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CONSULTING GROUP, INC.

REGISTERED PROFESSIONAL ENGINEER
ANNJANETTE DODD
No. 77756
Exp. 6/30/2025
CIVIL
STATE OF CALIFORNIA

TECHNICAL MEMORANDUM

FROM: Annje Dodd, PhD, PE
NorthPoint Consulting Group, Inc.

TO: Highland Farms, LP
Attention: Autumn Karcey

RE: Highland Farms – UP 20-96 – Response to Appeal Comments Regarding Groundwater/Water Supply/Water Availability Analysis

DATE: **October 11, 2024**

The purpose of this Technical Memorandum (TM) is to provide a technical review of the January 20, 2022 Water Availability Analysis[1] (referred to herein as "WAA") prepared by Summit Engineering, Inc. and a response to the letter from the Appellants Attorney dated July 26, 2024[2] (referred to herein as "Appeal Comments").

The total outdoor cultivation area has been reduced from the original project. The revised cultivation amounts are summarized in Table 1.

Table 1. Summary of Outdoor, Mixed Light, and Nursery Cultivation Areas.

	Total Outdoor Cultivation Area			Mixed Light Canopy		Nursery Canopy	
	Phase 1a	Phase 1b	Phase 2	Phase 1a&1b	Phase 2	Phase 1a&1b	Phase 2
Original Project	702,629 ft^2 (16.13 ac)	n/a	534,957 ft^2 (12.28 ac)	0	34,404 ft^2 (0.79 ac)	0	34,404 ft^2 (0.79 ac)
Revised Project	405,907 ft^2 (9.32 ac)	480,793 ft^2 (11.04 ac)	368,168 ft^2 (8.45)	0	20,748 ft^2 (0.48 ac)	0	20,748 ft^2 (0.48 ac)

Review of WAA

1. Water Demand

The demand estimates provided in the WAA, are evaluated in the TM using common literature reported estimates of water demand for cannabis cultivation. The CalCannabis Environmental Impact Report (CDFA, 2017) uses 6.0 gallons per day per plant as an estimated water demand for cannabis cultivation. This is 1.0 gallon (gpd) per plant more than reported by Bauer et. al. (2015), who reported up to 5.0 (gpd) per plant (18.9 Liters/day/plant). Using the more conservative estimate of 6.0 gpd (CDFA, 2017), the demand is 3,000 gpd (2.1 gallons per minute [gpm]) per acre of canopy. The estimate of 6.0 gpd is a largely conservative estimate for a large outdoor plant, measured in the driest period of the season. Another estimate used for outdoor cultivation 1.2 to 14.7 gallons per canopy square foot per year (Ascent, 2017) which equates to 290-3,560 gpd per acre of canopy, and is a function of plant size. The applicant anticipates cultivating about 3,000 plants per acre with an average daily demand of 0.75 to 1.0 gallons per plant or 3,000 gallons per day per acre of canopy. This is an average daily demand over the cultivation period which is lower during seedling/vegetative/early flower states and higher during the full bloom period. Assuming 65% of the time the cultivation is in the vegetative/early flower state and 35% it is in the full bloom state and the water use during the full bloom period is about 1.7 times the water used during the vegetative/early flower state, the total estimated irrigation water demand is summarized in Table 2 through Table 4. To be conservative, outdoor demand was assumed over 180 days (April-October) over the entire cultivation area. Mixed light cultivation demand was estimated assuming four cultivation cycles, totaling about 246 days, for 34,404 ft^2 of mixed light canopy. Nursery irrigation demand was assumed to equal mixed light irrigation demand, vegetative state, and nursery cultivation is assumed to occur year-

[1] Water Availability Analysis dated January 20, 2022
[2] Appeal Comment Letter

round for 20,748 ft^2 of nursery canopy.

As part of Phase 2, the project proposes cannabis processing, which is defined as drying and storage, which does not require water.

The project proposes portable sanitation facilities during Phase 1 and full bathroom facilities to be included during Phase 2, which would be an additional water demand from project employees during Phase 2 of operations. The water demand is based on 22 full-time employees and up to 30 part-time employees. Employee demand is assumed to be equivalent to sanitary sewer generation for factories without shower facilities, which, according to the Lake County Rules and Regulations for On-Site sewage Disposal (Lake County, 2010), is 15 gallons per day, per person.

Table 2. Phase 1b Estimated Water Demand (1,000 gal).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Outdoor Irrigation	0	0	0	265	821	795	821	1,081	1,351	766	0	0	5,899
Total	0	0	0	265	821	795	821	1,081	1,351	766	0	0	5,899

Table 3. Phase 2 Estimated Water Demand (1,000 gal).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Outdoor Irrigation	0	0	0	203	629	609	629	828	1,035	586	0	0	4,517
Mixed-Light	0	0	55	91	147	98	103	145	91	124	72	0	926
Nursery Irrigation	35	32	35	34	35	34	35	35	34	35	34	35	417
Employees	10.2	9.2	10.2	16.7	17.2	16.7	17.2	17.2	16.7	17.2	9.9	10.2	168.6
Total	46	41	100	345	829	757	784	1,026	1,177	763	117	46	6,029

Table 4. Summary of Total Estimated Water Demand Compared to the WAA (AF=Acre-Feet, gpm=gallons per minute).

Demand Source	WAA (Phase 2)	This Evaluation (Phase 1b)	This Evaluation (Phase 2)
Cultivation (AF/Year)	15.44	18.10	18.50
Cannabis Processing (drying & storage only) (AF/Year)	3.76	0	0
Employees (AF/Year)	3.46	0	0.52
Total (AF/Year)	22.66	18.10	19.02
Max Daily (gallons/day)	32,580	45,000	39,200
Maximum 8-hour Pump Rate (gpm)	68	94	82

To be conservative, the cultivation demand estimated in this TM was based on the revised, total cultivation area (Table 1), so is somewhat higher than the estimate provided in the WAA, which is based on canopy area during Phase 2 (project buildout). Cannabis drying and storage does not require water. Projected employee water demand is much less than estimated in the WAA, because it is based on typical employee demand numbers provided by the Lake County Rules and Regulations for On-Site sewage Disposal (Lake County, 2010). Thus, the total demand provided in the WAA is higher than projected herein. Even so, excluding the processing building demand from the WAA (because it is accounted for in the employee demand, drying and storage activities do not require water), the total annual demand estimate is the same from both the WAA and this TM are about 19.0 AF/year during Phase 2. However, the peak daily demand estimated herein is higher than the WAA. This is because both flowering and vegetative cycles are accounted for in the monthly demand estimations; daily demand is higher during flowering cycles.

The demand estimates for Phase 2 provided in the WAA are reasonable estimates for cultivation demand.

2. Groundwater Recharge

The project is located in an area of rocks predominately associated with the Franciscan Group. McNitt (1968) mapped the project area's geology primarily as Lower Unit, Jurassic-Cretaceous graywacke with minor interbedded shale and conglomerate (JKL) and basalt (b) (Figure 1). Based on the Well Completion Reports for the project's wells, the primary water bearing unit for Well #1 appears to be the "JKL" unit (screened in shale/sandstone) and the "b" unit (screened in green rock) for Well #2 and #3. The wells screened in the basalt unit exhibit higher well yields than the well completed in the "JKL" unit.

The entire Highland Creek Watershed area (Figure 2), which is approximately 14 square miles (8,960 acres) and encompasses the project area and "JKL" and "b" water bearing units, contributes recharge to the water bearing units in the area. The WAA used a recharge area of 502 acres, which is the recharge area associated with the project's parcels, all of which overlie the "JKL" and "b" water bearing units. Water recharging over the project's parcels can be considered as the project's contributing recharge area.

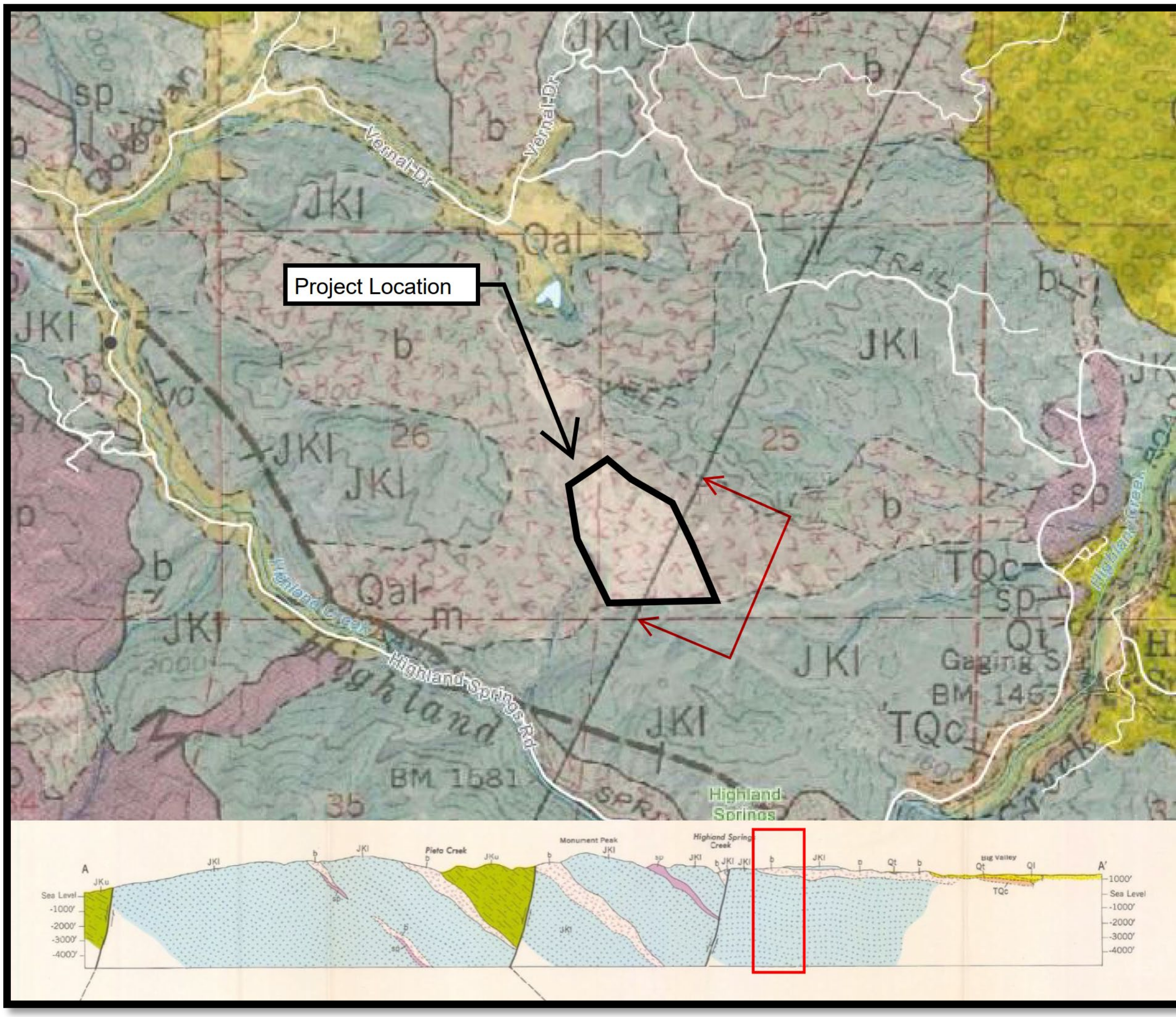


Figure 1. Geology in the Vicinity of the Proposed Project (McNitt, 1968). (Red arrows and outline indicate project area).

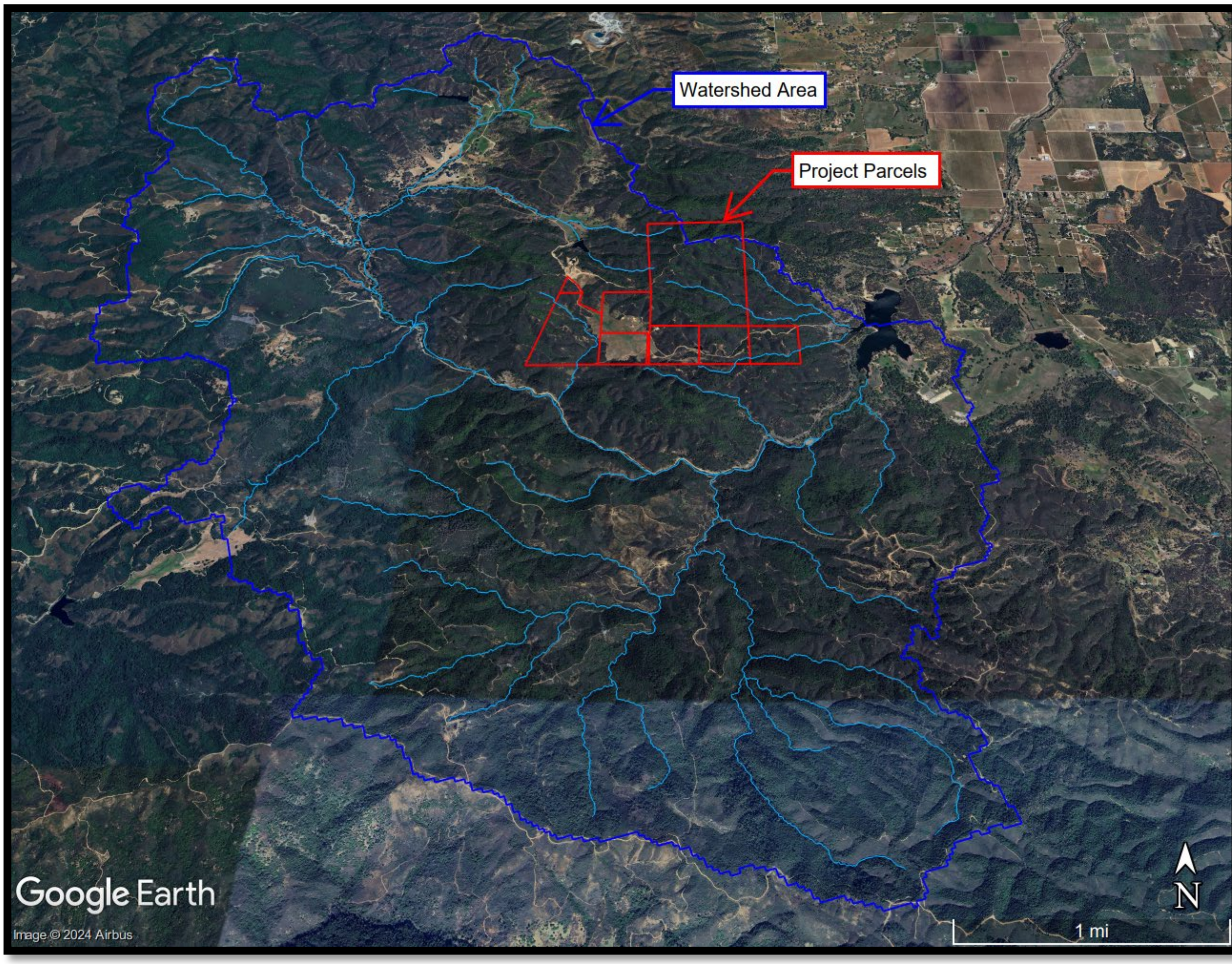


Figure 2. Highland Creek Watershed and Project Parcels

Long-term average groundwater recharge has been estimated to be between 10 and 66 percent of precipitation (USGS Fact Sheet 2007-3007). The PRISM Climate Group[3] gathers climate observations from a wide range of monitoring networks and provides time-series values of precipitation for individual locations. The site-specific annual precipitation from 2000 to 2023 is provided in Figure 2. The annual recharge over this period, based on 10% of the precipitation, is provided in Figure 3. The lowest total precipitation over a three-year period occurred from 2020 to 2022 and the average annual recharge during this period, based on 10% of the precipitation, was 95.7 acre-feet. The WAA estimated recharge to be 62.5 acre-feet, based as 5% of the average annual precipitation of 29.86 inches, which was based on climate normal from 1990-2020 NOAA Climate average precipitation.

The recharge area and estimates provided in the WAA are reasonable.

[3] PRISM Climate Group

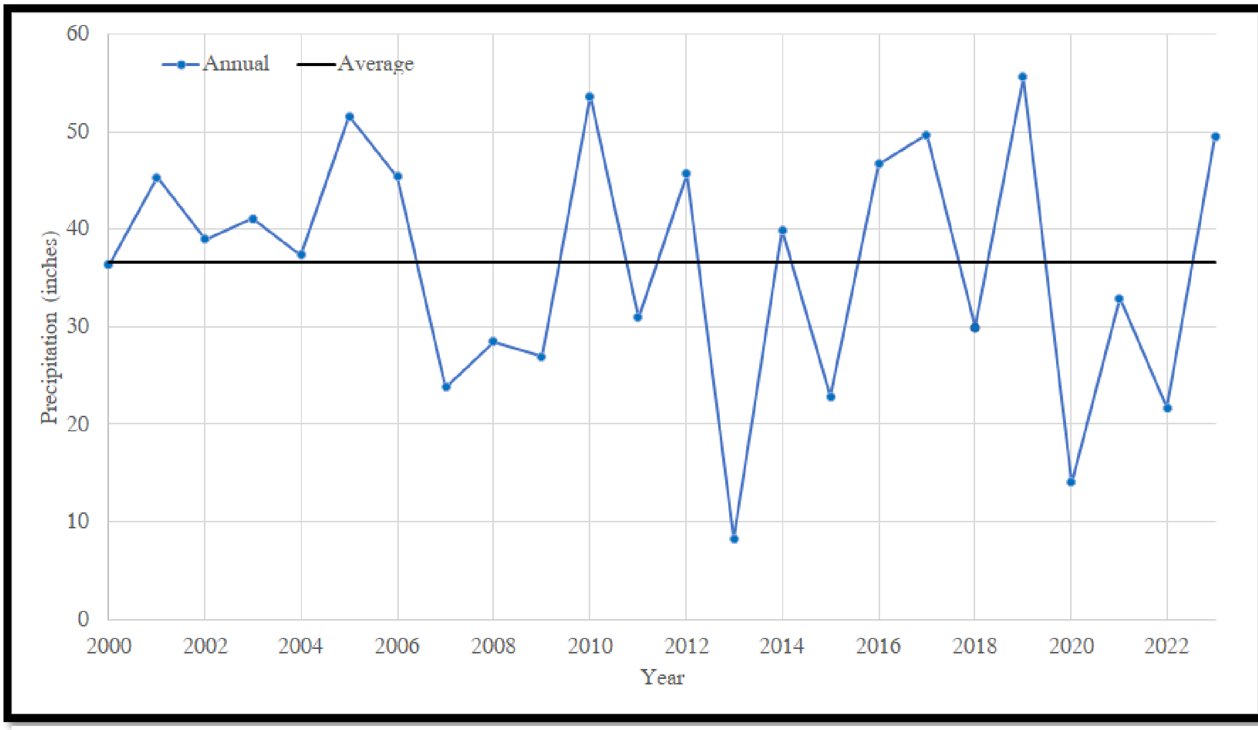


Figure 3. PRISM Climate Group Precipitation from 2000 through 2023 at the Project Site.

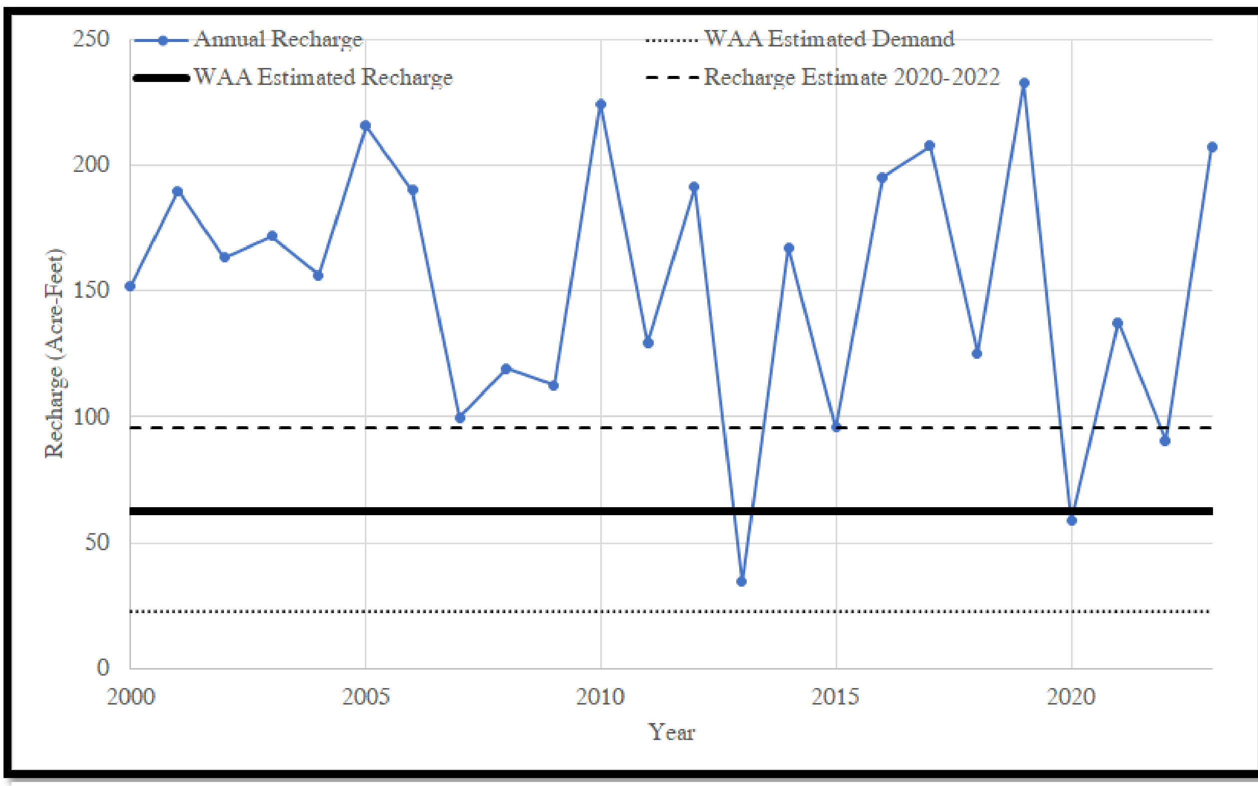


Figure 4. Annual Recharge Generated over 502-acre Project Parcel Recharge Area Based on 10% of Precipitation. Includes WAA Estimated Demand and Recharge and Average Recharge Estimate from 2020-2022.

3. Drawdown and Radius of Influence

The drawdown in a groundwater well is the difference between the water level in a well when it is pumping and when pumping has ceased. The Theis equation was developed to model the response of a confined aquifer to pumping (Fetter, 2001) and can be used to estimate drawdown at a specific distance from each well based on the project's pumping demand. Transmissivity (T) at each well location was estimated herein using the Cooper-Jacob Method for confined aquifers (Gupta, 2017) and the well pump test results. Calculations are attached.

The project's pumping demand for each well was estimated using the maximum estimated daily demand from Table 4 (94 gpm) and the contributing water use, based on cultivation amounts, of each well (11% from Well #1 or 10.3 gpm, 48% from Well #2 or 45.1 gpm, and 41% from Well #2 or 38.5 gpm). These pump rates represent the maximum daily demand over an 8-hour pumping period. In addition, the project proposes 140,000 gallons of irrigation water storage to be installed during Phase 1 and an additional 192,000 gallons during Phase 2, for a total of 332,000 gallons of irrigation water storage. This represents about 8-days of water storage during peak season, allowing for days of well recovery time.

The drawdown from the project's wells after 8-hours of pumping, for various distances from the well, is provided in Figure 4. The radius of influence of a well is the distance where the modeled drawdown from groundwater extraction under these conditions is negligible (less than 6-inches). The radius of influence for Wells #1, #2, and #3 are approximately 375 ft, 425 ft, and 600 ft, respectively.

The WAA provided estimates using the maximum well yields rather than the maximum pumping rates required for cultivation operations. Therefore, the WAA is overly conservative (high) in the drawdown estimates.

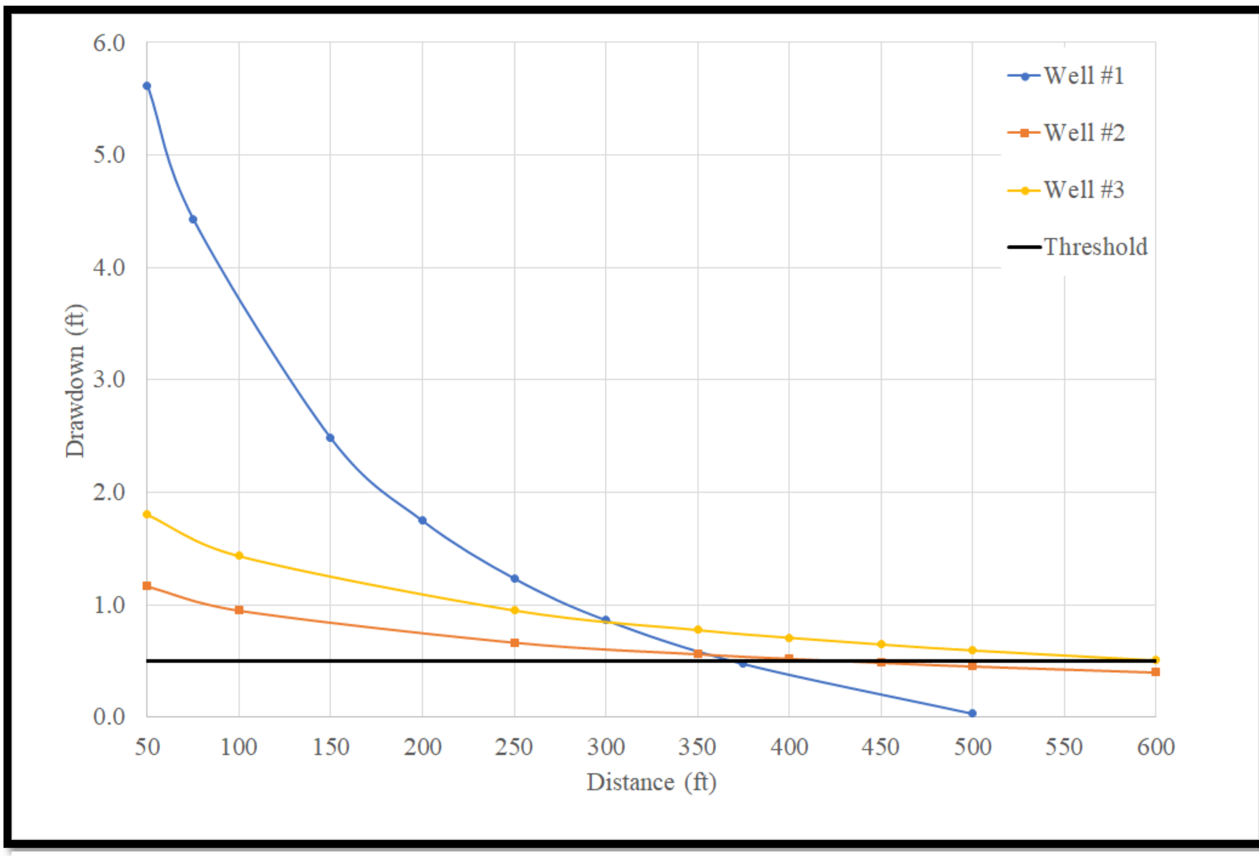


Figure 5. Estimated Radius of Influence (distance) Associated with the Project's Wells (Threshold = 6 inches).

Response to Appeal Comments

The responses summarized below are related to comments regarding groundwater, water supply, and water availability as provided in the Appeal Comments.

1. Appeal Comments, Attachment B, Section G – The Hydrology Study and Water Availability Analysis Are Incomplete

Comment G1: A Hydrology Study and Water Availability Analysis (WAA) were prepared for the Project. (See MND, pp. 15, 49.) Neither assessed impacts to the neighboring spring nearest to the Project site. This is a critical omission given that the Project will drawdown the aquifer up to 15 feet (MND, p. 49), and evidence exists that there is connectivity to a neighboring spring, discussed below.

> Response: Drawdown estimates represent the drawdown in the groundwater well due to pumping, not drawdown in the entire aquifer. The location of the spring was not provided. A comment was submitted to the County regarding the spring and the spring was discussed during the Planning Commission hearing. From this information, it is was determined that the spring is located to the north on APN 007-056-01. The property line to this APN is located approximately 1,100 feet northwest of the northernmost well (Well #1) related to the proposed project. As discussed above, the radius of influence of Well #1 is approximately 375 feet, which does not go beyond the project's property boundaries.

Comment G2: At the Planning Commission hearing, the applicant's civil engineer stated that surface water feeds springs and, because the Project is not diverting surface water, it is not affecting springs. However, this is inaccurate logic. A neighbor submitted a written comment to the County prior to the hearing, and made the same comment at the hearing, that his perennial spring, upon which for decades he relies for his livelihood, went dry during the last months of the last year of the historic drought. His spring is fed by both surface water and groundwater. The WAA relies on the ability of surface water to recharge groundwater through precipitation (primarily rainfall) for enough quantity of groundwater to serve the Project. (WAA, pp. 5-8.) However, during drought years, groundwater recharge is reduced and water table levels become low. (See, e.g., Lake County's Drought Management Plan Update (Apr. 12, 2021), p. 1.) If there is not enough groundwater recharge, and as a result water tables get too low, then there may not be enough water in the aquifer to support the Project and maintain necessary flows in neighboring springs.

> Response: The WAA estimated recharge using the project parcel's contributing area. Recharge can occur from precipitation percolating or infiltrating down from the ground surface within the recharge area. However, confined aquifers are generally recharged where the aquifer materials are exposed at the surface. The USGS estimated aquifer recharge between 10-66 percent of precipitation. The WAA estimated recharge based on 5% of precipitation. As discussed above, recharge was evaluated herein over the project site using localized precipitation from 2000 to 2023, which includes the lowest precipitation year on record in 2013. The recharge over just the project's parcels exceeds the demand for all years (Figure 3). This is consistent with the conclusions in the WAA.

Comment G3: Indeed, any aquifer drawdown may impact the availability of spring water on adjacent properties. This impact must be evaluated. The WAA fails to look at this impact entirely, despite the fact that the neighboring spring at issue is within the Project's cumulative impact area (see WAA, enc. A) and despite the assumed connectivity between the aquifer and the spring (discussed above).

> Response: See responses to Comment G1 through G3.

Comment G4: The WAA also does not appear to account for the slope of the terrain and overall basin topography and runoff when calculating groundwater recharge and absorption (see Figure G1).

> Response: Refer to the review of the WAA above. The WAA used a recharge area of 502 acres, which is the recharge area associated with the project's parcels, all of which overlie the "JKL" and "b" water bearing units. Water recharging over the project's parcels can be considered as the project's contributing recharge area.

Comment G5: The WAA estimates that cannabis cultivation and process will require 22.7 acre-feet per year, to be derived from a groundwater well. (PC Staff Report, p. 12.) Much of this water would be required during summer months and during dry years, when area groundwater-fed spring flows are reduced or stop altogether. This potentially critical issue needs to be investigated and addressed in the MND.

> Response: Please see review of WAA and responses above. In addition, the project's Drought Management Plan provides drought management and risk reduction and strategies to address water usage during declared dry or drought conditions.

References

Ascent (2017) Draft Environmental Impact Report for the Amendments to Humboldt County Code Regulating Commercial Cannabis Activities. SCH# 2017042022 Commercial-Cannabis-Draft-EIR-20mb-PDF (humboldtgov.org)

CDFA (2017) CalCannabis Cultivation Licensing Program Draft Program Environmental Impact Report. State Clearinghouse #2016082077. Prepared by Horizon Water and Environment, LLC, Oakland, California. 484 pp.

Fetter, C.W. 2001. Applied Hydrogeology. Fourth Edition.

Gupta, R.S. (2017). Hydrology and Hydraulic Systems, 4th Edition. Waveland Press, Long Grove IL.

McNitt, J.R. (1968) Geology of the Kelseyville Quadrangle, Sonoma, Lake, and Mendocino Counties, California, California Division of Mines and Geology, Map Sheet MS-009 https://ngmdb.usgs.gov/Prodesc/proddesc_391.htm

USGS. 2007. USGS Fact Sheet 2007-3007. https://pubs.usgs.gov/fs/2007/3007/

Attachments

Theis Equation Drawdown Calculations for Project Wells

	Well #1								Well #2								Well #3								**Notes:**
Storativity	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	0.00075	Storativity - Average of Multiple Sources (see below)
Test Drawdown (ft)	44	44	44	44	44	44	44	44	20	20	20	20	20	20	20	20	57	57	57	57	57	57	57	57	Drawdown during pump test
Yield Q (gpm)	75	75	75	75	75	75	75	75	126	126	126	126	126	126	126	126	126	126	126	126	126	126	126	126	Stabilized pump rate during pump test
T (ft^2/day)	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	4439.4	4439.4	4439.4	4439.4	4439.4	4439.4	4439.4	4439.4	2219.7	2219.7	2219.7	2219.7	2219.7	2219.7	2219.7	2219.7	Using T = 2.3*Q/(4pi*drawdown during pump test) (Gupta)
Project Q (gpm)	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	45.1	45.1	45.1	45.1	45.1	45.1	45.1	45.1	38.5	38.5	38.5	38.5	38.5	38.5	38.5	38.5	
Q (ft^3/d)	1990	1990	1990	1990	1990	1990	1990	1990	8686	8686	8686	8686	8686	8686	8686	8686	7419	7419	7419	7419	7419	7419	7419	7419	conversion ft^3/d = 0.00519481 gpm
Time (days)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	
r (ft)	50	75	150	200	250	300	375	500	50	100	250	350	400	450	500	600	50	100	250	350	400	450	500	600	
u	0.01338	0.03011	0.12045	0.21413	0.33457	0.48178	0.75278	1.33828	0.00032	0.00127	0.00797	0.01561	0.02039	0.02581	0.03186	0.04588	0.00064	0.00255	0.01593	0.03123	0.04079	0.05162	0.06373	0.09177	Fetter (2001) Equation 5.10
w(u)	3.7499	2.9555	1.6562	1.1667	0.8243	0.5768	0.3179	0.0219	7.4746	6.0892	4.2633	3.5980	3.3357	3.1054	2.9007	2.5498	6.7817	5.3974	3.5781	2.9203	2.6626	2.4376	2.2386	1.9010	Fetter (2001) Equation 5.11: W(u) ~ -0.5772-ln(u)+u-u^2/(2*fact2)
Drawdown [h-ho] (ft)	5.6	4.4	2.5	1.7	1.2	0.9	0.5	0.0	1.2	0.9	0.7	0.6	0.5	0.5	0.5	0.4	1.8	1.4	1.0	0.8	0.7	0.6	0.6	0.5	Fetter (2001) Equation 5.11
Drawdown [h-ho] (in)	67.4	53.1	29.8	21.0	14.8	10.4	5.7	0.4	14.0	11.4	8.0	6.7	6.2	5.8	5.4	4.8	21.6	17.2	11.4	9.3	8.5	7.8	7.1	6.1	

Sources:
Applied Hydrogeology, Fourth Edition, C.W. Fetter. 2001
Groundwater Wells, Second Edition, F.G. Driscoll 1986. (https://sehydrogeology.com/using-specific-capacity-monitor-well-performance/#:~:text=The%20Specific%20Capacity%20of%20a,penetrated%20by%20the%20well%20screens.)
Gupta, R.S. (2017). Hydrology and Hydraulic Systems, 4th Edition. Waveland Press, Long Grove IL (Equation 6.20)

Storativity - Confined Aquifer (Sources)

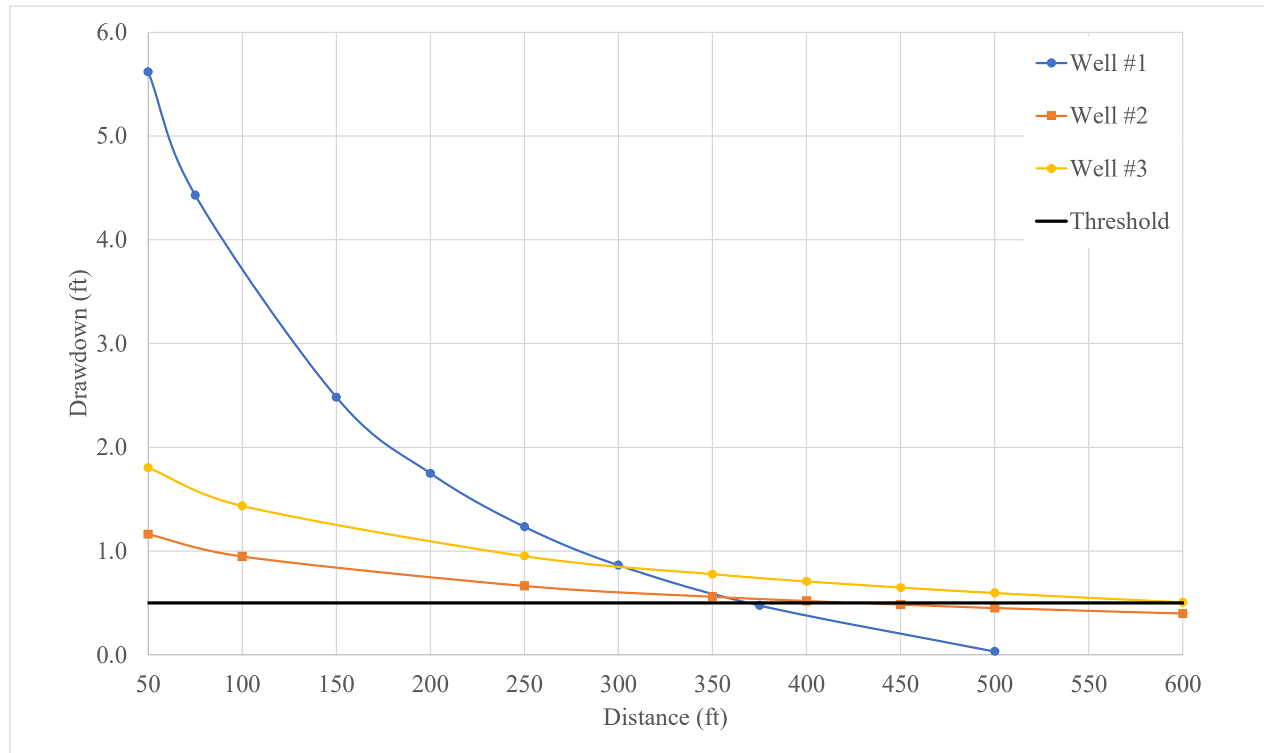
	Minimum	Maximum	Average	
	0.00005	0.005	**0.0007544**	Average of all Storativity Estimates
	0.00001	0.0001		
Well #1 (using 2nd Source below)	0.000044	Aquifer Thickness*0.000001		
Well #2 (using 2nd Source below)	0.00002	Aquifer Thickness*0.000001		
Well #3 (using 2nd Source below)	0.000057	Aquifer Thickness*0.000001		

Total Project Q (gpm) 94
Source: http://www.aqtesolv.com/aquifer-tests/aquifer_properties.htm

aquifer (or aquitard) thickness [L].

The typical storativity of a confined aquifer, which varies with specific storage and aquifer thickness, ranges from 5×10^{-5} to 5×10^{-3} (Todd 1980).

Specific storage is the volume of water that a unit volume of aquifer (or



Source: https://www.sciencedirect.com/topics/earth-and-planetary-

from the expansion of water and compaction of the aquifer, both of which are exceedingly small. For confined aquifers the storativity generally ranges between 0.0001 and 0.00001, and for leaky confined aquifers it is in the range of 0.001. One method to estimate storativity for confined aquifers is to multiply the aquifer thickness by 0.000001. The small storativity for confined aquifers means that to obtain a sufficient supply from a well there must be a large pressure change throughout a wide area. This is not the case with unconfined aquifers because the water derived is not related to expansion and compression but comes instead from gravity drainage and dewatering of the aquifer.