Brunsing Associates, Inc.
Engineers and Geologists

May 18, 2020 Project No. 12685.01

David Bowers
2590 Telegraph Avenue
Berkeley, CA 94707

RE: Assessing Impact of Pond Filling to Nearby Surface Waters
7955 St. Helena Road
Santa Rosa, California, 95404

Dear Mr. Bowers,

In an April 17, 2019 letter, and through various email communication (Appendix A), Sonoma County Permit and Resource Management Department (PRMD) has requested Brunsing Associates, Inc. (BAI) to address quantitatively the impact from filling the planned onsite irrigation pond on the nearby spring and tributary at the subject property. It is BAI's understanding that the irrigation demand for the proposed use permit will be approximately 2.0 acre-feet. Preliminary plans prepared by Adobe Associates, Inc. (AAI) indicate that the pond is designed for 2.55 acre-feet (830,220 gallons) (Plans shown in Appendix B). AAI also estimates that the precipitation and surface runoff refill for the pond during the wet season for a normal year will be approximately on average 441,475 gallons, and approximately 379,327 gallons during a drought year. According to a March 10, 2020 letter from AAI (Appendix B), that leaves approximately 470,708 gallons of the pond to be filled from the well during a normal year and approximately 513,853 gallons of the pond to be filled from the well during a drought year. AAI has confirmed through email communication, that these values include evaporative loss during the year and irrigation used. The owner has mentioned that they intend to fill the pond with water pumped from the well during the months of January, February, and March. The owner also intends to use the water in the pond only for cannabis irrigation, with excess water reserved for fire suppression.

Quantitative Analysis Projecting Well Pumping on Surface Discharge

PRMD has requested BAI to conduct a quantitative analysis determining the effects of well pumping on the spring and general discharge to the on-site wetland and tributaries. To do so, we have implemented an online model calculator, STRMDEPL08, which simulates streamflow depletion by nearby pumping wells (Reeves, 2008). For the site, we are primarily focusing on spring flow and tributary flow. Mark West Creek tributaries typically have bedrock at their stream beds, with pockets of alluvium. Therefore, for the pumping effects on the spring and tributary, we will implement the calculations involving a fully penetrating stream and no streambed resistance model. The models requires the following inputs:

1. *Distance of surface flow from well (in feet):* ***~150 ft to spring, ~400 ft to east tributary***

BAI has noted in our previous 2019 report that the spring is approximately 150 feet from the well location. Considering the spring flow likely influences and correlates with the water inflow for the wetland and adjacent tributary, we will use this distance for our analysis.

2. *Transmissivity (ft^2/day):* ***72.6 ft^2/day***

Transmissivity values can be calculated from well pump tests, using the following Modified Cooper-Jacob Equation (Driscoll, 1986) for unconfined aquifers:

$$T = (Q/S)$$

where:

T	= Transmissivity (ft^2/day)
Q	= Pumping rate of test (gpm)
S	= drawdown during test (feet)

Our 8-hour pump test in February 2019 recorded an average pumping rate of 20 gpm. Drawdown of the groundwater from pumping was 53 feet.

3. *Storage coefficient (unit-less):* ***0.15***

Common storage coefficient used for Sonoma Volcanic ash tuff aquifer (Report on the Hydrologic Characteristics of Mark West Creek, 2015)

4. *Pumping rate (gallons per minute, gpm):* ***3.63 gpm (normal year), 3.96 gm (drought year)***

For the subject site's proposed usage, 470,708 gallons is assumed during normal years to be pumped from the well into the pond from January – March, which is approximately 90 days. During drought years, 513,853 gallons is assumed to be pumped from the well into the pond from January – March during drought years. The calculated pumping rates in gallons per minute (gpm) is approximately 3.63 gpm for normal years, and 3.96 gpm for drought years.

5. *Days of pumping (days):* ***Approximately 90 days***

After communicating with the client and PRMD, there has been mention of the pond likely being filled to capacity during three months within the wet season (January, February, and March). The approximate total days for these three months is 90 days.

Model Results and Conclusions

Both spring and tributary model results showing stream depletion over the timespan of pumping from the well during January through March, for normal years and drought years is shown in Appendices C - G. At 90 days of pumping, the spring would face a depletion of about 0.0049 cubic feet per second (cfs) and 0.0054 cfs in a normal and drought year respectively, while the tributary would face a depletion of approximately 0.0014 cfs and 0.0015 cfs in a normal and drought year respectively. Based on these simulated values, the spring will likely see a noticeable drop in flow rate during the months of pumping. However, all of the above depletion values are negligible compared to threshold of 14.4 cfs or higher required from the reported Mark West Gauge values in order for the onsite well to be pumped during these winter months. If the gauge meets this threshold value of 14.4 cfs, pumping from the well under the permit conditions would be permissible, and the negligible depletion effects from pumping will likely not impact overall Mark West Creek flow.

It is important to note, that during our site visits within the growing season, the tributary has been observed to be dry, with the spring observed to still have some degree of flow. The observed conditions in the growing months indicates that the tributary at the site isn't vital in feeding the larger tributaries in the region, which eventually feed into main Mark West Creek. The spring is also too distant from the main Mark West Creek branch or its larger tributaries to have a considerable impact. The spring is however vital for the onsite wetland. BAI anticipates that both spring and tributary flow will rebound after pumping ceases. A rebound in spring flow should help maintain input into the wetland.

LIMITATIONS

The conclusions regarding this property are based on observations of the existing conditions, and limited field and analytical work performed by BAI during the time of the investigation and may be subject to change. Tabulated analytical data and other data gathered during this and previous BAI investigations, and presented herein, are to the best of our knowledge complete and correct. This report has been presented in accordance with generally accepted geologic and engineering principles and practices. No other warranty, either expressed or implied, is made.

If you have any questions regarding this report, please contact Zach Mason at zmason@brunsing.com or (707) 838-3027.

Sincerely,

BRUNSING ASSOCIATES, INC.

CERTIFIED ENGINEERING GEOLOGIST ERIK E. OLSBORG No. EG 1072 STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER KEITH A. COLORADO No.2894 GEOTECHNICAL STATE OF CALIFORNIA

Erik E. Olsborg, C.E.G.
Engineering Geologist - 1072

Keith A. Colorado
Geotechnical Engineer - 2894

Zachary Mason
Staff Geologist

List of Attachments

Plate 1. Vicinity Map
Plate 2. Site Map

Appendix A. PRMD Correspondence
Appendix B. Adobe Associates, Inc. Preliminary Pond Documents
Appendix C. Tributary Depletion Model Results (Normal Year)
Appendix D. Tributary Depletion Model Results (Drought Year)
Appendix E. Spring Depletion Model Results (Normal Year)
Appendix G. Spring Depletion Model Results (Drought Year)

References Used

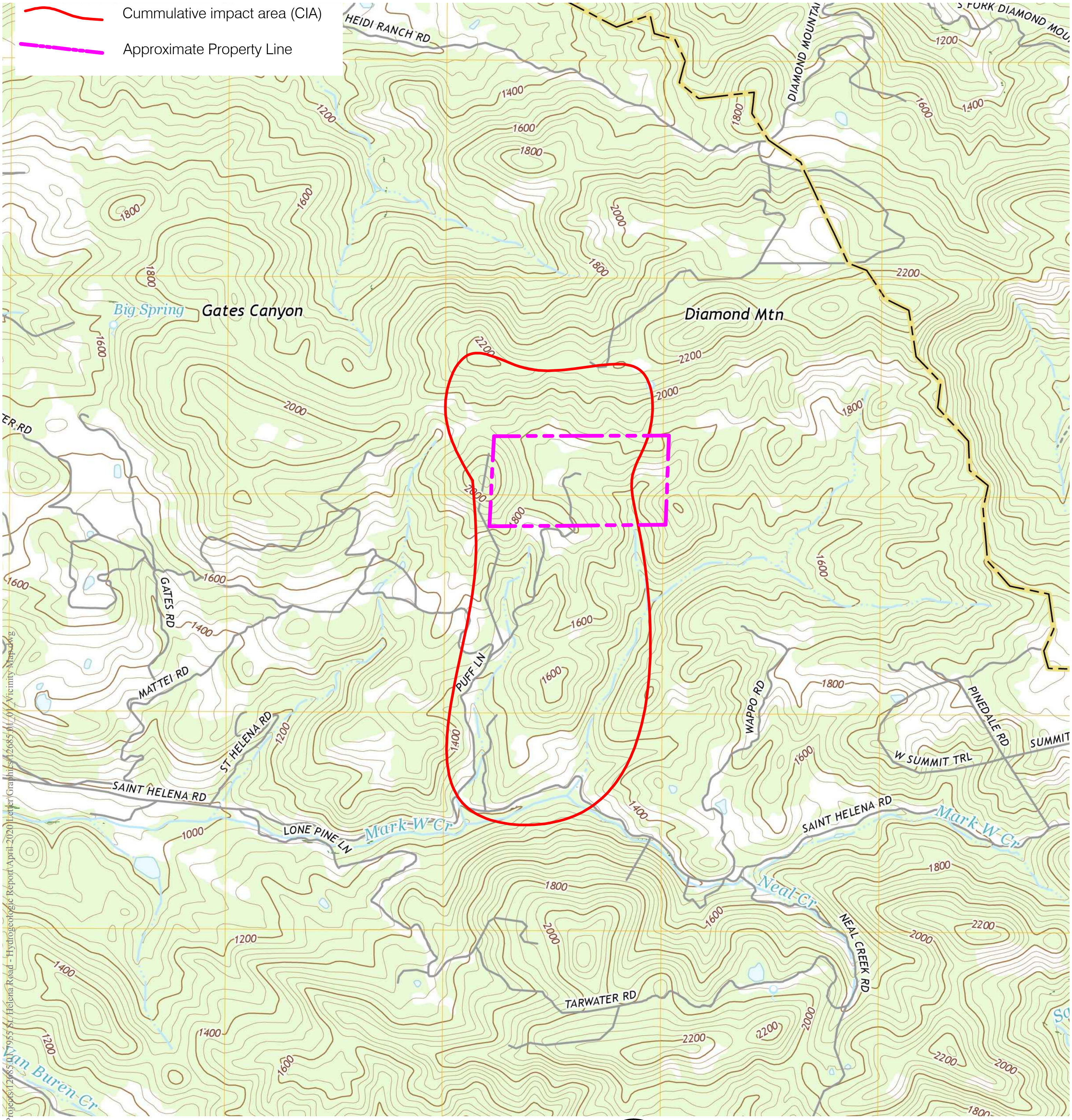
Driscoll, F.G., 1986, Groundwater and wells (No. 551.49/D779).

Reeves, H.W., 2008, STRMDEPL08—An extended version of STRMDEPL with additional analytical solutions to calculate streamflow depletion by nearby pumping wells: U.S. Geological Survey Open-File Report 2008–1166, 22 p. Date Posted: June 16, 2008: [https://pubs.water.usgs.gov/ofr20081166/]

U.S. Geological Survey, 2015, USGS US Topo 7.5-minute map for Calistoga, CA 2015, USGS - National Geospatial Technical Operations Center (NGTOC)

Center for Ecosystem Management and Restoration, 2015, Report on the Hydrologic Characteristics of Mark West Creek, CEMAR. (updated January 28, 2015)

Plates



REFERENCE:
Calistoga Quadrangle
7.5-Minute Series, USGS, 2018

Latitude: 38.533418
Longitude: -122.592433

NORTH

APPROXIMATE SCALE (FEET)
0 1000 2000 4000

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Brunsing Associates, Inc.
5468 Skylane Blvd., Suite 201
Santa Rosa, California 95403
Tel: (707) 528-6108

Job No.: 12685.01
Appr.: KAC
Date: 05/18/20

VICINITY MAP
7955 St. Helena Road
Santa Rosa, California

PLATE
1

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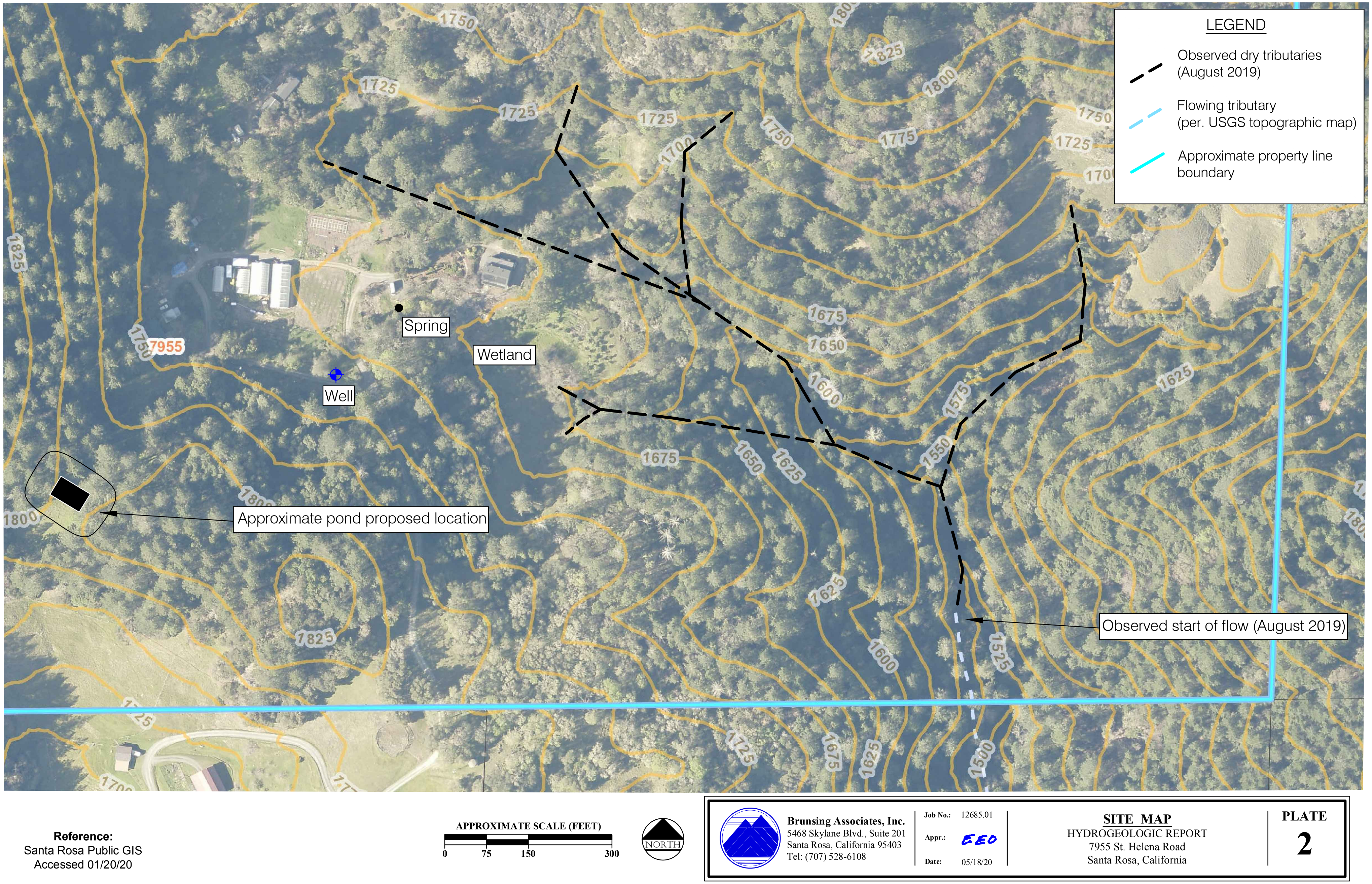

Reference:
Santa Rosa Public GIS
Accessed 01/20/20

Brunsing Associates, Inc.
5468 Skylane Blvd., Suite 201
Santa Rosa, California 95403
Tel: (707) 528-6108

Job No.:	12685.01
Appr.:	EEO
Date:	05/18/20

SITE MAP
HYDROGEOLOGIC REPORT
7955 St. Helena Road
Santa Rosa, California

PLATE
2

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Appendix A
PRMD Correspondence

permit SONOMA

County of Sonoma
Permit & Resource Management Department

RESPONSE and DRAFT NR GEOLOGIST CONDITIONS - USE PERMIT

DATE:	17 April 2019
TO:	Permit and Resource Management Department, Project Review Section ATTN: Richard Larrouy
FROM:	Robert Pennington, P.G., Natural Resources Geologist
PROJECT TYPE:	Cannabis Use Permit

SUBJECT	File Number:	UPC17-0089
	Applicant Name:	David Bowers
	Site Address:	7955 St Helena Road, Santa Rosa
	APN:	028-260-029

Project Description:

Request for use permit for cannabis operation to include 32,051 sf of outdoor, 4,520 sf of mixed light and 636 sf of indoor on an 80 acre parcel zoned RRD.

Comment:

The proposed project is located within a Class 4 Groundwater area. According to PRMD Policy 8-1-14, discretionary projects within Class 4 groundwater scarce areas are subject to requirements of General Plan Policy WR-2e. General Plan Policy WR-2e calls for a hydrogeologic study that details potential impacts to groundwater resources from the project.

A hydrogeologic report prepared by Brunsing Associates Inc., dated May 23, 2018, was prepared in accordance with Permit Sonoma Policy and Procedure #8-1-14. Permit Sonoma reviewed the Report and found that there was not sufficient information to demonstrate groundwater extraction would not negatively impact interconnected surface waters. A letter dated October 11, 2018 requested additional information including a well yield test and analysis of potential impacts to interconnected surface waters. Of particular concern is not fully or adequately addressing the project specific and cumulative impacts to the onsite spring, wetland, and stream flows in Mark West Creek and tributaries thereof.

In response, the applicant provided a revised hydrogeologic report dated March 20, 2019 (Report). The Report included presentation of results from an 8 hour well yield test conducted on February 2, 2019. Key aspects of the Report are summarized below.

Water Use

The Report provided cannabis irrigation water use estimate (based off site specific data) for the operation of 6.5 acre feet (2,120,000 gallons) per year. Water use for the months of April through November is estimated to be roughly 75% of the estimated annual use.

Estimated water use is higher than most other cannabis applications and above the default water use rate for outdoor cannabis cultivation assumed by Permit Sonoma of 2 acre feet per acre per year. It is expected that the operation should be able to reduce water consumption substantially through modification of irrigation practices and other water conservation measures.

Other onsite water uses include domestic uses of two existing residences and landscape irrigation. Average annual water use for rural residences is estimated by Permit Sonoma to 0.5 acre feet. Thus existing onsite water use is estimated to be 1.0 acre feet per year.

Well Yield Test

A well pump test was conducted of February 2, 2019. The static water level was recorded at 17 feet below the ground surface. After pumping the well at a constant rate of 20 gallons per minute for 8 hours the drawdown level in the well was recorded at 70 feet below the ground surface. Results from the pump test are generally consistent with a pump test conducted in 1994 on the project well. These results indicate the project well has suitable capacity to support the project and that groundwater conditions have been stable over the last 25 years.

Influence of Groundwater Pumping on Surface Water

The Report discussed qualitatively that it is unlikely that pumping the project well would directly influence streamflow in Mark West Creek. This is supported by a mapped outcrop of low permeability Franciscan Formation basement rock between the project well and Mark West Creek. This finding is considered reasonable; however, potential impacts to the onsite spring and wetland that form the headwaters to a tributary channel that flows to Mark West Creek have not been adequately addressed.

The Report concluded that pumping of groundwater is not expected to impact the onsite spring. Spring flow was measured before and after the 8 hour well pump test conducted on February 2, 2019. Recorded springs yield of 0.45 and 0.44 gallons per minute were measured. The Report stated that there was no observed impacts to spring flow as a result of groundwater pumping through the 2018 growing season; however, the Report did not provide any supporting observations.

A quantitative analysis of potential impacts of groundwater pumping on the onsite spring and wetland was requested in the October 11, 2018 letter from Permit Sonoma. The Report did not provide a quantitative analysis. The Report did not analyze if an 8 hour pump test would have been expected to impact the spring given the spatial and hydraulic characteristics of the aquifer. It is unclear if an 8 hour pump test was a sufficient test length to assess the potential hydraulic connection between the project well and the spring. The Report also did not quantitatively assess the impacts of groundwater pumping over the length of the growing season.

Recommendations

The Report was reviewed and is found to not adequately consider potential impacts of groundwater pumping on the onsite spring and wetland. Given these potential impacts, conditions of approval that limit use of groundwater to a defined date range, and subject to restrictions based on observed flow in Mark West Creek are recommended to address direct and cumulative impacts on surface waters.

Streamflow data from the USGS streamflow gauging station USGS 11466800 Mark West NR Mirabel Heights CA (Mark West Gauge) indicate that in most years average monthly streamflow in Mark West Creek drops near or below the Aquatic Base Flow in June of each year. Aquatic Base Flow was defined through the State Water Resources Control board's Cannabis Cultivation Policy using a methodology that specifies with the base stream flow required to maintain aquatic ecosystem health. For Mark West Gauge the Aquatic Base Flow is specified as 7.2 cubic feet per second.

Given the potential to influence the onsite spring, wetland and tributary flows toward Mark West Creek, off-stream water storage with a sufficient capacity to meet irrigation demand for July through October is advised. Storage may be filled with groundwater in the months of January, February, and March, (IF) flow at the Mark West Gauge is at or above 14.4 cubic feet per second, twice that of the Aquatic Base Flow. Water storage could also be filled in accordance with standards defined through an active Small Irrigation Use Registration or other water right with the California Division of Water Rights.

Draft Conditions of Approval

Draft conditions of approval are provided below. These conditions are recommended for projects in sensitive habitat watersheds determined to have high potential to impact streamflow during summer baseflow conditions.

PRIOR TO OPERATION AND VESTING THE USE PERMIT:

1. An Easement is required to be recorded for this project to provide Sonoma County personnel access to any on-site water well or other water source serving this project and any required monitoring well or water meter to collect groundwater level measurements and water meter readings. Access shall be granted Monday through Friday from 8:00 a.m. to 5:00 p.m. All Easement language is subject to review and approval by Permit Sonoma Project Review staff and County Counsel prior to recordation.

1. Water well(s) serving this project shall be fitted with a groundwater level measuring tube and port, or electronic groundwater level measuring device.

2. Totalizing water meter(s) to measure all groundwater extracted for the parcel and the use shall be installed.

3. Totalizing water meter(s) to measure all surface water diverted for the use shall be installed.

4. A Site Plan showing the location of the project well(s) with the groundwater level measuring device(s), water storage ponds, tanks, and reservoirs, and the location of all water meter(s) shall be submitted to PRMD. The monitoring well(s) shall be marked with a measuring reference point. The well's Global Positioning System (GPS) coordinates (in NAD83 California State Plane II or WGS 84lat./long.) shall be noted. The height of the water level measuring reference point above the ground surface shall be specified. Attached to the Site Plan should be the monitoring well(s) well completion reports (with owner information redacted, as is publicly available through California DWR).

5. A Water Conservation Plan prepared by a qualified professional that estimates monthly and annual water use, subject to review and approval by the Director. The water conservation plan should consider practical methods to conserve groundwater pumping in the months of April through October.

6. Off stream water storage for cannabis irrigation with a minimum storage capacity sufficient to provide cannabis irrigation for the months of July through October as

specified in the most recent approved Water Conservation Plan or 100,000 gallons per 10,000 square feet of cannabis cultivation area, whichever is greater, shall be designed and installed, subject to approval by the Director.

OPERATIONAL REQUIREMENTS:

7. Monitoring and Meter Calibration
    a. Groundwater levels and quantities of groundwater extracted for the use shall be measured monthly on the last day of each month. Data shall be reported to PRMD in January of the following year pursuant to Section WR-2d of the Sonoma County General Plan and County policies. Data should be provided on template monitoring forms provided by PRMD.
    b. The flow rate from the onsite spring shall be measured monthly on the last day of each month. Data shall be reported to PRMD in January of the following year.
    c. Water meters shall be calibrated, and copies of receipts and correction factors shall be submitted to PRMD Project Review staff at least once every five years.

8. Any associated water right or small irrigation use registration with the State Water Resources Control Board shall be provided to PRMD.

9. All Statements of Diversion and Use submitted to the State Water Resources Control Board shall be provided to PRMD by January 31 of the following year.

10. Groundwater extraction for cannabis irrigation, is limited as follows:
    a. Groundwater shall not be extracted for the purposes of cannabis irrigation in the months of July, August, September and October;
       And
    b. Groundwater shall not be extracted when streamflow at the compliance gage for Mark West Creek (USGS 11466800 Mark West NR Mirabel Heights CA) is at or below 14.4 cubic feet per second, equivalent to double the Aquatic Base Flow of 7.2 cubic feet per second as specified by the State Water Resources Control Board's October 2017 Cannabis Cultivation Policy. An alternative compliance gauge and associated Aquatic Base Flow may be used if the alternative gauge site is more representative of streamflow in Mark West Creek near the project site with supporting documentation and approval by the Director.
       And
    c. Groundwater shall not be extracted for the purpose of filling off-stream storage in all months except January, February, and March, and only if conditions above are met.

And

d. Total well water extraction for the use shall not exceed 2.0 acre feet per year and 0.1 acre feet between July and October of each year. In the event that groundwater use exceeds 2.0 acre feet per year the applicant shall update and implement a Water Conservation Plan to reduce water use, subject to review and approval by Permit Sonoma. In the event that groundwater use exceeds 2.0 acre feet per year by more than 10% or 0.1 acre feet between July and October Permit Sonoma shall bring this matter back to the BZA for review.

Please feel free to contact Robert Pennington, Project Geologist, at (707) 565-1352 or Robert.Pennington@sonoma-county.org, should you have any questions on the above information.

RE: 7955 St. Helena Road Pond

Robert Pennington <Robert.Pennington@sonoma-county.org>

Thu 1/16/2020 11:51 AM

To: Zach Mason <zmason@brunsing.com>

I believe yes, but would want to see an analysis that groundwater pumping in winter is unlikely to impact spring flow or groundwater discharge to the wetland/tributary during the summer. You should be able to use the USGS StreamDep Model for this purpose.

From: Zach Mason <zmason@brunsing.com>
Sent: Thursday, January 16, 2020 11:43 AM
To: Robert Pennington <Robert.Pennington@sonoma-county.org>
Subject: Re: 7955 St. Helena Road Pond

EXTERNAL

Hey Robert - Quick question. David Bowers has asked:

"From what Robert said, we can fill the pond with water during December and January from the well and not in the dry season. Is this correct?"

I vaguely recall you saying this as well but I just wanted to make sure.

Best,
Zach

***Zachary E. Mason*, G.I.T.**
Staff Geologist
(707) 838-3027 (x225)
www.brunsing.com

5468 Skylane Blvd., Suite 201
Santa Rosa, CA 95403
email policy

From: Robert Pennington <Robert.Pennington@sonoma-county.org>
Sent: Tuesday, October 1, 2019 10:42 AM
To: Zach Mason <zmason@brunsing.com>
Subject: RE: 7955 St. Helena Road Pond

Hi Zach,

Appendix B
Adobe Associates, Inc. Preliminary Pond Documents

"A Service You Can Count On!"

March 10, 2020
JN 20030

David Bowers
2590 Telegraph Avenue
Berkeley, CA 94704

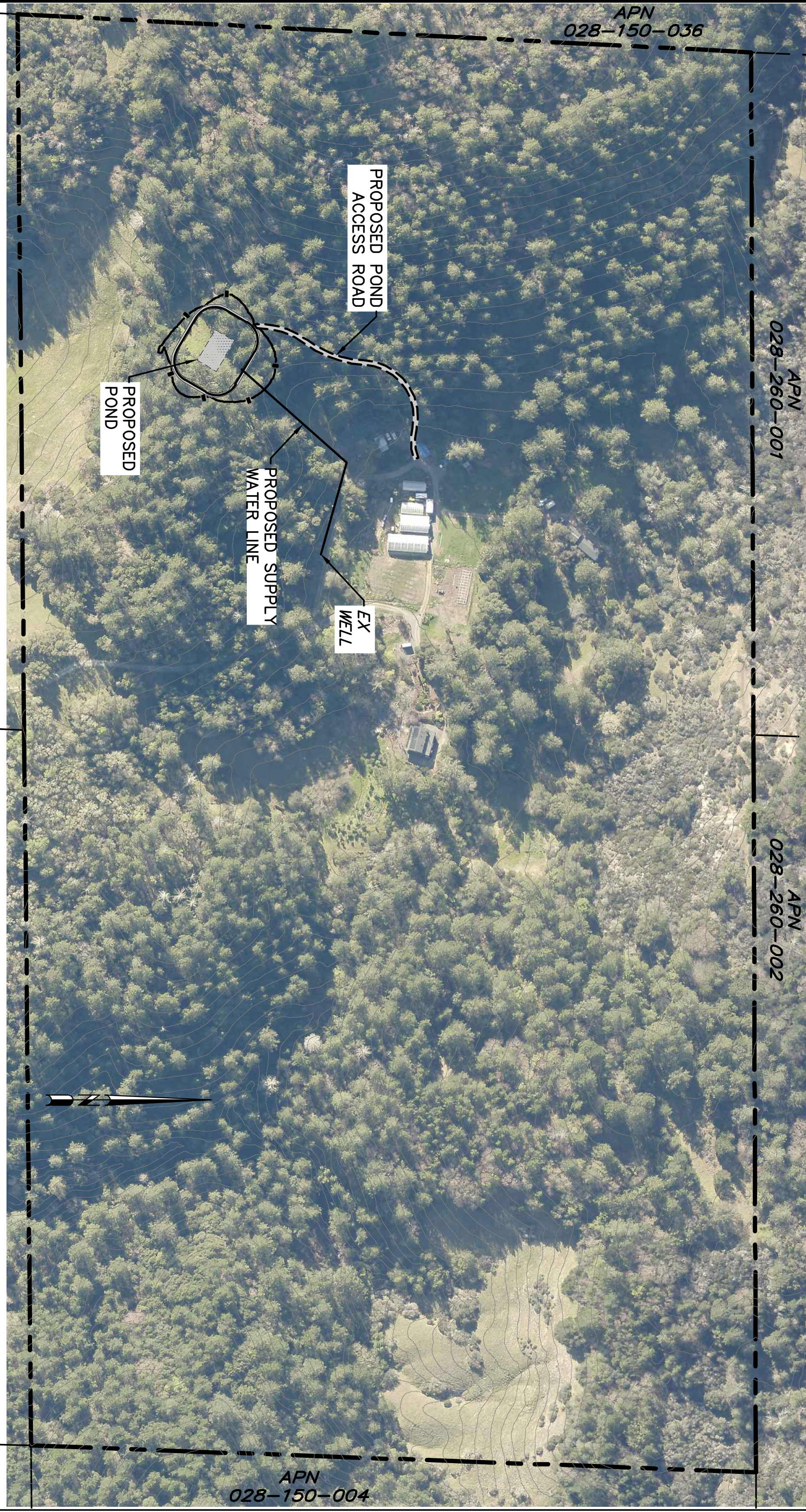
Re: Sonoma County UPC17-0089
Response to Letter Date 17 April 2019

Dear David,

My understanding is you have applied for a Cannabis Grow Use Permit and that storage of irrigation water will be necessary. The necessary irrigation demand for your grow is anticipated to be approximately 2.0 acre-ft annually based upon other cannabis use permits we are working on and consensus amongst cannabis growers. I also understand that storage may be filled with groundwater in the months of January, February and March as long as the Mark West Gauge reads 14.4 cubic feet per second or higher. Attached please find a preliminary pond design that provides 2.55 acre-ft (830,220 Gal) of storage. This pond will receive some surface runoff and would anticipate approximately 441,475 gallons of surface water runoff during a normal year and approximately 379,327 gallons in a drought year to replenish the Pond. This would leave approximately 470,708 gallons (normal year) or 513,853 (drought year) respectively to be pumped from groundwater during the winter months. I trust this letter will be of assistance as you move your Use Permit application along. Please call with any questions you may have.

Sincerely,

David R. Brown, RCE 41833
My license expires 3/31/2022



APN 028-260-034

APN 028-260-039

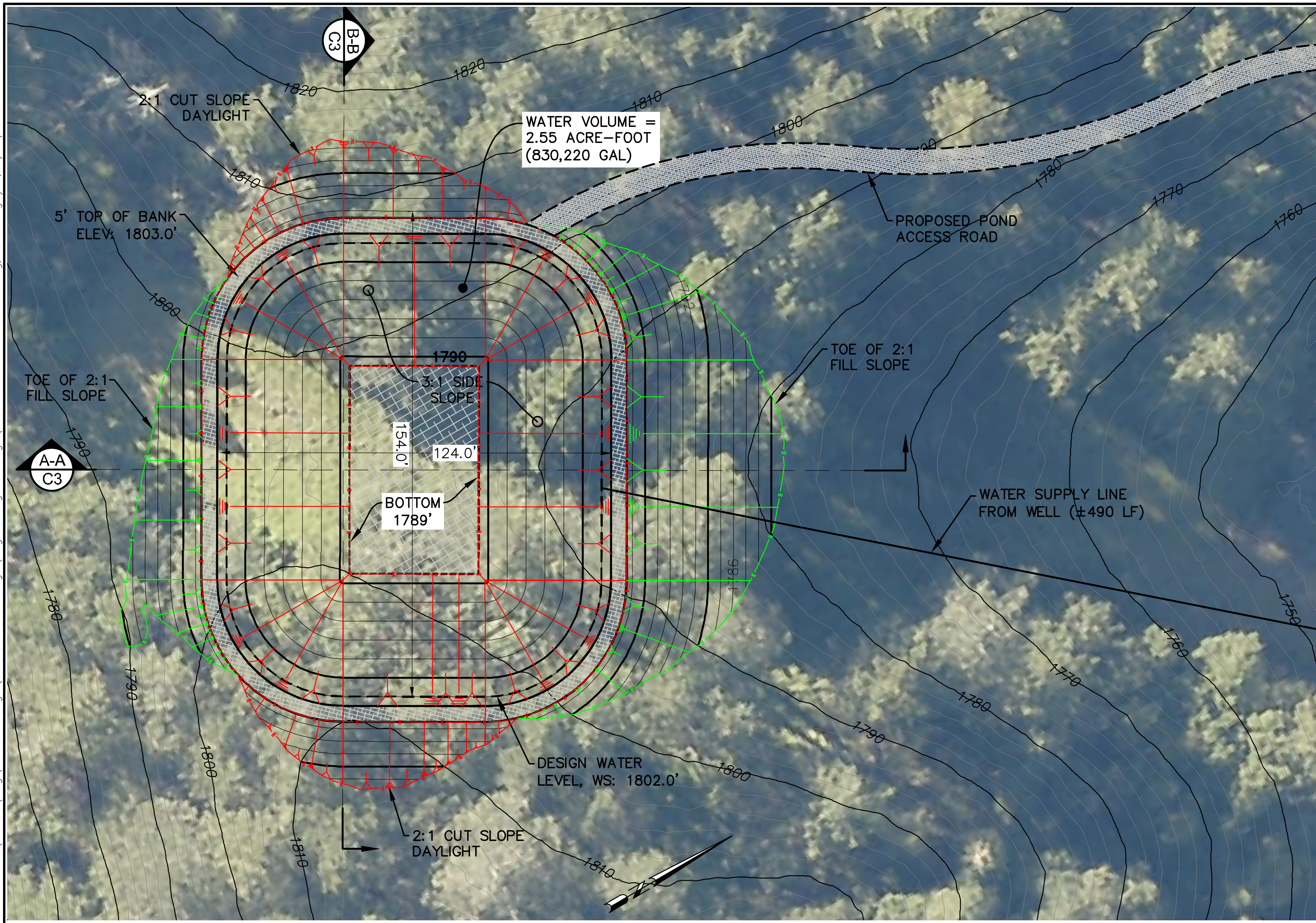
OVERALL SITE PLAN

200' 100' 0 100' 200' 400' 600'

Graphic Scale: 1" = 200'

DATE: 03/16/2020	LANDS OF BOWERS IRRIGATION POND OVERALL SITE PLAN		
C1 1 of 3 Sheets Job 20030	7955 St. Helena Road Santa Rosa, California APN 028-260-029	REGISTERED PROFESSIONAL ENGINEER DAVID R. BROWN No. 41833 Exp.3/31/2022 CIVIL STATE OF CALIFORNIA David R. Brown, RCE 41833 My license expires 3/31/2022	adobe associates, inc. civil engineering I land surveying I wastewater 1220 N. Dutton Ave., Santa Rosa, CA 95401 P. (707) 541-2300 F. (707) 541-2301 Website: www.adobeinc.com "A Service You Can Count On!"

NOT FOR CONSTRUCTION



STORAGE VOLUME : 2.55 ACRE-FOOT
GRADING QUANTITY: 3,050 CY (CUT=FILL)

PRELIMINARY GRADING PLAN

SCALE: 1" = 30'

adobe associates, inc.
civil engineering | land surveying | wastewater
1220 N. Dutton Ave., Santa Rosa, CA 95401
P. (707) 541-2300 F. (707) 541-2301
Website: www.adobeinc.com
"A Service You Can Count On!"

REGISTERED PROFESSIONAL ENGINEER ★ STATE OF CALIFORNIA ★ DAVID R. BROWN No. 41833 Exp.3/31/2022 CIVIL

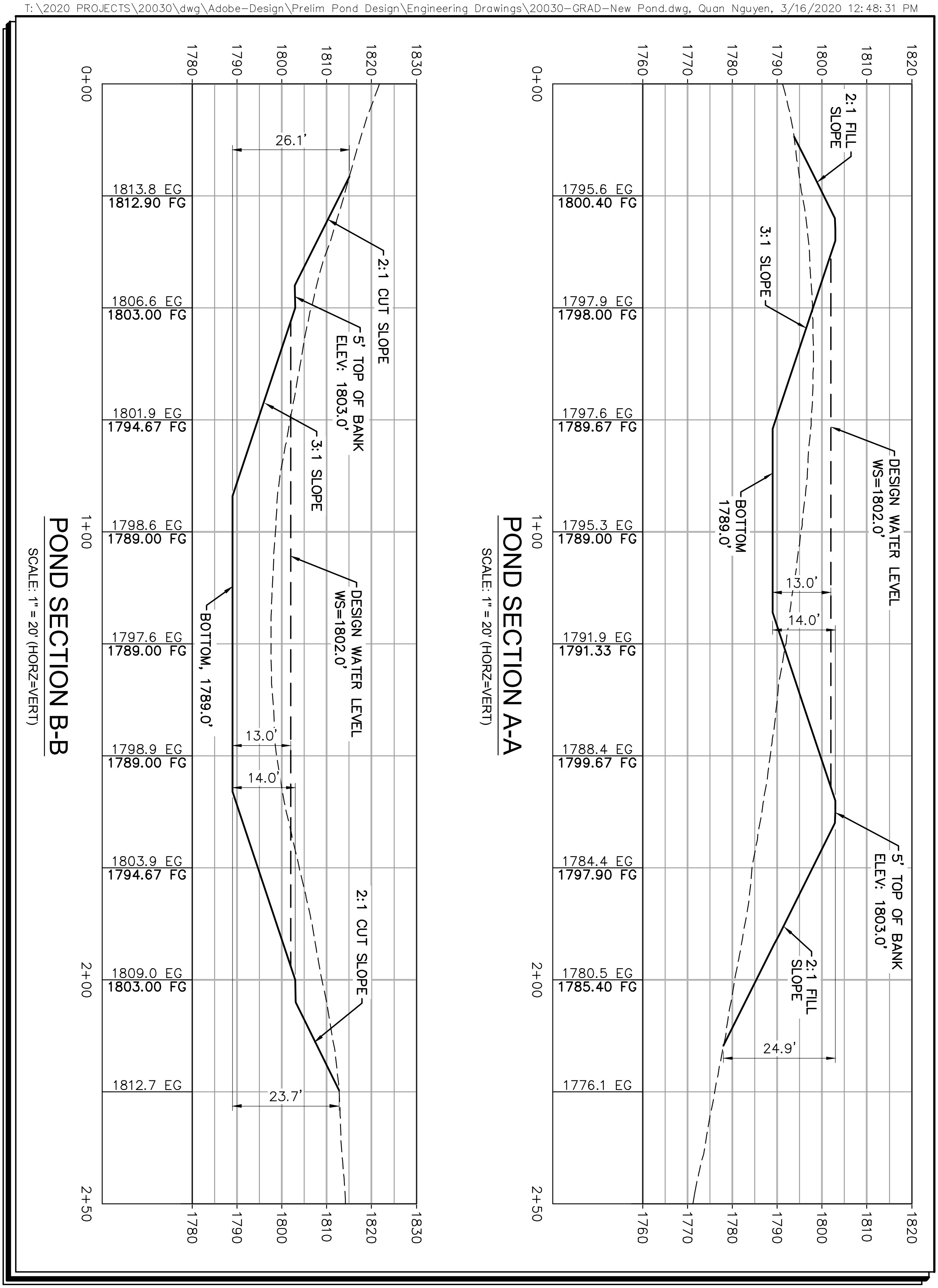
David R. Brown, RCE 41833
My license expires 3/31/2022

LANDS OF BOWERS
IRRIGATION POND
PRELIM GRADING PLAN
7955 St. Helena Road
Santa Rosa, California
APN 028-260-029

DATE: 03/16/2020

C2
2 of 3 Sheets
Job 20030

NOT FOR CONSTRUCTION



Job 20030
3 of 3 Sheets
C3
DATE: 03/16/2020

LANDS OF BOWERS
IRRIGATION POND
POND SECTIONS
7955 St. Helena Road
Santa Rosa, California
APN 028-260-029

REGISTERED PROFESSIONAL ENGINEER
DAVID R. BROWN
No. 41833
Exp.3/31/2022
CIVIL
STATE OF CALIFORNIA

David R. Brown, RCE 41833
My license expires 3/31/2022

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1220 N. Dutton Ave., Santa Rosa, CA 95401
P. (707) 541-2300 F. (707) 541-2301
Website: www.adobeinc.com
"A Service You Can Count On!"

NOT FOR CONSTRUCTION

Irrigation Pond Water Balance Evaluation

For

Lands of Bowers

7955 St. Helena Road, Santa Rosa, CA
APN 028-260-029

JN 20030
April 28, 2020

Prepared for: David Bowers
2590 Telegraph Avenue
Berkeley, CA 94704
(510) 540-7878
David@patientscarecollective.com

David R. Brown, RCE 41833
My license expires 3/31/2022

REGISTERED PROFESSIONAL ENGINEER
DAVID R. BROWN
No. 41833
Exp.3/31/2022
CIVIL
STATE OF CALIFORNIA

Prepared by:

adobe associates, inc.
civil engineering | land surveying | wastewater
1220 N. Dutton Ave., Santa Rosa, CA 95401
P. (707) 541-2300 F. (707) 541-2301
Website: www.adobeinc.com

Prepared By:____________
Checked By:____________

Table of Contents

Appendices

Lands of Bowers – Irrigation Pond

Pond Water Balance Evaluation

A. Pond and Weather Input Data

Table 1 – Depth - Surface – Volume relationship

Water Depth (ft)	Pond water surface (Sq. Ft)	Storage Volume (Gallon)
0	2,706	0
1	3,383	22,624
2	4,120	50,702
3	4,914	84,436
4	5,764	124,432
5	6,670	170,892
6	7,634	224,422
7	8,654	285,224
8	9,730	354,106
9	10,863	431,068
10	12,053	516,716
11	13,299	611,454
12	14,601	715,888
13	**15,960**	**830,220**

Table 2 shows monthly precipitation values (average, 1981-2010, see Appendix A) and monthly precipitation volumes corresponding to the pond watershed including the pond area (A1=17,300 SqFt, C=1.0) and surrounding slopes that drain to the pond (A2=9,200 SqFt, C=0.50).

In a drought year as of 2017-2018, the total rainfall in Santa Rosa was 29.80 inches or 92% of the average precipitation. Thus, a factor of 0.90 is used for drought year precipitation in Table 2.

Average evaporation values in Table 3 are per California Irrigation Management Information System (CIMIS 2012, see Appendix B). Lake Evaporation Coefficient is assumed 0.77.

Table 2 – Precipitation Normal vs Drought Years

Month	Normal Year		Drought Year (90%)	
	Mean Precipitation (in)	Monthly Precipitation (Gal)	Mean Precipitation (in)	Monthly Precipitation (Gal)
January	5.97	81,750	5.37	73,575
February	6.02	82,434	5.42	74,191
March	4.53	62,031	4.08	55,828
April	1.82	24,922	1.64	22,430
May	1.28	17,528	1.15	15,775
June	0.23	3,149	0.21	2,835
July	0.01	137	0.01	123
August	0.07	959	0.06	863
September	0.35	4,793	0.32	4,313
October	1.73	23,690	1.56	21.321
November	4.04	55,321	3.64	49,789
December	6.19	84,762	5.57	76,286
Total	32.24	441,475	29.02	379,327

Table 3 Evaporation (Lake Evaporation Coefficient = 0.77)

Month	Mean Evaporation rate (in)	Mean Lake Evaporation rate (in)
January	0.93	0.72
February	1.68	1.29
March	2.79	2.15
April	4.20	3.23
May	5.58	4.30
June	6.30	4.85
July	6.51	5.01
August	5.89	4.54
September	4.50	3.47
October	3.10	2.39
November	1.50	1.16
December	0.93	0.73
Total	**43.91**	**33.81**

B. Proposed Irrigation Water Use

Table 4 – Proposed Irrigation Water Use

Month	Irrigation Use (Gallon)
January	12,400
February	11,200
March	12,400
April	12,000
May	12,000
June	84,000
July	86,800
August	120,900
September	117,000
October	120,500
November	45,600
December	12,400
Total	647,200

C. Pond Water Balance Evaluation

Pond Net Volume = (Precipitation) + (Well Supply) – (Evaporation) – (Irrigation Use)

Volume End of the Month = Volume Begin of the Month + Pond Net Volume

Whereas,

- "Well Supply" is limited to 3 months from December to February.
- Evaporation volumes have been calculated with water surface of pond corresponding to the average depth of pond water within the month.

Conclusions

- For normal years the pond will need to be filled with **467,210 gallons** well water within three months January to March. Minimum reserve pond water would be **132,623 gallons** (end of October).

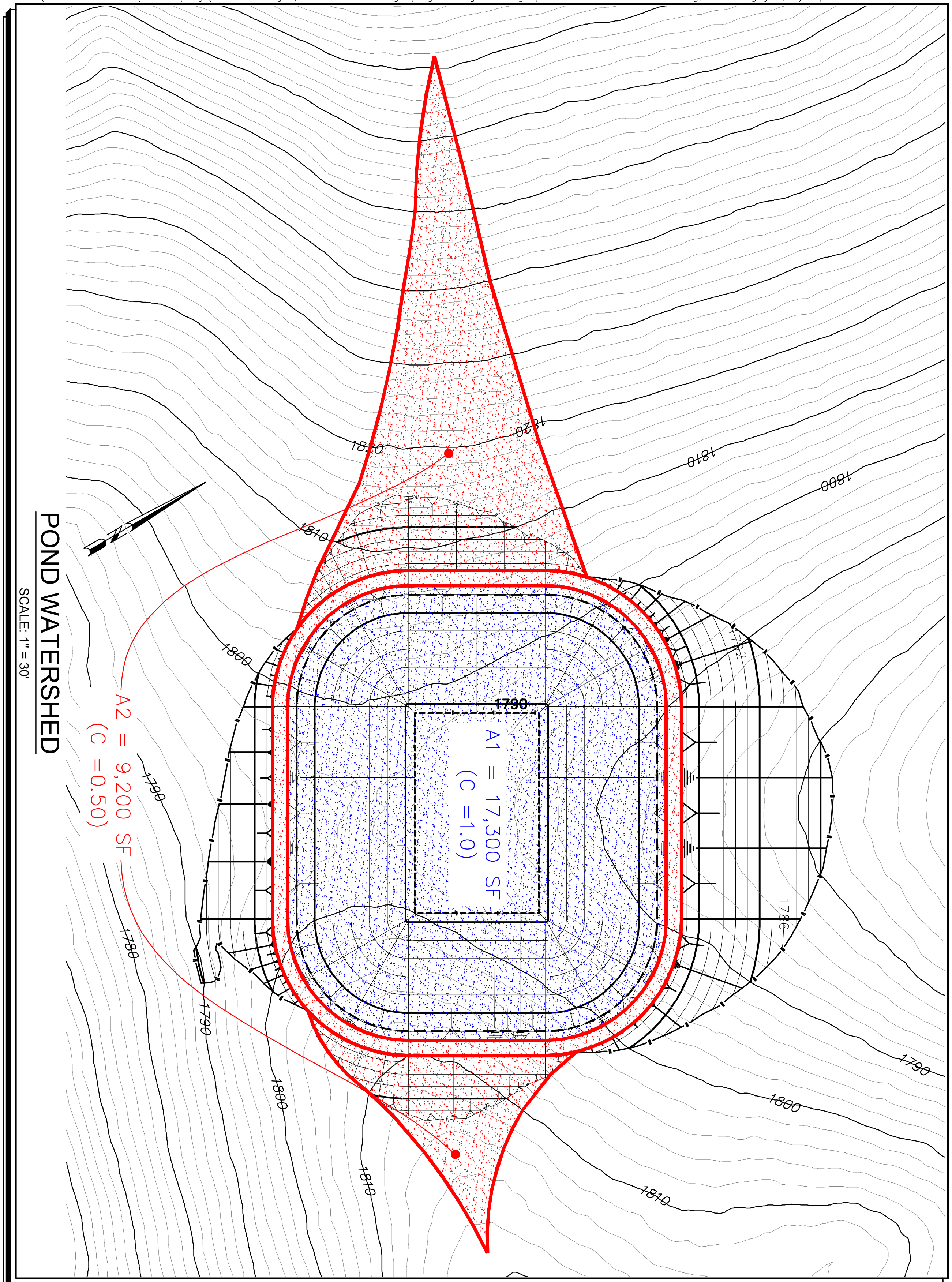
- For drought years the pond will need to be filled with **508,894 gallons** well water within three months December to February. Minimum reserve pond water would be **126,311 gallons** (end of October).

Table 5 – Pond monthly water balance - Normal Years

Month	Precip. Volume (Gal)	Evap. Volume (Gal)	Irrigation Use (Gal)	Well Supply (Gal)	Net Volume (Gal)	Volume Beginning of the month (Gal)	Volume End of the month (Gal)	Average Pond Water Depth (ft)
January	81,750	5,101	12,400	160,000	+225,201	206,840	432,041	7.6
February	82,434	11,540	11,200	160,000	+221,215	432,041	653,258	10.3
March	62,031	21,135	12,400	147,210	+176,928	653,258	**830,186**	12.2
April	24,922	32,178	12,000	-	-18,977	**830,186**	811,209	**12.9**
May	14,528	41,533	12,000	-	-36,483	811,209	774,726	12.8
June	3,149	44,157	84,000	-	-125,007	774,726	649,719	12.0
July	137	40,371	86,800	-	-127,034	649,719	522,684	10.7
August	959	31,374	120,900	-	-151,316	522,684	371,869	9.2
September	4,793	19,379	117,000	--	-131,586	371,869	239,782	7.3
October	23,690	10,349	120,500	-	-107,159	239,782	**132,623**	5.3
November	55,321	4,278	45,600	-	+5,443	**132,623**	138,066	**4.2**
December	84,762	3,587	12,400	-	+68,774	138,066	206,841	6.4
Total	**441,475**	**264,983**	**647,200**	**467,210**	-			

Table 6 – Pond monthly water balance - Drought Years

Month	Precip. Volume (Gal)	Evap. Volume (Gal)	Irrigation Use (Gal)	Well Supply (Gal)	Net Volume (Gal)	Volume Beginning of the month (Gal)	Volume End of the month (Gal)	Average Pond Water Depth (ft)
January	73,575	5,139	12,400	170,000	+227,217	187,380	414,597	7.2
February	71,191	11,615	11,200	170,000	+223,173	414,597	637,770	10.1
March	55,828	21,209	12,400	168,894	+192,409	637,770	**830,178**	12.2
April	22,430	31,927	12,000	-	-21,497	**830,178**	808,681	**12.9**
May	15,775	41,423	12,000	-	-37,868	808,681	770,813	12.7
June	2,835	43,835	84,000	-	-124,921	770,813	645,892	11.9
July	123	40,332	86,800	-	-127,048	645,892	518,844	10.7
August	863	31,176	120,900	-	-151,071	518,844	367,763	9.1
September	4,313	19,379	117,000	--	-132,065	367,763	235,698	7.3
October	21,321	10,208	120,500	-	-109,387	235,698	**126,311**	5.2
November	49,789	4,151	45,600	-	+38	**126,311**	126,349	**4.0**
December	76,286	3,587	12,400	-	+61,032	126,349	187,380	4.7
Total	**397,327**	**263,980**	**647,200**	**508,894**	-			



Job 20030

H1

DATE: 03/10/2020

LANDS OF BOWERS IRRIGATION POND

POND WATERSHED

7955 St. Helena Road
Santa Rosa, California
APN 028-260-029

REGISTERED PROFESSIONAL ENGINEER
DAVID R. BROWN
No. 41833
Exp.3/31/2022
CIVIL
STATE OF CALIFORNIA

David R. Brown, RCE 41833
My license expires 3/31/2022

adobe associates, inc.
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APPENDIX A

“SUMMARY OF MONTHLY NORMALS 1981-2010, SANTA ROSA STATION”, NOAA

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Summary of Monthly Normals
1981-2010
Generated on 03/09/2020

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 174 ft. Lat: 38.4380° N Lon: -122.6977° W
Station: **SANTA ROSA, CA US USC00047965**

Precipitation (in.)								
	Totals	Mean Number of Days				Precipitation Probabilities Probability that precipitation will be equal to or less than the indicated amount		
	Means	Daily Precipitation				Monthly Precipitation vs. Probability Levels		
Month	**Mean**	**>= 0.01**	**>= 0.10**	**>= 0.50**	**>= 1.00**	**0.25**	**0.50**	**0.75**
01	5.93	13.8	9.1	4.0	1.8	3.39	5.32	8.73
02	6.02	12.0	8.6	4.3	1.9	2.61	4.76	9.24
03	4.53	11.5	7.7	3.6	1.1	2.06	3.51	5.76
04	1.82	7.4	4.3	1.2	0.3	0.64	1.47	2.65
05	1.28	4.4	2.6	0.9	0.3	0.11	0.78	1.74
06	0.23	1.4	0.6	0.1	0.0	0.00	0.04	0.42
07	0.01	0.3	-7777	0.0	0.0	0.00	0.00	0.01
08	0.07	0.4	0.1	-7777	-7777	0.00	0.00	0.01
09	0.35	1.8	0.9	0.2	0.1	0.00	0.08	0.24
10	1.73	4.7	2.6	1.2	0.7	0.76	1.22	3.06
11	4.04	10.3	6.0	3.2	1.2	1.66	3.43	5.89
12	6.19	12.9	8.7	4.0	2.0	2.91	4.01	10.46
Summary	32.20	80.9	51.2	22.7	9.4	14.14	24.62	48.21

-7777: a non-zero value that would round to zero

Empty or blank cells indicate data is missing or insufficient occurrences to compute value

APPENDIX B

"REFERENCE EVAPORTRANSPIRATION ZONES" CIMIS, JANUARY 2012

CIMIS

REFERENCE EVAPOTRANSPIRATION ZONES

CALIFORNIA IRRIGATION MANAGEMENT INFORMATION SYSTEM

The color map inside shows the reference evapotranspiration zones in California. It may be used to help in urban and agricultural water management planning and water budgeting, as well as designing irrigation systems, planning irrigation schedules, and designing open water evaporation systems.

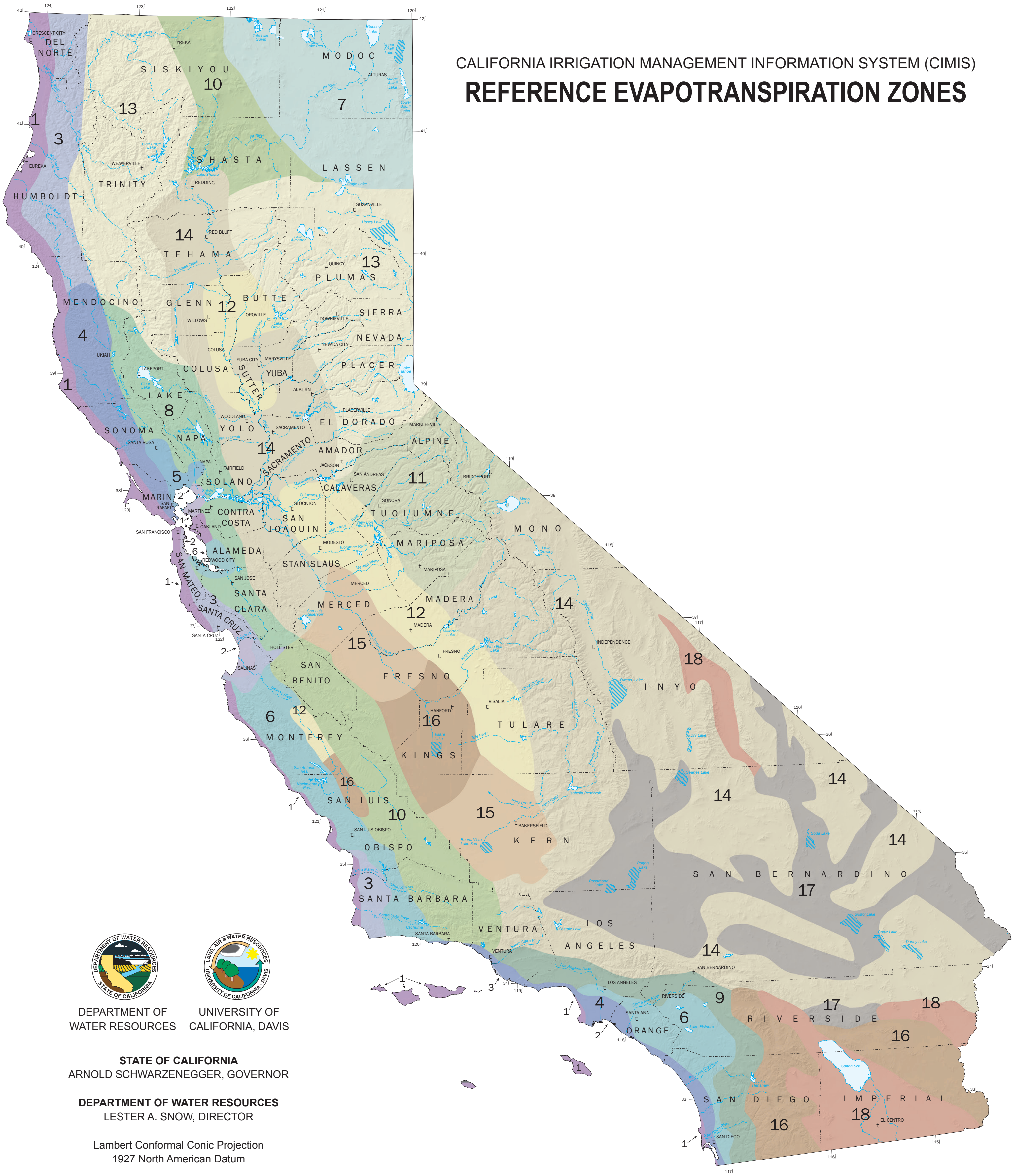
The map was developed as a cooperative project between the Department of Land, Air and Water Resources, University of California, Davis and the Office of Water Use Efficiency, California Department of Water Resources; Baryohay Davidoff.

The map was prepared by David W. Jones, 1999. The data was developed by Richard L. Snyder, Simon Eching, and Helena Gomez-MacPherson. The background data came from Teale and USGS sources.

CALIFORNIA DEPARTMENT OF WATER RESOURCES
JANUARY 2012

CALIFORNIA IRRIGATION MANAGEMENT INFORMATION SYSTEM (CIMIS)

REFERENCE EVAPOTRANSPIRATION ZONES



DEPARTMENT OF WATER RESOURCES

UNIVERSITY OF CALIFORNIA, DAVIS

STATE OF CALIFORNIA
ARNOLD SCHWARZENEGGER, GOVERNOR

DEPARTMENT OF WATER RESOURCES
LESTER A. SNOW, DIRECTOR

Lambert Conformal Conic Projection
1927 North American Datum

Reference EvapoTranspiration (ETo) Zones

1 **COASTAL PLAINS HEAVY FOG BELT** lowest ETo in California, characterized by dense fog

2 **COASTAL MIXED FOG AREA** less fog and higher ETo than zone 1

3 **COASTAL VALLEYS & PLAINS & NORTH COAST MOUNTAINS** more sunlight than zone 2

4 **SOUTH COAST INLAND PLAINS & MOUNTAINS NORTH OF SAN FRANCISCO** more sunlight and higher summer ETo than zone 3

5 **NORTHERN INLAND VALLEYS** valleys north of San Franciaco

6 **UPLAND CENTRAL COAST & LOS ANGELES BASIN** higher elevation coastal areas

7 **NORTHEASTERN PLAINS**

8 **INLAND SAN FRANCISCO BAY AREA** inland area near San Francisco with some marine influence

9 **SOUTH COAST MARINE TO DESERT TRANSITION** inland area between marine & desert climates

10 **NORTH CENTRAL PLATEAU & CENTRAL COAST RANGE** cool, high elevation areas with strong summer sunlight; zone has limited climate data & the zones selection is somewhat subjective

11 **CENTRAL SIERRA NEVADA** mountain valleys east of Sacramento with some influence from delta breeze in summer

12 **EAST SIDE SACRAMENTO-SAN JOAQUIN VALLEY** low winter & high summer ETo with slightly lower ETo than zone 14

13 **NORTHERN SIERRA NEVADA** northern Sierra Nevada mountain valleys with less marine influence than zone 11

14 **MID-CENTRAL VALLEY, SOUTHERN SIERRA NEVADA, TEHACHAPI & HIGH DESERT MOUNTAINS** high summer sunshine and wind in some locations

15 **NORTHERN & SOUTHERN SAN JOAQUIN VALLEY** slightly lower winter ETo due to fog and slightly higher summer ETo than zones 12 & 14

16 **WESTSIDE SAN JOAQUIN VALLEY & MOUNTAINS EAST & WEST OF IMPERIAL VALLEY**

17 **HIGH DESERT VALLEYS** valleys in the high desert near Nevada and Arizona

18 **IMPERIAL VALLEY, DEATH VALLEY & PALO VERDE** low desert areas with high sunlight & considerable heat advection

Monthly Average Reference Evapotranspiration by ETo Zone (inches/month)

Zone	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	0.93	1.40	2.48	3.30	4.03	4.50	4.65	4.03	3.30	2.48	1.20	0.62	32.9
2	1.24	1.68	3.10	3.90	4.65	5.10	4.96	4.65	3.90	2.79	1.80	1.24	39.0
3	1.86	2.24	3.72	4.80	5.27	5.70	5.58	5.27	4.20	3.41	2.40	1.86	46.3
4	1.86	2.24	3.41	4.50	5.27	5.70	5.89	5.58	4.50	3.41	2.40	1.86	46.6
5	0.93	1.68	2.79	4.20	5.58	6.30	6.51	5.89	4.50	3.10	1.50	0.93	43.9
6	1.86	2.24	3.41	4.80	5.58	6.30	6.51	6.20	4.80	3.72	2.40	1.86	49.7
7	0.62	1.40	2.48	3.90	5.27	6.30	7.44	6.51	4.80	2.79	1.20	0.62	43.3
8	1.24	1.68	3.41	4.80	6.20	6.90	7.44	6.51	5.10	3.41	1.80	0.93	49.4
9	2.17	2.80	4.03	5.10	5.89	6.60	7.44	6.82	5.70	4.03	2.70	1.86	55.1
10	0.93	1.68	3.10	4.50	5.89	7.20	8.06	7.13	5.10	3.10	1.50	0.93	49.1
11	1.55	2.24	3.10	4.50	5.89	7.20	8.06	7.44	5.70	3.72	2.10	1.55	53.1
12	1.24	1.96	3.41	5.10	6.82	7.80	8.06	7.13	5.40	3.72	1.80	0.93	53.4
13	1.24	1.96	3.10	4.80	6.51	7.80	8.99	7.75	5.70	3.72	1.80	0.93	54.3
14	1.55	2.24	3.72	5.10	6.82	7.80	8.68	7.75	5.70	4.03	2.10	1.55	57.0
15	1.24	2.24	3.72	5.70	7.44	8.10	8.68	7.75	5.70	4.03	2.10	1.24	57.9
16	1.55	2.52	4.03	5.70	7.75	8.70	9.30	8.37	6.30	4.34	2.40	1.55	62.5
17	1.86	2.80	4.65	6.00	8.06	9.00	9.92	8.68	6.60	4.34	2.70	1.86	66.5
18	2.48	3.36	5.27	6.90	8.68	9.60	9.61	8.68	6.90	4.96	3.00	2.17	71.6

Variability between stations within single zones is as high as 0.02 inches per day for zone 1 and during winter months in zone 13. The average standard deviation of the ETo between estimation sites wihtin a zone for all months is about 0.01 inches per day for the 200 sites used to develop the map.

Appendix C
Tributary Depletion Model Results
(Normal Year)

Day	Stream Depletion (cubic foot per second) 1 cubic foot per second=448.8 gallons per minute
1	0.0000
2	0.0000
3	0.0000
4	0.0000
5	0.0000
6	0.0000
7	0.0000
8	0.0000
9	0.0000
10	0.0000
11	0.0000
12	0.0000
13	0.0000
14	0.0000
15	0.0000
16	0.0000
17	

18	0.0000
19	0.0000
20	0.0000
21	0.0000
22	0.0000
23	0.0000
24	0.0001
25	0.0001
26	0.0001
27	0.0001
28	0.0001
29	0.0001
30	0.0001
31	0.0002
32	0.0002
33	0.0002
34	0.0002
35	0.0002
36	0.0002
37	0.0003

38	0.0003
39	0.0003
40	0.0003
41	0.0003
42	0.0004
43	0.0004
44	0.0004
45	0.0004
46	0.0004
47	0.0005
48	0.0005
49	0.0005
50	0.0005
51	0.0006
52	0.0006
53	0.0006
54	0.0006
55	0.0006
56	0.0007
57	0.0007

	0.0007
58	
	0.0007
59	
	0.0008
60	
	0.0008
61	
	0.0008
62	
	0.0008
63	
	0.0009
64	
	0.0009
65	
	0.0009
66	
	0.0009
67	
	0.0009
68	
	0.0010
69	
	0.0010
70	
	0.0010
71	
	0.0010
72	
	0.0010
73	
	0.0011
74	
	0.0011
75	
	0.0011
76	
	0.0011
77	

	0.0012
78	0.0012
79	0.0012
80	0.0012
81	0.0012
82	0.0013
83	0.0013
84	0.0013
85	0.0013
86	0.0013
87	0.0014
88	0.0014
89	0.0014
90	0.0014

Appendix D
Tributary Depletion Model Results
(Drought Year)

Day	Stream Depletion (cubic foot per second) 1 cubic foot per second=448.8 gallons per minute
1	0.0000
2	0.0000
3	0.0000
4	0.0000
5	0.0000
6	0.0000
7	0.0000
8	0.0000
9	0.0000
10	0.0000
11	0.0000
12	0.0000
13	0.0000
14	0.0000
15	0.0000
16	0.0000
17	

	0.0000
18	
	0.0000
19	
	0.0000
20	
	0.0000
21	
	0.0000
22	
	0.0001
23	
	0.0001
24	
	0.0001
25	
	0.0001
26	
	0.0001
27	
	0.0001
28	
	0.0001
29	
	0.0001
30	
	0.0002
31	
	0.0002
32	
	0.0002
33	
	0.0002
34	
	0.0002
35	
	0.0003
36	
	0.0003
37	

38	0.0003
39	0.0003
40	0.0003
41	0.0004
42	0.0004
43	0.0004
44	0.0004
45	0.0005
46	0.0005
47	0.0005
48	0.0005
49	0.0006
50	0.0006
51	0.0006
52	0.0006
53	0.0007
54	0.0007
55	0.0007
56	0.0007
57	0.0008

	0.0008
58	
	0.0008
59	
	0.0008
60	
	0.0009
61	
	0.0009
62	
	0.0009
63	
	0.0009
64	
	0.0010
65	
	0.0010
66	
	0.0010
67	
	0.0010
68	
	0.0010
69	
	0.0011
70	
	0.0011
71	
	0.0011
72	
	0.0011
73	
	0.0012
74	
	0.0012
75	
	0.0012
76	
	0.0012
77	

	0.0013
78	0.0013
79	0.0013
80	0.0013
81	0.0014
82	0.0014
83	0.0014
84	0.0014
85	0.0014
86	0.0015
87	0.0015
88	0.0015
89	0.0015
90	0.0015

Appendix E
Spring Depletion Model Results
(Normal Year)

Day	Stream Depletion (cubic foot per second) 1 cubic foot per second=448.8 gallons per minute
1	0.0000
2	0.0000
3	0.0000
4	0.0001
5	0.0003
6	0.0004
7	0.0006
8	0.0007
9	0.0009
10	0.0010
11	0.0012
12	0.0013
13	0.0015
14	0.0016
15	0.0017
16	0.0018
17	

18	0.0020
19	0.0021
20	0.0022
21	0.0023
22	0.0024
23	0.0025
24	0.0025
25	0.0026
26	0.0027
27	0.0028
28	0.0029
29	0.0029
30	0.0030
31	0.0031
32	0.0031
33	0.0032
34	0.0032
35	0.0033
36	0.0034
37	0.0034

38	0.0035
39	0.0035
40	0.0036
41	0.0036
42	0.0037
43	0.0037
44	0.0037
45	0.0038
46	0.0038
47	0.0039
48	0.0039
49	0.0039
50	0.0040
51	0.0040
52	0.0040
53	0.0041
54	0.0041
55	0.0041
56	0.0042
57	0.0042

	0.0042
58	0.0043
59	0.0043
60	0.0043
61	0.0043
62	0.0044
63	0.0044
64	0.0044
65	0.0044
66	0.0045
67	0.0045
68	0.0045
69	0.0045
70	0.0046
71	0.0046
72	0.0046
73	0.0046
74	0.0047
75	0.0047
76	0.0047
77	

78	0.0047
79	0.0047
80	0.0048
81	0.0048
82	0.0048
83	0.0048
84	0.0048
85	0.0048
86	0.0049
87	0.0049
88	0.0049
89	0.0049
90	0.0049
	0.0049

Appendix G
Spring Depletion Model Results
(Drought Year)

Day	Stream Depletion (cubic foot per second) 1 cubic foot per second=448.8 gallons per minute
1	0.0000
2	0.0000
3	0.0000
4	0.0001
5	0.0003
6	0.0004
7	0.0006
8	0.0008
9	0.0010
10	0.0011
11	0.0013
12	0.0014
13	0.0016
14	0.0017
15	0.0019
16	0.0020
17	

	0.0021
18	
	0.0023
19	
	0.0024
20	
	0.0025
21	
	0.0026
22	
	0.0027
23	
	0.0028
24	
	0.0029
25	
	0.0030
26	
	0.0030
27	
	0.0031
28	
	0.0032
29	
	0.0033
30	
	0.0033
31	
	0.0034
32	
	0.0035
33	
	0.0035
34	
	0.0036
35	
	0.0037
36	
	0.0037
37	

	0.0038
38	0.0038
39	0.0039
40	0.0039
41	0.0040
42	0.0040
43	0.0041
44	0.0041
45	0.0042
46	0.0042
47	0.0043
48	0.0043
49	0.0043
50	0.0044
51	0.0044
52	0.0044
53	0.0045
54	0.0045
55	0.0045
56	0.0046
57	

58	0.0046
59	0.0046
60	0.0047
61	0.0047
62	0.0047
63	0.0048
64	0.0048
65	0.0048
66	0.0049
67	0.0049
68	0.0049
69	0.0049
70	0.0050
71	0.0050
72	0.0050
73	0.0050
74	0.0051
75	0.0051
76	0.0051
77	0.0051

	0.0051
78	0.0052
79	0.0052
80	0.0052
81	0.0052
82	0.0052
83	0.0053
84	0.0053
85	0.0053
86	0.0053
87	0.0053
88	0.0054
89	0.0054
90	0.0054