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Memorandum

To: Andy Malone, Samantha Adams, Lauren Salberg, West Yost
Borrego Watermaster Members
Technical Advisory Committee Members
Geoff Poole, General Manager, Borrego Water District

From: Travis Huxman, Nicole Fiore, Laurel Brigham, University of California, Irvine

Subject: Response to 11 February 2026 TAC/EWG meeting and West Yost Comments on GDE Identification and Monitoring Program Report and Recommendations

Date: 12 March 2026

This memorandum provides a response to commentary from West Yost and members of the TAC / EWG regarding the GDE Identification and Monitoring Program Report and Recommendations (hereafter UCI GDE report, UCI et al. 2025) dated May 15, 2025 in addition to our comments at the February 26, 2026 Joint TAC/EWG Meeting.

We thank the individuals that continue to communicate their thoughts on the UCI GDE Report and we remain available to respond to commentary, clarify uncertainties, and elucidate aspects of our assessment of groundwater dependent ecosystems (GDEs) in Borrego Springs. We remain confident that the combined data illustrate substantial acreage of groundwater-dependent vegetation, that there are signatures of groundwater use in each of the hypothesis testing approaches used in the UCI GDE Report, and that there is logical consistency among the independent lines of evidence that is not present in the alternative hypotheses that continue to be raised. At the onset of this communication it is important to reflect on SGMA requirements surrounding GDE treatment, to highlight approaches in our study that provide robust inference, and to discuss steps that would drive management actions.

We would like to remind our readers that guidance documents for identifying and monitoring GDEs are well established in the literature (Richardson et al. 2011; Eamus et al. 2016; Rohde et al. 2018; The Nature Conservancy 2019). For example, Rohde et al. (2018) provides detailed definitions, methods, and evaluation criteria for SGMA-relevant GDEs that the UCI GDE Report followed closely. This document was reviewed by the California Department of Water Resources (CA DWR) and is publicly available through the Groundwater Resource Hub (https://www.groundwaterresourcehub.org/).

Under this guidance, SGMA-relevant **GDEs are defined as plant species or communities that rely on groundwater for some or all of their water needs at any time—seasonally, episodically, or**

intermittently. GDEs are not required to use 100% groundwater; use of alternative water sources such as run-on, infiltrated precipitation, perched water, treated effluent, or irrigation return flows does not preclude GDE status, provided groundwater is also one of the water sources.

Mesquite are facultative phreatophytes capable of using both groundwater and surface-derived water, and therefore we do not expect them to be 100% groundwater dependent. In fact, very few ecosystems on Earth are supplied entirely by groundwater. Most phreatophytic species use groundwater during dry seasons, rely on precipitation when it is available, and may shift between water sources seasonally or interannually. Requiring proof of exclusive (100%) groundwater dependence (as has been suggested by various groups in recent TAC / EWG meetings) is inconsistent with ecological science, does not reflect the regulatory definition of a GDE, and imposes a higher burden of proof than SGMA requires. The guidance documents further emphasize SGMA's precautionary intent to avoid significant and unreasonable adverse impacts. Accordingly, **best practices recommend assuming that species with GDE potential are groundwater dependent unless direct evidence demonstrates otherwise** (Rohde et al. 2018).

We used these documents as our guiding framework and followed the recommended multiple-lines-of-evidence approach to GDE identification and management (Rohde et al. 2018), implementing as many of the suggested methods as were feasible within the three-year project period. For this reason, it is **important that readers consult these guiding documents to fully understand our analytical approach, the terminology we used, and the basis for designating the entire habitat as a GDE**. While discussion of alternative hypotheses can be informative, such interpretations should be motivated by observation, supported by empirical evidence, and evaluated within the same multiple-lines-of-evidence framework applied in the UCI GDE Report.

In summary, the analyses presented in the UCI GDE Report indicate that a substantial portion of the mapped mesquite bosque exhibits characteristics consistent with groundwater-dependent ecosystems. Under SGMA guidance, identification of a GDE does not require proof that every individual plant relies exclusively on groundwater. Rather, the objective is to identify ecosystems in which groundwater contributes to vegetation function and where groundwater management actions could potentially affect ecosystem health since the onset of SGMA (January 1, 2015). As such, the data generated through this study provide a scientific foundation for evaluating groundwater–ecosystem interactions and identifying areas where changes in groundwater levels could influence mesquite bosque condition. Continued monitoring and adaptive management will help refine the understanding of these dynamics over time. Decisions regarding how these findings are incorporated into basin management remain the responsibility of basin stakeholders and the Borrego Watermaster. It was our intent that vested stakeholders, through the governance of the Watermaster, would use the diverse data products provided by the UCI GDE Report to draw consensus conclusions on the acreage of groundwater dependent vegetation using science-based methodologies. Based on the available evidence, founded in

the consensus basin conceptual hydrologic model, and supported by scientific findings from throughout the southwestern US, the conclusions of the UCI GDE Report remain the most robust interpretation of the GDE presence in the Borrego Springs Subbasin.

General Response A. Suggestions of long-term soil moisture storage in the deep vadose zone

The proposed alternative hypothesis that redistribution of runoff across the landscape results in long-term storage of moisture within the deep vadose zone sufficient to sustain the 1,850 acre mesquite bosque in the Borrego Sink is inconsistent with earth and environmental science research in the southwestern U.S throughout the last 40 years.

Decades of water balance studies in arid and semi-arid environments demonstrate that evapotranspiration consumes the vast majority of precipitation, leaving only a small fraction available for runoff or deep drainage. Extreme rainfall events can produce temporary percolation through the soil profile (Schreiner-McGraw & Vivoni 2017), but meaningful downward movement beyond approximately 1–2 m (3.3 - 6.6 ft) is rare because infiltrated water is rapidly taken up by vegetation (e.g., Gee et al. 1994; Smith et al. 1995; Scott and Biederman 2019). As a result, deep percolation in arid basin soils is typically extremely limited, with infiltrated water quickly returned to the atmosphere through evaporation and plant transpiration.

Our field observations are consistent with these findings. Soil moisture sensors installed at Borrego Springs mesquite bosque Site 1 show that between August 2023 and July 2024, Tropical Storm Hilary was the only rainfall event that produced infiltration deeper than 30 cm. All other storms generated only shallow, short-lived soil moisture pulses that dissipated quickly after precipitation. Consistent with these observations, the current conceptual hydrologic model for subbasin does not identify recharge through the soil column as a significant source of groundwater recharge (Faunt et al. 2015).

Figure 1, reproduced from Figure 9 in Scott and Biederman (2019), illustrates this pattern in a comparable desert environment in the Sonoran Desert of southern Arizona, with the most complete, high quality data available from aridland systems in North America. In this example, evapotranspiration closely tracks annual precipitation, while runoff and drainage beyond the root zone represent only minor components of the water budget. Additionally, evapotranspiration assessments in Deep Canyon near Palm Springs, California show similar within- and between-year water balance behavior, where mean annual evapotranspiration closely matches mean annual precipitation, with little evidence for long-term subsurface moisture storage (Rungee et al. 2019). To our knowledge, there are no examples in the peer-reviewed literature demonstrating redistribution and long-term storage of vadose-zone moisture at the spatial scale necessary to support the levels of vegetation activity observed in the Borrego Springs mesquite bosque.

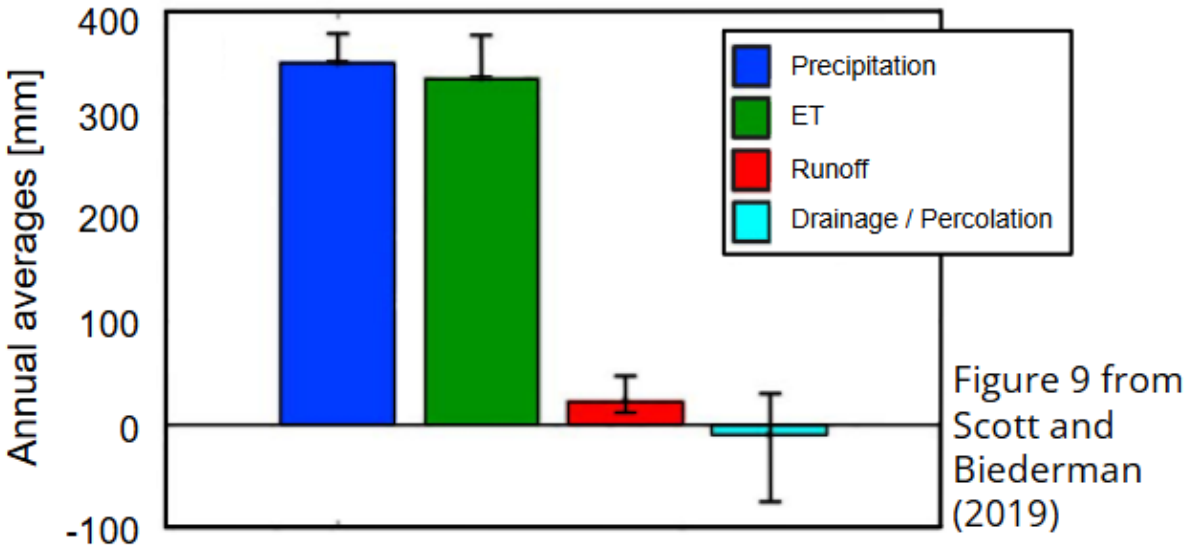


Figure 1. Figure showing annual averages of precipitation, evapotranspiration (ET), runoff, and drainage/percolation based on 13 years of observations in the Santa Rita Mesquite Savanna in the Sonoran Desert of southern Arizona (reproduced from Figure 9 in Scott and Biederman, 2019). The results demonstrate that the majority of precipitation is returned to the atmosphere through evapotranspiration, with only a small amount of runoff and negligible recharge.

The spatial distribution of vegetation further challenges the alternative hypothesis that episodic runoff infiltration alone supplies the water sustaining the bosque. Healthy mesquite stands occur in all directions around the Borrego Sink and across a wide range of elevations and slopes, including many locations far from ephemeral channels or areas where concentrated runoff infiltration would occur (such as the mesquite patches south of the Borrego Sink). This pattern suggests that localized runoff infiltration cannot reasonably account for the sustained water supply required across the entire 1,850 acre bosque.

Taken together, several decades of ecohydrologic research across the southwestern United States challenge the alternative hypotheses raised in the TAC and West Yost comments. In particular, existing water balance measurements indicate that redistribution of runoff across the landscape is unlikely to produce the sustained subsurface water storage required to support the magnitude and spatial extent of evapotranspiration and vegetation productivity observed within the Borrego Sink mesquite bosque.

As a thought experiment, for runoff infiltration and deep vadose-zone soil moisture to fully sustain the mesquite bosque, several key ecohydrologic processes would need to be demonstrated with empirical data, supported by peer-reviewed literature, and an exploration

of their consequences for additional processes in the basin. This alternative hypothesis would require:

1. **Revision of the basin conceptual model.**
   The conceptual hydrologic model of the basin, upon which the GMP is based, would need to be revised to demonstrate substantial and widespread surface–subsurface exchange capable of transmitting runoff-derived water into the deep vadose zone across areas occupied by mesquite. This would require extension, logically, to other spatial localities in the basin, as the above mechanism cannot be a special geophysical case that 'only-happens' in a narrow context, such as only near the Borrego Sink and not the canyon outlets.
2. **Sufficient runoff generation.**
   Storm events would need to generate substantial volumes of runoff reaching the mesquite bosque, even after accounting for losses along flow paths from the mountain front (e.g., along Coyote Creek). To sustain the observed GDE behavior, these runoff inputs would need to either exceed precipitation minus evapotranspiration over multi-year timescales or occur at very high frequency. However, observations indicate that substantial overland flow events are relatively infrequent, typically occurring only during sporadic summer monsoon storms or occasional large winter storm events.
3. **Substantial local infiltration of runoff.**
   A significant fraction of this runoff would need to infiltrate within the mesquite bosque habitat—both within channels and across adjacent interchannel areas—rather than being transported downstream to the Borrego Sink. This infiltration would need to occur broadly across the landscape to sustain the widely distributed GDE behavior observed in mesquite (located up to ~200 m away from ephemeral channels). This runoff infiltration would be visible in soil moisture sensor data.
4. **Long-term soil moisture storage.**
   Infiltrated water would need to be stored in the soil profile of the bosque for extended, mutli-year periods. Soil moisture would need to persist well beyond seasonal timescales across both channel and interchannel areas, rather than occurring as short-lived wetting events that are rapidly consumed by vegetation or lost to evaporation. If this phenomenon were true, it would be present in water balance estimations at other sites throughout the US Southwest.
5. **Deep percolation into the vadose zone.**
   Infiltrated water would need to consistently penetrate well beyond the shallow rooting zone and move downward into the deep vadose zone. Soil moisture measurements would show wetting fronts regularly reaching depths far greater than the typical 1–2 m observed in desert soils, indicating sustained deep percolation rather than shallow infiltration pulses that rapidly evaporate or are transpired by shallow-rooted vegetation.

6. **Lateral redistribution across the landscape.**
   Water infiltrated in channels would need to move laterally through the vadose zone over large distances to supply vegetation across the basin floor. Hydrologic processes would need to demonstrate consistent lateral transport of water across hundreds of meters to kilometers, providing a distributed subsurface water supply to mesquite growing both near and far from channels or the Sink. By extension, this transport of water would likely be observed in well elevations.
7. **Closure of the long-term water budget.**
   The combined magnitude and frequency of these processes would need to supply enough water to offset evapotranspiration losses from the bosque over long time periods. In other words, the long-term water budget would need to balance after accounting for evaporative losses, plant transpiration, and downstream transport. This would require demonstrating that runoff-derived infiltration alone could sustain the magnitude of evapotranspiration observed across the 1,850 acre mesquite bosque.

General Response B. Isotopic Analyses

Of the many datasets provided, the water isotope data represent an example where we are encouraged that stakeholders are actively engaging with the information. However, we caution that these data should be interpreted in a manner consistent with how they were collected and within the broader context of the basin's surface ecohydrology. As previously stated, our analysis used simple assumptions regarding the source end-members in this system that conservatively estimate water composition in plants. This approach was intentional, designed to avoid introducing inadvertent bias and to allow stakeholders the opportunity to independently evaluate the dataset.

Regardless of the analysis applied, we strongly disagree with the assertion that the isotopic data suggests that there must be another water source for the creosote and saltbush. This is because the average deuterium-excess values of the soil profile in Borrego Springs overlaps with creosote and saltbush, indicating consistency between these shrubs and shallow soil water sources. In contrast, mesquite isotope values show no to limited overlap with the soil profile (overlap occurs only at a single time point–August 2024). Together, these results suggest mesquite trees use different water sources than the creosote or saltbush throughout the majority of the time period we measured, and that uptake from the surface is minimal or opportunistic, which is the expectation.

We also disagree with how the data have been applied in regards to source-endmember modeling or analysis in bulk by TAC/EWG participants. The isotope dataset is both spatially and temporally

structured, and evaluating the data in aggregate combines samples from different sites and seasons in a way that can lead to misinterpretation. For example, the Aquilogic isotope analysis aggregated all data from Sites 1 -5, and from all seasons, and concluded that soil isotope values from August 2024 could explain mesquite water signatures measured in 2023, which is not physically plausible given the temporal separation between the samples. In addition, understanding source origin and applying the accepted conceptual model of the basin is critical for determining end-members. Patterns of infiltration in US Southwestern landscapes are well studied, and the basin's conceptual hydrologic model clearly identifies the sources of groundwater as mountainfront recharge. Thus, groundwater recharge is governed by different physical processes than localized precipitation infiltration, and therefore soil water derived from recent precipitation will not exhibit the same isotopic signature as groundwater.

We also suggest interpreting these data in the context of other lines of evidence. For instance, the isotope data interpreted alongside the leaf water potential data provide a snapshot of the hydraulic status of co-occurring plants and the underlying mechanisms controlling plant water use. In our report, we show that creosotebush in the middle of summer exhibits leaf water potentials indicative of significant water limitation, such that they are clearly restricted in their ability to transpire water. In contrast, mesquite, a profoundly less drought tolerant plant sits immediately adjacent and has a leaf water status similar to that of a plant that has been well watered. Creosote has the ability to put roots to significant depths (several meters) and if there was substantial moisture in the soil column resulting from run-on redistribution and infiltration, we would expect creosote not to show summer water stress. Considering how these datasets interact provides confidence in our conclusion that groundwater is supporting mesquite in Borrego Springs.

Responses to Comments from West Yost

Below we provide responses to comments made by West Yost. Where appropriate we combine responses, cross reference responses between comments, or reference details in the UCI GDE Report relevant to the issue.

1. Mapping of Mesquite Bosque

Please see our 11 February 2026 response to Jim Bennett's comment regarding mapping of the mesquite bosque. If West Yost still feels an independent assessment is necessary, we encourage them to include this effort as a monitoring suggestion.

2. *Study Site and Tree Selection for Ecological Data Collection*

We appreciate the suggestion that more intensive field work should have been conducted at Site 4 than Site 1, but we disagree with the rationale behind the suggested approach. First, it is worth noting that the only additional field work conducted at Site 1 relative to Sites 2 through 4 was the addition of pre-dawn and midday leaf water potential. While leaf water potential is an important dataset for assessing mesquite water availability and water stress and can be used to further contextualize isotope data, the isotope data directly tested for a signature of groundwater use and these data were collected at all sites.

The mesquite bosque habitat health is heterogeneous due to variation in the depth to groundwater across the habitat and the expectation of individual trees responding to stress; the variation in health is well illustrated in our report (see sections Mesquite Bosque Health and Ecological Condition Assessment and Field Assessments of Live and Dead Trees and Figures 4.9 and 4.10 of the UCI GDE Report). Site 4, located north of the Borrego Sink where pumping has resulted in greater declines in the depth to groundwater than south of the Sink (Faunt et al. 2015), has more degraded mesquite bosque habitat than Site 1. Furthermore, because of the small size of the parcel on which Site 4 is located, there was a reduced likelihood of capturing a representative range of environmental and ecological variability.

3. *Mapping Depth to Groundwater*

We acknowledge the dataset and resulting raster are imperfect and would benefit from additional well data, but the exercise was important, in part, to demonstrate the relevance of the data product over groundwater contours. For instance, the raster we created can be compared to rooting depths as one line of evidence for GDE status (p. 26 of the UCI GDE Report). See our responses to commentary on the groundwater raster in our 11 February 2026 response document for further context.

4. *Shallow Soil Conditions*

Please see General Response A.

We would also like to comment on the assertion that "the hypothesis of "hydraulic lift" suggests the existence of a soil moisture reservoir deeper than 5 ft-bgs" (p. 23 of the commentary). Hydraulic lift refers to the absorption of water at depth (which we suggest comes from the regional aquifer, not a vadose zone soil moisture source) and the loss of that water from the root in drier topsoil due to a water potential gradient. Given the isotopic signatures in the source endmembers, composition of water in plant tissue, and differences in leaf hydraulic status, the redistribution of groundwater into the soil profile via hydraulic lift is the parsimonious explanation.

5. Isotopic Analysis

See General Response B.

6. Water Potential

The literature does not support the existence of deep vadose zone soil moisture that could support mesquite transpiration throughout the dry season; see General Response A. Hence, we disagree with the alternative explanation provided by West Yost that the more negative leaf water potential of creosote relative to mesquite could be caused by mesquite having access to a deeper source of water (other than the regional water table) to which creosote does not have access.

We disagree with West Yost's interpretation that leaf water potential is overall more negative at the Borrego Springs site than the Clark Dry Lake site–this is only the case for midday leaf water potential in August 2023 and overall leaf water potential in April 2024.

7. Remote-Sensing Analysis (NDVI)

The interpretation of NDVI thresholds presented in the comment stating that "NDVI ranging from 0.20-0.30 are indicative of partial canopy loss or drought stress and that NDVI values >0.30 are indicative of healthy Mesquite canopy at peak leaf-out" (p. 32 of the commentary) does not account for well-known characteristics of NDVI in sparse desert ecosystems.

NDVI values are strongly influenced by fractional vegetation cover, soil background reflectance, and image spatial resolution, meaning that relatively low NDVI values do not necessarily indicate vegetation stress in arid environments (Weiss et al. 2004). In patchy desert systems such as the Borrego Springs mesquite bosque, individual tree canopies are interspersed with large areas of bare soil, which lowers pixel-scale NDVI values even when the vegetation itself is healthy. As a result, NDVI values in the range of ~0.2–0.3 can be observed for healthy desert vegetation when vegetation cover is sparse or when moderate spatial resolution imagery integrates vegetation with surrounding soil.

Because NDVI integrates both canopy vigor and vegetation cover, **fixed thresholds developed for dense vegetation or agricultural systems cannot be directly applied to the mesquite bosque.** For this reason, the UCI GDE Report analysis did not rely on absolute NDVI thresholds to infer plant stress or groundwater use. Instead, the analysis focused on temporal dynamics, spatial patterns, and direct comparisons to known GDE at Clark Dry Lake and non-GDE areas, which provide a more reliable basis for evaluating vegetation function and groundwater dependence in Borrego Springs. We recommend that West Yost include these comparisons in any future remote sensing analysis to ensure correct interpretation of NDVI data. Explicit comparisons of these areas are available in the UCI

Project Update published in Spring 2024 (UCI et al. 2024), and detailed explanations of the impacts of vegetation cover and image resolution are available in the UCI Technical Memorandum published in Spring 2023 (UCI et al. 2023).

Additionally, see our 11 February 2026 response to AAWARE's Comment 11 for an in-depth explanation of the three remote sensing approaches and the thresholds used, which are based off of the non-GDE area: The three remote sensing approaches used in the UCI GDE report apply a well-established "green island" framework for GDEs, which evaluates whether vegetation maintains anomalously high greenness during varying conditions relative to known GDE and non-GDE reference systems (Dresel et al. 2010; Eamus et al. 2006; Eamus et al. 2016). This framework is specifically designed to distinguish vegetation supported by persistent groundwater use from vegetation reliant on transient soil moisture, lateral rooting, or short-term drought adaptations.

To minimize the influence of transient surface soil moisture, all three approaches focus on dry-season or annual-scale metrics and incorporate a non-GDE reference area along Coyote Creek that contains mesquite trees. This non-GDE area receives episodic surface-water flow from the creek but is underlain by very deep groundwater (Faunt et al. 2015), making it representative of a surface water dominated system, but in a similar landscape context as the GDE positions. As such, it provides an appropriate upper limit for vegetation greenness supported by surface water alone, allowing truly anomalous greenness associated with groundwater-supported vegetation to be identified with higher confidence. Approach 1 evaluates NDVI change during days 50–80 of the growing-season drought, when near-surface soil moisture is likely depleted. Approach 2 focuses on days 80–120 of the drought, a period characterized by extreme heat and minimal soil moisture, and benchmarks vegetation response against the maximum NDVI observed in the non-GDE reference area. Approach 3 assesses cumulative NDVI across the full water year, again using the non-GDE maximum as a benchmark to identify vegetation with sustained productivity indicative of persistent water availability. These approaches were applied in both 2023, a relatively wet year, and 2024, an exceptionally dry year. Despite substantial differences in precipitation between years, the spatial patterns of NDVI and indicators of GDE behavior were highly consistent. This persistence across contrasting hydrologic conditions increases confidence that the observed vegetation response reflects groundwater availability rather than rainfall or short-term soil moisture inputs.

8. Dry Period Evapotranspiration in the GDE

See General Response A for a discussion of deep vadose zone soil moisture.

With respect to the higher ET rates observed at the Clark Dry Lake Site 5 compared to Borrego Springs Sites 2 and 4, it is important to consider differences in vegetation cover and structure within the ET sensor footprint. The CDL site contains the densest mesquite cover and larger trees within the

measurement footprint, whereas Sites 2 and 4 have substantially lower mesquite cover. As a result, differences in the magnitude of evapotranspiration are expected, as ET scales strongly with vegetation cover and leaf area (Hoek van Dijke et al. 2020). Interpreting the lower ET observed at Sites 2 and 4 as evidence of reliance on deep soil moisture is therefore not supported by the data, particularly given the limited rainfall during the monitoring period and the low likelihood of long-term deep soil moisture storage under these conditions.

Regarding measurement accuracy, the ET sensors used in this study are considered one of the most direct and reliable methods for measuring ecosystem ET because they measure water vapor flux directly in the field. In contrast, approaches such as OpenET or CIMIS rely on modeled estimates derived from remote sensing or weather data. In response to atmospheric mixing and the presence of other plant species: the data were filtered to include only day time conditions and the analysis focused on the dry season, when evapotranspiration from non-GDE vegetation is minimal.

Finally, a non-GDE / non-mesquite ET sensor was installed at a comparison site near the UCI Desert Research Center; however, a faulty cable during the initial deployment prevented those data from being included in the UCI GDE Report. The system has since been repaired, and the available data show that ET at the non-GDE site closely tracks precipitation and does not exhibit the sustained dry-season evapotranspiration observed at the mesquite sites, indicating no evidence of deep soil moisture storage in the system. Updated ET sensor data will be posted to the UCI Dryad collection and submitted as an upcoming public comment.

9. Historical Precipitation Trends

The intent of this analysis was to evaluate surface water availability during a time of strong declines in mesquite cover (1980s - 2024) in order to align with the remote sensing data. The trend between precipitation and time was assessed with a linear model and no significant relationship for this time period was detected ($P > 0.05$). To reiterate, this analysis was not conducted to contradict the Watermaster's findings of a decline in precipitation between 1948 and 2024 (Borrego Springs Watermaster 2025), but to provide context for the remote sensing data. Different relationships will be found amongst variables when different time periods are examined. That said, our analysis does not demonstrate a reduction in rainfall derived surface water during the periods raised as concern for the mesquite bosque. In other work we have carried out in the region, we have shown that vegetation change over time cannot be explained by changes in precipitation alone, which are minimal (Hantson et al. 2021). We assert that in the basin floor of Borrego Springs, the documented changes in groundwater elevation are larger system drivers affecting vegetation as compared to any measured change in precipitation or temperature, which aligns with the findings in a similar mesquite GDE in Arizona (Stromberg et al. 1992).

10. Considering GDEs in Minimum Thresholds

We respectfully disagree that there are too many data gaps to establish data-based minimum thresholds with a consideration of undesirable results for the mesquite bosque. We provided one possible route towards a data-based consideration of minimum thresholds for wells in the vicinity of the mesquite bosque in the UCI GDE Report, but we acknowledge there are multiple ways to approach this issue. The commenter refers to the maximum rooting depth of mesquite in the mesquite bosque in Borrego Springs as a data gap. This will be impossible to definitively measure and costly. Alternatively, the existing rooting depth measured by Jenkins et al. (1988) could be used or The Nature Conservancy's Plant Rooting Depth Database publicly available through the Groundwater Resource Hub (https://www.groundwaterresourcehub.org/). Though the existing root depth from Jenkins et al. (1988) is likely not a maximum value and mesquite could extend roots beyond rooting depths listed in The Nature Conservancy's database, these are freely available data that supply reasonable estimates provided it is recognized that there is variability in rooting depth (both above and below) listed values.

Multiple independent lines of evidence support the groundwater dependence of the Borrego Springs mesquite bosque. In keeping with the precautionary intent of the SGMA, we believe it is beneficial to recognize and manage GDEs proactively rather than waiting until irreversible decline occurs. If the bosque is ultimately confirmed as a GDE, postponing its designation and the creation of GDE-relevant minimum thresholds increases the likelihood of irreversible loss of mesquite habitat and other undesirable impacts.

11. Mesquite Bosque Health and Ecological Condition Assessment

We would like to remind the commenter that the Mesquite Bosque Health and Ecological Condition Assessment is located in the "characterization" section of the UCI GDE Report. As such, the goal of this assessment was to (1) characterize current and recent vegetation condition in the BS mesquite bosque relative to a healthy reference mesquite bosque (Clark Dry Lake), (2) identify spatial patterns of high, moderate, and low productivity within the Borrego Springs mesquite bosque to assist with conservation efforts, and (3) establish a quantitative, transparent, and reproducible method for remote long-term monitoring using Sentinel's high-resolution (10 m), long-term (available since water-year 2019), frequently updated (3-5 return interval) satellite record.

By categorizing NDVI in direct comparison to the Clark Dry Lake reference each year, the method inherently controls for interannual climate variability, as both systems experience similar regional temperature and precipitation dynamics and occupy comparable geomorphic settings (both systems are located near a sink that receives runoff). Thus, the analysis is designed to assess relative condition rather than absolute productivity in any single dry or wet year, which would be vulnerable to interannual climate variability.

We would also like to point out that 2022 and 2023 were years with monsoonal activity. If the Borrego Springs mesquite bosque were completely dependent on surface water or runoff, we would expect to see **increases** in high and moderate productivity acreage in those years (UCI GDE Report Figure 3.5 on p. 79). Instead, we see consistent decreases, which warrants consideration of groundwater decline.

Finally, the method itself is not meant to assume a single cause of decline; rather, it provides a consistent framework for detecting and tracking changes in vegetation productivity in the bosque over space and time in relation to a healthy groundwater-dependent reference system at Clark Dry Lake. We would also like to remind the commenter that the resulting raster datasets can be overlaid with parcel boundaries to prioritize high quality habitat for conservation, or combined with other datasets such as depth to groundwater or elevation to better understand the drivers of mesquite productivity.

12. Field Assessments of Live and Dead Trees

We appreciate the question regarding the patchiness of mesquite mortality, but we question the logical inconsistency that allows for variability in surface water availability to impact mesquite health but not variability in groundwater availability. For instance, groundwater declines are not uniform across the basin; greater declines in the depth to groundwater have been found north of the Sink compared to south of the Sink (Faunt et al. 2015, see Figure 45C p. 111), which aligns well with spatial patterns of NDVI found in the UCI GDE Report. Additionally, on a smaller spatial scale, variability in mesquite mortality reflects individual mesquite trees' ability to access a declining groundwater table (Stromberg et al. 1992). Factors such as tree age and size influence rooting depth and the capacity of mesquite to track falling water levels. As a result, we would expect differences in individual trees' ability to respond to water table declines, leading to spatial variability in survival.

13. Quantification of Mesquite Groundwater Transpiration

We agree with West Yost that the ETgw estimates presented in the UCI GDE Report represent an upper-bound estimate of groundwater use by the Borrego Springs mesquite bosque, as intended and described in the report. For future analyses, we recommend relying on the ET sensor data, which provide direct measurements of evapotranspiration and therefore offer more accurate estimates than remote sensing or weather-based models such as OpenET. If OpenET is used, its estimates should be validated against the ET sensor data using approaches established through the land-surface atmosphere exchange research community (Volk et al. 2023; Volk et al. 2024).

Regarding potential evapotranspiration demand from non-mesquite vegetation, it is important to note that precipitation was subtracted from the ET estimates, which largely accounts for evapotranspiration supported by recent rainfall and therefore helps control for the influence of non-mesquite vegetation. Please see General Response A for a discussion of runoff and deep soil moisture storage, and the lack of

peer-reviewed evidence supporting this mechanism as a significant long-term water source for mesquite.

14. Chronic Lowering of Groundwater Levels

We question the logical inconsistency that allows for declines in groundwater depth to cause adverse impacts to the Borrego Springs mesquite bosque prior to SGMA but not after SGMA's implementation, despite continued declines in the depth to groundwater at rates comparable to pre-SGMA declines across wells examined in the UCI GDE Report (UCI GDE Report Table 4.2 on p. 110). We feel there is insufficient evidence to support the commenter's assertion that the recent drought was responsible for declines in NDVI post-SGMA implementation, especially considering that 2020 was abnormally wet, and 2022 and 2023 had monsoonal activity.

15. Changes in Mesquite Bosque Health

We disagree with the assertion that "patchy" patterns of NDVI increases or decreases are inconsistent with mesquite response to declines in groundwater levels. Variability in tree response is expected based on tree age and size as these have consequent effects on rooting depth and ability to access a declining water table. See Comment 12 of this document.

16. Perched Aquifer Evaluation

Please see our response to Comment 7 and 8 from Jim Bennett in our 11 February 2026 response document.

17. Monitoring Recommendations

While we appreciate the monitoring methods provided by West Yost because it signals a step forward, we have several concerns. Please see Appendix A for our questions on various components of the proposed monitoring plan.

18. Management Recommendations

We appreciate that West Yost agrees that at least part of the mesquite bosque could be a beneficial user of the regional aquifer system. The mesquite bosque is a productive and diverse habitat that provides innumerable ecosystem services, and it is the only widespread woody habitat found in the Borrego Springs Subbasin. Recognizing that at least part of this habitat is groundwater-dependent is an important step forward.

While we disagree that it is premature to establish minimum thresholds for groundwater levels at wells, we do agree that additional ET sensor data would help refine estimates of mesquite evapotranspiration for inclusion in the subbasin water budget. At the same time, recognizing the mesquite bosque as a potential beneficial user of groundwater highlights the importance of proactive, adaptive management approaches, such as those recommended in the SGMA GDE guidance, which allow management strategies to be refined over time as new information becomes available. Please see our response to Comment 10 above regarding the establishment of minimum thresholds.

References

Borrego Springs Watermaster. 2025. Water Year 2024 Annual Report for the Borrego Springs Subbasin. March 2025. Prepared by West Yost.

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Appendix A: Questions on Proposed Monitoring Plan

General Questions

- How will a GDE be defined?
    - Will any use of surface water lead to discounting GDE status?
- What if some lines of evidence show different outcomes?
- Will predictions be defined beforehand?
- What criteria will be used for determining whether sampling units (e.g., wells, equipment installation, pixels) are spatially representative of mesquite conditions (e.g., canopy density, rooting depth, distance to Sink, geomorphic/landscape position)?

Questions Specific to West Yost's Recommendations

I. Constructing additional monitoring wells

A. Number of wells

1. Would several wells be required in order to improve the accuracy of the mapped groundwater depths in the vicinity of the Sink?
2. Would a spatially dispersed plan be necessary to add power to the design?

B. Well Locations

1. How will well locations be selected to ensure they are representative of mesquite conditions?
2. Which lands are available for adding a monitoring well?

C. Priority of Site 4

1. Why choose a site (Site 4) where groundwater is deeper and proximate to pumping?
2. If groundwater is already deeper at Site 4, how does that location best test dependency in the healthy mesquite stands?
3. Is Site 4 meant to reflect typical mesquite conditions, or is it a stress-test location?

D. Check for the presence or absence of "perched" groundwater conditions

1. What are the criteria evaluated to establish the presence of "perched" groundwater conditions? Predictions on which to test hypotheses should be clarified before drilling.
2. How will the drilling and data collection on soil moisture be coordinated?

3. What screen intervals will be used (shallow vs deep aquifer zones)?
4. How will the data collected distinguish between regional aquifer levels vs deeper vadose zone soil moisture?

E. Collect soil samples and analyze soil moisture and isotopic water chemistry across the vadose zone and capillary fringe.

1. When will drilling and sampling occur given that timing relative to plant activity is important?
    a) If there is to be sampling soil for isotopic analysis and for soil moisture, sampling will have to occur at a time when mesquite are active in order to sample a water source that might be used by mesquite.
2. How many nearby mesquite need to be concurrently sampled to compare to deep soil moisture isotopes and well water isotopes?
3. How many boreholes are needed to capture lateral variability?
4. What isotope mixing model or analysis method will be used?
5. How will material be evacuated during drilling? How is this compatible with measuring soil moisture or collecting isotope samples?

F. Inspect the borehole sediments through the vadose zone and capillary fringe for evidence of live mesquite tree roots.

1. Given it is extremely common to miss roots in a single heterogeneous soil core of a complex landscape, what if no roots are found?

G. Install soil moisture sensors across the vadose zone and capillary fringe to track seasonal and long-term changes in soil moisture.

1. What is the technology and approach to placing soil moisture measurements at a depth?
2. Which sensors are to be used and what is the monitoring plan?
3. How will it be determined whether there is hydraulic connection between the deeper vadose waters and the capillary fringe / regional aquifer?

II. Comparing groundwater levels to metrics of mesquite health, including NDVI

A. The new monitoring well(s) recommended above would improve the accuracy and resolution of such mapping efforts.

1. Would adding a single monitoring well improve the accuracy of the groundwater raster?

B. NDVI analysis using Landsat-derived NDVI data (1984-2025) could be performed at specific cells (or groups of cells) where the Mesquite trees in BS Mesquite Bosque were once or are currently dense, so that other non-mesquite vegetation is screened out.

1. How can Landsat pixels (30 × 30 m; 900 m^2) represent mesquite canopies (typically only 3–20 m in diameter) or individually dispersed trees (1-3 m)?
2. How will the analyses not be biased by the dynamics of bare ground and the subcanopy plant species?
3. Would a higher resolution dataset be more valuable (Figure A1)?

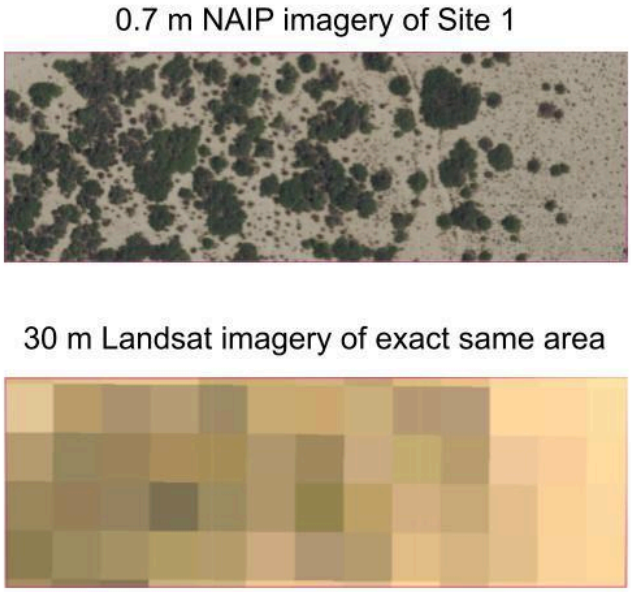


Figure A1. Comparison of NAIP (0.7 m resolution) and Landsat (30 m resolution) imagery.

4. How does detecting a precipitation signal in NDVI demonstrate absence of groundwater use, since mesquite are facultative phreatophytes known to use both groundwater and precipitation when available?
5. Is not a correlation between NDVI and precipitation expected?
6. How does a relationship between NDVI and precipitation preclude groundwater dependence?

7. Since temperature influences physiological stress in all vegetation, including GDEs, what does NDVI response to temperature do to distinguish between groundwater dependent and non-groundwater dependent ecosystems?
8. Elevated temperatures can reduce canopy greenness or photosynthetic activity even when groundwater remains accessible. How will the long-term NDVI trajectories (increasing, stable, or declining) be diagnostic of groundwater use? Could groundwater-connected mesquite show: declines due to falling water tables, stability under steady groundwater conditions, or increases following episodic rainfall or stable groundwater conditions?
9. Why is this approach (comparing NDVI to individual variables) better than the approach in the peer-reviewed literature testing for NDVI persistence during extended dry periods, when soil moisture from precipitation has been depleted? This is a well-established indicator of groundwater access (Dresel et al., 2010; Eamus et al., 2006; Eamus et al., 2016).

III. Quantifying deep soil moisture

A. Quantification of the total storage capacity and the current volume of soil moisture in the vadose zone that could be available to the Mesquite tree roots

1. How will this be measured from the drilling effort?
2. Is collecting soil moisture at a single time point during well construction sufficient for characterizing the deeper vadose zone soil moisture, particularly in a location where soil moisture would change as the dry season progresses?
3. Does a single soil profile (or even three) address the spatial extent sufficient for assessing deeper vadose zone soil moisture across the entire 1,850 acre mesquite bosque?

B. These storage estimates could be compared to the ET demands of the BS Mesquite Bosque to better understand the capacity of the vadose zone to supply water to the Mesquite tree roots.

1. Will this use the UCI-installed ET sensors or OpenET?
2. At what time scale will ET and soil moisture be compared (daily, monthly, seasonally, etc)?
3. What additional measures of water composition or flux will be used to relate soil water extraction to plant transpiration?

C. **Quantification of the water budget of vadose zone underlying the BS Mesquite Bosque**
    1. What justifies this expense, when ecohydrological work throughout the southwestern US over the past 40 years does not motivate this hypothesis? Meaningful percolation beyond 1 - 2 m is a rare phenomena due to vegetation uptake (e.g., Gee et al. 1994, Smith et al. 1995, Scott and Biederman 2019).

D. **Mapping of the flood events after large storms could potentially be performed using video/photo monitoring by drones**
    1. What is the downstream analysis of this data product?
    2. How will short-lived flash flood pulses be captured logistically?
    3. How will the volume of water distributed by runoff in each mesquite area be quantified?
    4. How will channel loss, evaporative loss, ephemeral plant consumption, infiltration, and percolation throughout the vadose zone be estimated with the drone imagery?

IV. Annual drone photos

A. **Imagery collection across bosque and specific NDVI analysis sites**
    1. How will the entire 1,850 acre mesquite bosque be mapped in a way that is compliant with state laws and state agency regulations around drone use?
    2. When will drone flights occur?
    3. What sensors will be used on the drone?
    4. Will NDVI be included in drone imagery processing to provide a quantitative value of "health?"

V. Field surveys

A. **Assessing live and dead mesquite**
    1. Will the existing field-work and established sites that UCI employed be leveraged?
    2. Could additional points be added to the existing survey, or will a new effort be employed?

VI. Monitoring and analysis of ET data

A. **Monitoring and analysis of ET data could be performed over time to better understand water use within the BS Mesquite Bosque. The**

monitoring/analysis techniques should be evaluated and recommended by the TAC and EWG with input and advice from UCI.

1. How will UCI be engaged on the ET approach?
2. How will you support the existing data collection or incorporate existing sensors into the research design?

B. Consideration should be given for the potential role of soil moisture in satisfying at least a portion of the ET demands of the Mesquite Bosque areas.

1. How is this diagnostic of GDE behavior or different from the approach already taken by UCI?
2. Is the loss of the recognized GDE north of Airport Road indicative of the fact that surface water alone cannot support the bosque?

C. Consideration should be given to the ET demands of other non-Mesquite vegetation within the Mesquite Bosque areas.

1. UCI's approach included the ET contributions of non-mesquite vegetation, so what is the goal of this exercise and how is this diagnostic of the question of GDE?