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Water Availability Analysis

Barnett Vineyards Winery Use Permit (P19-00125-UP), Viewshed Protection Program (P20-00121-VIEW), and Exception to the Road and Street Standards
Planning Commission Hearing Date January 7, 2026

Water Availability Analysis

Barnett Vineyards
4070 Spring Mountain Road
Napa, CA 94574
Napa County APN 020-300-047

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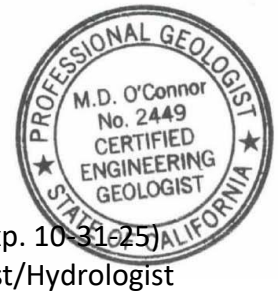

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Introduction

Barnett Vineyards is seeking to modify an existing use permit issued by County of Napa to increase winery production from 20,000 to 30,000 gallons per year (gpy), construct a new 1,700 ft^2 (+/-) winery building, increase the number of winery employees and guests, and make additional improvements to the parcel. The project parcel is located at 4070 Spring Mountain Road (Napa County APN 020-300-047), approximately five miles northwest of St. Helena (Figure 1). Water is supplied by two existing wells on the parcel.

This Water Availability Analysis (WAA) was developed based on the guidance provided in the Napa County Department of Planning, Building, & Environmental Services' (PBES) Water Availability Analysis Guidance Document formally adopted by the Napa County Board of Supervisors in May 2015. The WAA includes the following elements: estimates of existing and proposed water uses within the project recharge area, compilation of drillers' logs from the area and characterization of local hydrogeologic conditions, analyses to estimate groundwater recharge relative to proposed uses (Tier 1), and a screening analysis of the potential for well interference at neighboring wells located within 500-ft of the project well (Tier 2). The February 2023 revision of this report was necessary to comply with two changes in PBES policy pertaining to WAA's:

- groundwater recharge estimates must be based on a 10-year average of PRISM rainfall data for the years 2012 through 2021 developed by PBES, and
- required Tier 3 WAAs for wells within 1,500 ft of streams specified by PBES to evaluate groundwater-surface water interactions and risks of streamflow depletion posed by project wells.

Limitations

Groundwater systems of Napa County and the Coast Range are typically complex, and available data rarely allows for more than general assessment of groundwater conditions and delineation of aquifers. Hydrogeologic interpretations are based on the drillers' reports made available to us through the California Department of Water Resources, available geologic maps and hydrogeologic studies, and professional judgment. This analysis is based on limited available data and relies significantly on interpretation of data from disparate sources of disparate quality. Existing and proposed future water use on and near the project site is estimated based on information received from the applicant and on regionally-appropriate water duties for the observed and expected uses. The recharge estimates presented below are based on established soil water balance modeling techniques for calculating infiltration recharge and they do not account for the role of surface water/groundwater interaction or bedrock geology in controlling recharge and groundwater availability.

In the project area the depth to water is in the range of 430 – 510 feet below ground surface. Taken together with uncertainty regarding the hydraulic characteristics of the fractured rock aquifer and the relatively frequent occurrence of "dry" test wells in the area, the relationship

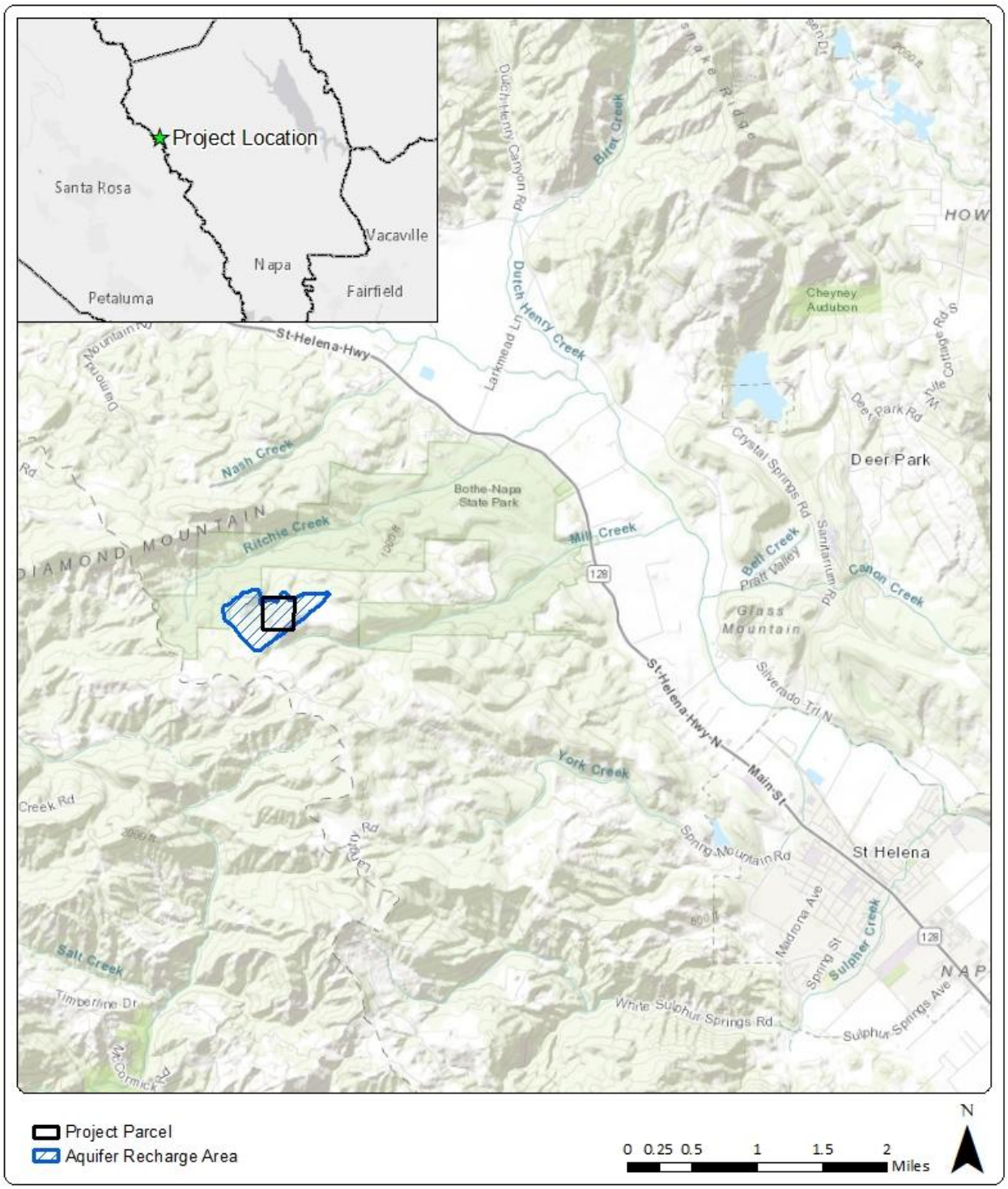

Figure 1: Project location map.

between groundwater recharge generated within the project parcel and vicinity and groundwater availability at the project well is not expected to be tightly coupled. The origin of groundwater obtained from project wells is uncertain and may be as likely supplied by groundwater inflows from a broad surrounding area as from recharge from rainfall directly on the landscape overlying the project site. Analysis of the age and sources of the deep groundwater occurring beneath the project parcel is beyond the scope of this study.

Hydrogeologic Conditions

The project parcel is located near the crest of the Mayacamas Mountains, approximately five miles northeast of St. Helena (Figure 1). This area is underlain by a large, heterogeneous block of the Sonoma Volcanics. Based on regional mapping, this block is known to extend a significant distance to the north, east and west (Graymer et al., 2007). The block thins to the south with the underlying Franciscan Complex becoming exposed near the Napa-Sonoma County line (Figure 2).

The Pliocene to late-Miocene-aged Sonoma Volcanics have been described as an "extremely complex assemblage of flows, dikes, plugs, mudflows, breccias, pumice beds, and intercalated bodies of stratified materials" (Cardwell, 1958). Many units are of limited lateral extent and well yields are highly variable. Near the project parcel, the Sonoma Volcanics may be conceptualized as interleaved strata of the Tuff of Petrified Forest (map unit Tstp) and andesitic to basaltic flow rocks (map unit Tsa). These are underlain by the Cretaceous and late-Jurassic-aged Franciscan Complex (map unit JKfss). The Tuff of Petrified Forest consists of silicic tuff, tuff breccia, and agglomerate with intercalated andesitic to dacitic lava flows (Delattre and Gutierrez, 2013). Tuffs such as this are generally considered to be one of the highest yielding units of the Sonoma Volcanics. The underlying flow rocks consist of very hard dark grey to brownish andesite and basalt which may be locally banded with platy partings (Delattre and Gutierrez, 2013). These flow rocks are largely impermeable and act as confining beds which restrict the movement of groundwater (Caldwell 1958). However, successful wells may be developed where they intersect water-bearing fractures. These fractures typically store little water but may have reasonably high transmissivities (Nishikawa, 2013).

Well Data

Well Completion Reports for wells within the vicinity of the project parcel were obtained through the California Department of Water Resources (DWR) Well Completion Report Map Application. The subset of these logs which could be accurately georeferenced based on APN, address, and sketch location are discussed below and included in Attachment A.

Two wells have been successfully completed on the project parcel. The first of these, Well 1, was completed to a depth of 640 feet in 2003. Based on a one-hour air lift test performed at the time of completion, the well was estimated to have a yield of 40 gpm (Table 1). Water was first encountered at a depth of 510 feet whereas the static water level was 422 feet, indicative of a pressure head on groundwater and suggesting confined aquifer conditions. The well is screened at depths of 281 – 301 and 481 – 621 feet in layers described by the driller as "mixed black, red, gray, and tan volcanic rock". This may be interpreted as andesitic to basaltic lava flow rocks, not

volcanic tuff. The second well, Well 2, was completed to a depth of 530 feet in 1984. Based on a three-hour bailer test, the well was estimated to have a yield of 14 gpm. After completion the static water was at 430 feet. The well is screened between 420 and 530 feet in layers described by the driller as “hard volcanic rock”.

Well Completion Reports indicate that five dry test holes (Wells 3 – 7) were drilled on the project parcel between 1978 and 2001. Although the address given on four of these reports does not match the project address, the parcel APN and the state well number match the project parcel. Of these five test holes, the shallowest, Well 4, was drilled in a mixture of volcanic tuff and lava flow rocks. Others were drilled as deep as 720 feet (Well 7), fully penetrating the volcanic tuff and several hundred feet into the underling andesitic to basaltic lava flows.

Two productive wells and three dry test holes are located on the neighboring parcel to the west (APN 020-300-035). The two successful wells (Wells 8 and 9) were completed to depths of 630 and 700 feet respectively. The estimated yield for both wells is 10 gpm. Well 8 is screened in both the overlying volcanic tuff and the underlying volcanic flows. Well 9 is only screened in the underlying volcanic flows but did penetrate one or more intercalated tuff layers at depths of 520 to 640 feet. The three dry holes on the neighboring parcel were drilled to between 585 and 760 feet indicating that the areal extent of water bearing features may be limited, similar to conditions on the project parcel. With the exception of Well 13, wells to the south are typically dry or screened in the Franciscan Complex.

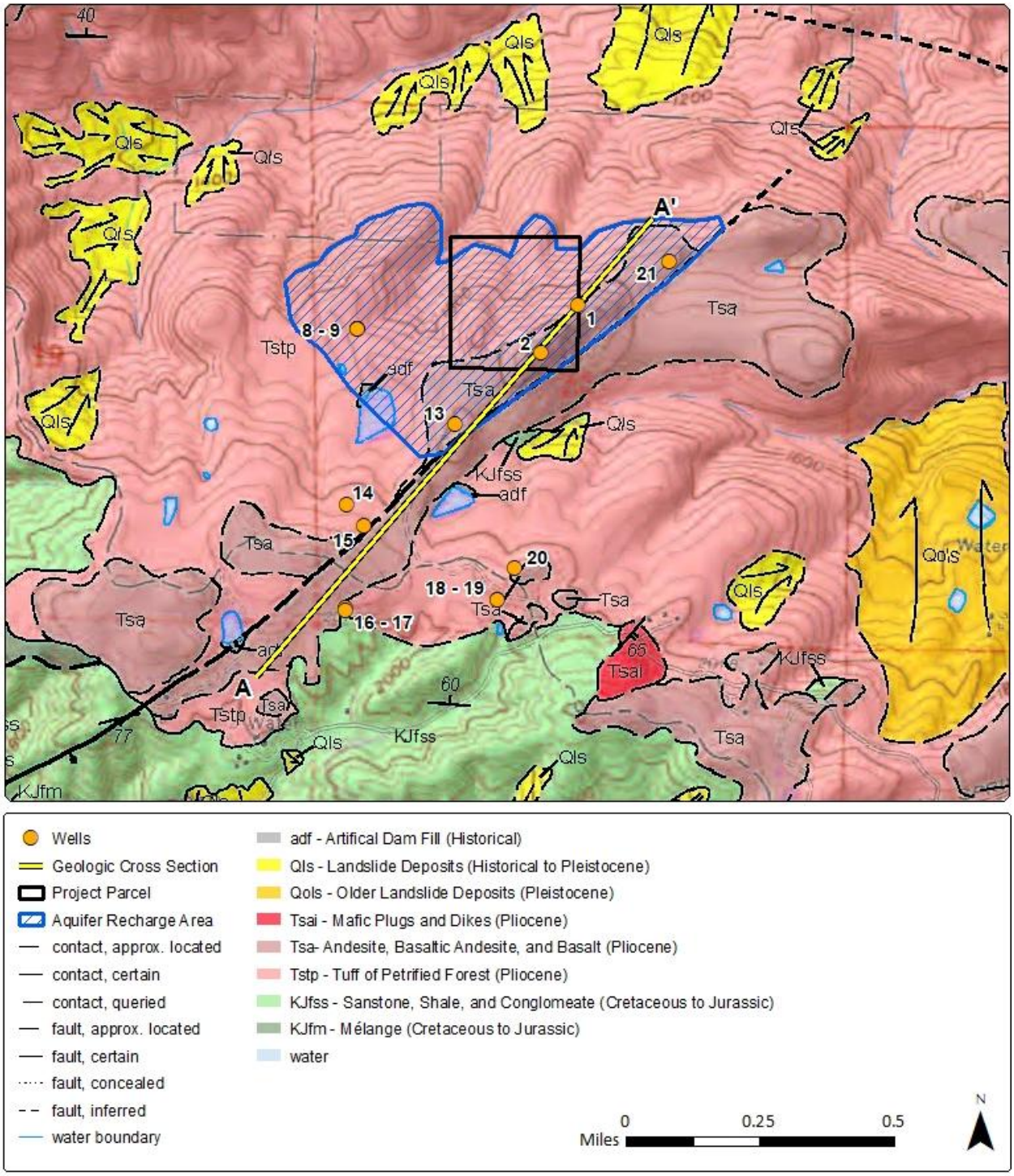

Figure 2: Surficial geology and locations of wells in the vicinity of the project parcel. Surficial geology based on the Preliminary Geologic Map of the Calistoga 7.5' Quadrangle (Delattre and Gutierrez, 2013).

Table 1: Well completion details for the project wells, neighboring wells, and dry holes for which data was available.

Well ID	1	2	3	4	5	6	7
Year Filed	2003	1984	1978	1980	1975	1983	2001
Depth (ft)	640	530	385	97	185	413	720
Estimated Yield (gpm)	40	14	0	0	0	0	0
Static Water Level (ft)	422	430	-	-	-	-	-
Top of Screen (ft)	281	420	-	-	-	-	-
Bottom of Screen (ft)	621	530	-	-	-	-	-
Geologic Map Unit	Tst/Tsa	Tst/Tsa	Tst/Tsa	Tst/Tsa	Tst/Tsa	Tst/Tsa	Tst/Tsa

Well ID	8	9	10	11	12	13	14
Year Filed	1999	2017	1999	2017	2016	1996	1989
Depth (ft)	630	700	585	760	630	526	480
Estimated Yield (gpm)	10	10	0	0	0	65	0
Static Water Level (ft)	370	480	-	-	-	263	-
Top of Screen (ft)	50	280	-	-	-	200	-
Bottom of Screen (ft)	625	700	-	-	-	500	-
Geologic Map Unit	Tst/Tsa	Tst/Tsa	Tst/Tsa	Tst/Tsa	Tst/Tsa	Tsv/ KJfs	Tst/Tsa

Well ID	15	16	17	18	19	20	21
Year Filed	2002	2002	2007	1968	1998	2004	Unk.
Depth (ft)	480	640	620	80	190	160	Unk.
Estimated Yield (gpm)	0	17	2	20	40	20	Unk.
Static Water Level (ft)	-	288	233	42	45	Unk.	Unk.
Top of Screen (ft)	-	285	158	50	50	65	Unk.
Bottom of Screen (ft)	-	585	598	80	190	135	Unk.
Geologic Map Unit	Tst/Tsa	KJfs	KJfs	KJfs	Tsv/KJfs	Tsv/KJfs	Unk.

Geologic Cross-Section

A geologic cross-section oriented southwest to northeast through the two project wells is shown in Figure 3 (see Figure 2 for location). Elevations along this cross-section range from over 2,000 feet along the ridgeline near the project parcel to approximately 1,600 feet at the northeast end close to Ritchie Creek. Plotted along this cross-section, potentiometric water surface elevations mirror surface topography, suggesting that the direction of groundwater flow likely mimics surface topography.

Near the project parcel, wells encountered a 100 – 200 foot thick layer of the Tuff of Petrified Forest (map unit Tstp) overlying hundreds of feet of andesitic to basaltic flow rocks (map unit Tsa). Wells are generally screened in the volcanic flow rocks, not the overlying tuff. This layering appears to extend as far as a topographic saddle immediately southwest of Well 13. The layering reported in Wells 14 and 15 is different, and neither of these two wells were successfully completed.

This cross-section also obliquely interests a southwest to northeast trending fault, which is perpendicular to regional faults such as the nearby Petrified Forest Thrust Zone. Based on geologic logs from nearby wells and from surficial geology mapping, there appears to be a large offset in the depth to the Franciscan Complex across this fault. On the northwest side, which includes the project parcel, wells do not report encountering the Franciscan Complex, even at depths of up to 700 feet. On the southeast side, many wells encountered the Franciscan Complex at depths of less than 100 feet. This, combined with the surficial geology maps showing surficial exposures of the Franciscan Complex (map unit KJfss), suggest that the Sonoma Volcanics southeast of this fault are of limited vertical thickness (Figure 2).

Project Recharge Area

The project aquifer is conceptualized as the fractured andesitic to basaltic flow rocks underlying the ridgeline near the project parcel. Based on available Well Completion Reports, this aquifer appears to be limited to a triangular-shaped portion of ridgeline encompasses by Wells 1, 2, 8, 9 and 13. The southern edge of this aquifer is defined by the southwest to northeast trending fault. There is a significant vertical offset across this fault, and, on the southern side, the Franciscan Complex is believed to be present at the same elevation as the screened intervals of the project wells. Due to its very low permeability, inflows from the Franciscan Complex opposite this fault are believed to be minimal. Additionally, the fault itself may function as a barrier to groundwater flow.

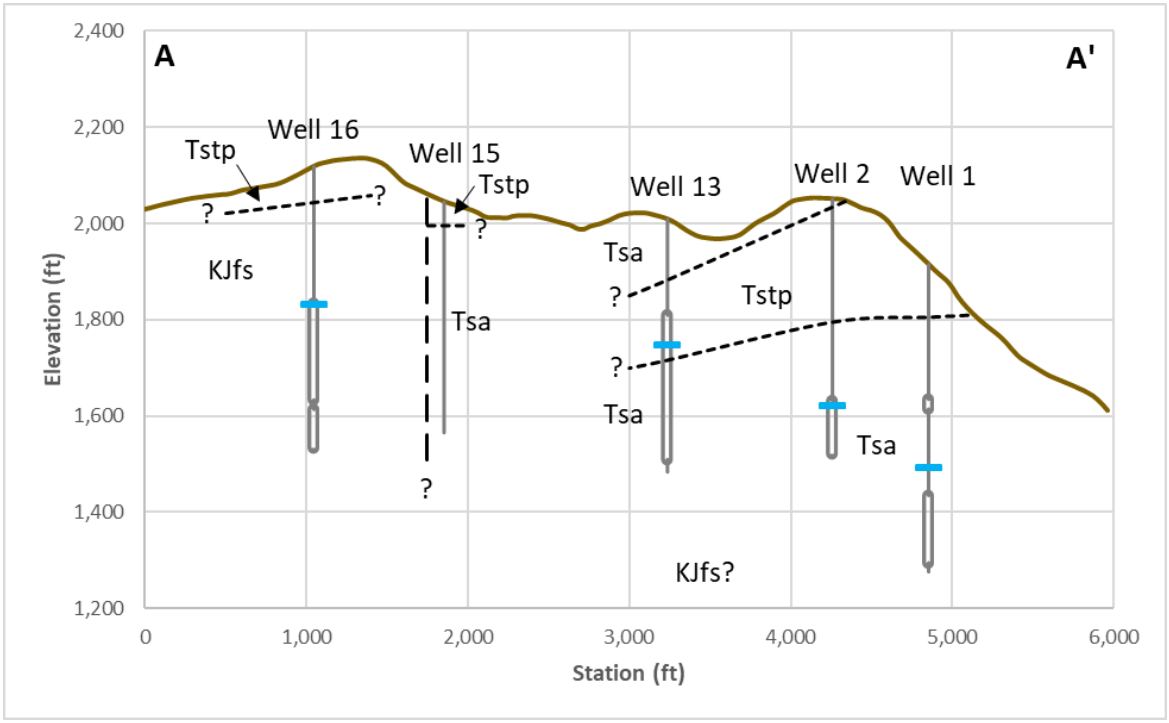

Figure 3: Hydrogeologic cross section A -A' through the project parcel (see Figure 2 for location and geologic map units).

The western boundary has been defined as a nearby watercourse. This watercourse defines the discrete section of ridgeline on which the project parcel is located, and, west of this watercourse, wells drilled in the Sonoma Volcanics did not yield useful quantities of water (Wells 14 and 15). The northern boundary is defined by a surface contour (1,600 ft elevation) approximately 400 feet below the surface elevation of the two project wells. Although the project wells are screened at greater depths, the groundwater flow gradient is believed to be oriented from south to north. This contour was selected to approximate, based on groundwater elevation, the northward extent from which groundwater recharge may contribute to the project aquifer.

The total area of the project recharge area is 129 acres, all of which is underlain by various units of the Sonoma Volcanics. Given the the pressure heads observed in several wells, the project aquifer is likely confined or semi-confined.

Water Demand

Within the project recharge area, water demand was estimated for permitted, existing, and proposed conditions. Permitted and existing use on the project parcel was determined using site details provided by the project applicant and verified using satellite imagery and the County of Napa's Public Winery Database. Uses on other neighboring parcels within the project recharge area were determined using the County of Napa's Agricultural and Winery Geodatabase and using satellite imagery. Permitted winery production, employee counts, and annual guest totals for the three wineries located within the project recharge area were accessed from the County of Napa's Public Winery Database, accessed June 5, 2023. All water use rates were estimated using data from the County of Napa's Water Availability Analysis Guidance Document dated May 12, 2015.

Permitted and Existing Use

The project parcel contains a vineyard, a winery, and residential uses. Based on the publicly available agricultural areas shapefile from the County of Napa's GIS Data Catalog, there are approximately 8.6 acres of vineyard on the project parcel. Per the County of Napa's Public Winery Database, the winery on the project parcel is permitted to produce up to 20,000 gpy and have two full-time employees (Table 3a). Existing water use summarized in Table 3b differs from permitted water use with respect to employees (5) and tasting room visitors (8,400 per year or about 23 per day based on peak annual visitation over the period 2009-2019) and marketing event visitation (310 guests per year for catered events; use rounded up to 0.01 AF/yr for Guest & Employee Use subtotal) One primary and one secondary residence are located on the parcel. The primary residence also has a pool and approximately 7,500 ft^2 of lawn. Of this, 1,000 ft^2 was included in the water use estimate for the primary residence and the water use for the remaining 6,500 ft^2 was estimated separately.

Neighboring parcels within the project recharge area are predominately vineyard, but also contain several wineries and residences. Based on the agricultural areas shapefile from the County's GIS Data Catalog, neighboring parcels included within the project recharge area contain approximately 63.4 acres of vineyard. While some of these vineyards may be irrigated using surface water, it is unknown if they also use groundwater. To be conservative, all water uses were assumed to be supplied with groundwater. Per the County's Public Winery Database, there are three wineries on neighboring parcels within the recharge area: Behrens Family Winery, Sherwin Family Vineyards, and Smith Madrone Winery. Combined, these three wineries produce up to 44,500 gpy and are permitted to hold up to 12,376 tastings and have up to 560 guests at marketing events each year. Areal imagery shows that the neighboring parcels have two primary residences, one secondary residence, and one pool. There are also extensive lawns and landscaped areas on these parcels. In total, these parcels irrigate approximately 12,000 ft^2 of lawn and 5,000 ft^2 of drought tolerant landscaping beyond what is included in residential use estimates.

Based on these uses, existing water demand within the project recharge area is estimated to be 41.39 acre-ft/yr (Table 2). Project parcel permitted use is 6.12 acre-ft/yr (Table 3a) and existing

use is 6.51 acre-ft/yr (Table 3b). Most of the remaining water use is for vineyard irrigation on neighboring parcels (Table 4).

Table 2: Estimated groundwater use within the project recharge area in the permitted, existing and proposed conditions; the distinction between permitted and existing is based solely on Barnett Winery use and does not account for other wineries that may or may not have increases above permitted use.

	Permitted Condition (acre-ft/yr)	Existing Condition (acre-ft/yr)	Proposed Condition (acre-ft/yr)
Project Parcel	**6.12**	**6.25**	**6.59**
Residential Use	1.27	1.27	1.27
Irrigation Use	4.30	4.30	4.30
Winery Use	0.53	0.53	0.80
Employee/Guest Use	0.02	0.15	0.22
Neighboring Parcels	**35.27**	**35.27**	**35.27**
Residential Use	2.10	2.10	2.10
Irrigation Use	31.70	31.70	31.70
Winery Use	1.18	1.18	1.18
Employee/Guest Use	0.29	0.29	0.29
Total	**41.39**	**41.52**	**41.86**

Table 3a: Estimated groundwater uses on the project parcel as permitted.

	# of Units	Use per Unit	Annual Water Use (AF/yr)
Residential Use			**1.27**
Residences, Primary	1 Residence	0.75 AF/Residence	0.75
Residences, Secondary	1 Residence	0.35 AF/Residence	0.35
Pools	1 Pool	0.10 AF/Pool	0.10
Lawn, Additional	6500 sq. ft.	0.10 AF/10,000 sq. ft.	0.07
Agricultural Use			**4.30**
Vineyard	8.6 Acres	0.50 AF/acre/yr	4.30
Winery Use			**0.53**
Process Water	20,000 Gallons	2.15 AF/100,000 gal.	0.43
Domestic & Landscaping	20,000 Gallons	0.50 AF/100,000 gal.	0.10
Guest & Employee Use			**0.02**
Employees	2 Employees	15 gal./shift @ 250 shifts/yr	0.02
Total			**6.12**

Table 3b: Estimated groundwater uses on the project parcel in the existing condition.

	# of Units	Use per Unit	Annual Water Use (AF/yr)
Residential Use			**1.27**
Residences, Oversized	0 Residences	1.00 AF/Residence	0.00
Residences, Primary	1 Residence	0.75 AF/Residence	0.75
Residences, Secondary	1 Residence	0.35 AF/Residence	0.35
Pools	1 Pool	0.10 AF/Pool	0.10
Lawn, Additional	6500 sq. ft.	0.10 AF/10,000 sq. ft.	0.07
Agricultural Use			**4.30**
Vineyard	8.6 Acres	0.50 AF/acre/yr	4.30
Winery Use			**0.53**
Process Water	20,000 Gallons	2.15 AF/100,000 gal.	0.43
Domestic & Landscaping	20,000 Gallons	0.50 AF/100,000 gal.	0.10
Guest & Employee Use			**0.15**
Tasting Room Visitations	8,400 Guests	3 gal./Guest	0.08
Employees	5 Employees	15 gal./shift @ 250 shifts/yr	0.06
Marketing Events (Catered)	310 Guests	3 gal./Guest	0.003
Total			**6.25**

Table 4: Estimated groundwater uses on neighboring parcels within the project recharge area; these estimates apply to permitted, existing, and proposed conditions.

	# of Units	Use per Unit	Annual Water Use (AF/yr)
Residential Use			**2.10**
Residences, Primary	2 Residences	0.75 AF/Residence	1.50
Residences, Secondary	1 Residence	0.35 AF/Residence	0.35
Pools	1 Pool	0.10 AF/Pool	0.10
Lawn, Additional	12,000 ft^2	0.10 AF/10,000 sq. ft.	0.12
Other Landscaping, Addtl.	5,000 ft^2	0.05 AF/10,000 sq. ft.	0.03
Agricultural Use			**31.70**
Vineyard	63.4 Acres	0.50 AF/acre/yr	31.70
Winery Use			**1.18**
Process Water	44,500 Gallons	2.15 AF/100,000 gal.	0.96
Domestic & Landscaping	44,500 Gallons	0.50 AF/100,000 gal.	0.22
Guest & Employee Use			**0.29**
Tasting Room Visitations	12,376 Guests	3 gal./Guest	0.11
Events w/ On-Site Catering	560 Guests	15 gal./Guest	0.03
Employees	13 Employees	15 gal./shift @ 250 shifts/yr	0.15
Total			**35.27**

Proposed Use

In the proposed condition, winery production will be increased from 20,000 gpy to 30,000 gpy. Along with this increase in production, the number of employees will increase to nine, and the winery will have up to 32 tasting visitors per day (11,680 tasting visitors per year) and have up to 460 guests at nine catered marketing events throughout the year (catered Marketing Events use rounded up to 0.01 AF/yr for Guest & Employee Use subtotal). No changes are proposed to vineyard acreage or the number of residences.

Based on these proposed uses, water use on the project parcel is estimated to increase by 0.47 acre-ft/yr to 6.59 acre-ft/yr (Table 5). Total water use within the project recharge area will increase to 41.86 acre-ft/yr (Table 2).

Table 5: Estimated water uses on the project parcel in the proposed condition.

	# of Units	Use per Unit	Annual Water Use (AF/yr)
Residential Use			**1.27**
Residences, Primary	1 Residence	0.75 AF/Residence	0.75
Residences, Secondary	1 Residence	0.35 AF/Residence	0.35
Pools	1 Pool	0.10 AF/Pool	0.10
Lawn, Additional	6500 sq. ft.	0.10 AF/10,000 sq. ft.	0.07
Agricultural Use			**4.30**
Vineyard	8.6 Acres	0.50 AF/acre/yr	4.30
Winery Use			**0.80**
Process Water	30,000 Gallons	2.15 AF/100,000 gal.	0.65
Domestic & Landscaping	30,000 Gallons	0.50 AF/100,000 gal.	0.15
Guest & Employee Use			**0.22**
Tasting Room Visitations	11,680 Guests	3 gal./Guest	0.11
Events (Catered)	460 Guests	3 gal./Guest	0.004
Employees	9 Employees	15 gal./shift @ 250 shifts/yr	0.10
Total			**6.59**

Groundwater Recharge Analysis

Methods

Groundwater recharge within the project recharge area was estimated using the Soil Water Balance (SWB) model implemented by OEI for the area comprising Napa County. This model utilizes the U.S. Geologic Survey's SWB modeling software and produces a spatially distributed estimate of annual recharge. This model operates on a daily timestep and calculates runoff based on the Natural Resources Conservation Service (NRCS) curve number approach and Actual Evapotranspiration (AET) and recharge based on a modified Thornthwaite-Mather soil-water-balance approach (Westenbroek et al., 2010). Details of this model are included in Appendix B.

To address elevated concerns regarding groundwater availability Napa County PBES mandated in December 2022 the use of the 10-year precipitation average from Water Years 2012 to 2021 developed by the PRISM Group at Oregon State University. The PRISM data is distributed by PBES in a GIS format.

Groundwater recharge for this project area was previously simulated for Water Year 2010 which was selected because annual precipitation in that year was nearest to the 30 year average for the period 1981-2010. OEI's SWB modeling also estimated recharge for Water Year 2014 to represent drought year conditions.

OEI's use of the SWB model is believed to provide more accurate estimates of potential groundwater recharge because it is a physically based distributed model that incorporates information characterizing the water balance in the soil column. Calculation of evapotranspiration using local climate data along with soil moisture storage and precipitation is believed to provide a more accurate representation of local conditions; evapotranspiration is the largest component of the water balance. Unfortunately, the SWB model structure does not allow for a groundwater recharge calculation based on a mathematical average because the model is driven by daily climate data. Consequently, OEI has adapted the SWB model estimates for the prior "average year" (WY 2010) and the "drought year" (WY 2014) to provide an estimate for the average annual rainfall for the period 2012-2021 developed by County of Napa.

OEI has utilized SWB models for WY 2010 and WY 2014 for dozens of project sites in the County of Napa. We have observed that potential recharge for WY 2010 is consistently much greater than for WY 2014 across a wide variety of terrain, vegetation, soils and climate. This is most easily characterized by the percentage of annual precipitation available for recharge that we calculate for each project site. Our approach for adapting the SWB model outputs to estimate groundwater recharge for the specified annual average precipitation is to assume that the percentage of annual rainfall available for groundwater recharge is a linear function of annual rainfall and interpolating between the recharge percentage for WY 2010 and WY 2014. The linear interpolation procedure is unique for each project site; the application for this project site is graphically displayed in Figure 4. The water balance data from the SWB model years is tabulated in Table 6.

Groundwater Recharge

For the period 2012-2021 average annual precipitation was 33.9 inches across the project recharge area. For the simulation of Water Year 2010, precipitation was 46.3 inches averaged across the project recharge area and simulated evapotranspiration (AET) was 22.1 inches. Simulated groundwater recharge varied from 9.0 to 17.9 inches across the recharge area, with a spatial average of 14.5 inches. For the simulation of Water Year 2014, precipitation was 27.9 inches averaged across the project recharge area and AET was 14.9 inches. Groundwater recharge varied from near zero to 6.3 inches across the recharge area with a spatial average of 4.9 inches (Table 6). **Assuming a linear relationship between the precipitation of the selected average and dry year results of simulated recharge percent (Figure 4), Water Years 2012 to 2021 average had a result of 7.5 inches recharge (Table 6)**.

Table 6: Summary of water balance results for the project recharge area estimated by the SWB model for WY 2010 & 2014 and calculated recharge for the average of 2012-2021 WYs.

	2010 Normal Year		2014 Dry Year		2012-2021 WY Avg	
	inches	% of precip	inches	% of precip	inches	% of precip
Precipitation	46.3	-	27.9	-	33.9	-
AET	22.0	47%	14.9	53%	-	-
Runoff	10.1	22%	11.3	41%	-	-
Δ Soil Moisture	-0.3	-1%	-3.2	-11%	-	-
Recharge	14.5	31%	4.9	18%	7.5	22%

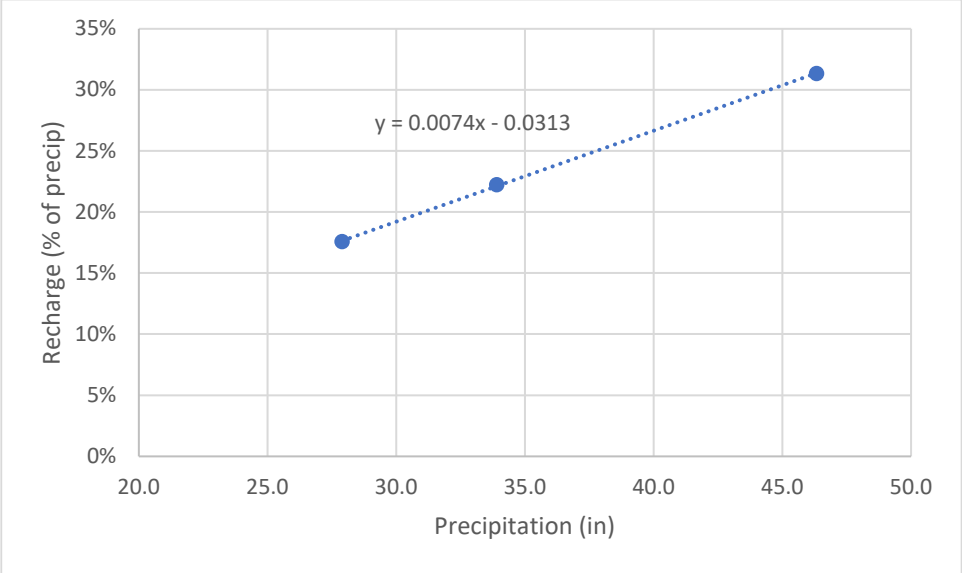

Figure 4: Relationship between precipitation and percent of precipitation as recharge

Water budget estimates are available for several nearby watersheds including Dry Creek and the Napa River near Calistoga. Average annual recharge for these watersheds is estimated to be between 6 and 19% of average annual precipitation (LSCE, 2013). Regional estimates are also available for the Napa River watershed, the Santa Rosa Plain, Sonoma Valley, and the Green Valley Creek watershed. These regional analyses estimated that mean annual recharge was equivalent to between 7% and 28% of mean annual precipitation (Farrar et. al., 2006; Flint and Flint 2014, Kobor and O'Connor, 2016; Wolfenden and Hevesi, 2014). While comparisons to these water budgets are useful for evaluating SWB predictions, precise agreement is not expected owing to significant variations in climate, land cover, soil types, and underlying hydrogeologic conditions. It should be noted that the project recharge area is located along a ridgetop in one of the highest precipitation areas of Napa County. Compared to the larger-scale model referenced above, which typically include large valley bottom areas with lower precipitation, it is not unreasonable for recharge to comprise a greater part of the hydrologic budget.

Groundwater recharge estimates can also be expressed as a total volume by multiplying the estimated recharge rate by a representative area. **For the 129-acre project recharge area, these calculations estimate recharge of 81.0 acre-ft/yr based on average annual precipitation over the period 2012-2021; estimated recharge apportioned for the 40-acre project parcel is 25.1 acre-ft/yr (Table 7)**. The estimated recharge rates assume that water draining through the soil that is not lost to evapotranspiration percolates to groundwater.

Comparison of Water Demand and Groundwater Recharge

The total proposed groundwater use for the project recharge area is estimated to be 41.9 acre-ft/yr, 6.6 acre-ft/yr of which will originate on the project parcel. Groundwater use in the project recharge area is equivalent to 52% of the estimated 81.0 acre-ft/yr recharge based on average precipitation for the period 2012-2021; groundwater use on the project parcel is equivalent to 26% of the estimated 25.1 acre-ft/yr recharge apportioned to the project parcel (Table 7).

Table 7: Comparison of proposed water use to estimated average groundwater recharge for the project recharge area and for the project parcel.

Domain	Total Proposed Demand (ac-ft/yr)	Averaged Water Years 2012-2021		
		Recharge (ac-ft/yr)	Recharge Surplus	Demand as % of
Project Recharge Area	41.9	81.0	39.1	52%
Project Parcel	6.6	25.1	18.5	26%

Well Interference Analysis-Tier 2

There are no neighboring wells within 500 feet of either of the the project wells (Well 1 & 2). The nearest well to Well 1, Well 17, is located approximately 990 feet to the northeast. A Well Completion Report was not available for this well, but its location was reported by the applicant based on correspondence with the neighboring landowner. The nearest well to Well 2, Well 13, is located approximately 1,100 feet to the southwest. Based on the WAA guidance document, a Tier 2 well interference analysis is not required given that all non-project wells are located greater than 500-feet from the project wells.

Groundwater-Surface Water Interactions-Tier 3

Hydrogeologic Conditions

Napa County Tier 3 WAA guidance for assessment of groundwater-surface water interactions was modified 2022; PBES has identified streams of concern in the County and requires a Tier 3 assessment of projects with groundwater wells located within 1,500 ft of an identified stream of concern. The project wells are both located within the area subject to the Tier 3 WAA screening requirements as shown in Figure 5; both wells are within 1,500 ft of the nearest stream of concern (Mill Creek) for potential streamflow depletion as identified by County of Napa. Well 1 is located 975 ft from Mill Creek while Well 2 is located 685 ft from Mill Creek.

Interactions between groundwater and surface water are discussed in detail in Chapter 6 of the recently released Napa Valley Subbasin Groundwater Sustainability Plan (GSP) (LSCE, 2022). In Chapter 6 of the GSP, Mill Creek is identified as one of many tributaries to the Napa River with intermittent flow in a 2015 mapping effort by the Napa County Resource Conservation District (LSCE, 2022). In contrast with perennial streams, which are assumed to have a hydraulic connection to groundwater, intermittent streams are believed to have the potential to be connected but for only limited periods of time. A hydraulic connection is defined as the condition where the water table elevation is at or above the surface water channel, a situation where streamflows would possibly be influenced by changes in the groundwater table elevations. There are no alluvial units mapped along Mill Creek along the project reach. Although some shallow alluvium is likely present in the creek bed it is presumed that any hydraulic connection between Mill Creek and groundwater would be via the fractured bedrock aquifer of the Sonoma Volcanics.

Well 1 is presumed to be screened entirely within the andesitic to basaltic lava flow rocks, the Tsa unit of the Sonoma Volcanics, a fractured bedrock aquifer which is known to have a relatively low permeability. Well 1 is perforated between 281 and 301 ft below ground surface (bgs); however, the screened interval of Well 1 that intersects water (initially at 551 ft bgs) begins at 481 ft bgs which equates to approximately 277 ft below the bed of Mill Creek (Table 8). The Well Completion Report for Well 1 (Appendix A) provided an estimated yield of 40 gpm after a 1 hour air-lift test in 2003. Well yields derived from short duration air-lift yield tests overestimate operational pumping rates. The project applicant reports the working pumping rate of this well

is approximately 8 gpm, consistent with our experience regarding pumping capacity reported by drillers at the time of well completion.

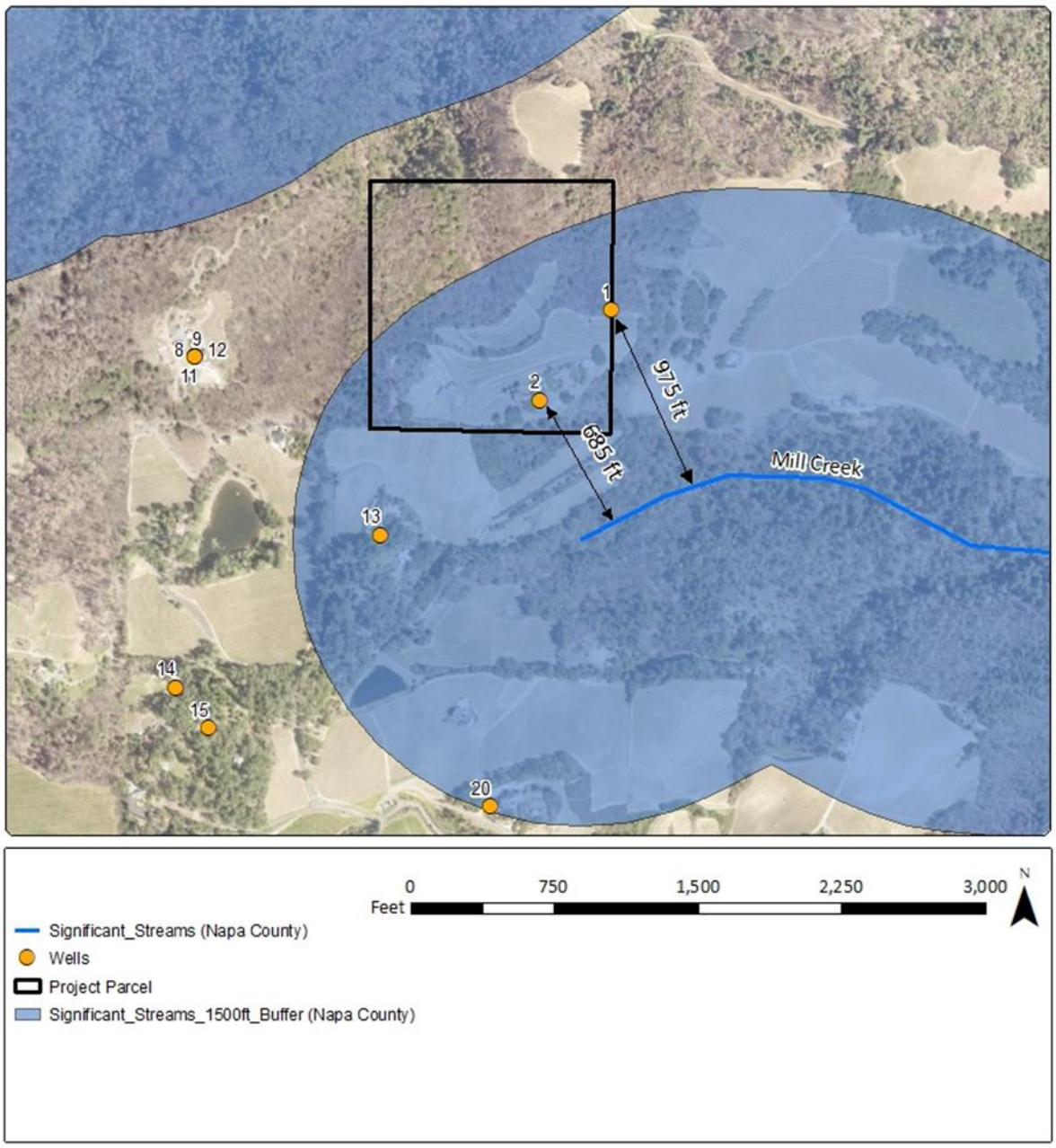

Figure 5: Locations of project Well 1 and Well 2 1500ft buffers to show distances to and closest water bodies.

Well 2 is also screened entirely within the andesitic to basaltic lava flow rocks, the unit Tsa of the Sonoma Volcanics. The screened interval of Well 2 begins at 420 ft bgs which equates to approximately 167 ft below the bed of Mill Creek at its closest point (Table 8). The well completion report for Well 2 reported an estimated yield of 14 gpm after a 3 hour bailer test in

1984. As noted above, well yields derived from shorter duration tests at time of well completion typically overestimate operation pumping rates, so a lower pumping rate would be expected. The project applicant reports the working pumping rate of this well is also approximately 8 gpm.

Table 8. Project well construction details and distances to nearby streams all units in feet.

Project Well Name	Depth to Top Perforation	Depth of Surface Seal	Distance To Mill Creek
Well 1	281	55	975
Well 2	420	20	685

Guidance for preparation of Tier 3 WAA's provided by County of Napa (May 2015) describes some conditions where wells nearer than 1,500 ft to a stream of concern may also be regarded as posing no significant risk of streamflow depletion. Effective pumping rate, transmissivity of the aquifer material, the depth of the well seal from the ground surface, and the depth of well perforations are factors considered that could also demonstrate that there is no significant risk of streamflow depletion as described further below.

Well pumping capacity is one criterion used to assess potential effects of the proposed well on surface flow per County guidance for Tier 3 WAA's. Both wells pump at a rate of approximately 8 gpm. Both wells pump into a 12,000 gallon storage tank which, per the project applicant, has never been empty even during seasons of peak use. Assuming both wells pump at 8 gpm, the tank would be filled from empty in 12.5 hours. Typical pumping durations are likely much shorter than 12.5 hours.

The effective pumping rate for the project can be determined by calculating the continuous pumping rate required to meet annual water demand for the project. Per Table 7, groundwater demand for the proposed demand on the project parcel is equal to 6.6 acre-ft/yr; that volume of water is equivalent to a continuously pumping well yield of about 4.1 gpm. This rate confirms that the estimated pumping rate of 8 gpm for either project well is sufficient to meet annual demands.

Tier 3 WAA Guidance

The Tier 3 WAA guidance provides well set-back standards and construction assumptions that "if applicable would be expected to preclude any significant adverse effects on surface waters". Specifically, the "Tier 3 Groundwater Surface Water Interaction Criteria" section (pp. 10-13 of the Napa County guidance document dated May 12, 2015) states:

> *The groundwater/surface water criteria are presumptively met if the distance standards and project well construction assumptions are met (see Tables 3, 4, and 5).* (p. 10)

These standards consider the pumping rate of the project well along with the well depth, screened interval and seal depth along with aquifer hydraulic conductivity values and present acceptable distances based on specific combinations of all parameters. Tables 3, 4 and 5 in the

Napa WAA guidance document present these distance standards and assumptions for wells constructed in unconsolidated (e.g. alluvium) aquifer materials and unconfined aquifers; these assumptions are intended primarily for wells in the Napa Valley Groundwater Basin (NVGB). The project well in this case is not in alluvium and is outside the boundary of the NVGB.

The Tier 3 WAA guidance for wells drilled in bedrock in the "hillside zone" (All Other Areas excluding the MST aquifer in southeast Napa) is as follows:

> *All Other Areas, will be subject to other distance standards based on site-specific aquifer conditions. Distance standards for project wells completed in consolidated formations will generally be no more restrictive than those shown in* ***Tables 3, 4, and 5*** *for hydraulic conductivity values of 0.5 ft/day*. (p. 11)

As described previously, the project wells (Well 1 and Well 2) are both screened entirely within the andesite unit of the Sonoma Volcanics. The screened interval of Well 1 begins at 281 ft bgs (277 ft below the bed of Mill Creek) and there is a cement and bentonite surface seal extending to 55 ft bgs; the well pumps at a rate of 8 gpm. Well 2 is screened beginning at 420 feet bgs (167 ft below the bed of Mill Creek), has a concrete surface seal extending 20 ft bgs and pumps at a rate of 8 gpm.

The effective pumping rate and actual pumping rate of the project wells (described above) are consistent with the "Very low capacity pumping rate" category of wells (defined by Napa County to be less than 10 gpm). Therefore, distance standards are evaluated using Table 3 (page 12 of the Napa WAA Guidance document). Table 3 is reproduced below.

Table 3. Well Distance Standards and Construction Assumptions; Very low capacity pumping rates (i.e., less than 10 gpm), constructed in unconsolidated deposits in the upper part of the aquifer system (unconfined aquifer conditions).

Aquifer Hydraulic Conductivity (ft/day)	Acceptable Distance from Surface Water Channel			Minimum Surface Seal Depth (feet)	Depth of Uppermost Perforations (feet)
	500 feet	1000 feet	1500 feet		
80	✓			50	100
50	✓			50	100
30	✓			50	100
0.5	✓			50	100

For a well in a consolidated formation such as the andesite unit of the Sonoma Volcanics, the *de facto* hydraulic conductivity category would be 0.5 ft/day; as shown in the table above an "acceptable distance" of 500 ft or more indicates that "the groundwater/surface water criteria are presumptively met" provided that additional well construction criteria are met.

Project well construction details and distances from nearby waterbodies are summarized in Table 8. Project Well 1 is located 975 feet from Mill Creek, nearly twice the nominal acceptable distance of 500 feet. The surface seal depth of 55 ft meets the construction assumption for a

surface seal while depth to the upper most perforations of Well 1 (281 ft) is more than twice the minimum stated in Table 3 (100 ft). Per assumptions stated above the groundwater surface water criteria are met since both well construction and distance standards have been met by Well 1 with respect to Mill Creek. Therefore, we conclude no significant adverse effects to surface water will occur from pumping of Well 1 to meet project water demands.

Project Well 2 is located 665 feet from Mill Creek, greater than the nominal acceptable distance of 500 feet. Depth to the upper most perforations of Well 2 (420 ft) is more than four times the minimum stated in Table 3 (100 ft) while the surface seal depth of 20 ft does not meet the construction assumption for a surface seal (50 ft). In the case of Well 2, surface water criteria are nearly met since the depth to the top of the well screen is greater than 100 ft and the 500 ft distance standard is exceeded by Well 2 with respect to Mill Creek. Although the depth of the surface seal is less than the minimum assumed depth in Table 3, the screened interval lies 167 feet below the base of the closest segment of channel in Mill Creek and within the low permeability fractured bedrock of the Sonoma Volcanics. This vertical separation between the well screen and closest surface waters, the horizontal separation of 665 ft including the as well as the low permeability of the project aquifer will make it very unlikely that a hydraulic connection exists between Well 2 and Mill Creek. **The depth of the surface seal is not a potentially significant control on groundwater-surface water interaction given the topographic relationship of the well in relation to Mill Creek and the depth to groundwater.** Therefore we conclude that no significant adverse effects to surface water will occur from pumping of Well 2 to meet project water demands.

Summary

Estimated annual groundwater recharge based on average annual precipitation for the period 2012-2021 is 25.1 acre-ft/yr apportioned to the project parcel and 81 acre-ft/yr for the project recharge/impact area. The proposed water use on the project parcel of 6.6 acre-ft/yr is equivalent to 26% of estimated annual recharge; groundwater use in the project recharge area is equivalent to 52% of the estimated recharge.

The nearest neighboring well is located more than 500-ft from the either of the project wells indicating that a Tier 2 well interference analysis is not required.

Both project wells are located within 1,500 ft of the surface waters of Mill Creek requiring a Tier 3 groundwater surface water interaction analysis. Well construction and distance standards are met for Well 1 while Well 2 meets all standards except for the well surface seal standard of 50 ft. Analysis of well construction, well operation, and local hydrogeologic conditions relevant to surface water-groundwater interaction indicated that the project wells conform with County guidance regarding conditions under which that no significant adverse effects to surface water will occur.

References

Cardwell, G.T., 1958. Geology and Ground Water in the Santa Rosa and Petaluma Valley Areas, Sonoma County, California. U.S. Geologic Survey in Cooperation with the California Department of Water Resources. Geological Survey Water Supply Paper 1427.

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APPENDIX A

WELL COMPLETION REPORTS

Well 1

ORIGINAL
File with DWR

Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. e008458

DWR USE ONLY — DO NOT FILL IN
08N06W20
STATE WELL NO./ STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. Well #1-'02
Date Work Began 10/13/2003, Ended 11/5/2003
Local Permit Agency Napa County Environmental Mgmt
Permit No. 96-12526 Permit Date 10/13/2003

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL — HORIZONTAL — ANGLE — (SPECIFY)
DRILLING METHOD ROTARY FLUID AIR

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
0 : 110	BOULDER & VOLCANIC ASH
110 : 180	LARGE FRACTURED VOLCANICS
180 : 280	BLACK & TAN VOLCANICS
280 : 485	MIXED VOLCANICS
485 : 490	RED VOLCANICS
490 : 640	MIXED VOLCANICS (BLACK, RED, GRAY, TAN)

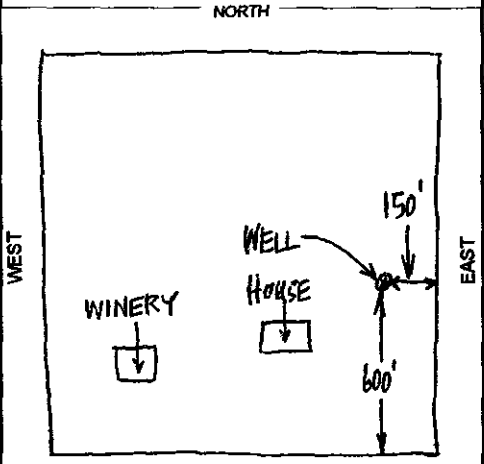
TOTAL DEPTH OF BORING 640 (Feet)
TOTAL DEPTH OF COMPLETED WELL 621 (Feet)

WELL OWNER

WELL LOCATION

Address 4070 Spring Mountain Road
City St. Helena CA 94574
County Napa
APN Book 20 Page 300 Parcel 47
Township — Range — Section —
Latitude — DEG. MIN. SEC. — DEG. MIN. SEC.

LOCATION SKETCH



Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)
✓ NEW WELL
MODIFICATION/REPAIR
— Deepen
— Other (Specify)
— DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)
WATER SUPPLY
— Domestic — Public
✓ Irrigation — Industrial
MONITORING —
TEST WELL —
CATHODIC PROTECTION —
HEAT EXCHANGE —
DIRECT PUSH —
INJECTION —
VAPOR EXTRACTION —
SPARGING —
REMEDIATION —
OTHER (SPECIFY) —

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 510 (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 422 (Ft.) & DATE MEASURED 11/5/2003
ESTIMATED YIELD * 40 (GPM) & TEST TYPE air lift
TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN N/A (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0 : 60	12								
60 : 640	9								
0 : 281		✓				PVC-F480	6	SDR-21	
281 : 301			✓			PVC-F480	6	SDR-21	.032
301 : 481		✓				PVC-F480	6	SDR-21	
481 : 621			✓			PVC-F480	6	SDR-21	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to Ft.	TYPE: CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0 : 25	✓			CONCRETE
25 : 55		✓		CHIPS
55 : 621			✓	#6 SAND

ATTACHMENTS (✓)
— Geologic Log
— Well Construction Diagram
— Geophysical Log(s)
— Soil/Water Chemical Analysis
— Other —
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME HUCKFELDT WELL DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
2110 Penny Lane ADDRESS — Napa CITY — CA STATE — 94559 ZIP
Signed [signature] WELL DRILLER/AUTHORIZED REPRESENTATIVE — 11/05/03 DATE SIGNED — 439-746 C-57 LICENSE NUMBER

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Well 2

ORIGINAL

File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

020 300 047

Do not fill in

No. 162367

Notice of Intent No.
Permit No. or Date

State Well No.
Other Well No 08N06W20F

(2) LOCATION OF WELL (See instructions):

County Napa Owner's Well Number
Well address if different from above Spring Mt. Rd.
Township Range Section
Distance from cities, roads, railroads, fences, etc.

A.P. # 20-300-47

WELL LOCATION SKETCH

(3) TYPE OF WORK:

New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:

Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:

Rotary ☒ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) GRAVEL PACK:

Yes ☒ No ☐ Size 3/8
Diameter of bore
Packed from 20 to 530 ft.

(7) CASING INSTALLED:

Steel ☒ Plastic ☐ Concrete ☐

From ft.	To ft.	Dia. in.	Gage or Wall
0	530	6 5/8	.188w 420

(8) PERFORATIONS:

Type of perforation or size of screen

From ft.	To ft.	Slot size
530		1/8

(9) WELL SEAL:

Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20 ft.
Were strata sealed against pollution? Yes ☐ No ☒ Interval ft.
Method of sealing cement seal

(10) WATER LEVELS:

Depth of first water, if known ft.
Standing level after well completion 430 ft.

(11) WELL TESTS:

Was well test made? Yes ☒ No ☐ If yes, by whom? driller
Type of test Pump ☐ Bailer ☒ Air lift ☐
Depth to water at start of test 430 ft. At end of test 500 ft
Discharge 14 gal/min after 3 hours Water temperature
[redacted]cal analysis made? Yes ☐ No ☒ If yes, by whom?
[redacted]electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG:

Total depth ft. Depth of completed well ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	1	top soil
1	260	boulders embedded in clamshells
260	350	hard volcanic rock
350	362	red volcanic lava
362	530	hard volcanic rock

Work started Nov. 1984 Completed Nov.26 1984

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED ED FISCH by kathy baker (Well Driller)
NAME FISCH BROS. DRILLING INC. (Person, firm, or corporation) (Typed or printed)
Address 5001 Gravenstein Hwy.N.
City Sebastopol, Ca. Zip 95472
License No. 399226 Date of this report 11-28-84

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Well 3

ORIGINAL

File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

020 300 047

Do not fill in

No. 43239

Notice of Intent No.

Local Permit No. or Date

State Well No.

Other Well No. 8N/6W-20F

(2) LOCATION OF WELL (See instructions):

County Napa Owner's Well Number

Well address if different from above Near 4018 Spring Mt. Rd.

Township St. Helena Range Section

Distance from cities, roads, railroads, fences, etc.

A.P.# 20-300-47

WELL LOCATION SKETCH

(3) TYPE OF WORK:

New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:

Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:

Rotary ☒ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☐

(6) GRAVEL PACK:

Yes ☐ No ☒ Size

Diameter of bore 8"

Packed from ft. to ft.

(7) CASING INSTALLED:

Steel ☐ Plastic ☐ Concrete ☐

From ft.	To ft.	Dia. in.	Gage or Wall
Test hole was dry			

(8) PERFORATIONS:

Type of perforation or size of screen

From ft.	To ft.	Slot size

(9) WELL SEAL:

Was surface sanitary seal provided? Yes ☐ No ☒ If yes, to depth ft.

Were strata sealed against pollution? Yes ☐ No ☒ Interval ft.

Method of sealing ------

(10) WATER LEVELS:

Depth of first water, if known ------ ft.

Standing level after well completion ------ ft.

(11) WELL TESTS:

Was well test made? Yes ☒ No ☐ If yes, by whom? driller

Type of test Pump ☐ Bailer ☐ Air lift ☒

Depth to water at start of test ft. At end of test ft

Discharge 0 gal/min after 1 hours Water temperature

Chemical analysis made? Yes ☐ No ☒ If yes, by whom?

Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG:

Total depth 385 ft. Depth of completed well --- ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	3	Topsoil
3	18	Red clay w/basalt boulders
18	80	Hard basalt
80	140	Hard fractured basalt
140	210	Hard basalt
210	385	Hard fractured basalt

Work started Nov. 1 19 78 Completed Nov. 4 19 78

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Erwin C. Grow p.g. (Well Driller)

NAME American Well & Pump Service (Person, firm, or corporation) (Typed or printed)

Address 23002 Arnold Dr.

City Sonoma, CA Zip 95476

License No. 246342 Date of this report Nov. 10, 1978

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM 43816-950 7-76 50M QUAD ⓘT OSP

Well 4

ORIGINAL

File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

020 300 047

Do not fill in

No. 050461

[redacted] of Intent No._____

[redacted] Permit No. or Date_____

State Well No._____

Other Well No. 08N06W20F

(2) LOCATION OF WELL (See instructions):

County Napa Owner's Well Number 20-300-47

Well address if different from above 4018 Spring Mtn. Road

Township St. Helena, CA Range_____ Section_____

Distance from cities, roads, railroads, fences, etc._____

WELL LOCATION SKETCH

(3) TYPE OF WORK:

New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:

Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:

Rotary ☐ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) GRAVEL PACK:

Yes ☐ No ☐ Size_____
Diameter of bore 9 7/8, 6 1/2, 5 5/8
Packed from - to - ft.

(7) CASING INSTALLED:

Steel ☒ Plastic ☐ Concrete ☐

From ft.	To ft.	Dia. in.	Gage or Wall
0	21	7"	10 ga.

(8) PERFORATIONS:

Type of perforation or size of screen

From ft.	To ft.	Slot size

(9) WELL SEAL:

Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20 ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval_____ ft.
Method of sealing Neat cement on pack

(10) WATER LEVELS:

Depth of first water, if known_____ ft.
Standing level after well completion N / A ft.

(11) WELL TESTS:

Was well test made? Yes ☐ No ☐ If yes, by whom?_____
Type of test Pump ☐ Bailer ☐ Air lift ☐
Depth to water at start of test_____ ft. At end of test_____ ft
Discharge_____ gal/min after_____ hours Water temperature_____
[redacted]cal analysis made? Yes ☐ No ☐ If yes, by whom?_____
Was electric log made? Yes ☐ No ☐ If yes, attach copy to this report

(12) WELL LOG:

Total depth 96½ ft. Depth of completed well - ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	20	Extremely hard boulders with thin streaks of clay
20	50	Extremely hard boulders with clay streaks
50	82	Extremely hard multi-colored rock with streaks of clay
82	96½	Rock with streaks of tuffa, extremly hard black rock

Work started 3 - 19 19 80 Completed 4 - 2 1980

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Gerald G. Thompson, By: Mary E. Thompson (Well Driller)

NAME WEEKS DRILLING AND PUMP COMPANY (Person, firm, or corporation) (Typed or printed)

Address 6100 Sebastopol Rd.

City Sebastopol, CA Zip 95472

License No. C57-177681 Date of this report April 11, 1980

Mary E. Thompson

NOT A PUBLIC USE WELL
DO NOT USE FOR PUBLIC USE
WATER CODE SEC. 13752

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Well 5

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

ORIGINAL
File with DWR

CONFIDENTIAL LOG
Water Code Sec. 13752

WATER WELL DRILLERS REPORT

020 300 047

Do Not Fill In

No 91024

State Well No. _____

Other Well No. 8N/6W-20F

(2) LOCATION OF WELL:

County Napa Owner's number, if any P

Township, Range, and Section 20 - 300 - 47

Distance from cities, roads, railroads, etc.

(3) TYPE OF WORK (*check*):

New Well ☒ Deepening ☐ Reconditioning ☐ Destroying ☐

If destruction, describe material and procedure in Item 11.

(4) PROPOSED USE (*check*):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary ☐
Cable ☐
Other ☐

(6) CASING INSTALLED:

STEEL: OTHER:
SINGLE ☐ DOUBLE ☐

From ft.	To ft.	Diam.	Gage or Wall

If gravel packed

Diameter of Bore	From ft.	To ft.

Size of shoe or well ring:

Size of gravel:

Describe joint

(7) PERFORATIONS OR SCREEN:

Type of perforation or name of screen

From ft.	To ft.	Perf. per row	Rows per ft.	Size in. x in.

(8) CONSTRUCTION:

Was a surface sanitary seal provided? Yes ☐ No ☐ To what depth ft.

Were any strata sealed against pollution? Yes ☐ No ☐ If yes, note depth of strata

From ft. to ft.

From ft. to ft.

Method of sealing

(9) WATER LEVELS:

Depth at which water was first found, if known ft.

Standing level before perforating, if known ft.

Standing level after perforating and developing ft.

(10) WELL TESTS:

Was pump test made? Yes ☐ No ☐ If yes, by whom?

gpm/sq. ft. cal./cu. with ft. drawdown after hrs.

Temperature of water Was a chemical analysis made? Yes ☐ No ☐

Was electric log made of well? Yes ☐ No ☐ If yes, attach copy

(11) WELL LOG:

Total depth ft. Depth of completed well ft.

Formation: *Describe by color, character, size of material, and structure*

ft. to	Formation
	Dry Hole
0 - 33	Yellowish & boulders
33 - 49	Brownish
49 - 52	Brownish
52 - 163	Brownish
163 - 185	Blue Clay & boulders

Dry Hole

Work started Sept 1973 Completed Oct 3 1975

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Pattiani & Sullivan
(Person, firm, or corporation) (*Typed or printed*)

Address 1544 Main St. West Napa Cal.

[SIGNED] Walter Pattiani
(Well Driller)

License No. 282649 Dated Oct 7, 75

SKETCH LOCATION OF WELL ON REVERSE SIDE

CONFIDENTIAL LOG
Water Code Sec. 13752

DWR 188 (REV. 9-68)

25179-950 9-68 SCM TRIP △D OSP

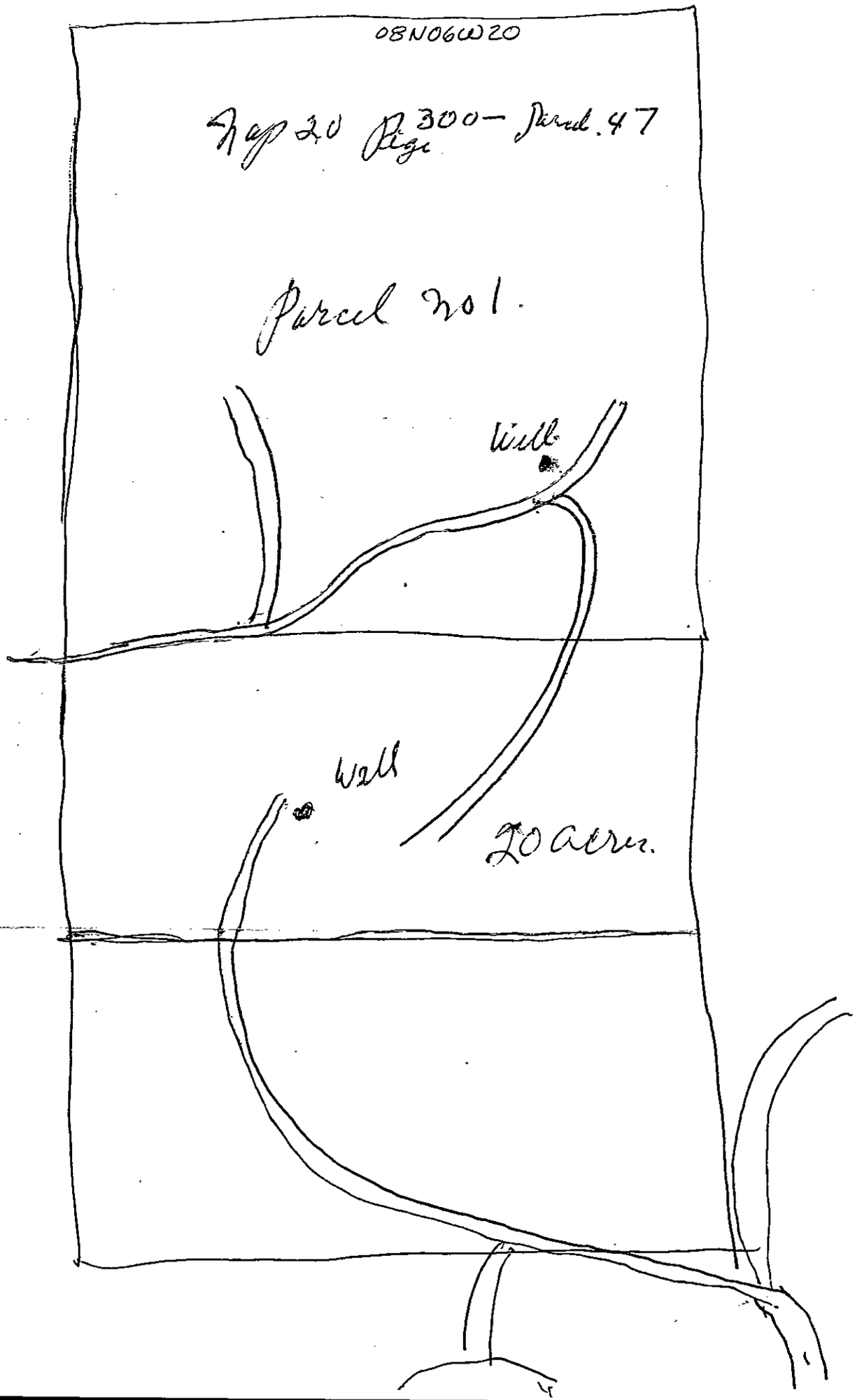
Well 5, cont.

No. 91024

08N06W20

Map 20 Page 300 – Parcel 47

Parcel No 1.



Well 5, cont.

No 91024

VOL 934 PAGE 531

West 198.91 feet; thence North 85° 23' 30" West 125.63 feet; thence North 24° 59' 30" West 257.08 feet; thence North 01° 29' 30" West 372.06 feet; thence North 34° 13' East 193.32 feet; thence North 11° 06' East 443.0 feet; thence North 12° 00' West 130.34 feet; thence North 01° 15' West 302.86 feet; thence North 34° 28' West 122.27 feet; thence North 59° 52' West to the western line of the East half of the Northeast quarter of the Northwest quarter of the Southwest quarter of said Section 20, herein called point "A".

b) A right of way 60 feet wide, the Eastern line of which commences on the Western line of the East half of the Northeast quarter of the Northwest quarter of the Southwest quarter of said Section 20, at a point 30 feet South of point "A" of the right of way above described and runs North 220 feet more or less, to a point 1.00 foot North of the Northern line of the Southwest quarter of said Section 20, said point herein called point "B".

c) A right of way 60 feet wide, the Northern line of which commences at a point "B" of the right of way above described and runs East, parallel to and 1.00 foot Northerly of the Northern line of the Southwest quarter of said Section 20, a distance of 990 feet.

Dated: March 6, 1973.

Dear,

The Taf statement says: Taf Rate Area #30807 85001

Map 20 PG-Bek 300 Parcel #47
Acreage 39.96

Hope this is the information you need. Regards,

Well 6

ORIGINAL

File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

020 300 047

Do not fill in

No. 239710

[redacted] of Intent No.
Local Permit No. or Date EH 12526

State Well No.
Other Well No. 08N06W20F

(2) LOCATION OF WELL (See instructions):

County Napa Owner's Well Number 20-300-47

Well address if different from above 4018 Spring Mtn. Road

Township St. Helena Range Section

Distance from cities, roads, railroads, fences, etc.

[redacted]

WELL LOCATION SKETCH

(3) TYPE OF WORK:

New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:

Domestic ☐
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

(5) EQUIPMENT:

Rotary ☐ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) GRAVEL PACK:

Yes ☐ No ☒ Size N/A
Diameter of bore 9 7/8, 6 3/4
Packed from to ft.

(7) CASING INSTALLED:

Steel ☐ Plastic ☐ Concrete ☐

From ft.	To ft.	Dia. in.	Gage or Wall
	N/A		

(8) PERFORATIONS:

Type of perforation or size of screen

From ft.	To ft.	Slot size
	N/A	

(9) WELL SEAL:

Was surface sanitary seal provided? Yes ☐ No ☐ If yes, to depth ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval ft.
Method of sealing

(10) WATER LEVELS:

Depth of first water, if known ft.
Standing level after well completion ft.

(11) WELL TESTS:

Was well test made? Yes ☐ No ☐ If yes, by whom?
Type of test Pump ☐ Bailer ☐ Air lift ☐
Depth to water at start of test ft. At end of test ft
[redacted] arge gal/min after hours Water temperature
[redacted] ical analysis made? Yes ☐ No ☐ If yes, by whom?
Was electric log made? Yes ☐ No ☐ If yes, attach copy to this report

(12) WELL LOG:

Total depth 413 ft. Depth of completed well -0- ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	10	Reddish-brown clay
10	26	Moist brown clay
26	48	Brown clay and tufa
48	60	Hard gray boulders, brown clay, and tufa
60	83	Brown tufa & gray rock
83	109	Conglomerate tufa & rock
109	187	Conglomerate rock
187	413	Conglomerate rock and tufa
		Dry Hole - Abandoned

Work started 7/18 19 83 Completed 7/25 19 83

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

SIGNED Gerald G. Thompson, By: Ward Thompson (Well Driller)

NAME WEEKS DRILLING AND PUMP COMPANY (Person, firm, or corporation) (Typed or printed)

Address P. O. Box 176

City Sebastopol, CA Zip 95472

License No. C57-177681 Date of this report July 27, 1983

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Well 7

ORIGINAL
File with DWR

CORRECTED COPY

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 775476

DWR USE ONLY -- DO NOT FILL IN

08N06W20F

STATE WELL NO./ STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

Page 1 of 1

Owner's Well No. Test Hole #2

Date Work Began 8/30/01, Ended 9/17/01

Local Permit Agency Napa Co Environ Health

Permit No. 96-11854 Permit Date 7/10/01

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD AIR ROTARY FLUID N/A

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
	TEST HOLE
0 21	Basalt boulders
21 427	Fractured basalt with sand, red clays
427 562	Red clay, red cinder rock
562 625	Basalt
625 720	Basalt with multi-colored volcanic rock

Welded steel plate on conductor

TOTAL DEPTH OF BORING 720 (Feet)

TOTAL DEPTH OF COMPLETED WELL N/A (Feet)

WELL OWNER

WELL LOCATION

Address 4070 Spring Mountain Road

City St Helena CA

County Napa

APN Book 020 Page 300 Parcel 047

Township Range Section

Latitude DEG. MIN. SEC. DEG MIN SEC

LOCATION SKETCH

NORTH

WEST

EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR

Deepen

Other (Specify)

DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG"

PLANNED USES (✓)

WATER SUPPLY

✓ Domestic Public

✓ Irrigation Industrial

MONITORING

TEST WELL

CATHODIC PROTECTION

HEAT EXCHANGE

DIRECT PUSH

INJECTION

VAPOR EXTRACTION

SPARGING

REMEDIATION

OTHER (SPECIFY)

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE 1

DEPTH OF STATIC WATER LEVEL N/A (Ft.) & DATE MEASURED

ESTIMATED YIELD N/A (GPM) & TEST TYPE N/A

TEST LENGTH N/A (Hrs.) TOTAL DRAWDOWN N/A (Ft.)

May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0 40	12"HB								
40 720	8"HB								
+1 22	13"			✓		STEEL	8"	.188	

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to Ft.	TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0 22	✓			

ATTACHMENTS (✓)

Geologic Log

Well Construction Diagram

Geophysical Log(s)

Soil/Water Chemical Analysis

Other

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Weeks Drilling & Pump Co
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. Box 176 Sebastopol CA 95473
ADDRESS CITY STATE ZIP

Signed
WELL DRILLER/AUTHORIZED REPRESENTATIVE

12/04/01
DATE SIGNED

177681
C-57 LICENSE NUMBER

DWR 188 REV 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Well 7, cont.

DWR

Page 1 of 1

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 775476

DWR USE ONLY — DO NOT FILL IN

08N06W20F

STATE WELL NO./ STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

Owner's Well No. Test Hole #2

Date Work Began 8/30/01, Ended 9/17/01

Local Permit Agency Napa Co Environ Health

Permit No. 96-11854 Permit Date 7/10/01

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD AIR ROTARY FLUID N/A

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
		TEST HOLE
0	21	Basalt boulders
21	427	Fractured basalt with sand, red clays
427	562	Red clay, red cinder rock
562	625	Basalt
625	720	Basalt with multi-colored volcanic rock

Test hole backfilled and abandoned per Napa County requirements

TOTAL DEPTH OF BORING 720 (Feet)

TOTAL DEPTH OF COMPLETED WELL N/A (Feet)

WELL OWNER

WELL LOCATION

Address 4070 Spring Mountain Road

City St Helena CA

County Napa

APN Book 020 Page 300 Parcel 047

Township Range Section

Latitude DEG. MIN. SEC.

DEG. MIN. SEC.

LOCATION SKETCH

NORTH

WEST EAST

SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR

Deepen

Other (Specify)

DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG"

PLANNED USES (✓)

WATER SUPPLY

✓ Domestic Public

✓ Irrigation Industrial

MONITORING

TEST WELL

CATHODIC PROTECTION

HEAT EXCHANGE

DIRECT PUSH

INJECTION

VAPOR EXTRACTION

SPARGING

REMEDIATION

OTHER (SPECIFY)

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER N/A (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL N/A (Ft.) & DATE MEASURED

ESTIMATED YIELD * N/A (GPM) & TEST TYPE N/A

TEST LENGTH N/A (Hrs.) TOTAL DRAWDOWN N/A (Ft.)

May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	40	12"HB								
40	720	8"HB								
+1	720									

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)

ATTACHMENTS (✓)

Geologic Log

Well Construction Diagram

Geophysical Log(s)

Soil/Water Chemical Analysis

Other

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Weeks Drilling and Pump Company, Inc.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. Box 176 ADDRESS Sebastopol CITY CA STATE 95473 ZIP

Signed Melissa G Lopez WELL DRILLER/AUTHORIZED REPRESENTATIVE

10/03/01 DATE SIGNED

177681 C-57 LICENSE NUMBER

DWR 188 REV 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Well 8

DWR

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 822299

DWR USE ONLY — DO NOT FILL IN

08N06W20E

STATE WELL NO./STATION NO

LATITUDE LONGITUDE

APN/TRS/OTHER

Page 1 of 1

Owner's Well No. #1

Date Work Began 10-30-99 Ended 11-5-99

Local Permit Agency NAPA COUNTY ENVIRONMENTAL MANGT.

Permit No. 96-113167 Permit Date 10-14-99

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD AIR ROTARY FLUID ___

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	2	TOP SOIL
2	24	RED CLAY-BOULDERS
24	31	YELLOW ASH-BOULDERS-HARD BASALT
31	65	TAN ASH-BOULDERS
66	117	WHITE ASH
117	135	RED ASH
135	182	YELLOW ASH BOULDERS
182	528	HARD BROKEN BASALT
528	630	ORANGE RED GREEN AIRFALL VOLCANIC MIX ROCK

TOTAL DEPTH OF BORING 630 (Feet)

TOTAL DEPTH OF COMPLETED WELL 625 (Feet)

WELL OWNER

WELL LOCATION

Address 4018 SPRING MT RD

City ST HELENA

County NAPA

APN Book 20 Page 300 Parcel 35

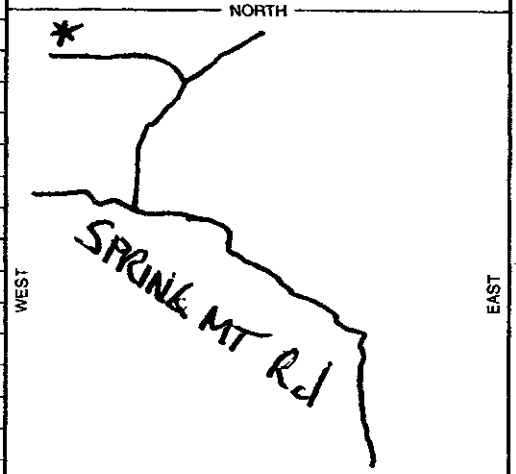
Township ___ Range ___ Section ___

Latitude ___ DEG. ___ MIN. ___ SEC. NORTH

Longitude ___ DEG. ___ MIN. ___ SEC. WES

LOCATION SKETCH

NORTH



SOUTH

*Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. **PLEASE BE ACCURATE & COMPLETE.***

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY *(Describe Procedures and Materia Under "GEOLOGIC LOC*

PLANNED USES (✓)

WATER SUPPLY

✓ Domestic ___ Public

___ Irrigation ___ Industri

___ MONITORING

___ TEST WELL

___ CATHODIC PROTECTION

___ HEAT EXCHANGE

___ DIRECT PUSH

___ INJECTION

___ VAPOR EXTRACTION

___ SPARGING

___ REMEDIATION

___ OTHER (SPECIFY)

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 569 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 310 (Ft.) & DATE MEASURED 11-5-99

ESTIMATED YIELD * 10 (GPM) & TEST TYPE AIR LIFT

TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN NA (Ft.)

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	50	11"	X				ARCE 480	5"	.200	
50	625	8 3/4"	XX				ARCE 480	5"	.200	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	52	✓			
52	625			✓	3/16 PEA GRAVEL

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME D. BOSS WATER WELL DRILLING (PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS 1115 SAN GEORGE AVE CITY NAPA STATE CA ZIP 94558

Signed ___ (WELL DRILLER/AUTHORIZED REPRESENTATIVE) DATE SIGNED 11-16-99

C-57 LICENSE NUMBER 499022

Well 9

STATE OF CALIFORNIA

WELL COMPLETION REPORT

No. e0280361

E: 05/15/17

DWR USE ONLY --- DO NOT FILL IN

08N06W20

STATE WELL NO. STATION NO.

38 31 28 N 122 33 04 W

LATITUDE LONGITUDE

APN / TRS / OTHER

OWNER'S WELL No. 9625

Date Work Began 2/1/17 Ended 2/9/17

Local Permit Agency NAPA

Permit No. E16-00482 Permit Date 7/29/2016

GEOLOGIC LOG

ORIENTATION Vertical Degree of Angle .....

DEPTH TO FIRST WATER .....(ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft.	Ft.	DESCRIPTION
0	140	brown ash & boulders
140	180	brown & red ash & rock
180	505	basalt
505	520	brown & blue clay
520	640	volcanic rock & ash
640	700	blue clay

recommended pump setting of 640'

TOTAL DEPTH OF BORING 700 (Feet)

TOTAL DEPTH OF COMPLETED WELL 700 (Feet)

WELL LOCATION

Address 4078 SPRING MOUNTAIN RD

City ST HELENA County NAPA

Apn Book 020 Page 300 Parcel 035

or Township ..... Range ..... Section ..... 1/4 ..... 1/4

or Latitude ..... Deg. ..... Min. ..... Sec. NORTH Longitude ..... Deg. ..... Min. ..... Sec. WEST

LOCATION SKETCH

ACTIVITY NEW WELL PLANNED USE(S)

DRILLING METHOD FLUID

DEPTH OF STATIC WATER LEVEL 480 (Ft.) & DATE MEASURED Feb 9, 2017

ESTIMATED YIELD * 10 (G.P.M.) & TEST TYPE Airlift

TEST LENGTH. 2 (Hrs.) TOTAL DRAWDOWN N/A (FT.)

*May not be representative of a well's long-term yield.

CASING

DEPTH FROM SURFACE Ft.	To Ft.	BORE-HOLE DIA.	TYPE	Material / Grade	Dia.	Gauge	Slot size
0	80	12.4	BLANK	F480 PVC	5	SCH	17
80	120	10	BLANK	F480 PVC	5	SCH	17
120	150	8 3/4	BLANK	F480 PVC	5	SCH	17
150	280	7 7/8	BLANK	F480 PVC	5	SCH	17
280	700	7 7/8	PERF	F480 PVC	5	032	w/cap

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	To Ft.	Seal Material	Filter Pack (Type / Size)
0	50	Bentonite	
50	700		1/4 X 1/8

Attachments

...no... Geologic Log

...no... Well Construction Diagram

...no... Geophysical Logs

...no... Soil Water Chemical Analyses

...no... Other

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Fisch Bros. Drilling, Inc.

(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5001 Gravenstein Hwy No. Sebastopol CA. 95472

Signed 3-10-17 399226

WELL DRILLER / AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

Well 10

File with DWR

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

Page 1 of 1

Owner's Well No. Test Hole # 1

No. 822298

Date Work Began 10-18-99 Ended 10-30-99

Local Permit Agency Co of Napa Environmental Mangt.

Permit No. 96-11367 Permit Date 10-14-99

08N06W20E
STATE WELL NO./STATION NO

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD AIR ROTARY FLUID ___

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	3	Top Soil
3	180	Volcanic Ash Boulders
180	585	Hard Black Solid Basalt.

DRY HOLE

TOTAL DEPTH OF BORING 585 (Feet)

TOTAL DEPTH OF COMPLETED WELL ___ (Feet)

WELL OWNER

WELL LOCATION

Address 4078 SPRING MT Rd

City ST. HELENA CA.

County NAPA

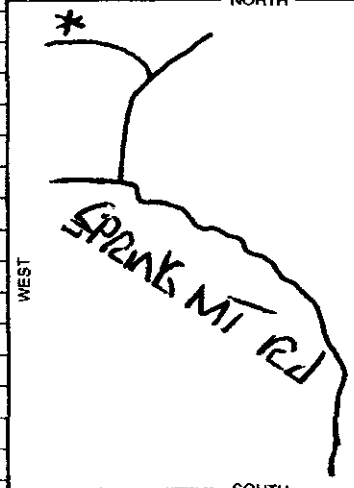
APN Book 20 Page 300 Parcel 35

Township ___ Range ___ Section ___

Latitude ___ DEG. ___ MIN. ___ SEC. NORTH Longitude ___ DEG. ___ MIN. ___ SEC. WEST

LOCATION SKETCH

NORTH



SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. ***PLEASE BE ACCURATE & COMPLETE.***

ACTIVITY (✓)

___ NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

PLANNED USES (✓)

WATER SUPPLY
___ Domestic ___ Public
___ Irrigation ___ Industrial

___ MONITORING
___ TEST WELL
___ CATHODIC PROTECTION
___ HEAT EXCHANGE
___ DIRECT PUSH
___ INJECTION
___ VAPOR EXTRACTION
___ SPARGING
___ REMEDIATION
___ OTHER (SPECIFY)

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL ___ Ft. & DATE MEASURED ___

ESTIMATED YIELD * ___ (GPM) & TEST TYPE ___

TEST LENGTH ___ (Hrs.) TOTAL DRAWDOWN ___ (Ft.)

N/A

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft	to Ft	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)

NOT CASED

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft	to Ft	TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	585			✓	

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME D. BESS WATER WELL DRILLING
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS 1115 MT. GEORGE AVE. NAPA CA. 94558
CITY STATE ZIP

Signed ___
WELL DRILLER/AUTHORIZED REPRESENTATIVE

11-9-99 DATE SIGNED

487071 C-57 LICENSE NUMBER

DWR 188 REV 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Well 11

STATE OF CALIFORNIA

WELL COMPLETION REPORT

No. e0330214

R: 5/15/17

DWR USE ONLY --- DO NOT FILL IN

09N06W20

STATE WELL NO. STATION NO.

38 31 28 N 122 33 04 W

LATITUDE LONGITUDE

APN / TRS / OTHER

OWNER'S WELL No. 9428

Date Work Began 2/14/17 Ended 2/21/17

Local Permit Agency NAPA

Permit No. E16-00482 Permit Date 7/29/2016

GEOLOGIC LOG

ORIENTATION Vertical Degree of Angle .....

DEPTH FROM SURFACE DEPTH TO FIRST WATER .....(ft.) BELOW SURFACE

Ft.	Ft.	DESCRIPTION
0	100	brown & blue ash & boulders
100	205	brown & blue ash
205	685	basalt
685	760	blue clay
		dry hole

TOTAL DEPTH OF BORING 760 (Feet)

TOTAL DEPTH OF COMPLETED WELL ..... (Feet)

WELL OWNER

WELL LOCATION

Address 4078 SPRING MOUNTAIN RD

City ST. HELENA County NAPA

Apn Book 020 Page 300 Parcel 035

or Township ..... Range ..... Section ..... 1/4 ..... 1/4

or Latitude ..... NORTH Longitude ..... WEST

Deg. Min. Sec. Deg. Min. Sec.

LOCATION SKETCH

ACTIVITY NEW WELL PLANNED USE(S)

DRILLING METHOD FLUID

DEPTH OF STATIC WATER LEVEL ..... (Ft.) & DATE MEASURED .....

ESTIMATED YIELD * .....(G.P.M.) & TEST TYPE ..... Airlift

TEST LENGTH. 2 (Hrs.) TOTAL DRAWDOWN ..... (FT.)

*May not be representative of a well's long-term yield.

CASING

DEPTH FROM SURFACE Ft.	To Ft.	BORE-HOLE DIA.	TYPE	Material / Grade	Dia.	Gauge	Slot size

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	To Ft.	Seal Material	Filter Pack (Type / Size)
0	30	Bentonite	
30	760	BENTONITE	3/8

Attachments

...no... **Geologic Log**

...no... Well Construction Diagram

...no... Geophysical Logs

...no... Soil Water Chemical Analyses

...no... Other

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Fisch Bros. Drilling, Inc.

(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

5001 Gravenstein Hwy. No. Sebastopol CA. 95472

Signed _____ 2/23/17 399226

WELL DRILLER / AUTHORIZED REPRESENTATIVE DATE SIGNED C- 57 LICENSE NUMBER

Well 12

State of California

Well Completion Report

Form DWR 188 Auto-Completed 2/27/2017

WCR2016-005776

Owner's Well Number 020-300-035-000 | Date Work Began 06/20/2016 | Date Work Ended 07/07/2016

Local Permit Agency Napa County Planning Building and Environmental Services

Secondary Permit Agency | Permit Number E16-00382 | Permit Date 06/15/2016

Well Owner (must remain confidential pursuant to Water Code 13752)

Name XXXXXXXXXXXXXXXXXXX

Mailing Address XXXXXXXXXXXXXXXXXXX

XXXXXXXXXXXXXXXXXXX

City XXXXXXXXXXXXXXXXXXX State XX Zip XXXXX

Planned Use and Activity

Activity Drill and Destroy

Planned Use Destruction

Well Location

Address 4078 Spring Mountain RD

City ST HELENA Zip 94574 County Napa

Latitude Deg. Min. Sec. N Longitude Deg. Min. Sec. W

Dec. Lat. 38.5321761 Dec. Long. -122.5580502

Vertical Datum Horizontal Datum WGS84

Location Accuracy Location Determination Method

APN 020-300-035-000

Township 08 N

Range 06 W

Section 20

Baseline Meridian Mount Diablo

Ground Surface Elevation

Elevation Accuracy

Elevation Determination Method

Borehole Information

Orientation Vertical Specify

Drilling Method Direct Rotary Drilling Fluid Air

Total Depth of Boring 630 Feet

Total Depth of Completed Well Feet

Water Level and Yield of Completed Well

Depth to first water (Feet below surface)

Depth to Static Water Level (Feet) Date Measured

Estimated Yield* (GPM) Test Type

Test Length (Hours) Total Drawdown (feet)

*May not be representative of a well's long term yield.

Geologic Log - Free Form

Depth from Surface Feet to Feet		Description
0	25	LOOSE RED DIRT & BOULDERS
25	65	BROWN CLAY & GRAVEL
65	85	BROWN CLAY & ROCKS
85	525	HARD BLACK BASALT
525	630	GREY SHALE CLAY

Well 12, cont.

Casings

Casing #	Depth from Surface Feet to Feet		Casing Type	Material	Casings Specificatons	Wall Thickness (inches)	Outside Diameter (inches)	Screen Type	Slot Size if any (inches)	Description

Annular Material

Depth from Surface Feet to Feet		Fill	Fill Type Details	Filter Pack Size	Description
0	30	Cement	10.3 Sack Mix		
30	600	Filter Pack	Other Gravel Pack	6	BIRD'S EYE GRAVEL

Destruction Details:
HOLE WOULD NOT STAY OPEN DUE TO EARTHQUAKE

Other Observations:

Borehole Specifications

Depth from Surface Feet to Feet		Borehole Diameter (inches)
0	630	10

Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name: PULLIAM WELL EXPLORATION INC (Person, Firm or Corporation)

1663 HOWELL MTN RD (Address) | ANGWIN (City) | CA (State) | 94508 (Zip)

Signed: *electronic signature received* (C-57 Licensed Water Well Contractor) | 08/15/2016 (Date Signed) | 808508 (C-57 License Number)

DWR Use Only

CSG #	State Well Number	Site Code	Local Well Number

N — Latitude Deg/Min/Sec

W — Longitude Deg/Min/Sec

TRS:

APN:

Well 13

DWR

Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 557089

DWR USE ONLY — DO NOT FILL IN
STATE WELL NO./STATION NO.: 08N06W
LATITUDE / LONGITUDE / APN/TRS/OTHER

Owner's Well No. 1
Date Work Began 8/20/96, Ended 9/20/96
Local Permit Agency Co. of Napa Environmental Management
Permit No. 43098 Permit Date 9/20/96

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

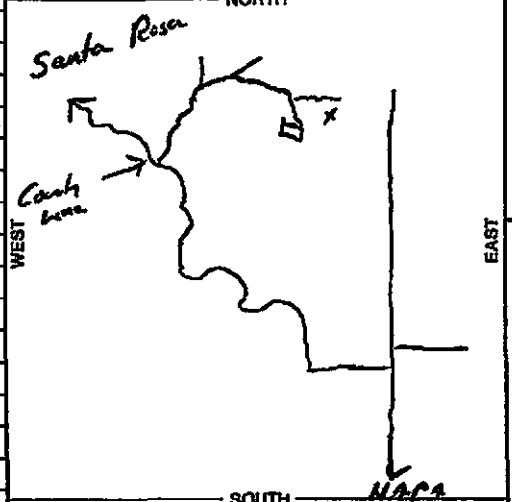
DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	7	Top Soil
7	10	Red Clay
10	26	Clay - Rock
26	127	Loose Rock - Very Hard Vol
127	148	Red Vol Ash
148	196	Ash - Mixed with Hard Lava Rock
196	260	Soft Ash
260	263	Water Bearing Rock Hard Vol
263	290'	Cream colored Ash Vol.
290	293	Vol Rock 2-3 GPM
293	297	White Vol Ash
297	386	Red Clay & Rock Imbedded
386	410	Hard Rock
410	415	Soft Clay
415	432	Hard Vol Rock/Gravel mix
432	446	Soft Ash
446	484	Hard Vol Rock
484	526	Soft Gumbo shale Clay

TOTAL DEPTH OF BORING 526 (Feet)
TOTAL DEPTH OF COMPLETED WELL 510 (Feet)

WELL OWNER

Address Tulucay Spring MT Road
City St. Helena
County Napa
APN Book 20 Page 300 Parcel 43
or Township ___ Range ___ Section ___
or Latitude ___ DEG. ___ MIN. ___ SEC. NORTH Longitude ___ DEG. ___ MIN. ___ SEC. WEST

LOCATION SKETCH



Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USE(S) (✓)

___ MONITORING
WATER SUPPLY
✓ Domestic
___ Public
✓ Irrigation
___ Industrial
___ "TEST WELL"
___ CATHODIC PROTECTION
___ OTHER (Specify)

DRILLING METHOD Air changed to (FLUID)

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 263' (Ft.) & DATE MEASURED 9-23-96
ESTIMATED YIELD* 65 (GPM) & TEST TYPE Air Lift
TEST LENGTH 4 (Hrs.) TOTAL DRAWDOWN N/A (Ft.)
* *May not be representative of a well's long-term yield.*

CASING(S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	24'	10 3/4	X				PVC F480	5"	200	
24	200	8"	X				PVC F480	5"	200	
200	500	8	X	X			PVC F480	5"	200	.030

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE: CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE / SIZE)
0	23'	✓			
23	526			✓	3/8 Pea Gravel

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME D. Bess Pump & Well (PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
ADDRESS 1115 MT George Ave CITY Napa STATE Ca ZIP 94558
Signed Dan Bess (WELL DRILLER/AUTHORIZED REPRESENTATIVE) DATE SIGNED 9/25/96 C-57 LICENSE NUMBER 487027

DWR 188 REV. 7-90 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

1627

Well 14

ORIGINAL
File with DWR

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

WATER WELL DRILLERS REPORT

Do not fill in
No. 291253

Notice of Intent No. _____
Local Permit No. or Date 24548

State Well No. _____
Other Well No. 08N06W20N

(2) LOCATION OF WELL (See instructions):
County Napa Owner's Well Number 20-300-60
Well address if different from above Spring Mtn. Rd.
Township St. Helena Range _____ Section _____
Distance from cities, roads, railroads, fences, etc. _____

WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☐
Irrigation ☐
Industrial ☐
Test Well ☐
Municipal ☒
Other ☐
(Describe)

(5) EQUIPMENT:
Rotary ☐ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☐ No ☒ Size _____
Diameter of bore 9 7/8, 6 3/4
Packed from _____ to _____ ft.

(7) CASING INSTALLED:
Steel ☐ Plastic ☐ Concrete ☐

From ft.	To ft.	Dia. in.	Gage or Wall
	N/A		

(8) PERFORATIONS:
Type of perforation or size of screen

From ft.	To ft.	Slot size
N/A		

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☐ No ☐ If yes, to depth _____ ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval _____ ft.
Method of sealing _____

(10) WATER LEVELS:
Depth of first water, if known _____ ft.
Standing level after well completion _____ ft.

(11) WELL TESTS:
Was well test made? Yes ☐ No ☐ If yes, by whom? _____
Type of test Pump ☐ Bailer ☐ Air lift ☐
Depth to water at start of test _____ ft. At end of test _____ ft.
Discharge _____ gal/min after _____ hours Water temperature _____
Chemical analysis made? Yes ☐ No ☐ If yes, by whom? _____
Was electric log made Yes ☐ No ☐ If yes, attach copy to this report

(12) WELL LOG: Total depth 480 ft. Completed depth -0- ft.

from ft.	to ft.	Formation (Describe by color, character, size or material)
0	8	Sandy red clay with multi-colored gravels
8	24	Yellow, orange & green tufa
24	29	Gray tufa
29	46	Gray tufa with multi-colored volcanic conglomerate
46	89	Greenish-gray clay with multi-colored volcanic gravels
89	109	Hard sandy gray & sandy green rock with greenish-gray clay
109	117	Very hard snady blue-green rock
117	147	Very hard sandy blue-green rock
147	174	Hard multi-colored conglomerate with gray clay
174	182	Very hard snady blue-green rock with traces of sandy gray & sandy burgundy rock
182	334	Hard blue-green rock with traces of multi-colored volcanic rock
334	347	Very hard blue sandy blue-green rock
347	363	Hard sandy blue, green, gray and burgundy rock
363	397	Very hard sandy blue, green, gray & burgundy rock
397	426	Multi-colored volcanic conglomerate
426	480	Hard blue sandy blue and sandy multi-colored rock
		Dry Hole - Backfilled and Abandoned

Work started 9-1 1989 Completed 9-7 1989

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Signed Ward Thompson (Well Driller)
NAME WEEKS DRILLING AND PUMP COMPANY, INC. (Person, firm, or corporation) (Typed or printed)
Address P.O. Box 176
City Sebastopol, CA ZIP 95473
License No. C57-177681 Date of this report 9-22-89

DWR 188 (REV. 12-86) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

86 96355

Well 15 WR

Page 1 of 1

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 806862

DWR USE ONLY — DO NOT FILL IN

08N06W

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

Owner's Well No. _____

Date Work Began 7-9-02 , Ended 7-11-02

Local Permit Agency Napa County Environmental Mgmt.

Permit No. 96-12128 Permit Date 6-26-02

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD rotary FLUID _____

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	6	volcanic boulders
6	50	volcanic ash
50	300	black volcanic
300	335	hard black volcanics
335	380	mixed black & green volcanics
380	420	red volcanics
420	480	black & green volcanics
		BACKFILLED TEST HOLE WITH CUTTINGS AND PEA GRAVEL TO 22'. INSTALLED CONCRETE TO 4' PLACED NATURAL SOILS TO SURFACE.

TOTAL DEPTH OF BORING 480 (Feet)

TOTAL DEPTH OF COMPLETED WELL _____ (Feet)

WELL LOCATION

Address Same

City _____

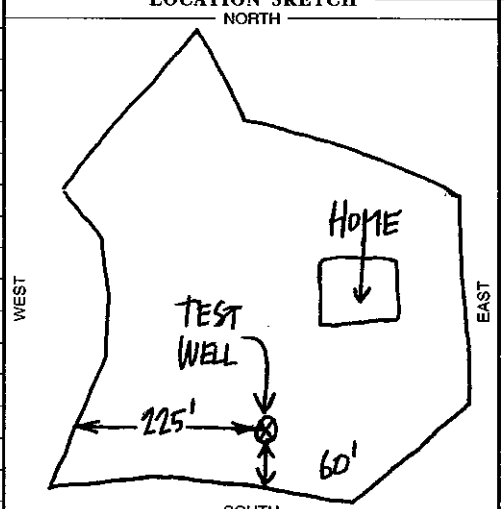
County Napa

APN Book 20 Page 300 Parcel 61

Township _____ Range _____ Section _____

Latitude ___ DEG. ___ MIN. ___ SEC. NORTH Longitude ___ DEG. ___ MIN. ___ SEC. WEST

LOCATION SKETCH



Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

PLANNED USES (✓)

WATER SUPPLY

___ Domestic ___ Public

___ Irrigation ___ Industrial

MONITORING ___

TEST WELL X

CATHODIC PROTECTION ___

HEAT EXCHANGE ___

DIRECT PUSH ___

INJECTION ___

VAPOR EXTRACTION ___

SPARGING ___

REMEDIATION ___

OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER _____ (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL _____ (Ft.) & DATE MEASURED _____

ESTIMATED YIELD * _____ (GPM) & TEST TYPE _____

TEST LENGTH _____ (Hrs.) TOTAL DRAWDOWN _____ (Ft.)

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	480	9								

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	4			X	soil
4	22	X			concrete
22	480			X	cuttings

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other _____

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME HUCKFELDT WELL DRILLING (PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

2110 Penny Lane ADDRESS Napa CITY CA STATE 94559 ZIP

Signed _____ WELL DRILLER/AUTHORIZED REPRESENTATIVE

8-30-02 DATE SIGNED

439-746 C-57 LICENSE NUMBER

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Well 16 WR

Page 1 of 1

Owner's Well No. _____

Date Work Began 7-12-02, Ended 8-6-02

Local Permit Agency Sonoma County Environmental Mgmt.

Permit No. WEL02-0325 Permit Date 7-12-02

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 806863

DWR USE ONLY — DO NOT FILL IN

08N06W20

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD rotary FLUID bentonite

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0	60	volcanic ash
60	70	green volcanics
90	95	gray clay
95	100	serpentine
100	195	shale & clay
195	320	sandstone with shale stringers
320	420	greenstone & shale
420	430	gray clay
430	435	greenstone
435	510	gray shale & clay
510	525	greenstone
525	600	sandstone with shale stringers
600	640	shale & clay

TOTAL DEPTH OF BORING 640 (Feet)

TOTAL DEPTH OF COMPLETED WELL 585 (Feet)

WELL OWNER

Name _____

Mailing Addres _____

CITY _____ STATE _____ ZIP _____

WELL LOCATION

Address same

City _____

County Sonoma

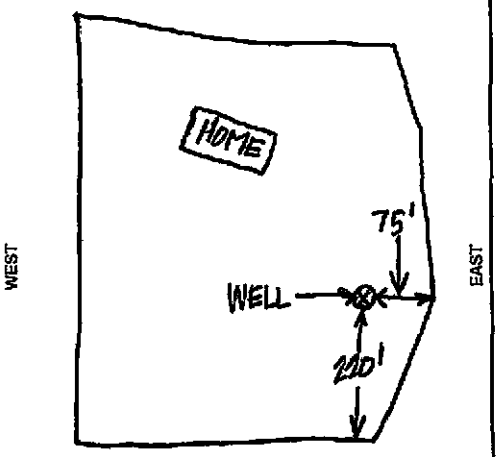
APN Book 28 Page 270 Parcel 19

Township _____ Range _____ Section _____

Latitude _____ DEG. _____ MIN. _____ SEC. NORTH

Longitude _____ DEG. _____ MIN. _____ SEC. WEST

LOCATION SKETCH



*Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. **PLEASE BE ACCURATE & COMPLETE.***

ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

PLANNED USES (✓)

WATER SUPPLY

X Domestic ___ Public

___ Irrigation ___ Industrial

___ MONITORING

___ TEST WELL

___ CATHODIC PROTECTION

___ HEAT EXCHANGE

___ DIRECT PUSH

___ INJECTION

___ VAPOR EXTRACTION

___ SPARGING

___ REMEDIATION

___ OTHER (SPECIFY)

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 315 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 288 (Ft.) & DATE MEASURED 8-6-02

ESTIMATED YIELD * 17 (GPM) & TEST TYPE air lift

TEST LENGTH 3 (Hrs.) TOTAL DRAWDOWN N/A (Ft.)

** May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CON-DUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	60	13								
60	640	10								
0	285		X				PVC F480	6	SDR-21	
285	485			X			PVC F480	6	SDR-21	.032
485	505		X				PVC F480	6	SDR-21	
505	585			X			PVC F480	6	SDR-21	.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CE-MENT (✓)	BEN-TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	52	X			concrete
52	585			X	#6 sand

ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other _____

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME HUCKFELDT WELL DRILLING (PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS 2110 Penny Lane CITY Napa STATE CA ZIP 94559

Signed _____ WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED 8-30-02

C-57 LICENSE NUMBER 439-746

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Well 17

ORIGINAL
File with DWR

Page 1 of 2

STATE OF CALIFORNIA
WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No e051246

DWR USE ONLY — DO NOT FILL IN
08N06W20
STATE WELL NO / STATION NO
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No Well #1
Date Work Began 1/8/2007 Ended 1/30/2007
Local Permit Agency Sonoma County PRMD
Permit No WEL06 0621 Permit Date 11/29/2006

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD MUD ROTARY FLUID Bentonite

DEPTH FROM SURFACE Ft	to Ft	DESCRIPTION *Describe material grain size color etc*
0	21	Brown clayee volcanics
21	42	Gray shale and clay
42	96	Gray shale streaks serpentine
96	135	Dark gray shale
135	145	Green stone
145	195	Gray shale
195	205	Serpentine
205	242	Green stone and shale
242	345	Gray shale and clay
345	385	Gray shale and green stone
385	432	Gray shale and clay
432	448	Green stone
448	563	Gray shale and clay
563	568	Gray rock
568	590	Gray shale streaks gray rock
590	620	Gray shale and clay

TOTAL DEPTH OF BORING 620 (Feet)
TOTAL DEPTH OF COMPLETED WELL 598 (Feet)

WELL OWNER

WELL LOCATION

Address 4050 Spring Mountain Road
City ~~St Helena~~ CA Santa Rosa
County Sonoma
APN Book 028 Page 270 Parcel 019
Township ___ Range ___ Section ___
Latitude ___ DEG MIN SEC ___ DEG MIN SEC

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate Describe by Drawing Direction from Road Bldg Fence Rivers etc and attach a map Use additional paper if necessary **PLEASE BE ACCURATE & COMPLETE**

ACTIVITY (✓)

✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under GEOLOGIC LOG

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
___ MONITORING
___ TEST WELL
___ CATHODIC PROTECTION
___ HEAT EXCHANGE
___ DIRECT PUSH
___ INJECTION
___ VAPOR EXTRACTION
___ SPARGING
___ REMEDIATION
___ OTHER (SPECIFY)

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft) BELOW SURFACE 1
DEPTH OF STATIC WATER LEVEL 233 (Ft) & DATE MEASURED 1/30/2007
ESTIMATED YIELD 175.2 (GPM) & TEST TYPE AIR LIFTED
TEST LENGTH 3 (Hrs) TOTAL DRAWDOWN 588 (Ft)
May not be representative of a well's long term yield

CASING (S)

DEPTH FROM SURFACE Ft	to Ft	BORE HOLE DIA (Inches)	TYPE (✓) BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	51	11								
51	620	7 7/8								
+2	598		✓				PVC	5	CL200	
158	178			✓						032
198	238			✓						032
258	278			✓						032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft	to Ft	TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	9	✓			concrete
9	53		✓		
53	598			✓	1/8 x 1/4 gravel

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other ___
ATTACH ADDITIONAL INFORMATION IF IT EXISTS

CERTIFICATION STATEMENT

I the undersigned certify that this report is complete and accurate to the best of my knowledge and belief
NAME Weeks Drilling & Pump
(PERSON FIRM OR CORPORATION) (TYPED OR PRINTED)
P O Box 176 ADDRESS — Sebastopol CITY — CA STATE — 95473 ZIP
Signed Melissa G Lopez WELL DRILLER/AUTHORIZED REPRESENTATIVE — 02/09/07 DATE SIGNED — 177681 C 57 LICENSE NUMBER

DWR 188 REV 11 97

IF ADDITIONAL SPACE IS NEEDED USE NEXT CONSECUTIVELY NUMBERED FORM

Well 17, Cont.

DWR

Page 2 of 2

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No e051246

DWR USE ONLY DO NOT FILL IN

08N06W20

STATE WELL NO / STATION NO

LATITUDE LONGITUDE

APN/TRS/OTHER

Owner s Well No Well #1

Date Work Began 1/8/2007 Ended 1/30/2007

Local Permit Agency Sonoma County PRMD

Permit No WEL06 0621 Permit Date 11/29/2006

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD MUD ROTARY FLUID Bentonite

DEPTH FROM SURFACE Ft	to Ft	DESCRIPTION *Describe material grain size color etc*
0	21	Brown clayee volcanics
21	42	Gray shale and clay
42	96	Gray shale streaks serpentine
96	135	Dark gray shale
135	145	Green stone
145	195	Gray shale
195	205	Serpentine
205	242	Green stone and shale
242	345	Gray shale and clay
345	385	Gray shale and green stone
385	432	Gray shale and clay
432	448	Green stone
448	563	Gray shale and clay
563	568	Gray rock
568	590	Gray shale streaks gray rock
590	620	Gray shale and clay

TOTAL DEPTH OF BORING 620 (Feet)

TOTAL DEPTH OF COMPLETED WELL 598 (Feet)

WELL OWNER

WELL LOCATION

Address 4050 Spring Mountain Road

City St Helena CA

County Sonoma

APN Book 028 Page 270 Parcel 019

Township ___ Range ___ Section ___

Latitude ___ DEG MIN SEC ___ DEG MIN SEC

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Ill t t D be D t f W ll f m Road B ld ngs
Fences Ri ers etc and attach a map Use add t onal paper if ecessary PLEASE BE ACCURATE & COMPLETE

ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under GEOLOGIC LOG

PLANNED USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial

___ MONITORING
___ TEST WELL
___ CATHODIC PROTECTION
___ HEAT EXCHANGE
___ DIRECT PUSH
___ INJECTION
___ VAPOR EXTRACTION
___ SPARGING
___ REMEDIATION
___ OTHER (SPECIFY)

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft) BELOW SURFACE 1

DEPTH OF STATIC WATER LEVEL 233 (Ft) & DATE MEASURED 1/30/2007

ESTIMATED YIELD 175 2 (GPM) & TEST TYPE AIR LIFTED

TEST LENGTH 3 (Hrs) TOTAL DRAWDOWN 588 (Ft)

May not be representative of a well s long term yield

CASING (S)

DEPTH FROM SURFACE Ft	to Ft	BORE HOLE DIA (Inches)	TYPE (✓) BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
318	358			✓						032
418	458			✓						032
478	498			✓						032
558	598			✓						032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft	to Ft	TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	9	✓			concrete
9	53		✓		
53	598			✓	1/8 x 1/4 gravel

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other ___

ATTACH ADDITIONAL INFORMATION IF IT EXISTS

CERTIFICATION STATEMENT

I the undersigned certify that this report is complete and accurate to the best of my knowledge and belief

NAME Weeks Drilling & Pump
(PERSON FIRM OR CORPORATION) (TYPED OR PRINTED)

P O Box 476 ADDRESS — Sebastopol CITY — CA STATE — 95473 ZIP

Signed Melissa Lopez WELL DRILLER/AUTHORIZED REPRESENTATIVE — 02/09/07 DATE SIGNED — 177681 C 57 LICENSE NUMBER

DWR 188 REV 11 97

IF ADDITIONAL SPACE IS NEEDED USE NEXT CONSECUTIVELY NUMBERED FORM

Well 18

ORIGINAL

File Original, Duplicate and Triplicate with the REGIONAL WATER POLLUTION CONTROL BOARD No. ..... (Insert appropriate number)

WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code) 6107

THE RESOURCES AGENCY OF CALIFORNIA

Do Not Fill In

No. 112818

State Well No. .....

Other Well No. 8/6-19

(1) OWNER:

Name .....

Address .....

.....

(2) LOCATION OF WELL:

County Sonoma. Owner's number, if any—

R. F. D. or Street No. on Oldest Helena Rd. Spring mountain on Napa & Sonoma Co. lines

(3) TYPE OF WORK (check):

New well ☑ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):

Domestic ☑ Industrial ☐ Municipal ☐

Irrigation ☑ Test Well ☐ Other ☐

(5) EQUIPMENT:

Rotary ☐

Cable ☑

Dug Well ☐

(6) CASING INSTALLED:

SINGLE ☑ DOUBLE ☐

From 0 ft. to 86 ft. 8 Diam. 188 Gage or Wall

Type and size of shoe or well ring Fix 6x8

Describe joint Butt Weld.

If gravel packed

Diameter of Bore	from ft.	to ft.

Size of gravel:

(7) PERFORATIONS:

Type of perforator used Mach. sawed.

Size of perforations 18 in., length, by 3 in.

From 56 ft. to 80 ft. 3 Perf. per row 18 Rows per ft.

(8) CONSTRUCTION:

Was a surface sanitary seal provided? ☑ Yes ☐ No To what depth 30 ft.

Were any strata sealed against pollution? ☐ Yes ☐ No If yes, note depth of strata

From ft. to ft.

Method of Sealing Cement Grout

(9) WATER LEVELS:

Depth at which water was first found 35 ft.

Standing level before perforating ft.

Standing level after perforating 42 ft.

(10) WELL TESTS: 120 gpm per hr @ 54 ft.

Was a pump test made? ☑ Yes ☐ No If yes, by whom? Bailer

Yield: 20 gal./min. with 12 ft. draw down after 1 hrs.

Temperature of water Was a chemical analysis made? ☐ Yes ☑ No

Was electric log made of well? ☐ Yes ☑ No

(11) WELL LOG:

Total depth 80 ft. Depth of completed well ft.

Formation: *Describe by color, character, size of material, and structure.*

0	14	Red clay & boulders
14	32	Gray & yellow ash.
32	36	Soft blue ash
36	40	Hard blue ash
40	53	Shale & serpentine
53	60	Brn shale & rock
60	80	Hard green & blue rock.

CONFIDENTAL LOG
Water Code Sec. 7030

FOR OFFICIAL USE ONLY

Work started Jan 23 1968. Completed Jan 28 1968

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME Walter Rettiles (Person, firm, or corporation) (Typed or printed)

Address 1541 Mark West Springs Rd.

Santa Rosa Calif.

[SIGNED] Walter Rettiles (Well Driller)

License No. 163052 Dated July 1, 1968

87649 5-63 25M QUIN ① △ SPO

DWR 188 (REV. 3-54)

Well 19

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

DWR

Page ___ of ___
Owner's Well No. ___
Date Work Began 11/6/98, Ended 11/11/98
Local Permit Agency SONOMA COUNTY PUBLIC HEALTH
Permit No. ___ Permit Date 10/28/97

No. 812556

DWR USE ONLY — DO NOT FILL IN
08N06W27
STATE WELL NO./STATION NO.
LATITUDE ___ LONGITUDE ___
APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ___ FLUID ___

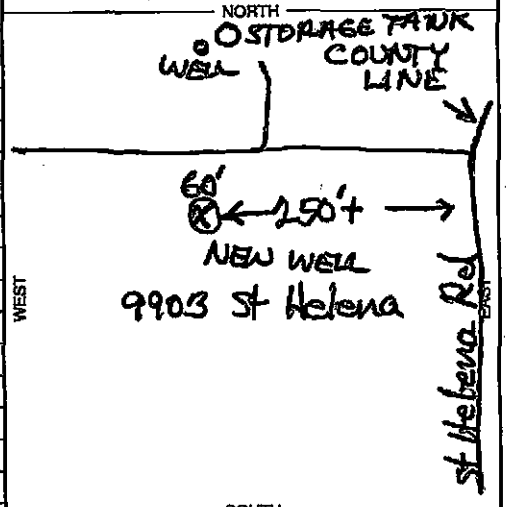
DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION *Describe material, grain size, color, etc.*
0 to 95	sonoma volcanics
95 to 115	very broken Franciscan shale
115 to 180	Blue Franciscan sandstone
180 to 190	Blue shale

TOTAL DEPTH OF BORING 190 (Feet)
TOTAL DEPTH OF COMPLETED WELL 190 (Feet)

WELL LOCATION

Address 9903 St Helena Rd
City Santa Rosa
County Sonoma
APN Book 028 Page 270 Parcel 045
Township ___ Range ___ Section ___
Latitude ___ DEG. MIN. SEC. NORTH
Longitude ___ DEG. MIN. SEC. WEST

LOCATION SKETCH



Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

ACTIVITY (✓)
✓ NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES (✓)
WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 45 (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 45 (Ft.) & DATE MEASURED 11/11/98
ESTIMATED YIELD * 40+ (GPM) & TEST TYPE air lift
TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN 170 (Ft.)
* *May not be representative of a well's long-term yield.*

CASING (S)

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0 to 50	9"	✓				F480PVC	5"	SCH40	
50 to 190	"		✓			"	"	"	.032"

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft. to Ft.	TYPE: CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0 to 20	✓			
40 to 190				fine pea gravel

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME NUNNING & JENSEN DRILLING (PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
ADDRESS 1924 GRAVENSTEIN HWY SO CITY SEBASTOPOL STATE CA ZIP 95472
Signed Larry Jensen (WELL DRILLER/AUTHORIZED REPRESENTATIVE) DATE SIGNED 11/15/98
C-57 LICENSE NUMBER 340854

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

Well 20

ORIGINAL
File with DWR

Page 1 of 1

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. 0916077

DWR USE ONLY — DO NOT FILL IN
08N06W20
STATE WELL NO./ STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Owner's Well No. Well #1
Work Began 6/8/2004, Ended 6/16/2004
Local Permit Agency Napa Co Environ Health
Permit No. 96-12678 Permit Date 6/7/2004

GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD MUD ROTARY FLUID Bentonite

DEPTH FROM SURFACE Ft.	to Ft.	DESCRIPTION *Describe material, grain, size, color, etc.*
0	3	Top soil, volcanic boulders
3	26	Clay, sandstone, boulders
26	29	Hard rock
29	130	Fractured rock, gravel, clay
130	160	Soft shale, clay gumbo

TOTAL DEPTH OF BORING 135 (Feet)
TOTAL DEPTH OF COMPLETED WELL 135 (Feet)

WELL OWNER

WELL LOCATION

Address 4028 Spring Mountain Road
City Saint Helena CA
County Napa
APN Book 020 Page 300 Parcel 63
Township ___ Range ___ Section ___
Latitude ___ DEG. MIN. SEC. ___ DEG. MIN. SEC.

LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. **PLEASE BE ACCURATE & COMPLETE.**

ACTIVITY (✓)

___ NEW WELL
MODIFICATION/REPAIR
___ Deepen
✓ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG"

PLANNED USES (✓)

WATER SUPPLY
___ Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ✓
Reconstuction

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL ___ (Ft.) & DATE MEASURED ___
ESTIMATED YIELD * 20 (GPM) & TEST TYPE AIR LIFTED
TEST LENGTH 3 (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
May not be representative of a well's long-term yield.

CASING (S)

DEPTH FROM SURFACE Ft.	to Ft.	BORE-HOLE DIA. (Inches)	TYPE (✓) BLANK	SCREEN	CONDUCTOR	FILL PIPE	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)
0	55	11 7/8	✓				PVC	5		
55	65	9 7/8	✓				PVC	5		
65	135	9 7/8		✓			PVC	5		.032

ANNULAR MATERIAL

DEPTH FROM SURFACE Ft.	to Ft.	TYPE CEMENT (✓)	BENTONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	51	✓			
51	57		✓		
57	135			✓	8 x 16 sand

ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analysis
___ Other ___
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME Weeks Drilling & Pump (PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
P.O. Box 176 ADDRESS Sebastopol CITY CA STATE 95473 ZIP
Signed Melissa G Lopez WELL DRILLER/AUTHORIZED REPRESENTATIVE
06/22/04 DATE SIGNED
177681 C-57 LICENSE NUMBER

DWR 188 REV. 11-97

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

C

APPENDIX B

NAPA COUNTY GROUNDWATER RECHARGE ANALYSIS

October 3, 2019

Napa County Groundwater Recharge Analysis

Introduction

Developing accurate estimates of the spatial and temporal distribution of groundwater recharge is a key component of sustainable groundwater management. Efforts to quantify recharge are inherently difficult owing to the wide variability of factors controlling hydrologic processes, the wide range of available tools/methods for estimating recharge, and the difficulty in assessing the accuracy of estimates because direct measurement of recharge rates is, for the most part, infeasible (Healy 2010, Seiler and Gat 2007).

Numerical modeling is a common approach for developing recharge estimates. Soil-water-balance modeling is one category of numerical models particularly well-suited for estimating recharge across large areas with modest data requirements. This study describes an application of the U.S. Geological Survey's (USGS) Soil Water Balance Model (SWB) (Westenbroek et al. 2010) to develop spatial and temporal distributions of groundwater recharge across Napa County. This model operates on a daily timestep and calculates surface runoff based on the Natural Resources Conservation Service (NRCS) curve number method and potential evapotranspiration based on the Hargreaves-Samani methods (Hargreaves and Samani 1985). Actual evapotranspiration (AET) and recharge are calculated using a modified Thornthwaite-Mather soil-water-balance approach (Westenbroek et al. 2010).

It is important to note that the SWB model focuses on surface and soil-zone processes and does not simulate the groundwater system or track groundwater storage over time. The model also does not simulate surface water/groundwater interaction or baseflow; thus, the runoff estimates represent only the surface runoff component of streamflow resulting from rainstorms and the recharge estimates represent only the infiltration recharge component (also referred to as diffuse recharge) of total recharge (stream-channel recharge is not simulated).

This modeling work and summary report has been prepared by O'Connor Environmental, Inc., for it's private use in relation to Water Availability Analyses (WAA) prepared on behalf of private clients for projects using groundwater in "hillside" areas of Napa County as required by Napa Planning, Building & Environmental Services. The modeling to-date is complete in its current form but remains subject to revision; it is considered a working draft with information suitable for use to support WAA projects. Parties interested in obtaining more information regarding the modeling or who may wish to offer comments should contact O'Connor Environmental, Inc.

Model Development

The model was developed using a 30-meter (98.4 ft) resolution rectangular grid. Water budget calculations were made on a daily time step. Key spatial inputs included a flow direction map developed from the USGS 1 arc-second resolution Digital Elevation Model (DEM), a land cover map derived from the U.S. Forest Service (USFS) CALVEG dataset that was supplemented by a database of agricultural areas maintained by the County of Napa (Figure 1), a distribution of Hydrologic Soil Groups (A through D classification from lowest to highest runoff potential; Figure 2), and a distribution of Available Water Capacity (AWC) developed from the NRCS Soil Survey Geographic Database (SSURGO) (Figure 3).

A series of model parameters were assigned for each land cover type/soil group combination including an infiltration rate, a curve number, dormant and growing season interception storage values, and a rooting depth (Table 1).

Infiltration rates for hydrologic soil groups A through D were applied based on Cronshey et al. (1986) (Table 2) along with default soil-moisture-retention relationships based on Thornthwaite and Mather (1957) (Figure 4). Curve numbers were assigned based on standard NRCS methods. Interception storage values and rooting depths were assigned based on literature values and from previous modeling experience including a SWB model covering Sonoma County and calibrated using runoff volumes from several stream gages (OEI 2017).

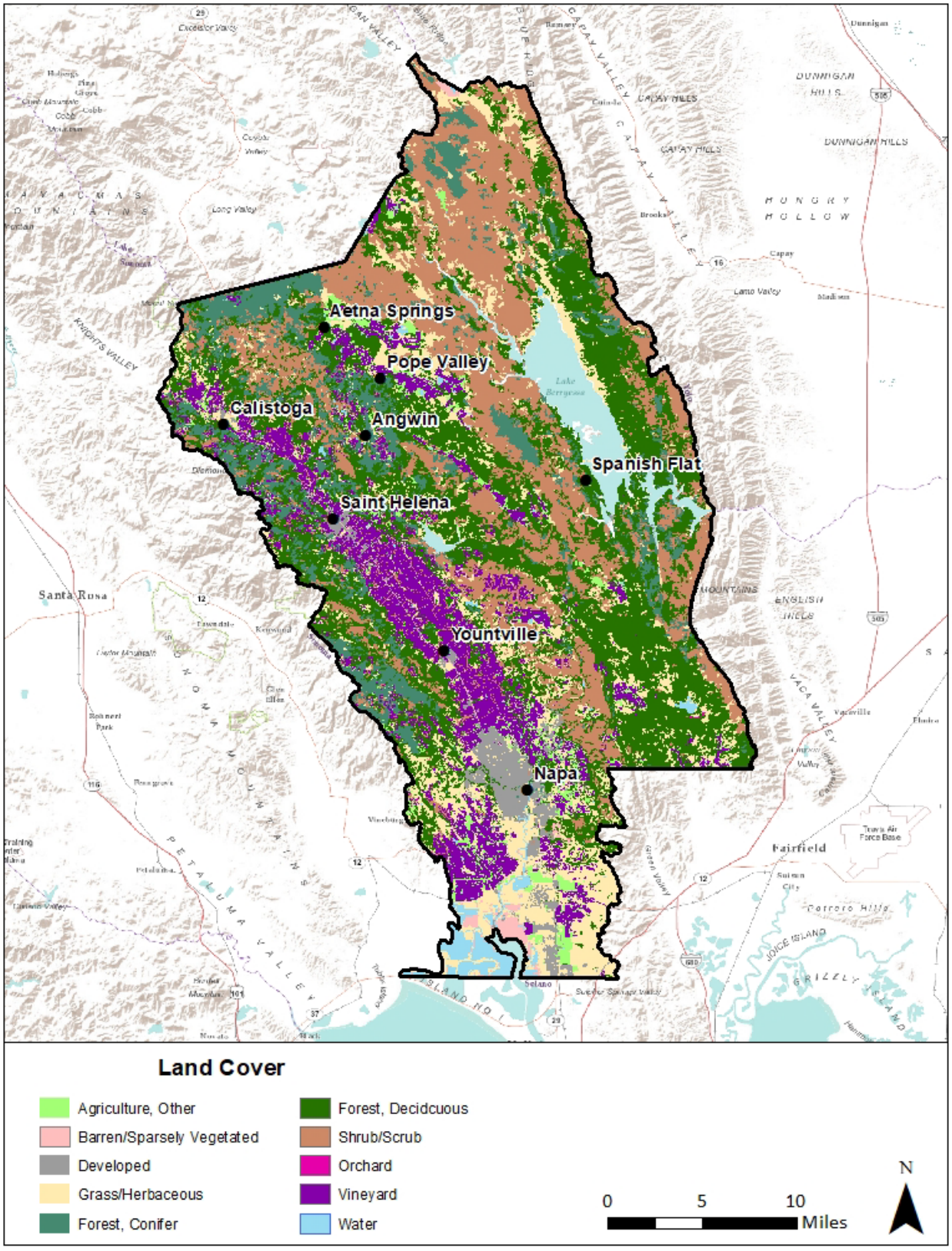


Figure 1: Land cover distribution used in the Napa County SWB model.

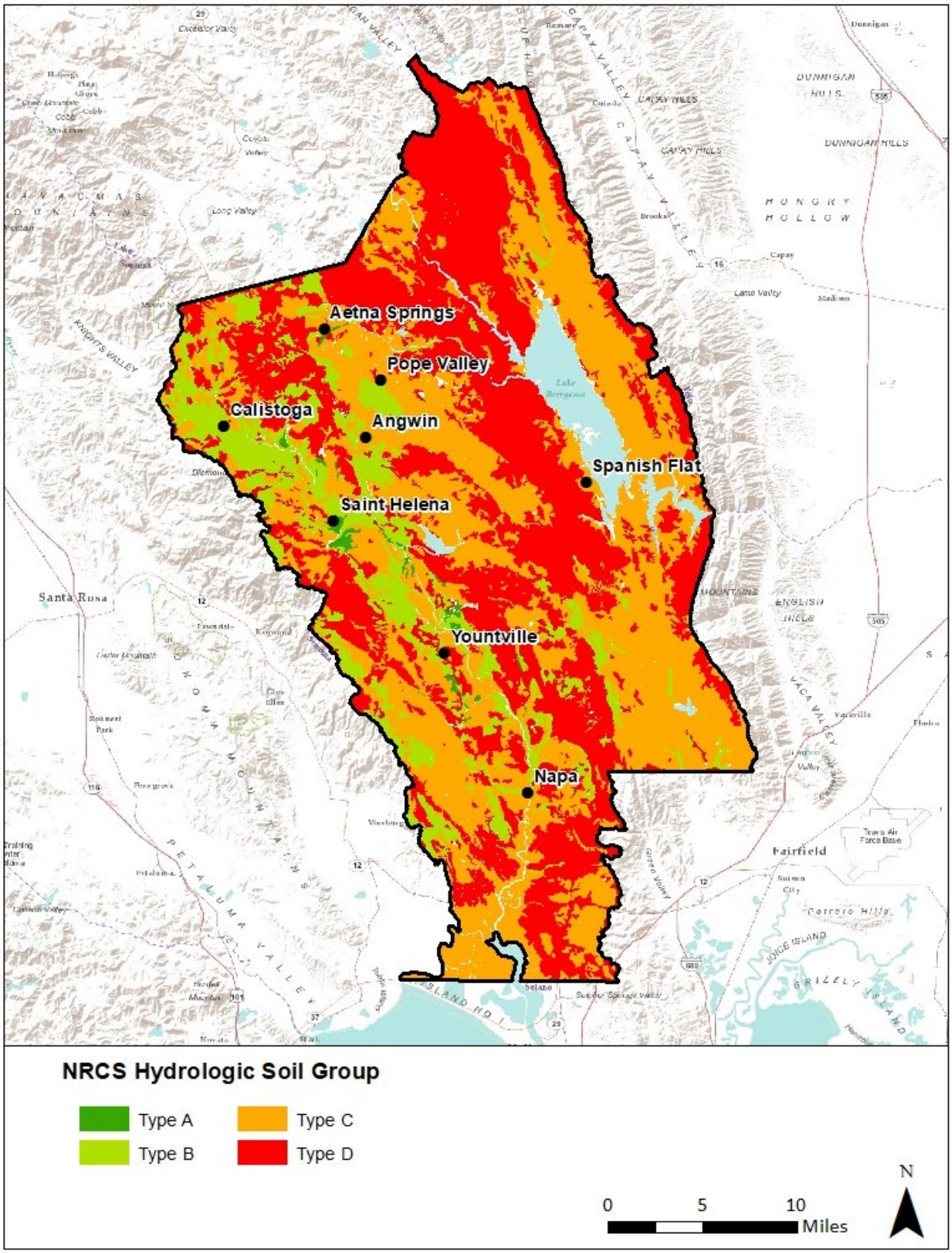


Figure 2: Hydrologic soil group distribution used in the Napa County SWB model.

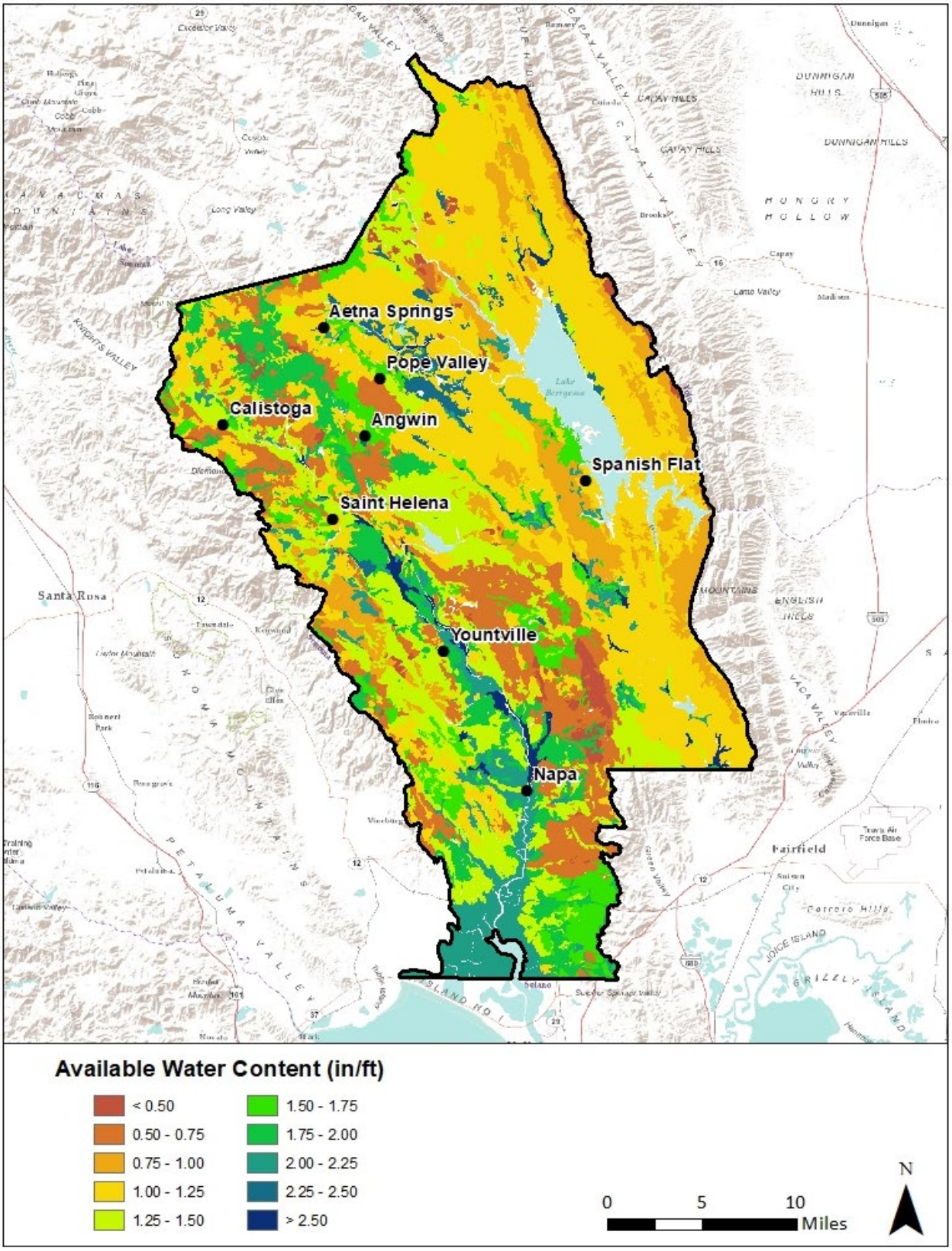


Figure 3: Available water capacity distribution used in the Napa County SWB model.

Table 1: Soil and land cover properties used in the Napa County SWB model.

Land Cover	Interception Storage Values ()		Curve Number by NRCS Soil Type ()				Rooting Depth by NRCS Soil Type (ft)			
	Growing Season	Dormant Season	Type A	Type B	Type C	Type D	Type A	Type B	Type C	Type D
Agriculture, Other	0.080	0.040	38	61	75	81	2.0	1.9	1.8	1.7
Barren	0.000	0.000	77	86	91	94	0.0	0.0	0.0	0.0
Developed	0.005	0.002	61	75	83	87	2.3	2.1	2.0	1.8
Grassland/Herbaceous	0.005	0.004	30	58	71	78	1.3	1.1	1.0	1.0
Forest, Coniferous	0.050	0.050	30	55	70	77	5.9	5.1	4.9	4.7
Forest, Deciduous	0.050	0.020	30	55	70	77	5.9	5.1	4.9	4.7
Shrub/Scrub	0.080	0.015	30	48	65	73	3.2	2.8	2.7	2.6
Orchard	0.050	0.015	38	61	75	81	3.2	2.8	2.7	2.6
Vineyard	0.080	0.015	38	61	75	81	2.2	2.1	2.0	1.9
Water	0.000	0.000	100	100	100	100	0.0	0.0	0.0	0.0

Table 2: Infiltration rates for NRCS hydrologic soil groups (Cronshey et al. 1986).

Soil Group	Infiltration Rate (in/hr)
A	> 0.3
B	0.15 - 0.3
C	0.05 - 0.15
D	<0.05

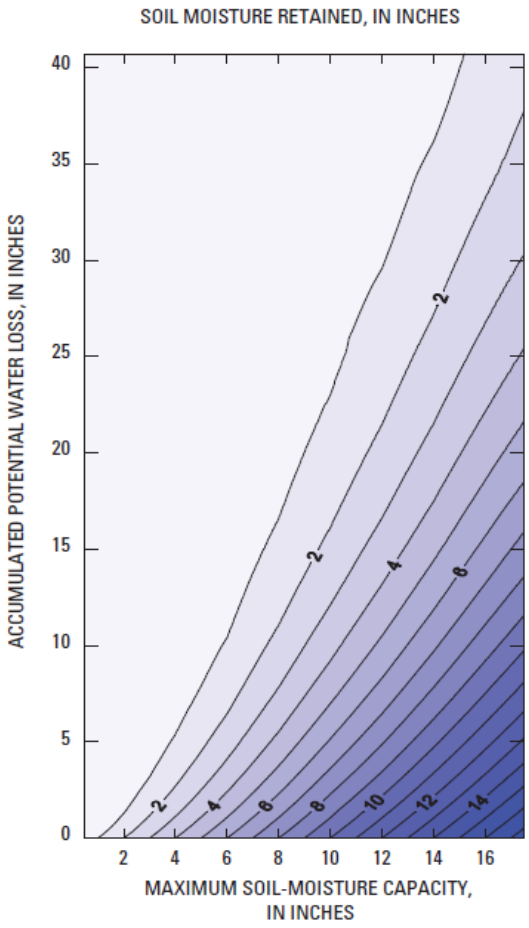


Figure 4: Soil-moisture-retention table (Thornthwaite and Mather 1957).

The SWB model utilizes daily precipitation and mean daily temperature data derived from climate stations. To account for the spatial variability of these parameters, daily precipitation and mean daily temperature were input as gridded (spatially-distributed) time-series. The gridded precipitation time-series was created using data from 15 weather stations in Napa County, and the gridded mean temperature time-series was created using data from 8 stations (Table 3). These stations were selected based on completeness of the records and to provide station data representative of the range of climates experienced in the county. Data was obtained from the California Data Exchange Center (CDEC), the National Climatic Data Center (NCDC), and from Napa One Rain.

To create the gridded time-series, the model domain was divided into discrete areas represented by individual weather stations (Figures 5 and 6). This delineation was based on climate variations described by existing gridded mean annual (1981-2010) precipitation and temperature data (PRISM 2010) and local knowledge of climatic variations across the county.

For the precipitation time-series, each area representing a weather station was subdivided into four to twenty-three zones based on 1-inch average annual precipitation contours. Within each zone the raw station data was multiplied by a unique scaling factor. This scaling factor was calculated as the ratio of average annual precipitation within a zone to average annual precipitation at the representative rain gage. In certain locations, typically near the boundary of areas represented by gages located on the valley bottom and at higher elevations, this scaling was unable to smoothly resolve differences in annual and event precipitation totals. To more accurately estimate precipitation near these boundaries, precipitation records from the two gages in question were averaged using weights calculated proportionally to the difference between PRISM mean annual precipitation at a rain gage and within a selected zone. The resulting gridded time-series is comprised of 220 individual time-series based on the scaled station data from 15 stations.

The assignment of temperature stations was based on the understanding that the spatial variability of temperatures across Napa County is relatively homogenous, with elevation being the primary variable. Temperature records were classified either as Mountain, Valley Bottom, or East County and applied within areas the PRISM datasets described as being similar. To smooth the transition from Mountain zones to Valley Bottom and East County zones, Hillside zones were created where the temperature records of the two nearest gages were averaged.

Missing and suspect data was encountered in the raw precipitation and temperature data from the weather stations used by the model. Values that were significantly outside the typical range, and where similar observations were not found at nearby stations, were removed from the datasets. These and missing values were filled using scaled data from other nearby stations. Precipitation data used for gap filling was scaled using the ratio of the 1981 to 2010 mean annual precipitation (PRISM 2010) between the two stations. Temperature data was scaled using the ratio of the 1981 to 2010 mean monthly minimum and maximum temperatures (PRISM 2010) between the two stations.

The current analysis focuses on Water Year 2010 (October 1, 2009 – September 30, 2010) and Water Year 2014 (October 1, 2013 – September 30, 2014). These years were selected because they represent periods with data available from most weather stations in the county and where most stations reported annual precipitation totals close to the long-term average (WY 2010) and significantly below the long term average (WY 2014). Based on a comparison between station data and PRISM average precipitation depths during Water Year 2010, rainfall averaged 101% of long-term average conditions and ranged from 78% at Lake Hennessey to 111% at the Napa County Airport. In Water Year 2014, rainfall averaged 55% of long-term average conditions and ranged from 41% at Lake Hennessey to 73% at the Napa State Hospital (Table 3).

Table 3: Weather stations used in the Napa County SWB model. See Figures 7- 9 for associated timeseries.

Station	Data Used	1981 - 2010 Mean Annual Precip (in)	WY 2010		WY 2014	
			Precip (in)	% Avg	Precip (in)	% Avg
Angwin[1]	Precip & Temp	42.54	44.64	105%	25.04	59%
Atlas Peak[1]	Precip & Temp	41.76	39.04	93%	20.08	48%
Berryessa[1]	Precip & Temp	28.97	28.16	97%	13.97	48%
Calistoga[2]	Precip	39.41	41.75	106%	18.18	46%
Knoxville Creek[1]	Temp Only	-	-	-	-	-
Lake Hennessey[3]	Precip Only	34.09	26.52	78%	13.92	41%
Mt. George[3]	Precip Only	31.15	29.64	95%	18.24	59%
Mt. Veeder[3]	Precip Only	44.81	46.44	104%	28.6	64%
Napa County Airport[2]	Precip & Temp	21.14	23.56	111%	9.87	47%
Napa River at Yountville Cross Rd[3]	Precip Only	31.86	32.72	103%	14.93	47%
Napa State Hospital[2]	Precip & Temp	26.81	28.85	108%	19.66	73%
Petrified Forest[3]	Precip Only	42.39	46.6	110%	22.84	54%
Redwood Creek At Mt. Veeder Road[3]	Precip Only	34.71	37.36	108%	23.48	68%
Saint Helena[2]	Precip & Temp	37.43	39.11	104%	19.11	51%
Saint Helena 4WSW[1]	Precip & Temp	45.44	47.88	105%	28.88	64%
Sugarloaf Peak[3]	Precip Only	32.20	26.16	81%	17.12	53%

1 – Data accessed from California Data Exchange Center (CDEC)
2 – Data accessed from National Climate Data Center (NCDC)
3 – Data access from Napa One Rain

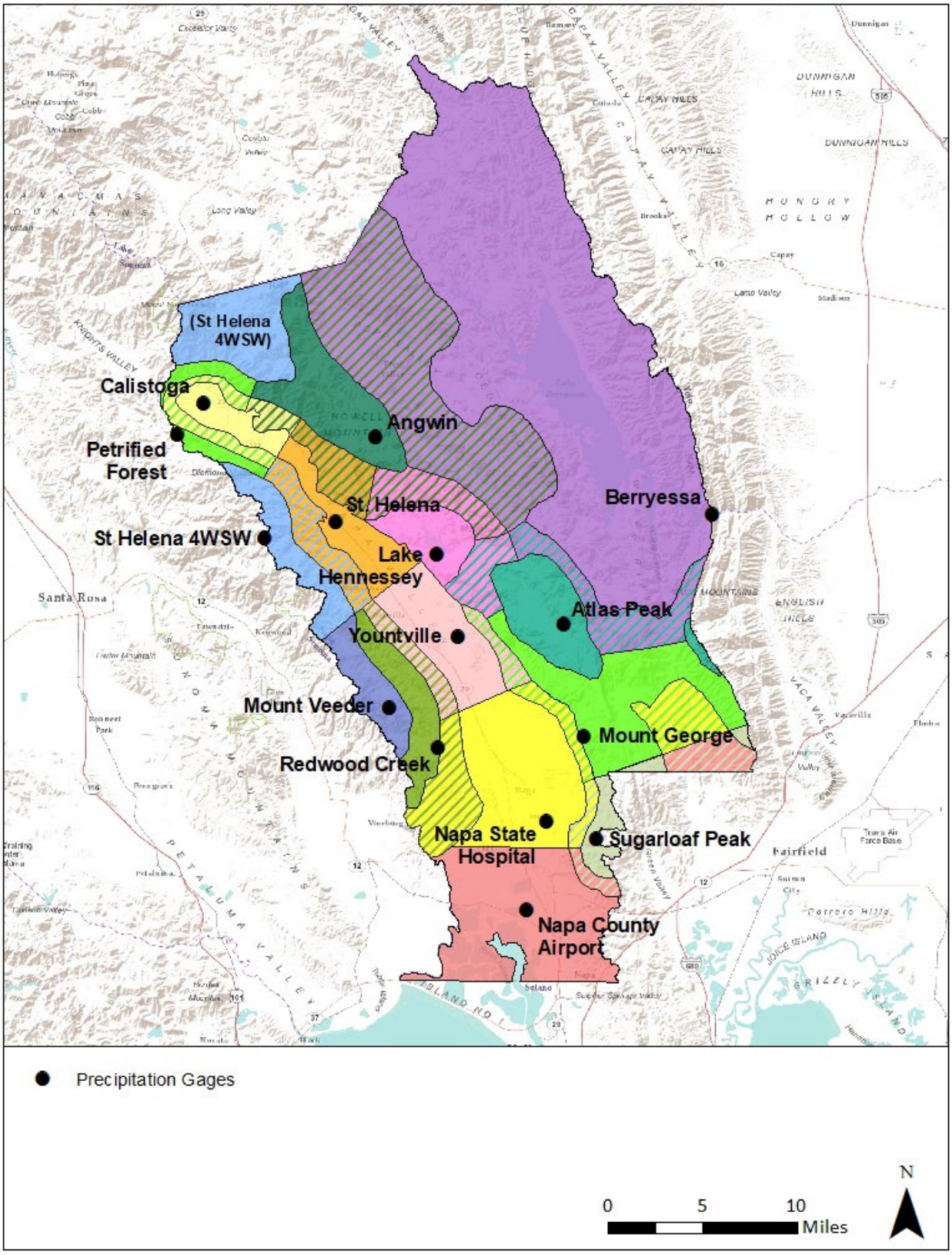


Figure 5: Precipitation zones used in the Napa County SWB model. Hatching indicates areas where two precipitation records were averaged across a zone.

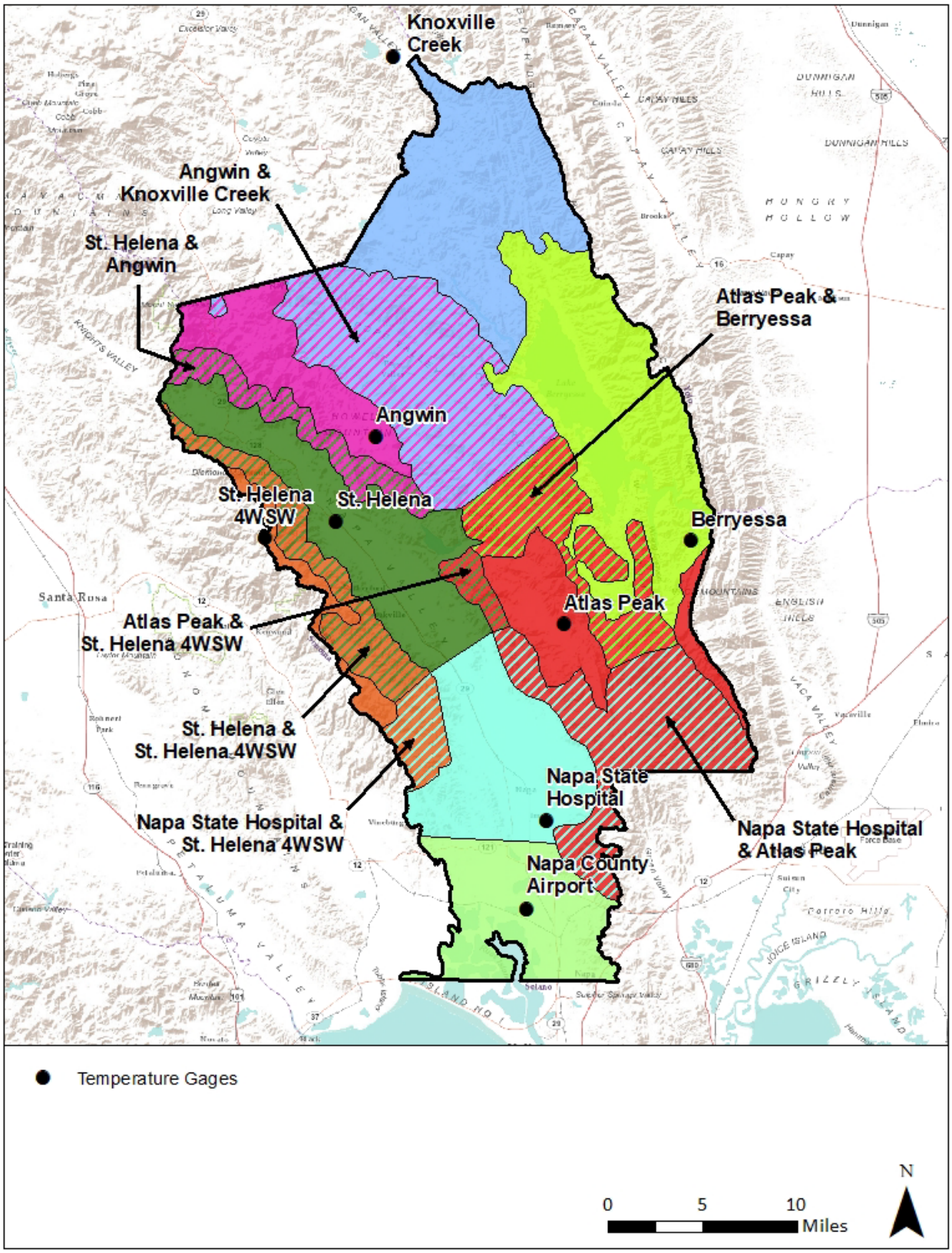


Figure 6: Temperature zones used in the Napa County SWB model. Hatching indicates areas where two temperature records were averaged across a zone.

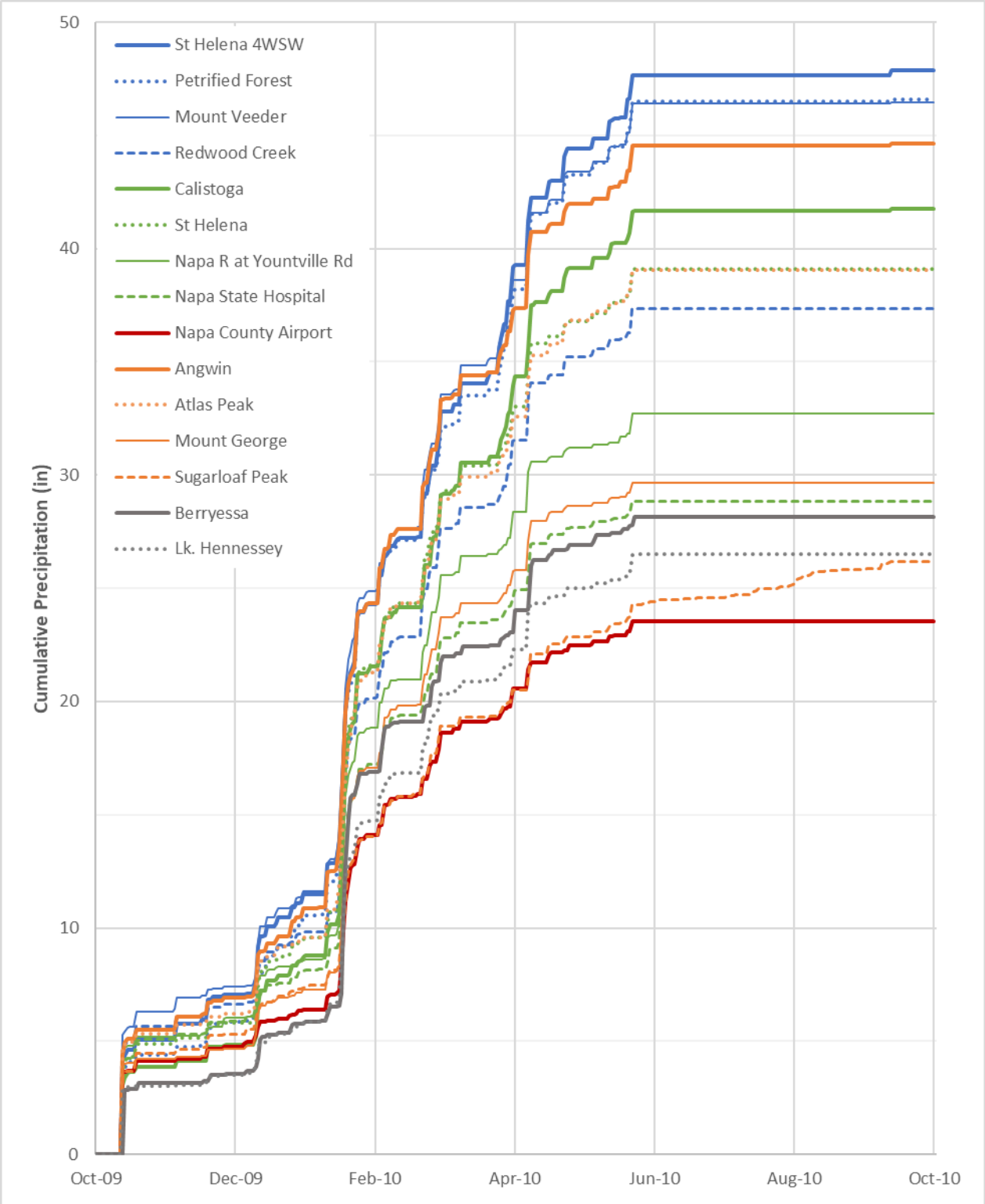


Figure 7a: Daily precipitation data used in the Napa County SWB model for WY 2010.

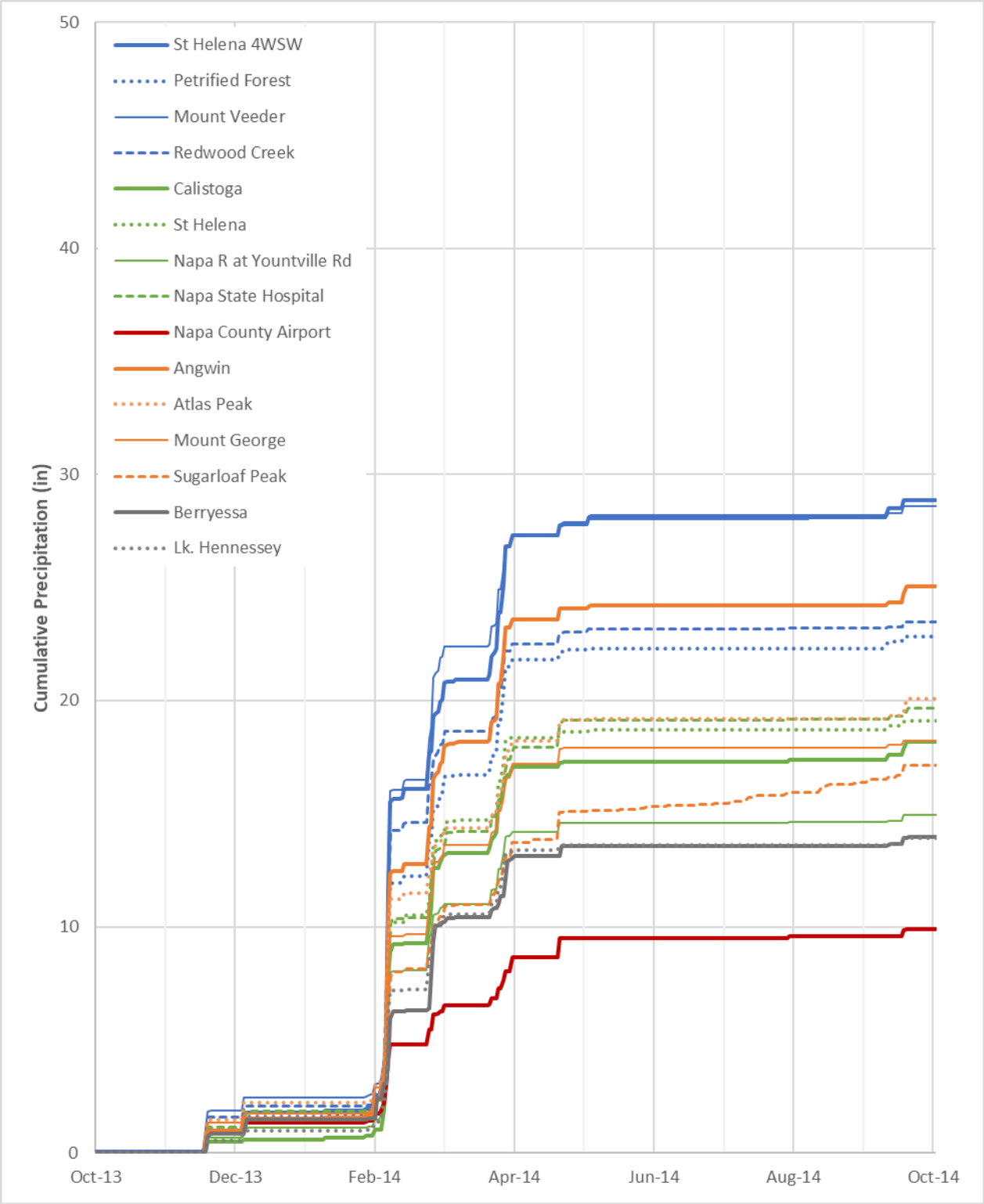


Figure 7b: Daily precipitation data used in the Napa County SWB model for WY 2014.

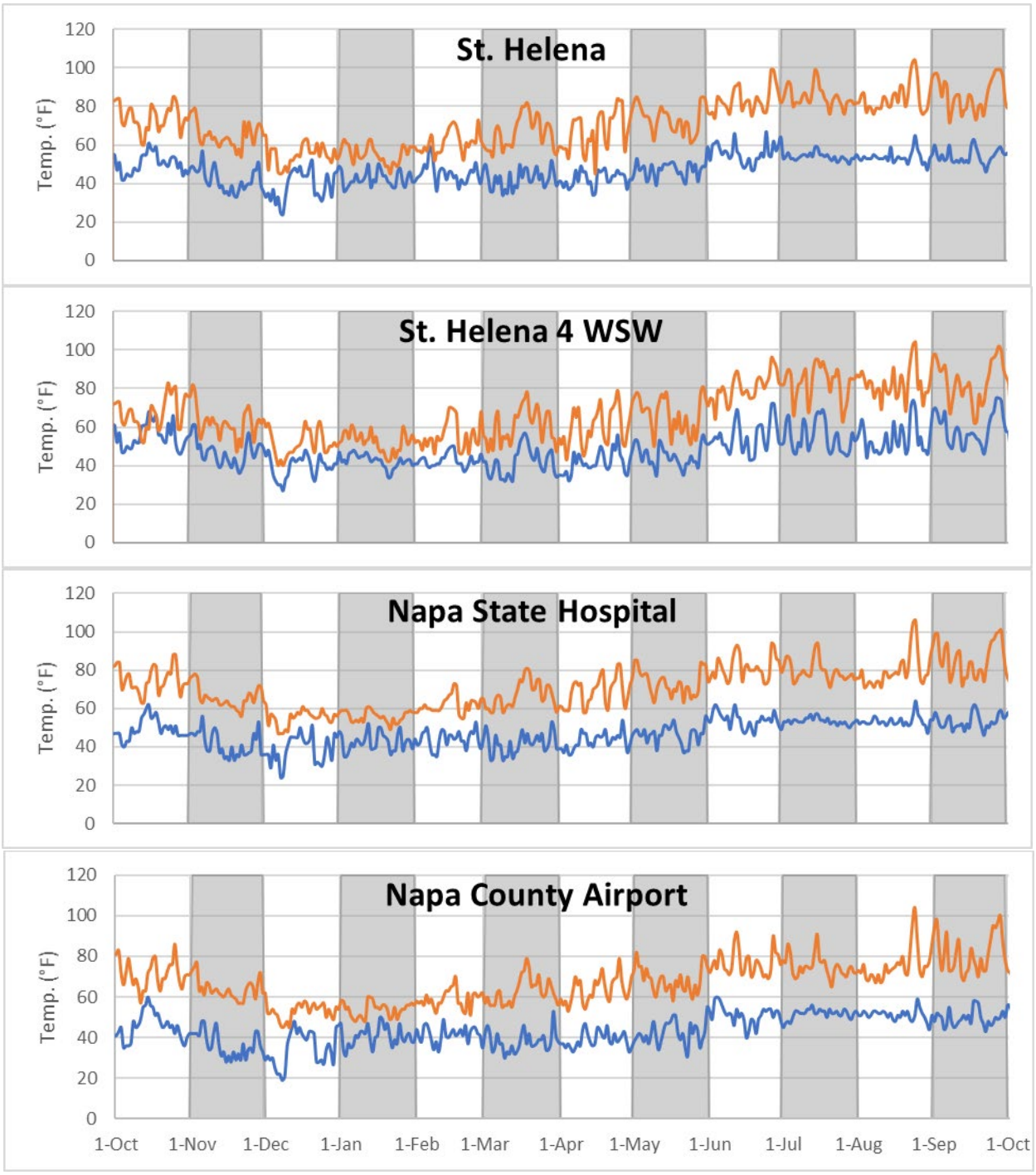


Figure 8: Daily minimum and maximum temperature data used in the Sonoma County SWB model for WY 2010.

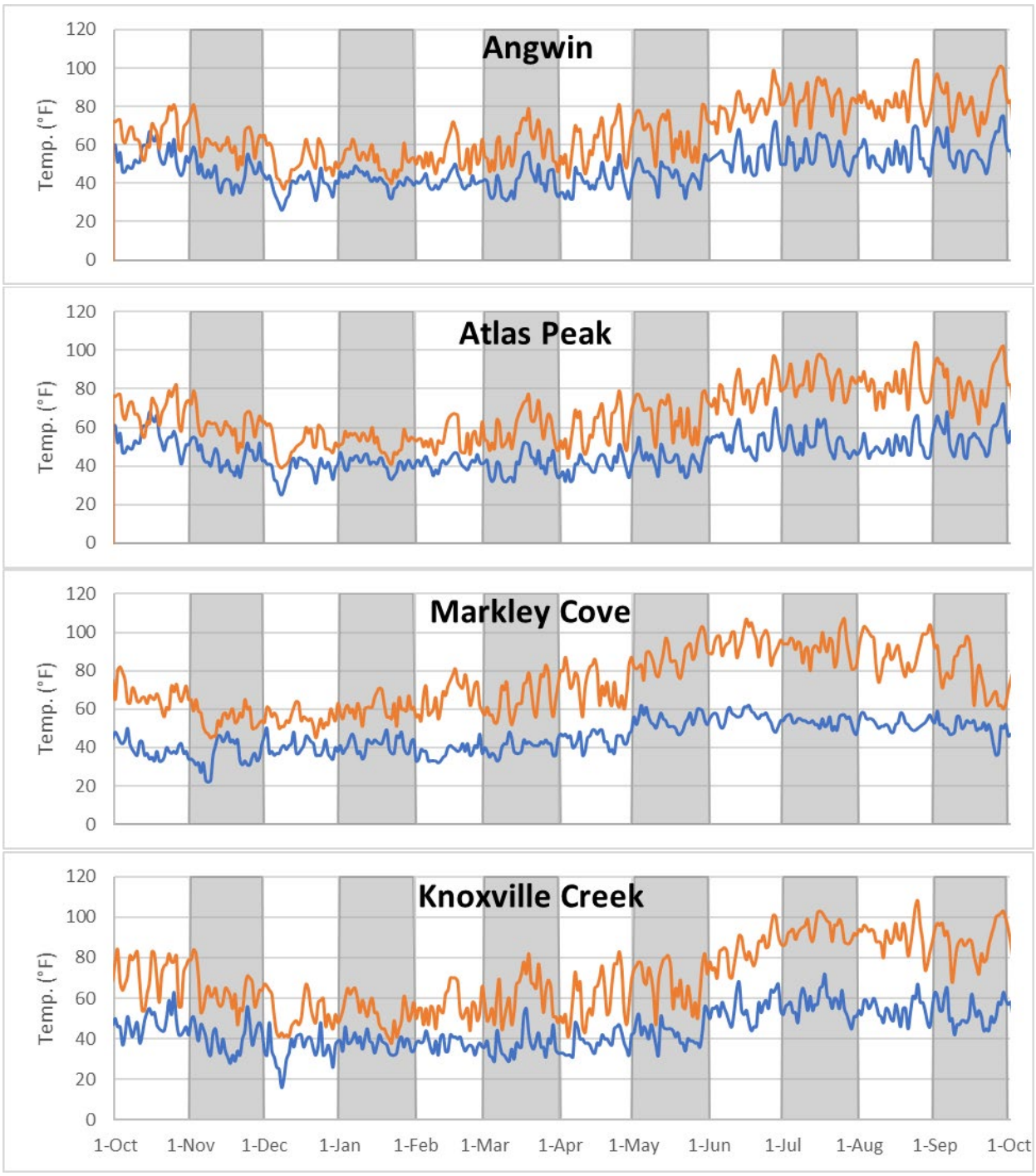


Figure 8 – cont.

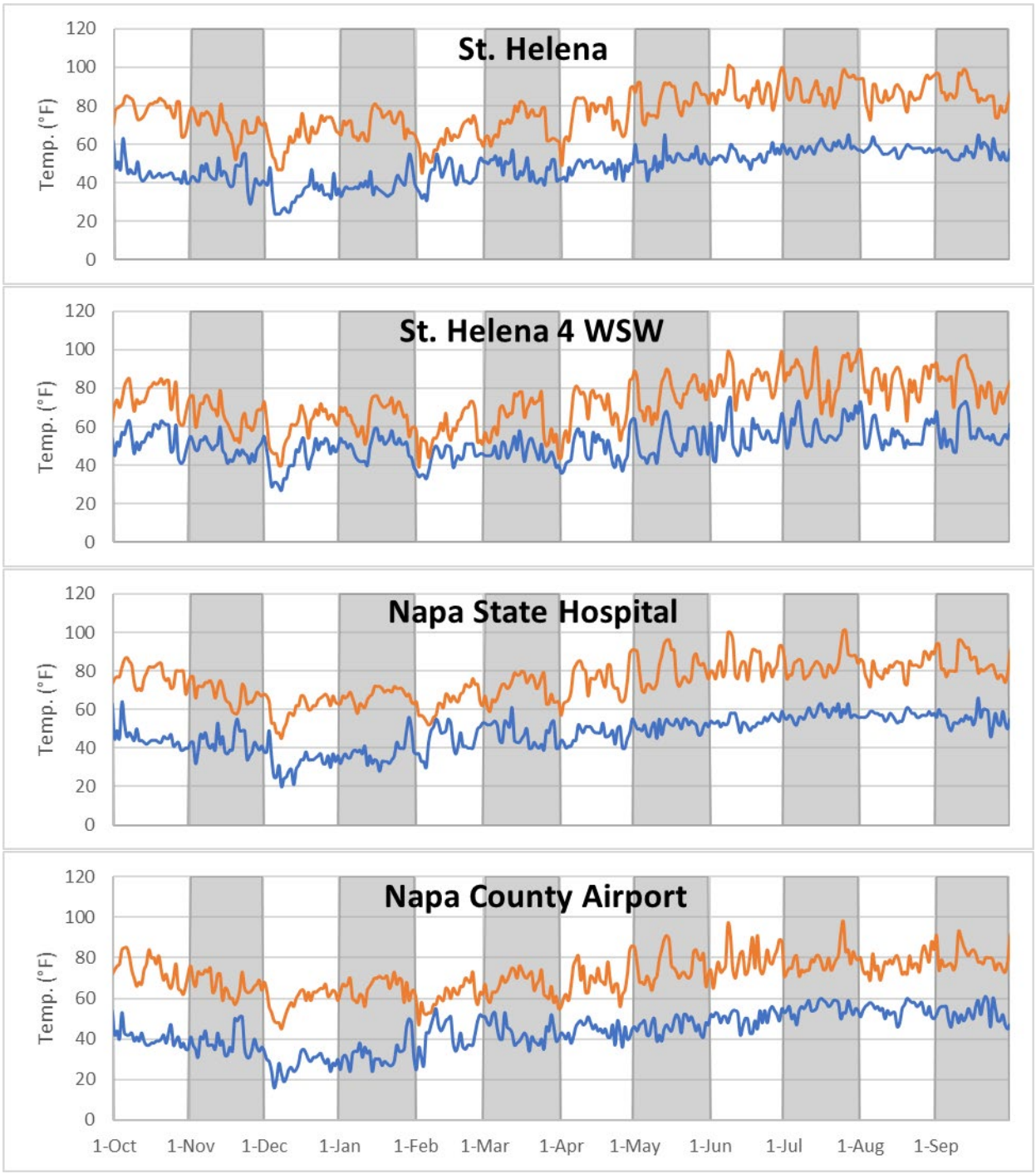


Figure 9: Daily minimum and maximum temperature data used in the Sonoma County SWB model for WY 2010.

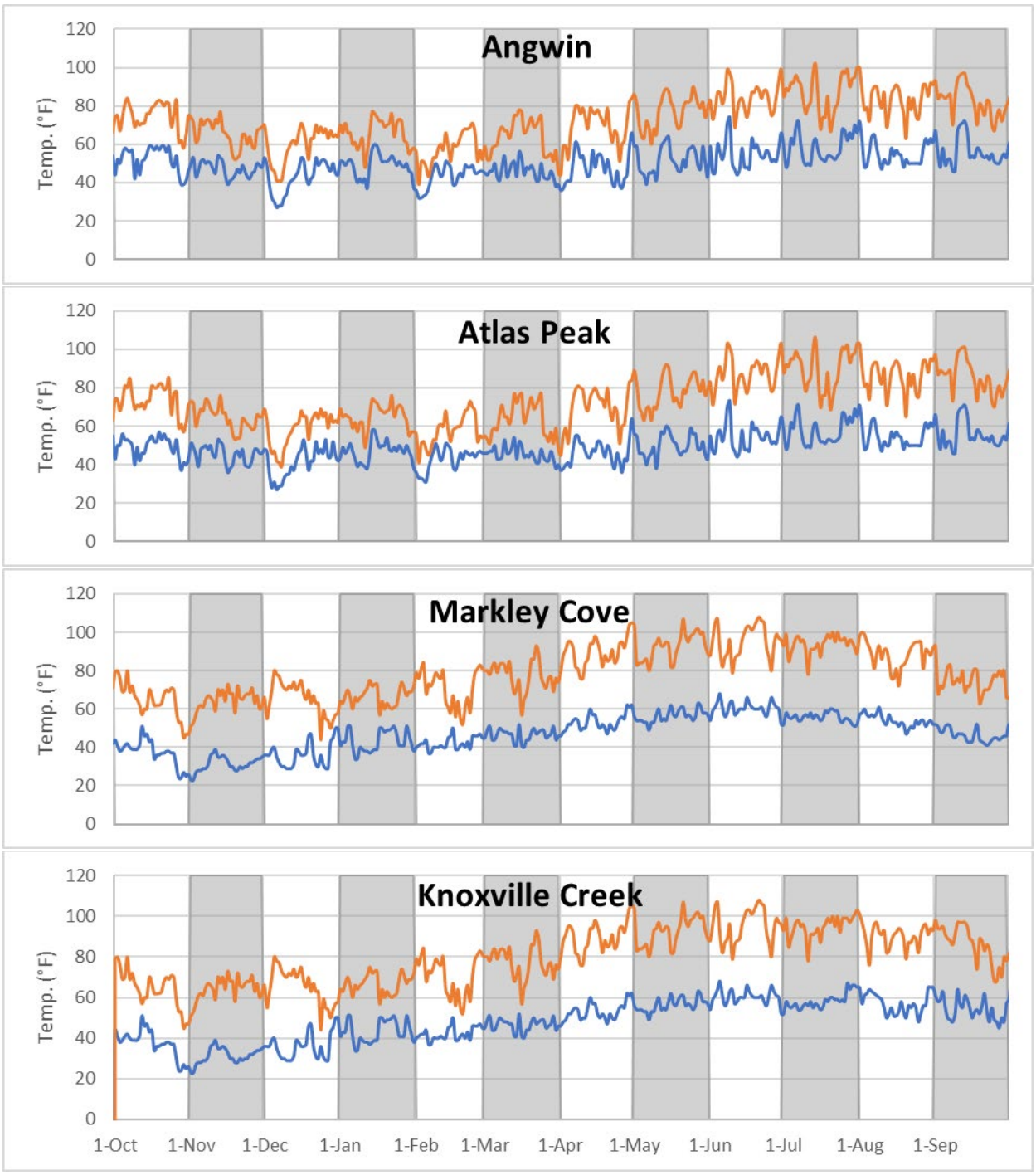


Figure 9 – cont.

Model Calibration

Available data are insufficient to calibrate the Water Year 2010 and 2014 SWB simulations; however, the land cover and soil properties used in the model were obtained from a previously prepared and calibrated SWB model of Sonoma County (OEI 2017). The Sonoma County model was calibrated against total monthly runoff volumes derived using baseflow separation of streamflow data for five watersheds within Sonoma County. Gages were selected because they represented relatively small watersheds (1.2 – 14.3 mi^2) without significant urbanization, diversions, groundwater abstraction, reservoir impoundments, or large alluvial bodies where significant exchanges between surface water and groundwater may be expected. These attributes are desirable because the hydrographs can more readily be separated into surface runoff and baseflow components and the surface runoff pattern is more directly comparable to the SWB simulated surface runoff which does not account for water use, reservoir operations, or surface water/groundwater exchange.

SWB utilizes a simplified routing scheme whereby surface runoff is routed to downslope cells or out of the model domain on the same day in which it originates as rainfall, thus it is not capable of accurately estimating streamflow over short time periods. The use of the total monthly surface runoff volumes provided a means of calibrating the Sonoma County SWB model to measured surface runoff data within the limitations of the model's approach to simulating surface runoff.

The SWB model of Sonoma County reproduced seasonal variations in surface runoff in all five calibration watersheds. Monthly Mean Errors (ME) ranged from -0.2 to 0.4 inches with a mean value of 0.1 inches. Annual surface runoff totals ranged from an under-prediction of approximately 10% at Franchini Creek to an over-prediction of approximately 19% at Buckeye Creek, with a mean over-prediction of approximately 6% across the five watersheds. These results indicate that the SWB model was able to reproduce monthly surface runoff volumes with a reasonable degree of accuracy and that the model tends to over-predict surface runoff somewhat, suggesting that the model may generate a low-range estimate of recharge.

Although the climate in Napa County is slightly drier than in Sonoma County, the vegetation, soils, and geology are similar and parameters calibrated using data from Sonoma County should be applicable to Napa County. Calibration of the Napa County SWB model was not performed due to a lack of publicly-available contemporary discharge records in suitable watersheds. Contemporary discharge records exist for USGS gaging stations located along the Napa River near St. Helena and Napa, but the watersheds above these gages are large and contain significant groundwater abstraction, reservoir impoundments, and alluvial bodies. USGS gages on smaller watersheds in Napa County have been inactive since 1983 or earlier. Discharge records exist through Napa One Rain for several streams gaged by the Napa County Resource Conservation District (RCD) but the RCD has cautioned against use of these discharge records for calibration purposes due to incomplete rating curve development.

Estimates of groundwater recharge are also available from an earlier model prepared by Luhdorff and Scalmanini Engineers and MBK Engineers (LSCE 2013). This report provided estimates of average annual recharge as a percentage of average annual precipitation for nine watersheds in Napa County. Averaged across the same nine watersheds, the SWB model predicts significantly higher rates of recharge than the model prepared by LSCE, which predicts slightly lower AET but significantly more runoff (Table 4). Differences in methodology between these two models complicate direct comparisons. The LSCE model calculated infiltration into the soil as the difference between monthly precipitation and discharge volumes within each watershed. Discharge volumes were calculated from USGS stream gages and included both direct runoff and baseflow from groundwater. Inclusion of baseflow with direct runoff in these calculations may inappropriately reduce the estimated volume of water infiltrated into the soil and available for recharge.

Table 4: Comparison of results from SWB model and Luhdorff and Scalmanini model.

USGS Gage	HUC	Mean Precip, 2010 (in)	Mean AET, 2010 (% Precip)		Mean Runoff, 2010 (% Precip)		Mean Recharge, 2010 (% Precip)	
			SWB	LSCE	SWB	LSCE	SWB	LSCE
Conn Ck nr Oakville	11456500	34.8	59%	53%	21%	25%	21%	21%
Dry Ck nr Napa	11457000	41.5	56%	50%	18%	43%	25%	6%
Milliken Ck nr Napa	11458100	32.3	52%	41%	20%	51%	28%	8%
Napa Ck at Napa	11458300	36.6	61%	43%	16%	46%	23%	11%
Napa R nr Napa	11458000	39.5	56%	48%	20%	35%	24%	17%
Napa R nr St Helena	11456000	47.9	46%	45%	23%	42%	30%	14%
Redwood Ck nr Napa	11458200	39.6	53%	49%	26%	40%	22%	10%
Tulucay Ck nr Napa	11458300	27.0	64%	49%	16%	47%	20%	5%

Model Results

The principal elements of the annual water budget simulated with the Napa County SWB model for Water Years 2010 and 2014 are presented in map form in Figures 10 - 19 and in tabular form for 27 major watershed areas in Napa County (Tables 5 - 8). The watersheds are based on USGS HUC-12 watersheds and are named for the stream which comprises the largest proportion of the area; in many cases the areas consist of multiple tributary streams (Figure 20).

In Water Year 2010 (representing "average" hydrologic conditions) precipitation varied from 21.8 inches in the Ledgewood Creek watershed to 53.3 inches in the Saint Helena Creek watershed (Figure 10, Table 5). Actual evapotranspiration (AET) ranged from 13.4 inches in the Jackson Creek watershed to 25.2 inches in the Saint Helena Creek watershed (Figure 11). Surface runoff ranged from 3.4 inches in the Ledgewood Creek watershed to 13.5 inches in the Saint Helena Creek watershed (Figure 12). Recharge ranged from 3.3 inches in the Ledgewood Creek watershed to 14.4 inches in the Saint Helena watershed. (Figure 13). Small decreases in soil moisture storage (up to 1.8 inches) occurred in most watersheds, with changes in most

watersheds being less than an inch (Figure 14). Note that the San Pablo Bay estuaries have been excluded from these comparisons.

Expressed as a percentage of the annual precipitation, AET ranged from 77% in the Ledgewood Creek watershed to 45% in the Jackson Creek watershed (Table 6). Surface runoff ranged from 15% of precipitation in the Ledgewood Creek watershed to 42% in the Jackson Creek watershed. Recharge ranged from 10% of the precipitation in the Jackson Creek watershed to 27% in the Saint Helena watershed.

In Water Year 2014 (representing "dry" hydrologic conditions during the second year of an extreme three-year drought) precipitation varied from 10.1 inches in the American Canyon Creek watershed to 32.2 inches in the Saint Helena Creek watershed (Figure 15, Table 7). Actual evapotranspiration (AET) ranged from 10.3 inches in the Jackson Creek watershed to 17.8 inches in the Saint Helena Creek watershed (Figure 16). Surface runoff ranged from 0.7 inches in the American Canyon Creek watershed to 13.2 inches in the Saint Helena Creek watershed (Figure 17). Recharge ranged from 0.6 inches in the Wragg Canyon watershed to 4.1 inches in the Saint Helena watershed. (Figure 18). Large decreases in soil moisture storage of between 2.3 and 4.3 inches were also simulated (Figure 19).

Expressed as a percentage of the annual precipitation, AET ranged from 55% in the Saint Helena Creek watershed to 121% in the Jackson Creek watershed (Table 8). These very large AET rates caused significant decreases in soil moisture. Decreases in soil moisture ranged from 9% of precipitation in the Saint Helena watershed to 36% in the American Canyon Creek watershed. Surface runoff ranged from 7% of precipitation in the American Canyon Creek watershed to 41% in the Saint Helena Watershed. Recharge ranged from 18% in the Milliken Creek Watershed to 5% in the Jackson Creek and Wragg Canyon watersheds.

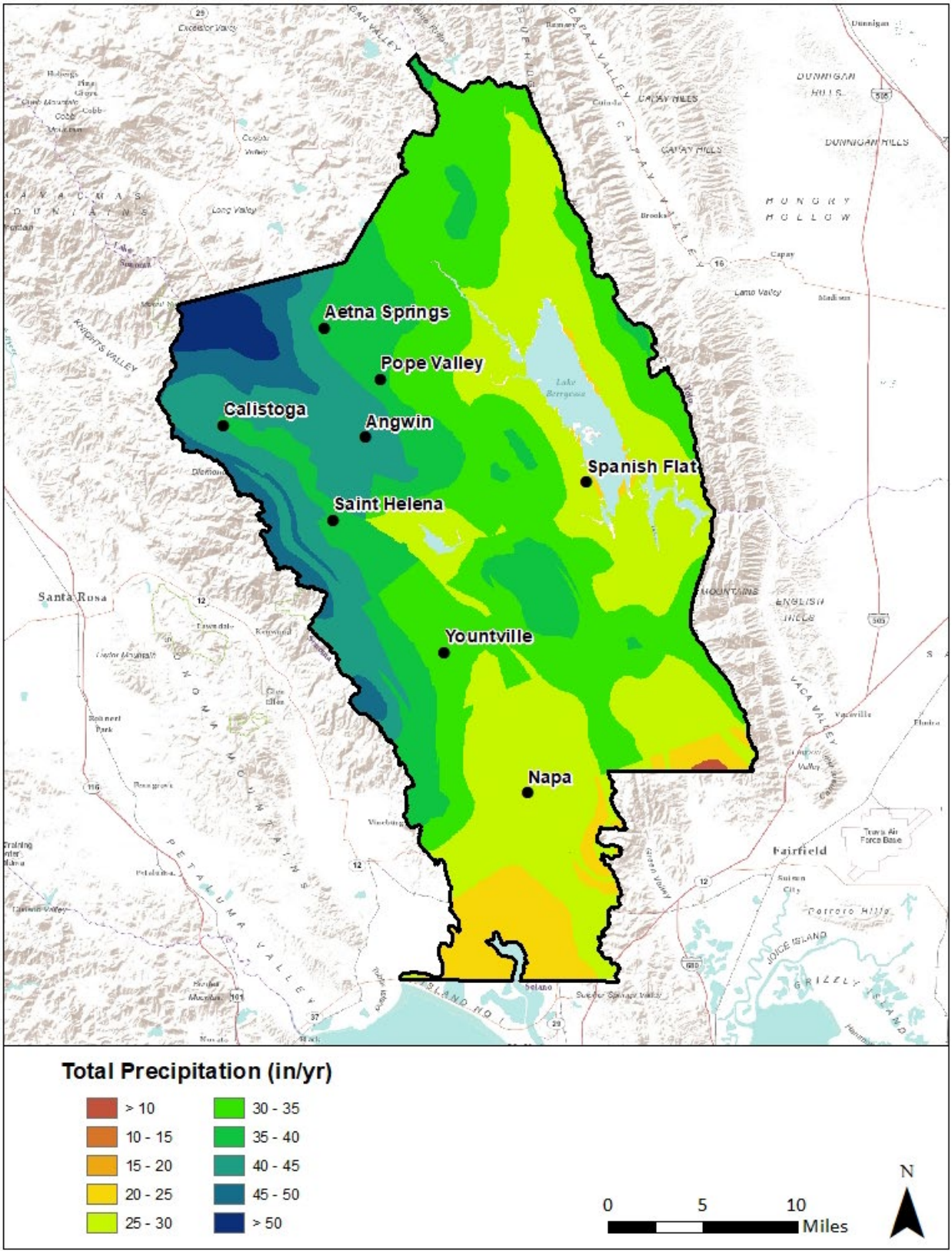


Figure 10: Water Year 2010 precipitation simulated with the Napa County SWB model.

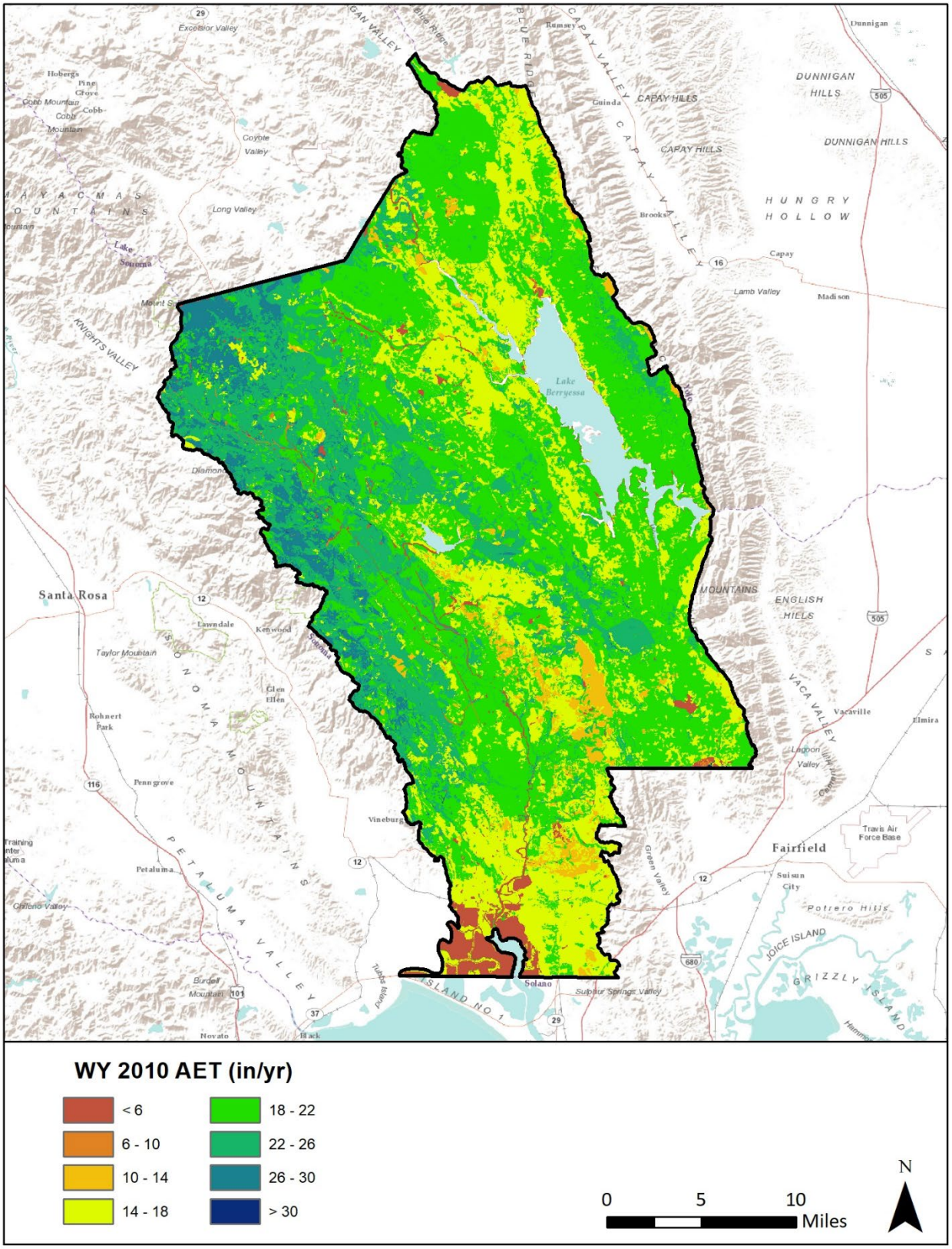


Figure 11: Water Year 2010 AET simulated with the Napa County SWB model.

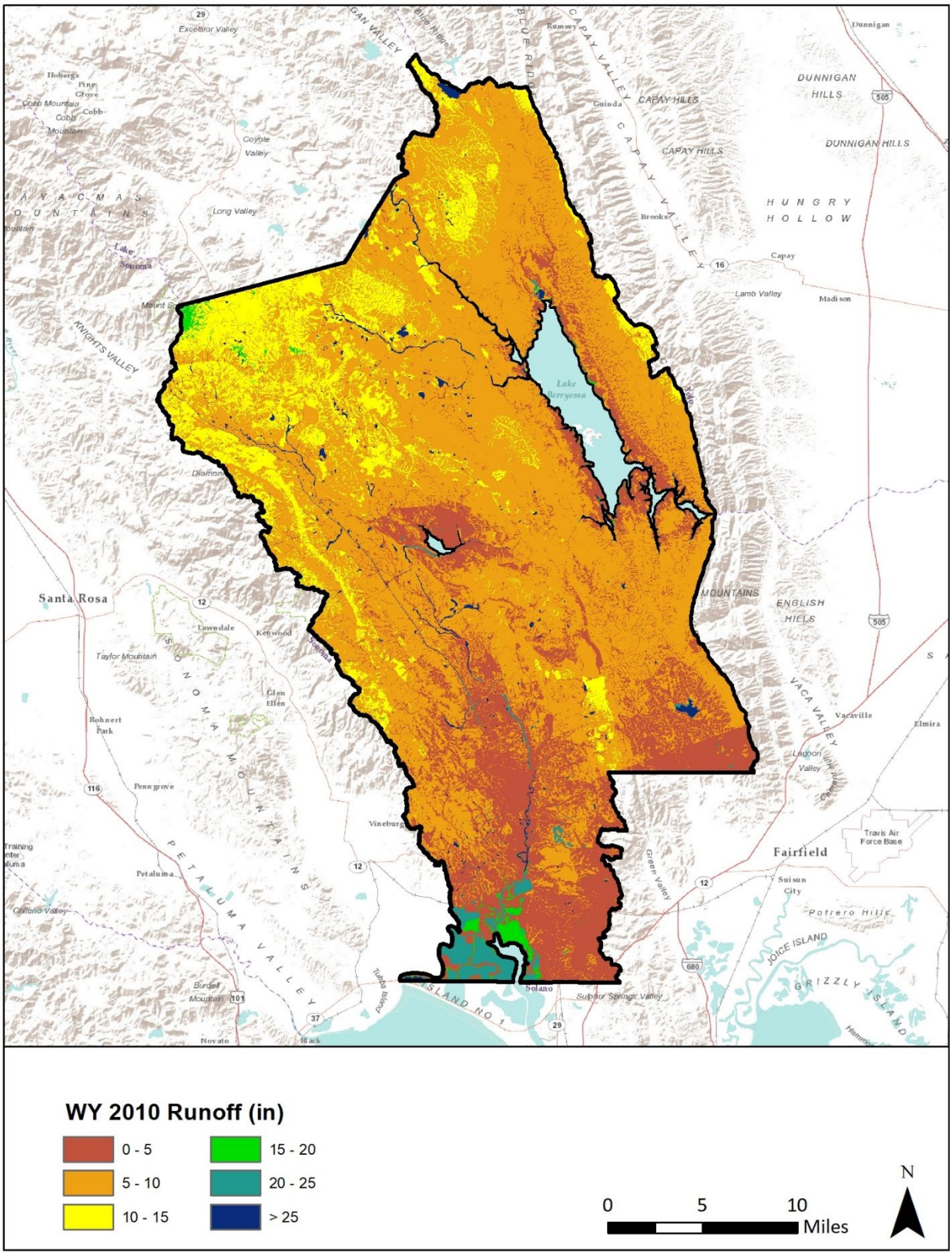


Figure 12: Water Year 2010 runoff simulated with the Napa County SWB model.

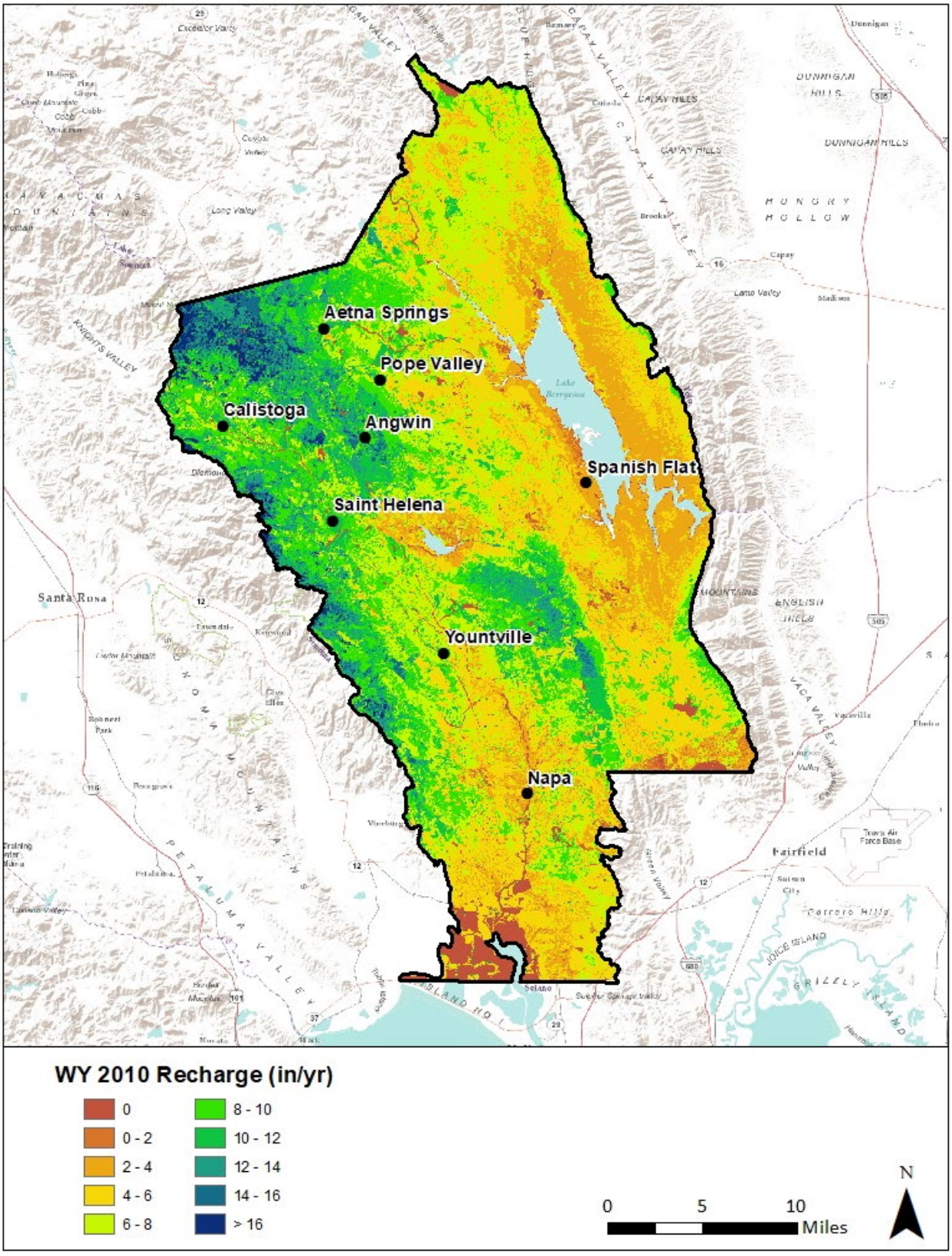


Figure 13: Water Year 2010 recharge simulated with the Napa County SWB model.

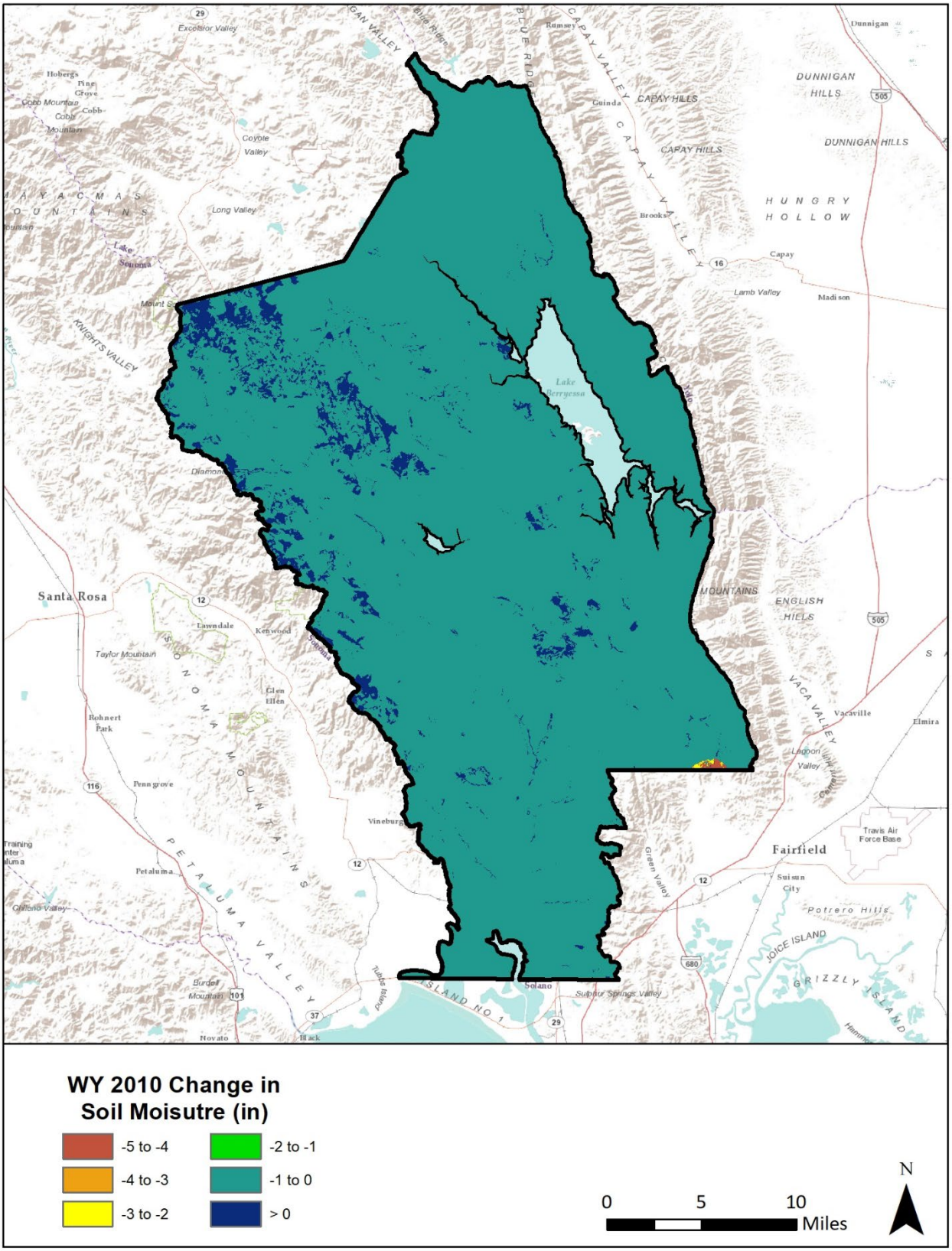


Figure 14: Water Year 2010 change in soil moisture content simulated with the Napa County SWB model.

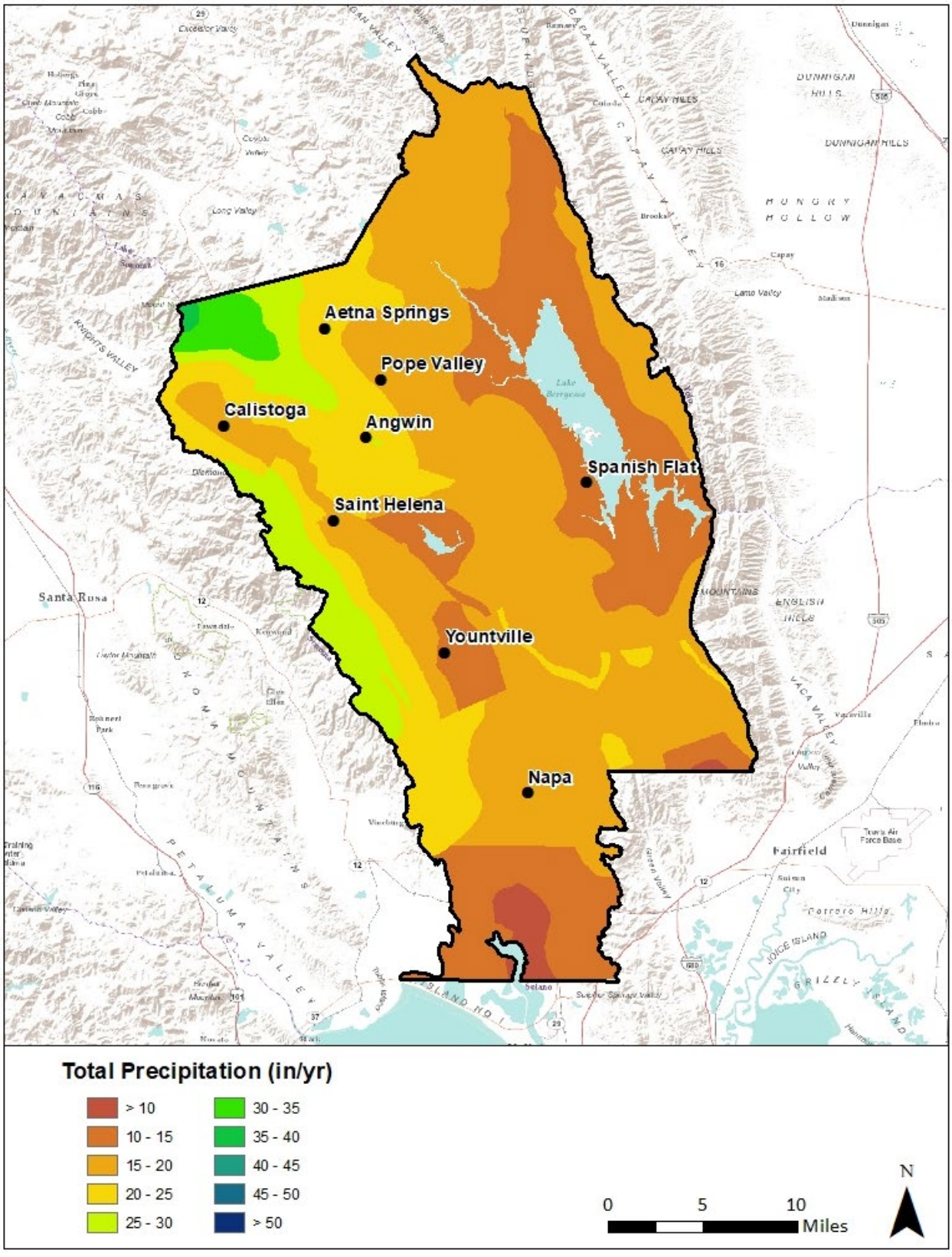


Figure 15: Water Year 2014 precipitation simulated with the Napa County SWB model.

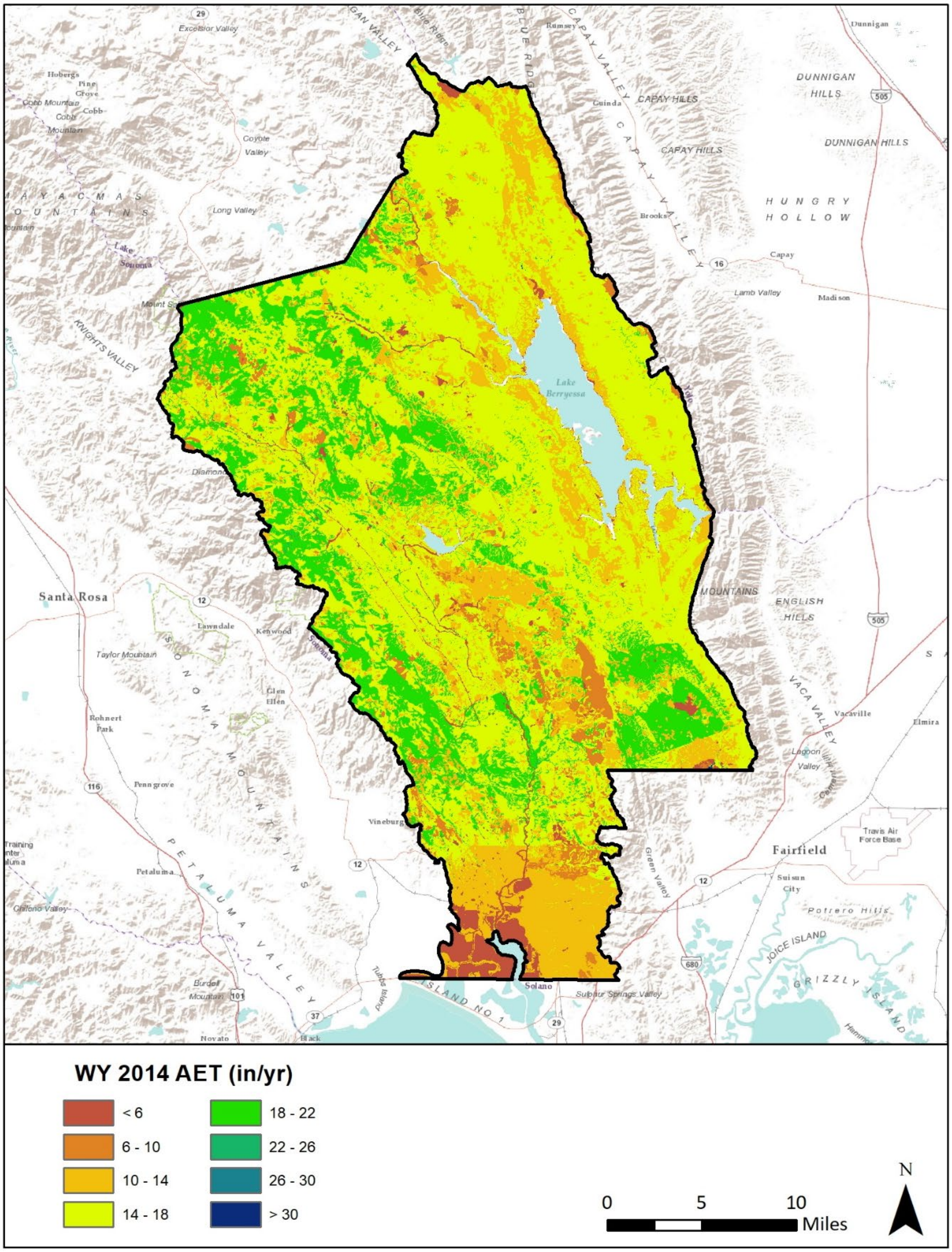


Figure 16: Water Year 2014 AET simulated with the Napa County SWB model.

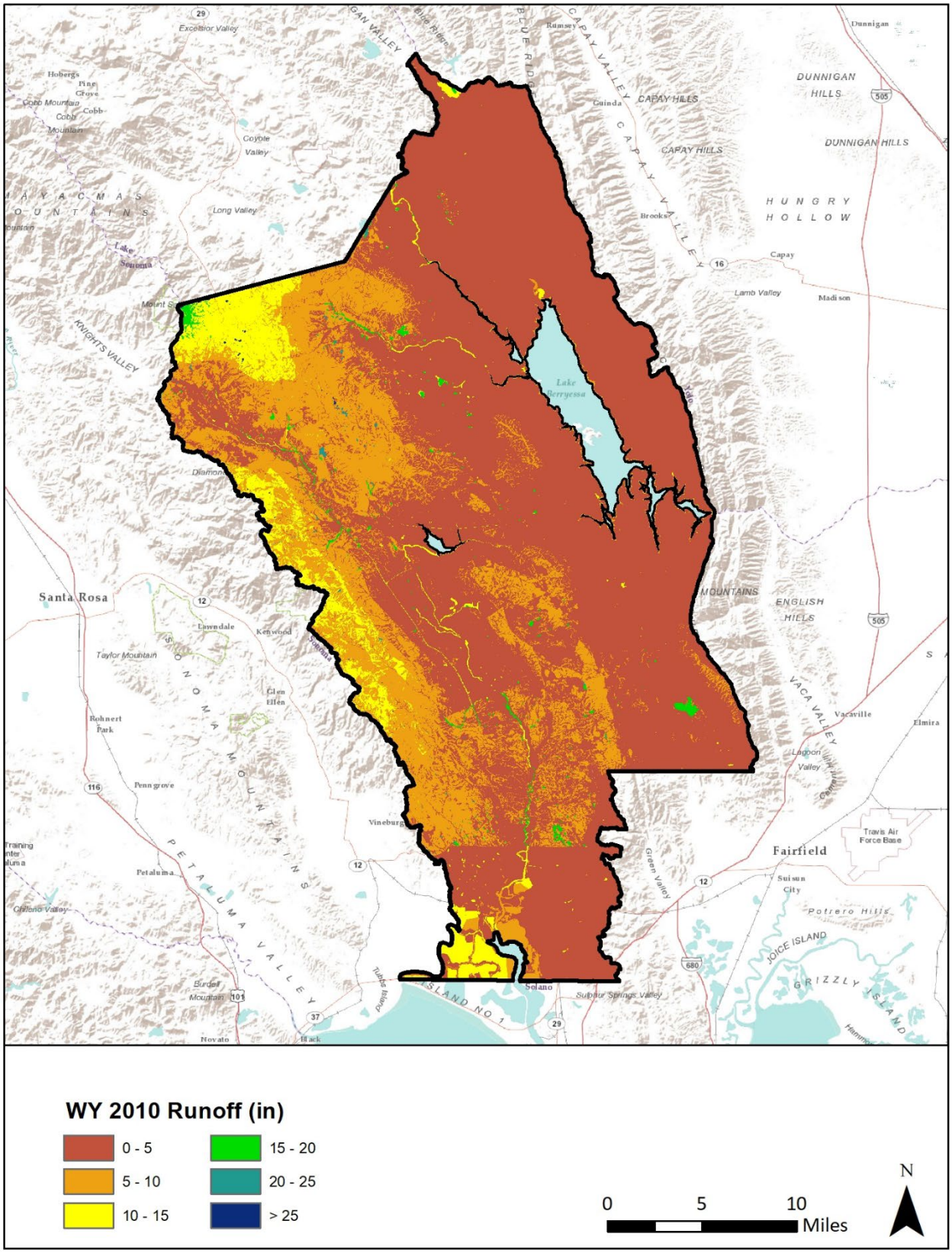


Figure 17: Water Year 2014 recharge simulated with the Napa County SWB model.

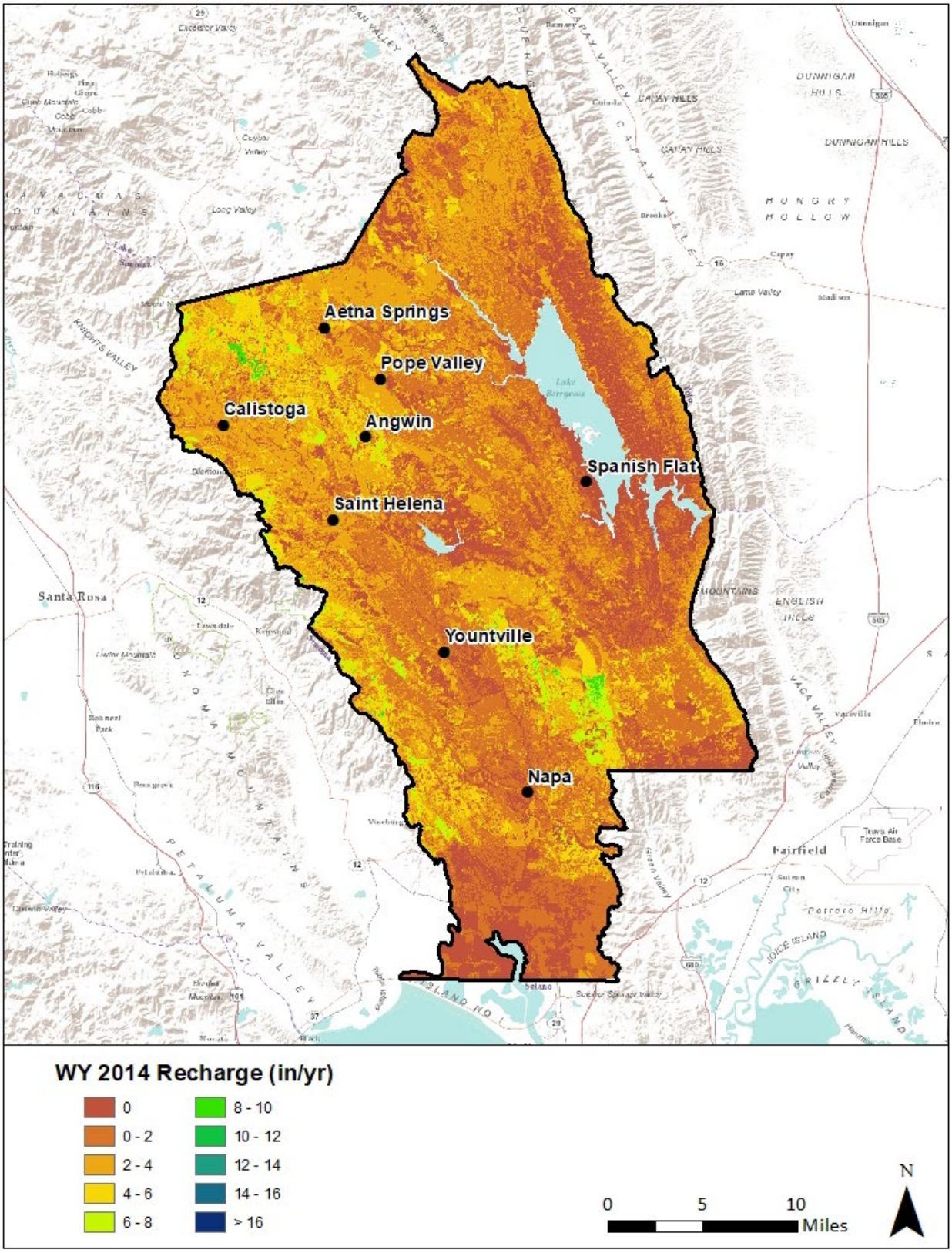


Figure 18: Water Year 2014 recharge simulated with the Napa County SWB model.

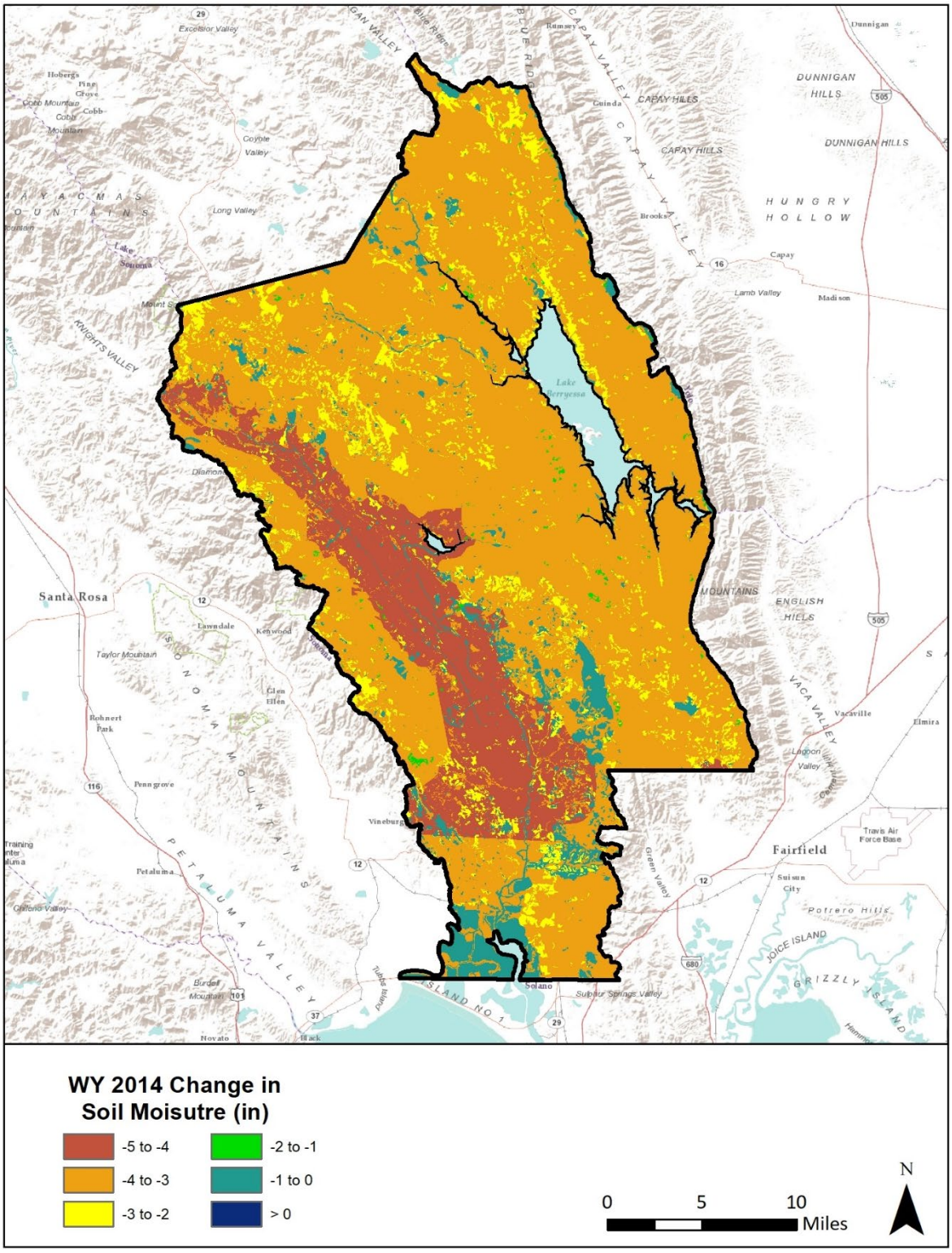


Figure 19: Water Year 2014 change in soil moisture content simulated with the Napa County SWB model.

Table 5: Simulated precipitation and recharge values averaged across HUC-12 watersheds in Napa County for Water Year 2010 expressed as depths. See Figure 20 for watershed locations.

Name	Drainage Area (mi^2)	Precipitation (in)	AET (in)	Surface Runoff (in)	Recharge (in)	Soil Moisture Change (in)
American Canyon Creek	10.8	24.1	16.3	3.7	4.7	-0.6
Bucksnort Creek	1.9	47.9	24.5	12.1	11.1	0.1
Butts Creek-Putah Creek	49.9	33.0	17.4	9.7	6.2	-0.7
Capell Creek	43.0	31.1	19.1	7.4	5.0	-0.6
Carneros Creek	29.7	28.0	18.6	5.2	5.5	-0.6
Chiles Creek	32.0	34.6	21.1	7.1	6.8	-0.5
Dry Creek	28.8	37.0	22.2	7.2	8.4	-0.5
Hunting Creek	12.0	33.7	19.0	9.7	5.7	-0.8
Jackson Creek-Putah Creek	54.5	29.9	13.4	12.6	3.0	-0.5
Lake Curry-Suisun Creek	16.4	30.7	18.9	6.5	5.9	-0.6
Lake Hennessey-Conn Creek	20.0	35.1	19.6	8.5	7.3	-0.4
Ledgewood Creek	6.4	21.8	16.9	3.4	3.3	-1.8
Lower Eticuera Creek	44.0	30.0	17.7	8.1	4.7	-0.7
Lower Napa River	45.0	31.7	19.9	5.6	6.7	-0.6
Lower Pope Creek	31.8	33.9	18.0	9.7	6.5	-0.6
Maxwell Creek	35.1	34.7	19.6	8.7	6.9	-0.6
Middle Napa River	60.3	39.9	22.8	8.5	9.2	-0.5
Milliken Creek	29.7	30.9	16.9	6.6	7.9	-0.6
Rector Creek-Conn Creek	22.3	32.8	18.0	7.1	8.2	-0.7
Saint Helena Creek	7.7	53.3	25.2	13.5	14.4	0.1
San Pablo Bay Estuaries	19.5	23.9	8.1	13.8	2.3	-0.3
Tulucay Creek	34.2	26.1	16.7	4.6	5.4	-0.7
Upper Eticuera Creek	25.6	31.2	17.2	8.6	6.1	-0.8
Upper Napa River	44.6	44.7	23.6	10.6	10.8	-0.4
Upper Pope Creek	21.7	44.5	22.7	10.5	11.5	-0.3
Wooden Valley & Suisun Creeks	23.3	29.0	19.0	5.1	5.5	-0.6
Wragg Canyon-Putah Creek	34.2	28.3	16.3	8.6	3.3	-0.6

Table 6: Simulated precipitation and recharge values averaged across HUC-12 watersheds in Napa County for Water Year 2010 expressed as a percentage of precipitation. See Figure 20 for watershed locations.

Name	Drainage Area (mi^2)	Precipitation (in)	AET (%)	Surface Runoff (%)	Recharge (%)	Soil Moisture Change (%)
American Canyon Creek	10.8	24.1	67%	15%	19%	-3%
Bucksnort Creek	1.9	47.9	51%	25%	23%	0%
Butts Creek-Putah Creek	49.9	33.0	53%	29%	19%	-2%
Capell Creek	43.0	31.2	61%	24%	16%	-2%
Carneros Creek	29.7	29.7	66%	19%	20%	-2%
Chiles Creek	32.0	34.6	61%	21%	20%	-1%
Dry Creek	28.8	37.8	60%	20%	23%	-1%
Hunting Creek	12.0	33.7	56%	29%	17%	-2%
Jackson Creek-Putah Creek	54.5	29.7	45%	42%	10%	-2%
Lake Curry-Suisun Creek	16.4	30.7	61%	21%	19%	-2%
Lake Hennessey-Conn Creek	20.0	36.0	56%	24%	21%	-1%
Ledgewood Creek	6.4	21.8	77%	15%	15%	-8%
Lower Eticuera Creek	44.0	30.0	59%	27%	16%	-2%
Lower Napa River	45.0	31.7	63%	18%	21%	-2%
Lower Pope Creek	31.8	33.9	53%	29%	19%	-2%
Maxwell Creek	35.1	34.7	56%	25%	20%	-2%
Middle Napa River	60.3	40.4	57%	21%	23%	-1%
Milliken Creek	29.7	30.9	55%	21%	26%	-2%
Rector Creek-Conn Creek	22.3	32.8	55%	22%	25%	-2%
Saint Helena Creek	7.7	53.3	47%	25%	27%	0%
San Pablo Bay Estuaries	19.5	23.9	34%	58%	10%	-1%
Tulucay Creek	34.2	26.1	64%	18%	21%	-3%
Upper Eticuera Creek	25.6	31.2	55%	28%	19%	-3%
Upper Napa River	44.6	44.7	53%	24%	24%	-1%
Upper Pope Creek	21.7	44.5	51%	23%	26%	-1%
Wooden Valley & Suisun Creeks	23.3	29.0	65%	18%	19%	-2%
Wragg Canyon-Putah Creek	34.2	28.3	58%	31%	12%	-2%

Table 7: Simulated precipitation and recharge values averaged across HUC-12 watersheds in Napa County for Water Year 2014 expressed as depths. See Figure 20 for watershed locations.

Name	Drainage Area (mi^2)	Precipitation (in)	AET (in)	Surface Runoff (in)	Recharge (in)	Soil Moisture Change (in)
American Canyon Creek	10.8	10.1	12.3	0.7	0.7	-3.6
Bucksnort Creek	1.9	28.8	17.6	11.5	2.6	-3.0
Butts Creek-Putah Creek	49.9	16.9	14.2	3.9	1.9	-3.2
Capell Creek	43.0	15.8	14.8	3.1	1.1	-3.1
Carneros Creek	29.7	15.0	14.7	4.6	2.0	-3.7
Chiles Creek	32.0	18.3	16.5	3.7	1.5	-3.3
Dry Creek	28.8	21.5	16.5	6.8	2.5	-3.7
Hunting Creek	12.0	16.7	15.4	3.1	1.6	-3.4
Jackson Creek-Putah Creek	54.5	14.9	10.3	6.1	0.7	-2.3
Lake Curry-Suisun Creek	16.4	18.4	16.1	3.7	1.9	-3.4
Lake Hennessey-Conn Creek	20.0	19.1	14.8	5.7	2.2	-3.2
Ledgewood Creek	6.4	12.2	13.9	1.7	0.8	-4.3
Lower Eticuera Creek	44.0	14.9	14.0	2.6	1.3	-3.1
Lower Napa River	45.0	19.4	15.9	5.0	2.2	-3.6
Lower Pope Creek	31.8	17.8	14.5	4.5	2.0	-3.2
Maxwell Creek	35.1	18.3	15.9	3.8	2.0	-3.3
Middle Napa River	60.3	21.3	16.5	6.6	2.5	-3.7
Milliken Creek	29.7	18.7	13.7	4.5	3.4	-2.9
Rector Creek-Conn Creek	22.3	16.5	13.6	4.0	2.3	-3.4
Saint Helena Creek	7.7	32.2	17.8	13.2	4.1	-3.0
San Pablo Bay Estuaries	19.5	10.4	6.0	5.6	0.5	-1.6
Tulucay Creek	34.2	14.6	13.5	2.6	1.7	-3.3
Upper Eticuera Creek	25.6	15.5	14.1	2.5	2.1	-3.2
Upper Napa River	44.6	22.9	16.2	6.9	3.3	-3.5
Upper Pope Creek	21.7	25.6	16.8	8.5	3.5	-3.2
Wooden Valley & Suisun Creeks	23.3	17.9	16.4	3.1	2.0	-3.5
Wragg Canyon-Putah Creek	34.2	14.1	12.6	3.6	0.6	-2.8

Table 8: Simulated precipitation and recharge values averaged across HUC-12 watersheds in Napa County for Water Year 2014 expressed as a percentage of precipitation. See Figure 20 for watershed locations.

Name	Drainage Area (mi^2)	Precipitation (in)	AET (%)	Surface Runoff (%)	Recharge (%)	Soil Moisture Change (%)
American Canyon Creek	10.8	10.1	121%	7%	7%	-36%
Bucksnort Creek	1.9	28.8	61%	40%	9%	-10%
Butts Creek-Putah Creek	49.9	16.8	84%	23%	11%	-19%
Capell Creek	43.0	15.8	94%	20%	7%	-20%
Carneros Creek	29.7	17.6	98%	30%	13%	-25%
Chiles Creek	32.0	18.4	90%	20%	8%	-18%
Dry Creek	28.8	22.1	77%	32%	12%	-17%
Hunting Creek	12.0	16.7	92%	18%	10%	-20%
Jackson Creek-Putah Creek	54.5	14.7	69%	41%	5%	-16%
Lake Curry-Suisun Creek	16.4	18.4	88%	20%	10%	-19%
Lake Hennessey-Conn Creek	20.0	19.6	78%	30%	12%	-17%
Ledgewood Creek	6.4	12.2	114%	14%	7%	-35%
Lower Eticuera Creek	44.0	14.9	94%	18%	9%	-21%
Lower Napa River	45.0	19.4	82%	26%	11%	-19%
Lower Pope Creek	31.8	17.8	81%	25%	11%	-18%
Maxwell Creek	35.1	18.3	87%	21%	11%	-18%
Middle Napa River	60.3	21.8	77%	31%	12%	-18%
Milliken Creek	29.7	18.7	74%	24%	18%	-16%
Rector Creek-Conn Creek	22.3	16.5	83%	24%	14%	-21%
Saint Helena Creek	7.7	32.2	55%	41%	13%	-9%
San Pablo Bay Estuaries	19.5	10.4	58%	53%	4%	-16%
Tulucay Creek	34.2	14.6	93%	18%	12%	-23%
Upper Eticuera Creek	25.6	15.5	91%	16%	14%	-21%
Upper Napa River	44.6	22.9	71%	30%	14%	-15%
Upper Pope Creek	21.7	25.6	66%	33%	14%	-12%
Wooden Valley & Suisun Creeks	23.3	17.9	91%	17%	11%	-20%
Wragg Canyon-Putah Creek	34.2	14.1	90%	26%	5%	-20%

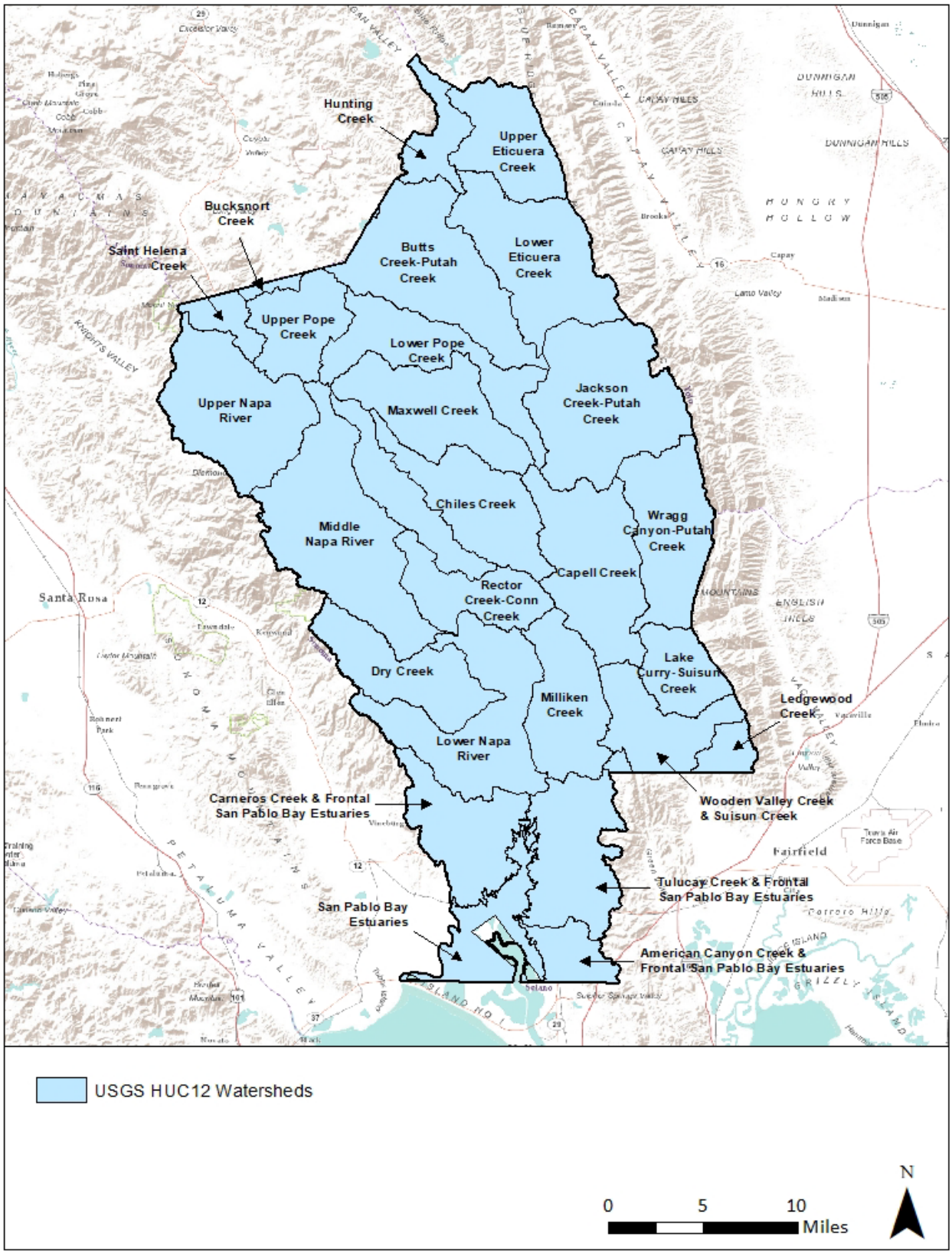


Figure 20: Major watersheds areas used to summarize water budget information in Tables 5 - 8.

Discussion and Conclusion

Numerous previous modeling studies have estimated water budget components in several larger watershed areas in Sonoma and Napa Counties including the Santa Rosa Plain, the Green Valley and Dutch Bill Creek watersheds, and the Sonoma Valley (Farrar et. al., 2006; Kobor and O'Connor, 2016; Woolfenden and Hevesi, 2014). Comparisons to these water budgets are useful for evaluating the SWB results, but one would not expect precise agreement owing to significant variations in climate, land cover, soil types, underlying hydrogeologic conditions, and different spatial scales of modeling studies. These regional analyses estimate that average annual recharge varies from 7% to 19% of the annual precipitation. The equivalent county-wide value from this study is slightly higher at 20%.

Water budgets for the Napa River and selected sub-basins were also estimated in a previous study by Luhdorff and Scalmanini Engineers and MBK Engineers (LSCE 2013). The LSCE study estimated that, as a percentage of annual precipitation, AET comprised slightly less, runoff significantly more, and recharge substantially less of the typical annual water budget. LSCE (2013) calculated infiltration of precipitation based on the difference between total monthly streamflow at selected gaging stations and total monthly precipitation for the gages' drainage area. Streamflow volumes include both direct runoff (overland flow and interflow) and baseflow from groundwater. Inclusion of baseflow with direct runoff in these calculations may inappropriately reduce the estimated volume of water infiltrated into the soil and available for recharge; the LSCE approach therefore tends to underestimate groundwater recharge. Additionally, many of the gauging stations used for the analysis are located in reaches that may be significantly influenced by upstream reservoir releases, surface water diversions, groundwater abstraction, and/or surface water groundwater exchanges, further complicating the interpretation of the LSCE (2013) runoff rates and the interrelated calculations of AET and recharge rates. In contrast, the SWB model presented here is based on calibrated parameter values developed for a similar model in Sonoma County which was calibrated to gauges specifically selected to minimize the effects of reservoir releases, water use, or significant surface water/groundwater interaction, and after separating and removing the baseflow component of streamflow.

The recharge estimates presented here arguably represent the best available county-wide estimates produced at a fine spatial resolution using a consistent and objective data-driven approach. This analysis focused on two Water Years, 2010 and 2014, which represent average and drought conditions respectively. Input parameters were determined based on literature values and values calibrated through prior modeling experience in Sonoma County.

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