madrone)
Pinus sabiniana (gray-foothill pine)
Pseudotsuga menziesii (Doug fir, need to check for occurrence)
Torreya californica (California nutmeg)
Umbellularia californica (California Bay)
Quercus spp.

Additional diversity
Eriophyllum lanatum (whooly sunflower, uncertain on calcine)
Gnaphalium californicum (sp?, uncertain on calcine*)*
Mimulus aurantiacus (sticky monkey flower; not observed on calcine)
Penstemon heterophyllus
Stachys sp.

plant list from work of CD Thomsen, 2012

Appendix 2. Disturbance area projected for revegetation activities at Corona Mine involving calcine consolidation and capping, infiltration trenches and settling basins. Burleson Consulting, 2016.



Appendix 3. Disturbance area projected for revegetation activities at Twin Peaks Mine involving calcine consolidation and capping, infiltration trenches and settling basins. Burleson Consulting, 2016.