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Water Availability Analysis

MEMORANDUM

January 16, 2016

To: Ms. Schatzi Throckmorton
Behrens Family Winery
4078 Spring Mountain Road
St. Helena, CA 94574
Sent via email (schatzi@behrensfamilywinery.com)

Job No. 574-NPA01

cc: Jon Webb
Albion Surveys, Inc.
Sent via email (jwebb@albionsurveys.com)

From: Chris Wick and Anthony Hicke
Richard C. Slade & Associates LLC

Re: Results of Napa County Tier 1 Water Availability Analysis
for Existing Behrens Family Winery
4078 Spring Mountain Road
Vicinity St. Helena, Napa County, California

Introduction

Provided herein are the key findings, conclusions, and preliminary recommendations regarding the groundwater availability at the subject ±20-acre Behrens Family Winery property. This winery property, known herein as the "subject property", is situated in the hills on the west side of Napa Valley, in the Spring Mountain area of St. Helena, in Napa County. Specifically, the subject property is comprised of a single parcel (Napa County APN 020-300-035), which is located roughly ½-mile north of Spring Mountain Road, and about 5 miles northwest of St. Helena. Figure 1, "Well Location Map," shows the parcel boundaries of the subject property superimposed on the local USGS topographic map for the Calistoga quadrangle. Parcel boundaries shown on Figure 1 were adapted from assessor's parcel data that are freely available via the Napa County GIS website. Also illustrated on this figure is the location of an existing onsite well, which is known as the "Well No. 1". Figure 2, "Aerial Photograph of the Subject Property," shows the location of the Well No. 1 and the reported locations of two neighboring offsite wells superimposed on an aerial photograph of the subject property.

In addition to the onsite winery, a single residence and approximately 0.6 acres of vineyards exist at the subject property. Water demands for the winery operation and the associated landscaping, the onsite residence and the existing vineyards are currently supplied by pumping groundwater from Well No. 1.

We understand that, from our previous discussions with Messrs. Behrens, the current phase of the project includes the proposed increase in the existing winery production capacity from 10,000 gallons (4,150 cases) of wine per year to 20,000 gallons (8,300 cases) of wine per year. Hence, the purpose of this project is to submit a permit application for the existing winery that reflects proposed changes to certain aspects of the winery operation. As part of that permit submittal, a Water Availability Analysis (WAA) must be submitted to the County for the property. Hence, the purpose of this Memorandum is to comply with Napa County's Water Availability Analysis (WAA) guidelines, which were promulgated by the County in May 2015.

This Memorandum meets the County requirements of a "Tier 1" WAA per those May 2015 guidelines. A "Tier 2" WAA is presumptively met for this project because the two following criteria are applicable to the project, as stated in Appendix F (page 26) of the May 2015 WAA Guidelines:

- "The Tier 2 well interference criterion is presumptively met if there are no non-project wells located within 500 feet of the existing or proposed project well(s)." (WAA May 2015)
- "The Tier 2 spring interference criterion is presumptively met if no natural springs in use for domestic or agricultural purposes are located within 1,500 feet of any proposed project well(s)." (WAA May 2015)

Scope of Services

Based on our proposal to you, dated April 30, 2015, our scope of services for this Water Availability Analysis included the following tasks:

Task 1A.1 – Collect and Review Available Data

Task 1A.2 – Site Meeting and Field Reconnaissance

Task 1A.3 – Data Analysis and Prepare Memorandum

This current Memorandum represents the culmination of our Task 1A.3 work. Wholly excluded from our work on this project is any and/or all geotechnical and engineering geology work related to such site development as: grading and earthwork; slope stability; building foundations; road construction; fault hazards and related ground shaking issues; landslide activity; site drainage; and all work related to the feasibility, design, construction, operation, maintenance, and/or impacts to the subsurface resulting from any/all of your existing and/or future subsurface sewage disposal operations.

Site Conditions

From our field reconnaissance visits at the subject property on July 21, 2015, the following key items were noted and/or observed (refer to Figures 1 and 2):

a. The subject property is composed of a single parcel located in the hills northwest of St. Helena in Napa County, with the Assessor's Parcel Number (APN) of 020-300-035.

b. As observed in the field, the basic features of the subject property consist of naturally-vegetated, wooded, and/or landscaped areas. Topographically, a northwest-southeast trending ridgeline traverses across the west-central portion of the site; much of the site slopes at rather steep inclinations to the northeast, away from this ridgeline.

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c. One water well (known herein as "Well No. 1") was observed to exist on the subject property, the location of which is shown on Figures 1 and 2. At the time of our July 21, 2015 site visit, this active well was not pumping.

d. The offsite areas surrounding the subject property consist primarily of existing vineyards and/or wooded hillsides.

e. A minor unnamed swale exists in the southwestern portion of the subject property near Well No. 1; at the time of the site visit, this swale was observed by the RCS geologist to have a small amount of flow in it. Reportedly, there is some seasonal flow from an offsite spring that may have been the source for the water in the swale. No other information (including its exact location) is known about this offsite spring.

   The northeast portion of the property drains offsite into an unnamed ephemeral channel that eventually flows into the existing drainage course of Ritchey Creek (see Figure 1).

f. No offsite wells were directly observed during the site visit. However, the reported locations of two neighboring offsite wells were provided to RCS via email from Mr. Sean Behrens, of Behrens Family Winery; the reported locations of these wells are shown on Figure 2. These two offsite wells lie approximately 820 ft northeast, and 1,520 ft southwest, respectively, from existing onsite Well No. 1. No construction information or pumping data were provided for either of these offsite wells owned by others.

Key Construction Data for Existing Onsite Well

As mentioned above, one water well is located in the southwestern corner of the subject property (see Figures 1 and 2; the well is shown as Well No.1 thereon). A California Department of Water Resources (DWR) well completion report (also known as a driller's log) was available for the existing well and was provided to RCS by Mike Muelrath of Applied Civil Engineering (ACE), the project Engineer. The driller's log lists the well name as "#1".

Key data for Well No. 1 are summarized below:

a) This well was drilled and constructed by Dave Bess Well Drilling (D. Bess) of Napa, California, in November 1999, using the air rotary drilling method.

b) The pilot hole depth (the borehole drilled before well casing is placed downhole) was reported to be 630 feet below ground surface (ft bgs).

c) The well is cased with PVC well casing having a nominal diameter of 5 inches; total casing depth was 625 ft bgs.

d) The well was constructed with a cement (grout) sanitary seal to a depth of 52 ft bgs. As such, groundwater from this well can be used for irrigation-supply, domestic-supply, and public-supply in the County.

e) Casing perforations are machine-cut and have slot opening widths of 0.032 inches (32-slot). Perforations in this well were placed continuously between the depths of 50 ft and 625 ft bgs. It is true that the log shows that the bottom of the cement seal extends two feet into the upper perforations in the well. It is unknown if this is actually the case, or a typographic error on the driller's log. It is more likely a typographical error because, if the cement material did enter the perforations during well construction, development of the well would be very difficult.

f) Gravel pack material listed on the driller's log for Well No. 1 is a "3/8 pea gravel".

g) At the time of our July 21, 2015 site visit, this well was observed to be equipped with a permanent pump, but was not actively being pumped at that moment. The reported depth of the pump intake is 615 ft bgs. As stated above, groundwater pumped by this well is reportedly used to meet all onsite water demands. A static water level (SWL) of 464 ft below the wellhead reference point (brp) was measured by the RCS geologist during the site visit. The wellhead reference point was measured to be approximately 1.9 ft above ground surface (ft ags).

One pilot borehole, drilled in October 1999 (just prior to the drilling of Well No. 1), and named on the driller's log as "Test Hole #1", was termed by the driller at the time to be a "dry hole". Therefore, no casing was installed in the borehole (the borehole was backfilled by the driller). This borehole is located approximately 340 ft east of Well No. 1, near the existing winery, as seen on Figure 2. As reported on the driller's log for the borehole, air rotary drilling was used.

Summary of Key Well Test Data

On the driller's log for Well No. 1, a brief summary of the original, post-construction testing data are provided. Original test data for this well, as reported on the available driller's log, include:

- Depth to "first water" was reported to be 568 ft brp (this may represent the depth at which the driller first encountered water in the borehole when drilling with air).
- The initial SWL was reported to be 370 ft brp on November 5, 1999.
- The reported airlifting rate during initial post-construction airlift testing was 10 gallons per minute (gpm). As a rule of thumb, operational pumping rates for a new well are typically on the order of only about one-half the originally-reported airlifting rate.
- The pumping water level (PWL) and the water level drawdown were not listed on the log, because pumping water levels cannot be measured during airlifting activities; thus the specific capacity (SC) value for this well could not be calculated. Specific capacity, in gallons per minute per foot of water level drawdown (gpm/ft ddn), represents the ratio of the pumping rate in a well (in gpm) divided by the amount of water level drawdown (in ft ddn) created in the well while pumping at that rate.

In February 2015, Oakville Pump Service, Inc. (OPS) of Oakville, California was contracted by the Owner to perform additional pumping tests in Well No. 1. This testing reportedly included a 9-hour constant drawdown test. Data collected by the OPS pumper were provided to RCS for review. The following provides a short summary of the data collected by the pumper during these tests:

- An initial (pre-test) SWL of 469 ft brp was measured prior to the commencement of pumping.
- A final pumping rate of 5 gpm was recorded by OPS at the end the constant drawdown test.

- Just prior to the end of the 9-hour pumping period of this test, a final PWL of 567.5 ft brp was reported by the pumper. This represents a maximum water level drawdown of 98.5 ft from the initial SWL. Based on a pumping rate of 5 gpm, the specific capacity of the well from these data is approximately 0.05 gpm/ft ddn.
- After a period of 7 hours following the cessation of pumping in this well, water levels had recovered to within 2 ft of pre-test SWLs (or 98% recovery). After 14 hours, water levels had recovered back to the pre-test SWL depth of 469 ft brp (or 100% recovery); this recovery represents full recovery for this constant drawdown test.
- A SWL of 464 ft brp was recorded by the RCS geologist during their July 21, 2015 site visit. Thus, SWLs have risen slightly since the pumping test was performed in February 2015. This July 2015 SWL of 464 ft is approximately 94 ft deeper than the SWL (at 370 ft) recorded by D. Bess following construction of this well in November 1999.

Local Geologic Conditions

Figure 3, "Geologic Map," illustrates the types, lateral extents, and boundaries between the various earth materials mapped at ground surface in the region by others. Specifically, Figure 3 has been adapted from the results of regional geologic field mapping of the Calistoga quadrangle, as published by the California Geological Survey (CGS) in 2013 (Delattre, M.P and Gutierrez, C.I.). Key earth materials mapped at ground surface in the area, as shown on Figure 3 include, from geologically youngest to oldest, the following:

a. Landslide deposits (map symbol Qls). Several landslides have been mapped in the region (see the yellow colored areas on Figure 3), but none of these locations occur on the subject property. These offsite landslides primarily occur west, north and northeast of the subject property, although a few exist in offsite areas to the south and southeast. Arrows within these mapped landslide areas show the general direction of ground surface movement with each slide.

b. Sonoma Volcanics (map symbols Tsa and Tstp). Typical rock types of the Sonoma Volcanics, as mapped by others, occur as ground surface exposures throughout most of the area shown on Figure 3, including all of the subject property. Typical rock types include: hard lava flows of basaltic and andesitic composition; basaltic and andesitic breccias, and volcanic agglomerate and tuff. As shown on Figure 3, tuffaceous volcanic materials (map symbol Tstp and shown in rose pink colors) of Pliocene geologic age, are exposed at ground surface throughout the entire subject property. Hard basaltic lava flow rocks (map symbol Tsa and shown in light brown/beige colors) are shown to exist at ground surface immediately southeast of the subject property and along a prominent fault line (this fault is discussed below). Based on information from the driller's log for the existing onsite well and test hole, these volcanic materials are interpreted to extend to depths greater than 630 ft bgs beneath the subject property.

   Generally, these hard volcanic rocks tend to produce more groundwater wherever and whenever they are highly fractured and/or deeply weathered. However, fine-grained ash flows and deeply weathered volcanic tuffs, if and where present, tend to have a lower permeability and, as a result, these materials are typically capable of providing groundwater at lower production rates to wells.

Review of the driller's logs for the onsite well (Well Completion Report No. 822299) and the onsite test hole #1 (Well Completion Report NO. 822298) reveals the driller encountered typical rocks of the Sonoma Volcanics throughout the total drilled borehole depth at each site. Typical driller-terminology for the drill cuttings on those logs included: "yellow ash-boulders-hard basalt;" "white ash;" "hard broken basalt;" and "hard black solid basalt." Again, only Well No. 1 was completed with perforated casing to create the existing onsite well; the borehole for Test Hole No. 1 was not cased by the driller because he/she determined it to be a "dry hole."

c. Bedrock. Underlying the volcanic rocks at even greater depths beneath the subject property, and also exposed at ground surface to the south and east of the property, as shown on Figure 3, are various rocks of the Franciscan Complex. Principal rock types in these geologically older earth materials are thick-bedded sandstone with shale and conglomerate interbeds (map symbol KJfss and shown in light green colors) and mélange (map symbol KJfm and shown in olive green colors). Because of their high degree of consolidation and/or cementation, their overall fine-grained nature, and their great geologic age, these diverse rocks are typically considered to be non-water bearing; only a small and variable amount of water may occur in the limited number of fractures and/or fissures. Hence, these older rocks represent the bedrock of the area. Based on the driller's log, neither Well No. 1 nor the onsite Test Hole encountered this bedrock.

Local Hydrogeologic Conditions

Earth materials exposed throughout the subject property can generally be classified into two basic categories, based on their relative ability to store and transmit groundwater to wells. These two basic categories include:

Potentially Water-Bearing Materials

The principal water-bearing materials at and beneath the subject property and its environs are represented by the hard, fractured volcanic rocks and volcanic tuffs of the Sonoma Volcanics. The occurrence and movement of groundwater in these rocks tend to be controlled primarily by the secondary porosity within the rock mass, that is, by the fractures and joints that have been created in these harder volcanic flow-type rocks over time by various volcanic and tectonic processes. Specifically, these fractures and joints have been created as a result of the cooling of these originally molten flow rocks and volcanic ash deposits following their deposition, and also from mountain building or tectonic processes (faulting and folding) that have occurred over time after the rocks were erupted and hardened. Some groundwater can also occur in zones of deep weathering between the periods of volcanic events that yielded the various flow rocks, and also within the pore spaces created by the grain-to-grain interaction in the volcanic tuff. The amount of groundwater available at a particular drill site for a new well in such hard volcanic flow rocks would depend on such factors as:

- the number, frequency, size and degree of openness of the fractures/joints
- the degree of interconnection of the various fracture/joint systems in the subsurface
- the size of the pore spaces that exist in the volcanic tuffs
- the amount of recharge from local rainfall that becomes available for deep percolation to the fracture systems

- the extent to which the fractures may have been filled over time by chemicals precipitates/deposits and/or weathering products (clay, etc.)

As stated above, the principal rock types exposed at ground surface on the property and also expected in portions of the subsurface beneath the property are a combination of fine-grained ash flows and weathered tuffs and hard, volcanic flow rocks of basaltic composition (Figure 3 map symbols, Tstp and Tsa, respectively) that appear to be fractured to varying degrees, based on interpretations by RCS of descriptions of drill cuttings available on the driller's logs. From our long-term experience with these harder flow rocks for numerous other water well construction projects in Napa County, pumping capacities in individual wells have ranged widely, from rates of 5 to 10 gpm, to rates of 200 gpm, or more. The finer-grained, clay-rich, ash deposits have a much lower permeability and a potential to yield only small amounts of groundwater to a well.

Potentially Nonwater-Bearing Rocks

This category includes all geologically older and fine-grained sedimentary rocks that are exposed south and west of the subject property. Specifically, this includes all rocks assigned to the geologically ancient Franciscan Complex. These rocks are also known to directly underlie, but at unknown depths, all volcanic rocks beneath the subject property.

In essence, these rocks are well-cemented and well-lithified, and have an overall fine-grained nature and low permeability. Even in areas of abundant fractures, successful well yields are often only a few gpm in these rocks, and the water quality can be marginal to poor in terms of total dissolved solids concentrations, etc.

Geologic Structure

An unnamed fault, as mapped by others, is shown on Figure 3. This fault, which is located immediately southeast of the subject property, is aligned in a northeast-southwest direction across the region. The possible impacts of this fault on groundwater availability are unknown. In some cases, faults can be barriers to groundwater flow. However, as is often observed in the Sonoma Volcanic rocks, this fault could also serve to increase the amount and frequency of fracturing in the local volcanic rocks. If the latter has occurred, it would tend to increase the open area in the rock fractures which, in turn, could increase the ability of the local volcanic rocks to accept more recharge and to also store and transmit groundwater to wells.

Please note that it is not the purpose of this report to assess the potential seismicity or activity of any faults that may occur in the region.

Proposed Future Water Use

Groundwater demands for the project, as discussed herein, were provided to RCS by Applied Civil Engineering (ACE) of Napa, CA. Table 1, "Water Use Estimate Calculations by ACE," is adapted from a data table provided to RCS by ACE, and is intended to categorize the specific water use demands of the project and other onsite uses. As shown on Table 1, the ACE-estimated annual groundwater demands for the proposed project are as follows:

a. Winery Process Water = 0.43 acre feet per year (AF/yr)
    - These demands include water used for winery production operations.
b. Potable Water used for Winery Non-Process Water = 0.23 AF/yr

- o This category includes potable water used by the tasting room staff as well as Winery staff and administration, and also used for daily visitors, and during events with catered meals.

c. Irrigation Demand for Winery Landscaping = 0.25 AF/yr

- o This demand represents all landscaping for the winery.

d. Irrigation demand for the ±0.6 acres of existing onsite vineyards = 0.18 AF/yr

- o This demand represents all groundwater used to irrigate the onsite vineyards.

e. Residential Domestic Water Use = 0.50 AF/yr

- o This demand is for water used at the one onsite residence (0.50 AF/yr).

f. Total proposed groundwater demand for project = a + b + c + d + e = 1.59 AF/yr.

For comparison, and as shown in Table 1, the current (existing) water use at the subject property is 1.21 AF/yr. Hence, as calculated by ACE, the proposed project (1.59 AF/yr) will use only approximately 0.38 AF/yr more groundwater than is estimated to be currently used at the subject property (1.21 AF/yr). Note that 1AF = 325,851 gallons.

Assuming this average groundwater demand for the proposed new project (1.59 AF/yr) is to be met solely by pumping groundwater from Well No. 1 at a 100% operational basis (that is, pumping 24 hours per day, every day, 365 days per year), then Well No. 1 would need to pump at a rate of about 1 gpm. However, RCS does not recommend that a well be pumped 24 hours per day, every day (i.e., 100% of the time). On a more realistic 50% operational basis (a well pumping for only 12 hours per day, every day, throughout the year), then the well would need to pump at a rate of about 2 gpm to meet the total groundwater demand for the project.

Rainfall

Long-term rainfall data for the subject property are essential for estimating the average annual recharge at the subject property. Average annual rainfall totals strictly within the boundaries of subject property are not directly known. However, the nearest rainfall gage is reported to exist roughly 3 miles south of the subject property. Data from this gage is available from the California Data Exchange Center (CDEC) website (http://cdec.water.ca.gov) of the DWR, and the gage is known as "St. Helena 4WSW" (SH4). Data from the CDEC website shows data beginning in 1984, but the water year (WY) 1984-85 appears to be missing several days and/or months of rainfall data; the water year is defined as October 1 of one year through September 30 of the following year. Also, there appears to be erroneous and/or missing data in four other years in the data set (WY 1986-87 through WY 1989-90). RCS removed the obviously erroneous data from the set before calculating an average rainfall for this gage (for example, for the day of December 31, 1986, the data set includes a daily rainfall total of 811.1 inches; it is not possible that 811.1 inches of rain fell on that single day in December 1986). Note that RCS only removed rainfall totals; no rainfall data were "added" to the data set. With these assumed erroneous years removed from the data set, then an average rainfall of 41.5 inches is calculated for this SH4 rain gage. This rain gage is located at roughly the same elevation as the subject property, and therefore, the average annual rainfall at the subject property could be considered to be roughly similar to that experienced at this known gage location.

The nearest rain gage to the subject property with a significantly longer data record is a gage located in Calistoga, roughly 5 miles northwest of the subject property. The data for this gage are available from the Western Regional Climate Center (WRCC) website (http://www.wrcc.dri.edu); the period of record for rainfall data is listed as 1906 through August 2015. For this period of record, the average rainfall at this Calistoga gage is reported to be 36.6 inches. Note that between 1906 and 1944, several months and/or years of rainfall data are missing from the data set. Also, the WRCC does not list rainfall data per "water year," but rather per calendar year. Thus, RCS removed 1906 through September 1944 from the data set, and re-formatted the rainfall data from calendar year to Water Year (WY). The average annual rainfall for WY 1944-45 through WY 2014-15 was calculated by RCS to be 37.4 inches. This rain gage, however, is located at a lower elevation (±400 ft above mean sea level, msl) than the subject property (±1,700 to ±1,900 ft msl), and therefore, the rainfall at the subject property would tend to be somewhat higher than that experienced at this known gage location.

To further help confirm the average rainfall data calculated for the CDEC SH4 gage, RCS also reviewed the precipitation data published by the PRISM Climate Group at Oregon State University. This data set, which is freely available from the PRISM website (http://prism.oregonstate.edu/), contains "spatially gridded average annual precipitation at 800m (800-meter) grid cell resolution." The date range for this dataset includes the climatological period between 1981 and 2010. These gridded data provide an average annual rainfall distributed across the subject property. Using this data set, RCS determined that the average rainfall for the subject property for the stated data range would be 45.4 inches (3.8 ft).

An isohyetal map (a map showing contours of average annual rainfall) is available that covers all of Napa County, and is freely available for download from the online Napa County GIS database (*gis.napa.ca.gov*). The download page for the file named "isohyetal_cnty" can be accessed via:

> http://gis.napa.ca.gov/giscatalog/catalog_xml.asp?srch_opt=all&db_name=x&theme=x&sort_order=layer&meta_style=fgdc&submit=Submit

As described in the metadata for the file (also available via the download page at the web link shown above), the isohyets are based on a 60-year data period beginning in 1900 and ending in 1960. Unfortunately, and as also stated in the metadata for the file, the contour interval for the map is reported to be "variable due to the degree of variation of annual precipitation with horizontal distance", and therefore the resolution of the data for individual parcels can be difficult to discern. The subject property is located within the boundaries of the 55-inch rainfall contour on the map. From the 55-inch contour, the next contour interval is 65 inches. Based on our interpretation of the isoheyetal contour map (not reproduced herein), the long-term average annual rainfall at the subject property could be on the order of 60 inches.

Table 2, "Comparison of Rainfall Data Sources" below, shows a comparison of the data collected from the different sources discussed above:

Table 2 – Comparison of Rainfall Data Sources

Rain Gage and/or Data Source	Years of Available Rainfall Record	Average Annual Rainfall (inches)
CDEC St. Helena 4WSW	WY 1985-86 through present[1]	41.5

WRCC Calistoga	WY 1944-45 through present	37.4
PRISM Climate Group	1981 to 2010	45.4
Napa County Isohyetal Map	1900 to 1960	60.0

Notes: (1) Not including WY 1986-87 through WY 1989-90.

Based on the various rainfall data described above, RCS will conservatively assume that the long-term average annual rainfall at the subject property is 41.5 inches (3.46 ft), even though two of the available datasets presented above indicate that a higher average annual rainfall may have occurred at the subject property. This 41.5-inch per year estimate is based on the data source with a relatively shorter period of record (26 years) of any of the rainfall data sources listed above. Even though the WRCC Calistoga rain gage is the data source with the longest period of record (71 years), it is also at a much lower elevation than the subject property; thus the average annual rainfall at the subject property would realistically be higher than the average of 37.4 inches at this WRCC rain gage. Note that at the location of the WRCC Calistoga gage, the isohyetal map shows an average rainfall of 35 inches/year, and the PRISM data set shows an average rainfall of 39 inches per year.

Estimating Groundwater Recharge as a Percentage of Rainfall

Groundwater recharge on a long-term average annual basis at the subject property can be estimated as a percentage of average rainfall that falls on the subject property and becomes available to deep percolate into the aquifers over the long term. The actual percentage of rain that deep percolates can be variable, based on numerous conditions such as the slope of the land, the soil and rock types that exist at the property, the evapotranspiration that occurs on the property, the intensity of the rainfall, etc. Estimates of each of these factors can be spurious. Therefore, we must look to various analyses of deep percolation into the Sonoma Volcanics by RCS for other properties, and/or by other consultants, and/or by government agencies.

Estimates of groundwater recharge as a percentage of rainfall are presented for a number of watersheds in Napa County in the report titled "Updated Napa County Hydrogeologic Conceptual Model" (LSCE&MBK, 2013), prepared for Napa County. Watershed boundaries within Napa County are shown Figures 8-3 and 8-4 in that report. At the request of RCS, those watershed boundaries were provided to RCS by MBK Engineers via email. Figure 4, "Watershed Boundaries," was prepared for this project using those received boundaries. As shown on Figure 4, the subject Behrens Family Winery property is located within the watershed known as "Napa River at St. Helena." As shown on Table 8-9 on page 97 of the referenced report (LSCE&MBK, 2013), 14% of the average annual rainfall that occurs within this watershed was estimated to be able to deep percolate as groundwater recharge.

As stated above, the ground surface area of the subject property is 20 acres. Assuming that a conservative value of 41.5 inches (3.46 ft) of rain falls on the property on a long-term average annual basis, then the total volume of rainfall available for deep percolation over the long term is approximately 69.2 AF (20 acres x 3.46 ft). Assuming 14% of the average annual rainfall can deep percolate to the groundwater beneath the subject property, then the average annual groundwater recharge at the subject property would be approximately 9.7 AF/yr.

Recharge estimates that have been used by others for the Sonoma Volcanics throughout Napa County in different watersheds range from a conservative estimate of 7% to perhaps 14% or higher. RCS has typically assigned a deep percolation estimate of 9% to 10% for the Sonoma Volcanics. These estimates are based, in part, on our review of USGS Water Resources Investigation Reports WRI 77-82 and WRI 03-4229 (USGS 1977 and USGS 2003, respectively) and from our experience in preparing numerous hydrogeologic assessments throughout Napa and Sonoma counties for properties underlain by the Sonoma Volcanics. One groundwater study prepared by others as a part of the Napa Pipe Project Environmental Impact Report estimated that 10.5% rainfall recharge occurred within the Sonoma Volcanics (BHFS 2011).

In the reference "Introduction to Hydrogeology" by J.C. Nonner, 2002, estimates of groundwater recharge were presented as percentages of rainfall for many different rock types in various climates (arid, temperate, and tropical). In that reference (page 172) recharge rates in volcanic rocks in arid regions were discussed in general terms. "Generally, but not everywhere, recharge rates less than 10% of the precipitation were reported for volcanic complexes in arid areas. "For example, recharge percentages on the order of 7 to 9% of an annual precipitation of about 600 mm [23.6 inches] have been assessed for the Deccan Trap basalts..." (Nonner 2002). The text goes on to state on page 173 (Nonner, 2002) that "Rates of recharge from precipitation... for volcanic rock complexes in temperate and tropical areas are higher than the rates for similar volcanic rocks in arid areas." Because the subject property is underlain by volcanic rock aquifers in a temperate climate, an estimate of 10% deep percolation of rainfall is considered to be a conservative estimate by the standards set forth in the Nonner text.

A slightly more site-specific estimate of the deep percolation of rainfall at the subject property can be made using the data from the LSCE&MBK (2013) reported in conjunction with the PRISM rainfall data set. Figure 5A, "Watershed Geology," shows the same watershed boundaries (LSCE&MBK, 2013) shown on Figure 4, but it superimposes a geologic base map of the region (USGS, 2007); Figure 5B shows the geologic legend for that map. Importantly, a reddish-brown line is shown on the map to denote/separate the alluvial deposits of the Napa Valley from the hillside areas of the County; this reddish-brown line is adapted from DWR Bulletin 118-03 (DWR, 2003). The areas within that reddish-brown line along the floor of Napa Valley represent the Napa Valley subbasin of the Napa-Sonoma Valley Groundwater Basin, as defined by DWR.

As discussed above, the referenced report (LSCE&MBK 2013) estimated that 14% of the average annual rain that falls within the "Napa River at St. Helena" watershed is available to deep percolate to recharge the groundwater. It is likely that, in reality, the percentage of rainfall that deep percolates into the alluvial deposits is higher than the percentage of rainfall that deep percolates into the geologic materials that are exposed throughout the hillside areas of the watershed (in general, the hillsides are composed of either volcanic rocks, or older, well-cemented sandstones and siltstones). The total area within the brown-boundary groundwater subbasin shown on Figure 5A is roughly 14.8 square miles. The remainder of the "Napa River at St. Helena" watershed area that is not underlain by the reddish-brown-lined groundwater subbasin is comprised by a total of 64.8 sq. mi. By assuming that the deep percolation percentage of rainfall onto the groundwater subbasin (underlain by alluvium) is 25% (instead of 14%), then the estimated percentage of infiltration in the adjoining hill and mountain areas can be calculated. To do so, the amount of rain that falls in each of the areas must be determined. This can be accomplished using a GIS system and the PRISM dataset. Because the PRSIM dataset is distributed for equal-sized areas throughout the County, then the average rainfall can be calculated for any size or shaped area within the County. Using the Prism data set, and the assumptions stated above, Table 3, "Calculation of Theoretical Rainfall Recharge Percentage, Napa River Watershed at St. Helena," was created to determine the percentage of rainfall that may be available for deep percolation.

As shown on Table 3, assuming the average rainfall as calculated using the PRISM data set, three scenarios are presented in which the deep percolation percentage of the valley floor of the Napa Valley is adjusted to values higher than 14%. The results of the three scenarios shown on Table 4 are as follows:

- Scenario 1 assumes a valley floor deep percolation percentage of 20%, with a resultant deep percolation percentage for the hill and mountain areas of the watershed of 13%.
- Assuming the deep percolation of rainfall in the alluvium is 25% for Scenario 2, the percentage of rainfall that is calculated to deep percolate at the subject property (and throughout the watershed) is 12%.
- A deep percolation percentage in the alluvium for Scenario 3 of 30% yields a deep percolation percentage for the hill and mountain areas of 11%.

Therefore, based on the analyses presented in Table 3, a value of 11% may be an appropriate assumption for the percentage of rainfall that can deep percolate to recharge the groundwater beneath the subject property. Assuming a deep percolation of 11%, a surface area of the subject property of 20 acres, and a long-term average annual rainfall total of 41.5 inches, then the average annual groundwater recharge at the subject property is estimated to be 7.6 AF/yr.

<u>Possible Effects of "Prolonged Drought"</u>

California is currently experiencing a period of extended drought. Here, drought is defined as a meteorological drought, that is, a period in which the total annual precipitation is less than the average annual precipitation (DWR 2015). For similar projects in the County, Napa County PBES has asked RCS to consider what the effects on groundwater availability at a particular property might be if a period of "prolonged drought" were to occur in the region, and if the proposed project begins to operate as planned. Recharge volumes estimated in this report have been based on the long-term average rainfall value. Recall that an average rainfall calculation always includes periods of below-average rainfall and above-average rainfall that occurred during the period over which the average was calculated. Therefore, it is our opinion that the preceding calculations do inherently include consideration of drought year conditions.

However, to help understand what potential conditions might exist in the local volcanic rocks beneath the property during a "prolonged drought period", a "prolonged drought" must be defined. As discussed by DWR, "there is no universal definition of when a drought begins or ends, nor is there a state statutory process for defining or declaring drought." (DWR 2015). California's most significant historical statewide droughts were defined by DWR as occurring during the following periods (DWR 2015):

- WY 1928-29 through WY1933-34 - six years
- WY 1975-76 through WY 1976-77 – two years
- WY 1986-87 through WY 1991-92 – six years
- WY 2006-07 through WY 2008-09 – three years
- Current drought – WY 2011-12 through WY 2014-15 – four years to date

Table 4, "Drought Period Rainfall as Percentage of Average," shows the average amount of rainfall that occurred during each drought period for which rainfall data exist; that drought period rainfall amount is also expressed on Table 4 as a percentage of the total rainfall that fell. As shown on Table 4, determining the amount of rain that might fall during a "prolonged drought" is variable, and depends on the period of record for the specific rain gage. Clearly, the WY 1975-76 to WY 1976-77 drought period recorded by the Calistoga WRCC gage had the lowest total rainfall at 40% of the long-term average, and lasted two years. The WY 1986-87 to WY 1991-92 drought period lasted for six years, but rainfall was found to be 75% of the average annual rainfall at the Calistoga WRCC gage during this period. It is important to note that the drought year percentages listed on Table 4 are completely dependent on the period of record for each individual gage. An example of this is the CDEC St. Helena 4WSW (SH4) gage data. Because the period of record for the gage is short and includes two drought periods during that time span, then the two available drought year period rainfall percentages are shown to be 74% and 80% of the long-term average.

For the purposes of this report, and to present a conservative analysis, we will consider a typical drought period rainfall to be 40% of the average annual rainfall that occurs at the Calistoga WRCC gage. Further, to be conservative, we will estimate a "prolonged drought period" to be 6 years, which is the longest drought period on record according the DWR (DWR, 2015); see Table 4. This six-year period is a conservative estimate, because the 40%-of-average figure corresponds with a two-year drought period, not a six-year drought period.

To meet six years of groundwater demand for the proposed subject property, a total combined onsite groundwater extraction of 9.5 AF is estimated to be required (1.59 AF/yr multiplied by 6 years = 9.5 AF). Assuming groundwater recharge is reduced to 40% of the average annual recharge during a theoretical "prolonged drought period", then approximately 18.0 AF of groundwater recharge might occur during the 6-year drought period, as calculated below:

a. From page 12, the average annual groundwater recharge at the property was estimated to be 7.6 AF/yr. Taking 40% of this annual volume yields a drought period recharge volume of 3.0 AF/yr.

b. Assuming a drought period duration of 6 years, then 18.0 AF (3.0 AF/yr times 6 yrs) of groundwater would be able to recharge the volcanic rocks beneath the property by virtue of deep percolation of the direct rainfall recharge within the boundaries of the subject property.

Therefore, assuming a conservative six-year drought period in which only 40% of the average annual rainfall might occur, a conservative estimate of the total drought-period recharge at the subject property (18.0 AF) would still exceed the estimate of the total groundwater demand (9.5 AF) that may occur over the same six-year drought period.

Groundwater Quality

Laboratory testing was performed for a limited number of water quality analytes on February 19, 2015 from a groundwater sample collected by others from Well No. 1. The limited laboratory analyses were performed by Brelje and Race Laboratories, Inc., of Santa Rosa, California. Key results of that analysis include:

- Total hardness (TH) was reported to be 57 milligrams per liter (mg/L). Water with a TH less than 60 mg/L is typically considered to be "slightly hard".
- The pH of groundwater was reported to be 7, indicating that the water is neutral (pH equal to 7).
- Nitrate and Nitrite (as N) were reportedly below their laboratory detection limits (i.e., not detected).
- Iron (Fe) and manganese concentrations were reported as not detected. The State Secondary Maximum Contaminant Level (MCL) for Fe is 300 micrograms per liter (µg/L) for water to be used for domestic purposes; Mn has a Secondary MCL of 50 µg/L for domestic use.
- The arsenic (As) concentration was reported to be 2.9 µg/L. Arsenic has a State Primary MCL of 10 µg/L for domestic purposes.

Key Conclusions and Recommendations

- As described above, the future groundwater demand for the proposed Winery project is 1.59 AF/yr. This translates into a well needing to pump at a rate of approximately 2 gpm to meet the average annual demand for the project, assuming the well is pumped on a 50% operational basis (pumping 12 hours per day, every day) throughout the year.
- During the constant drawdown test of Well No. 1 in February 2015 by OPS, approximately 98.5 ft of water level drawdown was observed in this well following the pumping of the well for a continuous period of 9 hours, and at final pumping rate of 5 gpm. This pumping rate is greater than the typical pumping rate (2 gpm) that will be needed from Well No. 1 to meet the average annual onsite groundwater demands (1.59 AF/yr) for the project. Hence, the existing onsite well is clearly capable of meeting the groundwater demands for the proposed Winery project.
- Groundwater recharge at the subject property on a long-term average annual basis is estimated to be 7.6 AF/yr; this value is based on conservative estimates of average annual rainfall at the property and conservative estimates of the percentage of rainfall that deep percolates into the fractured and jointed rocks of the Sonoma Volcanics that underlie the subject property. This average annual recharge volume is higher than the estimated groundwater demand for the subject property of 1.59 AF/yr.
- Estimates of the recharge that may occur during a "prolonged drought" (as defined herein) show that, over a six-year drought period in which only 40% of the average annual rainfall fell, a total of 18.0 AF of rainfall recharge would occur. This "prolonged drought" recharge exceeds the total estimated groundwater demand of 9.5 AF that is necessary for the project over the same six-year drought period.

References

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  Napa County GIS database, 2015. https://gis.napa.ca.gov.

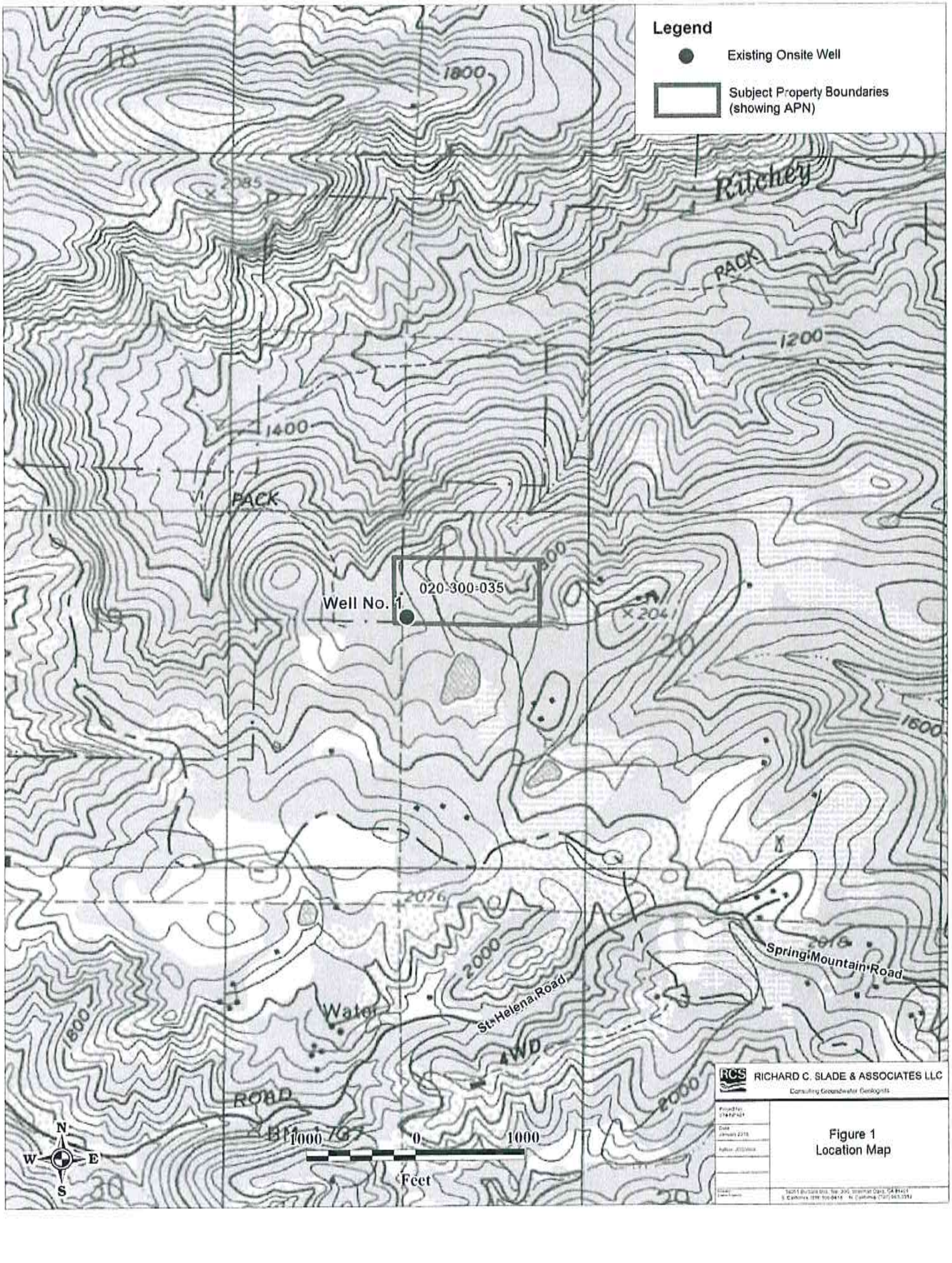
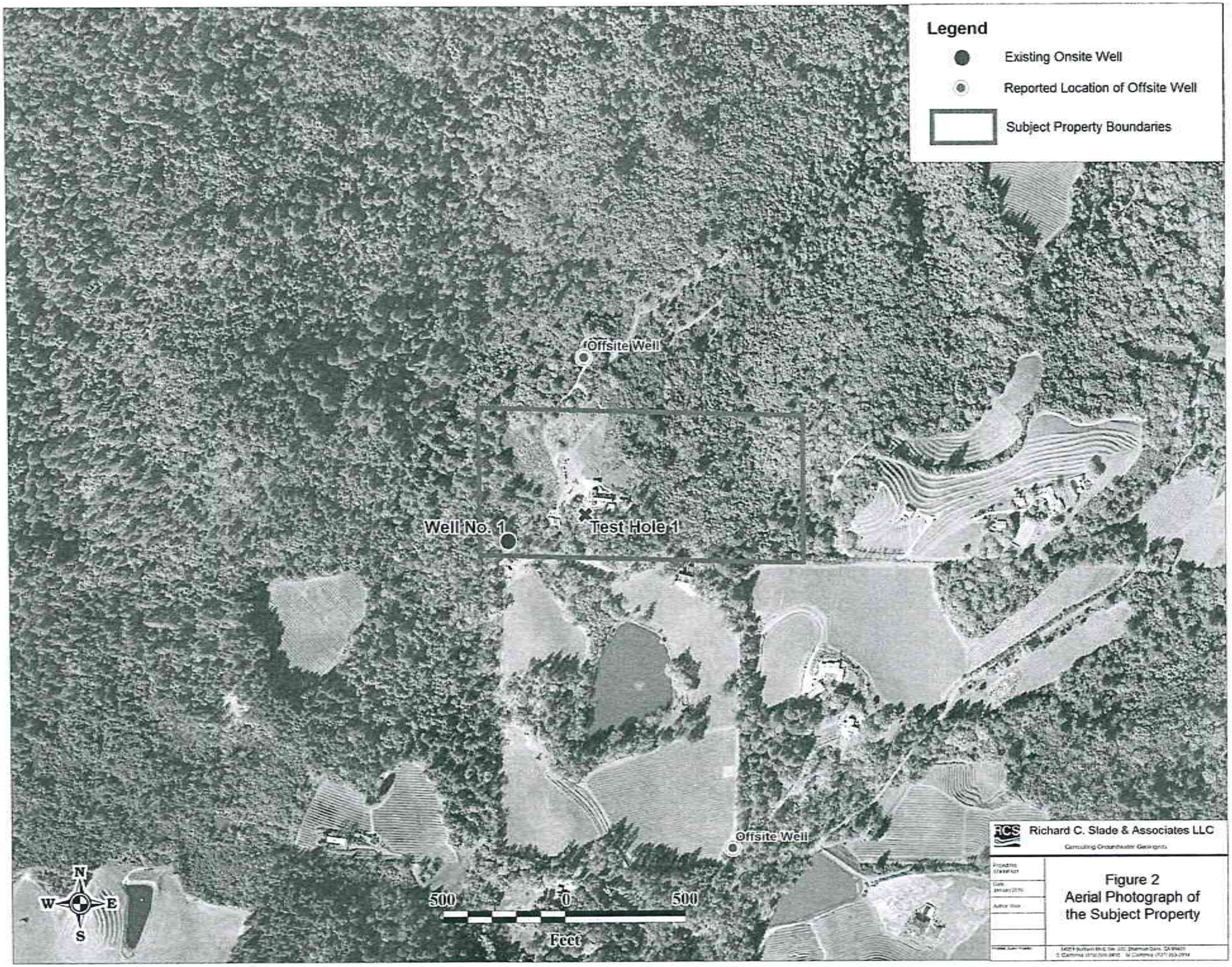


Figure 1
Location Map


Legend
Existing Onsite Well
Reported Location of Offsite Well
Subject Property Boundaries
Offsite Well
Well No. 1
Test Hole 1
Offsite Well
N
W
E
S
500
0
500
Feet
Richard C. Slade & Associates LLC
Figure 2
Aerial Photograph of
the Subject Property

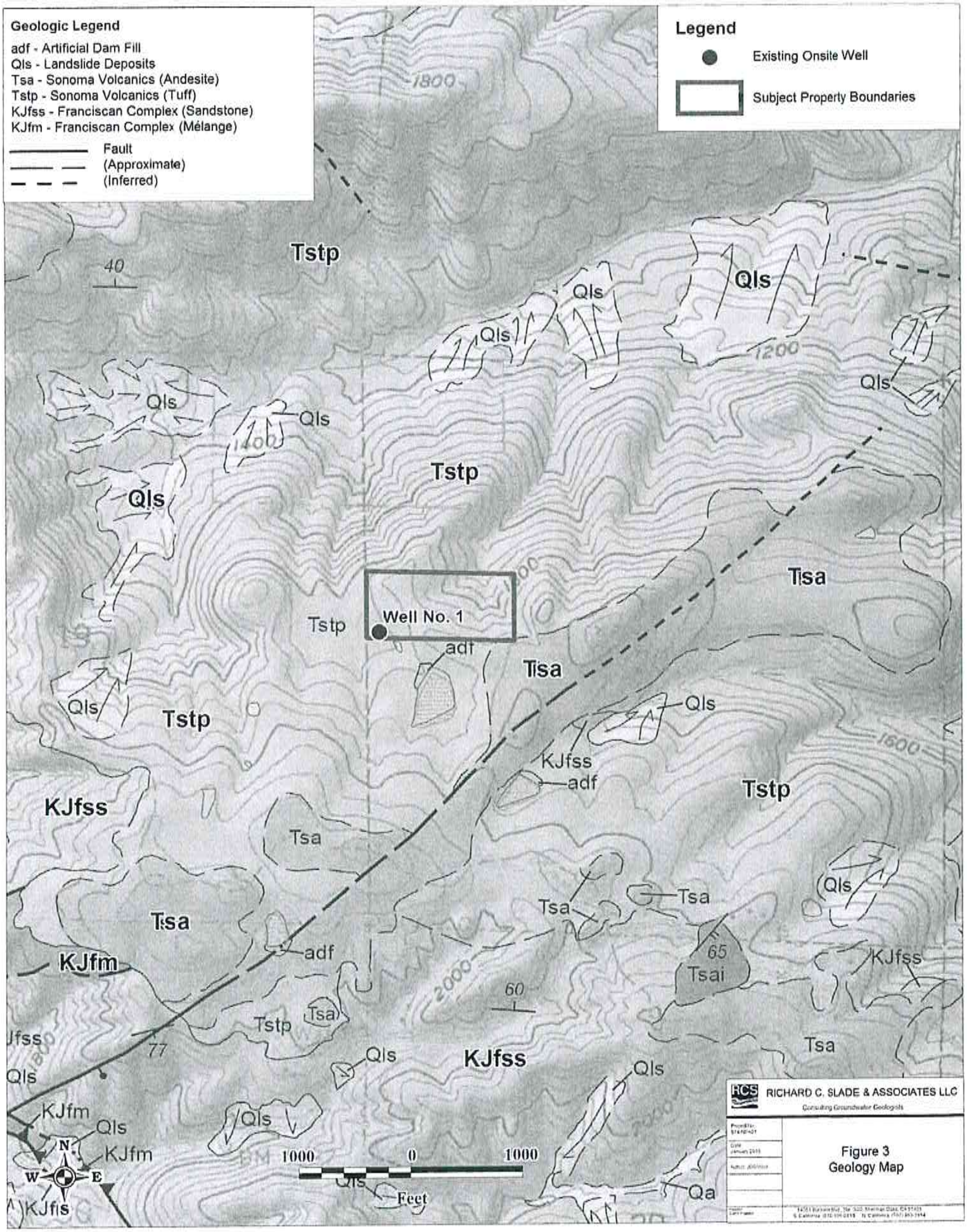
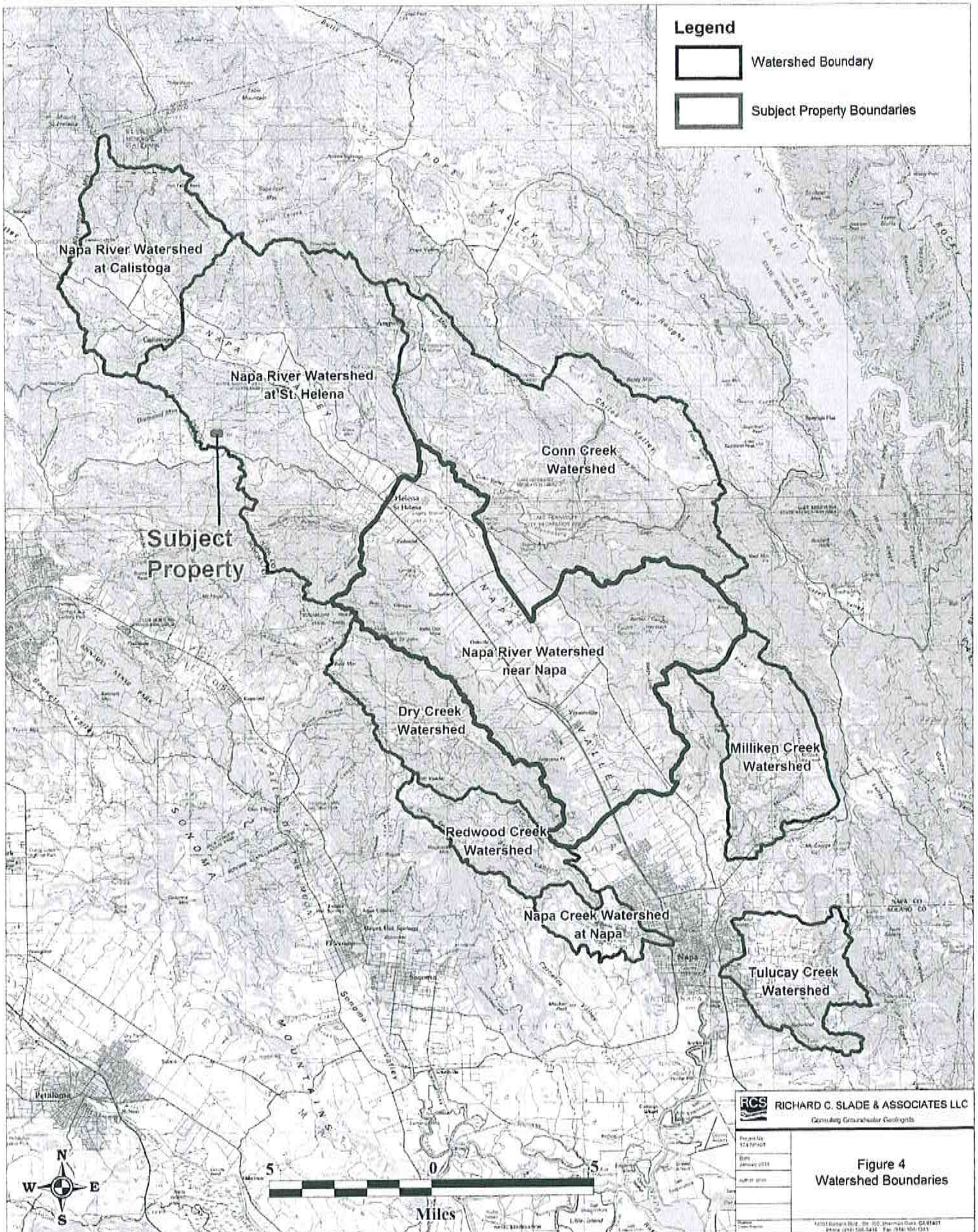
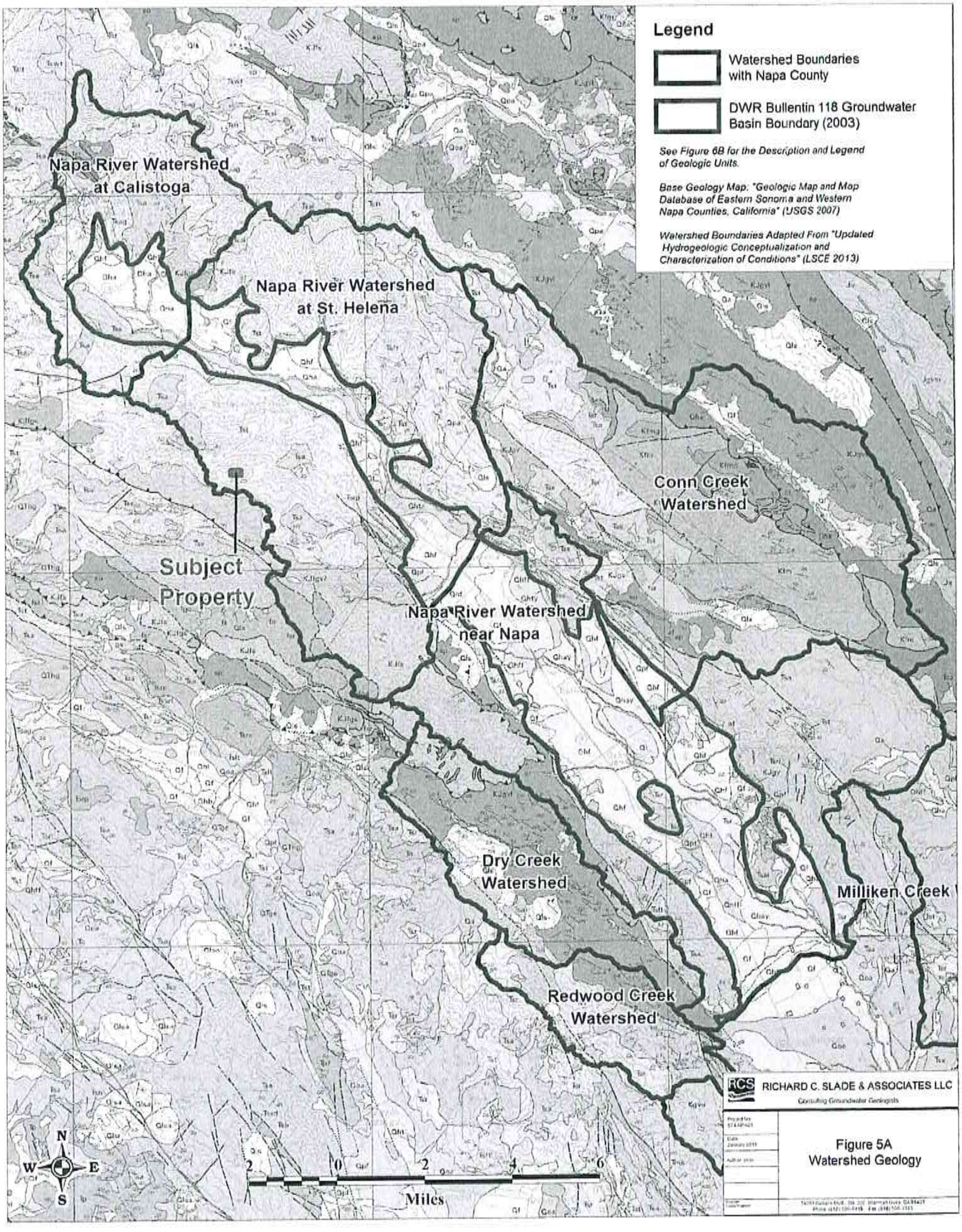


Figure 3
Geology Map



Legend
Watershed Boundary
Subject Property Boundaries
Napa River Watershed at Calistoga
Napa River Watershed at St. Helena
Conn Creek Watershed
Subject Property
Napa River Watershed near Napa
Dry Creek Watershed
Milliken Creek Watershed
Redwood Creek Watershed
Napa Creek Watershed at Napa
Tulucay Creek Watershed
5
0
5
Miles
N
W
E
S
RICHARD C. SLADE & ASSOCIATES LLC
Consulting Groundwater Geologists
Figure 4
Watershed Boundaries


Legend
Watershed Boundaries with Napa County
DWR Bullentin 118 Groundwater Basin Boundary (2003)
See Figure 6B for the Description and Legend of Geologic Units.
Base Geology Map: "Geologic Map and Map Database of Eastern Sonoma and Western Napa Counties, California" (USGS 2007)
Watershed Boundaries Adapted From "Updated Hydrogeologic Conceptualization and Characterization of Conditions" (LSCE 2013)
Napa River Watershed at Calistoga
Napa River Watershed at St. Helena
Conn Creek Watershed
Subject Property
Napa River Watershed near Napa
Dry Creek Watershed
Milliken Creek
Redwood Creek Watershed
N
W
E
S
2
0
2
4
6
Miles
RCS
RICHARD C. SLADE & ASSOCIATES LLC
Consulting Groundwater Geologists
Figure 5A
Watershed Geology

LIST OF MAP UNITS

[Some unit exposures on the map are too small to distinguish the color for unit identification. These units are labeled where possible, and unlabeled units are attributed in the database.]

SURFICIAL DEPOSITS

af	Artificial fill (Historic)
afbm	Artificial fill over Bay mud (Historic)
alf	Artificial levee fill (Historic)
Qhc	Stream channel deposits (late Holocene)
Qhay	Younger alluvium (late Holocene)
Qhty	Terrace deposits (late Holocene)
Qha	Alluvium (Holocene)
Qht	Terrace deposits (Holocene)
Qhf	Alluvial fan deposits (Holocene)
Qhff	Fine-grained alluvial fan deposits (Holocene)
Qhl	Natural levee deposits (Holocene)
Qhb	Basin deposits (Holocene)
Qhbm	Bay mud (Holocene)
Qa	Alluvium (Holocene and late Pleistocene)
Qt	Terrace deposits (Holocene and late Pleistocene)
Qf	Alluvial fan deposits (Holocene and late Pleistocene)
Qls	Landslide deposits (Holocene and late Pleistocene)
Qlsa	Andesitic composition
Qlsr	Rhyolitic composition
Qpa	Alluvium (late Pleistocene)
Qpt	Terrace deposit (late Pleistocene)
Qpf	Alluvial fan deposits (late Pleistocene)
Qoa	Alluvium (late and early Pleistocene)
Qlso	Landslide deposits (late and early Pleistocene)

Clear Lake Volcanics

Qr	Rhyolite (Pleistocene)
QTob	Olivine basalt (Pleistocene and Pliocene)
QTt	Tuff (Pleistocene and(or) Pliocene)
Tr	Rhyolite (Pliocene)
QTc	Cache Formation (Pleistocene and(or) Pliocene)
QTge	Glen Ellen Formation (early Pleistocene? and Pliocene)
QThg	Huichica and Glen Ellen Formations, undivided (early Pleistocene? and Pliocene)

Sonoma Volcanics

Tsv	Sonoma Volcanics, undivided (Pliocene and late Miocene)
Tsr	Rhyolite flows
Tsri	Rhyolite plugs
Tsrs	Soda rhyolite flows
Tsrp	Perlitic rhyolite
Tsrb	Rhyolite breccia
Tsa	Andesite to basalt lava flows
Tsai	Andesite to dacite plugs
Tsb	Basalt flows
Tsbl	Basalt or andesite lava flows and sediments
Tst	Pumiceous ash-flow tuff
Tswt	Welded ash-flow tuff
Tstx	Tuff(?)
Tsag	Agglomerate
Tstb	Tuff breccia
Tstf	Tuff
Tss	Volcanic sand and gravel
Tsd	Diatomite
Twg	Wilson Grove Formation (late Pliocene to late Miocene)
Tc	Sand and gravel of Cotati (Pliocene and late Miocene)
Tp	Petaluma Formation (early Pliocene and late Miocene)
Tdr	Donnell Ranch Volcanics (late Miocene)
Tn	Neroly Sandstone (late Miocene)
Tci	Cierbo Sandstone (late Miocene)
Tbm	Burdell Mountain volcanics (late and middle? Miocene)
Tms	Unnamed sandstone (middle Miocene)
Tkt	Kirker Tuff (early Miocene and(or) Oligocene)
Tu	Unnamed sandstone (Eocene and Paleocene)
Te	Unnamed sandstone (Eocene? or Paleocene?)

GREAT VALLEY COMPLEX

Great Valley sequence

KJgv	Sandstone, shale, and conglomerate (Late Cretaceous to Late Jurassic)
Kgvu	Sandstone, shale, and conglomerate (Late Cretaceous)
Kv	Venado Formation (Late Cretaceous)
KJgvl	Sandstone and shale (Early Cretaceous and Late Jurassic)
KJsp	Sedimentary serpentinite member
Jk	Knoxville Formation (Late Jurassic)
Jsp	Sedimentary serpentinite member
Jgvm	Mélange

Coast Range ophiolite

Jv	Basaltic pillow lava and breccia (Jurassic)
Jmi	Mafic intrusive complex (Jurassic)
Jgb	Gabbro (Jurassic)
sp	Serpentinite (Jurassic)
sc	Silica-carbonate rock
spm	Serpentinite-matrix mélange

FRANCISCAN COMPLEX

fsr	Mélange, including blocks, mapped locally, of:
fsp	Serpentinite
fs	Graywacke
fc	Chert
fgc	Greenstone and chert
fg	Greenstone
fm	High-grade metamorphic rocks
Kfss	Sandstone (Late Cretaceous, Turonian?)
Kfm	Metagraywacke (Late and Early Cretaceous)
Kfmc	Metachert (Late and Early Cretaceous)
Kfmg	Metagreenstone (Late and Early Cretaceous)
KJfs	Graywacke and melange (Early Cretaceous and Late Jurassic)
KJfc	Chert (Cretaceous to Jurassic)
KJfgc	Greenstone and chert (Cretaceous to Jurassic)
KJfgs	Greenstone (Cretaceous to Jurassic)

MAP SYMBOLS

- **Contact**—Depositional or intrusive contact, dashed where approximately located, dotted where concealed
- **Fault**—Dashed where approximately located, small dashes where inferred, dotted where concealed, queried where location is uncertain, orange denotes Quaternary-active fault, magenta denotes Holocene active-fault
- **Reverse or thrust fault**—Dashed where approximately located, small dashes where inferred, dotted where concealed, queried where location is uncertain; sawteeth on upper plate
- **Anticline**—Dashed where approximately located, dotted where concealed
- **Syncline**—Dashed where approximately located, dotted where concealed
- **Strike and dip of bedding**
- **Strike and dip of bedding, top indicator observed**
- **Strike and dip of bedding, approximate**
- **Overturned bedding**
- **Overturned bedding, top indicator observed**
- **Crumpled bedding**
- **Air photo attitude**
- **Vertical bedding**
- **Horizontal bedding**
- **Strike and dip of foliation**
- **Strike and dip of foliation and bedding**
- **Vertical foliation**
- **Strike and dip of joint**

Legend from "Geologic Map and Map Database of Eastern Sonoma and Western Napa Counties, California" (USGS 2007)

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FIGURE 5B
DESCRIPTION AND LEGEND OF GEOLOGIC UNITS

Job No. 574-NPA01

January 2016

Table 1
Water Use Estimate Calculations by ACE

Water Use Type	Estimated Water Use (acre-feet/year)		Remarks
	Existing	Proposed	
Winery Process & Domestic Water Use			
Process	0.215	0.430	Based on 7 gallons of water per gallon of wine[1] at 10,000 gallons (E) and 20,000 gallons (P) max permitted production
Total Winery Process Water Use	**0.215**	**0.430**	
Daily Visitors	0.000	0.108	Based on 32 visitors per day average at 3 gallons per visitor[2]
Events with Catered Meals	0.000	0.007	Based on 4 events per year with 20 guests; 1 event with 60 guests; and 1 event with 300 guests[3]
Employees	0.067	0.118	Based on 4 employees (E) and 7 employees (P) at 15 gallons per day per employee per Napa County WAA Guidelines - Appendix B
Total Winery Non-Process Water Use	**0.067**	**0.233**	
Total Winery Water Use	**0.282**	**0.663**	
Irrigation Water Use			
Landscape at Winery	0.25	0.25	0.1 acre-feet/year per 2,000 sq. ft. of landscape per Napa County WAA - Appendix B
Vineyard	0.18	0.18	0.6± acres of vineyard at 0.3 acre-feet/acre/year
Total Irrigation Water Use	**0.43**	**0.43**	
Residential Domestic Water Use			
Residence	0.50	0.50	Based on Napa County WAA Guidelines - Appendix B
Second Dwelling Unit	0.00	0.00	Based on Napa County WAA Guidelines - Appendix B
Total Residential Domestic Water Use	**0.50**	**0.50**	
Total Combined Water Use	**1.21**	**1.59**	

Notes:

WAA = Water Availibility Analysis

E = Existing; P = Proposed

[1] Napa County Water Availability Analysis Guidelines estimate 7 gallons of water per gallon of wine produced

[2] 3 gallons of water per visitor is based on project wastewater disposal feasibility report Applied Civil Engineering (ACE).

[3] 5 gallons of water per guest is based on project wastewater disposal feasibility report by ACE.

This table has been adapted from "Water Use Estimate Calculations" table provided by ACE.

Table 3
Calculation of Theoretical Rainfall Recharge Percentage
Napa River Watershed At St. Helena

Portion of "Napa River Watershed at St. Helena" (See Figure 5)	Area		Average Rainfall per PRISM Dataset (1980-2010)	Rainfall Volume	Scenario 1		Scenario 2		Scenario 3	
	(sq mi)	(acres)	(in)	(AF)	Deep Percolation Percentage (%)	Deep Percolation Volume (AF)	Deep Percolation Percentage (%)	Deep Percolation Volume (AF)	Deep Percolation Percentage (%)	Deep Percolation Volume (AF)
Valley Floor Portion of Watershed	14.8	9,472	38.5	30,389	20%	6,078	25%	7,597	30%	9,117
Hillside Area Portion of Watershed	64.8	41,472	42.4	146,534	13%	18,706	12%	17,187	11%	15,667
Entire Watershed	79.6	50,944	41.7	177,030	14%	24,784	14%	24,784	14%	24,784

Table 4
Drought Period Rainfall as Percentage of Average

Statewide Drought Period as Defined by DWR (DWR 2005)	Drought Duration (years)	Calistoga Raingage, WRCC Period of Record - WY 1944-45 through WY 2014-15			St. Helena 4WSW Raingage, CDEC Period of Record - WY 1985-86 through WY 2014-15		
		[D] Total Gage Average (in)	[E] Drought Period Ave. (in)	[E÷D] Drought Period Rainfall as % of Average	[G] Total Gage Average (in)	[H] Drought Period Ave. (in)	[H÷G] Drought Period Rainfall as % of Average
WY 1928-29 to WY 1933-34	6	ND	ND	ND	ND	ND	ND
WY 1975-76 to WY 1976-77	2	37.4	15.1	40%	ND	ND	ND
WY 1986-87 to WY 1991-92	6	37.4	28.1	75%	ND	ND	ND
WY 2006-07 to WY 2008-09	3	37.4	26.6	71%	41.5	30.9	74%
WY 2011-12 to WY 2014-15	4*	39.4	32.2	82%	41.5	33.1	80%

* Drought could potentially continue into WY 2015-16; the duration of the current drought is unknown.

ND = Rainfall data are missing for the corresponding drought period.