April 12, 2023

Mr. Robert Pennington, P.G.
County of Sonoma - Permit and Resource Management Department
2550 Ventura Avenue
Santa Rosa, CA 95404

RE: Hydrogeologic Assessment Report – Supplemental Information
2750 Burnside Road (the site)
Sebastopol, CA 95472
APN 073-061-018
Hurvitz Environmental Project No. 5187.01

Dear Mr. Pennington:

This letter presents Supplemental Information to Hurvitz Environmental Services (HES) November 22, 2022, Hydrogeologic Assessment Report (HAR) prepared for the Site. This Supplemental Information was prepared in response to comments presented in a March 8, 2023, letter from Mr. Robert Pennington of the Sonoma County Permit and Resource Management Department (Permit Sonoma). Mr. Pennington requested that the project applicant present supplemental information to further support the conclusion that the project will not have significant impacts on streamflow. Specifically, the letter requested an assessment of the cumulative impacts on streamflow and summer rearing habitat in Hudspeth and Jonive Creek (tributaries of Atascadero/Green Valley Creek).

Therefore, on behalf of the applicant, we have presented the following information related to stream flow depletion caused by groundwater extraction primarily based on recent analysis of Green Valley/Atascadero Creek[1]. This includes analysis of pumping ratios and stream depletion calculations so that Permit Sonoma and other jurisdictional agencies can further evaluate the surface water/groundwater interaction at the site and within the cumulative impact area (CIA) defined in the HAR. Further, the Applicant has proposed to reduce their overall water usage for the project from 1.6 ac-ft/yr to 0.6 ac-ft/yr by applying several water conservation practices including: Hügelkultur Farming Methods; Irrigating with Drip Emitters; Application of Mulch and Rainwater Capture.

Based on the results presented herein and within the November 2022 HAR, we conclude that the groundwater usage rate proposed for this project appears sustainable, and consistent with previously designated rates. Therefore, the potential pumping effects on stream depletion for this project are considered **de minimis**.

1 Kobor, J., & O'Connor, M., 2016. Integrated Surface and Groundwater Modeling and Flow Availability Analysis for Restoration Prioritization Planning, Green Valley\Atascadero and Dutch Bill Creek Watersheds, Sonoma County, California, 149 p.

Green Valley\Atascadero Watersheds

The site is located in the Upper Atascadero watershed which is part of the Green Valley subwatershed (HUC 12-180101100901). The western edge of the site is bounded by upper Hudspeth Creek. Hudspeth Creek drains northward to the West Fork of Upper Atascadero Creek, commonly known as Jonive Creek. Green Valley Creek and its tributaries (Atascadero, Purrington, and Jonive Creeks) encompass an area of approximately 38 miles^2. Land use practices in Green Valley Creek have seriously impacted anadromous fish habitat. Legacy effects due to intense timber harvest, land conversion, and the development of road networks have increased sediment inputs to streams. In addition, lack of instream habitat, increased summer temperatures, and decreases in summer flows have affected juvenile fish survival. Although habitat conditions have declined over the years, CDFW identified Green Valley Creek as optimal Coho Salmon spawning and rearing habitat and the area produces some of the largest smolts within the lower-basin Russian River[2] The Green Valley Creek Watershed has been identified as one of the "Core" areas for the National Marine Fisheries (NMFS) Coho Recovery Plan.

Coho habitat has not been documented in upper Atascadero Creek, however reaches with flow conditions suitable for providing juvenile coho rearing habitat are present throughout much of the upper watershed, and juvenile steelhead do currently utilize these areas. However, the 0.5-mile reach upstream of the confluence of Atascadero and West Fork Atascadero Creeks, which is where the site lies, usually becomes disconnected even under average water year conditions[1].

Streamflow Depletion Analysis

For the purposes of this analysis, streamflow depletion is defined as the reduction in streamflow resulting from groundwater pumping. Streamflow depletion is a consequence of the law of physics requiring the conservation of mass applied to water balance models describing the movement of water in watersheds and groundwater aquifers. In such water balance models, inflows to an aquifer must be balanced by outflows from the aquifer adjusted for changes in the volume of water in storage. In most watersheds, streamflow accounts for the majority of outflow; as groundwater pumping proceeds, the volume of water supplied to wells is largely balanced by decreases in streamflow and/or aquifer storage. In the short-term, water supplied to wells is derived primarily from decreases in aquifer storage. Over longer periods these storage changes generally stabilize and streamflow depletion becomes the primary source of water pumped from wells[3].

For a conceptual watershed water balance with a control volume including groundwater aquifers, the status of the hydrologic system can be expressed most simply as:

Inflow = Outflow +/- Change in Storage

[2] Sonoma Water and California Sea Grant. 2019. Implementation of California Coastal Salmonid Population Monitoring in the Russian River Watershed. Santa Rosa, CA..
[3]Barlow, P.M., & Leake, S.A., 2012. Streamflow Depletion by Wells – Understanding and Managing the Effects of Groundwater Pumping on Streamflow, U.S. Geological Survey Circular 1376, 84 p.

For a water balance describing a groundwater system, inflows to an aquifer typically include groundwater recharge and subsurface inflow. Outflow terms typically include streamflow, groundwater pumping, evapotranspiration from groundwater, and subsurface outflow[4]. Over long periods of time (years or decades), groundwater recharge generally represents the majority of inflow to an aquifer and stream baseflow (streamflow) and groundwater pumping generally represent the majority of outflow. Consequently, an approximate aquifer water balance can be restated as:

Groundwater Recharge ≈ Streamflow + Groundwater Pumping +/- Change in Storage

As groundwater pumping increases, those increases must be balanced by either reductions in streamflow (streamflow depletion), reductions in storage, or increases in groundwater recharge. Over the long-term, changes in storage and recharge generally stabilize such that the majority of water supplied to wells is balanced by streamflow depletion[3].

As the rate of groundwater pumping approaches the rate of groundwater recharge, streamflow approaches zero; this scenario is equivalent to a ratio of groundwater pumping to groundwater recharge equal to one. From these relationships, it can be seen that the ratio of groundwater pumping to groundwater recharge (i.e., groundwater pumping divided by groundwater recharge) provides an objective, hydrologically significant, indicator of the relative magnitude of streamflow depletion occurring in a given watershed.

To determine the stream depletion for this site HES used parameters that were estimated for the Jonive Creek (HUC-14) subwatershed estimated in the Sonoma County Well Ordinance Public Trust Review (PTR) Area Delineation dated March 2023[5].

- Mean annual groundwater use 1-2 in/yr
- Groundwater Recharge 9-12 in/yr
- Pumping Ratio (water Use/Recharge) 10-20 %

Permit Sonoma has estimated these parameters, by parcel number, in their well ordinance update webpage[6]. For the Site (APN 073-061-018) these parameters estimates were as follows:

- Water use = 648.36 ac-ft/year
- Surface water use = 9 ac-ft/yr
- Groundwater use = 639.36 ac-ft/yr
- Mean annual recharge = 10.10 inches/yr
- Pumping ratio = 0.187806
- Aquatic habitat and PTRA Class 2

[4] Healy, R.W. (2010) Estimating Groundwater Recharge. Cambridge University Press, Cambridge.
[5] https://permitsonoma.org/Microsites/Permit%20Sonoma/Documents/Divisions/Engineering-construction/Well-Septic/Well%20Ordinance%20Update/April%204%20Board%20MeetingSignificant%20Interest/Att%20H%20Public%20Trust%20Review%20Area%20Deliniation%20Report.pdf
[6] https://sonomacounty.maps.arcgis.com/apps/webappviewer/index.html?id=8baedfd50be640b0b11548537f89fee2

To classify each subwatershed as having a Low, Medium, or High level of streamflow depletion the PTR used the findings of Richter et al. (2012)[7] who proposed presumptive standards for environmental flow protection in the absence of detailed studies evaluating site-specific environmental flow needs. A high level of ecological protection is presumed to be provided when flow alterations are no greater than 10% and a moderate level of protection is provided when flow alterations are in the 11-20% range[7]. The distributed model scenarios indicate that streamflow depletion of 10% or less occurs when the groundwater pumping ratio remains below ~5% and streamflow depletion of 11-20% occurs when the groundwater pumping ratio remains below ~10%. Based on these findings, subwatersheds with a groundwater pumping ratio of less than 5% were coded as Low for streamflow depletion, subwatersheds with a groundwater pumping ratio of between 5 and 10% were coded as Medium, and subwatersheds with a pumping ration in excess of 10% were coded as High for streamflow depletion. Based on this criterion the site is in a Jovine Creek subwatershed is within the "High" streamflow depletion range.

Stream Depletion Factor

Another important factor when considering stream depletion is the connectivity and response time between the Sites domestic well and the nearby Hudspeth Creek. This evaluation can help determine the time required for well water withdraws to effect stream flow at a given location. The two factors that most influence the timing and rate of streamflow depletion are the distance from a well to the stream and the aquifer's hydraulic diffusivity[3]. For an unconfined aquifer, hydraulic diffusivity (D) can be calculated as:

$D = Transmissivity/\text{Storage Coefficient}$
D= T/S

Using data from the Santa Rosa Plain Groundwater Sustainability Plan[8] we estimate that the Wilson Grove Formation has a hydraulic conductivity (K) range between 3 ft/day and 65 ft/day and that these values are consistent with aquifer conditions at the site. Therefore, based on the relationship between transmissivity and hydraulic conductivity, and using the estimated hydraulic conductivity value of 34 ft/day, we can calculate the aquifers transmissivity (T) using the following relationships and equations.

T = K*D (Aquifer Thickness)
D = 73 ft (Average Well Screen Thickness in CIA)
K = 34 ft/day (Wilson Grove Formation Estimate)

T = 34 ft/day x 73 ft
T = 2,482 /ft^2/day

To calculate the aquifer storage coefficient, we relied on information presented in the California Department of Water Resources Bulletin 118-4 which indicates that the Wilson Grove Formation

[7] Richter, B.D., Davis, M.M., Aspe, C., and Konrad, C., 2012. A Presumptive Standard for Environmental Flow Protection, River Research and Applications 28: 1312-1321.
[8] Santa Rosa Plain Groundwater Sustainability Plan, http://santarosaplaingroundwater.org/wp-content/uploads/000_Santa_Rosa_GSP_508.pdf

has specific yields between 10-20%[9]. Therefore, hydraulic diffusivity (D) can be estimated using the following calculation.

D= T/S
D = 2,482 ft^2/day / 0.15 (Wilson Grove Formation[9])
D = 16,547 ft^2/day

Barlow and Leake[3] use the hydraulic diffusivity and distance to a well to define a term they call the Stream Depletion Factor (SDF), which is a relative measure of how rapidly streamflow depletion occurs from groundwater pumping:

$SDF = d^2 / D$

So, for this Project: d = 985 feet = distance between the pumping well and Hudspeth Creek

SDF = 985ft^2 /16,547 ft^2/day
SDF = 58.63 days

The SDF, which Barlow and Leake[3] speculate could more specifically be called "streamflow depletion response-time factor" is in units of time. A low SDF indicates that streamflow depletion will occur relatively quickly, while a high SDF indicates that streamflow depletion will occur relatively slowly[10]

For this site the Stream Depletion Factor of **58.63 days** indicates a relatively slow response for stream depletion when groundwater withdraws are occurring and subsequently means a relatively slow stream adjustment once pumping is stopped. This timing suggests that scheduled winter pumping from the groundwater well could help to reduce the effects of pumping on stream depletion in the Jovine subwatershed.

Streamflow depletion is less significant during the winter due to reduced demand, and increased streamflow from precipitation and run-off. Additionally, during the winter, water that is withdrawn from the well is more likely to be replaced by precipitation, as opposed to water from nearby Creeks. Therefore, we recommend that the applicant fill the 20,000-gallons of water storage tanks in January when stream depletion is less concerning for Coho Salmon. Based on the ~58-day response time estimate, the pumping effects will have ceased in March and not likely to take effect again for 2-3 months. While this winter pumping and storage practice would not reduce the overall groundwater demand, it would reduce the affects that the groundwater use has on stream depletion proximate to the site.

Project Water Usage and Conservation Plans

Since the site is located in a sensitive watershed that is part of the NMFS long-term plan for Coho recovery there is heightened concern for potential groundwater/ surface water interference and what

[9] Herbst, C.M. 1982. Evaluation of Ground Water Resources: Sonoma County, Volume 3: Petaluma Valley. California Department of Water Resources Bulletin 118-4. 94 p.
[10] Jenkins, C.T., 1968a, Computation of rate and volume of stream depletion by wells: U.S. Geological Survey Techniques of Water-Resources Investigations.

effect that may have on the Coho recovery in Jonive Creek subwatershed. Therefore, the applicant has proposed to reduce their overall water usage 1.6 ac-ft/yr to 0.6 ac-ft/yr by applying several water conservation practices including:

- Hügelkultur Farming Methods
- Irrigating with Drip Emitters
- Application of Mulch
- Rainwater Capture

The Applicant had previously stated that the anticipated annual groundwater demand for the entire site including cannabis irrigation, employees and livestock would total 521,687 gallons/year (1.6 ac-ft/yr). However, the applicant now believes that through their sustainable farming practices and water conservation methods they will only use approximately 195,630 gallons/year (0.6 ac-ft/yr). The applicants revised monthly water usage estimate is presented along with the original monthly water usage estimate in TABLE 1, below.

TABLE 1 – Revised Monthly Water Usage for Cannabis Cultivation

Source	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total	Total
	---------Gallons---------													acre-ft
Original Outdoor Cultivation/Employees/Livestock	1,125	1,125	1,125	69,475	71,475	72,475	74,475	77,475	77,475	73,207	1,125	1,130	521,687	1.60
Revised Outdoor Cultivation/Employees/Livestock	1,125	1,125	1,125	20,000	23,000	30,000	30,000	35,000	32,000	20,000	1,125	1,130	195,630	0.60

Hügelkultur Farming Methods

The Applicant plans to utilize Hügelkultur® farming methods for his cannabis cultivation, which involves the burying of logs and organic matter several feet below the surface and then backfilling with specially formulated soils. According to the Applicant, the high precipitation in the area will allow the buried logs to soak up water in the winter and spring and retain moisture throughout the summer. This method of planting and farming allows the plants to tap moisture stored deep within the soil matrix and ultimately decreases the amount of water required to irrigate the cannabis. The applicant has performed this type of cultivation on properties within nearby watersheds and is confident that this approach to farming will allow him to reduce his initial water estimate by nearly 50%.

Irrigating with Drip Emitters

The outdoor cannabis plants will be grown in raised beds using a combination of hand watering and drip irrigation. In addition, cannabis irrigation will be performed early in the day while temperatures are coolest to minimize evaporation rates.

Application of Mulch

The application of mulch will help to minimize evaporation from the soil especially during the late summer months. Evaporation from irrigated soils during the summer months can be as high as 0.1-inches/day. Therefore, it is estimated that 10% of the daily irrigation water is lost to evaporation. However, McMillen [11] estimated that the application of 5cm (~2-inches) of mulch material can reduce soil evaporation rates in soil by as much as 40%. Therefore, the application of mulch to the canopy area could potentially reduce the sites groundwater demand by an additional 4%.

Rainwater Capture

Even though the revised water usage rates are reasonable, and appear to be supported by the average annual rainfall and aquifer recharge presented in the HAR, the Applicant now plans to capture and store rain water from the proposed structures onsite and will store and use that rainwater during the dry summer months. This practice will reduce the need for groundwater resources which will in turn reduce the stream depletion potential. The proposed structures onsite consist of two (2), 10 ft x 20 ft buildings, and two (2), 10 ft x 10 ft sheds. The approximate roof area available for rain water catchment is estimated at 600 ft^2. Based on this surface area and the estimated 35-inches of rain (estimate in the HAR), we estimate the Sites rainwater capture potential below.

Max Volume = 0.6 x 0.62 x Roof Area (ft^2) x Average Annual Precipitation (inches)[12]

0.6 (efficiency factor) x 0.62 (conversion factor) x 600 ft^2 (roof area) x 35-inches =
7,812 gallons/year = 0.024 acre-feet/year = Rainwater Capture Potential

The applicant intends to capture and store the 7,812-gallons of rain water each year in two (2) additional 5,000-gallon tanks that will be designated for rainwater capture. This will increase the total proposed water storage onsite to 30,000-gallons. The collection and use of rainwater will reduce the sites groundwater demand by approximately 4%. The rainwater can be used for cannabis irrigation in the summer when stream flow is lowest and depending on rainfall conditions, the applicant could also potentially use the rain water for early season (April) irrigation, while still having the ability to partially refill the tanks from spring rain.

[11] Michael McMillen 2013 The Effect of Mulch Type and Thickness on the Soil Surface Evaporation Rate, Horticulture and Crop Science Department California Polytechnic State University San Luis Obispo.

[12] Permit Sonoma 8-2-1 Water Supply, Use and Conservation Assessment Guidelines https://permitsonoma.org/policiesandprocedures/8-2-1watersupplyuseandconservationassessmentguidelines

Conclusion

Stream depletion at the site has been defined as "High" based on the Permit Sonoma Model that compares groundwater pumping to aquifer recharge (groundwater pumping/recharge) on a subwatershed level. In addition to the "High" steam depletion designation for the site, Coho Salmon rearing habitat exists within ½ mile downstream of the site in Atascadero Creek and Green Valley Creeks. Therefore, the project applicant has proposed to reduce the sites groundwater use from 1.6 acre-feet/year, to 0.6 are-feet/year (a 62.5% reduction) in order to minimize the projects potential impact on the Jonive subwatershed. The proposed reduction in groundwater use will primarily be through sustainable farming practices, however, the applicant is also adding 1) rainwater capture off of structures, 2) additional 10,000-gallons in water storage capacity to the Site, and 3) proposes to pre-fill their water tanks in the winter to further reduce the impacts. Factoring in the groundwater stored from the winter well pumping (20,000-gallons) and rainwater capture (7,812 gallons), the applicants annual groundwater usage that will affect streamflow is further reduced from 0.6 acre-feet/year to 0.52 are-feet/year.

By reducing the sites groundwater demand to 0.6 acre-feet/year, the applicant will have a site water usage rate consistent with a single-family residence and a usage rate that is already accounted for within the Permit Sonoma Stream Depletion Model[3]. Additionally, strategic pumping from the site well in the winter, and using available captured rain water for irrigation, will further reduce the potential impacts of streamflow depletion. Based on the results presented herein and within the November 2022 HAR, we conclude that the groundwater usage rate proposed for this project appears sustainable, and consistent with previously designated rates. Therefore, the potential pumping effects on stream depletion for this project are considered **de minimis**.

We appreciate the opportunity to be of service to you and trust that provides the information you require at this time. If you have any questions or require any additional information, please feel free to contact us at 707-824-1690 or www.hurvitzzenvironmental.com.

Sincerely,
HURVITZ ENVIRONMENTAL SERVICES

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