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Water Availability Analysis

Hard Six Cellars Winery P16-00333 & Use Permit Exception to
Conservation Regulations P19-00315
Planning Commission Hearing October 16, 2019

MEMORANDUM

February 9, 2017

To: Ms. Donna Oldford
Plans 4 Wine
Sent via email (dboldford@aol.com)

cc: Mr. and Mrs. Wayne and Kara Fingerman
Via email (wfingerman44@gmail.com; karafinger@gmail.com)

Job No. 635-NPA01

From: Sean Bowen, Anthony Hicke and Richard C. Slade
Richard C. Slade & Associates LLC (RCS)

Re: Results of Napa County Tier 1 Water Availability Analysis
For Hard Six Cellars
Napa County APN 020-100-014
1755 S. Fork Diamond Mountain Rd
Calistoga, Napa County, California

Introduction

Provided herein are the key findings, conclusions, and preliminary recommendations regarding our Water Availability Analysis, in conformance with Napa County Tier 1 requirements, for your proposed project in Napa County, California. The property, known herein as the "subject property", is located at 1755 South Fork Diamond Mountain Road in the Calistoga area of Napa County. Figure 1, “Well Location Map,” shows the boundary of the subject property superimposed on the local USGS topographic map for the Calistoga quadrangle, along with the locations of two existing onsite water wells. Property boundaries shown on Figure 1 were adapted from assessor's parcel data that are freely available from Napa County on the Napa County GIS website. Figure 2, “Aerial Photograph Map,” shows the same property boundaries and locations of the onsite wells on an aerial photograph of the area; this aerial photograph was also obtained directly from the Napa County GIS website (the date of the imagery is August 2007).

Currently, the 53.6-acre subject property is currently occupied by a residence and four acres of vineyards. We understand that the proposed project includes the development of a new winery with a proposed production of 20,000 gallons of wine per year. Two water wells currently exist at the property as shown on Figure 1. As reported by Delta Consulting & Engineering (Delta), one of these two wells is planned to be permanently destroyed (the “Inactive Well”), whereas the other well will reportedly be used to meet the future groundwater demands at the subject property (the “Primary Well”). These future onsite water demands reportedly include those for the winery operations, the onsite residence and the existing onsite vineyards.

As part of the permit submittal for the proposed new vineyard development, a Water Availability Analysis (WAA) is required by the County. Hence, the purpose of this Memorandum is to comply with Napa County's WAA guidelines, which were promulgated by the County in May 2015. Specifically, this Memorandum reflects a "Tier 1" WAA, but does not include analyses consistent with a "Tier 2" WAA. This is because there are no offsite wells located within 500 ft of the active onsite well proposed to be used for the project; Figure 1 shows the location of the nearest reported offsite well. Hence, a "Tier 2" WAA has been presumptively met.

Scope of Services

Based on our revised proposal to you dated October 21, 2016, our scope of services for this County Tier 1 Water Availability Analysis (Groundwater Recharge Estimate) included the following tasks:

Task 1 – Collect and Review Available Data

Task 2 – Site Meeting and Field Reconnaissance

Task 3 – Data Analysis and Prepare Memorandum

This current Memorandum represents the culmination of our Task 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 visit to the subject property on November 17, 2016, the following key items were noted and/or observed (refer to Figures 1 and 2):

a. The single-parcel property has a County Assessor's Parcel Number (APN) of 020-100-014; the total assessed acreage of the subject property is approximately 53.6 acres.

b. Topographically, the subject property is situated between Diamond Mountain and Napa Valley. Drainage from the property is variable, as there are many small peaks on the property, and various portions of the property drain in different directions. Much of the property appears to drain toward the pond located in the center of the property. The pond has the ability to overflow to the east if the water level in the pond becomes high enough. The pond is filled naturally, and is not filled using onsite groundwater.

c. The subject property is currently occupied by a single-family (primary) residence which is located in the northern portion of the property; a pool also exists adjacent to the primary residence.

d. Approximately four acres of vineyards currently exist onsite. The remaining portions of the property were observed to be generally undeveloped and covered by native brush, trees and grasses.

e. Two water wells (known herein as the "Primary Well" and "Inactive Well") were observed on the subject property. As shown on Figures 1 and 2, these wells are located in the west-central portion of the property. Currently, the Primary Well reportedly supplies all domestic and vineyard irrigation needs for the property. The Inactive Well is unused and slated for destruction. It is unknown how long the Inactive Well has been out of service. The Primary Well will reportedly be used to meet the future groundwater demands of the entire property.

f. The offsite areas surrounding the subject property consist primarily of existing residences and naturally vegetated and/or wooded hillsides; a few small vineyards exist on adjacent properties to the north, east, and west.

g. Only one offsite well owned by others was directly observed by the RCS geologist during our November 2016 site visit. Figures 1 and 2 show that this offsite well lies ±900 to 1,000 ft east of the nearest onsite well. Thus, as shown on Figure 1, no offsite wells are known to exist within 500 ft of the existing onsite wells.

Key Construction Data for Existing Onsite Well

A California Department of Water Resources (DWR) "Well Completion Report" (also known as a driller's log) was provided to RCS for the Primary Well. The driller's log (listed as Log No. 049670 for the Primary Well) was provided by the Napa County Environmental Health Division at the request of RCS Geologist; a copy of this log is attached hereto. No well construction data are available for the Inactive Well, because no driller's log is available for this well.

Key data listed on the driller's log for the Primary Well include:

a. It was constructed in December 2006 by Weeks Drilling and Pump Company (Weeks), of Sebastopol, California using the mud rotary drilling method.

b. Well casing used to construct the well was PVC having a nominal diameter of 5 inches; the total casing depth is 400 ft bgs.

c. Casing perforations are machine-cut slots and have slot opening widths of 0.032 inches (32-slot); the perforations were placed between the depths of 160 to 200 ft, 220 to 300 ft and 320 to 400 ft bgs. Therefore, there is no cellar casing in the bottom of this well; instead, the perforations extend to the bottom of the well casing.

d. The gravel pack material listed on the driller's log for the Primary Well is described as "1/8 x 1/4 sand" and was emplaced from 25 ft to 400 ft bgs.

e. The Primary Well was constructed with a sanitary seal consisting of cement (grout) to a depth of 18 ft bgs, and it is underlain by bentonite from 18 ft bgs to a depth of 25 ft bgs. Hence, the total sanitary seal depth for the well is 25 ft.

Summary of Key Well "Test" Data

The driller's log for the Primary Well provides a brief listing of the original, post-construction airlift data, as follows:

- An initial static water level (SWL) following completion of well construction was reported to be 174 ft bgs.
- Flow rates during initial post-construction airlifting were reported to be 27 gallons per minute (gpm) after a period of 4.5 hours of airlifting. As a rule of thumb, RCS

geologists estimate normal operational pumping rates for a new well equipped with a permanent pump are typically on the order of only about one-half the airlifting rate reported on a driller's log.

- The "water level drawdown" amount was listed as 397 feet on the driller's logs. However form our experience, this is not an actual water level drawdown measurement, but actually the depth to the bottom of the airline during airlifting; drawdown cannot be measured during airlifting operations. , Therefore, the original post-construction specific capacity (SC) values for these wells cannot be calculated from the data on the driller's logs. 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 at that rate.

On February 25, 2015, a short-term constant-drawdown pumping test of the Primary Well was conducted by Weeks; data for that test were provided by the property owner. Key data available from that "Test Pump Log" report by Weeks are summarized below[1]:

- A static water level of 224 below the wellhead reference point (brp) was recorded by the pumper before pumping began; this static water level is deeper than the 174-foot depth to the water level measurement reported for the well following its construction in 2006. Insufficient water level data exist to determine if this decline is related to the recent drought conditions, or other factors.
- Pumping began at a rate of 18.5 gpm. Following 40 minutes of pumping, the pump was "throttled back" to help stabilize the pumping water level in the well.
- After a period of 2 hours of pumping, the pumping rate was reported to be stable at 15 gpm. A maximum pumping water level (PWL) was measured at depth of 250 feet.
- The well was pumped for a total period of 3 hours.
- It is noteworthy that the "Test Pump Log" shows the depth of the well to be 300 feet. This is 100 feet shallower than what is listed on the driller's log for this well. No data are available to explain the discrepancy between the two documents.

Well Data from Site Visit

As discussed above, a field reconnaissance of the subject property was performed by an RCS geologist on November 17, 2016. The following information for the onsite wells was gleaned from this site visit:

- Primary Well – This well was observed to be equipped with a permanent pump, and was not pumping at the time of our visit. A SWL of 229 ft brp was measured by the RCS geologist during the visit; the reference point for this measurement is approximately 1.33 ft above ground surface (ags). There was no totalizer flowmeter device on the discharge piping, and the well was not pumping; thus, a current pumping rate of the well could not be determined during our site visit.

[1] Note that it is not clear from the data provided by Weeks whether or not the measurements are reported in feet bgs, or feet below the wellhead reference point (ft brp). Hence, we will assume ft brp for the Weeks measurements.

- Inactive Well – This well is no longer connected to a power source or discharge piping, but it appears that the pump column, and presumably the pump, are still installed inside the casing. A SWL of 139.1 ft brp was measured by the RCS geologist during the November 2016 site visit; the reference point was measured to be approximately 1 ft ags. No totalizer flowmeter device was equipped on the discharge piping.

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.; Gutierrez, C.). Key earth materials mapped at ground surface in the area, as shown on Figure 3 include, from geologically youngest to oldest, the following:

a. Alluvial-type deposits. These deposits consist of the following: undifferentiated and/or undivided alluvial fan, stream channel, and/or stream terrace materials (map symbols Qhf, Qa, and Qf. on Figure 3). These deposits are generally unconsolidated, and consist of layers and lenses of sand, gravel, silt, and clay. These geologic materials do not occur at or below ground surface at the subject property, but are shown to exist only in canyon areas to the north and northeast of the subject property.

b. Landslide and debris flow deposits (map symbol Qls and Qodf, respectively). Six small landslides were mapped in the region by others (see the yellow colored area on Figure 3). Arrows within this mapped landslide area show the general direction of ground surface movement with this slide. No landslides have been mapped on the subject property.

c. Sonoma Volcanics (map symbols Tsa, Tstp, and Tsrc). The Sonoma Volcanics, as mapped by others, occur as ground surface exposures throughout most of the area shown on Figure 3, including the entirety of the subject property. As shown on Figure 3, rhyolitic flows and domes (map symbol Tsrc) represent the types of volcanic rocks exposed at ground surface at the subject property. The Tuff of the Petrified Forest (map symbol Tstp) is comprised of silicic tuff and tuff breccia, and these materials are mapped at ground surface in areas are shown to exist in the region at ground surface southwest of the subject property; this material does not occur at ground surface within the boundaries of the subject property.

   Review of the driller's descriptions of drill cuttings listed on the available log for the Primary Well revealed that the drilling of this well encountered typical rocks of the Sonoma Volcanics throughout the total drilled borehole. Typical driller-terminology for the drill cuttings on the driller's logs included: "tan and brown clayey volcanics;" "brown rock and ash;" "hard gray rock;" "multi-colored rock and ash;" "red and black volcanics;" "multicolored volcanics;" "gray clayey ash;" "gray and white volcanics and ash;" Therefore, based on the driller's logs, the Sonoma Volcanics are interpreted by RCS geologists to extend to a minimum depth of 400 ft bgs (in the vicinity of the

Primary Well. It is very likely that the volcanic rocks extend to even deeper depths beneath the property.

d. Bedrock. Underlying the volcanic rocks at even greater depths beneath the subject property, but not exposed at ground surface anywhere in the area mapped on Figure 3 are geologically older, well consolidated to cemented rocks of the Franciscan Complex. Principal rock types in these geologically older Franciscan Complex rocks are thick-bedded sandstone, pebble conglomerate, siltstone and shale. These geologically older rocks are considered to underlie the Sonoma Volcanics beneath the property, and are considered to represent the local bedrock.

   Again, based solely on RCS interpretations of the driller's descriptions of the drill cuttings listed on the available driller's logs for the onsite wells, and based on RCS's experience in the area, these fine-grained geologic bedrock materials are interpreted to occur at some unknown depth below the drilled depths of the onsite wells.

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 flow rocks and volcanic tuff breccias 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 flow breccias deposits following their deposition, and also from mountain building or tectonic processes (faulting and folding) that have occurred over time in the region 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 in between individual grains of volcanic ash and breccia in the tuff deposits.

The amount of groundwater available at a particular drill site for a new well in such hard volcanic flow rocks beneath the subject property would depend on such factors as:

- the number, frequency, size and degree of openness of the fractures/joints in the subsurface;
- the degree of interconnection of the various fracture/joint systems in the subsurface;
- the extent to which the fractures may have been filled over time by chemicals precipitates/deposits and/or weathering products (clay, etc);
- the amount of recharge from local rainfall that becomes available for deep percolation to the fracture systems; and

- to a lesser extent, the size of the pore spaces formed by the grain-to-grain interaction of volcanic ash particles.

As stated above, the principal rock types exposed at ground surface on the property and also expected in the subsurface to a depth of at least 400 ft beneath the property are a combination of hard, volcanic flows of andesitic composition and tuff breccias that appear to be fractured to varying degrees (Figure 3, map symbol Tsrc and possibly Tstp). Descriptions of drill cuttings by the well driller that are recorded on the available driller's logs for the onsite wells are consistent with typical descriptions of Sonoma Volcanic rocks. From our long-term experience with the harder flow rocks for numerous other water well construction projects in Napa County, pumping capacities in individual wells have ranged widely, from rates as low as 5 to 10 gpm, to rates as high as 200 gpm, or more. Any finer-grained, clay-rich, ash deposits tend to have a lower permeability and a potential to yield lower rates of groundwater to a new well.

Potentially Nonwater-Bearing Rocks

This category includes all geologically older and fine-grained, well-consolidated, sedimentary and/or crystalline rocks of the Franciscan Complex. These rocks would underlie the volcanic rocks that exist beneath the subject property and that are also exposed directly at ground surface in different directions and at different distances from the subject property. These potentially nonwater-bearing rocks are also interpreted to directly underlie the Sonoma Volcanics at depths greater than 400 ft bgs, as interpreted by RCS from information available on the driller's logs for the Primary Well.

In essence, these diverse rocks that are well-cemented and well-lithified, have an overall low permeability. Occasionally, localized conditions can allow for small quantities of groundwater to exist in these rocks wherever they may be sufficiently fractured. However, 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

Two unnamed, northwest-southeast trending faults, as mapped by others, are shown on Figure 3. One of these faults is located just southwest of the subject property, and traverses roughly parallel to the southwestern property boundary. The possible impacts of these faults on groundwater availability in the region are unknown due to an absence of requisite data necessary to make that determination (such as, for example, water level data from multiple wells on both sides of the faults). These faults could serve to increase the amount of frequency of fracturing in the local volcanic rocks. If such fractures occurred, it would tend to increase the amount of open area in the rock fractures which, in turn, could increase the ability of the local volcanic rocks to store groundwater. It is unknown if these faults are barriers to groundwater flow.

Please note: 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 Project Groundwater Demands by Others

Groundwater demand estimates for the subject property were provided to RCS by Delta, with the exception of the Landscape Water demand estimate, which was prepared by Wendt

Landscape Architecture. As shown in the documents received from others, the proposed (future) water demands for the project are as follows:

a. Residential Water Use = 0.26 acre feet per year (AF/yr)
    a. These demands are based on the existing water use at the property for the onsite three bedroom residence.
b. Vineyard Irrigation Demand for four acres of existing vines = 0.79 AF/yr
    - Delta reportedly received the estimate of future groundwater use for the property from the onsite vineyard manager.
c. Winery Domestic Water Use = 0.14 AF/yr
    - This water use includes potable supply for winery visitors, employees, and event guests.
d. Winery Process Water Use = 0.49 AF/yr
    - This demand reflects a total annual production of 20,000 gallons of wine per year.
e. Landscape Irrigation Water Use = 0.16 AF/yr.
f. Total proposed groundwater demand for project
    a. a + b + c + d + e = 1.86 AF/yr
    - Note that 1 AF = 325,851 gallons

As discussed above, all of the existing onsite water demands are currently met by pumping groundwater from the existing Primary Well.

To determine an appropriate estimated peak combined pumping rate from the onsite well, it will be conservatively assumed that all future water demands at the subject property (irrigation, winery process, and domestic demands) will be required during the 16-week vineyard irrigation season. In reality, domestic use water demands (including both the winery and the onsite residence) will be required year-round (365 days/year), and all landscape and vineyard irrigation water demands will be required during a 16-week to 20-week (or longer) irrigation season each year. Therefore, assuming that the entire project water demand will occur during a 16-week season represents a conservative approach.

Hence, in order to meet the future groundwater demands of the project, the onsite wells would need to pump at a rate of approximately 7.5 gpm to meet the average annual demand of 1.86 AF for all existing and proposed water demands in the future. This pumping rate assumes that the well(s) would be pumped at a 50% operational basis, that is, 12 hours/day, 7 days/week, during the entire, assumed 16-week irrigation season each year. During the non-irrigation portions of the year, the peak pumping rate required of the onsite well would be much less. Hence, based on the reported pumping rate for the Primary Well of 15 gpm by Weeks in February 2015, it appears that this well is more than capable of meeting this instantaneous groundwater flow demand.

Rainfall

Long-term rainfall data for the subject property are essential for estimating the average annual groundwater recharge that may occur at the subject property. Average annual rainfall totals specifically at the subject property are not directly known, because no onsite rain gage exists. However, the nearest rain gage exists approximately 3 miles northwest of the subject property, in the hills west of Calistoga. Data for this gage are available from the Napa One Rain website (https://napa.onerain.com/), maintained by Napa County, and the gage is named “Petrified Forest.” Data from the Napa One Rain website for this gage are available for water year (WY) 2000-01 (October 2000 – September 2001) through WY 2015-16. The average annual rainfall for WY 2000-01 through WY 2015-16 at this gage is calculated to be 38.1 inches (3.18 ft). This rain gage is located at a similar elevation (1,090 ft above sea level, asl) than that of the subject property (between ±1,090 ft and ±1,450 ft asl), and therefore the average annual rainfall at the subject property is likely to be similar to that experienced at this known gage location. However, the data record for this rain gage is relatively short (only 16 years in duration), and therefore these data may not be representative of the long-term annual average rainfall in the area surrounding the subject property.

Another rain gage with publicly available data exists approximately 4 miles south of the subject property, in the hills west of St. Helena. Data for this gage are available from the California Data Exchange Center (CDEC) website (http://cdec.water.ca.gov/), maintained by the California Department of Water Resources (DWR), and the gage is named “St. Helena 4WSW.” Data from the CDEC website shows data beginning in 1984, but WY 1984-85 appears to missing several days and/or months of rainfall data. Also, there appears to be erroneous and/or missing data in four other years in the data set (WY 1986-87 through 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 41.7 inches (3.48 ft) is calculated from this CDEC rain gage. This rain gage is located at a higher elevation (1,730 ft asl) than that of the subject property, and therefore the average annual rainfall at the subject property is likely to be lower than that experiences at this known gage location.

The nearest rain gage to the subject property with a significantly longer data record is the rain gage located in Calistoga (approximately 3 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). For this rain gage, the period of record is listed as March 1906 through December 2016. Note that there are several months and/or years of rainfall data missing between 1914 and 1931, and between 1934 and 1943. For the available period of record, the average annual rainfall (mean rainfall) at this Calistoga gage is reported to be 36.4 inches (3.03 ft), as calculated by the WRCC. This rainfall gage, however, is located at a lower elevation (410 ft asl) than the subject property, and therefore, the total rainfall at the subject property would be greater than that experienced at this Calistoga gage location.

To help confirm the average annual rainfall data derived from the Napa One Rain, CDEC and/or WRCC gages, RCS 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 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 date range is approximately 42.4 inches (3.53 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. As 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 is difficult to discern. The subject property is located within the boundaries of the 45-inch rainfall contour on the map. Based on our interpretation of the actual isohyetal contour map (not provided herein), the long-term average annual rainfall at the subject property is likely on the order of 50 inches (4.17 ft).

Table 1, “Comparison of Rainfall Data Sources,” shows a comparison of the data collected from the different rainfall sources discussed above. Based on the various rainfall data sources described in Table 1, RCS will conservatively assume that the long-term average annual rainfall at the subject property is 36.4 inches (3.03 ft), even though the other available datasets presented above with somewhat similar elevations compare to the subject property indicate that a higher average annual rainfall may have occurred at the subject property. The 36.4-inch per year estimate is based on the data source (WRCC) with the longest period of record (±110 years) of any of the rainfall data sources listed above.

Estimates of Groundwater Recharge

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 fractured volcanic rock 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 type that exists 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, and by other consultants and government agencies for other properties.

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 (MBK) via email. Figure 4, “Watershed Boundaries,” was prepared for this project using those watershed boundaries. As shown on Figure 4, the subject property is located within the watershed referred to by MBK as

"Napa River Watershed 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. Note that, as shown on Table 8-9 of LSCE&MBK (2013), calculations for the "Napa River Watershed at St. Helena" are part of a number of other smaller "up-river" watersheds that are tributary to the Napa River Watershed near Napa.

As stated above, the ground surface area of the subject property is 53.6 acres. Assuming a conservative amount of 36.4 inches (3.03 ft) of rain falls onto the property on a long-term average annual basis, then the total volume of rainfall available each year for deep percolation over the long term is approximately 162.4 AF (53.6 acres x 3.03 ft). Assuming 14% of the average annual rainfall could deep percolate to the groundwater beneath the subject property, the average annual groundwater recharge at the subject property would be approximately 22.7 AF/yr.

It is possible that a 14% deep percolation factor is not appropriate for the Sonoma Volcanics in the area of the subject property. Recharge estimates that have been regularly used by others for the Sonoma Volcanics in different watersheds throughout Napa County range from a quite conservative estimate of 7% to perhaps 14% or so. RCS has typically assigned a deep percolation estimate of 9% to 10%, to as high as 14% for the Sonoma Volcanics. Those 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 hillside properties underlain by the Sonoma Volcanics.

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 superimposed on a geologic base map of the region (USGS 2007); Figure 5B shows the geologic legend for that map. Importantly, a red-brown line is shown on the map to denote/separate the alluvial deposits of the Napa Valley from the hillside areas on both sides of the valley; this red-brown line is adapted from DWR Bulletin 118-03 (DWR 2003). The areas within that red-brown line along the floor of Napa Valley represent the Napa Valley subbasin of the Napa-Sonoma Valley Groundwater Basin, as defined by DWR (Bulletin 118, Update 2013).

As discussed above, the referenced report (LSCE&MBK 2013) estimated that 17% of the average annual rain that falls within the "Napa River Watershed near St. Helena" is available to deep percolate to recharge the groundwater. The watershed includes more porous alluvial-type aquifers as well as hard, fractured volcanic rock aquifer systems. It is likely that, in reality, the percentage of rainfall that deep percolates into the alluvial deposits that lie along the floor of the Napa Valley 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 Napa County hillsides are composed of either volcanic rocks, or geologically much older, well-cemented sandstones and siltstones). The total area within the red-brown colored groundwater subbasin boundary shown on Figure 5A contains roughly 14.8 square miles (sq mi); this area is the "alluvial area" of the watershed. The remainder of the "Napa River Watershed at St. Helena" watershed area that is not underlain by the red-brown colored 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% or higher[2] (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 both of the areas must be determined. This can be accomplished using a GIS software package and the PRISM dataset. Because the PRISM dataset is distributed for equal-sized areas throughout the County, then the average rainfall can be calculated for the size or shape of any area within the County. Using the PRISM data set, and the assumptions stated above, Table 2, "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 2, 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 (i.e., alluvial sediments) of the Napa Valley are adjusted to values higher than 14%. The results of the three scenarios shown on Table 2 are as follows:

- Scenario 1 assumes a valley floor deep percolation percentage of 20%, and a resultant deep percolation percentage for the hill and mountain areas of the watershed would be 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 hillside areas of the watershed) would be 12%.
- A deep percolation percentage in the alluvium of 30% for Scenario 3 would yield a deep percolation percentage for the hill and mountain areas of 11%.

Therefore, based on the analyses presented in Table 2, and to be conservative, a value of 11% (from Scenario 3) may be an appropriate assumption for the percentage of rainfall that may be able to deep percolate to recharge the groundwater beneath the subject property. Assuming a deep percolation of 11%, a surface area of the subject property of 53.6 acres, and a long-term average annual rainfall total of 36.4 inches (3.03 ft), then the average annual groundwater recharge at the subject property is estimated to be 17.9 AF/yr.

Possible Effects of "Prolonged Drought"

California is currently experiencing a period of prolonged drought. Here, drought is defined as a meteorological drought, that is, a period in which the total annual precipitation is less than the long-term average annual precipitation (DWR 2015). For similar projects in the County, Napa County Planning, Building and Environmental Services Department (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, assuming the project were to operate in the future as described herein. Recharge volumes estimated in this Memorandum are based on the long-term average rainfall value determined for the subject property using available data. Recall

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[2] The purpose of this assumption is to help determine a more conservative deep percolation percentage for the Sonoma Volcanics onsite. The alluvial sediments are estimated to be generally more permeable than the Sonoma Volcanics. In the 2013 LSCE&MBK, the statement is made on page 5 that "The high permeability of the alluvial sediments permits precipitation and surface water to readily infiltrate and recharge groundwater throughout the majority of the Valley." Further, Figure 6-1 therein (LSCE&MBK 2013) shows the "Napa Valley Alluvium" on the Valley Floor is shown as a "unit of greatest recharge potential." In addition, while not directly related to recharge percentage estimates, the relative permeability of the alluvium is greater than that of the Sonoma Volcanics. Specific yield values for alluvial sediments in the Napa-Sonoma Valleys are estimated to be as high as 25% (Kunkel and Upson, 1960), whereas values assigned to the Sonoma Volcanics for similar studies are typically as 10%.

that a calculation of average annual rainfall for any long-term period 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
- Recent drought – WY 2011-12 through WY 2015-16[3] – five years

Table 3, "Drought Period Rainfall as Percentage of Average," shows the average amount of rainfall that occurred during each drought period for which rainfall data exist at the three rain gages discussed above and shown on Table 1; that drought period rainfall amount is also expressed on Table 3 as a percentage of the total rainfall that fell. As shown on Table 3, 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 rain gage and reported by the WRCC had the lowest total rainfall at 41%, compared to the long-term average, and it lasted for two years. The WY 1986-87 to WY 1991-92 drought period lasted for six years, but rainfall during this drought was 72% of the average annual rainfall at the Calistoga rain gage. It is important to note that the drought year percentage listed on Table 3 is completely dependent on the period of record for each individual gage. An example of this is the Napa One Rain gage data; because the period of record for this gage is short, and includes many drought years, then the last available drought year period rainfall percentage is shown to be 84% of the long-term average.

Hence, for the purposes of this Memorandum, we will conservatively consider a "prolonged" drought period rainfall to be 41% of the average annual rainfall that occurred (using the data from the Calistoga WRCC rain gage). Further, to again be conservative, we will estimate a "prolonged drought period" to last 6 years, which is the longest drought period on record according to DWR (DWR 2015); see Table 3. This six-year period is a conservative estimate, because the 41%-average figure corresponds with a two-year drought period, not a six-year drought period.

To meet six years of groundwater demand at the subject project, a total onsite groundwater extraction of 11.2 AF is estimated to be needed (1.86 AF/yr times 6 years). Assuming

[3] The DWR 2015 drought document was published in February 2015, and lists the current drought through the 2013-14 water year only; the drought continued throughout the state into the 2015-16 water year. Due to the recent rains in late-2016 and early-2107, various sources, including the National Drought Mitigation Center website (NDMC 2017), have declared an end to the drought in Northern California, which would include Napa County.

groundwater recharge is reduced to 41% of the average annual recharge during such a theoretical "prolonged drought period", then a total of approximately 46.2 AF of groundwater recharge might occur during the entire six-year drought period, as calculated below:

- From page 12, the average annual groundwater recharge at the subject property is estimated to be 17.9 AF/yr. Taking 41% of this annual volume yields a drought period recharge volume of 7.3 AF/yr.
- Assuming a drought period duration of 6 years, then 43.8 AF (7.3 AF/yr times 6 years) 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 theoretical six-year drought period during which only 41% of the average annual rainfall might occur, a conservative estimate of the total drought-period recharge at the subject property (43.8 AF) would still exceed the estimate of the total groundwater demand (11.2 AF) that may occur over the same six-year drought period.

Key Conclusions and Recommendations

1. The existing property is currently occupied by a single-family residence and four acres of exiting vineyards. The remaining portions of the property were observed to be generally undeveloped and covered by native brush, trees and grasses. Existing water demands for the property are currently met by pumping groundwater from the Primary Well.
2. The future annual groundwater demand for the entire parcel (including the proposed Winery) has been estimated by the project Engineer, Landscape Architect and the onsite vineyard manager to be 1.86 AF/yr.
3. All future water demands at the subject property will be met my pumping groundwater from the Primary Well. To meet the average annual groundwater demands of the proposed project (1.86 AF/yr), the onsite well would need to pump at an operational rate of 15 gpm. This pumping rate assumes the well would be pumped on a 50% operational basis (pumping 11 hours per day, every day) throughout the entire 16-week irrigations season each year. During the non-irrigation portions of the year, the combined pumping rate to meet the onsite demands (i.e., residential demands) would be much lower.
4. In February 2015, Weeks reported that the Primary Well was equipped with a pump having an operational pumping rate of 15 gpm. This operational rate is higher than the pumping rate (7.5 gpm) that is estimated herein to be needed from this well to meet the average annual onsite groundwater; this pumping rate assumes that all groundwater demands will be pumped from the well on a 50% operational pumping basis during a 16-week irrigation period each year. In reality, the groundwater demand for domestic and winery processes will be met throughout the year, and therefore, the 7.5 gpm pumping rate calculated herein is conservative. Hence, the Primary Well is capable of meeting the groundwater demand for the proposed project.
5. Groundwater recharge at the subject property on an average annual basis is estimated to be 17.9 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 could be available to deep percolate into the fractured and jointed rocks of the Sonoma Volcanics

MEMORANDUM

that underlie the subject property. This average annual recharge volume of 17.9 AF/yr is much higher than the average annual groundwater demand estimated for the subject property of 1.86 AF/yr.

6. Conservative estimates of recharge that may occur during a “prolonged drought” (as defined above) show that, over an assumed six-year drought period in which only 55% of the average annual rainfall might occur, a total of 43.8 AF of rainfall recharge would occur within the boundaries of the subject property. This “prolonged drought” recharge estimate exceeds the total estimated groundwater demand of 11.2 AF that is necessary for the subject property over the same six-year drought period.

7. Ongoing monitoring of static and pumping water levels and pumping rates/volumes of the onsite well is strongly recommended. Such water level monitoring (at a minimum, on a once per week basis, for both static and pumping water levels) allows for the observation of changes in regional groundwater levels over time, as well as changes in the specific capacity of the onsite well over time. Monitoring and recording of the totalizer flow dial readings from each wellhead should also be performed at least weekly, as the total volume extracted from the well can be calculated from these data.

   Thus, each well should be: provided with a dedicated 1-inch diameter sounding tube that is installed to the depth of the installed pump (to permit the accurate monitoring of water levels, preferably with the use of an automatically-recording pressure transducer); and also a dual reading flow meter installed at a proper location in the discharge pipe near the wellhead.

References

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- **(USGS 2003)** Farrar, C.D. and L. F. Metzger. 2003. Ground-water resources in the Lower Milliken-Sarco-Tulucay Creeks area, southeastern Napa County, California, 2000-2002. USGS. Water-Resources Investigations Report 03-4229.
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Table 1
Comparison of Rainfall Data Sources
Hard Six Cellars

Rain Gage and/or Data Source	Years of Available Rainfall Record	Average Annual Rainfall in Inches (ft)	Elevation of Rain Gage[1] (ft asl)	Distance of Rain Gage from Subject Property (mi)	Elevation Relative to Subject Property
Napa One Rain Petrified Forest	WY 2000-01 through WY 2015-16	38.1 (3.18)	1,090	3.0	Similar
CDEC St. Helena 4WSW	WY 1984-85 through WY 2015-16[2]	41.7 (3.48)	1,730	3.0	Higher
WRCC Calistoga	1906 through December 2016[3]	36.4 (3.03)	410	4.0	Lower
PRISM Climate Group	1981 to 2010	42.4 (3.53)	---	---	---
Napa County Isohyetal Map	1900 to 1960	50 (4.17)	---	---	---

Notes:

1. The subject property is located at an elevation between ±1,090 and ±1,450 ft asl
2. Erroneous and/or missing data in WY 1984-85 and WY 1986-87 through WY 1989-90.
2. Several months and/or missing years of rainfall between 1914 and 1931, and between 1934 and 1943.

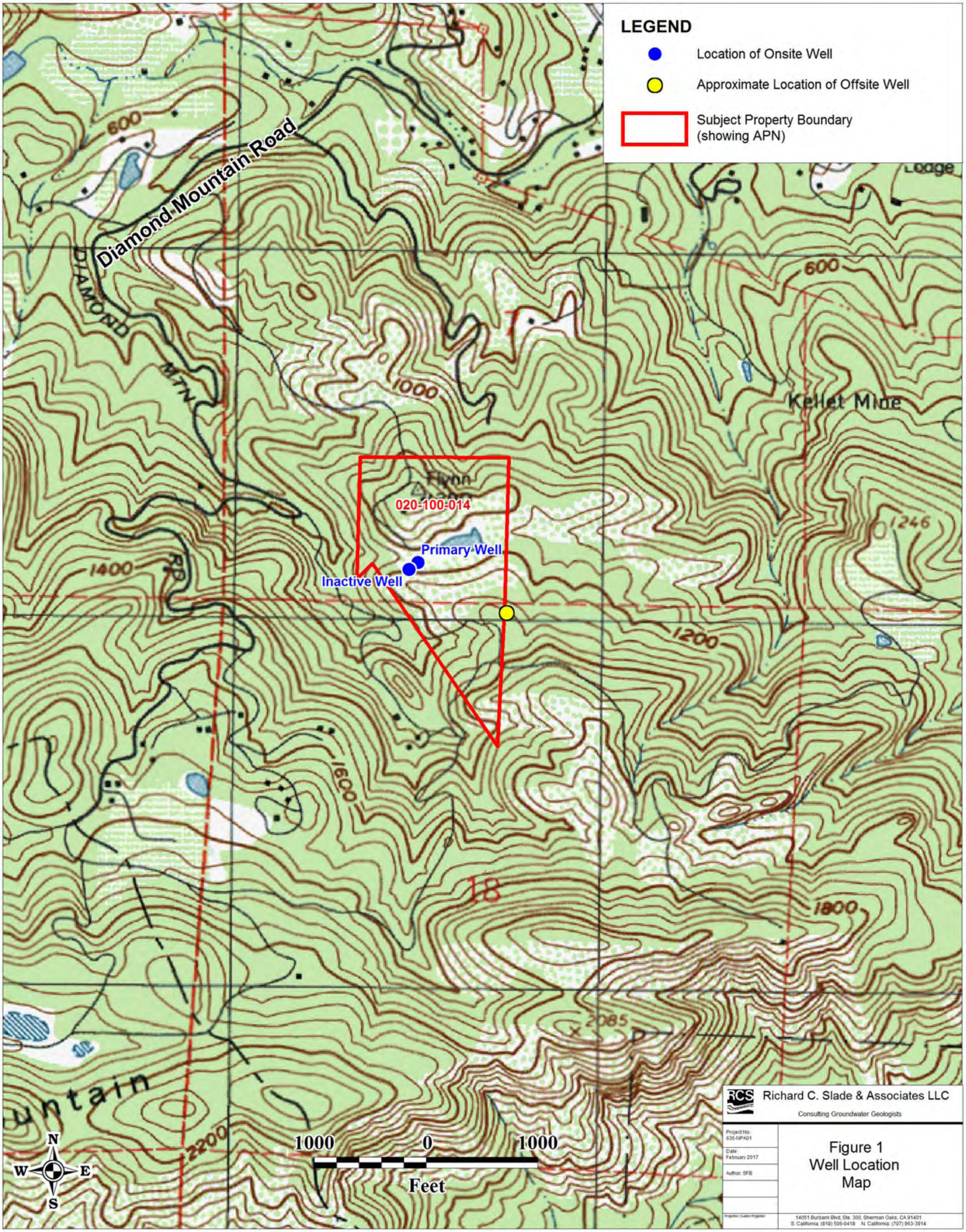
Table 2
Calculation of Theoretical Rainfall Recharge Percentage
Napa River Watershed At St. Helena

Portion of "Napa River Watershed at St. Helena" (See Figure 4)	Area (sq mi)	Area (acres)	Average Rainfall per PRISM Dataset (1980-2010) (in)	Rainfall Volume (AF)	Scenario 1 Deep Percolation Percentage (%)	Scenario 1 Deep Percolation Volume (AF)	Scenario 2 Deep Percolation Percentage (%)	Scenario 2 Deep Percolation Volume (AF)	Scenario 3 Deep Percolation Percentage (%)	Scenario 3 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 3
Drought Period Rainfall as Percentage of Average

Statewide Drought Period as Defined by DWR (DWR 2005)	Drought Duration (years)	Average Rainfall by Raingage								
		Calistoga WRCC Period of Record - 1906 through Dec 2016			St. Helena 4WSW CDEC Period of Record - WY 1984-85 to WY2015-16			Petrified Forest Napa OneRain Period of Record - WY 2000-01 to WY 2015-16		
		[A] Total Gage Average (in)	[B] Drought Period Ave. (in)	[B÷A] Drought Period Rainfall as % of Average	[C] Total Gage Average (in)	[D] Drought Period Ave. (in)	[D÷E] Drought Period Rainfall as % of Average	[E] Total Gage Average (in)	[F] Drought Period Ave. (in)	[F÷E] Drought Period Rainfall as % of Average
WY 1928-29 to WY 1933-34	6	ND	ND	ND	ND	ND	ND	ND	ND	ND
WY 1975-76 to WY 1976-77	2	36.4	15.1	41%	ND	ND	ND	ND	ND	ND
WY 1986-87 to WY 1991-92	6	36.4	26.1	72%	ND	ND	ND	ND	ND	ND
WY 2006-07 to WY 2008-09	3	36.4	26.5	73%	41.7	30.9	74%	38.1	29.2	77%
WY 2011-12 to WY 2015-16	5	36.4	28.5	58%	41.7	35.4	85%	38.1	32.1	84%

ND = No rainfall data avaialble for the corresponding drought period.


LEGEND
Location of Onsite Well
Approximate Location of Offsite Well
Subject Property Boundary
(showing APN)
Diamond Mountain Road
DIAMOND
MTN
RD
600
1000
1400
1600
1200
1246
1800
2085
2200
Lodge
Kellet Mine
Flynn
020-100-014
Primary Well
Inactive Well
18
untain
N
W
E
S
1000
0
1000
Feet
RCS
Richard C. Slade & Associates LLC
Consulting Groundwater Geologists
Project No: 635-NPA01
Date: February 2017
Author: SFB
Figure 1
Well Location
Map
14051 Burbank Blvd, Ste. 300, Sherman Oaks, CA 91401
S. California: (818) 506-0418 N. California: (707) 963-3914

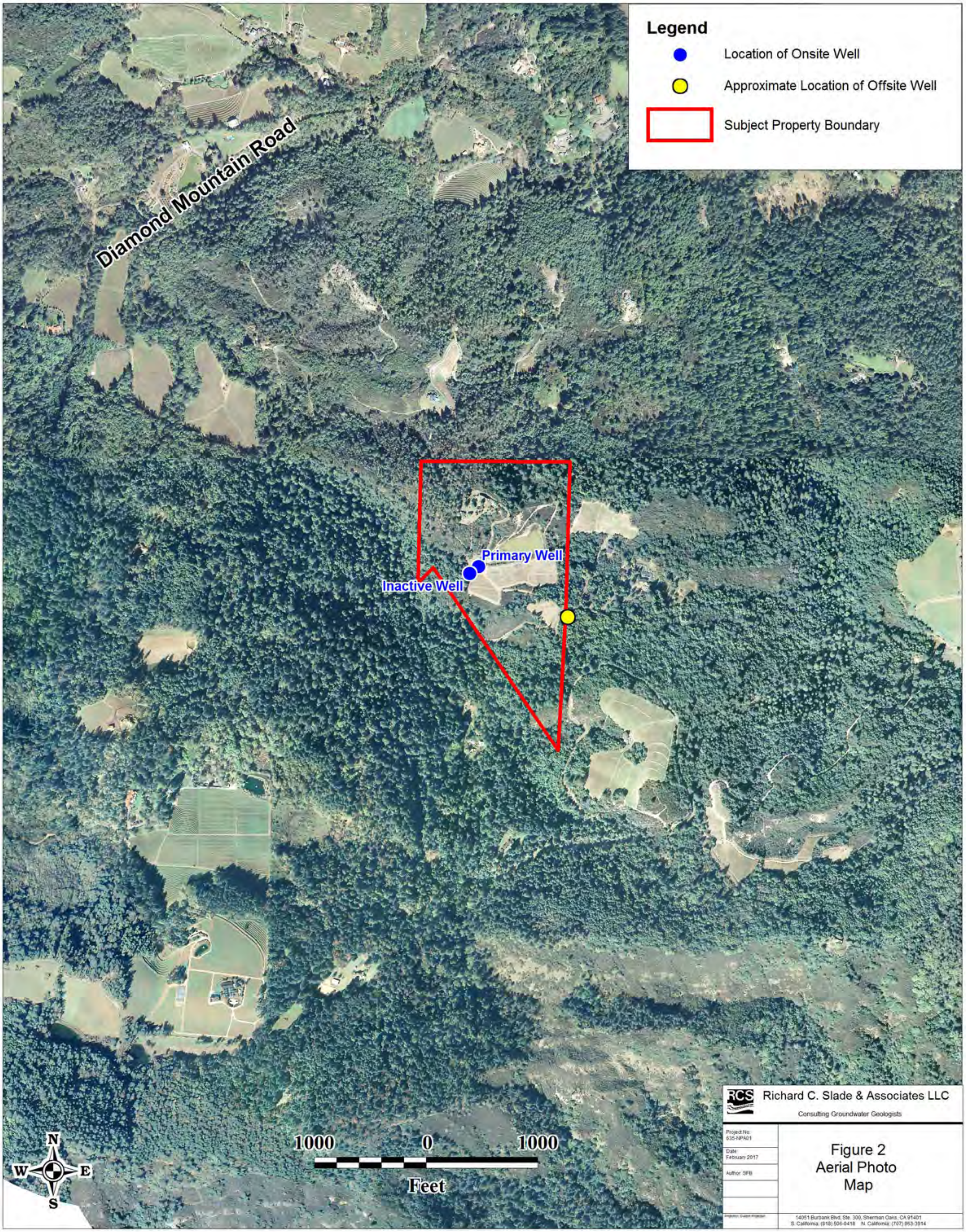
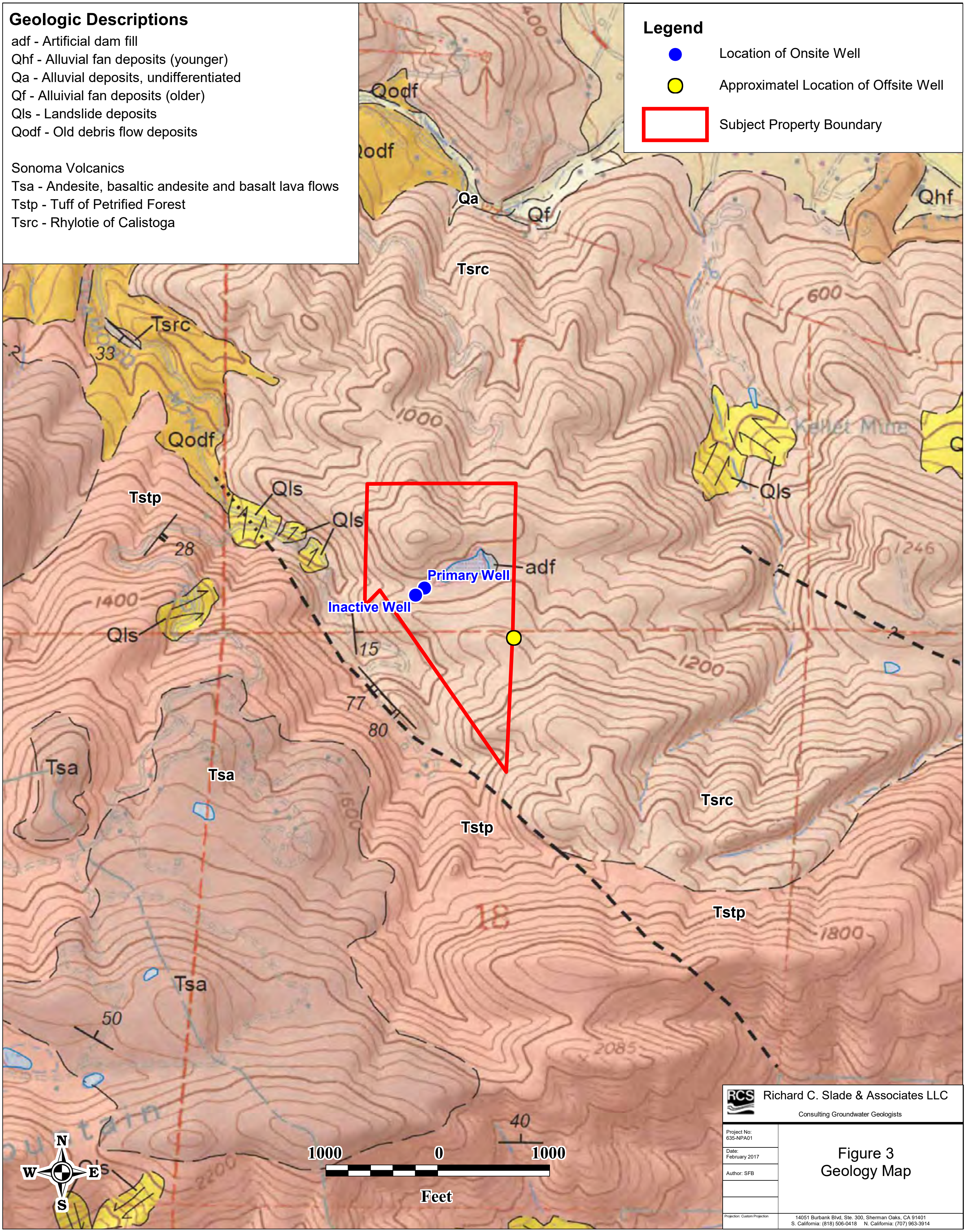


Figure 2
Aerial Photo
Map



Richard C. Slade & Associates LLC
Consulting Groundwater Geologists

Project No: 635-NPA01
Date: February 2017
Author: SFB
Projection: Custom Projection

Figure 3
Geology Map

14051 Burbank Blvd, Ste. 300, Sherman Oaks, CA 91401
S. California: (818) 506-0418 N. California: (707) 963-3914

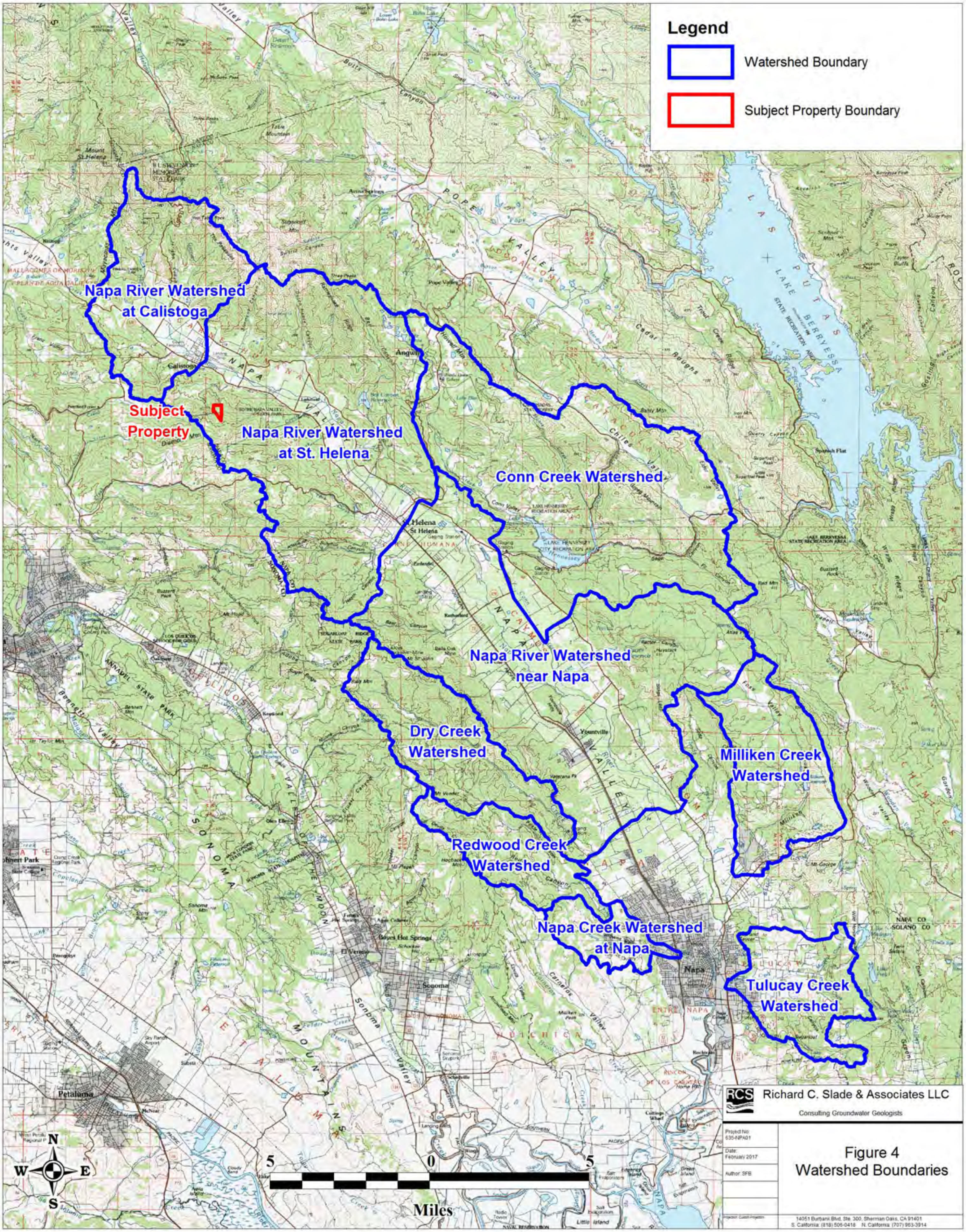


Figure 4
Watershed Boundaries

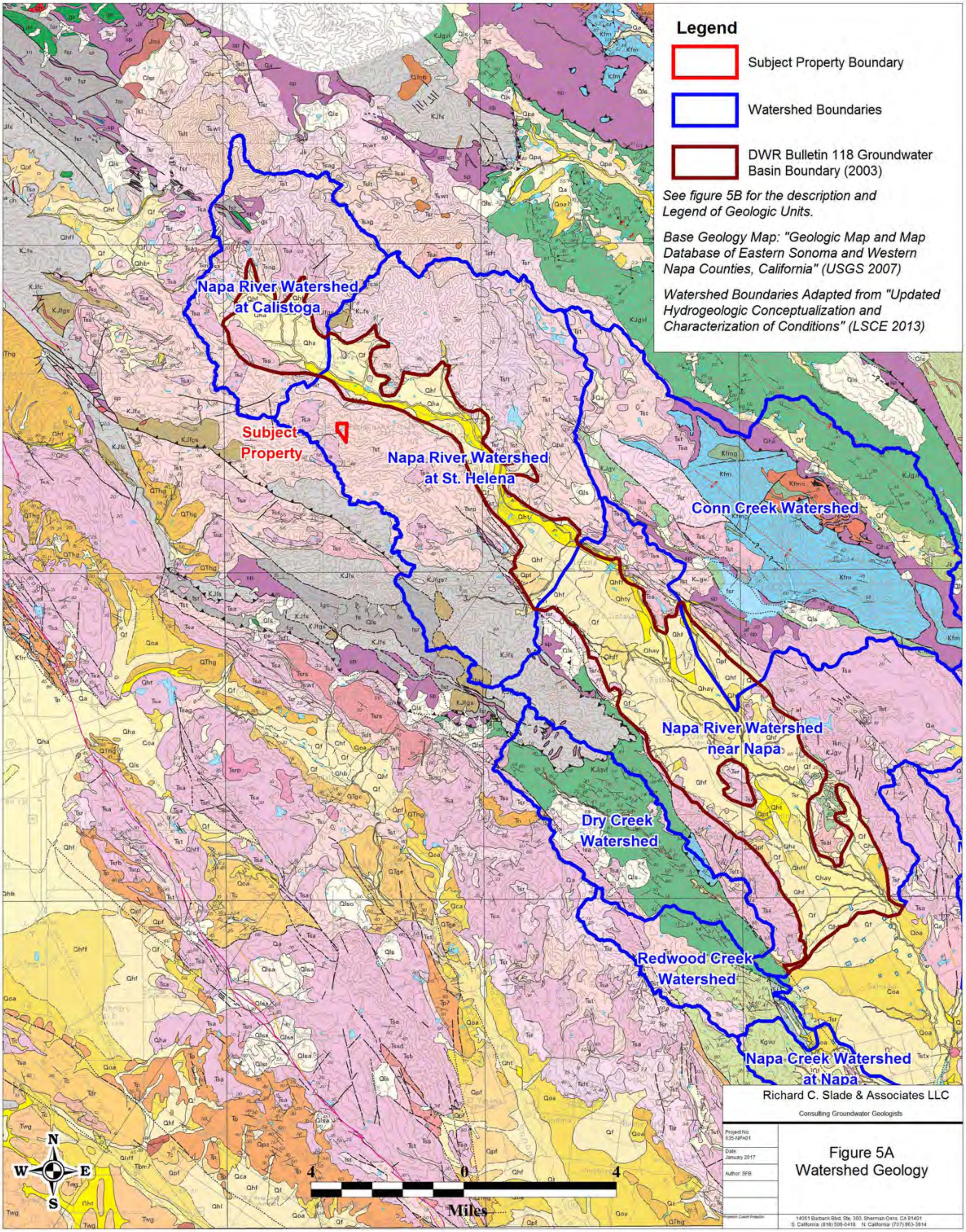


Figure 5A
Watershed Geology

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
Tsfd	Basalt or andesite lava flows and sediments
Tst	Pumiceous ash-flow tuff
Tswt	Welded ash-flow tuff
Tstx	Tuff(?)
Tsag	Agglomerate
Tstt	Tuff breccia
Tsft	Tuff
Tss	Volcanic sand and gravel
Tssd	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)
Td	Unnamed sandstone (Eocene and Paleocene)
Ts	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)
ss	Silica-carbonate rock
spm	Serpentinite-matrix mélange
	FRANCISCAN COMPLEX
fsr	Mélange, including blocks, mapped locally, of:
sp	Serpentinite
fs	Graywacke
ch	Chert
fgc	Greenstone and chert
fg	Greenstone
m	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

- 35 Strike and dip of bedding
- 46 Strike and dip of bedding, top indicator observed
- 20 Strike and dip of bedding, approximate
- 83 Overturned bedding
- 79 Overturned bedding, top indicator observed
- 45 Crumpled bedding
- 25 Air photo attitude
- Vertical bedding
- Horizontal bedding
- 35 Strike and dip of foliation
- 73 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. 635-NPA01 **February 2017**