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Lake County Board of Supervisors
c/o Community Development Department
Planning Division
Lakeport, CA 95453
Transmitted by email: Mireya.Turner@lakecountyca.gov
Mary.Claybon@lakecountyca.gov

July 13, 2026

Subject: Comments on Lack of Demonstration of a Sustainable Water Supply, Agenda Item 6.12 Board of Supervisors Meeting Tuesday July 14, 2026 Proposed Expansion of Pasta Farms 3 Cannabis Cultivation Operation, 10750 Siegler Springs Road, Kelseyville Major Use Permit Application PL-26-115 and MND,

Dear Planning Commissioners:

I am a Senior Consultant Hydrogeologist with Geosyntec Consultants based in the Oakland, California Office. I have a BS in Geology and a PhD in Earth Sciences and am a registered professional geologist and certified hydrogeologist in California. I have worked as a consulting hydrogeologist for over thirty years. My resume is provided as **Attachment A** to document my qualifications as an expert to review and comment on estimates of sustainable production of groundwater.

I have been engaged by Adidam Holy Domains to review documents related to the proposed water supply for the proposed expansion of the Pasta Farms Cannabis Cultivation Operation.

Following a summary of my main comments below, this letter provides detailed technical comments on portions of the Staff Report dated June 11, 2026, the Water Availability Analysis dated January 13, 2025 and Appendices (Exhibit A5 to the Staff Report), and also the required CEQA process based on my review, experience, and expertise.

SUMMARY

1. Yield of wells cannot be reliably estimated by pumping tests of only a few hours, especially for wells that tap fracture rock.
2. Five to six months of groundwater water level monitoring data recorded from Project Wells 1 and 2 during June to December 2024 show that the groundwater levels continue to decrease during irrigation season when the wells are pumped several hours each day.

3. After the irrigation season when there was no pumping for a couple months, the groundwater levels do not recover to the levels before the irrigation pumping started in June. By mid-December, the recovery of groundwater water levels is only approximately 50% of the decrease (drawdown) that occurred during the irrigation season.
4. The monitoring data establishes that the project pumping exceeds the recharge rate and depletes the groundwater resources.
5. Reported estimates of available groundwater in storage are too high.
6. The estimated average annual recharge to groundwater beneath the 602.5 acres Project Site that is reported in the January 2025 Water Availability Analysis is equivalent to approximately 46% of average annual rainfall. This recharge rate is a gross overestimate that is on the order of ten times higher than likely occurs.
7. For projects that are subject to the CEQA, such as the proposed expansion of the Pasta Farms Facility, the local agency (the County) has authority to require appropriate site-specific testing of wells and/or operational data to demonstrate that the wells can meet the water demand of the proposed projects with less than significant impacts to groundwater resources and ecosystems. This is needed to comply with the CEQA requirements before the proposed project can be approved.
8. The CEQA requires a formal SB 610 Water Supply Assessment is required if the project facility occupies more than 40 Acres of land. This likely applies to the proposed project because with the proposed expansion, the cannabis canopy would be 30.1 acres, and the Project Site occupies 602.5 acres.
9. The project would require one or more annual operating permits from the CA Department of Cannabis Control (DCC). The DCC reviews evaluation of compliance with the CEQA requirements, which includes demonstration of a viable water supply, and addressing potential cumulative impacts on groundwater resources.

PROJECT WATER DEMAND AND PROPOSED WATER SUPPLY

The project site consists of 10 parcels with a total area of 602.5 acres. The proposed expansion of the Cannabis Cultivation Facility would increase the Cannabis Canopy from 20 to 30.1 acres and add another processing facility, and a nursery facility.

The proposed sole source of water for the project is groundwater from wells completed in fractured volcanic rock (the Project Wells). The Staff Report indicates that the "project plans to utilize groundwater from two existing, permitted on-site wells" as the primary source to meet the estimated total annual demand of 107.37 acre feet per year (AFY), which includes irrigation, dust control, and use of water by employees. The total annual demand of 107.37 AFY equates to ~67 gallons per minute (gpm) if the pumping is constant and continuous throughout the year. But most of the water demand and pumping of the wells would likely occur during an approximately 3.5-month irrigation period from late June to mid-October. Constant and continuous pumping of 107.37 AF over a period of 3.5 months would equate to ~200 gpm.

Based on the Well Completion Reports (WCRs), the Project Wells (Well 1 and 2) are screened from depths of 200 and 245 ft to approximately 300 ft below ground surface (ft bgs) in volcanic rocks identified as red or black basalt. First groundwater detected during drilling of Well 1 in 2001 and Well 2 in 2021 was reported at 160 and 200 ft bgs, respectively. And static depth to groundwater after construction of the wells was reported at 120 and 200 ft. Groundwater in the volcanic rocks typically occurs in fractures, and higher water levels after completion of the wells indicates that the groundwater occurs under confined conditions (pressurized) within the fractures, so it rises within the well casing.

COMMENTS ON WATER AVAILABILITY ANALYSES

1. Estimated Well Yields Based on Pumping Tests of Only a Few Hours are Not Valid

Based on a 4-hour test of Well 1 and a 2-hour test of Well 2, the reported estimated yields of the wells are 275 gpm and >=400 gpm. However, **short-term testing, especially for wells completed in fractured rocks, is not a valid method to reliably estimate the long-term yield** from the Project Wells and ability to meet the project water demand for multiple years. The amount of groundwater available to a well in the volcanic rocks is highly dependent on the size, openness, frequency, and interconnection of fractures and joints encountered in the well (e.g. CDM, 2006, Lake County Well Inventory and Analysis).

2. Sustainable Yields of Fractured Rock Aquifers is Highly Uncertain and Typically Decline With Time

Conditions in fractured rock and alluvial or sandstone aquifers are generally entirely different. Figures 1A and 1B below illustrate contrasting conceptual models of an alluvial aquifer and a fractured rock aquifer.

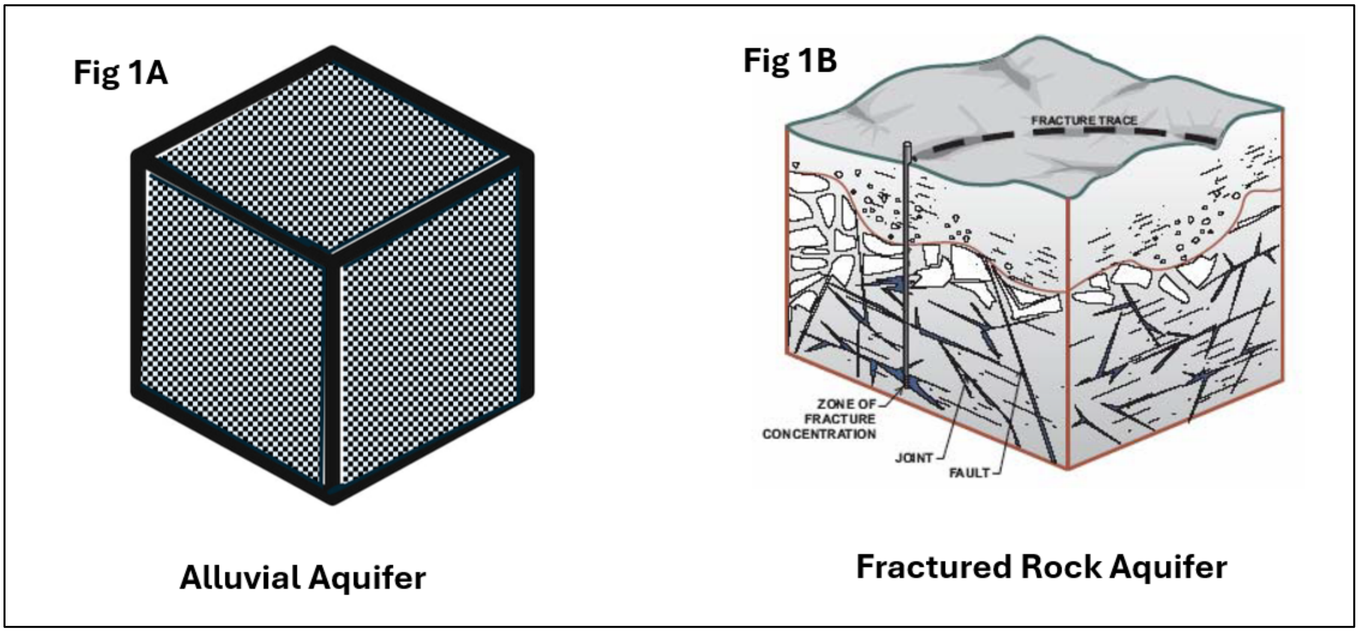


Figure 1. Contrasting Conceptual Models of Alluvial and Fractured Rock Aquifers

Hydraulic properties (e.g., permeability and porosity of alluvial) aquifers are relatively uniform but are typically highly variable and highly uncertain in fractured rock aquifers. The volumetric portion of extractable groundwater in fractured rocks is generally much lower than in alluvial aquifers; and fractures can be isolated and not connected. Credible estimates of hydraulic properties and sustainable yields of unconsolidated alluvial aquifers and some sedimentary rocks are commonly possible, based on testing, calculations, and modeling. However, due to unknowns regarding groundwater conditions in fractured rock, long-term testing or operational monitoring data are imperative to estimate sustainable yield of wells in fractured rock.

Yields of wells in fractured rock commonly decline over time. The typical declining yield and drop in water levels with time is largely due to much slower recharge to fractures compared to drainage of fractures during pumping.

An abundance of long-term operational data and scientific publications establish that production rates during initial short-term testing of wells completed in fractured rock commonly are not sustainable in the long-term and are notorious for decreases with time. This well-established fact is succinctly documented and explained by a two-page 2004 informational flyer published by the Washington State Groundwater Association *to educate the public and its membership on the* *proper protection and use of ground water resources.* This publication is cited in a footnote below[1] and is provided as **Attachment B** to this document.

3. Data for Project Wells 1 and 2 Show Declining Groundwater Levels and Incomplete Recovery

The Water Availability Analysis by EBA Engineering dated January 13, 2025 (EBA Jan 2025 WAA, Exhibit A5 to the Staff Report) includes water level hydrographs (Exhibit 3 and 4 on pages 21 and 22) that present monitoring data recorded in Project Wells 1 and 2 from late-June until mid-November 2024, which includes intermittent pumping for irrigation during the growing season. These two hydrographs are provided as **Figures 2A and 2B** below.

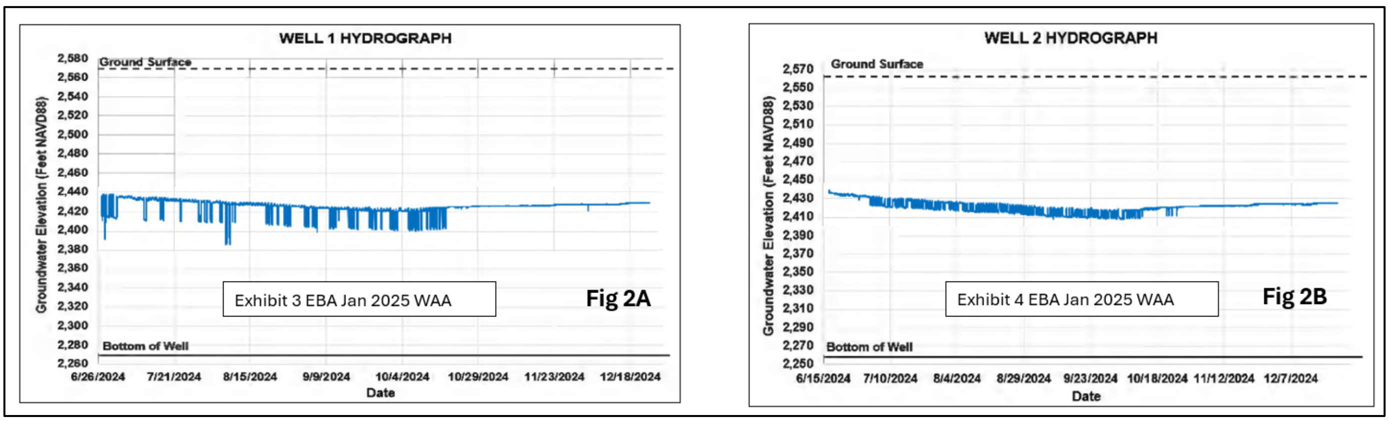


Figure 2. Hydrographs Showing Water Levels in Project Wells 1 and 2

Figure 3A and 3B, below, are zoomed-in versions of the same water level data, which was provided by the Applicant, with annotations and trend lines, are inserted below.

[1] F. Michael Krautkramer, Robinson, Noble & Saltbush, Inc., 2004, Fractured-rock Wells in the Pacific Northwest foothills: Not your average water source, *Washington State Ground Water Association Informational flyer,* which is included as Attachment B to this letter.

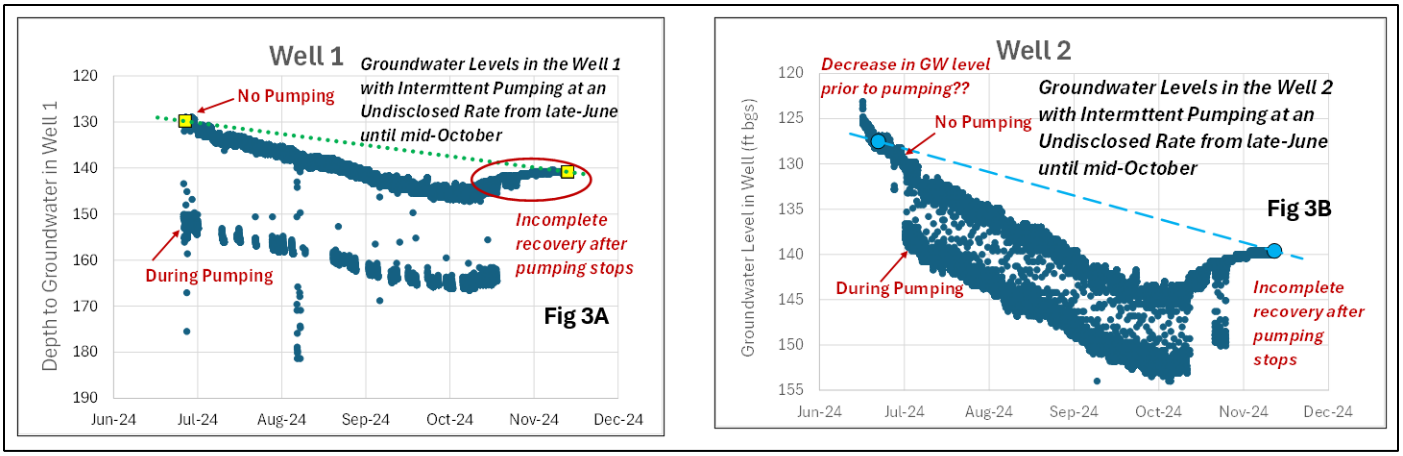


Figure 3. Zoomed-In Hydrographs Showing Water Levels in Project Wells 1 and 2

Unfortunately, the pumping rate data and/or total volume pumped with time at each of the two wells, which would facilitate analysis of the hydraulic properties of the fractured rock aquifer, are not provided. Nonetheless the monitoring data clearly document decreasing trends of water levels in the two wells and incomplete recovery to pre-pumping water levels when pumping is terminated after the irrigation season.

EBA states (Jan 2025 WAA, last bullet of the Conclusions Section, pg 23): "Groundwater elevations in Well 1 and Well 2 declined approximately 17 and 21 feet, respectively, from June through October, and gained back approximately 9 and 10 feet, respectively from October through December under non-pumping conditions." Slightly different changes in groundwater level are estimated from the zoomed-in versions, which include a shorter duration of the data after pumping stopped. The estimates are provided for both versions in **Table 1**, below. Approximately 1month after pumping stopped, the recovery is 25% to 33% of the decrease in during the irrigation pumping period. And after an additional month without pumping, the recovery is approximately 50% of the decrease in during the irrigation pumping period. **In all cases the recovery is far less than 95% of the decrease during the period with pumping**.

Table 1.
Estimates of Decreases in Water Levels in Wells 1 and 2 During the Irrigation Season and Subsequent Recovery

Project Well	Decrease in Groundwater Level with Pumping from late-June until mid-Oct (ft)	Increase During ~2 Months (EBA) or ~1 Month (Geosyntec) after Pumping Stopped in mid-Oct (ft)	Recovery as Portion of Decrease in GW Levels During Pumping
	Reported in EBA Jan 2025 WAA		
Well 1	17	9	53%
Well 2	21	10	48%
	Estimated by Geosyntec from the Data Provided		
Well 1	15	5	33%
Well 2	16	4	25%

The trend lines of the groundwater levels included on **Figures 3A and 3B**, above, which are fitted to the non-pumping water levels at the start and of the irrigation season and after ~one month of recovery when pumping was terminated, are extrapolated forward in time beyond June 2028 on **Figure 4**, below. Assuming similar pumping each irrigation season**, the extrapolated linear trends show groundwater levels dropping below the top of the well screens in Well 1 and Well 2 in 2028 and 2026, respectively.** As the groundwater levels drop below the top of the well screens, the yields of the wells are likely to decrease, and the groundwater levels are likely to drop more quickly.

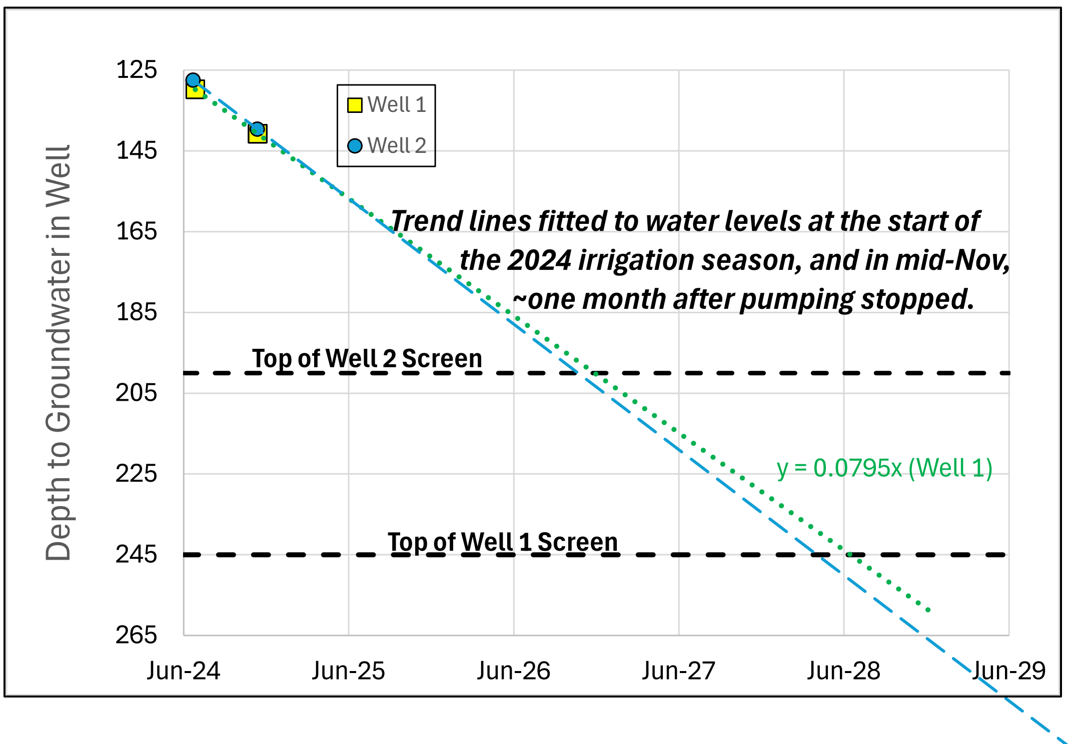


Figure 4. Extrapolated trendlines of groundwater levels recorded in Wells 1 and 2 during 2024 (see Figure 2A and 2B, above)

Additional water level data for Wells 1 and 2, such as for 2025 would be helpful and facilitate refinement of this analysis. Also, operational data from other wells that have been used during several previous years of operation of the Pasta Farms Facility would be helpful.

4. Estimates of Available of Groundwater Beneath the Project Site and Surrounding Area Are Too High

The calculations of estimated groundwater available in storage beneath the Project Site provided on page 11 of the EBA Jan 2025 WAA are too high because the aquifer thickness the specific yield values should be lower. For groundwater under confined conditions the static groundwater level is above the top of the aquifer because the groundwater is pressurized. The depth at which first groundwater was observed during drilling, is likely a more reliable indication of the top of the aquifer. And the screened interval or production wells is commonly used as an estimate for the aquifer thickness. Also, the Specific Yield (Sy) value of 7 percent, which is the drainable volumetric portion of groundwater in the aquifer, is optimistically high.

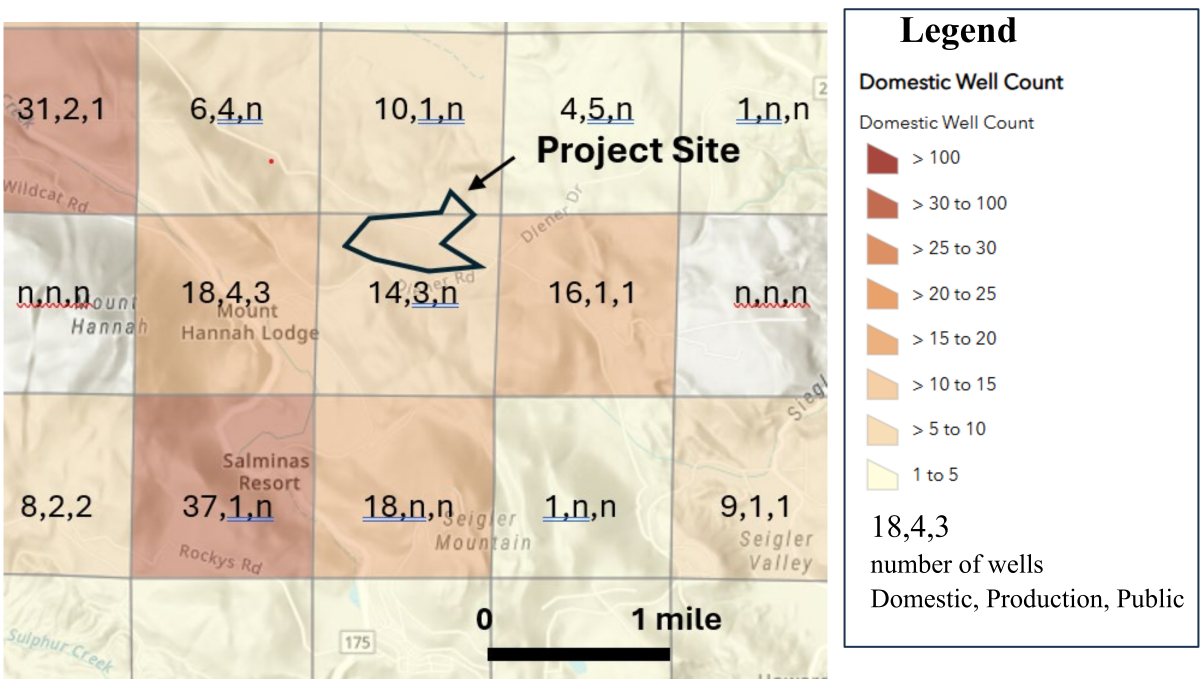
The reported estimate a groundwater storage capacity of 6,593 acre feet (AF) in the fractured rock aquifer beneath the Project Site uses an aquifer thickness of 156 ft and a specific yield of 7 percent. Using an average value for aquifer thickness of 72.5 ft based on the screened intervals and depth of first water encountered during drilling of wells at the Project Site, and a specific yield value of 5 percent the groundwater storage capacity would be 2,184 AF. More importantly, as stated in the on page 13 of the EBA Jan 2025 WAA, "**it is not likely that the entire amount of groundwater in storage can be efficiently extracted.**"

Similarly, the reported estimate of the quantity of available groundwater beneath the surrounding area (cumulative impact area, CIA) is too large. However, the extent of the CIA based on the radius of influence of the project pumping is flawed, as discussed below.

5. Basis of the Reported Extent of Influence of Project Pumping is Flawed

Section 5.5 (page 18) of the EBA Jan 2025 WAA presents calculations of the extent of influence of the proposed project pumping, beyond which the lowering of groundwater levels would be less than one foot. The aquifer hydraulic properties for the calculations are based on a 4-hour pumping test, which is much too short to provide valid estimates of the aquifer hydraulic properties. Moreover, water levels recorded in Well 4 during to pumping at Well 1 were used for the estimates of the aquifer properties, but the top of the screened interval of Well 4 is approximately 100 feet shallower than the top of Well 1, and the bottom of the screened interval of Well 4 is 40 feet higher than the top the screened interval of Well 1. In other words, the two wells are screened in entirely different depth intervals. Accordingly, the response in Well 4 to pumping from Well 1 is expected to be substantially less than would be observed if Well 4 were screened within the same interval as Well 1.

Most importantly, the calculation of extent of influence of pumping is based on only 515 minutes (8.6 hours) of pumping, which would be the daily duration of pumping from the two project wells to meet the maximum daily demand during the irrigation season. Accordingly, as stated on page 20 of the EBA Jan 2025 WAA, **"the analysis assumes 95 percent recharge [recovery] in the respective wells before initiating the next pumping cycle." But, as clearly documented by the water level monitoring data presented above, this assumption is not valid.** The cumulative influence of pumping cycles and potential impacts to the numerous wells in the general area must be considered. **Figure 4**, below, shows well densities in square mile sections in the vicinity of the Project Site.



Source: https://dwr.maps.arcgis.com/apps/webappviewer/index.html?id=181078580a214c0986e2da28f8623b37

Figure 5. Well Density Map

6. <u>Reported Estimates of Recharge to Groundwater are Too High</u>

Section 5.2 of the EBA Jan 2025 WAA presents calculations of the estimated recharge rate to groundwater beneath the Project Site. The annual water demand of 107.37 is reported to be approximately 8.9 percent of the average annual recharge rate to groundwater. As shown in Table 2 below, this would mean that the average annual recharge rate to groundwater is 46% of average annual rainfall, which is far too much (on the order ten times too much).

Table 2.
Calculation of Reported Recharge as a Portion of Average Rainfall

Project Site area	602	acres
avg annual rain fall	52.4	in/yr
avg annual rain on the Project Site	2628.3	AFY
annual project water demand	107.3	AFY
avg recharge if demand is 8.9%	1205.3	AFY
avg recharge as percent of avg rainfall	46%	

Also, the groundwater source is within fractures in volcanic bedrock hundreds of feet below the ground surface. The source of recharge is likely from locations hundreds or thousands of feet from the Site where the bedrock fracture system is closer to the ground surface. Much of the recharge likely takes decades or even centuries to reach the well at the site. And a small portion of precipitation at the site that percolates into the ground at the Site would take many decades to reach groundwater hundreds of feet below.

COMMENTS ON COMPLIANCE WITH REQUIREMENTS OF CEQA AND CA DEPT OF CANNABIS CONTROL

7. <u>Local Agencies Have Authority to Require Appropriate Testing of Well Yields to Meet the Project Water Demand</u>

For projects that are subject to the CEQA, such as the proposed expansion of the Pasta Farms Facility, that the local agency has authority to require appropriate site-specific testing of wells or operational data to demonstrate that the wells can meet the water demand of the proposed projects with less than significant impacts to groundwater resources and ecosystems.

But the evidence before the Commission does not include any long-term testing data, which in my opinion is necessary to support the findings regarding sustainable groundwater supply, potential impacts to the environment and neighboring water resources, fire protection, and associated CEQA compliance. Water levels data for the Project Wells 1 and 2, however, does establish that the wells do not recover adequately following one season of irrigation pumping.

The North Coast State Water Resources Control Board Well Capacity Determination Methods for Wells in Bedrock would be an appropriate testing method of the yields from the Project Wells. The document is provided as Attachment C and can also be accessed from the internet with this link: 9b_well_capacity_determination_bedrock.pdf

8. A Formal SB 610 Water Supply Assessment is Required if the Project Facility Occupies more than 40 Acres of Land

The CA Water Code Section 10912(a) requires a formal water supply assessment when a city or county determines a proposed project is subject to CEQA, which Pasta Farms proposed expansion is, and the proposed project is covered by the definitions of "project" in Water Code Section 10912(a).

The definition of a project subject to SB 610 Water Supply Assessment includes a manufacturing or processing facility that occupies more than 40 acres of land, which likely applies to the Pasta Farms Facility. The proposed cannabis canopy alone is 30 acres, and the Project Site is 602.5 acres.

Precedent was established for a composting facility that was ruled to be subject to a formal WSA per Water Code Section 10912(a), see the following link to an internet website: https://www.hklaw.com/en/insights/publications/2010/09/ceqa-update-water-supply-assessment-case-injects-u

9. Comments from the CA Department of Cannabis Control

The letter from the CA Department of Cannabis Control (DCC) indicates that the IS/MND needs to "address cumulative impacts from groundwater diversions on the health of the underlying aquifer, including impacts on other users and impacts on stream-related resources connected to the aquifer".

And the Project would require one or more annual cannabis cultivation licenses from DCC.

CONCLUSIONS

In conclusion, the evidence before the Commission and Board of Supervisors is insufficient to demonstrate (1) an adequate sustainable source of groundwater to meet the project demands, and (2) to support the required finding that all potential impacts associated with the project can be mitigated to a less-than-significant level. At a minimum, the unresolved questions regarding sustainability of the proposed groundwater supply, and potential cumulative impacts on groundwater resources justify the necessity of additional credible evidence, analysis, and review in accordance with the CEQA before potential approval of the project.

Respectfully,

PROFESSIONAL GEOLOGIST
GORDON THRUPP
No. 541
CERTIFIED
HYDROGEOLOGIST
Exp. 2/29/28
STATE OF CALIFORNIA

Gordon Thrupp, PhD, PG, CHG

Attachments:

A. Resume for Gordon Thrupp, PhD, PG, CHG
B. Washington State Ground Water Association Informational Flyer: Fractured-rock Wells in the Pacific Northwest Foothills: Not your average water source
C. Well Capacity Determination Methods, North Coast Regional State Water Resources Control Board

Copies by email to:

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Duncan Gamlen, Fire Marshal for Adidam Holy Domains Sanctuary in Lake County, duncan@gamlen.net

Attachment A

Geosyntec consultants

GORDON THRUPP, PhD, PG, CHG

hydrogeology and geology
aquifer testing and groundwater modeling
sustainable development of groundwater resources
site characterization and remedial design
litigation support

EDUCATION

PhD, Earth Sciences, University of California, Santa Cruz, 1987
BS, Geology, Stanford University, Stanford, California, 1980

REGISTRATIONS AND CERTIFICATIONS

Professional Geologist (PG), California, Number 5849
Certified Hydrogeologist, California, Number 541
Registered Geologist, Arizona, Number 58233

CAREER SUMMARY

Gordon Thrupp, PhD, has over 30 years of experience as a consulting hydrogeologist. He is an expert in quantitative analysis of flow of groundwater and soil gas. For numerous projects, he has conducted hydrogeologic evaluations and developed groundwater flow models as tools for assessing water resources and engineering design alternatives, designed wells and hydraulic testing programs, and evaluated aquifer-testing and stream flow data. Gordon's areas of expertise include evaluation of sustainable yield of groundwater resources, investigation of the potential for contaminant migration, and conceptual design of remediation alternatives for soil and groundwater. Examples of Gordon's experience follow with focus on evaluation of sustainable production of groundwater from bedrock wells, testifying at public hearings and legal proceedings.

Neutral Expert for Evaluation and Mediation of Influence of Pumping from Bedrock Wells on Spring Flows, *San Diego County, California*. Gordon was engaged as a neutral expert to advise a judge in arbitration proceedings regarding claims that pumping from bedrock wells completed in the Elsinore Fault Zone interfered with spring flows in a nearby canyon to which one party has water rights. He reviewed hydrogeology, historical data, aquifer tests of wells, and expert reports prepared for each party. Gordon specified aquifer testing and monitoring procedures and analyzed the data. He attended hearings, was deposed, and specified an interim solution that entailed delivery of a portion of the water pumped from the wells to the party with rights to the spring flows that was based on the impact to the springs demonstrated by the testing.

Water Supply Sustainable Yield Assessment at a Proposed Subdivision, *San Luis Obispo County, California.* Gordon was engaged by SWCA Environmental Consultants to conduct a third-party review for San Luis Obispo County of an assessment of sustainable yield for the Laetitia Agricultural Cluster Subdivision–a proposed development totaling 1,800 acres with 102 1-acre residential lots. Groundwater pumped from four wells completed in fractured bedrock was proposed as the sole water supply for the project. Gordon evaluated hydrogeology, lithologic logs, well construction, production data, and hydrographs; analyzed three phases of pumping tests to estimate sustainable groundwater pumping capacities; and determined that previous estimates of production potential of the wells based on short-term tests were unrealistically high. In addition, Gordon evaluated potential influence of groundwater pumping on the base flow of an adjacent creek. For a more sustainable water supply with reduced impact on the local riparian corridor ecosystem, he recommended curtailment of pumping from July through November for a well with connection to the base flow of a creek. Gordon presented the findings at several public hearings.

Review and Testimony of Modeling of Slant Well Subsurface Intakes at Proposed Desalination Facility, Monterey Regional Water Authority, Monterey Peninsula Water Supply Project, *Monterey, California.* Gordon reviewed hydrogeology and groundwater modeling of slant well subsurface intakes as documented in draft environmental impact reports for the proposed Monterey Peninsula Water Supply Project. He also prepared rebuttal testimony and was cross-examined during legal proceedings before the California Public Utilities Commission related to the project.

Feasibility Study of Water Wells to Replace Canal Diversions for Irrigation Water, Pacific Gas and Electric Company (PG&E), *Butte County, California.* On behalf of PG&E and in collaboration with the Butte County Department of Water and Resource Conservation, Gordon evaluated the feasibility of new groundwater wells to replace irrigation water supplied by diversions from a canal originally used for hydroelectric power. The scope of work included characterizing diversions from the canal; estimating the likely yield of wells in the project vicinity and the number of wells required to replace water diverted from the canal; and evaluating the feasibility, including costs, to install wells. The hydrogeology and well yield analysis included review of Department of Water Resources (DWR) well completion reports for 131 wells and hydraulic properties assigned to the Butte Basin Groundwater Model. Gordon developed a probabilistic assessment of well production potential based on the existing production data. Based on the hydrogeologic setting and typical water well yields in the vicinity, Gordon determined that wells are likely not feasible for replacing the water diverted from the canal.

Groundwater Resources Evaluation at the El Toro Area, Monterey County, *California.* Gordon directed an evaluation of groundwater resources. Tasks included compilation, review, and evaluation of existing geologic and hydrologic data, including available information for over 100 water wells. The objective was to evaluate groundwater resource capacity, and as appropriate recommend revisions to the extent of zoning that restricts development.

Groundwater Production Capacity and Impact Study, Confidential Client, *Briones Hills, California.* Gordon evaluated groundwater production capacity of fractured bedrock for a proposed development in the Briones Hills Agricultural Preserve. He reviewed an aquifer testing analysis that was done in support of the proposed development. The aquifer testing analysis was technically flawed and did not support that the new well could sustain the design flow rate for the proposed project. Gordon advocated that the aquifer test should not be used in support of a mitigated negative declaration for environmental impact.

Water Resource Capacity Study, San Luis Obispo County*, Nipomo Mesa, California.* Gordon conducted a groundwater resource capacity evaluation of the Nipomo Mesa area for San Luis Obispo County Departments of Planning and Public Works. The project included reviewing DWR reports, consultant's reports, and regional groundwater models; compiling hydrogeologic data for the area; variable-density flow modeling with SEAWAT to evaluate sea water intrusion for a range of pumping rates; and making recommendations to San Luis Obispo County that were used to determine appropriate limits on growth rates and development on Nipomo Mesa. Gordon presented his findings at public hearings.

Water Supply Feasibility Study and Preliminary Engineering Report, Josephine County, *Oregon.* In the Illinois Valley, domestic wells were the sole source of drinking water for the town of Kerby. Historically, water in an irrigation ditch provided recharge to shallow alluvial aquifers and sustained the production from many of the domestic wells, but many wells dried up when diversion from the Illinois River to the ditch was stopped. Water quality was a serious health concern where separation distances between septic systems and wells was inadequate. Gordon evaluated alternatives for a community drinking water supply, including a system of community wells, a reservoir in a local drainage, diversion from the Illinois River, and connection to a municipal system at the adjacent City of Cave Junction. He prepared preliminary design and cost estimates for each alternative. Connection to the Cave Junction Municipal Water System was recommended as the most reliable and cost-effective solution.

Review of Groundwater Modeling of Sea Water Intrusion, Confidential Client*, Monterey County, California.* Gordon provided technical modeling expertise supporting litigation regarding seawater intrusion into aquifers caused by groundwater pumping. He evaluated the design of a proprietary variable-density groundwater flow and transport model that was developed to predict seawater intrusion into aquifers because of proposed increases in the development of groundwater supply along the coastal margin in the Monterey Bay Area.

Review of Hydrogeologic Report and Well Testing*, Minor Subdivision, Carmel Valley Highlands,* Gordon provided third-party review of aquifer testing and estimated production capacity of a well in fractured bedrock in the Carmel Hills that was proposed as the sole water supply for a proposed development.

Aquifer Pumping Test and Groundwater Production Assessment, City of Poway, *Poway, California*. Gordon directed a pumping test to assess the potential yield of a groundwater well completed in bedrock and evaluation of the groundwater quality and production capacity of the well for irrigation of a public park. Gordon recommended an operation schedule and maximum drawdown to prevent dewatering of the water bearing fractures.

Bedrock Irrigation Well Feasibility Study, Tamalpais Valley Community Service District, *Marin County, California*. Gordon conducted a feasibility study of installing wells at community facilities to provide irrigation water. He compiled and reviewed geologic data, including 70 well logs, and evaluated irrigation water needs and costs for well installation. Based on geologic information and statistical analyses of well production data, Gordon determined that the probability was greater than 75% that a single well installed to a depth of approximately 200 feet in Tam Valley would produce enough water of adequate quality to meet the irrigation needs at community facilities.

Fate and Transport Evaluation of Infiltrated Wastewater in Groundwater, Confidential Client, *Klamath Falls, Oregon.* Dr. Thrupp compiled and evaluated hydrogeologic data in the vicinity of wetlands and ponds to which wastewater is discharged near the Klamath River. He developed a three-dimensional groundwater flow model with MODFLOW and MODPATH to evaluate the fate and transport of the infiltrated effluent. Calculations with the groundwater model indicated that a negligible portion of the infiltrated discharges to the Klamath River and the vast majority that is not removed by evapotranspiration flows downward with groundwater and beneath the river due to a regional pumping at depth.

Feasibility Evaluation of Subsurface Seawater Intakes at Proposed Desalination Facilities, Poseidon Water and West Basin Water District, *Huntington Beach and El Segundo, California.* Gordon directed compilation and evaluation of geologic, hydrogeologic, geotechnical, and offshore geophysical data for the San Pedro and Santa Monica shelves and coastal margins near proposed desalination facilities, which require seawater intake rates of 127 million gallons per day (MGD) and at least 40 MGD, respectively. Gordon directed development of MODFLOW groundwater flow models as tools to evaluate the feasibility and likely number of wells required to achieve the design intake rate for options including a series of vertical beach wells and slant wells, radial collector wells, and horizontal wells extending beneath the coastal margin. The models were also used to evaluate potential for pumping from the subsurface intakes to lower the water table near coastal margin and draw water from inland aquifers. Gordon also directed evaluations of alternate sites for subsurface intakes along the coastline of Santa Monica Bay and Orange County in accordance with the California Ocean Plan, and presented at public hearings.

Basin Evaluation and Water Supply Feasibility Study, Soquel Creek Water District, *California.* Gordon evaluated alternatives to enhance the water supply in the Soquel Creek Water District. Alternatives included additional groundwater pumping, enhancement of recharge, a shared County desalinization plant, diversion from Soquel Creek or exchange of water with an adjacent district, and groundwater banking with aquifer storage and recovery (ASR) wells. The project was part of an environmental impact study for a required California Environmental Quality Act (CEQA) process involving several consulting firms and agencies. In 2017, Gordon was a member of an independent advisory panel convened by the National Water Research Institute (NWRI) for the District's PURE Water Soquel Groundwater Replenishment Project.

Water Supply Assessments, other Technical Studies and Peer-Review for Environmental Impact Reports for Proposed Projects**, **Several CEQA Projects, Clients include Consulting Firms, Municipalities, and Developers.

Construction Dewatering Modeling for Sub-Grade Parking Garage, Sares Regis, *Belmont, California.* Gordon reviewed local geology, boring logs, and groundwater monitoring data and developed analytical and numerical dewatering models. The models were calibrated to influx to a test pit to estimate construction groundwater inflow during excavation into fractured bedrock for a mixed commercial and residential development. In addition to estimating flows during construction dewatering, the model was used to estimate long-term groundwater influx rates into a sub-grade drainage system for the garage for design and permitting.

Evaluation of Reservoir Seepage, Confidential Client, *Escondido, California.* Gordon developed a three-dimensional numerical model to simulate groundwater seepage from a proposed reservoir for storage of recycled water in a bedrock excavation at Harmony Grove Village. The model served as a tool to estimate and compare seepage rates into bedrock from the reservoir with different liner options. The design of the model was based on regional hydrogeology, site-specific hydrogeology and topography, and previous groundwater modeling in the vicinity. The model was also used to evaluate potential flow influence of leakage from the reservoir on Escondido Creek.

Modeling of Influx of Groundwater and Surface Water at the Aromas Quarry, Graniterock, *San Benito County, California.* Gordon directed the development models to evaluate flux of groundwater and stormwater into a large quarry in granitic rock. Geosyntec also conducted bench-scale testing of both anaerobic and aerobic degradation of benzene in water and sediment samples from the bottom of the quarry, which is associated with naturally-occurring petroleum hydrocarbon deposits near the quarry. The modeling and analyses provided evaluation of the rate of influx of groundwater and petroleum hydrocarbons with increasing depth of the quarry, potential impact on the adjacent river, water balance for the final pit, and the long-term water level in the quarry and concentration of benzene in the water. The long-term hydrologic condition and potential concentration of benzene and other hydrocarbons in the water in the pit are important components for development of a reclamation plan required for regulatory permitting.

Evaluation of Failed Construction Dewatering, Confidential Client, *San Diego, California.* For a construction dewatering project, Gordon developed a calibrated numerical groundwater model using MODFLOW for litigation support of changed conditions of permeability. The model also served as a useful tool to design a successful dewatering approach after the initial dewatering effort failed.

Groundwater Influx Management for Open-Pit Mines, Multiple Projects, Multiple Clients, *Australia.* For three open-pit coal-mines in New South Wales, and two in Queensland, Gordon evaluated hydrogeology, conducted aquifer testing, and developed calibrated regional finite-element groundwater flow models as tools for mine dewatering design. The models were used to help design advance dewatering alternatives and to assess possible impacts on a nearby major river of a mine in the Hunter Valley.

Hydrogeologic Evaluation for Proposed Gold Mining Activities, Confidential Client, *Northern Territory, Australia.* Gordon performed hydrogeologic evaluations for an environmental impact assessment of proposed gold mining activities at Coronation Hill in Kakadu Park, a world heritage site. He developed a numerical model of groundwater flow through fractured bedrock to assess the possible impact on a nearby river and feasibility of a water supply well for ore processing. Gordon assessed the potential for cyanide in a tailings pond to reach the river.

Litigation Support and Expert Review of Concrete Degradation Model, Confidential Project and Client, *Confidential Location.* Gordon reviewed a numerical model that simulated solute advection, diffusion, and chemical reaction in concrete. The model was intended to predict future degradation of concrete. Gordon's expert declaration challenging the reliability of the model helped eliminate the model as litigation evidence.

PROFESSIONAL EXPERIENCE

Geosyntec Consultants, San Francisco, California, 2005–Present
S.S. Papadopoulos & Associates, 2000–2005
Geomatrix Consultants, Inc., 1992–2000
Mackie Martin & Associates, Sydney, Australia, 1990–1992
Macquarie University, Sydney, Australia, 1990

Macquarie University/CSIRO, Sydney, Australia, 1987–1990
University of California, Santa Cruz, California, 1980–1987
Texas Testing Laboratories, San Antonio, Texas, 1980
Conoco, Inc., Falls City, Texas, 1979–1980
Stanford University, Stanford, California, 1978
United States Geological Survey, Menlo Park, California, 1977–1979

AFFILIATIONS

National Groundwater Association
Groundwater Resources Association of California
Association of California Water Agencies
California Water and Environmental Modeling Forum

REPRESENTATIVE PUBLICATIONS

Gordon has published several articles in major journals or books and over 25 abstracts in proceedings for professional conferences. A selection follows:

25-01 Thrupp, G., J. Lottig, 2025 (*in press*). "Air injection barrier to mitigate migration of soil vapor with chlorinated volatile compounds away from an industrial waste landfill", Proceedings, *Sardinia 2025: 20th International Landfill Symposium*, CISA, Cagliari, Italy.

18-01 McAlary, T., J. Gallinatti, G. Thrupp, W. Wertz, D. Mali, and H. Dawson. 2018. "Fluid Flow Model for Predicting the Intrusion Rate of Subsurface Contaminant Vapors into Buildings." *Environmental Science and Technology.* vol. 52, issue 15, pp. 8438-8445.

16-01 Thrupp, G., J. Chambon, and M. Kavanaugh. 2016. "Site-Specific Hydrogeologic Investigation and Groundwater Modeling to Evaluate Feasibility of Subsurface Intakes for Ocean Water Desalination." *Abstract for Poster Presentation at University of California, Davis State of Science and Policy Workshop: Weathering Change: The Impact of Climate and the Sustainable Groundwater Management Act on California's Water.* 4-5 April.

11-01 Suchomel, E., M. Verwiel, and G. Thrupp. 2011. "A New Method for Calculating Waste Acceptance Criteria for Soil and Landfill." Proceedings, *Sardinia 2011: 13th International Waste Management and Landfill Symposium*, eds., R. Cossu et al., CISA, Cagliari, Italy.

10-01 McAlary, T., P.J. Nicholson, L.K. Yik, D.M Bertrand, and G. Thrupp. 2010. "High Purge Volume Sampling–A New Paradigm for Sub-slab Gas Monitoring." *Ground Water Monitoring and Remediation*, vol. 30, issue 2, pp. 73-85.

10-02 Nicholson, P., D. Bertrand, T. McAlary, and G. Thrupp. 2020. High purge volume tests for managing variability in sub-slab soil gas. Air and Waste Management Association–Vapor Intrusion. Vol 2. January.

08-01 Pearson, A., B. Janke, G. Thrupp, G. Criollo, and H. Franklin. 2008. "Spatial Analysis of Groundwater Resources in El Toro, Monterey County." *AWRA 2008 Spring Specialty Conference–GIS and Water Resources V*, San Mateo, California. Abstract and poster. 17-19 March.

08-02 Thrupp, G., J. Fortuna, H. Franklin, and P. Kwiek. 2008. "Evaluation of Groundwater Resources for Sustainable Development, El Toro Planning Area, Monterey County, California." Abstract accepted for *AWRA 2008 Annual Water Resources Conference*, New Orleans. November.

07-01 Morel, D., M. Verwiel, G. Thrupp, and W. Fowler. 2007. "Study of Basalt Dikes Influence on Groundwater Flow, Waimanalo Gulch Sanitary Landfill, Oahu, Hawaii." Proceedings, *Sardinia 2007: Eleventh International Waste Management and Landfilling Symposium*, eds. R. Cossu, L. Diaz, R. Stegmann, CISA, Cagliari, Italy.

05-01 Thrupp, G., and J. Oster. 2005. "Beware of Limitations of Jacob Methods for Aquifer Analyses." *California Water & Environmental Modeling Forum (CWEMF) Annual Meeting*, Monterey (Asilomar), California. March. Abstract and poster.

04-01 Thrupp, G., and C. Neville. 2004. "Modeling Tidal Dilution of Groundwater Discharging to Surface Water." *California Water & Environmental Modeling Forum (CWEMF) Annual Meeting*, Monterey (Asilomar), California. February. Abstract and poster.

02-01 Neville, C., G. Thrupp, and M. Riley. 2002. "Modeling Tidal Dilution of Groundwater Discharging to San Francisco Bay." *Geological Society of America Cordilleran Section Meeting*, Corvallis, Oregon, Abstracts with Programs, vol. 34, no. 5, pp. A-111. May.

01-01 Verwiel, M., G. Thrupp, S. Purdy, and S. Rogers. 2001. "Landfill Expansion Beneath the Water Table in Central Arizona." Proceedings, *Sardinia 2001: Eighth International Waste Management and Landfill Symposium*, eds. T.H. Chirstensen, R. Cossu, R. Stegmann, CISA, Cagliari, Italy, vol. 4, pp. 77-86.

99-01 Thrupp, G., J. Lamborn, and T. Delfino. 1999. "Landfill Gas Generation Rates Estimated from Pressure Rebound in Extraction Systems." Proceedings, *Sardinia 99: Seventh International Landfill Symposium*, eds. T.H. Chirstensen, R. Cossu, R. Stegmann, CISA, Cagliari, Italy, vol. 3, pp. 449-456.

98-01 Thrupp, G., J. Baker, and J. Gallinatti. 1998. "Leakage Controls Radius of Influence of Landfill Gas Extraction Wells." Proceedings, the *20th International Madison Waste Conference*, pp. 363-372.

96-01 Thrupp, G., J. Gallinatti, and K. Johnson. 1996. "Tools to Improve Models for Design and Assessment of Soil Vapor Extraction Systems." *Subsurface Fluid-Flow Modeling,* ASTM STP 1288, eds. J.D. Ritchey and J.O. Rumbaugh, American Society for Testing and Materials, Philadelphia, pp. 268-285.

94-01 Thrupp, G., L. Edwards, K.A. Johnson. 1994. "Tracer Experiments to Investigate Soil Gas Flow Associated with Soil Vapor Extraction." *EOS, American Geophysical Union Transactions*, vol. 75, no. 44, pp. 276.

94-02 Thrupp, G., and L. Edwards. 1994. "Implementation of Soil Gas Tracer to Assess and Optimize the Performance of Soil Vapor Extraction Systems." *Groundwater*, vol. 32, pp. 859-860.

94-03 Thrupp, G., and D. Wuthrich. 1994. "Earthquake-Induced Water Level Fluctuation Recorded in Chino Basin Wells." *EOS, American Geophysical Union Transactions*, vol. 75, pp. 103-104.

93-01 Gallinatti, J., G. Thrupp, and D. Wuthrich. 1993. "Horizontal to Vertical Anisotropy of Hydraulic Conductivity in an Alluvial Fan Aquifer." *EOS, American Geophysical Union Transactions*, vol. 74, pp. 273-274.

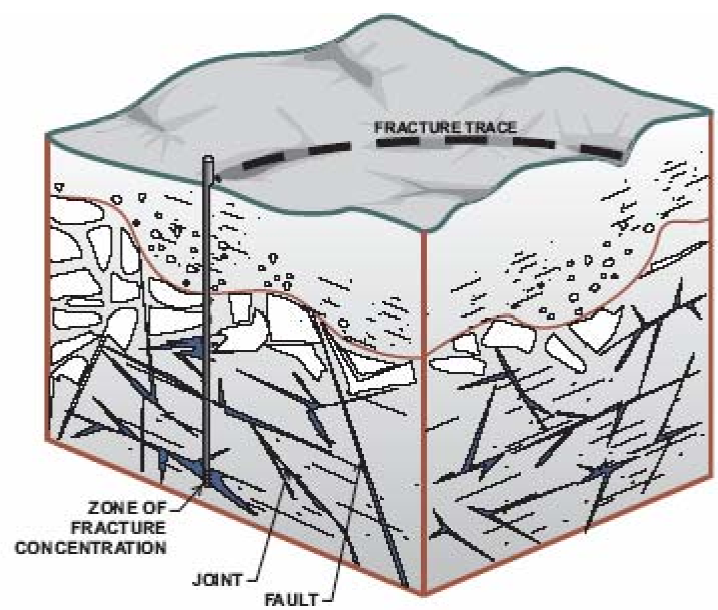
Attachment B

Fractured-rock Wells in the Pacific Northwest foothills: Not your average water source

By: F. Michael Krautkramer, Robinson, Noble & Saltbush, Inc.

Very generally, there are three different geologic settings that support water wells in the Pacific Northwest. The most common setting is unconsolidated sediments laid down by glaciers and rivers (or other erosional processes). While the aquifers formed in these sediments can vary, this setting is clearly the most successful in providing ground water. The next major setting, mostly found east of the Cascade Mountains, is the regionally extensive basalts like those of the Columbia Plateau. Wells completed in the basalts (or more accurately between the basalt flows) can also be highly variable, but the current understanding of the geometry and hydrogeology of the basalt layers provides some certainty to water development projects. The final geologic setting is much more enigmatic: the fractured-rock groundwater environment of the mountain foothills (particularly the Coast Ranges or Cascades). While wells completed in fractured rock are invaluable in many areas as a source for domestic wells, and occasionally serve as a reliable source for higher production, they tend to be less predictable and less reliable than other wells. The reason lies in the fundamental difference in the way fractures-rock aquifers transmit water.

The ability to transmit water (permeability) in an unconsolidated aquifer is a result of the interstitial spaces (pore spaces) between each individual clast of sediment and the degree to which these spaces are connected to one another. As such, there is a significant amount of open area through which water can flow (typically 10% to 30%). What is more, these characteristics are usually found consistently over a significant lateral extent. Similar characteristics can be found in some rock settings, such as sandstone, where significant amounts of water can flow through the spaces inherent in those types of rock. In hydrogeology, this is called the “primary permeability” of the material.



In a fractured-rock environment, such as found in the foothills of the Cascades and the Coast Ranges (and below the sediment cover elsewhere in the Pacific Northwest), the primary permeability is extremely low. Almost no water at all can pass through the rock itself, so water can only be transmitted through cracks and fractures that result from the folding and faulting of the rock over time. Fractures create “secondary” permeability. Aquifers which rely on secondary permeability generally have much lower capacity to transmit water. This lower capacity results from both a smaller amount of open space (the size of the fracture) and a smaller lateral extent of the aquifer (fracture zones are not consistent throughout the rock), as compared to the primary permeability found in sediments. As a consequence, many rock wells are limited in the amount of water that they can reliably produce in the long term. Typically, these wells can have an apparent production during short-term testing that is higher than the actual amount that can be supported by the surrounding fracture-rock aquifer. As a result, the incidence of “well failure” is much higher in fractured rock wells than in other settings.

As if the poor ability to transmit water isn’t enough, such settings also usually have difficulty collecting and storing water to transmit. In fractured-rock environments, an appreciably lower percentage of the precipitation over the area ends up getting into the groundwater system. This means that a smaller volume of water is available annually throughout the region served by an aquifer. This concept is known as the aquifer water budget. When more water is being removed through the wells in a region than is recharged from the precipitation (and other sources), the water levels in the wells of that region fall through time. If this is a chronic problem, eventually some or all of the wells become unable to produce water at the rate necessary to meet their demand.

Between the production constraints imposed by permeability issues in fractured-rock and the inherent water budget issues, caution must be used in the use of fractured-rock wells. Monitoring of the water levels and production of a rock well is essential, as is being aware of the regional-level changes (such as: is it a low water year? are neighboring wells experiencing similar patterns of change?). It is easy to be fooled into thinking a fractured-rock well will have a sustainable level of water production based on the initial (short-term) testing. Since these aquifer systems are unique, predicting a long-term production rate takes more care and often cannot be determined just from the testing done when the well is completed. Clearly, when dealing with this type of rock well, forewarned is forearmed – more than one vacation dream property has lost its value when the well gave out. Whether operating a water system or a single well for a home in the hills, keeping records of water levels and production will provide key information in defining a sustainable yield for fracture-rock wells.

The *Washington State Ground Water Association* is dedicated to technical and professional leadership in the advancement of the drilling and ground water industry. The Association produces these informational flyers to educate the public and its membership on the proper protection and use of ground water resources. The Association can be contacted at: (360) 757-1551 or online at www.wsgwa.org

Robinson, Noble & Saltbush, Inc. is a geologic and environmental consulting firm specializing in environmental property assessments and the development and protection of groundwater resources. The company has supported the well-drilling industry for over 20 years as a Technical Division member of the Washington State Ground Water Association. The author may be contacted at: (253) 475-7711 or by email at mkrautkramer@robinson-noble.com

State Water Resources Control Board
Division of Drinking Water
50 D Street, Suite 200, Santa Rosa, CA 95404

9B

https://www.waterboards.ca.gov/drinking_water/programs/districts/docs/sonoma/permit_forms/9b_well_capacity_determination_bedrock.pdf

Well Capacity Determination Methods for Wells in Bedrock
Bedrock formation is such that the water produced is yielded by secondary permeability features (e.g. fractures or cracks)

NOTE: These testing procedures are based on the California Code of Regulations, Title 22, Section 64554(g). Before beginning any well yield pump test, the Well Completion Report must be reviewed to determine if this is an alluvial or bedrock aquifer. Due to Sonoma volcanics and other formations, the determination often is not clear. It is recommended that you submit the Well Completion Report to this Division to determine the type of pump test procedures to be used.

Methods to determine the sustained yield of a well drilled in a bedrock formation are described below.

Method 1: Report, §64554(g)(1).
The public water system must submit a report for Division review and approval, proposing a well capacity based on well tests and the evaluation and management of the aquifer from which the well draws water. The report must be prepared and signed by a California registered geologist with at least three years of experience with groundwater hydrology, a California licensed engineer with at least five years of experience with groundwater hydrology, or a California certified hydrogeologist. Acceptance of the proposed well capacity by the Division shall, at a minimum, be based on the Division's review and approval of the following information presented in the report in support of the proposed well capacity:

1. The rationale for the selected well test method and the results;
2. The geological environment of the well;
3. The historical use of the aquifer;
4. Data from monitoring of other local wells;
5. A description of the health risks of contaminants identified in a Source Water Assessment, as defined in Section 63000.84 of Title 22, and the likelihood of such contaminants being present in the well's discharge;
6. Impacts on the quantity and quality of the groundwater;
7. How adjustments were made to the estimated capacity based on drawdown, length of the well test, results of the wells test, discharge options, and seasonal variations and expected use of the well; and
8. The well test(s) results and capacity analysis.

Method 2: Pumping Test, §64554(g)(2).
Before the testing:

1. Submit the following to the Division prior to conducting the well capacity test:
   a. The name and qualifications of the person who will be conducting the test;
   b. The proposed pump discharge rate;
   c. A copy of a United States Geological Survey 7 ½-minute topographic map of the site at a scale of 1:24,000 or larger (1 inch equals 2,000 feet or 1 inch equals less than 2,000 feet) or, if necessary, a site sketch at a scale providing more detail, that clearly indicates;
      I. The well discharge location(s) during the test, and
      II. The location of surface waters, water staff gauges, and other production wells within a radius of 1000 feet;
   d. A well construction drawing, geologic log, and electric log, if available;
   e. Dates of well completion and well development, if known;
   f. Specifications for the pump that will be used for the test and the depth at which it will draw water from the well;
   g. A description of the methods and equipment that will be used to measure and maintain a constant pumping rate;
   h. A description of the water level measurement method and measurement schedule;
   i. For wells located in or having an influence on the aquifer from which the new well will draw water, a description of the wells' operating schedules and the estimated amount of groundwater to be extracted, while the new well is tested and during normal operations prior to and after the new well is in operation;
   j. A description of the surface waters, water staff gauges, and production wells-shown in (c)(ii);
   k. A description of how the well discharge will be managed to ensure the discharge doesn't interfere with the test;
   l. A description of how the initial volume of water in the well's casing, or bore hole if there is no casing at the time, will be addressed to ensure it has no impact on the test results; and
   m. A written description of the aquifer's annual recharge.
2. Determine if the test will be conducted for 72 hours or 10 days. If the test is conducted for 72 hours, 25% of the pumping rate will be granted (An assigned well capacity may be revised by the Division if subsequent pumping data collected during normal operations shows that the assigned capacity is not representative of the actual well capacity.) If the test is conducted for 10 days, 50% of the pumping rate will be granted. (An assigned well capacity may be revised by the Division if subsequent pumping data collected during normal operations shows that the assigned capacity is not representative of the actual well capacity.)
3. Ensure discharge from the pump is piped far enough away to avoid recharge.

Conducting the testing:
During the months of August, September, or October, conduct either a 72-hour well capacity test or a 10-day well capacity test, and determine the well capacity using the following procedures:

1. Procedures for a 72-hour well capacity test:
   a. For the purpose of obtaining an accurate static water level value, at least twelve hours before initiating the next step, pump the well at the pump discharge rate proposed in step 1(b), Before the Testing, for no more than two hours, then discontinue pumping;
   b. Measure and record the static water level and then pump the well continuously for a minimum of 72 hours starting at the pump discharge rate proposed in step 1(b), Before the Testing;
   c. Measure and record water drawdown levels and pump discharge rate:
      I. Every thirty minutes during the first four hours of pumping,
      II. Every hour for the next four hours, and
      III. Every four hours thereafter until the water drawdown level is constant for at least the last four remaining measurements, and;
   d. Enter the measurements on the attached spreadsheet using the tab corresponding to the test performed. A plot will automatically be generated on the Graph tab corresponding to the test performed. If you choose not use the attached spreadsheet, plot the drawdown and pump discharge rate data versus time data on semi-logarithmic graph paper, with the time intervals on the horizontal logarithmic axis and the drawdown and pump discharge rate data on the vertical axis.

2. Procedures for a 10-day well capacity test:
   a. For the purpose of obtaining an accurate static water level value, at least twelve hours before initiating the next step, pump the well at the pump discharge rate proposed in step 1(b), Before the Testing, for no more than two hours, then discontinue pumping;
   b. Measure and record the static water level and then pump the well continuously for a minimum of 10 days starting at the pump discharge rate proposed in step 1(b), Before the Testing;
   c. Measure and record water drawdown levels and pumping rate:
      I. Every thirty minutes during the first four hours of pumping,
      II. Every hour for the next four hours,
      III. Every eight hours for the remainder of the first four days,
      IV. Every 24 hours for the next five days, and
      V. Every four hours thereafter until the water drawdown level is constant for at least the last four remaining measurements, and;
   d. Enter the measurements on the attached spreadsheet using the tab corresponding to the test performed. A plot will automatically be generated on the Graph tab corresponding to the test performed. If you choose not use the attached spreadsheet, plot the drawdown and pump discharge rate data versus time data on semi-logarithmic graph paper, with the time intervals on the horizontal logarithmic axis and the drawdown and pump discharge rate data on the vertical axis.

Recovery Data:
The well must demonstrate that, within a length of time not exceeding the duration of the pumping time of the pumping test (72 hours or 10 days), the water level has recovered to within two feet of the static water level measured at the beginning of the well capacity test or to a minimum of ninety-five percent of the total drawdown measured during the test, whichever is more stringent. If the well recovery does not meet these criteria, the well capacity cannot be determined using the proposed pump discharge rate.

1. To demonstrate meeting the recovery criteria, the following water level data in the well shall be measured, recorded, and compared with the criteria:
   a. Every 30 minutes during the first four hours after pumping stops,
   b. Hourly for the next eight hours, and
   c. Every 12 hours until either the water level in the well recovers to within two feet of the static water level measured at the beginning of the well capacity test or to at least ninety-five percent of the total drawdown measured during the test, whichever occurs first.

Well Capacity:
Following completion of a 72-hour or 10-day well capacity test, the well shall be assigned a capacity no more than:

- For a 72-hour test, 25 percent of the pumping rate at the end of a completed test's pumping. (An assigned well capacity may be revised by the Division if subsequent pumping data collected during normal operations shows that the assigned capacity is not representative of the actual well capacity.)
- For a 10-day test, 50 percent of the pumping rate at the end a completed test's pumping. (An assigned well capacity may be revised by the Division if subsequent pumping data collected during normal operations shows that the assigned capacity is not representative of the actual well capacity.)

Submittal to the Division:
A report must be submitted to the Division that includes, but is not limited to:

1. Pumping test methods and calculations.
2. Static water level, pump discharge rate, all recorded drawdown and recovery data from the attached spreadsheet. If a transducer is used, provide an electronic file of the transducer data.
3. Other pertinent observations associated with the well capacity test.
4. Plot of the drawdown, pump discharge rate, and time data.