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Water Availability Analysis

Water Availability Analysis

Vine Cliff Winery, Napa County APN 032-030-027

(Applicant)

Vine Cliff Winery
7400 Silverado Trail
Napa, California

Prepared by:



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Introduction

Vine Cliff Winery is seeking permits from the County of Napa to renovate winery facilities at 7400 Silverado Trail (APN 032-030-027) which is located about 2.8 miles east of Oakville in the hills east of the Napa Valley floor. The subject parcel lies outside of the boundaries of the Napa Valley Groundwater Sub-basin. This Water Availability Analysis (WAA) is an update to the prior approved WAA for the parcel prepared by OEI in December 2017. The update includes a new well search in the project area and vicinity and revisions to the Tier 1 analysis to conform with updated County of Napa Groundwater guidance from Department of Planning, Building, & Environmental Services. No change in water use is expected.

The WAA includes the following elements: estimates of existing and proposed water uses on the project parcel and within the project recharge area, compilation of drillers' logs from the area and characterization of local hydrogeologic conditions, and execution of Tier 1 and Tier 2 screening criteria including estimates of groundwater recharge relative to proposed uses (Tier 1) and the potential for well interference at neighboring wells (Tier 2). No wells are within 500 ft of the project wells; per County guidance, no additional well interference analysis is required. The project well does not lie within 1,500 ft of any County-designated significant stream; hence no additional analysis of potential surface water-groundwater interaction is required (Tier 3).

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 available data and relies significantly on interpretation of data from disparate sources of disparate quality.

Given the significant depths to water in wells near the project parcel (160 to 626-ft), the relationship between groundwater recharge generated on the project parcel and groundwater availability at the project wells is uncertain. It is likely that water flowing to the project wells is supplied by groundwater inflows from surrounding areas as well as from recharge occurring on the overlying landscape comprised by the subject parcel. Analysis of the age and sources of the deeper groundwater occurring beneath the project parcel is beyond the scope of this study.

The water balance approach used to estimate groundwater recharge for this study simulates potential recharge from infiltration of precipitation and does not include verifiable estimates of the capacity of the project aquifer materials to accept recharge. Where bedrock of low permeability and/or fractured bedrock underlies the subject parcel and study area, a significant proportion of the potential recharge may exit the project area as shallow subsurface flow rather than percolating and recharging the local aquifer. Quantifying the proportion of the potential recharge that percolates to underlying bedrock aquifers is beyond the scope of this analysis; we have attempted to characterize aquifer hydraulic parameters from available data. Data

describing subsurface conditions of soil and bedrock, local aquifer hydraulic characteristics, and local processes and pathways of groundwater percolation are rarely available and difficult to obtain in the absence of focused and well-funded hydrogeologic investigations.

Hydrogeologic Conditions

The tier 1 WAA focuses on estimating groundwater recharge for comparison to groundwater use. Groundwater recharge in hillside areas of Napa County results primarily from infiltration of precipitation distributed across the land surface. To accomplish Tier 1 objectives in a manner consistent with hydrogeologic principles and water balance techniques used to estimate groundwater recharge, we define an area of landscape encompassing the project parcel that represents the likely source of infiltration recharge of the aquifer utilized by the project wells. The so-defined project recharge area is also used to estimate existing groundwater use on surrounding parcels so that a more comprehensive assessment of groundwater availability can be performed to assess project groundwater use in the context of the regional project aquifer. The recharge area thus also represents the project groundwater impact area and is sometimes referred to as the project recharge /impact area.

The project parcel is located in the foothills east of the Napa Valley in the northwest portion of a relatively large (~32 square miles) block of andesitic and basaltic lava flows of the Tertiary-aged Sonoma Volcanics. These volcanic rocks comprise much of the mountains east of the Napa Valley from the northern portion of the Milliken-Sarco-Tullockay (MST) basin north to Lake Hennessey (Figure 1). At the east edge of Napa Valley within the lowest-lying portions of the project parcel and immediately west of the parcel, alluvial fan deposits (map units Qf and Qhf) overlie the Sonoma Volcanics, mapped locally to be andesite and basalt flows (map unit Tsa, Figure 1). A project recharge area was developed for this project and is bounded by ridgelines delineating groundwater flow on the east north and south sides and the geologic contact with the alluvium of the Napa Valley floor to the west. This project recharge area is approximately 306.6 acres in size. Geologic cross sections in the vicinity of the project parcel indicate that the Tsa unit extends to the west beneath portions of the alluvium of the Napa Valley and that wells in the area completed to depths as high as 600-ft do not fully penetrate the Tsa unit (see geologic Sections B and C, LSCE, 2013).

The Tsa unit is part of the lower member of the Sonoma Volcanics which was described by Weaver (1949) as comprised of individual lava flows displaying great variability in thickness and texture over short distances. Given this heterogeneity it can be expected that hydrogeologic conditions exhibit similar spatial variability and yields from wells completed anywhere in the Tsa unit, ranging from minimal yield to several hundred gpm (LSCE, 2013).

Driller's logs (Well Completion Reports) for wells around the project parcel were obtained from the California Department of Water Resources and from County files. A subset of these logs was compiled and georeferenced based on parcel and location sketch information available for some wells (Figure 1). The project parcel has two wells. The upper well (Well 1) is in the central-east portion of the parcel and was completed in 1996 to a depth of 385-ft. The lower well (Well 2) is

in the south-east portion of the parcel and was completed in 1996 to a depth of 280-ft (Table 1 & Figure 1). Static water level was not reported in well 1 but was reported at 150 feet bgs in well 2 at the time of construction.

Alluvial fan deposits in the southwest corner of the subject parcel are expected to be highly permeable relative to the underlying volcanic bedrock that comprises the project aquifer. Groundwater recharge processes are likely to be enhanced by the alluvial fan deposits because water may more readily percolate into and saturate the fan deposits and establish a perched water table overlying the bedrock aquifer that could provide for more effective percolation to the bedrock. This phenomena affects only a small portion of the parcel but could have a disproportionate effect on overall recharge occurring on the subject parcel.

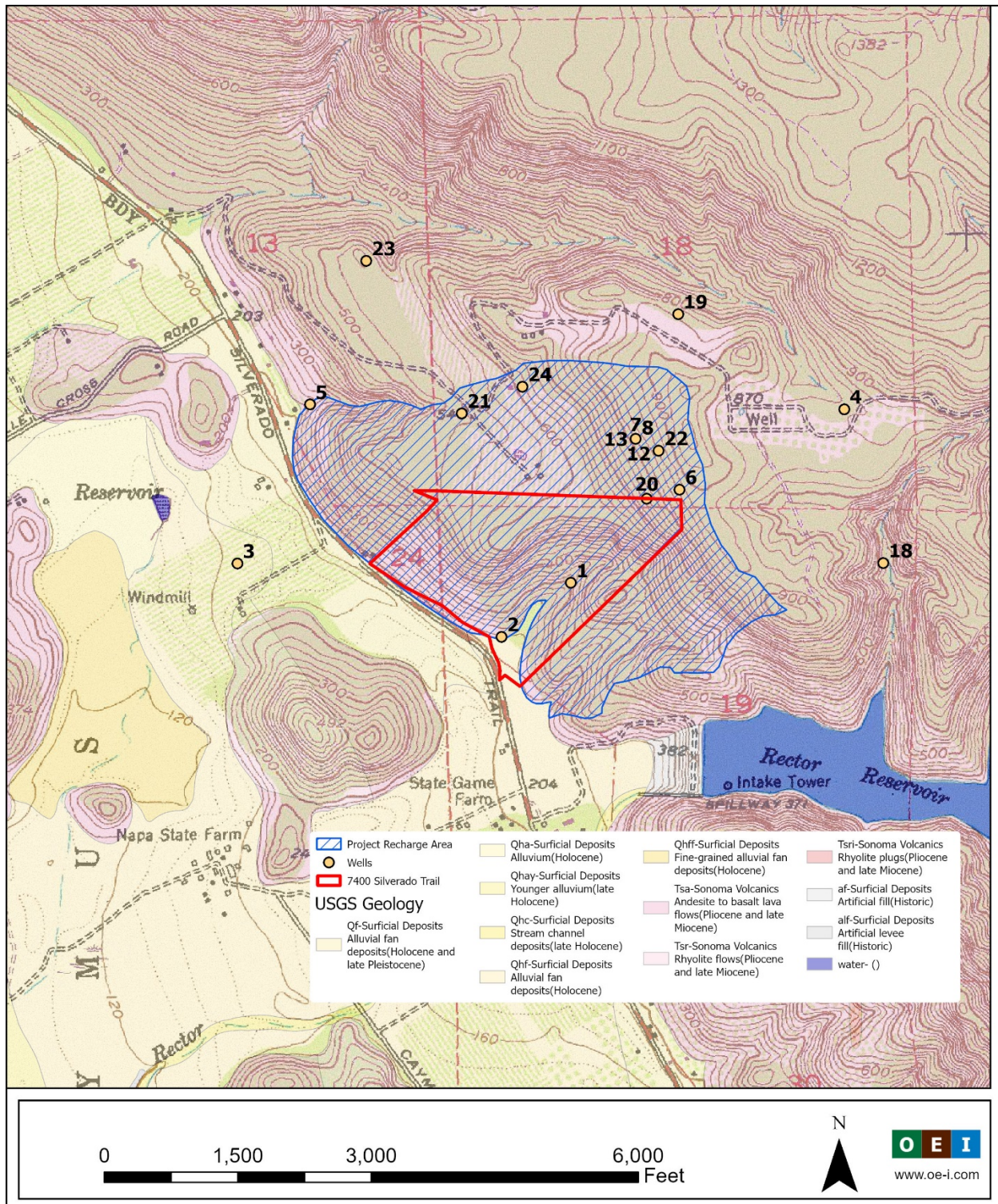


Figure 1: Surficial geology and locations of wells in the vicinity of the project parcel (Graymer et al., 2007). Units are as follows:

Table 1: Well completion details for the upper well (Well 1), lower well (Well 2), and wells on nearby parcels. Wells indicated by * were not included in the 2016 analysis but have been included from improved records and well search in 2024.

Well No.	1	2	3*	4*	5*	6	7*	8*	9*	10*	11*	12*
Year Completed	1996	1986	1977	1995	1998	2007	2004	2004	2004	2004	2004	2004
Depth	385	283	240	800	600	690	300	300	300	300	300	300
Static Water Level	-	150	15	182	350	480	-	-	-	-	-	-
Estimated Yield	120	200	220	30	20	90	-	-	-	-	-	-
Top of Screened Interval	200	183	40	60	80	360	-	-	-	-	-	-
Bottom of Screened Interval	300	283	240	80	600	690	-	-	-	-	-	-
Geologic Unit	Tsa	Tsa	Qhf	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa
WCR No.	547492	119629	103154	547445	324026	1073642	802399	802400	802401	802402	802403	802404

Well No.	13*	14*	15*	16*	17*	18	19*	20	21*	22*	23*	24
Year Completed	2004	2004	2004	2004	2004	1999	1999	1978	1998	1998	1992	2000
Depth	300	300	300	300	300	1125	753	350	595	810	637	590
Static Water Level	-	-	-	-	-	271	393	220	275	375	400	260
Estimated Yield	-	-	-	-	-	300	150	20	60	100	60	60
Top of Screened Interval	-	-	-	-	-	385	433	150	245	440	397	130
Bottom of Screened Interval	-	-	-	-	-	585	753	350	545	810	637	590
Geologic Unit	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa	Tsa
WCR No.	802405	802406	802407	802408	802409	e0177367	778357	-	528419	528473	482234	710238

Water Demand

Existing groundwater uses within the project recharge area (described below in the Groundwater Recharge Analysis section) consist of Residential Use for eight residences, Winery Use for the 48,000 gallon per year Vine Cliff Winery, and Irrigation Use for 121 acres of vineyard of which 26 acres are on the project parcel.

The existing Residential Use is estimated to total 7.15 ac-ft/yr. The existing Winery Use (Vine Cliff Winery) is estimated to total 2.41 ac-ft/yr, and the existing Irrigation Use is estimated to total 60.57 ac-ft/yr for a Total Existing Use of 70.11 ac-ft/yr. Approximately 17.06 ac-ft/yr or 24% of the existing use is associated with the project parcel with the remainder associated with neighboring parcels (Tables 2-4). These values vary slightly from water use estimates associated with the 2017 WAA due to updated water use calculations and changes in land use on surrounding parcels. The proposed project actions include the addition of a commercial kitchen. However, water use on the project parcel will not change as a result of this as precious water demand estimates assume water demand based on the annual number of attendees at catered events which will not change between existing and proposed conditions as a result of this project. No change in water use is expected as part of this project. Water for the project parcel is supplied by wells 1 and 2 (Table 1 and Figures 1 & 3)

Table 2: Existing and proposed annual groundwater uses (ac-ft/yr) within the project recharge area.

	Existing Condition (acre-ft/yr)	Proposed Condition (acre-ft/yr)
Project Parcel	17.06	17.06
Residential Use	1.80	1.80
Irrigation Use	12.84	12.84
Winery Use	2.03	2.03
Employee/Guest Use	0.39	0.39
Neighboring Parcels	53.05	53.05
Residential Use	5.35	5.35
Irrigation Use	47.70	47.70
Total	70.11	70.11

Table 3: Existing and proposed water use on the project parcel. Note that landscaping water use was reported as a flat rate rather than a per-acre rate.

	# of Units	Use per Unit	Annual Water Use (AF/yr)
Residential Use			1.80
Residences, Oversized	1 Residence	1.00 AF/Residence	1.00
Residences, Secondary	2 Residences	0.35 AF/Residence	0.70
Pools	1 Pool	0.10 AF/Pool	0.10
Agricultural Use			12.84
Vineyard	25.67 Acres	0.50 AF/acre/yr	12.84
Winery Use			2.03
Process Water	48000 Gallons	2.15 AF/100,000 gal.	1.03
Domestic & Landscaping	- Gallons	0.50 AF/100,000 gal.	1.00
Guest & Employee Use			0.39
Tasting Room Visitations	14600 Guests	3 gal./Guest	0.13
Events w/ On-Site Catering	2100 Guests	15 gal./Guest	0.10
Full-Time Employees	12 Employees	15 gal./shift @ 250 shifts/yr	0.14
Part-Time Employees	4 Employees	15 gal./shift @ 125 shifts/yr	0.02
Total			17.06

Table 4: Existing and proposed groundwater use on neighboring parcels within the groundwater recharge area.

	# of Units	Use per Unit	Annual Water Use (AF/yr)
Residential Use			5.35
Residences, Oversized	1 Residence	1.00 AF/Residence	1.00
Residences, Primary	4 Residences	0.75 AF/Residence	3.00
Pools	3 Pools	0.10 AF/Pool	0.30
Other Landscaping, Addtl.	21000 sq. ft.	0.05 AF/1,000 sq. ft.	1.05
Agricultural Use			47.70
Vineyard	95.4 Acres	0.50 AF/acre/yr	47.70
Total			53.05

Groundwater Recharge Analysis

Groundwater recharge within the project recharge area was estimated using a Soil Water Balance (SWB) of Napa County developed by OEI. This model implements 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 uses daily values for precipitation and evapotranspiration along with soil hydrologic parameters and vegetation cover. The model 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 and the hydrologic data and simulated water budget outputs are provided in Appendix B.

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. In late-November 2022, the County of Napa instituted a new policy prescribing that for purposes of estimating groundwater recharge, the mean annual precipitation to be used is that mean for Water Years 2012-2021 derived from the newest PRISM data. County of Napa has provided gridded GIS data of the mean precipitation for this period for use by WAA practitioners.

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 water balance data from the SWB model years is tabulated in Table 5.

Results

Updated WAA guidance from the County of Napa requires the use of the updated 2012-2021 average precipitation dataset provided by County of Napa and produced by PRISM Climate Group at Oregon State University. This dataset provides spatially distributed 10-year average precipitation data at the location of this project. The 10-year average precipitation at the site is approximately 27.7 inches. We assume that a linear relationship exists between precipitation and runoff and use the simulated 2010 and 2014 SWB data to predict average recharge based on the 10-year average precipitation data. This method results in an average recharge estimate of 6.2 inches of 22.5% of average precipitation, slightly less than the 2010 normal year prediction.

Table 5: Summary of water balance results from the SWB model.

	2010 Normal Year		2014 Dry Year		2012 - 2021 Avg.	
	inches	% of precip	inches	% of precip	inches	% of precip
Precipitation	29.4	-	15.1	-	27.7	-
AET		-		-	-	-
Runoff		-		-	-	-
Δ Soil Moisture		-		-	-	-
Recharge	6.8	23.1%	2.1	13.8%	6.2	22.5%

Groundwater Storage

Groundwater storage is estimated as the product of the aquifer surface area (assumed to be equivalent to the project recharge area), the depth of the saturated zone of the aquifer intersected by wells, and the porosity of the fractured bedrock. The surface area is about 306.6 acres. The depth of the saturated zone was defined as the average difference between the static water level and the bottom of the screened interval in the two project wells (Wells 1 and 2 in Table 1 & Figure 1). The estimated depth of the saturated zone is therefore about 100-ft. Note that the depth of the aquifer is defined by well depth, and that the saturated zone of the aquifer probably extends to substantially greater depths. The potential aquifer storage capacity is therefore likely to be underestimated.

The porosity of the fractured bedrock is expected to lie between <1 and 10% (Freeze and Cherry, 1979; Weight and Sonderegger, 2000). Given the relatively low specific capacities (for fractured bedrock) of wells (Table 1) in the project aquifer, we assume a low-end (conservative) porosity of 1%. The estimated groundwater storage in the bedrock aquifer is calculated as 306.6 ac-ft.

Comparison of Water Demand and Groundwater Recharge/Storage

The total proposed water use for the project recharge area is estimated to be 70.1 ac-ft/yr. This represents 44% of the estimated 10-year average annual recharge of 159.4 ac-ft/yr (Table 6). This comparison indicates that the project aquifer has a modest surplus of water in terms of annual use compared to annual recharge, and that the aquifer storage is more than six times the annual recharge. When the comparison is restricted to the footprint of the project parcel, the total proposed water use is a smaller percentage (33%) of the mean annual groundwater recharge (Table 6).

Table 6: Comparison of total annual Water Use and groundwater recharge.

Domain	Total Proposed Demand (ac-ft/yr)	Dry Water Year (2014)		
		Recharge (ac-ft/yr)	Recharge Surplus (ac-ft/yr)	Demand as % of Recharge
Project Recharge Area	70.1	159.4	89.3	44%
Project Parcel	17.1	51.8	34.7	33%

The significant volume of groundwater in storage is expected to moderate the impacts of climatic variations on aquifer conditions. The effects of dry years and wet years are likely balanced out over the period of years or decades required for water to move through the aquifer, such that short-term reductions in groundwater storage associated with periods of reduced groundwater recharge during dry years would be compensated by increases in storage during wetter years.

The use of the 2012-2021 average precipitation as required by County of Napa guidelines implicitly acknowledges this aspect of groundwater resources.

There is no new water use associated with this project at Vine Cliff Winery; the water use estimates in this report incorporate land use changes since about 2016. This updated WAA estimated an increase of 0.45 ac-ft/yr of residential use and 4.04 ac-ft/yr of vineyard irrigation. This WAA concluded that an additional 8.1 acres of vineyard were planted in project recharge area. This updated WAA also incorporated groundwater recharge estimates based on the County-wide SWB model developed by OEI (Appendix B). This iteration of the SWB model predicted a higher rate of groundwater recharge than the limited SWB model developed for OEI's prior WAA. The prior WAA estimated that groundwater use on the project parcel was 52% of mean annual recharge as compared to 33% in the updated WAA (Table 6).

Well Interference Analysis

The closest neighboring well to the two existing wells on the project parcel appears to be located about 1,275 feet northeast of well 1lk on the adjacent parcel to the north (Well 20 in Table 1 & Figure 1). Based on the WAA guidance document, a Tier 2 well interference analysis is not required given that non-project wells are located greater than 500-feet from the project wells.

Summary

Application of the Soil Water Balance (SWB) model and updated 10-year average precipitation data to estimate water available for aquifer recharge in the project area revealed that average recharge is ~6.2 inches/yr or 159.4 ac-ft/yr. No new water use is associated with this project. On the project parcel, groundwater demand is equivalent to 33% of the estimated annual recharge in an average water year; in other words, groundwater recharge is almost double groundwater use on the parcel. The total Water Use for the project recharge area is estimated to be 70.1 ac-ft/yr which represents 44% of the mean annual recharge indicating that the project is unlikely to result in significant declines in groundwater elevations or depletion of groundwater resources over time.

The closest neighboring well to the project wells is located more than 500 feet from the project wells, hence it is presumed that significant well interference is unlikely to occur per County guidance. There are no County-designated significant streams within 1,500 ft of the project parcel.

References

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Weight, W., and Sonderegger, J., 2000. Manual of Applied Field Hydrogeology. McGraw-Hill, 608 pgs.

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APPENDIX A

WELL COMPLETION REPORTS

QUADRUPLICATE
For Local Requirements

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

DWR USE ONLY - DO NOT FILL IN

RECEIVED
STATE WELL REGISTRATION NO. _____
OCT 21 1996
LATITUDE _____ LONGITUDE _____
ENVIRONMENTAL MANAGEMENT

Page 1 of 1
Owner's Well No. _____ No. **547492**
Date Work Began 9-19-96, Ended 10-2-96
Local Permit Agency Napa Co. Dept. of Environmental Hgmt
Permit No. 42920 Permit Date 8-27-96

GEOLOGIC LOG				WELL OWNER																																																					
ORIENTATION () ☒ VERTICAL ☐ HORIZONTAL ☐ ANGLE _____ (SPECIFY) DEPTH TO FIRST WATER _____ (Ft.) BELOW SURFACE DESCRIPTION <i>Describe material, grain size, color, etc.</i>				Name _____ Mailing Address _____ CITY _____ STATE _____ ZIP _____																																																					
<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2">DEPTH FROM SURFACE</th> <th rowspan="2">DESCRIPTION</th> </tr> <tr> <th>Ft.</th> <th>to Ft.</th> </tr> </thead> <tbody> <tr><td>0</td><td>43</td><td>Brown rock</td></tr> <tr><td>43</td><td>65</td><td>Soft brown rock</td></tr> <tr><td>65</td><td>88</td><td>Soft brown shale</td></tr> <tr><td>88</td><td>155</td><td>Black and gray rock</td></tr> <tr><td>155</td><td>192</td><td>Red rock</td></tr> <tr><td>192</td><td>200</td><td>Hard black rock</td></tr> <tr><td>200</td><td>280</td><td>Hard gray rock</td></tr> <tr><td>280</td><td>385</td><td>Hard black rock</td></tr> <tr><td colspan="3">Continued from below</td></tr> <tr> <td></td><td></td><td>blank screen slot size</td> </tr> <tr><td>300</td><td>320</td><td>x</td></tr> <tr><td>320</td><td>340</td><td>x .030</td></tr> <tr><td>340</td><td>360</td><td>x</td></tr> <tr><td>360</td><td>380</td><td>x .030</td></tr> <tr><td>380</td><td>385</td><td>x</td></tr> </tbody> </table>				DEPTH FROM SURFACE		DESCRIPTION	Ft.	to Ft.	0	43	Brown rock	43	65	Soft brown rock	65	88	Soft brown shale	88	155	Black and gray rock	155	192	Red rock	192	200	Hard black rock	200	280	Hard gray rock	280	385	Hard black rock	Continued from below					blank screen slot size	300	320	x	320	340	x .030	340	360	x	360	380	x .030	380	385	x	WELL LOCATION Address <u>7400 Silverado Trail</u> City <u>Napa</u> County <u>Napa</u> APN Book <u>32</u> Page <u>030</u> Parcel <u>27</u> Township _____ Range _____ Section _____ Latitude _____ North Longitude _____ West DEG. MIN. SEC.			
DEPTH FROM SURFACE		DESCRIPTION																																																							
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43	65	Soft brown rock																																																							
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LOCATION SKETCH 				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) _____																																																					
TOTAL DEPTH OF BORING <u>385</u> (Feet) TOTAL DEPTH OF COMPLETED WELL <u>385</u> (Feet)				DRILLING METHOD <u>Rotary-Air</u> FLUID <u>Foam</u> WATER LEVEL & YIELD OF COMPLETED WELL DEPTH OF STATIC WATER LEVEL _____ (Ft.) & DATE MEASURED <u>10-2-96</u> ESTIMATED YIELD* <u>120</u> (GPM) & TEST TYPE <u>Airlift</u> TEST LENGTH <u>4</u> (Hrs.) TOTAL DRAWDOWN <u>Complete</u> <i>* May not be representative of a well's long-term yield.</i>																																																					

DEPTH FROM SURFACE		BORE-HOLE DIA. (Inches)	CASING(S)							DEPTH FROM SURFACE		ANNULAR MATERIAL				
Ft.	to Ft.		TYPE ()				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	Ft.	to Ft.	TYPE			
		BLANK	SCREEN	CON- DUCTOR	FILL PIPE											CE- MENT ()
0	200	13%	x				F-480	8"	cl 200		0	55	x			
200	220			x							55	57		x		
220	240		x								57	385			x	Pea gravel
240	260			x												
260	280		x													
280	300		x													

ATTACHMENTS ()		CERTIFICATION STATEMENT	
☐ Geologic Log ☐ Well Construction Diagram ☐ Geophysical Log(s) ☐ Soil / Water Chemical Analyses ☐ Other _____		I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief. NAME <u>Doshier-Gregson Inc</u> (PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED) <u>5365 Napa-Vallejo Hwy</u> <u>American Canyon, Ca 94509</u> ADDRESS CITY STATE ZIP Signed _____ DATE SIGNED <u>258826</u> WELL DRILLER/AUTHORIZED REPRESENTATIVE	

No. 119629

DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

Notice of Intent No. _____

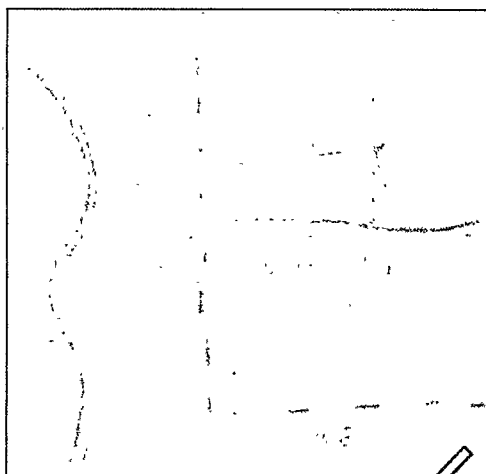
Local Permit No. or Date _____

State Well No. _____

Other Well No. _____

(1) OWNER: Name [REDACTED]
Address [REDACTED]
City [REDACTED] Zip [REDACTED]

(2) LOCATION OF WELL (See instructions):
County Napa Owner's Well Number 32-030-27
Well address if different from above Silv. Tr. below Rector dam
Township _____ 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 13 3/4"
Diameter of bore 13 3/4"
Packed from 20 to 283 ft.

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

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

From ft.	To ft.	Dia. in.	Cage or Wall	From ft.	To ft.	Slot size
0	183	8	200	183	283	.040

(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 grout

(10) WATER LEVELS:

Depth of first water, if known 110 ft.
Standing level after well completion 150 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 150 ft. At end of test complete
Discharge 200 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 283 ft. Depth of completed well 283 ft.
from ft. to ft. Formation (Describe by color, character, size or material)
0 - 3 topsoil & boulders
3 - 25 grey rock
25 - 50 brown & grey rock
50 - 100 grey & lb. brown rock
100 - 125 dk. grey & green rock, hard fractured
125 - 150 grey green rock stringers red rock
150 - 200 dk & lt grey & green rock hard frac
200 - 283 dk. grey green & red rock brown rock stringers black hard fractured

Work started 7/14 19 86 Completed 7/23 19 86

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 _____ (Well Driller)

NAME Doshier and Gregson Drilling, Inc.

Address 5365 Napa-Vallejo Highway

City Vallejo Zip 94589

License No. 294001 Date of this report 7/23/86

QUADRUPLICATE
Use to comply with
local requirementsSTATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

No. 103154

Notice of Intent No. _____

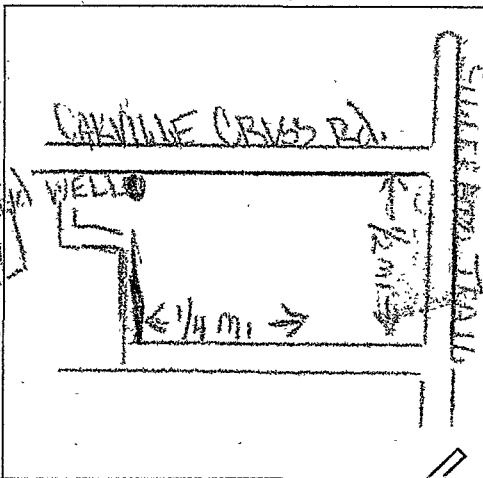
State Well No. _____

Local Permit No. or Date _____

Other Well No. _____

(1) OWNER: Name _____
Address _____
City _____ Zip _____
(2) LOCATION OF WELL (See instructions):
County Napa Owner's Well Number 070-09
Well address if different from above Same
Township _____ Range _____ Section _____
Distance from cities, roads, railroads, fences, etc. _____

(12) WELL LOG: Total depth 240 ft. Depth of completed well 240 ft.
from ft. to ft. Formation (Describe by color, character, size or material)
0 - 2 soil & boulders
2 - 17 cemented gravel
17 - 21 blue clay
21 - 25 blue clay, gravel imb.
25 - 34 brittle hard brown rock
34 - 43 brown tuffa, multi colored hard
rock str



(3) TYPE OF WORK:

New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐

Destruction ☐ (Describe
destruction materials and
procedures in Item _____)

(4) PROPOSED USE:

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

WELL LOCATION SKETCH

(5) EQUIPMENT:

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

(6) GRAVEL PACK:

Yes ☒ No ☐ Size 3/4"
Diameter of bore 12 1/2"
Packed from _____ to 20

(7) CASING INSTALLED:

Steel ☒ Plastic ☐ Concrete ☐

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	240	8	188	40	240	
				on top		

(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 Grout

(10) WATER LEVELS:

Depth of first water, if known 43' ft.
Standing level after well completion 15' ft.

(11) WELL TESTS:

Was well test made? Yes ☒ No ☐ If yes, by whom? Drillers
Type of test Pump ☐ Bailer ☐ Air lift ☐
Depth to water at start of test 43' ft. At end of test 10 ft.
Discharge 220 gpm 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

43 - 47 multi colored fractured rock
47 - 67 black & green fractured rock
67 - 74 granular brown fractured rock
74 - 78 red, green & black fractured rock
78 - 79 black & brown fractured rock
79 - 94 hard black large fractured rock
94 - 101 hard black red & green lge. frac.
rock
101 - 110 hard black & brown lge. frac. rock
110 - 113 hard grn. & black lge. frac. rock
113 - 118 hard grn. & brn. rock sm. fractures
118 - 131 semi hard granular grn. grey &
black rock
131 - 133 hard black rock very lge. frac.
133 - 137 hard blk rock, sm. fractures
137 - 141 semi hard blk & grn rock frac.
141 - 146 hard blk rock, sm. fract.
146 - 148 large fract.
148 - 148 hard blk rock no fractures
148 - 149 hard blk very lge. frac. rock
149 - 154 semi hard blk, red & green rock
154 - 159 semi hard blk & grey frac. rock
159 - 161 blk volcanic foam-rock
161 - 167 semi hard blk fractured rock
167 - 171 hard blk fractured rock
171 - 186 blk. volcanic foam rock
186 - 194 hard blk rock fractured
194 - 208 black granular rock
208 - 213 hard black rock fractured
213 - 224 black & red granular rock
224 - 240 hard grey & red rock, soft grey
strs

Work started 12-7 19 77 Completed 12-29 19 77
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 J.D. Doshier
(Well Driller)
NAME Doshier-Gregson Drilling, Inc.
(Person, firm, or corporation) (Typed or printed)
Address 5365 Napa-Vallejo Hwy
City Vallejo, Ca Zip 94590
License No. 294001 Date of this report 12/20/77

Environmental

Cover Sheet

APN	032-030-052-000
Permit #	
Program	WEU
DocType	WL
Street #	
Street Name	SILVERADO TRL
Year	



QUADRUPLICATE
For Local Requirements

Page 1 of 1

Owner's Well No. 6-19-95 No. 547445

Date Work Began 6-19-95 Ended 7-21-95

Local Permit Agency Napa Co. Dept. of Environmental Mgmt.

Permit No. 39478 Permit Date 6-19-95

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION (✓)			DEPTH TO FIRST WATER <u>370</u> (Ft.) BELOW SURFACE		DESCRIPTION
☒	VERTICAL	HORIZONTAL	ANGLE	(SPECIFY)	
Ft.	to	Ft.			
0	2		Topsoil		
2	20		Brown Rock Soft		
20	40		Gray & brown med.		
40	70		Gray Rock Hard		
70	100		Gray & brown rock hard		
100	145		Lt. red & gray rock med.		
145	160		Gray & red rock med.		
160	205		Black & gray rock med.		
205	235		Black, gray, rock, stringers red fract.		
235	265		Gray rock med		
265	295		Gray & red rock fract. med		
295	310		red, gray & brown rock		
310	355		Red, black & brown rock, soft		
355	370		Brown, red & black rock, fract.		
370	400		Black, brown & red rock		
400	455		Gray & brown rock, med.		
455	500		Gray rock, hard		
500	530		Gray & Black rock, med.		
530	560		Brown, black & red rock, med.		
560	590		Black, & brown rock, med.		
590	605		Black, brown & red		
605	635		Black & red rock, med.		
635	665		Black & green rock, med!		
665	700		Dk gray & black rock, med.		
700	735		Black, red & brown rock, med.		
735	755		RED, black & brown rock, fract.		
755	775		Black rock, fract. med.		
775	805		Black & gray rock, fract. med.		

TOTAL DEPTH OF BORING 805 (Feet)
TOTAL DEPTH OF COMPLETED WELL 800 (Feet)

WELL OWNER
Name [REDACTED]
Mailing Address [REDACTED]
CITY [REDACTED] STATE [REDACTED] ZIP [REDACTED]

WELL LOCATION
Address 7781 Silverado Trail
City Napa
County Napa
APN Book 32 Page 030 Parcel 07-52
Township [REDACTED] Range [REDACTED] Section [REDACTED]
Latitude [REDACTED] NORTH Longitude [REDACTED] WEST

LOCATION SKETCH
NORTH SOUTH
WEST EAST
#5497

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 Mud & Air rotary Water-Bentonite
WATER LEVEL & YIELD OF COMPLETED WELL
DEPTH OF STATIC WATER LEVEL 182 (Ft.) & DATE MEASURED 7-26-95
ESTIMATED YIELD 30 (GPM) & TEST TYPE Pump
TEST LENGTH 8 (Hrs.) TOTAL DRAWDOWN complete (Ft.)
* May not be representative of a well's long-term yield.

DEPTH FROM SURFACE			CASING(S)					DEPTH FROM SURFACE			ANNULAR MATERIAL			
Ft.	to	Ft.	TYPE (✓)				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	TYPE			FILTER PACK (TYPE/SIZE)
Ft.	to	Ft.	BLANK	SCREEN	CON- DUCTOR	FILL PIPE					CE- MENT (✓)	BEN- TONITE (✓)	FILL (✓)	
0	60		X				i-c-1	8	F-480				X	Pea Gravel
60	80			X			i-c-1	8	F-480	.032				
80	800						Perf. & solid staggered							
2	1					X								

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.

Doshier-Gregson, Inc.

NAME 5365 Napa-Vallejo Hwy

Vallejo, Ca 94590

ADDRESS [REDACTED]

CITY [REDACTED]

STATE [REDACTED]

ZIP 94590

Signed [REDACTED]

WELL DRILLER/AUTHORIZED REPRESENTATIVE

DATE SIGNED 08-01-95

C-57 LICENSE NUMBER

QUADRUPLICATE
Use to comply with
local requirements

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
WATER WELL DRILLERS REPORT

Do not fill in
No. 095283

Notice of Intent No. _____

Local Permit No. or Date _____

State Well No. _____

Other Well No. _____

(1) OWNER: Name _____
Address _____
City _____ Zip _____

(2) LOCATION OF WELL (See instructions):
County Napa Owner's Well Number 32-030-07175
Well address if different from above Silverado Trail
Township Napa Range _____ Section _____
Distance from cities, roads, railroads, fences, etc. _____

(12) WELL LOG: Total depth 500 ft. Depth of completed well 500 ft.
from ft. to ft. Formation (Describe by color, character, size or material)
0 - 150 Red clay & soft red rock
150 - 175 Gray rock - hard fract.
175 - 200 Gray, red & green rock, med. hard
200 - 225 Yellow, bl. & br. rock, fract.
225 - 250 Green & Gray rock, soft
250 - 275 Black & brown rock - soft
275 - 325 Brown, green rock, med. hard
325 - 350 Brown, green & black rock - soft
350 - 400 Green, yellow & bl. rock - soft
400 - 500 Red, black, yellow & green rock - hard fract.

(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 ☐

WELL LOCATION SKETCH

(5) EQUIPMENT:

Rotary ☐ Reverse ☐

Cable ☐ Air ☒

Other ☐ Bucket ☐

(6) GRAVEL PACK:

Yes ☐ No ☐ Size _____

Diameter of bore _____

Packed from _____ to _____ ft.

(7) CASING INSTALLED:

Steel ☒ Plastic ☐ Concrete ☐

(8) PERFORATIONS: Machine

Type of perforation or size of screen _____

From ft.	To ft.	Dia. in.	Cage or Wall	From ft.	To ft.	Slot size
0	500	6"	188	400	500	5/8x3"

(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 Grout

(10) WATER LEVELS:

Depth of first water, if known 415 ft.

Standing level after well completion 300 ft.

(11) WELL TESTS:

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

Type of test Pump ☐ 300 Bailer ☐ Air lift ☒

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

Discharge 60 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

Work started 11-5 80 Completed 12-1 80

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 _____ (Well Driller)

NAME Doshier-Gregson Drilling, Inc.

(Person, firm, or corporation) (Typed or printed)

Address 5365 Napa-Vallejo Hwy.

City Vallejo Zip 94590

License No. 294001 Date of this report 12/4/80

Local

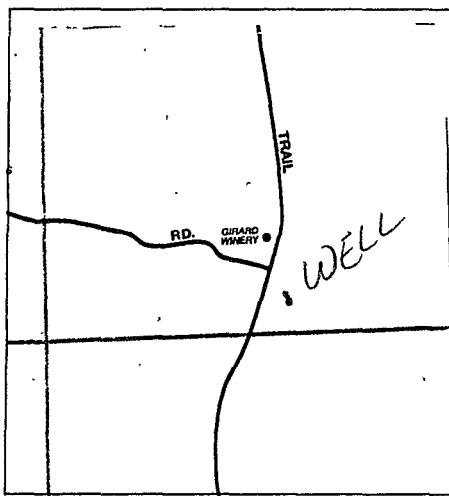
No. 324026

✓ JLL 1/6/99
Do not fill in

State Well No. _____
Other Well No. _____

(12) WELL LOG: Total depth 600 ft. Completed depth 600 ft.
from ft. to ft. Formation (Describe by color, character, size or material)

0	-	55 Boulders & Brown Soil
55	-	70 Red Rock Soft
70	-	90 Dark Gray Rock Hard
90	-	110 Dark Gray & Black Rock Hard Stringers Red
110	-	130 White Light Gray Rock Stringers Red Clay Soft
130	-	150 Brown Red Gray & Black Rock
150	-	170 White Red Black & Brown Rock Soft
170	-	190 White&Brown Rock Stringers Light Gray Clay
190	-	230 White Brown & Black Rock Soft
230	-	250 Reddish Brown Clay Stringers Black&White Rock
250	-	270 Gray Clay
270	-	290 Red Rock Soft
290	-	430 Dark Gray Black Rock Stringers Green Red
	-	Hard Fract
430	-	600 Dark Gray Black Rock Stringers Green Rock
	-	Hard Fract



(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 ☐

~~(G) GRAVEL PACK:~~

Yes ☒ No ☐ Size 8 3/4" (219 mm)
Diameter of bore 27 to 600 (686 to 15240 mm)
Packed from _____ to _____

(7) CASING INSTALLED:

Steel ☐ Plastic ☒ Concrete ☐

(8) ~~PERFORATIONS:~~

Type of perforation or size of screen

From ft.	To ft.	Dia. in.	Gage or Wall	From ft.	To ft.	Slot size
0	600	3	F480	80	600	factory

(9) WELL SEAL:

Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 27 ft

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

Method of sealing concrete

(10) WATER LEVELS:

Depth of first water, if known _____ ft.

Standing level after well completion _____ 350 ft.

(11) WELL TESTS:

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

Type of test Pump ☐ 350 Bailer ☐ Air lift ☒ 550

Depth to water at start of test 350 ft. At end of test 350 ft.

Discharge 20 gal/min after 6 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

Work started 09/16 19 98 Completed 10/16/ 19 98

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 Sherry Baker
(Well Driller)

NAME McLean & Williams, Inc.

878 El Centro Ave. (Person, firm, or corporation) (Typed or printed)

Address Napa 94558

City 396352 Zip 11/20/98

License No. 37832 Date of this report 11/29/98

QUADRUPLICATE
For Local Requirements

STATE OF CALIFORNIA
WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. **1073642**

Page 1 of 1

Owner's Well No.

Date Work Began 2/05/2008, Ended 2/27/2008

Local Permit Agency Napa County

Permit No. W07-00051

Permit Date 12/28/2007

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO. W07-00051

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

WELL OWNER

ORIENTATION (✓)		V. VERTICAL — HORIZONTAL — ANGLE — (SPECIFY)	
DEPTH FROM SURFACE		DRILLING METHOD	
Ft. to Ft.		Rotary FLUID Air	
		DESCRIPTION	
		Describe material, grain size, color, etc.	
0	6	Brown Clay & Brown Ash	
6	57	Hard Purple Rock, Some Brown Clay	
57	125	Hard Purple Rock	
125	160	Brown & Red Clay	
160	240	Brown Clay & Hard Gray Rock	
240	330	Hard Black & Gray Rock	
330	360	Red Ash & Hard Gray Rock	
360	400	Hard Fractured Gray Rock	
400	560	Hard Black & Gray Rock	
560	610	Med. Hard Black Ash	
610	630	Med Hard Black & Yellow Ash	
630	690	Med. Hard Black & Gray Ash	

Name

Mailing Address

CITY

WELL LOCATION

Address 770 Silverado Trail

City Oakville

County Napa

APN Book 032 Page 030 Parcel 054-000

Township 10 Range 030 Section 054-000

Lat. N Long. W

DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH NORTH

ACTIVITY (✓)

☒ NEW WELL

MODIFICATION/REPAIR

☐ Deepen

☐ Other (Specify)

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

USES (✓)

WATER SUPPLY

☒ Domestic ☐ Public

☒ Irrigation ☐ Industrial

MONITORING ☐

TEST WELL ☐

CATHODIC PROTECTION ☐

HEAT EXCHANGE ☐

DIRECT PUSH ☐

INJECTION ☐

VAPOR EXTRACTION ☐

SPARGING ☐

REMEDICATION ☐

OTHER (SPECIFY)

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.

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 510 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 480 (Ft.) & DATE MEASURED 2-27-08

ESTIMATED YIELD 490 (GPM) & TEST TYPE AB

TEST LENGTH 3 (Hrs.) TOTAL DRAWDOWN 11.5 (Ft.)

GPM at day

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

TOTAL DEPTH OF BORING 690 (Feet)

TOTAL DEPTH OF COMPLETED WELL 690 (Feet)

DEPT. OF

ENVIRONMENTAL MANAGEMENT

ENVIRONMENTAL MONITORING															
DEPTH FROM SURFACE		BORE-HOLE DIA. (Inches)	CASING (S)							DEPTH FROM SURFACE		ANNULAR MATERIAL			
Ft. to Ft.			TYPE (✓)				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	TYPE				
			BLANK	SCREEN	CON- DUCTOR	FILL PIPE					CE- MENT (✓)	BEN- TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)	
0	53	14	✓			Plastic	8	1/4"		0	52	✓			
53	360	12 1/4	✓			"	"	"		52	690			Re Gravel	
360	690	12 1/4	✓			"	8	"	0.32						

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 Pulliam Well Exploration

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

5110 Highway 128

Napa

CA

94558

ADDRESS

CITY

STATE

ZIP

Signed

C-57 LICENSED WATER WELL CONTRACTOR

DATE SIGNED 2-5-08

C-57 LICENSE NUMBER

QUADRUPPLICATE
For Local Requirements

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

Page 1 of 11
Owner's Well No. HE-1
Date Work Began 8-31-04, Ended 9-17-04 No. 802399
Local Permit Agency NAPA COUNTY
Permit No. E04-0364 Permit Date 8-26-04

GEOLOGIC LOG

ORIENTATION () ☒ VERTICAL ☐ HORIZONTAL ☐ ANGLE ☐ (SPECIFY)

DEPTH FROM SURFACE

FL to FL

DESCRIPTION

Describe material, grain size, color, etc.

0 100 RED CLAY SOFT W/ COBBLES

100 160 MUDSTONE W/ GRAVEL

160 240 MUDSTONE - HARD BLACK ROCK

240 300 HARD BLACK ROCK

RECEIVED

NOV - 7 2005

DEPT. OF ENVIRONMENTAL MANAGEMENT

TOTAL DEPTH OF BORING 300 (Feet)

TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

WELL OWNER

Name WDC EXPLORATION & WELLS

Mailing Address 7770 SILVERADO TRAIL

CITY NAPA STATE CA ZIP 94558

WELL LOCATION

Address 7770 SILVERADO TRAIL

City NAPA County NAPA

APN Book 032 Page 030 Parcel CS4-000

Township 3N Range 4E Section 36

Latitude 38.2 MIN. 10 SEC. 00 NORTH Longitude 122.2 MIN. 10 SEC. 00 WEST

LOCATION SKETCH

WEST EAST

SILVERADO TRAIL

CEC BIRDS LOCATION

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 300 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 300 (Ft.) & DATE MEASURED 9-17-04

ESTIMATED YIELD * 10 (GPM) & TEST TYPE 30 MIN

TEST LENGTH 30 (Hrs.) TOTAL DRAWDOWN 300 (Ft.)

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

DEPTH FROM SURFACE		BORE-HOLE DIA. (Inches)	CASING (S)						DEPTH FROM SURFACE		ANNULAR MATERIAL			
Ft.	to Ft.		TYPE ()	MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	Ft.	to Ft.	CE-MENT ()	BEN-TONITE ()	FILL ()	FILTER-PAK (TYPE/SIZE)	
0	300	6"	☒	POLYETHYLENE	1"	SDR-11		0	300	☒	☒			

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 WDC EXPLORATION & WELLS

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

PC Box 141 ZAMORA CA 95698

ADDRESS CITY STATE ZIP

Signed TOWNE DATE SIGNED 11/4/05 283326

WELL DRILLER/AUTHORIZED REPRESENTATIVE C-57 LICENSE NUMBER

QUADRUPPLICATE
For Local Requirements

Page 2 of 11

Owner's Well No. HE-2

Date Work Began 8-31-04, Ended 9-17-04

Local Permit Agency NAPA COUNTY

Permit No. EC4-0364 Permit Date 8-26-04

STATE OF CALIFORNIA
WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 802400

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

GEOLOGIC LOG
ORIENTATION () ☐ VERTICAL ☐ HORIZONTAL ☐ ANGLE (SPECIFY) _____
DRILLING METHOD _____ FLUID _____

DEPTH FROM SURFACE		DESCRIPTION <i>Describe material, grain size, color, etc.</i>
Ft.	to Ft.	
0	100	RED CLAY SOFT W/ COBBLES
100	160	MIDSTONE W/ GRAVEL
160	240	MUDSTONE - HARD BLACK ROCK
240	300	HARD BLACK ROCK

WELL OWNER
Name: _____
Mailing Address: _____
City: _____ STATE _____ ZIP _____

WELL LOCATION
Address: 7770 SILVERADO TRAIL
City: NAPA
County: NAPA
APN Book 632 Page 630 Parcel 054-000
Township _____ Range _____ Section _____
Latitude _____ NORTH _____ WEST
DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH
NORTH _____ SOUTH _____
WEST _____ EAST _____
SILVERADO TRAIL
CROSSING LOCATION
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) _____

RECEIVED

NOV - 7 2005

DEPT. OF
ENVIRONMENTAL MANAGEMENT

TOTAL DEPTH OF BORING 300 (Feet)
TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

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.

DEPTH FROM SURFACE			BORE-HOLE DIA. (Inches)	CASING (S)							DEPTH FROM SURFACE			ANNULAR MATERIAL			
				TYPE (✓)				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS				SLOT SIZE IF ANY (Inches)	TYPE		
Ft.	to	Ft.		BLANK	SCREEN	CON- DUCTOR	FILL PIPE				CE- MENT (✓)	BEN- TONITE (✓)	FILL (✓)		FILTER PACK (TYPE/SIZE)		
0	300	6"	✓				POLYETHYLENE	1"	SDR-11		0'	300'		✓			

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 WDX EXPLORATION & WELLS
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS PO BOX 141 CITY ZAMORA STATE CA ZIP 95698

Signed [Signature] DATE SIGNED 11/4/05 WELL DRILLER/AUTHORIZED REPRESENTATIVE 283326 C-57 LICENSE NUMBER

QUADRUPLICATE
For Local Requirements

Page 3 of 11

Owner's Well No. HE-3

Date Work Began 8-31-04

Local Permit Agency NAPA COUNTY

Permit No. E04-0364

STATE OF CALIFORNIA
WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 802401

Ended 9-17-04

Permit Date 8-26-04

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION () ☒ VERTICAL ☐ HORIZONTAL ☐ ANGLE (SPECIFY)

DEPTH FROM SURFACE

FL. to FL.

DESCRIPTION

Describe material, grain size, color, etc.

0 100 RED CLAY SOFT W/CUBBLES

100 160 MUDSTONE W/GRAVEL

160 240 MUDSTONE - HARD BLACK ROCK

240 300 HARD BLACK ROCK

RECEIVED

NOV - 7 2005

DEPT. OF ENVIRONMENTAL MANAGEMENT

WELL OWNER

Name [REDACTED]

Mailing Address [REDACTED]

CITY [REDACTED] STATE [REDACTED] ZIP [REDACTED]

WELL LOCATION

Address 7770 SILVERADO TRAIL

City NAPA

County NAPA

APN Book 032 Page 030 Parcel 054-000

Township [REDACTED] Range [REDACTED] Section [REDACTED]

Latitude [REDACTED] NORTH Longitude [REDACTED] WEST

LOCATION SKETCH

NORTH SOUTH WEST EAST

SILVERADO TRAIL

CEOBARS LOCATION

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.)

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

DEPTH FROM SURFACE	BORE-HOLE DIA. (Inches)	CASING (S)						DEPTH FROM SURFACE	ANNULAR MATERIAL					
		TYPE ()				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)		GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	TYPE			
FL. to FL.		BLANK	SCREEN	CON- DUCTOR	FILL PIPE									CE- MENT ()
0 300	6"	☒				POLYETHYLENE	1"	SDR-11		0 300		☒		

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 WDC EXPLORATION & WELLS

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

PO BOX 141 ZAMORA CA 95698

ADDRESS [REDACTED] CITY [REDACTED] STATE CA ZIP 95698

Signed [Signature] DATE SIGNED 11/4/05 C-57 LICENSE NUMBER 983326

WELL DRILLER/AUTHORIZED REPRESENTATIVE

QUADRUPLICATE
For Local Requirements

Page 4 of 11

Owner's Well No. HE-4

Date Work Began 8-31-04, Ended 9-17-04

Local Permit Agency NAPA COUNTY

Permit No. ED4-0364 Permit Date 8-26-04

STATE OF CALIFORNIA
WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. **802402**

DWR USE ONLY - DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION ($\angle$) ☒ VERTICAL ☐ HORIZONTAL ☐ ANGLE ☐ (SPECIFY)

DRILLING METHOD ☐ FLUID

DEPTH FROM SURFACE	DESCRIPTION
Ft. to Ft.	Describe material, grain size, color, etc.
0 100	RED CLAY SOFT W/ COBBLES
100 160	MUDSTONE W/ GRAVEL
160 240	MUDSTONE - HARD BLACK ROCK
240 300	HARD BLACK ROCK

WELL OWNER

Name [REDACTED]

Mailing Address [REDACTED]

CITY [REDACTED] STATE [REDACTED] ZIP [REDACTED]

WELL LOCATION

Address 7770 SILVERADO TRAIL

City NAPA

County NAPA

APN Book 032 Page 030 Parcel 054-000

Township Range Section

Latitude NORTH Longitude WEST

LOCATION SKETCH

WEST NORTH EAST SOUTH

SILVERADO TRAIL

GEDBORG'S LOCATION

ACTIVITY ($\angle$)

☐ NEW WELL

☐ MODIFICATION/REPAIR

☐ Deepen

☐ Other (Specify)

☐ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

PLANNED USES ($\angle$)

☐ WATER SUPPLY

☐ Domestic ☐ Public

☐ Irrigation ☐ Industrial

☐ MONITORING

☐ TEST WELL

☐ CATHODIC PROTECTION

☒ HEAT EXCHANGE

☐ DIRECT PUSH

☐ INJECTION

☐ VAPOR EXTRACTION

☐ SPARGING

☐ REMEDIATION

☐ OTHER (SPECIFY)

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NOV - 7 2005

DEPT. OF
ENVIRONMENTAL MANAGEMENT

TOTAL DEPTH OF BORING 300 (Feet)

TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

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.

DEPTH FROM SURFACE			BORE-HOLE DIA. (Inches)	CASING (S)						DEPTH FROM SURFACE			ANNULAR MATERIAL			
				TYPE ($\angle$)				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)				GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	TYPE	
Ft.	to	Ft.		BLANK	SCREEN	CON- DUCTOR	FILL PIPE			CE- MENT ($\angle$)	BEN- TONITE ($\angle$)	FILL ($\angle$)			FILTER PACK (TYPE/SIZE)	
0	300		6"	✓			POLYETHYLENE	1"	SDR-11				✓			

ATTACHMENTS ($\angle$)

- ☐ 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 WDC EXPLORATION & WELLS

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

PO BOX 141 ZAMORA CA 95698

ADDRESS CITY STATE ZIP

Signed [Signature] DATE SIGNED 11/4/04 - 283326

WELL DRILLER/AUTHORIZED REPRESENTATIVE C-57 LICENSE NUMBER

QUADRUPLICATE
For Local Requirements

STATE OF CALIFORNIA
WELL COMPLETION REPORT

Refer to Instruction Pamphlet

Page 6 of 11

Owner's Well No. HE-6

No. 802404

Date Work Began 8-31-04, Ended 9-17-04

Local Permit Agency NAPA COUNTY

Permit No. EC4-0364 Permit Date 8-26-04

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

WELL OWNER

ORIENTATION (°) VERTICAL HORIZONTAL ANGLE (SPECIFY)
DRILLING METHOD FLUID

Name [REDACTED]
Mailing Address [REDACTED]
CITY [REDACTED] STATE [REDACTED] ZIP [REDACTED]

DEPTH FROM SURFACE
Ft. to Ft.

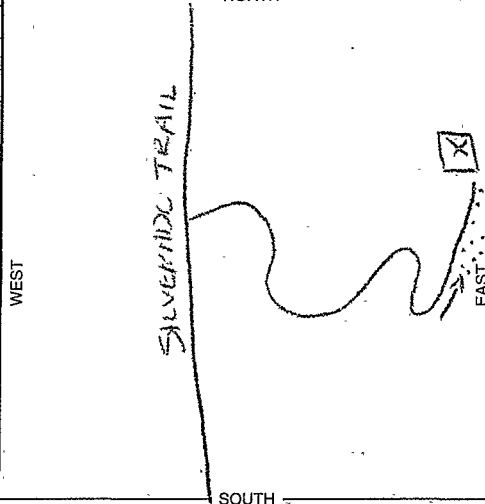
DESCRIPTION

Describe material, grain size, color, etc.

0 100 REDCLAY SOFT W/ COBBLES
100 160 MUD STONE W/ GRAVEL
160 240 MUDSTONE - HARD BLACK ROCK
240 300 HARD BLACK ROCK

WELL LOCATION
Address 7770 SILVERADO TRAIL
City NAPA
County NAPA
APN Book 032 Page 030 Parcel 054-000
Township Range Section Longitude
Latitude DEG. MIN. SEC. NORTH DEG. MIN. SEC. WEST

LOCATION SKETCH



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) _____

RECEIVED

NOV - 7 2005

DEPT. OF
ENVIRONMENTAL MANAGEMENT

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.

TOTAL DEPTH OF BORING 300 (Feet)
TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

DEPTH FROM SURFACE			BORE-HOLE DIA. (Inches)	CASING (S)						DEPTH FROM SURFACE			ANNULAR MATERIAL						
				TYPE (☐)				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)				GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	TYPE				
Ft.	to	Ft.	BLANK	SCREEN	CON- DUCTOR	FILL PIPE									Ft.	to	Ft.	CE- MENT (☐)	BEN- TONITE (☐)
0	300		6"	☒				Polyethylene	1"	SDR-11				0'	300'		☒		
																			</

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 WDC EXPLORATION & WELLS
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
ADDRESS P.O. BOX 141 CITY ZAMORA STATE CA ZIP 95698
Signed [Signature] DATE SIGNED 1/4/05 C-57 LICENSE NUMBER 283326
WELL DRILLER/AUTHORIZED REPRESENTATIVE

QUADRUPLICATE
For Local Requirements

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

Page 7 of 11

Owner's Well No. HE-7

Date Work Began 8-31-04

Ended 9-17-04

No. 802405

Local Permit Agency NAPA COUNTY

Permit No. EOL-0364

Permit Date 8-26-04

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE

LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION () ☒ VERTICAL ☐ HORIZONTAL ☐ ANGLE (SPECIFY)

DRILLING METHOD

FLUID

DEPTH FROM SURFACE

DESCRIPTION

Describe material, grain size, color, etc.

Fl.	to	Fl.	DESCRIPTION
0	100		RED CLAY SOFT W/ LOBBLES
100	160		MUDSTONE W/ GRAVEL
160	240		MUDSTONE - HARD BLACK ROCK
240	360		HARD BLACK ROCK

RECEIVED

NOV - 7 2005

DEPT. OF ENVIRONMENTAL MANAGEMENT

WELL OWNER

Name

Mailing Address

CITY

STATE

ZIP

Address

City

County

APN Book

Page

Parcel

Township

Range

Section

Latitude

DEG. MIN. SEC.

NORTH

Longitude

DEG. MIN. SEC.

WEST

LOCATION SKETCH

NORTH

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)

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.

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER (Fl.) BELOW SURFACE

DEPTH OF STATIC

WATER LEVEL (Fl.) & DATE MEASURED

ESTIMATED YIELD * (GPM) & TEST TYPE

TEST LENGTH (Hrs.) TOTAL DRAWDOWN (Fl.)

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

TOTAL DEPTH OF BORING 300 (Feet)

TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

DEPTH FROM SURFACE			BORE-HOLE DIA. (Inches)	CASING (S)							DEPTH FROM SURFACE			ANNULAR MATERIAL			
				TYPE ()				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS				SLOT SIZE IF ANY (Inches)	TYPE		
Fl.	to	Fl.	BLANK	SCREEN	CONDUCTOR	FILL PIPE									Fl.	to	Fl.
0	300	6"	✓				Polyethylene	1"	SDR-11		0'	300'			✓		

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 WDC EXPLORATION & WELLS

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

PO BOX 141

ADDRESS

CITY

STATE

ZIP

Signed

WELL DRILLER/AUTHORIZED REPRESENTATIVE

DATE SIGNED

C-57 LICENSE NUMBER

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

Permit No. E04-0364 Permit Date 8-26-04

WELL OWNER

Name _____
Mailing Address _____
City _____ State _____ ZIP _____

WELL LOCATION
Address 7770 SILVERADO TRAIL
City NAPA
County NAPA
APN Book 032 Page 030 Parcel 054-000
Township _____ Range _____ Section _____
Latitude _____ NORTH Longitude _____ WEST
DEG. MIN. SEC. DEG. MIN. SEC.

- ACTIVITY ($\leq$)

☐ 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) _____

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.**

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.**

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.*

[illegible]

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 WDC EXPLORATION & WELLS
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. BOX 141

ADDRESS

Signed _____
WELL DRILLER/AUTHORIZED REPRESENTATIVE

ZAMKFT

CA 95698

CITY

STATE

ZIP

DATE SIGNED _____

283326
G-57 LICENSE NUMBER

QUADRUPLICATE
For Local Requirements

Page 9 of 11

Owner's Well No. HE-9

Date Work Began 8-31-04

Local Permit Agency NAPA COUNTY

Permit No. E04-0364

STATE OF CALIFORNIA
WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 802407

Ended 9-17-04

Permit Date 8-26-04

DWR USE ONLY — DO NOT FILL IN.

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

WELL OWNER

ORIENTATION () ☐ VERTICAL ☐ HORIZONTAL ☐ ANGLE (SPECIFY)

DRILLING METHOD

FLUID

DESCRIPTION

Describe material, grain size, color, etc.

DEPTH FROM SURFACE
FL. to FL.

0 100 RED CLAY SOFT W/ COBBLES
100 160 MUDSTONE W/ GRAVEL
160 240 MUDSTONE - HARD BLACK ROCK
240 300 HARD BLACK ROCK

Name

Mailing Address

CITY STATE ZIP

WELL LOCATION

Address 7710 SILVERADO TRAIL

City NAPA

County NAPA

APN Book 032 Page 030 Parcel 054-000

Township Range Section

Latitude Longitude

DEG. MIN. SEC. NORTH WEST

LOCATION SKETCH

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 ☐

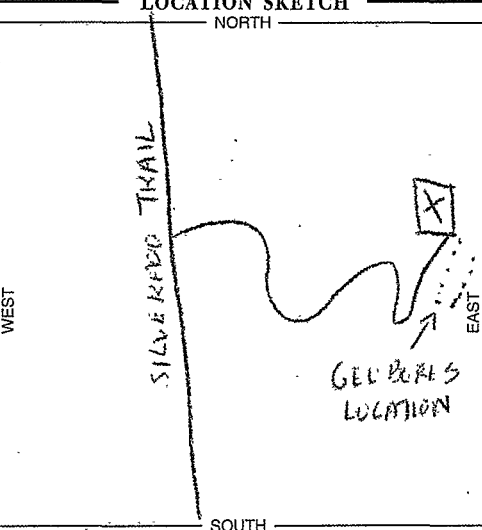
INJECTION ☐

VAPOR EXTRACTION ☐

SPARGING ☐

REMEDIATION ☐

OTHER (SPECIFY) ☐



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.

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER (FL) BELOW SURFACE

DEPTH OF STATIC

WATER LEVEL (FL) & DATE MEASURED

ESTIMATED YIELD * (GPM) & TEST TYPE

TEST LENGTH (Hrs.) TOTAL DRAWDOWN (FL)

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

TOTAL DEPTH OF BORING 300 (Feet)
TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

DEPTH FROM SURFACE			BORE-HOLE DIA. (Inches)	CASING (S)							DEPTH FROM SURFACE			ANNULAR MATERIAL				
				TYPE ()				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS				SLOT SIZE IF ANY (Inches)	TYPE			
Ft.	to	Ft.	BLANK	SCREEN	CON- DUCTOR	FILL PIPE									Ft.	to	Ft.	CE- MENT ()
0	300		6"	✓				Polyethylene	1"	SDR-11		0'	300'		✓			

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 WDC EXPLORATION & WELLS
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. BOX 141

ADDRESS

Signed

WELL DRILLER/AUTHORIZED REPRESENTATIVE

ZAMORA

CITY

CA 95698

STATE

ZIP

11/4/05

DATE SIGNED

283326

C-57 LICENSE NUMBER

QUADRUPLICATE
For Local Requirements

Page 10 of 11

Owner's Well No. HE-10

Date Work Began 8-31-04, Ended 9-17-04

Local Permit Agency NAPA COUNTY

Permit No. E-04-0364 Permit Date 8-26-04

STATE OF CALIFORNIA
WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 802408

DWR USE ONLY — DO NOT FILL IN.

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

WELL OWNER

ORIENTATION (°) _____ VERTICAL _____ HORIZONTAL _____ ANGLE _____ (SPECIFY)
DRILLING METHOD _____ FLUID _____

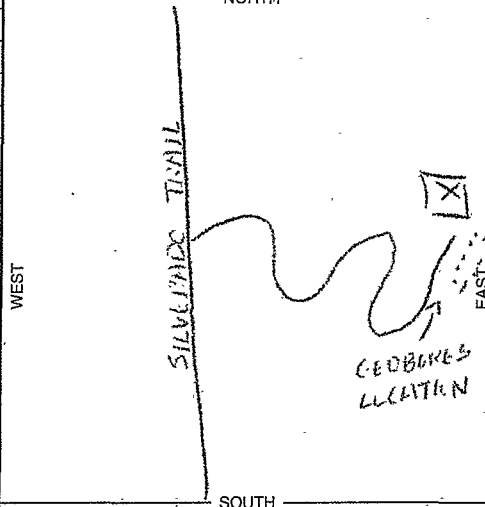
Name _____
Mailing Address _____
CITY _____ STATE _____ ZIP _____

DEPTH FROM SURFACE Fl. to Fl.	DESCRIPTION Describe material, grain size, color, etc.
0 100	RED CLAY SFT W/ CLBBLS
100 160	MID STONE W/ GRAVEL
160 240	MID-TONE - HARD BLACK BLK
240 300	HARD BLACK ROCK

WELL LOCATION
Address 7770 SILVERADO TRAIL
City NAPA
County NAPA
APN Book 32 Page 030 Parcel 054-000
Township _____ Range _____ Section _____
Latitude _____ NORTH _____ WEST _____
DEG. MIN. SEC. Longitude DEG. MIN. SEC.

LOCATION SKETCH

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) _____

RECEIVED

NOV - 7 2005

DEPT. OF ENVIRONMENTAL MANAGEMENT

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.

WATER LEVEL & YIELD OF COMPLETED WELL

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

TOTAL DEPTH OF BORING 300 (Feet)
TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

DEPTH FROM SURFACE		BORE-HOLE DIA. (Inches)	CASING (S)						DEPTH FROM SURFACE		ANNULAR MATERIAL				
			TYPE ($\angle$)				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)			GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	TYPE		
Ft.	to Ft.		BLANK	SCREEN	CONDUIT	FILL PIPE									CE- MENT ($\angle$)
0	300	6"	✓				Polyethylene	1"	SDR-11			✓			
															</

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 WDI EXPLORATION & WELLS
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. BOX 141 ZIMMERA CA 95698
ADDRESS CITY STATE ZIP

Signed [Signature] DATE SIGNED 11/4/05 C-57 LICENSE NUMBER 283326
WELL DRILLER/AUTHORIZED REPRESENTATIVE

QUADRUPPLICATE
For Local Requirements

Page 11 of 11

Owner's Well No. HE-11

Date Work Began 8-31-04

Local Permit Agency NAPA COUNTY

Permit No. E04-0364

STATE OF CALIFORNIA
WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 802409

Ended 9-17-04

Permit Date 8-26-04

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.									
LATITUDE					LONGITUDE				
APN/TRS/OTHER									

GEOLOGIC LOG

ORIENTATION: () ☒ VERTICAL ☐ HORIZONTAL ☐ ANGLE ☐ (SPECIFY)

DRILLING METHOD ☐ FLUID ☐

DEPTH FROM SURFACE			DESCRIPTION
Ft.	to	Ft.	
0	100		RED CLAY SOFT W/ COBBLES
100	160		MUDSTONE W/ GRAVEL
160	240		MUDSTONE - HARD BLACK ROCK
240	300		HARD BLACK ROCK

RECEIVED

NOV - 7 2005

DEPT. OF
ENVIRONMENTAL MANAGEMENT

WELL OWNER

Name: [REDACTED]

Mailing Address: [REDACTED]

CITY: [REDACTED] STATE: [REDACTED] ZIP: [REDACTED]

WELL LOCATION

Address: 7770 SILVERIDE TRAIL

City: NAPA

County: NAPA

APN Book C32 Page 030 Parcel 054-000

Township: Range: Section:

Latitude: NORTH WEST

DEG. MIN. SEC. DEG. MIN. SEC.

LOCATION SKETCH

NORTH

WEST

SILVERIDE TRAIL

EAST

LEG BORES LOCATION

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.)

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

TOTAL DEPTH OF BORING 300 (Feet)

TOTAL DEPTH OF COMPLETED WELL 300 (Feet)

DEPTH FROM SURFACE			BORE-HOLE DIA. (Inches)	CASING (S)						DEPTH FROM SURFACE			ANNULAR MATERIAL					
				TYPE (✓)				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)				GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	TYPE			
Ft.	to	Ft.		BLANK	SCREEN	CONDUCTOR	FILL PIPE			CE- MENT (✓)	BEN- TONITE (✓)	FILL (✓)			FILTER PACK (TYPE/SIZE)			
0	300	6"	✓				Polystyrene	1"	SDR-11			0'	300'		✓			

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 WDC EXPLORATION & WELL

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

ADDRESS PO BOX 141

CITY ZAMBER

STATE CA ZIP 95695

Signed [Signature]

WELL DRILLER/AUTHORIZED REPRESENTATIVE

DATE SIGNED 11/4/05

C-57 LICENSE NUMBER 283326

ORIGINAL
File with DWR

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. **e0177367**

Page 1 of 1

Owner's Well No. **1-2013**

Date Work Began **5/29/2013**, Ended **7/3/2013**

Local Permit Agency **Napa County Environmental Mgmt**

Permit No. **96-11125** Permit Date **6/23/1999**

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.	
LATITUDE	LONGITUDE
APN/TRS/OTHER	

GEOLOGIC LOG

ORIENTATION (✓) ☒ VERTICAL ☐ HORIZONTAL ☐ ANGLE (SPECIFY)		DRILLING METHOD ROTARY	FLUID AIR
DEPTH FROM SURFACE		DESCRIPTION	
FL	to FL	Describe material, grain, size, color, etc.	
0	10	BOULDERS	
10	80	HARD BLACK VOLCANICS	
80	160	RED, BLACK VOLCANICS	
160	260	TAN, GRAY VOLCANICS	
260	355	GRAY VOLCANICS	
355	420	GRAY, TAN VOLCANICS	
420	460	BLACK, RED VOLCANICS	
460	645	BLACK VOLCANIC ROCK	
645	680	BROWN, RED VOLCANICS	
680	790	GRAY, TAN VOLCANICS	
790	820	RED VOLCANICS	
820	870	BLACK VOLCANICS	
870	880	RED VOLCANICS	
880	900	GRAY, TAN VOLCANICS	
900	950	GRAY, RED, TAN VOLCANICS	
950	970	RED VOLCANICS	
970	985	BLACK, GREEN VOLCANICS	
985	1000	RED VOLCANICS	
1000	1020	BLACK VOLCANICS	
1020	1035	GRAY VOLCANICS	
1035	1045	RED, BLACK VOLCANICS	
1045	1080	BLACK VOLCANICS	
1080	1140	GRAY, GREEN, RED VOLCANICS	
CONTINUED CASING LAYOUT			
605	685	SCREEN	STEEL 8" .060 SLOT
685	725	BLANK	STEEL 8"
725	865	SCREEN	STEEL 8" .060 SLOT
865	925	BLANK	STEEL 8"
925	1105	SCREEN	STEEL 8" .060 SLOT
1105	1125	BLANK	STEEL 8"

TOTAL DEPTH OF BORING **1140** (Feet)

TOTAL DEPTH OF COMPLETED WELL **1125** (Feet)

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SEP 4 2013

WELL OWNER

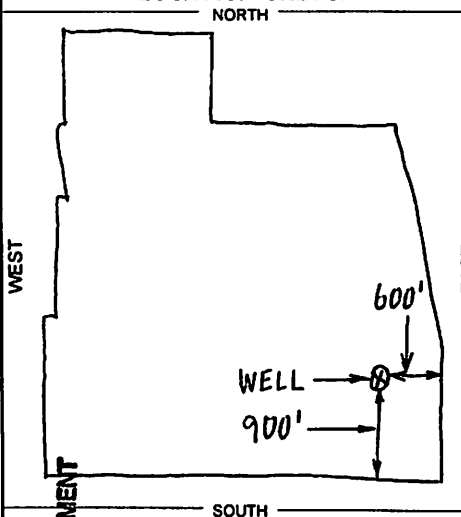
Name **Oakville Ranch Vineyards**
Mailing Address **1832 Baker Street**
San Francisco **CA** **94115**
CITY STATE ZIP

WELL LOCATION

Address **7781 Silverado Trail**
City **Napa** **CA**
County **Napa**
APN Book **032** Page **030** Parcel **052**
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 ☐
REMEDICATION ☐
OTHER (SPECIFY) ☐

WATER LEVEL & YIELD OF COMPLETED WELL

DEPT. OF FIRST WATER **280** (FL.) BELOW SURFACE
DEPT. OF STATIC WATER LEVEL **271** (FL.) & DATE MEASURED **7/3/2013**
ESTIMATED YIELD • **300** (GPM) & TEST TYPE **AIR LIFT**
TEST LENGTH **2** (Hrs.) TOTAL DRAWDOWN **N/A** (FL.)

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

DEPTH FROM SURFACE Fl. to Fl.	BORE - HOLE DIA. (Inches)	CASING (S)					
		TYPE (✓)			MATERIAL / GRADE	INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS
		BLANK	SCREEN	CONDUCTOR FILL PIPE			
0	1140						
0	385	✓			STEEL	8	.250
385	465		✓		STEEL	8	.250
465	505		✓		STEEL	8	.250
505	585		✓		STEEL	8	.250
585	605	✓			STEEL	8	.250

DEPTH FROM SURFACE Fl. to Fl.	ANNULAR MATERIAL			
	TYPE			
	CE- MENT (✓)	BEN- TONITE (✓)	FILL (✓)	FILTER PACK (TYPE/SIZE)
0	54	✓		10 SK SAND
54	1125		✓	#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, INC.**
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

2110 Penny Lane
ADDRESS

Signed

Wm Huckfeldt
WELL DRILLER/AUTHORIZED REPRESENTATIVE

Napa CA 94559
CITY STATE ZIP

07/24/13 439-746
DATE SIGNED C-57 LICENSE NUMBER

QUADRUPLICATE
For Local Requirements

Page 1 of 1

Owner's Well No.

Date Work Began 7-31-01

STATE OF CALIFORNIA
WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 778357

Ended 8-13-01

Local Permit Agency

Napa County Environmental Mgmt.

Permit No. 96-11123

Permit Date 6-23-99

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

ORIENTATION () ☒ VERTICAL ☐ HORIZONTAL ☐ ANGLE (SPECIFY)

DRILLING METHOD

rotary

FLUID

DESCRIPTION

Describe material, grain size, color, etc.

DEPTH FROM SURFACE

Ft. to Ft.

0 12

fractured boulders

12 60

black volcanic rock

60 120

red volcanics

120 280

black volcanics

280 380

red & whitewolcanic ash

380 420

yellow ash

420 500

black volcanics

500 520

red volcanics

520 580

red & black volcanics

580 760

black volcanics

250 5 GPM

460 30 GPM

690 150 GPM

TOTAL DEPTH OF BORING 760 (Feet)

TOTAL DEPTH OF COMPLETED WELL 753 (Feet)

WELL OWNER

Name

Oakville Ranch Vineyards

Mailing Address

7781 Silverado Trail

CITY

Napa

CA

94558

STATE

ZIP

WELL LOCATION

Address

same

City

Napa

County

Napa

APN Book

32

Page

030

Parcel

52

Township

Range

Section

Latitude

DEG. MIN. SEC.

NORTH

Longitude

DEG. MIN. SEC.

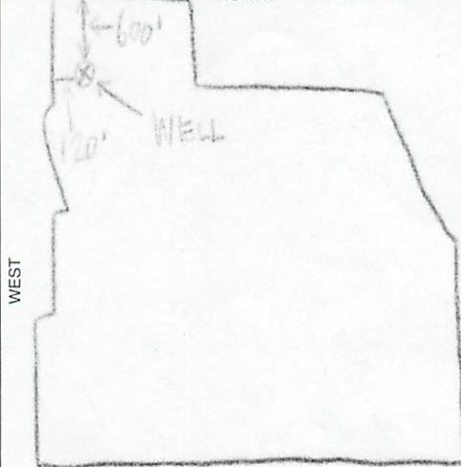
WEST

LOCATION SKETCH

NORTH

WEST

EAST



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

REMEDICATION

OTHER (SPECIFY)

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 250 (Ft.) BELOW SURFACE

DEPTH OF STATIC 393 (Ft.)

WATER LEVEL 150 (Ft.) & DATE MEASURED 8-13-01

ESTIMATED YIELD 3 (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.

DEPTH FROM SURFACE			BORE-HOLE DIA. (Inches)	CASING (S)					DEPTH FROM SURFACE			ANNULAR MATERIAL						
				TYPE ($\leq$)				MATERIAL / GRADE				INTERNAL DIAMETER (Inches)	GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	TYPE			
Ft.	to	Ft.	BLANK	SCREEN	CON- DUCTOR	FILL PIPE									Ft.	to	Ft.	CE- MENT ($\leq$)
0	25		13									0	22		X			concrete
25	760		12									22	753			X		pea gravel
0	433			X				steel	8 $\frac{1}{2}$	.188								
433	633				X			steel	8 $\frac{1}{2}$	.188	.090							
633	653				X			steel	8 $\frac{1}{2}$	.188								
653	753					X		steel	8 $\frac{1}{2}$	.188	.090							

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

CITY

Napa

CA

94559

STATE

ZIP

Signed

WELL DRILLER/AUTHORIZED REPRESENTATIVE

8-20-01

DATE SIGNED

439-746

C-57 LICENSE NUMBER

QUADRUPLICATE
For Local Requirements

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

DWR USE ONLY - DO NOT FILL IN

STATE WELL NO./STATION NO. 11-11-99

LATITUDE 34° 11' 11" N LONGITUDE 119° 11' 11" W

APN/TRS/OTHER 11-11-99

Page 1 of 1
Owner's Well No. 528419
Date Work Began 3-11-99 Ended 3-22-99
Local Permit Agency Napa County
Permit No. 7041 Permit Date 11-23-98

GEOLOGIC LOG

ORIENTATION (✓) ☒ VERTICAL ☐ HORIZONTAL ANGLE (SPECIFY) _____

DEPTH TO FIRST WATER 290 (Ft.) BELOW SURFACE

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION Describe material, grain size, color, etc.
0 18	brown clay
18 140	gray rock with brown sh
140 170	red ash
170 310	gray rock with gray sh
310 380	purple rock
380 465	red sh
465 530	dark red ash
530 580	black ash
580 610	brown clay

TOTAL DEPTH OF BORING 610 (Feet)
TOTAL DEPTH OF COMPLETED WELL 595 (Feet)

WELL OWNER

Name _____
Mailing Address _____
CITY _____ STATE _____ ZIP _____

WELL LOCATION

Address 1770 Silverado Tr
City Napa
County Napa
APN Book _____ Page _____ Parcel 030-45
Township _____ Range _____ Section _____
Latitude _____ Longitude _____

LOCATION SKETCH

WEST _____ EAST _____
NORTH _____ SOUTH _____

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 Mud Rotary FLUID mud

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 275 (Ft.) & DATE MEASURED 3-22-99
ESTIMATED YIELD 60 (GPM) & TEST TYPE 1.1 T
TEST LENGTH 5 (Hrs.) TOTAL DRAWDOWN 300 (Ft.)
* May not be representative of a well's long-term yield.

DEPTH FROM SURFACE Ft. to Ft.	BORE-HOLE DIA. (Inches)	CASING(S)						DEPTH FROM SURFACE Ft. to Ft.	ANNULAR MATERIAL							
		TYPE (✓)				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)		GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	TYPE					
		BLANK	SCREEN	CON- DUCTOR	FILL PIPE											
0 295	10	✓				Plastic	6	200								
295 595			✓			"	"	"	Factory	31	595					Per Gravel

ATTACHMENTS (✓)

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

CERTIFICATION STATEMENT

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

NAME Pulliam Drilling
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
ADDRESS 2877 Piedmont Ave Napa Ca 94558 CITY Napa STATE CA ZIP 94558
Signed Jon Pulliam WELL DRILLER/AUTHORIZED REPRESENTATIVE
DATE SIGNED 4-5-99 C-57 LICENSE NUMBER 248677

QUADRUPPLICATE
For Local Requirements

STATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

DWR USE ONLY - DO NOT FILL IN

STATE WELL NO. / STATION NO. 158199

LATITUDE _____ LONGITUDE _____

APN/TRS/OTHER _____

Page _____ of _____

Owner's Well No. _____ No. **528473**

Date Work Began 1-4-98, Ended 3-17-98

Local Permit Agency Alameda County

Permit No. 45651 Permit Date 1-5-98

GEOLOGIC LOG

ORIENTATION () ☒ VERTICAL ☐ HORIZONTAL ☐ ANGLE _____ (SPECIFY)

DEPTH TO FIRST WATER 410 (Ft.) BELOW SURFACE

DEPTH FROM SURFACE		DESCRIPTION
Ft.	to Ft.	
0	60	hard gray rock
60	110	brn ash
110	135	hard gray rock
135	170	brn ash
170	230	hard gray rock
230	400	brn ash, black ash
400	400	brn ash
400	555	brn ash, black ash, gray rock
555	620	hard gray rock
620	770	brn ash
770	810	red, black ash
810		brn, red ash

Describe material, grain size, color, etc.

RECEIVED

NOV 17 1998

DEPT. OF ENVIRONMENTAL MANAGEMENT

TOTAL DEPTH OF BORING 810 (Feet)

TOTAL DEPTH OF COMPLETED WELL 810 (Feet)

WELL OWNER

Name _____

Mailing Address _____

WELL LOCATION

Address 7770 Shiloh Tr

City San Jose

County San Jose

APN Book _____ Page _____ Parcel _____

Township _____ Range _____ Section _____

Latitude _____ North Longitude _____ 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 **FLUID** Air

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 375 (Ft.) & DATE MEASURED 3-17-98

ESTIMATED YIELD 100 (GPM) & TEST TYPE Air Lift

TEST LENGTH 4 (Hrs.) TOTAL DRAWDOWN 375 (Ft.)

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

DEPTH FROM SURFACE	BORE-HOLE DIA. (Inches)	CASING(S)						DEPTH FROM SURFACE	ANNULAR MATERIAL							
		TYPE ()				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)		GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	TYPE					
Ft.	to Ft.	BLANK	SCREEN	CON- DUCTOR	FILL PIPE									Ft.	to Ft.	CE- MENT ()
0	440	10				Plastic	8	200		0	25					
440	810	11				"	"		Factory	25	810					As 6 mwp

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 Pullman Well Drilling

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

ADDRESS 2577 Piedmont

CITY San Jose STATE CA ZIP 95131

Signed Jon Pullman

WELL DRILLER/AUTHORIZED REPRESENTATIVE

DATE SIGNED 3-31-98 C-57 LICENSE NUMBER 248677

QUADRUPLICATE
For Local Requirements

Page 1 of 1

Owner's Well No. _____

Date Work Began 11/23/92, Ended 1/11/93

Local Permit Agency Napa County Env. Dept. of Health

Permit No. 32121

Permit Date 11/19/92

STATE OF CALIFORNIA

WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. **482234**

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE

LONGITUDE

APN/TRS/OTHER

GEOLOGIC LOG

WELL OWNER

ORIENTATION (✓) ☒ VERTICAL _____ HORIZONTAL _____ ANGLE _____ (SPECIFY)

DEPTH TO FIRST WATER 400 (Ft.) BELOW SURFACE

DESCRIPTION

Describe material, grain size, color, etc.

DEPTH FROM SURFACE Ft. to Ft.	DESCRIPTION
0 to 26	Brown & red clay
26 to 40	Brown sand stone
40 to 70	Dk. gray & brown rock med. hard
70 to 145	Brown, gray, black & red rock, hard fracture
145 to 160	Dk. gray rock, hard fracture
160 to 220	Brown, gray rock stringers, red hard fracture
220 to 250	Lt. green, brown & gray rock hard fracture
250 to 265	Gray, brown & red rock hard
265 to 310	Red rock, medium hard
310 to 340	Red & brown rock hard
340 to 370	Black, gray & red rock hard fracture
370 to 400	Black, red, green & brown rock hard
400 to 490	Green, red & black rock med. fracture
490 to 520	Black, red, green & stringers brown rock hard fracture
520 to 600	White, red, black, gray & green rock hard
600 to 630	Green, black rock stringer dk. gray, fracture
630 to 640	Dk. gray rock hard

Name _____
Mailing Address _____
CITY _____ STATE _____ ZIP _____

WELL LOCATION
Address 7776 Silverado Trail
City Oakville
County Napa
APN Book 32 Page 030 Parcel 06
Township _____ Range _____ Section _____
Latitude _____ NORTH Longitude _____ WEST

LOCATION SKETCH

NORTH

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) _____

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

DRILLING METHOD Mud & air rotary FLUID water, bentonite foam

WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 400 (Ft.) & DATE MEASURED _____

ESTIMATED YIELD 60 (GPM) & TEST TYPE AIR

TEST LENGTH 4 (Hrs.) TOTAL DRAWDOWN complete (Ft.)

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

RECEIVED

JAN 13 1993

DEPT. OF

ENVIRONMENTAL MANAGEMENT

TOTAL DEPTH OF BORING 640 (Feet)

TOTAL DEPTH OF COMPLETED WELL 637 (Feet)

DEPTH FROM SURFACE			BORE-HOLE DIA. (Inches)	CASING(S)						DEPTH FROM SURFACE			ANNULAR MATERIAL			
				TYPE (✓)				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)				GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	TYPE	
Ft.	to	Ft.	BLANK	SCREEN	CON- DUCTOR	FILL PIPE										CE- MENT (✓)
0	397		X				1-C-2	8	F-480	032		X				
397	637			X									X			
1	3				X									X	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 Doshier & Gregson, Inc.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

ADDRESS 5365 Napa Vallejo Hwy

CITY Vallejo

STATE CA. ZIP 94589

Signed _____
WELL DRILLER/AUTHORIZED REPRESENTATIVE

DATE SIGNED 1/12/93

258826

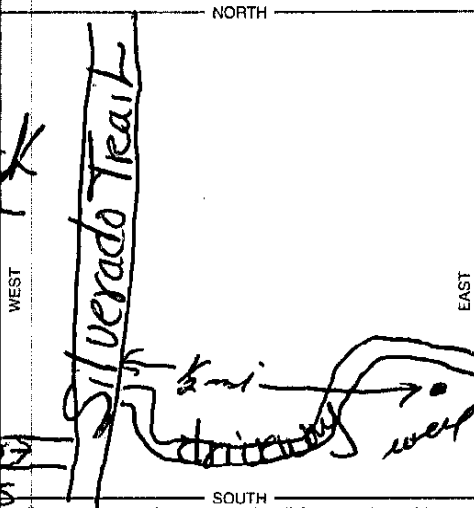
C-57 LICENSE NUMBER

ORIGINAL
File with DWRSTATE OF CALIFORNIA
WELL COMPLETION REPORT
Refer to Instruction Pamphlet

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

Page ____ of ____

Owner's Well No. 10-30-00 Filed 11-6-00 No. 710238Date Work Began 10-30-00 Local Permit Agency Napa County
Permit No. 96-11657 Permit Date 9-14-00

GEOLOGIC LOG ORIENTATION () ☒ VERTICAL ☐ HORIZONTAL ☐ ANGLE (SPECIFY) DRILLING METHOD <u>rotary</u> FLUID <u>Air</u> DEPTH FROM SURFACE Ft. to Ft. DESCRIPTION Describe material, grain size, color, etc. <u>0 20 brown clay & rock</u> <u>20 135 gray ash, black rock</u> <u>135 150 red volcanic rock</u> <u>150 315 gray ash & black rock</u> <u>315 365 red volcanic rock</u> <u>365 570 brown ash, streaks of broken up black rock</u> <u>570 590 gray ash & black rock</u>		WELL OWNER Name <u>Charles Saunders</u> Mailing Address <u>7777 Silverado Tr.</u> <u>Napa</u> <u>Ca. 94558</u> CITY STATE ZIP Address <u>Same</u> WELL LOCATION City <u>Same</u> County <u>Napa</u> APN Book _____ Page _____ Parcel <u>032-030-040</u> Township _____ Range _____ Section _____ Latitude _____ NORTH _____ Longitude _____ DEG. MIN. SEC.	
TOTAL DEPTH OF BORING <u>595</u> (Feet) TOTAL DEPTH OF COMPLETED WELL <u>590</u> (Feet)		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.	
WATER LEVEL & YIELD OF COMPLETED WELL DEPTH TO FIRST WATER <u>140</u> (Ft.) BELOW SURFACE DEPTH OF STATIC WATER LEVEL <u>260</u> (Ft.) & DATE MEASURED <u>11-3-00</u> ESTIMATED YIELD <u>260</u> (GPM) & TEST TYPE <u>11-3-00</u> TEST LENGTH <u>3</u> (Hrs.) TOTAL DRAWDOWN <u>580</u> (Ft.) * May not be representative of a well's long-term yield.		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) _____	

DEPTH FROM SURFACE			BORE-HOLE DIA. (Inches)	CASING (S)						DEPTH FROM SURFACE	ANNULAR MATERIAL						
				TYPE (≦)				MATERIAL / GRADE	INTERNAL DIAMETER (Inches)		GAUGE OR WALL THICKNESS	SLOT SIZE IF ANY (Inches)	TYPE				
Ft.	to	Ft.	BLANK	SCREEN	CON- DUCTOR	FILL PIPE									Ft.	to	Ft.
0	23	10 5/8"	X				PLASTIC	5"	200		0	23	X				
23	130	8"	X				"	"	"		23	590					PEA GRAVEL
130	590	8"	FACT	PREF	"	"	"	"	5/32								

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 <u>Pulliam Well Drilling</u> (PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED) ADDRESS <u>2877 Piedmont Ave Napa Ca. 94558</u> CITY STATE ZIP Signed <u>Brian Pulliam</u> DATE SIGNED <u>12-2-00</u> WELL DRILLER AUTHORIZED REPRESENTATIVE C-57 LICENSE NUMBER <u>248677</u>
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APPENDIX B

NAPA COUNTY GROUNDWATER RECHARGE ANALYSIS

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 its 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).

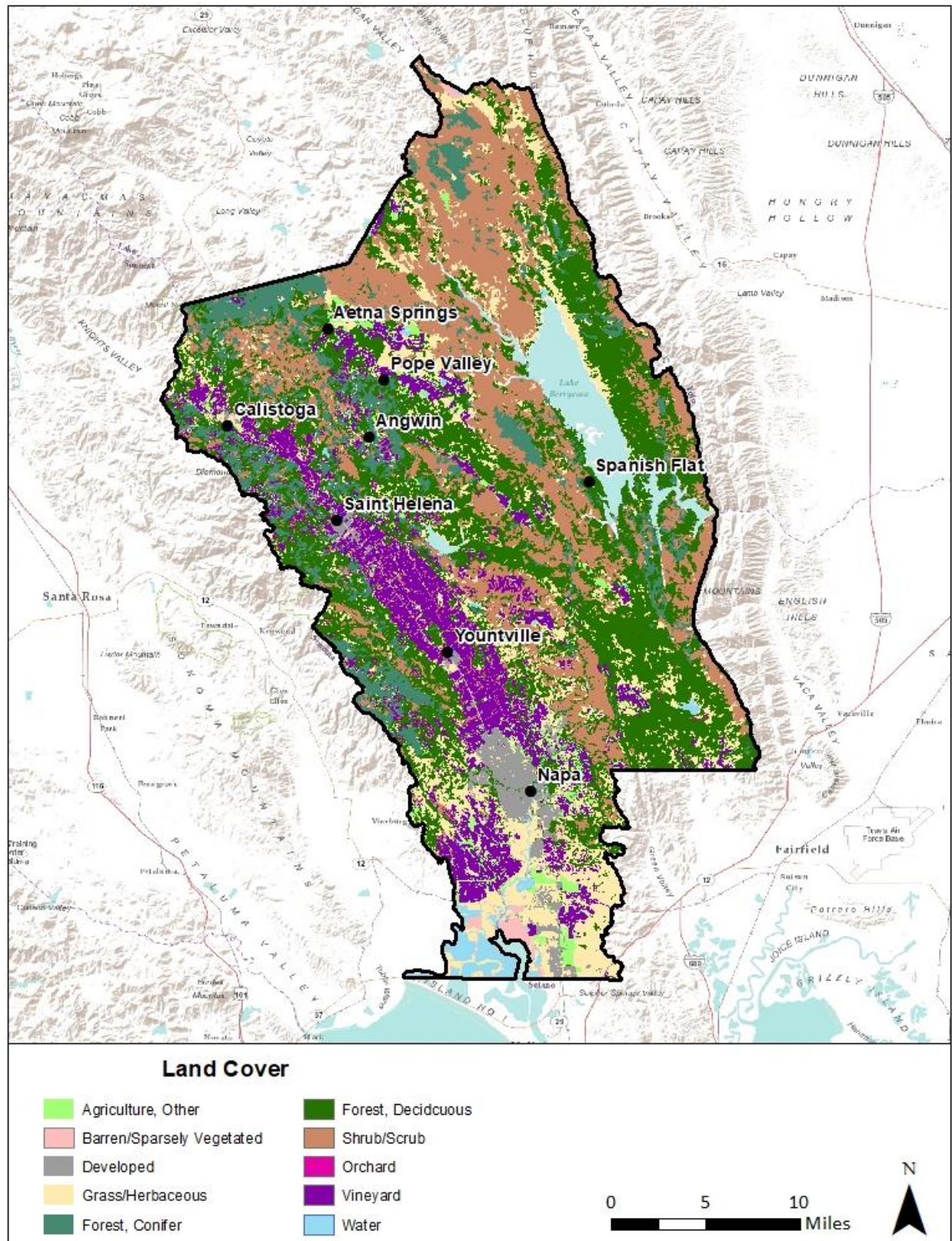


Figure 1: Land cover distribution used in the Napa County SWB model.

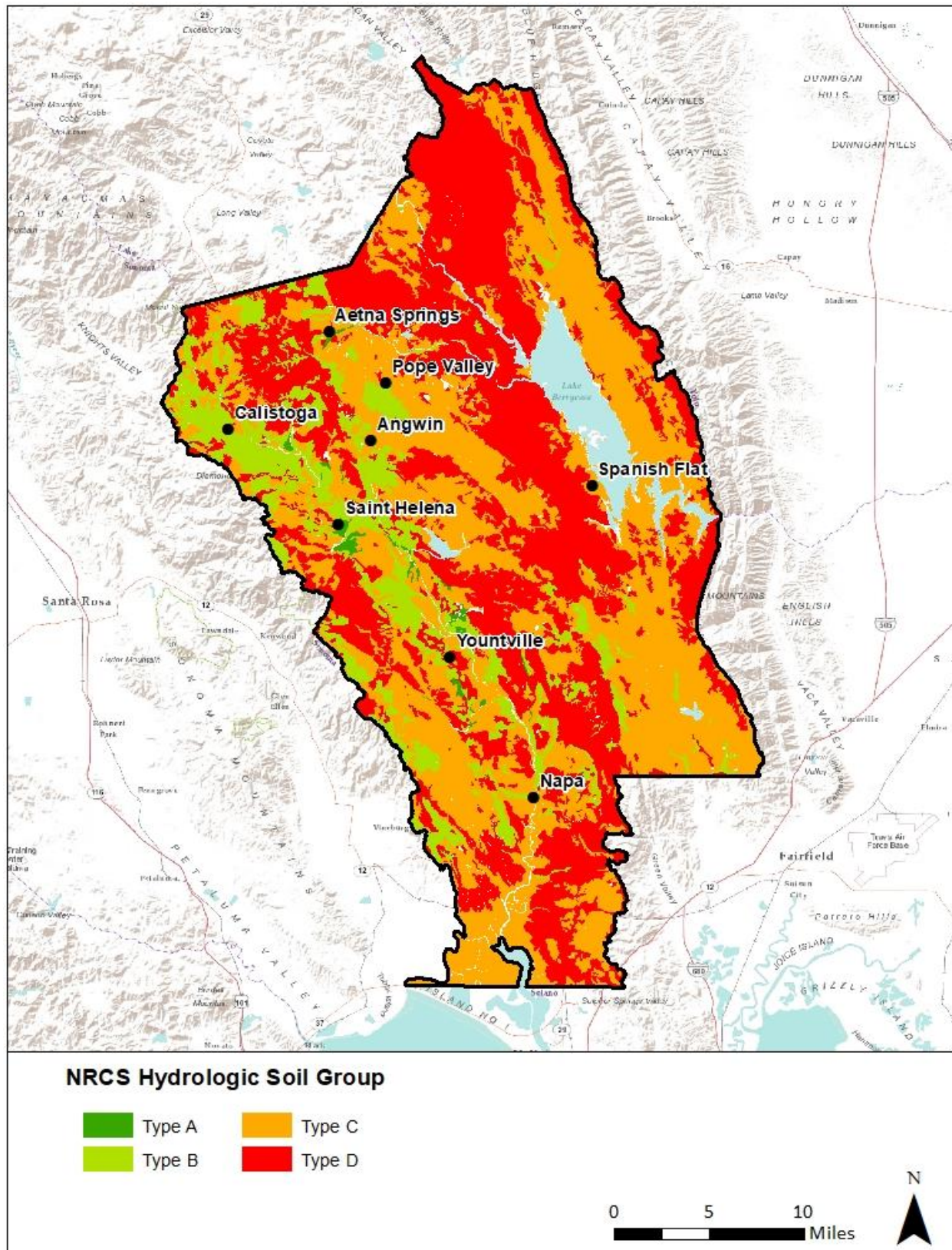


Figure 2: Hydrologic soil group distribution used in the Napa County SWB model.

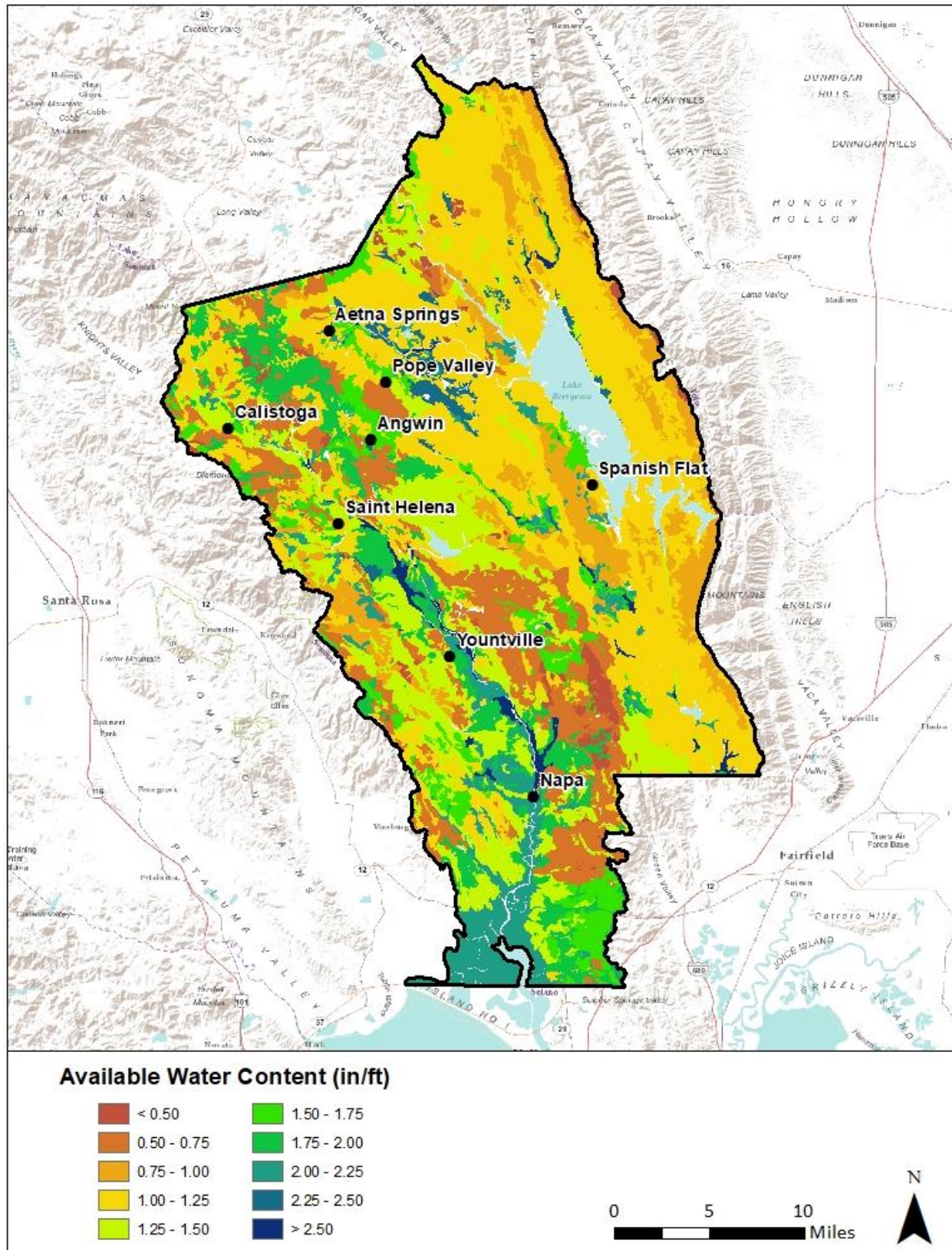


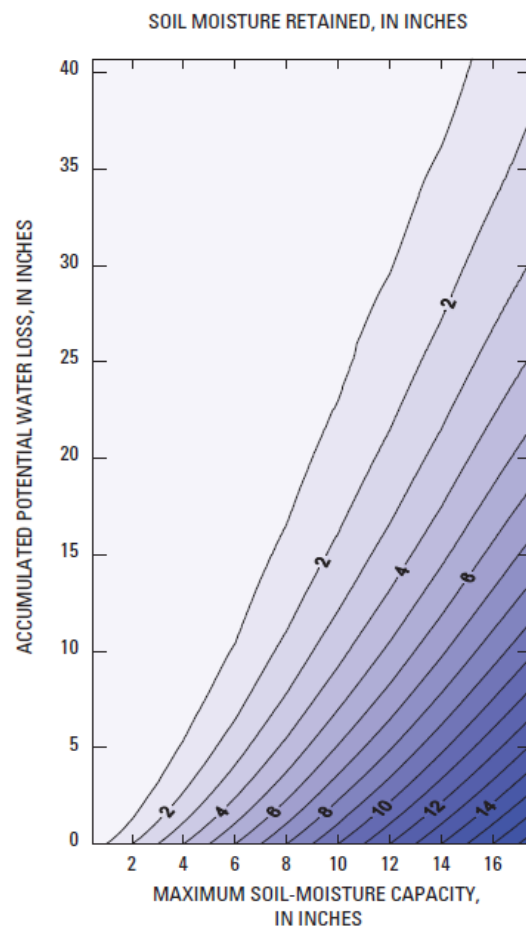
Figure 3: Available water capacity distribution used in the Napa County SWB model.

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 (Thorntwaite 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

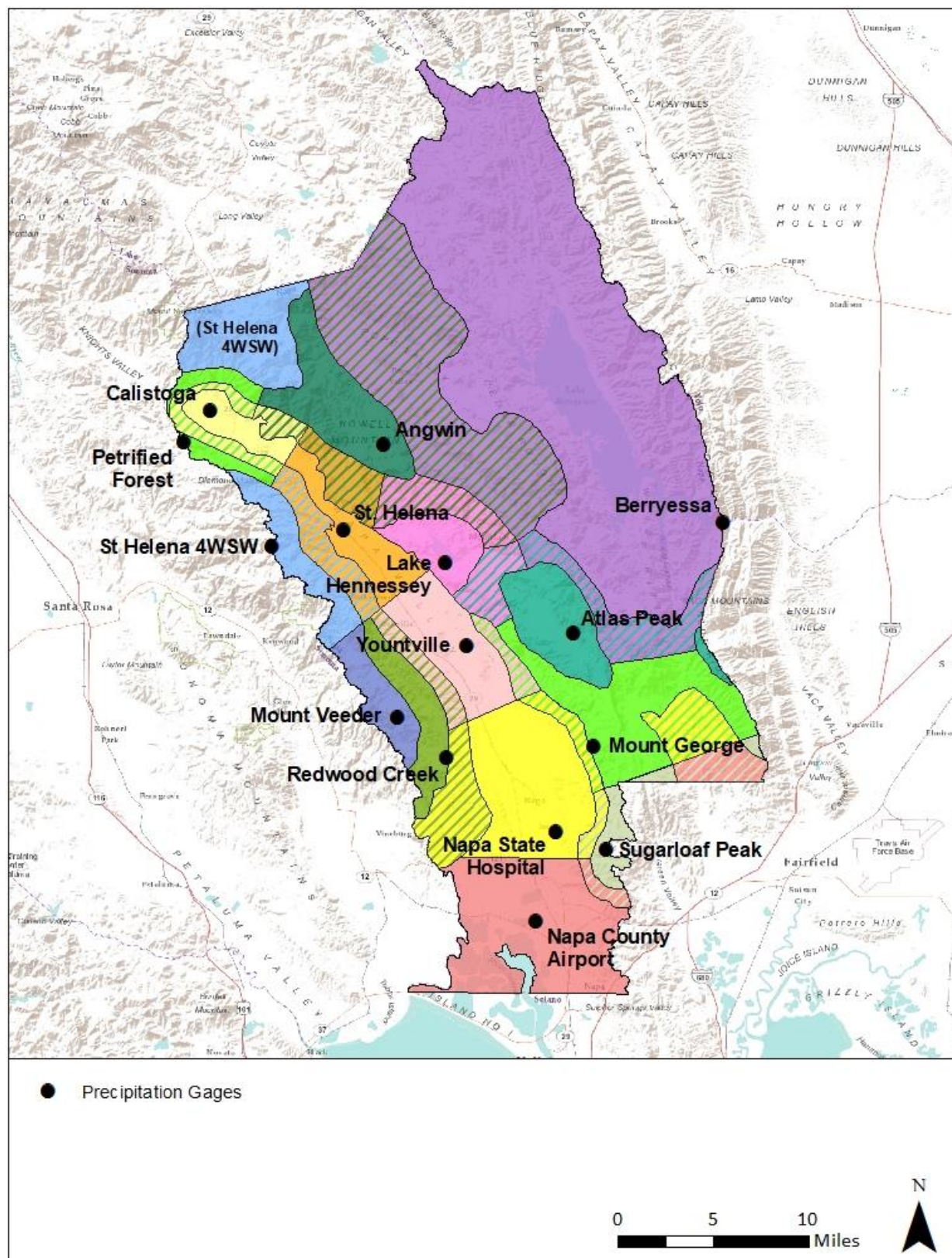


Figure 5: Precipitation zones used in the Napa County SWB model. Hatching indicates areas where two precipitation records were averaged across a zone.

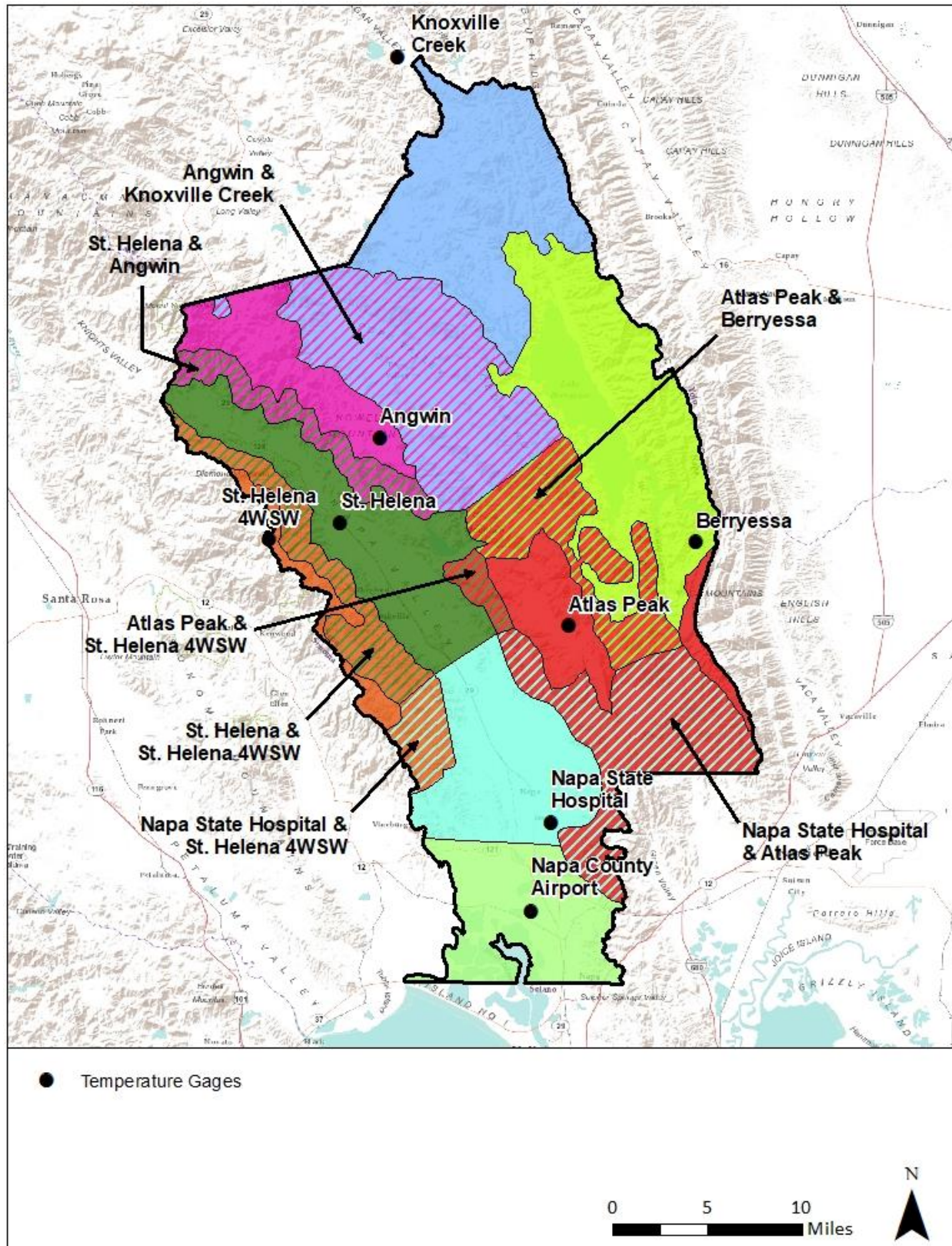


Figure 6: Temperature zones used in the Napa County SWB model. Hatching indicates areas where two temperature records were averaged across a zone.

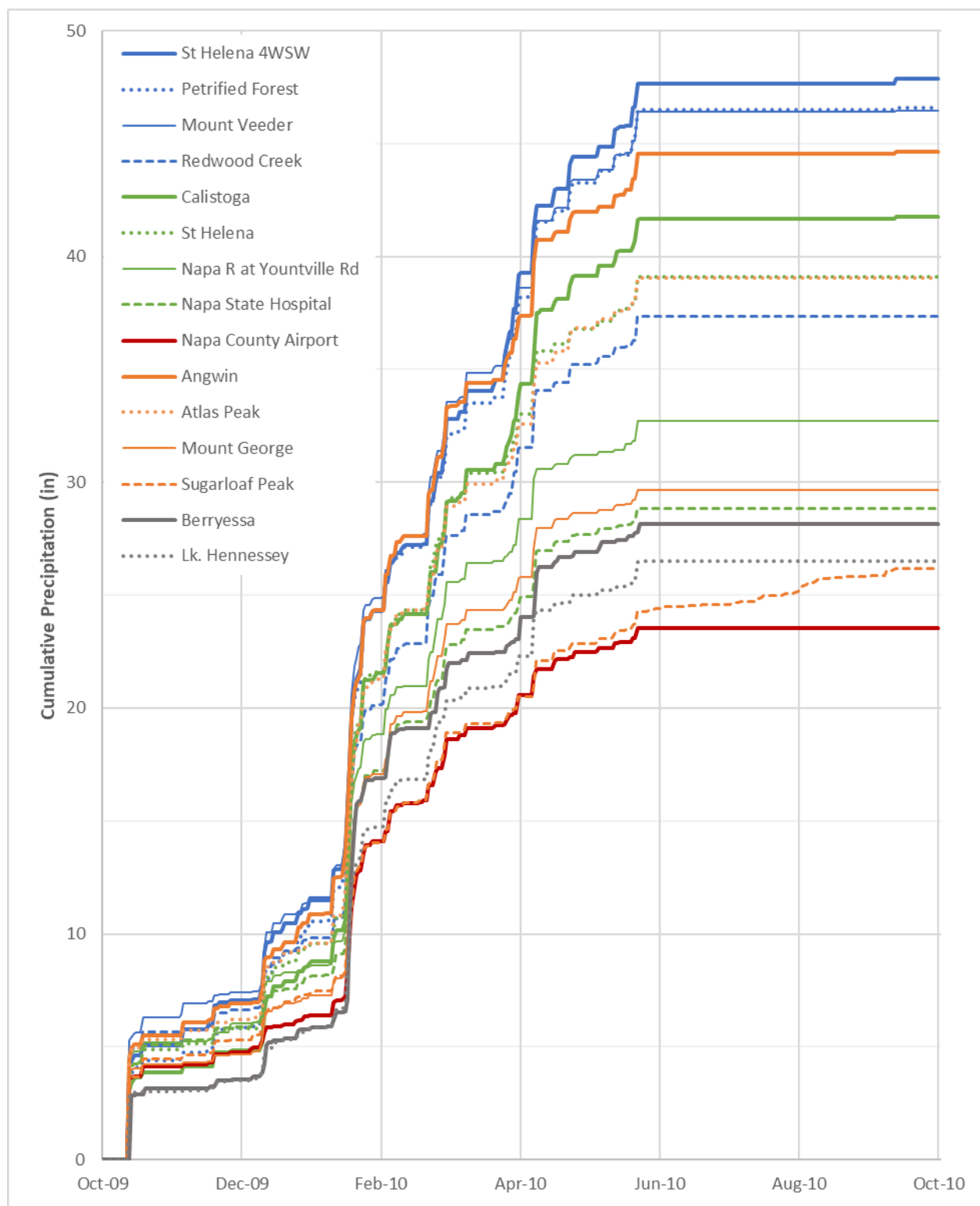


Figure 7a: Daily precipitation data used in the Napa County SWB model for WY 2010.

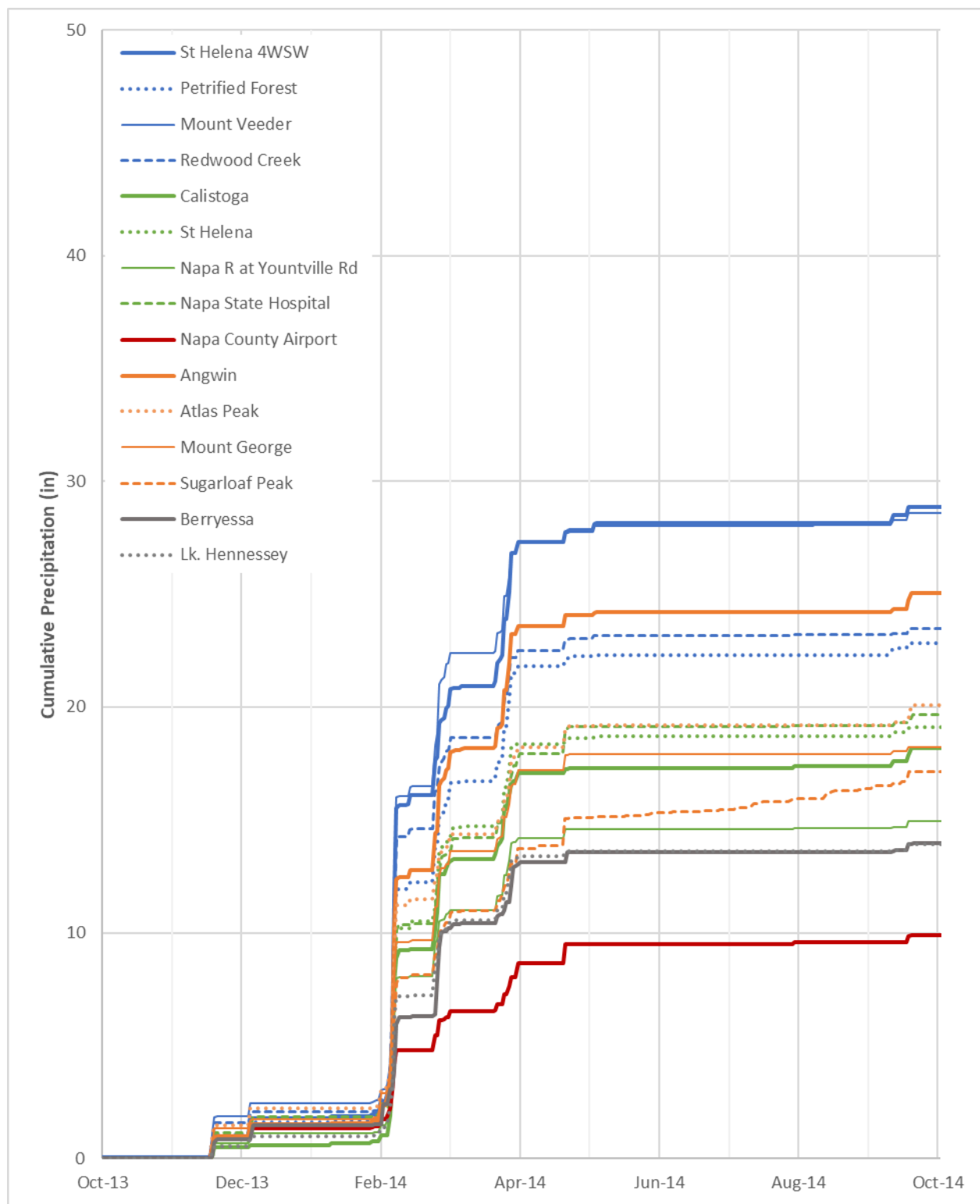


Figure 7b: Daily precipitation data used in the Napa County SWB model for WY 2014.

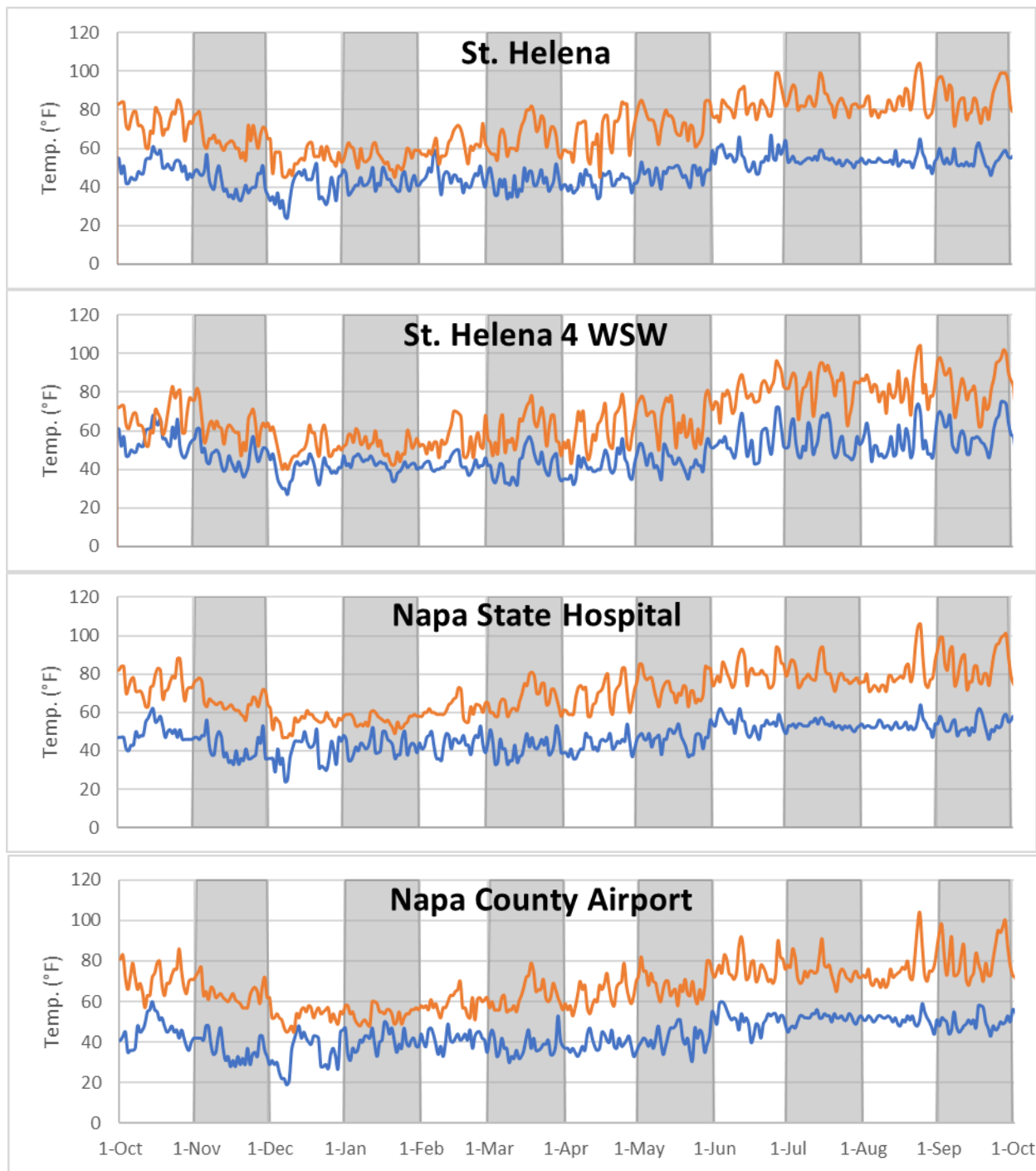


Figure 8: Daily minimum and maximum temperature data used in the Sonoma County SWB model for WY 2010.

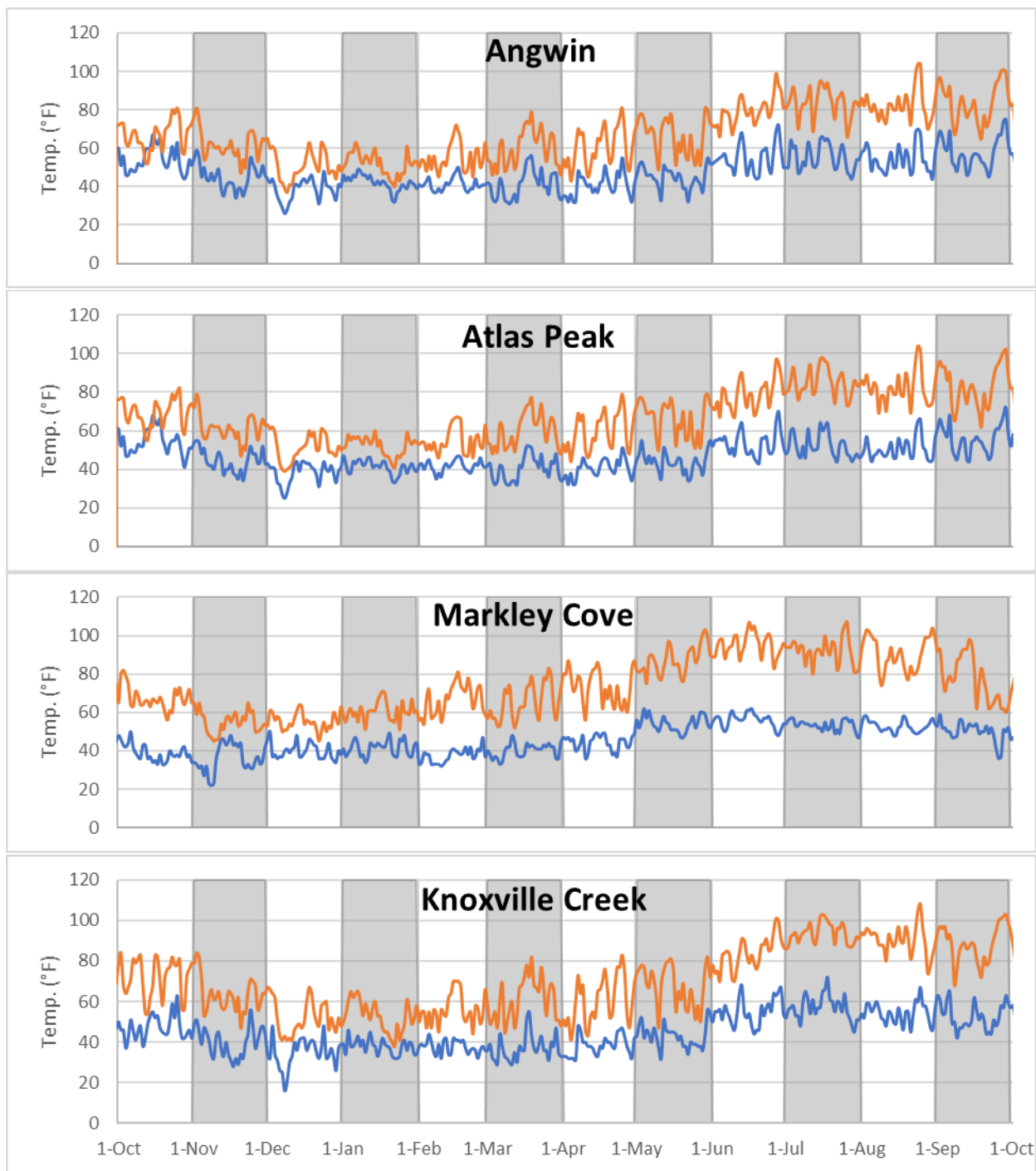


Figure 8 – cont.

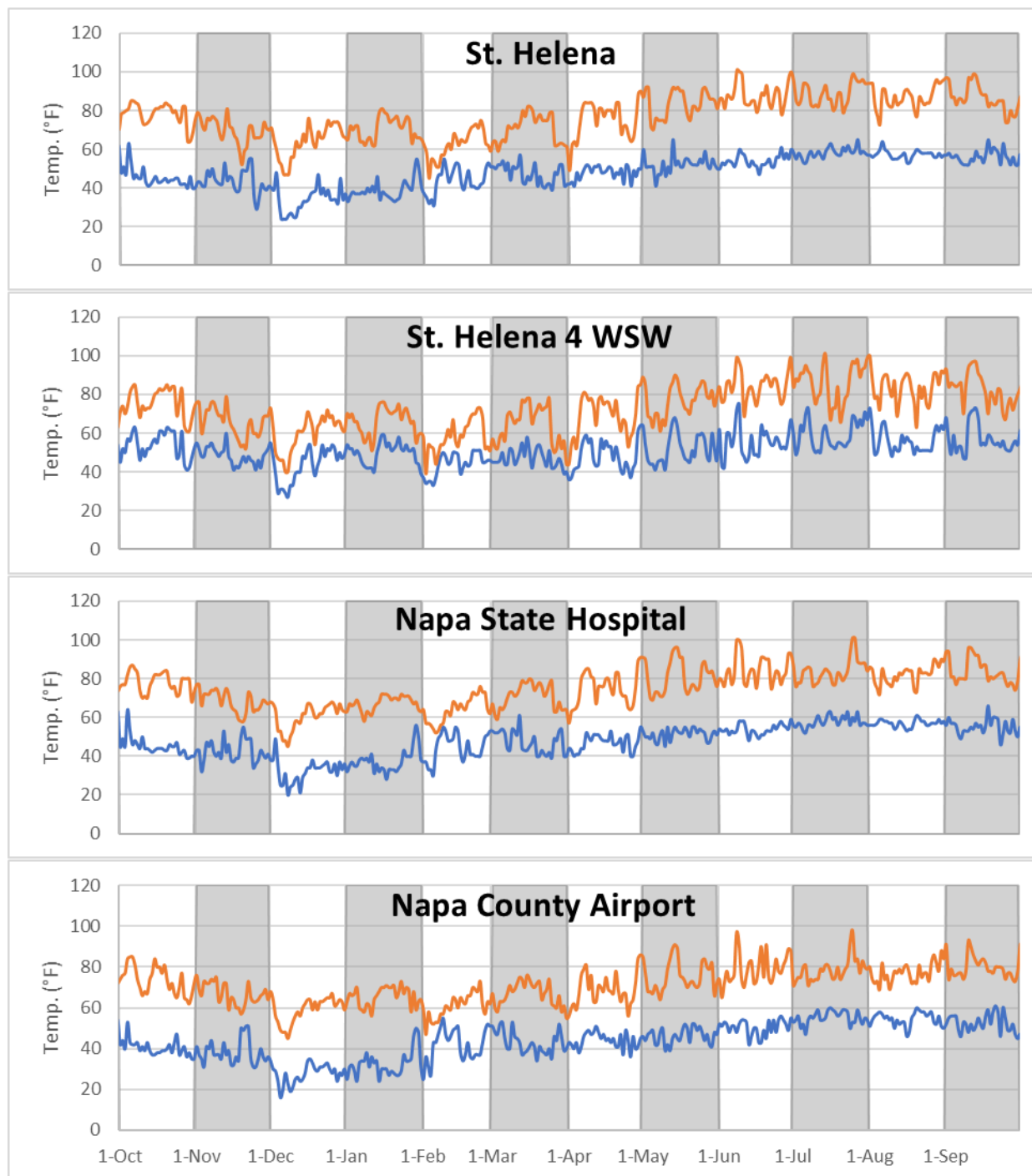


Figure 9: Daily minimum and maximum temperature data used in the Sonoma County SWB model for WY 2010.

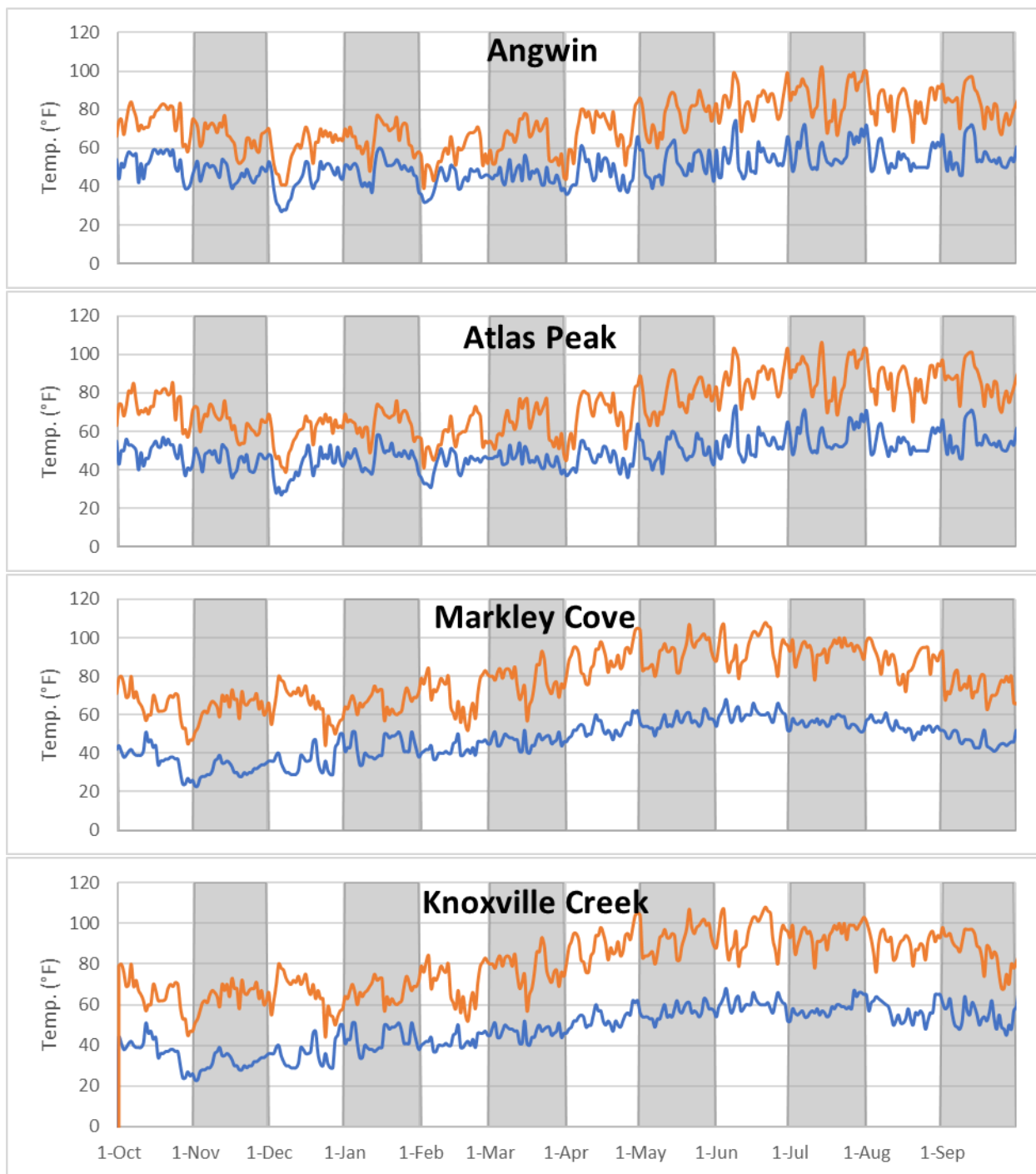


Figure 9 – cont.

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 mi²) 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%
Tuluca 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 Ledge 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 Ledge Creek watershed to 13.5 inches in the Saint Helena Creek watershed (Figure 12). Recharge ranged from 3.3 inches in the Ledge 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.

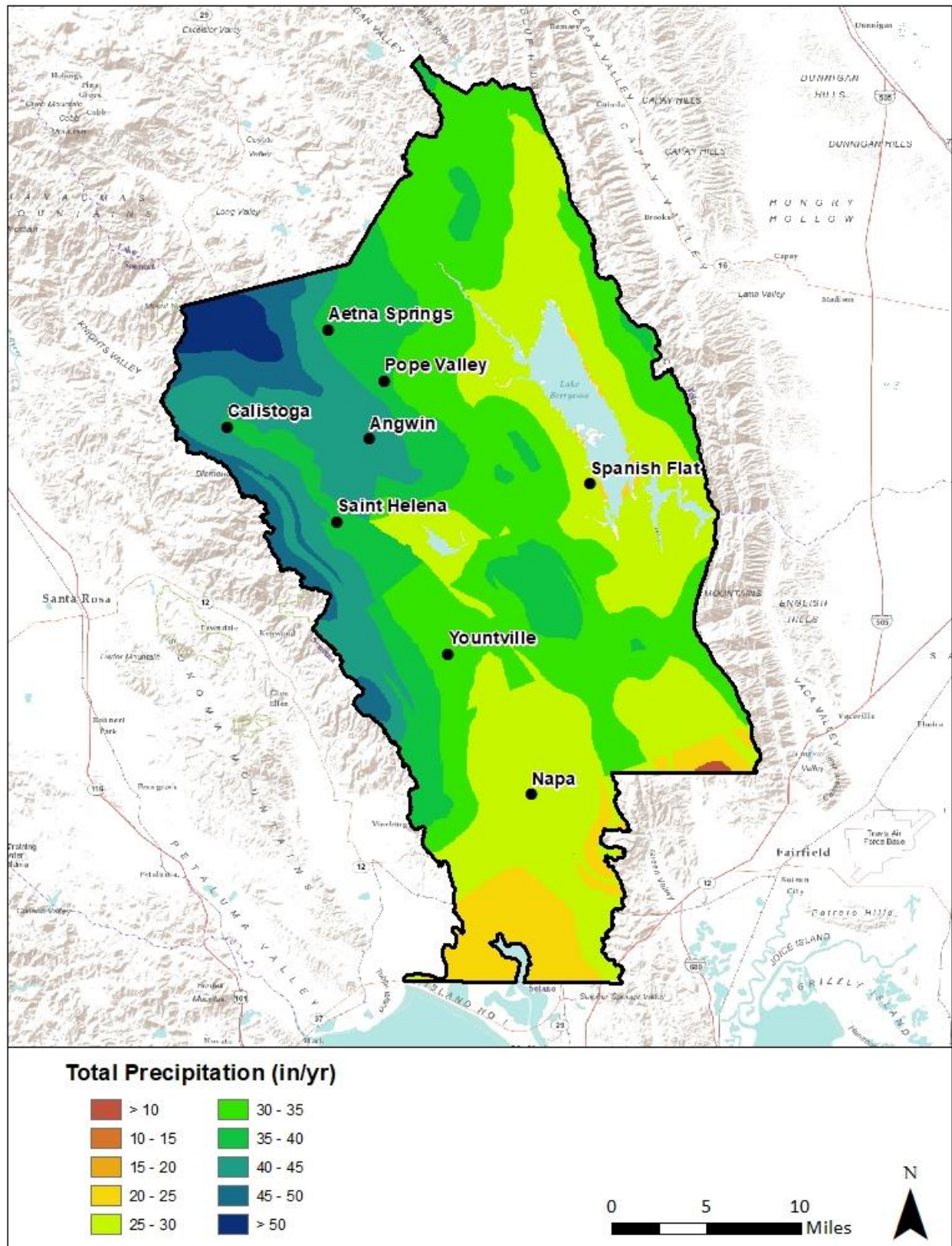


Figure 10: Water Year 2010 precipitation simulated with the Napa County SWB model.

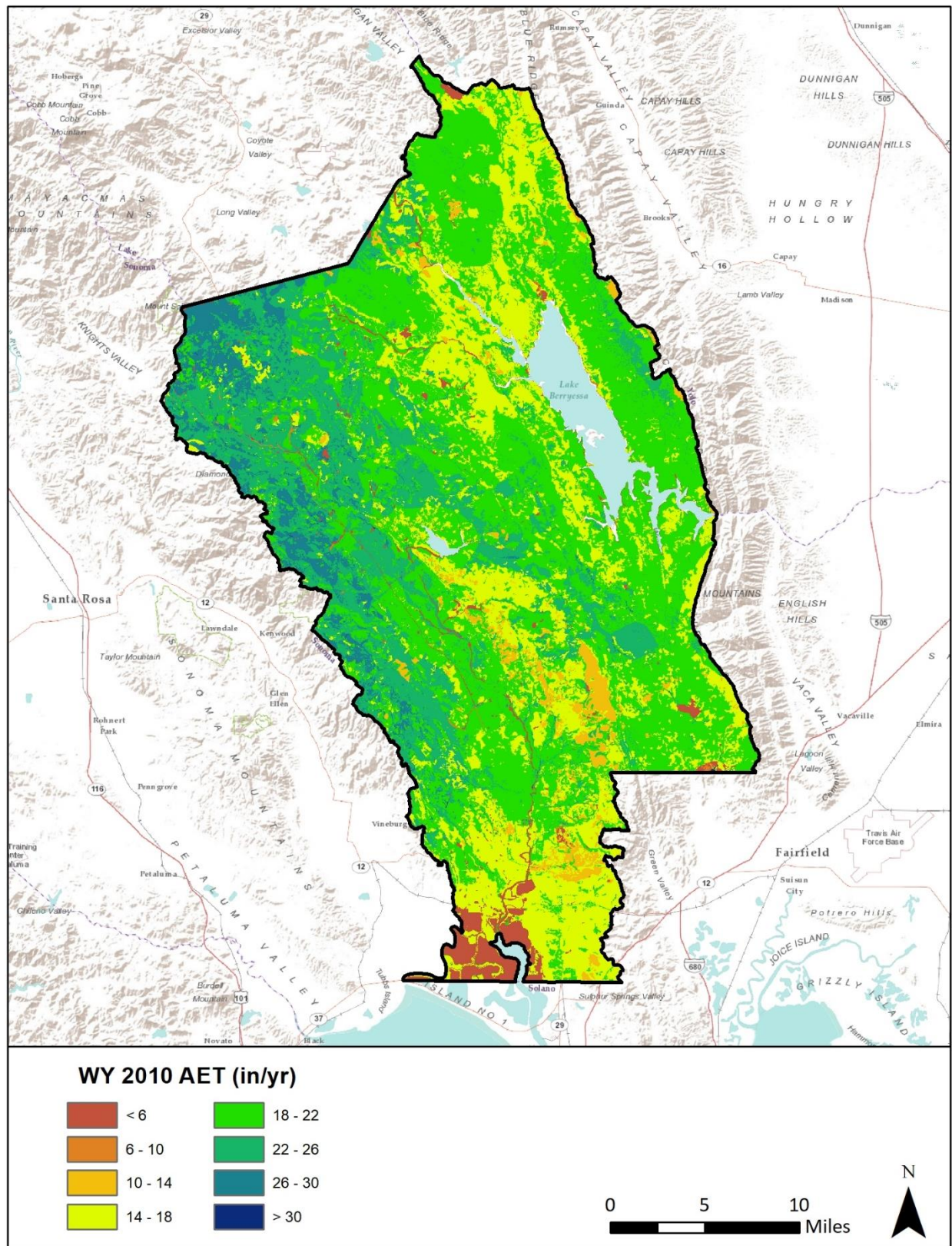


Figure 11: Water Year 2010 AET simulated with the Napa County SWB model.

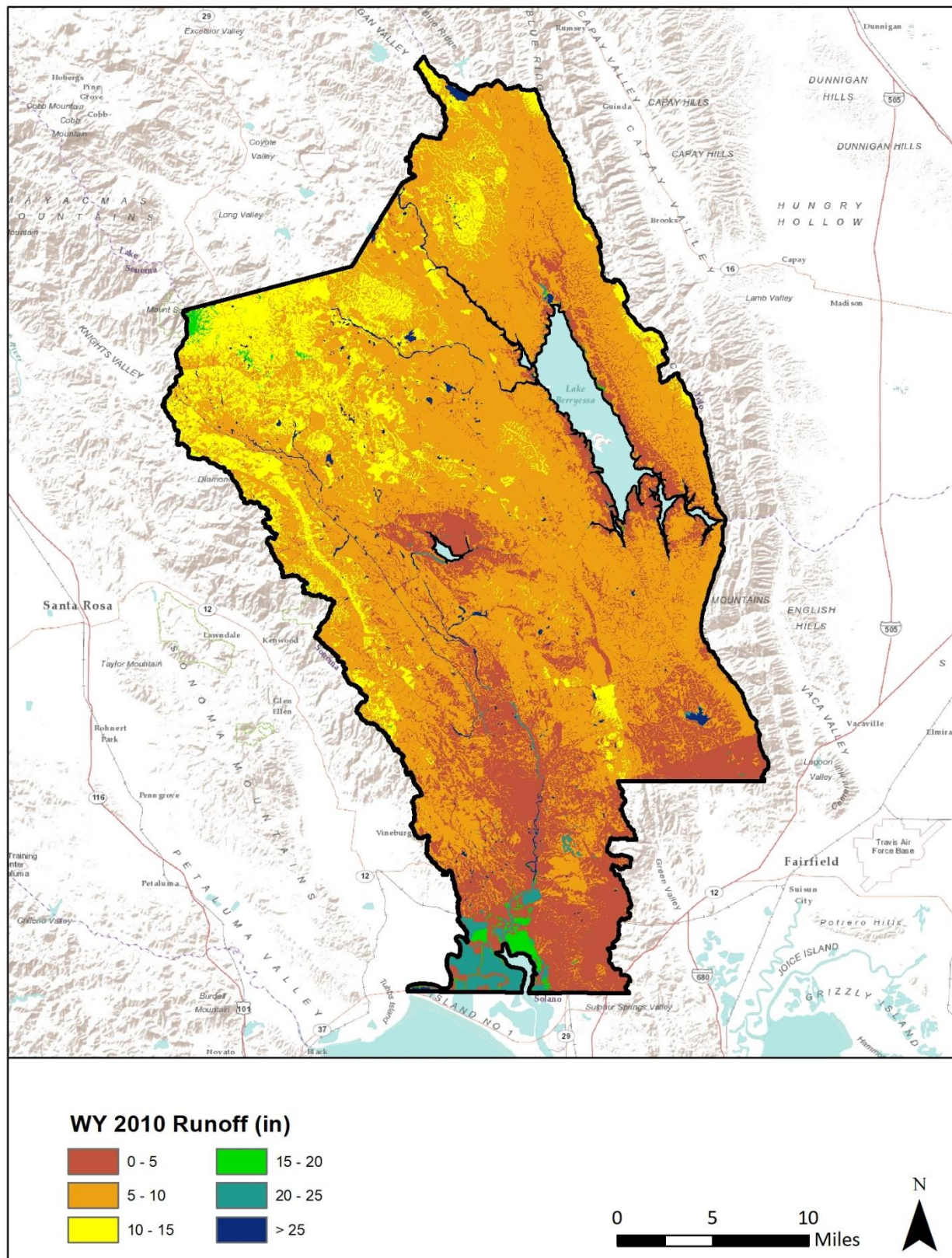


Figure 12: Water Year 2010 runoff simulated with the Napa County SWB model.

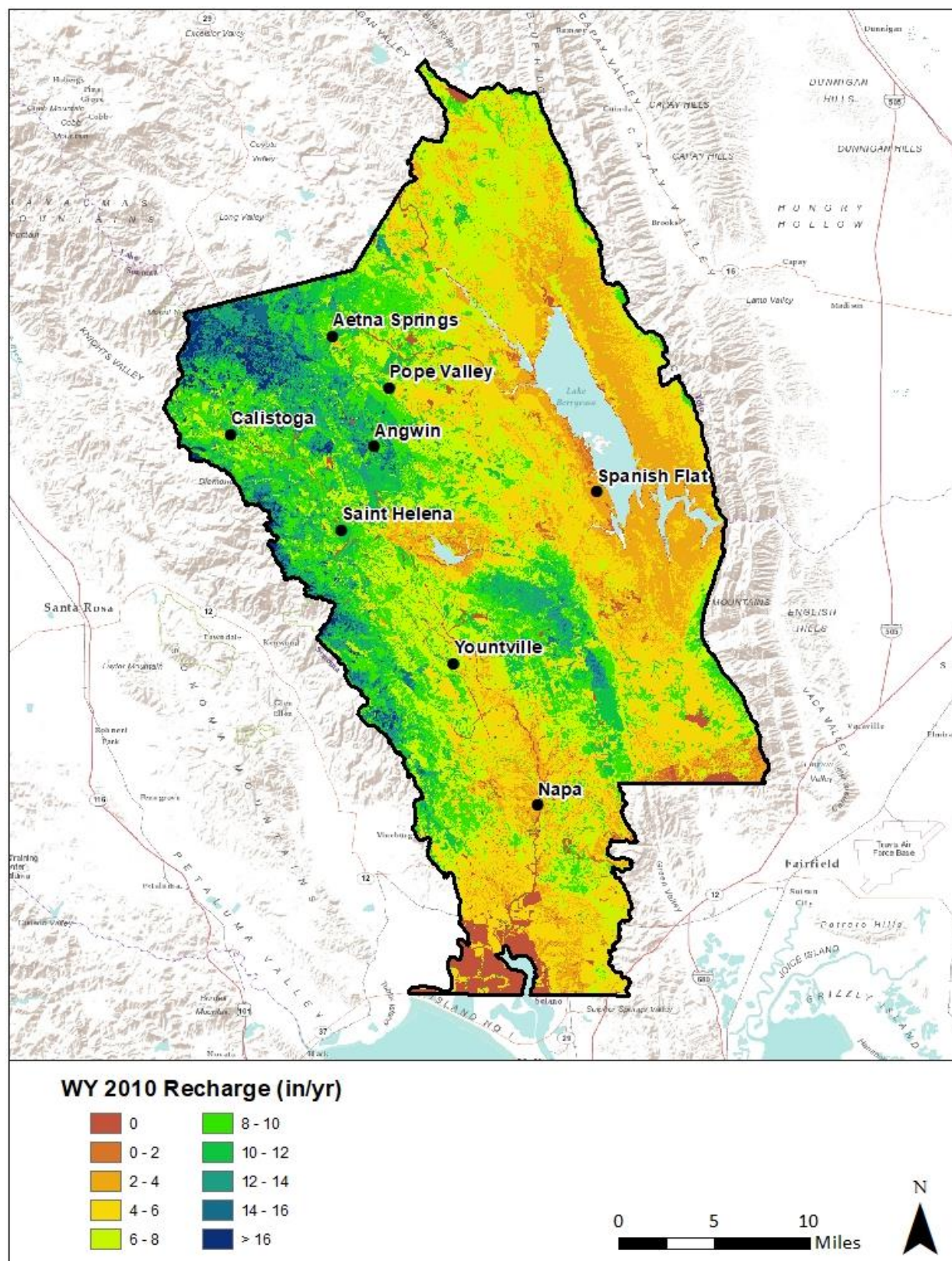


Figure 13: Water Year 2010 recharge simulated with the Napa County SWB model.

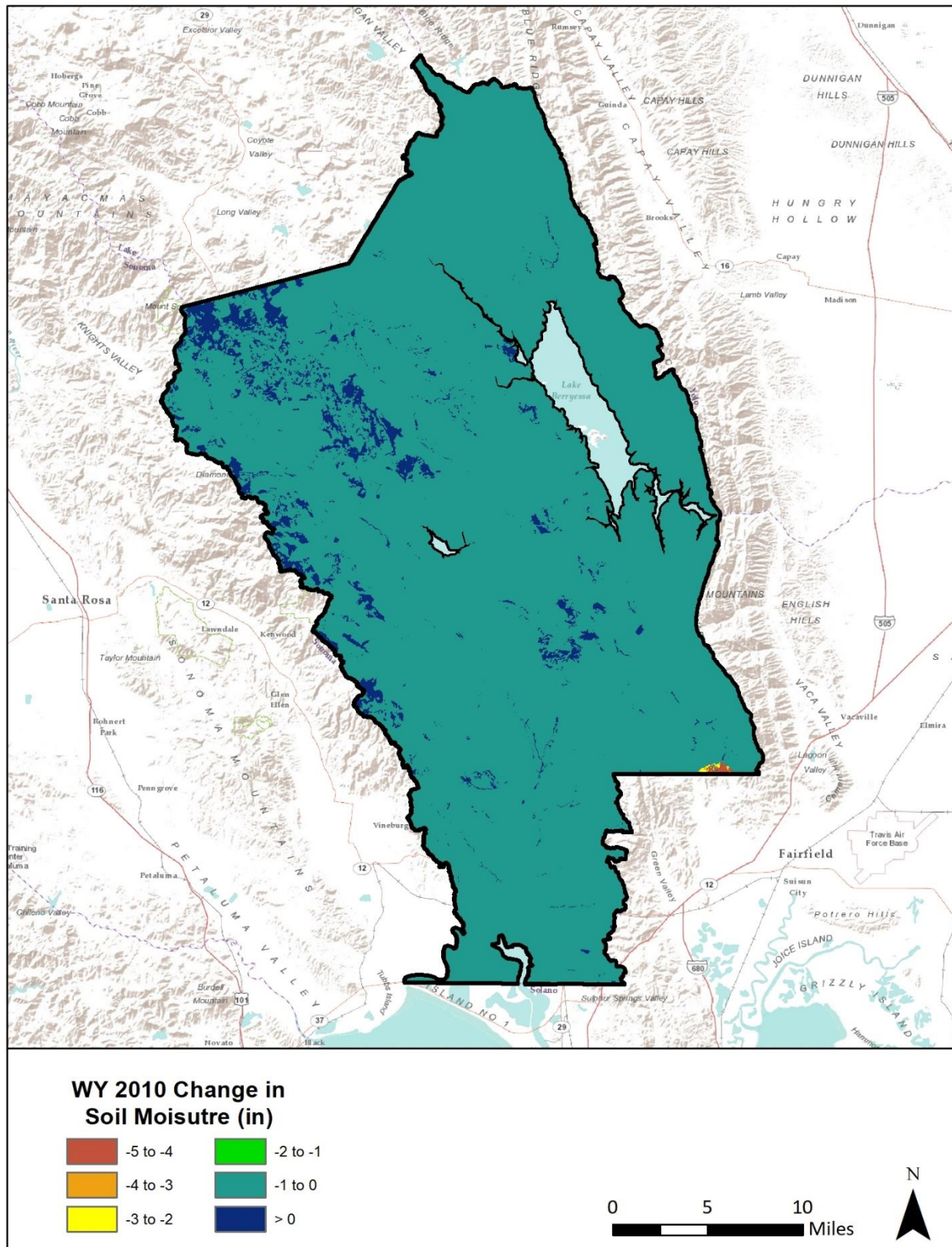


Figure 14: Water Year 2010 change in soil moisture content simulated with the Napa County SWB model.

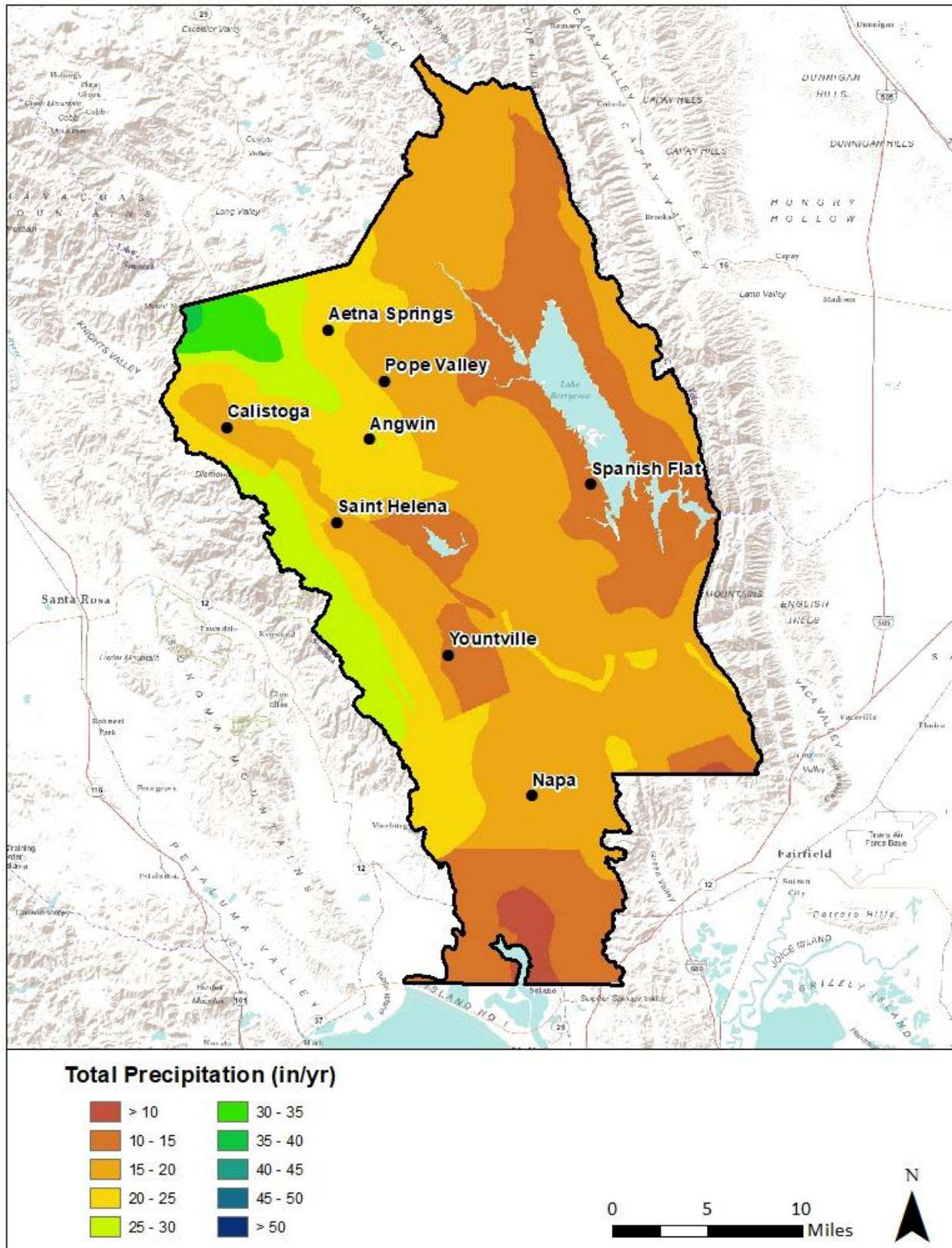


Figure 15: Water Year 2014 precipitation simulated with the Napa County SWB model.

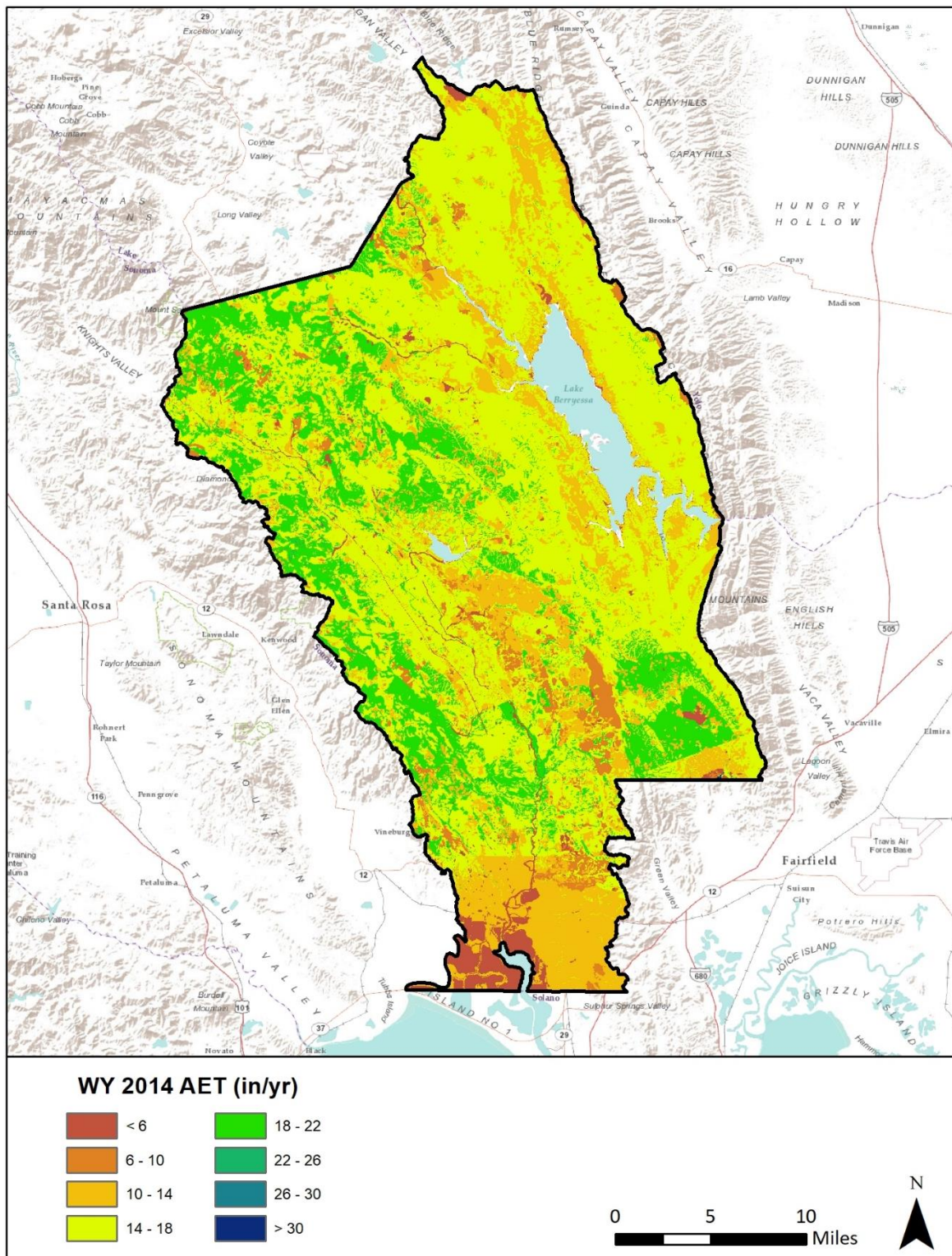


Figure 16: Water Year 2014 AET simulated with the Napa County SWB model.

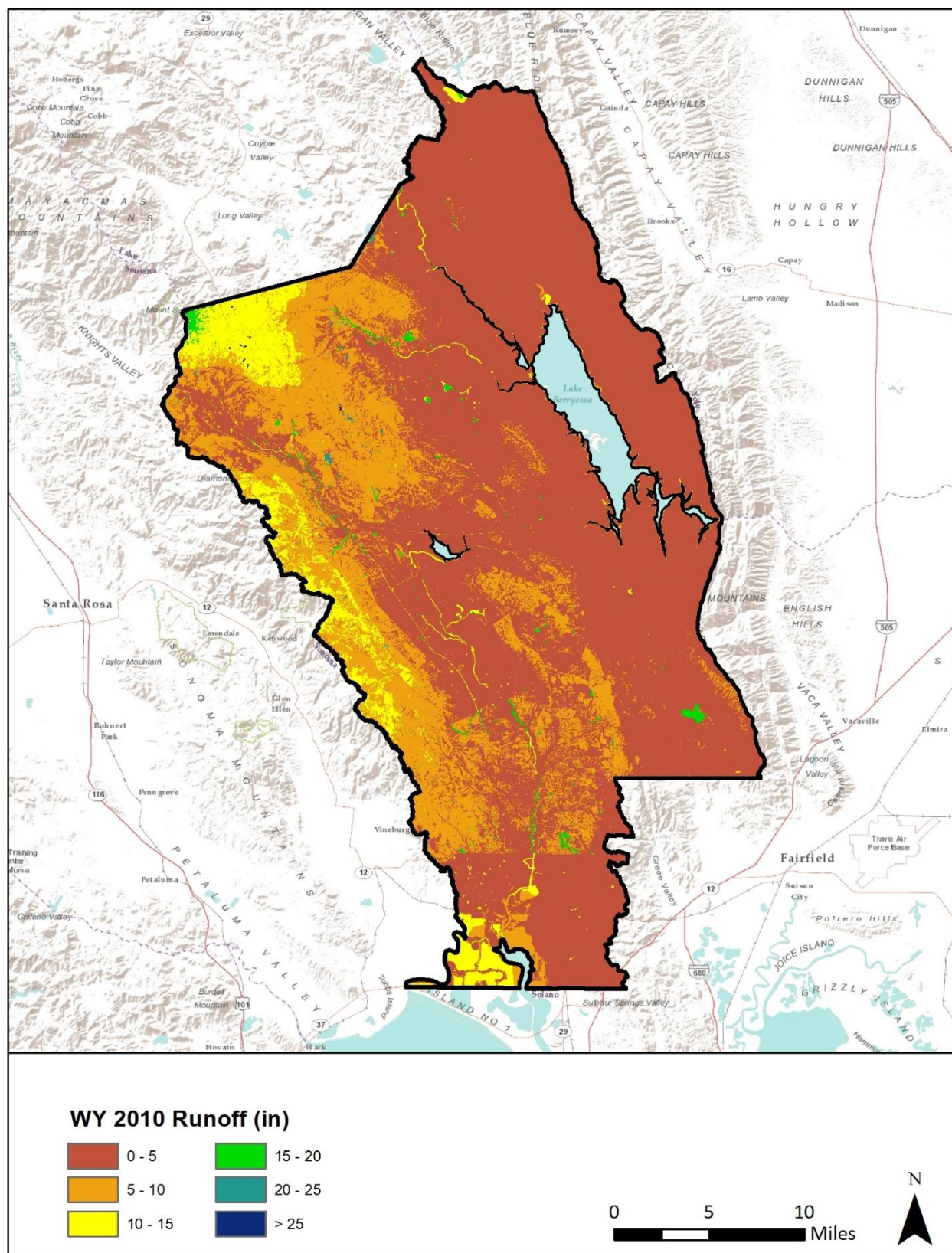


Figure 17: Water Year 2014 recharge simulated with the Napa County SWB model.

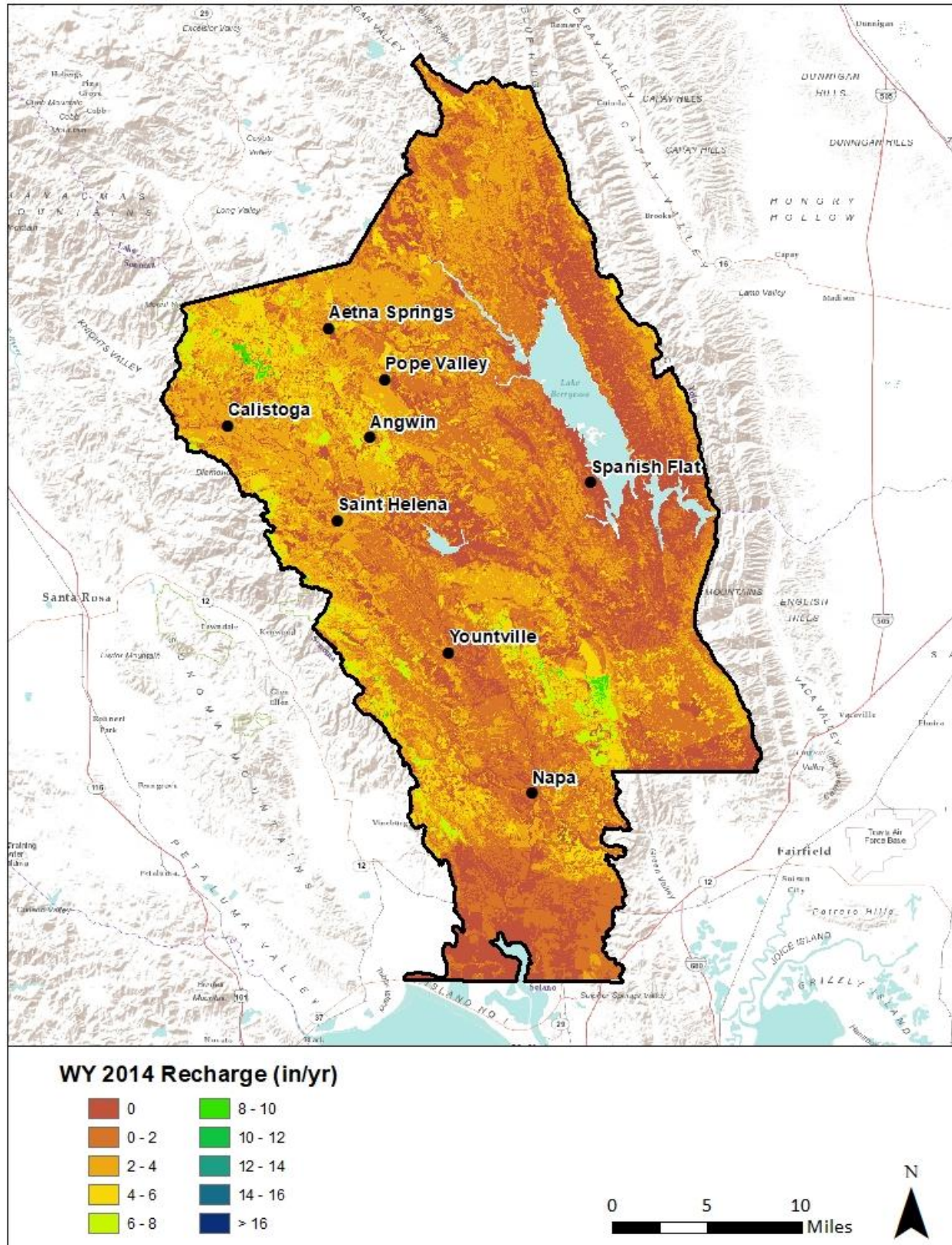


Figure 18: Water Year 2014 recharge simulated with the Napa County SWB model.

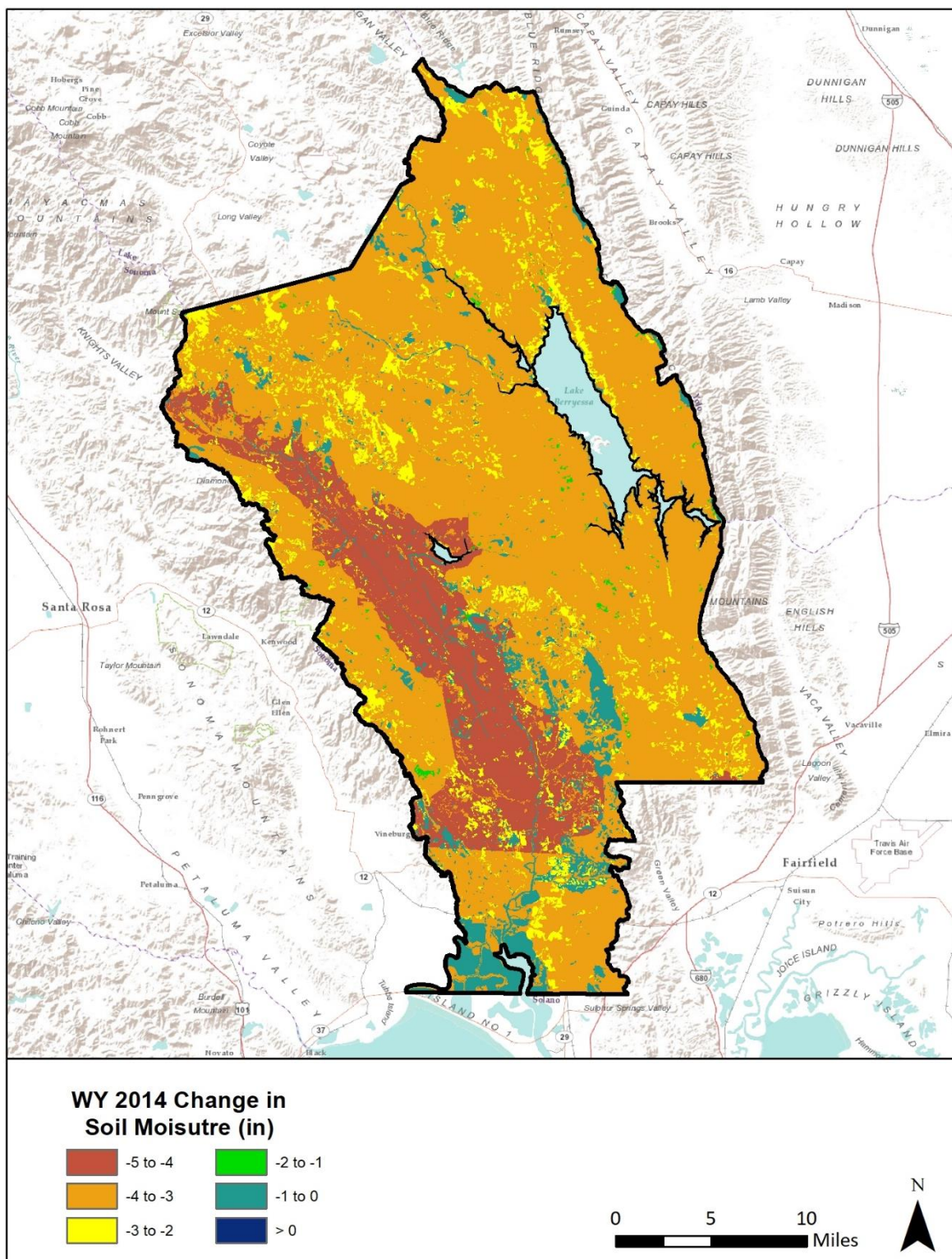


Figure 19: Water Year 2014 change in soil moisture content simulated with the Napa County SWB model.

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
Tuluca 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%
Tuluca 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
Bucksnot 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
Tuluca 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%
Bucksnot 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 Elicuera 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%
Tuluca Creek	34.2	14.6	93%	18%	12%	-23%
Upper Elicuera 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%

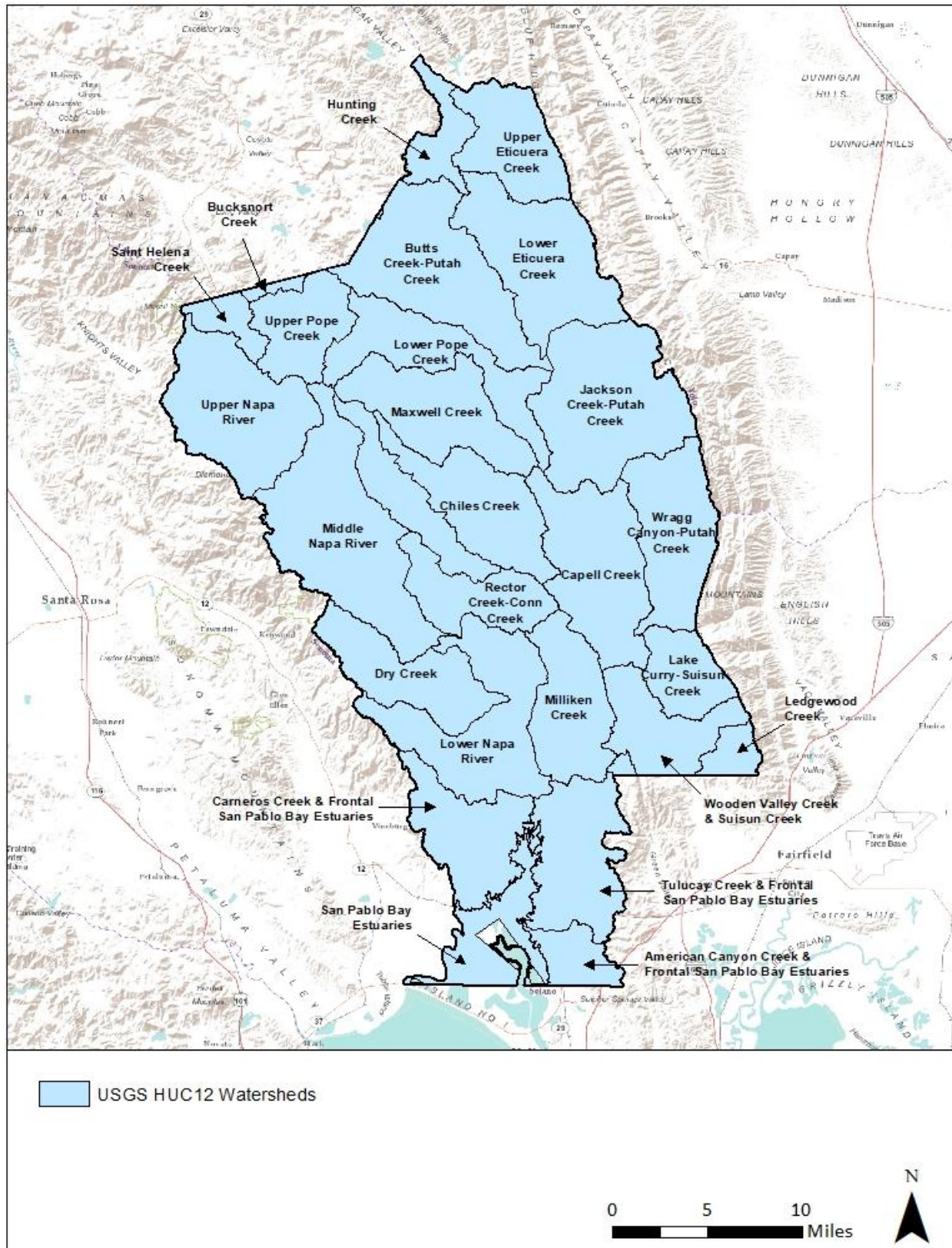


Figure 20: Major watersheds areas used to summarize water budget information in Tables 5 - 8.

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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