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Geological Study

August 10, 2015

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FROM:

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Subject: Geologic Assessment of Slope Stability
3646 SMR Vineyard Winery
3646 Spring Mountain Road
Saint Helena, CA 94574

Introduction

This geologic assessment considers the potential effect on slope stability of proposed winery construction on the above referenced property (APN 022-150-026), including the inherent earth stability of the site. O'Connor Environmental, Inc. (OEI) was engaged by the property owner, Andrew Rudd, to conduct this geologic assessment. I have conducted several similar slope stability assessments in Napa County and Sonoma County in addition to several years of experience mapping landslides and evaluating slope stability in Washington and northern California. I am a Certified Engineering Geologist in California and a Licensed Engineering Geologist in Washington.

The 56+ acre parcel has about 8.5 acres of existing vineyards, a single family residence, a small outbuilding near the residence, and a 1.0 acre unlined off-stream pond. A proposed winery project of about 1.7 acres would be built on gently sloping ground currently occupied by the existing outbuilding and unimproved driveway. An additional 1.0 acre vineyard block has been cleared but not yet planted. The conceptual site plan (Appendix A) shows the existing and proposed conditions on the parcel. It is assumed that this assessment accompanies all relevant documents submitted to the County of Napa, and that detailed descriptions of the project and the project site need not be repeated here.

Methods

To evaluate existing and potential slope stability hazards at the project site, the following tasks were undertaken: reviewed available geologic maps, reviewed available historic aerial photographs, reviewed soil survey data, performed field reconnaissance on July 28, 2015, and synthesized available information regarding existing and likely future stability of the site.

Regional & Site Geology

The project is located within the California Coast Ranges geomorphic province. Numerous faults oriented northwest-southeast occur in this region, and extensive tectonic activity has created a landscape of northwest-southeast trending ridges and valleys. The tectonic activity is associated with the collision between the Farallon and North American plates occurring particularly in the late Mesozic (about 100 million years before present), and with movement along the San Andreas Fault which formed in the mid-Cenozoic (about 30 million years before present) at the boundary between the Pacific and North American plates

The project site lies near the ridge crest separating Napa Valley from Mark West and Santa Rosa Creek drainages to the west. The site lies about one mile east of the Petrified Forest Thrust Zone a thrust fault extending northwest-southeast running parallel to the ridge crest. The rocks east of the fault have been uplifted relative to those on the west. This fault is not considered active.

The bedrock unit within which the landslide unit is mapped is a member of the Sonoma Volcanics described as a pumiceous ash flow tuff (map unit Tst in Figure 1 from Graymer et al 2007). These Tertiary volcanic rocks overlie older greywacke and mélange of the late-Mesozoic Franciscan Complex that crops out upslope (west) of the project site; bedding planes in the Franciscan and Sonoma Volcanics dip steeply to the north-northwest.

The more recent geologic mapping (Delattre and Gutierrez 2013) provides a more detailed description of Sonoma Volcanics in this area, describing them as *Tuff of Petrified Forest*, a "[t]hick section of silicic tuff, tuff breccia, and agglomerate, with several intercalcated andesitic to dacitic lava flows. Tuffs are largely pumiceous and lithic ash flows, with some water lain reworked tuff, minor air fall tuff, and locally welded tuff."

In addition, Delattre and Gutierrez (2013) shows that the project parcel is underlain by geologic map unit *Qols-Older landslide deposits (Pleistocene?)* described as "deeply dissected landslide deposits consisting of undifferentiated Sonoma Volcanics". The map includes a younger landslide unit *Qls-Landslide deposits (historical to Pleistocene)*. The smaller scale geologic map of the area (Graymer et al. 2007) does not include the more detailed surficial mapping of landslides. The landslide deposits mapped by Delattre and

Gutierrez (2013) are super-imposed on a regional geologic map (Graymer et al. 2007) showing the project parcel and vicinity along with bedrock units of Graymer et al. (Figure 1).

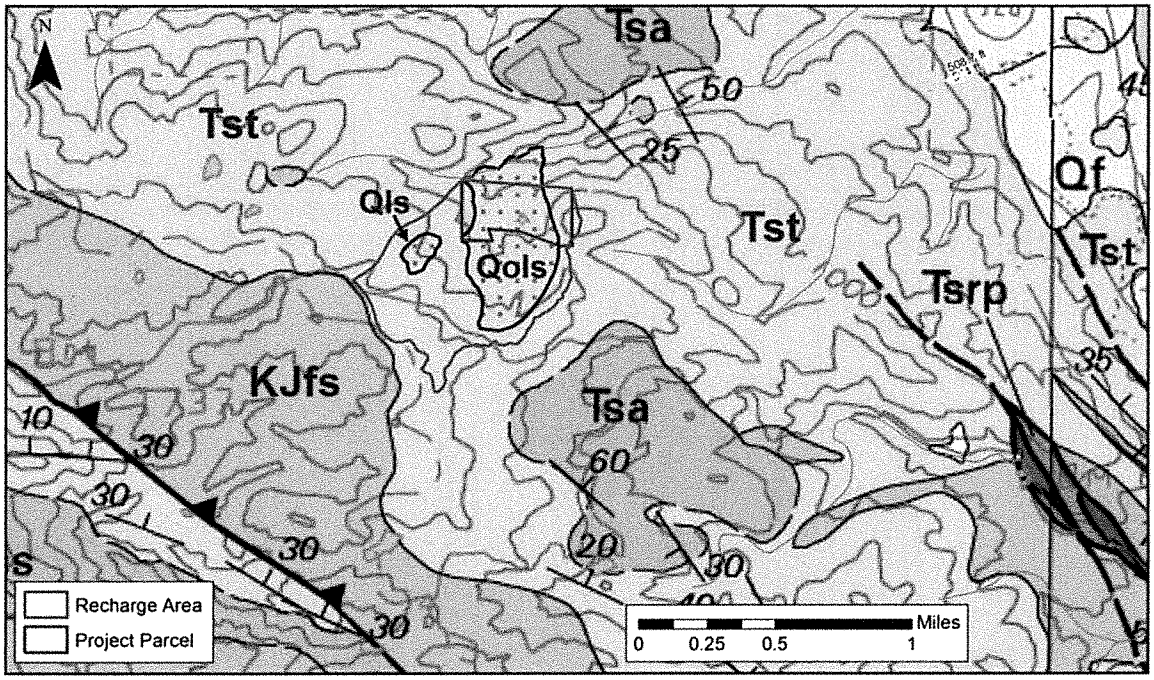


Figure 1. Geologic map of the project site and vicinity (after Graymer et al. 2007 & Delattre and Gutierrez, 2013). Units are as follows: Tst - Pumiceous ash-flow tuff, Tsa - Andesite to basalt lava flows, KJfs - Graywacke and melange, Qf - Alluvial fan deposits, Qls - Landslide deposits, Qols - Older landslide deposits.

Soils and Slopes

Soil types and distributions in the vicinity of the proposed winery site were reviewed through the NRCS Web Soil Survey and by reference to the Napa County Soil Survey (Lambert and Kashiwagi 1978). Soil type distribution is shown in Figure 2; soil conditions are summarized in Table 1. The Forward soils are typically derived from rhyolitic tuff, consistent with site geologic maps; the Boomer loam is typically derived mixed igneous rocks, which may include tuff, and is also consistent with geologic mapping.

Table 1. Summary of soils and slope data

Soil Map Unit	Dominant Soil	Soil Depth (inches)	Erosion Hazard	Runoff Rate
107	Boomer loam, 2 to 15% slopes	44	Slight	Medium
140	Forward gravelly loam, 30 to 75% slopes	35	High to Very High	Very Rapid
139	Forward gravelly loam, 9 to 30% slopes	35	Slight to Moderate	Medium

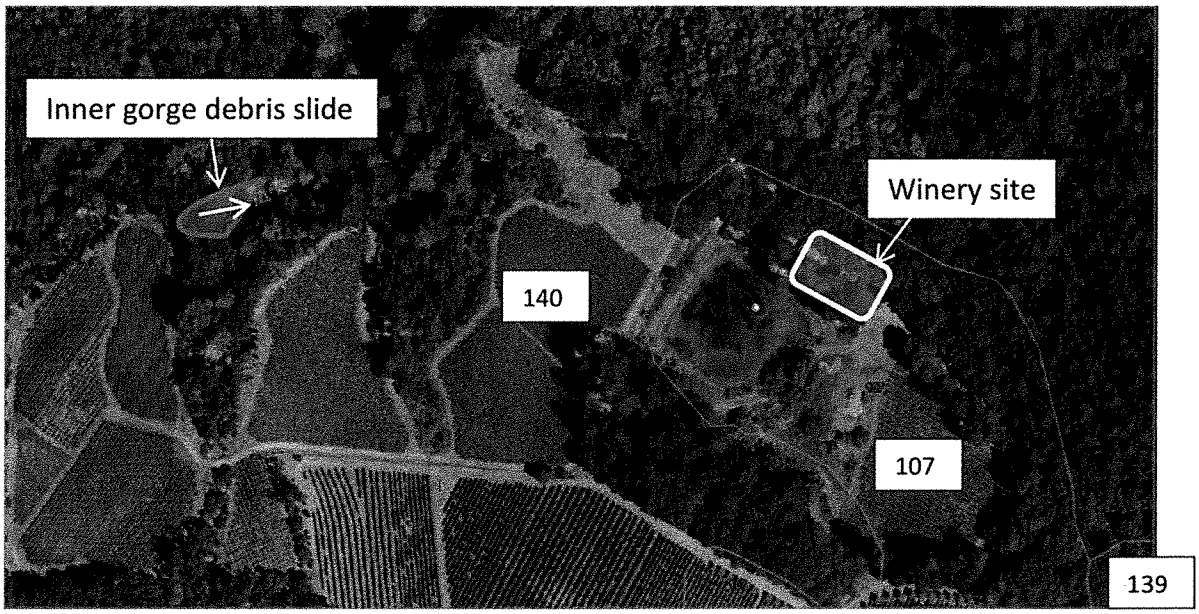


Figure 2. Distribution of soil types on project parcel. The approximate location of the proposed winery site is shown; a more detailed footprint for the winery site and access driveway are shown in Appendix A. An inner gorge debris slide observed in the field is also located. North to top of page; no scale provided with this image. Refer to Appendix A for scale.

With respect to slope stability, only the Forward gravelly loam, 30 to 75% slopes would be considered susceptible to mass wasting, particularly on the steepest slopes (about 65% and greater) with convergent slope shape. The soils and terrain at the proposed winery site and driveway are generally stable and susceptible to erosion if left bare and/or subjected to concentrated runoff.

Aerial Photo Review

Historical aerial photography available on Google Earth was reviewed for evidence of landslides at or near the project parcel. The available imagery was abundant for the period covering the most recent decade; the oldest image from this source was 1993. There was some evidence of a shallow landslide within the inner gorge of the ephemeral or intermittent stream flowing from south to north between the two western-most vineyard blocks over 800 feet from the winery site. No landslides were observed nearer to the winery site.

Observed Slope Conditions

On July 28, 2015, I conducted a wide-ranging field reconnaissance of the project parcel by walking the perimeter of the vineyard fields and the edges of riparian zones of channels draining the site, as well as the proposed winery site.

Slope gradients within the construction envelope are generally less than 15% as observed in the field and shown in the topographic map of the site (Appendix A), with the exception of a short cut slope associated with an existing unimproved driveway. Slope instability is uncommon on such moderate slopes, hence it is generally expected

that the winery site would be stable. Nevertheless, it is possible that unstable soils and/or large-scale slope deformation could occur within large, deep landslide features such as the mapped landslide (Figure 1). For this reason, my reconnaissance extended across the entire developed portion of the parcel, which corresponds with the body of the mapped ancient landslide. If the landslide remains active at the scale of the mapped feature, I would expect to find small scarps, tension cracks, and deranged drainage patterns on the body of the landslide. These features were absent, indicating that the mapped landslide is inactive with respect to the scale and style of movement associated with the mapped landslide feature.

The most common mass wasting that occurs on ancient landslides are debris slides (shallow, rapid slope failures; California Department of Conservation 1999) originating on steep terrain associated with morphologic features of large, deep landslides: the landslide toe (at the bottom of the landslides), the slopes of deeply incised stream channels draining landslide bodies (i.e. inner gorges), and at steep head and lateral scarps formed at the edges of the landslide body.

The aerial photographs and field reconnaissance identified instability in the inner gorge at the location shown in Figure 2. A head scarp about 10 to 12 feet high was found about 30 to 50 feet beyond the northern tip of the western-most vineyard block at an elevation of about 1550 feet (see topographic map, Appendix A). At the base of this scarp there is a block of down-dropped soil and mature forest vegetation about 30 to 50 feet wide and about 150 to 200 feet long with some "jackstrawed" douglas-fir trees about 15 inches diameter. I believe that this largely un-deformed block of soil dropped in response to a debris slide on the very steep slope of the inner gorge below, which I could not readily observe. The toe of the debris slide approximately 100 feet below the head scarp appears to lie adjacent to the steep intermittent or ephemeral stream channel draining from south to north across the parcel. The toe of the debris slide is bare soil, and this area appears to remain unstable. The uppermost extension of this debris slide scarp does not appear to have moved in recent years, but remains well defined.

No such evidence of instability is found near the proposed winery site, nor is there an inner gorge feature located near the winery site. There are steep forested slopes lying below (north) of the winery site. The mature coniferous forest on this slope displays no evidence of instability, and the roots of these trees help maintain slope stability. There are some areas as steep as 65% to 70% slope with convergent topography just beyond the fence line lying about 30 to 50 feet beyond the northern edge of the winery driveway. This area is presently stable, but could be vulnerable to small-scale mass wasting and gully erosion if subjected to increased runoff or concentrated drainage from the winery and driveway.

Site Specific Drainage Considerations

A 100 ft-wide portion of the slope immediately to the north of the proposed winery (Figure 3) should be considered to have some potential for erosion and small scale instability if subjected to increased runoff and concentrated drainage. During development of the site, permanent drainage measures should be implemented to prevent increased or concentrated runoff to this portion of relatively steep and convergent slope. The slopes to the west and east of this location have planar shapes that will not concentrate water, and are more suitable to receive drainage. Nevertheless, concentrated runoff from paved areas, including the driveway and winery roofs, should not be concentrated for discharge on these slopes. Flow spreaders should be employed if storm runoff is to be discharged on these slopes. Where possible, drainage should be routed to the south of the winery building and driveway.

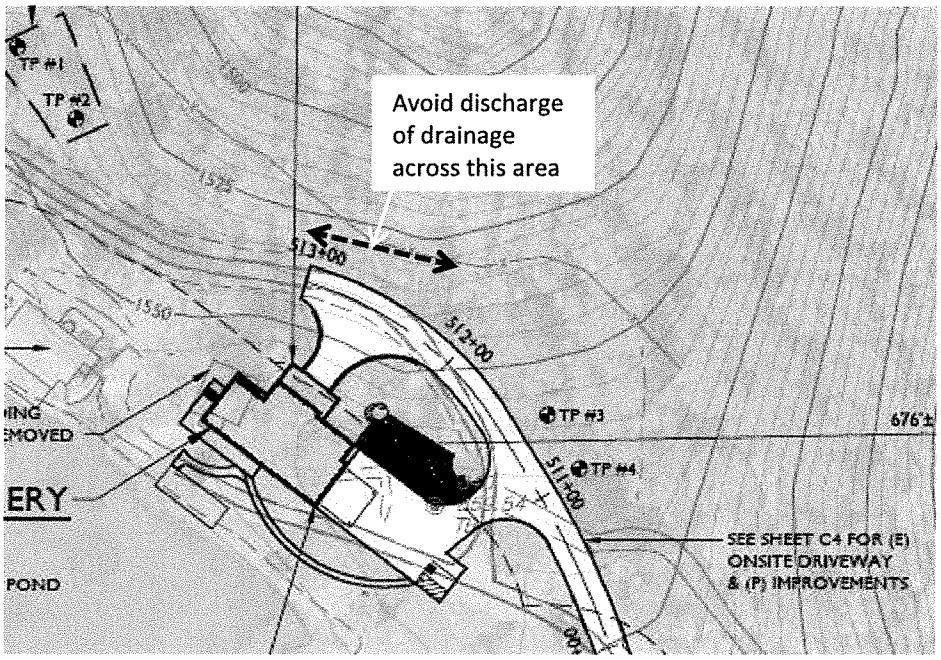


Figure 3. Recommended drainage management at winery site.

Conclusions and Recommendations

Based on the foregoing assessment of site conditions, the proposed winery development is not expected to cause any significant decrease in slope stability nor any increase in erosion. There is one erosion hazard area across the slope immediately north of the proposed winery site where drainage should not be directed. The absence of previous landslides at the winery site, and the gentle to moderate slope at the proposed winery indicate that there is no significant slope stability hazard associated with this project. The winery site is unaffected by, and cannot affect, the debris slide observed on the steep slopes of the inner gorge area over 800 feet west of the winery site.

Limitations

This slope stability and erosion assessment has been prepared with generally accepted principles and practices of Professional geology. The conclusions and recommendations presented are based on available data, site observations, and professional judgment.

References Cited

California Department of Conservation, 1999. Factors Affecting Landslides in Forested Terrain. Division of Mines and Geology Note 50, 5 p.

Delattre, M.P., and Gutierrez, C.I., 2013. Preliminary Geologic Map of the Calistoga 7.5' Quadrangle, Napa and Sonoma Counties, California: A Digital Database, California Geologic Survey.

Graymer, R.W. et al. 2007. Geologic Map and Map Database of Eastern Sonoma and Western Napa Counties, California. USGS Scientific Investigation Map 2956.

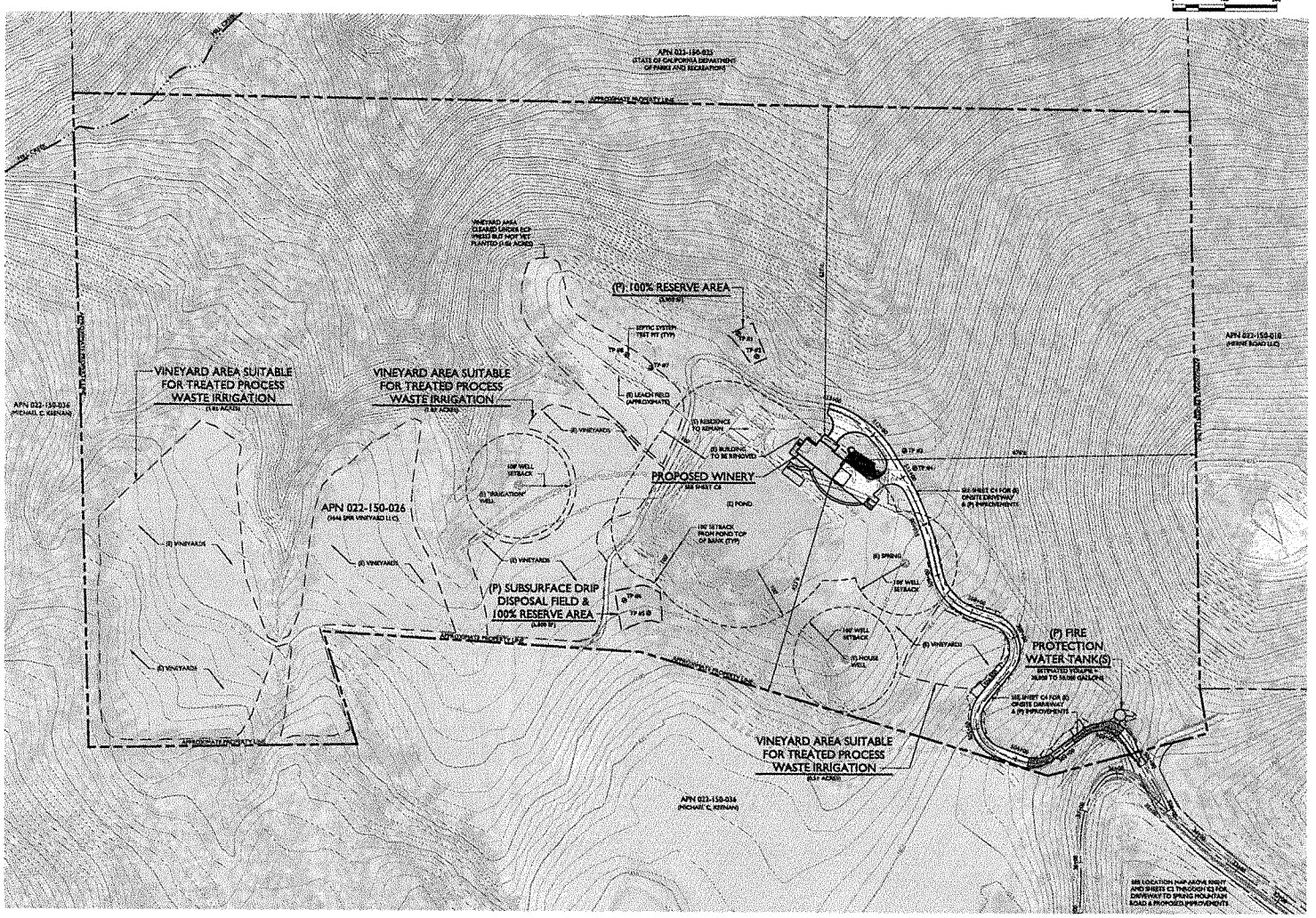
Lambert, G. and Kashiwagi, J. 1978. Soil Survey of Napa County. USDA Soil Conservation Service, in Cooperation with University of California Agricultural Experiment Station.

APPENDIX A

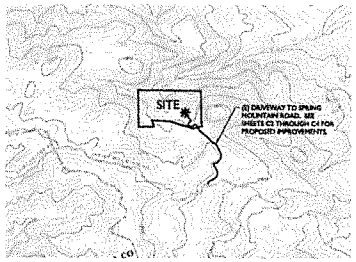
Use Permit Conceptual Site Plans

3646 SMR VINEYARD WINERY

USE PERMIT CONCEPTUAL SITE PLANS



OVERALL SITE PLAN
SCALE: 1" = 100'



LOCATION MAP
SCALE: 1" = 2,000'

PROJECT INFORMATION:

PROPERTY OWNER & APPLICANT:
3646 SMR VINEYARD LLC
CARE OF: ANDREW RUDD
2175 NORTH CALIFORNIA BOULEVARD #400
WALNUT CREEK, CA 94596

SITE ADDRESS:
3646 SPRING MOUNTAIN ROAD
SAINT HELENA, CA 94574

ASSESSOR'S PARCEL NUMBER:
022-150-026

PARCEL SIZE:
56.75± ACRES

PROJECT SIZE:
1.7± ACRES

ZONING:
AGRICULTURAL WATERSHED (AW)

DOMESTIC WATER SOURCE:
PRIVATE WELL

FIRE PROTECTION WATER SOURCE:
STORAGE TANK

WASTEWATER DISPOSAL:
ONSITE TREATMENT AND DISPOSAL

SHEET INDEX:

NOTES:

1. TEST PITS ONE THROUGH EIGHT (TP #1 - TP #8) WERE EXCAVATED BY R.D. SHERILL INC. ON NOVEMBER 7, 2013 AND WERE WITNESSED BY MIKE MUELRATH OF APPLIED CIVIL ENGINEERING INCORPORATED AND A REPRESENTATIVE OF THE NAPA COUNTY PLANNING, BUILDING AND ENVIRONMENTAL SERVICES DEPARTMENT - ENVIRONMENTAL HEALTH DIVISION (SEE E13-00720).
2. FADED BACKGROUND REPRESENTS EXISTING TOPOGRAPHIC FEATURES. THE TOPOGRAPHIC INFORMATION AND APRIL 9, 2011 AERIAL PHOTOGRAPHS SHOWN ON THE OVERALL SITE PLAN WERE OBTAINED FROM THE NAPA COUNTY GEOGRAPHIC INFORMATION SYSTEM (GIS) DATABASE. THE TOPOGRAPHIC INFORMATION SHOWN ON THE REMAINING SHEETS WAS OBTAINED FROM THE "MAP OF TOPOGRAPHY OF A PORTION OF THE LANDS OF 3646 SPRING MOUNTAIN ROAD" PREPARED BY ALBION SURVEYS, INC. DATED JUNE 23, 2014. APPLIED CIVIL ENGINEERING INCORPORATED ASSUMES NO LIABILITY REGARDING THE ACCURACY OR COMPLETENESS OF THE TOPOGRAPHIC INFORMATION.
3. CONTOUR INTERVAL:
   SHEET C1: FIVE (5) FEET, HIGHLIGHTED EVERY TWENTY FIVE (25) FEET
   REMAINING SHEETS: ONE (1) FOOT, HIGHLIGHTED EVERY FIVE (5) FEET
4. BENCHMARK:
   SHEET C1: VERTICAL DATUM BASED ON NAVD 88
   REMAINING SHEETS: VERTICAL DATUM ASSUMED
5. THE PROPERTY LINES SHOWN ON THESE PLANS DO NOT REPRESENT A BOUNDARY SURVEY. THEY ARE APPROXIMATE AND ARE PROVIDED FOR INFORMATIONAL PURPOSES ONLY.
6. ACCORDING TO FEMA FIRM COMMUNITY PANEL 06055C0245E THE SUBJECT PARCEL IS DETERMINED TO BE OUTSIDE OF THE 500 YEAR FLOOD BOUNDARY. SEE FEMA FIRM COMMUNITY PANEL 06055C0245E FOR MORE INFORMATION.

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MICHAEL R. MUELRATH
No. 67455
Exp. 12/31/2016
12/15/2015
CIVIL
STATE OF CALIFORNIA

DESIGNED BY: MRM
DRAWN BY: BT DRAFTING
CHECKED BY: MRM

3646 SMR VINEYARD WINERY
USE PERMIT CONCEPTUAL SITE PLANS
OVERALL SITE PLAN

3646 SMR VINEYARD LLC
3646 SPRING MOUNTAIN ROAD
SAINT HELENA, CA 94574
NAPA COUNTY APN 022-150-026

DATE: JANUARY 15, 2015
JOB NUMBER: 13-143
FILE: 13-143CON_OSP.DWG
ORIGINAL SIZE: 24" X 36"
SCALE: AS NOTED
SHEET NUMBER: C1
OF 6